1. TRC 20 CET RP2_Waste-Glass Powder as a Partial Substitute for Cement in the Sustainable Construction of Pavement Blocks, White topping and Bridge Piers

Effective substitution of building materials with less expensive and abundant substitutes has been a favourite pursuit of decision makers and technologists to promote sustainability in the construction field. Waste glass is a significant concern in India and management solutions seek. Finely ground waste glass possesses good pozzolanic properties, which make it potential for concrete applications as cement replacement. Limitations of waste glass cullet in concrete like decrease in slump, attainment of slow strength gain and weaker bond, and expansion due to alkali silica reaction could be rectified by the utilisation of glass having a decreased particle size.

The study aims to investigate the potential use of waste glass powder (GP) in structural concrete. The main feature of the present study lies in the simultaneous incorporation of two glass powders having different fineness, in equal proportions as partial cement replacement. The physical and chemical properties of the binding materials were verified. The maximum dosage of fine glass powders (partial replacement of cement) for varying grades of concrete has been arrived and the corresponding mechanical properties (compressive strength, flexural strength and split tensile strength) for the different grades of these concrete composites were found. Optimal concrete mixtures were selected to further study GP incorporation in concrete paver blocks. The durability indicators like water absorption, sorption, chloride-ion penetration, drying shrinkage and moisture movement in GP concrete and acid attack in GP mortar were verified. Mechanical performance of the GP concrete specimens exposed to elevated temperatures under both air-cooling and water-cooling regimes were carried out. Influence of GP on the bond strength of concrete-to-concrete interface by slant shear test and bond-slip behaviour by pull-out test on GP concrete were investigated. Cylinder test under uniaxial compression were done to analyse the stress-strain behaviour of unconfined concrete composites. Experimental investigation on the structural behaviour of GP concrete beams and behaviour of GP concrete piers under seismic-type loading were carried out.

The physical and chemical characteristics of the cementitious materials considered in the study revealed that both the GP samples are siliceous, amorphous and fine-powdered pozzolans. Compressive strength of GP mortar mix 1:3 revealed a marginal increase from that of conventional mortar mix. The concrete mixes were prepared by partially replacing the cement

with GP by 10 %, 20 %, 30 % and 40 %. Analyses of the hardened properties revealed that 30 % GP substitution produced the highest compressive strength. An increased paver block compressive strength was produced by the GP incorporated paver blocks. The GP concrete mixes exhibited improved performance in the durability indicators like water absorption, sorptivity, chloride permeation and moisture movement, but show a marginal increase in drying shrinkage. Acid resistance test revealed that the mortar composite with 10 % replacement has the least resistance towards sulphate attack. Exposure of GP concrete specimens to elevated temperatures resulted in an increase in mechanical strength up to 600^0C than at ambient temperature. A slight decrease in the strength values was observed for water-cooled specimens compared to air-cooled ones under similar thermal exposition. Enhanced interface bond strength of the GP concrete specimens was observed from the slant shear and pull-out tests. Improved flexural properties like bend strength, mid-span deflection and flexural toughness were demonstrated by the GP beams than the normal ones, despite a variation exists in the ductility and stiffness values in the case of heavily reinforced beams. The highlight of the GP concrete cylinder specimens under axial compression loading is its increased strength than the normal cylinders. Higher load capacities were exhibited by the GP concrete piers than the normal ones besides its reduced displacement and decreased strain values within a drift ratio of 9%.

Experimental studies revealed that, the concrete with 30% partial cement replacement by waste glass powder is a potential option for its implementation in the construction of paver blocks, white topping and bridge piers, thus contributing to a circular economy.

Deliverables:

- ✓ Optimal Glass Powder (GP) Dosage Identification
- ✓ Performance Analysis of GP Concrete
- ✓ Durability Assessment of GP Concrete
- ✓ Thermal Performance Evaluation
- ✓ Structural Behavior Testing

Societal Relevance:

- ✓ Waste Management and Recycling
- ✓ Environmental Sustainability
- ✓ Cost Reduction in Construction

- ✓ Enhanced Infrastructure Durability