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Techno-Economic Aspect Of Reinforced Earth Construction Works

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***ABSTRACT*:** *In recent years considerable research has been carried out in the field of Reinforced Earth Technology. A lot of literature is available based upon British Standard code. B.S.8006:1995. Code of practice for 'Strengthened / reinforced soils and other fills'. This code contains guidelines and recommendations for the application of reinforcement techniques to soils, as fill or in situ, and to other fills. This code also provides guidelines for safety margins in terms of partial material factors and load factors for various application and design lives.*
In recent years Systematic investigation has been carried out to determine the economy in soil reinforced wall as compare to conventional retaining wall. Result indicate that there are vast scope and need for these materials for developing country like India.
Development of Geosynthetic materials are major contribution of technology in this century. Inclusion of polymer based grids or nets in civil engineering industry are also a significant development as a construction material and have added a complete new dimension to engineering problem solving.
So here in this paper I m going to highlight few points regarding" Feasibility and cost effectiveness of Reinforced Earth Construction works".
Keywords - *Facing, Geogrid, Reinforced Earth (R E), Reliable, Stabilize*

1. INTRODUCTION

The basic principle involved in reinforced earth technique is simple to grasp and have been used by man for centuries. Recognition and the interest in the subject have gained impetus because of the technical and commercial success that has been demonstrated by the practitioner like **Henri Vidal**. The concept of reinforcing soil has also attracted the attention of the academic world for although the concept is easily grasped the theoretical aspects involved are numerous.
Reinforced Earth retaining structures are an economical way to meet ordinary and extraordinary earth retention and load support needs for highways and bridges, railroads and mass transit systems, waterfronts, airports, loading docks, industrial and mining facilities and commercial and residential developments. Each wall is a coherent gravity structure, custom-engineered to project-specific requirements including applied loading, foundation conditions, and aesthetics.

1.1 Previous Technique.

Prior to the introduction of the reinforced earth technique as a method of stabilizing embankments, the technique primarily in use was the RCC/PCC retaining structure. But the main problem with this technique was on the economic front. Also, it called for tedious construction methods. Therefore, a need was felt for the introduction of an innovative technique which would solve the above problems and it was in this context that the reinforced earth technique was initiated, incorporated and implemented on construction projects.

1.2 Definition Of Reinforced Earth

Reinforced Earth is a composite material formed by embedding reinforcing material in a soil fill at regular intervals and these reinforcing materials must be able to resist tensile stresses and also interact with soils through friction and or adhesion. The structure thus formed is provided with a facing to facilitate soil confinement on a vertical face. The facing comprises of rows and facing panel placed vertically one over other and connected to the reinforcing strips. The facing can be made water tight by adopting concrete facing element with suitable waterproofing material at the joints.
The soil is reinforced to to improve its strength to manifold for making it strong enough to carry out the desired functionality satisfactory.

1.3 Mechanics Of Reinforced Earth

Reinforced soil is the technique where tensile elements are placed in the soil to improve stability and control deformation. To be effective, the reinforcements must intersect potential failure surfaces in the soil mass. Strains in the soil mass generate strains in the reinforcements, which in turn, generate tensile loads in the reinforcements. These tensile loads act to restrict soil movements and thus impart additional shear strength. This results in the composite soil/reinforcement system having significantly greater shear strength than the soil mass alone.

2. COMPONENTS MATERIALS AND SPECIFICATIONS.

The present chapter discusses the components of Reinforced Soil Systems and the specifications of materials to be used for construction.

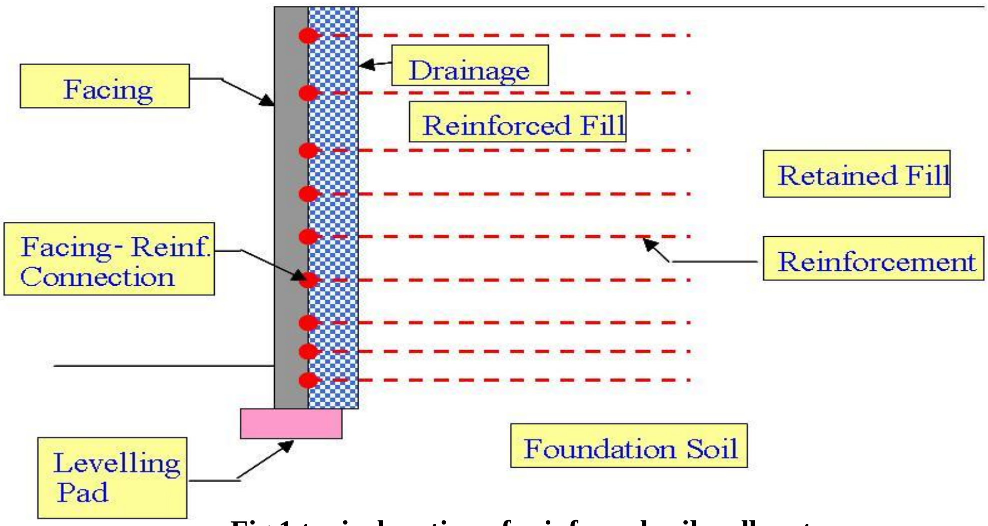

Fig.1 typical section of reinforced soil wall system

2.1 Foundation Leveling Pad

Leveling pad is used to distribute the weight of the concrete facia elements over a wider area and to provide level and working surface for erection of panels.The leveling pad shall consist of a plain cement concrete strip footing of 450mm width and 200 mm thickness, unless otherwise shown in the drawings. Concrete used shall have a minimum grade of M15.

2.2 Facing Unit

The facing unit provides the following functions:

Formwork **-** acts as form work for compaction of soil zone placed behind the facing unit.

Stability at the Facing Unit – The facing units provides support to the soil masses behind the units and also protects against backfill sloughing and erosion, and provides in certain cases drainage paths.

Aesthetics – Depending on the functional requirements and surroundings of the RSW, different facing units can be chosen for better aesthetics.

The reinforced concrete panel units used as facia element shall satisfy the specifications given in the following sections. The panels shall have a compressive strength of 35 MPa at 28 days. Concrete facing elements shall conform to the details and dimensions shown on the approved drawings.

2.3 Soil Reinforcing Structural Elements

2.3.1 Geogrids

Geogrids are used to stabilize the reinforced fill into a coherent mass by virtue of its tensile strength, stiffness and interaction with soil. The Geogrids are manufactured in accordance with a Quality Management System which complies with the requirements of BSEN ISO 9001.Since Geosynthetics are manufactured from polymers, which are visco-elastic in nature, they are susceptible to creep or long term deformation within the structures in post construction stages. Generally its tensile strength is 4o KN/M. Typical bodkin and polymer connector used for connecting the facia and geogrid.

2.3.2 Galvanized Smooth Steel Strips

Galvanized smooth steel strips conforming to IS 2062 and of suitable width and thickness will be used as soil reinforcement. Generally Ribbed strips are used of a 50-mm (2-in.) width and varying lengths as required by the design of the structure. The strips stabilize the fill into a coherent mass by virtue of its tensile strength and stiffness and interaction with soil. The reinforcement strips will be galvanized with a zinc coating thickness of 140 microns. The steel strips must have minimum ultimate tensile strength of 410 MPa.

2.5 Reinforced Fill

Reinforced soil is a composite structural material consisting of horizontal layers of tensile elements (uniaxial geogrids/ steel strips) and compacted soil placed behind the drainage fill or directly behind the facia. The role of soil in reinforced soil is comparable to that of concrete in reinforced concrete. Hence the fill is as important as the reinforcement material and hence considerable care has to be taken in fill material selection, characterization and construction quality control. An ideal fill material should have – high shear strength, low compressibility, and high permeability should not damage the reinforcement mechanically, chemically or electro-chemically and
should have good compaction characteristics.

2.6 Retained Fill

The soil immediately behind the reinforced fill is known as retained fill. The main properties required are strength and unit weight based on evaluation and testing of subsurface data. Angle of internal friction and unit weight can be determined from either drained direct shear tests or consolidated drained triaxial tests.

2.7 Drainage

Reinforced fills in RSW should be freely draining granular materials. However many retaining wall failures are caused by poor drainage. This is due to the increase in the percentage of fines in the reinforced fill. Poor drainage leads to the development of hydrostatic pressures or seepage forces in the retained soils that in turn generate additional destabilizing forces on the wall and reduce the shear strength of the soil.

Table 1: Electro-chemical properties of fill used with plain or galvanized steel reinforcement (After BS 8006: 1995)

Property	**Test Method**	**Structures out of water**	**Structures in water (not sea)#**
pH	BS 1377-3:1990) / Test 9	5 ≤ pH ≤ 10	5 ≤ pH ≤ 10
Chloride content	BS 1377-3:1990 / Test 7.2	≤ 0.02%	≤ 0.01%
Soluble sulphate content	BS 1377-3:1990) / Test 5	≤ 0.10 %	≤ 0.05 %
Resistivity (saturated)	BS 1377-3:1990 / Test 10.4	≥ 1000 Ohm-cm	≥ 3000 Ohm-cm

3. FEASIBILITY STUDY

Cost Comparisons Between Cantilever Retaining Wall And Reinforced Earth Wall

3.1 Estimate of Earth reinforced wall

For comparison we have found out quantities & estimate of 7.04 m wall high and 30 m long with plain cement concrete panels and ACE geogrid as shown in fig. 2

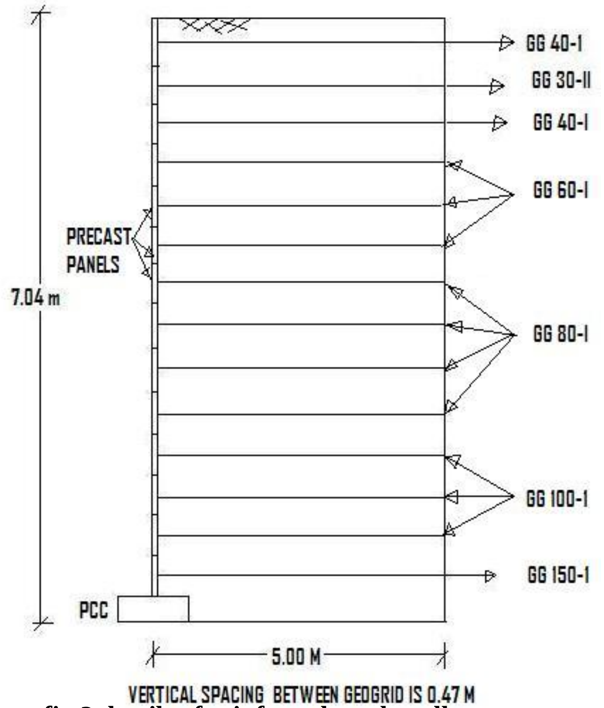

fig.2 details of reinforced earth wall

The total estimated cost for reinforced earth work is as follows

Table 2: The total estimated cost for reinforced earth work

Total Rs.	1020828=00
Add 5% for contingency in Rs	51041=00
Grand total in Rs	1071869=00

3.2 Estimate of cantilever retaining wall

Find quantities of 7.4 m wall high and 30 m long with cement concrete (1:2:4) and steel reinforcement as shown in fig.3

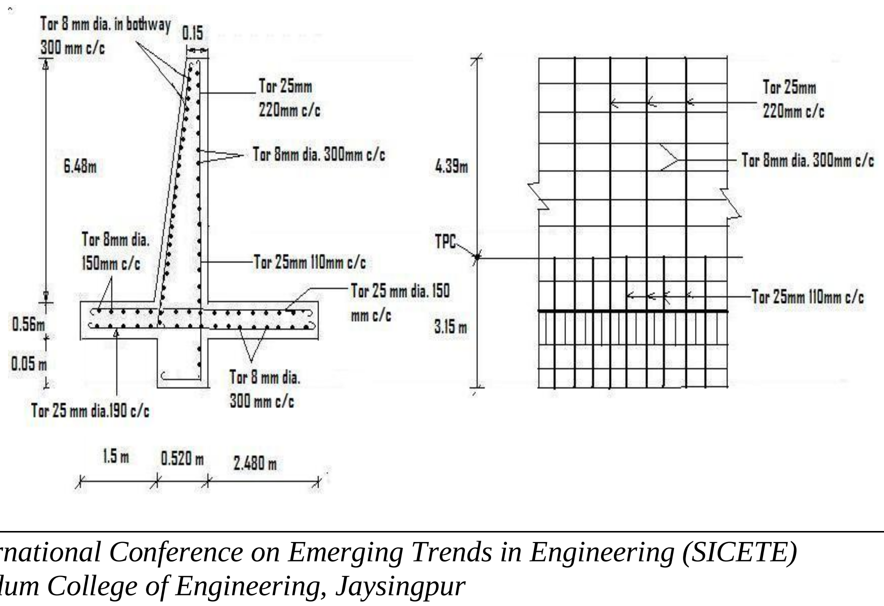

fig.3 details of reinforced earth wall

The total estimated cost for cantilever retaining wall is as follows :

Table 3: The total estimated cost for cantilever retaining wall

Total Rs.	1399979=00
Add 5% for contingency in Rs	69998=00
Grand total in Rs	1469977=00

Note that above values shows that R E walls are near about 30% Cost effective over the cantilever retaining wall.

4. CONCLUSION

Today, on flyover construction projects, the key issue is durability and speed construction. Their profitability depends on how fast returns start flowing. Any time or cost overrun can be thus proving to be very expensive irrespective of the method of funding. the choice of equipment technology , construction method and material all reflects the need of comply with the tightening quality requirements and time schedules. It has been found that reinforced earth techniques possesses many novel characteristics which render it eminently suitable for construction of engineering structures.The application area includes bridge abutments, earthfill dam's embankments, highways, railway embankment, settlement tanks and retaining walls.

It has been observed that the basic mechanisms of reinforced earth wall is that the lateral force which would have developed otherwise in the absence of reinforcements, are transferred to the geogrid on account of the soil strap interface friction, with the result that geogrid takes the care of all these lateral forces, if any force carry on to the facing of such wall are almost negligible. Thus the function of panel facing is to give a pleasing appearance if desired.

Finally, a comparison between the reinforced earth walls and reinforced concrete retaining wall on the basic of cost incurred indicates the use of reinforced wall technique there is 25-30% saving in cost.

Thus we conclude that with detail and accurate planning, precision in construction technique, proper storage and handling of materials the reinforced earth technique will become a economical, safe and reliable component in construction project.

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