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28–30 April 2014, Split, Croatia

## Road and Rail Infrastructure III

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## THE IMPLEMENTATION OF INTELLIGENT INFORMATION SYSTEMS TO INCREASE SAFETY IN RAIL LEVEL CROSSINGS

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### Abstract

On the HŽ-Infrastructure network there are total 1503 level crossings (LC). LC are the intersections of rail and road traffic in the same level. As such they represent a point of high risk on which often comes to extraordinary events with the worst consequences. The most common accidents are caused by motor vehicles drivers (95%), who are unfortunately the most endangered in railroad accidents. Raising safety awareness to a new level is carried out with technical and technological solutions and actions that encourage traffic discipline, drivers and pedestrian culture when crossing the rail tracks. To improve traffic information provided to vehicle drivers, it's necessary to implement intelligent information system (ITS-Intelligent Information Services). Intelligent Information Services is the provision of timely and effective information of dangerous situations (real-time warning systems). In this work is presented application of the level crossing geo-referenced data, on a HŽ Infrastructure railway network, to ensure accurate and timely information delivery to drivers arriving at the level crossing.

*Keywords: level-crossing, geo-referenced data, improve safety, HŽ-Infrastructure*

### 1 Introduction

Level crossings (LC) are the intersections of rail and road traffic in the same level. Therefore they represent a point of high risk in which often comes to accidents with the worst consequences. Participants of road traffic often suffer from accidents on LC, although in accidents of heavy road vehicles and rail passenger trains can also cause serious injury to passengers and railway workers, and major damage to vehicles in railway transport. Number of killed and injured people, significant material damage due to vehicles damages (road and rail), and significant losses (economic and time) because of the traffic stop - indicate the seriousness of the problems of security and regularity of traffic on the LC.

Table 1

Year	2007.	2008.	2009.	2010.	2011.	2012.	2013.
Number of killed	12	9	15	7	15	8	11

Table 2

Year	2007.	2008.	2009.	2010.	2011.	2012.	2013.
Seriously injured	12	15	17	10	8	15	12

Raising safety at level crossings is implemented with technical and technological solutions and campaign that encourage traffic discipline and drivers or pedestrian habits when crossing the tracks. Although in crashes of train and road vehicles the most vulnerable are precisely drivers of road vehicles, astonishingly, they are the ones who blame for 98% of accidents at level crossing. An additional astonishing fact is that many semi-barriers, which enable the highest level of security, are damaged. Although only 23%, of total number of level crossings on HŽ-Infrastructure network, are secured in this way. Comparable data of accidents on the LC in Croatia, Slovenia, Austria, Germany, France and Denmark are presented in Table 4.

**Table 3**

Year	2007.	2008.	2009.	2010.	2011.	2012.	2013.
Broken semi-barriers	682	670	706	613	572	534	518

**Table 4** The number of Level-crossing accidents relative to train km

Year Country	2011.	2012.
Croatia	0,70	0,69
Slovenia	0,29	0,40
Austria	0,28	0,24
Germany	0,05	0,07
France	0,08	0,07
Denmark	0,03	0,08

\* according to – ERAIL (European Railway Accident Information Links)

It is therefore necessary, in addition to technical solutions and campaign that promote drivers culture and the respect of traffic signs, improving system of informing drivers of road transport by establishing smart information systems.

## 2 Program and campaign for solving LC problems

### 2.1 Program for solving LC in RC

Level crossings or rail-road crossings, in security terms are the critical point of the rail and road transport network, and so the quality of solutions should definitely relate to both branches of traffic. They are the main entities that are responsible for the implementation of this program together with the local authorities interested in the general security of the local population. For all these reasons the Department of railway traffic of Ministry of Sea, Transport and Infrastructure has launched an initiative to create the measures and activities related to systematic and continuous solution to the traffic safety on the LC, which is in cooperation with the working group from HZ-infrastructure resulting in the document entitled "Program of solving LC in the Republic of Croatia" (Program).

The Program was conceived as a national program, which is one of the preconditions for a systematic problem solving of LC in big traffic system (HŽ, HC, ŽUC), all administrative, organizational and technological levels of local communities. This Program makes up one segment of the entire "National rail infrastructure program".

The Program has processed the range of technical and technological solutions on the LC; ensuring safety with light/audible ringing signals and half barriers, the removal of crossings with or without reduced roads construction and two-level constructions.

The Team for solving the level crossing issues in HŽ-Infrastructure during the last years, 2007-2013.g., achieved significant results with technical solutions foreseen in the Program:

- 105 – ensuring safety with light/audible ringing signals and half barriers;
- 64 - removal of crossings with or without reduced roads construction;
- 8 - two-level constructions.

In the upcoming period enhanced investments are going to be in this area. Making of a new 5-year 'Program for solving LC' and better cooperation with local governments, as well as Croatian Roads and County Road Administration - will contribute to the acceleration of solving level crossing issues according to the Program.

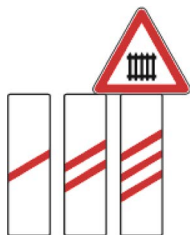
## 2.2 Campaign "Train is always faster"

Educational and promotional campaign 'Train is always faster' HŽ-Infrastructure carried out since 2000 year, in collaboration with Police Departments and primary schools across the Croatian. The target groups of this campaign are; the drivers of road vehicles, school-age children, the local community and media.

Statistics shows that with the increase in the level of security at level crossings does not decrease number of accidents in the same proportion. The general trends are educational-marketing activities aimed at raising awareness of traffic participants. Also, since 2011 HŽ-Infrastructure has actively participated in the campaign marking the International Level Crossing Awareness Day (ILCAD). The campaign synchronizes International Union of Railways in collaboration with the European Commission, in order to change misperception that level crossings accidents are a problem only for railways companies. Program and campaign have achieved many positive effects, and maintain a state without a significant increase in accidents at level crossings in a time of increasing the number of road vehicles and a hectic pace of life.

## 3 Proposal for increasing security

Existing methods of warning drivers about approaching LC are only with the road signs of approaching the rail, in the 240, 160 and 80 meters before the rail (Figure 1 and Figure 2).



**Figure 1** Approaching the level crossing with barriers or semi-barriers.



**Figure 2** Approaching the level crossing without barriers or semi-b.

Those signs according to the 'Regulations on traffic signs, signals and equipment on the roads' belong to the group of 'signs for dangers', which stipulates that participants in road traffic approaching to a place where they could be in danger.

Because of the astonishing fact in which motor vehicle drivers are blamed for 98% LC accidents, it is obvious that we need better solutions in alerting road drivers.

The European Parliament 2010<sup>th</sup> is adopted the 'Directive 2010/40/EU' - on the implementation of intelligent transport systems in the field of road transport and interfaces with other types

of traffic. The goal is improving system of informing drivers of road transport by establishing smart information systems (ITS- Intelligent Information Services). It is a time efficient, informative and effective warning about possible dangerous situations (real-time warning systems). The information system must be interoperable, applicable and available to as many drivers as possible. Smart information systems are part of the everyday life of the majority of EU citizens. Accurate and timely information about dangerous situations in traffic will help us to increase the level of traffic safety but also to increase the efficiency of the transport system.

ITS which would inform road drivers of approaching the level crossing can be carried out by using geo-referenced data of level crossing on the HŽ-Infrastructure network.

## 4 Technical solutions for increasing security on LC

### 4.1 Data collection and processing

Existing data about LC in HŽI has conducted in tables, and for database is used Microsoft Excel. It is good enough for all current and planned future needs and is due to the simple architecture and data using, selected for further use.

Each LC is assigned my unique identifier in the form of a new column ID. In the database terminology, the primary key of a relational table uniquely identifies each record in the table. In this paper we have used a data of the level crossings on wider area of Zagreb.

Absolute positioning via GNSS devices with the possibility of receiving corrections of EGNOS system is chosen for data collection method. During storage in memory, handheld computer, with the number of points and coordinates, each recorded point is assigned an attribute name ID of a level crossing according to the database.

Geo-referencing is aligning geographic data to a known coordinate system so it can be viewed, queried, and analyzed with other geographic data. The collected data are transmitted to a computer with the help of software solutions Trimble GPS Pathfinder Office, and the result is a text file (CSV) with a list of points, the corresponding coordinates (E, N) and a unique ID of each LC. The road navigation and web applications (Google Maps / Earth, OpenStreetMap) use the World Geodetic System (WGS84) datum as the underlying coordinate system for navigation purpose and imagery base (spatial coordinate's  $\phi$  and  $\lambda$ ).

To transform rectangular coordinates in Croatian coordinate system to WGS84, official program of Republic of Croatia State Geodetic Administration, T7D for coordinate transformation (Figure 3). For simplicity's sake and difference between HTRS96 and WGS84 coordinates (which is irrelevant for this work), HTRS96 is used.

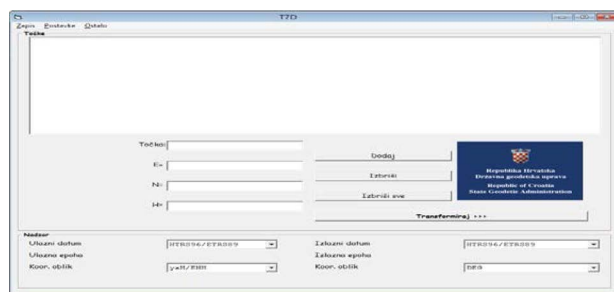


Figure 3 The official program of the SGA to coordinate transformation - T7D

Coordinate transformation converts data to an ASCII file containing the aforementioned geographic coordinates in hexadecimal system (decimal degrees). The prepared data are ready for use in navigation devices.



## 4.2 Application for inform drivers of road vehicles

Orientation and navigation has never been easier than today, using GPS technology. Whether for the protection of life, reaching destination faster, entertainment or any other use you can imagine. GPS navigation is becoming an increasingly important in everyday use.

Points of interest (POI) are points stored in GPS device memory called “waypoints”. House, Airport, Level Crossing or famous cultural - historical places that you would like to re-visit are some of the examples of positions that can be saved and later found. In GPS-receiver memory can be created points that show places where you were and GPS-receiver becomes a navigational device showing users the way to go.

For the purpose of informing drivers of road vehicles on the arrival of the railroad POI file for Garmin devices was created. POI file, for each location contains a name, a brief description and coordinates. Attached file could be a picture that will be displayed on the map at locations in the POI file. Sound warning for vehicle drivers is designed out of the soundtrack to alert drivers to the presence of LC (a combination of audible warning light-sound devices and quotations from campaign “Train is always faster”).

Using the POI Loader (Garmin’s free program to record the waypoints in the device) and prepared files, we made POI files with proximity detection (garminZCPZagrebwav.gpi). Proximity detection is set so that you’ll be automatically notified when you’re approaching 100 m of the level crossing. With the same program POI file is transferred to internal memory of a GPS device to be used in road navigation (Figure 4).

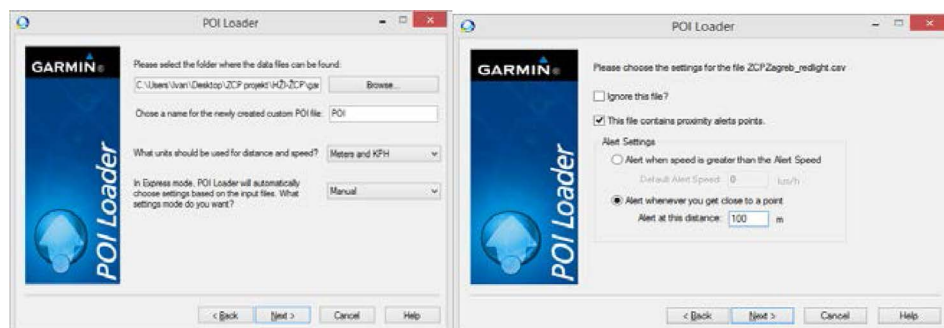


Figure 4 An example of the POI file

Short film attached to this paper, shows how road navigations works with the included POI files and audio-visual experience of road drivers when encountering the level crossings.

## 5 Other possibilities of using geo-referenced data on LC

### 5.1 Improving LC records

Spatial data obtained this way can be used to connect each LC with DGU Geoportal or display that combines following layers: digital orthophoto maps, spatial units, digital cadastral and others.

When user in Excel “clicks” on a prepared link, default web browser is started with preloaded view centered exactly on the level crossing. From the DGU Geportal for each LC were extracted attribute data on the number of the cadastral parcel and the name of cadastral municipalities (Figure 5).

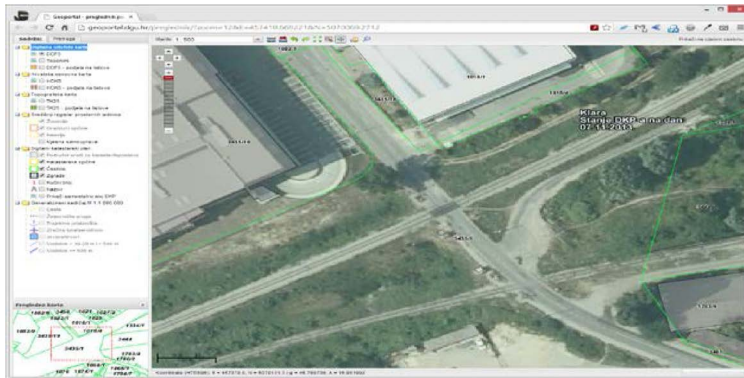


Figure 5 Web browser view centered on the level crossing

## 5.2 Use of LC data on the Internet

By collecting data on the field every level crossing was photographed four times;

- a perpendicular to the axis lines, right side of the railroad chainage;
- b in the direction of the tracks, toward the beginning chainage;
- c in the direction of the tracks, toward the end chainage;
- d perpendicular to the axis lines, left side stripes .

Each photograph generic name has been renamed so it contains ID and photographing direction (ID-A, ID\_B etc). To view photos online, these were transferred to the Internet using Google services, Picaso Web Albums. The same allows free storage, and makes sharing photos a snap. For each photo automatically generated web address was merged with LC database imported in Google Fusion Tables. So in the browser we have all the data from basic Excel table with pictures for each level crossing (Figure 6).

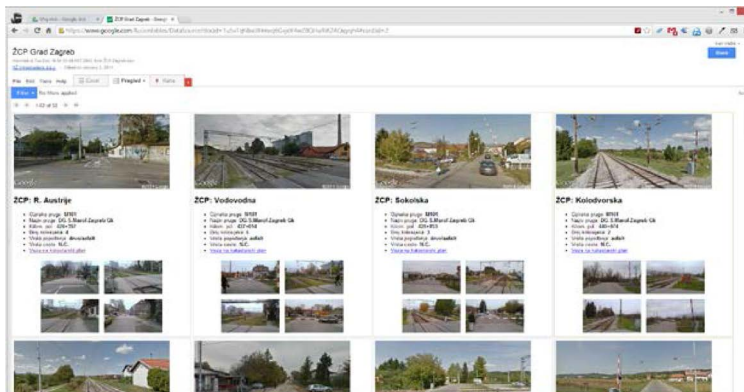


Figure 6 View data of level crossings

By adding view cards in Fusion tables we can visualize LC data on Google Maps (Figure 7). The red dots on a map represent LC's locations. Each dot is interactive, and by clicking on each one you can open an information window with basic information about level crossings.

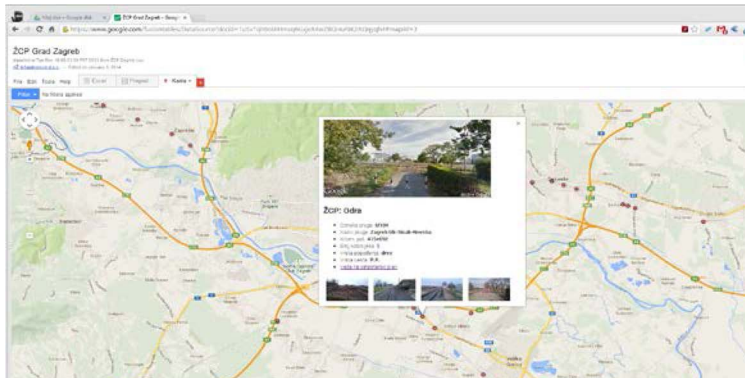


Figure 7 Data Visualization of LC on the map

It is also possible to filter the data so that at any moment user can make queries depending on particular needs, and for all attributes defined in the database. If you wish to display data of pedestrian crossings in the filter, select attribute PP and choose find and Fusion Tables shows the map with filtered data of pedestrian crossings.

## 6 Conclusion

The level crossings are potentially dangerous point because of its specificity, and the crossing of two types of traffic at the same level. Increasing the safety of movement of vehicles and pedestrians are carried out by technical and technological solutions, and campaign that encourage traffic discipline and drivers or pedestrian habits when crossing the tracks. The number of deaths and injuries, and especially the number of avoided accidents (broken semi-barrier) illustrate the need for additional improvements. By using new technologies it is possible to achieve improvement of the system informing drivers of road vehicles on the dangers when approaching the level crossing. Development of technology simplifies usage of navigation devices in everyday life.

Collecting and processing geo-referenced data on the level crossing network Railways Infrastructure, it is possible to use them as an Intelligent Information Services to inform drivers to approach level crossing. Because of facts that vehicle drivers are the ones to blame for 98% of accidents at level crossing, it can be expected that use of ITS can reduce the number of accidents at level crossings. Collected spatial data can also be used as improvement of information about level crossings, and in every work of Railways Infrastructure employees, external traffic experts, police, local government, etc.

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