Evaluation of Slip Resistance

for Company Y

by

Diane T. Hunter

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Dr. Bryan R. Beamer
Research Advisor

The Graduate School
University of Wisconsin-Stout
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The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Hunter, Diane T.**

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ABSTRACT

The purpose of this study was to evaluate and identify preferred slip resistant floor surface(s) for new and existing homes owned and managed by Company Y. Data was gathered to evaluate the extent to which existing facilities at Company Y differed in coefficient of friction of floor surfaces used. This was determined by performing a visual inspection of the restrooms at three specific sites in Menomonie, Wisconsin; measuring the coefficient of friction of flooring material used; and reviewing Company Y's injury report for period January 1, 2006 to October 1, 2008. The coefficient of friction was compared to the Standard, Americans with Disabilities Act, 28 CFR Part 36, *Standards for Accessible Design,* Section 4.5, and compared to Company Y's incidence rates as it relates to slips and falls. The results of this study proved that Facility 010, the first site tested, did not meet industry standards using Neolite or leather test sensors. At Facility

119, the coefficient of friction exceeded ADA standards, regardless of floor condition, when Neolite test sensors were used; leather, on the other hand, only approached ADA standards when the floor was dry, but surpassed ADA standards when the floor was wet. The final site, Facility 074, exceeded ADA industry standards for both wet and dry conditions, regardless of test sensor material. Data shows that the performance of Neolite and leather test sensors both improved as testing advanced from one facility to the next; however, there was a more noticeable improvement when using leather test sensors than when Neolite test sensors were used. When cleaning floors, it is recommended that signs and barricades be used to warn people of wet floors and that blowers be used to hasten floor drying time. It is also recommended that employees wear different shoes for work than they do for walking to work.

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Chapter I: Introduction

Each year, thousands of people find themselves the victim of a slip-and-fall accident. Slip and fall accidents account for a large number of deaths and serious injuries in community, home, and work settings. In 2004, falls ranked the third highest cause of deaths (14.3%) among all workers and the third highest in occupational injuries among U.S. private sector wage and salary workers in terms of number of cases with days away from work (20.3%) (National Safety Council, 2007, p. 56).

According to Beschorner, Redfern, Porter, and Debski, (2007), slips, trips, and falls were estimated to cause between 20% and 40% of disabling injuries in the developed world. Slips, trips, and falls are a major source of hospital visits in many sectors including services, manufacturing, retail, and construction. In 2004, across the entire age spectrum, falls were the leading cause for admission to hospital emergency departments in the U.S. with the exception of the 15-24 year old age group. Perhaps this is because this age group is likely to be the most athletically fit group in society (National Center for Injury Prevention and Control, CDC, 2004).

Slippery surfaces are a major source for falls. Regardless of frequent inspections, many property owners learn of their floor safety problem after a serious injury has occurred (Kendzior, 2001, p. 202). Thus the prevention of slips is an important public and occupational health issue.

Statement of the Problem

Variations in types of floor surfaces could place employees of Company Y at significant risk of injury due to slipping or falling when assisting consumers with personal cares in the bathroom.

Purpose of the Study

The purpose of this study was to evaluate and identify preferred slip resistant floor surface(s) for new and existing homes owned or managed by Company Y.

Data was gathered during the fall of 2008 to evaluate the extent to which existing facilities of Company Y differed in coefficient of friction of floor surfaces used. Floor surfaces that were being considered for homes being built in the future were also evaluated. Data collection was accomplished by measuring the slip resistance of dry and wet floor surfaces and reviewing historical records.

Goals of the Study

The primary goals of this study were:

1. To compare coefficient of friction (COF) of measured surfaces to the standard.
2. To compare coefficient of friction to Company Y's incidence rates as it relates to slips or falls.
3. To make recommendations on types of floor surfaces to install in future homes built for Company Y and for the possible remodeling of existing homes.
4. To make any other recommendations necessary to help prevent slips and falls at company Y.

Background and Significance

Background. Company Y is an agency that provides a full spectrum of individualized care to adults who are 18 years of age or older that have developmental disabilities, mental health issues, dual diagnoses and traumatic brain injuries. These individuals are cared for in community-based residential facilities (CBRF) or in licensed adult family homes.

Company Y has 7 area offices in northwestern Wisconsin, that serves 33 communities with more than 100 community based residential facilities (CBRF) and adult family homes. Representatives from Company Y selected two community-based residential facilities (CBRF) and one adult family home from Menomonie, Wisconsin to participate in this study and represent the remaining facilities managed by Company Y. These three Menomonie sites were chosen because of the extreme care consumers residing in these facilities need as compared to other facilities, and the assurance for employees that when handling the consumer, the risk of slipping and falling, is minimized or eliminated as the employee comes in contact with the floor's surface.

It was requested by Company Y that the bathroom be the focal point of this study since the bathroom is an area that receives frequent use and has an increased potential for slips and falls over other areas of the facility. Company Y also wanted to identify flooring materials to use in future construction and in updating surfaces in current homes.

Significance. According to the United States Department of Labor, Bureau of Labor Statistics (2003), nursing and personal care facilities rank highest in the number of non-fatal occupational injuries and illness, with 12.6 injuries per 100 full-time employees reported in 2002. The agency also reported that one-third of these injuries resulted in absence from work, and that nursing aides and orderlies were reported to have the highest number of absentee days (44,000) due to musculoskeletal disorders.

Health care workers or caregivers lift, reposition, and transfer patients on a daily basis as they tend to the personal needs of consumers. When combining these activities with a slippery floor surface, it puts both the caregiver and the patient at greater risk of injury.

Falls are one of the leading causes of workers comp injuries. The average total cost incurred per claim due to a fall was $22, 802, only to be surpassed by motor vehicle claims at an average cost of $35, 873 (National Safety Council, 2007, p. 54). Falls carry a significant burden of morbidity and mortality, affect life style choices, are a high cost to the organization, and potentially preventable according to Steinberg, Cartwright, Peel, and Williams (2000, p. 227).

Limitations of the Study

This study included the following limitations:

1. This analysis relied strictly on historical records to quantify the extent of injury.
2. No employees were interviewed.
3. The coefficient of friction was evaluated at only three of the 100 or more sites managed by Company Y. All three of these sites were located in Menomonie, Wisconsin; No regional sites were selected to participate in this study.
4. The floor surfaces measured in this study may not be indicative of surfaces at other sites.
5. Data presented in this study represented occupational injuries only. Injuries sustained by consumers were not addressed since the exact etiology of falls incurred by consumers could not be definitively identified.
6. The data represented recordable incidents only. First aid cases are not represented in the study.
7. Some falls may not have been reported, particularly if no injury results from the fall.

Definition of Terms

Adult family home. "A place where 3 or 4 adults not related reside in which care, treatment or services above the level of room and board but not including nursing care are provided to persons residing in the home" (HFS 88, 2007).

Coefficient of friction. It is the division of the horizontal force by the vertical force. Concrete, with 0.8 COF, would have more traction, and be less slippery, then ice, with a COF of 0.3.

Community based residential facility. "A place where 5 or more unrelated adults reside in which care, treatment or services above the level of room and board but not including nursing care are provided to resident as a primary function of the facility" (HFS 83, 2007).

Consumer. "An adult resident who lives and sleeps in a CBRF or adult family home who receives care, treatment or services in addition to room and board" (HFS 83, 2007).

Friction. Friction is the resistance to lateral movement caused by the contact between two surfaces (Miller, B.C., 1999).

Occupational injury. "Any injury such as a cut, fracture, sprain, amputation, etc., which results from a work-related event or from a single instantaneous exposure in the work environment" (U.S. Department of Labor, Bureau of Labor & Statistics Glossary, n.d., n.p.).

Recordable injury. Recordable cases include work-related injuries and illnesses that result in one or more of the following: death, loss of consciousness, days away from work, restricted work activity or job transfer, medical treatment beyond first aid (U.S. Department of Labor, Bureau of Labor & Statistics Glossary, n.d., n.p.).

Personal care. "Help with eating, dressing, bathing, ambulation and other self-care activities of daily living" (HFS 88, 2007).

Chapter II: Literature Review

This chapter provides an explanation of the coefficient of friction and how to measure it. In addition, major factors contributing to slips-and-falls are discussed. The chapter concludes with standards that have been developed to guide and protect employees, consumers, and guests from slips-and-falls.

What is Coefficient of Friction?

In the US, walkway slip resistance of a surface has been defined in terms of static coefficient (COF), which is the horizontal force required to set the object in slow motion, divided by the applied vertical force or weight (Sotter, 1995, p. 28). The coefficient of friction (μ) is defined as the ratio between friction force (F) to normal force (F_N) or mathematically expressed as:

$$\mu = \frac{F}{F_N}$$

"Static" refers to the object resting on top of the floor surface ready to be set into motion across the floor, like a shoe. COF has become one of the common performance measures for products like floor finishes (Miller, 1999, p. 62). In 1953, the coefficient of friction was defined to be a static measure of 0.5. Coefficient of friction values can be interpreted as 0.5 or less (relatively slippery), 0.5-0.6 (generally acceptable), or .6 or higher (relatively not slippery). A COF of 0.5 has become the working definition for most state laws, municipal ordinances and building codes. Most codes recognize a static coefficient of friction of 0.5 to be both legal and enforceable for slip-resistant pedestrian walkways.

Appropriate Testing Protocols

There are many different slip-resistance testing standards, many of which are not intended to test product in the "field", but rather in a laboratory under dry conditions. Laboratory testing is a valuable tool in measuring a product's performance; however, the lack of an accurate field test does little to support the "real world" results of such products (Kendzior, 2001, p.202).

ASTM-C1028 is the standard test protocol to use in measuring the static coefficient of friction on ceramic tile and other like surfaces. Both the Horizontal Dynamometer Pull-Meter and the American Slip Meter are used to measure the coefficient of friction of surfaces under wet or dry conditions. These particular methods allow for testing in the laboratory or in the field (High Safety Consulting Services, n.d.).

Various materials have been used to test for slip resistance, including leather, Neolite, and various rubbers. Neolite, a registered trademark of Goodyear Tire & Rubber Company, has been used in the shoe industry as a heel and sole material due to the material's ability to remain constant, regardless of wear and moisture. Its traction properties are in the median range of commonly used shoe-bottom materials. Neolite has proven reliable and repeatable as a friction pad material for horizontal pulls for many years (Goodwin). Neolite test sensors are used in conjunction with the American Slip Meter to measure coefficient of friction. Leather is extremely absorbent and highly sensitive to humidity. Once leather gets wet, its properties are permanently altered. Leather is not representative of heel material because most heels are made from a synthetic compound. Essentially, shoes having rubber heels and leather soles are more readily the cause for slipping. Leather reacts differently, depending upon how worn the material.

Standards

Standards and codes give guidance for establishing a baseline for safe walkways. Three standards that apply to slip-resistant surfaces are discussed.

American National Standard Institute (ANSI). An important ANSI standard was approved in 2001 to deal with slip resistance on working/walking surfaces. ANSI/ASSE A1264.2-2001, *Standard for the Provision of Slip Resistance on Walking/Working Surfaces,* was developed to further define the term "slip resistance" and to set forth practices for providing reasonably safe walking and working surfaces in areas where slips and falls are possible (Professional Safety, 2005, p.73). A1264.2-2001 includes a 0.5 coefficient of friction (COF) slip-resistance guideline for dry floor conditions only. It also recognizes that the 0.5 COF guideline should not be used alone when evaluating slip resistance (Maynard, 2002, p.135). Other factors must include floor surface characteristics, footwear traction properties, environmental factors (water, oil, etc.) and management controls.

Occupational Safety and Health Administration (OSHA). Under the General Duty Clause, Section 5(a)(1) of the OSH Act, employers are obligated to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees". In addition, Section 5(a) (2) of the OSH Act requires employers to "comply with occupational safety and health standards promulgated under this Act" (OSHA, n.d., n.p.).

The OSHA standards for walking/working surfaces apply to all permanent places of employment, except where domestic, mining, or agricultural work only is performed. General requirements of OSHA's housekeeping regulations (29 CFR 1910.22(a) (1)) states that the floors must be kept clean, orderly, and dry. Where wet processes are used, there must be some form of drainage (non-slip mats, false floors, platforms), a dry place to stand, or appropriate waterproof footgear must be provided (29 CFR 1910.22(a) (2) and 29 CFR 1910.141 (a) (3) (ii)). If mechanical handling equipment is used, the aisles and other passage ways must be wide enough for turns to be made. The aisles and passageways must be kept clean, in good repair, and free of obstructions that could create a hazard CFR 1910.22(b) (1) and (2) (OSHA, n.d., n.p.).

A new OSHA rule (20CFR 1910.132 (h)) which became effective as of February 13, 2008, requires employers to purchase personal protective equipment (PPE) for employees if it is required for the task. Payment for PPE was required to be implemented by employers no later than May 15, 2008. For example, if slip-resistant footwear is required for the task, the employer is responsible for the cost of the footwear, unless it meets the exceptions identified under Section (h) of 20CFR 1910.132. The employer is not required to pay for routine non-slip street shoes, however, if special floor stripping shoes are required, the employer must then pay.

Americans with Disabilities Act (ADA). People who have difficulty walking or maintaining balance or who use crutches, canes, or walkers, and those with restricted gaits are particularly sensitive to slipping and tripping hazards. For such people, The Americans with Disabilities Act, 28 CFR Part 36, *Standards for Accessible Design,* Section 4.5 requires ground and floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs, and curb ramps, be stable, firm, and slip-resistant. To assist and best protect persons with disabilities, a static coefficient of friction of 0.6 is recommended for accessible routes and 0.8 for ramps.

Legal Concerns

Contributing to the disparity between lab testing and real-world results is that most slip-and-fall lawsuits have been targeted at the business owner instead of the manufacturer of the product, leaving the manufacturer with little incentive to assume additional responsibility towards improving resistance to slipping. "Tort law suggests that if building owners and operators want maximum protection from negligence lawsuits, maintaining their floor's slip resistance must be a continuing, proactive and documented process (Sotter, 1995, p. 33). Up until recently, property owners and operators accused of negligence in a slip-and-fall accident were considered "dead ducks." Sotter, member of the Coefficient of Friction Committee of the Ceramic Tile Institute of America, stated,

"It is now possible to obtain just verdicts if owners and operators can demonstrate that they were not negligent. The issue of notice, either actual or constructive, is usually the most important in establishing negligence in premises liability cases. Actual notice occurs when the owner or operator is aware of the potential exposure but fails to safeguard against it. Constructive notice is established when the problem would have been discovered by the defendant, using ordinary care. Building owners and operators have a duty to ensure that routine inspections uncover any conditions that create a hazard."

Causes of Slip and Falls

Slip-and-fall injuries can be serious and sometimes fatal. They can also be life-changing. Falls arise from the complex interplay between the condition of the individual, the activity in which the individual was engaged, the footwear worn, and the condition of the floor at the time of the accident (Sotter, 1995). This interaction is further exacerbated by the presence of hazards such as floor contamination, insufficient lighting and cleaning protocols. The following factors should be considered when investigating a slip-and-fall incident:

Condition of the individual. Was the person under the influence of alcohol, drugs, or medication? Was he or she not wearing prescription eyewear? Was the person emotionally distraught or perhaps, distracted by someone or something? Was the person a victim of the sun's glare or a reflection? Or was the person obese, or perhaps, in the late stages of pregnancy?

Activity. Tasks performed have a direct effect upon the force characteristics associated with a person's behavior, movement patterns and gait. Was the person in a hurry? Changing directions quickly? Pushing a wheelchair? Carrying something that was blocking their view? Or talking to someone and not paying attention to the path ahead?

Footwear. Was the footwear that was worn in good condition and suitable for the activity? Did a strap or heel break at the time of the accident? Friction or traction between the shoe and floor depends on floor surface material, surface finish, contamination on the floor, and shoe sole tread. Water tends to decrease the coefficient of friction, thereby, increasing the potential for falling. It is not known how much greater the risk has increased because it depends upon the factors mentioned above. This is why it is difficult to predict when a slip-and-fall will occur. Many employers have vague policies on footwear, while others require slip-resistant soles (Healthcare Risk Management, 2005). But simply requiring slip-resistant soles is not really enough to be effective. For instance, wearing tennis shoes does not mean that it is a slip-resistant shoe, particularly if the tread pattern is worn.

The floor. Flooring surfaces can play a significant role in helping prevent injury from falls. Most same-level falls are a result of slipping caused by faulty housekeeping or defects of the floor surface (Maynard, 2002, p.134). Was the floor wet or dry at the time of the accident? Were tripping hazards present? Was the individual transitioning from one flooring surface to another? Was the floor sloping? Dirt, grease, water and other contamination on the floor represents one of the biggest risks for falls in health care facilities. Liquids on floors can come from a variety of sources, including overspray from sinks, leaky toilets, transitioning in and out of the shower/bath area, incontinent patients, as well snow and rainwater tracked in from outside. A small amount of contaminant on the floor is all that is needed to present a slip, trip, or fall hazard. Obstacles in the pathways also contribute to slips and falls. Supplies and equipment lining the walkway, laundry and medication carts, and lifts are examples of very common scenes in health care.

Rough floor surfaces offer more slip-resistant characteristics by offering sharp peaks, which contacts the shoe's sole. However, grease, dirt or other contaminants can reduce that benefit by filling in the voids and the peaks can wear over time, thus reducing the slip-resistance benefit (Maynard, 2002, p.134).

Floor cleaning operations. Efforts to clean the floors properly may actually introduce potential hazards. Cleaning products may seem safe and slip-resistant when the floor is dry, but that can quickly change as soon as the surface becomes wet for any reason (Healthcare Risk Management, 2005). Unfortunately, cleaning and maintenance can quickly destroy the slip resistance of many floor coverings, including the most expensive ones (Sotter, 1995). "It cannot be assumed that a flooring surface is fine because the slip resistance was tested and it scored well when in the dry condition. A good flooring surface will perform well in both dry and wet conditions when tested" (Healthcare Risk Management, 2005). An unnecessary slip-and-fall hazard is introduced if cleaning is done when people are likely to traffic through the area while it is wet.

Lighting conditions. Lighting can disguise a defect or hazardous condition. Dim lighting makes it more difficult to see these potential exposures. Another risk posed by lighting is the abrupt change going from bright to dim, or vice versa. The sudden change in light often affects a person's vision, sometimes significantly (Healthcare Risk Management, 2005). Glare and either too much or too little contrast in the walking environment can reduce the eye's ability to identify hazards. Miller (1999) stated the following:

> The walking surface should be evenly illuminated and should have a brightness level of at least 20 foot candles – a basic quantitative unit of light measurement. And the contrast (ratio of dark to light) should be no less than 3:1 and no more than 20:1. A photographic light meter can be used to measure the luminosity and contrast.

Slip and Fall Prevention Program

Developing an effective slip and fall prevention program can reduce or eliminate the causes that contribute to the complexity of slips and falls. The following is a guideline for developing such a program (Maynard, 2002):

Housekeeping.

- Develop floor cleaning protocols. Be sure to identify the contaminant and the cleaners that will break it down. Identify the concentration of the cleaner needed to remove the contaminant and the tools needed.
- Establish a cleaning schedule and assign accountability to perform the cleaning.
- Provide enough trash cans to dispose of waste. Strategically place these cans where the most waste is generated.

Behavioral controls.

- Conduct periodic inspections to monitor the effectiveness of the cleaning procedures.
- Conduct training on proper maintenance and cleaning of floors, as well as safe handling and disposal of chemicals and solutions, emergency conditions and operations, and recordkeeping related to housekeeping and maintenance.
- Maintain “sweep logs”.
- Perform routine and unannounced inspections and record the results.
- Recognize employees for good performance.

Signage.

- Provide warning whenever slip and fall hazards are identified. Reference ANSI Z535.3 *Criteria for Safety Symbols.*
- Provide barricades and warning signs to isolate a hazardous area.
- Take appropriate corrective action to remove identified slip and fall hazards.

Floors and floor treatment.

- Determine if current floor surface is providing sufficient slip resistant protection. If not, consider replacement.
- When not practical to replace flooring surface, consider applying treatments to floor surface to improve floor's slip resistance.
- If mats are used, secure them so they don't present themselves as a trip hazard.

Footwear.

- The tread pattern on the sole should be raised with a crosshatching pattern, or a similar design.
- Tread pattern should extend over entire sole and heel area.
- Sole should have a flat, flexible bottom construction. Consider a low-density midsole that conforms to the ground and maximizes contact area.

Chapter III: Methodology

Variations in types of floor surfaces could place employees at significant risk of injury due to slipping or falling when assisting consumers with personal care in the bathroom. The objective of this study was to evaluate and identify preferred slip resistant floor surfaces for new and existing homes owned or managed by Company Y.

This chapter includes information about how the sample was selected, a description of the sample, and the instrument used. In addition, data collection and data analysis procedures are provided. The chapter concludes with the methodological limitations.

Subject Selection and Description

Company Y selected three Menomonie facilities to participate in this study. These three Menomonie locations were selected because the personal needs of those residing in these facilities were more acute as compared to other facilities, and the assurance for employees that when handling the consumer, the risk of slipping and falling, is minimized or eliminated as the employee comes in contact with the floor's surface. Since the bathroom was a frequent location where employees had experienced slipping while assisting consumers with bathing and showering needs, as well as using the toilet and brushing teeth, it was requested that this room be the focal point of this study.

Instrumentation

Many types and designs of slip meters or friction measuring devices have been developed over the years in laboratories, but few devices have actually been field tested, under both wet and dry conditions. The American Slip Meter has been tested in the field under both environments. For this reason, the American Slip Meter, Model ASM 725, was used to determine the static coefficient of friction of the sampled surfaces.

The American Slip Meter Model ASM 725 weighed 4.70 pounds and was designed to quickly test the static coefficient of friction, using widely recognized test sensor materials, Neolite and leather.

Neolite is a registered trademark of Goodyear Tire & Rubber Company used by the footwear industry to make heels. It was composed of an elastomer and a resin and had proven reliable and repeatable over many years in service as a friction pad material for horizontal pull testing. The material characteristics did not change under normal conditions, regardless of wear or moisture. Its traction properties were in the middle range of commonly used shoe-bottom materials.

Leather is an organic material. Each piece could be considered a unique material. It is highly absorbent and highly sensitive to humidity. Once leather is used for wet testing, its properties are permanently altered. Leather can react differently depending on how worn the material has become. Leather is also not representative of heel material. Most heels are of a synthetic compound. Essentially, slips occur more on the rubber heels of leather-soled shoes.

Methods and Procedures

Prepare sensors. Three test sensors of similar material were screwed to the bottom of the metering device. The device, with legs attached, was placed on a piece of 400 grit wet or dry sandpaper and slowly pulled across sandpaper. The slip meter was rotated 90 degrees three more times while the meter was pulled across sand paper. The test sensors were cleaned prior to each sample taken, by sanding and brushing, after each 90 degree rotation to prevent contaminants from accumulating on the sensors.

Reset Gauge. The reset button located on the top end of the gauge was pressed to assure the needle was pointing to just below 0.10 on the dial. If the gauge did not reset properly, the ring was gently pulled until the gauge needle approached 1.00 and the reset button was pressed again.

Calibration. Prior to measurements being taken, the device was calibrated by attaching a hook and calibration chain to the ring at the end of the slip meter. With the hook and chain in place, the gauge was stood vertically and lifted off the floor's surface. The reading was required to be ± 5% of 1.00 for correct calibration.

Operating procedures. The reset button was pressed to tare the gauge. With prepared test sensors or legs attached to the meter, the meter was placed on the floor. The hook and chain was then attached to the ring on the meter. With the chain held taught, and the hand held parallel to the floor surface and in alignment with the meter, steady pressure was applied on the attached chain until the slip meter moved. The reading on the meter was noted. The reset button was pressed and the process was repeated.

Testing under dry conditions. The floor was tested "as is", meaning the floor was not swept prior to taking measurements. Loose dirt and other contaminants in the area were then swept up and the floor was retested. Sample readings were taken in each 90 degree direction for both dry conditions. Each set of four readings were then averaged; the average reading was recorded in the appropriate area on the form (see Appendix A) for both dry situations.

Testing under wet conditions. Bathroom floors often times get wet due to bathing, leaky faucets, and overspray. Therefore, each floor was tested under wet conditions. Using, a small commercial 3M sponge, the floors were wetted down with a mixture of water and detergent. The ratio of water and detergent used in this study was the same ratio that is typically used at this facility. The sponge was submersed in the cleaning solution and then gently squeezed to remove excess water. The wet sponge was applied in a zigzagged motion at a moderate pace to one square foot of sampled floor area.

The meter was not allowed to touch the floor's surface until ready to test since the weight of the meter would displace any moisture beneath the sensors. To maintain consistent recordings on the wet surface, the slip meter was held in one hand, the reset button was pressed, and the hook and chain was attached to the ring on the metering device. With the other hand holding the chain, the meter was finally set on the floor and testing began, making note of the meter reading after each 90 degree rotation. The four readings were then averaged and recorded.

Data Collection

Using the form in Appendix A, the bathroom floors in the three Menomonie sites were visually inspected with respect to the condition of the floors' surface and was recorded as either (1) a dry substance such as dirt or sand was present, (2) moisture potentially caused by fixture leaks, sink or shower overspray, snow, etc, was noticed, (3) wetness due to a cleaning agent was detected, or (4) no obvious contaminants were visible that could lead to slips, trips, or falls. Also noted was the flooring material, the cleaning agent used and frequency of cleaning.

Using Neolite test sensors, sample readings were taken in each 90 degree direction so that a total of four measurements were obtained for one wet and two dry conditions mentioned above. Each set of four readings were averaged and recorded in the appropriate area on the form (see Appendix A). Average readings for each condition were compared to ADA standards. This process was repeated with leather test sensors.

Data Analysis

Average slip meter gauge readings were compared to ADA accepted industry standards for static coefficient of friction. Although a value of 0.5 is the accepted industry standard for nonhazardous walkway surfaces, the Americans with Disabilities Act, 28 CFR Part 36, Section 4.5 requires that ground and floor surfaces along accessible routes be stable, firm, and slip-resistant for persons with disabilities. Consequently, to best protect persons with disabilities, ADA recommended a static coefficient of friction of 0.6 or above for accessible routes.

Incident data as it relates to slip and falls from the previous two and three-quarter years of injury reports were reviewed and compared to the measured coefficient of friction for the respective sites visited.

Limitations

As stated previously in Chapter I, limitations of this study included:

1. A small sample population limiting the precision of the results
2. Assurance that everyone reports injuries
3. That the study is limited to employed caregivers only, not consumers
4. The study does not take into consideration tribology, or other factors that contribute to the cause of slips and falls

Summary

Upon measuring static coefficient of friction of sampled surfaces, understanding Company Y's current floor cleaning practices, and reviewing historical data, enough knowledge was gained to make recommendations for installing new floor surfaces along with improving floor conditions and reducing the incidence of slips and falls at the sites visited.

Chapter IV: Results and Discussion

The purpose of this study was to evaluate floor surfaces that are currently in the homes managed by Company Y, as well as investigate and identify preferred slip-resistant floor surfaces for new homes designed for Company Y and for existing homes considering remodeling. The objectives of this study were to (1) compare coefficient of friction (COF) of measured surfaces to the industry standard, and (2) compare coefficient of friction to Company Y's incidence rates as it relates to slips and falls. The instrument used in this study to measure coefficient of friction was the American Slip Meter.

Background

Company Y assigns a number to identify each facility. Three Menomonie sites selected to participate in this study included: 010, 119, and 074. Coefficient of friction measurements were taken in this order as well. While visiting each site, flooring material, cleaning agent used, and protocol for cleaning was noted on the data collection form (see Figure 1). A visual inspection of each facility's restroom revealed the following:

Community Based Residential Facility (CBRF) 010 had a ceramic tile floor surface. No obvious floor contamination (water, oil, dirt, debris) was visible around the shower, toilet, sink, or entrance to the bathroom. Johnson Wax Professional STRIDE Neutral Cleaner Concentrate # 03904 was used to clean the floor. Once a day, one capful of concentrate was mixed with approximately 2 gallons of water to clean the floor, and again, on an "as needed" basis. To minimize exposure to falling, floor cleaning was conducted after employees performed daily cares for consumers. Because of the acute and chronic needs of the consumer, a roll out shower was necessary. The shower had a slight taper for easier access and removal of consumers in wheelchairs. Rubberized slip-on shoes, Shoes for Crews, were available if employees chose to use them.

The floor in the bathroom at the adult family home, Facility 119, was rolled linoleum. No obvious floor contamination was present at the time testing was performed. The surfactant, Fabuloso Multi-Purpose Cleaner by Colgate-Palmolive, was used to clean the surface of the floor. The cleaning was performed once per day, and "as needed", after daily cares were completed. The ratio, one-fourth cup to one gallon of water was mixed to clean the floor.

The last facility visited was 074. The surface of the floor in this bathroom appeared to be constructed of linoleum tiles. Again, Johnson Wax Professional STRIDE Neutral Cleaner Concentrate # 03904 was used to clean the tiled flooring. The cleaning solution was mixed at a rate of 2 ounces of surfactant per gallon of water. No visible contamination was present; however, other potential hazards, such as reduced lighting and having to step up into the shower could conceivably lead to a trip and fall accident.

Objective 1: Compare Coefficient of Friction (COF) of Measured Surfaces to the Industry Standard

Accepted industry standards as adopted by Underwriters Laboratory (UL) and the American Society of Testing and Materials (ASTM) has traditionally recognized 0.5 COF or above for providing nonhazardous walkway surfaces. American Disabilities Act (ADA) recommends 0.6 or above for walkways and 0.8 for ramps.

Using the methodology established in Chapter 3, each of the three specified Menomonie locations was tested to determine the coefficient of friction on the sampled floor surface. The results were as follows:

Results. Facility 010 does not meet industry standards using either Neolite or leather (reference Table 1). Neolite's performance on ceramic tile remained relatively stable, regardless of whether conditions were wet or dry. The leather sensors performance improved, and nearly approached the COF of Neolite on wet surfaces.

Table 1: *Average Coefficient of Friction at Facility 010*

Average Coefficient of Friction at Facility 010			
Floor Condition	Neolite	Leather	Comments
"As Is"	.43	.29	Floor: Ceramic Tile
Dry	.43	.28	Surfactant: Johnson Wax
Wet	.46	.44	

Testing the Coefficient of Friction at Facility 119 exceeded ADA industry standards using Neolite, while it approached ADA standards for dry floor conditions and exceeded wet floor conditions when leather sensors were used (reference Table 2).

Table 2: *Average Coefficient of Friction at Facility 119*

Average Coefficient of Friction at Facility 119			
Floor Condition	Neolite	Leather	Comments
"As Is"	.63	.55	Floor: Linoleum, rolled
Dry	.62	.59	Surfactant: Fabuloso
Wet	.67	.65	

Facility 074 exceeds ADA industry standards for wet or dry conditions, regardless of whether Neolite or leather was used for testing (reference Table 3).

Table 3: *Average Coefficient of Friction at Facility 074*

Average Coefficient of Friction at Facility 074			
Floor Condition	Neolite	Leather	Comments
"As Is"	.70	.64	Floor: Linoleum Tile
Dry	.69	.72	Surfactant: Johnson Wax
Wet	.67	1.00	

Discussion. Looking at the results of the study, linoleum proved to offer greater slip resistance, whether walking on dry or wet surfaces when wearing a rubber-based or leather soled shoe.

The Coefficient of Friction was first tested at Facility 010, then 119, and finally, 074. Data shows that the performance of Neolite and leather both improved as testing was advanced from one facility to the next. Though COF improved while moving from Facility 119 to 074, there was a more noticeable improvement in leather than in Neolite.

Objective 2: Compare coefficient of Friction to Company Y's Incidence Rates as it Relates to Slips and Falls

During the period of January 2006 through the first 3 quarters of 2008, Company Y had incurred a total of 1074 incidences. Of that, 134 (13%) of these incidences were classified as slips and falls. These slips and falls occurred both inside and outside the

Chapter V: Conclusions and Recommendations

The purpose of this study was to evaluate new and existing floor surfaces for slip resistance in homes owned and managed by Company Y. The goals were to make recommendations on types of floor surfaces to install in future homes built for Company Y and for the possible remodeling of existing homes, as well as make recommendations necessary to help prevent slips and fall at Company Y. The methodology used to obtain the needed information was to compare the coefficient of friction of measured surfaces to the standard and then compare the coefficient of friction to Company Y's incidence rates as it relates to slips and falls.

The American Slip Meter was used to measure the coefficient of friction on bathroom floor surfaces at three Menomonie sites. The results of the first site visited, Facility 010, showed average COF on ceramic tile did not meet ADA standards of 0.6 COF using either Neolite or leather as a test sensor. The COF did, however, improve once both sensor materials were moistened. Testing the COF at the next site, Facility 119, where rolled linoleum floor was used revealed that Neolite exceeded the standard when dry and improved slightly with moisture; leather, however, approached the ADA standard but did not exceed it until moisture was applied. The final surface, linoleum tile at Facility 074, exceeded ADA standards for wet and dry floor conditions, regardless of whether Neolite or leather test sensors were used.

Company Y had 1074 incidences during the test period, with 134 (13%) classified as slips and falls. Four slip and falls were cited as having taken place at Facility 010, while none were cited at Facilities 119 or 074. One of these falls was a result of tripping, the other three were weather-related slips. Two of the four falls required medical attention. None of the falls occurred in the bathroom where slip resistance was investigated.

Conclusions

Following are conclusions that were drawn from the data presented in Chapter IV of this study:

- Freshly used test sensors at site 010 demonstrated that the coefficient of friction was not sufficient to protect employees and consumers from slips and falls.
- The same test sensors were used for subsequent COF measurements.
- As testing advanced from one facility to the next, the COF continued to improve and eventually exceeded the 0.6 ADA standards.
- Leather made the most significant change.
- As mentioned in Chapter III, leather is highly absorbent and its properties are permanently altered when wet.
- The performance of leather also responds differently depending upon how worn the leather is.
- Accuracy of the results of this study is questionable. Further testing is necessary to support the findings of this study.

Recommendations

The following are recommendations which should be considered in order to minimize exposure to slip and fall injuries:

- Delineate where an incident occurred so that corrective action can be taken. Detailed injury logs are important from a general liability standpoint. The value of them will prove invaluable in the event that a claim is litigated and needed to be defended.

- Continue to mop floors during low traffic hours. Mop half of the room at a time to leave a pathway for walking, if necessary. Use barriers and "wet floor" warning signs.

- Depending upon the circumstance, floor blowers may be helping in speeding up the dry time for wet floor surfaces.

- Employees should wear different shoes for work than they do for walking to work.

- Change flooring at Facility 010 in order to facilitate proper coefficient of friction to prevent future slips, trips and falls.

Areas of Further Research

Areas of further research developed from this study are as follows:

- If this study was to be repeated, it is suggested that new and dry Neolite and leather test sensors be used to test COF for each floor surface sampled, under both dry and wet conditions in order to obtain more accurate results.

- Conduct another study to evaluate flooring materials. Expand the sample size and consider other factors such as: tasks performed, footwear, flooring surface, floor cleaning treatments, and lighting conditions.

- Further investigate the use of current floor cleaning products and maintenance. The interaction of cleaning agents and flooring surface affect COF. Insufficient dilution of cleaning compounds, use of inappropriate detergents or floor finishing compounds, inadequate rinsing, hard-water scum, and settled or tracked-in dirt can destroy a floor's slip resistance.

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Wis. Admin. Code [HFS] § 83 (2007)

Wis. Admin. Code [HFS] § 88 (2007)

Appendix A: Data Collection Form

Date & Time: ______________________________

Address: ______________________________

Floor Material: ______________________________

Surfactant Used: ______________________________

Cleaning Procedure: ______________________________

Frequency of cleaning: ______________________________

Visual Inspect of floor surface:

1. Dirt & sand present
2. moisture due to leaks, oversprays, etc
3. wet due to cleaning agent
4. no obvious contamination visible

Other hazards present- lighting, ramp, obstacles, etc: ______________________________

____

Existing - with Neolite

Direction	COF
↓	
→	
↑	
←	
Average	

Existing - with Leather

Direction	COF
↓	
→	
↑	
←	
Average	

Dry -Sweep only - use Neolite

Direction	COF
↓	
→	
↑	
←	
Average	

Dry -Sweep only – use Leather

Direction	
↓	
→	
↑	
←	
Average	

Wet Condition - use Neolite

Direction	COF
↓	
→	
↑	
←	
Average	

Wet Condition - use Leather

Direction	
↓	
→	
↑	
←	
Average	

Appendix B

Incident Record Between January 1, 2006 to October 1, 2008 of Sites Measured for Slip Resistance

Operation	DOI	Cause	Type of Injury	Injury Description	Body -Part	Sub-mitted
10	7/6/2007	Slips/Falls	Scrape/bruise	Staff was attempting to run after a consumer in a wheelchair when she tripped and fell - medical attention sought	Right knee	Yes
10	9/18/2007	Slips/Falls	Scrape/bruise	Staff's shoes were wet due to the weather and she slipped and fell on garage floor - no medical attention sought	Left Hip	No
10	2/25/2008	Slips/Falls	Sprain/strain	Staff was dropping off timesheet at Menomonie office - slipped on ice and fell - medical attention sought	Left wrist	Yes
10	3/17/2008	Slips/Falls	Scrape/bruise	Just starting shift - walking on the sidewalk to operation - fell on ice hurting left arm - no medical attention sought	Left arm	No