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# A REVIEW ON ASSESSMENT OF LIME STABILIZED SLAG FLY ASH MIXES FOR HIGHWAY MATERIAL

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***ABSTRACT: - In this paper is mainly study to enhance the inherent strength of wastes like fly ash and crushed blast furnace slag (CBFS) from the different survey. This will automatically reduce the use of natural soil in addition to mitigate the disposal problems of industrial solid wastes in a great way. Fly ash and blast furnace slag was collected from Rourkela steel plant (RSP). The motive of the paper is to utilize the industrial wastes like slag and fly ash instead of natural soil and aggregates for the highway construction after stabilizing the slag- fly ash mixes with lime. Tests were conducted by blending fly ash and blast furnace slag in different proportions. The compaction characteristics, strength properties and the bearing value of different mixes are determined. From the compaction tests the optimum moisture content and the maximum dry density are determined for respective mixes. The strength parameters that are the unconfined compressive strength and CBR value for different mixes compacted to their respective MDD at OMC are evaluated. Aswell as we will determine the California Bearing Ratio test of the lime stabilized slag- fly ash mixes for Soaked and Unsoaked Condition at 0 and 28 days of curing. Accessing the suitability of above stabilized mixtures for different components of pavement So it is concluded that appropriate blending of fly ash with slag gives a better strength compared to individual materials. Further the desired strength required for different component of road can be achieved by stabilizing the mix with appropriate amount of lime.***

## I. INTRODUCTION

Conventionally road pavements are constructed using soil, aggregates and binder. Aggregates form major portion of the total volume of pavement structure and is the primary mineral material used in road construction. Large volumes of aggregates are consumed by the road building programme and similar quantities are used in maintenance works. It is estimated that construction of one cubic meter of Water Bound Macadam (WBM) involves use of about 1 .2 to 1 .4 cubic meter of aggregates, and laying of bituminous pavements involve even higher quantities. The aggregate extraction from natural rocks results into a lot of noise, dust, impacting vibrations, hazards, etc. Such ecological effects are creating worry in many parts of the nation. Unplanned exploitation of natural rock mass may sometimes lead to landslides of weak and steep hill slopes.

In addition to aggregates and binder, tremendous amounts of soil are likewise required for development of roadway, highway and embankments Loss of valuable topsoil in this procedure renders the agricultural lands unfit for cultivation. Research and development studies ponders and fruitful field exhibit ventures have demonstrated that industrial waste like fly ash, iron and steel industry slags, rice husk, marble slurry dust, etc. can be used for roadway construction. While using such materials, the construction procedure would be broadly similar to construction of roads using conventional materials.
The fly ash used was collected from the Rourkela steel plant and blast furnace slag from the slag crusher unit of Rourkela steel plant. The geotechnical properties of fly ash and blast furnace slag were then evaluated by conducting various laboratory experiments. Specific gravity test was conducted for various fly ash- blast furnace slag mixes. Modified Proctor test was also performed for evaluating the optimum moisture content (OMC) and maximum dry density (MDD) of fly ash-slag mixes. Lime stabilized samples were obtained for slag-fly ash mixes by enhancing the lime percentage (0%, 2%, 4%, and 8%). These stabilized samples were then subjected to unconfined compressive strength test following 0, 7 and 28 days of curing and California bearing ratio test for soaked and unsoaked conditions following 0 and 28 days of curing.

## II. LITERATURE REVIEW

Fly ash is a byproduct generated from the thermal power plants. The main issue with fly ash is its disposal which possesses huge economic loss to the power plants. Thus, a special consideration is required for the utilization of fly ash in highway, embankment constructions as a replacement to conventional natural materials. Blast furnace slag is formed as a co product in the process of iron production. The utilization of blast furnace slag in geotechnical constructions needs a study. Lime is produced by calcination of limestone in a lime kiln at temperatures above 1000°C

### AN OVERVIEW OF A PAVEMENT LAYER

The various layers in a pavement generally consist of sub grade, sub base course, base course, and surface course. The sub grade consists of existing soil, which should be clean and free from organic matter. Moreover, the CBR value should not be less than 25%. The sub base course layer is made up of granular material and is an optional layer if the sub grade is of good quality. The CBR value for this layer lies between 20-30%. The base course lies just below the wearing course, hence quality of the material used should be highlighted. The CBR values of this layer lies between 80-100 %. However, depending upon the expected traffic the strength of these layers may vary.

  


Figure 2.1 Different pavement layers

ENGINEERING PROPERTIES ON COMPACTED/STABILIZED FLY ASH

Lav (2000) carried out an analysis considering the microstructural, chemical, mineralogical, and thermal properties of fly ash, to use as a pavement base material. For this work the fly ash was stabilized separately for cement and lime. The effects of lime and cement stabilization were studied. The results obtained from the lime and cement stabilized samples showed that for both types of stabilizing agents the hydration products are same that accounts for strength gain.

Pandian and Krishna (2002) made a study on the CBR behavior of cement stabilized soil fly ash mixes and obtained the suitability for use as road sub-base. The CBRs corresponding to the two optimum levels are 24.7% and 33% after 28 days of curing with 3% cement, which was significant for field application. A minimum CBR of 20% was recommended for use in the sub base layer for road pavement. Hence in the present work the cement content has been restricted to 3%.

Fernandez et al. (2004) conducted a microscopic study on a set of fly ash samples which are activated by an alkali and thermally cured. The morphology of fly ash particles was studied that can be applied to physical life situation. The fly ash was thoroughly mixed with alkaline activators and the paste was allowed to solidify by curing. The results show that with time the degree of reaction is increasing continuously.
Lav et al. (2005) studied on the utilization of class F fly ash as a base material in road pavements. In this work only aggregate, fly ash and cement were used as the main motive is to use the waste material. In this study, cement content was varied (2%, 4%, 8%, 10%) to prepare samples. The test results obtained from the tests were then incorporated into pavement study.

Ghosh and Subbarao (2006) investigated the suitability of lime/gypsum stabilized fly ash as a roadway material. In this study unconfined compressive strength, bearing ratio, tensile strength and slake durability test were conducted. The effect of lime content, gypsum content and curing period on the above characteristics was highlighted. From this study, it can be said that stabilized class F fly ash has a potential for providing a strong road base.

Bera et al. (2008) carried out unconfined compressive strength test on both unreinforced fly ash and reinforced fly ash with jute geotextiles. The effect of degree of saturation, size of the sample, number of jute geotextile layers and age of the sample on UCS has been investigated.
Nassarr et al. (2013) studied the effect of high volume fly ash on pavement construction. From the study it was found that the fly ash in pavement can be used as partial replacement for cement due to enhanced durability characteristic.
Pal and Rajak (2015) investigated the CBR values of soil mixed with fly ash and lime in different percentages. Soil was mixed with lime at 5%, 8%, 10% and 12% and with fly ash at 10%, 20%, 30% and 40% to enhance its CBR values. The optimum moisture content increases and dry density decreases with increase in fly ash and lime percentage due to the variation in clay and silt size particle. Addition of fly ash and lime enhanced the Unsoaked CBR value of the soil

ENGINEERING PROPERTIES ON COMPACTED/STABILIZED SLAG

Wild et al. (1998) focused on the use of granulated ground blast furnace slag for highway and other different foundation layers by evaluating the beneficial effect on strength by substituting GGBS for lime in lime-stabilized clay soils, particularly in the presence of gypsum. The result shows that there is improvement in strength by the addition of lime with GGBS and the content of lime and slag is to be maintained for required bearing capacity and strength.

Behiry (2012) evaluated the effect of quality of steel slag on mechanical properties of mixes with crushed limestone aggregates, which was used as sub base material. The results show that by increasing the steel slag percentage to the limestone in the blended mix increases the mechanical properties such as maximum dry density, California Bearing Ratio and resilient modulus. The best density and strength for the layer with the least construction costs obtained at a blended mix of 70% steel slag percentage to 30% limestone.

Bhattacharyya (2012) made a study on use of Blast Furnace Slag in sub base/base layer of pavement. Test was conducted for suitability of slag in pavement layers. Various field studies of BFS layers after laying and after compaction were made analyzed. From the analysis it was obtained that cumulative % retained decreases. It was concluded that the material was very useful alternative of stone material in GSB layer.

Sinha et al. (2013) focused on the geotechnical characteristics of slag design. The stability analysis of embankment, sub-grade and sub base layers and suitability of slag in bituminous layers were highlighted. In this study the utilization of slag in different layer of roads was carried out. From the study it was observed that slag can be used for embankment construction and for sub grade, but not suitable for bituminous layers.

Yadu and Tripathi (2013) focused on the effectiveness of granulated blast furnace slag in improving the engineering behavior of soft soil(CI-MI). Different proportions of GBS such as 3%,6%,9% and 12%was combined with the soil and CBR as well as UCS test was conducted and it was obtained that 9% GBS is optimum for improving strength.

  

ENGINEERING PROPERTIES OF COMPACTED/STABILIZED FLY ASH- SLAG MIXES

Puertas et al. (2000) carried out a study on activation of fly ash / slag pastes with NaOH solution. The effect of curing temperature, activator concentration and fly ash slag
ratios were studied. From the study it was observed that with increase in slag content, the compressive strength also increases. Moreover, the curing temperature has a positive trend at initial days, and at longer days the effect is reversed. It was observed that at a curing temperature of 25°C the strength attained was higher.

Singh and Ramaswamy (2005) conducted a study to assess the suitability of cement stabilized fly ash- granulated blast furnace slag(GBFS) mixes for its use as embankment, base and sub- base courses of highway pavement. The compaction characteristics, unconfined compressive strength and CBR value of the stabilized fly ash- GBFS mixes were evaluated . In the study cement content was varied from 0 to 8 percent at 2 % interval, whereas slag content was varied from 0 to 10, 20, 30 and 40 % respectively. From the compaction test it was studied that the mixes show an increase in MDD. Moreover, the UCS and CBR values of compacted mixes depend, to a large extent, on the cement content.

Shen et al. (2009) evaluated the properties of steel slag, fly ash and phosphogypsum for utilization as a road base material. The strength characteristics, resilience modulus and splitting strength were studied. It was observed that the early strength was higher than that of lime- fly ash and lime- soil mixes and also the long term strength was much higher than the cement stabilized materials. Thus it has a potential to be a good road base material.

Singh et al. (2008) studied on cement stabilized fly ash–(GBFS) mixes for suitability in road embankments and in pavement layers. For this study compaction test, unconfined compressive strength (UCS) test and California Bearing Ratio (CBR) test were conducted by varying the cement content and slag content. The test results shows that with increase in cement and slag content the MDD of the mixes increases and OMC decreases. Similarly the CBR values were also on increasing trend with addition of cement and slag. Thus, the mixes can suitably use in base and sub- base courses.

Deb et al. (2014) studied the effect on the strength development of geopolymer with the addition of ground granulated blast-furnace slag (GGBFS) with class F fly- ash when cured in ambient temperature. Here, GGBFS was mixed in increasing percentage of 0%, 10% and 20% of the total binder with variable activator content of 35 and 40%. From the study, it was seen that there is increase in strength and decrease in workability with higher GGBFS values.

Gao et al. (2015) investigated the effects of the raw materials on the workability, setting times, reaction kinetics, gel characteristics and compressive strength of cured alkali activated slag, fly ash and limestone mixes. From the study it was observed that slump flow increases with fly ash content and the setting time was reduced with increase in slag content.

Sharma and Sivapullaiah (2016) investigated the effect of the joint activation of fly ash, and ground granulated blast-furnace slag, on the unconfined compressive strength of mixtures of the two materials. The strength was found to increase with slag content. However, the specimens consisting of 30 and 40% of slag and cured for 28 d showed higher strength than the individual materials. Moreover, the effect of different percentages of lime on the strength of the fly ash–slag mixtures was investigated. Tremendous increase in strength was observed with the addition of even 2% of lime. This study suggests that properly designed combinations of fly ash–slag–lime can be used as construction materials for infrastructure projects such as structural fills or subgrade and sub-base courses in pavements without requiring large quantitities.

## III. CONCLUSION

It is concluded from the above discussion that there is need to incorporate the above mentioned without
limitations to specific uses of fly ash stabilization. Literature discussed in the present paper has given an overview of advantages of Fly ash is mostly well graded material within its size range having specific gravity lower than that of slag. The literature surveyed has also listed that the desired lime stabilized fly ash- slag mix will be a promising material in reducing the use of natural soil in addition to mitigate the disposal problems of industrial solid wastes in a greater way and can be successfully utilized in base and sub- base courses of highway pavement.

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