BUFFERS FOR RAILWAY VEHICLES: MEASURES FOR AN IMPROVED VELOCITY ON THE RAILWAYS

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Abstract: The paper presents the original solution of a buffer that solves the problems that are nowadays in the construction of these systems of the railway vehicles. These problems and the measures that are considered by the Expert Commitee ORE in order to solve them are discussed. The superior characteristics of the proposed buffer are presented, along with their main advantages for all those involved.

Keywords: railway wagons, buffers, shock absorbers, springs

1. State-of-the-art

On the occasion of the aniversary of 150 years of the Dutch Railways and with the 150 reunion of the Expert Commitee ORE (ERRI) B 12, a join symposium of the B12 and B36 comissions was held. An evaluation of the state-of-the-art regarding the construction of the railway wagons was performed, and an evaluation of the neccesities and / or the possible evolutions in order to have a railway transport competitive with regard to its competitors (especially with regard to the road transport). With this occasion, several essential problems to be solved were highlighted:

1) the decrease of the costs related to the railway items;

2) the decrease of the costs related to the mantaining of the railway material;

3) the increase of the velocity of the trains;

4) the insurance of the security of the transports. The annual costs of the repairs of the wagons, consequence of minor accidents, was 16.678.000 DM/year for DB (0,3% of the frontal parts), CFF and SNCF, while the costs of the payments due to the bad condition of the items transported, as a consequence of the shocks produced by the frontal contacts of the wagons reach some 22.421.000 DM/year [1].

5) the decrease of the longitudinal forces for which the wagons are tested, by using frontal buffers with superior characteristics;

6) environment protection, especially for the transport of dangerous items [2, 3, 4].

In order to solve with low costs all the problems that stay in the way of the increase of the competitiveness of the railway transport, UIC recommend the pan-european cooperation of those interested [7, 8, 10, 11]. In order to achieve this, a general reorganization, at a European level, of the system of standards and institutions of technical, operational and commercial supervision of the railway domain is required. With the occasion of [7], different objectives to be reached until 2020, for the european transport

system, are: increasing by a factor of 2 the traffic of persons and by a factor of 3 of the traffic of different items; 50% reducing of pollution.

From a technical point of view, problems **3**, **4**, **5** and **6** are possible to be solved, but the costs of the existing solutions do not allow their large scale application, because:

7) 140 and even 160 km/h velocities are possible with wagons for the transport of different items, but the cost of the bogie would be three times bigger than the one of a bogie that reaches but 120 km/h, while the wear of the railway and of the wheels may increase significantly, also due to the transversal forces thar appear in the buffers when passing through curves;

8) Some buffers of the C category (with a minimum of 70 kJ and a displacement of 105 mm, according to UIC 526-1) and buffers of the L category (a 130 or 150 mm displacement, according to UIC 526-3) may provide a sufficient protection of the structure of the wagons and of their load, but their price is 2-3 times higher [1] than the one of an A category (min. 30 kJ and a displacement of 105 mm), which has the minimum accepted and necessary characteristics for the new wagons.

As a consequence, in Europe, out of the two or three pair of wheels wagons, just 1% of them have the C category buffers and less than 0,1% L category ones. Out of the 4 pair of wheels wagons, 4,5% have the C category buffers and less than 0,1% have L category ones [1]. Because of the costs, superior characteristics buffers are used only where the UIC asks that (for freight wagons of 2 RID class).

9) A problem related to the buffers used, but that also has implications on the safety of the transports, on the wear of the wheels, is given by the forces transversal with regard to the displacement direction, forces that appear in the buffers when passing through curves.

2. Conclusions and measures of the joined commissions of experts ORE (ERRI) B12-B36, Utrecht, october 1990

In **[9], the following conclusions** were pointed out: 1) it is recommended to reduce the dynamic elongation efforts, especially at heavy load trains; 2) it is recommended to have a diminishing from 2000 kN to 1200-1500 kN of the compression efforts provided when testing nowadays wagons; 3) it is possible to decrease the load of the wagons, a goal that may be reached if: 4) a general use of the hydrodynamic buffers would be done; 5) the characteristic of the buffers would take into account the difference between wagons in the period of testing and those in the period of work (it suggests the use in the shock absorbers of a pneumatic switcher from the second pneumatic link).

In **[10],** among others, **the following conclusions** were taken: 6) the forward increase of the maximum weight and volume of the wagons; 7) the increase of the velocities of the trains; 8) the improvement of the protection of the transported freight, by using long displacement buffers; 9) the decrease of the prices and of the repairs costs; 10) the increase of the total transport distance of the wagons for different items from 100.000 km, nowadays, to 200.000 km, in the future.

In **[11]:** 11) the conversion to the automatic couple can be done only if a substantial decrease of the costs (from 15.000 DM to 10.000 DM / vehicle) can be achieved; 12) in order to provide the safe pass through curves with a radius < 150 m, it is

necessary to take special measures in order to obtain decreased forces between the buffers and the linking system.

The most recent concerns of the UIC are in all the aspects related to the construction and the use of the wagons (presented in this part of the paper), the **buffers** are included – regarding the neccesity to protect the load and / or the structure of the wagons [12-15], and the transversal forces generated when passing through curves, forces that have a certain influence on the safety of the transports [16-18]. The importance of solving these problems are proved by the number of studies developed [18-26] or undergoing [27-29] at ORE.

3. The original proposal

In order to meet the present and the future requirements regarding the buffers, we have conceived one [30] able to satisfy all the specified conditions. This element represents a development of the hydrostatic technology. The construction for using at the buffers of the railway wagons, the hydrostatic solution developed, is presented in figure 1.

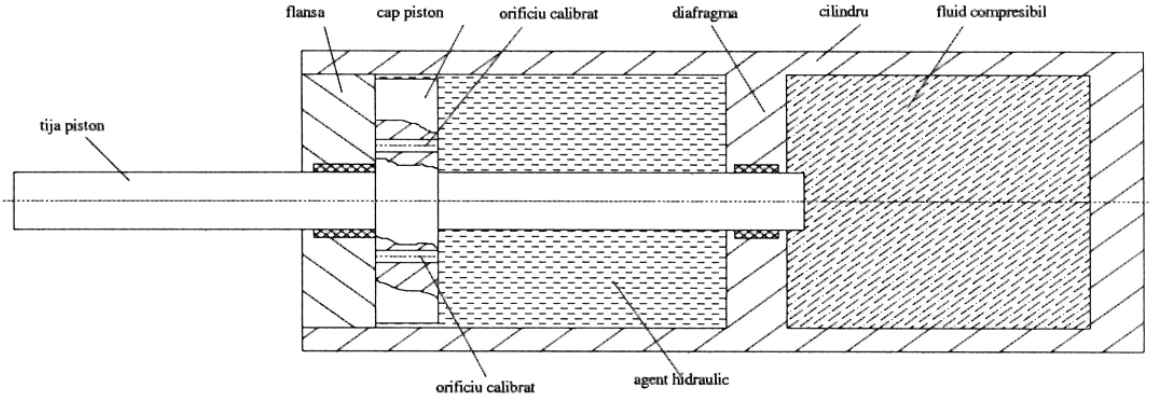

Fig.1. The spring & shock absorber assembly developed

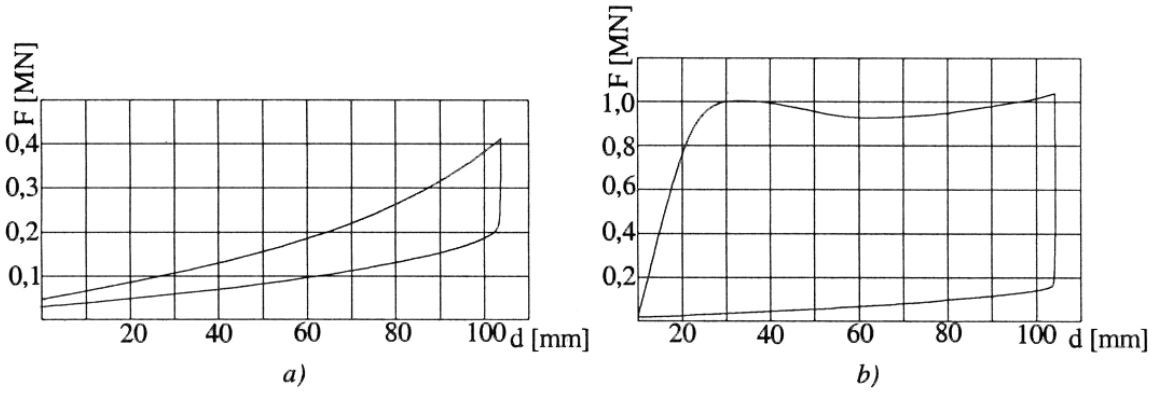

Fig. 2. The diagram of the spring & shock absorber developed assembly: a) static regime; b) dinamic regime

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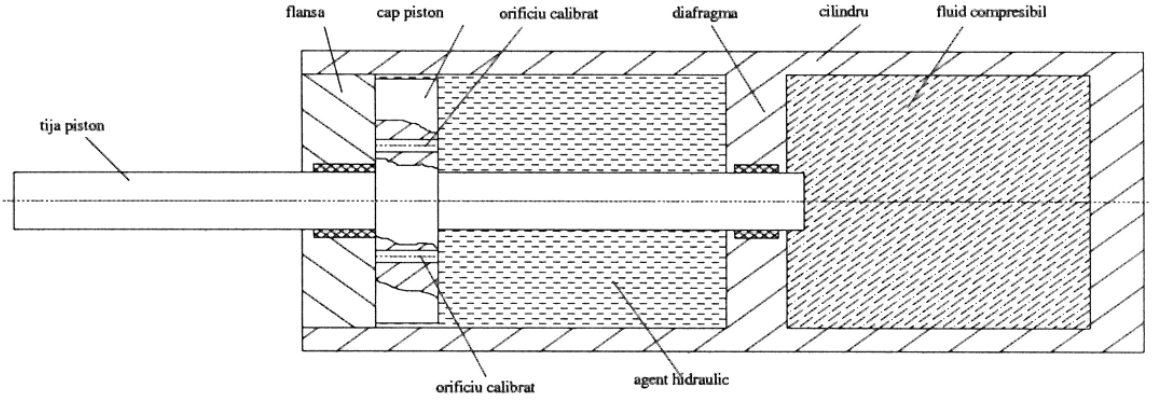

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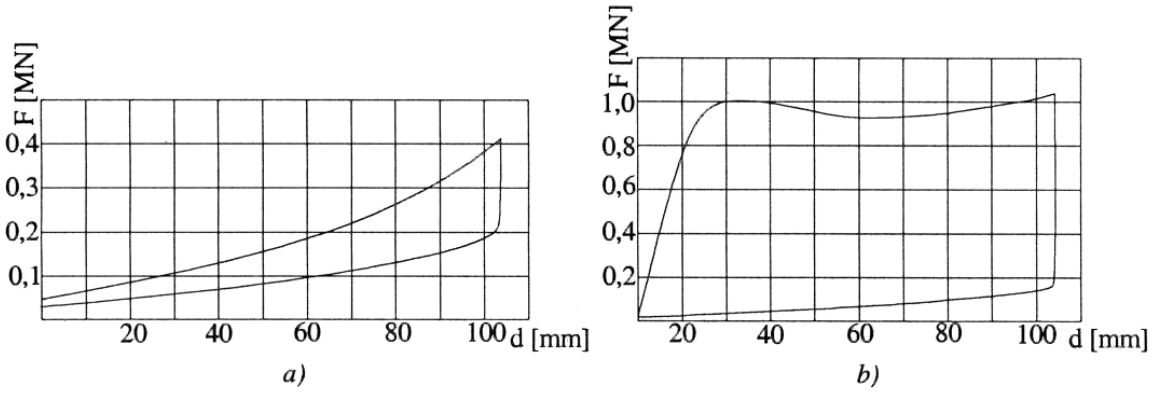

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$$V_0=F_i \cdot l/p_i \cdot k_i \quad (1)$$

where: k_i = the compressibility of the fluid at the calculus force [%]; l_i = the displacement of the spring; F_i = the compression force; V_o = the necessary volume of fluid in the uncompressed stage; p_i = the pressure in the cylinder at the "l_i" displacement of the spring;

In the case of the system presented in figure 4, when both buffers are compressed, they behave as if they weren't linked, while in the case when a single buffers is compressed, at the same deformation, a force half of the previous one is obtained, because the volume of fluid that is compressed is double. The static diagram will be in this case the one presented in figure 5.

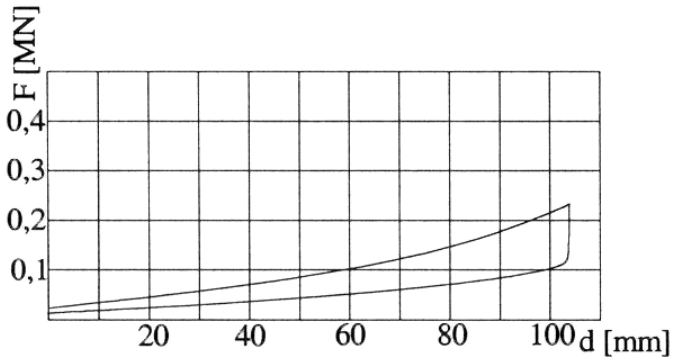

Fig.5. The static diagram

In figure 6, the forces that appear when passing through curves with a 150 m radius is presented, when the dimension between the centers of the buffers is 19,4 m. According to the calculus, the summed deformation of the two springs (including the one of the tensile apparatus) is 113,5 mm. According to UIC 520, the maximum force allowed between the two buffers in order pass safely through curves is equal to 250 kN.

4. The main characteristics and advantages of the designed shock absorber

From figure 6, one can conclude that the forces that appear for the wagons provided with the proposed buffers are 2...2.9 times smaller than in the case of the buffers built with the hydrostatic technology and 1.5 times smaller than those of the best nowadays buffers. Other **characteristics** are:

- constructive simplicity; easy to mantain; functional characteristics at the level of the best hydrodynamic buffers of the C and L category;
- it can change the static characteristic with regard to the condition of the wagon: in repairs or functioning. In addition, this buffers can work differently in the situation when the wagon is single or in a convoy, without being necessary to link it at the air circuit of the wagon;
- the spring of the buffer may be designed with a displacement of up to 200 mm, in the overall size conditions imposed nowadays; the spring of the assembly an its characteristic may be adapted, with minimum costs, in order to be also used as the spring of the automatic couple, in the case when this type of couple will be applied in Europe as well;

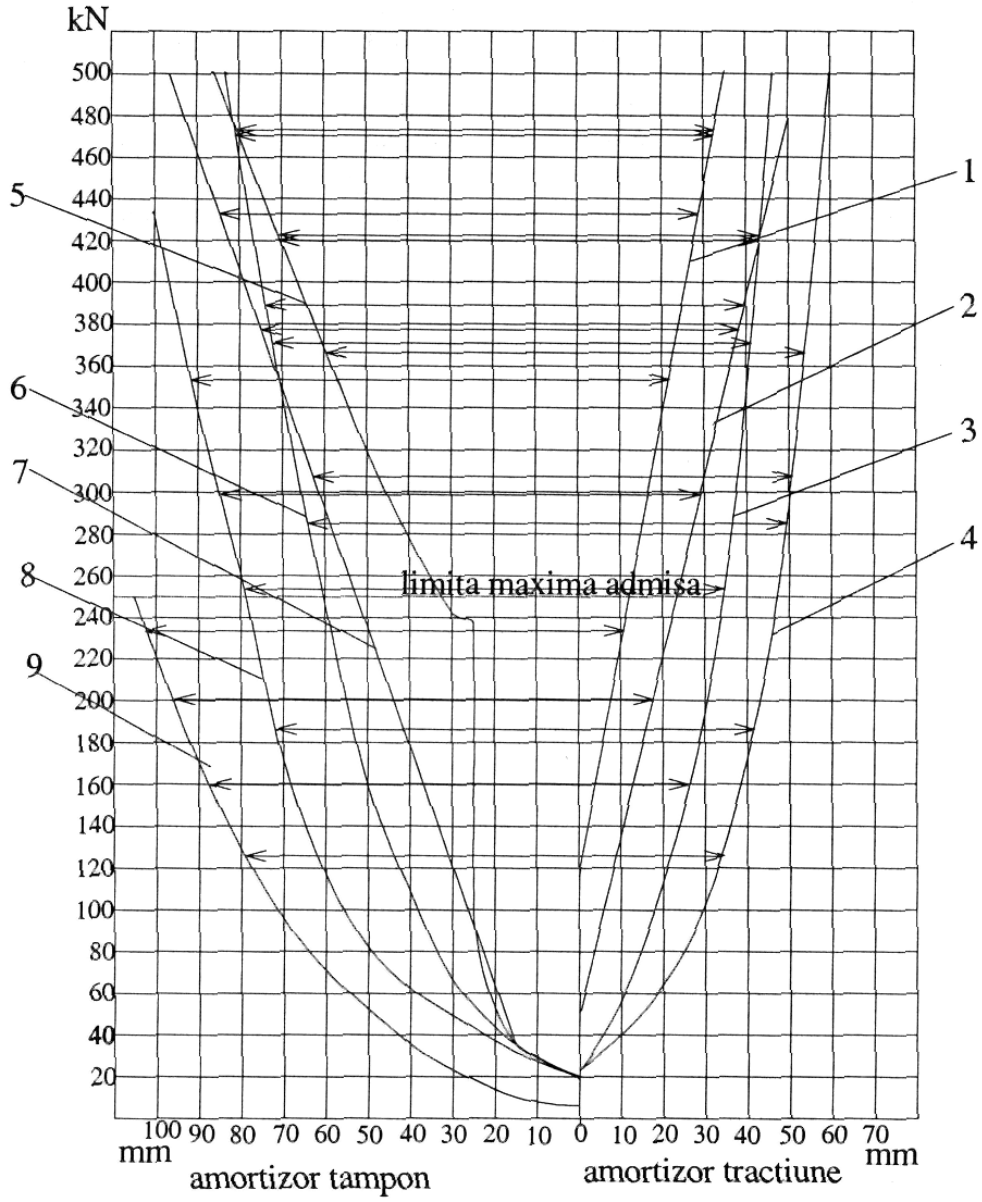

Fig.6. Forces that appear when passing through curves with a 150 m radius: 1. ring spring for the automatic couple; 2. elongation ring spring; 3. elongation spring butyl DB; 4. elongation spring butyl SNCF; 5. classic hydrostatic shock absorber; 6. elastomer thermoplastic shock absorber; 7. ring spring for the shock absorber system; 8. hydrodinamic shock absorber; 9. shock absorber proposed in the paper

- the spring designed especially for the automatic couple simplifies the way the head of the couple is linked to the shock absorber, reducing the costs; the spring may be designed for any type of railway wagon for parrangers, freight or locomotives).

The use of this buffer, with a displacement of 105 mm, 150 mm or higher, with characteristics of the C or L category, brings **advantages** for all those involved in the railway transport:

a) for the owner of the wagon, by decreasing the costs of buying and mantainance; a better protection of the structure; smaller wears of the buffers, of the spring and of the wheels. A minimum 50% increase of the transport distance between to repairs of the weared wheels is estimated; reduces the costs of the trasfer to the automatic couple by using again the sring of the shock absorber.

b) for the transport company, by providing a better protection of the load of the wagon and by decreasing the curves in which the transport can be performed with no special measures like the ease of the screw of the elongation device and by reducing the neccesary power of the locomotivei at the train start, when the shock absorber and the elongation device or the automatic couple is used;

c) for the owner of the railway, by reducing the wear in the curves;

d) for the wagons manufacturer, by an increase of the guarantee period for some sub-assemblies.

The costs for the manufacturing of this buffer is bellow the one for any of the nowadays one of the C category.

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TAMPOANE PENTRU VEHICOLE FEROVIARE MASURI PENTRU MARIREA VITEZEI DE CIRCULATIE

Abstract: Lucrarea prezintă soluția originală a unui tampon propus de autori, care rezolvă problemele actuale din construcția acestor sisteme ale vagoanelor de căi ferate. Sunt discutate aceste probleme și măsurile considerate de către Comisia de Experți ORE pentru a le rezolva. Se prezintă caracteristicile superioare ale tamponului propus, împreună cu principalele sale avantaje referitor la toți cei implicați.

Referent: Prof. dr. ing. Dorin DEHELEAN – ISIM Timisoara