Influence of laminar-to-turbulent transition on 3D flow in turbine subsonic cascade

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This study presents a numerical simulation of a 3D viscous flow in a subsonic turbine cascade taking into account the laminar-to-turbulent transition. The numerical simulation is performed using the RANS equations and the k-ω SST turbulence model. The Langtry’s PTM model is used for transition modeling. Computations of both fully turbulent and transitional flows are carried out. Much attention is given to the comparison between the present numerical results and the existing experimental data, which was based on the surface distributions of velocity, friction velocity, flow acceleration coefficient, the displacement thickness and shape-factor, the momentum thickness Reynolds number, and velocity profiles upstream and downstream the transition point. Most of the compared data demonstrates good agreement. Our numerical results show the influence of the transition on the secondary flow pattern. When compared with the fully turbulence flow case, the endwall boundary layer cross-flow starts upstream, and it is more intensive, but less massive due to thinner boundary layer in the laminar flow region in the case of transitional flow. Because of these effects, the near-endwall discrete vortex in the wake is more intensive, but the total cascade energy losses are smaller. This mixed influence of the transition on the energy losses in various regions of the 3D flow gives an opportunity for improving cascade efficiency by controlling the transition point location. We can conclude that the proposed approach reflects main features of such flows and allows studying an influence of the laminar-to turbulent transition on the 3D cascade flow structure.

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Comparison between complex Eigen value and modes pairs of two-piece disc brake in squeal prediction

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Automotive brake noise and vibration is considered as a stubborn problem over the past few decades, and it has become a major source of customer complaint. Many of methodologies for understanding the noises have been suggested, however, it is not clearly investigated, since various reasons with complicated mechanism can induce the noises. However, the squeal, one typical type of brake noise, was unveiled a phenomenon caused by dynamic instability, so it can be defined as a type of elastic instability that includes elastic modes within the audible frequencies of brake components. Analytical approaches for predicting squeal are generally adopting finite element methods. The complex Eigen value method as conventional way to predict squeal is coming from the slip-stick phenomenon on the interface, which is inducing unsymmetrical part on the stiffness matrix by friction. The newer tendencies in research for squeal are focusing on the relationship between the in-plane and the out-of-plane modes of a disc rotor, which can be influenced to the squeal by the coupling of in-plane circular vibration and out-of-plane diametric vibration. However, the comparison between mentioned methods was not clearly studied, and limited to the traditional one-piece rotor. In this study, the two-piece rotor, which is known as performance brake and will suffer tough operating condition, is FE modeled and analyzed by two different methods – complex Eigen value calculation and modal superposition inspection – and correlated with noise test and modal test result of manufactured brake. And comparison to find relationship is carried out for the correlated analysis result.

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