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PROPERTIES OF CONCRETE AT ELEVATED TEMPERATURES

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The stress-strain response of concrete to elevated temperatures is very complex. It depends on the one hand on the concrete mix, aggregate,cement, water/cement ratio, thermal properties of aggregate and cement paste, state of humidity etc. But on the other hand it depends strongly on the way heat is applied to the concrete: e.g. as a thermal shock, like fire, uncontrolled heat flow from sunshine, at hot spots of a PCPV etc., or as a controlled heat application in laboratory tests or as foreseen with the temperature control system of the Austrian PCPV. The influence of thermal test conditions on concrete properties may be more significant than the applied temperature level. This fact makes it sometimes difficult if not impossible to compare test results without the exact knowledge of test conditions.

For the assessment and long-term operation of a PCPV with hot liner and elevated wall temperature a great number of normal and light-weight concretes with high strength at elevated temperatures were tested extensively.

In order to avoid unsuitable random influences on the test results, the testing procedure, the application of heat, the state of humidity were controlled very carefully. To insure the applicability of the results in praxis, only aggregates, cements and additives available on the market were used. Measures were taken to improve the heat resistance of the concretes tested. The results show a loss of compressive strength due to temperature cycling in the range of 5-25% of initial strength. The loss occurs during the first cycle, further cycling shows a stabilization and a tendency for recovery.

On the basis of these tests suitable concretes were selected for the construction of the prototype vessel at Seibersdorf Research Center. For long-term investigations a test facility was built to study the temperature influence on Young's modulus, coefficient of thermal expansion, shrinkage and creep under realistic conditions simulating the temperature and load history of the vessel. Sealed and unsealed specimens have been used. The applied temperatures are in the range of 2o-15o-25o^{o}C for the structural concrete and 2o-3oo-4oo^{o}C for the insulating concrete. The specimens tested were taken from the original cast of the vessel.
The results obtained up to now confirm strong dependence of creep on temperature history. There is a pronounced difference between the creep behaviour of sealed and unsealed specimens. Unsealed concrete reaches much earlier a stable state. The test results are in excellent agreement with measurements taken on the prototype vessel during its thermal stabilization.