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SCRAP TIRES

INTRODUCTION

The significant increases in the automotive industry all over the country lead to increase the production of scrap tires. Scrap tire, according to Ohio EPA, is defined as any tire that does no longer serve its main purpose as vehicles tire. It has been estimated that 13.5 million tons of tires are scrapped each year in USA alone. In Malaysia, it has been estimated that 245,087 tons of scrap tire was produced in 2010 and millions of tires reached their end-of-life every year and discard as scrap tires. It has been estimated that, by 2020, 20 million units of tires will be disposed annually in Malaysia. Scrap tires which are considered as solid waste are disposed without proper treatment due to the lack of enforcement law and also the improper management pertaining to legal disposal method of scrap tires in Malaysia. This illegal disposal is causing environmental problem as it leads to consuming huge areas of landfill or dumpsite and turns it to a potential breeding ground for mosquitoes, rats, and rodents. The act of illegal burning of scrap tires harm the environment as in the event of a fire in the landfill area, scrap tires are highly flammable material and produce heavy and black smokes.

Scrap tires are being used as supplementary fuel in cement production as it reduces cost and produce maximum heat recovery. However, tires as supplementary fuel emit high carbon dioxide (CO_2) which leads to greenhouse effect. In addition, the production of one ton of cement requires 4.7 million British thermal unit (BTU) of energy and generates nearly a ton of CO_2. International agreement on climate change has been adopted in 1997 to address

the high emission of greenhouse gas (GHG), known as Kyoto protocol. Kyoto protocol aims to fight global warming by reducing greenhouse gas concentrations in the atmosphere, focusing on main greenhouse gases such as carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

On the other hand, illegal burning of scrap tires generates a massive amount of black, toxic and hazardous smokes, and oil deposited which endanger the environment and health. Heavy metals emitted by the tires during fire or burning such as iron, lead, zinc, chromium and cadmium endangers the nearby living organisms. Various mutagens and carcinogen chemical are usually emitted from controlled and uncontrolled burning of tires. The leachate from the combustion of scrap tires capable to reach and contaminate the groundwater source due to the liquefaction of rubber. In addition, scrap tires are bulky with 75% of the volume is void, hence accumulating this waste in landfill or dumpsite consumes valuable space. And also, improper management of scrap tires potentially provides a breeding ground for disease-carrying rat, mosquitoes, and pests which consequently, leads to health problems. In ancient time, clay brick was the most popular construction materials and it was produced by sun dry or high temperature firing process. The topsoil must be removed in order to acquire good quality clay for brick manufacturing, which causes the depletion of agricultural land. Therefore, recent researches are focusing on producing bricks that minimize environmental risk and promote sustainability. Thus, it is essential to reuse the scrap tires as part of concreting materials, in the form of crumb rubber to produce masonry interlocking brick.

WASTE TIRES

The disposal of scrap tires has resulted in major environmental problems worldwide. The problem is due to the massive number of tires produced yearly due to a significant increase in number of

vehicles globally. According to the United States Environmental Protection Agency [1], approximately 290 million scrap tires were generated and 275 million scrap tires were already in landfill in 2003. Meanwhile, in Australia, approximately 51 million tires reached the end of their life in 2014 and around 60% of it ends up either in landfill, stockpiled, or illegally dumped. Similar conditions are also occurred in Malaysia where a report stated that 8 million of tires reach their end-of-life stage every year where most of it ended up in landfill or dumpsite (Figure 1.1). By 2020, it has been estimated that 20 million units of tires will be disposed annually in Malaysia. Globally, scrap tires production is exceeding 1 billion units per year [2]. Considering the massive production of scrap tires, scrap tires management becomes crucial for development and environmental protection worldwide as poorly managed scrap tires can lead to severe complications.



Figure 1.1 Accumulated scrap tires in dumpsite [3]

Due to the lack of specific law or obligation for the management of scrap tires the difficulty of separating scrap tires which are usually mixed with normal household waste, and the high gate fee in landfill sites; have led to illegal dumping activities. Without a proper disposal system, scrap tires that are illegally dumped or improperly stored pose a grave threat

to public health and safety, as well as to the environment since it is a non-biodegradable waste. Scrap tires are also being used as supplementary fuel due to their high calorific value, which can be considered as an excellent material for energy recovery. Nevertheless, this method harms the environment due to the toxic emissions produced during the combustion processes.

The complications in disposing scrap tires are becoming a global issue that adversely affects the global community and environment. One of the major problems faced by poor management in discarding tires is disease-carrying vectors. Scrap tires have already been considered as a major threat to the environment, especially scrap tires that provide substantial breeding ground of Aedes albopictus mosquitoes. The bulky, round and hollow shape of tires make them an ideal breeding ground for mosquitoes. European Union took the initiative to resolve the problem pertaining to the disposal issue of the scrap tires by prohibiting the disposal of whole tires into the landfill. They had also revised the law by banning the shredded tires from being dumped in the landfill. Even in South Australia, the discarding of the whole tires into the landfill is forbidden as it occupies huge areas and encourages the breeding of mosquitoes, rat and pest.

On the other hand, the accumulation of scrap tires in dumpsite also exposed them to the risk of fire. Unlike normal fires, a fire outbreak in scrap tires is very difficult to be extinguished and the fire could be continued up to several weeks while emitting toxic smoke depending on the number of tires. The oil emitted during the burning of tires are also able to contaminate the water supply and harm nearby society. Tire fires are usually caused by accidents but there are numerous cases where scrap tires are intentionally burned as a mean of disposal, although this method is considered illegal due to environmental concerns. Heavy metals emitted by the tires during fire or burning such as iron, lead, zinc, chromium and cadmium endanger nearby living organisms. Therefore, some government bodies have taken measures to prevent uncontrolled burning.

Burying scrap tires into the landfill will be causing the shortage of the service life of the burial site as the buried scrap tires tend to float or emerge to the surface, destroying the anti-leakage cover in landfills due to the inability to compress of tires. In addition, during rain, where rainwater is able to infiltrate through the torn-out landfill cap, the leachate produced from mixing rainwater with the landfill waste is able to reach and contaminate nearby water sources, subsequently threatening the health of consumers. The torn-out cap provides entry for rodents and insects to cause health and environmental issues. Therefore, a holistic and environmental friendly alternative method of disposal is necessary to solve the problems concerning scrap tires. Scrap tires are classified as special solid waste due to the difficulties in treatment, upkeep, and storage or disposal that requires special provisions. Through recycling, scrap tires can provide a valuable resource for producing sustainable and environmental friendly products and also provides a viable solution for proper management of discarding scrap tires.

RECYCLING OF SCRAP TIRES

Scrap tires recycling is categorized into two, where the scrap tires are being used as a whole or in the form of mechanically modified shapes. Scrap tires can be used as a whole tire for slope stability and as boat bumpers to protect the ship from scratching or hitting the wharf (Figure 1.2). While the mechanically modified scrap tires can be used as infill materials for the embankment. Recycled scrap tires also can be used in several applications such as moulded rubber products. There are many potential applications of scrap tires such as electrical coating, sports field surface, rubber product, rubberized bitumen and playground surface. Besides that, the lifespan of tires can be prolonged through re-treading, but eventually, they will still be considered as scrap tires.

In South Australia, if the tires are not suitable for recycling purposes, it will be shredded or chopped into pieces of 250 mm



Figure 1.2 Scrap tires used to reduce collision between the boat and the port [4]

or finer particles before disposal into landfills. As of today, one of the environmentally friendly methods of recycling scrap tires is to reduce them into crumb rubber by shredding and granulating t into smaller particles. here The shredded tires can be used as tire-derived aggregate (TDA) in civil engineering applications, materials for building insulation (noise and vibration insulation), and also in road pavement.

However, tires are not entirely made of rubber. Only seventy percents of car and truck tires can be salvaged into crumb rubber and the rest as steel and fibre. Figure 1.3 shows the composition of a tire comprising these elements. In United States alone, 975,000 tons of scrap tires have been used in the ground rubber applications in the year 2013, while in 2015, the amount has been raised to 1,020,000 tons. The ground rubber application consumed about 26% of the total scrap tires generated, while 7% has been used in civil engineering application as illustrated in Figure 1.4.

In conclusion, most of the countries in the world are facing problems in disposing of scrap tires. The steps to overcome the scrap tires problem experienced by some countries are summarized in Table 1.1. Government agencies must encourage and implement the recovery and proper management system of scrap tires by providing specially designed disposal facilities for scrap tires to reduce the stockpiling problem.

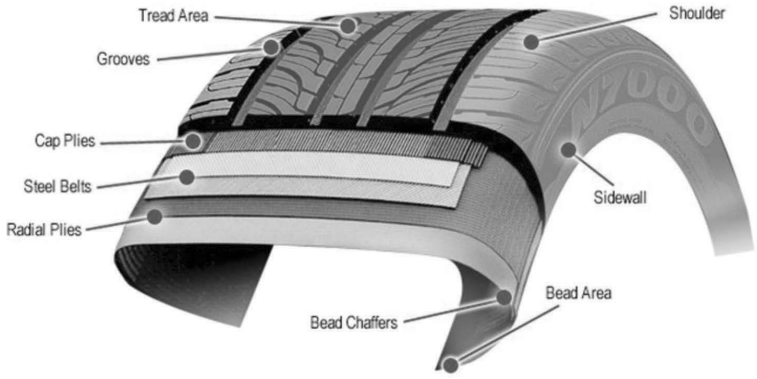

Figure 1.3 Cross section of a tire [5]

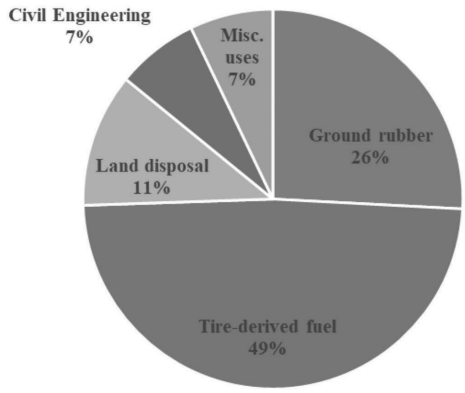

Figure 1.4 Distribution of scrap tires generated in U.S. 2015 [6]

Table 1.1 Actions by countries to the waste tires problems

Country	Action
Government of Nepal	i. Banned the uncontrolled burning of scrap tires [7] (Shakya, 2006)
South Australia	i. Banned the disposal of whole tires in the landfill ii. Chipped the tires into pieces of 250 mm or smaller before dispose in landfill [1]
European Union	i. Banned the whole tires from being disposed in the landfill ii. Banned the shredded tires from the landfill [8]
United States	i. Scrap tire management program [3]

PRODUCTION OF CRUMB RUBBER

Waste tires or scrap tires can be recycled into crumb rubber before being used in other applications. Scrap tires consist of rubber, steel wire and textile. In order to utilize scrap tires in other applications, it must undergo a process to cut the tires into smaller pieces. There are two methods in tire processing which is a mechanical and cryogenic process. For the mechanical process, the crumb rubber production involves shredding, chipping and grinding of scrap tires into small sizes. On the other hand, the cryogenic process requires liquid nitrogen to freeze tire chips or rubber particles before size reduction.

In the mechanical process, scrap tires are to be collected from tire retailers and sent to the factory for processing. These tires are sorted based on their size and the process starts by separating the steel wires from the sidewalls by using rotating corrugated steel drums or cracker mill. The shredding process of tires reduced the size of rubber into 100 mm to 50 mm. The first and second stages of the granulation process then further reduced the size from 50 mm to 10 mm. The screen and gravity separator are used to remove the steel fiber, and then tires chips are ground to a smaller size to produce crumb rubber. Generally, the processed scrap tires are classified according to a size such as rubber chips with size ranges between 25 mm to 50 mm and rubber powder with size ranges between 4.75 mm to 0.075 mm. As rubber chips size is equivalent to coarse aggregates size, and rubber powder size is equivalent to fine aggregate size; therefore, rubber chip and rubber powder have been used in concrete industry as a replacement to coarse and fine aggregates.

The inclusion of crumb rubber into the concrete leads to various effects on the of the concrete properties depending on several factors such as the amount of aggregate replaced and the size of the crumb rubber. Different sizes of crumb rubber are shown in Figure 1.5

In the mechanical process of scrap tires to produce crumb rubber, the collected tires are sorted based on the size prior to the

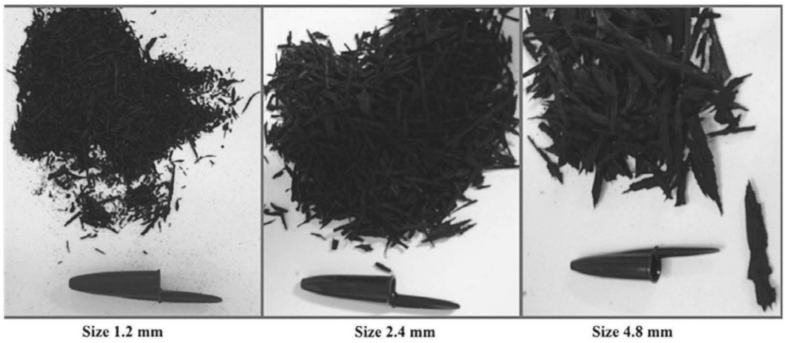

Figure 1.5 Different sizes of crumb rubber [9]

cutting process as shown in Figure 1.6. Most of the crumb rubber production factories only process big size tires such as lorry tires due to the higher amount of rubber obtained from the lorry tires compared to car tires. The crumb rubber production is started by removing the steel wires at the sidewalls of the scrap tires to ease the cutting process as shown in Figure 1.7. The steel wires are separated by using hot temperature machine known as rotating corrugated steel drums as illustrated in Figure 1.8. The machine removes the steel wires by melting the rubber. Figure 1.9 shows the end product of steel wires attained from sidewalls of the scrap tires. The steel wires are usually sent to scrap metal factory for other purposes.

The scrap tires are then undergoing the cutting process to turn it into long narrow tire strips as shown in Figure 1.10. Then, the tire stripes are shredded by a granulator for further processing as shown in Figure 1.11. The first stage of granulation forms the tire chips of 50 mm to 100 mm. Meanwhile, the second granulation of the tire chips further reduces the size to 10 mm to 50 mm. The steel fibres at the centre of the tire are removed by using gravity separator. The steel fibres which are pulled out from tire granules are pushed through sieves. Finally, the rubber powders, chips, granules and crumb are separated according to their sizes as shown in Figure 1.12 before being sold and used for a wide range of innovative applications.



Figure 1.6 Scrap tires are first collected in a place



Figure 1.7 Separating the steel wall of scrap tires

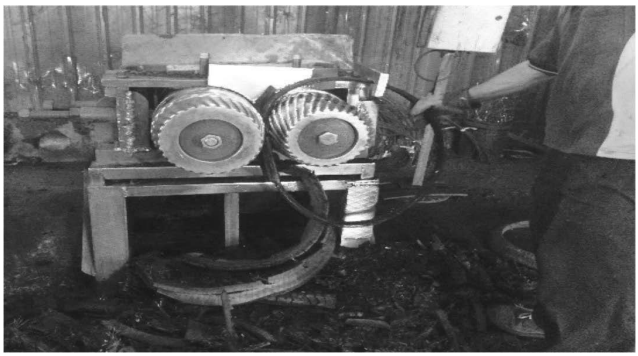

Figure 1.8 Process to separate the steel wire at sidewall

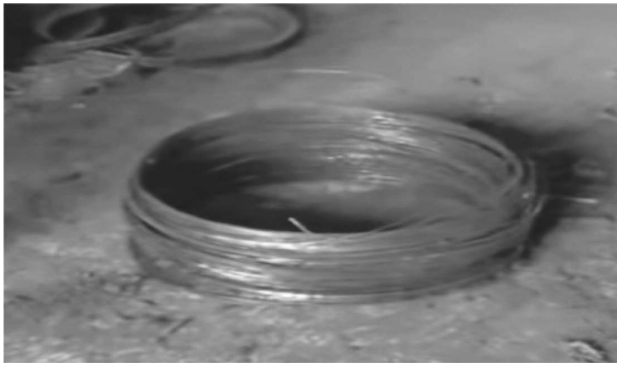

Figure 1.9 Separated steel wires

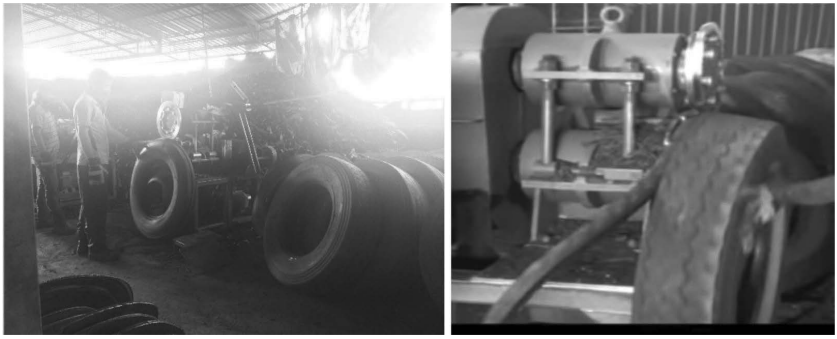

Figure 1.10 Cutting the middle part of the scrap tire



Figure 1.11 Shredded scrap tires



(a) (b)

Figure 1.12 End product of scrap tire process, a) Steel fiber extracted from the scrap tire, b) Crumb rubber are collected according to the particle size

APPLICATION OF CRUMB RUBBER IN CONSTRUCTION INDUSTRIES

While using crumb rubber in concrete mixtures as partial replacement to fine aggregate has been well documented in the literature, very limited and scarce research works have been conducted in using crumb rubber in the production of bricks. This is due to the difficulty of producing dry mixtures containing crumb rubber for bricks production. The following sections will shed the light on utilizing crumb rubber in the production of concrete mixtures and bricks.

Utilization of Crumb Rubber in Concrete

Crumb rubber can be used in a wide range of civil engineering applications such as in asphalt pavement, breakwater, retaining wall, artificial turf field, concrete and for architectural purposes. Crumb rubber application in asphalt pavement helps in mitigating the noise pollution in the urban area. Crumb rubber is also used as backfill materials in retaining structures application. Using

shredded scrap tire as backfill materials is lead to reduction in the cost up to 60% and reducing tires stockpiling. Part from reducing scrap tire stockpile, rubber playground floor exhibits various advantages over the traditional playground surface as it requires less maintenance, durable, long-lasting and safer.

Recently the research trend is focusing on utilizing crumb rubber as part of constituent in civil engineering application especially in concrete and mortar. Worldwide, the annual production of concrete is about 3820 billion cubic meter which puts the consumption of concrete per capita is second after water. Figure 1.13 shows the Portland cement consumption which is directly proportioned to concrete consumption.

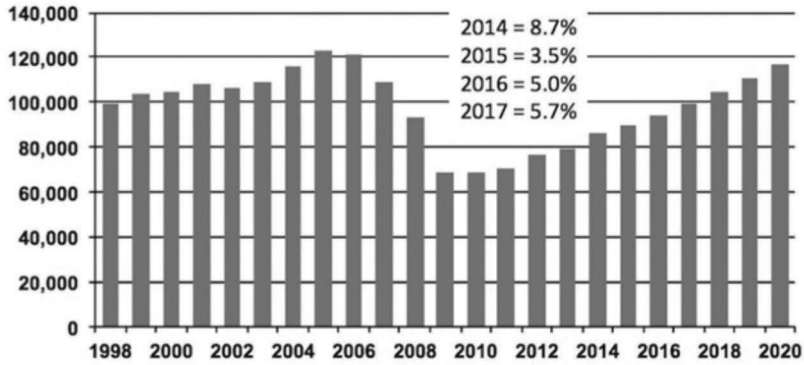

Figure 1.13 Portland cement consumption in thousand metric tone [10]

Concrete containing crumb rubber as partial replacement to aggregate is known among researchers by many terms such as crumb rubber concrete, rubberized concrete and rubbercrete. Throughout this book, the rubbercrete term will be used to refer to concrete containing crumb rubber.

Rubbercrete exhibits several advantages, however in the current research trendthe main focus is on partially replacing fine aggregate with crumb rubber. This is justified by findings which showing that instead of replacing coarse aggregates, substituting fine aggregates with crumb rubber results in better performance of the rubbercrete.

Several attempts have been made to establish the optimum rubber content in the concrete to fit certain purposes and criteria.

The density of rubbercrete is inversely proportioned to the crumb rubber content as shown in Figure 1.14. A higher amount of crumb rubber replacement to fine aggregate leads to a lower density of rubbercrete. This is mainly due to the low specific gravity of crumb rubber in comparison to fine aggregate. In addition, the non-polar surface of crumb rubber particles that traps air during the mixing process affects the density as the number of voids increasing upon hardening of the rubbercrete which results in a lower density. The decrease in the density of the rubbercrete allows the development of lighter concrete. The density of the 100% crumb rubber replacement has been decreased by 20% compared to conventional concrete.

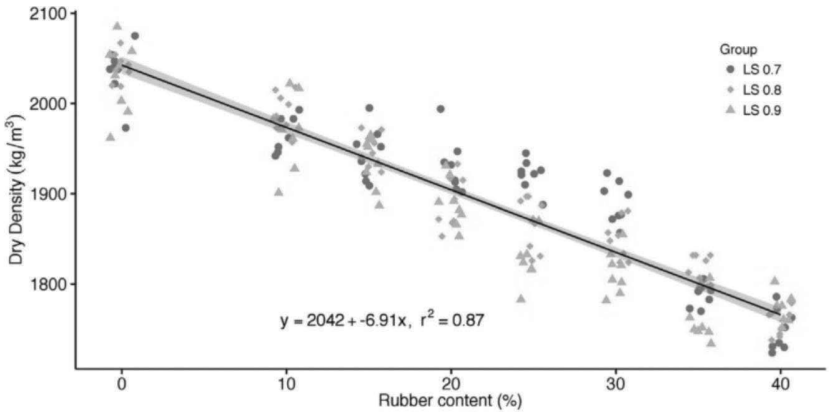

Figure 1.14 Dry density of rubbercrete brick [11]

On the other hand, higher replacement of crumb rubber in concrete also causes a reduction in the modulus of elasticity of rubbercrete as shown in Figure 1.15. This reduction is due to the lower modulus of elasticity of the crumb rubber particles in comparison to mineral aggregates. Usually, static modulus of elasticity is conducted to ascertain the deformation capability of concrete. Developed concrete incorporating rubber ash and rubber

fiber exhibits an average of 41% reduction in modulus of elasticity. Hence, rubbercrete possess higher flexibility and lower stiffness than normal concrete.

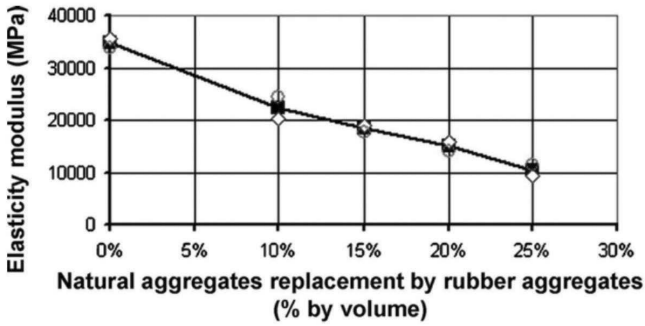

Figure 1.15 Estimated modulus of elasticity proposed [12]

Rubbercrete exhibits higher ductility and gradual failure behavior in contrast with normal concrete which exhibits sudden failure or brittle failure behavior. Rubbercrete remains intact beyond the failure load due to the elongation and ductile behavior of the rubber and the ability of rubber to abridge the cracks as shows in Figure 1.16. In view of this property, it is possible to prevent the disintegration failure of the concrete through the utilization of crumb rubber. This is also contributed to the superior ability of rubbercrete to absorb dynamic load and resist crack propagation as well as its high ductility and energy dissipation capacity. Ductile behavior of rubbercrete is essential for safety purposes and suitable for earthquake prone area as high energy absorption is required to minimize the structural damage. However, an appropriate amount of crumb rubber is to be considered to increase ductility in rubbercrete.

Rubbercrete also exhibits large spilling deformation without disintegration when reaching the ultimate load (Figure 1.17) due to the ability of rubbercrete to undergo higher lateral deformation before buckling failure. As a result of low modulus of elasticity of crumb rubber particles which enable it to act as a damper to reduce stress concentration, rubbercrete exhibits resistance to



Figure 1.16 Rubbercrete still intact after failure [13]

propagation of micro cracks and enhances capacity of deformation before cracking. The deformation and toughness of concrete can be enhanced by replacing aggregates with crumb rubber. the deflection of concrete increases with increasing the amount of crumb rubber replacement to fine aggregate as shown in Figure 1.18.

Rubbercrete also exhibits good sound absorption compared to normal concrete. Sound absorption is defined as the incident sound that strikes a material and is not reflected. Hence, the sound



Figure 1.17 The large deformation without complete disintegration in rubbercrete

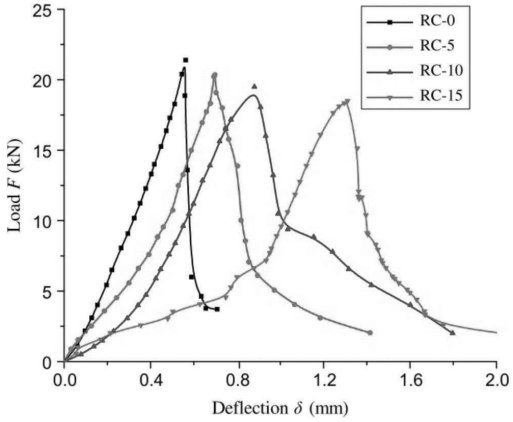

Figure 1.18 Load-deflection curve rubbercrete [16]

was easily absorbed through the entrapped air on crumb rubber surface inside the microstructure of rubbercrete. Crumb rubber also performs well as a modifier in a bituminous binder, allowing better noise reduction.

Rubber is essential insulator material in the electrical industry. Utilizing crumb rubber in concrete offers better electrical insulation property to the rubbercrete compared to the conventional concrete. Additionally, crumb rubbers also able to enhance the surface resistivity of the concrete. The high surface resistivity indicates the rubbercrete has a good electrical resistivity.

Thermal resistance of the rubbercrete is much better in comparison to normal concrete. The increase in the amount of crumb rubber replacement increases the thermal resistivity, in other words, decreasing the thermal conductivity of the rubbercrete in comparison to conventional concrete. 50% crumb rubber replacement reduces the thermal conductivity up to 50% as depicted in Figure 1.19.

In essence, utilizing crumb rubber in rubbercrete allows several advantages namely the reduction of density, an increase in ductility and deformation before failure, and also improving thermal and acoustic properties. Although many advantages can be derived by replacing fine aggregates with crumb rubber, several adverse effects can also be observed.

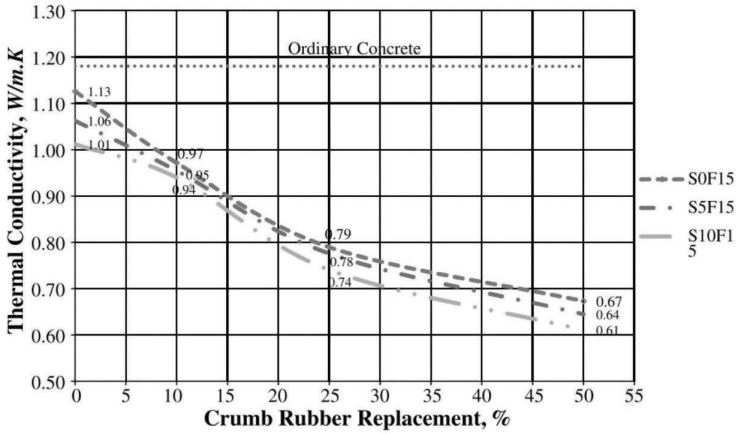

Figure 1.19 Thermal conductivity of hollow rubbercrete block [17]

Compressive strength is one of the most adversely affected properties of the rubbercrete. Utilizing crumb rubber in concrete, regardless either as a replacement to fine aggregates or coarse aggregates, will lead to a reduction in the compressive strength. A maximum of 100 % crumb rubber replacement by volume to fine aggregates could lead to a substantial reduction of compressive strength reached up to 82% as shown in Figure 1.20.

To avoid a huge reduction in the compressive strength of rubbercrete, it has been suggested that crumb rubber replacement should not exceed 20%. The reduction in compressive strength may be attributed to the replacement of dense and hard aggregates with less dense and weak crumb rubber. Crumb rubber is soft by nature and possesses lower stiffness compared to hardened cement paste and aggregates. This is one of the main causes for compressive strength reduction in a rubbercrete. During loading, the soft crumb rubber particles act as stress concentrators points in the composite, thus leading to the debonding of crumb rubber and initiation of microcracks. This detachment of rubber particles results in the creation of holes and an increase in voids, hence reducing the compressive strength as well as the modulus of elasticity of the rubbercrete.

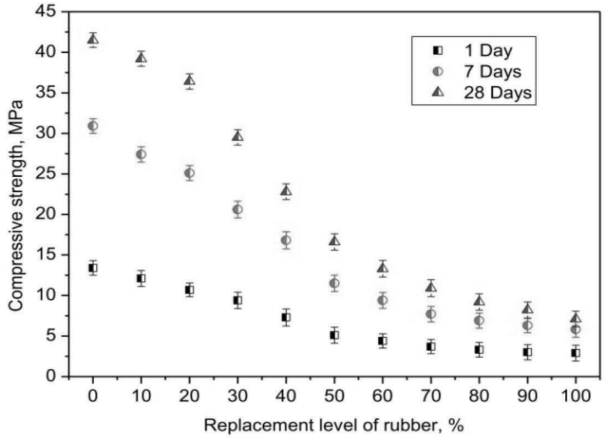

Figure 1.20 Compressive strength of rubbercrete [18]

In addition, the reduction of the compressive strength is also caused by the poor adhesion between the rubber particles and the cement paste due to the soft and smooth surface of the rubber particles, which leads to weakening its adhesion with the cementitious paste. This effect, however, can be mitigated through the utilizing of pozzolanic materials such as silica fume and fly ash as cement replacement and that to densify the interfacial transition zone between the crumb rubber particles and cement paste which consequently leads to improving the compressive strength of the rubbercrete

Therefore, incorporating crumb rubber in concrete decreases the compressive strength. However, a certain percentage of crumb rubber replacement could still be used without affecting the compressive strength significantly. The compressive strength of the rubbercrete could still be preserved by adding pozzolanic materials or finer particles to the mixture to densify the interfacial transition zone between the crumb rubber particles and the hardened cement paste.

Modulus of rupture decreases with the increasing addition of crumb rubber content. The reduction in modulus of rupture is due to weak bonding between crumb rubber particles and hardened cement paste. Figure 1.21 shows the three point bending test on rubbercrete

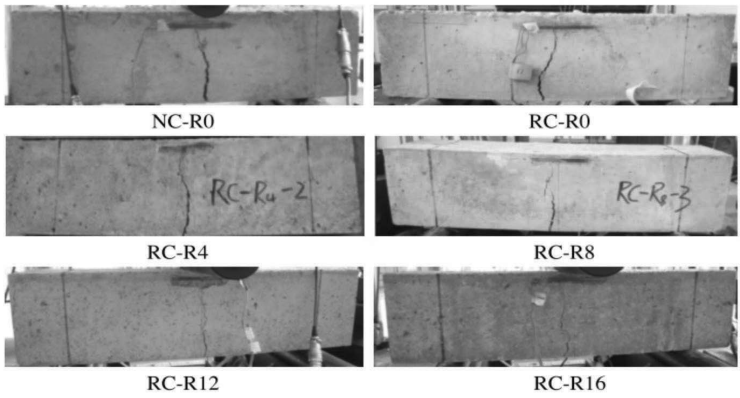

Figure 1.21 Failure mode of rubbercrete due to modulus of rupture test [19]

prisms, whereas the failure mode of the rubbercrete can be observed that the width and depth of the main crack decreased as the crumb rubber content increased, indicating the ability of crumb rubber to improve the anti-cracking performance under bending loads.

Also, increasing the amount of crumb rubber content in concrete would escalate the total of its porosity. This is explained through the hydrophobic nature of crumb rubber, which tends to repel water and entrap air on its surface during mixing, thus creating voids in rubbercrete upon hardening and consequently increasing the porosity, as illustrated in Figure 1.22.

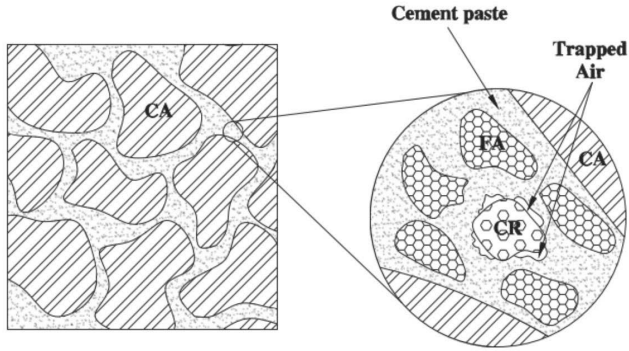

Figure 1.22 Microstructure of rubbercrete due to hydrophobic nature of crumb rubber [17]

The irregular and impervious surface of crumb rubber particles also contributeto the reduction of bonding between crumb rubber particles and the hardened cement paste, as shown in Figure 1.23. During the loading of rubbercrete, cracks developed and propagated from the area with a weak bond. Crumb rubber particles act as an impedance to crack initiation and propagation in the rubbeercrete by absorbing energy across the structures, thus slowing down the damage process. However, the weak interfacial transition zone between crumb rubber particles and cement paste leads to the initiation and propagation of microcracks that developed around the crumb rubber particle and, under loading, the differential strain rates between rubber and hardened cement paste exacerbate the problem.

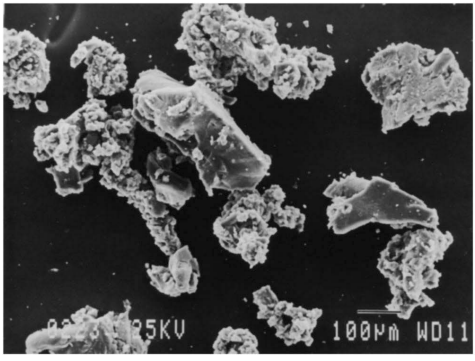

Figure 1.23 The scanning electron microscopy (SEM) of crumb rubber particles [20]

Water absorption of the rubbercrete generally depends on the rubber content. Increasing crumb rubber content in the rubbercrete leads to an increase in water absorption. Water absorption is closely related to porosity as the voids in the rubbercrete might be filled with water. The water absorption and porosity of rubbercrete can be reduced through the addition of silica fume or fly ash to help in filling the voids due to their filling ability and also to densify the interfacial transition zone. The inclusion of crumb rubber into the concrete leads to preserve low capillary water absorption. In

conclusion, crumb rubber particles entrapping air on its surface and expel water during the mixing process leading to high void ratios in the rubbercrete. Hence, the water absorption increases as water fill the voids.

Utilization of Crumb Rubber in Masonry Production

Incorporating of waste materials in bricks is common nowadays as it provides a win-win situation through sustainable solid waste management while also improving certain properties of bricks. For example, utilizing lime and high fly ash volume has resulted in a light weight and high thermal insulation brick. The fly ash and lime brick are able to replace the aerated cellular concrete. Moreover, utilizing fly ash as part of the constituent in brick production helps to reduce the adverse environmental impact. Fly ash and lime brick possess low raw materials cost and production process since fly ash is cheaper than cement. It is similar to rubbercrete brick which utilizes waste materials as part of the constituent.

Crumb rubber is used in brick production to improve its properties and as well as to provide feasible waste management of scrap tires. The rubbercrete brick can be produced by utilizing up to 70% of crumb rubber as a replacement to fine aggregate as shown in Figure 1.24. The developed rubbercrete brick has several advantages such as low cost, lightweight, improved acoustic, high electrical resistance and high thermal resistance in comparison to other types of bricks. Load-bearing and non-load-bearing hollow concrete block containing crumb rubber has been developed (Figure 1.25) by utilizing mesh 30 crumb rubber as a partial replacement to fine aggregate up to 50%. To mitigate the loss in strength of the hollow rubbercrete block, fly ash and silica fume have been used as partial replacement to the ordinary cement. The developed hollow rubbercrete block has exhibited lower density, better acoustic properties, lower thermal conductivity and higher electrical resistance in comparison to conventional hollow concrete block.

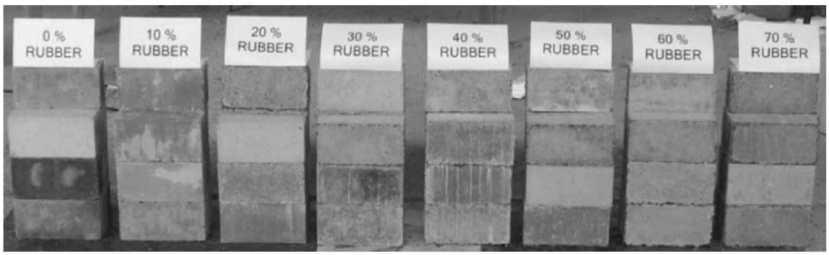

Figure 1.24 Rubbercrete bricks [21]



Figure 1.25 Rubbercrete hollow concrete block [17]

Utilizing fly ash and silica fume (pozzolanic materials) as a replacement to cement in the production of rubbercrete is due to their physicochemical effects. Chemically, pozzolan reacts with Ca(OH)2 (cement hydration's product) to produce C-S-H gel responsible for strength. At the same time, the physical effect is due to the fill-ability of this pozzolan on filling the micro voids inside the hardened cement paste and as well as the interfacial transition zone (ITZ).

Rubbercrete bricks remain intact and experienced large deformation after failure, indicating ductile behaviour due to rubber particles' flexibility and ability to rotate around its axis. The ductile behaviour of rubbercrete brick reflects high energy absorption.

SUMMARY

Tire stockpile have created many unwanted issues as it is non-biodegradable materials, hence keeping these scrap tires in landfill would not solve the problems. The hollow and bulky shape of tires provide an ideal breeding ground for disease-carrying rats, mosquitoes and rodents, leading to various health problems. Tires accumulation also increase the tendency to fire hazard as tires are highly flammable material. The easiest and cheapest mean of disposing scrap tires is by burning them. However, toxic smoke released will harm the environment and health. Considering the massive production of scrap tires all over the world, scrap tires management becomes crucial for development and environmental protection worldwide as poorly managed scrap tires can lead to severe complications. There have been many discoveries and inventions to utilize scrap tires in daily life applications whether in civil engineering or non-civil engineering application.

Incorporating crumb rubber in concrete allows several advantages that conventional concrete could not achieve. Rubbercrete possess a better reduction in density and modulus of elasticity, an increase in ductility and deformation before failure and an improvement in acoustic and thermal properties. However, incorporating crumb rubber in concrete and brick lead to a reduction of the compressive strength. Nevertheless, it is still can be used in load-bearing masonry as the minimum compressive strength requirement in accordance to ATSM C 90 is 11.7 MPa.