



## The Most Effective Safety Codes on Occupational Accidents Prevention in Construction Sites

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### ABSTRACT

**Background:** Rapid pace of the construction projects have led to safety negligence on the part of the contractors causing higher numbers of accidents in construction industry. Thus, over 2200 legal provisions have been established for the prevention of accidents on construction sites. Not only contractors are unable to implement all provisions, but also it is hard for regulatory bodies to implement all rules, but they are also hard to remember and attend to by regulatory forces. Therefore, identifying the set of codes with the highest effect on reducing accidents would be most beneficial. The aim of this study was to determine the most effective legal provisions in reducing accidents on construction sites in Zanjan city.

**Methods:** In this study, 378 work-related accidents in construction sites in Zanjan city, already registered in the Labor Inspection Authority, were investigated. Then the codes that had not been respected in the construction industry accidents were identified. Effective codes were determined based on their frequency on Pareto chart.

**Results:** Results indicated that out of 2200 legal matters, only 164 were broken in the accidents.

**Conclusion:** Application of Pareto chart could raise safety professionals' awareness of the specific broken codes in accidents, thus draw higher attention to the codes.

## 1. Introduction

Construction is a dynamic and hazardous industry with numerous occupational threats. This industry usually consists of contractors and workers in various occupations (1, 2). Thus, lots of threats and problems are caused on construction sites that may lead to injuries and damages in construction industry. Occupational threats on different construction sites are more or less similar and include factors like fall from height, mobile

machinery, electrical shock, mechanical failure, falling objects, improper climatic conditions, and structure collapse (2, 3).

There are a lot of reasons for increasing the number of construction accidents including: nature of these projects, socio-economic development, and urban sprawl (4). Thus, construction has been considered as a threatening industry with numerous fatal and nonfatal accidents worldwide

(1, 2). Based on the International Labor Organization reports the number of deaths due to work accidents has been estimated to be 350 thousand in 2014, out of which 60 thousand cases have occurred on construction sites (2, 5). In the US, death rate in running construction projects is 9.9 per 100 thousand which is remarkably higher compared to other industries with an average death rate of 3.4 per 100 thousand (2, 6). According to the reports of Labor Department Statistics Office of Iran, over 37% of the accidents in industries (including deaths and missed work hours) occur in construction projects whereas only 14% of the nation's workers are employed in construction sector(7).

Although awareness of safety and occupational hazards in construction industry has improved over the past decades, the rate of accidents in this industry is still higher than other industries (8).

The threat control and prevention of fatal accidents on construction sites is a multifactorial problem which may demonstrate establishment of over 2200 legal safety laws and regulations provisions in this sector. However, it is impossible to remember and implement all those 2200 regulations by contractors and enforcement agents.

Regarding the lessons from accidents, identifying the legal codes with the highest effect would be beneficial to accident reduction. This study aimed to determine the most significant legal codes contributing to accident reduction on construction sites in Zanjan city.

## 2. Material and Methods

This cross-sectional study investigates the urban construction accidents within 2010 to 2014 period in Zanjan city. All accidents and their possible causes were investigated during a five -year period. A total of 378 accidents with full information were entered into the study. The study was conducted based on the construction accidents reports. These reports are prepared by certified inspectors of Labor Department on construction sector. The reports include a variety of information such as violated legal codes connected

with the accident. As a result, extraction of violated codes out of these reports is possible.

The obtained data were analyzed by Excel 2000 software, and the violated laws and regulations were identified for all accidents.

## 3. Results and Discussion

The investigation showed that out of 2200 legal protection codes on construction sites, only 164 legal codes were violated in the accidents.

Accident prevention requires the knowledge and identification of major violated legal codes in the accidents. To do this, Pareto chart could be used to identify the most important factors and legal codes in the form of a chart (Figure 1).

The study carried out on the work- related accidents in Zanjan city represented that the violation of 164 legal codes caused the past five-year accidents, among which 44 legal codes were violated more than once (2 to 72 times) (table 1). As shown in Table 1 the most frequent violated legal codes are code 23 (Personal protection devices) code 15 (The guard of cliffs), and code 55 (the use of scaffolding) respectively.

It is accepted that a high percentage of work accidents could be prevented by following the laws and regulation. Regarding the safety measures, enforcement of rules and regulations will reduce construction accidents significantly (9).

At present, there are numerous laws and regulations on construction. However, it was clarified in this study that 164 cases had been violated within five years.

The violated laws are mainly related to work safety at height. This is not surprising because the majority of work accidents in construction industry concerns fall from height. The related codes include codes 15, 23, 55, 65, 66, 67, 69, 86, 87, 90, 93, 94, 97, 98, 100, 137, 167, 168, 180, 186, 187, 221, of safety regulations on construction sites; codes 144, and 145 of construction building protection; codes 12, and 15

of safety regulations of construction building; codes 7, and 8 of general safety and health code; and code 79 of personal protection regulations. The Pareto chart indicates that the majority of work accidents (%75) in construction sites are related to safety regulations of

Construction sites most of which concern work accidents at height and unsafe work platform within construction operation at height (unsafe platform, unsafe scaffolding, and unguarded openings.

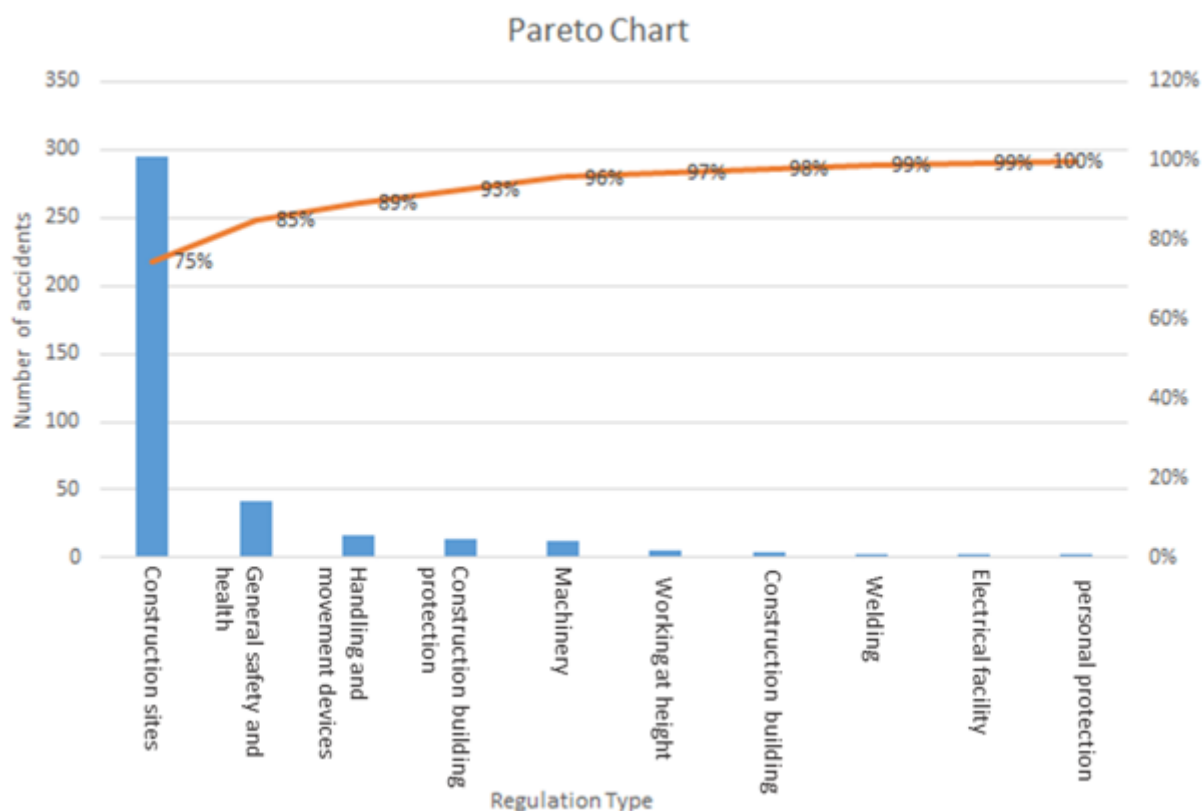


Fig. 1: Pareto chart to show the most repeated regulation codes.

#### 4. Conclusion

Safety in practice involves to provide checklists based on codes and regulations (10). Providing checklist, however, may not be practically usable when there is a huge pool of codes. Since construction industry consists of various stages with specific contractors in each stage, the 164 violated legal codes in construction accidents could be classified based on contractor groups with a checklist extracted for each group including

major violated laws ending in accidents. The violated laws could be attached to the contracts in order to draw the attention of contractors and project owners to these codes and the Consequences of neglecting those codes.

Furthermore, the experts on supervision and safety sectors should pay great attention to ensure that the legal codes are enforced with an emphasis on the most hazardous situations. On the other

hand, short checklists can be used as a tool for hazard identification and considering legal codes in construction industry.

**Table 1:** The frequency of regulations and legal codes.

Legal article	The title of legal regulations	Frequency of violated legal code
1. Code 23, protection regulations of construction sites	The use of protective equipment	72
2. Code 15, protection regulations of construction sites	The use of cliff guards	50
3. Code 55, protection regulations of construction sites	The use of scaffolding at locations	36
4. Code 66, protection regulations of construction sites	Appropriate and solid harness of work platform	24
5. Code 25, protection and public health regulations	The use of guards on rotating parts of machinery	24
6. Code 32, protection regulations of construction sites	The harness and appropriate installation of elevator	12
7. Code 1, protection regulations of transportation vehicle and shipment on construction sites	Requirements of working with elevator	11
8. Code 15, protection regulations of construction sites	The use of guards around all cliffs placing somebody at location	9
9. Code 26, protection and public health regulations	The use of Loto switching	9
10. Code 20,21 protection article of construction sites	Safe distance from power transmission lines	8
11. Code 98, protection regulations of construction sites	Fixing the timber of work platform	8
12. Code 3, machinery and tool regulations	Guards of cutting board parts	8
13. Code 187, protection regulations of construction sites	The use of plastic wedges for slippage prevention	7
14. Code 69, protection regulations of construction sites	No use of bricks and barrels as base plate	6
15. Code 192, protection regulations of construction sites	Technical inspections of demolition site	6
16. Code 198, protection regulations of construction sites	The beginning of demolition operation from the highest part	6
17. Code 240, protection regulations of construction sites	Strengthening of the excavation wall	6
18. Code 87, protection regulations of construction sites	No setting of work platform on bricks or any other loose objects	5

19. Code e 100, protection regulations of construction sites	Setting lateral guards around the whole platform	5
20. Code 287, protection regulations of construction sites	Safety precautions while opening the concrete mold	5
21. Code 12, protection regulations of construction sites	The use of guards around all cliffs	5
22. Code 8, protection and public health regulations	The use of guards around the stairs and landings	5
23. Code 67, protection regulations of construction sites	The harness of scaffolding bases and slippage prevention	4
24. Code 99, protection regulations of construction sites	The minimum safety distance between timbers of work platform	4
25. Code 60, machinery and tool regulations	Fixing the part at cutting time	4
26. Code 94, protection regulations of construction sites	The use of safe timber	3
27. Code 217, protection regulations of construction sites	Evacuation of all individuals during demolition operation using strength	3
28. Code 221, protection regulations of construction sites	Setting appropriator work platform during demolition of the roof	3
29. Code 212, protection regulations of transportation vehicles and shipment on construction sites	The use of safety hook and pawl	3
30. Code 126, working at height	Preventing individuals from passing by the loading areas	3
31. Code 97, protection regulations of construction sites	Placing three supports for timbers of work platform	2
32. Code 168, protection article of construction sites	The use of ladders with appropriate rungs(steps)	2
33. Code 186, protection regulations of construction sites	The use of appropriate support for ladders	2
34. Code 203, protection regulations of construction sites	No leaving of half walls after demolition	2
35. Code 239, protection regulations of construction sites	Safe distance from excavation site	2
36. Code 286, protection regulations of construction sites	Fixing concrete molds	2
37. Code 322, protection regulations of construction sites	No manual handling and lifting of heavy loads	2
38. Code 17, protection regulations of transportation vehicles and shipment on construction sites	Daily inspection of transportation vehicles	2

39. Code 144, Site building safety regulations	The use of guard around all	2
40. Article 145, Site building safety regulations	No replacement of the guards from the edge of cliffs	2
41. Code 7, protection and public health regulations	The use of guards around all cliffs	2
42. Code 23, regulations of work at height	The use of proper equipment for personal protection at height	2
43. Code 79 regulations of personal protection	Setting safe work platform and personal protection equipment for work at height	2

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