Cement mortar studies by replacing M-sand with Sub Surface Rock powder collected at different depths

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ABSTRACT

In this experimental study, the influence of subsurface rock powder in cement mortar was done with partly and fully with M- Sand. Rock dust of different depths has been used (200ft, 400ft, and 600ft). The specimen being used here is a square cube of 50mmx50mmx50mm. The samples were cured and tested for 7 days and 28 days. The parameters studied here are chemical analysis, marsh cone analysis, flow table, and compressive strength. Superplasticizer dosage was fixed as 1.3 %. If the depth increases the fineness of the subsurface rock powder increases and the flow decrease. The highest 7days compressive strength of 200ft, 400ft and 600ft depth subsurface rock powder are 21.63 N/mm^2, 20.19 N/mm^2 and 21.19 N/mm^2 and for 28 days 35.65 N/mm^2, 25.87/mm^2 and 25.99 N/mm^2.The general pattern showed that there was an increase in the compressive strength from 7 days to 28 days of curing.

Keyword: *- subsurface rock-powder, marsh cone, flow table, compressive strength*

1. INTRODUCTION

Conventional cement mortar is a complex material obtained by mixing cement, fine aggregate and water. Aggregates have a significant influence on mechanical as well as rheological properties of the cement mortars. Physical properties such as particle size distribution, specific gravity, shape and surface texture markedly influence various properties of mortar in their fresh state. Mineralogical composition, modulus of elasticity, toughness, and degree of alteration of aggregates are generally found to affect their properties in the hardened state. Keeping in view the ill effects and ecological imbalances resulting out of removal of sand from river beds, the authorities have banned sand mining. This has led to an exponential increase of cost of natural sand. Under these circumstances, search for a suitable alternative material to natural river sand without compromising the strength and durability aspects of mortar becomes important to support the infrastructural development and to save the environment.

Various researchers have conducted experimental studies on cement mortars and reported that M-sand mortar is less work due to angular shaped particles and rough surface texture when compared to natural river sand. Generally, M-sand contains high fines, whereas a lesser amount of clay and silt. Rock dust is the major component of these fines. The effects of particle texture and shape of fine aggregates are more predominant than the effects of coarse aggregates in concrete. The better interlocking of particles can be achieved by using an angular shape of fine aggregates, which could inturn lead to an improvement in the strength of cement concrete. M-sand possesses high angularity and when used in cement concrete produces less workability due to the increased surface area. This results in an increase of segregation in the fresh state due to gap gradation. Dosage of admixtures as per manufacturers recommendations are not much effective in manufactured sand mortars, as in case of mortars with natural sand fine aggregates, which even when used in high dosages, failed to attain the flow ability or air content observed in natural sand mortar. The porosity of M-sand cement mortar was found to be higher than that with natural sand whereas the compressive strength of M-sand mortar is higher than that of natural sand mortar. Replacement of natural river sand with crushed limestone sand enhances the long term performance of mortars exposed to chemical solutions. In the present study properties of M- sand cement mortar and properties of sub surface rock powder collected at different depths (200ft, 400ft, and 600ft) is evaluated at various replacement levels for flow and compressive strength.

[1] (2014) worked on the Study of the admixture-cement compatibility for the economic production of special concretes. They get a homogeneous workable concrete at low water-cement ratios, which is less susceptible to bleeding and segregation. The addition of superplasticizers not only improves the rheological properties of the concrete but imparts it more compactness and strength in the hardened state. This concludes that PCE based superplasticizers should be used.

[2] (2005) studied on the Marsh Cone as a viscometer: theoretical analysis and practical limits. In this study, we carry out Marsh cone and rheumatic measurements on glycerol-water mixes in the first part. In a second part, a simple modeling is proposed linking flow time to Newtonian viscosity. In EN 12 715, the nozzle diameter recommendation of 4.75 mm has then to be followed.

[3] (2009), investigates the mortar composition defined according to rheometer and flow table tests using factorial designed experiments. The main purpose of this paper is to implement a factorial experimental design to help formulate mortars, defined accordingly to results obtained on flow table and rheological tests. He concluded that it was possible to optimize the formulation process of mortars containing water/binder ratio below 0.35 based on information obtained from the rheometer and spread on the table and the effects estimations showed that spread value on flow table test is more related to yield stress than to plastic viscosity.

[4](2004) evaluated that effect of sand content on strength and pore structure of cement mortar. The mechanical behavior of cement-based materials is predominately dependent on its composite structure and the presence of pores can adversely affect the material's mechanical property.

[5] (2013) evaluated that reduction of cement content in mortars made with fine concrete aggregates. Fine crushed concrete mortars are used as a replacement of cement mortar which provides good performance and it is both environmental and economical. This gradually decreases the energy consumed in the cement manufacture and the mortar costs are directly lowered

[6] (2008) evaluated that replacement of fine ceramics in mortars with fine ceramics, and it was found that the use of cement can be lowered without altering the properties of the mortar

[7] (2017) evaluated that the use of cement kiln dust as a Nano material in cement mortar and it showed a surprising result where in compressive strength was increased by 15-30%

[8] (2009) evaluated that the use of the fine fraction of quartz sand during the milling process is obtained experimentally using a natural impurity called albite. It is shown that the glass made from the fine sand fraction is optically and structurally lower to that made out of the course fraction.

2. EXPERIMENTAL PROGRAM

2.1 Materials

- For the experimental purpose, 53 grade ordinary Portland cement has been used.
- Chemical Admixtures: superplasticizer
- Fine Aggregates: Manufactured sand, Sub-surface subsurface rock powder

2.2 Methodology

- Study on properties of the mortar ingredients
- Marsh cone analysis to check the compatibility of cement material with chemical admixtures and to fix dosage.
- Flow table test is conducted to determine the consistency of fresh mortar.
- Experimental investigation on mortar replacing M-Sand with sub-surface subsurface rock powder collected at different depths.
- Compressive strength study on mortar cubes of standard size by replacing M-sand in different ratios with sub-surface subsurface rock powder.

3. RESULTS

3.1 Test on ingredients

3.1.1 Specific gravity

Table 1

SI NO	MATERIAL	SPECIFIC GRAVITY
1	Cement OPC	3.06
2	M-Sand	2.70
3	Chemical admixture	1.09

3.1.2 Chemical analysis

For subsurface rock powder 200ft depth

Table 2

Sl. No.	Parameters used	Test results	Test method	Requirement as per IS:383-2016(Table2)
1	pH value	9.14	IS:2720(part 26)-1987	Not specified
2	Chloride content	0.0065	IS:4032-1985(RA2014Z	Not specified
3	Sulphate content	0.094	IS:4032-1985(RA2014)	Not specified
4	Organic impurities	Not harmful	IS:2386part2-1963(RA2011)	The aggregate shall not contain harmful organic impurities in sufficient to affect the strength of mortar

5	Alkaline aggregate reactivity 1. Reduction in alkalinity of 1.0N NaOH 2. Silica dissolved	60.0millimoles/lt 13.16millimoles/lt	As per IS: 2386 the sample fall under Innocuous aggregate, the tested sample do not indicate the potential deleterious degree of alkali reactivity.

For sub surface rock powder 400ft depth:

Table 2

Sl. No.	Parameters used	Test results	Test method	Requirement as per IS:383-2016(Table2)
1	pH value	9.20	IS:2720(part 26)-1987	Not specified
2	Chloride content	0.009	IS:4032-1985(RA2014Z	Not specified
3	Sulphate content	0.084	IS:4032-1985(RA2014)	Not specified
4	Organic impurities	Not harmful	IS:2386part2-1963(RA2011)	The aggregate shall not contain harmful organic impurities insufficient to affect the strength of mortar
5	Alkaline aggregate reactivity 1. Reduction in alkalinity of 1.0N NaOH 2. Silica dissolved	75.0millimoles/liters 27.88millimoles/liters	As per IS: 2386 the sample fall under Innocuous aggregate, the tested sample do not indicate the potential deleterious degree of alkali reactivity.	

For sub surface rock powder 600ft depth:

Table 3

Sl. No.	Parameters used	Test results	Test method	Requirement as per IS:383-2016(Table2)

1	pH value	9.05	IS:2720(part 26)-1987	Not specified
2	Chloride content	0.0071	IS:4032-1985(RA2014Z	Not specified
3	Sulphate content	0.088	IS:4032-1985(RA2014)	Not specified
4	Organic impurities	Not harmful	IS:2386part2-1963(RA2011)	The aggregate shall not contain harmful organic impurities in sufficient to affect the strength of mortar
5	Alkaline aggregate reactivity 1. Reduction in alkalinity of 1.0N NaOH 2. Silica dissolved	75.0millimoles/liters 27.24millimoles/liters	As per IS: 2386 the sample fall under Innocuous aggregate, the tested sample do not indicate the potential deleterious degree of alkali reactivity.	

3.1.3 Marsh cone analysis:

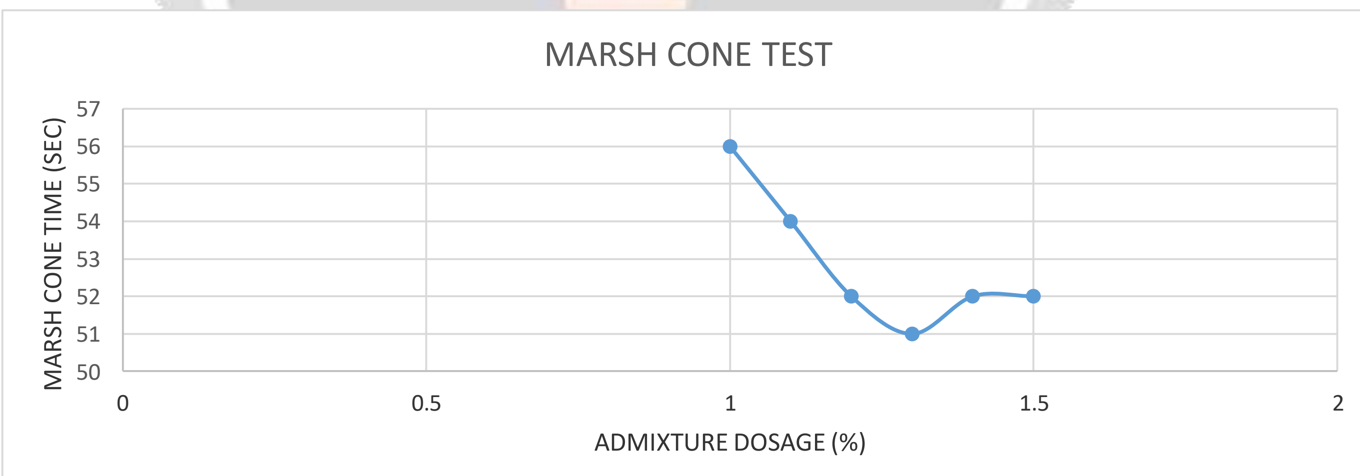


Fig 1: marsh cone analysis result

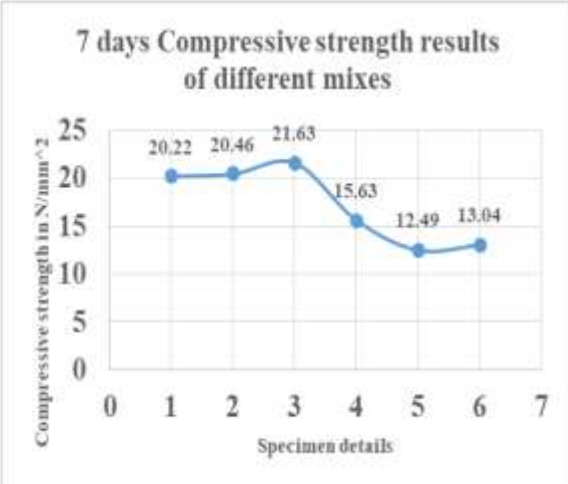
3.1.4 Flow table test:

The obtained suitable water-cement ratio is as follows

Table 4

SI. NO.	MIX	FLOW (mm)	SUITABLE W/C (%)
1.	CM 200 100 0	110.714	0.42
2.	CM 200 80 20	110.714	0.44
3.	CM 200 60 40	110.714	0.44
4.	CM 200 40 60	110.714	0.46
5.	CM 200 20 80	110.714	0.46
6.	CM 200 0 100	110.714	0.48
7.	CM 400 100 0	110.714	0.42
8.	CM 400 80 20	110.714	0.44
9.	CM 400 60 40	110.714	0.44
10.	CM 400 40 60	110.714	0.46
11.	CM 400 20 80	110.714	0.46
12.	CM 400 0 100	110.714	0.48
13.	CM 600 100 0	110.714	0.42
14.	CM 600 80 20	110.714	0.44
15.	CM 600 60 40	110.714	0.44
16.	CM 600 40 60	110.714	0.46
17.	CM 600 20 80	110.714	0.46
ssss18.	CM 600 0 100	110.714	0.48

3.1.5 Compressive strength:



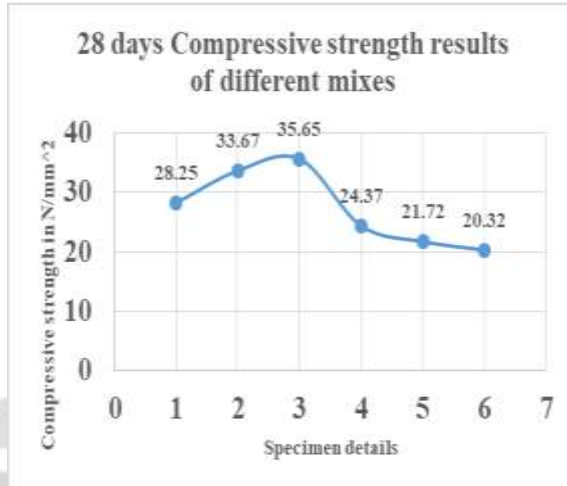
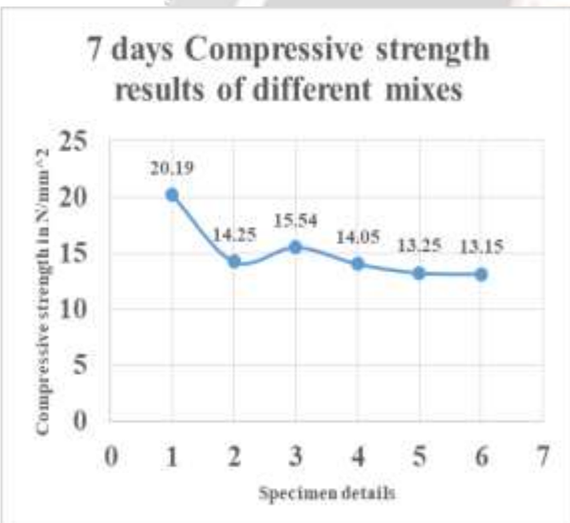


Fig 2: 200ft depth rock powder specimens (7 days)

Fig 3: 200ft depth rock powder specimens (28 days)



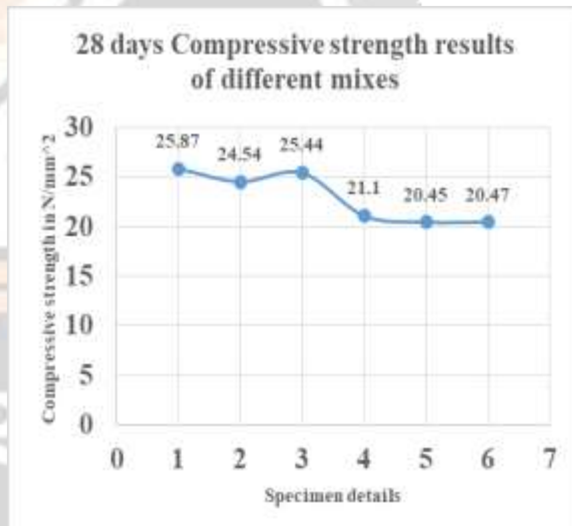
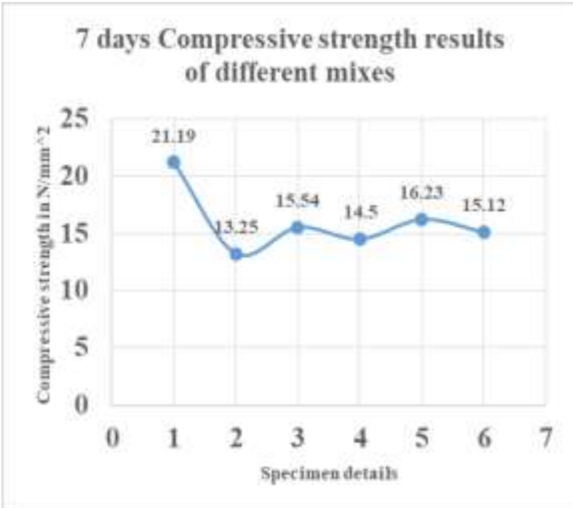


Fig 4: 400ft depth rock powder specimens (7 days)

Fig 5: 400ft depth rock powder specimens (28 days)



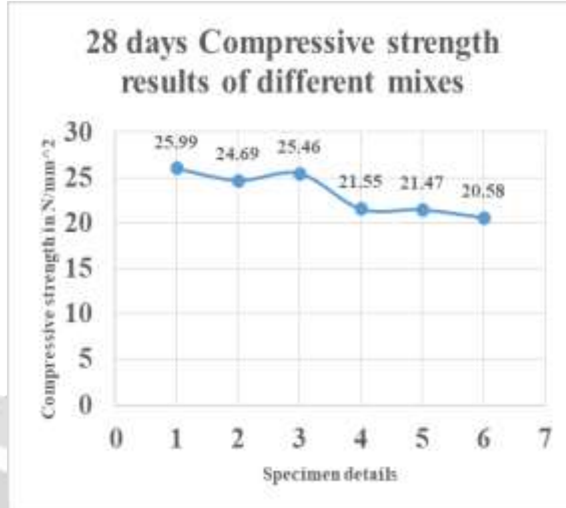


Fig 6: 600ft depth rock powder specimens (7 days) Fig 7: 600ft depth rock powder specimens (28 days)

4. PHOTOS:

Fig 28: Marsh cone analysis

Fig 28: Prepared sample for marsh cone test

Fig 8: Mortar mixer

Fig 9: Flow table

Fig 10: Compacted mortar

Fig 11: Flow table result 1

Fig 12: Flow table result 2

Fig 13: cube vibrating machine

Fig 14: Cement mortar cubes

Fig 15: Cement mortar cubes

Fig 16: Compression testing machine

Fig 17: Testing of CM 400 cube

Fig 18: Test samples of CM 200 CM 400 CM 600 cubes

5. CONCLUSIONS

- From the above study subsurface rock powder can be used as a raw material for the mortar mix.
- Subsurface rock powder of different depths is obtained as a waste material, a considerable amount of subsurface rock powder is produced at the time of digging a water bore well.
- As the subsurface rock powder is available in limited quantity it is used only in localized projects.
- The applications of subsurface rock surface powder can be also used in the manufacture of stabilized mud blocks for non-load bearing walls and other construction projects.

- From the above experiment perform, i.e., the flow table test, it was found that as the depth increases the fineness of the sub surface rock powder also increase which in term require high water content ratio.
- The general pattern showed that there was an increase in the compressive strength from 7 days to 28 days of curing.

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