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OFFICE MEMORANDUM

Subject : Design criteria for flood protection embankment sections — A December, 1977 publication of the Ganga Flood Control Commission, Patna

A copy of the above publication is circulated for guidance of all the Technical Officers.

To

All Technical Officers of the Roads Wing/All Regional Superintending Engineers and Engineer-Liaison Officers.

DESIGN CRITERIA FOR FLOOD PROTECTION EMBANKMENT SECTIONS

(Ministry of Agriculture and Irrigation, Ganga Flood Control Commission, Patna — December 1977)

In order to ensure uniformity in preparation and processing of schemes for flood protection embankments, the following design criteria are being laid down. These criteria do not apply to embankments on tidal rivers.

(1) SPACING OF EMBANKMENT

In case of embankments on both Banks of the river the spacing between the embankments should not be less than 3 times Lacey's wetted perimeter, while in case of embankment on only one bank, the spacing of the levee/embankment should preferably be at a distance equal to Lacey's wetted perimeter from the river bank or about 1.5 times Lacey's P.W. from the midstream of the river. In fixing the alignment, care should be taken to obviate costly river training works or anti-erosion works.

(2) DESIGN HIGH FLOOD LEVEL

Subject to availability of observed hydrological data, the design H.F.L. may be fixed on the basis of flood frequency analysis. In no case, the design H.F.L. should be lower than the maximum on record. For small rivers carrying discharge upto 3000 cumecs, the design H.F.L. shall correspond to 25 years return period. For the river carrying peak flood above 3000 cumecs, the design H.F.L. shall correspond to 50 years return period. However, if the embankments concerned are to protect big townships, industrial areas or other places of strategic importance the design H.F.L. shall generally correspond to 100 year return period.

In the case of double embankments, the design H.F.L. shall be determined keeping in view the anticipated rise in the H.F.Ls. on account of jacketing of the river.

(3) FREE BOARD

In earthen embankments along rivers carrying design discharge upto 3000 cumecs, a free board of 1.5 metre (5 ft.) above the design H.F.L. shall be provided. In earthen embankments along rivers carrying more than 3000 cumecs design discharge, a free board of 1.8 metre (6 ft.) over the design H.F.L. shall be provided. This shall also be checked for ensuring a minimum of about 1 metre (3 ft.) free board over the design H.F.L. corresponding to 100 year return period.

(4) TOP WIDTH

Earthen embankments along rivers carrying design discharge upto 3000 cumecs shall have top width of 5 metres (16 ft.) In the case of protective embankments along major rivers carrying design discharge above 3000 cumecs, the top width shall generally be 5.5 metres (18 ft.). Turning platforms 15 m to 30 m long and 3 m wide with side slope of 1 : 1.5 shall be provided along the country side slope of the embankment at every kilometre.

(5) HYDRAULIC GRADIENT

Hydraulic gradient line has to be determined on the basis of the analysis of the soils which are to be used in the construction of embankments. However, keeping in view the present provisions and practices in different schemes, the following is recommended as guidelines for preparation of project report and estimates.

Type of fill	Hydraulic Gradient
Clayey soil	1 in 4
Clayey sand	1 in 5
Sandy soil	1 in 6

In case the hydraulic gradients flatter than those suggested above are proposed this should necessarily be supported by results of laboratory tests and recommendations from the State Research Laboratory.

(6) SIDE SLOPE :**(i) RIVER SIDE SLOPE :**

The river side slope should be flatter than the angle of repose of the material used in the fill. Considering conditions of saturation and draw-down, the river side slope of embankments upto 4.5 metre height shall not be steeper than

1 in 2 and that in higher embankments will not be steeper than 1 in 3. In case, the higher embankments are protected by rip-rap, the river side slope of earthen embankments upto 6 metres high may be 1 in 2 or 1 in 2.5 depending upon the type of slope protection. In embankments constructed of sandy materials, the river side slope should preferably be protected with cover of 0.6 m (2 ft.) thick good soil.

(ii) COUNTRY SIDE SLOPE

The countryside slope will largely depend on the hydraulic gradient line in different types of soil used in the fill. In order to avoid seepage of water from the countryside face and consequent damage to the bank, minimum cover of 0.6 m over the hydraulic gradient line would be necessary. Generally for embankments upto 4.5 m height, the countryside slope should be 1 in 2 from the top of embankment upto the point where the cover over hydraulic gradient line is 0.6 m, after which either a berm of suitable width with the countryside slope of 1 : 2 from the end of the berm upto the ground level may be provided or the slope may run parallel to the hydraulic gradient line down to the ground level. For the embankments above 4.5 m and below 6 m heights, the corresponding slope should be 1 : 3. In this case also, the provision of berms or a slope running parallel to the hydraulic gradient line from the point where the cover over the hydraulic gradient line is 0.6 m only may be considered. Generally the berm will be 1.5 metre (5 ft.) wide. In selecting a section for the embankment, the economics of the type adopted will be examined.

For embankments above 6 m height detailed design may be furnished in the project estimate.

(iii) SLOPE PROTECTION WORKS

Generally the side slopes and 2 ft. wide (0.6 metres) on top from the edges of the embankments should be turfed with grass sods. In embankments which are in imminent danger of erosion, necessity of protective measures such as slope protection by rip-rap and/or river training works should be examined separately.

(iv) TREATMENT ON TOP OF EMBANKMENTS

For embankments protecting bigger towns, industrial establishments and places of strategic importance, the necessity of providing all weather road surface such as water-bound-macadam or brick-on-edge soling or creteways or moorum surface in 3 to 3.5 metres width should be examined for such reaches which are not easily accessible from the existing net-work of roads in order to ensure proper repair and maintenance of the embankments especially during emergencies. In general only creteways should be provided on major embankments from flood sector. If for some special reasons proper road surface is to be provided on top of embankments, the cost thereof should not be borne by the flood sector.

(v) LAND ACQUISITION

To ensure uniformity in respect of land acquisition for flood protection embankments, it is suggested that the provision for land acquisition should include at least 1.5 metres additional width beyond the toe of the embankments on the river side and width of 3 metres beyond the toe of embankment on the countryside.

(7) BORROW AREAS

Generally the borrow area will be on the river side of the embankment. However, in unavoidable circumstances, when the earth is to be borrowed from the countryside, the borrow pits shall not be closer than 10 m from the countryside toe of the embankment. In certain cases when the depth of the borrow pit is limited to 0.3 metres (1 foot) the borrow pit may be closer to the embankment but in no case the distance between the toe of the embankment and the edge of the borrow pit shall be less than 5 metres (16 ft.). In order to obviate development of flow parallel to the embankment 5 to 6 metres wide cross bars spaced at 50 to 60 metres center to center shall be left in the borrow pits.