# STABILIZATION OF SOIL WITH GLASS (POWDER FORM) AND MARBLE DUST FOR HIGHWAYS- REVIEW

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**Abstract -** *Soil need some improvements as per design characteristics as mentioned the stabilization of soil shall be done by chemicals, waste materials, cement, fibers etc. in this study the waste materials for stabilization shall be use glass and marble dust. These waste materials available in huge quantity so we need to utilize these materials to reduce the load on environment. Need of soil stabilization for achieved designed characteristics*

***Key Words***: Soil, marble dust, glass, stabilization and environment.

## 1. INTRODUCTION

Every civil engineering structure, whether it is construction of a building or road pavement, are to be found on soil. The soil on which the structure is to be built should be capable of withstanding the loads. However, naturally there exist problematic soils. The soil is a building material taking on the distinct properties that vary from place to place. In some areas, it may have a beneficial strength for less depth whereas; it might not have adequate strength at an impressive profundity for which it gets basic to make building improvement strides for its stabilization. Traditionally, soil, stone aggregates, sand, bitumen, cement, etc. are used for road construction. However, the cost of sourcing for such materials is high and processing of such materials in adequate quantity is increasing. Also, demand of quality for the construction of any structure is increasing. Hence, a lot of research is on-going to identify and develop alternative materials for construction and industrial waste products are one of such alternatives. If these materials can be identified and suitably utilised in construction, the attendant pollution and disposal problems may be greatly reduced. Weak soils need treatment prior to use as an engineering material so as to have desired properties. These treatments are generally classified into two processes, viz. (1) soil stabilization and (2) soil modification.

**1) Soil stabilization** is a technique for modifying the properties of soil by mixing and combining new materials. In the present day, the growing trend of using waste material in soil stabilization or soil strengthening is operating worldwide. The key reason behind this phenomenon is the excessive production of waste such as marble powder and waste glass powder which not only poses hazards but also creates problems with disposal. The use of these waste materials in the building would ease adverse environmental effects, save energy and money, add economic value to the waste, and reduce total costs. It is generally utilized to stabilize soil for the construction of road pavement, railways foundations, embankments, buildings, beneath connecting docks, earthen dams, terminals for rail and wagon, and an economical base for roadways, building cushions, and reservoir linings, composting facilities and as a mixture material for several purposes in construction work.

**2) Soil modification** is the stabilization process which improves some property of the soil but does not result in a significant increase in soil strength and durability. Stabilization derived by thermal, mechanical, chemical or electrical means. Thermal and electrical is rarely used and less data is available about these two. Mechanical stabilization is the densification of soil by compaction, expelling air from the soil voids without much change in moisture content. More concisely, "soil stabilization" is mainly the addition of chemical admixtures to soil which results in chemical improvement.

**Solid wastes** are the wastes which are solid in nature and remain at the place of their disposal. It becomes more severe, if they are non-biodegradable materials. Solid waste may be divided into following groups based on the source of their generation;

i) Industrial solid wastes (Blast furnace slag, Red mud, Fly ash, Copper slag, etc.)

ii) Agricultural solid wastes (Ground nut shell, Rice husk, Bagasse, etc.)

iii) Hospital solid wastes (Syringes, Plastic bottles, etc.)

iv) Domestic solid wastes (Incinerator ash, Waste tyre, etc.) and

v) Mineral solid wastes (Marble dust, glass powder, Quarry dust, etc.).

**LITERATURE REVIEW**

The stabilization technique has an additional benefit of providing an environment friendly way to deal with industrial waste and household wastes. Various researches for the stabilization of soil, which are related to my work, are as under:

**1. Okagbue, and Onyeobi, (1999) [1]** evaluated potentiality of marble dust as a stabilizing additive to red tropical soils i.e., Auchi soil, Igarra soil and Ore soil in their natural state as well as when mixed with varying proportions of marble dust (2%, 4%, 6% and 8%). The parameters tested included the particle size distribution, specific gravity, Atterberg imits, the standard compaction characteristics, the compressive strength and CBR. Results showed that by the addition of marble dust, plasticity was reduced to 33%, strength was increased to 46% and CBR was increased from 27% to 55%. The highest strength for all types of red tropical soils was obtained at 8% and maximum CBR value was achieved at 8% addition of marble dust for Auchi and Ore soils and 6% for Igarra soils. Although these results imply marked improvement in the geotechnical parameters of red tropical soils, the strength developed is not enough for to be used as a base material in the construction of heavily trafficked flexible pavements. The improved material may, however, be successfully used as base material for lightly trafficked roads and as a sub-base material for heavily trafficked roads.

**2. Eskioglou, (2004) [2]** evaluated the effectiveness of shredded tire and marble dust as a soil stabilizer especially in forest roads. Marble dust was added in percentages of 2%, 4%, 6%, and 8%. Plasticity and strength parameters were determined by conducting respective tests. Plasticity was reduced by 12.5% to 24% and the strength increased by 34% to 43% by the addition of marble dust. The highest strength was obtained at 8% marble dust.

**3. Sabat, and Nanda, (2011) [3]** had studied the effects of marble dust on the expansive soil stabilized with rice husk ash (RHA) at optimum content of rice husk ash i.e., 10%. Marble dust was added up to 30%, at an increment of 5%. Compaction tests, unconfined compression tests, soaked CBR tests, swelling pressure tests and durability tests were conducted on these samples. The unconfined compression test, and soaked CBR of rice husk ash-stabilized expansive soil increased on adding of marble dust up to 20%. There is 228 % increase in unconfined compressive strength and 293% increase in Soaked CBR, when compared with virgin soil. Further increase in addition of marble dust had negative effects on these properties. The dry density goes on decreasing and optimum moisture content goes on increasing. The swelling pressure was found to be 112 $kN/m^2$ for virgin soil and 0 $kN/m^2$ at 25% marble dust replacement. Further, it was found that addition of marble dust made the soil-rice husk ash mixes durable. The optimum proportion of soil: rice husk ash: marble dust was found to be 70:10:20.

**4. Olufowobi, et al., (2014) [4]** assesses the stabilizing effect of powdered glass on clayey soil in varying proportions of 1%, 2%, 5%, 10% and 15% along with 15% cement (base) by weight of the soil sample throughout. Consequently, Atterberg's limits, moisture content, specific gravity & particle size distribution tests were carried out to classify the soil which corresponded to Group A-6 soil according to ASSHTO classification system. Thereafter, compaction, CBR and direct shear test were carried out on the soil with and without the addition of the powdered glass. The results showed increase in the maximum dry density values on addition of the powdered glass up to 5% content after which it started to decrease. The highest CBR values of 14.90% for soaked and 112.91% for unsoaked treated samples were obtained at 5% glass powder content on 5mm penetration. The maximum cohesion of 17.0 and angle of internal friction of 15.0 were obtained at 10% glass powder content.

**5. Gurburz, (2015) [5] investigates** the effect of the marble powder on the strength and durability of clay treated with and without the effect of freeze–thaw cycles. The addition of waste marble powder to the clay in percentages of 2.5%, 5%, 10%, 15%, 20% and 25% was done and consistency limits, standard proctor test and unconfined compressive strength were determined. There was 5% increase in plastic limit. The unconfined compressive strengths of specimens subjected to 12 freeze–thaw cycles were around 22% smaller than the results of the samples not exposed to freeze–thaw cycles. It was observed that the average mass loss at the end of 12 freeze–thaw cycles was around 5%. The ductility of samples increased with an increase in the marble powder up to 10%, and then the trend reversed. The optimum marble content resulting in peak strength was 10% by weight of dry soil.

**6. Singh, and Arora, (2017) [7]** carried out stabilization on non-plastic silt using marble powder as a stabilizing agent in different percentage replacement of soil by marble dust (5%,10%,15% and 20%) by weight of soil and carried out unconfined compressive strength and standard proctor test. Maximum unconfined compressive strength of sample was found to be 1.032 $Kg/cm^2$ for 15% marble dust addition. The optimum value of marble dust comes out to be 15% by weight of dry soil. With increase in percentage of marble dust dry density decreases and optimum moisture contain increases. Samples turned brittle on higher percentage of marble dust.

**7. Sohail, et al., (2018) [10]** analyzed the behavior of clay soil with glass powder alone, sodium hydroxide (NaOH) alone and combination of both. When the soil is treated with glass powder in varying proportions, optimum moisture content increases and maximum dry density decreases up to 17.5% by weight and further increase will reverse the action. When the content of glass powder is increased from 2.5% to 17.5%, the compressive strength increased from 17% to 62% for 3 days of curing and from 18% to 60% for 14 days of curing of sample on comparing with untreated soil. When the same soil is treated with NaOH (5% to 20%), optimum moisture content decreased, maximum dry density increased, and the compressive strength decreased from 47% to 8% for 3 days of curing and 33% to 6% for 14 days of curing. Again by treating the soil with 2.5% of glass powder and varying percentages of NaOH, it was found that optimum moisture content decreased and maximum dry density increases up to 15% of NaOH and the compressive strength decreased from 67% to 49% for 3 days of curing and 75% to 37% for 14 days of curing and further increase in NaOH will reverse the action. So the sample treated with 2.5% glass powder with 5% NAOH will give the maximum strength. The CBR test was carried for optimum content like 2.5% glass powder, 15% NAOH and 2.5% glass powder with 5% NAOH. It is concluded that the clay soil can be stabilized using glass powder and addition of NAOH content up to 5% will also give the best result in development of strength compare to soil treated with glass powder alone.

**8. Yadav, and Kumar, (2019) [11]** utilized foundry sand and marble dust in soil sub-grade stabilization and carried out standard proctor compaction test and CBR test at different percentages of marble dust (0%, 10%, 14%, 18% and 22%) and foundry sand (0%, 10%, 14%, 18% and 22%). The maximum dry density achieved was 1.85 g/cc on addition of 10% marble dust and 1.99 g/cc on addition of 22% foundry sand. CBR value achieved was 12.38% on addition of 14% of marble dust in the parent soil, whereas the maximum CBR value achieved on addition of foundry sand was 18.68% at 22% addition in un-soaked condition. Maximum CBR value achieved was 10.56% on addition of 14% of marble dust, whereas the maximum CBR value achieved on addition of foundry sand was 15.03% at 22% addition in soaked condition. The maximum value for optimum moisture content obtained was 20% at 22% addition of marble dust while there was a decrease in the optimum moisture content on addition of foundry sand.

**9. Sahu, et al., (2019) [12]** incorporated glass powder and rice husk ash (RHA) into the soil. He performed particle size distribution, Atterberg's limit, Compaction and CBR tests etc. on normal soil. 15% of rice husk ash was added by weight of the soil & glass powder was added at the rate of 1%, 2%, 5%, 10% & 15%. There is an appreciable improvement in the optimum moisture content and maximum dry density for the soil treated with glass powder and rice husk ash. The soil becomes non-plastic with the addition of glass powder and rice husk. It was found that the optimum percentage of the powdered glass in sandy soils lies between 5% and 10% by mass of the soil. This is because the corresponding maximum values from both the compaction and CBR tests were obtained at 5% glass powder content while the maximum values from the shear strength test were obtained at 10% glass powder content.

**10. Javed, and Chakraborty, (2020) [15]** investigated the effect of glass powder in cohesive soils. Glass powder was mixed with the soil samples by 2%, 4%, 6%, 8% and 10% of dry weight of soil. Liquid limit, plastic limit and plasticity index continuously decreased and were found to be 33.9%, 18.4% and 15.5% respectively at 10% of glass powder. Both unsoaked and soaked CBR increased with the addition of glass powder and found maximum viz., 22.5% and 10.4% respectively. Unconfined compressive strength was increasing up to 8% of glass powder and found maximum of 133.5 $kN/m^2$ and then decreased to 119.7 $kN/m^2$ when 10% of glass powder as added. The maximum dry density value increased from 1.83% to 2.03% with the addition of waste glass up to 8% and then remain constant when added 10%. On the other hand, optimum moisture content decreased from 17.53% to 10.5% with the increment of glass powder. This study found that the optimum percentage of glass powder is 8% of dry weight of soil. Though a number of researches have been conducted to stabilize the soils using different waste materials, the comparison of waste glass powder and waste marble dust will make my research a novel in comparison with others.

**MATERIALS TO BE USED**

Various materials which are to be used in this research include soil, and waste materials. The waste materials which I have chosen are **waste glass powder** and **waste marble dust**. Both glass powder and marble dust are non-biodegradable residues that permanently occupy a large amount of space in dumping sites. Consequently, we can treat the soil with them to check the performance of soil.

**Soil:-**The soil is a building material taking on the distinct properties that vary from place to place. There are eight types of soil deposits in India i.e., Alluvial soil, Black soil (Regur soil), Red soil, Laterite soil, Desert soil (Arid soil), Forest and mountainous soil, Saline soil (alkaline) and Peaty soil (marshy soil). The soils may be classified as clay, silty, sandy, peaty, chalky and loamy. Any locally available soil will be taken and characterized according to the IS: 2720 and BIS.

**Glass powder:-**The most common type of glass is soda-lime glass. Most glass powder is sourced from used glass and then ground down. It is estimated that over 200 million tones of glass waste are sent to landfill annually.

**Fig.1.1-Glass (Powder form)**

**Marble dust:-**Marble dust is generated in large quantity during production, cutting, sawing & polishing process of marble & it is found that about 20-25% of original marble mass is lost in the form of dust.

**OBJECTIVES**

The main objectives of this research are as follows:-

 To find out the effects of glass powder and marble powder of sub-grade soil by performing the concerned IS tests.

 To compare the properties of virgin soil and modified soil for highway sub-grade.

 To find the optimum percentage of glass powder and marble dust for stabilization of soil (in case if glass powder and marble dust enhance the soil properties).

 To modify soil for construction of highway sub-grade at economical cost.

**IMPORTANCE**

There are various stabilizing admixtures available, but I had chosen glass powder and marble powder which are wastes as well as non-biodegradable substances. By stabilizing the soil with any waste products, we can reduce the waste in our environment and also side by side can improve the soil properties to support pavements and foundations like in roadways, parking areas, site development projects, airports & many other situations where sub-soil is not suitable for construction. Various researchers have concluded that by using these waste materials in the building would increase the stability of the soil, add economic value to the waste and reduce total costs.

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