

Smart Safety Design to Prevent Slips, Trips and Falls

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.



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Safety affects everyone and is an integral component to the operations of any corporation. Safety affects not only the way employees and customers view a company, but also worker productivity, efficiency and the quality of workmanship employees provide, all of which directly affect sales. Slips, trips and falls have proved to be leading causes of workplace injuries. Floors, walkways and ground surfaces are shown to be the main areas where these accidents occur. Days away from work, litigation, and worker's compensation caused by slips, trips and falls cost companies billions of dollars each year.

Defining Slips, Trips and Falls

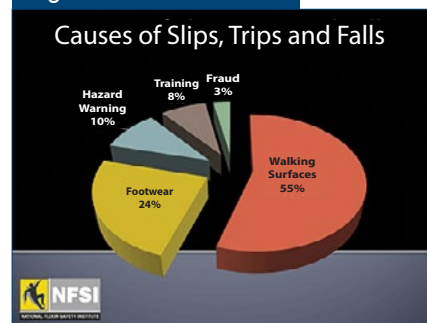
Falls may occur when a person loses their balance, slips or trips. There are two types of falls: same-level falls and falls from elevation. Statistics from the Canadian Centre for Occupational Health and Safety show that the majority of falls (60%) result from slips and trips on the same level. The remaining 40% are falls to a lower level, which

can include stairs, ladders and platforms.¹ Slips happen when a person's shoe slides across a walking surface due to insufficient traction. Causes of slips include low friction (a static coefficient of friction (SCOF) that is less than 0.4), slippery substances, inadequate footwear and flooring that has different degrees of traction in all areas. Trips occur when a person's foot comes in contact with an object or uneven surface, causing imbalance. Trips are caused by uneven or damaged flooring, unexpected increases in friction, objects and/or an obstructed view. As shown in Fig. 1, according to the National Floor Safety Institute, flooring is 55% of the reason for slip-and-fall accidents. The U.S. Bureau of Labor Statistics also reports that floors, walkways and ground surfaces are the largest reasons for occupational injuries and the main reasons for days away from work (as shown in Fig. 2).

Coefficient of Friction

Coefficient of friction (COF) is a measurement most commonly used by regulatory agencies to measure slip resistance. It is the ratio of force causing a body to slide along a plane to the normal force pressing the two surfaces together. There are two types of force: static and kinetic. Static is the ratio of horizontal force needed to start an object sliding to the force pressing an object normal to the surface. In other words, SCOF can prevent an object from sliding down a sloped surface. Kinetic is the ratio of horizontal force needed to keep an object sliding to the force pressing an object normal to the surface. In other words, the

Figure 1



The most common causes of slips, trips and falls according to the National Floor Safety Institute.

Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

resistance felt when pushing a book across a desk.

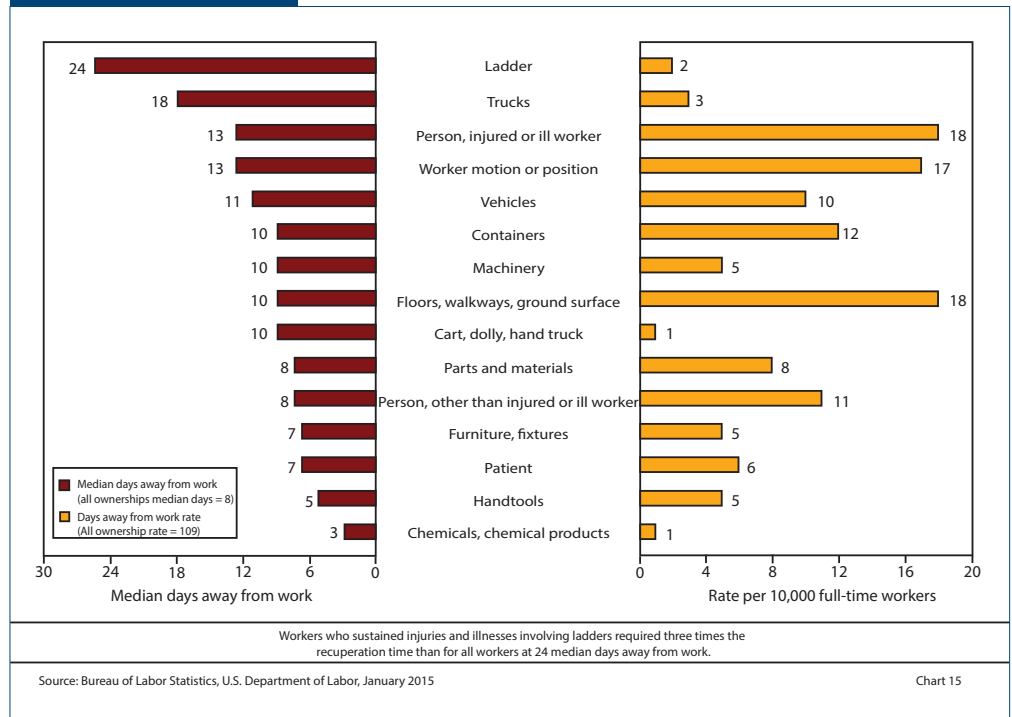
ASTM International

ASTM International is an organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems and services. There are various standards for measuring COF. ASTM 1679 utilizes the English XL (variable incidence tribometer). ASTM E303 measures frictional properties for wet and oily surfaces using the British pendulum tester. ASTM D2047 measures SCOF for dry surfaces by utilizing the James machine. ASTM F1677 uses a portable, inclinable articulated strut slip tester for determining slip resistance of footwear against wet, dry and contaminated conditions. ASTM C1028 covers the measurement of SCOF of surfaces in wet and dry conditions utilizing a neolite sole and a 50-lb. drag sled.

Test Methods and Machines

Machines used to determine COF are the English XL variable incidence tribometer, the British pendulum, the James machine and the Brungraber mark. The English XL uses simultaneous application of vertical and horizontal forces, mimicking a human stepping motion. The British pendulum measures energy loss when the rubber slider is propelled over a test surface. The James machine measures the dry static COF of a shoe's sole and heel materials on controlled walking surfaces. The Brungraber mark, also known as a portable, inclinable articulate strut slip tester, tests the dry SCOF of a shoe's sole and heel materials on controlled walking surfaces. The Brungraber mark, in accordance with ASTM F1677, is the most accurate.

Figure 2



Median days away from work and incidence rate due to injuries and illnesses by source, all ownerships, 2013.

Agencies

There are various agencies that use the COF measurement to set standards and recommendations for slip resistance. The U.S. Occupational Safety and Health Administration (OSHA) makes reference to a 0.5 COF and also states that all stair treads must be reasonably slip-resistant and the nosings shall be of a non-slip finish.² The Americans With Disabilities Act (ADA) states that general floor surfaces and ramps shall be slip-resistant in the standards for accessible design. The act also recommends that flat surfaces have a COF of at least 0.6 and inclined surfaces should have a COF of at least 0.8.³ The National Floor Safety Institute (NFSI) and the American National Standards Institute (ANSI) define high-traction surfaces as those walking surfaces with a wet SCOF greater than 0.6.⁴ Underwriters Laboratories (UL) define slip-resistant surfaces as those that possess a dry (leather) SCOF that is greater than 0.5.⁵

In December 2009, the ANSI/NFSI B101.1-2009 "Test Method for Measuring Wet SCOF of Common Hard Surface Floor Material" was published, establishing the first wet test method. This standard does not simply categorize walkways as safe or unsafe due to its COF value; it divides its traction range into three categories: high traction, moderate traction and low traction. The testing device is a BOT-3000 digital tribometer.

In 2015, OSHA was scheduled to release new rules for “Walking and Working Surfaces” (29 CFR Part 1910). An agency group continues to review and revise the proposed rule.⁶ The new regulation will raise the bar for floor care, safety and inspection. Under the proposed new rules, OSHA will now require that, “Only qualified persons shall be permitted to inspect, maintain or repair walking and working surfaces.” A “qualified person” is defined as one “capable of identifying existing or potential hazards in specific surroundings or working conditions that may be

hazardous or dangerous to employees and has been trained for the specific task assigned.”²

It is clear that, by OSHA mandate, every employer will be required to designate a qualified person to inspect walkways to ensure they are in compliance with the newly referenced ANSI standards, which state that walkways with a wet SCOF of 0.60 or greater or wet dynamic coefficient of friction (DCOF) of 0.42 or greater are defined as “high traction” under the ANSI/NFSI B101.1 and ANSI/NFSI B101.3 standards, respectively.

ASTM tests and testing devices are not referenced and will not be accepted for measuring and identifying SCOF or DCOF.

Figure 3



Locations that may benefit from slip-resistant flooring options.

Costs of Slip-and-Fall Accidents

Exposing the public to unsafe conditions can lead to injury and/or fatality, bad public relations such as negative press, insurance costs such as increased premiums and ratings, liability and litigation, as well as personal trauma to the person and family. Statistics by the Bureau of Labor Statistics (BLS) show the average number of days away from work for a slip-and-fall accident is 28 days.⁷ The National Safety Council (NSC) estimated that slip-and-fall injuries represent more than 65% of all work days lost and the compensation and medical costs associated are approximately US\$70 billion annually.⁸

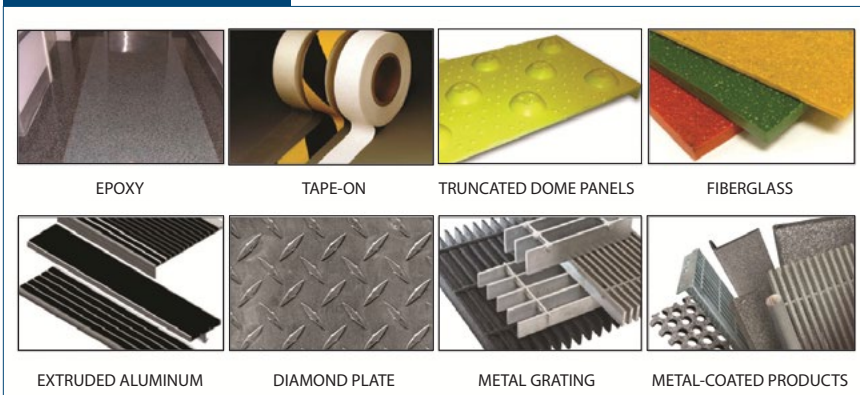
Industries

Slip-and-fall accidents can happen on stairways, ladders, platforms, catwalks, drainage areas, entrance ramps, walkways and many other places. These accidents can occur from ice, oil, wax, grease, cleaning substances, high traffic and lack of visual contrast, among other possibilities.

Any industry will benefit from safe working and walking surfaces, including but not limited to: the utility, municipal, water/wastewater, transportation, food processing, manufacturing, oil and gas, metal and mining, military, commercial and education industries (see Fig. 3).

Specific to the steel industry, pickling and oil areas, coil storage, cold mill operation areas, casting areas, flow lines, crossovers, lift tables and recycling trenches are just a few places where heavy oil is present in mills and anti-skid products are necessary.

Figure 4



Examples of slip-resistant products.

Slip-Resistant Options

There are numerous types of slip-resistant products that can be used for a variety of applications. Factors to consider when choosing a product are the cost, aesthetics, environment, maintenance and operations; lower-cost products can lead to unexpected costs of maintenance or reapplication, while higher initial costs may save money down the road. The product chosen must be able to stand up to the environment and traffic. As shown in Fig. 4, there are many non-slip flooring options available, such as an epoxy (can be applied to many surfaces, but stripping and reapplication is time-consuming), tape-on products (inexpensive but needs to be replaced often), truncated dome panels (not intended for slip resistance but provides high visibility and identification), fiberglass (lightweight but can fracture or splinter), extruded aluminum with aluminum oxide grit (available in a variety of colors but pre-manufactured), diamond plate (cost-effective but slippery when wet depending on the pattern), manufactured metal grating (sharp edges provide initial traction but edges become worn), and slip-resistant metal-coated products (durable and long-lasting but higher initial investment).

Preventive Measures

From the beginning stages of design to daily operations, everyone plays a key role in developing and sustaining safety. Architects and engineers have the ability to incorporate safe walking surfaces into building design. Plant, maintenance and safety managers have the ability to create and enforce guidelines. Safety committees play a large role in keeping a facility safe and a safety plan up to date. Employees have the ability to follow regulations and make safety a priority.

Safety Plan

To create a safety plan, a facility should identify problem areas, consult a safety professional, invite a safety representative to assess problem areas, research options, talk to other companies and develop a plan for correcting problems. Plans should always be compliant with OSHA and ADA recommendations, and training and educational programs for employees should be held. Safety plans should be re-evaluated quarterly or by season. Periodic inspection of work

areas should also be performed. Training that is offered to employees should be documented, and employees should be encouraged to discuss and contribute to safety plans and enforcement. Another way to ensure safety is a top priority within a company is to organize a safety committee, comprised of employees from various rankings and departments. The responsibility of the committee is to review accidents, evaluate safety plans, and provide suggestions and feedback. The objective of a safety committee is to get employees involved and boost morale, as well as get an insider's perspective on workplace hazards and procedures.

Conclusion

Preventive measures are the key to creating and maintaining a safe work environment. Accidents can be prevented. Safety is everyone's responsibility, from the architect who designs a building to the employee working in the application. The cost and time associated with safety prevents higher costs down the road and even more time spent later. An accident not only costs money, but could cost someone's life.

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