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Investigate Rheological and Mechanical Properties of CNT modified Fly Ash/Cement Blended Concrete: Experimental versus Machine Learning Approaches

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Abstract—Growing infrastructural development has made it necessary to employ environmentally friendly binding materials. Substituting ordinary Portland Cement (OPC) with low carbon materials like slag and fly ash as concrete binders resulted in a significant reduction in GWP (global warming potential). While Carbon Nano tubes (CNTs) possess the ability to transform ordinary Portland cement (OPC), typically brittle in tension, into a Nano-composite exhibiting remarkable mechanical characteristics. The aim of this study is to develop cement-based composites with partial replacement of fly ash, while incorporating CNTs as an additive, and investigate the fresh and hardened properties such as workability, compressive, splitting tensile and flexure strength of CNT modified concrete for 49 MPa target compressive strength. Total of sixty (60) specimens were prepared to examine the fresh and hardened mechanical properties of CNT modified concrete. The specimens were created using three different CNT percentages 0.04%, 0.06%, and 0.08%by weight of cement, with 20% replacement of fly ash in cement. To assess the fresh and harden properties of CNT modified concrete various test including slump cone test, compressive strength test, splitting tensile test and flexural strength test were carried out. The test results exhibited that CNTs had significant positive impact on compressive strength, flexural strength and tensile strength while negative impact on workability. At 28 days, the optimum strength was achieved at 0.08% of CNTs with notable increase of 29.68% in compressive strength, 26.29% in split tensile strength, and 26.44% in flexural strength. After the completion of the studies, several machine learning models were successfully trained and tested using the input variables to predict the compressive strength of CNT modified concrete.

Keywords— CNT, Fly Ash, Machine Learning Model, Compressive Strength, Splitting Tensile Strength, Flexure Strength