

# Study on safety risk prevention and evaluation management of tunnel construction

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**Abstract.** With the progress of The Times, our infrastructure is constantly developing, the construction of highways is expanding, tunnel construction specifications are also expanding. Tunnel construction is an extremely important part of highway traffic construction. The construction environment of tunnel engineering is relatively special, and it is a systematic project. In the construction process, it will be affected by a variety of factors, and there are more safety risks. Therefore, it is beneficial to the smooth development of tunnel engineering projects to study the reasonable safety inspection process and evaluation technology of tunnel construction site. Based on this, based on the reality, this paper analyzes and studies the key points of tunnel construction safety prevention and safety evaluation, and mainly describes the specific measures of safety risk prevention and evaluation technology from the aspects of tunnel consultation classification and management, personnel post duty classification, consultation implementation basic procedures and consultation report preparation and approval process, for reference.

**Keywords.** Tunnel engineering, security precautions, evaluation.

## 1. Introduction

As we all know, tunnel safety risk prevention plays an important role in tunnel construction. Risk prevention and evaluation is a major service for project owners, industry safety authorities and other on-site safety hazard inspection and evaluation work, by relying on experienced technical personnel in-depth tunnel construction site safety measures implementation and potential safety hazards to check records, summarized and analyzed problems, and give objective scientific suggestions and evaluation opinions. In order to improve the safety of the tunnel construction site, the scientific and effective technology and methods are applied to the safety control in time, so as to minimize the probability of risk occurrence and ensure the safety of the tunnel project.

## 2. Tunnel construction safety risks

### 2.1. Inadequate pertinence of tunnel construction scheme

In the tunnel construction, according to the technical requirements, the construction team will formulate the site construction scheme, but in the actual application, there are some factors, such as the scheme is not strong guidance, does not conform to the actual situation and the scheme is unreasonable, and the vast majority of the tunnel construction implementation scheme is only formulated for one or part of the factors, not applicable to the tunnel construction project in different water level geological conditions. At the same time, the formulation and approval procedures of most schemes or reports are not rigorous enough and are too formal [1,2].

### 2.2. Unreasonable tunnel construction management

The unreasonable management of tunnel construction is also one of the main reasons for the hidden danger in tunnel construction. Because some construction parties are familiar with some common tunnel construction schemes, they have loose requirements and management on their internal employees, while some construction technicians and operators have certain tunnel construction experience. Therefore, they blindly implement the construction in accordance with the experience in specific work rather than strictly follow the relevant regulations. It is easy to make the construction system and construction scheme become a form, unable to play their actual utility [3].

### 2.3. The tunnel risk assessment technology is not mature

At present, many tunnel construction risk assessment technologies are still in their early stages of development, and there are some defects in the risk technologies during and after construction, which is easy to cause some sudden safety accidents in the construction process. Once problems occur in construction, it is difficult to take remedial measures in time, thus missing the best opportunity for risk prevention and control, and threatening the quality of the entire construction project [4].

### 3. Tunnel security risk prevention and evaluation management

#### 3.1. Basic Requirements for tunnel security risk prevention

The prevention and evaluation of tunnel construction safety risk shall be organized and implemented in the manner of project leader according to the number and scale of tunnels involved in the project. The project leader shall be appointed by the department management leader, and the project leader shall be responsible for project planning, expert coordination, personnel management, project implementation and quality management. The prevention and evaluation of tunnel construction safety risk mainly includes the prevention of safety risk on the tunnel site and the summary analysis of expert opinions, and the proposal of comprehensive evaluation opinions and rectification opinions or suggested measures [5,6].

#### 3.2. Classification and management of consulting projects

Project classification shall be determined according to project classification, technical grade, complexity of construction conditions, project scale, and taking into account the importance of the project to the company's market development. The project is divided into three levels: A, B and C:

- (1) Level A is a project of high level, large scale and complicated technology;
- (2) Grade B refers to the projects that do not reach Grade A on the whole, but contain some complex engineering nodes and individual complex professional/special projects.
- (3) Level C is the general level, which refers to the projects with small scale and relatively simple technical difficulty;

The classification and grading of tunnel construction safety inspection and evaluation consulting items are shown in Table 1 below.

**Table 1.** Technical consulting project classification and management

Classification	Project classification	Division principle	Review content at company level	Corporate review process	Major measures (including but not limited to)
Tunnel security risk prevention and evaluation	A	Tunnel technical consulting projects with long tunnels and tunnels with overall construction safety risk level III, or tunnels with overall construction safety risk level IV	Work programme; Special plan; Stage results; Final product	Whole process	Comprehensive supervision
	B	unnel technical consulting projects with long tunnels or tunnels with grade III overall risk level of construction safety	Stage results; Final product	Periodic results review Publication of results	Check record Proofreading records, publication release slips
	C	Other	---	---	---

Requirements for hierarchical management of projects are as follows:

- (1) Project classification is determined according to the "Project Classification and Classification Table" (i.e., Table 1) and reflected in the work outline and technical instructions.
- (2) In case of major changes during the implementation of the project, the responsible department shall timely report to the Chief Engineering Office, and the company will adjust the classification of the project according to the changes of the project.
- (3) The project shall strictly implement the "two-level check". The whole process of A-level projects shall be reviewed at the company level; Class B projects shall be submitted to the Chief Engineering Office for quality review of the specified content and links, and the rest shall be completed by the responsible department. The quality review of Grade C projects shall be completed by the responsible department. The publishing process of technical achievements shall be carried out, and relevant materials shall be sorted and filed for the verification of the integrity of quality review records and the compliance of quality management process.

#### 3.3. Personnel position and duty classification

Risk assessment units need to formulate personnel positions and duty classification in the construction process. Tunnel construction safety risk prevention inspection and evaluation involves professional deputy chief engineer, experts, department heads, project leaders, liaison personnel. The division of responsibilities of each post is shown in Table 2 below.

**Table 2.** Post classification and division of responsibilities

Personnel classification	Post requirement	Job responsibility
Company professional deputy chief engineer	---	(1) Review and approve the project work plan, special plan, stage results and final results according to the project classification; (2) Supervise and spot check project plans and results, and put forward rectification suggestions.
Expert	Senior engineers of tunnel engineering, geological engineering, engineering management, tunnel, geotechnical and other titles or members of the expert database of administrative departments such as transportation department and law enforcement bureau; Familiar with tunnel construction technology and safety management knowledge; Rich experience in tunnel construction safety management.	Carry out on-site inspection of the project according to the inspection plan; Scientifically and objectively take photos of the scene situation and record the problems found one by one; Put forward suggestions or opinions on the rectification of tunnel problems.
Head of department	Good communication skills, negotiation skills, organizational skills, consulting and testing skills. Good resource integration and explanation ability, writing and language expression ability, familiar with tunnel construction safety system knowledge, strong professional knowledge. Rich experience in tunnel construction safety management.	Conducting business negotiations with the entrusting party, other owner units and construction units; Assign the project leader according to the project situation, and rationally coordinate and allocate human resources of the department; Project planning, technical proposal review, problem analysis, report review;
Project leader	Good communication and coordination skills; Qualified as bridge tunnel test and inspection engineer; Familiar with tunnel construction safety system knowledge.	Daily communication with the entrusting party and other participating units; Project planning, technical program preparation, problem analysis and report writing; Project settlement, measurement and payment collection.
Liaison officer	Good communication, coordination and presentation skills	Have the basic working ability to complete the work arranged by the project leader efficiently and timely.

### 3.4. Reasonable consultation and implementation of basic procedures

The implementation of tunnel construction safety risk prevention and control should be carried out in the following aspects:

1. After the project construction is confirmed, the person in charge of the safety risk inspection department shall designate the project leader;
2. The project leader shall, according to the entrusting party's requirements, actively collect the laws and regulations, administrative measures, normative guidelines, tunnel design, construction safety special schemes and other materials that may be involved in the project;
3. The project leader prepares the implementation plan (draft) (including work plan and special plan) according to the collected data;
4. According to the regulations of project classification management, organize relevant personnel to participate in the discussion of the implementation plan (draft), modify and improve the implementation plan (final draft), and submit the formal implementation plan (including the work plan and special plan) to the deputy director of the corresponding department, the department's full-time position or the deputy chief engineer of the company for review and approval according to Table 3;
5. Carry out the project in accordance with the approved implementation plan;
6. After the completion of the project, the project leader shall analyze and complete the consulting analysis and evaluation report (including the stage result report and the final result report) as soon as possible according to the inspection results of the experts and the contract agreement;
7. According to the project classification management regulations, submit the report to the professional deputy chief engineer of the company for review and approval according to Table 3;
8. Submit reports to the entrusting party, and archive and hand over project materials as required.

### 3.5. Report approval procedure

The consulting report shall be submitted to the entrusting party only after it has been approved by the department level and the company level.

Documents involved in tunnel construction safety inspection and evaluation mainly include inspection record form, implementation plan (including work plan and special plan), analysis and evaluation report (including stage result report and final result report). According to the project classification management regulations, the preparation, review and approval of various documents such as consulting plan and report shall be carried out according to the following procedures (as shown in Table 3 below. The compilation, review and approval personnel are shown in Table 4 below).

1. The project implementation plan shall be prepared by the project leader and submitted to the entrusting party after being examined and approved by the deputy head of the department, the head of the department or the deputy chief engineer of the company in accordance with the provisions of the hierarchical management of the project;

2. The inspection record form shall be filled in and signed by experts;

3. The consulting report shall be prepared by the project leader and submitted to the entrusting party after being examined and signed by the deputy head of the department, the head of the department or the deputy chief engineer of the company in accordance with the provisions of the hierarchical management of the project. The project materials shall be archived and handed over as required.

**Table 3.** Preparation, review and approval process of various documents of the consulting project

Project level	Division principle	Inspection record	Implementation plan	Analysis and evaluation report
A	Tunnel technical consulting projects with long tunnels and tunnels with overall construction safety risk level III, or tunnels with overall construction safety risk level IV	Expert signature	Project leader preparation, department head review, the company's professional deputy chief worker sign for approval	Responsible person preparation, department head review, the company's professional deputy chief worker signature
B	Tunnel technical consulting projects with long tunnels or tunnels with grade III overall risk level of construction safety	Expert signature	Project leader preparation, department head deputy or department head review and approve	Project leader preparation, department head deputy or department head review, the company's professional deputy chief worker signature
C	Other		--	--

**Table 4.** List of personnel for the preparation, review and approval of consulting project plans and reports

Project	Personnel	Remarks
Plan and report preparation	Project leader/Engineer	Project leader, responsible for A,B,C project planning and report preparation
Plan and report review	Chief Engineer/Senior Engineer	B,C project plan and report review
	Senior engineer	Class A project plan and report review
Plan and report approved	Senior engineer	Class C project plan and report approval; Class B project plan approved
	Deputy chief Engineer/Senior engineer or above	A approval of Class A project plan and report Class B project report approved

### 3.6. Review and supervision of results

As for the review of tunnel construction safety risk prevention and control and evaluation results, the work should be completed by the professional deputy chief engineer of the company in the way of supervision and random inspection, and the implementation plan and analysis and evaluation report of Class A projects should be reviewed and supervised by the professional deputy chief engineer of the company in the whole process. For Class B and Class C projects, the professional deputy chief engineer of the company will conduct random checks on the implementation plan of the project, the format standardization of the analysis and evaluation report and the compliance of the management process from time to time. Put forward rectification suggestions for those that do not meet the requirements. Make the risk assessment results more reasonable, reduce the occurrence of safety accidents.

#### 4. Closing Remarks

The tunnel safety has an important influence on the construction of Chinese road engineering. The tunnel construction time is relatively long, therefore, in the construction process is prone to various safety risks, the construction process cannot be completely guaranteed, therefore, the tunnel construction risk management is extremely important. Before tunnel construction, relevant personnel must do some preparatory work in advance. In addition, risk prevention should not only be carried out in the design stage, but also throughout the whole process of tunnel construction. Only in this way can the safety of the tunnel construction process be ensured.

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