

The development of Alkali Aggregate Reaction at the Kainji spillway structure during 50 years of operation

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The 760 MW Kainji hydropower plant is located at the river Niger in Nigeria. It was commissioned in 1968. The plant suffers Alkali Aggregate Reaction (AAR), especially the spillway structure. The process was noticed during inspections already in the 1970ies, and was confirmed for the first time through a comprehensive investigation campaign in 1993. Thus the mass concrete structures on both sides of the spillway applies a thrust on the spillway structure, leading to deformations of the spillway piers and compressive stress on the spillway bridge and crane beams. Most critical failure mode is that the spillway gates get blocked between the piers, which could cause a major safety concern for the plant. Further the strength of the concrete could be reduced, which might have an impact on safe spillway operation. Thus an update of the safety evaluation of the spillway structure was required and carried out in 2019.

Spillway structure rehabilitation works were carried out in 1996/97, comprising slot cutting for relief of compressive stresses, the drilling of drainage holes and the installation of additional monitoring instruments. According to the provided measurement data, the swelling of the concrete due to alkali aggregate reaction must have significantly slowed down. The blockage of the spillway gates is currently not an issue. However, the conclusion is not conclusive, as monitoring data is not comprehensively available. The rehabilitation of the monitoring instruments is in progress and might allow more detailed evaluation of the AAR progress in future.

Based on the construction history of the spillway structure, its stress conditions due to AAR, locally accelerated AAR due to higher temperatures and sun radiation, the crack pattern observed during visual inspection will be explained. Finally it was possible to demonstrate that the crack pattern observed at the spillway piers, bridge and crane beams does not significantly reduce their bearing capacity. The safety of the spillway structure is currently

provided. However AAR and concrete expansion will continue unabated, albeit with slow velocity. The importance of surveillance and monitoring is emphasised.

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