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Performance of Rubberized Concrete When Replacing Coarse Aggregate with Chip Rubber at Lower Replacement Levels

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Abstract

The disposal of end-of-life tyres (ELTs) poses a significant environmental challenge due to their non-biodegradable composition and the potential release of harmful chemicals. Simultaneously, concrete stands as the second most consumed material in the world after water while contributing to the depletion of natural aggregate (NA) on a global scale. In light of these challenges, recent studies have investigated the use of rubber aggregate (RA) as a partial substitute for NA in concrete. Although numerous studies have indicated that rubberized concrete (RuC) diminishes mechanical properties, identification of the optimum RA replacement ratio (RR) that can be replaced for coarse aggregate in concrete is still discoverable due to conflicting findings in the literature. Consequently, in this study, chip rubber (CH) ranging in size from 5-20 mm was employed to partially replace the coarse aggregate in concrete with RRs of 2.5%, 5%, 7.5%, 10%, 12.5%, and 15% by the coarse aggregate volume. The study assessed the impact of CH replacement on both the fresh (wet density and workability) and the hardened concrete properties (uniaxial compressive strength and flexural strength). The results reveal a gradual reduction in both wet density and workability as the CH content increases. However, the reduction in wet density remains below 5%, even with a 15% replacement of CH. As a consequence of inadequate bonding between rubber particles and the cement matrix, compressive and flexural strength decreased as the CH content increased. Besides, the reduction in 28-day compressive strength and flexural strength was only 24% and 11%, respectively, compared to plain concrete with up to a 5% as-received CH content. In conclusion, recommending the use of this size of CH in as-received conditions to replace coarse aggregate in concrete is still challenging due to the observed strength reduction. However, it can be suggested for non-structural applications without additional modifications.

Keywords: Chip rubber, Compressive strength, Flexural strength, Rubberized concrete, Sustainability

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