ASSESSMENT OF USE OF MUNICIPAL SOLID WASTE AS A BACKFILL MATERIAL IN REINFORCED EARTH WALL UNDER DYNAMIC LOADING

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Abstract- Nowadays, Reinforced earth wall is preferred over conventional RCC rigid retaining wall, because of ease in construction, reduced cost, and better performance. The huge mound of garbage at Pirana landfill (Ahmedabad, Gujarat) has become a complex problem due to its environmental impact. Generally cohesionless material is used as a backfill in Reinforced Earth wall and recent studies have confirmed that municipal solid waste(MSW) is a cohesionless material. Also the result of using MSW were quite satisfactory under static loading. The main objective of present research work is assessment of Municipal solid waste of Pirana landfill as a suitable backfill material for Reinforced earth wall through segregation and infusement of synthetic reinforcement at suitable positions. For this purpose, load-settlement and load-displacement tests are carried out under dynamic loading on sand, MSW, dry mixture of 1sand:3MSW and on mixture of 1sand:3MSW at 40%, 50% and 60% saturation. Geogrid is used as a reinforcement. The length of geogrid used is 525mm and it is placed at a spacing of 150 mm in five layers. Further various chemical tests are also done.

IndexTerms: Reinforced , MSW, Backfill, Dynamic, Geogrid.

I . INTRODUCTION

Reinforced earth is a material formed by combining earth and reinforcement. The term "earth" covers all types of ground found in nature, or produced by physical or chemical means, including both granular soils and earth which exhibits some slight cohesion. It can include all particle sizes (silt, sand, gravel, stones, and all sizes of rocks); it can be formed of prefabricated elements (concrete, for example). The word "reinforcement" is used to define all linear components which can withstand major tensile stresses. Thus, earth is a mass of constituents with compact shapes, close to a sphere or cube; as a result, we will call them "grains" or "particles". Reinforcing members are elongated elements, with one dimension clearly greater than the others. Earth alone, or at least granular earth, according to the definition used in soil mechanics, is made up of non-cohesive particles, but when horizontal beds of flexible, rectilinear reinforcement are introduced into this earth, the whole mass exhibits some cohesion. It is a body of reinforced earth. This cohesion of reinforced earth arises from friction of grains of earth against the reinforcing members. There is a transmission of forces by friction between the grains and the reinforcements, introducing true cohesion to the whole mass. This assumes that there is grain-reinforcement friction without sliding; therefore, the reinforcing members must be so arranged that this condition is always met. Since reinforcement can be placed along the directions of the three axes of a trihedral, it can easily be understood that a reinforced earth body may present cohesion in all directions. Consequently, it is possible to build structures of reinforced earth in any desired shape. In such structures, the stresses developed in the reinforcement depend on the sum of the contact actions between the earth particles. As a result, if the reinforcement is properly placed and designed, it is possible to avoid any shear and any sliding, so that the entire mass behaves like a cohesive solid capable of withstanding both internal and external forces. Now dumping of MSW has been a huge problem that the whole world is facing today. It utilizes important piece of land and also have impact on health of people living in surrounding areas. The only way to get rid of these problems is to utilize it in some or the other manner. The present study emphasizes on assessment of use of MSW as a backfill material in Reinforced Earth wall under dynamic loading. The reason for using dynamic loading is because under static loading MSW gave good results. Also the Reinforced Earth wall undergoes various seasonal changes and lowering and rising of water table takes place which affects the property of backfill material. Such changes can only be studied by cyclic loading. Also it is important to see how the particle fabric of MSW behaves under cyclic loading as it is modified by leachate interactions, decomposition.

II. EXPERIMENTAL STUDY

2.1 MATERIAL COLLECTION AND PROPERTIES

a) Sand

Sand that was used as backfill material has following engineering and index properties:

Table 1: Index and Engineering properties of sand

Test	**IS code**	**Symbol**	**Value**
Grain size analysis	IS: 2720-4:1985	Cu	3.89
		Cc	1.43
Soil classification	IS: 1498-1970		SP
Specific gravity	IS: 2720-3:1980	G	2.63
Relative density	IS: 2720-14:1983	ϒmax (kN/m^3)	18.70
		ϒmin (kN/m^3)	15.20
Direct box shear	IS 2720-13:1986	C (kN/m^2)	0
		ϕ	31°

b) Municipal Solid Waste(MSW)

MSW of pirana site was used after passing it through 4.75 mm sieve. The MSW has following index and engineering properties:

Table 2: Index and Engineering properties of MSW

Test	**IS code**	**Symbol**	**Value**
Grain size analysis	IS: 2720-4:1985	Cu	5.16
		Cc	1.32
Soil classification	IS: 1498-1970		Similar to SP
Specific gravity	IS: 2720-3:1980	G	2.28
Relative density	IS: 2720-14:1983	ϒmax (kN/m^3)	13.83
		ϒmin (kN/m^3)	10.58
Direct box shear	IS 2720-13:1986	C (kN/m^2)	3
		ϕ	34°

c) Geogrid

The geogrid that was used as a reinforcement has following properties:

Table 3: Mechanical properties of Geogrid

Parameter	Value
Tensile Strength- MD	60(kN/m)
Tensile Strength- CMD	20(kN/m)
Creep reduction factor	1.47
Partial factor- Installation damage	1.07
Partial factor- Environmental effects	1.10

2.2 EXPERIMENTAL SETUP

Model tests were performed in a steel tank of size 700mm x 990mm x 750mm. Both sides of the tank were provided with perspex sheet to observe the rupture surface. The wooden facing panel of 30 mm thickness was fixed to the open face of the tank model. The panel was made up of 8 no. of blocks having size of 300 mm x 175 mm and 4 no. of blocks having size of 150 mm x 175 mm. According to BS 8006:2010, five layers of geogrid having length of 525 mm and a spacing of 150 mm were fixed to the facing panel by means of clamps. To carry out the tests on reinforced earth wall model, the vertical downward load was applied by means of mechanical jack. To measure the displacements, total 6 dial gauges were setup in RE Wall model, out of which 2 dial gauges were setup in order to measure vertical settlement of backfill material and 4 dial gauges viz. H1,H2, H3, H4 were setup in order to measure the horizontal displacement of RE wall.

Table 4: Location of dialgauges

Designation(mm)	H1	H2	H3	H4
Horizontal distance(left to right)	85	260	435	610
Vertical distance(bottom to top)	690	540	390	60

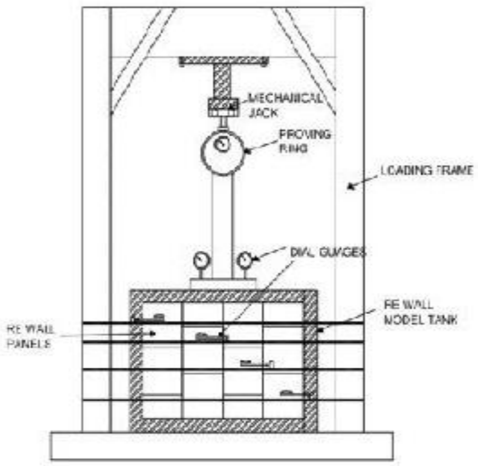

Fig 1: Schematic diagram of Reinforced Earth wall test model

2.3 TEST PROCEDURE

A load settlement and load displacemement test was carried out on RE model to know the displacement characteristic of RE wall and settlement characteristic of backfill material. Following is the procedure for performing test:

1) The sand is placed in a square tank of size 700mm*990mm*750mm.

2) The tank was filled with 80% relative density in five layers.

3) The geogrid was placed with length 525 mm and spacing of 150mm.

4) Aluminium plate of size 250mm*250mm was placed on top to transfer the load from hydraulic jack to soil.

5) A hydraulic jack was placed on the aluminium plate.

6) Two dial gauges were placed on the plate surface to measure vertical settlement, and four dial gauges were placed on wooden panel in diagonal position at specific interval to measure horizontal displacement.

7) The displacement and settlement was measured by using dial gauges of sensitivity 0.01 mm Figure 2 shows actual test setup.

8) The load was applied in increment of 2.4 kN and was applied till the settlement was less than 0.02 mm per minute, and sudden removal of load was done to impart cyclic loading effect. The test was done till the failure takes place

Fig. 2: Reinforced wall test setup

III. RESULTS AND DISCUSSION

The result obtained for displacement and settlement are shown in following graphs.

5.1. LOAD DISPLACEMENT CURVE

5.1.1. At H1 dial gauge location:

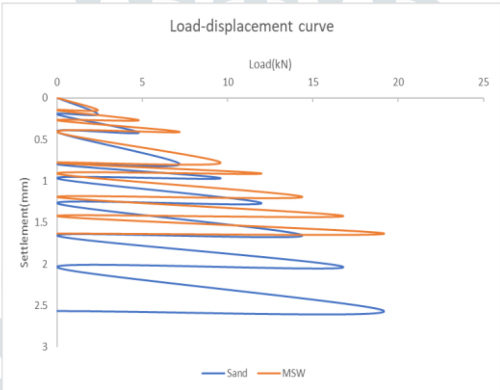

Fig. 3: Load v/s Displacement characteristics for Sand and MSW at dialgauge location H1

5.1.2. At H2 dial gauge location:

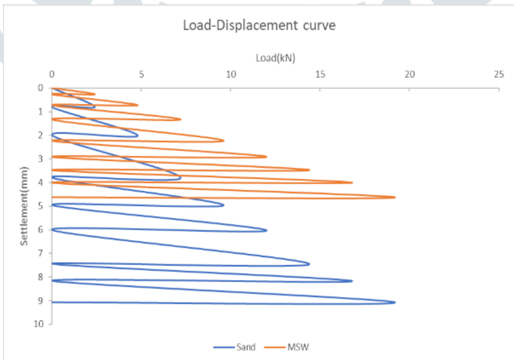

Fig. 4: Load v/s Displacement characteristics for Sand and MSW at dialgauge location H2

5.1.3. At H3 dial gauge location:

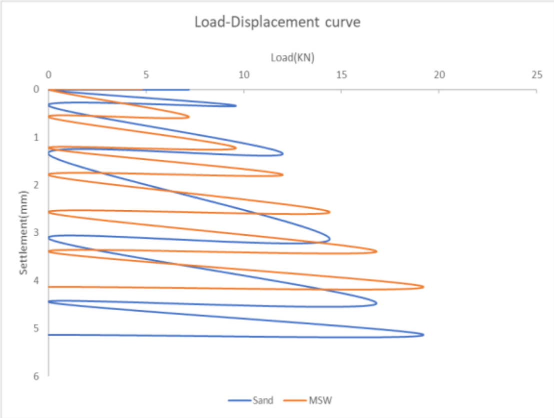

Fig. 5: Load v/s Displacement characteristics for Sand and MSW at dialgauge location H3

5.1.4. H4 dial gauge location:

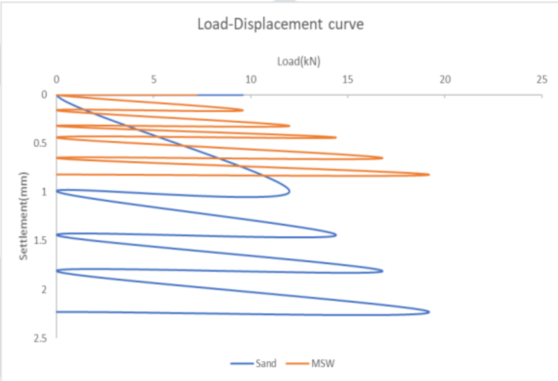

Fig. 6: Load v/s Displacement characteristics for Sand and MSW at dialgauge location H4

The above graphs show that for cyclic loading the horizontal displacement for sand is more compared to MSW. Also the horizontal deflection is more in centre panels compared to edge panels. The deflection at H1, H2, H3, H4 for Sand and MSW at 19.2 kN are 2.57, 9.07, 5.13, 2.23 and 1.82 , 4.62, 4.13, 0.82 mm respectively.

5.2 Load-Settlement curve:

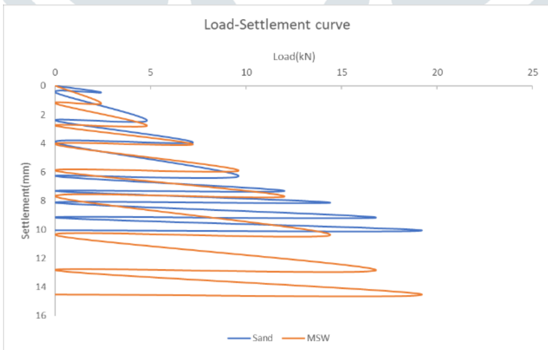

Fig. 7: Load v/s Settlement characteristics for Sand and MSW

The above graph shows the settlement of Sand and MSW for cyclic loading. It can be easily observed that settlement in MSW is more compared to settlement of Sand which is opposite to displacement characteristic.

IV. CONCLUSIONS

The summary of conclusions for this study are as follows:

The settlement for MSW is quite more than that of Sand. And horizontal displacement in MSW is less as compared to Sand.

Also the load carrying capacity of backfill material decreases under cyclic loading that is for same material and density the backfill material will fail at a greater load under static loading.

V. ACKNOWLEDGEMENT

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