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Time-variable normal contact force influence on dry-friction damping of self-excited vibration of bladed turbine wheel

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Abstract: Recently [1-2], the new calculation approach based on modal synthesis method is proposed for evaluation of structural and dry-friction damping effect on self-excited vibrations due to aero-elastic instability in the bladed turbine wheels. Due to the modal reduction, the calculations are made computationally very efficient. The method will be herein used to study a dry-friction damping of self-excited vibration of an industrial turbine wheel with 66 blades. The aerodynamic excitation arises from the spatially periodical flow of steam through the stator blade cascade. The self-excited aero-elastic forces of blades are described by Van der Pol model [3]. For evaluation of damping effect, the blade tie-boss couplings are applied on this particular turbine wheel. Therefore, neighboring blades are interconnected by rigid arms that are on one side fixed to one blade and are in friction contact on their free side with the other blade. The contact point pairs of two neighboring blades overlap in undeformed state of the cascade and static normal contact forces are prescribed. The relative contact displacements due to blade cascade deformation are calculated from kinematics of relative blade motions. Due to relative normal motions in contacts, the prescribed contact forces will vary in time during vibration. In the contribution, the effect of variable magnitude of normal contact forces with respect to the angle of contact surfaces on the wheel dynamics and on level of friction damping will be analyzed. Friction forces in contacts are driven by the modified Coulomb friction law. The analysis will be oriented on the narrow frequency range and on the case when a slip motion is prevailing in the contacts.

Keywords: turbine blades, dry-friction contact, flutter, travelling wave, Van der Pol model.

[1] Pešek, L., Šnábl, P., and Prasad, C., 2020. "Suppression of classical flutter oscillations in bladed wheel us ing inner damping effect". In Proc. XI International Conference on Structural Dynamics EURODYN 2020, pp. 401–411.
[2] Pesek, L., Snabl, P., Prasad, S.P.: Reduced modal model of bladed turbine wheel for study of suppression of self-excited vibration by dry-friction contacts, Proc. of SIRM2021, Gdansk, IMP PAN Publishers, pp.371-380.
[3] Půst, Ladislav, Pešek, Luděk, Byrtus, M. Modelling of flutter running waves in turbine blades cascade. Journal of Sound and Vibration. 2018, 436(December), 286-294. ISSN 0022-460X, doi: 10.1016/j.jsv.2018.08.011