STUDY ON STABILIZATION OF SOIL USING STONE DUST

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ABSTRACT - *Stone dust can be obtained from stone quarry. Stones are extensively used in all building constructional activities.. The stone dust is comparatively lighter in weight and stronger than common clay bricks. Since stone dust is being accumulated as waste material in large quantity near stone quarry.*

The waste product from quarry which can be used as soil stabilizer. The appropriate use of waste product gives the stability and also gives strength to soil. The Stone dust is easily available and which can be generally obtained at very cheaper rate.

The object of this project is to represent the information regarding Stone dusts properties and their uses in a most concise, compact and to the point manner.

And also, in this project various laboratory experiments were carried out on stone dusts samples. Some of them are CBR Test, Standard Proctor Test etc.

***Key Words**: Soil Stabilisation, Stone dust, Bearing Capacity, Bearing strength, CBR etc.*

1. INTRODUCTION

Soil stabilization a general term for any physical, chemical, biological or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities, tensile strength, and overall performance of in-situ sub-soils, sands, and other waste materials in order to strengthen road surfaces.

Some of the renewable technologies are: enzymes, surfactants, biopolymers, synthetic polymers, co-polymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fibre reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride and more. Some of these new stabilizing techniques create hydrophobic surfaces and mass that prevent road failure from water penetration or heavy frosts by inhibiting the ingress of water into the treated layer.

However, recent technology has increased the number of traditional additives used for soil stabilization purposes. Such non-traditional stabilizers include: Polymer based products (e.g. cross-linking water-based styrene acrylic polymers that significantly improves the load-bearing capacity and tensile strength of treated soils), Copolymer Based Products, fibre reinforcement, calcium chloride, and Sodium Chloride. Soil can also be stabilized mechanically, for example, using geogrids or geocells, which are a 3D mechanical soil stabilization technique.

Traditionally and widely accepted types of soil stabilization techniques use products such as bitumen emulsions which can be used as a binding agents for producing a road base. However, bitumen is not environmentally friendly and becomes brittle when it dries out. Portland cement has been used as an alternative to soil stabilization. However, this can often be expensive and is not a very good "green" alternative. Cement fly ash, lime fly ash (separately, or with cement or lime), bitumen, tar, cement kiln dust (CKD), tree resin and ionic stabilizers are all commonly used stabilizing agents.

Stone Dust:

Stone dust is a waste material obtained from crusher plants. It has potential to be used as partial replacement of natural river sand in concrete. Use of stone dust in concrete not only improve the quality of concrete but also conserve the natural river sand for future generations. In the present investigation, an experimental program was carried out to study the workability and compressive strength of concrete made using stone dust as partial replacement of fine aggregate in the range of 10%-100%. M25 grade of concrete was designed using Portland pozzolana cement (PPC) for referral concrete. Workability and Compressive strength were determined at different replacement level of fine aggregate which is a referral concrete and optimum replacement level was determined based on compressive strength. Results showed that by replacing 60% of fine aggregate with stone dust concrete of maximum compressive strength can be made as compared to all other replacement levels.

Requirements and Advantages:

Stone powder produced from stone crushing zones appears as a problem for effective disposal. Sand is a common fine aggregate used in construction work as a fine aggregate. In this study, the main concern is to find an alternative of sand. Substitution of normal sand by stone powder will serve both solid waste minimization and waste recovery.

The study focuses to determine the relative performance of concrete by using powder sand. From laboratory experiments, it was revealed that concrete made of stone powder and stone chip gained about 15% higher strength than that of the concrete made of normal sand and brick chip. Concrete of stone powder and brick chip gained about 10% higher strength than that of the concrete normal sand and stone chip concrete. The highest compressive strength of mortar found from stone powder which is 33.02 Mpa, shows that better mortar can be prepared by the stone powder. The compressive strength of concrete from stone powder shows 14.76% higher value than that of the concrete made of normal sand On the other hand, concrete from brick chip and stone powder produce higher compressive value from that of brick chip and normal sand concrete.

It improves the strength of the soil thereby increasing the bearing capacity of soil. It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation.

Benefits of soil stabilization:

Save on Time: Delays and setbacks can be quite common in major projects. With the application of a soil stabilizer such as EarthZyme, you can eliminate any unnecessary stoppages in work caused by rainfall or factors that are beyond your control. Minimal Environmental Footprint: constant traffic, especially on mine sites where haul trucks carry massive loads on a daily basis, can have negative impact on the environment. A soil stabilizer can ensure the roads are not damaged during and after the project.

Easily transported: EarthZyme is very concentrated, enabling it to be packaged and shipped in 20-litre totes. Just 1 litre of EarthZyme can treat 33 m3 of compacted soil. This makes the cost per 1km or mile of road negligible compared to alternative products.

1. Stabilization helps reduce soil volume change due to temperature or moisture.
2. Stabilized soil functions as a working platform for the project.
3. Stabilization reduces dust in work environment.
4. Stabilization upgrades marginal materials.
5. Stabilization conserves aggregate materials.

Table 1 Geotechnical properties of stone dusts

Sr No	Properties of soil	SA
1.	Grain size distribution Sand size (2-4.75mm) Medium Sand(0.425-2mm) Fine sand (0.075-0.425mm) Silty size (0.002-0.075mm) Clay size (<0.002mm)	 7 32 45 16
2.	Specific Gravity	2.75

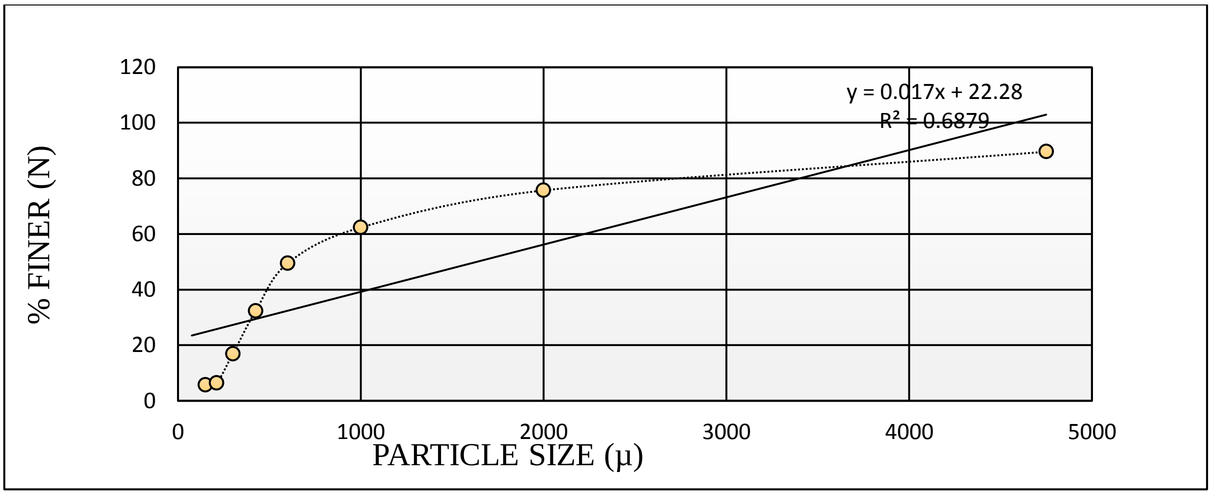
3.	Compaction Characteristics Max dry density Optimum moisture content %	 1.89 12.40
4.	Soaked CBR value %	20.76

2. PERFORMANCE ANALYSIS

2.1 PARTICAL SIZE DISTRIBUTION

Table 2.a: Particle Size Distribution

No	IS Sieve	Particle Size	Mass retained(g)	% Retain	Cumulative % age	% Finer
01	4.75mm	4.75mm	41.70	10.43	10.43	89.58
02	2mm	2mm	55.61	13.90	24.33	75.67
03	1mm	1mm	53.30	13.33	37.65	62.35
04	600 µ	0.600mm	51.60	12.90	50.55	49.45
05	425 µ	0.425mm	68.60	17.15	67.70	32.30
06	300 µ	0.300mm	61.60	15.40	83.10	16.90
07	212 µ	0.212mm	41.80	10.45	93.55	6.45
08	150 µ	0.150mm	3.00	0.75	94.30	5.70
09	75 µ	0.75mm	4.40	1.10	95.40	4.60
10	Pan	-	18.39	4.60	100	0.00



Graph 2.a: Particle size distribution

- **The Values Corresponding To D10, D30, D60**

Unconformity coefficient C_u

$$C_u = \frac{D_{60}}{D_{10}}$$

= (900\250)

= 3.6

Coefficient of Curvature c_c

$$C_c = \frac{(D_{30})^2}{D_{60} \cdot D_{10}}$$

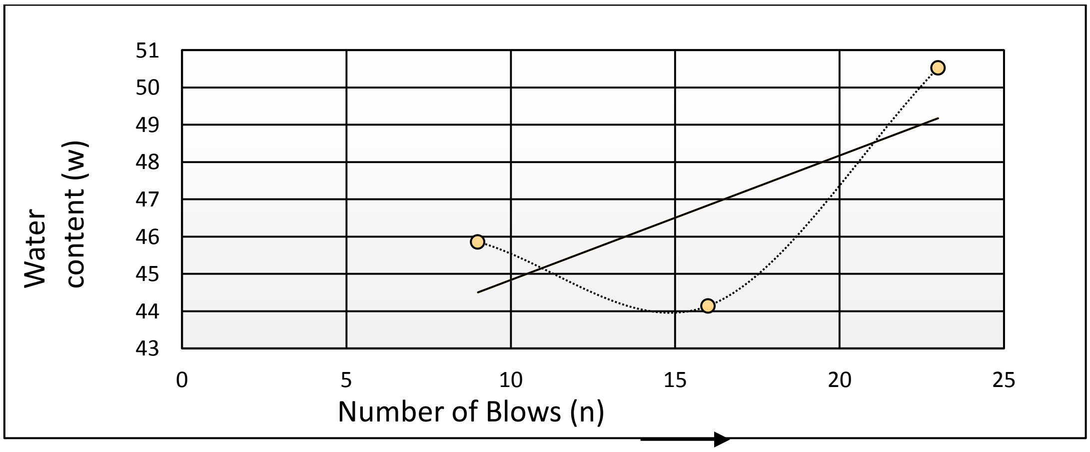
= (410^2/900x250)
= 0.7

- C_c **between 1 and 3** also indicate a well-graded soil.
- Hence, we found the soil is well graded soil means that a soil which has a distribution of particles over a wide size range.
- C_u **< 3** indicates a **uniform soil**, i.e. a soil which has a very narrow particle size range.

2.2 LIQUID LIMIT TEST (PLAIN SOIL)

Table 2.b: Liquid Limit Test (Plain Soil)

DETERMINATION NO	NOTATION	I	II	III
Container Number		96	91	18
Number of Blows		09	16	23
Weight of Container	W_0 (grams)	11.99	11.92	12.22
Weight of Container + Wet Soil	W_1 (grams)	27.67	28.05	29.05
Weight Of 1Container + Oven-dry Soil	W_2 (grams)	22.74	23.11	23.40
Weight of Water	W_1-W_2 (grams)	4.93	4.94	5.65
Weight of Oven-dry soil	W_2-W_0 (grams)	10.75	11.19	11.18
Water Content (as a percentage)	$W = \left[\frac{W1 - W2}{W2 - W0}\right] X\,100$	44.14	45.86	50.53



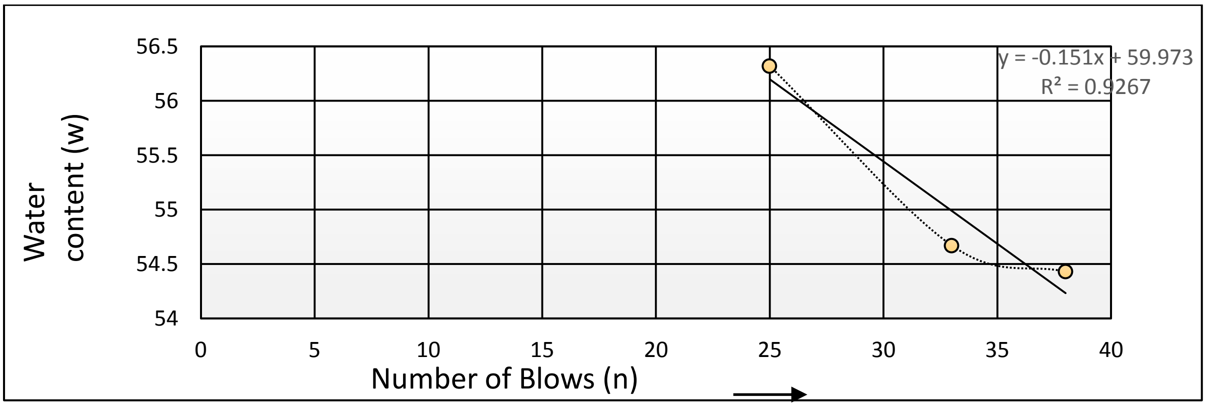
Graph 2.b: Liquid Limit of Plain Soil

AVERAGE WATER CONTENT: W = 46.84 %

2.3 LIQUID LIMIT TEST (PLAIN SOIL+4% STONE DUST)

Table 2.c: Liquid Limit Test (Plain Soil+4% Stone Dust)

DETERMINATION NO	NOTATION	I	II	III
Container Number		93	06	19
Number of Blows		25	33	38
Weight of Container	W_0 (grams)	12.35	12.29	12.86
Weight of Container + Wet Soil	W_1 (grams)	14.41	14.92	14.74
Weight Of 1Container + Oven-dry Soil	W_2 (grams)	13.64	14.10	13.84
Weight of Water	W_1-W_2 (grams)	0.77	0.82	0.90
Weight of Oven-dry soil	W_2-W_0 (grams)	1.51	1.81	1.58
Water Content (as a percentage)	$W = \left[\frac{W1 - W2}{W2 - W0}\right] X\,100$	56.32	54.67	54.31



Graph 2.c: Liquid Limit (Plain Soil+4% Stone Dust)

AVERAGE WATER CONTENT: W=51.09%

2.4 PLASTIC LIMIT TEST (PLAIN SOIL)

Table 2.d: Plastic Limit Test (Plain Soil)

DETERMINATION NO	NOTATION	I	II
Container Number		96	91
Weight of Container	W_0 (grams)	11.99	11.92
Weight of Container + Wet Soil	W_1 (grams)	12.35	12.92
Weight of Container + Oven-dry Soil	W_2 (grams)	12.67	12.63
Weight of Water	W_1-W_2 (grams)	0.32	0.29
Weight of Oven-dry soil	W_2-W_0 (grams)	0.68	0.71
Water Content (as a percentage)	$W = \left[\frac{W1 - W2}{W2 - W0}\right] X\,100$	47.05	40.84

PLASTIC LIMIT: W_P = 43.94 %

PLASTICITY INDEX:

PLASTICITY INDEX = LIQUID LIMIT – PLASTIC LIMIT

PLASTICITY INDEX = 15.53%

2.5 PLASTIC LIMIT TEST (PLAIN SOIL+4% STONE DUST)

Table 2.e: Plastic Limit Test (Plain Soil+4% Stone Dust)

DETERMINATION NO	NOTATION	I	II
Container Number		18	97
Weight of Container	W_0 (grams)	12.22	11.84
Weight of Container + Wet Soil	W_1 (grams)	14.19	13.88
Weight of Container + Oven-dry Soil	W_2 (grams)	13.72	13.27
Weight of Water	W_1-W_2 (grams)	0.47	0.61
Weight of Oven-dry soil	W_2-W_0 (grams)	1.5	1.43
Water Content (as a percentage)	$W = \left[\frac{W1 - W2}{W2 - W0}\right] X\ 100$	31.33	42.65

PLASTIC LIMIT: W_P = 37 %

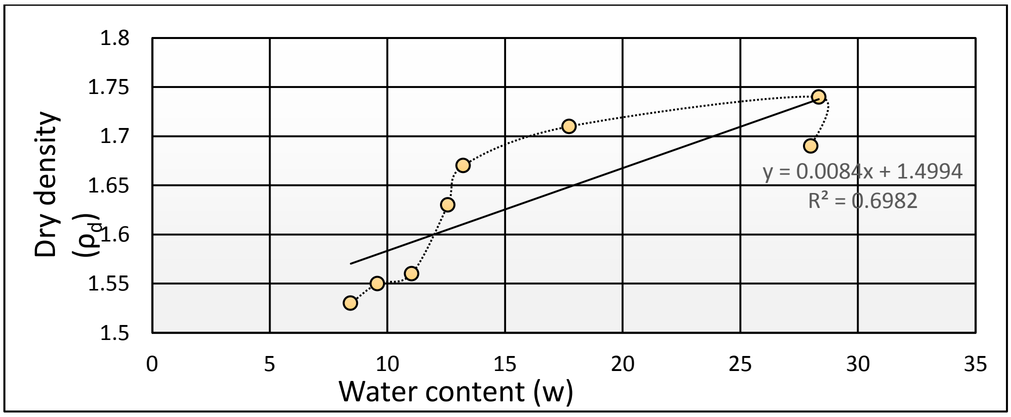
PLASTICITY INDEX = LIQUID LIMIT – PLASTIC LIMIT

PLASTICITY INDEX = 10.53%

2.6 STANDARD PROCTOR TEST (PLAIN SOIL)

Table 2.f: Standard Proctor Test (Plain Soil)

Trial Number	NOTATION	I	II	III	IV	V	VI	VII	VIII
Weight of Soil		2.5kg	2.5kg	2.5kg	2.5kg	2.5kg	2.5Kg	2.5Kg	2.5Kg
Weight of mould (without collar)		3661g	3661g	3661g	3661g	3661g	3661g	3661g	3661g
Weight of mould+soil		5243	5239	5324	5437	5526	5625	5653	5582
Container Number		91	94	18	13	15	02	12	6
Weight of Container	W_0 (grams)	11.92	12.26	12.22	11.90	12.16	11.84	20.86	21.40
Weight of Container + Wet Soil	W_1 (grams)	15.12	16.55	19.29	18.15	18.60	19.21	28.45	27.39
Weight of Container + Oven-dry Soil	W_2 (grams)	14.84	16.23	18.50	17.42	17.96	18.10	27.12	26.07
Weight of Water	W_1-W_2 (grams)	0.28	0.32	0.79	0.73	0.64	1.11	1.33	1.32
Weight of Oven-dry soil	W_2-W_0 (grams)	2.92	3.79	6.28	5.52	5.8	6.26	6.26	4.67
Density		1.68	1.68	1.76	1.88	1.98	2.08	2.11	2.03
Water Content (%)	$W = \left[\frac{W1-W2}{W2-W0}\right] X\ 100$	8.44	9.58	11.03	12.57	13.22	17.73	28.34	28.01
DRY DENSITY	$\frac{M/V}{1+w}$	1.53	1.55	1.56	1.63	1.67	1.71	1.74	1.69



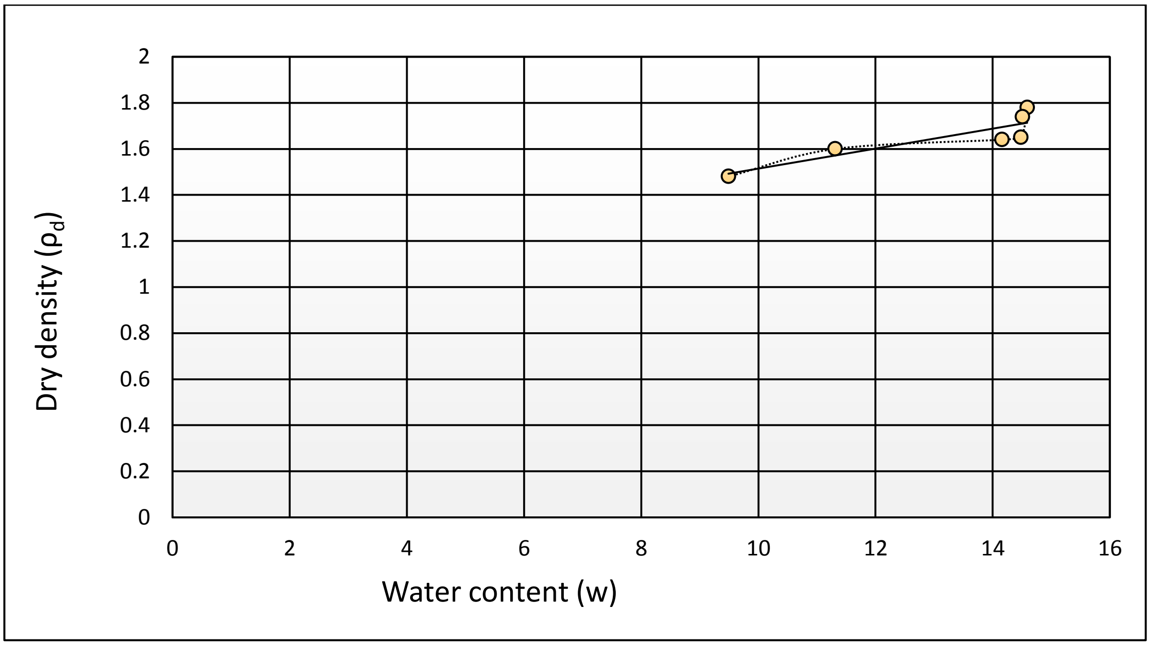
Graph2.f: Standard Proctor Test (Plain Soil)

The maximum dry density of soil is 1.78 at 11.02 % of water content

2.7 STANDARD PROCTOR TEST (PLAIN SOIL+4% STONE DUST)

Table 2.g: Standard Proctor Test (Plain Soil+4% Stone Dust)

Trial Number	NOTATION	I	II	III	IV	V	VI
Weight of Soil		2.5kg	2.5kg	2.5kg	2.5kg	2.5kg	2.5kg
Weight of mould (without collar)		3661g	3661g	3661g	3661g	3661g	3.661g
Weight of mould+soil		5215	5330	5436	5448	5603	5543
Container Number		13	02	99	94	12	15
Weight of Container	W_0 (grams)	11.90	11.84	12.08	12.26	20.86	12.16
Weight of Container + Wet Soil	W_1 (grams)	17.31	18.07	16.19	17.09	26.75	18.80
Weight of Container + Oven-dry Soil	W_2 (grams)	16.76	17.53	15.68	16.47	26	17.96
Weight of Water	W_1-W_2 (grams)	0.55	0.54	0.51	0.62	0.75	0.84
Weight of Oven-dry soil	W_2-W_0 (grams)	4.86	5.69	3.6	4.21	5.14	5.8
Density		1.65	1.76	1.88	1.90	2.05	2.00
Water Content (%)	$w = \left\|\frac{W_1 - W_2}{W_2 - W_0}\right\| \times 100$	9.49	11.31	14.16	14.48	14.59	14.51
DRY DENSITY	$\frac{M/V}{1+w}$	1.48	1.60	1.64	1.65	1.78	1.74



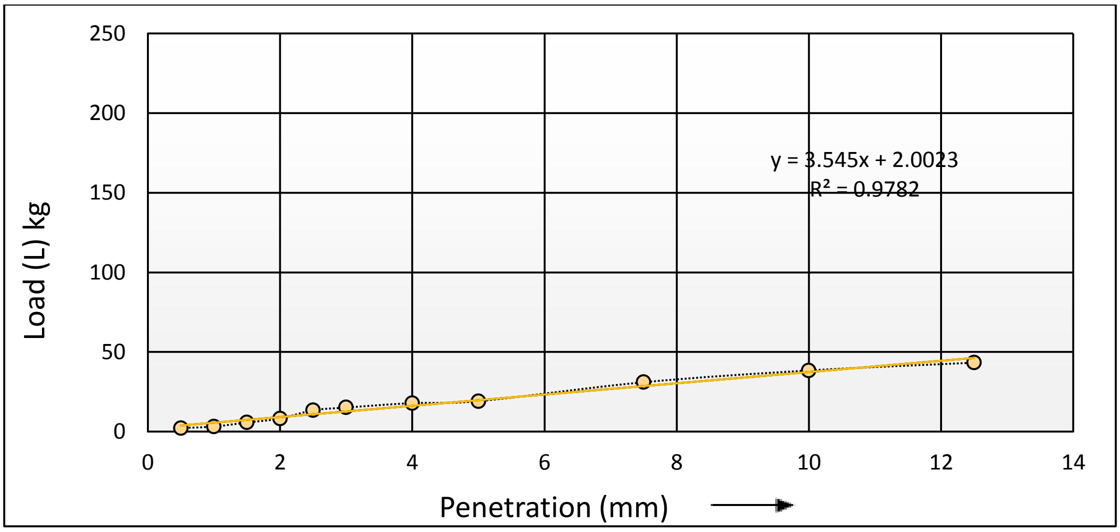
Graph 2.g: Standard Proctor Test (Plain Soil+4% Stone Dust)

The maximum dry density of soil is 1.78 at 14.59 % of water content.

2.8 UNSOAKED C.B.R. TEST (PLAIN SOIL)

Table 2.h: Unsoaked C.B.R. Test (Plain Soil)

Sr. No	PENETRATION(mm)	DIAL READING
1	0.5	2.2
2	1	3.2
3	1.5	5.7
4	2	8.2
5	**2.5**	**13.4**
6	3	15.1
7	4	17.9
8	**5**	**19.1**
9	7.5	31.0
10	10	38.4
11	12.5	43.3



Graph 2.h: Unsoaked C.B.R. Test (Plain Soil)

1. **THE CBR VALUE AT 2.5 MM = 5.23%**
2. **THE CBR VALUE AT 5 MM = 4.97 %**

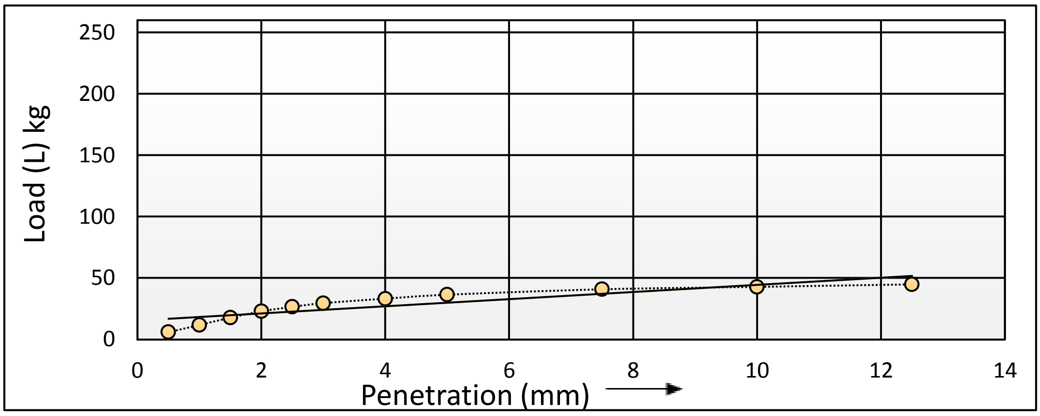
THE CBR VALUE OF SOIL IS= 5.23%

2.9 UNSOAKED C.B.R. (PLAIN SOIL+4% STONE DUST)

Table 2.i: Unsoaked C.B.R. (Plain Soil+4% Stone Dust)

Sr. No	PENETRATION(mm)	DIAL READING
1	0.5	5.9
2	1	11.7
3	1.5	17.7

4	2	22.9
5	**2.5**	**26.5**
6	3	29.5
7	4	33.2
8	**5**	**36.4**
9	7.5	40.8
10	10	42.8
11	12.5	44.8



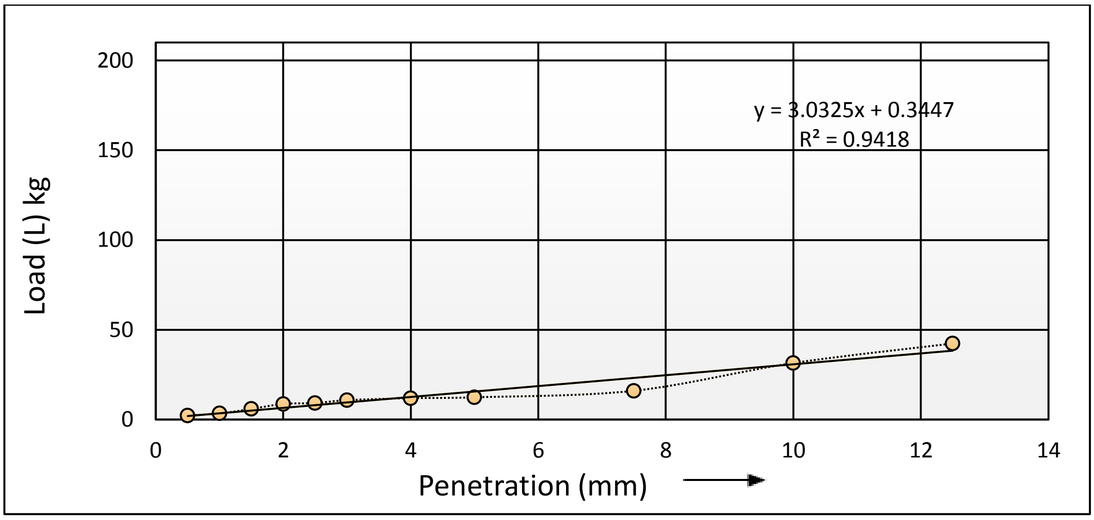
Graph 2.i: Unsoaked C.B.R. (Plain Soil+4% Stone Dust)

1. THE CBR VALUE AT 2.5 MM = 6.63 %
2. THE CBR VALUE AT 5 MM = 6.32 %
THE CBR VALUE OF SOIL IS = 6.63%

2.10 SOAKED C.B.R. TEST (PLAIN SOIL)

Table 2.j: Soaked C.B.R. Test (Plain Soil)

Sr. No	PENETRATION(mm)	DIAL READING
1	0.5	2.2
2	1	3.3
3	1.5	5.8
4	2	8.6
5	**2.5**	**9.1**
6	3	10.7
7	4	11.8
8	**5**	**12.3**
9	7.5	15.9
10	10	31.4
11	12.5	42.3



Graph 4.j: Soaked C.B.R. Test (Plain Soil)

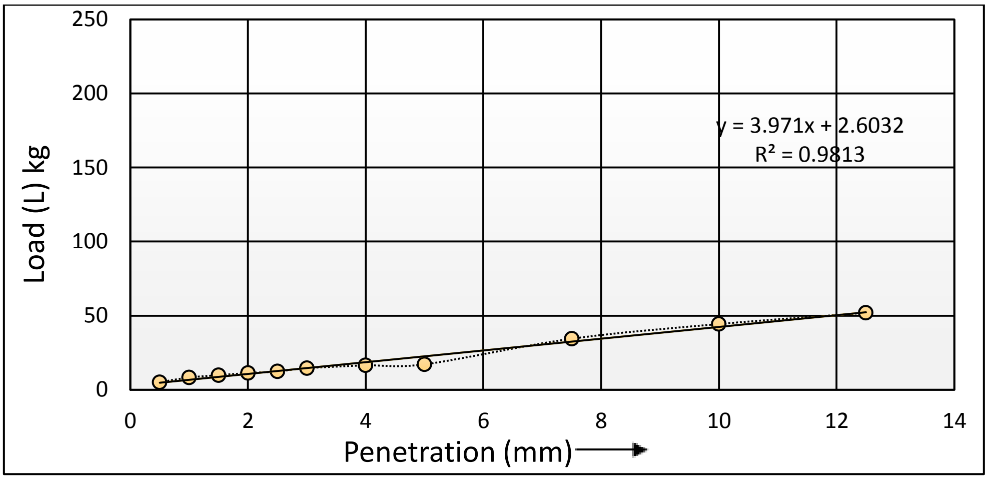
1. THE CBR VALUE AT 2.5 MM = 3.55%
2. THE CBR VALUE AT 5 MM = 3.20 %

THE CBR VALUE OF SOIL IS = 3.55%

2.11 SOAKED C.B.R. (PLAIN SOIL+4% STONE DUST)

Table 2.k: Soaked C.B.R. (Plain Soil+4% Stone Dust)

Sr. No	PENETRATION(mm)	DIAL READING
1	0.5	5.1
2	1	8.2
3	1.5	9.8
4	2	11.2
5	**2.5**	**12.3**
6	3	14.5
7	4	16.4
8	**5**	**17.1**
9	7.5	34.4
10	10	44.3
11	12.5	51.9



Graph 2.k: Soaked C.B.R. (Plain Soil+4% Stone Dust)

1. THE CBR VALUE AT 2.5 MM = 4.80 %
2. THE CBR VALUE AT 5 MM = 4.45 %

THE CBR VALUE OF SOIL IS = 4.80%

CONCLUSIONS

The following are the soil conclusions. The conclusion is based on the test carried out on soil selected for the study.

- The waste product removed from Stone Crusher which can be used as soil stabilizer.
- The appropriate use of stone dust gives the stability and also gives strength to soil.
- It is observed that value increases significantly after addition of 1.0% Stone Dust content.
- In earth soils Stone Dust can be used as a soil stabilizer enhanced the Engineering properties of the soil.
- As the strength of soil increases with an addition of Stone Dust, the quality, strength of soil will be more as compare to plain soil.
- It is an industrial by product having benefits like maintenance of ecological balance.

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