

## TABLE OF CONTENTS

<b>19.</b>	<b>PROTECTION AND DIVERSION WORKS</b>	19-1
19.1	SCOPE	19-1
19.2	GENERAL	19-1
19.3	DIVERSION WORKS	19-1
19.3.1	GENERAL	19-1
19.3.2	OPERATIONS INVOLVED	19-2
19.4	PILCHI/ SARKANDA MATTRESS	19-2
19.4.1	COMPOSITION	19-2
19.4.2	LAYING	19-2
19.5	STONE PITCHING/ RIPRAP AND REINFORCED CONCRETE SLOPE PROTECTION	19-3
19.5.1	DESCRIPTION	19-3
19.5.2	STONE PITCHING/ RIPRAP PROTECTION	19-3
19.5.3	REINFORCED CONCRETE SLOPE PROTECTION	19-4
19.6	PILCHI/ BRUSHWOOD/ SARKANDA/ PITCHING	19-5
19.6.1	SCOPE	19-5
19.6.2	QUALITY	19-5
19.6.3	DIMENSIONS	19-5
19.6.4	LAYING	19-5
19.7	GROYNES	19-6
19.7.1	SCOPE	19-6
19.7.2	LAYING	19-6
19.8	GABIONS	19-6
19.8.1	SCOPE	19-6
19.8.2	MATERIAL REQUIREMENTS	19-6
19.8.3	CONSTRUCTION REQUIREMENTS	19-7
19.9	MEASUREMENT AND PAYMENT	19-8
19.9.1	COMPOSITE RATE	19-8
19.9.2	LABOUR RATE	19-8
19.9.3	QUANTIFICATION	19-8

## 19. PROTECTION AND DIVERSION WORKS

### 19.1 SCOPE

- a) The protection and diversion works shall consist of works that may be required to divert the river stream or currents and/or to adopt such measures as may be necessary to strengthen and protect an existing work or an embankment. Such river training and diversion works shall though consist primarily of constructing embankments and dykes, excavating cunnetts and placement of protective pitchings, mattresses, rolls, nevertheless may include certain anticipated works to be executed performed or administered by the contractor to the extent of which is unforeseen or is not capable of portrayal in the drawings at the time of issue of the order for execution.
- b) The scope shall, however, include furnishing all labour, materials, plant, equipment, instruments, accessories and services necessary to complete the work in accordance with herein stated specifications, requirements and stipulations or as directed by the Engineer-in-Charge.

### 19.2 GENERAL

- a) Whenever construction of cunnetts, earthen excavations, construction of earthen embankments or raising earthen dykes are required to be constructed, specifications and requirements detailed in Section 3, Earthwork shall be adhered to, unless such specifications/requirements have been specially modified by the Engineer-in-Charge.
- b) All materials such as pilchi, ban, bamboo's etc. shall be fresh & new and other materials such as bags (whether of jute/gunny or cloth) & ropes, GI wire and Taranga's etc. shall be new. They shall be produced by the Contractor for approval of the Engineer-in-Charge before use. Where specified, the old bags shall also be used.
- c) The stone for dumping and pitching shall consist of natural rock, quarried from approved locations. The stone for pitching shall be well graded within the limits as specified.
- d) Rock spalls shall be not more than 25% larger than 4 inches & not more than 5% smaller than 2 inches.
- e) Base course under pitching stone shall be not more than 25% larger than 3 inches & not more than 10% shall be smaller than 2 inches.
- f) Cement/Aggregates and water for concrete and mortar shall conform to the applicable provisions of Section 5 - Plain & Reinforced Concrete.
- g) The specific gravity of stone materials should not be less than 2.6. The water absorption shall not exceed 6%.
- h) The loss under Los Angles rattler test (ASTM Designation C-131) shall not exceed ten percent (10%), by weight at 100 revolutions or 40% by weight at 400 revolutions.

### 19.3 DIVERSION WORKS

#### 19.3.1 GENERAL

The diversion works are needed to change the course of existing channel for some specific purpose or protection of existing structure.

All the materials required such as brushwood, pilchi / sarkanda, wooden trestles, ropes, mats/ tarpaulins, gunny bags, stones and earth for construction of bunds for diversion shall be collected at site before undertaking closing operation for diversion of flow. Also sufficient labour and dozing equipment shall be arranged and made available for the work.

### **19.3.2 OPERATIONS INVOLVED**

- a) The site for final closing of a channel for diversion shall be one, where depths are not too great and bed is comparatively firm. Also, earth for construction of the bunds is available close at hand. The site finally selected shall be demarcated by dag belling the alignment of the closure bund on dry ground on either side of the channel.
- b) The diversion for closing or redirection of a running channel shall be started by dozing the piled earth from both ends simultaneously at the approved point of closing when the flow is at its lowest stage and completed quickly.
- c) In the active part of the channel (where water may be flowing) the bunds shall be constructed between specially formed pilchi rolls to prevent wastage of earth by the flowing water.
- d) The pilchi roll shall be prepared from freshly cut pilchi/sarkanda and shall be generally 1 ft. (0.3 m) in dia and 11.5 ft. to 13 ft.(3.5 m to 4 m) long. Also they shall be well compacted and tightly tied with coarse munj ban or binding wire of steel at 12 inches (30 cm) intervals.
- e) Whenever, directed by the Engineer-in-Charge (as in case when discharge in the channel is about 56.70 cumecs( 2,000 cusecs) or more, stones in tar angers or wire crates, instead of trestles, shall be placed/tipped at some specified distance/alignment on the upstream of proposed earthen bund such that their placing is advanced simultaneously from both the ends and the earthen bunds are continued behind them. The wire for crates shall conform with provisions for wire for gabions subsection 19.8.2.2.
- f) Pilchi/sarkanda rolls shall be arranged against the stakes/stone placements to form a base. Mats and gunny bags sewn together shall be then placed over the pilchi/sarkanda rolls as directed by the Engineer-in-Charge, for their staunching against the flow through them.
- g) The earth bunds shall be advanced simultaneously from each side till they meet and close the flow.
- h) Where final head across the closing bund is likely to be more than about 1 m another pilchi roll base shall be put in to step down the head and facilitate the closure.
- i) As pilchi/sarkanda rolls, mats and any bits of stakes in case of their breakage, get buried at site of closure and are a source of weakness: another earthen bund of specified dimensions, density/compaction, shall therefore, be placed below the closure bund, as specified or as directed by the Engineer-in-Charge.
- j) The operations shall remain under continuous vigilance for safety of operations and their successful completion. Any remedial action which may become necessary shall be promptly taken.

### **19.4 PILCHI/SARKANDA MATTRESS**

#### **19.4.1 COMPOSITION**

Unless otherwise specified or directed by the Engineer-in-Charge, pilchi/sarkanda mattresses shall consist of freshly cut pilchi/sarkanda rolls weaved tightly to form mattress of specified thickness, or as directed by the Engineer-in-Charge, usually 15 cm thick. The pilchi/sarkanda rolls laid as headers and stretchers shall be tied together with coarse munj ban at 15 cm centers.

#### **19.4.2 LAYING**

Pilchi/sarkanda mattress of specified sizes shall be rolled/carried/carted to channel edge, floated and placed in position after unrolling to protect channel bed against scour under diversion bunds. The mattresses may be loaded as directed by the Engineer-in-Charge or stones in munjt rangers, or gunny trangers, steel crates, cloth bags filled with sand, earth, bajri or brick bats to avert uplifting or flooring.

## **19.5 STONE PITCHING/RIPRAP AND REINFORCED CONCRETE SLOPE PROTECTION**

### **19.5.1 DESCRIPTION**

This work shall consist of furnishing and placing a protective covering of erosion resistant material as stone pitching/riprap or reinforced concrete slope protection on the locations shown on the plans for slopes or pier foundation protection. The work shall be done in accordance with the specifications and conformity with the lines, grades, thickness and typical cross-sections shown on the plans. The terms stone pitching and riprap are synonymous for these specifications.

The areas to receive slope protection of any kind shall be dressed smooth to the slopes or shapes called for on the plans and shall be free from stumps, organic matter, or waste materials. The base course under pitching stone/riprap shall be provided as shown on Drawings. Toe trench and/or base material is to be constructed; as specified and directed by the Engineer-in-Charge.

All materials, regardless of type or kind, shall be placed as per lines and levels called for on the Drawings.

### **19.5.2 STONE PITCHING/RIPRAP PROTECTION**

#### **19.5.2.1 MATERIAL REQUIREMENTS**

Stones, base material, rock spalls for pitching/riprap shall conform with the provisions of Sub-Section 19.2(c), (d) & (e). Stones for pitching/riprap unless otherwise required shall be one of the following classes as shown on the Drawings or determined by the Engineer-in-Charge.

Class A: Stones ranging in weight from a minimum of 15 kg to a maximum of 25 kg with at least 50% by weight of the stones weighing more than 20 kg.

Class B: Stones ranging in weight from a minimum of 30 kg to a maximum of 70 kg with at least 50% by weight of the stones weighing more than 50 kg.

Class C: Stones ranging in weight from a minimum of 60 kg to a maximum of 100 kg with at least 50% by weight of the stones weighing more than 50 kg.

#### **19.5.2.2 CONSTRUCTION REQUIREMENTS**

a) Excavation

The bed for the stone pitching/riprap shall be excavated to the required depths and compacted, trimmed and shaped to the entire satisfaction of the Engineer-in-Charge or as shown on the plans.

b) Placing

i) Toe Trench

The stone shall be set in a toe trench as shown on the Drawings. The toe trench shall be filled with stone of the same class as the one specified for the pitching/riprap, unless otherwise specified. All toe trenches and excavations shall be approved by the Engineer-in-Charge with firm sub-grade or base prior to placement of stones. Stones shall be placed so as to provide minimum of voids. Larger stones shall be placed in the toe trench and on the outside surface of the slope.

ii) Slopes

Stones placed below water line shall be distributed so that the minimum thickness of the pitching is not less than the specified.

Stones above the water line shall be placed by hand. They shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with ends in contact.

The pitching shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be chinked with rock spalls firmly rammed into place.

Unless otherwise provided, stone pitching/riprap shall have the following minimum thickness, measured perpendicular to the slope:

Class A:	20 cm (8 inches)
Class B:	45 cm (18 inches)
Class C:	60 cm (24 inches)

The surface of riprap placed above the water line shall not vary from the theoretical surface by more than 8 cm (3 inches) at any point.

iii) Dry Stone Pitching/Riprap

The dry stone pitching/riprap unless otherwise directed shall be started from ground level and shall be placed in layers manually or other methods approved by the Engineer-in-Charge, all to secure a stable mass. Surface irregularities of the slope shall not vary more than 8 cm (3 inches) along the intended slope. All interstices, hollows and inequalities between stones shall be filled with sand, small pieces and wedged up tight with spawl driven in with slight hammering to the satisfaction of the Engineer-in-Charge.

iv) Grouted Stone Pitching/Riprap

Stone for this purpose shall, as far as practicable, be selected of the size and shape so as to secure fairly large, flat-surfaced stone which will lay up with a true and even surface and a minimum of voids. The stones shall be placed first and roughly arranged in close contact, the larger stones being placed near the base of the slope. The spaces between the larger stones shall be filled with stones of suitable size, leaving the surface smooth, reasonably tight, and conforming to the contour required. In general, the stone shall be laid with a degree of care that will ensure for plane surfaces a maximum variation from a true plane of not more than 3%. Warped and curved surfaces shall have the same general degree of accuracy as specified above for plane surface.

As each of the larger stones is placed, it shall be surrounded by fresh mortar and adjacent stones shall be shoved into contact. After the larger stones are in place, all of the spaces or openings between them shall be filled with grout consisting of one part of Portland Cement and three parts of the fine aggregates, with sufficient water to produce a plastic mix and the smaller stones then placed by shoving them into position forcing excess mortar to the surface, and ensuring that each stone is carefully and firmly bedded laterally. Mortar shall not be placed in temperature lower than five degree C. During hot, dry weather the work shall be protected from the sun and kept moist for a minimum of 3 days after placement. Stones shall be kept wet during placing of the mortar.

After the work has been completed as above described, all excess mortar forced up shall be spread uniformly to completely fill all surface voids. All surface joints shall then be roughly pointed up either with flush joints or with shallow, smooth raked joints.

Weep holes shall be provided through the riprap cover as shown on the plans or as directed by the Engineer-in-Charge.

### **19.5.3 REINFORCED CONCRETE SLOPE PROTECTION**

#### **19.5.3.1 MATERIALS**

Materials for reinforced concrete slope protection shall conform with provisions of Sub-Section 19.2(f).

#### **19.5.3.2 CONSTRUCTION REQUIREMENTS**

The slopes with suitable material shall be prepared with appropriate compaction to form a sub-grade approved by the Engineer-in-Charge and formwork shall be completed accordingly.

After furnishing and fixing the steel reinforcement, reinforced concrete slope protection shall be constructed after light spray of water at the locations shown on the plans or where directed by the

Engineer-in-Charge. Placing and finishing of concrete shall conform to the requirements specified in Section 5 – Plain & Reinforced Concrete.

## **19.6 PILCHI/ BRUSHWOOD/ SARKANDA/ PITCHING**

### **19.6.1 SCOPE**

Unless otherwise specified or directed by the Engineer-in-Charge, Pilchi/Brushwood/ Sarkanda/ Pitching will cover preparing the slopes of river embankments and/or the downstream of falls in the Irrigation canals/drains and laying Sarkanda, Farash or Pilchi rolls in headers and stretchers to protect the bank(s) from side erosion and wave wash.

### **19.6.2 QUALITY**

- i. The pilchi, farash or sarkanda used for pitching shall be of the best quality, mature not over or under grown locally available and duly approved by the Engineer-in-Charge.
- ii. It shall be used when it is still green.

### **19.6.3 DIMENSIONS**

- i) Unless otherwise specified or directed by the Engineer-in-Charge. The rolls as headers shall be nearly 5 ft. (1.5 m) long and 6 inches (15 cm) in diameter and those used as stretchers 30 ft. (9.5 m) long and 6 inches (15 cm) in diameter.
- ii) The rolls shall be well-compacted and tightly tied with coarse munjban or binding wire at 12 inches (30 cm) interval.

### **19.6.4 LAYING**

- i) The inner side of the embankment shall be cut out to accommodate the pitching or pitching shall be done on the surface of the existing bank strictly as specified or directed in writing by the Engineer-in-Charge.
- ii) Unless otherwise specified or directed by the Engineer-in-Charge, the pitching shall be started from the ground level.
- iii) The first or the lowest layer of rolls shall be laid as headers and as close to each other as possible in order to get one compact layer of pilchi.
- iv) The second layer, unless otherwise specified shall be laid across the first layer, shall consist of stretcher rolls tied down by means of 1 meter long pegs driven at 1.5 m interval. The stretcher roll shall be so located that it lies just within the inner slope of the embankment.
- v) After laying header and stretcher rolls a layer of good earth shall be placed and thoroughly compacted to make it level with the top of stretcher roll.
- vi) The second and subsequent layers of header and stretcher rolls shall then be laid as previously and then process repeated till the pitching has been carried to the specified level.
- vii) In case of new construction the pitching shall be done along-with the embankment and horizontal layer in the main embankment shall correspond with the earthen layers placed between two consecutive layers of the rolls and compacted simultaneously.
- viii) The position of the ends of the headers viz-a-viz that of stretcher rolls shall be kept to maintain the specified slope. However, in case the slope had been scoured earlier the overall dimension of the embankment shall be slightly increased.

#### **NOTE.**

- i) Use of farash shall be avoided, if pilchi is available.
- ii) Sarkanda shall be used as a last resort. In case of sarkanda mattress or pitching the distance of pegs shall be reduced as directed by the Engineer-in-Charge or his authorized subordinate to check its tendency of floating.

## **19.7 GROYNES**

### **19.7.1 SCOPE**

Unless otherwise specified or directed by the Engineer-in-Charge groynes shall consist of brush wood filled between two or more rows of stakes (killas or bamboos) inter twinned by coir ban. The brush wood filling is loaded down as specified and/or as directed by the Engineer-in-Charge by ropes and weighted down with stone crates for bank protection.

### **19.7.2 LAYING**

Killas or bamboo's of specified lengths and diameter are sharpened at one end and driven as specified or as directed by the Engineer-in-Charge.

In the river bed they are driven in rows of specified numbers and placed in line with the current. Green brush wood is filled between stakes and intertwined. When directed by the Engineer-in-Charge the brush wood is loaded/weighted down with stone etc.

The brush wood is replenished regularly as scour occurs and brush filling settles.

## **19.8 GABIONS**

### **19.8.1 SCOPE**

This work shall consist of wire-mesh gabions, furnished and placed in accordance with these specifications, and the specifications for the other work items involved, and at the locations and in conformity with the lines and grades shown on the Drawings. The work in general, covers gabions used for river and stream stabilization work, such as bank revetments, jetties, groins deflector, scour protection and retaining structures.

### **19.8.2 MATERIAL REQUIREMENTS**

#### **19.8.2.1 GENERAL**

Gabions shall be enclosed by galvanized steel wire mesh, which shall be supplied folded flat to facilitate transport and handling.

Gabions shall be furnished in accordance with the various lengths, widths and heights required, by the Drawings, or as directed by the Engineer in-charge. If not otherwise required, all gabions shall be 40 inches (one meter) in width. The lengths shall be multiples of 2,3 or 4 times the width of the gabion and heights shall be three tenth (0.3), one half (0.5) or one (1) meter. e14 inches, 20 inches or 40 inches.

#### **19.8.2.2 WIRE**

All wire shall be a good commercial quality of steel and size as per Drawings coated with a prime western speller or equal (AASHTO M 120) applied at a rate of not less than 0.8 ounces per square foot (0.25 kg/ Sq.M) of uncoated wire.

Uniformity of coating shall withstand ten (10) one-minute dips by the Preece Test in accordance with AASHTO T-66. "Uniformity of Coating by the Preece Test (Cooper Sulphate Dip) on Zinc Coated (Galvanized) Iron or Steel Articles". Wire mesh shall withstand 220 hours of exposure before failure by rusting of any part when subjected to a salt spray test in accordance with ASTM B 117.

The tensile strength of the wire shall be in the range of four thousand (4,000) to six thousand (6000) kg / sq. cm. and shall have an elasticity to permit elongation of the mesh equivalent to a minimum of ten (10) % without reducing the gauge or tensile strength of the wire.

The minimum size of the wire used in fabrication of the gabion baskets shall be as follows:

Description	Diameter(mm)	US SteelWire Gauge
Body Wire	2.3	11
Selvedge or Perimeter Wire	2.8	9
Tying and Connecting Wire	1.95	13

### 19.8.2.3 FABRICATION

Gabions shall be in the form of rectangular baskets of the required dimensions and shall be manufactured from wire as specified above. Gabions shall be made of steel wire triple twisted forming a uniform hexagonal mesh pattern with openings eight (8) cm or by twelve (12) cm. The edges shall be formed into securely connected selvedges adequate to prevent raveling. Individual basket ties and connections shall be made by using a quantity of wire not less than 8 percent of the weight of each basket.

When the gabion length exceeds its width, it shall have securely tied diaphragms connected at all edges to form individual cells of equal length and width. Diaphragms shall be of the same material and manufacture as specified above for the gabions.

Four cross-connecting wires shall be provided in each cell having a height of one half the width or less, and eight (8) cross-connecting wires shall be provided in each cell having a height greater than one half the width.

All the characteristics and values given in the above specifications are subject to the tolerance of plus or minus five (5) percent.

### 19.8.2.4 ROCK FILL

Fill for gabions shall consist of hard, durable rock pieces that will not deteriorate when submerged in water or exposed to severe weather conditions. Rock pieces shall be generally uniformly graded in sizes ranging from ten (10) cm to twenty (20) cm. Filled gabions shall have a minimum density of one thousand three hundred sixty (1,360) kg per cubic meter. Void spaces shall be evenly distributed and shall not exceed a maximum of thirty (30) percent.

The rock shall meet the requirements of AASHTO M 63 except that the Sodium Sulphate Soundness Loss shall not exceed nine (9) % after five (5) cycles.

### 19.8.3 CONSTRUCTION REQUIREMENTS

Installation shall be performed in a workmanlike manner as approved by the Engineer in-charge. Beds for gabions shall be suitable level. Gabions forming elements of structures shall be securely connected along the complete length of top contract edges by means of the above specified tying and connecting wire.

Before the rock fill is placed the gabions shall be stretched in such manner as will permit proper shape, alignment and compaction of fill.

Rock fill for exposed faces of gabions walls shall be carefully selected for uniformity or size, and the pieces shall be hand placed to provide a neat appearance as approved by the Engineer in-charge.

The vertical joints of gabion baskets shall be staggered as in running bond brickwork.



## **19.9 MEASUREMENT AND PAYMENT**

### **19.9.1 COMPOSITE RATE**

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

### **19.9.2 LABOUR RATE**

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

### **19.9.3 QUANTIFICATION**

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR are measured in the above mentioned criteria;  
Item No.: 19-1, 19-11 to 19-13, 19-15, 19-17 to 19-23, 19-29 to 19-33, 19-37 to 19-39 and 19-55 to 19-57
2. For surface area items, the quantity of work shall be measured by surface area. The unit of measurement shall be Square meter Square foot. Following item of CSR are measured according to this criteria;  
Item No.: 19-2, 19-9, 19-24 to 19-28, 19-34 to 19-36, 19-59 and 19-60
3. Following items shall be measured as %age No. ;  
Item No.: 19-7(a), 19-8(a), 19-10, 19-41 to 19-44, 19-49 and 19-50
4. The following items shall be measured as Each;  
Item No.: 19-3 to 19-6, 19-14, 19-40 and 19-48
5. The following items shall be measured as %age Nos. per 30 Meter;  
Item No.: 19-7(b& c), 19-8(b& c), 19-45 to 19-47 and 19-51 to 19-54
6. The following item shall be measured per 30 Meter;  
Item No.: 19-58