

Indian Standard
GUIDELINES FOR THE DESIGN OF
GROUT CURTAINS
PART 1 EARTH AND ROCKFILL DAMS

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INDIAN STANDARDS INSTITUTION
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*Indian Standard***GUIDELINES FOR THE DESIGN OF
GROUT CURTAINS****PART 1 EARTH AND ROCKFILL DAMS**

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Indian Standard

GUIDELINES FOR THE DESIGN OF GROUT CURTAINS

PART 1 EARTH AND ROCKFILL DAMS

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Indian Standards Institution on 26 February 1985, after the draft finalized by the Foundation and Substructure Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 There are various measures for seepage control which are given in IS : 8414-1977*; one of which is grout curtain. This standard covers the design of grout curtain for earth and rockfill dams.

0.3 Design requirements for a grout curtain depend on its function, for example, when the grout curtain is designed to function as the principal measure of seepage control and it constitutes the main seepage barrier, it shall be of adequate depth and width and the permeability within the grouted zone shall be reduced to acceptable limits. On the other hand the grout curtain may be considered as a complementary measure of other seepage control measures. In such cases the curtain is essentially an exploratory line of closely spaced holes aimed at sealing the wider and more open cracks and voids so that the efficacy of the system is not impaired by excessive concentrated seepage along the major cracks joints and voids. The method of grouting is covered in IS : 6066-1985†.

0.4 This standard is being prepared in two parts; Part 2 covering masonry and concrete dams is under preparation.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960‡. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Guidelines for design of under-seepage control measures for earth and rockfill dams.

†Recommendations for pressure grouting of rock foundation in river valley projects (first revision).

‡Rules for rounding off numerical values (revised).

1. SCOPE

1.1 This standard covers the design of grout curtains in alluvium and rock when used as principal measure of seepage control.

2. GROUT CURTAINS IN ALLUVIUM

2.1 Choice of Number of Rows of Grout Holes

2.1.1 In alluvium and other type of pervious soils, multiple rows of holes are necessary for effective sealing when the curtain constitutes the principal seepage barrier. The choice of numbers of rows of holes is governed by the following considerations:

- a) In heterogeneous formations effective sealing may be achieved on the central row or rows, the outer rows being employed primarily to block the open passage and seal the larger voids so that over travel of the more fluid grout injected through the central rows is prevented; and
- b) The curtain width should be adequate to ensure adequate resistance to leaching and internal erosion.

2.2 Resistance of Grout to Internal Erosion and Leaching

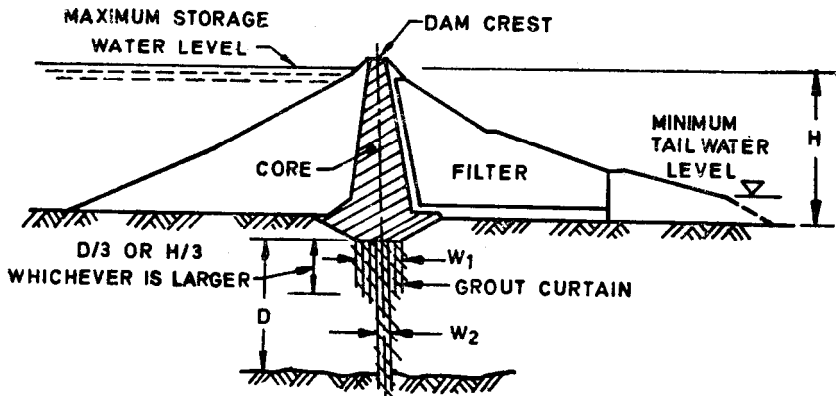
2.2.1 The ratio of the width of the curtain to the hydraulic head across the curtain depends on the nature of the grout material and the formation treated by the grout. Clay cement and bentonite cement grout injected into coarse sand and gravel are known to have withstood hydraulic gradients as high as 7 : 1. Prolonged laboratory tests of one year duration have indicated virtual permanence of the clay-cement-bentonite grout for specimens of grouted sand and gravel subjected to gradients as high as 20. On the other hand the softer bentonite silicate grouts used for treatment of medium sand may be eroded at gradients of the order of 10. For permanent curtains hydraulic gradient for bentonite silicate grout have been restricted to 3 : 1. Bentonite silicate grouts should be used with caution since their behaviour is very much dependent on the nature of bentonite, and its reaction with the fluidifier and salts in the soil.

2.2.2 Silicate aluminate gels are known to be stable and are known to withstand hydraulic gradients of 4 : 1 or even higher. Data presently available indicate that acrylamide grout are permanent. The permanence of other types of grouts need to be investigated, and their application is not advised for important and permanent curtains. For permanent curtains choice of grout materials is generally limited to clay cement, bentonite and silicate aluminate grouts.

2.3 Curtain Width

2.3.1 The curtain width should be chosen on the basis of following criteria:

- a) The curtain width at the core contact should match the core base, usually width in the range of $1/3$ to $1/5$ head is provided (Fig. 1);



Recommended Maximum Curtain Width

$W_1 = H/3$ to $H/5$ for stable grouts clay cement, bentonite cement.

$W_2 = H/7$ Sodium silicate — aluminate, acrylamide.

FIG. 1 GROUT CURTAINS IN PERVIOUS SOILS

- b) The main curtain should extend to rock or impervious stratum and the width should be reduced from the width at core contact to the main curtain width. Usually this is achieved in a zone of about $\frac{1}{4}$ the depth of the pervious alluvium;
- c) The main curtain should have two or more rows depending upon the requirements of strata. For clay cement silicate aluminate grouting the main curtain should have a width of $1/7$ head; and
- d) The residual head, downstream of the curtain measured as excess head with regard to tail water should be 20 percent or lower of the total head from tail water to head water. This reduction in head is achieved by appropriate choice of curtain width and by bringing about sufficient of permeability in the curtain width. Usually grouting is effective when the post-grouting permeability values are brought down to one hundredth of initial values.

3. GROUT CURTAINS IN ROCK

3.1 Curtain Width

3.1.1 For effective control of seepage in large zones of fractured and jointed rocks it is necessary to treat the contact of the core and rock foundation by blanket grouting. The depth of blanket grouting hole should be at least 6 m.

3.1.2 The normal practice of splitting the spacing starting with an initial spacing of 6 to 12 metres is recommended for each of the rows. The final spacing would be related to the spacing of joints and normally 3 metres spacing may be necessary, but special geological condition may require closer spacing.

3.1.3 The main curtain would consist of one or more rows of holes. In the first row grouting operations are carried out by split spacing method. If the permeability can be brought down to 5 lugeon with a final spacing of 3 m or larger, a single line curtain would be adequate. If further drilling and grouting of holes at closer spacing is required, two line curtain should be preferred.

3.2 Types of Grout in Rock

3.2.1 Normally for grout curtains in rock, neat cement grout should be used and if admixtures are used to reduce cement consumption, only non-colloidal fillers such as fine sand, flyash may be used. For grout curtains in rock colloidal admixtures such as bentonite would not be normally permitted since the addition of bentonite/clay would reduce the resistance of grout to internal erosion and leaching. Use of such admixtures should be combined with sand in small quantities, about 2 percent by weight of cement, to obtain a more pumpable grout mix.

3.3 Depth of Curtain

3.3.1 The depth of the curtain shall be related to the design of the drainage system and the depth to an essentially impervious and inerodable rock formation. In stratified rock and in massive igneous or crystalline metamorphic rock an impervious formation may often be established at shallow depth below rock surface and 3 metres would be sufficient penetration of the grout curtain into such formations.

3.3.2 Grouting cannot be relied upon to prevent internal erosion in clayey or silty gauged zones and solution cavities filled by heterogenous mixture of clay, silt, sand and rock fragments.

3.3.3 In such cases, it is essential to excavate and backfill seams in the entire core contact zone and blanket if necessary special care is needed when material filling seams consists of silt and dispersive clay vulnerable to erosion.

3.3.4 The grout curtain should normally extend to relatively impervious rock of permeability 3 lugeon or less. When this cannot be realized due to deep pervious formations the curtain should extend to a depth ranging from $H/3$ to H with reference to the core and core rock contact. The greater depth may be necessary up to reservoir head when the rock contains seams and defects vulnerable to internal erosion.