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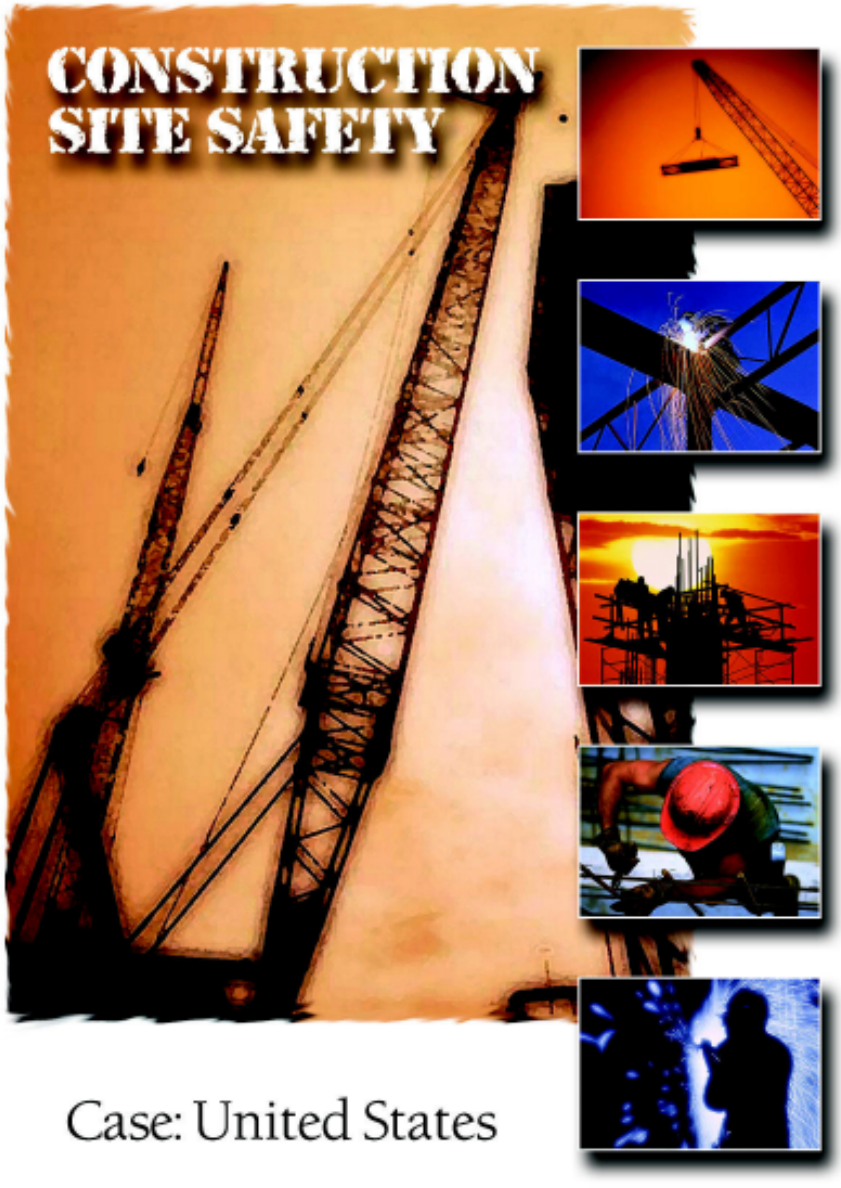
VTT RESEARCH NOTES

VTT TIEDOTTEITA

Jaana Koota

Construction site safety
Case United States



TECHNICAL RESEARCH CENTRE OF FINLAND

ESPOO 2001

VTT TIEDOTTEITA – MEDDELANDEN – RESEARCH NOTES 2120

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Building and Transport

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ISBN 951–38–5931–2 (soft back ed.)
ISSN 1235–0605 (soft back ed.)

ISBN 951–38–5932–0 (URL:http://www.inf.vtt.fi/pdf/)
ISSN 1235–0605 (URL:http://www.inf.vtt.fi/pdf/)

JULKAISIJA – UTGIVARE – PUBLISHER

Valtion teknillinen tutkimuskeskus (VTT), Vuorimiehentie 5, PL 2000, 02044 VTT
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Technical editing Maini Manninen

Otamedia Oy, Espoo 2001

Koota, Jaana. Construction site safety. Case United States. Espoo 2001. Technical Research Centre of Finland, VTT Tiedotteita – Meddelanden – Research Notes 2120. 39 p. + app. 3 p.

Keywords construction, occupational safety, accidents, injuries, accident prevention, costs, management, legislation, safety standards, USA

Abstract

Attention to occupational health and safety in the construction companies has increased in the United States over the past decades. The 1990s is called the "decade for construction safety". The high number of fatal accidents and injuries has led to the greater emphasis on safety. Although construction work has become safer during the years, there is still need for further improvements to reduce the numbers of fatalities and serious injuries in the industry. The construction industry in the United States employs about 5% of entire industrial workforce. However, the construction sector has generally accounted for nearly 20% of all industrial worker deaths. According to the statistics, 18% of work-related deaths and 15% of all workers' compensation cases occur in the construction industry. Approximately 1000 construction workers are killed each year. Accidents in the construction industry alone cost over $17 million annually (1993).

Falls are the most common source of construction worker fatalities. After falls, the most common cause of fatalities was being struck. Incidents in which a worker was caught in or between objects were the third most common cause of construction worker fatalities. Electrical shock was the fourth most common cause of fatalities. Of all fatalities, 11% are the result of contacts with overhead power lines.

Construction Industry Institute (CII) has an on-going research group, "Making Zero Accident a Reality", whose purpose is to develop a communication and education component to assist in understanding and implementation of best practices that support a Zero Accident culture. CII studies indicate that use of the Safety Best Practices may also contribute to improved cost and schedule performance. Contractors can expect to save more than $500 000 on the typical $50 million heavy industrial project and get schedule reductions from 6 to more than 9 weeks by making full use of the Safety Best Practices. Drug and alcohol testing is one part of Safety Best Practices, but it is a controversial topic in which the rights of workers to privacy and freedom of choice in their private behavior are pitted against the rights of the company and its workers rights to have a safe and productive workplace. Drug testing is shown to be effective in reducing the incidence of injuries. It is a common means of addressing safety, especially on large projects or in large construction companies.

Many companies in the construction industry have made studies in accident prevention. Over the last twenty years the construction death rate has been reduced about 40% by the industry in general. Certain groups of companies have reduced the death rate even up to 60%. There are many companies in the United States, especially in the petrochemical construction industry, that have made significant progress in reaching near zero accident rates.

OSHA Standards are focused on general industry, maritime, agriculture and construction. In general, the greatest emphasis is placed on the general industry standards. The construction industry must comply with the Code of Federal Regulations (CFR) for the Construction Industry (29, CFR Part 1926) and the code for the General Industry (29, CFR Part 1910). All employers and employees in the construction sector are required to comply with these standards.

Determining whether a contractor/subcontractor can perform a job safely is difficult. Safety performance measures are used primarily to compare different units or groups of individuals and also to compare one unit or group of individuals over time. There are two different types of measures presently in use: OSHA reportable injury incidence rates and experience modification ratings (EMR).

Preface

In recent years considerable efforts have been taken to increase safety at work on construction sites. In this literature survey construction safety is discussed mainly in terms of occupational safety and health on construction sites. The survey gives basic information inter alia about safety legislation, incident causation, and safety performance in companies and on construction sites. The survey is based on information and research results published in the American literature.

The aim of this study was to get acquainted with the basic knowledge of the safety culture in the construction industry in the United States. The work was part of a three-year programme "Safe Buildings" (RTE Futures 2001–2003) funded by VTT Building and Transport. Information and valuable comments concernig the text were kindly given by Dr. Nancy L. Holland at Texas A&M University, Department of Construction Science, and Dr Leena Sarvaranta, Dr. Arja Merra and Dr. David Payne, all of VTT Building and Transport.

Jaana Koota

Contents

1. Introduction

Construction quality and occupational safety and health are fundamental subjects in the construction sector. They are increasing in importance not only in economic terms, but also from the social and environmental perspective. Attention to occupational health safety in the construction companies has increased in the United States over the past decades. The 1990s is called the "decade for construction safety". The high number of fatal accidents and injuries has led to the greater emphasis on safety. Although construction work has become safer during the years, there is still need for further improvements to reduce the numbers of fatalities and serious injuries in the industry. /2,3,6/

The construction industry in the United States employs about 5% of entire industrial workforce. However, the construction sector has generally accounted for nearly 20% of all industrial worker deaths. There are about 636.000 construction companies in the United States and more than 7,5 million workers are currently employed in the construction sector. According the statistics, 18% of work-related deaths and 15% of all workers' compensation cases occur in the construction industry. Approximately 1000 construction workers are killed each year. Accidents in the construction industry alone cost over $17 million annually (1993). /8,10/

Comparisons have been made between the construction industry and other industrial sectors. The injury and fatality rates has consistently been high in the construction industry, which can be seen in Figure 1. /2/

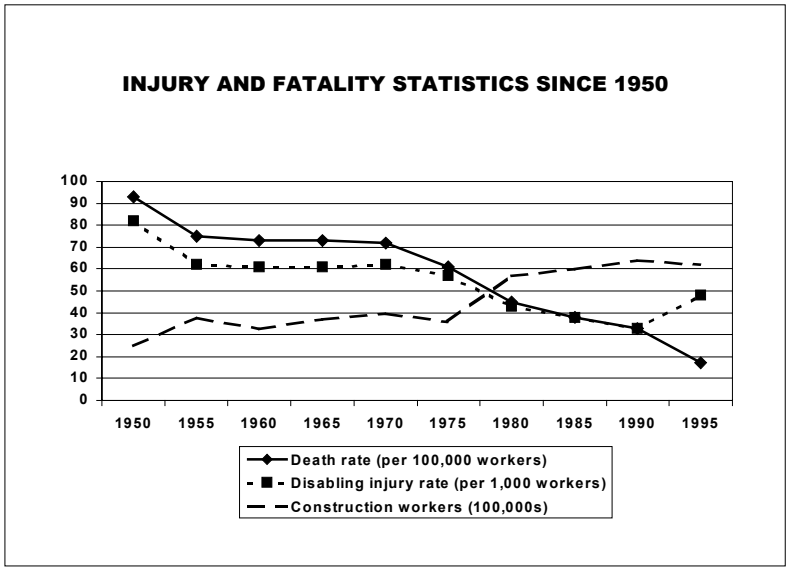

Figure 1. Injury and Fatality Statistics since 1950. Source: /2/.

Many companies have made studies in accident prevention. Over the last twenty years the construction death rate has been reduced about 40% by the industry in general. Certain groups of companies have reduced the death rate even up to 60 %. There are many companies in the United States, especially in the petrochemical construction industry, that have made significant progress in reaching near zero accident rates. /3/

In recent years, some safety professionals have brought forward a new concept about safety management - Total Safety Culture (TSC), a theory incorporating the principles of Total Quality Management (TQM) into the safety arena. In a TSC, everyone acknowledges responsibility for safety and pursues it on daily basis. /10/

2. Safety legislation

2.1 Occupational safety and health act

The Occupational Safety and Health Act (also called the Williams-Steiger Act) was passed on December 29, 1970. In this Act, Congress addressed both the employers' and the workers' responsibilities for safety compliance. Section 5a of the OSH Act requires employers to provide a workplace free from recognizable hazards. Section 5b requires workers to obey all safety regulations. /1,2,5,6,7/

The Purpose of the OSH Act:

"…. to assure…. Every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources…."

- To encourage employers and employees to reduce workplace hazards and to implement new or improve existing safety and health programs
- To provide for research in occupational safety and health to develop innovative ways of dealing with occupational safety and health problems
- To establish "separate but dependent responsibilities and rights" for employers and employees for the achievement of better safety and health conditions
- To maintain a reporting and record-keeping system to monitor job-related injuries and illnesses
- To establish training programs to increase the number and competence of occupational safety and health personnel
- To develop mandatory job safety and health standards and enforce them effectively, and
- To provide for the development, analysis, evaluation and approval of sate occupational safety and health programs

/3,4/

During the years OSHA standards have gone through many modifications. Most of the revisions have been driven by the need to address specific hazards more effectively. In 1976, the courts ruled that the language used by Congress in the Act places an obligation for safety only upon the employer. Therefore, the Occupational Safety and

Health Administration decided that they had no authority to enforce worker safety compliance. According to the recent OSH Act, workers have no responsibility for their own safety and, only the employer is cited for safety violations. There are differences between nations; for example in Canada when a workplace safety violation occurs, both the employer and the worker can be cited. Although actions against individual workers in Canada are infrequent, that potential is still a viable safety motivator. /2,3,4,5, 6,7/

During the first half of the twentieth century, the common law defenses gave way to workers´ compensation laws. Despite this legislation, a high number of worker injuries persisted in the 1960s. That led to the passage of legislation mandating that employers provide their employees with a safe work environment. Employers were charged with the maintenance of worker well-being in addition to the financial responsibility for worker injuries. /2,6,7/

The OSH Act's Coverage

- In general, coverage of the Act extends to all employers and their employees in the 50 states, the District of Columbia, Puerto Rico, and all other territories under Federal Government jurisdiction.
- Coverage is provided either directly by federal OSHA or through an OSHA-approved state program.
- The following are not covered under the Act:
  - Self-employed persons
  - Farms at which only immediate members of the farm employer´s family are employed
  - Working conditions regulated by other federal agencies under other federal statutes

/3,4/

Table 1. Agencies under OSH Act. /2,4,5/

Safety agency		Responsibilities
OSHA	Occupational Safety and Health Administration	• Promulgating new regulations • Enforcing regulations in the places of work • Employer site inspections by OSHA compliance officers • Gathering statistics on injuries and job-related illnesses
NIOSH	National Institute for Occupational Safety and Health	• Research institute of OSHA
OSHRC	Occupational Safety and Health Review Commission	• Performs a judiciary role, hearing cases in which employers disagree with OSHA´s determination that its regulations have been violated.

Safety agencies under OSH Act, and their responsibilities are shown in Table 1. The enforcement of the OSHA regulations can be delegated to the states. The states that have elected to assume the enforcement role are called state-plan states. The state-plan states also have the power to promulgate their own safety regulations. Those regulations have to be at least as stringent as the federal regulations. Although some state-plan states have adopted the OSHA regulations with virtually no significant changes, others have initiated considerable numbers of new safety regulations. Some of the changes adopted by state-plan states have subsequently been adopted in federal standards. Currently there are 21 state-plan states: Alaska, Hawaii, Arizona, New Mexico, California, Nevada, Utah, Oregon, Washington, Wyoming, Minnesota, Iowa, Michigan, Indiana, Kentucky, Tennessee, Virginia, North Carolina, South Carolina, Maryland and Vermont. New York and Connecticut have state plans only for public-sector employees. /2,3/

2.2 Rules and regulations for the construction sector

OSHA Standards have different focus areas. These are general industry, maritime, agriculture and construction. In general, the greatest emphasis is placed on the general industry standards. The construction industry must comply with the Code of Federal Regulations (CFR) for the Construction Industry (29, CFR Part 1926) and the code for the General Industry (29, CFR Part 1910). All employers and employees in the construction sector are required to comply with these standards. /1,2,3,4,5/

Employers and employees must also comply with other standards, such as adopted by the

- National Fire Protection Association (NFPA),
- the American Society of Agricultural Engineers (ASAE),
- the American National Standards Institute (ANSI),
- American Standards for Testing and Materials (ASTM) and
- the American Society of Mechanical Engineers (ASME).

Most of the OSHA regulations provide direct guidance for maintaining safe physical conditions in the workplace. Some minor exceptions include regulations that focus on management´s responsibility to assist in maintaining project safety and training the workers. /1,2,4/

After many additions and modifications over the years, the federal regulations containing the OSHA standards for the construction consist of over 200 sections and more than 1000 subsections. The sections are grouped into 26 subparts (A through Z). /1/

1. General (Subpart A)
2. General Interpretations (Subpart B)
3. General Safety and Health Provisions (Subpart C)
4. Occupational Health and Environmental Controls (Subpart D)
5. Personal Protective and Life Saving Equipment (Subpart E)
6. Fire Protection and Prevention (Subpart F)
7. Signs, Signals, and Barricades (Subpart G)
8. Materials Handling, Storage, Use, and Disposal (Subpart H)
9. Tools – Hand and Power (Subpart I)
10. Welding and Cutting (Subpart J)

11. Electrical (Subpart K)
12. Scaffolds (Subpart L)
13. Fall Protection (Subpart M)
14. Cranes, Derricks, Hoists, Elevators, and Conveyors (Subpart N)
15. Motor Vehicles, Mechanized Equipment, and Marine Operations (Subpart O)
16. Excavations (Subpart P)
17. Concrete and Masonry Construction (Subpart Q)
18. Steel Erection (Subpart R)
19. Underground Construction, Caissons, Cofferdams and Compressed Air (Subpart S)
20. Demolition (Subpart T)
21. Blasting and the Use of Explosives (Subpart U)
22. Power Transmission and Distribution (Subpart V)
23. Rollover Protective Structures; Overhead Protection (Subpart W)
24. Stairways and Ladders (Subpart X)
25. Diving (Subpart Y)
26. Toxic and Hazardous Substances (Subpart Z)

Employer's responsibility is to keep all employees informed about OSHA standards and any proposed or implemented changes. They must also inform employees about any construction materials or substances that are thought to pose some type of health threat. The OSHA Hazard Communication Standard 29 CFR 1926.59 requires a company to inform its employees of the hazards associated with use of and exposure to chemicals used in the workplace. The employer must offer guidance in the proper handling of such materials. That guidance must include material safety data sheets, training programs and labels attached to containers. Employers must post OSHA posters (Form 2203), which informs employees of their rights and responsibilities and employers must provide employees with copies of OSHA rules and regulations. /2,3,4,6,7/

The Occupational Safety and Health Act requires all employers with 11 or more employees to maintain a log of recordable occupational injuries and illnesses. Therefore, any employee who receives medical treatment, suffers a loss of consciousness, a restriction of work motion, time lost from work, or an injury-related transfer to another job must have the accident details recorded on the company´s OSHA log (called the OSHA 200 Log). Employers must report to OSHA, within 8 hours if there is any accident that results in one or more fatalities or the hospitalization of 3 or more employees. The OSHA 200 Log must be maintained on each job site and made

available for review during an OSHA inspection. During February of each year, the OSHA 200 Log must be posted at the work site. /2,3,4,7/

2.3 OSHA workplace inspection

The OSHA agency has an authority to inspect workplaces. During regular working hours, the OSHA inspector has the right to entry to the workplace without needless delay by the employer. The Fourth Amendment to the Constitution of the United States protects private property from unreasonable searches. The courts have ruled that an unreasonable search is any inspection conducted without a warrant, unless the employer or an authorized agent consents to that particular search. Therefore, employers have the constitutional right to refuse OSHA inspector access to their site without a legally obtained warrant. Employers also have the right to limit the scope of an OSHA inspection.

The OSHA inspection can be based on the complaint by an employee on the workplace. If the complaint is done by telephone, it must be confirmed in writing. In every case of employee complaint, the name of the employee is kept confidential. Based on the complaint, the OSHA Area Director decides if an imminent danger condition exists. If there is possibility for imminent danger, OSHA inspectors have an immediate inspection on the work-site.

The OSHA inspector points out violations and unsafe conditions to the employer´s representative. The inspector suggests possible corrective measures and notes all actions which employer takes to correct unsafe conditions at the time of their observance. Even conditions that are immediately corrected, however, may become the basis for a citation or a penalty. /2,3,4,5,6/

OSHA Inspection Priorities

1. Imminent Danger - Top Priority
   - Condition that may cause death or serious physical harm
2. Catastrophes and Fatal Accidents
   - Second priority is fatal accident or the hospitalization of three or more employees - must be reported within 8 hours of accident
3. Programmed High Hazard Inspections
   - Selected industries or employers based on past experience
4. Follow-Up Inspections

/3,4/

Citations by an OSHA inspector for alleged violation of OSHA standards are not a violation of law. It is only a statement of that particular OSHA inspector´s opinion. It is up to OSHA to prove that the violation occurred and represented a danger to the employees´ safety and health. Employers who receive a citation from OSHA have fifteen days to contest that citation. The Copy of Citation must be posted on site until the hazard is abated. /2,3,4/

OSHA Types of Violations

1. Other than Serious Violation - up to $7000 for each violation - does not cause serious physical harm

2. Serious Violation - substantial probability that it would cause death or serious physical harm

- Mandatory $7,000 for each violation

3. Willful Violation - employer knowingly commits a violation with indifference to the law or is aware that a hazard exists and makes no reasonable effort to improve.

- Penalty up to $70,000 per violation
- Minimum penalty of $5,000
- A willful violation resulting in a death may incur a penalty of $250,000 for an individual or $500,000 for a corporation (imprisonment, criminal prosecution)

4. Repeated Violation - Citation for the same violation - penalty up to $70,000 per violation

5. Failure to Abate - failure to correct the condition causing the citation to be issued

- Penalty $7,000 per day per violation

6. DeMinimis Violation - no penalty - no direct relationship to health or safety

/3,4/

The OSHA Penalties	
• Willful	
- Maximum	$70 000
- Minimum	$5 000
• Repeated	
- Maximum	$70 000
• Serious, Other-than-Serious, Other Specific Violations	
- Maximum	$7 000
• Failure to Abate for each calendar day beyond abatement date	
- Maximum	$7 000
• OSHA Notice	$1 000
• Posting of OSHA 200 Summary	$1 000
• Posting of Citation	$3 000
• Maintaining OSHA 200, OSHA 101	$1 000
• Reporting Fatality/Catastrophe	$5 000
• Access to Records under 1904	$1 000
• Notification Requirements under 1903.6	
(Advance Notice)	$2 000
/3,4/	

General construction associations have national committees that are concerned with safety and health and often have state and regional groups as well. Among such organizations are:

- the American Society of Safety Engineers

- the National Safety Council

- the National Constructors Association (NCA)

- the Associated General Contractors (AGC)

- the Associated Builders and Contractors (ABC)

- associations of the various specialty contractors (such as Electrical Contractors Association).

Construction safety company representatives not only have the opportunity through these associations to attend meetings at which new information is presented, but they can also join with others to develop common materials and plan concerted actions.

Both on-the-job and formal training are also available from the state and national OSHA organizations, as are a number of booklets and other materials which can be useful in training managers and workers.

For safety professionals working with unionized construction companies, the building trade unions are another very important group to contact and work with. A number of unions, for example, the Operating Engineers, have their own safety representatives. Both the Building and Construction Trades Department of the American Federation of Labor have their own staffof safety and health professionals. /2,6,7/

3. The costs of accidents

In the early days of building construction, it was common practice to assume that accidents would claim one life for each two floors of a building or for each million dollars of general construction work or for each half-mile of tunnel construction. At that time, these numbers were actually put in the job estimate.

The main problem has been that the methods of cost accounting typically used by construction companies for keeping track of project costs bury accident costs. /2,10/

The direct costs of past accidents, including medical bills and workers´ compensation benefits, are frequently combined with other insurance costs. The costs associated with injuries consist of the direct and indirect costs. The cumulative direct costs are reflected by the experience modification rating (EMR). The indirect costs of project accidents are difficult to discover from project financial statements. They are hidden in extra labor, material, and equipment costs that result from accidents. Indirect costs related to medical case injuries and to restricted work and/or lost workday injuries are shown in Tables 2. and 3. /2,10/

Table 2. Indirect costs related to medical case injuries (CII study)/10/.

Injured worker	• 3,7 productive hours on the day of the injury • 8 productive hours subsequent to the day of the injury • 4 hours lost productivity (productivity level at 90 % for 8 hours for crew of 5)
Transporting of worker	• 3 productive hours lost on the day of the injury • 3 hours of vehicle time and mileage
Crew costs	• 12 hours lost by a crew of 5 reduced to a crew of 4
Workers idled by watching	• 5 hours of other workers´ time
Damaged materials/equipment	• 2 hours of worker time to repair the damage • 2 hours of additional time to restore conditions • $100 to replace damaged materials/equipment
Replacement worker	• 0,06 hours of lost productivity
Supervisory time	• 2,7 hours to assist injured worker and respond to the situation • 1,5 hours to investigate the accident • 1,3 hours to complete reports
Other impacts	• 1 hour impact of OSHA compliance officers • 2 hour impact of media personnel

Table 3. Indirect costs related to restricted work/lost workday injuries (CII study)/10/.

Injured worker	• 6 productive hours on the day of the injury • 60 productive hours subsequent to the day of the injury • 10 hours lost productivity (productivity level at 84 % for 90 hours)
Transporting of worker	• 4 productive hours lost on the day of the injury • 4 hours of vehicle time and mileage
Crew costs	• 8 worker hours lost by a crew working below optimal level
Workers idled by watching	• 6 hours of other workers´ time
Damaged materials/equipment	• 5 hours of worker time to repair the damage • 5 hours of additional time to restore conditions • $100 to replace damaged materials/equipment
Replacement worker	• 10 hours of lost productivity due to new worker • 4 hours to train the replacement worker •
Supervisory time	• 4,2 hours to assist injured worker and respond to the situation • 8,5 hours to investigate the accident • 3 hours to complete reports
Other impacts	• 10 worker hours of impact of OSHA compliance officers • 4 hour impact of media personnel • 10 hours related to planning and handling losses

According to these tables, the total indirect costs in the case of lost workday injuries are about 2,4-times higher than in the medical case injuries. The breakdowns of the indirect costs of the injuries are shown in Figures 2 and 3. For example, the indirect costs of medical-case injuries are about $600, and the indirect costs of restricted-activity or lost-workday cases are about $14.000. The indirect costs of medical-case injuries nearly match the direct costs. Although the field indirect costs of lost-workday injuries average

little more than 20% of the direct costs, the total cost tends to be more than double the direct costs when liability claims are taken into account. /2,10/

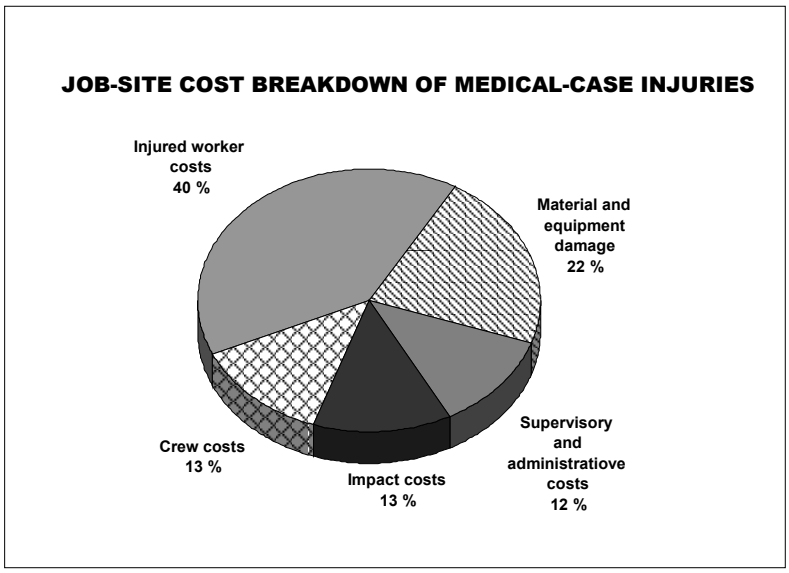

Figure 2. Job-site cost breakdown of medical-case injuries, Source: /2/.

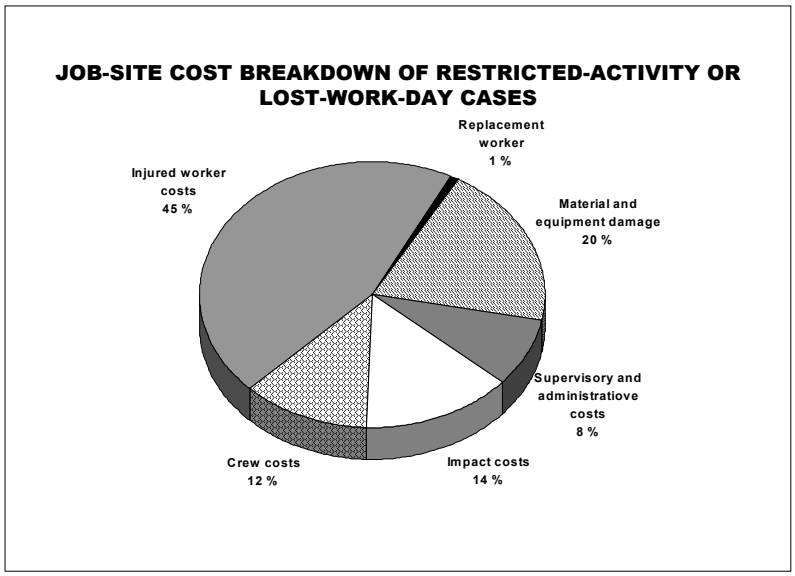

Figure 3. Job-site cost breakdown of restricted-activity or lost-work-day cases, Source: /2/.

It is estimated than companies spend about 1–10% of project costs on safety. There are lots of differences in amounts of money, but also in the items included in safety. For example, one contractor may include the costs of hard hats, goggles, gloves and other standard gear but also the scaffolding in the safety cost category. Another contractor feels that the scaffolding is the only way to accomplish the work and may not consider it as safety expenditure. /2/

4. Safety culture in the company

4.1 Best safety practices

Construction Industry Institute (CII) has an on-going research group, “Making Zero Accidents a Reality”, whose purpose is to develop a communication and education component to assist in understanding and implementation of best practices that support a Zero Accident culture. /8/

CII has 90 member companies around the nation. The "Zero Accident Study" was based on two studies: 1) Surveying largest US construction companies (ENR 400), and 2) Detailed interviews on 38 North American construction projects (value $50–$600 billion). Construction projects were on petrochemical, industrial, public works, transportation, commercial buildings and, hotel-casino construction. Four projects of these 38 projects interviewed had achieved zero recordable accidents and, 21 projects had zero lost-workday incidents. /8,9/

CII has established Nine Industry Best Practices to achieve zero accident in construction. These are:

- Demonstrated management commitment
- Staffing for safety
- Safety planning - pre-project/pre-task
- Safety training and education
- Worker participation and involvement
- Recognition and rewards
- Subcontractor management
- Accident/incident reporting and investigation
- Drug and alcohol testing

According to the study over thirty key findings revealed companies utilizing these best practices had significantly lower recordable injury rates. Results of implementing some of these practices are briefly the following:

1. Demonstrated Management Commitment
   - If the top management did not participate in the incident investigation of every injury, the Recordable Incident Rate (RIR) was 6 times higher than if top management participated.

- If the company president/senior management did not review safety performance reports, the RIR was 7 times higher than if they did.
- If the home office had safety inspections on the project every week or bi-weekly, the RIR was cut into half.

2. Safety Staffing
   - If the safety professional was responsible for less than 50 workers, the RIR was almost half compared to if there were more workers per safety professional.
   - If the safety representative reported to the corporate staff about incidents, the RIR was about half.

3. Safety Planning
   - A site-specific safety program has a strong influence on incident rate. If there were not any site-specific safety program, the RIR was more than 3 times higher.
   - The pre-task meetings cut the RIR to half.

4. Safety Training and Education
   - On the whole, if there were not any formal safety orientation or training for workers and superintendents/project managers, the RIR was about 3 times higher.
   - An interesting point is, that if the safety meeting was held only on Mondays instead of daily meeting, the RIR was more than 3 times higher.

5. Worker Involvement and Participation
   - A formal worker behavior observation and filling safety observation reports cut the RIR to half.

6. Recognition and Rewards
   - If the incentives were based on zero injury objectives and were given to workers weekly/bi-weekly, the RIR was one third of the incident rate when workers got their incentives quarterly or if it was not based on zero incident objectives.
   - If the field supervisors were not evaluated on safety, the RIR was 4 times higher.

CII studies indicate that use of the Safety Best Practice may also contribute to improved cost and schedule performance. Contractors can expect to save more than $500 000 on the typical $50 million heavy industrial project and get schedule reductions from 6 to more than 9 weeks by making full use of the Safety Best Practice. /8,9/

In following figures is shown the comparison of Recordable Incident Rate (RIR) and Lost Workday Case Incident Rate (LWCIR) between CII members and the industry on the whole. The CII performance is about 5 times better than the industry on recordables and nearly 14 better on lost workday cases, which can be seen in Figures 4. and 5. /8,9/

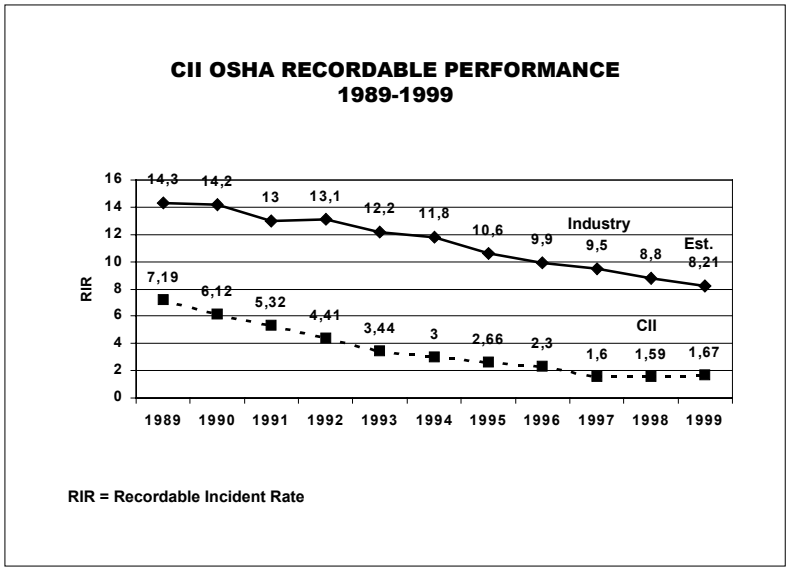

Figure 4. CII OSHA recordable performance, source: /9/.

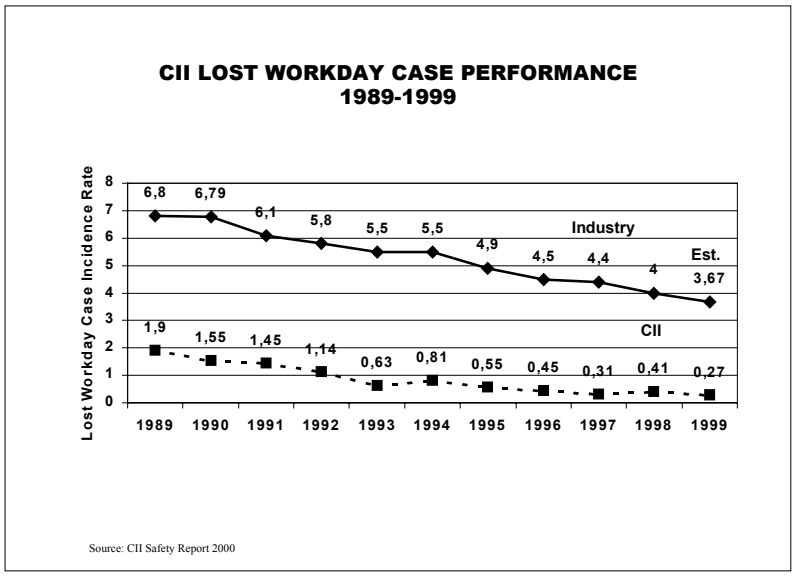

Figure 5. CII lost workday case performance, source /9/.

4.2 Company size and safety

A common mean of classifying firms is size. In the United States the majority of contractors are small employers with fewer than ten employees. In 1994 the Bureau of Labor Statistics published an analysis of nonfatal injuries, in which it was reported that the general size of a company is related to its safety performance. The results show that companies with 20–249 employees had the worst injury records. There are clear reasons, why smaller companies have better safety records than medium-size ones. One key feature of small firms, those with fewer than 20 employees, is that top management

is typically closely involved in monitoring construction progress. To make monitoring by top management possible, the home office must be located close to the projects. Many small firms undertake projects only in their immediate metropolitan areas. Many small companies restrict most of their operations to a 25–50-mile radius. Companies that have most of their projects in close to the home office have better safety records. /2/

One reason is that top management is more accessible to the field personnel. That accessibility makes it possible for the field superintendents to have backup. It may also be related to the project control in that the home office personnel can lend more support to the field when they can be on the project within a matter of minutes or in less than an hour. Safer companies are those in which there are no layers of management between the worker and the company owner or president. Fewer levels of management mean that more direct communication can be maintained between the different levels within the company. The safety performance is better if the top management or the owner of the company visits the job sites frequently. The injury frequency begins to be higher when three or more levels of management exist. Figure 6 implies that some benefit to safety occurs when the number of levels of management gets quite large. Large firms with several levels of management may be of such magnitude that they must deal with safety concerns in a more formal manner. /2/

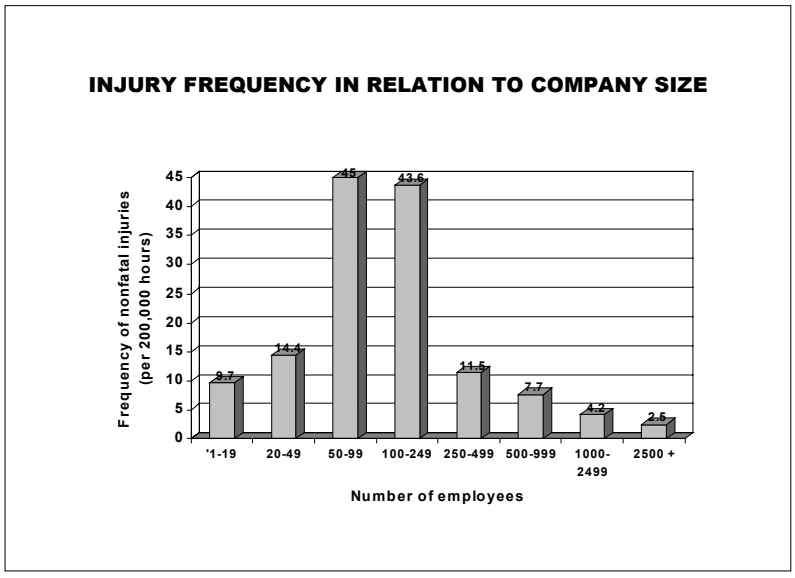

Figure 6. Injury frequency in relation to company size, source: /2/.

4.3 Safety personnel and safety program

The OSHA regulations stipulate that certain personnel be assigned to construction sites. Such personnel are mentioned in various paragraphs in the standards. Some of the more common definitions (29 CFR §1926.32) are the following: /1,2,3,4/

- *Authorized person* means a person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location at the work-site.

- *Competent person* means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.

- *Designated person* means "authorized person" as defined before in this section

- *Qualified person* means one who, by possession of recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work or the project

The staffing requirements for job-site safety may be established to some extent by the construction contract. Safety personnel must perform many different duties such as:

- Keep records of job-site safety performance; the occurrence of injuries, near misses, and non-compliance activities.

- Make regular job-site inspections to provide assurance that employee safety is maintained.

- Keep up-to-date on the OSHA regulations, current safety technology and other safety matters.

- Be involved in worker orientation, and provide training on specific matters.

- Hazard communication.

- Be involved in project planning in different planning stages of a project.

/2,3,6,7,10/

The company is responsible for the adequacy and safety of all construction methods and procedures and the safe prosecution of the work. It is responsible for conducting the work and keeping the work site in compliance with all safety laws and requirements. Every construction project should have a safety program, which includes:

- Hazard analysis

- Safety meetings
- Safety committees
- Safety budgets
- Substance abuse programs
- Subcontractor compliance
- Inspection of the work-site by regulatory personnel
- Safety performance evaluation
- Emergency plans
- Accident reporting
- Investigation of accidents and incidents
- Avoiding liability
- Selection of an insurance carrier

/2,6,7,10/

A successful safety program is broadly based and adopted within a company. Every worker on the company´s construction projects should realize that all work activities have to be safe ones and every worker is capable of performing the work in a safe manner. Drug testing is designed to reduce the hiring of workers who may be substance abusers and may therefore work in an unsafe manner and endanger other workers. Particularly safe workers are those who not only have worked for the same firm for an extended period but also have transferred together from project to project under the same job superintendent or project manager. /2,6,7,10/

4.4 Project participants and safety

The responsibility for worker safety has frequently been extended to others involved in construction projects. There have been several legal cases where owners, designers, construction managers, suppliers and lenders have been held responsible for worker safety in addition to the injured worker's employer. A major effort to expand safety legislation resulted after 28 workers died in the collapse in Bridgeport, Connecticut of the L'Ambiance Plaza Building during its construction. /10/

4.4.1 Management levels

Middle managers, superintendents and project managers are in key positions to set the tone for safety at the project level. Company policies are viewed as being implemented by middle managers, and middle managers communicate project concerns to top management. Top company managers have many different titles; owner, president, and chief executive officer. Company's safety policies are set at the very top level of management. If top management expresses support for certain issues, those issues will be promoted at the work-site. One model of top management´s role in safety performance is shown in Figure 7. /2,7/

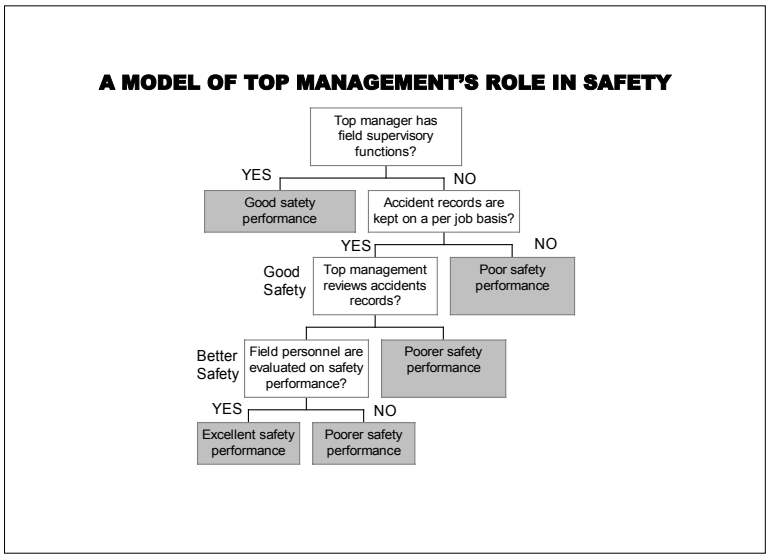

Figure 7. A model of top management's role in the safety, source /2/.

4.4.2 Contractor and subcontractor

Contractually, the general contractor typically has an agreement with the owner, and subcontracting firms enter into an agreement directly with the general contractor. The subcontracting firm does not have an agreement with the owner and, it is regarded by the owner as an employee of the general contractor. The main contract agreement (likewise the subcontract agreement) may address safety to some extent. It is common for contractors and subcontractors to be contractually required to comply with the OSHA regulations. The American Institute of Architects (AIA) Document A401 includes a requirement that the subcontractor notify the general contractor within three days of the occurrence of an injury to an employee or agent of the subcontractor. /2,6,7/

4.4.3 Owner

Owners have become increasingly more mindful of the importance of the role they play in worker safety. Owners can help contractors buy into the zero-accidents philosophy. Traditionally owners have had a very passive role in construction safety. Nowadays owners have both a legal and moral responsibility to adapt proactive measures to promote construction job site safety. Owners are now looking at company lost-time accident data and OSHA citation records to decide on a contractor´s eligibility to bid on their work. Companies with good safety efforts allocate safety expenditures at the corporate level and assess accident costs at the project level. The safety records of bidders are significant criteria in the contractor selection process. By demanding the safety records, owners can disqualify unsafe contractors from bidding. /2,6,7,10/

One technique that many companies employ to capture the interest of workers in the safety agenda is to provide safety incentives. Owner-sponsored incentive programs are good in encouraging safe work practices and achievements. These incentives could be Safe Worker Award and Recognition, Supervisor incentives or Contractor incentives. The reward may be cash, if for example $0,25 is set aside for each period that a worker remains accident free. Some companies provide a variety of gifts that are considered to be valued by the workers. The cost of maintaining a safety incentive program may range from $2/month to $150/month, but the most typical amount is about $20 per month per worker. Owner's safety personnel identifies both contractors and workers with safe or unsafe work practices and adopts corrective or awarding measures accordingly. /2,6,7,10/

4.4.4 Designer

The design plays an important role in construction worker safety, and many design-build firms have accepted that role for many years. Designers have become increasingly more sensitive to this issue. Many owners look for safety-minded design firms that address the safety of the construction workers in their design decisions. Design-for-safety and the design toll may potentially reduce a designer's liability exposure resulting from lawsuits initiated as a result of worker injuries. On a typical design-bid-build project a designer crosses the boundary between design and construction when implementing design-for-safety knowledge. A failure to employ the safety knowledge may lead to increased liability exposure for design professionals. Today's design standards and design codes, such as the Uniform Building Code (ICBO 1994), typically provide standards that target the safety of the facility's end user. /2,10/

5. Safety performance measures

Determining whether a contractor/subcontractor can perform a job safely is difficult. Safety performance measures are used primarily to compare different units or groups of individuals and also to compare one unit or group of individuals over time. There are two different types of measures presently in use: OSHA reportable injury incidence rates and experience modification ratings (EMR).

Many construction buyers request that prospective contractors provide them with the names of past clients as references. In addition to asking previous clients for data about accidents or claims, these buyers typically ask previous clients questions such as whether the contractor maintained a clean job site and whether the contractor cooperated with the customer´s own safety personnel and programs. /2,7,10/

5.1 OSHA recordable incident rate

A company´s OSHA incidence rate is available at the end of each year just completed. It counts the number of OSHA reportable injuries per 200 000 man-hours. OSHA publishes guidelines for reporting these injuries and requires that contractors do so on a log sheet each year. OSHA recordable incident rate is based on company´s entries from the Log and Summary of the OSHA no. 200 form. The yearly total for fatalities, injuries and illnesses with lost workdays and injuries and illnesses without lost workdays are used. The other information needed to calculate the incidence rate comes from payroll or other time records: the number of hours all employees actually worked during the year.

The formula used by the Bureau of labor Statistics, Department of Labor is:

Incident rate = (number of injuries and illnesses x 200 000) / employee hours worked.

The 200 000 hours in the formula represent the equivalent of 100 employees working 40 hours per week, 50 weeks per year, and it provides the standard base for the incidence rates. /7/

The Bureau of Labor Statistics has the average incidence rate for the different types of construction. The statistics are organized into following categories of construction:

1. Under general building contractors
   a) Non-residential building construction
   b) Operative builders

c) Residential building construction

2. Under heavy construction contractors

a) Heavy construction, except highway
b) Highway and street construction

3. Under special trade contractors

a) Carpentering and flooring
b) Concrete work
c) Electrical work
d) Masonry, stonework and plastering
e) Miscellaneous special trade contractors
f) Painting, paper hanging and decorating
g) Plumbing, heating and air conditioning
h) Roofing and sheet-metal work
i) Water well drilling

This method of evaluating company safety performance permits the company incidence rate to be compared to the average incidence rate for all companies in that type of construction. Compared to EMR, the OSHA recordable incidence rate has the advantage of being more recent and of being applicable to small companies as well as to medium-sized and large ones. Its disadvantage is that it is less objective because companies may not use exactly the same definitions of what is an OSHA recordable case. The total number of OSHA reportable accidents for a project during a given period includes fatalities, injuries, and illnesses with and without lost workdays. This measure is a better reflection of project safety performance than just injuries and illnesses with lost workdays. To make comparison between different projects, it is fairer to use a measure which takes into account the number of hours worked on the project, as the larger the number of employee hours worked, the greater the exposure to injuries. /7/

Using the number of lost-time accidents as a measure of either company or project safety performance has three disadvantages: 1) the relative infrequency of lost-time accidents, 2) the encouragement it gives to keeping "the walking wounded" on the job, and 3) the fact that lost-time accidents by themselves are a poor reflection of insurance costs. /7/

5.2 Experience Modification Rating (EMR)

Prior to workers´ compensation laws, injured workers were required to prove that the employer was responsible for the worker being injured in order to receive any compensation for injuries received on the job. Workers´ compensation insurance was developed to provide a non-fault plan for dealing with industrial injuries. Under the workers´ compensation laws, workers injured on the job lose the right to sue their employers for the costs of injuries. In return, they gain paid medical treatment and compensation for the time off work through insurance provided by their employers. /2,7/

The cost of workers´compensation insurance has two components. The first component, the "manual rate", is based on the average of medical costs and benefits paid out in the previous year for each type of work. The second component, the "experience modification rating " (EMR), is based on each employer´s accident costs compared to the average. /7/

The manual rates are calculated by states annually for about 450 work classifications (e.g. plumbing, reinforcing steel installation) based on the medical costs and benefits paid for accidents in each particular work classification plus an amount to cover administrative costs and profits of the insurance company and administrative costs for the rating bureau. /7/

Contractor's experience modification rating (EMR) is the ratio of the company´s actual workers´ compensation insurance claims costs to the company´s expected workers compensation losses for its type of work, averaged over the oldest 3 of the last 4 years. The advantage of this measure is that it is the most difficult for a contractor to manipulate. State rating bureaus use premium and claim data supplied by insurance carriers to compute each employer´s EMR. The purpose of EMR is that contractors who have experienced more accidents and higher claims costs than the average pay a surcharge, while those with lower than average claims costs receive a discount./2,7/

The rating bureaus calculate each eligible employer´s experience modification rating. Four states have their own rating organizations: California, Delaware, New Jersey, and Pennsylvania. Six states (Nevada, North Dakota, Ohio, Washington, West Virginia, and Wyoming) have funds set up by the state to pay workers´compensation claims. These are called "Monopolistic State Funds" and a state board administrates them. These six states use different methods for calculating the EMR, ranging from systems very similar to the intrastate ratings to those giving little credit for better safety records. The remaining states use the national Council on Compensation Insurance as their rating organization. /7/

There are therefore two classifications of experience modification rating: the interstate EMR and the intrastate EMR. The interstate is based on the accident claims experience of a contractor in any or all of the 40 states using the service. The intrastate EMR is based on a contractor´s claims experience in the one state giving the rating. /7/

More construction companies are deciding to combine safety and insurance responsibilities. Major reasons for this trend are the increased costs of workers´ compensation and other insurance costs. Also there is the need for a close monitoring of reserves in order to reduce their experience modification rating. To meet this need, more safety professionals are taking additional training in insurance management.

6. Problem areas in construction safety

Even though the construction industry continues to improve its safety performance, there are still several problem areas. The National Safety Council study produced the following results with respect to the root causes of industrial accidents:

- 10% due to unsafe conditions
- 88% due to unsafe behaviors
- 2% due to unknown causes /10/

In 1996, about 17% of all work-related deaths occurred among construction workers. That is, approximately three construction workers died each day from injuries sustained on the job. Falls caused 31% of these deaths, and ironworkers and roofers accounted for 75% of fall-related deaths. Nonfatal injuries also occur frequently among construction workers. In 1995, construction workers experienced more than 182 000 illnesses and injuries causing lost workdays. Contact with or being struck by an object accounts for more than 50% of all compensable injuries. /10/

Falls are the most common source of construction worker fatalities. After falls, the most common cause of fatalities was being struck. Incidents in which a worker was caught in or between objects were the third most common cause of construction worker fatalities. Electrical shock was the fourth most common cause of fatalities. Of all fatalities, 11% are the result of contacts with overhead power lines. /2,6,10/

Worker fatalities are recorded in the OSHA database known as the Integrated Management Information System (IMIS). The causes of most construction accidents are classified into five broad event types. These are

1. Falls,
2. Struck-by incidents,
3. Caught-in/between incidents,
4. Electrical shock and
5. Other.

Drug and alcohol abuse is currently a subject of great concern in construction industry. Many companies are considering the use of urinalysis or other tests to screen out workers who might be under the influence of substances which could lead to safety hazards for themselves and their co-workers. It is noticed that drug abusers have an impact on construction costs. According to CII statistics drug use increases overall

construction costs by 8,4%, health-care costs by 16,4%, worker´s compensation costs by 17,6%, and it increases liability costs by 14,4%. /2,6,7,10/

Drug testing is a controversial topic in which the rights of workers to privacy and freedom of choice in their private behavior are pitted against the rights of the company and its workers rights to have a safe and productive workplace. Drug testing is shown to be effective in reducing the incidence of injuries. It is a common means of addressing safety, especially on large projects or in large construction companies. For large companies, especially those with annual construction volumes exceeding $50 million, almost all companies have a standard practice of conducting prescreening drug tests before hiring any workers. Drug testing is recarded as helping companies in promoting safety. The average drug testing costs $12–$42. /2,6,7,10/

From the safety perspective, one problem area also is that most construction workers in the United States have a series of temporary jobs. Usually many workers are on the payroll of a company for a particular project and then may or may not be rehired. The reason for this is that most North American construction companies do not have permanent positions for all of their non-supervisory personnel. Employers in construction cannot always hire enough skilled labor to meet their current job needs. Traditionally, in the construction industry management has not wanted to invest much company time in training and in long-range development of these "temporary" craft people. Lack of training has a strong affect on safety. According to studies, 57% of the workers had worked for their current employers for at least one year out of previous five. Additionally, 20% of the workers had worked for their current employers for the entire five years. Studies also show that 25% of all construction accidents happen to workers who have been on the job for one month or less. /6,7/

There have been many attempts to explain the causes of worker accidents. The physical conditions in the workplace and the states of mind of the workers are the primary factors under consideration. There are different theories of accident causation. These are:

- The Accident-Proneness Theory
- The Goals-Freedom-Alertness Theory
- The Adjustment-Stress Theory
- The Distractions Theory
- The Chain-of-Events Theory

The accident-proneness theory is perhaps the oldest and best-known theory of accident causation. It has been the subject of considerable research, but the other theories have

not been subjected to rigorous testing. Though largely untested, the theories do appear to help explain accident causation. /2/

When injury data are examined over a period of time, patterns of occurrence have been identified. The most common patterns relate to the hour of day, the day of the week, and the season of the year. The distribution of injuries by hour and time of the year is shown in Figure 8.

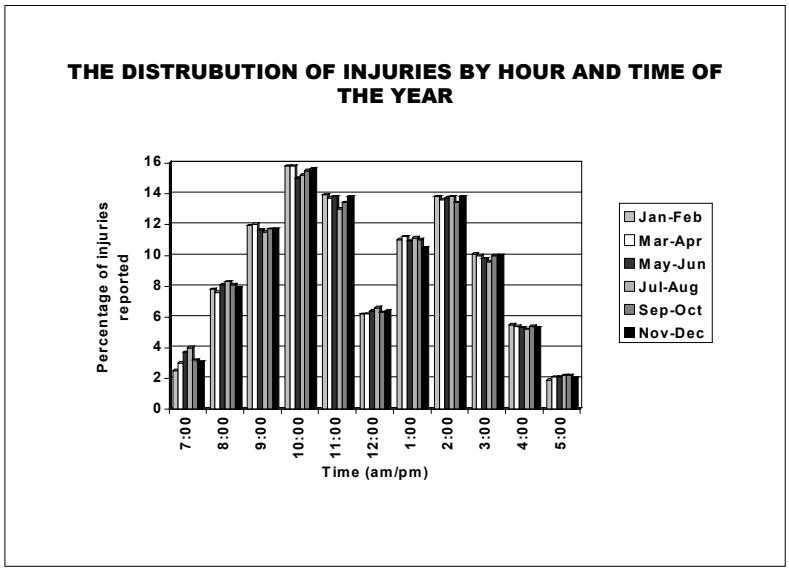

Figure 8. The distribution of injuries by hour and time of the year, source: /2/.

7. Summary

Construction quality and occupational safety and health are increasing in importance not only in economic trems, but also from the social and environmental perspective. In the United States the Occupational Safety and Health Act was passed in 1970, and since that it has gone through many modifiations. According to the recent OSH Act, workers have no responsisbility for their own safety and, only the the employer is cited for safety violations. The Act requires all employers with 11 or more employees to maintain log of recordable occupational injuries and illnesses.In the United States the majority of contractors are small employers with fewer than ten employees the general size of a company is related to its safety performance. One key feature of small firms, those with fewer than 20 employees, is that top management is typically closely involved in monitoring construction progress. Large firms with several levels of management may be of such magnitude that they must deal with safety concerns in a more formal manner.

The OSHA regulations stipulate the certain personnel be assigned to construction sites. The staffing requirements for job-site safety may be established to some extent by the construction contract. Every construction project should also have a safety program. Many companies provide safety incentives to capture the interest of workers in the safety agenda. Owner-sponsored incentive programs are good in encouraging to safe work practices and achievements. Traditionally owners have had a very passive role in construction safety. Nowadays owners have both a legal and moral responsibility to adapt proactive measures to promote construction job site safety. Many owners also look for safety-minded design firms that address the safety of the construction workers in their design decisions.

The total costs of accidents are difficult to determine. Indirect costs of project accidents are difficult to discover from project financial statements. They are hidden in extra labor, material, and equipment costs that result from accidents. It is estimated than companies spend about 1–10% of project costs on safety, but there are lots of differences in amounts of money and in the items included in safety.

Construction Industry Institute (CII) has 90 member companies around the United States. CII has an on-going research group, “Making Zero Accidents a Reality”, whose purpose is to develop a communication and education component to assist in understanding and implementation of best practices that support a Zero Accident culture. CII has established Nine Industry Best Practices to achieve zero accident in construction.

Even the construction industry continues to improve its safety performance, there are still several problem areas. Unsafe behavior is the most common root cause of industrial

accidents. In the industry, approximately three construction workers died each day from injuries sustained on the job (1996). Falls are the most common source of construction worker fatalities. After falls, the most common cause of fatalities is being struck. Incidents in which a worker is caught in or between objects are the third most common cause of construction worker fatalities. Electrical shoch is the fourth most common cause of fatalities. Drug and alcohol abuse is currently a subject of great concern in construction industry. For large companies, especially those with annual construction volumes exceeding $50 million, almost all companies have a standard practice of conducting prescreening drug tests before hiring any workers. From the safety perspective, one problem area also is that most construction workers in the United States have a series of contemporary jobs. Of all construction accidents 25% happen to workers who have been on the job for one month or less.

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Appendix A: Key terminology

Accident

Unplanned event, generally with negative consequences, that may or may not be associated with property damage or an injury

Authorized person

A person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location or locations at the work-site

Census of Fatal Occupational Injuries (CFOI)

Program established by the Bureau of Labor Statistics in 1992 to accurately document the number of fatalities occurring in different industries

Competent person

An individual who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees and has authorization to take prompt corrective measures

Death rate

Ratio of the number of worker deaths per 100,000 workers employed for one year

Employee

Every laborer or mechanic under the Construction Safety Act regardless of the contractual relationship which may be alleged to exist between the laborer or mechanic and the contractor or subcontractor who engaged him or her

Experience modification rating

Multiplier applied to the manual rate paid on workers' compensation by a firm, based on its history of workers' compensation claims, reflecting both injury frequency and injury severity

Injury frequency

Ration of the number of injuries incurred per 200,000 hours of worker exposure or per 100 full-time workers employed in one year

Lost workday injury

A work-related injury of an employee in which the employee experiences either days away from work, days of restricted work activity, or both

Material Safety Data Sheet (MSDS)

Written or printed material concerning a hazardous chemical that contains information on its identity, its ingredients, the material or materials in it that are known to be hazardous, physical and chemical characteristics of the hazardous chemical, its physical and health hazards, symptoms of exposure, any medical conditions generally recognized as being aggravated by exposure to the chemical, the primary route of entry, the OSHA permissible exposure limit, precautions to be taken during handling and use, and steps to be followed upon exposure

Medical case injury

Worker injury requiring the service s of a physician

Near miss

Incident involving no injury and no property damage, but high potential for such occurrence

Occupational Safety and Health Administration (OSHA)

Agency created by the Occupational Safety and Health Act to promulgate safety and health standards, enforce compliance with the safety regulations, and monitor industry safety performance

Qualified person

A person who by reason of experience or training is familiar with a particular operation to be performed and the typical hazards involved

Recordable injury

A work-related injury of an employee resulting from an event on a construction site and requiring treatment by medical personnel or causing loss of consciousness, restriction of work or motion, or transfer to another job

Zero accidents

Philosophy adopted by some companies in which the goal is to have no worker injuries

Published by

Vuorimiehentie 5, P.O.Box 2000, FIN–02044 VTT, Finland
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Series title, number and report code of publication

VTT Research Notes 2120
VTT–TIED–2120

Author(s)
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Title

Construction site safety
Case United States

Abstract

Attention to occupational health and safety in the construction companies has increased in the United States over the past decades. The 1990s is called the "decade for construction safety". The high number of fatal accidents and injuries has led to the greater emphasis on safety. Although construction work has become safer during the years, there is still need for further improvements to reduce the numbers of fatalities and serious injuries in the industry. The construction industry in the United States employs about 5% of entire industrial workforce. However, the construction sector has generally accounted for nearly 20% of all industrial worker deaths. According the statistics, 18% of work-related deaths and 15% of all workers' compensation cases occur in the construction industry. Approximately 1000 construction workers are killed each year. Accidents in the construction industry alone cost over $17 million annually (1993).

Falls are the most common source of construction worker fatalities. After falls, the most common cause of fatalities was being struck. Incidents in which a worker was caught in or between objects were the third most common cause of construction worker fatalities. Electrical shock was the fourth most common cause of fatalities. Of all fatalities, 11% are the result of contacts with overhead power lines.

Construction Industry Institute (CII) has an on-going research group, "Making Zero Accident a Reality", whose purpose is to develop a communication and education component to assist in understanding and implementation of best practices that support a Zero Accident culture. CII studies indicate that use of the Safety Best Practices may also contribute to improved cost and schedule performance. Contractors can expect to save more than $500 000 on the typical $50 million heavy industrial project and get schedule reductions from 6 to more than 9 weeks by making full use of the Safety Best Practices. Drug and alcohol testing is one part of Safety Best Practices, but it is a controversial topic in which the rights of workers to privacy and freedom of choice in their private behavior are pitted against the rights of the company and its workers rights to have a safe and productive workplace. Drug testing is shown to be effective in reducing the incidence of injuries. It is a common means of addressing safety, especially on large projects or in large construction companies.

Many companies in the construction industry have made studies in accident prevention. Over the last twenty years the construction death rate has been reduced about 40% by the industry in general. Certain groups of companies have reduced the death rate even up to 60%. There are many companies in the United States, especially in the petrochemical construction industry, that have made significant progress in reaching near zero accident rates.

OSHA Standards are focused on general industry, maritime, agriculture and construction. In general, the greatest emphasis is placed on the general industry standards. The construction industry must comply with the Code of Federal Regulations (CFR) for the Construction Industry (29, CFR Part 1926) and the code for the General Industry (29, CFR Part 1910). All employers and employees in the construction sector are required to comply with these standards.

Determining whether a contractor/subcontractor can perform a job safely is difficult. Safety performance measures are used primarily to compare different units or groups of individuals and also to compare one unit or group of individuals over time. There are two different types of measures presently in use: OSHA reportable injury incidence rates and experience modification ratings (EMR).

Keywords
construction, occupational safety, accidents, injuries, accident prevention, costs, management, legislation, safety standards, USA

Activity unit
VTT Building and Transport, Business and Process Management,
Hermiankatu 8 G, P.O.Box 1802, FIN–33101 TAMPERE, Finland

ISBN	Project number
951–38–5931–2 (soft back ed.) 951–38–5932–0 (URL: http://www.inf.vtt.fi/pdf/)	R1SU00275

Date	Language	Pages	Price
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