DGIS GOB

MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MES II
MEGHNA ESTUARY STUDY

MES PILOT PROJECTS

TECHNICAL NOTE MES-042

NIJHUM DWIP PERMEABLE CROSS DAM TRIAL SECTION

June 2001

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD
SURFACE WATER MODELLING CENTRE

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1. SITE DESCRIPTION

1.1 Location, site selection and time schedule

Nijhum Dwip is located in the southern part of the Meghna Estuary in the mouth of the Meghna River. The cross dam trial was built in the channel between the islands Nijhum Dwip and Hatia in the Noakhali district. The coordinates of the location are 606275 m East and 443502 m North. The location is shown in Fig-1.

The reason for the choice of this location is that the Nijhum Dwip channel has been favorite location for acceleration of accretion for two decades (ref. 21)
A closed cross dam is a traditional earthen dam that completely closes of the channel. A pilot has been implemented from March 4 to 21 1997. This was just to try the technique and assess the soil properties in the area.

1.2 Soils

Nijhum Dwip and South Hatia are part of the young lower Meghna estuarine flood plain. The soils are seasonally flooded, poorly drained and have been developed from moderately fine textured silt loams (ref. 8).
The soils of Nijhum Dwip are mainly undeveloped and slightly developed Meghna alluvial deposits. The surface soil is mostly medium textured silt loam. However, detailed investigations of the characteristics of different groups of soils of Nijhum Dwip have not been carried out.
The average median grainsize diameter of the bedding material as defined by LRP is 0.023 mm.

The soils are olive-grey to olive, finely stratified, usually slightly calcareous, silt loam to silty clay loam affected by salt to varying degrees. They are flooded to less than 30 cm for 3 to 4 months in the monsoon season. The land outside the embankment on Hatia has generally poor fertility. South Hatia has somewhat older soils, finely stratified usually calcareous and slightly alkaline (pH 6.6 to 8.3) whereas Nijhum Dwip has younger, much more poorly developed soils that are more calcareous and alkaline. The pH of the surface soil is lower than of the subsurface soil. These soils are generally poor in organic matter and low in nitrogen. Crop yields are generally low.

1.3 History

Satellite imagery shows that Nijhum Dwip is a relatively young island, which started to emerge in the 1950s (ref. 8). During the 1970s and 1980s the higher parts of Nijhum Dwip, as well as south Hatia, silted up to about MHW line (+2.2 m PWD). The coastline development during the last decades shows a natural tendency to shift in an eastward direction, see Fig- A2 Nijhum Trial Section.

Satellite imagery indicates that the total area of Nijhum Dwip has increased from 1,105 ha to 3,108 ha over the period 1973-1984. In 1996 the total area of Nijhum Dwip was 3,272 ha. This means that the natural gain of newly accreted land over the period 1973-1984 is about 182 ha per year. Over the period 1984-1996, the formation of new accreted land is circa 15 ha per year. A recent satellite image of 2000 indicates that the rate of formation of intertidal areas is high. The coastline of south Hatia shows a tendency to shift in a southeasterly direction.
Between 1997 and 2000 an island appeared in the channel, this island is now part of the proposed location of the cross dam.

1.4 Bathymetry

The bathymetry is presented in Fig- A3 Nijhum Trial Section. This is the situation in 2000. The Nijhum Dwip channel is bordered on both sides by the shallow part of the main channels. In the west the depths of the channel is deepest on the west side, with a lowest bedlevel of -11 m PWD. The east side is less than -6 m PWD.

On the east side, the Nijhum Dwip channel is sheltered from the Bay of Bengal by Damar Char, which first appeared in 1990. This char deflects the current in a southern direction causing the deepest area around Damar Char to be in the South.
Comparison of depth contour lines of bathymetric maps of 1988, 1990, and 1993 distinctly show the dynamic behavior of the Hatia - Nijhum Dwip Channel and adjacent shallow areas. The width of the Hatia Nijhum Dwip Channel decreases in an easterly direction. The maximum depth of the channel shows a tendency to increase in an easterly direction. In the vicinity, the maximum depth of the channel is -6 m to -8 m PWD.

The development of the Hatia - Nijhum Dwip channel, is illustrated by changes in cross-sectional area over the period 1997-2000. It is clear from Fig- A4 that the average bottom has come up. The average bottom level is -3.3 m PWD in 1997 and -1.6 in 2000. In addition Fig- A5 Nijhum Trial Section shows that the whole channel has silted up in this period.

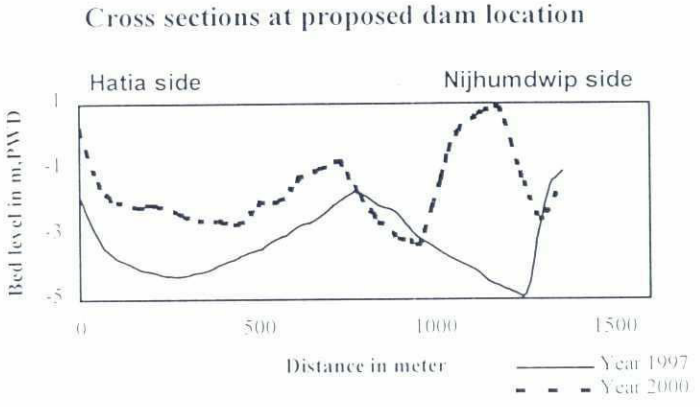

Fig- A4. 1997 and 2000 cross sections at the proposed dam location in the Nijhum Dwip channel

1.5 Flow

Currents and discharges in the channels are tide dominated, even in the monsoon season when large quantities of fresh water from the Shahbazpur Channel pass through the Nijhum Dwip Channel. During spring tide in the pre- and post-monsoon periods, the tidal volume amounts to some 40 million m3 during flood and 60 million m3 during ebb. The tidal volume during flood and ebb counterbalance more or less during neap-tide conditions at circa 30 million m^3.

Generally, the channel is ebb dominated. Current measurements in the dry season (pre- and post-monsoon) indicate that the maximum ebb velocity in the deeper parts of the channel is about 1.1 to 2.2 m/s and maximum flood velocity 1.1 to 2.4 m/s, (ref.8).

Float tracking measurements were taken in November and December 2000. The minimum found maximum current speeds during a neap tidal cycle are 0.5 m/s in both directions. The maximum current velocities are 1.7 m/s in the west direction and 1.4 m/s in the east direction during spring tide

Waves often have an important influence on the erosion and deposition processes. For this location the wind is also regarded as important as the area is in a more exposed location. Waves generate an orbital velocity, which is superimposed on the normal velocities in an area, thus stimulating erosion from the bottom and preventing settling of suspended sediment. In shallow areas, the waves may break thus generating a lot of turbulence in the water, which is even more effective for generating erosion. Calculations of the significant wave height for the dry period indicate that the average significant wave height near Nijhum Dwip is 0.3 to 0.9 meters. The prevailing wave and wind direction is S-SE with average wind speed of 8 to 12 m/s. During monsoon wave attack can be more severe.

2. THE PILOT SCHEME

2.1 Objectives

The first permeable cross dam has been installed successfully by MES at Char Montaz during January – March 1999. Monitoring of the pilot scheme has shown encouraging result with regards to acceleration of accretion in the channel. However, since it was the first pilot project of innovative type of cross dam, the site selected for implementation of the new concept, for obvious reasons, had relatively easy conditions as far as channel width, depth, flow velocity etc are concerned.

To test the sustainability of such permeable cross dam under more severe morphological conditions the channel in between Nijhum Dwip and South Hatia has been selected. At this channel hydraulic forces would be much more strong. In particular the effect of exposure of geotextile screen to wave induced force, which is an unknown factor in relation to the overall durability of the permeable cross dam concept, can be tested at this pilot scheme.

3. DESIGN

3.1 Bed Protection Mattress

A bed protection mattress of size 30m x 50m will be installed to accommodate a trial section of permeable cross dam of length 10m. The dam will be placed at one end of the mattress along its 50 m length. Thus an extra bed protection of 40 m beyond the tip of the open dam will be there.

The bed mattress will be prepared from composite type of geotextile fabric both woven and non woven sewn together. Five strips of Geotextile sheet each 5.2 m wide are sewn together to make 30m wide mattress. At both sides of the mattress two woven and non woven sheets of type propex 6288 and Rig EDY 200.1 will be used while at mid strip of 10 m width more thick non woven material of type RIG EDY 300.1 will be used along with propex 6288.

In addition another piece of geotextile bed mattress of size 10 m x 50 m composed of propex 6288 and RIG – EDY 300.1 will be attached to the mid strip of the bigger mattress to make the mid strip more strong to bear the load of cross dam base.

Bamboos at the interval of 4m will be attached to the mattress to facilitate installation. After installation they will be released from the mattress.

3.2 A-Frame

A-frames will be made from G.I. pipe and M.S. U-channels. One arm of the A-frame will be made of 10 cm dia G.I. pipe while the other arm will be from a pair of 10 cm size M.S. U-channels. Length of both the arms will be 6 m.

Both the G.I. pipe and pair of U-channels will be connected at top and bottom through a pair of 10 cm size U-channels (Fig-2).

3.3 A-Frame screens

A-frame screen will be made from geotextile of woven propex 6088 type. Its size will be 1.7 m x 4.5 m. Two pieces of 22 mm dia and 6 mm thick walled PVC pipes will be attached to the screen across to it to resist contraction of screen during flow. Two pieces of 7.5 cm dia G.I pipe will be attached at both upper and lower ends to facilitate hanging of the screen with A-frames.

3.4 Anchor slab

The anchor slabs will be an RCC structure of ⊥-type shape. Length will be 2 meters to cover the full distance in between two A-frames. The other dimensions of the anchor slab are as per Fig-6.

The idea behind selecting ⊥-type shape of anchors is that it can hold the concrete blocks dumped in between two anchors through the vertical stem. Vertical stems will resist displacement of the dumped blocks from the alignment of the cross dam.

Another advantage of this anchor is that it will provide more base area for concrete blocks to be dumped over and thus it will hold the A-frames more effectively under strong current force.

This new type of anchor blocks will be used in this pilot scheme to test the installation process and their effectiveness.

3.5 Ballasting materials

The geotextile bed mattress will be ballasted through dumping of concrete blocks cast inside synthetic bags (C.C.Bags) Weight of each block will be 75 Kg. Blocks are to be dumped over the mattress at the rate of 2 Nos/m^2 and will be tied to the loops of the geotextile through use of a steel hook attached to the blocks during casting. Divers will be engaged to tie the blocks to the mattress under water.

The mattress will be secured at the edges through tying two lines of geobags filled with coarse sand. Further, blocks of size 30 cm x 30 cm x 40 cm. provided with an M.S. hook will be attached to the edges at the rate of 1 No/meter length of edge (Fig-5).

Along the base of the cross dam an initial layer of concrete blocks cast inside synthetic bags will be dumped. Over this initial layer concrete blocks of size 45 cm x 45 cm x 45 cm will be dumped again up-to height of 1.3 m. Base width of this under water dam is 8 meters.

3.6 Foot bridge

Provision of a foot- bridge has been kept at lop of the A-frames. Width of the foot bridge will be limited to 1.00 meter to be used by pedestrians to cross the channel.

The stability of the bridge will depend on stability of the A-frames and their anchor blocks. If differential settlement occurs at the anchor blocks the footbridge will no longer remain in true alignment and level, and thus it will not be effective.

4. EXPECTED IMPACT

The 10 m long permeable cross dam installed over a riverbed close to the shoreline will act as partial obstruction to the flow. It will induce accretion at its both sides. Concentration of flow at the tip of the dam will cause turbulence in the area. However, the extra length of bed mattress provided beyond the cross dam will resist bed scouring in that area.

The cross dam will not cause any obstruction to navigation or fishing as it is placed close to the shore at South Hatia side of the channel.

5. COST ESTIMATE

Cost estimate for implementation of the pilot scheme is as follows:

1 NLG = 24 Taka

Item	Foreign [NLG]	Local [Tk]	Total [NLG]
Person power		150,000	6,250
Materials	7,000	1,282,000	60,416
Equipment		300,000	12,500
Total	7,000	1,732,000	79,166

6. IMPLEMENTATION

6.1 Implementation Period

March 2000

6.2 Bed Protection

- Preparation of bed protection mattress

The bed mattress was made through stitching together 6 pieces of 5.2 m wide sheet of composite type geotextile fabric each of length 50m. The middle two strips were made of woven material propex 6288 and non-woven material RIGEDY 300.1 stitched together. The outer edges were made of woven material propex 6288 and non-woven material RIGEDY 200.1. (Fig-4).

An extra piece of bed mattress of size 10 m x 50 m was made of same materials as in the middle 2 strips of the big mattress. It was again stitched over the middle strip of the big mattress to make the middle two strips more strong.

Bamboos of 8 meter length were attached to the bed mattress at a spacing of 4 meters in between. The mattress was prepared at Hanarchar site and carried to Nijhum Dwip cross dam site by cargo ship in rolled form.

- Installation of bed protection mattress

The bed mattress was laid in position through the use of Twin Hull Pontoon (THP), tender boat, and engine boats

The bed mattress was floated to site in rolled form. Then it was unrolled to be floating on water surface. After tying the edge of the mattress to engine boats dumping of ballast blocks started. Final securing of the mattress was done through dumping of concrete blocks cast inside synthetic bags (CC bags) to the bed mattress. The edges of the mattress were secured through attaching 2 lines of geobags filled with coarse sand. In addition concrete blocks of size 30 cm x 30 cm x 40 cm were tied beyond the edge line through nylon rope at the rate of 1 no. per meter length of edge.

6.3 Anchor Block

- Manufacturing of anchor blocks

Anchor blocks are made of reinforced concrete. Shape of the anchors blocks will ⊥ Type having base width of 1.10 m and length of 2.0 m. The length of the blocks is same as the spacing in between A-frames. Thus the whole space in between A-frames will be covered by the base of the blocks, over which CC cubes will be dumped.

The stem of the anchor blocks is 80 cm high over which the arm of the A-frame will be attached through a swivel joint.

The stem of the anchor blocks which is vertical in position will resist the horizontal pressure coming out of the screen and block dumping. As such the stem is additionally strengthened through a vertical column attached to it.

6.4 A-frames

- Preparation of A-frames

A-frames are prepared from 10 cm dia G.I. pipe, 7.5 cm x 7.5 cm size U-channels and 5 cm x 5 cm size steel angle.

One arm of the A-frame is prepared from 10 cm dia G.I. pipe and the other arm from a pair of 7.5 cm x 7.5 cm size U-channel all of length 6 meters. The G.I pipe will meet the U-channels at a distance of 4.4 meters from bottom. These will be connected across through a nut-bolt system (Fig-2).

An arrangement for footbridge is made at top of A-frame as shown in Fig-2. The width of the footbridge is 1.00 m. It's deck is prepared through laying a Bamboo Tarja in double layer over cross ties.

The foot of the A-frame is provided with arrangement so that it can be connected to the anchor block through swivel joint system.

- Installation of A-frames

Three numbers of A-frames are attached to anchor blocks at bottom of their both arms. This set of 3 A-frames are hung with the lifting frame of THP. During this activity problem was faced regarding the anchor blocks to keep them in line. Again as per design each anchor block is supposed to just touch the other. But practically it was found that spacing in between A-frames was somewhere insufficient to accommodate the slabs. The reason is that even shortage of one centimeter in the space in between A-frames will make it problematic to install the anchors. Practically it will not be possible to maintain such accuracy. However, after much effort of the workers the blocks were brought to line and the set of 3 A-frames are placed at river bed over the bed mattress in true alignment of the cross dam.
In the next attempt the rest 3 A-frames along their anchor blocks are placed in the same alignment.

During hanging of the anchor blocks one joint in between the block and arm of A-frame failed due to failure of the swivel. To attach the bottom of the arm of A-frame with the anchor block drilling was done to make a hole at the concrete wall of the vertical stem of anchor block. The G.I. pipe already provided with a hole at its bottom was then tied to the anchor slab by using 10 mm dia flexible steel wire and steel clamp.

6.5 A-frame Screens

- Preparation of A-frame screens

  Vertical screens in between A-frames were made with woven geotextile propex 6088. Size of the screen was 1.7 m x 4.5 m to keep an opening of 30 cm width in between screens. At both top and bottom ends of the screen a piece of 7.5 cm dia G.I. pipe was attached to connect the screen with A-frame. Two pieces of 22 mm dia 6 mm thick-walled PVC pipes were attached to the screen body to resist it from contraction during flow of water.

- Installation of A-frame screens

  After completion of dumping of concrete blocks along the dam alignment the screens were installed through hanging them to the A-frames at their top and bottom ends. 10 cm size D-shackles were used to connect them.

  The installation process was done during low water period when minimum water depth was encountered by the workers.

7. MONITORING AND EVALUATION

7.1 Monitoring

7.1.1 During installation

The initial site selected was at a distance of about 500m from the North bank of the channel in the selected alignment of the dam. Since the means to install the trial section were limited the best conditions were selected as far as tide and weather was concerned. On 29 February 2000 very favorable neap tide conditions were expected with an amplitude of only 1m and slack water at a very convenient time during the day.

Unfortunately the preparations in Dhaka were delayed due to unavoidable circumstances and a nightly attack by pirates on the THP and load carrying vessels further delayed the arrival at site.

When everything was finally ready to start the installation of the bed mattress the tidal currents had already become much stronger and strong winds prevailed much earlier than expected. In particular the anchoring system of the THP was not adequate under these conditions and several attempts to install the trial section of the cross dam failed.

For that reasons the attempts to install the works were halted and try again during the next neap tide period. To facilitate the installation works it was decided to move the site for installation much closer to about 150 m from the shore.

However, the weather conditions remained very windy and it appeared impossible to strengthen the anchoring system of the THP sufficiently so that it remained stable in the currents, waves and winds. In the end the only way that remained to install the trial section was to move very close to the shore so that 2 shore anchors could be established.

The bed level at this location is about 1.5m higher than at the original location so the maximum loading on the screens by waves will be less than designed. However the dynamic nature of the loading is expected to be fully tested on the screens.

It also appeared difficult to install the supports of the A-frames in the current since slack water at the site was very short. Another problem was posed by the fact that the trial section was

partly installed on recent silt deposit so that substantial (unequal) subsidence of the footings of the A-frames occurred.

Although installation was far from smooth, still a lot of lessons have been learned by all involved in the exercise, lessons that should be remembered when the Nijhum Dwip cross dam is finally going to be built.

7.1.2 After installation

The performance of the structure has been closely monitored during the period of post installation till December 2000. After installation it was found that the A-frames had not been fixed properly on the footings while ballast blocks had not been dumped evenly on top of these footings. Additional strengthening has been carried out in May 2000.

The main purpose of installing a trial section was to determine the durability of the geotextile screens under the attack of waves. Unfortunately the trial section has been installed near the shallow shore so the dynamic loading by waves was less than it would have been in the deeper parts of the channel. On the other hand the fetch length for the predominant waves direction was the longest.

Anyway the screens apparently were not seriously damaged although some stitches got loose. It has to be mentioned that serious wave attack occurred when a cyclone passed the southwestern part of Bangladesh in October 2000.

One or two cuts were found in the screens, the watchman explained that this had been done by fishermen while he was absent for a while and at night.

The water levels at the test site have been recorded while the currents were measured by float tracking in November/December 2000 (Ref. 21).

7.2 Evaluation

The trial section of the permeable cross dam in the Nijhum Dwip channel has not been installed in the proper location, as a result the screens have not been tested under the full dynamic forces of waves.

Although a small section of cross dam was built at Nijhum Dwip, accretion of silt has been observed both at upstream and downstream of the dam section. Thus it indicates positive effectiveness of the permeable cross dam over the existing morphological conditions of Nijhum Dwip channel.

8. OVERALL IMPACT AND LESSON LEARNED

8.1 Overall Impact

Installation of a 10 m long section of permeable cross dam near the shoreline did not have any significant effect on the overall morphological condition of the area. Most of the geotextile materials were buried under silt on the riverbed and thus they did not render any environmental pollution to the area.

8.2 Lessons Learned

- Stitching of geotextile fabric was done through textile workers manually. Till now no problem has been faced regarding strength of the stitches. However, the process is quite slow and a big number of textile workers has to be engaged for volumous work. It is

proposed to engage stitching machine parallel to manual stitching and compare the strength of the stitches of both the system in a laboratory.

- Very important lessons were learned with regard to proper timing of the installation works; the under water works and installation of frames has to be competed by the month of February to avoid the risk of inclement weather conditions.

- Much attention will have to be given to the anchoring system of the THP under the prevailing strong currents.

- The proper installation of A-frames with ⊥ angle shaped footings as designed for this trial section was not possible under the prevailing weather conditions and lack of slack water. This design should be reviewed.

9. REVIEW DESIGN OF NIJHUM DWIP CROSS DAM

9.1 General Consideration

Taking into consideration the lessons learned during installation and monitoring of Char Montaz Pilot Scheme, Hanarchar Erosion Control Pilot scheme and the trial section installed in the Nijhum Dwip channel itself, the design of the Nijhum Dwip Cross Dam has been updated.

The following major adjustments have been included in the update

1. Replacement of the steel A-frames with reinforced concrete frames and larger footings that will be more stable could be considered.
2. Addition of a geotextile membrane to reduce leakage through the under water concrete block dam
3. Reinforcement of the geotextile screens and adjustment of the design of the suspension system for the screens
4. The Twin Hull Pontoon used for installation of Pilot Schemes during MES may be used for installation of the Nijhum Dwip cross dam. It is recommended to replace the hand-operated winches by electrically operated winches and control system.
5. The handling and anchoring of the THP has to be improved in order to ensure efficient and accurate installation of the various components of the dam.

9.2 Design and Implementation Methodology

In the Nijhum Dwip channel a trial section of an improved version of the Char Montaz cross dam has been in place since April 2000. The main purpose of this trial section was to obtain data on the behaviour of the geotextile screens under actual site conditions in particular with waves generated by wind. Unfortunately due to delays in mobilising material and equipment, it was not possible to install the trial in the middle of the channel as planned but close to the shore. However valuable lessons were learnt about implementation under inclement weather and tide conditions prevailing at site after arrival of the equipment.

A design for the Nijhum Dwip cross dam with concrete A-frame is presented in Appendix - 1 for further considerations.

The following remarks are made on this design:

9.2.1 Final alignment of the cross dam

This can only be fixed after detailed bathymetric surveys show the most favourable alignment. However it Is expected that the final location of the dam will be close to the selected alignment based on the year 2000 bathymetry.

9.2.2 Bed protection

The bed protection mattresses have been widened to 30 m to cope with the increased head across the dam as well as with longer overtopping of the dam at high tide than at Char Montaz. This will induce more turbulence in the flow passing through the dam and result in increased scour power at both edges of the protective mattresses. The geobags and sharp edged cube-shape concrete blocks used in Char Montaz have been replaced by rounded concrete blocks cast in synthetic bags.

9.2.3 A-frames

The introduction of A-frames of solid pre-cast reinforced concrete frames on raft footing with a weight of about 10,000 kg is proposed for consideration (Appendix 1). The design change would resolve the apparent corrosion of the exposed steel works and the problems encountered with slipping connections in the A-frames at Char Montaz. It was also deemed necessary to increase the distance between the supporting frame of the geotextile screens to provide sufficent space for the footings. The c.o.c distance is now 3.3 m so that the width of the geotxtile screens is about 3.0 m.

9.2.4 Geotextile screens

The design of the geotextile screens has to be strengthened at several points. An improved design is indicated in Appendix - 1. Where possible a stitching machine has to be used to ensure maximum strength of connections in the screens. The edges of the screens have been hemmed to reduce physical damage.

The clamping arrangement has to be adjusted in view of increased waterpressure/forces. The diameter of the GI pipes of the clamping arrangement has to be determined based on testing in a laboratory. The connection to the concrete frame also needs detailed review to ensure sufficient strength under all loading conditions. Conservation of the steel parts should be specified in detail.

9.3 Remarks on implementation methodology:

- The existing Twin Hull Pontoon may be used for the installation of the bed protection and the pre-cast concrete frames. However the site conditions are such that radical changes are required. The results of float tracking as well as simulated velocities provide valuable information what to expect during installation activities (Ref. 21).

- During the installation of the trial section a Nijhum Dwip it became abundently clear that the anchoring system of the THP is not adequate. Heavier anchors as well as heavier winches will be required to keep the THP in position. In order to facilitate positioning of the THP in relatively strong currents, the existing hand operated winches should be replaced by an electric operating and control system

- Since the installation works have to start right after the post-monsoon rains, it has to be studied how to ensure that sufficient concrete frames and ballast bags are available when required according to the planning. It may be required to pre-cast at least part of these concrete elements elsewhere and arrange transport to site.

- Special measures like the use of frames will be required to lower the bed matresses and to keep them in position as long as the ballasting of the mattress is not sufficient. Bamboos attached to the mattress during installation should all be removed.

- If concrete frames are used, their weight will be much more than the weight of the steel A-frames. In order to be able to lower at least two concrete frames into position it will be required to replace the existing hand operated winches by electric driven winches and an easy control system

- Detailed procedures for ballasting and installation of (concrete) frames have to be prepared before the start of the work. In particular recording of the distribution of ballast blocks is essential to avoid weak spots in the bed protection.

- The number of divers employed at site has to be matched with the planned progress of the works, taking the fact that usually only limited time is available for under water works

- In order to be able to work most efficiently it is essential that the divers are equipped with modern diving gear. Use of primitive diving equipment shall not be allowed.

- Working in two shifts as well as working at night time is deemed necessary to minimize the time required to install the bed protection mattresses. Delays may cause scour holes to develop where the currents will be increased over a long period of time due to contraction

9.4 Cost Estimate

Length of permeable dam = 1000 meter
Length of earth dam = 300 meter
Length of flanking embankment = 400 meter

1 NLG = 24 Taka

Item	Foreign [NLG]	Local Taka
Mobilization / Demobilization		2,500,000
Supply	600,500	86,346,200
Person Power		27,560,000
Earthwork for flanking embankment /earth dam		14,190,000
Others		1,900,000
Sub total		**132,496,200**
Add 10% Contingency	60,050	13,249,620
Total	**660,550**	**145,745,620**

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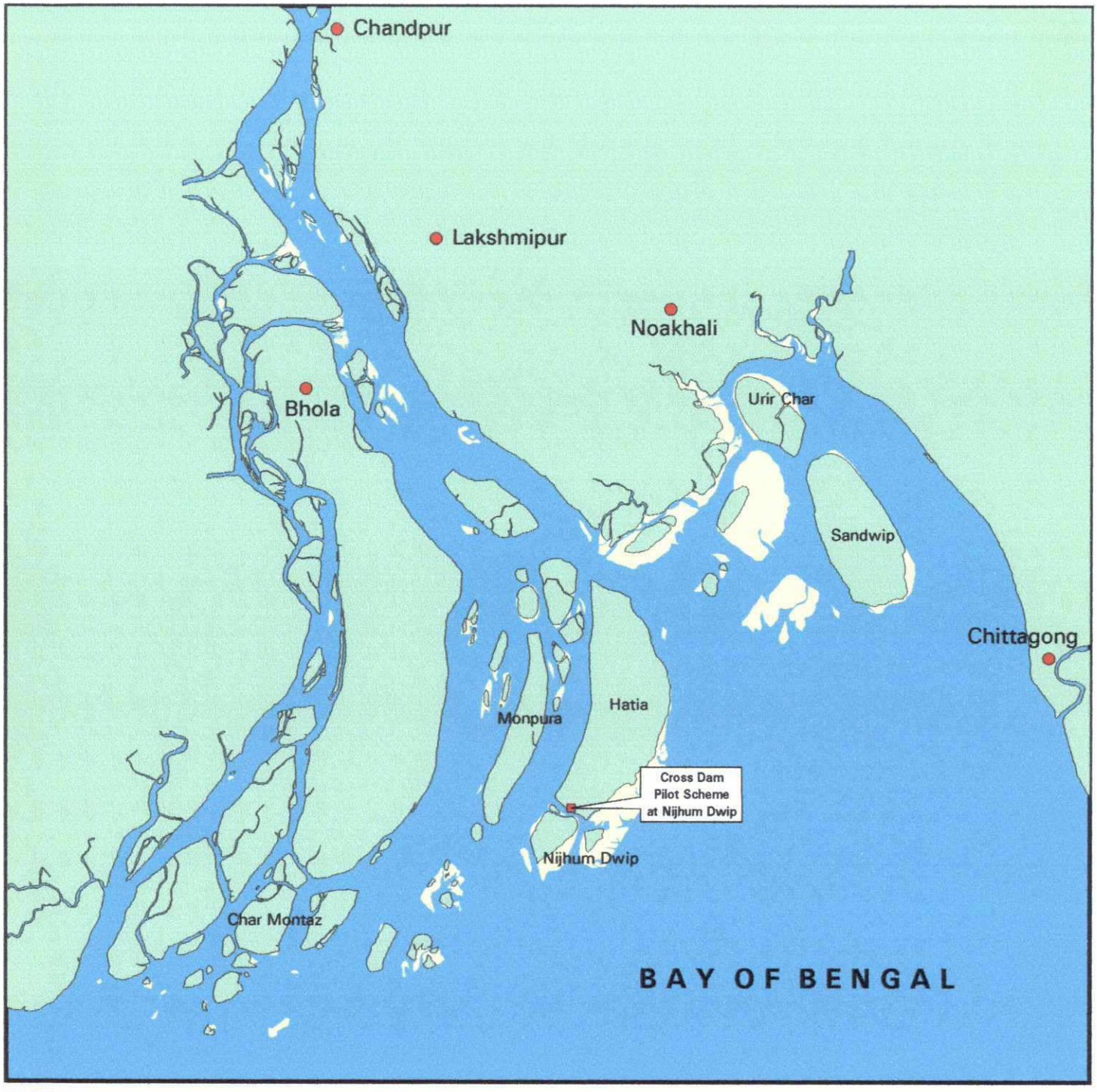
19 Brammer, H. 1996 The Georaphy of the soils of Bangladesh
    University Press Limited, Dhaka, Bangladesh.
20 MES. 1997 Char Alexander bank protection pilot scheme
    Submitted to Ministry of Water Resources, Bangladesh Water Development Board, by

DHV consultants BV and associates, June 1997 Technical note MES-007
21 MES. 2000 Review design and implementation of Nijhum Dwip cross dam
Submitted to Ministry of Water Resources, Bangladesh Water Development Board, by DHV consultants BV and associates, December 2000
22 MES. 1998 Master Plan, volume 7: Forestry
Submitted to Ministry of Water Resources, Bangladesh Water Development Board, by DHV consultants BV and associates, September 1998
23 FAP 24. 1996 Final Report of River Survey Project, annex 5: Morphological Characteristics, Ministry of Water Recourses WARPO, Dhaka, Bangladesh.
24. MES 1999. Installation of Hanarchar Erosion Control Pilot Schemes, Internal Document
25. MES 1997. Haimchar Erosion Control Project, Internal Document
26. MES 1997. Installation of Nijhum Dwip Cross Dam Pilot Scheme. Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV and associates, Technical Note MES 006.
27. MES 1997. Installation of Char Alexander Bank Protection Pilot Scheme, Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV and associates, Technical Note MES-007.
28. MES 1998. Installation of Haimchar Erosion Control Project. Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV and associates, Technical Note MES-020.
29. MES 1998. Innovative Bank Protection Measure, Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV and associates, Technical Note MES-019.
30. MES 1998. Design Report Pilot Schemes, Char Montaz Cross Dam and Hanarchar Erosion Control Project, Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV, and associates.
31. MES 2000. Brief of Key paper on Installation of Erosion Control, Bank Protection and Cross Dam Pilot Scheme, Produced at Training Program on Design and Implementation of Erosion Control works and Cross Dams. Organized by Bangladesh Water Development Board, WARPO & Meghna Estuary Study.
32. MES 1998. Installation of Khorki Erosion Control Project, Ministry of Water Resources, Bangladesh Water Development Board by DHV Consultants BV and associates, Technical Note MES 021.
33. Odgaard A.J. and Spoljaric O. 1989. Technical Report on Sediment Control by Submerged Vanes, Design Basis. American Geographical Union.

FIGURES

Figure - 1

Location map of pilot scheme at Nijhum Dwip



Legend:

- Land of 2000
- Mudflat
- Water body
- Location of Pilot Scheme(s)
- District HQ

mes MES II **Meghna Estuary Study - II**

10 0 40km

SCALE

Prepared by: GIS/RS/CAD Section of Meghna Estuary Study II

Note: Bankline were digitized from the Landsat TM imagery of January 2000

File- E:\MES-II\Civil\Emdad\Nijhm-loc.cdr

Nijhum Dwip Permeable Cross-Dam

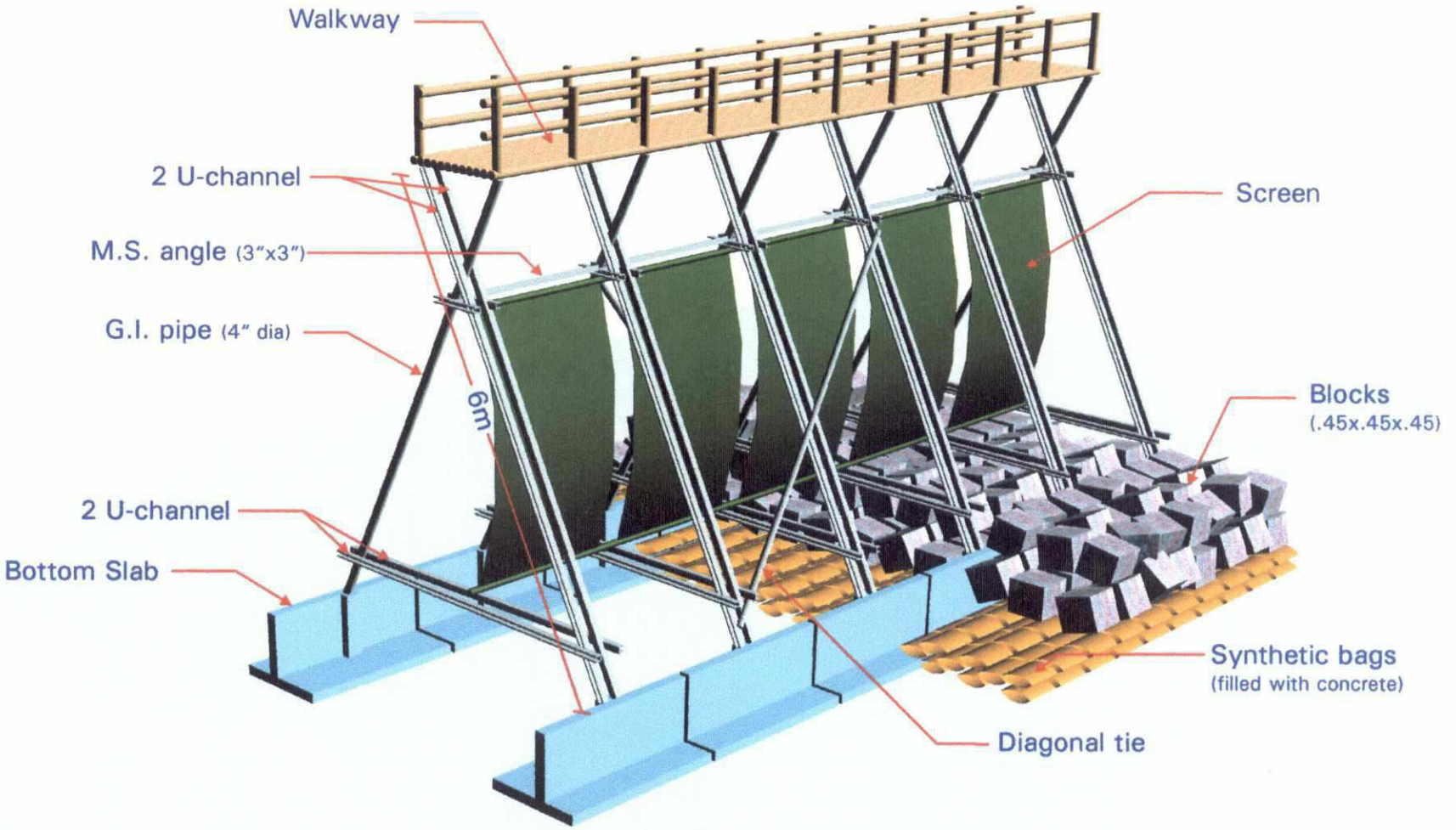


Figure - 2

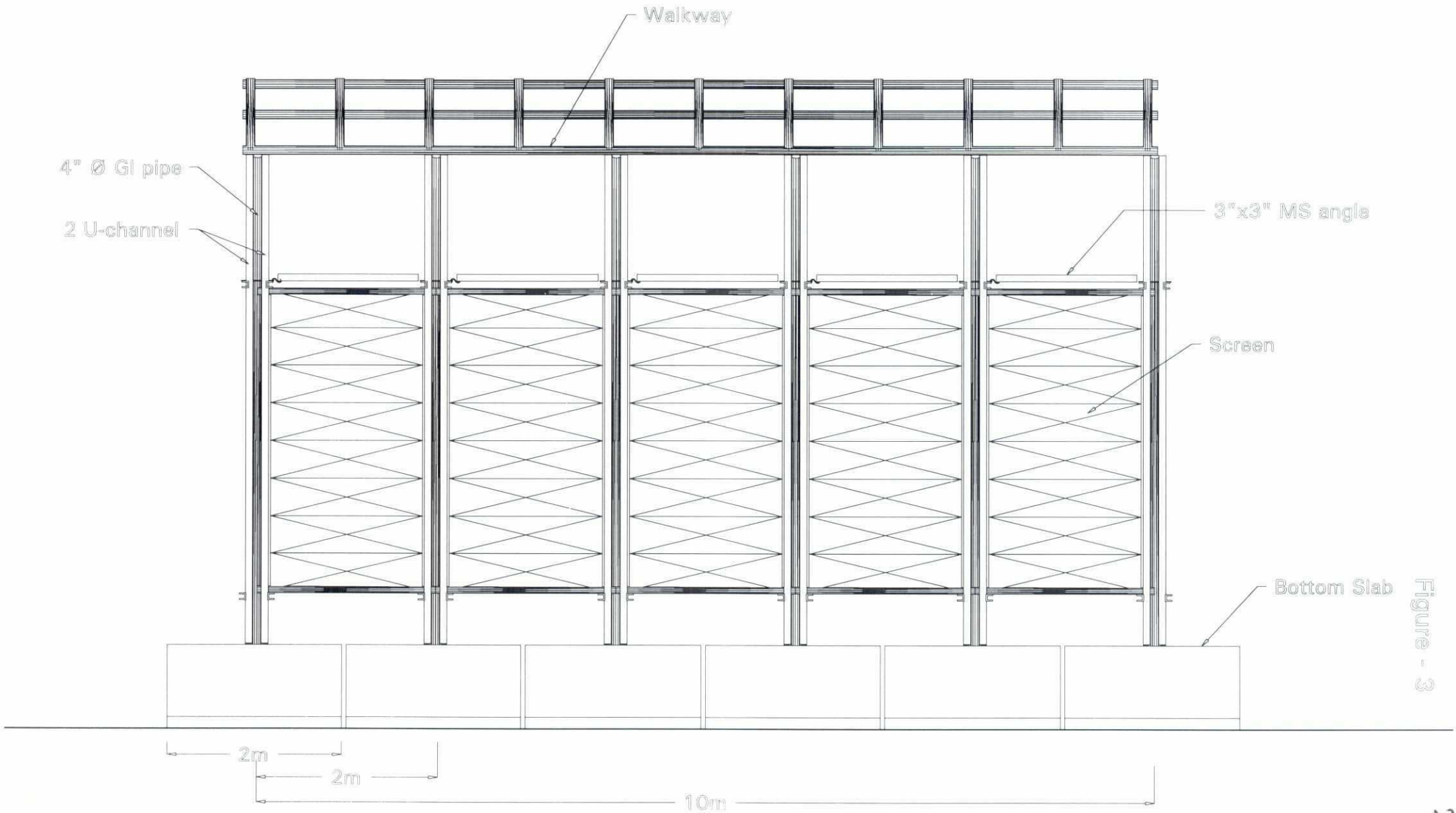
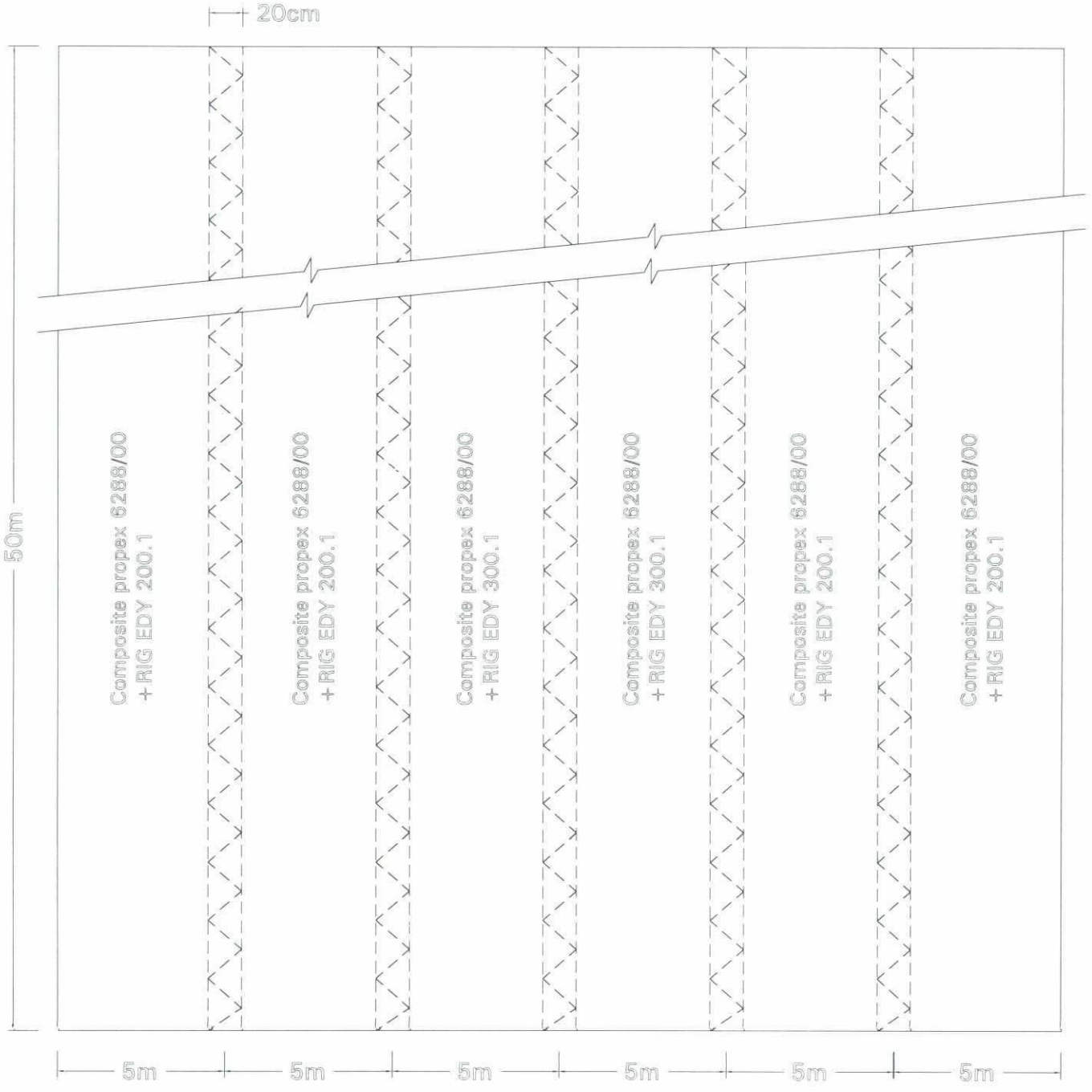

Walkway
4" Ø GI pipe
2 U-channel
3"x3" MS angle
Screen
Bottom Slab
2m
2m
10m

Figure - 3

Figure - 4

Bed protection matress



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BED PROTECTION MATTRESS FOR
NIJHUM DWIP PERMEABLE CROSS DAM

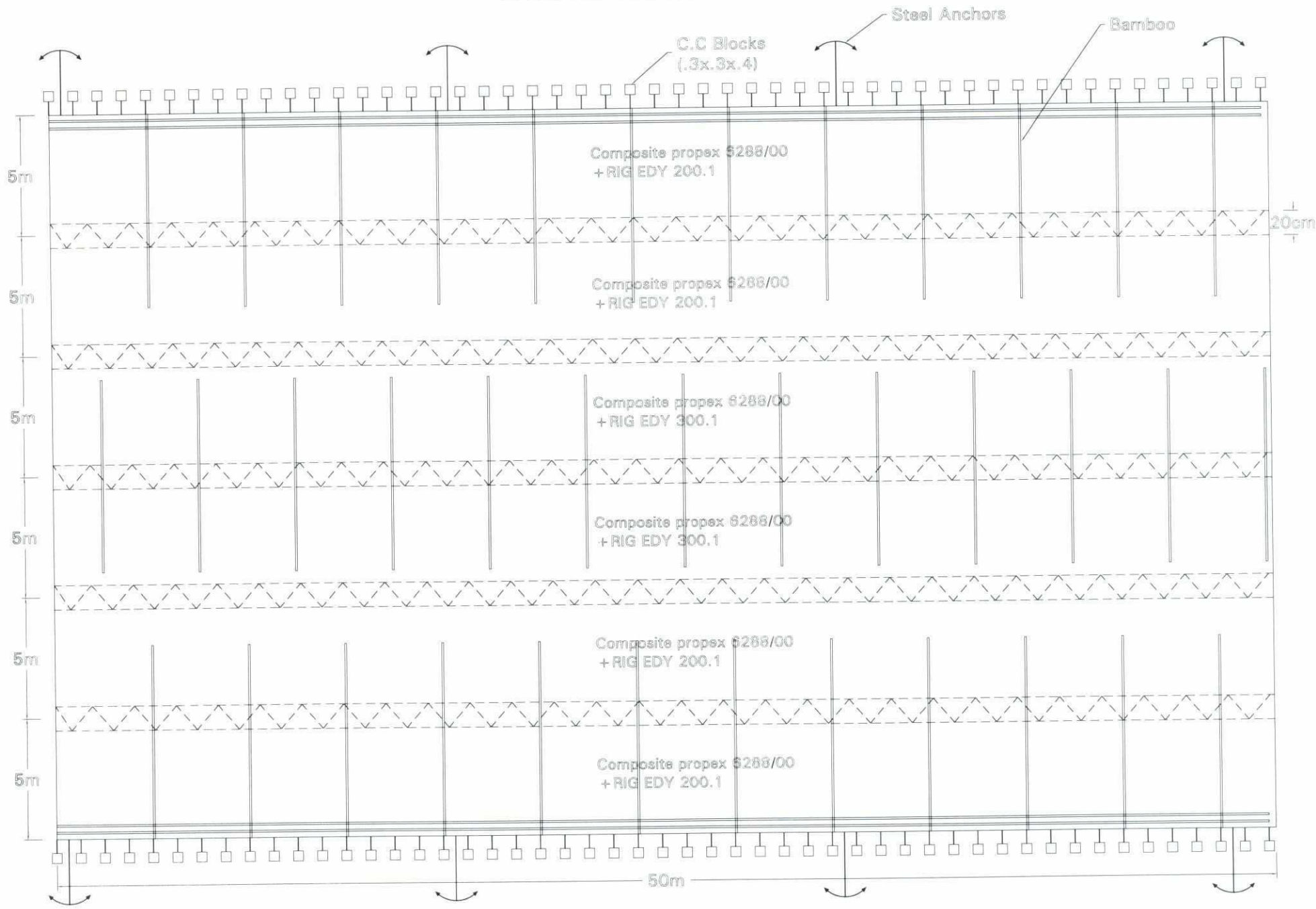

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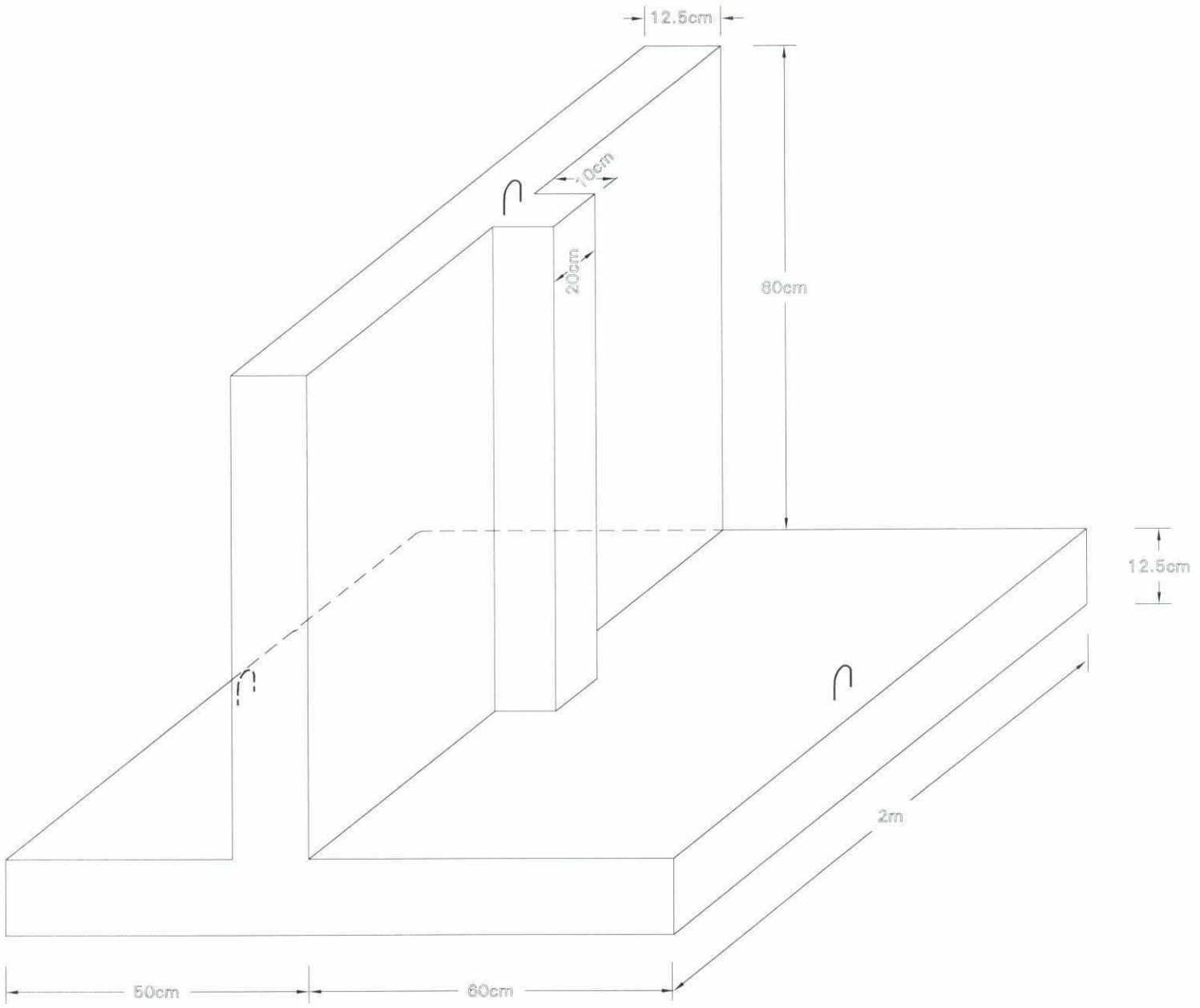
Figure - 5



Anchor slab profile for Nijhum Dwip X-dam

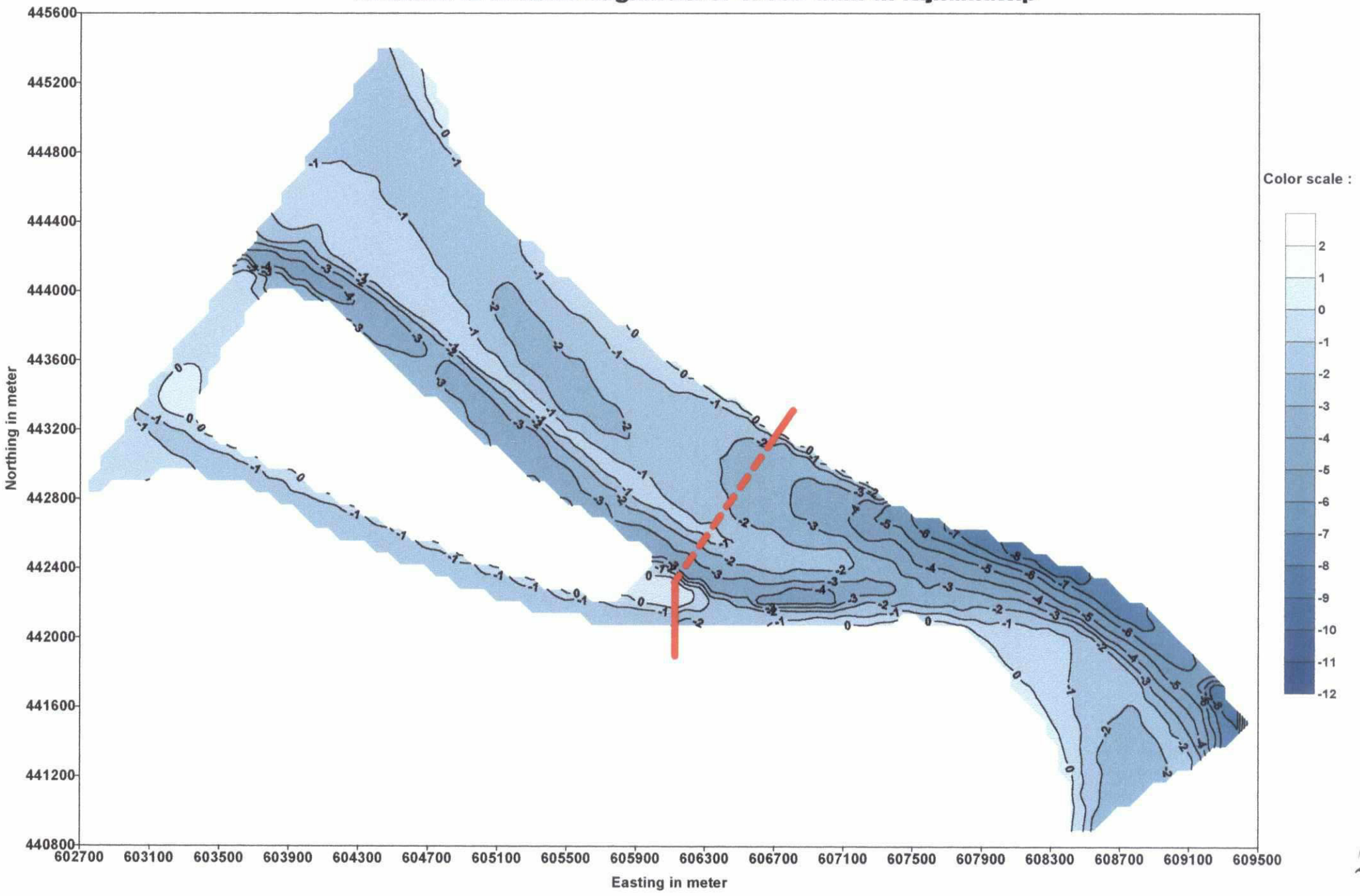
Scale 1:10

File D:\Civil\Anc-Slb2.dwg

Figure - 6

Appendix–1

Improved Design of Cross Dam


Location of revised alignment of cross dam at Nijhumdwip
Color scale :
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
Northing in meter
445600
445200
444800
444400
444000
443600
443200
442800
442400
442000
441600
441200
440800
Easting in meter
602700
603100
603500
603900
604300
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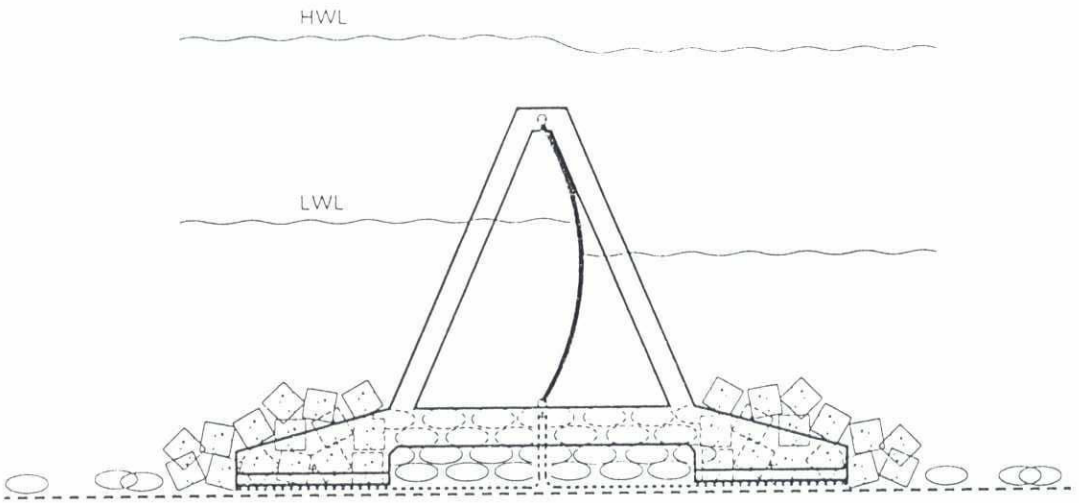

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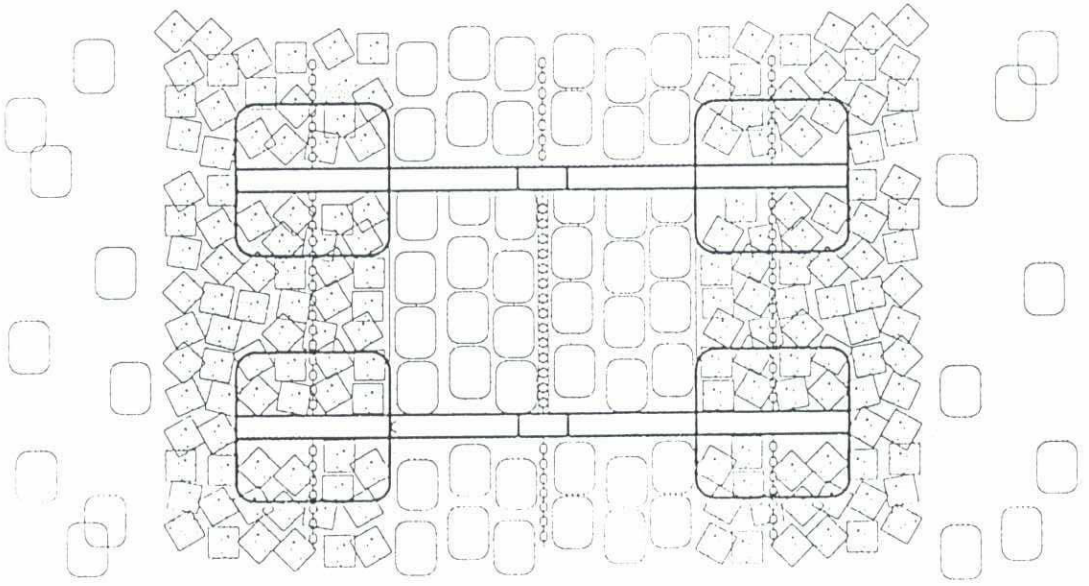

PLAN
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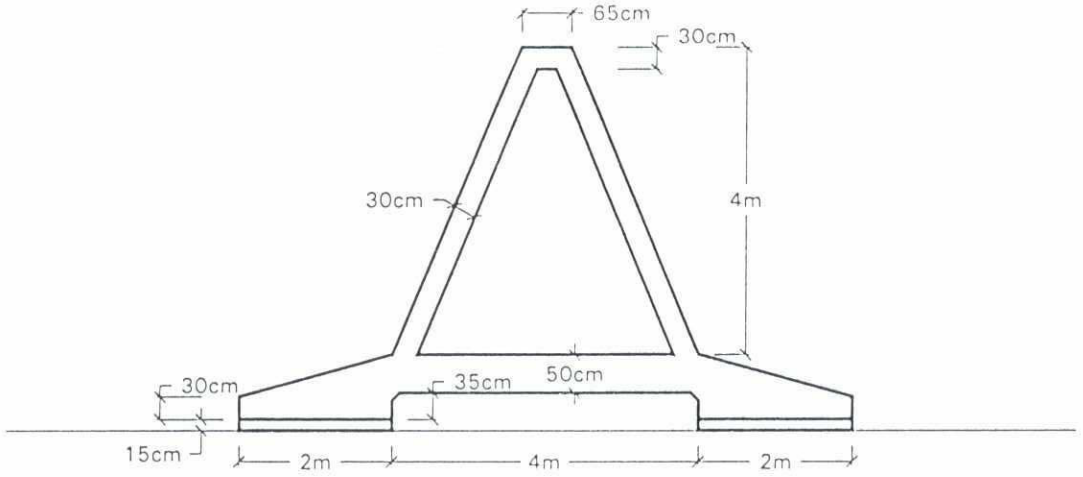

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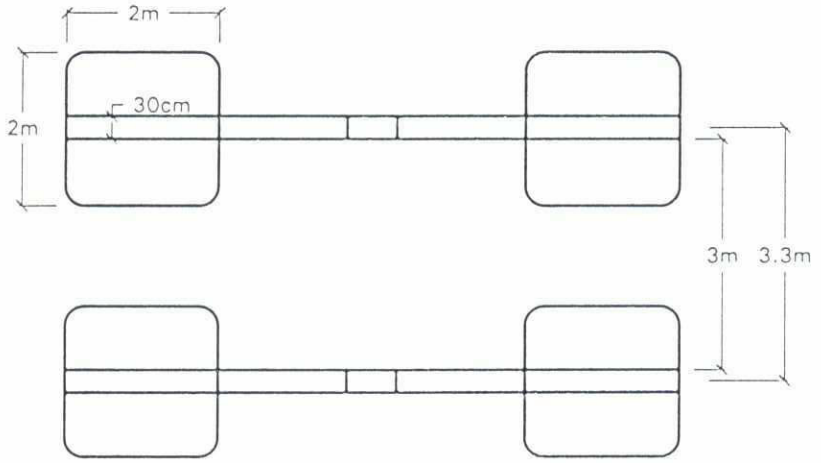

PLAN
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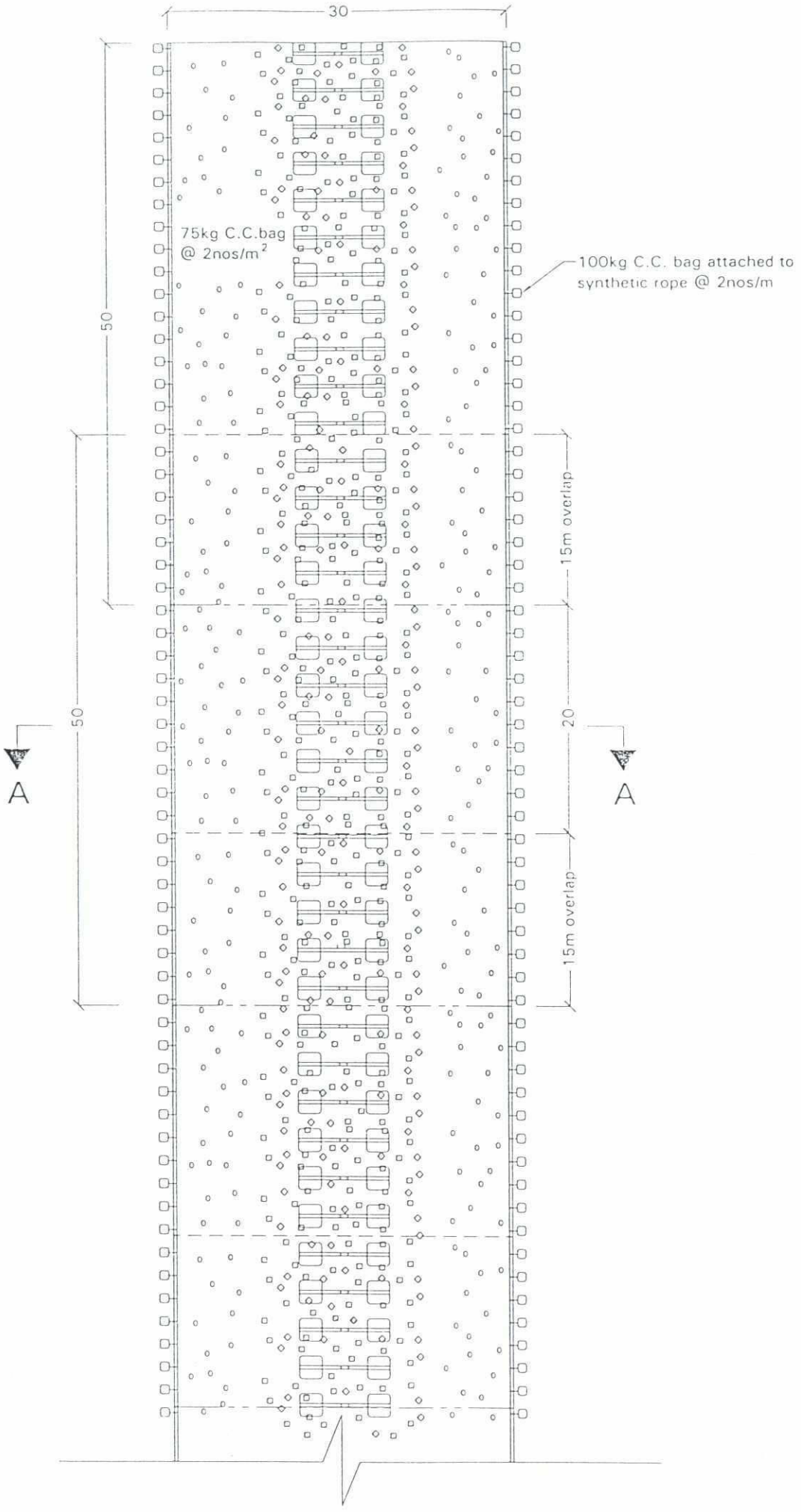
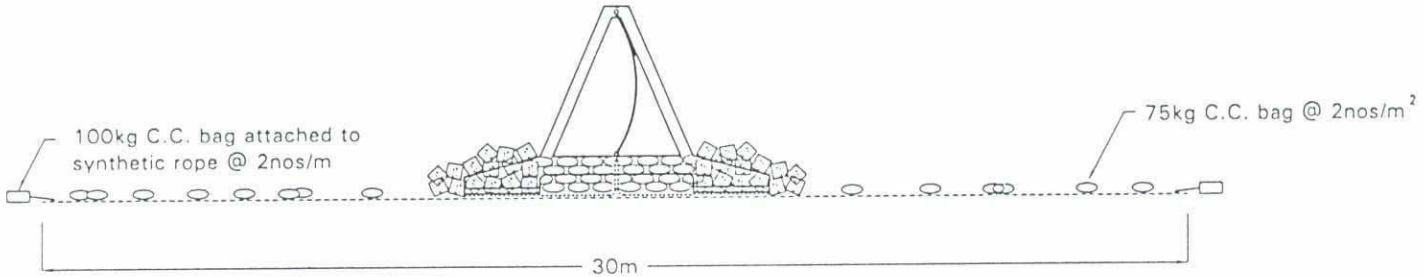
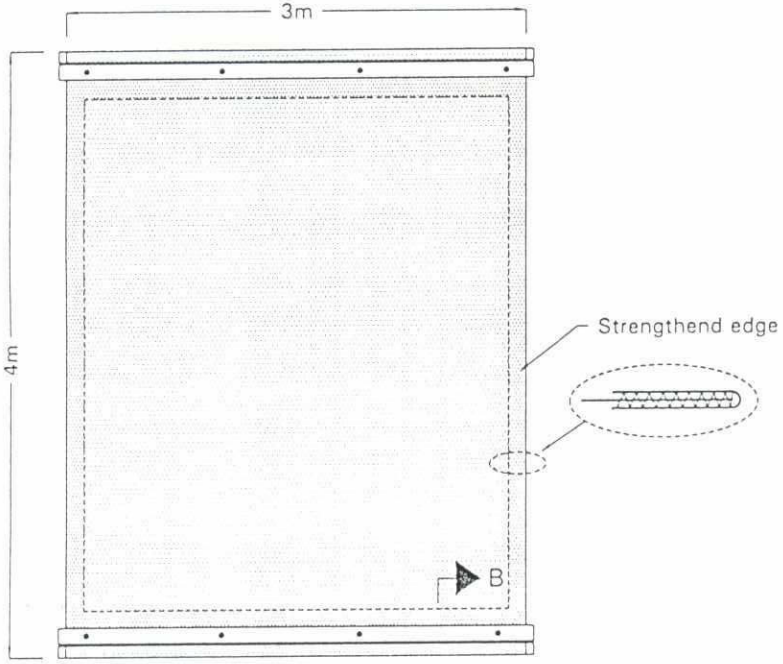


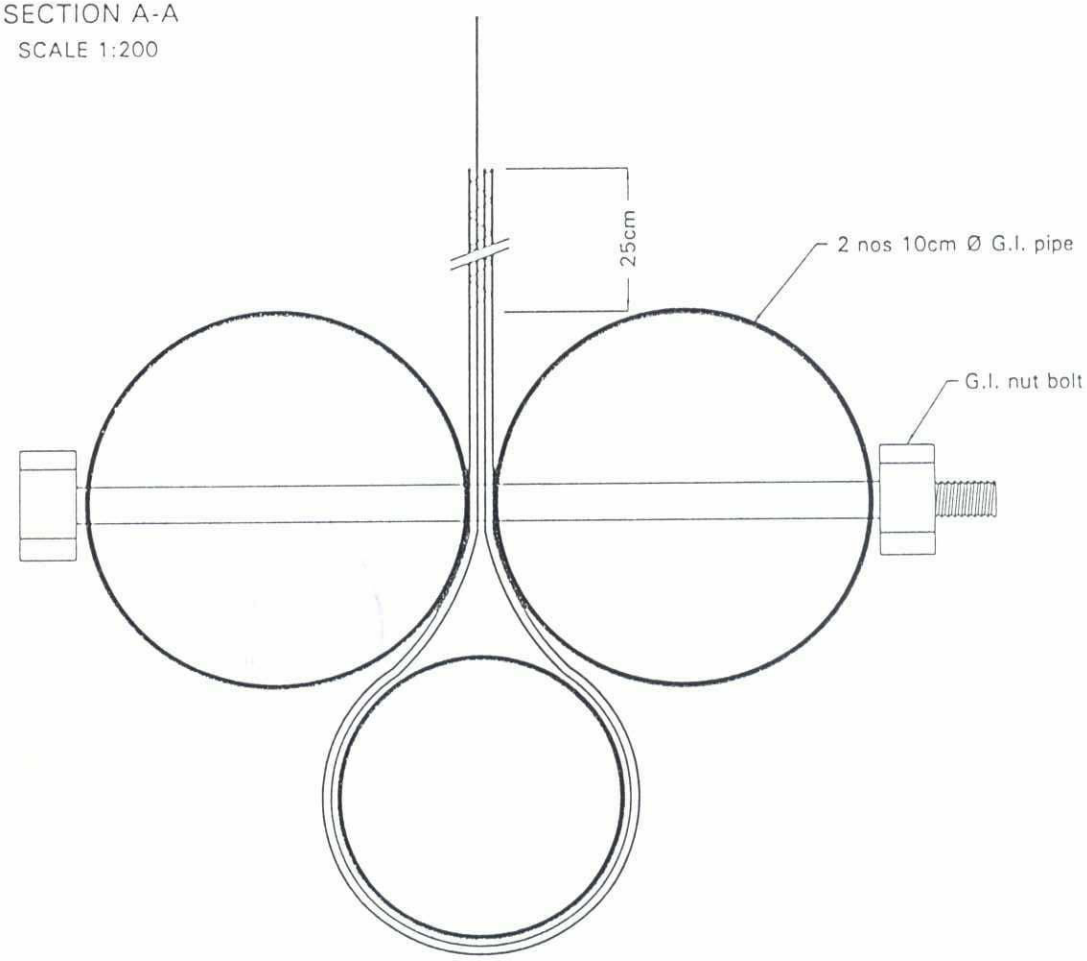
PLAN
SCALE 1:500



SECTION A-A
SCALE 1:200



VERTICAL SCREEN
CROSS DAM
SCALE 1:50



SECTION B-B
SCALE 1:2