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Properties of the Concrete from the Orlik Dam after 50 Years in Operation

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Abstract: Orlik dam is one of the most significant buildings that have ever been in the Czech Republic built. This building was completed and opened in 1961. Its contribution lies not only in size and speed of construction project in the technological process, but also in material used for construction. For the massive construction of the dam body was used because a significant proportion of cement with fly ash. Fly ash was used in order to reduce the amount of heat of hydration during curing of concrete. Nowadays more and more talk about using a stronger fly ash in concrete and therefore need to be given to the performance of these materials. Orlik dam thus offers a unique opportunity to experimentally verify the functionality, strength, material properties and durability of such material after 50 years of operation. This article deals with one of the important mechanical properties of concrete - compressive strength.

Keywords: Orlik Dam, Concrete, Fly Ash, Compressive Strength

1. Introduction

Orlik dam was built between the years 1956 to 1961. It is one of the most important buildings constructed in the Czech Republic. This building was challenging technologically and economically. Price is around 1 billion crowns (currently estimated by such a construction cost of at least CZK 30 billion.). Unusually for the period during which construction took place, the proposal was consulted on the work with researchers. A very important role played in this direction and staff of CTU in Prague. Orlík is part of the Vltava cascade, which is one of more dams Lipno Hněvkovice, Kořensko, Kamýk, Slapy, Štěchovice and Vrané. Orlik dam shall perform the following purposes - ensuring minimum flow in the Vltava River, power generation, supply, surface water, protection from floods.

Direct gravity concrete dam is 81.5 m high above the ground and a long 450 m and formed by 33 blocks (Fig. 1). The first part of the body of the dam was concreted in 1956 and in 1961 the building was handed over in operation. Although it seems almost incredible, everything was catching on the scheduled dates. The intensity of construction is the fact that 83% of the total cubage was concreted in two and a half years. Overall on the dam was used 923,000 m^3 of concrete.

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Fig. 1. Gravity concrete Orlik dam

2. Concrete used for construction

Production of concrete was fully mechanized and automated. Because of higher price and the unsuitability of crushed stone from local quarries and gravel terraces of the Vltava River was imported Elbe gravel. This stone has been classified into five fractions and transported through the construction of the trains. Cement was used in cement Králův Dvůr, but needed a thorough inspection, because of its very varied quality. Therefore, the established building site during construction and inspection was carried out several thousand non-destructive testing and measurement. Because of problems with the heat of hydration was used fly ash in a mixture of concrete. In Table 1 is seen as the ratio of cement and fly ash in concrete core and wrap.

Table 1. Composition of binder concrete using fly ash in the construction of the Orlik dam

Concrete		Composition [kg/m^3]	
Designation	Placing	Cement	Fly Ash
B170	wrap	200	50
B80	core	130	50

3. Test samples

For analysis were made drill holes with diameter 80 mm and length up to 3 m (3 x coring and 3 x wrapping concrete). These samples with diameter 80 mm are used for chemical and microscopic analysis.

From the dam were moreover obtained parts of the drill hole for line of air - conditioning. The drill hole was led through the dam and had a diameter 300 mm. Part of the samples was used for Splitting test. The remaining sections were cut cubes on edge 200 mm. On them were tested for compressive strength. The cube

was placed in the press between two steel plates. Figure 2 shows ready for the test cube and cube after test. Four tests were performed.

Fig. 2. Test compressive strength of concrete mixed with fly ash from Orlík dam after 50 years

4. Evaluation of the test

After the test were the compressive strength evaluated. Graphical representation of strength is shown in Figure 3. Strength test samples are between 40 to 50 MPa. This scatter can be given as the composition of the material (large aggregates) and the tale that is part of the transition between the wraping and core concrete.

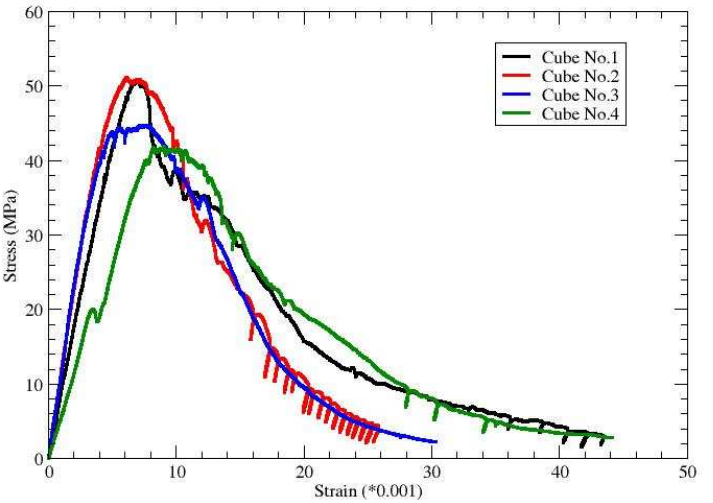

Fig. 3. Evaluation of compressive strength of concrete mixed with fly ash from Orlík dam after 50 years

5. Conclusion

If you should be summarized in one graph measurements during construction and after 50 years of measurements and plotted so that the horizontal axis is ln t (natural logarithm of time), it is possible to do linear regression. The result is a foot in Figure 4. Deviation from the exponential is very small. Graph refers to the concrete B80, where fly ash accounted 28% binder. The result conclusively demonstrates the excellent durability of concrete with a strong admixture of fly ash. While fly ash used was not always good quality.

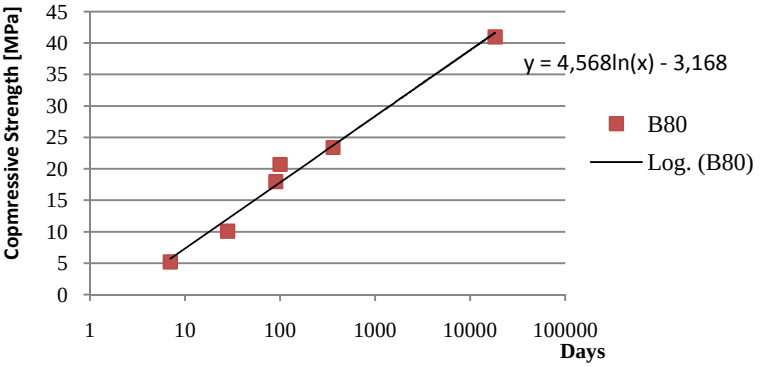

Fig. 4. The increase in strength concrete B80

From the samples it was found that it was a great technological process. Whether in terms of reducing heat of hydration development and in terms of granulometry of aggregates used. The aim of further work is therefore an in-depth analysis of this material 50 years old, which should bring more interesting findings and confirmed by the use of fly ash as a partial replacement of Portland cement does not bring long-term risks. This would allow a wider use of fly ash in concrete. It would be very desirable, because the Czech Republic is among the largest producers of fly ash per capita in the world. Fly ash is no longer regarded as waste but as a useful resource.

6. Acknowledgement

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