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Tread braking and winter conditions

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Background

- Railway tread braking utilizes brake blocks being pushed towards wheel tread
- Traditionally used cast iron brake blocks are being phased out because of rolling noise issues
- Novel LL-brake blocks are a retro-fit solution having
  - Reduced rolling noise
  - Same braking performance
  - Better wear properties

LL brake blocks occasionally show weak braking at severe winter conditions.

Swedish Transport Agency arranged winter tests to find root causes and to restore safe operation

CHARMEC participated in planning of tests and analyzed measured data

Background

LL brake blocks – winter usage guidelines:

Perform a brake application every 10 to 15 minutes.

Winter testing – four driver instructions studied

Driver instruction	Denomination	Brake usage
1	normal brake conditioning	Brake application **every 10 minutes** with main brake pipe pressure lowered by **0.6 bar**. Brakes applied for **13 s**.
2	enhanced brake conditioning	Brake application **every 15 minutes** with main brake pipe pressure lowered by **1.0 bar**. Brakes applied for **10 s**.
3	provocative brake conditioning	Employ “Driver instruction 2” up to first stopping test. **No brake applications for 30 min prior to 2nd test.**
4	frequent stop braking	**Every 15 minutes a braking test is performed to stop**. No additional brake applications.

2 stop tests in 160 km

Test train and Instrumentation

Test train: RD locomotive and 5 wagons

- The locomotive had no operating brakes during the test runs.
- Wagons with Y25 bogies, brake block configuration 2 × Bgu
- Unloaded (empty) wagon 26 tonnes and loaded 60 tonnes.
- No artificial de-icing of the wagons was performed during the test campaign.
- Two sets of five wagons were used:
  - One with organic composite blocks and one with sinter blocks
  - Both wagon sets had a detailed sensor instrumentation on three of the wagons.

Test train and instrumentation

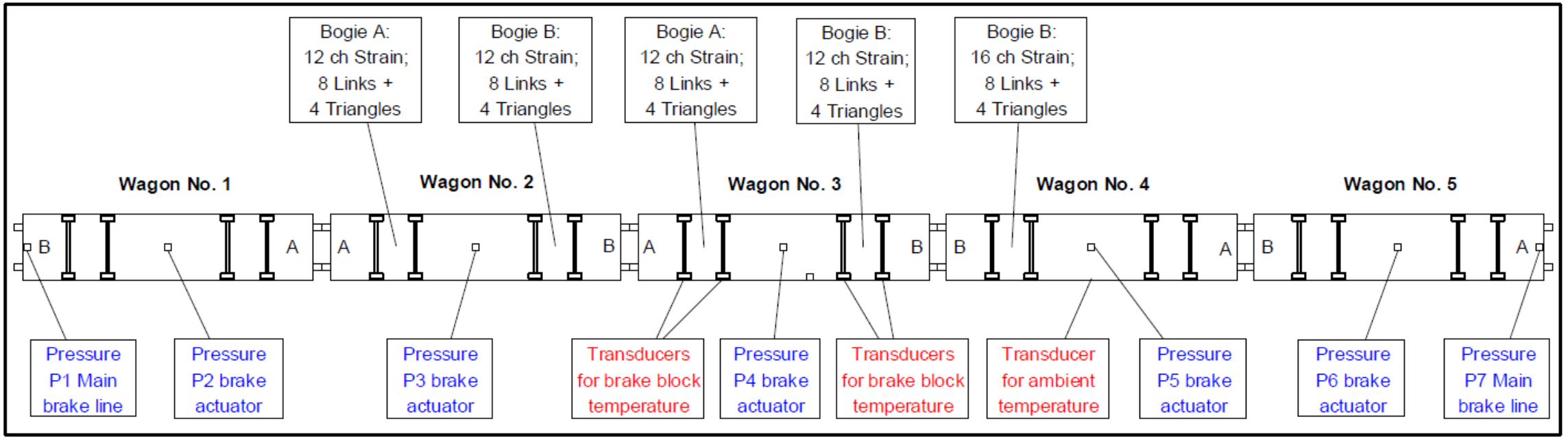
GPS for speed and distance

Sensor instrumentation on three of the wagons:

- Pneumatic pressures
- Block friction and normal force

Block temperatures on one wagon

Video documentation of “ice-status” of wagons



Winter condition grading

R0 no whirling snow;

W1– W2 mild conditions with third wagon visible from locomotive

W3 – W5 severe conditions, first wagon, or parts of first wagon, visible

Results - distances

Loaded wagons and organic blocks

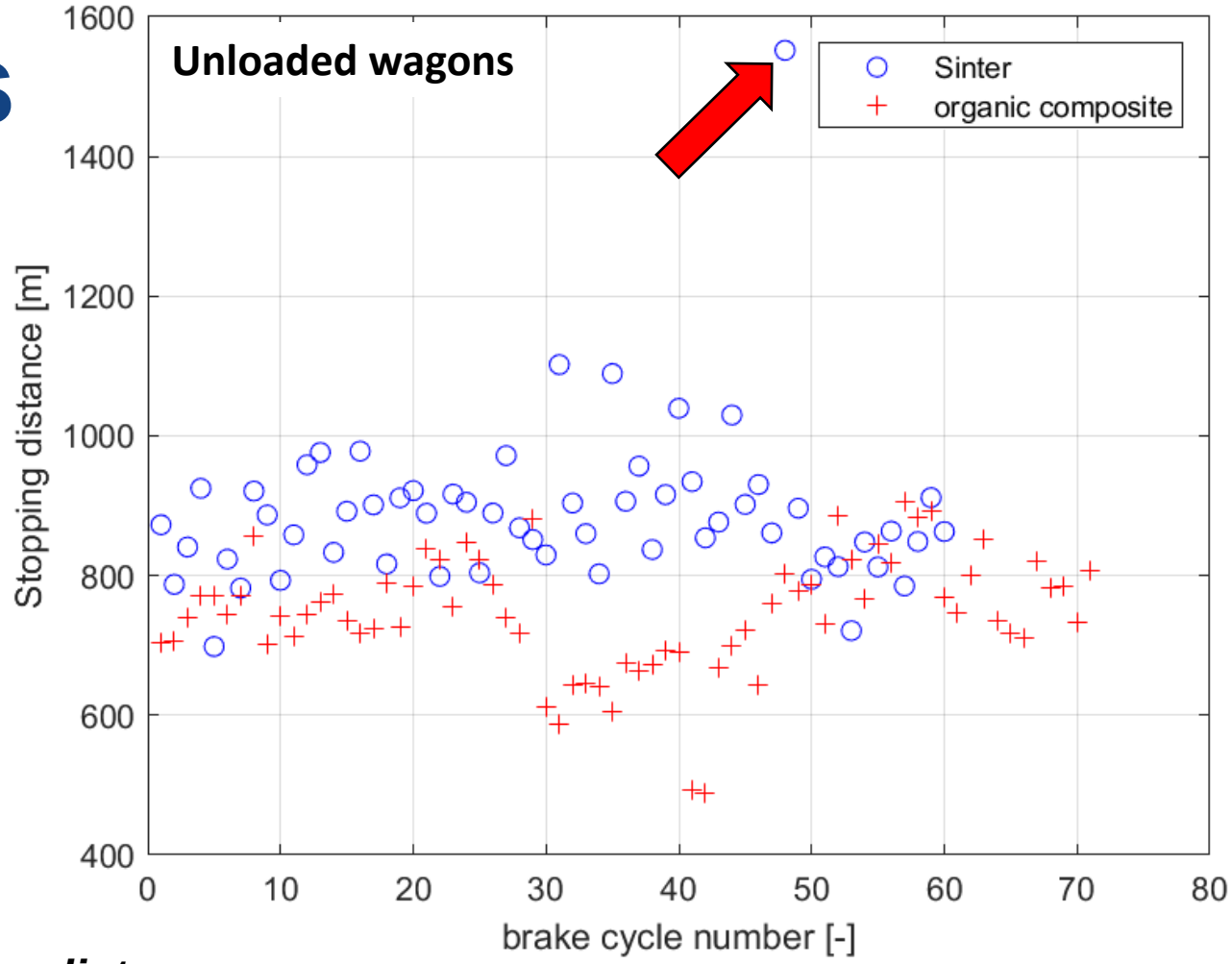
Very short stopping distances (not in figure)

Wheel flats! Tests aborted after one day

Empty wagons - braking distances

Sinter brake cycle no 48 is 1550 m.

- "*Provocative brake conditioning*"
- Large amounts of ice between block(s) and wheel(s) came off on wagons 2 and 4.
- Brake cylinders at maximum extension position
  No braking force to the brake rigging system
- ***Dangerous and extreme case of prolonged braking distances***
  Indicated sensitivity to driver behavior (occasionally not applying brakes during 30 min)
  Disregard for the remaining assessments.



Distances

Organic

Driver instruction 1 short and consistent stopping distances.

Driver instruction 2 - UIC winter indices W3–5

- Longer stopping distances

  Some sensitivity to driver instruction

Driver instruction 3 “provocative brake conditioning”

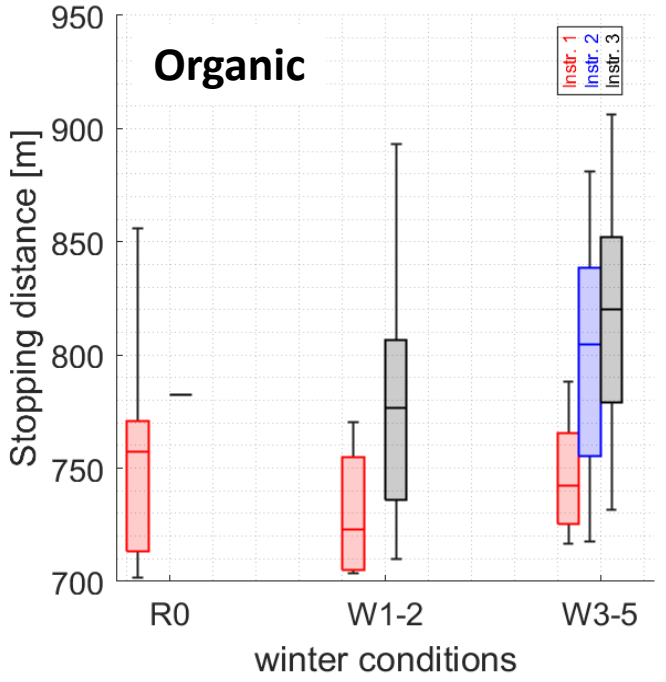
- Somewhat increased braking distances

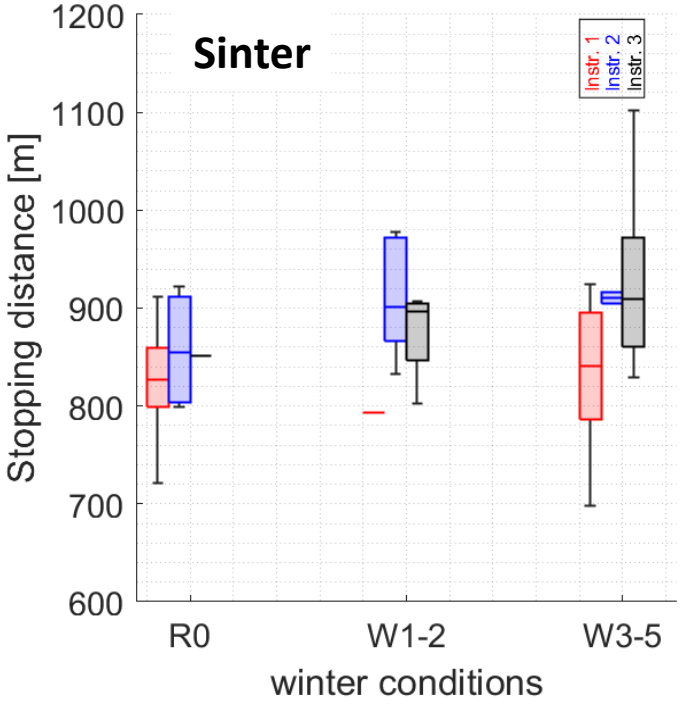
  Not very sensitive to “flawed” driver behaviour

Driver instruction 4 “frequent stop braking”

Substantially shorter stopping distances

Implementation of realistic driver instructions are imperative for winter testing of brake block performance





Distances

Sinter

Driver instruction 1 short and consistent stopping distances

Driver instruction 2

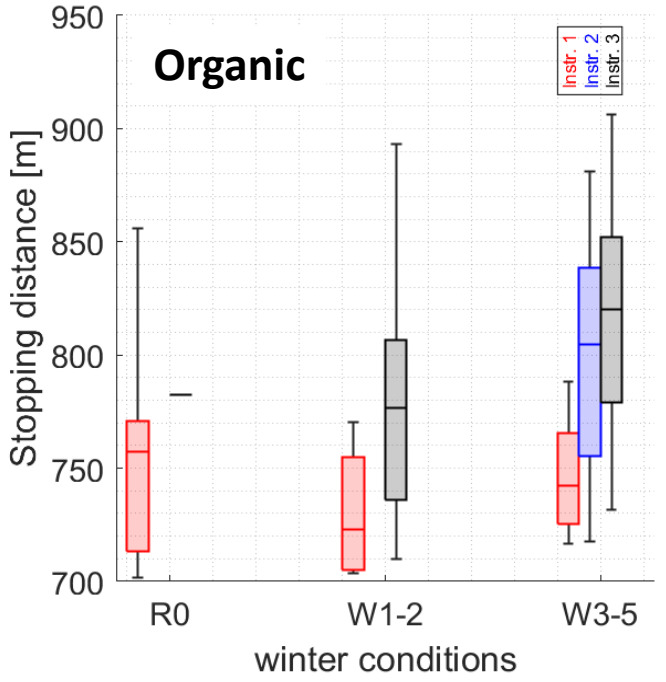
- Longer stopping distances

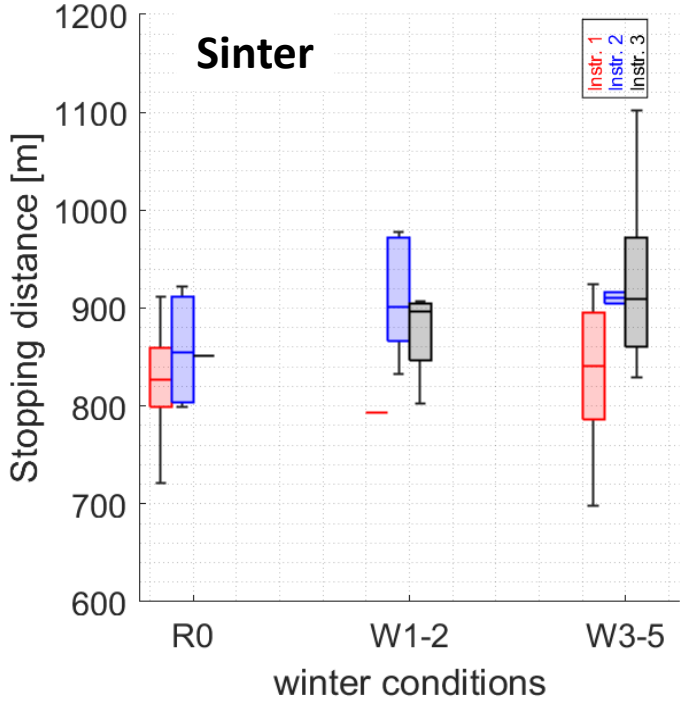
  Some sensitivity to driver instruction!

Driver instruction 3 “provocative brake conditioning”

- Substantially longer braking distances for W3–5
- Longest braking distance 1100 m - 20 % longer than R0 longest.

Sensitive to absence of conditioning brake applications!





Time delay to onset of friction

Time from start of the pneumatic pressure rise in the brake cylinder until the time at which the friction force reaches 50 % of maximum value for wagon

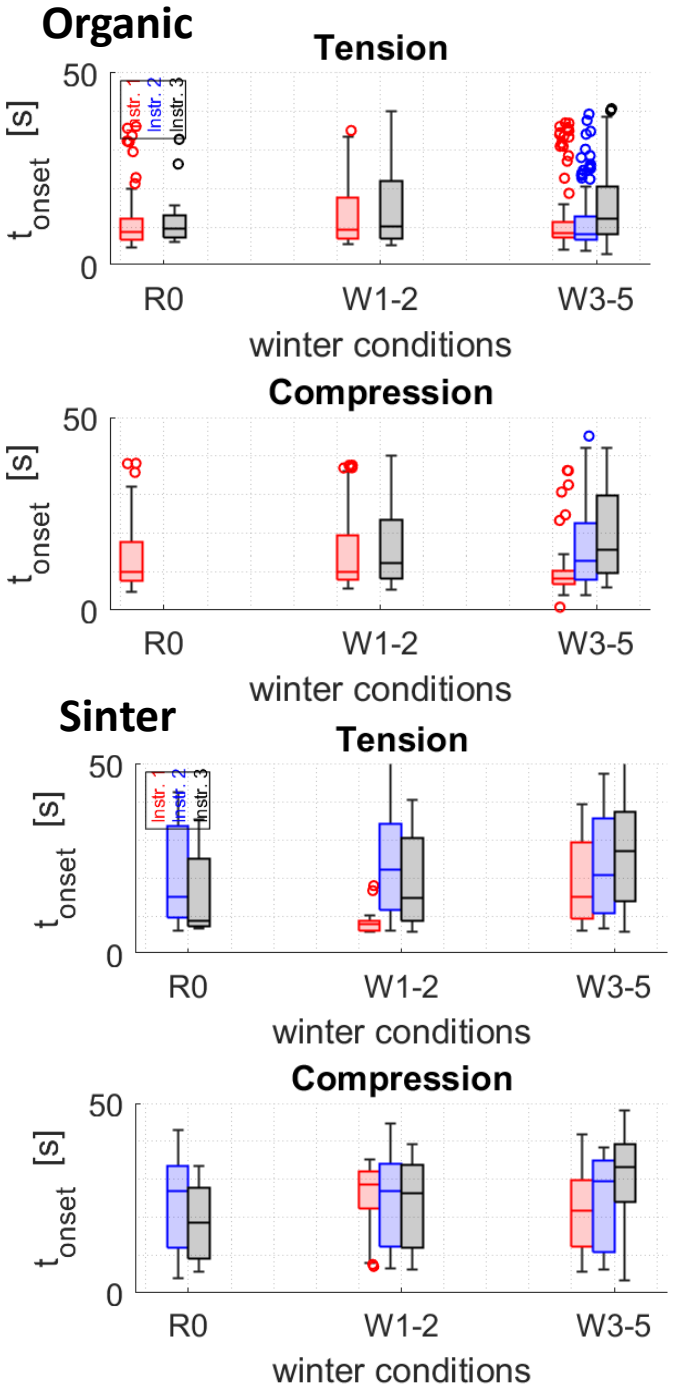
Organic blocks and driver instructions 1 and 2 median below 13 s

Organic blocks and instruction 3 - some seconds longer.

Sinter blocks and driver instructions 1–2 median values 18 to 30s
Substantially longer than for organic blocks.

Sinter blocks and driver instruction 3 W3–5 *showing 27 to 33 s!*

Interquartile ranges (difference between upper and lower quartile) are substantially larger for sinter blocks than for organic blocks
More unreliable braking performance for sinter blocks



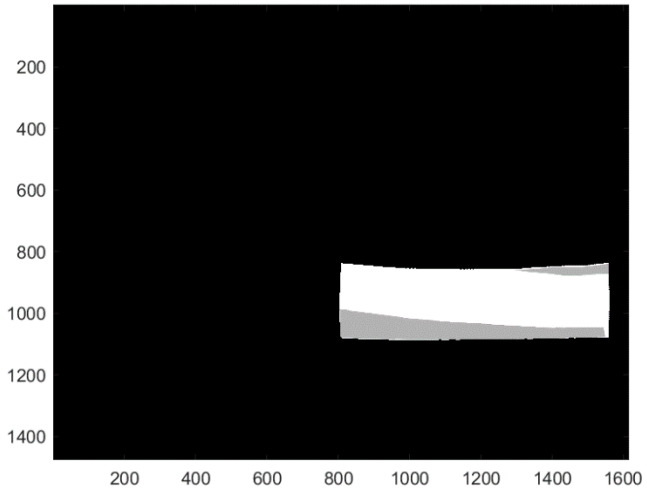
Brake block bedding-in

Organic blocks were perfectly bedded

Sinter block contact surfaces to wheel was between 60-100%

Opportunity to investigate winter behavior for sinter blocks

Will friction force depend on Bedding in Ratio (BR)



Brake block bedding-in

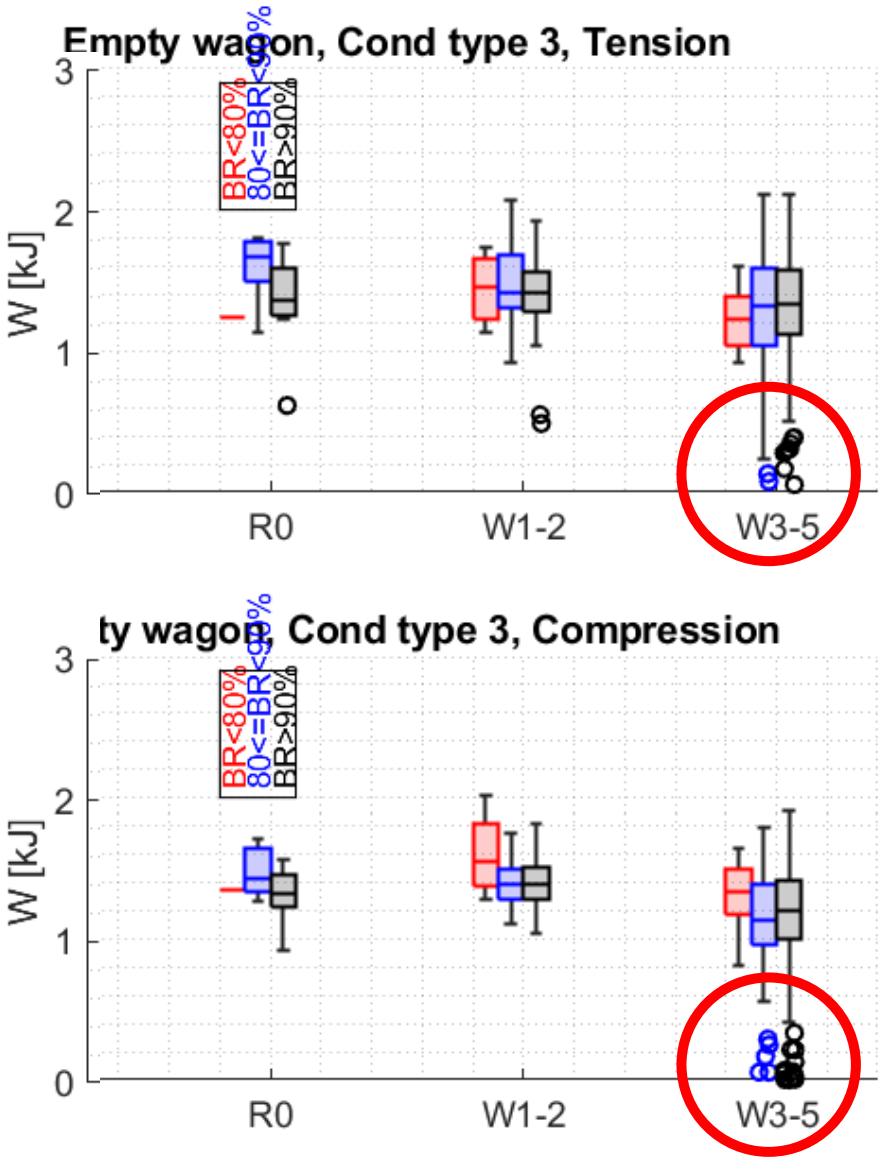
Sinter blocks: Energy and Bedding in Ratio (BR)

The least bedded blocks show

1. Smaller interquartile ranges than the more bedded-in blocks indicating a more reliable braking performance.
2. Very few occurrences of very low friction forces *Zero occurrences with work less than 50% of average, whereas they are plenty for the more bedded-in blocks.*

Similar results for instructions 1-2.

The braking performance for the least bedded-in blocks (<80% bedded-in surface) is superior to the more bedded-in blocks at severe winter conditions with lots of snow whirling around wagons



Brake block ice build-up

Grading of ice build-up on wagon 3 (entire campaign)

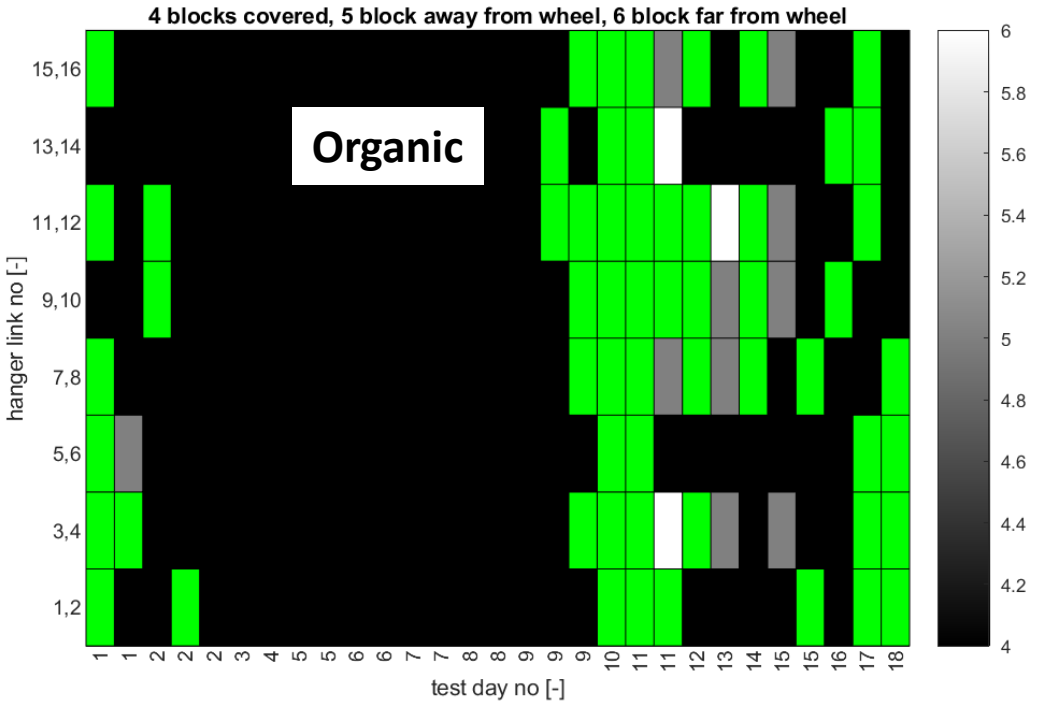
- *Green squares: no ice or snow near contact surface*
- Black / grade 4: both block types often completely covered in ice and snow: *cannot inspect contact.*
- Gray / grade 5: *several inspections* show snow and ice present between block and wheel
- White / grade 6: s*ome few occasions* large amounts if ice and snow was packed between block and wheel.

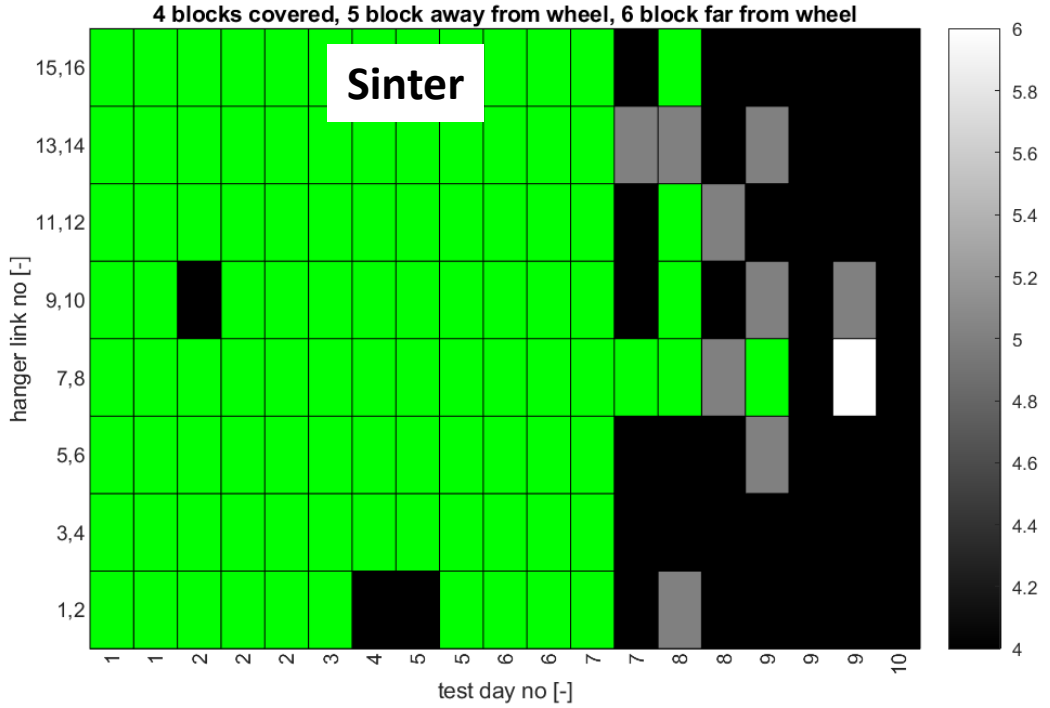
Organic blocks: Covered in ice and snow (black) at most of the days.

Complete de-icing imposed by increase in air ambient temperature to 0ºC on day 10.

Sinter blocks: very little ice/snow when employing driver instructions 1 and 2 (day 1-7).

Driver instruction 3 increases ice/snow on blocks (day 8-10).





Brake block temperatures and ice/snow

Maximum temperatures between ambient and +30°C

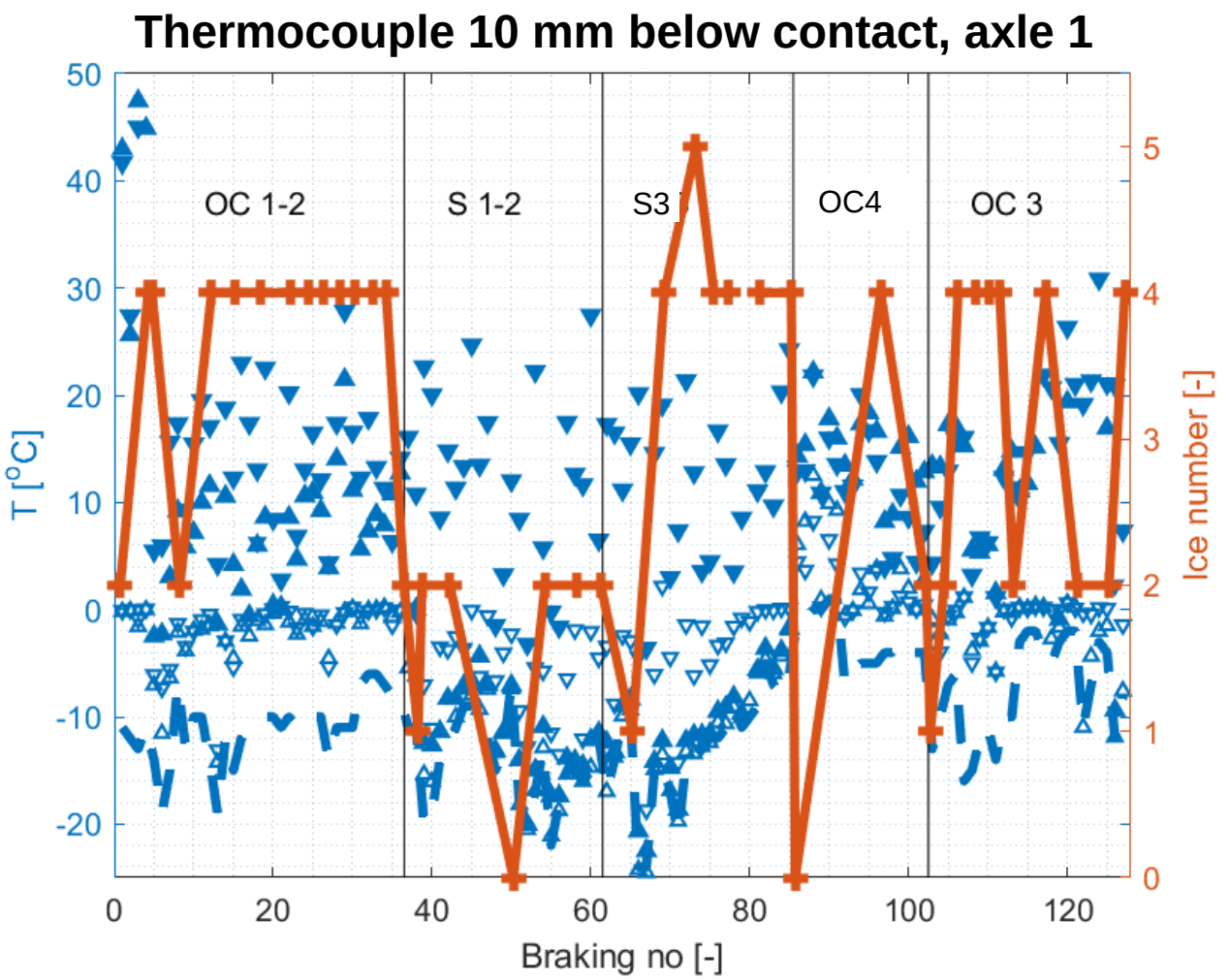
Block temperatures before stops normally below 0°C.

Organic blocks: “Frequent braking” instruction 4, also gives build-up of ice/snow (stop tests every 15 min).

Air temperature near 0 °C gives de-iceing

Sinter blocks: Initial block temperatures and also maximum temperatures similar to organic blocks

For driver instruction 3: large amounts of ice/snow (air temperature –20 °C to –5 °C) - often low block temperatures



Conclusions

Both blocks show sensitivity to driver instructions 1 and 2: *Instruction 1 is the preferred one*

Organic blocks - unloaded wagons (axle load of 6.5 tonnes)

- Behave rather well for all driver instructions, although the “provocative” driver instructions has the longest stopping distances
- Ice and snow build-up on the blocks during testing to a high degree for all three driver instructions. *Blocks cannot be inspected*

Sinter blocks - unloaded wagons (axle load of 6.5 tonnes)

- Behave rather well for normal and enhanced driver instructions (longer distances than organic blocks). *Blocks operate mostly ice-free*
- Longer (almost double) time until the friction force reaches a significant level as compared to organic blocks
- Blocks with a low degree of bedding-in are less prone to really low friction forces
- Occurrences of substantially prolonged braking distances for “provocative driver instruction”.
- Two wagons lost braking when accumulated ice and snow fell off - doubling of the braking distance
- *Sensitive to driver instruction implementation of driver*

Thank you for your interest!
Questions?

Contact information

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Detailed report

https://www.transportstyrelsen.se/globalassets/global/publikationer/jarnvag/tsj-2019-5343-swedish-tests-of-ll-brake-blocks-under-winter-condition-winter-2020-2021.pdf