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Diagnostics of railway track
Railway track
Buffer stop

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APPLICATION OF BUFFER STOPS ON RAILWAY SIDINGS

Abstract *The railway siding the railway track must be completed with a buffer stop and current regulations require the acquisition of a release certificate to construction operation. In case a commonly used steel buffer stop, a gravel layer is necessary to use ahead of the buffer stop in order to stop a group of wagons. In case a self-braking buffer stop is used, the energy is absorbed by the buffer or the friction caused by the clamp jaws of the buffer. This paper presents the characteristics of the buffer stops used for railway sidings, the calculation of the gravel layer and the principle of selecting buffer stops.*

ZASTOSOWANIE KOZŁÓW OPOROWYCH NA BOCZNICACH KOLEJOWYCH

Abstract (in polish) *Na bocznica kolejowych tory kolejowe muszą być zakończone kozłem oporowym, a obecnie obowiązujące przepisy nakazują uzyskanie świadectwa dopuszczenia do eksploatacji tych budowli. W przypadku powszechnie stosowanych kozłów stałych wymagane jest zastosowanie zasypki żwirowej przed kozłem, w celu zatrzymania składu wagonów. W kozłach samohamujących energia pochłaniana jest przez zderzak lub tarcie wywołane szczękami zacisków zderzaka. W referacie przedstawiono charakterystykę stosowanych kozłów oporowych na bocznicach kolejowych, sposób obliczania zasypki żwirowej i zasady doboru kozłów oporowych.*

1. INTRODUCTION

At the end of a track not connected to a different track and on the protection stub track, a buffer stop should be localized that contain a release certificate [1,2].

The following buffer stops can be applied on railway tracks:

- Steel rail buffer stops or buffer stops made of sections (Fig. 1),
- Concrete buffer stops (Fig. 2),
- Self-breaking buffer stops.

Under current regulations [1,3], protection stub tracks or other track types finished with a buffer stop, with a length of at least 30 m before the buffer stop at the entry semaphore and 15 m at the exit semaphore, should be covered with a gravel layer with a height of 100 mm above the rail head, and the protective stub track or track leads toward a

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cliff, a river or other permanent barrier, the distance from the buffer stop to the barriers should be at least 100 m and the track should be covered with a gravel layer with a height from 150 mm to 300 mm above the rail for at least 30 m length before the buffer stop.

Fig. 1. Steel buffer stop

Fig. 2. Concrete buffer stop on the siding at the port

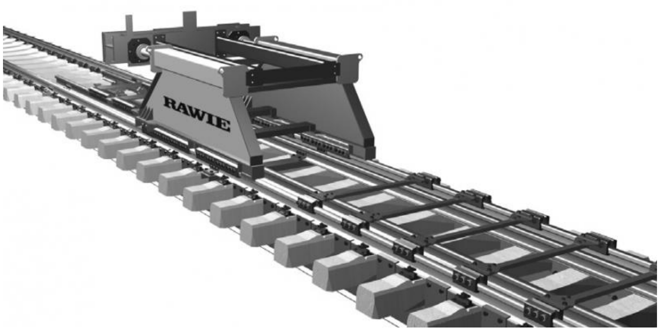

Fig. 3.Self-breaking buffer stop RAWIE Company [4]

If such a distance cannot be obtained because of the terrain, it is possible to reduce the distance from the buffer stop to the barrier to 50 meters, provided that the ground behind the buffer stop will be covered with a horizontal gravel layer with a thickness of at least 500 mm in length and not less than 30 m.

Application of this regulation to railway sidings would reduce the operational length of siding tracks and is also pointless in terms of safety due to velocity, which usually is 5 km/h.

2. CHARACTERISTICS AND RULES FOR SELECTING BUFFER STOPS

Currently used construction solutions for buffer stops can be divided into two main groups:

- Permanent - construction of the buffet stop is fixed and the kinetic energy is absorbed by the gravel layer, the construction of the buffet stop and energy-consuming elements (wood beams, buffers), or special hydraulic buffers (hydrostatic) fixed to the structure of the buffet stop (Fig. 1, 2, 4),

Fig. 4 Buffer stop with impact energy-absorbing buffers [4, 6]

- Not permanent - construction of a buffer stop moves on rails or other structural elements and the kinetic energy is absorbed by the jaw of the braking equipment (Fig. 3.5).

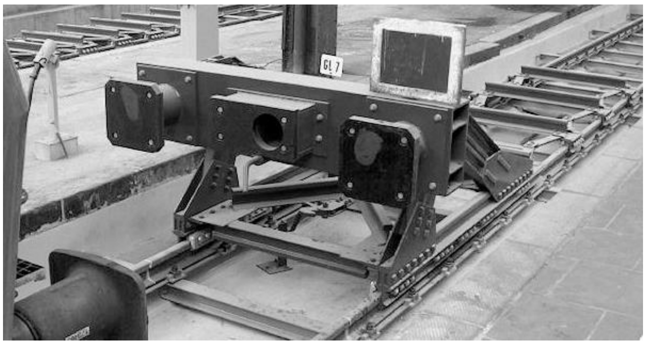

Fig. 5. Self-braking buffer stop [5]

The main factors influencing the selection of a particular design solution of a breaking stop are: The mass of the train (or a group of wagons), velocity and length of track on which construction will be built (Fig.6).

Train of mass *m* [t] velocity *V* [m/s] obtain kinetic energy (Fig. 7) equal to:

$$E = \frac{mV^2}{2} [kJ],$$

which must be consumed in order to stop.

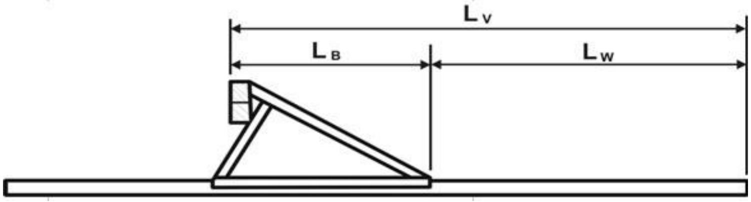

Fig.6. Dimensions characterizing the parameters of the buffering stop [5]

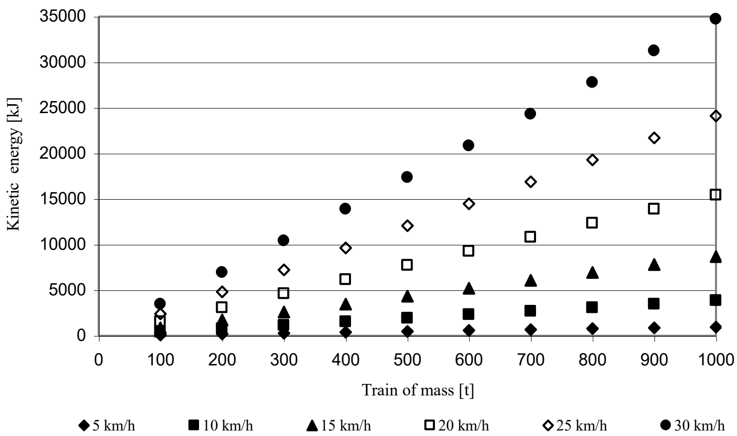

Fig.7. The kinetic energy of the train

A self-breaking buffer stop jaw mechanism used to stop the train's kinetic energy must be balanced with potential energy due to frictional resistance.

The breaking distance L_w of the buffering stop depends on the number of jaw mechanisms nh, a braking resistance force of one mechanism F_h [kN] and is equal to:

$$L_w = \frac{E}{\eta_h F_h} [m]$$

The value of the resisting force of the jaw mechanism depends on breaking distance and is assumed [5]:

$F_h = 40$ kN if $L_w \leq 5$ m,
$F_h = 36$ kN if $5n < L_w \leq 8$ m,
$F_h = 32$ kN if $8 < L_w \leq 12$ m.

In practice, the selection of a particular type of buffering stop is made on the basis of the calculated kinetic energy from a moving train (a group of wagons) of a certain mass and velocity, and the availability of land for buffering stop constriction *Lv* (Table 1).

Table 1 Potential energy absorbed by the buffering stop

Buffering stop type	Number of breaks	Breaking distance L_w [m]											
		1	2	3	4	5	6	7	8	9	10	11	12
		Potential energy absorbed by the buffering stop *W* [kJ]											
4	4	160	320	480	640	800	944	1088	1232	1360	1488	1616	1744
6	6	240	480	720	960	1200	1416	1632	1848	2040	2232	2424	2616
8	8	320	640	960	1280	1600	1888	2176	2464	2720	2976	3232	3488
10	10	400	800	1200	1600	2000	2360	2720	3080	3400	3720	4040	4360

Assuming a train mass of 1000 tonnes and velocity on the siding equal to 5 km/h, the value of kinetic energy will be obtained equal to E = 965 kJ. Using Table 1, the type of buffering stop is selected that will consume this energy. A type 4 buffering stop can be used (the length of braking distance is 7 metres), type 6 (5 m), type 8 (4 m) or type 10 (3 m).

In case a buffering stop with a gravel layer, the path length on which the group of wagons will stop, is calculated from the conditions of conservation of kinetic and potential energies at the braking length of the group of wagons and forces work acting on the group on the stop path.

A result of changing a formula is being able to calculate the braking distance lz, in which the group pf wagons should stop going at a velocity Vp at the time of entry into the embankment of gravel layer:

$$l_z = \frac{\alpha V_p^2}{2g(i + w_p)} \quad [\mathrm{m}]$$

where: α - coefficient takes into account the rotating mass part (cargo set, depending on load α = 1.03 - 1.08) - assigning α = 1.06
g - gravitational acceleration [m/s^2]
i - the inclination of the siding track (sign "+" slope, "-" elevation) [‰]
wp – resistance resulting from the layer of sand or gravel different altitudes (100 ÷ 300 mm) on the track; parameter taken in the range of 20÷30 N/kN

Assuming that the track is horizontal and the resistance due to the gravel layer on the track is at a height of 300 mm is wp = 26 N/kN (1000 t group of wagons), the length of the gravel layer was calculated as a function of velocity (Fig. 8).

At a velocity Vdop= 5 km/h, the stopping distance of a group of wagons on the track should be around 4.00 m from the point of entry into the gravel pile.

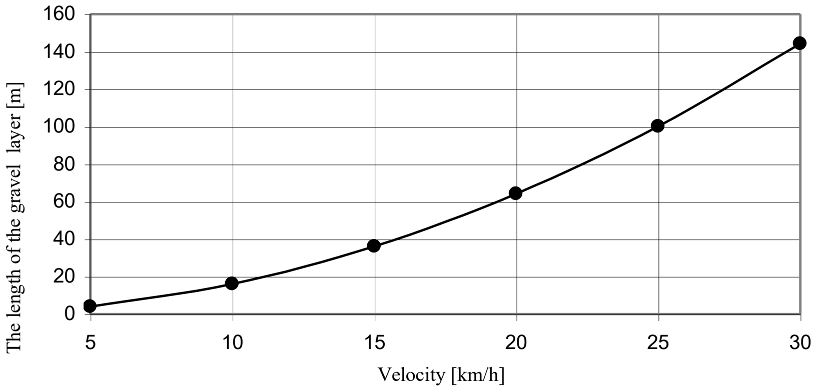

Fig. 8. The length of sand layer as a function of velocity

3. SUMMARY

The analysis indicates that on railway sidings, where the maximum velocity does not exceed 5 km/h on economic grounds, there should be a permanent buffer stop with a layer of gravel or sand.

In places where the velocity of a train, or a group of wagons, is greater than 10 km/h because of the considerable gravel layer length, it should be confirmed whether a more cost-effective solution is applicable for self-breaking buffer stops. As is clear from the calculations, a very long gravel layer is needed to stop a group of wagons at higher velocitys on siding tracks to stop the group of wagons before the buffer stop, there is a need to have very long gravel layer, and thus reduce the length of use of these tracks.

4. REFERENCES

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