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Influence of Marble and Aluminium Waste Powder on the Performance of Concrete

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Abstract **- With increase in the construction industry, the demand for sand is also increasing. Sand is one of the most important ingredients in concrete and mortar production. Due to its high consumption, sand is becoming a scarce material such that a stage where the natural deposits of sand i.e. the river banks are vanishing which leads to erosion, floods, etc. So, it is important to think of other alternatives that could be used as replacement of sand. Marble industry contributes its fair share in environmental deterioration, producing voluminous amounts of mud and other excess residues obtained from marble and granite processing, polluting soil, water and air. Reusing these products in other products will not just prevent our environment from polluting but also help with economy. Aluminium waste Powder available from Aluminium industries can also be utilized. In this, we have studied the influence of replacing natural sand in concrete by 0%, 5%, 10% and 15% of marble powder, along with the addition of Aluminium waste powder by 0.25% and 0.50% by weight of sand individually and in combination in concrete. Cubes were casted and compressive strength was studied. Results showed that the compressive strength was gradually increasing and then decreases.**

Keywords - Marble Powder, Aluminium Powder, Compressive Strength, Concrete.

INTRODUCTION

The most commonly used composite material in construction industry is concrete. It is a mixture of cement, fine aggregates (sand) and coarse aggregates. A series of chemical reactions called hydration between cement, sand and aggregates which hardens and gains strength to form a rock like mass as concrete. Concrete is plastic and malleable when freshly mixed, strong and durable when hardened. The use of sand in construction results in sand mining which is objectionable. Due to rapid growth in construction activity, the available sources of natural sand are not only getting exhausted but also the river banks are vanishing which leads to erosion, floods, etc. Therefore, it is necessary to replace natural sand in concrete by an alternate material either partially or completely without compromising the quality of concrete. The most thriving industry in India are marble and granite industry. Marble waste when dumped on open land affects adversely the productivity of land as it reduces the porosity and affects ground water recharge. The marble is widely used in buildings due to its beauty, strength & resistance to fire.

2. OBJECTIVE

- To investigate the compressive strength of concrete made by addition of 0%, 0.25% and 0.50% (by weight of cement) of aluminium powder.
- To investigate compressive strength of concrete made by replacement of sand with marble powder in percentages of 0%, 5%, 10% and 15%.
- To investigate the compressive strength of concrete made by combinations of replacement of sand with marble powder in percentages of 0% ,5%, 10% and 15% and addition of 0%, 0.25% and 0.50%(by weight of cement) of aluminium powder.
- To compare the results obtained from control concrete mix, marble powder based concrete, aluminium powder based concrete and combination of both aluminium powder and marble powder.

3. LITERATURE REVIEW:

- Rana Shabbar *et al* (2017) investigated the behaviour of aerated concrete with different Aluminium powder content under monotonic loads. The proportion of aluminium powder was kept 0%, 0.25%, 0.5%, 0.75% and 1% by weight of cement content. The mixture was a cement mortar mix with one part cement and two parts sand and different proportions of aluminum powder. The test results showed that with increase in aluminium content the dry density decreased also the compressive, flexural strength and modulus of elasticity of the specimens declined according to the increase of the content of the aluminium powder.

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- Rihan Maaze, *et al* (2016) studied the influence of marble powder and aluminum powder on the performance of bricks. For this three different series of mixtures was made along with Black Cotton Soil, Red Soil and fly ash. The first mixture had only marble powder, the second had only aluminum powder and the third had a combination of both marble powder and aluminum powder. The proportion of marble powder was kept to be 5%, 10% and 15% by weight of Red Soil and for aluminum powder was kept 1%, 2% and 3% by weight of Black Cotton Soil. The bricks manufactured from only marble powder showed only 30-70% increase in compressive strength, from only aluminum powder showed 10- 20% increase in compressive strength and from the third mixture which was a combination of both marble powder and aluminum powder no improvement in compressive strength but the bricks were lighter, thus decreasing its dead load.

- G. Latha, *et al* (2015) their work was focused on M20, M30, M40 grades of concrete. The percentage of Waste Marble Powder that replaced cement in this investigation was 0%, 5%, 10%, 15 % and 20 %. The fresh properties are workability and hardened properties was compressive strength at the age of 7 and 28 days of curing. The split tensile strength and flexural strength of concrete at curing age of 28 days were determined. Results showed that the workability and compressive strength, flexural strength and split tensile strength of concrete are increased with partial replacement of cement by waste marble powder between 10% and 15%.

3. MATERIAL USED:

3.1 CEMENT: Cement is a binding material which is finely ground and usually grey in colour. When cement is mixed with water, it acts as an adhesive binding sand, crushed stones or aggregates to form concrete which is hard and is a most commonly used construction material in the world. Ordinary Portland Cement of grade 53 (ACC) is used for preparation of concrete mix.

Table 1: Physical Properties of Ordinary Portland cement used.

S. No	Characteristics	Result Obtained	Requirement as Per IS: 12269 - 2013
1.	Normal consistency (%)	30%	-
2.	Setting Time (in minutes)		
	Initial	110	<30 Min
	Final	170	<600 Min
3.	Compressive Strength (MPa)		
	3 days	35.5	< 27.0
	7 days	42.0	< 37.0
	28 days	53	< 53.0
4.	Fineness , m^2/kg	341	< 255

3.2 FINE AGGREGATE: Fine aggregate is used in the experimental investigation and confirming to zone-II of IS 383-1970.Sand is used in the work which has the particle was less than 4.75mm. The fine aggregate used in this study was natural river sand. The specific gravity is 2.66 and fineness modulus was 2.52.

3.3 COARSE AGGREGATE: The aggregates which is retained in 4.75mm IS sieve is called coarse aggregate. According to size coarse aggregate is described as graded aggregate of its nominal size i.e. - 40mm, 20mm, 16mm, 12.5mm and 10mm. In this study coarse aggregate of size 10mm and 20mm are used. Its specific gravity was found to be 2.67.

3.4 MARBLE POWDER: The Marble dust powder was collected from the locally available manufacturing unit in Dhanas. Specific gravity of marble dust powder is 2.73.

3.5 ALUMINIUM POWDER: the waste Aluminium powder was obtained from nearby. It is the most commonly used air entraining agents used in concrete to obtain light weight concrete. Aluminium reacts with alkalis (OH) found in Portland cement concrete. When these two chemicals are combined together, the reaction produces hydrogen gas. Hence, when reaction is occurred in wet concrete one will notice tiny bubbles coming to the surface.

Table 2: Physical Properties of Aluminum Powder

Sl. No.	PROPERTY	RESULT
1.	Colour	Grey
2.	Form	Powder
3.	Specific Gravity	2.7

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3.6 WATER:

Fresh and clean tap water was used for casting and curing of the specimens in present study. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per clause 5.4 of IS 456: 2000. Quality of water plays an important role as impurity in water may interfere with setting of the cement and may cause straining of its surface which may lead to the corrosion of reinforcement.

4. CONCRETE MIX DESIGN:

Based on the Indian Standard (IS: 10262 – 1982), design mix for M25 grade of concrete was prepared by partially replacing fine aggregate with different percentages by weight of marble powder (0%, 5 %,10%, and 15%) and also the addition of Aluminium powder at percentages of 0.25% and 0.50% by weight of cement was done individually and in combination was done. The various ingredients for M25 concrete for 1 m^3 are shown:

Table 3: Ingredients per cum of M25 Grade Concrete

Mix Identification	Cement (kg)	Aluminum Powder (Al. P) (kg)	Fine Aggregate (kg)	Marble Powder (MP) (kg)	Coarse Aggregate (kg)	Water (kg)
Control Mix	398	-	660	-	1161	191
Al. P (0.25%)	398	0.995	660	-	1161	191
Al. P (0.50%)	398	1.99	660	-	1161	191
MP (5%)	398	-	627	33	1161	191
MP (10%)	398	-	594	66	1161	191
MP (15%)	398	-	561	99	1161	191
MP (5%) + Al. P (0.25%)	398	0.995	627	33	1161	191
MP (10%) + Al. P (0.25%)	398	0.995	594	66	1161	191
MP (15%) + Al. P (0.25%)	398	0.995	561	99	1161	191
MP (5%) + Al. P (0.50%)	398	1.99	627	33	1161	191
MP (10%) + Al. P (0.50%)	398	1.99	594	66	1161	191
MP (15%) + Al. P (0.50%)	398	1.99	561	99	1161	191

TEST SPECIMENS:

Cubes of size 150 mm ×150 mm× 150 mm were casted. Cubes specimens were cured and tested at 7, 14 and 28 days to obtain the compressive strength of the concrete. The rate of loading is as per Indian Standard Specification.

5. RESULTS AND SPECIFICATION:

5.1 Compressive Strength Test:

Cubes of size 150mm ×150mm×150mm were prepared and tested for its Compressive Strength. It can be observed that the Compressive Strength of Concrete prepared with Replacement of sand with marble powder exhibits more strength at 5% and 10% replacement whereas strength decreases at 15% replacement. The compressive strength decreases with increase in percentage of Aluminium Powder.

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Table 4: Compressive Strength of M25 Grade Concrete.

Mix identification	Compressive Strength (MPa)		
	7 days	14 days	28 days
Control Mix	20.54	28.44	31.3
Al. P (0.25%)	18.7	25.88	27.23
Al. P (0.50%)	17.66	22.48	24.59
MP (5%)	21.20	29.17	33.07
MP (10%)	22.45	31.92	35.08
MP (15%)	19.38	27.34	30.48
MP (5%) + Al. P (0.25%)	19.02	26.52	29.54
MP (10%) + Al. P (0.25%)	21.89	28.9	32.15
MP (15%) + Al. P (0.25%)	18.04	24.61	28.85
MP (5%) + Al. P (0.50%)	17.38	25.75	27.49
MP (10%) + Al. P (0.50%)	19.63	25.18	29.41
MP (15%) + Al. P (0.50%)	16.58	22.92	25.63

Graphs: The graphs are show below:

1. Compressive strength values for Control Mix, Aluminium Powder at 0.25% and 0.50% for 7, 14 and 28 days.
2. Compressive strength values for Control Mix, Marble Powder at 5%, 10% and 15% replacement of sand for 7, 14 and 28 days.
3. Compressive strength values for Control Mix, Marble Powder at 5%, 10% and 15% replacement of sand and Aluminium Powder at 0.25 % (by weight of cement) for 7, 14 and 28 days.
4. Compressive strength values for Control Mix, Marble Powder at 5%, 10% and 15% replacement of sand and Aluminium Powder at 0.50 % (by weight of cement) for 7, 14 and 28 days.

CONCLUSIONS:

1. With increase in percentage of aluminium powder the compressive strength decreased. The compressive strength at 0.25% of aluminium powder was found to be 27.23 MPa and with 0.50% it was found to be 24.59 MPa at 28 days. This is due to the rate of production calcium silicate hydrate (C-S-H) gel may decrease which corresponds with the reduction in the strength.

2. An increase in compressive strength was seen by replacing sand with marble powder at 10% replacement of sand with marble powder. The value was found to be 35.08 MPa at 28 days as marble powder acts as filler. But it decreased at 15 % of marble powder. Optimum percentage of marble powder was found at 10%.

3. The compressive strength of concrete made by combinations of replacement of sand with marble powder in percentages of 5%, 10% and 15% and addition of 0.25% and 0.50%(by weight of cement) of aluminium powder was found to be : At at 10% marble powder and aluminium powder 0.25% the compressive strength was found to be 32.15 MPa. And at 10% marble powder and aluminium powder 0.50% the compressive strength was found to be 29.41 MPa.

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