International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.10, October 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Review on Utilisation on Flyash, Copper Slag and Zinc Slag in Road Construction and Embankment

Sanyog Yadav[1], Jay veer2, Ranjesh Gupta[3], Praveen Yadav[4]

1Students, Department of Civil Engineering,

Noida Institute of Engineering and Technology, Greater Noida, India.

2Students, Department of Civil Engineering,

Noida Institute of Engineering and Technology, Greater Noida, India.

3Students, Department of Civil Engineering,

Noida Institute of Engineering and Technology, Greater Noida, India

4Students, Department of Civil Engineering,

Noida Institute of Engineering and Technology, Greater Noida, India.

ABSTRACT

The use of industrial wastes in various engineering projects has been trending in India. This is necessitated by the disposal problems associated with it. Fly ash, Copper slag and Zinc slag, are the most extensively used waste materials in the construction industry in recent times. Large quantities of these wastes are accumulated and dumped on costly land, causing wastage of good cultivable land. Mixing these wastes with existing soil type without completely removing and refilling with another soil type can be an alternative improvement technique to cement mixing, road construction, embankment filling and soil stabilization which are expensive. The use of fly ash in national highway road and embankment construction not only facilitate mass disposal of fly ash but also provide significant benefits in terms of engineering and economic consideration. In this paper, a review of the previous research studies carried out by various researchers on effective usage of Fly ash, Copper slag and Zinc slag are presented.

Key Words:* *Fly ash, Copper slag, Zinc slag, Road construction, Embankment, waste utilization, Economic consideration, properties.

I.INTRODUCTION

Fly ash is the waste material generated from the large number of thermal powerplant. There are 125 thermal power plants in our country, which currently produced about 170 million tons of fly ash of every year. The current worldwide production of fly ash is more than 700 million tons. With the increase in demand of power energy and coal being the major source of energy, more and more thermal power plants are expected to be commissioned in near future. As per estimates, fly ash generation is expected to increase to about 225 million tons by 2017. Copper slag are the industrial wastes with commercial value which improve some engineering characteristics of the soil such as strength, workability, texture and plasticity. The selection of type and determination of the percentage of additive to be used is dependent upon the classification and the degree of improvement in soil quality desired. Copper is one of the basic elements which is often used in construction and electrical industries. It is a by-product of copper extraction by smelting. Copper slag (CS) is a waste productwhich comes out from the smelting of copper. The process of extracting copper slag varies according to the type of ore and the purity of the final product. The unwanted materials are physically or chemically removed to get proper concentration of slag. Copper ore is mixed with powdered coke and sand which is heated at a high temperature in blast furnace. The furnace consists of steel plates lined inside with fire clay bricks. Hot air is introduced from the tuyerenearthe base of the furnace. The upper layer consists of slag and is removed while the lower layer is called matte which is a mixture of cuprous sulphide and unchanged ferrous sulphide.Copper slag The production of one ton of copper generates approximately 2-3 tonnes of copper slag.Utilization of copper slag in soil stabilization can solve a hazardous problem for environment. Copper slag is also widely accepted as embankment and structural fill material.

Zinc slag, a ferro-silicate slag, also referred to as ISF slag, is a by product generated during the primary smelting of zinc ore in a form of blast furnace. It is a granulated , glassy material and has the appearance of dark coloured sand .

1.1Fly ash- During the recent past, road transport has come to occupy a dominant role in the transportation system. Growth of road transport has been around 8 to 10 percent in respect of both freight and passenger traffic. Share of the freight traffic by road, has risen phenomenally from 11 percent in 1951 to about 60 percent at present. The total numberof automobiles on our roads has increased from 0.30 million in 1951 to about 27 million at present. The development of road network has not kept pace with it. Neglect of road network has led to a host of problems like congestion, delay and higher vehicle operating cost, accidents and environmental degradation. Resources provided, so the quality of our road network needs large scale improvement. The use of fly ash in National Highway Roads and embankment construction not only facilitate mass disposal of fly ash but also provide significant benefits in terms of Civil engineering and economic considerations. This Project report emphasis on the proper Management of fly ash in the Construction of National Highway Projects.

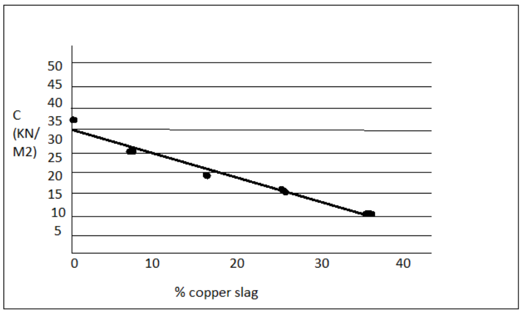
Fig:1 fly ash

IJARSE
ISSN: 2319-8354

1.2 Copper Slag: Copper slag (CS) is a waste product which comes out from the smelting of copper. The process of extracting copper slag varies according to the type of ore and the purity of the final product. The unwanted materials are physically or chemically removed to get proper concentration of slag. Copper ore is mixed with powdered coke and sand which is heated at a high temperature in blast furnace. The furnace consists of steel plates lined inside with fire clay bricks. Hot air is introduced from the tuyers near the base of the furnace. The upper layer consists of slag and is removed while the lower layer is called matte which is a mixture of cuprous sulphide and unchanged ferrous sulphide.

Fig:2 Copper slag

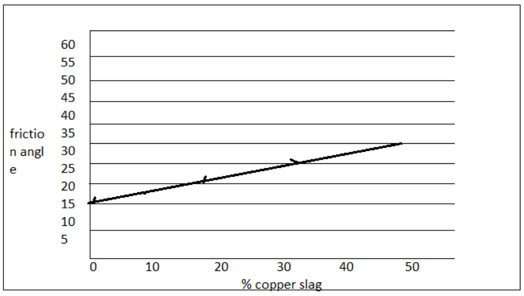
The production of one ton of copper generates approximately 2-3 tonnes of copper slag. Utilization of copper slag in soil stabilization can solve a hazardous problem for environment. Copper slag is also widely accepted as embankment and structural fill material.



cohession intercept v/s % copper slag

lf it is assumed that a linear relationship between shear stress and normal stress exists, the effect of percentage of copppcr slag on the cohesion intercept C and on the angle of internal friction C) is shown on Figure 9 and Figure IO. The data trend in Figure 9 shows a decrease in C with increase in the percentage of copper slag consistent with respect to natural materials. On the other hand the results shown in Figure l0 indicate an increase in O with the percentage of copper slag. Although the amount of friction angle is obtained in this manner is not an indication of the mineralogy of the material, when the data is plotted against the liquid limit WL, as shown in the Figure 11, a general decrease in Q) with WL is observed.

International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.10, October 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354



1.3 Zinc slag:Having no major application, zinc slag generated during imperial smelting process (ISP) all over the world is simply dumped. Some occasional research attempts, seen in the literature, are limited to its use as a replacement for aggregates in construction related applications. This study is a part of our activities towards complete utilization of slag for building material applications using geo polymerization process, which involves formation of a new rock like species from various aluminosilicate minerals under strong alkaline environment,This slag has been subjected to short grinding in a high-energy AG0-2 mill to enhance its reactivity. The paper particularly focuses on the influence of the grinding atmosphere, viz. air or CO2 on the geopolymers prepared from milled slag. Studies have shown that the particulate characteristics mostly remain unaffected by the milling atmosphere. However, conduction calorimetric experiments have shown that the milling atmosphere has a bearing on the reactivity of slag despite their similarityin particulate, characterstics, CO2_milled slag has been found to e more reactive than air milled slag. Both air and CO2 milled slag has been found good geopolymerization behaviour leading to high compressive strength of the geopolymer product;

Higher compressive strength value for the geoplymer prepared from the later further shows its enhance reactivity over the former .

II.LITERATURE REVIEW:

Chatterjee,(2011) reported that about 50% of fly ash generated is utilised with present efforts. He also reported that, one may achieve up to 70 replacement of cement with fly ash when high strength cement and very high reactive fly ash is used along with thesulphonatednaphthalene formaldehyde superplasticizer. He reported improvement in fly ash property could be achieved by grinding and getting particles in submicrocrystalline range.

Subramaniam, Gromotka , Shah, Obla Hill, (2005) investigated the influence of ultrafine fly ash on the early age property development, shrinkage and shrinkage cracking potential of concrete. In addition, the performance of ultrafine fly ash as cement replacement was compared with that of silica fume. The mechanisms responsible for an increase of the early age stress due to restrained shrinkage were assessed', free shrinkage and elastic modulus were measured from an early age. In addition, the materials resistance to tensile fracture and increase in strength were also determined as a function of age . comparing all the test results authors indicated the benefits of using ultrafine fly in reducing shrinkage strains and decreasing the potential for restraint shrinkage cracking.

The effect of copper slag can be seen by replacing a part of the cement in concrete. The study conducted by CRRI, New Delhi showed that fine sand with copper slag upto 40 can be used as fine aggregate in pavement quality concrete as well as in dry lean concrete 4.Copper slag mixed with fly ash and clayey soil produces effective results in different proportions with suitability in embankment, sub-base and base of a road pavement 5. Copper slag, when mixed with locally available soil in a proportion of 30 CS and 70 of soil, the plasticity index of the soil was reduced by 40 6. The physical properties of copper slag as obtained from Birla Copper Unit, Hindalco's Industries Ltd, Gujarat India is shown in the table-l.

III.EXPERIMENTAL WORK:

Table 1. Physical properties of copper slag

copper slag is a blackish material similar to the coarse sand as shown in figure.2above .

Property	Value
Specific gravity	3.51
Plasticity index	Non-plastic
Swelling index	Non-selling
Hardness, mohr'sscale 6-7	
Granular shape	Angular, sharp edges

Gravel %	1.00
Sand %	98.9
Silt + clay	0.05
Colour	Black

The siliceous and silica-aluminous substances available in copper slag are considered pozzolanic. They react chemically with calcium hydroxide in the presence of water at normal temperature to form cementitious products in the form of a gel. Further addition of copper slag to lime or cement form calcium-alumina-silicates which have excellent binding characteristics 71.A number of studies have been carried out in India as well as abroad to study the impact of copper slag and silica fume as partial replacements of cement and soil stabilizers and the results are encouraging.

carried out life-cycle analysis for the use of industrial waste slag in the construction of road which yielded effective conclusions for the reuse of waste by-products Improved soil with 35 Cu slag can be used as a subgrade material and the tensile and compressive characteristics can be improved substantially. The California Bearing Ratio (CBR) value can be increased by more than 50 %.

Copper slag is also used as a replacement forsand in sand drains and sand piles. Mixing of copper slag with expansive soil has a good potential and economical 10. Studies show that the behaviour of copperslag is similar to that of medium sands and can be used as construction material in place of sands, such as backfill of retaining walls and landfill for the construction of shallow foundations. The chemical composition of copper slag is shown in table-2.

Table 2: Chemical composition of copper slag

Iron oxide	42-48
Silica	26-30
Aluminium oxide	1-3
Magnesium oxide	0.8-1.5

IV.TEST AND OBSERVATION:

Leach testing

It was considered impractical to undertake meaningful in-situ leach tests on the trial road sections due to contamination at the BZL site. Assessment of leaching therefore focused on leach testing in the laboratory of the concrete used in the road sections. Leach testing on cores cubes Leach testing (using the draft method developed by CENTC292WG2 4 for leaching of monolithic wastes) on cores (from the demonstration concrete roadway) and site-compacted cubes at 7 days age, showed the following resuts.

1. Levels of lead (Ph) were below the detection limits in both control and ISF samples (equiv to 0.004 mg/kg)

2. Levels of arsenic (As) leached from all specimens were negligible and were similar for control and ISF samples.

3.Levels of zinc (Zn) were highest for ISF core sample. Levels leached from cubes were negligible and were similar for control and ISF samples

Leach testing of crushed material

One potential concern with concretes made with secondary aggregates can be the potential for leaching when the concrete is crushed and recycled. This was addressed by assessing leachability from crushed material

Concrete cubes made from the demonstration phase concretes (ISF and control concrete) have been crushed and duplicate samples sent for Leachate Availability Test (LAT) compliance test to BSEN 12457-3:2002 5. Results are as follows:

The amounts of zinc and arsenic reached from the ISF concrete were comparable to those from the control mixes.

The amount of lead leached from the crushed ISF concrete is greater than that leached from the unbound ISF slag itself. This is due to the enhanced solubility of lead under alkaline conditions. However, this situation is expected to Improve as the concretein the road ages and becomes less alkaline.

Slags from primary and secondary production of zinc (such as ISF slag) are classified as hazardous waste in the European waste catalogue. This means that leaching test evidence would need to be presented to the Environment Agency (EA) before their wider adoption as aggregates and any exemptions from waste management requirements could be considered on a local basis. Exemptions from waste management regulations are likely to be more

Environmental regulatory issues

Laboratory leach testing of high quality ISF slag concrete with landfill acceptance tests has provided evidence that contaminants within the ISF slag arc effectively bound up when three slag is used as an aggregate in concrete. Furthermore, a properly designed and co structed road will in fact minimise water ingress and percolation through its structure. Both these facts provide re-assurance that contaminants in the ISF slag would be effectively immobilised in the matrix of a concrete road structure in since.

At the end of its life, the road would be suitable for crushing to produce recycled aggregate for new construction. One remaining concern could be disposal of the road materiaI to landfill. Assessment of the crushed concrete material (made with ISF slag) against landfill acceptance criteria for granular waste has indicated that levels of lead Ieached from crushed concrete containing ISF slag exceeds the limits for inert waste. However, it is most likeIy that in fact the road material would be recycled.

3.1 CONCLUSION

1.1 Fly ash concrete is most important building material for the sustainable construction and consumption of large volumes of fly ash. Literature discussed in the present paper has given an overview of advantages of fly ash concrete to increase workability and durability of concrete.

1.2 The literature surveyed has also listed the slower strength gain at early ages as major problem in making fly ash concrete very popular in the Indian construction industry which is only focused on short term strength gain.

1.3 A detailed mix design procedure along with conformation of results for designing fly ash concrete to achieve required strength at 28 days is needed. It is must to shift contractors focus on economical and durable fly ash concrete even if higher days of curing are required.

1. Copper Slag has the potential to use as admixture to improve the properties of problematic soils.

2. Copper slag is recommended for sub grade, sub-base and bitumen mixes. O 9001:2008 Certified Journal Page 1837.

3. Utilizing and reusing the industrial waste products like copper slag and silica fume, the wastage of good cultivable land can be avoided.

4. Soil stabilized by silica fume and copper slag can be used for backfilling retaining walls and embankments.

Having no major application, zinc slag generated during imperial smelting process (ISP) all over the world is simply dumped. Some occasional research attempts, seen in the literature, are limited to its use as a replacement for aggregates in construction related applications. This study is a part of our activities towards complete utilization of slag for building material applications using geo polymerization process, which involves formation of a new rock like species from various aluminosilicate minerals under strong alkaline environmentThis slag has been subjected to short grinding in a high-energy AG0-2 mill to enhance its reactivity.

REFERENCE

1. C. Lavanya. A. Sreerama Rao and N.Darga Kumar, " A Review on utilization of Copper Slag in Geotechnical Applications", Kochi.
2. Chhaya Negi, R.K. Yadav and A.K. Singhai. " Effect of Silica fume on Index Properties of Black Cotton Soil" (2013) .

3. Vasant G.Havanagi. Sudhir Mathur, P.S. Prasad, C. Kamaraj, "Feasibility of Copper Slag- Fly ash- Soil mix as a Road Construction Material", CRRI, Delhi
4. . Sh. Binod Kumar. "Utilization of Copper Slag as Fine Aggregate in Cement Concrete", CRRI, Delhi.
5. TandelYagendra. K., "Utilization of Copper Slag as a subgrade", Srilanka..
6. Chu.S.C and Kao.H.S. (1993): A Study of Engineering Properties of a Clay Modified hy Fly ash and CappLr Slag". ProceedingS, Flyash for soil improvement. American Society of Civil E ngineers. Geotechnical SpL'cial Edition, No.36, pp 89-99.
7. Mrouch.U.M., Laine-YlijokiJ "Life-Cycle Jmpacts "f the use of Industrial By-products in Road and Earth Construction".
8. U.P. Nawagamuwa and H.K.P. Madushanka "Ground Jmprovement with Waste Copper Slag".
9. Jegandan.S, Liska.M and Osman A, "Sustainable Binders for Soil Stabilisation" Proceedings of the ICE-Ground Improvement163(l):pp.53-61.