



THE EFFECT OF WASTE MARBLE DUST IN STABILIZATION OF EXPANSIVE SOIL

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Abstract: The matter with expansive soil has been recorded everywhere in the globe. Most of the civil engineering structures fail due to improper stabilization of soil. It is, therefore, necessary to mitigate the issues related to expansive soils to prevent structures from cracking and also to enhance its durability. In this paper, the effect of waste marble dust on the properties of the expansive soil mass has been investigated. The plastic limit, linear shrinkage, liquid limit, swelling pressure and free swell index decreased with an increase in the percentage of marble dust but California bearing ratio increased with an increase in the percentage of marble dust. The use of 30% marble dust content found economical and also provides good strength to subgrade of flexible pavement.

Keywords: Expansive Soil, Stabilization, Waste Marble Dust, California Bearing Ratio, Swelling.

I. Introduction

Environment is one of the prominent factors among all of these & any engineer should keep this in mind that this should not be affected at any cost. To meet its target, sustainable development has to ensure all these components should remain safe and balanced. Depending on the state these are solid, liquid or gaseous in state. Liquid or gaseous wastes can be disposed of by many of the ways but difficult for solids [1]. In India marble production is very high and number of industries is available for cutting marble stones. By the dressing or finishing work of marble lot of waste is produced in solid state, so it is necessary to use of waste marble dust as a admixture to improve the engineering properties of construction material [2]. In current time we need alternate material required for construction which is having good engineering properties. For the soil stabilization different type admixtures are used but the waste marble dust used for stabilizing, it is economical and easily available in the market [3]. Waste marble stone are in the category of metamorphic lime stone [4] and which is widely used the construction. The number of alternative materials is founded in previous researches to improve the geotechnical properties of expansive soil to make it more suitable for constructional work. Stabilization of soil using pyroclastic dust [5], lime & brick powder dust [6], rice husk ash and cement [7], Quarry dust [8] etc. are useful to stabilization of expansive clay soil. In this work, the waste marble dust is used to stabilization of expansive clay soil which is easily available.

II. Experimental Material and Its Properties

A. EXPANSIVE CLAY SOIL

The expansive soil samples collected from Rania region (District – Sirsa, Haryana, India). It is well known as 'NALI' region as the Ghaghar River is flowing in this area. The table 1 shows the properties of soil.

Table 1: Major Properties of Expansive Soil

SR. NO.	Properties	Values
1	Analysis of Grain Size	Clay size-59% Sand Size-17% silt size-27%
2	Specific Gravity	2.67
3	Atterberg's Limits	LL-69% PL-37%
4	Optimum Moisture Content	24%
5	CBR	3.9%
6	Swelling Pressure	2.4kg/cm ²
7	Free Swell Index	81%
8	Shrinkage Limit	28%

B. WASTE MARBLE DUST

The waste marbles were collected from Sangria (Hanumangarh, Rajasthan) marble industry. The marble stones were broken into small pieces with the help of hammer. Los Angeles abrasion machines with steel balls used to make the marble powder and pass through 0.075mm sieve. The properties of the powdered dust have been represented in table 2.

Table 2: Engineering Properties of Waste Marble dust

Sr. No.	Properties	Values
1	Analysis of Grain Size	Clay size-21% Sand size-46%, Silt size-33%
2	Compaction Characteristics	OMC-16.5%
3	Shearing parameters	Cohesion-8.2KN/m ² and Angle of internal friction-41°
4	Specific Gravity	3.04

III. Sample Preparation And Test Performed

A. SAMPLE PREPARATION

The waste marble dust was added in the expansive soil in six groups with varying percentage of marble dust and three samples of each group has been taken for experiment. The composition of each group of waste marble dust and expansive soil has been shown in table 3.

Table 3: The composition of waste marble dust and expansive soil

S.N	Group	Waste marble dust weight (%)	Expansive soil weight (%)
1	WMD 1	5	95
2	WMD 2	10	90
3	WMD 3	15	85
4	WMD 4	20	80
5	WMD 5	25	75
6	WMD 6	30	70

B. TEST PERFORMED

- **LIQUID LIMIT AND PLASTIC LIMIT**- The liquid limit, plastic limit and shrinkage limit tests are performed as per the Indian standard code (IS 2720-5-).
- **SHRINKAGE LIMIT**- The Shrinkage limit test results are determined as per guidelines of Indian standard code (IS 2720-6)
- **CALIFORNIA BEARING RATIO TEST**- The Soaked CBR test is performed as per the Indian standard code (IS 2720-16).
- **FREE SWELL INDEX**- The determination of free swell index was according to Indian Standard code (IS: 2720-11).
- **SWELLING PRESSURE**-The Swelling pressure test is performed as per the Indian standard code (IS 2720-41).

IV. Results And Discussion

A. ATTERBERG'S LIMIT

The liquid limit of untreated expansive soil was 69% but on adding 5 % waste marble dust to total weight of soil, a decrease in liquid limits by 5% has been observed. On gradually adding of 5% of waste marble dust up to 30%, the liquid limit decreased from 69% to 37% (see **figure 1**). Similar decreases in liquid limit has been reported by Srikanth Reddy [6] when use the lime and brick powder.

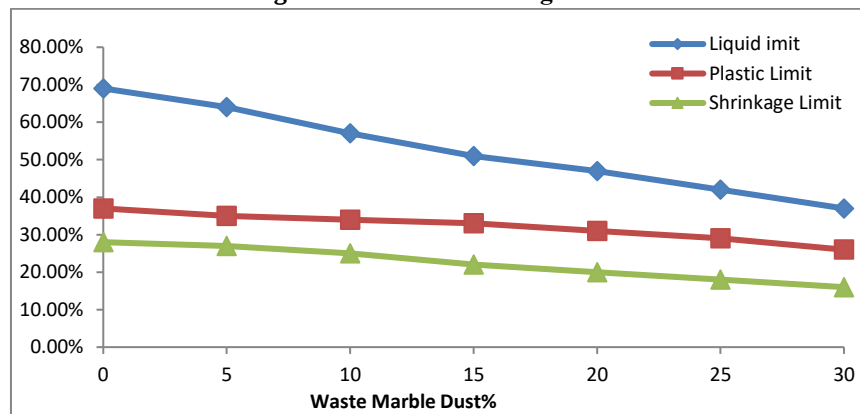
The plastic limit was reduced from 37 to 26 on mixed the waste marble dust from 5% to 30%. The decreased result of plastic limit was shows in (see **figure 1**).

The Shrinkage limit a result was decreased 28 to 16 (see **figure 1**) as the waste marble dust (5% to 30%) mixed in the expansive soil. Similar decrease in plastic limit has been reported by Modarres and Nosoudy [9] and when used the waste coal and lime for soil stabilization.

The Atterberg's results decrease mainly two reasons

- The ratio of fine particles of soil was changed [10]. When the waste marble dust mixed with the expansive soil the fine particles ratio in the soil sample was reduced.
- The results of atterberg's limit was also decreased due to change in soil group CH to CL reported by A. K. Sabat [11].

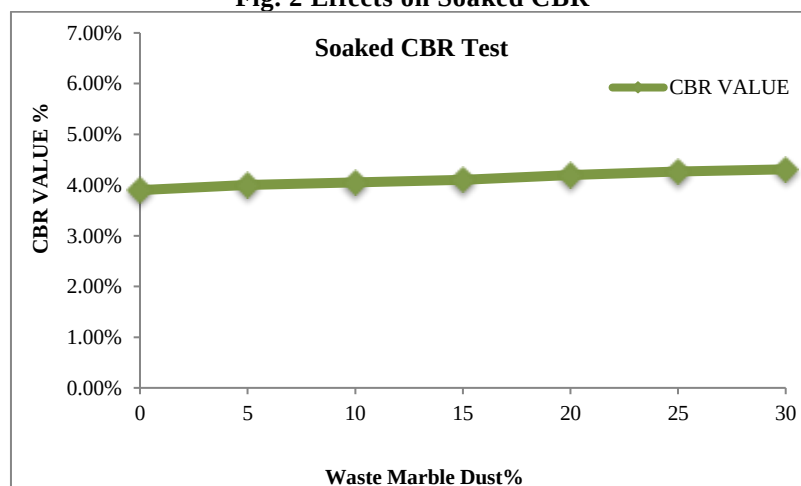
Fig. 1 Effects on Atterberg's limit



B. CALIFORNIA BEARING RATIO TEST

Soaked CBR test is a penetration test which observes the subgrade strength of the pavement [12]. In this experimental work found that the untreated value of CBR was 3.9% but after enhancement of waste marble dust (5% to 30%) the value was 4.3. The increased Soaked CBR results was also reported by of Madurwar, Shinde, and Thikare [13] when waste marble dust, stone dust and fly ash mixed in the expansive soil. CBR values of expansive soil increases due to change in optimum moisture content and Atterberg limits value [14] when adding the waste marble dust.

Fig. 2 Effects on Soaked CBR

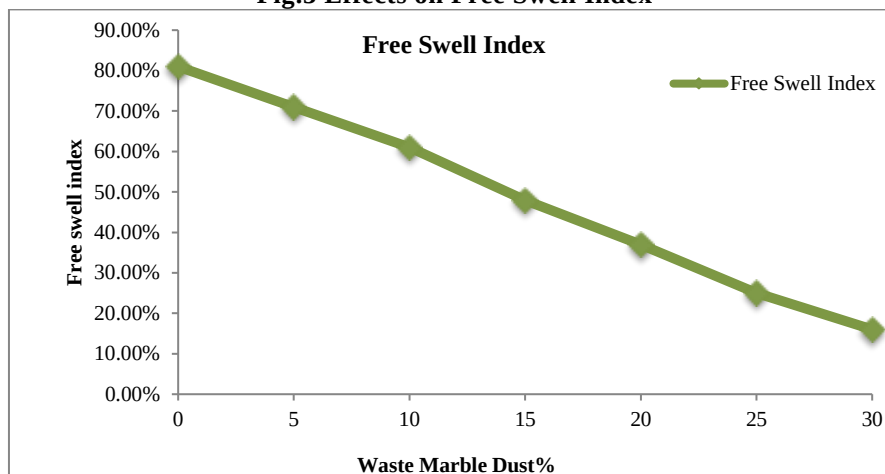


C. FREE SWELL INDEX

The volume of soil mass increases without water pressure and any type of external forces is responsible of free swell of soil [15]. In this test observed that when the enhancement of waste marble dust (5% to 30%) in the expansive soil, the free swell index was decreased from 80% to 16%. The decreased free swell index result was

also reported by of Aldeeky, Hussien and Al Hattamleh, Omar [16] when mixed waste fine steel slag in expansive soil.

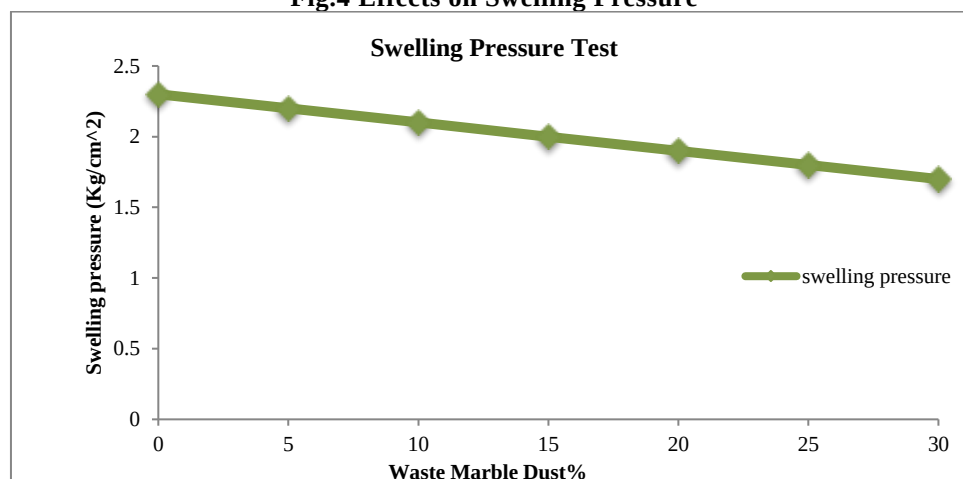
Fig.3 Effects on Free Swell Index



D. SWELLING PRESSURE

Presence of moisture content in the soil is effect on volumetric changes in the soil mass is responsible for swelling of expansive clay soil [17]. The swelling pressure of expansive soil was 74.3% decreased when mixed the waste marble dust (5% to 30%) as compared to untreated sample. In experimental test observed that the Swelling pressure of soil was decreased from 132KN/m² to 34KN/m² when the percentage of waste marble dust was increased from 5% to 30%.The swelling pressure was also decreased with the rice husk ash and other waste material which is used for soil stabilization reported by Attom and Al-Sharif [18].

Fig.4 Effects on Swelling Pressure



V. Conculusions

It has been concluded the waste marble dust material is effective for stabilization of expansive soil. The following conclusions have been observed:

1. The liquid limit and plastic limit were decreased by the use of waste marble dust.
2. The soaked CBR was increased with use of waste marble dust and showed better performance with use of 30% waste marble dust to the total weight of soil.
3. The swelling pressure and free swell index were rapidly decreased with use of waste marble dust, and free swell index decreased about 79.5% of untreated expansive clay soil.

4. The soil group changed from CH to CL.

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