ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XXIV, NR. 1, 2017, ISSN 1453 - 7397

The Structural Analysis of the Classic Constructive Solution of a Bridge Deck with a Railroad – Part II

Tudorel Ene, Dorian Nedelcu

Using the analysis from the first part of the paper [1], the deck geometry is analyzed on several constructive solutions, which differ in the way of strut and lonjeron placement and in the way of loads placement. The optimal solution should take into account the maximum values of tension and distortion and the number and placement of weldings between the deck elements. Finally, a comparison between the results of the classic method and the improved method of the deck geometry is presented.

***Keywords**: bridge, deck, structural analysis, SolidWorks*

1. Introduction.

The stresses distribution of the initial geometry of the deck, identified as **variant 1** [1], revealed that the struts are not loaded.

Also, according to [2], point 9.5.1., the lonjerons and the struts of the metallic base of the deck are made up of solid beams. The lonjerons and struts with heights less than 1/12 and 1/10 of the deck span must be avoided.

In the geometry of **variant 1,** presented in part I, both the lonjerons and the struts are undersized from this point of view, the stress difference being taken up by the marginal beams.

In the present paper a modified geometry is proposed, identified as **variant 2**, where the profiles I HEM 320 h1 359 x b1 309 are allocated to lonjerons no. 1 and 4, located in the area of the wagon way, and the other elements are made up of profiles I HEM 160 h1 -180 x b1-166.

The structural analysis has the following objectives:

• creating the new 3D geometry of the deck, identified as **variant 2**;

• the structural analysis of the **variant 2** geometry, which aimed to determine the stresses and deformations on the deck.

• the comparison of the results obtained on **variant 1** and **variant 2** respectively.

2. The geometry of the variant 2.

The geometry of **variant 2**, Figure 1, is designed in the following configuration: the profiles I HEM 320 h1 359 x b1 309 are assigned to the marginal struts and to the lonjerons no. 1 and 4, while the rest of the elements are made from the profiles I HEM 160 h1 180 x b1 166.

The mass properties of **variant 2** are shown in Table 1.

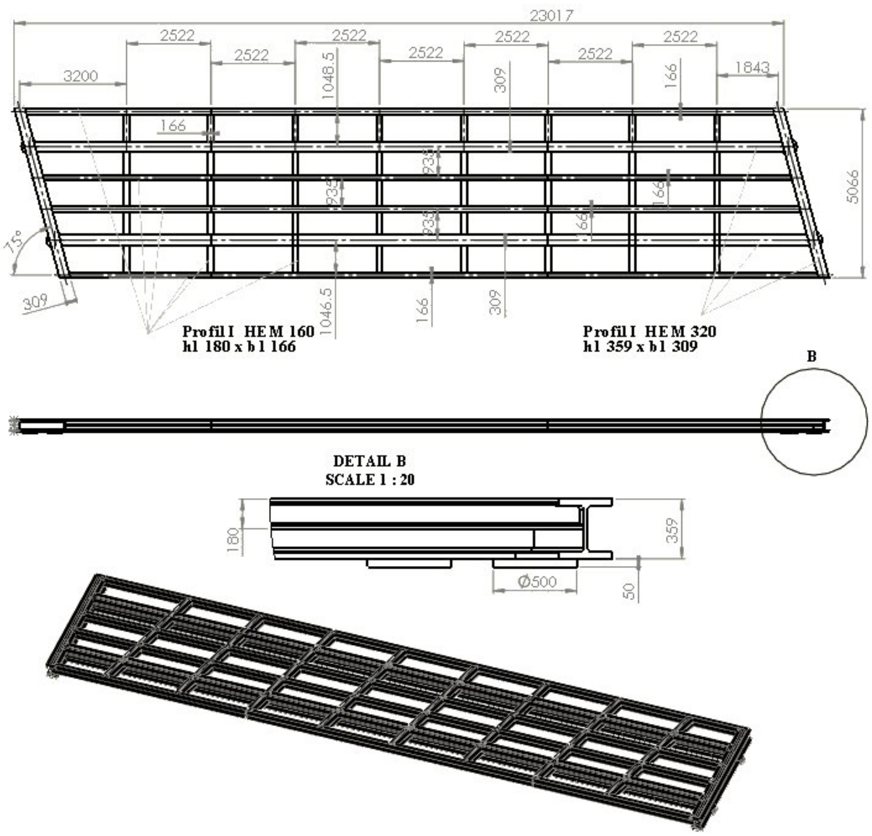

Figure 1. The geometry of the **variant 2**

Table 1

Property	Values	Units
Mass	33897042 = 33,8	grams / tons
Volume	4307121047	cubic millimeters
Surface area	364746561	square millimeters
Center of mass	X=12024.16; Y=49.34; Z=2457.08	millimeters

3. The structural analysis of the variant 2.

The analysis conditions were similar to those in the structural analysis of **variant 1** [1]. The geometry of **variant 2**, Figure 2 ÷ 7, was loaded on the lonjerons no. 1 and 4, made from profile I HEM 320 h1 359 x b1 309, on each of the 6 elements corresponding to the lonjerons (left, center, right), Table 2. Each of the 6 segments has a different length which is specified in the table. The total prescribed force of 250,000 N was distributed over the 6 segments, proportional to the length of each segment. The mesh was done with beam elements for profiles and solid types for the supports.

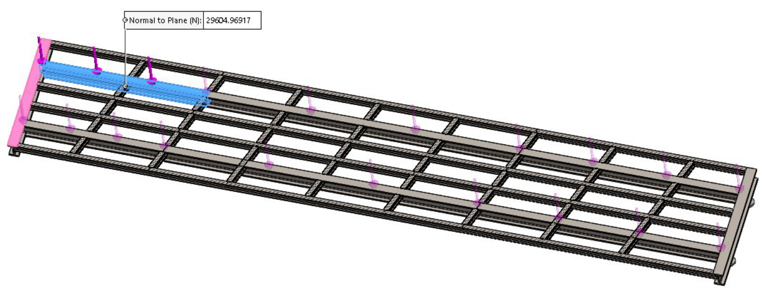

Figure 2. The load applied to the left lonjeron no. 1

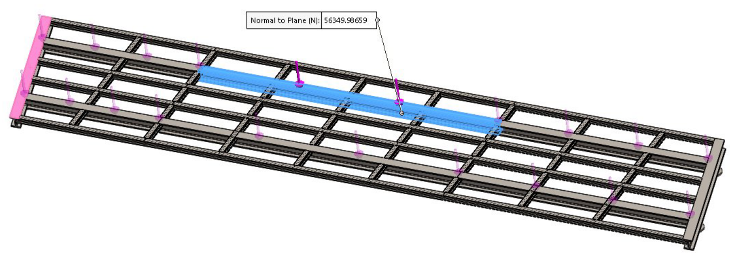

Figure 3. The load applied to the center lonjeron no. 1

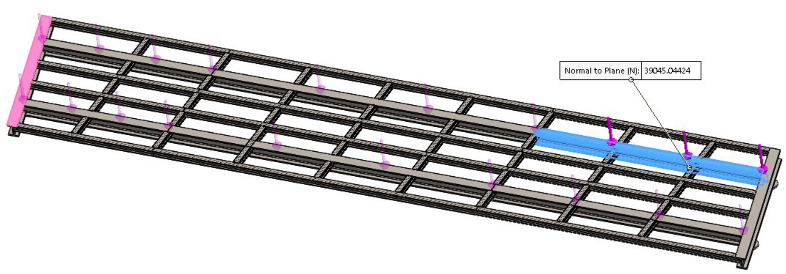

Figure 4. The load applied to the right lonjeron no. 1

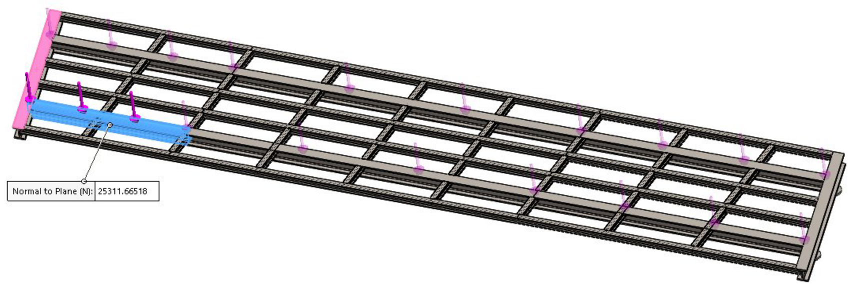

Figure 5. The load applied to the left lonjeron no. 4

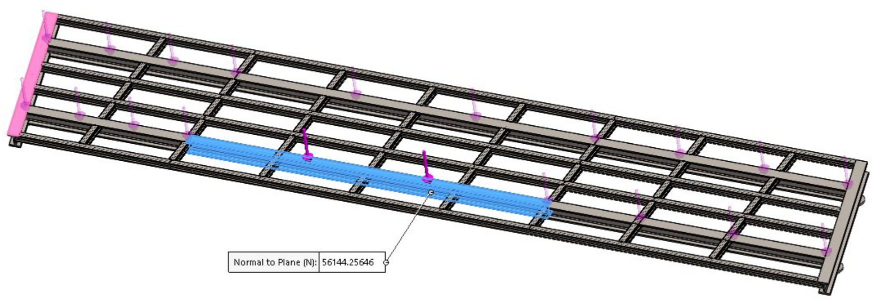

Figure 6. The load applied to the center lonjeron no. 4

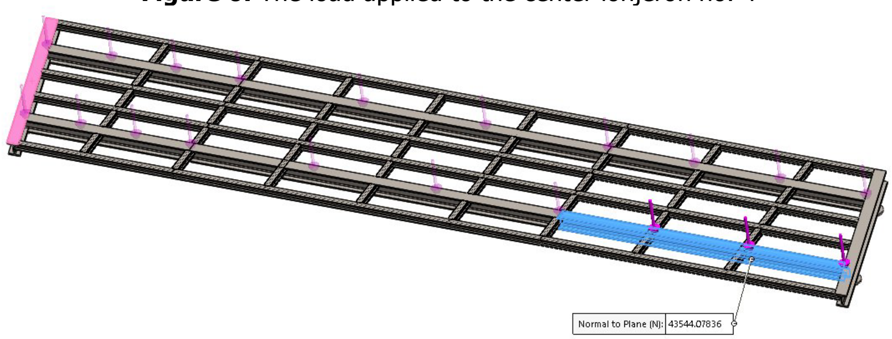

Figure 7. The load applied to the right lonjeron no. 4

The results are presented as the distribution of maximum stress and displacement.

The maximum stress resulted in the area of the four supports, with a value of 56,6 MPa, Figure 8. Figure 8, respectively, the graph in Figure 10, shows the stress distribution on struts, measured at the middle of each segment.

The two figures show that the stress on the supports are reduced to the middle of the segment, with a maximum of about 13.5 MPa near the supports.

Table 2.

Lonjeron no.	The position of the lonjeron segment on the deck	The length of the segment lonjeron [mm]	Force [N]
1	Left	5300	29604.97
1	Center	10088	56349.99
1	Right	6990	39045.04
4	Left	4548	25311.67
4	Center	10088	56144.26
4	Right	7824	43544.08
	The total force [N]		250000

Figure 9, respectively, the graph in Figure 11, shows the stress distribution on lonjerons, measured at the middle of each segment.

The two figures show that the tensions vary in the length of the lonjerons, with a maximum of about 52.9 MPa in their central area, the maximum peak values of 56.6 MPa recorded at the ends being due to the stress concentration on the supports.

The maximum displacement was recorded in the middle of the deck, with a value of 54,8 mm, Figure 12.

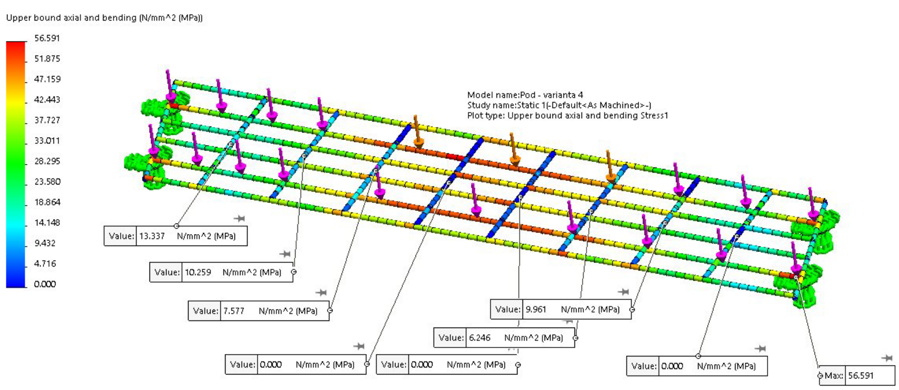

Figure 8. The stress distribution on the struts **variant 2**.

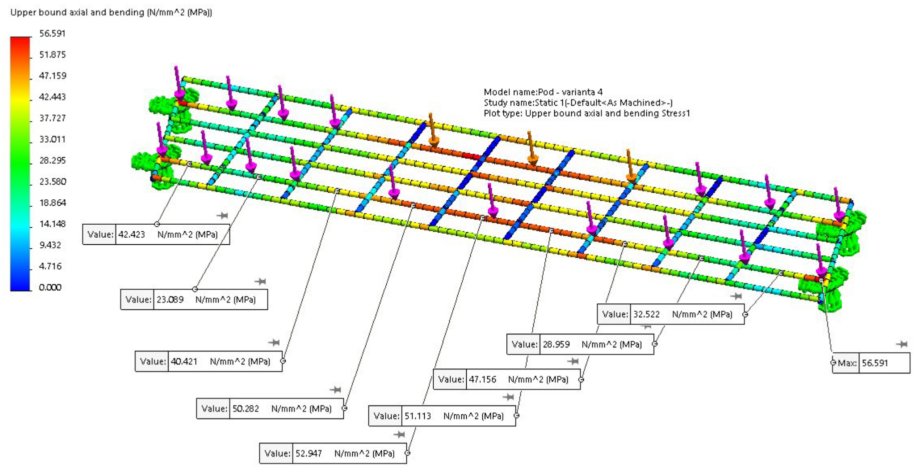

Figure 9. The stress distribution on the lonjerons **variant 2**.

Figure 10. The stress distribution along the struts **variant 2**.

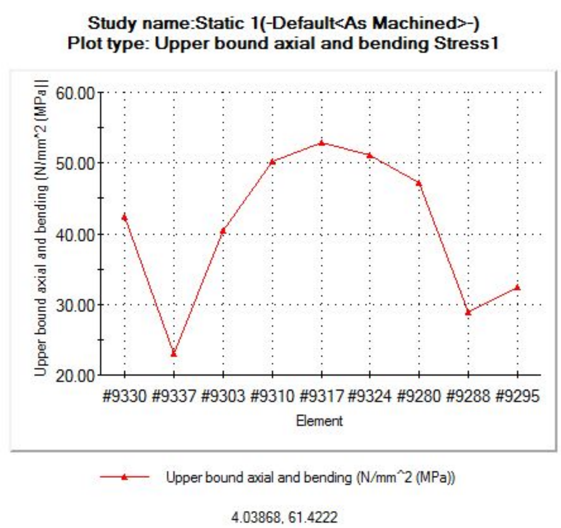

Figure 11. The stress distribution along the lonjerons **variant 2**.

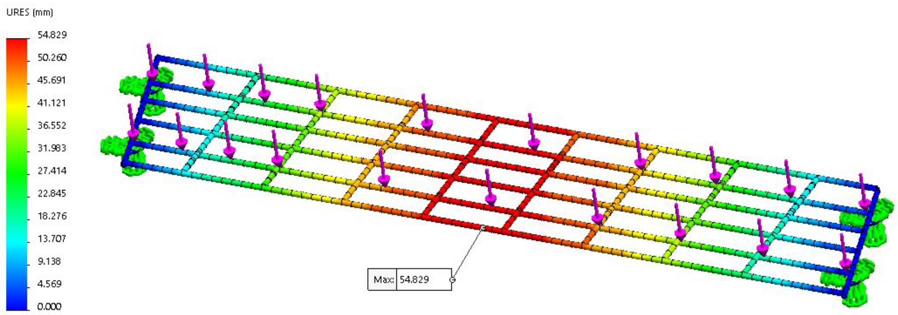

Figure 12. The displacement distribution **variant 2**.

4. Conclusions.

The comparison of the results is presented in Table 3.

Table 3.

Variant	Maximum stress on the struts [MPa]	Maximum stress on the lonjerons [MPa]		The maximum displacement in central area [mm]	Mass [tons]
		In the supports	In central area		
1	6	313,482	120	187,7	22,7
2	13,5	56,6	52,9	54,8	32,1

The following conclusions are drawn from the analysis:

- the struts are very rarely loaded in **variant 1**, their cross section can be reduced by replacing profile HEM 320 h1 359 x b1 309 with profile I HEM 160 h1 180 x b1 166;
- the maximum stress is recorded on the longitudinal axis of the lonjerons in the central area, the maximum stress value for **variant 2** being 2.3 times smaller compared to **variant 1**;
- the maximum displacement value is 3.4 times smaller compared to **variant 1**;
- the mass of variant 2 is 40% bigger compared to **variant 1**;
- increasing the rigidity of the deck in case of **variant 2**, will allow the resizing of the marginal beams, their weight decreasing substantially, which will also reduce the weight of the bridge;
- for **variant 2**, lonjerons with lengths close to the length of the supplyer can be used, welded with only the central struts, cut at lengths equal to the distance between the lonjerons, which will improve the

strength of the deck and will reduce the number of ribs, the number of corner welds and the execution time.

References

[1] Ene T., Nedelcu D., *The structural analysis of the classic constructive solution of a bridge deck with a railroad–Part I,* Multi-Conference on Systems&Structures, SysStruc'17, Resita, 9-11th Nov., 2017.

[2] ASRO, SR 1911, *Poduri metalice de cale ferată. Prescripţii de proiectare,* Octombrie 1998.

Addresses:

- Assoc. Prof. Dr. Eng. Tudorel Ene, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, t.ene@uem.ro
- Prof. Dr. Eng. Dorian Nedelcu, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, d.nedelcu@uem.ro