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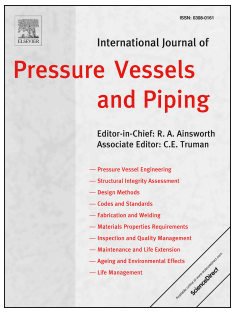

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Shakedown Analysis for Structural Design Applied to a Manned Airtight Module

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Abstract

An airtight module is one of the most important components of a manned spacecraft because it not only provides the habitable and working spaces but also ensures the safety of the astronauts during flight in orbit and atmospheric reentry. Structural design of the airtight module is generally performed according to the elastic limit rule with different load cases during flight. The structure of the manned airtight module experiences different types of stress during service, which makes the solution obtained with the elastic limit rule conservative to an extent. From this perspective, shakedown analysis is a novel approach to determine the structure response with consideration of plastic behavior, which causes the structure to be designed in a relatively practical way. The proposed method is validated through a theoretical derivation and numerical simulation, and it is proven to be applicable for cases ranging from a simplified structure to the fully airtight module. Moreover, a given problem for the design of the connecting structure is investigated to obtain an optimal solution for the airtight module. This approach for determining structure behavior enables meeting the demands of lightweight design for long-life manned airtight modules, particularly those applied on a manned space station.

Keywords: Manned airtight module, Shakedown, Direct method (DM), Lightweight design

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