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SUITABILITY OF SOIL FOR CIVIL CONSTRUCTION INDISTRICT MORENA, M.P., INDIA

Ramakant Sharma[1], V.K. Jain[1], & Kapil Shroti[1]
Department of Chemistry,
Ambah P.G. (Autonomous) College, Ambah, Morena, MP, India

M.K. Singh[2]
Department of Chemistry,
Govt. P.G. College, Dholpur, Rajasthan, India

Abstract: **Due to the developmental age in the present circumstances, it has become a very necessary task to evaluate the suitability of soil as well as its technical characteristics for use as a building material in construction of buildings. So the goal of this research is to look at previously published studies on soil samples and compare them with soil suitability criteria for selection of soil suitability for construction of buildings etc. In order to determine the suitability for routine construction purposes, geotechnical parameters of soil samples were matched to tests used in earlier research and compared with different requirements. In all, thirty-forty different published research article and books were thoroughly studied, out of which we found useful information in nearly fifteen researches. The three geotechnical properties of soils were matched and analyzed extensively. Maximum dry density, specific gravity, and optimal moisture content are these three properties. Recommendations for the appropriateness of different soil samples for three primary applications in earth building were developed based on the values of soil characteristics discovered in the literature, while other soil samples were determined to be outside the recommendations. Some of the earth building procedures employed in past research were revealed to be different from the approved approaches. It was also discovered by some researchers that some soil samples that were considered suitable for one land construction were not suitable for others. To determine the applicability of these studies, we randomly collected and examined soil samples from ongoing roadside construction work in Morena District. The investigation then found that it was extremely important to evaluate the suitability of the soil for soil formation, and any type of soil found to be unsuitable should be stabilized before use.**

Keywords: **Soil suitability, earth construction, geotechnical properties, specific gravity etc.**

I. INTRODUCTION:

Soil is a pervasive environmental component that is widely accessible almost everywhere in the world and can be used in the methods of building a variety of clay objects related to earth construction, including rammed earth, cob and stabilize clay blocks like bricks etc. The weak strength, low durability, and high compressibility of silty soils, as well as the swelling-shrinking characteristic of highly-consolidated swelled clays, provide significant geotechnical issues in these manufacturing processes. The poor soil quality or weaken properties may prove to be a significant impediment to successfully executing green infrastructure projects that are appropriate with current environmental circumstances. Identifying an appropriate supply of soil suitable for economic stability is a significant challenge before soil is used as a building material in a construction project. Looking closely throughout the history, Soil has been one of the most widely used building materials as an ingredient in construction work [1]. Because of its availability, abundance, low cost and low environmental impact, clay materials are still frequently used throughout the world [2]. It is constantly growing in demand as a construction material on our planet because to its abundant availability and little environmental effect. [3]. Even with its polymorphic use, continuous research work is being done on it all over the world. The use of locally accessible material for construction purposes not only saves money but also reduces the sober environmental impact. The need to mitigate the construction industry's environmental and social impact has renewed interest in earth construction [4]. Since it's more convenient and simplicity of the earth construction technique, a local unskilled labor force can be easily deployed, providing work opportunities to rural towns and reducing the cost of lodging and transportation of migrant workers coming afar.

In today's scenario earth construction techniques rely heavily on raw clay to make walls, soil evaluation should be a top priority, as not all soil types are suitable for earth construction [5].The stability of civil engineering constructions is strongly influenced by geotechnical characteristics of soils, and mostly geotechnical features of soils impact each other. The addition of lime and RHA (rice husk ash) to the soil enhanced the compressive and flexural strength of clay bricks in the process of earth construction and the addition of sand to the stagnant soil also improved the water holding capacity according to Muntohar's findings [6]. Adegun and Adedeji [7] glanced at more than 135 academic outputs from over 15 African nations and did a detailed analysis of empirical evidence to highlight the benefits and drawbacks of clay building materials in terms of energy, efficiency, cost, and thermal aspects of construction. Ngowi AB [8] through his research work looked at ways for increasing soil formation in two main villages of Botswana and found that employing certain proportions of cement and lime as stabilizers might improve traditional earth formation. Hamard et al. [9] reviewed bibliographic data on the cob process and described the many cob process variants in their research, taking into consideration the data gathered from previous studies and the various heterogeneous outcomes. Kouakou [10] noted that soil is a complex substance made up of sand, minerals, organic matters and the behavior of each one of these constituents impacts the features of the soil, such as its nature, structure, flexibility, cohesion, and permeability etc. Malakawi et al. [11] stated in his study that the presence of organic matter in the soil enhances soil flexibility. On the basis of 50 pertinent studies, Laborel Preneron et al. [12] assessed the contemporary level of research on the effect of several renewable and natural resources on unfired earth components such as compressed earth blocks, plasters, and elongated and stabilized blocks. All of these studies included the characterization of particles and treatments, recombination tables of material compositions, and durability demonstrations of mechanical, physical, hygro-thermal, and Earth-based materials. Danso et al. [13] conducted an in-depth review of 56 published studies on the effect of stabilization on the performance characteristics of soil blocks and found that few studies have been conducted on the durability properties of enhanced soil blocks as compared with physico-mechanical properties. Delgado and Guerrero [14] examined more than 20 technical publications, including standards from national standards agencies, and studied the provisions they provided about soil suitability for the use of unstabilized earth, as well as the various approaches and types of suggestions provided. Bryan [15] summarized the important characteristics of soil and compared the boundaries suggested by other scientists and their studies. A laboratory research was also conducted by him on fifteen soil samples from the South West of England to identify the characteristics of soil texture, its plasticity, and strength, stabilization ability along with cement. Ciancio and Jaquin [16] studied the limitations of the various available guidelines in depth and determined whether and what types of recommended evaluation criteria are appropriate. The study concluded that more research is needed to understand the effects of water suction, water-cement ratio, and mineralogy of clay on the mechanical behavior of rammed earth. Many researchers also assessed the advancements in rammed earth construction as published in over two hundred books, journals, conference papers, scientific reports etc. and they highlighted historic rammed earth projects in the UK. In the research study by Roy and Bhalla [17], different geotechnical properties of soils, such as specific gravity, density index, consistency limits, particle size analysis, compaction, consolidation, permeability, shear strength, their interactions and applications for the purpose of civil engineering structures were discussed. The characteristics of soil must be assessed in order to determine if it is suitable for usage as a foundation or as a construction material. The evaluation of basic engineering properties of soils through laboratory testing is very important in understanding and interpreting how soils will behave in the field [18].The physical and engineering properties of soils existing in our environment are intrinsic and the strength of the soil, its characteristics, can be used as a frame of reference for behavior [19]. Soil exists in different locations around the world with a variety of physico-chemical properties and characteristics, indicating the potential for impacts on the performance of structures built with clay. It is very important to identify the characteristics of any available soil before it can be used for construction purposes. The future of almost all types of landscaping works depends on the physical and chemical properties of the soil. Natural soils exist in a variety of different formations at different locations on Earth, depending on their geological distribution and geomorphology, for which certain proportions of these soil elements may make it a good material for building structures. This presents the need for testing of any given soil before it is used in the construction industry as a filler or structural material. The difficulty now is that, because not all soils are good for all types of work, and depending on the technology employed, certain classes of soils are preferable. Therefore, it is necessary to use some way of evaluating them and this study reviews and analyzes soil properties in the literature to determine its appropriateness for earth construction.

II. METHOD:

During this study, we adopted a mixed approach, in which the results of several previous studies (in the form of

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secondary data) were extracted and analyzed in depth. The various geotechnical properties of the soil samples used in these previous studies were compiled and compared against various criteria and requirements to ascertain their suitability for serving construction purposes. Thirty-one papers were consulted in total, and more than fifteen of them contributed useful information. In this way, three different geotechnical properties of soils were specially focused, compiled and analyzed. These properties are specific gravity, maximum dry density and optimum moisture content. A wide and long range of properties exist to determine the characteristics of soil for construction purposes [20], but these properties were selected because they are the main properties to be included in almost all previous studies to characterize soil samples. However, in order to compare the results obtained from research studies and to check the quality of soil of Morena district, we did a small research work in Morena district of Madhya Pradesh. For which we collected some samples of soil randomly from roadside construction works in Morena and sent them carefully to certified laboratory for testing. For this, all the standard procedures related to handling and testing were strictly followed. The results of the tests conducted for three different parameters are shown here in Table-01.

III. RESULT & DISCUSSION:

The specific gravity of a soil is used to relate a soil's weight to its volume and to determine the phase relationships, or the relative volume of solids to water and air in a given volume of soil [21]. Specific gravity is a proportion that tells you how much organic matter and porous particles are in a sediment or soil, and it's usually around 3.0 for sediment or soil that contains heavy compounds[22].The specific gravity of soil, in a way, indicates how heavy or lighter the soil is than water. Many situations require the soil to be compacted to its maximum dry density during various construction processes [23]. The process of compaction is the mechanical condensation of soil by pressing soil particles together in a closed state of contact, allowing trapped air to be more easily pulled out from the soil mass [24].By standard proctor test, the relationship between maximum dry density of soil and optimum moisture content can be obtained from compaction process of soil. This relationship helps to determine the optimum water content by which the maximum dry density of soil can be determined through compaction [25, 26]. The amount of water at which maximum dry density of soil can be achieved after compaction is known as optimum moisture content (OMC). The maximum dry density of the soil is the density that is achieved by compaction on the OMCs of the soil.Table-01 shows data on the specific gravity, optimum moisture content, and maximum dry density used in our study, obtained after testing the soil samples we have taken in Morena from the road side construction work. We compared these outcomes with the data provided on the specific gravity of the soil samples used in the earlier research as a result of the examination of twenty-seven soil samples in twenty-one studies. It can be observed from Table-01 and earlier study reveals that, with the exception of two probes during literature review, all our four soil samples achieved specific gravity values between 2.00 and 2.53, as recommended by FM5-472 [27]. Millogo et al.[28] achieved a specific gravity of 3.02, which was higher than the recommendation, whereas Alavez Ramrez et al.[29] obtained a specific gravity of 1.82, which was lower than the recommended.

Table-01: Showing the specific gravity, optimum moisture content, and maximum dry density of soil samples from Morena city.

Particulars / Sample No.	1	2	3	4
Weight of the Mould (g)	2770	2770	2770	2770
Weight of mould + compacted Soil (g)	7218	7469	7672	7546
Weight of compacted Soil (g)	4448	4699	4902	4776
Volume of Mould (cc)	2250.0	2250.0	2250.0	2250.0
Wet density (g/cc)	**1.977**	**2.088**	**2.179**	**2.123**
Container No.	25	14	15	16
Weight of Container (g)	12.0	12.0	12.0	12.0
Weight of container + wet soil (g)	66.8	69.4	73.6	67.7
Weight of container + dry soil (g)	61.5	63.2	66.1	60.6
Weight of dry soil (g)	49.5	51.2	54.1	48.6
Weight of water (g)	5.3	6.2	7.5	7.1
Moisture content %	**10.68**	**12.04**	**13.82**	**14.68**
Dry density (gm/cc)	**1.786**	**1.864**	**1.914**	**1.851**
Specific gravity	**2.27**	**2.00**	**2.53**	**2.17**
Results of Appropriateness				
Optimum Moisture Content (OMC)	**13.82%**			
Maximum Dry Density (MDD)	**1.914 g/cc**			
Specific Gravity (SG)	**2.53**			

Standard Proctor Test As per IS: Code 2720 (Part-8)

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The optimum moisture content values of more than twenty soil samples of earlier researches were also compared with the results obtained and shown in Table-1. The study investigated the values that were closely related to the results, since there are no defined criteria for acceptable optimal moisture content in soil. According to the aforementioned investigations and the study that accompanied them, ideal moisture content values of 09.00 to 29.80 % were strongly linked to spacing of not more than 3.00 percent [30].The optimum moisture content in the samples which we evaluated was also 10.68 to 14.68 %, which was in accordance with the range established in prior studies, as shown in Table-1.Consequently, it has been advised that the soil moisture content be kept between 9.00 and 29.80 to be acceptable for civil construction work, based on the existing data and numerous investigations. With the exception of Degirmenci's research [31], several results show that all other soil samples were within the acceptable range while some of the soil samples in the study had an optimum moisture content of 37.70%, which is much greater than the recommended limit. The maximum dry density of the soil samples we evaluated, ranged from 1.786 to 1.914 g/cm^3, is similarly shown in Table-1. The earlier research studies reviewed by us revealed that the maximum dry density obtained for fifteen soil samples out of twenty tests was in the range of 1.06 to 1.94 g/cm^3. The findings of a thorough review of all of the data demonstrate that all parameters are closely inter connected. As an outcome, all of the maximum dry density values shown in Table-1 can be approved. When the particle size, morphological distribution and the Atterberg's limit are compared to the specific gravity, optimal moisture content, and maximum dry density of soil samples, it can be seen that these factors have minimal impact on determining soil suitability for earth formation.

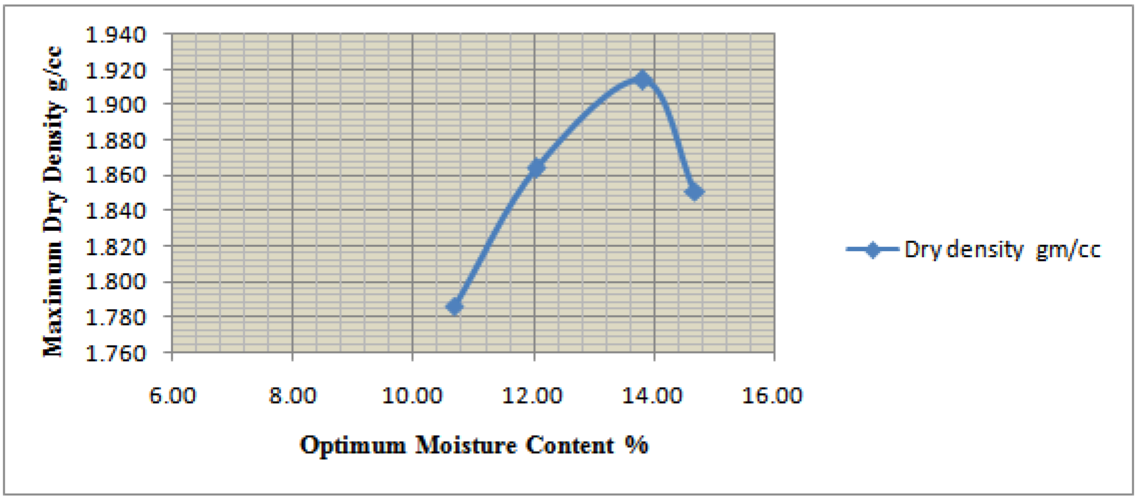

Figure-01: Graphical Representation of Standard Proctor Test.

Here in figure-01 the relationship between maximum dry density and optimum moisture content is shown through a graphical representation. From the upward straight line obtained in the graph, it can be assumed that the maximum dry density of soil and optimum moisture content are approximately proportional to each other. That is, as the value of one of these two parameters increases in the soil sample, the value of the other increases and when the value decreases, the value of the other also decreases. From this it can be concluded that the value of one parameter in the soil sample affects the value of the other parameter. Due to which the quality of the soil and the suitability of the soil for land formation is affected.

IV. CONCLUSION:

In order to assume a suitable soil for earth construction, the findings acquired from the collection of soil samples in previous researches were meticulously reviewed and compared with the suitability requirements of the soils. Following that, the findings of our roadside construction soil analysis, as well as the soil's suitability requirements were compared to prior researches in order to suggest an appropriate soil for construction purposes. Some soil samples were examined, and suggestions for the acceptability of different soil samples for the three basic earth formation techniques (compressed soil blocks/bricks, rammed earth and adobe) were offered relying on the diverse qualities of soils discussed in the literature while some soil samples were reported to be outside the criteria. As researchers usually do not determine the texture, particle size distribution, morphology etc. of soil samples before adopting the appropriate technology to use, hence it turns out that some of the earth formation techniques used in previous studies that used soil samples was different from the recommended techniques. It was also observed that some soil samples that were found suitable for one particular purpose, were found to be unsuitable for other purpose, while some soil samples that were recommended for one method in one particular test were recommended for a different technique in another test. Testing of soil samples obtained from the sites of multiple infrastructure projects in Morena city revealed that mostly all the soil samples were appropriate for construction work, whereas many other specimens were found to be unsatisfactory too. According to the overall findings, many past researchers conducted various types of tests on soil samples for knowing the soil formation and durability, and conclude that if any soil is found to be inadequate according to the recommended criteria, a good stabilizer should be used for soil stability keeping construction purposes in mind. As an outcome, the study emphasizes that determining the soil's suitability for earthen construction is crucial, and any soil that is found to be inappropriate should be stabilized before being used for earthen construction.

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