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Nonlinear problem of head-on-web effect solved with a use of the "beam-inside-beam" model

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Railway mechanics and especially its dynamics still seek new modelling approaches to represent complex phenomena appearing in rail track. The paper describes a recently built "beam-inside-beam" model of rail based on double beam system [1]. This new approach to the rail dynamics analysis is still open for a more detailed analysis in the cases of more advanced systems containing the "beam-inside-beam" component.

Rail is represented by a system of two coupled dynamic differential equations describing the infinitely long Euler-Bernoulli beams. The head of rail is treated as a beam immersed in another beam representing the whole rail. It was shown in previous publications [2], that this kind of analysis clearly reflects the existence of so called head-on-web effect, i.e. differences between dynamic behaviour of head of rail and remaining part of rail in terms of vibrations.

In this paper, a hybrid semi-analytical method of solution is applied to similar model under assumption of nonlinear properties of rail track foundation [3, 4]. The system response to the load moving with constant velocity along the beam is analysed for various sets of physical parameters. All mechanical characteristics are taken from real structures, i.e. exemplary rail track and rail vehicles. Vertical vibrations and the system sensitivity are analysed depending on experimentally verified foundation stiffness nonlinearity.
Several computational examples are shown with detailed discussion regarding solution convergence and applicability of the developed model.

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