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EXPERIMENTAL STUDY ON STRENGTH BEHAVIOR OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND COARSE AGGREGATES WITH TYRE

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Abstract- *A very large amount of waste rubber tire are being generated each year all around the world. Being non biodegradable in nature their recycling is not easy. On burning they produce very toxic and harmful smoke. So the only option is to dump them to landfills. It is also not a proper solution as it takes a lot of space and stockpiles of waste rubber leads to soil pollution and contaminate water bodies along with ground water. Statistics show that every year more than 500 million tires are discarded to landfills, and the estimation is about 5000 million tires would be discarded by 2030. Many research studies has shown that the waste rubber tires could be used in concrete. Concrete with rubber tire has shown reduction in compressive and flexural tensile strength but they do possess some positive aspects as they have better toughness, impact resistance, thermal and sound properties.*

The main objectives of this study is to investigate the strength properties of M30 grade concrete by replacing cement with silica fume and rubber tyre aggregates (RTA). The percentage of silica fume and rubber tyre used as 0%SF+0%RT, 5%SF+10%RTA, 10%SF+20%RTA, 15%SF+30%RTA, 20%SF+40%RTA.

1. INTRODUCTION

Concrete has been present for many years; the Minoan culture is said to have used a substance similar to concrete for the first time about 2000 BC. The Romans discovered that combining sand-like volcanic ash with lime mortar produced a hard, water-resistant material that we now know as concrete during the early stages of the Roman Empire, circa 300 BC. The predominant type of cement used in modern concrete is Portland cement, other types of cement available include; Blended cement, which is similar to Portland cement but may contain materials such as fly ash slag or silica fume; High early strength cements, which as the name suggests gains strength a lot quicker then Portland or blended cements; Low heat cements, used when limits are placed on the heat of hydration of the concrete; Shrinkage limited cements; Sulphate resisting cements; Coloured cements; Masonry cement.

Portland cement is made by mixing calcium carbonate commonly found in limestone or chalk and silica, alumina and iron oxide found in clay or shale. The two ingredients are ground and mixed together in either a dry or wet state depending on the characteristics of the rocks being used. The mix is then placed in a kiln at temperatures as high as 1400 degrees Celsius, at this temperature the two rocks fuse together to form clinker. The clinker is allowed to cool and gypsum is added at around 1 – 5 percent. The mix is then ground to the required fineness and distributed to concrete batch plants. Portland cement derives its name from the Portland limestone because of the close resemblance of the finished concrete to the Portland Limestone.

Concrete is one of the most popular materials for construction owing to the fact that it can be cast into just about any shape, it has good compressive strengths, is readily available just about anywhere and is relatively cheap in comparison to other materials available for construction, such as steel or fibre composites. Concrete is made from a mixture of cement powder coarse and fine aggregates, normally sand and crushed rock and water. It can be either mixed in a hand mixer or by a large batch plant.

Since manufactured sands possess different properties to natural sands it would be beneficial to be able to predict the properties of the resultant concrete without extensive laboratory testing. There have been numerous attempts to model the influence of the physical and chemical characteristics of aggregates on the fresh and hardened properties of concrete and provide concrete mix design procedures. These, to some extent, take into account a number of the aggregate characteristics: the particle size distribution, maximum aggregate size and aggregate type (natural or crushed). However, as these procedures are based on statistical data from many concrete mixes, the results are generalized and in the case of a specific type of aggregate, like crusher dust or manufactured aggregates, might not yield the expected final concrete properties. Furthermore, the concrete compressive strength estimates are based on the w/c ratio, which for typical aggregates might be correct, but for very angular or very fine aggregates might prove to be an inaccurate representation of the strength. Similar effects might be encountered in consistency measurements.

Objectives of the study

For the current study the following conclusions were made

1. Determine the workability, strength of M30 grade concrete containing silica fume and rubber tyre aggregates.
2. To compare the test results with conventional mix concrete.
3. To determine the concrete strength values for different percentages of silica fume and rubber tyre aggregates.
4. Determine compressive strength, split tensile strength and flexural strength of concrete

2 LITERATURE REVIEW

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This paper studied about Concrete is the most commonly used in construction material. Concrete is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. The hunger for the higher strength leads to other materials to achieve the desired results and thus emerged the contribution of Cementitious material for the strength of concrete. The mechanical properties start showing increasing trend with increase in the quantity of Nano-silica. The development of construction materials technology, particularly concrete is growing very rapidly in the presence of nanotechnology. Nano technology finds application in various fields of science and technology. The use of Nano materials in concrete is new revolution. Nano materials like Nano-silica, Nano titanium oxide, carbon Nano tubes, Nano alumina etc. which are presently used in concrete to improve its strength properties. The objective of this project is to study the mechanical properties of concrete such as Compressive strength and workability of M20 and M30 grades of concrete with the use of Nano silica (0%, .5%,1%, 1.5%, 2%, 2.5%) as partial replacement of cement Specimens namely cubes are cured for 28 days in standard environment, after this curing period test to calculate the mechanical properties of Nano silica concrete are carried out and the results were compared with the Normal Cement Concrete (NCC).

From this study it was concluded that the workability of concrete with partial replacement of Nano silica which is decreasing by increasing the amount of Nano silica. Nano silica absorbs the quantity of mixing water, reducing the workability. The Characteristic Compressive Strength of concrete at 7 days and 28 days was found in N/mm2. For Batch A the result shows a slight decrease in the strength with addition of Nano silica at first. Further with addition of Nano silica more than 0.5 %, there was an increase in the strength up to 2.0 % after which the strength again decreased. This led us to conclude that 2.0% is the ideal silica dosage. For batch A and B the percentage increase in the compressive strength with addition of Nanosilica with 0.5% replacement of cement workability percentage in increased and compressive strength of specimen is decreased at 3.032 and 3.284.The percentage increase in the compressive strength for 2.5% replacement of cement is decreased for both batches after that 2% replacement of cement is increased up to 15.911 and 18.666.

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This paper describes Concrete can be nano-engineered by incorporating nano sized building blocks or objects (e.g., nano particles and nano tubes) to control material behaviour and add novel properties. In this work an attempt has been made to study the effect of nano alumina on the properties of concrete composite. In order to investigate the effect of nano-alumina on the mechanical strength of cement composite, the specimens with different volume percentages (0%, 0.5%, 0.75% and 1%) nano-alumina, in each proportion three sample were cast totally making 58 specimens and after 28 days of curing they were tested. Based on experiment, the compressive strength of concrete cubes was all increased by incorporating nano alumina into matrix, when the fraction of nano alumina was 1% of the cement by weight the compressive strength of composites increased by 33.14% at 28 days. The test results showed that addition of nano alumina enhanced the compressive strength and reduced the initial setting time of concrete composite. Micro analysis was carried out by Scanning Electron Microscope (SEM) and Energy Dispersive Spectroscopy (EDS).The studies indicated that nano particle was uniformly distributed by improving the microstructure of concrete.

From this study it was concluded that The accompanying were the conclusions touched base from the analyses directed on specimens in Standard condition: Based on the outcome, it was found that for the expansion in rate of nano alumina, mechanical properties demonstrated reliably enhanced results. The compressive strength expanded significantly, the split tensile strength increased marginally. However the split tensile strength of the concrete could be enhanced by utilizing more reasonable reinforcements with nano particles. The SEM contemplates demonstrated that the nano particles are consistently conveyed and there by microstructure of cement is progressed. The SEM perceptions likewise uncovered that the nanoparticles were going about as filler, as well as an activator to elevate hydration demonstrates and to enhance the microstructure of the concrete if the nano-particles were consistently scattered. The void investigation done utilizing image J programming uncovered that the rates void brought down when the extent on nano alumina expanded. The rate voids if there should be an occurrence of 1% nano alumina content cement is relatively lesser than that of 0% nano alumina concrete. Additionally ponder toward this path is suggested, since more number of perceptions is required for getting the ideal amount of nano-particles.

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Concrete is the most versatile material due to the persistent and continuous demands made on concrete, Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials like fly ash, silica fume, granulated blast furnace slag and steel slag etc. The use of large quantity of cement produces increasing co2 emissions and consequence the green house effect. Nano technology is one of the most promising areas of science. The use of nano materials in concrete is new revolution. Nano materials like nano silica, nano titanium oxide, carbon nano tubes, nano alumina etc… which are presently used in concrete to modify its strength properties. In the present study strength properties such as compressive strength, split tensile strength and flexural strength of M20 grade of concrete with the use of nano silica (2%, 4%, 6%, 8%, 10%) as partial replacement of cement were studied. It was found from the experimental study that concrete composites with superior properties can be produced using nano silica.

From this study it was concluded that Cement replacement up to 6% with NS, leads to increasing compressive strength, split tensile strength and flexural strength for M20 grade of concrete. Beyond 6% of NS

there is decreasing in compressive strength, split tensile strength and flexural strength for M20 mix. The maximum replacement level of nano silica is 6% for M20 grade concrete.
3. The percentage increase in compressive strength, split tensile strength and flexural strength of concrete with combination of NS at 6% for 28 days is (30%,11.7%, 13%) which is More when compared to normal concrete of M20 grade.

3. MATERIALS AND METHODOLOGY

Cement

The raw materials required for make of Portland cementare calcareous materials, for example, limestone or chalk, and argillaceous material, for example, shale or clay. There are two procedures known as wet and dry procedures relying on whether the blending and crushing of crude materials is done in wet or dry condition.

Aggregates

Aggregates are the main constituents in concrete. They offer body to the concrete, diminish shrinkage and impact economy. Aggregates are inactive granular materials, for example, sand, rock or smashed stone that are a final result in their own crude materials. They are additionally the crude materials that are a fundamental fixing in concrete.

Aggregates are divided into two categories from the consideration of size.

i).Coarse aggregate ii) Fine aggregate

Coarse aggregates

Coarse aggregates are particles more note less that 4.75mm however for the most part run between 9.5mm to 37.5mm in measurement. They can either be from essential, auxiliary or reused sources. Essential or virgin aggregates are either land or marine-won. Rock is a coarse marine-won total, arrive won coarse aggregates incorporate rock and smashed shake. Rock constitute the dominant part of coarse aggregate utilized in concrete with pulverized stone making up the greater part of the rest of.

Fine aggregate

Fine aggregates are fundamentally sands won from the land or the marine condition. Fine aggregates by and large comprise of normal sand or smashed stone with most particles going through a 4.75mm sieve.

Water

Water is a vital element of concrete as it effectively takes an interest in the compound response with bond. Since it shapes the strengthen giving concrete gel, in the amount and nature of water is required to be investigated deliberately. C3S requires 24% of water by weight and C2S requires 21%. It has additionally been evaluated that on a normal 23% of water by weight of bond is required for substance response with Portland concrete intensifies .This 23% of water synthetically joins with bond and, consequently, it is called bound water. It has been additionally evaluated that 15% by weight of concrete is required to top off the gel-pores.

Silica fume

Silica fume, also referred to as microsilica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture. Condensed silica fume is essencially silicon dioxide in

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noncrystalline form. It has spherical shape. It is extremely fine with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles. Silica fume has specific surface area of about 20,000 m^2/kg, as against 230 to 300 m^2/kg.

Micro silica is the most commonly used mineral admixture in high strength concrete. It has become the chosen favourites for high strength concrete and is a good pozzolan & can be used in a big way, Adding to the concrete mix will dramatically enhance the workability, strength & impermiability of concrete mixes while making the concrete durable to chemical attacks, abrasion & reinforcement corrosion, increasing the compressive strength. There is a growing demand in the production of concrete mixes, high performance concrete, and high strength, low permeability concrete for use in bridges, marine environment, and nuclear plants.

Silica fume

Rubber tyre aggregates

The scrap tyre rubbers are cut into aggregates with help of cutting machine and cutting to maximum nominal sizes equal to 20mm. The replacement of natural aggregates with rubber aggregates tends to reduce the density of the concrete. This reduction is attributable to the lower unit weight of rubber aggregate compared to ordinary aggregate. The unit weight unit weight of rubberized concrete mixtures decreases as the percentage of rubber aggregate increases. Reclaimed rubber has been obtained from karnool district and cut into small pieces.

Rubber aggregates

Superplasticizers

Superplasticizers constitute a generally new classification and enhanced variant of plasticizer, the utilization of which was created in Japan and Germany amid 1960 and 1970 separately. They are artificially unique in relation to typical plasticizers. Utilization of superplasticizers allows the decrease of water to the degree upto 30% without lessening usefulness as opposed to the conceivable decrease up to 15% if there should be an occurrence of plasticizers.

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Mix Design of Concrete

Cement = 394 kg/m3

Water = 197 kg/m3

Fine aggregates = 638.6 kg/m3

Coarse aggregate = 1071.16 kg/m3

Water-cement ratio = 0.50

Final trial mix for M30 grade concrete is 1:1.62:2.7186 at w/c of 0.50

4. EXPERIMENTAL INVESTIGATION

Casting of cubes and cylinders

Throwing of concrete shapes and barrels as improved the situation M25 and M30 review concrete, the blend extent is for which we are cubes, cylinders and prisms for ordinary cement, with the incomplete substitution.

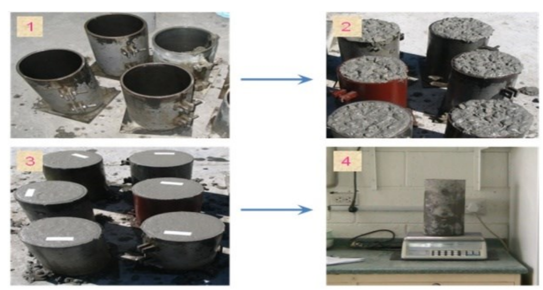
Filling the mould (for 150 mm cube 3 equal layers)

Compacting with compacting bar

150 mm molds ought to be filled in three around break even with layers (50 mm profound). A compacting bar is accommodated compacting the solid. It is a 380 mm long steel bar, weighs 1.8 kg and has a 25 mm square end for smashing. Amid the compaction of each layer with the compacting bar, the strokes ought to be disseminated in a uniform way finished the surface of the solid and each layer ought to be compacted to its full profundity.

Compacting the concrete in the cube mould (For 150 mm cube at least 35 tamps per layer)

Finishing



Cylindrical moulds

Curing

The solid samples were restored utilizing six unique procedures until when their compressive strengths were resolved at ages 7, 28 days and 56 days.

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Curing of cubes and cylinders

Tests to be conducted on concrete

Tests to be conducted on fresh concrete

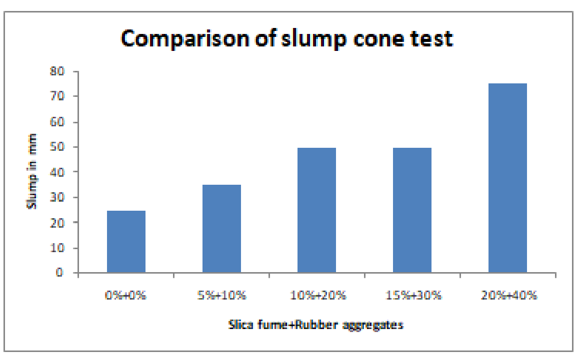
1. Slump cone test
2. Compaction factor test

Tests to be conducted on Hardened concrete

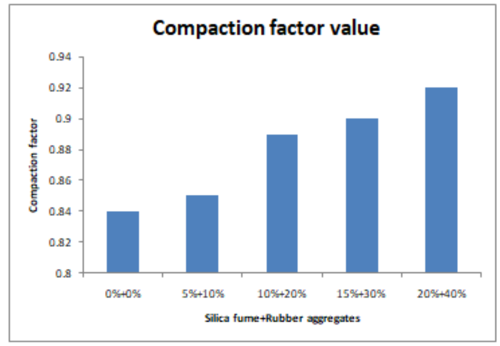
1. Compressive strength of concrete
2. Split tensile strength of concrete
3. Flexural strength of concrete
4. Durability of concrete

5. RESULTS AND ANALYSIS

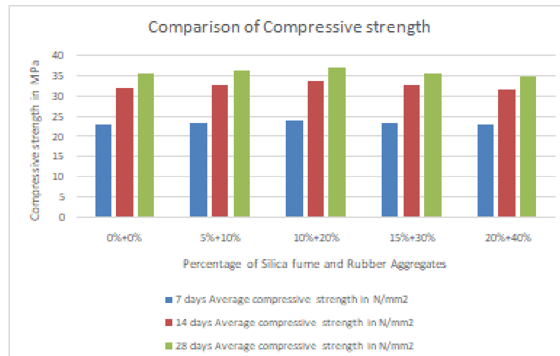
Slump cone test of concrete



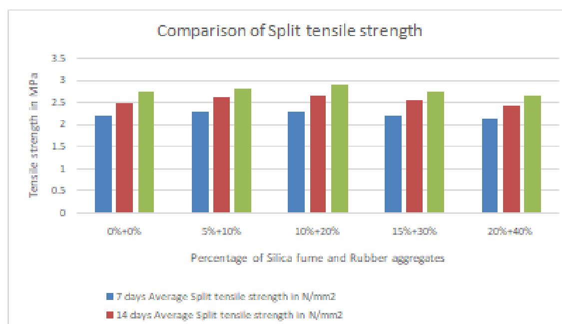
Compaction factor test of concrete



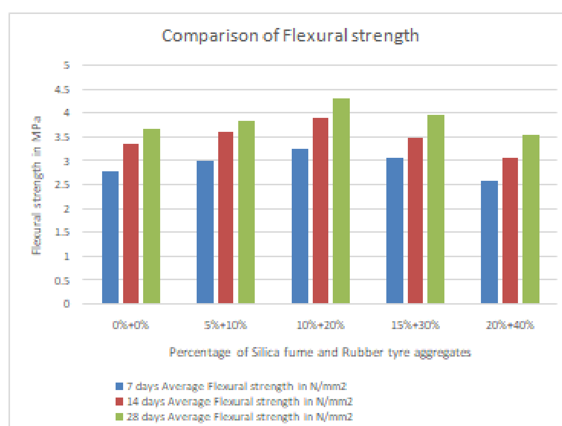
Compressive strength of concrete



Split tensile strength of concrete



Flexural strength of concrete



6 CONCLUSIONS

Eco friendly, Green Concrete has been promoted worldwide to encourage Sustainable Development in the field of Construction where huge amount of concreting works are carried out. Utilizing silica fume and rubber waste as a partial replacement for Cement and coarse aggregates provides a significant role in its disposal due to its adversarial effects. When investigated for partial replacement the following highlights were noted:

1. From the observations, it is noted that unit weight of beam and cylindrical specimen's has been reduced upto increasing the percentage of chipped rubber into concrete. From this test it has to be concluded that rubberized concrete is used in the light weight structures and restricted to the structural application.
2. Silica fume and rubber aggregates concrete has been highly effective in increasing the workability of the fresh concrete easing the placement of concrete.
3. A gradual increase in the workability was promisingly observed in Slump Cone and Compaction Factor Test.
4. For Compressive strength the optimum replacement of cement were observed for 10%silica fume+20% rubber aggregates. Further increase in Silica fume and rubber aggregates reduced the Compressive Strength.
5. For Split Tensile strength and Flexural Strength the optimum replacement of cement were observed for 5%silica fume+20% rubber aggregates mix. Further increase in Silica fume and rubber aggregates showed a gradual drop.

Upon careful examination, a suitable proportion where optimum results in strength characteristics were obtained at 5%silica fume+20% rubber aggregates mix. Further investigation over Silica fume and rubber aggregates with extensive chemical characteristics could be tested for replacement in cement with higher proportion

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