International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

Characteristic Studies on Concrete by Partial Replacement of Fine Aggregate with Waste Granite Powder

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***Abstract*— Concrete is the main construction material in the world. It consist of cement, fine aggregate, coarse aggregate and water as main ingredients. Now days due to high global consumption of natural sand, sand deposit are being depleted and causing serious threat to environment as well as society. River sand is becoming a scarce commodity and hence an exploration alternative to it has become imminent. Manufactured sand is the good alternative to river sand and it is purposely made, fine crushed aggregate produced under controlled conditions from a suitable sand source rock. Plastics are non-biodegradable common environmental polluting materials. These are going to affect the fertility of soil.**

In present study the detailed characteristic studies of concrete is carried out by partial replacement of natural sand by waste granite powder in concrete composition with different percentages (0%, 10%, 20%, 30%, 40%, 50%).The mechanical properties of concrete like compressive strength, tensile strength are carried out by replacing the quantity of sand with waste granite powder with different percentages as mentioned above.

Hence an attempt is made to find the optimum strength properties at which percentage of replacement it will gives better strength properties.

Keywords*— *Concrete, waste granite powder, compressive strength, tensile strength.

I. INTRODUCTION

The usual relevance of concrete in actually all civil engineering exercise and constructing construction works cannot be overemphasized Concrete is a mixture of cement, excellent and coarse aggregates and water which are combined in a precise unique strength. The cement and water react together chemically to form a paste which binds the combination particles together The combination units into a rock-like stable mass, which has full-size compressive power. However, the development enterprise depends heavily on traditional cement, granite and sand for the production of concrete. The high and growing value of these substances has greatly hindered the development of refuge and other infrastructural facilities in creating countries. As the infrastructure of the entire world is kept developing, the construction industry is in need of large amount of raw materials. As the consumption of raw materials increases the demand increases material. The growing situation of aid depletion and international air pollution has challenged many researchers and engineers are to be looking for and advance new substances relying on renewable resources. These consist of the use of by-products and waste materials in constructing construction. Many of these by-products are used as combination for the production of lightweight concrete. The most considerably used outstanding combination for the making of concrete is the natural sand mined from the riverbeds. However, the availability of river sand for the teaching of concrete is turning into scarce due to the immoderate nonscientific techniques of mining from the riverbeds, lowering of water desk and sinking of the bridge piers amongst others, is turning into frequent treats.

The international consumption of sand as high-quality mixture in concrete manufacturing is very high, and a number of growing nations have encountered some stress in the furnish growing needs of infrastructural improvement in current years Nonetheless, accumulation of unmanaged wastes specially in developing countries has resulted in an increasing environmental concern. Concrete is considered to be the biggest structural fabric due to its quality to form up in extra than a few geometrical configurations. In some conditions, one may count on that every day weight concrete is inconvenient due to its density (2200-2400kg/m3). Replacing partly or totally the daily weight mixture concrete with limit weight aggregates produces light-weight mixture concrete large growing quantity in the populace of the world requires large group of the settlement.

Now-a-days, due to excessive international consumption of herbal sand, sand credit are being depleted and inflicting serious danger to surroundings as nicely as society. River sand is becoming a scarce commodity and consequently an exploration choice to it has emerge as imminent. Manufactured sand is the exact alternative to river sand and it is purposely made, fine crushed combination produced under managed stipulations from an appropriate sand source rock. Concrete is most extensively used building fabric in world. It is manmade constructing material it can be mold into any shape. Concrete is composite cloth having homes of excessive compressive electrical energy, low tensile strength, low post cracking capacity, brittleness and low have an effect on strength. These residences can be prolonged with the aid of the usage of addition of fiber in the concrete. The fibers are dispersed and dispensed randomly in the concrete throughout mixing and this improves certain residences like tensile strength, flexural electricity etc. Fiber bolstered concrete can be described as composite materials consist of cement in particular based totally matrix containing an ordered or randomly disbursed of fibers. The regular fibers used in the concrete are steel, glass, asbestos, jute, coir,

International Journal of Engineering Research & Technology (IJERT)
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polypropylene, nylon, sisal. The uses of sisal fibers in the concrete are going to enhance the mechanical houses of concrete.

II. METHODOLOGY

MATERIALS

*Cement***:**
Ordinary Portland cement conforming to IS 12269:1987 was used. The followings are the test results of cement.

Table 1: Test results of cement

S.no.	Description	Test results	Is code limits	Is codes
1.	Specific gravity	3.13	3.10 - 3.15	IS: 269-1989
2.	Fineness modulus	4.33 %	<10 %	IS: 4031-1988
3.	Normal consistency	29 %	>26 %	IS: 4031 - 1988 (Part 4)
4.	Initial setting time	60 mins	> 30 mins	IS: 269-1989
5.	Final setting time	9 hrs 45 mins	< 10 hrs	IS: 269-1989

Fine Aggregates:
Locally available river sand passing through 4.75mm IS sieve is used.

Table 2: Test results of fine aggregates

S.no.	Property	Value (%)	IS specification
1.	Bulk density	1569 Kg/m^3	IS: 2386 (Part-4)-1963
2.	Specific gravity	2.70	
3.	Water absorption	0.15%	

Coarse Aggregates:
Crushed granite aggregate available from local sources has been used.

Table 3: Test Results of Coarse Aggregates

S.No.	Property	Value (%)	IS Specification
1	Bulk density	1488 Kg/m^3	IS: 2386 (Part-4)-1963
2	Aggregate Impact value (%)	11	
3	Flakiness Index (%)	12	
4	Elongation Index (%)	11	
5	Specific gravity	2.65	
6	Water absorption	15	

Waste Granite Powder:

The main concern is the non-renewable nature of natural sand and the corresponding increasing demand of construction industry. River sand that's one of the fundamental ingredients inside the manufacture of concrete has end up especially scarce and luxurious. Therefore seeking out an opportunity to river sand has come to be a need. Hence, the crusher granite dirt which is also known as waste granite fines can be used as an opportunity cloth for the river sand. Waste own similar residences as that of river sand and consequently normal as a building cloth.

Fine granite powder is one of the maximum used among such materials to update river sand, an opportunity to satisfactory mixture in concrete. Fine granite powder is a nice aggregate that is produced by way of crushing stone, gravel or slag. The combination fabric less than four.75 mm this is processed from beaten rock or gravel and supposed for production use. Fine granite powder is a material of high quality, in contradiction to non-refined surplus from coarse aggregate production. Fine granite powder is widely used all technicians of major projects around the world insist on the compulsory use of fine granite powder because of its consistent gradation and zero impurity. The followings are the test results on granite waste powder.
Specific gravity of granite fines G=2.23
The maximum bulking of the given granite fines is 0.29 @4% of moisture content.

Mix design:
M_{30} Concrete mix design
Coarse Aggregate: 20 mm
Design based on BIS recommended guidelines for mix design as per SP: 23-1982-BIS Publications

4.1.1. Design mix test data as per (IS: 10262)

a) Design Stipulations
1) Characteristic compressive strength required in the field @ 28 days: 30 Mpa
2) Max size of Aggregate : 20 mm (Angular)
3) Degree of workability : 0.9 (compaction factor)
4) Degree of quality control : Good
5) Type of exposure : Moderate

b) Target Mean Strength of Concrete
The target mean compressive strength for the specified characteristic cube strength = 30+ (1.65*6) =39.9 Mpa

c) Selection of Water – Cement ratio
Water/Cement ratio required for the target mean strength of 39.9 Mpa is = 0.38.But minimum W/C ratio based on workability =0.40
Therefore W/C = 0.40<0.55 (Max. for Moderate exposure) hence ok
For 20 mm Max .Size of aggregate, air content = 2 %

d) Selection of water and sand content
For M_{30} Grade concrete, for 20 mm Max. Size of aggregate and sand conforming to grading Zone- 2, water content per cubic meter of concrete = 185 kg and sand content as % of total aggregate by absolute volume = 35%. For change in value in water-cement ratio compacting factor and for sand belonging to Zone-2, the following adjustments are required.

The required sand content as% of total aggregate by absolute volume = (35-3.0) =32 required water content = (185+3 %(185) =190.58 lit/m^3 say 191 lit/ m^3

Selection of water and sand content.

Change in condition	**Adjustments Required**	
	Water content (%)	% Sand in total Aggregate
For decreasing water cement ratio of (0.55-0.40)=0.15	0	-3.0
For increase in compacting factor (0.90)	+3.0	0
Total	+3.0	-3.0

e) Determination of cement content

Adopting water – cement ratio = 0.40
Water = 191 liters
Cement =191/0.40 =477.5 kg/m^3< 550 kg/m^3 (Max. cement content)
Adopting cement content = 450 kg/m^3

f) Determination of coarse and fine aggregate content

The Specified Maximum Size of Aggregate of 20 mm, the quantity of entrapped air in the wet concrete is 2 % taking this into consideration and applying equations

$0.98= [185+ (450/3.15) + (1/0.32)*(fa/2.7)] (1/1000)$ and $[185+ (450/3.15) + (1/0.68)*(ca/2.65)] (1/1000)$

F_a=563.45 say 565 kg / m^3
$C_{a=}$ 1175.0 kg / m^3 say 1175 kg / m^3
The Mix Proportion then becomes
0.4 1 1.25 2.61

g) Actual qualities required for the Mix per cubic meter of cement

1) Cement = 450 kg
2) Sand = 565 kg
3) Coarse Aggregate = 1175 kg
4) Water = 185 lits

DETAILS OF CUBES, CYLINDERS

Concrete cubes of size 15 cmx15cm are used to determine the compressive strength of concrete.
The split tensile strength can be calculated by using concrete cylinders of size 15cm diameter and 30cm length
Number of cubes casted= 6 (3 for 7 days & 3 for 28 days)
Number of cylinders casted = 6 (3 for 7 days & 3 for 28 days)

TEST SETUP AND TESTING
Cubes compressive strength test:

Compression test on cubes is conducted with 1200 KN capacity compression testing machine. The machine has a least count of 2 KN.

Fig 1: Compressive testing machine

SPLIT TENSILE STRENGTH TEST:
The cylinder is placed on the bottom compression plate of the testing machine and is aligned such that the centre lines marked on the ends of the specimen are vertical.

Fig 2: Split tensile strength test

III. RESULTS AND DISCUSSION

Based on the experimental investigations, the results of cubes are presented below.

Table 4: Compressive strength of concrete specimens at 0% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm^2	Avg.compressive strength in N/mm^2
7	1	8.44	640	28.44	27.77
	2	8.34	610	27.11	
	3	8.39	625	27.77	
28	1	8.43	935	41.56	41.63
	2	8.41	940	41.78	
	3	8.52	935	41.56	

Table 5: Compressive strength of concrete specimens at 10% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm²	Avg.compressive strength in N/mm²
7	1	8.50	670	29.77	29.62
	2	8.52	680	30.22	
	3	8.52	650	28.88	
28	1	8.53	960	42.66	42.51
	2	8.077	960	42.66	
	3	8.35	950	42.22	

Table 6: Compressive strength of concrete specimens at 20% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm²	Avg.compressive strength in N/mm²
7	1	8.35	720	32	31.7
	2	8.41	740	32.88	
	3	8.45	680	30.22	
28	1	8.26	1040	46.22	42.96
	2	8.21	900	40.00	
	3	8.35	960	42.66	

Table 7: Compressive strength of concrete specimens at 30% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm²	Avg.compressive strength in N/mm²
7	1	8.58	780	34.66	33.77
	2	8.56	740	32.88	
	3	8.50	760	33.77	
28	1	8.63	1020	45.33	45.62
	2	8.41	1050	46.66	
	3	8.55	1010	44.88	

Table 8: Compressive strength of concrete specimens at 40% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm²	Avg.compressive strength in N/mm²
7	1	8.44	680	30.22	31.11
	2	8.62	700	31.11	
	3	8.58	720	32.00	
28	1	8.60	980	43.55	43.84
	2	8.23	970	43.11	
	3	8.62	1010	44.88	

Table 9: Compressive strength of concrete specimens at 50% fine granite waste

No. of days	cube numbers	weight of cube	load in KN	compressive strength in N/mm²	Avg.compressive strength in N/mm²
7	1	8.25	670	29.77	29.62
	2	8.51	680	30.22	
	3	8.54	650	28.88	
28	1	8.69	1050	40.66	44.21
	2	8.63	1030	45.77	
	3	8.70	1040	46.22	

Test results on concrete cylinder:

Table 10: Split tensile strength of concrete specimens at 0% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensilestrength in N/mm²	Avg. split tensilestrength in N/mm²
7	1	12.93	120	1.69	1.64
	2	12.95	120	1.69	
	3	12.90	110	1.55	
28	1	12.93	140	1.98	1.98
	2	13.23	140	1.98	
	3	13.10	140	1.98	

Table 11: Split tensile strength of concrete specimens at 10% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensilestrength in N/mm²	Avg. split tensile strength in N/mm²
7	1	13.60	120	1.69	1.73
	2	13.07	120	1.69	
	3	13.35	130	1.83	
28	1	12.97	160	2.26	2.21
	2	12.65	160	2.26	
	3	12.85	150	2.12	

Table 12: Split tensile strength of concrete specimens at 20% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensile strength in N/mm²	Avg. split tensile strength in N/mm²
7	1	12.94	150	2.12	2.49
	2	12.85	200	2.82	
	3	12.75	180	2.54	
28	1	13.05	180	2.50	2.90
	2	12.82	230	3.25	
	3	12.95	210	2.97	

Table 13: Split tensile strength of concrete specimens at 30% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensilestrength in N/mm²	Avg. split tensile strength in N/mm²
7	1	12.84	230	3.25	2.82
	2	12.96	180	2.54	
	3	12.88	190	2.68	
28	1	13.15	200	2.80	3.00
	2	12.96	230	3.25	
	3	13.10	210	2.97	

Table 14: Split tensile strength of concrete specimens at 40% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensilestrength in N/mm²	Avg. split tensilestrength in N/mm²
7	1	13.49	180	2.54	2.72
	2	12.95	200	2.82	
	3	13.00	200	2.82	
28	1	13.50	150	2.12	2.97
	2	13.00	260	3.67	
	3	12.95	220	3.12	

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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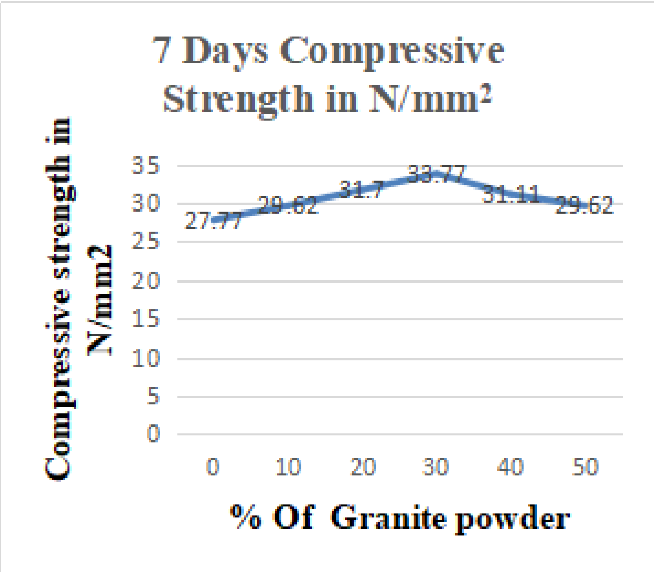
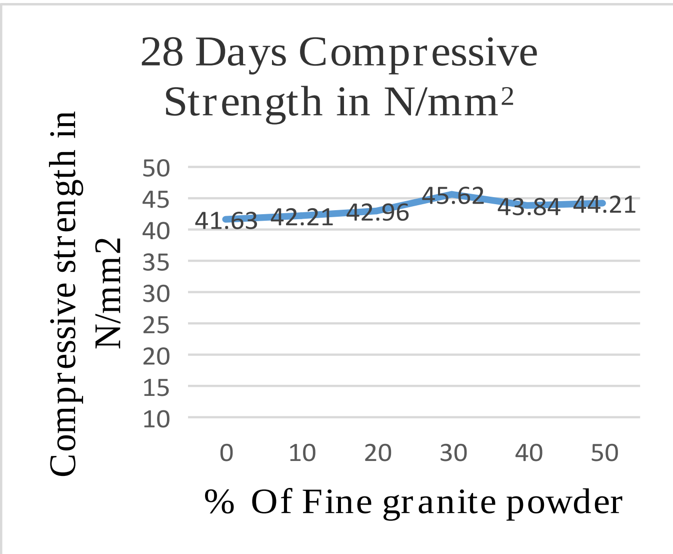
Table 15: Split tensile strength of concrete specimens at 50% fine granite waste

No. of days	cylinders number	weight of cylinders	load in KN	split tensilestrength in N/mm²	Avg. split tensilestrength in N/mm²
7	1	13.66	110	1.55	1.59
	2	13.48	110	1.55	
	3	13.35	120	1.69	
28	1	13.99	160	2.26	2.26
	2	13.76	150	2.12	
	3	13.55	170	2.40	

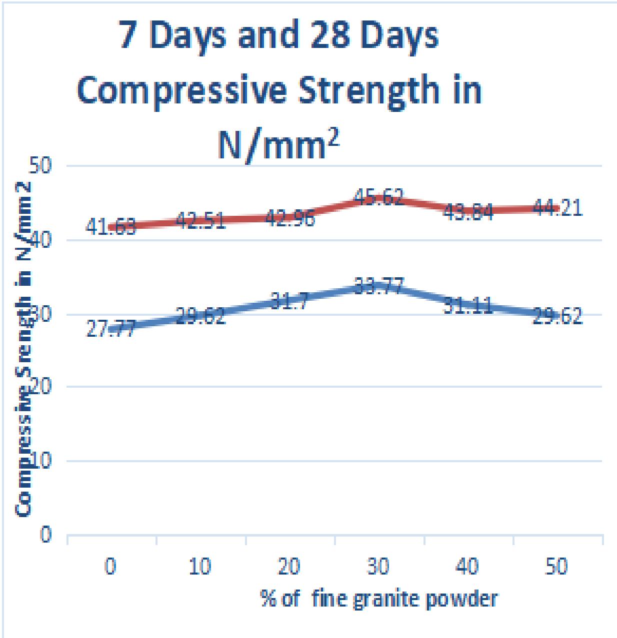
GRAPH 1: 7 DAYS COMPRESSIVE STRENGTH OF CONCRETE



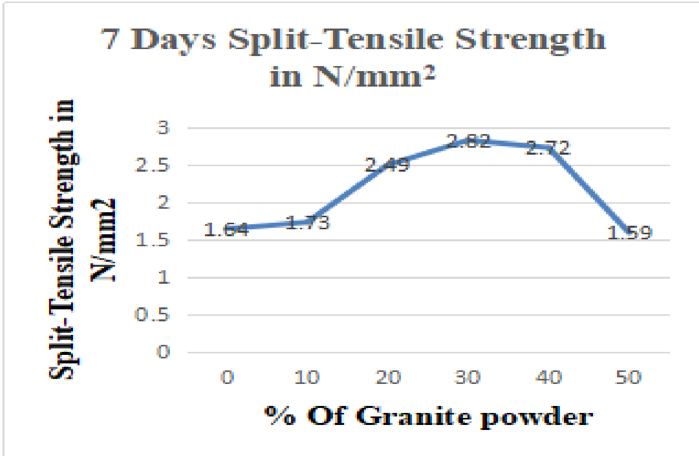
GRAPH 2: 28 DAYS COMPRESSIVE STRENGTH OF CONCRETE



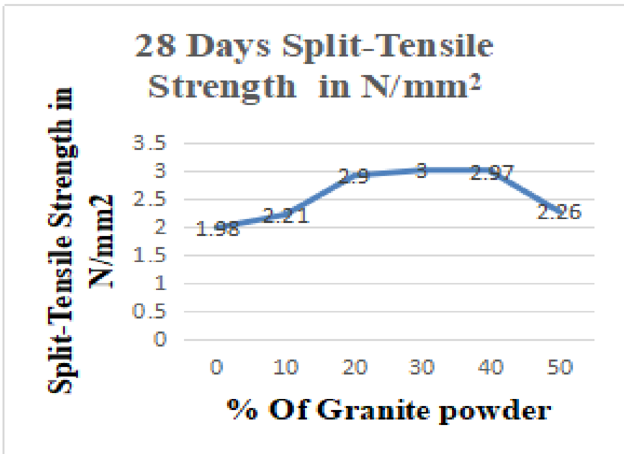
GRAPH 3: COMPARISION OF 7 DAYS AND 28 DAYS COMPRESSIVE STRENGTH



GRAPH 4: 7 DAYS SPLIT-TENSILE STRENGTH OF CONCRETE



GRAPH 5: 28 DAYS SPLIT-TENSILE STRENGTH OF CONCRETE



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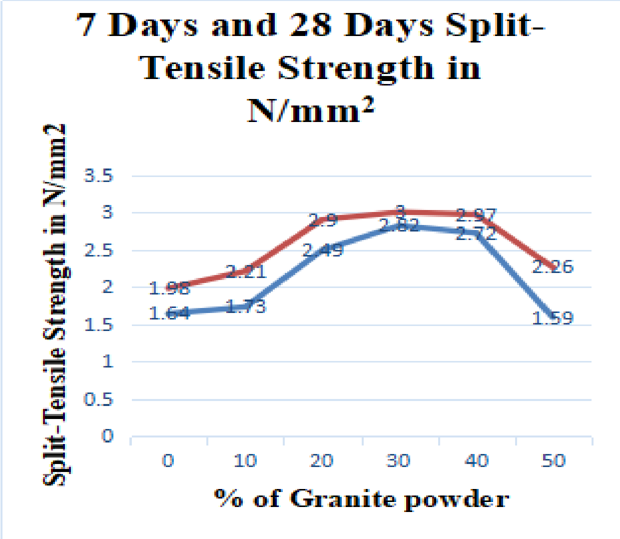
GRAPH 6: COMPARISION OF 7 DAYS AND 28 DAYS SPLIT-TENSILE STRENGTH



IV. CONCLUSION AND SCOPE FOR FUTURE INVESTIGATION

Conclusion:

1. The cost of concrete is less than conventional concrete. The concrete becomes environment friendly, due to use of waste industrial material.
2. There is an increase of 17% compressive strength for 30% replacement of fine aggregate compare with normal concrete for 7-days and 8.74% increase in strength for 28-days.
3. The split tensile strength also follows the similar pattern compare with the compressive strength that is at 30% replacement of fine aggregate with waste granite fines it shows the maximum split tensile strength.
4. Hence, we can conclude from the above results that the maximum compressive and split tensile strength is obtained at 30% replacement of fine aggregate with waste granite fines

Scope for the future investigation:

1. The mechanical properties of Concrete with the waste granite powder as a replacement for fine aggregate in concrete can be studied by using Super Plasticizer.
2. Stability Studies can be approved on this existings.
3. The behavior of Reinforced Concrete can be studied by replacing the fine aggregate with waste granite powder.
4. High Strength Concrete with other mixtures can be tried.

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[2] **Manasseh Joel (2010)**: He also recommended that 20% replacement of natural sand by crushed granite powder when laying rigid concrete pavements gives increased compressive strength and split tensile strength can be found.

[3] **T. Felixkala (et al 2010)**: He had obtained the test results that granite powder of marginal quantity as partial sand replacement has beneficial effects on the mechanical properties such as Compressive Strength, Split Tensile Strength and Modulus of Elasticity. They also indicated that the values of both plastic and drying shrinkage of concrete in the granite powder concrete specimens

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