SOIL STABILIZATION BY FERROCHROME SLAG

A.ALEKHYA[1] GUNDEPUDI ABINAYA[2] PASULADI GAYATHRI[3] PILLI RAKSHITHA[4] THOGARU HARIKA[5]

[1]Assistant Professor Department of Civil Engineering, Anu Bose Institute of Technology, K.S.P.Road, Paloncha, Khammam Dist, 507115

[2, 3, 4, 5]Scholar, Department of civil engineering, Anu Bose Institute of Technology, K.S.P.Road, Paloncha, Khammam Dist, 507115

ABSTRACT Various efforts are being made to use the industrial wastes as an alternate construction material to conserve the natural resources and effective utilization of the industrial waste to sustain the industrialization. But limited attempts have been made to characterize Indian ferrochrome slag as a construction material. In today scenario, lack of stable ground for development of infrastructures is very common. In view of this, construction of buildings on unsuitable ground is unavoidable and making a suitable ground before constructions is real challenging issue for Engineers. To overcome the difficulties experienced with problematic soil in geotechnical applications on one side and safe disposal of solid wastes on the other side, an attempt is made in this investigation to explore the possibilities of utilizing solid wastes to improve the engineering behavior of problematic soil.

In this, in this present investigation the type of solid waste namely ferrochrome slag for stabilization is selected to study the effects of same on the index and engineering characteristics of soil. The ferrochrome slag is mixed with soil in various proportions like 0%, 5%, 10%, 15%, and 20%. The various tests were conducted on these proportions and optimized proportion is arrived.

KEY WORDS: Industrial wastes, constructions, ferrochrome slag, utilizing, engineering characteristics

I INTRODUCTION

Ferrochrome is the major chromium source for use as the main raw material for stainless steel production, and Ferrometals is one of the largest ferrochrome alloy producers in the world. Submerged-arc furnaces are most commonly utilised to smelt chromite ores by using suitable carbonaceous reductants such as coke, bituminous, char, etc. During the smelting process slag is created and metallic ferrochrome coalesces into droplets, which being the heavier phase, separate out of the slag by settling through the slag to the bottom of the furnace.

Ferrochrome slag consists mainly of Si02, Ah03 and MgO in different proportions but also smaller amounts of CaO, chromium and iron oxides, with significant quantities of chromium in the form of PAC and entrained alloy (Hayes, 2004). The amount of chromium in slag is much influenced by the slag composition, temperature and the tapping arrangement. The role of the slag in the process is thus essential and specific chemical, physical and mineralogical properties are required not only for process monitoring, but also for metallurgical accounting. For metallurgical accounting, utilization of the best practices available to obtain reliable (accurate and precise) data is essential, be it chemical, physical or mineralogical data. The reason for this is that mass balances are done to calculate the amounts of ferrochrome alloy and slag produced, based on the slag and alloy analysis.

The laboratory techniques for obtaining these data usually involve sampling and sample preparation processes, for which utilization of the best practices is also essential, such that errors introduced by these processes are kept at minimum levels. The techniques utilized should also allow rapid turnaround times so that any deviations in the process can be detected and rectified as soon as possible. At the moment good metal accounting practice at ferroalloy producers (using submerged-arc furnace technology) is seriously hampered by biases, poor representatively of samples and very slow information turnaround times, based on the laboratory practices (Bartlett, 2003).

Before the characterization techniques of slags are investigated, it is sensible to look at the production processes that produce these slags to obtain some understanding at the sources of the various slag components, and its physical and chemical behaviour.

Objective of the study

From this study the following objectives were made

1. To study the atterberg limits for soil by using ferrochrome slag.
2. To study the OMC and Maximum dry density for different proportions of ferrochrome slag.
3. To study the maximum strength of soil for different proportions of ferrochrome slag.
4. To calculate the UCS values for different proportions of ferrochrome slag.

II. LITERATURE STUDIE

Lind (2001) investigated that "leaching tests with salt seawater and PH adjusted water reveal low leachability from the slag for most elements. It was also reported that in road construction, there was a low migration of particles from the slag to the under lying soil and that the leaching from the Ferrochrome slag to the groundwater was low for the elements analyzed, with the exception of potassium.

Shao-peng *et al*., (2003) analyzed to use steel slag stone matrix aggregate (SMA) is usable as a concrete materials for design. This material was found to highly rigid and excellent friction resistance on the basis of its characteristics.

Tossavainen (2005) noted that the extraction of rock material and ore for construction and metal production involves large quantities of wastes and by-products such as iron and steel making slag has durability qualities and latent cementious properties which are positive in construction.

Nkohla (2006) investigated that the best practices for the characterization of ferrochrome smelter slag by following the robust and accurate analytical technique which is essential for process control, and he discussed its implications to the performance of the smelting process. Slag samples from a ferrochrome smelter were analysed using an XRF powder pellet an analytical technique in contrast to the ICP technique used at the plant laboratory, to determine their composition.

III MATERIAALS USED

Ferrochrome slag (FS)

The crude material in the generation of ferrochrome is chromite and iron oxides. The chromite is utilized as knotty minerals or fine focuses, which must be commonly agglomerated to make them useable charge for the heater. Fine concentrate is first ground and made into pellets in the sintering plant and afterward the pellets are sintered in the heater at a temperature of 1400°C. Various minerals like quartzite, bauxite, dolomite, corundum, lime and olivine are utilized as fluxing materials to get the correct piece of slag. The purified items got from the refining heaters are ferrochrome amalgam and slag. The slag generation is 1.1-1.6 t/t FeCr relying upon feed materials. In the present examination ferrochrome slag from Balasore Ferro Alloys Ltd., Somonathpur, was gathered.

Figure 1: Dumping yard of ferrochrome slag, Balasore Ferro Alloys Ltd.

Red Soil (RS)

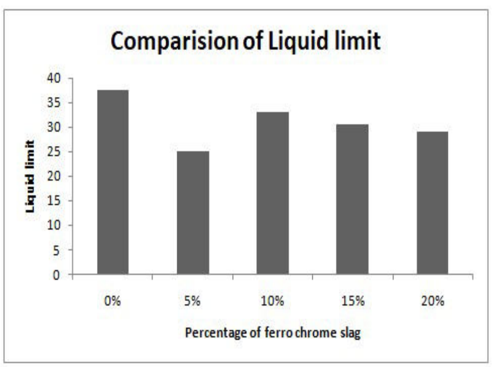
The red soil shown in Figure 3.6 is the red coloured fine grained residual soil collected from the shallow surface, which is not suitable for the construction of pavements. The red soil is used in the present study for comparison of properties as sub-grade soil to the ferrochrome slag and also characterization of stabilized red soil with ferrochrome slag as sub-grade soil for the construction of pavement.

Figure 2: Red soil

IV TESTS AND RESULTS

Liquid limit

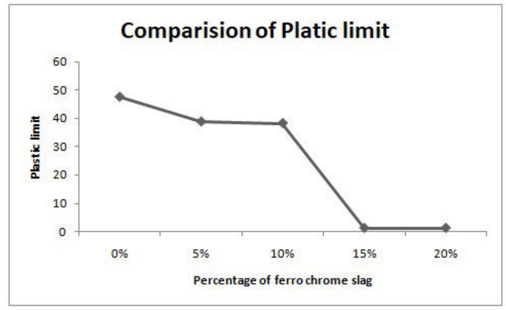
liquid limit is the water content where the dirt begins to act as a fluid. Liquid limit is estimated by putting a dirt example in a standard cup and making a partition (groove) utilizing a spatula. The cup is dropped till the partition evaporates. The water content of the dirt is gotten from this example.



Graph 1: Comparison of liquid limit results

Plastic limit

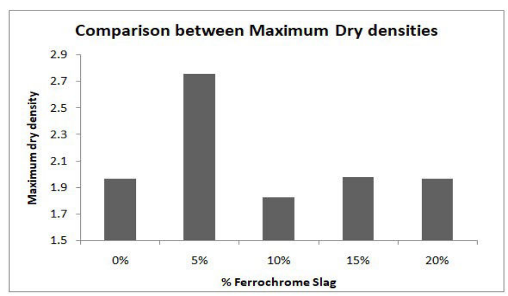
The plastic limit is the water content at which a dirt water glue changes from a semisolid to a plastic consistency as it is moved into a 3.175-mm (1/8-inch) distance across string in a standard test.



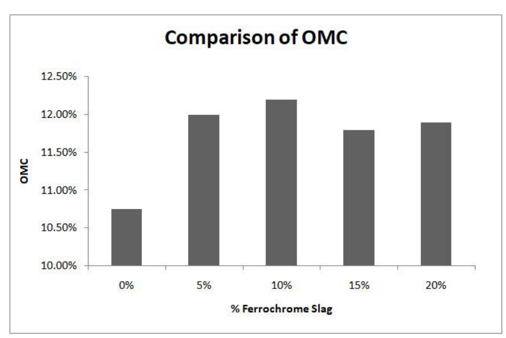
Graph 2: Comparison of Plastic limit results

Compaction test

A research center compacting method to decide the ideal water content at which a dirt can be compacted to yield the greatest thickness (dry unit weight). The technique includes setting (in a predefined way) a dirt example at a realized water content in a shape of given measurements, exposing it to a compactive exertion of controlled size, and deciding the subsequent unit weight (ASCE, 1958, term 74). The strategy is rehashed for different water substance adequate to build up a connection between water content and unit weight. The most extreme dry thickness for a given compactive exertion will as a rule produce an example whose immersed strength is close to greatest.



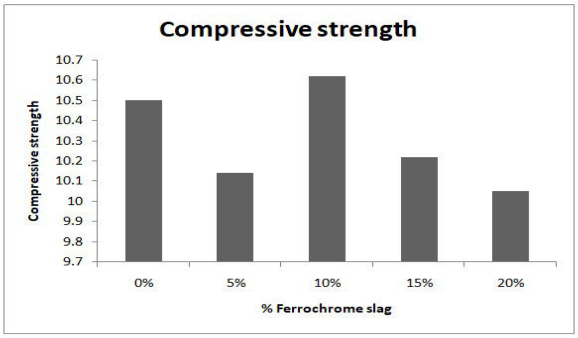
Graph 3: Comparison of Maximum dry density values



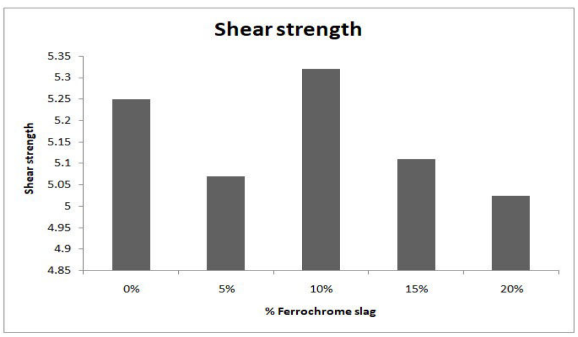
Graph 4: Comparison of OMC values

Unconfined compression Test

The Unconfined Compression Test is a lab test used to determine the Unconfirmed Compressive Strength (UCS) of a stone example. Unsubstantiated Compressive Strength (UCS) represents the most extreme pivotal compressive pressure that an example can endure under zero restricting pressure.



Graph 5: Comparison of compressive strength values



Graph 6: Comparison of shear strength values

V CONCLUSIONS

1. Ferrochrome Slag is used as an excellent soil stabilizing materials for highly active soils which undergo through frequent expansion and shrinkage.
2. The Ferrochrome Slag as an additive decreases the swelling, and increases the strength of the black cotton soil.
3. The material properties for black cotton soil like particle size distribution and specific gravity was observed as 3.2% and 2.61%
4. The maximum value of liquid limit was observed at 10% of Ferrochrome Slag as 33%
5. The higher value of water content was observed for 10% of Ferrochrome Slag in plastic limit test.
6. The maximum value of dry density was observed for 5% of Ferrochrome Slag.
7. The maximum value of optimum moisture content was observed for 10% of Ferrochrome Slag.
8. The maximum value of compressive strength was observed for 10% of Ferrochrome Slag and is less than when compared with 0% for black cotton soil.
9. The maximum value of shear strength was observed at 10% of Ferrochrome Slag is less when compared with 0% for black cotton soil.
10. Soil stabilization by using 10% of Ferrochrome Slag of cement is preferable black cotton soil.

REFERENCES

[1]. Aarathi Prasad and Sujatha Bai, K. (1999), “Lime reactivity in some Indian coal ashes”, Proc. Nat. Seminar on Fly Ash Characterization and its Geotechnical Applications, Bangalore, India, pp:15-20

[2]. Ali M. S. and Koranne S. S. (2011), “Performance Analysis of Expansive Soil Treated With Stone Dust and Fly Ash”, EJGE, Vol. 16, Bund. I, Page 972 – 982.

[3]. Balamurugan G. and Perumal P. (2013), “Behaviour of Concrete on the Use of Quarry Dust to Replace Sand – an Experimental Study”, IRACST – Engineering Science and Technology: An International Journal (ESTIJ), December, No. 6, Vol. 3, ISSN: 2250-3498.

[4]. Bhikshma V., Kishore R. and Raju N.H.M. (2010), “Flexural behaviour of high strength stone dust concrete”, Challenges, Opportunities and Solutions in Structural Engineering and Construction – Ghafoori (ed.), Taylor & Francis Group, London, ISBN 978-0-415-56809-8.

[5]. C. Rajasekhar(1995). “Retention and permeability characteristics of clays and clay fly ash systems subjected to flow of contaminants”, Ph.D. Thesis, Indian Istitute of Science, Bangolore.

[6]. Das, S. K., and Yudbir,(2005), “Geotechnical Characterization of some Indian Fly ashes”, Journal of Materials in Civil Engineering, ASCE,17(5), pp.544- 552.

[7]. Gray D. H.and Lin Y. K.(1972). “Engineering properties of compacted fly ash.” J. Soil Mech. Foundation Engng, ASCE, 98, 361–380.

[8]. Hart, B.R., Powell, M.A., Sahu, K.C., Tripathy, S. and Fyfe, W.S. (1991),"Mineralogic and element association of coals from the Gevra mine, Korba coal 60 | P a g e field, Madhya Pradesh, India", Proc. Inter. Conf. on Environmental Impact of Coal Utilization, IIT Bombay, India, pp:39-58.
[9]. Kapgate S. S. and Satone S. R. (2013), "Effect of Quarry Dust as Partial Replacement of Sand in Concrete", Indian Streams Research Journal, Vol. 3, Issue. 5, June, ISSN:-2230-7850.
[10]. Lind, B.B., Fallman, A-M and Larsson L.B., (2001). "Environmentai impacts of ferrochrome slag in road construction", Waste Management, 21; 255-264.
[11]. Miners, K., (1973), "Alcan's experience of the disposal of red mud from the Bayer ore process", Proc., 1st Int. Tailings Symposium, Miller Freeman, San Francisco, 553-562.
[12]. Pandian, N.S.(2004). "Fly ash characterization with reference to geotechnical applications." J.Indian Inst. Sci., 84, pp:189-216
[13]. Reuter, M., Xiao, Y., and Boin, U., (2004). "Recycling and environmental issues of metallurgical slags and salt fluxes", VII International Conference in South African Institute of Mining and Metallurgy.
[14]. Yilmaz, A., Karasahin, M., (2010). "Mechanical properties of ferrochromium slag in granular layers of flexible pavements, materials and structures", vol. 43: 309-317.