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STUDY OF MARBLE SLURRY STABILIZATION FOR LAND FILLING USING CLAY AS ADDITIVE

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ABSTRACT

In India there are many industrial by product, which is being dumped as waste material, creating disposal problem and pollution hazard. The major volume of various waste produced in different industries, like Fly ash, Red mud, blast furnace slag and locally available low cost material can be used successfully in different works. A variety of marble i.e. white, pink, greenish etc- is available m the state of Rajasthan. Diamond cutting tools are extensively used in marble cutting. Cutting waste is in the form of slurry, which consists of very fine particles of marbles. As a result of industrial growth, several waste materials are accumulating in huge quantities causing environmental pollution and creating disposal problem, a waste material produced by these marble industries is one such requiring immediate attention. Till today, there is no specific use of this marble slurry industrialists are dumping the slurry here and there according to their facility, creating large illegal dumping yards along the road side of these mining area. Town Makrana and bye pass road near Kishangarh, Ajmer are best examples for this type of pollution. The use of fly ash in embankment construction not only facilitates the disposal of fly ash but also provide significant benefits in terms of engineering and economic considerations.

Keywords: Waste Material, Slurry, Analysis, Investigation, Research.

I. INTRODUCTION

SOIL STABILIZATION is the process of changing the properties of soil to satisfy a specific engineering requirement. A soil's properties can be changed in a variety of ways, including chemical, thermal, mechanical, and other methods. It must be understood, however, that because to the wide variety of soils, no single approach is even effective in more than a small percentage of them. There are several methods of stabilization may be grouped under two main types:

1. Modification or improvement of properties of existing soil i& performed without addition of any admixture, and
2. Improvement of properties with the help of adding admixtures.

Drainage and compaction are the examples of first type, which Improve inherent shear strength of soil. Whereas mechanical Stabilization, lime stabilization with cement, bitumen and by various chemical are the examples of the second type. Hence when a less stable Soil is treated by any means to improve its strength and resistance against deformation, it is said to be stabilized. Marble as raw material for building construction was not extensively used in ancient time. People belonging to higher strain of the society used marble as decorative slabs in houses, monumental buildings etc. Lesser use of marble generated less wastage but commercial production of marble and rapid urbanization has placed its use as first choice even of middle class; thereby increase in waste material is manifold. As per Indian mineral year book 1993, there are total of 1004.3 million tones reserves of marble in our country. Out of the total reserves more than 90% are in Rajasthan. The year wise production of marble in Rajasthan is as under.

Table 1. Year wise production of marble in Rajasthan

Year	Production in Tones
2017-18	13199265
2018-19	8252000
2019-20	10621000

The figures given above shows that the production has raised from 82.5 lac tones to 106.2 tons in 1 year i.e. an average is more than 20% per year.

To put the marble rock in its final shape as per necessity, the marble industry was dumping 15% solids here and there waste including blasting muck, marble pieces (waste of cutting machine) etc. with technological changes wastage has gone down. Smaller pieces of marble are crushed or finally grounded and used as abrasive in soaps and other products. Crushed marble is also used in paving roads and in manufacturing roofing materials and soil treatment products. But wastes produced by machi9ne like Diamond gang saw, Diamond wire saw is in very fine powdered form, passing 75 micron is still of no commercial use and therefore, being thrown away here and there. Heaps of this powder can be seen on roadsides of Makrana-Kishangarh bypass, Rajnagar etc. the powder blows away with wind causing air pollution. The gravity of the problem can be visualized by the fact that a plot of more than 50 bhiga land arranged by the municipality of Makrana town was completely filled by this waste within a few years.

Mathur, K.K, (2000) admix the marble slurry with clay for making bricks. He concluded that only 5% marble slurry is useful to increase the strength of bricks. No more literature is available on reuse of marble slurry

II. METHODOLOGY

TEST PROGRAM AND PROCEDURE

1.GENERAL

- The laboratory investigation on marble slurry stabilization with Clay were conducted. The marble slurry was brought from marble cutting factory and Clay used here to be investigating with Marble slurry was taken from a site nearby Jaipur. It is moderately stiff in nature

2. MATERIALS

(a) Marble Cutting Powder

The marble powder used to admix for stabilization was obtained from local marble cutting machine of Jodhpur as marble slurry, after sun dried it was used as marble powder. The physical properties of the marble powder were tested, and the same are reported as under:

Table 2. Physical properties of Marble Cutting Powder

S.No.	Physical properties of marbles cutting powder	
1.	Max. Dry density (ρ_{dmax})	1.714gm/c.c
2.	Optimum moisture Content	18.1%
3.	Specific gravity	2.70
4.	Particle smaller than 75 micron	100%

Table 3. Chemical Composition of Marble of Rajasthan

Chemical Analysis	**Locality**			
	Piloti	**Ghoratankari**	**Perwa**	**Serngwa**
Insoluble	3.97	16.16	8.32	7.80
$Fe2O_3$ AI_2O_3	0.67	0.74	0.54	0.02
CaO	49.55	47.89	51.49	52.58
MgO	3.47	0.70	0.90	0.11
Loss on Ignition	42.34	34.82	39.36	39.72

The particle size analysis of marble powder is determined by I hydrometer and is shown in Fig. 2, A typical pattern of the moisture content, dry density CHART is shown in Fig, 2. Optimum moisture content was determined by conducting light compaction test. The direct shear test was carried out under stress control condition determined angle of internal friction and cohesion as shown in Fig 3

3. CLAY

- Clay consist of microscopic and sub-microscopic particles derived from the chemical decomposition of rocks
- Contains large quantity of clay minerals.
- It exhibits considerable strength when dry.

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- It is a cohesive soil.
- It can be made plastic by adjusting the water content.

Physical & Chemical properties of Clay:

- Clay contains minerals; out of them 3 main types of mineral govern the chemical as well as physical properties of clay soil. These three minerals are Montmorillonite. Kaolinite & Illite.
- Clay minerals are composed of two basic structural units: (1) Tetrahedral unit, (2) Octahedral unit.
- Clay has high plasticity and swelling property due to clay mineral Montmorillonite.
- Their particles are colloidal in shape. Due to such shape they assembled either in flocculated or in depressed state.
- Clay has high specific surface. Due colloidal particle it remains in suspension for longer time.
- When it assembled in loose state it possess high voids ratio. However it has very low permeability or low seepage. This paradox shown by clay can be explained by its particles shape.
- Its particles have very thin sheet type structure on saturation a water film form surround the each particle and this water which called adsorbed water obstruct the flow of water through clay by surface tension force.
- A high value of toughness index indicates a high percentage of colloidal clay containing mineral montmorillonite.
- Clay used here to be investigating with Marble slurry was taken from a site nearby Jaipur. It is moderately stiff in nature

4. TEST PROGRAM

✓ **TEST FOR INDEX PROPERTIES,**

- Determination of Liquid limit,
- Determination of Plastic limit,
- Determination of Shrinkage limit,
- Determination of Plasticity Index,
- Determination of Flow index,
- Determination of Toughness index &

✓ **TEST FOR ENGINEERING PROPERTIES,**

- Standard Proctor Test
  - Determination of Optimum moisture Continent.
  - Determination of Maximum dry strength.
- Direct Shear Test

(A-Strain Controlled Test / B-Stress Controlled Test)

  - Determination of Shear angle
  - Determination of Cohesion value

✓ SAMPLE TAKEN FOR VARIOUS TESTS

(100% Mp & 0% Clay)

(90% Mp & 10% Clay), (80% Mp & 20% Clay)

(70% Mp & 30% Clay), (60% Mp & 40% Clay)

(55% Mp & 45% Clay), (50% Mp & 50% Clay)

(45% Mp & 55% Clay), (40% Mp & 60% Clay)

(35% Mp & 65% Clay), (30% Mp & 70% Clay)

(20% Mp & 80% Clay), (10% Mp & 90% Clay)

(0% MP & 100% Clay)

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III. RESULTS AND DISCUSSION

The results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. This section should be typed in character size 10pt Times New Roman.

Table 4. Comparison of displacement of all 4 cases

SN.	Model Type	Seismic Zone	Displacement
1	Model-A	4	10.044 mm
2	Model-B	4	11.335 mm
3	Model-C	4	10.248 mm
4	Model-D	4	11.364 mm
5	Model-E	4	12.16 mm
6	Model-F	4	10.99 mm
7	Model-G	4	11.29mm
8	Model-H	4	13.20mm
9	Model-I	4	9.2mm

GENERAL

The Following test has been conducted to find the Liquid limit, Plastic limit, Shrinkage limit, Plasticity Index, Flow index and Toughness index

LIQUID LIMIT

- Liquid limit test for (100% Mp & 0% Clay)
- Liquid limit test for (90% Mp & 10% Clay)
- Liquid limit test for (80% Mp & 20% Clay)
- Liquid limit test for (70% Mp & 30% Clay)
- Liquid limit test for (60% Mp & 40% Clay)

Table 5

Liquid Limit for 100% MP& 0% Clay					
Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)	No. of Blows
1	23.25	35.36	31.21	52.13	14
2	24.96	40.39	35.14	51.56	17
3	31.52	45.14	40.69	48.53	23
4	29.7	44.03	39.44	47.13	35
5	35.68	51.46	46.47	46.23	41

LIQUID LIMIT----48.13%	
No. of Blows	Water Content (w%)
11	65.98
19	63.24
24	61.97
29	60.49
39	58.17

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Table 6 Liquid Limit for 90% MP & 10 %Clay (Table 4.3)

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)	No. of Blows
1	31.53	43.89	39.71	51.09	19
2	29.7	45.37	40.12	50.36	22
3	31.05	44.48	40.08	48.73	29
4	35.68	49.87	45.26	48.13	32
5	22.11	37.45	32.52	47.36	39

Table 7 Liquid Limit for 80% MP & 20 %Clay

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)	No. of Blows
1	23.26	35.36	31.21	52.23	17
2	31.52	46.95	41.70	51.58	19
3	29.71	43.34	38.79	50.12	27
4	35.68	49.82	45.22	48.21	35
	LIQUID LIMIT----50.52%				

Table 8 Liquid Limit for 70% MP & 30 %Clay

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)	No. of Blows
1	31.52	43.19	39.07	54.58	14
2	35.68	51.05	45.80	51.87	19
3	29.67	43.83	39.20	48.59	37
4	29.77	43.25	38.75	50.12	27
5	22.1	37.19	32.20	49.39	31
	LIQUID LIMIT----51.49%				

Table 10 Liquid Limit for 50% MP & 50 %Clay

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)	No. of Blows
1	26.21	37.93	33.78	54.81	21
2	29.21	44.32	39.07	53.27	27
3	29.63	42.68	38.28	50.87	33
4	24.48	38.24	33.62	50.52	37
5	25.31	39.88	34.89	52.11	29

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LIQUID LIMIT----53.89%	
No. of Blows	Water Content (w%)
18	56.47
23	55.13
25	54.73
29	53.52
36	53.07

PLASTIC LIMIT

- Plastic limit test for (100% Mp & 0% Clay)
- Plastic limit test for (90% MP & 10% Clay)
- Plastic limit test for (80% MP & 20% Clay)
- Plastic limit test for (70% MP & 30% Clay)
- Plastic limit test for (60% MP & 40% Clay)

Table 11 Plastic Limit for 100 % MP

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)
1	26.2	33.45	31.15	46.51
2	29.23	36.81	34.41	46.37
3	29.62	107.85	82.85	46.97
4	24.47	31.05	28.95	46.85
5	25.35	33.50	30.90	46.83
6	31.97	39.18	36.88	46.85
7	23.22	29.80	27.70	46.85
1. PLASTIC LIMIT :- 46.73%				

Table 12 Plastic Limit for 90 % MP

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)
1	23.25	29.96	27.86	45.53
2	31.54	39.84	37.24	45.6
3	24.96	32.30	30.00	45.67
4	29.7	37.36	34.96	45.65
5	29.68	38.57	35.77	45.95
6	22.11	31.32	28.42	45.97
7	29.76	36.43	34.33	45.97
1. PLASTIC LIMIT :-45.76%				

Table 13

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)

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1	35.68	43.73	41.23	45.07
2	29.71	38.07	35.47	45.17
3	24.97	34.28	31.38	45.27
4	31.54	39.88	37.28	45.26
5	23.25	29.99	27.89	45.25
6	29.77	39.07	36.17	45.29
7	22.1	30.43	27.83	45.35
1. PLASTIC LIMIT :- 45.23%				

Table 14 Plastic Limit for 70 % MP

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)
1	30.64	37.43	35.33	44.73
2	24.78	32.82	30.32	45.12
3	26.16	35.51	32.61	44.99
4	29.14	38.44	35.54	45.31
5	31.01	39.74	37.04	44.75
6	29.58	38.89	35.99	45.27
7	24.58	31.32	29.22	45.27
1. PLASTIC LIMIT :- 45.06%				

Table 15 Plastic Limit for 60 % MP

Test No.	Wt. Of Empty Crucible (W_1) gm	Wt of Empty crucible + Wet Sample (W_2) gm	Wt of Empty Crucible + Dry Sample (W_3) gm	Water Content (w%)
1	24.78	33.17	30.57	44.91
2	26.17	34.26	31.76	44.76
3	29.15	38.21	35.41	44.73
4	31.01	40.40	37.50	44.67
5	24.58	32.32	29.92	44.97
6	29.76	36.22	34.22	44.89
1. PLASTIC LIMIT :- 44.82%				

3 SHRINKAGE LIMIT

- Shrinkage limit for (100% MP& 0% Clay)
- Shrinkage limit for (90% MP & 10% Clay)
- Shrinkage limit for (80% MP & 20% Clay)
- Shrinkage limit for (70% MP & 30% Clay)
- 4.17 Shrinkage limit for (60% MP & 40% Clay)

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TABLE 16 Observations for Shrinkage Limit

A	Water content of wet soil paste	100%MP	10%Clay+ 90%MP	20%Clay+ 80%MP
1.	Shrinkage Dish no.	E	B	D
2.	Mass of shrinkage dish(Empty)	8.87 gm	9.17 gm	8.18 gm
3.	Mass of shrinkage dish + Wet soil paste	41.23 gm	41.70 gm	40.81 gm
4.	Mass of shrinkage dish + dry soil paste	29.86 gm	31.02 gm	29.78 gm
5.	Mass of dry soil paste	20.99 gm	21.85 gm	21.6 gm
6.	Mass of water	11.37 gm	10.68 gm	11.04 gm
7.	Water content of soil paste (w)	54.16 %	48.87 %	51.11 %
B	**Volume of wet soil paste**			
1.	Mass of evaporating dish	50.65	50.65	50.65
2.	Mass of mercury filling shrinkage dish + evaporating dish	315.44	310.04	310.4
3.	Mass of mercury filling shrinkage dish	264.79	259.39	259.75
4.	Volume of wet soil paste(V)	19.47 cm^3	19.07 cm^3	19.0799cm^3
C	**Volume of dry soil paste**			
1.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste) + evaporating dish	125.57	116.53	123.13
2.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste)	74.86	65.88	72.48
3.	Mass of mercury displaced by dry paste	189.93	193.51	187.27
4.	Volume of dry paste(V_d)	13.96 cm^3	14.23 cm^3	13.769cm^3
D	**Calculation:-**			
1.	Shrinkage limit w_s=(w-(V- V_d)/M_d)*100	27.90	26.72	26.43
2.	Shrinkage ratio sr= M_d/ (V_d*P_w)	1.5036	1.5235	1.5687

TABLE 17 Observations for Shrinkage Limit

A	Water content of wet soil paste	30%Clay+ 70%MP	40%Clay+ 60%MP	45%Clay+ 55%MP
1.	Shrinkage Dish no.	C	A	D
2.	Mass of shrinkage dish(Empty)	9.24 gm	9.48 gm	8.18 gm
3.	Mass of shrinkage dish + Wet soil paste	42.02 gm	41.27 gm	41.42 gm
4.	Mass of shrinkage dish + dry soil paste	30.82 gm	29.87 gm	31.2 gm
5.	Mass of dry soil paste	21.58 gm	20.42 gm	23.02 gm
6.	Mass of water	11.2 gm	11.4 gm	10.22 gm
7.	Water content of soil paste (w)	51.899 %	55.82 %	44.41 %
B	**Volume of wet soil paste**			
1.	Mass of evaporating dish	50.65	50.65	50.65
2.	Mass of mercury filling shrinkage dish +	315.72	317.03	310.4

	evaporating dish			
3.	Mass of mercury filling shrinkage dish	265.07	266.38	259.75
4.	Volume of wet soil paste(V)	19.49cm^3	19.586 cm^3	19.099 cm^3
C	**Volume of dry soil paste**			
1.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste) + evaporating dish	128.00	139.17	116.7
2.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste)	77.35	88.52	66.05
3.	Mass of mercury displaced by dry paste	187.72	177.86	193.7
4.	Volume of dry paste(V_d)	13.8 cm^3	13.08 cm^3	14.25 cm^3
D	**Calculation:-**			
1.	Shrinkage limit w_s=(w-(V- V_d)/M_d)*100	25.53	23.95	23.34
2.	Shrinkage ratio sr= M_d/ (V_d*P_w)	1.563	1.561	1.615

TABLE 18 Observations for Shrinkage Limit

A	**Water content of wet soil paste**	**50%Clay+ 50%MP**	**55%Clay+ 45%MP**	**60%Clay+ 40%MP**
1.	Shrinkage Dish no.	D	C	E
2.	Mass of shrinkage dish(Empty)	8.18 gm	9.24 gm	8.87 gm
3.	Mass of shrinkage dish + Wet soil paste	40.82 gm	41.37 gm	43.12 gm
4.	Mass of shrinkage dish + dry soil paste	29.78 gm	30.82 gm	32.39 gm
5.	Mass of dry soil paste	21.6 gm	21.58 gm	23.52 gm
6.	Mass of water	11.04 gm	10.88 gm	10.73 gm
7.	Water content of soil paste (w)	51.11 %	48.89 %	45.62 %
B	**Volume of wet soil paste**			
1.	Mass of evaporating dish	50.65	50.65	50.65
2.	Mass of mercury filling shrinkage dish + evaporating dish	310.4	315.72	315.44
3.	Mass of mercury filling shrinkage dish	259.75	265.07	264.79
4.	Volume of wet soil paste(V)	19.099 cm^3	19.49 cm^3	19.47 cm^3
C	**Volume of dry soil paste**			
1.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste) + evaporating dish	133.26	128	125.51
2.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste)	82.61	77.35	74.86
3.	Mass of mercury displaced by dry paste	177.14	187.72	189.93
4.	Volume of dry paste(V_d)	13.025 cm^3	13.8 cm^3	13.969 cm^3
D	**Calculation:-**			
1.	Shrinkage limit w_s=(w-(V- V_d)/M_d)*100	22.99	22.52	22.23

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2.	Shrinkage ratio sr= M_d/ (V_d*P_w)	1.658	1.563	1.6837

TABLE 19 Observations for Shrinkage Limit

A	Water content of wet soil paste	65%Clay+ 35%MP	70%Clay+ 30%MP	80%Clay+ 20%MP
1.	Shrinkage Dish no.	D	C	E
2.	Mass of shrinkage dish(Empty)	8.18 gm	9.24 gm	8.87 gm
3.	Mass of shrinkage dish + Wet soil paste	39.74 gm	42.91 gm	39.65 gm
4.	Mass of shrinkage dish + dry soil paste	29.78 gm	32.13 gm	27.58 gm
5.	Mass of dry soil paste	21.6 gm	22.89 gm	18.71 gm
6.	Mass of water	9.96 gm	10.78 gm	12.07 gm
7.	Water content of soil paste (w)	46.11 %	47.09 %	64.45 %
B	**Volume of wet soil paste**			
1.	Mass of evaporating dish	50.65	50.65	50.65
2.	Mass of mercury filling shrinkage dish + evaporating dish	310.4	315.72	315.44
3.	Mass of mercury filling shrinkage dish	259.75	265.07	264.79
4.	Volume of wet soil paste(V)	19.099 cm^3	19.49 cm^3	19.47 cm^3
C	**Volume of dry soil paste**			
1.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste) + evaporating dish	123.13	138.3	170.33
2.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste)	72.48	87.65	119.68
3.	Mass of mercury displaced by dry paste	187.27	177.42	145.11
4.	Volume of dry paste(V_d)	13.769 cm^3	13.045 cm^3	10.67 cm^3
D	**Calculation:-**			
1.	Shrinkage limit w_s=(w-(V- V_d)/M_d)*100	21.43	20.7029	17.46
2.	Shrinkage ratio sr= M_d/ (V_d*P_w)	1.5687	1.7547	1.7535

TABLE 20 Observations for Shrinkage Limit

A	Water content of wet soil paste	90%Clay+ 10%MP	100%Clay
1.	Shrinkage Dish no.	B	A
2.	Mass of shrinkage dish(Empty)	9.17 gm	9.45 gm
3.	Mass of shrinkage dish + Wet soil paste	41.45 gm	42.97 gm
4.	Mass of shrinkage dish + dry soil paste	30.83 gm	31.73 gm
5.	Mass of dry soil paste	21.71 gm	22.28 gm
6.	Mass of water	10.62 gm	11.25 gm
7.	Water content of soil paste (w)	48.92 %	50.45 %
B	**Volume of wet soil paste**		

1.	Mass of evaporating dish	50.65	50.65
2.	Mass of mercury filling shrinkage dish + evaporating dish	310.04	317.03
3.	Mass of mercury filling shrinkage dish	259.39	266.38
4.	Volume of wet soil paste(V)	19.07 cm^3	19.586 cm^3
C	**Volume of dry soil paste**		
1.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste) + evaporating dish	143.75	153.1
2.	Mass of mercury equivalent to vol of (shrinkage dish-dry paste)	93.1	102.45
3.	Mass of mercury displaced by dry paste	166.29	163.93
4.	Volume of dry paste(V_d)	12.227 cm^3	12.053 cm^3
D	**Calculation:-**		
1.	Shrinkage limit $w_s=(w-(V- V_d)/M_d)*100$	17.3999	16.64
2.	Shrinkage ratio $sr= M_d/ (V_d*P_w)$	1.7755	1.8485

IV. CONCLUSION

After conducting tests following conclusion is drawn for mixing Clay in Marble slurry as additive to stabilize it for filling purpose

- ✓ It was found that Liquid limit also are same for lime content but plastic limit varied with increasing % of lime content for Dhaka clay [Soil A] but the liquid limit change with increasing % of cement both Dhaka clay [Soil A] and River sand [Soil B].
- ✓ It was found that Maximum Dry Density (MDD) decreased with the increase in % of lime content for Dhaka Clay but MDD increased with increasing % of cement content both Dhaka Clay and River Sand
- ✓ Optimum Moisture Content decreased with increasing (0-6) % of cement content but it increased for 8% of cement content
- ✓ OMC increased linearly with increasing % of lime content
- ✓ It was also found that liquid limit also same CHARTically between previous study and our study for lime content but liquid limit (LL) varied for cement content.
- ✓ Maximum dry density (MDD) almost remained same between our study and previous study
- ✓ Optimum moisture content (OMC) varies previous study than our study for both lime and cement content.
- ✓ Marble Powder has low plasticity Index and higher value of shrinkage Limit as compare to clay. Hence it almost non-plastic and has less shrinkage as compare to clay. So it can be used to fill low-lying areas with mixing some amount of clay as additive to impart cohesion.
- ✓ Compaction characteristics of MP-Clay Mix proportions show that in the range between 45%MP & 55% Clay to 60% MP & 40% Clay give better dry density to use Marble Powder as land filling material.
- ✓ Its Shear strength parameters show that it is better to use MP-Clay mix in above-mentioned range in back filling for retaining wall as it has got adequate shearing strength

Environmental Damage Due to marble Slurry

Marble slurry is environmentally hazardous in following way The porosity and permeability of topsoil is reduces tremendously and in due course of time, it results in water logging problem.

- ✓ The fine marble dust reduces the fertility of the soil by increasing its alkalinity.
- ✓ It causes respiratory ailments in the nearby residential areas.
- ✓ It causes contamination of underground water resources.

- ✓ Adverse effect on the landscape beauty or the area. Disposal on land results in the formation of ugly mosquito breeding lagoons., Etc….

V. SUGGESTIONS FOR FUTURE WORK

There is lot of research is to be done in the field of Marble slurry , I suggest some of future work that could be done.

- ✓ It is suggested that further study & experimentation should be done on Marble Powder / Slurry to examine its feasibility as soil sub grade material in road construction.
- ✓ Further study & experimentation should be performed to determine any procedure or method to produce cementing property in Marble Slurry / Powder.
- ✓ Further study and experimentation should be performed to examine the feasibility of use of marble Slurry / Powder as ingredient or admixture in concrete mix to impart workability.

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