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# Experimental Investigation on Concrete Beams with Granite Powder and Hybrid Rods as Replacement Materials

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**ABSTRACT:** Concrete is one of the core materials in the construction industry, which is subjected to a number of researches. The civil engineering field also needs alternative replacement materials in concrete in order to enhance its properties such as workability, strength, durability etc., and also to reduce its manufacturing cost. The most urgent need is to find alternative material for sand to be replaced in concrete due to high price and also save the ground water resources. The study involves the use of granite powder, a waste material obtained from as a by-product from the granite industries. This work is carried out by replacing the granite powder with sand in concrete with 0%, 4%, 8%, 12%, 16% and 20% respectively. A total of 25 cubes (150 mm X 150 mm), 25 cylinders (150 mm dia and 300 mm height), 25 prisms (150 mm X 700 mm X 150 mm) and three beams were tested for compressive, split tensile and flexural strength at the age of 28 days. Also TMT bars were replaced with square rods to study the behavior of concrete beams and the load carrying capacity of the beams are tested and interpreted.

**KEYWORDS:** Granite powder, Hybrid rods, Ground water, Compressive, Split tensile, Flexural strength

### I. INTRODUCTION

Granite is a rock which falls under the category of Igneous rock. Nowadays, granite is one most important flooring material used in the construction industry due to its benefits such as strength, hardness, and good appearance. Granite stones are cut and polished in the industries in order to meet the market demand. This process results in the production of huge quantity waste material in a semi-powder state, which is dumped by the industries resulting in environmental hazard. Granite powder can be effective used in concrete as a replacement material for sand to improve the workability properties such as slump value, compaction factor etc., and the hardened concrete properties such as compressive, split tensile and flexural strength. The use of granite powder in concrete reduces the cost and the risk of environmental hazard. TMT bars are conventionally used in concrete from the olden days. Attempt has been made in this work by using hybrid square rods instead of TMT bars. The main advantages or benefits derived is that, the size of rods can be reduced and the dead weight of the member is minimized.

### II. RELATED WORK

Rania Hamza et al (2011) G.Prince Arulraj et al (2013) examined the usage of marble and granite powder in concrete bricks. They reported that, the marble and granite powder bricks have similar mechanical and physical properties. They also reported that water absorption is the major drawback in using the slurry bricks, as it is satisfied only in 0%, 10% and 20%. They concluded that the bricks with slurry have sufficient abrasion resistance. Manasseh JOEL (2010) studied the suitability of crushed granite fine in rigid pavement construction by replacing river sand from 0% to 100%. They concluded that the use of granite fines in concrete requires high water-cement ratio when compared to the river sand. They also concluded that peak compressive strength and indirect tensile strength is obtained when crushed granite fines were replaced with 20% of river sand in the manufacture of concrete. Based on their study, they suggested that

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granite fines can be replaced up to 20% for river sand in rigid pavements and it can be completely replaced in low to moderate traffic roads. Divakar Y, Manjunath S et al (2010), Kamble Ambarish et al (2011), Kanmalai Williams C et al (2008) investigated the behavior of concrete with the use of granite fines. In this work the granite fines was replaced by 0%, 5%, 15%, 25%, 35% and 50% with fine aggregate. It was reported that the compressive strength increases by 22% with 35% replacement of fine aggregate, the split tensile strength shows no change in strength for 35% replacement of fine aggregate, the flexural strength of prisms without reinforcement has no much changes and the flexural strength of prisms with reinforcement has considerable increase with granite fines. Hence it is concluded that an overall increase in strength is achieved with 35% replacement of granite fines. H. V. Ramakrishna et al (2006) studied the utilization of granite powder as Filler for Polybutylene Terephthalate Toughened Epoxy Resin and observed the mechanical properties such as tensile, flexural, compressive strengths and impact strength. The composites are prepared by thoroughly washing the granite powder and drying it in oven and to which 1% solution of silane coupling agent is mixed. It was concluded that the mechanical properties of the composites under study were maximized at 50% granite powder filler content and the composites prepared had good chemical resistance and lower water absorption.

### III. OBJECTIVE OF THE STUDY

The main objective of the study is to determine the workability and hardened properties of concrete by replacing sand with granite powder. Also to analyze the load carrying capacity of beams with replacement of TMT bars with hybrid rods.

### IV. EXPERIMENTAL MATERIALS

#### IV.I. CEMENT

Cement is a building material used for binding the ingredients of concrete. In this research study, most commonly available Ordinary Portland Cement of grade 53 is used. Test such as consistency tests, setting time test, specific gravity were carried out to determine the properties of the cement. Table 1 gives the test values for OPC.

Table 1. Properties of Ordinary Portland Cement tested in the laboratory conditions showing the obtained values and the prescribed values for OPC in ordinary field conditions

S.No	Property tested	Result obtained	Standard value
1.	Consistency	29 %	-
2.	Initial setting time	39 mins	Not less than 30 mins
3.	Final setting time	400 mins	Not more than 600mins
4.	Compressive strength	66 MPa	Not less than 53 Mpa
5.	Specific gravity	3.14	-

#### IV.II. FINE AGGREGATE

Sand is a naturally formed granular material which consists of rock and mineral deposits in it. Locally available river sand is used as fine aggregate in this study. Tests such as specific gravity and sieve analysis are carried out to ensure the properties of fine aggregates as specified by Indian Standards and the results are presented in table 2 and Grain size distribution curve for sand are shown in figure 1.

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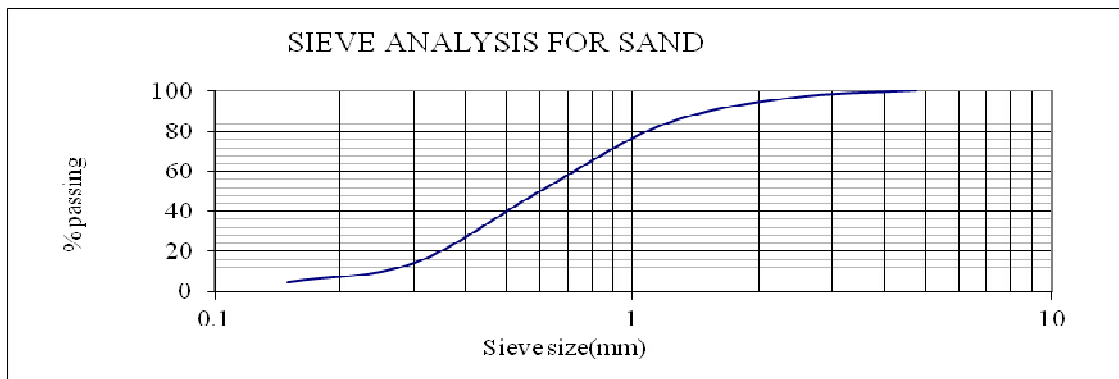
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Table 2. Properties of Fine Aggregate tested in laboratory under ordinary field conditions

S.No	Property tested	Result obtained	Standard value
1.	Specific gravity	2.72	-
2.	Fineness Modulus	3.21	-

Figure 1. Graph shows the Particle size distribution curve for sand carried out in laboratory under ordinary field conditions



### IV.III COARSE AGGREGATE

Coarse aggregate gives volume and strength to the concrete. A standard size of 20 mm crushed aggregate collected from the locally available quarry is used in this work. Tests such as Specific gravity, Impact test and crushing test were carried out to determine the physical and mechanical properties of coarse aggregate. Table 3 gives the test results for coarse aggregate.

Table 3. Properties of Coarse Aggregate tested in laboratory under ordinary field conditions

S.No	Property tested	Result obtained	Standard value
1.	Specific gravity	2.18	-
2.	Impact strength	25 %	-
3.	Crushing strength	89 %	-

### IV.IV GRANITE POWDER

Granite powder used as a replacement material for fine aggregate in this work is collected from Madhav Marbles, Thoppur, Tamilnadu, India. Specific gravity test, Grain size distribution test were carried out to study and compare the properties of granite powder with fine aggregate. Table 4 gives the test results for granite powder and the grain size distribution of granite powder is shown in figure 2

Table 4. Properties Of Granite Powder tested in laboratory under ordinary field conditions

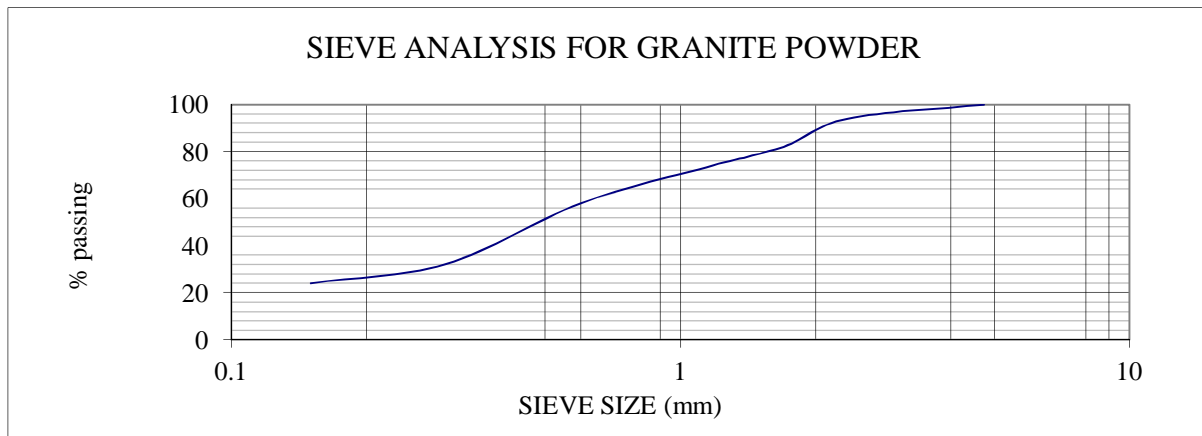
S.No	Property tested	Result obtained	Standard value
1.	Specific gravity	2.63	-
2.	Fineness modulus	4.53	-

Figure 2: Grain size distribution curve for granite powder to study its particle size variation and fineness tested in laboratory under ordinary field conditions

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## V. EXPERIMENTAL STUDY

### V.I. MIX PROPORTION

Mix proportion is carried for a grade M40 concrete as per the specifications of IS 10262-2009. In this course of study, granite powder was replaced with fine aggregate by 0%, 4%, 8%, 12%, 16% and 20% respectively. Mix proportion has varied with respect to the percentage replacement of granite powder and presented in table 5.

Table 5. Mix proportion for M40 grade concrete with the different quantities of the ingredients as shown in the tale

Water	Cement	Fine aggregate	Coarse aggregate
180.65 (Lit)	586.5 (Kg/m <sup>3</sup> )	366 (Kg/m <sup>3</sup> )	1049.72 (Kg/m <sup>3</sup> )
0.30	1	0.62	1.79

### V.II DESIGN MIX PROPORTION FOR VARIOUS CONCRETE

Table 6 shows the design mix proportion for different percentages of granite powder replaced with fine aggregate.

Table 6. Mix designation for different mixes adopted in the study with its designation and the percentage to be replaced

S.No	Mix designation	Fine aggregate replace with granite powder
1.	CC	Conventional concrete
2.	GP 1	4% replacement
3.	GP 2	8% replacement
4.	GP 3	12% replacement
5.	GP 4	16% replacement
6.	GP 5	20% replacement

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## V.III DETAILS OF SPECIMENS CAST

The details of specimen cast for different percentage of replacement are given in table 7.

Table 7. Shows the number of specimen cast with various percentage of replacement of sand with granite powder with its designation

S.No	Mix designation	% replacement	Cube	Cylinder	Prism
1.	CC	0	6	6	6
2.	GP 1	4	6	6	6
3.	GP 2	8	6	6	6
4.	GP 3	12	6	6	6
5.	GP 4	16	6	6	6
6.	GP 5	20	6	6	6

## V.IV TEST RESULTS

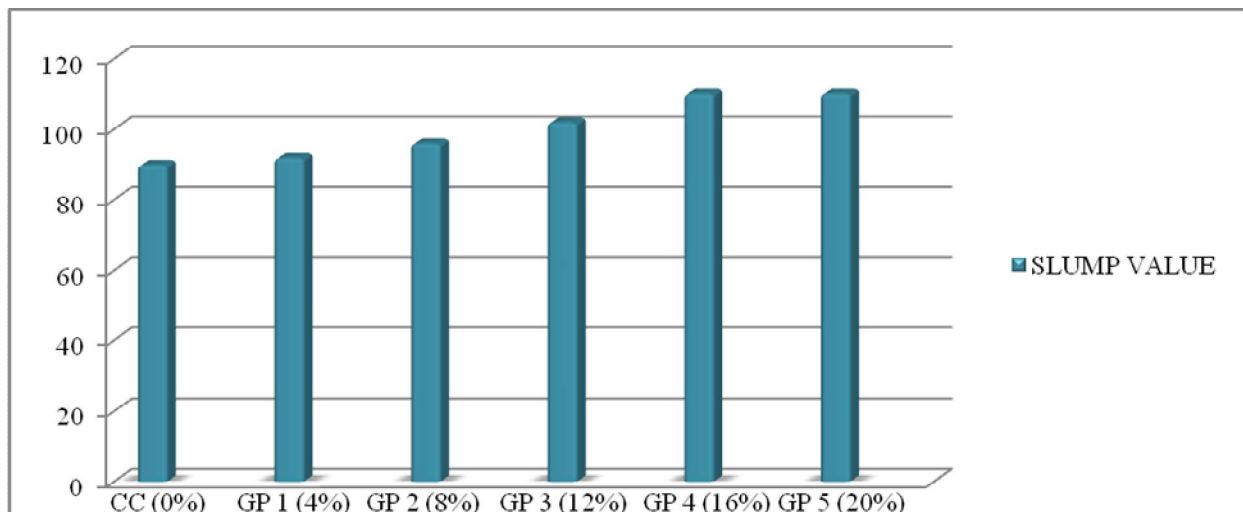
### V.IV.I. WORKABILITY RESULTS

Workability test were carried out for each mix designation and the results are presented in table 8.

Table 8. Shows the different Workability test results with various percentage of replacement of sand with granite powder with its designation

S.No	Mix designation	% replacement	Slump value	Compaction factor
1.	CC	0	90	0.95
2.	GP 1	4	92	0.93
3.	GP 2	8	96	0.92
4.	GP 3	12	102	0.90
5.	GP 4	16	110	0.87
6.	GP 5	20	118	0.86

Figure 3. Shows the Slump test results of various mix designations and the pattern of variation for each mix with the replacement material



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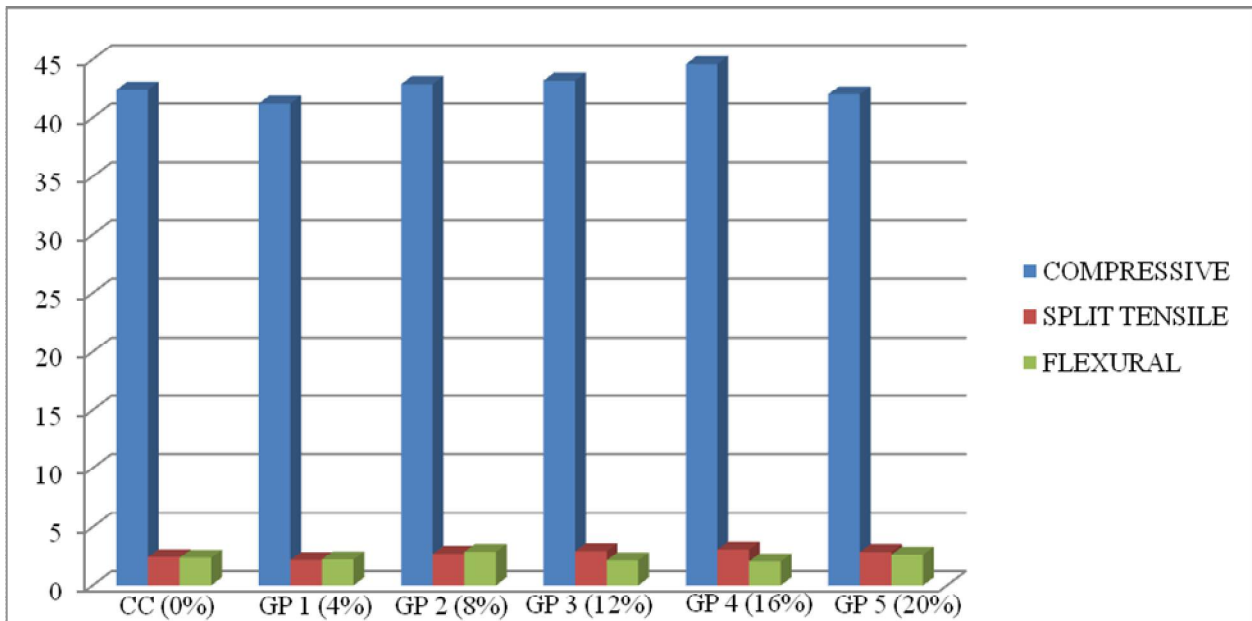
## V.IV.II HARDENED CONCRETE RESULTS

After completing the workability tests, cubes, cylinders and prisms were casted for each mix designation and the results are presented in table 9 and hardened concrete test are presented in figure 5.

Table 9. Shows the different Hardened concrete test results with various percentage of replacement of sand with granite powder with its mix designation

S.No	Mix designation	Compressive strength (Mpa)		Split tensile strength(Mpa)		Flexural strength(Mpa)	
		7 days	28 days	7 days	28 days	7 days	28 days
1.	CC	27.2	42.4	1.82	2.42	1.68	2.37
2.	GP 1	26.5	41.2	1.76	2.16	1.57	2.22
3.	GP 2	28.4	42.9	1.88	2.71	1.74	2.89
4.	GP 3	30.0	43.2	1.95	2.94	1.44	2.13
5.	GP 4	32.8	44.6	2.35	3.08	1.31	2.04
6.	GP 5	30.6	42.0	2.05	2.87	1.62	2.65

Figure 5. Shows the Bar chart for hardened concrete test of various mix designations and the pattern of variation in strength for each mix with the replacement material



## VI. SELECTION OF OPTIMUM MIX PROPORTION:

Based on the hardened concrete test results, it can be observed that the strength of concrete increases with increase in the percentage replacement of granite powder upto 16%. Thereafter the strength of the concrete reduces due to high fineness of granite powder. Hence, this proportion (GP4) is selected for casting the beams with TMT bars and hybrid rods.

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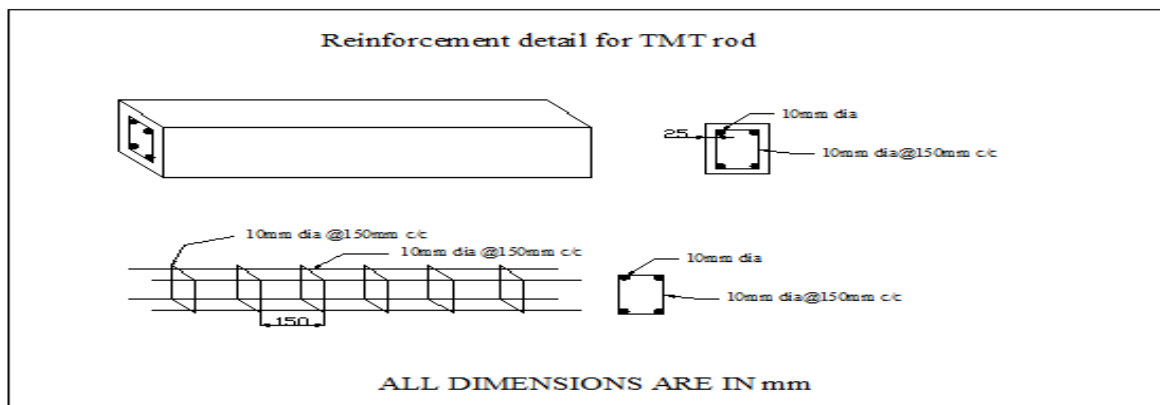
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## V.I CASTING OF BEAM

Two beams of length 1 m is casted, one with conventional TMT bars and the other with hybrid square rods of 5mm in diameter. The reinforcement details are given figure 6.

Figure 6. Shows the Design of Reinforcement details for beams with TMT bars including the size of the bar to be used with ties and spacing of bars



## VI.II TESTING OF BEAM

After casting the beams, it is cured for a period of 28 days at room temperature. Then it is under tested in a loading frame for different load intensities and the corresponding deflections are recorded as shown in figure 7.

Figure 7: Shows arrangement and the loading of beam casted with TMT Rods with visible deflection crack at the middle and hairline cracks emerging from there onwards





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The beam with TMT bars takes a maximum load of 51 kN and sustains a deflection of 6.9 mm, while the beam with hybrid square rod takes a maximum load of 58 kN and sustains a deflection of 5.2 mm. The load deflection curves are plotted separately as shown in figure 8 and figure 9.

Figure 8. Shows Load Deflection curve of beam casted with TMT bars along with the load carrying capacity of the beam and the corresponding deflection due to the ultimate load

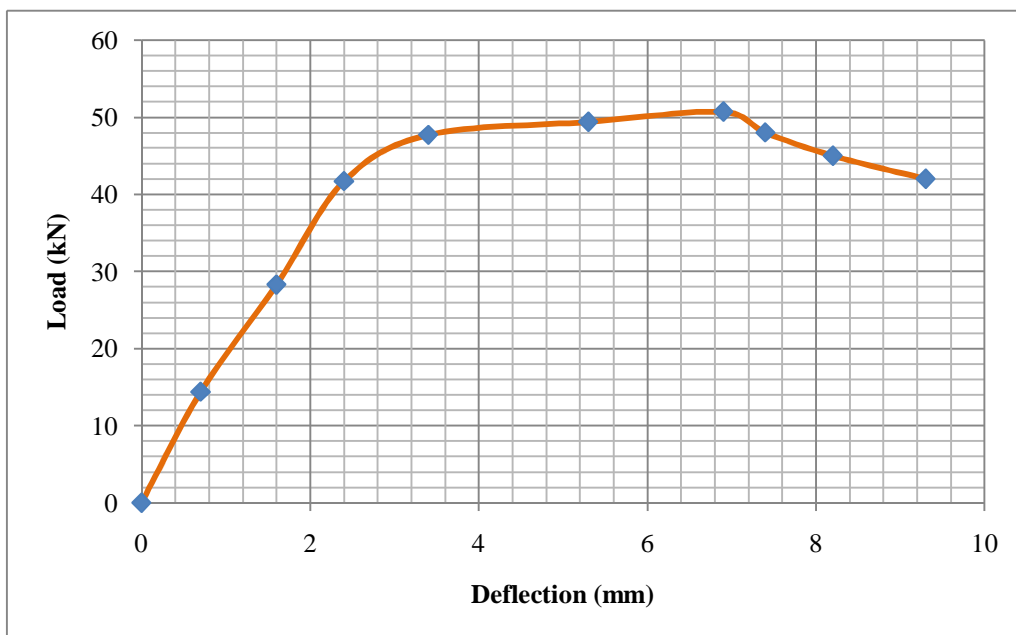
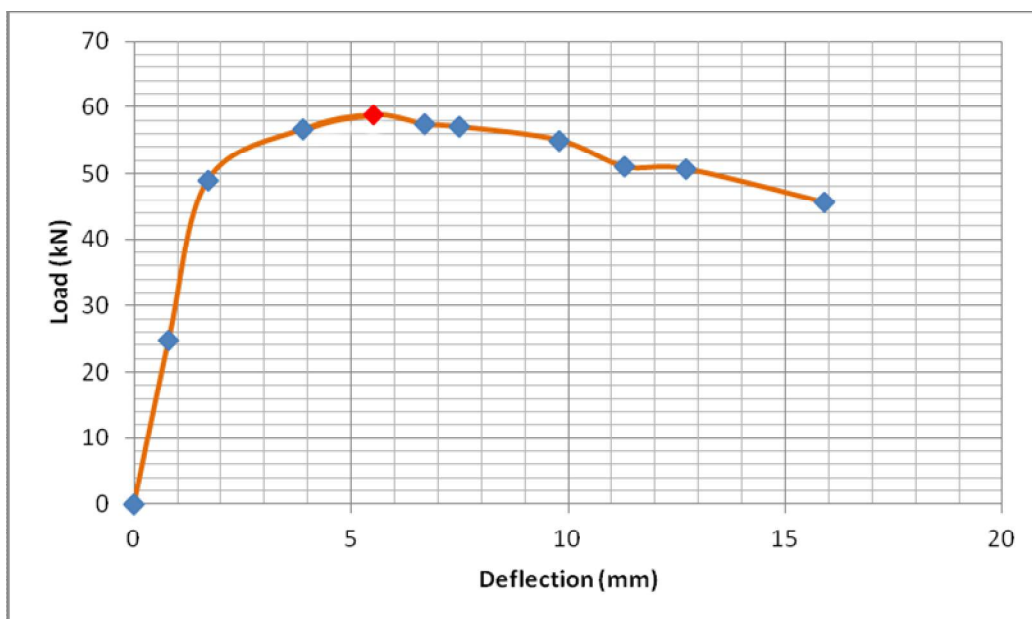


Figure 9. Shows Load Deflection curve of beam casted with hybrid bars along with the load carrying capacity of the beam and the corresponding deflection due to the ultimate load





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## VII. CONCLUSION

From the above research study, the following conclusions are arrived.

1. The workability of concrete increases due to the fineness of granite powder. Hence, it can be successfully used in situations where high degree of workability is required.
2. The compressive strength increases with increase in percentage of granite powder as compared to the conventional concrete.
3. The optimum percentage of replacing granite powder for sand in concrete is 16%.
4. Under static loading conditions, the beam with hybrid rod takes maximum load minimum deflection when compared to the TMT bars in same proportion of granite powder. Therefore, hybrid rods improves the load carrying capacity of the beams.
5. By replacing granite powder to sand in concrete thus improving the workability, it can also be used in some special concretes such as Self compacting concrete etc.,
6. Use of granite powder in construction field reduces the demand for river sand and helps in minimizing the cost of the project.
7. Granite powder can be successfully used as an alternative material in the construction industry.

## REFERENCES

- [1] Manasseh JOEL, "Use of Crushed Granite Fine as Replacement to River Sand in Concrete Production" Leonardo Electronic Journal of Practices and Technologies, pp 85-96, 2010.
- [2] Divakar Y, Manjunath S and Dr. M.U. Aswath, "Experimental Investigation on Behaviour of Concrete with the Use of Granite Fines" International Journal of Advanced Engineering Research and Studies, pp 84-87, 2012.
- [3] Rania Hamza, Salah El-Haggar, Safwan Khedr "Utilization of Marble and Granite Waste in Concrete Bricks" International Conference on Environment and BioScience, vol.21 IPCBEE, Singapore, 2011.
- [4] Dr.G.Prince Arulraj, Mr.A.Adin and Mr.T.Suresh Kannan, "Granite Powder Concrete" IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.3, No.1, pp 193-198, February 2013.
- [5] Kamble Ambarish, Manjunath. S, Dr. Renukadevi.M.V and Dr. K. S. Jagadish, "Effect of Granite Fines on Strength of Hollow Concrete Blocks" International Journal of Advanced Engineering Technology, Vol.II, pp 475-479, 2011.
- [6] Kanmalai Williams C, Partheeban P, Felix Kala T, "Mechanical Properties of High Performance Concrete Incorporating Granite Powder as Fine Aggregate" International Journal on Design and Manufacturing Technologies, Vol.2, , pp 67-73, July 2008.
- [7] H. V. Ramakrishna and S. K Rai, "Utilization of Granite Powder as Filler for Polybutylene Terephthalate Toughened Epoxy Resin" Journal of Minerals and Materials Characterization and Engineering, Vol 2, pp 1-19, 2006.
- [8] Oyekan G.L and Kamiyo O.M, "Effects of granite fines on the structural and hydrothermal properties of sand crete blocks", Nigeria journal of Engineering and Applied sciences, vol 3, no.3, pp 735-74, 2008.
- [10] IS: 10262, 'Recommended Guidelines for Concrete Mix Design' Indian Standard Institution, New Delhi.
- [11] IS: 12269 Indian standard Specification For 53 Grade Ordinary Portland Cement (First Reprint September 1993).