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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

B.N-866
A-1025(1)

MEGHNA ESTUARY STUDY



TECHNICAL NOTE MES-021

INSTALLATION OF KHORKI EROSION CONTROL PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
AQUA CONSULTANTS AND ASS. LTD.

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Technical Note on:

**INSTALLATION REPORT
KHORKI EROSION CONTROL PILOT SCHEME**



Dhaka, September 1998

Project Name : Meghna Estuary Study (MES)
Location : Meghna River, north east coast of Bhola Island
Key words : Installation techniques open spurs and under water screen
Description of activities and timing
Evaluation installation methodology
Recommendations for improvement of technology

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1. INTRODUCTION

The works executed under the Khorki Bank Protection Pilot Scheme consists of works distributed at two locations in the Meghna Estuary Study (MES) area. These are:

1. Haimchar erosion control project about 20 km down to Chandpur.
2. Khorki Bank Protection at south east of Bhola island.

The location of these pilot projects is shown on Figure 1.

The Haimchar erosion control project consists of installation of 2 nos. spurs, 12 nos. of screens and installation of profix system at both sides of the spurs. The installation of the Haimchar works has been reported separately in Technical Note MES-020.

The Khorki Bank Protection project consists of installation of 3 spurs, 108 nos. of screens & installation of profix system at both sides of the spurs, see Figure 2.

This installation reports describes the manufacturing of geotextile bottom screens and bed mattresses as well as the installation of same. In addition the preparation and installation of spur caissons is described in detail.

Also the use of a Twin Hull Pontoon and other auxiliary equipment like tug boat and pontoon is described in the report.

All lessons learned and recommendations for improvement of the designs and installation methodology are listed in chapter of the report

2. SITE WORK ANALYSIS

2.1 Geotextile Screen

2.1.1 Preparation of screens

A geotextile screen measuring 5m x 4m size with 3 nos. 0.20m dia PVC float pipes at top and 0.20m dia R.C.C beam covered by PVC pipe at bottom requires the following materials. (Figure 3)

- ⇒ Geotextile material propex 6288 = 5.2m x 6.5m.
- ⇒ 0.20m dia 5.20m long PVC float pipes = 3 nos.
- ⇒ 0.20m dia 5.20m long both ends open PVC pipe = 1 no.
- ⇒ 0.20m dia R.C.C beam covered by the above mentioned PVC pipe = 1no, see (Figure 4)
- ⇒ 22mm dia 6mm thick PVC pipe = 4 nos.
- ⇒ Anchor blocks 1.5m x 1.5m x 0.125m size = 4 nos.
- ⇒ Sewing yarn
- ⇒ D Shackles 4" size = 4 nos.

For sewing each screen 12 nos. skilled labourers (cobblers) were needed.

2.1.2 Anchor base slab

A pair of concrete slabs one over the other measuring 1.5m x 1.5m x 0.125m each was used at each end of the screens as anchor slabs to hold the screens in position at the river bed. The bottom slabs were resting on 4 anchor legs 20cm long made of mild steel angles. The idea of these legs is that the legs will sink to the river bed to give better anchorage (Figure 5). A 10cm dia 1.0 meter long hook made of 25mm dia mild steel rod was fixed to the bottom slab to tie the system with the screen by steel chain or flexible steel wire through D-shackles.

2.1.3 Installation of screen

For installation of screen the following equipment were used:

- ⇒ Twin Hull Pontoon (THP) - 1 no.
- ⇒ Flat top auxiliary pontoon 6.00m wide and 16m long - 1no.
- ⇒ Tug boat 250 - 300 BHP -1 no.
- ⇒ Tender boat -1 no.
- ⇒ Mobile crane of 3 ton capacity with boom length of 6m - 1 no.
- ⇒ Diver's equipment -2 sets.
- ⇒ Chain Pully - 1 ton capacity - 2 nos.
- 500 kg capacity -3 nos.
- ⇒ Tripod stand -2 ton capacity - 2 nos.
- ⇒ Push Trolley - 3 nos.

Twenty nos. of skilled and 4 nos. unskilled labourers were divided into two groups 12 nos. in each for installation of screens.

Eight nos. skilled labourers with 4 more unskilled ones were engaged in loading the anchor blocks from the shore to the auxiliary pontoon with the help of tripod stand, push trolley and mobile crane. This group loaded anchor blocks sufficient for 8 screens per day. Their activity were confined preferably at night time.

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The next group of 12 no. of skilled labourers were engaged in dropping the screens. 2 nos. divers helped them in releasing the wire connections under water. 4 winch operators were engaged in winches. This group of workers initially could install 4 screens per day at 2 slack water periods available. But experience helped to install upto maximum 9 screens per day afterwards at Khorki site. However, considering re-positioning of the THP with anchors planning for installation of 8 screens per day is ideal during early monsoon. During monsoon spring tide no installation was possible for one week time.

At Haimchar site low water slack was more favourable for working condition as high tide velocity was less than the low tide velocity. But at Khorki site the case was reverse. High water slack was more favourable than low water slack. This is due to the distance of the sites from the outfall point of the river Meghna.

At Haimchar site attempt was taken to use the lifting frames in lifting four anchor blocks to install two screens at a time. But one of the lifting frames failed to carry the load as the loading point was in between the lifting points. Afterwards work was continued with one screen at a time without the help of lifting frames. In this process at Khorki site it was possible to install 4 screens per day. Later on the system was improved by lifting 4 pairs of anchor blocks at a time a 4 lifting points by 4 winches. The auxiliary pontoon was removed and the first screen was lowered by using two pairs of blocks at correct angle of the screen. Then the rest two pairs of blocks were transferred in hanging position to the correct hooks through winches and the next screen was installed by shifting the THP in right position. This system took about an hour to install two screens which made it possible to install 8 to 9 screens a day at two slack periods.

At Khorki in between spurs KC-1 & KC-2 and also north of KC-1 the depth of water was shallow and as such it was necessary to reduce the screen height from 4 meters to 3 meters. However, in between KC-2 and KC-3 and also at downstream of KC-3 the depth was more and found no problem with 4m height screen. But during high water slack the length of the winch chord was found short to reach bed of the river with screens. The depth of water measured at that time was 13 m at south of KC-3 spur.

Working time

Fabrication of screens, geobags and bed mattress was started at Dhaka on 1st March and was completed in mid April by average 30 cobblers per day. Installation of screens at Haimchar was done in the month of April, and that at Khorki in the months of May and June.

It was a time just before monsoon when the tidal effect of the Meghna river has increased, tide range and current velocity both were high. The available slack period was very short, some times half an hour, which was not adequate for installation of screens in proper angle. As such it is proposed that such type of work should be done during period November to mid March and not later than end of March.

Table 2.1 provides an overview of the time frame in which the works were accomplished, including date of unworkable and inclement weather conditions.

Table 2.1 : Working schedule for installation of spurs and screens

Haimchar site

Date	Remarks
29.03.98-31.03.98	Stormy weather
02.04.98	Lowering of 12m caisson at spur-1
	Eid-ul-Azha holidays during 1st week of April and site work resumed after mid April.
07.04.98	Stormy weather
17.04.98	Stormy weather
19.04.98	Lowering of 12m caisson at spur-2
20.04.98	Lowering of rest 6m caisson at spur-2
	Storm and rain continues since 20.04.98. Norwester on 23.04.98.
24.04.98	2 screens installed at 4-00 pm. Rain & Strong wind continues.
25.04.98	4 screens installed. 2 nos. at 12-30 pm. And 2 nos at 4-30 pm.
26.04.98	4 screens installed.
27.04.98	2 screens installed.
	Total 2 spurs and 12 screens installed at Haimchar.

Khorki site

Date	Remarks
07.05.98-	One full 12m caisson installed at KC-3.
08.05.98	One half 6m caisson installed at KC-3. Spring tide starts.
11.05.98	2 screens installed.
14.05.98	One full 12m caisson installed at KC-2.
15.05.98	One half 6m caisson installed at KC-2.
17.05.98	One full 12m caisson installed at KC-1.
18.05.98	One half 6m caisson installed at KC-1.
19.05.98	Storm signal no. 7. Anwasha shifted to Kaligonj, a safe place at Mehendigonj thana.
21.05.98	2 nos screens installed.
22.05.98	4 nos screens installed.
23.05.98	4 nos screens installed.
24.05.98	9-30 am low water slack. 2 screens dropped. Strong wind. 3-30 pm high water slack. 2 screens dropped. Strong wind.
25.05.98	Stormy weather. New moon spring tide.
26.05.98	Stormy weather. New moon spring tide.
27.05.98	Storm & Rain. New moon spring tide.
28.05.98	Storm & Rain. New moon spring tide.
29.05.98	Cloudy. Spring tide.
30.05.98	4 screens installed.
31.05.98	8 screens installed. Neap tide starts.
01.06.98	8 screens installed.
02.06.98	10 screens installed.
03.06.98	6 screens installed. Norwester in the afternoon.
04.06.98	9 screens installed.
05.06.98	9 screens installed.
06.06.98	6 screens installed.
07.06.98	9 screens installed.
08.06.98	6 screens installed. New moon spring tide starts. High waves.
09.06.98	Norwester. THP tears off from anchors. Weather signal no. 2 continues.
10.06.98	Storm signal no. 3.
13.06.98	4 screens installed.
14.06.98	5 screens installed.
15.06.98	8 screens installed
	Total 3 spurs and 108 screens installed at Khorki.

2.2 Bed Mattress

2.2.1 Preparation

Bed mattress used under caisson and in front of it were made of Geotextile fabrics with 8m long bamboo attached. (Figure 6).

The mattress was prepared by two types of woven Geotextile, propex 6284 & Propex 6288 with another nonwoven filter fabric RIG EDY 200.1 sewn together. Propex 6288 is stronger than propex 6284.

Propex 6288 with RIG EDY 200.1 is placed under the caisson base to carry load of caisson itself and ballast materials. Propex 6284 with RIG EDY 200.1 acts as bed protection.

One bed mattress of 15m x 20m size requires the materials and labourers for installation:

- ⇒ Geotextile materials = 312 m^2
Propex 6284 + RIG EDY-200.1 and propex 6288 + RIG EDY 200.1
- ⇒ Bamboos = 61 nos.
- ⇒ Nylon rope = 5 kg.
- ⇒ Steel anchor 15 kg wt. = 6 nos.
- ⇒ Skilled labour = 12 nos.
- ⇒ Divers = 2 nos

2.2.2 Installation

Placing in position

After preparation of the bed mattress with bamboos fixed, it is rolled down from shore to water in a tied bundle form, floated to caisson site by labourers and tender boat or even by tug boat depending on distance and tide condition. It is placed under caisson (caisson is still hanging to the THP beams) or in front of it as per design. The bottom portion of the bullahs and bamboos of the caisson are tied firmly to the bamboos of the bed mattress at an interval not more than 50 cm.

In case of bed protection in front of the caisson the mattress is placed with 3m overlap with the mattress under the caisson. Sometimes it was observed that the mattress under the caisson did not have sufficient or at all extension beyond the caisson end. This case appeared due to two reasons.

1. The bed mattress could not be stretched sufficiently in floating condition under the caisson (hanging) due to friction.
2. To adjust overlap to the upper (shore side) bed mattress.

In such cases to provide 3m overlap between the mattress under the caisson and that in front of it the lap portion of the front mattress including attached bamboos is cut along the caisson length at two points to go inside the toe end of the caisson. Thus the problem was solved.

Spreading of flap portion

The bed mattress has 6m flap portions both at upstream and downstream side beyond the attached 8m long bamboos. Spreading of the mattress flaps through underneath the THP was done by 2 divers and one helper.

Anchoring

Initially during design stage it was conceived of using 1.5m x 1.5m x 0.125m R.C.C. Slabs as anchors to spread the bed mattress at upstream and downstream ends. But due to heavy weight of the slabs it was found difficult to handle them under water. Instead it was found easy and serving the purpose to use fishing boat anchors made of Mild steel. 3 nos 12 kg to 16 kg weight anchors were used at each upstream and downstream side for each bed mattress of 15m length across the river. Divers initially fixed the anchors in proper place with a nylon rope / anchor wire rope through the ring fixed with the anchors. One end of the rope was tied to the edge of the mattress and the other end to a tackle block over THP. This end was pulled through the tackle block to spread the mattress gradually. To resist this pull force by the steel anchors two geobags filled with soil were tied to the anchors to make them more strong. (Figure 7)

Two rows of 25 cm dia 1.25m long sausage type geo-bags filled with soil were tied at the upstream and downstream of all mattresses and also at front side of the front mattress.

2.3 Spur Caisson

Spur Caissons consisting of 4 nos. 6m long 4m wide panels were found suitable for installation. Height of the caisson could vary from 3m to 6m according to the depth of water available.

2.3.1 Preparation of caisson

Preparation of one caisson 12m long 4m wide and 6m high needs the following materials and manpower.

- | | | |
|----|---------------------|-----------|
| a) | 15m dia shal bullah | = 425m |
| b) | 7.5 cm dia bamboo | = 450m |
| c) | Nylon rope | = 15 kg |
| d) | G.I. wire | = 15 kg |
| e) | Skilled labourers | = 32 nos. |

2.3.2 Site selection

Before site selection for installation of caissons the bed of the river were checked whether there were any tree roots, abrupt changes in slope, steep slope etc. Beyond the caisson end also the bed was checked by divers to install bed protection geo-mattress. At two points site had to be changed at Khorki after checking by the divers. The bed profile was then surveyed through sounding ropes to determine the slope. A gentle slope of about. 1:10 or less was found ideal for installation of caisson.

2.3.3 Fabrication

After preparation of 6m long 4 panels for one caisson, they were floated on water and dragged to site by manual labour / tug boat. They were hung by the lifting frames in position, drilled by using 2 power drills to fabricate into a caisson through nut bolt joints. During fabrication materials and manpower were needed as follows:

- | | | |
|---|------------------------------|----------------------------------|
| ⇒ | Labourers | = 14 nos. skilled + 10 unskilled |
| ⇒ | Generator (20 kw) | = 1 no. |
| ⇒ | Power drill | = 2 nos. |
| ⇒ | Nut bolts | = 44 nos. |
| ⇒ | Tie rope | = 10 kg. |
| ⇒ | THP, Tug boat & Tender boat. | |

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It took about 8 hours for the above party for fabrication of one caisson through drilling and connecting by nut bolts.

2.3.4 Sinking of caisson

The bed mattress is brought underneath the caisson (caisson panels are hanging to the THP lifting frames) and tied to it. At slack period sinking work starts. Initial ballasting is done by earth filled gunny bags dumped inside the caisson and outside it over the bed mattress in scattered position. Care should be taken so that the flap portion of mattress outside bamboos remain free from loading. The flaps are stretched out to tie with previously placed anchors as per item 1.2.2.2. The tide direction should be followed during stretching out the mattress flaps when water velocity is significant. Although the sinking process was always started during slack time sometimes slack period was not sufficient to complete the process. Water velocity started increasing during spreading the Geotextile and in such case the tide direction had to be followed.

Sinking of caisson was done upto water depth of 6m without problem. Quick initial ballasting upto 1.00m height during neap tide made it stable. However dumping of more synthetic bags or c.c blocks was done upto 2.00m height before spring tide.

For sinking purpose the following man power and materials were used:

- | | |
|-------------------------------|-------------|
| ⇒ Skilled labourers | = 14 nos. |
| ⇒ Unskilled labourers | = 20 nos. |
| ⇒ Divers with equipment | = 2 nos. |
| ⇒ THP & Tender boat. | |
| ⇒ Floating rafts | = 5 nos. |
| ⇒ Earth filled synthetic bags | = 1500 nos. |

For dumping earth filled synthetic bags inside a caisson it was initially thought of using walkway over it to be used by labourers. But after installation of caisson on a slope bed it was observed that a walkway could not be placed over it because the top did not attain a regular level or regular slope. But however, if the caisson is placed on river bed of minimum slope the idea may be suitable which will help dumping the bags quickly and efficiently by labourers. However, care should be taken when the caisson will jerk and settle during loading process.

2.3.5 Type of soil

The soil available near the work site is silty type. This soil when used in filling synthetic bags comes out as wash material when it is exposed to wave or current action. Even in geobags with nonwoven inner filter layer also the same consequence was observed, however washing out of materials was much slower.

Remedy

The exposed sides of the dumped heap of bags should be covered by Geotextile. Ballasting over the bed mattress may be done by c.c blocks instead of synthetic bag or Geobags. If Geobags or synthetic bags are to be used somewhere, they should be filled with local sand of F.M. value 1.50.

3. PROBLEMS FACED AND REMEDIES PROPOSED

Most of the problems faced were due to the late working season. Some times the weather was foul with strong wind, high velocity of current and high fluctuation of tidal range (about 2.5m at Khorki). Such type of work should be completed by not later than end of March.

Use of the THP is vital in such project. The present facilities attached to THP needs to be improved as follows to adjust with the requirements at site:

- i) The anchor chords 6mm dia were found sometimes too weak to keep the THP in position. During stormy weather or spring tide they failed several times resulting in missing of anchors. 10mm dia chords may be ideal.
- ii) The lifting points of the lifting frame are not placed vertically in position. These should be corrected.
- iii) The lifting frames are not strong enough to carry required load. These may be strengthened by welding extra steel plates at the mid section of the frames.
- iv) A lifting frame set may be devised in such a way so that two screens can be placed in proper angle at a time without shifting the THP.
- v) While maneuvering the THP through tug boat most of the small winches were disturbed and some of them were damaged.
- vi) The mooring point at the shore side was sometimes more than 60m far and the anchor chords were short to reach there.
- vii) Two of the 5 ton capacity big winches were disturbing. Their safety device some times failed and moved freely causing accident to the winch operators while lowering with anchor blocks. These need to be repaired.
- viii) The two booms attached to the THP came to no use to the work as they could be rotated or moved neither on horizontal plane nor on vertical one. These could come to great use if installed properly with horizontal and vertical movement provisions.
- ix) The two side winches used for anchoring purpose are fixed at outer corners of each of the rafts of the THP at 90° angle to the body. Normally the anchor is placed at about 45° angle. So there was problem. It damaged the anchor wires through wear & tear. These should be turned to 45° angle.
- x) Initially lifting the anchors for repositioning the THP was problem. It took 12 labourers to lift it. But afterwards it became easier and possible by 4 labourers only by tying the lifting rope with the bottom end of the anchors instead of top hook of the anchor stem. However it needs help of the tender boat also. An easier mechanical lifting device may be thought of.

Figure 1: Map with location of Project

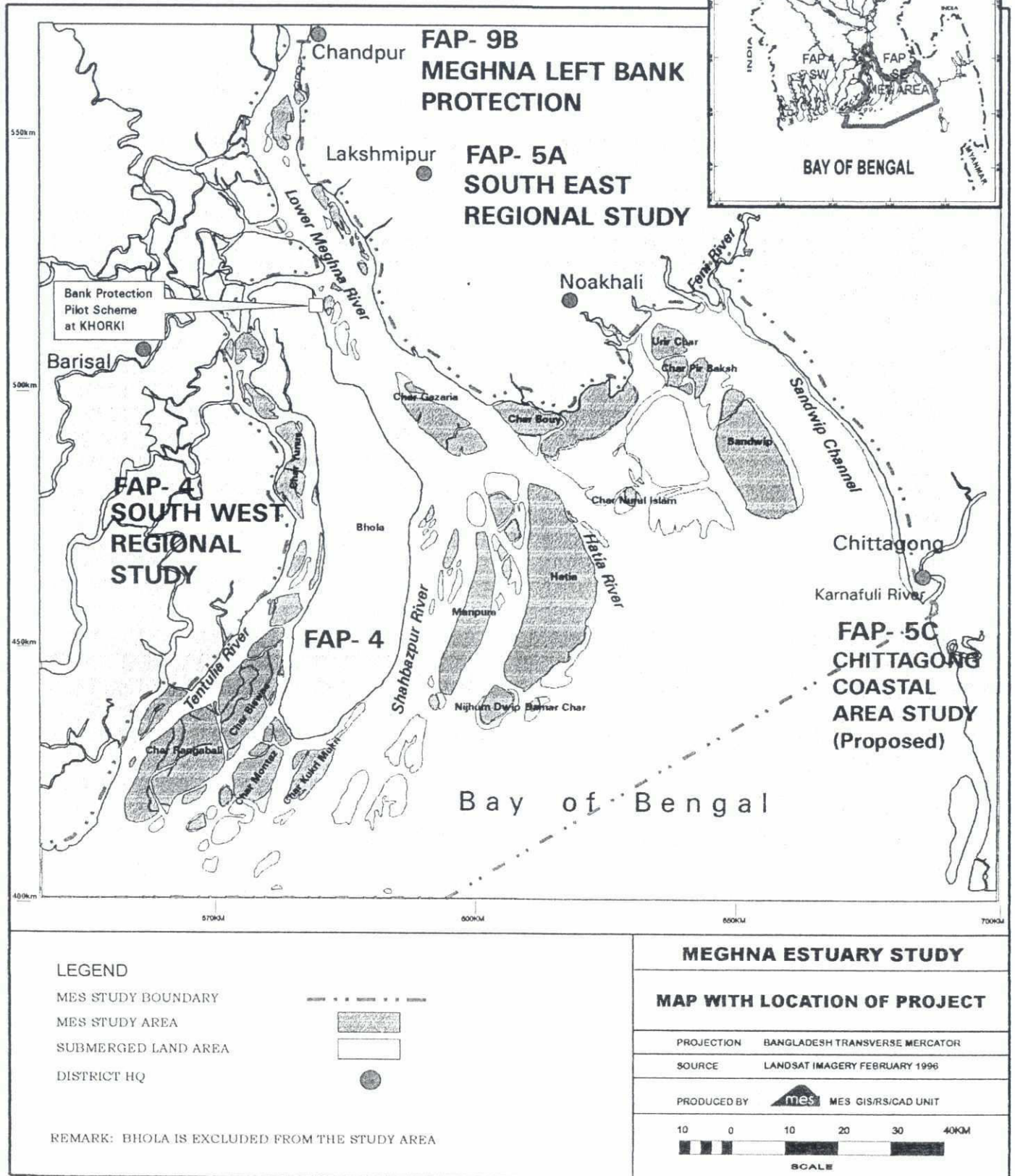
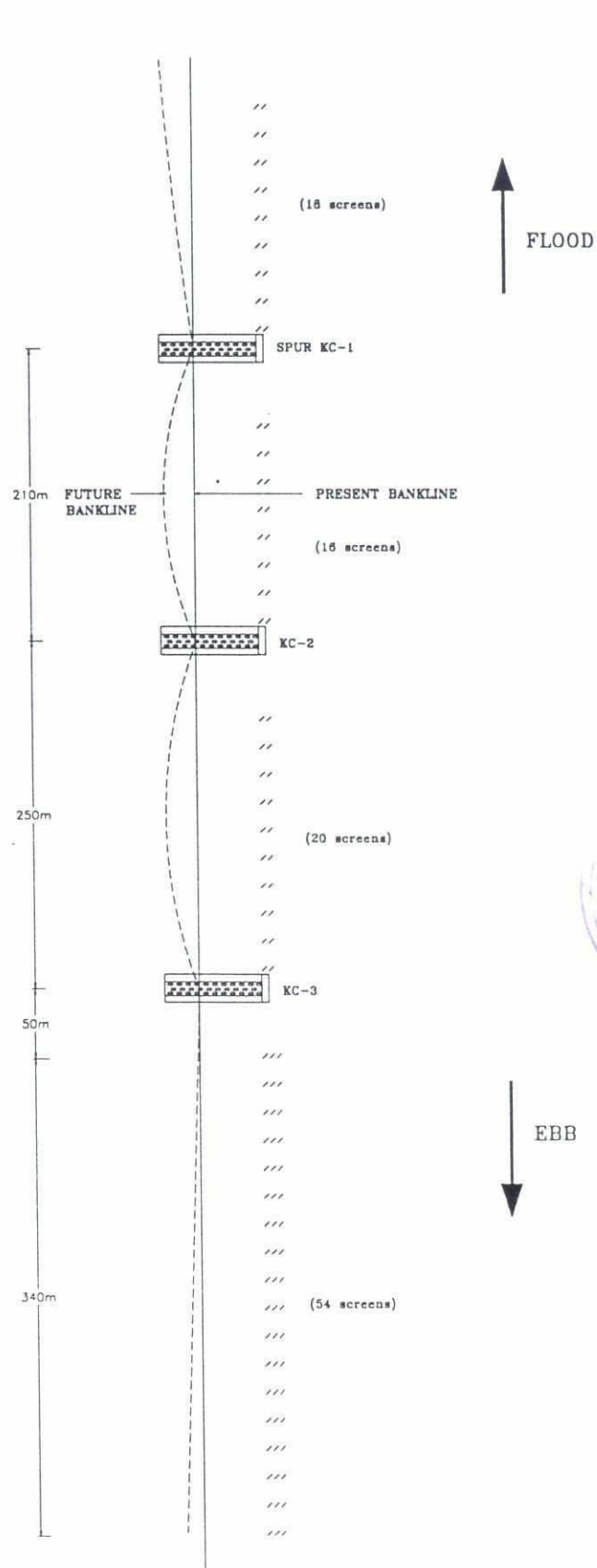


Figure 2: LAY-OUT OF SCREENS AND SPURS AT KHORKI



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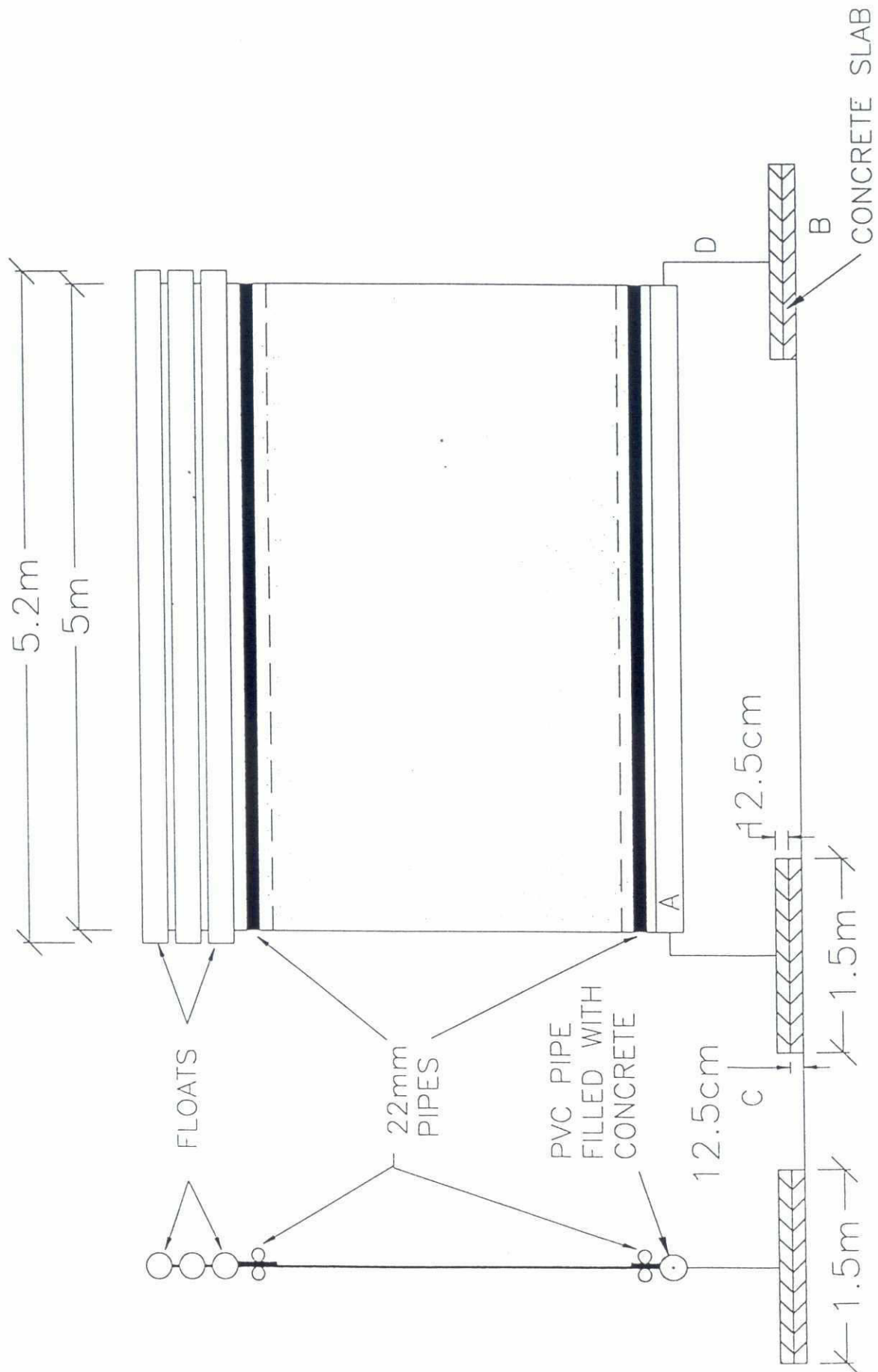
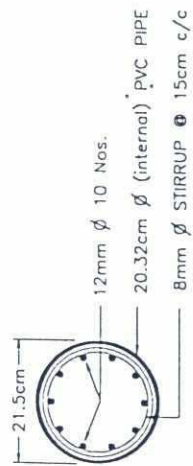
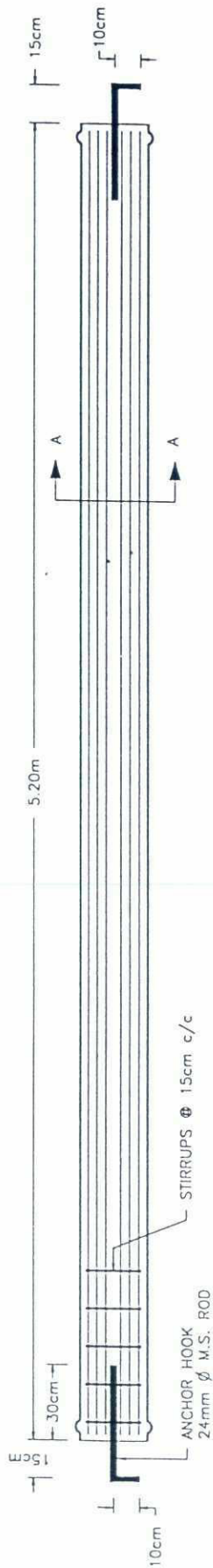


Figure 3: Assembling geo-textile screen

DRAWING OF R.C.C BEAM



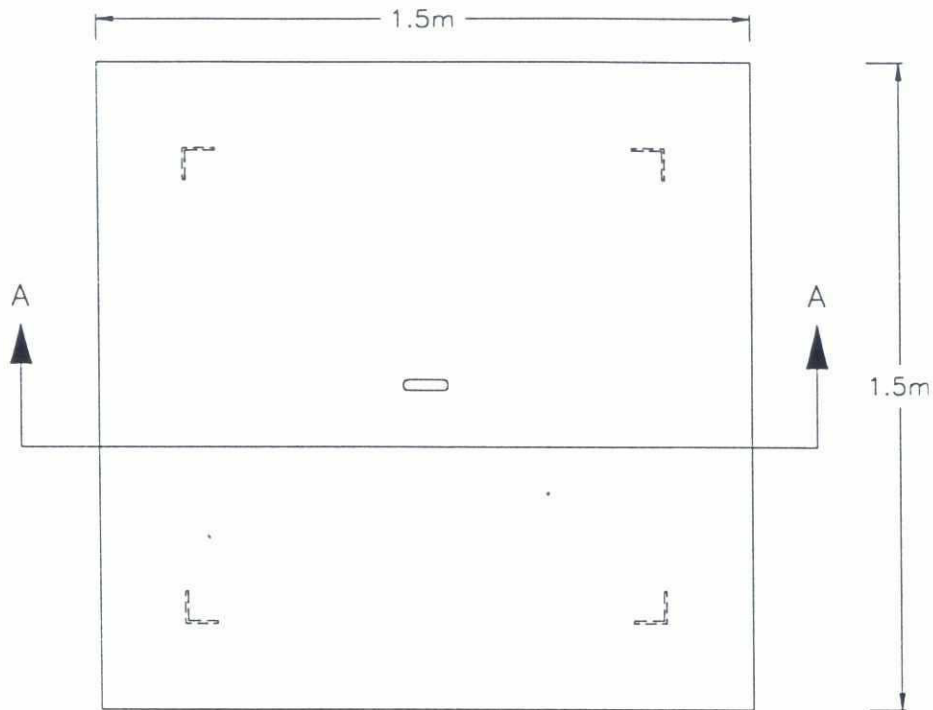
SECTION A-A



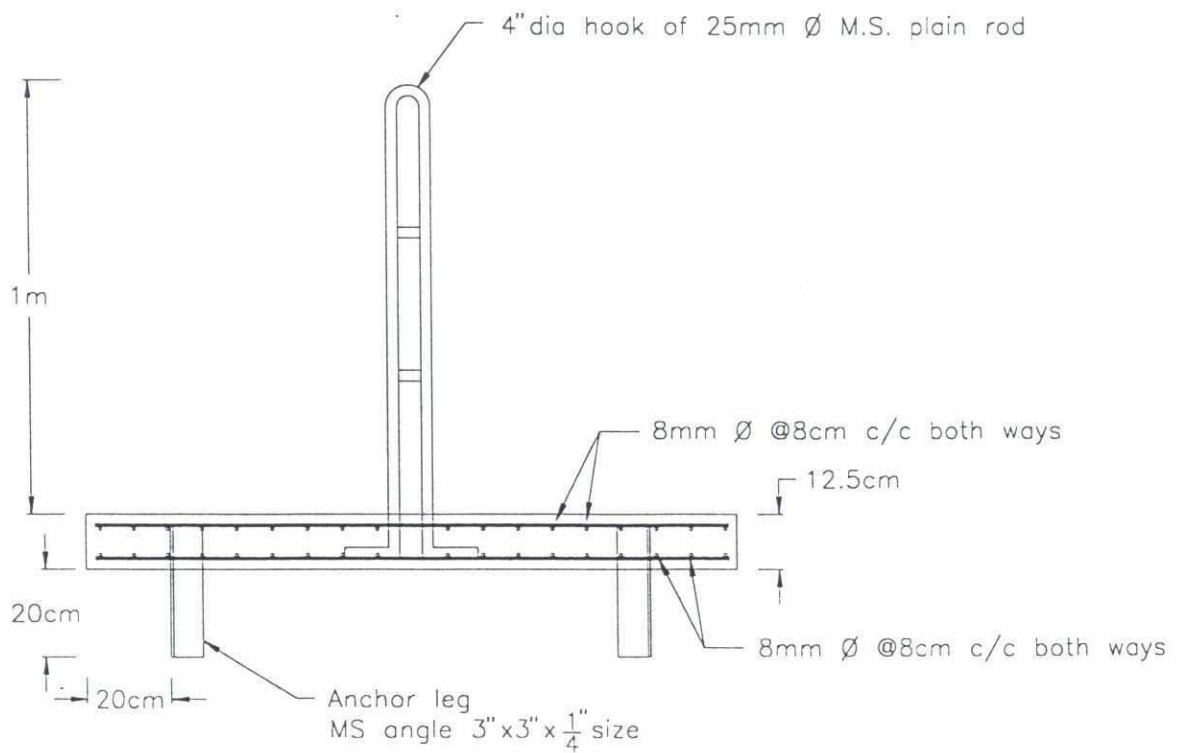
DETAIL OF ANCHOR HOOK

Figure 4 : R.C.C BEAM

Figure 5a : ANCHOR BASE-BOTTOM SLAB



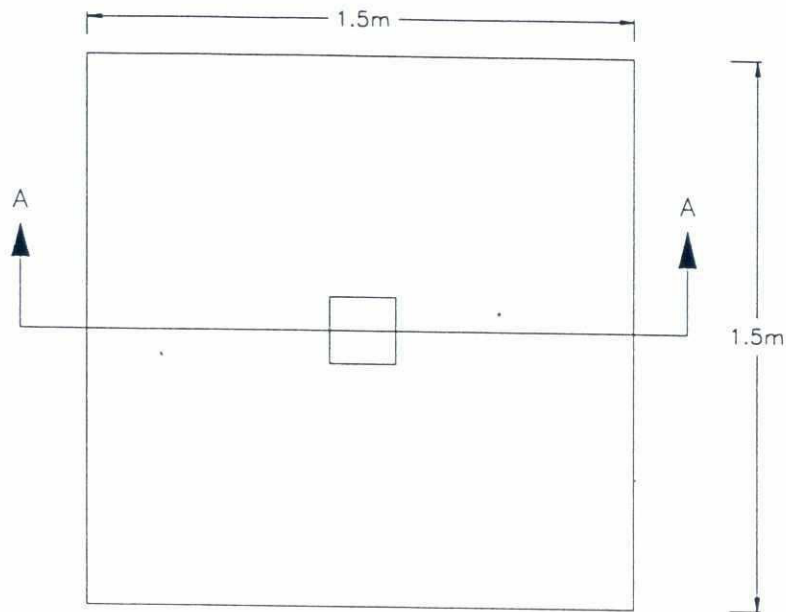
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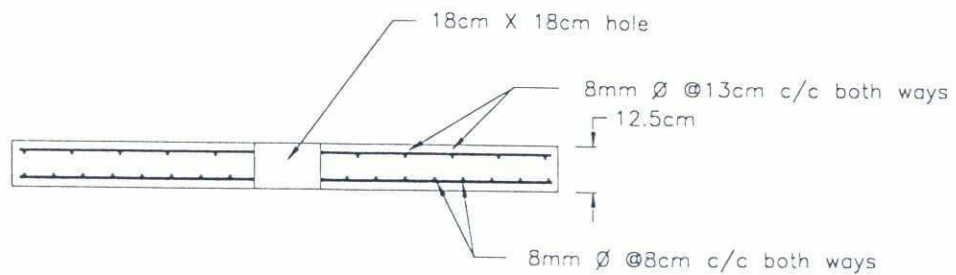
SECTION A-A (for Khorki, bottom slab)

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Figure 5-b: ANCHOR SLAB - TOP SLAB



PLAN



SECTION A-A

Figure 6 : Layout of Geotextile Mattress

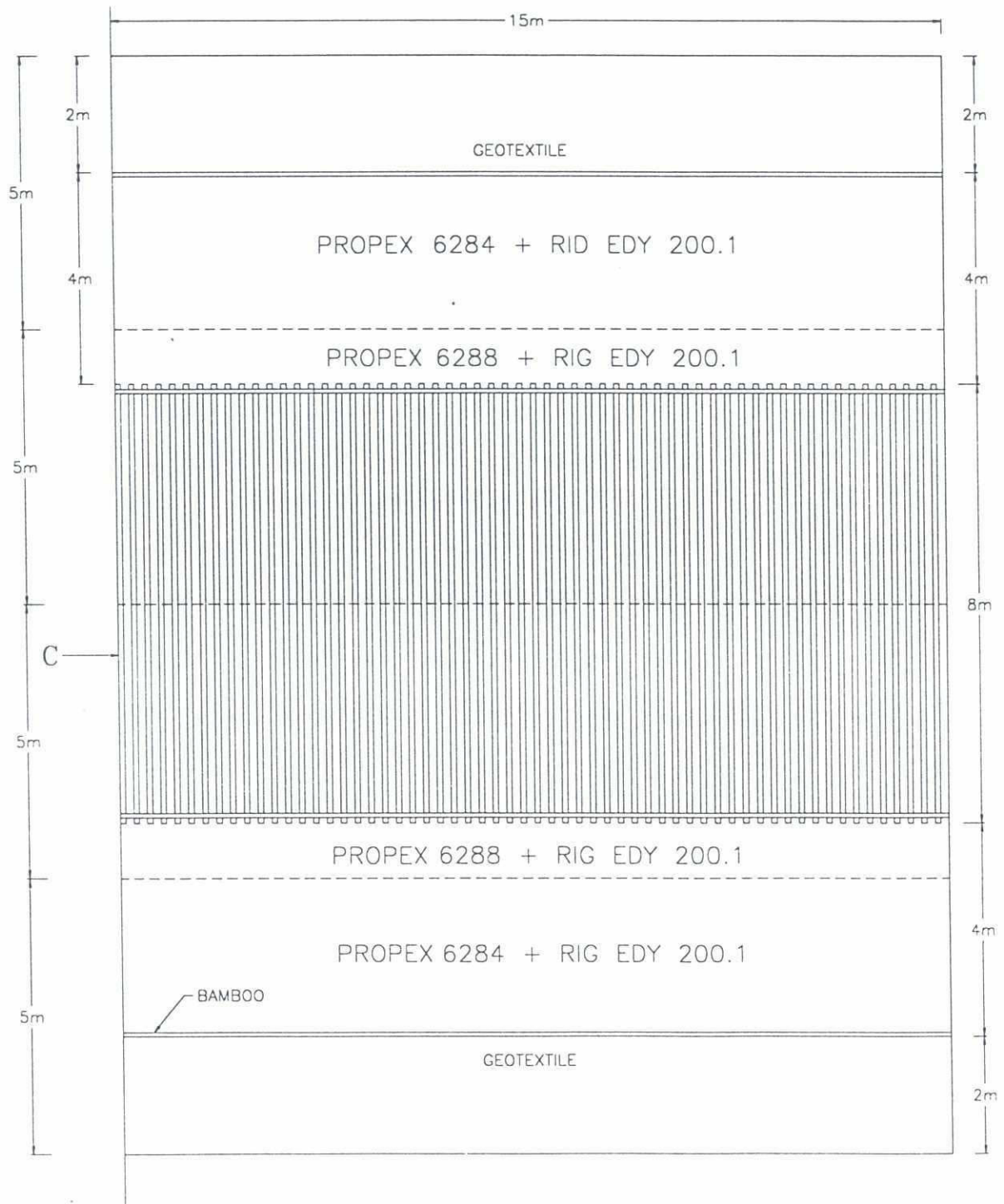
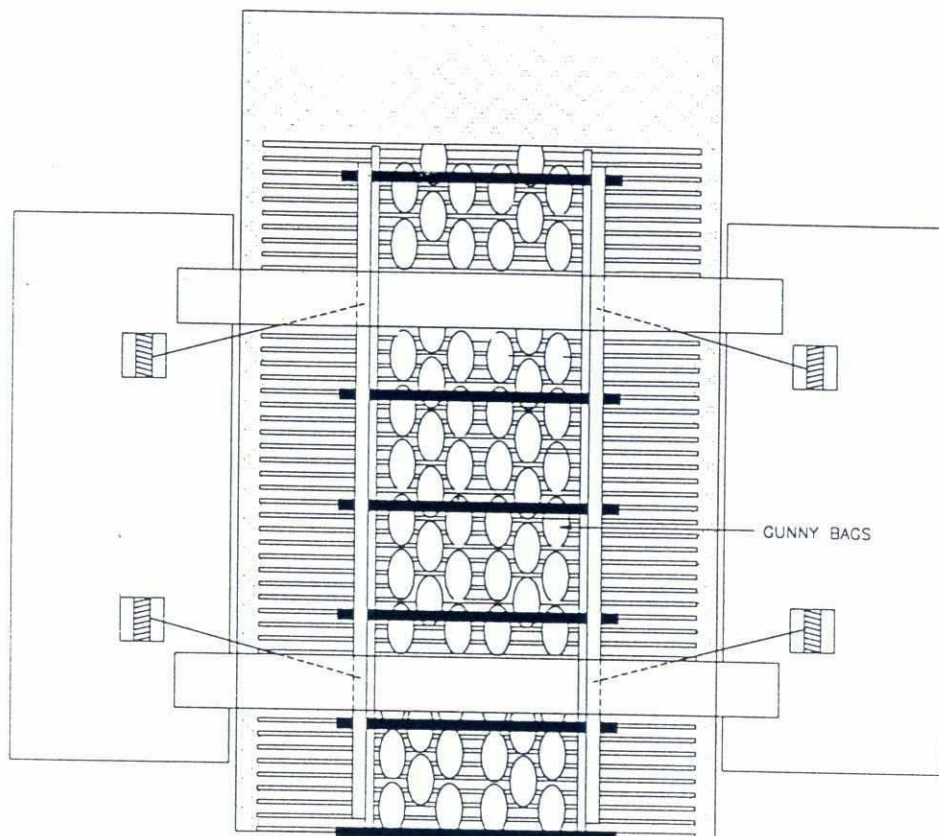
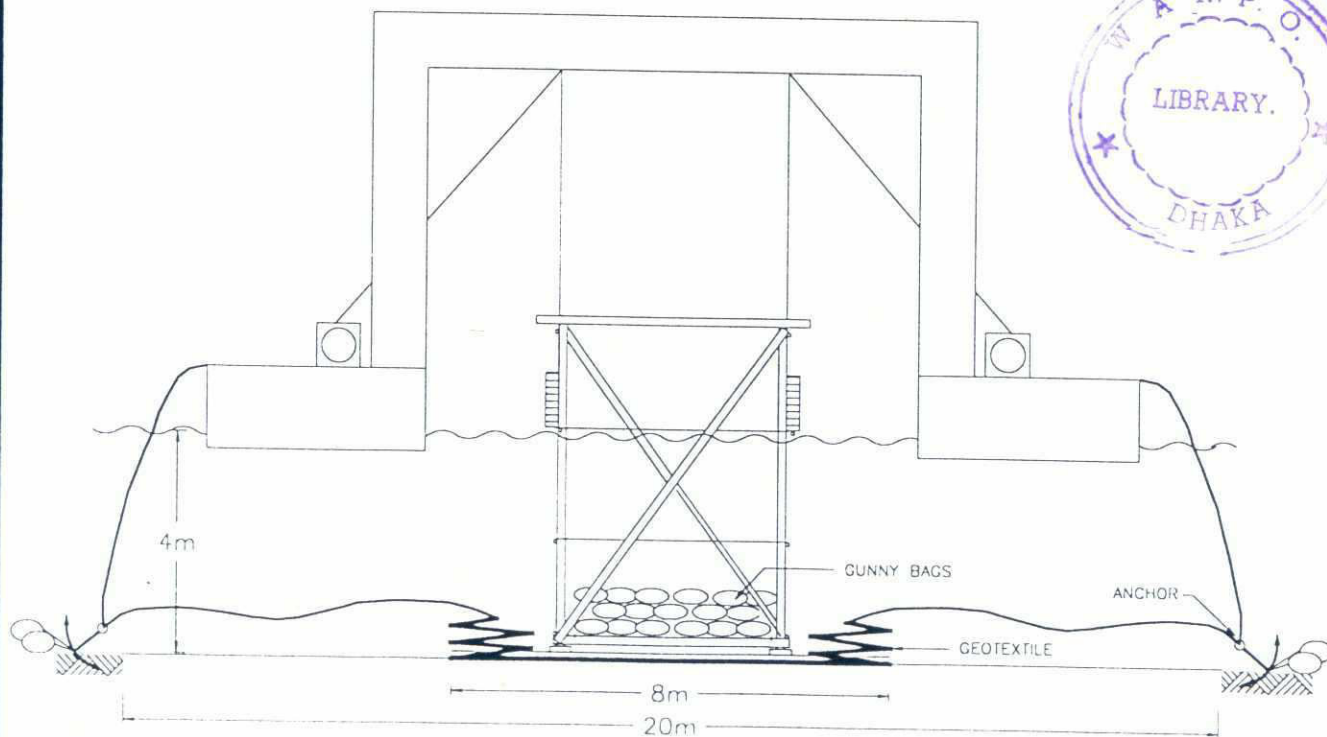


Figure 7: Spreading Bed-Mattress



PLAN OF PONTOON



FRONT VIEW



