REAL-TIME TEMPERATURE MONITORING AND SIMULATION OF CONSTRUCTION PROCESS BASED FEEDBACK DESIGN OF TEMPERATURE CONTROLLING MEASURES FOR CONCRETE DAMS

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ABSTRACT

Years of Research has demonstrated the close link between cracking and temperature variation process within mass concrete. To prevent cracking, years of practices and in-depth research have been conducted on revealing mechanism of temperature cracking and effects of various controlling measures. However, concrete cracking is not vanishing consequently. It is still trapping engineers. For instance, during design and construction of Xiaowan double-curvature arch dam in China, strict measures have been incorporated in materials and construction technics to prevent cracking according to experimentation and simulation results, but 16 cracks were found in 6 monoliths in the initial stage of construction.

From previous research, some important facts that have been increasingly attracting most scholars' attention are as follows:

(1) To have an overall understanding of the developing process and distributing pattern of temperature stress, the variation process and distribution pattern of temperature fields must be accurately defined.

(2) The accuracy of concrete thermal parameters and environmental parameters involved in initial conditions and boundary conditions are remarkably contributing to simulation results of temperature and stress fields. Moreover, in most practical cases, due to the variation of construction scheme, real boundary conditions of each concrete block might be significantly different from on which the temperature and stress simulations are based. Accordingly, more valuable results of temperature and stress simulation should be based on more accurate parameters of the simulation process.

(3) The most concerned factor during construction is the effect of temperature controlling measures for concrete dams. Therefore, to fully utilize monitoring data for predicting risk zone and guiding engineers to take steps as early as possible to prevent the occurrence of undesirable cracks is of great importance.

For these reasons, an integrated concept, named feedback design of temperature controlling measures, which incorporates temperature real-time monitoring, temperature simulation, construction process simulation and optimization of construction measures as a large system is set up in this paper. On the basis of this concept, feedback design of temperature controlling measures for concrete dams is done along the following steps:

(1) monitoring temperature variation process and collecting data through distributed temperature sensors embedded in typical concrete blocks;

(2) reconstructing temperature fields and back analyzing thermodynamic parameters of construction materials according to collected temperature data;

(3) simulating dam construction process by incorporating construction scheme parameters with quality restriction to obtain accurate parameters of construction schedule for determination of accurate constructing environmental parameters;

(4) simulating temperature and stress fields within dam concrete by incorporating initial temperature controlling measures, material parameters from step (2), environmental parameters from step (3) and construction schedule from step (3) to predict distribution and other details of temperature fields and stress fields;

(5) assessing effects of initial temperature controlling measures by comparison with results from step (4) and temperature design standards to determine revised measures if design standards are not satisfied;

(6) if there are revised measures, repeating step (4) to step (5) until temperature design standards are satisfied.

Works from step (1) to step (6) are repeated in each concrete block to propose individuated controlling measures for respective concrete blocks.

Our research team takes Xiluodu arch dam as a study case and implements the above works from the commencement of dam construction in Mar. 2009. Construction of this dam will be completed in May. 2013. So far the results of the feedback design approach have been proved efficacious.

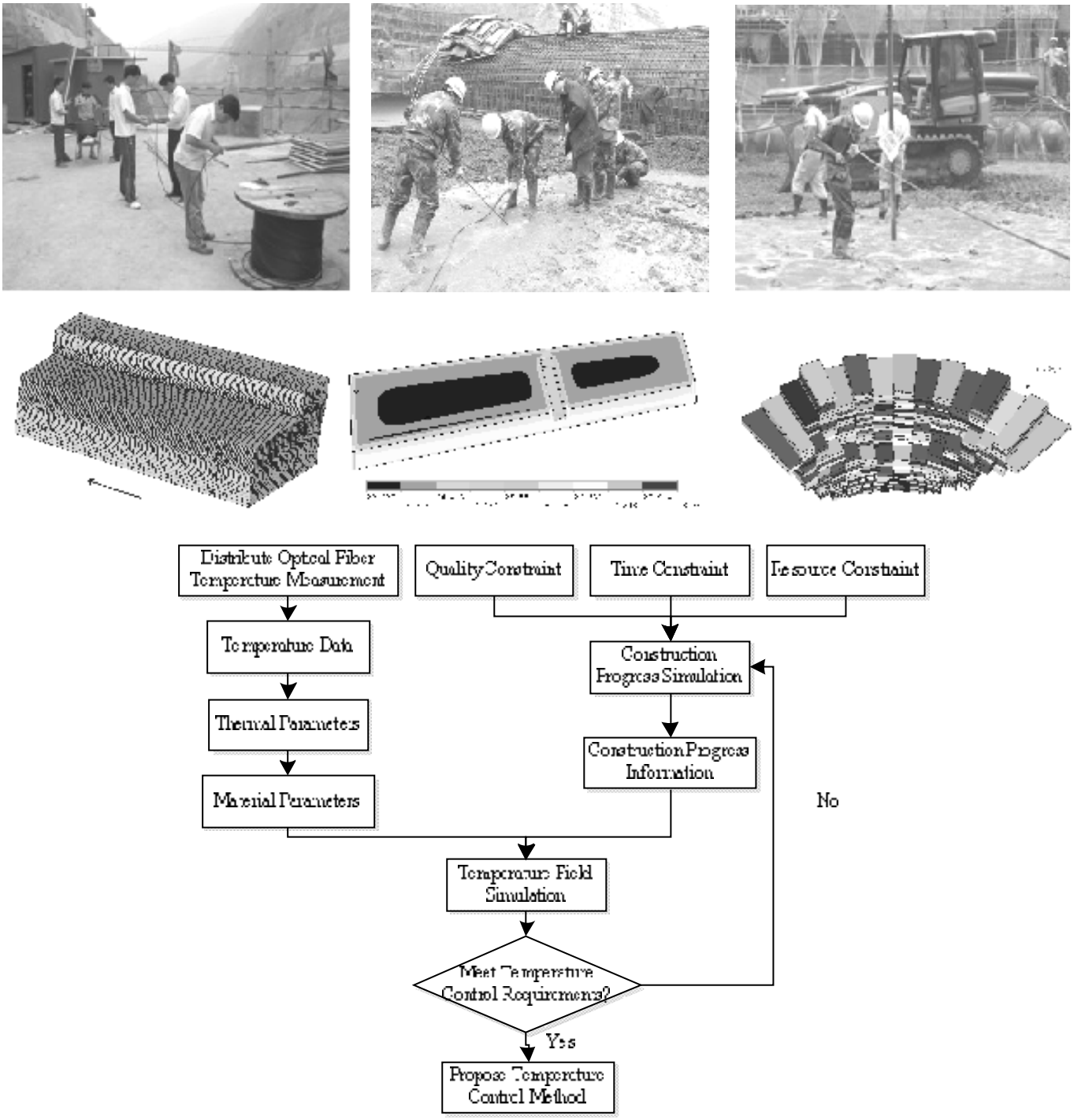

Figure 3: *Temperature Control Method Optimization Flow*

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