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TYRE RUBBER AS AGGREGATE IN CONCRETE

DEPAETMENT OF CIVIL ENGINEERING

Name of 1st Author : Sayali Vijay Kamble [1]Designation of 1st Author: BE (Civil)

Name of 2nd Author: Aishwarya Babaji Bhagul [1]Designation of 1st Author: BE (Civil)

Name of 3rd Author: Ishawari Diwakar Chandurkar [1]Designation of 1st Author: BE (Civil)

Name of 4rd Author: Samdersh Subhash Mistry [1]Designation of 1st Author: BE (Civil)

Name of 5rd Author: Sahil Satish Bhalekar [1]Designation of 1st Author: BE (Civil)

Name of Department of 1st Author: Pravin Gorde

City :-Pune

Country:-India

DR. D. Y. PATIL INSTITUTE OF ENGINEERING,

MANAGEMENT & RESEARCH, AKURDI, PUNE.

SAVITRIBAI PHULE PUNE UNIVERSITY,PUNE

Abstract : Discarded vehicle tyres constitute one important part of solid waste which had historically been disposed of into landfills. Recent policies on the Landfilling of Waste have however put a ban on the landfilling of whole or shredded tyres, creating an imminent need to investigate any possible viable uses of this waste product. An emerging use is the production of concrete, in which tyre rubber particles partially replace natural aggregates. This has the additional advantage of saving in natural aggregates used in the production of concrete which are becoming increasingly scarce. This research investigated a wide range of physical and mechanical properties of concrete containing recycled tyre aggregates, to assess its suitability as a construction material. The influence of factors such as rubber aggregate content and size, as well as curing time was also considered. The quantities of concrete produced worldwide for such applications could ensure the viability of this product. Therefore, this type of concrete shows promises for becoming an additional

sustainable solution for tyre rubber waste management.

Key words : Waste tyre rubber, application of concrete, Mechanical Properties, Rubber aggregate concrete.

Introduction :

Concrete is a mixture of cement, coarse aggregate, fine aggregates and water. Concrete is cured for 28 days to attain good strength. Various properties are linked with concrete. Workability is considered as fresh concrete property, where as compressive, tensile, and flexural strengths belong to hardened concrete properties. Course and fine aggregate used in concrete serve as filling and densifying the material.

Now a days concrete has become the most widely used material due to easy and local availability of sand and coarse aggregates. But there are many drawback of using aggregates in concrete on a large scale. Coarse aggregates are obtained from mountains and rocks through quarry and crushing. Nevertheless, these processes are hazardous and are badly damaging the environment.

There is a possible use of rubber tyre particles instead of course and final aggregate in concrete. Millions of rubber tyres become waste every year and their disposal has become a serious concern. Moreover, the burning of the waste rubber tyres become a cause of pollution for environment. Using Rubber in concrete by particle replacing aggregates do not increase compressive and tensile strength than an ordinary concrete but a suitable strength still can be obtained for use in structures. Rubber can be reused in sizes of course aggregates as well as ground to the scale of fine aggregates. Solid waste management has gained a lot of attention to the research community in recent days. As concerned solid waste, accumulated waste tyres, has become a problem of interest because of its non- biodegradable nature.

Most of the waste tyre rubbers are used as a fuel in many of the industries such as thermal power plant, cement kilns and brick kilns etc. unfortunately, this kind of usage is not environment friendly and requires high cost. Thus, the use of scrap tyre rubber in the preparation of concrete has been thought as an alternative disposal of such waste to protect the environment.

It has been observed that the rubberized concrete may be used in places where desired deformability or toughness is more important than strength like the road foundations and bridge barriers. Apart from these the rubberized concrete having the reversible elasticity properties may also be used as a material with tolerable damping properties to reduce or to minimize the structural vibration under impact effect'

The difficulties associated to the theoretical investigations to identify the mechanical properties of the rubberized concrete have necessitated the need for the experimental investigations on rubberized concrete. Therefore, in this study an attempt has been made to identify the various properties necessary for the design of concrete mix with the coarse tyre rubber chips as aggregate in a systematic manner.

Literature Review :

Synergistic effects of rubber tire powder & flurogypsum in cement based composite.

Sandra L 2020 et.al, studied the effect of incorporating two waste materials (rubber-tirepowder and fluorogypsum) was studied in a Portland cement mixture diluted with CaCO3. The remnant of H2SO4 contained on the surface of fluorogypsum is an option to chemically treat the surface of the tire particles and improve their interaction with the cement matrix. The characterization of the chemically treated material, the hydration evolution and the physico- mechanical properties were evaluated. In the hydration process, it was observed that a low fluorogypsum content slightly accelerated the cement reactions, while the rubber-tire-powder inhibited them.

The main conclusions of this research are summarized below: 1 The chemical treatment of the rubber-tire powder by fluorogypsum, improve the transfer of mechanical stresses between the rubber-tire powder and the cement matrix. This is due to 3 effects: (i) a reduction in the impurities on the surface of the rubber-tire powder, (ii) a homogeneous mixture with the fluorogypsum particles which have a greater rigidity than rubber-tire powder and (iii) fluorogypsum can accelerate the C3S hydration reactions. [1].

Evaluating the synergistic effect of waste rubber powder & recycled concrete aggregate on mechanical properties & durability of concrete.

Mostafa Amiri 2021 et.al, studied the use of waste materials in the concrete mixture can help human beings to preserve the environment and achieve environmentally-friendly concrete. In this study, the influences of simultaneous replacements of cement by waste rubber powder (WRP) and coarse aggregate by recycled concrete aggregate (RCA) on the mechanical properties and durability of concrete were investigated experimentally. To do so, concrete specimens containing the WRP with the replacement ratios of 0 %, 2.5 %, and 5 % by weight of cement, and the RCA with the replacement levels of 0 %, 25 %, and 50 % of coarse aggregate were prepared.

The mechanical properties of the concrete containing WRP and RCA are lower than those of the reference concrete. For the concrete containing the WRP, larger capillary pores and higher porosity of the paste are formed because of the hydrophobic characteristics of WRP. • In the case of RCA included concrete, the lack of proper connection of RCA with the paste of the concrete in the interfacial transition zone (ITZ) causes the degradation of mechanical properties. In the concrete containing both WRP and RCA, the negative effects of adding WRP and RCA on the mechanical properties..

Cost effective treatment of crumb rubber to improve the properties of crumb rubber concrete.

Rida Alwi Assaggaf 2022 et.al, noted that the selected treatment methods cause crucial changes in the surface texture and shape of CR particles. The NaOH, - KMnO4,- and cement-treated CR exhibited a remarkable improvement in the sedimentation coefficient being 51.8%, 99.6% and 99.0%, respectively, compared to value of 37.2% for the untreated-CR. The NaOH- and KMnO4- treatment methods increased the compressive- and flexural-strength of CRC at low quantity of CR. But at higher quantities of CR, there was a degradation in the mechanical properties due to the agglomeration of CR particles. However, the agglomeration phenomenon was overcome by applying a cement coating that resulted in 64% and 33% increase in the compressive- and flexural-strength, respectively, in CRC with 40% replacement of CR with fine aggregate. The statistical analysis indicated that cement coating is the most effective treatment method as it significantly enhances the mechanical properties of CRC. In addition, there was a 22% decrease in the cost of CRC due to the cement-treatment of CR 4 [3].

Study on the strength mechanism of red clay improved by waste tire rubber powder.

Mingxing Gao 2022 et.al, has discovered that,(1) Based on the results from the triaxial compression test, the Duncan–Chang model is established, and the model's relevant parameters are examined. The Rf value is above 0.8 when the rubber powder content is between 0% and 3%; when the rubber powder content exceeds 3%, the Rf value decreases more dramatically, resulting in severe damage to the sample. According to the progressive value of the principal stress difference in the model, the principal stress difference is significantly higher than the four other admixtures at 3%. (2) In the 3D surface map obtained using the super-field microscope, it can be seen that the addition of rubber powder substantially expands the area of relatively flat surfaces, reduces the area of holes, and smoothens the surface. (3) The average area contact rate for red clay is calculated based on the porosity of the mercury injection test, we can obtain the following results: RCA1 (average contact area of pure red clay) < RCA2 (average contact area of modified red clay). We determine that pores of modified red clay exhibit a significantly higher fractal dimension than those of pure red clay. (4) By adding 3% rubber powder to the mixed soil, the pore volume distribution will change, the fractal dimension of the pore will increase, the structure of the soil will become more complex, and the mechanical properties of the soil will improve. [4].

Effect of modified rubber powder on the mechanical properties of cement-based materials.

Shengtian Zhai 2022 et.al, has studied a novel modification method of waste rubber powder (WRP) combining mechanochemistry action, ultrasonic energy accumulation and the coating effect was proposed. The particle size distribution, specific surface area, hydrophilicity, morphology and structure of rubber were characterized by a laser particle size analyser, scanning electron microscopy (SEM), etc. The distribution of WRP in the cement-based materials was determined. The interfacial bonding and microstructure of ReC were analysed by SEM. The compressive and flexural strengths of cement-based materials with different contents of rubber were studied. The results showed that the ReC interface was significantly improved, and rubber particles were uniformly distributed in the cement mortar. The particle size of rubber particles showed a standard normal distribution, the surface cracks and pores were filled and coated, and the hydrophilic angle decreased from 94.6 to 68.0. [5].

Experimental study of mechanical properties and durability of green concrete containing slag, waste rubber powder & recycled aggregate with artificial neural network.

Farzad Hatami 2022 et.al, has discovered to find ways to cope with waste material and incorporate it into concrete mixtures to replace the cement to protect the environment by lowering cement consumption. Even so, before they can be used in practical applications, the properties of concrete containing recycled materials must be investigated. The synergic consumption of the rubber powder, GGBFS, and RCA as three waste materials on the mechanical characteristics and durability of the samples, were evaluated in this examination. Conclusions were deduced as follows: The compressive strength of samples containing 20% slag at 28 and 91 days is, on average, 11.3 and 17.7% higher than the 7-day samples. By doubling the replacement percentage, this betterment increases to an average of 18.9 and 28.3. By decreasing the ratio of water to cement, the effectiveness of slag on compressive strength dwindles. During this procedure, the hydration products turn into a more homogeneous shape and include a lower amount of Portlandite. This occurrence results in a lower hydration reaction of GGBFS and water in lime and reduces the enhancement level. Regarding the compressive strength of samples, including rubber powder, it was observed that, in general, the compressive strength declines by increasing the replacement percentage of WRP. By replacing 5% of cement with rubber powder, the compressive strength of samples reduced 11.2%, 15.3%, and 17.9% at 7, 28, and 91 days of curing, averagely, compared to the samples without adding waste materials.[6]

Strength of concrete containing rubber particle as partial cement replacement.

Siti Radziah Abdullah 2016 et.al, has studied that Uncontrolled issues of disposal waste tire rubber create huge environmental impact and health hazards. An alternative viable solution to minimize these problems is by utilizing the waste rubber tires in construction materials, which in turn can reduce the use of natural resources and eventually lessen the cost of construction. This paper mainly focuses on the use of waste rubber tires particles in concrete with different set of composition ranging from 3 to 12% of cement replacement.

This paper provides initial study on the effect of rubber as cement replacement in concrete on the compressive and tensile strength of the concrete. In conclusion, the replacement of cement with suitable percentage of rubber can be used in concrete with acceptable compressive and tensile strength as compared to normal concrete. [7].

Effect of waste tyre rubber particles on concrete abrasion resistance under high speed water flow.

Ling-Yun Feng 2021 et.al, has discovered in this paper, several tests were performed on various concrete compositions, including slump, compressive strength, splitting tensile strength, abrasion resistance, and grinding performance, and the efect of RP size and dosage is discussed. Te conclusions can be summarized as follows: • Te slump of RC initially increases with increasing RP content and then decreases. Te slump of RC with smaller RPs is larger than that with larger RPs. • Te compressive strength and splitting tensile strength of RC decrease linearly with increasing RP content, and the former is greater for RC with larger rubber particles. The reduction range of the splitting tensile strength with increasing RP content is less than that of the compressive strength. Te rubber pre-treatment method can improve the compressive strength and splitting tensile strength of RC, for which the NaOH+KH570 treatment has the best effect. • Te abrasion resistance of RC increases with increasing RP content. For the same RP content, RC with large RPs has a higher abrasion resistance than the RC with small RPs. • For RC with the same RP size, RP content, and reference concrete, the abrasion resistance is inversely proportional to the compressive strength. • Te RP content has the greatest influence on RC abrasion resistance, followed by compressive strength. RP pre-treatment methods can improve the abrasion resistance of RC, of which the NaOH+KH570 treatment yields the best response. [8].

Review paper overview of trends in the application of waste materials in self compacting concrete production.

Adeyemi Adesina 2019 et.al, has studied innovative application of industrial wastes in self-compacting concrete production, with the aim of finding the most appropriate technique in SCC material use. Also, the potential limitations in using some of the waste materials as sustainable alternatives were highlighted. This study found that several materials emanating from industrial rejects have been mostly investigated as a potential material for making SCC, which showed that the incorporation of waste materials into SCC could be a viable approach. However, in order to achieve optimal performance of SCC, an adequate material composition is necessary. It is clear from this study that factors such as embodied carbon, energy and cost of SCC production can notably be reduced with the incorporation of waste materials. The study also identified areas for further investigations that can help in the improvement of SCC for construction applications. [9].

A comprehensive review of the features of self compacting rubberized concrete in the fresh & hardened states.

Md.Toriqule Islam 2022 et.al,has discovered 1. Inclusion of RA in SCC negatively affects the fresh properties of SCRC, i.e., flow and passing ability, resistance to segregation decreased, and viscosity increased. This fresh condition decrease is likely due to the increased inter-particle friction between the rubber particles and the interlocking effect. However, the new properties of SCRCs can be maintained and improved by utilizing various chemical admixtures, such as VMA, SP, HRWR, etc. 2. Compressive strength decreased substantially as the percentage of replacement of RA was increased with particle size, owing to the weak rubber-cement interface, the lower modulus of elasticity of RA, and the existence of entrapped air and voids. To strengthen SCRCs' compressive strength, incorporating various supplementary cement materials (SCMs) such as fly ash, slag, and Metakaolin is quite successful. Moreover, pre- treatment of RA also can be applied to improve the compressive strength. 3. Flexural and splitting tensile strengths were also decreased by adding RA because compressive strength was diminished. However, RA replacement, not more than 15%, the addition of SCMs, and the inclusion of longer crimped fibres can help to enhance the pull-out resistance .[10].

The durability of concrete containing recycled tyres as a partial replacement of fine aggregates.

Mohamad Syamir Senin 2017 et.al, presents an overview of the use of waste rubber as a partial replacement of natural fine aggregate in a concrete mix. 36 concrete cubes measuring 100mm x 100mm x 100mm and 12 concrete cubes measuring 150mm x 150mm x 150mm were prepared and added with different percentages of rubber from recycled tyres (0%, 3%, 5% and 7%) as fine aggregate replacement. The results obtained show that the replacement of fine aggregate with 7% of rubber recorded a compressive strength of 43.7MPa while the addition of 3% of rubber in the concrete sample recorded a high compressive strength of 50.8MPa. This shows that there is a decrease in the strength and workability of concrete as the amount of rubber used a replacement for fine aggregate in concrete increases. On the other hand, the water absorption test indicated that concrete which contains rubber has better water absorption ability. In this study, 3% of rubber was found to be the optimal percentage as a partial replacement for fine aggregate in the production of concrete. [11].

Use of vulcanized rubber in concrete as a partial replacement of coarse aggregates.

Aejaz Ahmad Wani 2020 et al, checked the performance of concrete made rubber aggregates was studied. The following conclusions were drawn: 1.Fresh concrete properties such as Unit weight and Slump decreased with the higher replacement levels of rubber. 2.Increase in rubber content decreased the compressive strength of the concrete significantly. 3.There is a great potential for rubber to be used in the concrete, thus saves area from becoming as landfill and is thus eco-friendly with environment. 4.The combined action of air and rubber creates a discreet thermal insulation that pre- vents the transport of heat. If we analyse such properties in relation to density in the hardened state, we can note an increase of the thermal conductivity with the density increasing, the increase of density corresponds to a more compact structure, so to a reduction of its porosity 5.In reference to the test concerning the resistance of rubber Crete to Sulphatic attack, it is evident that, all the blends have lower compressive strength compared to the normal condition, consequently they are all vulnerable to attack by sulphate ions. [12].

Use of waste tyre rubber in a partial replacement of aggregate in concrete .

Mr. Neeraj Kumar Gupta 2017 et.al, has suggested to use this waste tires as an additive in portland cement concrete mixes, which would partially help in solving this problem. India manufacture 11.92 Crore tires in year 2010 – 11 increase by 22.72% than year 2009 – 10 (ATMA – Automotive Tire Manufacturer Association). With the exponential growth in number of automobiles in India during recent years, the demand of tires as original equipment and as replacement has also increased. The quantity of scrap tires produced in India is not exactly available but the increasing trend of use of road transportation will definitely create a problem of disposal in very near future. The total number of registered buses, trucks, cars/jeeps/taxis and two wheelers up to 1997 in India were 0.5 million, 2.25 million, 4.7 million and 26 million, respectively. Considering the average life of the tires used in these vehicles as 10 years after rethreading twice, the total number of waste disposable tires will be in the order of 112 million per year. That's why this is one of the most crucial environmental issues all around the world is the disposal of the waste materials. [13].

Case study rubber concrete: mechanical & dynamical properties.

Najib N. Gerges 2018 et.al, has studied the strength reduction may be attributed to two reasons. First, because the rubber particles are much softer (elastically deformable) than the surrounding mineral materials, and on loading, cracks are initiated quickly around the rubber particles in the mix, which accelerates the failure of the rubber–cement matrix. Second, soft rubber particles may behave as voids in the concrete matrix, due to the lack of adhesion between the rubber particles and the cement paste. 3 For a design mix strength ranging between 30 MPa and 50 MPa, the reduction in the compressive strength is consistent and almost at a constant ratio with the increase in the percent of powdered rubber. The reduction in strength is an average of 30, 35, 50, and 63% against a powdered rubber replacement of fine aggregates at 5, 10, 15, and 20%, respectively. 4 The addition of powdered rubber yields a slight improvement in the concrete tensile strength at all rubber percentages but still results in less improvement compared to the compressive strength reduction rate. 5 The addition of powdered rubber to the concrete mix results in a negative effect on the modulus of elasticity. The decrease of elasticity reflects the capability of rubberized concrete to behave in an elastic manner when loaded in tension, thus improving the failure manners of typical concrete. 6 Rubberized concrete exhibits enhanced energy absorption since the concrete did not undergo a typical brittle failure yet it encountered a ductile, plastic failure mode. [14]

Study on the behaviour of rubber aggregates concrete beam using analytical approach.

Priyanka Asutkar 2016 et.al, has studied As this scrap rubber waste is an elastic material having less specific gravity, energy absorbent material can be used as a replacement material for obtaining lightweight concrete. In present study an attempt is made to partially replace the rubber aggregates by coarse aggregates in concrete and to study its impact on properties of concrete. A modified concrete is prepared by replacing coarse aggregates in concrete with rubber aggregates by varying the replacement proportion from 0% to 20% with increment of 5%. 3 cubes for each percentage of replacement are casted and tested after 28th days of curing. The physio mechanical properties like density, compressive strength and elastic properties of modified concrete are determined from concrete cubes experimentally and further stresses and displacement at every 50 mm depth of beams are determined analytically by method of initial functions (MIF). MIF is an analytical method in which elastic properties and theoretical loads are used to analyse the beams without conducting any experimental programme. The analytical results by MIF are compared with bending theory. [15].

Utilization of rubber powder of waste tyres in foam concrete.

Imtiaz Ali Bhatti 2019 et.al, has studied to investigate the potential of foam concrete incorporating with rubber powder of waste tire and admixture as an additive material to improve its strength and workability. Thus, the use of rubber powder in this study could enhance the strength by filling the voids in foam concrete. The amount of rubber powder added as additive in foam concrete is 0%, 5%, 10%, 15% and 20% respectively. The amount of plasticizers used is limited to less than 0.4% to the weight of cement. The mix design was set to achieve density of 1800kg/m3. The workability of foam concrete is decreasing as the percentage of rubber power was increasing. The foam concrete containing 5%of rubber powder has highest compressive strength with value of 20.6 MPa for 7 days water curing and 22.3 MPa for 28 days water curing. Significantly showing an increase of 1.7 MPa. The highest value of tensile strength for both air curing 7 and 28 days are 1.86 MPa and 1.97 MPa also held by 3% of rubber powder mix. As a conclusion the optimum rubber powder content to be used in foam concrete is 5% that gives the highest results in terms of workability and strength.[16].

Strength properties of concrete using crumb rubber with partial replacement of fine aggregate.

S.Selvakumar 2015 et.al, studied the effective utilization of rubber tyre waste as been developed and it made to used in the concrete mixture as fine aggregate. At present the crumb rubber production in the south India is very less than north. So the material availability was less, because of less knowledge about that. Based on the test results the following conclusions were made. These can also include non primary structural applications of medium to low strength requirements, benefiting from other features of this type of concrete. Even if rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used tyres. [17].

Scrap tyre rubber replacement for aggregate in cement concrete experimental study.

Partha Sarathi Parhi 2012 et.al, has studied Slump value is decreased as the percentage of replacement of scrap tyre rubber increased. So decrease in workability. The compressive strength is decreased as the percentage of replacement increased, but rubber (MCR03) concrete developed slightly higher compressive strength than those of without rubber (MC-00) concrete. The split tensile strength is increased with decreased percentage of scrap tyre rubber. Decrease in compressive strength, split tensile strength and flexural strength of the specimen. Lack of proper bonding between rubber and cement paste matrix. In the rubberized concrete the loss of strength was 45% with 15% replacement of coarse aggregate by rubber particles. [18]

Crumb rubber concrete deterioration caused by sulphate attack

Jinhua Xu 2015 et.al, has studied the following conclusions can be drawn: (1) The 5 and 15 % in volume replacements with rubber powder in concrete can obviously improve resistance to sulphate attack. But too much rubber content results in decreasing its performance. (2) Mixture proportion with rubber content of 5% will achieve larger compressive strength and better resistance to sulphate attack of crumb rubber concrete. (3) Mixture proportion with rubber content of 20% will be unfavourable to mechanical performance of crumb rubber concrete.[19].

Assessment of cement replacement with fine recycled rubber particles in sustainable cementitious composites.

Mohamed Atef 2021 et.al, has researched the deals with the expansion of novel techniques for rubber powder recycling for various purposes in a robust construction. Recycled rubber particles (RRP) are mixed with ordinary Portland cement (OPC) using various water to binder ratio (W/B) at 0.3 and 0.4. The Fourier transform – infrared (FT-IR) spectra is measured for RRP. The compressive strength (C.S) is investigated for the rubberized cement pastes at 1, 3, 7, 14 and 28 days. The results aimed to enhance the compressive strength of rubberized cement pastes through improving the bonding strength between RRP and OPC by using fine particles of RRP. It is concluded that the cement replacement with RRP causes deterioration in the strength. However, the new rubberized cement mixture (R5-0.3) can be used in different applications instead of cement type 32.5N. The initial porosity decreases as the W/B ratio decreases, followed by an increase in compressive strength. Utilizing nonbiodegradable and recycled materials like rubber could be used as a cement replacement. Thus, a new approach is developed to produce a sustainable building material that might be useful in some industrial applications such as solid and hollow cement blocks, interlock paves and plastering layer. [20]

A review on using crumb rubber in concrete.

Mayank Bharadwaj 2017 et.al, has studied that Reinforced concrete is a kind of building material obtained from the deformation of traditional concrete, it is light, strong and has excellent thermal insulation properties, so it was originally used for civil engineering such as railways and highways. In an attempt to alleviate this problem, crumb rubber modifiers (CRMs) derived from used tire rubber have sparked interest in asphalt reinforcement. The use of crumb rubber in asphalt reinforcement is considered a smart solution for sustainable development through waste recycling, and it is believed that crumb rubber modifiers (CRMs) can be an alternative polymeric material to improve the performance of hot mix asphalt. However, depending on the temperature and mixing time, the rubber particles may depolymerize and the viscosity may decrease. The modification of rubber granules also improves the properties of asphalt by increasing the elastic modulus and losses. With light weight, noise reduction, high strength, thermal insulation and other excellent properties, rubber concrete has great potential. Since the beginning of rubber concrete research, methods related to basic mechanics, rubber particle size, and rubber content have yielded many theoretical results, but in many practical applications, these methods are limited and many problems need to be solved. (1) External composite rubber type, size, quality, no uniform technical standards. (2) There is no technical specification for rubber concrete production guide. (3) Modifiers, the dosage of which is still being researched and needs to be tested for reliability for various applications. (4) The effect of the difference between cement and additives on the performance of rubber concrete has not yet been established in a unified theory, and the influencing factors are discrete, so more research is needed. (5) Lack of specialized institutions or associations to facilitates the compatibility of rubber concrete coating operations with theoretical results. [21].

Use of crumb rubber as fine aggregate in concrete to increase the strength of concrete block.

Abhay Kumar 2017 et.al, has find uses for tyre rubber that don't require a lot of investment and can be implemented on a large scale was necessary for society. In order to safeguard the environment, it has been proposed that used rubber from discarded tyres be used in the production of concrete. By substituting crumb tyre rubber for aggregates in this study, an effort has been made to discover the various qualities required for the construction of concrete mix. The reference concrete specimen has been determined to be M20 grade concrete. In place of traditional fine aggregate, recycled tyre rubber powder has been used as fine aggregate. In addition to enabling the sustainable use of our available aggregates, this will also enable the efficient and widespread management of rubber. Low workability is a property of concrete with a higher percentage of crumb rubber. For example, the workability of concrete reduces as the percentage of crumbed rubber increases. When 15% of the sand is replaced by crumbed rubber, the flexural strength of the concrete is reduced by around 56%. When 15% of the sand is substituted with crumb rubber, the compressive strength of the concrete is reduced by around 25%. It is impossible to prevent the loss of strength when crumb rubber is added. These figures, however, only offer a rough indication of how much local modified concrete will lose strength when compared to ordinary concrete with a 20 MPa goal strength. Additionally, rubberized concrete is employed for heat and sound insulation. Consequently, it can be utilised as an insulating material in residential walls. crumb rubber, the compressive strength of the concrete is reduced by around 25%. It is impossible to prevent the loss of strength when crumb rubber is added. These figures, however, only offer a rough indication of how much local modified concrete will lose strength when compared to ordinary concrete with a 20 MPa goal strength. Additionally, rubberized concrete is employed for heat and sound insulation. Consequently, it can be utilised as an insulating material material in residential walls. [22].

Epoxy resin & ground tyre rubber replacement for cement in concrete: compressive behaviour & durability properties.

M.A. Fernandez-Ruiz 2018 et.al, has studied pulverised rubber (also known as tyre powder) was used as a cement substitute, and the compressive behaviour of concrete mixtures including epoxy resin with and without hardener was examined. Different experimental mixtures with different polymer/cement mass ratios were created. In order to compare polymer- cement and traditional concretes fairly, a basic design criterion was employed for creating the combinations. Mechanical and durability tests were used to describe concrete mix designs. Compressive and flexural tests were performed on mechanical components. Through research on chloride infiltration into the concrete matrix, durability was assessed. Results reveal that the use of polymer-cement concrete affects the stress-strain curve's post-peak slope, demonstrating improved ductility and being particularly relevant to earthquake engineering. [23].

Effect of cement content & recycled rubber particle size on the performance of rubber modified concrete.

Katelyn A. Stallings 2018 et.al, has studied The Rubber Manufacturer's Association estimates that in 2015, the United States produced 3664 thousand metric tonnes of discarded tyres. Although the majority of used tyres are recycled, almost 409.5 thousand metric tonnes were dumped in landfills. The alternative use of used tyres in place of natural aggregates in concrete mixtures is examined in this study. This study looked at the compressive strength and characteristics of new concrete. Different aggregate rubber particle sizes, including 19-mm tyre chips (TCs) and 30-mesh crumb rubber, were tested (CR). In the concrete mixtures, TCs were used to replace coarse aggregates and CR was used to substitute fine aggregate in increments of 10% by volume. Instead of experiencing larger strength losses, concrete's loss of strength was decreased when fine aggregate was replaced with CR. In this work, the impact of recycled rubber aggregates on the initial characteristics and compressive strength of rubberized concrete mixtures was investigated. 24 combinations in all were assessed. The use of TC as a substitute for coarse aggregate in three series of mixtures with varied cement percentages of 362, 392 and 418 kg/m3 (611, 660, and 705 lb/yd3) was done in increments of 10% by volume up to a maximum of 50%. CR was substituted for fine aggregate in one set of combinations with a cement percentage of 392 kg/m3 (660 lb/yd3) in increments of 10% all the way up to 40%. Finally, two combinations that substituted percentages of coarse and fine aggregates for their rubber equivalents were assessed. Overall, it was discovered that fresh concrete is significantly impacted by rubber granules.[24].

Rubberized concrete properties & its structural engineering applications- an overview.

Hesham M. Fawzy 2020 et.al, has studied The features of rubberized concrete mixtures, including their strength, ductility, sound absorption, water absorption, and resistance to acids and sulphates, are reviewed in this study. In addition, it reviews the use of rubberized concrete in structural components and its impact on ductility and ultimate compressive strength. Compared to regular concrete mixes, rubberized concrete mixtures have reduced strength. Conversely, rubberized concrete exhibits a higher degree of ductility and energy dissipation. In comparison to regular concrete, rubberized concrete demonstrated a higher resilience to freeze-thaw, sulphate, and acid attacks. Steel tubes filled with rubberized concrete are the most prevalent type of structural member (RUCFST). In addition to the advantages of rubberized concrete already described, the steel tube's enclosing quality makes up for the concrete's reduced strength. When employing powdered rubber, the density of the concrete mix decreases as the amount of rubber particles increases, and this density loss becomes more pronounced. Rubberized concrete can be made in lightweight mixes to satisfy the needs of various applications due to its lower density. When compared to regular concrete mixtures, rubberized concrete has reduced compressive strength. If rubber makes up no more than 20% of the overall aggregate content, the decrease in compressive strength is tolerable. The compressive strength noticeably decreases sharply over this ratio. Any coupling agent can be used to treat rubber particles to lessen the loss in compressive strength. Rubberized concrete's abrasion resistance, water absorption, and shrinkage are all increased by adding more rubber to the mix. It facilitates freezing .[25]

Properties of waste tyre rubber powder

Melik Bekhiti 2014 et.al, has studied Tire scraps are a common and dangerous waste. More and more, the sector of civil engineering uses the aggregates produced by crushing used tyres (geotechnical, hydraulic works, light concretes, asphaltic concretes, etc.). The physical and mechanical properties of these aggregates may vary depending on the type of used tyres, their diameters, and any potential separations and treatments. Three gradation classes of scrap tyre rubber powder were subjected to some physical, chemical, and direct shear tests. To produce empirical connections between cohesiveness, friction angle, and particle size of waste tyre powder rubber, the test findings were coupled with information from earlier investigations. Compared to linear and quadratic models, a cubic (third order) regression model seems to be more suited. Numerous applications in both civil and non-civil engineering use waste tyre rubber powder. In this work, the particle size, density, chemical composition, cohesiveness, and friction angle by direct shear test have been determined for rubber powder made from crushing light car waste tyres without steel fibre. Mechanically crushed rubber powder at room temperature revealed an extremely low density of 0.83 and a cohesiveness range of 6.5 to 50 kPa. Depending on the average size of the rubber particle, the friction angle ranged from 8 to 25 degrees. Cubic regressions are suggested using the findings from this study as well as earlier findings from other studies. Using a cubic model, cohesion and friction angle vs particle size provide.[26].

Impact of chemically treated waste rubber tyre aggregates on mechanical, durability & thermal properties of concrete.

Yih Chen Khern 2020 et.al, has studied The adding leftover tyre rubber granules to concrete weakens it, makes it more porous, and diminishes its heat conductivity. The impact of surface-modified rubber aggregates on the characteristics of concrete, however, has only been the subject of a small number of investigations. This study looks at how different oxidising solutions and varied treatment times affect the mechanical, long-lasting, and thermal properties of concrete when scrap tyre rubber is used as coarse aggregate. The qualities of concrete containing 8% rubber coarse particles (by volume of natural aggregates) were subjected to three different treatments for lengths of time: 2, 24, and 72 hours, respectively, with water (H2O), 20% sodium hydroxide (NaOH), and 5% calcium hypochlorite [Ca(ClO)] In this study, the effects of chemically treating rubber aggregates with calcium hypochlorite solution [Ca(ClO)2] and sodium hydroxide solution (NaOH) on the mechanical, transport, and fresh properties of concrete were examined. All combinations had the same quantity of rubber aggregates, or 8% replacement. These inferences can be made based on the results presented: It has been discovered that adding rubber particles in place of 8% of the natural aggregate lessens slump because the friction between the rubber aggregates is higher. NaOH and Ca(ClO)2 treatments did not appear to have any discernible impact on slump. Compared to the reference mixture, the compressive strength after 28 days was 18% lower when 8% of the natural aggregates were replaced with tyre rubber. When compared to rubber aggregates that weren't treated, the depth of water penetration has been dramatically reduced. Additionally, compared to the reference concrete, some of the treatments had reduced water penetration depths .When compared to concrete made with untreated aggregates, the heat conductivity of the aggregates treated with NaCl and Ca(ClO)2 solutions increased by 1.66 and 9%, respectively. This might be brought on by improved cement paste-treated aggregate bonding, which reduced air gaps in the concrete and increased its thermal conductivity. In comparison to NaOH and water, pretreatment with Ca(ClO)2 solution was found to be more effective overall. Additionally, statistical analysis revealed that if significant benefits are desired, the course of treatment must be extended by 72 hours. Even though the results presented here are undoubtedly encouraging, it is obvious that more study is required. To begin with, only one replacement percentage (8%) was investigated. It's probable that a longer treatment period would be required if more rubber aggregates were to be used. Additionally, even though Ca(ClO)2 treatment has demonstrated to be effective, the underlying process is still not well understood. If pretreatment techniques are to be scaled up and employed commercially in the manufacture of concrete, it is crucial to have a fundamental understanding of the process.[27]

Effect of irradicated crumb rubber on rubberized concrete properties .

Dheaa Sh. Zageer 2016 et.al, has discovered This essay aims to investigate how rubberized concrete's mechanical properties are affected by irradiating crumb rubber. To find out how the two percents (30% and 70%) of irradiation treated crumb rubber content as a sand substitute influenced some properties of rubberized concrete, an experimental model was run on 30 standard cubes. The ultimate compressive strength, non-destructive tests for rubberized concrete with slump, wet and dry densities, and absorption tests, as well as scanning electron microscopy for irradiated rubber powder, were carried out. Gamma rays were used in the air medium for the irradiation process, with Co-60 radiation units as the source and a dosage rate of 0.3 kGy/h with a total absorbed dose of 70 kGy. The experimental results showed a significant decrease

1. Notable surface modifications are visible in the micrograph produced by the Scanning Electron Macroscopy (SEM) for unirradiated and irradiated crumb rubber particles. These findings provide a preliminary indication for improving the bond in terms of the final mechanical characteristics of rubberized concrete.2.As the percentage of unirradiated rubber crumbs in sand replacement rises, the compressive strength of rubberized concrete is noticeably reduced. However, it was found that the strength of the rubberized concrete significantly increased when it was combined with irradiated crumb rubber. The Pulse Velocity test yielded the same results. 3. It is discovered that the radiation of crumb rubber has no effect on the workability, absorption, or hammer test results for rubberized concrete. 4.The quantity of cavities with irradiated crumb rubber on the rubberized concrete failure surface. [28]

Experimental study of concrete with crumb rubber.

Karthika K 2017 et.al, has studied Concrete requires aggregates, inert granular materials, as one of its primary components. Since aggregates make up a significant portion of concrete (between 60 and 75 percent), choosing the right aggregates based on their material, shape, gradation, and size is crucial before mixing the concrete. However, because aggregates are the most exploited material for construction purposes, many developing nations like ours have difficulty procuring them. In many areas of our country, the supply of aggregates derived from natural sources is now scarce due to overexploitation. Therefore, a modification can be accomplished as a partial or whole replacement of these aggregates with any new material, which could potentially induce greater performance in order to meet the need for aggregates.

The workability of concrete was not affected by the addition of crumb rubber, and this is also attributed to the addition of admixture (i.e., a super plasticizer named Master Rebuild 619). These conclusions are based on the experimental study of concrete with crumb rubber, that was partially replaced with coarse aggregates and fine aggregates respectively. The cement matrix and crumb rubber were able to adhere to one another without any issues. This demonstrated that the crumb rubber has a good capacity for binding and absorbing in the concrete. On the third, seventh, and 28th days of testing, the compressive strength evaluated significantly increased. As a result, it was determined that the overall compressive strength was higher than that of regular concrete. The concrete's hardened strength bent into two [29].

Sustainable concrete with waste tyre rubber- an overview.

A. Sofi 2016 et.al, has discovered the best technique to utilise waste tyre rubber appears to be to substitute natural aggregates in concrete with scrap tyre rubber. This study discusses the studies done to ascertain the water absorption, water penetration, compressive strength, and flexural tensile strength of employing rubber tyre waste in concrete. In this paper, images from scanning electron microscopy (SEM) were also given. Researchers have shown that adding recycled tyre rubber to concrete produces superior outcomes to using regular concrete mix.

It seems that replacing natural aggregates in concrete with scrap tyre rubber is the best way to utilise waste tyre rubber. The investigations conducted to determine the water absorption, water penetration, compressive strength, and flexural tensile strength of using rubber tyre waste in concrete are covered in this paper. Images from scanning electron microscopy (SEM) were also provided in this publication. Researchers have found that recycled tyre rubber improves the performance of conventional concrete mix. [30]

Optimum super plasticizer added to rubberized concrete prepare by adding powder rubber as cement replacement.

Mustafa Maher Al-Tayeb 2015 et.al, has discovered Rubberized concrete was produced by replacements 5% of cement by 0.15–0.6mm waste rubber powder. Rubberized concrete with 0.5%, 1.0%, 1.5% and 2.0% superplasticizer contents were prepared without change the water cement ratio purposely to study the effects of superplasticizer to the rubberized concrete. This study was carried out to investigate the effect of superplasticizer to improve the workability and mechanical properties of rubberized concrete was produced by replacements 5% of cement by 0.15– 0.6mm waste rubber powder. (a) The slump value for concrete increased from 5 mm to 80 mm with increasing the superplasticizer content by 2%. (b) It can be deduced from the results that the 1.5% of superplasticizer will have the best mechanical properties such compressive, Splitting-tensile, and flexural strengths of rubberized concrete when added to rubberized concrete containing 1 mm waste crumb rubber. (c) Ultrasonic pulse velocity test show that the 1.5% of superplasticizer content were produced highest velocity. This indicated that the quality of the concrete was good which means the little of voids existed in the concrete. However, extended work is underway, to analyse the mechanical properties of rubberized concrete with superplasticizer under dynamic loading.[31].

Recycled rubber as an aggregate replacement in self compacting concrete

Robert Buši´c, 2018 et.al, has studied in the past few decades, due to the exponential increase of the world's population, the number of discarded waste tires has become a serious ecological and environmental problem. Decomposition of waste tire rubber can take longer than 50 years, and every year the number of discarded tires is rapidly growing. With the inclusion of waste tire rubber into self-compacting concrete this global problem can be reduced. Waste tire rubber can be incorporated in self-compacting concrete by partially replacing the natural fine and coarse aggregate, reducing consumption of sand and gravel and preserving these natural materials. In addition, recycling and reusing waste tire rubber avoids the need for tire landfilling, as one of the major ecological problem of the near future. The main objective of this review article was a literature overview of fresh and hardened properties of self-compacting concrete with partially replaced natural fine and/or coarse aggregate with recycled aggregate material. From this, it can be concluded: • Waste tire rubber can be used as a replacement aggregate material in self-compacting concrete. • Many scientists conducted their experimental work by replacing fine aggregate with rubber aggregate, likely because of the better results that were obtained from experiments with fine aggregate replacement as compared to results obtained with coarse aggregate replacement. • On behalf of future investigations, it can be suggested that experimental investigations of concrete properties should be investigated with fine aggregate replacement, perhaps with even smaller rubber particles such as waste tire powder. • From relationship between overviewed fresh and hardened properties of concrete with number of analysed test results for each property depending on concrete type it can be concluded that further experimental work on properties of self-compacting rubberized concrete still needs to be conducted, because of its high potential to be used in structural applications.[32].

Overview of concrete performance made with waste rubber tyres: a step toward sustainable concrete

Jawad Ahmad 2022 et.al, has studied the Utilizing scrap tire rubber by incorporating it into concrete is a valuable option. Many researchers are interested in using rubber tire waste in concrete. The possible uses of rubber tires in concrete, however, are dispersed and unclear. The following were the key findings. • Increase in rubber concentration. Rubberized concrete loses workability. However, it may be enhanced by adding admixtures such as plasticizers or other filler ingredients; • The lower specific gravity and tendency to absorb air of rubber, rubberized concrete density reduces significantly when rubber content is increased. Rubberized concrete is hence advantageous for lightweight buildings;1]Concrete's mechanical strength may generally be decreased by adding rubber, and this tendency becomes worse as rubber content rises. Due to the poor adherence of rubber with cement paste, a broad and porous weak interfacial transition zone (ITZ) was seen in rubberized concrete. The detrimental effects of rubber on the strength qualities of regular concrete may be lessened if the bond is strengthened at ITZ by any practical and affordable techniques. As a result, the construction industry would be able to employ rubberized concrete efficiently in a variety of concrete buildings;2]The decline in flexural capacity was lower than the decline in compressive capacity;• The silane coating agents (SCA) process transforms the rubber's hydrophobic surface into a hydrophilic one and creates a chemical link between it and the cement matrix, enhancing the rubberized concrete's mechanical characteristics and durability.[33].

Mechanical performance test of rubber -powder modified concrete

Yan Cong ZHANG 2018 et.al, has discovered A number of rubber cement concrete specimens that rubber-powder dosage different were obtained using same cement, water and fine aggregates, by adjusting the dosage of rubber powder. A number of rubber cement concrete specimens that rubber powder dosage different were obtained using same cement, water and fine aggregates, by adjusting the dosage of rubber powder. Then it was used to research the influence of rubber powder dosage on performance of cement concrete by measuring its liquidity, strength and toughness. The result shows that: 1, When water-cement ratio was equal, and rubber powder replaced sand by equivalent volume amount, the workability of cement concrete linearly increased with rubber powder dosage increasing. 2, Compress strength and flexural strength of cement concrete gradually reduced with dosage of rubber powder increased. When dosage was greater than 10%, strength decreased sharply with dosage increasing. Meanwhile, the ratio of flexible strength and compress strength increased. 3, When water-cement ratio was equal, rubber powder replaced sand by equivalent volume amount, and rubber powder dosage was less than 30%, toughness of cement concrete increased with dosage of rubber powder increasing. 4, Rubber powder improved brittleness of cement concrete. It maintained concrete keeping flexible at a large strain range.[34].

Study on modification of waste rubber powder in cement-based composites mixed with waste rubber powder

Jianmei Zho 2019 et.al, has studied In view of the disadvantage that the mechanical properties of cement-based composites can be significantly reduced by incorporating waste rubber powder in situ, the surface modification methods of the original rubber powder by coupling agent KH560, sodium hydroxide, polyvinyl alcohol (PVA), methyl hydroxyethyl cellulose ether (MHEC) and tetraethyl orthosilicate (TEOS) as precursors were adopted respectively. The modification of waste rubber powder in cement-based composites mixed with waste rubber powder was analysed and studied. It was found that KH560, NaOH and TEOS were used to modify waste rubber powder, which had good effect in cement-based composites. Among them, TEOS hybrid modification had the best effect. The 28-day flexural strength and compressive strength of cement-based materials were increased by 28.3% and 31.7% respectively. The mesh of waste rubber powder also has a certain influence on the properties of cement-based composites. From the point of view of replacing cement with waste rubber powder, 60 mesh of waste rubber powder is suitable. Scanning results of modified waste rubber powder showed that when the structure of modified waste rubber powder was bulging and tended to flaky porous structure, it was beneficial to its combination with cement-based materials and hydration products, and further explained the reason why hybrid modified rubber powder had good modification effect.[35].

Use of waste rubber tyre in concrete: mini review

Anwar Khitab 2017 et.al, has studied Waste-Tyre rubber is one of the most significant environmental hazards worldwide. Because of the increase in auto mobile production, 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 depleting, various countries have already outlawed the retention of waste-tyre rubber in disposal areas.Use of rubber particles in concrete can be useful against its environmental impacts. Its use in concrete reduces its density, workability and strength. The strength reduction can be compensated by a number of other factors. It enhances the ductility and air content of the concrete. It can be used in special circumstances, such as non-load bearing structural members, noise reduction, earthquake resistant structures, foundations for machineries and railways etc.[36].

Experimental investigation on the effect of rubber powder on mechanical properties of PVA fiber concrete

Linling Ma, 2021 et.al, has studied To verify the damping improvement by replacing partial sand with rubberpowder in the concrete process, this study investigated the effects of the rubber powder (5%, 10%, 15%, and 20%) on the mechanical properties and micromechanism of polyvinyl alcohol (PVA) fiber-reinforced concrete. In the experiment, a kind of concrete mixed with the rubber powder and PVA fiber was prepared, and the static mechanics test and free vibration test of these specimens were carried out. following conclusions were drawn from the current results: (1) In the range of the test dosage, PVA fiber can improve the compressive strength at 28 days, but the compressive strength decreases with the increase of the rubber content.)e fibers cannot compensate for the weakening effect of rubber on compressive strength. Moreover, both fiber and rubber reduce the flexural strength of concrete. (2))e results of the free vibration test show that the damping ratio can be increased by various energy dissipation methods provided by the PVA fiber. (3))e addition of fiber increases the dynamic stiffness of the cantilever beam, but the increase of the rubber powder will aggravate the loss of dynamic stiffness. (4))e relative damping ratio of concrete increases with the reduction of mechanical strength. For fiber concrete, when the rubber content is 5%, its damping ratio increases to the maximum, and its strength decreases within 30%. (5) Microscopic experiments show that the pores of rubber and its weak adhesion to the cement matrix and the bridging and blocking effects of the PVA fiber have positive effects on increasing the damping ratio, but they reduce the mechanical strength. (6) According to the material content and concrete preparation method described in this experiment, the damping ratio of concrete prepared with a rubber content of 5% and fiber content of 2.4 kg/m3 is increased to 3.83%, and the compressive strength is 34.8 MPa.Furthermore, the influence of PVA fiber length and thickness on damping ratio of composite concrete is still unclear and needs further study.[37].

Tyre recycled rubber for more eco sustainable advanced cementitious aggregate.

Matteo Sambucci 2020 et.al, has researched on using ground tire rubber (GTR) with different grain sizes as a replacement for the mineral aggregates used in a cement-based mixture suitable for extrusion-based Additive Manufacturing.This paper examines the usage of two types of GTR fillers (rubber powder and rubber granules) as substitutes for fine mineral aggregates in a cement-based mixture suitable for AM. Based on the experiments performed, subsequent conclusions are reported: 1. The greater deformability of fillers compared to fine mineral aggregates implies less rigidity of the deposed filaments and therefore better inter-layer adhesion. The internal morphology of the hardened rubberized materials is homogeneous and free of structural defects, while the Ref. samples show voids and cavities due to poor layers bonding. 2. Permeable porosity of cement mixtures modified with rubber fillers is lower than the Ref. mixture. The lower w/c ratio required for the realization of rubberized mixtures compared to the standard formulation minimizes the formation of pores related to the aging process. Besides, fillers synergy plays a key role in the microstructural properties of the material: rubber powder ensures the mixture compaction, while rubber granules hinder the crack propagations in the matrix. 3. The presence of rubber aggregates increases material hydrophobicity. This aspect is crucial regarding the material's inertia to moisture and damaging agents. 4. Water sorptivity test showed very good permeability performances for all the mixtures developed in this research work. The high freedom of design offered by AM can be used to perform topology optimization studies in order to improve technological properties by operating on prototype shapes and geometries.[38].

Rubber powder as a partial replacement to fine aggregate in geopolymer ferrocement

Mr. Ranjeet R.Karle, 2022 et.al, has studied Tyre manufacturing over the world has increased as the automobile industry

has rapidly grown. The waste tyre disposal is very time-consuming and environmentally damaging process. Even though it is frequently disposed of in landfills, issues with supply and demand mean that the shortage and lack of available landfill space is very big concern. 1. A 12% to 15% sand replacement level in ferrocrete mixes was found to be optimal for increasing strength and durability after 28 days. A low coefficient of permeability was found in all samples of ferrocrete containing Rubber Powder. 2. The regular controlled specimen has flex. Strength is between 4.75-5.5KN,which means we can get better result up to 10% to 15% replacement of fine aggregate by rubber powder. 3. Increase in the thickness and molarity concentration in the GF panels increased the load-carrying capacity,ductility, energy absorption, and stiffness of the element and decreased the crack width and crack spacing. 4. The cracking behavior of the various specimen shows that the cracking region and the cracking space are less in the geopolymer specimens and large number of cracks compared with the control specimens. 5. The rubber addition in mix increases the flexural strength of geopolymer base panel by 1.41times with lesser crack pronouncement. 6. The impact resistant property of the rubberised geopolymer ferrocement is slightly more than conventional ferrocrete 7. The increased rubber powder ratio decreased the compressive strength and the modulus of rupture of the panel but delays the appearance of first crack and final failure.[39].

Rubber as partial replacement to coarse aggregate to establish green concrete

Mohd Yunus Ishak 2016 et.al, has studied The industrial area in Taman Universiti, Skudai had been chosen as the subject area for this research. It had been identified that rubber is one of the major product of the waste in that area. The rubber waste is generated by the shoes factory and it is in a form of rubber sheet which it is unused or unwanted in the shoes productions. This waste will then being disposed of in landfill and thus affect the environment that caused by water pollution which activated by leachate. Green concrete has been introduced as the problem solving to that matter. Conclusions were made after the analysis of result completed. In this chapter, all the findings are being concluded. It gives the overall view of the research whether the objectives had been achieved or not. Based on the analysis of results, the conclusions that can be made are: i. The workability of rubberized concrete decrease as the percentage of rubber increase. ii. Lack of cohesiveness and proper bonding between rubber and cement causes shear slump. iii. Compressive strength of normal concrete is higher compared to rubberized concrete. iv. The pulse velocity in rubberized concrete decreases as the percentage of rubber increases. v. Replacement of rubber reduces the weight of the concrete.[40].

A review on the suitability of rubberized concrete for concrete bridge decks

Ishtiaq Alam 2015 et.al, has studied The following conclusions have been drawn from research on using rubber as aggregate in concrete □ When rubber was used instead of aggregates in concrete it shows less compressive strength when compared with ordinary concrete. But it also shows some ductile behavior before failure. □ Rubberized concrete shows reduction in density of concrete when compared with control concrete specimen. □ Concrete made of crumb rubber as fine aggregate shows much strength when compared with concrete made of chipped rubber as coarse aggregate. □ No appreciable increment in the compressive strength of concrete density by using different percentage of rubber as fine aggregates in concrete. □ It is recommended to use silica fume in rubberized concrete to increase its compressive strength. □ It is recommended to use rubberized concrete small structures like road curbs and non-bearing walls etc.[41].

Strength of concrete containing rubber particle as partial cement replacement

Mohamad Syamir Senin 2017 et.al, has discovered the Workable rubberized concrete mixture can be made with scrap tires [43]. The workability can be similar to normal concrete by using admixtures without any increase in the quantity of water [10]. The literature made it clear that the density of rubberized concrete decreases with increasing amount of rubber [44]. The loss in density would be severe when powdered rubber is used to replace aggregates. The rubber can also produce light weight concrete for special purposes. The compressive strength of the rubberized concrete would be affected by the use of rubber in concrete. The reduction of compressive strength can be avoided if the replacement of rubber does not exceed 20% of the total aggregate content [8]. Rubber powder reduces the flexural strength but rubber fiber increases the flexural tensile strength. By using any coupling agent, severe loss in compressive strength could be avoided. Most researchers mentioned that the abrasion resistance got improved with the addition of rubber in cement. Only few researchers found that rubberized concrete reduces the abrasion of concrete [45]. Water absorption and water penetration increase with the increase of rubber content in concrete. The addition of rubber increases the damping ratio of the concrete. Rubberized concrete seems to be suitable to be used for concrete bridge deck as there were positive results. As recommendations for future work, a proper study on the application of rubberized concrete could be performed. Furthermore, a study on carbonation and damping effect of rubberized concrete could be performed. An in-depth study on the properties of tire rubber ash concrete could also be carried out to maximize its applications.[42].

Strength of concrete containing rubber particle as partial cement replacement

Siti Abdullah 2016 et.al, has studied the effect of rubber as cement replacement in concrete on the compressive and tensile strength of the concrete. In conclusion, the replacement of cement with suitable percentage of rubber can be used in concrete with acceptable compressive and tensile strength as compared to normal concrete. This is because the range of strength reduction is only 6-21 percentage compare with normal concrete. There is room for improvement for rubber as cement replacement such as pre- treatment of the material to increase its strength without adverse effect on workability, durability, and cost of the concrete.[43].

Conclusion

1. The experimental investigation is carried out to study the behaviour of concrete using partial replacement of cement as tyre rubber powder subjected to compressive and split tensile strength.

2. The test results are compared with that of the conventional concrete of grade M40.

3. Compressive strength and split tensile strength of concrete is decreased as the percentage of replacement increased.