PARTIAL REPLACEMENT OF FINE AGGREGATE AND COURSE AGGREGATE WITH GRANITE POWDER AND CERAMIC TILE AGGREGATE IN CONCRETE

[1]Mrs.G.KALYANI, [2]GAJJALA SUSHMA,[3] KARANATI MARKS, [4]MOHAMMED ZUBAIR, [5]N.SRAVAN KUMAR

[1]ASSOCIATE PROFESSOR, DEPARTMENT OF CIVIL ENGINEERING CMR COLLEGE OF ENGINEERING & TECHNOLOGY

[2,3,4,5] B-Tech, DEPARTMENT OF CIVIL ENGINEERING CMR COLLEGE OF ENGINEERING & TECHNOLOGY

Abstract:

Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like ceramic tile and granite powder came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic tile waste is not only occurring from the demolition of structures but also from the manufacturing unit.Studies show that about 20-30% of material prepared in the tile manufacturing plants are transforming into waste. This waste material should have to be reused in order to deal with the limited resource of natural aggregate and to reduce the construction wastes. Crushed waste ceramic tiles, crushed waste ceramic tile powder and Granite powder are used as a replacement to the coarse aggregates and fine aggregate. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20%, 30%, 40% and 50%. Granite powder and ceramic tile powder werereplaced in place of fine aggregate by 10% along with the ceramic coarse tile. M25 grade of concrete was designed and tested. The mix design for different types of mixes were prepared by replacing the coarse aggregates and fine aggregate at different percentages of crushed tiles and granite powder. Experimental investigations like workability, Compressive strength test, Split tensile strength test, Flexural strength test for different concrete mixes with different percentages of waste crushed and granite powder after 7, 14 and 28 days curing period has done. It has been observed that the workability increases with increase in the percentage of replacement of granite powder and crushed tiles increases. The strength of concrete also increases with the ceramic coarse tile aggregate up to 30% percentage. Keywords: Crushed tiles, Compressive strength, Flexural strength, Granite powder,Split Tensile strength.

INTRODUCTION:

Concrete:

Concrete is a composite material consist of mainly water, aggregate, and cement. The physical properties desired for the finished material can be attained by adding additives and reinforcements to the concrete mixture. A solid mass that can be easily moulded into desired shape can be formed by mixing these ingredients in certainproportions. Over the time, a hard matrix formed by cement binds the rest of the ingredients together into a single hard (rigid) durable material with many uses such as buildings, pavements etc., The technology of using concrete was adopted earlier on large-scale by the ancient Romans, and the major part of concrete technology was highly used in the Roman Empire. The colosseum in Rome was built largely of concrete and the dome of the pantheon is the World's largest unreinforced concrete structure. After the collapse of Roman Empire in the mid-18th century, the technology was re-pioneered as the usage of concrete has become rare. Today, the widely used man made material is concrete in terms of tonnage.

Historical Background

Although high strength concrete is considered as relatively a new material, its development has been gradually increasing over years. In 1950s, USA considered the concrete with a compressive strength of 34mpa as high strength. In 1960's, the concrete with compressive strength 41mpa to 52mpa was used commercially. In the early 1970's, 62mpa concrete was been made. With in the world state of affairs, however, within the last fifteen years, concrete of terribly high strength entered into theconstruction sector of high-rise buildings and long span bridges. The compressive strength over 110mpa has been thought-about by IS 456-2000 for the applications in pre-stressed concrete members and cast-in-place buildings. However, recently reactive concrete could be the one that having a compressivestrength of nearly 250mpa. It is fully supported by pozzolanic materials. The first distinction between high-strength concrete and nominal-strength concrete refers to the relation of utmost resistance offered by compressive strength of the concrete sample for the application of any type of load. Though there is no correct separation between 3 high-strength concrete and normal-strength concrete, the Yankee Concrete Institute defined the compressive strength greater than 42mpa as high strength concrete.

Properties Of Concrete

Generally the Concrete is a material having high compressive strength than to tensile strength. As it has lower tensile stress it is generally reinforced with some materials that are strong in tension like steel. The elastic behavior of concrete at low stress levels is relatively constant but at higher stress levels start decreasing as matrix cracking develops. Concrete has a low coefficient of thermal expansion and its maturity leads to shrinkage. Due to the shrinkage and tension, all concrete structures crack to some extent. Concrete prone to creep when it is subjected to long-duration forces. For the applications various tests be performed to ensure the properties of concrete correspond to the specifications. Different strengths of concrete are attained by different mixes of concrete ingredients, which are measured in psi or Mpa. Different strengths of concreteare used for different purposes of constructions. If the concrete must be light weight a very low-strength concrete may be used. The Lightweight concrete is achieved by the addition of lightweight aggregates, air or foam, the side effect is that the strength of concrete will get reduced. The concrete with 3000-psi to 4000-psi is oftenly used for routine works. Although the concrete with 5000-psi is more expensive option is commercially available as a more durable one. For larger civil projects the concrete with 5000-psi is oftenly used. The concrete strength above 5000 psi was often used for specific building elements. For example, the high-rise concrete buildings composed of the lower floor columns may use 12,000 psi or more strength concrete, to keep the columns sizes small. Bridges may use concrete of strength 10,000 psi in long beams to minimize thenumber of spans required. The other structural needs may occasionally require high- strength concrete. The concrete of very high strength may be specified if the structure must be very rigid, even much stronger than required to bear the service loads. For these commercial reasons the concrete of strength as high as 19000-psi has been used.

OBJECTIVES:

Basically there is only one method for making lightweight concrete, by inclusion of air in concrete. This is achieved in actual practice by three different ways.

- By replacing the usual mineral aggregate by cellular porous or lightweight aggregate.
- Introducing the gas or air bubbles in mortar, known as aerated concrete.
- Omitting the sand from the aggregates, called as No-fines concrete. Lightweight concrete has become more popular in recent years and have more advantages over the conventional concrete.

MATERIALS AND PROPERTIES:

Materials Used

In this investigation, the following materials were used:

➢ Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989

➢ Fine aggregate and coarse aggregate conforming to IS: 2386-1963.

➢ Water.

Cement

Ordinary Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It developed from other types of hydraulic lime in England in mid 19thcentury and usually originates from limestone. It is a fine powder produced by heating materials to form clinker. After grinding the clinker we will add small amounts of remaining ingredients. Many types of cements are available in market. When it comes to different grades of cement, the 53 Grade OPC Cement provides consistently higher strength compared to others. As per the Bureau of Indian Standards (BIS), the grade number of a cement highlights the minimum compressive strength that the cement is expected to attain within 28 days. For 53 Grade OPC Cement, the minimum compressive strength achieved by the cement at the end of the 28th day shouldn't be less than 53MPa or 530 kg/cm2 . The color of OPC is grey color and by eliminating ferrous oxide during manufacturing process of cement we will get white cement also. Ordinary Portland Cement of 53 Grade of brand name Ultra Tech Company, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent itfrom being effected by atmospheric conditions. The cement thus procured was tested for physical requirements in accordance with IS: 169-1989 and for chemical requirement in accordance IS: 4032-1988. The physical properties of the cement are listed in Table – 1

SL.NO	Properties	Test results	IS: 169-1989
1.	Normal consistency	0.32	
2.	Initial setting time	50min	Minimum of 30min
3.	Final setting time	320min	Maximum of 600min
4.	Specific gravity	3.14	
5.	Compressive strength		
	3days strength	29.2 Mpa	Minimum of 27Mpa
	7days strength	44.6 Mpa	Minimum of 40Mpa
	28days strength	56.6 Mpa	Minimum of 53Mpa

Fine Aggregates

Sand is a natural granular material which is mainly composed of finely divided rocky material and mineral particles. The most common constituent of sand is silica (silicon dioxide, or SiO2), usually in the form of quartz, because of its chemical inertness and considerable hardness, is the most common weathering resistant mineral. Hence, it is used as fine aggregate in concrete. River sand locally available in the market was used in the investigation. The aggregate was tested for its physical requirements such as gradation, fineness modulus,specific gravity in accordance with IS: 2386-1963.The sand was surface dried before use.

S.No	Description Test	Result
1	Sand zone	Zone- III
2	Specific gravity	2.59
3	Free Moisture	1%
4	Bulk density of fine aggregate (poured density) Bulk density of fine aggregate (tapped density)	1385.16 kg/m3 1606.23kg/m3

EXPERIMENTAL DETAILS:

This chapter deals with the various mix proportions adopted in carrying out the experiments and experimental results obtained with respect to their workability, compressivestrength, split tensile strength, flexural strength and durability test.

GENERAL

Different types of mixes were prepared by changing the percentage of replacement of coarse and fine aggregates with crushed tiles, crushed tile powder and granite powder. Total 14 types of mixes are prepared along with conventional mixes. The coarse aggregates are replaced by 10%, 20%, 30%, 40% and 50% of crushed tiles and the fine aggregate is replaced by 10% of both crushed tile powder and granite powder individually but along with the coarseaggregate. The details of mix designations are as follows:

Table 3: Details of aggregate replacement for mix codes

S.no	Mix Code	Cement (%)	Coarse Aggregate (%)		Fine Aggregate (%)		
			Natural Coarse Aggregate	Crushed Tiles	Sand	Crushed tile powder	Granite Powder
1	M0	100	100	0	100	0	0
2	M1	100	90	10	100	0	0
3	M2	100	80	20	100	0	0
4	M3	100	70	30	100	0	0
5	M4	100	60	40	100	0	0
6	M5	100	50	50	100	0	0
7	M6	100	90	10	90	10	0
8	M7	100	80	20	90	10	0
9	M8	100	70	30	90	10	0
10	M9	100	60	40	90	10	0
11	M10	100	90	10	90	0	10
12	M11	100	80	20	90	0	10
13	M12	100	70	30	90	0	10
14	M13	100	60	40	90	0	10

Workability

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation inthe finished product. Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete.

Procedure:

➢ To find the workability of concrete thoroughly mix cement, sand And coarse aggregate according to designed mix proportions to form a homogenous mix of concrete.

➢ Find the Weight of empty cylinder (W1).

➢ Fill the upper hopper with the freshly prepared concrete and after 2 minutes, release the trap door of the hopper. Immediately after the concrete has come to rest, open the trap door of the lower hopper and allow the concrete to fall into the cylinder which brings the concrete to a partially compacted state.

➢ Remove the excess concrete over the top of the cylinder by a trowel.

➢ Clean the cylinder properly and weigh it with the partially compacted concrete (W2).

➢ Empty the cylinder and refill it with the same sample of concrete in four layers, compaction of each layer by giving 25 blows with the tamping rod.

➢Level up the mi and weigh the cylinder with the fully compacted concrete (W3).

RESULTS:

The ideal concrete is the one which is workable in all conditions i.e, can prepared easily placed, compacted and moulded. In this chapter, the workability is assessed by two methods as follows: Slump Cone Test The test was conducted for fresh concrete prepared beforethe moulding process. A total of 14 concrete mixes are prepared at different times.

Workability Results obtained from slump cone test for M25 grade of concrete is shown in table 4. Table 4: Test results from slump cone test for workability in mm

S.No	Mix Designation	Aggregate Replacements % (CCA+CFA+GP)	Workability (mm)
			M25
1	M0	0+0+0	62
2	M1	10+0+0	65
3	M2	20+0+0	68
4	M3	30+0+0	73
5	M4	40+0+0	78
6	M5	50+0+0	81
7	M6	10+10+0	63
8	M7	20+10+0	67
9	M8	30+10+0	71
10	M9	40+10+0	76
11	M10	10+0+10	72
12	M11	20+0+10	79
13	M12	30+0+10	86
14	M13	40+0+10	102

The workability from the slump cone test is in increasing manner as the mix proportion replacement increasing. The workability range of concrete increasing as mentioned while being in medium range overall. 34 6.3 Compaction Factor Test The compaction factor test was conducted to the same mix that tested for workability by slump cone. The results obtained from the compaction factor test forthe workability of various mixes of replacements of M25 grade of concrete are tabulated as follows:

Table 5: Test results of compaction factor test for workability

S.No	Mix Designation	Aggregate Replacements % (CCA+CFA+GP)	Compaction Factor
			M25
1	M0	0+0+0	0.82
2	M1	10+0+0	0.84
3	M2	20+0+0	0.855
4	M3	30+0+0	0.87
5	M4	40+0+0	0.89
6	M5	50+0+0	0.93
7	M6	10+10+0	0.83
8	M7	20+10+0	0.86
9	M8	30+10+0	0.88
10	M9	40+10+0	0.91
11	M10	10+0+10	0.85
12	M11	20+0+10	0.90
13	M12	30+0+10	0.93
14	M13	40+0+10	0.95

The workability of M25 grade of concrete by compaction factor test is similarto that of slump cone test. The pattern of increment for the mixes is quite same whichwill be discussed in detail further.

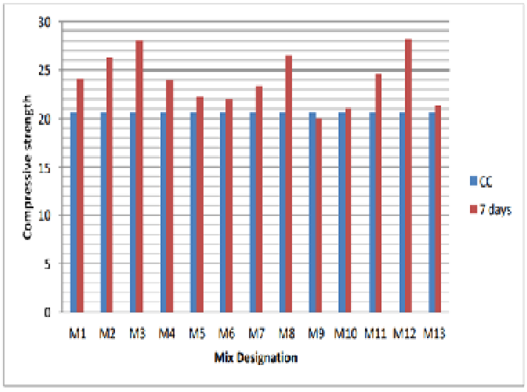

Figure 1: Comparison of Compressive strength of M25 at 7 days

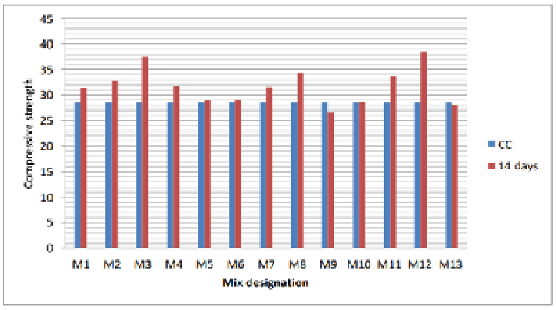

Figure 2: Compressive strength of M25 concrete at 28 days

CONCLUSION:

The following conclusions are made based on the experimental investigations on compressive strength, split tensile strength and flexural strength considering the—environmental aspects also:

1.The workability of concrete increases with the increase in tile aggregate replacement. The workability is further increased with the addition of granite powder which acts as admixture due to its chemical properties.

2.The properties of concrete increased linearly with the increase in ceramic aggregate up to 30% replacement later it is decreased linearly.

3.M3 mix of concrete produced a better concrete in terms of compressive strength, split tensile strength and flexural strength than the other mixes. Butthe mixes up to 50% of ceramic coarse aggregate can be used.

4.The excessive usage of granite powder has decreases the properties of concrete.

5.Granite powder using as fine aggregate has more influence on the concrete than the ceramic fine because of chemical composition it is made of and works as admixture.

6.The addition of granite powder along with the ceramic coarse tile aggregate improves the mechanical properties of concrete.

7.The split tensile strength of ceramic tile aggregate is very much in a linear compared to the conventional grade of concrete.

FUTURE SCOPE:

There is a vast scope for research in further the recycled aggregate usage in concrete especially ceramic tile waste. The possible research investigations that can be done are mentioned below: • The usage of marble floor tiles can be studied as it is similar to that of tile waste generation and also it is quite hard compared to the natural crushed stones using in conventional concrete. • The usage of granite powder in concrete as an admixture to improve the workability of concrete and the strength parameters can also be studied at various percentages.

• A combination of different tiles (based on their usage) in different proportions in concrete and their effects on concrete properties like strength, workability etc can bedetermined.

• By the use of ceramic tile aggregate in concrete, the physical properties like durability, permeability etc., can be analyzed to prepare a concrete with more advantageous than conventional concrete.

• A study on properties of concrete made with combination of recycled aggregate and tile aggregate in different proportions can be investigated to enhance the concrete properties and also to reduce the pollution of waste generation from construction industry.

• A further investigation on the use of granite powder alone as a replacement to fine aggregate can be carried out.

• The mechanical properties of concrete with marble aggregate (waste) either from manufacturing units or from construction demolition can be investigated to improve the properties like permeability; resistance to sound etc.

• Ceramic tile aggregate in high strength concrete can be studied further to check the possibility of its use in high rise buildings.

REFERENCES:

1. Aruna D, Rajendra Prabhu, Subhash C Yaragal, Katta Venkataramana IJRET:eISSN: 2319-1163 | pISSN: 2321-7308.

2. Batriti Monhun R. Marwein, M. Sneha, I. Bharathidasan International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016 ISSN 2229-5518.

3. Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 31, No. B5, pp 561-565 Printed in The Islamic Republic of Iran, 2007

4. Department of Engineering and Agricultural Sciences, University of Leon, Avenida Portugal 41, Leon 24071, Spain.

5.International Journal of Innovative Research in Science,Engineering and TechnologyISSN(Online): 2319-8753 ISSN (Print): 2347-6710.

6.N.Naveen Prasad, P.Hanitha, N.C.Anil IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13,Issue 6 Ver. V (Nov. - Dec. 2016), PP 168-176.

7.Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN:

3159-0040 Vol. 2 Issue 11, November - 2015
8. Paul O. Awoyera , Julius M. Ndambuki , Joseph O. Akinmusuru , David O. Omole-4048 2016 Housing and Building National Research Center. Production and hosting by Elsevier B.V. 15 November 2016)
9. P.Rajalakshmi, Dr.D.Suji, M. Perarasan, E.Niranjani International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online) Vol. 4, Issue 1, pp: (114-125), Month: April 2016 - September 2016.
10. Prof. Shruthi. H. G, Prof. Gowtham Prasad. M. E Samreen Taj, Syed Ruman Pasha International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 - 0056 Volume: 03 Issue: 07 | July-2016 p-ISSN: 2395-0072)
11 Vemuri, R.K., Reddy, P.C.S., Puneeth Kumar, B.S., Ravi, J., Sharma, S., Ponnusamy, S., "Deep learning based remote sensing technique for environmental parameter retrieval and data fusion from physical models", Arabian Journal of Geosciences, 2021, Vol. 14-Issue 13, PP-
12 Premalatha, B., Babu, P.R., Srikanth, G., "Compact Fifth Iteration Fractal Antenna for UWB Applications", Radioelectronics and Communications Systems, 2021, Vol. 64-Issue 6, PP.325-329.
13 Premalatha, B., Srikanth, G., Abhilash, G., "Design and Analysis of Multi Band Notched MIMO Antenna for Portable UWB Applications", Wireless Personal Communications, 2021, Vol. 118-Issue 2, PP-1697-1708.
14 Saba, L., Sanagala, S.S., Gupta, S.K., Koppula, V.K., Johri, A.M., Sharma, A.M., Kolluri, R., Bhatt, D.L., Nicolaides, A., Suri, J.S., "Ultrasound-based internal carotid artery plaque characterization using deep learning paradigm on a supercomputer: a cardiovascular disease/stroke risk assessment system", International Journal of Cardiovascular Imaging, 2021, Vol. 37-Issue 5, PP.1511-1528.
15 Kumar Dash, C.S., Behera, A.K., Nayak, S.C., Dehuri, S., "QORA-ANN: Quasi Opposition Based Rao Algorithm and Artificial Neural Network for Cryptocurrency Prediction", 2021 6th International Conference for Convergence in Technology, I2CT 2021, 2021, Vol. ,Issue, PP.