

Research on Systematic Analysis and Countermeasures of the Buildings Construction Safety Problems

Shen Liangfeng^{1,2}, Li Jie³, Fan Yeming²

(1. School of Civil Engineering, Hunan University of Science and Technology, Xiangtan 411201, China;

2. Naging Chixia Development Co., Ltd., Naging 210037, China;

3. School of Civil Engineering, Nanjing Forestry University, Nanjing 210037, China)

Abstract: The buildings construction safety problems contain various safety-hidden dangers that caused by the human unsafe behaviors, the substance unsafe conditions, operation environment unsafe factors and management defects. The authors summarize comprehensively the problems of buildings construction safety in China at present based on grasping the whole safety status of buildings construction, and the synthetic countermeasures including the systems about laws, management, technology and education civilization for buildings construction safety management are brought up based on the viewpoint of safety system theory. Then it is thought that building scientific management mechanisms and popularizing effective management methods and measures are the fundamental ways for improving further the level of safety management for buildings construction in China at present.

Key words: building construction; safety management; problem; countermeasures

1 Introduction

Construction projects, as the designed and constructed object in the construction activities, possesses the characteristics of uniqueness, being delivered by general contract with subcontract, pipelining operations and being subject to environmental change. Thus, construction safety is totally different from the production safety of other industries. Specially, it is also different from other countries because of Chinese special market and social environment.

In the other countries, especially in UK, US and Japan, the construction safety has been improved obviously after 20 ~ 30 years' efforts. They have accumulated a plenty of experience and as a result, the casualty rate of construction industry has been decreased. Nevertheless, construction industry is still the industry with high accidents rate for every country^[1].

In China, nearly 40 millions construction workers in the industry is the largest labor group in the world due to the tremendous construction. In the analysis report of national construction safety released by the Safety Management Committee of Construction Ministry in 2005, 2288 construction accidents (including 2607 deaths) were reported. These numbers decreased 11.4 % and 6.5 % respectively compared to 2004^[2], but are near to the half of the deaths (5986 deaths) in the colliery industry in 2005^[3]. These accidents re-

sulted in tremendous direct and indirect economic loss and the rigorous situation of construction safety management. A lot of literatures show the main reasons for this are random design, wrong command and operation, workers' low quality. The passing of the random designs reveals the flaws of drawing's examination and design management; Wrong command, operation and construction reflects substandard and loose construction and safety management; Low quality of workers' indicate the insufficient investment on safety training. Other important reasons may be a. the strong uniqueness and obvious characteristics of the construction projects made their operation and management difficult; b. the relevant law and technical specification on safety and health can't be updated in time; c. The ways and measures of safety management lacks innovation; d. The risks on the safety cannot be controlled effectively. Sum them up, the lots of problems on construction safety are close related to the lacks of analyzing the problems systematically and providing the effective solutions.

The development of System Science in 1950s provides the theoretical and scientific foundation for the development of Safety System Science. Due to the need of improvement of safety management of industrial technology, the analysis methods and techniques for the safety system engineering have been developed step by step in the technological field of safety engineering.

Because of the scientific natures of integrity and quantification of safety system engineering, its theory and methods have been introduced to the field of building construction safety management. The main principle of building construction safety management is to apply the theory, methods and techniques of safety system engineering to analyzing the problems of building construction safety based on system science. The purpose is to control the safety factors such as human, society, environment, technology and economy etc. and to reach the goals of construction safety. Hence it is significant to analyze the problems lying in the construction safety in China presently and to study the countermeasures that improve the current safety situation and to innovate in the safety management methods, based on the systematic analysis.

2 The Problems of Construction Safety in China

The building's construction safety problems generally refer to all kinds of potential safety hazard caused by people's unsafe actions, object's unsafe state, operational environment's unsafe factors and managerial defects during construction activities. The serious problems may lead to safety accidents. The occurrence of safety accident directly relates to the life of operators, further influencing the schedule, quality and investment effect of construction projects, as well as the sustaining development of national economy and the overall situation of social stabilization. At present there are following problems of construction safety in China:

2.1 Substandard Behaviors of Every Party in Projects' Construction^[4]

2.1.1 Unsafe behaviors of the owner

Primarily: indifferent legal consciousness, disobedience of the legal construction procedures, evading the supervision of governmental departments; no censor on the construction drawings according to the law, no bidding and application for the construction works, no application for the quality and safety supervision, no application for permission of the construction according to the law; delivering construction contracts to the contractors or the person who do not meet specific qualifiers of relative regulations. It should be aware that these phenomena are the principal reasons that cause frequent construction accidents, the worse and the worst malignant accidents.

2.1.2 The unsafe behaviors of supervision engineers

For example: set up the branches to sublet projects to others at will, the branches having no necessary professional nor instruments, even no project office,

and the supervision engineer appearing only when he is needed to sign the document; supervisor's energy distracted because of over-projects and ineffective supervised effect; the supervision staff can't perform their duties well, checking and examining the construction plan and special item of construction safety plan made by contractors loosely and superficially; no supervision on contractor's implement of the advices of eliminating the potential safety hazard given by the administrative departments of construction and safety supervising institutions.

2.1.3 The unsafe behaviors of designers

For example: too many out-house (not in-house, who just using the registered designer's certificate) designers, no guarantee on the design quality, frequent violation of the enforceable designing standards; after going through the censoring of the construction permission, pleasing the owners and the contractors by making discretionary variations and lowering the designing standard, which bring the potentials of safety accidents.

2.1.4 The unsafe behaviors of contractors

The contractor is the party who has the most safety problems. The frequent problems are: indifferent safety consciousness, bad safety guarantee system; no well-established construction safety bylaws and responsibility system, or some having, but no strict execution or ignoring bylaws and operating recklessly; no enough full-time safety supervisor, less than needed and unqualified; subletting works or attaching to other construction company without permission; operation groups and labor teams hiring workers without permission; no execution on the enforceable technical standards; substandard operation and command; the on site operators' lacking basic safety and protection knowledge; bad consciousness of self-protection; poor pertinence of the employee's three-level safety education which is not practical; serious phenomena of paying great attention on production but little attention on safety, great attention on the cost, little attention on investment; winning contracts by lowering the grade and the tender sum, running into tight budget during construction which results the safety management organization and personnel and protection instruments can't be allocated as needed; commonly using nonstandard headframes which have no safety protection device on site; unsafe using of electricity during construction; the fabrication of scaffolds not keeping up with the progress of construction, which lead to lack protective devices for the marginal operators high above the ground; unsafe building of the supporting system of formworks, which often lead to massive casualty accidents; insufficient

protection of Holes and Margins on site.

2.1.5 The unsafe behaviors of safety supervisors

The principal misacts of the supervisors are the loose supervision and examination. For example, the super administrative department of construction and superintending institutions enforces the laws passively; don't allocate the supervision duties by "allocating tasks into sections and allocation responsibilities to the individuals"; don't strengthen the routine inspection duties of the principal supervisor to the construction projects. These misacts result in the behaviors of evading supervision cannot be found and stopped in time and the safety supervision cannot be taken effect; for the projects which has been under supervision, the potential safety hazards can not be investigated and stopped effectively, the countermeasures being not determined and the correction under supervision not fully executed; some supervisors don't have good professional knowledge, then they cannot perform their duty correctly, some even derelict.

2.2 Laws and Statutes

Since 1980s, a series of laws, standards, regulations and policies on building construction safety has been made in China. The regulations on safe construction management of construction projects enforced in 2004 indicated the construction safety supervision has entered into a new stage which is enforced by law. But some problems, such as morbidity and poor operability of laws and statutes, make the government supervision mechanism can not keep up with the requirement of market economy. As a result, the effective exterior supervision mechanism has not come into being.

Currently, four external supervisions to the construction enterprises are running. They are, firstly, supervision from chief administrative law enforcement departments in charge of construction; secondly, the workers accident insurance specified in "Construction Law", supervised by the insurance company; thirdly, the supervisions specified in "Regulations on the Insurance of Industrial Injuries" (State Council Order No. 375) on the enforcement of regulations and standards of safety and health of construction contractors and the prevention of construction accidents; fourthly, supervision from the supervising engineers. As for the first supervision above, it is difficult to create an effective external monitoring mechanism because of the lack of full-time organization, funds and low business level of law enforcement personnel. The second supervision has never been executed by insurance companies in the actual practice. The third supervision, as a social insurance method, lacks basic authorities and operability. The fourth supervision can be serviceable only after the

sound and better laws, regulations and specifications are established, and then the supervising system on construction safety will played the better role as an external supervision^[5].

2.3 Construction Safety Culture

From the view of Mister Xu Deshu^[6] safety culture comes into being during the course of mankind's subsistence, multiplication and development. It is the combination of material and spiritual safety wealth created to maintain human being's physical and psychological safety/health and to prevent, avoid, control and eliminate contingencies and calamities in the fields of production, living and practice; to set up the safe, credible and harmonious environment and the safety system matching the environment; to make the human being becoming more and more safe and healthy and longevous; to make the world the friendly, peaceful and flourishing. According to the concept, most of construction enterprises in China have not established their safety culture system. The construction industry hasn't set up the uniform mode of constructing safety culture too. Launching the activity, such as intensive examination of safety measures, establishing Civilized Site, special month for safe construction, appraising and choosing excellent of safe, only can push to establish the culture of construction safety. These activities are not equal to safety culture itself, its intension, gradation and categories are less than enough.

2.4 Supervision Mechanism

From the external of construction enterprises, firstly, the government department in the supervision of the construction market is not in place, there are loopholes in the supervisory system. The safety analysis report issued by Ministry of Construction has pointed out that some construction administrative departments have failed to be effective to execute the documents on strengthening management of construction safety issued by the CPC Central Committee and State Council, as well as the safety measures are not in place. For the projects which should be under supervision, there is no effective supervision; Sense of executing law is weak, as well as performing the supervised duty. The serious out of control supervisions give the opportunity to circumvent the regulatory that resulted in many hidden dangers of accidents and the frequently occurring accidents. Secondly, the social supervision, lack of operability, has not played a main role in the monitoring.

From the internal of construction enterprises, due to the excessive competition, their profits often can not compensated for the costs of building construction safety, let alone the cost of safe measures to ensure construction safety. More importantly, in order to maxi-

mize profits, the construction enterprises will not take the initiative to strengthen its own self-regulation, which will increase their costs, let alone the supervision of the safety of sub-contractors. Therefore, the internal control mechanisms of construction safety exist only in name.

2.5 Safety Input

The safe construction of building projects requires the qualified workers and instruments, the processed objects, energy, power that met standards, the mature technology, the perfect facilities which ensure the safety, as well as safety monitors and personnel. These all call for the money invested on them. A lot of facts have proved that the safety inputs are far less enough. For instance, though the overall quality of construction workers is low in China, the construction enterprises do badly on implementation of safety education. The safety education and training are serious inadequate and no sustainable contents. In addition, the relatively laggard science and technology of construction safety insufficient research fund invested result in the difficult situation that the safety technology and management can not meet the current construction safety requirements of construction projects that is full of high-techs, difficult to be constructed and highly risky.

2.6 Safety Management Tools

Due to the construction is still in a management state of the mainly manual operation and absent of systematic, ongoing management system to ensure safety, the construction safety is easily ignored. The management target is to finish the construction task. The laws, regulations and rules related to construction safety can not be carried out and safety supervision is ignored to execute during the construction process. The detailed explanation of safe construction is in the blank state, as well as the supervisions and inspections. The measures of safety management are simple and monotone, often being "after handle" which handles the accidents after occurring. In this passive working style, the insecure people's behaviors, objects' state and environmental factors can not get effectively controlled beforehand and the organizational, technical, economic and contractual safety measures can not be effectively implemented^[7]. So the construction enterprises must establish the safety management system to change this backward management model as quickly as possible.

2.7 The Order of Construction Market

The administrations of the construction market are chaotic with serious problems, such as, attached to qualified contractors to win the contract then transferring the contract to those unqualified, dismembering contracts to small packets to deliver, taking no care of

contracts after winning it. For example, some project offices deliver the most dangerous, tiring and dirty work to the migrant workers or the temporary workers at the lowest price, don't check the subcontractor's qualification in the process of sub-contracting, don't explain the technique of safe construction to the operators and ignore the safety management in the course of construction. These often cause some unexpected accidents which shouldn't happen. Though some winning construction enterprises may establish the project organization, they only take charge of coordination, charges and collecting the construction information to be used for delivering the project, the construction is organized by the subcontractors themselves, who simplify all procedures in order to short construction time and save money. Construction plan, if any, is only for the bidding, not for the use of guiding the construction. The other safety management measures are avoided as far as possible, if not avoided, they are just the formality. The foreman of the operation group is also the operator who leads the operation, no other operators allocated. Furthermore some enterprises pursue the profits by selling brand.

2.8 Emergency Response Mechanism of Safety Rescue

At present, the construction enterprises have not established an effective mechanism of construction safety emergency rescue, including the contingency plans for the rescue, emergency and rescue organizations, the availability of the emergency and rescue equipment and personnel. The constructional enterprises are often in frantic rush after safety accidents occur, and fail to carry out relief work in a timely and effective manner.

3 The Countermeasures of Improving Chinese Building Construction Safety

Construction safety is a systematic engineering involving entire process, all round and full participants of construction. It has the characteristics of integrality, synthesis, relativity and dynamics, involving aspects of nature, society, economic, politics, as well as crossing of multi-subjects. To improve the present situation of construction safety in China, the synthetic countermeasures must be taken based on the principles of safety system.

3.1 Legal System

At present, the legal system related to the normalized, standardized and institutionalized construction safety management has been established preliminarily. Further more attached statutes should be established to facilitate its operation. The nonstandard behaviors of all parties should be corrected based on the related

laws and statues. The owners should rigorously enforce market entree, which means construction works must be delivered by competitive bidding to select the contractor who can execute a work with measures ensuring construction safety and implement procedures as reporting construction safety and getting construction permission. The architects must consider the requirements of safe operations and protections, designing works based on the laws and statues and the enforceable construction specifications; to provide advises for protecting safety accidents, they should label the important sections and procedures related to the construction safety. The superintendence engineers must take substantial responsibilities to supervise the works, demanding the contractors to correct potential safety accidents if finding, in serious cases, should suspend the suspicious works, reporting to the relative super charge department of the contractors don't obey the instructions. The contractors should carry on the construction works within their safety qualifier. The constructions surpassing the qualifier requirement are forbidden, as well as using other contractor's qualifier and subcontracting without permission. The intendance administration department of construction must normalize and harmonize the supervising system, pinpointing their supervising duties, strengthening the enforcement of safety measures. They should apply construction laws, policies and conferences into all departments, construction parties, sites and positions and carry out the responsibility investigation.

3.2 The Managerial System

3.2.1 The renovation of management concepts

The construction safety management is based on the concepts to deal with and assist the safety accident after happening, lacking the risk prediction and management before. With the development of technology, new materials, techniques and workmanships coming forward, new risks are brought to the safety problems inevitably, thus, new requirements for the construction safety. New risk management methods on construction safety should be studied to pre-control the risk sources that may cause safety problems in life cycle especially in construction phase of a project to ensure the goal of safe construction^[8-10]. Now researches on this problem are far less enough, instead of mainly focusing on the safety management of construction phase based on project insurances.

3.2.2 The innovation of management methods

Safety management should be of all procedure, all aspects, all participants and all weather instead of only looking out the responsibility after safety accidents happening. Some effective management, such as safety

targets-oriented management, non-hidden dangers management, should be insisted and improved further in the practice. Meanwhile, to ensure the continuity, effectiveness and durative of safety management, new safety encouragement methods and the mechanism of in-house safety management, based on people's safe psychology, should be studied and formed^[7].

3.2.3 The establishment of emergency aid

The Law of Safe Operation of People's Republic of China (LSOOPRC) has expressly required that the construction firms should set up and execute the preparative plan of emergency aid for the firm itself and should set up the organization for it to reduce the loss of people and properties, save the wounded, prevent the accidents from expanding. The preparative plan for construction safety accidents should include: the outline of construction works (scope, structure type, commencement and completion date), the basic constitute of project office (the name and certificate's number of project manger, safety principal, safety operators), the on site aid organization (the specific principal's position and phone number, the outfit of rescue aid, the institutions of rescuing safety accidents including municipal or county medical rescuing aid centre, hospitals' name, telephone, traffic lines). The plan should be put on records as attached files of the reports of safety measures to the super department who is responsible to the construction safety management. It also should be told to the operators on site. During construction, its content should be post on obvious space on site.

3.3 Technical System

3.3.1 The application of safety technique

Safety technique can be applied by standardizing the operation procedures to normalize people's behaviors. Studies have showed that the behaviors normalized by scientific standard operation can facilitate controlling unsafe behaviors and reducing operation mistakes. In addition, as technique rules, standardization can get rid of unsafe situation and help to establish good operative order and environment. It is obvious that construction safety technique is an important measure to ensure protect personal safety of operators and facilitates the process of construction. Therefore, the safety measures should be strengthened and different level's inspection carried out. During construction, the construction safety technology of sections and items should be told based on operational environment, positions and contents, incorporating with the actual practice. The execution of them should be inspected strictly. Meanwhile, the specific construction safety techniques and plan, which should be authorized, assessed

and inspected strictly, should be made. In addition, based on the safety operation standards issued by Construction Ministry, all level's industrial inspection, as well as firm's and project office's inspection, self-inspection of operation groups and inter-inspection between them, should be executed. In that way, the hidden dangers should be found and corrected in advance.

3.3.2 The innovation of safety techniques

At present, there is still difference between the safety techniques, appliances and equipments in China from developed countries. Their degrees of standardization, definitizing and industrialization are very low. Thus, to develop the effective safety protection techniques, the technological brainstorm and innovation of safety techniques should be organized designedly and step by step, based on the available knowledge. The successful application of safety watching and protection system of big tower crane, IT technology applied in construction safety information management, the remote and visual safety system of material's elevator and the raising technology of whole false work synchronously controlled by computers improved the technical measures of construction safety management and reached the new target of the innovation of safety techniques.

3.4 Educational System

3.4.1 The investment of education and training

Fang Dong ping, the Chinese famous expert on construction safety management, has said that the investment on the safety equipment and education (training) invested by project offices can promote the performance of construction firm's safety record most obviously^[12,13]. In the constitutes of investment on construction safety, the majority is on the safety equipments, only small part on the safety training of the personnel on site, which is said 0.91%. A lot of examples of safety accidents show the majority of the accidents were caused by the lack of safety training for the personnel on site. In that case, the investment on safety education should be increased greatly. Only by that, the consciousness, initiative and creativity of safe construction of the personnel can be improved, the safe operation knowledge learned and the safety by laws executed.

3.4.2 Safety culture

The studies on safety culture have showed that the safety culture can play an active role to improve the safety performance because the behaviors of the organization with good safety culture will construct in safer way, the corresponding safety performance being better^[14]. Therefore, to establish a good safety culture, advocating and constructing it is important measure to

improve the safety consciousness of all administrative stuff and other personnel. To establish the safety culture, the content, method, concept and effectiveness of safety management presently should be rebuilt and reevaluated. First, the traditional safety management concepts and methods should be assimilated with present and future values to form acknowledgeable safety concept, by-laws and management mechanism, then, to construct the content of the safety culture with emphasis and orderly based on the target of safety construction. The construction corporation should treat the safety culture as a part of corporation culture, pushing it forward from the up to the down with all stuff involved, advocating it powerfully.

4 Conclusion

Building construction safety not only relates to the benefits of investment, quality and program of construction works, but also the life and property safety of the public, as well as the sustaining development of countries and social stabilization. As China is under the large scale of economical construction, though the general situation of building construction safety system is under control, the quantity of the safety accidents and death toll is high. As a result, effective management and control of construction safety and ensuring the anticipative safety target is one of the central missions of project management for the managerial stuff. The author sums up the safety problems lying in the Chinese building construction industry, presents the safety managerial countermeasures which incorporates law, management, technology and education based on the views of safety system. The author also thinks the scientific management mechanism and the effective managerial methods and measures are the basic solution to improve the level of construction safety management in China.

References

- [1] Fang Dongping, Huang Xingyu, Jommie H. Project Safety Management (second edition) [M]. Beijing: China Water Conservancy and Hydropower Press, Intellectual Property Press, 2005. 5
- [2] Construction Ministry of the People's Republic of China. National Construction Safety Analysis Report (2005) [R]. 2006
- [3] State Administration of Coal Mine Safety. Brief Analysis and Measures of National Coal Mine Safety Situation in 2005 [R]. 2006, 2
- [4] Zhao Zhong. Discussion on construction safety management problems and solutions [J]. Building safety, 2005, 1: 13 - 15.
- [5] Ren Hong, Lan Dingjun. Construction Safety Management [M]. Beijing: China's construction industry Press, 2005, 4
- [6] Xu Deshu, Qiu Cheng. Enterprise's Safety Culture [M]. Beijing: Chemical Industry Press, 2004, 12
- [7] Shen Liangfeng. Research on Incentive Mechanisms of Building Construction Safety Management [A]. Proceedings of CRIOCM 2006 International Research Symposium on Advancement of Con-

- struction Management and Real Estate [C]. 2006,11;259 – 265
- [8] Jia Junfeng, Liang Qinghuai. WBS – RBS and AHP application in safety risk assessment of civil engineering construction [J], Journal of Chinese Safety Science, 2005,15 (7): 101 – 103,107
- [9] Qiao Lin. Construction Risk and Insurance [M]. Shanghai: Shanghai Science and Technology Literature Press. 1999,8
- [10] Liang Qinghuai, Jia Junfeng. Civil engineering construction safety risk management mode of engineering insurance[J], Journal of Chinese Safety Science , 2005,15 (6): 54 – 56
- [11] Zhou Huoju, Liu Xin. Technological innovation and approaches of construction safety [J], Journal of Chinese Safety Science, 2002, 12 (5): 63 – 66
- [12] Fang Dongping ,Huang Xingyu, Li Qiang, et al. Analysis on safety input and performance of construction projects [J]. Construction Economy, 2001 ,3: 9 – 12
- [13] Qiang Maoshan, Fang Dongping, Xiao Hongping, et al. Study on safety input and performance of construction projects [J]. Journal of Civil Engineering, 2004,32 (11): 101 – 107
- [14] Huang Jixin, Fang Dongping, He Weiyong. Rethinking on safety culture of construction industry[J]. Journal of Chinese Safety Science, 2006,16 (8): 78 – 81

Author

Shen Liangfeng, male, born in 1968, Dr. graduated from Dongnan University now is associate professor of School of Civil Engineering, Hunan University of Science and Technology. Mr. Shen current research field: Engineering Management. He can be reached by E-mail: slf535@163.com

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