CHAPTER II

LITERATURE REVIEW

2.1 Granulated Blast Furnace Slag (GBFS) Performance

The utilization of industrial by-products from the steel-making industry like ground granulated blast furnace slag which is a byproduct of burning pulverized coal in electric generation power plants has been established in a number of applications in the civil engineering industry. Review from the past research, Jafer et al (2015), showed that the use of the waste and by-product materials for soil stabilization can help mitigate the issues of disposal and environmental pollution.

Granulated blast furnace slag is most suitable for increasing the strength of the soil. One of the study was done by Kumar (2014). In the study, the blast furnace slag was used as replacement of coarse aggregate on subbase layer, and also used modified red soil as a filler material.

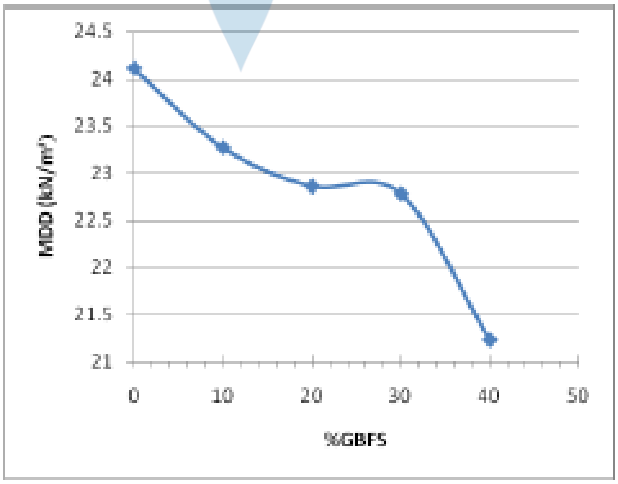

Fig. 2.1 Max Dry Density for Various (%) GBFS
Source: Kumar, 2014.

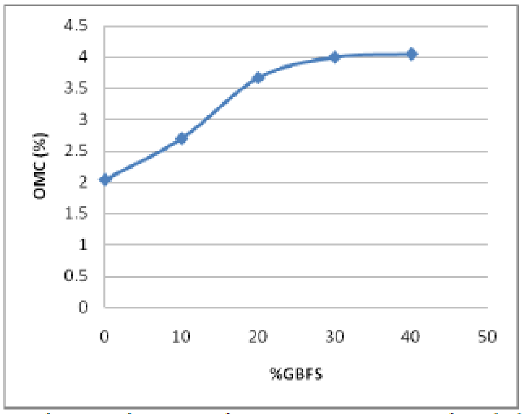

Fig. 2.2 Optimum Moisture Content for Various (%) GBFS
Source: Kumar, 2014.

The test was done using 5 varieties of blast furnace slag percentage as an aggregate replacement, starting from 0%, 10%, 20%, 30%, and 40%. Natural aggregate stand as the highest maximum dry density (MDD) and the lowest optimum moisture content (OMC). Based on the replacement of GBFS, the maximum dry density (MDD) is considerably decreasing with increase of GBFS proportion (Fig. 2.1) and the optimum moisture content (OMC) is increasing with increase of GBFS proportion (Fig. 2.2). This is caused by GBFS lower specific gravity compared to natural aggregate's specific gravity.

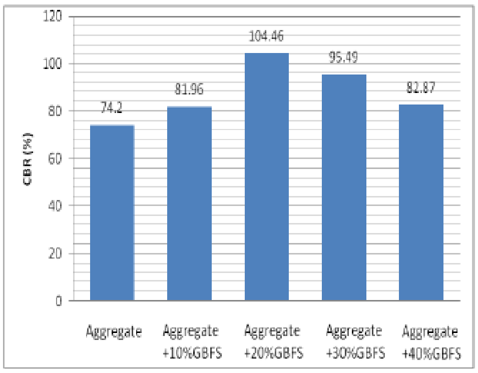

Fig. 2.3 Unsoaked CBR Values for Each Subbase Material
Source: Kumar, 2014.

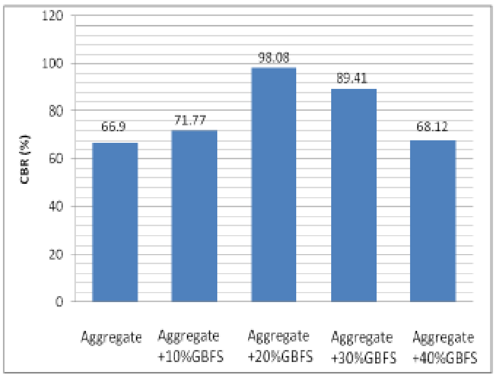

Fig. 2.4 4-Day Soaked CBR Values for Each Percentage of Subbase Material
Source: Kumar, 2014.

While Fig.2.3 and Fig. 2.4 show the strength of the subbase mixture. CBR test was carried out in unsoaked and 4-day soaked condition. From the graphs from CBR test, it could be concluded that the maximum CBR value is obtained up to 20% replacement of GBFS for both conditions. After 20% replacement, the addition of GBFS will decrease the CBR value in both conditions. For unsoaked condition, the CBR value was increased up to 40,78% and for the 4-day soaked condition up to 46,60%. The increase of CBR values is caused by cementitious properties possessed by GBFS.

2.2 <u>Correlation between DCP – CBR Value</u>

The dynamic cone penetrometer (DCP) has been widely used for estimating the strength of soils. Also, the California bearing ratio (CBR) test is the most widely used in highway pavement design all over the world. Sahoo et al. (2009), has been tried to evaluate the relationship between DCP and CBR values for fine grained soils. Different types of soils were collected from IIT Kharagpur campus and India (Kharagpur town). In this study was conducted the Proctor compaction test to determine optimum moisture content (OMC) and maximum dry density (MDD) of the soils. The five types of soil were prepared with five samples of each soils.

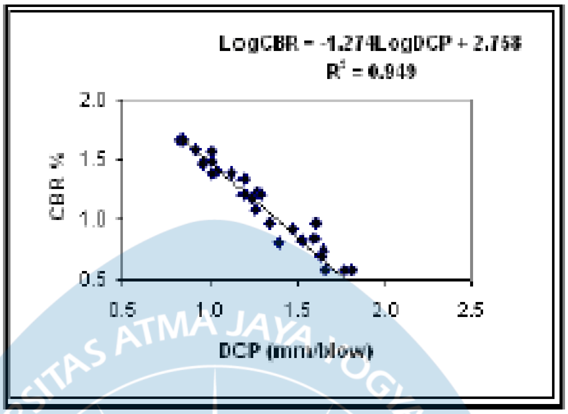

Fig. 2.5 Lab DCP – lab CBR relationship (combined data)
Source: Sahoo, 2009.

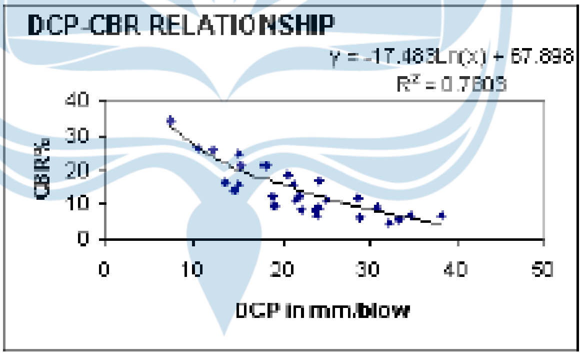

Fig. 2.6 Field DCP – field CBR relationship (combined data)
Source: Sahoo, 2009.

From the Fig. 2.5 and Fig. 2.6, it can be concluded that there is strong correlation between CBR value and DCP value for combined data. The strength between two variables are provided from the R-square results. For laboratory DCP – CBR relationship, R-square that obtained is 0.949. While for the field DCP – CBR relationship, obtained the R-square of 0.7803. The relationships are given as Log10 Lab CBR = 2.758-1.274 Log10 Lab DCP and Ln CBR= 67.898 - 17.483Ln (field

DCP). This approach is reliable to evaluate the subgrade layer and improve the credibility of DCP as an accurate, portable, and cheaper method of in situ testing. DCP test can be used for rapid measurement of strength of subgrades in the laboratory and the field.