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Study of Suitability of Artificial sand in Plastering & Concrete

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Abstract—As a building material, the construction industry consumes a considerable amount of natural resources such as sand, gravel, crushed rock, and so on. Aggregate is the most important component in concrete, accounting for more than 70% of the matrix. Because of the wide usage of concrete, mortar, and plastering materials, the global use of natural sand is extremely large. To examine the applicability and truthfulness of the Plain cement-Natural sand mortar using Manufactured Sand, Silica Sand, and Blast Furnace slag Sand in Indian climatic circumstances, an analytical and experimental examination was carried out. For the current study, four distinct products from market leaders were investigated, along with a control mortar.

Keyword: Natural sand, Manufactured Sand, Silica Sand, Blast Furnace slag Sand, Suitability, ANSYS

1. INTRODUCTION

Cement mortar is a compound made by mixing cement, a good amount, and water. Aggregates have a major impact on both mechanical and rheological properties of cement mortar. Materials such as particle size distribution, specific gravity, shape, and surface roughness all have a significant impact on the characteristics of the new mortar. Mineralogy, modulus flexibility, durability, and aggregate conversion rate are all known for influencing their properties in a strong way. Sand mining has been banned due to adverse impacts and environmental inequalities caused by the removal of sand from rivers. As a result, the price of natural sand has risen sharply. Under these circumstances, the search for a viable alternative to natural river sand that does not endanger the strength and resilience of the mud becomes critical to allow for the growth of the infrastructure while protecting the environment.

One or more layers of mortar may be applied to a concrete, brickwork, stone masonry or lathing surface for plastering. It must be long-lasting and resistant to moisture infiltration, as well as weather uniformly. It should also be visually appealing. These attributes are determined by the materials used, the mix composition, the degree of mechanical bond between the plaster and the backing surface, and the craftsmanship. Plastering does not immediately increase structural member strength, but it does help to keep the structure in good serviceable condition until failure.

1.1. Natural River Sand

After washing it with clean water, natural sand with a 2.78 coneness module and compliant with zone II as defined by IS: 383-1970 was used for testing. The gravitational pull of this natural sand is estimated to be 2.55. The water absorption rates and the moisture content of the used sand were found to be 6 percent and 1.0 percent, respectively. Due to a few of the above problems, natural sand (NS) is weak in many respects when used for concrete production.

1.2 Manufactured Sand

Manufactured Sand (MS) is a product of crushing and quarrying. As the aggregates are ground, the quarry is produced in large quantities. Crushed stone sand, stone sand, crushed sand, and fine crushed compound are some of its names. Quarter finishes are a mixture of particles of coarse sand, medium, and fine sand, and part of the clay / mud known as the 'filler' range. The industry defines filling equipment equipment as less than 0.075mm (75 microns) in size.

1.3 Silica Sand

Limestone with silica and amounts of coal, clay, and other minerals is what is known as silica sand. Quartz sand and industrial sand are typical names for this material, which is frequently employed in a wide range of construction projects. Rust can be triggered by the presence of silica sand in metal items. Many industrial applications use silica sand based on the grain size and form of the sample being used.

1.4 Blast Furnace slag Sand

The blast furnace is a metal mold that lowers the metal into molten metal in the presence of coke and fluxes. In addition to molten metal, the furnace produces slags

weighing between 250 and 500 kg per ton of hot metal. An alumino silicates lime glass including slag is a non-metallic byproduct of conversion operations.

2. EXPERIMENTAL INVESTIGATION

The adaptability and truthfulness of the Plain cement-Natural sand mortar with Manufactured Sand, Silica Sand, and Blast Furnace slag Sand in Indian climatic conditions were investigated experimentally. For the current study, four distinct products from market leaders were investigated, along with a control mortar. They had been,

- Mix A: Plain cement-Natural sand mortar
- Mix B: Plain cement-Manufactured Sand mortar
- Mix C: Plain cement-Silica Sand mortar
- Mix D: Plain cement-Blast Furnace slag Sand mortar

Experiments were carried out to explore the mechanical, physical, and morphological aspects of these mortars.

2.2 Mortar mix

The cement and sand were mixed in a 1:3 weight ratio, and the water/cement ratio was kept at 0.35. Fig. 1 depicts the mixing technique.

Fig 1 Procedure for preparation of Mix

2.3 Mechanical tests

1) Compressive strength test (IS 4456 Part-1: 1967)

A total of twelve 7.67 cm cube specimens were created. The specimens were wet cured till the testing age.

At the ages of 3, 7, 28, 56, and 90 days, three cube specimens of each mix were examined for compressive strength. For cube testing, a compression testing machine (CTM) with a capacity of 2000 KN was employed. During the test, the loading rate was held constant at 45 N/mm2/min. The ultimate failure loads were recorded, and compressive strength was estimated using the formula below:

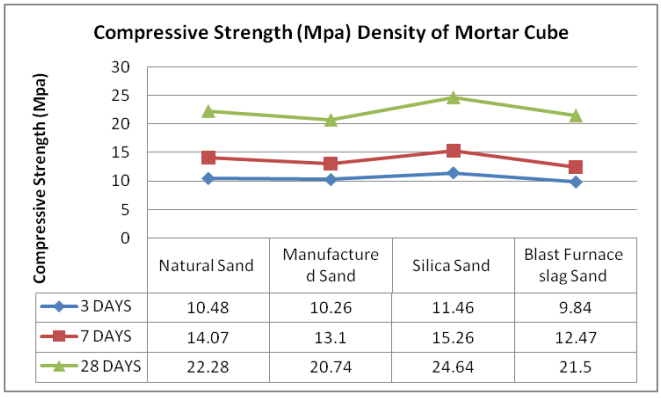
$$\text{Compressive strength (N/mm2)} = \frac{\text{Ultimate failure load in compression (Pc) in N}}{\text{Cross sectional area (A) in sq. mm}}$$

Here, A = 7.67 cm x 7.67 cm

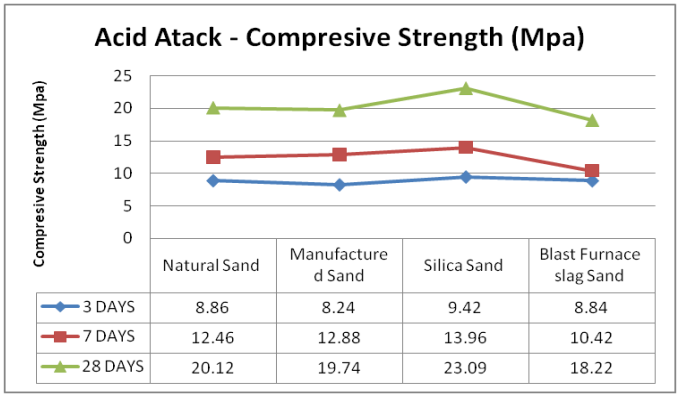
Fig 2 Load application on cube

Table 1 Result For Density of Cube

Compressive Strength (Mpa) Density of Mortar Cube			
SAND	**3 DAYS**	**7 DAYS**	**28 DAYS**
Natural Sand	10.48	14.07	22.28
Manufactured Sand	10.26	13.1	20.74
Silica Sand	11.46	15.26	24.64
Blast Furnace slag Sand	9.84	12.47	21.5



Graph 1 Compressive strength



Graph 2Acid Attack

Having made a 7.67 cm x 7.67 cm cube out of Natural Sand, Manufactured Sand, Silica Sand, and Blast Furnace slag Sand and testing it with a compression testing machine revealed that the compressive strength of silica sand is more feasible than that of Natural Sand, Blast Furnace slag Sand, and Manufactured Sand..

2) Acid attack test

7.67 cm' 7.67 cm' 7.67 cm concrete cubes for testing acid attack by various degrees of silica smoke infusion. Specimens are cast and cured into the body for 24 hours, after which they are dismantled and stored in a healing tank for 7 days. After 7 days, all samples are kept in place for 2 days to maintain a consistent weight, then measured and infused with 5% sulfuric acid solution (H2SO4) for 60 days. The pH of the acidic medium was 0.3. The pH level is regularly monitored and maintained at 0.3. After 60 days of immersion in the acidic mass, the specimens were extracted and rinsed with running water before being kept in the atmosphere for two days for the same weight. After that, the samples were weighed, and the weight loss percentage was calculated..

Table 2 Results for acid attack

Acid Attack - Compressive Strength (Mpa)			
SAND	3 DAYS	7 DAYS	28 DAYS
Natural Sand	8.86	12.46	20.12
Manufactured Sand	8.24	12.88	19.74
Silica Sand	9.42	13.96	23.09
Blast Furnace slag Sand	8.84	10.42	18.22

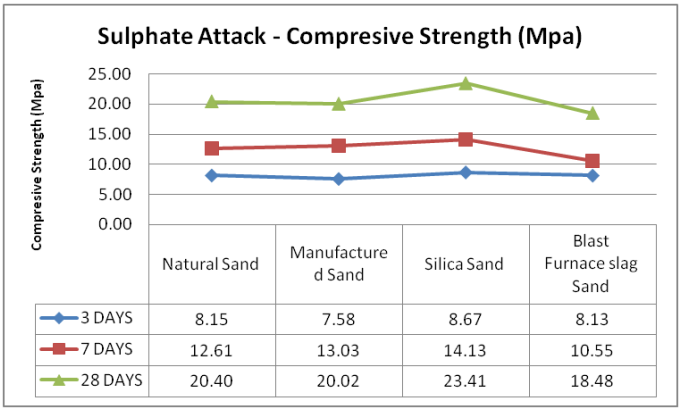
Prepare a 7.67 cm x 7.67 cm cube with Natural Sand, Manufactured Sand, Silica Sand, and Blast Furnace Slag Sand for the durability test, and then immerse it in sulphuric acid (H2SO4) for 28 days for the acid attack test. The cube is next tested with a compression testing machine to assess its compressive strength for various types of sands. Silica sand has a higher compressive strength than natural sand, manufactured sand, and blast furnace slag sand.

3) Sulphate attack test

Sulphate attacks on concrete have been investigated for more than 60 years worldwide. However, the mechanisms of attack have not yet been fully understood, and the dissolution of sulphate concrete is ongoing. Sulphates can come from an 'external' or 'internal' source. External sources include natural sulphates from the environment and sulphates produced by industrial or other human activities (for example, fertilizers usually release sulphates in soil and groundwater). Internal sulphate sources may include cement sulphates used to make concrete. To test the durability of concrete in sulphate attack, standard tests have been designed. Some of these tests, but not all, consider the sulphate attack methods described in previous studies.

Table 3 Results for Sulphate attack

Sulphate Attack - Compressive Strength (Mpa)			
SAND	3 DAYS	7 DAYS	28 DAYS
Natural Sand	8.15	12.61	20.40
Manufactured Sand	7.58	13.03	20.02
Silica Sand	8.67	14.13	23.41
Blast Furnace slag Sand	8.13	10.55	18.48



	Natural Sand	Manufactured Sand	Silica Sand	Blast Furnace slag Sand
3 DAYS	8.15	7.58	8.67	8.13
7 DAYS	12.61	13.03	14.13	10.55
28 DAYS	20.40	20.02	23.41	18.48

Graph 3Sulphate Attack

A compression testing machine is used to assess the compressive strength of cubes for various types of sands. Sulphate Attack silica sand has a higher compressive strength than Natural Sand, Manufactured Sand, and Blast Furnace Slag Sand..

3. FEM ANALYSIS

Prepare a 3 m length and 2.2m height wall with concrete blocks for the FEM analysis, then apply a layer of plasters with sand replacement using Plain cement-Natural sand mortar, Plain cement-Manufactured Sand mortar, Plain cement-Silica Sand mortar, and Plain cement-Blast Furnace slag mortar. Check for pull out pressure and exterior temperature with sand mortar with a thickness of 15mm.

MODEL 1	Plain cement-Natural sand mortar
MODEL 2	Plain cement-Manufactured Sand mortar
MODEL 3	Plain cement-Silica Sand mortar
MODEL 4	Plain cement- Blast Furnace slag Sand mortar

3.1 Normal Elastic Strain Mpa

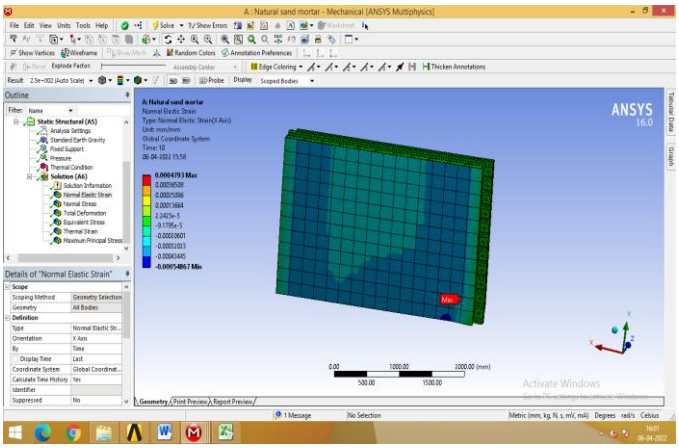


Fig 2 Normal Elastic StrainNatural Sand

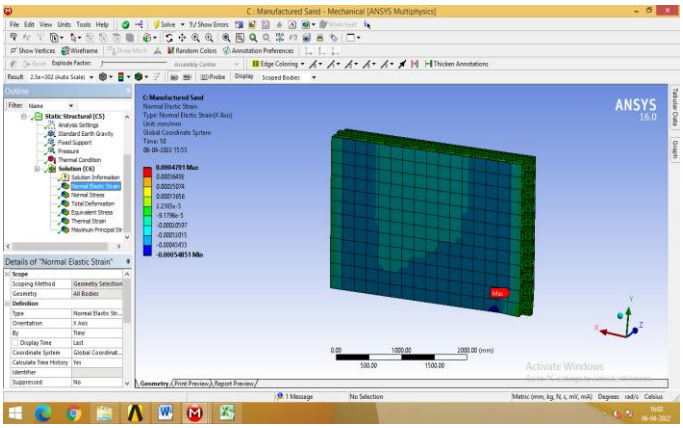


Fig 3 Normal Elastic StrainManufactured Sand

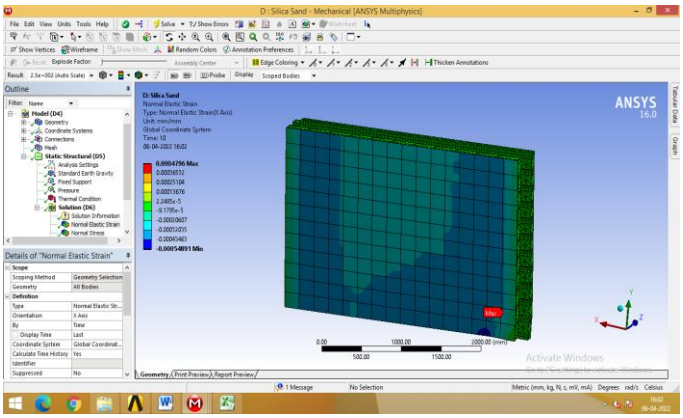


Fig 4 Normal Elastic StrainSilica Sand

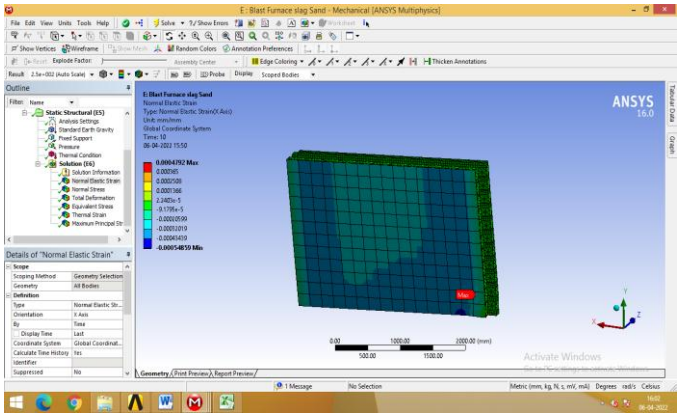
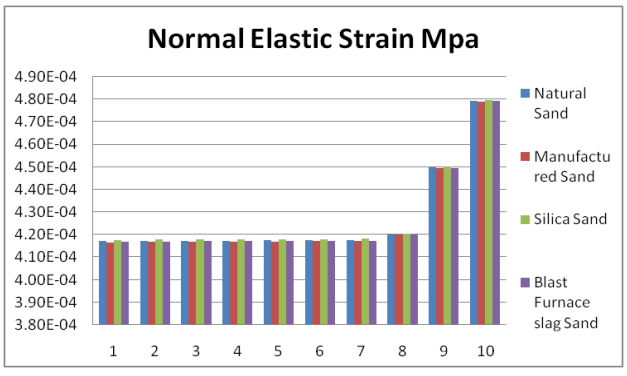


Fig 5Normal Elastic Strain Blast Furnace slag Sand

Table 4 Normal Elastic Strain

Normal Elastic Strain Mpa				
Load Steps Kn	Natural Sand	Manufactured Sand	Silica Sand	Blast Furnace slag Sand
1	4.17E-04	4.17E-04	4.18E-04	4.17E-04
2	4.17E-04	4.17E-04	4.18E-04	4.17E-04
3	4.17E-04	4.17E-04	4.18E-04	4.17E-04
4	4.17E-04	4.17E-04	4.18E-04	4.17E-04
5	4.17E-04	4.17E-04	4.18E-04	4.17E-04
6	4.18E-04	4.17E-04	4.18E-04	4.17E-04
7	4.18E-04	4.17E-04	4.18E-04	4.17E-04
8	4.20E-04	4.20E-04	4.21E-04	4.20E-04
9	4.50E-04	4.50E-04	4.50E-04	4.50E-04
10	4.79E-04	4.79E-04	4.80E-04	4.79E-04



Graph 4 Normal Elastic Strain

The graph above depicts the Normal Elastic Strain results for mortar using Natural Sand. Blast Furnace Slag, Manufactured Sand, and Silica Sand Sand Plaster with Silica Sand has a higher normal elastic strain capacity than plaster with Natural Sand. Blast Furnace Slag and Manufactured Sand

5. CONCLUSION

The applicability and truthfulness of four different sand materials for mortar products for plastering tasks were tested experimentally. Materials were chosen from major producers in the Indian market. Also, for analytical purposes, make a 7.67 cm x 7.67 cm cube and test it for compressive strength, acid attack, and sulphate attack. Prepare a 3 m length and 2.2m height for the FEM study if the wall is made of concrete blocks, and put a layer of plasters with sand replacement. Plain cement-natural sand mortar, Plain cement-manufactured sand mortar, Plain cement-silica sand mortar, and Plain cement-blasted furnace slag mortar Check for pull out pressure and exterior temperature with sand mortar with a thickness of 15mm.

- Making a 7.67 cm x 7.67 cm cube out of Natural Sand, Manufactured Sand, Silica Sand, and Blast Furnace slag Sand and evaluating it with a compression testing machine demonstrated that silica sand had a higher compressive strength than Natural Sand, Blast Furnace slag Sand, and Manufactured Sand.

- For the acid attack test, create a 7.67 cm x 7.67 cm cube using Natural Sand, Manufactured Sand, Silica Sand, and Blast Furnace Slag Sand and immerse it in sulphuric acid (H2SO4) for 28 days. The cube is next tested with a compression testing machine to assess its compressive strength for various types of sands. Silica sand has a higher compressive strength than natural sand, manufactured sand, and blast furnace slag sand.

- In order to generate sulphate attack, sulphate and hardened concrete components engage in a series of chemical reactions. Because these reactions can cause cracking, spalling, or strength loss in concrete structures, proper test procedures are required to measure concrete resistance to sulphate exposure. Prepare a 7.67 cm × 7.67 cm cube of Natural Sand, Manufactured Sand, Silica Sand, and Blast Furnace Slag Sand for the durability test. The test procedure accelerates the assault process by immersing mortar specimens in a solution with a high sulphate concentration.

The cube is next tested with a compression testing machine to assess its compressive strength for various types of sands. The compressive strength of Sulphate Attack silica sand is less expensive than that of Natural Sand, Manufactured Sand, and Blast Furnace Slag Sand. Blast Furnace Slag, Manufactured Sand, and Silica Sand Sand Plaster with Silica Sand has a higher normal elastic strain capacity than plaster with Natural Sand. Blast Furnace Slag and Manufactured Sand

- With Natural Sand Mortar, the normal stress results Silica Sand Sand, Manufactured Sand and Blast furnace slag are all examples of manufactured sand. Natural sand has a lower typical stress capacity than Silica sand in plaster. Manufacturing Sand and Slag from a Blast-Furnace

- For Natural Sand Mortar, Blast Furnace Slag, Manufactured Sand, and Silica Sand Sand, the total deformation results Manufactured Sand plaster has less overall deformation than natural sand. Manufacturing Sand and Slag from a Blast-Furnace.

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