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Use of Waste Ceramic as Aggregate in Concrete

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Abstract: ***This research paper represents the experimental study on use of ceramic waste material as an aggregate in concrete. To reach the goal of sustainable development utilization of waste materials in concrete production is very much useful. The ceramic aggregate used in this study was recycled from industrial ceramic tile waste in India. From the results it can be seen that it is possible to produce a concrete with good strength by using ceramic waste as an aggregate in .It is also seen from the results that the compressive strength characteristics of ceramic aggregate concrete met the required criteria set by various international standards and codes, which shows the ability of ceramic waste to be used as a substitute to the conventional aggregates in concrete. We replaced the coarse aggregate in concrete by 100% to thewaste ceramic aggregate of size 10mm. The water cement ratio taken was 0.30 for concrete production and compared it with normal aggregate concrete of M20 grade. By the decrease in water/cement ratio, high strength concrete can be obtained. But it is found that the workability will be very low. In our project the required workability was achieved by the use of maximum water-cement ratio .To overcome this use of several admixtures like super-plasticizers and silica fume are recommended to add in the mixing so that the workability can be improved.***

Keywords: Sustainable development, Ceramic waste as aggregate

I. INTRODUCTION

Concrete is one of the most globally used construction material, this is so because of its durability, resistance to fire, simple to use etc, and all these under very economical price value , due to which its use is increasing day by day. Due to this high demand of natural aggregates for concrete production, a drastic reduction in natural aggregates have been seen which is harming the environment. To decrease the environmental impact of concrete production many substitute materials have been used as a replacement of natural aggregate for concrete production. The alternative materials that can be used in place of aggregate in concrete can be found out from construction and metallurgical industries. Ceramic have been very popular as a furnishing material. But, when ceramic reaches the end of its lifetime, it loses its value and becomes mere wastes.

The ceramic wastes are increasing every day and it has become a burden on the industries to adopt a solution for its disposal. If these wastes are not removed and disposed efficiently than it will cause several negative impact to the environment and this is pressurizing the construction industries to adopt an effective way for disposing these wastes, which calls for an urgent necessity for proper management of these wastes.

Also, the removal process of these wastes adds an extra maintainance cost to the total production cost . That's why reusing ceramic waste as aggregate in concrete is a good way for ceramic waste reuse and also the strength of the ceramic waste aggregate concrete is slightly more than that of conventional concrete.

The main problem was to make this ceramic waste aggregates workable as they were flaky in nature so we decided to use them of 10mm size by which there workability increased.

II. LITERATURE REVIEW

1) *Atul Uniyal (Assistant Professor, HSST, SRHU Jollygrant) and, Karan Singh(Assistant Professor, HSST, SRHU Jollygrant)(2019):* They replaced the aggregates with tile powder by 5%,10%,15% and 20. From there tests they concluded the following: They found the most optimal percentage for the replacement of ceramic tile powder with cement was 15 %. Above this percentage the compressive strength of their concrete decreases.
2) *Parminder Singh and Dr. Rakesh Kumar Singla (2015):* They prepared three different concrete mix designs M 20, M25 & M30 to find the effect of tile aggregates on strength of concrete and they replaced it with natural aggregates by proportion of 0%,5%, 10% & 20%. They found limited use of tile aggregate in concrete due to its flaky nature. After performing various tests they concluded that: Tile aggregate shows similar mechanical properties to that of normal aggregates but not completely same. They found out that the water absorption, crushing value and impact value, were higher than natural coarse aggregate without compromising the strength we can substitute 20% of normal 20mm aggregates in M20 grade concrete.

3) *Sentharamai (2005):* Senthamarai concluded that ceramic tile waste can be effectively used as aggregates in concrete making, due to its strength. He found out that the crushing value as 27, impact value as 21, abrasion value was 28% for ceramic and for natural coarse aggregate these were 24, 17 and 20% respectively. At last they concluded that ceramic does not have much variation with respect to the natural aggregates.
4) *Mashitah (2008):* Mashitah concluded that homogenous ceramic tiles can be reused in preparation of concrete block. As compared with natural coarse aggregate ceramic tile aggregate surface was found as smooth, angular shaped and sharpen edges as compared with natural coarse aggregate also the flatter particles consumed more amount of quantity of cement paste to generate better inter facial transition zone.
5) *Veera Reddy (2010):* Veera Reddy found out that the impact value of ceramic scrap was 18.2 and crushing value of ceramic scrap was 24.7% respectively. These values found out were within the permissible limits according to IS 383-1970, hence she concluded that it is safe to use tile aggregate as a coarse aggregate in concrete composition.
6) *Md Daniyal, et.al (2015):* He replaced crushed ceramic with natural coarse aggregates by 10%, 20%, 30%, 40% and 50% of substitution. From the results he concluded that, the optimum value of waste ceramic tile to be used in the concrete mix with a water/cement ratio of 0.5 was determined as about 30%. The compressive strength of tile concrete was found to be 5.43% higher than the normal concrete and the flexural strength was higher by 32.2%.. The optimal case of using waste ceramic tiles as coarse aggregates aggregates is found in between 10- 30%.

III. MATERIAL SPECIFICATION

A. *Materials*

The materials used for concrete production are sand and coarse aggregate sand was sieved from 4.5mm sieve size and coarse aggregate of 15mm to 20mm size were adopted and ordinary Portland cement was used for normal concrete, for ceramic waste aggregate concrete, in place of coarse aggregate the crushed ceramic of size 10mm is used as an aggregate.

Fig 2.1- Crushed ceramic tiles.

B. *Methodology*

Firstly, 3 normal concrete blocks of 100mmX100mmX100mm size are prepared by mixing sand, coarse aggregate and ordinary Portland cement which was available at our college lab, the water cement ratio was kept as 0.5 for M20 grade of concrete. The concrete was filled up nicely in three layers in mould and tamped 30-35 times on each layer.

Then the three blocks of concrete were left for curing of 3,7 and14 days. After that ceramic tiles were crushed manually using hammer and sieved uniformly from 10mm size sieve, the mix proportion of this concrete was kept same as that of M20 grade concrete that is, for 1 kg of ordinary Portland cement we have used 1.5 kg of sieved sand and 3 kg of crushed tile as coarse aggregate.

All the dry ingredients were mixed uniformly after that a water-cement ratio of 0.30 have been used to make the concrete workable. If the water cement ratio has been kept low, the concrete must have possessed more strength, but it couldn't be workable at less water cement ratio.

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Once the concrete is ready it was again filled in three layersin 100mmX100mmX100mm mould size.

Fig 2.2.1 – Crushed ceramic concrete block.

Three cubes of this concrete were prepared and they havebeen left for curing period 3,7 and 14 days.

Fig 2.2.2- Specific gravity and water absorption test for tileaggregate.

As our ceramic aggregate was of size 10mm so the test for specific gravity and water absorption have been performed in the pycnometer After completion of curing period of 3,7 and 14 days the cubewere tested in UTM(universal testing machine) for the compressive strength test. Resultswere noted down from the UTM for normal concrete and ceramic waste concrete and theresults were compared.

Fig2.2.3: Compressive strength test of concrete.

C. Experimental Result

Following were the results obtained by different testsperformed:

1) Specific Gravity and Water Absorption Test: Following are the results of specific gravity and water absorption test done on normal as well as ceramic aggregates of size 10mm in the pycnometer.

s.no.	Aggregate	specific gravity value	Water absorption value
1.	Convention-al	2.6	1.20%
2.	Crushed tile of 10mm size	2.24	0.72%

Table 2.3.1: Specific gravity and water absorption testresults.

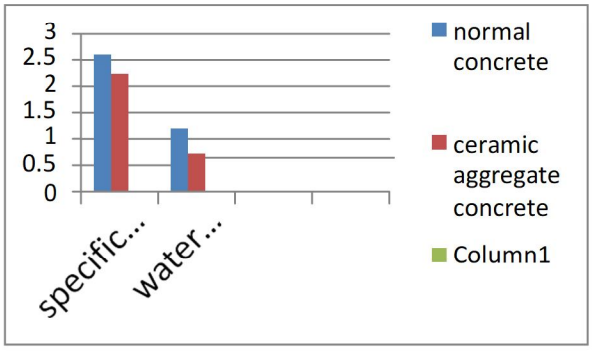

Fig 2.3.1: Results of specific gravity and water absorptiontest for normal and ceramic aggregate.

2) Properties of Normal Aggregate and Tile Aggregates

s.no.	Properties	Normal aggregate	Tile aggregate
1.	Shape	Angular	Flaky
2.	Texture	Rough	All side rough excepttop

3) Result Of Compressive Strength Test

s.no.	Days of curing period	Compressive strength of normal aggregates(in N/mm2)	Compressive strength of ceramic tile aggregate(in N/mm2)
1.	3 days	7	8
2.	7 days	10	11
3.	14 days	16	18

Table 2.3.3: Compressive strength of normal concrete andceramic waste concrete after 3,7 and 14 days.

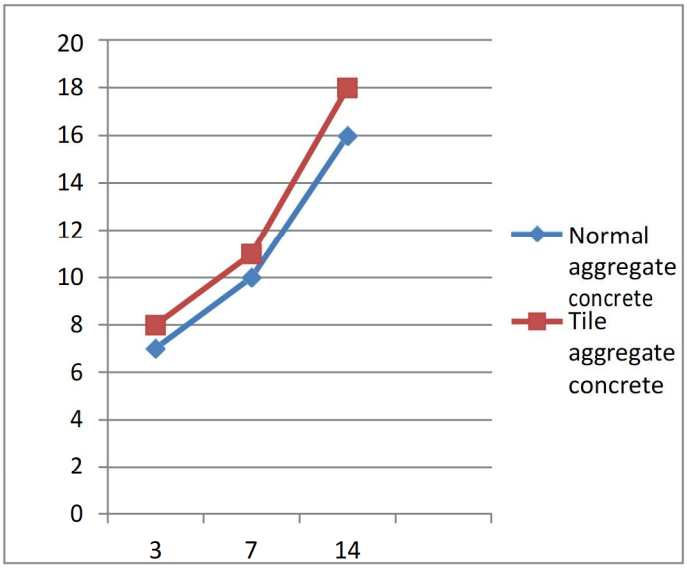

Fig 2.3.3: Graph of compressive strength between normal and aggregate and different percentages of replacement of natural ceramic aggregate concrete after 3,7 and 14 days.

D. Future Scope

It is found out that the ceramic aggregate doesent differmuch from that of natural coarse aggregate in terms of their properties. These aggregates are economical than natural aggregate as they are easily available from demolished buildings etc. As we saw that compressive strength of tile concrete was more than that of normal concrete also, modulus ofelasticity of tile aggregate is similar to that of steel so by theabove we can conclude that this concrete can be easily used for construction as it fulfills all the requirements. As we compared this waste ceramic concrete with M20 grade so it can be used in the places where M 20 grade concrete can be used, places like domestic floors and foundations (for light structural weight).Also good for bases of workshop, garage, etc. So it is useful in all the ways hat normal concrete can be used. For safe disposal of such waste this method can be adopted form this way it will be reused properly and will have less effect on environment.

IV. CONCLUSIONS

The aim of our project was to replace the normal aggregate to tile or ceramic waste. As we know the normal aggregate we use comes from natural resources and from the current scenario we know that the natural resources are reducing day by day and its high time that we should start replacing them with other materials. Tiles or ceramic is a material which is used in every type of building may it be industrial, domestic, or public building by destruction of such building huge amount of tile waste generates from replacing themwith natural aggregates we can reuse this waste tile aggregate.

We replaced the ceramic aggregate by 100% in our project and in terms of strength it was slightly more than that of normal concrete aggregate as confirmed by the compressive strength test of 3,7 and, 14 days. Tile aggregate concrete is found to be bit more economical as compared to conventional concrete. For effective use of the waste of ceramic products it can be used in concrete and play a vital role in construction industry.

In our experimental study only tests for compression strength was performed, for the effect on tensile strength and flexural strength of concrete with aggregate as tile can be furthur investigated.

The strength of concrete can be increased by decreasing water-cement ratio. But the workability will be very low. In our project the required workability was achieved by the use of maximum water-cement ratio .To overcome this use of several admixtures like super-plasticizers and silica fume arerecommended to add in the mixing so that the workability can be improved.

To get more different outcomes and higher strength characteristics more trials can be done with different particle sizes of tile aggregate.

V. ACKNOWLEDGEMENT

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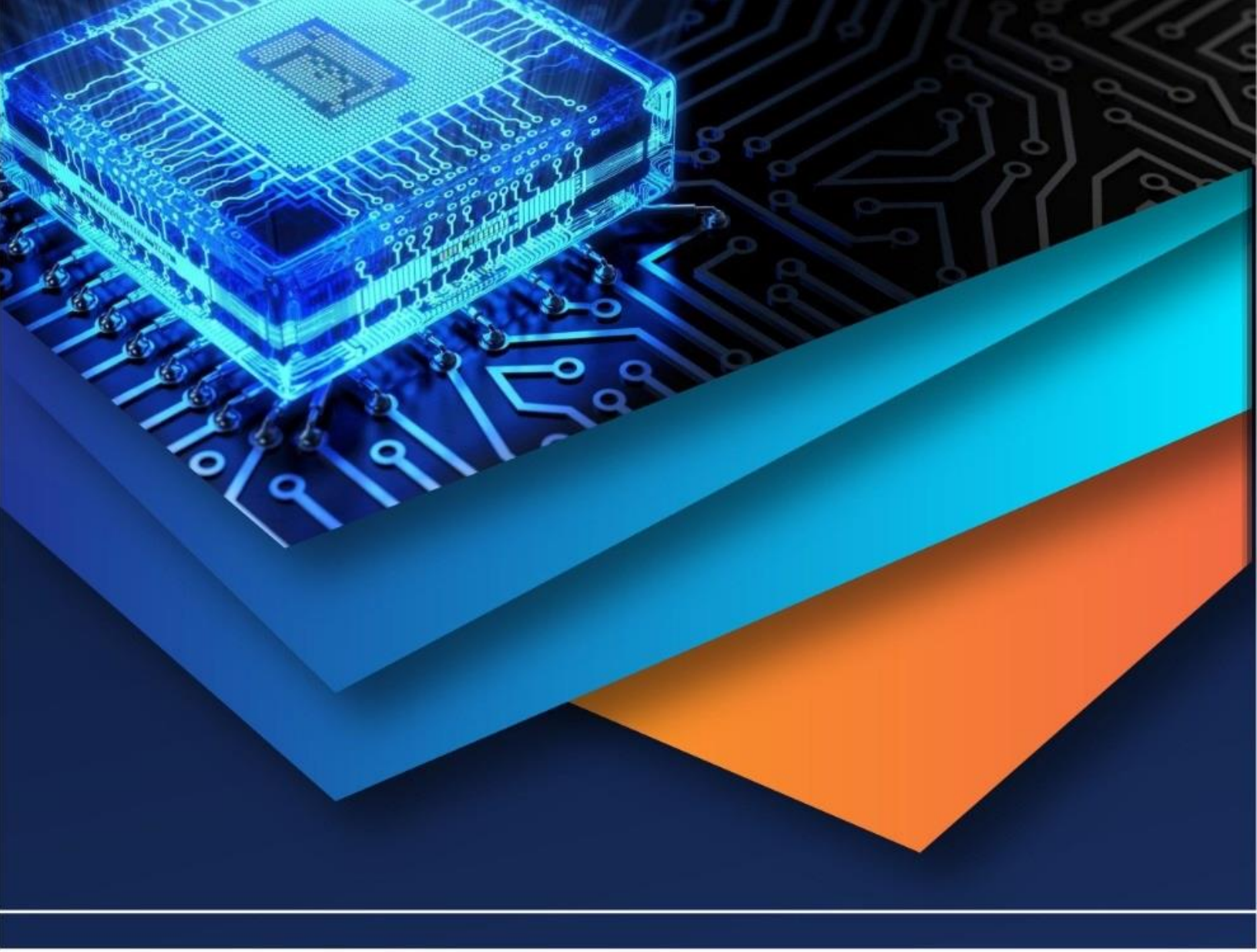

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