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Experimental study on Improvement of Bearing Capacity of Soil by Using murrum

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***Abstract*—India has a large geographical area and population that demands vast infrastructure with network of roads and buildings. Land is being utilized for various structures from ordinary house to sky scrapers, bridges to airports and from rural roads to expressways. Improving Bearing capacity of soil is the one of the essential processes which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives. Behaviour of soil with murrum has been explored. From the results obtained it has been experienced that Addition of murrum in silt soil to achieve the best compaction is less effective and adding murrum in Black cotton soil is also effective in achieving the dry density of whole mass at optimum moisture content.**

***Index Terms*—Geo-synthetic, Bearing capacity, Black cotton soil, Murrum, Standard proctor test, OMC, Dry density**

I. INTRODUCTION

Everywhere land is being utilized for various structures from ordinary house to sky scrapers, bridges to airports and from rural roads to expressways. Almost all the civil engineering structures are located on various soil strata. Soil can be defined as a material consisting of rock particles, sand, silt, and clay. In India, soils are classified into six groups namely alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, sand dunes and boulder deposits. Encountering land having soft soil for construction leads to an attention towards adopting ground improvement techniques such as improving bearing capacity of soil.

Improving Bearing capacity of soil is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives.

The different types of methods used for improving bearing capacity of soil are: Improving bearing capacity of soil using cement, improving bearing capacity of soil using lime, improving bearing capacity of soil using bitumen, Chemical, Grouting, Replacement of poor soil, increasing depth foundation, compaction of soil and a new emerging technology of stabilization that is stabilization of soil by using Geo textiles and Geo synthetic fibers. Improving bearing capacity of soil using Geo-synthetic Material Geo synthetics are synthetic products made from various types of polymers

which may be either Woven or Non-Woven. These are used to enhance the characteristics of soil and have provided a practical way of constructing civil engineering structures economically.
In this study, we are using Murrum as Geo-synthetic material for improving of bearing capacity of soil. With the introduction of Murrum to the soil and finding the Standard proctor density test value (SPT) values may show the possibility of improvement and thickness of pavement layer also may get reduced. It may also reduce the intensity of stress on sub-grade geotextile is such a Murrum material which is easily available, eco-friendly and also cost effective. With the application of improving bearing capacity of soil technique in construction process the overall cost may get reduced when compared to the ordinary method of construction. Thus, this experimental work has been carried out to explore how the addition of back cotton soil, silty soil, sandy soil, clay, and sedu soil in murrum can improve the dry density of soil

II. LITERATURE REVIEW

A. Literature survey

Literature survey related to the improvement of bearing capacity of soil by compaction test method.

The study of the mix proportion, design, content was also conducted. Technical article published in the proceeding and other journals; standard books have been referred to determine the content of work. Many types of research and academician have work on the different proportion and joints and time lag.

Kalyani Rajendra Kedar et.al. (2021) [1] studied on Use of geo-synthetics is very useful in bearing capacity problems to increase bearing capacity and reduce settlements. The technique has been implemented successfully in many problematic areas. Research is continuing on the material development, design methodologies, construction influences, and guidelines. The overall study concludes that geo-synthetics are substance that gains the strength of soil

Maharaj, Resham et.al. (2019) [6] these authors concluded that Testing for evaluating the potential or ability of the geotextile in bettering of the bearing capacity of the sand are carried out. Three layers of geotextile (for reinforcement) is placed below the 50cm x 30cm x 40cm in rectangular footings in testing soil. The ratio of reinforcement depth to span or width of respective footing (D/B) is varied from 0.20 to 2and therefore reinforcement area varying between 1B × 1B to 4B × 4B.

Panigrahi and Pradhan (2019) [2] studied the experimental study has been carried out to improve the bearing capacity of soils by using geotextile. In the present study geo-jute (gunny bags) is used as geotextile, whereas sand is used as soil media. This research presents the results of laboratory load tests on model square footings supported on reinforced sand beds. Total thirty-two model load tests are conducted to evaluate the potential of geotextile (geo-jute) for bearing capacity improvement. A single layer of geo-jute (for reinforcement) is placed beneath the 50 mm and 75 mm square footings in sandy soil. The ratio of depth of reinforcement to width of footing (Dr/b) is varied from 0.25 to 2. Also, the area of reinforcement is varied from 1b×1b to 4b×4b.

Aziz and Ozdemir (2016) [3] in this paper authors have pointed out that proper location and construction the soft soil are not suitable for runway way. Due to their undesirable characteristics

such as Poor grading, low strength, He is used the stabilized soil samples are prepared at different fly ash contents, i.e., 0%, 3%, 5%, 7%, and 10%. The samples are subjected to soaked California Bearing Ratio tests after 0-, 7-, and 28-days analysis are performed. The results of the study show that bearing capacity of soft soil can be improved substantially and swell can be reduced. This research investigated the effect of fly ash addition on some geotechnical purpose of soft soil.

Kolay, Kumar, et.al. (2013) [4] has concluded about the.effect of geo-grids on sand layer underlain by silty clay soil towards the improvement of bearing capacity of rectangular footing. The silty clay soil and sand used are classified as CL and SP, respectively, based on the Unified Soil Classification System (USCS). A number of model tests were performed to evaluate the load-carrying capacity of a rectangular model footing supported on the silty clay soil overlaid with small thickness of sand and with inclusion of geo-grids at different depths from the base of the footing

B. Research Gap

Even though test on various soils is conducted, the murrum has not been considered as Geo-synthetic substances. Along with other soils, Sandy soil is also used as the soil media for testing. Only the Standard Proctor density test has been adopted for testing of bearing capacity.

III. METHODOLOGY

The Proctor density test is a laboratory method of determining the optimal moisture content experimentally at which a given soil type will become most dense and achieve its maximum dry density. The dry density of a soil for a given compaction effort depends on the amount of water the soil contains during soil compaction. This original test is most commonly referred to as the standard Proctor density test; his test was later updated to create the modified Proctor density test.

This laboratory tests conducted consist of compacting soil at known moisture content into a cylindrical mold with a collar of standard dimensions of height and diameter using a compaction effort of controlled magnitude. The soil is usually compacted into the mould to a certain number of equal layers, each receiving a number of blows from a standard weighted hammer at a specified height. This process is then repeated for various moisture contents and the dry densities are determined for each. The graphical relationship of the dry density to moisture content is then plotted to establish the compaction curve. The maximum dry density is finally obtained from the peak point of the compaction curve and its corresponding moisture content, also known as the optimal moisture content.

General procedure includes the following steps:

a. Preparation of soil sample for 5% & 10% addition of murrum.
b. Soil samples to be tested for dry density using standard proctor density test for various water content & results plotted to obtained OMC.

Results we have to collect & interpret graphically or in respective tables.

IV. RESULTS AND DISCUSSION

The experimental investigation was conducted to evaluate the influence of murrum addition on the compaction characteristics of different soil types. The study considered five soil types, namely black cotton soil, clay soil, sandy soil, silty soil, and sedu soil. Murrum was added at 5% and 10%, and the Standard Proctor compaction test was used to determine the maximum dry density (MDD) and optimum moisture content (OMC) of the soil mixtures.

The experimental results are presented in Table 1. The variations in maximum dry density and optimum moisture content provide an indication of how the addition of murrum influences the compaction behaviour of different soils.

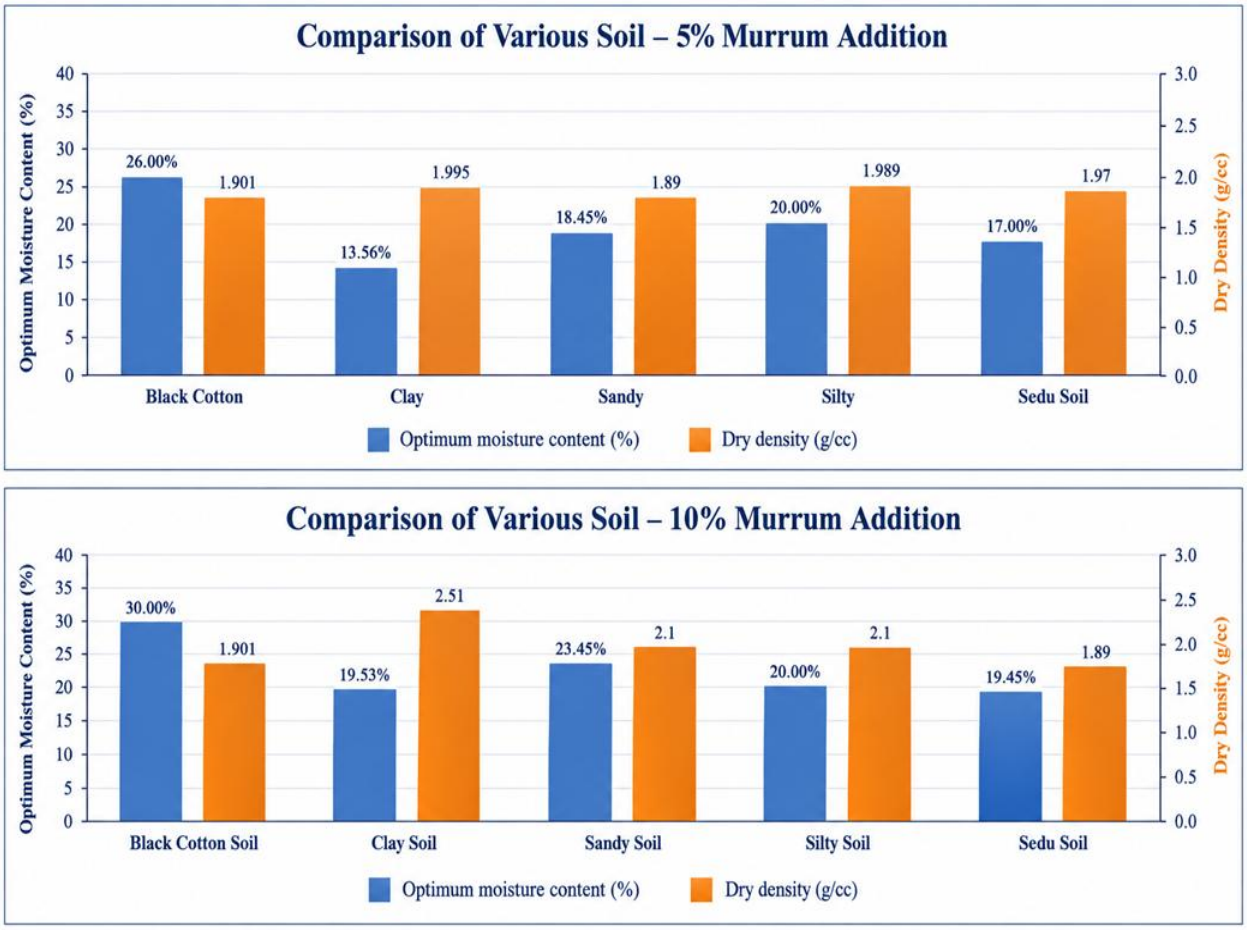

Fig. 1 and 2: Murrum added in various soil types in 5% and 10%

Table 01 Comparison of 5% & 10% addition of Murrum

Sr No.	Type of Soil	Percentage Added 5%		Percentage Added 10%	
		Dry Density (gm/cc)	OMC (%)	Dry Density (gm/cc)	OMC (%)
1	Black Cotton Soil	1.901	26.00	1.901	30.00

2	Clay Soil	1.995	13.56	2.51	19.53
3	Sandy Soil	1.89	18.45	2.10	23.45
4	Silty Soil	1.989	20.00	2.10	20.00
5	Sedu Soil	1.97	17.00	1.89	19.45

A. Effect of Murrum Addition on Maximum Dry Density

The results indicate that the effect of murrum addition on maximum dry density varies with the type of soil. For black cotton soil, the reported dry density remained constant at 1.901 g/cc for both 5% and 10% murrum addition. This indicates that increasing the murrum content from 5% to 10% did not produce a measurable change in the reported maximum dry density.

For clay soil, the reported dry density increased from 1.995 g/cc at 5% murrum addition to 2.51 g/cc at 10% addition. This represents the largest reported increase among the investigated soil types. However, this value should be verified against the original laboratory records before drawing a final Conclusion.

In sandy soil, the dry density increased from 1.89 g/cc to 2.10 g/cc when the murrum content increased from 5% to 10%. Similarly, the reported dry density of silty soil increased from 1.989 g/cc to 2.10 g/cc. These results suggest that increasing the murrum content may improve the compaction characteristics of these soil mixtures.

In contrast, the dry density of sedu soil decreased from 1.97 g/cc at 5% addition to 1.89 g/cc at 10% addition. This indicates that a higher murrum content did not improve the reported dry density of every soil mixture. The reduction may be associated with differences in particle-size distribution, particle arrangement, and moisture requirements, although further testing is required to establish the actual cause.

Overall, the findings suggest that the influence of murrum on soil compaction depends on the properties of the original soil and the proportion of murrum added. Therefore, the suitability of a particular mixture should be assessed separately rather than assuming that increasing the murrum content will always improve maximum dry density.

B. Effect of Murrum Addition on Optimum Moisture Content

The optimum moisture content also varied with soil type and murrum percentage. For black cotton soil, the reported OMC increased from 26.00% at 5% murrum addition to 30.00% at 10% addition. This indicates that the mixture required a higher moisture content to achieve its reported maximum dry density at the higher murrum proportion.

For clay soil, the OMC increased from 13.56% to 19.53%. In sandy soil, it increased from 18.45% to 23.45%, while in sedu soil it increased from 17.00% to 19.45%. These observations indicate that the reported moisture requirement increased with murrum addition for these four soil types.

For silty soil, the OMC remained unchanged at 20.00% for both proportions. This suggests that the increase in murrum content did not change the reported optimum moisture requirement of the silty soil mixture.

The variation in OMC may be related to changes in particle-size distribution, pore spaces, and the water required to facilitate particle rearrangement during compaction. However, these mechanisms cannot be confirmed from the reported density and moisture values alone.

C. Comparative Assessment of the Investigated Soil Mixtures

A comparison of the results shows that the response to murrum addition was not uniform across all five soil types. Clay soil exhibited the largest reported increase in dry density, followed by silty soil and sandy soil. Black cotton soil showed no change in the reported dry density, whereas sedu soil exhibited a reduction at 10% murrum addition.

The moisture-content results further demonstrate that changes in dry density and OMC should be considered together when evaluating a soil mixture. A higher OMC does not necessarily indicate an improvement in strength or bearing capacity. Similarly, an increase in maximum dry density indicates a change in compaction behaviour but does not, by itself, establish an increase in the load-carrying capacity of a foundation.

The findings provide a preliminary basis for identifying soil–murrum combinations that may warrant further investigation. Additional testing, including California Bearing Ratio (CBR) tests or laboratory plate-load tests, would be required to establish whether the observed changes in compaction characteristics translate into improved bearing performance under the intended field conditions.

D. Engineering Implications

Murrum is a locally available material in the Nashik region and may offer a practical option for investigating soil improvement. The present results indicate that its effectiveness depends on the soil type and the proportion used. Accordingly, the selection of an appropriate mixture should be based on laboratory test results, the required engineering performance, and the intended application. For practical construction, the mixture should be evaluated using suitable compaction control criteria and strength or bearing-capacity tests. The present study provides preliminary information on maximum dry density and optimum moisture content; further validation is necessary before recommending any particular mixture for foundations, road subgrades, or other load-bearing applications.

V. CONCLUSION

The present experimental study investigated the effect of adding 5% and 10% murrum to different soil types, namely black cotton soil, clay soil, sandy soil, silty soil, and sedu soil. The Standard Proctor compaction test was used to evaluate the maximum dry density (MDD) and optimum moisture content (OMC) of the soil mixtures. Based on the reported results, the following conclusions are drawn:

a) The addition of murrum influenced the compaction characteristics of the investigated soils differently. The changes in maximum dry density and optimum moisture content depended on the soil type and the percentage of murrum added.
b) For black cotton soil, the reported maximum dry density remained constant at 1.901 g/cc for both 5% and 10% murrum addition, whereas the optimum moisture content increased from 26% to 30%. This indicates that the higher murrum proportion did not produce a measurable increase in the reported maximum dry density.
c) For sandy soil, the reported maximum dry density increased from 1.89 g/cc to 2.10 g/cc when the murrum content increased from 5% to 10%. Similarly, for silty soil, it increased from 1.989 g/cc to 2.10 g/cc, while the optimum moisture content remained at 20% for both proportions.
d) For sedu soil, the reported maximum dry density decreased from 1.97 g/cc at 5% murrum addition to 1.89 g/cc at 10% addition. This indicates that increasing the murrum content does not necessarily improve the compaction characteristics of every soil.
e) For clay soil, the reported maximum dry density increased from 1.995 g/cc at 5% addition to 2.51 g/cc at 10% addition. This value should be verified using the original laboratory records before drawing a definitive conclusion regarding the effectiveness of murrum in clay soil.
f) Overall, the experimental findings indicate that murrum may be a potential material for modifying the compaction characteristics of locally available soils. However, the optimum percentage of murrum should be determined separately for each soil type through appropriate laboratory testing.

Since the present investigation was based on the Standard Proctor compaction test, further studies using California Bearing Ratio (CBR) tests or laboratory plate-load tests are recommended to establish whether the observed changes in compaction characteristics lead to an actual improvement in soil strength and bearing capacity.

Thus, the study provides preliminary experimental information on the use of murrum in soil improvement. Further verification of the experimental data and additional strength and bearing-capacity tests are necessary before recommending specific soil–murrum mixtures for field construction applications.

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