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Dynamic Impact Test of the Railing with Dissipative Elements

By definition, the railing is a wall or a railing of little height witch serves to delimit the edge of a road, a bridge, aimed at stopping vehicles and restoration mainly on carriageway, pedestrians and conveyance of other road users.

Keywords: *railing, steel, deformation, protection, safety*

1. Introduction

Romania develops and modernizes the road network to cope with the new model of transportation resulting from the evolution and development of its economy. As part of this process, Romania leads in recent years, a policy of greater accessibility to both trade and economic ties with its neighbors and with member countries of the European Union.

It is therefore particularly important that its network of roads to be at the highest standards, in response to an effective demand increasingly higher vehicle traffic.

Standards and methodologies for the design, construction and upgrading of roads and the location of buildings and installations in their area should ensure, in the conditions of high-tech and economic efficiency, the judicious combination of public roads and exploitation, achieving a uniform road network, storage and use of existing road network upgrading saving and rational use of land, increasing the efficiency and safety of road transport.

More than half of these roads have guardrails, gangways and pillars for markings that are not far from the European safety norms. According to the rules imposed by the European Union and adopted by Romania, handrail manufacturers must have a number of certificates and test reports for the product in question.

In the last decade, the entire planet has been mobilized in the fight to prevent road accidents. In the European Union, more than 40 000 deaths annually occur in road accidents. In Romania, reducing the number of accidents is the national priority, according to a decision taken by the Inter-Ministerial Council for road safety.

2. Dynamic impact test of the railing with dissipative elements

In this experiment the design problem and achieve a new kind of railing with optimal behavior on application of shock. The solution proposed in this case wanted to be more effective from the point of view of the produced energy amortization during the impact and the appearance of a price as low cost technology. Unlike previous solutions, which do not contain elastic with disposal through dry friction, this solution takes the form of cushioning systems concentrates, mounted in the grip area of the parapet of the pole. Installation and location of the parapet was realized in dynamic test stand as shown in figure 1.

Figure 1. Spectrum test stand

Dissipative elements of arc blade mounted on the parapet can be visualized in Figure 2 (front view) and Figure 3 (rear view).

Figure 2. Loss element (front view)

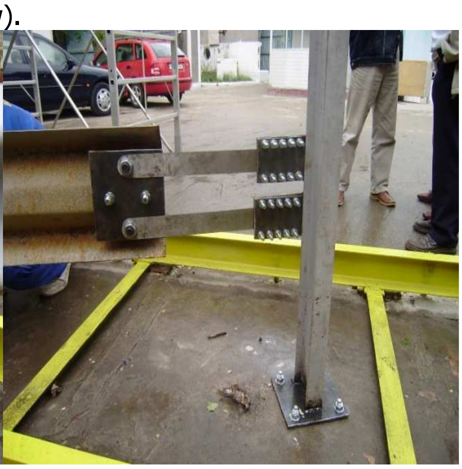


Figure 3. Loss element (back view)

The experimental test bench used to study the impact of the behaviour of the absorption system proposed consists of impactor ramping, forklift, concrete floor, speed measurement system and loss element, with the only difference that the segment was extended to 3.5 m.

The impactor was trolley made from rolled profiles from U16 chassis with 16 compartments, the calibrated masses were introduced in cast iron, resulting with a seating modular chassis mass of one tonne, as can be seen in Figure 4.

Figure 4. Trolley loaded with masses

Detached from the moment of launch sequences trolley impactor, loaded with a mass of 1 tonne and deformation as a result of the impact of the depreciation system with elastic strips spring steel and parapet, are shown in Figure 5.

Figure 5. Deformation mode for railing with lamellar elements at either end

Figure 6. Railing deformation

How to surrender in upon impact was in the field of plastic slip surface by dry rubbing dissipative elements, as well as a slight deformation of flexural and torsional support pillars (figure 6 and figure 7).

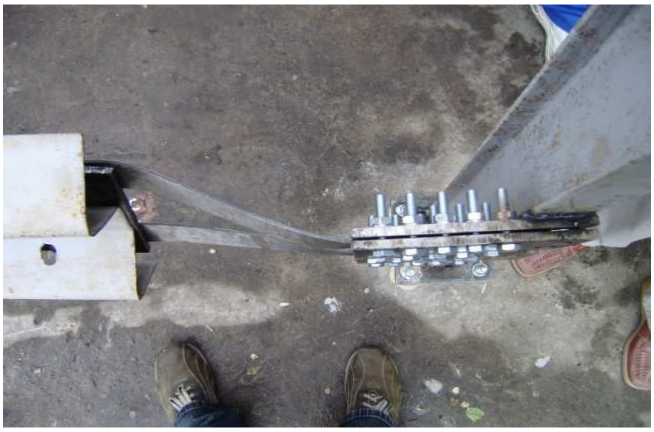


Figure 7. Pillar deformation

The following experiment arrows, compared with those obtained from computer modelling are presented in table 1:

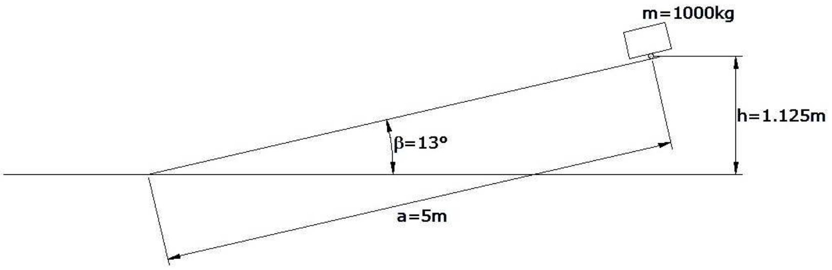
Table 1.

Nr. crt.	Experimental model			Theoretical Model of a computer simulation	
	The total burned to arrow railing [mm]	The width element elastic displacement		The total burned to arrow railing [mm]	The movement of the point of attachment [mm]
		Shifting the point of fastening [mm]	slip surface by dry rubbing [mm]		
1	75	190.0	17	65.3	180.2
			16		
2	74	188.0	14	65.3	180,2
			17		

In figure 8 are presented aspects of measurements after the shock impact.

Figure 8. Aspects of measurements

To outlining the similarities between experimental results (deformations of the parapet with dissipative elastic) and computing model by finite element mesh (dissipative items from bulwark, slat, steel poles and impactor table) it was considered a value of absorbed energy calculated below, obtained as a result of the energy balance in the amount of 11045 J. Figure 9 shows the system resulting from deformation mesh with finite elements, and in Figure 10 summarizes schematization of elastic plate bracket.



$$\begin{array}{lll} E_I = E_p = mgh & h = a \cdot \sin\beta & \dfrac{mv^2}{2} = mgh \Rightarrow v = \sqrt{2gh} \\ E_{II} = E_c = \dfrac{mv^2}{2}, & h = 5 \cdot \sin 13^o & \\ & h = 1{,}125m & v = \sqrt{2 \cdot 9.81 \cdot 1.125} \cong 4.7 m/s \end{array} \qquad (1)$$

$$E_c = \frac{mv^2}{2} = \frac{1000 \cdot 4.7^2}{2} = 11045J \qquad (2)$$

The energy dissipated by the system with the blades with the relation:

$$\Delta W_{d,total} = 4 \cdot \Delta W_d = 4 \cdot 5 kN/mm \cdot (17 mm)^2 = 5780 J \qquad (3)$$

Coefficient of absorption of energy by heat dissipation with plates with dry friction is:

$$k = \frac{\Delta W_{d,total}}{E_c} \cdot 100 = 52{,}33\%, \qquad (4)$$

The energy dissipated by elasto-plastic deformation in the guardrail with the relation:

$$\Delta W_{el+pl} = E_c - \Delta W_{d,total} = 11045 - 5780 = 5265 J \qquad (5)$$

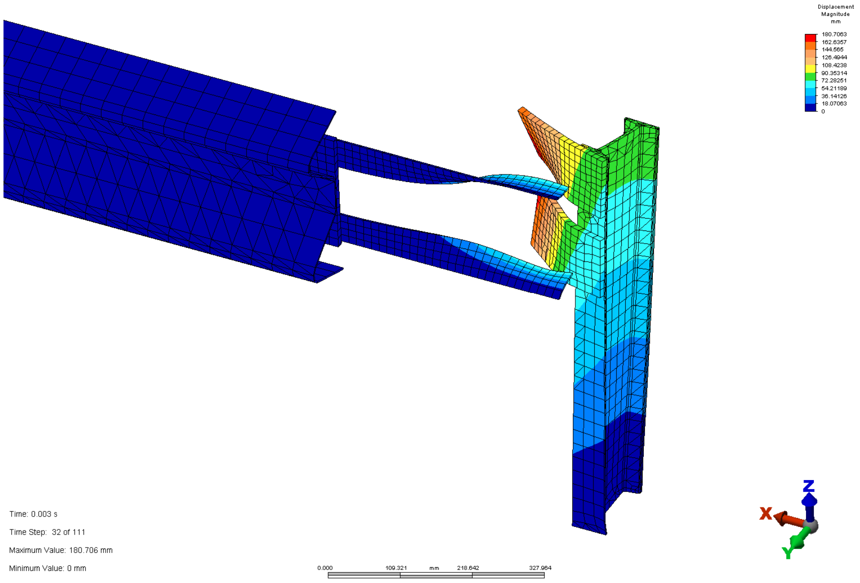


Figure 9. Mesh with finite elements

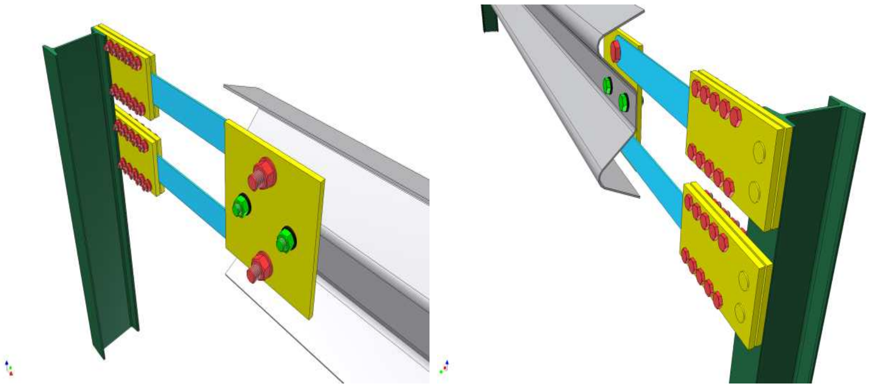


Figure 10. Grip schematization of elastic plate

3. Conclusion

By adding system components with the slat with absorption of energy by friction, was a dissipating the energy of the impact by about 50%, the remainder being taken over by energy elastic-plastic deformation of steel railing.

Protective guardrails are executed worldwide by a number of joint stock companies through their plants, technological lines equipped with specialized machines. These lines are equipped with high-performance machines which carry out production to design parameters.

Protective guardrails are made of steel sheet of 3, 4, 5 or 6 mm and are designed to withstand shocks produced by their eventual impact by some motor vehicles under a certain angle.

The behavior and strength of these enclosures deformable products through the possible impact shocks by some vehicles, depends on the angle of incidence of the impactor. If this angle is greater than 20^0 barriers cannot ensure stewardship or recovery vehicles. Choosing types of parapets in general is made according to the technical grade of the road, configuration of the land, the geometry of the road, the height of embankments or walls of support, other local conditions.

Worldwide protective guardrails were obtained in different geometric configurations, depending on how foundations, fixing the location of road and with a view to enhancing the capacity of resistance to the front or side impact.

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