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(Reaffirmed 1999)

भारतीय मानक

जलोट नदियों में पुलिन-रोध की योजना और डिजाईन — मार्गदर्शी सिद्धान्त

(पहला पुनरीक्षण)

Indian Standard

PLANNING AND DESIGN OF GROYNES IN ALLUVIAL RIVER — GUIDELINES

(First Revision)

UDC 627·421·1 : 624·04

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

April 1994 **Price Group 4**

River Training and Control Works Sectional Committee, RVD 22

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the River Training and Control Works Sectional Committee had been approved by the River Valley Division Council.

Groynes (spurs) are structures constructed transverse to the river flow and extend from the bank into the river. These are widely used for river training and bank protection.

This standard was first published in 1976 under the title 'Criteria for river training works for barrages and weirs in alluvium'. Now, since different river training works are being covered in detail in different standards, in this revision only provision relating to groynes (spurs) are covered incorporating the latest practices being followed in the field of planning and design of both permeable and impermeable groynes. Other types of training works such as guide banks, approach and afflux embankments are covered in separate standards. The provisions in respect of construction and maintenance of groynes are being covered in a separate Indian Standard.

For highly capital intensive protective works or groynes located on the upstream of important structures such as bridges, barrages, water intakes, etc, it is desirable to carry out model studies.

Indian Standard

PLANNING AND DESIGN OF GROYNES IN ALLUVIAL RIVER — GUIDELINES

(First Revision)

1 SCOPE

This standard covers the planning and design of groynes (spurs) in alluvial river.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
4410 (Part 3) : 1988	Glossary of terms relating to river valley projects: Part 3 River and river training (*first revision*)
8237 : 1985	Code of practice for protection of slope for reservoir embankment (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the terms defined in IS 4410 (Part 3) : 1988 shall apply.

4 GENERAL DESIGN FEATURES

4.1 Alignment

Groynes may be aligned either normal to the dominant flow direction or at an angle pointing upstream or downstream.

4.1.1 A groyne pointing upstream repells the river flow away from it and is known as repelling groyne. When a groyne of short length changes only direction of flow without repelling, it is known as deflecting groyne. A groyne pointing downstream attracts the river flow towards it and is known as attracting groyne.

4.2 Functions of Groynes

4.2.1 Groynes serve one or more of the following functions:

a) Training the river along the desired course to reduce the concentration of flow at the point of attack,

b) Protecting the bank by keeping the flow away from it,

c) Creating a slack flow with the object of silting up the area in the vicinity of the river bank, and

d) Improving the depths for navigation purpose.

4.3 Classification of Groynes

These can be classified as follows, according to:

a) The methods and materials of construction, namely permeable, impermeable and slotted;

b) Height of groyne with respect to water level, namely submerged, non-submerged and sloping (partially submerged);

c) Action, namely deflecting, attracting and repelling (*see* Fig. 1) (*see* **4.1.1** also); and

d) Special shapes, namely *T*-headed, hockey type or Burma type, kinked type, etc (*see* Fig. 1).

4.3.1 Impermeable or solid groynes are constructed with earth or rockfill. Nose and adjacent shank portion are protected by heavy materials like stones, stones or boulders in crates or cement concrete blocks. The groynes may be designed to attract or deflect the flow and guide it along a desired course.

4.3.2 In case of deep and narrow rivers or rivers carrying considerable suspended sediment, permeable groynes are preferred. These groynes offer flexibility in construction and maintenance and any alternation, if required, at a later stage is possible. These groynes cause partial obstruction to flow and promote deposition of sediment as the flow is retarded. Common construction material for permeable groynes are ballies, trees, bamboos, etc. Following types of permeable groynes are generally in use (*see* Fig. 2):

a) Pile groynes,

b) Tree groynes, and

c) Porcupine groynes.

4.4 Groynes can be used singly or in series. They can be used in combination with other training measures also. If the reach to be protected is long, single groynes may not be enough. In that case a number of groynes may be required. The spacing, orientation and length of groynes is usually decided by model experiments.

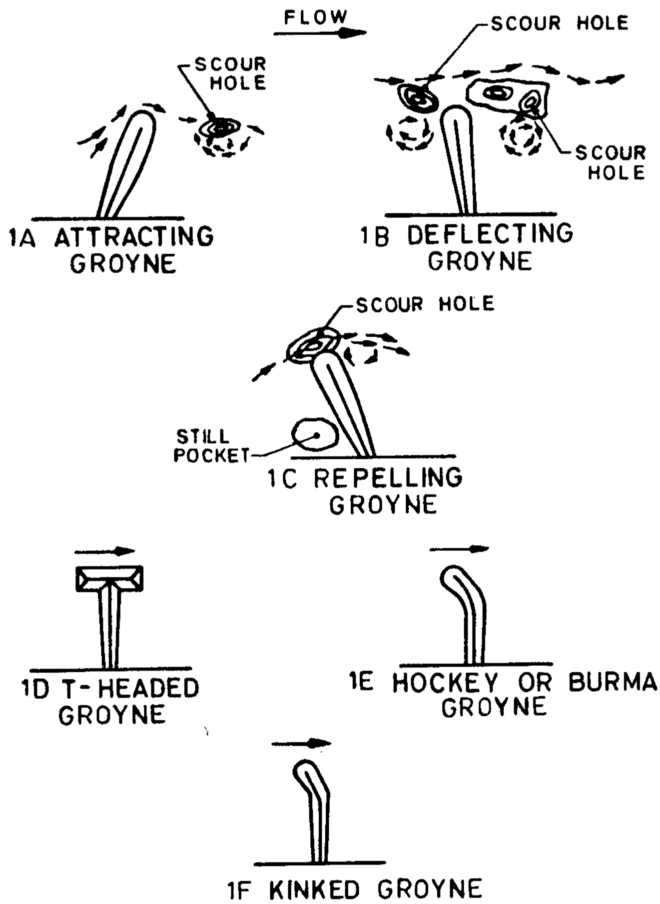

FIG. 1 TYPES OF GROYNES

5 DESIGN OF GROYNE

5.1 The design discharge for the groyne should be equal to that for which any structure in close proximity is designed or 50 year flood whichever is higher.

5.2 Length of Groyne

Length of groyne should be decided on the basis of availability of land on the bank. Length should not be less than that required to keep the scour hole formed at the nose away from the bank. Thus assuming angle of repose of sand to be 2·5 H : 1V and anticipated maximum depth of scour below bed be 'ds', the length should be more than 2·5 ds. Short length may lead to bank erosion on upstream and downstream of the groyne due to eddies formed at the nose. On the other hand too long a groyne may constrict the river and may not withstand the attack on account of heavy discharge concentration at the nose and too high a differential head across the groyne.

Normally the effective length of groyne should not exceed 1/5th of width of the flow in the case of single channel. In case of wide, shallow and braided rivers, the protrusion of the groyne in the deep channel should not exceed 1/5th of the width of the channel on which the groyne is proposed excluding the length over the bank. The spacing of the groyne is normally 2 to 2·5 times its effective length. For site specific cases model studies may be conducted.

5.3 Top Level of Groyne

The top level of groyne will depend on the type namely, submerged, partially submerged or non-submerged and will be best decided by model experiments. In case of non-submerged groynes the top level should be above design flood level with adequate free board.

5.4 Top Width

The top width of groyne should be 3 to 6 m as per requirements.

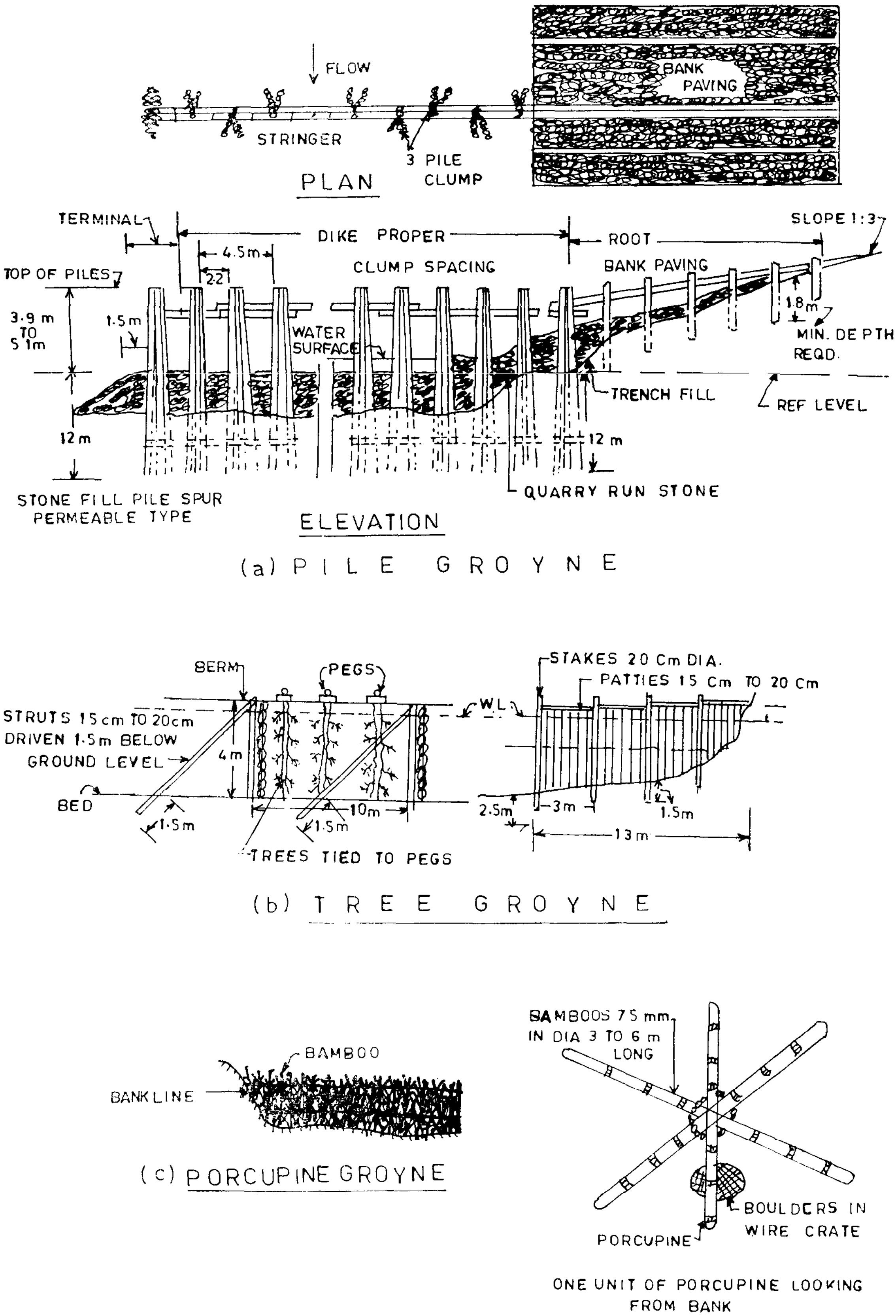

FIG. 2 TYPES OF PERMEABLE GROYNES

5.5 Freeboard

A freeboard of 1 to 1·5 m should be provided above the design flood level.

5.6 Side Slopes

Slopes of the sides and nose of the groyne would be between 2 : 1 and 3 : 1 depending upon the material used.

5.7 Size of Stone for Pitching

The weight of the stones required on sloping surface to withstand erosive action of flow may be determined using the following relationship or by using Fig. 3.

$$W = \frac{0{\cdot}02323\ S_s}{K\ (\ S_s - 1\ )^3}\ V^6$$

where

$$K = \left[\ 1 - \frac{\sin^2\ \theta}{\sin^2\ \phi}\ \right]^{\frac{1}{2}},$$

W = weight of stone in kg,

S_s = specific gravity of stones,

ϕ = angle of repose of protection material,

θ = angle of sloping bank, and

V = velocity in m/s.

In case of crates filled with stones, the mass specific gravity of the protection is required to be worked out to account for the porosity. The empirical relation for the porosity '*e*' is given below:

$$e = 0{\cdot}245 + \frac{0\ 0864}{(\ D_{50}\ )^{0\ 21}}$$

where

D_{50} = mean diameter of stones used in crate in millimeters.

The openings in wire net used for crates should not be larger than the smallest size of stone used. The mass specific gravity of the protection can be worked out using following relationship:

$$S_m = (\ 1 - e\ )\ S_s$$

For working out volume of crates, S_m should be used instead of S_s Shape of crates or blocks should be as far as possible cubical. Crates may be made of G.I. wire or nylon ropes of adequate strength and should be with double knots and closely knit.

5.8 Thickness of Pitching

Thickness of pitching should be equal to two layers of stones determined for velocity as indicated in **5.7** in the case of free dumping stones. Thickness of protection layer should be checked for negative head created due to velocity from following formula:

$$T = \frac{V^2}{2\ g\ (\ S_s - 1\ )}$$

where

V = velocity in m/s,

T = thicknes in m, and

S_s = specific gravity of stones.

In the case of crates, the thickness of crates be decided on the basis of the above formula subject to the condition that the mass of each crate should not be less than that determined on the basis of velocity consideration in **5.7**.

5.9 Launching Apron

5.9.1 *Size of Stone*

The required size of stones, concrete blocks, crates, etc for launching apron can be determined using procedure given in **5.7**.

5.9.2 The depth of scour for different portions of groyne can be adopted as given in Table 1.

Table 1 Depth of Scour

Sl No.	Location	Maximum Scour Depth to be Adopted
(1)	(2)	(3)
i)	Nose	2·0 *D* to 2·5 *D*
ii)	Transition from nose to shank and first 30 to 60 m in upstream	1·5 *D*
iii)	Next 30 to 60 m in upstream	1·0 *D*
iv)	Transition from nose to shank and first 15 to 30 m in downstream	1·0 *D*

where

D = the depth of scour below HFL estimated using Lacey's formula, in which

$D = 0{\cdot}473\ [\ Q/f\ ]^{1/3}$

where

Q = discharge in cum/sec, and

f = silt factor

= $1{\cdot}76\ \sqrt{d}$, where d is the mean diameter of river bed material in mm

When the discharge intensity is known, following formula may preferably used:

$D = 1{\cdot}33\ [\ q^2/f\ ]^{1/3}$

where

q = intensity of discharge in cum/sec/m.

5.9.3 *Thickness*

The thickness of the launching apron should be 25 to 50 percent more than the thickness of pitching on slopes (*see* **5.8**).

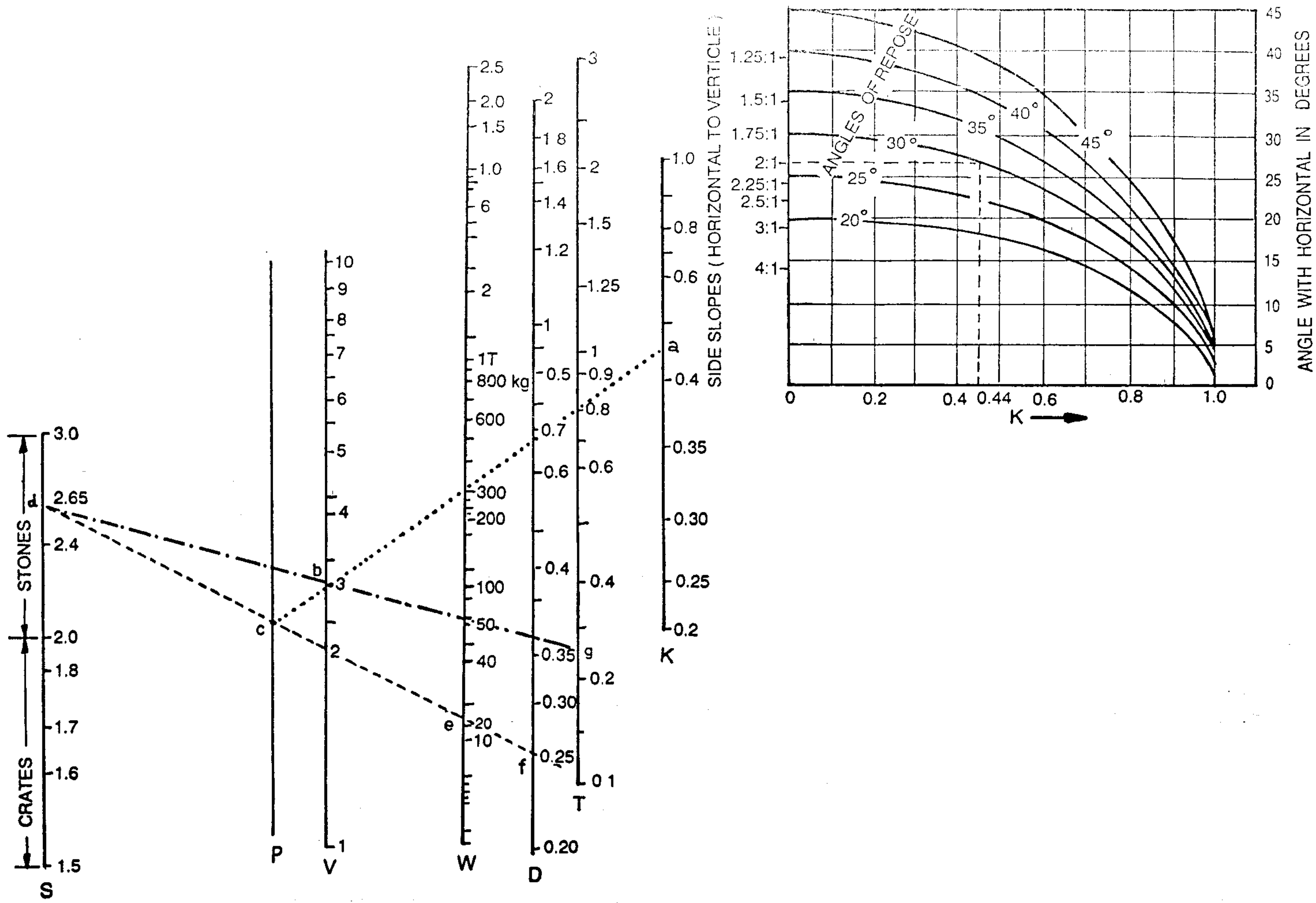

ILLUSTRATION	$K = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\phi}}$		
Velocity 3 m/s	$W = \frac{0.023\,23}{K} \cdot \frac{S_s}{(S_s - 1)^3} V^6$		
Bank slope 2 : 1		Expressions	
Angle of repose 30 degrees	$T = \frac{V^2}{2g\,(S_s - 1)}$		
Specific gravity 2·65	$D = 0.124 \sqrt[3]{\frac{W}{S_s}}$		

STEPS

1. From bank slope and angle of repose find from upper diagram, $K = 0.4$
2. Locate *a* on *K* line
3. Locate *b* on *V* line corresponding to 3 m/s
4. Join *a b* and extend to meet *P* line at *c*
5. Locate *d* on *S* line
6. Join *d c* and extend to meet *W* line at *e*. Read the weight $W = 20$ kg
7. Extend *d c e* to meet *D* line at *f*
   Read the stone diameter as $D = 0.25$ m
8. Join *d b* and extend to meet *T* line at *g*
   Read the thickness of pitching as $T = 0.25$ m

For safety purpose provide two layers of stones weighing 20 kg ($D = 0.25$ m) so that the total thickness of pitching is 0·50 m

Fig. 5 Nomograph for River Bank Protection by Stones

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5.9.4 *Slope of Apron After Launching*

The slope of the launched apron may be taken 2 H : 1 V for loose boulders or stones and 1·5 H : 1 V for concrete blocks or stones in crates. Adequate quantity of stone for the apron has to be provided to ensure complete protection of the whole of the scoured face according to levels determined in **5.9.2** and slopes.

5.9.5 *Shape and Size of Launching Apron*

A width of launching apron equal to 1·5 D_{max}, where D_{max} is the depth of maximum scour below designed apron level should be provided at semi-circular nose and should continue up to 60 to 90 m on the upstream or for such a length of upstream shank up to which the river action prevails (whichever is more). In next 30 to 60 m on the upstream, the width of launching apron may be reduced to 1·0 D_{max}. In the remaining reach nominal apron or no apron may be provided depending upon the flow conditions. The width of the launching apron on the downstream should be reduced from 1·5 D_{max} to 1·0 D_{max} in 15 to 30 m and should continue in next 15 to 30 m. If the return flew prevails beyond the above specified reach, the apron length may be increased to cover the region of return flow. A typical design of groyne is illustrated in Fig. 4.

5.10 Filters

A graded filter generally specifying the standard criteria conforming to IS 8237 : 1985 should be provided below the protection. The filter is

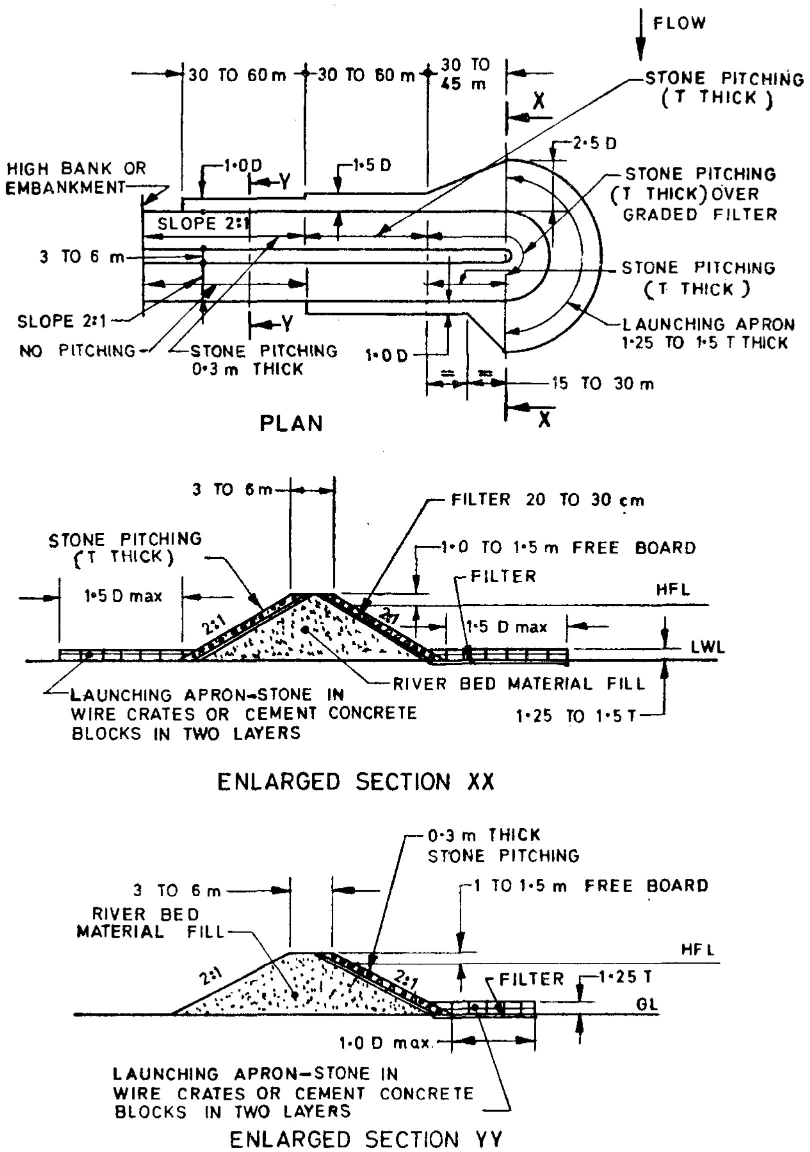

FIG. 4 TYPICAL DESIGN OF GROYNES

required below pitching on the slope as well as below the apron also. The use of synthetic filter may be preferable from the point of quality control and convenience of laying. The criteria for synthetic filter is given in Annex A. A 15 cm thick sand layer should be provided on the filter to prevent the mechanical rupture of the fabric by armoured layer.

ANNEX A

(*Clause* 5.10)

CRITERIA FOR SELECTION OF FILTER FABRIC

Geotextile filters may be recommended because of ease in installation and their proven effectiveness as an integral part of protection works. The following criteria, depending on the gradation of bed material, may be used to select the correct filter fabric:

a) For granular material containing 50 percent or less fines by weight, the following ratio should be satisfied:

$$\frac{\text{85 percent passing size of bed material (mm)}}{\text{Equivalent opening size of fabric (mm)}} \geqslant 1{\cdot}0$$

In order to reduce the chances of clogging, no fabric should be specified with an equivalent opening size smaller than 0·149 mm. Thus the equivalent opening size of fabric should not be smaller than 0·149 mm and should be equal to or less than 85 percent passing size of bed material.

b) For bed material containing at least 50 percent but not more than 85 percent fines by weight, the equivalent opening size of filter should not be smaller than 0·149 mm and should not be larger than 0·211 mm.

c) For bed material containing 85 percent or more of particles finer than 0·074 mm, it is suggested that use of non-woven geofabric filter having opening size compatible to the equivalent values given in (a) above may be used.

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Amendments Issued Since Publication

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