NEW EXPERIENCES WITH PARTIAL PRESTRESSING OF PCRV BASED ON LARGE MODEL TESTS

(Neuere Erkenntnisse zur partiellen Vorspannung von SBB anhand von Großmodell-Versuchen)

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SUMMARY

Prestressed concrete reactor pressure vessels built in Europe up to now or being under construction had to be designed under the condition that tensile stresses are strictly limited in undisturbed regions of the vessel walls. The consequences are large wall dimensions and very strong prestressing, i.e. high costs.

Thus, it becomes desirable to build vessels with concrete tensile stresses and, hence, cracking being permitted also in normal regions. The THTR 1 : 5 scale model, which was built in order to confirm the design concept of the PCRV of Schmehausen nuclear power plant and which was no longer used for this purpose, offered a good chance to study the service behaviour of a vessel with partial prestressing only. The vessel was considered to work under 60 kp/cm^2 normal operating pressure and a temperature of 80 °C at the internal surface. Some assessments had shown that the existing crack pattern resulting from previous overload tests would correspond to loading conditions like that.

Testing started May 1975. First, the vessel was heated up to the mentioned temperature. During about two months the vessel was kept without long-time internal pressure. Only several short time cycles with increasing pressure were carried out. Then two periods with constant operating pressure of seven and four weeks followed with about four weeks of interruption. Subsequently the model was cooled down by three steps, a lot of short time pressure cycles being undertaken during this procedure. It is intended to heat the vessel once more in order to demonstrate the possibility of running temperatures of a partially prestressed concrete vessel in any way wanted.

Measurements and observations of the model surface have shown that local cracking propagated during the tests periods with hot and pressurized vessel especially near the blower penetrations and in the end slabs. Long-time deformations indicated by vibrating wire gages were influenced to a certain degree by temperature dependent creep. But the overall response of the vessel on short-time and long-time pressure cycles remained always constant, also in comparison with suitable loading states of years ago. That means, deformations due to internal pressure were fully reversible. — A number of most important results is shown by diagrams.

In short, the operating behaviour of a partially prestressed concrete reactor vessel, as far as concerning the characteristics tested, is fully reliable. Since the present calculating techniques allow a sufficiently accurate consideration of cracking, this concept should be taken into account for future vessel design.