Study The Effect of Granite Powder & M-Sand on Pull-Off Strength, Ultrasonic Pulse Velocity, Water Absorption & Density of Conventional Concrete

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Abstract- *India is one of the largest country in world. It is ranked in 2nd in terms of population. Most flourishing industry is construction industry to accommodate huge population of the country.India is accounted as one of the prime Dimensional Stone export country worldwide. The principal ingredients of concrete i.e. cement, fine aggregate, coarse aggregate, water, which are obtained from natural resources. Decay of natural resources eventually effect the environmental conditions. Cement is the main binder content of concrete which produces maximum Co_2. Co_2 is the prime greenhouse gas. To minimize the emission of greenhouse gas, it is required to less production of cement. Our research work aimed to use Granite Powder up to 20% replacement of cement and use of M-Sand up to 100% in place of Natural River Sand. To understand the behavior of these alternative materials Density , water absorption, pull off & UPV test were performed on 150mm x 150mm x 150mm cube specimen at 28 Days. After, preliminary investigations it is found that at 10% replacement of Granite powder with cement and 30% replacement of natural river sand with M-Sand provides satisfactory result.*

Keywords- Granite Powder,Manufacturing Sand,Pull-Off , UPV, Water Absorption, Density

I. INTRODUCTION

India is endowed with abundant resources of a wide variety of granite. Granite technically refers to a light-colored granulose plutonic rock composed of felspars, plagioclase, quartz (35% approx.) and minor amounts (45% approx.) of mafic minerals, such as, biotite, hornblende, pyroxene, iron oxides, etc. India possesses enormous deposits of all types of dimension stones. It is one of the largest producers of dimension stones in the world. The Dimension Stone Industry employs a workforce of over one million at its various sectors. This Industry plays a vital role in the economy of the states like Tamil Nadu, Andhra Pradesh, Karnataka and Rajasthan. Rural economy of many developing States like Madhya Pradesh, Uttar Pradesh, Odisha and North-Eastern States is dependent on this Industry. state wise breakup of total resources reveals that Karnataka & Rajasthan share about 20% each of the resources which are followed by Jharkhand (19%), Gujarat (18%), Andhra Pradesh (5%) and Madhya Pradesh (4%)- these states together account for 86% of the total resources. We have used Granite Powder, which is a waste product generated during processes of quarrying and cutting & polishing. The properties of granite which are normally valued for exploitation are compressive strength, tensile strength, density, p-wave velocity, etc.

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction . Manufactured sand is produced from hard granite stone by crushing.The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm.Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world.Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed.Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.It is well graded in the required proportion. It does not contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be

maintained. It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete. M-Sand is obtained from specific hard rock (granite) using the state-of-the-art International technology, thus the required property of sand is obtained. M-Sand is cubical in shape and is manufactured using technology like High Carbon steel hit rock and then ROCK ON ROCK process which is synonymous to that of natural process undergoing in river sand information. Modern and imported machines are used to produce M-Sand to ensure required grading zone for the sand.
We have used these two new supplementary construction material, which can be used successfully in construction industry also easily available and provide adequate strength. The objective of this work is to control cost in construction industry and achieving strength . Along with this to minimize the environmental issue associated with waste
production.

II. EXPERIMENTAL PROGRAM

Materials:

In this study, Ordinary Portland cement was used and replaced partially with granite dust at various percentages which were 0%, 5%,10%,15% & 20% by weight of cement properties are listed in Table-1. It has been observed that 50% of particles had a diameter of 7µm and 90% of particle had a diameter lower than 50 µm and a specific gravity of 2.55. The value of Blaine fineness was 1.50m^2/g. The concrete mixture consisted of natural river sand, Coarse aggregate & Manufacturing Sand. The cement to water ratio of 0.40 was maintained in all batches and Admixture dosage were changed to maintain the same workability.

TABLE – I CEMENT PROPERTIES

Parameters	Results Obtained	Requirement as per IS 269	Parameters	Results Obtained	Requirement as per IS 8112
Physical Analysis			**Chemical Composition**		
Normal Consistency	27%		Loss on Ignition (% by mass)	1.8	Not More than 5.0%
Fineness	285 m^2 / kg	225 (Minimum)			
Setting Time (Minutes)			Magnesia (MgO) (% by mass)	0.9	Not More than 6.0%
Initial	125	30(Minimum)			
Final	280	600(Maximum)	Sulphuric Anhydride (SO3) (% by Mass)	2.7	Not More than 3.5%
Compressive Strength (MPa)					
72 ± 1h (3 Days)	32.2	23.0 (Minimum)	Chloride Content (% by Mass)	0.021	Not More than 0.1% (for general purpose) & not more than 0.05% for pre-stressed structures
168 ± 2h (7 Days)	41.1	33.0 (Minimum)			
672 ± 4h (28 Days)	56.3	43.0 (Minimum)	Insoluble Residue (% by mass)	0.4	Not More than 5%
Soundness					
Le-Chatelier Expansion (mm)	1.0	10.0 (Maximum)	*Specific Gravity of Cement is = 3.15		
Auto-Clave Expansion (%)	0.08	0.8 (Maximum)			

TABLE –II PERCENTAGE PASSING VALUES FOR COARSE AGGREGATE, FINE AGGREGATE & MANUFACTURE SAND

	Cumulative % Passed		
IS Sieve Size	Coarse Aggregate	Fine Aggregate	M-SAND
12mm	100	100	100
10mm	89.57	100	100
4.75mm	9.77	96	93
2.36mm	4.78	91	89
1.18mm	0	81	68
600µ	0	66	44.9
300µ	0	18	22.6
150µ	0	2	9.5

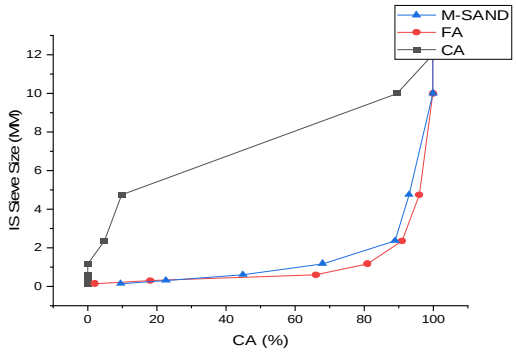


Figure 1Gradation curve of Aggregates

TABLE III PHYSICAL & CHEMICAL PROPERTIES OF MANUFACTURING SAND

Fineness modulus	2.69
Bulk density	1505.0 kg/m3
Close packing density	1728 kg/m3
Apparent density	2647.8 kg/m3
Bulk voidage	43.14%
Crushing value	15.54%
Powder content	4.9%
Clay lump content	0.4%

Mixture Proportions & Test Specimens

Total Five series were casted. In each series, 6 replacements were done. In First series, Granite Powder percentage kept at 0% and M-Sand percentages are varying 10%, 20%, 30%, 40%, 50% & 100%. In Second series Granite Powder percentage increased up to 5% and M- Sand replacement percentages are kept same. In further series, Granite powder increased up to 20% with an interval of 5%. Mix design were done as per IS: 10262 along with IS: 456 guidelines. Density, Water Absorption , UPV & Pull-Off tests were performed at 28 days on 150mm x 150mm x 150mm Cube. Water absorption & Density test was performed as per ASTMC 642 (2006),Pull-off strength test was performed as per BS, 1881: Part 207:1992, Ultrasonic Pulse Velocity test was conducted in accordance with IS:13311:1992. The values are provided in the result table are average of 3 values.

Experimental procedures

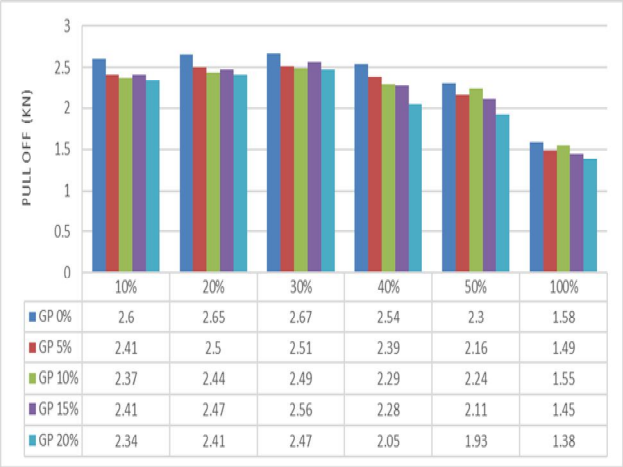
Density : ASTMC 642 (2006) standard specification was used for the testing. The weight of Three concrete samples of 150mm sizeis determined, either as received or, when so is requested, after the storing in water or after the drying at 105 ºC, to the closest value of the constant weight. The volume of the test specimen is determined through measuring if the specimen has a sufficiently regular form, otherwise through weighing under water.

Water absorption: ASTMC 642 (2006) standard specification was used for the testing. Three concrete samples of 150mm size were oven dried at 100 _C and kept at room temperature for a day before the initial weights were tabulated. Concrete samples were kept in water for 48 h with 50mm maintained as the free board. The specimens were uncrated, wiped with a clean fabric before the weight was catalogued.

Pull-off strength test: A portable instrument which measures the tensile strength ofcover concrete was used for determining the pull-off strength ofconcrete specimens (as per BS, 1881: Part 207:1992). The test wascarried out to 28 days cured concrete specimens. The test is used tofind the highest perpendicular force (in tension) that a surface areacan bear before detaching a plug of material. A detachable materialin the form of an iron disc having 50 mm diameter was used toperfectly bond with the concrete surface (with epoxy adhesive).The concrete samples were kept undisturbed for 24 h to assist thebonding between the concrete sample and the iron disc. A constantforce of 5-10 KN/minute was loaded and the maximum force topull the attached disc along with the concrete cover was reported.

Ultrasonic Pulse Velocity test: In India, ultrasonic testing is conducted according to IS 13311-1992. This test indicates the quality of workmanship and to find the cracks and defects in concrete. An ultrasonic pulse velocity test is an in-situ, nondestructive test to check the quality of concrete and natural rocks. In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure or natural rock formation. This test is conducted by passing a pulse of ultrasonic wave through concrete to be tested and measuring the time taken by pulse to get through the structure. Higher velocities indicate good quality and continuity of the material, while slower velocities may indicate concrete with many cracks or voids.Ultrasonic testing equipment includes a pulse generation circuit, consisting of electronic circuit for generating pulses and a transducer for transforming electronic pulse into mechanical pulse having an oscillation frequency in range of 40 kHz to 50 kHz, and a pulse reception circuit that receives the signal. The transducer, clock, oscillation circuit, and power source are assembled for use. After calibration to a standard sample of material with known properties, the transducers are placed on opposite sides of the material.

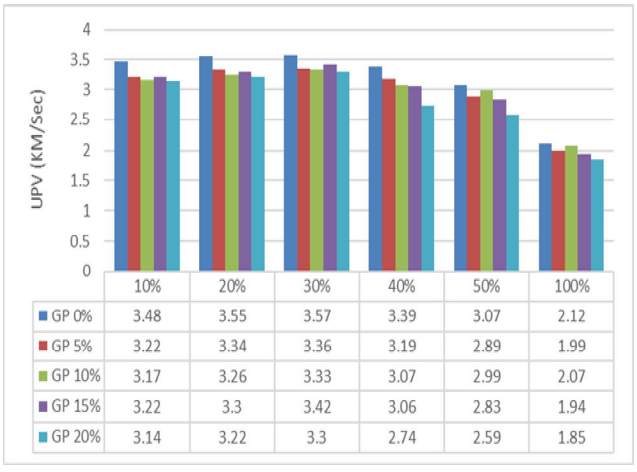
III. RESULT & DISCSSION



	10%	20%	30%	40%	50%	100%
GP 0%	2.6	2.65	2.67	2.54	2.3	1.58
GP 5%	2.41	2.5	2.51	2.39	2.16	1.49
GP 10%	2.37	2.44	2.49	2.29	2.24	1.55
GP 15%	2.41	2.47	2.56	2.28	2.11	1.45
GP 20%	2.34	2.41	2.47	2.05	1.93	1.38

Figure 3: Pull-Off Values

Density is one of the prime experiment to understand the concrete quality. Less porous concrete generally achieves high strength and less water absorption. Generally, concretetakes one year to achieve its 99% of strength after one year also strength gradually increased. Density of control concrete noted as 2740.74kg/m^3. However, with 30% replacement of natural river sand with M-Sand provides 2791.11 kg/m^3 density which is 1.83% more than controlled concrete. Again, with 30% M-Sand along with 15% Granite powder provides 2776.30kg/m^3 density which is also on higher side than control concrete. Due to increase in packing density of concrete the density of hardened concrete is more than controlled concrete. The significant particle size effect of Granite powder along with M-Sand noticeable very firmly.



	10%	20%	30%	40%	50%	100%
GP 0%	3.48	3.55	3.57	3.39	3.07	2.12
GP 5%	3.22	3.34	3.36	3.19	2.89	1.99
GP 10%	3.17	3.26	3.33	3.07	2.99	2.07
GP 15%	3.22	3.3	3.42	3.06	2.83	1.94
GP 20%	3.14	3.22	3.3	2.74	2.59	1.85

Figure 2: UPV Values

It directly indicated that aggregate size and shape have an good effect on concrete density properties indirectly on strength properties.

Water absorption directly related to density. Which also , shows from the result table. Control concrete having water absorption 1.09% . However, when we used M-Sand in place of natural river sand water absorption decreases around 6.42%. Which indicated that water absorption capacity of M-Sand is less than natural river sand. On the another hand, when we added Granite powder ranging from 5%,10%,15% & 20% , water absorption of concrete even decreases more around 9.50%. With this results, we can conclude that use of Granite powder along with M-Sand decreases water absorption of concrete which directly related to durabilitycharacteristics of concrete, Indicating advantages in long term use in concrete.

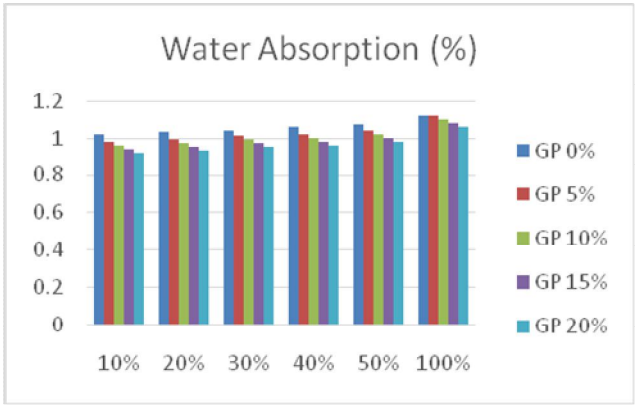


Figure 4: Water Absorption Values

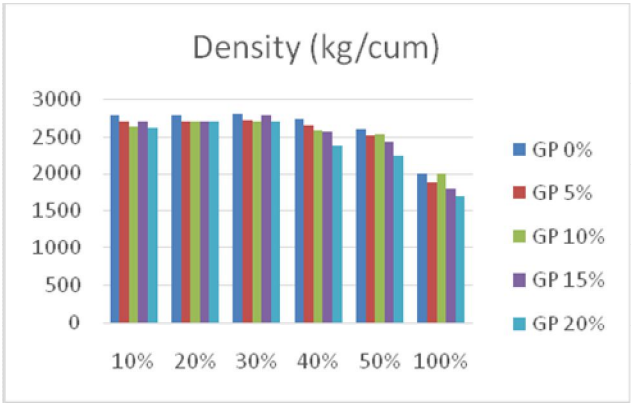


Figure 5: Density Values

Ultrasonic Pulse Velocity are the measure of impermeable concrete. Result shows that it gives better value with granite powder and M-sand concrete rather than control concrete.

Pull of test is performed to understand the bond behavior of concrete constituents. Results with M-Sand replacements gives good results than controlled concrete and Granite powder also helps to increase the strength of concrete. This gives a good packing efficiency due to various particle

size , which also helps to maintain the imperiousness of concrete structure. When we compare relationship with compressive strength and pull off strength, it shows high correlation between them.

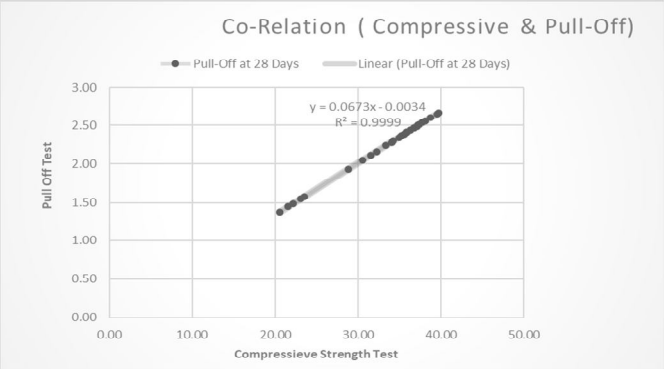


Figure 6: Correlation between Compressive & Pull-Off

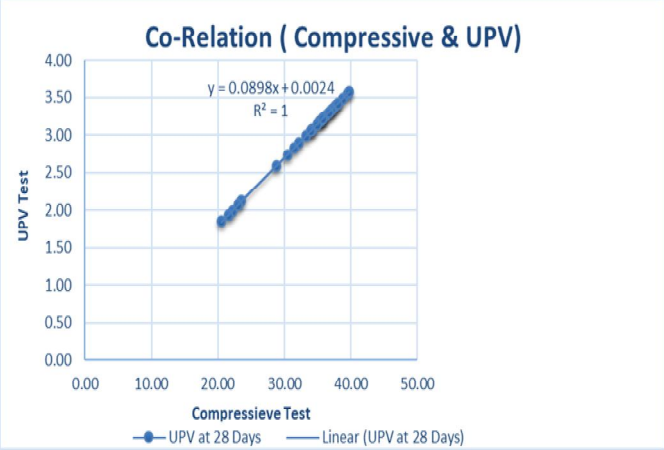


Figure 7: Correlation between Compressive & UPV

IV. CONCLUSION

Based on the above experimental investigation, we can conclude the following points:

1. Water absorption capacity of M-Sand is less than of natural river sand. M-sand particle size are coarser than natural river sand. When we replace M-Sand with natural river sand water absorption of concrete reduces and packing density also increases.
2. Granite powder is coarser than of cement particle size but up to 15% replacement of Granite powder makes the concrete very well graded which helps to increase the porousness of concrete.
3. Density and water absorption are directly related to each other. Both alternative materials are having less water absorption capacity than conventional material which makes the concrete more porous and gives an indication that for long term use of these material helps to improve quality of concrete.
4. Pull off strength also increased than control concrete which shows a good bonding in between concrete constituents.
5. Pull-Off strength & Compressive strength are in high correlation shows better characteristics of concrete.
6. UPV test are also in high correlation with compressive strength , which is an indicative result of denser, less permeable & imperious concrete without cracking, honey combing between the concrete constituents.
7. These all are concluded at 28 days test , however to understand the behavior in bigger view long term test need to be performed at least up to 365 days.

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