British Journal of Applied Science & Technology
20(5): 1-13, 2017; Article no.BJAST.33275
ISSN: 2231-0843, NLM ID: 101664541

SCIENCEDOMAIN *international*
www.sciencedomain.org

One Hundred Months of Construction Accidents in the Southeast of Mexico

Rómel Gilberto Solís Carcaño[1*]

[1]*College of Engineering, University of Yucatan, Mexico.*

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/BJAST/2017/33275
Editor(s):
(1) Aurora Angela Pisano, Solid and Structural Mechanics, University Mediterranea of Reggio Calabria, Italy.
Reviewers:
(1) Michal Kraus, Institute of Technology and Business in České Budějovice, Czech Republic.
(2) A. Carreño Ortega, University of Almeria, Spain.
Complete Peer review History: http://www.sciencedomain.org/review-history/18914

Original Research Article

Received 7th April 2017
Accepted 30th April 2017
Published 4th May 2017

ABSTRACT

Construction work is considered to be one of the most dangerous activities, in which the workers are exposed to multiple risks. Due to the complex interdependence of the tasks and the fact that the productive plant changes location constantly, it is more difficult to manage injury prevention and safety in construction sites, with respect to other activities. The present study was conducted in Yucatan, Mexico, where low levels of prevention and compliance with obligatory norms have been reported. The aim was to analyze a sample of over one hundred construction accidents in building works in order to determine the causes and consequences of the lack of prevention. The risks which caused the accidents were analyzed with regard to their incidence and severity; the resulting injuries and the occupations of the workers affected were also analyzed. It was concluded that urgent measures are required in order to prevent four main risks (Concrete and masonry construction, Fall protection, Scaffolds, and Electrical); In addition, no actions were observed providing evidence that the phenomenon of lack of prevention in construction works is a priority for the authorities, companies or the trade unions.

Keywords: Construction; prevention; risks; accidents; human resource.

**Corresponding author: E-mail: tulich@correo.uady.mx;*

1. INTRODUCTION

Construction is an activity carried out by workers and organized by a company, whose administrators have the obligation to manage work-related risk prevention; This term will subsequently be referred to with the abbreviated form: risk prevention. The aim of this management is to achieve an adequate work environment, where the workers can carry out their activities with dignity, while allowing them to participate in the ongoing effort to improve health and safety conditions [1].

Every time a construction project is initiated, the productive plant must change its location and thus, the transformation of inputs into products is carried out in a system which is in a permanent phase of implementation, without ever reaching a state of stable operation. This makes the company function in a decentralized and mobile manner, while the workers are dispersed in different projects and work places, under a contracting scheme which propitiates continuous rotation [2].

Currently, construction work is recognized as one of the most dangerous activities, with a fatality rate in the USA of 15.6 per 100,000 construction laborers [3]. This can be attributed to the great diversity of factors which can put the health and lives of the workers in danger due to the fact that, generally speaking, one company can carry out various types of projects; In addition, it is common to find many occupations intervening simultaneously. Hiring of casual labor and labor instability must also be considered, among other aspects.

Due to the complex interdependence of construction tasks, the most important characteristics of the risks to which the workers are exposed are: Intermittence, repetition and short duration [4]. Because of these factors, in construction projects, it is usually very difficult to establish actions to prevent risks, train laborers and ensure that the tasks are carried out safely [5].

The environment of construction works is a good example of how the joint action of a group of people produces settings which can be unsafe for many members of an organization. The complex interaction between the workers in a project can cause the actions of a few to generate risks which can affect many others simultaneously; Thus one worker's lack of safe behavior can provoke problems of social dimensions [6].

Gordon recognized a parallelism between a work-related accident and the theory of how a disease overwhelms a susceptible patient. An accident situation was considered to require the same elements as a person falling ill: A host, an agent, and an environment. The agent in the accident analogy was considered to be some form of damage-inflicting energy. At a later date, Houston replaced these elements by a driving force (agent), a target (host) and a trigger, which caused the driving force to injure the target. Threshold values were considered for the targets and triggers, below which the accident could not occur [7].

Environments or unsafe acts can cause a work-related accident, which is defined as follows "*an Occupational accident is an unexpected and unplanned occurrence, including acts of violence, arising out of or in connection with work, which results in one or more workers incurring a personal injury, disease or death. The term occupational accident also refers to any travel, transport or road traffic accidents in which workers are injured and which arise out of or in the course of work, i.e. while engaged in an economic activity, or at work, or carrying on the business of the employer*" [8].

The study reported herein was conducted in Yucatan, a state located in the southeast of Mexico. In this geographical context, most of the constructions are not particularly large or high. Horizontal type constructions predominate due to the flat terrain and also due to the lack of prevision to protect the territorial reserve of the region. In accordance with the level of development in the region, building activity is carried out, generally speaking, in a framework of low technological level, in which most of the accidents arise from artisanal construction activities [2]. Table 1 presents the main statistical data characterizing construction activity in Mexico.

Over the last decade, the phenomenon of the lack of risk prevention in Yucatan has been studied in depth. In order to facilitate a better understanding of the context of this work, Table 2 shows a synthesis of the main conclusions presented in previously published works.

Table 1. Characterization of construction in Mexico [9]

Statistics	Data	Year
Number of construction companies	18,637	2009
Contribution of construction to the GDP	6.75 %	Average 2006-2011
Construction works (percentage of the total value of investment in construction)	45.6 %	2011
Private construction (percentage of the total value of investment in construction)	48 %	2011
Public construction (percentage of the total value of investment in construction)	52 %	2011
Population occupied in construction	3, 610,336 (7.7 % of the national total)	2011
Monthly remuneration per worker employed in the construction of a building	258 US dollar	2010
Construction workers with access to health services	19.8 %	2011
Female construction workers	3.6 %	2011

Table 2. Studies carried out on the state of prevention of work-related risks in building works in Yucatan, Mexico

Authors	Main conclusions
Solís, Arcudia & Campos [2]	The construction of housing projects was studied. A poor culture of risk prevention and a low level of compliance with the norms were observed. The indifference of the construction companies was noted and the workers were seen to act as if they were unaware that an accident could affect both their physical integrity and their family's well-being.
Solís & Arcudia [10]	Accidents in construction works were analyzed. The conclusion was that extreme measures of prevention must be taken in the pouring of concrete roof slabs and when working in the proximity of power lines. It was observed that prevention does not form a part of the cultural values of the region, which was reflected in the inability of the government to achieve compliance with the regulations, the fact that the construction companies give no priority to prevention and that the workers are willing to work without preventive measures.
Solís & Sosa [6]	In the case study of a leading construction company in the region, a low level of compliance with the safety regulations was observed. A system of safety and health management was proposed which, in accordance with a calculated financial flow, was found to be economically feasible, with economic benefits for the company after the second year of operation.
Solís, Ayora & González [11]	Projects of public works were studied and it was found that government officials appear to have a biased vision of risk prevention given that they consider this to be the exclusive responsibility of the participants involved in the implementation phase of the projects (construction companies and supervisors) and thus do not plan safety measures. It was also observed that government dependencies do not convert the experiences of the accidents occurring on their work sites into explicit knowledge; nor do they provide training for the work supervisors to avoid the repetition of similar events.
Solís & Franco [12]	The perception of construction workers in housing projects was studied. It was found that these workers have a low educational level and have received very little training in competencies for the work or in risk prevention. They showed poor integration in the culture of safety in the workplace and do not seem to perceive this lack as an aspect that affects them negatively. The worker's perception is that prevention of accidents depends mainly on them and that being careful is the best way to avoid them.

The aim of this work was to analyze a large sample of construction accidents in building sites to determine the causes and consequences of the lack of risk prevention in the southeast of Mexico.

2. METHODOLOGY

Research procedure involved the compilation of information, analysis, and emission of conclusions. Information was gathered from local newspapers covering a period of 100 months, during which construction accidents occurring in Yucatan, Mexico were reported.

The information collected for each accident included:

- The description of the incident which had an effect on the workers' health. Whenever possible, the description of the accident was complimented with eye-witness testimonies from people who were present at the moment of the accident, both workers and passers-by. This information was registered in chronological order. The accidents occurring on the construction site and those occurring during the transportation of the workers to the site were studied.
- The type of client involved in the construction project, with two categories: private or public, managed by people or private entities, or by government dependencies.
- The size of the construction, based on the Mexican norm NOM-031-STPS-2011 [13], which classifies a work site with a surface area under 350 m^2 and/or a height under 10.5 m as small; a surface area between 350 and 10,000 m^2 and/or height between 10.5 and 16.5 m as medium; and a surface area greater than 10,000 $m^2$and/or a height greater than 16.5 m as large.
- The number, occupation and age of the affected workers.
- Physical injuries suffered by the workers.

Analysis of the information consisted in the:

- Determination of the main risk that caused the accident. The risks were classified based on the subparts of the Standard number 1926 in the Safety and Health Regulations for Construction of the Occupational Safety and Health Administration [14]. For each accident, only one risk was taken into consideration and this was judged to be the cause of the accident.
- Determination of the number of accidents and the number of workers affected which could be attributed to each risk category of the Standard number 1926.
- Calculation of the incidence of each type of risk.
- Calculation of the mortality rate caused by each type of risk.
- Classification of the type of injury received by the affected workers.
- Classification of the type of occupation of the affected workers.
- Descriptive statistics of the age of the workers affected in the accidents.

3. RESULTS

One hundred and nine accidents were studied throughout the 100 months of investigation (8 years and four months), of which 103 occurred on the construction site and 6 during transportation of the workers to the site. Seventy three percent of the accidents occurred in private construction works and 27% in public constructions managed by various government dependencies.

Ninety two percent of the constructions in which the accidents occurred were classified as small, mainly residential works or maintenance. The remaining 8% included medium-sized construction sites (a museum, a hospital and a shopping mall**),** or large (a convention center, a hotel, two apartment buildings and an industrial plant).

The total number of workers affected in the accidents (deceased or injured) was 262, of which 199 suffered injuries on the construction site and 63 during transportation. Table 3 presents, for each year of the study, the number of workers affected in the accidents which occurred on the construction site and Table 4 presents the workers affected in the accidents occurring during transportation.

Table 3. Workers affected in the accidents occurring on the construction site.

Year	Months	Accidents	Deaths	Injured
2008	2	2	2	7
2009	12	10	7	42
2010	12	8	3	12
2011	12	8	4	5
2012	12	6	3	3
2013	12	14	7	12
2014	12	13	2	31
2015	12	10	5	4
2016	12	29	16	29
2017	2	3	1	4
Total	**100**	**103**	**50**	**149**

From here on all the results presented will refer only to the accidents which occurred on the construction site. The 103 accidents classified in accordance with the subparts of the Standard number 1926 in the Safety and Health Regulations for Construction of the OSHA. Table 5 shows the number of accidents and workers affected, in accordance with the risk categories of the aforementioned standard.

Taking into account the criteria of risk incidence, Fig. 1 presents the percentage of accidents per category. Similarly, for the criteria of severity, Fig. 2 shows the percentage of deceased workers for each risk category.

Table 4. Workers affected in the accidents occurring during transportation to the construction site

Year	Accidents	Deaths	Injured
2009	2	3	24
2011	1	3	0
2012	1	0	4
2014	1	1	15
2015	1	0	13
Total	**6**	**7**	**56**

Table 5. Accidents and affected workers per risk category in the accidents that occurred on the construction site (Standard number 1926 OSHA)

Subpart	Risk category	Accidents	Deaths	Injured
C	General safety and health provisions	4	1	8
E	Personal protective and lifesaving equipment	1	1	0
F	Fire protection and prevention	1	0	1
G	Signs, signals and barricades	1	0	3
H	Materials – handling, storage, use and disposal	5	4	3
I	Tools-hand and power	1	0	1
J	Welding and cutting	1	0	0
K	Electrical	19	11	8
L	Scaffolds	18	7	18
M	Fall protection	16	10	6
O	Motor vehicles, mechanized equipment, and marine operation	6	3	4
P	Excavations	1	0	1
Q	Concrete and masonry construction	20	11	87
T	Demolition	4	0	4
X	Stairways and ladders	2	0	2
AA	Confined spaces in construction	1	2	0
CC	Cranes and derricks in construction	2	0	3
	Total	103	50	149

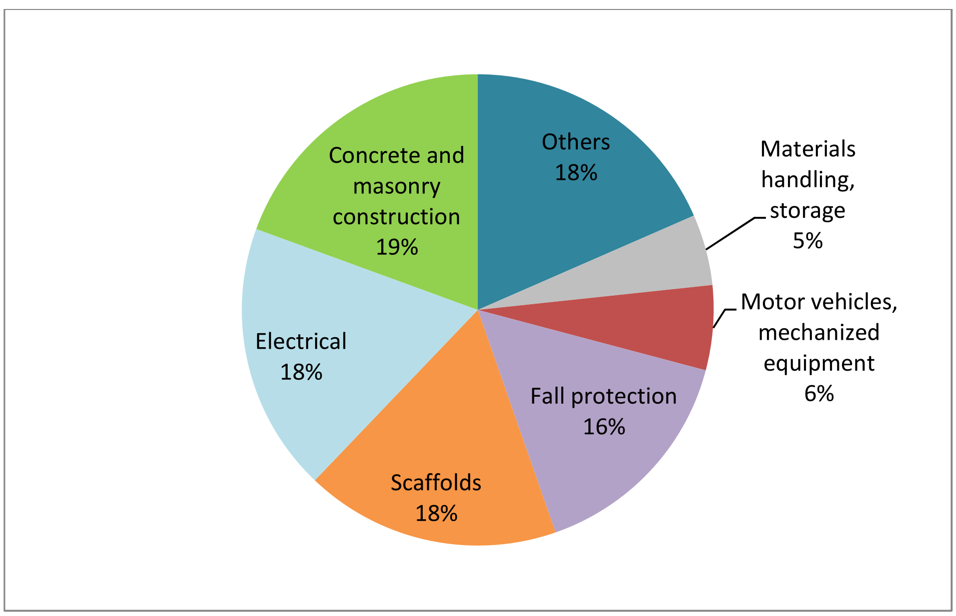

Fig. 1. Percentage of accidents per risk category

Taking into consideration the total number of workers affected, Fig. 3 shows the percentages of the types of injuries sustained as a consequence of the accidents.

The affected workers were also classified with respect to the type of occupation they were performing when the accident occurred. Fig. 4 presents the percentages of each work category. In particular, two of the workers who were affected by the accidents were civil engineers (work supervisors); One was hit by a front loader and the other died when he was struck by lightning while using a cell phone in adverse atmospheric conditions.

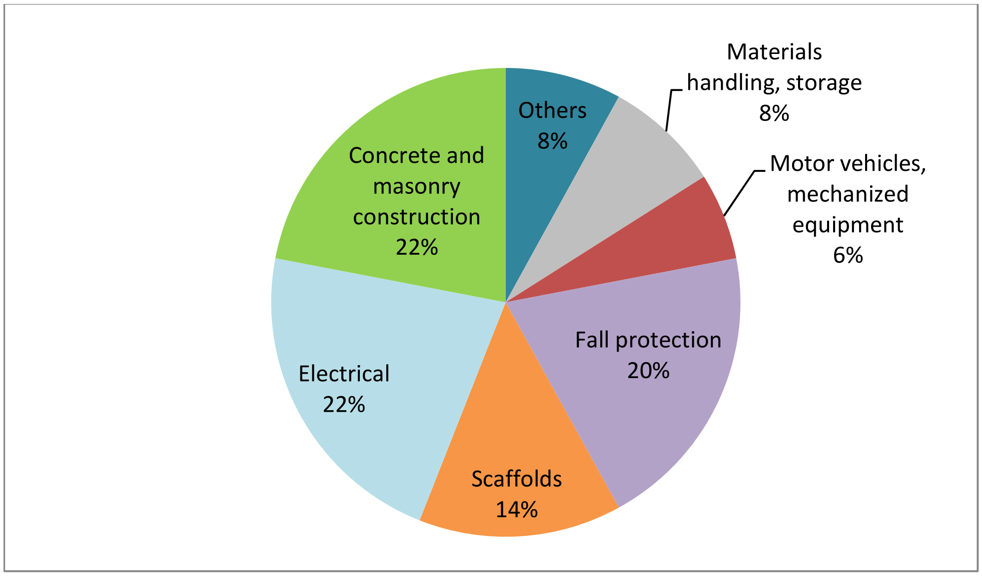

Fig. 2. Percentage of fatalities per risk category

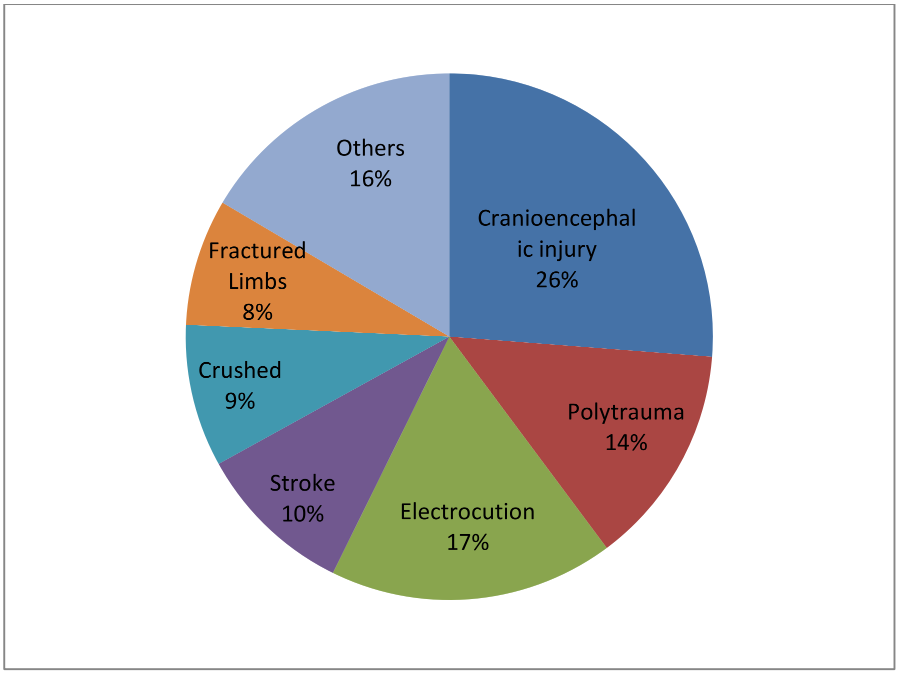

Fig. 3. Percentage of each type of injury sustained by the workers affected in the accidents

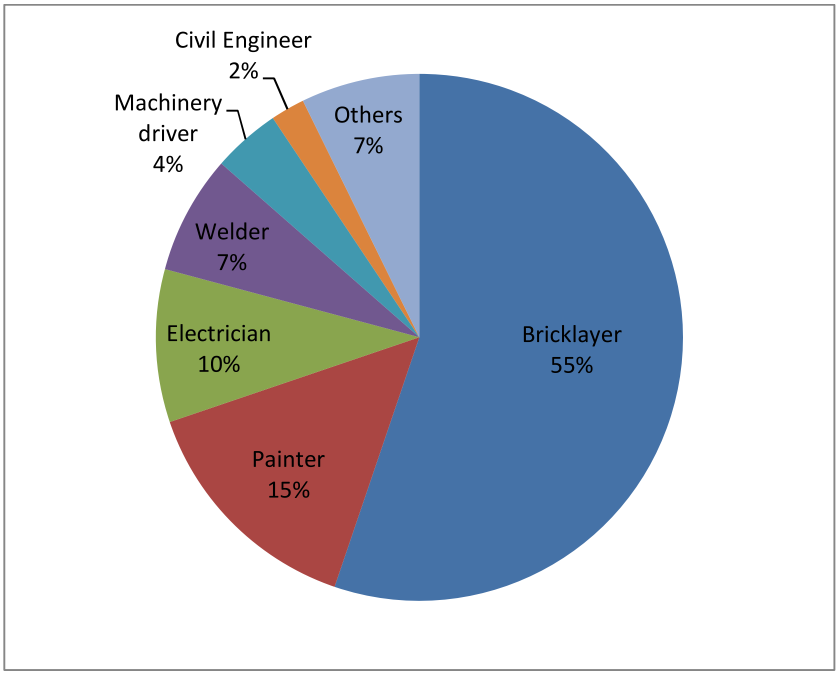

Fig. 4. Percentage of each type of occupation of the workers affected by the accidents

In the case of the workers who died in the accidents, their distribution by age was obtained. Fig. 5 shows the frequency histogram of the ages of 50 workers who died in the 45 accidents in which fatalities occurred; this figure also includes a normal distribution chart corresponding to the data. The average age of this group of workers was 34.7 years and the standard deviation was 12.5 years.

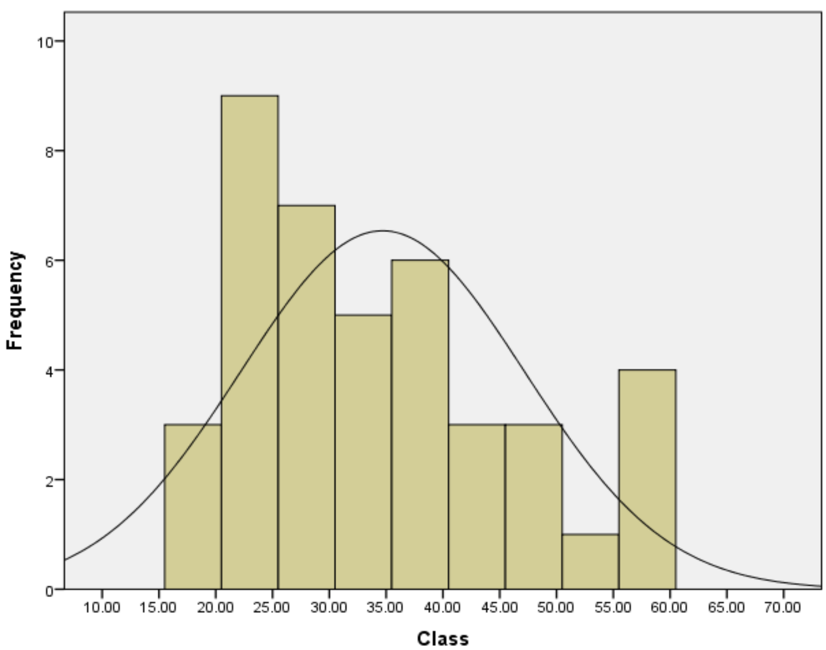

Fig. 5. Age distribution of the people who died in the accidents

4. JOURNALISTIC DISCOURSE ANALYSIS

Regarding the reconstruction of discourse production conditions, it is important to note that all the texts were extracted from the same information source (Diario de Yucatan 2008 - 2017). Founded almost 100 years ago, this newspaper is of a conservative orientation and has always taken a critical position in regard to social and political events occurring in the Yucatan Peninsula, Mexico. Its opinions are expressed mainly at a corporate level rather than an individual level. The socio-economic profile of its readers is middle and upper class.

At the iconic level, all the journalistic texts were published in the Local Section of the newspaper with headings and sub-headings, both in lower case and with highlighting typography. With respect to the micro sublevel of the discourse level, no trace of the speaker was found in the texts as the items were reported in the passive voice. The past tense was used in all the texts. At the macro sublevel, the majority of discourse operations in the texts were descriptive.

No meta discourse operations were identified in any of the texts giving explicit articulations, neither with linguistic markers nor with a rhetorical organization. It was observed that there was no correlation between the importance given by the newspaper and the affected number of people, either deceased or injured. The assignment of the columns in each case could be related to other factors not included in the analysis, such as corporate policies of the newspaper or the daily relationship between availability of space and number of news.

In general, discourse in the texts was informative and the analysis did not reveal the position taken by the speaker regarding the phenomenon of safety in construction work, or any manifestation of ideological, political or social points of view.

5. DISCUSSION

5.1 Public Construction *vs*. Private Construction

The percentage –in value- of public construction in Mexico is almost equivalent to that of private construction [9], however, in this study, an incidence of accidents almost three times greater was observed in private works, in comparison with public construction. Initially, one could assume that the government dependencies are carrying out a more adequate management of risk prevention; however, it is important to take into consideration that only building projects were studied, which are mainly of a private nature, while the public works generally correspond to infrastructure (transportation, electricity, water, oil, etc.).

According to the data of this study, every 3.6 months, an accident occurred in a public construction work. Three of these constructions were classified as medium or large (a hospital, a museum and a convention center) and, according to the Mexican norm NOM-031-STPS-201, the promoters of the project had the obligation to provide a health and safety system; however, 4 accidents occurred in these three construction sites, in which 4 workers lost their lives. In light of these incidents, it is difficult to accept that there is an acceptable management of risk prevention in public construction works. This affirmation is consistent with that published by Solís et al*.* [12] in a study on risk prevention in public construction projects in the same region of Mexico.

5.2 Risks in the Transportation to the Construction Site

On average, every 16.7 months, a vehicle transporting construction workers to their work site was involved in an accident, affecting 13 people per incident. The bricklayers in Yucatan usually live in rural villages in close proximity to the state capital, and are therefore transported to the construction site on a daily basis. These workers generally use vans that have been in use for many years, which provide transportation at a low cost; in other instances, the workers are transported in the bed of a pickup truck, making their transportation even more dangerous.

In Mexico, as in many other parts of the world, the injuries sustained by the workers during their transportation to the work site are considered to be work accidents [15]. Under this scheme the worker would have the right to receive medical care, hospitalization, prostheses, rehabilitation, and cash benefits; however, in reality less than a fifth of the construction workers have access to social security [9]. Taking into account all of the above, transportation to the work sites in this region must be considered an important risk for the workers.

5.3 Main Risks

The four main risks, from the point of view of their incidence and their severity, were as follows:

- Electrical.- Causing 18% of the accidents, with 22% fatalities and 10% of the total number of workers affected. In 42% of the cases, the accident occurred because the electricians worked without protective equipment and other general requirements; and in 58% of the cases, workers with other occupations came into contact, directly or indirectly, with electric conductors, in particular non-insulated overhead lines.
- Scaffolds.- Causing 18% of the accidents, with 14% fatalities and 13% of the total number of workers affected. Half of the accidents were caused by uncoupling of parts of the scaffolding, resulting in its collapse; and in the other half, the worker slipped or lost his balance and fell off the scaffolding. These incidents demonstrate that in no case were the general requirements complied with.
- Fall protection.- Causing 16% of the accidents, with 20% fatalities and 8% of the total number of workers affected. All the cases of affected workers who fell to a different level are analyzed in a subsequent section.
- Concrete and masonry construction.- Causing 19% of the accidents, with 22% fatalities and 49% of the total number of workers affected. It is important to note that this risk caused almost half of the total number of workers affected; mainly due to the fact that in 13 of the accidents studied (13%) the roofs collapsed, either when the concrete was being poured or in the following days. This means that not only a deficiency in the management of risk prevention must be taken into consideration, but also a deficiency in techniques (a lack of design and/or supervision of the shoring systems), resulting in a significant number of accidents and affected workers. According to Sawacha et al. [16], the technical factor is one of seven factors which can have an influence on safety in constructions sites. The other factors reported are: Historical, economical, psychological, procedural, organizational, and the working environment.

The sum of the data relating to these four main risks shows that, in conjunction, they caused 71% of the accidents, 78% of the fatalities and 80% of the total number of workers affected. Solís & Arcudia (2013) had already reported a large number of accidents in this region, caused by collapsed roofs and electrocution of workers.

The international literature on construction occupational safety and health [17] has reported that the four great dangers in construction are falls, electrocution, trauma from being hit by objects and situations where the worker is trapped (among equipment, materials or ground). Rahim et al [18] identified in Malaysia the following main risks at construction sites through the literature review: scaffold, power access equipment, ladder, and roof work. Weeks [4] reported that the most common fatal accidents in the United States are falls (30%), transportation accidents (26%), contact with objects or equipment (19%) and exposure to harmful substances (18%), most of which (75%) are electrocutions from contact with electrical wiring, overhead power lines or electrically powered machinery or hand tools. These four types of events account for nearly all (93%) fatal injuries among construction workers in the United States. All of the above risks are consistent with those reported in the present study.

5.4 Fall to a Different Level

In 46 accidents out of the 103 studied (45%) the affected workers fell to a different level; a total of 80 affected workers suffered this kind of mishap. Table 6 shows the different types of occupations of these workers, as well as the types of main risks which caused the accident, as they were classified in Table 5. The above shows that almost half of the accidents and half of the workers affected could have been avoided by the adequate management of risk prevention for falls from roofs, scaffolding and ladders.

Four types of fall protection systems can be recognized [19]:

- Guardrails and handrails.- Passive restraint allows the user to work or transit between locations while remaining protected within the guardrail/handrail.
- Fall arrest.- A fall arrest system will allow for a free fall, but will prevent the worker from striking the ground or a lower object while limiting the arresting forces.

- Suspension.- Suspension systems are designed to lower and support a worker while allowing a hands-free work environment.
- Positioning/Restraint.- A fall restraint system is a travel restriction system that stops the worker before they reach the edge. A positioning system is a system that allows a worker to lean back and work hands free**.**

5.5 Bricklayers

The greatest number of hours used in the construction of a building corresponds to the bricklayers, making their occupation the most likely to suffer accidents. In this study, 54% of the deceased workers had this occupation, 55% of the total workers affected and 76% of those who fell to a different level.

The bricklayers suffered 55 accidents (53% of the total), which were classified as presented in Table 7, in accordance with the Standard number 1926.The six main risk categories contained in this table can be regrouped in the four greatest risks in construction work, mentioned above [17].

5.6 Main Types of Injuries

Fifty seven percent of the injuries sustained by the workers are concentrated in three categories: Cranioencephalic injury (26%), Polytrauma (14%) and Electrocution (17%). The first two categories, with very few exceptions, correspond to accidents in which the workers fell to a different level. In the USA, it has been reported that 2,210 construction workers died because of traumatic brain injuries from 2003 to 2010; a rate of 2.6 per 100,000 workers. These deaths represented 25% of all construction fatalities [20]. The same study also reports that workers in small construction companies (fewer than 20 employees) were more than 2.5 times more likely than those in larger companies to die from a traumatic brain injury. Most of the accidents reported in the present work correspond to small constructions, executed by small construction companies.

Electrocution occurred in almost equal proportions in the group of workers with the occupation of electrician, and in the group with other occupations (mainly bricklayers, painters and welders). McCann et al*.* [21] report the need to adopt a lockout/tagout standard for construction, and training for non-electrical workers in basic electrical safety.

Electrical fatalities have also been reported as one of the main problems in construction work. Over 2,000 electrocution deaths were identified among U.S. construction workers in one decade, with the highest mean annual mortality rate, of 2.5 per 100,000 people. Nearly 40% of the 5,083 fatal electrocutions, in all industries combined, occurred in construction, and 80% were associated with industrial wiring, appliances, and transmission lines. Electrocutions ranked as the second leading cause of death among construction workers [22].

5.7 Personal Protective Equipment

In the present study, only one accident classified in the risk category Personal protective and lifesaving equipment (subpart E del Standard number 1926); In this accident an electrician fell from a post due to the inadequate collocation of his safety harness. However, it was evident that the great majority of the accidents could have been avoided, or could have been less severe if the workers had used adequate personal protective equipment, particularly in the falls to a different level and electrical risks.

It is clear that the first objective must be to protect the workers from falling off scaffolding and electrocution by means of collective preventive measures and general requirements; with the posterior use of personal protective equipment as back-up. This was the criteria used in this study in order not to attribute many other accidents to the risk contained in the subpart E, although a general absence of personal protective equipment was observed.

5.8 Safety Hazard Risk Assessment Matrix

According to the criteria of incidence and severity, Table 6 presents a safety hazard risk assessment matrix, which is based on the results presented in Figs. 1 and 2. The criteria of classification were taken from the Risk Evaluation Code (RAC) elaborated by the United States Air Force [23]. The first four risks of the matrix showed a high probability of occurrence and high severity, and were therefore classified as of imminent danger; The subsequent two risks of the matrix showed a medium probability of occurrence and high severity, and

Table 6. Occupation and risk category of the affected workers who fell to a different level

Risk category	Bricklayer	Painter	Electrician	Welder	Others	Total
Concrete and masonry construction	38	0	0	0	0	38
Scaffolds	13	3	0	1	1	18
Fall protection	9	2	0	3	2	16
Electrical	1	2	1	1	0	5
Stairways and ladders	0	2	0	0	0	2
Personal protective and lifesaving equipment	0	0	1	0	0	1
Total	61	9	2	5	3	80

Table 7. Accidents suffered by the bricklayers, according to the risk categories of the Standard number 1926

Risk category	Accidents
Concrete and masonry construction	19
Scaffolds	13
Fall protection	9
Electrical	4
Materials -handling, storage, use and disposal	3
Demolition	3
Others	4
Total	55

Table 8. Safety hazard risk assessment matrix of the six main risks observed

Risk category	Mishap probability	Hazard severity	Classification
Concrete and masonry construction	High	High	Imminent danger
Electrical	High	High	Imminent danger
Fall protection	High	High	Imminent danger
Scaffolds	High	High	Imminent danger
Motor vehicles, mechanized equipment, and marine operation	Medium	High	Serious
Materials -handling, storage, use and disposal	Medium	High	Serious
Transfer to work	High	High	Imminent danger

were therefore classified as serious risks; The risk of transfer to work was also included at the end of the matrix, and was classified as of imminent danger. These 6 types of risks represent conditions or practices with a certain level of danger which could reasonably be expected to cause death or serious physical harm immediately. Therefore, companies, syndicates and government dependencies must take action immediately in these situations of imminent danger.

6. CONCLUSIONS

A low level of risk prevention management was observed, which appears to be generalized in both private and public works.

The majority of the accidents occurred on small construction sites where the level of prevention seems to be almost zero.

The majority of the accidents could have been avoided if the workers had used basic personal protective equipment.

Urgent measures of prevention must be initiated in relation to the following risks:

- Concrete and masonry construction, improving the practices of shoring flexural elements in order to avoid their collapse.
- Fall protection, restricting access to higher levels only for authorized personnel, implementing collective preventive measures and using personal protective equipment against falls as a back-up.
- Scaffolds, using only those which comply with the general requirements and using personal protective equipment against falls as a backup.
- Electrical, using dielectric protection equipment and not working in close

proximity to energized electrical conductors.

Despite the existence of a legal framework which indicates the obligation of construction companies to organize and manage work-related risk prevention, – which one might assume would be sufficient–, there is no evidence of their compliance with this legal framework and no coercive measures have been taken to remedy this non-compliance.

The trade unions of the construction workers do not appear to be a contributing factor in the protection of their members.

Investors in the projects do not seem to show sufficient interest in including and ensuring compliance with the contractual clauses which oblige the construction companies to prevent risks.

The phenomenon studied in this work is a clear example of how the mere enactment of laws and regulations is of little help in resolving social problems if there is no will or conviction on the part of the different actors involved to work consistently on the improvement of the processes.

EPILOGUE

"The most tragic aspect is that a great many accidents, diseases and deaths could be prevented with adequate management measures. It is a question of respect for the dignity of the human being through respect for the dignity of work; a question which consists in forming policies which take into account the prime importance of the work of the people."

Juan Somavia

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. ISTAS. Salud laboral. Instituto Sindical de Trabajo, Ambiente y Salud, España; 2014. (Retrieved March 19 2017). Available:http://www.istas.net/web/index.asp?idpagina=1233
2. Solís R, Arcudia C. Campos C. Seguridad y salud en la construcción masiva de vivienda en México: Caso de estudio. Ingeniería y Universidad, Pontificia Universidad Javeriana. 2006;10(2):209-222. Available:http://revistas.javeriana.edu.co/index.php/iyu/article/download/919/518
3. BLS. Census of fatal occupational injuries (CFOI). Bureau of Labor Statistics; 2015. (Retrieved March 19 2017) Available:https://www.bls.gov/iif/oshcfoi1.htm
4. Weeks J. Health and safety hazards in the construction industry. ILO Encyclopaedia of Occupational Health and Safety, 4th Edition, Geneva; 1998. Available:http://www.ilocis.org/documents/chpt93e.htm
5. Fang D, Chen Y, Wong L. Safety climate in construction industry: A case study. Journal of Construction Engineering and Management. 2006;132(6):573-584. Available:http://dx.doi.org/10.1061/(ASCE)0733-9364(2006)132:6(573)
6. Solís R. Sosa A. Gestión de riesgos de seguridad y salud en trabajos de construcción. Revista Educación en Ingeniería, ACOFI. 2013;132(8):161-175. Available:https://www.educacioneningenieria.org/index.php/edi/article/view/304
7. Attwood D, Khan F, Veitch B. Occupational accident models –Where have we been and where are we going? Journal of Loss Prevention in Process Industries. 2006;19(6):664-682. DOI: 10.1016/j.jlp.2006.02.001
8. ILO. Resolutions concerning statistics of occupational injuries. Sixteenth International Conference of Labour Statisticians, Geneva; 1998. Available:http://www.ilo.org/public/english/bureau/stat/download/16thicls/repconf.pdf
9. INEGI. Estadísticas a propósito de la industria de la construcción. Instituto Nacional de Estadística y Geografía (México); 2012. (Retrieved March 19 2017) Available:fromhttp://internet.contenidos.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/estudios/economico/a_proposi_de/Construccion.pdf
10. Solís R, Arcudia C. Construction related accidents in the Peninsula of Yucatan, Mexico. Journal of Performance of Constructed Facilities. 2013;27:155-162. DOI: org/10.1061/(ASCE)CF.1943-5509.0000300

11. Solís R, González J, Ayora E. Workplace risk prevention in public building projects in Mexico. Journal of Building Construction and Planning Research. 2014;2(04):217-226.
    DOI: 10.4236/jbcpr.2014.24020
12. Solís R, Franco R. Construction workers' perceptions of safety practices: A case study in Mexico. Journal of Building Construction and Planning Research. 2014;2(1):1-11.
    DOI: 10.4236/jbcpr.2014.21001
13. STPS. Norma oficial mexicana NOM-031-STPS-2011, construcción-condiciones de seguridad y salud en el trabajo. Secretaría del Trabajo y Previsión Social (México); 2011.
    Available:http://www.stps.gob.mx/bp/secciones/dgsst/normatividad/normas/Nom-031.pdf
14. OSHA. Safety and health regulations for construction standard number 1926. Occupational Safety and Health Administration. Washington (USA); 1987.
    Available:https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=Construction
15. Ley Federal del Trabajo. Poder Legislativo, México; 2016.
    Available:http://www.diputados.gob.mx/LeyesBiblio/pdf/125_120615.pdf
16. Sawacha E, Naoum S. Fong D. Factors affecting safety performance on construction sites. International Journal of Projects Management. 1999;17(5):309-3015.
    DOI: 10.1016/S0263-7863(98)00042-8
17. ELCOSH. Los cuatro grandes peligros de la construcción. Electronic Library of Construction Safety & Health, Hispanic Contractors Association; 2017.
    (Retrieved March 19 2017)
    Available:http://elcosh.org/document/2284/d001049/Los%2BCuatro%2BGrandes%2BPeligros%2Ben%2Bla%2BConstrucci%25C3%25B3n%253A%2BPeligros%2Bde%2BQuedar%2BAtrapado.html
18. Rahim A, Zulkifli W, Singh B. Hazards at construction sites. Proceedings of the 5th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2003) 26 – 28 August 2003 Johor Bahru, Malaysia; 2003.
    Available:https://www.researchgate.net/publication/264622908_HAZARDS_AT_CONSTRUCTION_SITES
19. Nelson & Associates. Falls from elevation and the five types of fall protection systems. Nelson & Associates Safety Engineering; 2017.
    (Retrieved March 19 2017)
    Available:http://www.hazardcontrol.com/print.php?fs=falls&p=falls-from-elevation
20. Konda S. Traumatic brain injuries in construction. Center for Disease Control and Prevention; 2016.
    (Retrieved March 19 2017)
    Available:https://blogs.cdc.gov/niosh-science-blog/2016/03/21/constructiontbi/.
21. McCann M, Hunting K, Chowdhury R, Welch L. Causes of electrical deaths and injuries among construction workers. Journal of Occupational Medicine Forum. 2003;43(4):398-406.
    DOI: 10.1002/ajim.10198
22. Ore T, Casini V. Electrical fatalities among U.S. construction workers. Journal of Occupational Medicine Forum. 1996;38 (6):587-592.
    DOI: 10.1097/00043764-199606000-00009
23. AFI. The US air force mishap prevention program (91-202). Secretary of the Air Force (USA); 2015.
    (Retrieved March 19 2017)
    Available:http://static.e-publishing.af.mil/production/1/af_se/publication/afi91-202/afi91-202.pdf

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/18914