

GOVERNMENT OF THE PUNJAB
HIGHWAY DEPARTMENT

**STANDARD SPECIFICATIONS
FOR
ROAD & BRIDGE CONSTRUCTION**

(FIRST EDITION)

SEP. 1971

PRICE RS. 10

PREFACE TO THE FIRST EDITION

A set of standard specifications for road and bridge construction was compiled and presented in June 1971 as an interim publication. This has been received by the district and divisional officers with great enthusiasm as many useful suggestions have been received. In order to make this publication more comprehensive further sections have been added and the original sections have been revised to convey better sense. The FIRST EDITION now being presented covers nearly all the activities of the Highway Department. There will still be the necessity of adding some more sections and revising some of the existing ones as the need arises and experience is gained in applying these specifications to actual execution. Comments and suggestions for improvement will be welcome and should be addressed to Director Planning and Design.

Highway Engineering practices are fast developing due to improved techniques, introduction of better construction equipment and more understanding of local available material resources. Simultaneously larger and heavier vehicles coming on the roads are requiring better quality of roads and improved facilities. All these factors have a great impact on the techniques of road construction requiring constant revision and updating of specifications. Pace will be kept with development by adding and revising the specifications as more knowledge and experience are gained in the use of alternative construction methods and techniques. Periodic reviews, updating and expansion of these specifications will be constant feature.

I acknowledge with thanks the untiring effort of Mr. Muzaffar Iqbal Sheikh who did a lot of basic work in preparing the specifications, compiling the material and publishing the Interim draft and the first edition.

LAHORE
September, 1971

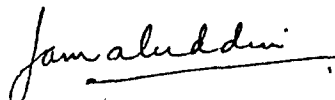

CHIEF ENGINEER
HIGHWAY DEPARTMENT
GOVERNMENT OF THE PUNJAB

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A. GENERAL

SECTION 101

DEFINITION OF TECHNICAL TERMS

WHENEVER in these specifications or in other documents pertaining to the Contract, the following abbreviations and terms appear their intent and meaning shall, unless specifically stated otherwise, be interpreted as given below:

AGGREGATE:	Inert material such as sand, shingle, broken stone, or broken bricks which, when bound together by an added matrix, forms a conglomerated mass, as in concrete or bituminous paving mixtures. The terms "coarse aggregate" is employed for aggregate coarser than the 3/16" sieve size for concrete and 1/8 in. for aggregates used in bituminous material.
ALIGNMENT:	The position and direction given to the centreline of a highway in plan or profile.
ALIGNMENT (HORIZONTAL):	The direction of a centreline of a highway in plan.
ALIGNMENT (VERTICAL):	The alignment in longitudinal profile of a highway along its centreline.
ALIGNMENT (RE-ALIGNMENT):	The alteration to the alignment of an existing road.
APRON:	A layer of concrete, masonry, stone or timber placed at the entrance or outlet of a culvert or waterway etc. to prevent scour.
AXLE LOAD:	The total load transmitted by all wheels whose centres may be included between two parallel transverse vertical planes 40 inches apart, extending across the full width of the vehicles.
BACK FILL:	Material used to replace or the act of replacing material removed during construction; also may denote material placed or the act of placing material at the back of abutments retaining walls or similar structures.

BASE COURSE:	The layer or layers of specified or selected material of designated thickness, placed on a sub-base or subgrade to support a surface course.
BATCHING PLANT:	The mechanical equipment for measuring either by weight or by volume, the quantities of different ingredients required to make up each complete charge of mixer.
BID:	It is priced offer by the contractor to accomplish specific items of work or the entire project, in accordance with terms and conditions of the contract documents.
BID SCHEDULE:	It is a priced bill of quantities containing rates offered by the contractor for completion of various work items according to specifications of the project.
BINDER:	A material used for the purpose of holding solid particles together as a coherent mass.
BITUMEN:	The by-product of the distillation or evaporation of crude petroleum either by natural process or in refinery; the basic constituents of Asphalt essentially consisting of hydro-carbons. It is characteristically solid to semi-solid; black to dark brown in colour, is adhesive, and melts or softens on the application of heat.
BITUMEN (STRAIGHT-RUN)	A bitumen obtained after the final stage of distillation of a petroleum of suitable type.
BITUMEN (CUT BACK):	Bitumen whose viscosity has been reduced by the addition of a suitable volatile diluent.
BITUMEN (EMULSION):	An emulsion in which bitumen is suspended in a state of minute sub-division in water or in an aqueous solution, with the aid of suitable emulsifying agents.
BITUMINOUS CONCRETE:	A designed combination of dense graded mineral aggregate filler and bituminous cement mixed in a central plant, laid and compacted while hot.
BLEEDING (OF BITUMINOUS ROADS):	A road condition in which free binder exudes in liquid form from the surface of a bituminous road in hot weather.
BLINDING:	The application of a loose layer of fine material to reduce bleeding due to excessive quantities of bitumen appearing on the surface at high air temperature.
BORROW:	Suitable material used primarily for road embankment.

BORROW PITS:	A place, outside the right of way unless otherwise specified from which borrow material will be obtained.
BOX CULVERT:	A culvert constructed of rectangular cross-section.
BRIDGE:	A structure designated to secure passage over an obstacle or waterway of more than 20 linear feet.
BREAST WALL:	A retaining wall on the hill side.
BY-PASS ROAD:	A road so constructed as to enable through traffic to avoid congested areas or other obstructions to movements.
C.B.R. (CALIFORNIA BEARING RATIO):	An empirical measure of the bearing capacity of a sub-grade base or pavement expressed as a percentage of the bearing capacity of a water bound macadam base course of crushed stone.
CAMBER:	The convexity given to the curved cross-section of a carriage way or foot path.
CARPET:	A wearing course containing a road tar or bitumen binder and having a compacted thickness not greater than 1½ inch.
CARRIAGEWAY:	That portion of a highway intended primarily for vehicular traffic.
CAUSEWAY:	A paved waterway raised above normal water level or the level of the adjoining ground.
CHIPPINGS:	Crushed angular stone fragments of single size material of nominal size between 1/8 in. and 1 in.
CONTRACT:	The written agreement covering the performance of the work as provided by specifications and tender documents.
CONTRACTOR:	The person, firm or corporation with whom the contract has been made by the employer, or to whom the contract has been assigned.
COMPACTION:	(a) General: The process of inducing a closer packing of particles in granular material. (b) Soil: The process whereby soil particles are constrained by rolling or other mechanical means to pack more closely together thus increasing the dry density of the soil.

CROWN:	The highest part of a curved surface such as an arch, or a carriageway in cross section commonly at or near the centre.
CULVERT:	A structure designated to secure passage over an obstacle or waterway of less than 20 linear feet.
DEPARTMENT:	The Highway Department, Government of the Punjab, if otherwise specified.
DETOUR:	A route formed by a highway to avoid an obstruction or to provide an alternate way for traffic.
DIVERSION:	A temporary detour.
DRAIN:	A trench cut in the ground for the purpose of receiving and conducting drainage water.
DRIVE WAY:	The accessway from a road to private property.
DRY DENSITY:	The weight of dry material after drying to constant weight at 105°C (221°F) contained in unit volume of undried material.
DRY DENSITY (MAXIMUM):	The dry density of soil obtained by a specified amount of compaction at the optimum moisture content.
DUAL CARRIAGE-WAY:	A road in which there are two physically separated carriage-ways reserved for up and down traffic separately.
EMBANKMENT:	The work built above the natural ground by the deposition of each material to support construction at a higher level.
EQUIPMENT:	All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also all tools and apparatus necessary for the proper construction and acceptable completion of work.
EXPANSION JOINT:	A space between two rigid parts of the same structure, formed to allow small relative movements to occur without the development of serious stresses, with or without provision of means to preserve functional continuity.
FILLER:	A finely divided mineral powder added to road tar, bitumen or the like, or to a mixture containing the same, in order to effect some desired change in the properties of binding material.

FLEXIBLE PAVEMENT:	A form of road construction which, for the purpose of design, is assumed to have no tensile strength.
FREE HAUL:	The maximum distance which excavated material is transported without extra charge.
GALLON:	The word 'gallon' used in the specifications designates the imperial gallon and not the U.S. gallon.
GRADED MATERIAL:	(a) Materials whose particles are of specified sizes lying between relatively wide limits. (b) Materials containing definite proportions of different particles sizes.
GRADIENT:	The rate of rise or fall with respect to the horizontal along the length of a road or other works.
GRADING:	(a) The proportions by weight of particle sizes in a granular material. (b) The operation of bringing the sub grade levels to the required grades by excavation or embankment where required.
GRAVEL:	Rounded or water worn stones of irregular shape and size occurring in natural deposits, with or without some finer material.
GRAVEL ROAD:	A road constructed with layers of gravel with or without the addition of sand or clay.
GRUBBING UP:	Uprooting small trees, hedges, bushwood and the like.
GUARD RAIL:	(a) A fence erected to prevent vehicles from leaving the carriageway at a dangerous place. (b) A fence erected for the safety of pedestrians.
GUTTER:	The part of the carriageway immediately adjacent to the edge which carries away water drained from the surface of the road to points of disposal.
HAUL:	The distance through which excavated material is transferred for use as filling or to the spoil bank (lead).

INTERCHANGE:	A grade separated intersection with one or more turning roadway for travel between intersection legs.
INTERSECTION:	The general area where two or more highways join or cross, within which are included the roadway and roadside facilities for traffic movements in that area.
ISLAND:	A central or subsidiary area in a carriageway, generally at road junctions, shaped and placed so as to constrain and control traffic movements.
JOINT FILLER:	A strip of compressible material used to fill the space between two rigid parts of a road or other structure in an expansion joint.
KERBS:	A border of bricks, stone, concrete or other rigid material formed at the edge of a carriageway or other pavement.
LOAM:	Soil consisting of a natural mixture of clay, sand and silt.
MAINTENANCE PERIOD:	The period during which a contractor may be required to maintain the contract works after completion.
MAJOR ROAD:	A road which has, or to which is assigned a priority of traffic movement over that of other roads.
MINOR ROAD:	A road which has, or to which is assigned, a lesser traffic value than that of a major road.
MEDIAN:	The portion of a divided highway or street separating the travelled ways for traffic movement in opposite directions.
OVERHAUL:	The distance of the haul in excess of the free haul.
PAVEMENT OR PAVEMENT STRUCTURE:	The combination of sub-base and surface course placed on a sub grade to support the traffic load and distribute it over the subgrade.
PAVING:	A wearing course laid upon a prepared foundation consisting of units fitted closely together or of a layer of bitumen, coated macadam, concrete or the like.
PENETRATION MACADAM:	A layer of a pavement structure formed by the application of a binder (Bitumen or Tar) in liquid state into the interstices of an open graded aggregate material after the

	latter has been spread on the subgrade or the subbase and lightly rolled. It is followed by a spreading of choke aggregate and compaction. One or more coats of surface treatment are then provided to seal the surface.
POTHOLE:	Marked local depressions in a surface layer roughly circular in plan, arising from the wearing away of material by traffic or by some other agent.
PRIME COAT:	An application of liquid bitumen or tar to a previously prepared subbase course or base course to provide bond with the surfacing. It also binds any loose aggregates and provides temporary seal against infiltration of surface water.
QUARRY FINES:	Broken stone, as crushed, which passes through the smallest screen or aperture.
RETAINING WALL:	A wall constructed to resist lateral pressure from the adjoining ground, or to maintain in position a mass of material usually the road embankment.
REVEMENT (PITCHING)	A facing of stone or other material laid on a sloping face of earth to maintain the slope in position or to protect it from erosion.
RIGHT OF WAY:	The land secured and reserved for development and construction of all structures and improvements pertaining to a road.
ROADBED:	The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.
ROAD FORMATION	A portion of right of way consisting of pavement and shoulders.
ROADWAY:	That portion of right of way which includes the road formation, slopes of embankment and road side ditches (in filling) or full width from back to back of retaining or breast walls, where so constructed (in hills).
SAFETY FENCE:	a) A fence erected to prevent vehicles from leaving the carriageway at a dangerous place. b) A fence erected for the safety of pedestrians. c) A fence on a highway to prevent any specified type of traffic from leaving the part of highway appropriate to its use.

SCARIFYING:	The systematic disruption and loosening of the top of a road or of natural ground by mechanical or other means.
SCREENING:	The application of fine material to fill voids or interstices in a layer of base course.
SEALING COAT:	Bitumen, road tar or an emulsion of either, applied as a thin film to a surface to close the voids with the object of rendering the surface waterproof.
SECTION:	Cross: A vertical section at right angles to the centre line, showing the elevation of the ground. Longitudinal: A vertical section showing the elevation of the ground usually along the centre line.
SERVICE ROAD:	A temporary road with reasonably good riding surface constructed parallel to main road for the transportation of machinery and construction material etc.
SHINGLE:	Round or water-worn stones of irregular size and shape as occurring in open beach formation and substantially free from sand.
SHOULDERS:	The portion of the road formation adjacent to and level with the pavement but generally of local soil or of lighter construction, to provide an opportunity for vehicles to leave the pavement for passing or parking or to provide lateral support to the pavement.
SOIL:	Any naturally occurring loose or soft deposit forming part of the earth's crust and resulting from weathering or break down of rock formations or from the decay of vegetation.
STABILIZED SOIL:	Any natural material which has been modified to improve and maintain its load carrying capacity and resistance to weathering.
SUBBASE:	A layer of material sometimes provided between the subgrade and the base, for a special purpose e.g. drainage or to add strength to the construction.
SUBGRADE:	The natural foundation or the fill which directly receives the loads from the pavement.
SUBGRADE LEVEL:	The level of the finished subgrade.
SUPERELEVATION:	The inward tilt or transverse inclination given to the cross section of a carriageway throughout the length of a horizontal curve to reduce the effect of centrifugal force on a moving vehicle.

SURFACE DRESSING:	The resurfacing process consisting of the application of liquid bituminous and cover aggregate superimposed upon a thin layer of road tar, bitumen or the like freshly applied to an existing road surface.
SURFACE TREATMENT:	One or more applications of liquid bitumen and cover aggregate on a prepared base course.
TACK COAT:	An application of liquid bitumen to an existing surface to provide bond with a superimposed course.
TON:	The word 'Ton' used in the specifications designates the long ton of 2240 lbs.
TRAFFIC LANE:	A unit of carriageway width sufficient to accommodate a single line of vehicular traffic with provision for slight lateral improvement.
WALL:	(a) Curtain: A thin wall used as a shield or protection (as distinct from retaining wall). (b) Head: A retaining wall formed as the termination of a culvert or pipe. (c) Toe: A low retaining wall constructed at the foot of an earth slope. (d) Wing: A wall in extension of an abutment, as in a bridge for retaining the side slopes or earth filling.
WATER BOUND MACADAM:	A form of road construction consisting of crushed stone or crushed gravel, compacted in the presence of water, the binding agent used being stone screenings or approved material.
WATER TABLE:	The level at which ground water would finally stand in an un-pumped bore hole, well or other depression, when equilibrium has been reached.
WEARING COURSE:	The top layer of the surfacing which carries the traffic.
WEEP HOLE:	A small aperture or pipe through a retaining wall or abutment which, by acting as a drain, prevent the accumulation of water.
ZONE (SAFETY):	A raised pavement or platform, or a guarded area, so sited in a carriageway as to divide the streams of traffic and to provide a safety area for pedestrians.

SECTION 201

CONSTRUCTION EQUIPMENT - GENERAL REQUIREMENTS

201-1 GENERAL

Unless restricted by the Specifications, Plans, Special Provisions or the Engineer, to a specific type or types, the equipment, tools, machinery, etc., to be used on the work shall be such as the Contractor elects for obtaining the specified and required results.

201-2 EQUIPMENT CONDITION AND APPROVAL

All equipment to be used in construction of the project, or in any stipulated portions of a project, shall be on the site in first class working condition and shall have been approved by the Engineer before construction is started, or a particular item of construction is started requiring special equipment. The number of units, the sizes, etc., of all equipment shall be adequate to insure completion of the work within the time specified in the contract. No equipment shall be removed from the site without written approval of the Engineer.

All equipment, tools, and machinery used shall be maintained in a satisfactory working condition throughout the required period of their use.

201-3 SPECIAL EQUIPMENT

Where a special type of plant or equipment is specified for a particular operation, the Contractor may with the written approval of the Engineer, use alternative equipment provided that he satisfies the Engineer at his own risk and cost that he can achieve the required result within the time schedule. If the Contractor does not achieve the result to the satisfaction of the Engineer, the Engineer will require him to revert to the originally specified method of carrying out the work.

201-4 CONTRACTOR'S RESPONSIBILITY

The approval of number of units, the sizes or particular types, by the Engineer does not absolve the Contractor of the responsibility of timely and satisfactory completion of the work.

SECTION 202

FIELD TEST LABORATORY

202-1 GENERAL

Every Contractor employed on the construction, widening and improvement programme of a road shall be required to provide and maintain a Field Test Laboratory. The laboratory will be furnished with the equipment listed in the Highway Department Quality Control Manual. Necessary laboratory furniture required to facilitate the testing work will also be provided. The Contractor shall also be required to employ necessary qualified technical staff to carry out the specified tests.

202-2 LOCATION

The laboratory shall be located at the site of work in a temporary building or a double fly tent spacious enough to accommodate laboratory equipment and furniture and allowing enough space for performing tests.

202-3 COST

The cost for the provision and maintenance of field test laboratory, pay of laboratory staff, cost of materials for testing shall be borne by the Contractor. The Contractor shall allow the Highway Department staff to use the laboratory for carrying out test checks and Quality Control. Such costs are considered as included in the unit rate of respective items.

SECTION 211

MAINTENANCE OF TRAFFIC

211-1 DESCRIPTION

The work specified in this Section consists of maintaining traffic within the limits of the project and for the duration of the construction period including any temporary suspensions of the work. It shall include the construction and maintenance of any necessary detour facilities. This work shall also include any special requirements shown or indicated on the Plans for the maintenance of traffic.

211-2 GENERAL REQUIREMENTS

The Contractor's responsibility for maintenance of traffic shall begin on the day he starts work on the project, or on the first day contract time is charged, whichever is earlier.

All lanes that are being used for the maintenance of traffic, including those on detours and temporary facilities, shall be adequately maintained with a substantial surface under all weather conditions. The lanes shall be kept free of dust and, when necessary to accomplish this they shall be sprinkled with water, or some other dust palliative shall be applied.

The Contractor will be required to maintain two-way traffic except as otherwise provided for in the Special Provisions or herein. Where one-way traffic is permitted, traffic is to alternative in direction so that it will not be delayed beyond a reasonable maximum.

The Contractor shall provide competent flagmen and at night proper and adequate lights to direct all one way or otherwise restricted traffic, and to direct traffic at all restricted bridges and other hazardous locations unless relieved of his requirement by written notice from the Engineer.

The Contractor will not be permitted to block any road or street which intersects or crosses the project, unless otherwise specifically permitted. Accommodations for intersecting or crossing traffic shall be provided and maintained. Connecting roads at the ends of the project shall not be obstructed by the Contractor's operations. Such accommodations may be for one-way traffic except where two-way facilities are specifically called for.

Where, in the opinion of the Engineer, traffic over the base or surface course would be injurious to such, all traffic passageways along the project shall be outside the pavement area.

* When traffic is specified to be detoured by the Department over other roads or streets, the Contractor will not be required to maintain such roads or streets, and all signing, including those at the intersections with the project, will be done by the Department.

The Contractor will not be permitted to isolate residence or places of business. Access shall be provided to all residences and all places of business whenever construction interferes with the existing means of access.

Barricades, warning and detour signs are to be erected by the Contractor wherever necessary, in accordance with 211-4 to insure that traffic does not deviate from the established useable roadway limit.

211-3 DETOURS OR DIVERSIONS

On all construction where the Contractor is required to maintain traffic, the Contractor will be required to construct and maintain detour facilities wherever it becomes necessary to divert traffic from any existing roadway or wherever construction operations block the flow of traffic. The minimum lane width should be 12 feet.

All detours are to be planned, constructed and maintained in such manner that they will be capable of conveniently carrying the traffic required throughout all conditions of weather. It will be the Contractor's responsibility to provide all detour facilities with adequate drainage to meet this requirement.

Unless otherwise indicated in the Plans all temporary detours are to be removed before the Contract is completed and all materials from the detour will become the property of the contractor and are to be disposed of by him, except such material as may be loaned to the Contractor by the Department and stipulated to be returned.

The Contractor will generally be required to provide all materials for the construction and maintenance of all detours, except that where the Plans call for the Department to provide borrow or other material pits the Contractor will be allowed to obtain material from these pits for detour. Unless otherwise shown no separate payment will be made for detour material from these pits.

In general, the requirements of the Standard Specifications pertaining to construction and material details shall not apply to detour construction, and it will be the responsibility of the Contractor to

select and to use construction methods and materials that will satisfactorily provide a stable detour facility of sufficient durability to remain in good condition, as supplemented by his maintenance, for as long a period as it is necessary to utilize the detour.

211-4 BARRICADES, WARNING AND DETOUR SIGNS

The Contractor shall erect and maintain all necessary barricades, suitable and sufficient red lights, danger signals and signs, shall provide a sufficient number of watchmen to direct the traffic and shall take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades on which shall be placed appropriate warning signs. The Contractor shall erect and maintain the proper warning and directional signs at all closures and intersections and along the detour routes, directing the traffic around the closed portion or portions of the highway, and such that the temporary detour route shall be indicated clearly throughout its entire length. All barricades and obstructions shall be illuminated at night and all lights shall be kept burning from sunset until sunrise.

During the entire period of construction operations at railway crossings it shall be the Contractor's responsibility to maintain, in a satisfactory and clearly legible condition, the advance warning signs which are normally installed by the Railways. Wherever such signs are not installed by Railways, the Contractor shall install and properly maintain adequate temporary advance warning signs which will be furnished to him by the Department.

The Contractor shall furnish all of the above required barricades, lights etc.

211-5 WATERING

The Contractor shall sprinkle the surface with adequate amount of water to keep down the dust.

211-6 MEASUREMENT

The item for Maintenance of Traffic at all points affected by the project will be job item.

211-7 RATE

The unit rate shall be full compensation for all costs of complying with the provisions of this Section and includes costs of all materials, labour and machinery etc.

211-8 PAYMENT

Payment shall be made under:

Item No. 211-8.1 - Maintenance of Traffic lump sum.

***B. CLEARING
CONSTRUCTION SITE***

CLEARING CONSTRUCTION SITE

SECTION 301

CLEARING AND GRUBBING

301-1 DESCRIPTION

The work specified in this Section consists of clearing and grubbing within the areas of the roadway Right of Way and borrow pits, lateral ditches, and other areas shown on the Plans. The work shall include the disposal of the resultant products and debris.

301-2. REQUIREMENTS FOR ALL CLEARING AND GRUBBING

301-2.1 GENERAL: Clearing and Grubbing shall include the removal and satisfactory disposal of all structures and of all other obstructions including underground structures such as septic tanks and building foundations and shall include the removal and disposal of existing pipes; except for any of such work which might be specifically included for removal under other items of work.

301-2.2 BUILDINGS: All parts of the buildings including utilities, plumbing foundations, floors, basements, steps, connecting concrete sidewalks or other pavements, septic tanks, and any other appurtenances shall be completely removed in any particular manner the Contractor elects, subject to the approval of the Engineer.

Any useful material obtained as a result of this operation shall be the property of the Department.

301-2.3 PROPERTY OBSTRUCTIONS: Property obstructions which are to remain in place, such as buildings, sewers, drains, water or gas pipe, conduits, railroads, poles, walls, posts, bridges, etc. are to be carefully protected from injury and are not to be displaced except as might be directed by the Engineer for unusual cases. Such property obstructions as have to be moved and reset or rebuilt shall generally be moved at the expense and risk of the owner, and the Department will be responsible for arranging for their removal. The Department, however, shall not be responsible for any delay which may be caused to the Contractor due to the non-removal of such obstructions, whether or not they are shown on the Plans except for any extension of time for completion, as specified in the Contract.

301-2.4 TIMBER AND CROPS: Any merchantable timber, fruit trees and crops that are cleared under the operations of clearing and grubbing may be disposed of as directed by the Engineer.

301-2.5 REMOVAL OF STRUCTURES: Structures, other than buildings shall be removed and disposed of in accordance with the requirements of Section 311.

301-2.6 LANDSCAPE AREAS: The work of clearing and grubbing shall include the careful preservation of any trees, vegetation, etc., outside the limits of construction and within any areas designated for being conserved.

301-2.7 PLUGGING ABANDONED WATER WELLS:

301-2.7.1 General: All water wells which are found within the right of way (including borrow pits and lateral ditches) and which are not required to remain in service shall be filled or plugged as specified or directed by the Engineer.

301-2.7.2 Plugging of Wells: Wells will be filled with material approved by the Engineer and capped with concrete, clay or other material which will prevent the flow of water down the well.

301-3 STANDARD CLEARING AND GRUBBING

301-3.1 WORK INCLUDED: Standard Clearing and Grubbing shall consist of the complete removal and disposal as directed by the Engineer, of all buildings, timber, brush, stumps, roots, grass weeds, sawdust, rubbish and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas.

301-3.2 AREAS COVERED IN GENERAL: Unless otherwise shown on the Plans, Standard Clearing and Grubbing shall be done within the following areas:

All areas where excavation will be done, including borrow pits, lateral ditches, right of way ditches etc.

All areas where roadway embankments will be constructed.

All areas where structures will be constructed, including pipe culverts and other pipelines.

301-3.3 ROOTS, STUMPS, ETC. - DEPTH OF REMOVAL: In all areas where excavation is to be done and where the excavated material is to be used in the construction of roadway embankment or roadway base or pavement; also in all areas where roadway embankments will be constructed; all stumps,

roots, and other debris shall be removed to a depth of at least one foot below the ground surface. Holes left by stumps and roots shall be back-filled with suitable material and compacted to the satisfaction of the Engineer.

301-3.4 TREES TO BE TRIMMED ETC. As an exception to the above provisions, where so directed by the Engineer trees within the roadway area shall be trimmed, protected and left standing. Branches of trees extending over the area occupied by the Roadway shall be trimmed as directed, to give a clear height of 15 feet above the Roadway.

301-3.5 BOULDERS: All loose boulders lying on the surface of the ground shall be removed and placed in neat piles along (but inside) the right of way line.

301-4 CLEARING ONLY

General: Clearing only, shall consist of removing and disposing of all vegetation, obstructions etc., as provided above except that where the Contractor so elects, in lieu of grubbing stumps roots etc., he may cut them off flush with the adjacent ground surface.

301-5 LEVELING TERRAIN

Within the areas between the limits of construction and the outer limits of clearing and grubbing all holes and other depressions shall be filled, all mounds and ridges cut down, and the area to sufficiently uniform countour that the Department's subsequent moving and cutting operations will not be hindered by irregularity of terrain.

301-6 DISPOSAL OF MATERIALS

301-6.1 GENERAL DISPOSAL: Any useless timber, stumps, brush, roots, rubbish and objectionable material resulting from clearing and grubbing shall be disposed of within the limits of the right of way by burning; however, as an exception to this requirement, such materials may be disposed of on private property provided, the Engineer is furnished with a written notice from the owner of the property giving permission for the disposal of the materials on his or their property. Areas provided by the Contractor for disposal of the debris, etc., shall be out of sight of the project and at least 300 feet from the nearest roadway right of way line of the project, unless such materials are buried, in which case the requirement that the areas be 300 feet distant will be waived.

301-6.2 BLOCKING WATERWAYS: Natural waterways or irrigation channels shall not be blocked in the disposal of debris from clearing, and grubbing operations.

301-6.3 BURNING DEBRIS: All burning shall be under the direction of the Engineer at all times and at such locations as will not cause injury to trees and shrubs adjacent to the cleared area.

301-7 MEASUREMENT

The unit of measurement for clearing and grubbing will be job item, for the entire area of the project designated for clearing and grubbing.

301-8. RATE

The lump sum rate for clearing and grubbing of the entire area designated on plans shall be lump sum price, which price shall be full compensation for all the work specified in this section and shall include all necessary hauling, furnishing and operation of equipment, and required furnishing of areas for disposal of debris, and any work of levelling terrain, as specified in 301-5.

It shall also include all costs of plugging of any existing water wells encountered, unless such work is specifically shown to be paid for otherwise.

301-9 PAYMENT

Payment shall be made under:

Item No. 301-9.1 - clearing and grubbing - lump sum

SECTION 311

REMOVAL OF EXISTING STRUCTURES

311-1 DESCRIPTION

The work specified in this Section consists of the removal and disposal of the materials from existing structures. The structures to be removed shall be: (1) those structures, or portions of structures, shown on the Plans to be removed; (2) those found within the limits of the area to be cleared and grubbed, and directed by the Engineer to be removed and (3) those structures or portions of structures which, in the opinion of the Engineer, it is necessary to remove in order to construct the new structures.

311-2 REMOVAL

The structure shall be removed in such a way as to avoid damage to the materials and to leave no obstructions to any proposed new structures or to any waterways. In the case of timber structures, all bolts, nails etc., shall be entirely removed from all useable materials, as determined by the Engineer, except that nail removal will not be required from two-inch by four-inch decking unless specifically required by the Plans. All piling shall be pulled or cut, or shall be broken off two feet below the finished excavation surface of the original ground surface. Structural steel members shall be marked as directed, for identification. Where a portion of the existing structure is to remain in place explosives shall not be used to remove reinforced concrete. Under ground structures and chambers shall be demolished to the depth shown on the Drawings. They shall be properly cleared out and filled with suitable material and compacted to the specified density.

On concrete bridges to be partially removed and widened, concrete shall be removed by manually or mechanically operated pavement breakers, concrete saws or chipping hammers. Wherever concrete is to be removed to neat lines the outlines of the work shall first be made with small trenches or grooves about one inch deep cut in the existing concrete surface. Care shall be taken to confine the breakage to the correct outline.

311-3 DISPOSAL

All waste materials shall be disposed of, as directed by the Engineer, with 3000 ft. haul. All useable material, as determined by the Engineer shall be stacked in neat piles within the right of way.

The provisions of 301-6 shall apply to the disposal of materials under this Section.

311-4 MEASUREMENT

The unit of measurement for Removal of Existing Structure will be job item, for the entire area of the project designated for Removal of Existing Structure.

311-5 RATE

The lumpsum rate shall be full compensation for all costs of complying with the provisions of this Section and includes costs of all materials, labour and machinery etc.

311-6 PAYMENT

Payment shall be made under:

Item No. 311-6.1 - Removal of Existing Structures - Lumpsum

C. EARTHWORK

EARTHWORK AND RELATED OPERATIONS

SECTION 401

REMOVAL OF EXISTING PAVEMENT

401-1 DESCRIPTION

The work specified in this section consists of removing and storing for re-use if so designated by the Engineer or otherwise disposing of all existing pavement materials such as bituminous surfacing, crushed rock or brick, whole bricks comprising the sub-base/sidewalk, curb and gutter or flexible road surface where it is shown on the plans or ordered by the Engineer to be removed or where required to be removed by the construction operations.

401-2 CONSTRUCTION METHODS

Except where specifically directed otherwise the contractor shall store all materials for use where directed by the Engineer. The Contractor shall be responsible for the materials until finally disposed of.

The provisions of 301-6.1 and 301-6.2 shall apply to the disposal of these materials, as are pertinent.

401-3 MEASUREMENT

The item for removal of existing pavement designated on the plans will be measured in superficial area. The unit of measurement will be one hundred square feet. The quantity shall be determined by actual measurement before removal.

401-4 RATE

The unit rate shall be full compensation for all costs of complying with the provisions of this Section and includes costs of all materials, labour and machinery etc.

401-5 PAYMENT

Payment shall be made under:

Item No.401-5.1 - Removal of Existing Pavement ..
..... per 100 sq. ft.

SECTION 402

EXCAVATION FOR STRUCTURES

402-1 DESCRIPTION

The work specified in this Section consists of the excavation for bridge foundations, box culverts, pipe culverts, storm sewers and all other pipe lines, retaining walls, headwalls for pipe culverts and drains, catch basins, drop inlets, manholes and similar structures. It shall also include (1) the construction and removal of cofferdams, sheeting, bracing etc., (2) pumping or otherwise unwatering the foundation; (3) the removal and disposal of any existing structures or portions of structures not covered by other items in the Contract, including the foundations, abutments, piers, wings, and all other materials, obstructions, etc., found necessary to clear the site for the proposed work; (4) backfilling, disposing of surplus material and final cleaning, as may be necessary for the proper execution of the work.

402-2 CLASSIFICATION

All materials excavated shall be unclassified and considered as excavation regardless of the material encountered.

402-3 COFFERDAMS

402-3.1 CONSTRUCTION: Wherever practicable all foundations shall be constructed by open excavation and the foundation openings shored, braced, or protected by cofferdams in accordance with approved methods. Cofferdams or cribs for foundation construction shall in general be carried well below the bottom of the footings and shall be well braced and as watertight as practicable. The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

Cofferdams shall be so constructed as to protect green concrete against damage from a sudden rising of the water and to prevent damage by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry except where might be so permitted, in writing, by Engineer.

For placing footings in the dry, the Engineer may require cofferdam sheeting to be driven to an elevation six feet below the elevation of the bottom of the footings and require sufficient pumping equipment to unwater and maintain the cofferdam in a comparatively dry condition.

For structure work, the Contractor shall submit upon request, drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the Engineer's drawings. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, will be subject to the approval of the Engineer, but other details of design will be left to the Contractor, who will be responsible for the successful construction of the work.

402-3.2 REMOVAL: Unless otherwise provided, cofferdam or cribs, with all sheeting and bracing, shall be removed by the Contractor after the completion of substructure. The removal shall be effected in such manner as not to disturb or mar the finished masonry.

402-4 EXCAVATION

402-4.1 REQUIREMENTS FOR ALL EXCAVATION: All excavation shall be carried to foundation materials satisfactory to the Engineer, regardless of the elevation shown on the Plans. All excavation located in the bed of a stream or canal shall be carried to a depth of at least four feet below the permanent bed of the stream, unless a firm footing can be established on solid rock before such depth is reached, and to such additional depth as may be necessary to eliminate any danger of undermining. Wherever rock bottom is secured, the excavation shall be done in such manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the masonry. All loose and disintegrated rock or thin strata shall be removed. All foundations shall be inspected and approved by the Engineer prior to placing of masonry.

The foundation pits shall be excavated to permit the placing of the full widths and lengths of footings shown on the Plans, with full horizontal beds. Corners or edges of footings shall not be rounded or undercut.

402-4.2 COMPACTION: The bottom of the trench shall in all cases be compacted to 95% Standard AASHO Max. dry density. Where the bottom of the trench is under cut and back filled with selected material, this material shall be compacted to at least 95% Standard AASHO dry density or to such other value as the Engineer may direct.

402-5 PRESERVATION OF CHANNEL

Unless otherwise shown on the Plans no excavation shall be made outside of caissons, cribs, cofferdams, or sheet piling, and the natural

stream bed or canal adjacent to the structure shall not be disturbed unless so ordered by the Engineer. If any excavation or dredging is made at the site of the structure before caisson, cribs or cofferdams are sunk in place, the Contractor shall, after the foundation is in place, backfill all such excavations to the original ground surface or river bed with material satisfactory to the Engineer.

Materials deposited within the stream area from foundation excavation or otherwise, shall be removed and the stream left in its original condition, unless otherwise shown on the Plans or ordered by the Engineer.

402-6 DISPOSAL OF SURPLUS

The excavated materials shall generally be used for backfilling and in constructing embankments over and around the structure. All excavated material not used for backfilling shall be disposed of as directed by the Engineer. When suitable, this material, in general, shall be used in the construction of roadway embankments, but material that is unsuitable or not required for this purpose shall be disposed of in such a manner as not to impair the appearance or utility of either the roadway or the waterway. In no case shall it be placed in the channel of the stream.

402-7 PUMPING

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping shall be done during the placing of concrete, or for a period of at least 24 hours thereafter, unless it is done from the suitable sump separated from the concrete work by a watertight wall.

402-8 BACKFILLING

402-8.1 REQUIREMENTS FOR ALL STRUCTURES: Backfilling to the original ground surface of openings made for structures, with a sufficient allowance for settlement shall be a part of the work of excavation, although the Engineer may require that the material used in making the backfill be obtained from a source entirely apart from the structure. All material used for backfill shall be of quality acceptable to the Engineer and shall be free from large lumps, wood, or other extraneous material. When the available material at the site of the excavation is not considered suitable for the backfill, the work of removing any of such material which might be surplus at the particular location and of bringing in material suitable for the backfill will be compensated for as provided in 411.

No backfilling shall be placed against any masonry abutment, wing-wall or culvert until permission has been given by the Engineer, and in no case until the masonry has been in place seven days. Traffic or movement of construction equipment shall not be allowed over concrete box culverts until they have been in place at least 14 days. All backfilling of areas within the formation width shall be compacted at least 95% standard AASHO Max. Dry Density or such other value as the Engineer may direct.

402-9 REPLACING OF PAVEMENT REMOVED FOR CONSTRUCTION OR CULVERTS

Where existing pavement, curb, curve and gutter, sidewalk, or valley gutter is removed only for the purpose of constructing or removing box culverts, pipe culverts, storm sewers, inlets, manhole etc., such pavement etc., shall be replaced and restored to as good condition, as determined by the Engineer, as before removal and without direct compensation therefor. The replaced pavement etc., shall be of the same or similar type as the removed except where permission is given by the Engineer for the use of other type.

402-10 CLEANING UP

Upon completion of the work, the Contractor shall leave the structure and all adjacent areas affected by these operations in a neat and presentable condition and shall remove and clear up all temporary structures, rubbish and surplus material and leave the space under the structure unobstructed and in such shape that drift will not collect nor scour be induced. All material from existing structures that have been removed by him shall be piled neatly on the bank or otherwise disposed of as directed by the Engineer. Falsework piling shall in general be pulled, except that, when permitted by the Engineer, they may be cut or broken off two feet below the ground line or stream bed.

402-11 METHOD OF MEASUREMENT

Excavation will be measured in its original position by the cross section method to determine the amount of material removed and will be that material actually removed below the original ground line or stream bed, but not including that shown on the plans to be paid for as Regular Excavation, (Section 411). No measurement will be made for material removed in excavation for footings of foundations outside of an area which is bounded by vertical planes one foot outside of the limits of the footing and parallel thereto.

When excavation for material below plan grade is called for on the Plans or authorized by the Engineer, the measurement shall include both the material excavated below grade and the material used for back fill.

402-12 MEASUREMENT

The item of Excavation for Structures will be measured by volume.
The unit of measurement shall be one thousand cubic feet.

402-13 RATE

The unit rate shall be full compensation for all costs of complying with the provisions of this Section and includes costs of unwatering of foundations, removal and disposal of surplus material, back-filling and final cleaning as may be necessary for the proper execution of the work.

402-14 PAYMENT

Payment shall be made under:

Item No. 402-14.1 - Excavation for Structures -- per 1000 cft.

SECTION 411

EXCAVATION AND EMBANKMENT

411-1 DESCRIPTION

The work specified in this Section consists of excavation of materials of whatever nature, encountered within the limit required for the proposed work, and shall include the removal, utilization and disposal of such materials, as required. It shall also include all excavation, haulage filling and placing, compaction, shaping and sloping necessary for the construction of all embankments, subgrades, shoulders and special backfills, in accordance with the required alignment, grade and cross sections shown on the plans.

411-2 CLASSIFICATION

411-2.1 GENERAL: All materials excavated shall be unclassified and paid for as regular excavation regardless of the material encountered.

411-2.2 REGULAR EXCAVATION: Regular Excavation shall include:

- (1) Road Excavation; and
- (2) Borrow.

411-2.2.1 Roadway Excavation: (a) General: It shall consist of the excavation and satisfactory disposal of all materials necessary for the construction of the roadway. It shall also include the excavation and disposal of muck, clay, rock or any other material that is unsuitable in its original position within the limits of the roadway including the removal of all suitable material lying within such planes which it is necessary to remove in order to excavate the unsuitable material.

(b) Protection of Work - While the excavation is being done and until the work is finally accepted, the contractor shall take the necessary steps to protect the work to prevent loss of material from the roadway, due to action of wind or water. During construction of the roadway, the subgrade shall be maintained in such condition that it will be well drained at all times.

(c) Removal of Trash, Vegetation etc. - On previously graded roadways, where no clearing and grubbing of the roadway is called for on the plans, all vegetation, bushes, shrubs, saplings etc. and including any trees for which removal is specifically called for in the plans, shall be removed as provided in Section 301, as a part of the work, under this Section.

411-2.2.2 Borrow: (a) General - Borrow shall consist of the material obtained from the authorized borrow pits. It shall include only material that is suitable for the construction of roadway embankments or other work of constructing embankments covered by the contract, and also unsuitable material that is necessary to excavate, as determined by the Engineer, to obtain suitable material.

Borrow shall be resorted to only when sufficient quantities of suitable material are not available, as herein prescribed, from roadway excavation, to properly construct the embankment, subgrade and shoulders and to complete the backfilling of structures. In no case shall material be borrowed until so ordered by the Engineer, and then only from the designated borrow pits. No borrow pits shall be opened until the Engineer has approved their location and, where borrow is to be measured in pits, their surface have been cross sectioned.

Unless otherwise indicated on the plans, the right of way for all borrow areas necessary for the completion of the work will be furnished by the department.

(b) Borrow Area Furnished by the Contractor - At the option of the Contractor in lieu of obtaining borrow from areas furnished by the Department, he may obtain borrow from other areas furnished by him, provided the Engineer determines the material from such areas meets the Departments standards, and other requirements for suitability for use in the particular sections of the work in which it is placed, and further provided that any increase in hauling or other costs shall be absorbed by the Contractor.

No borrow material shall be obtained from any substitute areas until the Contractor has requested, in writing, permission to use such areas, and the Engineer has approved, in writing, the use of the particular areas and has cross sectioned the surface. Upon such written approval by the Engineer, the substitute areas shall be considered as designated borrow areas.

(c) Excavation Requirements - When borrow material is to be measured the borrow pits shall be excavated neatly and the bottom and edges so shaped that accurate measurement are taken. Where the plans show the depth and width of excavation, such depth and width shall be considered approximate only and shall be subject to variation as directed. In borrow pits furnished by the Department, no material shall be excavated within three feet of the adjacent property lines.

(d) Provisions for Drainage - Where shown on the plans, the ditches for drainage of the borrow pits or roadway shall be constructed. The excavation of such drains shall be classified as borrow, and suitable material thus obtained, used, where required, on the works.

(e) Sequence of Construction - If the plans indicate sections within which a significant quantity of borrow is required in order to establish a balance within the limits of such sections then, except as

might be permitted otherwise in writing by the Engineer, the Contractor shall construct first those sections showing no borrow, such that all suitable surplus material therein will be utilized. In order to meet this requirement if the Contractor is required to haul a distance greater than the distance indicated on the plans, overhaul will be paid for as specified in 421-2.2 and 421-4.

411-3 HAUL ROADS

The Contractor shall provide and maintain at his own expense all necessary service roads necessary for hauling the material over the shortest practicable route as determined by the Engineer, to the points where it is to be used for doing all operations pertinent to the execution of work covered under this section. The Department will obtain any necessary property easements for haul roads leading to the pits furnished by it.

411-4 PLACING EMBANKMENT:

411-4.1 GENERAL: Embankments shall be constructed with suitable material true to lines, grades and cross sections shown on the plans within 0.1 foot tolerance as specified above. Embankments shall be constructed in successive layers of not more than nine inches in thickness, measured loose, for the full width of the embankment.

Embankment shall be constructed in lengths of not less than 300 feet or for the full length of embankments.

411-4.2 PLACING OUTSIDE THE DESIGNATED SLOPES: Where material is to be used in the embankment outside the designated slopes shown on the plans, it shall be placed in layers of not more than 18 inches in thickness measured loose.

411-4.3 PLACING IN UNSTABLE AREAS: Where the material is deposited in water or in low swampy ground that will not support the weight of trucks or other hauling equipment, the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers.

411-4.4 PLACING ON SLOPES: When embankments are made on a hill side sloping more than 20 degrees from a horizontal, the slopes of the original ground on which embankment is to be placed shall lie plowed deeply or cut into steps before the filling is started.

411-4.5 PLACING NEAR PIPE AND STRUCTURES: Embankments over and around pipes, culverts, arches and bridges shall be made with selected materials and thoroughly compacted in such manner as to avoid undue strains upon the structures and in accordance with the requirements of 402-8.

411-4.6 CONSTRUCTION OVER OLD ROAD: Where a new road is to be constructed on an old one, the material from the old road pavement shall be salvaged where this is economical. If the fill is less than two feet and the old work is left intact, only selected material shall be used in the fill.

411-4.7 MAXIMUM STONE SIZES: The maximum sizes of stones which shall be permitted in the embankment are as follows:

	<u>Max. Dimension</u>
In top 12 inches of completed embankment	3½ inches
12 inches to 2 feet	6 "
2 feet to 4 feet	12 "
4 feet to 8 feet	24 "

Where embankments are constructed adjacent to bridge and bents or embankments, stones larger than four inches in diameter shall not be placed within three feet of the location of any and bent piling.

411-4.8 UNSTABLE MATERIAL: Stumps, root brush rubbish or any other unsuitable material shall not be placed in the embankments.

411-4.9 TRAFFIC DISTRIBUTION OVER EMBANKMENT: All traffic over the work during the construction of embankments shall be distributed so as to cover the entire surface of each layer.

411-4.10 RESPONSIBILITY FOR STABILITY: The Contractor shall be responsible for the stability of all embankments made by him and shall replace at his own expense any portions which, in the opinion of the Engineer, have been displaced, due to carelessness or negligent work on the part of the Contractor, except for damages resulting from natural cause such as storms, cloud burst, movements of natural ground or due to shrinkage of the material of which the embankment is constructed.

411-5 EMBANKMENT COMPACTION

411-5.1 COMPACTION: All embankments shall be compacted in accordance with the following requirements.

Each layer of embankment material, except layers consisting of stones, shall be moistened or dried uniformly to the optimum moisture content, and then thoroughly mixed with a blade grade or disc harrow or any other suitable equipment and then compacted by rolling with sheeps-foot roller, tamping or pneumatic-tired roller or 3 wheel power roller.

Where the materials in the embankment permits practical density tests, the engineer may, during the progress of the work, make such tests in accordance with AASHTO T-147, modified to include only material passing a 3/4 inch sieve, and if the density thus found is less than the specified percentage of the maximum density as determined by AASHTO T-180 (Modified Proctor), the Contractor shall perform additional rolling.

On the written request of the Contractor, the Engineer may permit in writing compaction with types of equipment other than those specified above, provided the Contractor demonstrate that use of the alternate equipment will consistently produce densities of not less than the specified percent determined as provided above.

411-5.2 MOISTURE CONTENT: Materials shall be at a moisture content $\pm$ 2% of optimum moisture (AASHTO T-180). If not, either water shall be added or the material permitted to dry until the proper moisture content for the specified compaction is obtained.

411-5.3 COMPACTION REQUIREMENTS FOR NEW EMBANKMENTS: The subgrade embankment of 3' or less in height shall be compacted to at least 95% modified AASHTO, Max. dry density for their full depth and full width. Embankments over 3' in height shall have the top 3 feet compacted to not less than 95% modified AASHTO maximum-dry density to their full depth and width and those portions below 3 feet of the finished subgrade level shall be compacted to at least 85% of the modified AASHTO maximum dry density, to their full depth and width.

The compaction of each and every layer shall be tested and approved before next layer of fill is placed. The result shall be examined on a statistical basis, only one result in ten consecutive tests may fall below 95% relative compaction and no result shall be below 93% in case of upper 3 feet of the subgrade. Likewise for the lower portion, the degree of relative compaction shall be 85 percent for at least 9 tests out of 10 consecutive tests and for the tenth, it shall not be below 83 per cent.

411-5.4 COMPACTION REQUIREMENTS FOR WIDENING OF PAVEMENT: Where existing road pavements are to be widened, at least 6 feet width of the shoulder shall be excavated to the full depth of the existing pavement construction or more as specified by the Engineer so that the subgrade is properly rolled and compacted as laid down in para 411-6.

411-6 SUBGRADE SURFACE:

411-6.1 GENERAL: When the work under the contract includes the construction of a subbase, base or pavement course the subgrade surface shall be constructed as hereinafter provided.

411-6.2 WORK INCLUDED: The work shall consist of bringing the bottom of excavations and top of embankments of the roadway, between the outer limits of subgrade width, to a surface conforming to the grades, lines and cross sections shown on the plans, of uniform density, ready to receive the subbase, base or surfacing.

411-6.3 REMOVAL OF UNSUITABLE MATERIAL: All soft and yielding material, and other portions of subgrade which will not compact readily, shall be removed and replaced with suitable material and the whole subgrade brought to line and grade, with proper allowance for subsequent compaction. The entire subgrade, in both cuts and fills shall then be thoroughly plowed and mixed to a depth at least 12 inches below grade.

All submerged stumps roots or other perishable matter encountered in the preparation of the subgrade shall be removed to a depth at least two feet below subgrade.

411-6.4 MAINTENANCE OF SUBGRADE SURFACE: After the subgrade has been prepared as specified above, the contractor shall maintain it free from ruts and depressions and all damage resulting from the carriage or handling of any materials or machinery or tools etc. shall be made good to the required standards. Ditches and drains shall be constructed and maintained along the completed subgrade section. A completed subgrade equal to at least the length of base or pavement to be laid the next working day shall be maintained at all times.

411-6.5 TESTING OF SUBGRADE SURFACE: When a pavement is to be constructed the subgrade levels shall be checked by the use of levelling stakes and or other means, approved by the Engineer and any necessary correction etc. made as specified hereinafter.

The subgrade surface shall be tested with a subgrade templet. After the subgrade has been prepared (and forms set true to line and grade), and immediately before the paving course is laid, the subgrade shall be tested as to crown and elevation by the use of an approved subgrade templet; furnished by the Contractor. The templet shall be so construed that its lower or testing edge will just come to the true position of the subgrade when the templet is riding on the forms. Testing of the subgrade elevation shall be done by moving the templet back and forth without tilting or lifting. The templet shall be drawn along just ahead of the point where the materials for subbase course are being deposited and shall always be kept in position while material is being placed. Where the subgrade is found not to be at the proper elevation, material shall be removed or added, as the conditions necessitate and compacted to bring all portions of the subgrade to the correct elevation and to specified density. Where the subgrade is more than 24 feet in width it shall be tested in strips 24 feet or less in width by the use of crown stakes, temporary forms or other means approved by the Engineer.

411-7 SHOULDERS DITCHES AND SLOPES

The roadway, including the slopes, and all drainage structures shall be substantially completed before the construction of pavement is started.

During the construction of the pavement, a shoulder at least three feet wide shall be maintained in place to properly support the edges of the pavement. Upon completion of the pavement, the earth shoulders, slopes and ditches shall be completed and shaped to a surface which is within 0.1

foot above or below the true surface shown on the Plans. The shoulder lines shall not vary more than 0.1 foot horizontally from the true lines shown on the Plans.

Hand dressing of shoulders, slopes or ditches etc. will not be required except where necessary and directed by the Engineer.

Material which contains weeds, roots or other unsuitable matter shall not be used in the construction of shoulders.

411-8 SPECIAL BACKFILL

411-8.1 GENERAL: This work shall consist of selected material as defined hereinafter, furnished, placed and compacted in layers against the inside faces of retaining walls, wing walls, back faces of abutments and over the extrados of arches, in accordance with these specifications and in conformity with the requirements shown on the Plans.

411-8.2 MATERIAL: Selected material for special backfill may be either gravel, brick, crushed brick or stones or sand. Gravel crushed brick and crushed stones shall consist of sound, durable, particles, all of which shall be retained on a No. 4 sieve as determined by AASHO T-27. Any material not suitable for water percolation shall not be used.

411-9 DISPOSAL OF EXCAVATED MATERIAL

All suitable materials resulting from the excavation shall be used as far as practicable in the formation of embankments, subgrades, shoulders etc.

All suitable surplus material shall be used in widening embankments uniformly flattening embankment, slopes etc. as directed by the Engineer.

Where so shown on the Plans suitable material excavated from ditches shall be used in the construction of embankments.

Paving materials excavated in the removal of existing pavements, as such paving bricks, concrete slabs, lime rock, side walk, stone metal, curb and gutter etc., shall be disposed of as directed by the Engineer or stacked in neat piles within the area designated.

411-10 METHOD OF MEASUREMENT FOR REGULAR EXCAVATION

411-10.1 GENERAL: The quantity of excavation to be paid for as required under section 411-2 shall be the quantity measured in its original position, generally by the method of average end areas. Cross section of existing ground shall be taken at an interval of 100 feet along the centerline of the road. Such levels shall be recorded in a suitable and recognized

manner on field book as well as on drawings and shall be signed by the Contractor and Engineer's Representative.

411-10.2 METHOD FOR ROADWAY EXCAVATION: The measurement of roadway excavation shall include only the net amount of excavation between the original ground surface and the surface of the earthwork (subgrade levels) when the roadway is completed and accepted. The cross section of Original ground surface shall be taken and recorded at an interval of 100 feet, along the centerline of the roadway and then quantities computed by the end area method. The measurement shall also include all unavoidable slides in connection with the operations of roadway excavation. It shall also include any excavation done below subgrade level to remove unsuitable material and also the excavation done in borrow area within free haul distance for back-filling in place of unsuitable material removed, as stated above.

411-10.3 METHOD FOR BORROW EXCAVATION: Measurement of borrow excavation in borrow area shall also include unsuitable material that is necessary to excavate as determined by the Engineer in order to obtain suitable borrow material. The measurement of the borrow pit shall be made only when the sides and bottom of the trench has been levelled. The quantity excavated shall be determined by average end area method or as directed by the Engineer at site.

411-10.4 MEASUREMENT: All measurements for regular excavation shall be by volume. The unit of measurement will be one thousand cubic feet.

411-10.5 RATE: The unit rate of regular excavation shall be full compensation for all costs of complying with the provisions of this Section.

411-10.6 PAYMENT: Payment shall be made under:
Item No. 411-10.1 Regular Excavation - Per 1000 cu. ft.

411-11 METHOD OF MEASUREMENT FOR EMBANKMENT

411-11.1 GENERAL: The quantity of material placed for making embankment, in order to prepare the subgrade, shoulders, slopes and ditches as required under Section 411-2, 411-3, 411-4 and 411-5, shall be measured, in final deposition between the limits shown in the Plans or as directed by the Engineer by the cross section method after proper compaction in place.

411-11.2 MEASUREMENT: The measurement for embankment shall be by volume. The unit of measurement shall be one thousand cubic feet.

411-11.3 RATE: The unit rate for embankment shall be full compensation for all costs of complying with the provisions of this Section and shall include the cost of carriage, cost of watering, rolling, compaction, dressing and removal of trash and vegetation, etc., complete in all respects.

411-11.4 PAYMENT: Payment shall be made under:
Item No. 411-11.1 Making Embankment - Per 1000 cu. ft.

Copy of letter No. CEH/1277-1301/P2, dated. 30.12.1971
from Mr. A.A. Jamal-ud-Din, PSE, I, Chief Engineer, Highway Deptt;
Punjab Lahore to all SES/Exens in (Punjab Highway Department)

..-.-.-.

Sub:- STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTN.

The enclosed amendments have been approved by the Chief Engineer, Punjab Highway Department, Lahore which may please be incorporated in the respective clauses of the Standard Specifications for Road & Bridge Construction "1st Edition". The receipt of the same may please be acknowledged and the intending contractors whom the tender documents, if any, have been issued may also be informed of these amendments.

..-.-.-.-.-.

"AMENDMENTS".

CLAUSE 411-10.1 IS TO BE SUBSTITUTED AS UNDER:-

Clause 411-10.1 General: The quantity of excavation which cannot be used for embankment within free haul distance of 3000 ft. shall be paid for as regular excavation and shall be measured in its original position generally by method of average and areas. Cross sections of existing ground shall be taken at intervals of 100 ft. along the centre line of the road for the excavation to be measured. Such levels shall be recorded in a suitable and recognised manner on field book as well as on drawing and shall be signed by the Contractor and Engineer-in-Charge's representative.

FOLLOWING addition is to be made in Clause 411-11-1

The quantity thus measured shall include the earth collected ~~fr~~ from road excavation and selected borrow areas.

Clause 411-11.3 is to be substituted as under:-

The unit rate for embankment shall be full compensation for all costs of complying with provisions of this section and shall include the cost of regular excavation used for embankment, the cost of carriage, cost of watering, rolling, compaction, dressing and removal of trees and vegetation etc. complete in all respects.

..-.-.-.-.-.

No.

Dated.

Copy ~~farwar~~ for information is forwarded to the SDO, Highway Sub Division, Dina/Jhelum/Chakwal/Divisional Accountant/H.D/H.C.



EXECUTIVE ENGINEER
HIGHWAY DIVISION JHELM.

AJAZ



411-12 METHOD OF MEASUREMENT FOR SPECIAL BACKFILL

411-12.1 GENERAL Selected material furnished, placed and compacted in backfills as required under Section 411-8 shall be measured in final deposition by the cross section method.

411-12.2 MEASUREMENT: The measurement for special backfill shall be by volume. The unit of measurement shall be one thousand cubic feet.

411-12.3 RATE: The unit rate of embankment shall be full compensation for all costs of the complying with the provisions of this Section and shall include the cost of carriage, cost of watering, rolling compaction in layers, dressing, etc. complete in all respects.

411-12.4 PAYMENT: Payment shall be made under:

Item No.411-12.1 Special Backfill - Per 1000 cu. ft.

411-13 WORK NOT INCLUDED IN MEASUREMENT FOR PAYMENT

No payment shall be made for the excavation of any materials which are used for purposes other than those shown on the Plans or designated by the Engineer. No payment shall be made for materials excavated outside the lines and grades given by the Engineer, except that, in the operations of roadway excavation, and slides and falls of insecure masses of material beyond the regular slopes and not due to lack of precaution on the part of contractor shall be paid for at the contract unit price for the material involved.

SECTION 421

OVERHAUL OF EXCAVATION

421-1 DESCRIPTION

Overhaul shall consist of necessary hauling of excavated material a distance beyond that defined herein as the free haul distance. Unless otherwise shown on the Plans overhaul shall apply only to borrow material; and for these materials, only when called for on the Plans or as provided hereinafter.

As far as practicable all the excavated material shall be disposed of, as directed by the Engineer, within the free haul limits.

421-2 FREE HAUL

421-2.1 WHEN BID SCHEDULE SHOWS AN ITEM FOR OVERHAUL: When the Bid Schedule shows an item and approximate quantity for Overhaul, the free haul distance shall be 3,000 feet, provided that when the Plans indicate the bid item to be applicable only to a certain class of excavation, all hauling of other classes of excavation shall be considered as free haul, subject, however to the provision of 421-2.2; and further provided that, should material on which overhaul is to be allowed be obtained from substitute pits furnished by the Contractor, any increase in length of the haul due to such charge also shall be considered free haul and any decrease in length of haul shall not reduce the specified free haul distance.

421-2.2 WHEN BID SCHEDULE DOES NOT SHOW AN ITEM FOR OVERHAUL:
When Bid Schedule does not show an item and approximate quantity for Overhaul all hauling shall be considered as free haul except as follows:

When the location of a proposed borrow material pit is changed by the Engineer from that shown on the original plans, and such change entails the hauling of material a distance greater than the length of haul indicated on the original plans, the haul distance indicated on the original plans for such material shall be considered as the free haul distance and the necessary hauling of such material beyond this free haul distance shall be classed as overhaul. The Engineer may direct the Contractor to use selected material occurring within the right of way or in borrow pits within the free haul distance to be placed to form the top 1 to 2 ft. of the embankment. The cost of this will be considered as covered under Section 411.

421-3 METHOD OF DETERMINATION

The quantity of Overhaul to be paid for shall be determined by the mass diagram method. The pay quantity shall be computed as the product of the remaining number of 1000 cubic feet of material from any excavated area after proper deduction has been made for material placed within the free haul limits, multiplied by the distance (unit of one half mile) such material is hauled in excess of the free haul distance. The distance such material is hauled will be taken as the distance between the center of volume of such remaining excavation and the center of volume of the corresponding embankment. The distance between centers of volume shall be measured along the centerline of construction except in the case of borrow, when it shall be measured along the shortest practical line of haul, as determined by the Engineer.

421-4 RATE

When the Bid Schedule shows an item and approximate quantity for overhaul, the quantity, determined as provided in 421-3 and under the conditions of 421-2.1, shall be paid for at the unit price per half-mile 1000 cft., as established by the Contractor's bid, which price shall be full compensation for complying with the provisions of this Section and includes cost of all labour, machinery, tools etc.

When overhaul is encountered under the conditions set forth in 421-2.2, and such overhaul is not covered by a bid item, the quantity of such overhaul, determined as provided above, shall be paid for at the rate agreed upon in the contract.

One half mile 1000 cft. shall equal 1000 cubic feet of excavated material hauled one half mile in excess of the free haul distance.

421-5 PAYMENT

Payment shall be made under:

Item No. 421-5.1 - Overhaul (421-2.1) per half mile 1000 cft.

Item No. 421-5.2 - Overhaul (421-2.2) per half mile 1000 cft.

*D. SUBBASE AND BASE
CONSTRUCTION*

SECTION 501

SUB-BASE COURSE
MECHANICALLY STABILIZED SOIL AGGREGATE

501-1 DESCRIPTION

This work shall consist of the construction of a layer or layers of mechanically stabilized soil comprising either naturally occurring materials or mixtures of gravel, crushed aggregate or crushed brick, whichever is specified in the bid schedule, to suitable grading including fines, placed and compacted on a prepared formation to give a California Bearing Ratio value of at least 25 percent in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross section shown on the plans.

501-2 SOIL AGGREGATE MATERIALS

501-2.1 GENERAL: The soil aggregate material shall comprise of coarse and fine aggregate conforming to the grading requirements of Table 501-1 and shall be free from vegetable matter.

501-2.2 COARSE AGGREGATE: Coarse aggregate shall consist of hard durable fragments of stone, gravel or brick suitably crushed to give the required grading and may include some sand or other finely divided mineral matter. The coarse aggregate shall have a percentage wear by the Los Angeles abrasion machine test of not more than 50 at 500 revolutions as determined by AASHTO T-96.

501-2.3 FINE AGGREGATE: The fine aggregate shall consist of finely divided mineral matter (sand silt). The fraction passing the No. 200 sieve shall not be greater than two thirds of the fraction passing the No. 40 sieve. The fraction passing No. 40 sieve shall have a liquid limit not greater than 25 and plasticity index not greater than 6.

TABLE 501-1 - GRADING REQUIREMENTS FOR SOIL AGGREGATE MATERIALS

Sieve Designation.	<u>Percentage by weight passing square mesh sieves:</u>		
	<u>Grading</u>	<u>Grading</u>	<u>Grading</u>
	<u>A</u>	<u>B</u>	<u>C</u>
2 - in.	100	--	--
1 - in.	75-95	100	100
3/8 - in.	40-75	50-85	60-100
No. 4	30-60	35-65	50-85
No. 10	20-45	25-50	40-70
No. 40	15-30	15-30	25-45
No. 200	2-20	5-15	5-20

501-2.4 BLENDING MATERIALS: If fine aggregate or filler in addition to that naturally present in the material, is necessary in order to meet the grading requirements, or for satisfactory bonding of the materials, it shall be uniformly blended with the material at the screening and crushing plant or on the road. The material for such purposes shall be obtained from sources approved by the Engineer and shall be free from hard lumps. If the blending is done at the crushing and screening plant, and the material is then transported over a distance, water shall be added to prevent segregation.

501-3 CONSTRUCTION

501-3.1 PITS AND QUARRIES: Borrow and quarries shall be cleared and grubbed in accordance with the requirements of Section 301.

501-3.2 PREPARATION OF SUBGRADE: Subgrade including shoulders shall be constructed, prepared, and finished as provided under Section 411-6 and Section 411-7.

501-3.3 PLACING: The subbase course shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the Plans. The compacted thickness of each layer shall not be more than $4\frac{1}{2}$ " or less than 3". When more than one layer is required, each layer shall be shaped, compacted and tested before the succeeding layer is placed. The operations in the placing of upper layers shall be such so as not to disturb the lower layers.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from spreader boxes or from vehicles especially equipped to distribute the material in a uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted, making due allowance for any blending material that is to be added on the road, the layer shall have the required thickness.

When hauling is done over previously placed material, hauling equipment shall be routed as uniformly as possible over the entire area of previously constructed layers.

501-3.4 ADDING BLENDING MATERIAL: When additional fine aggregate or filler is required and it is to be blended with the material on the road, the blending material shall be uniformly placed with spreader boxes or other approved devices.

501-3.5 MIXING AND SPREADING: After each layer of subbase course material has been placed and blending material added when required, it shall be thoroughly mixed to its full depth by means of power graders, traveling mixers, or other mixing equipment or manually as may be approved by the Engineer. During the mixing, water shall be added in the amount necessary to provide the optimum moisture content for compacting as specified in article 501-3.6. When uniformly mixed, the mixture shall be spread smoothly to a uniform thickness or, in case of the top layer, to the cross section shown on the Plans.

501-3.6 COMPACTION: Immediately following final spreading and smoothing, each layer shall be compacted to the full width by means of smooth-wheel power rollers or pneumatic-tired rollers meeting the requirements of Para 501-3.5. Rolling shall progress gradually from the sides to the center line of the road, and shall continue until all the surface has been rolled. Any irregularities or depression that develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, headers, and walls, and at all places not accessible to the roller, the sub-base material shall be tamped thoroughly with mechanical tampers or with hand tampers if approved by the Engineer. The material shall be both bladed and rolled until a smooth, even surface has been obtained conforming to Plans.

The amount of rolling and tamping as required above is estimated as the minimum necessary for adequate compaction. During the progress of the work, the Engineer or his representative shall make density tests in accordance with AASHTO T-117, modified to include only material passing a 3/4 inch sieve, and if he finds the density is less than 100 per cent of the maximum density as determined by AASHTO T-180 (Modified Proctor), the Contractor shall perform additional rolling or tamping as may be necessary to obtain that density.

As specified in article 201-3, the Engineer may permit compaction with types of equipment other than those specified above, provided he determines that use of the alternative equipment will consistently produce densities of not less than 100 per cent, determined as provided above. The Engineer's permission for use of alternative compaction equipment shall be given in writing.

501-3.7 THICKNESS REQUIREMENTS: The thickness of the complete subbase course shall not vary more than 1/2 inch from the thickness shown on the Plans.

Immediately after final compaction of the subbase course, the thickness shall be measured at one or more points in each 300 linear feet of subbase course. Measurements shall be made by means of test holes or other approved methods. The points for measurement shall be selected by the Engineer at random locations within each 300 foot section in such manner as to avoid any regular pattern. Various points on the cross section shall

be covered. As the work proceeds without deviation in thickness beyond the allowable tolerances, the interval between tests may be increased at the discretion of the Engineer to a maximum of 1000 feet with occasional tests at closer intervals. Whenever a measurement indicates a variation from the thickness shown on the Plans of more than the allowable tolerance, it shall be corrected by removing or adding material as necessary and shaping and compacting as specified.

The cutting of test holes and refilling with materials properly compacted shall be done by Contractor to the entire satisfaction of the Engineer.

501-3.8 SURFACE REQUIREMENTS: When tested by a crown template, conforming to the typical cross section shown on the Plans, and a 10-foot straightedge applied at right angles and parallel, respectively, to the centerline of the roadbed, the variation of the surface from each testing edge between any two contacts with the surface shall at no point exceed 1/2 inch for the crown template and 3/8 inch for the straight edge.

501-3.9 STOCKPILING: When indicated on the Plans, sub base course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiling shall be performed in accordance with the requirements of Section 1031. Prior to stockpiling the material, the site shall be cleared, cleaned and levelled.

If the contractor elects to produce a stockpile aggregate prior to placement on the roadbed, the aggregates shall be stockpiled in accordance with the requirements of Section 1031.

501-4 MEASUREMENT

The sub-base course when compacted and finished to the required standard, thickness and grade line shall be measured by superficial area. The unit of measurement will be one hundred square feet.

501-5 RATE

The unit rate of sub base course of specified thickness shall be full compensation for preparing and shaping the sub-grade and replacement of the unstable sub-grade, filling test holes and furnishing all materials, labour equipment, tools and incidentals necessary to complete the work prescribed in this Section.

501-6 PAYMENT

Payment shall be made as under:

501-1 DESCRIPTION

This work shall consist of the construction of a layer or layers of mechanically stabilized soil comprising either naturally occurring materials or mixtures of gravel, crushed aggregate or crushed brick, whichever is specified in the bid schedule, to suitable grading including fines, placed and compacted on a prepared formation to give a California Bearing Ratio value of at least 25 percent in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross section shown on the plans.

501-2 SOIL AGGREGATE MATERIALS

501-2.1 GENERAL: The soil aggregate material shall comprise of coarse and fine aggregate conforming to the grading requirements of Table 501-1 and shall be free from vegetable matter.

501-2.2 COARSE AGGREGATE: Coarse aggregate shall consist of hard durable fragments of stone, gravel or brick suitably crushed to give the required grading and may include some sand or other finely divided mineral matter. The coarse aggregate shall have a percentage wear by the Los Angeles abrasion machine test of not more than 50 at 500 revolutions as determined by AASHTO T-96.

501-2.3 FINE AGGREGATE: The fine aggregate shall consist of finely divided mineral matter (sand silt). The fraction passing the No. 200 sieve shall not be greater than two thirds of the fraction passing the No. 40 sieve. The fraction passing No. 40 sieve shall have a liquid limit not greater than 25 and plasticity index not greater than 6.

TABLE 501-1 - GRADING REQUIREMENTS FOR SOIL AGGREGATE MATERIALS

Sieve Designation.	Percentage by weight passing square mesh sieves:		
	Grading A	Grading B	Grading C
2 - in.	100	--	--
1 - in.	75-95	100	100
3/8 - in.	40-75	50-85	60-100
No. 4	30-60	35-65	50-85
No. 10	20-45	25-50	40-70
No. 40	15-30	15-30	25-45
No. 200	2-20	5-15	5-20

501-2.4 BLENDING MATERIALS: If fine aggregate or filler in addition to that naturally present in the material, is necessary in order to meet the grading requirements, or for satisfactory bonding of the materials, it shall be uniformly blended with the material at the screening and crushing plant or on the road. The material for such purposes shall be obtained from sources approved by the Engineer and shall be free from hard lumps. If the blending is done at the crushing and screening plant, and the material is then transported over a distance, water shall be added to prevent segregation.

501-3 CONSTRUCTION

501-3.1 PITS AND QUARRIES: Borrow and quarries shall be cleared and grubbed in accordance with the requirements of Section 301.

501-3.2 PREPARATION OF SUBGRADE: Subgrade including shoulders shall be constructed, prepared, and finished as provided under Section 411-6 and Section 411-7.

501-3.3 PLACING: The subbase course shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the Plans. The compacted thickness of each layer shall not be more than $4\frac{1}{2}$ " or less than 3". When more than one layer is required, each layer shall be shaped, compacted and tested before the succeeding layer is placed. The operations in the placing of upper layers shall be such so as not to disturb the lower layers.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from spreader boxes or from vehicles especially equipped to distribute the material in a uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted, making due allowance for any blending material that is to be added on the road, the layer shall have the required thickness.

When hauling is done over previously placed material, hauling equipment shall be routed as uniformly as possible over the entire area of previously constructed layers.

501-3.4 ADDING BLENDING MATERIAL: When additional fine aggregate or filler is required and it is to be blended with the material on the road, the blending material shall be uniformly placed with spreader boxes or other approved devices.

- Item No. 501-6.1 Gravel Sub-base Course of the specified thickness - per 100 square feet.
- Item No. 501-6.2 Crushed Aggregate Sub-base Course of the specified thickness - per 100 sq. ft.
- Item No. 501-6.3 Crushed Brick Sub-base Course of the Specified thickness - per 100 sq. ft.

SECTION 511

SUB BASE COURSE CEMENT STABILIZED SOIL

511-1 DESCRIPTION

This work shall consist of constructing one or more courses of a mixture of aggregate and/or soil, water and portland cement in desired proportion by mix in place method in accordance with these specifications on a prepared surface and in conformity with the lines, grades, thickness and dimensions shown on the plans or established by the Engineer. The strength requirements will be given in the detailed specifications.

511-2 MATERIALS

511-2.1 CEMENT: Cement shall be normal portland cement to the requirements given in Section 1001.

511-2.2 SOILS: The soils used shall be that normally provided at formation level, although the Engineer may exercise his discretion regarding the selection of soil within the free haul limit to ensure that suitable soil for stabilization is placed in the upper layers of earthwork. The soil shall have the following particle size distribution limits:

Passing 3" sieve	...	100%
Passing 4" sieve	...	50-100
Passing No. 40 sieve	...	15-100
Passing No.200 sieve	...	0-50

The fraction of soil passing No. 40 sieve shall have liquid limit less than 40% and plasticity index less than 18.

511-3 EQUIPMENT

The following items of equipment shall be included in the plant provided for the work except as may be allowed by the Engineer in accordance with the Section 201-3.

(a) Spreader for spreading the cement to ensure that the cement is uniformly spread over the area to ensure that the maximum

variation as measured on an area 8 in. square shall not exceed $\pm 20\%$ of the weight specified, and the average rate of spread within $\pm 10\%$.

(b) Suitable mixing machinery that is capable of pulverising the soil and mixing the cement to the depth specified.

(c) Sufficient equipment to add the quantities of water required to bring the moisture content of the soil to that specified or required for compaction. This may be done by spraying the water evenly on to the surface through spary bars on the water trucks, or by pumping the water through a spray bar incorporated in the mixing machine.

(d) Adequate compaction plant to secure the required density without producing shear cracks in the surface, through the full thickness of the layer.

(e) A blade grader will generally be necessary to secure the finish required.

(f) A bitumen pressure sprayer for applying the curing/prime cost, if intended to be used by the Contractor.

511-4 TESTING AND DETERMINATION OF CEMENT CONTENT

Prior to the start of the works the contractor will carry out tests on the soils to be used to determine the exact percentage of cement to be used in consultation with the Engineer.

These tests shall include the following at the Engineer's discretion.

(a) Compaction Tests - Both heavy and normal compaction tests may be called for in accordance with AASHO T 99 or T 180. The compaction of samples shall be carried out one hour after the soil has been mixed with water and cement.

(b) Unconfined Compression Tests - Samples for unconfined compression tests will be made up in split moulds, of a size appropriate to the soil, having a height equal to twice the diameter. The required weight of sample will be uniformly rodded into the mould which will then be compacted to the specified volume by pushing the plungers in from both ends to ensure that the density is uniform. Samples will normally be made up to a minimum density equal to 100 per cent standard AASHO T 99 or higher. Cubes compacted to refusal may be used for coarse grained soils.

Cylindrical samples shall be wax cured for 7 days before testing, and may be tested in their as cured state or after further period of soaking. A minimum of 5 samples shall be used for unconfined compression tests.

(c) Durability Tests - Samples prepared in a similar manner to those for unconfined compression tests will be subjected to durability tests of cycles of wetting and drying, the sample being wire brushed at the end of each cycle.

(d) California Bearing Ratio Test - The Engineer may require laboratory California bearing tests to be carried out on the soil cement mixtures. This will in general be carried out on mixture compacted at modified AASHTO moisture content at modified and standard levels of compaction and after curing for 3 days and soaking for 4 days or curing for 7 days and soaking for 7 days.

From the results the Engineer will indicate the percentage by weight of cement to be used which he will translate into a rate of spread in lb/100 sq. ft.

511-5 CONSTRUCTION

511-5.1 PREPARATION OF THE FORMATION: The sub-grade shall be prepared to the level, line and grade in accordance with the Plans and compacted as specified in Section 411-8. The soil to be stabilised shall be taken from areas directed by the Engineer and placed over the prepared formation and compacted to give a firm surface on which cement can be uniformly spread. If material has to be obtained from borrow it will be paid for as defined in Section 411, and if overhaul is involved it will be paid for as defined in Section 423. Borrow or overhaul material will not be paid for extra if in the opinion of the Engineer suitable material is available within the right of way in free haul distance.

511-5.2 DEPTH OF MATERIAL TO BE STABILIZED: The depth of material to be stabilized shall not be less than 3 in. nor more than 6 in. compacted thickness unless the contractor demonstrates to the satisfaction of the Engineer that the plant will satisfactorily mix and compact a greater thickness.

511-5.3 SPREADING THE CEMENT: The cement shall be spread on the surface at the rate of spread directed by the Engineer. The total amount spread over a given area shall be checked, and shall be within ± 10 percent of the rate specified. From time to time the longitudinal and transverse rates of spread of the cement spreader shall be checked by collecting the cement in trays approximately 8 in. x 8 in. and weighing the contents. The weight in any one tray shall not vary from the rate specified by more than ± 20 percent.

511-5.4 MIXING: The mixing shall be carried out by single or multipass machinery to the full depth of the layer. At least three coverage passes will be carried out with multipass machinery before water is added until the mixed material has a uniform colour. The soil shall be pulverized so that 80 percent of the soil fines retained on No. 8 sieve shall pass No. 4 sieve. Water will then be added and further mixing passes given until the moisture content is uniformly distributed at the specified value desired for compaction. The spreading of cement, mixing and watering shall be completed within one hour. In case the work is of a smaller magnitude, the Engineer may allow this operation to be performed manually if the Contractor can achieve the same results.

511-5.5 COMPACTION: Compaction shall be carried out by suitable rolling equipment to produce the specified relative compaction, one hour after mixing the soil cement and water. Compaction shall be completed within 5 hours of starting.

Care shall be taken not to overstress the surface to produce shear cracks, and any such sheared material shall be removed.

During the compaction the surface may be lightly scarified and graded to correct levels. Material shall not be bladed into low spots without first scarifying to ensure a good bond.

511-5.6 SURFACE FINISH: The final surface shall be graded to the correct levels and cross fall and shall be within the following tolerances:

Sub base	...	$\pm 1/2$ in. for the crown template and $\pm 3/8$ in. under 19 ft. straight edge.
Base	...	$\pm 3/8$ in. for the crown template and under 10 ft. straight edge.

511-5.7 CURING: The finally compacted surface shall be cured lightly sprinkling with water to keep the surface damp for at least 48 hours. After this period for a further 5 days the surface shall be kept damp by watering, by placing a polyethylene sheet over the surface or if the Contractor so elects, by applying a curing coat of medium curing cut back bitumen at a rate of 9.1 gal. (imp) per sq. yd. after first brushing all loose material from the surface. The curing under this item shall not be paid for separately.

511-5.8 STABILIZING IN MORE THAN ONE LAYER: If the stabilization is to be carried out in more than one layer, once the compaction of the first layer has been accepted and the stabilization is satisfactory to the Engineer, the material for the second layer shall be spread. Until this is done, the surface of the first layer shall be kept moist. Stabilization of the second layer shall be carried out in a similar

manner, care being taken to leave no unmixed material between the two layers. This shall be checked during the density test measurements.

511-5.9 TRAFFIC CONTROL: No traffic shall be run on the freshly stabilized soil until it has cured for 7 days. If it is necessary to run traffic over the surface, the Engineer may, if in his opinion no damage will be caused, allow the contractor place the bitumen curing coat after 48 hours and blind this with sand after the bitumen has been allowed to penetrate for 2 hours. The contractor shall be responsible for making good any surface defects before the next layer is laid.

511-5.10 JOINTS AND PATCHING: All transverse joints occurring at the end of a days working shall be cut back vertically. If the stabilization is done in strips, the contractor shall ensure that each succeeding strip ties into the one already constructed so that there is no unstabilized material between the strips.

All areas of patches shall be cut out to a depth of at least three inches.

511-5.11 FIELD STRENGTH TESTING: The strength of the field mixed soil cement shall be determined by making unconfined compression cylindrical specimens as described in 511-4(b) from the mixed material immediately prior to compaction. At least 5 specimens shall be made at 100 per cent Standard AASHO density (AASHO T 99) and tested after 7 days of curing. The mean strength shall be 80 percent of that specified for the laboratory mix and no result shall be less than 70 per cent of the mean.

511-6 MEASUREMENT

The quantity of the cement stabilized soil having specified quantity of cement shall be measured by the area taken from the longitudinal length along the road and the clean lines shown on the plans for the full depth of the stabilized soil.

511-7 RATE

The unit rate of cement stabilized sub-base course or base course of specified thickness shall be full compensation for the provision and placing of soil, supplying and spreading cement, mixing, watering and compaction, including the compaction of the shoulders, including all plant, equipment, labour and tools necessary for carrying out the work.

511-8 PAYMENT

Payment shall be made under:

Item No. 511-8.1 Cement Stabilization of Specified thickness and
having specified quantity of cement,
complete -- -- per 100 square feet.

SECTION 512

SUB BASE COURSE LIME STABILIZED SOIL

512-1 DESCRIPTION

Lime Treated Sub-Base shall consist of one or more courses of soil stabilized with lime and water, uniformly and thoroughly mixed, placed and compacted in accordance with the following specifications and placed on the sub-grade to lines and grades and dimensions shown on the Plans, or established by the Engineer. It shall include a sufficient quantity of lime which when combined with soil will result in a mixture having a minimum C.B.R. value of 25 when tested as specified herein.

512-2 MATERIAL

512-2.1 LIME: The lime shall be hydrated lime, conforming to the requirements of Section 1021.

1. Chemical Composition:

- (i) Calcium & Magnesium Oxides
(Nonvolatile basis) Min. = 95%
- (ii) Carbon Dioxide (as received basis)
Max. = 7%

2. Residue:

- (i) Residue retained on No. 30
sieve Min. = 0.5%
- (ii) Residue retained on No. 200
sieve Max. = 15%

If lime with less free oxides is used, the percentage used in the field shall be increased to give the same amount of free oxide as used in the laboratory tests.

512-2.2 SOIL: The soil shall in general be the material placed at sub-grade level, but there may be some selection as directed by the Engineer.

512-3 CONSTRUCTION REQUIREMENTS

512-3.1 PREPARATION OF SITE: The sub-grade level shall be shaped to the required grade line etc. and the surface firmed. The lime will be spread by a suitable method to give a uniform distribution at the specified rate as directed by the Engineer.

512-3.2 PULVERIZATION AND MIXING: Soil and lime will then be mixed to the required depth by suitable machinery until a uniform colour is achieved.

512-3.3 ADJUSTMENT MOISTURE CONTENT: If the moisture content of the soil is higher than the optimum, it shall be aerated by continued passes of the pulverizer until it has dried to the required moisture content.

If the moisture content of the soil-lime mixture is lower than that specified for compaction, water shall be applied and the application closely followed by further mixing as above. Mixing shall be done to the full depth of construction, until the moisture content is within 2% of the specified amount. No flooding of the soil shall take place. The uniformity of mixing and the moisture content shall be checked and approved by the Engineer before compaction.

512-3.4 COMPACTION: Initial compaction shall be done with a light smooth wheeled roller or tandem vibrating roller having a static weight of not less than 3/4 tons and shall continue until the stabilized sub-base is capable of carrying the heavy roller without pushing or spoiling the profile.

Final compaction shall be done with a pneumatic tyred roller, weighting not less than 12 tons or an 8-12 tons smooth wheeled roller or a tandem vibrating roller having a static weight of not less than 3/4 ton for granular soil and not less than 1½ tons for adhesive soils. Other types of compaction equipment may be used at the discretion of the Engineer, provided they are capable of producing the specified minimum dry density of 100% of Standard AASHO T 134.

512-3.5 SURFACE TOLERANCES: There shall not be any irregularities of more than 1/2 inch under a 10 ft. straight-edge. The depression may be filled with bituminous mixture or alternatively the area shall be cut out and mended with freshly processed lime-soil mixture.

512-4 MEASUREMENT

The quantity of the lime stabilized soil having specified quantity of hydrated lime shall be measured by the area taken from

the longitudinal length along the road and the clean lines shown on the Plans for the full depth of the stabilized soil.

512-5 RATE

The unit rate of lime stabilized sub-base course of specified thickness shall be full compensation for the provision and placing of soil, supplying and spreading lime, mixing, watering and compaction, including the compaction of the shoulders, including all plant, equipment, labour and tools as required for carrying out the work.

512-6 PAYMENT

Payment shall be made under:

Item No. 512-6.1 Soil Lime Stabilization of Specified thickness
and having specified quantity of lime,
complete -- -- Per 100 square feet.

SECTION 521

SUB BASE COURSE - BRICK PAVED

521-1 DESCRIPTION

This item shall consists of one or more layers of bricks laid in sand and with the joints filled with sand with suitable bonding, over a prepared sub grade.

521-2 MATERIALS

521-2.1 BRICKS: The size of bricks shall be as per Section 1041. They shall be without frog, slightly over burnt without being vitrified. They shall be of uniform colour with reasonably square corners and parallel faces. They must be homogenous in texture and emit a clear ringing sound when struck. They shall be free from lime, air pockets, and marked laminations. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour, and shall show no signs of efflorescence on drying. Compressive strength shall not be less than 2000 lb./sq. in. when tested in accordance AASHO T 32.

They shall be burnt from suitable soil which shall not contain detrimental quantities of salts.

521-2.2 SAND: The sand on which the bricks are bedded and for filling the joints shall be free flowing and show no plasticity.

521-3 CONSTRUCTION REQUIREMENTS

521-3.1 SUB-GRADE: The sub-grade shall be constructed in accordance with the Section 411.

521-3.2 STACKING OF BRICKS: The bricks shall be delivered at site in stacks ten courses high and two bricks thick for the convenience of proper inspection.

521-3.3 PLACING OF BRICKS: The prepared sub-grade shall be covered by 1" of sand cushion over which the bricks shall be laid closely packed in parallel rows transverse to the center line with string courses 25 ft. apart along the length and on each side, or

as may be directed by the Engineer at site. The bricks shall be laid on edge or flat, in one or two courses as called for in the plans. If more than one course is to be laid the joints in the successive courses will be staggered. Each course shall be properly rolled and joints filled with sand before laying the next course.

As provided in Section 411-7 suitable material should then be placed on the shoulder and the shoulders compacted at the same time as the brick pavement is rolled.

521-4 MEASUREMENT

Brick subbase course of brick pavement when laid and finished to the required thickness and grade line shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

521-5 RATE

The unit rate for brick subbase course or brick pavement of specified thickness shall be full compensation for preparing and shaping the subgrade, replacement of unstable sub-grade, provision and laying of the approved sand, provision and laying of the bricks, filling the voids with sand and rolling the whole width for proper compaction and includes material, labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

521-6 PAYMENT

Payment shall be made under:

Item No. 521-6.1 Brick Sub-base course of the specified thickness -- -- per 100 square feet.

Item No. 521-6.2 Brick Pavement of the Specified thickness -- -- per 100 square feet.

SECTION 531

CALCIUM CHLORIDE TREATMENT

531-1 DESCRIPTION

Calcium Chloride Treatment shall consist of the application of calcium chloride to such areas as indicated on the Plans.

531-2 MATERIALS

Calcium Chloride shall conform to the requirements of AASHO Designation M-144.

531-3 CONSTRUCTION

Calcium Chloride treatment shall be applied in accordance with one of the following methods.

531-3.1 BASE STABILIZATION: Calcium Chloride shall be applied at the rate of five pound per 100 sq. ft. per inch of depth which is not to exceed six inches after which the mixing, shaping and compacting shall be completed. An additional application of eight pound per 100 sq. ft. shall then be spread on the surface and, when directed, water shall be added.

531-3.2 SURFACE APPLICATION: Upon the completion of the rotor or other type of mixing, nine pounds of calcium chloride per 100 sq. ft. shall be applied uniformly, after which shaping and compacting shall be completed and additional water being applied if necessary. Upon the completion of the shaping and compacting, 8 pounds per 100 sq. ft. shall then be spread on the surface and, when directed, water shall be added.

531-4 MEASUREMENT

The item of calcium chloride treatment shall be measured by weight. The unit of measurement will be One Ton.

531-5 RATE

The unit rate shall be full compensation for furnishing and applying calcium chloride including the material, labour, equipment, tools, and incidentals necessary to complete the work prescribed in this Section.

531-6 PAYMENT

Payment shall be made under:

Item No. 531-6.1 Calcium Chloride Treatement - per ton.

SECTION 541

DRAINAGE LAYER UNDER SHOULDERS

541-1 DESCRIPTION:

This item shall consist of providing a layer of crushed bricks, crushed or natural aggregate of specified gradation over a prepared and well compacted sub-grade under the whole shoulder width so as to provide a free drainage layer where the sub base does not cover the full width of the sub-grade.

541-2 MATERIALS

Slightly or well overburnt crushed bricks or other crushed aggregate or coarse sand shall be used. The gradation shall be as follows:

Sieve Designation	Percentage by Wt. passing through the Mesh Square Sieve.
-----	-----
1"	100%
3/4"	70 - 100%
100 No.	0 - 10%

541-3 CONSTRUCTION:

A layer of drainage materials as described in the previous paragraph shall be laid over the well prepared and compacted sub-grade outside the sub-base to the width shown on the Plans adjoining the sub base on either side with a four percent cross slope and rolled dry with two coverages of an 8-10 ton smooth wheel roller. Over this layer, the required material for the shoulders should be spread and compacted in lifts conforming to remaining thickness of the sub-base. The drainage layer shall be provided only when shown on the Plans.

The final surface shall be graded to the correct levels and cross fall and shall be within the following tolerances:

Under crown templet	...	$\pm$ 1/2"
Under 10' straight edge.	...	$\pm$ 3/8"

541-4 MEASUREMENT

The item of drainage layer under shoulders when completed to the actual thickness and to the clear lines shown on the plans for width and length shall be measured by superficial area. The unit of measurement will be one hundred square feet of the completed work.

541-5 RATE

The unit rate shall be full compensation for furnishing and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

541-6 PAYMENT

Payment shall be made under:

- Item 541-6.1 - Crushed Brick Drainage Layer of the specified thickness - per hundred square feet.
- 541-6.2 - Crushed Aggregate Drainage Layer of the specified thickness - per hundred square feet.
- 541-6.3 - Gravel Drainage Layer of the specified thickness - per hundred square feet.

SECTION 551

BASE COURSE
WATER BOUND MACADAM

551-1 DESCRIPTION

This work shall consist of constructing a base course composed of crushed stone aggregate placed and compacted with moisture control on a prepared sub-grade or sub-base course in accordance with these specifications and in conformity with the lines, grades, thickness and cross section on the Plans.

551-2 AGGREGATE

551-2.1 Coarse aggregate and screenings shall consist of crushed stone. It shall be of reasonable uniform quality throughout and shall be clear and free from excess of dust and flat or elongated pieces. Coarse aggregate shall have a percentage of wear by the Los Angeles Test of not more than 50 and a sulphate soundness loss of not more than 12 when using sodium sulphate and not more than 18 when using Magnesium Sulphate, or as may be directed by the Engineer. Screenings shall be of suitable binding quality.

551-2.2 GRADING REQUIREMENTS FOR COARSE AGGREGATE: Aggregate grades shall conform to either grading A or B given in the following table:

Sieve Designation:	<u>PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES</u>	
	Grading A	Grading B
	1" - 2" Size	1½" - 2½" Size
4"	--	--
3½"	--	--
3"	100	100
2½"	100	90-100
2"	95-100	35-70
1½"	35-70	0-15
1"	0-15	-
¾"	-	0-5
½"	0-5	-

551-2.3 GRADATION OF SCREENINGS: The screenings shall be of following gradations:

<u>Sieve Designation</u>	<u>Percentage Passing by WT.</u>
Passing 3/8 in. sieve	100
Passing No. 4 sieve	85-100
Passing No.100 sieve	10-30

551-2.4 QUANTITIES: Sufficient coarse aggregate and screenings shall be used to make a compact dense mass of the required thickness as indicated on the Plans.

551-3 CONSTRUCTION

551-3.1 PREPARATION OF PREVIOUSLY CONSTRUCTED SUBGRADE OR SUBBASE: All loose or foreign material shall be removed. Any ruts or soft yielding places that appear on the subgrade or subbase course shall be corrected and rolled until firm. Necessary sub-grade or subbase course material shall be added to conform to proper grade and cross section.

Subgrade or subbase course shall be rolled to even, firm foundations.

551-3.2 WEATHER LIMITATIONS: Water Bound Macadam work shall not be constructed during freezing weather or on a wet or frozen subgrade or subbase course.

When temperature is below 40° F. completed base course shall be protected against freezing, until it dries out, by a sufficient covering of straw, hay, or other approved material.

551-3.3 THICKNESS OF LAYERS: The base course shall be constructed in complete layers of not less than 3" or more than 4½" compacted thickness. The compacted thickness of layer more than 4½" may be allowed if the Contractor can demonstrate that he can achieve the specified densities throughout the depth of the course to the satisfaction of the Engineer by using special rolling equipment. When it is necessary to construct the base in more than one layer to conform to the required finished thickness, each layer shall be constructed as described below:

551-3.4 SPREADING COARSE AGGREGATE: Sufficient coarse aggregate shall be uniformly spread to give the required thickness for each layer when compacted.

All patches or areas of fine or undersized aggregate shall be removed and replaced with suitable aggregate.

The thickness of each layer shall be set by the use of depth blocks.

Coarse aggregate shall not be spread more than 15000 sq. ft. and never more than 500 lin. ft. in advance of rolling and application of screenings.

551-3.5 COMPACTION: Immediately after the spreading of the coarse aggregate, it shall be compacted to the full width by rolling with a power roller weighing at least 10 tons. The rolling shall begin with the outside rear wheel covering equal parts of shoulder and coarse aggregate and the roller shall be run forward and backward until the shoulder and coarse aggregate are firmly bound together.

When shoulders and edges of the base course have been firmly rolled, the rolling shall progress gradually from the edges to the center, each preceding rear-wheel track being uniformly lapped by one-half the width of such track, and shall continue until the entire area of the course has been rolled by the rear wheels. Rolling shall be continued until the aggregate is well keyed and does not creep ahead of the roller and until the surface is firm, even and true to line, grade, and crown. Places inaccessible to roller shall be compacted by mechanically operated or hand tampers or as directed by the Engineer.

551-3.6 APPLYING SCREENINGS: Immediately after the compaction of the coarse aggregate, sufficient clean, dry screenings shall be uniformly applied, to fill all voids. Dry rolling shall be continued while screenings are being applied. Hand brooms shall be used if the roller is not equipped with a broom. Screening shall be spread in thin layers at a uniform and slow rate to insure filling all voids.

Spreading screenings, brooming, and rolling shall be continued until the voids are completely filled.

551-3.7 SPRINKLING: Immediately after the voids of a layer have been filled with screenings, the macadam shall be sprinkled with water, the sprinkler being followed by the roller. All excess screenings forming in piles or cakes on the surface shall be scattered by light sweeping. The sprinkling and rolling shall continue, and additional screenings shall be applied where necessary, until all voids are completely filled and the coarse stone firmly set and bonded. The quantity of screenings and water shall be sufficient to completely fill and bond the entire depth of the coarse aggregate and to produce a granular surface.

Provision shall be made by the Contractor for furnishing water at the site of the work by equipment of ample capacity and of such design as to assure uniform application.

551-3.8 DENSITY REQUIREMENTS: As soon as proper conditions of moisture are attained the density tests shall be performed in accordance with AASHTO T 147 modified to include only material passing a 3/4 inches sieve. If the density is less than 100 per cent of the maximum density as determined by AASHTO T 180 (Modified Proctor), the contractor shall perform additional rolling as may be necessary to obtain that density.

551-3.9 TOLERANCES: The surface shall be true to the established grade. The surface shall not vary more than 3/8 in. in 10 ft. from the true profile and cross section. The thickness shall not be less than 1/4 in. from that required for the layer being constructed.

551-3.10 RECONSTRUCTING DAMAGED BASE COURSE: Should the subgrade or sub base at any time become soft or churned up with the base-course material the contractor shall, without additional compensation remove the mixture from the affected portion, reshape and compact the subgrade or sub base, and replace the removed section in accordance with the foregoing requirements.

551-3.11 MAINTENANCE AND PROTECTION OF BASE COURSE: The surface of any layer shall be maintained in its finished condition until the succeeding layer or pavement is placed.

551-4 MEASUREMENT

The Water Bound Macadam Base Course when compacted and finished to the required standards, thickness line and grade shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

551-5 RATE

The unit rate of Base Course of specified thickness shall be full compensation for preparing and shaping the subgrade or subbase course over which it is being laid, replacement of unstable subgrade or subbase course, filling test holes, furnishing all materials, labour, equipment, tools and incidentals necessary to complete the work prescribed in this section.

551-6 PAYMENT

Payment shall be made under:

Item 551-6.1 - Crushed stone water bound macadam base course of the specified thickness - per 100 sq. ft.

SECTION 552

BRICK EDGING

552-1 DESCRIPTION

This item shall consist of a 9 inch wide brick on edge layer, contiguous to the pavement edge and in line with the finished profile of the base course, in combination with a 3 inch wide brick on end course so as to make 12 inches wide brick edging. The bricks shall be laid with close joints over one inch sand cushion and sand grouted.

552-2 MATERIAL

552-2.1 BRICKS: The size of bricks shall be as per section 1041. They shall be slightly over burnt without being vitrified. They shall be of uniform colour with reasonably square corners and parallel faces. They must be homogenous in texture and emit a clear ringing sound when struck. They shall be free from lime, air pockets, and marked laminations. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour, and shall show no signs of efflorescence on drying. Compressive strength shall not be less than 2000 lb/sq. in. when tested in accordance AASHO T-32.

They shall be burnt from suitable soil which shall not contain detrimental quantities of salts.

552-2.2 SAND: The sand on which the bricks are bedded and for filling the joints shall be free flowing and show no plasticity.

552-3 CONSTRUCTION REQUIREMENTS

Except for the top most layer of the base course, all other layers of sub base and base course shall be laid and compacted without laying edging but after completion of the consecutive layers of earthen shoulders at the same level as the pavement layer to be rolled. If considered necessary, for each layer ordinary bricks may be used as form work on both sides to be removed after compacting the adjacent layers of sub base and base course.

While laying the top most layer of the base course 9 inch wide brick on edge layer shall be laid over 1 inch sand cushion with close joints and sand grouted. The top of these bricks after rolling shall be in line with the finished profile of the base course. The brick layer shall be rolled simultaneously with the final layer of base course after completion of the earthen shoulders.

Three in. wide brick on end course shall be laid after excavating the earthen shoulder contiguous to the 9 inches wide brick layer with top of the end course at the same level as that of the brick on edge course. The brick on end course shall be laid with close joints over 1 inch sand cushion and sand grouted.

552-4 MEASUREMENTS

Brick edging when laid and finished in accordance with the provisions of this section shall be measured in linear units. The Unit of measurement shall be one hundred feet of the brick edging.

552-5 RATE

The unit rate of brick edging shall be full compensation for provision of materials and completion of the work as specified in this section.

552-6 PAYMENT

Payment shall be made under:

Item 552-6.1 - Brick Edging - per hundred feet.

E. BITUMINOUS BASE & SURFACING

SECTION 601

BITUMINOUS PRIME COAT

601-1 DESCRIPTION

This work shall consist of furnishing and applying bituminous material to a previously prepared sub base or base material in accordance with these specifications and to the width shown on the typical cross section on the Plans.

601-2 MATERIALS

601-2.1 BITUMINOUS MATERIALS: Bituminous Materials shall be of the type and grade called for in the bid schedule and shall conform to the requirements of Section 1011. However, the bituminous materials used for prime coats should have high penetrating qualities. After curing it should leave a high viscosity residue in the voids of the upper portion of the base course. The suitable material for this purpose is liquid asphalt (cut-back) or road tar (RT) of low viscosity. Rapid curing (RC) grades are not generally used because of their rapid increase in viscosity after application. Medium curing (MC) grades are most widely used which best serve the purpose. The grade and rate of application will be governed by the condition of the existing surface.

The cutback MC-0 grade is best suited for priming very dense flexible base and rate of application usually varies from 18 to 32 lbs. per 100 sq. ft. A quantity of 20 lbs/100 sft. is usually recommended.

Grade MC-1 produces the best results on more granular type base course having a more open texture and the rate of application ranges from 27 to 54 lbs. per 100 sq. ft. on very open and loose surface.

The ideal rate of application of a primer is the maximum that will, under favourable weather conditions, be completely absorbed by the base material within 24 hours from the time of application.

601-2.2 BLOTTER MATERIALS: Generally a prime coat should be touch dry within 2-4 hours and completely dry in 24 hours. If it is necessary to use blotter materials because the section has to be opened to traffic or for other reasons, the blotter material shall be a clean sand Passing No. 4 sieve or, when called for in the special

provisions, it shall be suitable material furnished under another contract item.

601-3 CONSTRUCTION

601-3.1 WEATHER LIMITATIONS: Prime coat shall be applied only when the surface to be treated is dry or slightly damp and drying, when the atmospheric temperature in the shade is above 55°F., and rising or above 60°F, if falling and it shall not be carried out in rain or a dust storm.

601-3.2 EQUIPMENT: The equipment used by the Contractor shall include a power broom and/or a power blower, a self powered bituminous binder distributor and means for heating bituminous material and necessary parts of the Distributor to transfer bitumen. The Engineer may approve the use of hand brooms and tar boilers etc. if in his opinion satisfactory results can be achieved and sufficient labour is available.

601-3.3 CLEANING SURFACE: Immediately before applying the bituminous material all loose dirt and other objectionable material shall be removed from the surface with the broom and/or blower if required. If the Engineer so orders, the surface shall be slightly bladed and rolled immediately prior to the application of bituminous material, in which case brooming or blowing will not be required. When so ordered by the Engineer a light application of water shall be made just before the application of the bituminous material.

601-3.4 APPLICATION OF BITUMINOUS MATERIAL: Bituminous material shall be applied by means of a Distributor at the rate or rates directed by the Engineer, which will usually be from 12 to 18 pounds per 100 square feet, and at a temperature within the range for the type and grade of bitumen and the type of distributor. Successive spray widths shall be overlapped sufficiently to give an even distribution across the joints.

The surface of structures and trees adjacent to the areas being treated shall be protected in such manner as to prevent their being spattered or marred. No bituminous material shall be discharged into a borrow pit or gutter.

601-4 MAINTENANCE AND OPENING TO TRAFFIC

Traffic shall not be permitted on the primed surface until the bituminous material has penetrated and dried, and in the opinion of the

Engineer, will not pick up under traffic, provided that if it becomes necessary to permit traffic prior to that time, but in no case sooner than four hours after the application of the bituminous material, blotter material shall be applied as directed by the Engineer and traffic shall be permitted to use the lanes so treated. Blotter material shall be spread by hand or from trucks in such a manner that no wheel will travel uncovered wet bituminous material. When applying blotter material to a treated lane that adjoin a lane yet to be treated, a strip at least 8 inches wide along the adjoining edge shall be left uncovered, or if covered shall be uncovered when the second lane is being prepared for treatment, in order to permit an overlap of bituminous material as required in article 601-3.4 above.

The Contractor shall maintain the primed surface until the subsequent course is laid, which shall not be less than 48 hours. Any areas containing an excess or deficiency of priming material shall be removed by sweeping.

601-5 MEASUREMENT

The bituminous prime coat at specified rate shall be measured by superficial area. The unit of measurement shall be one hundred sft.

601-6 RATE:

The unit rate shall be full compensation for furnishing and placing the materials including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this section.

601-7 PAYMENT

Payment shall be made under:

Item No. 601-7.1 Bituminous Prime Coat at Specified Rate
of Application - per 100 sft.

SECTION 611

BITUMINOUS TACK COAT

611-1 DESCRIPTION

This work shall consist of furnishing and applying a thin layer of bituminous material to a previously prepared base or road surface, to provide bond with a super-imposed course in accordance with these specifications and to the full width of the proposed layer to be superimposed.

611-2 MATERIALS

Bituminous material shall be of the type and grade called for in the bid schedule and shall conform to the requirements of Section 1011. When more than one grade is shown in the bid schedule the grade shall be that directed by the Engineer. However, materials commonly used for tack coats include the rapid curing liquid asphalts, RC2, RC3, RC4, emulsified asphalt of quick breaking type, bitumen (asphalt cement) of 80/100, 120/150 or 150/200 penetration or lighter grades.

611-3 CONSTRUCTION

611-3.1 WEATHER LIMITATIONS: Tack coat shall be applied only when the surface to be treated is dry. It shall be carried out when the atmospheric temperature in the shade is above 55°F. and rising or above 60°F. if falling and it shall not be carried out in rain or dust storm.

611-3.2 EQUIPMENT: The equipment used by the Contractor shall include a power broom (hand brooms may be used if sufficient labour is available) and/or power blower, a binder - distributor, and equipment for heating bituminous material.

611-3.3 CLEANING SURFACE: When necessary in the opinion of the Engineer, the full width of surface to be treated shall be cleaned with a broom or power blower to remove loose dirt and other objectionable material. The surface to be treated shall be dry.

611-3.4 APPLICATION OF BITUMINOUS MATERIAL: Immediately after cleaning the surface, bituminous material shall be applied at the rate directed by the Engineer, but not to exceed 10 to 12 lbs. per 100 sq. ft., diluted emulsion being applied in the quantity necessary to obtain this rates based on the quantity of the original undiluted emulsion. Bituminous material shall be applied at a temperature in accordance with the type of binder and the distributor used. It shall be applied only when the surface is dry.

The surface of structures and trees adjacent to the areas being treated shall be protected in such manner as to prevent their being pattered or marred. No bituminous material shall be discharged into a borrow pit or gutter.

The surface shall be allowed to dry until it is in a proper condition of tackiness to receive the surface course. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. Until the surface course is placed, the contractor shall protect the tack coat from damage.

611-4 MEASUREMENT

The Bituminous Tack Coat at specified rate shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

611-5 RATE

The unit rate shall be full compensation for furnishing and placing the materials including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

611-6 PAYMENT

Payment shall be made under:

Item No. 611-6.1 - Bituminous Tack Coat at specified rate
of application per 100 sft.

SECTION 612

SURFACE TREATMENT OR SURFACE DRESSING

612-1 DESCRIPTION

This work shall consist of furnishing and applying bituminous material of the type and grade specified with cover material of specified size(s) in the detailed specifications.

612-2 MATERIALS

612-2.1 BITUMEN: Bituminous materials will be of the type and grade as specified taking into consideration climatic conditions and the intensity of traffic, and will be in accordance with the requirements of Section 1011.

612-2.2 AGGREGATE: The aggregate shall be of the specified nominal size in conformity with the grading given in Table 612-1.

Crushed gravel or crushed stone shall consist of clean, tough, durable fragments free from dirt or other objectionable matter, and shall not have a percentage of wear greater than 40 at 500 revolutions as determined by AASHTO T 96 (Los Angeles Abrasion Test).

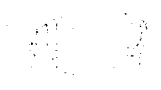
<u>3/4" Nominal Size</u>	<u>Passing</u>	<u>Retained</u>	<u>1/2" Nominal Size</u>	<u>Passing</u>	<u>Retained</u>
	100%	0%			
<u>3/8" sieve</u> 	85%	15%	<u>3/8" sieve</u> 	100%	0%
<u>1/2" sieve</u> 	90%	10%	<u>1/2" sieve</u> 	85%	15%
<u>3/8" sieve</u> 	75%	25%	<u>3/8" sieve</u> 	50%	50%
<u>No. 8</u> 	2%	98%	<u>1/2" sieve</u> 	7%	93%
	100%			100%	

TABLE 612-1 - GRADING SPECIFICATIONS FOR SINGLE SIZED CHIPPINGS

Nominal Size inch.	Specified Size			Oversize		Undersize			Maximum	
	Pass-	Retain-	Min.	All to	Max. of	Pass-	Max.	Pass-	Max.	Permis-
	ing	ed	Propor-	Pass	Nominal	ing	Propor-	ing	Fines	sible
	Sieve	Sieve	tion of	Sieve	Size Re	Sieve	tion of	Sieve		Flaki-
			Speci-		tained		under			ness
			fied		on		Size			Index
			Size		Sieve					
In.	In.	In.	Percent	In.	Percent	In.	Percent		Percent	
3/4	3/4	1/2	65	1	15	3/8	7	No. 8	2	35
1/2	1/2	3/8	55	3/4	15	1/4	7	No. 8	2	35
3/8	3/8	1/4	60	1/2	15	No. 4	10	No. 8	2	35
1/4	1/4	1/8	70	3/8	15	No. 8	10	No. 30	2	35

612-3 CONSTRUCTION

612-3.1 WEATHER AND SEASONAL LIMITATIONS: Bituminous material shall be applied only when the surface to be treated is dry or slightly damp and drying when the atmospheric temperature in the shade is above 55°F. and rising or above 60°F if falling and it shall not be carried out in rain or dust storm.

612-3.2 PREPARATION OF THE SURFACE FOR TREATMENT: The surface will be cleaned of all loose dust and deleterious material using mechanical broom and/or mechanical blower. Hand brooms may be approved by the Engineer if sufficient labour is available. All necessary patching shall be carried out to bring the surface of the patch to match the texture of the remaining road as closely as possible, at least ten days ahead of single treatment.

TABLE 612-2 - TYPICAL RATES OF APPLICATIONS OF MATERIALS FOR BITUMINOUS SURFACE TREATMENT

SURFACE TREATMENT		AGGREGATE		BITUMINOUS MATERIAL
Type	Application	Nominal Size (Inches)	Cubic Feet 100 sq. ft.	Lbs./100 sq. ft.
Surface Dressing	Initial	3/8	2.5	22
Triple Surface Treatment	Initial	1" to 1½"	5.5	40
	Second	½" to ¾"	2.75	25
	Third	¼" to 1/16"	1.5	14

(ASTM-D 1369-58)

612-3.3 APPLICATION OF BITUMINOUS MATERIAL: The bituminous material shall be applied through a distributor at the rate of spread in general conformity with Table 612-2 or as may be specified by the Engineer with the appropriate temperature range for the particular binder. Successive widths of spray shall overlap by an appropriate amount to give an even rate of spread over the joint. If the sprayer does not give a clean start and stop, building paper will be spread across the road and the spray started and stopped on this. The paper will be disposed of as directed by the Engineer. If the spray bar is not protected by a hood to prevent the binder being blown about, care shall be taken to protect such objects.

612-3.4 SPREADING THE COVER AGGREGATE: The cover aggregate for each layer of bitumen will be spread within 5 minutes of the application of bitumen. The rate of spread will be sufficient to give complete shoulder to shoulder coverage of chippings and in general conformity with Table 612-2 with about 5 per cent surplus. Any bare spots will be covered up by hand or brushing material from areas of surplus. Cover aggregate should be swept from the joint before the next width is sprayed.

612-3.5 ROLLING: Rolling may be done by self-propelled pneumatic tyred roller (min. weight 3/4 ton per wheel with 40 p.s.i. tyre pressure) or 6-12 ton three wheel rollers. Rolling should not be continued when the chippings show sign of crushing. After 24 hours, or longer period if the contractor elects, the surplus aggregate shall be removed by brushing, and the subsequent layers applied as specified in the same manner.

612-3.6 OPENING OF TRAFFIC AND TRAFFIC CONTROL: During the execution of work of surface treatment or surface dressing, diversion shall be provided and sufficient control exercised to prevent traffic coming on

the treated road until the bituminous material has dried, and in the opinion of the Engineer, will not pick up under traffic, provided that if it becomes necessary to permit traffic prior to that time, but in no case sooner than 24 hours after the application of bituminous material. Fine sand shall be applied as directed by the Engineer and then the traffic shall be permitted to use the road so treated.

612-4 STOCKPILING

When indicated on the Plans, cover aggregate on bitumen shall be stockpiled in the required amounts and at locations, with the approval of the Engineer and in accordance with Section 1031 and Section 1032.

612-5 MEASUREMENT

612-5.1 Surface treatment or surface dressing of a specified type shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

612-5.2 When indicated on the Plans and called for in the bid schedule cover aggregate shall be stockpiled in the required quantity and at location with the approval of the Engineer. The unit of measurement shall be 100 cubic feet.

612-6 RATE

The unit rate shall be full compensation for furnishing and applying bituminous material and aggregate in the specified quantities including all labour, materials, equipment, tools and incidentals to complete the work prescribed in this Section.

Where called for in the bid schedule, the unit rate for stockpiling of aggregate shall be full compensation for procurement supply and stacking of specified quality of aggregates.

612-7 PAYMENT

Payment shall be made under:

- | | |
|---|----------------|
| Item No. 612-7.1 - Tripple Surface Treatment | - Per 100 sft. |
| Item No. 612-7.2 - Surface Dressing | - Per 100 sft. |
| Item No. 612-7.3 - Stockpiling of Aggregate
of Specified Gradation | - Per 100 cft. |

SECTION 621

SEMI GROUT SURFACING

621-1 DESCRIPTION

This work shall consist of furnishing and placing three courses of graded aggregate and two applications of bituminous binders, with a bituminous seal coat and chip covering, constructed on a prepared surface, by the penetration method, in accordance with these specifications in reasonably close conformity with the lines, grades thickness and typical cross sections shown on the plans or established by the Engineer.

621-2 MATERIALS

621-2.1 BITUMEN: The type of bituminous material will be specified in the contract and the grade designated by the Engineer. The bituminous material furnished shall meet the requirements of Section 1011.

621-2.2 AGGREGATE: Aggregate shall consist of crushed clean, hard, tough and durable fragments of stone or gravel, free from soft and disintegrated pieces, organic impurities and other injurious material. Coarse aggregate shall be free from an excess of flat or elongated pieces. The flakiness index shall not exceed 35 per cent.

Screenings to fill the voids in the coarse aggregate shall be of crushed stone, quarry waste or any suitable material having some cementing properties as per gradations in Table 621-1.

621-2.3 GRADATIONS: Gradation of coarse aggregate (essentially single sized), key aggregate and cover aggregate shall conform to the requirements of Table 621-1 Aggregate Gradation. The nominal size of the coarse aggregate shall not be less than one half or more than 3/4 of the thickness of layer. Quantities of materials shall be in accordance with Table 621-2 - Quantities of Material.

TABLE 621-1

AGGREGATE GRADATION

		PERCENT PASSING BY WEIGHT				
		Coarse Aggregate	Key Aggregate	Cover Aggregate	Seal Aggregate	Screening
No. (1)	No. (2)					
3"	100					
2½"	90-100	100				
2"		90-100				
1½"	15-35	-				
1"	0-10	15-35	100			
¾"		0-10	55-85	100		
½"			0-15	90-100	100	
⅜"			-	-	85-100	100
No. 4			0-2	10-30	10-40	80-100
No. 8				0-3	0-10	-
No. 100						10-30

TABLE 621-2

QUANTITIES OF MATERIALS FOR 2" THICK
SEMIGROUT SURFACING

Sequence of Operation	QUANTITY OF MATERIALS PER 100 Sq. Ft.				
	Bitumen	Coarse Aggregate	Key Aggregate	Cover Aggregate	Seal Aggregate
	Lbs.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.
First Spreading	--	20	--	--	--
First Application	50	--	--	--	--
Second Spreading	--	--	6	--	--
Second Application	25	--	--	--	--
Third Spreading	--	--	--	3.5	--
Third Application	14	--	--	--	--
Seal Spreading	--	--	--	--	1.5

NOTE: The quantities of first spreading of aggregate and the first application of bitumen may be proportionately increased depending upon the thickness of the course. There will be no change in the subsequent operations.

621-3 CONSTRUCTION REQUIREMENTS

621-3.1 WEATHER LIMITATIONS: Semi grout surfacing shall not be done on any wet surface, when the air temperature is below 60°F or when weather conditions otherwise would prevent the proper construction of the pavement.

NOTE: Dates may be established between which no bituminous layer shall be placed except with written approval.

621-3.2 EQUIPMENT: The equipment to be used shall include a power broom (hand brooms may be used if sufficient labour is available), or a power blower, (8-12 ton) rollers, spreader as may be approved by the Engineer for spreading coarse aggregates, a bituminous binder distributor, and equipment for heating bituminous material.

621-3.3 PLACING AND COMPACTING COARSE AGGREGATE: Immediately before placing coarse aggregates the surface upon which the pavement is to be constructed, a layer of screenings @ 6.0 cft/100 sft. shall be placed in a uniform thickness.

Coarse aggregate shall be placed in the required amount by approved stone spreaders, or by other approved methods. All areas of non-uniformly graded aggregate shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking whenever necessary and shall be continued after initial rolling until the appearance and texture of the aggregate are uniform and all irregularities are corrected.

The coarse aggregate shall be dry rolled until the aggregate does not creep or wave ahead of the roller. Rolling shall be parallel to the road centre line and shall start at the outer edges of the road, overlap equal portions of aggregate and shoulder and progress toward the centre, overlapping on successive passes by at least one-half the width of the roller except that on super-elevated curves rolling shall progress from the lower to the upper edge. Finally sufficient water shall be added to make a slurry with the screening under the roller and rolling continued till the surface is even and firm.

Material which crushes under the roller or becomes segregated in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with the suitable aggregate. Any irregularities in the surface profile shall be made good by raking or filling.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly

with Mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 30 pounds, and have a face area of not more than 100 square inches.

Aggregate in any course that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed and replaced with clean aggregate, and the area shall be rerolled. Any dust or vegetable matter shall completely be removed and the slurry within 3/4" to 1" of the surface shall be cleaned and removed by coir brushes.

Prior to application of the bituminous material, the surface of the aggregate will be tested by the Engineer using a 10 foot straight edge at selected location. The variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall at no point exceed 3/16 inch. All humps or depression exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

621-3.4 APPLICATION OF BITUMINOUS MATERIALS: Bituminous material shall be uniformly applied by distributor at the rate specified. The bituminous binder shall be heated at the specified temperature for the grade of the bitumen used. Successive spray widths shall be overlapped by an amount sufficient to give a uniform rate of spread over the joint. During the application of bituminous material care shall be taken to prevent spattering adjacent pavement, structures and trees. The distributor shall not be cleaned or discharged into ditches, borrow pits or the shoulders or along the right of way.

621-3.5 APPLICATION OF KEY AGGREGATE: Immediately following the first application of bituminous material, key or choke aggregate shall be spread and worked into the voids of the coarse aggregate by broom dragging and rolling. Additional key aggregate shall be spread as required, broom dragged and rolled until the course is uniformly filled and compacted. If the layer of penetration is more than three inch compacted the process outlined above in sub section 3.3 to 3.5 shall be repeated for successive layers.

621-3.6 COVER AND SEAL COAT: Before a cover and a seal coat is applied the loose stone on the surface shall be brushed off, and the surface sprayed with the quantity of bitumen specified in Table 621-2 in the manner outlined in Sub Section 3.4. The cover aggregate of the size specified shall be spread within 15 minutes of applying the bitumen and rolled with a steel tyred roller or pneumatic tyred roller. Rolling shall not be continued if the aggregate shows excessive crushing. The surface may be opened to traffic after this treatment if no rain is anticipated for upto 3 months or otherwise the seal coat shall be provided at the earliest.

621-3.7 SEAL COAT: Seal coat forms an essential part of semi grout surface course which should not be delayed for more than 6 months and in any case should/provided before the first rainy season.
be

Before applying the final seal coat, all loose chipping or foreign matter shall be removed with brooms or blowers. The bitumen specified shall then be sprayed at the specified rate of spread and covered with seal aggregate within 15 minutes. The surface shall be rolled and surplus aggregate removed after 7 days.

621-4 STOCKPILING

Stockpiling of aggregate shall be carried at points specified on the plans or approved by the Engineer in accordance with Section 1031.

621-5 MEASUREMENT

Semi grout surfacing of specified thickness shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

621-6 RATE

The unit rate shall be full compensation for furnishing and applying the bituminous material and aggregates in the specified quantities (in all the 3 courses), including all material, labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

621-7 PAYMENT

Payment shall be made under:

Item 621-7.1 Semi Grout Surfacing of
Specified Thickness. .. Per 100 sq. ft.

SECTION 631

PENETRATION MACADAM

631-1 DESCRIPTION

This work shall consist of furnishing and placing one or more courses of graded aggregate and one or more applications of bituminous binders, with a bituminous seal coat and chip covering, constructed on a prepared surface, by the penetration method, in accordance with these specifications in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the Plans or established by the Engineer.

631-2 MATERIALS

631-2.1 BITUMEN: The type of bituminous material will be specified in the contract and the grade designated by the Engineer. The bituminous material furnished shall meet the requirements of Section 1011.

631-2.2 AGGREGATE: Aggregate shall consist of crushed clean, hard, tough and durable fragments of stone or gravel, free from soft and disintegrated pieces, organic impurities and other injurious material. Coarse aggregate shall be free from an excess of flat or elongated pieces. The flakiness index shall not exceed 35 per cent.

631-2.3 GRADATIONS: Gradation of coarse aggregate (essentially single sized), key aggregate and cover aggregate shall conform to the requirements of Table 631-1 Aggregate Gradation. The nominal size of the coarse aggregate shall not be less than one half or more than 3/4 of the thickness of layer. Quantities of materials shall be in accordance with Table 631-2 and 631-3 - Quantities of Material.

TABLE 631-1

AGGREGATE GRADATION

<u>PERCENT PASSING BY WEIGHT</u>				
	<u>Coarse</u>	<u>Key</u>	<u>Cover</u>	<u>Seal</u>
	<u>Aggregate</u>	<u>Aggregate</u>	<u>Aggregate</u>	<u>Aggregate</u>
	<u>No. (1)</u>			
3"	100			
2½"	90-100			
2"	35-70			
1½"	0-15	100		
1"	-	90-100		
¾"	-	40-75	100	
½"	-	15-35	90-100	100
⅜"	-	0-5	40-75	85-100
No. 4	-	0-5	5-25	10-40
No. 8	-	-	0-10	0-10
No. 16	-	-	0-5	-

TABLE 631-2

QUANTITIES OF MATERIALS FOR 3" THICK
PENETRATION MACADAM

Sequence of Operation	<u>QUANTITY OF MATERIALS FOR 100 Sq. Ft.</u>					
	<u>Bitumen</u>	<u>Coarse</u>	<u>Key</u>	<u>Cover</u>	<u>Seal</u>	
	<u>Lbs.</u>	<u>Aggregate</u>	<u>Aggregate</u>	<u>Aggregate</u>	<u>Aggregate</u>	
		<u>Cu. Ft.</u>	<u>Cu. Ft.</u>	<u>Cu. Ft.</u>	<u>Cu. Ft.</u>	
First Spreading	-	30	-	-	-	-
First Application	150	-	-	-	-	-
Second Spreading	-	-	6	-	-	-
Second Application	35	-	-	-	-	-
Third Spreading	-	-	-	4	-	-
Third Application (Seal)	14	-	-	-	-	-
Seal Spreading	-	-	-	-	-	1.5

TABLE 631-3

QUANTITIES OF MATERIALS FOR 2" THICK
PENETRATION MACADAM

Sequence of Operation	Bitumen	Coarse Aggregate	Key Aggregate	Cover Aggregate	Seal Aggregate
First Spreading		20 Cft.			
First Application	100 Lbs.				
Second Spreading			5 Cft.		
Second Application	25 Lbs.				
Third Spreading				3½ Cft.	
Third Application	14				
Seal Spreading					1.5

631-3 CONSTRUCTION REQUIREMENTS

631-3.1 WEATHER LIMITATIONS: Penetration macadam shall not be placed on any wet surface, when the air temperature is below 60°F or when weather conditions otherwise would prevent the proper construction of the pavement.

NOTE: Dates may be established between which no bituminous penetration macadam pavement shall be placed except with written approval.

631-3.2 EQUIPMENT: The equipment to be used shall include a power broom (Hand brooms may be used if sufficient labour is available), or a power blower, (8-12 ton) rollers, spreader as may be approved by the Engineer for spreading coarse aggregates, a bituminous binder distributor, and equipment for heating bituminous material.

631-3.3 PLACING AND COMPACTING COARSE AGGREGATE: Immediately before placing coarse aggregates the surface upon which the pavement is to be constructed shall be swept clean.

Coarse aggregate shall be placed in the required amount by approved stone spreaders, or by other approved methods. All areas of non-uniformly graded aggregate shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking whenever necessary and shall be continued after initial rolling until the appearance and texture of the aggregate are uniform and all irregularities are corrected.

The coarse aggregate shall be dry rolled giving two coverages of 8-12 ton roller. Rolling shall be a parallel to the road center line and shall start at the outer edges of the road, overlap equal portions of aggregate and shoulder and progress toward the center, overlapping on successive passes by at least one-half the width of the roller except that on superelevated curves rolling shall progress from the lower to the upper edge.

Material which crushes under the roller or becomes segregated in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with the suitable aggregate. The compacted coarse aggregate shall have a firm, even surface and any irregularities in the surface profile shall be made good by raking or filling.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 30 pounds, and have a face area of not more than 100 square inches.

Aggregate in any course that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed and replaced with clean aggregate, and the area shall be rerolled.

Dry rolling shall be stopped when the surface of the coarse aggregate will support the distributor and before the voids are closed to prevent the free uniform, penetration of the bituminous material.

Prior to application of the bituminous material, the surface of the aggregate will be tested by the Engineer using a 10-foot straight edge at selected location. The variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall at no point exceed 3/16 inch. All humps or depression exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

631-3.4 APPLICATION OF BITUMINOUS MATERIALS: Bituminous material shall be uniformly applied by distributor at the rate specified. The bituminous binder shall be heated at the specified temperature for the grade of the bitumen used. Successive spray widths shall be overlapped by an amount sufficient to give a uniform rate of spread over the joint. During the application of bituminous material care shall be taken to prevent spattering/pavements, structures and trees. The distributor shall not be cleaned or discharged into ditches, borrow pits on the shoulders or along the right of way.

631-3.5 APPLICATION OF KEY AGGREGATE: Immediately following the first application of bituminous material, key or choke aggregate shall be spread and worked into the voids of the coarse aggregate by broom dragging and rolling. Additional key aggregate shall be spread as required, broom

dragged and rolled until the course is uniformly filled and compacted. If the layer of penetration is more than 3 in. compacted the process outlined above in Sub Section 3.3 to 3.5 shall be repeated for successive layers.

631-3.6 COVER AND SEAL COAT: If the penetration macadam is to be opened to traffic, a cover and a seal coat shall be applied. The loose stone on the surface shall be brushed off, and the surface sprayed with the quantity of bitumen specified in the manner outlined in Sub Section 3.4. The cover aggregate of the size specified shall be spread within 15 minutes of applying the bitumen and rolled with a steel tyred roller or pneumatic tyred roller. Rolling shall not be continued if the aggregate shows excessive crushing. The surface may be opened to traffic after this treatment if no rain is anticipated for upto 3 months or otherwise the seal coat shall be provided at the earliest.

Before applying the final seal coat, all loose chipping or foreign matter shall be removed with brooms or blowers. The bitumen specified shall then be sprayed at the specified rate of spread and covered with seal aggregate within 15 minutes. The surface shall be rolled and surplus aggregate removed after 7 days.

631-4 STOCKPILING

Stockpiling of aggregate shall be carried at points specified on the plans or approved by the Engineer in accordance with Section 1031.

631-5 MEASUREMENT

Penetration Macadam in one or more courses as specified shall be measured by superficial area. The unit of measurement shall be one hundred square feet.

631-6 RATE

The unit rate shall be full compensation for furnishing and applying the bituminous material and aggregate in the specified quantities, including all material, labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

631-7 PAYMENT

Payment shall be made under:

Item 631-7.1 Penetration Macadam in one or more courses
of specified thickness Per 100 sq. ft.

SECTION 641

BITUMINOUS PLANT MIX BASE COURSE

641-1 DESCRIPTION

This item shall consist of a base course composed of mineral aggregate and bituminous binders mixed in a central plant constructed on a prepared road bed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

641-2 MATERIALS

641-2.1 AGGREGATES: The aggregate shall consist of coarse aggregate of crushed gravel or stone, composed of hard durable pebbles or fragments, and fine aggregate of crushed gravel or stone, or sand etc. The aggregate shall be free from vegetation, or clay or particles which soften appreciably on wetting.

Under the special provisions, the strength requirements for the aggregate to be used in each layer will be given (i.e. Los Angeles wear test, aggregate crushing or aggregate wear test, as may be applicable). The coarse aggregate shall have a percentage of wear by the Los Angeles abrasion test of not more than 50.

The crushed stone shall conform to any one of the following gradations and shall be well graded between these limits.

<u>(1) 1-in. to No. 4 Sieve</u>	<u>Per cent Passing by Weight</u>
Passing 1-1/2 in. sieve	100
Passing 1-in. Sieve	95-100
Passing 1/2 in. Sieve	25-60
Passing No. 2 Sieve	0-10
Passing No. 8 Sieve	0-5
<u>(2) 2-in. to No. 4 Sieve</u>	
Passing 2-1/2 in. Sieve	100
Passing 2-in. Sieve	95-100
Passing 1-in. Sieve	35-70
Passing 1/2 in. Sieve	10-30
Passing No. 4 Sieve	0-5

641-2.2 MINERAL FILLER: The filler shall be composed of finely divided mineral matter and shall be used when specified. It shall conform to Section 1034 and have the following gradation:

<u>Sieve Size</u>	<u>Per cent Passing (By Weight)</u>
No. 30	100
No. 80	95-100
No. 200	65-100
(Cement or hydrated lime are normal fillers)	

641-2.3 BITUMINOUS MATERIAL: The bituminous material shall be of the type and grade specified by the Engineer under the special provisions of the contract, and shall comply with the requirements of Section 1011.

641-3 MIX DESIGN

There are a wide variety of design methods for designing premixed bituminous materials which are suitable for bituminous base courses and wearing courses. The general compaction and temperature limits prescribed in the specification for each specific type are extreme ranges of tolerance that must not be exceeded regardless of any formula that may be set up.

641-3.1 BINDER CONTENT: The percentage of bituminous binder by weight of dry aggregate will usually be in the range of 3-7 per cent depending on the type of material. The exact percentage to be used shall be fixed by the Engineer on the basis of laboratory tests on the job mix.

641-4 CONSTRUCTION

641-4.1 WEATHER LIMITATIONS: Plant mix base course material can be laid in virtually all weather conditions except where there is standing water or very heavy rain. Plant mix base course shall only be constructed when the surface is dry, when the atmospheric temperature in the shade is above 40°F. and rising or above 50°F. if falling, and when there is no rain or dust storm.

641-4.2 TACK COAT: A tack coat, if required shall be in accordance with Section 611.

641-4.3 BITUMINOUS MIXING PLANT: The bituminous mixing plant shall be in accordance with ASTM Designation D 995-61T, or as may be specified and accepted by the Engineer.

641-4.4 TRANSPORTATION AND DELIVERY OF MIXTURE: The mixture shall be transported from the mixing plant to the point of use in pneumatic tyred vehicles having tight bodies and previously cleaned of all

foreign materials. To prevent sticking, the inside of the body may be lightly dusted with approved material, or wiped over with chiesel, ensuring that there is no surplus to contaminate the mixture. When directed by the Engineer, each load shall be covered with suitable tarpulines of sufficient size and thickness to protect it from the weather.

The mixing temperature shall be adjusted within the allowable tolerances to ensure that the material arrives on site at a temperature suitable for spreading, compacting and finishing.

641-4.5 SPREADING, LAYING, COMPACTING AND FINISHING: Immediately before spreading the bituminous mixture, the existing surface shall be cleared of loose or deleterious material by sweeping with a power broom supplemented by hand broom if necessary.

The placing and compacting of bituminous material shall progress in sections of not more than 1 mile in length. The bituminous mixture shall be spread, shaped and finished with a mechanical paver approved by the Engineer (in certain cases, hand spreading will be allowed). It shall then be properly compacted by rolling. After which the surface can be allowed to be used for hauling material for subsequent reach.

All transverse joints where spreading is stopped for more than two hours in the base course shall be tamped down and compacted. Before spreading is recommenced, the material shall be cut back square to a point where the layer has its full thickness and painted with hot bitumen. Longitudinal joints if not covered within four hours shall either be preheated so that compaction can be made to properly bond the material over the joint, or the joint shall be cut square and painted with hot bitumen. Joints in successive layers shall be staggered by at least one foot.

The speed of the laying machine shall be adjusted in relation to the supply of the material to give the minimum number of stoppages.

Compaction shall take place as close behind the spreading as it is practicable. When the rolling does not, in the opinion of the Engineer cause undue displacement, cracking or shoving, it shall be carried out using smooth wheel roller (3-wheel or 2 or 3 axle tandem) or pneumatic tyred roller to give the required density. The exact combination of roller and sequence of rolling operations may be worked out on the job in agreement with the Engineer.

641-4.6 SURFACE TREATMENT (SEAL COAT): If shown on the plans and called for in the bid schedule, a surface treatment (seal coat) of the type called for shall be applied to the finished plant mix surface.

641-4.7 THICKNESS AND WEIGHT REQUIREMENTS: Thickness and weight requirements, including test measurement and corrective measures shall be in accordance with the following:

- | | |
|--------------|---|
| i) Thickness | Not more than $\pm 3/8$ in. of the specified thickness. |
| ii) Weight | Not more than ± 10 per cent if specified on a weight per unit area basis. |

If a preceding layer is out of specification regarding thickness tolerances, the contractor may elect to provide, at his own cost, a layer of additional material required to ensure that the minimum thicknesses are provided to conform to the requirements.

641-4.8 SURFACE REQUIREMENTS: When tested by a crown template conforming to the typical cross section on the plans and a 10 ft. straight edge applied at right angles and parallel, respectively, to the centerlines of the road, the variation of the surface from each testing edge between any two contacts with the surface shall at no point exceed.

1/3 in. for the base course layer.

641-4.9 SHAPING EDGES: All edges shall be trimmed by the contractor to neat lines in accordance with the plans.

641-5 MEASUREMENT

The quantity of bituminous material for base course shall be measured either by weight or by superficial area of specified thickness compacted, placed and accepted. When measured by weight, the unit of measurement shall be one ton; when measured by superficial area the unit of measurement shall be 100 sq. ft. of specified thickness.

641-6 RATE

The unit rate shall be full compensation for furnishing, hauling and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

641-7 PAYMENT

Payment shall be made under:

- Item No. 641-7.1 - Plantmixed Bituminous Base
Course of Specified Thickness - Per 100 sq.ft.
- Item No. 641-7.2 - Plant Mixed Bituminous Base
Course of Specified requirement - Per ton.

SECTION 642

BITUMINOUS PLANT MIX CARPET

642-1 DESCRIPTION

The item shall consist of a coarse or surfacing composed of aggregate and bituminous material mixed in central plant, constructed on a prepared base course in accordance with these specifications and in conformity with the lines grades and typical cross section shown on the plans.

642-2 MATERIALS

Materials shall conform to the requirements specified in Section 641-2. The crushed stone shall conform to any one of the following gradations and shall be well graded between these limits. The percentage of wear by Los Angeles Test shall not be more than 45.

Compacted Depth	X		X	
Recommended	X	1" to 2"	X	3/4" to 1-1/2"
Sieve Size	X	Percentage	Passing	By Weight
Inch		No. (1)		No. (2)
3/4		100		--
1 1/2		80-100		100
3/8		70-90		80-100
No. 4		50-70		55-75
No. 8		35-50		35-50
No. 30		18-29		18-29
No. 50		13-23		13-23
No. 100		8-16		8-16
No. 200		4-10		4-10

642-3 GENERAL REQUIREMENTS

The work on the construction of the plant mix carpet wearing course as specified in Section 642-1 shall conform to the requirements of Section 641-3 and 641-4.

642-4 THICKNESS, WEIGHT AND SURFACE REQUIREMENTS:

Thickness, weight and surface requirements, including test measurements and corrective measures shall be in accordance with the following:

- | | |
|---------------|--|
| (i) Thickness | Not more than $\pm 3/8$ in. of specified thickness. |
| (ii) Weight | Not more than ± 10 per cent if specified on a weight per unit area basis. |
| (iii) Surface | Not to exceed $1/3$ " at any point from each testing edge between any contacts with the surface. |

642-5 MEASUREMENT

The quantity of bituminous mixture for plant mix carpet shall be measured either by weight or by superficial area of specified thickness (compacted) placed and accepted (as called for in the bid schedule). When measured by weight, the unit of measurement shall be one ton; when measured by superficial area the unit of measurement shall be 100 sq. ft. of specified thickness.

642-6 RATE

The unit rate shall be full compensation for furnishing, handling and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this section.

642-7 PAYMENT

Payment shall be made under:

Item No. 642-7.1 - Plantmixed Bituminous Carpet of specified thickness.	..	Per 100 Sq. Ft.
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Item No. 642-7.2 - Plantmixed Bituminous Carpet of Specified Requirements.	..	Per ton.
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F. PORTLAND CEMENT CONCRETE

SECTION 701

PORTLAND CEMENT CONCRETE

701-1 DESCRIPTION

This item shall consist of concrete composed of Portland Cement, fine aggregates, coarse aggregates, water together with admixtures for air-entraining, densifying or retarding, where specified or allowed by specifications, proportioned and mixed as provided in these specifications and shall be constructed where, and of the form dimensions and design shown on the plans.

Specific requirements for portland cement concrete structures, portland cement concrete pavement, precast concrete members and prestressed concrete are contained in subsequent section.

701-2 MATERIALS

701-2.1 PORTLAND CEMENT: The portland cement shall conform to the requirements for portland cement as contained in Section 1001.

701-2.2 FINE AGGREGATES: Fine aggregate shall conform to the specification as contained in Section 1032.

701-2.3 COARSE AGGREGATES: Coarse aggregates shall conform to the specifications as contained in Section 1031.

701-2.4 WATER: Water used in the concrete shall conform to the requirements as contained in Section 1051.

701-2.5 AIR ENTRAINING ADMIXTURES: The admixtures when desired to be used in the concrete shall conform to the requirements of Section 1052.

701-3 PLANT AND EQUIPMENT

701-3.1 MIXERS: All mixers shall be of an approved type and shall be so designed as to insure a uniform distribution of the materials throughout the mass. No mixer shall be used which has rated capacity of less than one bag batch. The mixer shall be equipped with a batch meter or other device for accurately recording the number of revolutions for each batch, and an attachment for automatically locking the charging device so as to prevent the emptying of the mixer until the materials have been mixed in the minimum specified time.

701-3.2 MEASURING DEVICES: Scales for weighing cement and concrete aggregates shall be of the beam or springless dial type. They shall be designed, constructed and installed so that they can be maintained within a tolerance of 0.4 per cent of the net load in the hopper. The value of the minimum graduation on any scale shall not be greater than two pounds. All cement handling weighing and batching apparatus shall be protected from the weather.

Ten 50-pound standard test weights shall be provided at each batch plant for testing weighing equipment.

The water measuring equipment shall be capable of accurate measurement, by volume or by weight and shall be capable of being set to deliver the required quantity accurately within the percent of the quantity of water required for the batch.

All scales shall be checked and the Engineer shall approve them before their use is permitted.

701-3.3 VIBRATORS: The type of vibrator and the number of vibrators proposed to be used shall be subject to approval by the Engineer. Vibrators shall be capable of producing vibrations at a frequency of not less than 3000 cycles per minute. Vibrators shall be placed at such places so as to ensure thorough vibration of the concrete at all parts. Vibrators shall not be secured to the steel reinforcement. At least one stand-by vibrator shall be held ready for immediate use in the event of breakdown.

701-4 PROPORTIONS OF INGREDIENTS

701-4.1 MLX: The concrete mix shall be designed by the minimum 28 days cube strength. The mix shall be based on the nominal mixes complying with this specification and having the required strength, as given in Table 701-1.

In all cases preliminary tests shall be made in accordance with instructions of the Engineer and no mix shall be used until it has been approved by the Engineer.

The proportions of coarse and fine aggregate given in the Table 701-1 are intended as guide. In actual practice the proportions in which the various ingredients shall be used in the concrete mix for different parts of the work, shall be designed in accordance with strength specified subject to variation ordered by the Engineer which shall be adopted without extra cost if tests show such variations to be necessary to produce a dense concrete of the specified strength and workability. The mix proportions shall be determined on the basis of producing concrete having workability density, impermeability, durability and the required strength without the use of an excess amount of cement.

701-4.2 WATER CEMENT RATIO: The total water content per batch shall be regulated to conform with the ratio, by weight, of free water to cement required for the particular mix as determined from the preliminary tests.

The total water content shall be taken to include water absorbed in the aggregates, and free water added at the mixer.

The quantity of water introduced into the mixes shall be regulated and arranged so as to ensure that the water-cement ratio shall be the minimum required to produce the concrete specified. So far as is practicable and as shall be ordered by the Engineer-in-Charge the water-cement ratio shall be constant and shall not exceed 0.43 unless otherwise approved by the Engineer

701-5 MEASUREMENT AND TRANSPORTATION OF MATERIALS

701-5.1 QUANTITIES PER BATCH: When cement is measured by the sack the quantity of aggregates for each batch shall be exactly sufficient for one or more full sacks of cement. No batch shall be run requiring a fractional sack of cement.

701-5.2 CEMENT: Cement shall be measured by the sack as packed by the manufacturer, or by weight. One sack of cement will be considered as equivalent to 112 pounds net. If bulk cement is used the amount for each batch shall be weighed by approved equipment and it shall be fully protected from contamination or damage during handling.

701-5.3 ADMIXTURES: The Contractor shall follow an approved procedure for adding the specified amount of admixture to each batch and will be responsible for its uniform operation during the progress of the work. He shall provide separate scales for such admixture as are to be proportioned by weight, and accurate measures for such admixtures as are to be proportioned by volume.

701-5.4 WATER: Water shall be measured in gallons with a calibrated device as provided in 701-3.2.

701-5.5 AGGREGATES: Fine and coarse aggregate shall be measured separately and accurately by weight. The transportation of aggregate from the proportioning platform to the mixer shall be done in such a manner as to insure the correct weight of materials being placed in the mixer.

701-6 MIXING CONCRETE

701-6.1 GENERAL REQUIREMENTS: No concrete shall be mixed when the air temperature in the shade and away from artificial heat is as low as 40° F., and falling. No heating of the aggregate or addition of salt or other chemicals (except air entraining admixtures or admixtures specifically required by the Specifications) shall be done. No materials containing frost shall be used. The concrete shall be mixed only in such quantity as is required for immediate use and any concrete which has developed initial set shall not be used. No retempering of concrete shall be done. No material that has overrun the mixer shall be used. Concrete not in place within 45 minutes after the introduction of the mixing water to the cement, shall not be used.

Concrete shall be mixed for a period not less than $1\frac{1}{2}$ minutes after all the materials are in drum. During the period of mixing, the drum shall operate at the speed for which it has been designed. Such speed, however, shall not be less than 175, or greater than 225 feet per minute at the periphery of the drum, or not less than 14, nor more than 20 revolutions per minute.

No mixer shall be operated above its rated capacity. The entire contents of the mixer shall be removed from the drum before the materials for the succeeding batch are placed herein. The skip and the throat of the drum shall be kept free of accumulations.

Each batch shall be so charged into the drum that some water will enter in advance of the cement and aggregate, and water shall continue to flow into the drum for at least five seconds after all the cement and aggregates are in the drum.

Upon the cessation of mixing of any considerable length of time, the mixer shall be thoroughly cleaned by flushing with water.

701-6.3 HAND MIXING: Hand mixing shall not be done except in case of emergency and under written approval of the Engineer. It shall be done only on watertight platforms. The sand and cement shall be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a crater and water added in the amount necessary to produce mortar of the proper consistency. The material in the outer portion of the crater ring shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least six times and until all the stones particles are thoroughly covered with mortar and the mixture is of uniform color and appearance. Hand-mixed batches shall not exceed 11 cu. ft. in volume. Hand mixing shall not be done for concrete to be placed under water.

701-7 TESTING CONCRETE

Following preliminary tests in accordance with B.S. 1881 shall be made in respect of each mix intended to be used and shall be repeated as and when required by the Engineer.

- (a) The Slump Test
- (b) Preliminary Cube Strength Test
- (c) The Compaction Factor
- (d) The aggregate moisture Absorption
- (e) Modulus of Rupture Test

701-7.1 SLUMP TEST: Concrete shall have a slump such that it shall be workable in the required position. It shall be of such a consistency that it will flow around reinforcing steel but individual particles of coarse aggregate when isolated shall show a coating of mortar containing its proportionate amount of sand. The quantity of mixing water shall be determined as specified above and shall not be varied without the consent of the Engineer.

The slump of the concrete placed by the vibration method shall not exceed the following, the slump being determined in accordance with the "Method of Test for Slump of Portland Cement Concrete" ASTM Designation C-143, latest issue.

(a) For mass concrete and reinforced concrete sections, easily accessible for spading and working due to amount of spacing of steel or other reasons not over 4 inches.

(b) For reinforced concrete sections, not easily accessible for spading and working due to amount of spacing of steel or other reasons not over 4 inches.

All concrete shall be as dry as it is practical to place and all batches in the same section shall be of uniform consistency.

701-7.2 CUBE STRENGTH TEST: The Contractor shall allow in his tender for making test cubes 6" x 6" of the concrete being used at various times when so requested by the Engineer and for testing same as specified in B.S. 1881.

Generally four cubes shall be taken from the first batch of concrete used for every separate portion of the work and subsequently whenever a change is made whether in the cement or aggregates or in the consistency of the concrete.

The test cubes shall be stored at a place free from vibration and covered with wet sacks for one day. The cubes shall then be removed from the moulds and stored in water until despatched for testing.

Unless otherwise specified concrete mixes shall conform to the strength requirements given in the following table:

TABLE 701-1

TABLE OF QUANTITIES AND STRENGTH REQUIREMENTS FOR VARIOUS
TYPES OF PORTLAND CEMENT CONCRETE

Type	(Nomi-	WORK CUBE CRUSHING STRENGTH		ROUGH PROP. OF MATERIAL			Volumes	Minimum		Remarks
	nal	LBS/SQ. IN.		Cement	Fine Aggre-	Coarse Aggre-	of Loose Material	Actual Yield	Size of Mixer	
	Mix)	@	@							
	7 days	28 days								
A	1:1:2	4500	6000	1.25Cft (1 bag)	1.25 Cft.	2.5Cft.	5.0 cft	3.5Cft	3.5Cft.	Used for roa Pavement and Prestressed Concrete
B	1:1½:3	2500	3750	1.25Cft	1.88Cft	3.75Cft	6.88Cft	4.5Cft	5 Cft	For R.C.C.Wo
C	1:2:4	2000	3000	1.25Cft	2.50Cft	5.00Cft	8.75Cft	5.75Cft	7 Cft	For R.C.C.Wo
D	1:3:6	1500	2000	1.25Cft	3.75Cft	7.50Cft	12.50Cft	8.5Cft	14 Cft	For Mass Con- crete in foundations
E	1:4:8	1200	1800	1.25Cft	5.00Cft	10.00Cft	16.25Cft	10.75Cft	-	"

701-7.3 COMPACTION FACTOR AND AGGREGATE ABSORPTION TESTS: If required, these tests shall be carried out according to British Standards.

701-7.4 MODULUS OF RUPTURE TEST: The modulus of rupture of the concrete test beams shall be determined when required, according to the current "Method of Test for Flexural Strength of Concrete (Using simple beam with center-point loading)" ASTM Designation C-203.

701-8 FORMS

701-8.1 FORM DESIGN: Forms shall conform to the various shapes, lines, grades and dimensions of the concrete as shown on the drawings or as established by the Engineer. Their material and design shall be subject to the approval by the Engineer before their construction is started. However, such approval shall not relieve the Contractor of the responsibility for the adequacy of the forms nor from the necessity for remedying and defects which may develop or become apparent with use. The Engineer may at any time condemn any sections of forms found deficient in any respect, and the Contractor shall promptly remove the condemned forms from the work and replace them at his own expense.

701-8.2 FORM CONSTRUCTION: Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. They shall be made of metal, of metal lined timber, or of smooth planed boards in good condition.

A smooth finished surface of concrete shall be required. The forms shall be true in every respect to the required shape and size, and shall be of sufficient strength and rigidity to maintain their position and shape under loads and operations incident to placing and vibrating the concrete.

All forms when erected shall be tight. Adequate and suitable means for removing the forms without injury to the surface of the finished concrete shall be provided.

Chamfer strips shall be placed in the form so as to produce levelled edges on permanently exposed concrete surfaces if indicated on the drawings or instructed by the Engineer.

All forms shall be properly secured in position so as to prevent floating, or other movements, during the placing of concrete. Form supports shall be carried to firm foundation so that no settlement of the forms is possible during construction.

Unless otherwise specified sliding forms shall be used for enclosing vertical structures which maintain a constant section to give a lift of concrete from 2 to 4 feet. In very tall structures they shall be made to move continuously during concreting operations

701-8.3 TREATMENT OF FORMWORK SURFACE: Unless otherwise specified in the faces of the formwork which come into contact with the concrete shall be treated with parting agents, such as, mineral oils, vegetable oils and

from adhering to formwork and to reduce the risk of damage when the formwork is struck.

701-8.4 REMOVAL OF FORMS: The time and method of removal of forms shall be as directed by the Engineer. Removal shall be done with care to avoid injury to the concrete. No loading on green concrete shall be permitted. As soon as the forms are removed, the surface of the concrete shall be carefully examined, and any irregularities immediately repaired to the satisfaction of the Engineer.

Unless otherwise specified, during a moderate weather (about 60°F) the form work of various types of work shall be removed after the period shown in the following table:

Type of Formwork	Ordinary Portland Cement	Rapid hardening Portland Cement
(a) Formwork to vertical surfaces such as beam, side wall and column	12 hours	-
(b) Slab (Props left under)	3 days	2 days
(c) Beam soffits (props left under)	7 days	4 days
(d) Props to slabs	7 days	4 days
(e) Props to beams	16 days	8 days

If the temperature falls down to 45° F, the above timing shall be multiplied by 1-1/2 and if it falls down still further i.e. upto 40° F. the time shall be doubled.

701-9 PLACING CONCRETE

701-9.1 WEATHER LIMITATIONS: No concreting is allowed in very cold or very hot weather. The Contractor shall keep a maximum and minimum thermometer on the site. The thermometer shall be exposed in a place permanently shaded from the sun.

701-9.2 COLD WEATHER CONCRETING: No concrete shall be placed when the atmospheric temperature is below 35° F. After concrete has been placed, if the temperature drops below 35° F, the Contractor shall provide sufficient canvas and framework or other parts of housing to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature of not less than 45° F. for a period of five days after the concrete is placed.

701-9.3 HOT WEATHER CONCRETING: No concrete shall be placed when the temperature in the shade exceeds 95° F. During hot weather the aggregate shall be stored in the shade where it is not exposed to the direct rays of the sun between 9 A.M. to 4 P.M. Stockpiles of aggregate shall be sprinkled with water. During concreting, the coarse aggregate shall be sprayed with water shortly before use for cooling. Nevertheless cooling water shall not be allowed to contaminate the concrete or alter the water cement ratio.

Cement shall be stored in cool place and shall not be used until its temperature is definitely below 70° F.

During hot weather, the concrete mixer shall be shaded from the direct rays of the sun. Forms, reinforcing steel, etc., shall be sprinkled with cool water and delays in placing concrete shall be avoided.

701-9.4 CONTRACTOR'S RESPONSIBILITY: The Contractor shall assume all risks connected with the placing of concrete under the above conditions, and permission given by the Engineer to place concrete under the above condition will in no way relieve the Contractor of the responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory, it shall be rejected.

701-9.5 TIME OF POURING: All concrete shall be placed in daylight and the placing of concrete in any portion of the work shall not be started unless it can be completed in daylight, unless written approval to the contrary is given by the Engineer. Such approval will not be given unless an adequate lighting system is provided.

701-9.6 INSPECTION BEFORE PLACING CONCRETE: No concrete shall be placed until the depth and character of the foundation and the adequacy of the forms and falsework have been approved by the Engineer. No concrete shall be deposited until all the reinforcement is in place and has been inspected and approved by the Engineer.

701-9.7 DEPOSITING CONCRETE: The arrangements for placing concrete are to be such that in all cases the material may be conveniently handled and placed in the required position without re-handling or segregation. Wherever possible the concrete is to be deposited from bottom opening skips and in all cases shall be deposited in layers of such depth that each layer can be easily incorporated with the layer below with the use of internal vibrators or by spading, slicing and ramming. In no case any layer is to slope except where specified and all temporary joints are to be formed square to the work. Concrete shall not be delivered by chute or dropped from borrow or otherwise through a greater height than 6 feet except with the approval of the Engineer who may order the concrete to be dropped on to a banker and it shall be turned over by hand before being placed. The height of any lift shall not exceed 6 feet unless otherwise permitted by the Engineer.

The area on which any concrete is to be deposited must be made and maintained free from standing water during concreting operations unless otherwise approved. Running water crossing or entering such areas must be brought under control before concreting proceeds.

viously executed the surface and ends are to be thoroughly roughened with a chisel-pointed pick to such an extent that no smooth skin of concrete that may be left from the previous work is visible. These roughened surfaces must be thoroughly cleaned by compressed air and water jets or other approved means, brushed and watered immediately before depositing concrete and if so instructed by the Engineer are to be covered with cement mortar 1/2 in. thick immediately before proceeding with the next layer of concrete.

When new concrete is to be deposited on or against rock or old concrete, the surface of the old work must be toothed to form an adequate bond, roughened if necessary, cleaned, washed and all loose material removed from it. The faces shall then be mortared as specified for joints in new concrete work.

Concrete in reinforced concrete work shall be deposited in small quantities in a plastic state with a water-cement ratio such as to give it the specified strength. The Depositing of concrete in individual members shall be continued without stoppage up to an approved pre-arranged construction joint or until the member is completed and shall be finished off in such manner that the junction of members shall be monolithic unless otherwise specified.

Mass concreting shall be carried out in sections previously ordered or approved by the Engineer and shall proceed continuously in each section until completed and no interval shall be allowed to lapse while the work is in hand.

701-9.8 VIBRATION OF CONCRETE: Except where otherwise permitted by the Engineer concrete shall, during placing be compacted by approved pattern internal vibrators. The vibrators shall be of the rotary out-of-balance type or the electromagnetic type and shall operate at a frequency of not less than 6,000 cycles per minute. The vibrators shall be designed for continuous operation. The vibrators shall be disposed in such a manner that the whole of the mass under treatment shall be adequately compacted at a speed commensurate with the supply of concrete from the mixers. Vibration shall continue until the concrete being placed shall be judged to be compacted by the appearance of a glistening and even surface except for slight irregularities where the coarse aggregate breaks through. All air shall by this time have been expelled.

Vibration is not to be applied directly or through the reinforcement to sections or masses of concrete which have hardened or after the initial set has taken place. Vibration must not be used to make the concrete flow in the formwork so as to cause segregation.

701-9.9 RETAMPERING: After placing and vibration of concrete, retampering that is, remixing with or without additional materials or water, will not be permitted.

701-10 JOINTS:

701-10.1 CONSTRUCTION JOINTS: When construction joints are definitely shown on the Plans, all concrete between consecutive joints shall be placed in a continuous operation.

In order to allow for shrinkage, concrete shall not be placed against the second side of construction or construction joints for at least 12 hours after that on the first side has been placed.

Approval of the Engineer must be secured for the placing of any construction joints not shown on the Plans.

The plans on which a day's work is to terminate shall be predetermined before depositing of concrete begins. They shall in general be perpendicular to the lines of principal stress and in regions of small shear. Horizontal joints will not be permitted in concrete girders, beams, abutments, or retaining walls, unless otherwise indicated on the Plans. Slabs acting with concrete beams or girders shall be deposited continuously with them, unless otherwise indicated on the Plans.

Unless otherwise indicated on the Plans, all construction joints shall be made with bulkheads provided with keys which clear all exposed surfaces approximately one third the thickness of the joint.

In piers or gravity abutments requiring a construction joint, it shall generally be a keyed vertical joint extending the full height above the footer. In piers, abutments or retaining walls the second portion placed at a vertical joint shall be placed not earlier than 24 hours after the first portion placed, except with the special permission of the Engineer.

Joints in cantilivered members, unless shown on the Plans, shall not be permitted.

When making horizontal construction joint, care shall be taken to have the concrete below the joint as dry as possible and any excess water or creamy material shall be drawn off before the concrete sets up. Within 12 hours after the concrete below the joint has been placed the top surface shall be thoroughly cleaned by the use of wire brushes and all laitance and loose material removed so as to expose clean solid concrete. Care must be taken not to loosen any of the coarse aggregate in the concrete. If for any reason this laitance is not removed within 12 hours after the concrete is placed it shall be removed using such tools and methods as may be necessary to secure the results specified above. Immediately before placing concrete above the joint, the surface of the concrete below the joint which has been cleaned as specified above shall be thoroughly wetted and flushed with mortar of the proportions used in the concrete. This mortar shall be thoroughly brushed into all openings and crevices with a stiff broom. On all exposed surfaces the line of the proposed joint shall be made truly straight, by tacking a temporary horizontal straight edge on the inside of the form, with its lower edge on

this edge, to allow for settlement.

Horizontal construction joints between bridge slabs and superimposed curbs, sidewalks and median strips, shall be placed and protected the same way as the remainder of the slab. They shall be cured in accordance with the requirements specified under Water Curing.

When existing walls are faced and raised with concrete or where walls or columns support slabs or beams, the concrete in the vertical member shall be deposited up to the bottom of the supported member and a period of at least 2 hours shall elapse for settlement before placing concrete in the horizontal member.

When the work is resumed the forms shall be tightened and the concrete previously placed shall be thoroughly cleaned of all foreign material and laitance, and flushed with a coat of one to one mortar, immediately before placing concrete.

When the Work is unexpectedly interrupted by break-down, storms or other causes and the concrete as placed would produce an improper construction joint, the Contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section in which there is shearing stress, he shall provide an adequate bond across the joint by forming a key, inserting reinforcing steel or by some other means satisfactory to the Engineer, which will prevent a plane of weakness.

701-10.2 EXPANSION JOINTS: Expansion joints shall be constructed as to permit absolute freedom of movement. After all other work is completed all loose or thin shells of mortar likely to spall under movement shall be carefully removed from all expansion joints by means of a fine chisel.

Joints to be sealed shall be prepared and the sealer heated and applied in accordance with approved manufacturer's direction.

701-10.3 ELASTIC JOINT FILLER: Elastic joint filler of an applied type shall be placed in joints of concrete structure where shown on the drawings. Unless otherwise specified, the elastic filler shall be performed, non extruding, resilient, self expanding type, formed from clean granular particles securely bound together by a synthetic resin of an insoluble nature. It shall be furnished wrapped in moisture proof covering.

The elastic joint filler and the concrete against which it is to be placed shall not be coated or painted. The filler shall be placed against the previously placed concrete before more concrete is placed. The edges of the filler shall be placed at a prescribed distance back from the finished surface of the concrete. In no case shall the elastic joint filler be unwrapped and placed in the joint more than four hours before placing the final section of concrete. Care shall be taken in storing and handling the filler so that the wrapping is not disturbed or broken, which may permit hydration.

701-11 CURING

701-11.1 WATER CURING: All surfaces not covered by forms shall be protected with wet burlap or wet jute, as soon after placing the concrete as it can be done without marring the surface and kept wet by the continuous application of water by means of suitable sprinkling device for a period of not less than 7 days. Wood forms without lines, if left in place longer than 2 days after the placing of concrete, shall be thoroughly wet down at least twice each day for the remainder of the curing period. Portions of the covering material may be removed temporarily and continuous sprinkling stopped when and as necessitated by any required finishing operation.

701-11.2 WATER PROOF MEMBRANE CURING: Immediately after the free water has disappeared on surface not protected by form and immediately after the removal of forms and surface finishing, or if forms are removed before the end of the 7 day curing period, the concrete shall be sealed by spraying as a fine mist, a uniform application of an approved curing material, in such manner as to provide a continuous, uniform impermeable film without marring the surface of the concrete.

The membrane curing shall be applied in one or more separate coats at the rate of at least one gallon per 200 sq. ft. of surface.

Unless adequate precaution are taken to protect the surface of the membrane, workmen, materials and equipment shall be kept off the membrane for the duration of the curing period.

701-12 REPAIRING CONCRETE SURFACE

If on the stripping of forms, concrete is found to be not formed as shown on the drawings, or is out of alignment or level, or shows a defective surface, it shall be considered not conforming to the intent of these specifications and shall be removed and replaced by the contractor at his expense unless the Engineer grants permission to repair the defective area, in which case patching shall be performed as described in the following sub-clauses.

Defects that require replacement or repair are honey comb surfaces resulting from the stripping of forms, loose pieces of concrete, bolt holes, tie rod holes, ridges at form joints and bulges caused by the movement of the forms. Ridges and bulges shall be removed by chipping or tooling followed by rubbing with a grinding stone. Honey comb and other defective concrete shall be chipped out, and the chipped openings shall be sharp-edged and shaped so that the filling shall be keyed in place. All holes shall be thoroughly moistened for 24 hours before the filling is placed. The surface of the filling shall be finished flush with the surrounding wall, and shall have the same texture. All patches shall be cured.

When in the opinion of the Engineer the extent of imperfections in structures exposed to view are such that patching alone would not produce satisfactory results, the contractor shall have to give a sack rubbed mortar finish in accordance with the instructions of the Engineer.

Imperfections, bolt and tie rod holes, shall be filled with dry patching mortar composed of one part of portland cement, two parts of regular concrete sand and just enough water so that ingredients are thoroughly mixed and mortar sticks together on being moulded into a ball by slight pressure of the hands which does not extrude free water. Mortar repairs shall be placed in thin layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod, bolt and pipe hole so that the entire depth of the holes is completely filled with compacted mortar. Where concrete is exposed to view mortar shall be made to match the colour of the concrete by substituting white cement in the required amount of a portion of the regular cement.

701-13 FINISHING

Unless otherwise specified the top face of the slabs shall be finished to a level surface suitable for receiving screeds.

Immediately after the removal of form work all surfaces to be left exposed shall be rubbed down with the carborundum blocks to remove board marks and roughness. This rubbing down shall be done with the addition of water only, but subsequently when so directed the Contractor shall at no extra cost fill and make good with an approved cement and sand mortar any exposed holes or sunken places.

All external exposed surfaces shall be brushed down with a wire brush to remove laitance and exposed aggregate.

The class of finish for formed surfaces shall be as follows:

(a) Formed surfaces of well curb or well transom slabs or surfaces against which backfill is to be placed will require no treatment after form removal, except for removal and repair of the defective concrete and for the work specified.

(b) Submerged and below ground formed surfaces which are not exposed to the action of flowing water and are not prominently exposed to public view shall need no sack rubbing except that needed for surface imperfections.

(c) In the case of formed surface above ground, there shall be no visible offsets. Surface irregularities measured for abrupt irregularities shall not exceed 1/8 inch and for gradual irregularities 1/4 inch.

(d) The surface of all waterways including the interior surface of culverts etc. shall not have surface irregularities exceeding 1/8 inch for abrupt irregularities and 1/4 inch for gradual irregularities.

(e) Unformed surface that will be covered by backfill or concrete shall be finished by sufficient levelling to produce an even uniform surface.

(f) A hard steel trowel finish shall be applied to unformed surfaces that shall be exposed to view or that shall be subject to action of flowing water. Floating and trowelling shall be started as soon as the screeded surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface free from screed marks and uniform in texture. Joints and edges shall be tooled.

701-14 PROTECTION OF CONCRETE

Unless otherwise directed by the Engineer, concrete bridge floors and culverts shall be closed to traffic for a period of at least 14 days after placing for normal strength concrete and 7 days for high-early-strength concrete, and for such additional time as may be deemed advisable. In the operation of placing, concrete may be wheeled across previously poured slabs after they have set for 24 hours, provided plank runways are used to keep the loads over the beams.

No stockpiles of aggregates, no heavy equipment or other material other than light forms or tools, shall be stored on concrete bridge floors until 14 days after they have been poured. All stockpiles, tools and equipment stored on bridge floors at any time shall be subject to approval by the Engineer, and the Contractor will be required to disperse any such stored materials or equipment to avoid over-loading any structural part.

In the case of piers or bents with concrete caps the weight of the superstructure or of beams shall not be placed on the caps until they have reached the ages required in the following table:

	<u>Normal Strength Concrete</u>	<u>High Early Strength Concrete</u>
Superstructure	7 days	3 days
Beams	3 days	24 hours

701-15 CONCRETE STRUCTURES

701-15.1 COLUMNS: Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The column shall be allowed to set at least 12 hours before the caps are placed. No concrete shall be placed in the superstructure until the column have been stripped sufficiently to determine the character of the concrete in the columns.

701-15.2 SLABS: Before any slab concrete is placed an approved templet and finish tool shall be on hand for striking off the surface of the slab to the required crown as shown on the Plans. Unless otherwise indicated on the Plans, intermediate web walls shall be poured at least 48 hours before the slabs are poured.

For each span the concrete in the slab and curbs shall be placed in one continuous operation, allowing no time for initial set between them, except where joints are shown on the Plans. Immediately after the curbs are poured the chamfer strips shall be set to correct elevation and alignment. Where longitudinal screed is used the concrete shall be placed in longitudinal screed strips the entire length span, and for the full depth. The width of the strips shall be such that concrete in any one strip shall not take its initial set before the adjacent strip is poured.

On continuous-beam spans the dead load shall be kept approximately symmetrical about the points of interior support by alternate placement of individual slabs in all spans of the continuous unit. In each span of continuous units the placing of slabs shall generally start near midspan and continue toward each bed.

701-15.3 DECK GIRDERS: The slabs and beam in T-beam or deck girder construction shall be placed in one continuous operation except that where special shear anchorage of keys are provided, as shown by the plans or approved by the Engineer the beams and slabs may be constructed in successive pours.

701-16 MEASUREMENT

701-16.1 GENERAL: For any item of work constructed under this Section, measurement shall be made by volume. The unit of measurement shall be one cu. ft. In computing the concrete quantity the dimensions used shall be the plan dimensions of the concrete with the neat lines shown on the plans except that no deduction will be made for weep holes and floor drains and no account shall be taken of chamfers, scorings, fillets of radii $1\frac{1}{2}$ square inches or less in cross section area.

The quantity to be paid for shall be the original plan quantity, measured as provided above, except that where the Plans call for an estimated quantity of miscellaneous concrete for contingent use such contingent concrete shall be measured as the actual quantity ordered by the Engineer, in place and accepted.

No measurements for or other allowances will be made for work or material for forms, false work, pumping, bracing, expansion joint material etc. The volume of all materials embedded in the concrete such as structural steel, pile heads, etc. except reinforcing steel, shall be deducted in computing the volume of concrete to be paid for.

In computing the volume of concrete in deck girders and beam spans the thickness of the floor shall be taken as the nominal thickness shown on the drawings, and the width shall be the horizontal distance measured across the roadway. The volume of lugs over beams shall be included in the volume to be paid for.

701-17 RATE

The unit rates for various types of Portland Cement Concrete listed in Table 701-1 shall be full compensation for all the work specified in this Section and shall include all forms, falsework, joints, weep holes, drain, pipes, conduits, bearing pads, setting anchor bolts and dowels, surface finish and cleaning up as shown on the plans or ordered by the Engineer.

701-18 PAYMENT

Payment shall be made under:

Item No. 701-18.1	-	Portland Cement Concrete	-	Per Cu. Ft.
		Type 'A'		
Item No. 701-18.2	-	" "	-	Per Cu. Ft.
		Type 'B'		
Item No. 701-18.3	-	" "	-	Per Cu. Ft.
		Type 'C'		
Item No. 701-18.4	-	" "	-	Per Cu. Ft.
		Type 'D'		
Item No. 701-18.5	-	" "	-	Per Cu. Ft.
		Type 'E'		

SECTION 711

PORTLAND CEMENT CONCRETE PAVEMENT

711-1 DESCRIPTION

The work specified in this section consists of construction of Portland Cement Concrete pavement, constructed in one course on a prepared sub-grade or base in accordance with these specifications and in conformity with the lines and cross sections shown on the plan and shall include curves where specified. The concrete for pavement construction shall be type A (Section 701) and shall be reinforced with steel bars, or steel mesh, where called for in contract and in accordance with the details shown on the plans.

711-2 MATERIALS

Materials needed to make type A concrete for pavement construction shall conform to specifications as contained in Section 701-2.

Reinforcing steel bars shall conform to specifications as contained in Section 821.

Materials for filling of joints shall be as specified on plans and approved by the Engineer.

711-3 PLANT AND EQUIPMENT

Plant and equipment needed for making type A concrete shall be in accordance with Section 701-3.

711-4 CONSTRUCTION DETAILS

711-4.1 PROPORTIONS OF INGREDIENTS: This shall conform to specifications contained in 701-4

711-4.2 MIXING AND TESTING CONCRETE: The concrete shall be mixed in accordance with specifications contained in 701-6 and tested according to specifications contained in 701-7

711-4.3 PAVEMENT BASE: The base on which the concrete pavement is laid shall have been constructed or prepared under other items of the contract and shall be smooth, compacted and true to the grades and cross sections shown on the Plans and shall be so maintained, throughout the period of placing concrete pavement. The base shall be moistened immediately prior to placing concrete.

To ensure proper depth and section, a template true to depth and section and resting on accurately set aside forms shall be moved over the surface immediately before placing concrete, and any irregularities shall be immediately corrected. High spots shall be planed down, and the Contractor shall have the option of either filling low spots to the proper elevation with approved material which shall be watered, compacted and struck off to the required grade or of placing additional concrete. No measurement or pavement shall be made for such additional concrete.

711-4.4 FORMS: Unless as may otherwise be directed by the Engineer, the forms shall be made of steel, of an approved section, with a base width of at least 8 inches, and the depth shall be equal to the thickness of the pavement at the edge. Each section of forms shall be straight and free from bends and warps at all times. No section shall show a variation greater than 1/8 inch in 10 feet from a true plane surface on top of the form, and the inside face shall not vary more than 1/4 inch from a plane surface.

Before placing forms, the underlying materials shall be excavated to the required grade if necessary and shall be firm and compact. The forms shall have full bearing upon the foundation throughout their length and shall be placed with exactness to the required grade and alignment of the edge of the finished pavement. They shall be so supported during the entire operation of placing, tamping and finishing the pavement that they will not deviate vertically at any time more than 1/8 inch from the proper elevation.

Forms shall be set to the required lines and grades well ahead of placing concrete preferably not less than 600 feet.

Forms shall not be removed for at least 12 hours after the concrete has been placed. Forms shall be carefully removed in a manner to avoid damage to the pavement. Under no circumstances will the use of pry bars between the forms and the pavement be permitted.

Forms shall be thoroughly cleaned and oiled each time they are used.

711-4.5 CONSISTENCY: The slump of the pavement concrete shall be from one to 3 inches or as directed by the Engineer.

The slump shall not vary more than one inch from batch to batch.

711-4.6 PLACING CONCRETE: Concrete shall be placed on the prepared and moistened base in such a manner as will require as little re-handling as possible to avoid segregation of materials and in accordance with specification contained in 701-9

If required by the Engineer, the forms shall be wetted immediately prior to the placing of concrete.

711-5 JOINTS

711-5.1 GENERAL REQUIREMENTS: All joints shall be constructed true to alignment and grade in accordance with the details shown on the plans or as may specifically be directed by the Engineer.

711-5.2 CONSTRUCTION JOINTS: At the end of each day's concreting or where an interruption in the work of more than 30 minutes occurs, a construction joint as shown on the Plans or as desired shall be placed only at the location of a contraction joint or at the midpoint of the slab between two adjacent, normally spaced transverse joints. Any excess concrete shall be disposed of as directed by the Engineer. The spacing of subsequent transverse joints shall be measured from the transverse contraction joints last-placed measured. All transverse joints, except mid-point construction joints shall be continuous across the full width of the pavement.

711-6 SPREADING, FINISHING AND FLOATING

711-6.1 GENERAL REQUIREMENTS: Except as otherwise specified, the striking off, compacting and floating of concrete shall be done by mechanical methods. Where the Engineer determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lanes of widths less than 10 feet.

711-6.2 MECHANICAL METHODS:

711-6.2.1 Spreading and Finishing: The Concrete shall be spread uniformly between the forms, immediately after it is placed, by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. The rate of vibration shall be not less than 3,500 vibrations per minute.

The concrete shall be spread full width before being struck off by the finishing machine. The concrete shall be struck off and compacted so that the surface will conform to the finished grade and

cross section shown on the plans and at the same time leave sufficient material for the floating operation. The spreading or finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer to ensure thorough compaction.

711-6.2.2 Floating: Except as otherwise specified, after the pavement has been struck off and compacted, it shall be finished with an approved longitudinal float.

The Contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by a rigid frame of a longitudinal float which works with a swing motion, while held in a floating position parallel to the road centerline and passing gradually from one side of the pavement to the other.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer.

711-6.3 MANUAL METHODS:

711-6.3.1 Striking Off and Compaction: When striking off and compacting by manual methods are permitted, the concrete shall be approximately levelled and then struck off to such an elevation that when properly compacted, the surface will conform to the required grade and cross section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated in a manner that will insure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper. The tamper shall be moved with a combined tamping and longitudinal motion, raising it from side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus of concrete shall be kept in front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross section is obtained and the mortar flushes slightly to the surface.

711-6.3.2 Straight Edge Testing: Immediately following final floating, the entire area of the pavement shall be tested with a 10 feet straight edge. Any depressions found shall be immediately filed

with fresh concrete which shall be struck off, compacted and finished. High areas shall be worked down and refinished. The straight edge testing and refloating shall continue until the pavement has the required surface contour.

711-7 CURING CONCRETE

In all cases in which curing requires the use of water the curing shall have prior right to all water supply. At no time shall more concrete be laid than can be immediately and properly covered, nor when that already laid is not being properly cured.

As soon as the concrete has hardened sufficiently to permit walking, the entire surface of the concrete shall be covered with burlap and shall be kept soaked with water for at least 72 hours unless otherwise directed by the Engineer. Thereafter, the burlap may be removed and the concrete kept moist by frequent sprinkling of water or by ponding with water for a total period of at least seven days after the concrete is laid.

711-8 OPENING PAVEMENT TO TRAFFIC

Pavement shall remain closed to traffic until tests show the concrete to have a minimum modulus of rupture, when tested in accordance with AASHO T-177 of not less than 500 pounds per square inch, but in no case shall the pavement be opened to traffic in less than 14 days after concrete is placed.

711-9 MEASUREMENT

Portland cement concrete pavement shall be measured by the volume of portland cement concrete laid on the pavement according to the thickness and cross section shown on the plans. The length shall be measured along the actual surface at the pavement and width from outside of completed pavement. The unit of measurement shall be one hundred cubic feet.

711-10 RATE

The unit rate for portland cement concrete laid for concrete pavement shall be full compensation for the work specified in this Section completed, cured with water, finished and accepted including cost of furnishing all materials labour, tools and equipment and operations necessary to complete the work.

711-11 PAYMENT

Payment shall be made under:

Item No. 711-11.1 - Portland Cement Concrete -
Pavement completed. Per 100 Cu.ft.

SECTION 721

PLUM CONCRETE

721-1 DESCRIPTION

The work covered in this Section shall consist of placing plum concrete, consisting of 40 per cent plum and 60 per cent portland cement concrete type D (Section 701), proportioned and mixed as provided in these specifications and shall be constructed where, and of the form dimensions and design shown on the plans.

721-2 MATERIALS

721-2.1 PORTLAND CEMENT CONCRETE: It shall be type D and conforming to specifications as contained in Section 701.

721-2.2 PLUM: Plum shall be of approved quality of Stones or boulders having a size of 4 inches and above. The quality of stones should be got approved from the Engineer.

721-3 OTHER REQUIREMENTS

In all other requirements this shall conform to specifications for Portland cement concrete (Section 701), except that plum shall be placed in such a way that it is covered by type D concrete on all the sides.

721-4 MEASUREMENT

The quantity of Plum concrete placed, cured, finished and accepted shall be computed by volume. The unit of measurement shall be one cubic foot.

721-5 RATE

The unit rate for plum concrete placed and accepted, shall be full compensation for all the work specified in this Section and shall include all materials and labour, all forms, false work, joints, weep holes, drains, pipes, conduits, setting anchor bolts and dowels, surface finish and cleaning up as shown on the plans or ordered by the Engineer.

G. HIGHWAY STRUCTURES

721-6 PAYMENT

Payment shall be made under:

Item No. 721-6.1	-	Plum concrete consisting 40% plum and 60% Type D concrete	Per Cu.Ft.
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SECTION 801

BRICKWORK

801-1 DESCRIPTION

Unless otherwise specified, all brick work shall be first class and finished in a workmanlike manner, true to dimensions and grades shown on the drawings according to the following specifications.

801-2 BRICKS

Bricks shall conform to Section 1041, Clay Bricks unless otherwise specified.

No brick bats shall be used, except where absolutely necessary for obtaining the dimensions of different courses or the specified bond, Before use all bricks, shall be soaked in clean water in tank or pit for at least 2 hours. In the case of masonry in mud mortar, however, dry bricks shall be used.

801-3 MORTAR

Cement mortar used for brick work shall be in the proportion of 1:3 or 1:6 cement sand, mixed by volume in a dry state first, and then mixed by adding sufficient amount of water to make it workable. When specified for face work, its color shall be of an approved quality and brand. Water proofing material shall be added to the mortar only when specially required or directed by the Engineer.

801-4 WATER

Water for brickwork shall conform to Specifications in Section 1051.

801-5 TOOLS

All equipment used for mixing mortar, transporting it and for laying bricks shall be clean and free from set mortar, dirt, or other injurious foreign substances. It shall be thoroughly cleaned at the end of each day's work.

801-6 BOND

Unless otherwise specified, all brick-work shall be laid in English Bond with frogs upward.

801-7 LAYING OF BRICKS

Each brick shall be set with both bed and vertical joints filled with mortar and thoroughly bedded in by tapping with Handle of trowel. At every fourth course bricks shall be flushed with mortar and grouted full.

801-8 JOINTS

Horizontal joints shall be parallel and truly level. Vertical in alternate courses shall come directly over one another. Thickness of joints, unless otherwise specified, shall not be less than $\frac{1}{4}$ of an inch and shall not be more than $\frac{3}{8}$ of an inch. The height of 4 courses and 3 joints as laid shall not exceed more than 1 inch the height of 4 bricks as piled dry one upon the other.

801-9 CORNER

At all corners alternate courses of bricks shall be laid header-wise and stretcher-wise so as to bond the two walls well together.

Where particularly required, cut or mould bricks shall be used in jambs, arches and projecting corners, so as to eliminate sharp angles from the inside of a building. This item shall be included in the unit rate if the radius of the finished (Plastered) corners does not exceed $\frac{3}{4}$ of an inch. In case it exceeds $\frac{3}{4}$ of an inch extra payment shall be made by making linear measurement.

801-10 ROUND PILLARS

Round pillars shall be built with quadrant shaped bricks; if the pillars are of considerable height flat circular discs of stone or cement concrete of the same diameter as the pillar about 3 inches thick shall be introduced at every 4 to 6 feet as bond stone. The cost of this operation will be included in the unit rate.

801-11 PLUMB BOBS AND STRAIGHT EDGES

All brickwork shall be truly plumbed and each set of 4 brick course shall be checked with plumb bob and straight edge.

801-12 FACE WORK

All face work shall be finished with neat drawn joints and pointed out if it has not to be plastered. If it has to be plastered the joints shall be raked out before any plaster is laid on. For face work the bricks shall be of true edges, uniform color and correct dimensions. If specially required, face work shall be laid up with pressed bricks. All brick courses shall be proportioned that they will work out evenly with the height of windows and doors.

801-13 JOINING WORKS

When fresh masonry is to join masonry that has partially or fully set, the exposed joining surface of the set masonry shall be cleaned, roughened and wetted so as to effect the best possible bond with the new work. All loose bricks and mortar shall be removed.

801-14 STRIKING OF JOINTS

Where in the case of brickwork in cement mortar, pointing or plastering to the face work is not provided as a separate item the joints in face work shall be struck. This operation shall be paid for separately.

801-15 RAKING JOINTS

The joints of brickwork, which is to be pointed or plastered, shall be raked out with a hook to a depth of half an inch. The raking shall be done before the mortar sets each day.

801-16 CUT BRICKWORK

Bricks shall be cut, dressed or grooved, as required for shaping jambs, fitting chokhats and for architectural features of the building. Corners shall be made with cut bricks; five bricks shall be used for each corner.

801-17 FIXTURES

Holdfasts and similar fixtures shall be built in with the surrounding brickwork in their correct position in specified mortar. They shall be built in as the work progresses and not inserted later on into space left for them.

801-8 PROGRESS

Brickwork shall be carried up in a uniform manner. No portion shall be raised more than 3 feet above another at the same time. Temporary spaces left during construction shall be raked and not toothed. Straight edges supplied to bricklayer shall have courses marked on them with saw cut or measuring rod shall be provided and height of course shall be checked all over the building from time to time so as to keep all courses level.

801-19 BED PLATES

Bed plates of concrete or stone shall be provided under each beam and joint. They shall conform to the dimension given in the drawing and shall be carefully laid in specified cement mortar to correct level.

801-20 BRICKLAYING IN FREEZING WEATHER

801-20.1 PROTECTION OF BRICKS: All bricks delivered for use in freezing weather shall be fully protected immediately upon delivery by a weather-tight covering that will prevent the accumulation of water, snow or ice on the bricks; loose board covering shall not be permitted.

801-20.2 HEATING OF SAND: All sand shall be heated in such a manner as will remove all frost, ice or excess moisture but will prevent the burning or scorching of the sand.

801-20.3 HEATING OF BRICKS: All frosted bricks shall be defrosted by heating them to a temperature of approximately 180° F.

801-20.4 HEATING OF WATER: All water used shall be heated to a temperature of approximately 180° F.

801-20.5 PROTECTION OF MORTAR AGAINST FREEZING: After the mortar has been mixed it shall be maintained at such temperature as will prevent its freezing at all times and if necessary the contractor shall use metal mortar board equipped with oil torches. No anti-freeze liquid, salt or other substance shall be used in mortar, except when specified or permitted by the Engineer.

801-20.6 ENCLOSURE AND ARTIFICIAL HEAT: All work under construction shall be protected from freezing for a period of 48 hours by means of enclosure, artificial heat or by other suitable methods duly approved by the Engineer.

801-21 OPENINGS

Door and window openings shall have flat or relieving arches or inlets spanning across them as shown on the drawing or as specified.

801-22 CENTRING

Centring for all openings shall be strong enough to support the lintels or arches spanning the openings. They shall be subject to the approval of the Engineer and shall remain in position till the brickwork has set. No additional payment will be made to the contractor for this item of work.

801-23 SCAFFOLDING

The contractor shall provide all scaffolding, staging, ladders, necessary for the work. All walls or other brickwork shall be securely braced and protected against damages by wind and storms during the construction period. No extra rate shall be paid for this item.

801-24 PUTLOGS

Only headers shall be left out to allow a putlog to be inserted and not more than one brick shall be left out for each putlog. Under no circumstances shall putlogs be made immediately under or next to the impost or skew back of arches.

801-25 PROTECTION WATERING

All brickwork shall be protected during construction from the effects of rain and frost by suitable covering. The brickwork laid in cement or in cement mortar shall be kept moist for a period of 10 days.

801-26 COPING

Unless otherwise specified, the top courses of all plinths, parapets, steps etc. shall be built in brick on edge. In case of parapet walls the outside half of the brick shall be weathered and throated. The corners shall be made by cutting fine bricks or by special bricks of 9" x 9" 4-3/8" size to give a radiated and keyed joint.

801-27 WINDOW SILLS

Unless otherwise specified, window sills shall be made by laying bricks on edge over $1\frac{1}{2}$ inch tile creasing to keep the joints in line. The bricks shall project 3 inches from the face of the wall and shall be weathered on upper edge and throated underneath upto 3 inches from either end.

801-28 CORNICES

Unless otherwise specified or directed by the Engineer, all cornices shall be in line with the straight and parallel faces. All exposed cornices shall be weathered and rendered on top in specified mortar and throated underneath. The profile shall be checked constantly with the sheet iron templates.

Cornices intended to be pointed shall be made with specially moulded bricks or bricks cut and rubbed so as to give mouldings true to drawings. In cornices to be plastered the bricks shall be roughly cut so as to allow the plaster to finish true to drawings and templates. Thickness of plaster shall be between $1\frac{1}{2}$ " and 1 inch.

801-29 STRING COURSES

String courses shall comprise bricks laid on edge or flat in one or two courses as actually specified.

801-30 EAVE BRICK WORK

Eave bricks shall be laid flat or on edge as specified with a projection of 3 inches and chamffered $1\frac{1}{2}$ inch on the upper edge.

801-31 DRIP COURSE

Brick work in drip courses when made of flat bricks shall be according to specifications for eave brick work and when built in bricks on edge it shall conform to specifications for window sills.

801-32 BRICK WORK IN ARCHES

801-32.1 The brickwork in arches shall conform to specifications for first class brickwork, but shall not commence till abutments have been built to their full width and upto the level of skew backs. Arch work shall be carried up evenly from both abutments and as soon as the arch is complete, masonry shall be built up evenly on both sides to the heights of crown so as to load the haunches.

801-32.2 In all arches, the voussoir joints shall be truly radial and not to exceed 1/4" in thickness. In gauged arches the thickness of arches shall not exceed 1/8".

801-32.3 Skew backs shall be formed of bricks correctly shaped to radiate from the centre of curvature and shall not be packed with mortar or chips.

801-32.4 For gauged arch work, the arch shall be laid out full size on the ground and joints carefully marked out. Templates shall then be made as a guide for special shapes of bricks, which shall be carefully cut and rubbed to the required shape. All bricks for an arch shall be prepared in full and set up dry on the ground before the work begins.

801-32.5 Segmental arches used over rectangular door or window openings shall have a flat rectangular soffit and segmental extrados.

801-32.6 Flat arches shall be built in the same manner as gauged arches but with all the voussoir joints converging on the apex of an equilateral triangle described on the soffit of an arch. Cross joints and extrados shall be parallel to the soffit. The arch shall be built with a camber of 1/8" per foot of the span.

801-32.7 Arches shall be built in concentric rings and each ring shall be completed before work on the one above is commenced. In all cases, the centerline of the brick face shall be radially placed. The arch ring shall, in all cases be bonded together by a special bond stone.(key stone) which shall be of stone, concrete or brickwork, as actually specified or directed by the Engineer.

801-32.8 Centres of arches over 5 feet in span shall be erected on wedges, those over 10 feet on double wedges and those over 20 feet span on sand boxes so as to allow the gradual lowering of centre.

For single segmental arch, centre shall be struck immediately after the arch is finished. For series of segmental arches, centre of each arch shall be struck as soon as the arch succeeding is completed. For semi-circular, elliptical or pointed arches, centres shall be struck as soon as the brickwork has reached two thirds the height of such arches.

801-33 MEASUREMENT

Brickwork shall be measured by volume. The unit of measurement shall be 100 cubic feet. The measurement of cut bricks shall be in number. The unit of measurement shall be 1000 bricks. No deduction

shall be made for openings having a superficial area of one square foot or less. The items of coping window sills, cornices eave brick work and drip course shall be measured by length. The unit of measurement shall be one running foot.

801-34 RATE

The unit rate shall be full compensation for carrying out Ist class brick work including the cost of bricks, mortar and any other material required, including curing and protection as per above specifications. It shall further include the cost of providing using and removing scaffolding, shuttering, centring, staging, ladders, supports and other tools and plants, required for carrying out Ist class brick work.

801-35 PAYMENT

Payment shall be made under:

- | | | |
|-------------------|--|----------------|
| Item No. 801-35.1 | - Ist Class Brick work
in Cement Mortar as
Specified. | Per 100 Cu.Ft. |
| Item No. 801-35.2 | - Coping, Window Sills
Cornices, Eave Brick or
Drip Course Work in 1:6
Cement Mortar. | Per R.Ft. |
| Item No. 801-35.3 | - Brick work in Arches | Per 100 Cu.Ft. |

SECTION 802

STONE MASONRY

802-1 DESCRIPTION

Unless otherwise specified, all stone masonry shall be finished in a workmanlike manner true to dimensions and grades shown on the drawings.

802-2 CLASSIFICATIONS

Unless otherwise specified, stone masonry shall be of the following classes:

- (a) Ashlar Masonry
- (b) Course Rubble Masonry
- (c) Random Rubble Masonry
- (d) Dry Rubble Masonry

802-3 STONE

Stone shall be procured from an approved source and shall conform to specification in Section 1046. Approved samples of stone shall be retained as standard of material to be furnished at the site of work. All stone used in the work shall be equal in all respects to the approved sample.

Through Bond Stones shall be procured and stacked separately and shall be marked on the face with tar or paint. Marks shall be made on the inner face or the face to be plastered.

Before use all stone shall be soaked in clean water in a tank or a pit for at least 2 hours, except in case of masonry in mud mortar, where dry stone shall be used.

802-4 DRESSING AND CUTTING OF STONES

Stone shall be dressed to the exact size specified and all its visible edges shall be free from chipping.

Cut stone work or moulding shall be executed accurately in accordance with the design and worked to approved templates.

Fine dressed stones shall be fine chisel dressed having the best surface which can be given to a stone without rubbing. A straight edge laid along the face of the stone so dressed shall be in tact with the surface at every point.

Chisel dressed stone shall be sparrow picked or chisel dressed so that no portion of the dressed face is more than 1/8" from a straight edge placed on it.

Rough tooled stone shall be sparrow picked or chisel dressed so that no portion of the dressed face is 1/4 inch from a straight edge placed on it.

Hammer dressed stone shall be dressed with a scabbling hammer without any picking, chiselling or rubbing.

802-5 MORTAR

Unless otherwise specified, mortar used for stone masonry work shall be 1:6 cement mortar, mixed by volume in a dry state first and then mixed by adding sufficient amount of water to make it workable. When specified for surface work the colour of the mortar shall be of an approved quality and brand. No water proofing material shall be added to the mortar unless specially required or directed by the Engineer.

802-6 WATER

Water shall conform to Specification of Section 1051.

802-7 TOOLS AND EQUIPMENT

All equipment used for mixing and transporting mortar and for laying stone shall be clean and free from set mortar, dirt, or other injurious foreign substances. The equipment shall be thoroughly cleaned at the end of each day's work.

802-8 LAYING STONE MASONRY

- (a) Every stone shall be laid in the work on its natural quarry bed or in such a manner that the stresses borne by it come normal to such bed.
- (b) Whenever possible, the entire masonry in any structure shall be carried up at uniform level. Where breaks are unavoidable; joints shall be made in gradual steps. Cross walls shall be carefully bonded into the main wall and all junctions of wall shall be formed at the time the walls are being built.
- (c) Each stone shall be set with both bed and vertical joints filled with mortar, except in case of dry stone pitching or masonry, and thoroughly bedded in.
- (d) All masonry shall be taken up truly plumb or at the specified slope in the case of batter.
- (e) Quoins and jambs shall be laid at a true right angle to the bed, the corners being straight and vertical. In the case of masonry with hammer dressed stone, a chisel draft one-inch wide shall be given on each external face to allow accurate plumbing, Quoins shall be laid headers and stretchers alternately.
- (f) Jambs for door and window openings shall be formed with quoins of the full height of the course. The length and breadth of the quoins shall be at least $2\frac{1}{2}$ times and $1\frac{1}{4}$ times the depth of the course respectively. For door openings three, and for window openings two of these quoins shall be stone of full thickness of wall. Door and window frames shall be let into $\frac{1}{2}$ inch chassis in the quoins.

802-9 FIXTURE

Holdfasts and similar fixtures shall be built in with the surrounding stone masonry in their correct position in specified mortar. These shall be built in as the work progresses and not inserted later on into space left for them.

802-10 LINTEL AND INSIDE STONE

All lintels and inside stone, not to be plastered over, shall be of the full width of the wall in which they are laid, including the thickness of the plastered face or faces.

802-11 OPENINGS

Door and window openings shall have flat or relieving arches or lintels spanning across them as shown on the drawing or as specified.

802-12 SCAFFOLDING

The Contractor shall provide all scaffolding, staging, ladders, etc., necessary for the work. All walls or other stone masonry of the building shall be securely braced and protected against damages by wind and storms during construction. No extra rate will be paid for this item of work.

802-13 CENTERING

The centrings for all openings shall be strong enough to support lintels or arches spanning the openings. They shall be subject to the approval of the Engineer and shall remain in position till stone masonry has set. No additional payment will be made to the Contractor for this item of work.

802-14 PUTLOGS

Only headers shall be left out to allow a putlog to be inserted and not more than one stone shall be left out for each putlog. Under no circumstances shall putlogs be made immediately under or next to the impost or skew back of arches.

802-15 ROUNDED CORNER

Corners shall be rounded where specified. (Such work shall be payable separately in the case of exposed masonry but not in the case of masonry to be plastered).

802-16 STRIKING OF JOINTS

The exposed surface shall be finished as specified. When not specified joints shall be struck simultaneously with masonry work keeping the face of the work clean. (Payment for striking the joints shall be made separately on superficial area of the masonry).

802-17 BED PLATES

Bed plates shall be provided under all beams and joints. They shall be chisel dressed on all faces and conform to the dimensions given in the drawing and shall be carefully laid having fine joints, with the specified packing to give the correct level.

802-18 CRAMPS

Cramps, joggles and dowels shall be used whenever specified or directed by the Engineer. Cramps shall be of copper or lead and shall be from 6 inches to 12 inches in length, 3/8 inch to 1 inch in thickness and 1 inch to 2 inches in width, as specified. They shall have each end turned at right angle. Copper cramps shall be forged, and set with neat cement. Lead cramps shall be formed by running molten lead into the dove-tail channels. Joggles and dowels shall be double wedge form and made of copper slate or similar stone and set in neat cement. On no account iron cramps, joggles or dowels, whether galvanized or otherwise shall be used.

802-19 PROTECTION AND WATERING

All stone masonry shall be protected during construction from the effects of rain and frost by suitable covering. The masonry laid in cement and lime shall be kept moist for a period of 10 days.

802-20 COPINGS AND CORNERS

Coping stone shall be full size throughout, of dimensions indicated on the drawing or as specified, if not shown on the drawing. Beds joints and top shall be fine pointed. All copings shall be dowelled or cramped, as specified, and the corners of pillars, skew backs and similar work shall be joggled to the stone below, if so specified.

802-21 STRING COURSES

The string courses shall tail at least 9 inches into the work with a full bearing for at least 4 inches and shall be paid for at a rate per running foot along the course. They shall also be throated on the underside, if so directed by the Engineer.

802-22 ASHLAR MASONRY

802-22.1 SCOPE: Ashlar masonry shall be finished in line with the specified architectural details, dimensions and grades in a workmanlike manner according to following specifications.

802-22.2 DRESSING: Every stone in fine ashlar shall be dressed on all beds, joints and faces, full true and out of winding, if the surfaces are plain or to uniform curves and twists, if so specified.

802-22.3 THICKNESS OF JOINTS: Stone shall be set in specified fine mortar, the beds or joints being in no case more than 1/8 inch in thickness. Each stone shall be struck with a maul, when laid, to bring it to a solid bearing, both to the bed and the joint.

802-22.4 SIZE OF STONE: Stone shall be laid in regular courses not less than 12 inches in height. All courses shall be of the same height, unless otherwise specified. No stone shall be less in breadth than $1\frac{1}{4}$ times its height or less in length than $2\frac{1}{2}$ times its height.

802-22.5 BOND: The face stone shall be laid header and stretcher alternately, unless otherwise specified. The headers are arranged to come as nearly as possible in the middle of the stretchers, below and the stone in adjacent layers shall break joints on the face for at least half the height of the course, and the bond shall be carefully maintained throughout.

802-22.6 THROUGH STONE: In walls $2\frac{1}{2}$ feet thick and less the header shall run right through the wall.

802-22.7 COURSES: The course line shall be horizontal and side joint vertical throughout.

802-22.8 JAMBS: Jambs in door and window openings shall be formed with quoins of the full height of the course. Unless otherwise specified the quoins shall not be less in breadth than $1\frac{1}{2}$ times or in length less than twice the depth. At least three quoins in case of doors, and two quoins in case of windows, shall be stones of the full thickness of the wall.

802-22.9 ROUGH TOOLED ASHLAR: The faces exposed to view shall have a fine dressed chisel draft, one inch wide, all round the edges and be rough tooled between the drafts, and on all beds and joints, which shall not exceed $3/8$ inch in thickness.

802-22.10 ROCK RUSTIC OR QUARRY FACED ASHLAR: It shall be similar to specifications of Section 802-22.9, except that the exposed faces of the stone between the drafts shall be left rough as the stone comes from the quarry. But no rock face or "bushing" shall project more than 3 inches from plane of drafts. The drafts may be omitted altogether, except at quoins if required for architectural purposes, or as specified.

802-22.11 OTHER RESPECTS: In all other respects the work shall comply with the specifications under paras 802-5 to 802-21.

802-23 COURSE RUBBLE MASONRY

802-23.1 HEIGHT OF COURSE: Stone shall be laid in horizontal courses not less than 6 inches in height. All stones in course shall be of equal height and all courses of the same height, unless otherwise specified. But no course shall be thicker than the course below it. All stones shall be set full in specified mortar in beds and joints.

802-23.2 DRESSING: The face stone shall be square on all joints in masonry. The beds shall be hammer or chisel-dressed, true and square, for at least 3 inches, back from the face, and the joints for at least $1\frac{1}{2}$ inches. The face of the stone shall be hammer dressed and "bushing" not to project more than $1\frac{1}{2}$ inches.

802-23.3 THICKNESS OF JOINTS: All side joints shall be vertical and beds horizontal, and no joint shall be more than $\frac{3}{8}$ inch in thickness. No pinning shall be allowed on face.

802-23.4 SIZE OF STONE: No face stone shall be less in breadth than its height, nor shall it tail into the work to a length less than its height; at least $\frac{1}{3}$ rd of the stone shall tail into the work at least twice its height or in walls thicker than 2 feet, three times its height.

802-23.5 THROUGH STONE AND HEADERS: Through stones shall be inserted 5 to 6 feet apart in every course, and shall run right through the wall, not more than 2 feet thick. When the wall is more than two feet thick, a line of two or more headers shall be laid from face to back, which shall overlap each other at least 6 inches. The headers shall have a length of at three times the height.

802-23.6 BREAKING OF JOINTS: Stone shall break joint by at least half the height of the course.

802-23.7 QUOINS: Quoins shall be of the same height as the course in which they occur, shall be formed of stone at least $1\frac{1}{2}$ feet long and shall be laid stretcher and header alternately. They shall be laid square on their beds which shall be fairly dressed to a depth of at least 4 inches.

802-23.8 INTERIOR FACE: The work on the interior face shall be precisely the same as on the exterior face, except that side joints need not be vertical.

802-23.9 HEARTING: The interior of the wall, called hearting, shall consist of flat-bedded stones carefully laid on their proper beds and solidly bedded in mortar. Chips and spawls of stone are wedged in, wherever necessary, so as to avoid thick beds or joints of mortar. No dry work or hollow spaces shall be left anywhere in the masonry. The face work and hearting shall be brought up evenly but the hearting shall not be levelled up at each course by the use of chips.

802-23.10 OTHER RESPECTS: In all other respects it shall conform to specification under Paras 802-5 to 802-21.

802-24 RANDOM RUBBLE MASONRY

802-24.1 GENERAL: Stone shall be hammer dressed on the face and on the sides and beds to such an extent that weak corners are chipped off and the stones come into close proximity, when laid. Each stone shall be laid on its quarry bed and shall be wedged or pinned strongly into position in the wall by spawls or chips which may show on the face.

802-24.2 JOINTS: No stone shall tail into the wall less than $1\frac{1}{2}$ times its height. The stone shall be arranged to break joints as much as possible. Care shall be taken to avoid long continuous vertical joints.

802-24.3 THROUGH STONE OR HEADERS: One header stone shall be inserted at least every 5 square feet of the surface (face) and shall run right through the wall if it is not more than 2 feet thick. If the wall is more than 2 feet thick, a line of headers shall be laid from face to back which shall overlap each other at least 6 inches.

802-24.4 HEARTING: Hearting or interior filling between the front and back face shall consist of rubble stone, less than 6 inches in any direction, carefully laid, hammered down with a wooden mallet into place and solidly bedded in mortar. Chips and spawls of stone shall be used wherever necessary, so as to avoid thick beds or joints

of mortar. No dry work or hollow spaces shall be left anywhere in the body of the masonry. Hearting shall be laid nearly level with each course except that at about 3 feet interval vertical "plumbs" projecting 6 to 9 inches shall be firmly embodied to form a bond between successive courses. Hearting shall not be brought to the same level as the front and back stones by the use of chips. The use of chips shall be restricted to only wedges in the hearting.

802-24.5 OTHER RESPECTS: In all other respects, the work shall comply with the specifications under Paras No. 802-5 to 802-21.

802-25 DRY RUBBLE MASONRY

802-25.1 SIZE OF STONE: Dry rubble masonry shall be constructed with the largest practicable size of the stone available - the larger stone being used in the lower courses.

802-25.2 BEDS: Stone shall be roughly dressed to secure the maximum bedding surface without unduly reducing the size of the stone. Each course shall be built through the entire thickness of the wall.

802-25.3 BOND STONE: Bond stone shall be provided in each course at an interval of 5 feet. It shall be of the height of the course in which it is to be used, at least as broad and of the greatest length procurable. No bond stone shall be less than 2 feet long. When the length is less than the thickness of the wall 2 or more stones shall be used overlapping each other by at least 6 inches to provide through bond from front to back. All bond stones shall be separately stacked before use and marked so that they can be identified after having been built in the wall.

802-25.4 FILLING: Whenever required, filling behind dry stone walls shall be done immediately with stone refuse or chips. Earth shall not be used where stone refuse is available.

802-26 COPING, CORNICES AND COLUMNS

802-26.1 STONE: Stone cornices, copings, pillars, string courses, corbels, brackets, chajjas and similar works shall be made from stone of uniform colour and texture and of the kind specified for each.

802-26.2 DRESSING: The stone shall be dressed full or to the approved templates. Unless otherwise specified, the exposed faces shall be fine chisel dressed. All visible angles and edges shall be free from chipping.

802-26.3 SIZE OF STONE: No stone shall be less than 18 inches in length nor less in height than the height of the copings. In cornices and string courses which do not extend right through walls, every stone shall tail into the wall by at least as much as the projection behind the face of the wall and in no case less than 6 inches. Coping stone shall extend the entire depth of the coping, unless otherwise specified or directed by the Engineer in writing.

802-26.4 MORTAR: Cornices, string courses, corbels and pilers shall be set in lime mortar or cement mortar of specified mix, depending upon the rest of the masonry.

802-26.5 CHAJJAS: Chajjas, in the case of isolated windows, shall consist of a single stone; in continuous chajjas all joints shall come over the brackets.

802-26.6 No joints shall be more than 1/8 inch in thickness.

802-26.7 WEATHERING AND THROATING: All outside cornices, copings, corbels and similar projecting courses shall be weathered on the top and throated underneath.

802-26.8 DOWELS: Coping stones and other similar works are to be cramped or dowelled and courses of pillars, skew back and similar works shall be joggled, whenever specified.

802-27 STONE MASONRY IN ARCHES

802-27.1 GENERAL: Unless otherwise specified, all stone masonry in arches shall be finished in a workmanlike manner, true to dimensions and grades shown on the drawings or according to the following specifications.

802-27.2 CUTTING, DRESSING OF STONE CENTRING: Stone to be cut and dressed shall follow the specification under 802-4.

802-27.3 CENTRING: Centring shall be strong enough to bear the weight of an arch without any deflection. The surface of centring shall be correctly struck to the curvature of the soffit of the arch.

802-27.4 WEDGES AND SAND BOXES: Centres of arches of over 5 feet span shall be erected on wedges. Centres of over 10 feet span shall be on double wedges and of those over 20 feet span on sand boxes so as to allow the gradual lowering of centre (i.e. striking).

802-27.5 BUILDING OF ARCHES: The building of arches shall not begin until the abutments have been built to their full width and up to the level of skew backs. Arch work shall be done evenly from both abutments, and as soon as the arch is completed, masonry shall be built evenly on both sides to the heights of the crown so as to load the haunches.

Stone masonry in arches shall conform to Specification under para 802-5 to 802-21 for stone masonry work, except with the following modification:

1. In all arches, the voussoir joints shall be truly radial. Stone shall be laid in full beds of mortar and shall be well rubbed and pressed into their beds so as to squeeze out surplus mortar and leave the joints as thin as possible.
2. Joints in arches shall not exceed $1/4$ inch in thickness at any point. Radial joints in gauged arches shall not exceed $1/8$ inch thickness.
3. Skew backs shall be formed of stone correctly shaped to radiate from the centre of curvature and shall not be packed with mortar or chips. Before the building of an arch is started abutments shall be exactly at the same level and skew backs in place.
4. For gauged arch work, the arch shall be laid out full size on the ground on lime plaster and all joints carefully marked out. Templates shall then be made as a guide for the special shapes of stones. Stones shall be carefully cut and then rubbed to the required shape. All the stones for any arch shall be prepared in full and set up dry on the ground before commencing work.
5. Segmental arches used over rectangular door or window openings shall have a flat rectangular soffit and segmental extrados.
6. Flat arches shall be built in the same manner as gauged arches but with all the voussoir joints converging on the apex of an equilateral triangle described on the soffit of the arch. Cross joints and extrados shall be parallel to the soffit. The arch shall be built with a camber of $1/8$ per foot of span.

7. Arches shall be built in concentric rings and each ring shall be completed before work on the ring above is started. In all cases, care shall be taken that the centre line of the stone face is radially placed. The arch ring shall in all cases, be bonded together by special bond stones.

802-27.7 SIZE OF STONE: Unless otherwise specified, the height of each stone shall be equal to the thickness of the arch up to 15 inches. Above this, two stones may be used, but no stone shall be less than 6 inches in height. The intrados of all stone shall be rectangular, no side being less than 4 inches (rhembold in skew arches).

802-27.8 BREAKING JOINTS: All stones in arches shall have their ends inside the walls squarely dressed. All joints shall break with each other and no stone shall lie over a circumferential joint by less than half the width of the extrados.

802-28 PARAPET WALLS

Selected stones, squared and pitched to line and with heads dressed shall be used in ends of parapet walls in all exposed angles and corners. Headers shall be well interlocked and as many as possible shall extend entirely through the wall. Both the headers and stretchers in the two faces of wall shall be well interlocked in the heart and shall comprise practically the whole volume of the wall. All interstices in the wall shall be completely filled with cement grout or with spalls completely surrounded with mortar or grout.

802-29 POINTING

The pointing or finishing of all joints shall be as shown on the plans or as specified in the special provision.

When raked joints are called for, all mortar in exposed face joints and beds shall be raked out squarely to the depth noted on the plans. Stone face in the joint shall be cleaned face of mortar.

The mortar in the joints on top surfaces shall be crowned slightly at the centre of the masonry to provide drainage.

802-30 WEEP HOLES

All walls and abutments shall be provided with weep holes. Unless otherwise shown on the plans or directed by the Engineer, the weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than 10 ft. centre to centre.

802-30.1 CLEANING EXPOSED FACES: Immediately after being laid, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed. Before final acceptance and if ordered by the Engineer, the surface of the masonry shall be cleaned using brushed and acid if necessary.

802-31 MEASUREMENTS

All types of stone masonry shall be measured by volume. The unit of measurement shall be one hundred cu. ft.

Cornices, string courses and chajjas shall be measured by length. The unit of measurement shall be one foot.

Copings shall be measured by volume. The unit of measurement shall be 100 cu. ft.

802-32 RATE

The unit rate for each specific type of masonry shall be full compensation for that type of masonry, which shall include furnishing and placing of all materials, including mortar, and for all labour tools, equipment and incidentals necessary to complete the work prescribed in this Section, except steel anchors which shall be paid for at the contract unit price per pound for reinforcing steel under Section 821.

802-33 PAYMENT

Payment shall be made under:

Item No. 802-33.1 - Ashlar Masonry	-	Per 100 Cu.Ft.
Item No. 802-33.2 - Course Rubble Masonry.	-	Per 100 Cu.Ft.

Item No. 802-23.3	- Random Rubble Masonry.	Per 100 Cu.Ft.
Item No. 802-23.4	- Dry Rubble Masonry.	Per 100 Cu.Ft.
Item No. 802-23.5	- Cornices, String Courses Chajjas	R.Ft.
Item No. 802-23.6	- Copings	Per 100 Cu.Ft.
Item No. 802-23.7	- Stone Masonry in arches	Per 100 Cu.Ft.

SECTION 811

PRESTRESSED CONSTRUCTION

811-1 DESCRIPTION

The work specified in this Section consists of furnishing prestressed concrete members and units that have been post tensioned, i.e. in which prestressing cables are installed in ducts within the concrete and are stressed and anchored after the development of the specified concrete strength, the duct being pressure grouted as a final operation. It shall therefore, include all operations required for the manufacture of the member consisting of formwork, assembly of prestressing cables, placing of cable sheaths in proper position, provision of anchorages, fabrication of reinforcing steel work, placing and curing portland cement concrete type A, transfer of stress, grouting of duct holes and all other operations necessary for the construction and erection of such a member in place all according to these specification and the line, thickness, dimensions and notes shown on the plans.

811-2 CONSTRUCTION REQUIREMENTS

811-2.1 PORTLAND CEMENT CONCRETE: This will comply with the requirements of Section 701. Portland cement concrete Type A shall be used.

811-2.2 REINFORCING STEEL WORK: This will comply with the requirements of Section 821. Only deformed steel bars shall be used.

811-2.3 HIGH TENSILE STEEL: This will comply with the requirements of Section 1061.

811-2.4 CONSTRUCTION EQUIPMENT: This will conform to the requirements of Section 201.

811-3 PRESTRESSING CABLES

811-3.1 GENERAL: Prestressing cable will be made out of high tensile steel wire, core helix, metal sheath, prestressing anchorages and binding tape.

811-3.2 ASSEMBLY: The cable shall be assembled by drawing the high tensile steel wire through a metal spacerplate, inserting the helix core and taping or tying at close intervals.

811-3.3 SHEATHING: The assembled cable shall be sheathed in an approved metal sheath of internal diameter shown on the plan. The sheath shall be rigid and adequately strong to withstand handling and placing of concrete without sagging between its supports. The tying of the cable shall be removed as it is inserted into the cable.

811-3.4 POSITIONING: The cables in the sheaths shall be positioned accurately as shown on the plans and securely held in position, both horizontally and vertically while the concrete is being placed. Unless self joining sheath is used, all joints between sheathing or between sheathing and anchorage shall be made with approved couplers specially designed for this purpose. All joints shall be adequately and securely taped to prevent the ingress of grout from the concrete and/or any relative displacement which might cause difficulties when threading or grouting the cables.

811-3.5 ANCHORAGE: The female cone anchorage shall be securely wired to the formwork and the cable sheath slipped on to the protruding part of the female cone. The junction shall be well wrapped with plastic tape to ensure water tightness.

811-3.6 INSPECTION: Every cable sheath shall be carefully inspected immediately prior to concreting in order to ensure that the alignment is correct, the joints secure and the sheathing is undamaged.

811-3.7 DUCTS FOR TRANSVERSE CABLES: Wherever shown on the plans, ducts for transverse cables shall be provided.

811-4 STRESSING CABLES:

811-4.1 GENERAL: Cables shall be stressed by using jacks at both ends, or from one end as specified. The sequence in which the cables are stressed shall follow exactly the instructions shown on the plans or approved by the Engineer.

811-4.2 STRESSING SCHEDULE: Stressing schedules are stipulated for all cables, giving the required cable extensions and the initial and final jack pressures. These schedules are based on estimated friction and other losses and on an assumed value of Young's modulus. This value of the modulus shall be checked against that given on the wire in manufacturer's test certificate for each individual batch of wire and the extensions shall be adjusted accordingly before stressing is started after approval of the Engineer.

811-4.3 STRESSING JACKS: All jacks to be used for stressing together with their gauges shall be calibrated by a reputable laboratory. Calibration by proving ring or other acceptable method shall be performed by an established testing company. During the process of work, if any jack or gauge appears to be giving erratic results, or if gauge pressure and elongations indicate materially differing stresses, recalibration will be required.

811-4.4 STRESSING OPERATION: Stressing operations shall be at all times under the personal supervision of an Engineer experienced in this type of work. During the operation, there may be a possible differences of approximately five percent in indicated stress between jack pressure and elongation. In such an event, the error shall be so placed that the discrepancy will be on the side of a slight overstress rather than understress. In the event of an apparent discrepancy between gauge pressure and elongation of as much as ten percent, the entire operation shall be carefully checked and the source of error determined before proceeding further.

811-4.5 STRESSING RECORD: The stressing record shall be prepared and maintained on the proforma approved by the Engineer incharge. This proforma shall be signed by the contractor's Engineer and the authorized deputy of the Engineer. Copies will be despatched to various offices as mentioned on the proforma soon after the stressing operation.

811-5 GROUTING CABLE DUCTS

After completion of stressing, the annular space between the sides of cable and sides of duct shall be grouted in the following manner:

All duct holes shall be thoroughly cleaned before grouting. The holes shall be flushed with water just prior to grouting and all surplus water shall be removed by compressed air. With the grouting vent open at one end of the core hole, grout shall be applied continuously under moderate pressure at the other end until all entrapped air is forced out through the open grout vent, as evidenced by a steady stream of grout at that vent, whereupon the open vent shall be closed under pressure. The grouting pressure shall be gradually increased to at least 75 psi, and held at this pressure for approximately 15 seconds, and the vent shall then be closed.

The grout shall consist of neat portland cement having a water cement ratio of not more than 0.50. The consistency of the grout mixture during operations shall be that of heavy paint. The grout shall be mixed in a high speed motor driven mixer specially designed for the purpose and shall then be sieved into a pump unit where it shall be continuously mixed at a slow speed by means of a mechanical or hand operated agitator. The pump unit shall be of the diaphragm type, preferably motor driven, with a bypass pipe to enable constant circulation of grout except when injection is actually taking place.

811-6 CUTTING WIRE

After all stressing operations are completed, the projecting wire ends shall be cut off approximately $1\frac{1}{2}$ inch. from the face of the anchorage either by mechanical means, for example with a high speed cutting disc designed for this purpose or by using a very small and very hot oxyacetylene flame for not more than 3 seconds per wire. If flame cutting is used, it is of utmost importance to ensure that there is no appreciable heating of the wire stubs at the anchorages. The use of specially tempered bolt croppers will also be permitted if required.

821-6 COLD BEND TESTS

For bend tests, except in the case of round bars one inch in diameter and under, the test piece when cold shall withstand, without fracture, being doubled either by pressure or by blows from hammer until the internal radius is not greater than $1\frac{1}{2}$ times the thickness of the test piece and the sides are parallel. In the case of round bars 1 inch in diameter and under, the internal radius of bend shall not be greater than the diameter of the bar.

821-7 YOUNG'S MODULUS (E)

The value of the E for steels used in structural works shall be of the order of 30×10^6 lbs. per square inch.

821-8 PROTECTION OF MATERIAL

Steel reinforcement shall be stored above the surface of the ground upon platforms skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work it shall be free from dirt, rust, scale, dust paint, oil or other foreign material.

821-9 BENDING

The reinforcement shall be bent cold to the shapes indicated on the plans. Reinforcement bars shall be fabricated as prescribed in the Construction Manual for detailing Reinforced Concrete Highway Structure.

821-10 PLACING AND FASTENING

Steel reinforcement shall be placed in the exact position, as shown on the plans, before the concrete is poured and shall be held accurately in place during the placing of concrete. Vertical stirrups shall always pass around to main tension members and shall be accurately attached thereto.

The reinforcing steel shall be spaced its proper distance from the face of the forms by means of approved precast mortar or concrete blocks or other approved device.

All reinforcing steel shall be wired, welded or otherwise fastened together at the intersections as shown on the plans or as directed by the Engineer. Where splices are authorized the bars shall be rigidly clamped or wired in a manner approved by the Engineer. The splice lap shall be 24 diameters, unless otherwise shown on the plans.

Before any concrete is placed all mortar shall be cleaned from the reinforcement.

821-11 UNIT WEIGHT

The unit weights to be used for measurement of quantities of steel, shall be as shown in the following table:

Bar No.	Size	Area	Nominal dia. in inches.	Perime- ter	Weight per ft. in pounds
2	1/4"	0.05	0.250	0.79	0.167
3	3/8"	0.11	0.375	1.18	0.376
4	1/2"	0.20	0.500	1.57	0.668
5	5/8"	0.31	0.625	1.96	1.043
6	3/4"	0.44	0.750	2.36	1.502
7	7/8"	0.60	0.875	2.75	2.044
8	1"	0.79	1.000	3.14	2.670
9	1-1/8"	--	1.128	--	3.400
10	1-1/4"	--	1.270	--	4.303
11	1-3/8"	--	1.410	--	5.313
12	1-1/2"	--	1.500	--	6.008

821-12 MEASUREMENTS

The quantity of reinforcing steel to be paid for under this Section shall be the computed weight in CWT of this material entering into the completed structure of item of work. The length to be used in the calculation shall be detailed length to be paid for and as shown on the plans.

The unit for measurement of steel shall be one cwt.

821-13 RATE

The unit rate shall be full compensation for all the work described in this Section and shall include all welding, all clips, spacers, ties, etc., and wire or other material used for fastening the reinforcement in place.

In case short bars are used when full length bars might reasonably be required, the weight paid for shall be only that which would be obtained if full length bars were used, no allowance being made for lap.

821-14 PAYMENT

Payment shall be made as under:

- | | | | |
|-------------------|---|--|----------|
| Item No. 821-14.1 | - | Furnishing and placing plain Reinforcing Steel Bar ... | Per cwt. |
| Item No. 821-14.2 | - | Furnishing and placing deformed reinforcing steel bars ... | Per cwt. |

SECTION 831

STRUCTURAL STEEL WORK

831-1 DESCRIPTION

The work specified in this Section consists of furnishing, preparing, fabricating, assembling, erection and painting structural steel, wrought iron, castings and forging, plates and bolts for structures or portions of structures. Such work shall be done in accordance with these specifications and in conformity with the design, and with the lines, grades, dimensions and notes shown on the Plans.

831-2 MATERIALS

The materials used shall conform to the requirements for grade 1 quality steel according to B.S. 15.

Except where otherwise shown on the Plans, all major members shall be of structural steel and rivets shall be of rivet steel. Castings shall be of either cast steel or cast iron, as shown on the Plans.

831-3 DRAWINGS

Construction plans, consisting of shop drawings and erection and other working plans showing detail dimension sizes of material, and other information and data necessary for the complete fabrication and erection of the steel work shall be furnished by the Contractor. Approval of the construction plans shall be secured before the fabrication of steel work is commenced. Such approval constitute approval of design only, and shall not relieve the Contractor of responsibility for accuracy of details. For any deviation from such approved plans the Engineer's written order will be required.

No changes shall be made in any drawing after it has been approved, except by written consent or direction of the Engineer. Substitution of section having different dimensions than those shown on the Plans shall be made only when approved in writing by the Engineer.

831-4 STORAGE OF MATERIALS

Structural steel materials shall be stored above the surface of the ground, upon platforms, kids, or other supports and shall be protected as is necessary and practicable, from exposure to conditions producing rust or other surface deterioration. They shall be kept free from accumulations of dirt, oil or other foreign matter. Girders and beams shall be placed upright and shored.

831-5 STRAIGHTENING MATERIAL

Any deformed structural material shall be properly straightened by methods which are non-injurious, prior to being laid off, punched or otherwise worked in the shop. Sharp kinks and bends will be cause of rejection.

Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient fracture.

831-6 WORKMANSHIP AND FINISH

The workmanship and finish shall be first-class and equal to the best practice in modern bridge shops. Shearing and clipping shall be done neatly and accurately and all portions of the work exposed to view shall be neatly finished.

831-7 WELDS

831-7.1 GENERAL: Where so shown on the Plans, connections shall be made by electric arc welding, according to B.S. 1856, General Requirements for the Metal Arc Welding of Mild Steel.

831-7.2 SHOP WELDING: Where practicable, the shop welding of main material including connections of girders flanges and webs, cover plate connections and shop splices of girders of truss members shall be done by the automatic submerged-arc process. The combination of rod and flux for which such evidence is not made available will be required to pass the procedure qualification as specified in the AWS Specifications.

Ends of member fabricated by welding, which are to be field connected by welding, shall be shop-assembled or assembled to a templet to check the accuracy.

831-8 RIVETS

831-8.1 GENERAL REQUIREMENTS: The diameter of the rivets as indicated on the Plans designates their diameter prior to heating. Heads of driven rivets shall be of approved shape, concentric with the shanks, true to size, full neatly formed, free from fins and in full contact with the surface of the member. Rivets shall be free from furnace scale on their shanks and from fine on the under side of the machine-formed heads.

831-8.2 FIELD RIVETS: Field rivets for each size and length shall be supplied in excess of the actual number to be driven, so as to allow for losses due to misuse, improper driving or other contingencies.

831-9 BOLTS AND BOLTED CONNECTIONS

831-9.1 HIGH STRENGTH BOLTS: Where so shown on the Plans connections shall be made by means of high-strength bolts, and nuts with hardened steel washers. In any connection detailed for rivets, the connection may, at the option of the Contractor, be made with an equal number of high-strength bolts.

Bolts, Screws, Nuts and Washers shall comply in all respects with B.S. 916.

The bolts shall be quenched and tempered heavy semi-finished hexagon bolts with heavy semi-finished hexagon nuts.

Bolted connections shall be of the friction type. The bolts shall be tensioned by calibrated power wrenches.

<u>Size of Bolt Inches</u>	<u>Required Minimum Bolt Tension Lbs.</u>
3/4	28,400
7/8	36,050
1	47,250

Calibration shall be performed by means of an instrument furnished by the Contractor which indicates the direct bolt tension. Calibration by torque alone will not be permitted. Calibration of power wrenches shall be performed daily. The same hose lengths shall be used in calibration as are used in installing the bolts. Calibration shall be rechecked whenever hose lengths or any other conditions of the installation are varied. Calibration shall be performed by rightening at least three typical bolts. Wrenches shall be set to stall or cut out at a bolt tensions lightly in excess of the minimum tensions listed above. Upon completion of the tightening of the bolts in any joints, the wrenches shall be returned to at least the half of bolts first tightened as a check against possible loosening.

831-10 SHOP ASSEMBLY OF MAIN MEMBERS

The holes for field connections in all main members, including trusses, portal bracing, girders, continuous I-beams, rigid frames, bents towers, etc. shall be subpunched, the parts shop assembled, and the holes reamed to full size while so assembled. Floor beams and stringer connection shall be reamed to a metal templet not less than one inch thick.

831-11 HOLES FOR RIVETS AND BOLTS

831-11.1 GENERAL REQUIREMENTS: Except for main members, as provided above, and where general reaming is not called for on the

plans, holes in material $3/4$ inch or less in the thickness may be punched full size. Holes in material more than $3/4$ inch in thickness shall be subpunched and reamed or drilled from the solid.

831-11.2 PUNCHED HOLES: Full size punched holes shall be $1/16$ inch larger than the nominal diameter of the rivet or bolt. The diameter of the die shall not exceed the diameter of the punch by more than $3/32$ inch. Holes must be clean cut, without torn or ragged edges. If any holes must be enlarged to admit the rivets or bolts, they shall be reamed.

831-11.3 DRILLED HOLES: Drilled holes shall be $1/16$ inch larger than the nominal diameter of the rivet or bolt. Burrs on the outside surface shall be removed.

831-11.4 SUB-PUNCHED AND REAMED HOLES: Subpunched and reamed holes for rivets having diameters greater than $3/4$ inch shall be punched $3/16$ inch smaller than the nominal diameter of the rivet, and for rivets having diameters $3/4$ inch or less, and for bolts, the holes shall be punched $1/16$ inch less than the nominal diameter of the rivet or bolt. The punch and die shall have the same relative size as specified for full sized punched holes. After the punching the holes shall be reamed to a diameter $1/16$ inch larger than the nominal diameter of the rivet or bolt. Burrs resulting from reaming shall be removed. Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers preferably shall not be directed by hand.

831-11.5 ACCURACY OF REAMED AND DRILLING HOLES: Reamed or drilled holes shall be cylindrical and perpendicular to the member, and their accuracy shall be the same as specified for punch holes, except that after reaming or drilling, 85 per cent of any group of contiguous holes in the same plan shall not show an offset greater than $1/32$ inch between adjacent thickness of metal.

831-11.6 DRIFTING OF HOLES: The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

831-11.7 GENERAL REAMING: General reaming may be required, in which case it will be shown on the Plans.

Where general reaming is required, all holes shall be subpunched and reamed in material forming apart of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet or bolt. Holes may be punched full size in material used for lateral, longitudinal, and sway bracing, lacing bars, stay plates and diaphragms not forming part of the section of main members, if the thickness of the material is not greater than the nominal diameter of the rivet or bolt. Holes shall be drilled in material in the thickness of which is greater than the nominal diameter of the rivet or bolt.

Reaming shall be done after the pieces forming a built member are assembled and firmly bolted together. Reamed parts shall not be interchanged.

Holes for field connections, except those in lateral, longitudinal and sway bracing, shall be reamed or drilled with the connected parts assembled, or else reamed or drilled to a metal templet not less than one inch thick.

831-12 RIVETING:

Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. The points of rivets shall not be heated more than the remainder. When ready for driving they shall be free from slag, scale and other adhering matter, and when driven they shall completely fill the holes. Burned, burred or otherwise defective rivets, and rivets which throw off sparks when taken from the furnace or forge, shall not be driven. Rivets shall be driven by power tools. The use of hand tools for riveting will not be permitted unless specifically authorized in writing by the Engineer.

Rivets which are loose burned, badly formed or otherwise defective shall be cut out. Calking and re-cupping of rivet heads shall not be done. In cutting out defective rivets care shall be taken not to injure the adjacent metal and, if necessary, the rivet shank shall be removed by drilling.

Countersinking shall be neatly done and countersunk rivets shall completely fill the holes.

831-13 SHOP ASSEMBLY

The component parts of a built member shall be assembled, drift pinned to prevent lateral movement, and firmly bolted to draw the parts into close contact before reaming, drilling or riveting is begun. The members shall be free from twists, bends or other deformations. Preparatory to shop connecting full size punched material, the holes shall be cleaned for admission of rivets or bolts by reaming.

End connection angles, stiffeners, angles, etc., shall be carefully adjusted to corrected locations and rigidly bolted, clamped or otherwise firmly held in place until connected.

Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

831-14 PLANNING

831-14.1 EDGE PLANNING: Sheared edges of material more than 5/8 inch in thickness shall, when required by the Engineer, be planned to a depth of not less than 1/8 inch. Re-entrant cuts shall be filleted before cutting.

831-14.2 PLANNING OF BEARING SURFACES: Ends of columns taking bearing upon base and cap plates shall be milled to true surfaces and correct bevels after the main section of these members and the end connection angles have been fully riveted.

Caps and base plates of columns and the sole plates of girders and trusses shall have full contact when assembled. The plates if warped or deformed, shall be hot straightened, planned, or otherwise treated to secure an accurate, uniform contact. After being riveted in place the excess metal of countersunk rivet heads shall be chipped smooth and flush with the surrounding metal, and the surfaces which are to come in contact with other metal surfaces shall be planed or milled, if necessary to secure proper contact. Correspondingly, the surfaces of base and sole plates which are to come in contact with masonry shall be rough-finished, if not free from warps or other deformities.

Surfaces of cast pedestals and shoes which are to come in contact with metal surfaces shall be planed and those which are to take bearing upon the masonry shall be rough finished. In planning the surfaces of expansion bearing the cut of the tool shall be in the direction of expansion. Surfaces of bronze bearing plates intended for sliding contact shall be carefully milled and polish-finished.

831-14.3 ABUTTING JOINTS: Abutting ends of compression members shall, after the members have been rivetted or bolted, be accurately faced to secure an even bearing when assembled in the structure.

Ends of tension members at splices shall be rough-finished to secure close and neat fitting joints.

831-15 END CONNECTION ANGLES

End connection angles of floor beams and stringers shall be flush with each other and accurately set as to position and length of member. In general, end connection angles shall not be finished unless so shown on the Plans. However, faulty assembling and riveting may be cause for requiring them to be milled, in which case their thickness shall be reduced, but not to exceed 1/16 inch, nor shall their rivet bearing value be reduced below design requirements.

831-16 LACING BARS

The ends of lacing bars shall be neatly rounded unless otherwise indicated on the Plans.

831-17 PLATE GIRDERS

Web plates of girders having no cover plates may be detailed with the top edge of the web flush with the backs of the angles. Web plates of girders having cover plates may be 1/2 inch less in width than the distance, back to back top flange angles.

Where web plates are spliced there shall be not more than $3/8$ inch clearance between ends of plates.

End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure a uniform, even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted.

Web plate plates and fillers under stiffeners shall fit within $1/8$ inch at each end.

831-18 PINS AND ROLLERS

Pins and rollers shall be accurately turned to detailed dimensions and shall be smooth, straight and free from flaws. The final surface shall be produced by a finished cut.

Pins and rollers having a diameter greater than six inches shall be forged and annealed.

Pins and rollers larger than eight inches in diameter shall have a hole not less than two inches in diameter bored longitudinally through their centers. The hole shall be bored after forging and before annealing. Pins and rollers showing defective interior conditions will be rejected.

831-19 BORING PIN HOLES

Pin holes shall be bored true to detailed dimensions, smooth and straight, straight angles with the axis of the member and parallel with each other unless otherwise required. A finished cut shall always be made.

The length outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from detailed dimensions more than $1/32$ inch. Boring of holes in built-up members shall be done after riveting is completed.

831-20 PIN CLEARANCES

The difference in diameter between the pin and the pin holes shall not be more than $1/32$ inch.

831-21 SCREW THREADS FOR PINS

Screw threads shall make close fits in the nuts and shall be U.S. standard except that for diameters greater than $1/2$ inches they shall be made with six threads to the inch.

831-22 PILOT AND DRIVING NUTS

Two pilot nuts and two driving nuts shall be furnished for each size pin unless otherwise shown on the Plans.

831-23 NOTICE OF ROLLING AND FABRICATION

The Contractor shall give ample advance notice to the Engineer of the beginning of work at the mill and shop, so that inspection may be provided. No material shall be rolled or fabricated before the Engineer has been notified where the orders have been placed.

831-24 FACILITIES FOR INSPECTION

The Contractor shall furnish all facilities for the inspection of materials and workmanship in the mill and shop, and inspector shall be allowed free access to the necessary parts of the premises.

831-25 REJECTION OF FABRICATED WORK AT SITE

The Engineer may waive shop inspection and make complete inspection of all fabricated work upon its delivery at the site of the structure.

Whether or not shop inspection is made fabricated steel may be rejected at any time it might be found as not conforming to the plans and specifications.

831-26 MARKING AND SHIPPING

Members weighing more than three tons shall have the weight marked thereon. Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and small packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels of convenient sizes. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

The weight of all tools and erection material shall be kept separate.

Anchor bolts washers and other anchorage or grillage materials shall be shipped to suit the requirements of the masonry construction.

The loading transportation and unloading of structural material shall be so conducted that the metal will be kept clean, and free from injury by rough handling.

831-27 SETTING ANCHOR BOLTS

Where the substructure and superstructure are built by different contractors, anchor bolts shall be set by the substructure contractor. It shall, however, be the responsibility of the superstructure contractor to provide the substructure contractor with anchor bolts and correct plans for their setting, and he shall cause the substructure contractor no delay in such work. In any case it shall be the responsibility of superstructure contractor to inspect the setting of anchor bolts at the time the work is being done and to check the placing of them. Any expense incurred because of any error in setting anchor bolts shall be borne by the superstructure contractor.

The location of the anchor bolts in relation to the slotted holes in expansion shoes shall be varied with the prevailing temperature. The nuts on anchor bolts at the expansion ends of spans shall permit the free movement of the span.

Unless otherwise shown on the Plans anchor bolts shall be set by one of the three methods specified below. Any one of these methods may be used at the option of the Contractor, unless the Engineer designates the methods to be used in any particular case.

(1) Setting Bolts in Drilled Holes: Anchor bolts holes shall be drilled in correct location, vertically to the plane of the bridge seat and the anchor bolts set in portland cement mortar therein. The mortar shall consist of one part cement of one part clean, fine grained sand, mixed sufficiently wet to flow freely. Anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. They shall then be set as follows:

Fill the holes about two thirds full of mortar and by a uniform, even pressure or by light blows with a hammer (flogging and ramming shall not be done) force the bolt down until the mortar rise to the top of the hole and the anchor bolt nut rests to the top of the holes and the anchor bolt nut rests firmly against the metal show or pedestal. Remove all excess mortar which may have flushed out of the hole, to permit proper field painting of the metal surface.

(2) Setting Bolts in Formed Holes: Bolts holes in concrete masonry may be formed by the insertion in the fresh concrete of oiled wooden plugs or metal pipe sleeves which are subsequently withdrawn after concrete has partially set. When the holes are formed by the latter method they shall be not less than four inches in diameter to allow for horizontal adjustment of the bolts.

(3) Setting Bolts Directly in Masonry: In this method, anchor bolts are set to the exact location in the concrete when it is placed.

In this case great care shall be exercised to insure the proper setting of the bolts, and any inaccuracies which would be detrimental to the structure shall be corrected by suitable means.

831-28 PREPARATION OF BEARING AREA AND SETTING SHOES AND PEDESTALS

Column bases, truss and girder pedestals, and shoes shall have full and uniform bearing on the substructure masonry. Masonry bearing plates shall not be placed on the bridge seat area of piers or abutments which are improperly finished, deformed or irregular.

The shoes and pedestals of truss and girder spans and of L - beam spans, the bases of column, and the center and end bearing of swing spans shall be rigidly and permanently located to correct alignment and elevations.

831-29 HANDLING MEMBERS

The field assembling of the component parts of structure shall be done by the use of methods and appliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No members slightly bent or twisted shall be put in place until its defects are corrected, and any members seriously damaged in handling will be rejected.

831-30 ALIGNMENT

Before the beginning of the field riveting the structure shall be adjusted to correct grade and alignment and the elevations of ends of floor beams properly regulated. For truss spans a slight excess camber will be permitted while the bottom chords are being riveted, but the correct camber and relative elevations of panel points shall be secured before riveting the top chord joints, top lateral system and sway bracing.

831-31 METHOD OF MEASUREMENT

The quantity of Structural Steel entering into and becoming a part of the completed structure, and accepted by the Engineer shall be the computed weight in CWT of this material entering into the completed structure of item of work. The length to be used in the calculation shall be detailed length to be paid for and as shown on the plans.

The unit of measurement of structural steel work shall be one CWT.

Structural steel weights shall be the computed weights, assuming the weight per cubic foot of the various metals to be as follows:

Structural and Rivet Steel	490 lbs.
Steel Castings and Forgings	490 lbs.
Gray Iron Castings	450 lbs.
Malleable Iron	480 lbs.
Phosphor Bronze	562 lbs.
Wrought Iron	485 lbs.
Lead	706 lbs.

The weights of rolled shapes, bars, plates and pipe railings shall be computed on the basis of the nominal weight as given in manufacturer's handbooks, using the dimensions shown on the Plans. The weight shall be computed on the basis of rectangular dimensions and ordered overall lengths for all structural shapes except that (a) when parts can be economically cut in multiples from material of larger dimensions, the computed weight shall be that of the material from which the parts are cut and, (b) all material shall be ordered to produce as little waste as possible when cut and finished by modern shop methods. The weight of shims shown on the Plans shall be included in the quantity of Structural Steel.

No deductions from the computed weight of rolled steel shall be made for caps, clips, sheared edges, punching, borings, drillings, milling or planning and no allowance shall be made for the weight of weld metal or for overrun in weight.

The weights of shop and field rivets and of high-strength bolts, included nuts and washers, all as installed and accepted shall be computed on the basis of average lengths in accordance with the following tables:

Diameter of Rivet or Bolt	3/4"	7/8"	1"
Weight in lbs. per 100 Nos.	50	100	150

The quantity to be paid for shall be the original plan quantity, determined as provided above.

831-32 RATE

The unit rate shall be full compensation for all the work described in this Section, including welding and all paint materials and painting. No separate payment will be made for false work or other erection expenses.

831-33 PAYMENT

Payment shall be made under:

Item No. 831-33.1 - Structural Steelwork - Per Cwt.

SECTION 841

WELL FOUNDATION

841-1 DESCRIPTION

The work to be carried out under this section is the construction of a well to be used as foundation for the pier or abutment of a bridge and comprises of five separate operations, the casting of a well curb in proper position, the erection of well steining by stages, the sinking of the erected curb and well steining to the required elevation, the proper plugging of the well and the construction of the transom slab, all according to the lines, dimensions and forms shown on the plan.

841-2 CONSTRUCTION REQUIREMENTS

841-2.1 CONSTRUCTION EQUIPMENT shall conform to the requirements of Section 201.

841-2.2 STRUCTURAL STEEL WORK shall conform to the requirements of Section 831.

841-2.3 REINFORCING STEEL WORK shall conform to the requirements of Section 821.

841-2.4 PORTLAND CEMENT CONCRETE shall conform to the requirements of Section 701.

841-2.5 BRICK WORK shall conform to the requirements of Section 801.

841-3 WELL CURBS

841-3.1 CUTTING EDGE of the well curb will be structural steel prefabricated and supplied in segments convenient for site assembly by bolting together as per lines and dimensions shown on the plan. The segments of the cutting edge shall be interchangeable. The fitting together shall be checked at the fabrications work by the assembly of at least two complete cutting edges, formed of segments

chosen at random before these are accepted for despatch to the site of work. None of the steel work is to be painted and no surface preparation is called for other than the removal of rust and loose adhering mill scale.

841-3.2 REINFORCING STEEL WORK in the cutting edge will be properly bolted to the steel work and placed and assembled as shown on the Plan.

841-3.3 PORTLAND CEMENT CONCRETE for the cutting edge will be Type C and shall be finished to the form and dimensions shown on the Plans.

841-4 WELL STEINING

Well steining shall be made either of brick work in (1:3) cement mortar or portland cement concrete type C as indicated and of the form and dimensions as shown on the Plan.

Reinforcing steel work will continue from the cutting edge into the well steining with spacers made of structural steel work consisting of mild steel plates of the size and dimensions as shown on the Plan.

841-5 WELL SINKING

Well sinking process includes all operations required to sink the well in position and to the required elevation.

841-5.1 POSITIONING: Each well curb shall be correctly positioned in place and approved by the Engineer before commencement of further work.

841-5.2 SUPPORT: Well curbs shall be adequately supported to prevent shift or tilt during the initial operations of excavation and sinking whether the well has been started on made up ground or in water or in excavation.

841-5.3 EXCAVATION FOR SINKING: The soil from inside the well shall be removed by mechanical grabbing or other device as approved by the Engineer. The accuracy of sinking will be the responsibility of the Contractor.

841-5.4 DEWATERING: The water from inside the well will be pumped out and the arrangements will be commensurate with the site conditions. The Contractor will be responsible for the safety of plant and labour during these operations.

841-5.5 SHIFT AND TILT: The limit of departure from true vertical position of any well shall not exceed one unit measured horizontally in a vertical distance of sixty units. The maximum horizontal displacement of any well away from its correct position shall not exceed six inches.

It will be entirely the responsibility of the Contractor to keep the tilt and shift within the specified tolerances. If the above limits are exceeded, the Contractor will be required to carry out at his own cost suitable approved remedial measures to overcome the adverse effects of such tilts and shifts. In any case the maximum pressure at the base of the foundations after accounting for all tilts and shifts has to remain within the specified limits. In all these cases suitable penalty for substandard work will be imposed on the Contractor as per decision of the Engineer.

841-5.6 KENTLEDGE: The sinking effort can be augmented by the use of sand bags, rails and other heavy weights and as aid in correcting errors of tilts and horizontal shift. All precautions will have to be taken to prevent damage to well steining during sinking.

841.5.7 LIMITS OF SINKING: Each and every well shall be sunk to the elevation indicated on the plan or to any other elevation approved by the Engineer according to the nature of soil strata.

841-5.8 SOIL SAMPLES: The Contractor will have adequate arrangements to the satisfaction of the Engineer to collect disturbed samples of soil at every 5 feet elevation and at every change of soil strata and to deliver it in proper bags to the representative of the Engineer. The Contractor will also be required to obtain three samples of the natural soil at the elevation at which the well curb has been stopped and another sample 10 feet below that elevation before he is allowed to plug the well.

841-6 PLUGGING OF WELL

When the well has reached the final elevation to which it is to sink and has been approved by the Engineer, the bottom of the well will be plugged by depositing Type C concrete under water using 10% additional quantity of cement. To prevent segregation the concrete shall be carefully placed in the final position by means of a clamp bucket or other approved method and shall not be allowed to be disturbed after being deposited. The concrete shall be placed in one continuous operation.

841-7 SAND FILLING

When the well bottom has been plugged, the well hole will be filled with sand as specified and shown on the Plan. The sand shall be free from deleterious substance.

841-8 TRANSOM SLAB

When the well bottom has been plugged, the well top will be provided with a transom slab made of portland cement concrete, Type C and Reinforcing Steel work, all according to the lines, dimensions and forms shown on the Plans.

841-9 METHOD OF MEASUREMENT AND UNIT RATE

841-9.1 GENERAL: For the various items of work constructed under this Section, measurement shall be made as specified in the respective sections. The quantity to be paid for shall be the original plan quantity measured as provided in the respective sections, except where change has been made by the Engineer and order has been given in writing.

No measurements for or other allowances will be made for work or material for forms, false works, supports, bracings, kentledge, pumping.

841-9.2 WELL SINKING: For any item of work carried out under this head, measurement shall be made per linear foot of twin or single well of the specified external diameter, sunk below the bed level shown on the Plan. The unit of measurement shall be one linear foot. The unit rate for sinking twin or single well shall include excavation, pumping, support, bracing, kent-ledge, tilt correction soil samples, all according to the requirements given in Section 841-5.

841-9.3 STRUCTURAL STEEL WORK FOR CUTTING EDGE: Shall be measured and paid for according to the requirements of Section 831.

841-9.4 PORTLAND CEMENT CONCRETE TYPE C FOR well curb, steining, plugging of well and transom slab shall be measured and paid for according to the requirements of Section 701. The unit rate includes the cost of 10% extra cement to be used where required.

841-9.5 REINFORCING STEEL WORK for well curb, steining and transom slab shall be measured and paid for according to the requirements of Section 821.

841-9.6 BRICK WORK in (1:3) cement mortar for steining shall be measured and paid for according to the requirements of Section 801.

841-9.7 FILLING SAND in well hole shall be measured as the volume of well hole required to be filled. The unit of measurement shall be one thousand cu. ft.

841-10 PAYMENT

Payment shall be made under:

- Item 841-10.1 - Structural Steel Work for Cutting Edge - Per cwt.
- Item 841-10.2 - Portland Cement Concrete Type C for Well Curb, Plugging of Well, Well Steining or Transom Slab - Per Cu.Ft.
- Item 841-10.3 - Ist Class Brick Work in (1:3) Cement Mortar for Well Steining - Per % Cu.Ft.
- Item 841-10.4 - Furnishing and Placing Deformed Reinforcing Steel Bars for Well Curb, Steining and Transom Slab - Per cwt.
- Item 841-10.5 - (a) Well Sinking - Twin Well of prescribed diameter - Per R.Ft.
(b) Well Sinking - Single Well of prescribed diameter - Per R.Ft.
- Item 841-10.6 - Sand Filling in Wellholes - Per 1000 Cu.Ft.

SECTION 851

BORED CONCRETE PILING

851-1 DESCRIPTION

The work specified in this Section consists of constructing bored cast-in-situ reinforced concrete piles of specified nominal diameter under abutments and piers as per lines, elevation and notes shown on the plan and as per requirements of the Engineer. This also includes the execution of temporary works such as sand islands or access bridge, etc. The load testing on test piles will form part of the work. The work will also include Portland cement concrete Type D in blinding concrete layer, and Portland cement concrete Type C in pile caps under abutment and piers including reinforcing steel work as specified as shown on plans and as directed by the Engineer.

851-2 CONSTRUCTION REQUIREMENT

851-2.1 CONSTRUCTION EQUIPMENT: The construction equipment shall conform to the requirement of Section 201.

851-2.2 REINFORCING STEEL WORK: This shall conform to the requirement of Section 821.

851-2.3 PORTLAND CEMENT CONCRETE: The concrete shall be Type C and shall conform to the requirement of Section 701. The amount of cement in dry mix shall be increased by 10% in comparison with standard mix design for concrete.

851-3 REQUIREMENTS FOR PILING

851-3.1 GENERAL: The minimum depth of penetration of the pile will be as shown on the Plan. Depending on the results of pile loading tests and supplementary soil information obtained during the course of execution of the actual piling work, the Engineer will decide the additional depth to which the piles should penetrate.

851-3.2 ADVANCEMENT OF CASING: The contractor may use any percussion, rotary or other method, or any combination thereof, for advancing the temporary outer casing to the elevation required but the use

of water jets or of any other method or methods of the advancement of the casing which tend to disintegrate or to appreciably loosen the strata shall not be allowed.

851-3.3 LIMITATION OF BORING: No boring operations shall take place closer than 15 feet from any pile for which concreting operations are in progress or from any newly completed pile until at least four days have elapsed from the last concreting operation on that pile.

851-3.4 REMOVAL OF SOIL: The soil inside the casing shall be removed by augering or some similar method. It is expressly prohibited to pump out or to attempt to pump out the water in casing or to use pumping or water jetting to assist the removal of soil or any other material from the casing. No lubrication of the inner surface of casing shall be permitted.

851-3.5 SOIL SAMPLES: Two soil samples shall be taken from the bottom 12 inches in each borehole and shall be preserved in sealed and adequately labelled glass jars until personally inspected by the Engineer who shall then issue instructions regarding further disposal of these samples.

In addition to these two bottom samples which shall be compulsory for each and every borehole, the Contractor shall also keep a complete borehole log with a visual soils classification supported by an adequate number of samples preserved in sealed and adequately labelled glass jars, for at least two pile boreholes for each pier and each abutment. These boreholes should be selected at the extreme ends of each footing and should they show significantly different results, the Engineer may order additional borehole logs to be kept for intermediate pile boreholes. In this context, an adequate number of samples shall mean not less than one sample for every 5 feet of borehole and in addition, not less than two samples at every significant change in the soil strata. This sampling shall be assumed to be included in the rate of piling work and nothing extra shall be paid on this account.

851-3.6 TOLERANCES: The out-of-position tolerance shall not exceed 2" (two inches) in any direction. The out-of-plumb tolerance for vertical piles shall not exceed 1% (one per cent) in any direction. Similarly, the out-of-rake tolerance for raked piles shall not exceed 1% (one per cent) in any direction. The bow shall not exceed 2" (two inches) in any direction.

851-3.7 NIGHT WORK: Night work shall only be allowed for the advancement of casing but not for any sampling, measurements or concreting of pile. Night work shall only proceed under adequate artificial lighting and shall be at the Contractor's own risk and expense. Nevertheless, the Engineer can stop all night work at his sole discretion.

851-4 CHECKING POSITION OF PILES

After temporary casing has reached its final penetration as shown on the plan or as finally decided by the Engineer as after it has been completely cleaned of all earth and otherwise made ready to receive the reinforcement and thereafter the concrete, the contractor shall inform the Engineer or his Representative who shall personally check the actual penetration achieved, the cleanliness of the borehole and the amounts and directions, if any, by which the borehole is out-of-position and/or out-of-plumb or out-of-rake and, having satisfied himself on these and on any other points which he may consider relevant shall personally sign an acceptance voucher for the borehole authorising the contractor to proceed with placing the reinforcement. The contractor shall under no circumstances proceed with placing the reinforcement in the borehole, or with the subsequent concreting without having first obtained this written authority signed separately for each and every borehole personally by the Engineer or by his Representative.

851-5 PILE REINFORCEMENT

The reinforcement for each pile shall be assembled on the ground and securely tied by means of binding, wire in such a manner as to form a rigid cage. Concrete spacer blocks specially precast for this purpose shall be securely attached to the reinforcement at a suitable spacing in such a manner as to ensure that the concrete cover stipulated on the plan is maintained throughout and that the reinforcement cage is not displaced in the casing in the course of subsequent concreting operation. Particular care shall be taken to ensure that none of these spacer blocks can swivel around to the inside of the reinforcement cage and that in general, there are no obstructions of any kind inside the reinforcement cage due to spacer blocks or lapped reinforcement or any other reason, which might interfere with smooth travel of the concreting skip if the underwater method of concreting described hereinafter is to be used. The entire reinforcement cage assembly shall then be carefully lifted and lowered into the borehole. The contractor may prefer to lower the reinforcement cage assembly into the borehole in two or three sections. In that case he has to observe the same lapping requirements as for assembly on the ground, namely, that the main longitudinal reinforcement shall be lapped for not less than 40 bar diameters and the spiral reinforcement shall be doubled over these laps. In addition, concrete spacer block must be located immediately below and immediately above the laps at three points spaced around the cage so as to ensure that correct positioning of the reinforcement cage in the casing. Upon completion of this operation, the contractor shall notify the Engineer or his Representative who shall satisfy himself of the adequacy of this work and shall then issue to the Contractor, separately for each and every pile, a written authorization to proceed with concreting.

851-6 CONCRETING

851-6.1 PLACING CONCRETE: The concrete shall be placed by means of a skip lowered and raised by appropriate mechanical means. The outer dimensions of the skip shall be such that it can be freely lowered and raised inside the reinforcement cage and the manner of lowering and raising it shall be carefully controlled in a manner ensuring that the reinforcement cage is not distorted or displaced in the course of concreting. The bottom of the skip shall be of a conical or appropriate pyramidal shape to enable it to easily penetrate into the previously deposited concrete by a distance of not less than 9 inches, and it shall be fitted with an automatic or manually operated device for opening the discharge trap when the skip has achieved that penetration. To ensure the satisfactory placing of concrete in this manner, the skip should be allowed to accelerate or even to drop freely near the bottom of its course whilst the withdrawal of the skip should be gradual in order to ensure that all the concrete in the skip is in fact deposited well below the level of the fresh concrete in the casing. The success of this method of concreting requires an experienced and conscientious skip operator as well as competent engineering supervision and the Engineer shall satisfy himself in these points before allowing the Contractor to proceed with this work.

851-6.2 RATE OF PLACING: The rate of placing concrete shall be such that casing is filled with concrete at a rate of not less than 30 feet per hour and not more than 50 feet per hour.

851-6.3 COMPACTION OF CONCRETE: With the method of placing described above and using concrete with a slump of 3 to 4 inches, no compaction other than the impact of the skip is necessary and none shall be allowed because of the danger of mixing in extraneous matter with concrete.

851-6.4 END OF CONCRETING OPERATION: Concreting shall continue until the concrete has reached an elevation 3 feet higher than the bottom of the future pile cap.

851-6.5 WITHDRAWAL OF TEMPORARY CASING: The direction of withdrawal of casing must be in the most strict alignment with the actual direction of the casing in the ground and the timing of the withdrawal and the method used for the withdrawal of the casing must be such as not to disturb the freshly cast concrete in the piles. The withdrawal of the casing requires an experienced operator and competent engineering supervision, and the Contractor shall not be allowed to proceed with this work until the Engineer is satisfied with the adequacy of the Contractor's equipment and with the proficiency of his personnel.

851-7 PILE TOPS

The top portions of the piles shall be inspected personally by the Engineer or by his Representative and the contractor shall then break back the concrete in the top portion of the piles to the final elevation of the top of the piles which is 3" (three inches) above the bottom of the future pile cap, at the same time also exposing the length of pile reinforcement required for lapping and bond within the pile cap. The contractor shall check and record the actual final elevations of the broken off tops of piles against previously established bench marks and the tolerance for this final elevation shall not be greater than plus or minus 1 inch. The contractor shall also establish and record the actual co-ordinates of the centres of the broken off pile tops with respect to the theoretical centreline of each pile cap as shown on the plan, and the tolerance in this respect shall not exceed 2 inches in any direction.

The unsatisfactory concrete in the top portions of some or all piles may extend further down than the final elevation of the tops of the piles, in that event the contractor shall break back such greater lengths of such piles as may be ordered by the Engineer, or his Representative and shall make up such piles with sound concrete upto the final elevation of the pile tops as stipulated hereinbefore.

851-8 TEST LOADING OF PILES

851-8.1 PURPOSE OF LOAD TESTS: The load tests stipulated in this Section of the specifications are intended for the purpose of adjusting in the field the penetration of piles actually required to obtain an ultimate load bearing capacity of the piles of not less than $2 \times \text{Dead Load} + 2 \times \text{Live Load}$ or such higher factor of safety as the Engineer may stipulate at his discretion. A secondary objective of these pile loading tests is to establish whether any significant pile settlements are likely to occur up to the design load values.

851-8.2 PILES TO BE TESTED: The test piles shall be located in the bed as instructed by the Engineer in the vicinity of the bridge. The penetration of piles shall be down to specified elevation and the effective embedment of these piles shall be limited to the specified level by means or device approved by the Engineer, for example, by leaving in place a sufficient portion of the steel casing, all in a manner calculated to simulate as closely as possible the actual conditions which may occur with maximum local scour.

851-8.3 TIME OF TESTING: Not less than 14 (fourteen) days shall elapse between the end of all concreting operations on any test pile and the application of any test loads.

851-8.4 METHOD OF READING SETTLEMENT: A reference bolt shall be set in the top of each test pile and two bench marks shall be established on permanent objects near the location of the test piles and not less than 30 feet from the nearest test pile. The bench marks should be so located as to allow cross bearing on all the test piles and, if necessary, a third bench mark shall be established for this purpose, provided that only two bench marks are used for observations on any one test pile. Observations of settlements shall be made with reference to these two bench marks for each test pile by readings taken on these bench marks and on the reference bolt set in the top of each test pile.

851-8.5 METHOD OF LOADING PILES: The apparatus for the application of test loads should be capable of applying known vertical loads to the top of the test pile without including any horizontal thrust, twist or moment in the pile. Any loading apparatus used shall be so designed as to allow the direct placing of a surveyor's target rod on top of the reference bolt referred to above set in the top of the pile, without any interference. Adequate precautions shall be taken by the contractor to avoid accidents owing to toppling over of the test load, sudden pile settlements or any other reason. The contractor would furnish details of the method of loading proposed to be adopted for approval by the Engineer.

851-8.6 LOADING AND UNLOADING TEST PILES: The first increment of load applied to the test pile shall be 25% of the pile design load. The load on the pile shall be increased to the test load by applying additional load in increments amounting to 50, 75, 100, 125, 150, 175 and 200 per cent. A minimum period of two hours shall intervene between the application of each increment of load except that no increment shall be added until a settlement of less than 0.005 of an inch is observed for a 15-minute interval under the previously applied increment. The settlement just after application of each load increment is applied, and at 15-minute intervals thereafter, shall be recorded. If there is a question as to whether the test pile will support the test load, the load increments shall be reduced by 50 per cent in order that a more closely controlled failure curve may be plotted. The full test load shall remain on the test pile not less than forty-eight hours. During the application of each increment of load, the load shall be kept constant by jacking if required. For each application of the load the total settlement of the top of the pile, while under load, shall be recorded, then the load shall be released for a period of 15 minutes and the total permanent settlement of the top of the pile, with no load, shall be recorded. All settlement measurements shall be referred to the original top elevations of the test pile. If, after release, the full test load has caused more than one-quarter inch of permanent settlement in a period of forty-eight hours of continuous application of the test load, the test pile will be considered to have

field the test, indicating that longer piles are required. If the pile does not fail under the test load, the load shall be released and readings continued to check rebound at 15-minute intervals until no further movement of the pile is observed. The test pile shall then again be loaded with the test load, and that load will be increased in 10-skip increments to determine the test piles ultimate load capacity which is the maximum load on the test pile which does not cause a total settlement with load of more than one inch or a permanent settlement in excess of one-quarter inch when the load is maintained for forty-eight hours, and then released.

851-8.7 LOAD TEST REPORT: A load test report shall be submitted in triplicate and shall contain the following information:

(a) Exact location of the test piles with reference to previously established monuments or other permanent features, drawn in a plan to a suitable scale. This plan shall also indicate the penetration of the top of the each of test piles in plan as well as the direction and amount of bow in test pile, if any, in as far as those data be ascertained.

(b) A borehole log for the test piles showing reduced levels of the existing ground levels of the top of the pile, and of the ground water table, and showing also the thickness and reduced levels of various soil strata encountered during boring as well as their visual classification.

(c) A time-load settlement graph for each pile plotting the time in hours on the horizontal axis, the load in tons and the recorded settlements, in thousandths of a foot being plotted to a suitable scale of the vertical axis respectively above and below the common time axis.

(d) A load-settlement graph with the load in tons plotted on the horizontal axis and the corresponding settlement in thousandths of a foot plotted downwards on the vertical axis, all to a suitable scale and annotated with descriptions of settlement variation with time at critical or otherwise important load values.

(e) A report giving a general description of each load test and copies of the load test log for each test pile in tabular form with observations of loads, settlements and times for each load test and remarks concerning any unusual or noteworthy occurrences during the entire operation.

851-9 MEASUREMENT

The bored concrete piling shall be measured per linear foot in the completed form. The length of the pile shall be measured from head to tip. The blinding concrete and concrete and steel in pile cap under abutment and pier shall be measured in cubic feet and cwt. respectively.

851-10 RATE

The unit rate for various items of work listed below shall be full compensation for completion of work as specified above and as additionally directed by the Engineer and includes supply of equipment, labour, materials and incidentals.

851-11 PAYMENTS

Payment shall be made under:

- | | | |
|-------------------|--|--------------|
| Item No. 851-11.1 | - Bored Reinforced Concrete
Pile of Specified Dia-
meter. | - Per ft. |
| Item No. 851-11.2 | - Portland Cement Concrete
Type C for Pile Caps. | - Per Cu.Ft. |
| Item No. 851-11.3 | - Furnishing and Placing
Reinforcing Steel for
Pile Caps. | - Per cwt. |
| Item No. 851-11.4 | - Portland Cement Conc-
rete Type D, as blin-
ding Concrete. | - Per Cu.Ft. |

SECTION 852

PRECAST CONCRETE PILING

852-1 DESCRIPTION

The work covered in this section shall consist of furnishing and driving precast concrete piles, of the size and type called for, in accordance with these specifications and in reasonably close conformity with the lines, grades and locations shown on the plans or authorized by the Engineer. This also includes the execution of temporary works such as sand island or access bridge etc., load testing piles, laying a layer of blinding concrete (type D), laying cement concrete type C (unless otherwise specified) in pile caps under abutments and piers including reinforcing steel work as specified and as shown on the plans.

Precast concrete piles shall consist of concrete Section properly reinforced to withstand handling and driving stresses. Precast concrete piles may be either precast concrete piles with deformed steel reinforcing bars or precast prestressed concrete piles with high tensile steel wires.

If a square section is specified, the corners shall be chamfered one inch.

852-2 CONSTRUCTION EQUIPMENT

852-2.1 GENERAL: The construction equipment shall conform to the requirements of Section 201.

852-2.2 HAMMERS FOR DRIVING: Precast concrete piles shall be driven with single acting steam or air hammer developing not less than 13,000 foot pounds of energy per blow.

The contractor shall furnish the Engineer with the manufacturers' specifications and catalog for all steam or air hammers used, showing all the data necessary for computing the bearing value of piles driven. Gravity or drop hammers shall be weighed in the presence of the Engineer, or a certificate of weight shall be furnished to the Engineer. Hammers so weighed shall have the exact weight stamped on them.

852-2.3 LEADS: Fixed lead pile drivers shall be used when driving piles. The use of hanging or swinging leads will not be allowed unless they are so constructed that they can be held in a fixed position during the driving operations. Leads shall be of sufficient length so that the use of a follower will not be necessary. Lead adapted to the driving of a batter piles shall be employed for trestle construction or for foundation work involving inclined piles.

852-2.4 WATER JETS: Water jets shall not be used unless, in the opinion of the Engineer, such use is necessary or desirable. When water jets are used the number of jets and the volume and the pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least one hundred pounds per square inch pressure at two, 3/4 inch. jet nozzles.

852-3 MATERIALS FOR CONSTRUCTION

852-3.1 PORTLAND CEMENT CONCRETE: The concrete for Precast Prestressed piles shall have a minimum compressive strength of 6000 pounds per square inch at the age of 28 days. The minimum compressive strength of concrete at the transfer of pre-stress shall be 4800 pounds per square inch.

The concrete for other precast piles shall be type 'A'.

852-3.2 REINFORCING STEEL: For precast-prestressed piles high tensile steel shall be used as reinforcement which shall be according to specifications contained in Section 1061.

For other precast piles the reinforcing steel shall be deformed bars conforming to the requirements of Section 821.

852-4 REQUIREMENTS FOR PILING

852-4.1 GENERAL: All piling shall be furnished by the Contractor in accordance with an itemized list which will be provided by the Engineer. This list will show the number and length of piles required and will be based on information secured from the driving of test piles or other data available to him. The lengths shown on this list shall be the length required below cutoff and the contractor shall increase the lengths, at his own expense in order to reach from the cutoff elevation upto the position of his driving equipment.

852-4.2 PILES DESTROYED IN HANDLING OR DRIVING: Any pile which is damaged or destroyed before or at the time it is being driven shall be replaced by the Contractor at his own expense.

852-4.3 PREPARATION FOR DRIVING: Foundation pits, including construction of cofferdams or cribs where required, shall be completely excavated before the driving of foundation pile is begun. Allowance for upheaval of the pit bottom, due to driving of the piles, shall be made, the amount of allowance depending upon the character of the material through which the piles are to be driven. Any material forced up between the piles to above the elevation shown for the bottom of the foundation pit shall be removed to the correct elevation. In the event that too great an allowance is made for upheaval, back filling with gravel will, in general, be permitted to raise the pit bottom to the correct elevation.

852-4.4 PENETRATION: In general, the penetration for any pile shall be not less than ten feet in hard material and not less than 20 feet in soft material, unless otherwise directed by the Engineer to overdrive to such additional penetration as requested, provided however, that jetting or other unusual means will not be required to secure the additional penetration.

852-4.5 ELEVATION OF CUTOFF: The tops of all piles shall be sawed or cut to a true plane as shown on the plans, and at the elevation fixed by the Engineer.

Piles driven below the cutoff elevation without the Engineers authority shall be withdrawn and replaced by new and, if necessary, longer piles at the expenses of the Contractor. All piles raised during the process of driving adjacent piles shall be driven down again if required by the Engineer.

852-4.6 ALIGNMENT: Unless otherwise called for on the plans piles shall be driven as nearly as possible in plumb position. Permissible variation is 1% from plumb line and upto 2" out of position. Any pile so out of line or plumb as to impair its usefulness shall be pulled and redriven or an additional pile driven by the contractor, as directed by the Engineer, at his own cost.

852-4.7 TEST PILES: Test piles shall be of the same size and materials as the permanent piles and shall be driven with the same equipment and in the same manner as specified for such pile. Test piles shall be driven in advance of final driving of permanent piles so that lengths for casting may be determined. During driving an accurate record of the penetration shall be kept. Load test shall be made with equipment approved by the Engineer and in accordance with Section 851-8.

852-5 CONSTRUCTION DETAILS

852-5.1 FORMS: Forms for precast concrete piles shall conform to the general requirements for concrete form work, as provided herein under Section 701. Forms shall be accessible for tamping and consolidation of the concrete.

852-5.2 REINFORCEMENT: Reinforcing bars, hoops, shoes, etc., shall be well wired and tied together and placed to the spacings shown. All reinforcement shall be in place in the forms before any concrete is placed.

852-5.3 CASTING: Piling may be cast either in a vertical or horizontal position. Care shall be exercised to vibrate and tamp the concrete around the reinforcement to avoid the formation of stone pockets. The use of internal vibrating tampers will be required when placing concrete in forms. Concrete shall be placed continuously in each pile, special

care being exercised to avoid horizontal or diagonal cleavage planes, and to see that the reinforcement is properly embedded in the concrete.

852-5.4 FINISHING: As soon as the forms are removed, concrete piles shall be carefully pointed with a 1:2 mortar, filling all cavities or irregularities. Trestle piling exposed to view shall be finished above the ground line in accordance with the provision governing the finishing of concrete columns. Foundation piling, that portion of trestle piling which will be below the ground or low water surface, and piles for use in salt water or alkali soils shall not be finished except by pointing as above set forth.

852-5.5 CURING: Precast concrete piling shall be cured with water. The concrete shall be kept wet continuously for a period of not less than 10 days when portland cement is used, and not less than 3 days when high-early-strength cement is used. Side forms may be removed at any time after twenty-four (24) hours from the placing of the concrete, provided the air temperature surrounding the concrete is maintained at a minimum temperature of fifty (50) degree Fahrenheit for a period of five days when portland cement is used and for three days when high-early-strength cement is used. Piling shall not be subjected to any handling stresses until the concrete for precast-prestressed concrete piles has attained a strength of at least 4,8000 pounds per square inch and for other precast piles has attained a strength of at least 3,300 pounds per square inch, as determined by test cubes cured with the piling. Test cubes shall be cast with each set of piles as they are poured.

852-5.6 STORAGE AND HANDLING: The method of storing and handling shall be such as to eliminate the danger of fracture by impact or undue bending stresses in curing or transporting the piles from the forms and into the leads. In general, concrete piles shall be lifted by means of a suitable bridle or sling attached to the pile at points not over twenty (20) feet apart and not more than ten (10) feet from the ends of the pile. In no case shall the method handling be such as to induce stress in the reinforcement in excess of twelve thousand (12,000) pounds per square inch, allowing one hundred (100) per cent of the calculated load for impact and shock effects. In handling piles for use in sea water or alkali soils, special care shall be exercised to avoid injury to the surface of the pile.

Piles shall not be subjected to any handling stress until a test cube, made from the concrete pour for the piles involved and cured with the piles, shows a strength of at least 4800 pounds per square inch for precast-prestressed piles or 3300 pounds per inch for other precast piles.

852-5.8 PROTECTION OF HEAD: The heads of all precast concrete piles shall be protected during driving by caps of approved design, with a suitable cushion next to the pile head and fitting into a casting, which in turn supports a shock block. The diameter of the inside of the cap shall be determined before the pile is cast and the head of the pile shall be formed to make a loose fit inside the cap.

852-5.9 EXTENSION OR BUILD-UPS: Extension, splices or 'build-ups' on precast concrete piles, when necessary, shall be made as follows after the driving is completed.

For precast-prestressed piles, any spalled concrete shall be removed and the pile shall be fresh-headed to provide a top surface that is perpendicular to the axis of the pile. Ten holes, $1\frac{1}{4}$ inches in diameter shall be drilled 26 inches deep in space between prestressing wires. Deformed bars, No. 6 ($3/4$ inches in diameter) shall be grouted in the drilled holes, and the necessary formwork shall be placed to form a build-up similar in cross section to the pile, care being exercised to prevent leakage along the pile. The concrete in the build-up shall be type 'A'.

For other precast piles the concrete at the head of the pile shall be cut away a depth of forty diameters of the bar size of the vertical reinforcing steel. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be firmly fastened to the projecting steel and the necessary formwork shall be placed, care being exercised to prevent leakage along the pile. The concrete in the build-up shall be of the same quality as that used originally in the pile.

Just prior to placing concrete, the top of the pile shall be thoroughly moistened. The forms shall remain in place at least three (3) days. Spliced piles shall not be driven.

852-6 MEASUREMENT

The precast concrete piling shall be measured per linear foot of the completed pile length of specified type, section and shape, from head to tip.

The blinding concrete and concrete in pile caps shall be measured by volume. The unit of measurement shall be one cu. ft.

The reinforcement in piles caps shall be measured by weight. The unit of measurement shall be one cwt.

852-7 RATE

The unit rate for various items of work involved as described above in this section shall be full compensation for all materials, labour, forms, equipments etc. necessary for the completion of work.

The unit rate for piles include the cost of deformed bars or High tensile steel whichever is prescribed to be used.

852-8 PAYMENT

Pyament shall be made under:

- | | | |
|------------------|--|-------------|
| Item No. 852-8.1 | - Furnishing and placing precast reinforced concrete piles of specified section. | Per Foot |
| Item No. 852-8.2 | - Furnishing and placing pre-cast-prestressed concrete piles of specified section. | Per Foot |
| Item No. 852-8.3 | - Furnishing and placing plain reinforcing steel for pile cap. | Per Cwt. |
| Item No. 852-8.4 | - Portland Cement Concrete Type C for pile caps. | Per Cu. Ft. |
| Item No. 852-8.5 | - Portland Cement Concrete Type D as blinding concrete. .. | Per Cu. Ft. |

SECTION 861

GUIDE BANKS

861-1 DESCRIPTION

This work shall consist of the construction of a guide bank consisting of an earthen embankment protected by a stone apron and stone pitching on the slope, all in accordance with these specifications and in conformity with the lines, thickness and typical cross sections shown on the Plans.

861-2 EARTHEN EMBANKMENT

Earthen embankment shall be constructed according to the requirements of Section 411.

All vegetation, bushes, shrubs, saplings, tree roots and other organic matter shall be removed, as a part of the work, under this Section.

Earth shall be borrowed initially from pits to be prepared to accommodate the stone apron and the base of the stone pitching. These pits shall be excavated and levelled as shown on the Plans.

Additional borrow areas shall be on the river side at least 300 feet away from the toe. River overburden shall be specifically removed and shall not be allowed to be used in the embankment.

Embankment shall be placed in accordance with Section 411-4.1 and compacted in accordance with the requirements of Section 411-5.

861-3 SLOPE PROTECTION

861-3.1 GENERAL: The river side slope of the guide bank embankment including the nose and a certain specified length on the return slope shall be protected with pitching stone. The slopes of the guide bank embankment remote from attack by the main stream of the river shall be protected from erosion by a covering of either pilchi (reeds on frames) or dhub or other approved grass.

861-3.2 PITCHING STONE: The pitching stone shall be angular limestone or other approved rock having a specific gravity of

not less than 2.6. It shall be hard, dense and durable. For the hand packed courses in the river side slope and noses of the guide bank, no individual stone shall weigh less than 90 lbs. or more than 150 lbs., and the minimum dimension of any stone shall be 6 inches. Rounded stone shall not be accepted.

861-3.3 APRON: Apron pit shall be excavated, levelled and dressed all according to the lines and levels shown on the Plan.

The stone pitching in the apron pit shall be laid roughly packed. At intervals of about 200 feet measured along the guide bank, the stone pitching in the apron shall be completed to its full height over widths of 5 feet extending across the full breadth of the apron. The levels of the tops of the stone in these preliminary works shall be checked and approved by the Engineer before the rest of the pitching stone is built up to the full depth and full breadth of the aprons.

861-3.4 ARMOURED SLOPE: The coursing of the stone on the armoured slopes and noses of the guide banks shall be according to the lines, dimensions and requirements shown on the Plans.

The base course shall consist of 6 inches thick quarry spawls, free from dust and fine stone.

The final course shall be 15 inches thick of hand packed stone, each stone placed and wedged in position with spawls to give an even surface, free from holes and pockets and with no individual stone protruding from its neighbours by more than one inch.

The laying of stone pitching on the armoured slope is to proceed after the completion of the stone aprons.

861-4 CONSTRUCTION PROGRAMME

The Contractor shall programme his construction in such a way that the entire work is completed in dry season and before the river begins to rise due to rain or flood.

If the Contractor fails to complete the work before the river commences to rise and any part of the guide bank gets damaged, it shall be made good by the Contractor at his own cost.

861-5 MEASUREMENT AND UNIT RATE

Measurement and unit rate for regular excavation shall be in accordance with Section 411-10.

Measurement and unit rate for making embankment shall be in accordance with Section 411-11.

Measurement for stone pitching in apron or armoured slope will be made to the outlines of the stone pitching in places and for the thickness shown on the plans or established by the Engineer within the lines to which regular excavation or the embankment slope have been measured. The stone pitching shall be measured by volume. The unit of measurement shall be one hundred cubic feet. The unit rate shall be full compensation for supplying, placing and finishing stone pitching including all materials, labour, tools and plants required for the work.

861-6 PAYMENT

The payments shall be made under:

- | | | |
|--------------|-------------------------------------|-------------------|
| Item 861-6.1 | - Regular Excavation for Guide Bank | - Per 1000 Cu.Ft. |
| Item 861-6.2 | - Making Embankment for Guide Bank | - Per 1000 Cu.Ft. |
| Item 861-6.3 | - Stone Pitching for Guide Bank | - Per 100 Cu.Ft. |

SECTION 871

PAINTING AND VARNISHING

871-1 DESCRIPTION

The work covered in this Section consists of painting or varnishing wood work, structural steel, hand rails, mile stones and any other structure or surfaces required to be painted; all as required under this Specification.

871-2 PAINT AND VARNISH

Paint and varnish shall be of an approved make and quality.

871-3 PAINTING AND VARNISHING NEW WOOD WORK

Wood work to be painted or varnished shall be finished smooth with the plane, but free from plane marks of every kind and rubbed smooth with sand paper, first with 2½ grade and then with 1½ grade or pumice stone.

After rubbing all knots in the wood it shall be killed or covered with two coats of patent knotting or shellac varnish.

After knotting, the surface shall be rubbed again with pumice stone, or fine sand paper before the priming coat is applied.

871-4 PRIMING PAINT

A priming coat without colouring matter shall first be applied, after which all cracks, holes knots, etc., shall be stopped with the specified putty.

871-5 PREPARING SURFACE

If the old paint is firm and sound the surface shall be rubbed with pumice stone and washed thoroughly with soap, washing soda and water till all dirt, grease, projections and blisters, if any, are removed and the surface is rendered smooth.

Greasy surfaces shall be cleaned by applying a coat of turpentine over them and then washing them with soap and water.

When the old paint is in a blistered, cracked or perished condition, it shall be completely removed by burning off with a blow lamp or by means of a paint remover as specified. After the paint has been removed, the surface shall be rubbed smooth with sand paper, washed down and allowed to dry completely. It shall be wiped clean before paint or varnish is applied.

871-6 PAINTING

All new surfaces shall be given three coats including priming coat.

Repainting shall be carried out after preparing surface as per section 871-5 and the surface shall be given one to three coats as required.

Paint shall be applied with proper brushes of approved quality or spraying machine as specified. Paint shall be constantly stirred while it is being applied. It shall be stirred with a smooth stick and under no circumstance with a brush.

When more than one coat is to be given, every coat must be completely dry, rubbed and all dust removed before the next is applied.

All coats shall be applied evenly and properly, so that the work does not show any hair or brush marks, or drops of paints. The method of crossing and laying off shall normally be applied.

871-7 VARNISH

The surface shall be prepared as per requirements of Section 871-3, 4 and 5.

If the wood work is to be stained, the staining colour shall be mixed with second coat of size which shall be applied regularly, evenly and quickly keeping the colour on the flow.

Varnish shall be applied in very thin coats with a special fine haired varnishing brush and not with an ordinary paint brush. The best gopal varnish shall be used. If more than one coat have been specified the first coat shall be rubbed with fine sand paper.

871-8 MEASUREMENT

Painting and varnishing shall be measured by superficial area. The unit of measurement shall be 100 square feet. For doors and windows painted on both sides, the flat area of surface on one side shall be measured, including glazing and chowkat and shall be multiplied by 2 for panelled, battened, glazed, partly glazed doors or windows and will be kept single for plate glass windows, wire gauze doors and windows, trellis work.

871-9 RATE

The unit rate shall be full compensation for all the materials and labour, tools and plants, required for the completion of work mentioned in this Section.

871-10 PAYMENTS

Payments shall be made under:

Item No. 871-10.1	- Painting new surfaces three coats	- Per 100 Sq.Ft.
Item No. 871-10.2	- Painting Old Surfaces one coat	- Per 100 Sq.Ft.
Item No. 871-10.3	- Painting old Surfaces three coats	- Per 100 Sq.Ft.
Item No. 871-10.4	- Varnishing Wood Work Specified number of Coats	- Per 100 Sq.Ft.

SECTION 872

PLASTERING AND POINTING

872-1 DESCRIPTION

The work covered in this Section consists of plastering or pointing brick work or stone masonry with cement mortar in conformity with lines and dimensions shown on the drawings and according to these specifications.

872-2 PREPARATION OF SURFACE

872-2.1 Before plastering or pointing, the joints of old brickwork or masonry shall be raked out with a hook to a depth of half an inch. In case of new masonry in cement mortar to be subsequently plastered or pointed the joints shall be raked out at the end of day's work before the mortar has set.

872-2.2 The earth and mortar dust coming out of these joints as a result of raking shall be washed off, and the work watered for 24 hours before plaster is applied.

872-2.3 All putlog holes shall be filled up before plastering or pointing as the scaffolding for masonry is being taken down.

872-3 MORTAR

872-3.1 COMPOSITION: Cement mortar shall consist of Portland Cement, sand and water. Waterproofing agent shall be added when specially required or directed by the Engineer. (This shall be paid separately when added).

872-3.2 MIX: Unless otherwise specified, the mortar shall be mixed by volume. The ratio of cement and mortar shall be either 1:6 or 1:3 unless otherwise specified for plastering work and 1:2 for pointing work.

872-3.3 PREPARATION: Cement and sand shall be thoroughly mixed in a dry state on a pucca platform or in troughs as directed by the Engineer. It shall be gauged with a quantity of water sufficient to make the mortar workable. Water shall be added with a fine rose. Only such quantity of mortar shall be prepared as can be used before the initial setting time. Any mortar which has not been used within 30 minutes of the addition of water shall be discarded.

872-4 PRECAUTIONS

Before starting work of plastering or pointing the following precautions shall be taken.

- (a) Fine aggregate i.e. sand shall be washed before use.
- (b) It shall be ensured that all joints are properly raked.
- (c) The surface to be plastered or pointed shall be kept moist but excessive moisture shall be avoided.
- (d) The scaffolding for plastering or pointing shall always be provided double.

872-5 PLASTERING

Unless otherwise specified or directed by the Engineer or his authorized subordinate in writing, wooden screeds three inches wide and having a thickness equal to the plaster shall be fixed vertically 8 feet to 10 feet apart to act as gauges and guides in applying the plaster.

The arrises shall then be plastered for a space of four inches on each side and up to the ceiling except in case of openings where it shall run around them. This plaster shall also serve as a guide for thickness etc. Unless otherwise specified or directed by the Engineer all corners and arrises shall be rounded off to a radius of 3/4 inch only and no more. This work is included in the unit rate of plastering.

The mortar shall be laid on the wall between the screeds, using a plasterer's float for the purpose and pressing mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straightedge reaching across the screeds. The straightedge shall be worked on the screeds with an upward and sideways motion, two inches or three inches at a time. Finally the surface shall be finished off with a plasterer's wooden float. Metal float shall not be used.

The plaster shall be laid to a true and plumb surface and tested frequently with a straightedge and plumb bob. The straightedge shall not be less than 10 feet in length. As the work proceeds, all horizontal lines and surfaces shall be tested with a level, and all jambs and corners with a plumb bob.

All mouldings and decorations shall be worked true to template and shall be neat, clean, level, and parallel, or truly plumb, as the case may be.

Unless otherwise specified, plaster shall not exceed half an inch in thickness and shall not be less than quarter of an inch at the thinnest part.

872-6 POINTING

Unless otherwise specified the following types of pointing shall be done:

872-6.1 DEEP OR STRUCK CEMENT POINTING: This type of pointing shall be done to all unplastered faces of brickwork where the brickwork is liable to be affected by dampness and saltpetre, such as in the plinths of buildings.

The mortar shall be prepared as per Specification contained in 872-3.

The mortar shall be filled in the joints flush with masonry or brickwork with a pointing trowel and then pressed with proper pointings tools. Lining with a spike on a mass of mortar shall not be allowed.

872-6.2 FLUSH CEMENT POINTING: This type of pointing shall be done to all brickwork with an exposed face, when the finish of the face is not important or when a flush floor surface is required or when the floor or brickwork is subject to wear or to the effects of dampness and saltpetre.

The mortar shall be prepared as per Specification contained in 872-3.

The mortar shall be filled and pressed into the joints with a pointing trowel, and finished off level with the edges of the bricks to give the smoothest possible appearance to the work.

872-6.3 POINTING TOOLS: The pointing tools for horizontal joint shall be such as to form weathered and struck joints; and for vertical joint, triangles, so as to make a (v) notch. Care shall be taken not to develop a cutting edge in the tools since the idea is to compress the green mortar into the joints and not to cut it away.

872-6.4 EDGE OF BRICKS: The mortar shall not be spread irregularly over the edges and corners of the bricks which shall be left clearly visible. The practice of smearing mortar over defects in bricks, to hide them shall not be allowed and shall render the whole brickwork liable to be rejected.

872-6.5 WASHING AFTER POINTING: After pointing, the face of the work shall be cleared off all surplus mortar sticking to the face. No washing shall be done till the pointing has set.

872-7 PROTECTION DURING CURING

After completion, plastering or pointing shall be kept wet for 10 days and shall be protected during that period from extreme fluctuations of temperature and weather.

All defects detected during curing or afterwards shall be treated at the Contractor's expense according to directions of the Engineer.

872-8 MEASUREMENT

Plastering or pointing shall be measured by the superficial area, no deduction being made for the opening of any size or additions for returns and soffits. The unit of measurements shall be 100 square feet. Ornamental work to be finished and plastered shall be measured and paid separately and their unit of measurement shall be one foot (linear).

872-9 RATE

The unit rate shall be full compensation for all the materials and labour required for the completion of work mentioned in this Section. It shall also include for preparing, cleaning, watering the surface, plastering or pointing surfaces and corners, curing and protection, providing, erecting and removal of scaffoldings and all other tools and plants required for the completion of work.

872-10 PAYMENT

Payment shall be made under:

- | | | |
|-------------------|--|----------------|
| Item No. 872-10.1 | - Cement Plaster in
1:6 Cement Mortar | - Per 100 Sft. |
| Item No. 872-10.2 | - Cement Plaster in
1:3 Cement Mortar | - Per 100 Sft. |
| Item No. 872-10.3 | - Ornamental Plaster
Work in 1:3 Cement
Mortar | - Per Rft. |
| Item No. 872-10.4 | - Deep Cut or Struck
Cement Pointing | - Per 100 Sft. |
| Item No. 872-10.5 | - Flush Cement
Pointing | - Per 100 Sft. |

SECTION 873

FLOORING

873-1 DESCRIPTION

The work covered in this Section consists of making cement concrete floor, stonolithic or terrazo floor in conformity with lines and dimensions shown on the drawings and according to these specifications.

873-2 CONSTRUCTION REQUIREMENTS

873-2.1 SAND: Sand shall conform to the requirements of mortar sand of Section 1033.

873-2.2 CEMENT CONCRETE: Portland cement concrete shall conform to the requirements of Section 701.

873-2.3 MARBLE CHIPS: Marble chips shall be of the approved grade, colour, size and quality.

873-3 BASE FOR FLOORING:

873-3.1 GENERAL: The base for flooring shall be laid when the earth in filling has been done up to the specified level in a layer of six inches and has been properly watered and consolidated and correctly levelled.

873-3.2 SAND: A layer of sand about 3 inches thick shall be laid and rammed after saturation so that a three inch layer is reduced to about two inches after compaction.

873-3.3 CONCRETE: Portland cement concrete Type D shall be laid in one operation in a uniform layer of specified thickness, absolutely true and parallel to the required level of the finished surface. Concrete shall be cured for at least 7 days before any topping is laid. Before laying the topping, the surface shall be washed and scrubbed with wire brushes so that the concrete in the base and the topping are well bonded.

873-4 CEMENT CONCRETE FLOORING

873-4.1 BASE: For ground floor the base shall be laid as per Section 873-3. For subsequent floors, the top surface of roof slabs shall be roughened with wire brushes while it is still green.

873-4.2 PANELS: Before laying the topping, the surface of the base shall be divided into symmetrical panels by wooden or iron screeds. The area of panels, unless otherwise specified, shall not exceed 16 square feet. The top of the screed shall be adjusted to the specified level of the finished floor surface.

873-4.3 CONCRETE: Cement concrete floor shall consist of laying a topping of cement concrete Type C of specified thickness over the prepared and finished base or roughed surface of roof slabs.

873-4.4 PLACING: Placing operation shall be specifically timed. No sooner the concrete has been evenly spread in a panel, then it shall be beaten for about 5 to 10 minutes with "wooden thapies" (about 5 lbs. weight).

873-4.5 FINISHING: Immediately after consolidation, the surface shall be levelled with a wooden trowel. Excessive trowelling in the early stages shall be avoided. The surface shall be tested with a straight edge to detect undulations, which, if found, shall be eliminated. The finer stuff in the concrete which has come to the surface with the stroking shall be quickly but carefully smoothed with the steel trowel. When the concrete has hardened sufficiently, troweling shall be done with steel trowel. No dry cement or a mixture of dry cement with sand shall be sprinkled on the surface for hardening the surface.

873-4.6 REMOVING OF SCREEDS: After twenty four hours of laying, the screeds shall be removed and strips of non-absorbent paper placed against the exposed side and folded over the finished surface so as to prevent concrete of adjoining panels from adhering to the edge or spreading over the finished surface. Panels shall be laid alternately, where possible; the adjoining panels shall be laid at an interval of 24 hours.

873-5 TERRAZO FLOOR

873-5.1 GENERAL: Terrazo floor shall consist of a layer of Portland Cement Concrete Type C of specified thickness with a mozaic topping.

873-5.2 BASE: For ground floor, the base shall be laid as per Section 873-3. For subsequent floors, the top surface of roof slabs shall be roughened with wire brushes while it is still green.

873-5.3 PANELS: Before laying terrazo floor, the surface of the base shall be divided into symmetrical panels by fixing 1/8 inch glass sheet of the required depth in (1:6) cement mortar. The area of the panel, unless otherwise specified, shall not exceed 16 square feet. The top of the glass screed shall be adjusted to the specified level of the finished floor surface.

873-5.4 CONCRETE: A layer of portland cement concrete Type C of the specified thickness shall be laid over the prepared and finished base or roughened surface of roof slab. It shall not be smooth finished but shall have a rough surface so that it shall be well bonded with the mozaic topping.

873-5.5 MOZAIC TOPPING: The mozaic topping shall consist of 2 parts of marble chippings, one part of marble powder and one part of cement by volume. It shall be laid while the bottom concrete is still plastic preferably the next day after the concrete has been laid. The terrazo mix shall be placed on the cleaned surface of the bottom concrete and compacted by tamping.

873-5.6 COLOURED MOZAIC: White mozaic or other coloured shades can be obtained by using white cement instead of grey cement. Necessary colour pigment shall be added.

873-5.7 DRYING: After laying the topping, the surface shall be covered either with damp hessian cloth or wet soft wood sawdust and every precaution shall be taken to prevent its being subjected to the effects of weather. The flooring shall be maintained in a damp condition till it is fit for grinding.

873-5.8 GRINDING: The grinding of terrazo shall commence 3 days after the laying is completed. The grinding of the flooring shall be done manually preferably with machine of approved type.

The first grinding shall be done with an approved coarse abrasive (carborandum bricks or disc) by sprinkling fine sand over the surface and by using an ample quantity of water to assist the grinding. The flooring shall be washed clean with plenty of water till trace of ground mud is removed and marble chips are visible.

All holes or open pores shall be made good with neat cement, the grout being well worked into the surface by rubbing with a stone and finishing a little above the level of the finished surface of floor. The portions so treated shall be kept damp till the floor is ready for the second grinding.

The second grinding shall be done after about 5 days using an approved medium graded coarse abrasive (carborandum bricks or disc), and pores, if any, shall be treated similarly as after the first grinding.

The final grinding shall be done with an approved fine graded carborandum stone and the surface thoroughly washed down with water.

873-5.9 FINISHING: After final grinding the floor shall be thoroughly washed. Tartaric or powder oxalic acid shall be sprinkled over the floor and rubbed with gunny bags wrapped round rods. The floor shall be allowed to dry and then more oxalic or tartaric acid shall be rubbed with cloth pads.

873-5.10 FINAL GLOSS: When floor is completely dry, the final gloss shall be given by an approved wax polish.

873-6 STONOLITHIC FLOOR

All the requirements of Section 873-5 will be applicable to this floor except that 1/8 inch stone chippings shall be used instead of marble chippings.

873-7 MEASUREMENT

The base for flooring, the cement concrete floor, the terrazo floor and the stonolithic floor shall be measured by the superficial area. The unit of measurement shall be 100 square feet.

873-8 RATE

The unit rate shall be full compensation for all the materials and labour required for the completion of work mentioned in this Section for various types of floors.

873-9 PAYMENT

Payment shall be made under:

- | | | |
|------------------|---|------------------|
| Item No. 873-9.1 | - Base for Flooring of the Specified Thickness | - Per 100 Sq.Ft. |
| Item No. 873-9.2 | - Cement Concrete Floor of the Specified Thickness | - Per 100 Sq.Ft. |
| Item No. 873-9.3 | - Terrazo Floor of the Specified Thickness | - Per 100 Sq.Ft. |
| Item No. 873-9.4 | - Coloured Terrazo Floor of the Specified Thickness | - Per 100 Sq.Ft. |
| Item No. 873-9.5 | - Stonolithic Floor of the Specified Thickness | - Per 100 Sq.Ft. |

SECTION 881

WOOD WORK

881-1 DESCRIPTION

The work specified in this Section shall consist of the furnishing and erection of wooden doors, windows, wardrobes etc. and other ancillary items of work such as glazing and wire gauze, according to dimensions and design shown on the drawings. The work of providing wooden beams, purlins, and rafter, according to size shown on drawings is also covered by this Section.

881-2 TIMBER

Unless otherwise specified all timber shall conform to specifications in Section 1071. The Engineer shall at his option inspect all logs or sleepers before they are used and may reject any, he considers defective. Timber so rejected shall be removed at once from the site of work at the cost of Contractor.

Unless otherwise specified the timber used in construction or joinery work shall be deodar, kail, chir or teak as called in the Bid Schedule.

881-3 SCREWS AND NAILS

All nails and screws shall be of an approved quality. Holes of correct sizes shall be drilled before inserting screws. Hammer shall not be used at all for driving in or starting in the screws. All screws shall be dipped in oil before they are inserted in the wood. The heads of nails or screws shall be sunk and puttied or dealt with as directed by the Engineer.

881-4 PRESERVATIVES

881-4.1 CREOSOTE OIL: The creosote oil shall be distillate of coal-gas or coke oven tar and shall contain no raw or unfiltered tar. It shall conform to the requirements as specified in AASHO Standard when tested in accordance with AASHO T-60.

Any other preservative like solignum or penta-chlorophenol solution may be used after getting approval from the Engineer.

881-4.2 APPLICATION: All portions of timber built into or against or those to masonry or concrete and all junctions or rafters, purlins, beams and wall plates shall be given two coats of any of the above mentioned wood preservatives.

881-5 WORKMANSHIP

881-5.1 GENERAL: All workmanship shall be of the best type and all joints shall fit accurately without wedging or filling. After the wood work has been erected, the Contractor shall, if any undue shrinkage or bad workmanship is discovered, forthwith correct the defect without any extra charge.

881-5.2 JOINTS: Unless otherwise specified all joints shall be simple tenon and mortise joints with the end of the tenon exposed to view. All mortise and tenon joints or scarfs shall fit truly and fully without fitting. Where specified, in the case of special high class joinery, the end of the tenon shall not show. Joint shall be painted with specified lead point before the frames are put together. Glue shall not be used in joints which are exposed to weather, and in such exposed work, any hard stopping shall be done with tight driving plug.

881-5.3 FINISH: All wood work shall be neatly and truly finished to exact dimensions specified.

881-5.4 FIXING: All wood work shall be fixed in accordance with the drawings or the instructions of the Engineer.

The Contractor shall be responsible for the easing or otherwise of all doors, windows etc. and the closing down of all open joints which may occur within six months of the completion of the work and which in the opinion of Engineer required attention.

881-5.5 BEARING: All beams and girders shall be bedded on plates with not less than 9 inches bearing. All joints shall bear not less than $4\frac{1}{2}$ inches on wall plates and every purlin or batten supported on a wall shall have a bearing in the direction of its length equal to its own depth.

881-5.6 PLANKS: All scantiling planks etc. shall be sawn straight and shall have uniform thickness. They shall be sawn in the direction of the grain and shall have full measurement from end to end. All planks and scantilings shall be supplied with straight square edge, or rebated, ploughed, tongued or dwelled, as may be directed.

881-5.7 AIR SPACE: An airspace of quarter of an inch shall be left along sides of battens and other wood work burried in masonry work.

881-6 DOORS AND WINDOWS

881-6.1 GENERAL: All timber, preservatives, screws and nails shall be according to specification in the foregoing paragraphs.

Unless otherwise specified, the workmanship for doors and windows shall conform to Specification No. 881-5 in all respects, except those specified in subsequent paras.

881-6.2 SIZES: The sizes of chowkats and leaves of doors and windows and that of their fittings shall be as shown on drawings or as directed by the Engineer.

881-6.3 CHOWKAT, FRAMING AND CORNERS: Chowkats shall be properly framed and mortised together. Doors and window chowkats shall have $4\frac{1}{2}$ inches wide horns left on the heads (also on sills where these are provided) or the corners of the chowkats bound with $2\frac{1}{4}$ " x $1/10$ " iron straps bent into a right angle having legs of a length equal to the depth of the chowkats, and fixed with four 2-inch screws.

881-6.4 REBATES: Chowkats shall have a rebate cut to receive the leaves. The rebates shall be $1/2$ inch deep and its width shall be equal to the thickness of the leaf. The other side shall be finished with a bead and quirk or other simple moulding, unless wire gauze is to be fitted. Where the plaster butts against the chowkat $1/2$ inch deep rebate with a slight cutback shall be given to serve as key to the plaster.

881-6.5 CHOWKATS IN JAMBS: Unless otherwise specified, doors and windows opening to another room, to a corridor or verandah, shall have the chowkats so fixed that they project $3/8$ " from the plastered face of the wall.

The plaster shall stop against the chowkat which shall have the rebate mentioned in the above paragraph (881-6.4) as key for the plaster.

Other doors and windows shall be set back $4\frac{1}{2}$ inches from the face of the wall.

881-6.6 HOLD FASTS: Chowkats shall be secured to the brick work or masonry by holdfasts which shall be built into the wall with specified mortar. Hold fasts shall be made of $1\frac{1}{2}$ " x $\frac{1}{4}$ " flat steel bent over at both ends leaving $13-3/4$ " clear length between bends, one bend shall have two screwed holes to which the chowkat is secured by $\frac{1}{2}$ " dia. bolt. The head of the bolt shall be sunk into the chowkats and the hole plugged with wood.

881-6.7 SEASONING: All doors and windows leaves shall be cut out and framed together as soon as possible after the commencement of the work and stacked in the shade to season. They shall not be wedged or glued, until one week before hanging. Before final gluing, all portions in which defects appear shall be replaced.

881-6.8 FRAMING LEAVES: All stiles and rails shall be properly and accurately mortised and tenoned. The thickness of the tenon shall not exceed one fourth the thickness of the plank, and the width shall not exceed five times the thickness. All rails, over 7 inches in depth shall have double tenons. All tenons shall pass completely through stiles and shall be haunched to the depth of groove for panels.

881-6.9 GLUING: All tenons at the final assembly of the doors shall be glued and wedged at top and bottom of the tenon with glued wedges. Immediately after gluing the frames shall be tightly clamped and so left till the glue has set.

881-6.10 DOOR FITTINGS, CHOCK AND STOPS: All fittings, hinges, and screws shall be according to details shown on the drawings or as directed by the Engineer. Before use one sample of each fitting shall however be got approved from the Engineer.

Hinges shall be counter-sunk into chowkat as well as in the leaf; the recess being cut to the exact size and depth of the hinge, no subsequent packing shall be allowed.

Screws of such diameter shall be used as fill completely the holes and cups in the fittings which they secure, and shall be oiled before being inserted. Unless the head can be counter-sunk flush with the fittings, round headed screws shall be used. The number of screws and their sizes to be used for any specific fitting shall be as shown on the drawing or as directed by the Engineer.

Hinged chocks shall invariably be fitted to all doors and windows to keep them open. Chocks shall be of hard wood and swung on 3 inches butt hinges and shall act on a sheet metal protector fixed to the door stile.

Wooden stops of a size suitable for the leaf concerned shall be fixed to the door or window chowkats to prevent the leaf from damaging the plaster of the jamb when fully opened.

881-7 PANELLED AND GLAZED DOORS AND WINDOWS

881-7.1 GENERAL: All timber preservatives, screws and nails shall be accordingly to specifications mentioned in para 881-5. Unless otherwise specified the workmanship shall be according to specification in 881-6, except that

(a) The design and dimensions of the panelled or glazed door, or windows shall be according to design shown on the drawings.

(b) The stiles and rails of the frame shall be mortised and tenoned together. The thickness of each tenon shall be approximately 1/3rd the thickness of the rail, and the width of each tenon shall not exceed 5 times its own thickness.

881-7.2 PANELS: Panels shall be made of solid wood or hard board or water resistant plywood, as shown on the drawings or called for in the bid schedule, having both sides properly finished. They shall be properly cut and framed into rebates to a depth not less than 3/8 inch. Their thickness shall not be less than 1/2 inch; in case of plywood and hard board it shall not be less than 5/16 of an inch. Panels shall be in one piece upto 12 inches clear in case of deodar and 18 inches clear in case of teak. In large sizes they shall be jointed, but the joint shall be glued and dowelled together to prevent all possibilities of its opening out afterwards.

Panels shall be absolutely smooth so that no marks are visible. Unless otherwise specified, panells shall be splayed and fielded on both sides and the arrises of the frame receiving the panels finished with a simple mould.

881-7.3 SASH BARS: Sash bars shall be of the same thickness on the leaf and shall be 1 inch to 1½ inch wide, according to the size of the doors, and shall be twice moulded and twice rebated and mitred on the outside. The size of the rebate shall be 3/8 inch x 1/2 inch to receive the glass and its fixing.

881-7.4 GLAZING: All glazing shall be done in accordance with specification mentioned in Para 881-11 and according to details shown on the drawings. The glass panels of appropriate size shall be fitted into 3/8 inch rebates and shall be retained in position with a thin layer of Putty which shall be covered with wood beading.

881-8 CLERESTORY WINDOWS

In all respects of the work of making clerestory windows shall be carried out according to specifications for "Glazed and Paneled Doors and Windows" specified above, and in conformity with lines and dimensions shown on the drawings except that:

(a) The Chowkat of clerestory windows shall be fixed as to project 3/8 inch from the inner face of the wall, unless otherwise specified.

(b) Brass Cleats of the slanting single button type approved by the Engineer shall be fixed by two brass screws to the polished wooden teak blocks with chamfered edges. The wooden blocks shall be 2" x 3½" x 3/4" and shall be firmly fixed to the wall by means of plugs and screws of an approved type.

(c) The leaves shall be hung 1 inch off centre so as to make them self closing.

881-9 WIRE GAUZE DOORS AND WINDOWS

881-9.1 LEAVES: Unless otherwise specified leaves of wire gauzed doors and windows shall be made from deodar wood, irrespective of the wood used in making the chowkat or other leaves hung from the same chowkat.

881-9.2 CHOWKAT: Wire gauzed doors and windows shall be normally hung from the same chowkat as other doors, and the rate shall include the provision of extra depth in the chowkat to take the rebate for the wire gauze leaf. Where wire gauze doors or windows are hung on separate chowkat, a special rate shall be settled.

881-9.3 WIRE GAUZE: Unless otherwise specified, wire gauze shall be of best quality and uniformly woven wire webbing 12 x 12 meshes to the square inch made from 22 gauze galvanized iron wire. All wire gauzed panel shall be in one piece, no joints being allowed in the gauze.

Wire gauze shall be fixed to the frame of the leaf after being stretched from out to out of rebate and nailed down taut by nails spaced at not more than 2 inches and then fixed by a fillet of 3/4" x 3/4" screwed into a rebate of that size. The screws shall not be less than 1½ inches in length, nor spaced further than 9 inches. All exposed edges of the fillet shall be finished with a small neat mould.

881-9.4 SPRING HINGES: All wire gauze doors shall be hung on self closing spring hinges which shall be of an approved quality.

Wire gauze windows shall not be provided with springs or spring hinges.

881-9.5 DOUBLE DOORS TO PROJECT: All double leaf wire gauze doors shall close with the meeting stiles butting against each other, a felt or niwar strip being fixed to one leaf to close the joint. The leaves shall close to such an extent that the junction projects from the face of the chowkat, the projection being one inch for each foot width of the leaf. The top of the chowkat shall be enlarged to a corresponding wedge shape, the cost of this being included in the rate.

Double hung wire gauze windows shall close flush with the chowkat without the meeting stiles projecting in any way.

881-10 FIXED WIRE GAUZE

881-10.1 WIRE GAUZE: Wire gauze shall conform to specification in 881-9.3.

881-10.2 FIXING: Wire gauze shall be fixed to the outside of chowkat and nailed down by nails spaced not more than 2 inches and a cover strip, 3/4 inch in thickness and of the same width as the chowkat so as to seem a part of the chowkat, fixed all round with 1½ inch screws fixed not more than 9 inches apart.

If specially required by the Engineer, the wire gauze shall be fixed to the chowkat by a fillet 3/4 inch x 3/4 inch, screwed into a rebate of the same size.

881-10.3 FINISHING: Exposed arrises shall be finished with a small but neat mould in each case. This is included in the rate for fixing wire gauge.

881-11 GLAZING

881-11.1 THICKNESS AND QUALITY: Unless otherwise specified, all glass shall be flat sheet glass of fine quality known in the trade as "seconds". Glass shall be of the following weights per square foot for the various sizes mentioned below:

- Not exceeding 12" x 14" - 16 oz (about 1/14" thick)
- Exceeding 12" x 14" but not exceeding 24"x24" - 21 Oz(1/10" thick)
- Exceeding 24" x 24" but not exceeding 30"x30" - 26 Oz(1/9" thick)
- Exceeding 30" x 30" but not exceeding 36"x36" - 32 Oz(1/7" thick)
- Exceeding 36" x 36" plate glass - (1/4" thick)

Glass shall be free from specks, bubbles, distortion and flaws of every kind, and shall be properly cut to fit the rebates, so as to leave a uniform space of 1/16 inch all round the panes between the edge of the glass and the rebate.

881-11.2 PUTTY (METHOD OF PREPARING): Putty shall be prepared from pure raw linseed oil and best whiting, specially dry and ground fine to pass a sieve of 45 x 45 meshes to a square inch. The two shall be well mixed by hand and kneaded into a stiff paste. It shall then be left for 12 hours and worked up in small pieces till it becomes quite smooth. If the putty becomes dry, it shall be restored by heating and working it up again while hot. Where the rebate is small a little white lead shall be added in making the putty. Putty required for glazing large panes or for bedding plate glass shall be made with a mixture of linseed oil and tallow with whiting so as to make it pliable and capable of standing expansion of the panes. Where required, putty shall be coloured to match the wood-work.

881-11.3 PAINING OR PRIMING REBATES: If rebates have not been painted, they shall be well primed with boiled linseed oil to prevent the wood from drawing oil out of the putty. Putty shall be painted at the same time and the same number of coats as wood work.

881-11.4 FIXING GLASS WITH PUTTY: Each pane of glass shall then be bedded on a thin layer of putty called "back putty" and secured into position with proper glazing springs or nails. "Front putty" shall then be applied chamfered and finished off neatly so as to ensure that the depth of the putty is exactly equal to the rebate.

881-11.5 FIXING GLASS WITH WOOD FILLETS: In the case of all panes exceeding 12 inches in width, front putty shall not be used but the glass secured with fillets of wood, without extra charge. The fillets shall be plain or moulded and of a size depending on the type of door being glazed. The glass shall be protected from contact with the wood by putty made with tallow to act as a cushion.

881-11.6 BLIND GLASS: Where blind glass is fixed the frosted face shall be away from the putty.

881-11.7 PUTTY (COMING OFF): All glass that has been fixed by the contractor shall if it becomes loose during the period specified in the contract, be refixed and puttied by him at his own expense.

881-11.8 CLEANING AND FINISHING: No glazing shall be considered complete until all paint and other stains have been removed from the surface of the glass. Glass shall be cleaned and polished with pads of damp newspaper, and then with a clean dry soft cloth (unsized). Cleaning shall be done by two men working on opposite sides of the same pane at the same time. The Contractor shall make good all glass broken by his workers while cleaning the glass. On completion of the work all doors and windows shall be cleaned, damaged putty or glazing repaired and the whole work left perfect with a workmanlike finish.

881-12 MEASUREMENT

881-12.1 The measurement of wood or planking shall be that net measurement after fixing in position. No allowance is to be made for waste overlaps, rebates or the dimensions supplied beyond those specified. The length of each piece, however, shall be taken overall so as to include projections for tenons or scarfs.

The unit of measurement shall be one cubic foot.

881-12.2 The measurement of doors and windows shall be done by the superficial area of the clean opening in brick work or masonry. In case of circular or other similar joinery, measurement shall be taken of the net area. In the absence of any special rate being paid, measurement shall be taken of the least square or rectangles to contain the opening in question. In case of double doors the superficial area of chowkat shall be included in one door only. The unit of measurement for wooden doors and windows, for wire gauzed doors and windows and for fixed wire gauze shall be one square foot.

881-12.3 In measuring glaziers work all fractional parts under half an inch shall be omitted, and all above that, taken as one inch. All curved or irregularly shaped pieces shall be measured as the least rectangle from which they can be cut. Measurement shall be made net, from inside of rebate.

The unit of measurement for glazing work shall be one square feet.

881-12.4 The unit of measurement for wooden wardrobes and almirahs of specified size and design shall be by number.

881-13 RATE

881-13.1 The unit rate for wood work shall be full compensation for the cost of materials such as timber, nails, and screws, glue, sawing, and labour for all items of woodwork such as fixing spikes, bevelled heading joint to boarding, boring for bolts, cramping and wedging, fixing hard-wood or bamboo pins, notching, firrings etc. etc. It shall also include the use of all tools, plants and scaffolding, staging and ladders etc. where necessary.

881-13.2 The unit rate for wooden doors and windows, panelled or glazed or wire gauzed as called for in the Bid Schedule, shall be full compensation for all materials, labour, fixtures, except spring hinges, etc. complete in all respects. This shall also include the use of ladders, supports, staging and scaffolding for execution of the work. The rate shall further include the cost of labour involved in applying two coats of wood preservatives on the chowkat.

881-13.3 The unit rate for glazing shall be full compensation for providing all materials, labour involved in carrying out work as specified above. It shall also include provision of all tools and plant required for glazing. It shall further include provision and removal of all ladders, scaffolding, staging and supports required for execution of work.

881-13.4 The unit rate for wooden wardrobes and almirahs shall be full compensation for all operations of work as discussed in 881-13.1.

881-14 PAYMENT

Payment shall be made under:

Item No. 881-14.1	-	Wood Work in Beams Purlins & Rafters etc.	.. ..	Per Cu. Ft.
Item No. 881-14.2	-	Panelled or glazed doors and windows.	.. ..	Per Sft.
Item No. 881-14.3	-	Wire Gauzed Doors and Windows.	.. ..	Per Sft.
Item No. 881-14.4	-	Fixed Wire Gauze	.. ..	Per Sft.
Item No. 881-14.5	-	Glazing of Specified Thick- ness and Quality.	.. ..	Per Sft.
Item No. 881-14.6	-	Wardrobe/Almirah of Speci- fied size and Design Complete	..	Each.

SECTION 882

DAMP PROOFING

882-1 DESCRIPTION

The work covered under this Section shall consist of damp proofing concrete surface, brick or stone masonry surface, in accordance with these specifications and at the locations shown on the Plan, or as ordered by the Engineer.

The concrete surfaces shall be damp proofed with bitumen by the absorptive method, whereas brick or stone masonry surfaces shall be first treated with a horizontal layer of portland cement concrete and then covered with bitumen damp proof course with hessian base. Vertical faces of walls likely to come in contact with earth shall be first plastered with cement plaster and then treated with bitumen by the absorptive method.

882-2 MATERIALS

882-2.1 BITUMINOUS MATERIALS: Bituminous materials for applications to concrete surface shall be bitumen (30/40 or 20/30) conforming to the requirements of AASHO M 115, Type B and as contained in Section 1011.

Bitumen damp proof course with hessian base shall conform to the requirements as contained in B.S. 743, Type A. It shall have a minimum weight of 7 lbs/square yard. The hessian base shall consist of a single layer of plain woven jute cloth with the appropriate moisture having a nominal weight of 6½ oz. per yard of 40 inches width. The saturating material consist of bitumen having a penetration within the range of 90-120 at 77 degree F. The maximum bitumen content in this type of d.p.c. shall vary from 83 to 106 oz/sq. yard.

882-2.2 PORTLAND CEMENT CONCRETE: Portland Cement Concrete shall be Type C, as contained in Section 701.

882-2.3 CEMENT PLASTER: Cement Plaster shall be of 1:6 cement mortar as contained in Section 872.

882-3 GENERAL REQUIREMENTS FOR THE LAYING OF D.P.C.

In order to obtain maximum efficiency in d.p.c. the following precautions shall be taken during laying:

(a) D.P.C. must extend through the full thickness of the wall including the pointing, applied rendering or other facing material.

(b) The mortar bed receiving d.p.c. shall be even and free from projections.

(c) Where site conditions necessitate a stepped d.p.c., a continuous flexible material should be used to avoid any weakness at the angles between the horizontal and vertical faces.

(d) Joints in flexible d.p.c. should be formed by lapping for at least 4 inches. Lapped joints should be sealed.

882-3 CONSTRUCTION

882-3.1 DAMP PROOF COURSE FOR CONCRETE SURFACES: After the concrete is cured then surfaces to be treated shall be allowed to dry to the satisfaction of the Engineer. They shall be coated thoroughly with (30/40 or 20/30) bitumen at the rate of 24 lbs. % sq. ft., applied cold with a brush, applied in two to three coats. Each coat shall be allowed to be absorbed before succeeding one is applied. After absorption, a seal coat at 12 lbs/100 sq. ft. shall be applied at a temperature of about 150 to 180 degree F. and brushed thoroughly into all surfaces. The seal coat shall have hardened before any water or earth is allowed to come against it. If ordered by the Engineer, the surface so treated may be sand blended. No coat shall be applied when the concrete or the preceding coat is damp, or at any time when in the opinion of the Engineer the weather is unsuitable.

882-3.2 VERTICAL DAMP PROOF COURSE FOR BRICK OR STONE MASONRY SURFACES: All unexposed surfaces which are likely to come in contact with earth or water shall be first plastered with 1:6 cement mortar and allowed to cure for at least 7 days and then allowed to dry. When, in the opinion of the Engineer, the surfaces had dried, they shall be coated thoroughly with bitumen (30/40 or 20/30) at the rate of 24 lbs. per % sq. ft., applied as stated in 882-3.1. After absorption a seal coat at 12 lbs. per % sq. ft. shall be applied at specified in 882-3.1.

882-3.3 HORIZONTAL DAMP PROOF COURSE: Horizontal damp course over points of structures, or where otherwise specified to be provided, shall be laid by first providing a layer of type C concrete $1\frac{1}{2}$ " to 2" thick and then allowed to cure and dry. When in the opinion of the Engineer, this is fully cured and dry it shall be covered with a layer of bitumen d.p.c. with hessian cloth base.

882-4 MEASUREMENT

The quantity of damp proofing shall be computed from the superficial area of surface damp proofed, completed and accepted. Separate measurements shall be made for damp proofing concrete surfaces, for providing vertical damp proof course to brick or stone masonry surfaces and for providing horizontal damp proof course. The unit of measurement in each case shall be one hundred square feet.

882-5 RATE

The unit price for damp proofing shall be full compensation for furnishing and placing all materials and for all labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

882-6 PAYMENT

Payment shall be made under:

- | | | |
|------------------|---|------------------|
| Item No. 882-6.1 | - Damp Proofing of Concrete Surfaces Complete | - Per 100 Sq.Ft. |
| Item No. 882-6.2 | - Vertical Damp Proofing Course Complete | - Per 100 Sq.Ft. |
| Item No. 882-6.3 | - Horizontal Damp Proof Course Complete | - Per 100 Sq.Ft. |

H. INCIDENTAL CONSTRUCTION

SECTION 901

HAND RAILS

901-1 DESCRIPTION

The work specified in this Section consists of the construction of hand rails of approved types either in Structural steel work or the portland cement concrete with reinforcing steel work. The work shall be constructed in accordance with these specifications and in conformity with the lines, grades, dimensions and notes shown on the Plans.

901-2 CONSTRUCTION REQUIREMENTS

901-2.1 PORTLAND CEMENT CONCRETE: Portland Cement Concrete shall be in accordance with Section 701 and of Type C.

901-2.2 REINFORCING STEEL WORK: Reinforcing Steel Work shall be in accordance with Section 821.

901-2.3 STRUCTURAL STEEL WORK: Structural Steel Work shall be in accordance with Section 831.

901-3 MEASUREMENT

The hand rail of the approved type constructed in accordance with these Specifications shall be measured by length in linear feet of hand rail actually constructed, in place and accepted. The quantity shall be determined by measurement of the completed hand rail from end to end of rails or ports. The unit of measurement shall be one linear foot.

901-4 RATE

The unit rate shall be full compensation for furnishing, constructing and shaping the hand rail all according to the requirements of this Section.

901-5 PAYMENTS

Payments shall be made under:

- | | | |
|------------------|---|-------------|
| Item No. 901-5.1 | - Hand Rail in Structural Steel | - Per foot |
| Item No. 901-5.2 | - Hand Rail in Portland Cement Concrete | - Per foot. |

SECTION 911

BRIDGE BEARINGS

911-1 DESCRIPTION

The work specified in this Section consists of furnishing and fixing in final position bridge bearing as specified in this Section and according to the lines, dimensions and notes shown on the Plans.

911-2 TYPES OF BEARINGS

The bearings to be specified will be either steel bearings, rubber bearings or roller bearings.

911-3 MATERIALS

911-3.1 STEEL BEARINGS: The material for steel bearings shall be hardened steel.

911-3.2 RUBBER BEARINGS: The material for rubber bearing shall be neoprene covered rubber with steel laminations as shown on the Plans.

911-3.3 ROLLER BEARINGS: The material for roller bearings shall be carbon steel clad with stainless steel to prevent corrosion.

911-4 SETTING IN POSITION

The specified bearing shall be set accurately in position on the pier and abutment caps and shall have a uniform bearing over the whole surface.

911-5 MEASUREMENT

The bridge bearings when completed and fixed in position as specified shall be measured in number. The unit of measurement shall be each number.

911-6 RATE

The unit rate shall be full compensation for procuring bridge bearings of the specified type and fixing in position all according to this Section and as shown on the Plans.

911-7 PAYMENTS

Payment shall be made under:

Item No. 911-7.1	- Steel Bearing	- Each
Item No. 911-7.2	- Rubber Bearing	- Each
Item No. 911-7.3	- Roller Bearing	- Each

SECTION 921

BRIDGES EXPANSION JOINTS

921-1 DESCRIPTION

The work specified in this Section consists of the construction of expansion joints of approved type in structural steel work all in accordance with these specifications and in conformity with the lines, dimensions and notes shown on the Plans.

921-2 CONSTRUCTION REQUIREMENTS

Structural steel Tee iron, angles, lugs and plates shall be supplied and fixed all in accordance with the requirements of Section 831, "Structural Steel Work".

921-3 MEASUREMENT

Expansion joint constructed in accordance with these specifications shall be measured by length in linear feet of expansion joint actually constructed, in place and accepted. The unit of measurement shall be one linear foot.

921-4 RATE

The unit rate shall be full compensation for furnishing, shaping and completing the expansion joint all according to the requirements of this Section.

921-5 PAYMENT

Payment shall be made under:

Item No. 921-5.1 - Expansion Joint - Per foot.

SECTION 931

RAIN WATER OUTLETS

931-1 DESCRIPTION

The work specified in this Section consists of furnishing galvanized mild steel pipes of 3 inch diameter and placing in correct position in bridge deck slabs, service ducts of foot paths if any, caps of piers and abutments all in accordance with the lines, dimensions and notes shown on the Plans.

931-2 MATERIALS

The rain water outlet pipes are to be galvanized mild steel pipes. The galvanized surfaces are to be entirely coated with zinc of a minimum weight of 1.25 ounces per square foot of surface area. The finished surface shall be perfectly smooth and uniform with the coating firmly adhering to the pipe.

931-3 MEASUREMENT

Rain water outlets when fixed in accordance with these specifications shall be measured in numbers of outlets actually fixed in place and accepted. The unit of measurement shall be one number.

931-4 RATE

The unit rate shall be full compensation for furnishing, shaping and fixing rain water outlets all according to the requirements of this Section.

931-5 PAYMENT

Payment shall be made under:

Item No. 931-5.1 - Rain Water Outlets - each.

SECTION 941

MILE STONES AND RIGHT OF WAY MARKERS

941-1 DESCRIPTION

The work covered in this Section consists of the supply and erection of concrete mile stones and right of way markers on which are molded or written certain marking as indicated on the Plans. These mile stones or right of way markers shall be placed as indicated on the Plans or as directed by the Engineer and shall be constructed in accordance with the details shown on the Plans or in Road Sign Manual, issued in June 1969.

941-2 MATERIALS

The concrete mile stone or right of way markers shall be furnished by the Contractor which shall be made of Type B concrete as specified in Section 701. The marking shall be as specified on Plans. Base concrete shall be Type C, Section 701.

941-3 CONSTRUCTION METHODS

The concrete mile stones or right of way markers shall be pre-cast in approved moulds and on approved platforms. These shall then be cured and stacked in sheds till removed for installation at site.

These shall be set in a concrete base of Type C concrete, as shown on the Plans. These shall then be painted with two coats of approved white paint and written with 3 coats of approved black paint. Thereafter, the Contractor shall be responsible for their maintenance until the final acceptance of the contract, keeping them in their proper location and condition at all times.

941-4 MEASUREMENT

The quantities to be paid for under this Section shall be the number of mile stones or right of way markers constructed completed and accepted. The unit of measurement shall be by the number.

941-5 RATE

The quantities determined as provided above, shall be paid for at the contract unit price each for mile stones or right of way markers complete including markings. Such prices and payments shall be full compensation for all the work specified in this Section.

941-6 PAYMENT

Payment shall be made under:

Item No. 941-6.1 - Mile Stone Complete - each

Item No. 941-6.2 - Right of Way Markers
Complete - each

SECTION 951

PRECAST CONCRETE PLANKS

951-1 DESCRIPTION

The work specified in this Section consists of furnishing and fixing precast concrete planks to cover the service ducts of the foot walk all according to these Specifications and the lines and dimensions shown on the Plans.

951-2 CONSTRUCTION REQUIREMENTS

951-2.1 PORTLAND CEMENT CONCRETE: This will comply with the requirements of Section 701. Portland Cement Concrete Type B shall be used.

951-2.2 REINFORCING STEEL WORK: This will comply with the requirements of Section 821. Plain steel bars shall be used.

951-3 STORAGE AND HANDLING

Planks shall be stored and handled in such a way that these are not subjected to overstress, spalling or other injury.

951-4 MEASUREMENT

Planks shall be measured in number. The specified dimensions will be shown on the Plans.

951-5 RATE

The unit rate shall be full compensation for furnishing and erecting planks in final position as shown on the Plans or required by the Engineer.

951-6 PAYMENT

Payment shall be made under:

Item No. 951-6.1 - Precast Concrete Planks of
Specified Dimensions - Each

*I. ROADWAY CONSTRUCTION
MATERIALS*

SECTION 1001

PARTLAND CEMENT

1001-1 SCOPE

These specifications cover five types of portland cement, as follows:

Type - I: For use in general concrete construction when the special properties specified for type II, III, IV and V are not required.

Type - II: For use in general concrete construction exposed to moderate sulphate action, or when moderate heat of hydration is required..

Type - III: For use when high early strength is required.

Type - IV : For use when low heat of hydration is required.

Type - V: For use when high sulphate resistance is required.

1001-2 BASIS OF PURCHASE

The purchaser should specify the type or types desired. When no type is specified, the requirements of Type I shall govern.

1001-3 DEFINITION

Portland cement is the product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulphate, except that addition of other non-deleterious materials may be added at the option of the manufacturer in an amount not to exceed 0.1 per cent.

1001-4 PHYSICAL REQUIREMENTS

Portland cement of each of the five types shown in Section 1001-1 shall conform to the requirements of ASTM Designation C150.

1001-5 PACKING AND MARKING

When the cement is delivered in packages, the name and brand of the manufacturer and the type shall be plainly identified thereon, except that, in the case of type I cement, the type need not be identified. When the cement is delivered in bulk this information shall be contained in the shipping advices accompanying the shipment. A bag shall contain 112 lb. net. All packages shall be in good condition at the time of inspection.

1001-6 STORAGE

The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weathertight building that will protect the cement from dampness and minimize warehouse set. Cement bags shall be stocked on a damp-proof floor or on timber raised at least one foot from the ground with air space below. There shall be similar air space between the stack and walls and roof of the building. The maximum height of stack shall not exceed eight bags.

1001-7 INSPECTION

Every facility shall be provided to the purchaser for careful sampling and inspection either at the mill or at the site of the work, as may be specified by the purchaser. The following periods from time of sampling shall be allowed for completion of testing.

1-day test	....	6 days
3-day test	....	8 days
7-day test	....	12 days
28-day test	....	33 days

1001-8 REJECTION

1001-8.1 The cement may be rejected if it fails to meet any of the requirements of these specifications.

1001-8.2 Cement remaining in bulk storage at the mill, prior to shipment, for a period greater than six months after completion of the tests may be tested and may be rejected if it fails to conform to any of the requirements of these specifications.

1001-8.3 Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random is less than that specified, the entire shipment may be rejected.

1001-8.4 Cement failing to meet the test for soundness in the autoclave may be accepted if it passes a retest, using a new sample, at any time within 28 days thereafter. The provisional acceptance of the

cement at the mill shall not deprive the purchaser of the right to reject on a retest of soundness at the time of delivery of the cement to the purchaser.

1001-9 METHOD OF SAMPLING AND TESTING

The sampling and testing of portland cement shall be in accordance with the following standards of the American Association of State Highway Official.

Sampling	...	T 127
Chemical	...	T 105

NOTE: Sodium and potassium oxides may be determined by either the flame photometary method outlined in T 105, Part II, or the gravimetric method outlined in T 105, Part I.

Finess:

Turbidimeter	...	T 98
Air permeability	...	T 153
Soundness	...	T 107

Time of Setting:

Gillmore needles	...	T 154
Vicat	...	T 131
Air Content of Mortar	...	T 137
Normal Consistency	...	T 129
Tensile Strength	...	T 132
Compressive Strength	...	T 106

1001-10 MEASUREMENT

Cement shall be measured by weight. The unit of measurement shall be one ton.

1001-11 RATE

The unit rate for supply of cement at site of work shall be full compensation for cost of cement, octroi charges, unloading from wagons/trucks, transportation to site of work, and its storage in godowns.

1001-12 PAYMENT

Payment for supply of cement, when specifically called for in bid schedule shall be made under:

Item No. 1001-12.1 - Supply of Portland Cement
of Specified Quality - Per ton..

SECTION 1011

BITUMINOUS BINDERS

1011-1 DESCRIPTION

The work covered under this Section consists of supplying bituminous binders (Penetration grade bitumens or cut backs only) of designated grades, in accordance with these specifications and at location designated by the Engineer.

1011-2 TYPES OF BITUMINOUS BINDERS

For the purposes of these specifications only one type of bituminous binder shall be considered which includes:

- i) Bitumen
- ii) Cut Backs and
- iii) Emulsions

Bitumen, which is also termed as Penetration grade bitumen, Asphalt Bitumen, Asphalt Cement (USA) Straight Run Bitumen and Residual Bitumen, is commonly used in Pakistan. This section therefore contains Specifications mainly for it.

1011-2.1 BITUMEN: Bitumen shall be obtained from crudes by either vacuum distillation or semi blowing or two stage blowing, or fluxing and solvent extraction methods.

The supply order for bitumen shall be designed by its penetration at 25 degree C (77-degree F). The grades of bitumen are usually designated by penetration limits such as 200/300, 180/200, 80/100, 60/70 etc. Grade Specifically required shall be designated.

1011-2.2 CUT BACKS: Cut backs shall consist of penetration grade bitumens mixed with a volatile solvent or flux which shall be either white spirit or Naphtha, a type of Kerosine or type of gas oil. Bitumens when mixed with naphtha or white Spirit, produces Rapid curing cut backs; when mixed with a type of Kerosine produces Medium Curing cut back and when mixed with a type of Gas Oil produces Slow curing cut back.

Grades of Cut backs are designated by the Kinematic Viscosity measured at a standard temperature of 140 degree F (60 degree C) or by Furol Say-bolt viscosity measured at varying temperatures. When designated by Kinematic viscosity, each grade is named by the lower limit of the viscosity and the upper limit for the grade is twice that of lower limit. These results in the grade being known as RC, MC, SC70; RC, MC, SC 250; RC, MC, SC 800 etc. When designated by Saybolts viscosity grades are designated as RC-0 to RC-5, MC-0 to MC-5 and SC-0 to SC-5.

1011-2.3 EMULSIONS: Bitumen Emulsion shall be of the oil-in-water type in which the oil phase constitutes usually between 30 and 70 per cent. Bitumen Emulsions shall be obtained by emulsifying the bitumen in order to render it sufficiently fluid for cold application.

Since this has a very limited scope of work in Pakistan, therefore, its specifications are not being described.

1011-3 STANDARD REQUIREMENTS

Standard requirements for bitumens and cut backs are given in Tables 1011-1 and 1011-2 (A&B). All bitumens and cut backs shall conform to specifications given in these tables.

1011-4 APPLICATION TEMPERATURES FOR BITUMENS AND CUT BACKS

Bitumens and cut backs of various grades, for applications shall be heated to temperatures shown in table 1011-3.

1011-5 SUPPLY OF BITUMEN

The agency supplying bituminous binders to the department shall do so either in tank trucks or in water proof drums, as called for in the Bid Schedule. The drums shall be Standard 45 gallons, made of 22 SW gauge, M.S. Sheet and properly welded to make it waterproof. The tank trucks shall be fully insulated. They shall be inspected prior to loading and if necessary they shall be drained and cleared.

1011-6 METHOD OF TEST

Latest revision shall apply:

(a)	Sampling	AASHTO T 40
(b)	Flash Point - (1) Tagliabue Cup	T 79
	(2) Cleveland Open Cup	AASHTO T 48
(c)	Saybolt Viscosity	AASHTO T 72
(d)	Water	AASHTO T 55
(e)	Distillation of Cutback Asphalts	AASHTO T 78
(f)	Penetration	AASHTO T 49
(g)	Ductility	AASHTO T 51
(h)	Determination of Bitumen (except that carbon tetrachloride shall be used in place of carbon disulphide)	AASHTO T 44
(i)	Loss on heating.	AASHTO T 47
(j)	Inorganic matter.	AASHTO T 111
(k)	Thin film oven test	AASHTO T 179

1011-7 STORAGE

The bituminous binder of specified grade shall be stored at site of work in water tight drums which shall conform to specifications contained in para 1011-5.

1011-8 MEASUREMENT

The supply of bituminous binder shall be measured by weight.
The unit of measurement shall be one ton.

1011-9 RATE

The unit rate shall be full compensation for supplying specified grade of bituminous binder at site of work including unloading from railway wagons/trucks, transportation, unloading and storage including all other incidentals like octroi charges etc.

1011-10 PAYMENT

Pyament shall be made under:

Item No. 1011-10.1	-	Bituminous Binder of Specified	
		Grade	.. - Per Ton.

TABLE NO. 1011-1
STANDARD REQUIREMENTS OF BITUMENS
PENETRATION GRADES

TEST	TEST METHOD	200/300	180/200	130/150	80/100	60/70	30/40	20/30
Specific Gravity at 25/25°C (77°F)	D-71	0.97-1.04	1.00-1.05	1.00-1.05	1.00-1.05	1.01-1.06	1.02-1.07	1.02-1.07
Softening Point (R&B)	D-36	---	37/43°C (100/110°F)	40-46°C (105/115°F)	45-52°C (110/130°F)	46-57°C (115-135°F)	55-64°C (130/150°F)	59-69°C (140/155°F)
Penetration at 25°C(77°F)	D-5	0.1 mm	0.1 mm	0.1 mm	0.1 mm	0.1 mm	0.1 mm	0.1 mm
Ductility at 15°C (60°F) cm min.		60	60	60	60	60	--	--
Ductility at 25°C(77°F) cm min.	D-113	100	100	100	100	100	60	30
Loss on Heating @ 325°F % Wt. max.	D-6	---	0.5	0.5	0.5	0.2	0.2	0.2
Drop in Pen. after Heating % Max.	D-5	63	20	20	20	20	20	20
Flash Point (Cleveland Open Cup)	D-92	177°C (350°F)	200°C (392°F)	225°C (425°F)	225°C (425°F)	225°C (425°F)	250°C (480°F)	250°C (480°F)
Solubility in CS2 % Wt. Min.	D-165	99	99	99	99	99	99	99

Used for surface Treatment

Used for Surface Treatment, Penetration Macadam Plant mix materials.

Used for damp proofing only.

TABLE 1011-2(A)

STANDARD REQUIREMENTS FOR CUTBACKS

TEST		RC0	RC1	RC2	RC3	RC4	RC5
Viscosity S.F. @ 77°F (25°C)	seconds	75-150					
Viscosity S.F. @122°F (50°C)	seconds	--	75-150				
Viscosity S.F. @140°F (60°C)	seconds	--	--	100-200	250-500		
Viscosity S.F. @180°F (82°C)	seconds	--	--	--	--	125-500	300-600
Flash Point C.O.C. *	°F Min.	--	--	80	80	80	80
Flash Point C.O.C. *	°C min.	--	--	26.7	26.7	26.7	26.7
<u>Distillation</u>							
Distillate to 374°F (190°C)% volume total		15+	10+	--	--	--	--
Distillate to 437°F (225°C)total distill-		55+	50+	40+	25+	8+	--
Distillate to 500°F (260°C)ate to 680°F		75+	70+	65+	55+	40+	25+
Distillate to 600°F (316°C) (360°C)		90+	88+	87+	83+	80+	70+
Residue from distillation							
to 680 degree F (360 degree C)%volume min.		50	60	67	73	78	82
<u>Test on Residue after Distillation</u>							
Penetration at 77 degree F (25 degree C) 0.1 mm		80-120	80-120	80-120	80-120	80-120	80-120
Ductility at 77 degree F(25 degree C) cm. min.		100	100	100	100	100	100
Solubility in CCl4	% wt. min.	99.5	99.5	99.5	99.5	99.5	99.5

* C.O.C. Cleveland Open Cup.

TABLE 1011-2(B)

STANDARD REQUIREMENTS FOR CUTBACKS

TEST	MCO	MC1	MC2	MC3	MC4	MC5
Viscosity S.F. @ 77°F (25°C) seconds	75-150	--	--	--	--	--
Viscosity S.F. @ 122°F (50°C) seconds	--	75-150	--	--	--	--
Viscosity S.F. @ 140°F (60°C) seconds	--	--	100-200	250-500	--	--
Viscosity S.F. @ 180°F (82°C) seconds	--	--	--	--	125-250	300-600
Flash Point C.O.C.* °F min.	100	100	150	150	150	150
Flash Point C.O.C.* °C min.	37.8	37.8	65	65	65	65
<u>Distillation</u>						
Distillate to 374°F (190°C) % volume total	--	--	--	--	--	--
Distillate to 437°F (225°C) distillate to	25-	20-	10-	5-	0	0
Distillate to 500°F (260°C) 680°F	40-70	25-65	15-55	5-40	30-	20-
Distillate to 600°F (316°C) (360°C)	75-93	70-90	60-87	55-85	40-80	20-75
Residue from distillation to 680 degree F (360 degree C) % volume min.	50	60	67	73	78	32
<u>Test on Residue after Distillation</u>						
Penetration at 77 degree F (25 degree C) 0.1 mm	120-300	120-300	120-300	120-300	120-300	120-300
Ductility at 77 degree F (25 degree C) cm min.	100	100	100	100	100	100
Solubility in CCl ₄ % wt. min.	99.5	99.5	99.5	99.5	99.5	99.5

* C.O.C. Cleveland Open Cup

TABLE No.1011-3

APPLICATION TEMPERATURES FOR BITUMENS AND CUTBACKS

GRADE	SPRAYING				Mixing	
	Atomising	Jets	Slot	Jets	°C	°F
	°C	°F	°C	°F		
Cutback MC/RC0	50-60	125-145	35-45	100-120	-	-
" MC/RC1	70-85	165-190	60-70	140-160	-	-
" MC/RC2	90-110	195-225	75-85	170-190	50-65	125-150
" MC/RC3	110-125	235-255	100-110	210-230	65-95	150-200
" MC/RC4	125-140	255-285	110-120	230-250	80-105	175-225
" MC/RC5	140-155	285-310	125-135	255-275	95-120	200-250
Bitumen 180/200	170-190	340-370	155-165	310-330	130-150	270-300
" 80/100	180-200	360-390	165-175	330-350	140-160	290-320

NOTES:

1. Owing to the inflammable nature of the solvent in RC type cutbacks the application temperatures of these grades should be kept to the lower end of the ranges quoted.
2. The temperature range given for each grade is necessarily rather wide because local climatic conditions and the type and conditions of the equipment affects the optimum spraying temperature.

SECTION 1021

L I M E

1021-1 DESCRIPTION

This work shall consist of supplying unslaked "stone lime" or "kankar lime" for construction work from an approved source.

1021-2 SOURCE

Stone, fat or white lime shall be manufactured from lime stone containing at least 90% pure carbonate of lime. Lime Stone shall be obtained from an approved source.

Kankar lime shall be burnt from good quality kankar modules having a blue grey fracture free from sand grains. The kankar shall be quarried from an approved source.

1021-3 QUALITY

The lime shall be of first class quality free from admixture of coarse sand or cinders.

1021-4 STORAGE

Lime shall be stored in dry and weather proof sheds, in a compact heap so as to expose to air as small an area as possible, in order to prevent air slaking. Lime shall not be stored for a long time after burning but used as fresh as possible.

1021-5 MEASUREMENT

Stone lime shall be measured by weight before slaking. The unit of measurement shall one maund. Kankar lime shall be measured in bulk before slaking. The unit of measurement shall be one hundred cubic feet.

1021-6 RATE

The unit rate for supplying of lime shall be full compensation for procuring, transportation to place of delivery, protection from slaking and loading, unloading etc. complete.

1021-7 PAYMENT

Payment shall be made under:

Item No. 1021-7.1	- Lime	- Per maund
Item No. 1021-7.2	- Kankar Lime	- Per 100 cu.ft.

SECTION 1031

COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

1031-1 DESCRIPTION

The work covered in this Section consists of supplying coarse aggregate which shall consist of crushed stone or brick or crushed or uncrushed gravel having clean, hard, tough durable pieces free from injurious amounts of soft, friable, thin, elongated, or laminated pieces, soluble salts, organic or other deleterious matter.

1031-2 SOURCE

Coarse aggregate shall be obtained from an approved source.

1031-3 GRADING

All coarse aggregate shall be uniformly graded from coarse to fine within the limits specified in Table 1031-1.

1031-4 QUALITY

Unless otherwise specified elsewhere the coarse aggregate shall conform to the following requirements:

- i) Percentage wear by Los Angeles
Abrasion test at 500 Revolutions
(AASHO-T-96) Not more than 45
- ii) Soundness of Aggregate by freezing
and thawing (AASHO-T-103) Max. per
centage loss on 15 cycles. .. Not more than 5
- iii) Soundness of Aggregate by use of
Sodium Sulphate or Magnesium Sulphate
(AASHO-T-104) - Max. percentage loss
on 5 cycles. Not more than 8

1031-5 IMPURITIES

The deleterious matter in any coarse aggregate shall not exceed the following:

Clay Lumps 0.25%

TABLE - 1031-1

COARSE AGGREGATE - GRADATION

Per cent by weight of Coarse Aggregate Passing Square Opening Laboratory Sieves

Grade	3-in	2-in	1½-in.	1-in.	¾-in.	½-in.	3/8-in.	No.4	No.10	No.16
3	100	97-100	97-100	40-75				0-5		
5		100	95-100	85-100	60-90	30-60		0-6		
6			100	97-100	75-95			0-5		
8			100	97-100	60-90	40-65	20-45	6-22	0-6	
9			100	95-100	75-100	35-70	5-30	0-7		
10			100		60-85	30-60	10-35		0-5	
11				95-100		0-30	0-6			
12				100	95-100	30-65	0-15			
13					100	90-100		0-10	0-2	
16						100	80-100	35-60	0-10	0-5

The above gradations represents the extreme limits for the various sizes indicated, which will be used in determining the suitability for use of coarse aggregate from all sources of supply. For any grade from any one source, the gradation shall be held reasonably uniform and not subject to the extreme percentages of gradation specified above.

1031-6 STOCKPILING AGGREGATE

The stockpile sites, as staked by the Engineer, shall be prepared by clearing, burning of all trees, stumps, bush and debris as provided in Section 301. The floor for each stockpile shall be comparatively uniform in cross section. The completed stockpiles shall be neat and regular in form shall be made to occupy the smallest feasible areas. Only when ordered by the Engineer shall the height of the piles or their average depth be more than 6 feet. The side slopes shall not be flatter than $1\frac{1}{2} : 1$.

To avoid segregation of the various sizes in each stockpile, the aggregate shall be deposited in uniform layer or lifts not exceeding 1 foot in thickness. The aggregate shall be placed in each lift by trucks or other types of hauling units. Stockpiling from a conveyor belt will not be permitted. The piles shall be so located and so constructed that no intermingling of grading will occur.

1031-7 MEASUREMENT

Coarse aggregate shall be measured in bulk. The unit of measurement shall be one hundred cubic feet.

1031-8 RATE

The unit rate shall be full compensation for furnishing coarse aggregate in well graded and clear state as per above specification at site of work, including loading, transportation, unloading and stacking at site of work to be defined in the bid schedule.

1031-9 PAYMENT

Payment shall be made under:

Item No. 1031-9.1 - Coarse Aggregate of
Specified Gradation for
Portland Cement Con-
crete. Per 100 cu. ft.

SECTION 1032

FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

1032-1 DESCRIPTION

The work covered under this Section consists of furnishing of and placing aggregates for portland cement concrete in stock piles in accordance with these specifications at the location shown on the plans or in the bid schedule.

1032-2 GENERAL REQUIREMENTS

1032-2.1 Fine aggregate shall consist of natural sand or subject to approval, other inert materials with similar characteristics, or combinations thereof, having hard, strong durable particles, and shall conform to the requirements of these specifications.

1032-2.2 Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the Engineer.

1032-3 DELETERIOUS SUBSTANCES

The amount of deleterious substance shall not exceed the following items:

	Recommended permissible Limit % By Weight	Maximum Permissible Limit Per Cent By Weight
Clay lumps not more than	0.5	1.0
Coal and ignite	0.25	1.0
Material Passing the No. 200 Sieve		
a) In concrete subject to surface abrasion, not more than	2	4
b) All other classes of concrete, not more than	3	5
Other deleterious substances (such as shale, alkali, mica, coated grains, soft and flaky particles.	As specified	

NOTE: The recommended limits percentage by weight should be specified on all work where it is economically practicable to obtain materials conforming thereto. Only one set of figures for per cent by weight should be included in purchase specifications.

1032-4 SOUNDNESS

1032-4.1 When the fine aggregate is subjected to five alternation of the sodium sulphate test, the weighted loss shall not exceed 10 per cent by weight.

NOTE: In case it is desired to use magnesium sulphate, a weighted loss should be specified which experience has shown will give results corresponding to a loss of 10 per cent when using sodium sulphate.

1032-4.2 The requirements for soundness given in 1032-4.1 above may be waived in the case of aggregate for use in structure or portions of structures not exposed to weathering.

1032-5 ORGANIC IMPURITIES

All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified in Section 1032-6. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall be withheld until test satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

1032-6 MORTAR-MAKING PROPERTIES

When subjected to the test for mortar-making properties, the fine aggregate shall develop a compressive strength at the age of 3 days when using Type III cement or at 7 days when using Type I or II cement, of not less than 90 per cent of the strength developed by a mortar prepared in the same manner with the same cement and graded sand having a fineness modulus of 2.40 ± 0.10 . The cement used shall be specified in Section 1001.

1032-7 GRADING

1032-7.1 Fine aggregate shall be well graded coarse to fine and when tested by means of laboratory sieves shall conform to the following requirements:-

	<u>Per Cent</u>
Passing a 3/8 in. Sieve	100
Passing a No. 4 Sieve	95-100
Passing a No. 16 Sieve	45-80
Passing a No. 50 Sieve	10-30
Passing a No. 100 Sieve	2-10

NOTE: The No. 8 and No. 30 sieves may be used in addition to these specified, if the Engineer desires to further control the grading of the material.

1032-7.2 Fine aggregate failing to pass the minimum requirement for material passing the No. 50 and/or No. 100 sieves may be used provided a satisfactory inorganic fine material is added to correct for the deficiency in grading.

1032-7.3 At the option of the Engineer when the fine aggregate is to be used in the construction of concrete pavements for bases, the specified minimum amount passing the No. 50 sieve may be reduced to 5 per cent and the specified minimum amount passing the No. 100 sieve may be reduced to 0 per cent.

1032-8 UNIFORMITY OF GRADING

The grading requirements given in Section 1032-7.1 represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus (Note) determination shall be made upon representative samples, submitted the Contractor, from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample submitted by the Contractor may be rejected.

NOTE: The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieve having square openings, and dividing by 100:

3-in., 1½ in., 3/4-in., 3/8-in., No. 4, No. 8,
No. 16, No. 30, No. 50, No. 100.

1032-9 METHODS OF SAMPLING AND TESTING

Sampling and testing of fine aggregate shall be in accordance with the following methods of the American Association of State Highway Officials:

Sampling	T	2
Clay lumps	T	112
Light Weight pieces in aggregates	T	113
Amount of Material Passing a No.200 Sieve	T	11
Organic Impurities	T	21
Mortar Making Properties	T	71
Sieve Analysis	T	27
Soundness (Sodium Sul-phate or Magnesium Sulphate)	T	104
Soundness (Freezing and thawing)	T	103

1032-10 STOCKPILING OF AGGREGATES

The stockpile sites, as staked by the Engineer, shall be prepared by clearing, burning of all trees, stumps, bush and debris as provided in Section 301. The floor for each stockpile shall be comparatively uniform in cross section. The completed stockpiles shall be neat and regular in form and shall be made to occupy the smallest feasible areas. Only when ordered by the Engineer shall the height of the piles or their average depth be more than 6 feet. The side slopes shall not be flatter than $1\frac{1}{2} : 1$.

To avoid segregation of the various sizes in each stockpile, the aggregate shall be deposited in uniform layer or lifts no exceeding 1 foot in thickness. The aggregate shall be placed in each lift by trucks or other types of hauling units. Stockpiling from a conveyor belt will not be permitted. The piles shall be so located and so constructed that not intermingling of gradings shall occur.

1032-11 MEASUREMENT

The quantity of aggregate of specified grades stockpiled shall be measured by volume. The unit of measurement shall be 100 cu. ft.

1032-12 RATE

The unit rate per unit of measurement shall be full compensation for furnishing and stockpiling all aggregates including all labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

1032-13 PAYMENT

Payment shall be made under:

Item No. 1032-13.1 - Fine aggregate of specified gradation for Portland Cement Concrete. .. Per 100 cu. ft.

SECTION 1033

MORTAR SAND

1033-1 DESCRIPTION

The work covered under this Section consists of furnishing and placing in stockpiles mortar sand for use in cement mortar/portland cement concrete in accordance with these specifications.

1033-2 GENERAL REQUIREMENTS

Mortar sand shall consist of hard, strong, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

1033-3 ORGANIC IMPURITIES

Mortar sand when subjected to the colorimetric test organic impurities and producing a color darker than the standard color shall be rejected unless the sand complies with the mortar strength test specified in Section 1033-4.

1033-4 MORTAR STRENGTH

When subjected to the test for mortar making properties, the fine aggregate shall develop a compressive strength at the age of 3 days when using type III cement or at 7 days when using type I or II cement of not less than 90 per cent of the strength developed by a mortar prepared in the same manner with the same cement and graded sand having a fineness modulus of 2.40 ± 0.10 . Type I, II and III cement are prescribed in the Standard Specifications for Portland Cement Section 1001.

1033-5 GRADING

Mortar sand shall be uniformly graded from fine to coarse within the following limits:

		<u>Per cent</u>
Passing No. 8	Sieve	100
Passing No. 50	Sieve	15-40
Passing No.100	Sieve	0-10
Passing No.200	Sieve	0-5

1033-6 METHODS OF SAMPLING AND TESTING

Sampling and testing of sand for mortar shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T	2
Organic Impurities	T	21
Mortar Making Properties	T	17
Sieve Analysis	T	27
Material Passing No.200 Sieve	T	11

1033-7 STOCKPILING

The stockpile sites, as staked by the Engineer, shall be prepared by cleaning, burning of all trees, stumps, brush and debris as provided in Section 301. The floor for each stockpile shall be comparatively uniform in cross section. The completed stockpiles shall be neat and regular in form and shall be made to occupy the smallest feasible areas. Only when ordered by the Engineer shall the height of the piles or their average depth be more than 6 feet. The side slopes shall not be flatter than $1\frac{1}{2} : 1$.

To avoid segregation of the various sizes in each stockpile, the aggregate shall be deposited in uniform layer or lifts not exceeding 1 foot in thickness. The aggregate shall be placed in each lift by trucks or other types of hauling units. Stockpiling from a conveyor belt will not be permitted. The piles shall be so located and so constructed that no intermingling of grading will occur.

1033-8 MEASUREMENT

Mortar sand shall be measured by volume. The unit of measurement shall be 100 cubic feet.

1033-9 RATE

The unit rate shall be full compensation for furnishing mortar sand/fine aggregate in a clean state as per specification mentioned above including its loading transportation to site of work, unloading to storage etc. complete.

1033-10 PAYMENT

Payment shall be made under:

Item No. 1033-10.1 - Mortar Sand Per 100 Cu. Ft.

SECTION 1034

MINERAL FILLER

1034-1 COMPOSITION

Mineral filler shall consist of lime, rock dust, portland cement, or any other inert mineral matter from approved sources. The mineral filler shall be thoroughly dry and free from lumps consisting of aggregations of fine articles. Ground phosphate will not be allowed as a mineral filler.

1034-2 GRADATION:

The mineral filler shall meet the following gradation requirements:

	<u>Per Cent</u>
Passing No. 30 Sieve	100
Passing No. 80 sieve	95-100
Passing No. 200 sieve	65-100

SECTION 1041

CLAY BRICKS AND CLAY TILES

1041-1 DESCRIPTION

The work under this section consists of supplying and stacking at construction site first class bricks or first class tiles according to following specifications.

1041-2 SOURCE

The bricks or tiles shall be supplied from the nearest approved brick kiln.

1041-3 CLAY FOR BRICKS OR TILES

1041-3.1 SOURCE: Clay shall be obtained from good earth containing 20 to 30% fine sand.

1041-3.2 QUALITY: Clay shall not contain more than 0.5% soluble salts; more than 0.2% sulphate; and more than 4% organic contents. It shall not contain any gravel, coarse sand, kankar, roots of grass and plant.

1041-3.3 PREPARATION: Clay before use shall be dug up and left to weather for a week. It shall be thoroughly watered, turned over for at least 48 hours and tempered until free from lumps and it is stiff. Any stone found shall be picked out by hand. The tempering shall be done in a pug mill, or by treading. When ready for moulding the clay shall be of such consistency (plasticity index 7 to 10 for hand moulding) so as to give a homogeneous brick or tiles.

1041-4 MOULDING

Hand moulding shall be carried out in wrought iron moulds having a size which shall give the required size of the brick or tile after burning. All bricks or tiles shall sand moulded.

1041-5 FROG

Each brick shall have a frog 1/4" deep on the upper face and, trade marks in it as approved by the Engineer.

There shall be no frog in the clay tile.

1041-6 HANDLING OF RAW BRICKS OR TILES

The raw bricks/tiles handled for drying and then taken to kiln for burning shall be handled with great care so that the corners or edges or other parts of the bricks are not damaged.

1041-7 BURNING

Bricks/tiles when loaded in kilns shall be burnt to specified standards.

1041-8 FIRST CLASS BRICKS AND TILES

The size of the bricks shall be specified. The standard size is 9" x 4½" x 3". They shall be well burnt without being vitrified. They shall be of uniform colour, regular in shape and size, with sharp and square corners and parallel faces. They must be homogeneous in texture and emit a clear ringing sound when struck. They shall be free from flaws and cracks. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour, and shall show no signs of efflorescence or drying. Compressive strength shall not be less than 2000 lbs. per square inch.

Tiles shall conform to clause No. 8 above for quality. The size shall be (i) 12" x 6" x 2" (ii) 12" x 6" x 1-1/4" (iii) 9" x 4-1/2" x 2" (or as specially specified).

1041-9 STACKING

The bricks shall be sorted and arranged in stacks of one or two thousands as specified. Each course shall be 10 courses high and two bricks thick so that at least one end of every brick is visible. At least three feet space between the stacks shall be left for each inspection.

1041-10 SAMPLING

The bricks or tiles required for carrying out the tests laid down in these specifications shall be taken by one of the methods given below:

1041-10.1 SAMPLING BRICKS OR TILES IN MOTION: Samples in this way shall be taken when the bricks or tiles are being loaded or unloaded. Samples shall be taken at random from each of a number of convenient portions of the consignment or batch.

1041-10.2 SAMPLING BRICKS OR TILES FROM A STACK: Samples shall be taken at random from a stack. The number of bricks required for the tests shall be taken from across the top of the stack, the sides accessible and from the interior of the stack by opening the trench from the top.

Whichever method is employed a sample of 50 bricks or tiles shall be taken at random from every consignment of 50,000 bricks/tiles or part thereof.

The samples thus taken shall be stored in a dry place not in contact with the ground until the tests are made. The bricks for tests shall be taken at random from the sample.

1041-11 MEASUREMENT

Measurement of bricks or tiles shall be in numbers. The unit of measurement shall be one thousand. If more than 10% bricks in the stacks do not conform to the specification, the whole consignment will be rejected but if it is less than 10% the batch may be accepted but below specification bricks rejected.

1041-12 RATE

The unit rate shall be full compensation for supply of bricks/tiles including loading, transportation to site of work, unloading and stacking including all incidentals etc. complete.

1041-13 PAYMENT

Payment shall be made under:

Item No. 1041-13.1	- Supply of Ist Class Bricks	- Per 1000 Nos.
Item No. 1041-13.2	- Supply of Tiles of Approved Quality	- Per 1000 Nos.

SECTION 1046

STONE FOR MASONRY

1046-1 DESCRIPTION

The work covered under this Section consists of supplying and stacking stone for stone masonry from an approved source. This shall be quarried according to an approved method.

1046-2 SOURCE

Stone shall be obtained from nearest approved quarry. If the same quarry has stone of varying nature in different sections, then stone from the approved section only shall be quarried and supplied.

1046-3 QUALITY

Stone shall be hard, tough, compact, durable, having uniform colour and free from faults and cleavage. It shall be of a kind that previous use has been proven to be satisfactory for the specified purpose.

Stone for Ashlar masonry shall be free of seams, laminations, and minerals, which, by weathering would cause discoloration of deterioration.

1046-4 SIZE AND SHAPES

Each stone shall be free from depressions and projects that might weaken it or prevent it from being properly bedded, and shall be of such shape as will meet both architecturally and structurally the requirements for the class of masonry specified.

In general, stones shall have thickness of not less than 5 inches, width of not less than $1\frac{1}{2}$ times their respective thickness, with minimum width of 12", and lengths of not less than $1\frac{1}{2}$ times their respective widths. Where headers are required their lengths shall be not less than the width of the widest adjacent stretches plus 12 inches.

At least 50 per cent of the total volume of the masonry shall be of stone having a volume of at least 1 cubic foot each.

1046-5 DRESSING AND CUTTING

The stone shall be dressed to remove any thin or weak portions. All visible edges shall be free from chipping. Face Stones shall be dressed to provide bed and joint lines with a maximum variation from true lines as follows:

- | | | |
|---------------------------------------|-------|-----------|
| (1) Random Rubble Masonry | ..... | 1½ inches |
| (2) Course Rubble Masonry (2nd Class) | ..... | ¾ " |
| (3) Course Rubble Masonry (1st Class) | ..... | ¼ " |
| (4) Ashlar Masonry | ..... | True |

1046-6 BED SURFACES

Bed Surfaces of face stones shall be normal to the faces of the stones for about 3 inches and from this point may depart from normal not to exceed 1 inch in 12 inches for ashlar masonry and 2 inches in 12 inches for all other classes.

1046-7 JOINT SURFACES

In all classes except ashlar masonry, the joint surfaces of face stones shall form an angle with the bed surface of not less than 45 degrees.

In ashlar masonry, the joint surfaces shall be normal to the bed surfaces. They shall also be normal to the exposed faces of the stone for at least 2 inches, from which point they may depart from normal not to exceed 1 inch in 12 inches.

The corners at the meeting of the bed and joint lines shall not be rounded in excess of the following radii:

- | | | |
|---------------------------------------|-------|-------------|
| (1) Random Rubble Masonry | ..... | 1½ inches |
| (2) Course Rubble Masonry (2nd Class) | ..... | 1 inches |
| (3) Course Rubble Masonry (1st Class) | ..... | No rounding |
| (4) Ashlar Masonry | ..... | No rounding |

1046-8 BEDDING

Rubble stone shall be evenly bedded and shall be quarried in as large blocks as will permit of being handled.

1046-9 STACKING

Stacking shall be done on even ground and closely packed. The length and breadth shall be in multiples of 10 and height may vary from 2 feet to 5 feet.

1046-10 MEASUREMENT

Stone shall be measured by volume, the unit of measurement shall be one hundred cubic feet. Actual stone contents shall be obtained by multiplying the stack measurement with a factor 0.75.

1046-11 RATE

The unit rate shall be full compensation for furnishing stone for a particular class of masonry conforming to the stone specifications and stacking at site of work including quarrying, dressing, loading, transportation and unloading etc. complete in all respects.

1046-12 PAYMENT

Payment shall be made under:

- | | | |
|--------------------|--|------------------|
| Item No. 1046-12.1 | - Stone for Random Rubble
Masonry | - Per 100 Cu.ft. |
| Item No. 1046-12.2 | - Stone for Course Rubble
Masonry (2nd Class) | - Per 100 Cu.ft. |
| Item No. 1046-12.3 | - Stone for Course Rubble
Masonry (1st Class) | - Per 100 Cu.ft. |
| Item No. 1046-12.4 | - Stone for Ashlar Masonry | - Per 100 Cu.ft. |

SECTION 1051

WATER

1051-1 DESCRIPTION

This work shall consist of furnishing and applying water to any of the civil engineering work concerned with highway construction or highway maintenance project in accordance with these specifications.

1051-2 SOURCE

Water shall be obtained from an approved source.

1051-3 QUALITY

Water shall be free from earth, vegetable, organic impurities and any other substance likely to cause efflorescence or inference with setting of mortars or otherwise prove harmful to the work. Broadly speaking any water which does not show any intensive odour or brackish taste shall be considered suitable for construction works.

1051-4 STORAGE

Water shall be stored in water tight tanks or containers so as to be adequately protected from the admixture of dust and other foreign matter.

1051-5 MEASUREMENT

Water shall be measured in bulk. The unit of measurement shall be 1000 gallons.

1051-6 RATE

The unit rate shall be full compensation for supplying and application of water and its transportation and storage etc. complete including all incidentals.

1051-7 PAYMENT

Payment shall be made under:

Item No. 1051-7.1 - Water Per 1000 Gal.

SECTION 1052

ADMIXTURES FOR CONCRETE (AIR ENTRAINING AND RETARDANT)

1052-1 DESCRIPTION

This Section covers specification for materials proposed to be used as air-entraining admixtures to be added to concrete mixtures in the field.

1052-2 DEFINITION

For the purpose of these specifications an air-entraining admixture is defined as a material that is used as an ingredient of concrete, added to the batch immediately before or during its mixing, for the purpose of entraining air.

1052-3 GENERAL REQUIREMENTS

The air-entraining admixture shall conform to the following requirements:

1052-3.1 BLEEDING: The percentage of bleeding by concrete containing the admixture under test shall not exceed 65 per cent of the bleeding of similar concrete without the admixture.

1052-3.2 COMPRESSIVE STRENGTH: The compressive strength of concrete containing the admixture under test shall be not less than 85 per cent of that of similar concrete without the admixture at all test ages.

1052-3.3 FLEXURAL STRENGTH: The flexural strength of concrete containing the admixture under test shall be not less than 85 per cent of that of similar concrete without the admixture at all test ages.

1052-3.4 RESISTANCE TO FREEZING AND THAWING: The relative durability factor of concrete containing the admixture under test shall be not less than 80.

1052-3.5 BOND STRENGTH: The bond strength of concrete containing the admixture under test shall be not less than 85 per cent of that of similar concrete without the admixture at the age of 28 days.

1052 3.6 VOLUME CHANGE: The volume change on drying of concrete containing the admixture under test, expressed as a percentage change in length, shall be not more than 0.01 greater than that of similar concrete without the admixture at ages of 28 days, 6 months, and one year.

1052-4 METHODS OF TESTING

The properties enumerated above shall be determined in accordance with the Standard Method of Testing Air Entraining Admixtures for Concrete (AASHTO Designation: T 157). It is recommended that, whenever practicable, tests be made in accordance with Section 2(d) of Methods T 157 using the cement proposed for specific work.

SECTION 1061

HIGH TENSILE STEEL

1061-1 DESCRIPTION

The work specified in this Section consists of supplying high tensile steel for prestressed construction.

1061-2 GENERAL REQUIREMENTS

High tensile steel wire shall comply with B.S. 2691, "Steel for prestressed concrete - Part I Plain Hard Drawn Steel Wire" and shall be prestraughtened and stress relieved. High tensile steel wire shall be 'stabilized' and have a relaxation loss at 20° C not exceeding 2% at 1000 hours from an initial load of 70% of the minimum guaranteed breaking load of the material.

1061-3 TEST CERTIFICATE

High tensile steel wire shall be the product of an approved manufacturer. Each coil of wire shall be accompanied by the manufacturer's test certificate giving the batch reference number or mark, the date of manufacture, the wire diameter, the tensile strength, the 0.1 per cent proof stress and the stress strain diagram.

1061-4 WIRE COILS

The wire shall be supplied in coils not less than six feet in diameter and weighing not more than 500 lbs. The coils shall be protected against damage through corrosion by wrapping in jute covered tarred paper or other impervious medium. Wire which has been pitted, splashed by weld metal or surface damaged in any way, shall not be used.

1061-5 PROOF STRESS

The 0.1 per cent proof stress as determined by slow loading and measured by a precision extensometer shall be not less than 80 ton per square inch and the ultimate tensile stress shall be within the limits of 105 and 110 tons per square inch.

1061-6 TENSILE TESTS

The tests for ultimate tensile strength and proof stress shall be carried out in accordance with B.S. 18: Tensile testing of metals. Tests to determine compliance with the proof stress requirements shall not be made until 48 hours after the wire has been drawn.

The ultimate elongation of the wire shall be at least 4% of its initial length in a gauge length of ten times the wire diameter.

1061-7 COLD BEND TESTS

The cold bend test for the wire shall be in accordance with B.S. 2691: Part I: Steel for prestressed concrete. The number of tests and retests shall be as stated therein.

1061-8 MEASUREMENT

Measurement for high tensile steel wire shall be by weight. The unit of measurement shall be one cwt.

1061-9 RATE

The unit rate shall be full compensation for furnishing and supplying high tensile steel wire according to these specifications at site of work or store.

1061-10 PAYMENT

Payment shall be made under:

Item No. 1061-10.1 - High Tensile Steel
Wire - Per cwt.

SECTION 1071

TIMBER

1071-1 DESCRIPTION

The work covered under this Section consists of supplying timber for wood work from an approved source and may consist of logs or sleepers obtained from deodar, kail, chir or teak as called for in the Bid Schedule.

1071-2 QUALITY

Timber shall be of good quality, felled not less than two years before use for carpentry and four years for joinery and shall be properly seasoned.

Timber shall be uniform in texture, straight in fibre, free from open shakes, bore holes, fungus attack, rots, dots, decay, warp, twist, spring or crook and all other defects and blemishes. Timber shall not be spongy or in brittle condition.

Sleepers shall be straight and out of winding with faces square to one another and shall be free from sapwood, heart shakes, serious cracks.

1071-3 KNOTS

Exposed surfaces of hard wood sills shall be free from knots other than isolated sound tight knots not exceeding $\frac{3}{4}$ inch in diameter.

Loose or decayed dead knots shall not be permissible in any joinery and shall be cut out and plugged properly. In all other cases sound and tight knots including knot clusters which appear on any surface shall be permitted subject to a maximum of one live knot measuring $1\frac{1}{2}$ " to 2" across the major diameter per 2 feet length or one dead knot measuring $\frac{1}{2}$ " to 1" across the major diameter per 3 feet length.

Glazing bars shall be free from all knots other than sound knots appearing on one surface only and not exceeding $\frac{1}{4}$ " diameter in the web and $\frac{1}{2}$ " diameter elsewhere.

1071-4 SHAKE

Straight splits or shakes shall be permissible in the ends upto a total for both ends of $1\frac{1}{2}$ " per foot of length at the time of passing.

1071-5 LOG SIZES

Round logs shall not be of size less than 10 feet in length and 60" in girth. The maximum length not to exceed 35 feet. Tapered logs shall not be less than 54" in girth at the small end.

1071-6 STORAGE

Timber shall be stacked on a raised wooden or paved platform to eliminate chances of white ant attack. It shall be stacked under a proper shelter where maximum aeration is possible without subjecting it to the direct sun, rain or other weathering agents.

1071-7 METHOD OF MEASUREMENT FOR LOGS

The procedure for taking measurements shall be as follows:

(i) Bark must be removed at the middle of the logs where the girth measurement will normally be taken.

(ii) Girth measurement shall exclude bark, knots and projections at the middle of the logs.

(iii) Length measurements shall be reduced for cut, split, star shakes, tapered or burnt ends. The ends shall be preferably sawn square. Rough sawn squares shall not be accepted.

(iv) The girth shall be taken in the middle of the accepted length of the log.

(v) The cubical contents will be calculated by multiplying length by $(\frac{G^2}{4})$, where G is the girth at the middle of the log or the mean girth.

1071-8 MEASUREMENT

The timber in logs or sleepers shall be measured in bulk. The unit of measurement shall be one cubic feet.

1071-9 RATE

The unit rate shall be full compensation for supply of timber conforming to the above specifications including loading, transportation, unloading and delivery and stacking at site of work.

1071-10 PAYMENT

Payment shall be made under:

Item No. 1071-10.1 - Timber in logs - Per Cu.Ft.

Item No. 1071-10.2 - Timber in Sleepers - Per Cu.Ft.

SECTION 1081

PAINTS

1081-1 DESCRIPTION

The work covered in this Section consists of supplying paint of prescribed quality from an approved source. It shall be packed in strong containers plainly marked with the weight per gallon, the volume of the paint contents in gallons, the colour, lot batch and exact type of paint. The name and address of manufacturers and date of manufacture should also be marked on the container. Any container not so marked shall not be accepted for use.

No paint shall be used after one year of its manufacture.

1081-2 QUALITY

The paint shall be thoroughly ground to a condition that stirring readily produces a smooth uniform mixture of such a consistency that it works well under the brush and satisfies the following requirements:

1081-2.1 Paint shall become surface dry in not more than 24 hours when tested, according to method discussed subsequently.

1081-2.2 The paint after complete removal of any surface skin, shall be well mixed by shaking and/or stirring. Two coats of the mixed paint shall then be applied by brushing on to a smooth, clean, non absorbent surface. The first coat shall be allowed to dry thoroughly before the application of the second one. The agreed sample shall be treated in the same way and at the same time, and the two surfaces after drying for 48 hours shall match in colour, opacity and finish.

1081-2.3 The change of the colour of the paint film, when exposed to the direct exposure of bright summer sunlight for 100 hours shall not be greater than that of a film of an agreed sample tested in the same manner and at the same time.

1081-2.4 The paint shall not contain more than 0.5 per cent of water.

1081-2.5 The flash point shall not be below 90 °F or 32.3 °C.

1081-3 METHODS OF TESTING

1081-3.1 GENERAL: Normally the paint manufacturers certificate regarding the specifications of the paints and enamels shall be accepted as enough evidence to ensure conformity with these specification. The Engineer may, however, at his discretion take a sample and test according to the following tests:

Any paint or enamel which, although inspected and approved at the point of manufacture, hardens in the containers so that it cannot be readily broken up with the paddle to a smooth, uniform painting consistency, will be rejected. Any paint or enamel too thick for proper brush application will be rejected even though otherwise according to specifications.

1081-3.2 TESTS:

1081-3.2.1 Drying Time - The mixed paint shall be brushed out on a clean non absorbent surface, say a piece of glass 6" x 6", and exposed in a vertical position in a well ventilated room at 95° to 105° F. The painted surface is illuminated by a diffused day light for at least six hours during the drying period. The paint when tested in the above manner should not become "surface dry" in less than 8 hours and should become "Hard Dry" in not more than 24 hours. Paint is "surface dry" when clean, dry silver sprinkled on to the surface of the paint and allowed to remain for about one minute, can be removed with a camel-hair brush without injury to the paint film. Paint is "hard dry" when a second coat of paint could be satisfactorily applied over it.

1081-3.2.2 Colour, Opacity, Finish and Consistency: The paint film, prepared as mentioned in 1081-3.2.1 should after drying for 48 hours, match in colour, opacity and finish (i.e. gloss, smoothness of surface, freedom from runs, specks etc.) a film prepared in the same way at the same time from an agreed sample .

1081-3.2.3 Fastness of Colour to Exposure - Direct exposure (i.e. glass not intervening) to bright summer sunlight for 100 hours is usually a sufficiently good test for fastness of colour to exposure. In the absence of such sunlight the paint film may be exposed to standard lamp for 80 hours.

The change of colour of the direct paint film, when tested as described above should not be greater than that of a film of an agreed sample tested in the same way at the same time from an agreed sample.

1081-4 TEST STANDARDS

Various raw materials required for manufacture of paint shall be tested according to AASHO/ASTM standards.

1081-5 COMPOSITION AND PHYSICAL PROPERTIES

The composition of paints and other physical properties shall depend upon the requirements of the job and shall be as specified by the Engineer.

1081-6 MEASUREMENTS

Paint shall be measured in bulk. The unit of measurement shall be one gallon.

1081-7 RATE

The unit rate shall be full compensation for supply of paint conforming to the specification at the site of work to be defined in the bid schedule.

1081-8 PAYMENT

Payment shall be made under:

Item No. 1081-8.1 - Paint of Specified Quality - Per gallon.

J. MISCELLANEOUS

SECTION 1101-

STANDARD BID SCHEDULE FORM

Sr. No.	PAY ITEMS		Quantity in Units	Units of Meaure- ment.	To be filled in by Tenderer		
	Number	Description			Tendered Unit Rates		AMOUNT
					In Words	In Figures	
1.	2.	3.	4.	5.	6.	7.	8.

MAINTENANCE OF TRAFFIC

211-8.1 Maintenance of Traffic Lump Sum

CLEARING CONSTRUCTION SITE

301-9.1 Clearing and Grubbing -do-

311-6.1 Removal of Existing Structure -do-

EARTH WORK

401-5.1 Removal of Existing Pavement. Per Hundred Sft.

402-14.1 Excavation for Structures. Per Thousand Cft.

411-10.1 Regular Excavation -do-

411-11.1 Making Embankment -do-

411-12.1 Special Back-fill -do-

421-5.1 Overhaul (421-2.1) Per Half Mile Thousand Cft.

421-5.2 Overhaul (421-2.2) -do-

1.	2.	3	4	5	6	7	8
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SUB-BASE AND BASE CONSTRUCTION

501-6.1	Gravel Sub Course of the specified thickness.	Per 100 Sft.
501-6.2	Crushed Aggregate Sub-base Course of the Specified thickness	Per 100 Sft.
501-6.3	Crushed Brick Sub-Base Course of the specified thickness	Per 100 Sft.
511-8.1	Soil Cement Stabilization of specified thickness and having specified quantity of cement.	Per 100 Sft.
512-6.1	Soil lime stabilization of Specified Thickness and having specified quantity of lime.	Per 100 Sft.
521-6.1	Brick Sub-Base Course of the Specified Thickness.	Per 100 Sft.
521-6.2	Brick Pavement of Specified Thickness.	-do-
531-6.1	Calcium Chloride Treatment	Per Ton
541-6.1	Crushed Brick Drainage Layer of the Specified Thickness.	Per 100 Sft.
541-6.2	Crushed Aggregate Drainage Layer of Specified Thickness	Per 100 Sft.

1.	2.	3.	4.	5.	6.	7.	8.
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541-6.3	Gravel Drainage Layer of the Specified Thickness.	Per 100 Sft.
551-6.1	Crushed Stone Water Bound Macadam of the Specified Thickness.	Per Hundred Sft.
552-6.1	Brick Edging.	Per Hundred Feet.

BITUMINOUS BASE AND SURFACING

601-7.1	Bituminous Prime Coat at Specified Rate of Application.	Per 100 Sft.
611-6.1	Bituminous Tack Coat at Specified rate of Application.	Per 100 Sft.
612-7.1	Tripple Surface Treatment	Per 100 Sft.
612-7.2	Surface Dressing	Per 100 Sft.
612-7.3	Stock-piling of Aggregate of Specified Gradation.	Per 100 Sft.
621-7.1	Semi Grout Surfacing of Specified Thickness	Per 100 Sft.
631-7.1	Penetration Macadam in on or more Courses of Specified Thickness.	Per 100 Sft.
641-7.1	Plant Mixed Bituminous Base Course of Specified Thickness.	Per 100 Sft.

1.	2.	3.	4.	5.	6.	7.	8.
641-7.2	Plant Mixed Bituminous Base Course of Specified Requirements.			Per Ton.			
642-7.1	Plant Mixed Bituminous Carpet of Specified Thick- ness			Per 100 Sft.			
642-7.2	Plant Mixed Bituminous Car- pet of Specified Requirements.			Per Ton.			
<u>PORTLAND CEMENT CONCRETE</u>							
701-18.1	Portland Cement Concrete Type 'A'.			Per Cu. Ft.			
701-8.2	Portland Cement Concrete Type 'B'.			Per Cu. Ft.			
701-18.3	Portland Cement Concrete Type 'C'			Per Cu. Ft.			
701-18.4	Portland Cement Concrete Type 'D'.			Per Cu. Ft.			
701-18.5	Portland Cement Concrete Type 'E'			Per Cu. Ft.			
711-11.1	Portland Cement Concrete Pavement Completed.			Per Hundred Cu. Ft.			
721-6.1	Plum Concrete Consisting 40% Plum and 60% Type 'D' Concrete.			Per Cu. Ft.			

1.	2.	3.	4.	5.	6.	7.	8.
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HIGHWAY STRUCTURES

801-35.1	First Class Brick Work in Cement Mortar as Specified	Per Hundred Cu.Ft.
801-35.2	Coping, Window Sills, Cornices Eave Brick or Drip Course Work in 1:6 Cement Mortar	Per Rft.
801-35.3	Brick Work in Arches	Per Hundred Cu. Ft.
802-33.1	Ashlar Masonry.	Per Hundred Cu. Ft.
802-33.2	Course Rubble Masonry	Per Hundred Cu. Ft.
802-33.3	Random Rubble Masonry	Per Hundred Cu. Ft.
802-33.4	Dry Rubble Masonry	Per Hundred Cu. Ft.
802-33.5	Cornices, String Courses, Chajjas.	Per Rft.
802-33.6	Copings	Per Hundred Cu. Ft.
802-33.7	Stone Masonry in Arches	Per Hundred Cu. Ft.
811-11.1	Prestressed Beam of Speci- fied Size.	Each.
811-11.2	Prestressed Diaphragm of Specified Size.	Each.
811-11.3	Prestressed Slab of Speci- fied Thickness.	Per Hundred Sq. Ft.

1.	2.	3.	4.	5.	6.	7.	8.
821-14.1	Furnishing and Placing Plain Reinforcing Steel Bars.			Per Cwt.			
821-14.2	Furnishing and Placing De-formed Reinforcing Steel Bars.			Per Cwt.			
831-33.1	Structural Steel Work.			Per Cwt.			
841-10.1	Structural Steel Work For Cutting Edge.			Per Cwt.			
841-10.2	Portland Cement Concrete Type 'C' for Well Curbs, Plugging of Wells, Well Steining or Transom Slab.			Per Cu.Ft.			
841-10.3	First Class Brick Work in 1:3 Cement Mortar For Well Steining.			Per Hundred Cu. Ft.			
841-10.4	Furnishing and Placing De-formed reinforcing Steel Bars for Well Curb, Steining and Transom Slab.			Per Cwt.			
841-10.5(a)	Well Sinking - Twin Well of Specified Diameter.			Per Rft.			
841-10.5(b)	Well Sinking - Single Well of Specified Diameter.			Per Rft.			
841-10.6	Sand Filling in Well Holes			Per Thousand Cft.			
851-11.1	Bored Reinforced Concrete Pile of Specified Diameter.			Per Foot.			

1.	2.	3.	4.	5.	6.	7.	8.
851-11.2	Portland Cement Concrete Type C for Pile Caps.			Per Cft.			
851-11.3	Furnishing And Placing Re- inforcing Steel For Pile Caps.			Per Cwt.			
851-11.4	Portland Cement Concrete Type 'D', as Blinding Concrete.			Per Cu. Ft.			
852-8.1	Furnishing and Placing Pre- cast Concrete pile of Speci- fied Section.			Per Foot.			
852-8.2	Furnishing and Placing Pre- cast Prestressed Concrete Pile of Specified Section.			Per Foot.			
852-8.3	Furnishing and Placing Re- inforcing Steel For Pile Caps.			Per Cwt.			
852-8.4	Portland Cement Concrete Type C for Pile Caps.			Per Cu. Ft.			
852-8.5	Portland Cement Concrete Type 'D' as Blinding Conc- rete.			Per Cu. Ft.			
861-6.1	Regular Excavation For Guide Bank.			Per Thousand Cu.Ft.			
861-6.2	Making Embankment For Guide Bank.			Per Thousand Cu. Ft.			
861-6.3	Stone Pitching For Guide Bank			Per Thousand Cu. Ft.			

1.	2.	3.	4.	5.	6.	7.	8.
871-10.1	Painting New Surfaces Three Coats.			Per Hundred Sq. Ft.			
871-10.2	Painting Old Surfaces One Coat.			Per Hundred Sq. Ft.			
871-10.3	Painting Old Surfaces Three Coats.			Per Hundred Sq. Ft.			
871-10.4	Varnishing Wood Work Specified Number of Coats.			Per Hundred Sq. Ft.			
872-10.1	Cement Plaster in 1:6 Cemen Mortar.			Per Hundred Sq. Ft.			
872-10.2	Cement Plaster 1:3 Cement Mortar.			Per Hundred Sq. Ft.			
872-10.3	Ornamental Plaster Work in 1:3 Cement Mortar.			Per Rft.			
872-10.4	Deep Cut or Struck Cement Pointing.			Per Hundred Sq. Ft.			
872-10.5	Flush Cement Painting.			Per Hundred Sq. Ft.			
873-9.1	Base for Flooring of the Specified Thickness.			Per Hundred Sq. Ft.			
873-9.2	Cement Concrete Floor of the Specified Thickness.			Per Hundred Sq. Ft.			
873-9.3	Terrazo Floor of the Speci- fied Thickness.			Per Hundred Sq. Ft.			
873-9.4	Coloured Terrazo Floor of the Specified Thickness.			Per Hundred Sq. Ft.			

1.	2.	3.	4.	5.	6.	7.	8
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873-9.5 Stonolithic Floor of The
Specified Thickness. Per Hundred Sq. Ft.

881-14.1 Wood Work in Beam, Purlins
and Rafters etc. Per Cu. Ft.

881-14.2 Panelled or Glazed Doors
and Windows. Per Sft.

881-14.3 Wire Gauzed Doors & Windows. Per Sft.

881-14.4 Fixed Wiregauze. Per Sft.

881-14.5 Glazing of Specified Thick-
ness and quality. Per Sft.

881-14.6 Wardrobe/Almirah of Speci-
fied Size and Design Complete. Each

882-6.1 Damp Proofing of Concrete
Surfaces Complete. Per Hundred Sq. Ft.

882-6.2 Vertical Damp Proofing Course
Complete. Per Hundred Sq. Ft.

882-6.3 Horizontal Damp Proofing
Course Complete. Per Hundred Sq. Ft.

INCIDENTAL CONSTRUCTION

901-5.1 Hand Rail in Structural Steel Per Foot.

901-5.2 Hand Rail in Portland Cement
Concrete. Per Foot.

911-7.1 Steel Bearings. Each.

1.	2.	3.	4.	5.	6.	7.	8.
	911-7.2	Rubber Bearings.		Each			
	911-7.3	Roller Bearings.		Each.			
	921-5.1	Expansion Joint.		Per Ft.			
	931-5.1	Rain Water Outlets.		Each.			
	941-6.1	Mile Stones Complete		Each.			
	941-6.2	Right of Way Markers Complete		Each			
	951-6.1	Precast Concrete Planks of Specified Dimensions.		Each.			

ROADWAY CONSTRUCTION MATERIALS

	1001-12.1	Supply of Portland Cement of Specified Quality.		Per Ton.			
	1011-10.1	Bituminous Binder of Specified Grade.		Per Ton.			
	1021-7.1	Lime.		Per Maund.			
	1021-7.2	Kankar Lime.		Per Hundred Cu. Ft.			
	1031-9.1	Coarse Aggregate of Specified Gradation for Portland Cement Concrete.		Per Hundred Cu. Ft.			
	1032-13.1	Fine Aggregate of Specified Gradation for Portland Cement Concrete.		Per Hundred Cu. Ft.			
	1033-9.1	Mortar Sand.		Per Hundred Cu. Ft.			
	1041-13.1	Supply of 1st Class Bricks		Per Thousand Number			

1.	2.	3.	4.	5.	6.	7.	8.
1041-13.2	Supply of Tiles of Approved Quality.			Per Thousand Number			
1046-12.1	Stone For Random Rubble Masonry.			Per Hundred Cu.Ft.			
1046-12.2	Stone for Course Rubble Masonry (2nd Class).			Per Hundred Cu.Ft.			
1046-12.3	Stone for Course Rubble Masonry (1st Class).			Per Hundred Cu. Ft.			
1046-12.4	Stone For Ashlar Masonry			Per Hundred Cu.Ft.			
1051-7.1	Water			Per Thousand Gallons.			
1061-10.1	High Tensile Steel Wire			Per Cwt.			
1071-10.1	Timber in Logs.			Per Cu. Ft.			
1071-10.2	Timber in Sleepers.			Per Cu. Ft.			
1081-8.1	Paint of Specified Quality			Per Gallon			

NOTES:

1. For each road project, the Engineer will select the items which relate to that project for preparing the bid schedule and insert the relevant quantities and units of measurement.
2. The quantities contained in column 4 of the Bid Schedule are estimated quantities to be used for comparing tenders and the Engineer does not expressly nor by implication agree that the actual quantities of work to be performed will correspond therewith.
3. The Units expressed in the Bid Schedule are in the English system.
4. When a discrepancy exists between the Unit Rate (column 6) and the extended total cost (column 8) the Unit rate shall be taken as correct and the total amounts adjusted accordingly.