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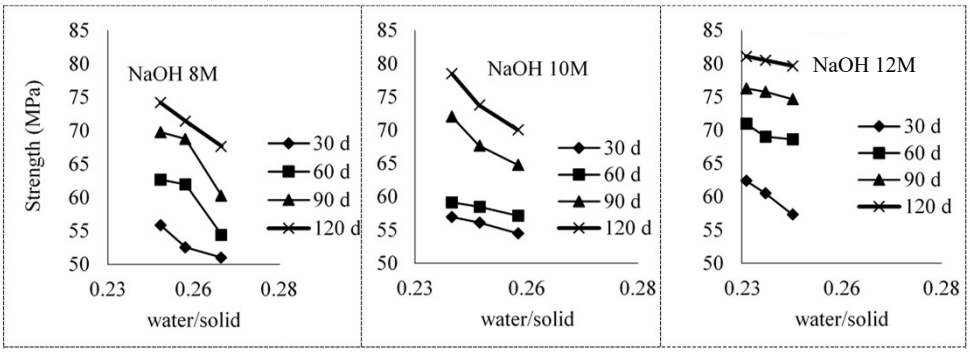
THE EFFECT OF ALKALI CONCENTRATION ON CHLORIDE PENETRATION IN GEOPOLYMER CONCRETE

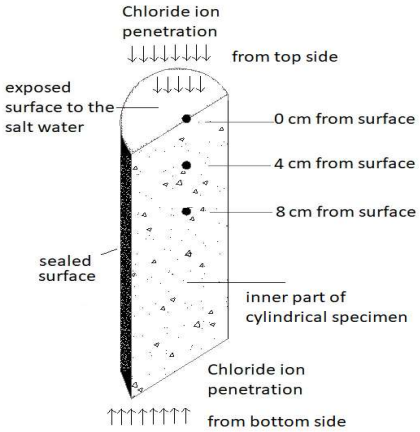
Introduction

In many research studies and application, class F fly ash is one of the most general materials to be used as geopolymer binder. As a waste of burning process from coal power plant, this material is favourable as cement replacement. Natrium hydroxide solution and natrium silicate are commonly used as the alkali activator to mix with fly ash. It was found that the effect of alkali concentration in the mixture influenced the geopolymer concrete strength. The higher the ratio of sodium hydroxide and sodium silicate the higher the strength of concrete. Besides of its higher mechanical properties, it is recognized that geopolymer concrete indicated better durability. This paper presents the corrosion probability of reinforcement bar in geopolymer concrete caused by ion chloride penetration. Different alkali ratio and concentration are the variation to make binders of geopolymer concrete.

Material and Methods

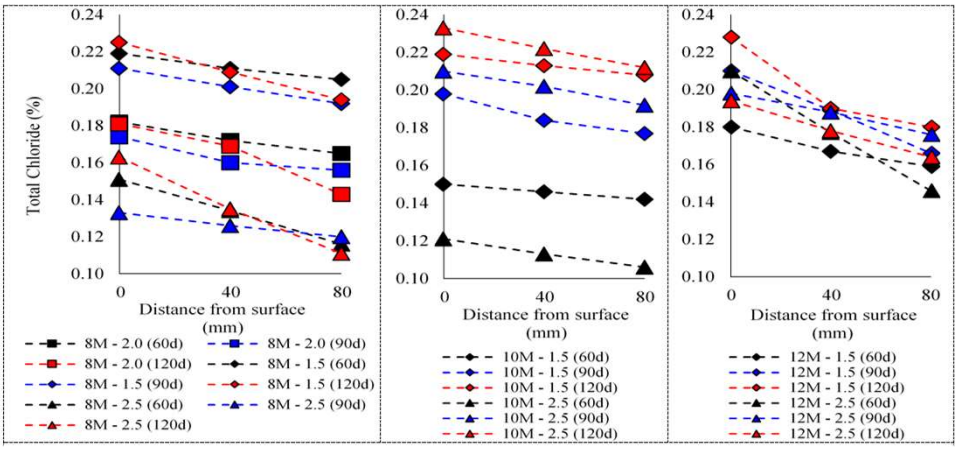
To determine the corrosion possibility of reinforcement, lollipop-shape specimens with the size of 10x10x15 cm were prepared with the plain steel bar in the middle of concrete. The fly ash-based geopolymer specimens were exposed to chloride ion penetration for 30-120 days. A class F fly ash with a specific gravity of 2.5 g/cm^3 was obtained from the power plant, in Gresik, Indonesia. The mixtures were varied with alkali concentration of 8M-12M with the mass ratio of Na_2SiO_3 to NaOH was varied from 1.5 to 2.5. Specimens made with portland cement concrete was also prepared as the control. The lollypop-shape specimens were prepared to fix the steel-bar with a diameter of 16 mm in the middle of concrete. The corrosion activity is monitored by measuring the copper/copper sulphate (Cu/CuSO4) half-cell potential according (HCP) to ASTM C-876 . For each variable, three identical concrete cylinders of 10 cm in diameter and 20 cm in height were prepared for some tests, such as compressive strength, chloride content, pH, XRD analysis and porosity





Results

The geopolimerization process still occured to cause the concrete became dense during immersion period for 90 days in salt-water. Higher silicate content provided by natrium silicate in the mixture contributed to increase the concrete strength in every NaOH concentration. This soluble silicate provided the certain ratio of Si/Al which is necessary to build the strength. For 90 days of curing period in salt-water, the chemical reaction of mixture to construct the concrete strength was more dominant than the effect of chemical reaction by NaCl to decrease the concrete strength. the role of higher NaOH concentration is also very important to keep the soluble silicate released from binders to salt-water. Alkali made with 12M of NaOH assure the existing soluble silicate in the mixture preserve the continuous strength development. Results from this experiment showed that chloride content in the geopolymer concrete is relatively high. The maximum chloride content on the surface of all specimens were maximum at 0.23. However, the binding capacity of geopolymer concrete was apparently better than conventional concrete. The cation from Na+ in the mixture is considered as a shield of Cl- penetration



Discussions & Conclusions

During 90 days exposure in salt-water, fly ash-based geopolymer concrete made with 12 M NaOH gain higher strength faster than that with lower concentration. This is because concrete has less pores as curing was prolonged continuously in wet condition. The effect of higher alkali ratio represented by soluble Na_2SiO_3 in the mixture prevented concrete from possibility to corrosion. The participation of soluble silica is believed to decrease pore size because of the formation of better geopolymeric gel. Evidently, higher NaOH concentration in fly ash-based geopolymer concrete resulted in better chloride binding capacity. It contributed also to the exchange chloride ion on the surface of concrete.

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