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Slope Stability of Railway Embankments

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Abstract

The paper presents a research regarding the stresses in the railway embankments taking into account the static and dynamic action of the rolling material. The railway is subjected to heavy and complex stresses, and the axle loads increase with the traffic speed. Therefore, it is necessary to know as accurately as possible the service conditions for the embankments to help the railway infrastructure to provide a sure and continuous support for the superstructure.
To search an earth bulk, it is necessary to know the distribution of the tensions inside it. The design model admits the idea of a homogeneous, isotropic, continuous and linear space that can be deformed. The study presents the manner in which railway vehicle loads are transmitted from the rail to the sleeper and then to the embankment through the ballast bed. The simulation was made with the Slope software, and maximum deformations for various heights of the embankments loaded with railway convoys were produced.

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Keywords: railway embankment stability; rail sleeper load; transmission of stresses in the railway; failure mode; bearing capacity; fill embankment.

1. Introduction

The railway is subjected to dynamic loads originating in the weight of the moving rolling material, in the shocks in the joint area, irregularities and other causes related to deviations from admitted tolerances. These stresses are transmitted through the rail-sleeper system to the ballast bed towards the embankment, where stresses and strains due to these forces and the own earth height occur.

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2. Railway embankments and surcharge loads

2.1. Generalities. Static and dynamic loads.

Railway embankments are subjected to stresses coming from convoy traffic, own weight and other accidental stresses affected by the vibrations caused by railway traffic and earthquakes. The classical railway superstructure is made up of a set of elements with variable elasticity values that convey to the deformable in itself railway platform, stresses originating in the dynamic and static action of the rolling material.

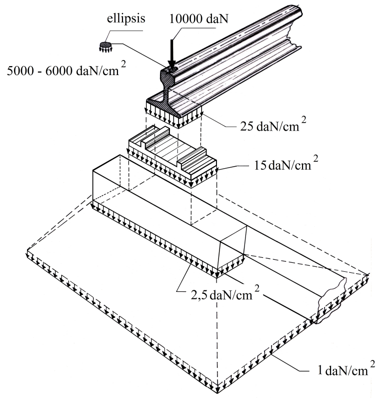

Fig. 1. Distribution of loads in the rail-sleeper-ballast prism - estimative values [7]

Loads transmission from the vehicle wheels to the railway platform is made through the rail, the support plate, sleeper and ballast bed, every mentioned element having differing elasticity features. The contact surface between the wheel and the rail has the shape of an ellipsis, the load application points differing dependent upon the aligned or curve vehicle movement [4].

The simplifying hypotheses admitted in finding the transmission of the loads to the embankment are:

- the vertical forces produced by the rolling material are applied in the rail symmetry plane;
- alignment railway track, with both lines stressed equally;
- the rail, fastening elements and sleepers weights are neglected;
- the rail is considered a continuous beam, of infinite length, in an elastic environment, freely supported;
- Winkler’s hypothesis is admitted (the rail elastic deformation is proportional to the prism reaction);
- the additional forces produced by vehicles movements are variable, maximum values are used.

2.2. Determination of the pressure under the sleeper

The sleeper is considered a finite length beam, in an elastic environment, with the pressure distribution diagram, as in Fig. 2.

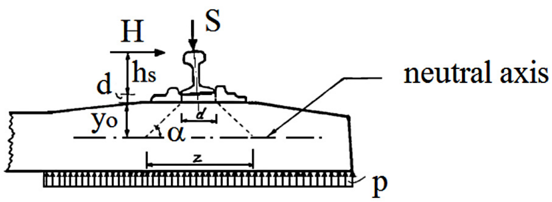

Fig. 2. Stresses distribution width from vertical and horizontal loads [7]