Extension of Reduced Modal Modelling of Turbine Wheel For Suppression of Self-Excited Torsional Vibration by Interblade Dry-Friction Tie-Boss and Shroud Dry-Friction Damping

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Recently [1-4], the new approach based on modal synthesis method was proposed and has been developing for assessment of dry-friction damping effect on self-excited vibrations due to aero-elastic instability in the bladed turbine wheels. The aerodynamic excitation of the wheel is assumed to arise from the spatially periodical flow of steam through the stator blade cascade creating the travelling deformation waves in the wheel. The neighbouring blades are interconnected by rigid tie-boss and as tip-shroud arms that are on one side fixed to one blade and are in friction contact on their free side with the other blade. Due to relative normal motions in contacts, the prescribed contact forces vary in time. Contact frictions forces in contacts are described by the modified Coulomb friction law. This approach enables to make a numerically effective analysis of the connection parameters, such as placement, length of arms, contact surface angles etc.

In our previous works, we dealt with Van der Pol model linked to absolute motion of the blades [1] and to relative motion between the blades in [2-3]. Furthermore the uniform space distribution of the aeroelastic forces along the blade length was considered. Due to this assumption and choice of number of stator blades the suppression of 2nd flexural mode vibrations of the wheel was mainly tackled. The numerical simulations showed an effectiveness of the tie-boss and shroud damping effect on both types of Van der Pol mode. In this paper we will come from the previous wheel modal model aiming, however, at the suppression of torsional modes of vibration. Based on new experimental results achieved on the torsional blade cascade in our laboratory [5], a new design of aeroelastic forces space distribution will be implemented. As the wheel design, the blade tie-boss couplings are applied on the particular industrial turbine wheel with 66 blades. The effect of the angles of contact surfaces of tie-boss and shroud arm ends on the wheel dynamics and on level of self-excitation suppression will be discussed.

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