USE OF TYRE DUST AS AGGREGATE REPLACEMENT IN MORTAR

PROJECT REPORT

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CERTIFICATE

Certified that the project work entitled ***USE OF TYRE DUST AS AGGREGATE REPLACEMENT IN MORTAR*** *is a bonafide work carried out by*

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CHAPTER 1

SYNOPSIS

With the ever increase in the demand of river sand and decrease in its availability, there is an immediate need for finding suitable alternatives which can replace sand partially or at a high proportion. Many research Projects investigates the effect of several waste products such as Glass sheet powder, Incinerated Sewage sludge, foundry bed waste, crushed rock flour, building demolition waste in the partial replacement of river sand. Utilization of waste is one of the active research areas that encompass the effectiveness of replacement in all the aspects of construction materials.

This paper deals with the experimental study on the **use of tyre dust as aggregate replacement in mortar**. In order to analyse the compressive strength at different exposure of heat, acid and salt, the samples were casted with 0%,5%,7%,10% replacements of sand using rubber tyre dust and tested for different periods of curing like 7 days. The optimum percentage addition of tyre dust is analysed considering the requirements of compressive strength of concrete.

Strength decreased severely to a very high extent. So, Its recommended not to use it in any load bearing structure.

CHAPTER 2

INTRODUCTION

Mortar is a holding material used to hold the building materials like brick or stone together. It is composed of thick mixture of cement (Binding Material), Sand (fine aggregate) and water. The water is used to hydrate the cement and to hold the mixture together. But in the recent past years, many unique combinations of ingredients was implemented for finding the same or more strength of the construction structure by replacing a portion of a particular ingredient with a cheaper product. Many waste materials which do not get decomposed or cannot be recycled are being brought in construction field for experiment for finding if they can be used for any construction purpose. One of the waste product is used tyres or used rubbers which do not get decomposed in the environment and contaminate the environment for hundreds of years. Recycling it for construction purpose will be a great achievement for cleanliness and also will reduce the construction cost to a specific extent. And it is easily available in many places like motor vehicle servicing stores, vehicle workshop, etc. Objective of the study is to use the rubber dust in replacement of fine aggregate by different percentage and check the outcome that if this mixture can be used in construction structures like buildings, bridges, etc. The experiments to be done is replacing sand (fine aggregate) to rubber dust by 0%, 5%, 7%, 10% and check the compressive strength in different conditions. The conditions that to be covered are calculating the strengths of each mixture to normal condition, over heated temperature, acidic condition and also in salted condition.

Chapter 3

Review of Literature

2.1 In this chapter we discuss about the literary works of other scholars throughout the world, who investigated the effects of substituting aggregates by crumb rubber and other associated materials in mortar and concrete by testing under different conditions.

Mushunje, Otieno and Ballim (2018)[1] proposed a review on Waste Tyre Rubber as an Alternative Concrete Constituent Material. The brief review shows that it is possible to manipulate rubber particles in order to achieve desired concrete strengths. An example is that when silica fume is used to increase the strength of concrete the thermal conductivity of rubberised concrete is comparable to that of plain concrete. The durability studies have do not give any conclusive trend that can be assorted with a specific feature of the rubber particles, although it can be seen from a strength perspective that rubberised concrete can be used for structural applications without many issues. Ultimately, there is consensus on the positive effect of tyre rubber on properties of concrete.

Jose and Sasi (2018)[2] studied on partial replacement of concrete below neutral axis of beam using seeding trays and polythene balls: Replacing concrete below neutral axis is an effective way to reduce the wt. and the construction cost. It can be used for environmental friendly construction work; the seeding trays are used for its low cost and aesthetic appearance. In addition, comparison was done with the result when replacement of concrete using polythene balls. It is observed replacement of concrete in RC beam does not require any extra labour or time.

Tarry (2018)[3] studied the effect of partial replacement of coarse aggregate with untreated and treated tyre rubber aggregate: Rubber can became permanent member of rubber family because of properties like better flexibility light wt. and easy availability. Treated rubber possesses more compressive strength compare to untreated rubberized concrete. Using Rubber aggregate decrease the workability of resultant mixture but it can be solved with plasticizers.

Sofi (2018)[4] experimentally observed that the compressive strength, flexural tensile strength & depth of water penetration of the rubberized concrete were less than that of the control mix while the observation resistance & water absorption exhibited better results than that of control mix concrete.

Asutkar, Shinde, Patel (2017)[5] experimentally investigated on the behaviours of rubber aggregate concrete beams using analytical approach & found that specific gravity & bulk density of rubber aggregates are less as compared to coarse aggregates. Also the density of concrete decrease where the use or rubber aggregates increase. The lightweight concrete reduced the weight of structure. But compressive strength decrease and toughness increase when rubber aggregates increase. It was concluded that optimum percentage of replacement of rubber aggregates can be up to 15%. Also this type of concrete can't be used in structural clement where high strength is required.

Jayaranjini and Vidivelli (2017)[6] experimentally investigated the possibility of using fly ash, silica fume and metakaol in as a replacement of cement and bottom ash as a replacement of sand to make high performance concrete mixtures. The test results indicated that beam with cement replacement by 10% silica fume and 10% metakaolin and fine aggregate replacement by 20% bottom ash exhibit 60% increase in load carrying capacity when compared to that of control beam. The specimens were tested in a standard load-testing frame of 500 kN capacity. All the beams were simply supported over a span of 3000 mm and tested under two point loading. The high performance concrete offers economy and superior performance in strength and long-term behaviour. In this study, all the beam specimens failed in flexure mode only. Sudden failure did not occur in high performance concrete beams.

Vidat and Abhay (2017)[7] found that as the rubber content increases workability increases but slump and unit weight decreases, may be super plasticisers can be added. Tensile strength decreases but max. Energy absorption during tensile loading increases even upon splitting rubber particles seemed to hold 2 parts of concrete specimen although technically failed. Reduction in strength due to voids created between rubber aggregate and concrete mix so de airing agents can also be added. It produces light weighted concrete.

Xue and Cao (2017)[8] conducted experiment on the amount of use of modified rubber particles on the properties of cement mortar. The experimental results should that on adding rubber particles the toughness of the cement concrete was increased. Also ratio of compressive strength to flexural strength was the smallest when the mixing amount of rubber was 19%. Meanwhile the impact resistance was high at that moment and drying shrinkage was rational. So it was concluded that appropriate mixing amount of rubber particle in this test was 19%.

Khitab, Arif, Awan, Anwar and Mughal (2017)[9] conducted that the Waste-Tyre rubber is one of the most significant environmental hazards in our world. Because day by day automobile production becoming spreading very fast in our world, there is a need to properly dispose the vast amounts of used rubber tyres. Owing to the fact that the available sites for waste disposal are rapidly consume, various countries have already prohibition the retention of waste-tyre rubber in disposal areas. Crumb rubber is thought to be a potential material for use in concrete technology. It is considered as an alternative to the natural aggregates, used as filler in concrete matrix. Owing to lower strength, the rubberized concrete is recommended for non-load bearing structures and structural members. Rubber aggregates in concrete are mechanically cut to the required sizes. It was effortful, and it takes lot of time time and was not easy to handle at the in initial levels. Rubber has lower specific gravity than the solid components of the concrete. Uses of waste rubber crumbs also reduces freeze and thaw damage; by adding 5-10 % rubber, mixture exhibits 60% higher durability factor after 300 cycles of freezing and thawing.

Abhilasha, Muthu (2016)[10] experimentally investigated the partial replacement of cement with fly ash which was obtained by burning powdered coal. It improved the existing property of concrete which included the slower rate of setting, hardening as an additive for enhancing workability, strength & durability in handled and cared properly.

Almaleeh, Shitote and Nyomboi (2016) [11] investigated recycling of waste rubber can be used as construction material. Tires cut into pieces with maximum size of 20 mm to use as course aggregate and crumb rubber tires used as fine aggregate. The replacement was done in 3 phases. One was rubber tires replaced 50 percent of normal sand. Second was course rubber tires replaced 50 percent of normal gravel. And final one was both fine and coarse rubber tires are used to replace the sand and gravel by 25, 50, 75 and 100 percent. Compressive strength, splitting tensile and flexural strength tests are conducted. Although, concrete made of tires have lower strength than normal concrete, it had elastic failure behavior. Compressive strength reduced to 5MPa on lower replacement and can be used in footpaths. The weight of concrete also reduced and gives advantage for architectural finishing. Plastic energy increased with increase of rubber content. The resistance of failure increased proportionally and also gives advantage for using it in sports field such as tennis field. The flexural strength decreased by 65 percent with increase of rubber percent. Thus, it doesn't sustain bending. Splitting tensile strength also reduced up to half of the strength of the control.

Lisantono, Wigroho and Purba (2016)[12] studied the shear behaviour of high-volume fly ash concrete as replacement Portland cement of Reinforced Concrete (RC) beams. The results show that increasing substitutions of fly ash as replacement of Portland cement tend towards a reduction of shear strength, led the High-Volume Fly Ash Concrete (HVFAC), and led the HVFAC beams to become brittle. The HVFAC beams failed in shear due to the low shear strength of the beams.

Rathan, Prabhu, and Pillai E Bb (2016)[13] researched that the main objective of this study the performance of various combinations of fly ash + slag with cement in concrete. There are four type of different concrete mixes were prepared. Here mainly the mechanical and durability properties were investigated. Concrete is a synthetic construction material made by mixing of cement, fine aggregates, coarse aggregates and water in the proper proportions. The ultimate load carrying capacity of the MC4 beam investigated in the study was found more than that of the MC beam because of their higher compressive strength. The gain of strength as long-term strength achievement was directly proportional to the percentage of replacement. At least 14 days the compressive strength was low due to the incorporation fly ash and slag. After 56days compressive and flexural strength of M40 concrete specimens were higher than control concrete specimens. The reaction involves each cement particle developing a type of growth on its surface which gradually spreads until it links with the growth from other cement particles. This link provides the bonding strength.

Sofi (2016)[14] investigated the effects of using scrap rubber tyre instead of Natural Aggregates in concrete. Brittle failure was found in control concrete whereas concrete with rubber did not show brittle failure. Under flexural tensile loading brittle failure was observed. When rubber content increased from 20-30% the flexural strength decreases. Brittle failure was found in control concrete whereas concrete with rubber did not show brittle failure. For control, concrete diagonal cracks were seen and for concrete using waste tyre rubber formation of horizontal cracks were observed. When crumb rubber percentage increases, flexural strength decreased. Water absorption decreases upon increase in size of the rubber particles. The crumb rubber particles present in the rubberized concrete arrested formation of cracks and material separation. Therefore, the main application of rubber concrete may be focussed in pavements, floors and concrete highways, hydraulic structures such as tunnels and dam spillways, and other similar structures.

Siddiqui (2016)[15] studied the addition of rubber aggregate in concrete mixes reduces the concrete density and it also reduces the concrete strength so it can be utilised in light wt. concrete rubber concrete may be used for M15 and M10 grade concrete. There is also a lack of bonding between rubber particles and cement paste. Introduction of rubber concrete mix reduces the slump and workability of various mixed sample. Reduction in unit wt. of 14.33% was observed corresponding to 15% by volume of course, aggregate was replaced by rubber aggregate.

Zageer (2016)[16] studied that the effect of irradiation crumb rubber on the mechanical properties of rubberized concrete. Here used for experiment, experimental model was carried out on 30 standard cubes to determine how some properties of rubberized concrete affected by the two percent’s (30% and 70%) of irradiated treated crumb rubber content as a sand replacement. The experimental results had been recorded a noticeable reduction in the ultimate compressive strength of rubberized concrete relative to normal concrete. While the tested results indicated a significant improvement in term of ultimate compressive concrete strength with irradiation rubber powder of 30% by weight of sand replacement relative to one without irradiation. The compressive strength of rubberized concrete had significant decreased when un-irradiated crumbs rubber percentage of sand replacement increased. It was found that the workability, absorption and hammer test results for rubberized concrete was not affected by the radiation of crumb rubber. This study leads to conclusion it was possible to produce structural rubberized concrete with a irradiated treated rubberized powder and still maintaining the other excellent properties in term of weight and impact resistance.

Khalid, Hameed (2015)[17] conducted experiment & found that when rubber treated concrete mixture was used there was a decrease in compressive strength 85%, where as there was a decrease in 50% tensile strength. But if the coarse aggregate was totally replaced by rubber. The decrease in compressive strength was 65% after the sand was replaced by fine scrap rubber.

Faraz, Singh, Jain and Jain (2015)[18] investigated the effects of using crumb rubber material on concrete mix. The resultant concrete mix is to be termed as Rubcrete. There was about 85% reduction in compressive strength and 50% reduction in tensile strength when the coarse aggregate was fully replaced by coarse rubber chips. However, it was observed that the specimen lost about 65% of their compressive strength and 50% of their tensile strength when the fine aggregate was fully replaced by fine crumb rubber. The present study is based on studying the effects of replacement of 5% and 10% of coarse aggregates by rubber crumbs on Portland cement concrete. The concrete mixes are prepared to achieve target strength of 10N/mm 2 (i.e. M 10 concrete). The proportion used for concrete mixing is 1:3:6. The addition of rubber crumb resulted in increase in workability, increase in compressive strength of concrete (at first and then it reduces). The more rough the rubber used in concrete mix the better the bonding developed between the surrounding matrix and the rubber particles which results in higher compressive strength.

Srinivas and Rao (2015)[19] studied flexural behaviour of RCC beam containing high volume of fly ash. There is a slight decrease of compressive strength when cement being replace up to 50% with fly ash, which is still more than the target mean strength so that it can be used. It is observed that the strength have suddenly fallen from 50% to 70% replacing cement with fly ash.

Palani and Sakthieswaran (2015)[20] experimentally studied out to reduce the self-weight of concrete and thus to reduce the load on the foundation of reinforced concrete buildings. Each building should be designed against dead load, live load, wind load, snow load and earthquake forces etc. Among all of these loads, Dead load acted a major role because it is the load, which is constantly acting on the building. Dead load was based on the unit weight of the materials, which were used in the buildings. The concrete whose density is less than the normal concrete, this type of concrete is known as lightweight concrete. The current study the light weight concrete was casted and checked weather it satisfy the criteria of structural light weight concrete and the flexural behavior was studied. Tested results showed that the behavior of light weight concrete made with 20% replacement of OPC by fly ash, 10% replacement of fine aggregate by saw dust and 10% replacement of coarse aggregate by coconut shell are found satisfactory to be used as structural light weight concrete.

Yazdi , Yang, Yihui, and H. Su (2015)[21] proposed that Uses of recycle waste tires into civil engineering practices, namely asphalt paving mixtures and cement based materials has been getting huge ground across the world. Different treatment methods have been discussed to improve the performance of rubberized Portland cement concrete. The review also includes the effects of size and amount of tire rubbers on mechanical and durability properties of PRC. The microstructure behavior of the rubberized concrete was detailed. Discarded end-of-life tires are the main source of rubber aggregates. We can use waste tire rubbers Chipped tire aggregate with the size of 25 mm to 50 mm is generated by mechanical grinding at ambient temperature and considered as coarse aggregate.

Aravind, Joanna (2014)[22] conducted experiment on reinforcement concrete beam & composite column joint with square steel cage & found that there is a significant increase in the lateral strength capacity & ductile ratio of the beam column when the joint is provided with square steel cage. In the specimen without square casting at joint, there was more crushing of concrete of concrete & major cracks propagated at beam junction column. But in case of square casting few cracks of fine width where observed. Also the specimen with two tiers & one concentric ring are found to has more strength then specimen with two tiers & two concentric rings.

Kotresh K.M and Belachew (2014)[23] conducted experiment on the use of waste type rubber as concrete aggregates & found that concrete showed enhanced toughness & sound insulation. It was concluded that compressive strength was reduced in comparison to conversional concrete. But the strength can be improved the improving the bond particles of rubber aggregate.

Hema latha, and Jesudhason (2014)[24] found that addition of EPS in the beams prevents the bending failure since EPS sheets undergo large without failure. However, the shear failure shows that EPS sheets does not provide the necessary cross section to resist shear. Hence replacing the core of concrete with EPS in the middle zone of the length of beam can be an effective solution of concrete and effective behaviour in bending and shear.

Fiore, Marano, Marti, and Molfetta (2014)[25] investigates the ameliorative effects of incorporating rubber particles from recycled tires on the Fresh/Hardened Properties of Cement Composites. Incorporation in cement-based materials of rubber aggregates, obtained from waste tires, can be a suitable solution for some engineering manufactures, simultaneously offering an opportunity to recycle non-reusable tires. Different percentages of rubber particles, from 0% to 75%, were used in the cement-based mixes and for each percentage; the suitable amount of sand was investigated by experimental sensitivity tests in order to achieve the best performances. Despite some drawbacks, such as the decrease in compressive and flexural strengths, the high shrinkage, and the vulnerability to sulphate attack, the tests demonstrate that the proposed rubber cement composites possess interesting properties that can be useful especially for non-structural applications.

Soman and Sobha (2014)[26] investigated that replacing 50 percent Ordinary Portland Cement (OPC) with 50 percent fly ash by mass in developing a concrete can improve the workability. The High Volume Fly Ash Concrete (HVFAC) can reduce water demand and also exhibit similar hardened properties as OPCC. Adding 50 percent fly ash reduce 7 day strength by 20 percent but aquires almost equal strength at 28 days and also attain higher strength thereafter. The investigation also reveals that HVFAC beam are more crack free compared to OPCC beams. From the study it can be considered that fly ash is a resource material and can be used in a productive way contributing to the sustainable development.

Fiore, Marano, Marti and Molfetta (2014)[27] experimentally observed that the ameliorative effects on some properties of cement-based materials, which can be obtained by incorporating rubber particles as, part of the fine aggregates. Main aim was found out optimal cement composite/mortar mixtures, containing recycled-tyre rubber particles, suitable for specific engineering applications. Different percentages of rubber particles, from 0% to 75%, were used and, for each percentage, the suitable amount of sand was investigated in order to achieve the best fresh/hardened performances. At last the final results presented in this paper show that the incorporation in cement-based materials of rubber aggregates, obtained from waste tires, can be a suitable solution for some engineering manufactures, simultaneously offering an opportunity to recycle non reusable tires. Above topics make the proposed rubber cement composites particularly feasible for non-load-bearing purposes in regions with harsh environmental conditions as in the case of roadway applications, paving slabs, flow able and trench fills, insulating barriers, and curtain walls.

Khalil, Abd-Elmohsen, and Anwar (2014)[28] investigated that impact loads due to ship collision on irrigation structures was significantly decreasing their durability. Loss of material and degradation are quite common problems facing lock walls and piers. They determine that the relationship between the mechanical properties and impact resilience is also presented. With the increase in rubber percentage the resistance to impact increased, but there was a decrease in specimen strength and modulus of elasticity. Here main disadvantage is that the increase in rubber content reduces the compressive strength of such mixes with respect to concrete mixes with no rubber content. And this type of loading, its contribution to the internal stresses and the necessary protection must be studied on various types of structures.

Xiangshu and Huang (2014)[29] stated that increasing production of tyres causes huge pile of waste tyre's as waste which are currently applied in civil engineering practises, such as used as modifiers to asphalt paving mixtures, used as an additive to Portland cement concrete, .used as light weight fillers, used in whole tires as crash barriers, bumpers, and artificial reefs. It was concluded that use of waste tyre in asphalt paving mixture is being now widely gaining attention due to it's economical, technical, environmental benefits. Addition of crumb rubber can lead to increase resistance to major modes of asphalt stresses. If constructed well then it can serve better than conventional asphalt roads.

Su, Yang, Ling, Gurmel Ghataora and Dirar (2014)[30] Concrete specimen made with large rubber particles show better workability than those with finer one. Concrete with finer rubber particles has better performance in strength than the large once.

Gokce and Simsek (2013)[31] After observing test results of Waste Concrete and Recycled Aggregate Concrete we come to know Hardened waste Concrete's Specific Values were increased simultaneously Schmidt rebound number and pulse velocity also increased in that Waste Water Concrete. Specific values increased mean Waste Water Concrete and other hand mean water absorption values were decreased that's mean That sample loss the ability of Water Absorption and the other hand The Waste concrete Sample's strength was increased.

After the tests we got to know that the Recycled Aggregate Concrete's ultrasonic pulse velocity were increased that's mean strength of concrete has been increased and sample specific gravity and rebound number also increased. In the sample Compressive strength increased and water absorption decreased. The Concrete compressively getting high and water absorptions capability getting low. This is the sign of the Concrete Quality being increased by this process.

Joanna, Rooby, Prabhavathy, Pretha, Pillai (2013)[32] conducted experiment on the behaviour of reinforced concrete beams with 50% fly ash. The experimental result should that the ultimate moment capacity of fly ash concrete beams was 16% less than ordinary concrete beams when tested at 28th day. But moment capacity increase with age. Also the deflection under design load was within allowable limited provided by IS456:2000. It also showed a deflection ductility within a range of 4 to 6. The result suggested that concrete with 50% fly ash replacement for cement could be used for RC beams.

Djamaluddin et al (2013)[33] experimented that on girder beams mostly of highway bridges are constructed using concrete structures. Especially concrete structural elements optimally resist bending is a part of outermost fibers on the compression side while the concrete on the tensile side is negligible. Therefore, concrete on compression side should be optimized whereas tension side should be minimized. It will reduce the self weight of the concrete structures and also usage of concrete will be reduced. Without concrete on the tension part, that is External Reinforcement Concrete Beam (ERCB) resulted in decrease of capacity to 86 percent from control specimen and also stiffness decreased to 60 percent compared to normal beams. The number of cracks in ERCB is much less than normal beam. The failure of normal beam is initiated by yielding of steel reinforcement while on ERCB failure was initiated by compression of concrete.

Arivalagan (2012)[34] investigated the effect of addition of fly ash in concrete as admixture is good rather dumping it. It lowers water-demand of concrete for same workability, reduced bleeding and lowering evolution of heat. Replacing cement by 50% by fly ash in concrete can give possible results like sustainable high performance concrete, high workability, high ultimate strength and high durability. In conclusion it was found fly ash reinforced concrete beams fails in flexure whereas others fail in shear. Adding fly ash slightly increased its ultimate flexural strength but reduced flexural cracking resistance. Crack width under service load was within permissible limit as per IS 456:2000.Load deflection study gave similar post crack behaviour in comparison to RCC beam. Whereas including fly ash in concrete has a minimal effect on beam stiffness.

Abaza and Shtayeh (2010)[35] researched that crumb rubber from used tires can be used with Portland Cement Concrete (PCC) for the production of non-structural PCC. Fine aggregate (beach Sand) can be replaced using the volumetric method used by crumbed tires at different percentage of replacement for the various types of PCC. As the percentage of crumbed rubber increases, the compressive strength decreases and also density decreases. Water absorption increases partially with increase of crumbed rubber. Abrasion, Noise insulation and Thermal Insulation also increases with increase of crumbed rubber percentage. It is recommended that crumbed rubber should be used for non-structural PCC such as floor rips, partitions, support stone structures, concrete blocks and other non-structural uses.

Ganjan, Khorami and Maghsoudi (2009)[36] investigated the performance of concrete when cement and aggregate is replaced with rubber of 5, 7.5, and 10 percent. Two sets were made, where one set had chipped rubber of different percentage by weight in replacement of aggregate and other had scrap tire powder of different percentage in replacement of cement. Different durability and mechanical tests were performed. The result showed up to 5 percent replacement in each set no major changes of concrete character. But further increase of rubber shown considerable changes like compressive strength at 28 days reduced to 10 to 23 percent for aggregate and 20 to 40 percent for cement replacement. Modulus of elasticity reduced to 17 to 25 percent in the case of 5 to 10 percent aggregate replacement and 18 to 36 percent reduction for powdered rubber. Tensile strength reduced to 30 to 60 percent in case of 5 to 10 percent replacement of aggregate and 15 to 30 percent for powdered rubber. Flexural strength also reduced to 37 percent for aggregate and 29 percent for cement. And water permeability increased in case of coarse aggregate replacement but decreased in case of cement replacement.

Marques, Akasaki, Trigo, Marques (2008)[37] experimentally investigated on the influence of the surface treatment of tire rubber residues add in mortar and found that there was a reduction in the mechanical properties. After addition of rubber & decrease the workability. Also there was a reduction in water absorption as compared to reference mix. The mechanical properties as compressive strength, splitting tensile strength & modulus of elasticity. The untreated tire rubber performed better them treated ones.

Kaloush, George , Han (2004)[38] found that compressive strength decreased as the rubber content increased, so did the air entrapped that's why de airing agent is added into mixing truck and is delivered prior placing the concrete. Crumb-rubber mix has more ductility, toughness but less flexural strength than control mix. CRC mix is more resistant to thermal changes. Due to no such field record of these mixes are present that is why they are recommended where high strength of concrete is not required.

Olivaresa and Barluenga (2003)[39] proposed that the behaviour of a high-strength concrete with silica fume toned down with various amounts of solid particles recycled from crumbed used tires. The objective of including elastomeric materials in a cementitious matrix are decreasing the stiffness of HSC in order to make it compatible with other materials and elements of the building, unexpected displacement of foundations and shrinkage, recycling of solid wastes and improving fire performance. HSC presents another important difference with regard to NSC. Reduce the risk of HSC explosive spalling when fire occurs. Solid wastes from used truck tires, reducing environmental impact. There are four compositions of HSC filled with different small volumetric fractions of solid fibre-shaped particles of recycled tire rubber (0%, 3%, 5% and 8%) were used. Fire performance of HSC filled with recycled tire rubber The study of the behaviour of HSC filled with solid fibre-shaped particles of recycled tire rubber under fire included a fire test following EN-UNE 1363-1 (equivalent to ISO 834).

Olivares, Barluenga, Bollati, Witoszek (2002)[40] experimentally investigated & found that the inclusion of fibre showed defects in the internal structured of the composite material & produced a reaction of strength & a decrease at stiffness. But when maximum strength is overcome fibre collaborated with concrete, avoiding the opening of cracks & therefore increased the energy absorbed strain & the breaking of concrete. Also microscopic study should the spectrum records a high concentration of calcium oxide on the surface coming from hydrated production of cement. So it was reacted with the rubber fibre exterior surface & a diffusion of the hydrated products took place, especially the ones with high calcium oxides content.

CHAPTER 4

MATERIAL INVESTIGATION

Detailed description of about the material used, specimen tested and testing methods are essential for an experimental investigation. Hence they are described.

4.1. MATERIALS USED:

A) Cement and Aggregates: 53 grade ordinary Portland cement conforming to IS12269:1987 with specific gravity 3.15 used, River sand and the locally available blue granite crushed stones aggregate of size 20 mm were used as fine aggregate and coarse aggregate respectively in the present investigation.

TABLE 4.1: PROPERTY OF CEMENT

Sl.No	Description	Values	Remarks
1	Consistency	30%	
2	Initial setting time	45 minute	
3	Final setting time	190 minute	
4	Specific gravity	3.15	
5	Fineness of cement	3%	
6	Compressive strength of mortar cube		
	Age of 3 days	28.2N/mm2	
	Age of 7 days	38.9N/mm2	

Table 4.2: PROPERTY OF FINE AGGREGATE		
Sl.No	Test Analysis	Experimental Value
1	Fineness Modulus	2.8
2	Specific gravity	2,67
3	Bulk density	1.48
4	% of void in sand	45.20

TABLE 4.3: PROPERTIES OF COARSE AGGREGATE		
Sl.No	Test Analysis	Experimental Value
1	Fineness modulus	3.6
2	Specific gravity	2,64
3	Bulk density	1.48

B) Water: potable water was adopted as the liquid for mixing and curing all the specimens through the experimentation.

C) Crumb Rubber: The tire rubber used in the experiments was applied in the following two size grading and it was obtained from nearest Rubber factory, Kolkata. Crumb rubber for the replacement of the replacement of fine aggregate in concrete. The size of the crumb rubber used is 20 meshes. The physical properties of crumb rubber in table 4.

Picture 1: Crumb Rubber

TABLE 4.4: PROPERTIES OF CRUMB RUBBER		
Sl No	Property	Tyre Rubber
1	Specific Gravity	1.23
2	Unit wt. (kg /m3)	1165
3	Tensile Strength (kg/cm2)	2000
4	Elongation at Break (%)	825
5	Water Absorption	Small
6	Swelling in Organic Solvents	Large
7	Tackiness	Light
8	Temperature Range	40-100C
9	Chemical Resistance	Better
10	Electricity	Depends on c

CHAPTER 5

EXPERIMENTAL INVESTIGATION

DETERMINATION OF STANDARD CONSISTENCY OF CEMENT:

APPARATUS:

1) Vicat's Apparatus.
2) Plunger for Standard Consistency: It is polished brass 10mm in diameter.

PROCEDURE:

1) Take 400 gm of cement.
2) Mix about 25% of Water by wt. of dry cement thoroughly to get a cement paste.
3) Fill the Vicat's mould resting upon the glass plate, with this cement paste.
4) Smoothen the surface of the paste.
5) Lower the plunger gently so that it touches the surface of test block and quickly release the plunger allowing it to sink into the paste.
6) Measure the depth of penetration and record it.
7) Prepare trail paste with varying percentage of water content until the depth of penetration became 33 to 33mm.

Picture 2: Compression Testing of Mortar Sample with 5% sand replaced with Crumb Rubber

Picture 3: 12 samples of mortar cube inside heater for Heat Test

CALCULATION:

P=W/C*100

W=Quantity of water added

C=Quantity of cement used

DETERMINATION OF SETTING TIME OF CEMENT:

APPARATUS:

1) Vicat's apparatus
2) Vicat's Mould
3) Glass plate
4) Plunger of 10mm diameter
5) Stop watch

PROCEDURE

1) Take 400gm of cement
2) Now add water and start the stop watch at the moment water is added to cement. Water of 0.85P is taken where P is consistency.
3) Now place the mix in vicat's' mould
4) Then place the vicat's mould on a non-porous plate (glass plate) and the plunger should touch the surface of vicat's mould gently.
5) Release the Plunger and allow it to sink into the test mould

1) 6. Note down the penetration of the plunger from bottom of mould indicated on the scale.
2) 7. Repeat the same experiment at different positions until the plunger stop penetrating 5from the bottom of mould.
3) The time period between the moment water is added to the time the plunger fails to penetrate the mould of 5mm when measured from the bottom of the mould is the initial setting time of cement.

8) Now replace the needle by one with an angular attachment. The cement is assume as a final set when the needle makes an impression therein while the attachment fail to do so.

4) The time period between water is added to the needle makes an impression whereas the attachment fail to do so is known as the final setting time of cement.

DETERMINATION OF FINENESS MODULUS OF SAND:

SAMPLE PREPARATION: Take a sample of fine aggregate in pan and place it in a dry oven at a temperature of 100 -110C. After drying take the sample and note down its weight.

PROCEDURE:

Arrange the sieve in descending order with the largest sieve at the top then place the sieve in sieve shaker for 5 min.

Then record the sample wt. retained on each sieve .Then find the cumulative weight retained. Finally determine the cumulative percentage on each sieve. Add all the cumulative percentage of each sieve and divide it with 100 we will get the value of fineness modulus.

COMPRESSIVE STRENGTH TEST FOR RUBBER CONCRETE:

SAMPLE PREPARATION: Mortar cubes 0f dimension 15cm*15cm*15cm are casted with 0%, 5% ,7% and 10% rubber replaced with fine aggregate .

APPARATUS:

1) Weight Machine
2) Compressive testing machine

PROCEDURE:

1) Mortar Cubes are casted inside moulds which are cleaned and oiled (3 of each) with 0%, 5%, 7% and 10% rubber replaced with fine aggregate.
2) After 24 hours deshuttering is done.
3) Mortar cubes are kept inside water for curing for seven days
4) After seven days cubes are taken out from water and it was dried normally and were tested in compressive testing machine and results were noted down.

Picture 4: Prepared mortar cube sample for heat test

HEAT TEST:

SAMPLE PREPARATION: Mortar cubes of dimension 15cm*15cm*15cm are casted with 0%, 5% ,7% and 10% rubber replaced with fine aggregate.

APPARATUS:

1) Weight Machine
2) Compressive testing machine
3) Heating machine

PROCEDURE:

1) Mortar Cubes are casted inside moulds which are cleaned and oiled (3 of each) with 0%, 5%, 7% and 10% rubber replaced with fine aggregate.
2) After 24 hours deshuttering is done.
3) Mortar cubes are kept inside water for curing for seven days.
4) After seven days cubes are taken out and were dried inside the heating machine for 2 hours at 100C and were tested at compressive testing machine and the results were noted down.

ACID ATTACK TEST:

SAMPLE PREPARATION: Mortar cubes 0f dimension 15cm*15cm*15cm are casted with 0%, 5%, 7% and 10% rubber replaced with fine aggregate.

APPARATUS:

1) Weight Machine
2) Compressive testing machine

PROCEDURE:

1) Mortar Cubes are casted inside moulds which are cleaned and oiled (3 of each) with 0% 5% 7% and 10% rubber replaced with fine aggregate.
2) After 24 hours deshuttering is done.
1) 3)Then the mortar cubes were kept in water for curing containing 5% of Sulfuric Acid of the weight of water for seven days.
3) After seven days cubes are taken out from water and it was dried normally and were tested in compressive testing machine and results were noted down.

SALT ATTACK TEST:

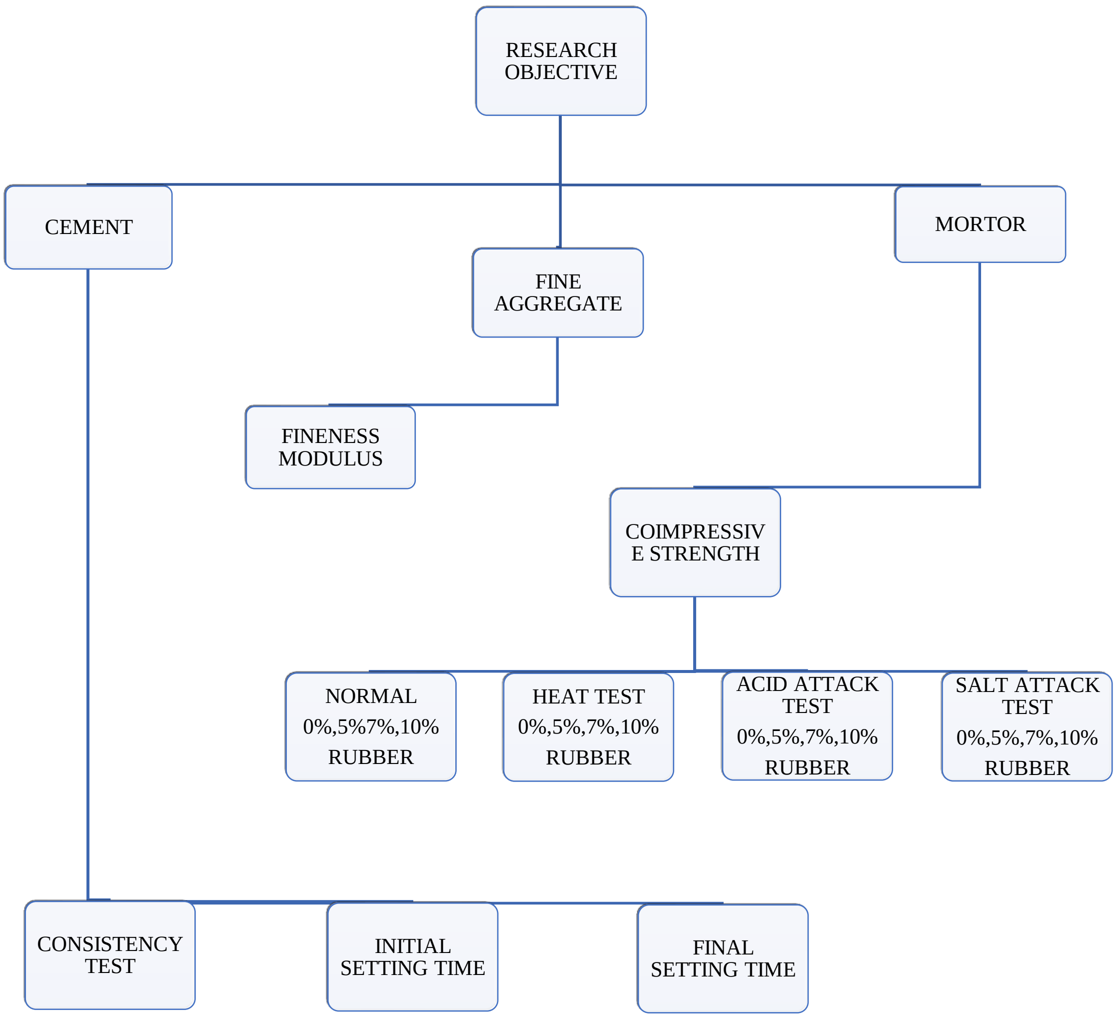
SAMPLE PREPARATION: Mortar cubes 0f dimension 15cm*15cm*15cm are casted with 0%, 5% ,7%and 10%rubber replaced with fine aggregate,

APPARATUS:

1) Weight Machine
2) Compressive testing machine

PROCEDURE:

1) Mortar Cubes are casted inside moulds which are cleaned and oiled (3 of each) with 0% 5% 7% and 10% rubber replaced with fine aggregate.
2) After 24 hours deshuttering is done.
3) Then the mortar cubes were kept in water for curing containing 5% of Nacl of the weight of water for seven days.
4) After seven days cubes are taken out from water and it was dried normally and were tested in compressive testing machine and results were noted down.



CHAPTER 6

RESULT

SL. NO	TERMINOLOGY	DESCRIPTION
1.	0C	0% of sand replaced by crumb rubber and was tested under compression.
2.	5C	5% of sand replaced by crumb rubber and was tested under compression.
3.	7C	7% of sand replaced by crumb rubber and was tested under compression.
4.	10C	10% of sand replaced by crumb rubber and was tested under compression.
5.	0H	0% of sand replaced by crumb rubber and was heated for 2hour then it was tested under compression.
6.	5H	5% of sand replaced by crumb rubber and was heated for 2hour then it was tested under compression.
7.	7H	7% of sand replaced by crumb rubber and was heated for 2hour then it was tested under compression.
8.	10H	10% of sand replaced by crumb rubber and was heated for 2hour then it was tested under compression.
9.	0A	0% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%acid by weight in water then it was tested under compression.
10.	5A	5% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%acid by weight in water then it was tested under compression.
11.	7A	7% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%acid by weight in water then it was tested under compression.
12.	10A	10% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%acid by weight in water then it was tested under compression.
13.	0S	0% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%Nacl by weight in water then it was tested under compression.

14.	5S	5% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%Nacl by weight in water then it was tested under compression.
15.	7S	7% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%Nacl by weight in water then it was tested under compression.
16.	10S	10% of sand replaced by crumb rubber and was kept for curing for 7 days with 5%Nacl by weight in water then it was tested under compression.

Table 6.1: Terminology Description

NORMAL-CONDITION

cube	weight (gm)	weight (kg)	(kg*9.80/1000 KN	volume mm^3	vol m^3	unit weight	avg unit weight	faillure load (KN)	strength	Average
0C1	745	0.745	0.0073	350402.625	3.5040E-04	2.0836E+01		60	12.07	
0C2	748	0.748	0.0073	350402.625	3.5040E-04	2.0920E+01	2.0864E+01	104	20.92	16.90
0C3	745	0.745	0.0073	350402.625	3.5040E-04	2.0836E+01		88	17.71	
5C1	760	0.76	0.0074	350402.625	3.5040E-04	2.1256E+01		70	14.08	
5C2	743	0.743	0.0073	350402.625	3.5040E-04	2.0780E+01	2.0827E+01	72	14.49	13.55
5C3	731	0.731	0.0072	350402.625	3.5040E-04	2.0444E+01		60	12.07	
7C1	710	0.71	0.0070	350402.625	3.5040E-04	1.9857E+01		46	9.26	
7C2	733	0.733	0.0072	350402.625	3.5040E-04	2.0500E+01	2.0267E+01	52	10.46	9.79
7C3	731	0.731	0.0072	350402.625	3.5040E-04	2.0444E+01		48	9.66	
10C1	669	0.669	0.0066	350402.625	3.5040E-04	1.8710E+01		32	6.44	
10C2	702	0.702	0.0069	350402.625	3.5040E-04	1.9633E+01	1.9288E+01	40	8.05	8.05
10C3	698	0.698	0.0068	350402.625	3.5040E-04	1.9522E+01		48	9.66	

Percentage of rubber replace	average compressive strength (N/mm^2)	PERCENTAGE
0	16.9	
5	13.55	19.822
7	9.79	42.071
10	8.05	52.367

Percentage of rubber replace	avg unit weight	PERCENTAGE
0	2.086E+01	
5	2.083E+01	0.179
7	2.027E+01	2.860
10	1.929E+01	7.551

Table 6.2: Results of Compression Test under normal conditions

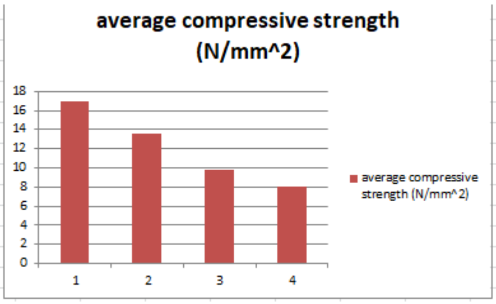


Fig 1: Average Compressive Strength

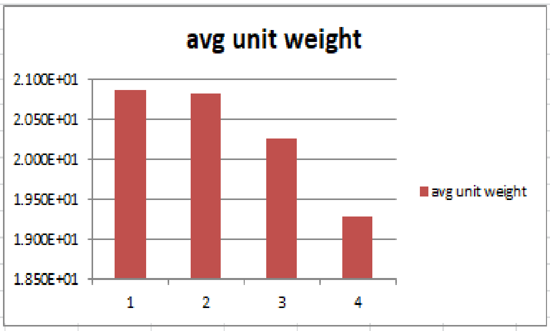


Fig 2: Average Unit weight

Fig 5: Failure pattern of Mortar cube with

5% sand replaced by crumb rubber

HEATED-CONDITION

Cube	Weight (gm)	Weight (kg)	Weight (kN)	Vol (mm^3)	Vol (m^3)	Unit Weight	Avg Unit Weight	Failure Load (KN	Strength	Average
OH1	745	0.745	0.0073	350402.625	0.00035	20.836	20.8640	81	16.297	16.498
OH2	748	0.748	0.0073	350402.625	0.00035	20.920		75	15.090	
OH3	745	0.745	0.0073	350402.625	0.00035	20.836		90	18.108	
5H1	760	0.76	0.0074	350402.625	0.00035	21.256	20.8267	55	11.066	12.407
5H2	743	0.743	0.0073	350402.625	0.00035	20.780		58	11.669	
5H3	731	0.731	0.0072	350402.625	0.00035	20.444		72	14.486	
7H1	710	0.71	0.0070	350402.625	0.00035	19.857	20.2674	40	8.048	8.853
7H2	733	0.733	0.0072	350402.625	0.00035	20.500		46	9.255	
7H3	731	0.731	0.0072	350402.625	0.00035	20.444		46	9.255	
10H1	669	0.669	0.0066	350402.625	0.00035	18.710	19.2885	40	8.048	7.780
10H2	702	0.702	0.0069	350402.625	0.00035	19.633		30	6.036	
10H3	698	0.698	0.0068	350402.625	0.00035	19.522		46	9.255	

Percentage of Rubber Replace	Avg Unit Weight	Percentage
0	20.8640	
5	20.8267	0.179
7	20.2674	2.860
10	19.2885	7.551

Percentage of Rubber Replace	Average Compressive Strength	Percentage
0	16.498	
5	12.407	24.797
7	8.853	46.341
10	7.780	52.846

Table 6.3: Results of Compressive Tests under Heated Condition

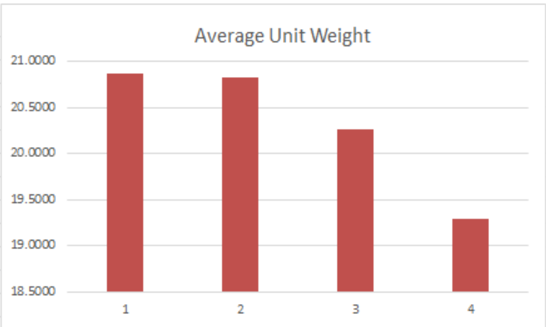


Fig 3: Average Unit weight (under heated condition)

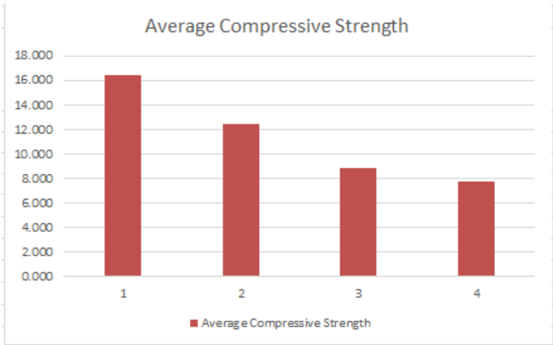


Fig 4: Average Compressive Strength (under heated condition)

Fig 6: Failure of Test Specimen

ACID-CONDITION

CUBE	WEIGHT (gm)	Weight (kg)	Weight (kN)	Vol (mm^3)	Vol (m^3)	Unit Weight	Avg Unit Weight	Failure Load (KN)	Strength	Average
0A	806	0.806	0.007899	350402.625	0.00035	22.542		50	10.05985614	
0A	812	0.812	0.007958	350402.625	0.00035	22.710	22.626	80	16.09576983	12.742
0A	809	0.809	0.0079	350402.625	0.00035	22.626		60	12.072	
5A	767	0.767	0.0075	350402.625	0.00035	21.451		48	9.657	
5A	767	0.767	0.0075	350402.625	0.00035	21.451	21.293	47	9.456	9.456
5A	750	0.75	0.0074	350402.625	0.00035	20.976		46	9.255	
7A	760	0.76	0.0074	350402.625	0.00035	21.256		36	7.243	
7A	778	0.778	0.0076	350402.625	0.00035	21.759	21.190	37	7.444	7.243
7A	735	0.735	0.0072	350402.625	0.00035	20.556		35	7.042	
10A	724	0.724	0.0071	350402.625	0.00035	20.249		36	7.243	
10A	700	0.7	0.0069	350402.625	0.00035	19.577	19.661	24	4.829	5.365
10A	685	0.685	0.0067	350402.625	0.00035	19.158		20	4.024	

Percentage of Rubber Replace	Avg Unit Weight	Percentage
0	22.626	
5	21.293	5.892
7	21.190	6.345
10	19.661	13.103

Percentage of Rubber Replace	Average Compressive Strength	Percentage
0	12.742	
5	9.456	25.789
7	7.243	43.158
10	5.365	57.895

Table 6.4: Results of compressive tests under Acidic conditions

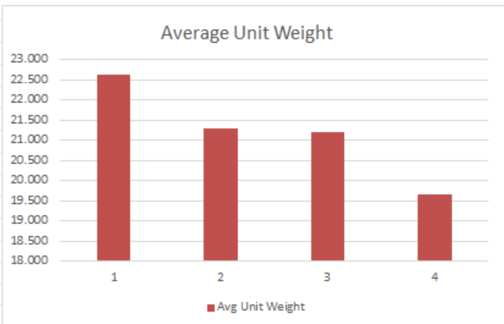


Fig 5: Average Unit weight (under acidic condition)

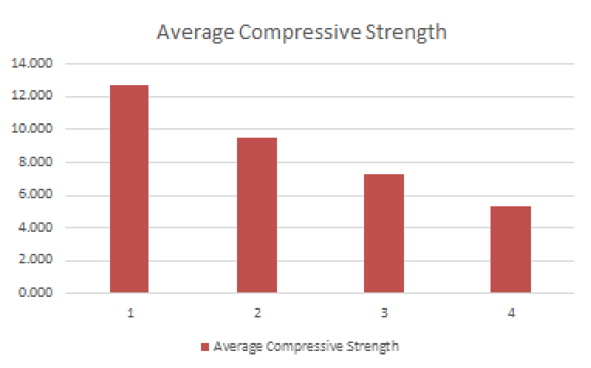


Fig 6: Average Compressive Strength (under acidic condition)

<u>SALTED-CONDITION</u>

CUBE	WEIGHT (gm)	Weight (kg)	Weight (kN)	Vol (mm^3)	Vol (m^3)	Unit Weight	Avg Unit Weight	Failure Load (KN)	Strength	Average
0S	810	0.81	0.00795	350403	0.00035	22.677		65	13.078	
0S	799	0.799	0.00784	350403	0.00035	22.369	22.7797095	75	15.090	13.145
0S	832	0.832	0.00816	350403	0.00035	23.293		56	11.267	
5S	750	0.75	0.00736	350403	0.00035	20.997		62	12.474	
5S	794	0.794	0.00779	350403	0.00035	22.229	21.6225264	50	10.060	10.865
5S	773	0.773	0.00758	350403	0.00035	21.641		50	10.060	
7S	722	0.722	0.00708	350403	0.00035	20.213		37	7.444	
7S	752	0.752	0.00738	350403	0.00035	21.053	20.3160293	40	8.048	7.713
7S	703	0.703	0.00690	350403	0.00035	19.681		38	7.645	
10S	733	0.733	0.00719	350403	0.00035	20.521		35	7.042	
10S	736	0.736	0.00722	350403	0.00035	20.605	20.4000184	35	7.042	7.109
10S	717	0.717	0.00703	350403	0.00035	20.073		36	7.243	

Percentage of Rubber	Avg Unit Weight	Percentage
0	22.779	
5	21.622	5.079
7	20.316	10.813
10	20.4	10.444

Percentage of Rubber	Average Compressive Strength	Percentage
0	13.144	
5	10.864	17.346
7	7.712	41.327
10	7.108	45.922

Table 6.5: Results of compressive tests under Salty conditions

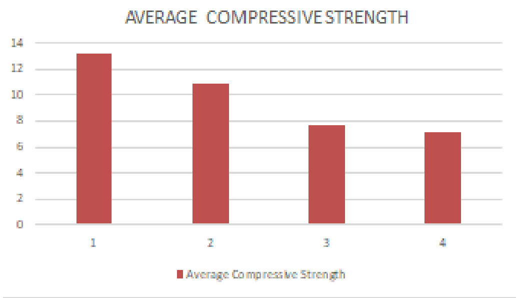


Fig 7: Average Unit weight (under acidic condition)

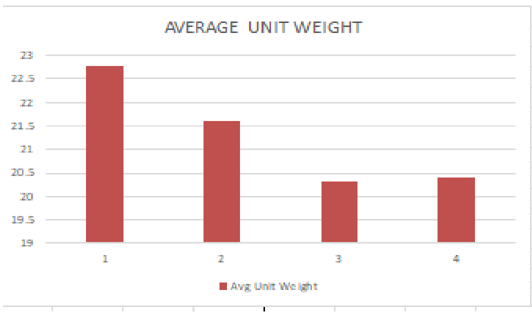


Fig 8: Average Compressive Strength (under acidic condition)

CHAPTER 7

DISCUSSION

NORMAL-CONDITION:

Here the experiment have been conducted under normal condition, to measure the performance of rubber (crushed-rubber) in normal condition with respect to traditional cement-sand mix. From the observe data what we have observed we can see repeated decrease in compressive strength of cubes as we add more rubber to the mix. This shows that the load carrying capacity of cement-rubber-sand mix is quite low than traditional mix. Out of our mixes (i.e 5H or 5% of rubber,7H or 7% of rubber,10H or 10% of rubber) we can use 5H cubes in non-load bearing structures whereas using 7H and 10H mix can cause risk to the structure.

HEATED-CONDITION:

Here experiment is being conducted for testing the performance of rubber in heated condition or in heated region (i.e northern states of India including Delhi, Gujarat, Haryana, Madhya, Pradesh etc). Increase in temperature can always have an adverse effect on building materials and their usage, that's why tested our cement-sand-rubber mix for heated condition. From the data observed from the experiment we can say that apart from 5H cube, other cubes are very much low in compressive strength and those cannot be used. 5H cubes can be used for sidewalks or anywhere except impact load application.

ACIDIC-CONDITION:

In this experiment we have conducted for testing durability and performance of rubber in acidic regions of the country. There are many industrial regions across the nation where emission of hazardous waste and gases are quite normal which results into acid rain which in return causes huge effect on construction materials and structures. Hence using cement-sand-rubber mix in acidic region can have drastic reduction in performance and durability with respect to traditional mix. We can barely use our mix in acidic region even if used there has to be made several improvements in the prepared mix.

SALTED-CONDITION:

Here we have conducted this experiment for coastal regions or those regions where we can observe salt in the atmosphere. The drastic depreciation in compressive strength shows us the durability and performance of rubber-mix. In this experiment we have exposed our cement-sand-rubber mix as well as traditional mix to salted condition (350gm of Nacl mixed with 7lt water) and according to results observed we can say that only 5H-cubes can be considered for use in areas of light-weight purpose or where no high load impact is expected.

CHAPTER 8

CONCLUSION

1. The use of Rubber tyre dust particle as aggregate has not only paved way for itself disposal method, but also it has improve the mechanical properties of concrete. The rubber mortar prepared from damage tyre dust to form an eco-friendly mortar.

2. Here we took 4 types of sample 1.0 percentage of Rubber 2.5 percentage of rubber and 3.7 percentage of rubber. And use 4 types of Mortar. 0H, 5H, 7H and 10H.

3. When we use 5% rubber on the mortar then we observed that the compressive strength of the mortar has not massively changed. So, we can use this mortar in non-load Bearing wall or any other Project.

4. When we put 7% of tyre dust in the mortar then we observed that Compressive Strength slightly decreased and water absorption of the mould Increased Simultaneously/ Respectively. We can use this concrete in Guard wall.

5. When we take 10% tyre dust for and tested the mould we observe that, water absorption increased vigorously and Compressive Strength decreased severely to a very high extent. So, it’s recommended not to use it in any load bearing structure.

CHAPTER 9

FUTURE SCOPE

- Studies related to dynamic and static behaviour of tyre dust mix mould correct is require to be observed.
- Studies on freezing and thawing resistance of Rubber dust mould need to be conducted.
- Putting tyre rubber dust in mix. Increasing water absorption test and decreasing compressive strength of mould.
- The existence of any chemical reactions between Tyre dust and the other components of the Tyre dust mould to make sure that there are no undesirable effect.

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