

UNIVERSITI TEKNOLOGI MARA

**EFFECTS OF CHLORIDE
TRANSPORT PROPERTIES IN
NANO METACLAYED ULTRA-HIGH
PERFORMANCE CONCRETE
TOWARDS CORROSION
CHARACTERISTICS OF
EMBEDDED STEEL**

MOHD FAIZAL BIN MD JAAFAR

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ABSTRACT

The major concern on the deterioration of reinforced concrete structure is due to the corrosion of steel reinforcement from the aggressive environment such as chloride penetration. Ultra-high performance concrete (UHPC) is an advanced concrete material having ultra-high strength with excellent durability properties. Inclusion of nano metaclay in UHPC is expected to overcome the chloride penetration resulting corrosion of steel embedded in UHPC by providing nano filler effect. In this study, chloride penetration resistance characteristics of concrete and corrosion steel embedded in concrete specimens were investigated. Four (4) types of concrete were cast namely normal performance concrete (NPC), high performance concrete (HPC), ultra-high performance concrete (UHPC) and a series of nano metaclayed-UHPC. The raw nano clay underwent the calcination process to produce nano metaclay and its chemical composition and morphology properties were determined by using X-Ray Diffraction (XRD) and Scanning Electron Microscope (SEM), respectively. The nano metaclayed-UHPC mixes were designed based on 1%, 3% and 5% levels of replacement of nano metaclay to Ordinary Portland Cement (OPC). The hardened concrete properties were examined in terms of compressive strength and chloride resistance characteristics. For chloride resistance characteristics, three (3) assessments were conducted which are chloride content, chloride depth and rapid chloride permeability. HACH spectrometer and colorimetric spray method were carried out to evaluate chloride content and chloride depth inside the immersed concrete specimens, respectively. Meanwhile, rapid chloride permeability test (RCPT) was carried out to determine the Coulombs charge passed through the concrete specimens. For corrosion monitoring, the steel embedded in concrete specimens were assessed by using half-cell potential and Fibre Bragg Grating (FBG) strain sensor. Finally, the change in pH of reinforced concrete and weight loss of corroded steel were examined. All the concrete specimens were immersed in 3% NaCl solution up to 365 days and the tests conducted were performed at 3, 7, 28, 56, 91, 182 and 365 days. It was found that UHPC1 which is inclusion of 1% nano metaclay in UHPC enhanced the compressive strength up to 10% corresponding to the plain UHPC. The results exhibited that UHPC1 demonstrated a superior performance in term of chloride penetration resistance. It is also noticeably that the corrosion potential of embedded steel in concrete recorded by half-cell potential can be explained by the variations in strain changes recorded by FBG sensor. It is demonstrated that inclusion of 1% nano metaclay significantly and positively affect corrosion resistant for embedded steel in concrete and these can be detected using both techniques. Moreover, Response Surface Method (RSM) was performed to determine the relationship. Based on RSM analysis, inclusion of nano metaclay in UHPC have strong relationship towards the strength, chloride resistance characteristics and corrosion resistance for its embedded steel reinforcement. Considering all these test results, it was attained that 1% of nano metaclay in UHPC exhibits excellent compressive strength and adequate durability performance in terms of chloride penetration resistance and delayed the embedded steel in concrete to corrode.

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