Relationships between Compressive Strength and Transport Properties of Ultrahigh-Strength Green Concrete Utilizing Ternary-Blended Binder

N. Muhamad Bunnori, Aktham H. Alani, Ahmed Tareq Noaman , Megat Azmi Megat Johari , T.A. Majid

One of the main aspects of sustainable engineering constructions is the recycling of byproduct materials or wastes, including those from different agricultural crops. The influence of ternary-blended binders—ordinary portland cement (OPC), ultrafine palm oil fuel ash (UPOFA), and silica fume (SF)—on the engineering and transport properties of ultrahigh-strength green concrete (UHSGC) has been investigated.

Up to 50% of the UPOFAwas combined with varying proportions of silica fume at 5%, 10%, 15%, and 20% from the volume of the portland cement in order to quantify their influence on the engineering and transport properties of the UHSGC. The results showed that the UPOFA inclusion reduced the early age strength of the UHSGC at 3 and 7 days, then slightly improved the strength at the ages of 28 and 90 days. Whereas, the SF inclusion, as a ternary-blended binder in combination with the UPOFA, significantly enhanced the early and longterm strength for all UHSGC mixes, in comparison with the OPC control mix. The highest compressive strength was realized at 20% SF content, which exceeds 152 and 157 MPa at the ages of 28 and 90 days, respectively. The transport properties of the UHSGC, specifically, porosity, water permeability, and rapid chloride permeability, were significantly improved with the utilization of the ternary-blended binder. Consequently, the overall results demonstrated the feasibility of utilizing up to 70% of byproduct based pozzolanic materials (UPOFAand

SF) as a blended binder to partially substitute the portland cement to improve the properties and durability performance of the UHSGC.Furthermore, new relationships between compressive strength and transport properties of the different mixes were presented, and a good correlation between these properties and compressive strength for this type of concrete was obtained.