CHAPTER 1

INTRODUCTION

1.1 Background of Study

Parallel to the advancements in concrete technology, a new class of cementitious composites known as ultra-high performance concrete (UHPC) has been developed and become a new focus in concrete industry (Rahman et al., 2005 and Serelis et al., 2015). UHPC was well-known for its advanced in strength, durability and long-term stability as compared to the normal concrete (NC) and high performance concrete (HPC) (Graybeal, 2006; Karmout, 2009; Tuan, 2011; Gu et al., 2015). According to Vogel et al. (2008) and Karmout (2009) stated that the compressive strength of UHPC can be achieved more than 100 MPa. Another various approaches have been developed concerning on ultra high strength to improve the performances. In general, UHPC was formulated by using coarse, fine and ultrafine aggregates, very low amounts of water, silica fume and high amounts of cement (Shihada and Arafa, 2010).

Despite of its outstanding properties, UHPC also has some limitations in terms of cost and availability of raw constituent materials. Large amount of sand, aggregate and cement are required to produce UHPC. This has led to depletion of natural sources, which is one of the greatest challenges in concrete industry nowadays. With respect to the material constituent in UHPC, sand can be seen as the most dominant material in the production of UHPC. Normally, quartz sand is usually used in UHPC mixtures instead of ordinary fine aggregates due to its excellent aggregates interface. But due to its high cost of quartz sand, it gives an idea to search for other substitution for natural raw material sources.

On the other viewpoint, the disposal of the waste materials such as bottle, glass, roof tiles and tyres is one of the most crucial environmental issues all around the world.
Tyre rubber waste is one of the significant waste that should be more concerned. The tyres waste production keep on increasing every year with the number of vehicles. There are no doubt that increasing of used tyres creating environmental concerns (Antil, 2014). The number of tyres from motor vehicles are expected to reach 1200 million representing almost 5000 million tyres to be discarded in regular basis by the year 2030 (Thomas et al., 2009; Pacheco-Torgal et al., 2012 and Rashad, 2015). In Malaysia, the most of tyre rubber waste are landfill disposed, which is the common method. These waste disposal contribute to a serious serious egological treat since it is not easily biodegradable (Pavithran et al., 2015). In positive view, tyre rubber waste is known for its light weight, elasticity, energy absorption, sound and heat insulating properties.

Several studies have been reported by previous researchers on possibility of the use of tyre rubber waste as replacement materials in concrete constuction field. It was found that the rubber aggregates contribute to the reduction of compressive strength and flexural strength in conventional concrete (Khatib and Bayomy, 1999; Eldin and Senouci, 1994; Youssf et al., 2014; Wang et al., 2016). However, according to previous investigation by Wang et al. (2016), revealed that the consumption of recycled tyre rubber waste (RTRW) in concrete had led to higher toughness, ductility, durability, damping ratio and impact resistance compared to conventional concrete. The utilization of tyre rubber waste in concrete technology will be such a good alternative to minimize the environmental degradation by reducing the disposal of tyres into nature, reduce costs and ensure the conservation of natural resources.

Eventhough the studies on the association of tyre rubber waste in concrete are abundant, but there is not much research done yet concerning the incorporation of coarse and fine rubber particles as a material in ultra-high performance concrete mixtures (Wang et al., 2016). Therefore, the exploration on the effect of recycled tyre rubber waste (RTRW) on the production of UHPC was investigated in the present study. In order to investigate the effect of RTRW on UHPC, the strength properties of a plain UHPC and three (3) series of rubberized-UHPC were investigated.
1.2 Problem Statement

Ultra-high performance concrete (UHPC) is a construction material with excellent mechanical properties and good durability. Basically, the conventional UHPC include steel fibres to improve both the tensile strength and the ductility of UHPC (Richard and Cheyrezy, 1995; Eide and Hisda, 2012; Gu et al., 2015). The commonly use of steel fibre would probably be due to the many favourable properties of this fibre type: High modulus of elasticity, high strength, high ductility and a very good durability in the alkaline environment of the concrete. However, the addition of steel fibres contributed to the higher cost of construction material. Therefore, an alternative construction material with similar properties should be explored to replace the steel fibres in UHPC.

Nowadays disposal of waste materials like bottle, glass, roof tiles, tyres rubber waste, furnace slags and so on are the huge headache for most of the developing countries. Tyre rubber waste is one of the significant waste that should be more concerned because these waste is not easily biodegradable. It then leads to a serious ecological treat. By considering these two significant problems, a new alternative solution should be taken into consideration to minimize the cost of UHPC production and also minimize the environmental degradation. Thus, utilization of tyre rubber waste in UHPC will be such a good alternative solution to overcome these upcoming issues. Moreover, tyre rubber waste is known for its light weight, elasticity, energy absorption, sound and heat insulating properties that matches well with the properties of steel fibres. The elimination of steel fibres thus are being occupied by presence of tyre rubber waste in UHPC. The limitation knowledge in bond performance between UHPC and waste product as material replacement. The dominant UHPC in market are proprietary is sand. UHPC require large amount of fine sand in the production of UHPC. It will be a promising solution to incorporate tyre rubber waste as a replacement for sand in UHPC. It not only reduces cost and minimize the degradation, but it also guides to sustainable development by ensuring the conservation of natural sources.