

Implementing a Pedestrian Safety System on Construction Work Sites

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ABSTRACT

Construction accidents include any incidents involving a construction worker, a resident, bystander, pedestrian or any other person in the immediate area of construction site. One important area that is often neglected when construction accidents are analyzed and management systems framed is the safety in relation to public interacting with a construction work site. Construction activities are frequently undertaken in areas accessible to the public. Children, local residents and other members of the public are often attracted to construction activities. These persons are generally much less sentient of hazards and necessary precautions on construction sites than are the construction workers and site personnel and thus more vulnerable to accidents. The purpose of this study is to isolate and analyze a particular aspect of construction safety – job site safety and interaction with pedestrians on construction projects. The material presented describes current analysis of the information and guidelines available related to the topic, and provides case examples of proper and improper safety protocols and their potential impacts when considering pedestrian safety on construction projects. A methodology for studying public interaction with a construction site has been proposed and its application on case projects is presented. Finally, the study is concluded by providing recommendations for preparation and preplanning of pedestrian safety in proximity to construction work sites.

Keywords: Safety protocols, OSHA, Public safety, Pedestrian safety

1. INTRODUCTION

The concept of construction safety can seem expansive and almost infinite in scale. A person could spend years studying the current volumes of safety literature while implementing the various techniques for keeping employees safe, and limiting costly accidents, only to find that safety systems have changed and work sites have evolved due to technological advancements and changes in construction methods.

Accidents on Construction sites are very common and often serious – in fact more fatal accidents occur in construction than any other industry. Research indicates that the safety record in the construction industry continues to be one of the poorest (Huang and Hinze, 2006). In the past twenty years, construction jobsite injuries and fatalities have been on the rise and have gained widespread attention in the United States. According to the National Safety Council, occupational injuries cost United States organizations approximately fifty billion dollars annually (Karuppann et al., 1996). The Bureau of Labor Statistics (BLS) concludes that in the year 2006, the American construction sector was responsible for 21% (1226 in count) of all workplace fatalities across all industries, and 10.4% (412,900 in count) of all the country's nonfatal occupational injuries and illnesses. Table 1

provides an overview of recent fatal occupational injuries and fatality rates (per 100,000 employees) over the period 2003-2006.

Table 1: Fatal Occupational Injuries and Fatality Rate (per 100,000 employed), All U.S., All ownerships (2003 – 2006): Construction vs. All Industries

Year	Construction		All Industries	
	Fatal Occupational Injuries	Fatality rate (per 100,000 employed)	Fatal Occupational Injuries	Fatality rate (per 100,000 employed)
2006	1,282	10.8	5,703	3.9
2005	1,243	11.0	5,734	4.0
2004	1,278	11.9	5,703	4.1
2003	1,171	11.7	5,575	4.0

Source: U.S. Bureau of Labor Statistics, U.S. Department of Labor, 2007.

One of the major contributors to the increase of construction hazards is the fact that today’s construction sites are constantly changing environments utilizing a variety of new construction methods and complex machinery (Teo et al, 2005).

In a broader perspective, construction accidents include any incidents involving construction workers, a resident, bystander, pedestrian or other persons in the immediate area of the construction sites. Typically construction accidents fall into three categories: falls, electrical accidents, and equipment accidents and often these are a result of contact with equipment, strikes from or against foreign objects, overexertion, falls, fires/explosions, assaults, or exposure to harmful chemicals or other substances (U.S. Dept. of Labor, 2007). Accidents may result in severe personal injuries such as spinal cord injuries, traumatic brain injury, quadriplegia, paraplegia, fractured necks, back, bones and death.

Construction companies need to inspect each job site and provide safety programs; however, despite these measures usually taken by the companies, accident rate is still high as shown by statistics (Table 1).

One important area that is often neglected when construction accidents are analyzed, statistics cited and management systems formulated is the safety in relation to public interacting with a construction work site. Construction activities are frequently undertaken in areas accessible to the public. Children, local residents and other members of the public are often attracted to construction activities. These persons are generally much less sentient of hazards and necessary precautions on construction sites than are the construction workers and site personnel and thus more vulnerable to accidents. In general, site access should be restricted to general public wherever possible or should be well guided with proper safety information and site personnel where access control is not applicable.

The purpose of this study is to isolate and analyze a particular aspect of construction jobsite safety – job site safety and interaction with pedestrians on construction projects. The material presented in this study will describe a current analysis of the information available related to this topic and will provide case examples of proper and improper safety protocols and their potential impacts when considering public safety in general and pedestrian safety in particular on construction projects.

2. RESEARCH RATIONALE

The rationale of the study was formulated around a case involving a pedestrian related accident. The case, resulting from an incident that was reported after the completion of a successful renovation project, went into litigation. The project involved the renovation of a shopping center located in Davie, Florida. The scope of work

included the rebuilding of the exterior facade of the shopping center along with the creation of a new passageway between one of the ninety degree turns in the building's structure.

The alleged accident involved a husband and wife walking through the new passageway opening while it was under construction. The previous building including the walls, storefront system, and slab was removed and steel was in place for the pending pour of a new side walk. The accident took place at nine p.m. on a weekday. The injured party was the wife, who was in her early forties. She reported a fall in which she tripped wearing high-heel shoes, while walking through the construction area accompanied but unassisted by her husband. The woman's alleged injuries included a broken nose and lacerations to the knees and hands. There were no witnesses, aside from the husband and wife. There was no police report of the accident.

The case was thrown out of court owing to the fact that the construction site met the safety standards for barricades in conjunction with the fact that the plaintiff in the case acknowledged that she was walking through an active construction site, bypassing the barricades to do so, and thus technically trespassing.

This case was aided by the record keeping and photography that took place during construction. Not all of that was undertaken with the mindset that these documents would be used in a case defense related to an accident, as a matter of fact; the majority of the photographs were taken as a result of the hurricane that passed near the region in the summer of 2004.

The events of this case have provided a "real world" example of the requirement for safety management on a construction site, not only in regards to the construction workers and tradesmen but also for the benefit of those who are non-construction workers, the pedestrians who use adjacent spaces and those who are not familiar with the dangers on an active construction site.

3. RESEARCH METHODS

In the first stage of the research, extensive literature review was conducted. The objectives included better understanding of the complexities of the issue, assessing the existing regulatory framework related to pedestrian safety on construction work sites, and devising recommendations for pedestrian safety considerations.

The first aspect of this literature review included a search for the statistics of pedestrian accidents on construction sites. OSHA records were consulted to determine if this agency would be responsible for recording this specific type of accident.

The second aspect of literature review included identification of an agency responsible for monitoring the occurrences and documenting the outcome of pedestrian incidents. The salient findings of the literature review are identified in section 4.

Following the literature review, recommendations were drafted for pedestrian safety considerations on work sites and a methodology was proposed for studying and researching public interaction with a construction site. In order to develop comprehensive recommendations and a workable methodology, discussions were made with industry experts including representatives of general and specialty contractors, project owners and consultants in the Florida construction industry. Based on the review and discussions, the recommendations and methodology were finalized, which are presented in sections 5 and 6 respectively.

In the final stage of the research study, the methodology was applied on a case study project and the findings were compiled. Based on the findings, recommendations were deduced and the study concluded.

4. LITERATURE REVIEW

In the United States, all construction safety is legislated by the Occupational Safety & Health Administration (OSHA), a federal agency that is part of the U.S. Department of Labor. OSHA developed a series of specific

construction standards, and policies for enforcing the standards to assist in the safety management process. The construction industry standards (29 CFR 1926) are not guidelines, but legal requirements that define the minimum protections construction organizations must provide their workforce on the job site. Table 2 lists the various topics covered in the OSHA construction standards. Table 3 shows the statistics for year 2006 for accidents reported on construction sites.

Table 2: OSHA Construction Standards 29 CFR 1926 (OSHA, 2006)

OSHA CONSTRUCTION STANDARDS 29 CFR 1926	
Subpart A: General	Subpart N: Cranes, Derricks, Hoists, Elevators, and Conveyors
Subpart B: General Interpretations	Subpart O: Motor Vehicles, Mechanized Equipment, & Marine Operations
Subpart C: General Safety and Health Provisions	Subpart P: Excavations
Subpart D: Occupational Health and Environmental Controls	Subpart Q: Concrete and Masonry Construction
Subpart E: Personal Protective and Life Saving Equipment	Subpart R: Steel Erection
Subpart F: Fire Protection and Prevention	Subpart S: Underground Construction, Caissons, Cofferdams, and Compressed Air
Subpart G: Signs, Signals, and Barricades	Subpart T: Demolition
Subpart H: Materials Handling, Storage, Use, and Disposal	Subpart U: Blasting and the Use of Explosives
Subpart I: Tools - Hand and Power	Subpart V: Power Transmission and Distribution
Subpart J: Welding and Cutting	Subpart W: Rollover Protective Structures; Overhead Protection
Subpart K: Electrical	Subpart X: Ladders
Subpart L: Scaffolds	Subpart Y: Commercial Diving Operations
Subpart M: Fall Protection	Subpart Z: Toxic and Hazardous Substances

It is important to note that, as evidenced by the data presented in Tables 2 and 3, neither OSHA standards (Table 2) nor accident statistics reported on construction sites by OSHA (Table 3) contain any data in relation to pedestrian safety. This is particularly surprising because the U.S. Department of Transportation Federal Highway Administration, on the contrary, has revealed that from 1997 through 2000, 17% of all work zone fatalities were pedestrians. This suggests that the OSHA jurisdiction does not seem to extend to the accidents that are encountered by pedestrians interacting with construction sites even though the volume of these accidents is not at a low enough level to warrant exclusion of this data.

The passage from the Manual on Uniform Traffic Control Devices (MUTCD) Part VI, authored by the U.S. Department of Transportation, Federal Highway Administration was found to include specific recommendations and guidelines for construction work and interaction with the pedestrian traffic. Although the central topic of the article revolves around traffic zones leading to highways and streets, the precautions and recommendations that are included in the article can be tailored to use for pedestrians in general.

Ironically, other than the recommendations and guidelines provided in MUTCD Part VI, not much research has been done in relation to pedestrian safety on construction work sites.

Table 3: OSHA Data on Current Violations including Citations and Penalties

Standard	#Cited	#Insp	\$Penalty	Description
<u>Total</u>	10301	3305	6799627	
<u>19260451</u>	1746	712	1281655	General requirements.
<u>19260501</u>	1654	1396	1704451	Duty to have fall protection.
<u>19261053</u>	498	360	217656	Ladders.
<u>19261052</u>	416	311	219745	Stairways.
<u>19260020</u>	406	360	253877	General safety and health provisions.
<u>19260404</u>	379	316	158149	Wiring design and protection.
<u>19260405</u>	372	263	108356	Wiring methods, components, and equipment for general use.
<u>19260100</u>	303	301	145746	Head protection.
<u>19260503</u>	300	282	112020	Training requirements.
<u>19260502</u>	288	192	188057	Fall protection systems criteria and practices.
<u>19101200</u>	284	138	23808	Hazard Communication.
<u>19260453</u>	280	251	251884	Aerial lifts.
<u>19260403</u>	200	167	97239	General requirements.
<u>19261101</u>	177	27	105968	Asbestos
<u>19260651</u>	171	103	213166	Specific Excavation Requirements.
<u>19260454</u>	161	146	58703	Training requirements.
<u>19260102</u>	156	154	65701	Eye and face protection.
<u>19260021</u>	146	143	94095	Safety training and education.
<u>19260025</u>	145	144	89041	Housekeeping.
<u>19260701</u>	145	145	114496	General requirements

5. RECOMMENDATIONS FOR PEDESTRIAN SAFETY CONSIDERATIONS

Based on the literature review, draft recommendations were proposed for pedestrian safety considerations. These recommendations were then discussed with experts and consequently, the following major recommendations are proposed for pedestrian safety considerations on a construction work site:

- Pedestrians should not be led into direct conflicts with work site vehicles, equipment, or operations.
- Pedestrians should not be led into direct conflicts with mainline traffic moving through or around the work site.
- Pedestrians should be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks or footpaths.
- The range of pedestrians that can be expected is very wide, including the blind, the hearing impaired, and those with walking handicaps. All pedestrians need protection from potential injury and a smooth, clearly delineated travel path.
- Signing should be used to direct pedestrians to safe street crossings in advance of an encounter
- When pedestrian movement through or around a work site is necessary, the aim of the engineer should be to provide a separate, safe footpath without abrupt changes in grade or terrain

- Judicious use of special warning and control devices may be helpful for certain difficult work area situations. These include rumble strips, changeable message signs, hazard identification beacons, flags, and warning lights.
- Whenever it is feasible, closing off the work site from pedestrian intrusions is preferable to canalizing pedestrian traffic along the site solely with temporary traffic control devices such as cones, tubular markers, barricades, or drums.
- Movement by work vehicles and equipment across designated pedestrian paths should be minimized and, when necessary, should be controlled by flaggers or temporary traffic control.
- At work sites of significant duration, especially in urban areas with high pedestrian volumes, and where falling debris is a concern (such as work on overhead structures), a canopied walkway is frequently needed to protect pedestrians from falling debris.
- Normal vertical curbing is not a satisfactory substitute for positive barriers when these are clearly needed.
- Temporary positive barriers may be necessary to prevent pedestrians from unauthorized movements into the active work area
- Tape, rope, or plastic chain strung between devices can help discourage pedestrian movements off the designated pathway.
- Good engineering judgment must be applied by qualified persons after appropriate engineering studies and with sound engineering judgment and common sense.

For protecting public from such accidents it suggested that work zone signs and markings are the best cues to safe travel for every pedestrian and it's up to the pedestrian to be alert and stay on the safe path through the work zone. Following are some important points in this relation:

WORK ZONE SAFETY TIPS FOR EVERY PEDESTRIAN TO REMEMBER

- Watch where you're going! Construction work may be fascinating to watch, but remember that your first responsibility is to get yourself through the work zone as safely as you can. Don't be a "sidewalk superintendent" unless there's a safe vantage point, such as under a well-constructed covered sidewalk in the case of building construction.

SAFETY CUES TO WATCH FOR IN WORK ZONES

- *Orange Work Zone Signs* – Communicate to both drivers and pedestrians what is going on and how to travel safely through the work zone. Signs can indicate that a sidewalk is closed and that a detour must be taken.
- *Pavement Markings* – Painted or taped lines can also indicate pedestrian paths.

6. METHODOLOGY FOR STUDYING PUBLIC INTERACTION WITH A CONSTRUCTION WORK SITE

It is recommended that the methodology for studying and researching the public interaction with a construction jobsite should include the following steps:

- Selecting a construction project to be located in an urban area (in public proximity).
- Visiting the construction site on regular intervals. For example, for a 12 month project, visiting monthly; for a 6 month project, visiting bi-weekly.
- Marking a site plan of the project showing pedestrian traffic routes and areas of concern.
- Photographing the conditions on the project that display potential hazards.
- Noting the areas of the project that are in close proximity to pedestrians and existing buildings that are being utilized by commercial or residential use.
- Documenting the signage, barricades, lighting, roadways, walkways, overhead conditions, construction traffic entering and leaving the site, adjoining structures, type structure, and if the project is a renovation/remodel of a building in use or new construction.

- Recording incidents that are unsafe and document any accidents that take place.
- Evaluating findings based on initial plan for project safety.

7. APPLICATION ON CASE STUDY PROJECTS

In order to study the condition of protecting the public during a construction project it was necessary to review current examples on construction projects that illustrate scenarios that warrant protective procedures. Thus the proposed methodology was applied on the cases presented underneath and based on the application, salient findings and recommendations have been presented.

The first project selected for the desired purpose was located on a site that included two 15-storey high-rise buildings purchased by a new owner for condo-conversion. The second project constituted 30 townhouse units, 2 swimming pools, a boat dock, a parking garage and a fitness center. Both sites were located in Maimi, Florida. The sites presented opportunity for assessing multiple scenarios for construction work that can take place in an occupied site.

Photos were taken for both project during the initial phases of construction. These photos were used in the study to help assess and illustrate the areas of concern in relation to pedestrian safety.

As an example, Plate 1 shows a snapshot of one of the 15-story buildings in the first project under consideration, which was under renovation for new balcony railings. The photo shows the work located on the 15th floor (circled), where an existing railing was demolished and a new glass railing installed. Below is a central pathway for delivery trucks and residents leaving their units to the parking lot. No signage was present to warn of overhead work.



Plate 1. Work located on top floor for a 15-story building under renovation for new balcony railings

Another example can be witnessed in the second project under consideration. Plate 2 shows a safety tape (marked by arrow) placed from column to tree on an excavation. While this may warn the public of construction activities, it does not stop a pedestrian from tripping over debris or walking into the excavation for water line repair.



Plate 2. A safety tape (marked by arrow) placed from column to tree on an excavation.

In the light of the findings of the study, the recommendation identified in section 8 should be considered in preparation and preplanning for pedestrian traffic in proximity to construction activities.

8. RECOMMENDATIONS FOR PREPARATION AND PREPLANNING OF PEDESTRIAN SAFETY

The steps to consider in preparation and preplanning for pedestrian traffic in proximity to construction activities include:

Post proper notice to the public to identify the construction project such as signage that states: “Caution Construction Work”, “Hard Hats Area”, “Construction Personnel Only” and “Caution Overhead Work”. The signage must pertain to the type of work being conducted at that time of construction. See Plate 1 regarding overhead work and Plate 2 displaying a site work project. Both projects show evidence of lack of signage informing the public and residents of the buildings that there is work taking place overhead for Plate 1 and that there is underground work taking place in Plate 2. While both projects used caution tape to mark off the areas of construction, this was easily removable by the residents of the building during the weekends while the project was shut-down. Once the tape is removed it is plausible for a pedestrian to walk into a hole adjacent to the walkway (Plate 2) or trip on debris that was left under the balcony demolition. The potential for an accident is magnified during a night-time condition when construction workers are not present to warn a resident who may be walking near these areas.

Place signage and distribute information for construction employees that illustrates the cautions involved in the proximity.

This aspect establishes the internal environment of safety on the work site. It is equally important for the construction workers to be made aware of the hazards that are present for pedestrians and the methods that the construction manager implements on and around the jobsite. This update and information should be provided to all employees during weekly safety meetings and during subcontractor *tool-box* meetings.

Properly train personnel to implement safeguards.

The use of personal protective equipment and jobsite safety precautions should extend to the safety of the pedestrians interacting with the project. It is necessary for a member of the management staff to develop and review the surrounding areas and create an environment that not only protects the workers but also the pedestrians

present. Department of Transportation manuals can provide a variety of signage options for use on and around the construction site.

Inspection of safety controls and monitoring.

A properly trained designated “competent person” should inspect the signage, barriers, and safety systems that are used on the project for proper installation, maintenance and exposure to the public. This should be implemented on a daily to weekly basis depending on the exposure of the systems to changes from internal (project phase changes) and external sources (pedestrian movement of temporary signs & barricades, weather conditions). Verification should be made by photographic means to record the placement of the safety devices at different intervals on the job site. This will allow for one of the most important aspects of the safety procedure which is a trail of documentation that the systems were in effect and not removed during the life cycle of the project.

Procedure Evaluation for effectiveness.

The responsible safety person should monitor the interaction of the public in relation to the safety system that is used in order to determine if the system accomplishes its goal of providing a safe environment in relation to the construction site. A check list will be necessary to compare the preplanning stages of safety systems to the actual results of their use. Some examples of these goals would include; a safe alternative route for pedestrian or vehicular traffic, noticeable and recordable acknowledgement by the public of construction work and traffic as directed by signage and barricades, and installation of effective barrier to isolate construction work from the general public.

Planning for future changes in scope of work and work environment.

A construction site moves through different phases that result in unique situations which require specific cautions. The initial phases of new construction include earthwork and excavations that can result in roadway and walkway instabilities and the creation of temporary surfaces for travel. Vertical work including erection of walls and windows can present falling object hazards that will require signage for such an event and walkway covers including safety harnesses/netting for falling objects. Welding and cutting work will necessitate signage and safety controls that include temporary fire protection and proper training for fire suppression procedures.

These are a few examples of situations that require a “look ahead” and the use of foresight to prepare for the changes on a project. A knowledgeable and conscientious construction manager should strive to have a system in place for the instant that an environmental condition changes not only for the protection of the workers but also for the pedestrians.

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