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Report 20a/07

Derailment tests carried out with goods wagons

Summary

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Summary:

The derailment tests carried out demonstrated that the EDT 101 trips reliably. The tripping times of the EDT 101 – 0.2 and 0.04 seconds after each of the derailment points – were linked very closely in time to the act of derailment. In both cases, the tripping of the EDT and the associated emergency braking that was initiated caused the train to be braked quickly. It is quite possible that in the test with loaded wagons, the tearing off of the main brake pipe caused by the overriding of the buffers would also have brought the train to a halt. However, this would certainly have occurred at a later stage, by which time the overturning of the tank-wagon could not have been ruled out. In the test with empty wagons, it is possible that the derailment would have remained undetected for much longer, as the initial effects of the derailment were apparently barely noticeable. Noise levels and dust formation were low, as were visible oscillations. The wagon would presumably have been dragged to the next points and would only have been noticed there as a result of greater damage occurring (e.g. overturning).

Basic parameters of the test arrangement:

In the light of previous investigations (derailment tests carried out by the TU Berlin in Frankfurt at Infraserv Höchst, TU Berlin report No. 11/00, IfSBT) and the consequent findings, the following test condition requirements were formulated in agreement with the participants:

– The minimum derailment speed should be v = 35 km/h, as supposedly, the lower speed ranges are not the critical ones, and these have already been demonstrated in other tests. It is assumed that at these higher speeds, the oscillations in the areas concerned are less dynamic.
– A “soft” derailment should be staged. This can be achieved by initial acceleration of the train on an additional construction in order to avoid the wheels being levered out jerkily. This should create a derailment scenario that arises in all derailments that occur, irrespective of the cause of the derailment. Tripping of the detector as a result of a “leverage jolt” or a single “falling down” of the wheels from the rail should be avoided.
– The derailment should occur on a bogie situated in the train composition in order to represent being guided by the following, non-derailed axles. As it is not necessarily the rearmost bogie of the last wagon that is affected in a real derailment, this requirement depicts both the most frequent type of derailment as well as the most difficult to detect.
– The derailment should be carried out with at least two different load scenarios. One test should be with an empty wagon and one should be with a loaded wagon.
– The use of Y25 bogies on the vehicle to be derailed is an important prerequisite for the transferability of the results to other vehicles. The Y25 bogie is the one used most frequently in European dangerous goods transport.

Carrying out the test:

The derailment tests were carried out on 11 and 12 October 2007 in Berlin-Schöneweide. A train composition with three 4-axle tank-wagons (type Rt500 with Y25 bogies) was accelerated by a diesel locomotive over the previously prepared line. Two derailment tests were carried out, one with an empty wagon and one with a loaded wagon. In the second test, the middle wagon, which was to be derailed, was filled with 50 m^3 of water to represent a load of 80 t total weight. The barrier wagon and lead wagon were not filled. The first and second wagons were each fitted with two EDTs 101. The EDT was fitted to the front and rear buffer beams (or impact beam) of the first and second tank-wagons (see diagram 1).

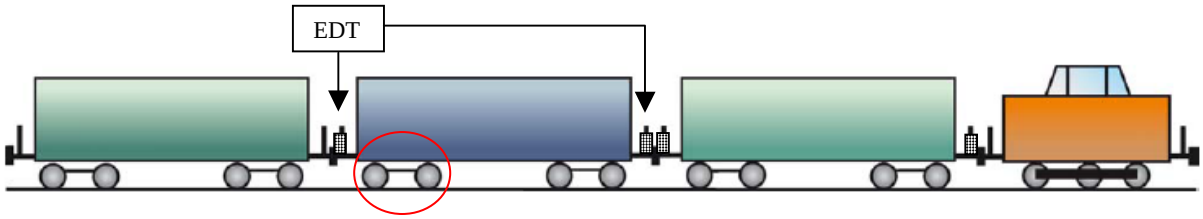

Diagram 1: EDT 101 installation point

The tripping values of the EDT were attested in a test certificate as 8.6 to 9.2 g. A total of 16 acceleration values were measured on the derailed wagon. The tests were carried out on the premises of DB Netz AG. Diagram 2 shows the auxiliary construction of the acceleration track.

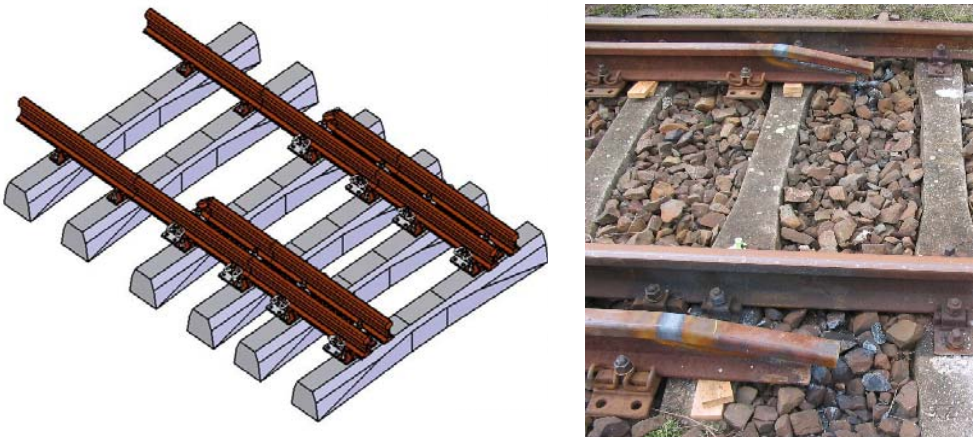

Diagram 2: Auxiliary construction of the acceleration track with ramp

At the end of the acceleration track, the back bogie of the tank-wagon was guided down a ramp into the ballast bed.

1. Test with the empty wagon:

The speed measured at the moment of derailment was around 50 km/h. This speed remained constant for almost another 4 seconds and then decreased to 0 km/h within the next 10 seconds.

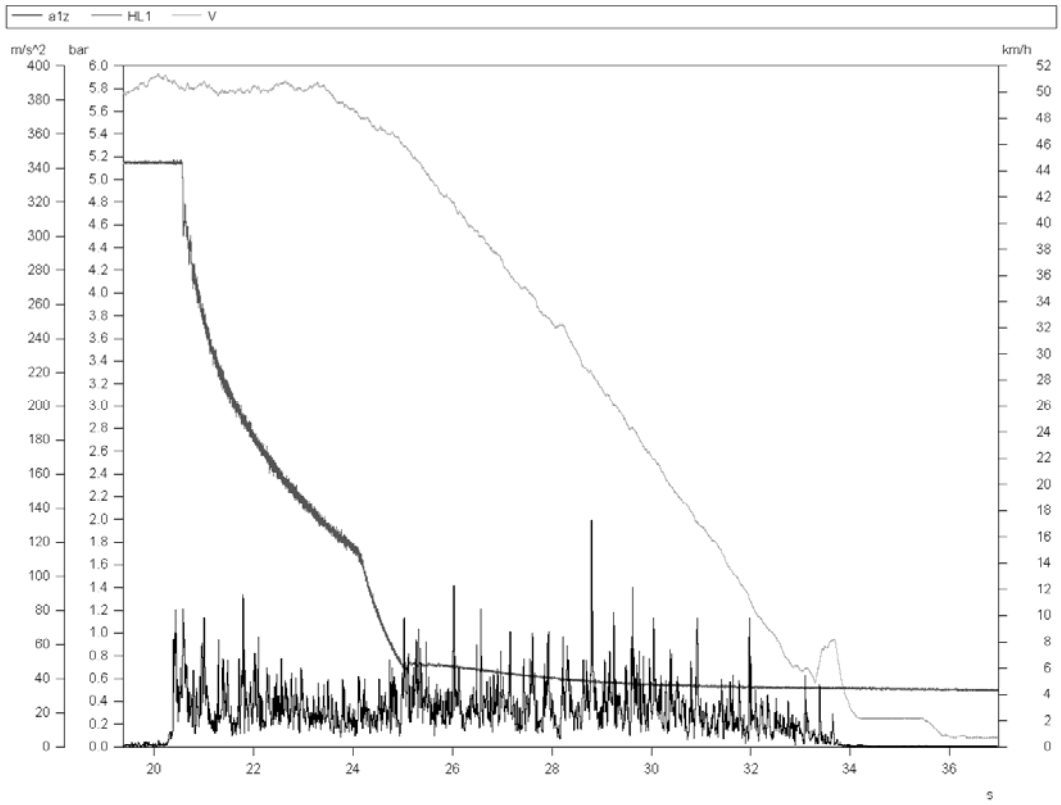

Diagram 3: Developments in speed, main brake pipe pressure and acceleration in z direction with the empty wagon

The distance travelled between the point of derailment and stopping was 122 m. This took just under 15 seconds. The track was badly damaged over the whole 122 m. Sleepers Nos. 1 and 2 remained undamaged. The EDT 101 on the impact beam of the derailed bogie on wagon 2 had tripped. The other EDTs did not trip. All the bogies except the derailed bogie remained on the rails. The analysis of the acceleration values (diagram 3) on the impact beam in z direction in conjunction with the pressure change in the main brake pipe indicate that the tripping process was first initiated when the fifth sleeper was touched. This took place around 0.2 seconds after the moment of derailment. The first amplitude of acceleration in z direction after the acceleration section is considered to be the moment of derailment. As the EDT 101 tripped with a slight time delay after the derailment occurred, it can be assumed that reliable detection occurred, despite the first sleepers being “skimmed over”. It is noticeable that on the subsequent section of line, further high acceleration values are recorded. This means that if the initial values had not been sufficient for the EDT to trip, because the derailment process happened differently owing to other causes, sufficiently high values would nevertheless have been reached on the following section of line for the device to have tripped.

2. Test with the loaded wagon:

The speed measured at the moment of derailment was around 46 km/h. The train was still accelerating. The speed decreased constantly to 0 km/h within around 9 seconds from the moment of tripping. The distance travelled between the point of derailment and stopping was around 71 m. This took less than 10 seconds. The EDT 101 on the impact beam of the derailed bogie on wagon 2 had tripped. Apart from the derailed bogie on the second wagon, the first bogie on the third wagon also derailed. The overriding of the buffers caused damage to the rear end of the second wagon and the front end of the third wagon. The assessment of the video recording and the traces on the ramp in the second test indicate that the bogie did go down the ramp and both axles of the derailed bogie on the second wagon touched the ramp (i.e. the wheels did not skim over the ramp). The overriding of the buffers caused the unused main brake air pipe to be wrenched off, together with the coupling and shut-off cock. However, the EDT 101 had tripped earlier. Tripping occurred around 0.04 seconds after the first amplitude of acceleration. As in the test with the empty wagon, more acceleration peaks occurred which exceed the threshold indicated. Values of more than 8.8 g (tripping threshold of the EDT) occurred down as far as the lower speed ranges.

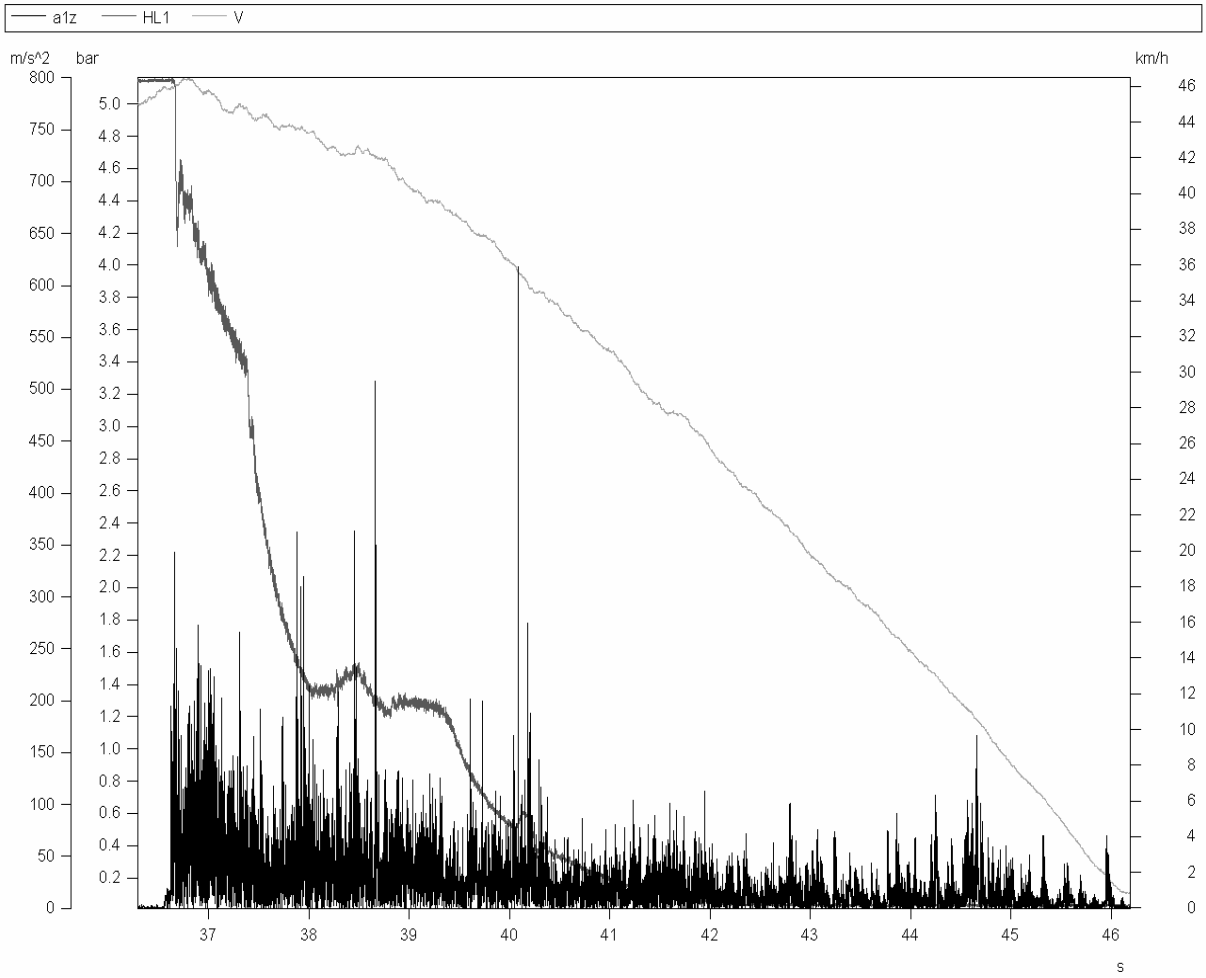

Diagram 4: Developments in speed, main brake pipe pressure and acceleration in z direction with the loaded wagon