ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Different Waste Stone Aggregate as A Partial Replacement of Coarse Aggregate.

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ABSTRACT

Booming construction activities impose heavy demand on the construction material especially on the components of concrete. Advancements in technology get better not only human comforts but also harm the environment. Use of waste stone as an aggregate in construction industry has become popular and safe now. At present construction industry is in need of finding cost effective material to enhance the strength of concrete. The effect of natural stone aggregate (NSA), Shabath stone aggregate (SSA)(25%,50%,75%) ,granite stone aggregate (GSA) (25%,50%,75%) and ceramic tilestone aggregate (TSA) (20%,40%,60%) were investigated. Experimental investigation was done using M30 mix and various tests were performed as per the codal provisions . Various aspects like the compressive strength, split tensile strength , flexural strength and durability were analysed in this research.

Keywords: natural stone aggregate (NSA), Shabath stone aggregate (SSA), granite stone aggregate (GSA) and ceramic tile stone aggregate (TSA).

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ISSN: 0975-8585

INTRODUCTION

Concrete is an vital component in every construction operation. It is the utmost used material in construction industry. High strength and durability are the main features of concrete. The construction industry is already facing a scarcity of materials, from natural resources, such as sand and stone aggregate, and most of the source materials such as cement are highly energy intensive. Therefore, the utilization of waste materials will go a long way in promoting sustainable development of the construction industry. So avoid the situation, the less load bearing structure can be constructed with help of waste stone aggregate. Thus there is the dual advantage of safe disposal of the waste as well as their effective utilization for the sustainable development of the construction industry.

The main aim of this experimental work is to study the experimental investigation on concrete with different waste stone aggregate as a partial replacement of coarse aggregate (1,2,3,4,5,6) in comparison with the physical and mechanical characteristics of normal aggregates and different waste stone aggregates. The experimental investigation has been carried out to study the effects on compressive strength, split tensile strength and flexural strength on concrete. The obtained results have been compared with strength and durability of different waste stone concrete and it's been tabulated.

The materials used in the present experimental investigation are

a. Cement – OPC – 53 grade (ultra tech) conforming to IS12269-1987.
b. Fine aggregate – sand .
c. Natural stone coarse aggregate (NSA) - 20mm (IS383-1970***).(11)***
d. Shabath stone aggregate (SSA) - 20mm
e. Granite stone aggregate (GSA) - 20mm
f. Ceramic Tile stone aggregate (TSA) – 20mm
g. Clean portable water conforming to IS 456-2000***(15)***

Table 1: Chemical properties of different waste of stone aggregates (9, 10)

CONSTITUENT	SHABATH COMPOSITION (%)	GRANITE COMPOSITION (%)	CERAMIC TILE COMPOSITION (%)
Aluminum Oxide	1 – 5	1 – 8	1 – 3
Calcium Oxide	40 - 52	49 - 61	38 - 48
Iron Oxide	10 – 13	14 – 19	8– 11
Magnesium Oxide	5 - 10	8 - 14	3 - 7
Manganese Oxide	6 – 9	8 – 12	4 – 6
Phosphorus Oxide	0.5 – 1	0.7 – 1.1	0.3 – 1
Silica	24 - 28	70 - 75	22 - 24

PARADIGM OF FUTURE GENERATION CONCRETE

The current policy of development emphasizes on self sustained technology and green global environment which puts constraints over higher production rates of materials(8,9). The production of cement liberates CO_2 in the atmosphere and polluting the environment. Globally efforts are taken to specify the minimum cement content for concrete subjected to different exposure condition without affecting its performance during its service life. More recently there has been growing awareness of the importance of sustainability in concrete construction and in particular the more effective use of materials. i.e. to use waste materials. The use of waste products judiciously. It is now progressively recognized that the use of waste aggregates in concrete construction represents a potential value added outlet for the materials and is often economically variable and economically beneficial.

ISSN: 0975-8585

Table 2: Physical properties of aggregates and shabath stone aggregate (ssa), granite stone aggregate (gsa) and ceramic tile stone aggregate (tsa)

S No	PROPERTIES	SHABATH STONE AGGREGATE	GRANITE AGGREGATE	CERAMIC TILE STONE AGGREGATE
1	Aggregate impact value (%)	11.81	12.96	8.1
2	Specific Gravity	2.68	2.56	2.32
3	Water absorption (%)	0.84	0.79	0.69
4	Crushing value (%)	19.89	24.6	15.7
5	Fineness modulus	2.65	2.48	3.23
6	Bulk density(kg/m^3)	1535.33	1600.62	1196.60

TEST RESULTS FOR CEMENT

- Ordinary Portland Cement 53 grade
- Specific gravity of cement is = 3.15
- Normal Consistency of Cement is = 29%
- Fineness of Cement = 97.80

Table 3: Nominal mix design

MATERIAL	QUANTITY PER M3 IN KG
Cement	511.1 kg
Fine aggregate	641.70 kg
Coarse aggregate	1038.35 kg
Water – Cement ratio	0.37

Table 4: Percentage of replacement for different waste stone aggregates

AGGREGATES	0%	25%	50%	75%
Shabath stone	1038.35kg	269.34kg	538.68kg	808.02kg
Granite stone	1038.35kg	258.28kg	514.56kg	781.65kg
Ceramic Tile	1038.35kg	(20%)186.53kg	(40%)373.06kg	(60%)560kg

PREPARATION OF TEST SPECIMENS

For the purpose of testing specimens, various concrete specimens were prepared as per M30 mix using rotating drum mixer. Preparation of concrete specimens aggregates, cement and was added. After thorough mixing, water was added and the mixing was continued until a uniform mix was obtained. The concrete was then placed in to the moulds which were properly oiled. After placing of concrete in moulds, proper compaction was given using the table vibrator. For compressive strength test, cubes of size 150mmx150mmx150mm were cast. For splitting tensile strength test, cylinders of size 150mm diameter and 200mm height were cast and for flexural strength test, 500mmx100mmx100mm with and without reinforcement were cast. Specimens thus prepared were demoulded after 24 hours of casting and were kept in a curing tank for curing. The durability test was done after 28 days of water curing.

TESING OF SPECIMENS

After completing the curing period of the test specimens were kept in dry place for few hours to attaining surface dry condition. Compressive strength machine (CTM) of 3000KN capacity. Compressive strength test was carried out on 150mm x 150mm x 150mm cube . Strength of each cube was evaluated after 7 days and 28 days. Cylinder specimens were also cast for finding split tensile strength and beam specimens were also cast for flexural strength after 28days as per specification following the standard test procedures.

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Table 5: Results of compressive, split tensile and flexural strength

S NO	PERCENTAGE OF AGGREGATES	COMPRESSIVE STRENGTH (MPa) 7 DAYS	COMPRESSIVE STRENGTH (MPa) 28 DAYS	SPLIT TENSILE STRENGTH (MPa) 28 DAYS	FLEXURAL STRENGTH (MPa) 28 DAYS
1	Control Mix	27.85	38.20	5.1	10.42
2	Shabath Stone 25%	26.60	34.52	4.38	8.45
3	Shabath Stone 50%	25.03	31.39	4.69	9.13
4	Shabath Stone 75%	26.66	32.89	4.81	10.02
5	Granite Stone25%	26.67	35.91	4.98	10.25
6	Granite Stone 50%	27.25	38.02	5.15	10.52
7	Granite Stone 75%	29.27	39.85	5.26	10.48
8	Ceramic Tile stone 20%	18.53	31.87	3.96	8.15
9	Ceramic Tile Stone 40%	15.71	26.82	3.14	6.53
10	Ceramic Tile Stone 60%	13.75	21.91	2.89	4.82

DURABILITY STRENGTH OF CONCRETE

Figure 1: Durability (RCPT) test for 28 days cylinder average test results

RCPT is performed by monitoring the amount of electrical current that passes through a sample 50mm thick by 100mm diameter in 6hours.the sample is typically cut as a slice of cylinder. A voltage of 60V DC is maintained across the end of the sample throughout the test. One lead is immersed in 3. 0% salt (Nacl) solution and the their in a 0.3 sodium hydroxide (NaoH) solution and test are done as per ASTM C 1202-10(14).

Table 6: Durability (RCPT) test results for 28 days

S.No	SPECIMEN	TOP (mA)	MIDDLE (mA)	BOTTOM (mA)	AVERAGE CHARGE PASSED (Coulombs)	CHLORIDE ION PERMEABILITY
1	Control Mix	112	119	117	352	Very low
2	Shabath Stone 25%	123	138	128	389	Very low
3	Shabath Stone 50%	126	136	129	391	Very low
4	Shabath Stone 75%	119	133	131	383	Very low
5	Granite Stone 25%	113	124	121	358	Very low
6	Granite Stone 50%	114	126	123	363	Very low
7	Granite Stone 75%	116	129	124	369	Very low

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8	Ceramic Tile Stone 20%	127	134	128	389	Very low
9	Ceramic Tile Stone 40%	129	139	133	401	Very low
10	Ceramic Stone 60%	131	141	137	409	Very low

COMPRESSIVE STRENGTH

The test was carried out to obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using compression testing machine of capacity 2000KN. It is observed that the compressive strength is maximum when replacing 25%,50%.75% replacement of coarse aggregate by Controller, Shabath stone aggregate (SSA) - 20mm ,Granite stone aggregate (GSA) 20mm,Ceramic Tile stone aggregate (TSA) – 20mm in concrete.

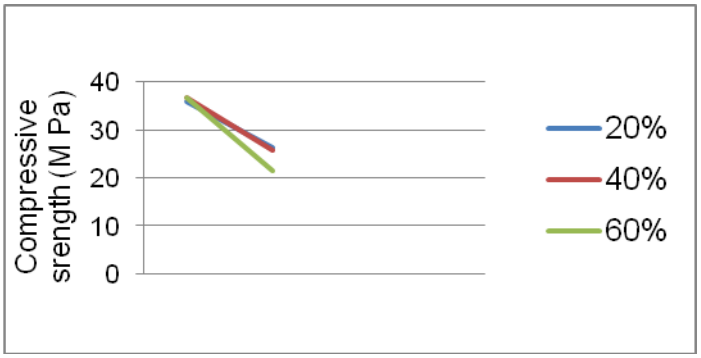

Fig 2: Comparison of compressive strength with different waste stone aggregate

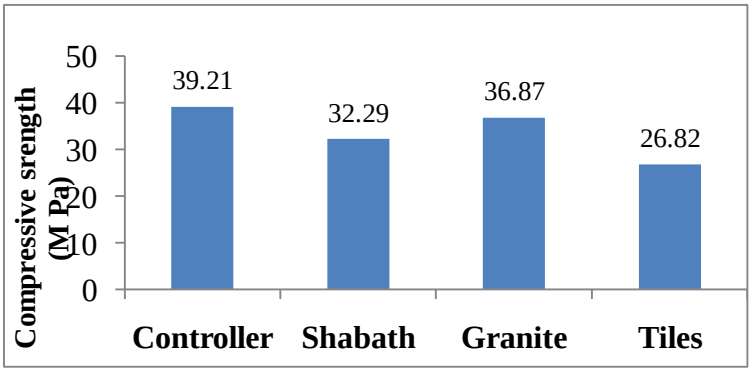

Fig 3: Comparison of Average compressive strength with different waste stone aggregate

SPLIT TENSILE STRENGTH OF CONCRETE

The test was carried out to find the split tensile strength of the concrete cylinders.The maximum split tensile strength was observed at 25%,50%.75% replacement of coarse aggregate by Shabath stone aggregate (SSA) - 20mm ,Granite stone aggregate (GSA) - 20mm,Ceramic Tile stone aggregate (TSA) – 20mm in concrete.

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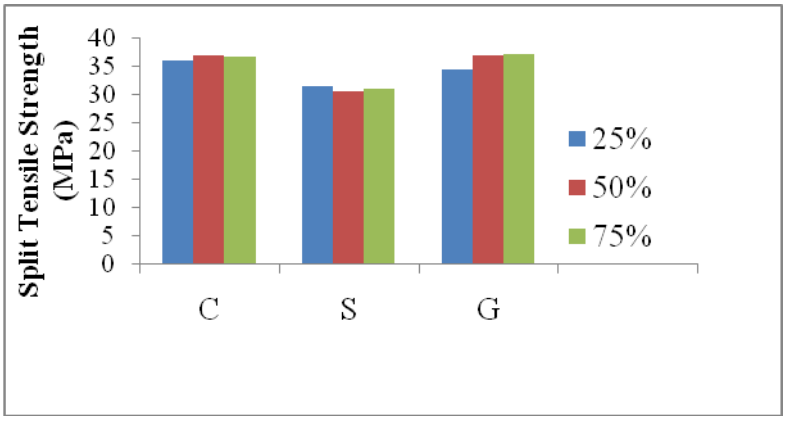

Fig 4: Comparison of split tensile strength with different waste stone aggregate.

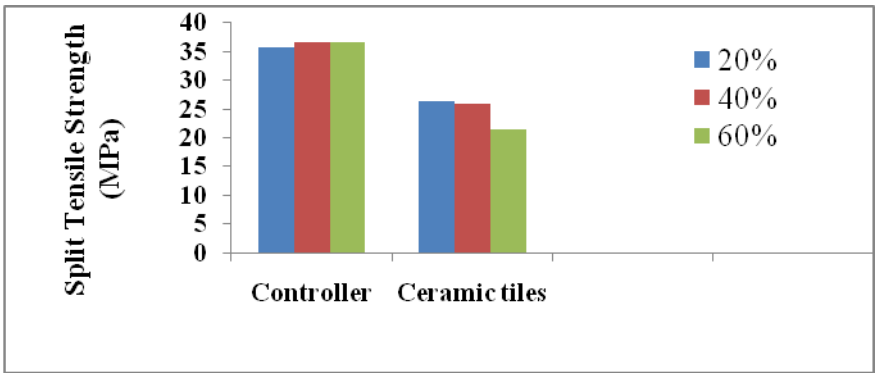

Fig 4: Comparisons of split tensile strength with ceramic tile stone aggregate

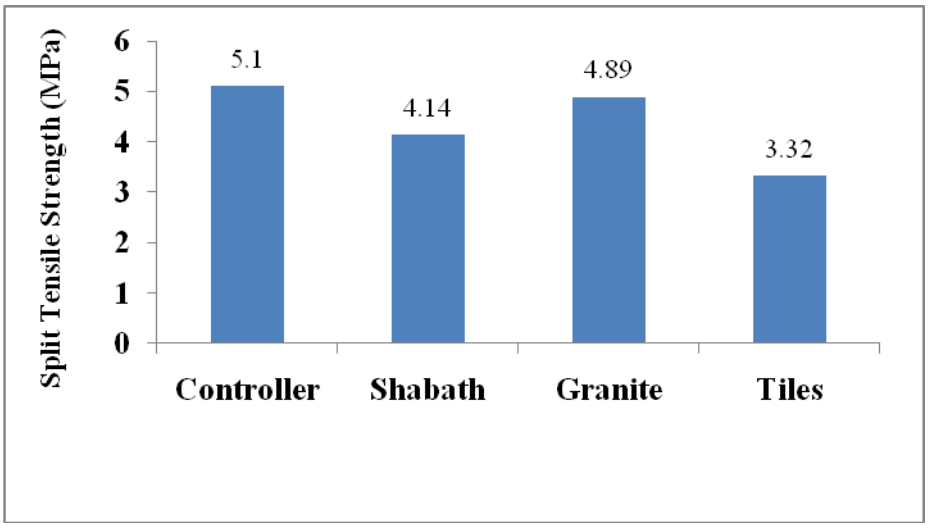

Fig 4: Comparison of average split tensile strength with different waste stone aggregate.

FLEXURAL STRENGTH OF CONCRETE

The results of flexural strength of normal concrete and replaced concrete were presented in Table (6). The test results shows the maximum flexural strength is obtained when 25%,50%.75% replacement of coarse aggregate by Shabath stone aggregate (SSA) - 20mm ,Granite stone aggregate (GSA) - 20mm,Ceramic Tile stone aggregate (TSA) – 20mm in concrete.

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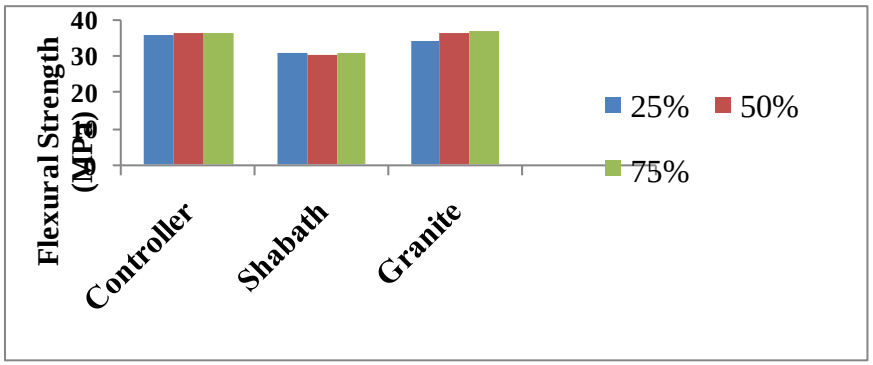

Fig 4: Comparison of flexural strength with different waste stone aggregates.

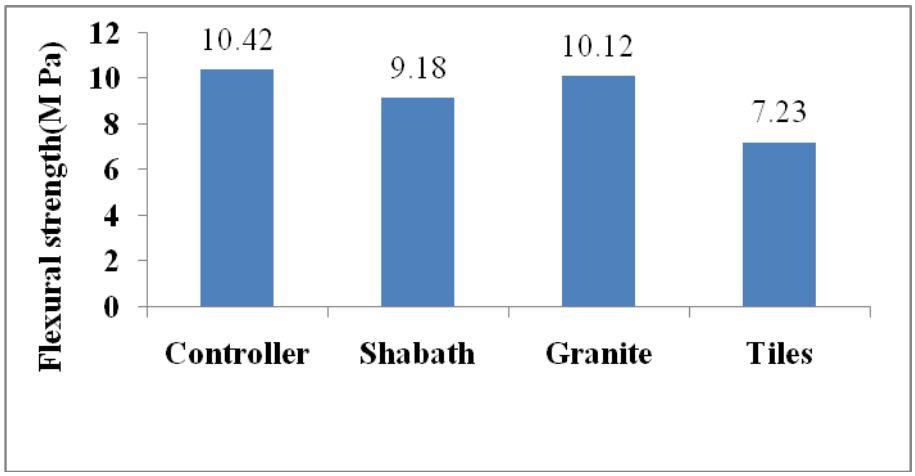

Fig 4: Comparison of average flexural strength with different waste stone aggregates

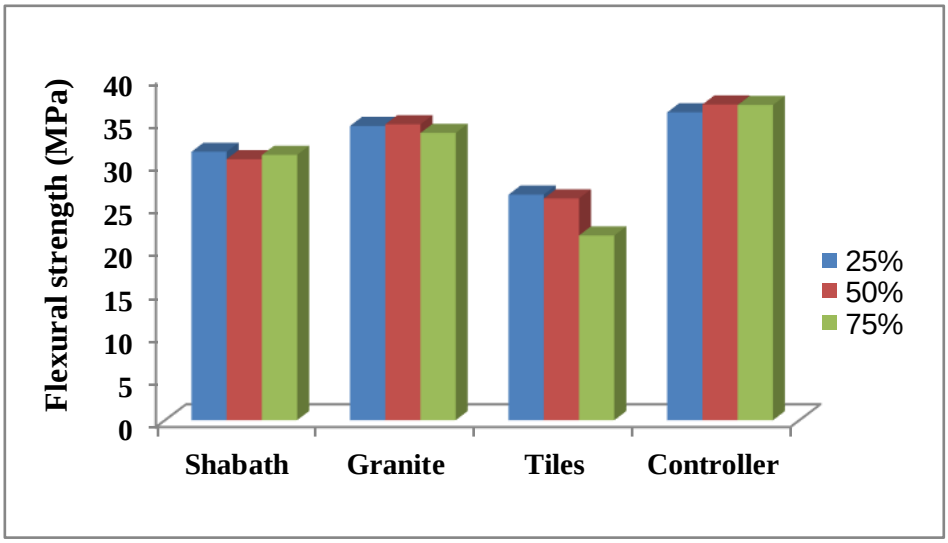

Fig 4: Comparison of flexural strength with various percentages of different waste stone aggregate.

RESULTS AND DISCUSSIONS

- It can be observed from the table 6 the compressive strength of NSA and 75%GSA is found to be 27.9N/mm² and 29.27 N/mm².

- Moreover the compressive strength of SSA, GSA and TSA were decreased by 14.64%, 8.78% and 6.69% respectively than that of the NSA.
- Similarly the Flexure strength of NSA is found to be 10.42N/mm². The Flexure strength of TSA, SSA and GSA was decreased by 10.15%, 7.38% and 4% than that of the NSA.
- The Split Tensile Strength of TSA, SSA and GSA were decreased by 14.52%, 8.71% and 5.39% than that of the NAC.
- The Durability strength of concrete TSA, SSA and GSA were decreased by tremendously.
- The strength of Ceramic Tile Stone Aggregate Concrete was found to be lower than that of the other aggregates mentioned above.

SUMMARY AND CONCLUSION

This project is to test the strength and performance of concrete and flexural behavior such as deflection and load acting on prisms of size 100mm×100mm×500mm, containing waste stone aggregate is been used as replacement of natural coarse aggregate of size 20mm, as opposed to that of reference concrete. For this research work, M30 grade of concrete is used and test is conducted by casting specimens for various proportion of waste stone aggregates replacement for Coarse aggregate with various percentages.

- From The test result shows that the Compressive strength, Split Tensile strength, Flexure Strength and Durability of TSA were found to be lower than SSA, GSA and TSA.
- The Strength of 50% & 75% GSA showed better performance than NSA and SSA Moreover the GSA gives similar strength that of the NSA.
- Hence waste Granite stone can be used as a coarse aggregate in construction industry depending upon the waste granite stone availability.
- Durability test also showed better performance of GSA compare with NSA.
- Shabath Stone can be used as an aggregate in concrete for unimportant construction works.
- Also the recycling plants should be encouraged to avoid the landfills and save our environment.

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