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STABILITY ANALYSIS OF AXIALLY MOVING MATERIAL WITH ELASTIC SUPPORTS

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In this presentation, we have used analytical approach for studying the dynamics and stability of a axially moving material with elastic supports. The motivation for this study arises from paper industry. The idea of this study is to formulate a model to approximate the structural rigidity of cylinders in paper mill. Using our results, it is possible to optimize the material comsumption when new paper mills are planned and constructed.

We have modelled the problem as an elastic beam of unlimited length, which travels axially between an infinite system of rollers (elastic supports) at a constant velocity. Transverse elastic displacements of the web are described by a fourth order differential equation that includes the centrifugal force, in-plane tension, bending term and elastic support reaction. The stability of the beam was investigated with the help of analysis of small periodic transverse displacements. The studies performed were mainly based on analytical approaches. In this connection the multipoint spectral stability problem for the beam, was formulated for the periodic interval, and Floquet's representation of solution was used. As a result, the basic relations characterizing the behaviour of the web at the onset of instability were found in an analytical form.

The critical velocity, that corresponds to the onset of instability in the form of divergence (buckling), was estimated in the frame of the performed spectral analysis. The obtained dependence of critical velocity on the support rigidity parameter $\varkappa$ was analysed, and in particular, it was shown that the instability of the moving beam with elastic supports coincides with the instability of the same beam with absolutely rigid supports (having $\varkappa = \infty$), when the rigidity of the elastic supports exceeds a critical value, $\varkappa \geq \varkappa_* = 4\pi^2$.