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(Reaffirmed 2002)

भारतीय मानक

पहाड़ी क्षेत्र की रिटेनिंग दिवारें — मार्गदर्शी सिद्धान्त

भाग 3 शुष्क पत्थर की दीवार का निर्माण

Indian Standard

RETAINING WALL FOR HILL AREA — GUIDELINES

PART 3 CONSTRUCTION OF DRY STONE WALLS

ICS 93.020

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

June 1998

Price Group 3

FOREWORD

This Indian Standard (Part 3) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hill Area Development Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

Retaining wall is a structure used to retain backfill and maintain difference in the elevation of the two ground surfaces. Retaining wall may be effectively utilized to tackle the problem of landslide in hill area by stabilizing the fill slopes and cut slopes.

From the initial construction cost considerations, one metre of extra width in filling, requiring retaining walls, costs much more than constructing the same width by cutting inside the hill. Similarly the cost of a breast wall is several times more than a non-walled cut slope. However, considering maintenance cost, progressive slope instability and environmental degradation from unprotected heavy excavations, the use of retaining walls on hill roads and terraces becomes essential. This standard (Part 3) is, therefore, being formulated to provide necessary guidanace in construction of dry stone retaining walls for stability of hill slopes, the other parts of the code being:

Part 1	Selection of type of wall
Part 2	Design of retaining/breast walls
Part 4	Construction of banded dry stone walls
Part 5	Construction of cement stone walls
Part 6	Construction of gabion walls
Part 7	Construction of RCC crib walls
Part 8	Construction of timber crib walls
Part 9	Design of RCC cantilever wall/buttressed walls/L-type walls
Part 10	Design and construction of reinforced earth retaining walls

The present practice in various Government departments is to construct retaining walls up to 4 m height in random rubble dry stone masonry. Retaining walls more than 4 m height are constructed either in lime or cement mortar masonry or in dry stone masonry panels separated by 0.6 m wide mortarred masonry sleepers laid 3 to 4 m apart both in horizontal and vertical directions. The specified norms prescribed by the respective departments usually do not give sufficient weightage to the nature and properties of the soil or rock below the wall base and at the back of the wall, or the weather conditions. It is normally assumed that the mortarred masonry or bands give sufficient strength to the wall for added stability and confines local failure, if any. In actual practice it has however been observed that a number of dry as well as banded or fully mortarred walls do collapse during rains without offering much resistance as such these walls are used only as a temporary measure. This part, therefore, gives definite guidelines to the field engineers for construction of dry stone retaining walls.

Dry stone masonry retaining walls generally fail due to construction of grossly inadequate section of walls. Good supervision is, therefore, the key to better quality of construction of dry stone masonry walls. Strict supervision is essential for longer life of these type of walls. It shall be ensured that skilled labour is used in construction of dry stone masonry walls.

The composition of technical committee responsible for the formulation of this standard is given at Annex A.

Indian Standard

RETAINING WALL FOR HILL AREA — GUIDELINES

PART 3 CONSTRUCTION OF DRY STONE WALLS

1 SCOPE

This standard (Part 3) deals with the construction aspects of dry stone retaining walls.

2 REFERENCES

The Indian Standard IS 1123:1975 'Method of identification of natural building stones (*first revision*)' contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated above.

3 GENERAL

3.1 A hill road masonry retaining wall is a gravity wall which shall be considered safe under the expected conditions of loading, if following conditions are satisfied:

a) it shall be safe against overturning,

b) shearing stress shall be less than shearing strength available, and

c) the pressure at the toe shall remain less than the safe bearing capacity of the foundation material.

It may be, however, assumed that there is adequate frictional bond between the stone layers from face to back and from top to base so that the entire section of the retaining wall acts as one unit. This may be very easily achieved by using stones of rectangular shape with sufficient overlap on each other enabling proper interlocking. The top width of the retaining wall shall be taken as 600 mm.

3.2 The stability of the retaining wall mainly depends upon the allowable bearing pressure of the foundation, particularly under the toe as compressive strength of properly constructed masonry section is usually adequate. Sliding at the base depends on the coefficient of friction between the wall base and the foundation soil. The total earth pressure above any level along the height of the retaining wall reduces parabolically from base upward, whereas the wall thickness reduces linearly. Therefore in most cases the critical section in the wall is at the base.

3.3 It cannot be asserted with any degree of certainty that fully mortarred masonry wall or a panelled masonry wall shall give a better performance than a dry stone retaining wall, on account of the following:

a) The value of bonding material or mortar is only from the point of view of making the wall an integral unit. However it is not assured in the case of hill roads and site development in hills; due to lack of supervision, non-availability of skilled labour, improper mixing of mortar, lack of post-construction, curing, etc and also sometimes paucity of water in the area.

b) Since both types of wall are not supposed to bear any tension, the strength of a dry stone masonry wall having the same section and similar soil conditions as a fully mortarred masonry wall, shall be adequate. The compressive strength of properly packed dry stone masonry is likely to be more than that of foundation soil on the hill slope.

c) For sliding at the base, coefficient of friction between the wall base and the foundation soil being same in both types, the behaviour shall not be different. Thus there is no particular utility of bands or mortar and the strength of a properly constructed dry stone masonry retaining wall shall be quite sufficient. On account of its flexibility, a dry stone masonry retaining wall may be expected to behave better than a fully mortarred masonry wall under seismic conditions.

d) Dry stone walls are easy to repair when it fails.

3.4 The design of dry stone masonry retaining wall shall be in accordance with Part 2 of this standard. A suitable computer program may be used for the design.

4 MATERIAL

Stone, the main material required for the construction of dry stone masonry retaining wall, is available in large quantity in hills. To select and utilize them for their satisfactory performance, it shall be necessary to know the various properties which can be determined according to relevant Indian Standards. The strength of rocks depends on its mineral constituents which form the basis of classification and identification of rocks. Identification of stones may be done in accordance with IS 1123.

5 BASE SLOPE

An inward slope provides good keying of the wall

in the hill face and also reduces the toe pressure, besides greatly increasing the sliding strength of the wall at base. Therefore, the base shall preferably be at right angles to the face of the wall. A minimum inward slope of 1 (Vertical) in 6 (Horizontal) shall be provided and it shall not be more than 1 (Vertical) in 3 (Horizontal). Base slope is very effective in seismic stability of walls.

6 STONE WORK

6.1 Rough flat stones shall be preferred as they give better contact and friction at joints. There shall be no dumping of stones. Stones shall be placed well interlocked at close proximity with each other. Size of stones below 225 mm × 100 mm × 75 mm (with mass of about 5 kg) shall not be used. The maximum size of stone shall be 600 mm × 200 mm × 300 mm with mass of about 45 kg. The largest dimension, that is, the length shall be placed across the length of the retaining wall for maximum stability as with this arrangement the wall face will not easily separate from the hearting. It shall result in greater unity and interlocking among the stones placed around it.

6.2 In dry stone masonry it shall be necessary to spread broken stone dust, stone chips, soil (gravelly or sandy soils) and soil mixtures, after placing each layer of stones to fill the voids. Filling of voids prevent filling of cavities by mud which is injurious to the wall as it makes it impervious to the flow of water. Fine grained soils and smooth river shingle shall not be used as these may lubricate the joint decreasing the frictional resistance. Only coarse angular particles shall be made use of. If available in the vicinity, water may also be sprinkled to moisten the filler material. Some ramming shall also be preferred. This helps in spreading the load of the overlying stones more evenly and increasing the weight of the wall and in turn increases the strength of the wall. Fig. 1(a), Fig. 1(b) and Fig. 1(c) represent bad construction practices liable to damage or cause failure of wall and shall be avoided.

7 PLACEMENT OF BACKFILL

No dumping of stones shall be done. The backfill shall preferably be done by hand packing to achieve the maximum angle of internal friction. The width of backfill shall be at least 500 mm. The backfill material shall be non-cohesive and as free draining as possible except the top layer of 300 to 500 mm thickness which shall be made as impervious as possible to minimize ingress of water from top surface.

8 DRAINAGE

8.1 The dry stone masonry retaining walls have the advantage that the masonry remains quite permeable to the flow of water and pressure normally does not build up. However, efficient drainage system above the top of the retaining wall is most essential. The top layer of backfill shall be laid at a proper camber and shoulder slope. The water flowing in the hill side drain shall be drained off through scuppers of appropriate design at regular intervals. The retaining wall top shall be kept slightly lower than the shoulder sloping outward so that water runs over the wall instead of seeping into the backfill. For site development, a 300 mm thick impervious soil layer (properly compacted) with boulders shall be laid above the top surface and backfill to prevent ingress of drain water. Typical sketch showing best retaining wall with good filling is shown in Fig. 1(d).

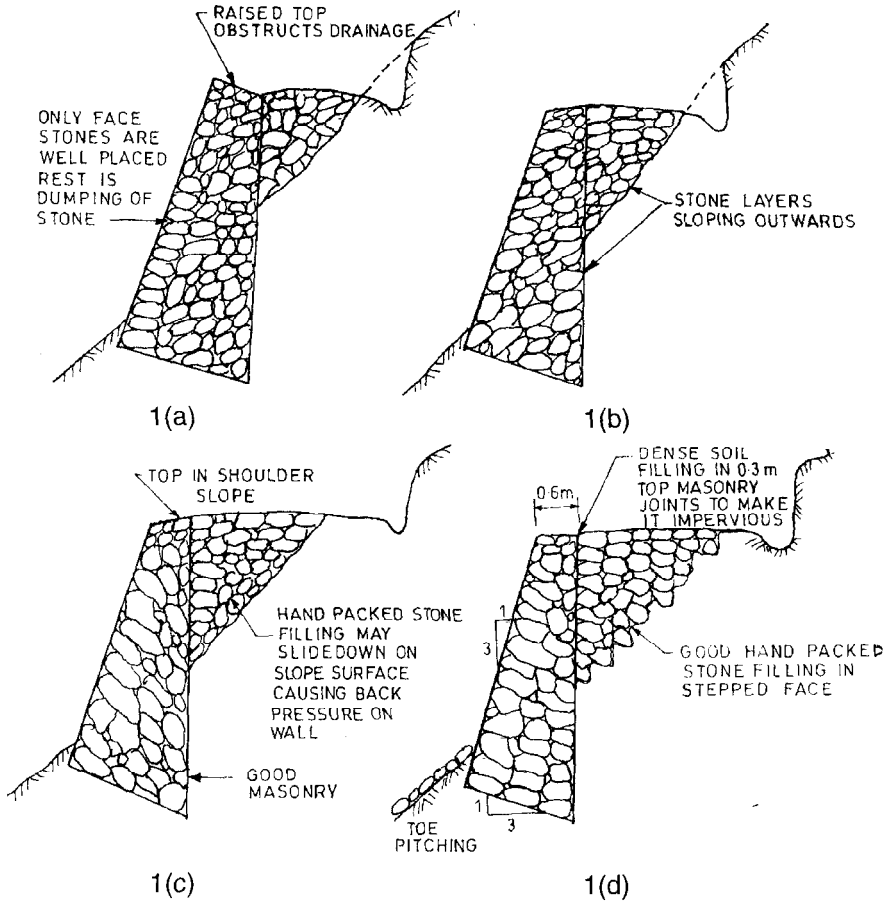
8.2 Excavated material from foundation if dumped by the side of the toe obstructs drainage. It must be sloped down below the top level of the toe projection.

9 TOE PROTECTION

The water coming out at high velocity from top of retaining wall can cause soil erosion at the toe and even below it by back erosion of soft rock or shale. Toe protection shall always be provided particularly in walls having height more than 3 m except where the toe rests on hard non-erodable rock.

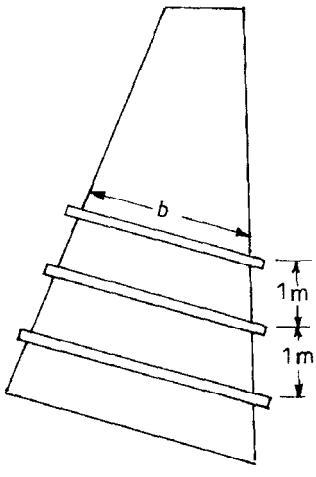
10 RCC BONDING ELEMENT

In thicker wall sections and tall retaining walls, say greater than 3 m, special duly staggered bonding elements through the masonry, going from earth face of the wall to its front face at regular spacing along the length and height, shall be used. The bonding elements shall be spaced at 1 m interval along the length of the wall. These elements may consist of with overlapping bond stones (scissor bond stones), wooden ballies or bamboos but considering the durability these may consist of reinforced concrete member of square cross-section of 75 mm × 75 mm or 100 mm × 100 mm and having a length equal to the thickness of the wall plus 150 mm so that it may project out of wall by 75 mm on both sides for easy checking as shown in Fig. 2.



1(a) RETAINING WALL OF VERY SMALL STRENGTH
1(b) RETAINING WALL OF POOR STRENGTH
1(c) GOOD RETAINING WALL BUT UNSTABLE FILLING
1(d) BEST RETAINING WALL WITH GOOD FILLING

FIG. 1 TYPICAL CONSTRUCTION DETAILS FOR DRY STONE MASONRY WALL



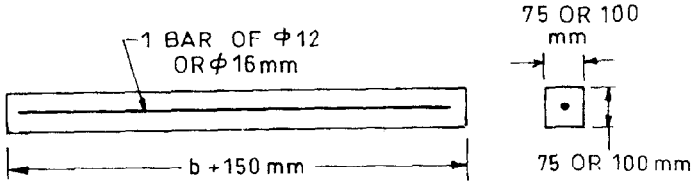


FIG. 2 RCC BONDING ELEMENTS

ANNEX A
(Foreword)

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'

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