ABSTRACT

Due to the huge increase in population and the uplift in living standards of people, there was a big growth in the number of vehicles. As a result of this, lots of tires are ending as waste every day. Disposal of waste tire rubber has become one of the major environmental issues in all parts of the world. Every year millions of tires are discarded or buried all over the world, representing a very serious threat to the ecology. One of the possible solutions for the use of waste tire rubber is to incorporate it into cement concrete, replacing some of the natural aggregates. This attempt is environmental friendly (as it helps to dispose the waste tires and prevent environmental pollution) and economically viable as some of the costly natural aggregates can be saved.

Many researchers have studied the properties of rubberized concrete. Waste tire rubber has been used as a partial substitute for cement and also for fine and coarse aggregates. Although many researchers have reported about their mechanical properties and density, only a few have reported about the chloride penetration, water absorption, freeze-thaw resistance, carbonation and shrinkage. A proper study is needed on their resistance to abrasion and their durability characteristics like corrosion of steel reinforcements and the resistance to aggressive environment (acid attack, sulphate attack, etc). In addition, a thorough study is required on the strength and durability properties of high strength rubberized concrete, as they were not noticed in the literature study.

In this study, M30 grade of concrete was studied in first series with a water-cement ratio of 0.4. Crumb rubber (waste tire rubber mechanically grinded into rubber crumbs) was partially substituted for fine aggregate from 0% to 20% in multiples of 2.5%. The properties of concrete such as compressive strength, flexural tensile strength, abrasion resistance, pull-off strength, water permeability, water absorption, resistance to acid and sulphate attacks, carbonation, depth of chloride penetration and corrosion of steel reinforcements were tested and Scanning Electron Microscopy (SEM) was used to study the micro structure. A total of six hundred specimens of various dimensions were casted for this series. The properties of concrete with water-cement ratios of 0.45 and 0.50 were also studied as the second and third series to determine the variation in different properties. In the fourth series, specimens with

M60 grade concrete with a water-cement ratio 0.30 was casted and the above mentioned tests were performed to study the different properties of high strength rubberized concrete.

From the results it was observed that the bulk density of concrete decreased with the increase in percentage of crumb rubber. For compressive, flexural tensile and pull-off strength tests and compressive strength test of sulphate attacked specimens, gradual decrease in strength was noticed as the amount of crumb rubber was increased in concrete. On the other hand, they showed better resistance to abrasion when compared to the control mix. The depth of water penetration has shown gradual increase when the amount of crumb rubber was increased from 0% to 20% and the water absorption of the control mix specimens was more than that of the rubberized concrete up to 7.5% substitution. Beyond 7.5% substitution, the water absorption was slightly higher when compared to the control mix concrete specimens. Similar results were obtained for the chloride ion penetration test.

The depth of carbonation of the concrete mixes in which crumb rubber was substituted from 2.5% to 15% were less than or equal to that of control mix concrete in the case a 0.4 water to cement ratio. Carbonation resistances of concrete with w/c 0.45, 0.5 and 0.3 were also studied and reported in the thesis. From the acid attack test, it was noticed that there was minimal loss in compressive strength and unit weight for the rubberized concrete when compared to the control mix concrete specimens. As all the readings obtained in the macrocell corrosion test were less than 10 μA, it was concluded that there is no significant proof of corrosion in the specimens up to 182 days of ponding. From the SEM analysis, it was observed that the bond between rubber particles and cement paste was not as good as with traditional rigid aggregates. More voids were observed in the concrete as the amount of crumb rubber was increased.

The above mentioned tests were performed and results are presented in detail in this thesis.