

# Compressive Strength Development of Inorganic Polymeric Mortars: Effects of Water Glass and Curing

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**Abstract.** We studied the development of compressive strength of inorganic polymeric mortars with and without water glass and different curing conditions. Ten different mixtures of inorganic polymer mortar were separated into two groups. Various mixtures of fly ash, sodium hydroxide solution, water glass and clean river sand were made and cured in two ways: in oven at 60°C for 48 hours and under ambient conditions. Compressive strengths were measured over 90 days. Results showed that water glass increases the compressive strength of these mortars but curing with high temperature reduced it. Moreover, mixtures with water glass cured at 60°C had the highest compressive strength (6.20 MPa) at 90 days. However, mixtures without water glass and cured under ambient condition had sufficient compressive strength for normal concrete work.

## Keywords:

Inorganic polymer mortar, curing temperature, compressive strength

## 1. Introduction

The cement industry has been identified as one of biggest sources of carbon dioxide released to the atmosphere. Davidovits [1, 2] reported that producing one ton of cement releases one ton of carbon dioxide. USGS reported that world cement consumption increased from 2.52 billion tons in 2006 to 3.36 billion tons in 2010 [3]. With this increasing rate, the global warming becomes a problem faster than expected. Reducing cement use might alleviate this situation. Geopolymer, an inorganic polymer, is an alternative material that has a potential to replace cement concrete. It can be produced with a wide range of compressive strengths and thus can replace normal or high strength concrete, even light weight porous concrete [4-6]. However, two key problems with geopolymers are their high viscosities and curing conditions. Geopolymer has a very high viscosity due to its mix proportion [7-9]. Viscosity depends on the amount of silica compound in the mixture [7]. Curing at 60 – 80°C for 24 – 48 hours enhances the compressive strength [10-13]. This discourages using geopolymer in place of conventional concrete in real work. Moreover, here we have studied a wider range of mixtures than specified by Davidovits'

patent [14], because very different compositions from geopolymer could meet the requirements of real work.

Curing conditions described to date are not practicable at a construction site. Therefore, this study focused on the effects of curing temperature on compressive strength of inorganic polymer mortars. Two curing conditions; 60°C in an oven and ambient conditions were assessed and compressive strengths of traditional geopolymer mortar and its variants, inorganic polymer mortars, were measured after 7 to 90 days.

## 2. Experimental Program

### 2.1 Materials

Fly ash (FA) collected from the Mae Moh lignite power plant (Lampang, Thailand; 18°17'45"N 99°45'00"E) was used as inorganic polymeric base, because of its known properties [15]. Fly ash mostly contains silica and alumina that are necessary for polycondensation of aluminosilicate. Moreover, its shape increases workability of the fresh mixture of inorganic polymer. The chemical composition is in Table 1.

Chemical compound	FA	WG
SiO <sub>2</sub>	37.4	53.3
Al <sub>2</sub> O <sub>3</sub>	19.6	-
CaO	16.2	-
Fe <sub>2</sub> O <sub>3</sub>	14.6	-
SO <sub>3</sub>	5.1	-
MgO	4.0	-
K <sub>2</sub> O	2.2	-
TiO <sub>2</sub>	0.5	-
Na <sub>2</sub> O	-	15.4
Other oxides	0.4	-

Table 1. Chemical composition of fly ash (FA) and water glass (WG) (wt %)

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