A STUDY OF USING WASTE POWDER RUBBER IN CONCRETE

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ABSTRAK

Sekarang pasir semulajadi menjadi semakin kecil dan mahal disebabkan oleh ketidakhadirannya. Tayar getah sampah sebagai agregat halus boleh menjadi alternatif ekonomi dan mampan untuk pasir. Dari kajian pratonton ia menunjukkan bahawa sampah peringkat menyebabkan masalah persekitaran tertentu. Dalam percubaan kajian ini telah dibuat untuk menggunakan tayar getah sisa sebagai pengganti sebahagian daripada agregat halus dalam bentuk getah sekerap serbuk. Kekuatan mampatan, kekuatan lentur, ketumpatan. (0%,10% dan 5% getah) telah diperolehi. Telah ditunjukkan bahawa kekuatan lenturan konkrit serbuk getah menurun dengan peningkatan peratusan serbuk getah manakala kekuatan lenturan konkrit diubahsuai meningkat dengan peningkatan peratusan kandungan gentian getah. Rintangan lelasan, kedalaman pengkarbonan, modulus keanjalan dan penembusan ion klorida konkrit serbuk getah dan konkrit diubahsuai juga dipengaruhi oleh penambahan abu getah dan gentian getah dalam konkrit. Untuk ujian kekuatan mampatan dan ujian lenturan, konkrit diuji pada 3, 7, dan 28 hari. Campuran konkrit direka bentuk dengan nisbah simen air sebanyak 0.225. Untuk ujian kekuatan mampatan, 18 kiub saiz 150mm x 150mm x 150mm diuji pada 3,7, dan 28 hari setiap satu. Selain itu, bagi ujian lenturan, 12 saiz rasuk konkrit 500mm x 100mm x 100mm telah diuji pada 7, dan 28 hari untuk setiap ujian. Kajian ini mendapati bahawa kekuatan mampatan dan lenturan berkurangan dengan menambah serbuk tayar.

ABSTRACT

Now a day's natural sand is becoming scarcer and costlier due to its non-availability. Waste rubber tire as fine aggregates can be an economical and sustainable alternative to sand. From previews study it shows that tier waste caused certain environmental issue. In this study attempt has been made to utilize waste rubber tire as partial replacement of fine aggregate in the form of powder scrap rubber. Compressive strength, flexural strength, density. (0%, 10% and 5% rubber) have been obtained. It has been shown that flexural strength of rubber powder concrete decreases with the increase of percentage of rubber powder whereas flexural strength of modified concrete is increased with the increase of the percentage of rubber fibers content. The abrasion resistance, carbonation depth, modulus of elasticity and chloride ion penetration of rubber powder concrete and modified concrete were also affected by addition of rubber ash and rubber fibers in concrete. For compressive strength test and flexural test, the concrete is tested on 3, 7, and 28 days. The concrete mixture was designed with water cement ratio of 0.225. For compressive strength test, 18 cubes size 150mm x 150mm x 150mm were tested on 3,7, and 28 days each. Moreover, for flexural test, 12 concrete beam size 500mm x 100mm x 100mm were tested on 7, and 28 days for each test. This study found that the compressive and flexural strength were decrease by increasing tire powder

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%	Percentage
^{o}C	Degree Celsius
Δ	Tolerance to Accommodate fixing precision

LIST OF ABBREVIATIONS

OPC	Ordinary Portland cement
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
w/c	Water-Cement ratio
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The waste material has received considerable attention to use as partial sand replacement in concrete. Scrap tyres are being generated and accumulated in large volumes causing an increasing threat to the environment. In order to eliminate the negative effect of these depositions and in terms of sustainable development there is great interest in the recycling of these non-hazardous solid wastes. The potential of using rubber from worn tyres in many civil engineering works has been studied for more than 30 years. Applications where tyres can be used and where the addition of tyre rubber has proven to be effective in protecting the environment and conserving natural resources include the production of cement mixtures, road construction and geotechnical works. Recycling of tyres in the applications mentioned above represents a suitable means of disposal for both environmental and economic reasons. Research on cement-based products modified with tyre rubber – such as concrete and mortar – has been carried out for many years in order to examine the potential utilisation of waste tyres in concrete production. Waste tyres have been used to partially replace the aggregates in mortars and concrete. Tyre rubber can be used to produce workable concrete for specific applications, provided that adequate selection processes are undertaken – including the amount, gradation and shape of tyre particles. This section deals with the properties of either mortar or concrete modified with waste tyre rubber. Nowadays, and researchers are looking for substitute materials that can provide an improvement to these forms of weakness, which will result in better concrete overall.

Over 1, 00,000 tons of waste tires are annually generated in Taiwan, and this number is increasing, but there is no solution for disposing of waste tires at present. The US ranks first in the world with 270 million waste tires generated annually, followed by Japan with over 110 million waste tires generated each year. Because of the environmental threat associated with waste tires, their proper disposal has attracted significant attention in recent years. In the United States alone, 290 million tires are generated per year, along with an existing 275 million tires currently stockpiled throughout the nation (Wang HerYung, 2016).

Waste tires need a larger storage space than other waste due to their large volume and fixed shape. They are unlikely to be decomposed, as burying the waste tires would shorten the service life of the burial ground and have low economic benefit. In addition, long-term buried waste tires often emerge from the burial ground surface or destroy the anti-leakage cover of the burial ground, and the exposed waste tires accumulate water that may breed bacteria, melds, insects or mice. In the case of fire, waste tires generate toxic gases, such as dioxin, that could result in severe pollution problems. Therefore, effectively recovering and reusing waste tires is an urgent and important issue. Landfill disposal, which is the most common method, will be drastically reduced in the near future due to the recent introduction of European Union directives that include significant restrictions on this practice in favour of alternatives oriented toward material and energy recovery. Furthermore, the disposal of used tires in landfills, stockpiles or illegal dumping grounds increases the risk of accidental fires with uncontrolled emissions of potentially harmful compounds.

1.2 PROBLEM STATEMENT

Tires are often deposited in an uncontrolled manner, because of the noticeable rapid depletion in sites available for waste disposal, causing major environmental problems. Water accumulation inside the tires ideal temperature and moisture conditions for the spread of mosquitoes, mice, rats and vermin. At the same time, the quantity of oxygen that exists in the interior of the tires is enough to cause fire in appropriate conditions. When it is decided that the used tyre is neither reusable nor reconstruct able, it is discarded and the recycling or recovery process begins. Environmental sustainability has been a recurrent theme in the face of increasing environmental pollution. Pollution is the introduction of substances into the environment whose by-products in time have harmful or negative effects on the environment.

Activity that directly and indirectly affects the environment. When a foreign substance is introduced into the environment in a high and unmonitored concentration, it becomes a pollutant and a threat to the environment. According to the European Environment Agency, pollution is the introduction of substances or energy into the environment, resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment. To understand why scrap tyres are environmental hazards, it is important to understand the properties of tyres. A tyre is a rubber covering, pneumatically inflated and placed round a wheel to provide a flexible cushion and form a soft contact with the road.

Tyres are manufactured for use in almost all forms of mechanical vehicles such as passenger cars, bicycles, tricycles, vans, trucks, airplanes, etc. The materials of modern pneumatic tyres are synthetic rubber, natural rubber, fabric, wire, carbon black and other chemical compounds. Most times, when tyres have served their original purpose, there are usually discarded in landfills or stockpiled or burned in open field. In many jurisdictions of the world.

1.3 RESEARCH OBJECTIVES

The main aim of this research is to study the mechanical performance of concrete containing tire waste powder rubber as partial fine aggregate replacement. The objectives of this study are as follows:

i. To investigate the influence of using specific particle sizes of powdered rubber in the compressive strength.
ii. To investigate the influence of using specific particle sizes of powdered rubber in the compressive strength.

1.4 SCOPE OF STUDY

The tire powder scrap rubber was ready from the factory in specific seize (0.225mm) slump test was the first step after mixing concrete. This study about the mechanical properties of tire waste in concrete production. To analyse the effect of tire rubber waste on compressive and flexural strength on concrete. 3 maxing had being conducted for this study (0%, 10% and 5% rubber). The machines that have been used in this work are compatriot test machine and flexural machine.

The compressive strength test is commonly one of the tests to identify the strength of concrete. By using this test, the cube was cured and should achieve the strength test above 25 MPa or Nimm2 at 28 days, 7 days based on the British standard the effective strength test is usually 28 MPa. It was tested for both conventional and control concrete to distinguish which one is higher in compressive strength. The test was carried out according to BS EN 12390-3:2002.

The flexural strength test is to determine the mechanical behaviour of concrete as a material' s ability to resist distortion under load. This test also will be conducted for both conventional and control concrete. The angular in shape of the waste crushed material and its rough surface will give and advantages for a better bond during mixing with cement phase, which could increase the flexural strength performance. The test was carried out in accordance to BS 1881: Part 118, 1983.

1.5 SIGNIFICANCE OF STUDY

The analysis of the check is required to pick out the result whether it is high quality the requirement or not. By carrying on the flexural electricity test, the ability of concrete to resist distortion beneath load can be set. Determining the suitability of tire scrap trite waste as a prattler for fine aggregate in 5% and 10% in concrete is very necessary for these researches convince people that waste material can be reused in the process. This is due to end result from the test will exhibit that whether 5% & 10% of tire scrap can obtain the minimum required for compressive energy take a look at and even higher.

The test to become aware of mechanical residences of POC & CSP concrete is integral to improvisation the houses of concrete by means of POC & CSP alternative in concrete production. We can end that how many in per cent POC & CSP are wished to make its residences in concrete robust and can attain the resistance to deformation load.

The learn about will serve at the properly appreciation on the effectiveness of the tire scrap waste as a partial fine aggregate substitute in the direction of excessive overall performance concrete in terms of compressive electricity and flexural test. Furthermore, this find out about will be satisfactory answer in retaining correct environment through reduction of tire waste.

CHAPTER 2

LITERATURE REVIEW

2.1 CONCRETE

The most common construction material used in the constructions is concrete. The range of specification is suitable to all application. Furthermore, an inexhaustible range of specifications can be manufactured to suit all applications. Normal weight concrete density is considered to have the usual density ranging from 2240 to 2480 kg /. Rajan, (2006) used treated and untreated chipped rubber particles to replace coarse aggregates in concrete. They found a reduction in thermal conductivity of 26.7% for 15% untreated rubber content and an increase of 17.8% for treated rubber when compared to the control mix. The treated rubber was treated with SILAN and it also exhibited an increase in compressive when compared with untreated rubberised concrete with m 3 (Presti D L, 2013). Concrete is made up by consolidating cement, aggregates, water and chemical materials in suitable amount and setting the outcome is harden over time. Concrete production is containing of a few systems to deliver a high-quality concrete that is batching, mixing, consolidation, finishing and curing. Every progressions of the procedure make an exceptional commitment to the nature of the final concrete product (Shu X and Huang B 2014). Due to the waste management issues and green building issue, concrete need to be advanced in the admiration of nature inside of an economic advancement point of view. Other than that, the formation of cement is delivering extensive measure of carbon dioxide which is detrimental to nature. Therefore, waste components such as palm oil and cockle are blended into solid while also considering the main purpose to decrease the waste material and moderate nature contamination.

2.2 DEVELOPMENT OF WASTE RUBBER AS A FILLER IN A COMPOSITES MATERIAL

Many researches paying attention in recycling the waste material especially on polymer based material such as plastic and rubber which resulting a novel sustainable composites. For example, during the 1980s and 1990s significant development and application of utilizing waste tyres were blooming especially in civil engineering (bin Samsuri A 2010). The technologies to recycle waste rubbers are continues to expand as more researchers started to pay attention to this area. Waste rubber were incorporated into various type of matrix such as concrete, latex, thermoplastic and thermoset materials (Imbernon L and Norvez S 2016). Their investigations has proven that addition of rubber waste has enhanced the properties of the composites such as; improved tensile strength, modulus and elongation at break (McKeen L W 2014) soft phase of rubber provides flexibility to the composites , having better thermal insulation properties Benazzouk (2008) Based from this discoveries it shows that use of rubber waste into many potential applications have been proven successful, diversify and they are keep emerging. Importantly, the development of rubber based fillers composites benefited for a betterment of the environment. This section will briefly explain the reviewed and development of few researchers in utilizing the waste rubber products into various types of composites such as polymeric based composite and concrete based composite.

2.2.1 WATE RUBBER TIRE AS FILLERS FOR COMPOSITES

The increment number of scrap tyres and stronger environment awareness worldwide makes all parties including federal regulations as well as researchers are giving attention to act for a sustainable approach towards waste tyres abundances. The waste tyres become a serious environmental issue due to their complex structure and component which makes it is difficult to degrade and it requires larger space in landfill and cause landfill limited area for other waste (Riyajan 2012). Many efforts has been conducted to minimizing the waste tyres stockpiling and dumping by treating the waste tyre as a source of sustainable materials.

Ramarad, (2016) as they addressed relevant information regarding waste rubber tyres being utilized as a reinforcement material or filler in polymeric material to form a composite. From the review, it found that one of the key element to recycle the waste tyre includes; the rubber needs to be ground and shredded prior being incorporated into the polymer. The ground rubber was then go for surface modification in order to enhance adhesion between the rubber particles with the polymer matrix. Surface modification was conducted either physically or chemically and also by DE vulcanisation or reclamation process. In this review, they discovered that thermoplastic matrix is commonly being studied by many researchers while natural rubber matrix is also getting extensive attention. On the other hand, little research being conducted for other rubber types of rubber such as butadiene rubber and ethylene propylene monomer (EPDM) rubber. In their review, they highlighted that, waste rubber tyres in rubber matrix is easy to process and its composites acquires an acceptable properties. Review also highlights the lack of studies concentrating on dynamic mechanical, aging, thermal and swelling properties of waste tyre rubber polymeric blends. On the other hands, Abu Jyadil et al. (International Rubber Study Group, (2016) conducted a development of polyester based composites filled with waste rubber tyre crumbs with an intention to be used as insulating material. They conducted up to 40% waste rubber crumb were added into the polyester and being characterized for its insulation properties such as thermal conductivity, water retention, density and thermal stability. They found that, an addition of rubber particles into the polyester matrix has potential to be used as a thermal insulator with the addition of waste rubber tyres has reduced the thermal conductivity and lower the water retention of the composites. The tensile strengths and compressive strength of the composite are higher than currently used insulating materials and it has similar strength to some of the construction materials. Ramarad (2015) has evaluated the capability of waste rubber to replace certain amount of virgin rubber in natural rubber mix. Their study shows that replacing 10-30% virgin rubber with waste rubber filler does not sacrifice the properties of the rubber mixture. They also found that incorporation of fine waste rubber powder with their surface being chemically treated into the asphalt concrete mixture has greatly improved the performance of the road pavement as the mixture is resistance to crack tip separation.Reviewed conducted by Shu and Huang. Adhikari (2000) reported that the used of waste rubber tyres into asphalt concrete is a successful effort as it improved properties and performance of the mixture. This successful outcomes is a result of good compatibility and interaction between waste rubber particles with the asphalt mixture binder. Lo Presti (2013) mentioned in his review that, waste rubber tyres has been used in flooring for playground and sport stadium, in shock-absorbing mat and roofing materials. While, Yang M. Forres, (2014) has investigated of using the scrap tyres as fillers in drainage structures such as for underground and horizontal drain and for ravine crossing. Mustafa and ElGawady highlighted that scrap tyres being used as fillers in concrete to improve the properties such as ductility, damping and impact resistance.

2.3 TIRE RUBBER RCYCLE

The impact of fine aggregate shape and composition on the quality hardened concrete is totally identified with the subsequent of the concrete, given that the fine aggregate has an evaluating inside regularly acknowledged points of confinement and that it should be reviewed before considering it in selecting concrete extents (ACI E1-07). (Sousa S P B, Ribeiro M C S, 2017). Use of Rubber as Aggregate in Concrete: A Review. International Journal of Advanced Structures and Geotechnical Engineering. Using as fuel in cement kilns, whose cost is lower than raw tire materials, which is an example of down cycling process (Yehia A, Abdelbary Y,2012) recycling by shredding process, where waste tires particles require having certain size for specific applications, varying from 0.15 mm to 19 mm; after shredding an electromagnetic process is applied for separation of rubber particles and steel fibers, for reusing them in several applications, for making rubber products such as floor mats, carpet padding, and plastic products, and as a substitute of fine aggregate in concrete (Rajan V V, Dierkes W K, Joseph R, and Noordermeer J W, 2006)..Recycled waste tires have been used in the construction industry; some examples of their uses are waste steel fibers from recycled tires as mechanical reinforcement of concrete, which makes possible the improvement of mechanical performances of the concrete (Aslani F, 2015).Recovered rubber as replacement of natural aggregates (fine and coarse), in which the elasticity features were improved and a lower diminution on the compressive strength and brittleness values were found; moreover, by adding rubber particles the reduction of the water absorption was possible; thus a better protection of the steel reinforcement against corrosion is obtained, as well as reduction in the structural weight (Ismail H, Galpaya D, and Ahmad Z, 2009) .Partial replacement, either sand or cement, by crumb rubber or powder rubber in concrete. The fracture characteristics of concrete were improved when adding crumb rubber; nevertheless, flexural strength was diminished. Moreover, light increment is done when adding powder. Other study points out large reductions in the strength and tangential modulus of elasticity as well as in the brittle behavior of the concrete when adding tire chips and crumb rubber particles (Esmizadeh E, Naderi G, Bakhshandeh G R, Fasaie M R, and Ahmadi S, 2017) recycling tires as foundation pad for rotating machinery and as vibrations damper in the railway station or where impact resistance, energy absorption, or blast is required the incorporation of crumb rubber aggregates from worn tires as lightweight aggregate in cement based materials which endows enhanced acoustic and thermal conductivity characteristics; moreover, when crumb rubber is used as insulation material allows potential savings on energy (Zanchet A2012).Although some advantages are obtained when adding recycled materials as rubber tire particles for improvement of the toughness of concrete, they present some disadvantages as lower values on the compressive strength, which should be attended. One alternative is the use of gamma radiation. Recent works have studied the effects of gamma radiation on compressive properties of polymer concrete; in one of them, the results show more resistance to crack propagation; moreover, compressive strain and the elasticity modulus depend on the combination of the particle sizes and the radiation dose (Zanchet A,2012).The gamma radiation is a type of high electromagnetic energy radiation, generally produced by radioactive elements or subatomic processes such as the annihilation of a positron-electron pair. One important characteristic is its capacity to penetrate matter deeper than alpha or beta radiation. In general, the gamma rays strike and pass through the material; it depends on the photon energies, thickness, or density of the materials.Application of gamma radiation in polymeric materials causes three different processes: cross-linking or scission of polymer chains and graft polymerization. The permanence of any of these processes depends on the nature of the radiation, the chemical structure of the polymer, and the applied dose (Kakroodi A R,2013). In general, molecular weight changes are produced after chemical reactions; content of gels with low molecular weight is obtained. After irradiating physical properties are affected. For example, the vulcanization of chlorine butyl rubbers by using gamma radiation decreases the tensile strength and elongation at break up to 25 kGy, but after this dose stability of such properties is observed, up to 200 kGy. Moreover, thermal stability is reduced through the degradation and scission of molecular chains (Siddique and T. R. Naik, 2004). In another study, polydimethylsiloxane rubber foams were gamma irradiated and their mechanical properties and chemical structure were evaluated, through compression test, infrared attenuated total reflectance spectroscopy (ATR), and X-ray induced photoelectron spectroscopy (XPS). The results show a higher cross-linking of polymer chains when increasing the irradiation dose; thus foams became harder (Karger-Kocsis, 2013).The high-energy radiation is not frequent in the preparation of composites; nevertheless it has special advantages in the control polymerization because it can be initiated uniformly within small thicknesses of material. This process, compared to thermal process or chemical attack, presents several advantages; for example, initiating radiation requires no activation energy and does not require catalysts or additives to initiate the reaction; the initiation is homogeneous throughout the system, the process can be carried out at any temperature and can be interrupted at a specific reaction time, the termination reaction is practically controlled, the polymer can be analysed to a specific reaction step, and during temperature initialization reaction is maintained, unlike the one presented in a conventional exothermic curing without irradiation, and, above all, it is faster spending less time and money (Fernandez, J. A. Azamar-Barrios, and C. R. Rios-Soberanis, 2008).Some studies covered the effects of gamma radiation on composite materials, for example, on the mechanical properties and durability of cement concretes. Some applications include concrete as material for nuclear power reactors; for this purpose the specimens were submitted to dosages from 227 MGy and 470 MGy with a dose rate of 5.0 kGy/h. The results show a diminution of about 10% on the elastic and tensile properties, as well as loss of weight, caused by one or more of the following mechanisms: "natural" drying (including gamma heating) radiolysis-induced accelerated drying (where large gas is released) radiolysis-induced carbonation; and degradation of the calcium-bearing cement hydrates (Ch.-T. Chiu, 2008).Another study is related to cement concrete and irradiated nylon fibers; it shows higher compressive strength values, when adding nylon irradiated fibers at 50 kGy. Load transfer mechanism between the concrete and fibers under loading is seen. Moreover, a reinforced concrete is created with high elastic modulus and high deformability. Furthermore, 50 key seems to be the dose at which the reaction mechanism changes from cross-linking to chain scission. Ionizing energy generates more contact points on the fibre surfaces and in consequence a larger contact area between the fibres and the concrete phase (Neocleous, H. Tlemat, and K. Pilakoutas, 2006). Another study is devoted to polymer-ceramic composite material, as gypsum/poly(methyl) acrylate composite where the] yield of polymerization increased up to 88% with increasing radiation dose and levelled off at a dose around 4 key [Aiello, F. Leuzzi, G. Centonze, and A. Maffezzoli, 2009]. Modifications on the cement and different mineral aggregates have been done by using gamma radiation; such materials are mixing into the concrete. In other cases all concrete components are mixed and then concrete specimens are irradiated. Both kinds of concretes are evaluated by mechanical tests. The results are different, and the scanning electron microscopy has been a good tool to evaluate the contribution of each component in no irradiated and irradiated concretes. After mechanical testing, morphological characterization on some fractured cement concrete pieces is carried out. SEM technique provides good images of distribution of dispersed phases in a matrix.

2.4 WATER

Tlemat, K, (2004) state that water is an important medium to the nature of mixing water since it’s identified with the impact on workability, quality and sturdiness (Cement Concrete & Aggregate Australia). Water for mixing concrete is known to be free from alkali, acid, oil and natural purities. As indicated by Wood, less water in mixing will certainly lead to a more strength and toughness of concrete yet guarantee it is workable. Moreover, excess of water bringing about feeble and permeable concrete. Intemperate debasements in blending of water not only may influence setting time and concrete quality, but also may bring about blossoming, recolouring, erosion of reinforcement, volume unsteadiness and lessened strength. Nonetheless, oversea nations like United States are utilizing waste water, for example, commercial ventures waste water and sewage water in blending concrete Neocleous, K. PPilakoutas, (2006) stat that Water is a main source for concrete production. It has a significant impact in the work of the spreading cement concrete so that each detail of aggregates closely covered with cement and will easily for the concreting work process. Furthermore, water is a substance for a chemical reaction in the cement to bind all the aggregates during concrete mixing Water cement ratio, (w/c) is unitary of the main factors that determine the strength of concrete. The ratio of (w/c) that is lower will produce a lot stronger concrete, while higher ratio of (w/c) will raise a concrete with lower intensity. Strength, resistance, and waterproof properties of concrete are dependent on the quantity of water applied. Only if amount of water is used more than the prescribed boundary, the durability and density of the concrete will be shortened. Else, if too little water is used, a more complicated concreting process work as well as hydration process will be faced.

2.5 MECHANICAI PROPERTIES OF TIRE RUBBER

Research has shown that the presence of tire rubber aggregates in concrete alters the performance of concrete both, positively and negatively. One major negative effect of using tyre rubber in concrete has been its marked reduction in its mechanical performance compared to conventional concrete. Researchers report notable reductions in the strength and elastic modulus of the rubberised concrete (Topçu, 2001). The reduction in the mechanical performance has been attributed to the significantly lower stiffness (<5 MPa) of the rubber, the uneven distribution of the rubber aggregate due to its light weight and the poor bonding between the rubber aggregate and the cement paste, (Topçu and N. Avcular, 2001). This shortcoming has been tackled but addressing each of supposed causes of the strength reduction. The lower stiffness of the rubber aggregates was controlled by limiting the amount of tyre rubber aggregates in the concrete and the size of tyre rubber aggregates. Several authors (Mohammed, K. M. Anwar Hossain, 2012) reported that chipped rubber result in greater strength losses compared to crumb rubber. Huang et al attributed the strength gain that happens when smaller size is used, to the reduction of the stress and strain concentrations in the concrete. The effect of tyre rubber content and rubber aggregate size on the mechanical performance of concrete was assessed by Li et al. (Pelisser, N. Zavarise, 2011). They found that high rubber content and smaller tyre rubber aggregate size reduced both the compressive strength and static young's modulus of rub Crete. However, the ultimate strain of the rub Crete increased as rubber content increased and particle size decreased. In addition to that crack length, width and occurrence decreased with an increase to tyre rubber aggregate content and smaller rubber aggregate size. Their findings concurred with separate studies by other researchers. Thus, with regards to rubber content and size, most researchers have suggested a maximum rubber content of not more than 20% total aggregate volume and a size no bigger than crumb rubber size. It was imagined that the soft rubber acted like air voids within the concrete thereby offering little resistance to loads thereby rendering the particles site as points of weakness within the concrete matrix. The lack of bond was addressed by two main approaches. Firstly, by using the rubber particles with. The rubber glove industry has grown tremendously over the years to meet the world demands due to rising healthcare awareness globally. This is due to standard of life improved and healthcare reforms. Subsequently, demand for protective products of healthcare safety such as gloves, condoms, latex thread, etc. are also increased (Benazzouk, O. Douzane, T. Langlet, K. Mezreb, J. M. Roucoult, and M. Quéneudec, 2015). It can be relate with the 26% increment of Malaysia rubber. export for the first quarter of 2017 that worth RM4 billion in sales if compared to the first quarter of 2016 which recorded RM3.2 billion. High usage of rubber gloves globally has led to high disposal of used gloves. In addition to the higher number of glove disposal also contributed by the high reject rate during the production process due to strict production specification and unstable nature of latex (Al-Tayeb, B. H. Abu Bakar, 2012). Due to their very complex structure and composition that contribute to excellent properties such tremendous elasticity, high resistance to acids, alkali, chemical solutions and environment agents, it makes rubber glove very difficult to degrade consequently creates a serious environmental problem. Glove's ingredients consist of latex (either it is natural or synthetic latex) and vulcanised agents (i.e: sulphur), surfactants, curing accelerator agents and pigments. Thus, dumping into landfill or any open area not only causing piling up but leaching off the ingredients of the glove components will pollute the water and soil. Rubber glove that possessed many unique properties were beneficial in developing numerous new functional material instead of being treated as invaluable garbage and pollutants but rather a valuable source of sustainable materials. Most importantly, glove are relatively cheap and easy to get thus provide low cost of waste rubber gloves source that lead to low processing cost of the new material . Elastic behavior of rubber glove can be also benefited into numerous field such as damping components, thermal and noise insulator and others. Few literatures has reported that composites with the waste rubber glove fillers shows better mechanical properties such as having better impact strength, better tensile properties and lower stiffness (Khaloo, , 2008). Besides that, there were few other findings that proved, fillers from waste rubber glove has improved the composites properties. For example, blending of filler from waste acrylonitrile butadiene rubber (NBR) glove with epoxidized natural rubber (ENR 50) and NBR rubber glove waste blended ENR 50 has shown improvement of tensile strength, modulus and elongation at break. A study mentioned that, they chose rubber glove specifically NBR waste gloves as a filler in their study because it has excellent puncture and tear resistance, with a reasonable impermeable to many types of chemicals. Thus, these properties will give additional value to the new develop material or composite. In addition using waste NBR glove helps to reduce cost of the material and also easy handling.

2.6 EFFECT ON IMPACT STRENGTH AND OTHER MECHANICAL PROPERTIES

Bravo and J. de Brito (2012) stat that two types of arrangements were made by using 15% of rubber tyre in equal amount of coarse aggregate. The first one was tyre rubber and second as chips dispersed. As a result increase in toughness was observed. But the stiffness as well as strength was considerably decreased. After applying peak load on Concrete it was observed that the ordinary concrete was dispersed while the rubberized concrete had deformation before failure. The rubber chip modified concrete takes fewer loads than fiber modified concrete before the failure of concrete mix.

2.6.1 EFFECT ON COMPRESSIVE STRENGTH

Fattuhi and L. A. Clark (2001) conducted various tests on rubberized concrete, having tyre articles and crumb rubber of sizes 36, 24 and 18 mm and found that there is a reduction of 85% in compressive strength and about 50% of reduction in split tensile strength but showed large absorption of energy. Kaloush K.E. et al investigated that increase in rubber content in concrete decreased the compressive strength. This reduction was due to the presence of entrapped air. Experiments have showed that compressive strength can be increased by adding some de-airing agents into rubberized concrete. Ling investigated that there was an organized decline in the compressive strength with the increase in rubber content from 0 % to 40% Felipe J.A. and Jeannette Santos, (2012) found that strength reduction of 50% was celebrated for a mix with 14% replacement in their studies. Achieved higher compressive strength in crumb rubber concrete by dropping trapped air in the mix. Neville A. M. studied, a reduction in compressive strength with the adding up of rubber aggregate in the concrete mix but there is still a possibility of increasing the compressive strength by using desiring agents.

2.7 TIRE RUBBER PARTICLR PROPERTIES

Bonilla, and J. Payá, (2012) stat that the unit weight of rubber particles is much less than that of mineral aggregates thus resulting in a 2-2.5 times more tyre rubber aggregate volume for the same mass of mineral aggregate. The elastic modulus and Poisson’s ratio of tyre rubber particles is <5 MPa and 0.5 respectively. Tyre rubber particles properties are largely derived from the rubber component of the tyre as it is the major component. These properties can be useful or detrimental. In his investigation pretreated crumb tyres with waste organic sulphur compounds from a petroleum refining factory. He found that the compressive, tensile, and flexural strengths of concrete samples containing treated rubber particles increased significantly Martínez-Barrera and O. Gencel, (2014) reported an improvement of 17 % in compressive strength when crumb rubber (maximum size 35 mesh) is pre-treated with 0.1M Sodium Hydroxide (NaOH). It was also found that NaOH surface pre-treatment was better suited for rubber particle size not bigger than crumb rubber. Huang et al. performed a two staged surface treatment to improve properties of rubber modified rubber cement composites. They used silane coupling agent to modify rubber particle surface and then use cement to coat the treated rubber particles. This method is said to result in up to 30% strength gain. that when crumb tyre rubber is pre-treated with carbon tetrachloride, the rubberised strength improved by 57%. Haibo et al. reported a 25.4% strength improvement in compressive strength at 10% rubber particle content when the rubber particles were treated with analytically pure anhydrous ethanol (AE) solvent, acrylic acid (ACA) and polyethylene glycol (PEG) for grafting hydrophilic groups on their surfaces. prepared their mechanically produced tyre rubber particles by soaking and washing them with water. Albano et al. (Cruz-Zaragoza and G. Martínez-Barrera, 2009) reports an increase in the compressive and splitting tensile strengths of rub Crete made form crumb rubber pre-treated with NaOH and silage. Cardoso, and A. B. Lugao, (2012) found that when crumb rubber was pre-treated with polyvinyl alcohol (PVA) and sodium hydroxide (NaOH), strength performance of rub Crete improved significantly. A pre-treatment method to generate strong chemical bonds between the rubber and the cement paste. The crumb rubber particles.

2.8 RECYCLED SCRAP TIERS MATERIALS

Sui, X., (2013), commented from their research on the use of recycled tyres as materials to be used in the concrete as partial or complete replacement of aggregate that there are four types of scrap tyre particles available which are classified in accordance to their particle size and the texture. These types consist of slit tyre particles in the form of slits which are halved in two halves. Apart from the slit tyre particles, there are shredded tyre particles which are also utilized in concrete as a replacement of aggregate in the concrete. The particle size varies from 300 to 400 millimeters long and 100-200 millimeters wide. There is also ground type of rubber tyre available for the utility in research work which is cut in the sizes of 19mm to 0.15 mm. The crumb rubber used in the concrete has to be having a nominal size equal to the standard sieve dimension of 4.75 mm. Clough,(2001), commented as part of their research work in which he used crumb rubber as partial and complete replacement fine aggregate in concrete and reported the various performance levels of concrete subject to the different phenomenon like shrinkage, segregation, workability, flexural bending stresses, shear bending stresses, normal consistency of cement paste and the initial and final setting times determination.the use of crumb tyre particles as the partial replacement sand in the concrete has better performance levels as compared to the full or complete replacement of sand in the concrete with the crumb tyre particles. The partial replacement of sand with crumb tyre particles are imparting better performance levels to the concrete at various serviceability levels as compared to the complete replacement of crumb aggregate with the sand. The sand in the concrete along with the crumb tyre particles are imparting better shear capacity, fire resistance and resistance to spalling due to various environmental hazards like, fire, rainwater and collective segregation in concrete. Engineering & Technology in India www.engineeringandtechnologyinindia.com ISSN Entrepreneurship and Management: Innovative Construction Techniques and Ecological Development. Vol. 2 Civil Engineering Zunaithur Rahman. D., Jeyamugesh. S., Sivaranjani. S., and Vijayaraghavan. J. Study on Waste Rubber Tyre in Concrete for Eco-friendly Environment 168 sustainable management of that aforesaid. Waste rubber tyre is a huge task to the industries and public sectors. Decomposing of waste rubber tyre which contains composed of materials and it cause serious contamination for environmental conditions. Another decomposing process is burning and harmful pollutions are causes by that gases exhausted from its Barbuta and M. Hrja, (2008) burning. Most of the studies were carried out to recycle and reuse scrap tyres in a variety of rubber products. Generating the electricity or as a fuel for cement clinks as well as in asphalt concrete by incineration For usage waste tyres in civil engineering is currently very low and its one of largest potential routes in construction. Depends on its examinations, another way is using the tyres in concrete. These results in the improvement of energy absorption, ductility and resistance to cracking which undergoes under (mechanical and dynamical properties [Le Pape, K. G. Field, and I. Remec, 2015). When we compared waste rubber mixture is too normal concrete it's more workable and also it is useful in making light weighted aerated concretes. Non-structural applications are mainly required usage of rubberized concrete (Kelly, J. Brocklehurst, D. Mottershead, and S. McNearney, 2011). In our present investigations were request the rubber aggregate which made by mechanical cutting the tyre into the required sizes. It not easy to handle at initial stage and it's very laborious and time consuming forever at these difficulties can be easily sorted out and proper cutting tools and machinery are made for these particular usage and large scale production is devised. Sources of rubber aggregates is the extracted and discarded tyre that is trucks tyres which is gathered and collected from the local market and rubber tyre coarse aggregates are prepared from aggregate crushing machine (Menchaca-Campos2012). In this study, the rubber aggregates are prepared mechanically by cutting the tyres to maximum nominal size equal to 20 mm and after cleaning with portable water kept for air drying. The specific gravity is obtained from test equal to 1.10.

CHAPTER 3

METHODOLOGY

3.1.1 INTRODUCTION

In this chapter, materials and the testing methods will be theoretically explained specifically. Several experiments have been conducted to study the effect of tire rubber scrap powder as fine aggregate replacement to the mechanical properties. All the testing conducted were in accordance to ASTM C 109/C 109M standard.

3.2 FLOWCHART OF RESEARCH

Flow chart plays an important role to ensure the study, flow chart progressing according to plan and to avoid any confusion during lab preparation. Process flowchart gives an overview of the research progress as shown in figure 3.1 and figure 3.2.

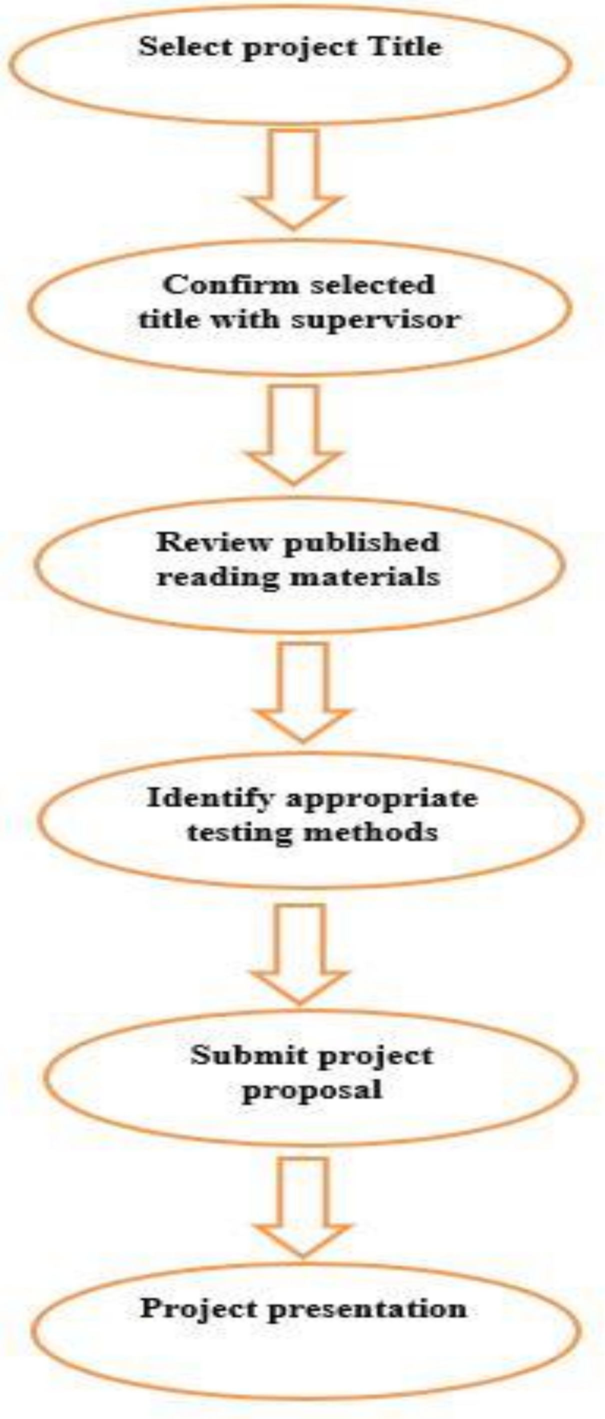

Figure 3. 1: Flowchart of final year project 1

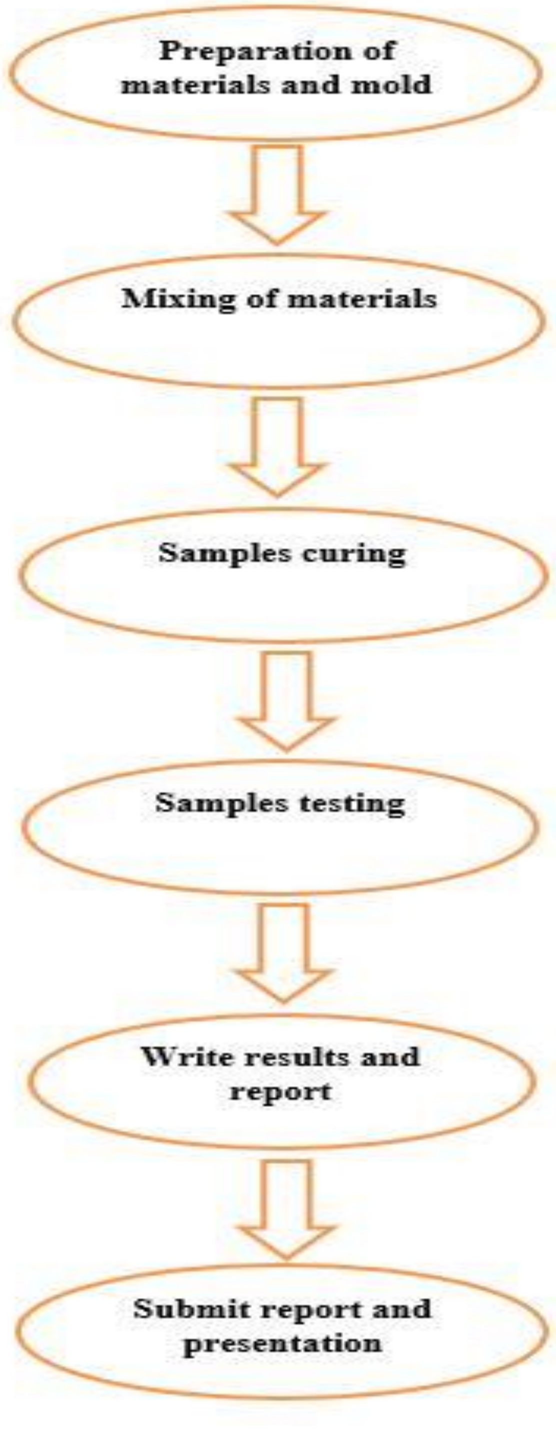

Figure 3. 2: Flowchart of final year project 2

3.3 MATERIALS

In this study, the materials that will be used are cement, tier rubber scrap powder, fine aggregates, coarse aggregate, Superplasticizers and water.

3.3.1 ORDINARY PORTLAND CEMENT

Ordinary Portland cement (simply called ordinary cement) refers to the hydraulic binding material ground by mixing Portland cement clinker, 6% ~ 15% blended materials, and appropriate amount of gypsum, code-named P• O. The maximum amount of active blended materials mixed in cement should not exceed 15% of the total mass. They are allowed to be replaced by kiln ash and inactive blended materials which should be no more than 5% and 10% of the cement mass respectively. The maximum amount of inactive blended materials mixed in cement should not exceed 10% of the total mass. According to Portland Cement, Ordinary Portland Cement (GB175-1999), the national standard, the strength grades of ordinary cement can be divided into: 32.5, 32.5 R, 42.5, 42.5 R, 52.5, 52.5 R, and their ages should be no less than the numerical value in Table 3.1 . The initial setting time of ordinary cement should not be earlier than 45 min, and final setting time should not be later than 10 h. The screenings left on the square-hole sieve of 0.08 mm should not exceed 10%. And boiling stability must be qualified. The ignition loss of cement should be less than 5.0%.

Table 3. 1: Requirements for the Strength of Ordinary Portland cement at Various Ages (GB175-1999)

Strength Grade	Compressive Strength (MPa)		Bending Strength (MPa)	
	3d	**28d**	**3d**	**28d**
32.5	11.0	32.5	2.5	5.5
32.5R	16.0	32.5	3.5	5.5
42.5	16.0	42.5	3.5	6.5
42.5R	21.0	42.5	4.0	6.5
52.5	22.0	52.5	4.0	7.0
52.5R	26.0	52.5	5.0	7.0

Figure 3. 3: Ordinary Portland Cement

3.3.2 FINE AGGREGATE

Fine aggregate is containing rougher material that has been approved in conformity with stipulations. Sand or fine aggregate comprises a portion of the aggregate, which has a small particle size. The use of fine aggregate is to fill the voids in the lightweight aggregate and to act as workability agent. The fine aggregate is oven dried before it is used to prepare concrete mix. Sand is one of fine aggregate that has a smaller in limit size equal to 0.07 mm. Particle size ranging from 0.06 millimetre to 0.02 mm can be classified as sediment and clay. For this study, the sand is select from laboratory availability. The size of fine aggregate or sand must lower than 2.36 mm. fine aggregate is also required to adopt the same procedure as coarse aggregate that is sieve analysis to produce the wanted size. Figure 3.3 shows an example of fine aggregate.

Figure 3. 4: Example of fine aggregate.

3.3.3 COARSE AGGREGATE

Coarse aggregate is mined from rock quarries or dredged from river beds, therefore the size, shape, hardness, texture and many other properties can vary greatly based on location. Even materials coming from the same quarry or pit and type of stone can vary greatly.

Most generally, coarse aggregate can be characterized as either smooth or rounded (such as river gravel) or angular (such as crushed stone). Because of this variability, test methods exist to characterize the most relevant characteristics, since exact identification would be impossible. Several key characteristics that are frequently used to describe the behaviour of coarse aggregates include relative density (or specific gravity), bulk density, and absorption.

3.3.4 Water

Water is one of the most important elements in construction and required for preparation of mortar, mixing of cement concrete and for curing work during construction work. The quality and quantity of water has much effect on the strength of concrete. The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The water cement ratio for all the cement mix process was performed for this study is set at 0.485 according to ASTM C 109/C 109M standard (Cement, Rooms, Statements, & Mass, 2008).

3.3.5 Tire rubber scrap powder

The tire was in the specific size from the factory and stored in the lap. Since the wheel got invented, it has been redesigned and recreated according to convenience of humans. Today, we can see there is a heavy load of traffic on roads. This load is more in the case of urban areas as compared to rural areas due to difference in life style and infrastructure. The number of vehicles (cars, buses, trucks, motorcycle) are increasing exponentially with time. These vehicles run on the road through wheels by means of tyres. Waste Tyres A lot of waste is generated from automobiles and one of these wastes is used tyres. The powder of these used tyres can be used as a substitute of raw material for the production of rubber. With the increasing number of cars and trucks all over the world, used tires are also available in large quantities and are extremely cheap for the production of rubber powder.

Figure 3. 5 :tire rubber scrap

3.3.6 Superplasticizers

Additives used in making high strength concrete. Plasterers are chemical compounds that enable the production of concrete with ca. 15% less water content. Superplasticizers allow reduction in water content by 30% or more. These additives are employed at the level of a few weight percent. Plasticizers and superplasticizers retard the curing of concrete. SPs are used where well-dispersed particle suspension is required to improve the flow characteristics (rheology) of suspensions such as in concrete applications. Their addition to concrete or mortar allows the reduction of the water to cement ratio without negatively affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete. They greatly improve the performance of the hardening fresh paste. The strength of concrete increases when the water to cement ratio decreases. The addition of SP in the truck during transit is a fairly modern development within the industry. Admixtures added in transit through automated slump management systems, such as Verify, allows concrete producers to maintain slump until discharge without reducing concrete quality.

Figure 3. 6: Superplasticizers

3.3.7 MIXING PROCESS

The preparation mixing process had be conducted once all materials needed for mixing are prepared. The mixing process can be done using a concrete mixer machine at civil engineering and earth resources laboratory. Mixing process is a process that involves manipulation of a heterogeneous physical system with the intent to make it more homogeneous. To produce a cement the raw materials are prepared and weighted according the mix ratio. The materials are mixed together with water in a mixer and then compacted into the mould. Once the concrete is formed, then the concrete need to be put into water for curing according to its specific days. Table 3.2 shows the total samples needed for all two tests. Figure 3.4shows concrete during water curing.

Figure 3. 7: concrete during water curing

Table 3. 2: shows the total samples needed for all two tests.

Type of Test	7 Days of Water Curing		28 Days of Water Curing		Total Samples
Compressive Test	0% 5% 10%	3 sample 3 sample 3 sample	0% 5% 10%	3 sample 3 sample 3 sample	18 cubes
Flexural Strength test	0% 5% 10%	3 sample 3 sample 3 sample	0% 5% 10%	3 sample 3 sample 3 sample	18 beams

3.4 COMPRESSIVE STRENGTH

Compressive strength test is the major testing to estimate the concrete strength. The compressive strength of all concrete cubes of (150 x 150 x 150 mm) were measured following the procedures stated in ASTM C39. A total of 36 specimens containing. All the specimens were subjected to water curing until the testing date. The specimens were tested at the age of 7 and 28 days of curing. Before the sample was placed inside the compressive strength test machine, the sample was weighed and recorded. Before placing the cube sample inside the compressive strength test machine, the testing machine bearing-surfaces was wiped to ensure it was clean. The sample was placed at the center of the lower plate and the load was applied as in figure 3.5. The maximum concrete strength was directly taken from the machine or calculated using Equation 3.1 (ASTM C39). Figure 3.6 shows cube failed under compressive force.

Calculation of compressive strength was done according to the following equation:

$$C = P/A \qquad \text{Eq (3.1)}$$

Where:

C = Compressive Strength, MPa;

P = Maximum Load, N indicated by the compression test machine

A = Area of upper and lower bearing surfaces of the sample, mm^2

Figure 3. 8: The maximum concrete strength

Figure 3. 9: cube failed under compressive force.

3.4 FLEXURAL STRENGTH TEST

This test is done to determine the modulus of rupture of specimens prepared and cured. The specimens are tested by using flexural testing machine as in figure 3.7. The load is applied to the upper surface of the specimen as in, which is a concrete with moulid size of 100 mm x 100 mm x 500 mm at 7 and 28 days of curing. The calculations result is taken to the nearest 1 psi or 0.01MPa as Eq. (3.2) follows:

$$R = PL / bd^2 \qquad \text{Eq (3.2)}$$

Where:

R = modulus of rupture, MPa.
P = maximum load indicated by the testing machine, N.
L = span length, mm.
b = average width of specimen at the fracture, mm.
d = average depth of specimen at the fracture, mm.

Figure 3. 10: Beam under flexural strength machine

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The mechanical properties and durability of concrete were significantly affected by introducing tire rubber powder into concrete. In this work, the variation of properties in concrete with the tier rubber powder content was investigated. Additionally, the effect of modifiers was evaluated by replacing fine aggregate (0%, 5%, and 10%) The samples are then tested to gain their respective compressive and flexural strength. A total of cubes and beams were casted and cured in different curing times; 7 and 28 days. This chapter presents the results obtained from the current study and discusses the results by comparing and contrasting them with the findings of past researchers.

4.2 COMPRESSIVE STRENGTH

Table 4.1 and Figure 4.1 show the results on compressive strength of concrete with respect to 7 and 28 days of curing period. According to the compressive test done, the results stated that the control samples with 0% tire rubber powder showed the highest compressive strength in comparison between the samples that contain tire rubber powder. The value recorded at 7 days for the control was 35.83 MPa. On the other hand, the samples with 10% rubber powder recorded the lowest compressive strength compared to other samples with 23.04 MPa. The different between the highest and lowest compressive strength at 7 days is 3.32 MPa. Next, at 28 days, the highest recorded value of compressive strength comes from the control samples with 0% tire rubber powder with 40.03 MPa. Meanwhile, the samples with 10% tire rubber powder recorded value of compressive strength is 27.75 MPa. The different between the highest and lowest compressive strength at 28 days is 2.68 MPA.

In conclusion, it can be said that concrete containing tire rubber powder produce lowest value of compressive strength than control samples. All the samples that contain tire rubber powder show decreases value of compressive strength. Thus, with the increase of tire rubber powder the value of compressive strength was decreased. This may be due to the size of particles and chemical composition of tire rubber powder as fine aggregate replacement. All of the results produced by the mixes showed increment in compression strength with the increment of curing period.

Table 4. 1: Results of compressive test at 7 and 28 days

Percentage of tire rubber powder (%)	**Compressive Strength (MPa)**	
	7 Days	**28 Days**
(0%)	35.83	40.03
(5%)	26.36	30.43
(10%)	23.04	27.75

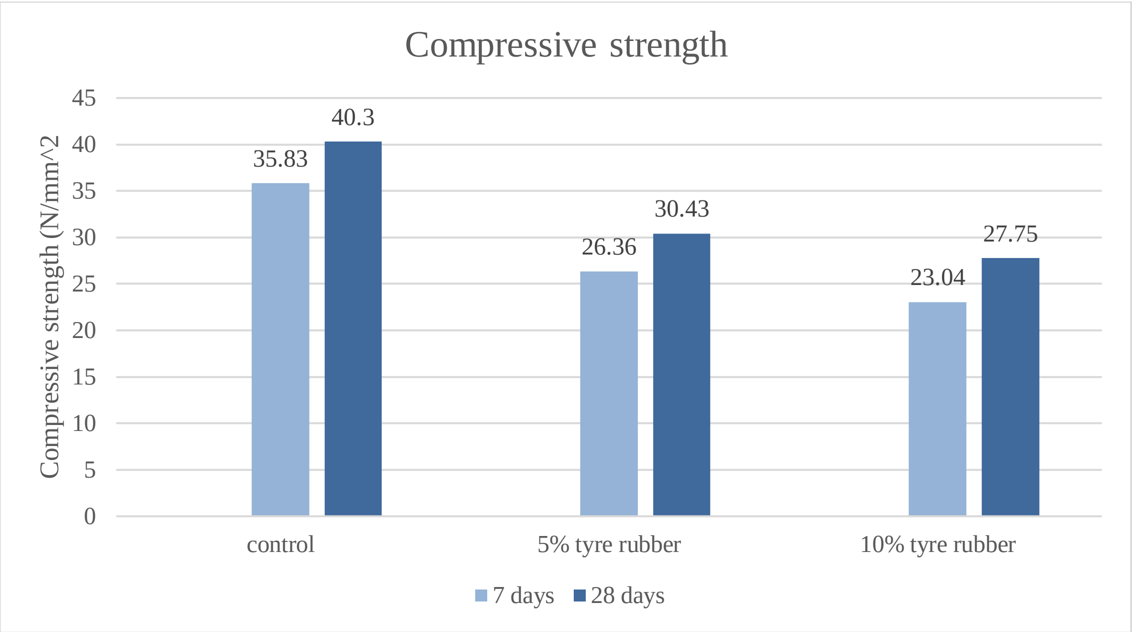

Figure 4. 1: Compressive strength at 7 and 28 days

4.3 FLEXURAL STRENGTH

Table 4.2 and Figure 4.2 show the results on flexural strength of concrete samples with respect to 7 and 28 days of curing period. In this section, the flexural tests conducted on the samples are presented. The average reading from the flexural test results of three samples of each type of samples are taken to increase the accuracy of the reading. Three types of samples were prepared, just like the compressive strength tests, the samples are the control samples with no tire rubber powder. And (5%, 10%) The samples were casted and labelled then went through 7 and 28 days of water curing before being tested. Firstly, at 7 days, the recorded value of flexural strength for control samples which contain 0% tire rubber powder is 3.66 MPa The control samples produced the highest flexural strength. On the other hand, the lowest recorded value of flexural strength comes from 10% tire rubber powder samples with the value of 3.74 MPa. The different between these two values is 0.06 MPa. Next, at 28days, the value gained from flexural test for control samples is 5.65 MPa. On the other hand, samples that contain 10% tire rubber powder CS showed the lowest flexural strength with the value of 4.31 MPa. The different between the highest and lowest flexural strength at 28 days is 0.59 MPa. In conclusion, the results clearly showed that samples of concrete containing 0% tire rubber powder showed the highest flexural strength compared to other mixes. In addition, with the increase of tire rubber powder the value of flexural strength was decreased. Tire rubber powder may not fill the void in the concrete appropriately, therefore the concrete had been low density and weaker. Thus, the concrete would not be able to exhibit high flexural strength compared to control sample.

Table 4. 2: Result of flexural strength test at 7 and 28 days

Percentage of tire rubber powder (%)	Flexural Strength (MPa) 7 Days	28 Days
(0%)	3.66	5.65
(5%)	3.47	5.26
(10%)	3.14	4.31

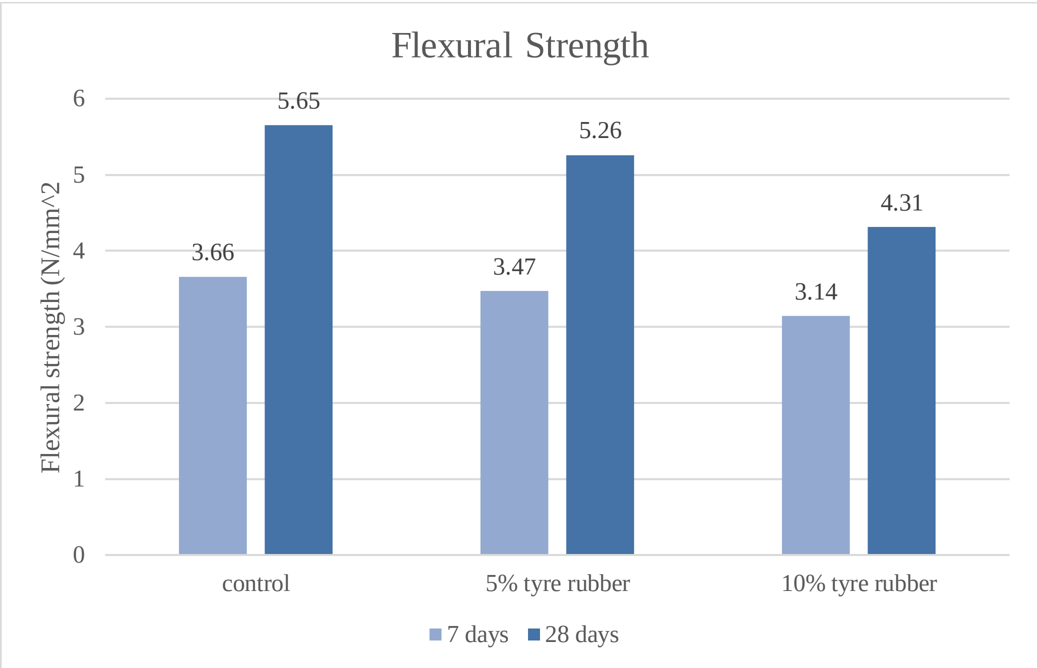

Figure 4. 2: Flexural strength at 7 and 28 days

CHAPTER 5

CONCLUSION& RECOMMENDATION

5.1 CONCLUSION

The objectives of this work are to investigate the effect of tire rubber powder as partial Fine aggregate replacement on compressive strength of concrete and to investigate the effect of tire rubber scrap powder as partial Fine aggregate replacement on flexural strength of concrete. The following conclusions can be drawn from the results obtained.

i. Concrete produced from the control (0% tire rubber powder) recorded the highest compressive strength compared to other samples and other percentages of tire rubber powder due to the size and chemical composition of tire rubber powder.

ii. The presence of tire rubber powder in Fine aggregate would affect the flexural strength. This study proved that the concrete contain tire rubber powder as partial Fine aggregate replacement would not achieve the highest flexural strength.

5.2 RECOMMENDATION

This study is mainly focus on the mechanical properties of tire rubber powder as partial Fine aggregate replacement in concrete. Researches on other performances such as durability and chemical properties are needed to understand the influence and produce better mix type to be applicable in industry. The following suggestion is made for further research by:

i. The research should be conducted for a longer duration of time to determine the effectiveness of concrete containing tire rubber powder when exposed to the weather changes and exposure to the environment.

ii. To further studies on the water absorption test to determine the rate of absorption of concrete that contains tire rubber powder.

iii. To further studies on the durability test.

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