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Modal characteristics of flow skirt for SMART

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Summary

Korea is developing one of advanced small and medium-sized reactor called SMART (System-integrated Modular Advanced ReacTor), an integral type pressurized water reactor with the thermal power of 330 MW, by combining innovative safety features and its own indigenous technologies with proven light water reactor technologies. The reactor assembly of SMART contains major primary systems such as fuel and core, 8 steam generators, a pressurizer, 4 main coolant pumps, and 25 control rod drive mechanisms in a single pressurized reactor vessel. The integrated arrangement of these components enables the removal of the large size pipe connections between major components of reactor coolant system, and thus fundamentally eliminates the possibility of large break loss of coolant accident.

Many innovative design features are also employed in the reactor vessel internals and one of them is flow skirt for distributing flow uniformly, restraining horizontally the lower part of core support barrel (CSB), and supporting core if the fuel assembly drops into the reactor vessel lower head due to CSB failure. For this kind of new design, it is necessary to investigate comprehensive vibration characteristics, which is being performed analytically and experimentally by the designer as a part of preparing a document for licensing purpose.

The flow skirt has a large number of holes and the analysis of this kind of perforated, by finite element method for instance, was a very costly and time-consuming technique which solves only one particular problem. But it is possible to model the perforated shell and to analyze it and it is no more time-consuming theses days due to the rapid development of the hardware and software. However, if a perforated shell is submerged in fluid it is almost impossible to model and analyze it as is and the fluid at the same time, which is needed to investigate the effect of the fluid-structure interaction. The simplest way to avoid time-consuming and costly analysis of perforated shell submerged in fluid is to replace the perforated shell by an equivalent solid one considering weakening effect of holes.

Therefore in this study, equivalent material properties are found and the modal characteristics of flow skirt are investigated using the finite element analysis with equivalent properties.