ALKALI ACTIVATION OF FLY-ASH BINDER IN POPBETON

Rostislav Šulc, Pavel Svoboda

Abstract
In this paper some production processes and possibilities of alkaline activation of fly ash are examined. This fly ash is used as a binder in new type of concrete without cement binder, called POPbeton. Program was focused on „cold way“ preparation of POPbeton without necessity of heating. In this program same types of so called „intenzifikaror” were used. These „intenzifikátor“ causes hardening of POPbeton mixture. Samples of cold way prepared POPbeton were explored with electron microscope and they were compared with POPbeton samples prepared with heating. This technology is following step to use waste materials such as fly ash and slag.

Keywords: POPbeton, fly-ash, alkali activator, production processes, binder

1 Introduction

In 2003 the close cooperation between the Department of glass and VŠCHT was set. Since that the examination of usage fly ash from a main hearth has been conducted. The core of the study is the alkali activation or geopolymerical reaction. Researchers from department of glass had started this study several years before. The aim of the research is the application of acquired results into praxis. The activation from black as well as from brown cold was investigated gradually. However, the necessity of tempering of new concrete mixture still remained an obstacle for broader application of activated ash as an agglutinant. POPbeton® prepared in this way could have been used just for building prefabricated smaller elements such as interlocking pavement. Thus it seemd necessary to develop the new technology of preparation of POPbeton® which would avoid temperation. Hence so called regulator of solidification was searched. A goal of implementation of this substance is to start the whole process of geopolymer reaction without the necessity to supply energy in the form of heat.

2. Production processes

For achievement optimum results was necessary optimize suitable progress of samples preparation. From former piece of knowledge were evident two possible processes. First possibility is activating fly-ash with NaOH (in solid or liquid state) and sodium-silica glass in liquid state. To the activated fly-ash is filler like dried aggregate added and subsequently is water on adjustment consistence added.

Alternate is turning this technological process. First moisten aggregate on min. 1,5% moisture of weight, after it dry NaOH, fly-ash and sodium-silica glass in liquid state and eventually next water on consistence is added.

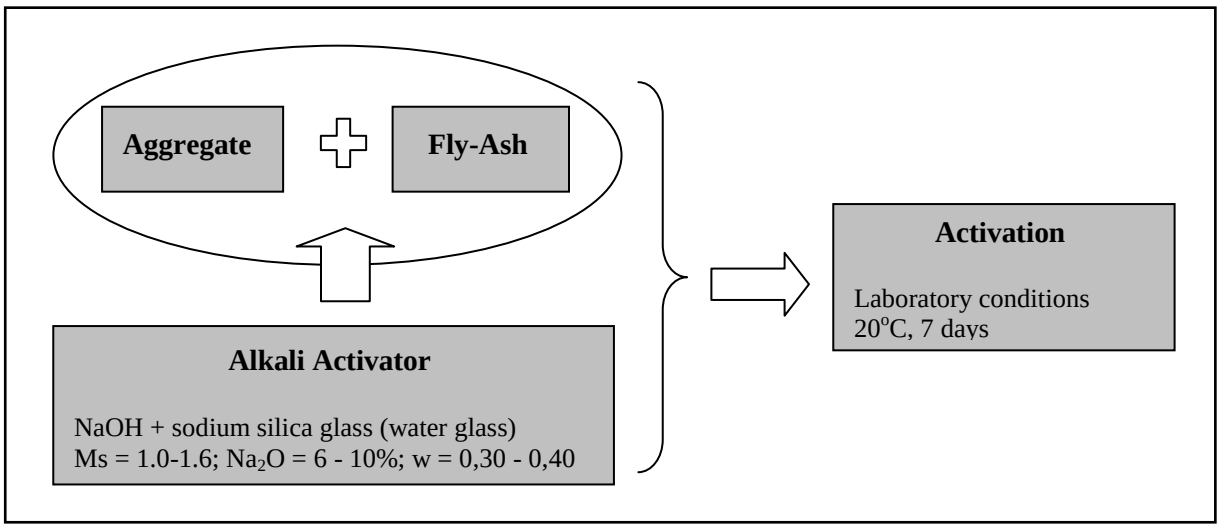

Figure 1: Activation scheme of POPbeton

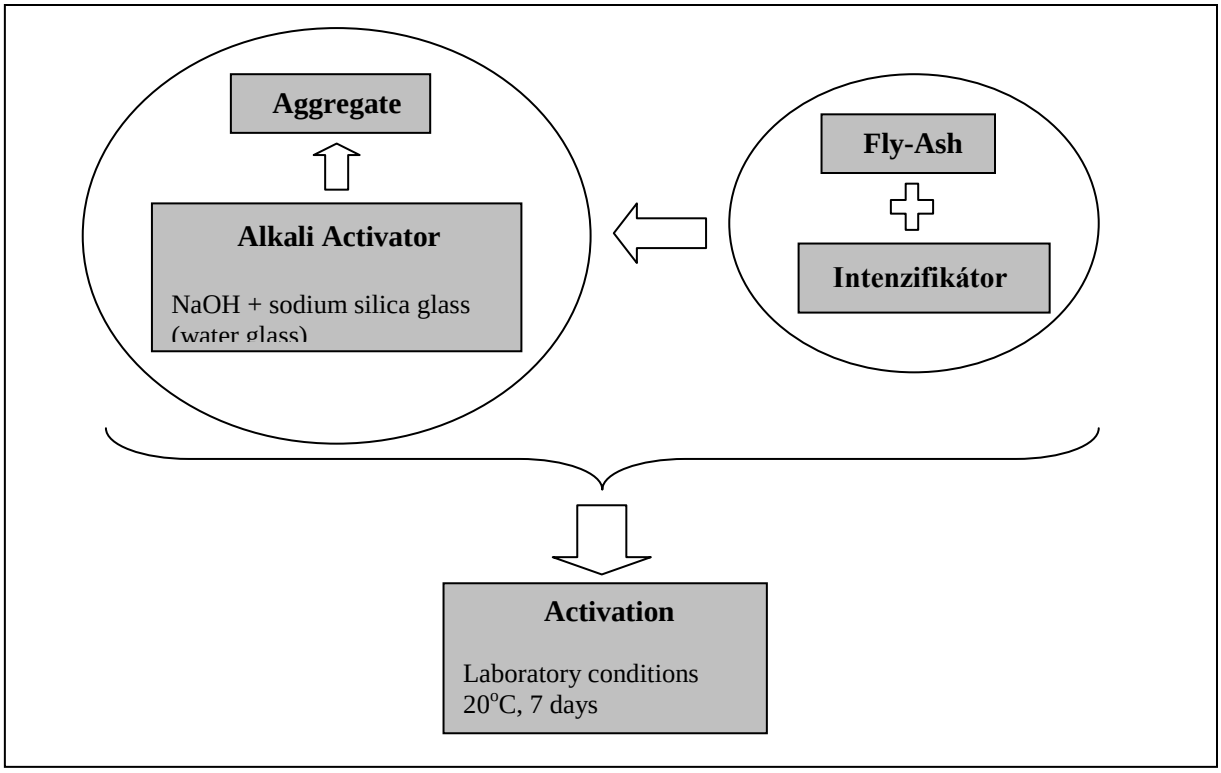

Figure 2: Modified activation scheme of POPbeton

3 Activation of Fly-Ash

3.1 Activation of Fly-Ash by tempering

Examinational cubes of size 100 x 100 x 100 were created. Press strength after 7, 14 and 28 days was examined on them. Long term press strength was examined as well. An amount of water in mixture highly influences the length of hardening of POPbeton® as well as the reached level of whole long term press strength. It seems therefore crucial to maintain the level on the minimum point to maintain a workableness of concrete mixture. A smaller amount of added water was used due to characteristics of black-coal fly ash. The effect of different amounts of water can be seen on the mixtures number 73, 76 which were the same in the rest of characteristics.

Table 1 Tempered mixtures

Series	Type of Fly-Ash
60	Opatovice – brown coal
73	Freiberg - EFA fuller – black coal
75	Dětmarovice – black coal
77	Chvaletice - brown coal
78	Freiberg - EFA fuller - black coal

The differences between black-coal and brown-coal POPbeton® are shown by press strength results. While press strength of black-coal fly ash are about 50 MPa press strength of brown-coal one are about 40 MPa. Levels of long time press strength were observed on these series. Press strength increases by around 10 MPa over time. This increase proceeds till the 40th day. Similar process was used for preparing of POPbeton® which was prepared without tempering.

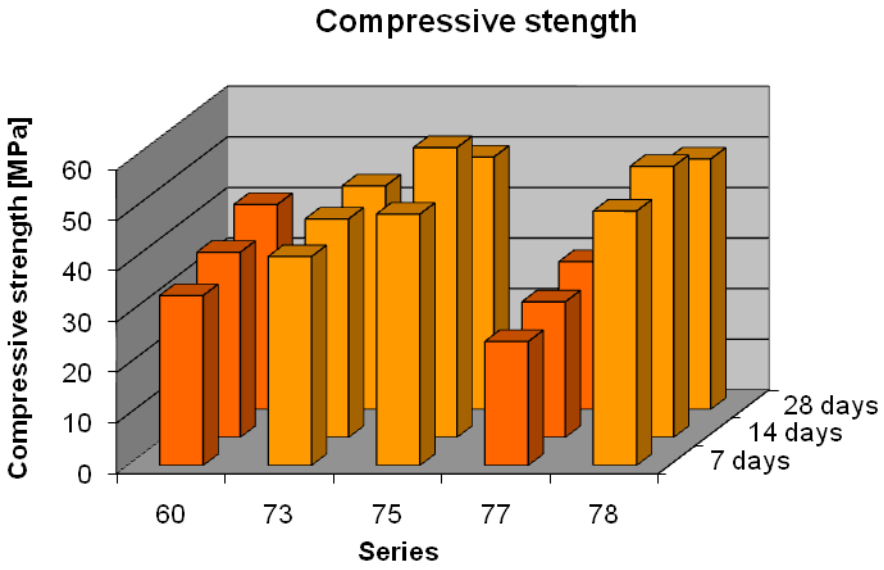

Figure 3: Compressive strength of POPbeton® - tempered

3.2 Activation of Fly-Ash without tempering

It was necessary to find a different way of mixing for this alternate because of different

technology of preparation of POPbeton® without heating. Thus fly ash itself was activated first and it was then added to aggregate. The whole mixture was mixed. The examinal cubes of sizes 100 x 100x 100 mm were created again. Water ratios were chosen to fulfil a demand for the minimum amount of water in the mixture and to maintain the same workability for all of the series. Results from the set number 147 did not correspond with other results. The fluid fly ash from this set was therefore excluded from following examinations.

Table 2 Non-tempered mixtures

Series	Type of Fly-Ash
123	Opatovice – brown coal
147	Opatovice – brown coal
126	Kladno - fluid
129	Freiberg - EFA fuller - black coal
146	Dětmarovice – black coal

Press strengths of POPbeton® were examined 7, 14 and 28 days. Press strengths were measured over time as well. All of the mixtures showed more gentle grow than the mixtures prepared with tempering. The resulted press strength after 28 days are about 10 MPa lower comparing with the tempering alteration.

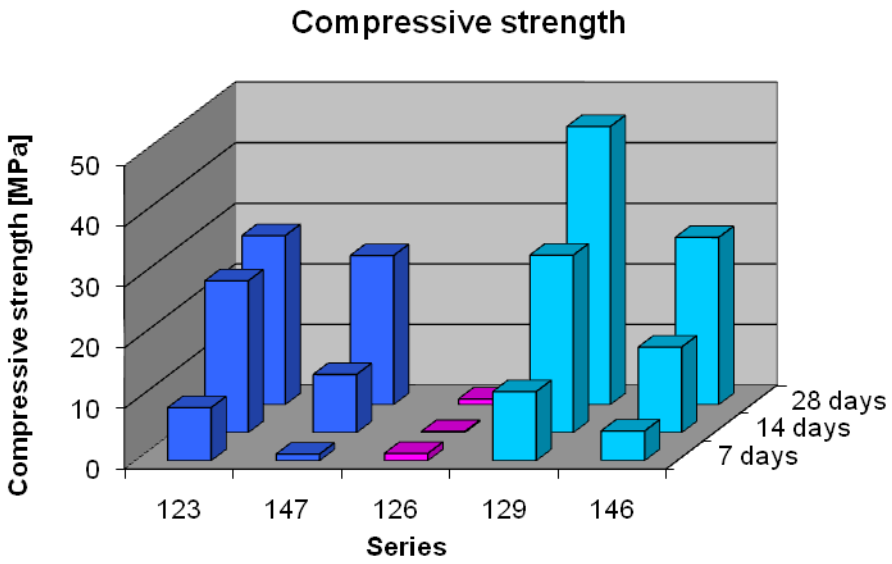

Figure 4: Compressive strength of POPbeton® - non-tempered

3.3 Long term compressive strengths

Investigating of long term compressive strengths provided us with interesting outcomes. The grow of press strengths is more gentle. To maintain the exact dosage of added water is very hard. Press strengths grow until 100th day. The reached press strengths are about 5 MPa lower that these of alteration prepared by tempering.

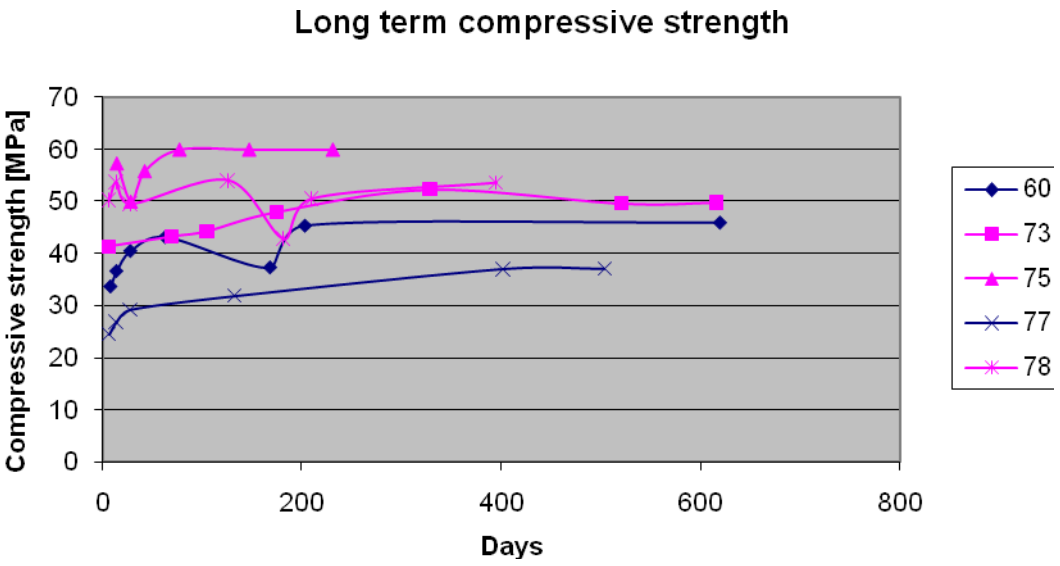

Figure 5: Long term compressive strength of POPbeton® - tempered

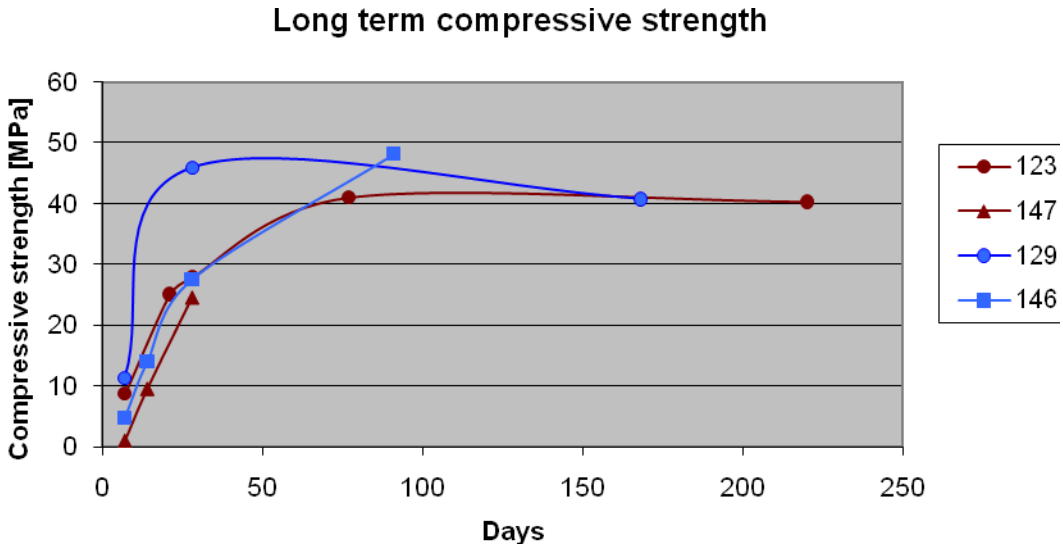

Figure 6: Long term compressive strength of POPbeton® - non-tempered

4 Conclusion

On the basis of achieved results it is possible state, that the characteristics of POPbeton like real mixture, where alkali activated fly-ash as binder is used, it is possible easily modulate how suitable technological processes at mixtures preparation, so adjustment feature of of fly-ash, like

milling of fly-ash. To achieve required features it is possible also with advantage usage of some admixtures.

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