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Development of Cost Effective Ultra High Performance Concrete by Using Locally Available Materials

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Abstract : Ultra high performance concrete (UHPC) is a type of cementitious material known for its exceptional strength, ductility, and durability. However, its production is often associated with high costs due to the significant amount of cementitious materials required and the use of fine powders to achieve the desired strength. The aim of this research is to explore the feasibility of developing cost-effective UHPC mixes using locally available materials. Specifically, the study aims to investigate the use of coarse limestone sand along with other sand types, namely, basalt sand, dolomite sand, and river sand for developing UHPC mixes and evaluating its performances. The study utilises the particle packing model to develop various UHPC mixes. The particle packing model involves optimising the combination of coarse limestone sand, basalt sand, dolomite sand, and river sand to achieve the desired properties of UHPC. The developed UHPC mixes are then evaluated based on their workability (measured through slump flow and mini slump value), compressive strength (at 7, 28, and 90 days), splitting tensile strength, and microstructural characteristics analysed through scanning electron microscope (SEM) analysis. The results of this study demonstrate that cost-effective UHPC mixes can be developed using locally available materials without the need for silica fume or fly ash. The UHPC mixes achieved impressive compressive strengths of up to 149 MPa at 28 days with a cement content of approximately 750 kg/m³. The mixes also exhibited varying levels of workability, with slump flow values ranging from 550 to 850 mm. Additionally, the inclusion of coarse limestone sand in the mixes effectively reduced the demand for superplasticizer and served as a filler material. By exploring the use of coarse limestone sand and other sand types, this study provides valuable insights into optimising the particle packing model for UHPC production. The findings highlight the potential to reduce costs associated with UHPC production without compromising its strength and durability. The study collected data on the workability, compressive strength, splitting tensile strength, and microstructural characteristics of the developed UHPC mixes. Workability was measured using slump flow and mini slump tests, while compressive strength and splitting tensile strength were assessed at different curing periods. Microstructural characteristics were analysed through SEM and energy dispersive X-ray spectroscopy (EDS) analysis. The collected data were then analysed and interpreted to evaluate the performance and properties of the UHPC mixes. The research successfully demonstrates the feasibility of developing cost-effective UHPC mixes using locally available materials. The inclusion of coarse limestone sand, in combination with other sand types, shows promising results in achieving high compressive strengths and satisfactory workability. The findings suggest that the use of the particle packing model can optimise the combination of materials and reduce the reliance on expensive additives such as silica fume and fly ash. This research provides valuable insights for researchers and construction practitioners aiming to develop cost-effective UHPC mixes using readily available materials and an optimised particle packing approach.

Keywords : cost-effective, limestone powder, particle packing model, ultra high performance concrete
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