May-June 2020
ISSN: 0193-4120 Page No. 6168 - 6173

Study on the Behaviour of Geosynthetic Reinforced Earth Retaining Wall With Waste Material as Reinforced Earth Fill

Mohanasudan V, PG Scholar, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode District, Tamilnadu, India.
Manjunath N V, Assistant Professor, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode District, Tamilnadu, India.
Dr B Soundara, Professor & Head of the Department, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode District, Tamilnadu, India.

Article Info
Volume 83
Page Number: 6168 - 6173
Publication Issue:
May-June 2020

Article History
Article Received: *19 November 2019*
Revised: *27 January 2020*
Accepted: *24 February 2020*
Publication: *18 May 2020*

Abstract:
Automotive vehicle manufacture and its parts supply are the main generations of foundry sand. Foundry sand is bonded to form mould for ferrous and nonferrous metallic element casting. Silica-based spent foundry sand from iron, steel and aluminium foundry are hazardous waste. The fly ash produced from the burning of pulverized coal-fired electric steam generating plants. Fly ash has some toxic particles can affect the lungs and brain. In this study, an try has been made for exact use of foundry sand and fly ash as different backfill materials in a reinforced retaining wall. A test tank is fabricated with wood then the test was carried out with jute fibre mattress. A strip load is placed at the top surface of the backfill material and the deformation where recorded under various load increment. The study shows that the comparison of foundry sand backfill and fly ash backfill and found which can be used as backfill material.

Keywords: *Foundry sand, Fly ash, Backfill, reinforcement*

I.INTRODUCTION

In India, 75% of energy is created from the thermal power stations which use coal as fuel by (Senapati 2011) [1] and they use great amount of coal as a by-product for burning. This combustion process gives out a huge amount of fly ash. Fly ash is leading solid waste material from the coal-burning power plants. Indian coal has a low-level calorific value of 3000-4000 kcal/kg which gives 35 to 50% of fly ash by (Kaniraj and Gayathri 2004)[2]. It creates environmental problems and needs a huge area for disposal. Wide-open land for removal in developing nation like India is hard. Ninety million tons of fly ash are produced every year and it requires 265 km2 of the area as ponds for its disposition by (Das and Yudhbir 2005)[3]. Less calorific value coal will give high fly ash. In India more than 120 of coal power station contribute 70% of electricity which create 120 – 150 million tons of fly ash per year. Presently 300 million tons of fly ash is produced worldwide and only 10 – 30% of fly ash is used as structural fill and rest should be deposited in ponds or old mines and reminds as air, water and soil pollution. In India only 25% fly ash is used as in concrete by (Bhattacharjee and Kandpal 2002)[4].

Breathing close to coal ash is toxic to human welfare, It origination heart disease, cancer, respiratory illness and stroke. Dumping of fly ash in ponds, open trenches and in mines leads to air pollution and soil pollution.

Waste Foundry sand is mainly fine aggregate. Foundry sand can be used as the partial replacement of fine aggregate by wast foundry sand Foundry sand can be used in numerous ways as natural or manufactured sands. This includes a lot of civil engineering requests such as embankments, flowable fill, hot mix asphalt (HMA) and Portland cement concrete (PCC). Foundry sands have also been used broadly agriculturally as topsoil.

Waste Foundry Sand (WFS) is a discarded material coming from the ferrous and nonferrous metal casting industry by Rafat Siddique and Gurpreet Singh (2011) [16]. There are many risks available for the foundry workers, foundries have much harmful substance like silica and dust which affects the workers present in foundries, workers are at risk from airborne particles which enters into human lungs and causes respiratory problems and lung cancer.

Reinforced Earth is used in retaining walls, sea walls, foundation slab and abutments. The flexibility of reinforcement is a beneficial quality. It enables fast construction, improves construction on poor foundation. Several researchers have studied the planar reinforced soil wall, e.g. Hatami et al. (2001),Simonini and Gottardi (2003)[5],Shinde & Mandal (2007)[6], Ma & Wu (2004)[7] and Hatami & Bathurst (2006)[8], Hazra and Patra(2008)[9]. To improve the bearing capacity of soil and under footing, road, embankments and in retaining walls cellular or geocell reinforcement has been used by Zhang et al.(2006)[10], Khedkar & Mandal (2009)[11], and Khedkar & Mandal (2009)[12],

This project work is carried out to find the alternative material for retaining wall earth fill.

II. CHEMICAL COMPOSITION

Table 1 Chemical Composition of Fly Ash

CHEMICAL	%
SiO_2	23.76
Al_2O_3	8.47
Fe_2O_3	2.12
Cao	0.29
BaO	1.54
K_2O	0.86
MgO	0.13
MnO	0.2
Na_2O	0.19
P_2O_5	0.09
SO_3	0.11
SrO	1.84
TiO_2	23.76

Table 2 chemical composition of foundry sand

Comp	%
SiO_2	55.1
Al_2O_3	1.89
CaO	5.25
MgO	8.85
Na_2O	0.41
K2O	0.74
Fe_2O_3	4.76
TiO_2	0.16
$P2O_5$	0.25
NiO	1.15
Cr_2O_3	1.4
MoO_2	0.66
Undet	1.38
LOI	18

III. EXPERIMENTAL SETUP

The test model was fabricated with plywood and its thickness is 20mm, Dimension of the model is 600mm long X 400mm width X500mm height or depth referring to B.Ram Rathan Lal and J. N.Mandal (2014) The test was done to find the behaviour of reinforced retaining wall with backfill. Retaining wall is provided at 100mm from one end of the test model. Hinged support is provided at the bottom of the retaining wall, Backfill is done with fly ash for the first test with jute fibre mattress and for second test foundry sand is used as backfill material with jute fibre mattress height of the model is divided into various layers bottom 30mm is used as base coarse in this layer backfill material is filled as a base material and it is compacted welled and the jute fibre is placed, again backfill is done layer by layer and height of layer is 25mm and compaction is done, jute reinforcement is placed at equal height as

May-June 2020
ISSN: 0193-4120 Page No. 6168 - 6173

shone in fig 1, LVDT'S are placed at equal distance between each other to record the deflection of the retaining wall for the applied force on the backfill with loading frame, LVDT'S are placed as shone in fig 1, Strip footing is placed above the backfill and the load is applied through strip footing to the backfill, water is sprayed during compaction process. Load is applied 100mm distance away from the retaining wall and strip footing help to transmits the load throughout the width of the test model and the strip footing is placed in the backfill as shone in fig 1. jute reinforcement is provided to the full length of the model it helps to improve the bearing capacity of the backfill and the reinforcement will reduce the deflection of the retaining wall, mostly deflection will be less until the reinforcement fails. Top three layers of reinforcement are very important it will improve the bearing capacity of the backfill and deflection of the retaining wall is less until this reinforcement is damaged, this reinforcement will take the more load and it reduces the effect on retaining wall. reinforcements are as shone in fig 1. Laboratory test layout of a reinforced retaining wall is as shone in fig 1. referring to B.RamRathan Lal (2014) [13] and B. Ram Rathan Lal and J. N. Mandal (2014) [14].

IV. INSTRUMENTATION AND DATA ACQUISITION

Steel plate is placed above the back as strip footing for effective load distribution. The load cell is placed above the strip footing with a capacity of 750kN was used for applying load on the backfill and it is used to measure the vertical load. The load applied to the backfill can be recorded up to the accuracy of 1kN. Three numbers of LVDT'S are placed inside the test model as shone in the layout of retaining wall fig 1. LVDT'S are used to find the horizontal deformation of the retaining wall during applied force on the backfill and the deformation can be recorded up to an accuracy of 0.01mm all LVDT'S are calibrated and are connected to the dater logger. The load was applied through the load cell placed centrally on a steel plate and the load is applied gradually and the horizontal deformations are recorded with the data logger. By using LVDT'S deflection can be recorded up to 100mm. To resist the lateral deflection steel bars are used to avoid the deflection of adjacent plywood movement of the box is resisted and not allowed to during applied load on the backfill now deflection will occur only in retaining wall, three LDVT'S are placed at an equal distance between each other.

V.CELLULAR REINFORCEMENT

The jute fibre mattress is used as cellular reinforcement. Jute fibre mattress is of size 500mm long x 400mm breath is used to increase the load bearing capacity of soil. This mesh is placed in every layer at an equal distance.

VI. PREPARATION OF MODEL AND TEST PROCEDURE

Before starting the test, the retaining wall was placed in a vertical position and the retaining wall was hinged to the bottom plate of the test tank. In this position, the backfill material fly ash for first test and foundry sand for the second test respectively was placed in the tank. Foundation layer is placed at the bottom of the tank to a depth of 30mm and proper compaction should be done. The first layer of reinforcement is placed directly on the surface of foundation layer and connected rigidly to the panel. Each 25mm depth should be backfilled and it should be compacted well and jute fibre mattress is placed as shone in fig 1, Flat metal plate is placed on the top of the surface as strip footing and at the centre of the strip footing loading cell is placed and static loading is applied and LVDT'S are placed as shone in fig 1, and load is applied and on the backfill and deflection of the retaining wall is observed and recorded using data logger referring to B.RamRathan Lal (2014) [13] and B. Ram Rathan Lal and J. N. Mandal (2014) [14].

VII. EXPERIMENTAL RESULTS

Test model is back filled with coal fly ash and it was compacted well, jute reinforcement is placed

May-June 2020
ISSN: 0193-4120 Page No. 6168 - 6173

to improve the load-bearing capacity of the backfill, strip footing is located above the backfill and load cell is placed above the strip footing and load is applied on the backfill through strip footing, load progressively increased to its ultimate load and deflections are recorded for increase in load for every 5kN. Table and column charts are prepared for easy and fast reading of results.

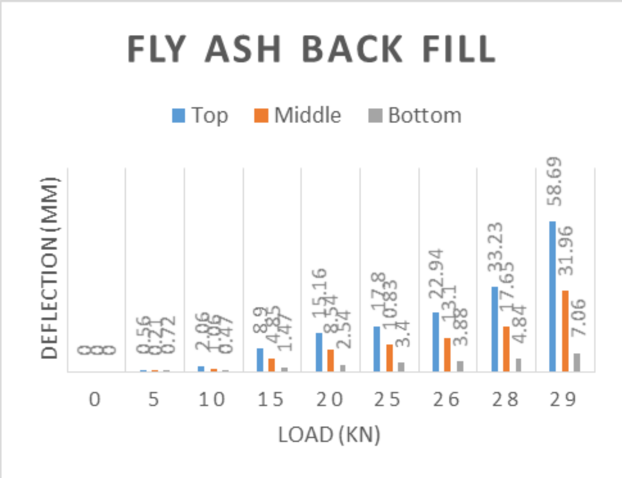

Fig no. 1 loads vs deflection graph for fly ash

Foundry sand is also used as backfill material for retaining wall and the test is carried out, Load is applied gradually as like as the previous test, load and deflection are recorded and the column chart is prepared.

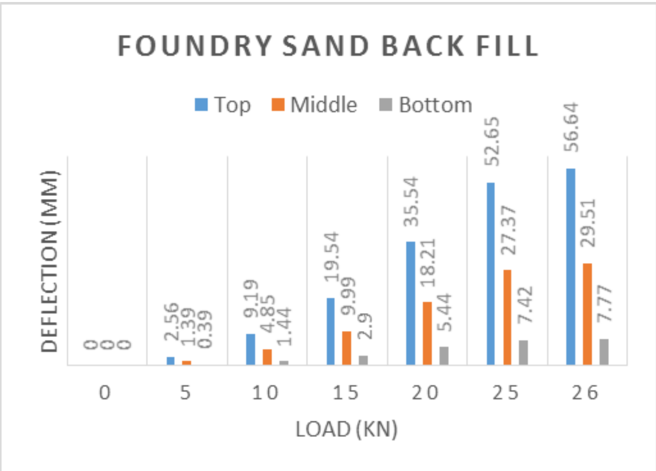

Fig no.2 load vs deflection graph for foundry sand

Crushed stone aggregate is used as the reference backfill material for retaining wall and the test is carried out, Load is applied gradually a like as the previous test, load and deflection are recorded and column chart is prepared.

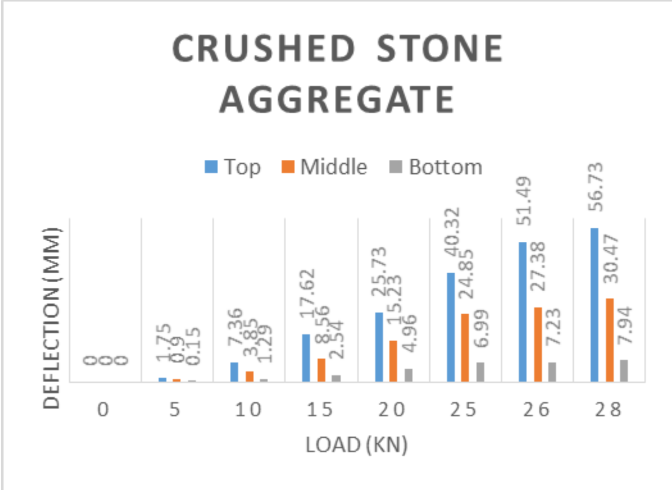

Fig no.3 load vs deflection for crushed stone aggregate

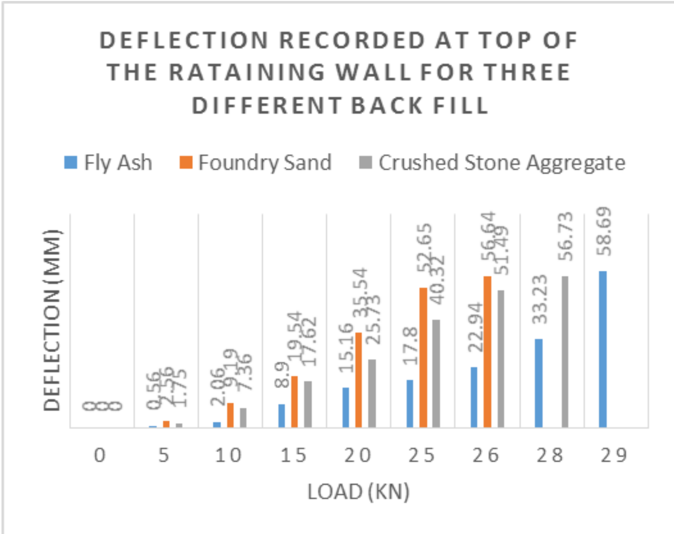

Fig no. 4 Comparing Fly ash, Foundry sand and crushed Stone Aggregate

Test has been carried out with three different materials they are Fly ash and Foundry sand, the first test is carried out with fly ash as backfill material with jute reinforcement this backfill withstands up to 29kN load and deflection of retaining wall at the top of the retaining wall is 58.69mm, at middle of the retaining wall is 31.96mm and at bottom of the wall is 7.06mm, this values are taken using LVDT'S and data logger.

The second test is carried out with foundry sand as backfill material with jute reinforcement this backfill withstand up to 26 kN load applied on the

May-June 2020
ISSN: 0193-4120 Page No. 6168 - 6173

backfill and deflection of retaining wall at top portion is 56.64mm, at middle of the retaining wall is 29.51mm and at the bottom of the retaining wall is 7.77mm, this values are taken using LVDT'S and data logger.

CONCLUSIONS

This study is carried out to find better alternative material for back-filling the retaining wall. The large quantity of fly ash and foundry sand can be removed only through geotechnical engineering application. Fly ash and foundry sand can be used as an alternative backfill material for the retaining wall, from the test results foundry sand and fly ash give approximately equal deflection and can withstand equal load when compared with crushed stone aggregate and can be used as the alternation material for retaining earth fill.

- For both foundry sand and fly ash max, deflection is at the top of the wall
- Displacement of the panel increases with increase in pressure
- Due to fines of fly ash deflection of the panel may be little greater than foundry sand
- Jute fibre mattress reinforcement helps to reduce the panel deflection in both foundry sand and fly ash
- Numerical analysis should be done as further work.

REFERENCES

1. Senapati,M. R. (2011).“Fly ash from thermal power plants—Waste management and overview .” Curr. Sci., 100(12), 1791–1794.
2. Kaniraj, S. R., and Gayathri, V. (2004). “Permeability and consolidation characteristics of compacted fly ash.” J. Energy Eng., 10.1061/(ASCE) 0733-9402(2004)130:1(18), 18–43.
3. Das, S. K., and Yudbhir, (2005). “Geotechnical characterization of some Indian fly ashes.” J. Mater. Civ. Eng., 10.1061/(ASCE)0899-1561 (2005)17:5(544), 544–552.
4. Bhattacharjee, U., and Kandpal, T.C. (2002). “Potential of fly ash utilisation in India.” International Journal of Energy, 27, 151–166.
5. Simonini, P., and Gottardi, G. (2003). “The viscoplastic behavior of a geogrid-reinforced model wall.” Geosynthetic International, 10(1), 34–46.
6. Shinde, A. and Mandal, J. N. (2007). “Behavior of reinforced soil retaining wall with limited fill zone.” International Journal of Geotechnical and Geological Engineering, 25(6), 657-672.
7. Ma, C.C., and Wu, J.T.H. (2004). “Field performance of an Independent Full Height Facing Reinforced Soil Wall.” Journal of Performance of Constructed Facilities,18(3), 165-172.
8. Hatami, K., and Bathurst, R. J. (2006). “Numerical model for reinforced soil segmental walls under surcharge loading.” Journal of Geotechnical and Geoenvironmental Engineering,132(6), 673-684.
9. Hazra, S. and Patra, N.R. (2008). “Performance of Counterfort Walls with reinforced granular and fly ash backfills: Experimental Investigation.” International journal of Geotechnical and Geological Engineering, 26, 25-267.
10. Zhang, M.X., Javad, A.A. & Min, X. (2006). “Triaxial tests of sand reinforced with 3D Inclusions.” International Journal of Geotextiles and Geomembranes, 24, 201-209.
11. Khedkar,M.S., and Mandal,J.N. (2009). “Behaviour of Cellular reinforced sand under triaxial
12. Khedkar,M.S., and Mandal,J.N. (2009). “Pullout behaviour of cellular reinforcement.” Geotextile and Geomembranes, 27, 262-271.
13. B.RamRathan Lal (2014) “Experimental and Finite Element Analysis of Geocell Reinforced Fly Ash Retaining Wall”
14. B. Ram Rathan Lal and J. N. Mandal (2014) “ Behavior of Cellular-Reinforced Fly-Ash Walls under Strip Loading.
15. Pathariya Saraswati C , Rana Jaykrushna K , Shah Palas A , Mehta Jay G ,Assistant Prof. Patel Ankit N (2013) “Application of Waste Foundry Sand for Evolution of Low-Cost Concrete” International Journal of Engineering Trends and

May-June 2020
ISSN: 0193-4120 Page No. 6168 - 6173

Technology (IJETT) – Volume 4 Issue 10 - Oct 2013

16. Rafat Siddique and Gurpreet Singh (2011) Utilization of waste foundry sand (WFS) in concrete manufacturing, Resources, Conservation and Recycling 55 pp 885– 892