The Model of Railway Crossings as Areas of Analyses of Hazard Risk Management

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Railway crossings are included in transport infrastructure designated by junction of railway lines with public roads, which are crossed on the level of rails. At railway crossings numerous hazards of losses/damages and harms to people and objects - participants of land transport are generated. For the requirements of risk management at railway crossings, RC-RISK method (Railway Crossing - Risk) has been worked out. This method is the implementation of the integrated TRANS-RISK method of risk management in transport. This article presents the model of railway crossings as areas of analyses in RC-RISK method. The model of railway crossing in RC-RISK method is a result of implementation of the rules of accepted formal scheme of description of railway crossing. This paper presents this formal scheme of description identifying railway crossings. General and particular rules of identification of elements of the model of railway crossings are also presented. Created model consists of 13 fields considering selected legal, technical and local conditions of the operation of railway crossings. The Poznań Railway Junction is presented. This junction includes 39 railway crossings and passages. On the basis of the railway crossing located in Krzesiny Street, the application of the model as areas of analyses of hazard risk management with RC-RISK method is presented on the basis of the railway crossing in Krzesiny Street.

Keywords: railway crossings, risk management, areas of risk analyses.

1. INTRODUCTION

Railway crossings and passages are significant elements of infrastructure of land transport. In this paper railway crossings and passages are considered as sets of objects connected with crossings of railway lines with public roads, which are crossed on the level of rails.

Poland has 19 thousand kilometres of railway lines, on which 16 thousand railway crossings and passages occur. They are areas in which hazard of losses/damages to people and object – participants of land transport - are generated. Activation of those hazards leads to undesirable events. According to [8] in first half of 2012 at railway crossings 107 undesirable events were noted, in which 19 people were injured and 15 people were killed.

The requirement to reduce contingency of hazard activation at railway crossings is obvious as well as to reduce effects of undesirable events. Following this requirement and implementing general rules of Integrated Safety Transport System, RC-RISK method (Railway Crossings – Risk) of hazard risk management at railways crossings was worked out. The algorithm of implementing RC-RISK method consists of a few steps. One of the steps of this algorithm generates detailed processes, procedures and models of RC-RISK method of hazard risk management at railway crossings. The model of railway crossings as areas of analyses in hazard risk management is one of the models of RC-RISK method.

The purpose of this article is to present the model of railway crossings as areas of analyses in RC-RISK method of hazard risk management at railway crossings.

Realizing the purpose of this article the following items are further presented:

– general and particular rules of the scheme identifying the areas of analyses for the requirements of hazard risk management at railway crossings;

– application of particular rules of the scheme identifying the areas of analyses of hazard risk on the basis of selected railway crossing.

2. THE RULESS OF THE SCHEME IING THE AREAS OF ANALYSES FOR THE REQUIREMENTS OF HAZARD RISK MANAGEMENT AT RAILWAY CROSSINGS

2.1. GENERAL RULES OF FORMAL SCHEME OF DESCRIPTION OF RAILWAY CROSSING AS AREAS OF ANALYSES OF HAZARD RISK

Legal acts referring to railway crossings comprise standards regulating the rules how users of railway crossings and service staff should proceed at railway crossings. Technical and local conditions that railway crossings should meet are also defined.

The formal scheme of description of railway crossings and passages was worked out, among others, on the basis of legal regulations [1,2,3]. Regulation [1] includes classification of railway crossings and passages. Regulation [1] presents as well, conditions of designing and constructing railway crossings and passages, constructing grade-crossing gates and technical conditions of their illumination. Regulation [2] includes classification of public roads. Guidance [3] presents, among others, general rules of equipping railway crossings with appliances safeguarding traffic.

On the basis of legal regulations, the most important groups of information influencing appropriate operation of railway crossings were selected for formal scheme of description of railway crossings.

For identification of railway crossings, among others, information about the category of railway crossings and applied appliances were used. In the scheme it is recommended to take into account all factors influencing appropriate operation of the areas of analyses such as illumination of railway crossings and track ways, designating railway crossings from the direction of the access road and from the direction of the track and the visibility of railway crossings. It is also suggested to give information about the condition of the pavement at railway crossings and of access roads and technical parameters of the railway line.

2.2. DETAILED RULES OF FORMAL SCHEME OF DESCRIPTION OF RAILWAY CROSSINGS AS ANALYSES OF HAZARD RISK

The idea of formal scheme of description of railway crossing is to clearly state all parameters of railway crossing. Properly filled in scheme is used to assess the operation of the areas of analyses. Data included in the scheme will be used for identification of the sources of hazard. The identification of the sources of hazard on the basis of description of technical conditions (illumination of railway crossings, traffic ratio, etc.) and local (maximum speed on the access road and the railway line, the condition of the pavement at railway crossings) aims at reducing contingency of occurring undesirable event or at reducing effects if undesirable effect happens. Formal scheme of description of railway crossings is presented in table 1.

Table 1. Formal scheme of description identifying railway crossings

No.	The name of a field of the scheme identifying the railway crossing	Characteristics of a field of the scheme identifying the railway crossing
1	Location of the railway crossing	The name of the street – district
2	No. of the railway line / Speed on the railway line	The number of railway line and the maximum allowed speed of trains on this line
3	Access road	Road category (national, province, county, commune) /type of pavement on the road /allowed speed [km/h]
4	Category	Category of the railway crossing: A, B, C, D or E
5	Applied appliances	Traffic lights, acoustic appliances, closed-circuit television camera
6	Location of buildings	Non-built-up area or distance from railway crossing to the nearest building [m]
7	Number of tracks	Single-track , double track, many-track {number of tracks} railway crossing
8	Condition of the pavement	Assessment of the pavement condition: very good, good, acceptable, bad
9	Types of pavement	Concrete slabs, rubber surface
10	Illumination	Illumination of the access road and illumination of the railway crossing

11	Visibility	Limited visibility of the railway crossing from the direction of the access road (bushes, trees, advertisements, buildings)
12	Traffic ratio	The value of traffic ratio
13	Remarks	Additional information

Source: own work

Detailed rules of wording information included in fields of formal scheme of description identifying railway crossings are presented below.

Field 1. Location of the railway crossing – the name of the city and the street in which the analysed railway crossing is located.

Field 2. No. of the railway line / Speed on the railway line – the number of railway lines and maximum speed on this line

Field 3. Access road to the railway crossing – division of the roads because of category according to [2] (national, province, county, commune roads) and the type of paving on the access road: surfaced road for pavements such as: concrete, asphalt, cobblestone etc. and unsurfaced road for gravel road, sand road etc. Maximum allowed speed on the road.

Field 4. Category of the railway crossing according to [1]:

- Category A – for railway crossings with grade-crossing gate (semi-grade-crossing gate) closing the whole width of the carriageway. Type of service at the railway crossing: on the spot or remote.
- Category B – for railway crossings with automatic traffic lights and with semi-grade-crossing gates.
- Category C – for railway crossings with automatic traffic lights .
- Category D – for railway crossings equipped with warning signs.
- Category E – for railway passages for public use.

Field 5. Applied appliances – type and number of appliances applied at railway crossings depends on the category of the railway crossing and on local conditions. Those appliances include:

- Traffic lights – single or double red light on the pole in front of the railway crossing.
- Acoustic appliances – audible signal informing the users of the railway crossing about approaching train.
- Close-circuit television cameras – image from the cameras is transferred to gatekeeper or train dispatcher.

Field 6. Location of buildings around the railway crossing – approximate distance in meters of the nearest building from the railway crossing and its function (dwelling building, factory, plant, business premises etc.).

Field 7. Number of tracks – type of railway crossing regarding the number of tracks: single-track, double-track or many-track railway crossing. Number of tracks in many-track railway crossing/number of tracks leading to a side track.

Field 8. Condition of the pavement – assessment of the condition of the pavement with the following grading scale:

- very good – lack of unevenness between the access road and the railway crossing,
- good – holes in the access road by the railway crossing,
- acceptable –rails sticking out of the slabs of the railway crossing,
- bad – holes in the access road by the railway crossing and in the pavement of the railway crossing or/and rails sticking out of the pavement of the railway crossing.

Field 9. Type of pavement at the railway crossing – concrete slabs or rubber surface**.**

Field 10. Illumination of railway crossings– number (2÷7) of lamps illuminating the railway crossing and additionally number of lamps illuminating the tracks. Information about illumination of the access road.

Field 11. Visibility – number and location of: advertisements (billboards), bushes, trees growing by the railway crossing and reducing visibility of the railway crossing from the access road or reducing visibility of the front of the train approaching the railway crossing. Location of the railway crossing in case it has influence on visibility i.e. location of the railway crossing in excavation or on a bend.

Field 12. Traffic ratio at the railway crossing– the value of traffic ratio i.e. ratio of average daily road traffic or rail traffic volume or alternatively defining as: high, moderate or little road traffic.

Field 13. Remarks – important information not included in other fields but influencing the operation of the object such as pedestrian traffic zoned places for pedestrians, information about location of the railway crossing in the vicinity of railway station, tram terminal etc.

3. APPLICATION OF THE FORMAL SCHEME OF DESCRIPTION IDENTIFYING THE AREAS OF ANALYSES OF HAZARD RISK ON THE BASIS OF SELECTED RAILWAY CROSSING

3.1. GENERAL RULES OF FORMAL SCHEME OF DESCRIPTION OF RAILWAY CROSSING AS AREAS OF ANALYSES OF HAZARD RISK

Railway lines represent railway infrastructure of linear characteristics. Their system comprises the area of the whole country and is connected with transport systems of neighbouring countries [11]. Railway lines comprise surface, roadbed, appliances safeguarding railway traffic and controlling train movement and appliances supplying power to electric traction [11]. Railway system is a set of railway lines bounded with operation points together with appliances necessary to carry out transport tasks and movement tasks [12].

Poznań Railway Junction integrates eight railway lines listed in table 2. From this list it can be found out that only one line – line number 356 (table 2) is a non-electrified line. In June 2011 this line was closed for modernization. Except railway lines listed in table 2, railway line (junction) number 395 between station Zieliniec and station Kiekrz included in national railway line number 351 goes through Poznań. Freight trains from Szczecin and Piła shuttle on this line to shunting yard in Franowo bypassing Poznań Central Station.

Five out of eight railway lines presented in table 2 (lines number: 3, 271, 272, 351, 353) are lines of national importance. Railway line number 3 is a part of international railway line E20 – part II of Pan-European Transport Corridor West-East, and line 271 is a part of corridor E59 – a part of international transport chain from Malmö – Ystad to Vienna, Budapest and Prague.

In Poznań there are 39 railway crossings and passages. Thirty eight are used, these are railway crossings and passages of category A, B, C, D and E. One of the railway crossings, although classified for public use leads to a private farmland. Railway crossings on the level of rails are located outside the centre of Poznań. In the city centre, where the road traffic volume is the highest, railway crossings and passages are replaced by railway bridges and underground tunnels for pedestrians.

3.2. SELECTION OF THE RAILWAY CROSSING FOR THE PRESENTATION

Railway infrastructure of transport system is an element binding other elements of transport system and its technical condition has influence on realization of transport tasks.

Table 2. List and characteristics of railway lines integrated in Poznań Railway Junction

Line number	Starting station – final station	Electrification of the railway line	Maximum allowed speed [km/h]	Length of the line [km]
271	Wrocław Główny – Poznań Główny	Yes	100	164.454
272	Kluczbork – Poznań Główny	Yes	120	200.903
351	Poznań Główny – Szczecin Główny	Yes	140	213.500
353	Poznań Wschód – Skandawa	Yes	120	389.056
354	Poznań Główny – Piła	Yes	100	92.538
356	Poznań Wschód – Bydgoszcz Gł.	No	70	127.800
394	Poznań Krzesiny – Kobylnica	Yes	60	15.978
3	Warszawa Zachodnia – Kunowice	Yes	160	475.016

Source: own work on the basis of [6,7,9]

On the basis of the formal scheme of description of railway crossings presented in subsection 2.2. railway crossings in Poznań were identified. One of 39 railway crossings and passages operating in Poznań was selected and further the formal description of it is presented. It

is the railway crossing located in Krzesiny Street (fig. 1). Selected railway crossing has category A, it is equipped with four semi grade-crossing gates closing the whole width of the street, it is remote controlled from the cabin of a train dispatcher. Railway traffic flows in two directions on parallel tracks. The railway crossing is situated on two railway lines (no. 394 and 272). At the railway crossing, the vehicle traffic flows in two directions. Because of the location of the railway crossing (road leading to a military airfield) traffic volume at this railway crossing is little. Pedestrians move on both sides of the railway crossing in zoned area separated from the road traffic with white continuous line (fig. 1c). Although the pavement of line 394 Poznań-Krzesiny was changed in 2008, this railway crossing is technically specified as a railway crossing with bad condition of the pavement. At this railway crossing the traffic ratio was not exceeded. In case the traffic ration at a railway crossing is exceeded, until it is modernized train drivers receive orders to drive through such railway crossing at speed of 20 km/h. Visibility of the railway crossing from the access road is good, however the visibility of the front of the train is limited. In the direction of the airfield it is limited by dwelling buildings and in the direction of Poznań it is limited by the old building of the cabin. Except illumination of the road, the manager of railway infrastructure applied at this railway crossing own illumination of the railway crossing consisting of four lamps.

3.3. THE SCHEME OF IDENTIFICATION OF SELECTED RAILWAY CROSSING AS AREAS OF RISK ANALYSES

Figure 1 presents the railway crossing located in south-eastern part of Poznań on railway lines Poznań Główny – Kluczbork and Poznań Krzesiny-Kobylnica.

a)

b)

c)

d)

Fig. 1. Railway crossing in Krzesiny Street in Poznań, state as in August 2011; a – view in the south-western direction (direction into the military airfield), b – view in the north-eastern direction, c – condition of the pavement at the railway crossing, d – view of the railway line to Poznań Główny.

Applying rules of constructing the formal scheme of description identifying railway crossings presented in table 1, description of the railway crossing located in Poznań in Krzesiny Street is presented in table 3.

Table 3. The formal scheme of description of the railway crossing located in Poznań in Krzesiny Street

No.	The name of a field of the scheme identifying the railway crossing	Characteristics of a field of the scheme identifying the railway crossing
-1-	-2-	-3-
1	Location of the railway crossing	Poznań – Krzesiny Street
2	No. of the railway line / Speed on the railway line	Line no. 272 / 100 [km/h] and line no.394 / 100 [km/h]
3	Access road	Commune (surfaced road) / 40 [km/h]
4	Category	Category A, semi-grade-crossing gate, remote control service (cabin)
5	Applied appliances	Traffic lights, acoustic appliances, closed-circuit television camera
6	Location of buildings	10 [m]
7	Number of tracks	Many-track railway crossing {3}
8	Condition of the pavement	Bad
9	Types of pavement	Concrete slabs
10	Illumination	Street illumination, illumination of the railway crossing by four lamps.
11	Visibility	The nearest dwelling building is located 10 m from the railway crossing, lack of bushes, advertisements etc.
12	Traffic ratio	Lower than 20 000
13	Remarks	Zoned traffic lane for pedestrians, little road traffic, built-up area

Source: own work

4. CONCLUSION

This article presents the model of railway crossings as areas of analyses in RC-RISK method. The model of a railway crossing in the meaning of RC-RISK method, is a result of implementing rules of accepted formal scheme of description identifying railway crossings. This article presents such formal scheme of description identifying railway crossings. General and detailed rules of identification of elements of the model of railway crossings are presented as well. The created model consists of 13 fields taking into account selected legal, technical and local conditions of operation of railway crossings. Poznan Railway Junction was described, in the area of which, 39 railway crossings and passages are located. On the basis of the railway crossing located in Krzesiny Street, the model of railway crossings as areas of analyses in hazard risk management with RC-RISK method was applied.

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