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EXPERIENCES ACQUIRED IN THE COURSE OF DESIGNING AND EXECUTION OF WORKS ON RECONSTRUCTION OF LEVEL CROSSINGS WITHIN THE SERBIAN RAILWAY LINE NETWORK

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Abstract

Due to increased traffic, which especially refers to road traffic, intersection of main roads with railway lines, i.e. level crossings, represents dangerous points with frequent irregular events. Analysis of these accidents primarily identifies human factor as primary cause, while other reasons such as current state of pavement, vehicles or equipment are often disregarded. Basic requirement for level crossings safety defining is reduction of number of accidents. There are different methods for achieving this goal and they depend on both existing and required on level crossing safety levels. Therefore, reconstruction of level crossing in sense of scope and quantity of necessary works is very specific process, having in mind that obstruction of both railway and road traffic should be minimized and at the same time performance of level crossing (construction and interlocking) must be optimized.
There are several criteria to be considered for improving interlocking system on level crossing: frequency of traffic, location of level crossing, interlocking level on the railway line, adjacent stations etc. This paper presents certain experiences for selection of adequate interlocking system for level crossing (according to theoretical model and experiences).
From the aspect of railway traffic, in the course of designing and execution of works on level crossing the existing state of railway infrastructure and traffic will be analyzed on the basis of which technological requirements for designed solution will be defined. This procedure will enable faster, more reliable and safer traffic flow over the level crossing (both railway and road). Organization of railway traffic and other railway related services during the execution of works will be prescribed in coordination with corresponding departments of the Serbian Railways, and organization of road traffic in coordination with corresponding road maintenance authority.
This paper finally shows that through designing process and execution of works higher safety level can be achieved. The experiences gained during development and implementation are summarized and also shown in the paper herein.

Keywords: railway and road traffic, level crossing, safety, reconstruction.

1 Introduction

Level crossing represents weak spot for both traffic modes – road and railway.
There are many level crossings on the road and railway map of Serbia which are “forgotten” (ie. poorly maintained) and which require increase of safety level, ie. reduction of irregular events probability.
Analysis of the level crossing present state from the aspect of safety gives conditions for further application of relevant measures for increasing the safety and interlocking level on

the level crossing. The applied measures are in accordance with traffic-technological, civil engineering and electrical criteria.

2 Specific activities in project phases

Standardized project for increment of safety level on level crossings located on the Serbian Railway Line Network should include as follows:

2.1 Analysis of the level crossing present stateConceptual design
2.2 Final design
2.3 Building permission
2.4 Construction and/or reconstruction of the level crossing

Each of the above mentioned item is important in fulfilling the final goal – increasing the safety level on the level crossing and therefore has to be fully implemented.

2.1 Analysis of the level crossing present state

Concerning traffic flow technology this analysis should include as follows:

- Location of the railway line and road intersections together with category of both railway line and road,
- Intensity of both road and railway traffic on the level crossing,
- Means used for road and railway traffic regulation,
- Irregular events on the level crossing (number, type, causes and material and non-material costs),
- Traffic flow technology on the both railway line and road fully in accordance with the Law on Traffic Safety and relevant Codes.

From the aspect of reconstruction, there are several factors which directly affect the selection of measures to be applied for the purpose of safety level increment such as:

- Location of the track in relation to the road in the level crossing area:
  - Tangent track – enables good visibility for vehicles from both directions
  - Curved track – incoming vehicle from the outer side of the curve has better visibility than the vehicle coming from the inner side
- Level crossing over more than one track:
  - Mostly in urban or station areas characterized with certain disadvantages. They require correction of reference level, special type of interlocking system and regular maintenance. Regulation of railway traffic is also required so as time of crossing could be optimized (Figure 1).
- Type of pavement structure
  The applied pavement structure types on the Serbian Railway Network are as follows:
  - Crushed stone, macadam (older solutions in rural areas on low category lines characterized with small frequency of road traffic)
  - Wooden sleepers (also older solution on the railway lines with higher frequency of railway and road traffic)
  - Asphalt (applied in the case of intersection with higher category roads – regional and arterial, with frequent road traffic)
  - Reinforced concrete slabs (for heavy traffic load – Figure 1)
  - Combinations of the above-mentioned types

Figure 1

Figure 2

From the electrical aspect, the present state analysis shall include as follows:

a Analysis of the interlocking system installed on the line section on which the said level crossing is positioned (e.g. standard interlocking system together with station interval, station interdependence with or without CTC, Figure 2, automatic block with or without CTC and examination of possible incorporation of the level crossing into the said interlocking system (adjustment level between interlocking devices installed on the line and complexity of interface required for connection, if needed)

b Analysis of the signaling-interlocking system installed in the railway station for level crossing control (e.g. mechanical signal box, electromechanical interlocking, relay interlocking, electronic interlocking) and examination of possible incorporation of the level crossing device into the said signaling-interlocking system (adjustment level between interlocking devices installed on the line and complexity of interface required for connection, if needed).

c Determination of the level crossing location in relation to other interlocking devices installed on the railway line (on the open line-outside distant signals, between distant and main signal, between main signal and first point, inside station tracks) and selection of the possible level crossing interlocking device type (AHB/AHBTC, SHB/SHBTC, DOHB).

In accordance with the stated analysis, technological requirements for the designed solution should be defined. These requirements must include all elements required for interlocking device to be installed on the level crossing together with required civil engineering structures that should be reconstructed as well as specific details of the certain level crossing resulting from requirements set by the Investor.

2.2 Conceptual design

The purpose of the Conceptual design is to inform the Investor about all possibilities required for level crossing present state improvement and to give preliminary cost estimate for the proposed works after the technological requirements have been fulfilled. Shortly, the design herein shall include layout and leveling plans required for execution of civil engineering works as well as cable plan of electrical works and definition of all other indoor and outdoor interlocking devices required for improvement of safety level on the specific level crossing.

2.3 Final design

This phase is a next step in the process of technical documents preparation. The conceptual design is accepted by the Investor in all aspects and analyses are carried out through more detailed level. It contains technological requirements fulfilled in traffic, civil works and electrical designs. From the electrical aspect, the Final design has to define all elements requi-

red for interlocking device: calculation of activation points, indoor and outdoor equipment requirements, cable network and cable calculations, cable plan, protection at work, mounting conditions, detailed bill of quantities and cost estimate, disposition of indoor and outdoor equipment.
Since in this phase the design engineer is expected to propose methodology of works execution together with time schedule, it is suppose to be a very difficult task since Contractors are those who dictate final time schedule and cost of works.
The designed solution offers new faster, more safe, more reliable and more accurate organization of both railway and road traffic.

2.4 Building permission

After the Final design has been reviewed and conditions and approvals of competent authorities and other public enterprises obtained, it should be necessary to provide building permission from the Ministry of Infrastructure (or approval for reconstruction in a case that the present level crossing is provided with certain signaling-interlocking system).

2.5 Construction or reconstruction of the level crossing

In accordance with the public tender procedure, the Investor should select the Contractor. Construction or reconstruction of the level crossing shall depend on financial capability of the Investor to execute all works specified in the Final design. There are very few fully completed projects. Most of them are completed through phases (interlocking works are completed while civil engineering works mostly include change of pavement type with minimum of works to be performed on both railway line and road).
In the course of execution of works on level crossing reconstruction, methodology of execution and organization of railway traffic shall be defined in cooperation with relevant departments of the "Serbian Railways" Public Enterprise. Issuing the permits for commencement of works, speed limitations, track closure and re-opening, as well as defining behavior rules in the area of work execution are in the competence of the "Serbian Railways" PE and fully in accordance with time schedule for works.
Moreover, temporary traffic organization measures about which railway staff and users of railway traffic should be informed in due time must be defined.
Reconstruction from the electric aspect includes upgrading of the present interlocking system installed on the level crossing. After decision on reconstruction has been made, standard procedure that shall result in selection of category and sub-category of device to be installed on the level crossing shall be apply. The same shall apply in the course of tender procedure when supplier of equipment shall be selected. In addition to basic law requirements for these types of works, in defining of conditions for interlocking device some specific requirements also have to be fulfilled in order to harmonize the whole reconstruction process:

1 New interlocking device must be provided with increased safety level in addition to the present device.
2 New interlocking device must be provided with additional functions
3 Easy use for operators and maintenance staff
4 New interlocking device must have smaller power consumption
5 Level crossing closure time must be reduced etc.

If during the execution of works, road traffic has to be redirected to the temporary level crossing positioned near the existing level crossing (so called "deviation", see Figure 3), it should be defined whether this deviation has also to be equipped with certain interlocking device (usually simple device operated by an authorized person appointed by the "Serbian Railways" PE).

Figure 3

3 Problem identification and solving

It is very difficult to predict all problems that could arise at the very beginning of the design process. However, all issues that emerged in the course of design preparation and execution of works were successfully solved, and they never occur again in later projects. First issue that came out was how and in what conditions rubber panels should be installed on the Serbian Railway Network. This issue was justified since technology of works in this case is supposed to be different on Serbian Railway Network than abroad. The main difference was in the existing state of the railway track, observed from the national standards aspect.
Simply said, railway infrastructure of the "Serbian Railways" PE requires firstly overhaul works on substructure and superstructure, and then partial reconstructions which are not included in the overhaul works, or where existing level is satisfactory. In cases where overhaul works were executed prior to mounting works, rubber panel mounting was both simple and short. But in cases where overhaul works were not performed, it is necessary to separate railway works from the road works and to ensure safe traffic flow. It means that railway track had to be overhauled in the defined zone of works, then pavement need to be prepared for rubber panels mounting, and road works completed after panels were mounted.
Road traffic organization during mounting works is enabled through the installation of temporary signaling equipment. The selected Contractor is obliged to install the said equipment according to the design, to inform in due time all authorized authorities (police, municipality, road operators etc.) about beginning and duration of works and finally to remove this equipment after work completion. Placing of permanent signaling equipment is also under the competence of the Contractor, as specified in the design.

Electrical reconstruction also opened some questions, some of them were:

a Design of possible interface between level crossing interlocking device and automatic line block or station interlocking device (in case of technologically different devices, e.g. electronic level crossing devices applied on the relay interlocking railway lines)
b Increased requirements of power supply stability and environmental conditions stability (temperature, pressure, humidity, induced voltage from catenary etc.) for electronic level crossing devices
c Compatibility between level crossing devices from different suppliers on the same section of railway line
d Surpass of limitations or unwanted mutual interaction between some older outdoor interlocking devices (e.g. treadles) and new level crossing interlocking devices

4 Conclusion

Reconstruction and improvement of level crossing interlocking system is a process influenced by numerous input parameters (sub processes). Optimizing their management we can reach unique decision about every single level crossing. Forming the unique database of level crossings with previously adopted technical and technological requirements to be fulfilled. The cost estimation according to the type of equipment and works (civil works, electrical and traffic) in the long term period, is a good way to make decisions. After completion of works, correctness of every single decision can be comparatively assessed as a base for modifications in future projects approach.

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