PKP POLSKIE LINIE KOLEJOWE S.A.

Zarządca narodowej sieci linii kolejowych

Experience of operating lines at speeds above 160 km/h

Krzysztof Waszkiewicz
Member of the Management Board responsible for railway maintanance

Pilsen, November 2024.

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Railway line No. 9:

- between 2007 and 2015, a comprehensive, multi-discipline modernisation of railway line No. 9 was carried out, allowing the introduction of speeds of 160 km/h for passenger trains and 120 km/h for freight trains;
- between 2019 and 2020 optimisation work was carried out to increase the speed for passenger trains to 200 km/h;
- from the 2020/2021 timetable, regular passenger train traffic on railway line No. 9 began at 200 km/h.

Railway line No. 4:

- in 1988, regular passenger train traffic started on railway line No. 4 at a speed of 160 km/h;
- between 2009 and 2013 the ETCS L1 system was installed, resulting in the start of regular passenger traffic at 200 km/h in 2014;
- according to current assumptions, the introduction of Vmax = 250 km/h is planned for 2026.

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Works carried out on line No. 4:

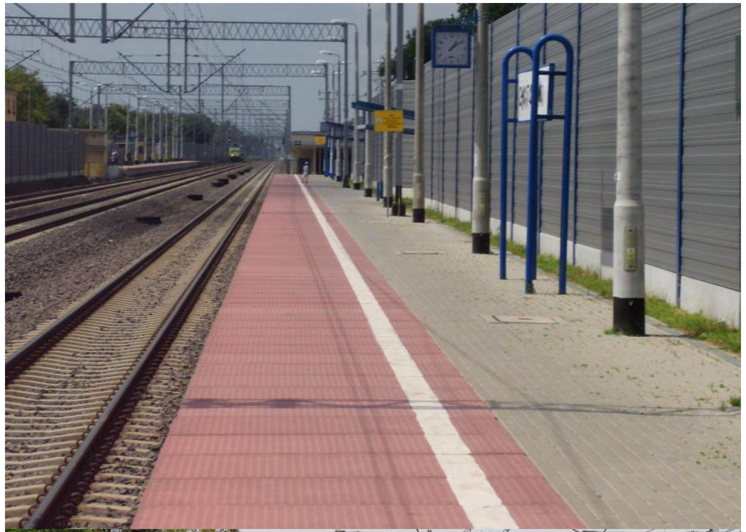
- reconstruction of engineering structures and execution of dynamic load tests;
- design of track adjustment (adjustment of canting to maximum speed);
- installation of the ETCS L1 system;
- removal of level crossings;
- modification of the power supply system (construction of new substations);

- In progress:
  reconstruction of SRK equipment and installation of ETCS L2 system

Experience of operating lines at speeds above 160 km/h

Works carried out on line No. 9:

- reconstruction of engineering structures and performance of dynamic load tests;
- design of track adjustment (adjustment of canting to maximum speed);
- installation of the ETCS L2 system;
- removal of level crossings;
- modification of the power supply system.



Experience of operating lines at speeds above 160 km/h

Tests and trials prior to implementation V > 160 km/h

First ETCS L1 tests - 2011:
https://www.youtube.com/watch?v=Jg9_p3paQHo

OHL tests:
https://www.youtube.com/watch?v=CsfUJ5Qw1a0

Civil engineering objects (railway bridges) tests:
https://youtu.be/A9dgmF6pEvA?si=OZdU3fTOXCLz-EkI&t=289

Turnouts tests:
https://youtu.be/-iwoE8B9N44?si=FgPqi4sbzCaCnrBQ&t=248

ED250 homologation up to 250 km/h - record V = 293 km/h
https://youtu.be/hMVL5Zu9Mlw?si=ImJepL1mpBOelwF2&t=460

Experience of operating lines at speeds above 160 km/h

Effective maintenance of the INF subsystem on HSR

IDENTIFIED PROBLEMS :
Track geometry quality

Assumptions of change:

- increasing the tolerance of acceptable geometric quality parameters,
- defining new assessment parameters,
- dissemination of qualitative measures (standard deviation),
- introduction of a four-step geometric quality assessment.

Benefits:

- improving the planning of maintenance works (quality measures),
- reduction in the number of geometry defects requiring intervention (thresholds, tolerance),
- ensuring travel comfort (new parameters - D2 waves).

Experience of operating lines at speeds above 160 km/h

Effective maintenance of the INF subsystem on HSR

IDENTIFIED PROBLEMS :
Flying ballast in winter conditions (uplift of ballast stones by falling ice blocks from the train)

Implemented actions - RU:

- Amendments to the DSU for the assessment of damage to SYOPE panels,
- use of measures to prevent snow and ice build-up on the ED250 chassis,
- limitation of the travelling speed in case of ice on the train.

Implemented measures - IM:

- changes to the regulations (profiled ballast prisms -2.0 cm),
- ensuring that the ballast prism is properly profiled,
- increased surveillance of the operation section (control

Experience of operating lines at speeds above 160 km/h

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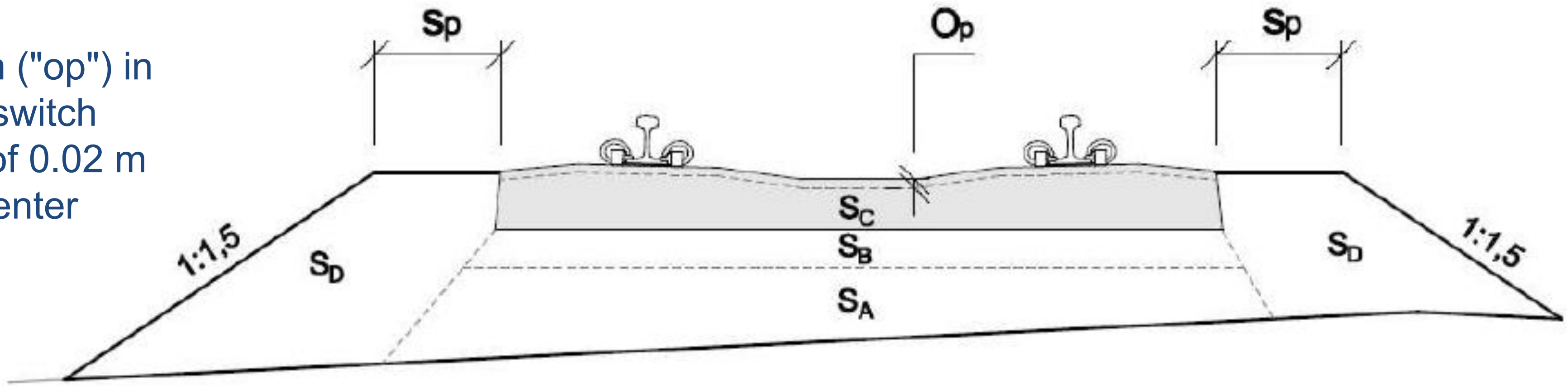
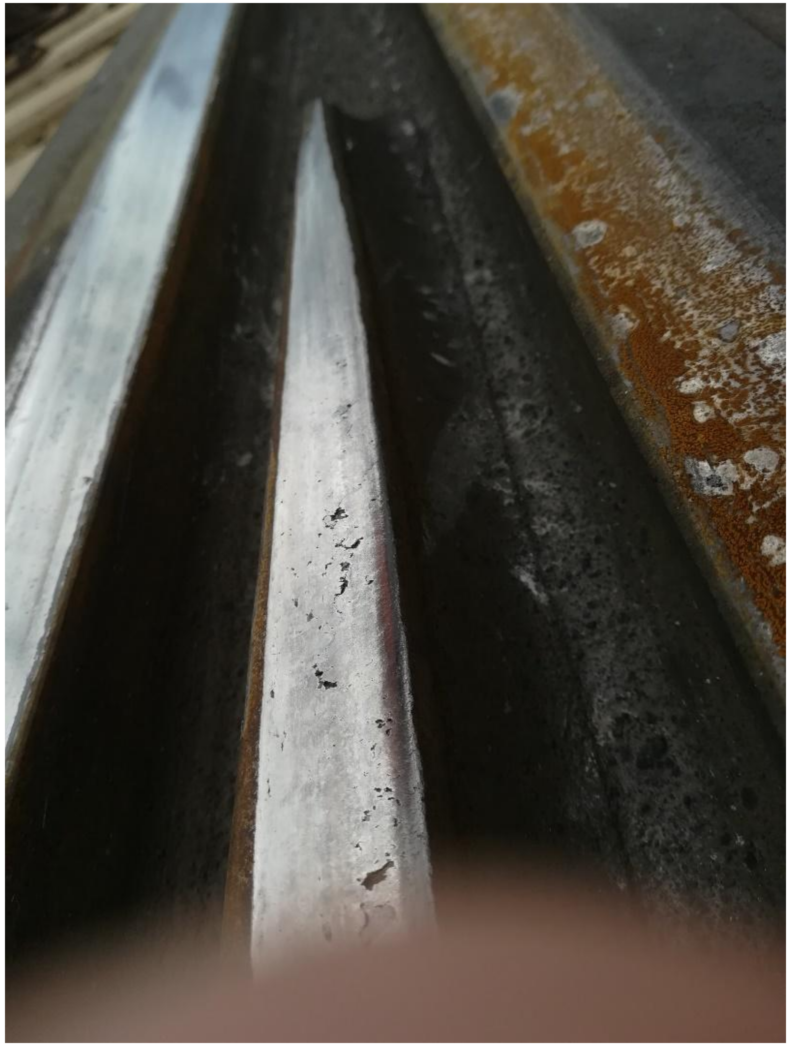
ST-T1-A8:
"The top surface of the ballast prism ("op") in the windows between the sleepers/switch sleepers shall be profiled to height of 0.02 m below the top edge of the sleeper center section..."



Experience of operating lines at speeds above 160 km/h

Effective maintenance of the INF subsystem on HSR

IDENTIFIED PROBLEMS :
Defects/geometry of the rail running surface



Assumptions of the change:

- introducing a catalog of surface defects,
- standardizing the treatment of defects,
- introduction of a four threshold assessment,
- introduction of new parameters to be assessed (ripple wear)
- raising awareness of the causes of defects and the consequences of not correcting them.

Benefits:

- slowing the rate of sufrace degradation (reduction of dynamic impacts from surface defects),
- a reduction in the number of ruptures and operational restrictions (raising of staff awareness),

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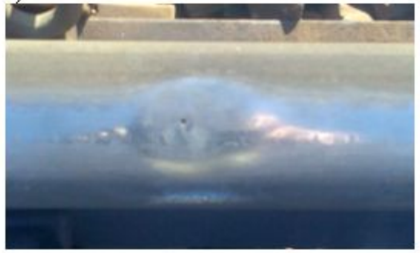
Name, no. from the UIC catalog

Description of the defect + examples

SQUAT - pęknięcie i miejscowe zagłębienie powierzchni tocznej	227

Charakterystyka, wygląd i przyczyny

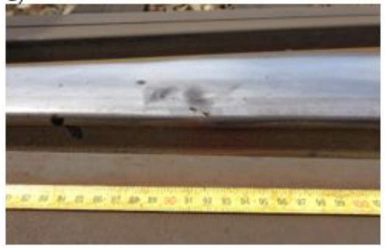
a)



b)

c)

d)



Powstaje na powierzchni tocznej w strefie styku koła z szyną. Wadę można rozpoznać wizualnie po następujących cechach:

- występuje wgłębienie na powierzchni tocznej,
- najczęściej towarzyszy jej miejscowe zaciemnienie powierzchni wzdłuż pęknięcia,
- występuje pęknięcie na powierzchni tocznej, typowo w kształcie litery V lub U, przy czym w przypadku defektów w zaawansowanym stadium rozwoju, pęknięcie może przybierać również inne kształty,
- w odróżnieniu od wybuksowań najczęściej występuje tylko na jednym toku szynowym.

W przypadku zaawansowanego stadium rozwoju wady te wykrywane są również metodą UT.

Wady SQUAT powstają najczęściej na odcinkach prostych lub łukach o dużym promieniu, w miejscach najbardziej obciążonych, między linią środkową i krawędzią szyny. Ponadto często pojawiają się w obszarze złączy spawanych/zgrzewanych.

W odróżnieniu od wielu innych rodzajów wad, squaty z uwagi na kontaktowo-zmęczeniowy charakter powstawania (wada RCF), stale zwiększają swój rozmiar (propagują) prowadząc ostatecznie do złamania szyny. Wady te często występują w skupiskach (wady wielokrotne), wobec czego należy je uznać za powodujące szczególne duże ryzyko wystąpienia wielokrotnego złamania szyny (Rys. e)

e)

Example "card" from the catalog of defects in rails (for 227 – SQUAT defect)

Skutki

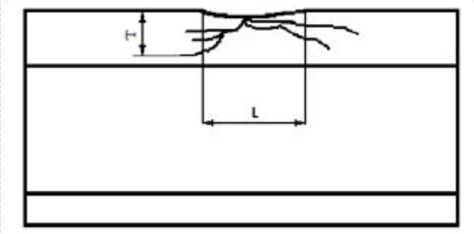
Początkowo pęknięcie te rozwija się pod małym kątem i przebiega blisko powierzchni tocznej, następnie na głębokości około 3-5 mm, zmianie ulega kierunek propagacji i dalej pęknięcie postępuje praktycznie pionowo, powodując złamanie szyny lub wykruszenia na powierzchni szyny (SPALLING).

Wady te powodują zwiększone oddziaływania dynamiczne podczas przejazdu taboru, co skutkuje możliwością powstania innych wad jak również uszkodzeń nawierzchni (zużycie faliste, wykruszenia podkładów betonowych w strefie podszynowej, uszkodzenia węzłów przytwierdzeń itp.).

Działanie i zapobieganie

Środkami zapobiegawczymi powstawaniu wad typu SQUAT jest przede wszystkim szlifowanie prewencyjne szyn. Ponadto odpowiednie utrzymanie nawierzchni, szybkie eliminowanie innych wad (wybuksowania, skaleczenia, zużycie faliste) od których wady SQUAT mogą powstać.

f)



W przypadku pojedynczych wad zaleca się stosować klasyfikację oraz metody i terminy ich usunięcia zgodnie z poniższą tabelą. Przy czym w tabeli stosuje oznaczenia charakterystycznych wymiarów wady squat: długość i głębokość, zgodnie z rys. f.

Klasyfikacja wady SQUAT

Działania		U1 (lekkie)	U2 (średnie)	U3 (ciężkie)		U4 (niebezpieczne)	
Metoda wykrycia	VT (długość)	L < 50 mm	L ≥ 50 mm	----			
	UT (głębokość)	brak wskazania	T ≤ 10 mm	T ≤ 25 mm		T > 25 mm	
Zabezpieczenie do czasu usunięcia wady		---	---	ściskacze do szyn[1]	---	ściskacze do szyn[1]	V ≤ 10 km/h
Termin usunięcia [dni]		---	90	90	30	30	niezwłocznie
Metoda naprawy	wady pojedyncze	napawanie HWR/THR	HWR/THR	HWR/THR szeroki luz		szeroki luz wstawka	
	wady wielokrotne	wstawka					

1) ściskacze do szyn – ograniczenie prędkości wynika z dopuszczenia SMS-PW-17

Komentarz

Za generujące szczególne ryzyko uznaje się wady wielokrotne – w zależności od ich rozmiarów, ilości oraz lokalnych uwarunkowań zaleca się je klasyfikować do progu U3 lub U4.

Wada SQUAT jest jedna z najczęściej spotykanych wad na sieci PKP PLK S.A.

Impact

Actions to be taken to prevent and remove

For selected defects (representing the biggest problem on PLK's network), detailed treatment guidelines

Additional remarks

Experience of operating lines at speeds above 160 km/h

Effective maintenance of the INF subsystem on HSR

IDENTIFIED PROBLEMS:
Durability of switches (fixed crossings)

Scope of changes:

- standardizing the profile of fixed crossings,
- introduction of new permissible deviations (tightening, threshold qualification: repair/replacement),
- Introducing efficient methods for checking the condition of fixed crossings.

Benefits:

- extending the life cycle of the crossings,
- improving the quality of fixed crossings assessments,
- better qualification of defects and selection of countermeasures,
- improving the quality of regeneration technology.

Slow trains < 80 km/h

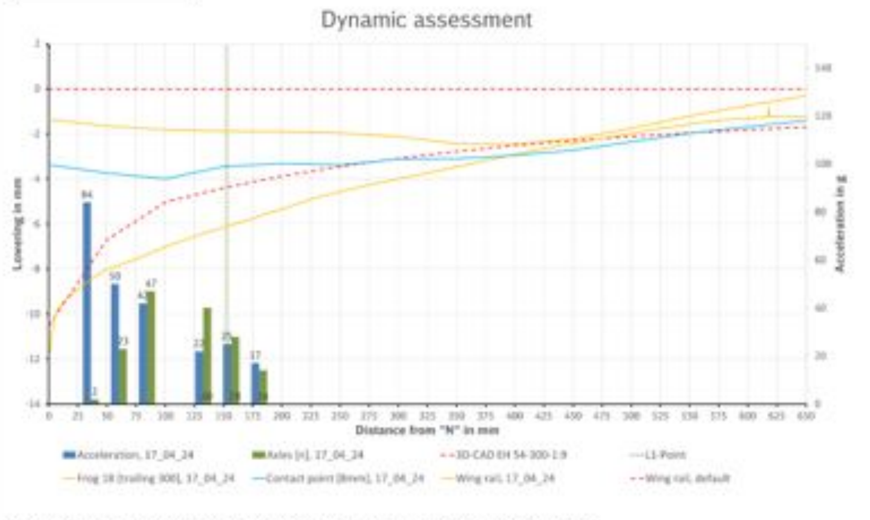


Figure 8: Frog ramp W18 with dynamic loads and wing rail progression, only slow trains

New CAD-target based on the wing rails wear

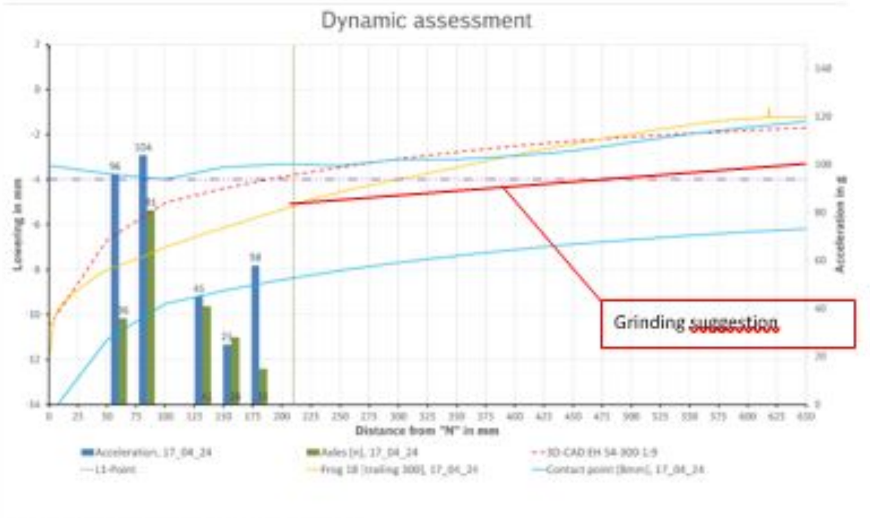


Figure 9: Frog ramp W18 and theoretical frog ramp

Experience of operating lines at speeds above 160 km/h

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Maintenance - diagnostics - knowledge: Exchange of experience

PKP PLK S.A.
Michał Migdal

- RĘCZNE BADANIA UT
- BADANIA GEOMETRII
  - BAD BADANIA GEOMETRII
  - DEF DEFEKTY GEOMETRII
  - TOR TOROMIERZE
  - GRW GEOTEC
- DEFEKTY
- ZŁAMANIA SZYN
- REJESTRACJE WIDEO
- INFRASTRUKTURA
- JEDNOSTKI
- FORUM

Forum Diagnostów (FD)

Nierówności toru (cz. II) ..., dlaczego fale D1 i D2?

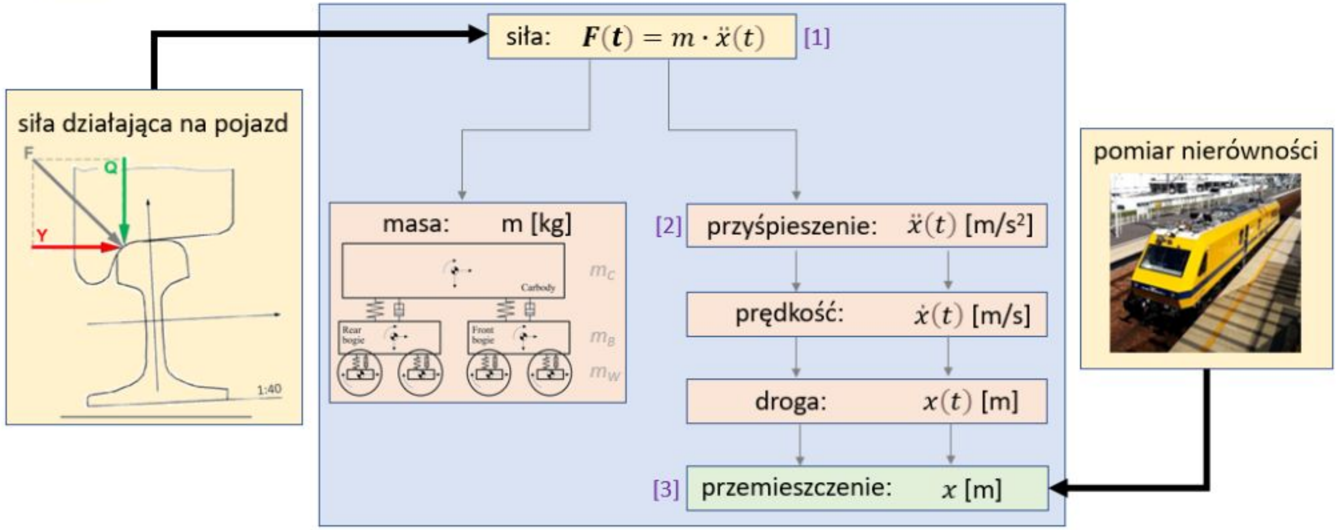
Parametry opisujące jakość geometryczną toru wg Modułu D4 1 1 49

Odpowiedz

Michał Migdal 21 mar 2021, 16:31

Po lekturze pierwszej części wpisu [Nierówności toru (cz. I)...] wiemy już, że nieważne czy mierzymy strzałki, czy też fale (D1, D2) to zawsze mamy do czynienia z lepszym (fale) bądź gorszym (strzałki) odwzorowaniem rzeczywistych nierówności występujących w torze. Przy czym wciąż nie udało się nam odpowiedzieć na pytanie - Na ile to „falowe" podejście jest lepsze i dlaczego?

Rozważania w tym zakresie, jak zwykle to bywa, wypadałoby rozpocząć od początku, tj. od ustalenia właściwie w jaki sposób jakość geometryczna toru wpływa na zachowania pojazdu podczas jego jazdy po torze. Aby lepiej zrozumieć tą relację, musimy po pierwsze zdawać sobie sprawę, że „zjawiskiem" które tak naprawdę wpływa na zachowanie (spokojność jazdy) pojazdu po torze nie jest jedynie dobrze nam znana nierówność, lecz jest tak wypadkowa wielu czynników, które to zależą zarówno od charakterystyki pojazdu (prędkość, masa i jej rozłożenie, skuteczność zawieszenia/usprężynowanie, etc.) jak i cech toru (typ nawierzchni, stan powierzchni tocznej szyn, a przede wszystkim układ geometryczny oraz jego jakość). Parametrem, który chyba najlepiej uwzględnia ogół ww. cech jest siła (wypadkowa) generowana na styku koło szyna {F(t)}. Siła jak wszyscy wiemy jest to iloczyn masy {m} oraz przyśpieszenia {a = x''(t)} – co opisuje równanie [1] pokazane na poniższym rysunku.



OPERATIONAL QUALITY AT HSR

IDENTIFIED PROBLEMS :

Safety and quality of inspections

Assumptions of change:

- automation of track inspectons (project - AOT),
- qualitative and quantitative information from inspections received in a digital form,
- improving the quality of diagnostics.

Benefits:

- worker safety,
- a reduction in the frequency of surveillance,
- reduction of supervision costs,
- improvement of the surveillance quality.

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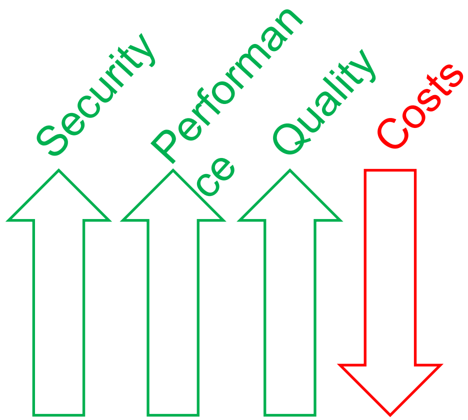
AOT project

HS line supervision, given the need to provide:

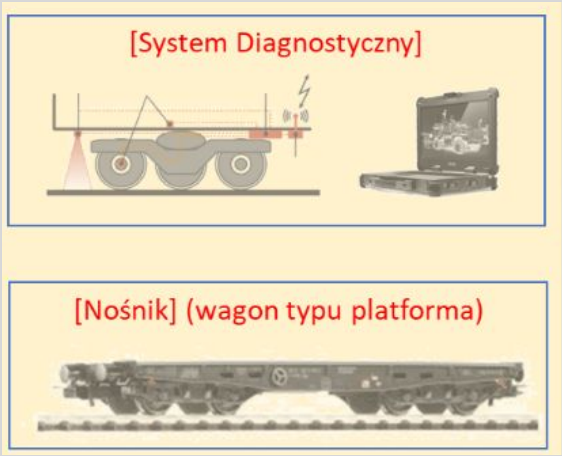
- worker safety,
- process performance,
- the high quality of the data obtained,
- digital data format - essential for expanding predictive models,

should be based on automated diagnostics minimising human involvement in the process.



A response to these needs is the Company's forthcoming <u>Automated Track Inspections</u> project, which aims to replace walking rounds with automated inspections, carried out using inspection vehicles equipped with a range of video inspection and measurement systems.

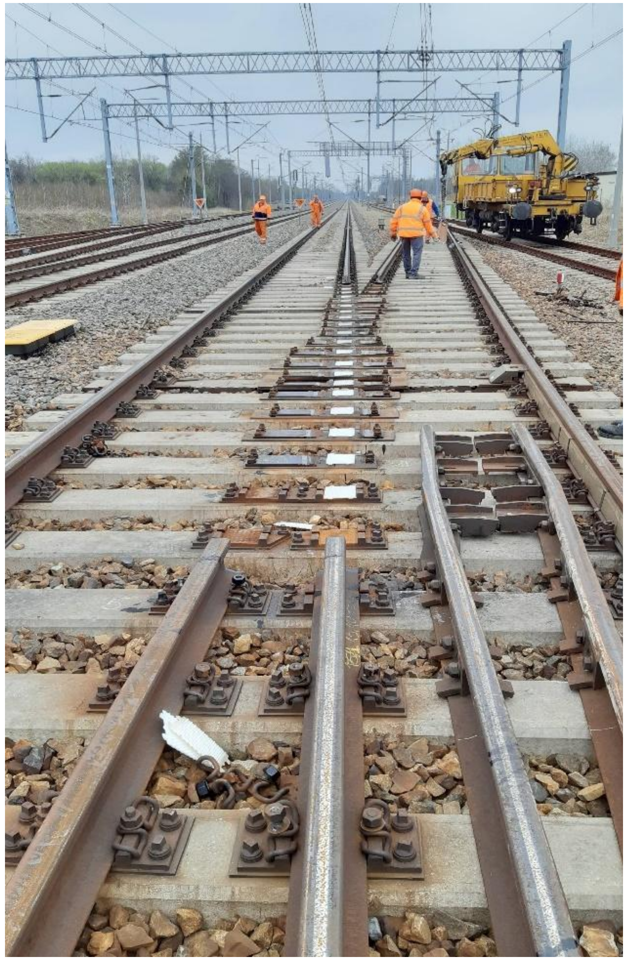
MOBILE PART = AOT VEHICLES + motorized bogies



STATIONARY PART = OPERATOR STATIONS

OPERATIONAL QUALITY AT HSR

IDENTIFIED PROBLEMS:
Troubleshooting/maintenance



Assumptions of change:

- provision of resources for rapid breakdown recovery (machinery),
- creation of strategic stocks (switch elements),
- temporary ways of securing (if long waiting times for parts),
- identification of parts (in track - passporting/DZIK, in stock - stock data).

Benefits:

- defect management - emergency status,
- recognition of switch parts - built-in, storage ones,

Operation experience
- OCLs for speeds above 160 km/h

The need for overhead contact lines with increased cross-sections from those previously used for speeds up to 160 km/h of 320 mm^2 to provide greater than 2,500 A long-term current carrying capacity and contact wires with a longer service life.

Current network design solutions are:

- YC120-2CS150 up to 200 km/h and cross section Cu 420 mm^2
- YC150-2CS150 up to 200 km/h and cross section Cu 450 $mm^{2,}$
- 2C120-2C-3 up to 250 km/h and cross section Cu 440 mm $^{2.}$

Their characteristics are:

- one or two suspension cables of 120 mm^2 or 150 mm^2;
- two contact wires of 100 mm^2 or 150 mm^2;
- spacing of support structures 60-65 m;
- tensions in contact wires (for 100 mm2) min. 950 daN for each conductor;
- tensions in the suspension line (for 120 mm2) min. 1400 daN);

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Operation experience - current design of the OCL

L.p.	Parameter or size	Measure	YC120-2CS150 (≤120 km/h)	YC150-2CS150 (>120 km/h)	2C120-2C-3 (>200 km/h)
1	Number and cross-section of suspension cables	mm^2	1 × 120 Cu	1 × 150 Cu	2 × 120 Cu
2	Number and cross-section of contact wires	mm^2	2 × 150 Cu Ag	2 × 150 Cu Ag	2 × 100 Cu Ag
3	Load line tension	kN	15,89	19,07	2x15,88 = 31,76
4	Running wire tension	kN	2x14,83 = 29,66	2x14,83 = 29,66	2x10,590 = 21,18
5	Length of normal span on a straight line	m	65	65	65
6	Offset (zig-zag) on straight line	m	±0,20	±0,20	±0,20
7	Stress length	m	1200	1200	1240
8	Construction height	m	1,7	1,7	1,7
9	Stress span	m	59-3-59-3-59	59-3-59-3-59	62-3-59-3-62
10	Nominal contact wire suspension height	m	5,20÷5,60	5,20÷5,60	5.20÷5.60 - V>200 km/h 5.08÷5.30 - V≥250 km/h
11	Long-term current carrying capacity Idd at Vw=0.6 m/s	A	1363	1364	1558
12	Suspension length "Y" Elastic cord	m	17	17	22 (integrated suspension cable system)

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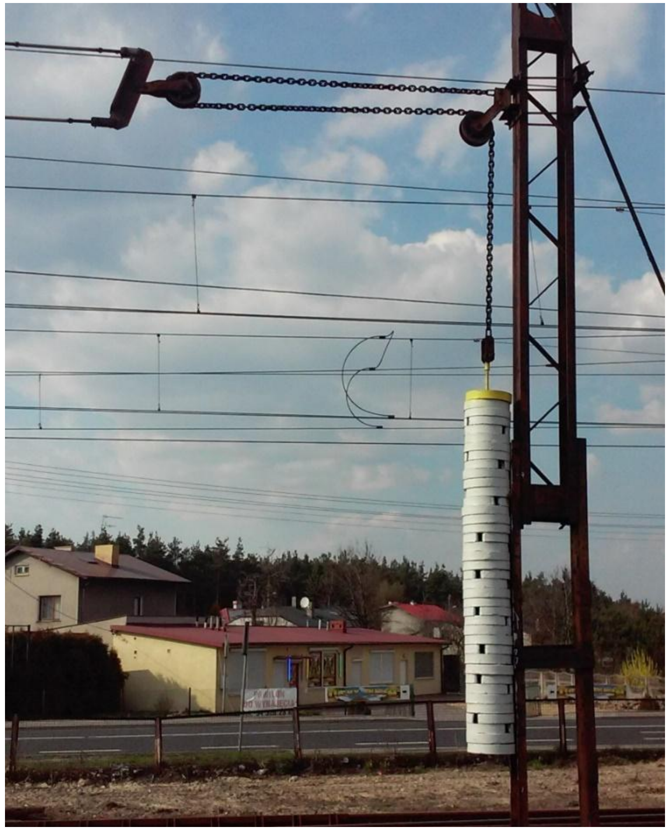
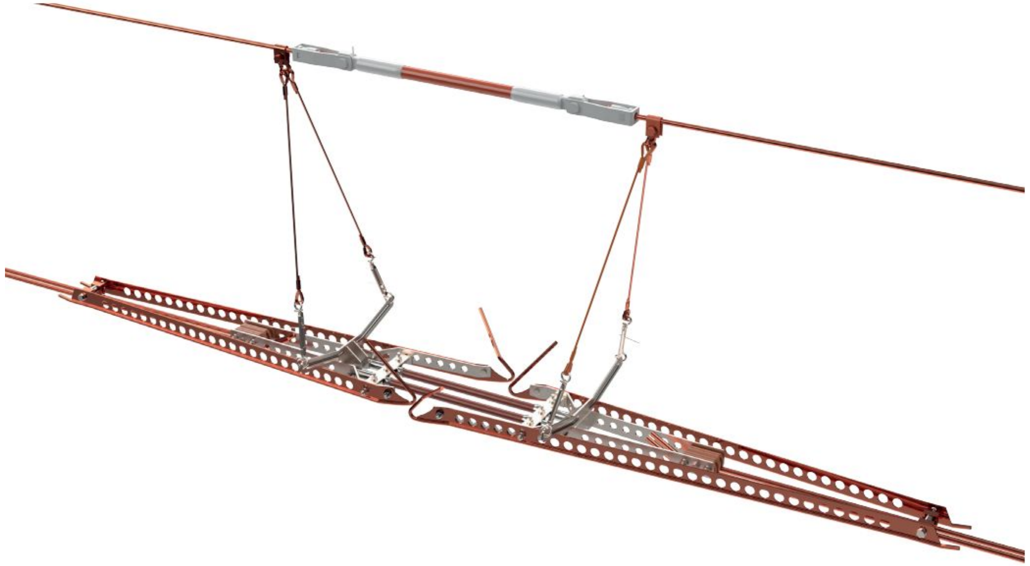
Operation experience – tensioning devices for speeds above 160 km/h

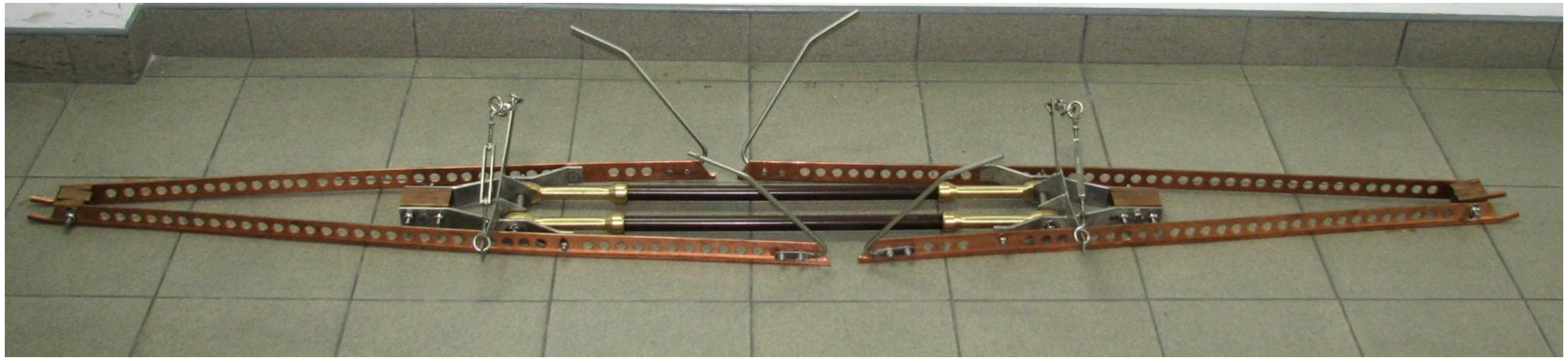
In order to ensure greater certainty of proper compensation of changes in the length of the network due to temperature changes, separate anchoring of the suspension cables and contact wires have been used, including the use of modern weightless tensioning devices.



Operation experience
- sectional insulators for speeds above 160 km/h

In order to improve the interaction at the current collector - OCL interface, a new generation of section insulators has been implemented to ensure uninterruptible passage of the contact strip through the electrically shared overhead contact line section.





REQUIREMENTS
for sectional insulators:

- breaking strength - not less than 100 kN;
- torsional strength - not less than 50 Nm torsional force;
- no mechanical shocks between the contact pads of the current collectors and the section insulator elements.

Operation experience
- analyses of power supply systems for speeds above 160 km/h

Power supply analysis with EN 50641-compliant software

Geographical considerations
- Horizontal profile
- Vertical profile
- Commercial/technical staging areas

Traffict conditions
- Timetable
  - Developed at the SW/WSPP
  - OBLIKO/SOLK
  - Passenger Transport Model (PMT)
- Commercial speeds

Rolling stock
- Planned by transport organisers
- Prospective in the project life cycle

Infrastructure
- Location of facilities power supply electrofracking
- MV/HV network (S_{ZW})
- Power demand from tangential lines
- Non-traction needs

Result:

- distribution of substations - 10 to 15 km;
- use of sectional cabs/cross-connections;
- quality index e.g. B2 - provision of power to each train in order to meet the timetable (mean useful voltage - ≥ 2700 V (2800 V for HS) - according to EN 50388-1;
- Provision of minimum unstable voltage > 2000 V - according to EN 50163.

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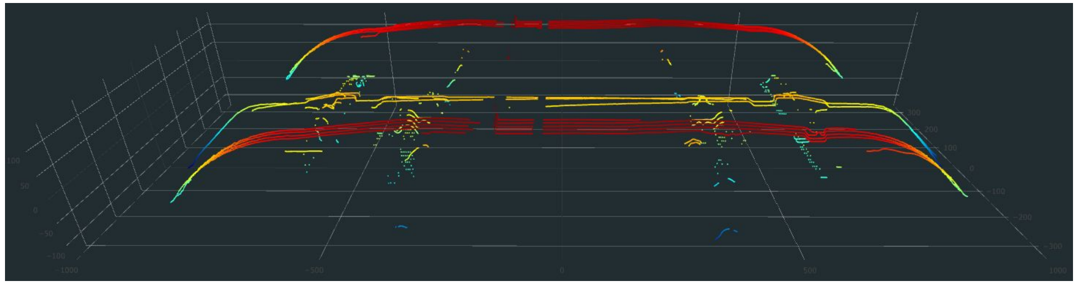
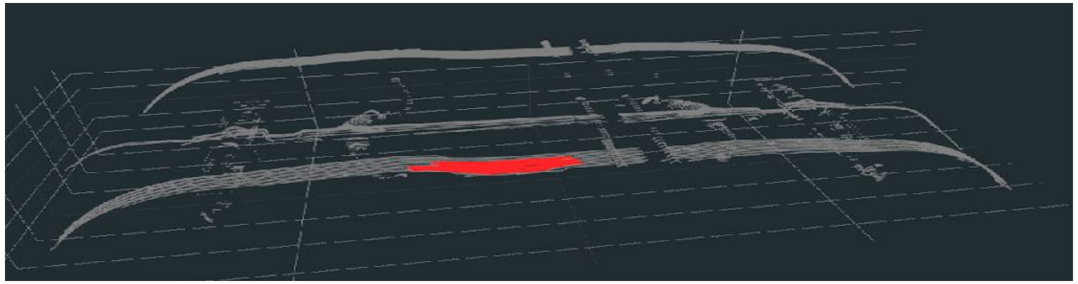
Digitalization in the field - supporting devices



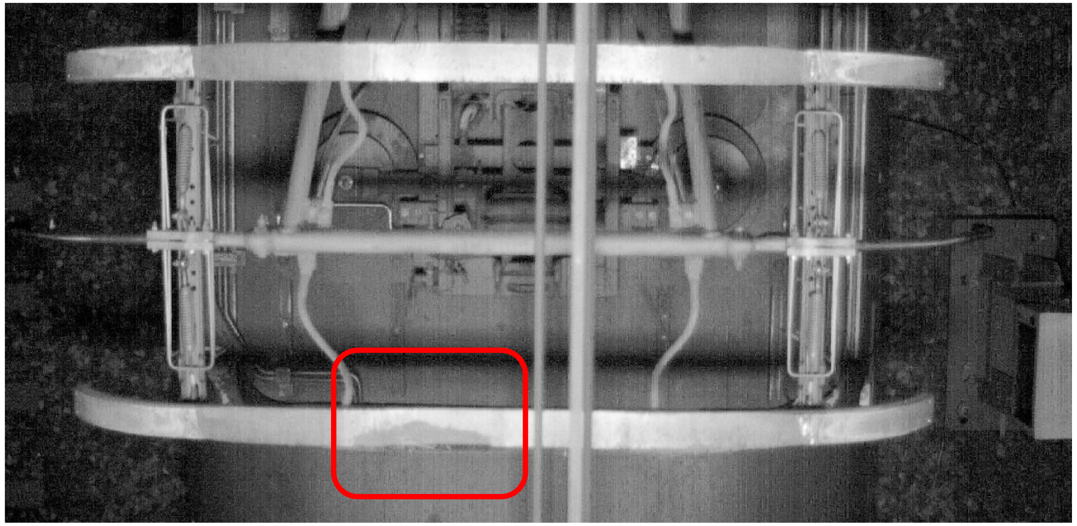


Statistics:

- 110,665 trains scanned;
- 6,965 (6.3%) trains with irregularities identified;
- 318 trains (4.6% of trains with an emergency condition) reported to operators on an urgent basis.

Next steps:

- expansion of the DSAP system (most heavily congested sections of



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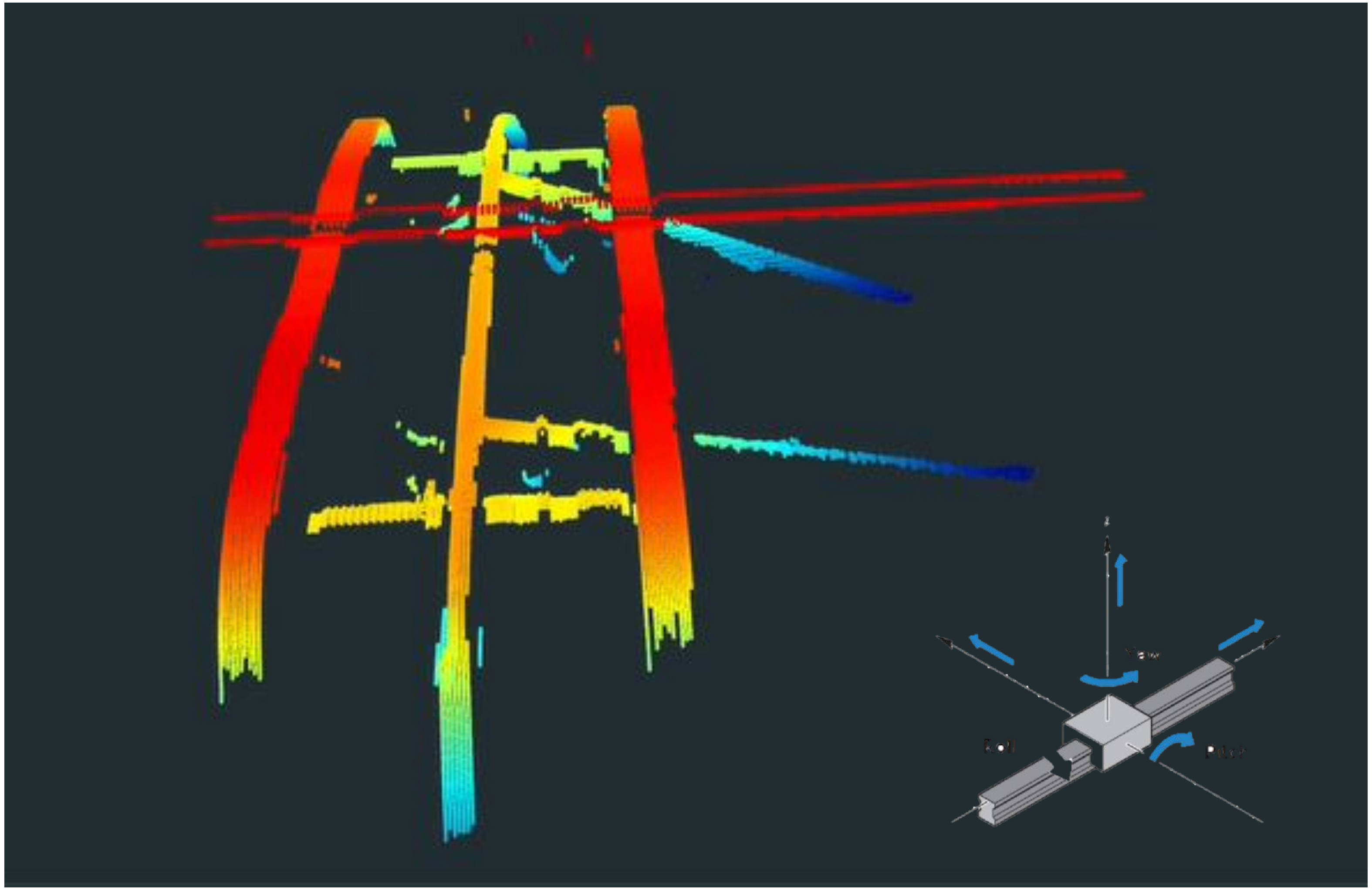
Zarządca narodowej sieci linii kolejowych

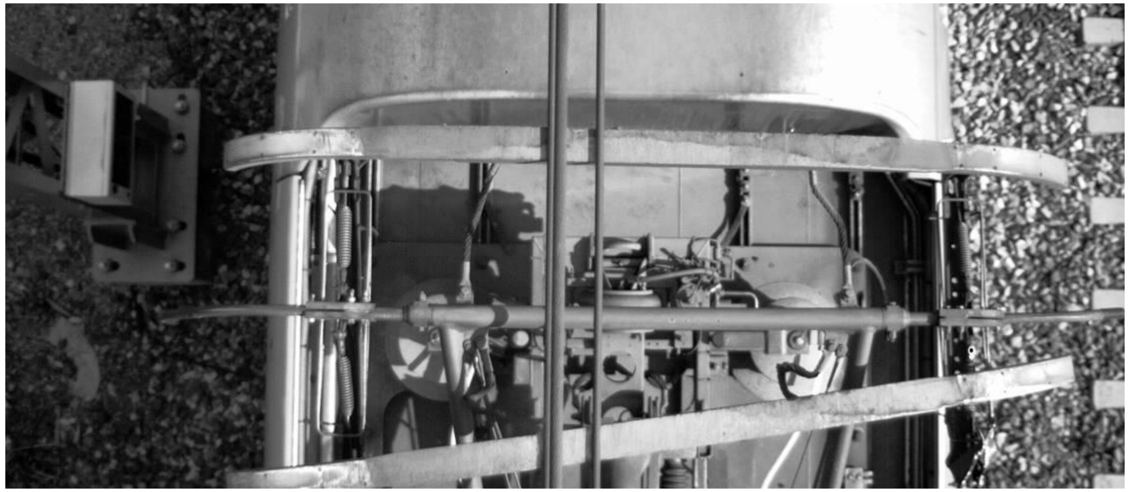
Pantograph Emergency Detection System (DSAP)

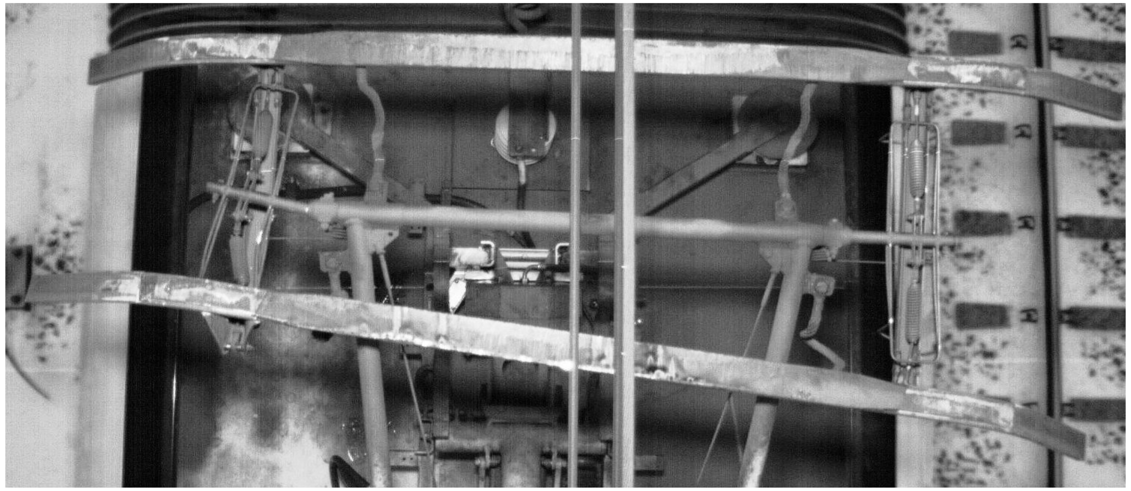
The DSAP system allows, among other things:

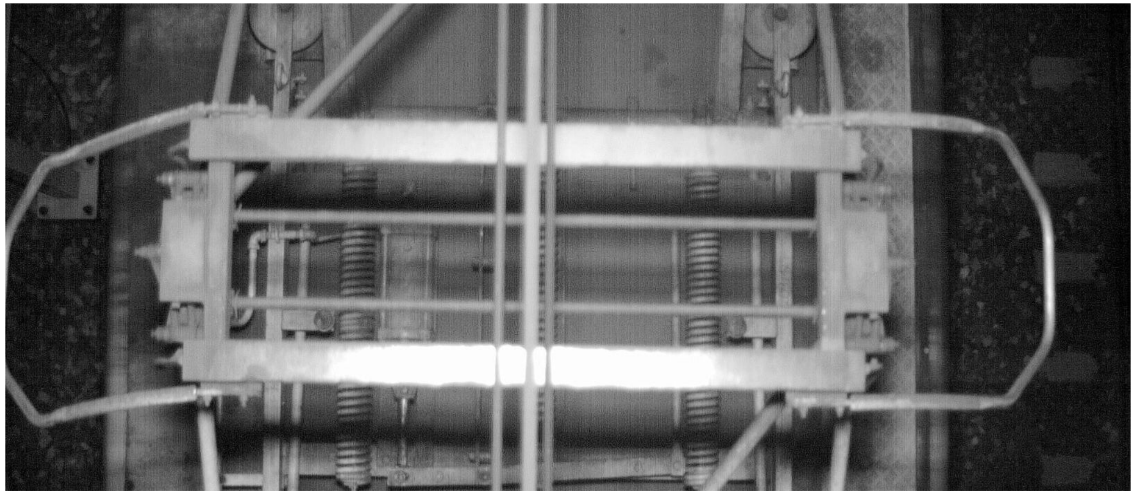
- measurement and verification of pantograph contact force,
- measurement of the wear and continuity of the carbon overlay (cracks, splits, chipping),
- measurement of wear asymmetry of carbon overlays,
- measurement of the position of the pantograph (in the x, y and z axes) relative to the vehicle,
- correctness of attachment of leading edges,

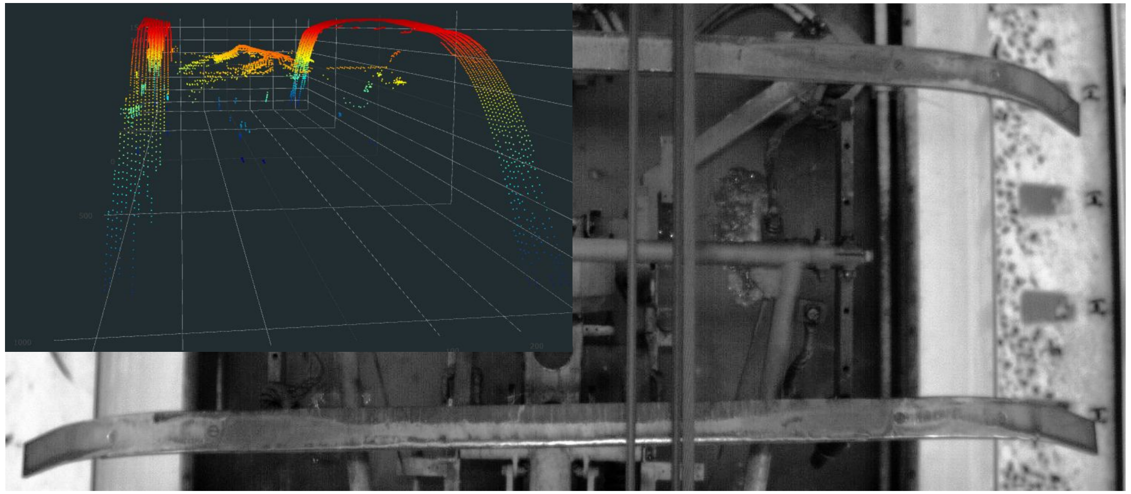


Pantograph Emergency Detection System (DSAP)









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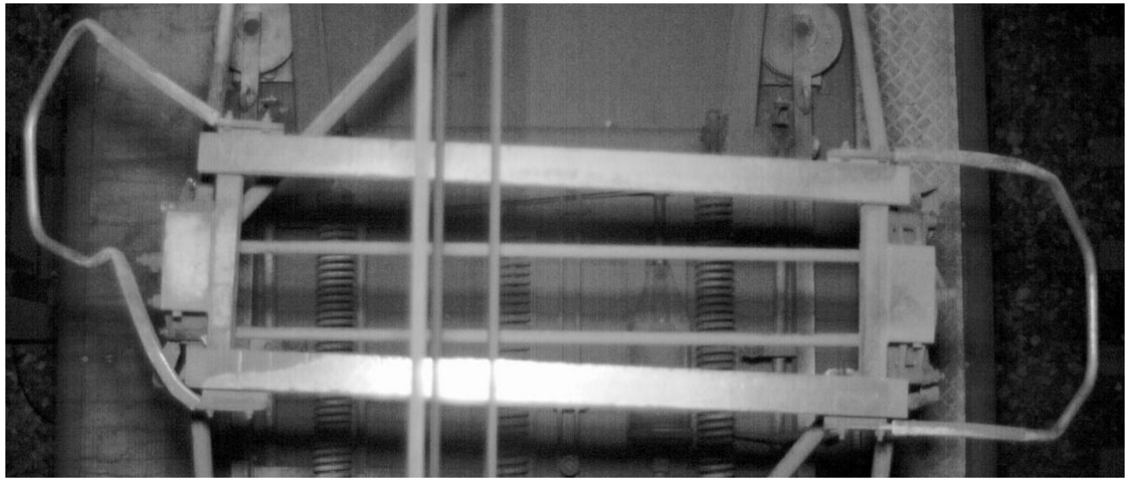
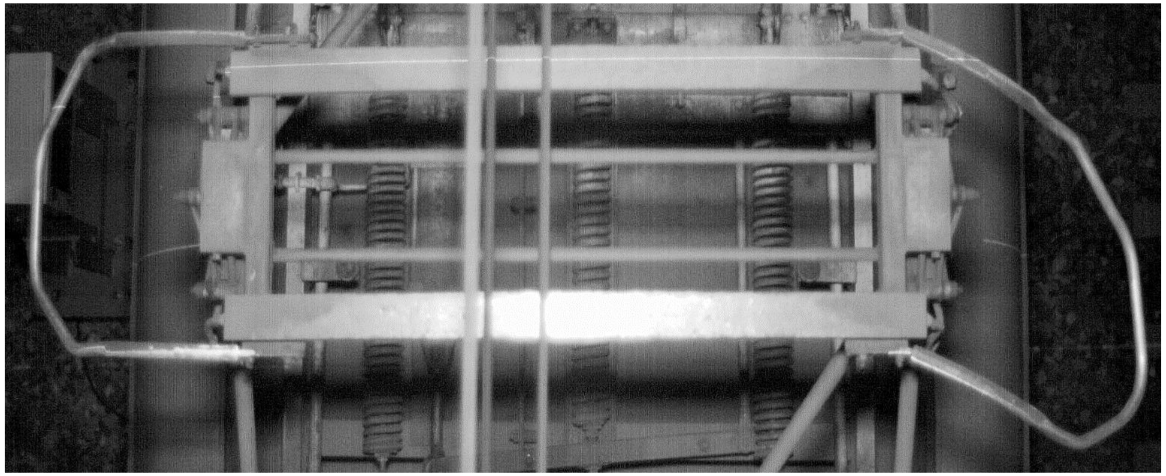
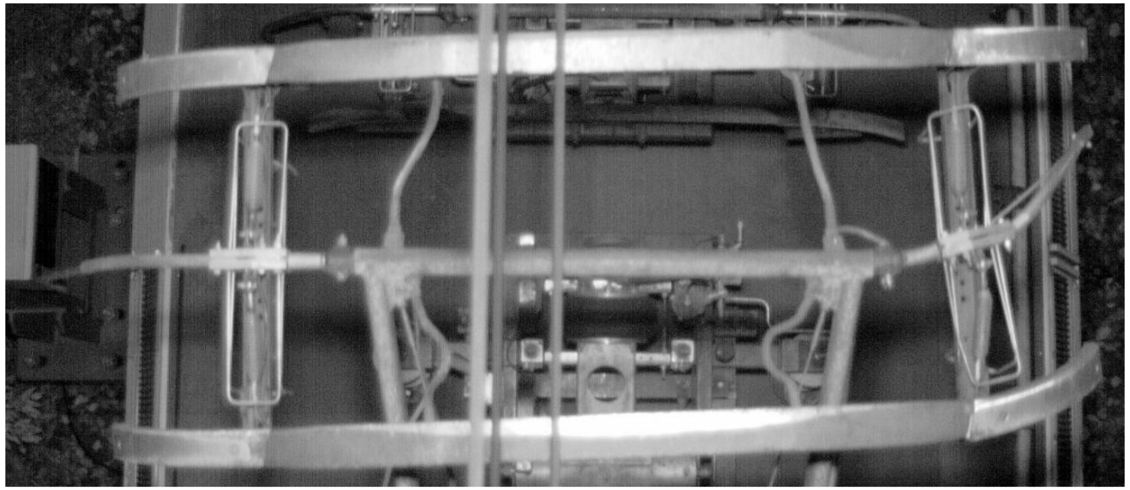
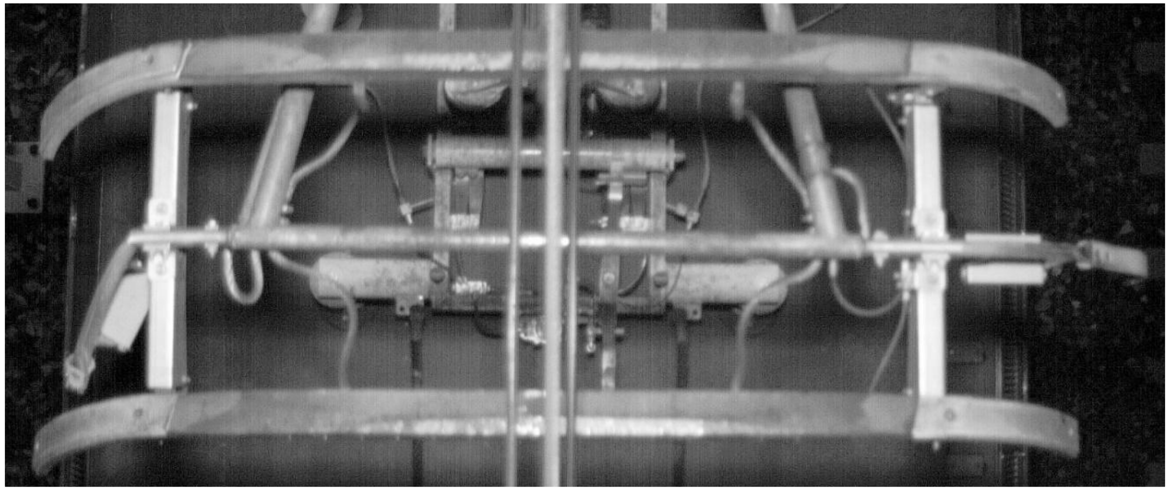
Zarządca narodowej sieci linii kolejowych

Pantograph Emergency Detection System (DSAP)









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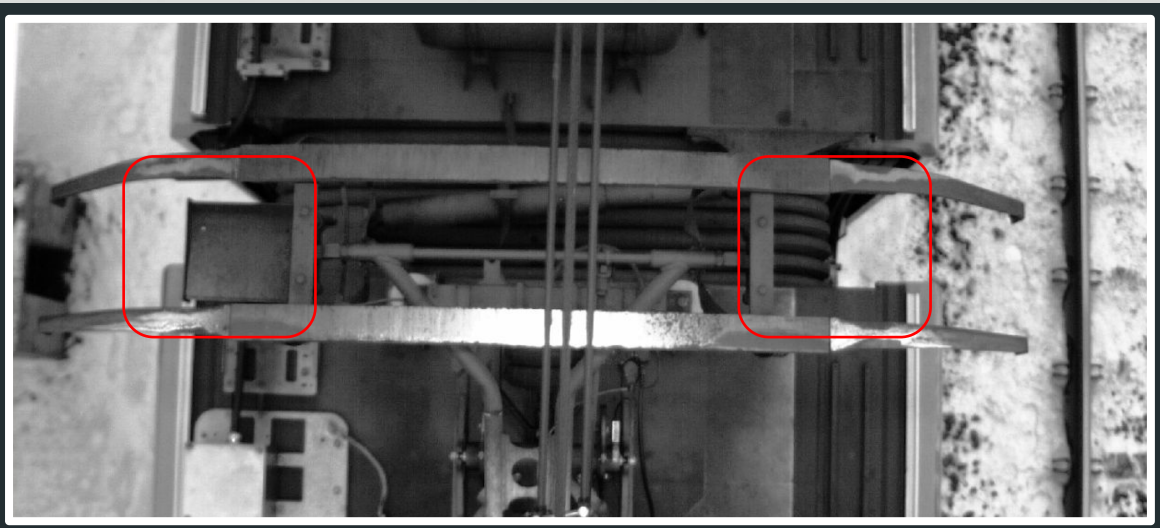
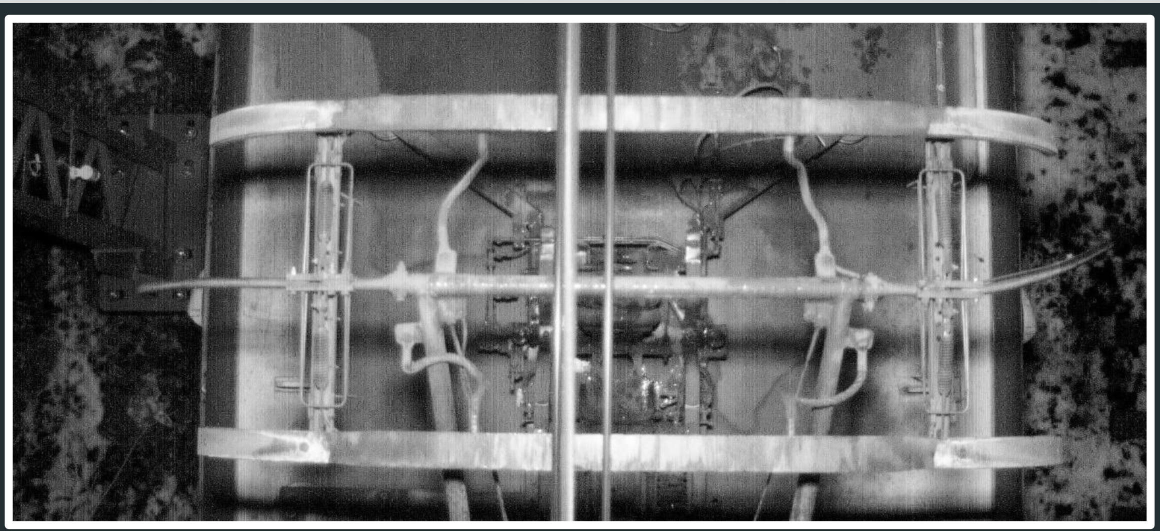
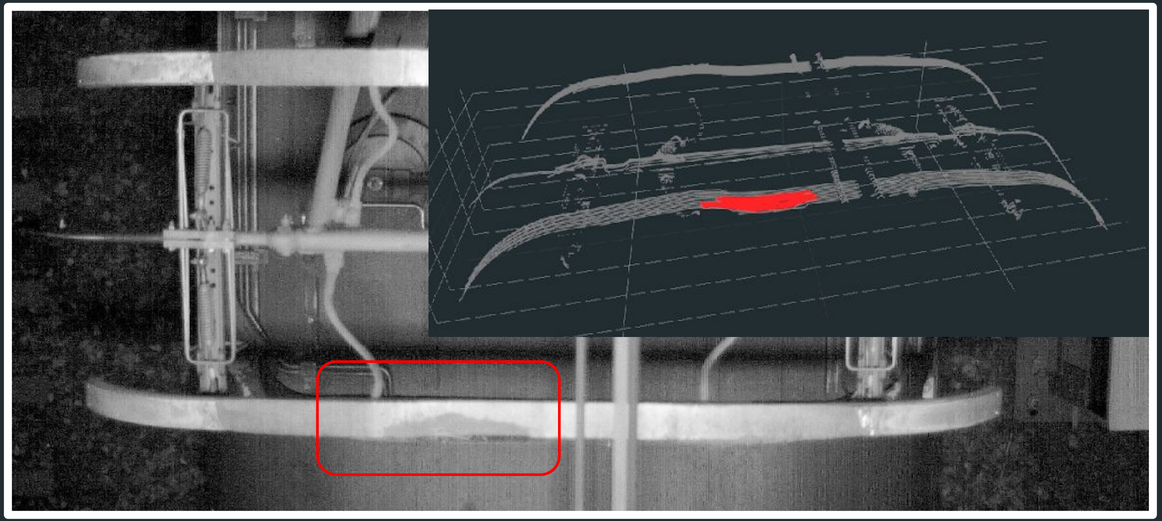
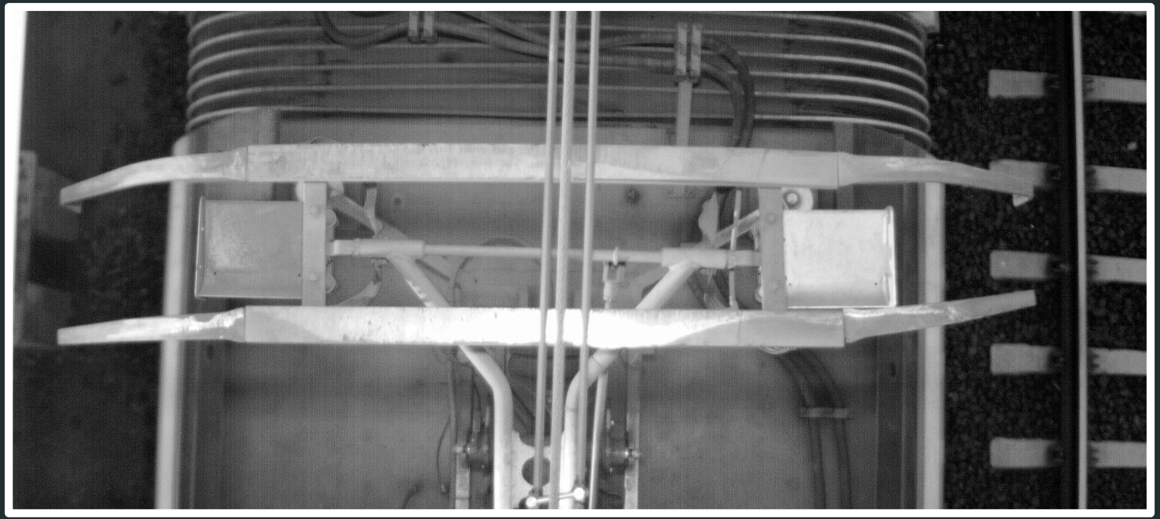
Zarządca narodowej sieci linii kolejowych

Pantograph Emergency Detection System (DSAP)

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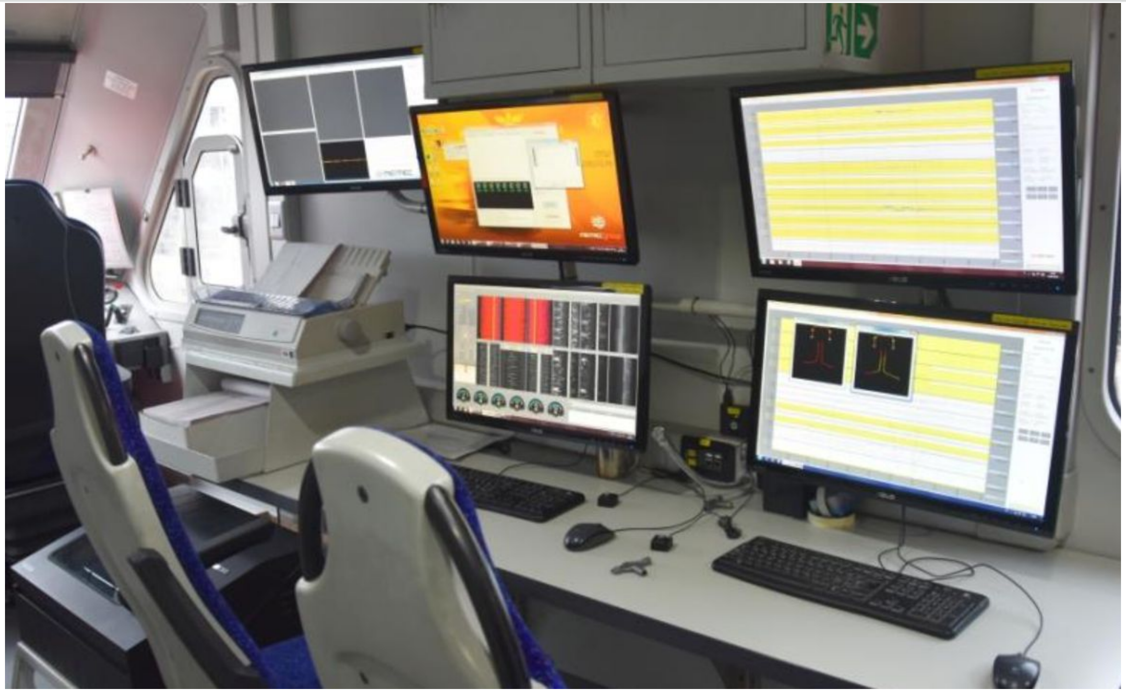
Zarządca narodowej sieci linii kolejowych

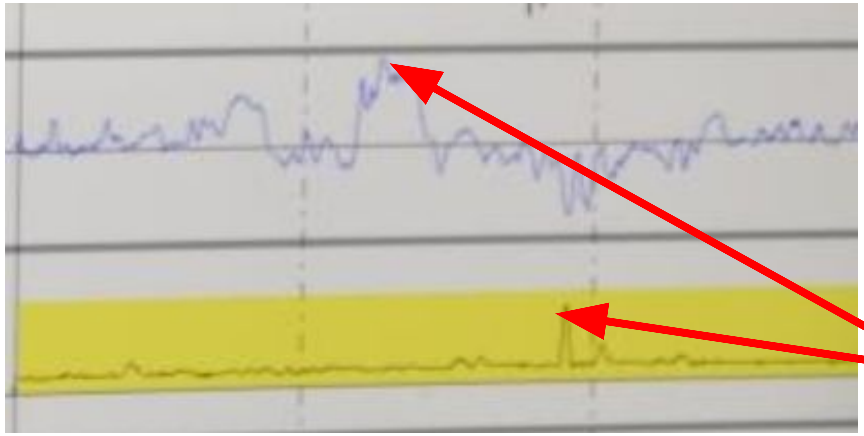
Digitalization in the field - supporting devices

DP 560 Draisine



Automatic measurements:

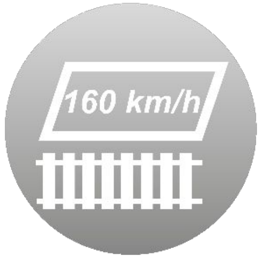
- offset
- djp suspension height
- wire thickness
- a detailed record of the diagnosed network section
- quick location
- network fault detection - inadequate regulation



Automatic recording exceedances of overhead line limit values.

Recording of overruns indication

Experiences of operating lines at speeds above 160 km/h
Railway traffic control



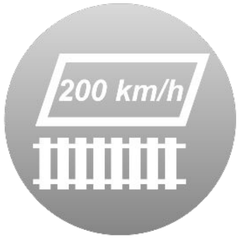
According to the current **regulation amending the regulation on general conditions for rail traffic operation and signaling,** operation at speeds > 160 km/h in Poland is only possible using the ETCS system.

The installation of the ETCS system on a line is necessary to enable traffic speeds of > 160 km/h.

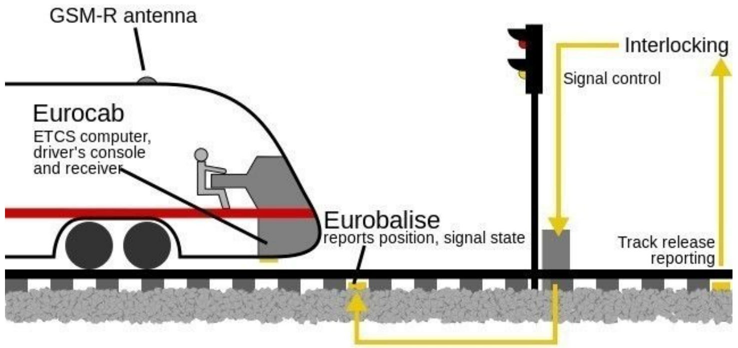
In the event of faults in either the trackside or onboard ETCS system, operation shall be restricted to the maximum speed of 160 km/h.

Operation of ETCS at speeds >160 km/h on the PLK S.A. network.

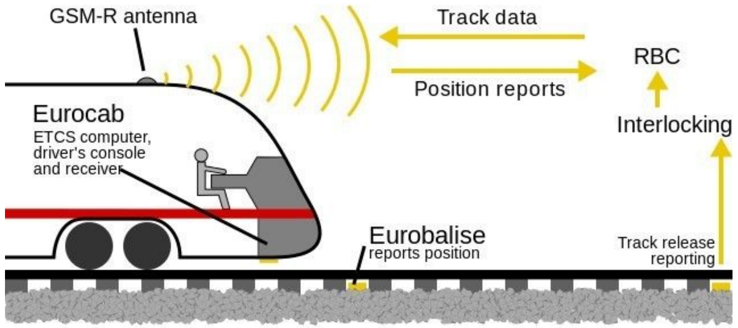
ETCS Level 1 provides the possibility for train operation at speeds >160 km/h - and it is a cheaper solution than ETCS Level 2.



- On the PLK S.A. network, traffic is carried out at speeds of up to 200 km/h using both ETCS Level 1 and ETCS Level 2.
- First implementation of ETCS for speeds > 160 km/h:
  - installation of ETCS Level 1 on the Central Railroad Line (line 4, section Grodzisk Mazowiecki - Zawiercie) for speeds of **up to 200 km/h**.



ETCS item 1
https://transport.ec.europa.eu



ETCS item 2
https://transport.ec.europa.eu

PKP POLSKIE LINIE KOLEJOWE S.A.
Zarządca narodowej sieci linii kolejowych

Challenges for PLK S.A.

Installation of ETCS on the Central Railroad Line in mixed traffic - both ETCS fitted and UN trains.

- The system is built as **an 'overlay'** on the SRK base layer equipment designed for a maximum speed of conventional trains (UN - unfitted) = 160 km/h.
- On the basis of analyses taking into account the point-to-point data transmission in ETCS Level 1, a maximum speed of 200 km/h was assumed for the length of the block intervals and the line interlocking rate.

At the time, the only rolling stock that was technically and formally capable of operating at speeds of up to 200 km/h was the ED250 (maximum operating speed 250 km/h; now also EU200 - up to 200 km/h).

- The results of the ETCS tests on the Central Railroad Line showed that ETCS on the ED250 calculates braking curves in a very restrictive way and that the calculation of braking curves according to Baseline 2 has not been harmonized at the European level.
- In order to avoid unnecessary brakings, the speed on the ETCS system on the Central Railroad Line has been limited to less than 200 km/h.

PKP POLSKIE LINIE KOLEJOWE S.A.

Zarządca narodowej sieci linii kolejowych

Central Railroad Line: current state and future plans

A project is currently underway on the CRL to install ETCS Level 2, as a result of which the operation speed will be raised to **250 km/h** and ETCS Level 1 will be dismantled.

The project will centralize control - over 200 km of this line will be covered by one Local Control Center (LCC) together with Radio Control Center (RBC).

ETCS Level 1 on the Central Railroad Line has been in operation at speeds of up to 200 km/h since December 2014.

https://gt-c.pl/

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Zarządca narodowej sieci linii kolejowych

Railroad line no. 9 (E 65 Warsaw-Gdynia section)

- Operation of trains is being controlled at speeds of up to 200 km/h.
- ETCS Level 2 as a system ensuring continuous instructions of Movement Authority (MA) to the onboard equipment limits the influence of the adopted installation method of the base Class B layer system (length of block intervals, line interlocking rates) on the maximum speed at which trains run.
- The installation of the ETCS system required changes to the configuration of the crossing systems.

ETCS Level 2 on railroad line 9 has been in operation at speeds of up to 200 km/h since December 2020.

Conclu
sions

- PLK S.A.'s experience shows that it is possible to operate trains at speeds above 160 km/h using both ETCS Level 1 in a decentralised configuration as well as ETCS Level 2.
- In the case of ETCS Level 1, a key problem may be to ensure an appropriate balance between the maximum speed and line capacity, particularly when operating mixed traffic on a given line.

PKP POLSKIE LINIE KOLEJOWE S.A.

Zarządca narodowej sieci linii kolejowych

Experience of operating lines at speeds above 160 km/h

Effective maintenance of the infrastructure subsystem on HSR

Types of railway vehicles operated by PKP PLK S.A.

PKP PLK S.A. is the owner, disposer and Entity in Charge of Maintenance (ECM): **2724 units** railway vehicles, of which the following types of rolling stock can be distinguished:

- Universal motor trucks - **496 units.**
- Measurement trains (draisines & carriages) - **8 units.**
- Diesel locomotives - **14 units.**
- On-track machines (OTMs) - **62 units**.
- Rail-road vehicles (excavators) - **42** units.
- Freight wagons - **472 units**.
- Snowploughs and other snow machines - **152 units.**
- Other special vehicles included in the rail technical rescue - **145 units.**
- Other special vehicles - **1333 units.**

Experience of operating lines at speeds above 160 km/h

Effective maintenance of the infrastructure subsystem on HSR

Rail vehicle purchases (and upgrades) completed between 2018 and 2024

Track maintenance:
- Universal motor truck type DH-350.11 - **50 units.**
- WM-15A type motor truck - **38 units.**

Diagnostics:
- Measuring draisine (DPD-660.00, DP-560.00) **- 2 units.**
- Rail-road vehicle for inspection of engineering structures (ZDS COPMA V4) - **1 unit.**
- Measuring draisine (EM-120) **- 2 units.**
- Ultrasonic inspection carriage- **1 unit.**

Railway construction machinery:
- Track tamping machines STOPFEXPRESS 09-3X NG DYNAMIC - **2 pcs**.
- Track tamping machine CSM 09-32 - **1 unit**.
- Universal tamping machine Unimat 09-4x4/4S Dynamic2 - **1 unit.**
- Turnout tampers Unimat 08-475 4S - **3 units.**
- Ballast regulator PP-300.02 - **1 pc.**
- Rail-road excavators 1604ZW and A 922 Rail - **16 units.**

Traction measures
- 6Dh diesel locomotives - **4 units.**

Rescue train:
- WM-15A/PRT00 technical rescue trains - **4 units.**
- UniRoller-S rail-road vehicles - **17 units.**






PKP POLSKIE LINIE KOLEJOWE S.A.

Zarządca narodowej sieci linii kolejowych

Thank you for your attention