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# Protection of Kamorta Island from Coastal Erosion – A Case Study

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# PROTECTION OF KAMORTA ISLAND FROM COASTAL EROSION - A CASE STUDY

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## ABSTRACT

*Soil erosion from steep banks of Kamorta Island due to rain and strong sea waves caused serious damages to slopes and threatened the safety of Helipad and Naval buildings on the Island. Two types of protective works were adopted in the area to stabilize the slopes and protect them from erosion. The adequacy of design, construction, performance and economy of these protective works are discussed in this paper. It is concluded that reinforced soil walls are more economical, easier in construction and more eco-friendly in remote islands as compared to conventional type of construction.*

## KEYWORDS

Coastal erosion, eco-friendly, economic analysis, geosynthetics, gravity wall, instability, protective works, reinforced soil wall

## INTRODUCTION

Kamorta is a small Island (28 Km long and 6 Km wide ) in Andaman and Nicobar Group of Islands. It is surrounded by open sea all around. The coast line contains the steep slopes of height ranging from 5 m to 13 m with loose soil (silty sand) experiencing strong wave action from the open sea. The island houses some of the important Naval building and a Helipad along the sea coast right on the bank.

The island experiences heavy rains and strong winds during most parts of the year in addition to strong wave action by open sea. With a result, the soil erosion from these banks under prevailing conditions is so severe that it caused the damages to the steep slopes and threatened the safety of the Naval buildings and Helipad located very close to the bank. The photograph in Fig 1 shows the severity of soil erosion at the steep banks due to sea waves.

## SCARCITY OF LOCAL RESOURCES

Kamorta is a remote island with civil population of approximately 5000 to 6000 people. A small Naval unit is located in the island. It is only connected with inter-island ship service with a frequency of once or twice a week. The local materials for construction like coarse aggregate, sand, boulders, timber etc. are not available on the island and the same are required to be transported by ship either from Port Blair or from main land. No local contractor or labour is available. Only limited electric supply is available through generating sets. There is no local market and the cost of material becomes considerably high in the islands due to heavy expenditure on their transportation.

## PROTECTIVE WORKS

Considering the above problems of the area and to avoid likely damage to Helipad and buildings in the island, two types of protective works have been provided to guard against the soil erosion both from rains and wave action depending on the nature and type of the embankment. These are :-

(a) Gravity Type Sea Wall with Revetment.

(b) Plain Cement Concrete Sea Wall .

The details of these walls are shown in Figs 2 and 3 respectively. The Gravity Wall with Revetment shown in

Fig 2 was required to provide protection to near vertical slopes of height of about 11 m near Officers Mess building. For areas which were having gentler slopes of lesser height and where buildings were located at a distance from the shore, the PCC wall was provided for protection. Fig 4 shows the photograph of completed work for Gravity wall with revetment and partly constructed PCC Wall. The Gravity wall with Revetment has been in use for last over eight years and its performance has been quite satisfactory. The work on PCC wall is still in progress.

## Limitations

Though the above types of protective measures are quite satisfactory for the stability of slopes, they suffered some limitations which are as under :-

1. Since large quantity of concreting was required in the work, a fairly large quantity of a ggregate, sand and cement was required to be transported to the island.

2. The concrete face of the sea wall does not match with the surroundings and it does not offer an opportunity to grow vegetation on it . Therefore, it does not go very much with the harmony of the surroundings.

3. The construction of concrete walls in islands is not an economical solution as the cost of transportation is high due to remote location of islands. Non availability of construction material in time and the inadequate shipping services , many times, cause undue delay in completion of projects which ultimately results in time and cost overrun.

## REINFORCED SOIL WALL

With the availability of latest technology and construction materials like Geosynthetics, the design of the Sea Walls is being given a fresh look. Reinforced Soil Wall is one of such technique which provides an economical and eco friendly alternative for protection works. The tensile strength of geosynthetics is utilised to resist the lateral soil pressure of respective layers so that no lateral pressure is transferred to the wall facia which is generally made self supporting. Various types of construction for the facia may be adopted as per the situation.

Two alternative designs of Reinforced Soil Walls which may be adopted for sea walls are illustrated in Fig. 5 and 6. The cross section of wall in Fig. 5 has been adopted to compare its cost with gravity wall shown in Fig. 2.

**Table 1**

**Comparison of Cost for Sea Walls**

| Ser No | Item | Unit Rate (Rupees) | Gravity Wall with Revetment | | Reinforced Soil Wall | |
|---|---|---|---|---|---|---|
| | | | Qty | Cost | Qty | Cost |
| 1 | Concrete filled in Jute Bags (cu m) | 1200 | 38 | 45,600 | - | - |
| 2 | Earth Fill ( Additional Quantity only) (cu m) | 120 | - | - | 38 | 4,560 |
| 3 | Geosynthetic Material | - | - | - | - | 25,000 |
| 4 | RCC Facia 250 mm thick (cu m) | 4000 | - | - | 1.5 | 6,000 |
| | Total | | | 45,600 | | 35,560 |
| | **Saving in Cost** | | **- Rs 10,040** | | **i.e. 22%** | |

### Economic Analysis

A comparison of the cost of these Soil Reinforced Walls per running meter length has been made in Table 1 and 2 respectively for Gravity Wall with Revetment and PCC Wall constructed in Kamorta. The cost of the geosynthetic materials have been taken in proportion to that of a 7.5 m high vertical embankment recently constructed on Okhla Fly Over in New Delhi where imported geosynthetic was used . It may be seen that with use of Geosynthetics the cost of the wall may be brought down by about 20 to 25 %. With the required type of orientated Geogrid now being manufactured in India the economy is further expected to be increased by 10 to 20%.

**Table 2**

**Comparison of Cost of PCC Wall with Reinforced Anchored Wall**

| Ser No | Item | Unit Rate (Rupees) | PCC Wall | | Reinforced Soil Anchor Wall | |
|---|---|---|---|---|---|---|
| | | | Qty | Cost | Qty | Cost |
| 1 | PCC (M25) (without Reinforcement) (cu m) | 3450 | 7.2 | 24,840 | - | - |
| 2 | RCC in Anchor Wall 200 mm thick (cu m) | 4000 | - | - | 1 | 4,000 |
| 3 | Geosynthetic Material | | - | - | - | 4,000 |
| | Total | | | 24,840 | | 18,000 |

**Saving in Cost - Rs 6,840 i.e. 26%**

The cost of comparison for different types of retaining walls prepared by California Department of Transportations is shown in Fig. 7. Similarly, Table 3 and 4 show the comparison of cost of 7.5 m high reinforced soil wall with conventional RCC wall adopted for Okhla Fly Over in New Delhi. These comparisons also confirm that reinforced soil walls are economical by about 20% or more in comparison with conventional type of construction.

**Table 3**

**Typical Cross Section Details of Abutment Walls at Okhla Fly Over**

**Length of Wall : 58 m**

| Description | RCC Wall | Reinforced Soil Wall |
|---|---|---|
| Height of the wall from GL | 6.5 m | 6.5 m |
| Foundation Depth | 2.0 m | 1.5 m |
| Foundation Width | 8.3 m | 7.1 m |
| Volume of Concrete (bed) | 0.85 $m^3$ | - |
| Volume of Concrete | 7.625 $m^3$ | 1.30 $m^3$ |
| Reinforcement Steel | 0.61 T | 0.1 T |
| Bioriented Tenax SAMP Geogrid (per Mtr wall) | - | 16 $m^2$ |
| Mono oriented Tenax SAMP Geogrid (per Mtr wall) | - | 47 $m^2$ |

**Table 4**

**Comparision of Cost : Abutment Walls at Okhla Fly Over**

| Ser No | Item | Cost in Rupees | |
|---|---|---|---|
| | | RCC Wall | Reinforced Soil Wall |
| 1 | Excavation @ Rs 50/ cu m | 900 | 600 |
| 2 | Bed Concrete @ Rs 2000/ cu m | 1,700 | - |
| 3 | Concreting @ Rs 3200/ cu m, including shuttering and curing | 24,400 | 4,160 |
| 4 | Reinforcement Steel @ Rs 18000/T including Fabrication | 10,980 | 1,800 |
| 5 | Geogrid | | 23,535 |
| | Total | 38,880 | 30,995 |

**Saving in Cost - Rs. 7,885 i.e. 20 %**

Fig. 1 Soil Erosion at 11 m High Bank Near Sea Coast

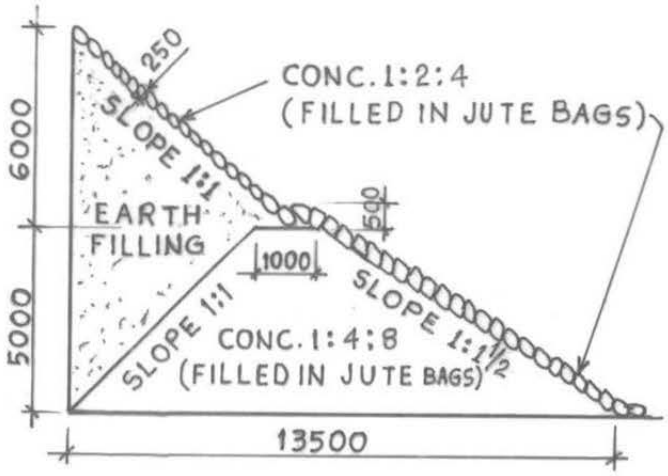


Fig. 2 Gravity Type Sea Wall With Revetment

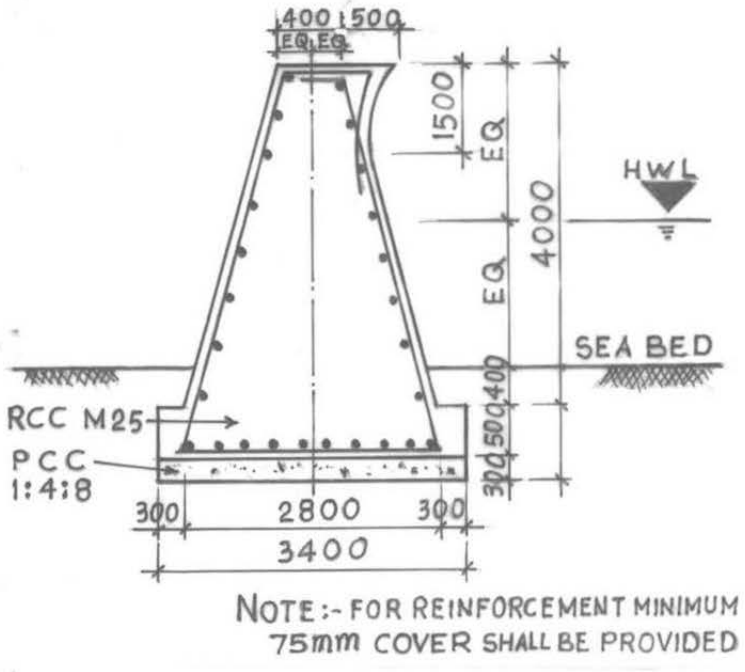


Fig. 3 PCC Sea Wall


**Fig. 4 Completed Gravity Sea Wall With Revetment and PCC Wall Partly Constructed**

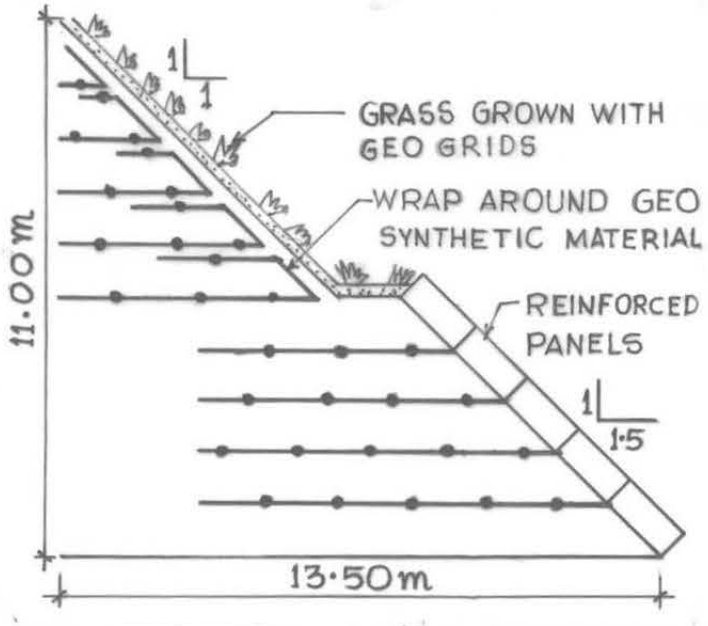


**Fig. 5 Reinforced Soil Wall**

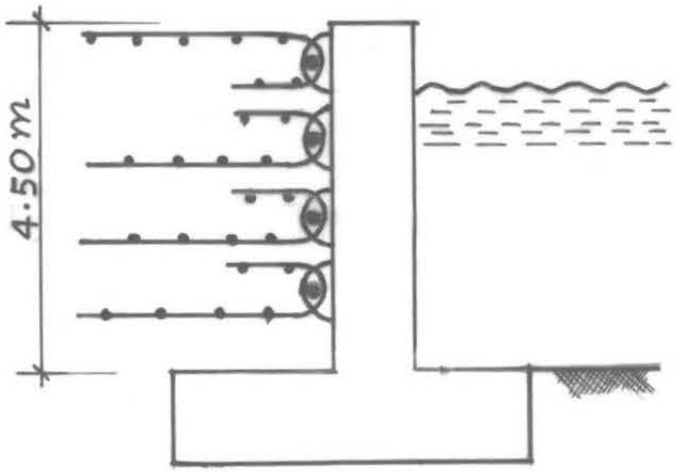


**Fig. 6 Anchor Wall**

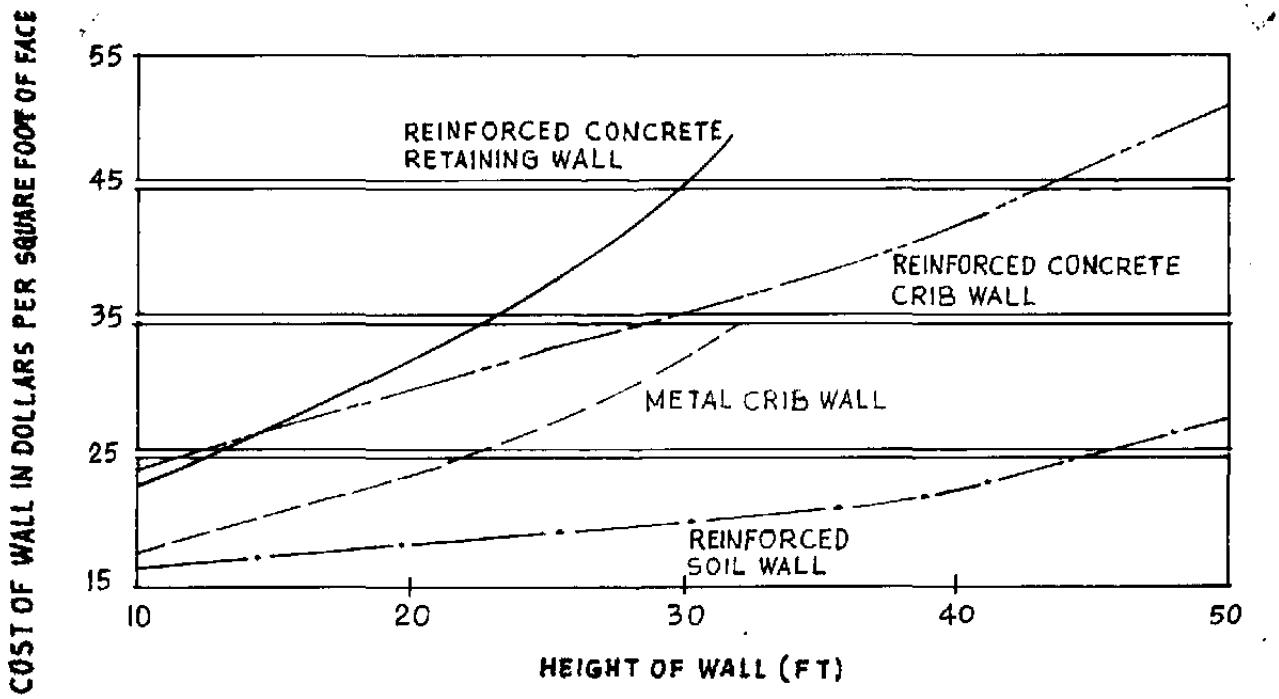


**Fig. 7 Cost Comparision Prepared by California Department of Transportation**

**Advantages**

It may, therefore. be concluded that by adopting the reinforced soil wall technique. the following advantages are achieved.

1. It cuts down the hassles & cost of transportation of heavy materials like boulders. course aggregate. and cement etc.

2. The construction time of the project in reduced considerably as the delays due to movement of stores are greatly reduced and construction is faster.

3. The growth of vegetation is possible on the slopes made with geosynthetics. Hence the construction is in harmony with the natural surroundings.

4. There is considerable reduction in quantity of query products required like coarse aggregate. stores dust. sea sand etc. which is considered more eco-friendly.

5. Overall cost is much less as compared to conventional construction.

6. The construction technique is easier even in adverse environmental conditions.

7. Possibility to use the soil available in situ as fill soil with consequent great saving on soil supply.

## CONCLUSIONS

The scarcity of construction materials in remote islands like Kamorta makes the construction of conventional type protective works costly and difficult. Reinforced soil technique in such areas does not only provide economical. faster and easier way of construction but it also helps in eco friendly construction in harmony with the natural surroundings without disturbing the beauty and the dignity of the coast line beyond acceptable limits.

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