

Simplified calculation method for coupled thermal–mechanical stress of drum using beam elements

yanjun Li¹, zhenhua Zhang¹, qingpeng Zeng¹, chenshuo Li¹, jianxin Shi¹, and guolei Zhang¹

¹Haerbin Engineering University

April 15, 2021

Abstract

The drum is the core part of a supercharged boiler that is prone to fatigue damage due to the dual action of thermal and mechanical stress. However, owing to its complex structure, complete modeling calculation of the drum requires considerable computational resources. Therefore, based on the basic theory of beam elements, we propose a simplified method using beam elements in place of solid tubes and evaluate the feasibility of this method. The results demonstrate that the simplified method reduced the overall mesh number of the model by 67.19% and the calculation time by 68.08%. Moreover, compared to the solid model, the maximum relative errors of stress and displacement were only 3.44% and 5.16%. Considering the dispersion of low-cycle fatigue life, we applied a statistical approach to the fatigue life assessment of the drum, and obtained the probability of failure corresponding to the fatigue life of the drum under the given operating conditions. This method provides an important basis for the systematic evaluation of fatigue life under various operating conditions and the prediction of failure occurrence.

Hosted file

manuscript.pdf available at <https://authorea.com/users/407937/articles/518114-simplified-calculation-method-for-coupled-thermal-mechanical-stress-of-drum-using-beam-elements>

Hosted file

Credit Author Statement.pdf available at <https://authorea.com/users/407937/articles/518114-simplified-calculation-method-for-coupled-thermal-mechanical-stress-of-drum-using-beam-elements>