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ISSUE TOPIC • Prevention of Traffic Accidents at Level Crossings

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Editor's note

The expert contribution "Applied Research Topics in Transport and Logistics" is a bilingual publication issued alongside the prestigious international scientific journal Promet – Traffic & Transportation.

The expert contribution "Applied Research Topics in Transport and Logistics" covers topics targeted at interest groups within the transport and logistics sector. It is published and designed to foster communication and correlation between science and industry, focusing on bringing scientific practices and achievements closer to the business sector.

The topics of this fourth edition in 2025 are focused on issues related to level crossings, with the prevention of accidents at these crossings highlighted as a key priority. The guest editor of this thematically intriguing and excellently prepared edition is Prof. Danijela Barić, Ph.D..

It is particularly important to mention the experts who have contributed to this significant topic, including representatives of institutions responsible for the safety of level crossings in Croatia and abroad. These include Oleg Butković, Deputy Prime Minister of the Republic of Croatia and Minister of the Ministry of the Sea, Transport and Infrastructure, Ivan Kršić, President of the Management Board of HŽ Infrastruktura d.o.o., Želimir Delač, Director of the Railway Safety Agency, Alana Vukić, Director of the Air, Maritime and Railway Traffic Accidents Investigation Agency, Starr Kidd, Head of the Human Factors Analysis Department at the Office of Research, Development and Technology of the Federal Railroad Administration (FRA) of the U.S. Department of Transport Canada and Isabelle Fonverne, Senior Safety and Interoperability Advisor at the International Union of Railways (UIC) in Paris.

Additionally, industry insights on the topic of level crossings include very interesting and expert contributors such as Zvonimir Viduka from ALTPRO d.o.o., Zdravko Zdunić from RMT GRUPA d.o.o. and Roman Wiesinger from Gmundner Fertigteile GmbH & Co KG.

We will also present upcoming events in our field, including the excellent international scientific

conference "The Science and Development of Transport – TRANSCODE 2025", organised by the Faculty of Transport and Traffic Sciences of the University of Zagreb.

I hope you will enjoy this thematically important edition and that we will continue, through this expert supplement, to bring science closer to practice in our dynamic and competitive field of transport and logistics!

Ivona Bajor, Editor-in Chief

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PREVENTION of Traffic Accidents at Level Crossings



Prof. Danijela Barić, Ph.D. Full professor, leader of the interdisciplinary research group for the study of risky behaviour and traffic accidents involving participants, education and prevention Faculty of Transport and Traffic Sciences of the University of Zagreb

1. Level Crossings

A level crossing is a point where a railway line or industrial siding intersects a road at the same level, which may also include crossings with pedestrian and bicycle paths or other routes intended for the passage of people, animals, vehicles or machinery [1]. From a construction perspective, it is the point where the roadway intersects with the top edge of the rail. Given the definition, it can be concluded that a level crossing is a specific traffic point not only because it represents the intersection of two traffic routes, but also because it is the point where two transport systems, road and railway, face each other. These systems differ in all relevant traffic, infrastructural, technical, technological and other parameters. Therefore, from a traffic safety perspective, a level crossing represents a potential high-risk traffic point, as indicated by the statistics of serious accidents, accidents and incidents the direct consequences of which include human casualties and material damage. However, the indirect consequences on society as a whole are also significant [2].

A level crossing is the only official point on a railway line designated for crossing, and the only place where road traffic participants are allowed to cross the railway line. Each level crossing is secured with a certain level or method of protection. Therefore, there are no unprotected level crossings. The basic classification of methods for securing level crossings, according to the recommendations of the European Union Agency for Railways, includes passive and active protection [3].

A level crossing with passive protection is considered to be one that is equipped with any warning signs, devices or other protective equipment that is permanent and does not change depending on any traffic situation. In the Republic of Croatia, passive protection involves the use of the *St. Andrew's Cross* road traffic sign along with the Stop sign and the prescribed visibility triangle. In the case of passive protection, the driver of a road vehicle, pedestrian, cyclist and any other user of the level crossing is solely responsible for observing the railway line and noticing the possibility of an approaching railway vehicle.

Active protection refers to any method of securing that responds by changing its state (such as light and sound signalling or protective measures) upon the approach of a railway vehicle. Active methods of securing level crossings may involve two types of systems: systems that require manual state changes and systems with automatic control of state changes (remotely from a central control station or systems that are activated/deactivated by the passage of a railway vehicle).

On the railway network in the Republic of Croatia,

which spans 2,617 km, there are a total of 1,438 level crossings for road and pedestrian traffic, of which 57% are passively secured, while 43% are actively secured [2].

2. Main Features of Serious Accidents, Accidents and Incidents at Level Crossings

Traffic accidents in the railway transport system are classified into categories of serious accidents, accidents and incidents. A serious accident is a train collision or derailment resulting in the death of at least one person, serious injuries to five or more people or significant damage to vehicles, railway infrastructure or the environment, as well as any other accident with similar consequences that has an obvious impact on the safety of the railway system or safety management. An accident is an unwanted or unintentional sudden event or a particular sequence of such events that has harmful consequences; accidents can include collisions, derailments, accidents at level crossings or pedestrian crossings over the line, accidents with human casualties involving a moving railway vehicle, fires and others. An inci*dent* is any event, other than an accident or serious accident, which affects or could affect the safety of railway transport. Broken half-gates are common incidents at level crossings and represent avoided accidents that could have resulted in accidents or serious accidents [1].

Statistical data on serious accidents, accidents and incidents since 2012 are publicly published by the railway infrastructure manager, HŽ Infrastruktura d.o.o., on its website in annual publications titled *Annual Report on the Network* [4]. Based on the data from the aforementioned reports, the following can be observed for the period from 2012 to 2023:

- The average annual number of serious accidents at level crossings is 6.
- The average annual number of accidents at level crossings is 28.

- The average annual number of broken half-barriers (incident category) is 461.
- The highest number of serious accidents at level crossings was 8, occurring in 2012 (8 fatalities), 2013 (11 fatalities) and 2022 (10 fatalities).
- The highest number of accidents at level crossings was 37, which occurred in 2012 (15 seriously injured).
- The highest number of broken half-gates occurred in 2017, totalling 525..

The comparison of serious accidents, accidents and broken half-barriers during the observed period shows a slight downward trend, while the data for 2023 indicates a significant reduction in serious accidents (two serious accidents in which two people were fatally injured) and accidents (28 accidents in which four people were seriously injured). Particularly concerning is the large number of broken half-barriers, as they can be characterised as narrowly avoided traffic accidents (Figure 1). Considering that they occur just before the passage of a railway vehicle, each broken half-gate could have led to an accident. In 2023, a total of 445 broken half-barriers were recorded, of which 76% were caused by the careless actions of an unknown user of the level crossing, 14% by the careless actions of a known user of the level crossing and 10% by natural disasters (such as strong winds, etc.).

An in-depth analysis of the characteristics of traffic accidents and incidents, their causes and consequences, points to human casualties and material damage. Serious accidents at level crossings resulting in fatalities account for, on average, about 30% of all accidents in railway transport, while they represent approximately one percent of fatalities in road traffic. However, an analysis of the causes of traffic accidents has shown that more than 90% of accidents were caused by road traffic participants who did not adhere to traffic rules, either intentionally (deliberate offences) or unintentionally (unintentional mistakes). Among the main causes of unintentional mistakes



are poor visibility when approaching the crossing (due to vegetation, line and road embankments and cuttings, the angle of the approach road and line, etc.), incorrect interpretation of warning signs, driver fatigue, bad weather conditions (rain, fog, sun glare), distraction during driving and external factors such as surrounding noise, advertising billboards and the like. On a global level, and similarly in Croatia, more than 95% of traffic accidents and incidents were caused by drivers of road motor vehicles and pedestrians [5]. This is supported by numerous research conducted on the causes of risky behaviour of level crossing users (for example, the results of multi-year research on the causes of risky behaviour of level crossing users at the local site named "Trnava Stop" in Zagreb are shown in Figure 2). Therefore, it can be concluded that the primary problem is the risky behaviour of level crossing users, namely the low level of compliance with traffic regulations, which primarily points to the responsibility of road traffic participants, although the prevailing opinion is that any accident occurring at level crossings is generally considered a problem of the railway sector.



Figure 2 Results of the research conducted by the Faculty of Transport and Traffic Sciences at the level crossing locally named "Trnava Stop" (KM 430+112, M102)

3. Prevention of Traffic Accidents at Level Crossings: The 5E Model

There is no single preventive measure that could prevent accidents at level crossings, or in traffic in general. Despite technical and technological improvements in infrastructure elements, safety systems and vehicle characteristics, the number of accidents remains significant, indicating the influence of the human factor, namely the primary responsibility of road traffic participants (drivers of road motor vehicles, cyclists, pedestrians), followed by the equipment.

To reduce the risk of traffic accidents and increase the safety of level crossings, the 5E Model has been designed, a comprehensive approach to improving road safety in various traffic environments. It encompasses education, engineering solutions, enforcement, engagement and evaluation (the five "Es" stand for Education, Engineering, Enforcement, Engagement, Evaluation). These five elements together form a robust safety framework that helps reduce accidents, promotes a safety culture, and ensures compliance with safety standards, which should consequently enable a safer overall traffic system.

Education involves teaching road users about safe movement in traffic, traffic rules and regulations, the importance of adhering to them, and raising awareness of the consequences of risky behaviour in traffic. Education programmes should include all categories of road users, of all age groups, with particular focus on the most vulnerable participants in traffic. Through education and frequent preventive activities, it is possible to raise awareness of road users of the consequences of risky behaviour and encourage responsible and safe movement in traffic.

Engineering solutions encompass technical solutions to complement both passive and active safety systems at level crossings, as well as modern solutions for vehicles. Engineering solutions, examples of good practices, as well as those implemented through pilot projects, have been selected and classified in the so-called SAFER-LC Toolbox, developed within the European HORIZON 2020 project *Safer Level Crossing by Integrating and Optimising Road-Rail Infrastructure Management and Design* [6]. It classifies the following measures: human-centred measures, low-budget measures, innovative measures, socalled self-explaining measures and measures that "forgive" human errors.

Enforcement ensures compliance with safety rules through regulations and supervision, including repressive measures.

Engagement involves encouraging the cooperation of all stakeholders and collectively motivating road users to follow guidelines for safe participation in traffic. The railway system should develop good cooperation with all stakeholders at all levels, from users of level crossings to national and local authorities, road infrastructure managers, the road sector in general and the academic community.

Evaluation involves assessing the effectiveness of the designed measures to enhance safety and implementing necessary improvements.

4. Research at the Faculty of Transport and Traffic Sciences of the University of Zagreb and Contribution to the Prevention of Traffic Accidents at Level Crossings

At the Faculty of Transport and Traffic Sciences of the University of Zagreb, an interdisciplinary research group was established in 2013 to study risky behaviour and accidents of traffic participants, as well as to focus on education and prevention. The group primarily deals with issues related to the risky behaviour of level crossing users. The idea was to establish a research group at the Faculty of Transport and Traffic Sciences that would facilitate the exchange of knowledge, experience and ideas, as well as foster collaboration among experts with interdisciplinary expertise at an international level. The aim is to develop long-term and applicable solutions that can prevent accidents at level crossings, enhance safety levels, ensure safer traffic flow and influence changes in risky behaviour patterns among level crossing users and other road users.

Since its establishment, members of the research group have participated in numerous studies, research projects and initiatives dedicated to addressing issues related to level crossings. Four of these projects have been carried out as part of the National Road Safety Plan of the Republic of Croatia. Listed below are selected activities of the research group dedicated to preventing risky behaviour among level crossing users and enhancing safety:

 Studies and projects: Around 20 studies and projects aimed at preventing traffic accidents at level crossings.

- International award: At the United Nations (UN) headquarters in Geneva, an award was presented for the best educational film from the European Union on traffic safety as part of the Global Road Safety Film Festival and UNECE (United Nations Economic Commission for Europe). The award-winning preventive-educational film "Safe with Andrew on the Way to School" was created as part of the National Road Safety Programme of the Republic of Croatia 2011–2020. It was developed within the project Implementation of Measures to Increase the Safety of the Most Vulnerable Road Users at Level Crossings, in collaboration with HŽ Infrastruktura [7].
- Innovation: The research group for the prevention of risky behaviour in traffic designed and implemented the innovation "APPLICATION FOR DRIVER EDUCATION ON SAFE DRIVING OVER LEVEL CROSSINGS IN A VIRTUAL ENVIRONMENT (VR 360°)," which has been included in the Catalogue of Innovations and Patents of the University of Zagreb (Figure 4) [8].
- The first *in situ* experiment of a collision between a passenger car and a railway vehicle at a level crossing in the Republic of Croatia was designed and organised in collaboration with HŽ Infrastruktura, HŽ Putnički prijevoz and other partners (Figure 5) [9, 10].
- Organisation of scientific and professional conferences; selected professional conferences in the field of risky behaviour of road users and accident prevention are listed below, and they gathered



Figure 3 The award for the best educational film on road safety from the European Union (UN, Geneva, 21 February 2017)



Figure 4 Innovation: The Application for Driver Education on Safe Driving Over Level Crossings in a Virtual Environment (VR 360°)

representatives from all stakeholders in the area of level crossings:

- The expert conference Preventing Road Accidents at Level Crossings: Engineering Solutions, Education and the Media was held on 12 November 2024 at the Faculty of Transport and Traffic Sciences as part of the project Design Model for Traffic and Technical Road Elements in the Area of Level Crossings, conducted within the framework of the National Road Safety Plan of the Republic of Croatia (Figure 6) [11].
- The international expert conference 10th Meeting of the Trespass and Suicide Prevention Network (TreSP-Network) was held in Zagreb on 12 and 13 September 2024, it was organised by the

International Union of Railways and the Faculty of Transport and Traffic Sciences, in collaboration with partners, and within the framework of the project *Design Model for Traffic and Technical Road Elements in the Area of Level Crossings*, which is part of the National Road Safety Plan of the Republic of Croatia (Figure 7) [11].

- The expert conference *Education and Innovation for Safety at Level Crossings* was organised in collaboration with partners, railway institutions, companies and the industry at the Faculty of Transport and Traffic Sciences, University of Zagreb (Zagreb, 2 February 2023) [10].
- In collaboration with the European Union Agency for Railways and the Railway Safety Agency of



Figure 5 The first in situ experiment of a collision between a passenger car and a railway vehicle at a level crossing in the Republic of Croatia (Graboštani, 14 December 2022)



Figure 6 The expert conference Preventing Road Accidents at Level Crossings: Engineering Solutions, Education and the Media

the Republic of Croatia, the international workshop Workshop on the Technical Pillar of the 4th Railway Package was organised and held at the Faculty of Transport and Traffic Sciences, University of Zagreb, from 1 to 2 October 2019 [12].

- In collaboration with the International Union of Railways (UIC), HŽ Infrastruktura and numerous partners from railway institutions, companies and the industry, the international conference *ILCAD – 10th International Level Crossing Awareness Day* was organised in Zagreb from 6 to 8 June 2018 at the Mimara Museum, the conference was attended by 200 participants from 29 countries worldwide (Figure 8) [7].
- In collaboration with the Finnish research centre VTT – Technical Research Centre of Finland, the international Roundtable *Traffic Safety of Level Crossings: Experiences of Croatia and Finland* was organised at the Faculty of Transport and Traffic Sciences, University of Zagreb, on 21 May 2014.
- Master's theses: 10 master's theses on the topic of accident prevention at level crossings were completed and defended under the supervision of

the research group leader.

- Doctoral dissertation: One doctoral dissertation was completed and defended, and research is currently underway for a second doctoral dissertation by a member of the research group under the supervision of the research group leader.
- Two Rector's Awards: Under the supervision of the research group leader, two student teams were awarded the Rector's Award for research papers on the topic of accident prevention at level crossings and in the gravitational area of level crossings.
- Dean's Award: Under the supervision of the research group leader, one student team was awarded the Dean's Award for a research paper on the topic of accident prevention at level crossings.
- Membership in established international institutions: Collaboration with the International Union of Railways (UIC) and membership in two expert working groups in the field of traffic safety (UIC Working Group): Global Level Crossing Network (GLCN) and Trespass & Suicide Prevention Network.
- Collaboration with the scientific international association WCTRS (World Conference on Transport Research Society) and active participation in the

Figure 7 Technical visits for the participants of the expert conference were organised in cooperation with HŽ Infrastruktura and the company ALTPRO







Figure 8 The 10th-anniversary international conference ILCAD (International Level Crossing Awareness Day) was organised in collaboration with the International Union of Railways and partners

working group SIG C4 – Traffic Safety Analysis and Policy, Special Interest Group, Topic Area C: Traffic Management, Operations and Safety.

Popularisation of science through education: To promote science, the research group, in collaboration with partner institutions and companies, organised numerous activities on the topic of research into risky behaviour in traffic, education and accident prevention, with a strong emphasis on involving the public through media and social networks. The activities are numerous and Figures 9 and 10 show selected activities in which young traffic participants were actively involved [7].

6. Recapitulation

There is no single measure that could prevent traffic accidents at level crossings. Investment in modernisation and contemporary technical solutions is essential, but education that raises awareness among users of level crossings about the consequences of risky behaviour in traffic and motivates them to act responsibly in traffic is key to prevention. Level crossings are not the most dangerous; the most dangerous is IGNORANCE. The analysis of traffic accident causes proves that every accident is preventable and can be avoided.

Together and through the collaboration of all stakeholders, we can make a significant contribution to preventing accidents at level crossings and influence the level of safety, safer traffic flow and changes in the patterns of risky behaviour of level crossing users and other road participants. Everyone can contribute both at the institutional and personal level and setting the "Vision of O Traffic Accidents at Level Crossings" must be a priority and the ultimate goal.



Figure 9 Popularisation of science through the involvement of primary school students in writing literary works on the topic SAFE AT THE LEVEL CROSSING, followed by a ceremonial award and recognition presentation in collaboration with HŽ Infrastruktura and the company ALTPRO (Zagreb, 13 October 2017)



Figure 10 Popularisation of science through the involvement of young people in creating and filming the preventiveeducational video "The Railway Line is Not a Playground – Traffic Safety Starts with You", in collaboration with Croatian Paralympian Mladen Tomić, child actors from the video in Vinkovci and secondary school students, with the video being filmed by SKIG from Gunja (Vinkovci, 2017)

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02

INSTITUTIONS

RESPONSIBLE FOR SAFETY AT LEVEL CROSSINGS IN THE REPUBLIC OF CROATIA

The Modernisation of Level Crossings is of Strategic Importance for the Railway Transport System in the Republic of Croatia



Oleg Butković, dipl. ing. Deputy Prime Minister of the Republic of Croatia and Minister in the Ministry of the Sea, Transport and Infrastructure

The Government of the Republic of Croatia has determined that investments in the railway will be a priority for further investments in the development of transport infrastructure. Over a ten-year period, investments amounting to 6 billion EUR are planned for this sector.

In this regard, significant investments in the railway sector have been initiated and are underway, both in the renovation and reconstruction of the existing railway network and in the procurement of new low-floor and battery-powered trains.

Part of the funding is drawn from available European resources, particularly for railway lines that are part of the European transport corridor network, while the renewal of local and regional railway lines across Croatia is financed through a loan from the European Investment Bank.

However, an important part of the investment is also focused on improving safety across all transport routes, including the railway network. In this regard, the Ministry of the Sea, Transport and Infrastructure has adopted the *Programme for the Resolution of Level* *Crossings and Pedestrian Crossings over Railway Lines for the Period 2023 to 2027.* This programme is a key document for the improvement and modernisation of level crossings in the Republic of Croatia.

The objectives of the programme include analysing existing level crossings, establishing a priority list for their resolution and the determination of the approach for addressing each individual level crossing, as well as implementing additional measures to enhance safety at both level crossings and pedestrian crossings.

In order to achieve the stated objectives, HŽ Infrastruktura, as the national operator the main mission of which is safety, i.e. the continuous improvement of safety levels, is implementing projects dedicated to the modernisation of level crossings. In addition, apart from installing modern devices and thus modernising level crossings, as part of railway line modernisation projects, some level crossings are being replaced with underpasses or overpasses to speed up traffic and achieve a higher level of safety.

At crossings that are secured with traffic signs, the

goal is to install automatic devices with half barriers and light and sound signalling. Currently, three projects related to the modernisation of existing crossings are being implemented, aiming to enhance safety levels at a total of 170 level crossings across Croatia.

However, in addition to these safety improvement measures, it is equally important to focus on measures that influence behavioural changes among all road users. These primarily involve informing, educating and warning of the dangers of moving near railway lines. For over 20 years, HŽ Infrastruktura has been implementing a highly valuable information campaign titled "Train is Always Faster", which is primarily aimed at children and the youth. The campaign receives strong support from the Ministry.

Equally important is collaboration with the

academic community, which conducts scientific research and proposes preventive measures to reduce accidents at level crossings. In this regard, we would like to highlight the successful collaboration with the Faculty of Transport and Traffic Sciences of the University of Zagreb, which has conducted several important studies and projects proposing possible measures to reduce the risk of accidents at level crossings.

In this crucial task, we expect the cooperation of all stakeholders, including relevant institutions, agencies, infrastructure managers, the academic community and industry to develop and implement long-term, high-quality solutions that will contribute to reducing traffic accidents and enhancing the overall safety of the transport system.

Continuous Investment in Raising the Safety Level on Croatia's Rail Network



Ivan Kršić, dipl. ing. grad. President of the Management Board HŽ Infrastrukture

One of the fundamental missions of HŽ Infrastruktura's business has been safety, i.e. continuous efforts to raise the safety level. Accordingly, as a company, we have been implementing a number of projects to ensure that the rail traffic safety level is as high as possible. Each new kilometre of reconstructed track section contributes to these efforts. In addition to installing modern devices, i.e. modernizing level crossings, as part of large-scale projects for the reconstruction and modernization of railways on corridor routes, mainly co-financed by EU funds, level crossings are being eliminated, and replaced with underpasses or overpasses. This, with the additional benefit of better traffic flow, maximizes safety level.

However, on most regional and local lines, HZ Infrastruktura seeks to modernize level crossings with the most modern devices. The goal is to install automatic devices with half-barriers and light and sound signaling on crossings that have been secured by the traffic signs. Three projects related to the modernization of level crossings have been in progress, and they also encompass raising the safety level at a total of 170 level crossings across the Croatian railway network.

Early this year, the Project for the Security and Modernization of 49 Level Crossings and 1 Pedestrian Crossing at 50 Locations in the Republic of Croatia, signed with Končar and financed by the World Bank, was completed. The implementation of this project, worth over EUR 10 million, further improved the safety level at critical points in the railway system.

Two other projects to increase the safety level at level crossings are currently being implemented: the project for the securing and modernizing the level crossings, which includes 94 level crossings and one pedestrian crossing, and the project for securing and modernizing another 26 level crossings.

As part of the first-mentioned project (95 level crossings), co-financed by EU funds, more than 20 level crossings have been modernized and put into operation so far. A total of about 40 level crossings







🔁 HŻ INFRASTRUKTURA

Mjesto križanja željezničke pruge i ceste zove se željezničko-cestovni prijelaz. Svi željezničko-cestovni prijelazi su uz oprez i poštivanje prometnih znakova sigurni za korištenje. Ta mjesta postaju opasna ako se ne poštuju prometni znakovi. Zato je važno da u školu uvijek kreneš na vrijeme. Obvezno stani prije nego kreneš prelaziti preko željezničke pruge. Ako je polubranik spušten, pričekaj da se digne, a ako polubranika nema, dobro pogledaj i uvjeri se da vlak ne nailazi.

Prostori uz željezničku prugu nisu mjesto za igru. Ima puno drugih dobrih mjesta na kojima možeš uživati sa svojim prijateljima.

Putovanje vlakom je lijepo i uzbudljivo. Putuj i ti, vozi se i uživaj u ljepoti krajeva kroz koje prolaziš.

Sretno.



Slušalice u ušima, pisanje poruka ili telefoniranje u prometu je opasno.



Gađanje vlakova kamenjem nije način zabave. To je opasna igra u kojoj se možeš ozlijediti, a mogu nastradati i putnici u vlaku ili strojovođa.

are expected to be put into operation by the end of this year, while the rest will be put into operation during 2026.

The project is co-financed by the European Union, and the total value of the works carried out by the Altpro company amounts to more than EUR 16 million.

As for the project to secure and modernize another 26 LCs, worth EUR six million, it is financed from the State Budget. The works contractor is Pružne gradevine, and the equipment installed is manufactured by Altpro. So far, works have been completed on seven LCs, works are ongoing on eight ones, while the completion of all works and putting into operation are expected during the next year.

However, international practice to date has shown that the most effective way to effect change in the behavior

of transport participants and to reduce the black figures of road fatalities has been education, highlighting the risks and issuing warning about the fatal dangers of careless movement along the tracks or crossing the tracks in places that are not intended for this!

That is why the "*Train is Always Faster*" campaign has been running at level crossings and in elementary schools for 24 years. Unfortunately, despite constant warnings, due to careless conduct and violations of traffic rules and traffic signals, accidents still occur, in which children and adults get seriously injured, so it is necessary to constantly warn about the following:

 It is strictly forbidden to play on and along the tracks, on bridges where the track passes, as well as to climb on the carriages and overhead contact line poles.





- It is dangerous to walk along or across the tracks with headphones on or with a mobile phone in one's hand. Because of the headphones, one cannot hear what is happening around, and the mobile phone distracts one from potential danger.
- Before crossing the railway tracks, one must stop and, and with respect to the traffic signs and traffic signals, cross the tracks only when one is sure that there is no danger. If the half-barrier is lowered, one should wait for it to rise, and if there is no halfbarrier, one should look around carefully and make sure that no train is coming.
- The braking distance of a train is up to 1500 meters, which is why the train driver, after spotting a car or person on the track, does not have the time to stop it in time. Trains are also increasingly low noise, so one cannot hear them until they are near the level crossing.
- One must be responsible and cross the tracks only at marked places for crossing. .It is strictly forbidden to walk on the tracks or on the paths directly to the tracks, as well as to throw stones at trains passing by.

The Croatian Railway Safety Agency and its Role in Risk Prevention at Level Crossings



Želimir Delač, dipl. inž. el. Director of the Croatian Railway Safety Agency

The Croatian Railway Safety Agency is the Croatian independent authority competent in terms of legislation on the safety and interoperability of the European Union railway system.

The competences of the Croatian Railway Safety Agency (hereinafter: the Agency) are prescribed by the Safety and Interoperability Railway System Act (Official Gazette No.: 63/2020; hereinafter: SIRS Act). Among other things, the Agency is responsible for issuing approvals for the placing infrastructure subsystems and their parts into service and for the supervision of subsystems based on knowledge of risks in the railway system.

The safety of the control command system (hereinafter: CCS) has a central place in the overall safety of the railway system. According to data from the Agency's annual reports, the largest number of serious accidents with fatal consequences occurred at level crossings as the part of the CCS with the highest risk in the railway system.

Pursuant to the SIRS Act, the infrastructure manager and railway undertakings, within the scope of their activities, are responsible for the safety of the European Union railway system and for managing the associated risks, and thus the responsibility for managing risks and achieving the safety objectives of level crossings lies with the infrastructure manager.

Taking into account such legislative context, the Agency, together with the infrastructure manager, harmonizes global risks and, as part of supervision, adopts appropriate measures to mitigate risks, especially those related to level crossings.

As part of improving the general safety of railway subsystems, and in particular the CCS, the Agency, through the procedures for supervision and issuing approvals for the placing infrastructure subsystems and their parts into service, requires that the safety of the subsystems is maintained and, where necessary, increased. This applies in particular to new level crossing's projects whose safety is ensured through automated level crossings with a high level of safety integration (SIL 4) and a high level of reliability. To this end, these projects must meet all legal requirements for safety and interoperability, including requirements relating to reliability, availability, maintainability and safety (RAMS).

Risk analysis related to the causes of failures of level crossings and their devices (signalling and safety devices) has a central place in the supervision process, as well as in the assessment of technical conditions for the issuing approvals for the placing infrastructure subsystems and their parts into service carried out by the Agency.

Supervision and assessing of the RAMS management process are inevitable in dealing with failures, in order to reduce risks and achieve high levels of safety in the signal and safety devices of level crossings.

Safety and failure avoidance in modern electronic signalling and safety equipment is achieved most effectively when RAMS factors are continuously controlled (preventively) throughout the project from its very beginning to installation, and during operation until uninstallation – throughout the entire life cycle of the subsystem instead of applying corrective processes.

Failures affect reliability, availability, maintainability and safety, where the level of this influence is determined by the functionality and design of the applied system – device. The risk associated with RAMS can be reduced by taking a combination of measures to reduce failures, reduce the frequency of events that result in failures, and reduce their severity.

In the context of risk strategy, the main ways in

which the risks associated with RAMS in signalling and safety devices can be reduced and thus ensure the planned level of safety are: improving reliability and availability.

Measures to improve reliability with respect to random failures include various aspects of system design, implementation of quality management systems, implementation of safety management systems as well as technical controls of the production process. On the other hand, there are several principles for improving availability – ensuring duplicate or backup systems (redundancy), ensuring the possibility of operating in degraded mode, and improving system sustainability and ensuring sufficient resources for repair and maintenance.

By implementing the above-mentioned strategies and measures in risk management, the Agency, together with the infrastructure manager, continuously improves the safety of the railway crossings as the riskiest places in the railway system in a professional and responsible manner. Preventing risks in the railway system and mitigating them within permissible limits is the strategic task of the Agency and its long-term priority.

Investigations of Traffic Accidents at Level Crossings



Alana Vukić, mag. iur. Director of the Air, Maritime and Railway Traffic Accident Investigation Agency

Traffic safety is one of the key factors affecting the quality of life and public trust in transport systems. Through continuous research, analysis and recommendations, the Air, Maritime and Railway Traffic Accident Investigation Agency, as an independent institution, protects the interests of passengers, crew and all users of the transport system and contributes to the preservation of traffic safety in the Republic of Croatia.

The Air, Maritime and Railway Traffic Accident Investigation Agency (AIA) was established to investigate the causes of accidents in the mentioned transport sectors and find measures to improve safety. It was established by the Government of the Republic of Croatia in accordance with European and international standards to ensure transparency and objectivity in the investigation of accidents.

The Agency, headquartered in Zagreb, employs a team of qualified experts of various profiles, with the basic goal of conducting a detailed analysis of each reported accident in order to determine the causes and recommend preventive measures.

The legislation relating to the AIA prescribes its powers and procedures in investigating accidents. The Agency has access to all relevant information and documentation and cooperates with domestic and international partners to jointly determine the causes of accidents and propose measures to improve safety.

Based on public authority, the Agency, as an activity of interest to the Republic of Croatia, performs:

- investigations of accidents and serious aircraft accidents,
- safety investigations to determine the cause of the accident and propose measures to avoid maritime accidents and improve the safety of navigation,
- investigations of every serious accident in the railway system and possible investigations of those accidents and incidents which under slightly different conditions could have led to serious accidents, including technical failures of structural subsystems or constituent parts of the interoperability of the railway system.

In this article, we provide a brief overview of accident investigations at level crossings:

Investigations of Accidents at Level Crossings

The Department for Railway Traffic Accident Investigations in the Republic of Croatia operates in accordance with Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety, which has been implemented into national legislation through the Act on the Establishment of the Air, Maritime and Railway Traffic Accident Investigation Agency ("Official Gazette", No. 54/13, 96/18) and the Act on the Safety and Interoperability of the Railway System ("Official Gazette", No. 63/20). The aim of investigating railway accidents and incidents is to improve the safety of the railway system and prevent future accidents.

The final report must follow the structure established by Commission Implementing Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure to be followed for railway accident and incident investigation reports.

The investigator leading the investigation will contact local authorities before arriving at the scene for the purpose of:

 securing the site of the emergency event (in most cases, the first to arrive at the scene are police, emergency medical teams and firefighters, who secure the site), ensuring all documents and records related to the emergency event, and providing the names and details of all participants in the event and all witnesses. Investigators must also consider their own health and safety at the scene of the event due to various inaccessible locations, potential fires, materials, debris and other hazards. All conducted investigations of railway emergen-

cies are published on the website of the Agency: https://ain.hr/category/novosti/.

Procedures to be followed during the investigation:

- examination of the scene without moving any evidence at the site (static phase of the investigation),
- locating traces that were created during the event (silent "witnesses"),
- marking the traces,
- photographing the accident scene,
- extracting data from recording devices (tachograph disc, memory card, etc.).
- On-site investigations also include:
- interviews with involved parties and witnesses (sometimes arranged later, depending on the



severity of the event),

- preliminary inspections of railway vehicles, infrastructure and safety system components,
- if possible, testing the functionality of equipment at the scene.

The phases of the investigation after the accident include:

- further evidence collection (documentation and interviews),
- retrieval of data from recording devices and analysis of the extracted data and records,
- sending equipment parts and components to laboratories for analysis and testing,
- examination and testing of system components, determining the sequence of events that led to the incident.

To obtain documentation on vehicle maintenance and condition, worker qualifications, weather conditions, etc., the lead investigator will contact the relevant organisations:

- infrastructure manager,
- organisations responsible for railway vehicle maintenance,
- railway undertaking,
- owner of the road vehicle,
- national body for railway system safety,
- meteorological services.

In every investigation, it is crucial to collect information, evidence and facts to conduct a thorough analysis of the event and determine its cause and the factors that led to the occurrence of a serious accident or incident.



For the collection and analysis of information, analytical models are used (such as the SHELL model, Reason's model, or the Swiss cheese model, among others), which include procedures, manuals, training, equipment and devices, weather conditions, operational personnel and so on.

Final reports are compiled according to the structure set out in Commission Implementing Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure that must be adhered to in reports on railway accidents and incidents.

Every final report that is issued is also published publicly on the AIA website: <u>https://ain.hr/status-istrage/zatvorene-istrage/</u>.

Year	Total number of open investigations	Total number of open investigations regarding level crossings	Total number of safety recommendations issued	Total number of safety recommendations issued regarding level crossings
2014	12	1	4	3
2015	8	4	7	2
2016	9	3	11	10
2017	11	1	11	9
2018	7	1	3	0
2019	6	1	3	0
2020	7	3	13	8
2021	7	2	9	2
2022	4	1	15	2
2023	6	0	15	1
2024	5	3	5	2

An overview of the total number of open investigations and the total number of safety recommendations issued from 2014 to 2024

An overview of the types of events in railway transport for which investigations have been opened from 2014 to 2024



Conclusion

When it comes to accidents, they should be taken seriously due to their potentially severe consequences and, most often, loss of human life. In the Republic of Croatia, accidents have been reduced to a minimum thanks to strict safety standards and controls. However, the AIA investigates extraordinary events to identify possible deficiencies and prevent future accidents.

An example of one of the investigations into an accident at a level crossing

On 17 June 2021, at 10:22 AM, at the "Stancija Grgur" level crossing, secured passively with traffic signs at kilometre point 103+821 on the R101 railway line, a collision occurred between a passenger car and passenger train number 1272. In the aforementioned serious accident, the driver of the passenger car was fatally injured, and significant material damage was recorded to the passenger car, while minor material damage was recorded on the passenger train.

The causal factor of the serious accident in question was the crossing of the passenger car over the "Stancija Grgur" level crossing just before the arrival of passenger train number 1272, despite the traffic signs (Andrija's cross and STOP sign), and the vehicle being struck by the train (Chapter 3.2.3.).

The factors that contribute to the accident include: the railway line R101, the terrain configuration and vegetation along the section of the railway line at the "Stancija Grgur" level crossing, as well as traffic intensity.

Systemic factors of the accident include: the failure of the driver of the passenger car to stop at the "Stancija Grgur" level crossing in accordance with the traffic signs (Chapter 3.2.3), possible lack of attention and distraction of the car driver (Chapter 3.1.9), failure to follow the prescribed operational processes by the operating train driver, i.e. not adhering to the prescribed speed limit (Chapter 3.1.7), failure to follow prescribed operational processes by the operating pilot, i.e. not warning the train driver about the prescribed speed limit on the section of the R101 railway line around the "Stancija Grgur" level crossing (Chapter 3.1.7) and the position of the pilot's seat in the train, from which there is no clear view of the train's speed (Chapter 3.2.3).

Safety recommendations

AIA/06-SR-11/2022: The railway undertaking involved in cases where train operation is conducted with the presence of a pilot should ensure at all times that the pilot has an unobstructed view of the current speed of the train.

AIA/06-SR-12/2022: The Railway Safety Agency should, when issuing Approval for the use of certain traction vehicles or train sets, pay greater attention to those vehicle series equipped with a pilot seat, ensuring that the pilot has an unobstructed view of the current speed of the train, considering the designated seating position in the cabin.

INSTITUTIONS

RESPONSIBLE FOR SAFETY AT LEVEL CROSSINGS – INTERNATIONAL EXPERIENCES

Highway-Rail Grade Crossing Safety in the United States from a Psychologist's Perspective



Human Factors Division Chief at Office of Research, Development, and Technology at US Department of Transportation's Federal Railroad Administration (FRA), Washington DC

Highway-rail grade crossings are locations across the world that need special attention from transportation engineers and psychologists alike. Improving grade crossing safety takes engineering, education, and enforcement of laws. And it also takes outreach and partnerships.

The United States (US) has approximately 212,000 locations where highways cross railroad tracks. In the US, we call these locations *highway-rail grade crossings*, whereas level crossings is a term used elsewhere throughout the world. Whether they're called grade crossings or level crossings, these are locations across the world that need special attention from transportation engineers and psychologists alike.

Why psychologists, you ask? I may have surprised you by including psychologists alongside transportation engineers as experts who can help us understand safety at grade crossings. Hear me out.

The US has the largest railroad network of any country in the world, about 225,000 km. The 212,000 grade crossings spread across the US are a combination of active and passive, public and private. Some crossings are equipped with gates, lights and bells that provide road users with physical, auditory and visual indicators that a dangerous intersection is ahead. Other crossings are equipped with just the crossbucks sign.

Dr. Starr Kidda

When the railroad network is so vast, and grade crossings' designs and contextual factors are so varied (e.g., gates or no gates, in a city or in a rural area, high or low pedestrian traffic), how can we possibly develop technologies and strategies to improve grade crossing safety?

My suggestion? Call in the psychologists!

My name is Starr Kidda and I manage a small team of engineering psychologists (also known as human factors engineers) at the US Department of Transportation's Federal Railroad Administration (FRA). My team focuses on improving railroad safety by studying the causes of human error in railroad operations and developing new technologies, non-regulatory guidance, and programs to mitigate those causes. Included in our research portfolio are projects related to grade crossing safety.

FRA believes that most accidents at grade



https://railroads.dot.gov/highway-rail-crossing-and-trespasser-programs/railroad-crossing-safety-trespass

crossings are preventable. We also believe the factors that lead to grade crossing accidents and trespass fatalities are discoverable and solvable. The goal of our research program is to investigate the root causes of incidents and develop applied corrective actions that address those root causes.

At FRA, we conduct research on grade crossing safety using both an engineering perspective and a human factors perspective. That is, we believe that technological innovation – engineering solutions– can only help so much without attention to how humans perceive, interact with, and make decisions based on conditions at grade crossings.

We may have different ways of referring to the location where railroad tracks cross a road (i.e., grade crossing or level crossing), but some examples of human behavior are universal among all cultures. People will make mistakes. People will try to beat the train at a crossing. People will approach crossings with distractions in the car or in a fatigued state. The list goes on and on.

> I'm passionate about grade crossing safety, because I know those accidents are preventable. As transportation safety professionals, we truly can make a difference. Let's work together to ensure people are careful around railroad crossings and #AlwaysExpectATrain.

Human behavior plays a primary role in the number of accidents at grade crossings. When a driver chooses to maneuver around lowered gates at an active crossing, he or she increases the risk of a



grade crossing incident or accident. We must also account for those who use passing trains to deliberately end their lives. In the last ten years, FRA safety data shows that human behavior accounts for up to 93 percent of vehicle crossing accidents for the US railroad system.

UIn the US, 8 people or vehicles are hit by a train every day at a grade crossing. That's once every three hours! According to FRA's safety data, that statistic has remained steady for nearly fifteen years. Prior to 2009, the US's grade crossing safety statistics showed a steady decline, a steady decrease in the number of fatalities at grade crossings. Since 2009, those statistics have plateaued.

FRA continues to conduct research to help reduce the number of accidents and fatalities at grade crossings. Beyond engineering research on new technologies at grade crossings, we conduct targeted outreach across the US and support educational campaigns. Over the past couple years, FRA traveled to communities who had especially high numbers of accidents and fatalities at grade crossings. Because the US railroad network is so vast and varied, we thought it was important to meet community leaders where they were. We offered up our insights on the causal factors of accidents and fatalities in their communities. We presented community leaders with best practices, potential funding opportunities they could pursue, and local strategies to reduce incidents.

If you're looking for catchy social media content to help conduct education and outreach related to grade crossing safety, please check out the <u>15-week</u> <u>targeted social media campaign</u> that FRA ran in 2020 to raise public awareness and discourage risky behavior around railroad tracks. The animated videos highlight the importance of safety around railroad tracks, telling viewers to #AlwaysExpectATrain.

In my 11-year career at FRA, I've learned that there's not a one-size-fits-all strategy to improve grade crossing safety. Improving grade crossing safety takes engineering, education, and enforcement of laws. And it also takes outreach and partnerships. •

Rail Safety in Canada

Maryam Hedayati A/Chief Engineer, Crossings and Signals, Railway Safety Operations Transport Canada

Transport Canada, a federal institution responsible for transportation policies and programs, promotes safe, secure, efficient and environmentally responsible transportation. Maryam Hedayati, an A/Chief Engineer for Crossings and Signals, Railway Safety Operations at Transport Canada gave an overview of rail safety in Canada with special emphasis on grade crossings.

Rail Safety in Canada

With nearly 41,711 route-kilometers of track, Canada has the third-largest rail network in the world. Railways played a key role in Canada. They continue to be important for Canadian economy as a primary mode of freight transportation.

Transport Canada's Role in Grade Crossing Safety

Transport Canada plays an essential role in ensuring crossing remain safe for all road users, including vehicles, pedestrians, and cyclists. Transport Canada's primary responsibility is to oversee the safety and security of the rail transportation system, including managing grade crossing safety through legislation, regulation, and enforcement. Transport Canada provides funding under the Rail Safety Improvement Program for projects that improve infrastructure or propose research or new technologies to increase safety at grade crossings and along rail lines.

Grade Crossings in Canada

There are about 14,000 public and 9,000 private



grade crossings along more than 40,000 kilometres of federally regulated railway tracks in Canada. A grade crossing is an intersection where a road, sidewalk, path or trail crosses railway tracks. Grade crossings are also known as level crossings. These crossings can be found in urban, suburban, and rural areas, each presenting unique safety challenges.

Grade Crossings Inventory and Map

 The list of grade crossings are published on <u>Government of Canada's Open Data portal</u>. In this portal crossing are ranked according to their risk using GradeX analysis tool, that compares crossings against each other based on various risk factors. The <u>Grade Crossing Map</u> also provides a visual representation of grade crossings that are federally regulated across Canada.

Legislation

Railway Safety Act: This Act includes provisions for the design, maintenance, and operation of railway crossings, ensuring they meet safety standards.

Grade Crossings Regulations: These regulations set the requirements for crossing safety, including the installation of warning devices (e.g., lights, gates) and the maintenance of clear sightlines.

Transport Canada's <u>Grade Crossings Regulations</u> (the regulations) help improve safety at these crossings. Transport Canada enforces regulations that govern grade crossings in Canada.

Role and Responsibilities:

In Canada, grade crossing safety is a shared responsibility between railway companies, road authorities, and private authorities. The Regulations clearly define who is responsible for the design, construction, maintenance and inspection of the crossing surface, signage, and warning systems.

Oversight Program

Transport Canada's Railway Safety Oversight Program monitors and ensures compliance with safety legislation requirements.

Rail safety inspectors determine whether a railway's operations, equipment, signals and infrastructure support safety. Approximately 150 inspectors carry out around 40,000 inspections across the country every year.

Transport Canada is dedicated to reducing the risk of accidents at grade crossings across the country through regulations, funding programs, and oversight. By collaborating with railway and road authorities, the department continues to prioritize safety, ensuring that Canadian roads and railways coexist in a safe and efficient manner. •

04

INTERVIEW

ACTIVITIES OF THE INTERNATIONAL UNION OF RAILWAYS (UIC) DEDICATED TO PREVENTING. ACCIDENTS AT LEVEL CROSSINGS.

GLCN i TreSP-Network: Global Working Groups of the International Union of Railways

Isabelle Fonverne Senior Advisor for Safety and Interoperability at the International Union of Railways (UIC), Paris



We spoke with Isabelle Fonverne, senior advisor for Safety and Interoperability at the International Union of Railways (UIC), based in Paris, about UIC activities on level crossing-related topics through two global working groups (GLCN and the TreSP-Network) that bring together experts from around the world.

Please briefly introduce the International Union of Railways?

The International Union of Railways (UIC) is the worldwide organisation that promotes rail transport globally and facilitates the collaborative development of the railway system. It brings together more than 200 members across all five continents, including railway undertakings, infrastructure managers, and railway service providers. UIC maintains close cooperative links with all stakeholders in the rail transport domain worldwide, including manufacturers, railway associations, and public authorities, as well as in other domains and sectors whose experiences may benefit rail development. UIC's main tasks include understanding the business needs of the rail community, developing innovation programmes to identify solutions to those needs, and preparing and publishing documents, such as reports, specifications, guidelines and IRSs that facilitate implementing these innovative solutions.

Please refer to the statistics on global level crossings?

According to International Union of Railways (UIC) estimates, there are more than half a million level crossings worldwide, including more than 100,000 in the European Union and more than 200,000 in the United States (with 20% and 40% respectively). In the EU, United States, and almost everywhere, accidents and fatalities involving level crossings account for nearly a third of all rail accidents. If incidents involving pedestrians trespassing on the tracks are included, this figure increases to over 90% of all rail accidents.

What would you highlight as the main problems?

I will highlight three main problems: accidents at level crossings, trespassing and rail suicides. According to the UIC safety report in 2022, the 34 partner railway companies (within 32 countries) reported an average of 9 weekly victims at level crossings. Most accidents at level crossings were collisions with vehicles, with 38% being fatal and 36% causing serious injuries. Pedestrians accounted for 19% of fatalities and 7% of serious injuries. Regarding trespassing, 62% of all major accidents involving at least one casualty (injury or fatality) were reported to have been caused by trespassing. Rail suicides accounted for between 1 and 18% of suicides nationwide. Suicides and suicide attempts occur mainly during the day when trespassing occurs both during the day and at night (in the majority of cases).

What is ILCAD?

The International Level Crossing Awareness Day (ILCAD) is a global initiative led by the UIC's "Global Level Crossing Network" (GLCN) to enhance awareness around level crossing safety. Since 2009, with backing from the global railway community, the International Union of Railways has coordinated this campaign, involving around 50 countries annually. An increasing number of road sector organisations, international institutions (e.g., UNECE, IRU, IRF, ETSC), and not-for-profits (Operation Lifesaver USA, Canada, Argentina and Estonia (OLE) as well as Tracksafe Australia and Tracksafe New Zealand) also support these awareness efforts. The goal is to encourage road users and pedestrians to "Act safely at level crossings".

A different partner country hosts the ILCAD launch conference every year, allowing experts to exchange safety practices to reduce accidents and casualties. First two ILCAD editions held in Brussels (2009, 2010), followed by Warsaw (2011), Paris (2012), Geneva (2013), Lisbon (2014), Istanbul (2015), Riga & Tallinn (2016), Montreal (2017), Zagreb (2018), Amersfoort (2019), online because of COVID-19 (2020, 2021), Denver (2022), Warsaw (2023), Buenos Aires (2024).



What is TRESPAD?

In addition to level crossings, trespassing and suicide incidents near railway tracks significantly impact the rail industry's safety and efficiency. Recognising the broad societal impact. Therefore, in June 2021, UIC and its working group TreSP-Network (Trespass and Suicide Prevention Network) launched a second campaign, "Trespass Awareness Day" (TRESPAD), to address these issues, with an inaugural event in June 2022 hosted by the Association of American Railroads (AAR); Federal Railroad Administration (FRA) and Operation Lifesaver inc. (OLI) in Denver, USA. In June 2023, the second edition was hosted by the Polish Railways (PKP) and PKP Group Foundation in Warsaw, Poland, and the third was hosted by JST in Buenos Aires, Argentina, on 5 June 2024 since then followed by ILCAD. This year, ILCAD and TRESPAD focused on "Vulnerable Users".

Can you announce the new edition of ILCAD and TRESPAD?

In 2025, UIC will be launching TRESPAD and ILCAD conferences jointly with NETWORK RAIL and RSSB (Rail Safety and Standards Board) at the National Railway Museum in York, Great Britain, to coincide with the 200th anniversary of the first-ever passenger railway. The 4th edition of TRESPAD (Trespass Prevention Awareness Day) is foreseen on June 4, 2025. The 17th edition of ILCAD (International Level Crossing Awareness Day) will take place on June 5, 2025. On Friday 6th June there will be some technical visits at level crossings. The theme of the 2025 ILCAD launch conference will be "Helping people make good decisions". The key areas are Engineering (What technologies could help people make good decisions, raise awareness and ultimately prevent accidents at level crossings?), Enforcement (partnerships involving railways, local authorities, and police forces to encourage responsible, safe behaviour) and community outreach (What are the best means of helping people (particularly vulnerable users) understand the safety risks at crossings?).

What do the International Union of Railways and the University of Zagreb, Faculty of Transport and Traffic Sciences have in common?

The International Union of Railways and the University of Zagreb, Faculty of Transport and Traffic Sciences, have a long-standing successful cooperation in level-crossing.

In June 2018, the International Union of Railways, together with the Faculty of Transport and Traffic Sciences University of Zagreb and the Croatian railway infrastructure manager (HZ Infrastruktura),



were pleased to co-host the 10th ILCAD international conference on June 7, 2018, in Zagreb, Croatia. The three-day conference was very successful, with around 200 participants from 29 countries around the world.

Prof. Danijela Baric is a member of both UIC working groups, GLCN and TreSP-Network, which are composed of about 60 experts from around the world. They are railway safety and road safety experts, academics, psychologists, and human behaviours specialists exchanging best practices and soft and hard measures to improve safety at level crossings, at and around railway tracks (including stations).

One of our Tresp-Network meetings occurred in September 2024 in Zagreb, Croatia. Prof. Baric had invited the members of the working group and the whole Croatian railway sector: the railway infrastructure manager, leading operator, national safety authority, national investigation body, police forces, and train driver. Seventy-seven individuals from 18 countries, including Canada, USA, Argentina, Japan, Australia and the EU, took part in person and online in the 10th TreSP-Network meeting kindly hosted by the Faculty of Transport and Traffic Sciences of the University of Zagreb. Speakers and participants exchanged views on best practices, research projects and technological solutions to prevent rail trespass and suicides.

Prof. Danijela Baric regularly represents the University of Zagreb, Faculty of Transport and Traffic Sciences, at our launch conferences or meetings to share best practices and research projects on level crossing safety, trespass and suicide prevention. She was also involved in the two E.U. projects that UIC coordinated, one on trespass and suicide prevention, RESTRAIL and its primary outcome a toolbox (www.restrail.eu) and one to improve level crossing safety called SAFER LC, and its toolbox (www.saferlc. eu).



Can you tell us something about the current UIC project "AI4SAFEBEHAVE"?

International Union of Railways launched the research project "AI4SAFEBEHAVE" on 15 October 2024 at UIC HQ in Paris. It involves using artificial intelligence to observe incorrect conduct at level crossings, trespassing, and suicidal behaviour. It will run until the end of June 2026. The company IMOTION ANALYTICS will be heavily involved in the project alongside the funding members: Danish State Railways (DSB), Network Rail, ProRail, Italian Railway Network (RFI), and Trafikverket and also supported by the research group of Prof. Barić from the University of Zagreb, Faculty of Transport and Traffic Sciences. • **ALTPRO:** Croatian manufacturer of innovative solutions for increasing safety at level crossings



Zvonimir Viduka, dipl. ing. Owner and director of the company ALTPRO

We spoke with Mr. Zvonimir Viduka, the owner and director of ALTPRO company, one of the global leaders in developing and producing safe and reliable signalling and safety systems for railway infrastructure and rolling stock.

Please briefly introduce the company ALTPRO.

ALTPRO is a specialized signalling company active in research, development and production of safety critical signalling systems used on railway infrastructure and in railway vehicles. Our product range includes train detection systems, level crossing protection systems and INDUSI based automatic train protection (ATP – I60 and PZB90).

We have more than 30 years of experience in research, development and production within the railway sector, and our solutions are applied in more than 50 countries on 6 continents. Flexibility and customer orientation allow us to successfully implement smaller, specific projects as well as larger projects for the modernization and construction of railway lines. In addition, our products are certified by independent international institutions for the highest level of safety integrity (SIL4), thus guaranteeing top safety and reliability.

Today, our team consists of more than 200 experts operating in 5 locations in Croatia and the region. With a vision of innovative, integrated and sustainable development of railway transport, we are dedicated to increasing safety on a global scale.

What are ALTPRO's products in the field of level crossing security?

At ALTPRO, we have developed innovative and reliable solutions for securing level crossings, which significantly increase traffic safety at these key points



of the railway infrastructure. Our goal is to ensure high efficiency and minimize the risk of accidents. Our systems include all the components necessary for securing level crossings, including the central device, train detection system, half-barriers and signals. This allows us to provide maximum flexibility to our customers, as all our products can be adapted to the specific needs and conditions of each project.

Level crossing security systems are used in many countries around the world. In addition to being present in Croatia, our products are actively used in numerous countries on three continents. For example, our systems have been installed in Austria, Greece, Indonesia, South Africa, Slovakia, Serbia and Turkey,

among others. Through this global presence, we can say that we have become a recognizable leader in the level crossing security sector, and our products contribute to increasing the safety and efficiency of railway traffic in different parts of the world.

What are ALTPRO's contribution to innovative solutions to increase safety on LCs?

Safety is our top priority, so all our systems, including the RLC23 level crossing system, are designed and certified to the highest safety standards. We place particular emphasis on SIL4 – the highest level of safety integrity according to international standards. This certification guarantees that our systems meet the strictest safety requirements in the railway industry, confirming the exceptional reliability of our products, especially in critical situations. Our approach reduces the risk of accidents, the-

reby ensuring the safety of passengers and all other road users, providing them with a safe and reliable environment.

How your products contribute to increasing safety and preventing accidents on LCs?

The global presence of our system confirms the high level of flexibility and adaptability of the RLC23 system, which can be implemented in various segments, such as obstacle detection, video surveillance, additional signaling, remote monitoring and connection to any type of signaling systems. The RLC23 system provides light, sound and/or physical protection at the level crossing, and any type of train detection subsystem (such as axle counters or isolated sections), road signaling, driver s signals, halfbarriers, obstacle detection and similar subsystems can be connected to the central unit of the system.

A unique PC application allows for extensive configuration options, including external equipment parameters, the number of controlled external units, and various information to be received by the station device. The functionality of the RLC23 system is highly configurable, and our internal project organization easily adapts to different customer requirements and specific applications. The APIS-RLC23 control system continuously receives information about the section occupancy, position, and direction of the train via the counting point from the BO23 axle counter system. Based on this data, the system automatically raises or lowers the half-barrier depending on the train position and takes other necessary actions, ensuring a high level of safety at each crossing.



What are your recommendations for a national plan to prevent accidents at level crossings?

For the national plan for the prevention of accidents at level crossings in Croatia, it is essential to implement a comprehensive approach that combines technical, organizational and educational solutions.

The first recommendation refers to the modernization of level crossings by introducing automated signaling systems, such as our RLC23. Special emphasis should be placed on the priority of high-traffic level crossings, where it is necessary to increase protection due to the large number of trains and road vehicles. It is also necessary to develop a categorization of level crossings according to the level of risk and adapt safety measures for each type of crossing. Investments in infrastructure, such as the construction of overpasses and underpasses and the provision of safe access routes for pedestrians and cyclists, will also significantly reduce the risk of accidents. Cooperation with international partners, the application of best practices and the use of EU funds for the modernization of infrastructure can further contribute to safety at level crossings.

Croatia is already actively working on the implementation of some measures, including projects to secure and modernize existing level crossings. We are currently working on projects that will provide over 100 secured and modern level crossings across Croatia.

In the context of education and awareness-raising, it is important to launch campaigns for drivers and pedestrians, especially in rural areas, and to include education on proper behavior at LCs in the school curriculum. Cooperation with local communities also plays a key role in promoting safety and security.

These comprehensive measures, with continuous implementation and monitoring, are essential for reducing accidents and improving safety at the national level.

The ALTPRO company is a prime example of how successful manufacturing can be in Croatia. How long is the journey from idea and product development to its commercialization and sales?

The path from the idea and product development to its commercialization and sale is a very complex and demanding process, especially in a high-tech industry such as the railway sector. The process begins with the identification of a specific problem or market need, based on user feedback, market trends or regulatory changes. After the initial idea is shaped into a concrete plan, the product development phase follows, where the development team begins designing and creating a prototype, which must undergo rigorous internal checks to ensure functionality and reliability. The next step is product certification according to international standards, which includes detailed testing, and then we move on to manufacturing and placing the product on the market.

The total duration of the process from idea to implementation can take several years, including all the mentioned stages. But adaptation and product placement to foreign markets, given foreign laws and regulations, may take even longer. The best example of this is India, where we were faced with bureaucratic challenges for almost ten years while we managed to meet all the necessary conditions for product placement. However, this very experience shows that the effort pays off - today India is one of our most important export markets, we have a reliable partner there and we receive significant orders every year.

The key to our success lies in a highly educated team of experts who understand the demands of the industry, flexibility and adaptation of products to specific customer needs, and continuous investments in research and development, which enables the creation of innovative products that are competitive on a global level. Although the process is demanding, it is certainly achievable in Croatia with expertise, dedication and strategic management.

You have been an export-oriented company since the beginning, and ALTPRO is a recognizable name worldwide. Where do you export your products?

That's right, from the very beginning, ALTPRO has been an export-oriented company. Our product portfolio has always been designed according to global needs and market potential, which has enabled us to be present in more than 50 countries around the world today, and that number is continuously growing.

Some of the most interesting projects we are currently working on include the detection of specific vehicles on the railway, such as monorails and APM (Automated People Mover) in the USA, China and Egypt. These projects require advanced technology for vehicle recognition and tracking, which is crucial for the safety and efficiency of the system. Also, India is one of the largest markets for axle counters in the world, and we are one of the few approved suppliers of such equipment. This market has enabled us to have long-term partnerships and significant orders, which speaks to the trust we have in the industry. In the UK, we are currently working on two very interesting projects. One concerns the modernization of British Railways' level crossings, while the other involves the delivery of new ATP systems for Stadler, which will be installed in new metro vehicles in Newcastle.

The last two countries we added to our "list" of markets are Uruguay and Azerbaijan, where we are also working on the modernization of level crossings. These expansions into new markets confirm our ability to recognize global trends and adapt to the needs of different markets.

What were the biggest challenges during the start of the company, and what challenges do you face today?

When starting a company, there are always many challenges, and each step towards success carries its own specific difficulties. In the initial stages of development, the biggest challenges were related to securing the necessary resources and financing. As a new company with an innovative approach, it was crucial to secure funds for research and development, as we were dealing with technologically demanding projects. In addition, establishing trust was crucial, as we had to prove our expertise and ability to develop solutions that met the highest security and technological standards, and the competition in the industry was very strong.

Today, although we have achieved significant growth, we are facing new challenges. One of the biggest is managing the company's rapid growth, while at the same time striving to maintain the high quality of our services and products. We are also expanding the scope of our business and working on optimizing our component supply chains. However, the biggest challenge that we share with many technology companies today, and even throughout Croatia and a good part of Europe, is the human factor. Qualified personnel have become a key resource for our continued competitiveness.

We are working on long-term and short-term solutions to attract and retain highly educated professionals. Long-term solutions are focused on educating and mentoring young staff, so that they can successfully adapt to our way of working and culture of innovation from day one. We also invest in providing them with specific knowledge that will enable them to develop within our teams. Fortunately, the young people who come for internships and whom we monitor throughout their education show a great desire to learn and progress. They very quickly become full members of our teams, which gives us hope that we will continue to be able to grow and develop despite the challenges in the labor market.

What are your experiences in collaborating with the academic community?

We have only positive experiences in cooperation with faculties and research institutions, because we believe that cooperation with the academic community has a long-term impact on the Croatian industry. Such cooperation contributes to the development of highly educated personnel who ensure a continuous influx of new experts for the market. We actively cooperate with prestigious faculties such as the Faculty of Transport Sciences, the Faculty of Electrical Engineering and Computing, the Technical University of Zagreb and many others.

We provide students with the opportunity to apply their acquired knowledge in practice through student internships and thesis writing. Our experienced engineers mentor students, helping them solve specific industrial challenges, thereby not only contributing to their education, but also continuously developing young talents who will later become key personnel for further growth and development. Such projects and mentorships allow students to prepare for real challenges in the market, while at the same time bringing new ideas and fresh perspectives on



technology to the company, which helps us innovate and improve our solutions.

ALTPRO is the winner of numerous domestic and international awards. You have numerous achievements, which ones would you single out as the most significant?

One of our latest awards, which we are extremely proud of, is certainly the Platinum Key for Continuous Excellence in Business awarded to us by the Croatian Exporters Association in December 2024. This award is a recognition of our constant efforts, innovation and contribution to the Croatian economy on the international scene. In addition to the Platinum Key, ALTPRO is also the owner of four Golden Keys for the best exporter in 2018 and 2020, as well as for the best exporter in the specific markets of India in 2019 and China in 2021, which reflects our strong presence in key markets around the world.

In addition to these awards, we are proud of the Golden Kunas that we received from the Croatian Chamber of Commerce, as well as the Order of Danica of Croatia from the Government of the Republic of Croatia.

In addition to awards in Croatia, ALTPRO is also the winner of a number of international awards for innovation. Our products have been recognized at numerous scientific congresses and fairs around the world, from the USA, Japan, Malaysia, Taiwan to various European countries. These awards are not only a testament to our excellence in engineering and technology, but also a confirmation of the global impact and importance of our work in developing safety systems for railway infrastructure.

What are the company's plans for the future?

Our plans are focused on further growth, new

projects and market expansion, as well as improving technologies that shape the future of the railway sector. The company's focus remains on innovation, sustainable development and strengthening our position in the global market.

In the field of technologies, we plan to further improve signaling and safety systems, as well as develop advanced digital solutions that will improve the efficiency and safety of railway transport. In addition, we are increasingly focusing on sustainability and the green transition, with the aim of developing technologies that will make railway transport safer, more efficient and more sustainable. In this direction, we are currently developing an innovative project that deals with the application of hydrogen as an alternative energy source for the railway sector, which is just one of the steps towards reducing emissions and increasing energy efficiency.

All these plans ensure that ALTPRO remains synonymous with excellence in the railway industry, setting high standards for safety and innovation on a global level. We continue to adapt to market needs, with the aim of remaining a leader in providing advanced solutions that shape the future of transport infrastructure.

INDUSTRY EXPERIENCES

BODAN®: Level Crossing Solution with Unique Characteristics



Executive director of RMT GRUPA



Roman Wiesinger, Ing., Dipl.Ing.(FH), M.Sc., EU-Rail Ing. Gmundner Fertigteile GmbH & Co KG

We talked about BODAN level crossing solutions with Zdravko Zdunić, Executive director of RMT GRUPA and Roman Wiesinger, international sales manager for BODAN systems in Gmundner Fertigteile.

What is BODAN system?

BODAN level crossing solutions are innovative, sustainable and efficient solutions that increase safety at level crossings. They are characterized by a rough and anti-slip surface, material resistant to salt,





water, oils, acids, alkalis, weather conditions; the life time of the panels is higher than 25 years, low maintenance costs and enable interoperable use, regardless of the type of track and sleepers.

What material is BODAN made of

It is made of polymer compound which is more solid than standard concrete with even higher flexibility and tensile strength.

What design methods is BODAN utilizing?

The so-called BRIDGE DESIGN which means that the panels are held by rubber profiles in the rail web & the edge beam only and do NOT touch the sleeper. Due to this design method BODAN can be used at any type of sleeper, any type of rail profile and any type of fastening system.

What happens to the weight of crossing vehicles?

The weight / load of any vehicle is distributed from the panels to the rail into the dedicated zones (under the rail) of the sleeper. The sleeper centre is never loaded, so no weight is forcing the sleeper to be damaged.

Why is independency of the rail/sleeper/fasting important?

The BODAN system is designed in a way that it can be used at every destination. Each panel has identical dimensions and is installed at any type of rail, any material and type of sleeper and any sort of sleeper fastening the same way. Even when a lc is being relocated or rail profiles are changed, the same panels can still be used!

What is the life time and life cycle costs of BODAN?

Due to the material characteristics of Polymer compound, the life time of the panels is higher than 25 years. Depending on the amount and load of traffic, only the rubber profiles need to changed (recommended when track maintenance is being carried out) ... the panels are used furthermore. Due to this unique low amount of maintenance the life cycle costs (LCC) in a period of 15-20 years are much lower than solutions of competitors.

How can I add markings or different colours to the BODAN system?

On one hand side the panels can be built pre-coloured in the production facilities or markings can be added on site by using standard road paint.

What kind of weight can BODAN be loaded with?

Each panel can be loaded with wheel, loads of up to 15 tons (which is more than allowed on official roads).

Can I cover also two tracks and the section in between?

Yes, single and even multi track pavement is applicable with the BODAN solution. Also in turnout sections the same panel design method is applied in order to have the same quality at any zone. •



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CONFERENCE AND CONGRESSES

International Scientific Conference – "The Science and Development of Transport – TRANSCODE 2025"

It is our pleasure to invite you on the 22nd International Scientific Conference – "The Science and Development of Transport – TRANSCODE 2025", to be held on December 11th–12th, 2025 at Hotel International, Zagreb, Croatia.

TRANSCODE is organized by the Faculty of Transport and Traffic Sciences, University of Zagreb, and has earned international recognition as one of the region's leading conferen-



THE SCIENCE AND DEVELOPMENT OF TRANSPORT

ces in fields of transport, logistics and aeronautics. The conference brings together around 200 participants annually from approximately 20 countries, supported by a distinguished International Programme Committee.

TRANSCODE provides a unique platform for networking, sharing current insights, and promoting innovative solutions in transport and logistics. It continually bridges the gap between scientific research and practical implementation, encouraging advancements that impact daily business operations and society at large.

The conference topics encompass a wide array of relevant themes, including sustainable mobility, logistics, traffic safety, applied data science, artificial intelligence, transport management, process automation, and improving competitiveness in the transport and logistics services market. With a rich history of successful events, the Faculty of Transport and Traffic Sciences has been recognized by numerous institutions, businesses, and associations for its continuous contributions to advancing these critical sectors.

As TRANSCODE enters its next chapter, we are focusing on "*The New Era of Transport & Logistics: Balancing Technology, Sustainability, and Accessibility*". This theme aims to address the evolving challenges and opportunities within the transport sector, fostering dialogue among scientists and practitioners to inspire meaningful innovation.

PUBLICATION OPPORTUNITY

SAll accepted papers will be published in the *Transportation Research Procedia* by Elsevier publishing house. Additionally, authors whose papers are accepted for TRANSCODE 2025 will receive a 25 % discount on potential publication in the journal PROMET – Traffic & Transportation (referenced in SCIE, WoS).

Participants from institutions with active project cooperation with the Faculty of Transport and Traffic Sciences, University of Zagreb, are eligible for a 15 % discount on all conference fees (excluding Accompanying Persons).

Important dates:

Deadline for paper submission: **May 15th, 2025** Notification of paper acceptance: **June 30th, 2025** For more details, please visit the TRANSCODE website or follow us on <u>LinkedInu</u>, <u>Facebooku</u> and <u>Instagramu</u>!

Best regards, The Organizing Committee



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