JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STRENGTH AND COMPRESSIBILITY CHARACTERISTICS OF SILICO MANAGANESE SLAG

D.Jyothi Swarup[1], C.N.V. Satyanarayana Reddy[2]

Research Scholar[1], Department of Civil Engineering, College of Engineering, A.U.

Professor[2], Department of Civil Engineering, College of Engineering, A.U.

Abstract: Due to rapid growth in construction activities in the past two decades the availability of soil with desirable properties is gradually reduced. Soil is the basic construction material used widely in various civil engineering structures like embankments, Reinforced Earth Retaining Walls (RERW), in foundations of structures like buildings, trenches, etc. Granular soils are generally suitable for the fill material in embankments/Reinforced soil wall construction and as backfill of retaining wall. The main causes for granular soils being suitable as a fill material is its high strength, capability to vanish excess pore water pressures, ease of compaction and their immanent resistance to creep. Due to increased construction activities, the conventional fill materials like river sand and moorum are become scarce and costly day by day. In order to overcome this problem, alternative materials have to be explored. The present paper is aimed at assessing the suitability of Silico Manganese Slag as a fill / backfill material. Extensive laboratory investigations are carried out on SMS to evaluate its index and engineering properties. The strength and compressibility characteristics of Silico Manganese Slag indicated potential for use as fill / backfill material in civil engineering constructions.

1.Introduction:

Reinforced earth retaining walls are being widely used in various civil engineering structures due to their advantages of faster and low-cost construction. Soil is used as both fill and backfill material in reinforced earth retaining walls. Select soils are used in construction of embankments and as backfill of conventional retaining walls. Compressibility of fill material/ soil is required for predicting the settlements to ensure the serviceability of structures founded on a compressible soil layer. Due to the increase in cost of conventional fill materials, alternative cost-effective fill materials are to be explored. Recent research studies revealed suitability of several Industrial wastes/ by-products such as coal ashes, crusher dust, Granulated Blast Furnace slag and other marginal soils such as fine sand etc. () and enabled their usage in construction of structures such as embankments and reinforced earth retaining walls. So, in the present study silico manganese slag has been evaluated based on index and engineering properties for its suitability in civil engineering structures as construction material.

2.Literature Review:

Prasanna Kumar et. al., (2017), Veera Reddy and Satyanarayana Reddy (2007) have emphasized on the use of crusher dust by comparing the strength properties on concrete by the replacement of natural sand with crusher dust. The results have shown that crusher dust is a good alternative material for natural sand as fine aggregates and is an ideal material for concrete.

Reddy et. al., (2013) have studied the potential of rock flour for use as fill material in the construction of reinforced soil structures. Interfacial frictional characteristics of Rock Flours of different parent rocks with woven geotextiles were evaluated and it is reported that the mobilized angle of friction is above the angle of shearing resistance of rock flours.

Radhikesh, et. al., (2010) have published a parametric experimental study for producing paving blocks using crusher dust. They have looked into a few of the mechanical and physical characteristics of paving blocks that have different amounts of crusher dust in place of fine aggregate (sand). According to the test results, replacing fine aggregate with crusher dust up to 50% by weight has no discernible impact on the decrease of any physical or mechanical qualities while yielding a cost savings of 56%. Although the savings % was lower, it was still very helpful for the bulk production of paving blocks.

RaiBahadur Reang and Sujit Kumar Pal (2016) evaluated the Strength Behaviors Of The Clayey-Silt Soil Mixed With Fly Ash And Sand. Fly ash and sand have both been applied to the clayey-silt soil in various weight-to-dry-weight ratios of 10, 20, 30, 40, 50, and 60%. For the California bearing ratio (CBR) testing, modified Proctor compaction was used using soil-fly ash and soil-sand mixtures. Under modified Proctor compaction, the soil's CBR is discovered to be 54.50 percent unsoaked and 3.90 percent wet, respectively. At regular Proctor compaction, both fly ash and sand are added to the soil, increasing its shear strength.

Prasanty and Malaya (2016) investigated Shear Strength Behaviour of Sand-Tyre and Rock Quarry Dust-Tyre Waste Mixes. Shear strength of dry sand- waste tyre chips and rock quarry dust-waste tyre chips mixes at different dry unit weights and shearing rates were determined using small direct shear tests. Different Sand - Tyre and Quarry Dust -Tyre mixes, in the range 0 to 40% by the weight of tyre waste, were tested. The optimum tyre content for both the mixes was reported to be 30%. The shear strength of Quarry Dust - Tyre mixes, mixes was found to be relatively more than that of Sand - Tyre mixes.

Though the usage of waste materials such as Coal ashes, Silico Manganese slag, fine sand, etc., is recommended from the previous studies based on strength parameters, the research on compressibility of the materials is limited. Hence, in the present paper, an attempt is made to study the compressibility characteristics of silico manganese slag along with its strength characteristics.

3.Details of the Study:

3.1. Silico Manganese Slag

Silico Manganese Slag (SMS) is generated as a by-product at Ferro Alloy Industries. About 3.2 lakh tones of SMS is produced every year. Detailed laboratory instigations are carried out for geotechnical characterisation of SMS collected from Abhijit Ferro Tech, Achuthapuram, Visakhapatnam District. IS heavy compaction tests (IS 2720 part are conducted to determine OMC and MDD values of SMS. The strength and compressibility characteristics of SMS are determined by testing the specimens prepared at OMC-MDD state. To study the properties of SMS in saturated state, the specimens prepared in OMC-MDD state are saturated and the tested .

Table.1 Index Properties of Silico Manganese Slag

Property	Value
Specific Gravity	2.05
Grain Size Distribution	
a) Gravel (%)	0
b) Sand (%)	100
c) Fines (%)	0
d) D_{10} (mm)	0.90
e) D_{30} (mm)	1.70
f) D_{60} (mm)	2.90
g) C_u	3.23
h) C_c	1.1
Plasticity Characteristics	
a) Liquid Limit	NP
b) Plastic Limit	NP
Equivalent IS Classification	SP (Poorly Graded Sand)

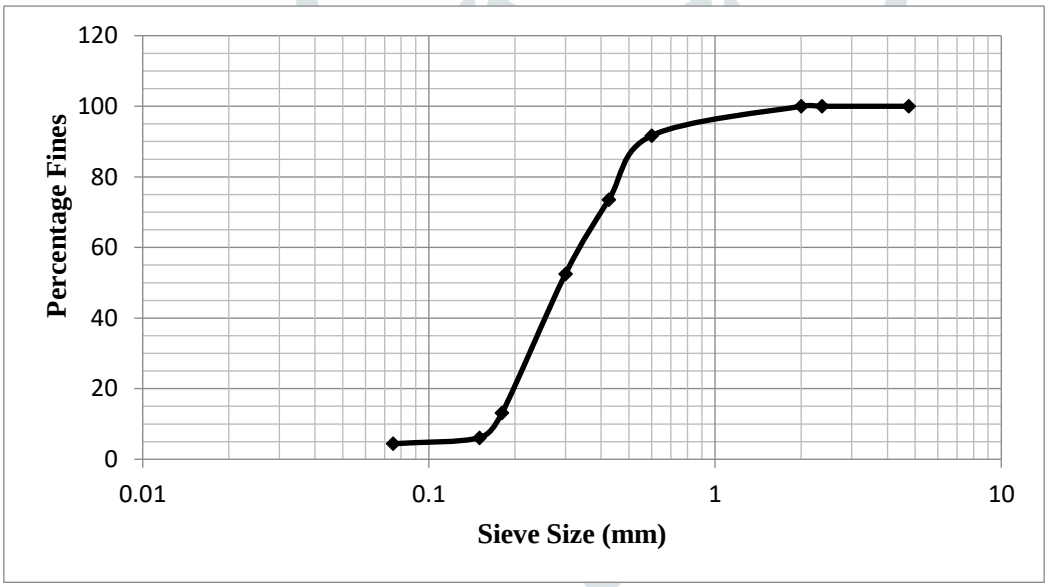

Figure.1. Grain Size Distribution of Silico Manganese Slag

Table 2. Engineering Properties of Silico Manganese Slag

Compaction Characteristics a) Optimum Moisture Content (%) b) Maximum Dry Density (g/cc)	 5.8 1.12
Shear Parameters a) OMC-MDD Condition b) Cohesion c) Shearing Resistance(ϕ) ii). Saturated Condition d) Cohesion e) Shearing Resistance(ϕ)	 0 44° 0 41°
CBR Value (%) i)Unsoaked Condition ii)Soaked Condition	 13.2 6.0
Coefficient of Permeability, k (m/s)	2.12×10^{-5}

Table .3.Coefficient of Consolidation of Silico Manganese Slag

Applied Pressure (kN/m^2)	**t_{90} (s)**	**C_V (m^2/s)**	**Avg.C_v(m^2/s)**
160	8.41	1.66×10^{-5}	
320	16	0.863×10^{-5}	0.98×10^{-5}
640	33.35	0.399×10^{-5}	

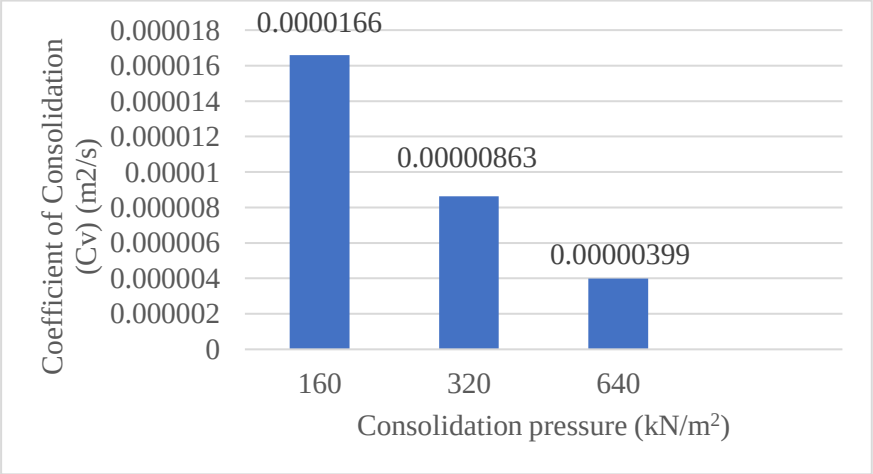

Figure.2. Variation of C_v with consolidation pressure for Silico Manganese Slag

Table.4. Compression Indices of Silico Manganese Slag

Compressibility State	C_c
OMC-MDD	0.09
Saturated	0.165

4.Results and Discussion:

4.1 Index Properties

From Table1, the gradation characteristics indicates that the SMS contains predominantly sand size particles. Hence, SMS is cohesionless and non-plastic in nature. Based on the C_u and C_c values determined from gradation curve (Fig. 1), it is classified in IS classification group as SP (Poorly Graded Sand).

4.2 Engineering Properties

From Engineering Properties of SMS presented in Table 2, the results indicate that the slag contains lower value of MDD (1.12g/cc) compared to the conventional fill materials (sand-1.8g/cc and Moorum-2.0g/cc). Further, SMS has higher value of shearing resistance (41°) in saturated state with no fines and it meets the requirements of frictional fill specified by Jones (1985). Hence, it may be used as fill material in construction of reinforced soil structures, particularly Reinforced earth retaining walls. The material is coarse grained with light weight and fair permeability (2.12×10^{-5}m/s) and so, it can be effectively used as back fill material behind the retaining structures. SMS possess soaked CBR value of 6% and hence, it can be used as fill material in construction of high embankments. Table 3 and Figure 4 indicate that the coefficient of consolidation is decreased with increase in consolidation pressure. Table 4 reveals that SMS has compression index (C_c) value in saturated state as 0.165, which is in the range of value of compression index of commonly used fill material of embankments, i.e low compressible clays (C_c= 0.14-0.23).

5.Conclusions:

Based on the experimental studies conducted on Silico Manganese Slag in the present work, the following conclusions are drawn.

- Silico Manganese Slag is light weight material compared to conventional fill material (Sand and Moorum) by about 35-45%. The light weight of the material is advantageous in construction of embankments on weak subgrades.
- Silico Manganese Slag is coarse grained material with no fines and has good frictional characteristics (ϕ= 41°) in saturated condition. Hence, it is suitable for use as backfill material in retaining structures and as fill in the construction of reinforced soil walls.
- Silico Manganese Slag is suitable for use in the construction of high embankments as it has soaked CBR of 6%. However, it need to be contained using moorum bunds on either side, as it is unbound material.
- The compression Index of Silico Manganese Slag (0.165) is in the range of compression index of commonly used embankment fill material, i.e., low compressible clay.

6.References`

1. Ashis Kumar Bera, Ashoke Das and Souvik Patra, " Influence of Granulated Blast Furnace Slag Contents on California Bearing Ratio Value of Clay GBFS Mixture", Proceedings of Indian Geotechnical Conference, December 15-17, (2016), Chennai.

2. Choi, S.G, Wang, K and Jian, C (2016) "Properties of Bio-cemented, Fiber Reinforced Sand", Construction and Building Materials, Vol. 120, pp 623-629.
3. IS : 2720- Relevant parts - Code of Practice for testing of soils, Bureau of Indian Standards, New Delhi.
4. Prasanty Borah and Malaya Chetia, "Shear Strength Behaviour of Sand-Tyre and Rock Quarry Dust-Tyre Waste Mixes", ", Proceedings of Indian Geotechnical Conference, December 15-17, (2016), Chennai.
5. Robinson, R. and Allam, M., "Determination of coefficient of Consolidation from early stage of Log t plot", Geotechnical testing Journal, Vol. 19, No. 3, 1996, pp. 316-320.
6. Yadu. L.K and Tripathi, R.K, " Stabilization of Soft Soil with Granulated Blast furnace Slag and Fly Ash,IJRET,volume 02, No.02
7. RaiBahadur Reang and Sujit Kumar Pal (2016), "Strength Behaviors Of The Clayey-Silt Soil Mixed With Fly Ash And Sand", Proceedings of Indian Geotechnical Conference, December 15-17, (2016), Chennai.