11th. World Congress on Computational Mechanics (WCCM XI)
20 - 25 July, 2014
Barcelona, Spain

Fatigue evaluation based on modified Green's function approach considering temperature-dependent material properties

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Key Words: *Fatigue monitoring, Green's function approach, Temperature-dependent material properties, Thermal stress analysis*

ABSTRACT

According to the IAEA PRIS (Power Reactor Information System), about 40% of reactors in the world are being operated beyond design life or are approaching their life. During long-term operation, various degradation mechanisms are occurred. Especially, fatigue caused by alternating operational stresses in terms of temperature or pressure change is one of important damage mechanisms in continued operation of Nuclear Power Plants (NPPs). To prevent the fatigue damage at major components of long-term operating NPPs, various requirements, such as fatigue monitoring or CUF calculation, are being used. To monitor the fatigue damage of components, fatigue monitoring system (FMS) has been installed. Most of FMS have used Green's function approach (GFA) to calculate the thermal stresses rapidly. However, there is a maximum peak stress discrepancy between a conventional GFA and a detailed FEM which temperature-dependent material properties are used because constant material properties are used in a conventional method. If a conventional method is used in the fatigue evaluation, thermal stresses for various operating cycles may be calculated incorrectly and it may lead to an unreliable estimation. So, in this paper, the modified GFA which can consider temperature-dependent material properties is proposed by using 3D Green's function and weight factor. To verify the proposed method, thermal stresses by the new method are compared with those by FEM. And then, the fatigue evaluation results between a conventional method and the proposed method are compared. Finally, pros and cons of the new method as well as technical findings from the assessment are discussed.