Archives of Transport System Telematics

Volume 4

Issue 2

May 2011

Structure of interlocking table

M. JURCZAK
Faculty of Transport, Silesian University of Technology, Krasińskiego 8/201, 40-019 Katowice, Poland,
EMAIL: jurczak.mateusz@tlen.pl

ABSTRACT
The topic of the article is to present performance of interlocking table. It has to bring nearer this problem. There are many different solutions in making of project tables. In the future it should be done more clearly to make work time shorter and project cheaper. In first part of the article there is model illustrative structure of interlocking table creation along with definitions. The second part of the article shows more detailed information about train route, which is closely connected to the topic of this publication. In the next part there is suggestion of model for route realization along with elements which participate in this global system. At the end of the article there is scheme of fictitious railway station as well as variations described with the benefit of contradictious and locking tables

KEYWORDS: interlocking table, rail safety

1. Introduction

The aim of the article is to present performance of interlocking table. It has to bring closer this problem. There are many different solutions in making this king of project tables. In the future it should be done more clearly to make work time shorter and project cheaper. In first part of the article there is exemplary illustrative structure of interlocking table creation along with definitions. The second part of the article shows more detailed information about train route, which is closely related to the topic of this publication. In the next part there is suggestion of model for route realization along with elements which participate in this global system. At the end of this article there is scheme of fictitious railway station as well as variations described with the benefit of contradictious and locking tables.

The interlocking tables are designed for controls clear performance, which is included on train and manoeuvre routes. They are created on basics of railway station's schematic plan and they are part of project's documentation. Tables are designed, especially in situations, when dispatchers need to decide by themselves about letting train go e.g. on replace signal.

The interlocking table consists of upper part, with heading of table and lower part, with closing table. The heading of interlocking table states type and quantity of internal, adjustable and block controls. On the other hand, closing table indicates point locks and mutual interactions between controls [1].

The structure of interlocking table indicates Figure 1.

2. Train routes

The basic point, from which should be started creation of interlocking table is construction of project documentations. It should be consistent with standards (norms) and railway instructions. Among many others, here can be included for example documentation of internal devices (systems), which is part of larger ventures such as line block, level crossing or even interlocking systems. The key part, which is the foundation of whole interlocking table is of course schematic plan of control devices.

The schematic plan – is created on the basic of layout plan of railway track system. There is presented layout of railway tracks and crossings in contaminated scale (longitudinal 1:2000, transversal 1:500) and there are marked

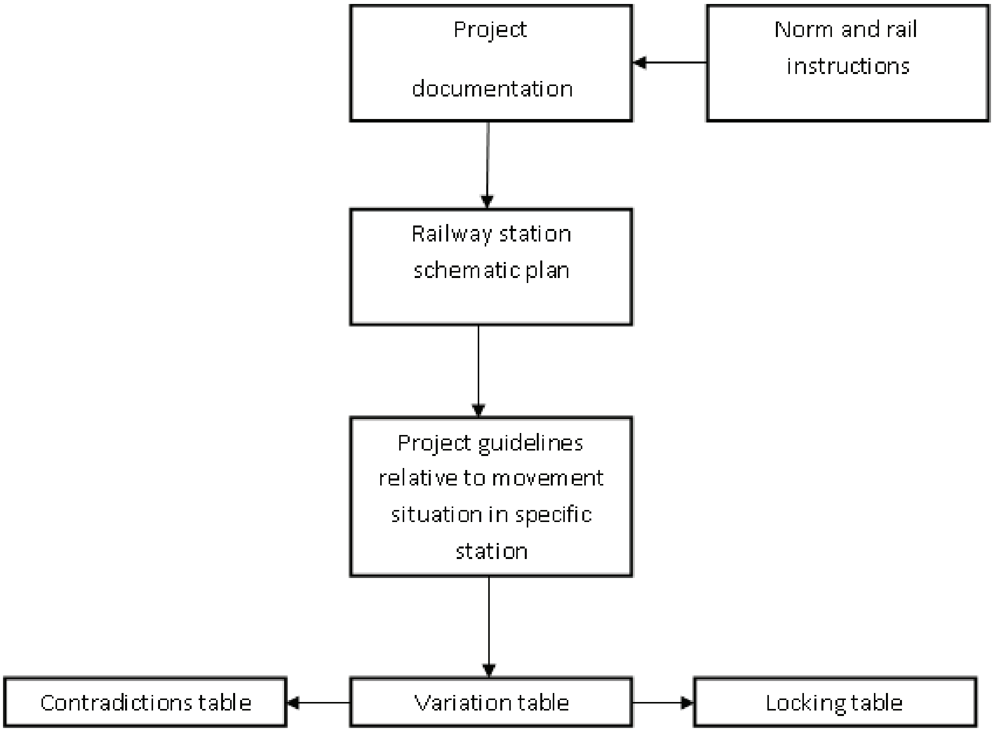


Fig. 1. The structure of creation interlocking table

railway control devices and routes of trains. It is allowed to apply different scale [1].

The next stage is creation of interlocking table for each specific station, however it is important to remember about limitations, which are results of the following:

- the depreciated speed, when train rides on hardened point in position minus or of a set of facing point
- distances between signals and other controls, which are shorter than usually
- lengthened safety road behind the semaphore

These as well as other cases, must be analyzed and interpreted from safety point of view. Besides, depending on needs, designers can decide about sense of railway routes existence.

According to Figure 1, interlocking tables consist of two main parts:

- contradictions table (with contradictions routes)
- closing table of railway interlocking devices.

The Contradictions table contains: rows and columns, which describe all possible routes that are implemented as well as variations between them. As variations, can be understood cases, when routes exclude one another through:

Various positions of controls in train routes

- overlap in some parts of train route
- converge of safety road along with train road, except route without stopping.

As a railway route can be understood – states set in order, in which should be found elements of controls, which are used to control railway traffic. They adjust, protect, and control define train route [2].

There are two types of railway routes, which needs to be taken into consideration in interlocking table:

- train route – this is route, which describes train's road [1]
- manouvre route – this route is set up for manoeuvring vehicles [1]

Main rules of train routes are as following:

- train route has to be restrainted and after this process there is no possibility to change state of elements, besides changing outgoing signaling device from green to red
- restraint of route can be half-open:

automatically – after driving through the last point, which is on the way of train

by personnel:

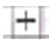
  - › immediately, regardless of route occupancy, with registration of this action;
  - › with time delay (90-120 seconds), however process of slowing down must be stopped automatically, when rolling stock takes over the route of train
- restraint track can be divided on sections restraints simultaneously with whole route, but still slowing down must be performed individually according to first point
- in some systems used to control railway traffic, closure of route can be initial phase in process of restraint.

- tracks without stopping should be held:
  - on main running routes
  - on additional running routes, if system of controls is adjusted to it
  - on routes equipped with controls, which have control system measuring track occupancy.

Main rules of railway traffic, connected with manoeuvring routs are following [1]:

- manoeuvring routes, not necessarily must have safety way and side guard
- manoeuvring routes can be divided into:
  - organized – depending on type of controls, can be closed or restrained. Routes like these should have permissive signal dependency, which would allow to restrain or close specific elements of train routes,
  - unorganized – restrain or closure of railroad points as well as exclusion of conflicting routes with other manoeuvres are not required
- in manoeuvring routes can apply układową control niezajętości drogi jazdy and period of rozjazdu;
- releasing routes can be performed:
  - automatically after fulfilling conditions the same as for train routes
  - by railway personnel:
    - with registration of this actions for restrained routes
    - without registration for closed routes
- it is recommended to use closed manoeuvring routes, released automatically.

Above rules are key with correct indication of variations:

-  conflicting routes as a result of various controls position (points and derailers)
-  the same routes
-  routes specially excluded.

When it comes to closures, designers use also the following remaining rules, which relates for instance to: derailing routes and specific descriptions:

- primary position (in plus) for point and derailer
- reversed position of point and derailer
- adequately wrote out isolated sections and controlled points
  - on train's road
  - on safety way or crossover
  - on safety side
- routes depending on route
- linear blocks – for all exits from railway station

In manoeuvring routes, not necessarily have to be controls (systems) described in points from c to e.

3. Example of route implementation model

Following rules from previous chapter, the model, which describes train's routes and manoeuvring routes (from variation point of view) can be created. Additionally correct implementation of both routes (set up and restraint) can be performed as well as switching on permissive signal on semaphore can be done.

To begin with, all controllers, which have influence on correct performance of route realization have to be specified. For train routes there are controls as following:

- Z – points and derail:
  - Z^P - in train road
  - Z^O - in safety road.

The most important are following attributes: position plus, position minus, out of control, stopping etc.

- S- signals in train road and side safe for routes:
  - S^P - train semaphores
  - S^M - manoeuvre semaphores.

The most important are following attributes: signal on the semaphore, burned of the red light, out of control etc.

- W- derails:
  - W^P - In train road
  - W^O - In safety road.

The most important are following attributes: position plus, position minus, out of control, stopping etc.

- I- isolated sections:
  - I^T - track section
  - I^Z - point section.

The most important are following attributes: occupied, out of control, stopping etc.

- B- line blocks:
  - B^S - automatic line blocks
  - B^P - semi-automatic line blocks
  - B^Z - telephone announcing.

The most important are following attributes: automatic route through the station, states of block which are inform about the first block signal and occupy sections, way of block etc.

- P- level crossings:

Crucial are displays of signals on road signalling devices, lowering crossing gates and restraint in closed position. Depending on to which category those crossings can be allocated, restraint as well as closure can be realized automatically or manually by the gateman or by dispatcher.

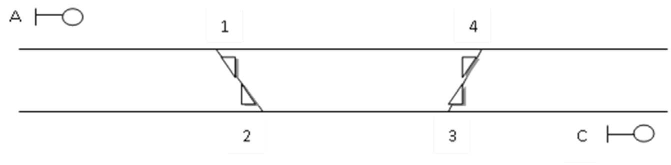


Fig. 2. Example station.

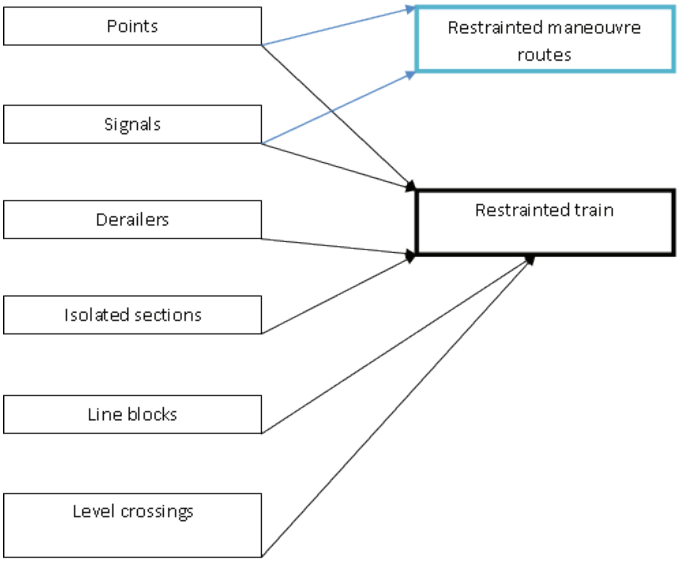


Fig. 3. Interlocking devices which influence for right route realization

Settings allowing signal on semaphore for specific route is a variation function of control's states and it can be sign as following:

$$A = Z \cap S \cap W \cap I \cap B \cap P \qquad (1)$$

where: each group of device/controls fulfill (due to their state/location) conditions for routes, and gives logic value equal 1. The simple example is shown on Fig. 2.

If logic 1 can be admitted as output consistent for route realization while logical 0 is the opposite for realization the route from semaphore A to C then it can be described as following equation:

$$A^2 = Z^p{}_1 \cap Z^p{}_2 \cap Z^p{}_3 \cap Z^o{}_4 \qquad (2)$$

where logical variations for each points have value equal 1, if are in consistent position in realization of this specific route:

- Z_1 and Z_2 in position minus, Z_3 in position plus – all in train road and Z_4 in position plus on safe side

Of course, over each point there have to be control, this is essential, as this is object that can be controlled.

To sum up, Figure 3 describes features, on which depends if semaphore signal allowing to start train's passage is going to be turned on.

The main problem of creating interlocking table is that engineering must working without right software tools and making manual a lot of tasks. The best idea for this problem is to automate the process of creating interlocking tables what lets them to minimize faults and give possibility to use it in next stages for control systems and interlocking systems. There could be output elements which will be read from specific railway station schematic plan and will be performanced as statistic block elements. These elements will be distinguished by names. Then there will be come into being routes which compose of blocks. These statistic elements (blocks) could be as input elements for make interlocking tables on paper of course and it will be changed manual by engineers if they need. Except this, blocks will be used for next stages for control systems and interlocking systems. The most difficult is to make software tools which in perfect situation read statistic elements from schematic plan which will be made for example by AutoCad. Figure 4 describes the process of illustrative automation interlocking table. Future articles will have got information about levels of automation creation of interlocking tables, start from choosing software tools and methods of reading schematic plan, to use these information to testing and working on by designers and railwayman.

4. Example of scheme with interlocking tables

On above figure example of simplified scheme of small railway station is presented. It can be noticed that under

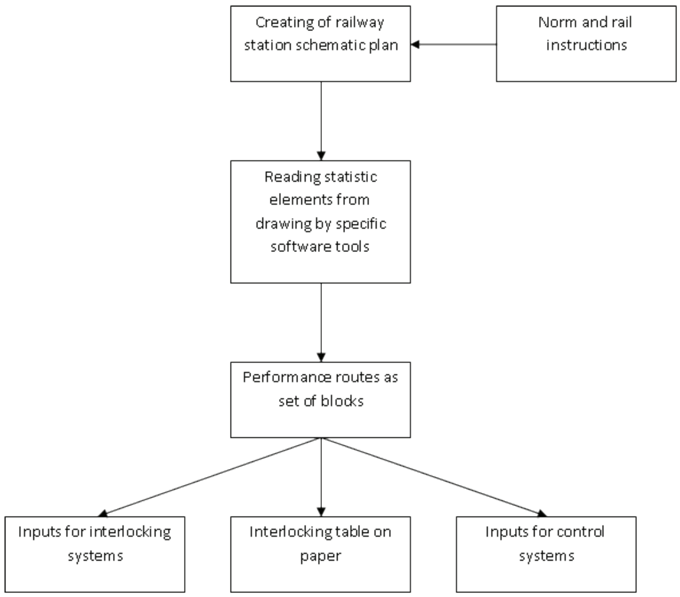


Fig. 4. Creating tables with using automation

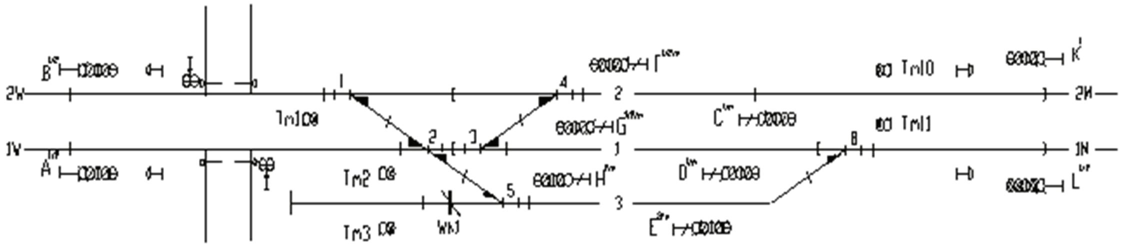


Fig. 5. Example of simplified scheme of fictitious railway station

Table 1 . Contradiction's table connected only to train's routes.

Routes	A^1	A_2^2	A_3^2	B^1	B_1^2	C^1	D^1	E_1^2	F^1	F_1^2	G^1	G_2^2	H_1^2	H_2^2	K^1	L^1	L_3^2
A^1	-	+	+		+					+	+	+	+	+		+	
A_2^2	+	-	+	+	+				+	+	+	+	+	+	+		
A_3^2	+	+	-		+						+	+	+	+			+
B^1		+		-	+				+	+		+		+	+		
B_1^2	+	+	+	+	-				+	+	+	+	+	+		+	
C^1						-									+		
D^1							-	+								+	+
E_1^2							+	-								+	+
F^1		+		+	+				-	+		+		+			
F_1^2	+	+	+	+	+				+	-	+	+	+	+			
G^1	+	+	+		+					+	-	+	+	+			
G_2^2	+	+	+	+	+				+	+	+	-	+	+			
H_1^2	+	+	+		+					+	+	+	-	+			
H_2^2	+	+	+	+	+				+	+	+	+	+	-			
K^1		+		+		+									-		
L^1	+				+		+	+								-	+
L_3^2			+				+	+								+	-

Table 2 . Table of closing devices

	Closing devices							Isolated sections	
Routes	1	2ab	2cd	3/4	5	8	Wk1	Points	Tracks
A^1	$+_o$	+	+	+	$+_o$			Jz2, Jz3	Jt1, JtA
A_2^2	$+_o$	+	+	-	$+_o$			Jz2, Jz3, Jz4	Jt2, JtA
A_3^2	$+_o$	+	-		-		$+_o$	Jz2, Jz5	Jt3, JtA
B^1	+	$+_o$		+				Jz1, Jz4	Jt2, JtB
B_1^2	-	-	+	+	$+_o$			Jz1, Jz2, Jz3	Jt1, JtB
C^1									JtK
D^1						+		Jz8	JtL
E_1^2						-		Jz8	JtL
F^1	+	$+_o$		+				Jz1, Jz4	JtB
F_1^2	$+_o$	+	+	-	$+_o$			Jz2, Jz3, Jz4	JtA
G^1	$+_o$	+	+	+	$+_o$			Jz2, Jz3	JtA
G_2^2	-	-	+	+	$+_o$			Jz1, Jz2, Jz3	JtB
H_1^2	$+_o$	+	-		-		$+_o$	Jz2, Jz5	JtA
H_2^2	-	-	-		-		$+_o$	Jz1, Jz2, Jz5	JtB
K^1									JtK, Jt2
L^1						+		Jz8	JtL, Jt1
L_3^2						-		Jz8	JtL, Jt3

outgoing signals apart of signal L, from which there is not possible to set route on track number 2, there is possibility to enter each track. This limitation does not disturb in setting routes through station from L on track number 2 and entry on this particular track. Apart of existing, for each route, locations of devices along tracks it is important to pay attention on existing side safety derailer Wk1. It is happening when routes are realized by the point in position minus. Key elements, especially for routes are crossings that are on station. This is exemplary railway crossing category A, which depends on routes on the station. All roads under signals A, B, F, G and H can be performed (it means that on signalizations there will be allowing signal) only when crossing is in closed position – so toll gates are lowered and restrainted on their positions. For crossings category B or C, information about activation could be enough, that would start up automatic closure of crossing system. It is obvious that on crossing's setting on station it is essential to correctly direct linear blocks

– block signals. Manoeuvre routes are realized under all entrance signals as well as on Tm1, Tm2, Tm3, Tm10, Tm11. On next pages in interlocking table there is not presented route, which on the other hand could be realized when it comes to system/device's capabilities. This is z road from signal F on track number 2 through point i. This type of road is very common and is called road on trapezium. Exactly the same situation can be applied to opposite route, excluded from specific z under signal B on track 2.

5. Conclusion

The purpose of the article is close-up of problems, which can be encountered by contemporary designers of railway controllers systems. Creation of the interlocking table is not easy thing to do. In example from chapter 4 can be noticed simple scheme of acting, however it is important to remember that this applies only to small railway stations. Problems start on more complicated nodal stations or ones which are equipped with manoeuvring regions. Everything should begin with starting position on segments, transportation needs and conclusions of railwayman, who are end users of whole system. Very important members of this process are not mentioned before, dispatchers, as they know the reality, which occurs on specific railway stations. Conclusions and proposals from this group of railwayman enable to choose the best possible suggestions made by designers. Thanks to this, during process of project implementation there is need to apply some changes, which influence on the structure of interlocking table or schematic plans. That is why, the process and rules of creation interlocking tables, as well as interpretation of movement situation, should be standardized. That would influence designer's decisions, which could become more certain. Such conditions, should be used especially along with modernization of existing lines and creation of new railway lines, because creation of unified system reduces costs and time of projects realization. Along with creation of possible unified project rules the input of railwayman should be exploit to maximum.

Bibliography

[1] Instrukcja kolejowa WTBE10 „Wytyczne techniczne budowy urządzeń sterowania ruchem kolejowym w przedsiębiorstwie Polskie Koleje Państwowe", 1996.
[2] DĄBROWA-BAJON M., Podstawy sterowania ruchem kolejowym, Warszawa 2007, Politechnika Warszawska.
[3] MIKULSKI J., MŁYŃCZAK J., FABER Ł., Model Symulatora Przekaźnikowych Urządzeń Sterowania Ruchem Kolejowym, Zeszyty Naukowe Politechniki Śląskiej. Seria Transport nr 45, Gliwice, 2002
[4] Instrukcja R1 „ Instrukcja o Prowadzenie ruchu pociągów na PKP S.A.", Warszawa 2007.