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मध्यवर्ती संकल्पचित्र संघटना
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दिंडोरी मार्ग, नाशिक - ४२२ ००४.
फोन नं. (०२५३) २५३०७०८.
फॅक्स : (०२५३) २५३०७०८.
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जा.क्र.मसंसं/दध-२/पूरसंरक्षक भिंत/५५८/२०२४ दिनांक: २२/११/२०२४

प्रति,

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मा. मुख्य अभियंता, गोसीखुर्द प्रकल्प, जलसंपदा विभाग, नागपूर.

विषय : पूरसंरक्षक भिंतीच्या संकल्पनाचे Standardization of Design Note on Flood Protection Wall तयार करणे बाबत.

संदर्भ: १) महाराष्ट्र शासन, जलसंपदा विभाग शासन निर्णय क्रमांक : मसंसं १०१४/ (प्र.क्र.३४/१४) मोप्र-१, मंत्रालय, मुंबई, दि.१६/०१/२०१५.
२) महाराष्ट्र शासन, जलसंपदा विभाग शासन निर्णय क्रमांक : पूसंभि-२०१९/ (प्र.क्र.११५/२०१९)/ सिं.व्य.(म.), मंत्रालय, मुंबई, दि.३१/०८/२०१९.
३) मा. महासंचालक, संकल्पन, प्रशिक्षण, जलविज्ञान संशोधन व सुरक्षितता, महाराष्ट्र अभियांत्रिकी संशोधन संस्था, नाशिक यांची दि.१८/०९/२०२४ रोजीची मंजूर टिप्पणी.

संदर्भीय विषयान्वये संकल्पचित्र संघटनेकडे सोपविण्यात आलेल्या प्रकल्पाचे संकल्पन व संकल्पनचित्रे तयार करण्याचे मार्गदर्शक तत्वे संदर्भ क्र.१ अन्वये देण्यात आलेले आहे. तसेच संदर्भ क्र. २ च्या शासन निर्णयाद्वारे पूरसंरक्षक योजनेच्या कामामध्ये प्रशासकीय मान्याता देण्याबाबत सुधारित धोरण नमूद करण्यात आले आहे. या शासन निर्णयातील मुद्दा क्र.६ अन्वये क्षेत्रीय स्तरावरून पूरसंरक्षक भिंतीचे प्रस्ताव या कार्यालयाकडे पाठविण्यात येतात. या कामाची व्याप्ती जास्त असल्याने तसेच मध्यवर्ती संकल्पचित्र संघटनेमध्ये नियमित पणे चालू असलेल्या संकल्पन व संकल्पचित्र कामांची

संख्या जास्त असल्याने व तुलनेत मनुष्यवळ कमी संख्येने असल्याने पूरसंरक्षक भिंतीच्या संकल्पनाच्या कामाला विलंब होण्याची शक्यता गृहीत धरून या संकल्पनासाठी प्रमाणित संकल्पन व रेखाचित्रे (Standard Design Note with drawings of different alternative) तयार करण्यात आले.

सदर प्रमाणित संकल्पनास संदर्भ क्र.३ अन्वये मा. महासंचालक, संकल्पन, प्रशिक्षण, जलविज्ञान संशोधन व सुरक्षितता, महाराष्ट्र अभियांत्रिकी संशोधन संस्था, नाशिक यांची मान्याता प्राप्त झालेली आहे. सदर प्रमाणित संकल्पनात खालील प्रमाणे विविध पर्यायांचे संकल्पन व रेखाचित्रे उधृत करण्यात आलेले आहे.

1) Flood protection wall on Hard Strata
2) Flood protection Wall on Soft Strata
    a. Resting on Raft
    b. Resting on Two piles
    c. Resting on Group of Piles
3) Cantilever Retaining Wall
4) Cantilever Retaining Wall with Heel Only
5) Cantilever Retaining Wall without Heel
6) Counterfort Retaining Wall
7) Gravity Wall with Slopes on Both Sides
8) Reinforced Cement Concrete Wall

क्षेत्रीय स्तरावरून पूरसंरक्षक भिंतीचे संकल्पन करताना शासनाच्या सर्व मार्गदर्शक सूचनांची अंबलबजावणी करणे, अचूक क्षेत्रीय माहिती सक्षम स्तरावरून प्रमाणित करणे, पुराचे परिमाण व लाल किंवा निळया रेषांच्या आरेखनास मुख्य अभियंता यांची मान्यता असणे, IS Codes चे तंतोतंत अनुपालन करणे या महत्वाच्या मुलभूत बाबी तांत्रिक मान्याता देताना सक्षम प्राधिकरणाने प्रमाणित करणे आवश्यक राहील.

सदर मान्यता प्राप्त पूरसंरक्षक भिंतीचे संकल्पन व रेखाचित्रे ५ प्रतीत आपल्या कार्यालयास माहिती व पुढील कार्यवाहीस पाठविण्यात येत असून पूरसंरक्षक भिंतीचे संकल्पन वरील प्रमाणित संकल्पनानुसार क्षेत्रीय स्तरावरून करावे व पुढील अनुषंगिक कार्यवाही करण्यात यावी.

हे आपल्या माहितीसाठी व पुढील कार्यवाहीसाठी सविनय सादर.

सोबत:- ५ प्रतीत

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प्रत:- १) मा.सचिव, (ला.क्षे.वि. व जलसंपदा), जलसंपदा विभाग, मंत्रालय, मुंबई यांना माहितीसाठी सविनय सादर.
२) मा. महासंचालक, संकल्पन प्रशिक्षण जलविज्ञान संशोधन सुरक्षितता, नाशिक यांना माहितीसाठी सविनय सादर.
३) मा. मुख्य अभियंता, मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांना माहितीसाठी सविनय सादर.

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GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT

STANDARD DESIGN NOTE ON
FLOOD PROTECTION WALL

DAM CIRCLE
CENTRAL DESIGN ORGANISATION
NASHIK

प्रस्तावना

प्राचीन काळापासून मानवी संस्कृती ही नदी काठी विकसित झालेली आहे. मानवाच्या प्रगतीत नद्यांचे स्थान सर्वोच्च आहे. जगभरातील सर्व प्रमुख महानगरे व शहरे हे नदीकाठी वसलेली आहेत.

सध्याच्या काळात नदीच्या नैसर्गिक प्रवाहामध्ये मानवी हस्तक्षेप झाले आहे. तसेच जागतीक तापमान वाढ, कार्बन उत्सर्जन, जंगलतोड यामुळे कमी वेळेत मोठे पर्जन्यमान होत असते. त्यामुळे व-याच वेळेस मोठ्या नद्या त्यांचे पात्र सोडून मानवी वस्तीत पाणी येते व भुस्खलन देखील होते. त्यामुळे जीवितहानी व आर्थिक हानी कमीत कमी होणे यावाबत उपाय योजना करणे आवश्यक ठरते.

महाराष्ट्र शासन, जलसंपदा विभाग शासन निर्णय क्र.पूसभिं-२०१९/(प्र.क्र. ११५/२०१९)/ सिं.व्य. (म.) मंत्रालय, मुंबई दिनांक ३१/०८/२०१९ मध्ये पूरसरंक्षक योजनेच्या कामांना प्रशासकीय मान्यतेबावत खालीलप्रमाणे निर्देशित केले आहे-

प्रशासकीय मान्यता:- जलसंपदा विभागाचा शासन निर्णय क्र. संकिर्ण २०१६/(२७/१६)/ ल.पा. २, दि. २६.०५.२०१७ अन्वये सिंचन प्रकल्पांच्या विशेष दुरुस्ती कामांना व विस्तार व सुधारणा अंतर्गत कामांना नियोजन विभागाच्या सहमतीने प्रशासकीय मान्यता देण्याचे अधिकार जलसंपदा विभागास देण्यात आले आहेत. त्याच धर्तीवर पूर संरक्षक कामांच्या रुपये ५.०० कोटी पर्यंतच्या कामांना जलसंपदा विभाग प्रशासकीय मान्यता प्रदान करेल. रु.५.०० कोटी पेक्षा जास्त किंमतीच्या अंदाजपत्रकांना नियोजन व वित्त विभागाची सहमती अनिवार्य असेल.

या शासन निर्णयातील मुद्दा क्र.६ अन्वये क्षेत्रीय स्तरावरून Flood protection wall चे प्रस्ताव मध्यवर्ती संकल्पचित्र संघटना यांच्याकडे पाठविण्यात येतात त्याबाबत निर्दशनास येते कि काही प्रस्तावित भिंतींची उंची ५ मी इतकी असली तरी लांबी जास्त असल्याने पूरसंरक्षक कामाच्या अंदाजपत्रकीय किंमत रु ५.०० कोटी पेक्षा जास्ती येत असल्याने संकल्पनाची कामे मध्यवर्ती संकल्पचित्र संघटनेकडून करुन घणेबावत नमुद असल्याने मोठ्या प्रमाणात पूरसंरक्षक कामांचे संकल्पनाचे प्रस्ताव मध्यवर्ती संकल्पचित्र संघटना कडे प्राप्त होत असतात. मध्यवर्ती संकल्पचित्र संघटनेमध्ये असलेल्या कामाची व्याप्ती व इतर संकल्पनविषयक कामांची संख्या जास्त असल्याने व तसेच कमी संख्येने असलेले मनुष्यवळामुळे उपरोक्त अंदाजपत्रकीय निकषानुसार पूर संरक्षक कामांचे संकल्पनाचे प्रस्ताव मोठ्या प्रमाणात प्राप्त होत असल्याने वेळेत संकल्पन देण्यास विलंब होण्याची शक्यता नाकारता येत नाही. त्यामुळे सदर पूरसरंक्षक भिंतीच्या संकल्पनाचे Standardization of Design Note of Flood Protection Wall तयार करण्यात आलेले आहेत.

सदर Standardization of Design Note of Flood Protection Wall मधील देण्यात आलेल्या पूर सरंक्षक पर्यायामधून क्षेत्रिय परिस्थितीशी सुसंगत व आर्थिक दृष्ट्या किफायतशीर होणा-या पर्यायास क्षेत्रिय मुख्य अभियंता यांची मान्यता घेवून पुढील आवश्यक कार्यवाही करण्यात यावी.

DESIGN NOTE ON
FLOOD PROTECTION WALL

1.0 INTRODUCTION

Floods are recurrent phenomena in India and also in Maharashtra from time immemorial. Almost every year floods of varying magnitude affect some parts of the Maharashtra or the other. Different Districts of the States have different climates and rainfall patterns and as such it is also experienced that while some parts are suffering under devastating floods, another part is suffering under drought.

With the increase in population and developmental activities, there has been a tendency to occupy the floodplains, which has often resulted in serious flood damages and loss of lives over the years. Because of the varying rainfall distribution, many a times, some areas, which are not traditionally prone to floods, also experience severe inundation.

Different measures have been adopted to reduce the flood/erosion losses and protect the flood plains. Depending upon manner in which they work, flood protection and flood management measures may be adopted.

2.0 FLOOD MANAGEMENT WORKS

The frequency and intensity of floods have grown in India and also in Maharashtra over the years primarily because of the increased encroachment in flood plains and climate change.

These trends demand better preparedness at local levels to make sure that appropriate and effective response measures are taken during flood emergency to minimize the loss of life and property. Several measures aiming to reduce the risk of flooding by managing land, rivers, coastal systems and flood defences.

While we do everything to reduce the chance of flooding, one should always be cautious that it is a natural process and can never be completely eliminated.

Flood management activities can be broadly classified into four major groups:

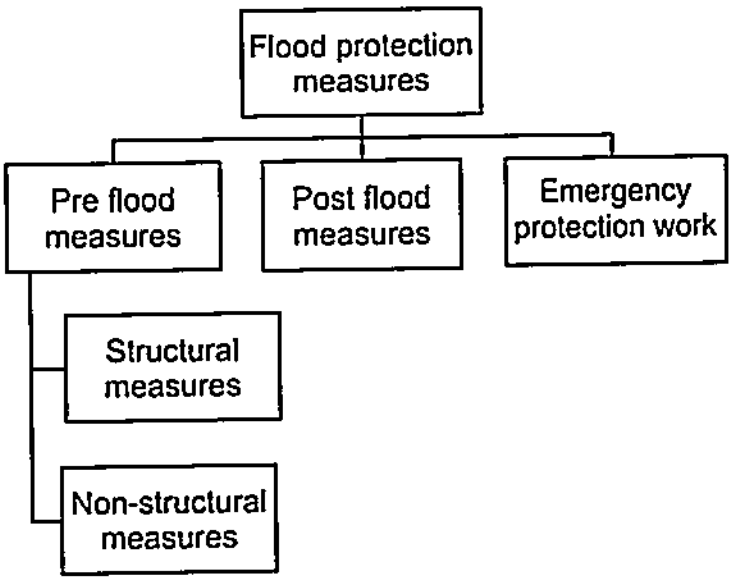
I. Attempts to modify the flood

II. Attempts to modify the susceptibility to flood damage

III. Attempts to modify the loss burden

IV. Bearing the loss

The flood protection systems can be briefly classified as below: -



Broadly, all measures taken up under the activity of "Modifying the flood" which are in the nature of physical measures are "Structural measures", while the others which are taken up as management tools without major construction activity are grouped as "Non-structural measures".

It is also important to consider the pre flood measures, aiming at reducing flood risks in the long term.

It could be a single measure or a combined measure which needs to be selected based on its suitability.

a. Flood conveyance structures designed to route flood waters away from areas of flooding risk via natural or artificial channels.

b. Flood storage structures that reduce the peak flood flows- Dams, reservoirs, check dams etc.

c. Flood defence and mitigation structures- levees, flood embankments, gryones, spurs, check dams etc.

d. Urban drainage system that increase infiltration

e. Ecosystem management includes utilizing wet lands, creating environmental buffers

2.1 The Non-structural methods: -

The Non-structural methods to mitigate the flood damages are as under:

- Flood Plain Zoning;
- Flood Forecasting and Flood Warning;
- Flood Proofing; and
- Living with Floods.

2.2 Structural measures: -

The general approach to tackle the problem of floods in the past has been in the form of physical measures with a view to prevent the flood waters from reaching potential damage centres. This approach had been extensively adopted in the Godavari, Krishna and Cauvery Deltas in South India and also in some areas of Indo-Gagnetic plain.

The main thrust of the flood protection programme undertaken in India so far has been in the nature of taking structural measures like:

A. Embankments, flood walls and sea walls

B. Dams and reservoirs

C. Natural detention basin

D. Channel improvement

E. Drainage improvement

F. Diversion of flood waters

The details of this note deals with the above mentioned topic 'A' Embankment, Flood walls etc. each is described in brief as follows: -

1) Embankments/Levees/Dykes

A levee is a natural or artificial embankment or dike (Figs. 1, 2 & 3), usually earthen, extending parallel to the river channel aligned on high ridge of natural banks of river. Embankments or bunds are type of embankment built behind the existing flood embankment as second line of defence or replacement of damaged bund/ embankment. These can also be built to contain river spill generated by rising of water level at barrage or bridge. Planning, design, construction and maintenance details shall be made according to IS 12094: 2000(Guidelines for planning and design of river embankments (levees), IS 11532:1995(Re affirmed 2001) Construction and maintenance of River Embankments (Levees)- Guidelines.

The core of the structures may be made of earth material, boulders or IRC:SP:113-2018 using geosystems like geotextile tubes, geotextile bags, and geocomposite bags. Existing embankments made of soil or earthen material can be reinforced in many ways to prevent them from breaching. One popular method is to strengthen the inner slope and crest with bio engineering measures using biodegradable and geo-synthetic mats, geo-synthetic wire mesh or an open concrete-block system.

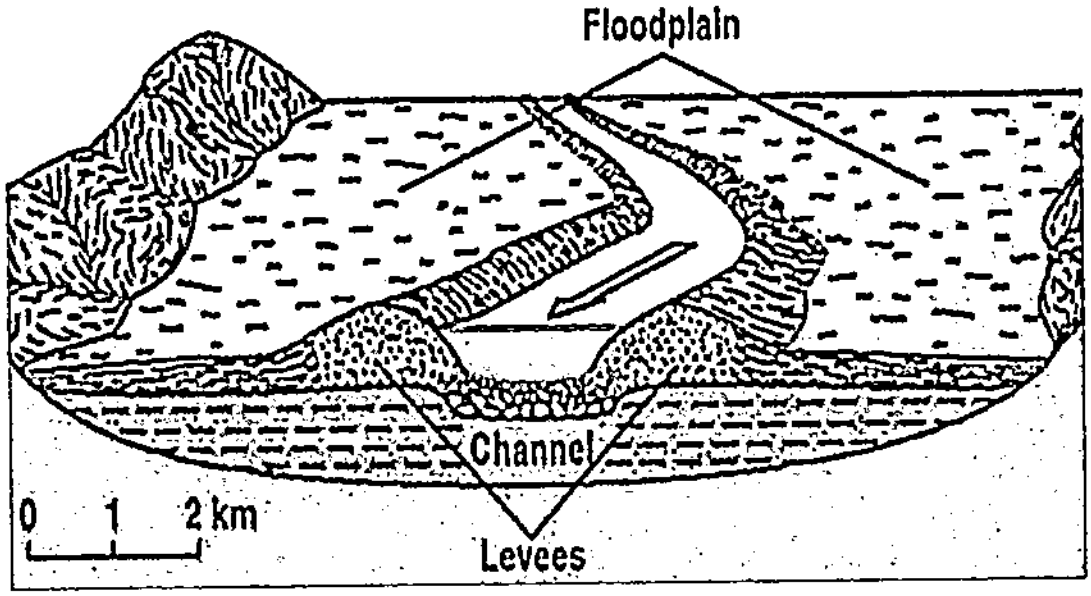
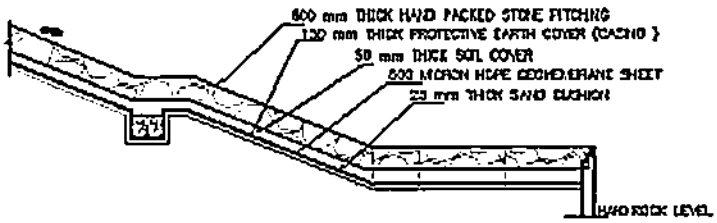
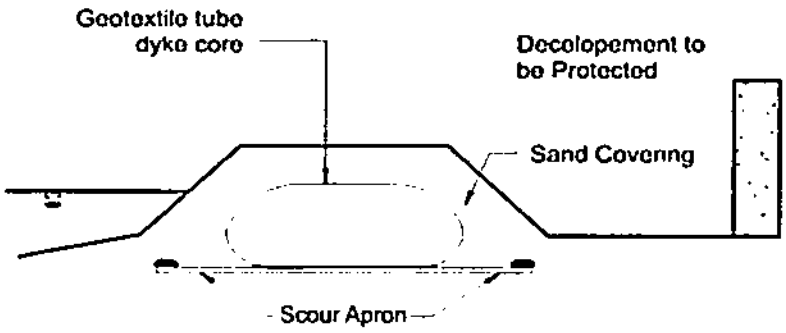


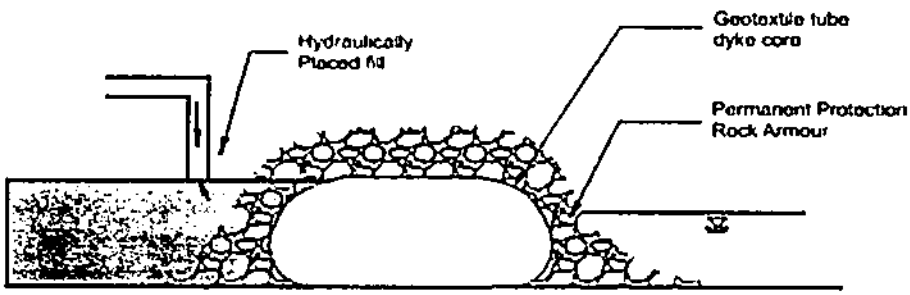
Figure 1 Embankments/ Levees/ Dikes



PITCHING DETAILS



(a)



(b)

Figure 2 a. Protection Dykes b. Containment using Geotextile Tubes.

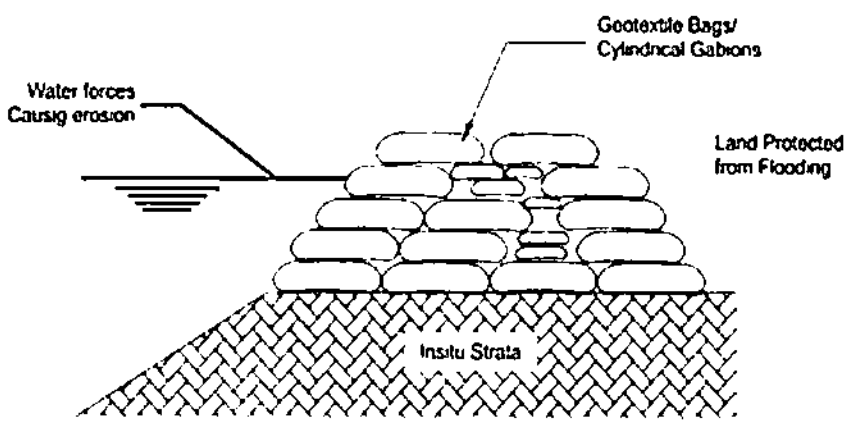


Figure 3 Protection Dyke using Geotextile Bags/

Cylindrical Gabions Lines with Geotextile

2) GUIDE BUNDS (IS 10751-1994)

Rivers in flood plains submerge very large areas during flood periods. Naturally when some structures (for example, bridge, weir, etc.) are to be constructed across a river, it is very expensive to construct the work spanning whole width of the river and it is necessary to restrict its course to remain flowing centrally through the barrage, weir or a bridge placed across that river. Some training works such as guide bunds (Fig.4) may be constructed to confine the flow of water within a waterway for economical purposes. There shall be no spurs projecting from the guide bund as the spurs produce swirls. The guide banks guide the river flow past a bridge or any other hydraulic structure without causing damage to the work and its approaches. They extend both upstream and downstream of the abutments of the hydraulic structure. The guide banks may be provided on either side of the hydraulic structure or on one side as required. For details on planning and design of guide bunds IS 10751 (Re affirmed 2001) "Indian Standard PLANNING AND DESIGN OF GUIDEBANKS FOR ALLUVIAL RIVERS-GUIDELINES" shall be referred.

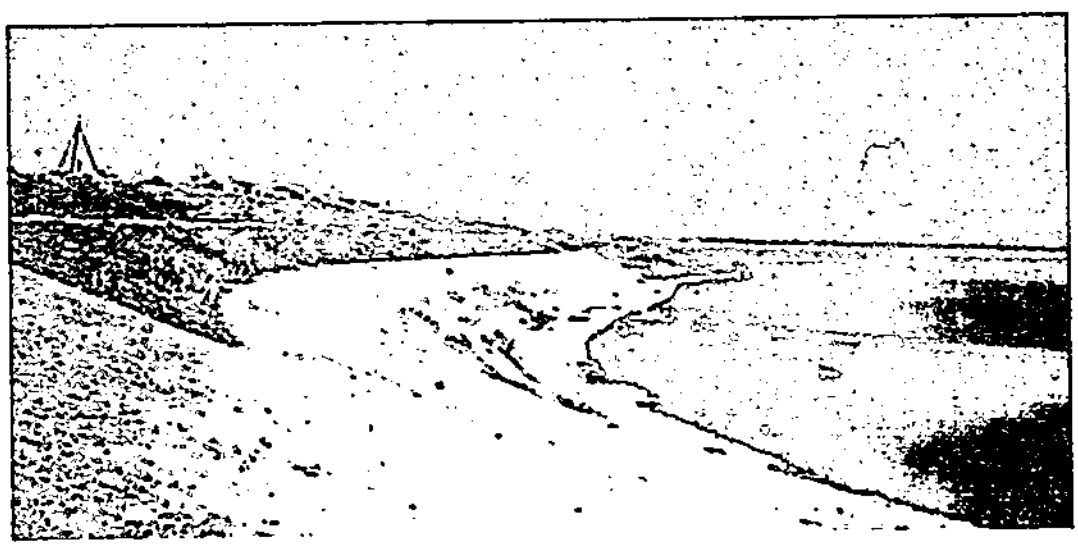


Figure 4 River Training Works- Guide Bund

3) TRANSVERSE STRUCTURES – GROYNES/SPURS

Groyne is a rigid hydraulic structure built from an ocean shore or from a bank (rivers) that interrupts water flow and limits the movement of sediment (Figs. 5& 6). Groynes are constructed transverse to the direction of river flow extending from the bank into the river. This form of river training works perform one or more functions such as training the river along the desired course to

reduce the concentration of flow at the point of attack, creating a slack flow for silting up the area in the vicinity and protecting the bank by keeping the flow away from it. It is most common method of countering lateral erosion on outer bank, extending into the streams, which are keyed into or supported by the bank preventing or minimizing erosion

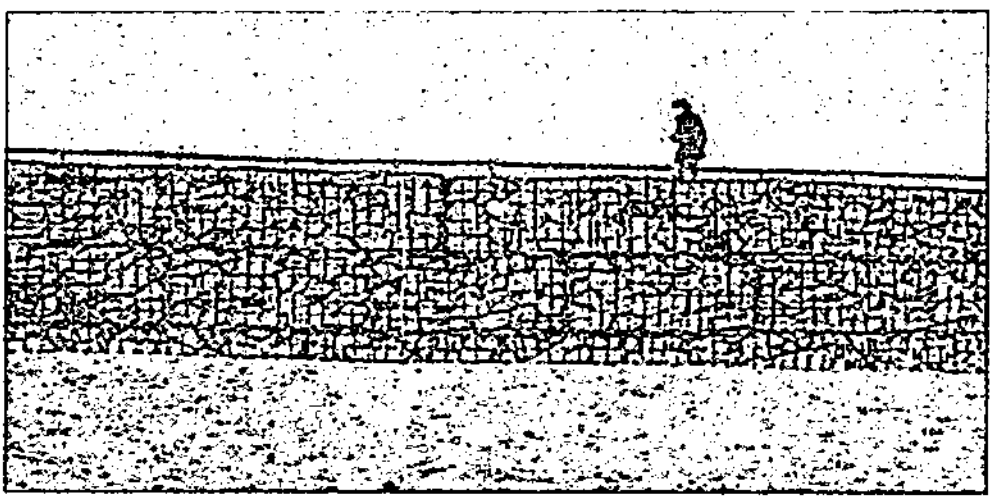


Figure 5 Photo Showing Groyanes made of Gabions

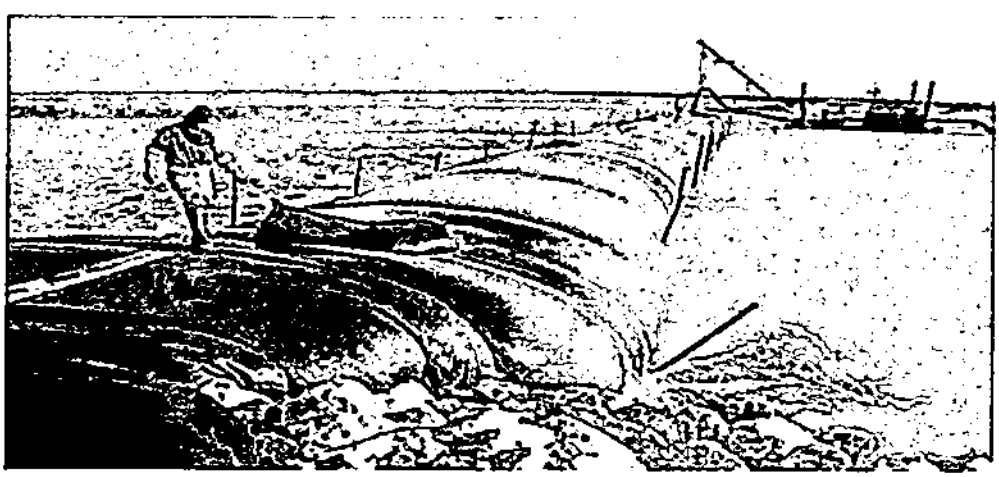


Figure 6 Groynes made of single Geotextile Tube

Thus above mentioned measures are to be commonly adopted for flood protection.

NEED OF FLOOD PROTECTION WALL :-

However wherever there are extreme possibility of loss of precious human lives, cattle and damage to public and private property which may create a sense of insecurity and fear in the minds of people living in the flood plains, ***the option of Flood protection wall can form a choice.***

Ancient civilisation was settled along banks of river. River banks were first choice for civilisation as they provided uninterrupted supply of drinking water and made land fertile for growing crops, fishing etc, so the small hamlets are developed into the major towns, River widths are narrowed in the city areas and banks of the river became much steeper (Almost vertical) in due course of time. As there is less space available for revetment in such cases a vertical retaining walls are required to be constructed.

In developed areas where adequate space is not available or land is very expensive, concrete or masonry floodwalls are constructed.

4) FLOOD PROTECTION WALL

A flood wall is a primarily vertical artificial barrier designed to temporarily contain the waters of a river or other waterway which may rise to unusual levels during seasonal or extreme weather events.

Flood walls are mainly used on locations where these is scarcity of available land such as cities or where building levees or (dykes) would interfere with other interests, such as existing roads, historical architecture or commercial use of embankments.

Flood protection walls can be built with rigid steel sheets (Fig. 7), masonry walls (Fig. 8), cement concrete or using gabions.

Gabions also have advantages over more rigid structures because they can conform to ground movement, dissipate energy from flowing water, and drain freely. Their strength and effectiveness increase with time as silt and vegetation fill the interstitial voids and reinforce the structure.

Flood walls often have floodgates which are large openings to provide passage except during periods of flooding, when they are closed.

Figure 7 Flood Protection Wall using Steel Sheets

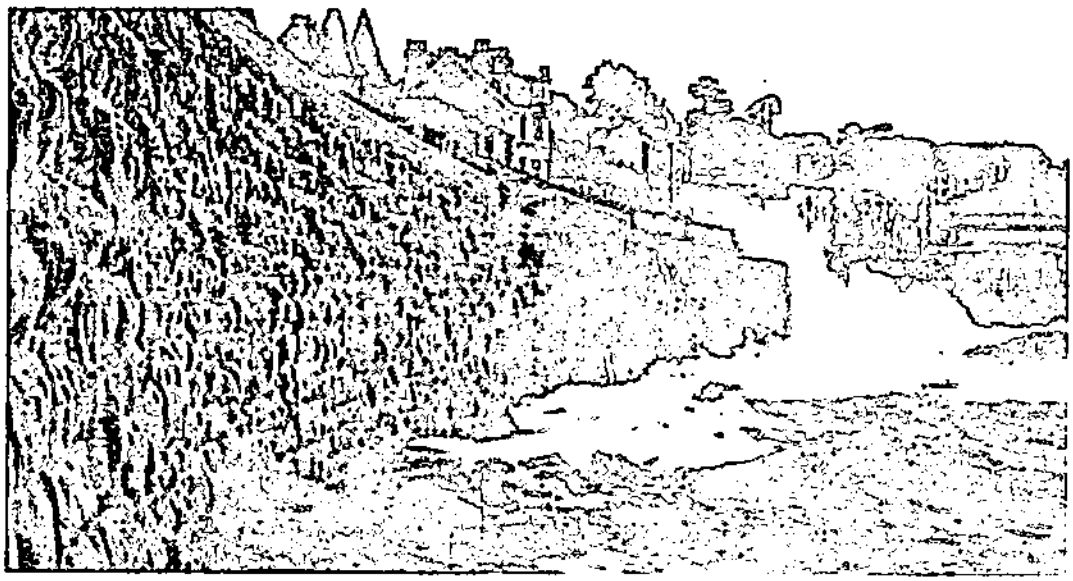


Figure 8 Flood Wall/ Barrier- Masonry Wall

5) SLOPE PROTECTION WORKS

Following types of Slope protection works options are available: -

1) With Soil Bank

Embankments are the oldest known forms of flood protection works and have been used extensively for this purpose. These serve to prevent inundation, when the stream spills over its natural section, and safeguard lands, villages and other property against damages. BIS code 12094: 200 "Guidelines for Planning and Design of River Embankments" stipulates the data required for planning of an embankment. BIS code 12094: 2000 is used for design of the embankment.

2) With Pitching

Banks may be protected by pitching using stone/boulders, concrete blocks, sand filled Geo bags/Geo-mattress. The bank pitching is provided along with the launching apron to prevent the scouring under the water and the consequent fall of pitching. IS code 14262:1995 (Reaffirmed 2001) is used for planning and design of revetment used for embankments and bank protection.

3) With Gabion Mattress Lining

A Gabion mat or basket is a structure made of zinc coated soft temper steel in a shape of hexagonal double twisted wire mesh filled with stones. A gabion mattress has a height between 0.17m to 0.50m. To stabilize the Gabion mattress on slope areas, a launching apron is commonly used. A launching apron has a similar shape as the gabion mattress that is made of a flexible double twisted mesh wire and filled with stones.

4) Geotextile---The geotextiles used in bank protection serve as a filter.

a) Geotextile Liner

b) Geotextile Bag lining

c) Grout Filled Mattresses etc.

The details are given as below:-

Option 1 :

Gabion Mattress Lining on Bed and Bank for River:

The erosion of river banks can be controlled by providing gabion mattress along the bank and bed (Fig. 9). This lining of banks prevents the surface erosion of banks and apron on the river bed prevents the failure of river banks due to scouring. Also, the section can be increased by cutting the bank on both sides and extending the banks to some extent.

In case of steep slopes there is a possibility for sliding of revetment material due to its dead weight : in such cases anchoring on the top of bank slope shall be provided

.However , provision of anchoring on the top is subject to careful installation as otherwise excavations may destabilize the bank slopes.

Gabion mattress shall be filled with stones or geotextiles bags depending on the availability of fill material, durability requirements etc. The details are given in figure below.

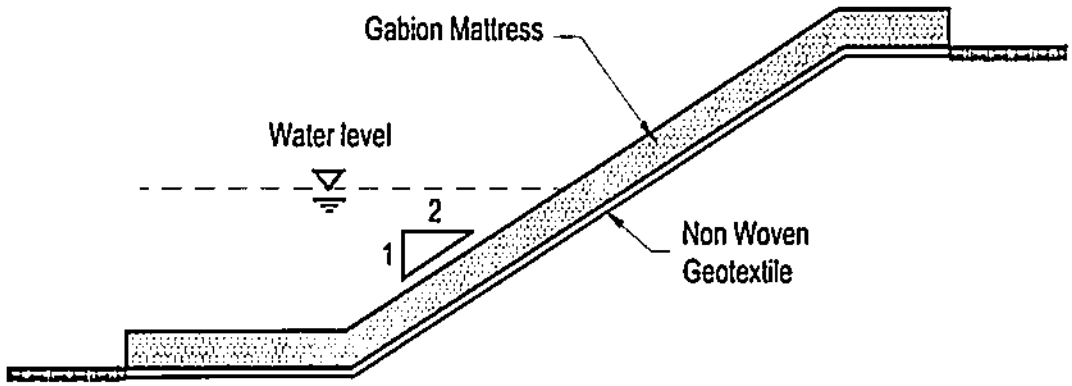


Figure 9 Bank Protection using Gabion Mattress

Option 2 –

Gabion Lining on Bank using Gabion Mattress and Scour Filling :

Gabion mattress and Gabion lining founded on dumped loose rock or stone filled sack gabions at the toe above poor bed material and to fill the existing scour holes (Fig. 10). Gabion mattress and cylindrical gabions shall be filled with stones or geotextile bags depending on the availability of fill material, durability requirements etc.

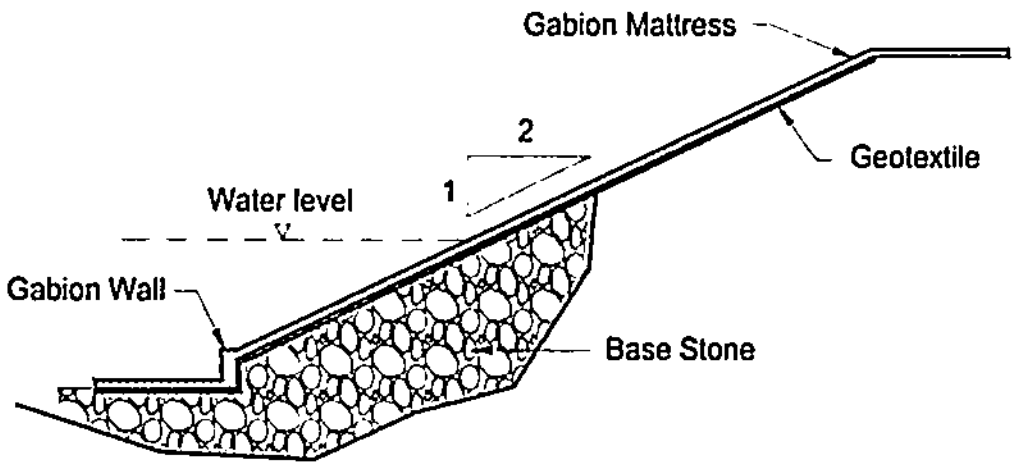


Figure 10 Bank Protection using Gabion Mattress and Gabion Wall

Option 3:

Geotextile Bag Lining for Bank Protection Geotextile bags are used for erosion control at river banks where scarcity of rock presents (Fig. 11). It is also used in highly contaminated water and shall be provided for significant flow velocity. However, suitable bag dimensions and geotextile material shall be selected based on the flow conditions.

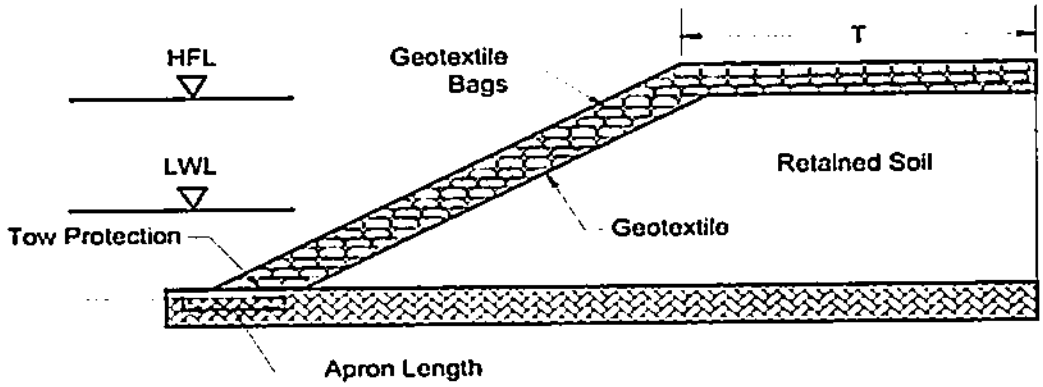


Figure 11 Bank Protection using Geotextile Bag/ Cylindrical Gabions

Option 4: Cylindrical Gabions:

The cylindrical Gabions are another alternative which can be used in case of emergency works, filling of scour holes and immediate dumping on river bank toes in order to control the damage. These cylindrical gabions can be either filled with stones or lined with Geotextile material and filled with sand. These are used for preparation of foundation base for the structures, which are not easily accessible and most of the times underwater. The containment system comes handy where the flow is turbulent and need to heavy mass blocks to sustain the impacts of flow. The geotextile lined sand filled containment units shall be used in places where availability of stone is scarce, where sand is available for filling. This system works as a composite system and helps in the areas where velocity of water is relatively high and Geotextile bags alone would not be able to withstand the shear stresses induced by the water on the system components.

5) Wooden Pile Fence

6) Concrete Lining.

2.3 Selection Of Gabion Wall :-

There are many types of slope protection work as shown in the Table,

The type of slope protection work at the site shall be selected based on the

a) Design velocity

b) Slope

c) Availability of construction materials near the site.

d) Ease of construction works and economy, etc.

When there are constraints due to the required boulder stones, during flood and the slope of the bank combination of the slope covering works shall be considered.

Table 1 Slope Protection Works

S. No.	Type of Protection Work	Design Velocity (m/s)	Slope (H:V)	Remarks
1	Sodded Riverbank with Pile Fence	<2.0	< 2 : 1	Not applicable for places near roads and houses. Diameter and length of wooden pile shall be determined considering past construction records. Diameter of fill boulder shall be determined
2	Dry Boulder Riprap	<3.0	< 2 :1	Diameter of boulder shall be determined. Height shall not exceed 3 meters.
3	Grouted Riprap (Spread Type)	<5.0	< 1.5 : 1	Use Class "A" boulders for grouted riprap and loose boulder apron.
4	Grouted Riprap (Wall Type)	<5.0	1.5 : 1 to 0.5 : 1	Use Class "A" boulders for grouted riprap and loose boulder apron.
5	Gabion (Spread Type)	<6.0	< 1.5 : 1	Advisable in case of high velocities where boulder riprap may fail. Economical where stones are costly.
6	Gabion(Pile-up type)	<6.0	1.5 : 1 to 0.5 : 1	Advisable in case of high velocities where boulder riprap may fail. Economical where stones are costly.
7	Reinforced Concrete	>6.0		Minimum thickness of 20 cm. Not feasible to construct underwater

The suitable type shall be included as per FHWA Guidelines.

3.0 FLOOD CONTROL DESIGN GUIDELINES AND STRUCTURAL METHODS:

3.1 Design of the Flood Embankment/Levees/Dikes/Road Embankments

Embankments near flood prone water bodies are special in the sense that, besides being safe against the various anticipated modes of failure, they must be strong enough to resist the attack of flood waters.

3.1.1 Design of New Embankments

When it comes to the planning, design and construction of new embankments, the options could be many in terms of the choice of materials, construction procedures and technology.

The design of new embankments for protection against floods must not only be safe against all possible modes of failure but its dike alignment should avoid unstable peat, muck, weak subsoil and loose sand foundation to prevent settlements, flow and liquefaction. The weak strata may need to be treated, if avoidance is not possible.

The design considerations include: -

a) selection of the Embankment height,

b) Design High Flood Level (HFL),

c) Free Board, Top width,

d) Slope and Berm designs and

e) Analysis of stability

a) Height shall be based on design flood level plus the required free board. Freeboard is defined as the margin from design flood level up to the elevation of the dike crest. It is the margin of the height which does not allow overflow. According to the aforesaid guidelines, the freeboard shall be based on the design flood discharge **(It varies between 0.6m and 2.0 m)** which shall not be less than the value given in Table 2 below.

Table 2 Minimum Required Free Board

Design flood discharge Q (cum/sec)	Freeboard (m)
Less than 200	0.6
200 and up to 500	0.8
500 and up to 2,000	1.0
2,000 and up to 5,000	1.2
5,000 and up to 10,000	1.5
10,000 and over	2.0

b) When the land-side ground level is higher than the design flood level, the crest width shall be 3 m or more regardless of the design flood discharge. Crest width shall be designed for multi-purpose use, such as for patrolling during floods and in the execution of emergency flood prevention works, Table 3.0.

Table 3 Minimum Crest Width of Dyke

Design flood discharge Q(cum/sec)	Crest Width (m)
Less than 500	3.0
500 and up to 2,000	4.0
2,000 and up to 5,000	5.0
5,000 and up to 10,000	6.0
10,000 and over	7.0

c) The approximate line of seepage (phreatic surface) in the cross-section of the proposed embankment should be known. It mainly depends upon the soils which are to be used in construction of the embankment.

Table 4 Hydraulic Gradient for Different Fill Materials

Type of Fill	Hydraulic Gradient
Clayey Soil	1 in 4
Clayey Sand	1 in 5
Sandy Soil	1 in 6

d) Slope design, whether on the river side or the country side is an important and complex matter because on it depends the embankment stability. Side slope design presupposes the knowledge of elements such as

(a) Nature of the material of which the embankment is constructed

(b) Method of construction

(c) Height of embankment and

(d) Duration, to which the embankment is exposed to the wave actions. The river side slope should be flatter than the, angle of repose of the material used in the fill as suggested in Table 5. This is to be further validated by stability analysis.

Table 5 Height of Embankment

Height of the Embankment	Recommended River Side Slope
Upto 4.5 m	1 in 2
>4.5 m	1 in 3

Mattress Geotextile Bags, Concrete Pitching using concrete blocks, Geotextile Mattress filled with sand.

The general Guidelines, for the country side slope are as given in Table 6:-

Table 6 River side slope

Height of the Embankment	Recommended River Side Slope
Upto 4.5 m	1 in 2 with berm of suitable width
> 4.5 m	1 in 3 with berm of 1.5 m width

[NOTE: -**The above guidelines are as per The Department of Public Works and Highway of Japan, Flood Control Vol-1 which provides Technical Standards and Guidelines for Planning and Design which have proven useful in engineering practice**.]

3.2 REVETMENT – PITCHING OF THE BANKS (IS 14262: 1995)

Revetments are sloping structures placed on banks in such a way as to absorb the energy of incoming water.

Typical slope protection works are shown in Fig. 12. Protection against the surfacial erosion on the river banks can be done by constructing a suitable revetment structure. The main function of the revetment structure is to protect the river bank or embankment from surface erosion caused mainly due to flow of water.

Revetment structure does not provide any geotechnical stability to the River Bank. So, in order to have geotechnical stability of the river bank, it shall be trimmed to stable slope before constructing any revetment structure. In case if it is inevitable to protect steep slopes of riverbank, the toe of the river bank shall be stabilized with a toe wall of required height (Depending on slope height).

This toe wall provides the geotechnical stability to the River Bank and further the stabilized slope can be protected from surface erosion by constructing an appropriate revetment structure on the slope.

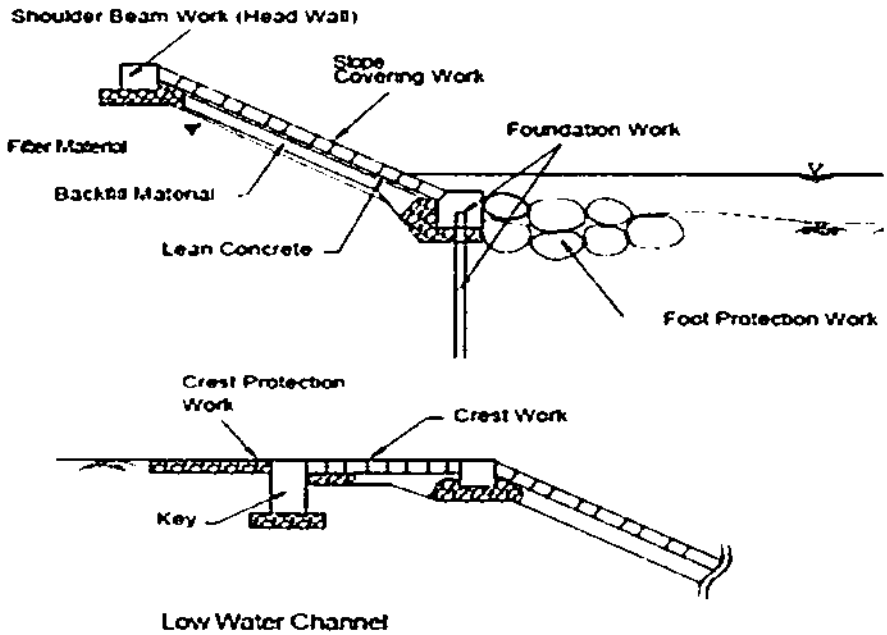


Figure 12 Typical Slope Protection Works

The detailed design of the revetment structure shall be adopted as per the following standards:

3.2.1 Design of rip rap or rubble pitching – IS 14262:1995

As per clause 5 of IS: 14262:1995

TOE PROTECTION:- To prevent the sliding and failure of the revetment on slope, toe is required to be protected. This may be in the form of simple key, a toe wall, a sheet pile or a launching apron. Different types of toe protections are

1) Simple key may be provided at the toe when rock or un erodible strata is available at the river bed and the overlying banks are under attack and subjected to erosion. The key is in the form of stones, bricks or concrete

blocks filled in trench at the toe below the hard river bed for depth equal to the thickness of pitching for proper anchorage (see Fig. 13). Sole purpose of this key is to provide lateral support. The stones, bricks or blocks may be laid in mortar if pitching on slope is in mortar.

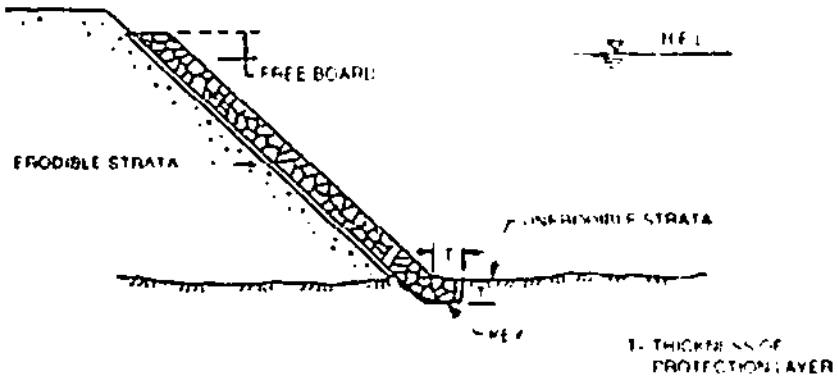


Figure 13

2) When hard strata is available below the river bed at a reasonable depth, toe wall is recommended. The thickness of toe wall depends upon the height of the wall and height of the overlying protection works. This wall may be constructed in masonry (see Fig. 14) and designed as a retaining wall with weep holes, etc.

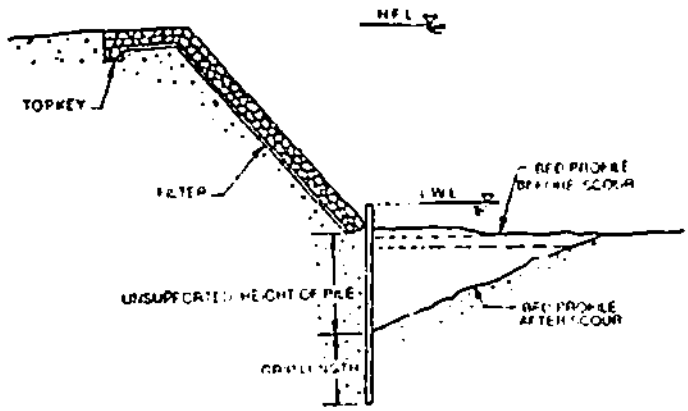


Figure 14

3) Launching apron should be laid at normal water level or at as low a level as techno- *economically viable. The stones in the apron should be designed to launch along the slope of the scour and provide a strong layer that may prevent further scooping out of the river bed material. The

size and shape: of the apron depends on the size of the stone, thickness of the launched apron, depth of scour and slope .of launched apron.

4) The slope of launching apron may be taken as 2 H : 1 V. Adequate quantity of stones for the apron has to be provided to ensure complete protection of the whole of the scoured face according to levels and slopes. The quantity of stones so calculated may be provided in a wedge shape having width of 1.5 DL and average thickness T. Thickness of the laid apron may be kept 0.8 T near the toe of the revetment and I-2 T at the river end.

3.2.2 Design of gabion mattress/ grout mattress revetment - FHWANHI-09-112 Criteria for selection of protection measures

Table 7 Selection Criteria

Nature of Strata	Solution
Rock or Un-erodible strata is available at the river bed	Key
Hard Strata available below river bed at a reasonable depth	Toe wall
Firm Strata is not available at reasonable depth below the river bed	Launching Apron and Sheet Piles

3.2.3 GABION REVETMENTS

Wire-enclosed rock, or gabion, revetments consist of rectangular wire mesh baskets filled with rock. These revetments are formed by filling pre-assembled wire baskets with rock, and anchoring to the channel bottom or bank. Wire-enclosed rock revetments are generally of two types distinguished by shape.

The primary advantages of wire-enclosed rock revetments include

(a) their ability to span minor pockets of bank subsidence without failure and

(b) the ability to use smaller, lower quality, and less dense, rock in the baskets.

Besides its use as a general bank revetment, wire-enclosed rock in the form of either mattresses or blocks is also used as bank toe protection. In some instances the wire-enclosed rock is used alone for protection of the

bank also. In other cases, the wire-enclosed rock is used as toe protection along with some other bank revetment.

Design Guidelines for the Gabion Revetments: -

The thickness of the mattress is selected considering the flow velocity that the mattress has to sustain slope angle of the river bank and the average stone fill size that would be available for filling the mattress box.

Indicative thickness of gabion mattress in relation to water velocity shall be given as per Table 8.

Selected thickness of mattress shall be checked for the tractive shear stress criteria i.e. the revetment stability check along the bed and slope portion as per FHWA-NHI-09-112.

Table 8 Criteria for the Determination of Gabion Thickness for Slope Protection

Bank Soil Type	Maximum Velocity (m/sec)	Bank Slope	Min Required thickness (m)
Clay, Cohesive Soils	3	< 1:3	0.22
	3.9 – 4.8	< 1:2	0.3
	Above 4.8	> 1:2	≥ 0.45
Silts, Fine sands	3	< 1:2	0.3
Shingle with Gravel	4.8	< 1:3	0.22
	6	< 1:2	0.3
	Above 6	> 1:2	≥ 0.45

3.2.3.1 **Geotextile Methods:-**

Geotextile bag or geo-bag, a geo-synthetic product made of polyester; polypropylene or polyethylene or jute is used worldwide for defending riverbanks and hydraulic structures from severe scouring and erosion. In this method, sandbags are placed at the slope below the water level, and the slope above the water level is protected with cement concrete blocks mostly to resist waves. Generally, the sandbags weigh 70 kg, 85 kg, 110 kg, or 230 kg. Sandbags are commonly used for both emergency and permanent shields.

3.2.3.2 Gabion Structure:-

Gabion baskets and mattresses are used as retaining wall structures, and channel linings. They are filled with light to heavy stone without mortar. A gabion mat or basket is a structure made of zinc coated soft temper steel in a shape of hexagonal double twisted wire mesh filled with stones. A gabion basket usually has a height between 0.5m 6 to 1m whereas, a gabion mattress has a height between 0.17m to 0.50m . A non- woven fabrication called a geotextile filter layer is used at the base of the gabion structure to prevent water leakage and wash away button soil particles

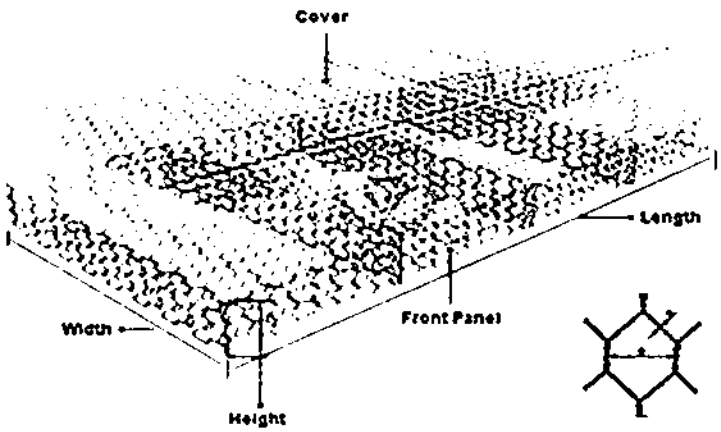


Fig:-Gabion Mattress, also known as Reno Mattress.

Figure shows hexagonal mesh of a gabion mattress. The parts of the gabion as well as the diameter and the width of the wire are marked.

4.0 NEED OF THIS NOTE: -

As per Government Resolution महाराष्ट्र शासन, जलसंपदा विभाग शासन निर्णय क्रमांक मसंसं :१०१४ /(प्र. क्र.३४/१४-मोप्र (१, मंत्रालय, मुंबई दिनांक १६/०१/२०१५. the mandate of Central Design Organization is finalized, which includes,

"संकल्पचित्र संघटनेकडे सोपविण्यात आलेल्या प्रकल्पाचे संकल्पन व संकल्पचित्र तयार करण्याबावतची मार्गदर्शक तत्वे" शासन निर्णयामध्ये पुढीलप्रमाणे नमुद आहे .

१) मोठे, मध्यम व उपसा सिंचन योजना

२) ५ मीटर पेक्षा जास्त पुराची उंची(Flood Lift) किंवा १० मीटर किंवा त्यापेक्षा जास्त अथ पात: (Fall) असलेल्या उत्सारी भागाचे संकल्पन करणे.

३) *लघु प्रकल्पाच्या बाबतीत ३० मी पेक्षा जास्त उंचीच्या धरणांच्या अथवा विशिष्ट समस्या असलेल्या धरणांच्या शीर्ष कामांची तपशीलवार संकल्पने व संकल्पने तयार करणे.*

४) *अस्तित्वात असलेल्या धरणांच्या मजबुतीकरणाचे/ उंची वाढविण्याचे संकल्पन करणे.* Government vide Resolution dated 31/01/2019 have enlisted norms to be followed as below:-

"पूरसंरक्षक योजनेच्या कामामध्ये प्रशासकीय मान्यता देण्याबाबतचे सुधारित धोरण" शासन निर्णयामध्ये पूरसंरक्षक कामाच्या संकल्पनामध्ये खालीलप्रमाणे नमुद आहे .

४) संकल्पने :- पूरसंरक्षक कामाचे अंदाजपत्रक रु.५.०० कोटी पेक्षा जास्त रक्कमेचेहोणार असल्यास ते मध्यवर्ती संकल्पचित्र संघटनेकडून तयार करण्यात यावे. तसेच १.०० कोटी ते ५.०० कोटी पर्यंतच्या कामांचे सविस्तर संकल्पन महामंडळा अंतर्गत संकल्पचित्र विभागाकडून करावे. रु.१०० कोटी रक्कमे आतील कामांचे अंदाजपत्रक क्षेत्रीय स्तरावर करण्यास हरकत नाही.

Thus vide this point proposals of Flood Protection Walls are referred to CDO on large scale from all over Maharashtra.

Taking into consideration the availability of manpower in CDO, it becomes quite difficult to issue designs in stipulated time on priority basis. Also data made available from site is inadequate , which further adds to complication. Hence an attempt is being made to standardize the design of flood protection wall with possible options.

So that suitable option can be selected by field competent authority and approved at their level.

5.0 SCOPE OF THIS NOTE: -

This note deals with flood protection wall, different options, assumptions made in their design, seismic zone considered, standard template of drawing, for heights varying from 3.5m to 20.0m

6.0 DIFFERENT TYPES OF FLOOD PROTECTION WALLS INCLUDE: -

1) Flood protection Gravity wall on Hard Strata---(a) one side slope
   ---(b) Both side slope
2) Flood Protection Gravity Wall on Soft Strata
   a. Resting on Raft
   b. Resting on Two Piles
   c. Resting on Group of Piles.
3) Reinforced Cement Concrete Wall

   In these walls, the stability against overturning is provided by the weight of the retaining wall. These are further classified into

A) **Cantilever Retaining Wall.**

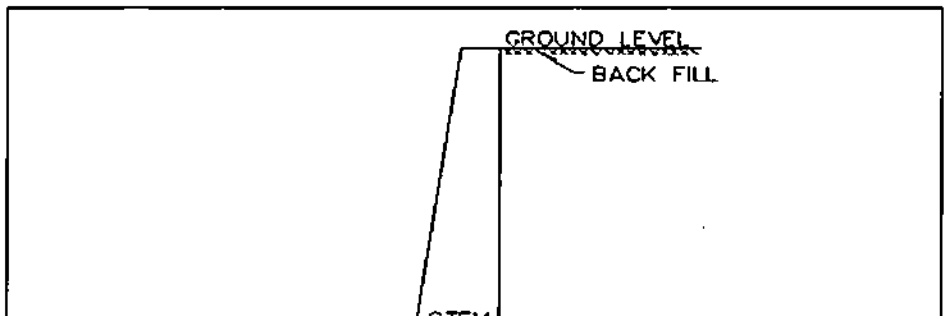


Fig 1: Cantilever Retaining Wall

- This wall is connected to the foundation and rests on the slab foundation.
- These walls can be constructed of RCC, prestressed concrete, or precast concrete.
- This type of retaining wall is used for up to **10 metres.**
- Stem and base slab are the two main components of the cantilever retaining wall.
- Part of the base slab rests under the backfill material.
- Notably, the heel and the toe of the cantilever retaining walls are vertical.
- Compared to a gravity retaining wall, this retaining wall uses less concrete.
- The failure in the cantilever retaining wall can occur by sliding, uplift pressure, and soil bearing pressure. The failure is also dependent on the various soil properties.

B) Cantilever Retaining Wall with Heel only.

C) Cantilever Retaining Wall without Heel

D) Counterfort Retaining Wall

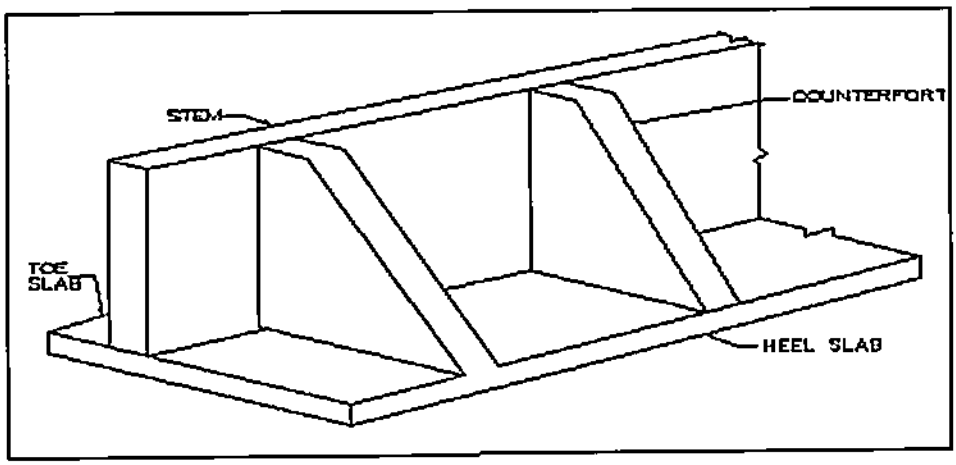


Fig 2: Counterfort Retaining Wall

- These walls comprise counterforts, which are thin vertical concrete webs at regular intervals along the rear of the wall.
- These are used for heights greater than 8 **metres.**
- This counterfort connects the slab and the base together, acting monolithically with both.
- The spacing between counterforts is more than one-half of the height.

E) Buttress Retaining Wall

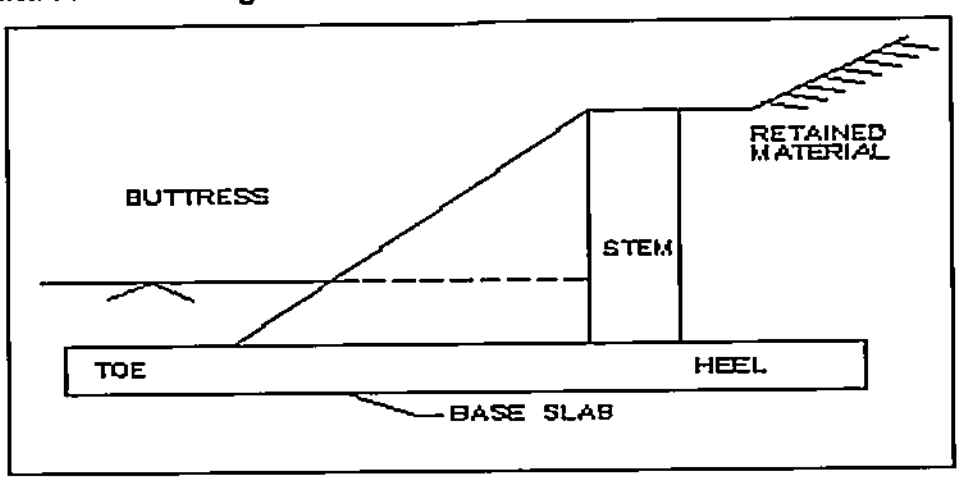


Fig 3: Buttress Retaining Wall

- Buttress is a special type of counterfort retaining wall.
- These are constructed on the face of the wall rather than within the backfill.

- They are not used due to the extra space occupied by buttresses.
- They are aesthetically inferior as compared to the cantilever retaining walls.
- But are used in special and exceptional cases.

7.0 ASSUMPTIONS MADE IN DESIGN :-

7.1 The following design parameters are adopted.

i	Density of retaining material	-	21 KN/m3
ii	Grade of steel	-	Fe-500
iii	Grade of concrete	-	M-20(For RCC Wall)
		-	M-15(For Gravity Wall)
iv	σcbc	-	7.00 N/mm2
v	σst	-	275 N/mm2
vi	SBC	-	(Suitably Assumed)

7.2 FORCES CONSIDERED: -

1) Dead load
2) Soil Pressure
3) Seismic Forces

7.3 SEISMIC ZONE -:

As per seismic zone map given in I.S. 1893-1984 (Reaffirmed 2018), Seismic zone-IV for which basic seismic co-efficient 'α 0' is 0.05 is considered.

Since major part of Maharashtra lies in seismic zone III and IV, Seismic zone IV which gives worst condition is considered for standardization, as it will give safe design.

As per the I.S. provision, importance factor '1.5' for design of RCC cantilever retaining wall

The horizontal seismic co-efficient is taken as 1.5 times 'α 0' acting at the top of non-overflow portion reducing linearly to zero at the foundation. The vertical co-efficient is taken as 0.075 times of horizontal seismic co-efficient.

8.0 GRAVITY WALL

STABILITY ANALYSIS OF WALL:

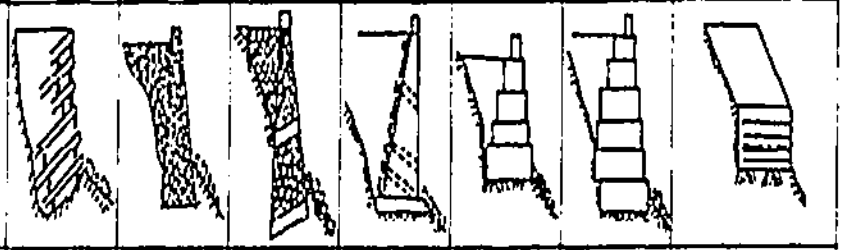
Stability analysis of gravity type wall is carried out using in house developed software program. Considering Grade of Concrete M15. The stability of gravity wall is calculated using program by adopting different slopes so as to satisfy criteria such as stresses and factor are within permissible limit as given by IS CODE 14458(Part-I) :1998 (Retaining Wall For Hill Area –Guidelines) Following is mentioned,

3.1.1 For hilly roads, being of low volume, walls may not be designed for earthquake forces. It is economical to repair failed walls after earthquake.

3.1.2 Earthquake considerations lead to excessive wall dimensions. High walls may, therefore, be avoided by alternative geometric designs of roads and terraces unless justified by risk analysis. Walls with dip at the base towards hillside will reduce the base width in seismic areas.

Above clauses are reproduced, so that it will facilitate the competent field authority in better comparison of selection to be done.

Table 1 Selection of Retaining Walls
(*Clause* 3.1)

	Type	Retaining Walls						
		Timber Crib	Dry Stone	Packed Dry Stone/ Masonry	Cement Masonry	Gabion		Reinforced Earth
						Low	High	
	Diagrammatic Cross-section							
CONSTRUCTION	Top width	2 m	0.6-1.0 m	0.6-1.0 m	0.5-1.0 m	1 m	1-2 m	4 m or 0.7-0.8 m
	Base width	—	0.5-0.7 H	0.6-0.65 H	0.5-0.65 H	0.6-0.75 H	0.65-0.65 H	4 m or 0.7-0.8 H
	Front batter	4:1	vertical	varies	10:1	6:1	6:1	3:1
	Rear batter	4:1	varies	vertical	varies	varies	varies	3:1
	Inward dip of foundation	1:4	1:3	1:3	horizontal or 1:6	1:6	1:6	horizontal
	Foundation depth below drain	0.5-1 m	0.5 m	0.5-1 m	0.5-1 m	0.5 m	1 m	0.5 m
	Range of height	3-9 m	1-6 m	6-8 m	1-10 m	1-6 m	6-10 m	3-25 m
	Hill slope angle	<30°	<35°	30°	35-60	35-60	35-60	<35
	Toe protection in case of soft rock/soil	Boulder pitching	Boulder Pitching					No
NOTES	General	Timbers 15 cm c/s with stone rubble well packed behind timbers. 10% of all timbers to extend into fill. Ecologically acceptable	Set stones along foundation bed. Use bony hard stones. Hand packed stones in back fill	Cement masonry bands of 50 cm thickness at 3 m c/c. Other specifications as for dry stone wall	Weep holes 15 x 15 cm size at 1-2 m c/c. 50 cm rubble backing for drainage.	Stones to be hand packed. Stone shape irregular, blocky preferable to tabular. Specify minimum/maximum stone size. No weathered stone to be used. Compact granular back fill in layers < 15 cm. Use H type gabion wall.		Granular back fill reinforced. Use geogrid for H < 4 m and tensar grid for H > 4 m. Provide drainage layer in case of seepage problems. Specify spacing of reinforcement grids.

		1. Foundations to be stepped up if rock encountered 2. All walls require durable rock filling of small to medium size 3. Drainage of wall faces not shown. Provide 15 cm thick gravel layer in case of clayey foundation			
Application		Least durable	Most durable	Can take differential settlement and slope movement	Huge potential used more as stable reinforced fill platform for road rather than protective method of slope support
		Not ductile structure most susceptible to earthquake damage		Very flexible structures	
		1 Design as conventional retaining walls. Assume surcharge on road of 2 t/m². 2 Used both as cut slope and fill slopes support. Breast wall is more economical for cut slope 3 Choice of wall depends on local resources, local skill, hill slope angle, foundation conditions and also slope of back fill wedges as discussed in diagrams and compatibility of materials			

Above table from IS 14458(Part-I):1998 will facilitate in selection of type of retaining wall. (ANNEXURE---)

In IS 14458(Part-2):1997(Retaining Wall For Hill Area –Guidelines)

Following is mentioned,

5.4 It is generally not possible to design each and every wall along the entire length of a road. Standard designs as given in Table 3 may be adopted for walls less than 8 m in height and 120 m^2 area in a low hazard zone provided the allowable bearing capacity is more than the maximum pressure indicated in the table.

For reference the table is reproduced:-

IS 14458 (Part 2) : 1997

Table 3 Standard Design of Cement Masonry and Dry Stone Masonry Retaining Walls
(Clause 5.4)

Back Fill Type	Particulars	Cement Masonry	Dry Stone Masonry
Good Back fill, Free Drainage	Top width in m	[illegible]	[illegible]
	Base width in m	[illegible]	[illegible]
GW, GP, SW, SP	Foundation pressure in t/m²	[illegible]	[illegible]
Fair Back fill, Low pore water pressure	Top width in m	[illegible]	[illegible]
	Base width in m	[illegible]	[illegible]
GM, SM, SC	Foundation pressure in t/m²	[illegible]	[illegible]
Poor Back fill, High pore water pressure	Top width in m	[illegible]	[illegible]
	Base width in m	[illegible]	[illegible]
GC, SC, ML	Foundation pressure in t/m²	[illegible]	[illegible]

NOTES
1 Wall Geometry: [illegible]
2 Back Fill Top: [illegible]
3 Select wall dimensions such that allowable bearing capacity is greater than the foundation pressure [illegible]
4 [illegible]

Above table can be referred as per decision of competent authority. (ANNEXURE---)

9.0 RCC CANTILEVER TYPE RETAINING WALL

STABILITY ANALYSIS OF WALL:

The wall section is designed as a R.C.C. cantilever type retaining wall for Various height of 6.0m, 8.0m, 10.0 m, 12.0 m, 14.0 m, 16.0m, 18.0 m, 20.0 m. care shall be taken to restrict the backfill up to guide wall top profile only.

The backfilling shall be done with the available excavated available material. Top level of toe and heel slab for guide wall is proposed at R.L. 6.0m, 8.0m, 10.0 m, 12.0m, 14.0m, 16.0m,18.0m,20.0m respectively.

The RCC cantilever retaining walls are proposed in C.C. M-20 grade with 150 MSA. Stability analysis for various heights of wall section at proposed foundation level has been carried out. The resulting stresses at foundation level for various load combinations are as mentioned below.

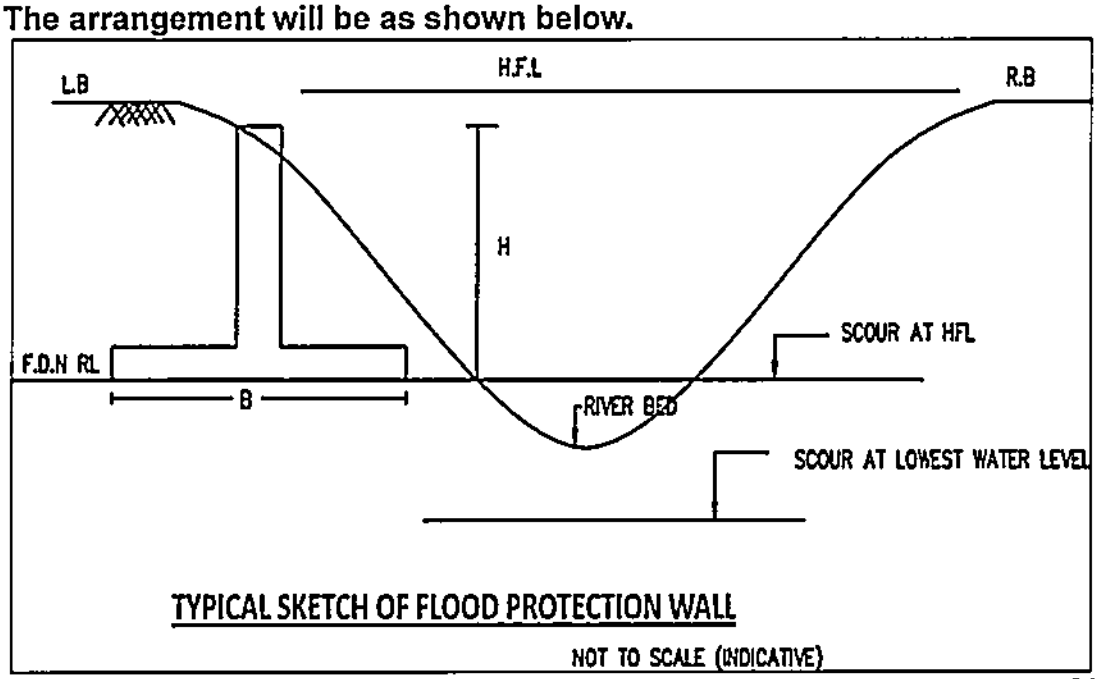
The two-dimensional analysis is performed as per I.S. 14458 (Part-II)- 1997-Reaffirmed 2017 and computer programme developed in C.D.O.

The details of each 6.0m, 8.0m, 10.0m, 12.0m, 14.0m and 16.0m are as below with stress table, Reinforcement table and the maximum bearing pressure for which the particular height can be used.

10.0 Walls on Soft Strata: -

The foundation of wall whether for shallow foundation or deep foundation shall be taken below the scour depth.

The arrangement will be as shown below.



TYPICAL SKETCH OF FLOOD PROTECTION WALL

NOT TO SCALE (INDICATIVE)

10.1 Wall Resting on Piled Raft (Group of piles.)

As the height of walls is significant that is upto 20m, design alternative of Pile supported RCC Cantilever walls are proposed. Due to piles, the wall height can be reduced. Below is the typical sketch of a Pile supported T wall (Reference: U S ARMY PUBLICATION EM 1110-2-2502 Dated 1 August 2022 Fig 8 .1)

Note: Indian Standard 2911: Part 1 Sec 2 (Attached in annexure 2 in this note) mentions that the standard is not applicable for use of bored cast in-situ concrete piles for any other purpose, for example, temporary or permanent retaining structure. (Clause:1.2)

DESIGN PHILOSOPHY: The RCC retaining wall is supported on an arrangement of piles in such a way the piles are at Center and equidistant from the Center of Pressure diagram of pressure occurring due to wall on soil. This allows to transfer the load from wall to piles axially.

These end bearing piles are designed for axial load.

10.2 Base Slab of Wall acting as Pile Cap

The base slab of wall acts a pile cap, which is checked for Bending moment and shear force, also the effective area of base slab for one single pile is checked for Punching shear failure.

The RCC cantilever retaining walls and RCC Piles are proposed in C.C. M-25 grade. Stability analysis for wall section level has been carried out.

The foundation of wall of can be shallow foundation or deep foundation. Foundation level of wall should be kept below scour depth criteria.

The scour depth calculations are supposed to be carried out to decide the foundation level as per the formula given below, as per IS 14262:1995 (Reaffirmed 2016)

Depth of scour may be worked out from the equation:

$$D_L = 0{\cdot}473\,(Q/f)^{1/3}$$

or $D_L = 1{\cdot}33\,(q^2/f)^{1/3}$, and

$$f = 1{\cdot}76\sqrt{d}$$

where

D_L = scour depth below HFL in m,

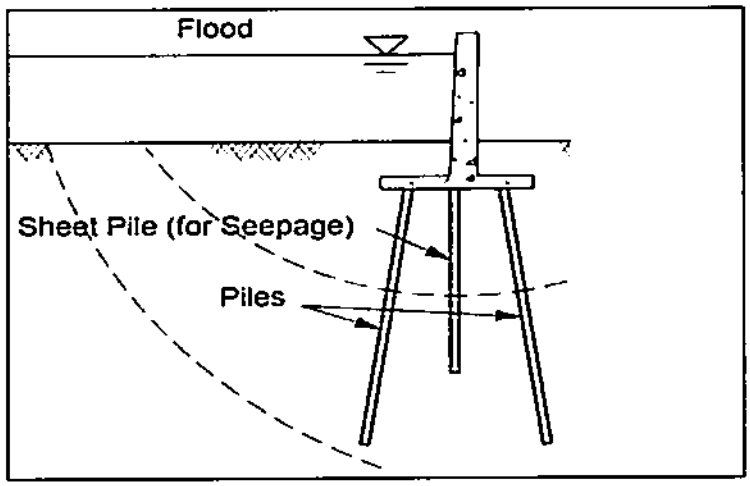
Q = discharge in m^3/s,

q = discharge per unit width in $m^3/s/m$,

f = silt factor, and

d = mean particle diameter of river bed material in mm.

Typical Sketch of Pile Supported T-Wall



i) RCC Retaining Wall

The following properties are taken into consideration

Table 1: Soil Properties

Properties	Value
Soil modulus, E_s (MPa)	50
Cohesion of soil, C_u (kPa)	50
Poison's ratio of soil, υ_s	0.45
Angle of internal friction, ϕ (degrees)	0
Unit weight (kN/m^3)	$\gamma_{sat} = 21$, $\gamma_{unsat} = 19$

Table 2: Pile Properties

Properties	Value
Modulus of elasticity, E_p (kN/m^2)	30×10^7
Diameter of the pile, d_p (m)	0.45
Length of the pile, L (m)	9.0m
Unit weight, γ (kN/m3)	25
Poison's ratio of the pile, u_s	0.3
Reinforcement in pile Main steel	7 Nos.25mm dia
Lateral Ties	8mmdia@60mm c/c

Table 3 :-Raft Properties

Properties	Value
Modulus of elasticity, E_r (kN/m^2)	3×10^7
Thickness, d (m)	1.0
Unit weight, γ (kN/m^3)	25
Poison's ratio of a raft, u_r	0.3
Length and breadth of a raft, L_r and B_r (m)	L × 7.0
Reinforcement----------25mm dia @150mm c/c.	

With this assumption the design is carried out the drawing of the same is attached herewith.

10.3 Walls resting on Soft strata at shallow depth: -

In such cases it is possible to rest wall on raft.

If the strata existing is soft an alternative of wall resting on raft is proposed. Here the base slab and toe slab is to be provided of depth equal to raft depth required , as per SBC provided or assumed if data is not made available.

IS 456: 2000 (Reaffirmed 2021 Provisions): -

Table no. 3 of the code titled "Environmental Exposure condition" is reproduced here: -

Sr. No.	Environment		Exposure Conditions
1	Mild	:-	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
2	Moderate	:-	Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water Concrete surfaces sheltered from saturated salt air in coastal area
3	Severe	:-	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water Concrete exposed to coastal environment.
4	Very severe	:-	Concrete surfaces ex posed to sea water spray. corrosive fumes or severe freezing conditions whilst wet Concrete in contact with or buried under aggressive sub-soil/ ground water
5	Extreme	:-	Surface of members in tidal zone Members in direct contact with liquid/ solid aggressive chemicals

11.0 Gravity Wall with both side slope; Resting on Piled Raft (Group of Piles)

Gravity wall with top width 1000mm and uniform slope on both sides 0.5 :1 is proposed (for ht=14.0m). Drawings of respective heights are attached.

The arrangement of weep holes 75mm diameter 3000mm c/c staggered is proposed. Also, filters are proposed on backfill side the details of same are shown on drawing.

The stability analysis of gravity retaining wall is carried out considering height of earth to be retained, its geometry, surcharge if any, angle of internal friction and seismic forces etc.

Various trials are taken with increasing slope of wall on one side such that the stresses and factor of safety is within permissible limits.

12.0 COUNTERFORT RETAINING WALL :

In case of cantilever retaining wall the bending moment in the vertical stem varies as h^3 , where h is height of stem. When this section exceeds 6m a thick section is required for the stem and design is uneconomical.

Thus for such cases Counterfort retaining walls are recommended.

The particular details are given for Counterfort retaining wall .

NOTE :- EXPOSURE CONDITION :

a. As per is 456:2000 (Reaffirmed 2021) Plain and Reinforced Concrete, as per table 3, "Environmental Exposure Conditions" exposure condition for concrete completely immersed in sea water, exposed to costal environment is mentioned as severe.

b. As per is 456:2000 (Reaffirmed 2021) Plain and Reinforced Concrete, as per table 5, minimum grade of concrete for severe exposure condition and reinforced concrete is mentioned as M30.

As per above exposure condition following minimum grade of concrete is given in tabular form in the code.

Sr. No.	Exposure	Minimum grade of concrete for Plain cement concrete	Minimum grade of concrete for Reinforced cement concrete
1	Mild	-	M20
2	Moderate	M15	M25
3	Severe	M20	M30
4	Very severe	M20	M35
5	Extreme	M25	M40

Thus, out of the suggested options, the options shall be blended and the combination that is techno-economically feasible shall be approved.

Drawings of all types are attached with Reinforcement in stem, heel and toe.

13.0 CONCLUSION:

The protection work for riverbank scouring prevention is provided as per CDO code of practice and relevant I.S. CODES and research papers. The design and drawings are submitted and recommended for approval.

14.0 POINTS FOR ATTENTION OF FIELD OFFICERS:

This design and drawing is prepared considering worst conditions, seismic zone IV, etc. Responsibility regarding accuracy of the data solely lies with the field officers, CDO will not be responsible for any mistakes in design due to inaccurate option selected by field competent authority).

1. Regarding flood protection walls Some points of the Government Resolution dated 31/01/2019 are reproduced below.

१) पूर संरक्षक कामाचा उद्देश नदीत किंवा नाल्यात पावसामुळे येणारा विसर्ग/ धरणातील विसर्ग यामुळे येणारा पूर प्रवाह काठ सोडून आजुबाजूच्या परिसरात पसरतो, त्याला अटकाव करुन संरक्षण करण्यासाठी आहे.'

२) पूरसंरक्षक कामात सर्वसाधारणत: पुढील बाबींचा समावेश असावा.

अ) नदी/नाला काठावर माती भराव करणे, दगडी/ संधानक अस्तरिकरण करणे.

ब) संधानकातील आधार भिंत/ Retaining Wall बांधणे.

क) नदी/नाला प्रवाहाला उचित दिशा देणे.

३) नदी/ नाल्याच्या या भागातील पूरप्रवण क्षेत्र निश्चित करण्यासाठी शासन परिपत्रक क्र. एफडीडब्ल्यू १०८९/ प्र.क्र.२४३/८९/सिं.व्य.(कामे) दिनांक २१/०९/१९८९ व शासन परिपत्रक क्र.पूरनि-२०१८/ (प्र.क्र.१८२/२०१८) /सि.व्य.(महसूल) दिनांक ३ मे, २०१८ नुसार पूररेषा निश्चिती व आखणी मुख्य अभियंता स्तरावर झालेली आहे काय, याची पडताळणी संबधित कार्यकारी अभियंता यांनी करावी.

पूररेषा निश्चिती झालेली नसल्यास प्रथम पूररेषा निश्चिती करुन त्याचे नकाशे निर्गमित करावे व तद्नंतर पूरसंरक्षक योजनाच्या कामाचे सर्वेक्षण व अंदाजपत्रक तयार करावे.

४) २५ वर्षातून एकदा या वारंवारितेच्या पूर विसर्गाने बाधित होणा-या भागासाठी म्हणजेच प्रतिबंधित क्षेत्रातील निळया पूररेषेच्या आतील भागांसाठी पूर संरक्षक कामे हाती घेता येतील.

५) निळया पूररेषांच्या आतील भाग हा प्रतिबंधित क्षेत्र असल्याने त्या भागात राष्ट्रीय हरित न्यायाधिकरणाच्या निर्देशानुसार नवीन बांधकामे करता येत नाहीत. (No Development Zones) तथापि, अस्तित्वातील जमिनी, लोकवस्ती घरे, रस्ते इत्यादींचे पूर्णत: स्थालांतरण वा पुनर्वसन शक्य नसल्याने पुरापासून संरक्षण मिळण्यासाठी पूरसंरक्षक कामे घेणे अनिवार्य आहेत. पूर संरक्षक कामे करतांना नदी प्रवाहात कुठलाही अडथळा येणार नाही, नदीची वहन क्षमता बदलणार नाही याची दक्षता घ्यावी.

६) संकल्पने :- पूरसंरक्षक कामाचे अंदाजपत्रक रु.५.०० कोटी पेक्षा जास्त रक्कमेचेहोणार असल्यास ते मध्यवर्ती संकल्पचित्र संघटनेकडून तयार करण्यात यावे. तसेच १.०० कोटी ते ५.०० कोटी पर्यंतच्या कामांचे सविस्तर संकल्पन महामंडळा अंतर्गत संकल्पचित्र विभागाकडून करावे. रु.१०० कोटी रक्कमेच्या आतील कामांचे अंदाजपत्रक क्षेत्रीय स्तरावर करण्यास हरकत नाही.

७) तांत्रिक तपासणी :- जलसंपदा विभागाचा शासन निर्णय क्र. २०१७/(५६६/१७)/सिं.व्य. (कामे), दि. ३१.०८.२०१८ प्रमाणे पूरसंरक्षक कामाच्या प्रशासकीय मान्यतेसाठी रु. २५.०० कोटी पेक्षा कमी किंमतीचे प्रस्ताव राज्यस्तरीय तांत्रिक सल्लागार समिती कार्यालय करीत असलेल्या छाननीप्रमाणे महामंडळ स्तरावर छाननी करुन प्रशासकीय मान्यता / सुप्रमा प्रस्ताव महामंडळाने सुस्पष्ट शिफारशीसह शासनास सादर करावे. तसेच रु.२५.०० कोटी पेक्षा जास्त

किंमतीच्या कामांना राज्यस्तरीय तांत्रिक सल्लागार समिती मार्फत सविस्तर तपासणी करुन छाननी अहवालासह महामंडळाने प्रस्ताव शासनाला सादर करावेत.

८) प्रशासकीय मान्यता:- जलसंपदा विभागाचा शासन निर्णय क्र. संकिर्ण २०१६/(२७/१६)/ल.पा. २, दि. २६.०५.२०१७ अन्वये सिंचन प्रकल्पांच्या विशेष दुरुस्ती कामांना व विस्तार व सुधारणा अंतर्गत कामांना नियोजन विभागाच्या सहमतीने प्रशासकीय मान्यता देण्याचे अधिकार जलसंपदा विभागास देण्यात आले आहेत. त्याच धर्तीवर पूर संरक्षक कामांच्या रुपये ५.०० कोटी पर्यंतच्या कामांना जलसंपदा विभाग प्रशासकीय मान्यता प्रदान करेल. रु.५.०० कोटी पेक्षा जास्त किंमतीच्या अंदाजपत्रकांना नियोजन व वित्त विभागाची सहमती अनिवार्य असेल.

All other condition given in the above Government Resolution should be strictly followed.

2. Even if the height of the flood protection wall are less than 5 m yet the estimate cost of the flood protection wall exceeds Rs. 5.00 crores because of the length of the flood protection wall.

   Thus taking into consideration height aspect it can be designed at field level office. Also the length of the flood protection wall of the project needs to be approved by the competent authority.

3. According to the Government Resolution dated 31/01/2019, demarcation and planning of red and blue lines must be approved from the Chief Engineer.

4. The foundation levels of Flood protection walls shall be decided only after detailed geological investigation. It is recommended to carry geotechnical investigation before starting actual construction on site and approved foundation level by the competent authority. Also, actual S.B.C report shall be carried out at field level before selecting design option.

5. **To avoid damages from these recurring floods it is recommended to use nonconventional flood-proofing methods. Structural measures like providing flood walls (levees) will overall increase the flood levels by restricting the waterway and may lead to more damage.**

6. **Wherever unusual strata is met with, the problems shall be referred to CDO.**

7. **Flexible protections shall be adopted, and only under unavoidable circumstances and rare situations, concrete wall shall be opted for.**

8. **Prior to adopting flood protection wall cross section the guidelines laid down by National Green Tribunal regarding construction of concrete work in natural stream shall be strictly followed.**

9. **Discrepancies found if any, may please be communicated to CDO (Dam).**

10. **These drawings are prepared for tentative typical section as per CDO Code of Practice with reference to relevant codes.**

11. **Typical Tentative Cross-Section of Retaining Wall is provided only for Estimate purpose.**

12. All necessary quality control norms shall be strictly followed throughout the construction stages so as to achieve the required strength and stability to structure. Also, handbook for design of flood protection anti-erosion measures and river training works by CWC, Government of India shall be referred.

13. **Technical & financial feasibility of the structure shall be ascertained at field level by the competent authority before giving approval to the option selected.**

14. The construction work should be planned such that natural flow of river shall not get obstructed.

15. Flood protection structure required for controlling water within streams. These streams are having small catchment areas ranging from few sq.km. to lakhs of sq.km. Hence standardised wall needs to sustain all odds such as variety of floods, turbulence, river meandering. Scouring etc for lifetime. Also, river bed has poor properties in terms of structural requirement such as low SBC, coeff of friction, scour etc whereas material to be retained has rich properties such as high density etc. Hence considering all these factors wall profile and its reinforcements are proposed.

16. For walls of height more than 7.5 m, second thought should be given by competent field authority before referring this design as they are more critical. If required CDO shall be consulted upon.

CERTIFICATE

1. The design and drawings are 100% technically checked by this office.
2. All original design calculations and related correspondence is preserved in this office.

Sd/-

(R. S. RAJPUT)
Sub divisional engineer
Designs Division, MD.2,
Central Designs Organisation,
Nashik - 422 004.

Sd/-

(R.S.DESHMUKH)
Executive Engineer,
Designs Division, MD.2,
Central Designs Organisation,
Nashik - 422 004.

Recommended for Approval.

Sd/-
(R. M. MORE)
Superintending Engineer (Dam)
Central Designs Organisation,
Dindori Road, Nashik -422 004.

Approved By

Option approved:- _____

Notes :-1)_____

2)_____

Field Chief Engineer

1) **HEIGHT :- 4.0 M (Earthquake Zone: IV)**

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.30 Other Side =0.30

Stress Table:-

Flood protection wall at height of 4.00 m					
Case	Stresses (KN/m²)		Permissible Stresses (KN/m²)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	12.72	1.48	(-) 15.0	375	2.23
Self Wt + Backfill + Eq	14.18	-.50	(-) 30.0	375	1.82

Reinforcement details :- Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m²

2) **HEIGHT :- 6.0 M (Earthquake Zone: IV)**

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.35 Other Side =0.35

Stress Table:-

Case	Stresses (KN/m²)		Permissible Stresses (KN/m²)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	21.18	(-)0.64	(-) 15.0	375	1.86
Self Wt + Backfill + Eq	23.69	(-)3.91	(-) 30.0	375	1.55

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m²

3) HEIGHT :- 8.0 M (Earthquake Zone: IV)

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.30 Other Side =0.30

Stress Table:-

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	30.08	-3.28	(-) 15.0	375	1.71
Self Wt + Backfill + Eq	33.67	(-)7.87	(-) 30.0	375	1.42

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways. This wall can be used for bearing pressure = 375 KN/m^2

4) HEIGHT :- 10.0 M (Earthquake Zone: IV)

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.35 Other Side =0.35

Stress Table:-

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	32.45	.39	(-)15.0	375	2.12
Self Wt + Backfill + Eq	36.12	-4.53	(-)30	375	1.77

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

5) **HEIGHT: - 12.0 M (Earthquake Zone: IV)**

Type: - Gravity Type Retaining Wall. (Both Sides Slope)

Back Fill Side=0.35 Other Side =0.35

Stress Table: -

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self wt + Backfill	39.84	-.79	(-)15.0	375	2.05
Self wt + Backfill + Eq	44.35	-6.80	(-)30	375	1.72

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

6) **Height: - 14.0 M (Earthquake Zone: IV)**

Type: - Gravity Type Retaining Wall. (Both Sides Slope)

Back Fill Side=0.35 Other Side =0.35

Stress Table: -

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self wt + Backfill	47.27	-2.03	(-)15.0	375	2.01
Self wt + Backfill + Eq	52.64	-9.14	(-)30	375	1.69

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

7) Height :- 16.0 M (Earthquake Zone: IV)

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.35 Other Side =0.35

Stress Table:-

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self wt + Backfill	54.74	-3.31	(-)15.0	375	1.98
Self wt + Backfill + Eq	60.96	-11.51	(-)30	375	1.67

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

8) Height :- 18.0 M (Earthquake Zone: IV)

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.40 Other Side =0.40

Stress Table:-

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	52.40	5.17	(-)15.0	375	2.5
Self Wt + Backfill + Eq	58.02	-2.68	(-)30	375	2.11

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

9) Height :- 20.0 M (Earthquake Zone: IV)

Type :- Gravity Type Retaining Wall.(Both Sides Slope)

Back Fill Side=0.40 Other Side =0.40

Stress Table:-

Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Overturning factor
	At Heel	At Toe	Minimum	Maximum	
Self Wt + Backfill	58.6	5.17	(-)15.0	375	2.48
Self Wt + Backfill + Eq	64.90	-3.60	(-)30	375	2.09

Reinforcement details: - Surface Reinforcement of 16 mm dia @240mm bothways.

This wall can be used for bearing pressure = 375 KN/m^2

A) Without Shear Key:-

1) HEIGHT: - 6.0 M

Type: - R.C.C. Cantilever Type Retaining Wall

Stress Table: -

Flood protection wall at height of 6.00m				
Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)	
	At Heel	At Toe	Minimum	Maximum
Static Condition	64.63	127.43	0.00	450.00
Seismic Condition	30.92	161.14	0.00	562.50 (1.25 x bearing Pressure)
Case	Factor Of Safety		Allowable Factor Of safety	
	Overturning	Sliding	Overturning	Sliding
Static Condition	3.72	1.76	2.00	1.50
Seismic Condition	2.64	1.42	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	16 mm dia. bar at 150 mm c/c
		Other face	16 mm dia. bar at 150 mm c/c
	Distribution Reinforcement	Both face	16 mm dia. bar at 150 mm c/c
Raft	Main Reinforcement	At top and Bottom	20 mm dia. bar at 250 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 250 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

2) HEIGHT :- 8.0 M

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

Flood protection wall at height of 8.0m				
Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)	
	At Heel	At Toe	Minimum	Maximum
Static Condition	90.14	100.54	0.00	400.00
Seismic Condition	53.43	137.26	0.00	562.50 (1.25 x bearing Pressure)
Case	Factor Of Safety		Allowable Factor Of safety	
	Overturning	Sliding	Overturning	Sliding
Static Condition	3.37	1.35	2.00	1.50
Seismic Condition	2.5	1.12	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	20 mm dia. bar at 140 mm c/c
		Other face	20 mm dia. bar at 140 mm c/c
	Distribution Reinforcement	Both face	16 mm dia. bar at 150 mm c/c
Raft	Main Reinforcement	At top and Bottom	20 mm dia. bar at 100 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 200 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

3) HEIGHT :- 10.0 M

Type :- R.C.C. Cantilever Type Retaining Wall

Flood protection wall at height of 10.0m				
Case	Stresses (KN/m²)		Permissible Stresses (KN/m²)	
	At Heel	At Toe	Minimum	Maximum
Static Condition	41.93	156.64	0.00	400.00
Seismic Condition	6.35	192.22	0.00	562.50 (1.25 x bearing Pressure)
Case	Factor Of Safety		Allowable Factor Of safety	
	Overturning	Sliding	Overturning	Sliding
Static Condition	3.53	1.90	2.00	1.50
Seismic Condition	2.47	1.52	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32 mm dia. bar at 200 mm c/c
		Other face	32 mm dia. bar at 200 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 300 mm c/c
Raft	Main Reinforcement	At top and Bottom	32mm dia. bar at 250 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m²

4) HEIGHT :- 12.0 M

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

Flood protection wall at height of 12.0m			
Stresses (KN/m^2)		Permissible Stresses (KN/m^2)	
At Heel	At Toe	Minimum	Maximum
102.6	302.53	0.00	400.00
		0.00	562.50 (1.25 x bearing Pressure)
Factor Of Safety		Allowable Factor Of safety	
Overturning	Sliding	Overturning	Sliding
		2.00	1.50
		1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32 dia. bar at 150 mm c/c
		Other face	32 mm dia. bar at 300 mm c/c
	Distribution Reinforcement	Both face	20mm dia. bar at 260 mm c/c
Raft	Main Reinforcement	At top and Bottom	32 mm dia. bar at 150 mm c/c
	Distribution Reinforcement	At top and Bottom	20mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

5) HEIGHT :- 14.0 M

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

16. Flood protection wall at height of 14.0m				
Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)	
	At Heel	At Toe	Minimum	Maximum
Static Condition	137.79	297.97	0.00	400.00
Seismic Condition	6.93	428.84	0.00	562.50 (1.25 x bearing Pressure)
Case	Factor Of Safety		Allowable Factor Of safety	
	Overturning	Sliding	Overturning	Sliding
Static Condition	3.31	1.57	2.00	1.50
Seismic Condition	2.08	1.16	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32mm dia. bar at 150 mm c/c
		Other face	32 mm dia. bar at 150 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 200 mm c/c
Raft	Main Reinforcement	At top and Bottom	32 mm dia. bar at 150 mm c/c
	Distribution Reinforcement	At top and Bottom	20mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

6) HEIGHT :- 16.0 M

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

Stress Table:-

17. Flood protection wall at height of 16.0m					
Sr. No.	Case	Stresses (KN/m²)		Permissible Stresses (KN/m²)	
		At Heel	At Toe	Minimum	Maximum
1	Static Condition	170.53	339.34	0.00	400.00
2	Seismic Condition	36.2	473.66	0.00	562.50 (1.25 x bearing Pressure)
Sr. No	Case	Factor Of Safety		Allowable Factor Of safety	
		Overturning	Sliding	Overturning	Sliding
1	Static Condition	3.5	1.65	2.00	1.50
2	Seismic Condition	2.24	1.24	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32 dia. bar at 90 mm c/c
		Other face	32 mm dia. bar at 110 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 150 mm c/c
Raft	Main Reinforcement	At top and Bottom	32 mm dia. bar at 90 mm c/c
	Distribution Reinforcement	At top and Bottom	20mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 KN/m²

7) **HEIGHT :- 18.0 M**

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

18. Flood protection wall at height of 18.0m			
Stresses (KN/m^2)		**Permissible Stresses (KN/m^2)**	
At Heel	**At Toe**	**Minimum**	**Maximum**
175.24	386.88	0.00	400.00
24.87	537.25	0.00	562.50 (1.25 x bearing Pressure)
Factor Of Safety		**Allowable Factor Of safety**	
Overturning	**Sliding**	**Overturning**	**Sliding**
3.3	1.58	2.00	1.50
2.13	1.21	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	Bundle of 32mmdia. bar at 140 mm c/c
		Other face	32mm dia. bar at 200 mm c/c
	Distribution Reinforcement	Both face	20mm dia. bar at 160 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32mmdia. bar at 100 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

8) **HEIGHT :- 20.0 M**

Type :- R.C.C. Cantilever Type Retaining Wall

Stress Table:-

19. Flood protection wall at height of 20.0m				
Case	Stresses (KN/m^2)		Permissible Stresses (KN/m^2)	
	At Heel	At Toe	Minimum	Maximum
Static Condition	248.07	336.73	0.00	400.00
Seismic Condition	76.96	507.84	0.00	562.50 (1.25 x bearing Pressure))
Case	Factor Of Safety		Allowable Factor Of safety	
	Overturning	Sliding	Overturning	Sliding
Static Condition	3.81	1.61	2.00	1.50
Seismic Condition	2.29	1.16	1.50	1.00

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	Bundle of 32mmdia. bar at 140 mm c/c
		Other face	32mmdia. bar at 140 mm c/c
	Distribution Reinforcement	Both face	25 mm dia. bar at 180 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32mmdia. bar at 160 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

B) R.C.C. RETAINING WALL WITH SHEAR KEY

1) HEIGHT :- 10.0 M

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

1.Flood protection wall at height of 10.0m					
Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Shear key Dimension	
At Heel	At Toe	Mini mum	Maximum	y	d
40.01	108.78	0.00	400.00	0.87	0.40
-12.75	161.54	0.00	562.50 (1.25 x bearing Pressure))		
Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
Overturning	Sliding	Overturning	Sliding	y	d
2.31	0.82	2.00	1.50	0.87	0.40
1.61	0.66	1.50	1.00		

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32mmdia. bar at 150 mm c/c
		Other face	32mmdia. bar at 150 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 220 mm c/c
Raft	Main Reinforcement	At top and Bottom	32 mm dia. bar at 90 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

2) HEIGHT :- 12.0 M

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

2.Flood protection wall at height of 12.0m					
Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
25.68	155.49	0.00	400.00	1.31	0.61
-43.76	224.94	0.00	562.50 (1.25 x bearing Pressure))		
Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
2.02	0.78	2.00	1.50	1.31	0.61
1.43	0.63	1.50	1.00		

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32mmdia. bar at 150 mm c/c
		Other face	32mmdia. bar at 150 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 220 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32 mm dia. bar at 140 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

3) HEIGHT :- 14.0 M

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

3.Flood protection wall at height of 14.0m					
Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
29.39	233.24	0.00	400.00	1.60	0.72
-76.44	339.07	0.00	562.50 (1.25 x bearing Pressure))		
Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
2.07	0.89	2.00	1.50	1.60	0.72
1.41	0.71	1.50	1.00		

Reinforcement Table :-

Compo nent	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32mm dia. bar at 150 mm c/c
		Other face	32 mm dia. bar at 150 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 150 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32 mm dia. bar at 120 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 300 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

4) **HEIGHT :- 16.0 M**

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

4.Flood protection wall at height of 16.0m					
Stresses (KN/m^2)		Permissible Stresses (KN/m^2)		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
48.05	210.28	0.00	400.00	2.30	1.04
-46.31	304.64	0.00	562.50 (1.25 x bearing Pressure))		
Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
2.18	0.84	2.00	1.50	2.30	1.04
1.52	0.67	1.50	1.00		

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32 dia. bar at 100 mm c/c
		Other face	32 mm dia. bar at 100 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 140 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32 mm dia. bar at 170 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 KN/m^2

5) HEIGHT :- 18.0 M

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

5.Flood protection wall at height of 18.0m					
Stresses (KN/m²)		Permissible Stresses (KN/m²)		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
34.86	244.30	0.00	400.00	3.05	1.39
-74.32	353.49	0.00	562.50 (1.25 x bearing		
Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
At Heel	At Toe	Minimum	Maximum	y	d
2.06	0.8	2.00	1.50	3.05	1.39
1.44	0.64	1.50	1.00		

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	32 dia. bar at 90 mm c/c
		Other face	32 mm dia. bar at 180 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 120 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32 mm dia. bar at 125 mm c/c
	Distribution Reinforcement	At top and Bottom	20 mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 **KN/m²**

6) HEIGHT :- 20.0 M

Type :- R.C.C. Retaining Wall With Shear Key

Stress Table:-

6.Flood protection wall at height of 20.0m							
Sr. No	Case	Stresses (KN/m²)		Permissible Stresses (KN/m²)		Shear key Dimension	
		At Toe	At Toe	Minimum	Maximum	y	d
1	Static Condition	66.21	169.73	0.00	400.00	3.90	1.77
2	Seismic Condition	-17.58	253.57	0.00	562.50 (1.25 x bearing		
Sr. No	Case	Factor Of Safety		Allowable Factor Of safety		Shear key Dimension	
		At Heel	At Heel	Minimum	Maximum	y	d
1	Static Condition	2.19	0.71	2.00	1.50	3.90	1.77
2	Seismic Condition	1.57	0.58	1.50	1.00		

Reinforcement Table :-

Component	Reinforcement Details (Fe 500)		
Stem	Main Reinforcement	Backfill face	Bundle of 32 mm dia. bar at 140 mm c/c dia. bar at mm c/c
		Other face	32 mm dia. bar at 170 mm c/c
	Distribution Reinforcement	Both face	20 mm dia. bar at 120 mm c/c
Raft	Main Reinforcement	At top and Bottom	Bundle of 32 mm dia. bar at 180 mm c/c mm dia. bar at mm c/c
	Distribution Reinforcement	At top and Bottom	25 mm dia. bar at 150 mm c/c

This wall can be used for bearing pressure = 450 KN/m²

COUNTER-FORT TYPE RETAINING WALL (HEIGHT =10.0M) :

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.8 0 m, bottom width = 0.80 m, height = 9.00 m
2. Heel slab : width = 2.550 m, thickness = 1.00 m
3. Toe Slab : width = 4.600 m, thickness = 1.00 m
4. Shear Key : depth = 0.80 m, width = 1.25 m
5. Counterfort : width = 0.80 m

   spacing of counterfort = l = 3.5m c/c

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	HORIZONTAL BARS
	UP TO 5.0 M HT.	32 Ø @ 90	32 Ø @ 110	12 Ø @ 100 C/C ON EACH FACE
	5.0 M TO 10.0 M	32 Ø @ 180	32 Ø @ 220	12 Ø @ 100 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 120	20 Ø @ 240	12 Ø 2 legged @ 300 C/C

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL .	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 120	20 Ø @ 240	12 Ø 2 legged @ 300 C/C

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COUNTERFORT	MAIN STEEL (INCLINED BARS)	HORIZONTAL TIES	VERTICAL TIES
		25 Ø 150 c/c	12 Ø LINKS @ 100 C/C	12 Ø LINKS @ 100 C/C

COUNTER-FORT TYPE RETAINING WALL (HEIGHT =12.0M) :

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.8 0 m, bottom width = 0.80 m, height = 11.00 m
2. Heel slab : width = 2.000 m, thickness = 1.00 m
3. Toe Slab : width = 6.200 m, thickness = 1.00 m
4. Shear Key : depth = 0.80 m, width = 1.25 m
5. Counterfort : width = 0.80 m
   spacing of counterfort = l = 3.5m c/c

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	HORIZONTAL BARS
	UP TO 6.0 M HT.	32 Ø @ 90	32 Ø @ 110	12 Ø @ 100 C/C ON EACH FACE
	6.0 M TO 12.0 M	32 Ø @ 180	32 Ø @ 220	12 Ø @ 100 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 100	20 Ø @ 200	16 Ø 2 legged @ 300 C/C

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL .	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 100	20 Ø @ 200	16 Ø 2 legged @ 300 C/C

The details of reinforcement in COUNTERFORT are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COUNTERFORT	MAIN STEEL (INCLINED BARS)	HORIZONTAL TIES	VERTICAL TIES
		25 Ø 150 c/c	12 Ø LINKS @ 100 C/C	12 Ø LINKS @ 100 C/C

COUNTER-FORT TYPE RETAINING WALL (HEIGHT =14.0M) :

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.8 0 m, bottom width = 0.80 m, height = 13.00 m
2. Heel slab : width = 3.500 m, thickness = 1.00 m
3. Toe Slab : width = 7.50 m, thickness = 1.00 m
4. Shear Key : depth = 0.80 m, width = 1.25 m
5. Counterfort : width = 0.80 m spacing of counterfort = l = 3.5m c/c

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	HORIZONTAL BARS
	UP TO 7.0 M HT.	32 Ø @ 90	32 Ø @ 110	12 Ø @ 100 C/C ON EACH FACE
	7.0 M TO 12.0 M	32 Ø @ 180	32 Ø @ 220	12 Ø @ 100 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 100	20 Ø @ 200	16 Ø 2 legged @ 300 C/C

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL .	SHEAR REINFORCEMENT PER M WIDTH.
		32 Ø @ 100	20 Ø @ 200	16 Ø 2 legged @ 300 C/C

The details of reinforcement in COUNTERFORT are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COUNTERFORT	MAIN STEEL (INCLINED BARS)	HORIZONTAL TIES	VERTICAL TIES
		32 Ø 150 c/c	12 Ø LINKS @ 100 C/C	12 Ø LINKS @ 100 C/C

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =10.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.75 m, bottom width = 1.50 m, height = 10.00 m
2. Heel slab : width = 3.500 m, thickness = 0.75 m
3. Toe Slab : width = 1.75 m, thickness = 0.75 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	10.0 M HEIGHT	32 Ø @ 200	32 Ø @ 300	20 Ø @ 300 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 250	12 Ø @ 200

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 250	12 Ø @ 200

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		1.50 X 0.5 M	32 Ø 8 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 1.50X0.5 M	16 Ø 6 BARS	16 Ø 2 BARS	16 Ø BARS, 6 NO.S ON EACH FACE

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =12.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.75 m, bottom width = 2.0 m, height = 12.00 m
2. Heel slab : width = 4.0 m, thickness = 1.0 m
3. Toe Slab : width = 2.0 m, thickness = 1.0 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	12.0 M HEIGHT	32 Ø @ 150	32 Ø @ 300	20 Ø @ 250 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 200	12 Ø @ 150

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 200	12 Ø @ 150

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		2.0 X 0.5 M	32 Ø 10 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 2.0 X 0.5 M	16 Ø 8 BARS	16 Ø 2 BARS	16 Ø BARS, 7 NO.S ON EACH FACE

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =14.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 0.75 m, bottom width = 2.5 m, height = 14.00 m
2. Heel slab : width = 4.5 m, thickness = 1.0 m
3. Toe Slab : width = 2.5 m, thickness = 1.0 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	14.0 M HEIGHT	32 Ø @ 110	32 Ø @ 200	20 Ø @ 200 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 120	12 Ø @ 150

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		32 Ø @ 120	12 Ø @ 150

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		2.5 X 0.5 M	32 Ø 14 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 2.5 X 0.5 M	16 Ø 10 BARS	16 Ø 2 BARS	16 Ø BARS, 8 NO.S ON EACH FACE

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =16.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 1.0 m, bottom width = 2.75 m, height = 16.00 m
2. Heel slab : width = 5.5 m, thickness = 1.2 m
3. Toe Slab : width = 2.75 m, thickness = 1.2 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	16.0 M HEIGHT	PROVIDE BUNDLES OF 2 BARS 32 Ø @ 150	32 Ø @ 200	20 Ø @ 150 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	12 Ø @ 150

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	12 Ø @ 150

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		2.75 X 0.5 M	32 Ø 16 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 2.75 X 0.5 M	20 Ø 7 BARS	16 Ø 2 BARS	16 Ø BARS, 8 NO.S ON EACH FACE

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =18.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 1.5 m, bottom width = 3.25 m, height = 18.00 m
2. Heel slab : width = 5.5 m, thickness = 1.2 m
3. Toe Slab : width = 3.25 m, thickness = 1.2 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	18.0 M HEIGHT	PROVIDE BUNDLES OF 2 BARS 32 Ø @ 150	32 Ø @ 200	20 Ø @ 150 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	12 Ø @ 150

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	12 Ø @ 150

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		3.25 X 0.5 M	32 Ø 18 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 3.25 X 0.5 M	20 Ø 10 BARS	16 Ø 2 BARS	16 Ø BARS, 10 NO.S ON EACH FACE

RCC CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAMS SECTION (HEIGHT =20.0M):

As per the calculations final dimensions of retaining wall are as below;

1. Stem : top width = 1.5 m, bottom width = 4.5 m, height = 20.00 m
2. Heel slab : width = 5.8 m, thickness = 1.5 m
3. Toe Slab : width = 4.7 m, thickness = 1.5 m

DETAILS OF REINFORCEMENT

The details of reinforcement in stem are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	STEM	VERTICAL BARS ON *SOIL FACE*	VERTICAL BARS ON OTHER *FACE*	DISTRIBUTION STEEL
	20.0 M HEIGHT	PROVIDE BUNDLES OF 2 BARS 32 Ø @ 150	32 Ø @ 150	25 Ø @ 150 C/C ON EACH FACE

The details of reinforcement in heel are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	HEEL SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	16 Ø @ 200

The details of reinforcement in toe are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM	
1.	TOE SLAB	TOP AND BOTTOM STEEL	DISTRIBUTION STEEL
		PROVIDE BUNDLES OF 2 BARS 32 Ø @ 100	16 Ø @ 200

The details of reinforcement in STIFFNESS COLUMN @5.0M clear spacing are tabulated below:-

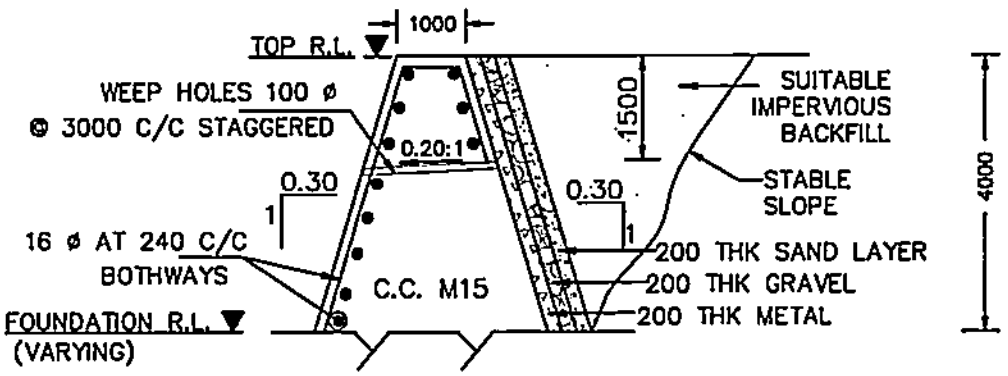
SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	COLUMN	COLUMN SIZE	VERTICAL REINFORCEMENT @ 0.8 % of Cross Section	LATERAL REINFORCEMENT
		4.5 X 0.5 M	32 Ø 24 BARS	10 Ø LINKS @ 200 C/C

The details of reinforcement in BRACING BEAM @3.0M clear spacing are tabulated below:-

SR.NO.	COMPONENT	STEEL DIA IN MM AND SPACING IN MM		
1.	BEAM	MAIN REINFORCEMENT	ANCHOR BARS (SPACER BAR = 25 MM Ø)	SIDE FACE REINFORCEMENT
	SIZE 4.5 X 0.5 M	20 Ø 12 BARS	16 Ø 2 BARS	16 Ø BARS, 12 NO.S ON EACH FACE

CROSS SECTION OF GRAVITY RETAINING WALL WITH BOTH SIDES SLOPE

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 4 M



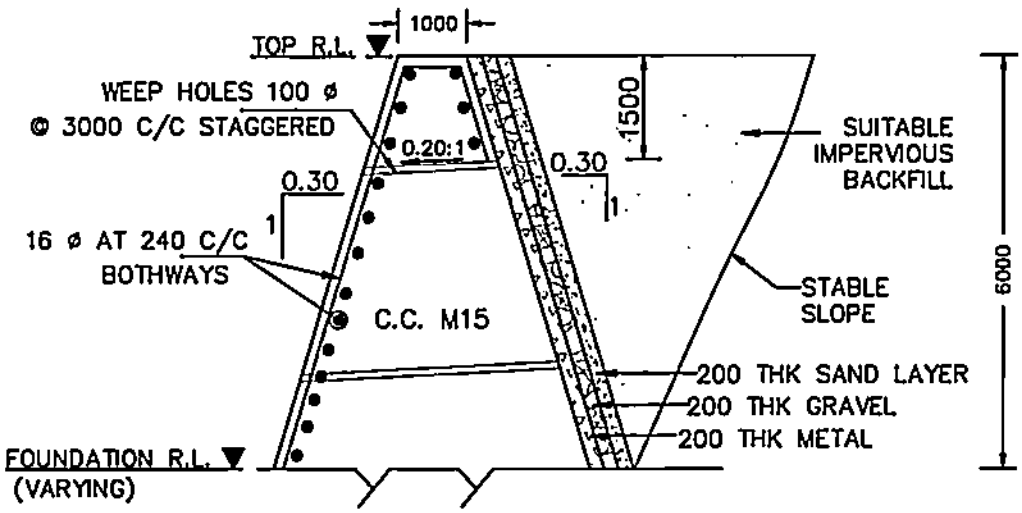
SCALE – 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 6 M



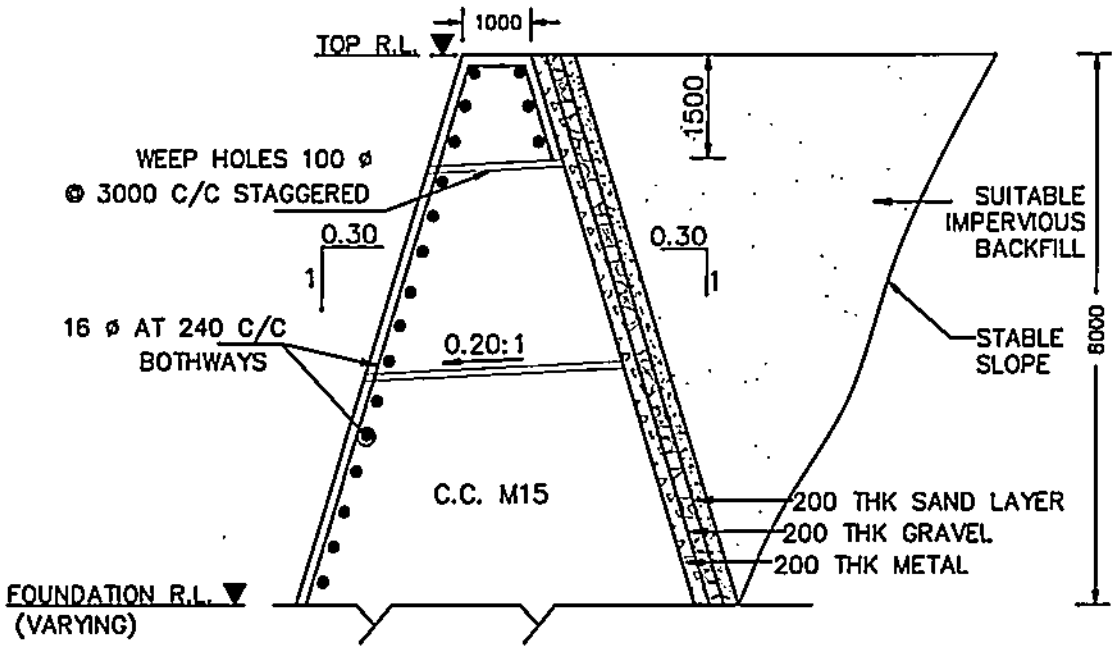
SCALE – 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 8 M



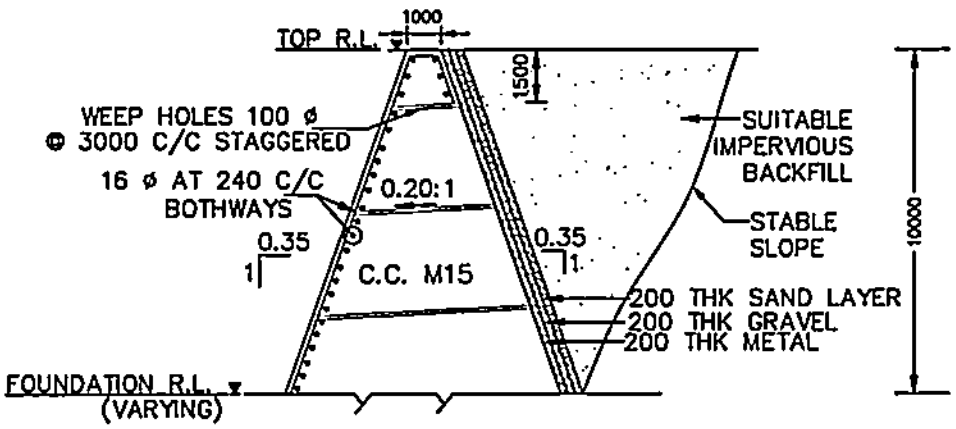
SCALE – 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 10 M



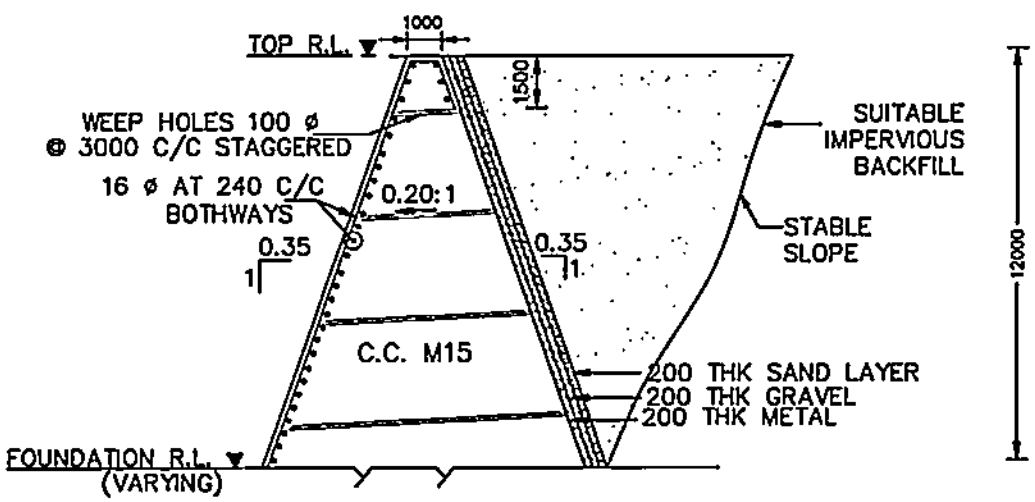
SCALE – 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 12 M



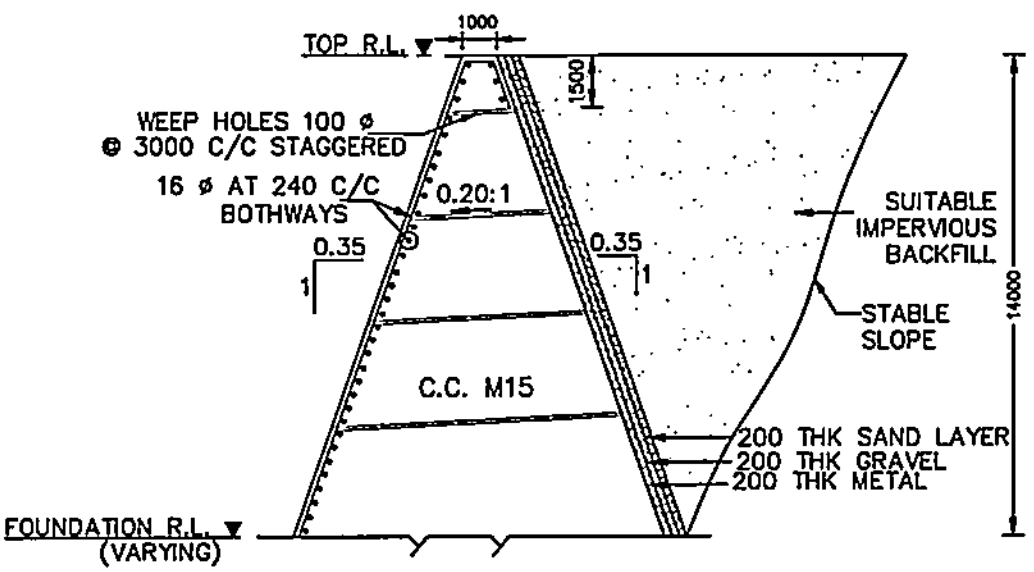
SCALE – 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 14 M



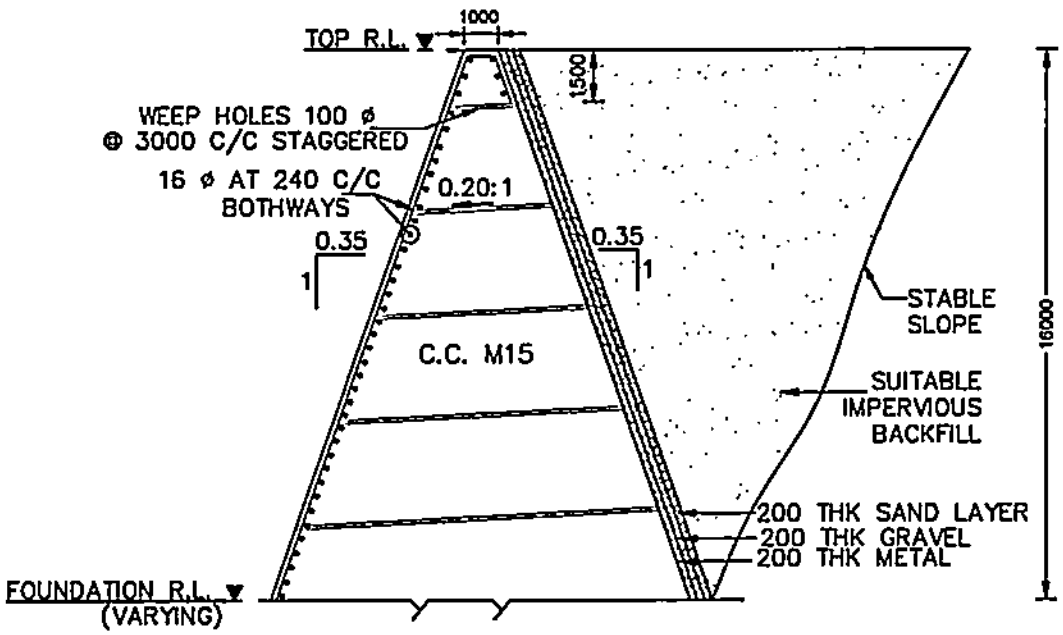
SCALE – 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 16 M



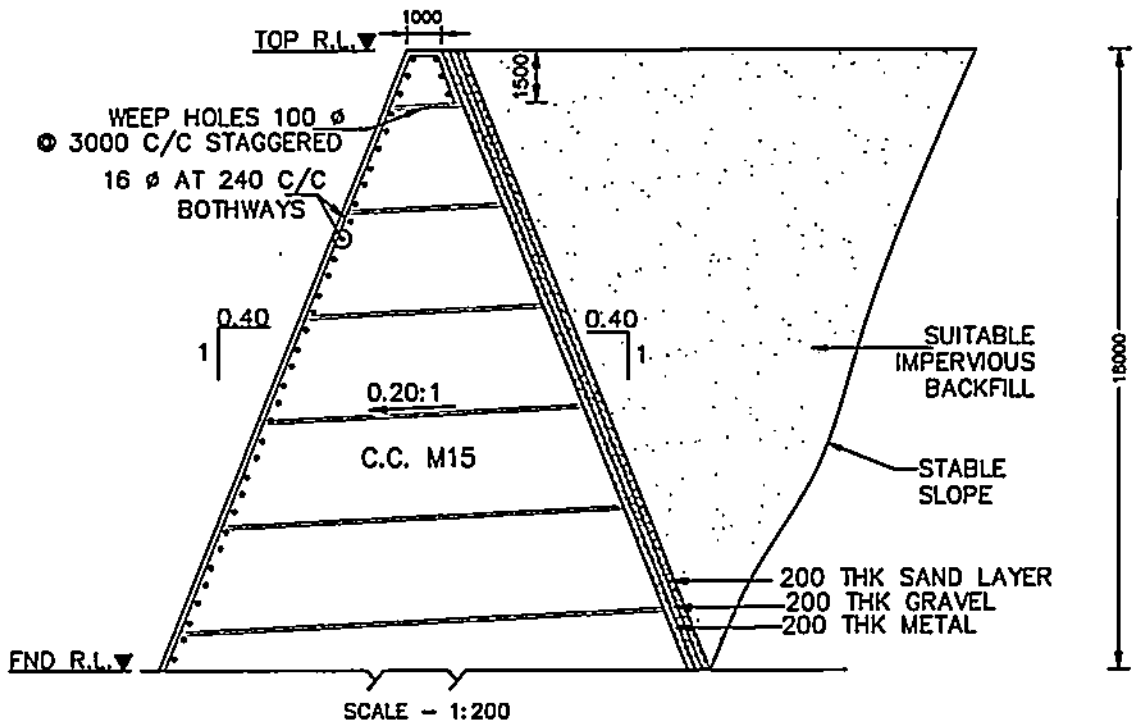
SCALE – 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

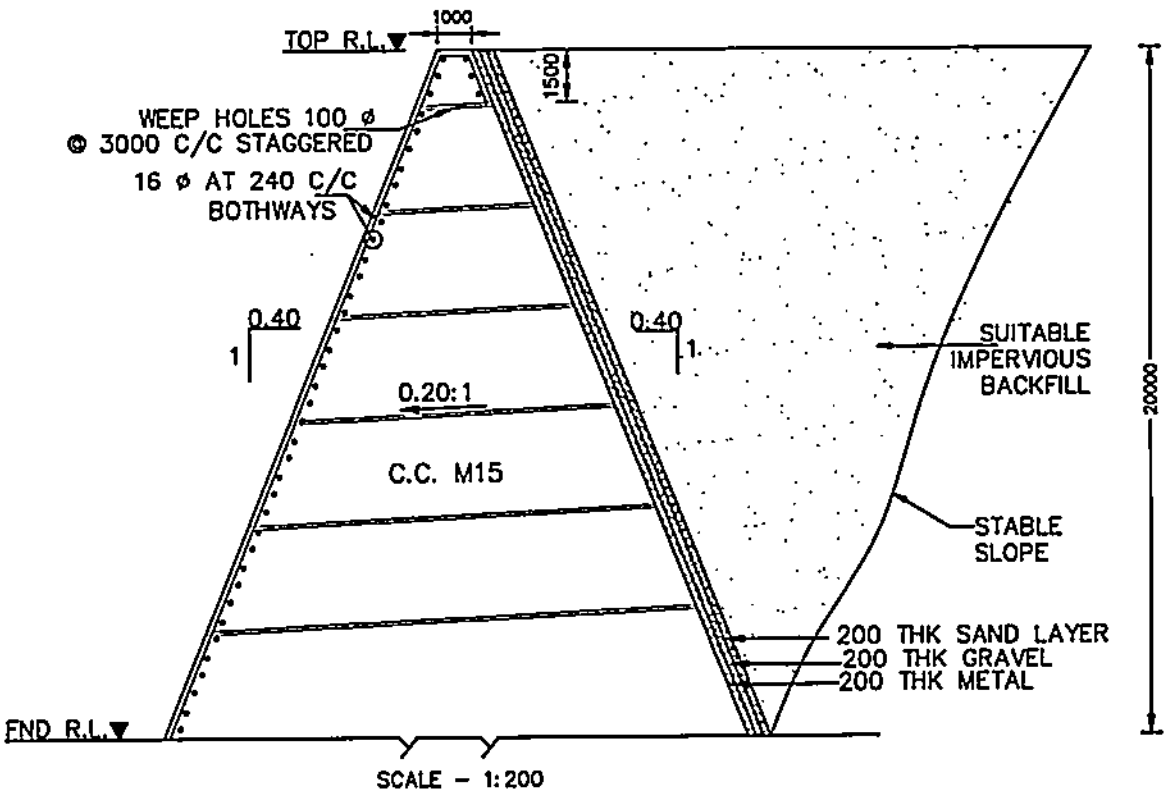
DRAWN BY:		
(P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 18 M



GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N.PATIL) ASSISTANT ENGINEER. CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL
HEIGHT OF WALL 20 M



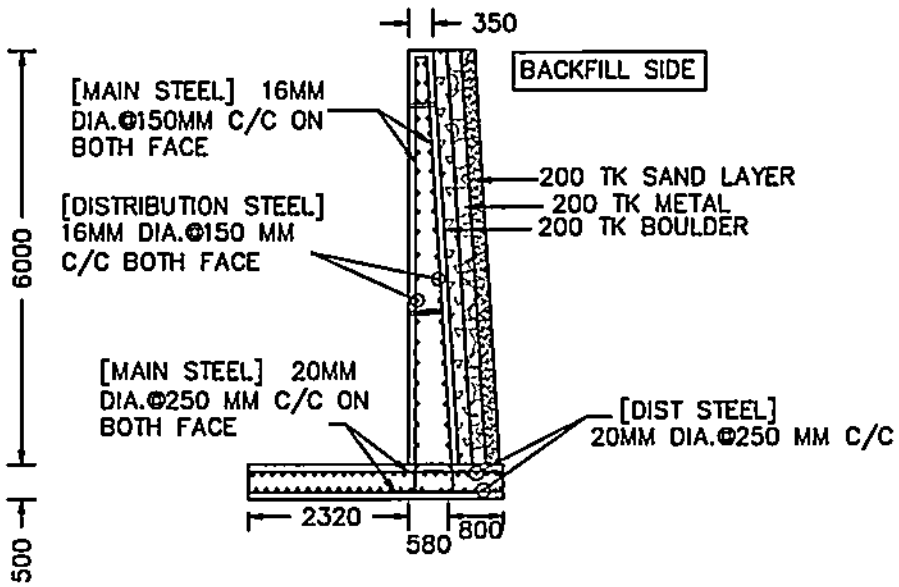
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY:		
(P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(T.N.PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL R.C.C. CANTILEVER TYPE WITHOUT SHEAR KEY

CROSS SECTION OF WALL
FOR HEIGHT 6.00 M



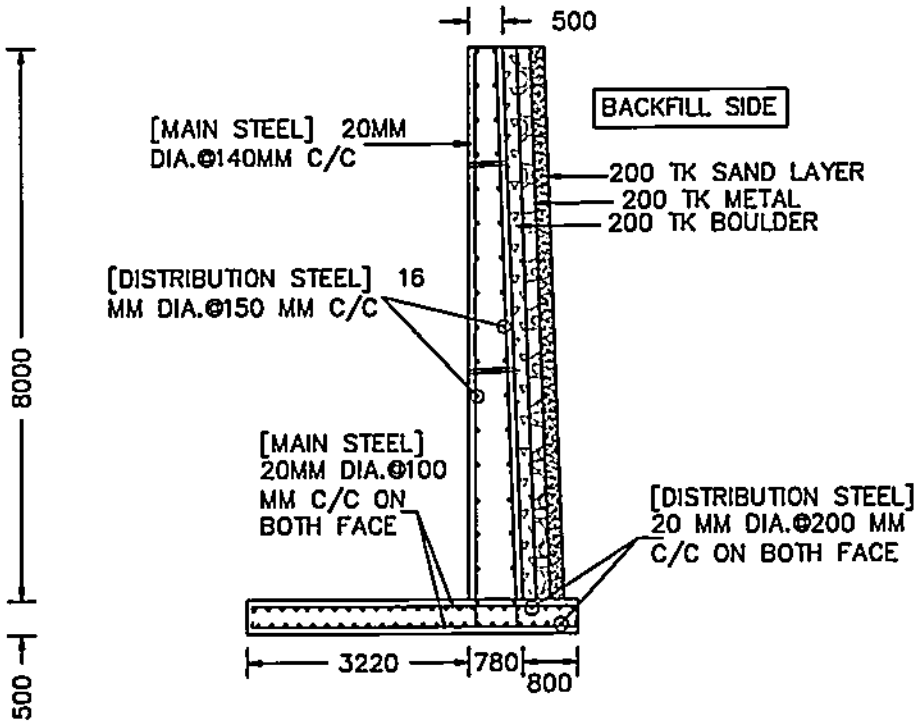
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

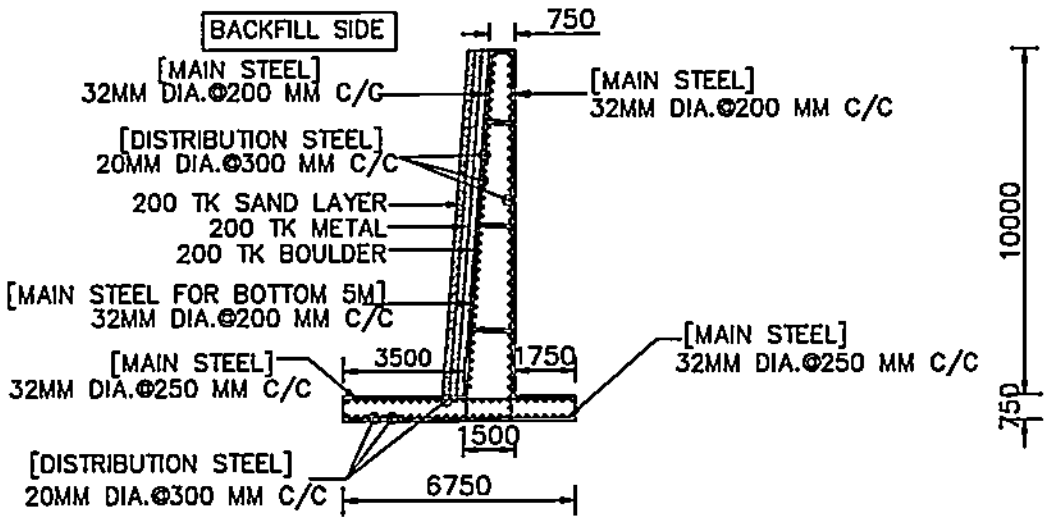
CROSS SECTION OF WALL FOR HEIGHT 8.00 M



SCALE: 1:100

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

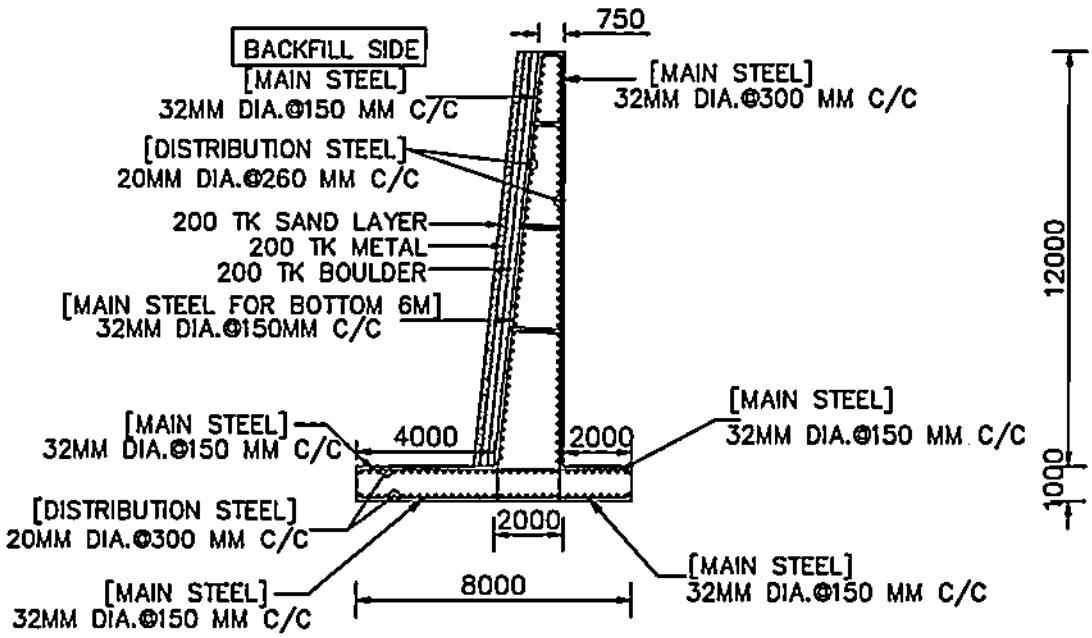
CROSS SECTION OF WALL
FOR HEIGHT 10.00 M



SCALE: 1:200

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 12.00 M



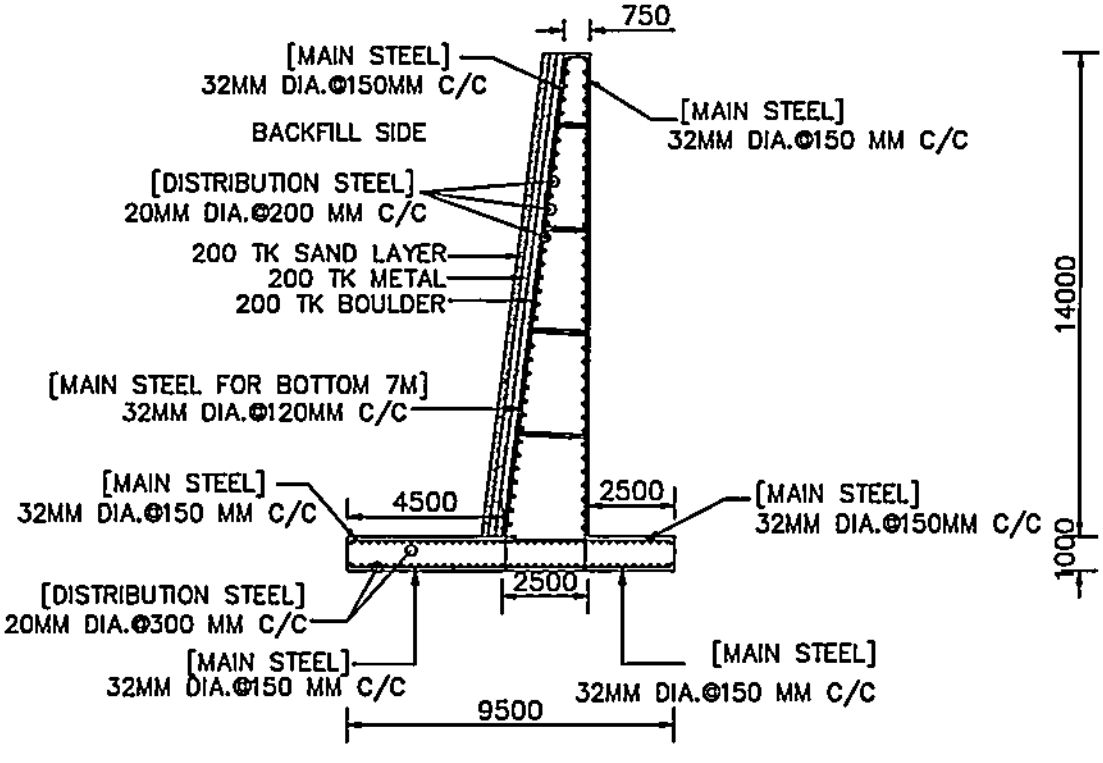
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 14.00 M



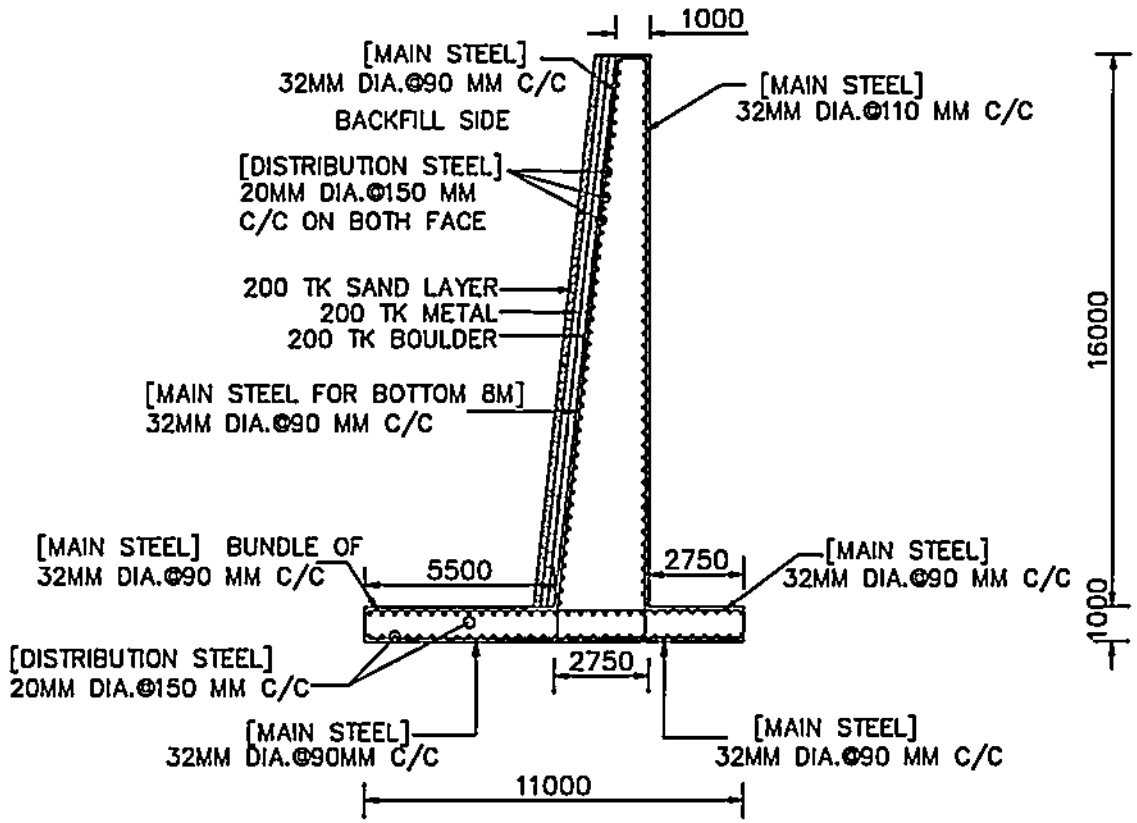
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

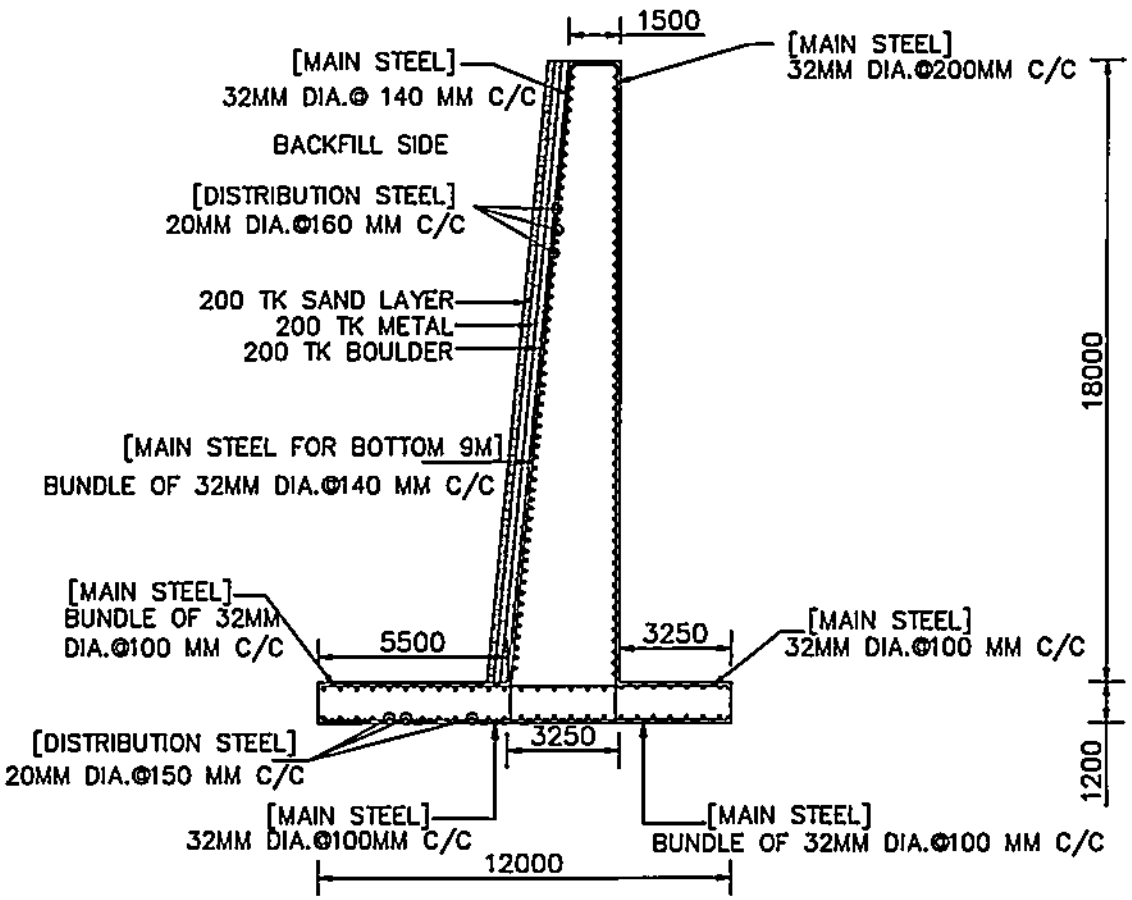
CROSS SECTION OF WALL
FOR HEIGHT 16.00 M



SCALE: 1:200

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER, CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER, CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 18.00 M



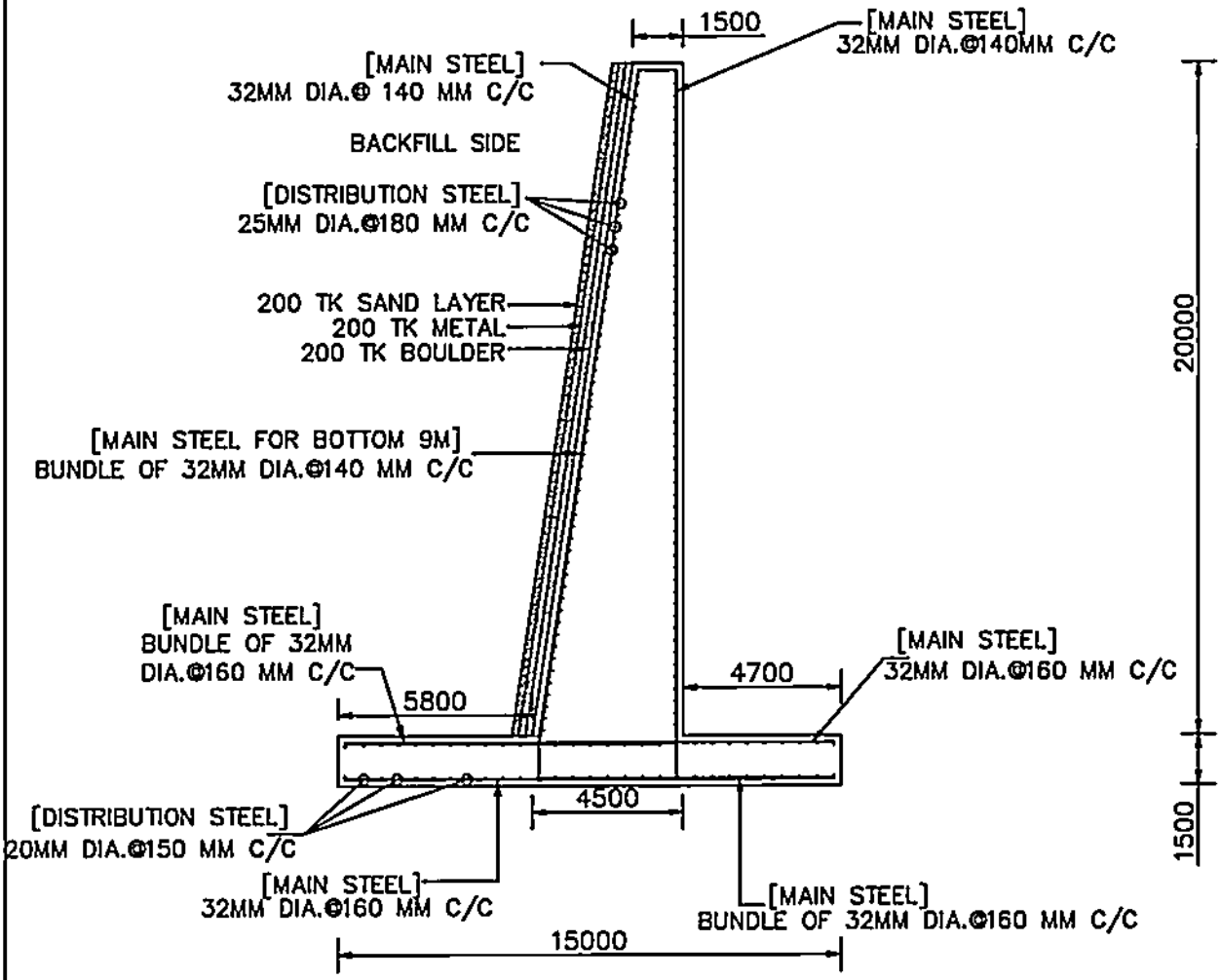
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 20.00 M

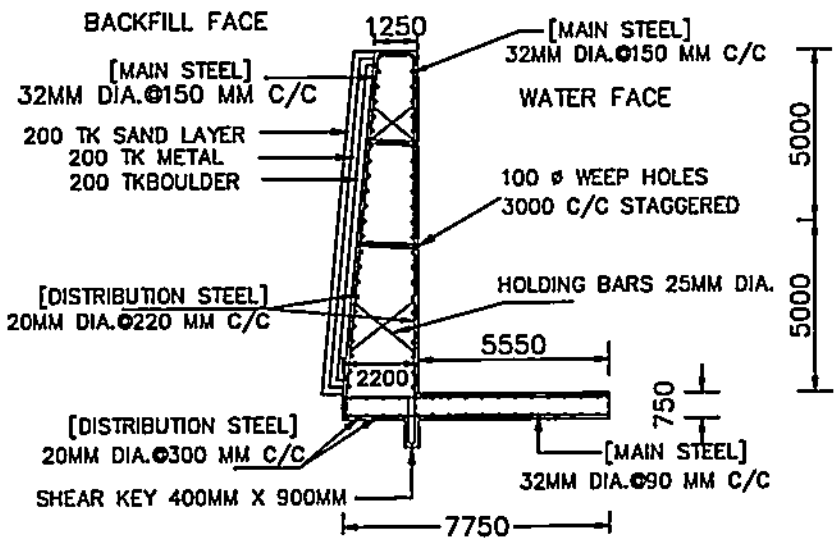


SCALE: 1:200

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
DRAWN BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF RCC FLOOD PROTECTION WALL WITH SHEAR KEY

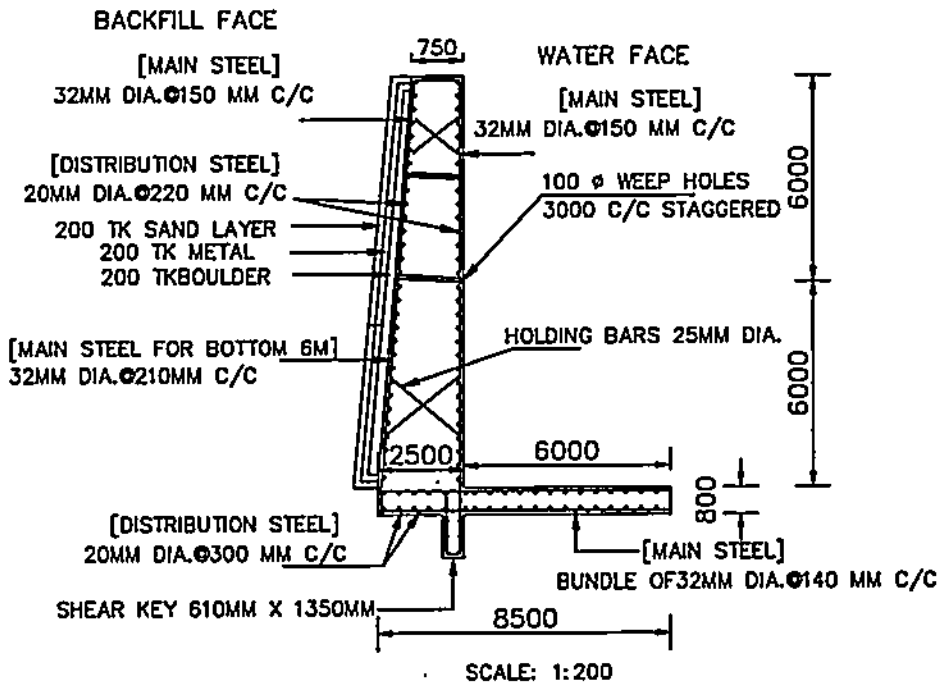
CROSS SECTION OF WALL
FOR HEIGHT 10.00 M



SCALE: 1:200

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

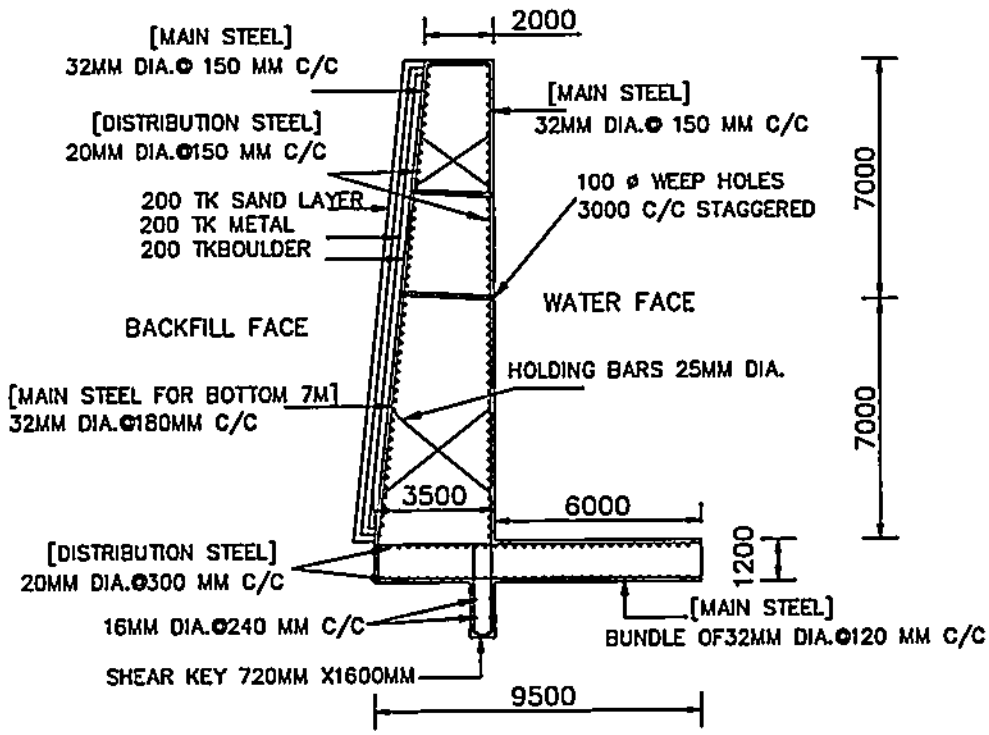
CROSS SECTION OF WALL
FOR HEIGHT 12.00 M



SCALE: 1:200

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 14.00 M



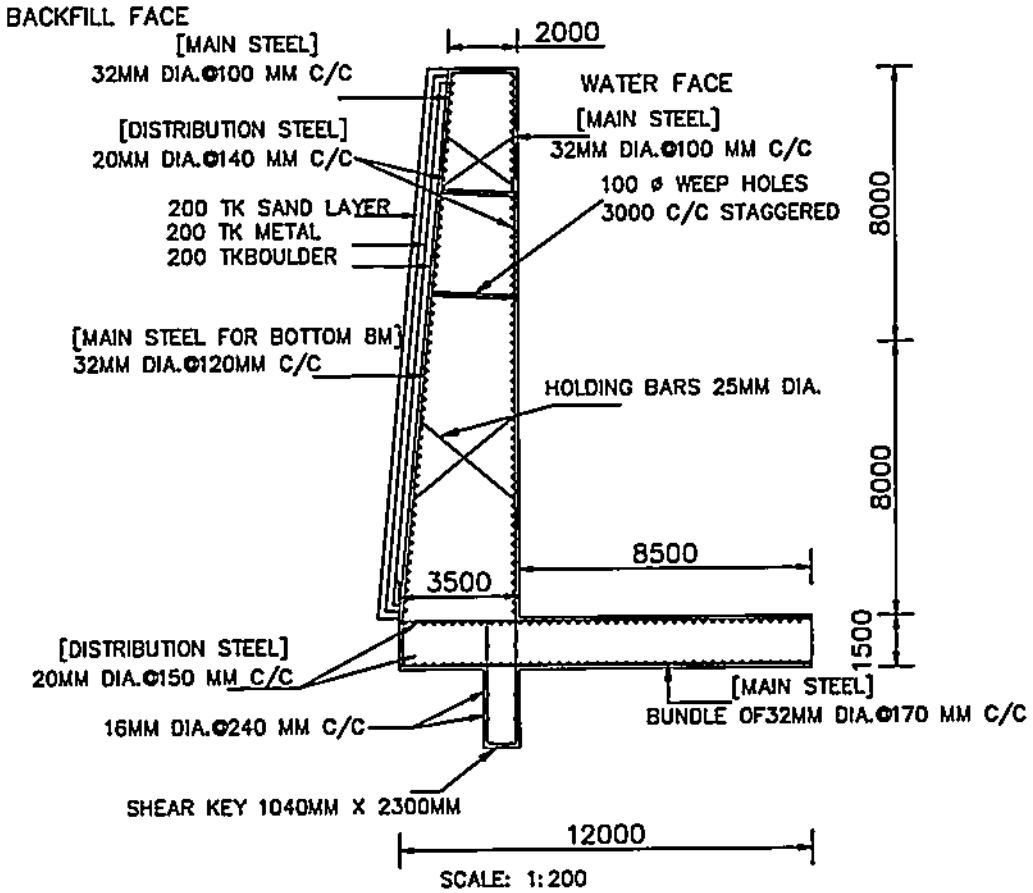
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

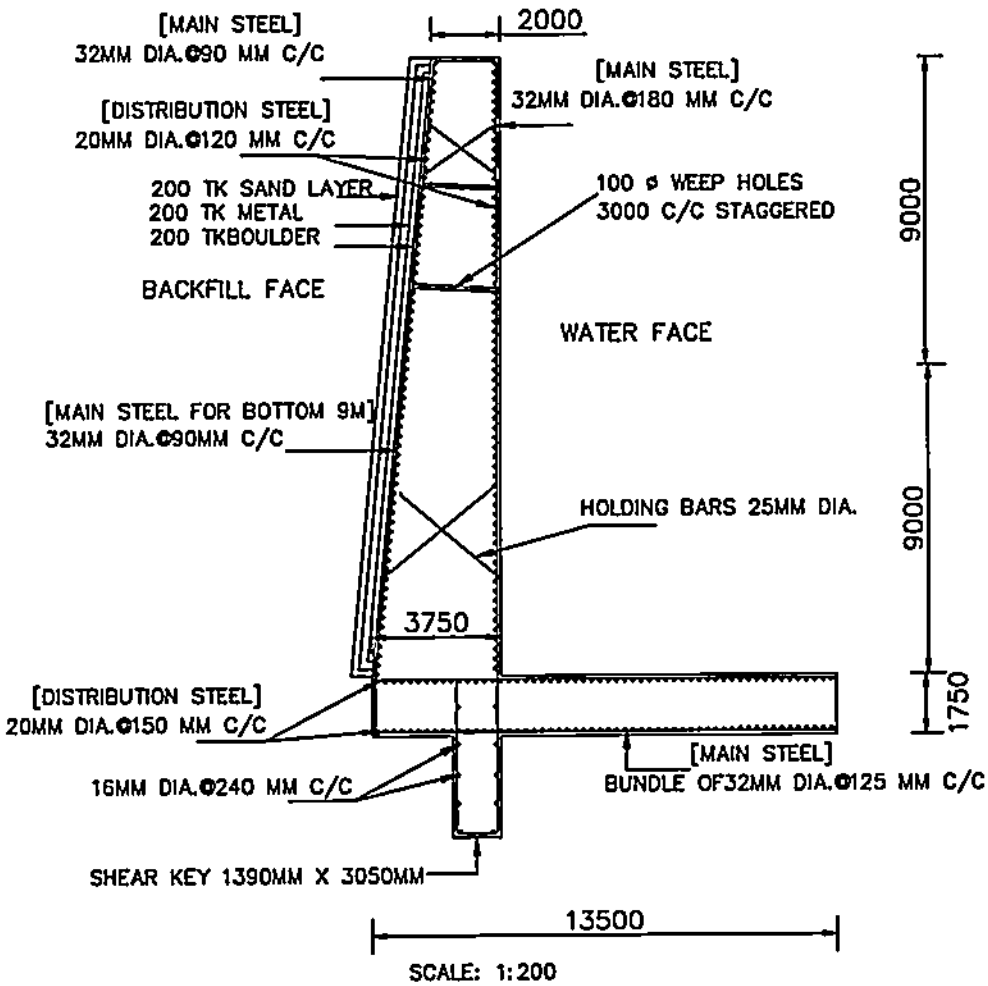
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 16.00 M



GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 18.00 M



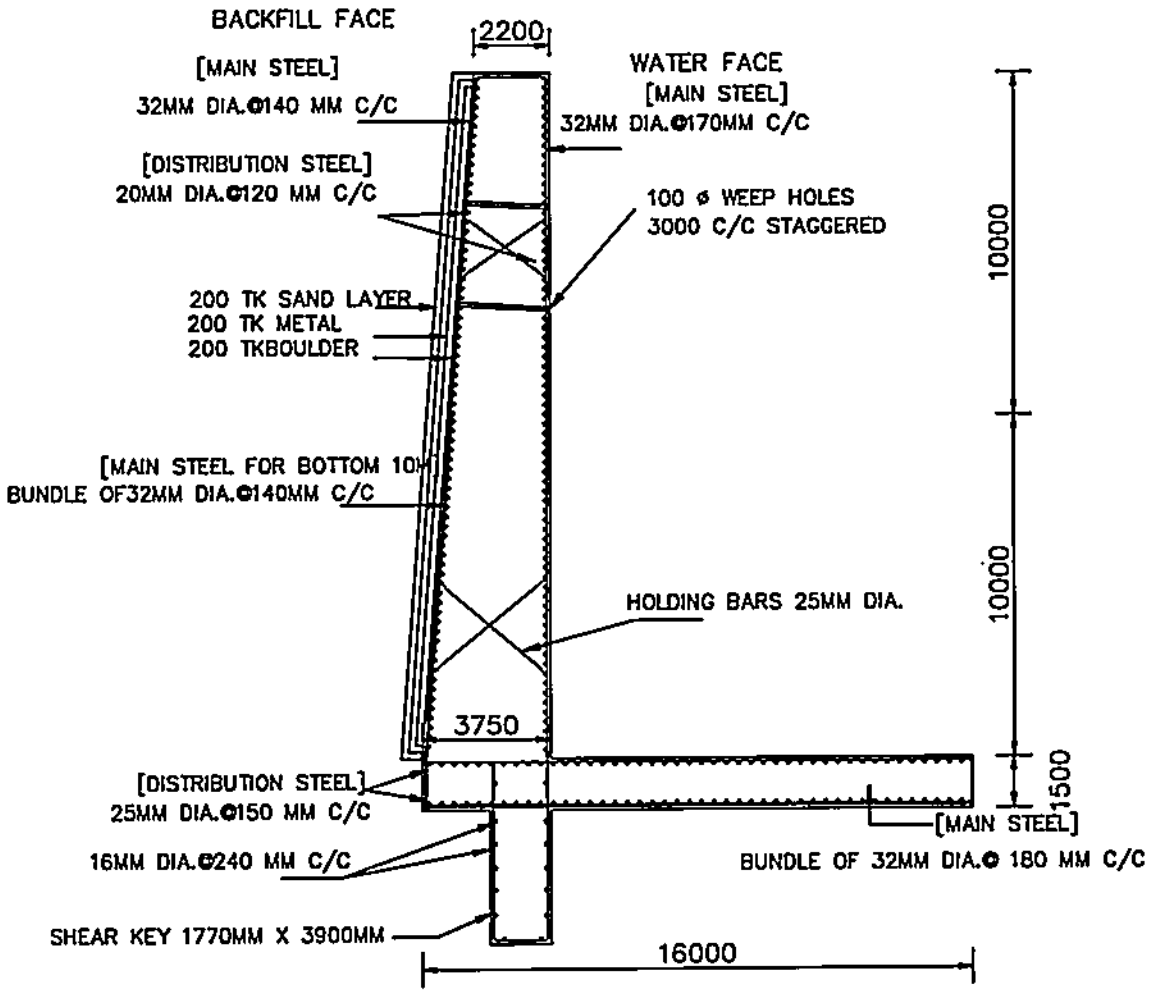
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 20.00 M



SCALE: 1:200

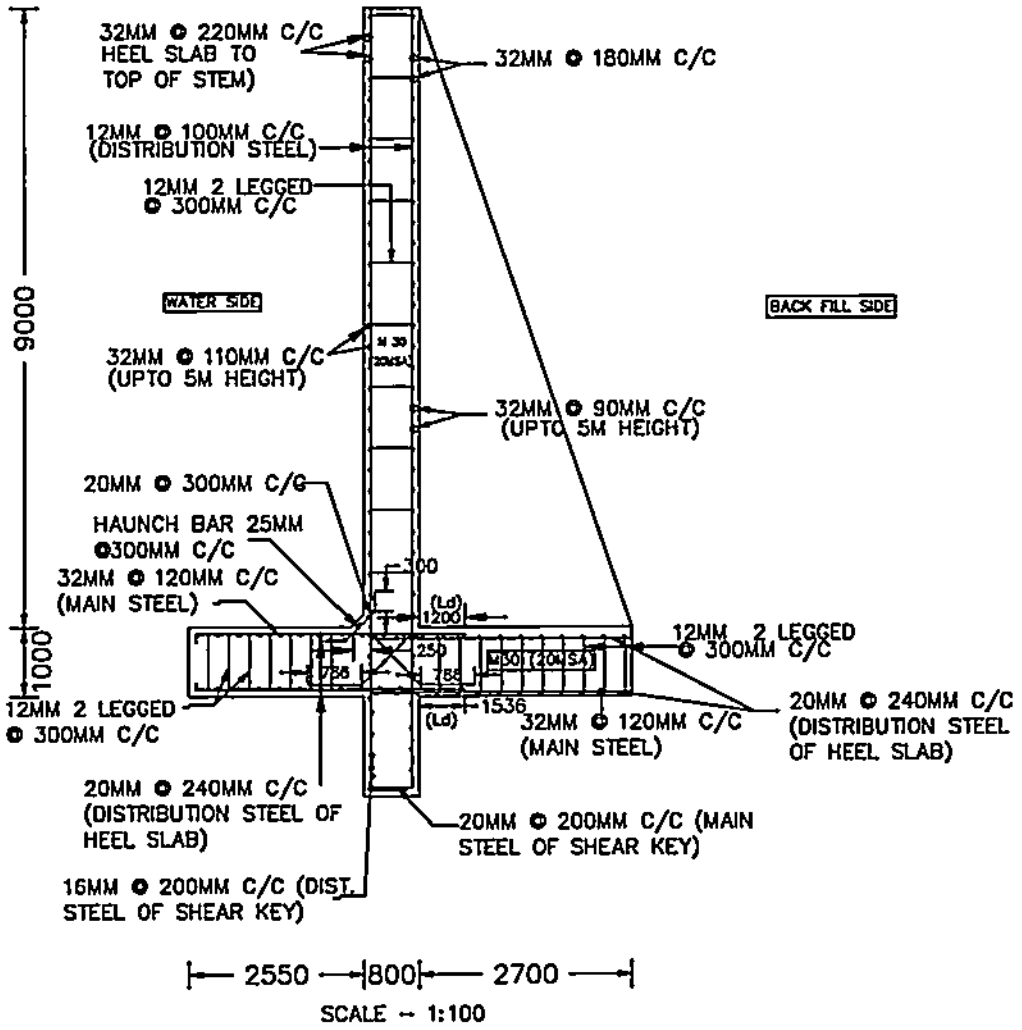
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF COUNTERFORT
FLOOD PROTECTION WALL

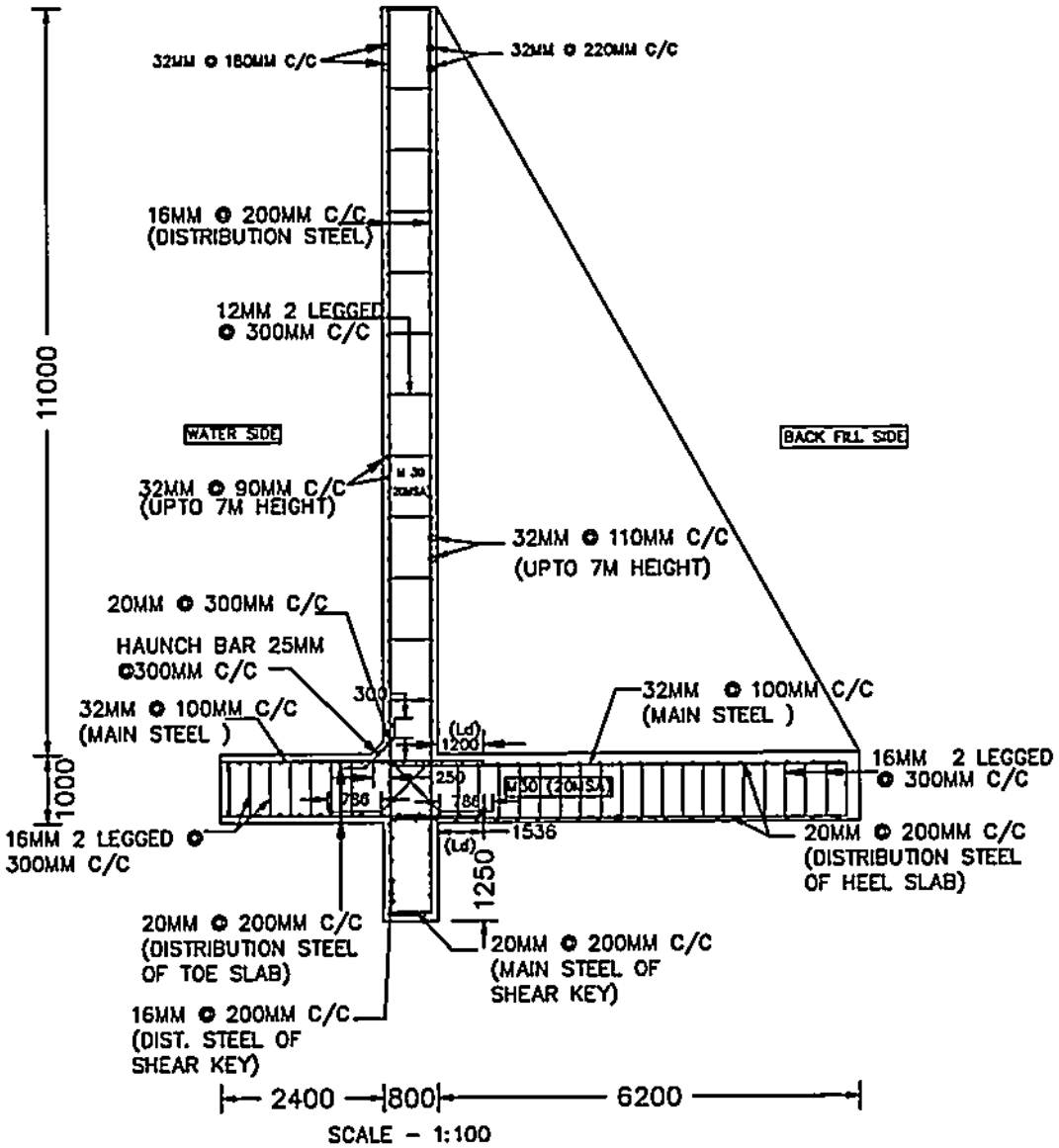
CROSS SECTION OF WALL
FOR HEIGHT 10.00 M



SCALE -- 1:100

GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 12.00 M



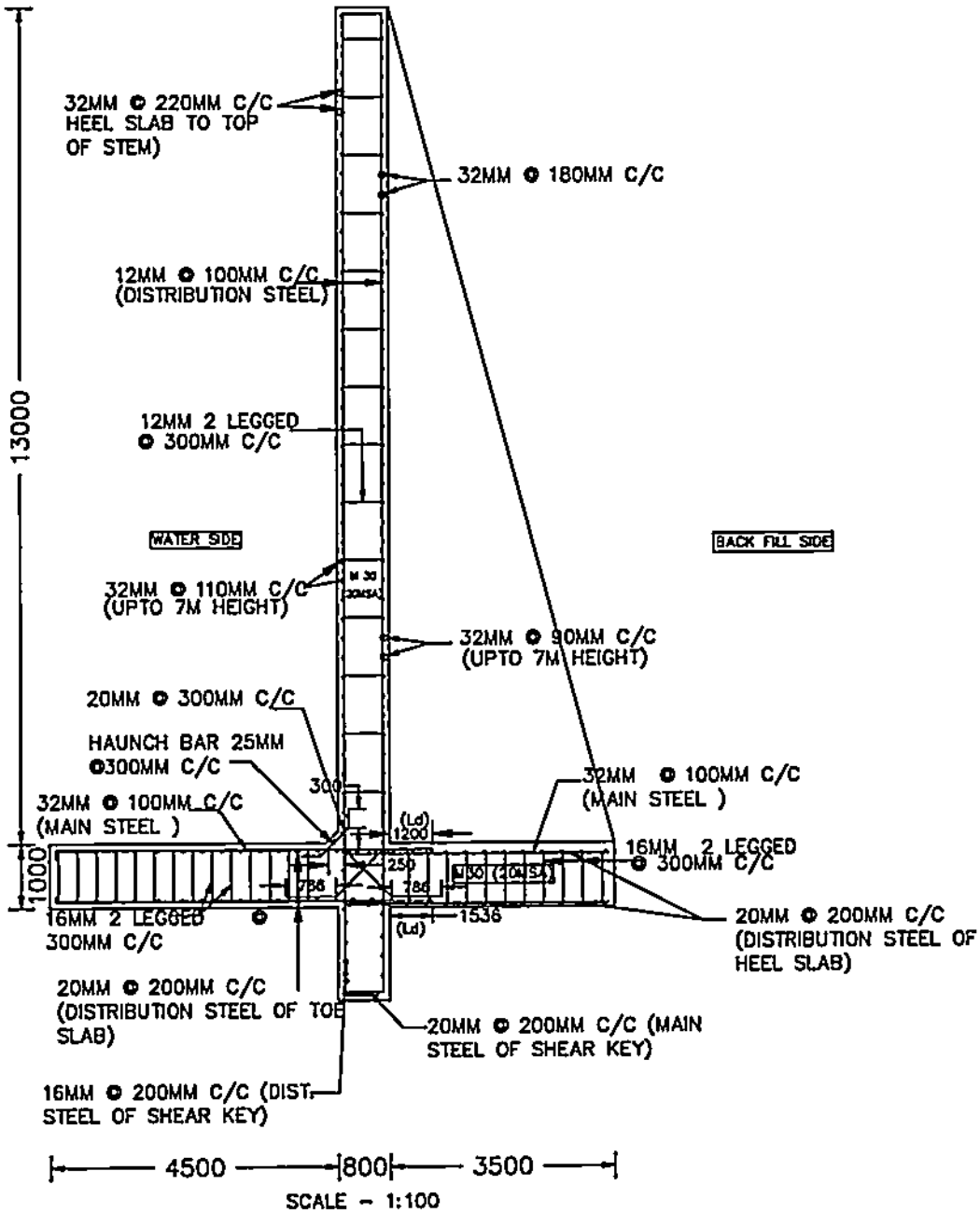
SCALE – 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINEER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL FOR HEIGHT 14.00 M



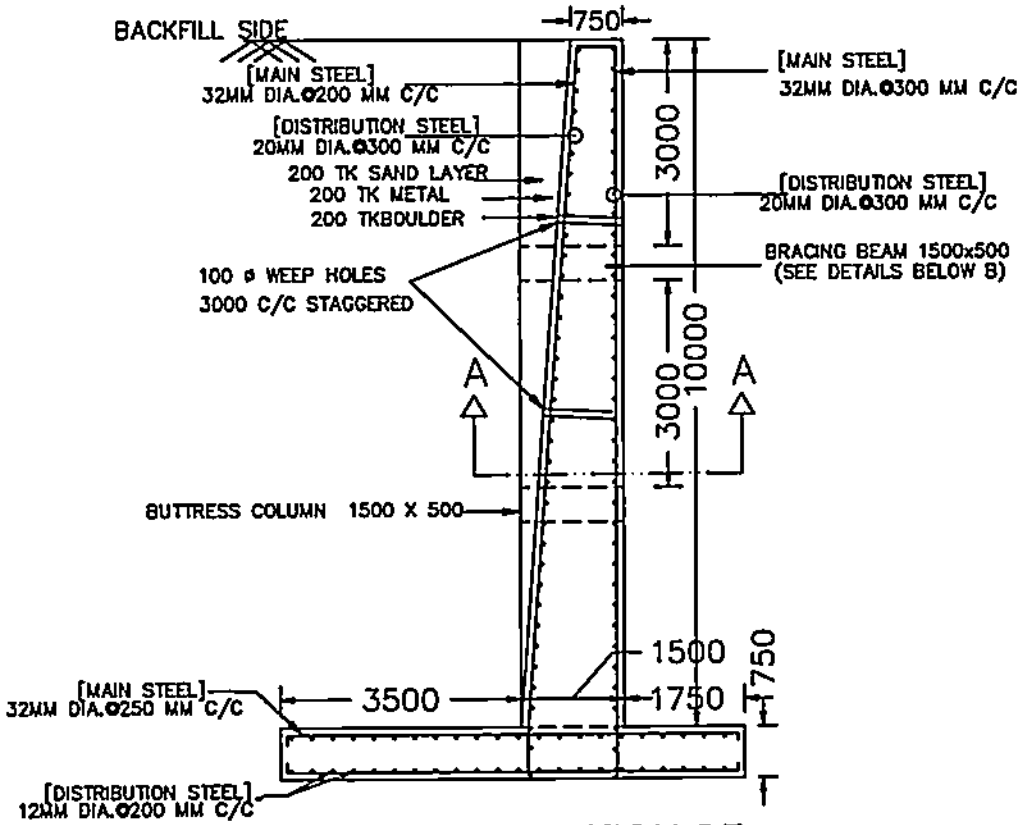
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

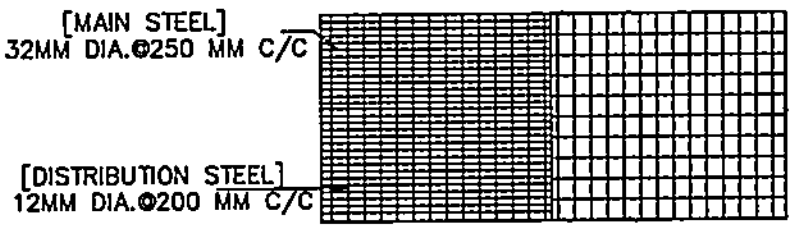
CROSS SECTION OF CANTILEVER WALL WITH BUTTRESS COLUMN AND BRACING BEAM

[PART 1]

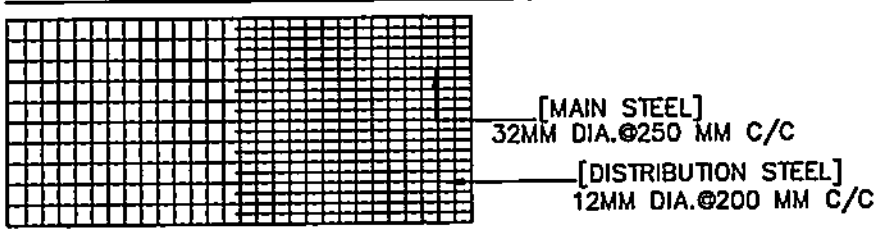


CROSS SECTION OF WALL FOR HEIGHT 10.00 M

SCALE: 1:100



R/F DETAILS FOR RAFT TOP

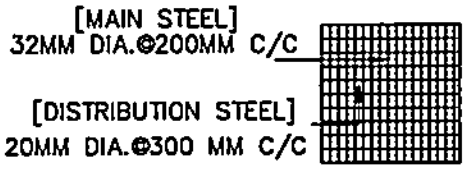


R/F DETAILS FOR RAFT BOTTOM

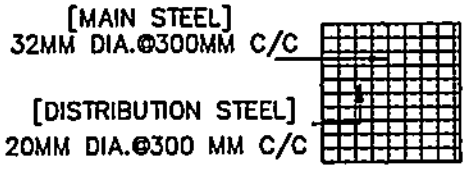
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

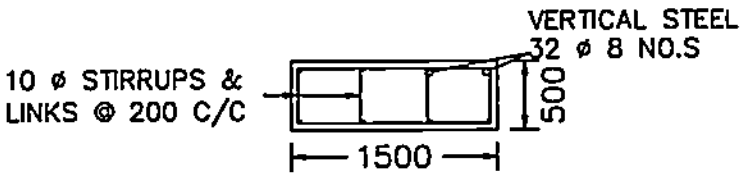
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.H. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER



R/F DETAILS FOR STEM ON BACKFILL SIDE

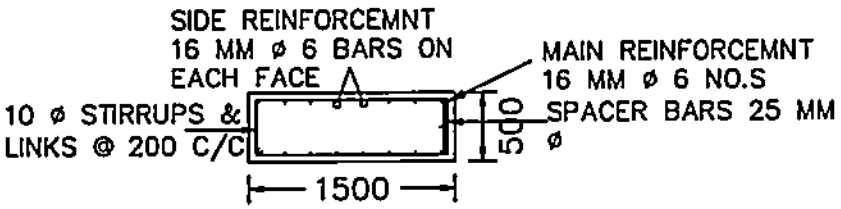


R/F DETAILS FOR STEM ON OTHER SIDE



DETAILS AT A STIFFNESS COLUMN

SCALE-- 1:50

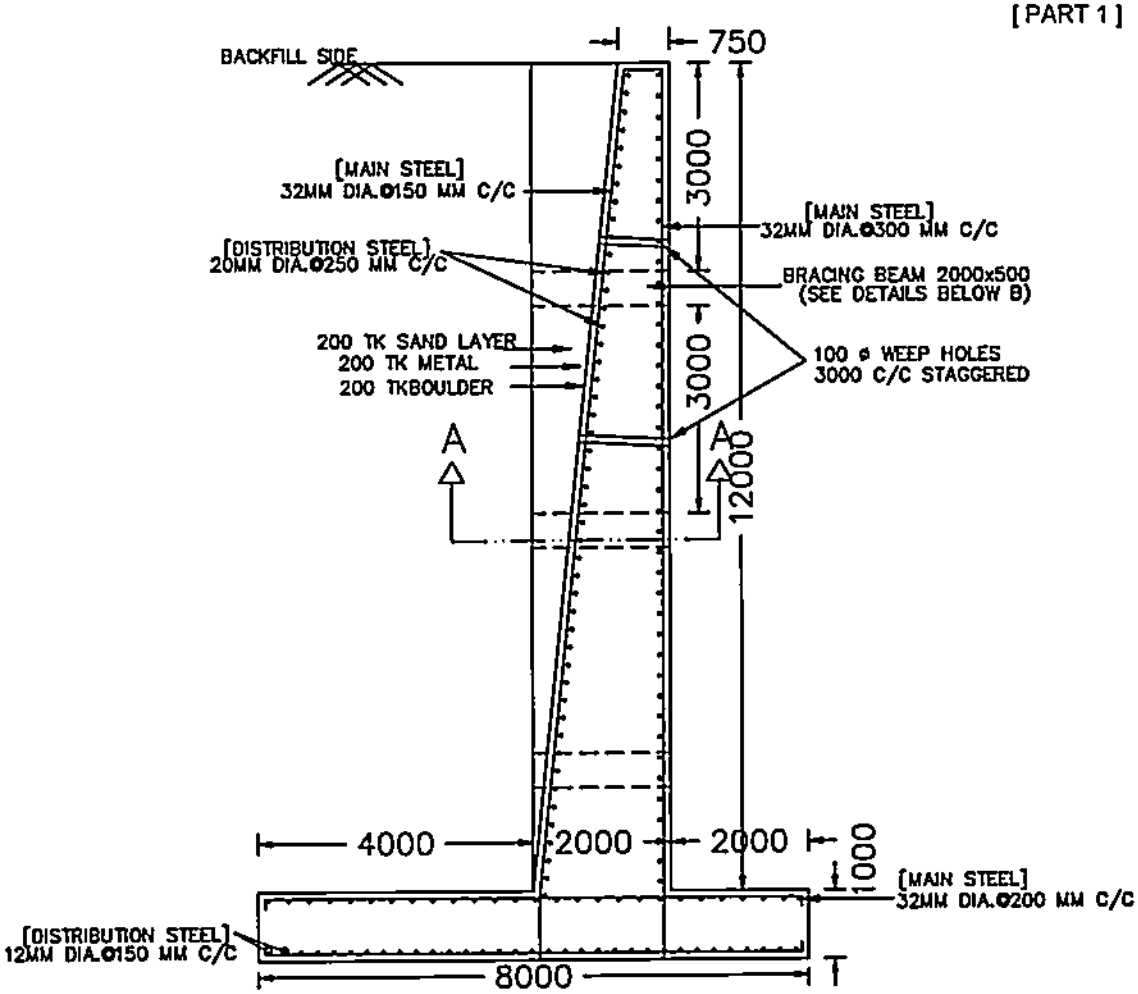


DETAILS AT B OF BRACING BEAM

SCALE-- 1:50

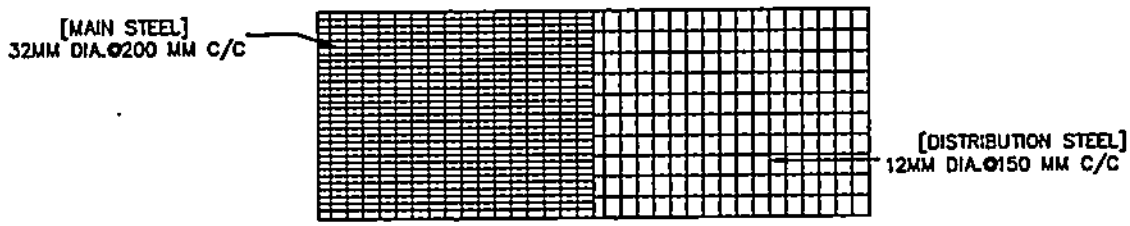
GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

[PART 1]



CROSS SECTION OF WALL FOR HEIGHT 12.00 M

SCALE: 1:100

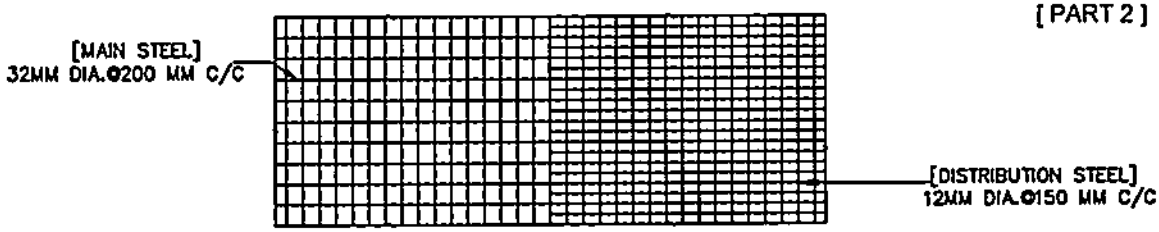


R/F DETAILS FOR RAFT TOP

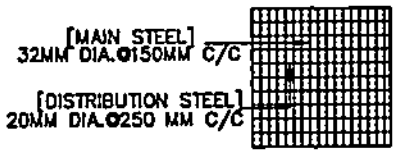
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

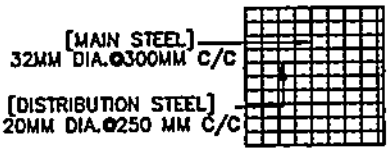
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER



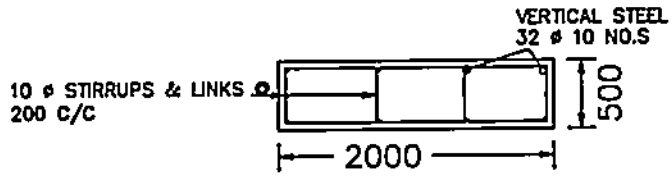
R/F DETAILS FOR RAFT BOTTOM



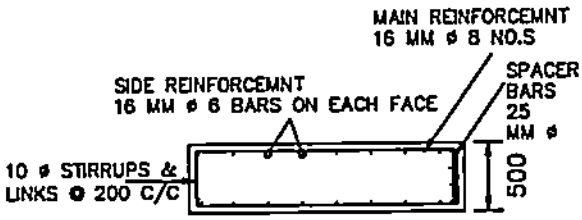
R/F DETAILS FOR STEM ON BACKFILL SIDE



R/F DETAILS FOR STEM ON OTHER SIDE



DETAILS AT A
BUTTRESSING COLUMN
SCALE– 1:50



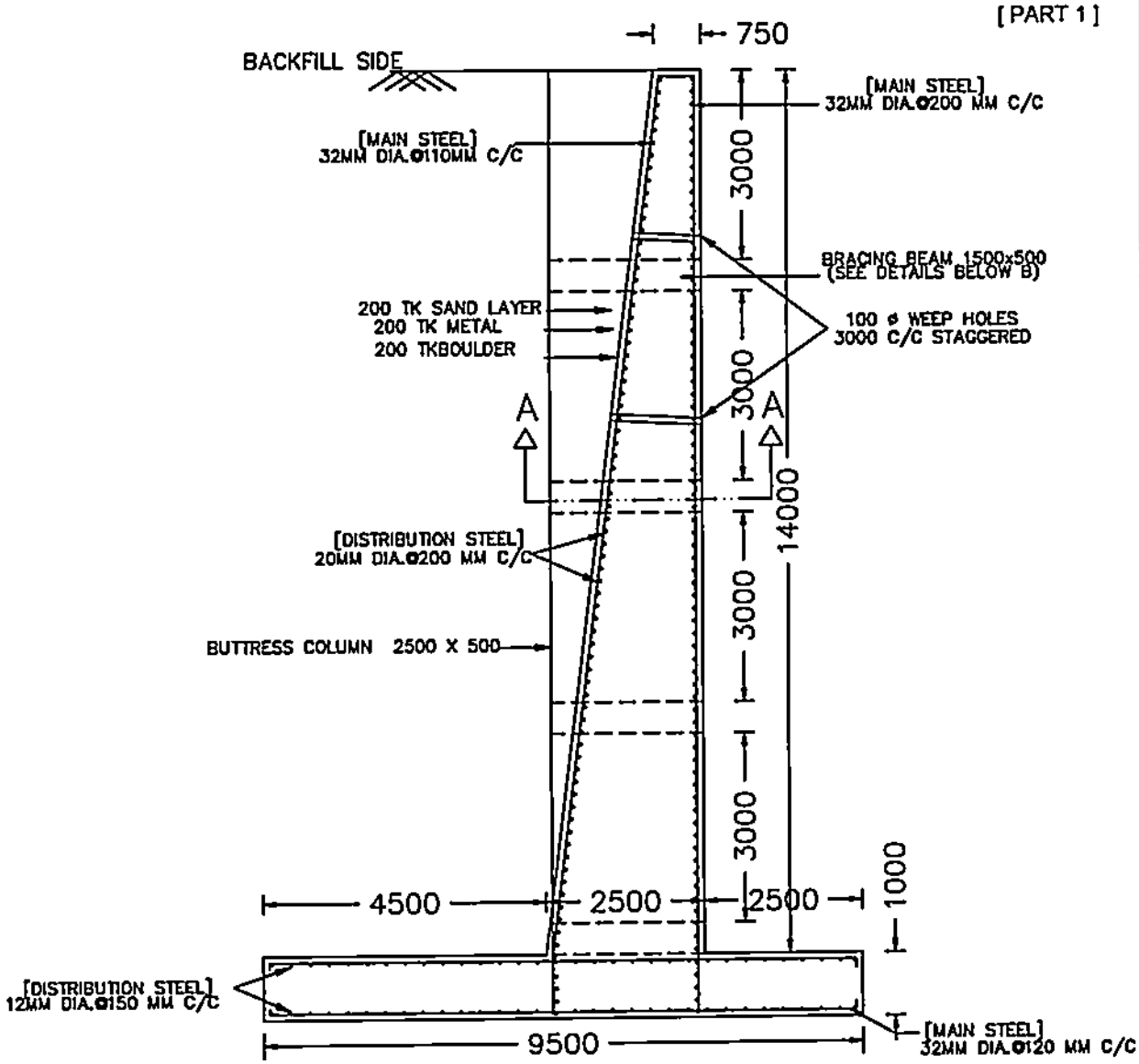
DETAILS AT B
OF BRACING BEAM
SCALE– 1:50

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

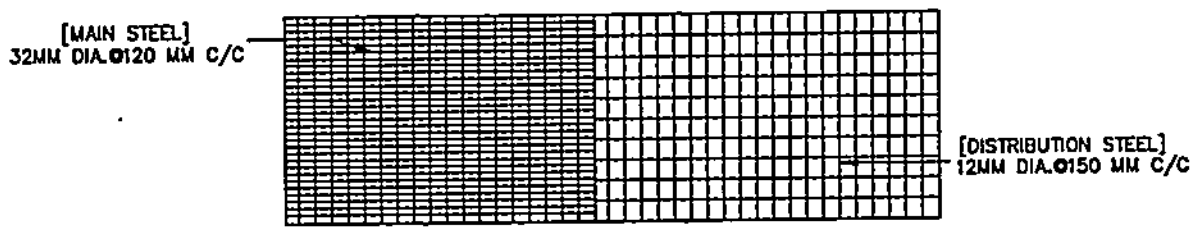
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

[PART 1]



CROSS SECTION OF WALL FOR HEIGHT 14.00 M

SCALE: 1:100

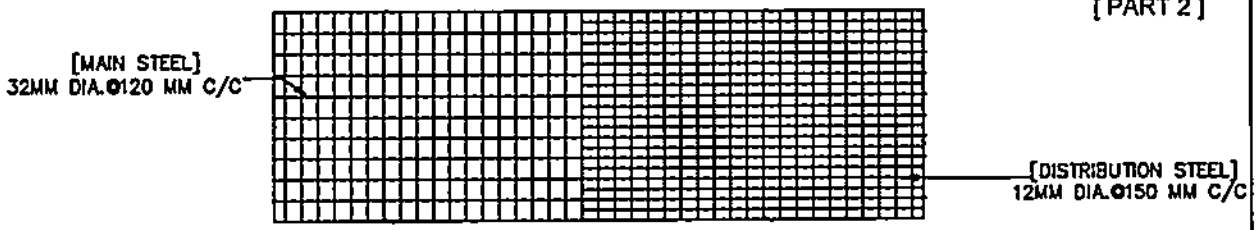


R/F DETAILS FOR RAFT TOP

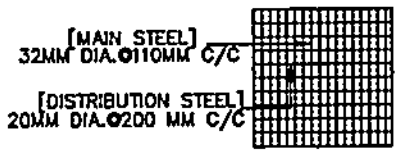
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

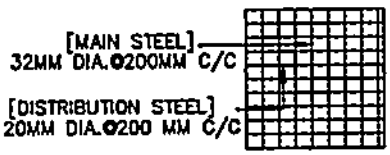
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER



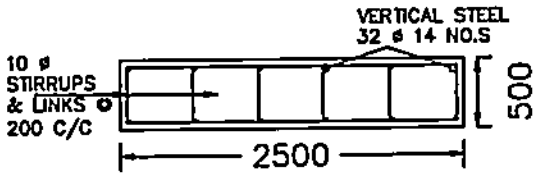
R/F DETAILS FOR RAFT BOTTOM



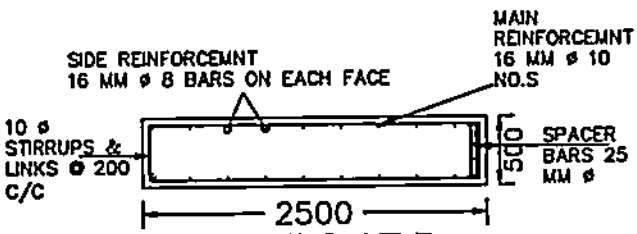
R/F DETAILS FOR STEM ON BACKFILL SIDE



R/F DETAILS FOR STEM ON OTHER SIDE



DETAILS AT A
BUTTRESSING COLUMN (C1)
SCALE– 1:50



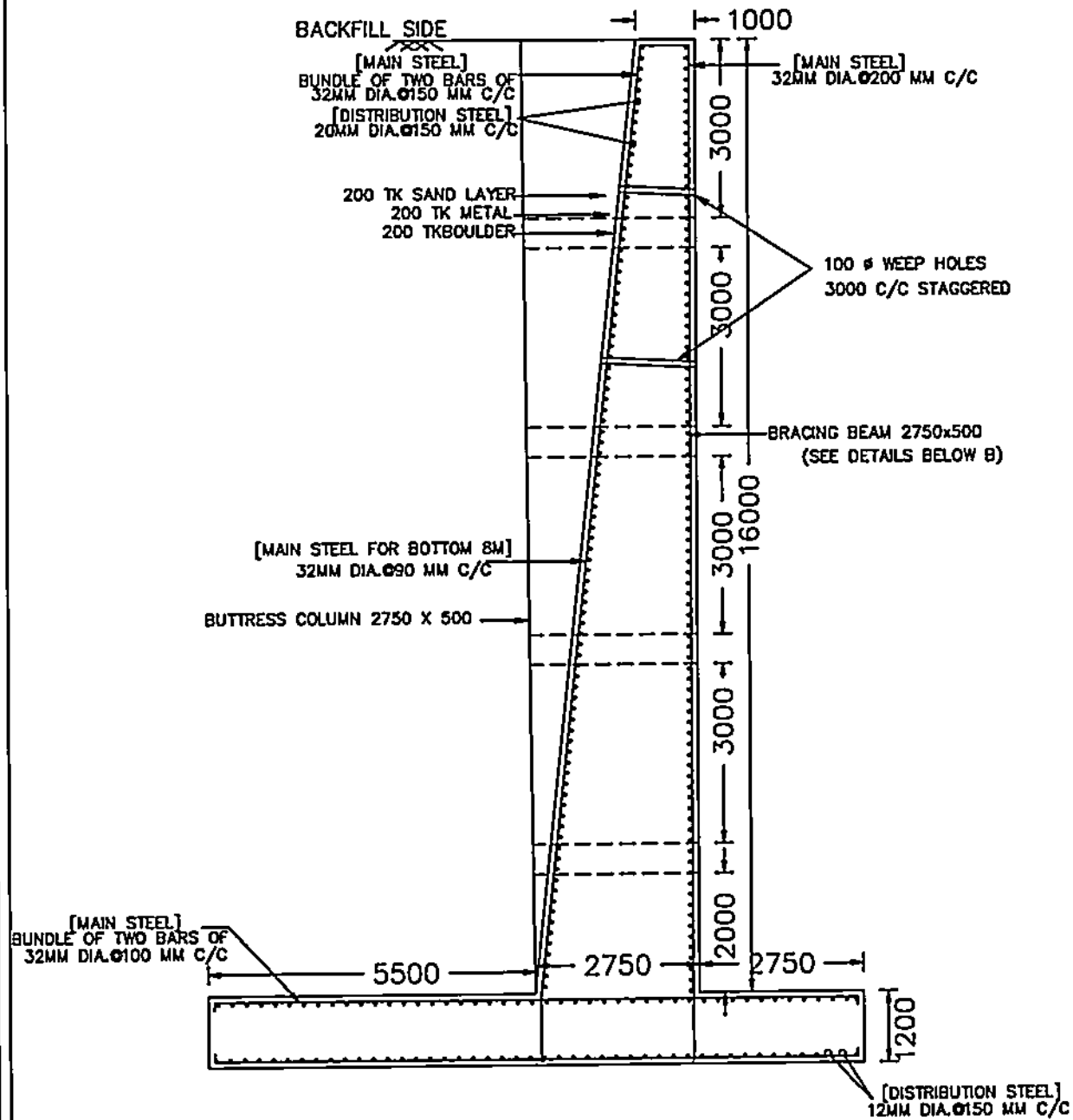
DETAILS AT B
OF BRACING BEAM
SCALE– 1:50

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

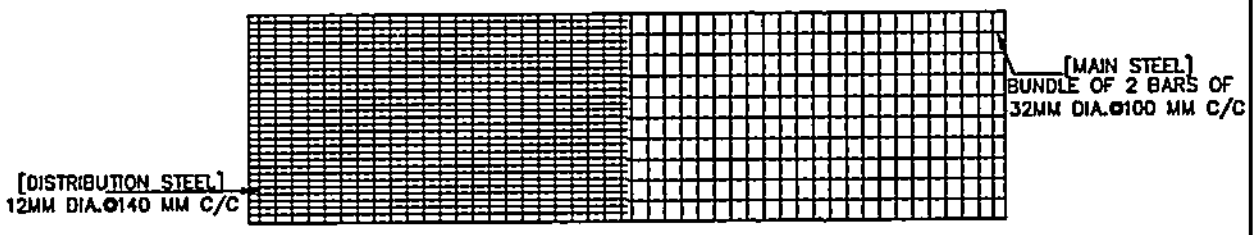
[PART 1]



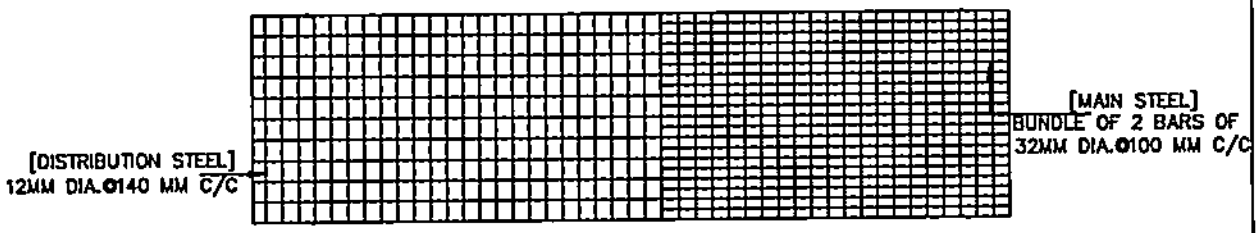
CROSS SECTION OF WALL FOR HEIGHT 16.00 M

SCALE: 1:100

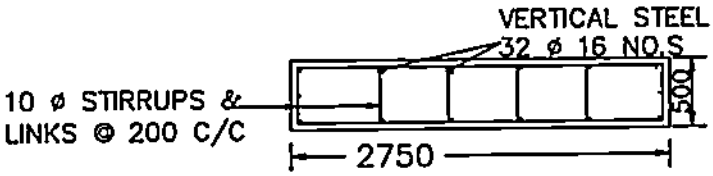
GOVERNMENT OF MAHARASHTRA WATER RESOURCES DEPARTMENT CENTRAL DESIGN ORGNIZATION ,NASHIK -4 (DAM CIRCLE)		
STANDARD FLOOD PROTECTION WALL		
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER



R/F DETAILS FOR RAFT TOP

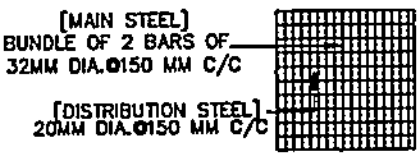


R/F DETAILS FOR RAFT BOTTOM

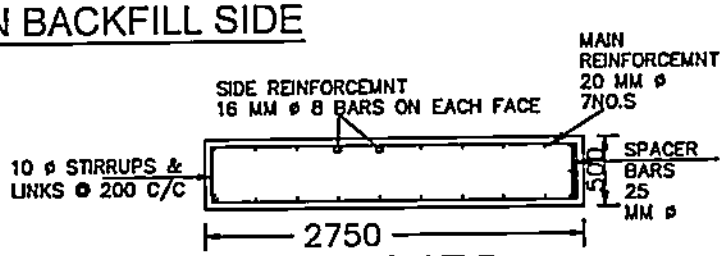


DETAILS AT A BUTTRESSING COLUMN

SCALE– 1:50

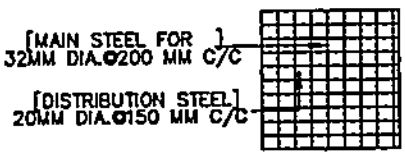


R/F DETAILS FOR STEM ON BACKFILL SIDE



DETAILS AT B OF BRACING BEAM

SCALE– 1:50



R/F DETAILS FOR STEM ON OTHER SIDE

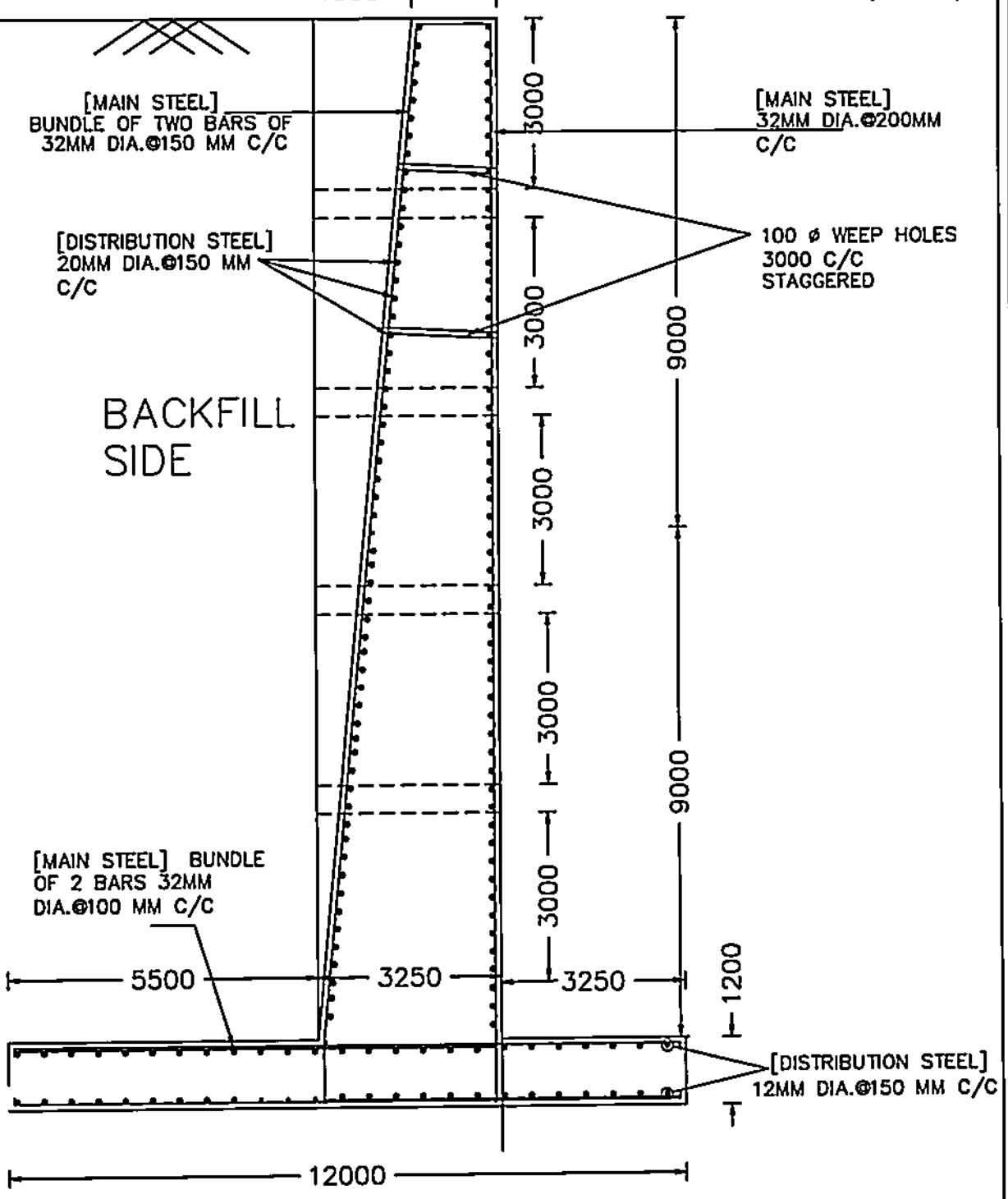
SCALE– 1:50

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

[PART 1]



CROSS SECTION OF WALL FOR HEIGHT 18.00 M

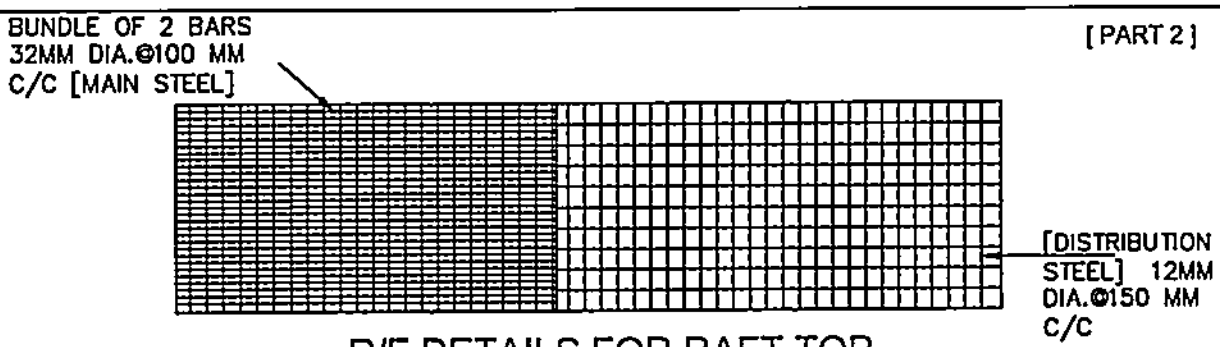
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

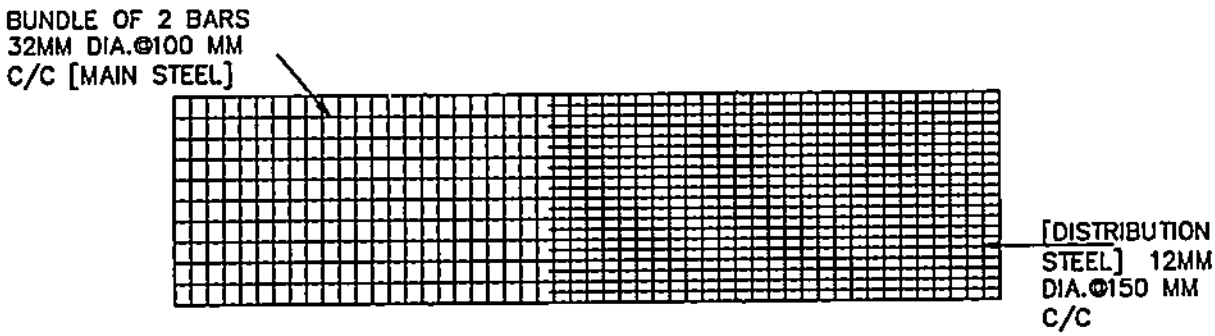
STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

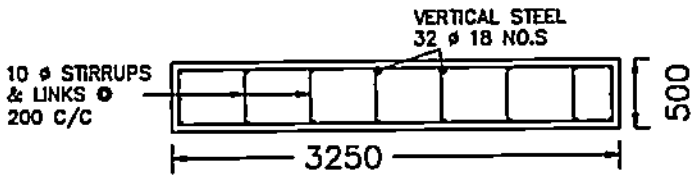
[PART 2]



R/F DETAILS FOR RAFT TOP

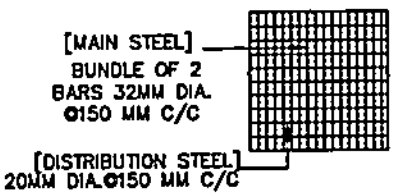


R/F DETAILS FOR RAFT BOTTOM

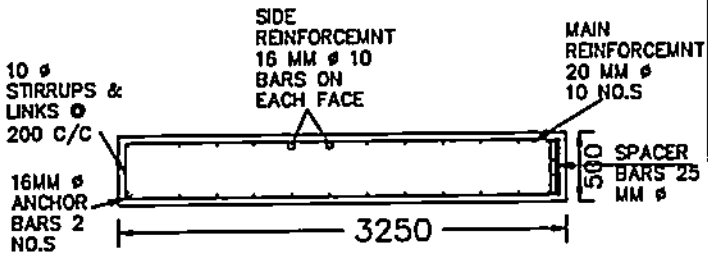


DETAILS AT A BUTTRESSING COLUMN (C1)

SCALE– 1:50

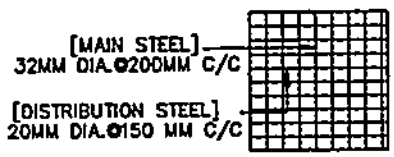


R/F DETAILS FOR STEM ON BACKFILL SIDE



DETAILS AT B OF BRACING BEAM

SCALE– 1:50



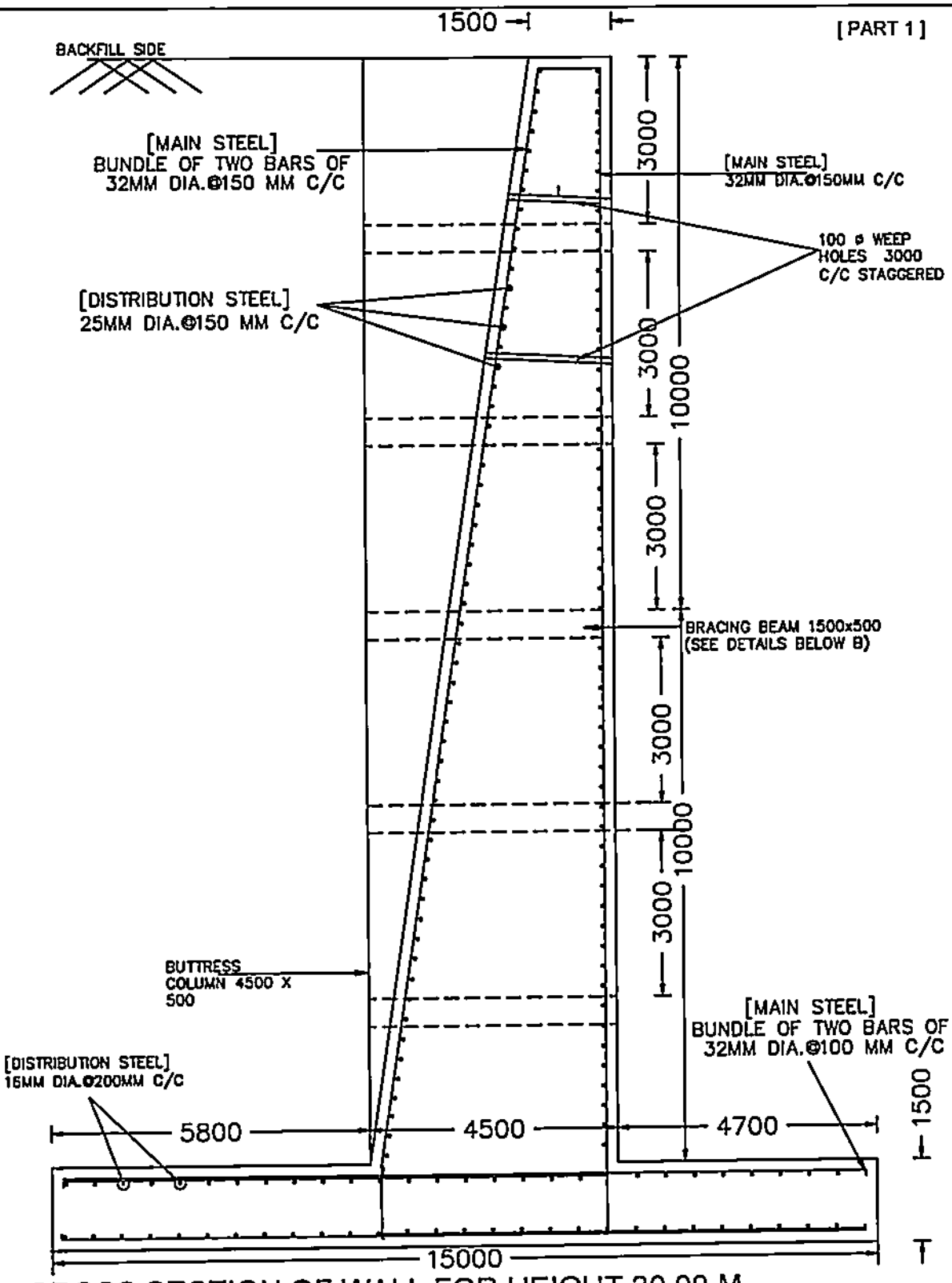
R/F DETAILS FOR STEM ON OTHER SIDE

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

[PART 1]



CROSS SECTION OF WALL FOR HEIGHT 20.00 M

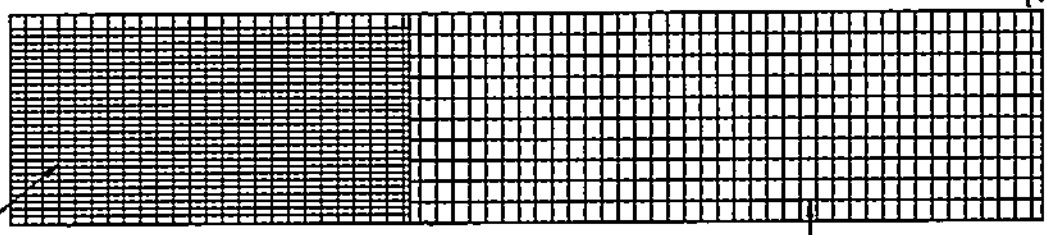
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

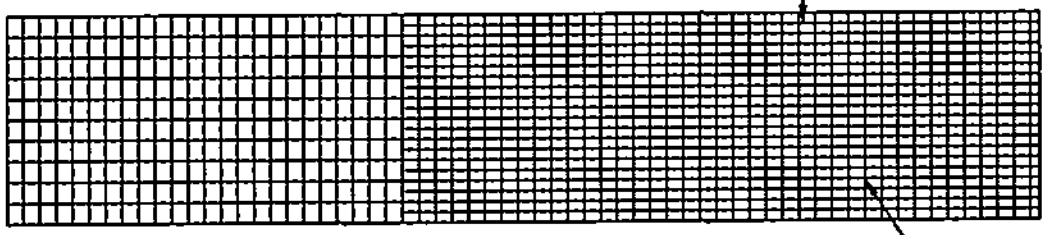
[PART 2]



[DISTRIBUTION STEEL] 16MM DIA.@200 MM C/C

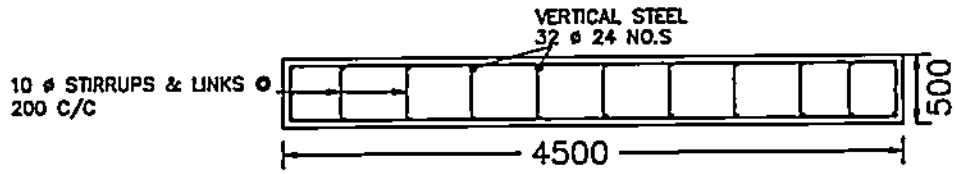
DETAILS FOR RAFT TOP

[MAIN STEEL] BUNDLE OF 2 BARS 32MM DIA.@100 MM C/C



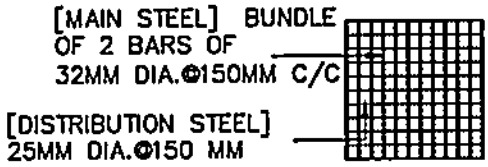
[DISTRIBUTION STEEL] 16MM DIA.@200 MM C/C

DETAILS FOR RAFT BOTTOM

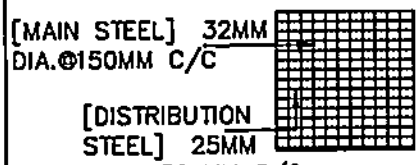


DETAILS AT A BUTTRESSING COLUMN

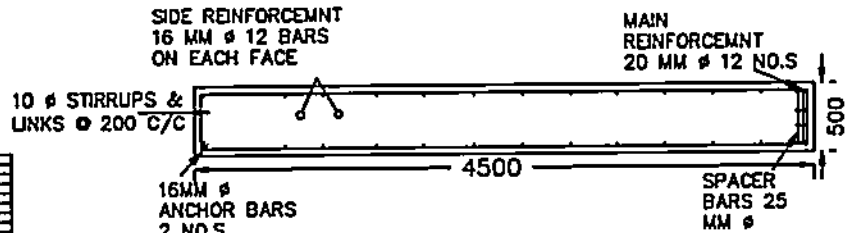
SCALE– 1:50



DETAILS FOR STEM ON BACKFILL SIDE



DETAILS FOR STEM ON OTHER SIDE



DETAILS AT B OF BRACING BEAM

SCALE– 1:50

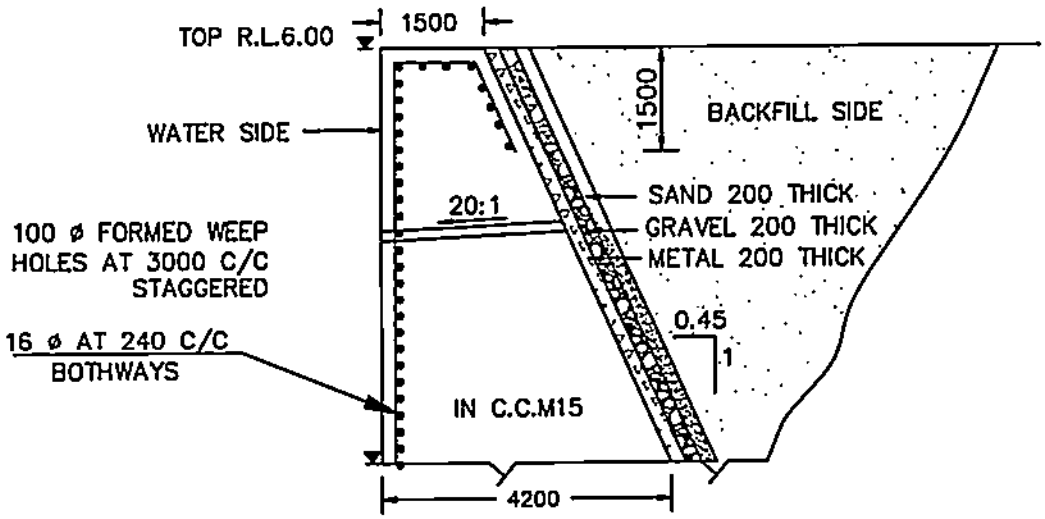
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF GRAVITY RETAINING WALL WITH ONE SIDE SLOPE (CONVENTIONAL GRAVITY)

CROSS SECTION OF WALL
FOR HEIGHT 6.00 M



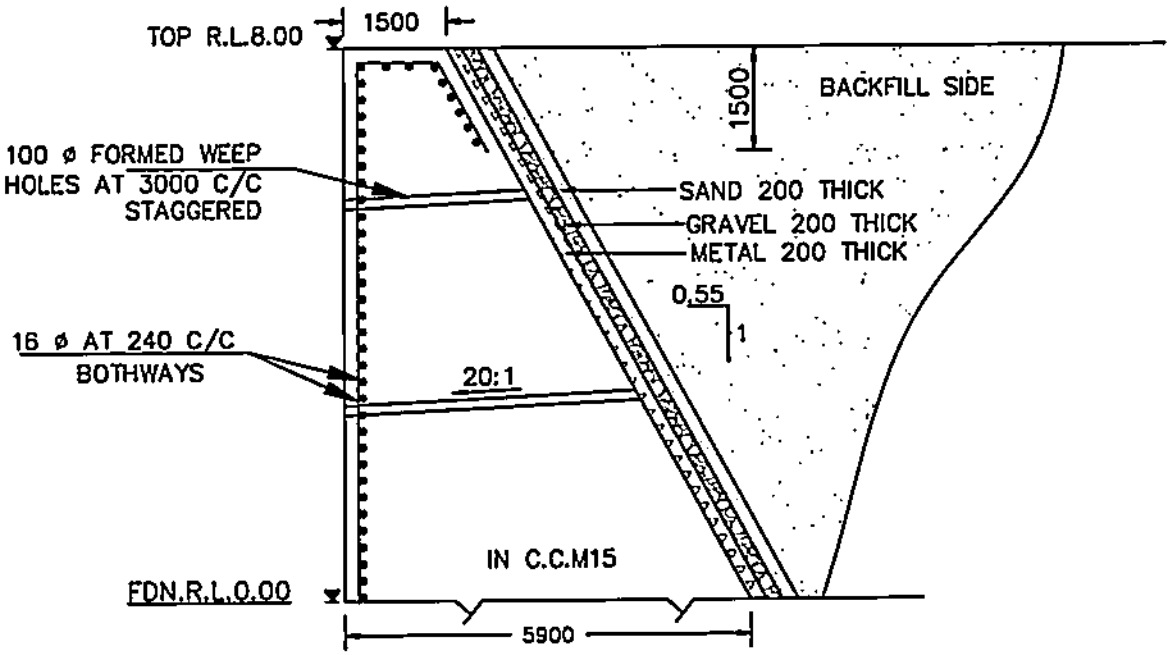
SCALE :– 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 8.00 M



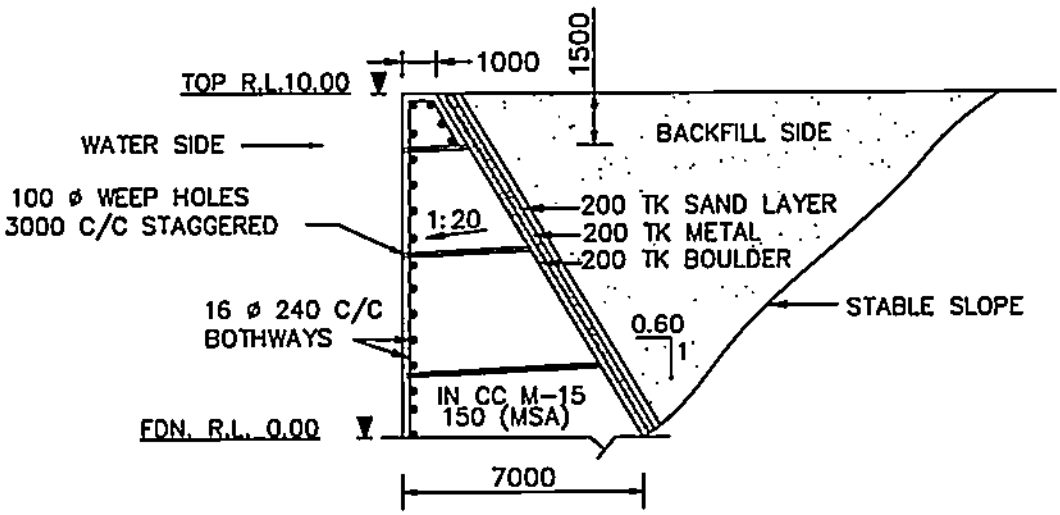
SCALE :– 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 10.00 M



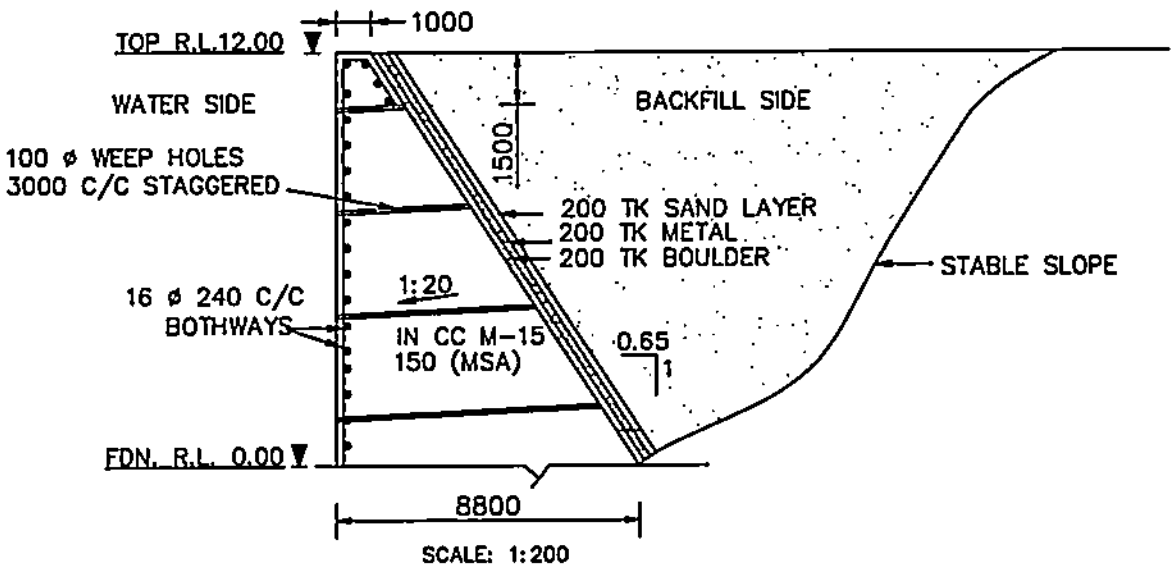
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 12.00 M

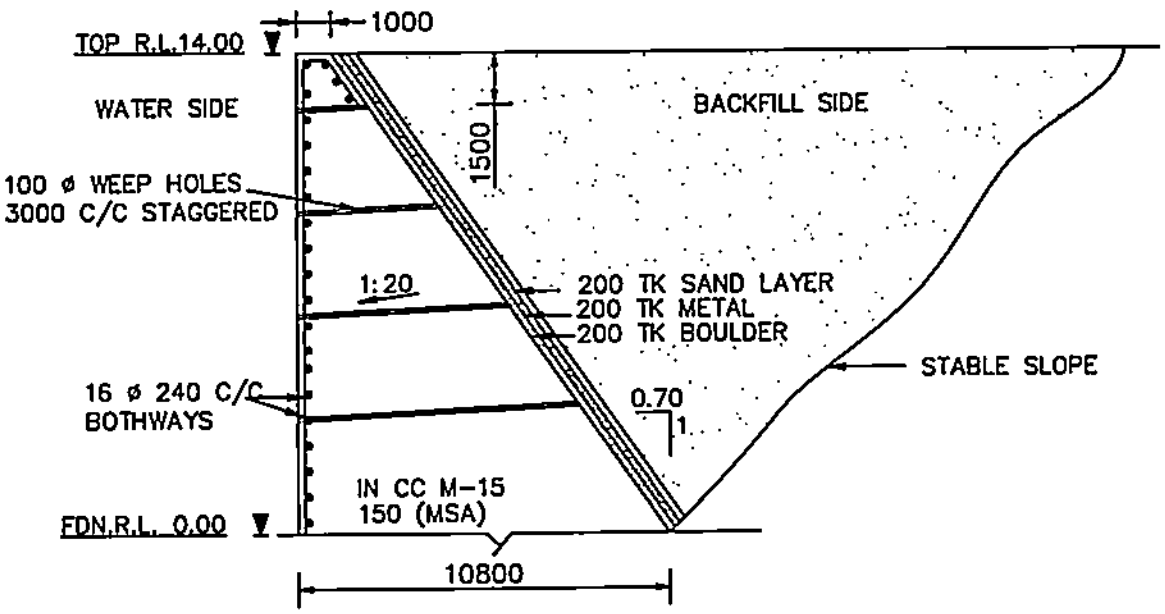


GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 14.00 M



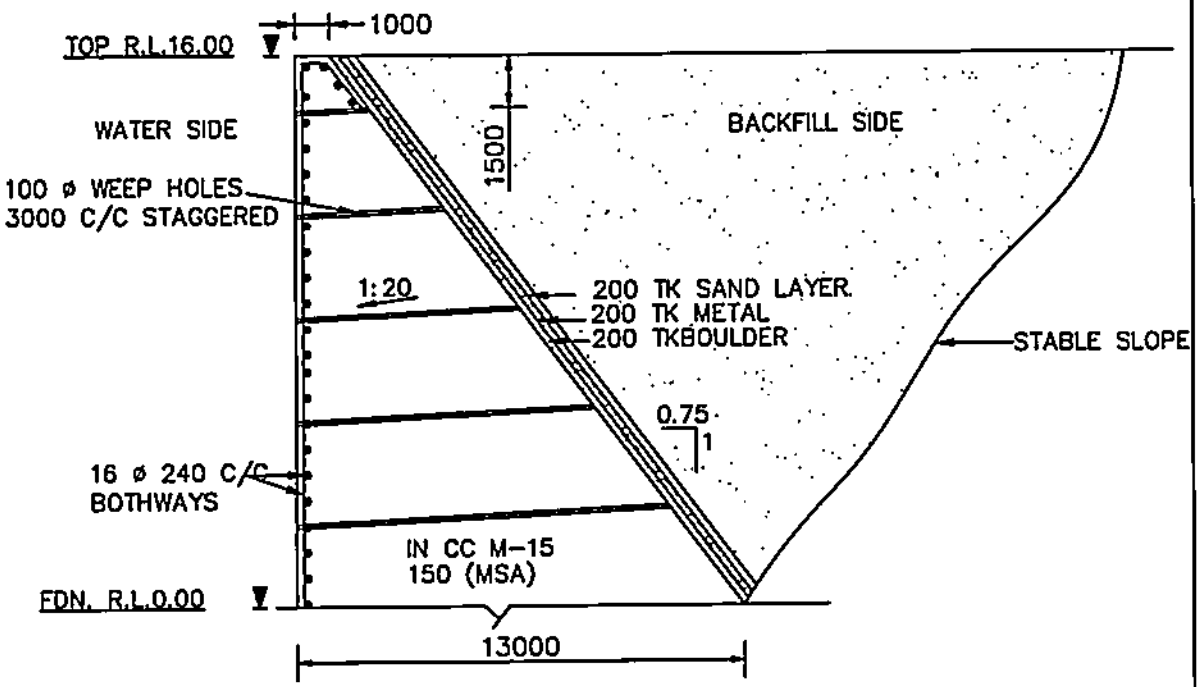
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER. CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 16.00 M



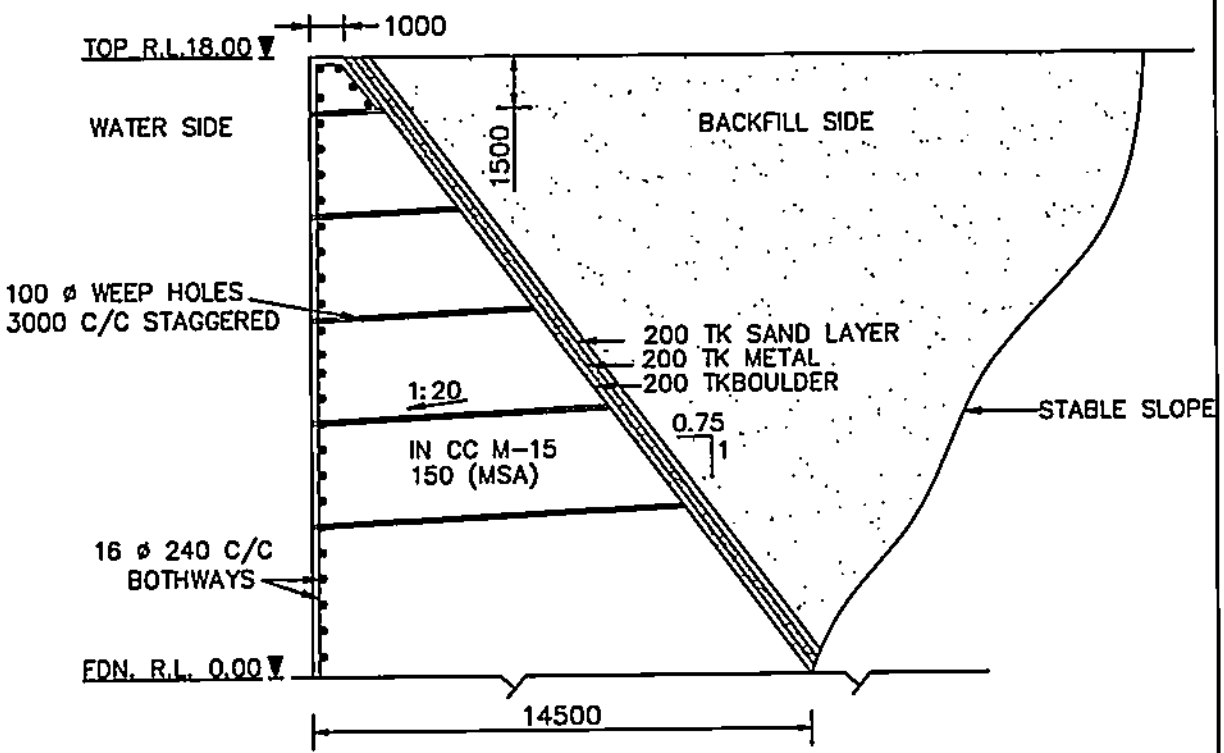
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER,	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 18.00 M



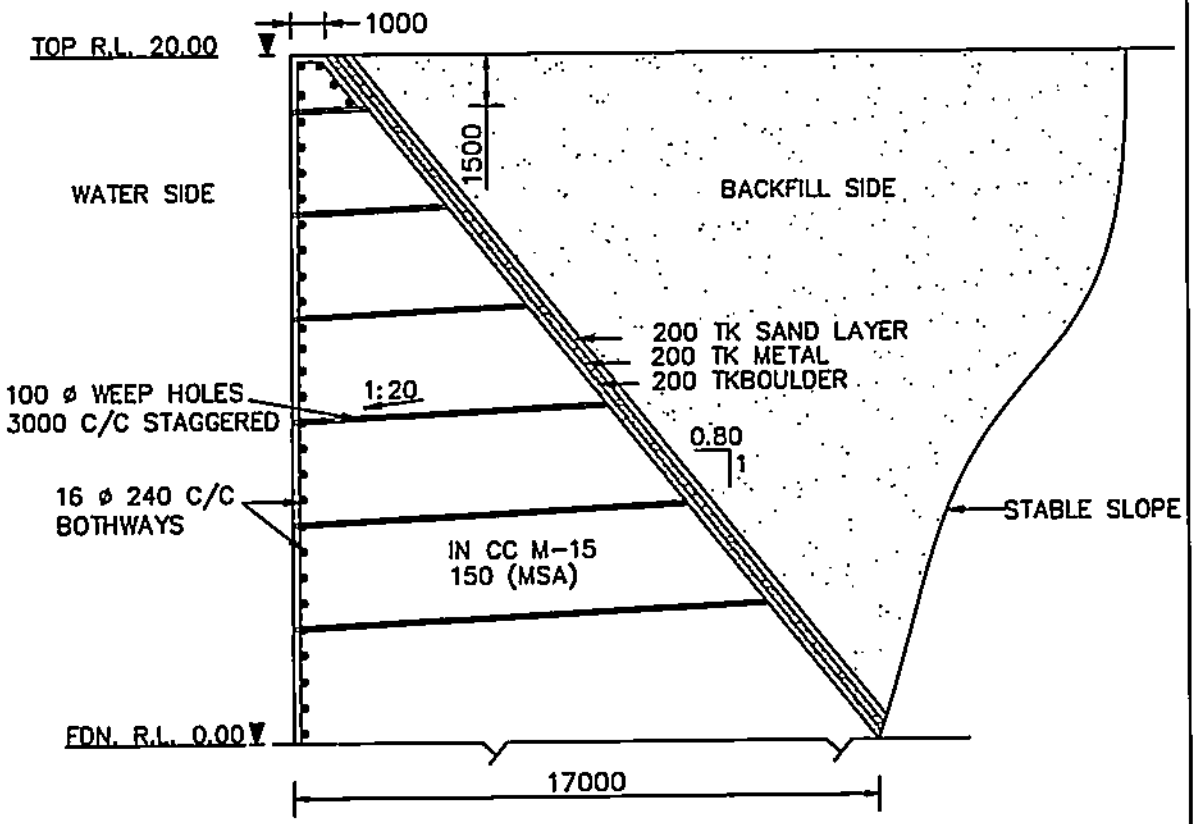
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 20.00 M



SCALE: 1:200

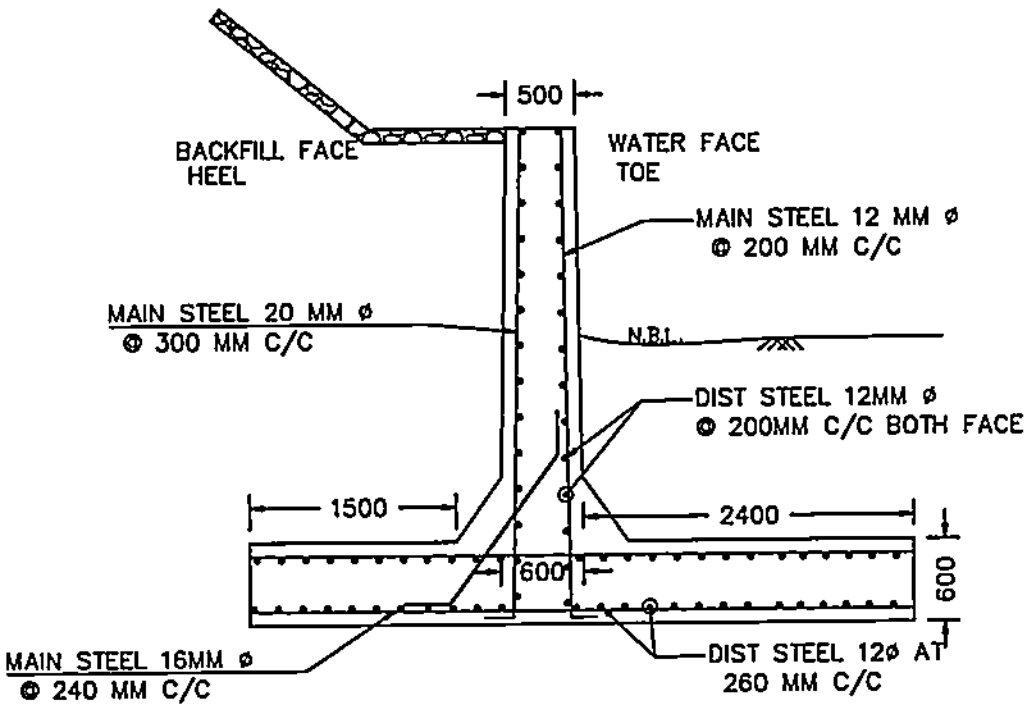
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

DRAWN BY: (P.R.JADHAV) ASSISTANT ENGINEER, CR II	(R.S. RAJPUT) SUB DIVISONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER, CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER,	CHIEF ENGINEER

CROSS SECTION OF FLOOD PROTECTION WALL WITH CANTILEVER

CROSS SECTION OF WALL
FOR HEIGHT 3.00 M



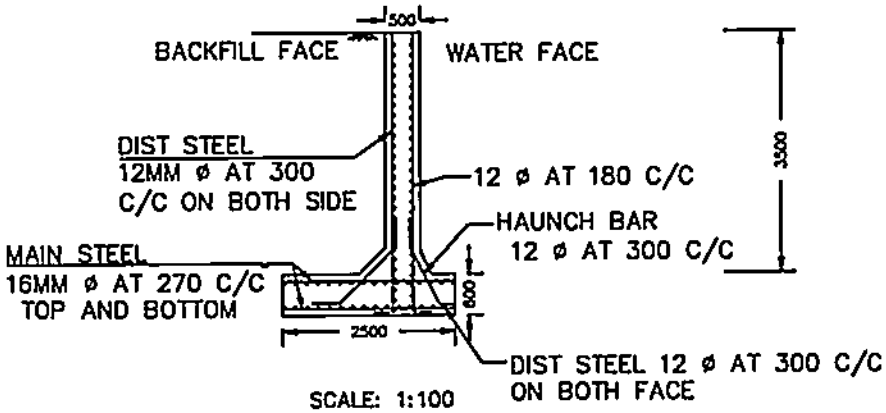
SCALE 1:50

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 3.50 M



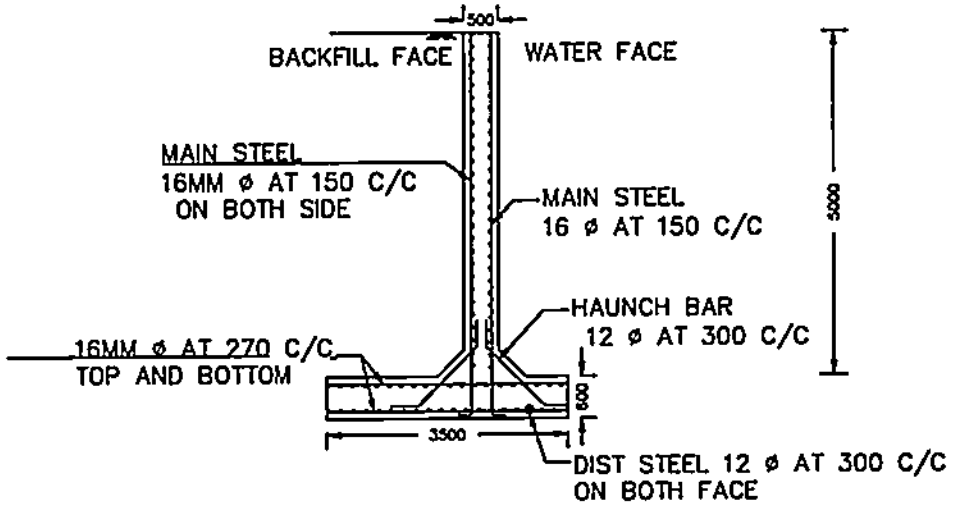
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 5.00 M



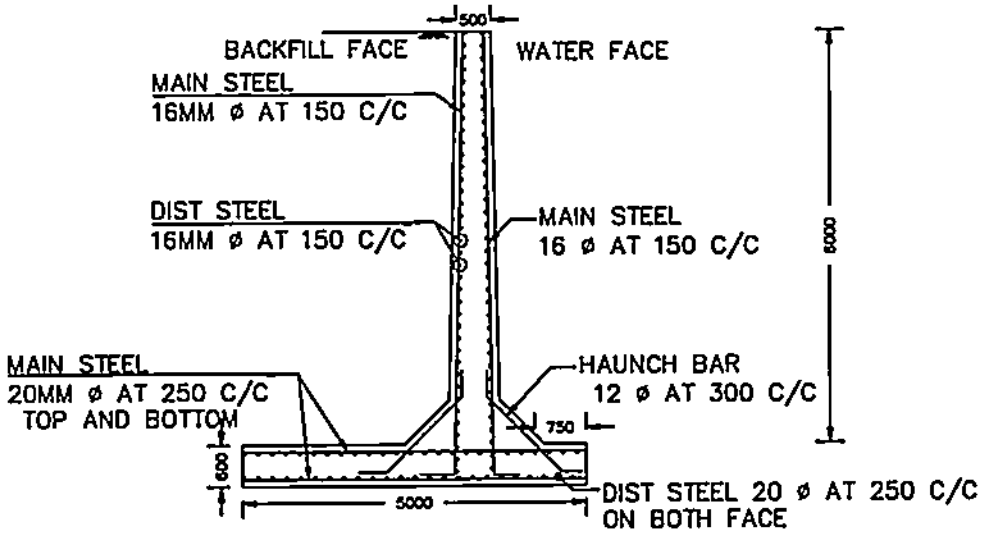
SCALE 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
FOR HEIGHT 6.00 M



SCALE: 1:100

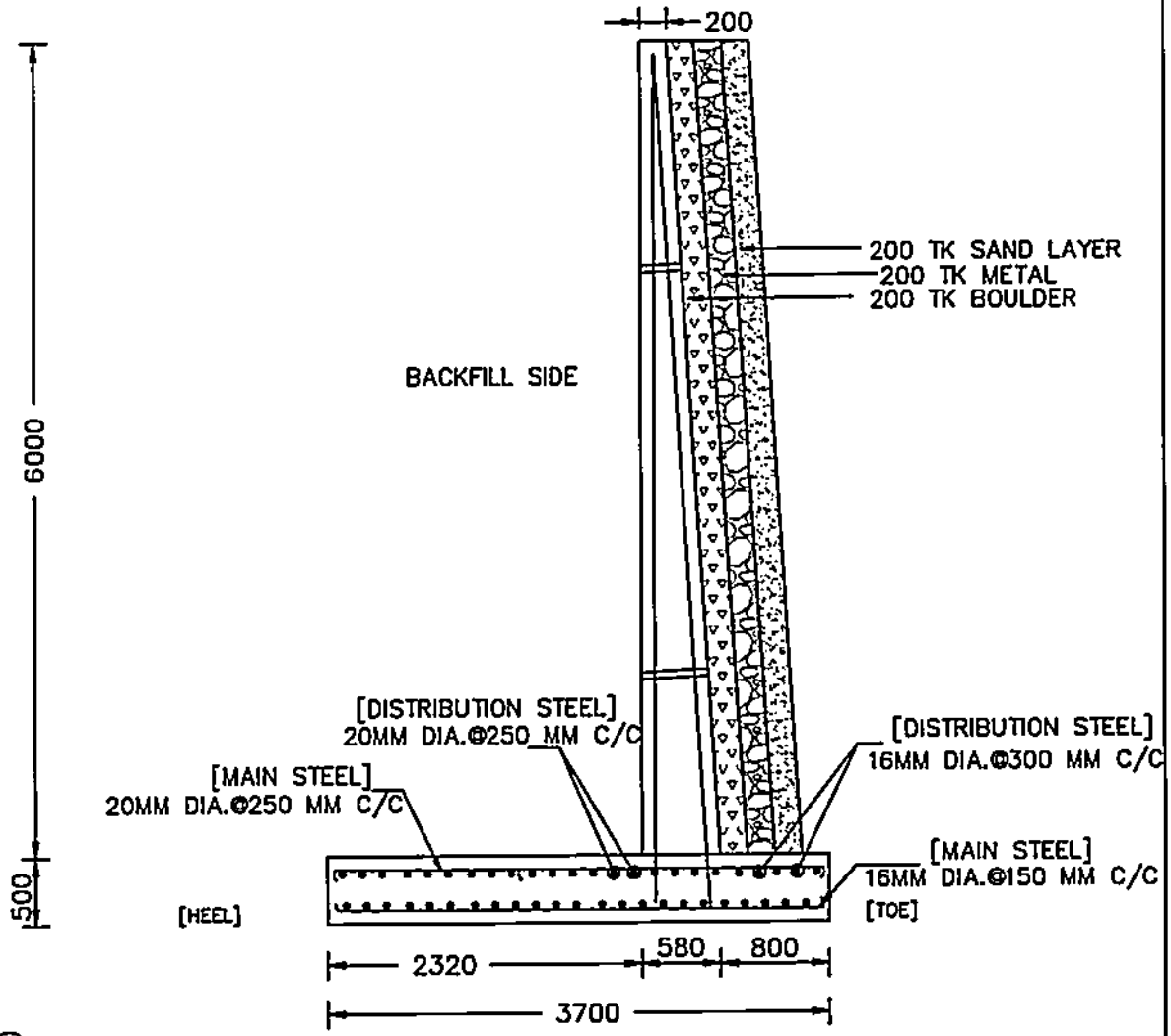
GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

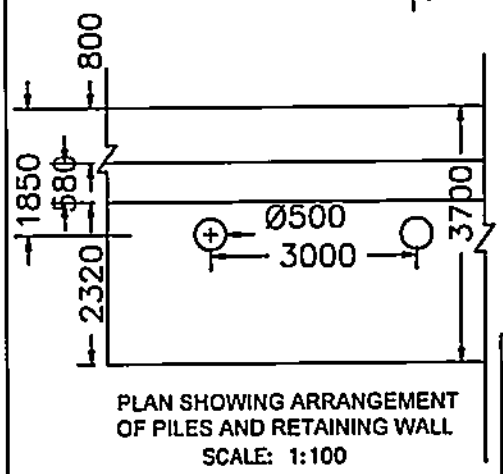
COMP. DRAFTED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF RCC FLOOD PROTECTION WALL RESTING ON PILE

CROSS SECTION OF WALL RESTING ON PILE RAFT (GROUP OF PILES) FOR HEIGHT 6.00 M (PART 1)



SCALE: 1:50



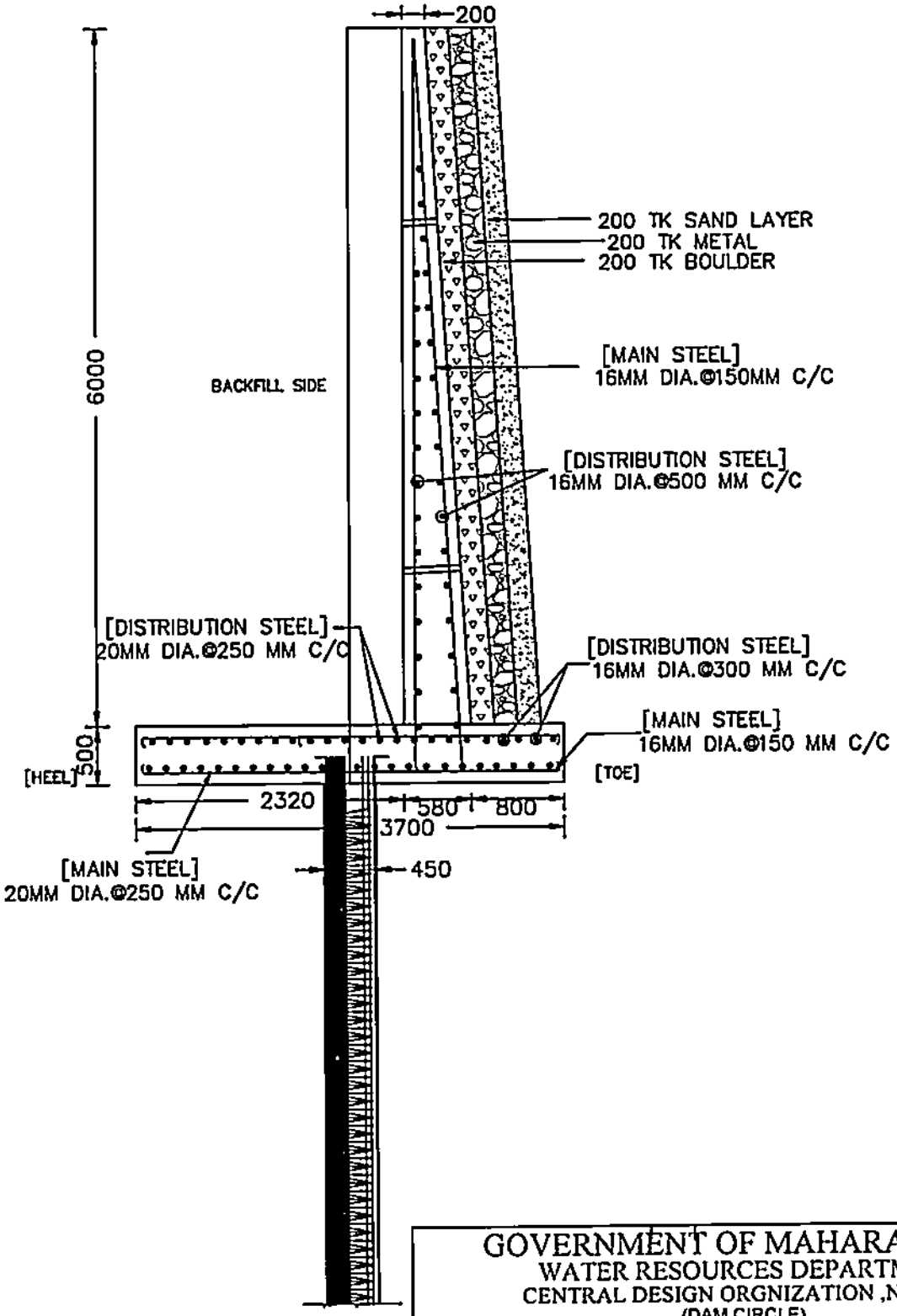
PLAN SHOWING ARRANGEMENT OF PILES AND RETAINING WALL
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL RESTING ON PILE RAFT (GROUP OF PILES) FOR HEIGHT 6.00 M (PART 2)



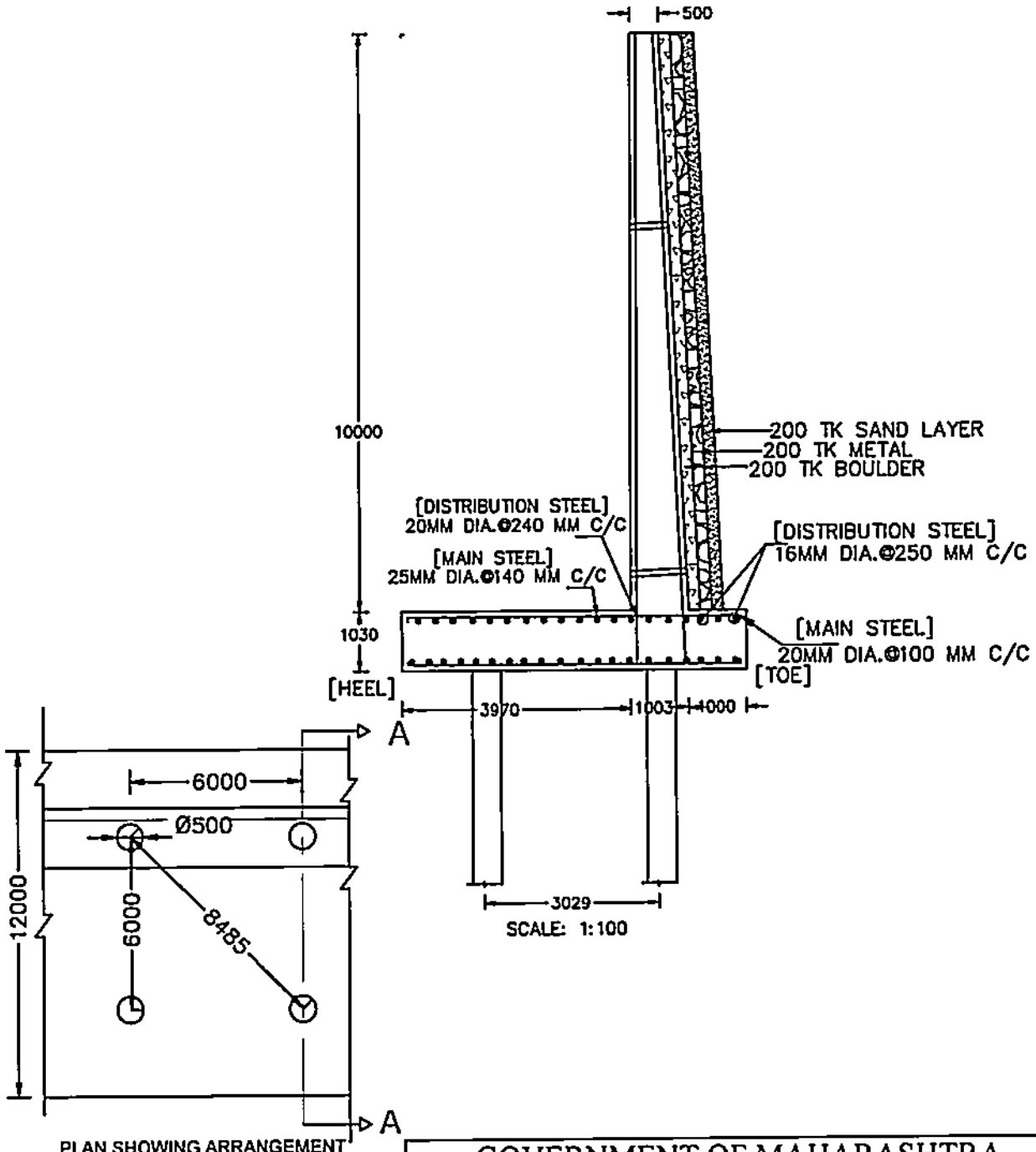
SCALE: 1:50

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER,	CHIEF ENGINEER

CROSS SECTION OF WALL
RESTING ON PILE RAFT (GROUP OF PILES)
FOR HEIGHT 10.00 M (PART1)

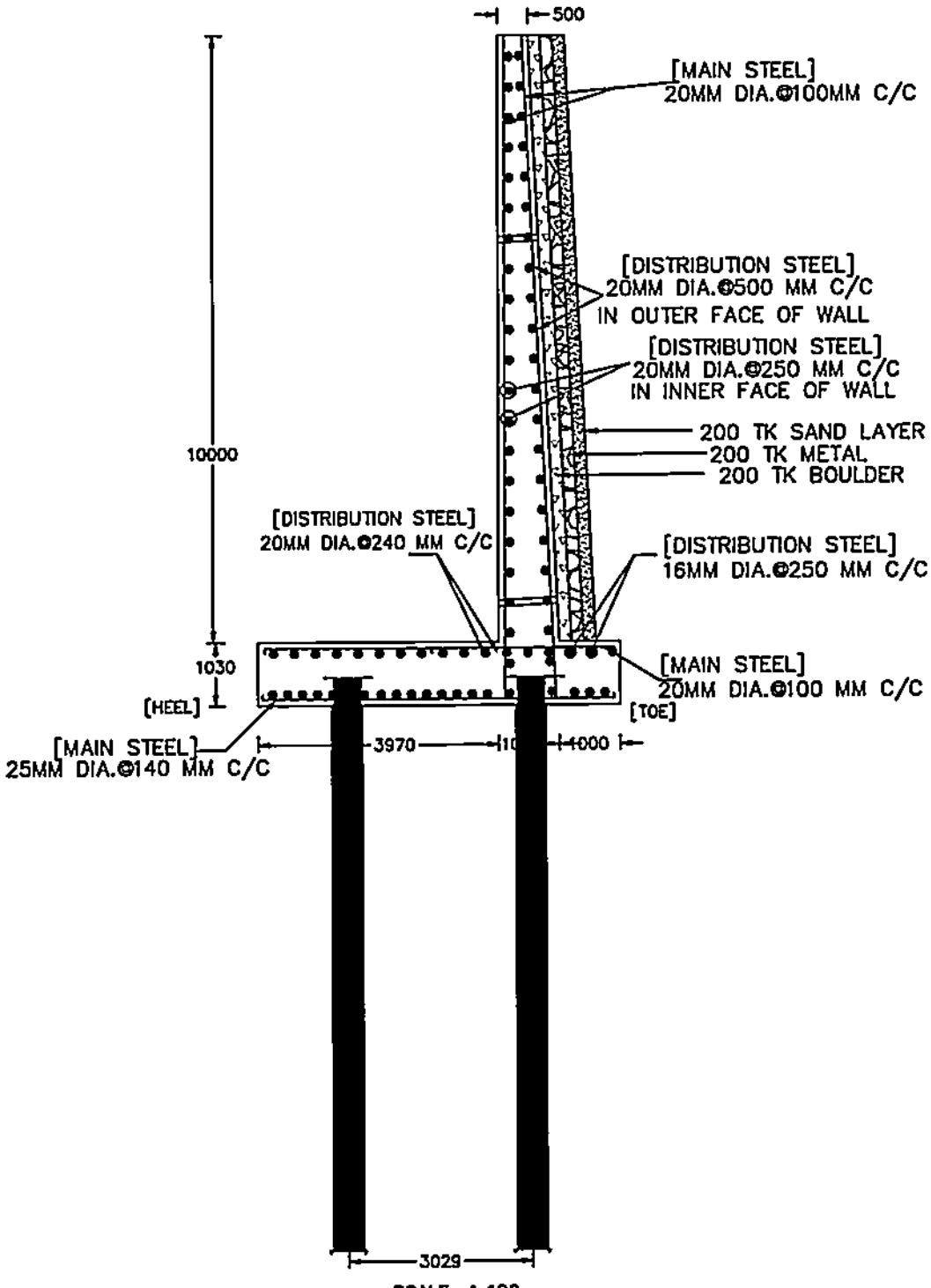


GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
RESTING ON PILE RAFT (GROUP OF PILES)
FOR HEIGHT 10.00 M (PART 2)



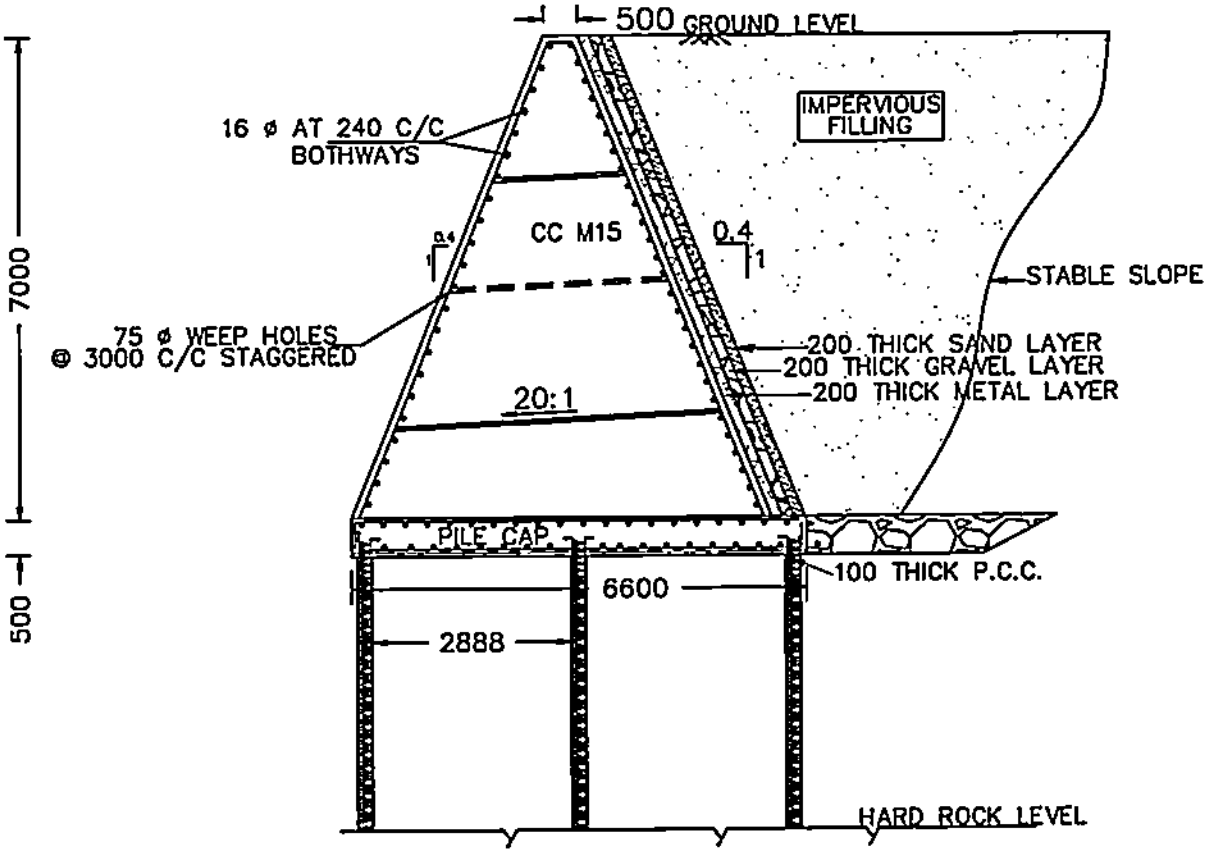
SCALE: 1:100

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

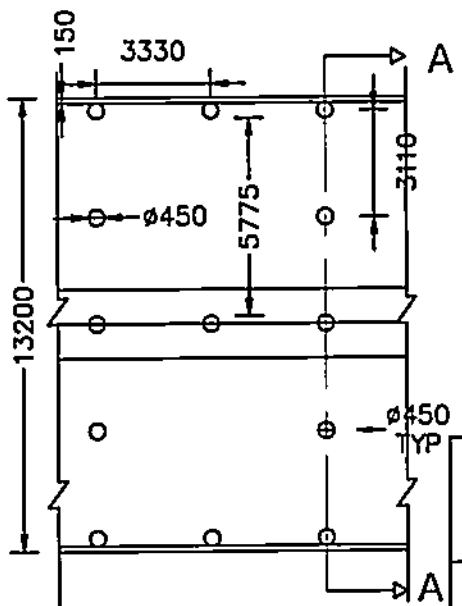
STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF GRAVITY WALL WITH BOTH SIDE SLOPES RESTING ON PILED RAFT FOR HEIGHT 14.00 M



SCALE: 1:200



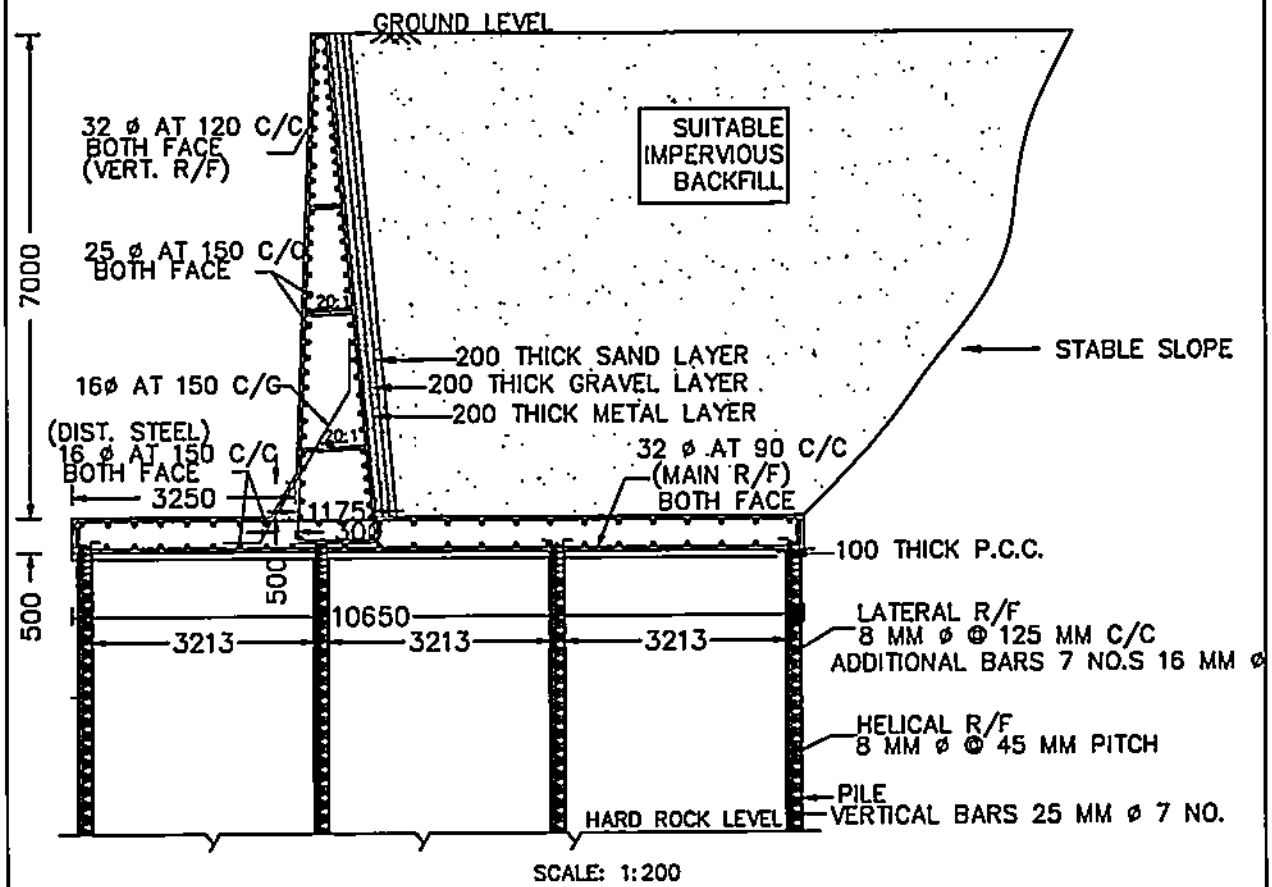
PLAN SHOWING ARRANGEMENT OF PILES AND RETAINING WALL
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
RCC RETAINING WALL WITH EXTENDED HEEL
FOR HEIGHT 14.00 M



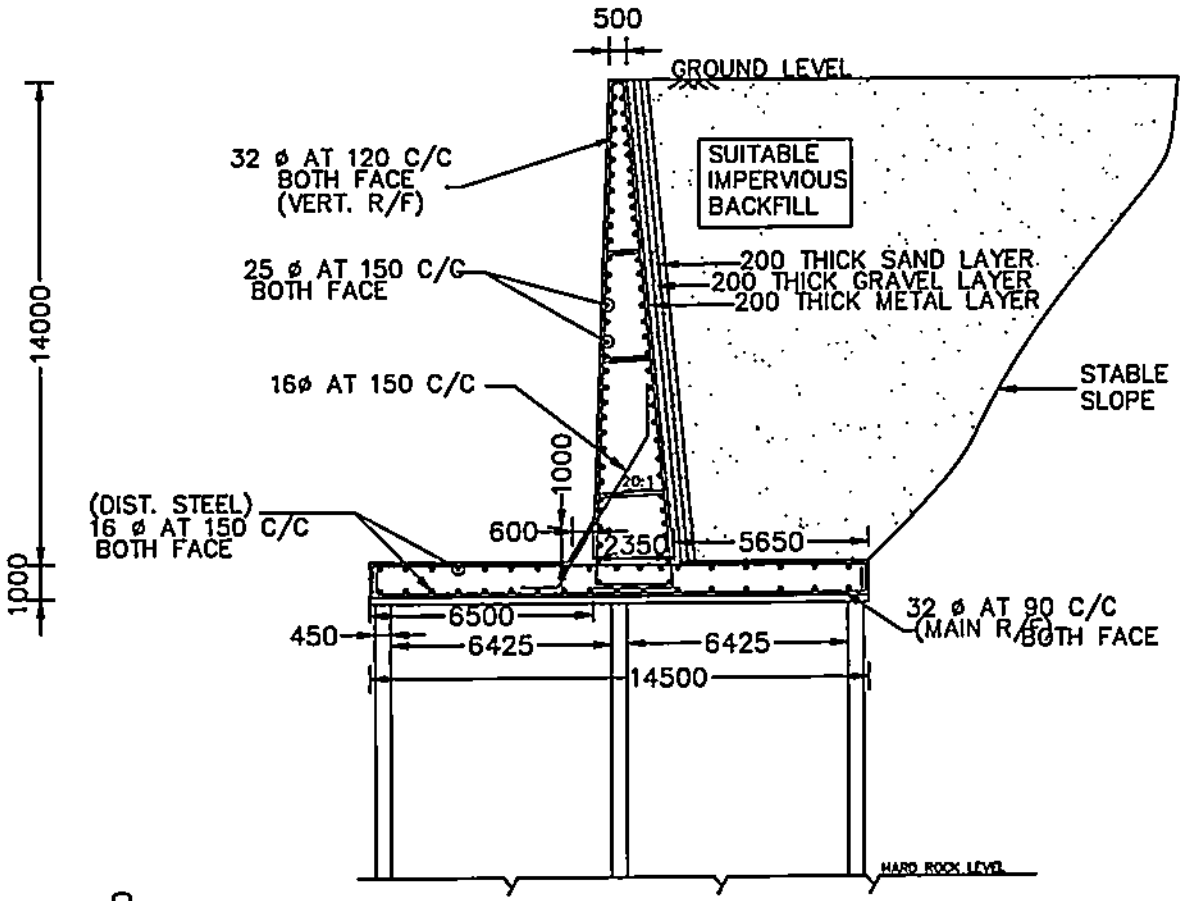
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

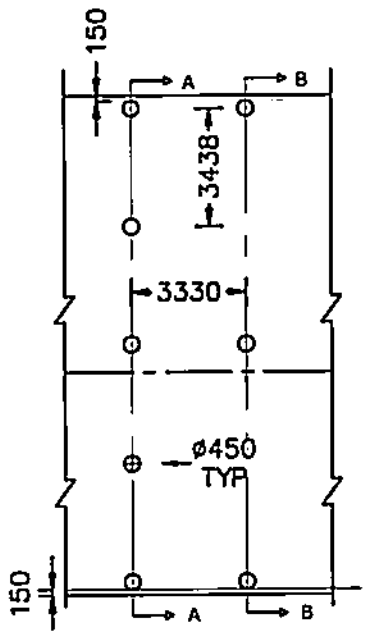
STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL RESTING ON PILE RAFT (GROUP OF PILES) FOR HEIGHT 14.00 M (PART 1)



SECTION A-A
SCALE: 1:200



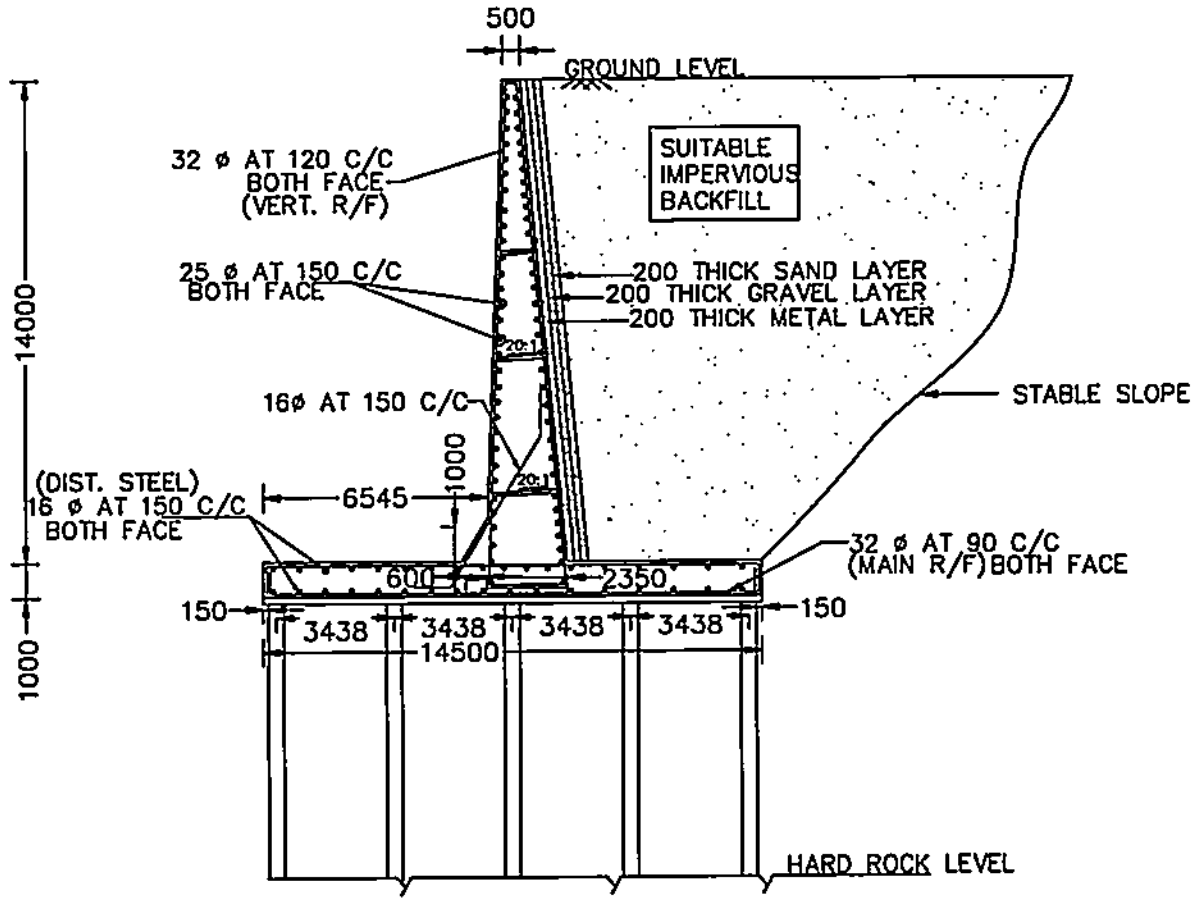
PLAN SHOWING ARRANGEMENT OF PILES AND RETAINING WALL
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER, GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER, GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER,	CHIEF ENGINEER

CROSS SECTION OF WALL
RESTING ON PILE RAFT (GROUP OF PILES)
FOR HEIGHT 14.00 M (PART 2)



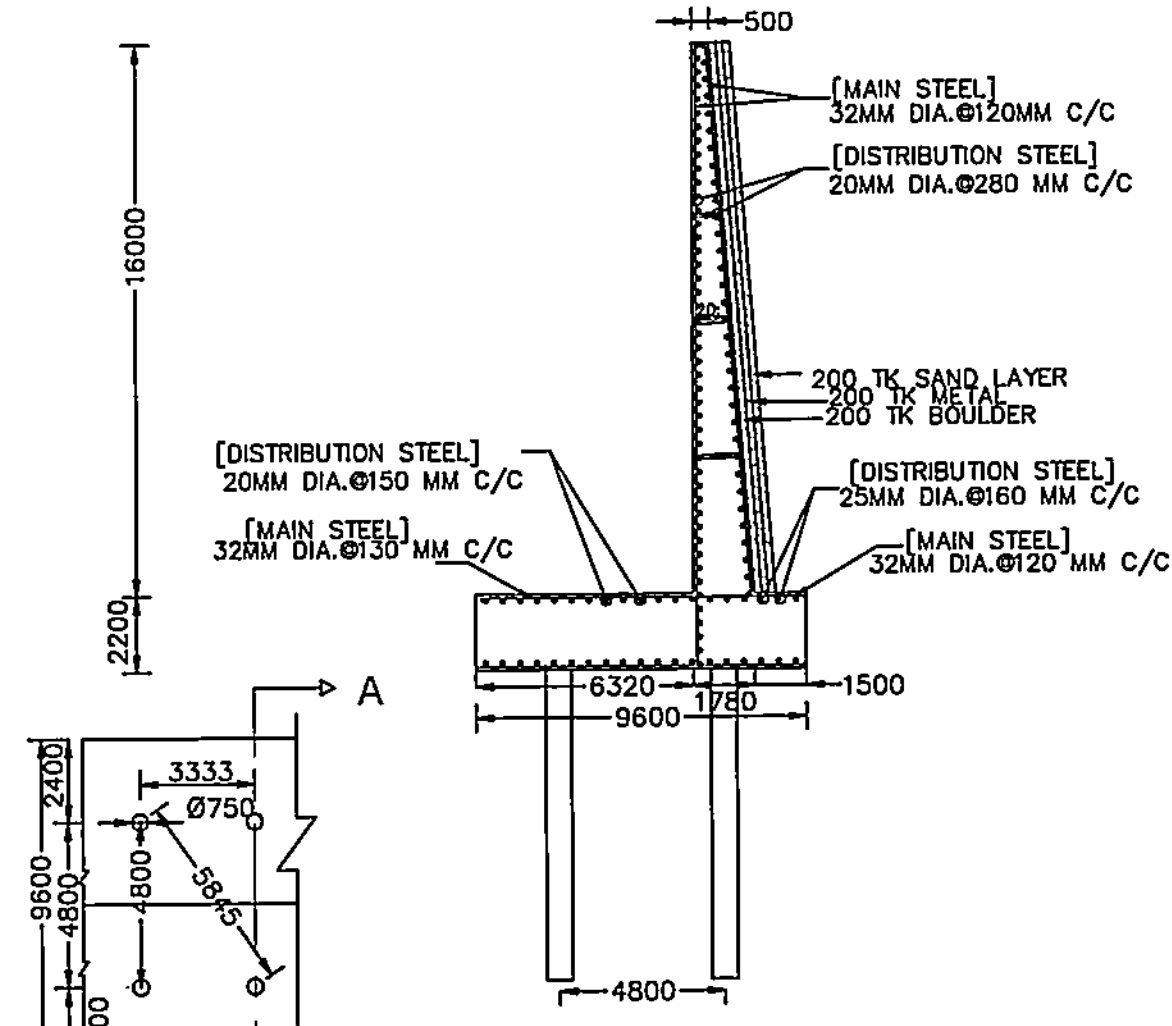
SECTION B-B
REINFORCEMENT DETAILS OF RETAINING WALL
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (T.N. PATIL) ASSISTANT ENGINEER, CR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER, CR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
RESTING ON PILE RAFT (GROUP OF PILES)
FOR HEIGHT 16.00 M
(PART1)



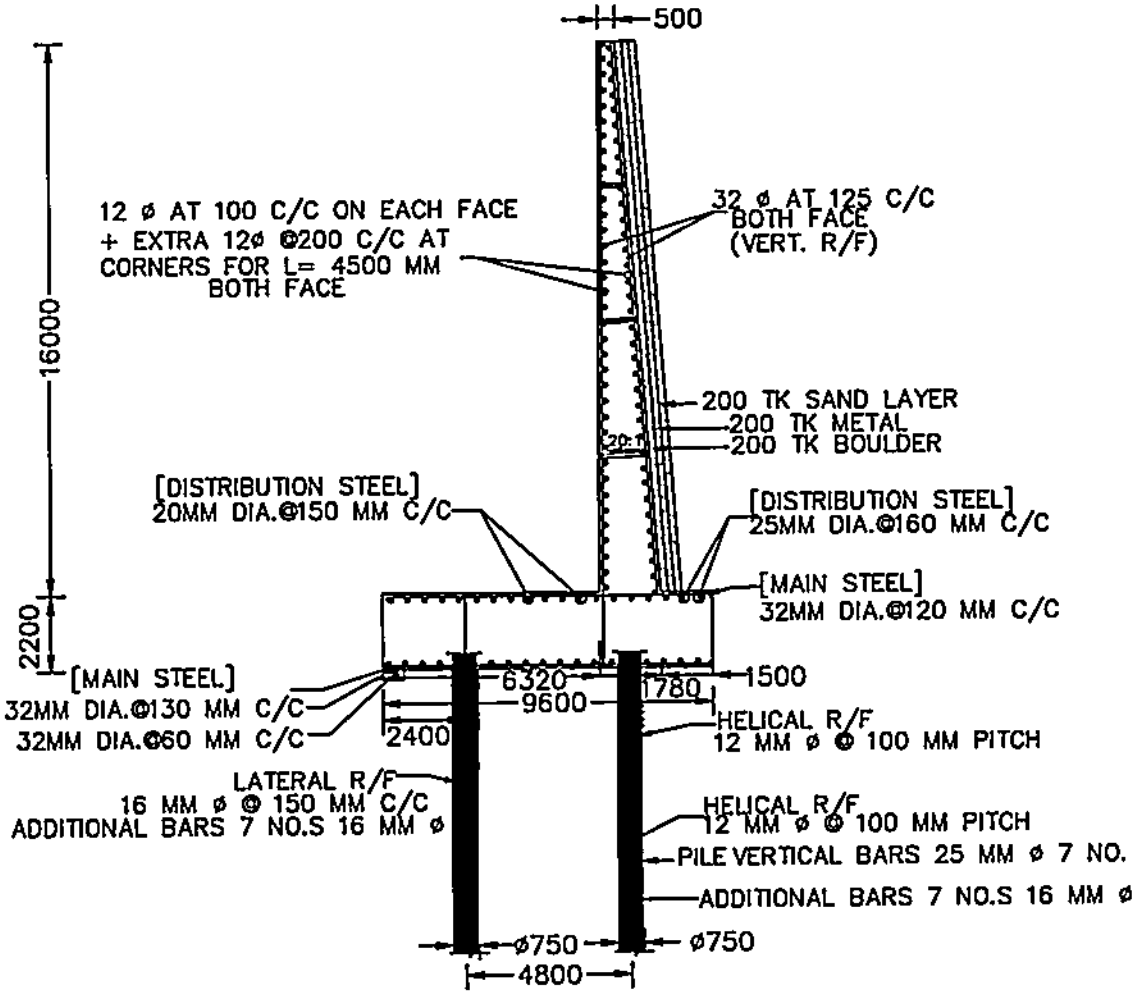
PLAN SHOWING ARRANGEMENT
OF PILES AND RETAINING WALL
SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY: (T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY: (V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

CROSS SECTION OF WALL
RESTING ON PILE RAFT (GROUP OF PILES)
FOR HEIGHT 16.00 M
(PART 2)



SCALE: 1:200

GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT
CENTRAL DESIGN ORGNIZATION ,NASHIK -4
(DAM CIRCLE)

STANDARD FLOOD PROTECTION WALL

COMP. DRAFTED BY:		
(T.N. PATIL) ASSISTANT ENGINEER. GR II	(R.S. RAJPUT) SUB DIVISIONAL ENGINNER	(R.M. MORE) SUPERINTENDING ENGINEER
CHECKED BY:		
(V.B.KHALANE) ASSISTANT ENGINEER. GR II	(R.S.DESHMUKH) EXECUTIVE ENGINEER.	CHIEF ENGINEER

ANNEXURES

पूरसंरक्षक योजनेच्या कामांना प्रशासकीय
मान्यता देण्याबाबतचे सुधारित धोरण.

महाराष्ट्र शासन
जलसंपदा विभाग
शासन निर्णय क्र. पूसंभि-२०१९/(प्र.क्र.११५/२०१९)/सिं.व्य.(म.)
मादाम कामा मार्ग, हुतात्मा राजगुरु चौक,
मंत्रालय, मुंबई - ४०० ०३२
दिनांक:- ३१ ऑगस्ट, २०१९

संदर्भ :-१) जलसंपदा विभाग, परिपत्रक क्र. एफडीडब्लू- १०८९/२४३/सिंव्य (कामे)दि.२१/९/१९८९.
२) जलसंपदा विभाग, परिपत्रक क्र. एफडीडब्लू - १०९२/१७०/ सिंव्य(कामे)दि.७/८/१९९२.
३) नियोजन विभाग, भारत सरकार परिपत्रक क्र. १६(१२)/१/९९/WR, दि.९/९/२००३
४) नियोजन विभाग, भारत सरकार परिपत्रक क्र. १६(१२)/१/९९/WR, दि.८/११/२००५.
५) जलसंपदा विभागाचा शासन निर्णय क्र. २०१७/(५६६/१७)/ सिं.व्य.(कामे)दि.३१.८.२०१८
६) शासन निर्णय क्र.२०१७/(५६६/१७) सिंव्य (कामे), दि.१९/१२/२०१७
७) शासन परिपत्रक क्र. एफडीडब्लू- १०८९/२४३/८९/सिंव्य (कामे), दि.३/५/२०१८
८) शासन परिपत्रक क्र. प्रशामा २०१६/(प्र.क्र.५५५/२०१६) सिंव्य (कामे), दि. २८/८/२०१८
९) जलसंपदा विभागाचा शासन निर्णय क्र. संकिर्ण २०१६/(२७/१६)/ ल.पा.२दि.२६/५/२०१७

प्रस्तावना:-

नाला ट्रेनिंगची कामे व पूर संरक्षण योजनेची कामे (नाला वळविणे) या दोन्ही कामाची गल्लत केली जात असल्याचे निदर्शनास आले आहे. कोणते काम नेमके कोणी करायचे, असा संभ्रम कृषी व पाटबंधारे विभागातील क्षेत्रीय अधिकाऱ्यांमध्ये झालेला दिसतो. सर्व नाला ट्रेनिंग कामाचे सर्वेक्षण व बांधकाम पूर्णपणे कृषी विभागानेच करावयाचे आहे, हे आता स्पष्ट झाले असून याबाबत ह्या प्रकरणावर संदर्भाधीन प्रसृत केलेल्या अनुक्रमांक ३ व ४ प्रमाणे अनुक्रमे पाटबंधारे विभाग व कृषी विभागाने शासकीय आदेश काढलेले आहेतच, तेव्हा यापुढे नाला ट्रेनिंगची कामे कृषी विभागाने व पूर संरक्षणाची कामे पाटबंधारे विभागाने करावयाची आहे. नाला ट्रेनिंग व पूर संरक्षण कशाला म्हणावे या विषयी सुस्पष्ट आदेश निर्गमित करण्याची आवश्यकता आहे.

नाला ट्रेनिंग (नाला सरळीकरण) :-

नाला ट्रेनिंगचा मुख्य उद्देश शेत जमिनीचा निचरा चांगला होऊन दलदलीचे व पाणथळ क्षेत्र कमी करणे हा होय. अशी दलदल निर्माण होण्याची मुख्य दोन कारणे असू शकतात. एक म्हणजे भूपृष्ठांतर्गत काही विशिष्ट भूस्तरीय रचनेमुळे भूगर्भातील पाण्याच्या प्रवाहात अडथळा निर्माण होणे ही परिस्थिती पाटबंधारे प्रकल्पाच्या लाभक्षेत्रात अधिक प्रकर्षाने जाणवते. लाभक्षेत्रात पाणथळ क्षेत्राचे प्रमाण कमी करण्यासाठी भूपृष्ठांतर्गत अडथळा नेमका कोठे आहे, ते ठरवून मुख्य नाल्याची ढाळ सुधारून खराब जमिनीतून भूपृष्ठांतर्गत चर खणून ते नाल्यास मिळविण्याची योजना गेली ७०-८० वर्षे पाटबंधारे संशोधन व विकास संचालनालय, पुणे यांचे मार्फत राबविली जात आहे.

लाभक्षेत्राच्या बाहेर पाणथळ क्षेत्र निर्माण होण्यास तेथील नाल्याचा सौम्य वा नदी नाल्यातील प्रवाहमार्गातील अतिक्रमण कारणीभूत होऊ शकतात. त्यामुळे नाल्याची वहनक्षमता कमी होते. पाणी दूरवर पसरते. अशा ठिकाणी नाल्याची रुंदी वाढवून वा त्यात सुधारून आजुबाजुच्या जमिनीचे संरक्षण पाण्याचा निचरा झाल्यामुळे होऊ शकते. ही कामे कृषी विभागाने करावयाची आहेत, हे स्पष्ट आहे.

पूर संरक्षणाची कामे :

पूर संरक्षणाचा उद्देश मात्र नदीत किंवा नाल्यात पावसामुळे होणारा पूर प्रवाह काठ सोडून आजूबाजूच्या परीसरात पसरतो, ज्यामुळे शेत जमीन, घरे व लोकवस्ती पाण्याखाली बुडतात, त्याच्या संरक्षणासाठी पूर संरक्षणाची कामे करणे अपेक्षित आहे. हा पूर काही तास टिकत असल्यामुळे शेतजमिनीचे सहसा काही नुकसान होत नाही. तथापी, वित्त हानी व प्राणहानी टाळण्यासाठी पूर प्रतिबंधक योजना राज्यामध्ये राबविणे जरूरीचे आहे. पूर प्रतिबंधक कामाविषयीचे सर्वेक्षण/अंदाजपत्रक जलसंपदा खात्याने करावयाचे आहे.

पूर संरक्षण योजनांच्या कामांना मान्यता देणेसंदर्भात संदर्भ -१ येथील शासन निर्णय घेतला आहे. या शासन निर्णयास २६ वर्षांपेक्षा जास्त कालावधी झालेला आहे. दरम्यानच्या काळात झालेली भाववाढ, नियोजन आयोग, भारत सरकार यांचे निर्देश, राष्ट्रीय हरित न्यायाधीकरणाने विविध न्यायालयीन प्रकरणात पूररेषा व पूर प्रवण क्षेत्रातील कामांबाबत दिलेले आदेश, याच अनुषंगाने निर्गमित केलेले शासन निर्णय, पूरसंरक्षक कामांना प्रशासकीय मान्यतेस सहमती देतांना नियोजन विभागाने नमूद केलेल्या बाबी तसेच जलसंपदा विभागास प्रशासकीय मान्यता करीता प्रदान केलेले वित्तीय अधिकार यांच्या अनुषंगाने पूरसंरक्षक कामासाठी प्रशासकीय मान्यता देण्याच्या दृष्टीने सुधारित धोरण निश्चित करवायाची बाब शासनाच्या विचाराधीन होती. त्याकरीता संदर्भ-८ येथील समिती स्थापन करण्यात आली होती. त्या समितीच्या शिफारशी शासनास प्राप्त झाल्या आहेत.

उपरोक्त बाबींचा सर्वकष विचार करुन पूरसंरक्षक कामे हाती घेण्याबाबतचे सुधारित धोरण निश्चित करुन प्रशासकीय मान्यता देण्याबाबत शासन पुढील प्रमाणे निर्णय घेत आहे.

शासन निर्णय:-

१. पूर संरक्षक कामाचा उद्देश नदीत किंवा नाल्यात पावसामुळे येणारा विसर्ग/ धरणातील विसर्ग यामुळे येणारा पूर प्रवाह काठ सोडून आजुबाजूच्या परिसरात पसरतो, त्याला अटकाव करुन संरक्षण करण्यासाठी आहे.

नदी/नाल्यातील या पूर विसर्गामुळे ज्या शेतजमिनी, घरे, रस्ते, लोकवस्ती, कारखाने, उद्योग, धार्मिक, ऐतिहासिक स्थळे पाण्याखाली बुडतात, शेत जमिनीची धूप होते. हा पूर विसर्ग काही तास टिकत असल्याने शेतजमिनीचे सहसा नुकसान होत नाही. तथापि, वित्त व प्राणहानी टाळण्यासाठी पूर प्रतिबंधक योजना राबविणे क्रमप्राप्त आहे.

२. पूरसंरक्षक कामात सर्वसाधारणत: पुढील बाबींचा समावेश असावा.

अ)नदी/ नाला काठावर माती भराव करणे, दगडी/ संधानक अस्तरिकरण करणे.

ब) संधानकातील आधार भिंत/ Retaining Wall बांधणे.

क) नदी/ नाला प्रवाहाला उचित दिशा देणे.

३. पूर संरक्षक कामाची मागणी महानगरपालिका /नगरपालिका/ ग्रामपंचायत / जिल्हा परिषद इ. स्थानिक स्वराज्य संस्था मार्फत जलसंपदा विभागाच्या कार्यकारी अभियंता यांचेकडे करण्यात यावी. (परिशिष्ट -२)

मागणी प्राप्त झाल्यावर नदी/ नाल्याच्या या भागातील पूरप्रवण क्षेत्र निश्चित करण्यासाठी शासन परिपत्रक क्र. एफडीडब्ल्यू १०८९/ प्र.क्र.२४३/८९/ सिं.व्य.(कामे) दिनांक २१/९/१९८९ व शासन परिपत्रक क्र.पूरनि-२०१८/(प्र.क्र.१८२/२०१८) /सिं.व्य.(महसूल) दिनांक ३ मे, २०१८ नुसार पूररेषा निश्चिती व आखणी मुख्य अभियंता स्तरावर झालेली आहे काय, याची पडताळणी संबधित कार्यकारी अभियंता यांनी करावी.

पूररेषा निश्चिती पूर्वीच झालेली असल्यासच पूरसंरक्षण कामाचे सविस्तर सर्वेक्षणाचे व अंदाजपत्रकाचे काम जलसंपदा विभागाने हाती घ्यावे.

पूररेषा निश्चिती झालेली नसल्यास प्रथम पूररेषा निश्चिती करुन त्याचे नकाशे निर्गमित करावे व तद्नंतर पूरसंरक्षक योजनाच्या कामाचे सर्वेक्षण व अंदाजपत्रक तयार करावे.

४. महानगरपालिका/ नगरपालिका/ ग्रामपंचायत/ जिल्हा परिषद वा इतर स्थानिक स्वराज्य संस्थाच्या कार्यक्षेत्रातील कामांची अंदाजपत्रके जलसंपदा विभागाच्या अधिका-यांनी संबधित स्थानिक स्वराज्य संस्थेच्या आयुक्त / मुख्याधिकारी / मुख्य कार्यकारी अधिकारी, जिल्हा परिषद यांचे संमतीपत्र घेऊन ती प्रशासकीय मान्यतेसाठी शासनास सादर करावी. (परिशिष्ट २ नुसार)

५. पूरसंरक्षक कामाचे प्रत्यक्ष बांधकाम संपल्यानंतर कामाचे पूर्णत्व प्रमाणपत्र (Work completion Certificate) प्राप्त झाल्यानंतर व निविदा शर्तीनुसार कामाचा दोष - दायित्व कालावधी (Defect Liability Period) पूर्ण झाल्यानंतर संबधित यंत्रणेला हस्तांतरित करण्यात येईल व तद्नंतर या बांधकामाची देखभाल दुरुस्ती संबधित स्थानिक स्वराज्य यंत्रणामार्फत करणेत यावी. याबाबतचे संमतीपत्र संबंधित स्थानिक स्वराज्य संस्थेने मागणी पत्रासमवेत सादर करावे व ते प्रशासकीय मान्यता प्रस्तावास जोडावे. (परिशिष्ट २ नुसार)

पूर संरक्षक कामांच्या प्रशासकीय मान्यताप्राप्त अंदाजपत्रकीय रक्कमेपैकी खालीलप्रमाणे सहभागिता रक्कम / निधी (Participatory Contribution) संबंधित स्थानिक स्वराज्य संस्थेने संबंधित कार्यकारी संचालक, पाटबंधारे विकास महामंडळ यांचे नावे वर्ग करण्यात यावी.

"अ" वर्ग नगरपालिका २५% सहभाग.
"ब" वर्ग नगरपालिका २०% सहभाग.
"क" वर्ग नगरपालिका १५% सहभाग.
"ड" वर्ग नगरपालिका १०% सहभाग.

याबाबतचे संमतीपत्र अंदाजपत्रकासोबत जोडावे. (परिशिष्ट - २ नुसार) नागरी भागातील नगरपालिका/ नगर परिषदा/ नगरपंचायत / कटकमंडळ इ. व ग्रामीण भागातील जिल्हा परिषदा/ पंचायत समिती / ग्राम पंचायत यांना सहभागिता रक्कम / निधी (Participatory Contribution) देण्यापासून सूट देण्यात येत आहे.

तसेच यापूर्वीच्या शासन निर्णयातील १०% लोकवर्गणी व ५०% राज्यशासनाचे कर्जरुपी सहाय्य ही अट पूर्णत: वगळण्यात येत आहे.

६. सर्वेक्षण व प्रशासकीय मान्यता प्राप्त कामांचा खर्च राज्य शासनाच्या निधीतून जलसंपदा विभागामार्फत करण्यात येईल.

राज्य शासनाच्या निधीतून घ्यावयाच्या कामांना वित्तिय मर्यादा नसेल. केंद्र शासनाच्या कार्यक्रमांतर्गत काम प्रस्तावित केल्यास त्यातील निर्देशांनुसार राज्य शासन व स्थानिक स्वराज्य संस्था यांची सहभागिता बंधनकारक असेल.

आंतरराज्य नद्यांवरील पूरसंरक्षक कामे व इतर कामे केंद्र शासनाच्या निधीतून / कार्यक्रमांतून घ्यावयाचे असल्यास नियोजन विभाग, भारत सरकार परिपत्रक क्र. १६(१२)/१/९९/WR, दि.९/९/२००३ च्या वा प्रचलित निर्देशानुसार हाती घ्यावे.

७. २५ वर्षातून एकदा या वारंवारितेच्या पूर विसर्गाने बाधित होणा-या भागासाठी (म्हणजेच प्रतिबंधित क्षेत्रातील / निळया पूररेषेच्या आतील भागांसाठी) पूर संरक्षक कामे हाती घेता येतील.

८. निळया पूररेषांच्या आतील भाग हा प्रतिबंधित क्षेत्र असल्याने त्या भागात राष्ट्रीय हरित न्यायाधिकरणाच्या निर्देशानुसार नवीन बांधकामे करता येत नाहीत. (No Development Zones) तथापि, अस्तित्वातील जमिनी, लोकवस्ती घरे, रस्ते इत्यादींचे पूर्णत: स्थालांतरण वा पुनर्वसन शक्य नसल्याने पुरापासून संरक्षण मिळण्यासाठी पूरसंरक्षक कामे घेणे अनिवार्य आहेत. पूर संरक्षक कामे करतांना नदी प्रवाहात कुठलाही अडथळा येणार नाही, नदीची वहन क्षमता बदलणार नाही याची दक्षता घ्यावी.

९. पूरसंरक्षक कामे प्रस्तावित करताना नवीन तंत्रज्ञान / GIS चा विचार करावा. झालेल्या कामाचे Mapping करावे. MRSAC/ Remote sensing images / Drone survey याचाही वापर करावा. तसेच झालेल्या कामाचे GIS Mapping करावे.

१०. प्रकल्पाची व्यवहार्यता व लाभ-व्यय गुणोत्तर -

प्रस्तावित कामाचे लाभव्यय गुणोत्तर काढून व्यवहार्यता तपासावी. त्याकरिताचे परिशिष्ट-१ सोबत जोडले आहे. त्यानुसार परिगणना करावी व ते अंदाजपत्रकाचा भाग असेल. सदर परिशिष्ट संबंधित मुख्य अभियंता यांचे स्वाक्षरीसह जोडावे . काम हाती घेण्याच्या निकडीची कारणमिमांसा नमूद करण्यासाठी मुख्य अभियंता यांनी स्थळ पाहणी करुन क्षेत्रीय भेटीची टिप्पणी तयार करावी. व ती अंदाजपत्रकास जोडावी.

११. संकल्पने, तांत्रिक तपासणी, प्रशासकीय मान्यता:-

अ) संकल्पने :- पूरसंरक्षक कामाचे अंदाजपत्रक रु. ५.०० कोटी पेक्षा जास्त रक्कमेचे होणार असल्यास ते मध्यवर्ती संकल्पचित्र संघटनेकडून तयार करण्यात यावे. तसेच १.०० कोटी ते ५.०० कोटी पर्यंतच्या कामांचे सविस्तर संकल्पन महामंडळाअंतर्गत संकल्पचित्र विभागाकडून करावे. रु. १.०० कोटी रक्कमेच्या आतील कामांचे अंदाजपत्रक क्षेत्रीय स्तरावर करण्यास हरकत नाही.

ब) तांत्रिक तपासणी :- जलसंपदा विभागाचा शासन निर्णय क्र. २०१७/(५६६/१७)/ सिं.व्य. (कामे), दि. ३१.०८.२०१८ प्रमाणे पूरसंरक्षक कामाच्या प्रशासकीय मान्यतेसाठी रु. २५.०० कोटी पेक्षा कमी किंमतीचे प्रस्ताव राज्यस्तरीय तांत्रिक सल्लागार समिती कार्यालय करीत असलेल्या छाननीप्रमाणे महामंडळ स्तरावर छाननी करुन प्रशासकीय मान्यता / सुप्रमा प्रस्ताव महामंडळाने सुस्पष्ट शिफारशीसह शासनास सादर करावे.

तसेच रु. २५.०० कोटी पेक्षा जास्त किंमतीच्या कामांना राज्यस्तरीय तांत्रिक सल्लागार समिती मार्फत सविस्तर तपासणी करुन छाननी अहवालासह महामंडळाने प्रस्ताव शासनाला सादर करावेत.

क) प्रशासकीय मान्यता:- जलसंपदा विभागाचा शासन निर्णय क्र. संकिर्ण २०१६/(२७/१६)/ ल.पा. २, दि. २६.०५.२०१७ अन्वये सिंचन प्रकल्पांच्या विशेष दुरुस्ती कामांना व विस्तार व सुधारणा अंतर्गत कामांना नियोजन विभागाच्या सहमतीने प्रशासकीय मान्यता देण्याचे अधिकार जलसंपदा विभागास देण्यात आले आहेत. त्याच धर्तीवर पूर संरक्षक कामांच्या रुपये ५.०० कोटी पर्यतच्या कामांना जलसंपदा विभाग प्रशासकीय मान्यता प्रदान करेल. रु. ५.०० कोटी पेक्षा जास्त किंमतीच्या अंदाजपत्रकांना नियोजन व वित्त विभागाची सहमती अनिवार्य असेल.

१२. जलसंपदा विभागाला नेमून देण्यात आलेल्या विषय- सुचीमधील अनुक्रमांक १३ नुसार प्रशासकीय मान्यता ही जलसंपदा विभागामार्फत देण्यात येत असल्याने मुख्य लेखाशिर्ष "४७११ , पूर नियंत्रण प्रकल्पावरील भांडवली खर्च" याखाली तरतूद उपलब्धता करुन घ्यावी.

१३. हा शासन निर्णय नियोजन विभागाचा अनौपचारिक संदर्भ क्र. ६३/१४३४, दि २२/४/२०१९, वित्त विभागाचा अनौपचारिक संदर्भ क्र.१४९/२०१९,/व्यय-१२ दि७/६/२०१९ ग्रामविकास विभागाचा अनौपचारिक संदर्भ क्र.१२/योजना-११, दि२२/४/२०१९ व नगर विकास विभागाचा अनौपचारिक संदर्भ क्र.११७/नवी-२०, दि २१/५/२०१९ अन्वये देण्यात आलेल्या सहमतीनुसार निर्गमित करण्यात येत आहे.

१४. सदर शासन निर्णय महाराष्ट्र शासनाच्या www.maharashtra.gov.in या संकेतस्थळावर उपलब्ध करण्यात आला असून त्याचा संकेताक क्र. २०१९०८३११७३०२१५६२७ असा आहे. हा आदेश डिजीटल स्वाक्षरीने साक्षांकित करुन काढण्यात येत आहे.

महाराष्ट्राचे राज्यपाल यांच्या आदेशानुसार व नावाने,

Atul Ashok Kapole

Digitally signed by Atul Ashok Kapole
DN: c=IN, o=Government Of Maharashtra, ou=Water Resources Department, postalCode=400032, st=Maharashtra, [illegible] cn=Atul Ashok Kapole
Date: 2019.08.31 17:36:00 +05'30'

(अ. अ. कपोले)
शासनाचे उप सचिव

प्रत,

१ मा. मुख्यमंत्री, यांचे अतिरिक्त मुख्य सचिव, मंत्रालय मुंबई.
२ मा.मंत्री (जलसंपदा) यांचे खाजगी सचिव, मंत्रालय, मुंबई
३ मा. राज्यमंत्री (जलसंपदा) यांचे खाजगी सचिव, मंत्रालय, मुंबई
४ प्रधान सचिव (जलसंपदा) यांचे स्वीय सहायक, मंत्रालय, मुंबई
५ सचिव (लाक्षेवि) यांचे स्वीय सहायक, जलसंपदा विभाग, मंत्रालय, मुंबई,
६ अ.मु.स. वित्त विभाग, यांचे स्वीय सहायक, मंत्रालय, मुंबई.
७ अ.मु.स. नियोजन विभाग, यांचे स्वीय सहायक, मंत्रालय, मुंबई.
८ प्रधान सचिव, महसुल व वन विभाग, यांचे स्वीय सहायक, मंत्रालय, मुंबई
९ प्रधान सचिव, ग्राम विकास विभाग, यांचे स्वीय सहायक, मंत्रालय, मुंबई
१० प्रधान सचिव, नगर विकास विभाग, यांचे स्वीय सहाय्यक, मंत्रालय, मुंबई
११ प्रधान सचिव, कृषी व पदुम विभाग यांचे स्विय सहाय्यक, मंत्रालय, मुंबई.
१२ सचिव, मृद व जलसंधारण विभाग यांचे स्विय सहाय्यक, मंत्रालय, मुंबई.
१३ सर्व जिल्हाधिकारी,
१४ सर्व विभागीय आयुक्त,
१५ कार्यकारी संचालक, कोकण पाटबंधारे विकास महामंडळ, ठाणे
१६ कार्यकारी संचालक, महाराष्ट्र कृष्णा खोरे विकास महामंडळ, पुणे,
१७ कार्यकारी संचालक, तापी पाटबंधारे विकास महामंडळ, जळगांव
१८ कार्यकारी संचालक, गोदावरी मराठवाडा पाटबंधारे विकास महामंडळ, औरंगाबाद,
१९ कार्यकारी संचालक, विदर्भ पाटबंधारे विकास महामंडळ, नागपूर,
२० महासंचालक, महाराष्ट्र अभियांत्रिकी संशोधन संस्था, नाशिक.
२१ मुख्य कार्यकारी अधिकारी, जिल्हा परिषद, सर्व.
२२ महालेखापाल -१ (लेखा व अनुज्ञेयता/लेखापरिक्षा), महाराष्ट्र राज्य, मुंबई
२३ महालेखापाल -२ (लेखा व अनुज्ञेयता/लेखापरिक्षा), महाराष्ट्र राज्य, नागपूर
२४ सर्व मुख्य अभियंता (जलसंपदा विभाग)
२५ सर्व अधीक्षक अभियंता, (जलसंपदा विभाग)
२६ आयुक्त, महानगरपालिका, सर्व.
२७ मुख्यधिकारी, नगरपरिषद / नगर पंचायत सर्व.
२८ सिं.व्य. (महसूल) निवडनस्ती

जलसंपदा विभाग, शासन निर्णय क्र. पूसंभि-२०१९/(प्र.क्र.११५/२०१९)/सिं.व्य.(म.) चे सहपत्र.

परिशिष्ट :-१

१)	पुराची वारंवारता (Frequency of flood) २५ वर्षात एकदा येणार पूर विसर्ग.....m३/sec
२)	पूरप्रतिबंधक कामाची अद्यावत किंमत रु.....
३)	सदर पूर प्रतिबंधक कामाऐवजी पर्यायी पुनर्वसनासाठी येणारा खर्च (तपशिलासह) रू.....
४)	तुलनात्मक तक्ता व अभिप्राय (मुख्य अभियंता यांनी प्रमाणित करावे.)
५)	लाभव्यय गुणोत्तर हे १ किंवा त्यापेक्षा जास्त असावे. लाभव्यय गुणोत्तर = पर्यायी पुनर्वसनासाठी येणारा खर्च (अ.क्र. ३) --- पूर प्रतिबंधक कामाची अद्ययावत किंमत (अ.क्र. २)
	टिप:- धार्मिक स्थळे, सांस्कृतिक वारश्याची ठिकाणे यांच्या करिताच्या पूर संरक्षक कामांना लाभ व्यय गुणोत्तर लागू होणार नाही. तथापि, या कामांच्या निकडीची कारण मिमांसा संबंधित मुख्य अभियंता यांनी त्यांच्या निरिक्षण टिप्पणीमध्ये स्पष्टपणे नमूद करावी.

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जलसंपदा विभाग, शासन निर्णय क्र. पूसंभि-२०१९/(प्र.क्र.११५/२०१९)/सिं.व्य.(म.) चे सहपत्र.

परिशिष्ट :- २

मागणी पत्र व संमतीपत्र (स्थानिक स्वराज्य संस्थेच्या शिर्षपत्रावर)

१)	पूरसंरक्षण कामाचे नांव - --------- गावाचे नांव..... ता. --------- जि. ---
२)	स्थानिक स्वराज्य संस्थेचे नांव ---------
३)	उपरोक्त पूर संरक्षक काम जलसंपदा विभागामार्फत हाती घेण्यासाठी आमच्या स्थानिक स्वराज्य संस्थेची मागणी नोंदवित आहे.
४)	प्रस्तावित कामासाठी निश्चित होणाऱ्या प्रशासकिय मान्यता अंदाजपत्रकाच्या रक्कमेच्या शासन निर्णय क्र. पूसंभि-२०१९/(प्र.क्र.११५/२०१९)/सिं.व्य.(म.), दि.३१/८/२०१९मधील तरतुदींनुसार सहभागिता रक्कम (Participatory Contribution) निविदा सूचना निर्गमित करण्यापूर्वी जलसंपदा विभागाकडे वर्ग करण्यास आमची संमती आहे.
५)	पूरसंरक्षक कामाचे प्रत्यक्ष बांधकाम संपल्यानंतर , कामाचे पूर्णत्व प्रमाणपत्र (Work Completion Certificate) कार्यकारी अभियंता, जलसंपदा विभाग यांनी दिल्यानंतर व निविदा शर्तीनुसार कामाचा दोष निवारण कालावधी (Defect and Liabilities period) हे काम आमची स्थानिक स्वराज्य संस्थेस हस्तांतरित करण्यात येईल. हे काम हस्तांतरित झाल्यानंतर या कामाच्या देखभाल व दुरुस्तीची पुढील जबाबदारी आमच्या स्थानिक स्वराज्य संस्थेमार्फत करण्यात येईल.

स्थळ:- स्वाक्षरी

दिनांक:- ( )

आयुक्त/ मुख्याधिकारी/ मुख्य कार्यकारी अधिकारी.

संकल्पचित्र संघटनेकडे सोपविण्यात
आलेल्या प्रकल्पाचे संकल्पन व संकल्पचित्र
तयार करण्याबाबतची मार्गदर्शक तत्वे.....

महाराष्ट्र शासन
जलसंपदा विभाग
शासन निर्णय क्रमांकः मंसस १०१४/(प्र.क्र.३३४/१४) मोप्र-१
मादाम कामा रोड, हुतात्मा राजगुरु चौक,
मंत्रालय, मुंबई ४०० ०३२
तारीख: १६/०१/२०१५

जलसंपदा विभागातील मोठया / मध्यम/ लघु/ जलविद्युत प्रकल्पांचे संकल्पन व संकल्पचित्र तयार करण्यासंदर्भातील पध्दतीबाबत शासनाकडून मध्यवर्ती संकल्पचित्र संघटना नाशिक व क्षेत्रिय अधिका-यांना वेळोवेळी आदेश देण्यात आले आहेत. आता याबाबत या पूर्वीची सोबतच्या परिशिष्ट क्र. १ मध्ये नमूद केलेली सर्व परिपत्रके, शासन निर्णय अधिक्रमित करुन खालील प्रमाणे आदेश देण्यात येत आहेत.

१.० मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांचेकडील कामाचे स्वरुप खालीलप्रमाणे राहील :-

१.१ प्रकल्प खर्चाची वाढ टाळण्यासाठी प्रशासकीय मान्यतेवेळेस मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांचेकडून प्रकल्पाच्या प्रमुख उपांगाचे (जसे की माती धरण, दगडी धरण, सांडवा इ.चे) संकल्पन अंतिम होणे आवश्यक आहे, जेणेकरुन अशा प्रमुख उपांगाच्या संकल्पचित्रातील बदलांमुळे होणारी प्रकल्पाच्या खर्चातील वाढ मर्यादीत राहू शकेल.

१.२ मोठे, मध्यम, व उपसा सिंचन योजना :-

१.२.१ प्रकल्प अन्वेषणाचे प्राथमिक काम व केंद्रीय जल आयोग, केंद्रीय विद्युत प्राधिकरणाकडून प्रकल्पांना मंजूरी मिळविण्याचे काम प्रकल्प अन्वेषण मंडळामार्फत केले जाते. मोठया, मध्यम व जलविद्युत प्रकल्पांच्या विविध घटकांचे तपशीलवार संकल्पन व संकल्पचित्रे तसेच संकल्पन अहवाल तयार करण्याचे काम क्षेत्रीय अधिका-यांकडून आवश्यक माहिती प्राप्त करुन घेऊन क्षेत्रिय विभागांच्या सहकार्याने मध्यवर्ती संकल्पचित्र संघटनेने करावयाचे आहे.

१.२.२ ३.५ मीटर पेक्षा जास्त पुराची उंची (Flood Lift) किंवा १० मीटर किंवा त्यापेक्षा जास्त अध:पात (Fall) असलेल्या उत्सारी भागाचे संकल्पन करणे.

१.२.३ १५ मीटर किंवा त्यापेक्षा जास्त जलस्तंभा एवढे शीर्ष असलेल्या अग्रस्थ नियंत्रकाचे (Head Regulator) संकल्पन करणे.

१.२.४ अस्तित्वात असलेल्या धरणांच्या मजबुतीकरणाचे / उंची वाढविण्यासाठीचे संकल्पन करणे.

१.२.५ बांधकाम पूर्ण झालेल्या प्रकल्पांचे बाबतीत किंवा बांधकाम चालू असलेल्या प्रकल्पांचे बाबतीत संकल्पन व संबंधीत बाबी यांचे बाबतीतील विशिष्ट समस्या यांचा मध्यवर्ती संकल्पचित्र संघटनेने अभ्यास शासनाच्या आदेशानुसार करुन उपाय सुचवावेत.

१.२.६ मध्यवर्ती संकल्पचित्र संघटनेस संदर्भ करण्यात आलेल्या सर्व मोठया व मध्यम प्रकल्पाचे बाबतीत संकल्पपूर अभ्यास करणे.

१.२.७ केंद्रिय जल आयोगाच्या प्रोफार्मा रिपोर्टमधील संदर्भीत प्रकल्पांच्या कामात क्षेत्रीय अधिकाऱ्यांना मार्गदर्शन करणे.

१.२.८ कालव्यावरील जी बांधकामे खाली नमूद केल्यापैकी कोणत्याही एका मापदंडात बसत असतील अशा बांधकामांची संकल्पचित्रे मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांनी करावीत.

(अ) ज्या बांधकामाची किंमत रुपये ५० लक्ष ते २५० लक्ष इतक्या मर्यादेत आहे, परंतु कालव्याचा विसर्ग ३५ घमी. / सेकंद पेक्षा जास्त आहे, अशा कालव्यावरील बांधकामाचे (स्ट्रक्चरचे) संकल्पन व संकल्पचित्रे.

(ब) कालव्यावरील बांधकामाच्या स्तंभाची (पिलरची) तळपातळी (फाऊंडेशन) पासूनची उंची जर १५ मी. अथवा त्यापेक्षा जास्त असेल तर अशा बांधकामाचे संकल्पन व संकल्पचित्रे.

(क) कालव्यावरील ज्या बांधकामाची किंमत २.५ कोटी रुपयांपेक्षा जास्त असेल अशाही बांधकामांचे संकल्पन व संकल्पचित्रे.

(ड) शीर्षकामे अथवा कालवा यापैकी कोणत्याही अपारंपारिक पध्दतीच्या (Non Conventional) रुपये १०० लक्ष (रु.शंभर लक्ष) रकमेपेक्षा जास्त किंमत असलेल्या बांधकामाचे संकल्पन व संकल्पचित्रे.

(इ) कालव्यावरील बांधकामास नुकसान पोहोचल्यामुळे होणारे नुकसान (हझार्ड पोटेंशिअल स्ट्रक्चर) जर एक कोटी रुपायांपेक्षा जास्त असेल तर अशाही बांधकामाचे संकल्पन व संकल्पचित्रे मध्यवर्ती संकल्पचित्र संघटनेमार्फत करण्यात यावीत. मात्र कालव्यावरील अशा बांधकामांच्या फुटीमळे होणा-या नुकसानीसंदर्भात म्हणजेच हझार्ड पोटेंशिअल संदर्भात संबंधीत मुख्य अभियंता यांनी प्रमाणपत्र देणे आवश्यक राहील.

(ई) कंत्राटदाराने तयार केलेल्या कालव्याच्या बांधकामाच्या संकल्पनाची तपासणी व मूल्यार्पण (Vetting)

१.३ लघु पाटबंधारे प्रकल्प :-

१.३.१ लघु प्रकल्पांच्या बाबतीत ३० मीटरपेक्षा जास्त उंचीच्या धरणांच्या अथवा विशिष्ट समस्या असलेल्या धरणांच्या शीर्ष कामांची तपशिलवार संकल्पने व संकल्पचित्रे तयार करणे. तसेच याशिवाय अधीक्षक अभियंता (मा.ध.) मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांच्या दि. १४/८/२००१ च्या परिपत्रकान्वये क्षेत्रीय मागणीनुसार १५ ते ३० मीटर उंचीमधील लघुपाटबंधारे योजनांचे माती धरण संकल्पन करण्याबाबत संबंधित क्षेत्रिय अधिका-यांना कळविण्यात आले आहे.

१.३.२ लघु पाटबंधारे प्रकल्पांच्या धरणांतून होणा-या गळती व दुरुस्तीचे प्रस्ताव-मध्यवर्ती संकल्पचित्र संघटनेकडे आवश्यक वाटल्यास खालील कार्यपध्दती अवलंबविण्यात यावी.

(अ) मध्यवर्ती संकल्पचित्र संघटनेकडे गळती / दुरुती प्रस्ताव अभिप्रायासाठी पाठवावयाचे असल्यास असे प्रस्ताव शासनाच्या मान्यतेने मध्यवर्ती संकल्पचित्र संघटनेस पाठवावेत.

(ब) प्रस्तावाचे योग्य समर्थन नमूद करावे.

(क) प्रस्तावासोबत धरणातील दोष/ उणिवा का उद्भवल्या, त्याबाबतची कारणमिमांसा, गुणवत्ता तपासणीबाबत नोंदवहया तपासून बांधकामाच्या दर्जाबाबत अभिप्राय, संबंधित बांधकामाच्या वेळी कार्यभार सांभाळणा-या कार्यकारी अभियंता / उप अभियंता हयांची नांवे व बांधकामाबाबत प्रकल्प केव्हा पूर्ण झाला, त्याची कार्यक्षमता यापूर्वी दोष / उणिवा दूर करण्यासाठी केलेली उपाययोजना, त्यावर आतापर्यंत झालेला खर्च व त्याचा उपयोग याबाबत सर्वसाधारण टिप्पणी प्रस्तावात नमूद करावी.

२.० मोठया, मध्यम पाटबंधारे, जलविद्युत प्रकल्प तसेच उपसा सिंचन योजना प्रकल्पांचे सर्वसाधारण आराखडे, संकल्पन व संकल्प चित्र प्रादेशिक मुख्य अभियंता यांच्या मंजूरीसाठी सादर करण्यासंदर्भात खालीलप्रमाणे पध्दती अवलंबिवण्यात यावी

२.१ जलविद्युत व मोठे पाटबंधारे प्रकल्प :-

(अ) जलविद्युत प्रकल्पासह मोठया पाटवंधारे प्रकल्पांच्या शिर्षकामांच्या सर्वसाधारण आराखडा, संकल्पन व संकल्पचित्रे यास मान्यता देण्याचे अधिकार महामंडळ कार्यालयातील मुख्य अभियंता स्तरावर देण्याचे दि. ९/१२/२००४ च्या परिपत्रकान्वये देण्यात आलेले आहेत. ज्या महामंडळ कार्यालयात मुख्य अभियंता हे पद नसेल त्या महामंडळाच्या संबंधीत क्षेत्रीय मुख्य अभियंता स्तरावर ही मान्यता देण्यात यावी.

(ब) सदर आराखडयाबाबत संबंधीत प्रादेशिक मुख्य अभियंता यांचे अभिप्राय मध्यवर्ती संकल्पचित्र संघटनेने प्राप्त करुन घ्यावेत. मुख्य अभियंता यांनी पर्यायी आराखडा सुचविला असल्यास त्याबाबत

तौलनिक वित्तिय विश्लेषण इत्यादिसह माहिती सर्वसाधारण आराखडा टिप्णीत अंतर्भूत असणे आवश्यक आहे.

(क) सर्वसाधारण आराखडयाबरोबर अनुषंगिक (appurtenant) कामाचे सर्वसाधारण आराखडेही उदा.दगडी धरण, माती धरण, पोहोच व पुच्छ कालवा, सांडवा, सिंचन विमोचक, सिंचन तथा विद्युतविमोचक, उर्जा अपाकरण व्यवस्था (E.D.A.), जलनिस्सारण गॅलरी, धरणात बसवावयाची उपकरणे व त्यासाठीचे समर्थन, दरवाजांचा आराखडा वगैरे शक्यतो समाविष्ट असावेत. यासाठी मध्यवर्ती संकल्पचित्र संघटनेतील विविध विभागांच्या सहकार्याने सर्वसामवेशक सर्वसाधारण आराखडा प्रथम तयार होणे अपेक्षित आहे.

(ड) वरील व्यतिरिक्त प्रमाणिकरण न झालेल्या दरवाजां संदर्भातील आराखडा व संकल्पचित्रे व नवीन प्रमाणिकरण करावयाच्या दरवाजांचा आराखडा व संकल्पचित्रे शासनास मान्यतेकरिता सादर करावीत.

(इ) विद्युत विमोचकाच्या आदान बांधकामाचा (Intake Structure)सर्वसाधारण आराखडा

(ई) सर्जचे संकल्पन

(फ) टेलरेस टनेल व टेल सर्जचे संकल्पन

(ह) जलविद्युत प्रकल्पासंदर्भातील वरील बाबीशिवाय मंजूर आराखडयात मोठया प्रमाणावर बदल सुचविणारे प्रस्ताव जसे की, कालव्याऐवजी बोगदयाचा अंतर्भाव, नलिका (Conduit) किंवा कालव्यास अस्तरीकरण करणे किंवा वगळणे, भूपृष्ठावरील विद्युतगृहाऐवजी भूपृष्ठाखालील विद्युतगृहाचा अंतर्भाव किंवा पेनस्टॉकची संख्या वगैरे, शासनास सादर करावेत.

(स) जलविद्युत व मोठया पाटबंधारे प्रकल्पाच्या उर्वरित घटक भागाचे संकल्पन व संकल्पचित्रे तसेच इतर सर्व उपघटकांचे संकल्पन व संकल्पचित्रे मध्यवर्ती संकल्पचित्र संघटनेने तयार करावीत व त्यास प्रदेशिक मुख्य अभियंता स्तरावर मान्यता देण्यात यावी. अशा संकल्पचित्रांची (अहवालासह) प्रत शासनास माहितीसाठी सादर करावी.

२.२ मध्यम प्रकल्प :-

मध्यम प्रकल्पांचा सर्वसाधारण आराखडा संबंधित प्रादेशिक मुख्य अभियंता यांच्याकडून याबाबतचा प्रस्ताव प्राप्त झाल्यावर मध्यवर्ती संकल्पचित्र संघटनेने तयार करावा. मध्यवर्ती संकल्पचित्र संघटनेने तांत्रिक दृष्टीकोनातून आवश्यक वाटल्यास योग्य ते बदल करावेत व त्यानंतर मध्यम प्रकल्पाचा सर्वसाधारण आराखडा व संकल्पन आणि संकल्पचित्रे तसेच सर्व उपघटकांची संकल्पचित्रे

मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांनी तयार करावीत. त्यास प्रादेशिक मुख्य अभियंता यांचे स्तरावर मान्यता देण्यात यावी व अशा संकल्पचित्रांची (अहवालासह) प्रत शासनास माहितीसाठी सादर करावी.

२.३ लघुपाटबंधारे प्रकल्प :-

लघु पाटबंधारे योजनांचे सर्वसाधारण आराखडे क्षेत्रिय स्तरावर तयार करुन संबंधीत अधीक्षक अभियंता यांनी ते मंजूर करावेत.

३.० संकल्पनासंबंधात अवलंबिवण्याची सर्वसाधारण एकत्रित पध्दत व निर्देश :-

(अ) मध्यवर्ती संकल्पचित्र संघटनेच्या वार्षिक संकल्पन कार्यक्रमास महासंचालक (सं.प्र.ज.सु.) मेरी, नाशिक हे मान्यता देतील.

(ब) मध्यवर्ती संकल्पचित्र संघटनेच्या प्रादेशिक मुख्य अभियंता यांचे मान्यतेकरिता सादर करावयाच्या अहवालात संकल्पने व संकल्पचित्रांची संपूर्ण तांत्रिक तपासणी केल्याचे संबंधित कार्यकारी अभियंता व पथकप्रमुख यांचे प्रमाणपत्र अंतर्भूत करणे आवश्यक आहे.

(क) संकल्पचित्र अहवालात सर्वेक्षणापासून भूतांत्रिक तपासणीपर्यंत सर्व परिमाणे (Parameters) अंतर्भूत करावीत. संकल्पचित्रात व अहवालात परिपूर्णता असावी.

(ड) संकल्पचित्र अहवालासाठी आधारभूत असलेली सर्व मूळ आकडेमोड असलेली कागदपत्रे मध्यवर्ती संकल्पचित्र संघटनेत जतन केली असल्याचा संदर्भ अहवालात नमूद करण्यात यावा.

(इ) वरील संकल्पचित्रांमध्ये अंतर्भूत नसलेली इतर सर्व संकल्पचित्रे व संकल्पने क्षेत्रीय अधिकाऱ्यांनी करावयाची आहेत. त्यास सक्षम अधिका-यांनी तांत्रिक मान्यता दयावयाची आहे.

(ई) मध्यवर्ती संकल्पचित्र संघटनेने संकल्पन टिप्पणी व संकल्पचित्रे निर्गमित करतांना संकल्पचित्रांवर खालील प्रमाणे टीप ठळक अक्षरात लिहिण्यात यावी.

Note - This drawing should not be used for execution till approval from the competent authority is obtained.

(फ) मध्यवर्ती संकल्पचित्र संघटनेने निर्गमित केलेल्या संकल्पन टिप्पणी व संकल्पचित्रे यांना संबंधित मुख्य अभियंता स्तरावर मंजुरी प्राप्त झाल्याशिवाय पुढील भागाची संकल्पन टिप्पणी व संकल्पचित्रे कोणत्याही परिस्थितीत निर्गमित करु नयेत. संकल्पचित्रातील बदलामुळे घटकांच्या किंमतीत लक्षणीय वाढ होत असल्यास सदर वाढीच्या अनुषंगाने होणा-या अतिरिक्त खर्चाच्या प्रस्तावास सक्षम अधिका-याची मान्यता घेतल्यानंतरच सुधारित संकल्पचित्रास मुख्य अभियंता यांनी तांत्रिक मान्यता

दयावी. अतिरिक्त खर्चास मान्यता (Excess note) अथवा सुधारित प्रशासकीय मान्यता घेण्यात यावी. सदर अभियांत्रिकी बदलामुळे होणाऱ्या अतिरिक्त खर्चाचा सुधारित अंदाजपत्रकात समावेश करावा.

(स) मध्यवर्ती संकल्पचित्र संघटनेने तयार केलेल्या संकल्पन टिप्पण्या व संकल्पचित्रांवर काही बदल सुचवावयाचे असल्यास ते संबंधित मुख्य अभियंता स्तरावरुन सुचविण्यात यावेत.

वरील मान्यते अभावी काम करणारे व त्याची अदायगी करणारे संबंधीत कार्यकारी अभियंता यांना सदर अनियमीततेबाबत जबाबदार धरण्यात येईल.

(ष) मध्यवर्ती संकल्पचित्र संघटनेने संकल्प चित्रांचे प्रमाणिकरण करावे.

(ह) असे आढळून आले आहे की, खूप मोठया संख्येने क्षेत्रीय बाबी तपशीलवार पृथःकरण व कार्यवाहीसाठी मध्यवर्ती संकल्पचित्र संघटनेकडे संदर्भीत केले जातात. यामुळे संघटनेवर कामाचा खूप भार वाढतो आणि पर्यायाने संकल्पचित्र अधिकाऱ्यांचा खूप वेळ व श्रम खर्ची पडतात. हयातून त्यांना थोडी मुक्तता देण्यासाठी व त्यांना कामाचे पृथःकरण, संकल्पन याकडे जास्त लक्ष देणे शक्य व्हावे यासाठी सर्व संबंधीत अधिकाऱ्यांना असे सूचित करण्यात येत आहे की, खालील बाबींचा मध्यवर्ती संकल्पचित्र संघटनेकडे संदर्भ करण्यात येवू नये.

i) जलाशयाच्या कार्यक्षमतेशी संलग्न अभ्यास.

ii) जलाशयाच्या पार्श्वजलाच्या परिणामांचा अभ्यास.

iii) धरणातून सोडलेल्या पुराचा धरणांच्या खालील भागांवर होणाऱ्या परिणामांचा अभ्यास.

Iv) जलाशयातील गाळाचा अभ्यास.

v) जलशास्त्रीय मूळ बांधकामांवरील निरीक्षण

४.० सार्वजनिक व खाजगी उपक्रमाकडील प्रकल्पांचे संकल्पन इत्यादी :-

अधीक्षक अभियंता, मध्यवर्ती संकल्पचित्र संघटना, नाशिक यांनी सार्वजनिक व खाजगी उपक्रमातील खालील प्रकारच्या धरण प्रकल्पांचे संकल्पन, नकाशे व अंदाजपत्रके यांची छाननी करावी. सार्वजनिक व खाजगी उपक्रमातील यंत्रणानी (उदा. M.M.R.D.A., M.J.P., M.I.D.C., CIDCO, MAHAGENCO, Municipal Corporation इ.) यांनी खाली नमूद केलेल्या धरण योजनांबाबत जलसंपदा विभागांस माहिती देणे आवश्यक आहे. तसेच या यंत्राणांनी मध्यवर्ती संकल्पचित्र संघटनेस प्रचलित नियमानुसार संकल्पनाकरिता शुल्क अदा करणे आवश्यक आहे.

(अ) धरणाची जलोत्सारित भागाची लांबी (Crest Length) ५०० मी.पेक्षा जास्त, असल्यास.

(ब) धरणामुळे निर्माण झालेल्या जलाशयाची क्षमता १ द.ल.घ.मी. पेक्षा जास्त, असल्यास.

(क) धरणाचा महत्तम पूर विसर्ग हा २००० घ.मी./सेकंद (७० हजार घ.फू. / सेकंद) पेक्षा जास्त आणि पायाच्या (Foundation) क्लिष्ट स्वरुपाच्या समस्या किंवा लघुत्तम सर्वसाधारण पायावरील १० मीटर उंचीच्या धरणाचे असाधारण संकल्पन.

५.० सल्लामसलत (Consultancy) तत्वावर करण्याबाबतची कामे :-

बाहेरील संस्थांनी मागणी केल्यास मोठया, मध्यम, व लघु प्रकल्पांची किंवा त्यांचे घटक यांची संकल्पने शासनाच्या मान्यतेनंतर सल्लामसलत तत्वावर तयार करण्यात अथवा तपासण्यात यावीत.

बाहेरील संस्थांनी मागणी केल्यास मोठया, मध्यम व लघु प्रकल्पांची किंवा त्यांचे घटक यांच्या नवीन संकल्पनांची कामे सल्लामसलत तत्वावर घेण्याचे अधिकार महासंचालक, सं.प्र.सं.सु. नाशिक यांना दि. २९/०९/२००६ च्या शासनपत्रान्वये देण्यात आलेले आहेत. तसेच नवीन सल्लामसलतीच्या कामांचे दर शासनाने निर्धारित केलेल्या दराच्या पध्दतीनुसार सुधारित करण्याचे अधिकारही महासंचालक यांना देण्यात आलेले आहेत.

६.० मूल्यार्पण तत्वावर करावयाची कामे (Vetting) :-

(अ) मध्यवर्ती संकल्पचित्र संघटनेच्या अनुभवाचा व तांत्रिक कार्यक्षमतेचा पूर्ण वापर होण्याच्या दृष्टीकोनातून महामंडळांनी त्यांचे अभिपत्याखालील प्रकल्पांच्या संकल्पनाची कामे खाजगी सल्लागारांकडून करुन घेणे बंद करावे अशा सूचना दि. ०२/०३/२०१३ च्या शासन पत्रान्वये सर्व महामंडळांना / विभागांना निर्गमित केलेल्या आहेत.

(ब) दि. २३/०७/२०१० पूर्वीच्या कामांच्या कंत्राटात खाजगी कंत्राटदारांकडून संकल्पने करुन घेण्यासंदर्भात तरतूद असल्यास मध्यवर्ती संकल्पचित्र संघटनेने संकल्पनांचे मूल्यार्पण (vetting) करुन देण्याच्या महासंचालक, मेरी, नाशिक यांच्या प्रस्तावास दि.०२.०३.२०१३ च्या शासन पत्रान्वये मान्यता देण्यात आलेली आहे.

(क) दि. २३.०७.२०१० नंतर झालेल्या निविदांमध्ये मध्यवर्ती संकल्पचित्र संघटनेकडून मूल्यार्पणाची (vetting) तरतूद करण्यात आली असेल तर ही बाब कोणतेही कायदेशीर बाब उद्भवणार नाही, याची दक्षता घेऊन निविदेतून वगळणे शक्य आहे किंवा कसे हे तपासून पहावे असे शक्य नसल्यास महामंडळाने स्वतंत्र एकत्रित प्रस्ताव सादर करुन शासनाची मान्यता घ्यावी, असे दि.०२.०३.२०१३ च्या शासन पत्रान्वये कळविण्यात आले आहे.

७.० मध्यवर्ती संकल्पचित्र संघटनेच्या अधिका-यांनी व क्षेत्रीय अधिका-यांनी वरील आदेश लक्षात घेऊन संकल्पने व संकल्पचित्रे तयार करण्यासंदर्भात उचित कार्यवाही करावी.

८.० वरील संकल्पचित्रांमध्ये अंतर्भूत नसलेल्या परंतु इतर कोणत्याही विशिष्ठ बाबी संदर्भात मध्यवर्ती संकल्पचित्र संघटनेस अशा कारणमिमांसेसह आवश्यक वाटल्यास त्या बाबींचे संकल्पन व संकल्पचित्र शासनास सादर करण्यात यावे.

सदर शासन निर्णय महाराष्ट्र शासनाच्या www.maharashtra.gov.in या संकेतस्थळावर उपलब्ध करण्यात आला असून त्याचा संकेतांक २०१५०११६१५००४९२९२७ असा आहे. हा आदेश डिजीटल स्वाक्षरीने साक्षांकित करुन काढण्यात येत आहे.

महाराष्ट्राचे राज्यपाल यांच्या आदेशानुसार व नावाने.

Ram Baswantrao Ghote

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(रा.ब.घोटे)

मुख्य अभियंता (द. व प्र.) व सह सचिव.

प्रति,

१. स्वीय सहायक, प्रधान सचिव (जलसंपदा), जलसंपदा विभाग, मंत्रालय, मुंबई.
२. स्वीय सहायक, सचिव (लाक्षेवि), जलसंपदा विभाग, मंत्रालय, मुंबई.
३. स्वीय सहायक, प्रधान सचिव, नगर विकास विभाग , मंत्रालय, मुंबई.
४. स्वीय सहायक, प्रधान सचिव, पाणी पुरवठा व स्वच्छता विभाग, मंत्रालय, मुंबई.
५. स्वीय सहायक, प्रधान सचिव, उर्जा विभाग, मंत्रालय, मुंबई.
६. कार्यकारी संचालक, कोकण पाटबंधारे विकास महामंडळ, ठाणे.
७. कार्यकारी संचालक, गोदावरी व मराठवाडा पाटबंधारे विकास महामंडळ, औरंगाबाद.
८. कार्यकारी संचालक, कृष्णा खोरे पाटबंधारे विकास महामंडळ, पुणे.
९. कार्यकारी संचालक, विदर्भ पाटबंधारे विकास महामंडळ, नागपूर.
१०. कार्यकारी संचालक, तापी पाटबंधारे विकास महामंडळ, जळगाव.
११. महासंचालक, मेरी, नाशिक
१२. महासंचालक, वाल्मी, औरंगाबाद
१३. स्वीय सहायक, सर्व मुख्य अभियंता व सह सचिव, जलसंपदा विभाग, मंत्रालय, मुंबई.
१४. सर्व मुख्य अभियंता (स्थापत्य), जलसंपदा विभाग.

१५.मुख्य अभियंता (यां), जलसंपदा विभाग, नाशिक

१६.मुख्य अभियंता (जलविद्युत), जलसंपदा विभाग, मुंबई.

१७.स्वीय सहायक, सर्व उप सचिव, जलसंपदा विभाग, मंत्रालय, मुंबई.

१८.सर्व अधीक्षक अभियंता (स्थापत्य, यांत्रिकी व जलविद्युत) जलसंपदा विभाग.

१९.सर्व अवर सचिव, जलसंपदा विभाग, मंत्रालय, मुंबई.

२०.सर्व कार्यकारी अभियंता (स्थापत्य, यांत्रिकी व जलविद्युत) जलसंपदा विभाग

प्रत :- मोप्र-१ कार्यासन संग्रहार्थ.

परिशिष्ट क्रमांक-१

शासन निर्णय क्रमांक- मंसस १०१४/(प्र.क्र.३३४/१४)

जलसंपदा विभाग मोप्र-१ दि.-१६ जानेवारी, २०१५

अ.क्र.	शासन निर्णय / परिपत्रक/ पत्र क्रमांक व दिनांक
१	मध्यवर्ती संकल्पचित्र संघटनेचे परिपत्रक क्र. सीडीओ/इडी/इडी-२/सर्क्युलर/ ५०३/११४० दि.१४/८/२००१
२	शासन निर्णय क्र. संकीर्ण २००१/६२/(६९०/२००१)/मोप्र-२, दि. १५/११/२००१
३	शासन निर्णय क्र. संकीर्ण ११०४/४९९/२००४/मोप्र-२, दि. ९/१२/२००४
४	शासन परिपत्रक क्र. संकीर्ण मसंसं/०३०८/ (१७३/२००८)/मोप्र-१, दि. ८/४/२००८
५	शासन परिपत्रक क्र. संकीर्ण मसंसं/ ०५०८/ ४४७/ (३७९/२००८)/मोप्र-१, दि.२२/८/२००८
६	शासन पत्र क्र. आढावा-२०१०/(५१/२०१०)/निवसं-३, दि. २३/०७/२०१०
७	शासन पत्र क्र. आढावा-२०१०/(५१/२०१०)/निवसं-३, दि. ०२/०३/२०१३
८	Govt.Circular no. MIP २२८१/३३५१(१३३१)-PRJ-२, dt.४/४/१९८४
९	शासन पत्र क्र. इएसटी १००६/(२२५/२००६)/लाक्षेवि(आ), दि. २९/०९/२००६
१०	शासन परिपत्रक क्र. सुप्रमा/०४११/(२६२/२०११)/मोप्र-१, दि. १०/०८/२०११
११	शासन पत्र क्र. आढावा-२०१०/(५१/२०१०)/निवसं-३, दि. ०२/०३/२०१३
१२	शासन परिपत्रक क्र. दुरुस्ती २००३/ २७००/ (२२/२००३)/ सिंव्य (कामे), दि.१५/२/२००३

5.1 Simple key may be provided at the toe when rock or unerodible strata is available at the river bed and the overlying banks are under attack and subjected to erosion. The key is in the form of stones, bricks or concrete blocks filled in trench at the toe below the hard river bed for depth equal to the thickness of pitching for proper anchorage (*see* Fig. 5). Sole purpose of this key is to provide lateral support. The stones, bricks or blocks may be laid in mortar if pitching on slope is in mortar.

5.2 When hard strata is available below the river bed at a reasonable depth, toe wall is recommended. The thickness of toe wall depends upon the height of the wall and height of the overlying protection works. This wall may be constructed in masonry (*see* Fig. 3) and designed as a retaining wall with weep holes, etc.

5.3 When firm strata is not available at a reasonable depth below the river bed, toe protection in the form of sheet piles is recommended. The sheet pile may be made up of RCC or steel or bamboos depending upon the availability of material. Sheet piles should be driven below the anticipated maximum scour plus grip length (*see* Fig. 6).

Depth of scour may be worked out from the equation:

$$D_L = 0{\cdot}473\ (Q/f)^{1/3}$$

or $$D_L = 1{\cdot}33\ (q^2/f)^{1{\cdot}3}, \text{ and}$$

$$f = 1{\cdot}76\sqrt{d}$$

where

D_L = scour depth below HFL in m,

Q = discharge in m^2/s,

q = discharge per unit width in $m^3/s/m$.

f = silt factor, and

d = mean particle diameter of river bed material in mm.

Maximum anticipated scour for launching apron may be taken as = $1{\cdot}5\ D_L$.

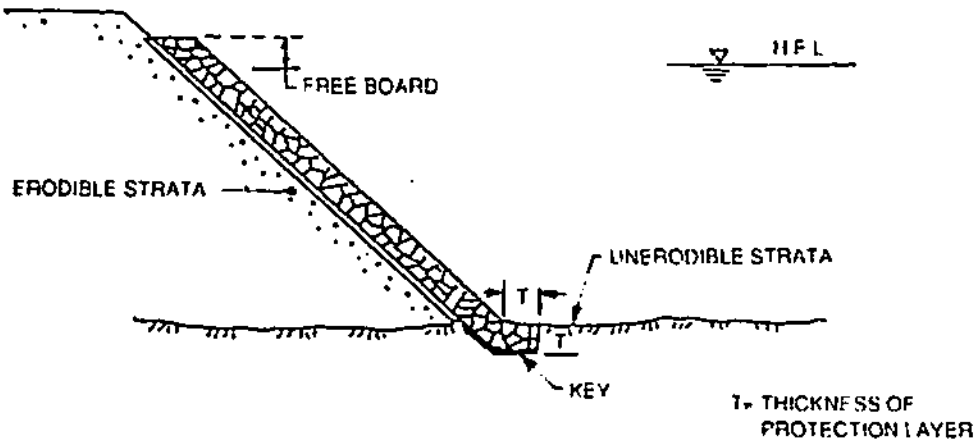


FIG. 5 TOE KEY

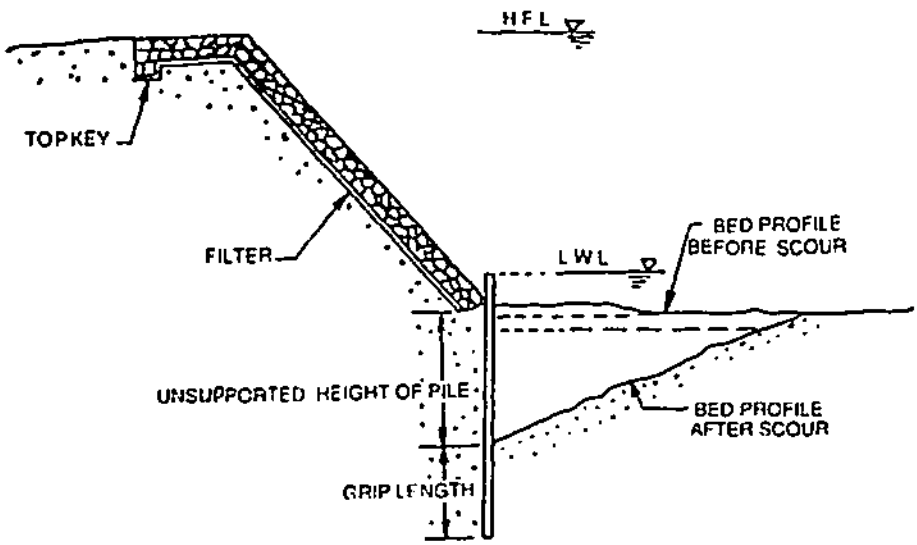
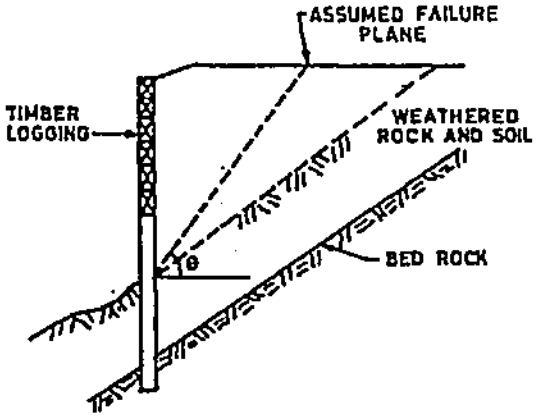
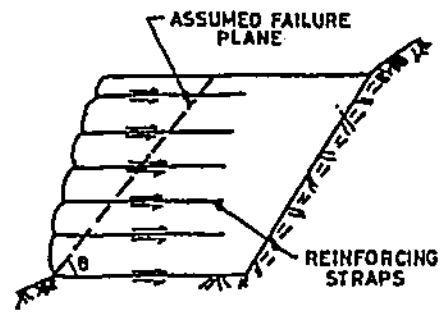


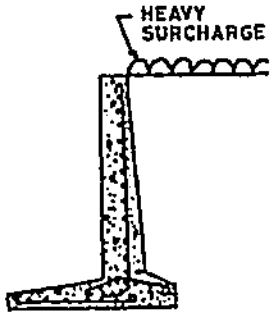
FIG. 6 TOE PROTECTION WITH PILE AND TOP KEY



1(c) DRIVEN CANTILEVER WALL



1(d) REINFORCED EARTH WALL



1(e) RCC WALLS

FIG. 1 DIFFERENT TYPES OF RETAINING WALLS

i) Reinforced earth
ii) Fabric

h) Anchored walls
i) Horizontal sheet pile
ii) Vertical sheet pile
iii) H-pile, timber logged

j) RCC walls
i) Cantilever
ii) L-type
iii) Buttressed wall
iv) Frame retaining walls

3 SELECTION OF TYPE OF WALLS

3.1 In general, the choice of wall depends on local resources, local skill, hill slope angle, foundation conditions, slope of backfill, compatibility of materials and seismicity of the region (*see* Tables 1 and 2). However, the guidelines given in 3.1.1 to 3.1.14 shall be considered for selection of the type of retaining wall to be constructed for the purpose of imparting stability to the slopes in hill area.

3.1.1 For hilly roads, being of low volume, walls may not be designed for earthquake forces. It is economical to repair failed walls after earthquake.

3.1.2 Earthquake considerations lead to excessive wall dimensions. High walls may, therefore, be avoided by alternative geometric designs of roads and terraces unless justified by risk analysis. Walls with dip at the base towards hillside will reduce the base width in seismic areas.

3.1.3 Front battered retaining walls are many times more expensive than back battered walls in steep hilly areas.

3.1.4 A retaining wall on a thin talus slope may not be able to prevent the failure of entire talus slope during monsoon because of the quick rise of water table above the relatively impervious bed rock.

3.1.5 The construction of series of retaining walls one above another on an unstable or marginally stable slope shall be avoided as it adds more pressure on the lower walls destabilizing the slope contrary to the aim of stabilizing the slope. In such cases, unstable slope shall be stabilized by afforestation, surface/sub-surface drainage system, etc.

3.1.6 Improper backfill and poor drainage behind the wall involve complicated drainage conditions which are normally not considered in normal design. Proper drainage behind the walls shall, therefore, be provided.

3.1.7 The practice of undertaking wall construction after road/hill cutting poses the problem of disposal of excavated material and loss of top soil that could otherwise be used for vegetation. Hence during construction of retaining walls, the excavated material shall be disposed off at suitable identified sites.

d) Water pressure due to water table/subsurface seepage;
e) Water pressure due to water table on toe side, if any;
f) Seismic forces; and
g) Special loads, if any.

The self weight of the structure, and live and imposed loads shall be estimated in accordance with IS 875 (Parts 1 to 5). In the usual cases live load may be taken between 250 kg/m^2 to 500 kg/m^2 on the top width of the wall.

The earth pressures and other seismic forces on the retaining structure shall be estimated in accordance with IS 1893. For low volume roads, the walls may not be designed for earthquake forces. In case of retaining walls for roads earth pressure due to surcharge shall be in accordance with IRC Codes.

The consideration of full water pressure behind the wall may lead to quite heavy section. Adequate arrangement for release of this water pressure shall be made. Atleast 30 percent water pressure shall always be considered even in case of provision of good efficient pressure release system.

5.2 Retaining walls and breast walls shall be designed as rigid walls, using following criteria:

a) Factor of safety against overturning	> 2.0 (static loads) > 1.5 (with earthquake forces)	(*see also* IS 1904)
b) Factor of safety against sliding	> 1.5 (static loads) > 1.0 (with earthquake forces)	

NOTE — The live loads and imposed loads adding to stability of the structure shall not be considered in working out the factors of safety given in 5.2(a) and 5.2(b).

c) Maximum base pressure ≤ q_a (allowable bearing capacity)
≤ 1.33 q_a (during earth-quake)

d) Minimum base pressure	> 0 (zero)	[*see also* IS 4247 (Part 3)]
e) Factor of safety against floatation	> 1.25	

f) In case of steep hills, the factors of safety for slip surface below foundation shall be greater than 1.5 and 1.0 in static and seismic conditions respectively.

The design of wall foundations shall meet the requirements of IS 1080 and IS 1904.

5.3 Sometimes, to achieve the minimum factor of safety given in 5.2(b) and thereby resist sliding it may be necessary to increase the base area or to add concrete keys monolithic with foundation slab or to provide piles.

5.4 It is generally not possible to design each and every wall along the entire length of a road. Standard designs as given in Table 3 may be adopted for walls less than 8 m in height and 120 m^2 area in a low hazard zone provided the allowable bearing capacity is more than the maximum pressure indicated in the table.

6 OTHER DETAILS

6.1 Depth of Walls

The depth of retaining wall and breast wall below ground level or terrace level shall be at least 500 mm below side drain within soil or highly jointed rock and foundation shall be on natural firm ground. All multiple breast walls shall be taken to the firm rock surface.

6.2 Stepping of Base of Wall on Rock Slope

If the retaining wall is made on rock slope, the foundation shall be stepped as shown in Fig. 2. In case of steep slopes (>35°), retaining walls with front face nearly vertical and back-face inclined shall be used as it will reduce the height of wall considerably.

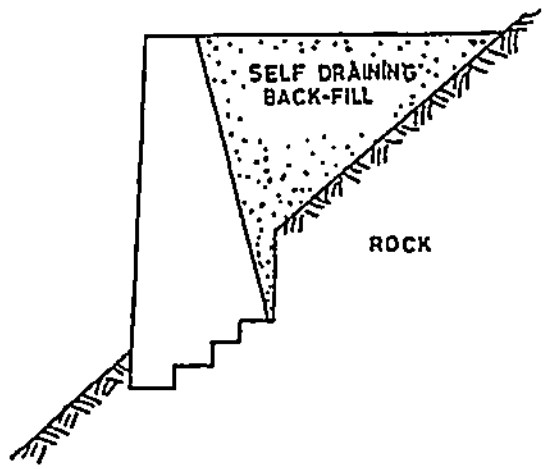


FIG. 2 STEPPING OF FOUNDATION OF WALL ON ROCK SLOPE

6.3 Dip of the Base of Wall Towards Hillside

A dip of the base of wall towards hillside to the extent of 3 : 1 (horizontal : vertical) proves very economical in seismic conditions (*see* Fig. 3). It increases factor of safety against sliding significantly.

6.4 Negative Batter of Backside of Breast Wall

Breast wall with negative batter (*see* Fig. 3) on cut-slope side reduces earth pressure significantly. So even nominal section of breast wall stabilizes cut slopes in soil, provided breast wall is founded on rock or firm natural ground. Negative batter of upto 1 : 3 (horizontal : vertical) is recommended.

Table 3 Standard Design of Cement Masonry and Dry Stone Masonry Retaining Walls

(*Clause* 5.4)

Back Fill Type	Particulars	Cement Masonry													Dry Stone Masonry								
		Ht 3M			Ht 6M			Ht 8M			Ht 10M			Ht 3M			Ht 6M			Ht 8M			Ht 10M		
Good Back-fill	Top width in m	0.65	0.70	—	0.75	1.00	1.00	0.80	1.00	1.00	0.90	1.00	—	0.70	—	—	0.75	0.95	1.00	0.85	1.00	1.00	0.90	1.00	—
Full Drainage	Base width in m	1.91	2.01	—	3.92	4.78	8.41	5.23	8.10	10.96	6.64	13.57	—	2.01	—	—	3.92	4.32	8.50	5.33	6.89	11.81	6.64	14.58	—
GW, GP SW, SP	Foundation pressure in t/m^2	14.00	13.00	—	25.0	20.00	13.00	33.00	20.00	17.00	40.00	21.00	—	11.00	—	—	22.00	20.00	17.00	29.00	20.00	13.00	36.00	16.00	—
Fair Back-fill	Top width in m	0.60	0.75	—	0.90	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.75	—	—	0.85	1.00	—	1.00	1.00	1.00	1.00	1.00	1.00
Low pore Water pressure	Base width in m	1.81	2.11	—	4.12	4.47	4.88	5.53	6.59	8.14	6.94	9.90	14.03	2.11	—	—	4.12	4.42	—	5.63	6.49	6.94	6.94	8.50	10.26
GM, SM SM, SC	Foundation pressure in t/m^2	15.00	13.00	—	25.00	22.00	20.00	32.00	25.00	20.00	39.00	25.00	11.00	11.00	—	—	22.00	20.00	—	28.00	22.00	20.00	34.00	25.00	20.00
Poor Back-fill	Top width in m	—	—	—	—	—	—	—	1.00	1.00	1.00	1.00	1.00	—	—	—	—	—	—	1.00	1.00	1.00	1.00	1.00	1.00
High pore Water pressure	Base width in m	—	—	—	—	—	—	—	6.49	7.89	8.50	7.79	11.01	—	—	—	—	—	—	6.54	8.65	8.70	7.84	10.11	11.97
GC, SC ML	Foundation pressure in t/m^2	—	—	—	—	—	—	—	22.00	20.00	19.00	29.00	23.00	—	—	—	—	—	—	22.00	20.00	16.00	25.00	20.00	18.00

NOTES

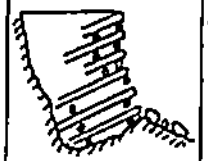
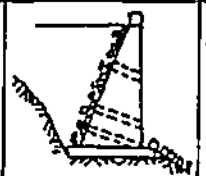
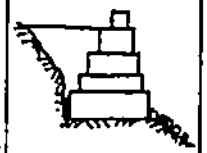
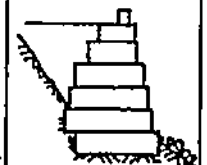
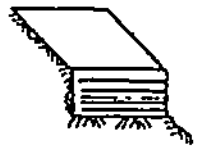
1 Wall Geometry : Front face vertical back, face inclined, base inclined with hill.

2 Back Fill Top : Horizontal with surcharge 1.5 t/m^2.

3 Select wall dimensions such that allowable bearing capacity is greater than the foundation pressure.

4 The base width for dry stone masonry wall is slightly less for cement masonry wall because wall friction angle is likely to be equal to angle of internal friction of back fill in the case of dry stone masonry

Table 1 Selection of Retaining Walls
(*Clause* 3.1)

	Type	Retaining Walls						
		Timber Crib	Dry Stone	Banded Dry Stone/ Masonary	Cement Masonry	Gabion		Reinforced Earth
						Low	High	
	Diagrammatic Cross-section							
CONSTRUCTION NOTES	Top width	2 m	0.6-1.0 m	0.6-1.0 m	0.5-1.0 m	1 m	1-2 m	4 m or 0.7-0.8 m
	Base width	—	0.5-0.7 H	0.6-0.65 H	0.5-0.65 H	0.6-0.75 H	0.55-0.65H	4 m or 0.7-0.8 H
	Front batter	4:1	vertical	varies	10:1	6:1	6:1	3:1
	Back batter	4:1	varies	vertical	varies	varies	varies	3:1
	nward dip of foundation	1:4	1:3	1:3	horizontal or 1:6	1:6	1:6	horizontal
	Foundation depth below drain	0.5-1 m	0.5 m	0.5-1 m	0.5-1 m	0.5 m	1 m	0.5 m
	Range of height	3-9 m	1-6 m	6-8 m	1-10 m	1-6 m	6-10 m	3-25 m
	Hill slope angle	<30°	<35°	20°	35-60	35-60	35-60	<35
	Toe protection in case of soft rock/soil	Boulder pitching	Boulder Pitching					No
	General	Timbers 15 cm φ with stone rubble well packed behind timbers. 10% of all headers to extend into fill. Ecologically unacceptable.	Set stones along foundation bed. Use long bond stones. Hand packed stones in back fill.	Cement masonry bands of 50 cm thickness at 3 m c/c. Other specifications as for dry stone wall.	Weep holes 15 × 15 cm size at 1-2 m c/c. 50 cm rubble backing for drainage.	Stones to be hand packed. Stone shape important, blocky preferable to tabular. Specify maximum/minimum stone size. No weathered stone to be used. Compact granular back fill in layers (< 15 cm). Use *H* type gabion wall.		Granular back fill prefered. Use geogrid for H <4 m and tensur grid for H> 4 m. Provide drainage layer in case of seepage problems. Specify spacing of reinforcement grids.

<table>
<tr><td colspan="2"></td><td colspan="3">1. Foundations to be stepped up if rock encountered.
2. All walls require durable rock filling of small to medium size.
3. Drainage of wall bases not shown. Provide 15 cm thick gravel layer in case of clayey foundation.</td><td></td></tr>
<tr><td colspan="2" rowspan="3">Application</td><td>Least durable</td><td>Most durable</td><td>Can take differential settlement and slope movement</td><td rowspan="3">Huge potential used more as stable reinforced fill platform for road rather than preventive method of slope support.</td></tr>
<tr><td colspan="2">Non ductile structure most susceptible to earth-quake damage</td><td>Very flexible structures</td></tr>
<tr><td colspan="3">1. Design as conventional retaining walls. Assume surcharge on road of 2T/m^2.
2. Used both as cut slope and fill slopes support. Breast wall is more economical for cut slope.
3. Choice of wall depends on local resources, local skill, hill slope angle, foundation conditions and also shape of back fill wedges as illustrated in diagrams and compatibility of materials.</td></tr>
</table>

8.2 Requirements for Durability

8.2.1 *Shape and Size of Member*

The shape or design details of exposed structures should be such as to promote good drainage of water and to avoid standing pools and rundown of water. Care should also be taken to minimize any cracks that may collect or transmit water. Adequate curing is essential to avoid the harmful effects of early loss of moisture (*see* 13.5).Member profiles and their intersections with other members shall be designed and detailed in a way to ensure easy flow of concrete and proper compaction during concreting.

Concrete is more vulnerable to deterioration due to chemical or climatic attack when it is in thin sections, in sections under hydrostatic pressure from one side only, in partially immersed sections and at corners and edges of elements. The life of the structure can be lengthened by providing extra cover to steel, by chamfering the corners or by using circular cross-sections or by using surface coatings which prevent or reduce the ingress of water, carbon dioxide or aggressive chemicals.

8.2.2 *Exposure Conditions*

8.2.2.1 *General environment*

The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 3.

Table 3 Environmental Exposure Conditions

(*Clauses* 8.2.2.1 *and* 35.3.2)

Sl No.	Environment	Exposure Conditions
(1)	(2)	(3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet
		Concrete exposed to condensation and rain
		Concrete continuously under water
		Concrete in contact or buried under non-aggressive soil/ground water
		Concrete surfaces sheltered from saturated salt air in coastal area
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation.
		Concrete completely immersed in sea water
		Concrete exposed to coastal environment
iv)	Very severe	Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet
		Concrete in contact with or buried under aggressive sub-soil/ground water
v)	Extreme	Surface of members in tidal zone
		Members in direct contact with liquid/ solid aggressive chemicals

8.2.2.2 *Abrasive*

Specialist literatures may be referred to for durability requirements of concrete surfaces exposed to abrasive action, for example, in case of machinery and metal tyres.

8.2.2.3 *Freezing and thawing*

Where freezing and thawing actions under wet conditions exist, enhanced durability can be obtained by the use of suitable air entraining admixtures. When concrete lower than grade M 50 is used under these conditions, the mean total air content by volume of the fresh concrete at the time of delivery into the construction should be:

Nominal Maximum Size Aggregate (mm)	*Entrained Air Percentage*
20	5 ± 1
40	4 ± 1

Since air entrainment reduces the strength, suitable adjustments may be made in the mix design for achieving required strength.

8.2.2.4 *Exposure to sulphate attack*

Table 4 gives recommendations for the type of cement, maximum free water/cement ratio and minimum cement content, which are required at different sulphate concentrations in near-neutral ground water having *p*H of 6 to 9.

For the very high sulphate concentrations in Class 5 conditions, some form of lining such as polyethylene or polychloroprene sheet; or surface coating based on asphalt, chlorinated rubber, epoxy; or polyurethane materials should also be used to prevent access by the sulphate solution.

8.2.3 *Requirement of Concrete Cover*

8.2.3.1 The protection of the steel in concrete against corrosion depends upon an adequate thickness of good quality concrete.

8.2.3.2 The nominal cover to the reinforcement shall be provided as per 26.4.

8.2.4 *Concrete Mix Proportions*

8.2.4.1 *General*

The free water-cement ratio is an important factor in governing the durability of concrete and should always be the lowest value. Appropriate values for minimum cement content and the maximum free water-cement ratio are given in Table 5 for different exposure conditions. The minimum cement content and maximum water-cement ratio apply to 20 mm nominal maximum size aggregate. For other sizes of aggregate they should be changed as given in Table 6.

8.2.5 *Mix Constituents*

8.2.5.1 *General*

For concrete to be durable, careful selection of the mix and materials is necessary, so that deleterious constituents do not exceed the limits.

8.2.5.2 *Chlorides in concrete*

Whenever there is chloride in concrete there is an increased risk of corrosion of embedded metal. The higher the chloride content, or if subsequently exposed to warm moist conditions, the greater the risk of corrosion. All constituents may contain chlorides and concrete may be contaminated by chlorides from the external environment. To minimize the chances of deterioration of concrete from harmful chemical salts, the levels of such harmful salts in concrete coming from concrete materials, that is, cement, aggregates water and admixtures, as well as by diffusion from the environment should be limited. The total amount of chloride content (as Cl) in the concrete at the time of placing shall be as given in Table 7.

The total acid soluble chloride content should be calculated from the mix proportions and the measured chloride contents of each of the constituents. Wherever possible, the total chloride content of the concrete should be determined.

8.2.5.3 *Sulphates in concrete*

Sulphates are present in most cements and in some aggregates; excessive amounts of water-soluble sulphate from these or other mix constituents can cause expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as SO_3, should not exceed 4 percent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix.

The 4 percent limit does not apply to concrete made with supersulphated cement complying with IS 6909.

8.2.5.4 *Alkali-aggregate reaction*

Some aggregates containing particular varieties of silica may be susceptible to attack by alkalis (Na_2O and K_2O) originating from cement or other sources, producing an expansive reaction which can cause cracking and disruption of concrete. Damage to concrete from this reaction will normally only occur when all the following are present together:

a) A high moisture level, within the concrete;

b) A cement with high alkali content, or another source of alkali;

c) Aggregate containing an alkali reactive constituent.

Where the service records of particular cement/ aggregate combination are well established, and do not include any instances of cracking due to alkali-aggregate reaction, no further precautions should be necessary. When the materials are unfamiliar, precautions should take one or more of the following forms:

a) Use of non-reactive aggregate from alternate sources.

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 *and* 9.1.2*)*

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	-	300	0.55	M 20
ii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.