Finite Element Modelling for Designing Geodetic Deformation Permanent Monitoring Projects - the Case of Hydro Power Plant and Large Dam

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ABSTRACT:

Worldwide, over 50,000 dams have been built, and a lot of the large rivers are obstructed by large dam. The economical value of producing energy as well as retaining water in large reservoir has motivated financial institutions such the World Bank and the European Fund of Development to invest significantly more in dam's construction, rehabilitation and protection. A dam is a large and complex engineering structure that requests a deep understanding to evaluate its behavior and reaction under water load under various conditions. Especially dams built more than 40-50 years ago that have been designed and erected with low quality control in the choice of materials and in the construction comparing with dams that are constructed recently. From this point of view, and especially when the responsible wants to increase the electricity production by installing new turbines, the automatic and permanent monitoring of old dams is gaining interest and non invasive methods are preferred to not impact the structure. Geodetic Permanent Deformation Monitoring system fits very well with that requirement especially when there is a possibility to integrate remaining geotechnical sensors in a global modeling. Geodetic Monitoring has proven to be successful to provide information to the responsible in charge of increasing the life time of their structure but still considered as expensive from the instrumentation. The question is therefore how to better design such monitoring installation to bring an affordable proposition while providing useful and pertinent feedbacks. From the author's point of view, to use of three dimensional Finite Elements Model (3D FEM) is mandatory while not easy especially when the original documentation has disappeared or has been destroyed. Water level and temperature variations must be taken into account when modeling the applied load. This kind of modeling reflects the behavior of the dam, and estimates under several hypotheses the reaction in term of displacements of discrete points in the structure that will guide the distribution of the measurement points (instruments and targets) and therefore the design of the geodetic monitoring network. To evaluate if the final accuracy requested will be reachable, the geodetic monitoring engineers are using rigorous statistical inference such Least Squares Adjustment in order to simulate the whole observational process and derive the parameters that will confirm the design. There is thus a great value to base the original design on the right deformation assumptions in order to derive useful feedbacks that will be the basis of any early warning, risk or disaster management system. The authors will illustrate their approach by using several cases such Hydro Power Plants that have been constructed in 1960's in Ukraine and even recently like in Iran.