

# An Experimental Study on the Use of Discarded Granite Stones in Concrete as Partial Replacement of Coarse Aggregates

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**Abstract-** Granite is the most important building stone because it is hardest, most durable naturally available construction material and has great ornamental value. Granite fines which are the byproduct produced in granite factories while cutting huge granite rocks to the desired shapes. It is extensively used in Civil Engineering projects, because of having the following main properties that it is a coarse grained rock, composed of Quartz, Alkali, Feldspar (Orthoclase and Monocline) and small amount of Biotite and Hornblende or both. The average Granite contains 30% Quartz and 10% Ferro-magnesium minerals. Normally the Granite is in light color with a white or pink tint according to the color of Feldspar. It can take fine polish and is the strongest stone amongst all the varieties of available building stones. More production equals more discarded, more discarded creates environmental concerns of toxic threat. An economically viable solution to this problem should include utilization of waste materials for new products which in turn minimize the heavy burden on the nation's landfills. The construction industry can start being aware of and take advantage of the benefits of using discarded materials. In this study a questionnaire survey targeting experts from construction industry is to be conducted in order to investigate the current practices of the uses of waste in the construction industry. In this paper an attempt is made experimentally to investigate the Strength Behavior of Concrete with the use of Granite stones as replacement aggregates. Concrete is organized with granite stones as replacement of coarse aggregates in altered quantities namely 10%, 20%, 30%, 40%, 50% and 100% and various tests such as compressive strength and Flexural strength were investigated and these values were compared with the conventional concrete without granite stones. Results revealed that, granite stones showed high strength results, economically viable and can be replaced at 100% with conventional coarse aggregates undoubtedly.

**Index Terms-** Granite, Orthoclase and Monocline, Ferro-magnesium minerals, Quartz, Alkali, Feldspar, compressive strength, Flexural strength.

## I. INTRODUCTION

Concrete is a composite material most commonly used in construction industry. It composed primarily of cement, aggregates, water and various types of admixtures based upon their needs. For the past decades many research papers have been studied for the replacements either partially or fully with some of the byproducts generated from the stone industries. The extreme discarded concern in the stone commerce is stone itself. It is specifically due to the forms of overburden, screening residual, wastewater sludge, bag house fines, and stone fragments. A survey in the year 2006 the University of Tennessee Center for Clean Products (UT) reported that from 3-93% of wastage occurs from the total material quarried, also in other hands studies report ranging from 15% to 78%. Additional waste is also gathered from fractured blocks, the sawing and polishing processes, and the rejection of broken or damaged slabs. It has been studied that for every 1000 tons of marble quarried, approximately only about 70 tons will be used in a completed building. The UT survey reported in 2006 states that for the marbles taken for the fabrication process ranges from 6-69% of the marbles is been wasted. It has also been taken into a major point, for the construction of Monument Structures 75% of marbles are wasted with all consideration of aesthetic aspects.

Granite has been used as a building material for many aesthetical and decorative segments. The environmental problems around the world involves industry's disposal of the granite powder material,

consisting of very fine powder. During the cutting course about 25% the original marble figure is lost in the form of dirt. This fusion of slurry coming out during cutting is termed stone waste. Use of stone waste in various engineering applications can solve the problem of disposal of stone waste and other purposes. Stone discarded can be used as a partial replacement of cement or replacement of fine aggregate and as accompanying addition to achieve changed properties of concrete. Wastes from quarry and fabrication operations impacts environment causing Environmental problems, Health problems and Economic problems.

**II. MATERIALS AND ITS PROPERTIES**

**Cement:**

Cement is a primary binding material in concrete. In this research PPC 43 grade, conforming to IS 1489 (Part I):1991 is taken for conducting test. The mechanical properties are found as per IS Code provisions.

Table.1. Physical properties of Cement

S.No.	Properties	Values
1	Consistency of Cement	34 %
2	Specific Gravity	3.11
3	Fineness of cement	7%
4	Initial setting time	30 min
5	Final setting time	600

**Water:**

Water is the key ingredient for the hydration process of cement. The water used is natural water taken from the ground water at the site. The water to be confirmed with IS 1172(1993).

**Fine aggregate.**

Fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies. Aggregate most of which passes 4.75-mm IS Sieve conforming to IS 383:1970.

Table.2. Physical properties of Fine Aggregate

S.No.	Properties	Values
1	Water absorption of fine aggregate	1.2 %
2	Specific Gravity	2.575
3	Fineness Modulus of fine aggregate	2.88

**Coarse aggregate:**

Coarse aggregates are locally available quarry stones used in this study. Coarse Aggregate most of which is retained on 4.75-mm IS Sieve conforming to IS 383:1970.

Table.3. Physical properties of Coarse Aggregate

S.No.	Properties	Values
1	Water absorption of coarse aggregate	1.5 %
2	Specific Gravity	2.57
3	Fineness Modulus of coarse aggregate	7.84
4	Impact strength value	19.8%
5	Crushing strength value	41%

**Granite chips:**



Granite is an igneous rock with at least 20% quartz by volume. This rock consists mainly of quartz, mica, and feldspar. Granite is usually found in the continental plates of the Earth's crust. Granites can be pink to gray in color, depending on their chemistry and mineralogy. Granite is nearly always massive (lacking internal structures), hard and tough, and therefore it has gained widespread use as a construction stone. Usually size of angular granite chips varies from: ¾" - 1". Granite pieces in the form of chips from the nearby quarries are collected for this study. Graded 20mm sized granite chips are used in this experimental study for the preliminary testing and work tests.

Table.4. Chemical composition of Granite

Chemical Composition	Percentage
Lime (CaO) –	1-4%
Silica (SiO <sub>2</sub> )	72-75%
MgO	20-25%
FeO+Fe <sub>2</sub> O <sub>3</sub>	-
Loss of ignition	5-10%

**Physical properties of Granites**

- The average density of granite is between 2.65 and 2.75 g/cm<sup>3</sup>
- Compressive strength usually lies above 200 MPa,
- Viscosity near STP is 3-6 • 1019 Pa•s.
- Melting temperature is 1215 - 1260 °C
- Granite stone is hard enough to resist harsh temperature
- The texture is usually non-slippery.

Table.5. Physical properties of coarse Aggregate

S.No.	Properties	Values
1	Water absorption of granite aggregate	1.3 %
2	Specific Gravity	2.46
3	Fineness Modulus of granite aggregate	6.68
4	Impact strength value	21.8%
5	Crushing strength value	39%

### III. MIX PROPORTIONS

Concrete mix has been designed based on Indian Standard Recommended Guidelines IS: 10262-1982.

#### Replacement ratio

The coarse aggregates is replaced with granite stones in percentage wise that is listed in below Table.6.

Table.6. Replacement ratio

Concrete type	Designation	Replacement Ratio (%)	
		Granite stones	Coarse aggregate
Control	M-1	0	100
Granite stones replaced concrete	M-2	10	90
	M-3	20	80
	M-4	30	70
	M-5	40	60
	M-6	50	50
	M-7	100	0

Final Quantity Arrived for Design Mix Proportion per m<sup>3</sup> Of Concrete

Cement	:	383.16 Kg/m <sup>3</sup>
Water	:	153.28 Kg/m <sup>3</sup> (20% of water reducing by adding SP-conplast 430)
Fine	:	539.55 Kg/m <sup>3</sup>

aggregate	:	
Coarse aggregate	:	1171.05Kg/m <sup>3</sup>
Water cement ratio	:	0.50

Table.7.Quantities arrived for different replacement ratios

Replacement ratio	Cement (Kg/m <sup>3</sup> )	Fine Aggregate (Kg/m <sup>3</sup> )	Coarse Aggregate (Kg/m <sup>3</sup> )	Granite Stone (Kg/m <sup>3</sup> )	Water (Lts/m <sup>3</sup> )	Adva- 950 (0.3%) (Lts/m <sup>3</sup> )
M-1	383.16	539.55	1171.05	0	153.28	0
M-2	383.16	539.55	1053.945	117.105	153.28	1.149
M-3	383.16	539.55	936.84	234.21	153.28	1.149
M-4	383.16	539.55	819.735	351.315	153.28	1.149
M-5	383.16	539.55	702.63	468.42	153.28	1.149
M-6	383.16	539.55	585.525	585.525	153.28	1.149
M-7	383.16	539.55	0	1171.05	153.28	1.149

### IV. TEST RESULTS

#### Compressive Strength Test of concrete

Compressive strength of concrete has been tested in compressive testing machine for 7 days, 14 days, 21 days and 28 days of curing. The results are shown below in figures.



Figure.1.Compressive strength Test

#### Compressive Strength of concrete without Admixture

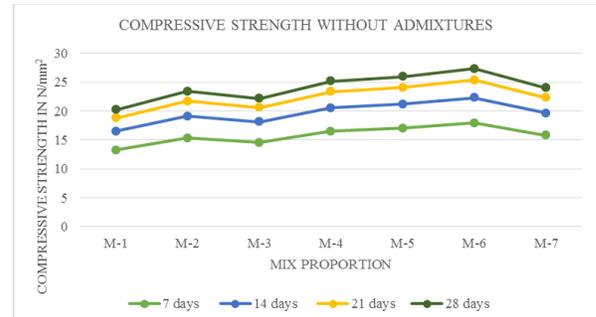


Figure.2.Compressive strength of solid cubes (devoid of admixtures)

Compressive Strength of concrete with Admixture (0.3% ADVA 950)

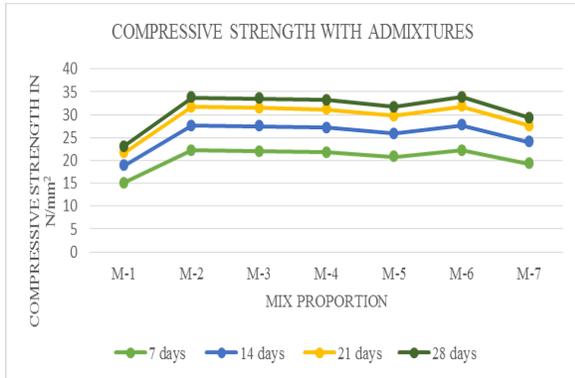


Figure.3.Compressive strength of solid cubes with admixture.

Comparison of compressive strength of concrete (with and without admixtures) Vs replacement ratio at 28 days

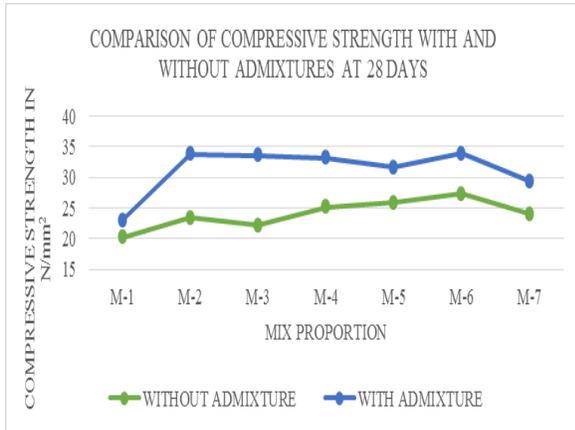


Figure.4.Comparison of Compressive strength of solid cubes without and with admixture.

Flexural Strength Test of concrete

Flexural Strength of hardened concrete is conducted at 28 days of curing with and without admixture.



Figure.5.Flexural strength test

Comparison of flexural strength of concrete (with and without admixtures) Vs replacement ratio at 28 days

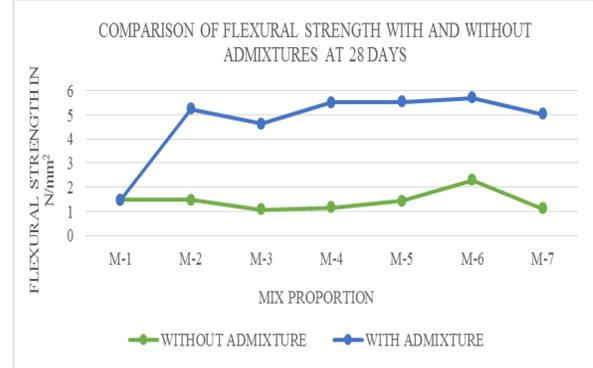


Figure.6. Comparison of flexural strength of concrete (with and without admixtures) at 28 days

V. CONCLUSION

- The strength parameter depends on the materials of the concrete. From the study it concludes that the compression and flexure strength of the granite stones replaced concrete varies than the conventional concrete. The use of the granite stones and chemical admixture plays a great role in increasing the strength parameters of concrete.
- Compressive strength results in 6.6 % increase at 50% replacement of granite stones.
- Without added admixtures compressive strength at 28 days, is 27.30 N/mm<sup>2</sup> at 50% replacement.
- If ADVA-950 is added, compressive strength at 28 days, is 33.90 N/mm<sup>2</sup> up to 50% replacement.
- Flexural strength attains its maximum both for conventional & non-conventional concrete at 50%, where 100% replacement also gave fair results satisfying the economical, and strength requirements.
- Based on the cost analysis done, granite stones proved to be a better economical alternative for normal coarse aggregates both in terms of strength and economy.

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