SUSTAINABLE HIGH-PERFORMANCE CONCRETE USING METAKAOLIN ADDITIVE AND POLYMER ADMIXTURE: MECHANICAL PROPERTIES, DURABILITY AND MICROSTRUCTURE

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ABSTRACT

In recent years, there has been a growing interest in the use of supplementary cementitious materials and polymers to produce high-performance concrete. This paper shows the results of a study on the effect of metakaolin and polymer admixture on mechanical behaviour and durability properties such as permeability, carbonation and chloride penetration, chemical attack, rate of water absorption and the corrosion rate of the steel reinforcement in the concrete. The results indicated that replacing Portland limestone cement with 15% of metakaolin and additional 4% of styrene-butadiene rubber and 1% of polyvinyl acetate polymer by weight of cement improve the properties of concrete. In addition, microscopic structure and chemical composition analyses were performed to confirm the underlying mechanisms and the improvement of material properties for this mix design. This study is aiming to preserve the environment by reducing CO_2 emissions in addition to the improvement of the sustainable high-performance concrete properties.

Keywords: Metakaolin, Polymer, SEM, XRD, microstructure

1. INTRODUCTION

Using mineral supplementary cementitious materials (SCMs), such as fly ash, silica fume and metakaolin (MK), as additives has already been proved effective to improve properties of concrete(Kamseu et al., 2014). With an increase of the environmental concern, in recent years, the use of MK as SCM has raised more and more interests (Aiswarya et al., 2013; Srinivasu et al., 2014) as the decreased supplying capacity of fly ash and silica fume (Souri et al., 2015). MK is normally produced by a thermal calcination of the kaolinite at a temperature ranging between 600°to~800°C (Rashad, 2013). MK is mainly composed of alumina (Al_2O_3) and silica (SiO_2), which determine an active pozzolanic behaviour (Ambroise et al., 1994). The pozzolanic reaction of MK, which consumes portlandite $Ca(OH)_2$, changes the hydration products of cement. Meanwhile, it made significant compositional changes of calcium silicate hydrate (CSH) gel, giving high Al uptake and low Ca content in the CSH phase (Souri et al., 2015). Previous studies showed that a 20% replacement of cement using MK had resulted in a substantial 50% increase of the compressive strength of mortar (Khatib et al., 2012); in addition,