Effect of Admixtures and Addition Agents on Physical-Mechanical and Chemical Characteristics of POPbeton® (Fly-Ash concrete)

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Since 2003 research work of fly-ash alkali activation has been proceeding. This work is provided by the Department of Construction Technology, Faculty of Civil Engineering, CTU in Prague and the Department of Glass and Ceramics ICT Prague. A very important part in activation process of fly ash grains is the quantity of alkali activator and water. Water is used for preparation of activator solutions, its volume and its quantity is deciding for workability of the mixture. To achieve optimum results it was necessary to search quantity of activators and their concentration in activator solutions that allows required workability. Of course it is necessary to keep mechanical and physical properties of fly ash binder. Quantity of water in activator solutions may be various, but quantity of alkali activators is the same. This paper describes problems with different water ratio in fly ash concrete mixtures especially with reference to concentration of alkali activator solutions.

POPbeton (fly-ash concrete) is new type of cement free concrete, where only fly-ash is used as binder. Whereas the term ash concrete signifies cement concrete with ash admixture as fine inert component supplementing the binder, the new type of concrete was named just POPbeton. POPbeton has ambitions to become new building material using some of further waste materials such as slag, metakaoline or fine glass waste. The area of POPbeton application can be extended for solidification of some dangerous waste materials, e.g. heavy metals.

The whole program is primarily focused on using brown coal fly-ash whose production is much higher than the production of black coal fly-ash in the Czech Republic. As the tests demonstrate brown coal fly-ash is less reactive and the final mixture has worse characteristics than the mixture with pure black coal fly-ash.

Fly-ash is activated by the help of silica sodium water glass solution (event. silica-potassium) – water glass and strong alkali – sodium hydroxide or potassium hydroxide. In this case Sodium water glass and sodium hydroxide were used to verify the effect of water quantity in the activation solution. The process of POPbeton production is more sophisticated from the point of view of the technological preparation. It has been demonstrated in numerous papers [1-4]. For fly-ash activation it seems to be suitable to temper the prepared samples in the drying oven at the temperature of 80°C for 24 hours. The second way is activation under laboratory conditions (temperature at 20°C). The tempered samples have in practice immediately after the tempering completion final physical characteristics. In the process without tempering it is necessary to use activators and so called “intensificators” which will equally start the activation reaction. The process of physical and mechanical characteristics rising is slower and proceeds till the 90th day of sample age. As test specimen cubes 100/100/100 mm were prepared, on which compressive strength and specific gravity were examined.

As one of possibility of speeding whole activation reaction, addition of some admixtures is. As suitable admixtures shows especially admixtures with higher content of CaO, as are e.g. blast-furnace slag, variety of clay and earths, fly-ash from fluid combustion, lime or cement. Experimental cubes size 100/100/100 mm where prepared. Blast-furnace slag and lime hydrate in different quantity as admixtures were used. They were prepared to alternate technological process.

Using of ground blast-furnace slag and lime hydrate showed like acceptable combination for achievement of optimum compress strength characteristics. 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 fly-ash, like milling of fly-ash. To achieve required features it is possible also with advantage usage of some admixtures. During this research should be proved how the water quantity in the mixture and the concentration of the activator solution change the final characteristics of POPbeton substance. In the relatively small range of water ration happens to drastically changes in the final values. Thus it can be expected that for keeping the declared POPbeton characteristics it is necessary to retain high standards for mixture processing, as it is by the cement mixtures as well.

Above stated estimations for final values of strength are partial base for corrections and comparison of POPbeton mixtures prepared from variously concentrated activator solutions.

References:

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