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Study on Resilience of Granite Concrete

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Abstract: ***Nowadays, concrete made with Portland cement is probably the most widely used man made material in the world. Despite this fact, concrete production is one of the concerns worldwide that impact the environment with major impact being global warming due to CO2 emission during the production of cement. Alternatively, when industrial wastes are recycled or reused, CO2 emissions are reduced and less material is dumped as landfill and more natural resources are saved. Hence, an attempt is made to replace the cement by granite powder in concrete. In this experimental study, granite powder was used in concrete as a cementetious material as partial replacement of cement. Replacement of cement was made by level of 5%, 10%, 15% and 20% by weight of cement. For each replacement strength test was conducted. Compressive strength after 7 and 28 days curing was obtained. From the test results it was found that concrete at the level of 15% partial replacement of cement with granite powder has better workability and high compressive strength of 7 days and 28 days curing. The granite dust powder is free of cost. Hence it seems to be economical.***

Keywords: GP (granite powder), PCC

I. INTRODUCTION

Concrete is one of the most widely used construction materials in the world. The environmental and economic concern is the biggest challenge concrete industry is facing. The ingredients of concrete is cement, fine aggregate, coarse aggregate and water. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits.

It is estimated that cement production is responsible for about 3% of the global anthrogenic greenhouse gas emission and for 5% of the global anthrogenic CO2 emission. As about 50% of the CO2 released during cement production is related to the decomposition of limestone during burning, mixing of clinker with supplementary materials called blending is considered as a very effective way to reduce CO2 emission.

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of granite dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the granite sludge dust in concrete production as partial replacement of cement.

In INDIA, the granite and granite stone processing is one of the most thriving industry the effects if varying granite dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. Most common blending materials used in cement production added in plant or sites are industrial wastes. This is due to the fact that recycling of industrial wastes as blending materials has technical, economical and environmental benefits besides the reduction of CO2 emission from cement production.

Granite dust powder which is a by-product of granite processing factory was studied by many researchers for its use in concrete and mortar production as sand replacing or cement replacing material. Most of the researches showed positive results and benefits. However as the by-product i.e. the powder differs chemically depending on the parent granite rocks which depends on the locality, degree of metamorphism and other factors; and also as the physical characteristics of the by-product depends on the polishing work, it is necessary to conduct similar research in our country to incorporate it in concrete and cement production for reduction of environmental pollution and sustainable use of natural resources.

Granite is a mixture of angular particles; colour can range from white to red to black and colours in between, ranging in size from pebbles to boulders. It is odourless and not flammable. Respirable dust particles containing silicon dioxide may be generated by handling granite. Its property is shown in table 1.

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Table 1. Physical Property of Granite Powder

S.N.	Specifications	Values
1	Specific gravity g/cc	2.77 – 2.82
2	Chemistry	Felsic
3	Density (lbs/ft^2)	166.5
4	Melting Point (°F)	Approx 3,000
5	Solubility In Water	Insoluble
6	Boiling Point (°F)	Approx 4,000
7	Thermal Conductivity (K)	~2.2
8	Particle Shape	Irregular
9	Mohrs Hardness	7.0
10	Odor and Appearence	Black and White No odor
11	Vapor Pressure	None
12	Color	Pink, Light gray, Dark gray

II. OBJECTIVES

A. To study the optimal percentage of granite powder to replace the cement in the concrete mix by checking mechanical properties like compressive strength and split tensile strength of concrete.
B. To study the effect of granite powder waste on the concrete mixture.
C. To study the economy and social benefits of using the granite powder on the concrete mix.

III. MATERIALS USED

1) *Cement* – ULTRATECH brand, OPC 43 grade cement was used.
2) *Fine Aggregate* – M sand was used.
3) *Coarse Aggregate* – size of 20 mm t0 12.5 mm was used The aggregate is in the shape of angular.
4) *Water* – Tap water having the PH value satisfying the I.S. Code was used.
5) *Granite Powder* – sieved on 90 micron was used.

IV. MIX DESIGN

Grade designation - M30
Type of cement - OPC 43 grade conforming to IS 8112
Maximum nominal size of aggregate - 20mm
Minimum cement content - 320 Kg/m^3
Maximum water-cement ratio - 0.5
Workability - 50 mm (slump)
Exposure condition - Severe (for reinforced concrete)
Degree of supervision - Good
Type of aggregate - Crushed angular aggregate
Maximum cement (opc) content - 450 kg/m^3

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Specific gravity of
- i)Cement - 3.145
- ii)Fine aggregate - 2.605
- iii)Coarse aggregate - 2.63

Water absorption
- i)Coarse aggregate - 0.5%
- ii)Fine aggregate - 1.0%

Sieve analysis
- i)Coarse aggregate - Conforming to table 2 of IS - 383
- ii)Fine aggregate - Conforming to zone 1 of IS- 383

A. Mix Proportion

Mass of cement = 413.33 kg/m^3
Mass of water = 186 liters
Mass of fine aggregate = 769.95 kg/m^3
Mass of coarse aggregate = 1017.9 kg/m^3
Water cement ratio = 0.45

PROPORTION = 1 : 1.863 : 2.463

Table 2. Details of Mix Proportioning

Mix	Mix Details
R	1 : 1.863 : 2.463
GD1	R – 5% Cement + 5% Granite Powder
GD2	R – 10% Cement + 10% Granite Powder
GD3	R – 15% Cement + 15% Granite Powder
GD4	R – 20% Cement + 20% Granite Powder

V. TESTS CONDUCTED

Compressive Strength and Split Tensile Strength test was conducted for 7 days and 28 days curing.
Casting of Specimens:

A. Cube = 15
B. Cylinder = 15

VI. TESTS RESULTS AND DISCUSSION

A. Compressive Strength

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time. Compression tests are used to determine the material behaviour under a load. Compressive strength of each concrete cube casted for 7 days and 28 days curing are given in the table 3.

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Table 3. Compressive Strength For Different Trails Mixes

% Replacement of GP	Load(KN)	Average Load(KN)	Compressive strength(N/mm2)	
	7 days	7 days	7 days	28 days
0%	500.28	504.68	22.43	29.84
	509.08			
5%	624.40	631.58	28.07	36.06
	638.76			
10%	660.42	664.88	29.55	40.81
	669.34			
15%	712.42	704.93	31.33	42.14
	697.44			
20%	494.64	501.53	22.29	31.77
	508.42			

Fig 1. Chart for compressive Strength for Different % of GP.

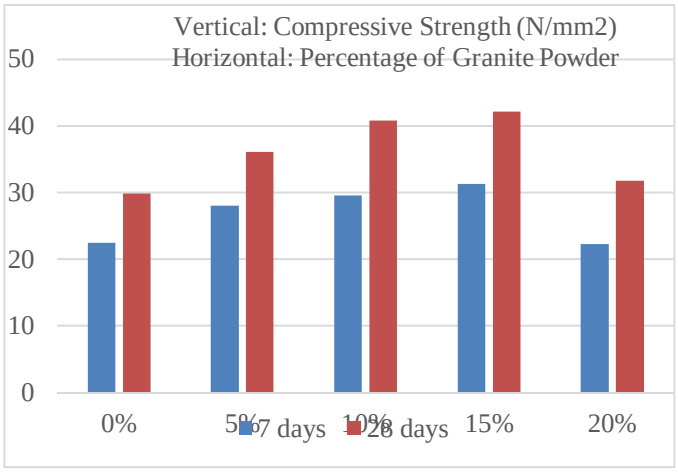

Table 4. Percentage Increase and Decrease of Compressive Strength.

% Replacement of GP	Compressive Strength of Concrete(N/mm2)		% increase or decrease of Compressive Strength	
	7 days	28 days	7 days	28 days
0%	22.43	29.84	-	-
5%	28.07	36.06	20.09	17.25
10%	29.55	40.81	24.09	26.88
15%	31.33	42.14	28.41	29.19
20%	22.29	31.77	-0.63	6.07

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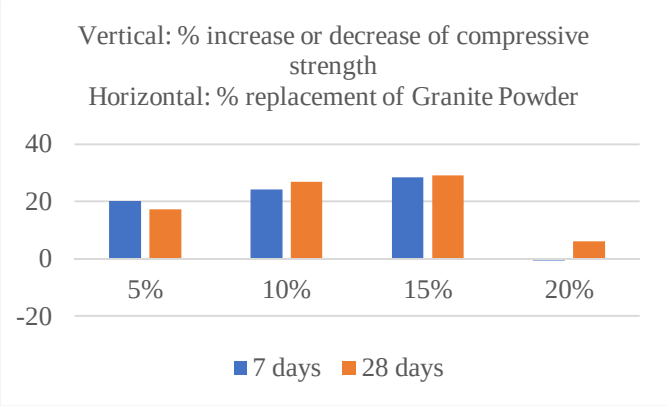
Fig 2. Chart for % increase or decrease of Compressive Strength



B. Split Tensile Strength

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Table 5. Split Tensile Strength for Different Trail Mixes

% Replacement of GP	Load(KN)	Average Load(KN)	Split Tensile Strength (N/mm2)	
	7 days	7 days	7 days	28 days
0%	218.62	221.95	3.14	3.85
	225.28			
5%	240.20	236.09	3.34	4.12
	231.98			
10%	252.12	257.30	3.64	4.33
	262.48			
15%	324.30	327.28	4.63	5.48
	330.26			
20%	278.67	291.93	4.13	4.95
	305.19			

Fig 3. Chart for Split Tensile Strength for different % of GP

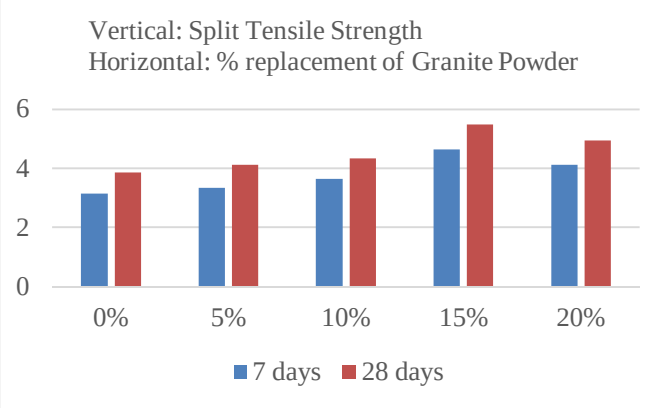


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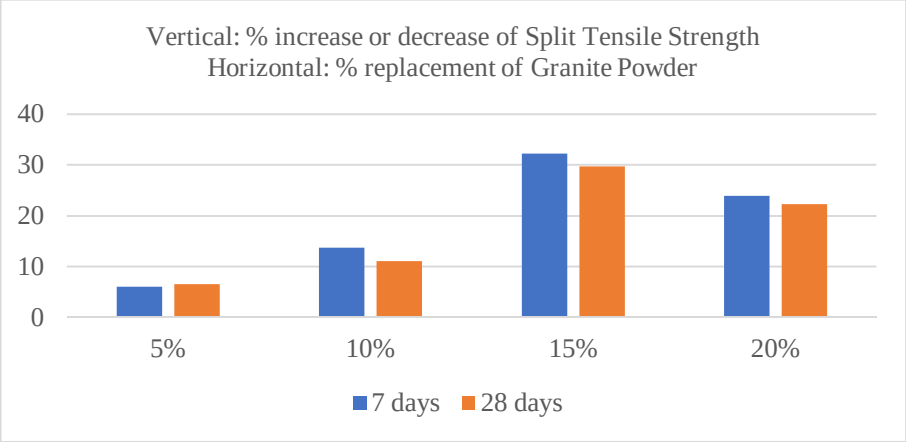
Table 6. Percentage of Increase and Decrease of Split Tensile Strength

% Replacement of GP	Split Tensile Strength of concrete(N/mm2)		% Increase or decrease of Split Tensile Strength	
	7 days	28 days	7 days	28 days
0%	3.14	3.85	-	-
5%	3.34	4.12	5.99	6.55
10%	3.64	4.33	13.74	11.09
15%	4.63	5.48	32.18	29.74
20%	4.13	4.95	23.97	22.22

Fig 4. Chart for % Increase or Decrease of Split Tensile Strength



VII. CONCLUSION

A. The experiment result shows increase in the strength of concrete with use of granite powder. Therefore with the use of granite powder as a partial replacement of cement in the concrete we can increase the strength and durability of concrete with the reduce in consumption of cement.

B. Mechanical strength tests confirmed that the optimum percentage of of granite powder replacement with cement is 15% as it gives best strength improvement in comparison to other specimens for 7 days and 28 days for curing period.

C. Compressive Strength of concrete goes on increasing upto 15% addition of Granite Powder is 28.41% for 7 days and 29.19% for 28 days.

D. Split Tensile Strength of concrete goes on increasing upto the 15% addition of granite powder is 32.18% for 7 days and 29.74% for 28 days.

E. The waste granite powder used for this purpose also reduces the environmental pollution is economical.

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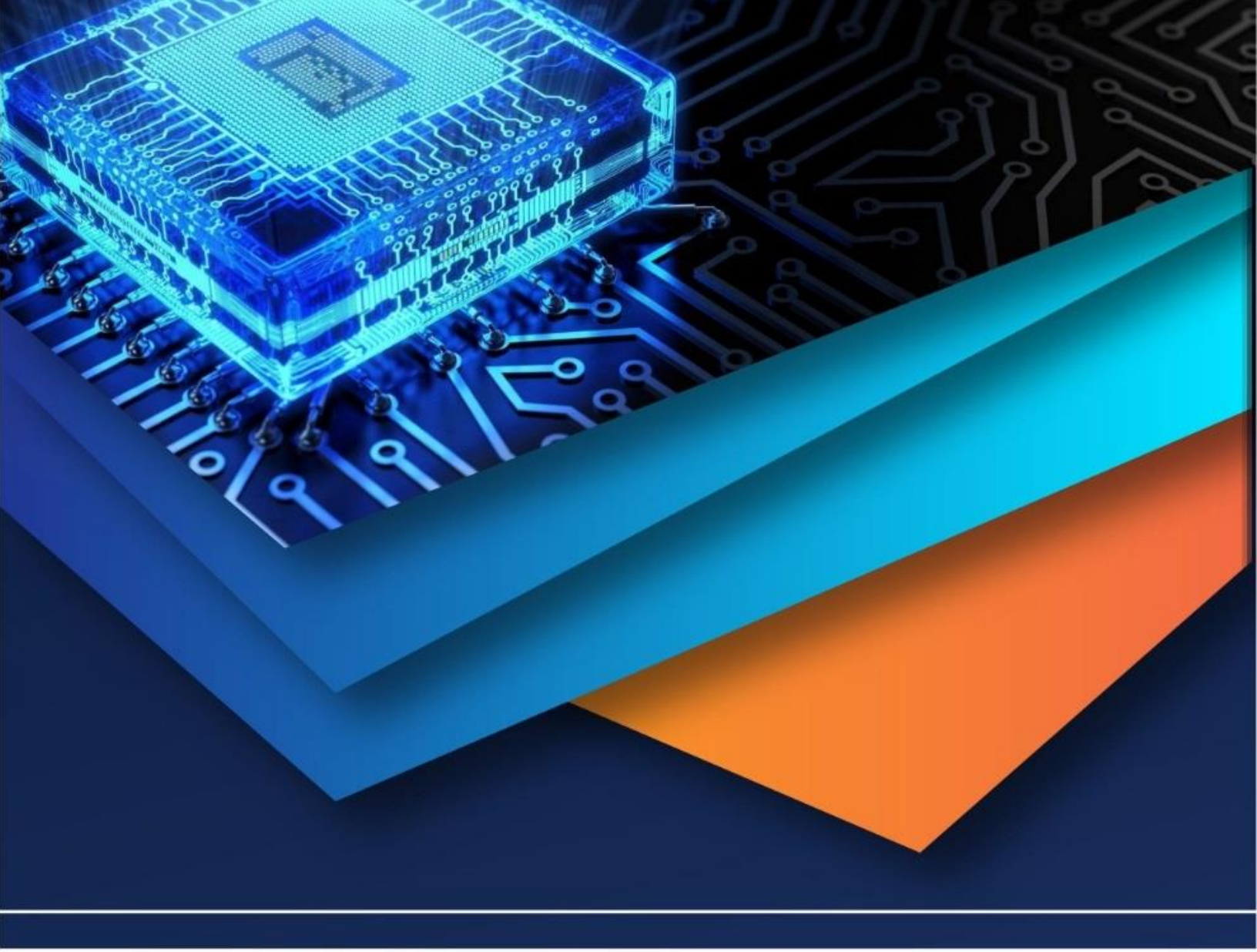

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