Geopolymer concrete can be manufactured by using the low-calcium (ASTM Class F) fly ash obtained from coal- burning power stations. Most of the fly ash available globally is low-calcium fly ash formed as a lay-product of burning anthracite or bituminous coal. Although coal burning power plants are considered to be environmentally unfriendly, the extent of power generated by these plants is on the increase due to the huge reserves of good quality coal available worldwide and the low cost of power need from these sources. The energy returned-to- energy invested ratio of coal burning power plants is high and second only to the hydro-power generation plants.

Therefore, huge quantities of fly ash will be available for many Years in the future (10). The chemical composition and the particle size distribution of the fly ash must be established prior to use. An X-Ray Fluorescence (XRF) analysis may be used to determine the chemical composition of the fly ash.

Low-calcium fly ash has been successfully used to manufacture geopolymer concrete when the silicon and aluminum oxides constituted about 80% by mass, with the- Si-to-Al ratio of about 2. The content of the iron oxide usually ranged from 10 to 20% by mass, whereas the calcium oxide content was less than 5% by mass. The carbon content of the fly ash, as indicated by the loss on ignition by mass, was as low as less than 2%.

The particle size distribution tests revealed that 80% of the fly ash particles were smaller than 50 pm .The reactivity of low-calcium fly ash in geopolymer matrix has been studied by Fernandez-Jimenez, et a1 [4, 7].

2.1.3 Aggregates

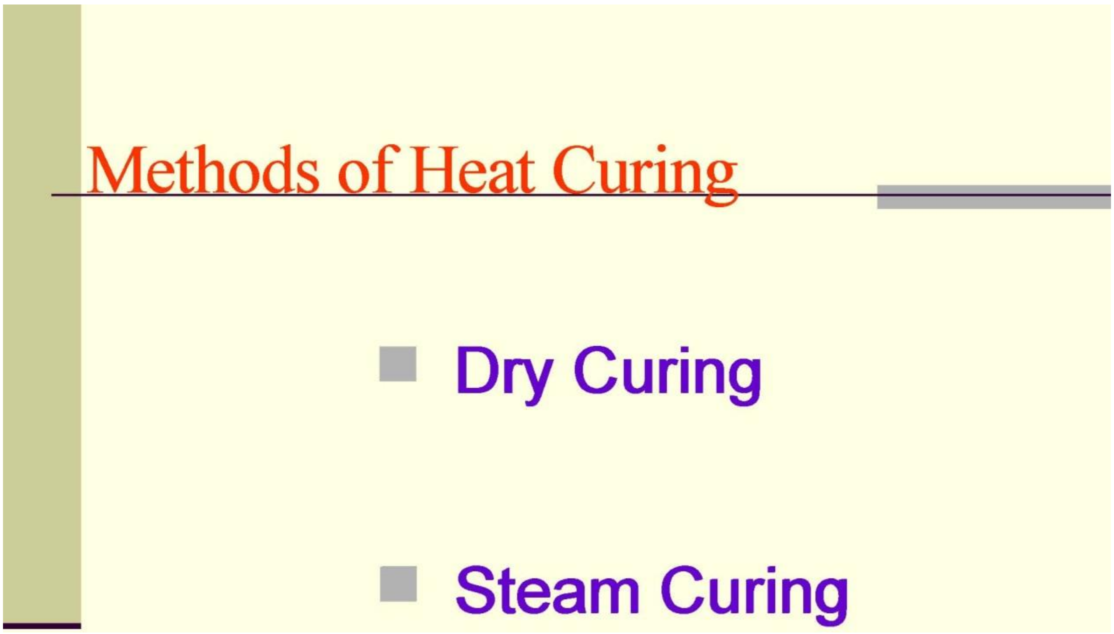
Coarse and fine aggregates used by the concrete industry are suitable to manufacture geopolymer concrete. The aggregate grading curves currently used in concrete practice are applicable in the case of geopolymer concrete [5]

2.1.4 Water

Water, expelled from the geopolymer matrix during the curing and further drying periods, leaves behind nano-pores in the matrix, which provide benefits to the performance of geopolymers. The water in a low-calcium fly ash-based geopolymer mixture, therefore, plays no direct role in the chemical reaction that takes place; it merely provides the workability to the mixture during handling.

This is in contrast to the chemical reaction of water in a Portland cement concrete mixture during the hydration process. However, a small proportion of calcium-rich source materials such as slag may be included in the source material in order to accelerate the setting time and to alter the curing regime adopted for the geopolymer mixture. In that situation, the water released during the geopolymerisation reacts with the calcium present to produce hydration products [5].

3.3 CURING



[6]

Heat curing substantially assists the chemical reaction that occurs in the geopolymer paste. Both curing time and curing temperature influence the compressive strength of geopolymer concrete.

The effect of curing time is illustrated in Figure (3.2). The test specimens were 100x200 mm cylinders heat-cured at 60°C in an oven. The curing time varied from 4 hours to 96 hours (4 days).

Longer curing time improved the polymerization process resulting in higher compressive strength. The rate of increase in strength was rapid up to 24 hours of curing time; beyond 24 hours, the gain in strength is only moderate. Therefore, heat-curing time need not be more than 24 hours in practical applications as shown in Figure (3.3)

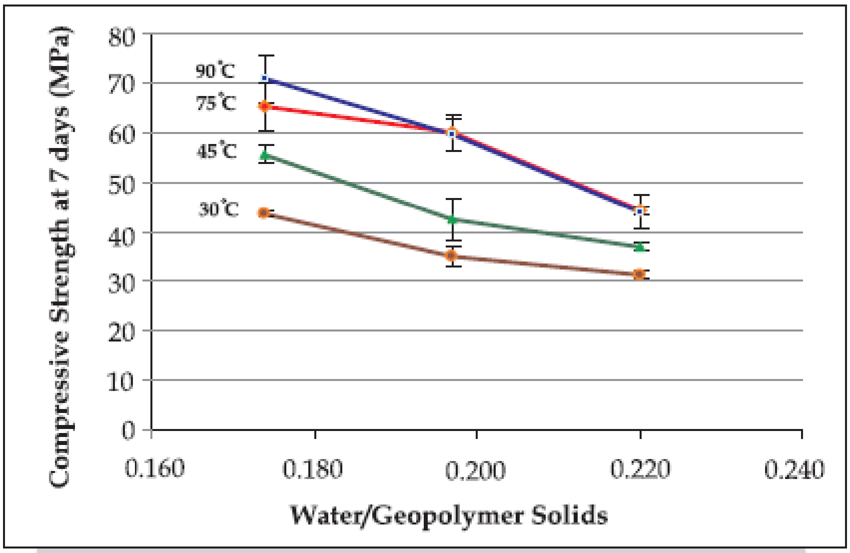


Figure (3.2) shows the effect of curing temperature on the compressive strength of geopolymer concrete.

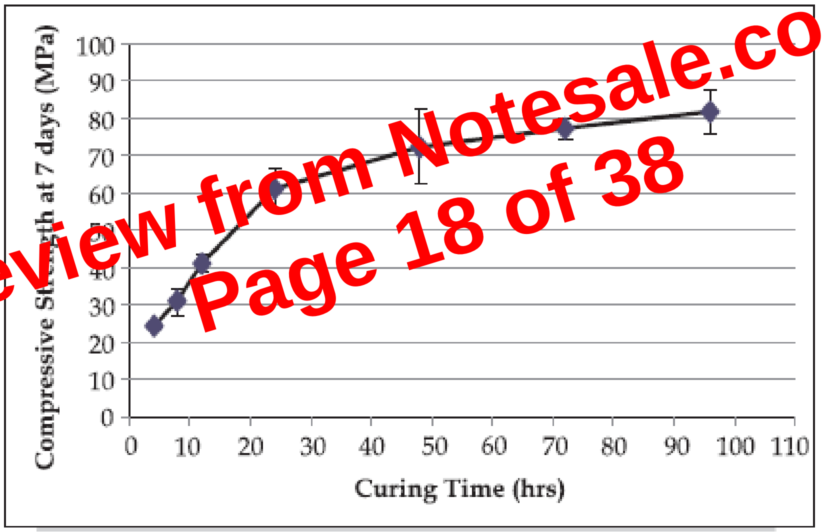


Figure (3.3) Effect of curing time on compressive strength of geopolymer concrete

Chapter Five

Conclusions

Based on several researches on geopolymer concrete, the following conclusions are drawn:

1. The ultimate structure of the geopolymer depends largely on the ratio of Si to Al (Si : Al).

2. Geopolymer concrete shall be manufactured without using any amount of ordinary Portland cement.

3. Geopolymer concrete did not harden immediately at room temperature as in conventional concrete. Geopolymer concrete specimens took a minimum of days for complete setting without leaving a nail impression on the hardened surface.

4. The advantages of geopolymer concrete are ; the price of by product materials are low, better compressive strength, higher resistance to heat, low permeability, eco-friendly and magnificent properties within both acid and salt environments.

5. The natural materials to be used in geopolymer concrete are , kaolinite, clays ..etc and the byproduct materials such as fly ash, silica fume, slag, rice-husk, red mud, etc. The choise of the source materials for making geopolymers depends on availability, cost, type of application.

6. Geopolymer concrete can be manufactured by adopting the conventional techniques used in the manufacture of Portland cement concrete.

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