**FLOOD CONTROL WORK**

In the benefited area river embankments exists on both sides of river branches but with escapes at the head of the doabs. The river embankments are of two types 1. Capital embankments 2. Other agricultural embankments.

Besides rivers there are some drains which helps in the discharge of doab water. Sometimes flood water also enters the drains through these escapes. In addition to these embankments, there are other types of embankments namely 3. The saline embankment and 4. The test relief embankments.

The saline embankment are put to prevent saline wave’s action to in gross inland. The test relief embankments are sometimes constructed to protect local areas against low and medium floods. The land of doabs is intersected by numerous small streams and creeks. In the doabs interior flow into large streams which meanders through the doab interior to the sea and provide the primary natural drainage for the doabs. Some of them however discharge to major river branches or to Chilika Lake.

Though Hirakud has a big storage reservoir. It is unable to control flood when the flood is big and the small reservoirs built in tributaries in Mahanadi have no flood reserve capacity. The Naraj barrage constructed at the off take of Kathajuri will protect the delta area in monsoon against the flood arising from 6 lakh cusecs to 10 lakh cusecs at Naraj (undivided Mahanadi) .This gated barrage will also divert a discharge less than 17,370 cumecs to Mahanadi and Birupa arm which is the design discharge for Mahanadi and Birupa barrage and this Naraj barrage provides irrigation in delta stage I command area. .In the case undivided flood in Mahanadi becomes more than the safe limit all the three barrages (Naraj, Mahanadi, Birupa) will be fully opened and the normal distribution shall pass in the respective rivers .If the flood exceeds the safe limits, then there is possibilities of breaches causing severe damage .In that case the damage will be distributed in both stage I and stage II area as per its natural distribution so that damages are not concentrated on any area by man -made control.

“There is a proposal of constructing Manibhadra project in the Mahanadi , which when done, shall control the flood at delta head to 9 lakh cusecs .So in addition to Naraj barrage if Manibhadra project is done , shall control all flood .”

**1. EMBANKMENTS**

In the command area of Mahanadi delta, river embankments3 exist on both sides of rivers to protect the irrigated land from river floods. The existing embankments are of five types **1**. Capital embankments (1038.10kms), **2**. Other agricultural embankments (403.19 km), **3**. Saline embankments (261.01 km), **4**. Test relief embankments (48.73kms) **5**. Protective gharry bundh or Rising bundh .

The first two are the river embankments and are continuous on both sides. These embankments have been raised from time to time. At present these are able to withstand a flood up to 26,900 cumecs and a flashy flood of 28300 cumecs at Naraj. Top levels of embankments at present are fixed with free board of 1.2m. The carrying capacity of the rivers with these embankments are only of a flood of 5 year return period but at some reaches these embankments are not continuous throughout with some low level escapes.

Saline embankments have been constructed in the Chilika lake area and in downstream of Mahanadi delta nearer to sea to prevent saline waves and tidal action to ingress into land excepting the cases when surge height is exceptionally high during cyclonic storms. The test relief embankments have been constructed by revenue authorities sometimes past, which can only protect the local area against low floods. The last varieties are small embankments constructed around the villages to protect them from flooding. In delta irrigation project report (1957) there was no proposal to construct gharry bundhs in various islands but later it has been constructed at different islands.

**2. RIVER TRAINING WORKS**

The rivers are flowing through alluvial deposits. Therefore erosion to banks are usual and is more acute at d/s reaches. In delta area very thickly populated villages have grown by the sides of rivers, in many villages flood plains have been encroached upon by villagers. During high floods breaches or scouring of embankments occur.

River training works are mainly spurs, revetments and launching aprons which are extensive and scattering in nature, have undergone improvement from time to time. These have been done throughout the year in order to maintain for the better discharge, as and when required depending upon the funds available. Sand screen has been executed in some low level escape channels to arrest the sand out of the flood water entering into irrigated land. Generally 0.3m toe wall has been provided in the reaches of embankments to protect it from seepage and wave scour of rivers.

***ESCAPES*** –

Escapes are provided for diverting excess flood water from Main River and these excess water are disposed of finally to sea, or to rivers in d/s reaches or to lakes. At the same branch rivers these escapes have no continuous embankments on both sides and create inundation.

***DRAINAGE CHANNELS*** –

The rainfall and floodwater are carried through the drainage channels and disposal is made either to sea, lake or to major rivers. The carrying capacity of these has been deteriorated due to silting up. The mouth of channels are silted up and shifted too much northward due to littoral drift. The existing drainage channels inside the doabs have aggraded, silted up, cross bunded, full of weeds and sometimes considerably encroached upon. Therefore, their carrying capacity is deteriorated to a great extent. Very inadequate provision of waterways in the construction of bridges and other cross-drainage structures has resulted in unexpected afflux. Non-availability of field drains and link drains aggravate the situation by prolonging the retention of water in the fields. The sediments carried in the drains get deposited in the channel and reduce the section of flow, raising the bed levels due to inadequate slope. The slope of some outfall channels ranges from 0.007% to 0.03%, which induce a velocity of 0.2m/s.

***RESERVORS*** –

Hirakud reservoir is constructed just at the entry of river Mahanadi into the Orissa region. Had there been no Hirakud dam in Mahanadi the flood problems would have been more acute. Besides Hirakud reservoir, there are other small reservoirs in the tributaries of Mahanadi. But its moderation of flood in later part of monsoon is poor and free catchments below Hirakud may produce high floods.

***NARAJ BARRAGE*** –

The Gated Naraj barrage constructed at the off take of Kathajuri protects the area in monsoon against the flood arising between 17000 to 28300 cumecs. This barrage also diverts a discharge up to 17,370 cumecs to Mahanadi and Birupa, which is their design discharge and they provide irrigation to the command area. In case undivided flood in Mahanadi becomes more than the safe limit all the gates of the barrages (Naraj, Mahanadi, Birupa) are fully opened and the normal discharge shall pass in the respective rivers. If the flood exceeds the safe limits, then there is possibilities of breaches causing severe damage.

**SPECIAL WORK OF FLOOD CONTROL**

1. CUTTACK CITY PROTECTION WORK –

Cuttack is the most important city in Orissa, which lies at the head of the Mahanadi delta. The city is protected by reverted ring embankments in river Mahanadi and Kathajuri up to flood of 42470 cumecs with free board of 1.9m to take care of high floods.

2. CLEARANCE OF RIVER MOUTH –

A strong littoral drift carrying nearly one million cubic meters of sediments pass along the eastern coast of India in the Bay of Bengal from south to north every year. Under its influence the sediments carried by rivers are deposited in northern side there by lengthening the river course. This formation of spit in the mouth of river Devi, Mahanadi, Kushabhadra reduces discharge capacity of floodwater into sea and consequently the rivers remain full. It has been attempted many a times in the past to clear the mouth of river Devi, Mahanadi, and Kushabhadra.

3. Cut to sea from Daya and Bhargavi mouth (Diversion) –

Rivers of Mahanadi delta meanders for a considerable distances at d/s reaches due to poor outfall conditions at mouth there by increasing the length of the river. The discharge rate becomes less and slow and causes afflux at u/s reaches and inundates vast cultivated areas. To avoid this and quicken discharge, straightening of meanders has been attempted. The river Daya at its off takes from Bhargavi travels for 67.3 kms again and merges with Daya and falls into Chilika lake.

Due to poor drainage parameters it creates serious drainage problems. Therefore, a pilot cut from left bank of Bhargavi has been proposed to reduce the length by 45 km called Gobkund cut3. It is proposed to divert the balance water of river Bhargavi after Gobkund cut through river Dhaudia called Mangala cut.

**A PRAGMATIC APPROACH**

***EMBANKMENTS-***

The existing embankments are not adequate to the higher floods. Allocation of adequate funds is vital for raising and strengthening the embankments. Raising and strengthening of embankments up to 35000cumecs (5 year flood) may be provided with the following specification in phases.

Crest width = 7.5m in place of 4.5m

River side slope = 3:1

Country side slope = 2:1 with 8:1 berm and 0.6m H.G.cover

H.G. = 8:1 and free board = 1.5m.

The above specification should be adopted taking the following parameters:-

**1**. To keep the seepage gradient inside body of embankments with minimum cover 0.6m

**2**. The alluvial soil recommends seepage gradients from 1:6 to 1:8

**3**. Sufficient crest width to make it road cum embankments on socio-economic consideration

New embankments are advocated on consideration of socio-economic and technical aspect of locality but priority must be given for the rehabilitation of damaged/dilapidated embankments with impervious blankets on upstream slopes.

***BANK PROTECTION –***

For bank protection under short term measure, scour depth on dominant discharge of channel is most important factor for adopting the following specification5 of continuous revetments and apron for river bank stabilization

**1**. Bank slope (earth cutting) 1:2

**2**. Bank revetments = two man size stone material over metal filter (1.25 cm to 1.85 cm broken stone material)

**3**. Toe wall of 0.3m may be provided to protect from seepage and wave scours of rivers in embankments.

**4**. Launching apron in cages of wire-nets.

Execution of high level and low level spurs, launching aprons, stone revetments and construction of new embankments are suggested to prevent further scours of high amounts.

***TREATMENT TO WEAK POINTS-***

The embankments are considered weak points where no adequate free board, no minimum H. G. line for the berm of the embankments and Lacey’s width is available. Even after raising and strengthening the embankments and providing necessary river training works there are 60 nos. of reaches out of 210 reaches remains as weak points. Weak points may be due to 1. Previous breach section, 2. Non availability of side berms, 3. Higher wave length, 4. Greater wave heights due to abrupt reduction of river section. The treatment of weak points will be done by

**1**. Providing dowel banks.

**2**. Revetments.

**3**. Widening the crest.

***DRAINAGE DEVELOPMENT (CHANNEL IMPROVEMENT):***

Out fall drain, secondary drains link drains, collection drains and field drains, are to be excavated to its full design section with a requisite slope and carrying capacity. No filling up of portion should be done as it may be maintained naturally by silting up. Additional vantage will be provided for the road bridges, which decreases the sufficient waterways. I n d/s and at tidal reaches marginal embankments along the drains are required.

One side of embankments of the outfall drains may be provided with necessary widths and surfacing so as to serve as service path. At the junction of link drains with secondary drains hume pipes or masonary control structures are to be provided to control the ingress of drainage water from secondary drains into link drains.

At the junction of secondary drains and out fall drains gated sluices are to be provided on secondary drains to control the water levels in secondary drains. The possibility of non discharge of drain water may occur due to tidal fluctuation of levels therefore control structures6 for preventing ingress of tidal water into channels at a suitable points of drains may be provided. This will obstruct the tidal entry into land and will accelerate discharges of drains as there will be no saltwater wedge requiring removal before the drainage water is released. This will also help in preventing saline ingress in to channels.

***TIDAL STRUCTURES*** –

Tidal control structures at the outfall points of all drains may be provided to prevent tidal ingress and spread of salinity. Tidal structures with marginal embankments constructed above high tide levels will prevent saline water at u/s and reduce saline inundation and hence reduce salinity of soils for better cultivation. These structures will check the receding flow of tides with much lesser distances. Cyclonic storms at Bay of Bengal are very common. During each storm, tidal waves rise several meters and inundate the coastal land making unsuitable for cultivation.

***SOIL CONSERVATION MEASURES*** –

Contour bunds, terraces, vegetative cover (strip cropping), afforastation, land management and stream bank protection may be undertaken to control soil erosion where the out fall drains meet the river with in tidal reaches, sea or lakes. Surface vegetation increases infiltration capacity and reduces surface runoff. Vegetal cover removes moistures from soil by transpiration and it promotes loose organic soils, which is favorable for infiltration of rainfall .It act like a sort of retarding basin.

***DIVERSIONS-***

Any diversion cut proposed in the coastal area is to be approached with extreme caution. It is necessary to provide judicious river training works for these cuts to maintain the diversion channel for better flood discharge and to avoid retrogression .