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MECHANICALLY STABILIZED EARTH

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ABSTRACT

This article presents the mechanical stabilized earth walls components, structural application, advantages, factor of safety. This article also discuss the ways of wall failure. The principle of stabilized (reinforced) earth is traditional method, Straw, bamboo, rods and similar alternative materials have long been used in technologically unsophisticated cultures to reinforced mud bricks and mud walls. Generally there are three basic components used as following: the earth fill, reinforcement, facing unit.

Keyword: bearing capacity, facing unit, joint filler, MSE, overturning, sliding, reinforced.

I. INTRODUCTION

Mechanically stabilized earth (MSE or reinforced soil) is soil constructed with artificial reinforcing. It can be used for retaining walls, bridge abutments, etc. Although the basic principles of this have been used throughout history, MSE was developed in 1960s.MSE tolerate some differential movement and stabilize steep slopes. In the 1970s French engineer Sir Henri Vidal invented the modern form of MSE, he termed Terre Armee (reinforced earth). Reinforcement placed in horizontal layers throughout the height of the wall provides the tensile strength to hold the soil together. The reinforcement materials of MSE can vary. Originally, long steel strips 50 to 120 mm (2 to 5 in) wide were used as reinforcement. These strips are sometimes ribbed, although not always, to provide added friction. There are also prefabricated pile sleeve options to reduce negative skin friction on piles embedded behind MSE bridge abutments. Sometimes steel grids or meshes are also used as reinforcement. Several types of geosynthetics can be used including geogrids and geotextiles. The reinforcing geosynthetics can be made of high-density polyethylene, polyester, and polypropylene. These materials may be ribbed and are available in various sizes and strengths.

II. MATERIALS FOR REINFORCED EARTH STRUCTURES

2.1 Wall Facings

Wall facing panels shall be of incremental height, precast reinforced concrete, manufactured in accordance with grade of "Concrete". The minimum concrete grade shall be M30.

Steel reinforcement shall be a minimum of 450 mm²/ meter in each of two directions at right angles to each other and located at mid depth of the panel thickness. Wall facing panels shall be designed to prevent relative displacement. A footing shall be designed to accommodate the wall facing panels.

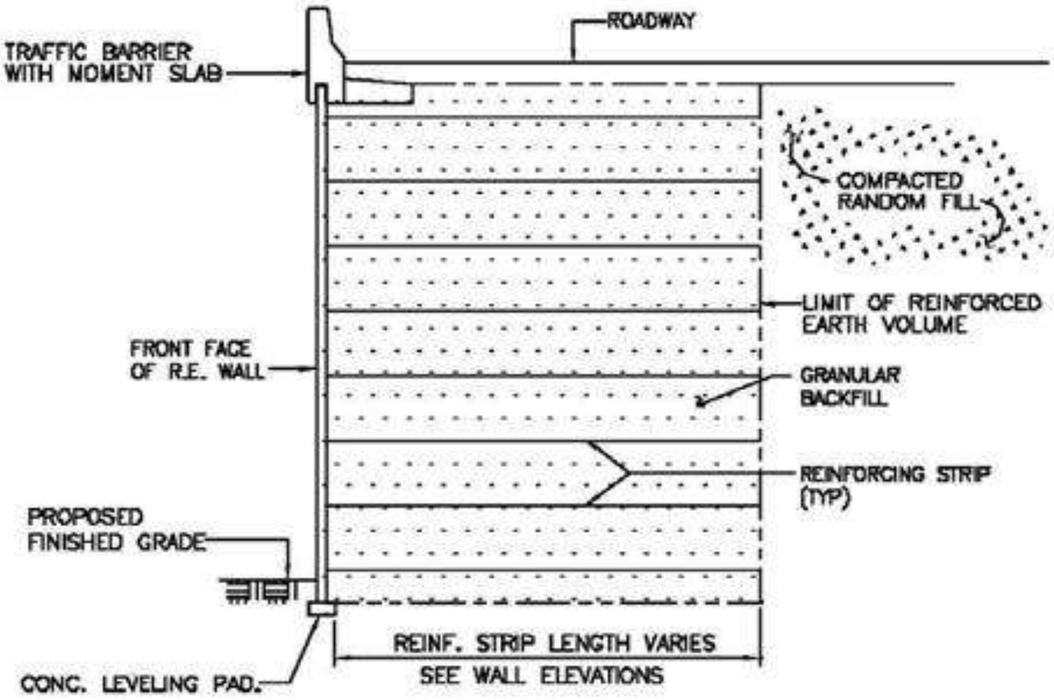

Fig. no.1 The Reinforced Earth Components.

2.2 Joint Fillers

Joint fillers between wall facing panels shall be composed of durable inert material resistant to attack from the soil material and the atmosphere. Joint fillers shall be provided to allow for joint rotation without spalling of concrete edges and to prevent loss of fines from the backfill material and staining of the panel faces.

2.3 Soil Reinforcing

Reinforcing strips or grids and their connections shall be fabricated from approved reinforcing products. Such products shall be sufficiently strong, stiff, stable and durable to satisfy the performance and design requirements of major reinforced soil structures and this Specification with a minimum of 10 years data from laboratory and site applications in representative conditions. Steel reinforcing shall comply with AS 3679, with a minimum base metal thickness of 5mm and hot dip galvanised after fabrication in accordance with AS 4680 with a minimum average coating thickness equivalent to 600 grams per square meter. Steel mesh shall comply with AS 4671 and hot dip galvanised after fabrication with zinc to AS4680 with a minimum average coating thickness equivalent to 600 grams per square meter.

2.4 Backfill

Select backfill shall comply with the requirements of the designer and have a particle size distribution, shear strength and coefficient of friction value to ensure the design parameters are achieved. Pulverised fuel ash (PFA) shall not be used as select backfill. Even fine particles are not used as a back fill material.

2.5 Connections

Materials connecting the wall facing panels with the reinforcing elements shall be electrolytically compatible to ensure that corrosion will not be promoted through the use of dissimilar metals. All materials forming connections shall be adequately protected for the in situ conditions, consistent with the protection provided for adjacent components and for the defined structure life.

III. FAILURE OF WALL

3.1 INTERNAL STABILITY

The verification of internal stability of a reinforced earth wall requires two steps:

(a) The calculation of tension in the reinforcement at various levels of the wall, and

(b) Checking the length of reinforcement to maintain adherence.

The tension in the reinforcement may be determined readily if it is assumed that the earth between the reinforcing strips is in a condition of limit equilibrium corresponding to the active condition prior to a tension failure of the reinforcement. This assumption is consistent with the observed behaviour during such a failure mode when a tension failure occurs progressively from the bottom of the wall upwards. Considering the local equilibrium between the tension in the reinforcement and the horizontal stress near the facing are obtained:

$$T = K_a \sigma_v \Delta H \qquad (1)$$

Various assumptions may be made for the distribution of vertical stress and the corresponding formulae for T result as follows:

For a uniform distribution of σ_v

$$T = K_a \gamma H \Delta H \qquad (2)$$

The critical length of reinforcement

$$L_a = \frac{T_m}{2b*\sigma*\tan\Psi} \qquad (3)$$

In practical design safety factors are applied to the calculated values for each failure mode as follows.

(a) The tensile stress in the reinforcement is limited to two-third of the yield stress.

(b) The length of reinforcement provided is at least twice the critical value La

3.2 EXTERNAL STABILITY

The external stability of a reinforced earth wall is checked in a manner similar to a conventional gravity structure. Following a calculation of the forces acting on the wall the possible failure modes are investigated: (a) overturning of the wall (b) sliding on the base (c) bearing failure of the foundation soil (d) overall slip circle failure and (e) differential settlement along the structure.

In practice, the flexible nature of reinforced earth and the usual dimensions adopted for actual structures permit some variation to the safety factors traditionally applied to gravity structures in concrete masonry. In this respect reinforced earth may be regarded as a material intermediate between masonry and earth. A failure by overturning is rarely critical for the dimensions of a reinforced earth wall are determined by other criteria.

The bearing capacity of the foundation soil may be calculated according to classical soil mechanics theory using the Terzaghi, Meyerhoff formulae appropriate to the wall geometry, surcharge loading and soil properties The flexibility of reinforced earth and the articulated nature of the facing elements ensure that the structure can safely withstand significant differential settlement along the wall. Based on measured differential settlements and the performance of actual structures founded on very weak subsoils as reported by Schlosser (1972) and Schlosser, Long and Sevestre (1973), the following criteria have been adopted for permissible differential settlement along the wall:

Metal facing - 2 percent

Concrete panels - 1 percent.

IV. FACTOR OF SAFETY AGAINST FAILURE

Minimum factor of safety required

Failure mode	Load combination		
	Static only	Static + Seismic	Static + Drawdown
Overturning	2.0	1.5	1.5
Sliding	1.5	1.1	1.2

Table no. 1 factor of safety against failure

V. STRUCTURAL APPLICATIONS

Reinforced Earth is used in urban, rural and mountainous terrain for:-

•Retaining Walls

•Seawalls

•Bridge Abutments

•Submerged walls

•Railway Structures

•Truck dumps

•Dams

•Bulk storage facilities

5.1 ADVANTAGES

The advantages of Reinforced Earth technology include:-

1) Flexibility - Reinforced Earth structures distribute loads over compressible soils and unstable slopes, reducing the need for deep foundations.

2) High load - carrying capability, both static and dynamic - applied structural loads are distributed through the compacted granular fill and earth pressure loads are resisted by the gravity mass.

3) Ease and speed of installation - prefabricated materials and granular soil simplify construction and minimize the impact of bad weather.

4) Pleasing appearance - panels may be given a variety of architectural treatments.

5) Economy - 15-50% savings over cast-in-place concrete walls, depending on wall height and loading conditions.

VI. CONCLUSIONS

Reinforced earth although a relatively new process has many applications in highways and its use is becoming more extensive. Considerable research has been carried out to explain the composite action of the earth and reinforcement, the exact details of which are not yet completely defined. However available data and current design practices which may be conservative are sufficient to ensure satisfactory performance. Research is continuing and the reinforced earth technique is being progressively extended into the field of general civil engineering.

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