Risk Analysis And Management Of Track Construction On Running Railway Line Of High Speed Railway For PDL

Zhao Teng[1,a], Liu Xin[1,b], Yang Wenqi[1,c]

[1]Graduate Academy of Southwest Jiaotong University, Sichuan, Chengdu, 610031, China

[a] 269165303@qq.com; [b]799609800@qq.com; [c] 463704573@qq.com

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Abstract. Along with the large-scale construction of the high speed railway for PDL, track construction on running railway line of high speed railway for PDL become more and more. Compared with the ordinary railway's construction safety management, the track construction on running railway line of PDL has its own characteristics. This essay starts from the analysis of these characteristics, next identify risk of track construction on running railway line of high speed railway for PDL, then establish the hierarchy analysis model, and use the analytic hierarchy process (AHP) for risk assessment. Last, put forward countermeasures and suggestions based on the evaluation results.

Introduction

Passenger Dedicated Lines(PDL)defined by the international union of railways：High speed railway refers to the rail way system whose speed reaches over 200km per hour after transformation and over 250km per hour of new railway system[1].

Railway safety is the top priority for railway transport department, and security incident on PDL has serious consequences. Therefore, risk management of track construction on running railway line of high speed railway for PDL is very important, therefore relevant research will have practical significance.

Characteristics of risk management of track construction on running railway line of PDL

Construction on running railway line is what affects traffic safety or the stability and use of equipment from running railway line. It is divided into construction work and maintenance operations. Compared with the ordinary line, the construction of running railway line used the "window", for which the time course of "window" is short, the task is heavy, and construction condition at night is poor, and the train is fast and imperceptible. On some occasions construction units would simplify the procedures and lower operation standards, in order to finish the work ahead of time. Sometimes releasing train illegal tends to threaten train's safety. So we must strengthen management to ensure driving safety[2].

Besides, line's structural properties is gentle, stable and high retention. And traffic density is high. Reliability and maintenance requires high reliability and serviceability, un-maintenance or less-maintenance, Settlement of roadbed or subsidence section needs "zero settlement", smooth and continuous stiffness. So higher construction quality and technical requirements, better protection work is needed. And it's important to avoid causing settlement of roadbed and protect embankment's revetment; In addition, dynamic detection, safety management throughout the construction, assigning enough personnel and equipment and rational organization is necessary.

Risk analysis of track construction on running railway line of PDL based on AHP

Risk identification

Specific steps are as follows[3,4]:First, investigating and collecting relevant information[5,6,7]. Second, on-site investigation and observation. Third, risk factors decomposition.

Risk assessment based on AHP

Establishing the analysis model. According to 2.1, the hierarchical model for Risk analysis of track construction on running railway line of high speed railway for PDL is shown in table 1.

Table 1 AHP model of risk evaluation

A level	B level	C level
Safety risk of track construction on running railway line of PDL	B_1 Risk to personal safety	C_{11} Inadequacy of precaution measures
		C_{12} Operation without blockaded
		C_{13} Illegal operations
		C_{14} Lack of security cordon
	B_2 Risk to train 's safety	C_{21} Foreign matter invasion
		C_{22} Scheduling violation
		C_{23} Work in unauthorized area
	B_3 Risk of construction and technical risk	C_{31} Violation of safety rules
		C_{32} Defects of technical quality
	B_4 Risk of management and organization	C_{41} Disorganization
		C_{42} Lack of supervision
	B_5 Risk of materials and equipments	C_{51} Tool storage violations
		C_{52} Risk of handling or storage machinery and equipment
		C_{53} Risk of transportation
	B_6 Risk of environmental and others	C_{61} Natural disasters
		C_{62} Harsh construction environment
		C_{63} Emergencies

Comparing any two factors and establishing judgment matrix. Using the score given by the experts to determine A-B levels of judgment matrix, shown in Table 2.

Table 2 judgment matrix of A-B level

A	B_1	B_2	B_3	B_4	B_5	B_6	Weight vector w
B_1	1	1	3	2	3	6	0.3176
B_2	1	1	3	2	5	7	0.2843
B_3	1/3	1/3	1	1/2	1	3	0.1824
B_4	1/2	1/2	2	1	3	5	0.0974
B_5	1/3	1/5	1	1/3	1	3	0.0830
B_6	1/6	1/7	1/3	1/5	1/3	1	0.0353
CR=CI/RI= 0.0175 / 1.24 = 0.0141 < 0.1							

Use the score given by the experts to determine B-C levels of judgment matrix.

Table 3 B_1-C_{ij} Judgment matrix calculation

B_1	C_{11}	C_{12}	C_{13}	C_{14}	Weight vector w
C_{11}	1	1/2	4	2	0.2935
C_{12}	2	1	5	2	0.4388
C_{13}	1/4	1/5	1	1/3	0.0746
C_{14}	1/2	1/2	3	1	0.1931
CR=CI/RI=0.0188/0.9=0.0209<0.1					

Table 4 B_2-C_{ij} Judgment matrix calculation

B_2	C_{21}	C_{22}	C_{23}	Weight vector w
C_{21}	1	1/2	3	0.3090
C_{22}	2	1	5	0.5815
C_{23}	1/3	1/5	1	0.1095
CR=CI/RI=0.0019/0589=0.0032<0.1				

Table 5 B_5-C_{ij} Judgment matrix calculation

B_5	C_{51}	C_{52}	C_{53}	Weight vector w
C_{51}	1	2	6	0.5876
C_{52}	1/2	1	4	0.3234
C_{53}	1/6	1/4	1	0.0890
CR=CI/RI=0.0103/0.58=0.0178<0.1				

Table 6 B_6-C_{ij} Judgment matrix calculation

B_6	C_{61}	C_{62}	C_{63}	Weight vector w
C_{61}	1	1/2	4	0.3150
C_{62}	2	1	7	0.6026
C_{63}	1/4	1/7	1	0.0823
CR=CI/RI=0.00108/0.58=0.0016<0.1				

Table 3 to table 6 are the calculation table of B-C level judgment matrix. Since all the CR are less than 0.1, we know that the judgment matrix of B-C level meets the requirements of Consistency.

Total ranking of risk factors. Calculate the comprehensive weight vector of C level , and test the conformance to determine the rank of all risk factors. The results are shown in table 7.

Table 7 calculating table of the synthesis weight vector for C level

Level B / Level C	B_1 0.2843	B_2 0.3176	B_3 0.0974	B_4 0.1824	B_5 0.0830	B_6 0.0370	Weight w	Sequence
C_{11}	0.2935						0.0833	5
C_{12}	0.4388						0.1247	2
C_{13}	0.0746						0.0211	13
C_{14}	0.1931						0.0548	8
C_{21}		0.3090					0.0980	4
C_{22}		0.5815					0.1846	1
C_{23}		0.1095					0.0347	10
C_{31}			0.8				0.0777	6
C_{32}			0.2				0.0194	14
C_{41}				0.6			0.1093	3
C_{42}				0.4			0.0729	7
C_{51}					0.5876		0.0487	9
C_{52}					0.3234		0.0267	11
C_{53}					0.0890		0.0073	16
C_{61}						0.3150	0.0116	15
C_{62}						0.6026	0.0222	12
C_{63}						0.0823	0.0029	17
CR=0.0145/0.5097=0.0284<0.1, meet the requirement of consistency test.								

Calculation results from the above tables are: (1) the greatest weights of risk is Scheduling violation, followed by operation without blockaded and disorganization. The weights of above mentioned situations are between (0.1, 1), classifying as serious risks which should be considered as the main preventive risks. (2) The weights of C_{11}, C_{13}, C_{14}, C_{21}, C_{23}, C_{31}, C_{32}, C_{42}, C_{51}, C_{52}, $C_{61}$and C_{62} are between (0.01, 0.1), classifying as general risks that can't be ignored in the track construction and should take appropriate measures to guard against.

Recommendations for safety management based on the results of AHP analysis

The significance of safety risk analysis

Current researches on safety in the construction on running railway line mainly focuses on safety regulations and technique of traditional track, such as rules of centralized repair, maintenance organization, responsibility for safety management of construction[5]. But researches on the safety risk analysis in the construction on running railway line of PDL is inadequate. In this paper, AHP is applied to safety risk analysis of the track construction on running railway line of high speed railway for PDL. It can guide the safety management work during the construction and make decision-making more scientific.

Countermeasures and suggestions

The authors have several specific recommendations to improve the level of construction safety management based on the calculation results.

Clear and implement each safety management work. In order to solve organizational confusion and the lack of supervision on the risk management, the construction safety management work and every job content need to be cleared and implemented[6], as shown in table 8.

Table 8 the safety manage work of Track construction of running railway line

No.	Job classification	Work content
1	The organizational structure of security management	Establish complete administrative organizations at different levels
2	Security resource Allocation	Make using plan of safety costs, earmarking, configure the appropriate security resources
3	Safety management System	Establish appropriate safety management system construction
4	Safety management objectives	Refine the decomposition security manages and management objectives
5	Safety education and training	Three categories of personnel have the security training examination certificate issued by competent authority or the ministry of Railways, Training of operating personnel
6	Special construction program	Preparing special programs, implement the amendments, and organize the implementation
7	Discussion of security technology	Discussion of security technology, record keeping
8	Contingency plans	Preparation of the corresponding contingency plans
9	Construction of running railway line	Reported construction plans, including: design of construction scheme, construction organization design, construction safety Agreement , organized and implemented according to plan
10	Security check	Self-examination and will be checked
11	Processing feedback information	React and deal with related issues

Give priority to train's safety and personal safety. Safety must be ensured first in the track construction on running railway line. Therefore, the protection and scheduling work should be carefully planned and make sure that during "window" time the tract is clear, and all the workers need to be cordoned off the operation line. In addition, operation without time blockaded is forbidden. Moreover, personnel, tools and materials can't invade the safe boundary.

Study technology and safety measures seriously. Construction sector needs to obey the methods and techniques of safety management regulations issued by railway department, organize and carry out related safety training work before construction. Technological explanation must be done before construction work begins. Moreover, it is important to monitor technology, safety and quality during the construction, inspect quality after construction work and avoid damaging the bridge structure, causing the roadbed settlement, etc.

Develop emergency plans and safety drills. Emergency plan is an important manifestation of implementing the "safety first, precaution crucial " principle. It consists of tasks, organization, responsibilities and division of labor. The safety knowledge of the construction on running railway line of high speed railway for PDL must be popularized at ordinary times. It covers how to storage and carry materials and equipment safely, proper use of equipment and the measures to deal with unexpected situations and natural disasters. Emergency plans should also be drilled regularly so that construction sector can rescue timely, reasonably and effectively after the accident.

Conclusion

Safety of the construction on running railway line of high speed railway for PDL can't be ignored, so safety risk management in the construction of running railway line of high speed railway for PDL is very important but defectiveness now, and risk analysis is also a new subject. In this paper, the judgment matrix based on AHP is assessed by comparing the results of individuals. The advantage is that everyone can come to a conclusion based on AHP. The disadvantage is it has certain subjectivity. Therefore, the reliability of the conclusions based on AHP depend on the experience, knowledge and judgment of expert. Similarly, each risk assessment method has its own

characteristics, which should be noted when applied.

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