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202. STONEWORKS

202.1.1 General

This chapter deals with all stone work with or without mortar bedding, constructional and/or decorative, such as retaining walls, paving, filters, rip rap, gabions, etc., covering the supply of all specified materials as well as laying, jointing and constructing of all elements shown on the Drawings and described in the Specifications.

Stones shall come from selected quarry layers to the approval of the Engineer. They shall be homogeneous, frost resistant, flawless, free of any crack, solid, and of equal grain and shall have the required qualities to give a regular facing. They shall give out a clear sound when hit with a hammer. Those which give out a dull sound due to soft parts and crumble into sandy grains instead of breaking into sharp splinters shall be rejected.

Stones shall have a minimum density of 2.5, bear a crushing load superior to 600 kg/cm² and conform to the approved sample submitted by the Contractor. Stones shall have sizes (length or width) reaching 20 to 50 cm. Their width shall be as shown on the drawings, and they shall have beds and joints perpendicular to the facing.

202.2 RUBBLE STONE PAVING

202.2.1 General

Rubble stone paving shall consist of layers of stone placed on a gravel blanket, to the lines and thickness shown on the Drawings or directed by the Engineer. The stones shall conform to the requirements of Subsections 202.3.2 and 202.3.3 hereafter and the gravel blanket to the requirements of Section 202.4 hereafter.

202.2.2 Quality of Stone

Rubble stone for paving shall consist of clean frost resistant, hard sound and durable natural cobbles or quarried stone fragments of roughly cubic shape. The stones shall be free of cracks, seams and other defects. Elongated and flat slablike stones shall not be permitted. Not less than 75% of the stones shall have the dimensions of the faces perpendicular to the paved surface approximately equal to the nominal thickness of the paving and none shall be smaller than three quarters of the nominal thickness in the said direction. The stones shall be approved by the Engineer before laying.

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202.2.3 Laying

Before laying the stone paving, earthworks shall be completed to final grades and lines, and the bedding shall be excavated and compacted to the finished slopes and levels. The gravel bedding shall then be placed and compacted as specified in Sub-section 202.3.4. The stones for rubble paving shall be placed on the gravel blanket and shall be hand packed as closely as possible to each other with their smallest side parallel to the paved surface and the exposed face flush with it. The joints shall be broken and no through joints will be allowed. The stones shall be bonded on all sides. The spaces between stones shall be filled either by a 1:3 cement-mortar or with rock chinking hammered into place. The paved surface shall be stable and reasonably flat and even, without any abrupt projections and/or depressions.

202.2.4 Gravel Blankets

Gravel blankets shall be placed as beddings under rubble stone pavements or, by themselves, as surfacing on soil areas, as shown on the Drawings or as directed by the Engineer. Material for gravel blankets and surfacings shall consist of natural river gravel or crushed stone in accordance with requirements of B.S. 882, Part 2 and to the satisfaction of the Engineer. Unless otherwise shown on the Drawings or directed by the Engineer, the size of the gravel, as specified in B.S. 882, Part 2, table 1, for single sized aggregates, shall be as follows:

- a) For gravel blankets under rubble stone pavements - nominal size of 40 mm
- b) For gravel surfacings on Soil areas - nominal size of 20 mm.

The gravel shall be placed in layers not exceeding 15 cm in thickness on a well-levelled and compacted subgrade. Each layer shall be thoroughly consolidated and compacted to the satisfaction of the Engineer. The finished blanket shall have a stable and even surface and be true to the lines and grades shown on the Drawings.

202.2.5 Methods of Measurement and Payment

Rubble stone pavements shall be classified by thickness of gravel blanket and stone layers and shall be measured for payment by m² of surface area of completed pavement. Unit rates for rubble stone pavements shall include for all materials and labour required for the completed pavement in place, including all excavation; supply and spreading of gravel blanket; supply and laying of stone and filling of joints with cement-mortar or rock-chinking; and all other works and materials required to make the pavement complete.

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Gravel surfacing shall be classified by thickness of gravel layer and shall be measured for payment by m² of surface area of completed surfacing. The unit rates for gravel surfacing shall include for all materials and labor required for the completed surfacing in place, as specified in this Subsection, above, for rubble stone pavements.

202.3 HAND PLACED RIP-RAP*202.3.1 General*

The work consists of hand placed rip-rap paving to the dimensions shown on the Drawings, laid on a graded gravel filter blanket on areas as shown on the Drawings and as directed by the Engineer.

202.3.2 Materials

Filter materials shall be supplied by the Contractor from approved sources and shall consist of natural washed sand and gravel or clean broken rock which does not break down into finer particles when it is placed. They shall be free from silt, clay and organic matter or other impurities or deleterious substances. Filter materials shall conform to the requirements of B.S. 882 - Coarse and fine aggregates from natural sources. The grading shall be as shown on the Drawings and as defined in the Particular Specification, and shall always be such that all permitted sizes are represented and there is no undue preponderance of any one fraction.

The Contractor shall furnish for testing and shall test, at his own cost, such representative samples of filter materials as may be required by the Engineer and shall have them tested in approved laboratories. The Engineer reserves the right to inspect the sites from which filter materials are obtained. The approval of materials from a particular source shall not be constructed as constituting an approval of all materials taken from that source, and the Contractor will be held responsible for the specified quality and gradation of gravel and sand delivered to the work site. If, in the Engineer's opinion, the filter material supplied by the Contractor fails to meet the requirements he shall be entitled to instruct the Contractor to take remedial steps such as washing the material, re-sieving it, etc..., or to reject it completely and have other material brought in by the Contractor, at no additional cost.

The material for the rip-rap shall consist of hard, dense, durable rock, resistant to weathering and water and wave action, with the following physical properties (to B.S. 812) :

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- Minimum bulk specific gravity (dry in air) 2.6
- Maximum absorption 3%
- Maximum abrasion 25%

The rip-rap shall consist of angular fragments of quarried rock with the cobbles, flat slabs and elongated pieces shall be rejected.

The grading of the filter material and of the rip-rap stones shall be as shown on the Drawings, as specified in the Particular Specification and as directed by the Engineer to meet the gradation requirements. A quantity of gravel and stone spalls sufficient to fill the voids between the stones shall be included in the material.

202.3.3 Workmanship

The area to be paved shall be excavated to a depth equal to the combined thickness of the gravel blanket and rip-rap stone, so that the face of the stone of the completed rip-rap paving shall be flush with the neat lines of the area, as shown on the Drawings.

Rip-rap of stones or rock fragments shall be dumped on the gravel. The stone of rip-rap need not be compacted, and shall be dumped and graded off in such a manner as to ensure that when completed, it will be well interlocked and stable, without tendency to slide. The rip-rap stones are to be uniform distributed with sizes of stones increasing toward the top, and the small fragments and spalls shall serve to fill the spaces between the larger stones. The completed rip-rap shall have a reasonable even surface and the required thickness.

The rip-rap stones shall be carefully placed by hand in a definite pattern, with a minimum amount of voids and with the top surface relatively smooth. Joints shall be broken, as much as possible. Openings to underlying blanket shall be avoided by carefully arranging the various sizes of stones and filling the openings with rock chinking hammered into place.

202.3.4 Methods of Measurement and Payment

Hand placed rip-rap and gravel blankets under hand placed rip-rap shall be measured for payment and paid for under separate items in the Bill of Quantities. The rip-rap and the blanket shall be measured for payment by square meters of completed surface actually placed in position to the lines and dimensions shown on the Drawings or as

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directed by the Engineer and shall be classified according to thickness of layer. The unit rates shall include for excavation and removal of surplus soil, supply, transportation, dumping and spreading of all gravel and stone, compaction of gravel blanket, and all materials and labor necessary to complete the work to the satisfaction of the Engineer.

The Contractor is warned that material for rip-rap and blanket which will comply with the grading specified may not be found in their natural state. The Contractor shall therefore make allowance in his rates for the fact that it may be necessary to sieve and make trial mixes or quarry for rock to obtain the correct grading by crushing rock with or without mixing with materials obtained from natural sources, all as directed by the Engineer, and at the Contractor's cost.

202.4 GABIONS*202.4.1 General*

Gabion walls are gravity retaining walls, disregarding the role of the gabions which give them a higher safety coefficient due to their tensile stress.

Gabions retaining structures are classified in 4 categories:

- 1) Gravity retaining structures
- 2) Half gravity retaining structures
- 3) Embankment structures
- 4) Thin anchored to ground walls with hexagonal mesh structure.

Gabion-baskets are parallelepiped structures consisting of metallic double twisted hexagonal wire meshes filled with broken stones of suitable grading.

Where shown on the Drawings or directed by the Engineer, the Contractor shall erect box or mattress gabion structures, consisting of galvanized wire mesh baskets filled with rocks or stones of suitable sizes and mechanical properties.

Each unit shall be firmly tied to the others using wires so as to form a monolithic structure.

202.4.2 Materials

The baskets shall be manufactured of hot dip galvanized or galvanized and plasticized wire double twisted hexagonal mesh. Wires shall comply with B.S. 443 - "Galvanized coating on wire" - and B.S. 1052 - "Mild steel wire" and shall have the following characteristics:

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- high mechanical strength
- high resistance to corrosion
- good deformation ability
- good resistance to the undoing of meshes
- good resistance to the undoing of meshes

Following are the characteristics of standard gabions:

Galvanized Gabions		
Mesh	Wire Ø mm	Thickness m
10 x 12	2.40	0.50
	2.70	
	3.00	
8 x 10	2.40	0.50
	2.70	
	3.00	
6 x 8	2.20	1.00
	2.70	
5 x 7	2.00	
	2.40	

Width: 1.00 - 2.00

Length: 2.00 - 3.00 - 4.00 for 1 m. wide gabions/

3.00 - 4.00 - 5.00 for 2 m. wide gabions.

The gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1 meter. Diaphragms shall be manufactured of the same wire as gabions and shall stiffen the structure and facilitate assembling. Gabions can be 1 or 2 meters wide.

Mechanical and quality properties of wires (breaking load, elongation at rupture, galvanization characteristics, etc...) must be consistent with the strictest standards.

Lacing and binding shall be done by means of hot dip galvanized wire of 2.2 mm minimum thickness, which will be supplied with the gabions and will have the same

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characteristics of gabions wires (hot dip galvanized annealed mild steel, double twist and hot galvanized, long term corrosion and oxidation resistance.

Filling materials for gabions shall be stones or others provided their weight and characteristics meet static, operation and duration requirements of the structure.

Rockfills shall consist of hard broken stones. It is advisable to use materials with a high specific gravity especially in the event of gravity retaining or submerged structures or works subject to the living force of waters. To ensure a long life time of the structure, stones should not be friable, soluble in water but frost resistant, hard dense and durable with a minimum bulk specific gravity (dry in air) of 2.6, maximum absorption 3% and maximum abrasion 25% (tests according to B.S. 812)

Dimensions of rock fills shall vary between 1 and 1.5 times the size D of the wire mesh, which prevents rock losses. The use of small-size rockfills (1-1.5xD) allows a better and a more economical filling, and therefore, a good load distribution and a high adaptability to deformation.

Boulders, rounded cables, flat slabs and elongated pieces shall be rejected.

202.4.3 Workmanship

The gabions shall be delivered to the site, folded and packed. Delivery of assembled gabions shall not be permitted. On the site, the gabions shall be opened up and laid flat on the ground, any unnecessary creases shall be straightened and the ends of diaphragms shall be lifted into a vertical position and placed together with binding wire to form the box. Adjacent arises shall be laced together and diaphragms fixed to lateral sides. The binding shall be carried out in a continuous lacing operation, the wire being passed through each mesh and around both edges which must be tied together, with two round turns after every second mesh.

Assembled gabions shall be placed in position for filling singly, or wired together in groups suitable for man-handling. All adjacent gabions shall be securely wired together at all corners and edges in the same manner as described above. Where there are more than one course of gabions, the ones in the upper course shall be laced to those below. Adjacent gabions shall be laced together afterwards.

To avoid bulging on the outside of the structure, tie wires (of the same material and thickness as building wires) shall be fitted inside the gabion compartments between

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the outer and inner skins. The tie wires shall be passed around at least two meshes on each side of the compartment. Vertical ties shall be fixed to the bottom of the gabion prior to filling and tied down to the lid on completion. Two ties at least shall be used per square meter of surface. Horizontal ties shall be placed either perpendicular to the sides or diagonally across the corners.

The disposition of gabions is conditional upon adopted types and required characteristics of the structure.

Filling shall be carried out manually and mechanically, with minimum of voids. Packing of the stones shall be as tight as practicable. After filling the gabions slightly over-full to allow for subsequent settlements, the lid shall be laced down with binding wire to the tops of all the sides and diaphragms.

A design calculation note shall be submitted in terms of the type and geometry of the structure and shall determine the required properties and dimension of gabions walls, taking into account the technical constraints of each site.

202.4.4 Methods of Measurement and Payment

Gabions shall be measured for payment by cubic meters of gabions in place, to the lines and dimensions shown on the Drawings. The unit rates shall include for any necessary excavation and disposal of surplus soil, supply and erection of the gabions, the supply and filling of stone and all materials and labor, required to complete the gabions in place as specified, as shown on the Drawings, and to the satisfaction of the Engineer.