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Experimental study on partial replacement of Coarseaggregate, Fine Aggregate and Cement by Crushed Tiles, Granite Powder and Silica Fume in Cement Concrete

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ABSTRACT

Sustainable development mainly aims to reduce the negative environmental impact caused by construction sector which is the largest consumer of the natural resources. Over a period of time, the waste management has become one of the most complex and challenging problem that we have to face. Day after day many new innovations and developments advancing in construction sector, the usage of natural aggregate is in high demand and at the same time production of solid wastes from the demolitions of constructions is also gradually increasing. Because of these reasons, the reuse of demolished construction wastes and granite powder came into the picture as a way to reduce the solid wastes and to minimize the scarcity of natural aggregates. Crushed waste tiles and granite powder helps to achieve our goal to reduce the demand on natural aggregates. So Crushed waste tiles and granite powder are introduced as a replacement for the coarse aggregates and fine aggregates. The waste crushed tiles were used as coarse aggregates' replacement by 10%, 20% and 30% and granite powder were replaced in place of fine aggregate by 10%, 20% and 30% without any change the mix design. M20 grade of concrete was designed to prepare the conventional mix. Different types of samples were prepared by replacing the coarse aggregate and fine aggregates with crushed tiles and granite powder at different percentage. We use cement instead of silica fume with a percentage of 10%. Experimental investigation like compressive strength test, split tensile strength test were tested. Different concrete mixes with different percentage of waste crushed tiles and granite powder after 7, 14 and 28 days curing period, it is observed that strength increases on replacement of Ceramic tile.

Key words : *Sustainable Development, Crushed waste tile, Granite powder, Ceramic tile*

Introduction

Concrete is the world's most important construction matrix. In its simplest form, concrete is a mixture of paste and aggregates. Utilization of waste ceramic tiles in concrete production will preserve the clean

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environment and reduces the usage of natural resources. By using Industrial waste as replacement in concrete is the possible way to avoid landfill and also to prevent the depletion of renewable sources. By using granite powder as a supplement of fine aggregate it reduces the constructional waste. In recent years, there is great interest in the silica fume as a supplementary cementitious material in concrete to improve its properties. Silica fumes also reduce the permeability in hardened concrete. Hence, by partially replacing Portland cement with silica fume not only reduces carbon dioxide emission, but also increases the service life of buildings. The utilization of silica fume as a replacement material is also environmentally friendly since it helps in reducing the CO2 emission to the atmosphere by the minimization of the Portland cement consumption.

Literature Review

The utilization of ceramic waste materials in the construction of the road is based on technical, cost efficiency, and ecological criteria. Because of the efficient utilization of ceramic wastes in constructing the highway, the pollution from wastes and the problem of disposal of wastes is partly reduced (4)

The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20%, 30%, 40%, Experimental investigations like workability, Compressive strength test, Split tensile strength test for different concrete mixes with different percentages of waste crushed floor tiles at 7 and 28 days curing period has done. The optimum of percentage addition of Ceramic waste is analyzed considering the requirements of mechanical properties of concrete A total number of 96 specimens were cast compression, tensile and flexural strength were founded. There by we conclude that the waste tiles and crusher dust could be used as alternative materials for sand and gravel in concrete. And we

have found that the partial replacement of sand and gravel by 24% and 15% by crusher dust and waste tiles is optimum Granite process industry generates large amount of waste mainly in the form of powder during sawing and polishing process, which pollute and damage the environment. This work in to characterize and evaluate the possibility of using the granite sawing waste Granite process industry generates large amount of waste mainly in the form of powder during sawing and polishing process, which pollute and damage the environment.(8)The granite fines exhibit the properties of fine aggregate such as size, fineness and filler capabilities.(9). It is suggested that substitution of natural aggregates by Granite powder by-product upto 20% is favourable for the concrete resistance.(5) Variations in the workability for these different mixes were studied and observed that, increase in the percentage of replacement of granite powder and crushed tiles 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(0%, 10%, 20%, 30%, 40%,50%)(6). Silica fume (SF) is very fine non-crystalline material, non-metallic and non-hazardous waste of industries. The results have indicated that the strength increases up to certain percentage (15% replacement of cement by silica fume), (20% replacement of fine aggregate by glass powder)(10) Silica fume is used as a partial replacement for cement by 0%, 10% and 20% in concrete. Compressive strength, split tensile strength and flexural strength are strength parameters studied for various combinations of silica fume content in concrete. Silica fume in concrete improves both the mechanical and durability characteristics of the concrete It is found the strength of the concrete rises with the adding of egg shell powder and silica fume and finally the comparison is made for the egg shell and silica fume added strength of concrete (12). The experimental work involving the replacement of coarse aggregates with recycled aggregates and cement with silica fumes to improve the properties of concrete The strength of concrete increases rapidly as we increase the silica fume content and the optimum value of compressive strength is obtained at 10 % replacement after 10% it starts decreasing (14).

Objective of the Study

(i) The aim of this study is to reduce the environmental degradation by minimizing the disposal of waste and maximizing the economical benefits.

(ii) To utilize the alternative materials in order to reduce the natural resources, which are being in demand and to overcome the demand where we can use the alternative materials as replacement of aggregates and cement.

(iii) To determine the Compressive strength and Spilt tensile test for various samples.

Materials

Cement

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens. The ordinary cement contains two basic ingredients namely argillaceous and calcareous. In argillaceous materials clay predominates and in calcareous materials calcium carbonate predominates. Grade 53 Ordinary Portland Cement was used for casting cubes and cylinders for all concrete mixes. The cement was of uniform color i.e. grey with a light greenish shade and was free from any hard lumps. Silica fume is a very reactive pozzolanic material. As the Portland cement in concrete begins to react chemically, it releases calcium hydroxide. The addition of silica fume to concrete improves the durability.

Fine Aggregate

The sand used for the experimental program was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was sieved through 120 microns sieve to remove any particles greater than 120 microns. The aggregates were sieved through a set of sieves in the sieve shaker apparatus to obtain sieve analysis. Granite is a plutonic igneous rock because it is formed due to solidification of magma at great depth. The word granite comes from Latin word Granum. Granite is massive, stratified and dense having specific gravity 2.6 to 2.8.

Coarse Aggregate

The material which is retained on BIS test sieve no. 480 is termed as a coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available black trap aggregate of 20 mm grading were used in our work. All the specifications as per IS:383-1970. The aggregates were washed to remove dust and dirt and were dried to surface dry. Ceramic tiles is used to replace the coarse aggregate and having the dimension of about 20 mm. Construction industry can be the end user of all ceramic wastes and in the same way can contribute Green building practices.

Water

Water is available in college campus confirming to the requirements of water for concreting and Curing as per IS: 456–2000.

Recycled Materials

Cement by Silica fume. Silica fume of 10% was replaced with Cement for various mixes. Specific gravity of silica fumes 2.2 to 2.30.

Coarse aggregate by Ceramic tiles Ceramic tiles waste is durable. When ceramic tiles used in concrete where it can be utilised effectively. In this study Ceramic tile waste is used in partial replacement of coarse aggregate as 10%, 20% and 30%. The specific gravity of ceramic tile is 2.5.

Fine aggregate by Granite powder Granite powder is by product from polishing industry which are largely left and unused. This is hazardous to human beings affect respiratory system when inhale. This powder got the properties which can relate to natural sand so in concrete which can be used as partial replacement in natural sand. The specific gravity of granite powder is 2.6.

Results and Discussion

Tests on coarse Aggregate

Tests on Hardened Concrete

In this we are discussing about the compressive strength and split tensile strength of the concrete. The result is shown in graphical representation. Three samples of each testing of concrete were tested to determine 7 days, 14 days, 28 days compressive strength and split tensile strength on concrete by partial replacement of ceramic tiles, granite powder and silica fume by mix. The Table 3 shows the mix ratio percentage.

Compressive Strength on Concrete

The compressive strength, as one of the most impor-

Table 1. Test on Coarse Aggregate shows the test on impact, abrasion and particle size test

Property	Coarse Aggregate	Coarse Aggregate (Tiles)
Impact test	12	5.43
Abrasion test	9.2%	12%
Particle size	4.13	4.46

Table 2. Mix ratio percentage.

Sample	Coarse Aggregate (%)		Fine Aggregate (%)		Cement (%)	
	Tiles	Aggregate	Granite powder	River sand	Silica fume	Cement
1	10	90	10	90	10	90
2	10	90	20	80	10	90
3	10	90	30	70	10	90
4	20	80	10	90	10	90
5	20	80	20	80	10	90
6	20	80	30	70	10	90
7	30	70	10	90	10	90
8	30	70	20	80	10	90
9	30	70	30	70	10	90

tant properties of hardened concrete, in general is the characteristics material value for classification of concrete. The result of compressive test of cube is tabulated and graphical representation. The comparison of 7 days, 14 days and 28 days by partial replacement of coarse aggregate by tiles in percentage of 10%, 20%,30% and fine aggregate by granite powder in percentage of 10%, 20%, 30% and cement by silica fume in percentage of 10%. Each cube of various percentage is replaced were tested to determine the 7 days, 14 days and 28 days compressive strength using 2000 kN compression testing machine. The compressive strength test on cube is conducted as per standards. The average compressive strength of the cube on 7 days, 14 days28 days were shown in Table 4 compressive strength of the cube on 7 days, 14 days, 28 days were shown in Table 3.

Split Tensile Strength On Concrete

Cylinder samples each of mix with various percentage is replaced and were tested to determine the split tensile after 28 days using 2000 kN compression testing machine. The tests were conducted as per standard specifications. The average split tensile

Table 3. Compressive strength on 7, 14 and 28 days

Sample	Average Compressive Strength (N/mm^2)		
	7 Days	14 Days	28 Days
1	9.2	19	21.33
2	8.88	17.77	22.2
3	8.88	17.77	22.2
4	8.9	17.5	21.77
5	8.44	16.88	21.5
6	6.85	13.77	20
7	6.77	13.55	19.8
8	6.55	13.11	19.5
9	6.4	12.9	19

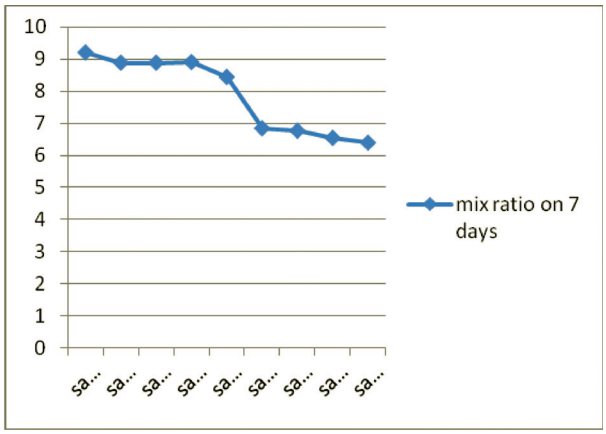

Fig. 1. Average compressive strength test - 7days

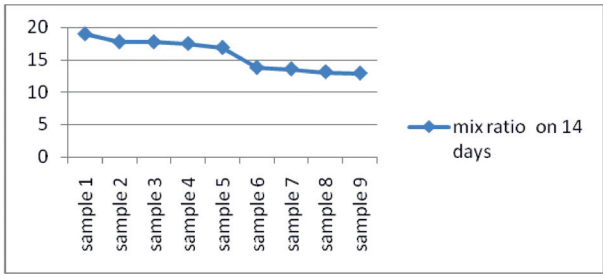

Fig. 2. Average compressive strength test- 14 days

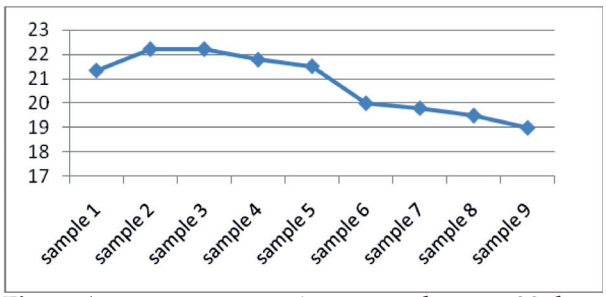

Fig. 3. Average compressive strength test - 28 days

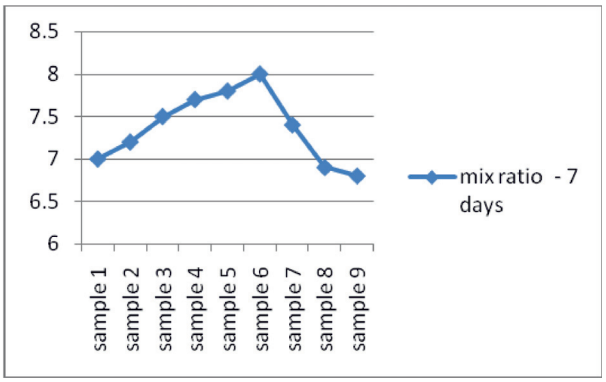

Fig. 4. Average split tensile strength test - 7 days

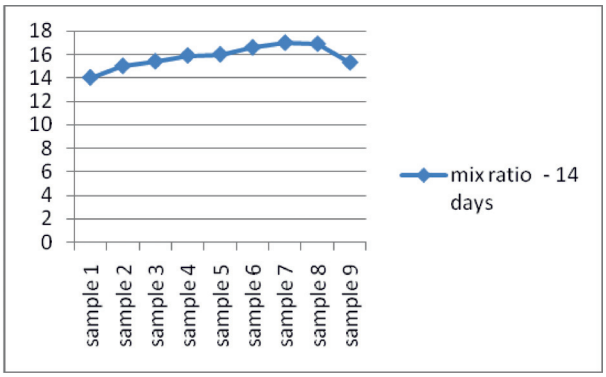

Fig. 5. Average split tensile strength test - 14 days

Table 4. Average Split tensile strength test

Sample	Average Split Tensile Strength (N/mm²)		
	7 Days	14 Days	28 Days
1	7	14	16
2	7.2	15	15.6
3	7.5	15.4	15.9
4	7.7	15.9	17.5
5	7.8	16	17.6
6	8	16.6	18.3
7	7.4	17	20.7
8	6.9	16.9	14
9	6.8	15.3	13.9

strength of cylinder is calculated. The Table 5 shows the average split tensile strength on 7 days, 14 days and 28 days.

Conclusion

Based on the experimental investigation, the following conclusions were drawn. It is observed that concrete is partially replaced by 20% of ceramic tiles,20% of granite powder and 10% of silica fume

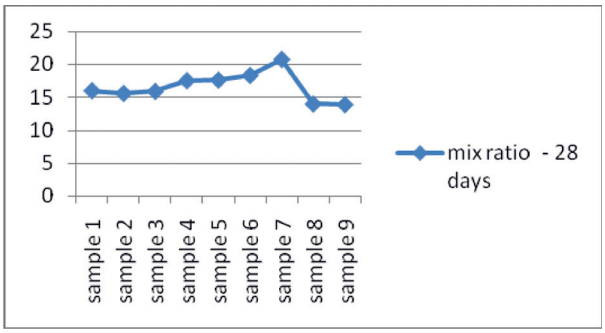

Fig. 6. Average split tensile strength test - 28 days

shows the optimum strength at the age of 7days, 14days and 28days. The degree of workability of concrete is normal by comparing conventional concrete. Use of constructional waste product saves the environment. By this substitution of coarse aggregate, fine aggregate and cement with ceramic tiles, granite powder and silica fume has positive impact on workability, consistency, compressive strength and split tensile strength. Based on the result, this replacement of ceramic tiles and granite powder is recommended in concrete for an economical construction.

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