



WStabilization of Expansive Soil using Dolochar and Lime



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Abstract

An experimental investigation is carried out to study the stabilization of local expansive soil by using dolochar and lime. Dolochar is added to the expansive soil from 5% to 30% by weight of total dry soil mixture with an increment of 5%. The geo-technical properties such as consistency, swelling, compaction and strength characteristic like California bearing ratio (CBR) of stabilized soil are studied. From the above study, the optimum dolochar content is found to be 30%. The lime (quick lime) is then added at low percentages i.e., 1% to 5% with an increment of 1% to the optimum soil-dolochar mixture. The mixed samples (soil-dolochar-lime) are soaked for 4, 7, 14, 21, 28 and 56 days to determine the CBR values. From the test results, it is seen that the maximum strength is achieved at the proportion of 70:30:4 for the soil-dolochar-lime mixture samples. The 4 days soaked CBR at 30% dolochar and 4% lime content of the expansive soil is increased by 672% as compared to soil alone. Further, it is observed that the concentrations of heavy metals leached from the stabilized soil with optimum mixture are found to be within the acceptable limits.

Keywords: California bearing ratio; Dolochar; Free swell index; Leachate characteristics; Lime; Stabilization

Introduction

The expansive soil undergoes volumetric changes due to the variation of its water content. The fine particles ($<75\mu$) present in the expansive soil have responsible for the water holding capacity. Further, due to the seasonal variation, the presence of water content in the expansive soil varies. The expansive soil undergoes swelling on wetting resulting loss of strength and shrinking on drying leading to the development of shrinkage cracks. The swelling and shrinkage characteristics of the expansive soil causes the differential movements resulting in severe damage to the foundations, buildings, roads, retaining structures, canal linings, etc. It has always been a great challenge for geo-technical engineers to improve the engineering properties of expansive soil through various innovative and cost effective techniques. Stabilization of expansive soil using various additives is one among them.

The industrial wastes namely, fly ash, dolochar, ground granulated blast-furnace slag (GGBS) and etc is generated from various industries in the state of Odisha. The industries are generally dumped the industrial wastes in their vicinity causing environmental hazards. Hence, there is an urgent need to explore the use of the above industrial wastes minimizing the environmental hazards. The review of literature reveals that a good number of research works have been carried out for stabilizing the expansive soils by using various industrial wastes via, fly ash, cement kiln dust, lime kiln dust, GGBS, rice husk ash, iron ore tailing, etc. [1-14]. Many others have studied the improvement of various engineering properties of expansive soil on addition of industrial wastes and lime.

They have shown that industrial wastes with lime can be useful additives to the expansive soil. In the present study an attempt has been made to study the stabilization of locally available expansive soils by using dolochar (industrial waste) with or without lime, which can satisfactorily be used for the construction of road, pavements, foundation, etc. The expansive soil and dolochar are collected from the Balasore, district of the state of Odisha, India, whereas lime (quick lime) is collected from the local market.

Experimental Programme

A detail experimental programme is prepared to study the geotechnical characteristics of soil stabilized by dolochar with and without the addition of lime. The soil-dolochar mixture samples are prepared by adding the dolochar to the parent soil separately with an increment of 5% by wt. of dry soil mixture from 5 to 30%, whereas soil-dolochar-lime samples are prepared by adding the lime to the 70% soil + 30% dolochar mixture sample from 1 to 5% by dry wt. of the mixture with an increment of 1%. All the stabilized samples are tested in the laboratory to study the consistency, swelling, compaction and strength characteristics (CBR). The stabilized soils (optimum mixture) are also tested to study its leaching potential in order to ascertain the sustainability of the stabilization method adopted.

Results and Discussions

From the test, it is revealed that the consistency and swelling characteristic of soil-dolochar and soil-dolochar-lime samples

are decreased with the increase of dolochar and lime content respectively whereas, the maximum dry density (MDD) of soil-dolochar and soil-dolochar-lime samples are increased with the increase of dolochar and lime content respectively. Strength characteristics such as California bearing ratio (CBR) of stabilized soils i.e., soil-dolochar and soil-dolochar-lime samples are increased with the increase of dolochar and lime content respectively. The effects of dolochar and lime on the CBR of the soil and soil-dolochar samples are presented at Figure 1 & 2.

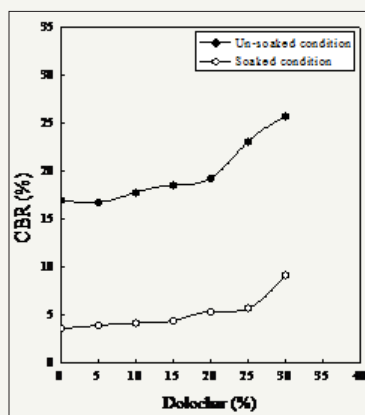


Figure 1: Effect of dolochar on the CBR of the expansive soil.

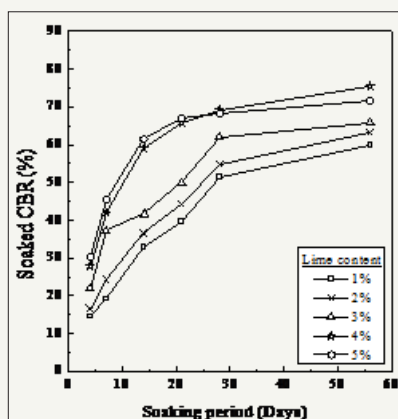


Figure 2: Effect of lime on the CBR at different soaking periods of soil - dolochar mixture.

The leaching properties of dolochar and stabilized materials namely soil-dolochar (70:30) and soil-dolochar-lime (70:30:4) are studied by column leaching tests and it is revealed that the concentrations of heavy metals leached from the soil mixtures are within the acceptable limits of drinking water as per IS 10500: 2012.

Conclusion

Based on the experimental investigation test results following conclusions are drawn.

- a) With addition of dolochar, the consistency and swelling characteristics of soils gradually decreases with the increase

of dolochar contents. Also, addition of lime to the soil-dolochar mixture reduces the consistency and swelling characteristics further. The free swell index of soil with 30% dolochar and 5% lime content, it reduced by 85%. At 30% dolochar content, the optimum moisture content decreases by 30% whereas, MDD increases by 15% for expansive soil. Addition of lime to the soil-dolochar mixture increases both OMC and MDD. CBR of soil-dolochar and soil-dolochar-lime samples increase with the increase of dolochar and lime content respectively. At 30% dolochar content, the 4 days soaked CBR of local expansive soil increases by 163%. With 30% dolochar and 4% lime content, the 4-days soaked CBR of expansive soil increase by 672% as compared to soil alone.

b) The optimum mixture design proportion of soil-dolochar-lime is found to be 70:30:04 for the materials i.e., soil, dolochar, lime, etc taken for the studies in this case.

c) The concentrations of heavy metals leached from the stabilized soil with optimum mixture are found to be within the acceptable limits.

Addition of 30% dolochar with 4% lime will definitely improve the local expansive soil for sustainable use in the construction of roads, pavements and foundations which will reduce the cost of construction and disposal problem of industrial wastes which otherwise lead to environmental hazards.

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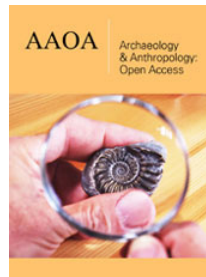
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