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Report for
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Transportstyrelsen

Preliminary version 1

Swedish tests of block brake performance in winter conditions Winter 2020-2021

*Braking distances for organic LL brake block IB116**

Summary

The Swedish Transport agency have arranged testing of LL brake blocks in the northern part of Sweden. Tests on LL brake block type IB116* were performed in January 2021 using a train built-up by one locomotive and five test wagons (2Bgu block configuration). The locomotive was unbraked during tests. The present report focuses on braking distances of the test train for these tests.

A total of 36 stop braking cycles were performed during the tests, 4 stops with loaded wagons and 32 stops with unloaded wagons. The stops for the loaded wagons were all for full service braking whereas for the unloaded wagons, 29 were for full service braking and 3 for reduced braking. The air temperatures during the tests were between -19 ºC and -6 ºC.

For loaded wagons the stopping distances of the test train were very short, with average braking distance 526 m. This can be compared to a nominal braking distance of 683 m, as calculated for the short test train based on information in UIC 544-1. For full braking of unloaded wagons, the average stopping distance was 765 m. This can be compared to a nominal braking distance of 847 m, as calculated for the short test train based on information in UIC 544-1.

These results for the organic composite brake block IB116* indicate highly efficient braking also for temperatures in the range from -20 ºC and -10 ºC.

These preliminary results seem to indicate that the risk of loss of brake performance for loaded (laden) freight wagons equipped with IB116* is indeed low. This conclusion may be drawn under the following conditions:

- The freight wagon is laden to a mass of 60t
- The brake configuration is 2xBgu
- The bogies are of Y25-type
- The static efficiency of the brake system is high, about 90%
- The conditioning of the brake equipment is maintained regularly at every 10 minutes at 0.6 bar brake pipe reduction

Further testing will be conducted. These first tests will be further analysed.

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1. BACKGROUND AND AIM

Reported safety incidents and general problems with winter braking performance for novel types of freight wagon brake blocks (read “not cast iron brake blocks”) in Sweden (but also Norway and Finland) have drawn the attention of the Swedish Transport Agency (Transportstyrelsen). For this reason, they have arranged winter testing of LL type brake blocks in the northern part of Sweden for four consecutive years.

Tests during the winter 2017-2018 were performed using wagons with a mix of cast iron and LL-type brake blocks, meaning that a comparison of braking distances resulting from the different types of brake blocks was not possible. The winter test performed 2018-2019, again employing wagons with mixed blocks types, were unfortunately delayed to April 2019, just after the winter had withdrawn. A large test campaign was performed during the winter 2019-2020. However, that winter was extremely mild also for the region of testing in the northern part of Sweden, with -8 °C being lowest temperature while testing organic composite blocks. For this reason, no clear conclusions could be drawn on braking performance.

Starting January 2021, similar to the two previous winters, a dedicated test train built-up by one locomotive and five test wagons (wagon type Habbins having 2Bgu block configuration) was employed for testing. Brake testing was performed both for loaded wagons and unloaded wagons, having average axle loads 15 and 7 tonnes respectively. The locomotive (Green Cargo locomotive of RD type) was unbraked during brake tests. At the tests, two versions of locomotive driver instructions were studied. The testing procedure was modified this year so that only four stop braking tests were performed per day[1]. During operation, driver instructions for winter operation of composite blocks were employed. This means that the brakes were exercised by shortly applying the brakes either every 10 minutes or every 15 minutes, according to test specifications.

The present report focusses on braking distances of the test train when having organic LL brake blocks of type IB116* on the test wagons. Measured data include train speed, pneumatic pressure of the main brake pipe (connection between locomotive and trailing wagon) and brake cylinder pressures. Later reports will deal with hanger link forces, brake triangle forces and brake block temperatures.

The analyses are based on data provided on Excel data sheets by on-train test engineers and the data files that were acquired during the tests[2]. To this end, data have been imported into Matlab[3] to allow for straightforward processing, structuring and visualization of results.

The general aim of the Swedish winter tests is to objectively investigate winter performance of LL brake blocks and to find specific weather conditions for which the brake performance may be deteriorated. The work presented in this report aims at revealing the braking performance of the winter train in an objective way and also strives for finding explanations of possible deteriorated braking performance based on measured data.

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[1] During the winter 2019-2020 one stop braking was performed once every 15 min.

[2] Nominal braking information in xlsx-format and time history data files in DeWeSoft-format supplied by AFRY Test Center, uploaded to common SharePoint drive.

[3] Matlab, version R2019b, *The MathWorks, Inc.*, Natick, Massachusetts, USA, 2019

2. SHORT RESULTS ON BRAKING DISTANCES

The same scheme for calculation of braking distances is employed in this report as in the analyses performed for the tests for winter 2019-2020.

2.1. Loaded wagons

For the loaded wagons a histogram of braking distances is shown in Figure 1. The four tests were all performed for UIC snow whirling conditions W3-W4 and temperatures between -13 ºC and -11 ºC. The average braking distance is 526 m and the standard deviation is 39 m. The braking distances are very short and it was found that the tests gave wheel flats on one axle. For this reason, the tests on fully loaded wagons was aborted at this stage of the test campaign. The resulting braking distances can be compared to a nominal braking distance of 683 m, as calculated for the short test train[4] based on information in UIC 544-1.

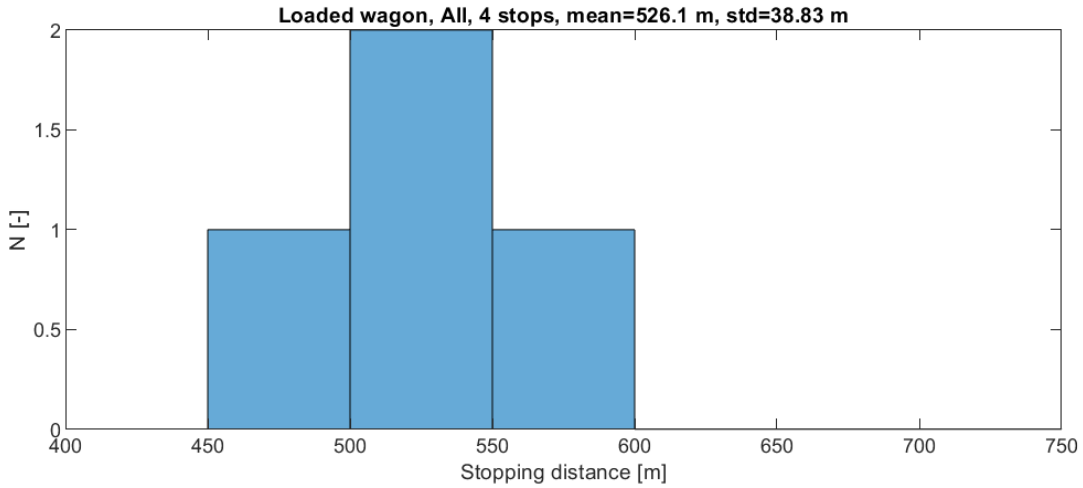

Figure 1 Histogram of braking distances for loaded wagons at full service braking.

2.2. Unloaded wagons

An overview of all braking distances for braking with unloaded wagons[5] is given in Figure 2. These results indicate that the differences between R0 and W1-W5 are rather minor. For R0 conditions (reference conditions with no snow whirling), the average braking distance is 759 m with a standard deviation of 55 m whereas for W1-W5 (with whirling snow around wagons), the average is 767 m with standard deviation 49 m. The braking distances as a function of air temperature at tests are shown in Figure 3. Note that for lower temperatures there seem to be no major differences in braking distances whether considering R0 reference conditions (unfilled markers) or W1-W5 conditions (filled markers). Moreover, no trend that points towards increasing braking distances at even lower temperatures can be found.

A more detailed view of the braking distances is provided in Figure 4. This figure shows that there is consistent braking for various conditions of whirling snow around the wagons.

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[4] The assumed braking efficiency of the five wagons is 90%

[5] The results are for all stops during the test campaign. Note that two different driver instructions were employed at the tests and that the influence of these are detailed in the following section.

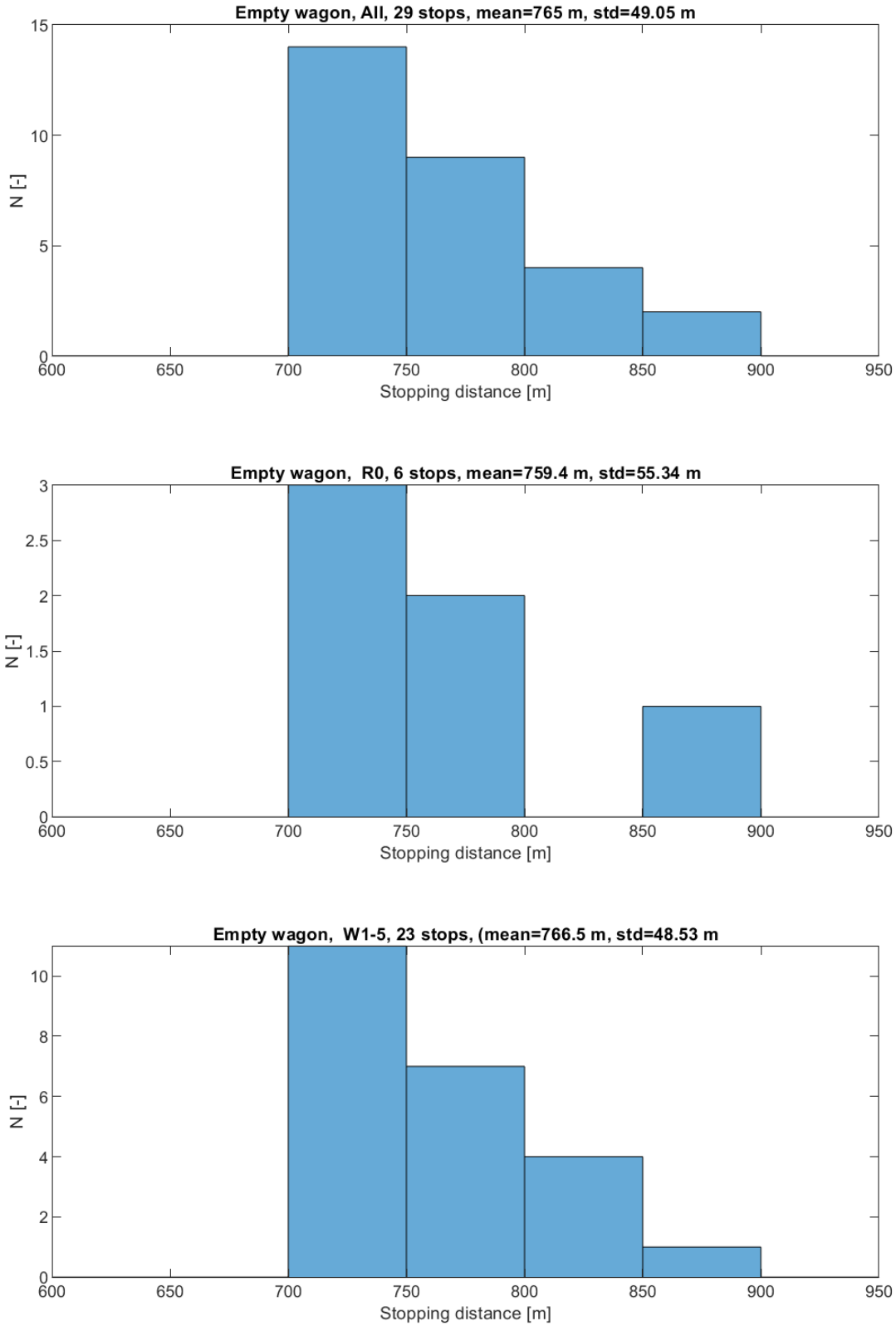

Figure 2 Histogram of braking distances for unloaded wagons at full service braking. All braking cycles (top), braking cycles in conditions R0 (middle) and in conditions W1-W5 (bottom).

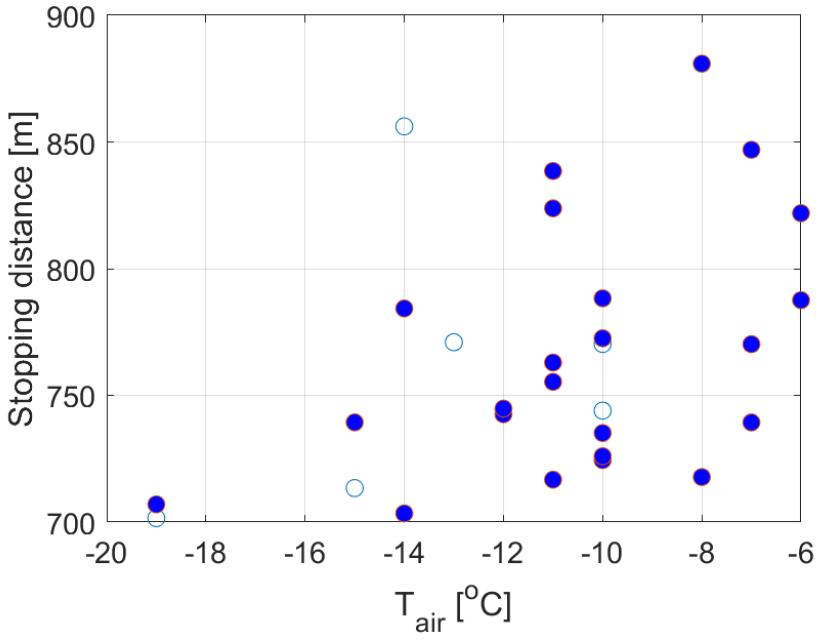

Figure 3 Graph over average stopping distance indicated by circles as function of air temperature at test. Filled circles are for winter conditions W1-W5.

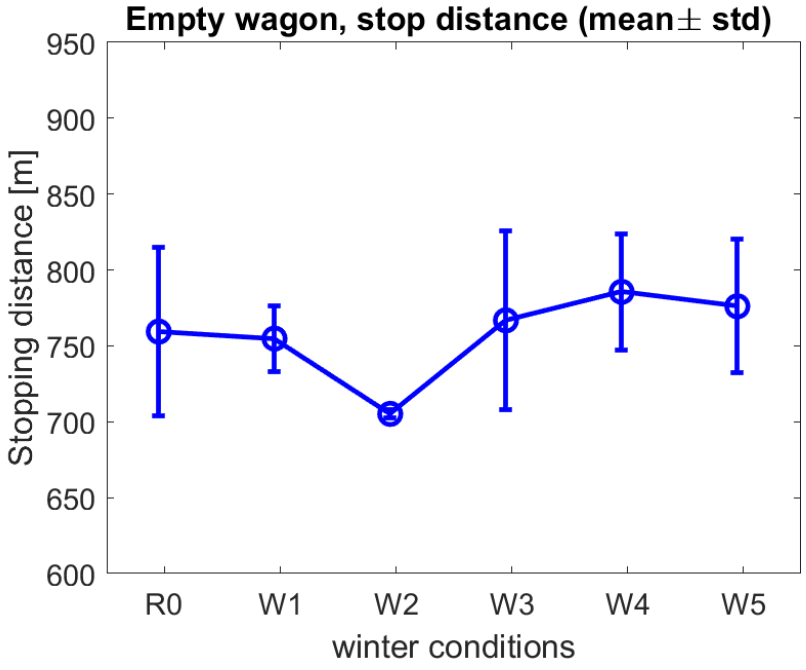

Figure 4 Graph over average stopping distance indicated by circles, with bar indicating standard deviation, as a function of UIC weather conditions.

2.3. Unloaded wagons and influence from locomotive driver instructions

Two different instructions were used at the tests for unloaded wagons presented above.

- *Version 1: Braking by 0.6 bar decrease of main pipe pressure every 10 minutes. The brakes are applied during 13 s.*
- *Version 2: Braking by 1.0 bar decrease of main pipe pressure every 15 minutes. The brakes are applied during 10 s.*

The results from these two driver instructions are presented in Figure 5. The results cannot be directly compared, but there are indications that brake cycles are somewhat shorter when driver instruction Version 1 is employed as compared to when using Version 2.

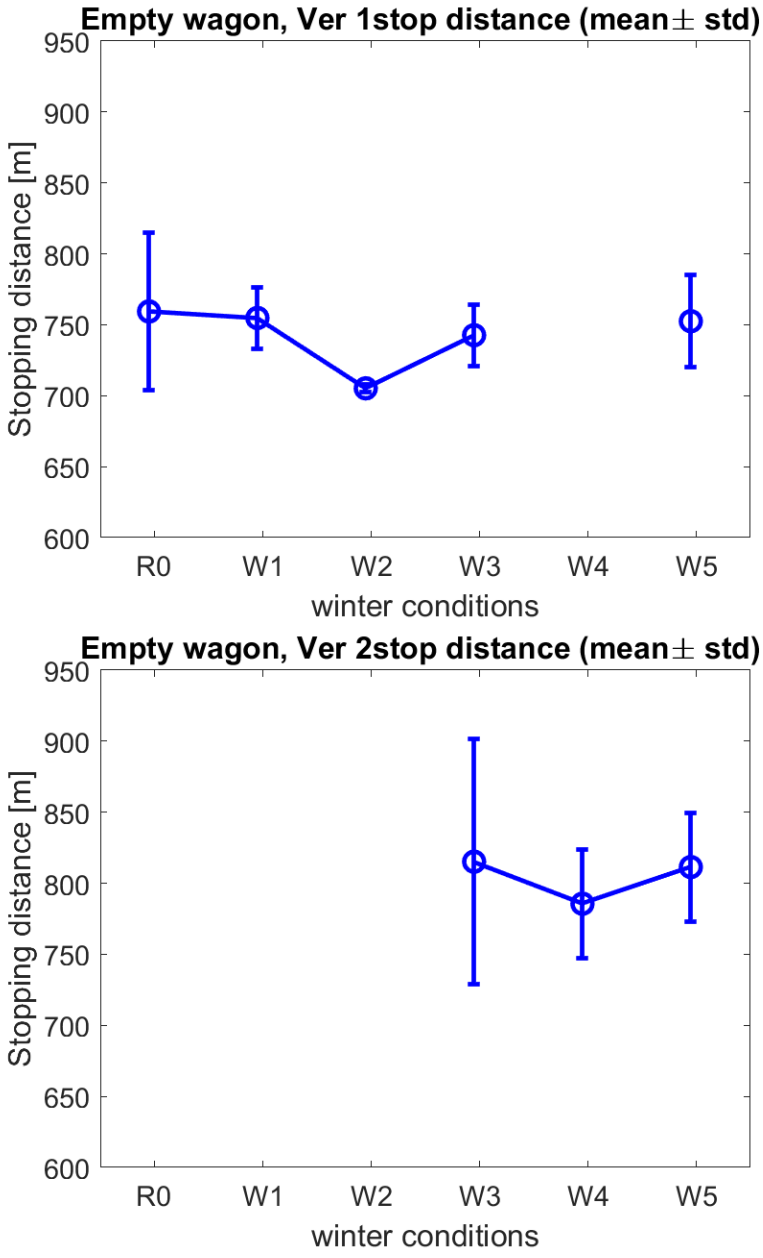

Figure 5 Graphs over average stopping distance indicated by circles, with bar indicating standard deviation, as a function of UIC weather conditions. Top: Driver instruction 1. Bottom: Driver instruction 2.

3. DISCUSSION

Braking with loaded wagons resulted in very stopping distances of the test train with an average braking distance 526 m. This distance can be compared to 683 m which is the estimated nominal braking distance based on information in UIC 544-1. At the tests, wheels flats were formed due to sliding of some wheels on the rails. There is a risk that problems with wheel flats can become a problem also in revenue service.

For full braking of unloaded wagons, the average stopping distance was 765 m that could be compared to a nominal braking distance of 847 m based on UIC 544-1. No problematic trend with a tentative lowering of air temperatures was found. This indicates good braking performance of the IB116* brake blocks at the tested conditions down to -20 ºC. A dependence of the braking distances on the employed driver instruction is observed. This is an indication that different driver instructions could be explored further for ensuring optimal braking performance.

These results expand the tested temperature range for the Transportstyrelsen tests of the organic blocks, since no data points were available below -8 ºC from the 2019-2020 test campaign. These results seem to remove the uncertainty from the previous winter season, where a problematic trend with continuously increasing braking distances for lower temperatures was reported.

More detailed analysis of the results will follow, with focus on relationship between braking distances and other measured data, e.g. forces and block temperatures.

It should be noted that the presented results are for a five wagon test train, braked in 2Bgu block configuration. The wagons have a high braking efficiency of about 90%.