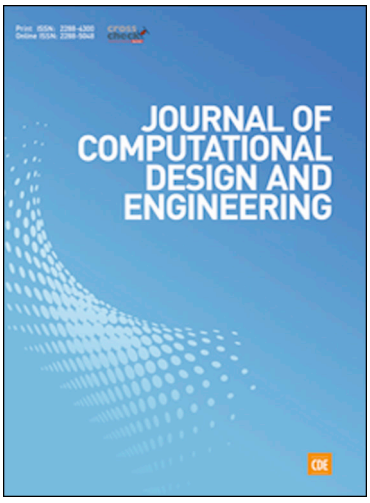

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Effect of Heat Treatment Residual Stress on Stress Behavior of Constant Stress Beam

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Abstract

Although most casting and heat treatment processes generate significantly high residual stress in the products, this factor is generally not taken into account in the design stage of the product. In this study, experimental study and numerical analysis were conducted on a constant stress beam to examine effects of the residual stress generated during the heat treatment process on yielding behavior of the product in use. A constant stress beam of SUS 304 was designed in order to test the stress behavior related to residual stress. The residual stresses generated during quenching heat treatment of the beam were measured in advance by ESPI (Electronic Speckle-Pattern Interferometry) equipment, and then the external stresses generated while applying a simple external load on the beam were measured. Also, the residual stress distribution generated during the heat treatment process was computed using a numerical analysis program designed for analyzing heat treatment processes. Then, the stress distribution by a simple external load to the beam was combined with the calculated residual stress results of the previous heat treatment step. Finally, the results were compared with experimental ones. Simulation results were in good agreement with the experimental results. Consistency between experimental results and computational results prove that residual stress has significant effects on the stress behavior of mechanical parts. Therefore, the residual stress generated in the previous heat treatment step of casting must be taken into account in the stage of mechanical product design.

Key Words: Stress analysis, Heat treatment, Residual stress, Initial stress, ESPI (Electronic Speckle-Pattern Interferometry)

1. Introduction

Generally, mechanical parts pass through scores of manufacturing processes such as casting, forging, heat treatment, extrusion, mold injection, welding, machining, etc., leaving behind some amount of residual stresses in the mechanical parts. Damage or defects can occur occasionally in the mechanical parts designed by inexperienced design engineers, even if the parts passed structural safety assessments, as these assessments are performed without considering the residual stress generated during the previous manufacturing process. Of course, experienced design engineers commonly give an excessive allowance for the safety factor in the stage of shape design to prevent unexpected fractures due to such defects. However, such use of the excessive safety factor can cause waste of material. Currently, the use of an excessive safety factor in the design stage is