

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING



An investigation into the use of shredded rubber as aggregate in concrete

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ABSTRACT

Numerous studies are available on incorporating waste tyre rubber for aggregates in concrete, for use in the construction industry. However, limited information is available on the extent to which higher percentage of rubber, replacing aggregates can be introduced so as to use them in non-structural works. This study focuses on analyzing the compressive strength and durability properties of the concrete, when fine aggregates are replaced at 7.5, 15, 25, 35 and 50% by volume with shredded tyre rubbers. The characteristics of rubberized concrete to changes in water-to-binder ratios (0.40 and 0.55) and binder types 70/30 Portland Cement (PC)/fly ash (FA) and 50/50 PC/ground-granulated blastfurnace slag (GGBS) are studied by varying one parameter at a time.

Concrete cubes were cast and compressive strength tests conducted at 7, 28 and 56 days, and durability index tests at 28 and 56 days.

The results indicated significant reduction in compressive strength of mix concrete with increase in percentage of rubber content replacing fine aggregate by volume. The addition of fly ash binder in rubberized concrete have beneficial effects on compressive strength compared to GGBS binder. The compressive strength of rubberized concretes was greatly influenced by a change in water binder ratio. At lower water binder ratio of 0.40, irrespective of binder type, the concrete specimens containing up to 50% replacement of fine aggregates with rubber particles, attained the acceptance criteria of at least 2 MPa above minimum characteristic strength required for plain and reinforced non-structural concrete works. At higher water binder ratio of 0.55, the acceptance strength requirement for non-structural plain concrete works was attained with the maximum of 50% in FA concrete, and with concrete containing only up to 35% rubber particles in GGBS concrete. However, for reinforced non-structural works, acceptance requirement was attained with only up to 25% fine aggregate replaced with rubber content in GGBS concrete and with 35% rubber content in FA concrete with prolonged curing.

For the parameters tested, the OPI of FA binder rubberized concrete exhibited higher values compared to rubberized concrete with GGBS binder, indicating better permeability, thereby concrete quality. GGBS rubberized concrete exhibited better water sorptivity and chloride conductivity indices compared to FA concrete. The extent to which change in water binder ratio and binder type affects the durability properties of rubberized concrete, varies depending on the percentage of rubber particles incorporated in the mix design. Increasing percentage of rubber particles decreased the sorptivity indices indicating better quality of concrete. Furthermore, increase in rubber content in concrete proved to be detrimental to concrete durability with respect to chloride conductivity, which improved with prolonged curing. Irrespective of the variations with water binder ratio and binder type, rubberized concrete exhibited good durability properties with respect to oxygen permeability, water sorptivity and chloride conductivity.