PEDESTRIAN
Hidden Hazar
Common Lands

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KEY TAKEAWAYS

- **Sidewalk- and edging-related falls are a major cause of occupational injuries for courier and delivery occupations. According to 2020 estimates, 18,730 couriers and messengers in addition to 334,810 postal service mail carriers are working in the U.S.**
- **Landscape edging has been determined to be the causative factor in many sidewalk fall incidents. The "open and obvious" legal doctrine is often used by both the plaintiff and defense in landscape injury lawsuits.**
- **Lacerations and fracture injuries from falls onto landscape edging are common for humans and pets. The populations with the greatest injury rates from landscape edging contact are the toddler through late teens age range, and the over 65 group.**

LANDSCAPE EDGING HAS CAUSED INJURIES to people from tripping or lacerations due to the sharp edging sometimes protruding from the ground. In some cases, these incidents lead to lawsuits and economic losses when people who come onto a property, whether invited or not, feel they were not appropriately warned or protected from the hazard.

Frederick Law Olmsted, considered the father of U.S. landscape architecture, was known for designing the landscapes of Central Park in New York City and the Biltmore house and its 125,000-acre estate near Asheville, NC. Now, some areas of both Central Park and the Biltmore Estate are edged while other areas have no edging. Even prior to Olmsted's work, gardening practices used edging materials in the 18th and 19th centuries. These edgings were typically constructed using plants such as boxwood or a material such as earthenware, stone, iron or wood (National Gallery of Art, 2021). At Monticello, built between 1767 and 1809, Thomas Jefferson marked the perimeters of garden beds using pieces of brick known as "brick bats" (National Gallery of Art, 2021).

In February 1900, a patent for lawn edging was granted in the U.S. The inventor claimed that the open top gutter was composed of terra-cotta or similar material and adapted to form an edging for lawns. The accompanying patent application drawing showed a lawn on one side and an adjacent path or road on the other side (Payne, 1900). The granting of this patent began a new wave of edging in lawn care and maintenance.

Injuries Due to Landscape Edging

The National Electronic Injury Surveillance System collects injury data from emergency visits across select U.S. hospitals. This database can be accessed to view summary statistics about causes and demographics of certain injuries. As shown in Figure 1, most injuries involving lawn edging occur in children under age 17. There is a record of injured persons over age 62 that spans to age 91, although the frequency of injuries in this age group is much lower than that of the under 17 age group. As shown in Figure 2, fractures and lacerations are the most common types of injuries suffered by patients 65 and older. Of the 110 cases detailed in Figures 1 and 2, 54 (49%) were noted to have involved metal edging (CPSC, 2019).

In a retrospective study, Rittichier and Bassett (2001) reviewed charts of 126 pediatric patients (age 1.5 to 18; median age 9) with injuries caused by metal landscape edging from 1995 to 1997 at three emergency departments in Colorado. The most frequent body parts for these landscape edging injuries were the feet (40%) and the knees (26%). While all injuries occurred from landscape edging, the majority (82%) of the mechanisms of injury were falling from walking or running, and walking or running barefoot. While 80% of the patients were treated with no closure or single-layer closure (skin closure only), the other 20% required double (includes subcutaneous suturing) or triple (includes muscle or fascia suturing) closures, as their injuries were more extensive. Ritticher and Bassett (2001) concluded that "although most injuries are small and receive single-layer closure, some injuries are more serious and require more extensive therapy."

ASTM C1055-20, Standard Guide for Heated System Surface Conditions That Produce Contact Burn Injuries, addresses the temperatures of heated surfaces that produce thermal burns to the skin. The standard notes that if no specific standard is given, the acceptable contact time is 5 seconds for industrial processes and 60 seconds for consumer items. The standard cites Wu (1972), advising that a 1-minute exposure limit be used for design purposes for persons with slow reaction times (e.g., infants, elderly) or for those who "freeze" under severe hazard conditions (i.e., do not react to the burn stimulus).

Based on Wu's findings and the relevance of higher thermal inertia materials, it can be concluded that natural options for landscape edging materials such as wood or natural composites will not be as hot to the touch as higher thermal inertia materials such as steel or aluminum. Thermal inertia is the "tendency of a material to resist changes in temperature" (Presley, 2002). Because they are a source of high thermal inertia and have higher thermal

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conductivities, steel and aluminum will not only heat up faster than other products such as wood, but will also have more heat at the surface (ASTM, 2020).

According to ASTM C1055-20, temperatures between 111 °F (43.9 °C) and 140 °F (60 °C) can cause pain, redness and thermal inactivation of tissue contents, also known as second-degree burns. Dense-graded asphalt and concrete have about the same specific heat of 0.90 kJ/kgK (FHWA, 2021). "Specific heat is the energy needed to raise a unit mass of a substance by one unit of temperature" (FHWA, 2021). Comparatively, the specific heat of aluminum is 0.91 kJ/kgK (Engineering Toolbox, 2003) and that of mild steel is 0.511 kJ/kgK (Engineers Edge, n.d.). With similar specific heat values, aluminum and asphalt can become heated to a temperature that can cause second-degree burns on a hot day. Choosing the appropriate landscape edging could therefore reduce the burn hazard potential.

Lawsuits & Case Law

Legal issues arise as injuries such as those described may involve expensive medical care or long-term treatment. In many of the cases in which an individual has been injured after tripping over landscape edging, both plaintiff and defense have relied upon the "open and obvious" provisions of premise liability law to support their arguments.

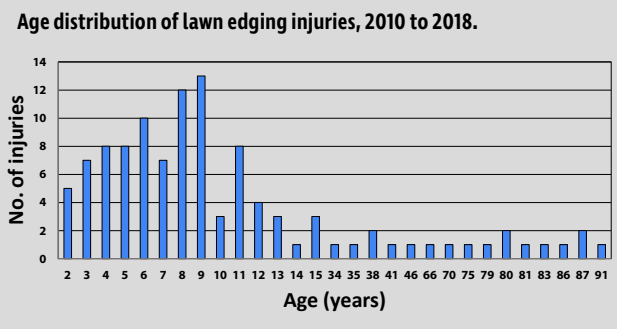
The American Law Institute established guidelines for that are often used by states and courts to interpret premise liability law. According to FindLaw (2017):

> These guidelines specify that a possessor of land is liable for harm caused by a condition on the land if [the person]:
>
> •knows about, or through reasonable care would discover the condition, and should realize that it presents an unreasonable risk of harm;
>
> •should expect that invitees won't discover the danger, or will fail to protect themselves against it; and
>
> •fails to exercise reasonable care to protect the invitees from the danger.

While the American Law Institute is a basis for decisions, the actual laws vary among states for landowner or resident responsibilities. The differentiation between an invitee and a trespasser is often important when specifying individuals that the landowner has a duty to protect. Invitees might be clarified as social, such as guests to a party at a residence, or business, such as patrons entering a restaurant or store. Anyone not invited or expected to be on a property is a trespasser.

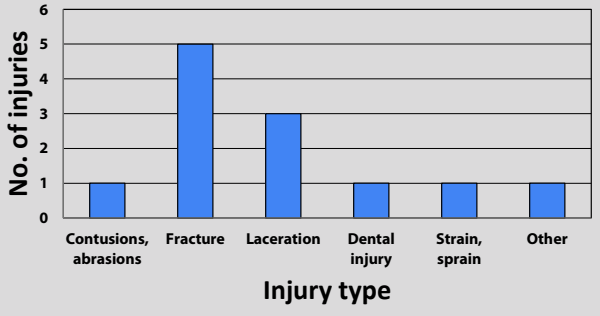
The open and obvious rule states that if a reasonable person with ordinary intelligence could discover the hazard or

FIGURE 1
LAWN EDGING INJURIES, 2010-2018



Note. Data from "NEISS estimates query builder," by U.S. Consumer Product Safety Commission, 2019.

FIGURE 2
LANDSCAPING INJURIES BY TYPE (AGE ≥ 65), 2010-2018



Note. Data from "NEISS estimates query builder," by U.S. Consumer Product Safety Commission, 2019.

condition upon casual inspection, the landowner is either not liable or less liable for not fixing the condition or warning the person injured. In theory, a visitor should be able to recognize open and obvious dangers and in turn protect themselves from harm (Broaddus, 2016; FindLaw, 2017; J.R. Leonard, personal communication, April 5, 2022; P.C. Ridgeway, personal communication, July 28, 2021). Trespassing laws may vary between states and between countries. Therefore, the property owner, property manager and others responsible should ensure that the grounds of a facility are safe for use and consult appropriate legal counsel for additional guidance. For additional information on where the open and obvious legal premise has been used, readers can reference the following cases involving injuries due to tripping or falling over landscape edging: *Pulley v. Rex Hospital*; *Webb v. North Carolina Department of Transportation; Ward v. Shoney Inc.; Held v. North Shore Condo Association;* and *Armentrout v. Myers Garden Center and Landscaping Inc.*

Photo 1 shows edging alleged to have caused a person's fall at the entrance to a nationwide chain restaurant. The sidewalk was designed with a 90° angle for adjoining sidewalk sections and did not include a curve at the junction of the two sidewalk sections, which created a desire path. However, the edging did make a 90° turn to follow the sidewalk (K. Waegerle, personal communication, July 27, 2021). All these ambulatory design issues are discussed in sections that follow.

Occupational Hazards

Segmented by industry sectors from the North American Industrial Classification System, the Occupational Employment and Wage Statistics (OEWS) provides estimates of industry sizes. For industry sectors 48 and 49, transportation and warehousing, the OEWS estimates that 18,730 couriers and messengers, and 334,810 postal service mail carriers were working in the U.S. in 2020. This data was filtered by Standard Occupational Classification title (BLS, 2021). Therefore, at least 353,540 workers have this exposure to sidewalk and landscape edging hazards and risks. Businesses that provide delivery services such as florists, restaurants, and furniture and appliance stores would also be exposed to sidewalk and landscape edging hazards and risks.

Bentley and Haslam (1998) conducted a retrospective analysis of 1,734 fall cases that occurred during the delivery of postal mail between April 1993 and March 1995 in Great Britain. Their analysis revealed that trips involved taking shortcuts, among other causes. This is addressed in this article as the use of desire lines and dog paths. The analysis showed that outdoor falls represent the largest cause of lost time for postal employees and constitute nearly 30% of the reported incidents and more than 35% of days lost. Andersson and Lagerlöf's (1983) analysis on slip and fall incidents revealed that tripping incidents were most often connected with walking surfaces. In Bentley and Haslam's (1998) analysis, respondents reported that taking shortcuts across grass areas or over walls or fences were contributing factors to falls.

Interviews with U.S. postal carriers confirmed that training provided to them made the use of sidewalks mandatory, and prohibited the use of shortcuts (e.g., walking across lawns or vegetated areas), use of ear buds or other auditory-compromising devices, and fingering the mail while working, and promoted maintaining a visual focus on the task (USPS letter carriers, personal communications, July 18, 2021).

A follow-up investigation addressed unsafe behavior and work practices, among other causative factors (Haslam & Bentley, 1999). The study found that taking shortcuts was commonplace and that 26 of the 40 employees interviewed (65%) admitted using this practice during normal working hours. Shortcuts included climbing over walls and walking across grass. Saving time was the most frequent reason given for taking the shortcuts.

Corazza et al. (2016) defined an evaluation index for sidewalk conditions as a

Photo 1 (left): Edging not flush with the walkway that allegedly caused a fall. Photo 2 (below): A sidewalk with major uplift from tree roots.

Photo 3 (above): Example of a beveled sidewalk because of uplift. Photo 4 (right): Campus desire path.

part of an efficient setup similar to those used for road management systems. It was validated as a case study of a residential district in Rome, Italy. The researchers found that the observed behavior patterns included walking with shopping carts (35%), walking with pets (25%) and general strolling (30%). In addition, the majority (about 65%) were jaywalking, detouring from the sidewalk or walking on the roadway. Sidewalk conditions that contributed to this behavior included edge disruption of the asphalt walkway (e.g., caused by tree roots). Photo 2 shows an example of a sidewalk with a major uplift of the concrete caused by tree roots. Where edge displacement has occurred, many municipalities or property owners bevel the adjoining section (Photo 3) so that a ramp is created that is compliant with the slope requirements of the existing building codes.

(Left to right) Photo 5: Concrete addition to eliminate 90° junction. Photo 6: Bent landscape edging due to high pedestrian traffic along desire line.

The Americans with Disabilities Act (ADA) Standards for Accessible Design specify that the beveled slope of edge displacements between 0.25 in. and 0.5 in. must have a minimum slope of 1:2 (U.S. Department of Justice, 2010). Some states such as North Carolina adhere to International Code Council (ICC) codes including A117.1 (2017). Chapter 11 of the North Carolina Building Code (2018) states that "buildings and facilities should be designed and constructed to be accessible in accordance with this code and ICC A117.1." ICC A117.1 (2017) contains a similar provision to the ADA standard, as it states that the maximum vertical level change shall be 0.25 in. and that the beveled slope of edge displacements between 0.25 in. and 0.5 in. should be a minimum slope of 1:2. When vertical displacement has occurred, such as is shown in Photos 2 and 3, it often requires repouring or repaving that section of the walkway.

Slips, trips and falls have been acknowledged as a worldwide hazard. Leamon and Murphy (1995) investigated the incidence of slips and falls from data available from a major insurance company and found that falls from the same level were more common than falls from elevation.

Desire Paths

In many of the cases noted, the plaintiff was following a desire path. Saxena et al. (2020) describe these as "unpaved tracks which are commonly used by pedestrians alongside paved paths wherever they are available." Desire paths create a shorter travel distance, but are unsafe for reasons such as uneven surfaces, potential for insect bites or slippery surfaces in wet weather (Saxena et al., 2020). These paths occur after many people repeatedly walk over a patch of natural landscape. Studies to determine what makes people take desire paths instead of using a sidewalk include the work of German researcher Dirk Helbing, who "discovered a human constant: that travelers will form a desire path if the prescribed route is 20% to 30% longer" (Schorr, 2019). Photo 4 shows an example of a desire path made naturally by students at North Carolina State University.

Some college campuses lay out their campus pathways through a process of allowing students to form the web of desire paths across the campus in an unpaved state, then placing pavement over the desire paths. Some planners start the layout process by predicting where the heavily trafficked areas of the campus will be. As Schorr (2019) explains:

> These pedestrian generators are typically parking locations, including car and moped lots as well as bike racks, metro stops, large lecture halls, student housing population centers, and main entrances and exits to the building. From there, they try to connect these places and trace the likely routes, relying as much on human instinct as comprehensive planning experience.

Photo 5 shows an example of a desire path with no shorter route as well as a markup of where a flare has been added to the sidewalk so that pedestrians are not walking on uneven ground or have debris in their desire path.

A desire line is often created by 90° turn angles as pedestrians cut the corner of the path to create a more desirable path despite obstacles such as landscape edging. They follow the desire line that balances convenience and shortness. In an open area with no landscaping, this desire path may pose less risk to the pedestrian, but falling and tripping risks arise when obstacles are in the desire path. As Photo 6 shows, landscape edging can become deformed over time as people walk over it.

According to Schatz and Sundloff (2017), "Landscape edging is commonly found in transitional landscape areas, often areas receiving a relatively high volume of pedestrian traffic." Many instances have occurred in which landscape edging has caused trips and falls from that high volume of traffic, resulting in serious injuries. Signage can sometimes help minimize the creation and use of dog paths, but that seems to be a temporary fix. A study conducted at a recreational park in the suburbs of Sydney, Australia, compared usage and other parameters of a desire line and a parallel paved concrete path. The desire line and paved path were 80 m (262 ft) and 92 m (302 ft), respectively. The study found that "the use of

FIGURE 3
HEEL STRIKE PHASE

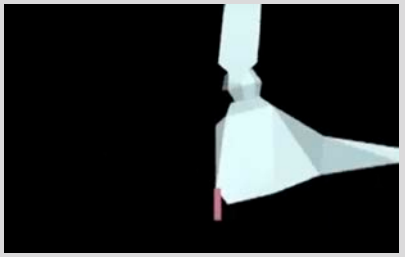
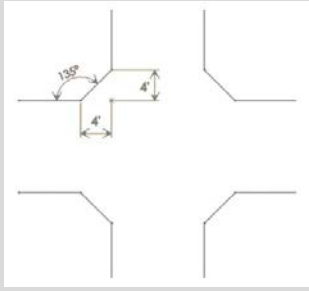


FIGURE 4
SWING PHASE

FIGURE 5
CHAMFERED 90° INTERSECTIONS



desire lines decreased from 44% to 9% after the use of signage but increased 4x as time passed, which shows a persistent disobedience" (Saxena et al., 2020). Additional design steps beyond signage must be taken to protect pedestrians and prevent them from making hazardous desire paths with uneven terrain.

Biomechanical Aspects of Walking

In order to design more pedestrian-friendly walkways, it is critical to recognize the biomechanical components of walking. The components of a walking step include the toe off, swing phase and heel strike where the cycle begins again. To analyze human biomotion regarding foot lift over a 1-in. obstacle (representing landscape edging), a gait analysis animation was created based on the gait of an older person. Using a 3D computer graphics program for making animations (Autodesk 3ds Max), the simulation was built to represent a standard biped with standard female body type padding. Stride length and stride height were obtained from two peer-reviewed sources.

Figures 3 and 4 represent an older adult attempting to walk over 1-in.-high landscape edging. Contact with the edging can be seen in Figure 3 during the heel strike phase of walking. Figure 4 shows the toe striking the edging during the swing phase of walking, indicating that the person could potentially trip over the 1-in.-high landscape edging. This model is based on an average older female adult with anthropometric characteristics for height, maximum foot clearance, walking speed and age.

Similar data and analyses are noted in texts such as *The Work Environment: Occupational Health Fundamentals,* where Hansen (1991) states:

> Slow-motion analysis of the path of a pedestrian foot in transit reveals that the heel of the foot skims across the floor surface as close as 0.25 in., therefore, if the walking surface provides an irregular protrusion of more than 0.25 in., which is not perceived by the pedestrian, a trip hazard exists.

Since the risk of same-level falls increases with age, walkways should be designed to keep the growing population of older citizens safe (Nemire et al., 2016).

As noted, these data are used as a model due to tripping hazards increasing for adults as they age. Grimmer et al. (2019) measured the physical and functional loss caused by aging. This body of work reviewed narrative literature to understand what mobility-related measures are influenced by aging. The findings identified a direct correlation between becoming older and the loss of mobility. Their research found:

- aging and chronic conditions result in wide-ranging losses in physical and sensory capabilities
- there is a need for mobility solutions to secure an independent daily life
- 20% of all daily trips for adults are performed by walking
- there are inevitable physical losses with increasing age or due to mobility impairments (Grimmer et al., 2019)

Sidewalks reduce the strain some may have when walking. Often, however, these are not the fastest or most comfortable routes to a pedestrian's destination and, because of this, many individuals might veer off the path, creating a desire line, to compensate.

90° Turns

Muscle strain can be worsened by having to turn corners sharply while walking, especially for older people. A study was done to measure how 90° turns and spin turns to the right influenced how a pedestrian's gait and speed might change while walking. The study concluded that "turning is likely to cause lateral slip at weight acceptance because of the increased centripetal force (force that must be exerted to move objects in a curved path) compared with straight walking" (Yamaguchi et al., 2017). This poses a risk for anyone who has trouble walking, such as people with disabilities or older people, because they will experience more strain when having to make sharp turns on sidewalks with a 90° turn.

Other than in military units and marching bands, the 90° turn is rarely seen. Therefore, sidewalks laid out in this manner have a section that is often unusable (i.e., the 90° angle formed by two sidewalks). The U.S. Postal Service (USPS, 2018) recognizes and addresses the impossibility of making 90° turns in aisleways. In its Supervisor's Safety Handbook, USPS specifies that all 90° intersections are to be chamfered by 4 ft at a minimum (Figure 5), which results in a 135° angle.

Kurosawa et al. (2020) evaluated the kinematic characteristics of healthy older adults using the timed up and go (TUG) test on 22 younger (ages 20 to 22) and 28 older (ages 65 to 81) healthy adults. The TUG test is a "clinically useful index for understanding the motor characteristics of older adults" (Kurosawa et al., 2020). Their results show that older adults require a longer time ratio to complete a walking task that required them to return to their point of origin. They also found that the trajectory for older adults was longer than that for younger adults, and that older adults' inclination angles during the turn was longer than that of younger adults. The study found that older adults had a longer trajectory during the turn subtask than younger adults that was significant at the $p < 0.001$ level and that the body level inclination of older adults (11.5° ± 3.2) was smaller than that of younger adults (15.3° ± 3.7), which was also significant at the $p < 0.001$ level of significance (Kurosawa et al., 2020). This shows that it is more difficult for older adults to make sharper turns and that 90° junction sidewalks are not as easy to navigate. Knowing that older adults make wide turns, it can be concluded that they might cut the corner to achieve a smaller radius of curvature for the turn and thus create a desire line.

In the same way that cars cannot make exact 90° turns (leading to local regulatory requirements mandating intersections of some roads and corners to be curved), humans struggle to make exact right turns. Desire lines demonstrate that people would rather walk in a curved path around a corner as opposed to completing a 90° turn that the layout of many sidewalks would require. Beyond desire lines, the data presented show that biomechanically, turning exact 90° angles causes strain on the human body. Because cars cannot make 90° turns, driveways and street corners are rounded to provide easier access and avoid cars running over curbs (Photo 7). Sharp turns such as corners on sidewalks can be curved (Photo 8) to avoid pedestrians walking over the inside edge and potentially tripping on any uneven surfaces or landscape edging.

Proposed & Existing National Standards

As of July 2021, no U.S. standards specifically address landscape edging, including its placement or height. Some standards apply to protrusions in walkways or include more general statements for pedestrian paths. ASTM F1637-95, Section 4.2, Walkway Changes in Level, states that changes in walkway levels of less than 0.25 in. (6 mm) in height may be without edge treatment. This indicates that any vertical displacement of the sidewalk that is more than 0.25 in. is not permissible. ASTM F1637-13, Section 5.7, Exterior Walkways, states that "Exterior walkways should be maintained so as to provide safe walking conditions" and "should be repaired or replaced where there is an abrupt variation in elevation between surfaces." Many areas in which landscape edging are risks are adjacent to the walkway instead of the walkway itself, making these standards inapplicable.

ASTM F1646-16 defines a foreseeable pedestrian path to be "any place where a pedestrian could reasonably be expected to walk." Based on the literature on desire lines, particularly with respect to 90° corners, this foreseeable pedestrian path might include the same property owner liability as other walkways. Therefore, the terrain of that path should reflect the same standards for vertical displacements in walkways (e.g., ASTM F1637-95) for landscape edging and other tripping hazards.

In a report containing recommendations for development of guidelines for newly constructed or altered pedestrian facilities, the Public Rights-of-Way Access Advisory Committee of the U.S. Access Board proposed Standard X02.1.11.1 discussing edge protection in conjunction with public sidewalks. Section B notes that "edge protection adjacent to public sidewalks containing pedestrian access routes is desirable in many instances because persons with disabilities often have limited agility and therefore have difficulty recovering if they encounter an uneven or potentially hazardous edge condition" (Barlow et al., 2001). The committee also addresses the need for safe boundaries along public sidewalks. The report notes that a level landscaped space "provides a discernible edge" for someone walking on the sidewalk. However, it further notes that a landscaping space that is not level with the sidewalk poses a hazard that warrants consideration of other edge protection. This proposed standard was not officially adopted in the draft guidelines released by the U.S. Access Board, but the consideration of using edge protection in scenarios with nonlevel landscaping surfaces is significant.

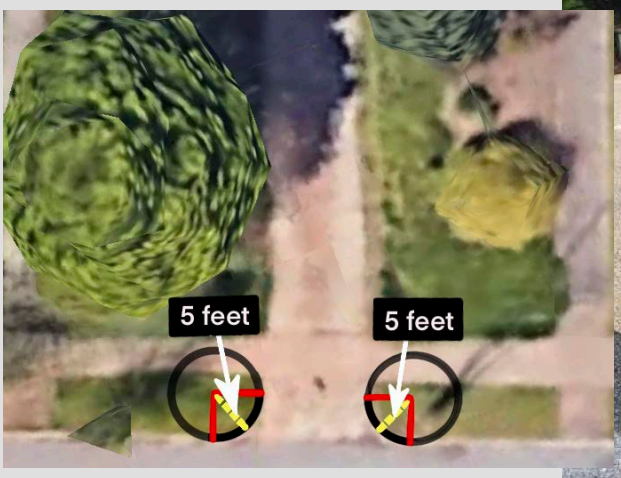


Photo 7 (above): Driveway radius of curvature with 10-ft diameter. Photo 8 (right): No edging along driveway.

When examining accessibility guidelines for pedestrian facilities, the Architectural and Transportation Barriers Compliance Board (2011) noted that:

> A "path of travel" includes a continuous, unobstructed way of pedestrian passage by means of which the altered area may be approached, entered, and exited, and which connects the altered area with an exterior approach (including sidewalks, streets and parking areas).

Landscape edging in an area that could be passed through when approaching or exiting an area might therefore be included, especially in legal challenges.

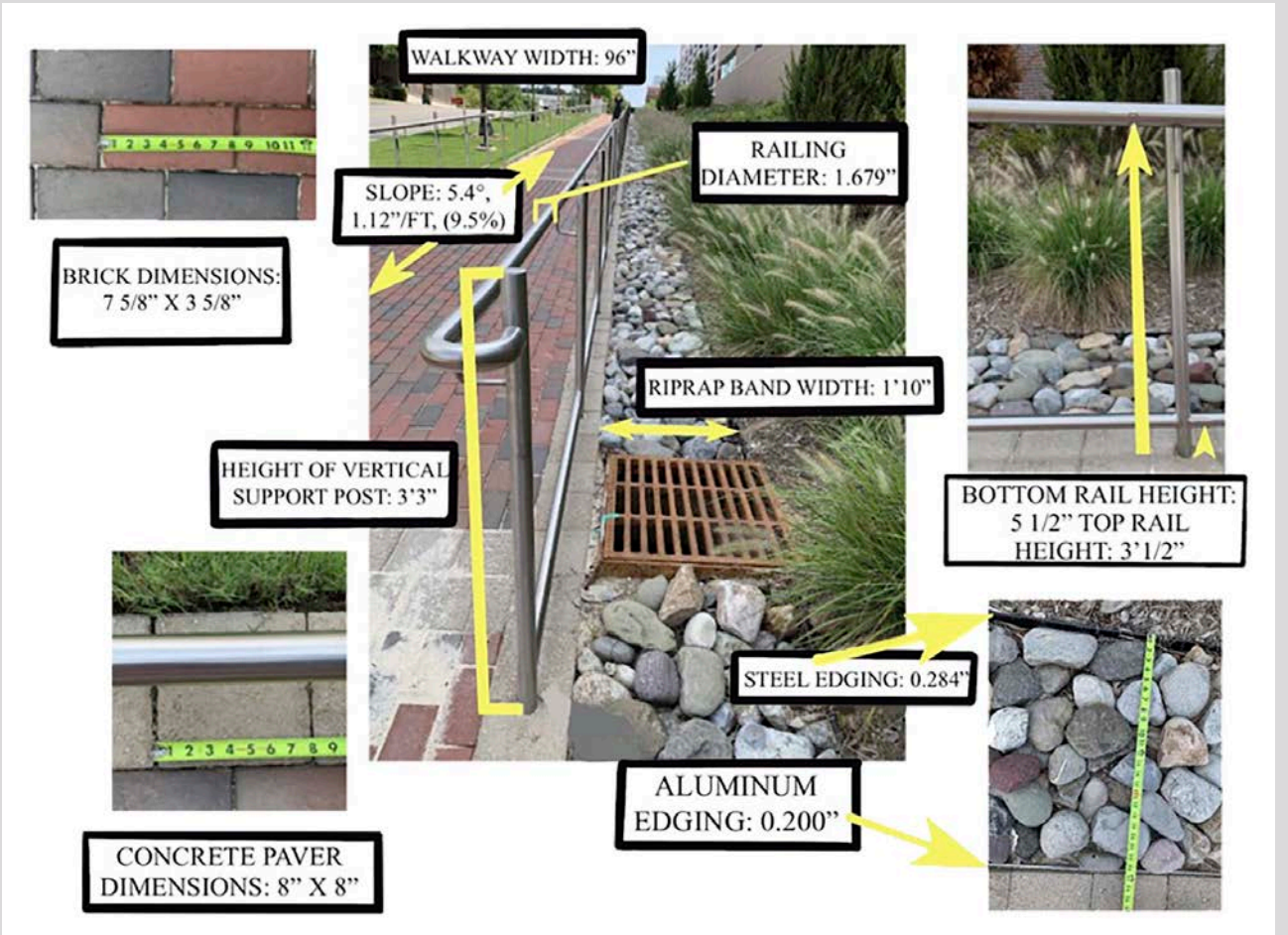
In the same way that vertical displacements on sidewalks are a tripping hazard, they also pose a challenge for those in wheelchairs or other wheeled mobility devices. They must "expend extra energy or effort that makes it more difficult for them to use the walking surface, and the resulting surface vibration can cause discomfort or pain that may prevent them from using the walking surface all together" (ATBCB, 2011). Landscape edging around desire lines, particularly corners, could cause the same difficulties as the edging is a vertical displacement that would impede the movement of the wheeled mobility device.

Edging & No Edging Choices

Permanent landscape edging comes in various materials depending on the purpose and style that the landscaper, builder/contractor or property owner desires. Steel, aluminum, plastic, wood, concrete, brick, natural stone and composites are frequently used. The strips of edging are staked at regular intervals and most of them can bend and contour with the lines of a walkway or vegetated bed. Steel and aluminum are popular due to their durability. Steel is often used because it is a strong, stiffer and long-lasting material. Aluminum weighs less and is more resistant to corrosion than steel. Plastic is a lighter-weight option but is more difficult to install and maintain. Other options may be more attractive and naturalistic but some, such as wood, are not as durable as the steel, aluminum or plastic options (PLANET & Associated Landscape Contractors of Colorado, 2011).

Landscape edging suppliers carry rubber-edge trim guards that can be placed along the top of metal edging to protect people from laceration, contusion and burn risks. Most are made of rubber or other pliable substances with a U-shape channel that slides over the top of the edging. These devices are an additional cost but protect people, especially children and pets, from the sharp top of the

FIGURE 6
WALKWAY OUTSIDE AT NORTH CAROLINA STATE UNIVERSITY



metal. While this reduces the risk of lacerations, contusions and burns, the tripping hazard is still present if the edging is not flush with the surfaces that abut both sides (Edge Right, n.d.).

The edging can also be installed flush with the surface of a walkway, as with the aluminum edging shown in Figure 6. According to Professional Landcare Network and Associated Landscape Contractors of Colorado (2011):

> Edging should be installed so that it is even with the top of the sod on one side and with the top of the decorative material on the opposite side. This will contain material while allowing a mower to pass over it. Edging that is not flush with surface materials can be a tripping hazard and can damage mowers.

Opting for no permanent edging for the lawn or landscaped area is an option. However, this option can require more maintenance (Gilmer & Schmidt, 2016).

Figure 6 shows an exemplary model of a pedestrian walkway adjacent to a vehicle roadway on a college campus. Elements used in the design include brick pavers and concrete block edging to create a 96-in.-wide walkway that allows for two wheelchairs to pass. An aluminum railing system is also used to provide edge protection from the riprap bed separating the walkway from the abutting mulch and flower bed. The riprap is held in place using aluminum edging flush with the walkway as well as thicker steel edging against the mulch bed to keep rocks and mulch in place. The use of railing to guard from hazardous walking conditions beside the walkway in addition to edging flush with the brick pavers eliminates a tripping or falling risk to pedestrians who might veer off the walkway. The layout and dimensions of these elements are shown in Figure 6.

Conclusions & Recommendations

Property owners, design engineers, landscape architects and property maintenance personnel among others should be cognizant of the risks associated with landscape edging to both humans and pets. Where desire lines are found on properties, the appropriate personnel should attempt to provide a transit area that embraces the desire line. A radius of curvature should be employed at the junction of two sidewalks to eliminate 90° angles and an extremely difficult turn for many segments of the walking population. Edging, where installed, should be maintained no greater than the height of the surfaces on both sides of the edging and of an appropriate material for the environment for which it has been chosen. Property owners and business managers should provide training to their staff that addresses safe walking practices and establish maintenance protocols for sidewalk and landscaping edging. Edging is one component of a landscape system, typically associated with transit paths and decorative beds. All components of that system should be designed and maintained in accordance with existing standards. **PSJ**

References

Anderson, M. (2021, March 23). Lawn edging: What is it? Why is it so important? Alaska Premier Services. https://bit.ly/3tJA2FG

Anderson, V., Afanuh, S. & Bell, J. (2012). Preventing slips, trips and falls in wholesale and retail trade establishments. NIOSH. https://doi.org/10.26616/nioshpub2013100

Andersson, R. & Lagerlöf, E. (1983). Accident data in the new Swedish information system on occupational injuries. *Ergonomics, 26*(1), 33-42. https://doi.org/10.1080/00140138308963310

Architectural and Transportation Barriers Compliance Board (ATBCB). (2011, July 26). Accessibility guidelines for pedestrian facilities in the public right-of-way (36 CFR 1190). *Federal Register*. https://bit.ly/3x0E4dE

ASTM International (ASTM). (1995). Standard practice for safe walking surfaces (ASTM F1637-95). https://bit.ly/3Q1w9ph

ASTM. (2013). Standard practice for safe walking surfaces (ASTM F1637-13). https://bit.ly/3x4Bx24

ASTM. (2016). Standard practice for safe walking surfaces (ASTM F1646-16). https://bit.ly/390bwcs

ASTM. (2019). Standard practice for safe walking surfaces (ASTM F1637-19). www.astm.org/f1637-19.html

ASTM. (2020). Standard guide for heated system surface conditions that produce contact burn injuries (ASTM C1055-20). www.astm.org/c1055-20.html

Barlow, J., Cannon, P., Dawson, D., D'Lil, H.L., Kozisek, L., Hilberry, G., Hilberry, E., Markesino, J., Nagel, C., O'Connor, M., Ryan, D., Vanderslice, E., Wai, F. & Wales, M. (Eds.). (2001). Public Rights-of-Way Access Advisory Committee final report, part III: Recommended standards, scoping and technical provisions. U.S. Architectural and Transportation Barriers Compliance Board. https://bit.ly/3aGgrzB

Bentley, T.A. & Haslam, R.A. (2010). Slip, trip and fall accidents occurring during the delivery of mail. *Ergonomics, 41*(12), 1859-1872. https://doi.org/10.1080/001401398186027

Bjorkstrand, D. (2018, July 30). Landscape edging benefits and best practices for homeowners. Parade of Homes. https://bit.ly/3mdJDAl

Bramley, E.V. (2018, Oct. 5). Desire paths: The illicit trails that defy the urban planners. *The Guardian*. https://bit.ly/3taM9Lx

Broaddus, D.W. (2016, March 3). Living on the edge: Court of appeals divided over whether landscaping edging is open and obvious. Secrest Wardle. https://bit.ly/3tgrA0x

Corazza, M.V., Di Mascio, P. & Moretti, L. (2016). Managing sidewalk pavement maintenance: A case study to increase pedestrian safety. *Journal of Traffic and Transportation Engineering, 3*(3), 203-314. https://doi.org/10.1016/j.jtte.2016.04.001

Dadashi, F., Mariani, B., Rochat, S., Büla, C., Santos-Eggimann, B. & Aminian, K. (2013). Gait and foot clearance parameters obtained using shoe-worn inertial sensors in a large-population sample of older adults. *Sensors, 14*(1), 443-457. https://doi.org/10.3390/s140100443

Davis, R. (2005). Fall's faller's fault. The Law. https://bit.ly/3Ooy5qb

Diffrient, N., Tilley, A.R. & Bardagjy, J. (1974). *Humanscale 1/2/3.* MIT Press.

Duffy, A.L. & Hackett, T.B. (2010). Canine pedal injury resulting from metal landscape edging. *Journal of Veterinary Emergency and Critical Care, 20*(5), 533-536. https://doi.org/10.1111/j.1476-4431.2010.00577.x

Edge Right. (n.d.). Protective edge guard: 22 feet long. https://bit.ly/3PY9cmO

Engineering Toolbox. (2003). Specific heat of some metals. https://bit.ly/3NhXba9

Engineers Edge. (n.d.). Specific heat capacity of metals table chart. https://bit.ly/3MgUvrX

Federal Highway Administration (FHWA). (2021, May 27). Pavement thermal performance and contribution to urban and global climate. https://bit.ly/3xBGBwh

FindLaw. (2017, March 30). What is the "open and obvious" defense? https://bit.ly/3MiManF

German, A. (2020, July 5). The heat is on: How hot common outdoor surfaces can get in the summer sun. WHAS-TV. https://bit.ly/3wYIyS4

Gilmer, M. & Schmidt, G. (2016, Aug. 18). Mow strips for edging your yard. Landscaping Network. www.landscapingnetwork.com/lawns/edging.html

Grimmer, M., Riener, R., Walsh, C.J. & Seyfarth, A. (2019). Mobility related physical and functional losses due to aging and disease: A motivation for lower limb exoskeletons. *Journal of NeuroEngineering and Rehabilitation, 16*(1). https://doi.org/10.1186/s12984-018-0458-8

Hansen, D.J. (1991). *The work environment: Occupational health fundamentals, volume 1*. CRC Press.

Haslam, R.A. & Bentley, T.A. (1999). Follow-up investigations of slip, trip and fall accidents among postal delivery workers. *Safety Science, 1,* 33-47. https://doi.org/10.1016/S0925-7535(99)00009-0

Helbing, D., Keltsch, J. & Molnár, P. (1997). Modelling the evolution of human trail systems. *Nature, 388*, 47-50. https://doi.org/10.1038/40353

Held v. North Shore Condo Association, No. 321786 Mich. Ct. App. (2016, Feb. 6). https://casetext.com/case/held-v-n-shore-condo-assn

HomeAdvisor. (n.d.). How much does lawn care cost? https://bit.ly/3xijp6o

Homewyse. (n.d.). Cost to install landscape edging. https://bit.ly/3apLzD9

International Code Council (ICC). (2017). Accessible and usable buildings and facilities (ICC A117.1). https://bit.ly/3MgnVGC

ICC. (2018). North Carolina state building code. https://codes.iccsafe.org/content/NCBC2018

Kurosawa, C., Shimadu, N. & Yamamoto, S. (2020). Where do healthy older adults take more time during the Timed Up and Go test? *Journal of Physical Therapy Science, 32*(10), 663-668. https://doi.org/10.1589/jpts.32.663

Labroad v. McEleney, 2000 Ct. Sup. 5405, Conn. Super. Ct. (2000). https://bit.ly/3GRmnBY

Leamon, T.B. & Murphy, P. (1995). Occupational slips and falls: More than a trivial problem. *Ergonomics, 38*(3), 487-498. https://doi.org/10.1080/00140139508925120

Lowe's. (2020, Dec. 24). Landscape edging ideas. https://low.es/3ObLnXs

Military.com. (2021, April 13). Understanding stationary drill. https://bit.ly/3NVXo2n

National Gallery of Art. (2021, April 6). Edging. https://bit.ly/3x93cPo

Nemire, K., Johnson, D.A. & Vidal, K. (2016). The science behind codes and standards for safe walkways: Changes in level, stairways stair handrails and slip resistance. *Applied Ergonomics, 52*, 309-316. https://doi.org/10.1016/j.apergo.2015.07.021

Payne, W.D. (1900). Gutter (U.S. Patent No. 643,677). U.S. Patent and Trademark Office. https://patents.google.com/patent/US5826372A

Presley, M.A. (2002). What can thermal inertia do for you? *Lunar and Planetary Science, XXXIII*. https://bit.ly/39JOw1r

Professional Landcare Network (PLANET) & Associated Landscape Contractors of Colorado. (2011). Landscape training manual for installation technicians. PLANET.

Pulley v. Rex Hospital, 326 N.C. 701, 392 S.E.2d 380. (1990). https://bit.ly/3xpIcWd

Rittichier, K.K. & Bassett, K.E. (2001). Metal lawn and garden edging: The hidden knife? *Pediatric Emergency Care, 17*(1), 28-31. https://doi.org/10.1097/00006565-200102000-00007

Saxena, N., Hossein Rashidi, T., Babana, J. & Cheung, C. (2020). Pedestrian characteristics that favor desire lines despite closure. *Journal of Urban Planning and Development, 146*(2), 04020016. https://doi.org/10.1061/(asce)up.1943-5444.0000577

Schatz, A.P. & Sundloff, J. (2017). Landscape architecture licensure handbook: Ensuring safe, healthy, and resilient natural and built environments. The American Society of Landscape Architects. https://bit.ly/3xg20uN

Schorr, P. (2019, April 24). Desire paths: The unofficial footpaths that frustrate, captivate campus planners. University of Wisconsin-Madison. https://bit.ly/3xfRFiF

Templer, J.A. (1995). *The staircase: Studies of hazards, falls and safer design*. MIT Press.

U.S. Bureau of Labor Statistics (BLS). (2021). OEWS research estimates by state and industry. www.bls.gov/oes/2020/may/oes_research_estimates.htm

U.S. Department of Justice. (2010). Americans With Disabilities Act Standards for Accessible Design. https://bit.ly/3xkh5dw

U.S. Consumer Product Safety Commission (CPSC). (2019). NEISS estimates query builder. https://bit.ly/3OwZDd7

U.S. Postal Service (USPS). (2018). Handbook EL-801 updated with Postal Bulletin revisions through June 7, 2018. https://bit.ly/3Qcv0vd

Ward v. Shoney Inc., 847 A.2d 367, Del. Super. Ct. 2002. (2002). https://casetext.com/case/ward-v-shoneys-inc

Webb v. North Carolina Department of Transportation, I.C. No. TA-17712, N.C. Ind. Comn. (2005, Oct. 1). https://bit.ly/3xc6umd

Wu, Y. (1972). Material properties criteria for thermal safety. *Journal of Materials, 7*(4), 573-579.

Yamaguchi, T., Suzuki, A. & Hokkirigawa, K. (2017). Required coefficient of friction in the anteroposterior and mediolateral direction during turning at different walking speeds. *PLoS One, 12*(6). https://doi.org/10.1371/journal.pone.0179817

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