



Comparative Analysis of Quality Accident Investigation Mechanisms in the Field of Infrastructure Construction in China

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Abstract. In the rapid development process of infrastructure construction in our country, quality accidents occur frequently, seriously threatening the safety of people's lives and property and causing economic losses. Accident investigation is of great significance in preventing accidents. This article focuses on the definition, grading standards, reporting and investigation requirements of quality accidents in housing construction and municipal infrastructure engineering, water conservancy engineering, and railway construction engineering. It horizontally compares the investigation mechanisms in various fields, reveals the characteristics of the current situation, and proposes suggestions for optimizing the quality accident investigation mechanism in China's highway and waterway engineering field through multi-faceted comparative analysis, providing reference for improving its quality and safety management level.

Keywords: quality accidents; Accident investigation; Investigation mechanism; Infrastructure construction

1 Introduction

At present, China's transportation industry is in a critical period of development, with risks and contradictions intertwined. The factors affecting transportation safety production are even more complex. By studying and analyzing the investigation mechanisms in various infrastructure construction fields, accelerating the improvement of the quality accident investigation mechanism in China's highway and waterway engineering field is an objective requirement for accurately grasping the laws and characteristics of transportation safety production in the new era, and an important guarantee for scientifically constructing a risk prevention system for transportation safety production accidents.

2 Quality Accident Investigation Mechanism in Major Infrastructure Construction Fields

2.1 Research on Accident Definition

According to the provisions of the Ministry of housing and urban rural development, engineering quality accidents refer to the situation that construction, survey, design, construction, supervision and other units violate the laws, regulations and standards related to engineering quality, resulting in quality defects such as structural safety and important use functions, resulting in casualties or major economic losses.

According to the provisions of the Ministry of water resources, the quality accident of water conservancy project is an event that causes the project quality to fail to meet the specifications and contract standards due to construction management, supervision, survey, design, consulting, construction, materials, equipment and other factors during the construction process, affecting the service life and causing hidden dangers and hazards to the safe operation of the project[1-3].

Quality accident of railway construction project refers to the event that the project quality does not meet the requirements of laws and regulations, mandatory standards for engineering construction or construction drawing design documents due to improper survey, design or construction during the construction of railway construction project, resulting in defects in structural safety, important use functions and other aspects, which must be reworked, repaired or reinforced, resulting in certain economic losses.

The accident definitions of housing construction and municipal infrastructure engineering (hereinafter referred to as " building project "), water conservancy engineering and railway construction engineering mainly have the following similarities and differences, as shown in Table 1:

Table 1. Main similarities and differences of accident definition

industry	Accident occurrence period	Cause of accident	Criteria for judging accidents
building project	not mentioned	Construction, survey, design, construction, supervision and other units violate laws, regulations and standards related to project quality	The project has quality defects such as structural safety and important use functions, resulting in casualties or major economic losses
water conservancy project	During the construction of water conservancy projects	Construction management, supervision, survey, design, consulting, construction, materials, equipment and other factors lead to the project quality not meeting the specifications and contract standards	Affect the service life and cause hidden dangers and hazards to the safe operation of the project
Railway construction project	During the construction of Railway construction project	The project quality does not meet the requirements of laws and regulations, mandatory standards for project	Defects in structural safety, important use functions and other aspects that must be reworked,

		construction or construction drawing design documents due to improper survey, design or construction	repaired or reinforced, resulting in certain economic losses
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From the time of the accident, the water conservancy project and railway construction project are both in the process of engineering construction. From the perspective of the causes of the accident, the violation of laws, regulations and standards related to project quality has been mentioned. In terms of the criteria for judging accidents, the structure and service life of construction projects are mentioned, and the economic losses caused by housing construction projects and railway construction projects are also taken as the criteria for judging accidents.

2.2 Research on Accident Classification

The quality accidents of housing construction projects shall be investigated by the competent departments of housing construction at all levels at different levels. According to casualties or direct economic losses, the classification standard is divided into four levels: particularly serious, major, major and general accidents, as shown in Table 2.

Table 2. Classification principles of quality accidents in housing construction projects

Level	Classification criteria
Especially serious quality accident	Accidents causing more than 30 deaths, or more than 100 serious injuries, or direct economic losses of more than 100million yuan
Major quality accident	Accidents causing death of more than 10 and less than 30 people, serious injury of more than 50 and less than 100 people, or direct economic loss of more than 50million yuan and less than 100million yuan
Major quality accident	Accidents that cause 3 to 10 deaths, 10 to 50 serious injuries, or direct economic losses of more than 10million yuan but less than 50million yuan
General quality accident	Accidents causing less than 3 deaths, or less than 10 serious injuries, or direct economic losses of more than 1million yuan but less than 10million yuan

Considering the direct economic loss, the impact on the construction period and the normal use of the project, the water conservancy project is divided into major, major, major and general quality accidents, as shown in Table 3.

Table 3. Classification principles of quality accidents in water conservancy projects

Level		Especially serious quality accident	Major quality accident	Major quality accident	General quality accident
Direct losses of materials, equipment, and labor required	Mass concrete. Metal structure fabrication and electromechanical installation works	>3000	>500, ≤3000	>100, ≤500	>20, ≤100
	Earth rock engineering concrete thin wall engineering	>1000	>100, ≤1000	>30, ≤100	>10, ≤30

for acci- dent han- dling (10000 yuan)					
Reasonable construction period re- quired for accident handling (months)	>6	>3, ≤6	>1, ≤3	≤1	
Impact on engineering function and ser- vice life after accident treatment	Affecting the normal use of the project and requiring re- stricted op- eration	It does not affect the normal use, but has a great impact on the service life of the project	It does not affect the normal use, but has a cer- tain impact on the ser- vice life of the project		No impact on normal use and Engineering Life

According to the economic losses caused by the accidents, the quality accidents of railway construction projects are divided into special major quality accidents, major quality accidents, major quality accidents and general quality accidents, as shown in Table 4.

Table 4. Classification principle of quality accidents in Railway Construction Engineering

Level	Classification criteria
Especially serious quality accident	Due to project quality reasons, there are particularly major defects in structural safety or important use functions, resulting in economic losses of more than 100million yuan.
Major quality accident	Major defects in structural safety or important use functions due to project quality, resulting in economic losses of more than 50million yuan and less than 100million yuan.
Major quality accident	Due to project quality, there are major defects in structural safety or important use functions, resulting in economic losses of more than 10million yuan and less than 50million yuan.
General quality accident	Due to project quality, there are defects in structural safety or important use functions, resulting in economic losses of more than 1million yuan and less than 10million yuan.

Quality accidents in housing construction projects, water conservancy projects and railway construction projects are divided into four levels, and economic losses are also used as the standard for accident classification. The difference is that the impact of water conservancy projects on the construction period and the normal use of the project is also included in the accident classification standard, which is also a factor worthy of reference in the field of infrastructure construction.

2.3 Research on Accident Investigation Contents

The competent department of housing and urban rural development shall, in accordance with the authorization or entrustment of the relevant people's government, organize or

participate in the accident investigation team to investigate the accident and perform the following duties[4-6]:

1. Verify the basic information of the accident, including the process of the accident, casualties and direct economic losses.
2. Check the basic information of the accident project, including the performance of legal construction procedures and the performance of duties of all participating units of the project.
3. Analyze the direct and indirect causes of the accident in accordance with relevant national laws and regulations and engineering construction standards and organize the detection and identification of the accident items and expert technical demonstration when necessary.
4. Identify the nature and responsibility of the accident.
5. Put forward suggestions on the handling of the units and personnel responsible for the accident in accordance with relevant national laws and regulations.
6. Summarize the lessons learned from the accident and put forward preventive and rectification measures.
7. Submit accident investigation report.

The main tasks of the water conservancy project accident investigation team are as follows:

1. Find out the cause, process, property loss and impact on subsequent works of the accident
2. Organize experts to conduct technical appraisal
3. Find out the responsibility of the unit responsible and the main responsible person of the accident
4. Put forward suggestions on engineering treatment and measures
5. Put forward suggestions on the handling of responsible units and people.
6. Submit accident investigation report.

The main responsibilities of the railway construction project quality accident investigation team include:

1. Find out the cause of the accident and organize technical appraisal if necessary
2. Check and ratify economic losses
3. Identify the responsible unit and person
4. Put forward suggestions on handling the accident responsible unit and person
5. Summarize the lessons of the accident and put forward the requirements for rectification and prevention
6. Write an accident investigation report.

To sum up, the accident investigation contents of housing construction projects, water conservancy projects and railway construction projects are basically the same, including finding out the cause and responsibility of the accident, putting forward improvement suggestions and submitting accident reports.

3 Investigation Mechanism and Thinking of Highway and Water Transportation Quality Accidents in China

3.1 Accident Definition

According to the provisions of the Ministry of Transport, the quality accident of highway and water transport construction project refers to the accident that the project fails to meet the technical standards and design requirements due to construction or survey and design before the end of the defects liability period, resulting in structural damage or certain direct economic losses. As an infrastructure construction project, using the practice of water conservancy projects for reference, the important functional defects caused by the damage of engineering structures can be included in the causes of accidents[7-8].

3.2 Accident Classification

According to the current standard, direct economic loss or engineering structure damage is divided into four levels: particularly major, major, major and general quality accidents. The direct economic loss lower than the general quality accident is a quality problem, as shown in Table 5.

Table 5. Classification principle of quality accidents in highway and Waterway Engineering

Level	Classification criteria
Especially serious quality accident	Accidents with direct economic losses of more than 100million yuan
Major quality accident	Accidents with direct economic losses of more than 50million yuan and less than 100million yuan or collapse of the main structure of the super large bridge
Major quality accident	Accidents with direct economic losses of more than 10million yuan and less than 50million yuan or collapse of relevant structures of Expressways
General quality accident	Accidents with direct economic losses of more than 1million yuan and less than 10million yuan or collapse of related structures except expressways

Since the important functional defects caused by the damage of engineering structures are included in the causes of accidents, the classification of structural damage and functional defects can also be refined. For example, major quality accidents can also include the collapse of the main structure of the super large bridge, the collapse of the super long tunnel structure, and the collapse of the main structure of large-scale water transport projects. Major quality accidents may include the collapse of the main structure of the medium bridge or bridge in the expressway project, the collapse of the structure of the medium tunnel or long tunnel, the overall sliding of the cutting and high embankment sections (open to traffic sections), and the collapse of the main structure of the medium-sized water transport project. General quality accidents include the collapse of small bridge structure, short tunnel structure in expressway projects, the

collapse of main structure of bridge (excluding super large bridge) in highway projects other than expressway, the collapse of tunnel (excluding super long tunnel) structure, or the collapse of main structure of small water transport projects.

3.3 Accident Investigation Contents

The current measures of the Ministry of transport do not stipulate the accident investigation process and contents. Referring to the accident investigation contents in other fields, the quality accident investigation team of highway and water transport engineering can assume the following responsibilities: responsible for verifying the process of the accident and economic losses; Find out the cause of the accident, determine the nature and responsibility of the accident, and put forward suggestions on the handling of the responsible unit and person; Summarize the lessons learned from the accident and put forward preventive and rectification measures; Form accident investigation report.

At the same time, the investigation and design documents, supervision logs, construction records, engineering related documents, etc. can be accessed during the accident site investigation, and relevant personnel can be asked to find out the cause of the accident; If necessary, the structural loss and functional defects can be found out through inspection and detection, technical appraisal, technical demonstration, etc.[9-10].

4 Conclusions

Based on a comprehensive analysis of the investigation mechanisms in various infrastructure construction fields, combined with China's basic national conditions and the current development level of highway and waterway quality accident investigation in China, the focus should be on improving the independence, professionalism, and technical level of accident investigation in the future period:

1. Enhance the independence of accident investigation. In the field of highway and waterway engineering accident investigation, based on the clear classification and reporting process of accidents, the main unit of accident investigation, the composition and basic requirements of accident investigation team are clarified. Ensure the independence and professionalism of accident investigation.

2. Strengthen the research and application of investigation techniques and methods. The field of highway and waterway engineering should draw on advanced technological means, such as non-destructive testing, numerical simulation, etc., to deeply analyze the causes of accidents, while paying attention to the standardization and normalization of investigation techniques to ensure the accuracy and reliability of investigation data.

3. Strengthen the professional capacity building of investigators. Targeting the characteristics of the field of highway and waterway engineering, carry out targeted training to improve the professional competence of investigators, establish a qualification

certification system for professional investigators, ensure that investigators have the corresponding abilities, and enhance the quality of investigation work.

4. Strengthen accountability and implementation of rectification measures. In the field of highway and water transportation engineering, efforts should be made to strengthen the accountability of units and individuals responsible for accidents, ensuring that accountability is in place; At the same time, strengthen the supervision and implementation of rectification measures to ensure their effective implementation and prevent similar accidents from happening again.

This article compares and analyzes the quality accident investigation mechanism in China's infrastructure construction field, revealing the similarities and differences in accident definition, grading standards, accident reporting and investigation in various fields. This article proposes corresponding suggestions and measures to address the existing problems and shortcomings, aiming to provide reference for the optimization and improvement of the quality accident investigation mechanism in China's infrastructure construction field. In the future, with the continuous development and improvement of infrastructure construction in China, the quality accident investigation mechanism will also be continuously optimized and improved, providing strong guarantees for the healthy development of the industry.

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