Developing Three-Dimensional Digital Image Correlation Method to Detect the Crack Variation at the Joint of Weld Steel Plate

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Abstract : The purposes of hydraulic gate are to maintain the functions of storing and draining water. It bears long-term hydraulic pressure and earthquake force and is very important for reservoir and waterpower plant. The high tensile strength of steel plate is used as constructional material of hydraulic gate. The cracks and rusts, induced by the defects of material, bad construction and seismic excitation and under water respectively, thus, the mechanics phenomena of gate with crack are probing into the cause of stress concentration, induced high crack increase rate, affect the safety and usage of hydroelectric power plant. Stress distribution analysis is a very important and essential surveying technique to analyze bi-material and singular point problems. The finite difference infinitely small element method has been demonstrated, suitable for analyzing the buckling phenomena of welding seam and steel plate with crack. Especially, this method can easily analyze the singularity of kink crack. Nevertheless, the construction form and deformation shape of some gates are three-dimensional system. Therefore, the three-dimensional Digital Image Correlation (DIC) has been developed and applied to analyze the strain variation of steel plate with crack at weld joint. The proposed Digital image correlation (DIC) technique is an only non-contact method for measuring the variation of test object. According to rapid development of digital camera, the cost of this digital image correlation technique has been reduced. Otherwise, this DIC method provides with the advantages of widely practical application of indoor test and field test without the restriction on the size of test object. Thus, the research purpose of this research is to develop and apply this technique to monitor mechanics crack variations of weld steel hydraulic gate and its conformation under action of loading. The imagines can be picked from real time monitoring process to analyze the strain change of each loading stage. The proposed 3-Dimensional digital image correlation method, developed in the study, is applied to analyze the post-buckling phenomenon and buckling tendency of welded steel plate with crack. Then, the stress intensity of 3-dimensional analysis of different materials and enhanced materials in steel plate has been analyzed in this paper. The test results show that this proposed three-dimensional DIC method can precisely detect the crack variation of welded steel plate under different loading stages. Especially, this proposed DIC method can detect and identify the crack position and the other flaws of the welded steel plate that the traditional test methods hardly detect these kind phenomena. Therefore, this proposed three-dimensional DIC method can apply to observe the mechanics phenomena of composite materials subjected to loading and operating.

Keywords : welded steel plate, crack variation, three-dimensional digital image correlation (DIC), crack stel plate

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