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Standards for friction management in the wheel-rail interface

Current status and additional need for research

Björn Kämpfer | OBS Rail | ISGRV | 19.09.2023

Introduction

Which level of friction is “save”?

- Answer related to traction and braking: A **HIGH** level of friction is safe!
- Answer related to safety against derailment and running stability: A **LOW** level of friction is safe!
- → A “safe” friction level depends on the current situation.
- → Different levels of friction might be desirable in different regions of the wheel-rail interface.

- Influence of friction levels on wear and damage of wheels and rails[1)]
  - High levels: Higher amount of wear expected
  - Low levels: Higher risk for thermal damages (e. g. more frequent wheel slide events)
- → Cost structures within the wheel/rail interface depend on the friction levels

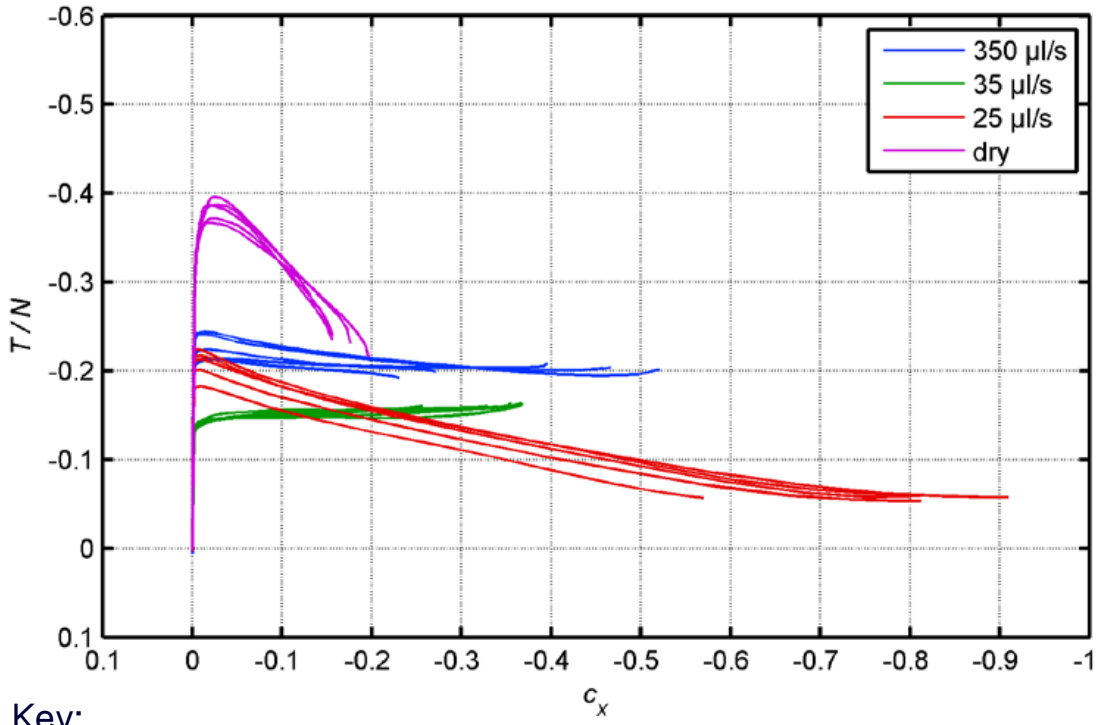
- ➔ Managing of friction levels is useful for a safe and economic railway!

[1)] Because of the complex wear and damage mechanisms, only rough trends can be mentioned here. Please refer to the relevant literature for more detailed information.

Introduction

What is friction management?

- In the field:
  - Wide range of friction levels and shapes of the creep curves
  - Current friction conditions depend on climate, season, surroundings (e. g. trees) and other parameters
  - Difficult to predict or measure (in the field)
- Friction management:
  - Artificial third body, which is put into the wheel rail interface for altering friction conditions
- Three types of friction management materials:
  - Flange lubricants (or gauge-face lubricants)
  - Top of rail materials
  - Adhesion materials



Key:

c_x: longitudinal creepage

T/N: tangential force T divided by normal force N (i.e. coefficient of friction)

Coloured lines: creep curves for different amounts of water being applied

Reference of Figure: Buckley-Johnstone, L.; Lewis, R.; Six, K.; Trummer, G.: Modelling and quantifying the influence of water on wheel/rail adhesion levels – Phase 2 report, issued by RSSB, London, 2016

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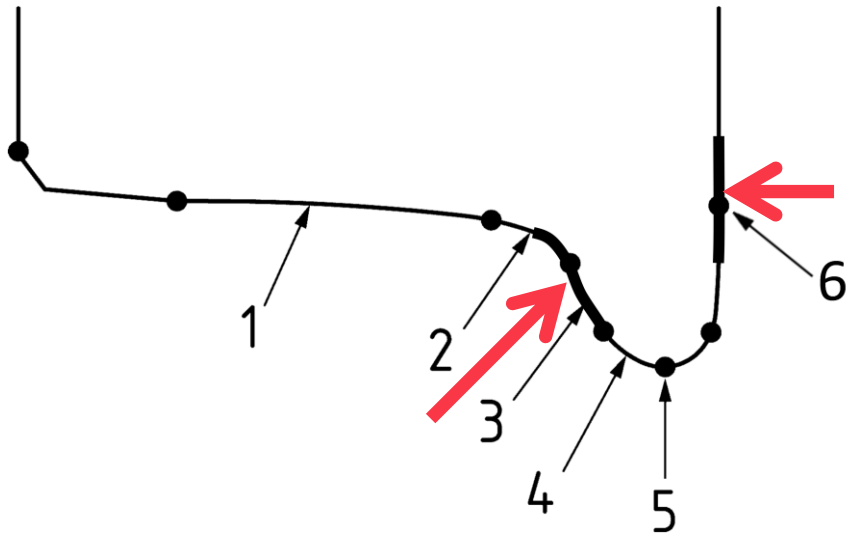
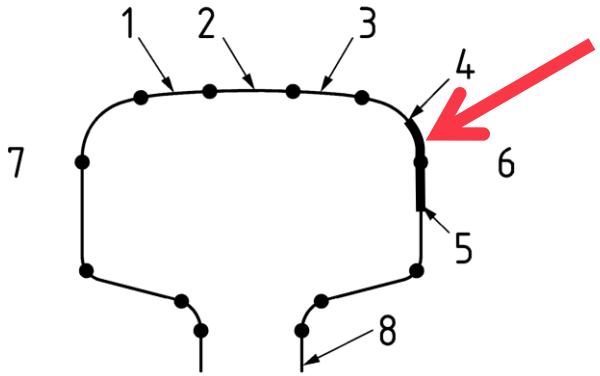
Friction management systems

Flange lubrication / Gauge face lubrication

- Purpose:
  - Reduction of flange wear on wheels
  - Reduction of side wear of rails
  - Reduction of wear on the flange back and on check rails
- Target regarding friction: reduction to a minimum
- Materials:
  - Non-solid (oil-based, grease etc.)
  - Solid
- Available systems:
  - On-board non-solid dispense systems
  - On-board solid stick systems
  - Trackside non-solid dispense systems



Key
1 tread
2 flange root
3 flange face
4 flange toe
5 flange tip
6 back of wheel



Key
1 field shoulder
2 crown
3 gauge shoulder
4 gauge corner
5 gauge face
6 inside of running rail (gauge face)
7 outside of running rail (field side)
8 web
9 centre of track

Reference of Figures: EN 15427-1-1:2022: Railway applications – Wheel/Rail friction management – Part 1-1: Equipment and Application – Flange Lubricants, CEN European Committee for Standardization, Brussels, 2022 (with additions)

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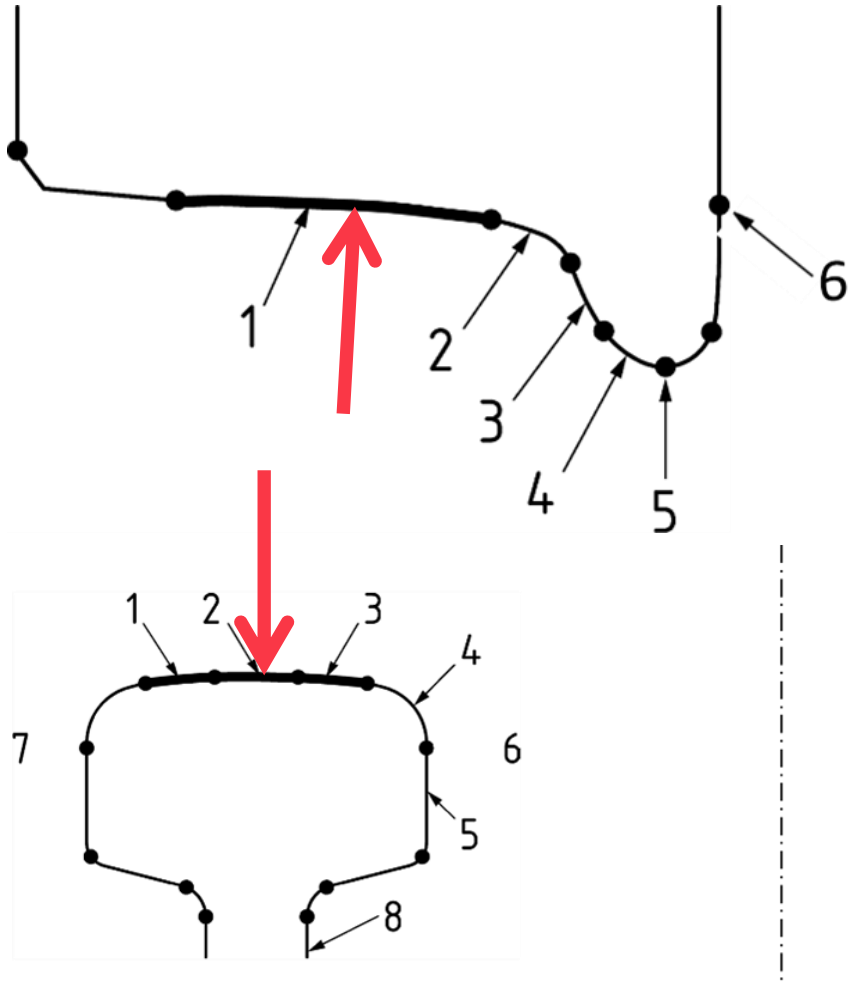
Friction management systems

Top-of-rail material application

- Purpose:
  - Reduction of energy consumption (mainly: North America)
  - Reduction of noise emissions – directly or indirectly (mainly: urban rail systems)
  - Reduction of wear and damage in the wheel/rail interface
- Target regarding friction: altering friction characteristics
- Materials:
  - Non-solid (oil-based, water-based etc.)
  - Solid
- Available systems:
  - On-board non-solid dispense systems
  - On-board solid stick systems
  - Trackside non-solid dispense systems



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Reference of Figures: FprCEN/TS 15427-1-2: 2023: Railway applications – Wheel/Rail friction management – Part 1-2: Equipment and Application – Top of Rail materials, CEN European Committee for Standardization, Brussels, 2023 (with additions)

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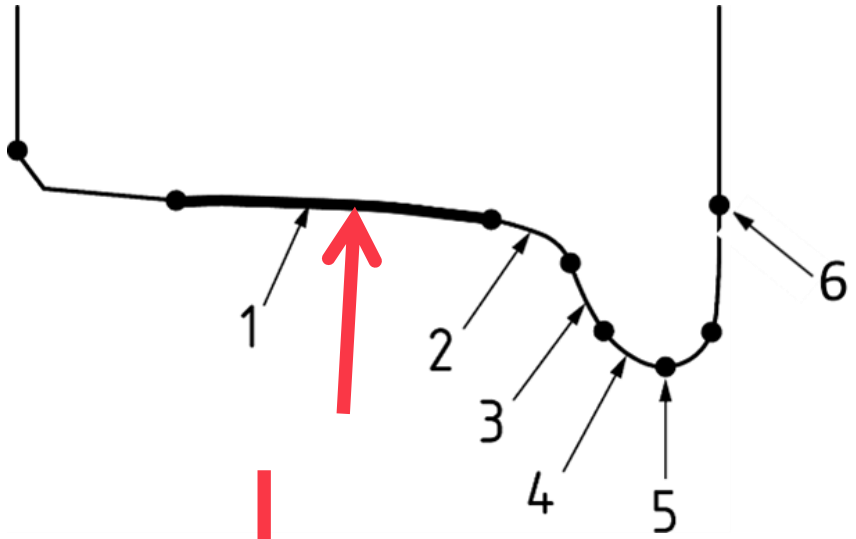
Friction management systems

Adhesion material application

- Purpose:
  - Maintaining braking distances
  - Maintaining traction capabilities
- Target regarding friction: enhancing
- Materials:
  - Non-solid (traction gels etc.)
  - Solid (sand)
- Available systems:
  - On-board non-solid dispense systems
  - On-board sanding systems
  - (Trackside non-solid dispense systems)



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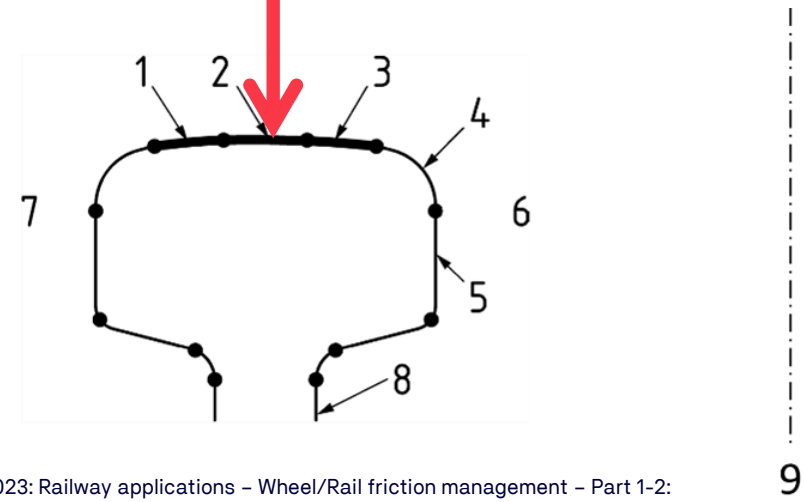

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Standardisation of friction management

CEN/TC 256/SC 2/WG 38

- Working Group re-established in the second half of 2010s
- Documents prepared:
  - EN 15427-1-1:2022: Flange Lubricants – System (“hardware”)
  - EN 15427-2-1:2022: Flange lubricants – Material properties
  - CEN/TS 15427-1-2: 2023: Top of Rail materials – System (“hardware”)
  - CEN/TS 15427-2-2: 2023: Top of Rail materials – Material properties
  - CEN/TS 15427-1-3: 2023: Adhesion materials – System (“hardware”)
  - CEN/TS 15427-2-3: 2023: Adhesion materials – Material properties
  - CEN/TR 15427-3: 2023: Technical Report
- Former EN 15427 and EN 16028 withdrawn

- Documents distinct between three types of friction management systems and
  - System lay-out and design
  - Material properties
- CEN/TS: Technical Specification issued by CEN (“Pre-standard”)
- Technical Report: background information about the documents
- Considering on-board and trackside applications
- Created for mainline applications, but adoption by urban rail systems recommended (if applicable)
- General information: CEN documents can only standardise existing technologies, but not new technologies
  → No budget within CEN for r&d projects etc.

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Standardisation of Friction Management

Content of CEN-documents

Documents regarding system lay-out and design

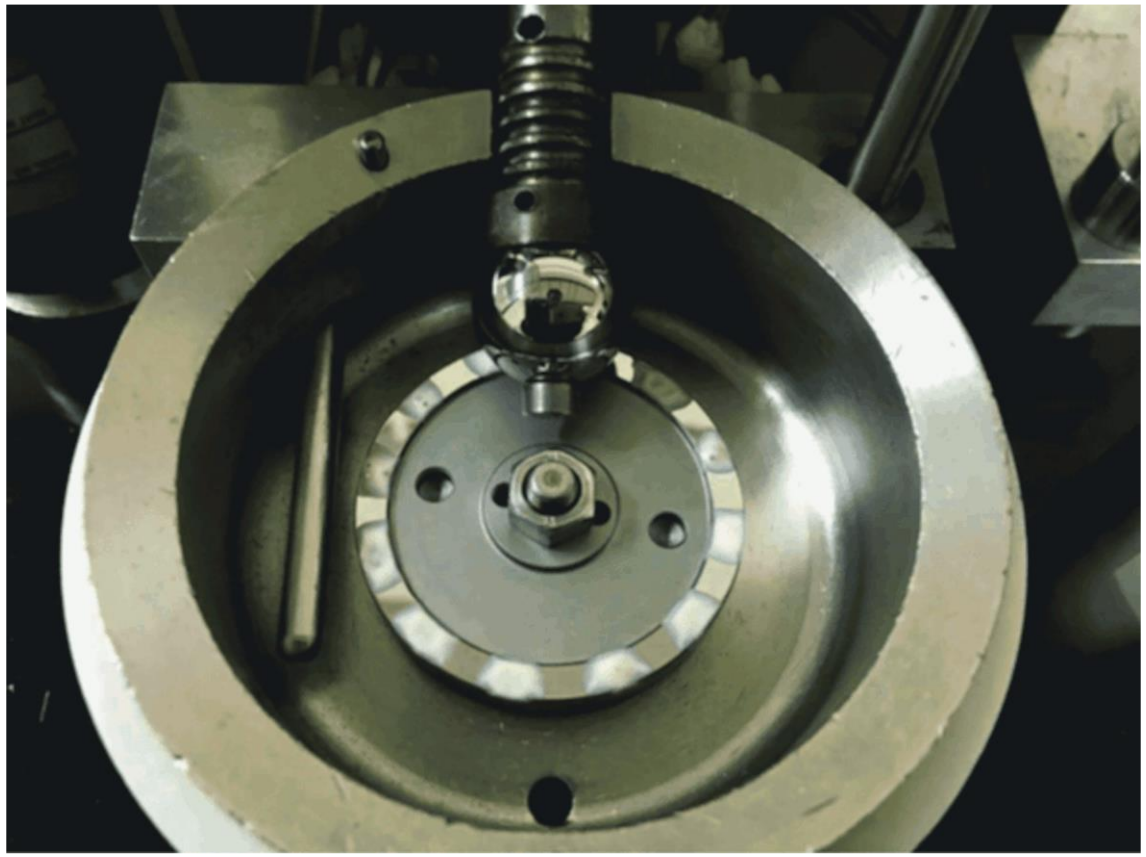
- High variation of use cases around Europe (e. g. climate conditions, track-alignment, vehicle design etc.)
- → Different system lay-outs interesting for different use cases
- → Only few direct requirements set within the documents (especially regarding safety issues)
- → Normative guidelines for: engineering, installation, maintenance, operation etc. of friction management systems
- Procedures for field tests (e. g. brake tests with top-of-rail materials for maintaining braking distances)

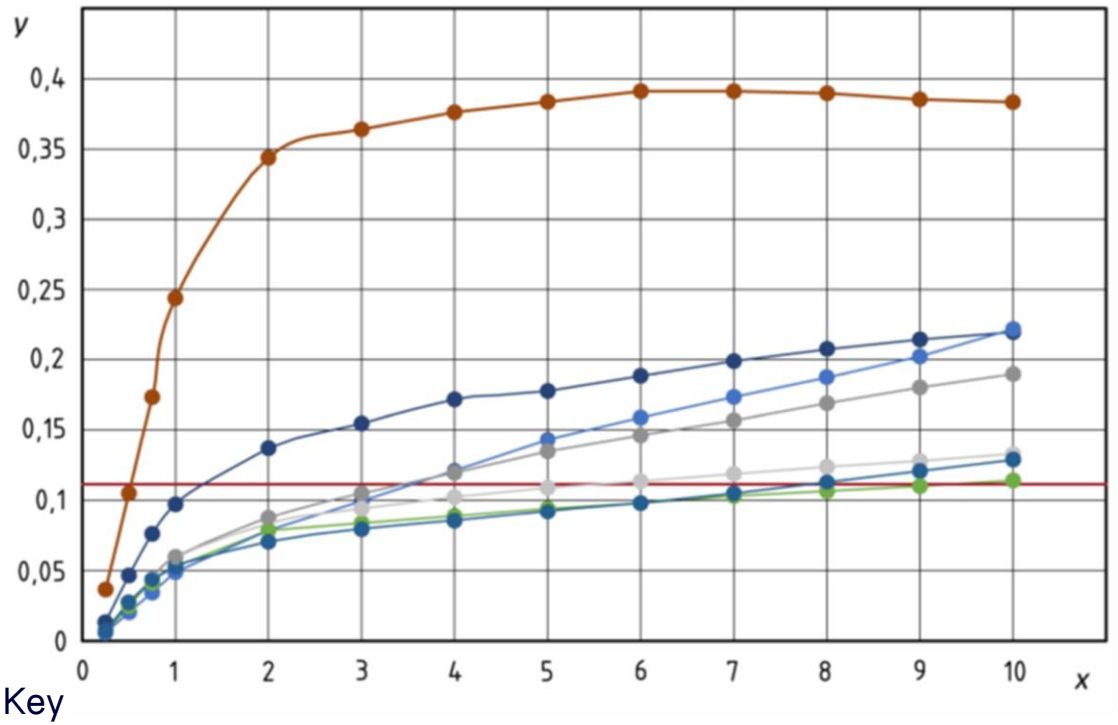
Documents regarding material properties

- Technical requirements (e. g. avoiding safety issues, environmental or health hazards etc.)
- Requirements for production, labelling of packages, shipping, storage etc.
- Requirements for type testing, routine testing and minimum information on data sheets
- In most cases: Requirements refer to other standards and documents
- If no other standard available:
  Procedures for lab-tests of materials
- → Aim: Making materials more comparative with each other with limited effort
- → However, optimal type of material depends on the use case

Standardisation of friction management

Example for lab testing of materials – determination of creep curves with mini traction machine (MTM)





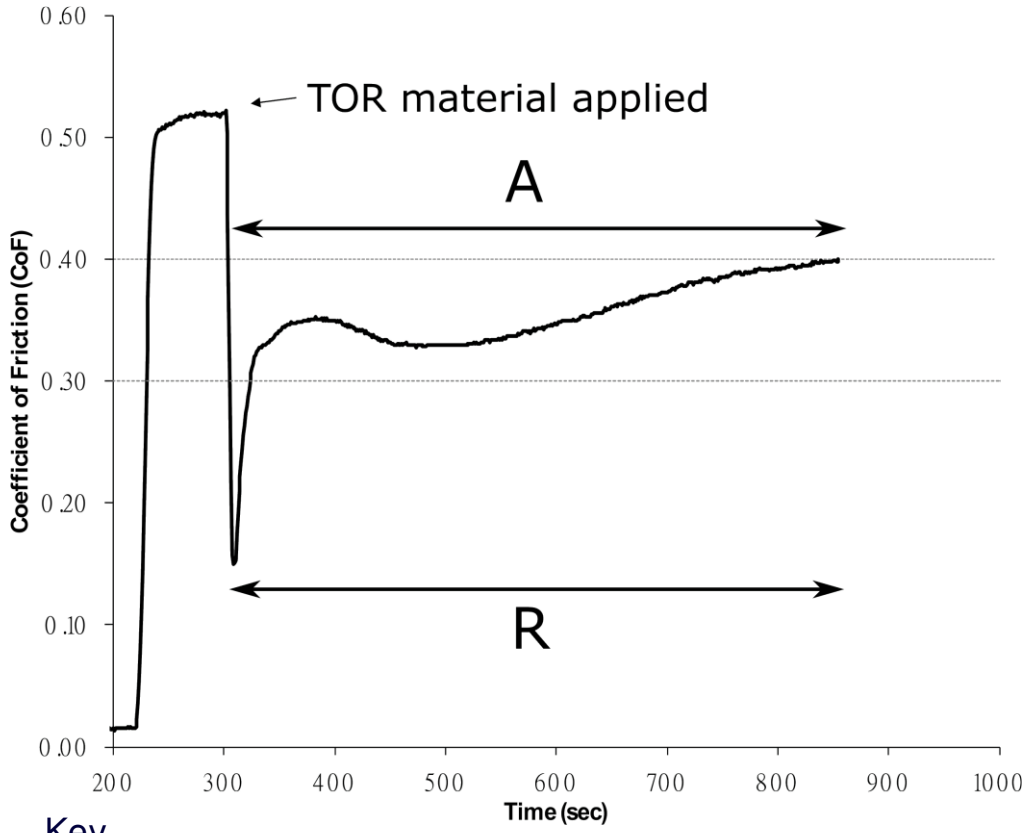
Key
x: creepage [%]
y: coefficient of friction [-]
Red line: indication of a coefficient of friction of 0.11
Other lines: results for different top of rail materials

Reference of Figures: FprCEN/TS 15427-2-2: 2023: Railway applications – Wheel/Rail friction management – Part 2-2: Properties and Characteristics – Top of Rail materials, CEN European Committee for Standardization, Brussels, 2023

Standardisation of friction management

Open questions

- Only few requirements regarding the performance friction management systems
- Example 1: Coefficient of Friction
  - No validated method available for measuring CoFs in the field
  - Lab tests not representative (e. g. amount of material in the interface) and results of lab tests not transferable to the field
  - → No direct requirements set for CoFs
  - → further research work necessary
- Regulatory rules cannot be set by standards
- Example 2: Compatibility with other materials
  - Series 15427: New material to be tested against all other materials used in the railway system
  - Who can provide the information, which materials are already in use within a mainline network???
  - Regulatory question!!!



Key
A: period used for average COF calculation
R: retentivity

Reference of Figure: FprCEN/TS 15427-2-2: 2023: Railway applications – Wheel/Rail friction management – Part 2-2: Properties and Characteristics – Top of Rail materials, CEN European Committee for Standardization, Brussels, 2023

Summary

- High variability of friction conditions of the wheel rail interface observed in the field
- Friction management systems can help to control the friction conditions with three different applications
  - Flange lubricants (or gauge-face lubricants)
  - Top of rail materials
  - Adhesion materials
- CEN working group has created six different Euronorms and Technical Specifications for all three applications regarding the system lay-out and design and regarding the materials
- If these six documents issued by CEN are obeyed, a safe and economic operation is possible!
- Some questions especially regarding the standardisation of the performance of friction management systems are still open → further research work is necessary
- Regulatory questions cannot by answered by standards
- Potential users are encouraged to use series 15427 documents and to share their experience with CEN/TC 256/SC 2/WG 38

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Do you have questions?

Björn Olaf Kämpfer, Dipl.-Ing. Dr. techn.

T.: +49 40 8557 2614

M.: bkaempfer@tuev-nord.de
bahn@tuev-nord.de