Reduction of Slip, Trip, and Fall Incidents Among Construction Workers at Company XYZ

By

Mukesh Shreevastav

A Research Paper

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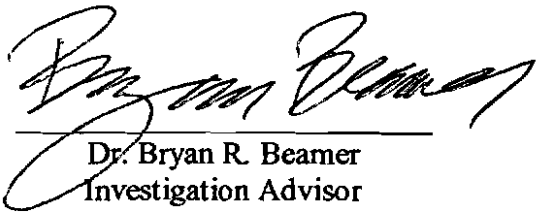

Dr. Bryan R. Beamer
Investigation Advisor

The Graduate School

University of Wisconsin-Stout

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The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Shreevastav, Mukesh K.**

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ABSTRACT

Slips, trips, and falls are frequent injury-causing events and can occur in every construction work situation. Risk factors for slip, trip, and fall accidents were identified in last five years at Company XYZ. An analysis was performed to identify deficiencies regarding incident/injuries. The analysis found that the key factors were poor housekeeping, uneven floors, inadequate lighting, and unsafe working practices. The impact of slip and trip accidents in Company XYZ can be large, but in many circumstances the causes can be relatively easy to eliminate, or adequately control. Guidelines and policies including commitment from managers and supervisors, regular inspection, and regular training were outlined to reduce the number of injuries due to slip, trip, and fall.

The Graduate School

University of Wisconsin Stout

Menomonie, WI

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Chapter I: Introduction

Many construction workers are injured because of slips, trips and falls. Slips, trips, and falls are a frequent injury-causing event that can occur in every construction work situation. Very serious injuries can result from incidents of slipping, tripping, or falling down. A fall can end careers, from suck injuries as broken bones, traumatic brain injury, spine injuries, and others (Margolin, 2007). Construction industry workers are particularly vulnerable to loss of life as the result of slip, trip, and falls. About 50 percent of all work related fall deaths involve construction workers (Mark, Ramani, & Joshep, 2001). In general terms, "slip and fall" accidents refer to situations where a person is injured by slipping or tripping and then falling due to a dangerous condition on the location.

According to OSHA, slips, trips, and falls cause 15% of fall accidental deaths and are second only to motor vehicles as a cause of fatalities (Bruce, 2001). In 1999, over one million people suffered a slip, trip or falling injury, and over 17,000 Americans died as a result. Of the estimated 3.8 million disabling injuries each year in the work force, 15 percent are due to slips, trips, or falls, which account for 12 to 15 percent of all workers compensation costs (Coral, William, & Charles, 2001). With an average cost to an employer of around $18,900, one worker's compensation claim for a slip, trip or fall on the same level incident can have a major impact on a business. The reoccurrence of slip, trip, and fall-related accidents at Company XYZ is resulting in significant human as well as financial based losses.

Problem Statement

The reoccurrence of slip, trip, and fall-related accidents at Company XYZ is resulting in significant human as well as financial based losses.

Purpose of the Study

The purpose of this study is to identify and recognize hazardous areas at Company XYZ facility that can result in slip, trip and fall accidents and choose the best way to prevent slip, trip, and fall hazards.

Goals of the Study

1. Identify the core reasons for slip, trip, and fall related hazards by interviewing employees
2. Evaluate the surface metrics for friction and unevenness
3. Analyze previous accidents/injury rates
4. Identify and analyze the significance of potential hazards by using Process Hazard Management Tools to generate and organize solutions

Background and Significance

Company XYZ manufactures precast concrete products for commercial buildings, has over 300 team members and has manufacturing facilities at different locations. According to a company person, between 1996 and 2006, 60% of reportable injuries were caused by slips, trips, and falls. According to Company XYZ, over 50 employees suffered slip, trip or fall injuries in the last ten years. The average cost (direct and indirect) for each disabling injury was $15,000. Most injuries are broken bones, back injuries, and property damage which can happen inside or outside a building. Thus it is important to reduce slip, trip, and fall incidents at Company XYZ.

Definition of Terms

Coefficient of Friction. Coefficient of friction can be determined by finding of the object, divided by the effort that is needed to move the object.

Falls. Falls are of two basic types: elevated falls and same-level falls. Same-level falls are generally slips or trips. Injuries result when the employee hits a walking or working surface or strikes some other object during the fall.

Force. Force can be defined as push or a pull.

Friction. Friction is a force that resists the motion of two objects that are in contact with each other

Slips. A slip is a loss of balance caused by too little friction between feet and the walking surface. Loss of traction is the leading cause of workplace slips. Slips can be caused by constantly wet surfaces, spills or weather hazards like ice and snow. Slips are more likely to occur when workers are in a hurry or run, wearing the wrong kind of shoes, or not paying attention to where they are walking.

Trips. A trip happens when an employee's foot collides (strikes, hits) an object causing them to lose the balance and eventually fall. The common causes of tripping are obstructed view, poor lighting, clutter in the way, wrinkled carpeting, uncovered cables, bottom drawers not being closed, and uneven steps in walking surface.

Limitations of the Study

The timeframe of the study limited the scope of discussion. However, the study did manage to achieve a reasonable sample of employee's interests. The study was also limited to one plant which is small compared to that of other plants of company XYZ.

Chapter II: Literature Review

The purpose of this study is to identify and recognize hazardous areas at Company XYZ that can result in slip, trip and fall accidents and choose the best way to prevent a slip, trip, and fall hazard. Slips, trips and falls are a major cause of injuries and fatalities in the construction business. Slip and fall incidents are very common and can happen in a variety of locations, including walk ways, pouring area, production area, yard area, equipment maintenance area, and storage area.

Hazardous Environments

Construction sites are dynamic places to work and almost all construction sites have unprotected sides and edges, wall openings or floor holes at some point in time. Various factors that can cause slips and trips include: cleaning fluid, oil, water, slippery shoes, and objects projecting into the walkway, poor lighting, uneven walking surface and other slippery substances on the walking surface (Andrea, 2004). Therefore, care must be exercised each day to reduce slip, trip, and fall incidents among construction workers at Company XYZ.

Same Level Falls

Carol, William and Charles (2001) mentioned that same level falls are generally slips or trips. Slip/fall and trip/fall are the most common example of same level falls. Slippery surface and wrong footwear are the primary reason for slip and fall. A high coefficient of friction between the shoe and walking surface is needed. Trip/fall occurs when the front foot strikes an object and is suddenly stopped.

Contributing Factors and Causes of Accidents

The main contributing factor for slip, trip, and fall incidents is poor housekeeping. Proper housekeeping and adequate lighting in work and walking areas can contribute to safety and the

prevention of falls (Carol, William, & Charles, 2001). According to the Bureau of Labor and Statistics (BLS) (1998), slips, trips, and falls accounted for the third greatest proportion of non-fatal injuries (19%) in all private industries. These incidents create workers compensation costs and loss of production costs as well. Slips occurs when worker are in urgency or run, wear the wrong selection of shoes, or don't pay attention to where they are walking.

Cayless (2001) analyzed 1,035 coroners reports of serious slip, trip, and falls (STF). The main purpose of the study was to relate building features and information in coroners reports to ascribe causation of death. Of STF deaths, 61.4% related to falls from stairs, 6.7% to falls from steps or ladders and 5.5% to falls from windows or roofs. About 60% involved infirm individuals, and alcohol was involved in 60% of the falls in the under 50 age group. Footwear was a factor commonly linked to stairways falls.

Zimmerman (2001) made a conclusion that employee behavior is the another major factor that causes slip, trip, and fall incidents. In his study, he also mentioned that research suggested that most slip, trip, and fall accidents were due to unsafe, timesaving work practices. Radomsky, Ramani and Flick (2001) concluded that workers are particularly vulnerable to loss of life as the result of slip, trip, and falls in construction industry. According to the author, falls from ladders, roofs, and scaffolds are the main cause of the accidents and most deaths. Jackson and Cohen (1995) concluded from an in-depth analysis of 40 stairway accidents that the greatest problem with accidents was not individual (user) or external variables, but dimensional inconsistency inherent in some stairways. This study was based on 40 stair accidents. In this study, 73% of plaintiffs were descending stairs at the time of the accident. Fifty percent (20) of accidents involved stairs with four or fewer risers. Of the 20 cases with four or fewer risers, 60% took place on stairways with only one or two risers. Nagata (1991) conducted a study based on labor

casualty reports from occupational stair accidents occurring within greater Tokyo. Victims were recognized and interviewed with questions posed relating to speed of walking, footwear type, carriage of objects and their perceptions of the likely causes of the fall.

Age is the major factor in both the frequency and severity of slip, trip, and fall incidents. Layne and Landon (1997) found that older workers have more fractures than younger workers. Kemmlert and Lundholm (2001) also concluded that older workers suffer a higher rate of injuries due to slip, trip, and fall incidents.

Direct and Indirect Cost

Lost work days is the another factor due to slip, trip, and fall incidents. According to the Bureau of Labor and Statistics (1998) and concluded by Mital, Pennathur and Kansal (1999), 28% of the workplace falls on the same level resulted in lost work time of more than 21 days. McGinn (2005) concluded that treating back injuries can create aches and pains in a waste firm's bottom line. According to the National Safety Council, ltascs, III, the cost of treating back injuries complaints ranges from $30 billion to $50 billion annually.

Mulcahy (1994) and Kemper National companies made a conclusion that long delays by employers in reporting on-the-job injuries to insurers can increase workers compensation claim costs by 48%. In addition, the average cost for claims was $12,082.

Coefficient of Friction

Roberts (1993) concluded that the industry that a walkway surface with a coefficient of friction higher than 0.5 is non-hazardous. Federal regulations from the Americans with Disabilities Act recommend a coefficient of friction of 0.6 or higher. The coefficient of friction is a measure of the slipperiness of a surface. He also mentioned that the coefficient of friction is the ratio of the weight of an object to the frictional force required to just move the object. According

to Roberts, if a block of concrete weighing 40 pounds requires 20 pounds to just start moving on a floor, the coefficient of friction is 20/40 or 0.5.

Miller (1983) also concluded that for persons walking unloaded on level surfaces, a coefficient of friction standard of 0.5 would be reasonable. He also mentioned that slip resistance requirements and accident prevention could be achieved more easily by controlling the type of shoe, type of task, or amount of surface contaminant rather than controlling only the coefficient of friction of the basic surface and its coating.

OSHA Regulations

Occupational Safety and Health Administration (OSHA) has promulgated regulations to control slip, trip, and fall hazards and the scope of these standards are broad which includes equipment, structure, training, management, and work procedure. OSHA's standards regarding slip, trip, and fall prevention can be found in 29 CFR Part 1926 (construction industry) and 29 CFR Part 1910 (general industry).

According to Mark, Ramani and Joshep (2001), Occupational Safety and Health Administration has covered slip, trip, and fall related topics which includes personal protective and live saving equipment (Subpart E); scaffolds (Subpart L); fall protection (Subpart M); underground construction (Subpart S); demolition (Subpart T); and stairways and ladders (Subpart X).

29 CFR 1910.22 *"General requirements"* specifies that all areas of employment should be kept clean and sanitary, the floors shall be kept clean and dry and where wet processes used, they shall be kept as dry as practical, aisles and passageways shall be marked.

29 CFR 1910.23 *"Guarding floor and wall openings and holes"* states that every stairway floor opening shall be guarded by a standard railing constructed in accordance with

paragraph (e) of 1910.23, every ladder floor opening or platform shall be guarded with a standard toeboard on all exposed sides (except all the entrance to opening), any floor hole that could be walked into must have standard railing or toeboard surrounding it, and for infrequently used floor holes; such as trapdoors, a cover that is of standard strength and construction shall be used; when the cover is not in place, the opening shall be constantly attended by someone or shall be protected by removable standard railings.

Chapter III: Methodology

Introduction

The purpose of this study was to identify and recognize hazardous areas at Company XYZ facility that can result in slip, trip and fall accidents and choose the best way to prevent a slip, trip, and fall hazard. Slips, trips and falls are a major cause of injuries and fatalities in the construction business. The goal of this study is to reduce the slip, trip, and fall incidents among workers at Company XYZ. This chapter will outline the company, process, and what testing area and methods will be used to conduct the research problem.

Goals of the Study

1. Identify the core reasons for slip, trip, and fall related hazards by interviewing employees
2. Evaluate the surface metrics for friction and unevenness
3. Analyze previous accidents/injury rates
4. Identify and analyze the significance of potential hazards by using Process Hazard Management Tools to generate and organize solutions

Data Collection

A multiple approach was taken in conducting this research, which was carried out in four main phases. The first phase involved the gathering of physical data and behavioral data from workplace. This phase also involved in the examination of the existing floor. The second phase involved in evaluation of the surface metrics for coefficient of friction. The third phase involved in the evaluation of the previous incident/injury rates and the fourth phase involved in the analysis of potential hazards by using process hazard management tools to generate and organize solutions.

First Phase

Physical data. Surface roughness dimensions and pictures were taken from work stations, steps, and walkways. The locations were chosen based on the past incidents. Four numbers of pictures from work area, and four numbers of pictures from walking areas were taken throughout the week from morning and afternoon shifts. Slipperiness pictures and data from the working and walking areas were taken during working hours in two hour intervals and after work complete.

Behavioral data. The key aspect of this case study was to establish employee's attitudes towards slip, trip, and falls. Semi-structured interviews method was used for data collection. Consent form (University of Wisconsin-Stout, Consent form format) was used for the interview process. The consent form can be found in Appendix A.

Semi-structured interviews. Interviews were carried out with 24 individuals, including drivers. Six individuals from plant A, plant B, plant C, and plant D were selected randomly. Additionally, interviews were carried out with two plant managers and one safety manager. The majority of the interviews were conducted at a lunch room when employees were taking a rest break. The interviews were semi-structured, allowing both responders and the interviewer to expand upon points of discussion as necessary. Topics discussed included: experience of falls, reason for slip and trip, access provision, slip/trip hazards, time pressure, training, effect of footwear and suggestions for reducing falls.

Second Phase

This phase involved in evaluation of the surface metrics for coefficient of friction. This will focus on the testing of existing floor by using a slip meter. An American slip meter was used to perform the test. Slip meter measures surface traction on a scale ranging from 0.0 to 1.0, with

values at the lower end indicating danger and values in the upper range showing increased degree of safety. A picture of the slip meter can be found in Appendix C.

Instrument description.

Name:	American Slip Meter
Apparatus:	Horizontal Dynamometer Pull Meter
Model number:	ASM 725
Weight:	4.70 lbs with sensor attached

Method

Test Sensors. Before taking measurements, the sensor needed to be tested. A drop of glue was used on the sensor mount. The pattern was placed against glue and slightly rotated to seat and spread glue evenly and allowed to dry for 24 hours before using.

Resetting Gauge. The Gauge should always reset to just below 0.10. Gently pulled D ring until gauge needle reaches 1.00 and pressed reset button to reset the gauge.

Calibration. The calibration chain was hooked to the "D" ring at the end of the slip meter. After that the reset button was pressed which is located on top end of gauge to assure lowest setting. With the hook in place, stand gauge vertically on a level surface and, using a calibration chain, lift slip meter from surface.

Operating Procedure. The following steps were used to perform the test by using slip meter:

- Pressed reset button and clean test sensor was placed
- Slip meter was set gently on floor
- Nylon monofilament was attached by placing hook into "D" ring of instrument

- Holding monofilament at its length, with first of hand doubled, rested palm of hand on surface in direct line with hook.
- By using index finger, slowly applied steady pressure until slip meter moves
- Reading of the meter was noted
- Three measurements were taken for accuracy.

Third Phase

The third phase involved in the evaluation of the previous incident/injury rates. Numbers of injury/incidents data from year 2002 to 2005 were collected from Company XYZ.

Fourth Phase

The fourth phase involved the analysis of potential hazards by using process hazard management tools to generate and organize solutions. A preliminary hazard analysis (PHA) was used to identify the hazards and analyze the various risk factors involved in different areas of Company XYZ. A risk assessment matrix was also used to rank the identified accidental events according to their severity. A PHA identifies hazards and their potential consequences. The PHA uses probability and severity to determine risks. The PHA will provide an inventory of hazards, assess their risks and provides a tool for prioritizing activities effectively and assigning resources to bring all risks under acceptable control.

The main assets the PHA will focus on are personnel, equipment, downtime, product, and environment. The risk assessment matrix (Appendix B) has a column for probability and severity and includes risk codes/actions for each hazard. The severity and probability interpretations (Appendix B) define the columns, which includes: impossible, improbable, remote, occasional, probable, frequent, catastrophic, critical, marginal, and negligible. Using both tables allows for prioritizing hazards and is based on a hazard occurring over a life cycle of 25 years.

Limitations

The timeframe of the study limited the scope of discussion. However, the study did manage to achieve a reasonable sample of employee's interests. The study was also limited to one plant which is small compared to that of other plants of Company XYZ.

Chapter IV: Results

Slips are primarily caused by slippery surfaces and compounded by wearing the wrong footwear. A "slip and fall" is the common term for an injury which occurs when someone slips, trips or falls as a result of a dangerous or hazardous condition. It includes falls as a result of water, ice or snow, as well as unexpected changes in flooring, poor lighting, or a hidden hazard, such as a gap or hard to see hole in the ground.

Purpose of the Study

The purpose of this study is to identify and recognize hazardous areas at Company XYZ that can result in slip, trip and fall accidents and choose the best way to prevent a slip, trip, and fall hazards.

Goals of the Study

1. Identify the core reasons for slip, trip, and fall related hazards by interviewing employees
2. Evaluate the surface metrics for friction and unevenness
3. Analyze previous accidents/injury rates
4. Identify and analyze the significance of potential hazards by using Process Hazard Management Tools to generate and organize solutions

Data Analysis

A multiple approach was taken in conducting this research, which was carried out in four main phases. The first phase involved the gathering of physical data and behavioral data from workplace. This phase also involved the examination of the existing floor. The second phase involved an evaluation of the surface metrics for coefficient of friction. The third phase involved

the evaluation of the previous incident/injury rates and the fourth phase involved the analysis of potential hazards by using process hazard management tools to generate and organize solutions.

First Phase

The key aspect of this phase was to gather physical data and behavioral data from the workplace by interviewing employees. Interviews were carried out with 24 employees, including drivers, lead man, supervisors, and workers. The majority of the interviews were conducted in the lunch room when employees were taking a rest break.

During the interview, employees were asked the most common reason for slip, trip, and fall incidents in their work area. The majority of interviewers responded that poor housekeeping is the core reasons for most of the slip, trip, and fall incidents. Photographs from different plant locations were used as a reference for discussion during interview. The interview question and consent form for the interview process can be found in Appendix A and photographs can be found in Appendix C. Results from the interview questions can also be found in Appendix A.

Second Phase

The second phase involved in the examination of metrics for friction and unevenness of the existing floor at different plant locations. The coefficient of friction was tested by ASM 725(American Slip Meter). The test was carried out in accordance with the procedure given in Chapter Three. The average coefficient of friction was found as 0.62. Based on a review of measurements from the different work areas, the coefficient of friction was found slightly low at area 3.The measurement table for coefficient of friction from area 1, area 2, area 3, and area 4 can be found in Appendix B.

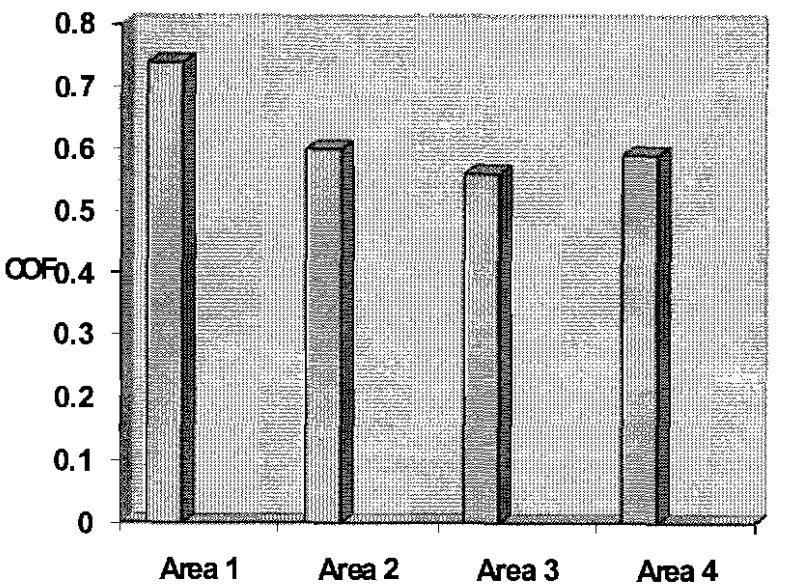

Figure 1. Coefficient of friction at area 1, 2, 3, and 4.

Third Phase

The third phase involved the analysis of previous injury/incident rates. After analyzing the last four years of injury/incident, it was found that poor housekeeping and unevenness floor was the contributing causes for most of the injury/incident. Injury/incident rate and core reason can be found in Appendix B.

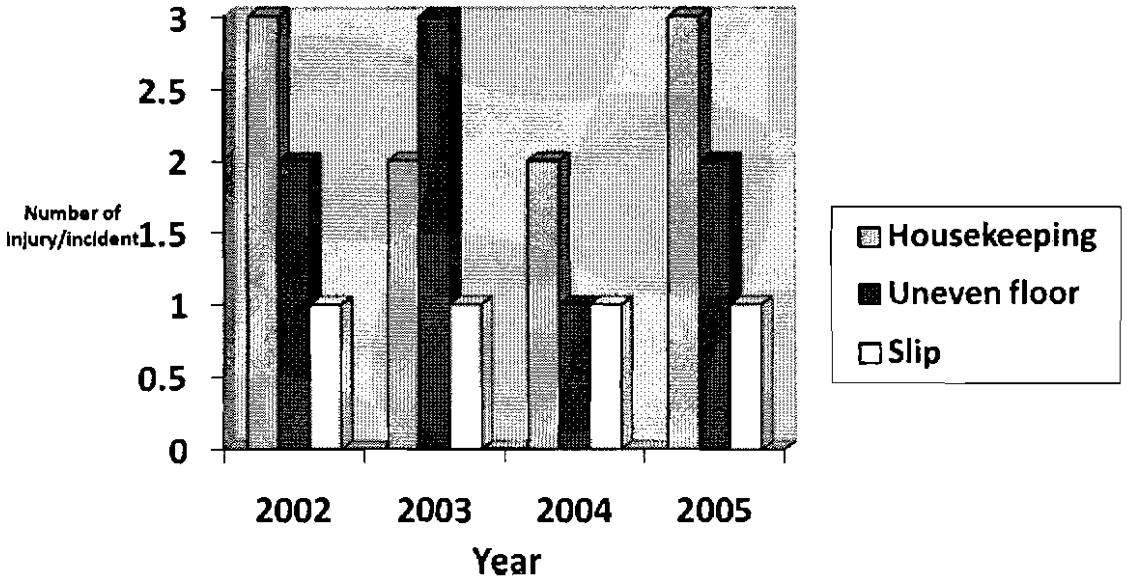

Figure 2. Number of injury/incidents between years 2002 to 2005

Fourth Phase

The fourth phase involved the identification of all potential hazard and accidental events that may lead to an accident and rank the identified accidental events according to their severity. Results were found from the Risk Assessment Matrix, which indicated that slips, trips, and falls are the frequent hazard in Company XYZ. Risk Assessment Matrix also indicates that slips, trips, and falls are most imperative to suppress the risk and the risk code was 1. While analyzing with severity/probability interpretations, slip, trip, and fall hazards were in critical position. After analyzing the accidental events, results indicate that slip, trip, and fall hazards are most frequent hazards because of poor housekeeping and uneven floor surface. The results of the PHA worksheet and risk matrix can be found in Appendix B.

Chapter V: Conclusions and Recommendations

The purpose of this study was to identify and recognize hazardous areas at Company XYZ that can result in slip, trip and fall accidents and choose the best way to prevent slip, trip, and fall hazards.

The goals of this study were to:

1. Identify the core reasons for slip, trip, and fall related hazards by interviewing employees
2. Evaluate the surface metrics for friction and unevenness
3. Analyze previous accidents/injury rates
4. Identify and analyze the significance of potential hazards by using Process Hazard Management Tools to generate and organize solutions

Conclusion

Based on the data collected during the evaluation performed on a construction Company XYZ, both slip and trip incidents are a result from poor housekeeping and unevenness of walking surfaces. The impact of slip and trip accidents in Company XYZ can be large, but in many circumstances the causes can be relatively easy to eliminate, or adequately control. Whereas the slip-resistant properties of flooring and footwear are very important considerations in the reduction of slip and trip accidents, many of these accidents are the result of poor housekeeping and inadequate cleaning regimes. Company XYZ's housekeeping planning are critical and created high risk of experiencing employee, equipment, facility, safe working environment, and financial based loss. These losses are important for Company XYZ to ensure success, and to reduce slip, trip, and fall injury/incidents. They can therefore be reduced or eliminated by the

introduction of simple, relatively inexpensive, easy-to-implement measures, which will have a considerable benefit for Company XYZ.

Recommendations

In order to ensure the reduction of slip, trip, and fall incidents, established policies and practices can be implemented to significantly reduce the number of injuries and incidents due to slips, trips and falls. The following recommendations are provided for Company XYZ.

- Managers and supervisors must make a commitment to prevent accidental slips, trips and falls.
- Keep work areas, passageways, and stairs in and around free from scrap, lumber and form lumber with protruding nails.
- Remove garbage, combustible scrap, and debris at regular intervals.
- Collect and separate waste, garbage, and flammable rags in containers.
- Regular inspections of working and walking areas should be conducted to identify environmental and equipment hazards which could cause slips, trips and falls. Special attention should be given to the working and walking surfaces, housekeeping, lighting, vision, stairways and ladders. Immediate corrective action should be taken.
- Extensive safety training on the prevention of slips, trips and falls should be provided for all new employees. Regular retraining should be provided for all employees. Special attention should be given to proper walking, carrying, climbing and descending stairways, ladders, vehicles and equipment. Unsafe practices should be corrected immediately.
- All workers should wear proper footwear for their work and environment whether in the office, shop, plant, feedlot or field.

- All slips, trips and falls, with or without injury, should be reported, recorded and thoroughly investigated. Corrective action to prevent such a repeat occurrence should be taken immediately.

References

Standard test method for static coefficient of friction of polish-coated surfaces as measured by the James machine. (1993). American Society for Testing and Materials, ASTM D2047-93, West Conshohocken, PA.

Cayless, S. M. (2001). Slip, trip, and fall accidents: Relationship to building features and use of coroners' reports in ascribing cause. *Applied Ergonomics*, *32*, 155-162

Canadian center for health and safety. (1999). Retrieved June 10, 1999, from http://www.ccohs.ca/oshanswers/safety_haz/falls.html#_1_2

Falls on stairways – health and safety laboratory. (2005). Retrieved April 28, 2005, from http://www.hse.gov.uk/research/hsl_ pdf/2005/hs10510.pdf

Jackson, P. L., & Cohen, H. H. (1995). An in-depth investigation of 40 stairway accidents and stair safety literature. *Journal of Safety Research*, *26*, 151-159.

Miller, J. M. (1983). Slippery work surfaces: Towards a performance definition and quantitative coefficient of friction criteria. *Journal of Safety Research*, *14*, 145-158.

McGinn, K. (2005). Back, occupational safety, waste management industry, ergonomics, injuries, and costs. *Waste Age, 36.*

Kemmlert, K., & Lundholm, L. (2001). Slip, trips, falls in different work groups-with reference to age and from a preventive perspective. *Applied Ergonomics, 32,* 149-153.

Layne, L. A., & Landon, D. D. (1997). A descriptive analysis of nonfatal occupational injuries to older workers, using a national probability sample of hospital emergency departments. *Journal of Occupational and Environmental Medicine, 29,* 855-865.

Mital, A., Pennathur A., & Kansal, A. (1999). Nonfatal occupational injuries in the United States: Part I overall trends and data summaries. *International Journal of Industrial Ergonomics, 25,* 110-130.

Mulcahy, C. (1994). Property and casualty/risk benefits management ed. *National Underwriter, 98.*

Nagata, H. (1991). Occupational accidents while walking on stairs. *Safety Science, 14,* 199-211.

Radomsky, M., Ramani R., & Flick, J. (2001). Occupational accidents, safety management, fatalities, construction industry, mining industry, regulatory agencies. *Professional Safety, 46.*

Appendix A

Consent Form, Interview Questions, and Results for the Interview Process

Consent Form for the Interview Process

I agree to participate in this research project entitled "Reduction of slip, trip, and fall incidents among construction workers at company xyz", which is being conducted by Mukesh Shreevastav, University of Wisconsin-Stout, Cell #715-497-0275. I understand that this participation is voluntary; I can withdraw my consent at any time and have the results of the participation returned to me, removed from the experimental records, or destroyed. I understand the basic nature of this evaluation and agree that any potential risks are exceedingly small. I also understand the potential benefits that might be realized from successful completion of this evaluation. I am aware that the confidentiality is guaranteed.

Questions or concerns about the research study should be addressed to Mukesh Shreevastav 715-497-0275, the researcher, or Dr. Bryan Beamer, phone # 715-232-1313, the research advisor. Questions about the rights of research subjects can be addressed to Sue Foxwell, Human Protections Administrator, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research, 11 Harvey Hall, Menomonie, WI, 54751, phone 715-232-1126.

Signature of Investigator, Date: _____

Signature of the Participant, Date: _____

PLEASE SIGN BOTH COPIES, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Interview Questions

1. Have you ever had any slip, trip accidents at work?
   Yes
   No

2. Do you notice **"CAUTION-WET FLOOR"** signs when floors are cleaned?
   Yes
   No

3. What are the most common reasons for slip, trip fall incidents in your work area?
   a. Uneven floor
   b. Poor light
   c. Wet floor
   d. Poor housekeeping
   e. All the above
   f. Other
   Explain: _____

4. Do slip and fall accidents occur more in wet and icy conditions?
   Yes
   No

5. How often do you inspect your shoes?
   a. Daily
   b. Weekly
   c. Monthly
   d. Never

6. How often you replace your shoes?
   a. 6 months
   b. 12 months
   c. 18 months
   d. 2 years
   e. As needed

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Interview Questions Result

Total participants 24

1. Have you ever had any slip, trip accidents at work?
   - Yes (16)
   - No (08)

2. Do you notice **"CAUTION-WET FLOOR"** signs when floors are cleaned?
   - Yes (19)
   - No (05)

3. What are the most common reasons for slip, trip fall incidents in your work area?
   - a. Uneven floor (06)
   - b. Poor light (04)
   - c. Wet floor (06)
   - d. Poor housekeeping (11)
   - e. All the above (07)
   - f. Other (03)

   Explain: _____

4. Do slip and fall accidents occur more in wet and icy conditions?
   - Yes (17)
   - No (07)

5. How often do you inspect your shoes?
   - a. Daily (09)
   - b. Weekly (04)
   - c. Monthly (02)
   - d. Never (09)

6. How often you replace your shoes?
   - a. 6 months (03)
   - b. 12 months (10)
   - c. 18 months (00)
   - d. 2 years (00)
   - e. As needed (11)

Appendix B

Tables for Coefficient of Friction and Injury/Incident in Previous Year

Table B1

Coefficient of Friction

Area	Trial (COF)			Average(COF)
	1	2	3	
1	0.64	0.78	0.80	0.74
2	0.58	0.64	0.60	0.60
3	0.48	0.58	0.60	0.56
4	0.50	0.60	0.68	0.59

Table B2

Number of injuries/incidents between years 2002 to 2005

Year	No. of Injuries			Total
	Housekeeping	Uneven floor	Slip	
2002	3	2	1	6
2003	2	3	1	6
2004	2	1	1	4
2005	3	2	1	6

Table B3

Preliminary Hazard Analysis

Brief Descriptive Title (Portion of system/sub-system/Operational Phases covered by this analysis):										
Probability Interval:	Date:	Risk Before				Description of Countermeasures	Risk After			
System Number:	Analysis: ☐ Initial ☐ Revision ☐ Addition	Hazard Target	Severity	Probability	Risk Code	Identify countermeasures by appropriate code letter(s): D = Design Alteration E = Engineered Safety Feature S = Safety Device W = Warning Device P = Procedures/Training	Severity	Probability	Risk Code
Hazard No. / Description									
• Hazards from poor housekeeping		P E T R V	II	A	1	D = Redesign housekeeping system P = Train the employee about housekeeping S = Hard hat, Gloves, Safety shoes W = Regular meeting	III	D	3
• Hazards from uneven floor		P E T R V	II	B	1	D = Redesign floor P = Train the employee S = Hard hat, Gloves, Safety shoes W = Regular meeting	III	D	3
• Hazards from trip		P E T R V	II	B	1	P = Train employee. S = Hard hat, Gloves, Safety shoes W = Regular meeting	III	D	3
• Hazards from slip		P E T R V	III	B	3	D = Redesign floor P = Train the employee about housekeeping S = Hard hat, Gloves, Safety shoes W = Regular meeting	III	E	3
Prepared by/Date:	*Target Codes: P - Personnel E - Equipment T - Downtime R - Product V - Environment						Approved by/Date:			

Severity/Probability Interpretations*

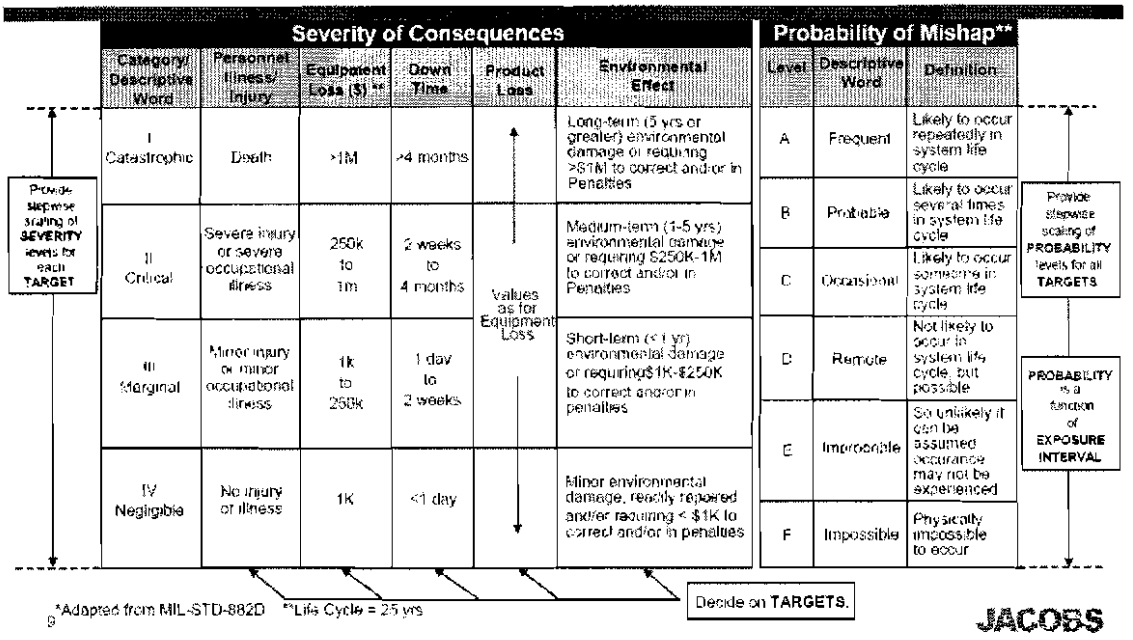

Figure B1. Severity/Probability Interpretations

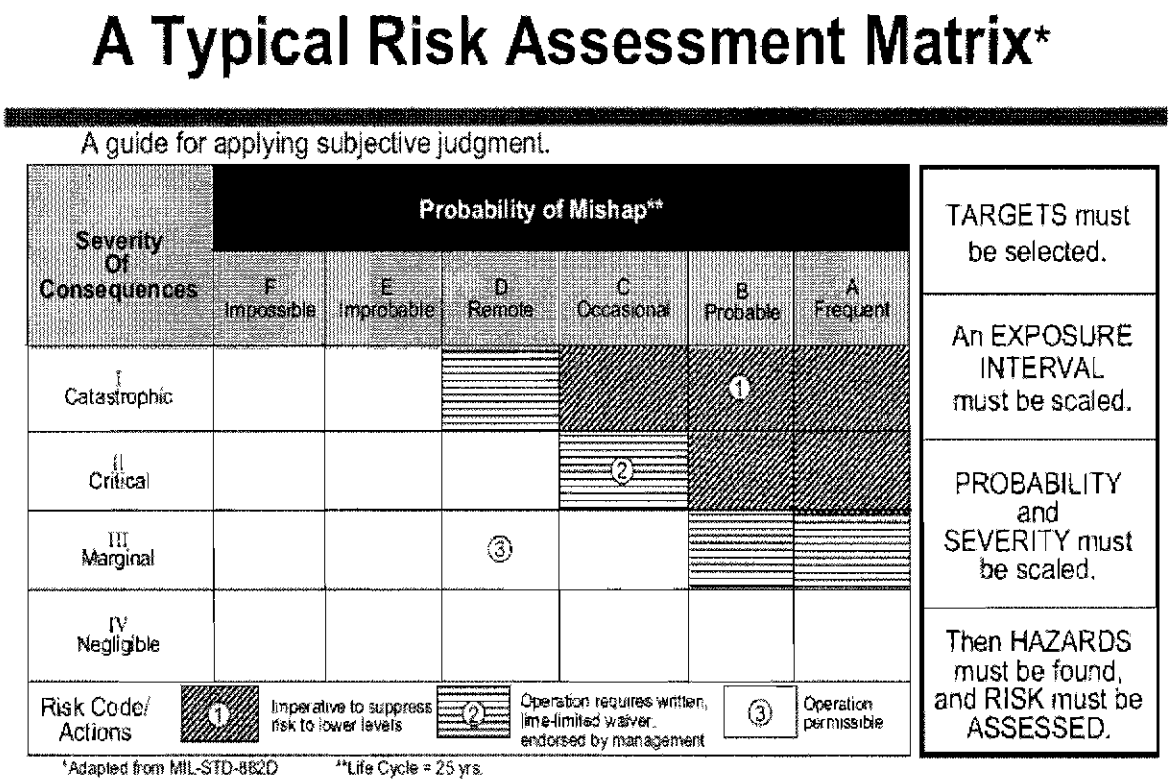

Figure B2. Risk Assessment Matrix

Appendix C

Photographs

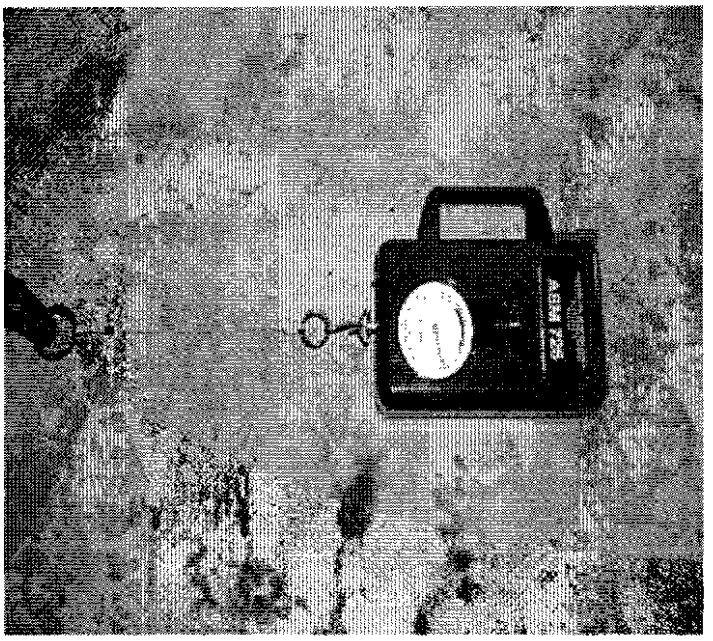

Figure C1. American Slip Meter (ASM 725), Front view

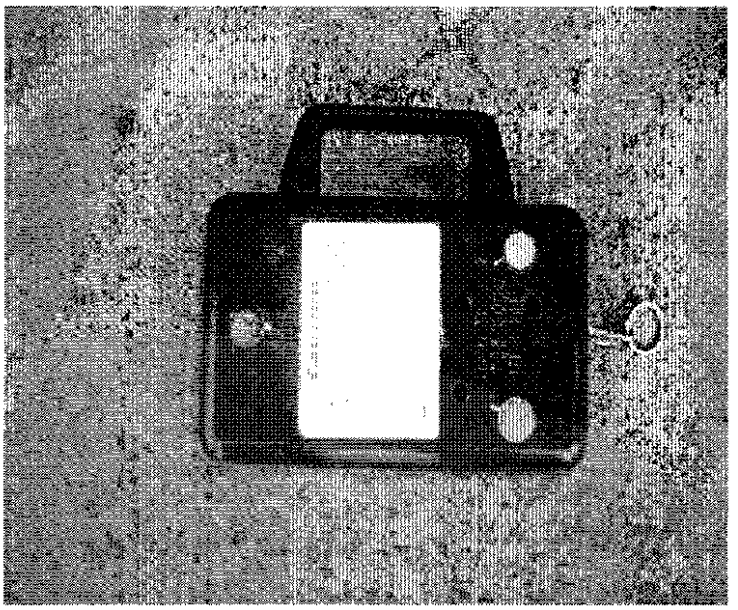

Figure C2. American Slip Meter (ASM 725), Rear view

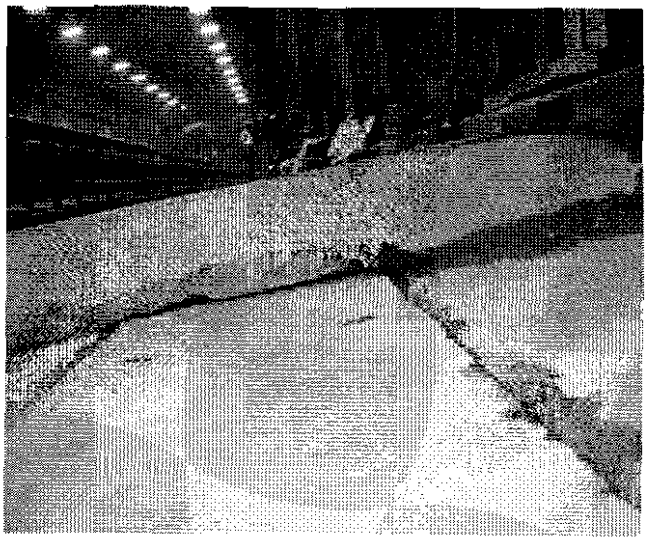

Figure C3. Uneven floor

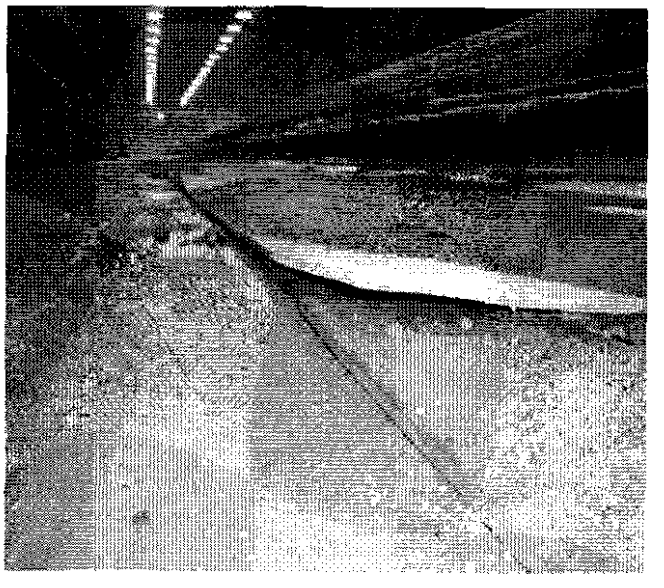

Figure C4. Trip and fall hazard

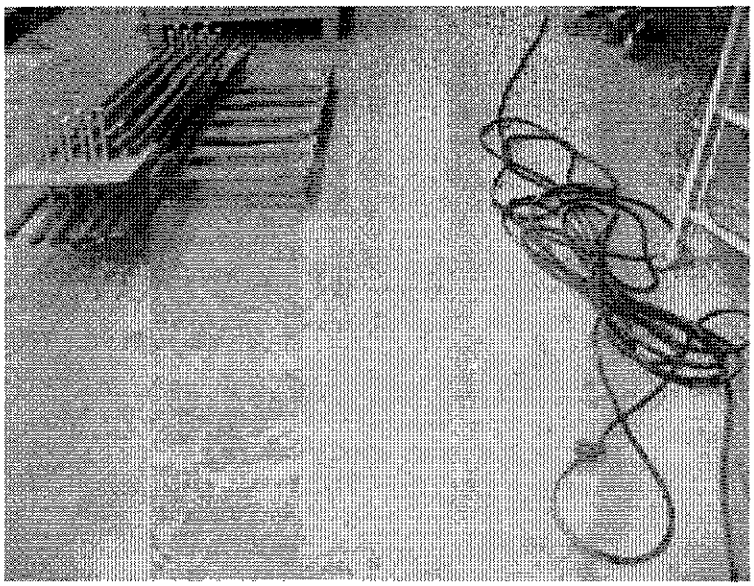

Figure C5. Poor housekeeping