Viconic Sporting DBA Viconic Health

Performance Analysis of Vinyl Flooring Systems with and without Viconic Fall Defense™

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Table of Contents

Background

Fall related injuries among the ever-growing North American elderly population are a major health concern. In the United States, nearly 340,000 hip fractures occur per year,[1] more than 90% of which are associated with falls.[2,3] It is estimated this number may double or triple by the middle of the century.[4] The repercussions of hip fracture among the elderly add to the concern surrounding the issue. Over 25% of hip fracture patients over 65 years of age die within 1 year of the injury, and more than 50% suffer major declines in mobility and functional independence.[5,6] Traumatic brain injuries (TBI) also make up a significant portion of fall-related injuries; seniors are hospitalized twice as often as the general population for fall-related TBI.[7] The risk for fall-related TBI increases substantially with age; persons over the age of 85 are hospitalized for fall-related TBI over twice as often as those aged 75-84, and over 6 times as often as those aged 65-74.[8] Despite efforts to reduce falls and risk of fall related injuries, studies show instances of fall related injuries have increased in recent years. A study conducted by the University of Michigan showed a 1.5% annual average increase in Medicare claims due to fall-related injuries from 2016-2019.[9] The COVID-19 pandemic has also put additional strain on the healthcare community which has affected care of the elderly population. According to data submitted to the Centers for Medicare and Medicaid Services Quality Reporting Programs, during the second quarter of 2022, skilled nursing facilities saw rates of falls causing major injury increase by 17.4%.[10] The financial burden associated with fall-related health care is significant and ever rising. As reported by the CDC, medical costs associated with falls are about $50 billion per year, and the financial burden will only increase with the aging population. The number of falls among the older adult population in the US is expected to increase by nearly 45% by the year 2030.[11] Additionally, fall-related injuries continue to be the most common type of professional liability claim faced by skilled nursing facilities. Skilled nursing facilities paid an average of $223,627 for fall related claims in 2021, a 19% increase from 2018.[12] In order to reduce the physical and financial toll of fall related injuries, it is the goal of Viconic to implement un underlayment system that will reduce impact forces and therefore reduce the potential risk of injury associated with fall-related impacts to the flooring surface.

Introduction

Viconic Health is a Michigan-based company that has been applying proprietary automotive and military grade energy absorbing technology to senior living flooring systems. Viconic's goal was to develop a flooring underlayment system that substantially reduces the risk of fall-related injuries while maintaining an individual's mobility, allowing older adults to maintain their health and independence. System cost, durability, thickness, ease of installation, and compatibility with a variety of flexible floor coverings was also a consideration.

Viconic Fall Defense™ is the resultant proprietary product of over five years or product development and collaboration with key stakeholders including: leading research institutions, flooring manufacturers, flooring installers, owner/operators, residents, caregivers, insurers, architects, and governing bodies. Key considerations included balancing injury risk reduction with mobility and stability, ADA accessibility, durability, comfort, and other system level requirements and specifications.

The system is engineered for flexible/resilient floor coverings including commercial sheet goods, luxury vinyl tiles, and carpet. Rigid floor coverings, such as wood, vinyl plank, ceramic tile and other rigid floor covings are not compatible with Viconic Fall Defense™, as point deformation and deflection of the flooring surface is essential for energy absorption. The modular engineered panels are made from resilient military-grade thermoplastics with integrated pressure sensitive adhesive to adhere adjacent panels. Acrylic pressure sensitive adhesives are generally recommended for adhering the floor covering to Viconic Fall Defense™. Subsurface support structures are also available to maintain the integrity of the flooring surface for localized areas expected to experience regular heavy rolling loads or long-term heavy static loading above 75 psi.

The data presented here compares the performance of commercial vinyl sheet with and without the Viconic Fall Defense™ system. All flooring systems were analyzed over a rigid concrete base at room temperature. Six industry accepted test devices were used to quantify the performance of the flooring systems for reduction in risk of TBI or head injury, reduction in risk of body injury, reduction in risk of hip fracture, surface firmness, surface stability, and comfort under foot. Viconic was also evaluated in an acoustics lab to quantify the sound transmission benefits provided by Fall Defense™. This report provides an overview of the test methods, methodologies, results, and analysis. Additional tests outside the scope of this report were also conducted to determine flammability properties, smoke density properties, static load limits, compression and recovery, and airborne sound transmission loss. Details and results of these evaluations can be found in the Appendix.

Methodology, Test Methods, Results, and Analysis Overview

Head Impact Testing – Falls often result in TBI. Performance testing to quantify the risk of TBI was conducted using an ASTM F355 E Missile and a NHTSA FMVSS201u Hybrid III free motion head form (FMH). The impactors have a mass of 4.5 kg and impacted the flooring surfaces at a velocity of 3.4 m/s. This velocity corresponds to a freefall height of 0.6 m and was selected based on relevant clinical fall data.[13] The test devices report a resultant Head Injury Criteria (HIC) and HIC_d for the ASTM head form and Hybrid III FMH, respectively. Lower HIC and HIC_d values indicate a reduction in risk of injury.

Body Impact Testing – Falls often result in injuries to various parts of the body. Performance testing to quantify the risk of body injury was conducted using an ASTM F355 A-Missile, a device commonly used to evaluate safety in sporting surfaces. The cylindrical missile has a mass of 9.1 kg, a diameter of 127 mm and achieves an impact velocity of 3.4 m/s. The device reports the peak G value (GMAX) the device experiences from an impact with the flooring surface. Lower GMAX values indicate a reduction in risk of injury.

Hip Impact Testing - Falls often result in hip fractures. Performance testing to quantify the reduction in risk of hip fracture was conducted at the University of Waterloo per CSA EXP08-17. The mechanical hip impact simulator approximates a 50th percentile older female falling on her hip at 2.8 m/s. The impact is concentrated on the greater trochanter and peak load is measured at the femoral neck where the vast majority of hip fractures occur during a fall. The key output is the percentage of force attenuation at the femoral neck. Higher levels of force attenuation indicate a reduction in the risk of hip fracture.

Mobility/Stability Testing – Flooring surfaces that are too soft may increase the occurrence of falls or restrict mobility. Performance testing to quantify the firmness and stability of surfaces was conducted using the Rotational Penetrometer. The device simulates the loading of a wheelchair caster and measures the depth of penetration before and after a 360° rotation to determine firmness and stability, respectively. Acceptable levels lie below 7.6 mm for a surface to be considered firm and 12.7 mm for a surface to be considered stable.

Surface Comfort Testing – Comfort under foot is of key interest to caregivers and patients. Performance testing to quantify the relative comfort under foot was conducted using the Advanced Artificial Athlete (AAA). The AAA measures both force reduction and energy return compared to concrete surface. The device outputs are percent force reduction (FR) and percent energy restitution (ER) compared to a concrete baseline. Higher force reduction and lower energy restitution are preferred since concrete has 0% force reduction and 100% energy restitution.

Acoustics Testing – Reduction of sound transmission through floors of adjacent rooms is a major consideration during the design and construction of senior living communities. Standard tests involving two test rooms, tapping machines, and microphones were conducted to quantify the sound absorption properties of the Viconic subfloor. These tests output an Impact Insulation Class (IIC), Sound Transmission Class (STC), the improvement in Impact Insulation Class (ΔIIC), and High-Frequency Impact Insulation Class (HIIC).

Head Impact Testing, Description, and Analysis

The abbreviated injury scale (AIS) is the primary tool used by scientists to assess the probability and severity of injury from minor to "maximum" or fatal. Figure 1 shows the AIS injury severity scale for head injuries.

AIS	Severity Code	Fatality Rate
1	Minor	0%
2	Moderate	0.1% - 0.4%
3	Serious	0.8% - 2.1%
4	Severe	7.9% - 10.6%
5	Critical	53.1% - 58.4%
6	Maximum (currently untreatable)	-

Figure 1: AIS Injury Severity Scale

AIS Severity	Injury
1	None
2	Headache, Dizziness
3	Unconscious < 1 hr
4	Unconscious 6-24 hrs
5	Unconscious > 24 hrs

Figure 2: AIS vs Loss of Consciousness

Caregivers often assess AIS severity post trauma by the length of time the victim experiences a loss of consciousness as detailed in Figure 2. AIS Level 1 would be described as moderate concussion without loss of consciousness. Level 5 would be a critical injury resulting in a coma. Level 6 is maximum or fatal.

The severity of head injuries is directly related to the magnitude of the deceleration and the duration of an impact event. Head forms with incorporated accelerometers have been developed to evaluate the deceleration versus duration response for use as a predictive tool in a lab environment. These devices have been correlated to human test subjects and aid scientists in determining the AIS severity during a simulated impact event. The device output is Head Injury Criteria (HIC).

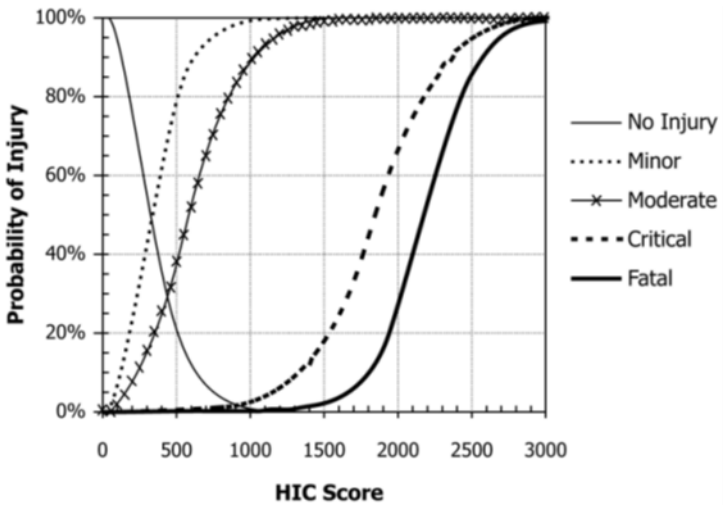

Figure 3: Probability for a Specific Head Injury for a Given HIC

The Society of Automotive Engineers (SAE) uses HIC to correlate the measured HIC from a simulated event to the probability and severity of the type of injury (as detailed in Figure 3) where levels 1, 2, 5 and 6 are shown as minor, moderate, critical, and fatal. The resultant HIC from a test can be used to determine the probability for risk of a specific AIS injury by identifying the y-value of the risk curve at the measured x-value (HIC). For example, a HIC of 1000 represents a 3% probability of critical injury and a 90% risk of moderate injury whereas a HIC of 500 represents less than 0.5% probability of critical injury and only a 40% chance of moderate injury.

ASTM F355E HIC Impact Attenuation

An independent test lab was contracted to evaluate the head impact attenuation properties of Viconic Fall Defense™ using the ASTM F355 E-Missile (Figure 4). This device is commonly used for assessing playground surfaces globally per ASTM F1292. It lacks a human like skin but outputs a worst case (HIC) from a surface impact. The impact mechanism consists of a 10 lb hemispherical aluminum missile equipped with a tri-axial accelerometer that has various fall height capabilities. The HIC value is calculated from an integration of the acceleration-time graph during an impact. Lower HIC values are indicative of lower risk of injury. Furthermore, HIC values under 1000 are desired and required under federal standards. At 1000 HIC there is very high risk of moderate head injury and a 3% chance of critical injury. The probability of critical injury increases exponentially as HIC scores increase above 1000. Figure 5 compares the HIC response of the flooring systems at a drop height of 0.6 m.

Figure 4: ASTM F355 E Missile

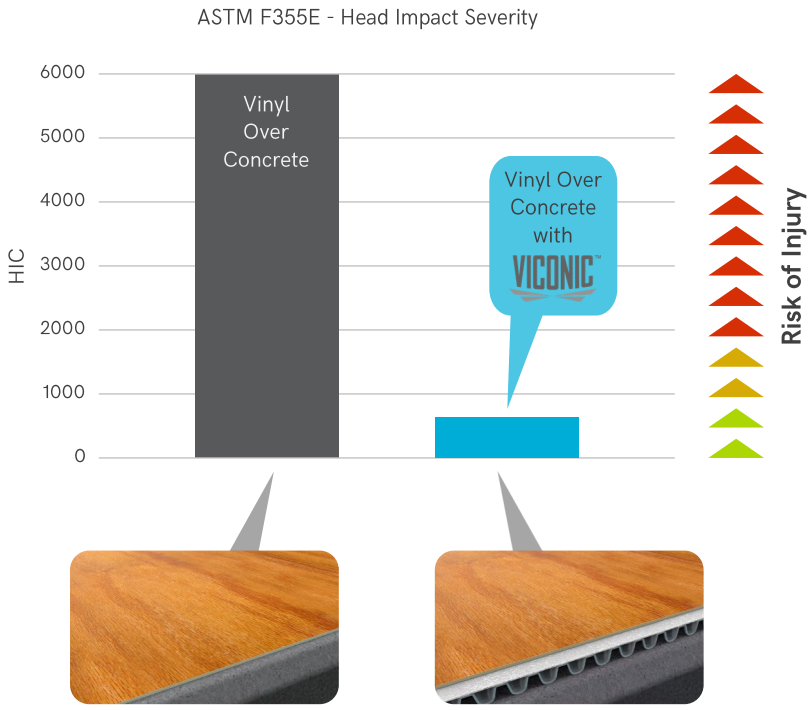

Figure 5: E Missile HIC Results

Analysis - Figure 5 clearly shows that the Viconic system substantially lowers HIC values and reduces the risk of injury compared to the baseline system when tested over concrete. The baseline vinyl system is over 6X the federal HIC limit of 1000, whereas the Viconic Fall Defense™ system under vinyl (626 HIC) is well under the federal limit. The Viconic system clearly demonstrates the potential to substantially reduce the risk of TBI and critical injuries.

Hybrid III HIC_d Impact Attenuation

The FMVSS201u Hybrid III free motion head form (FMH), as shown in Figure 6, is the test device specified by the National Highway Traffic Administration (NHTSA) for determining the risk of head injury inside all passenger vehicles sold in the US. The test device consists of a 4.54 kg (50th percentile male) Hybrid III aluminum head form with human like rubber skin and is equipped with a tri-axial accelerometer. The device output, HIC_d, is similar to HIC but takes into account movement of the neck during impact.

Figure 6: 50th Percentile Male Hybrid III FHM

North American automotive OEMs are required to test their vehicles per FMVSS201u and provide a report showing that all impact points tested within the vehicle upper interior result in HIC_d values less than 1000. Vehicles which do not provide ample protection and fail to meet this test criteria cannot be sold in the US market. Figure 7 compares the HIC_d response of the two flooring constructions.

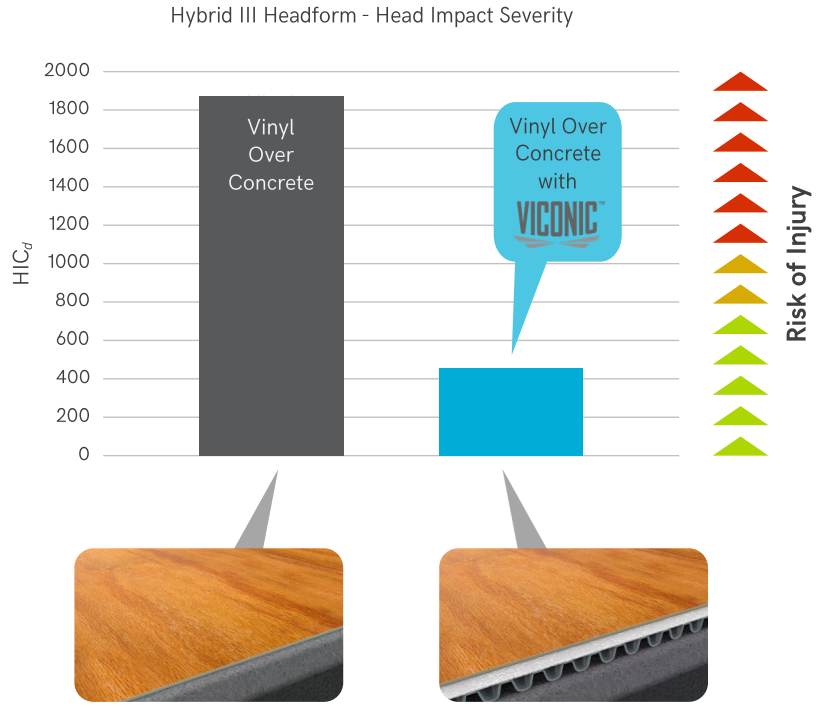

Figure 7: Hybrid III FMH HIC_d Results

Analysis - Figure 7 clearly shows that the Viconic system substantially reduces the risk of injury and lowers HIC compared to the baseline vinyl system over concrete at a 0.6 m drop height. The vinyl system (1875 HIC_d) would present 25% probability of an AIS 5 critical injury and over 95% probability of an AIS 4 moderate injury. Viconic under vinyl (455 HIC_d) represents less than 1% probability of AIS 5 critical injury and only 40% probability of moderate injury. The Viconic system demonstrates a roughly 20-fold reduction in risk of critical and moderate head injury when compared to the baseline system.

Body Impact Testing Description and Analysis

An independent test lab was contracted to evaluate the body impact attenuation properties of Viconic Fall Defense™ using the ASTM F355 A-Missile, which has long been used in North America to gauge the hardness and safety of synthetic turf playing surfaces. The device (as pictured in Figure 8) is a 9.1 kg test missile with a 12 cm flat bottom. The device outputs GMAX, the maximum deceleration experienced during a drop as a multiple of G, the force of gravity. Fields that fail to achieve a GMAX of less than a limit of 200 are deemed unsafe for play. Playing surfaces above this stiffness demonstrate increased risk for bodily injury due to falls onto the surface. Lower values of GMAX during falls are generally considered to present a lower risk of bodily injury. The test protocol requires that the missile be dropped 3 times from a height of 0.61m. The first drop is a conditioning drop; the last two drops are averaged and reported. Figure 9 compares the response of the flooring systems studied here.

Figure 8: ASTM F355 A Missile

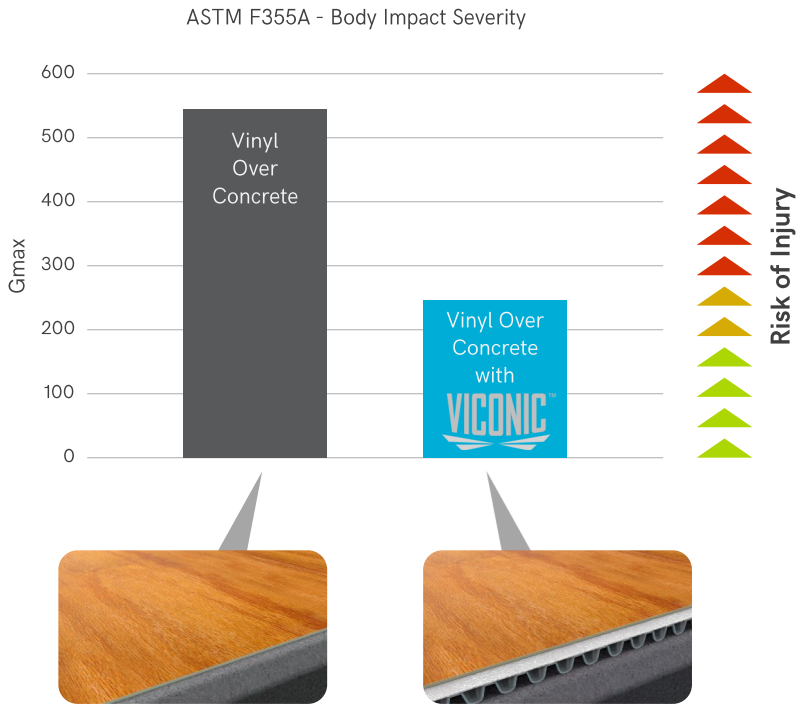

Figure 9: F355 A Missile GMAX Results

Analysis - Figure 9 clearly shows that the Viconic system substantially reduces the risk of body injury compared to the baseline vinyl system (545 GMAX). The Viconic system under vinyl (246 GMAX) had values at roughly the allowable GMAX for synthetic turf playing surfaces. The Viconic system's GMAX values are less than half that of the baseline system and demonstrate the capability of substantially reducing the frequency and severity of body impact injuries, including fractures, when compared to the baseline system.

Hip Impact Testing Description and Analysis

The University of Waterloo Injury Biometrics and Aging Laboratory (IBAL) conducts novel research related to the biomechanics of balance, mobility, falls, and fall related impacts. IBAL was contracted to perform impact testing on Viconic Fall Defense™ using their mechanical hip impact simulator. The baseline vinyl and Viconic systems were tested at an impact velocity 2.8m/s, which is determined as most relevant by IBAL.

The device is comprised of a mechanical surrogate pelvis including a simulated hip bone and surrounding soft tissues that mimic the characteristics of an average older adult female. The pelvis is mounted on a vertical guide track as illustrated in Figure 10 (courtesy of the University of Waterloo). The surrogate pelvis and carriage are dropped onto of the test samples which are attached to a steel force plate to capture ground reaction forces.

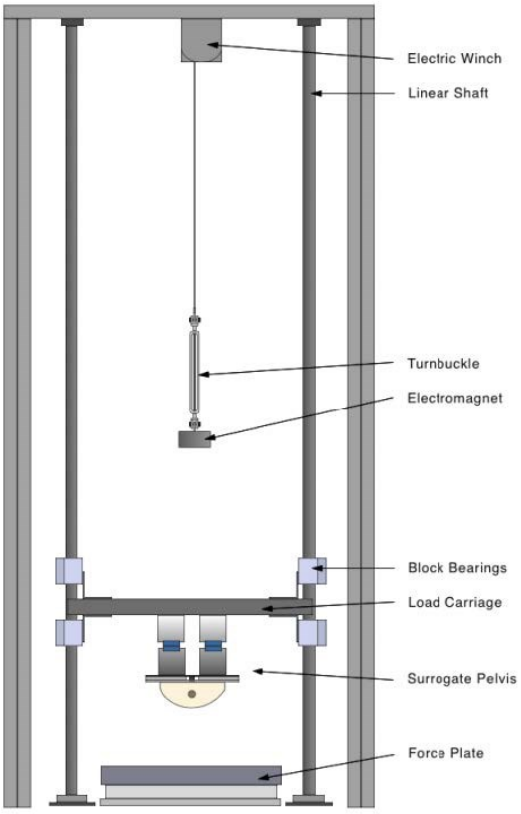

Figure 10: IBAL Mechanical Hip Impact Simulator

The surrogate pelvis is illustrated in Figure 11. It includes a synthetic femur encased in foam and affixed to a load cell at the base of the femoral neck. The load cell is also fixed to a base plate and pelvic springs tuned to match the flexure of an average older female. The load cell captures the forces during an impact on the femoral neck region, the most common location of hip fracture. CSA EXP08-17 details a device that was developed by leading research institutions and calibrated to simulate a 50th percentile female falling on her hip. The CSA test protocol is being used by leading research institutions, including the University of Waterloo, to evaluate wearable padding and safety flooring products to determine the reduction in load on the femoral neck during a fall. This reduces the risk of hip fracture.

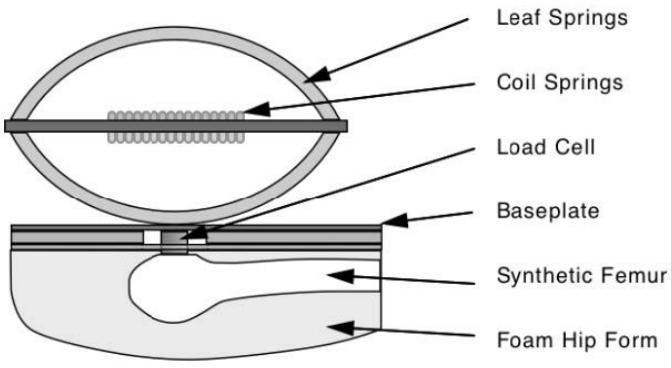

Figure 11: IBAL Surrogate Pelvis

The data outputs from the mechanical hip impact simulator were analyzed by the IBAL at the University of Waterloo. The variable data most relevant to fracture risk is the femoral neck force attenuation percentage. Research shows that reducing the load on the femoral neck during a fall reduces the probability, risk, and severity of hip fractures. Higher levels of force attenuation (FA) reduce the fracture risk. Figure 12 compares the response of vinyl only (Peak Femoral Neck Force of 2251 N and 0% FA) compared to the same vinyl over Viconic (Peak Femoral Neck Force 1843N and 18.2% FA).

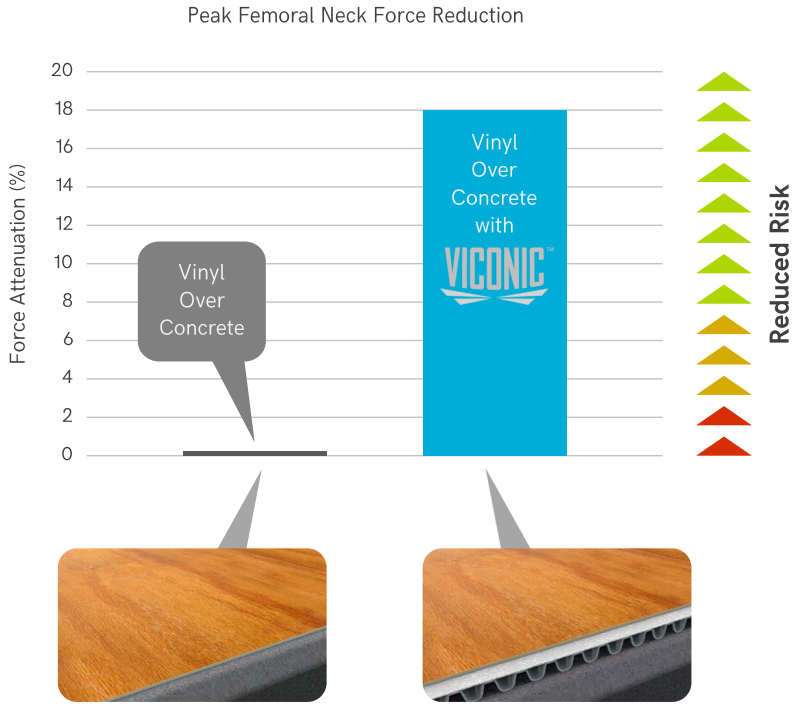

Figure 12: IBAL Surrogate Pelvis Peak Femoral Neck Force Attenuation Percentage Test Results

Analysis - The 18.2% peak femoral neck force attenuation percentage provided by the Viconic Fall Defense™ system is particularly significant because the average hip fracture threshold for older female femurs are in the range of 2000-3000N.[14] A reduction of 18% or 408N is quite substantial given that falls on vinyl baseline(2251 N) are within the neighborhood of the fracture range for the average older female whereas vinyl with Viconic Fall Defense™ (1843N) are below that fracture range.

Recently, a probabilistic model was developed at the University of Waterloo that predicts normalized factor of risk (FOR) of hip fracture based on 100,000 individuals that represents the Canadian older adult population. The subject characteristics that impact the hip fracture FOR for an older individual include bone density, age, mass, and sex.[15] In general terms, the subject FOR generally increases with: decreasing bone density, increasing age, decreasing mass, and if you're a female. The 18.2% force attenuation that Viconic Subflooring provides would translate to an average relative reduction of 55% in the number of hip fractures for males, and an average relative reduction of 21% in the number of hip fractures for females when applied to the probabilistic model. FOR may be higher or lower depending on the individual subject.

Mobility/Stability Testing Description and Analysis

Energy absorbing flooring surfaces may absorb impact energy and reduce risk of injury, but if too soft, can restrict mobility and increase the occurrence of falls. Performance testing to quantify the firmness and stability of surfaces was conducted using the Rotational Penetrometer in Figure 13. The device simulates the loading of a wheelchair caster and measures the depth of penetration statically (firmness) and after a 360° rotation (stability). Deformation must be below 7.6 mm for a surface to be considered firm and 12.7 mm for a surface to be considered stable. Although the addition of an energy absorbing underlayment negatively affected the values for both firmness and stability, all values still fell well within the criteria for a firm and stable flooring surface. Figures 14 and 15 compare the firmness and stability of four flooring systems.

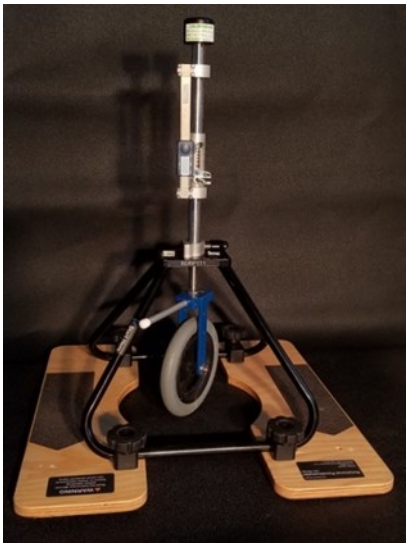

Figure 13: Rotational Penetrometer

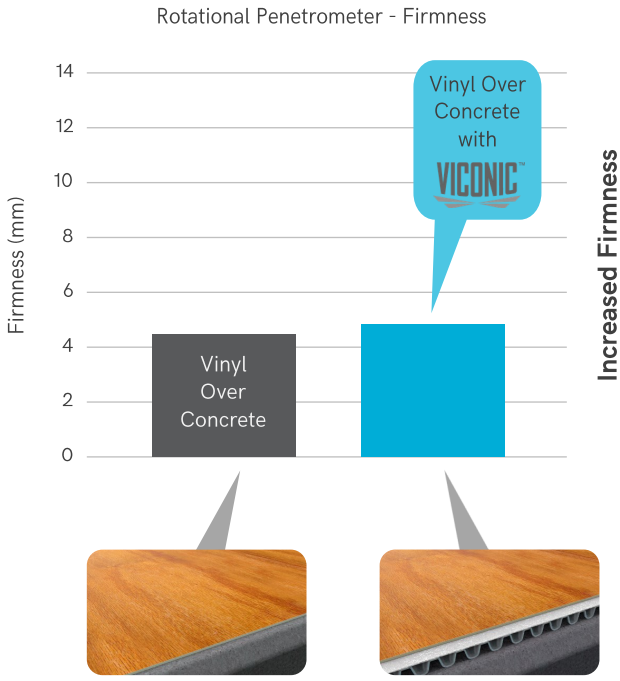

Figure 14: Rotational Penetrometer Firmness

Increased Firmness

Increased Stability

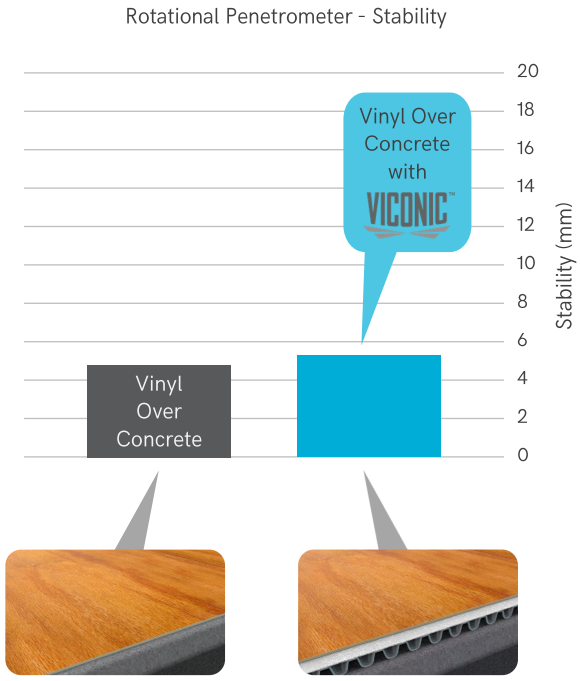

Figure 15: Rotational Penetrometer Stability

Analysis - The data above shows that all flooring systems are below the 7.6mm of deflection required to be considered firm and below the 12.7mm of deflection required to be considered stable.

Surface Comfort Testing, Description, and Analysis

An independent test lab was contracted to evaluate the surface comfort properties of Viconic Fall Defense™ using an Advanced Artificial Athlete. The AAA accurately measures the force reduction (FR) and energy restitution (ER) of flooring and sports surfaces. The AAA as seen in Figure 15 has a drop mechanism with an incorporated accelerometer and a spring designed to mimic a human footfall. The AAA registers acceleration as a function of time throughout interaction with the flooring surface. Three drops are completed in a test series. The first drop is a condition drop, and the average FR and ER of the 2nd and 3rd drops are measured and reported.

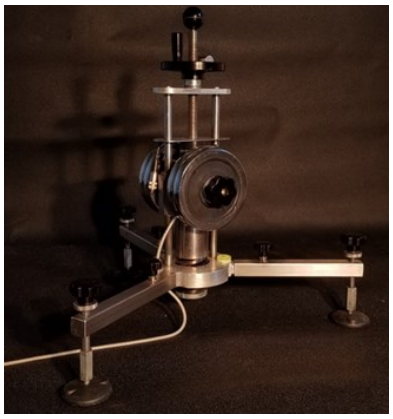

Figure 16: Advanced Artificial Athlete

Force Reduction - The percentage of force reduction (FR) is a relative comparison between the flooring surface and bare concrete. Concrete has 0% force reduction, meaning all the force of the footfall is absorbed by the body. Higher levels of force reductions from flooring surfaces lend to greater comfort under foot. Figure 17 compares the force reduction properties of the two flooring systems.

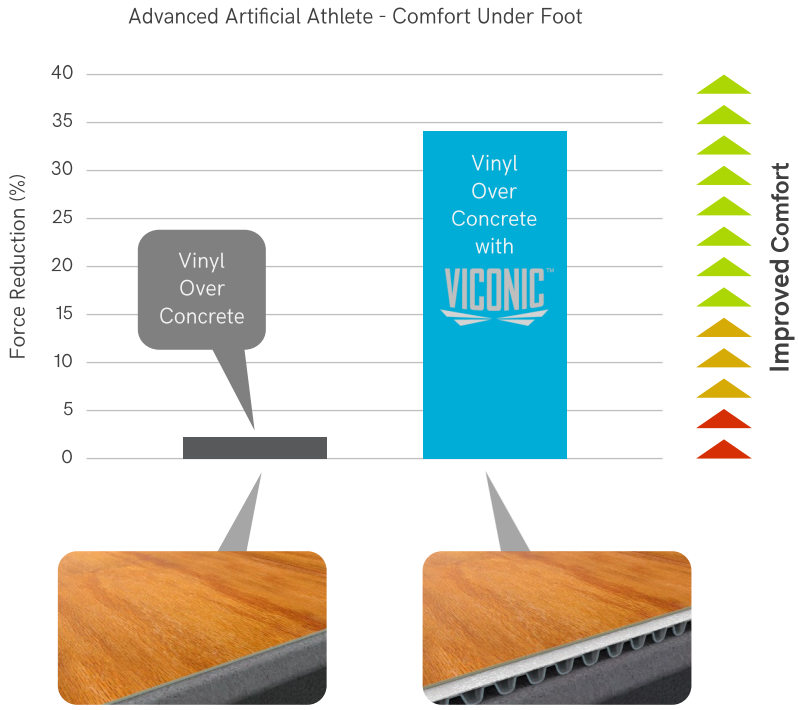

Figure 17: AAA Force Reduction Results

Analysis - Figure 17 clearly shows that the Viconic Fall Defense™ system provides greater FR and therefore provides great comfort under foot compared to flooring without Viconic. The baseline vinyl system (1% FR) is well below the same system with Viconic (34% FR). Absorbing a substantial amount of the force from a footfall means Viconic systems provide great comfort under foot for older adults and caregivers.

Energy Restitution - The percentage energy restitution (ER) is another measure of surface comfort under foot which is measured relative to bare concrete. Concrete pushes back 100% of the incoming energy back to the body so its ER is 100%. Floor coverings provide some level of energy restitution meaning you receive a percentage of the impact force back from the surface. Lower percentages of energy restitution indicate greater comfort under foot.

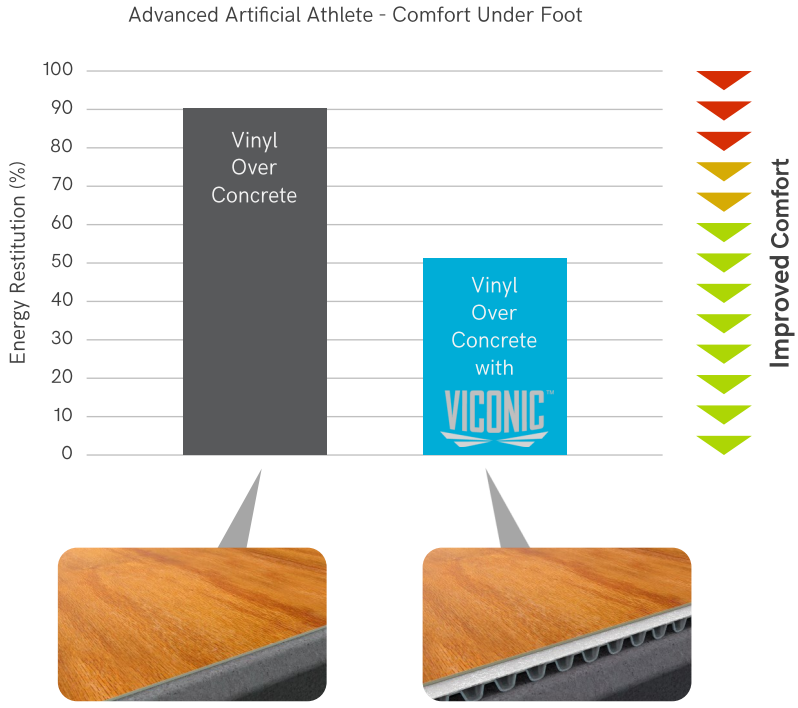

Figure 18: IBAL Surrogate Pelvis Peak Femoral Neck Force

Analysis - Figure 18 clearly shows that Viconic systems provide lower ER than traditional flooring systems without Viconic. The baseline vinyl sheet (96% ER) is well below the same system combined with Viconic (47% ER). Returning less energy back into the body from a footfall means Viconic systems provide great comfort under foot for older adults and caregivers.

Pilot Partner Installations, Fall Data, and Feedback

Beginning in January 2021, Viconic began establishing US pilot site partners and installations. Under the pilot partner agreements, Viconic provided Fall Defense™ panels and funded the installation of both Viconic and the floor covering. Each facility agreed to place high fall-risk residents in the installed suites and provide facility wide fall data and honest feedback on the installation from the perspective of all stakeholders.

Through this process, Viconic was able to evolve installation best practices and apply lessons learned to each subsequent installation. These facilities continue to be valuable sources of information as it relates to fall data, durability, and owner/operator perceptions. Real time gap analysis yielded Viconic engineered solutions that improved various aspects of installation, functionality, durability, and perception. Resultant improvements from a failure mode effects analysis included Viconic supplied non-visible surface transitions, localized load supports, and toilet flange seals

During focus groups conducted at the 2022 AHCA/NCAL and Leading Age annual conferences, the ability of Fall Defense™ to withstand the installation of a second floor covering was discussed and identified as a potentially valuable feature of the system. As a validation effort, in January 2023, Viconic contracted the removal and disposal of the vinyl floor covering previously installed over the Fall Defense™ system at a pilot partner facility. The Viconic layer was undamaged during floor covering removal, and the new flooring system was installed conventionally without issue. This process was also carried out at two other pilot partner facilities in 2024 with broadloom carpet, modular carpet, and luxury vinyl tile. In all cases, the Fall Defense™ layer was undamaged during the process, further confirming the system can be used through several flooring lifecycles.

Starting in late 2023, three additional pilot partners have been established in Minnesota, Pennsylvania, and Montana. In these installations, Viconic was able to evaluate an alternative more gradual ramped transition piece, and install directly over existing ceramic tile, which were both received very positively. As of publication of this report, fall data collection for these new pilot partners is either being established or in its infancy.

In addition to Fall Defense™ installations in select suites at pilot partner facilities, the first facility-wide installation of Viconic is currently taking place in Red Wing, Minnesota. The facility is expected to open in early 2025, and will have 24 beds providing, assisted living, memory care, and hospice care. Viconic is installed in all resident suites, corridors, and common areas. The fall data from this facility will be invaluable for Viconic moving forward.

Pilot Partner Fall Report Data

The first pilot partner chosen by Viconic is a 111 room assisted living facility near Indianapolis, IN. In January 2021, Fall Defense™ was installed in the kitchen, living space, and bedroom of three suites. A light commercial carpet system was chosen to by installed throughout the majority of each suite, with a vinyl product being chosen for the small kitchen area. Figure 19 shows the falls and injuries reported throughout the facility from January 2021 to November 2024.

		Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms		**108**	**3**
Total Falls		**830**	**30**
Total Injuries		**264**	**12**
Severe Injuries (Fracture, Head Trauma)		**57**	**2**
Percentage of Falls with Severe Injury		6.9%	6.6%
ER Visits		**77**	**2**
Percentage of Falls with ER Visit		9.3%	6.6%
Injury Type	Contusion	32	0
	Fracture	6	1
	Head Trauma	46	1
	Skin Tear, Abrasion, Laceration	118	7
	Other	61	3

Figure 19: Summarized Fall Data from Indianapolis Pilot Site. Jan 2021 - Nov 2024

Analysis - As a result of housing high fall-risk residents, it isn't unexpected that the documented fall rates and certain injury rates might be similar to, if not higher in the Viconic suites compared to the rest of the facility. Despite this, the fall data is largely encouraging. In the 44 months that Fall Defense™ has been installed, only 12 injuries have been reported. The most common injuries included skin tears, abrasions, and lacerations, all of which are not expected to be prevented by the addition of the Viconic system. Two reported injures were complaints of pain, one to the ribcage area and one to the collarbone area.

Report from Fall Requiring ER Visit - Unwitnessed, the male resident reported he fell getting out of bed. He experienced a head impact onto the flooring system that resulted in some localized bruising, swelling, and a brief loss of consciousness consistent with an AIS 1-2 minor/moderate concussion. "I remember falling and the next think I knew, I was on the floor". Unable to access his call pendant, he spent an extended period of time on the ground before help arrived resulting in other complications requiring treatment. The resident made a full recovery and was able to move back into the facility and resume normal activities shortly thereafter.

Report from Fall Resulting in Fracture - The female resident fell while ambulating in her apartment without her walker. She ultimately tripped and landed on her hip resulting in a fracture. The resident required surgery and physical therapy, but made a full recovery and was able to return to her apartment 5 weeks after the injury occurred.

Note - Fall Defense is not intended to prevent all injuries, but rather reduce the risk and severity of injuries. The AIS 1-2 minor/moderate injury experienced on Viconic could easily have been an AIS 3-4 serious/severe injury with a standard floor covering over concrete. Additionally, the fracture could have been more severe, preventing the resident from making a full recovery and moving back into her apartment.

The second pilot partner chosen by Viconic is a 65 room facility near Atlanta, GA offering both assisted living suites and a memory care unit. Viconic was installed in the living areas, bedrooms, and bathrooms of three suites in September 2021. A polyester backed vinyl sheet was chosen by the facility to be installed throughout each suite. Figure 20 shows the falls and injuries reported throughout the facility from September 2021 to February 2023.

		Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms		**62**	**3**
Total Falls		**170**	**22**
Total Injuries		**25**	**1**
Severe Injuries (Fracture, Head Trauma)		**2**	**0**
Percentage of Falls with Severe Injury		1.2%	0%
ER Visits		**6**	**0**
Percentage of Falls with ER Visit		3.5%	0%
Injury Type	Bruise	10	0
	Fracture	2	0
	Hematoma	2	0
	Swelling	6	1
	Other	5	0

Figure 20: Summarized Fall Data from Atlanta Pilot Site. Sep 2021 - Feb 2023

Analysis - The fall data from the Atlanta pilot site is also very encouraging. In total, 22 falls were reported with one instance of swelling being the only reported injury.

Note - The Atlanta pilot site facility changed ownership in early 2023. As a result of turnover in front office personnel, Viconic stopped receiving fall data after February 2023. Efforts are currently being made to reach an agreement with the new owner/operators that will reestablish the sharing of fall reports from the facility moving forward.

The third pilot partner chosen by Viconic is a 30 room assisted living wing in North Carolina. In February 2023, Fall Defense™ was installed in the living space and bedroom of three studio-style suites. A modular carpet system was chosen to by installed in two of the suites and a flexible glue-down LVT product was installed in the third suite. Figure 21 shows the falls and injuries reported throughout the facility from February 2023 to August 2024.

		Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms		17	3
Total Falls		56	45
Total Injuries		25	4
Severe Injuries (Fracture, Head Trauma)		1	0
Percentage of Falls with Severe Injury		1.8%	0%
ER Visits		0	0
Percentage of Falls with ER Visit		0%	0%
Injury Type	Hematoma	2	1
	Fracture	0	0
	Bruise	5	1
	Skin Tear, Abrasion, Laceration	15	2
	Other	3	0

Figure 21: Summarized Fall Data from North Carolina Pilot Site. Feb 2023 - Aug 2024

Analysis - The outcomes from the North Carolina beta sites have been extremely encouraging in the 18 months that they have been installed. In that time, the facility has reported 100 total falls, over 40% of which occurred in a Viconic suite despite Fall Defense™ being installed in only 15% of suites in the wing. The strategic placement of high fall-risk residents has proved beneficial so far, as only 4 fall related injuries have been reported in suites with Viconic Fall Defense™, all of which have been minor.

Note - The North Carolina pilot site facility changed ownership in August 2024. As a result of turnover in front office personnel, Viconic has stopped receiving fall dat. Efforts are currently being made to reach an agreement with the new owner/operators that will reestablish the sharing of fall reports from the facility moving forward.

Minnesota Pilot Partner - In October 2023, Viconic Fall Defense™ was installed in three memory care suites in a facility outside of St. Paul Minnesota. Both rooms are one bedroom suites with a bathroom. Viconic was installed under an LVT system in the bedroom and living space, and under a sheet vinyl system in the bathroom. To date, 16 falls have occurred on Viconic, none of which resulted in acute injury

	Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms	13	3
Total Falls	103	16
Total Injuries	17	0
Severe Injuries (Fracture, Head Trauma)	5	0
Percentage of Falls with Severe Injury	4.9%	0%

Figure 22: Summarized Fall Data from Minnesota Pilot Site. Oct 2023 - Nov 2024

Pennsylvania Pilot Partner - In February 2024, Viconic Fall Defense™ was installed in two skilled nursing suites in a facility outside of Lancaster, PA. Both rooms are studio apartments with a bathroom. Viconic was installed under a broadloom carpet system in the bedroom, and under a sheet vinyl system in the bathroom. This installation was the first to utilize a more gradual ramped transition piece, which was well received by residents and the nursing staff. To date, 24 falls have occurred on Viconic, resulting in two non-acute injuries where both residents experienced skin tears and bruising.

	Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms	71	2
Total Falls	295	24
Total Injuries	8	2
Severe Injuries (Fracture, Head Trauma)	1	0
Percentage of Falls with Severe Injury	0.3%	0%

Figure 23: Summarized Fall Data from Pennsylvania Pilot Site. Feb 2024 - Nov 2024

Montana Pilot Partner - In May 2024, Viconic Fall Defense™ was installed in two skilled nursing suites in a facility in Kalispell, MT. All rooms are studio apartments with a bathroom. Viconic was installed under a LVT system in each suite. To date, only four falls have occurred on the Fall Defense™ system which only resulted in one minor injury.

	Without Fall Defense™	With VICONIC® FALL DEFENSE™
Rooms	3	3
Total Falls	4	4
Total Injuries	2	1
Severe Injuries (Fracture, Head Trauma)	0	0
Percentage of Falls with Severe Injury	0%	0%

Figure 24: Summarized Fall Data from Montana Pilot Site. Jun 2024 - Nov 2024

Summary - While not a clinical trial, the observed outcomes from the pilot sites have been positive as anticipated. Despite the Viconic suites housing high fall-risk residents who have experienced numerous falls, the facilities have observed only one fracture and arguably no other injuries worse than an AIS 2 moderate injury to date in suites installed with Viconic Fall Defense™. The feedback from installers, facility management, and residents living in the suites has been very positive. Interviews highlighted that residents and management enjoy the peace of mind offered by Viconic all while having no negative effects on daily life. Additionally, the maintenance departments have reported no disruptions in their ability to carry out routine maintenance in suites with Fall Defense™. Finally, system ROI is higher than initially anticipated since one or more floor coverings may be installed over the initial Viconic installation.

Acoustics Testing, Description, and Analysis

Although Viconic Fall Defense™ was designed to reduce the risk of fall related injuries in the aging population, it has several secondary benefits, one of which is improved facility acoustics. The sound environment of communities affects the physical and mental health of the elderly.[16] Evaluations were conducted to evaluate the effectiveness of Viconic Fall Defense™ as a noise reduction product. Two subfloors were considered: a 152 mm concrete slab and a 457 mm open web truss. Additionally two floor coverings were evaluated: 2.2 mm commercial grade sheet vinyl and 5.5 mm commercial grade carpet tile. Four metrics are calculated to quantify the sound transmission properties of the flooring products: Impact Insulation Class (IIC), High-Frequency Impact Insulation Class (HIIC), Delta Impact Insulation Class (ΔIIC), and Sound Transmission Class (STC).

The impact sound transmission test was conducted in accordance with the ASTM E492 test method. The data obtained from this test is used to calculate Impact Insulation Class (IIC) and High-Frequency Impact Insulation Class (HIIC) in accordance with ASTM E989 and ASTM E3222, respectively. Higher values of IIC and HIIC correlate to better insulation performance. An IIC rating of 50 and above is required in most commercial in building code. HIIC is a relatively new metric used to determine the efficiency of flooring products to reduce high frequency sound transmission.

The delta impact insulation test was conducted in accordance with the ASTM E2179 test method. This method also dictates how the data is used to calculate delta impact insulation class (ΔIIC). Delta IIC highlights what a flooring product adds to an assembly in terms of isolating impact footfall noise. The procedure starts by testing the baseline concrete subfloor with no flooring products installed. The Viconic Fall Defense™ and floor covering is then installed and the same test repeats. The difference in IIC values is calculated and reported as ΔIIC. Higher values of ΔIIC indicate increased abilities of flooring products to reduce sound transmission.

Impact Insulation Class

Viconic Fall Defense™ was evaluated by an independent test lab to determine Impact Insulation Class (IIC) over two subfloor systems commonly used in commercial construction, 152 mm concrete slab and 457 mm open web truss. Additionally, two flooring systems were adhered to the Viconic layer and evaluated, 2.2 mm commercial vinyl sheet and 5.5 mm commercial carpet tile. To measure IIC, two test rooms are needed, a source room and a receiving room where the source room is located above the receiving room with the floor/ceiling assembly acting as a barrier. A standardized tapping machine taps the floor of the source room and microphones in the receiving room measure the sound levels at predetermined frequencies. Lower levels of measured sound pressure signify less sound transmission between rooms. Impact sound pressure is plotted against frequency and the IIC rating is calculated. Figures 25 and 26 show the performance of Viconic Fall Defense™ in conjunction with vinyl sheet and carpet over a concrete subfloor and open web truss subfloor, respectively.

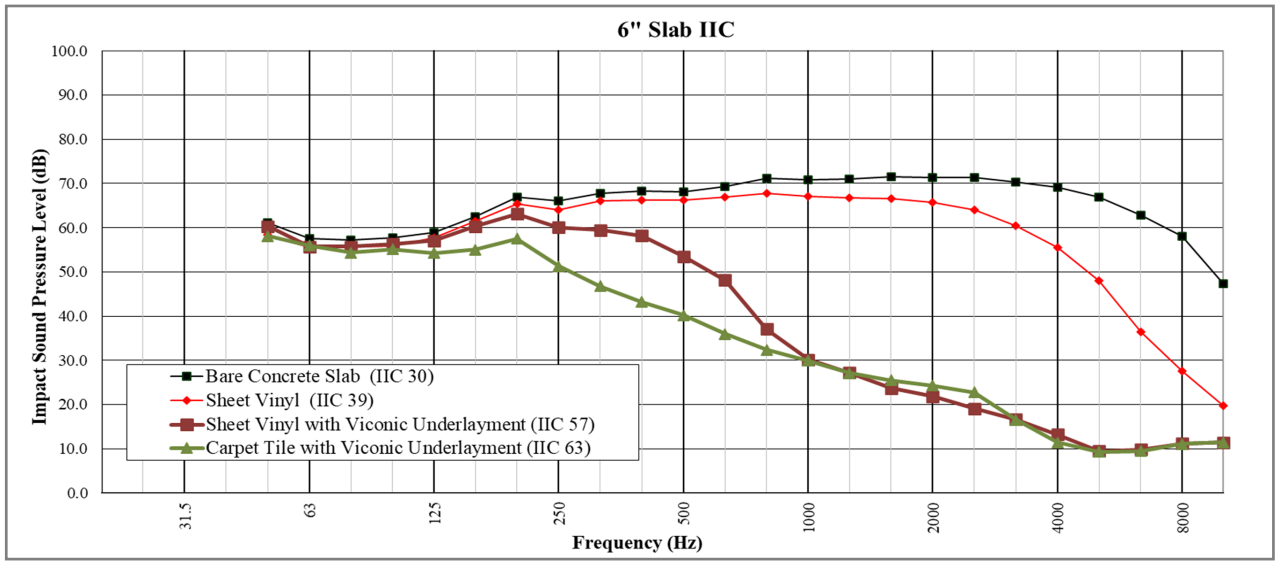

Figure 25: IIC Curves with Concrete Substrate

Analysis - Figure 25 clearly shows the acoustic benefits provided by Viconic Fall Defense™. Lower curves indicate lower levels of sound transmission from the source room into the receiving room. Although the curves are largely similar in lower frequencies, Viconic shows a vast improvement in mid to high frequencies. Lower frequencies are typical of "thud" type impacts from the source room such as dropped objects or someone walking heavily on their heels. The mid to high frequencies are typically associated with "click" type impacts such as the sound of walking in hard-soled shoes. Viconic's ability to reduce noise transmission in the mid to high frequencies has a significant effect in IIC ratings. The concrete baseline increased from 30 IIC to 39 IIC with the addition of a commercial grade vinyl sheet. The same floor covering combined with a Viconic Fall Defense™ increased the IIC value to 57, a 46% improvement. Furthermore, combining Viconic with a commercial grade carpet provided an IIC rating of 62, more than doubling the IIC value of the concrete baseline.

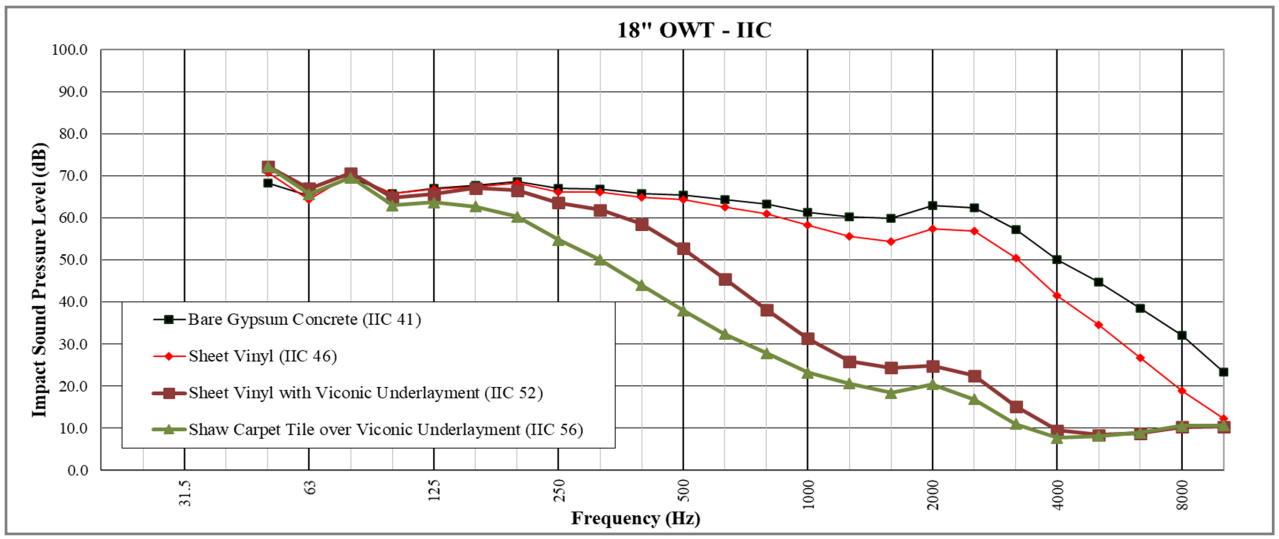

Figure 26: IIC Curves with Open Web Truss Substrate

Analysis - Figure 26 shows that adding Viconic Fall Defense™ also improves acoustics when using an open web truss subfloor construction. The subfloor without any floor covering had an IIC rating of 41 which increased to 46 IIC with the addition of a commercial vinyl sheet. The same vinyl sheet combined with Viconic increase the IIC value to 52, a 13% improvement. As seen with the concrete subfloor construction, combining Viconic with a commercial grade carpet further reduced sound transmission between rooms, improving to 56 IIC, a 37% improvement compared to the baseline subfloor.

High Frequency Impact Insulation Class

The same test procedure used to determine IIC is used to determine High-Frequency Impact Insulation Class (HIIC); however, only high frequency pressure levels are used in the calculations, specifically 400Hz to 3150Hz. HIIC better highlights the acoustical improvements provided by flooring and underlayments compared to IIC. This test is only conducted over a 152mm concrete slab subfloor. Figure 27 shows the results of the HIIC test and highlights the frequencies used to calculate HIIC.

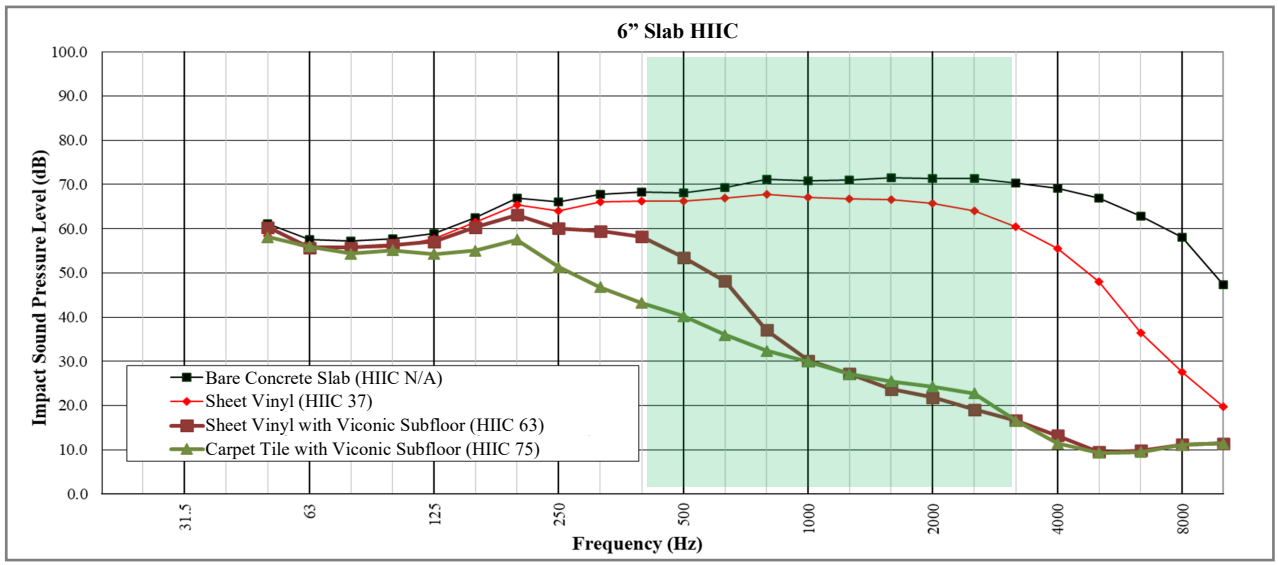

Figure 27: HIIC Test Results

Analysis - Figure 27 shows the significant performance improvement offered by the Viconic Fall Defense™ system when focused on high-frequency sound transmission. HIIC for commercial grade sheet vinyl was increased from 37 HIIC to 63 HIIC with the addition of Viconic, a 70% performance improvement. Implementing a commercial grade carpet further improved acoustic properties, increasing the HIIC value to 75, more than doubling the HIIC value of vinyl over concrete. These results clearly highlight the ability of Viconic to improve facility acoustics and increase quality of life for residents.

Delta Impact Insulation Class

Delta Impact Insulation Class (ΔIIC) highlights a flooring products ability to reduce sound transmitted between rooms such as footfall noise. The test compares a baseline concrete subfloor to the fully installed flooring system and reports the difference in IIC where the ΔIIC for bare concrete is zero. Delta IIC is the best sound rating to consider when comparing the performance of different types of flooring underlayments. Figure 28 shows the improvement in IIC provided by the addition of Viconic Fall Defense™.

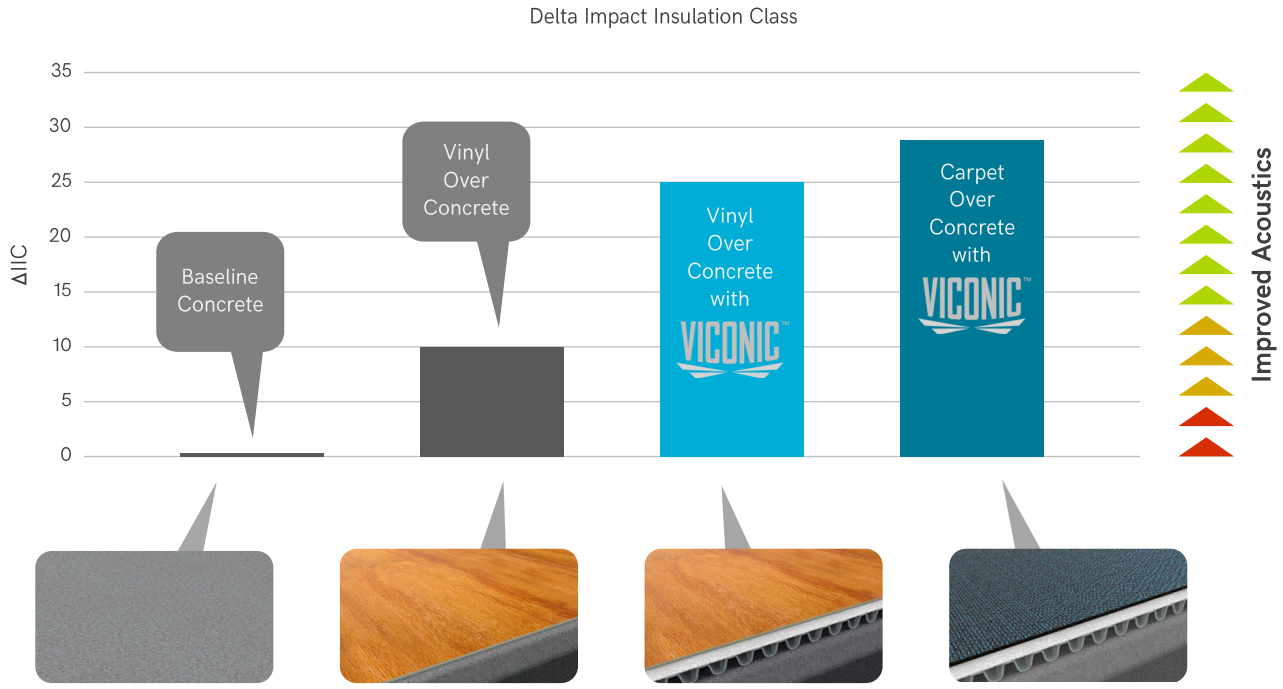

Figure 28: Delta IIC Test Results

Analysis - As demonstrated with the IIC and HIIC, Viconic has a much more favorable ΔIIC when compared to a traditional flooring system. By definition, the ΔIIC of a bare concrete subfloor is zero. The addition of a commercial grade sheet vinyl had a calculated ΔIIC value of 10. The addition of Viconic Fall Defense™ to the vinyl system increase ΔIIC to 25, a 150% performance increase. Utilizing a commercial grade carpet as the floor covering offered further improvements, increasing ΔIIC to 29, a nearly threefold increase compared to the baseline vinyl system. These results highlight the ability of Viconic to reduce sound transmitted through rooms and provide a safer and more comfortable living environment for residents.

Summary - The results of these acoustic tests are particularly significant due to commercial building codes. Most new construction is required to meet or exceed an IIC rating of 50. Depending on subfloor construction and floor covering used, the installed system may need an acoustic barrier to meet code. The inclusion of Viconic Fall Defense™ improves IIC to acceptable levels all while reducing risk of fall related injuries and improving comfort under foot.

Conclusion

Fall related injuries in the elderly, such as hip fracture and TBI, can reduce mobility and independence and be potentially life ending. The $50 billion annual financial burden associated with fall-related injuries in the US market alone presents a unique opportunity for the flooring industry to develop and supply innovative systems. Safety flooring systems like Viconic Fall Defense™ presented above demonstrate the capability to substantially reduce the risk of injury and death due to impacts with the flooring surface. While the results may vary slightly when combined with compatible floor coverings, the statistical analysis of commercial vinyl sheet goods combined with Viconic systems in general demonstrate:

- 20-fold reduction in risk of critical head injury
- 60% reduction in the probability of moderate head injury
- 2.4-fold reduction in GMAX
- 18.2% femoral neck force attenuation during falls for average older females
- 38% average reduction in hip fracture factor of risk for older adults
- Firmness and stability under foot supporting mobility
- Substantially greater comfort under foot for caregivers and older adults
- Significant improvement in impact sound transmission through floors

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Appendix

Viconic Fall Defense™ Product Specification Sheet

PRODUCT SPECIFICATION

VICONIC FALL DEFENSE™

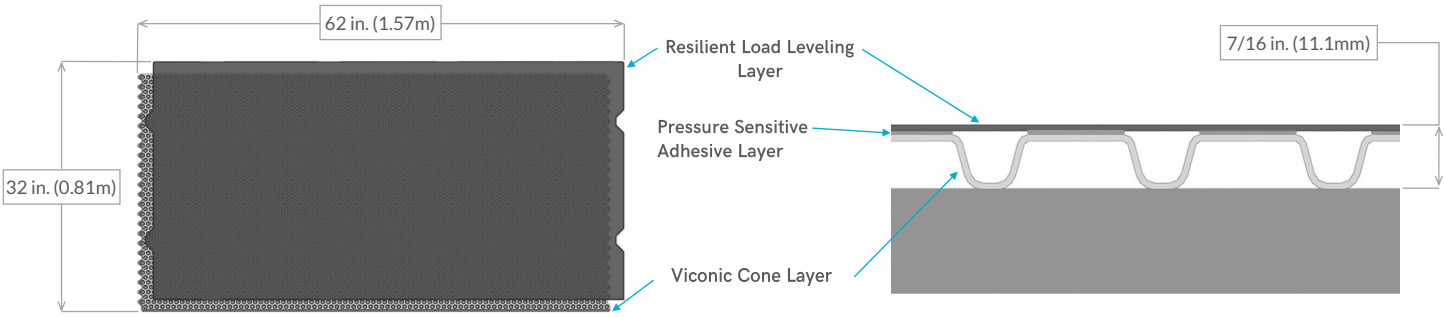
DESCRIPTION (all sizes and weights are nominal)

Thickness	7/16 in.	(11.1 mm)
Panel Width	32 in.	(0.81 m)
Panel Length	62 in.	(1.57 m)
Panel Coverage	12.9 ft²	(1.2 m²)
Weight	0.54 lb./ft²	(2.64 kg/m²)

PROPERTIES

- Compatible with most flexible flooring systems
- Offered with ADA compliant reducer ramp
- Non-adhered flooring underlayment
- Supplied in modular panels with integrated adhesive for assembly
- Can be loose-laid over most flat, rigid subfloors
- Compatible with most acrylic water based adhesives

SUBFLOOR SYSTEM STRUCTURE (all measurements are nominal; not to scale)



TEST DATA

Standard		Result
ASTM E492, Impact Sound Transmission*	IIC HIIC	57 63
ASTM E90, Airborne Transmission Loss*	STC	50
ASTM E2179, Delta Impact Insulation*	ΔIIC	25
ASTM F355, Impact Attenuation	A Missile E Missile**	212 G's 695 HIC
FMVSS 201u, Head Impact Protection		415 HIC_d
CSA EXP08-17, Hipform Force Reduction***		18%
ASTM F3189, Footfall Force Reduction	Force Reduction Energy Restitution Vertical Deformation	34.5% 51.5% 2.1 mm
Rotational Penetrometer, Mobility***	Firmness Stability	Pass (≤0.300 in.) Pass (≤0.500 in.)
ASTM F970, Static Load Limit	50 psi 75 psi 100 psi 125 psi	0.005 in. 0.006 in. 0.008 in. 0.009 in.
ASTM F36, Compression & Recovery	50 psi (4 hour exposure) 100 psi (4 hour exposure)	0.005 in. 0.006 in.
ASTM E662, Smoke Density	Flaming Non-Flaming	Pass (≤ 450) Pass (≤ 450)
FMVSS 302, Flammability		Pass (≤ 4 in/min)
ASTM C518, Thermal Insulation	Thermal Resistance, R	0.856

* System level evaluation with 2mm sheet vinyl over a 6" concrete slab
** A single drop height (2 ft.) was used based on relevant clinical fall data collected by the University of Waterloo
*** Evaluated as an assembled flooring system using 2mm heterogenous vinyl sheet

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MADE IN USA

PRODUCT SPECIFICATION
VICONIC FALL DEFENSE™

Test Information

The following list contains brief summaries, plus additional notes as needed, for the majority of the test standards noted in Viconic's product specification. Please refer to the actual standard for complete information. While Viconic makes every effort to ensure consistency in production, some minor variations in performance can occur between product lots. Additionally, choice in flooring system will result in altered performance of the assembled subfloor. Viconic generally uses 2mm heterogeneous sheet vinyl for system level evaluations.

ASTM E492, Impact Sound Transmission

- This method covers the laboratory measurement of impact sound transmission of floor-ceiling assemblies using a standardized tapping machine. It is assumed the test specimen constitutes the primary sound transmission path into a receiving room located directly below and that a good approximation to a diffuse sound field exists in this room. The data obtained from this test is used to calculate an Impact Insulation class (IIC). High-Frequency Impact Insulation class (HIIC) is also calculated and reported.

ASTM E90, Airborne Transmission Loss

- This test method is used to calculate sound transmission class (STC) through the measurement of sound transmission loss of building elements. Two adjacent rooms are arranged with the flooring assembly between them. A diffuse sound field is produced in the source room creating a sound field in the receiving room. The space and time average sound pressure levels in the two rooms are determined and used to calculate STC.

ASTM E2179, Delta Impact Insulation

- The test chamber consists of two reverberation rooms, one located directly above another. Care is taken that the only significant sound transmission between the rooms is by way of the test specimen. A tapping machine is operated in four different locations while the sound pressure levels are measured by microphone in the room below. The improvement in Impact Insulation class (ΔIIC) is reported.

ASTM F355, Impact Attenuation

- This method specifies how to measure the impact attenuation of playing surface systems and materials, specifically the peak impact acceleration. The test method uses a simulated hip-form (A missile) and head-form (E missile) to measure the impact attenuation of materials and components used as protective padding.
    - The A Missile reports the peak G value experienced when impacting a surface. Lower G values indicate a reduction in risk of injury.
    - The E Missile reports Head Injury Criteria (HIC), an indication of impact severity and risk of injury. Lower HIC values indicate a reduction in risk of injury, with values over 1000 indicating exponentially increasing probability of risk of critical injury.

FMVSS 201u, Head Impact Protection

- A FMVSS201u Hybrid III free motion headform is used to determine the risk of head injury in passenger vehicles. The device reports HIC where values over 1000 indicate exponentially increasing probability of critical injury risk.
- The headform impacted the flooring system at 11.34 ft/s (3. 46m/s) which is equivalent to a 2 ft. freefall drop.

CSA EXP08-17, Hipform Force Reduction

- The Canadian Standards Association has outlined a method for evaluating the force attenuation provided by hip protectors. A mechanical surrogate pelvis and steel force plate are used to determine femoral neck forces experienced during a fall related impact on the hip. The test surface is impacted at a velocity of 9.5-10.5 ft/s (2.9-3.2 m/s), and data is presented as a percentage of force reduction compared to a non-padded baseline impact.

ASTM F3189, Footfall Force Reduction

- The Advanced Artificial Athlete (AAA) simulates a foot interacting with a flooring surface and measures the acceleration as a function of time, outputting three values:
    - Force Reduction: The amount of force reduced by the flooring surface during the test foot impact compared to a concrete surface. Concrete has 0% force reduction. Higher values of force reduction percentage indicate increased comfort under foot.
    - Energy Restitution: The amount of energy returned to the test foot by the flooring surface, where bare concrete has 100% energy restitution. Lower energy restitution percentage indicate increased comfort under foot.
    - Vertical Deformation: The maximum measured deformation of the flooring surface during the impact of the test foot.

Rotational Penetrometer, Mobility

- The Rotational Penetrometer is designed to measure firmness and stability of ground and floor surfaces. An inter-laboratory study revealed the device produced repeatable measurements correlating with the amount of work required to propel a wheelchair as measured by ASTM F1951.
    - Firmness is measured by spring loading a wheelchair caster into the test surface and measuring the vertical displacement of the indenter wheel.
    - Stability is measured by rotating the loaded caster 360° and re-measuring the vertical displacement.
    - Firmness and stability measurements must be less than 0.3 in. (7.6 mm) and 0.5 in. (12.7 mm) for a surface to be considered firm and stable, respectively. Note: these displacements include compression of the wheel assembly.

ASTM F970, Static Load Limit

- This test determines the recovery properties of resilient flooring systems after indenting the surface with a 1.125 in. (28.6 mm) diameter flat indenter under a specified load. Residual indentation is measured 24 hours after load removal.

ASTM F36, Compression & Recovery

- This test method determines the short-term compressibility and recovery of materials at room temperature.

ASTM E662, Smoke Density

- This procedure is designed to measure the specific optical density of smoke generated by the test specimen within a closed chamber. Two burning conditions, flaming and non-flaming, are simulated.

FMVSS 302, Flammability

- This test is used to determine the burn resistance capabilities of materials used in the occupant compartments of motor vehicles. This test is typically performed on materials in passenger cars, trucks, and buses.

ASTM C518, Thermal Insulation

- This test is used to quantify the thermal insulation properties of a surface. The specimen is placed between two parallel plates at constant but different temperatures. A heat flow meter measures the heat transfer between heat sources, and thermal resistance is calculated.