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Research Paper

DEVELOPMENT OF ECO-FRIENDLY CONCRETE WITH INDUSTRIAL CERAMIC SLUDGE AND RECYCLED COARSE AGGREGATES

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ABSTRACT

The purpose of this study is to investigate the effects of concrete on the environment there is a huge growth in Construction industry. Many new technologies have evolved very rapidly to cater different difficulties in the construction industry. Concrete is one of the most important materials in a construction industry, among all the material used for construction purposes. The process of manufacturing of cement emits near about eight to ten parent of total world's carbon dioxide. The global warming gas is released when limestone and clays are crushed and heated to high temperatures. In recent year, the recycling of waste and industrial by products gaining popularity to make concrete environment friendly material and the concrete can be called as Green Concrete. Green concrete is defined as a concrete which uses waste material as at least one of its components, or its production process does not lead to environmental destruction, or it has high-performance and life cycle sustainability.

In the present study an experimental investigation was conducted by using recycled coarse aggregates and industrial ceramic sludge material in M30 grade concrete. The percentage of ceramic sludge and RCA is 0%CS+0%RCA, 5%CS+5%RCA, 10%CS+10%RCA, 15%CS+15%RCA, 20%CS+20%RCA and 25%CS+25%RCA. The workability like sump and compaction factor is determined with various CS and RCA the strength values like compressive, split tensile and flexural strength is determined with various percentages of CS and RCA.

Key words: Construction industry, cement, recycled coarse aggregates, industrial ceramic sludge, and green concrete

1. INTRODUCTION

Color has nothing to do with green concrete. It is a concept of thinking and environment into an every aspect of the raw materials manufacture over construction, mixture design to structural design, and durability. Green concrete is very often considered to be cheap to produce due to the use of recycled material whereby avoiding the charges for the disposal of waste, less energy consumption and greater durability.

While a normal construction practices are guided by short term economic considerations, sustainable construction is focused on best practices which emphasize on long term affordability, durability and effectiveness. At each stage of the life cycle of the construction, it increases ease and quality of life, while minimizing the negative environmental impacts and increasing economic sustainability of the construction. Any infrastructure designed and constructed in a sustainable way minimizes the use of resources

through the whole life cycle of the construction process in which the green concrete play a vital role in achieving the sustainable construction. Having so much of advantageous has led to popularity in construction world and one of the emerging technology in sustainable construction. Green concrete is miracle of present and tool for future when the natural resources are on the verge of extinction.

Due to growing interest in sustainable development, engineers and architects are motivated more than ever before to choose materials that are more sustainable. Selection of material for concrete is more sustainable and minimizes environmental impact. Cement production accounts for more than 6% of all CO2 emission which is a major factor in the world's global warming (Greenhouse gas). India is the third largest cement producer in the World and one of the largest consumers of cement per capita in the world. Rough figures are that India consumes about 1.2 Ton/year/capita, while as World average is 0.6 Ton/year/capita. CO2 emissions from 1 ton of concrete produced vary between 0.05 to 0.13 tons. 95% of all CO2 emissions from a cubic meter of concrete are from cement manufacturing. Cement is the one of the major component of the concrete. The production of one ton of cement releases one ton of a CO2 into the atmosphere. CO2 is known to be greenhouse gas that contributes to the global warming. The reduction in CO2 emission from a concrete can be achieved with a partial replacement of cement by the various supplementary cementitious materials. The use of these cementitious materials has resulted in an improvement of the properties of concrete.

Objectives of the study

The following are the objectives made for the current study

1. Determine the workability, the overall strength, as well as the rate of strength gain for concrete containing ceramic waste and recycled waste.
2. Compare the results of industrial ceramic sludge and recycled coarse aggregates concrete to a conventional mix.
3. To determine the strength values with various percentages of ceramic sludge and recycled coarse aggregates.
4. To develop the green concrete by using M30 grade concrete mix

2. LITERATURE REVIEW

Prof. Ashok Admute1 et al.,(2017) This paper was concluded from the Silica fume is a material which may cause air pollution; this is the by product of some industries. Addition of micro silica in cement reduces the air pollution and makes concrete more sustainable; as well as the optimum replacement of cement with silica 5% to 15% leads to increase in strength whereas the 20% replacement leads to decrease in strength of concrete.

Brett et al (2010) insist that the use of recycled aggregates in concrete is both economically viable and technically feasible. In addition to demolition waste sources, RA can also be composed of excess Concrete materials returned to the plant.

3. MATERIALS USED FOR THE STUDY

For this experimental study initially we have collect the necessary materials to make self compacting concrete the details of materials collection and specification are discussed in the below

2.1 Cement

Ordinary Portland cement of 53 grade was utilized in this experimentation adjusting to I.S. – 12269-1987. For the current examination I was gathered ACC cement of 53 grade from local area. The example cement bag utilized in this investigation is appeared in the below figure 1



OPC 53 grade cement

Coarse aggregate

Coarse aggregates are particles greater that 4.75mm but generally range between 9.5mm to 37.5mm in diameter. In this study coarse aggregate of nominal sizes of 20mm, 12mm are used.



20mm and 12mm size aggregates

Fine aggregates

Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.75mm sieve.

The fine aggregate used in this study is river sand which is obtained from local company



Fine aggregates

Recycled coarse aggregates

The recycled aggregate is obtained by breaking the tested laboratory concrete specimens of grades M20, M25 and M30. The concrete specimens were made into smaller fragments manually and the recycled aggregate obtained.



Recycled coarse aggregates

Industrial ceramic waste

Ceramics as well as other insulators like paraffin, rubber, plastic, paper and artificial marble are fired in a kiln, they can be fashioned into a wide variety of shapes with excellent heat resistance and durability. For these reasons, ceramics have long been used as insulators and give their services. Generation of large amount of ceramic insulator waste has been found in electricity board due to heavy voltage insulator becomes breaks. These ceramic insulator wastes have not been reused after breaking. In this research area these ceramic waste has been utilised for the replacement with fine or coarse aggregate.

2.7 Mix Design And Trials Used For The Study

The mix design used for this study is 1:1.62:2.7186 for M30 grade design mix as per the materials properties

For this study of experimentation I was taken five trials to get the optimum value of strength and durability values which are shown in the below discussions

1. 0% Recycled aggregates + 0% Ceramic waste : Mix 1
2. 5% Recycled aggregates + 5% Ceramic waste : Mix 2
3. 10% Recycled aggregates + 10% Ceramic waste : Mix 3
4. 15% Recycled aggregates + 15% Ceramic waste : Mix 4
5. 20% Recycled aggregates + 20% Ceramic waste : Mix 5
6. 25% Recycled aggregates + 25% Ceramic waste : Mix 6

3. METHODOLOGY

In order to test the strength and workability concrete using recycled aggregates and ceramic waste for M30 grade concrete we need to cast the cubes, cylinders and prism specimens for compressive strength, split tensile strength, flexural strength of various curing periods. Along with those strength tests workability is also studied for various trial mixes. For this project the following methodology is used

3.1 Batching

Batching is the process of taking the quantity of materials required for the project. Generally measuring the material quantity is done by two methods one is weight batching, second is volume batching. In the present study I was taken weight batching to measure the materials quantity.

3.2 Mixing Of The Concrete

After measuring the materials quantity I mixed the materials as per the trails. Firstly we have to mix coarse aggregates, fine aggregates, waste materials for some time to get uniform mix after that add cement and silica fume to the mixture again mix for some more time to get same mix throughout the material. Now add the water as per the calculations from the mix design to make freshly prepared concrete for M30 grade concrete.

3.3 Casting Of Specimens

After mixing the concrete materials we have to cast the specimens like cubes, cylinders, prisms to check the strength and durability. For this study we have to cast cubes, cylinders and prisms to check the compressive strength, split tensile strength and flexural strength at 7days, 14 days and 28 days curing period.

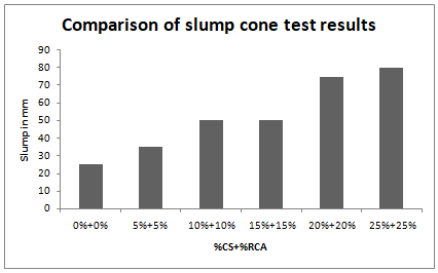
3.4 Curing Of The Specimens

In case of compressive strength, split tensile and flexural strength studies we have to cure the specimens for 7 days, 14 days and 28 days of curing periods with all five trial mixes.

4. RESULTS AND ANALYSIS

4.1 Workability Of Concrete

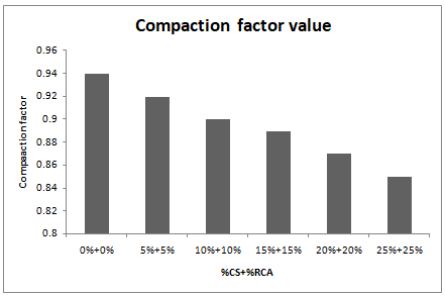
Workability is one of the most important property of the freshly prepared concrete mixtures in the present study workability of concrete mix is find out with the help of the slump cone test and compaction factor tests the below graph shows the slump cone comparison for various mixes



Comparison of slump cone test

4.2 Compaction Factor

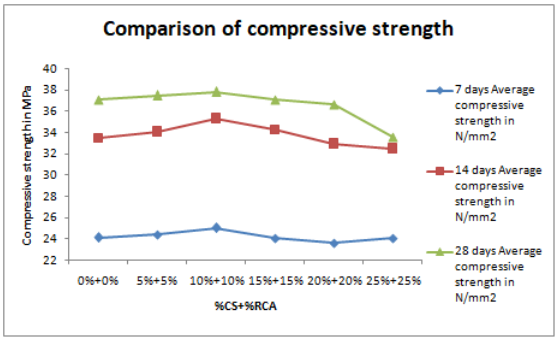
Compaction factor is the weight of partially compacted concrete to the weight of full compacted concrete. For the present study compaction factor is determined with the help of mix trials from mix trial 1 to mix trial 6 the below graph shows the compaction factor test results.



Comparison of compaction factor

4.3 Compressive Strength Of Concrete

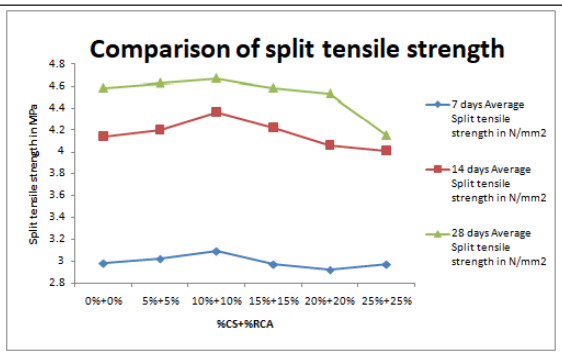
After curing cubes the compressive strength of concrete is resolved with the assistance of universal testing machine (UTM) for trial 1 to trial 6. The below figure shows the compressive strength of concrete for 7 days, 14 days and 28 days curing.



Comparison of Compressive strength

4.4 Split Tensile Strength

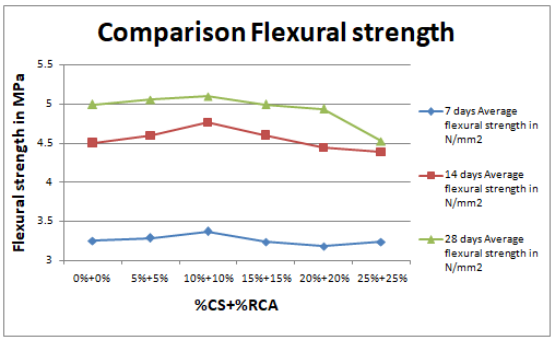
Split tensile strength of concrete is determined for M30 grade concrete with the help of cylinder specimens for various mix trials from trial 1 to trail. The dimension of the cylinder was taken as 150mm diameter and 300mm length. The below graph shows the split tensile strength for 7days, 14 days and 28 days.



Comparison of Tensile strength

4.5 Flexural Strength Of Concrete

Generally flexural strength of concrete is determined for prism specimens of 150mmX150mmX700mm dimensions. The flexural strength of prism specimens is determined for trials 1 to trails 6 for M30 grade concrete, the below graph shows the flexural strength of concrete for 7days, 14 days and 28 days curing



Comparison of Flexural strength

5. CONCLUSIONS

From this study the following conclusions were made

1. There is a need for the sustainable construction. Thus for achieving sustainable construction concept of green concrete is adopted.
2. With Green concrete Technology, we can save the natural materials for future use or the generations to come and sustain it for good amount of time.
3. Green concrete has reduced environmental impact with reduction of the concrete industries CO2 commissions by 30%. Green concrete is having good thermal and fire resistant.
4. In this concrete recycling use of waste material such as ceramic wastes, recycled aggregates, so increased concrete industry use of waste products by 20%. Hence green concrete consumes less energy and becomes economical in use.
5. The slump values by using ceramic waste and recycled concrete waste slump value increases from 0% to 50% for M30 grade concrete and the compaction factor decreases from the 0% to 50% in concrete.
6. The maximum values of compressive, split tensile and flexural strength are obtained at 10% ceramic sludge and 10% recycled aggregates in M30 grade concrete for all 7days, 14 days and 28 days curing.
7. Hence green concrete consumes less energy and becomes economical. So definitely use of concrete product like green concrete in future will not only reduce the emission of co2 in environment and environmental impact but also economical to produce.
8. Due to use of recycled aggregate in construction, energy and cost of transportation of natural resources and excavation is significantly saved. This in turn directly reduces the impact of waste material on environment.

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