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STATIC CALCULATION OF TYPE 65 RAILS FOR DIFFERENT TYPES OF BEARING

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Abstract

This paper analyzes the efforts of bending, the vertical movement of the rail and the reaction of the ballast bed for a superstructure in a medium condition composed of type UIC65 railway track, monoblock sleeper T17, U41 biblock sleeper and longitudinal ties concrete. The analysis is performed by using the fictitious beam. Although there are differences between efforts results (monoblock sleeper T17 and biblock sleeper U41: 5.3 %, bibloc sleeper and longitudinal ties concrete U41: 5.8 % monoblock sleeper T17 and longitudinal ties: 23.15 %) , biblock sleeper is the most convenient because the cost sleeper, element stiffness and shape allows easy maintenance of the path.

Rezumat

În lucrare se analizează starea de eforturi din încovoiere, deplasarea pe verticală a şinei şi reacţiunea patului de balast, pentru o suprastructură medie, alcătuită din şină de cale ferată tip UIC65, traversa monobloc T17, traversa bibloc U41 şi longrina din beton. Analiza se realizează utilizând metoda grinzii fictive. Deşi există diferenţă între eforturile rezultate (traversa monobloc T17şi traversa bibloc U41: 5.3%, traversa bibloc U41 şi longrina de beton: 5.8%, traversa monobloc T17 şi longrină: 23.15%), traversa bibloc este cea mai convenabilă deoarece costul traversei, rigiditatea elementelor şi forma permite întreţinerea uşoară a căii.

Key words: effort beam, rail, reaction, superstructure, longitudinal ties

1. Introduction

The calculation of the superstructure features is performed by the fictitious beam method which assumes that the path consists of all rail – the sleeper is treated as a continuous beam resting on an elastic bed rails through a beam subtitute ,which is a continuous fictive b0 width beam and, which from the static point of view has the same effect as the cross placed at a distance" a". To determine the bending moment in the rail, this method takes into account both the elasticity of the sleepers and the elasticity of the bed rails that the sleepers are placed on.

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Scheme for calculating the rail is shown in Figure 1.

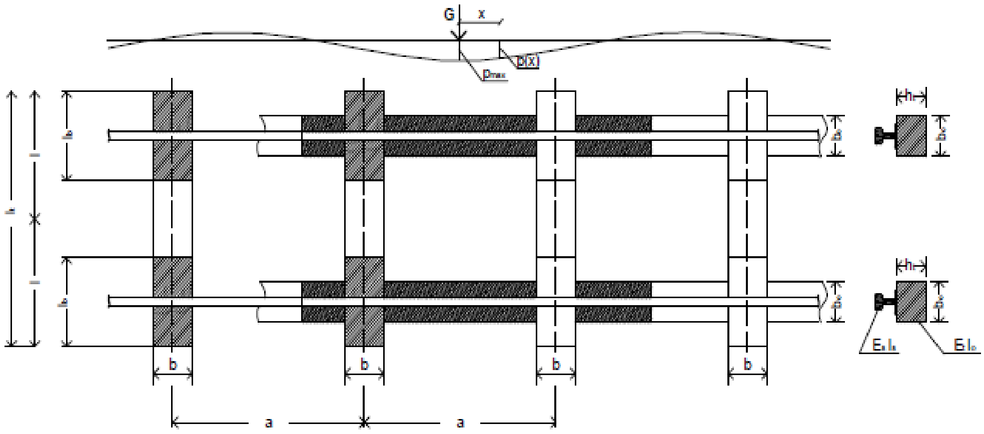

Figure 1. Calculation scheme rail [1]

2. Relations calculation

$$y = (1 + t \cdot c_v) \frac{G}{2 \cdot L \cdot C \cdot b_0} \cdot e^{\frac{-x}{L}} \cdot \left[\cos\left(\frac{x}{L}\right) + \sin\left(\frac{x}{L}\right)\right]$$ [1] -vertical movement of the rail; (1)

$$M = (1 + t \cdot c_v) \frac{G \cdot L}{4} \cdot e^{\frac{-x}{L}} \cdot \left[\cos\left(\frac{x}{L}\right) - \sin\left(\frac{x}{L}\right)\right]$$ [1] - bending moment; (2)

$$p = C \cdot y = \frac{G}{2 \cdot L \cdot b_0} \cdot e^{\frac{-x}{L}} \cdot \left[\cos\left(\frac{x}{L}\right) + \sin\left(\frac{x}{L}\right)\right]$$ [1] - reaction bed; (3)

$$L = \sqrt[4]{\frac{4(EI_x + E_t I_0)}{C \cdot b_0}}$$ [1] - equivalent length (coefficient of stiffness); (4)

$$\sigma_{s,i} = \frac{M}{I_X} \cdot y_{s,i}$$ - normal unitary effort calculated from upper rail fiber head or the flange lower fiber. (5)

(Navier's relationship)

where:

E_t (N/mm²) - elasticity module of the beam;
E (N/mm²) - elasticity module of rail track;
I_x (cm^4) - moment of inertia about the horizontal axis rail;
I_0 (cm^4) - moment of inertia of longitudinal ties;
b_0 (mm) - width fictitious longitudinal ties which we consider to be under the rail, it replaces the actual propping sleepers;
C (N/mm²) - coefficient of bed;
G = 250 kN - weights per axle.

In Table 1 are given the geometrical characteristics of the type of track that will perform the calculations:

Geometric characteristics of rail type UIC 65 are presented in Table 1.

Table 1 [2]

Rail type 65	A_s (cm^2)	h (cm)	I_x (cm^4)	W_s (cm^3)	W_i (cm^3)	y_s (cm)	y_i (cm)
	82.60	18.00	3548	368.43	423.89	9.63	8.97

where:
A_s (cm^2) – cross-sectional area of the railroad tracks;
h (cm) – height cross section of the track;
I_x (cm^4) – moment of inertia of rails calculated about the horizontal axis;
W_s (cm^3) – modulus about the horizontal axis fiber upper rail head;
W_i (cm^3) – modulus about the horizontal axis to bottom fiber of the rail foot;
y_s (cm) – distance from center of gravity to the upper surface of the rail head;
y_i (cm) – distance from center of gravity to the bottom of the rail foot.

3. Sleepers used

Types of bearing used for calculation: monoblock sleeper T17, U41 biblock sleeper, longitudinal ties concrete.
Monoblock sleeper T17 (figure 2) is executed of prestressed concrete, longitudinal reinforcement, 12 strings SPBI ø 3 mm, three strands.
- length L= 260 cm;
- width l = 27,8 cm;
- height h_t = 20,3 cm.

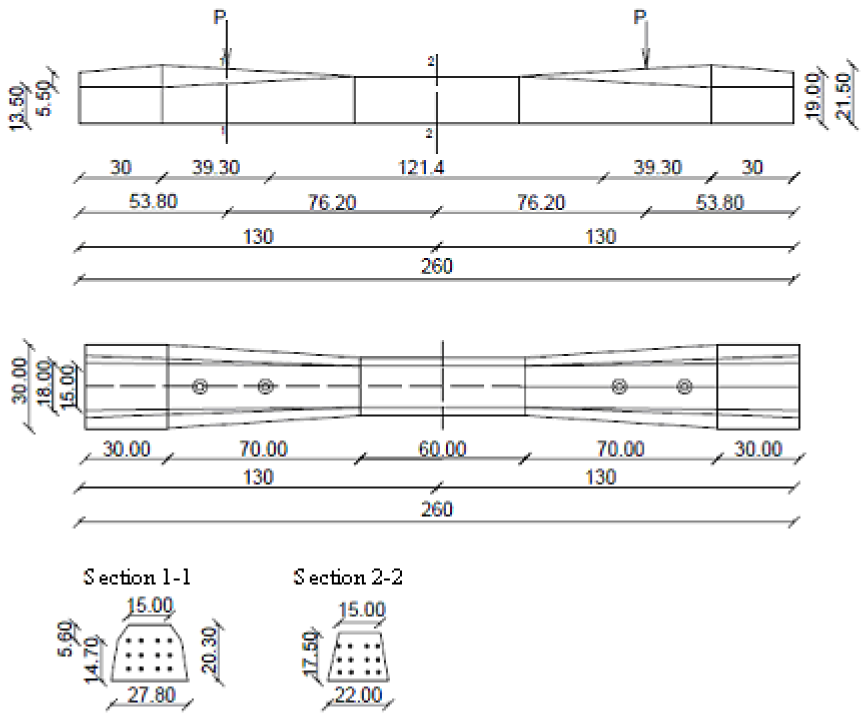

Figure 2. Monoblock sleeper T17 [2]

Bibloc sleeper U 41 (Figure 3) is a continuous concrete beam placed under the rail. Clamping track can be punctual or continuous.

- length L= 241,5 cm;
- width l = 29 cm;
- height h_t = 22 cm.

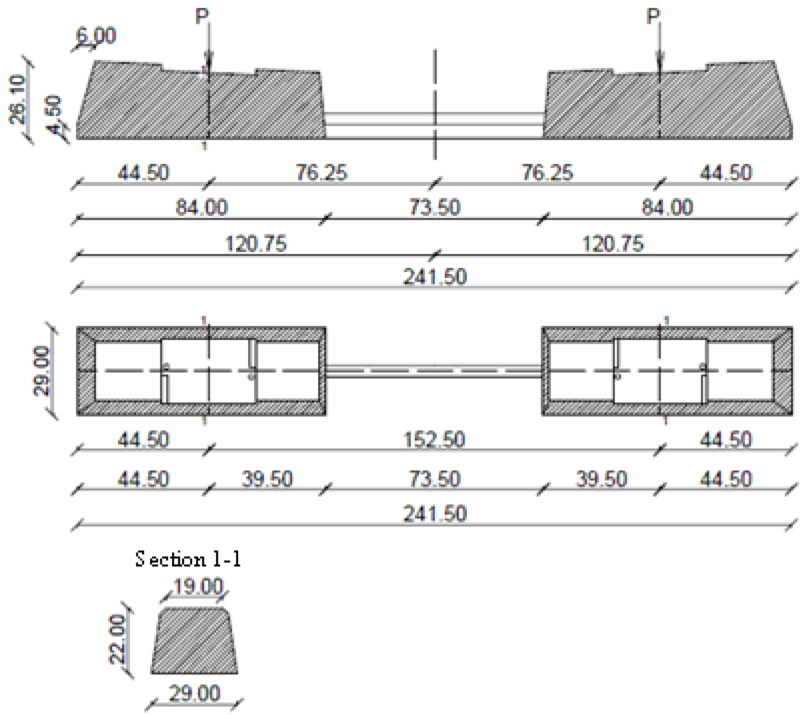

Figure 3. Biblock sleeper U41 [3]

Longitudinal ties concrete (Figure 4) is a continuous beam which from the static point of view has the same effect as the sleepers placed at a distance "a = 60 ... 65cm"

- width b_0 = 40 cm;
- height h_t = 25 cm.

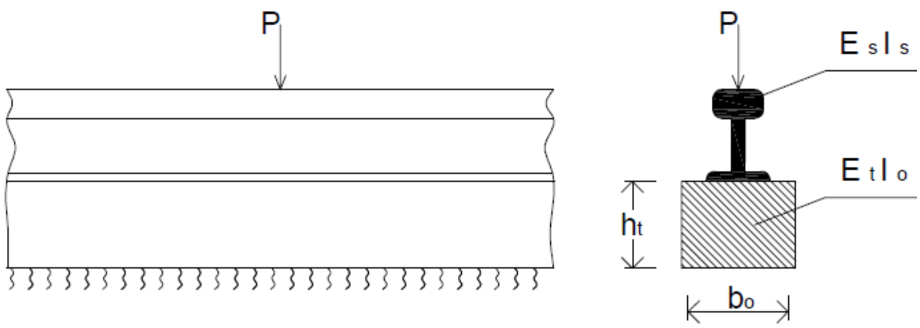

Figure 4. Concrete longitudinal ties

4. Characteristics of the superstructure

In table 2 are presented the calculation elements regarding the superstructure request.

UIC65 RAILS, MEDIUM SUPERSTRUCTURE Table 2

Sleeper / Characteristics of the superstructure.	Monoblock (T17)	Biblock (U41)	Longitudinal ties
b_0 (mm)	493.9	406	400
C (N/mm³)	0.05	0.05	0.05
Φ	1.714	1.714	1.714
L (mm)	1298.02	1411.31	1520.45
λ (mm)	104.59	82.36	105.99
Probab. p=99.7%	99.70%	99.70%	99.70%
$M_{max,s}$ (KNm)	34.981	33.11	26.88
σ_s (N/mm²)	94.946	89.862	72.945
σ_i (N/mm²)	88.439	83.703	67.945
y (mm)	3.96	4.43	4.17
p (N/mm²)	0.197	0.221	0.208

where:
b_0 (mm)- fictitious beam width;
C (N/mm³) – coefficient of bed;
Φ- dynamic coefficient;
L (mm)– equivalent length;
λ (mm)– superstructure characteristic
p=99.7% - probability accepted as a calculated effort to always be higher than those that appear in the section studied;
$M_{max,s}$ (kNm)– maximum bending moment calculated in the rail;
σ_s (N/mm²)– unitary effort calculated from upper fiber rail head;
σ_i (N/mm²)– unitary effort calculated at lower fiber rail foot;
y (mm)– vertical movement of the rails;
p (N/mm²)– reaction bed.

5. Conclusions

Relating to the variation in rail calculated efforts, after the use of three types of bearing (monoblock sleeper T17, U41 biblock sleeper, longitudinal ties concrete), we can say that the biblock sleeper is most convenient in terms of quality-cost, compared with the longitudinal ties concrete which has a high acquisition cost and raises maintenance problemes in terms of achieving path bed.

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