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Alternative of Natural Aggregates by Replacing it with Ceramic Tile Waste

Sandeep Kumar Chandel[1], Kshipra Kapoor[2]

[1]MTech Scholar, [2]AP & Head CE Department, UIET Lalru, (India)

ABSTRACT

Globally issues of environment and climate change are major problems. Now a day sustainable development is in demand. Sustainable development is possible by revising, rethinking, reducing, reusing. The use of waste materials (glass, plastic, slag, fly ash and so on) in concrete industrial is major due to its engineering, economic, eco-friendly and green paybacks. Thus, consumption of waste materials in concrete construction is very much useful to obtain the objective of the sustainability. As the natural sources of untouched aggregates are consuming with the time. The use of waste material will decrease the use of natural aggregates. In this way waste can help in maintaining ecological balance. In present study, ceramic tile waste has been used as construction waste. Tile waste is a major problem in large scale projects. Like other construction waste, tile waste is also an issue of disposal in India. This study is based on the performance of three different concrete mixes having different ratios of crushed, waste tiles with 20 mm maximum size as coarse aggregate. Three mixes M20, M25, M30 were adopted. Mix design was prepared for each batch. Concrete cubes were casted with 0%, 5%,10%, 20% ceramic tile waste replacement. All necessary tests were conducted on cement, fine aggregates and course aggregates. Six cubes casted for each category. Test results shows that except Mix 30 mix there is no major effect on compressive strength of concrete in Mix 20 and Mix 25 mixes up to 20% replacement of normal 20 mm coarse aggregates with tile aggregates.

Key Words:Concrete, Cement, Aggregates, Construction waste, Tile waste aggregates, Design mix

I. INTRODUCTION

In this era, concrete production is at peak and large amount of cementitious material, natural aggregates (fine and course) and water are being used. Aggregates impart about 70% to 75% of volume to concrete. In parallel to this many research works are under progress to find suitable alternatives of raw materials of concrete. Utilization of waste materials for example fly ash, plastic waste, construction waste are most common research areas. Tile waste is also a best sustainable alternative for course aggregates in concrete. Construction industry is producing huge amount of tile waste worldwide in small, medium and large projects. This broken tile wastes are deposited into environment as liability without any profitable return. Plenty of money is being spent for its deposition and even land become useless in most of the cases. So it is better to reuse this waste material in concrete as supplementary. Ceramic tile aggregates are hard having significant value of specific gravity, rough surface on one side and smooth on other side, are lighter in weight than normal aggregates. Consuming ceramic tile aggregate in concrete not only will be cost effective, but also will be good from environment point of view. This study focuses on preparing concrete of acceptable strength with crushed waste ceramic tile as aggregates (course) and finding the optimum course aggregate mix ratio to get this strength.

II. LITERATURE REVIEW

Kumar (2015)

In this study, different mixes are adopted, waste tiles are used to replace the coarse aggregate by 10% and 20% and tiles powder are also used to replace the fine aggregates by 10% and 20%. Total 9 types of mixes of M25 grade are adopted. A study on workability and compressive strength for 7 and 28 days of all 9 types of mixes has been succeed and recorded that with rise the percentage of tiles powder the strength and workability also increased of concrete. Compressive strength is increased for all mixes and maximum compressive strength is obtained the mix having 10% of crushed tiles and 20% of tiles powder. The best percentage of coarse aggregate that can be replaced by crushed tiles with 10%.

Alves (2014)

In this study reused ceramic fine aggregates, obtain00ed from crushed sanitary and crushed bricks ware on the mechanical properties such as compressive, modulus of elasticity, splitting tensile strength, and abrasion resistance of concrete. Seven concrete mixes were used to test these tough properties and six concrete mixes with replacement ratios of the 20%, 50% and 100% of natural fine aggregates by fine recycled brick aggregates or fine recycled sanitary ware aggregates. Compressive and splitting tensile strength do not appear to be affected by fine brick aggregates and these properties significantly reduced with the fusion of recycled fine sanitary ware aggregates.

Medina (2012)

Medina deliberate on consumption of ceramic waste as recycled coarse aggregate. Crushed sanitary ware was used in it and its shape curve of recycled ceramic aggregate was similar to the natural coarse aggregate. Uneven shape of aggregate was offered in the ceramic waste, resulted that superior surface area and improved bonding was observed in investigation.

Sekar (2011)

In this study, different industrial waste such as glass waste aggregates, ceramic tile waste aggregates, ceramic insulator waste aggregate with 100% replacement was studied. It was found that the concrete made with ceramic tile waste gives similar strength (split tensile, Compression, flexural) as conventional concrete. On the other hand, concrete with ceramic insulator and glass waste give lesser strength than traditional concrete.

Pacheco (2010)

In this study, it was concluded that concrete with ceramic waste residue has a minor strength loss have risen durability production because of its pozzolanic belongings. As for replacement of coarse aggregate with ceramic coarse aggregate, the outcomes are better but underachieved somewhat in water absorption and in the water permeability meaning that the replacement of sand by the ceramic sand is a superior choice.

Veera Reddy (2010)

Veera Reddy reported on impact value and crushing value of ceramic scrap as 18.2 and 24.7% respectively. These values were within the permissible limits according to IS 383-1970, hence it was safe to use as a coarse aggregate in concrete composition.

Paulo Cachim (2009)

Paulo Cachim studied on usage of ceramic aggregate, collected from ceramic industrial waste. Water absorption of waste from two different sources was 15.81 and 18.91% respectively. The higher water absorption of ceramic aggregates influenced the workability of concrete. It was observed that in first 2 minutes, 75% of total absorption observed and after 5 min at least 91% of total absorption occurred.

Mashitah (2008)

In this study it was concluded on recycling of similar ceramic tiles used in the preparation of concrete cubes. The surface of ceramic tile aggregate was found as angular shaped and smooth, sharpen edges as compared with traditional coarse aggregate. Flatter particles consumed extra amount of cement paste to make better inter facial transition zone.

Senthamarai (2005)

Senthamarai observed that ceramic tile scrap can be successfully used as aggregates in concrete production, on the basis of strength of ceramic waste aggregate. The abrasion values, crushing value, impact value for ceramic scrap were 28, 21 and 21% correspondingly and for natural coarse aggregate 20, 17 and 24% respectively. Ceramic waste does not have much difference with respect to the traditional natural aggregates.

Marcio (2004)

Marcio experimented on compressed stress, water absorption and modulus of elasticity of concrete made with ceramic aggregate. Crushed ceramic blocks were used as coarse aggregate in concrete fabrication. Specific density of aggregate was 2630 to 2310 kg/m3 for 0 to 100% replacement. Up to the replacement of 20%, Compression resistance and modulus of elasticity was equivalent with conventional concrete.

III. OBJECTIVE

Concrete consumption is two times more than any other building material around the world. So it is important to find sustainable alternatives of its raw materials. Because over consumption of traditional natural raw material is misbalancing environment.

Main objectives of this study are:

- To find alternative of traditional course aggregates in order to achieve sustainable progress.
- To minimize the construction waste
- To develop more economical concrete material.

IV. METHODOLOGY AND EXPERIMENT SETUP

M 20, M 25 & M 30, three different concrete mix design chosen to carry out the investigate the effect of tile waste as partial aggregate replacement. Below mentioned preparation will be made to caste samples

TABLE 1 SPECIMEN DETAILS

Total number of concrete mix designs will be prepared	3
Number of proportions in which tile aggregates will be replaced with normal aggregates in each design (i.e. 0%, 5%, 10% & 20%)	4
Therefore, total concrete batches will be prepared	12
Number of concrete batches will be prepared in a day	1
Number of cubes will be filled in each batch	6

Number of cubes will be casted for each mix design For M 20 – 24 cubes For M 25 – 24 cubes For M 30 – 24 cubes	24
Total number of cubes will be casted including all 3 concrete mix designs	24+24+24=72
Size of Specimen	150×150×150 mm cube
Name of Test	Compression Strength Test

V. RESULT AND COMPARISON

TABLE 2 RESULTS OF RAW MATERIAL

Sr. No.	Test	Results
1	Specific Gravity of Cement	2.74
2	Specific gravity of Coarse Aggregates	2.69
3	Specific gravity of Fine Aggregates	2.70
4	Fineness Modulus of Fine Aggregates	2.17
5	Specific Gravity of Tile Aggregates	2.24
6	Water Absorption of Tile Aggregates	14.4%
7	Impact Value of Tile Aggregates	20%

TABLE 3 RESULTS OF NORMAL AGGREGATES AND TILE MATERIAL

Sr. No.	**Properties**	**Normal aggregate**	**Tile aggregate**
1	Shape	Angular	Flaky
2	Texture	Rough	All sides rough except top
3	Water absorption	0.5%	14.4%
4	Impact value	15%	20%
5	Specific gravity	2.69	2.24

TABLE 4 AVERAGE STRENGTH RESULTS OF M20

No. of days	**Normal**	**5%**	**10%**	**20%**
7	21.25	20.44	19.55	19.03
28	29.03	28.21	27.33	26.81

TABLE 5 AVERAGE STRENGTH RESULTS OF M25

No. of days	Normal	5%	10%	20%
7	24.21	23.33	24.44	23.25
28	35.62	33.99	32.36	31.99

TABLE 6 AVERAGE STRENGTH RESULTS OF M30

No. of days	Normal	5%	10%	20%
7	32.29	30.73	29.92	28.78
28	38.73	36.73	35.92	32.96

TABLE 7 COMPARISON OF STRENGTH AFTER 7 DAYS

After 7 Days			
Proportion	M20	M25	M30
0%	21.25	24.21	32.29
5%	20.44	23.33	30.73
10%	19.55	24.44	30.73
20%	19.03	23.25	28.78

TABLE 8 STRENGTH AFTER 28 DAYS

After 28 Days			
Proportion	M20	M25	M30
0%	29.03	35.62	38.73
5%	28.21	33.99	36.73
10%	27.33	32.36	35.92
20%	26.81	31.99	32.96

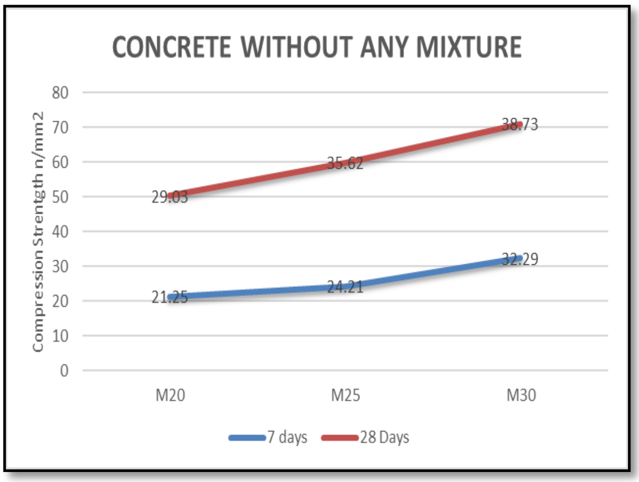

Figure 1: Normal Concrete

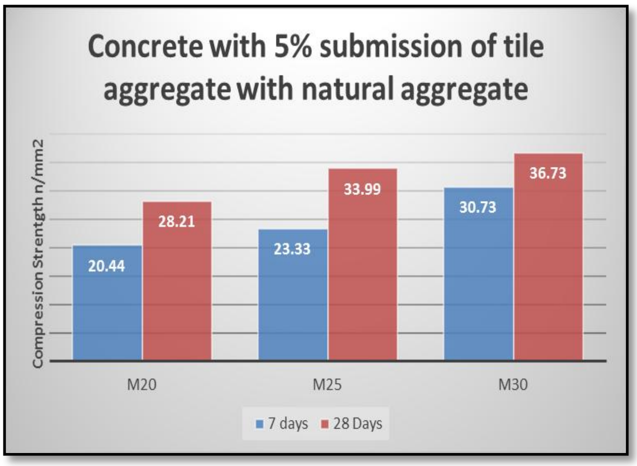

Figure 2: 5% Submission of Tile Aggregates With Natural Aggregates

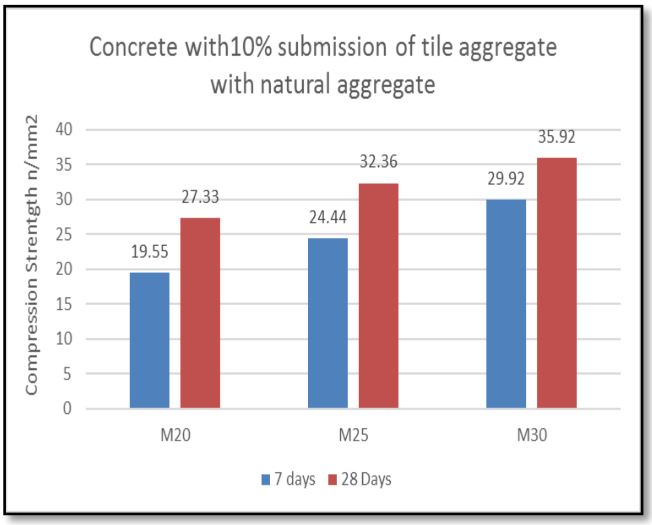

Figure 3: 10% Submission of Tile Aggregates With Natural Aggregates

VI. CONCLUSION

It is very much essential and important to find solution for construction waste and to find alternatives for natural raw materials of construction. As population is increasing day by day, demand of aggregates in concrete is also increasing. Simultaneously, concrete waste production is increasing. So the best solution for both of the problems is to reuse such waste in concrete production.

[1] Ceramic tile aggregate is an appreciated and appropriate concrete material for substitution into concrete composition based on its properties.

[2] Mechanical properties of ceramic aggregate are similar to the natural aggregate and its behavior is similar but not same. Water absorption, crushing value and impact value, are higher than natural coarse aggregate and lower by specific gravity i.e. 2.24 g/cm^3 .

[3] It is possible in M 20 grade concrete to substitute 20% of normal 20 mm aggregates with ceramic tile aggregates without compromising its required compressive strength. For all concrete mixes (M 20, M25, M30) compression strength of concrete decreases with increase in the proportion of replacement of natural aggregates with tile aggregates which is due to low specific gravity higher porosity of tile aggregates as

compare to natural aggregates.In M 30 grade concrete with 5% substitution of tile aggregates its strength decreases from 38.73 to 36.73 n/mm^2, which is less than target mean strength. So, as per results substitution should be avoided for this grade of concrete. M 20 and M 25 concretes are suitable for the replacement of aggregates.

[4] By addition of ceramic tile waste into concrete, proper effective utilization of ceramic tile waste can be achieved.

VII. FUTURE SCOPE

In this experimental study only compression strength has been checked, effect on tensile strength and flexural strength of concrete with inclusion of tile aggregates can be investigated.

Although by decreasing the water/cement ratio, high strength concrete can be obtained. But the workability will be very low. As in this study the required workability is achieved by using maximum water cement ratio. Therefore, it is recommended that adding admixtures such as super plasticizer and silica fume into the mixing so that the workability will be improved.

More trials with different particle sizes of tile aggregate and percentage of replacement of natural aggregate are recommended to get different outcomes and higher strength characteristics in concrete.

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