Chapter 15
Analysis on Construction Project Safety Based on Fuzzy Evaluation Method

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Abstract Due to their unique properties, the construction industries become more dangerous. The paper is based on the fuzzy evaluation method to the evaluation of construction engineering safety. Exploration in the construction industry is prone to the risk factors. Training management personnel safety consciousness, improve the construction of protective equipment, for the construction industry to provide some improvement measures.

Keywords Construction engineering • Fuzzy evaluation • Safety consciousness

15.1 Introduction

At present, due to the unique nature of the construction industry makes it one of the most dangerous building industries, construction safety construction workers and researchers pay most attention to a problem [1–3]. Some of the factors that directly affect the construction engineering safety, for example, worker's attitudes, construction company scale, security policy, project coordination, economic pressure, management training and safety culture. At present, China's construction safety is not optimistic, according to the 2000 China construction industry statistics show that, in 1999, there were 923 cases of three above the level of the building construction safety accident (draw each accident basically has killed 2 people, injured direct loss of 3–19, 1–3 billion yuan), one of every 1,097 people lost their lives. In 1999 the construction total working population of 24,286,000 people. The cause of these injuries accident probability is 3.8 deaths per 100,000 workers per 100,000 workers, 4.5 workers belonging to the 1–3 level disability [4]. The article from the architectural engineering security to explore the construction industry to the risk events, determine the construction site safety influence factors, in order to improve the construction industry safety put forward reasonable suggestions. Construction of the building industry in

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Table 15.1 The architecture of construction safety evaluation system

Architectural design	Design of basic provisions
	Indoor environment design
	The construction of various types of specialized design
Building fire protection	Basic provisions
	Structure design
	Enclosure structure
Construction equipment	Water supply and drainage equipment
	Gas equipment, electrical and lightning protection equipment
	Heating, ventilation and air conditioning equipment
Survey and foundation	Foundation investigation, foundation design, foundation design
	Slope, foundation of roadway
	Foundation treatment
	Building fire resistance rating classification, and fire-resistant limits
Structure design	General layout and layout
	Fire safety evacuation, fire fighting, and structure of elevator, fire extinguishing facilities
Anti-seismic design of building	Seismic fortification basis and classification
	Basic provisions, seismic design of structures
	Housing isolation and mitigation

the status of supervisory body. Including the development plan, regulate the construction market and construction institutions, as well as on construction safety monitoring [5]. The great man once said: While person is creating environment, the environment also created a person. The harmonious campus environment can encourage the student's emotion and motive, equally for forming the university student's creative character talented person to provide may; It can also stir up the student's endless imagination and guide them to search and pursue and struggle at the same time, thus for formed the university student of innovation characteristic to create condition. Harmonious campus environment at with his/her strong influence and permeate a dint help student gradually establishment rise correct philosophy of life, value, and construct one actively upward of creative character [6].

Construction safety evaluation system mainly includes six parts: first, building design; building fire; second, third, fourth, reconnaissance and construction equipment; foundation; structure design; fifth, sixth, building aseismic design. As shown in Table 15.1.

15.2 The Establishment of Safety Evaluation System

The academic atmosphere that forms harmony in the high school can guide the research that the student emphasizes science, climb science high peak and cultivate good campus and campus style spirit. Under the new situation, the high

school should hard construct excellent academic atmosphere and hard develop dependably, diligence, careful, the talented person of innovation. Meanwhile, we should insist taking essential culture as predominance. Socialism advanced culture included essential culture in campus culture; it was the essence of our national time spirit and campus spirit. Is to can't get away from the essential and cultural in harmonious campus cultural construction process, because it is to construct harmonious campus cultural foundation and assurance. Because the world is already diversified, present coming trend of not-essential culture of in campus culture currently, and have a lot of university students to mean favor to it, not-essential culture has already blown to have a warning to essential culture.

A complete architectural engineering safety analysis should be used to design, procurement, construction mode.

1. The design stage effects of engineering factors are: first, the design plan of work; second, design qualification and experience; third, design standards and norms; fourth, design quality; fifth, design depth and procurement and construction of cross; sixth, drawing construction; seventh, can be the change processing. Engineering design of safety evaluation system as shown in Fig. 15.1.
2. The complete procurement phase safety assessment analysis system should include: first, purchase plan; second, supplier selection; third, equipment performance and productivity; fourth, spare parts and after sale service; fifth, equipment factory inspection; sixth, equipment process. As shown in Fig. 15.2.
3. The complete construction safety evaluation system including safety management, civilized construction, base of roadway and template engineering, electricity, construction material hoist and elevator, the tower crane and hoisting, construction machinery. As shown in Fig. 15.3.

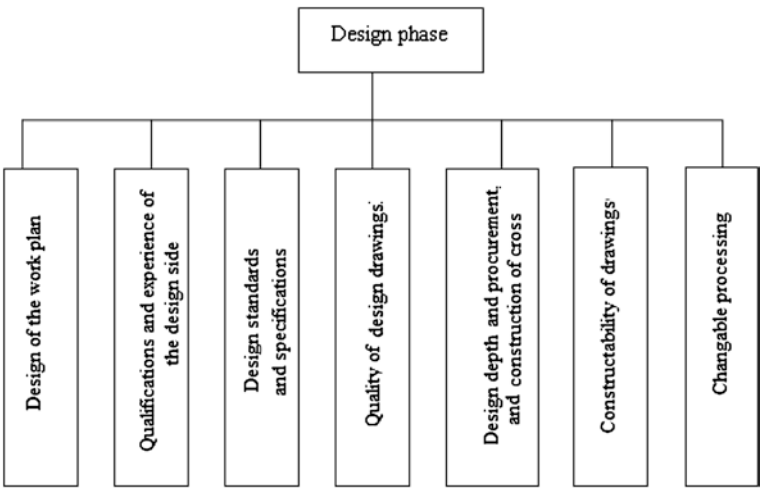

Fig. 15.1 The engineering design stage of safety evaluation system

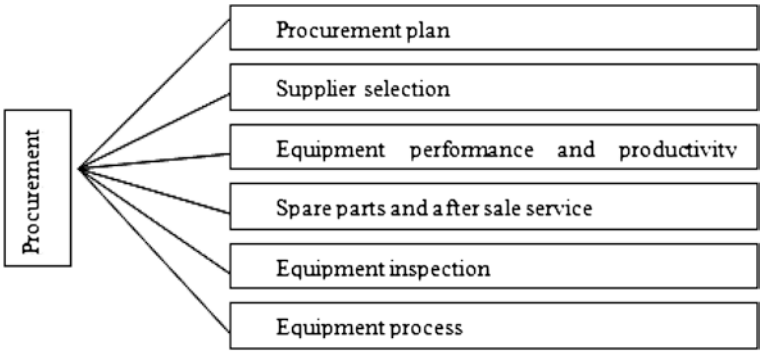

Fig. 15.2 The procurement phase of safety evaluation analysis system

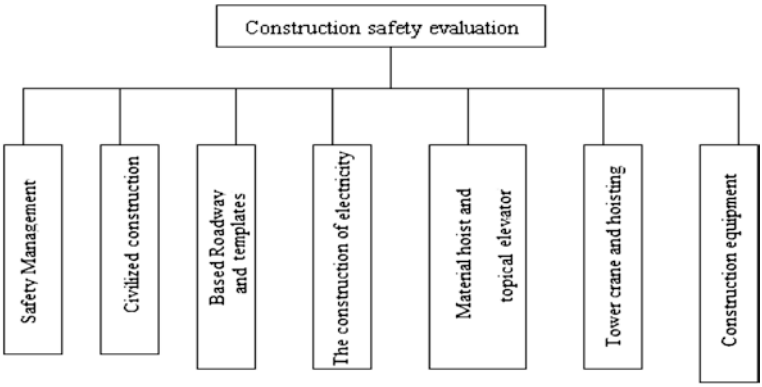

Fig. 15.3 The construction phase of the safety assessment analysis system

15.3 The Application of Fuzzy Evaluation Model

Use the method of fuzzy evaluation for construction engineering safety by fuzzy analysis. Fuzzy evaluation mainly involves three main factors [7–9]:

The first, establish the factor set $U = \{u_1, u_2, \ldots u_m\}$

Second, establish the evaluation set $V = \{v_1, v_2, \ldots v_n\}$

In third, the single factor judgment matrix [10]:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \tag{15.1}$$

Among them, judgment matrix R is single factor geometry U evaluation judgment, get V on the fuzzy set (2) the safety grade fuzzy evaluation analysis.

The domain for V, and the definition of $V_i = (i = 1, 2, l, m)$ with the increasing of i, system risk is gradually increasing. Make $W_i < W_{i+1}$ the domain of the V ranges for [11]:

$$\Omega = \{w_1 : w_2, w_1 : w_2, l, w_{m-1} : w_m\}$$

$$\overline{B} = \{u_{v1}, u_{v2}, \ldots u_{vm}\}, \text{ and the } \sum_{i=1}^{m} u_{vi} = 1 \tag{15.2}$$

Then, a security feature vector for grade [12]:

$$H_{uv} = \left[H_{uv}^{+}, H_{uv}^{-}\right] \tag{15.3}$$

In which, $H_{uv}^{-} = \sum_{i=1}^{m} u_{vi}\left[w_i + u_{vi}(w_{i+1} - w_i) \div 2\right]$

$$H_{uv}^{+} = \sum_{i=1}^{m} u_{vi}\left[w_{i+1} - u_{vi}(w_{i+1} - w_i) \div 2\right] \tag{15.4}$$

Fuzzy characteristic quantity of safety grade median [13]:

$$H_{muv} = \sum_{i=1}^{m} 0.5 u_{vi}(w_i + w_{i+1}) \tag{15.5}$$

When the $\left[H_{uv}^{+}, H_{uv}^{-}\right] \subseteq [w_i, w_{i+1}]$ When the, Safety grade is a 100 % chance;

When the $\left[H_{uv}^{+}, H_{uv}^{-}\right] \subseteq [w_i, w_{i+2}]$ When the, Security level as a possibility for [14]:

$$\pi_i = \frac{\int_{H_{uv}^{-}}^{w_{i+1}} u_{Fvi}(w)dw}{\int_{H_{uv}^{-}}^{w_{i+1}} u_{Fvi}(w)dw + \int_{w_{i+1}}^{H_{uv}^{-}} u_{Fvi}(w)dw} \tag{15.6}$$

15.4 Conclusion

Architectural engineering security related to the personal and property safety problems, but because of the current building design risk, uncertainty of many factors, the accurate and objective evaluation of construction engineering design safety is a difficult job. In this paper, based on the mathematical theory of fuzzy evaluation method for construction of the safety assessment and analysis, not only can understand and grasp the project design of the overall safety, but also can provide prevention and improvement measures.

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