



Technical Bulletin

Anti-Fatigue Mats: An Ergonomic Solution in the Workplace

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You may already know that the No. 1 job-related injury and illness problem reported in the United States is musculoskeletal disorders (MSDs), but do you know which simple ergonomic measures can significantly reduce the occurrence of MSDs?

Musculoskeletal disorders and ergonomics are not one and the same. Musculoskeletal disorders are the result of incompatibilities between the work conditions, work demands and the worker capabilities. Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of workers. In other words, musculoskeletal disorders are often the result of poor ergonomics, whereas good ergonomics is the solution to reducing MSDs.ⁱ

Research organizations, such as the National Institute of Occupational Safety and Health (NIOSH), Universities and 3M are independently researching possible solutions to these disorders, which have consequences that extend far beyond a missed workday for an injured worker.

To understand the magnitude of this issue and to fully appreciate the solutions that 3M has developed to help reduce workplace-related MSDs, consider the risks, the reduced productivity, and cost of injuries and illnesses. The regulatory climate associated with these potentially debilitating disorders is changing and some times confusing.

The Enemy: Musculoskeletal Disorders

OSHA defines MSDs as “injuries and illnesses of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs.”ⁱⁱ The severity of MSDs can range from mild periodic symptoms to severe chronic and debilitating injuries or conditions.

For the worker the effect of MSDs is more than pain or discomfort. At work MSDs most likely will reduce their productivity, increase their chances to make mistakes reducing their quality, and increase their absenteeism. At home MSDs can make it difficult to perform every day tasks, get exercise, do hobbies and even sleep.

For the employer, MSDs will likely reduce productivity, reduce product quality, increase worker absenteeism, increase OSHA recordables, increase worker lost time and increase overtime. These changes result in increased costs in production and worker compensation or other medical insurance premiums.ⁱⁱⁱ

MSDs of the feet, legs and lower back can be contributed to prolonged standing on hard flooring. Think of the last time you stood in a long line waiting. Did your feet, legs and back have pain or discomfort? How long did it take to become uncomfortable: 10, 20 or 30 minutes? Now think of jobs that require standing for eight hours a day and how uncomfortable those workers are.

A Historical Perspective

- Ramazzini in the 1700s, lists diseases of the hands, arms, legs and feet according to occupations (baker's hands, gamekeeper's thumbs and others), which are examples of MSDs.^{iv}
- In the late 1910s and early 1920s, many articles and books were written discussing the pain, suffering and deaths of the American worker caused by the poor and unsafe working conditions. References on how people tried to change their work are included.
- Workers compensation laws came into effect in the United States in 1923.
- Early interventions were a variety of materials that "softened" the area where workers had to stand. Cardboard, carpet and wood were commonly used.
- Early commercial products (1950s) were called "industrial mats," which evolved into "anti-fatigue mats."
- In the early 1960s, the military looked into ways to reduce standing fatigue, with the Navy contracting a company to build Watch Mats.
- In the mid-to-late 1980s, anti-fatigue mats are referred to as a type of "engineering control" by OSHA, when used to alleviate MSDs in the workplace for jobs requiring prolonged standing.

Risks to Industry

Work-related MSDs currently account for one-third of all occupational injuries and illnesses reported to the Bureau of Labor Statistics, constituting the largest job-related injury and illness problem in the United States.

For example^v:

- In 1997, 626,000 lost workdays attributed to MSDs were reported to the Bureau of Labor Statistics. These disorders accounted for \$1 of every \$3 spent for workers' compensation that year.
- Employers pay \$15 to \$20 billion in workers' compensation costs for these disorders every year. Adding the indirect expenses associated with MSD and the total comes to between \$45 and \$54 billion annually.
- The average workers' compensation for MSD claim costs are in excess of \$8,000, while non-MSDs claims cost half that.
- Workers with severe MSDs can face permanent disability that prevents them from returning to their jobs or handling simple, everyday tasks like combing their hair or pushing a shopping cart.

Risks to Workers' Health

Musculoskeletal disorders can be divided into two categories by regions of the body and the medical disorders associated with each.

- Upper body and extremities: Includes neck, upper back, shoulder, arm, wrist, hand and fingers
 - Common disorders: Cervical syndrome, cervical spondylosis, cubital tunnel syndrome and carpal tunnel syndrome
- Lower body and extremities: Includes lower back, hips, leg, knee, ankle and foot
 - Common disorders: Degenerative disc disease, disc herniation, osteoarthritis, tarsal tunnel syndrome, venous pooling (edema of lower leg) and vibration syndrome

Several personal risk factors can determine a person's risk of MSDs, including age, physical condition, heredity, certain diseases, anthropometry (weight, height, body mass index and obesity), and life's exposures (sprains, strains or fractures that happen before they reach working age).

Diabetes (can deteriorate the biosystem including the musculoskeletal system) and Osteoarthritis (commonly affects the cartilage in the weight-bearing joints and is the most common form of arthritis) are two conditions that have symptoms of an MSD. For people with diabetes and osteoarthritis, workplace conditions (like prolonged standing) can further exacerbate these symptoms of an MSD. An estimated 16 million people in the U.S., (half of whom are unaware of their condition^{vi}) have diabetes. Osteoarthritis afflicts more than 40 million Americans.^{vii}

These two examples alone point out that workers – and employers – may not be aware of the need to pay greater attention to workplace MSDs. Employers need to be aware that their ergonomics program has to address all workers – healthy workers as well as those with underlying personal risk factors.

Risks Found in the Workplace

OSHA has identified workplace risk factors that have potential to cause MSDs. These factors are too numerous to include here; however, OSHA has developed categories of specific risks, which include:

- Force
- Static posture
- Awkward postures
- Cold temperatures
- Repetition
- Contact stress
- Vibration

OSHA considers the following factors when analyzing risks of certain occupations, because they all play a role in the development of MSDs^{viii}:

- Length of time exposed to risk factors
- Configuration of the workstation layout and space
- Equipment used and objects handled
- Environmental conditions
- The organization of work (adequacy of recovery time)

Which is to Blame: Personal Risks or Workplace Risks?

How can the cause of a MSD be pinpointed? Did personal risk factors, workplace risk factors or both lead to the worker's disorder? Regardless of the source of a MSD, the worker and employer suffer. This doesn't mean, however, that employers are not responsible for taking measures to reduce the risk for all workers.

The federal government dictates that workplace risk factors must be addressed for all employees no matter what personal risk factors pre-exist. This is evident by the creation of both OSHA and the Americans with Disabilities Act.

Ergonomic Standards and Proposed Standards

OSHA published the final rule on the "OSHA – Ergonomic Program" standard on November 14, 2000 and it was repealed on March 20, 2001. OSHA is now getting further public comment on whether to proceed with a new revised ergonomic standard. Two states (California & Washington) have moved forward and instituted their own ergonomic standards and ten or more other states are developing their own ergonomic standards now that the federal OSHA standard has been repealed.

One of the premises that OSHA found during its first rule making hearings was that "good ergonomics is good economics."

During the development and public comment phase of the first OSHA rule-making process on the "Ergonomic Standard", the following information was brought forth:

Impact of the proposed standard^{ix}:

1. Approximately 300,000 workers could be spared from potentially disabling injuries, and \$9 billion could be saved each year under the proposed ergonomics program standard.
2. About one-third of general industry work sites – 1.9 million sites – would be affected and more than 27 million workers would be protected by the standard.
3. Each year 1.8 million Americans experience work-related musculoskeletal disorders. About one-third of these injuries – 600,000 – are serious enough to require time off work.
4. A "grandfather" clause gives credit to firms that already have effective ergonomics programs in place and are working to correct hazards.

Anti-Fatigue Matting as an Ergonomic Solution

In the repealed "OSHA – Ergonomic Program Final Rule", prolonged and static standing was identified as a risk factor^x and anti-fatigue matting was a control method for that risk factor.^{xi}

OSHA has more than 100 ergonomic reports that recommend the use of anti-fatigue mats. These reports point out the health risks associated with standing for prolonged periods of time and the importance of anti-fatigue mats used as engineering controls.

What follows are just two examples pulled directly from these ergonomic reports.

Known Hazard

"Employees have extended periods of standing which creates static loading on the muscles of the back and legs. This is consistent with the development of musculoskeletal injury and generalized fatigue. In addition this can lead to venous pooling of blood in the legs which is consistent with increased fluid pressure in the legs and the development of varicose veins."

Known Control

"Where employees are required to stand for long periods of time, provide anti-fatigue mats and/or shoes with well-cushioned insoles and insoles."

Known Hazard

“Statically standing in one posture reduces the flow of nutrients to and the removal of wastes from the muscles, tendons, and vertebra. This can lead to venous pooling of blood and an increase in pressure in the lower extremities. Additionally, it creates a contact stress to the bottoms of the feet. Statically standing in one place for prolonged periods of time increase the risk of development of MSDs of the legs and feet such as pain, fatigue, and varicose veins.”

Known Control

“Where employees are required to stand for long periods of time, provide anti-fatigue mats and/or shoes with well-cushioned insteps and insoles.”

University Research Supports Anti-Fatigue Matting

Physiological studies confirm anti-fatigue mats reduce the discomfort and pain associated with standing or walking on hard floors. This includes the lower back and extremities. In a floor mat study, the mats tested were found to be “significantly more comfortable than concrete” after a standing test duration of 1.5 hours. All of the lower body parts (upper leg, lower leg, ankle and foot) were significantly affected by floor surface.^{xii}

PART I

Redfern Study Shows 3M Mats Affect Worker Pain and Discomfort

3M Matting as an Ergonomic Solution

A physiological study confirms the significant impact 3M mats have on reducing the symptoms associated with MSDs, such as pain and discomfort in lower body parts.^{xiii}

Two versions of matting constructions were evaluated and compared to a hard floor surface to determine anti-fatigue properties. The test subjects were 10 healthy college students and the test duration was four hours of standing. Subjects were allowed two minutes of walking each hour. Subjects were asked to rate their degree of comfort or discomfort after each hour of standing. Physical measurements were taken during the test and subjects completed computer tasks to determine their ability to maintain work output.

Results for 3M mats:

1. Reduced lower back and lower extremity discomfort extending the time until fatigue became excessive. (See Bar Chart below)
2. Better retention of ability to perform routine computer scanning tasks. (Based on Stroop and Scanning Tasks)
3. Results are most dramatic between the third and fourth hour of standing.

Lower Leg and Extremity Discomfort

Time to Reach 12* on Discomfort Scale

		0	1	2	3	4 ^{3M Advantage}
Overall Tiredness	Hard Floor			2.0 HRS		
	3M Mat				2.8 HRS	40%
	Coil Construction					
Lower Back Discomfort	Hard Floor			2.0 HRS		
	3M Mat				3.0 HRS	50%
	Coil Construction					
Leg Tiredness Lower Leg	Hard Floor		1.6 HRS			
	3M Mat			2.15 HRS		35%
	Coil Construction					
Tiredness	Hard Floor		1.75 HRS			
	3M Mat				3.0 HRS	70%
	Coil Construction					
Foot Discomfort	Hard Floor	0.75 HRS				
	3M Mat			2.1 HRS		180%
	Coil Construction					

* 12 Rating is Extremely Stressful

PART II

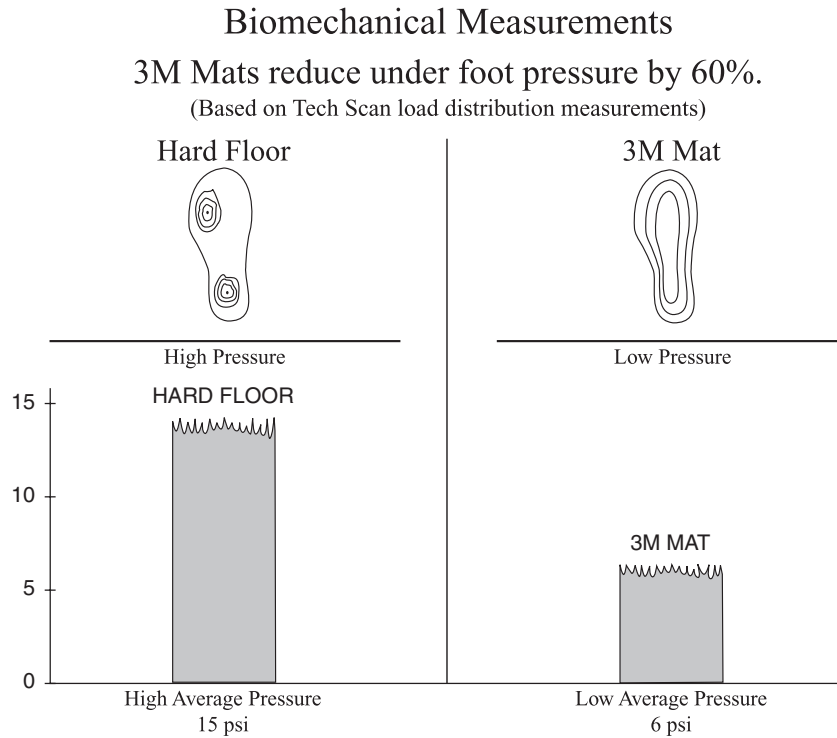
Lab Testing Shows 3M Mats Address Workplace Risk Factors

A. Reduced Point Pressures Under Foot

Biomechanical Measurements

3M mats reduce under foot pressure by 60%.

(Based on Tech Scan load distribution measurements)

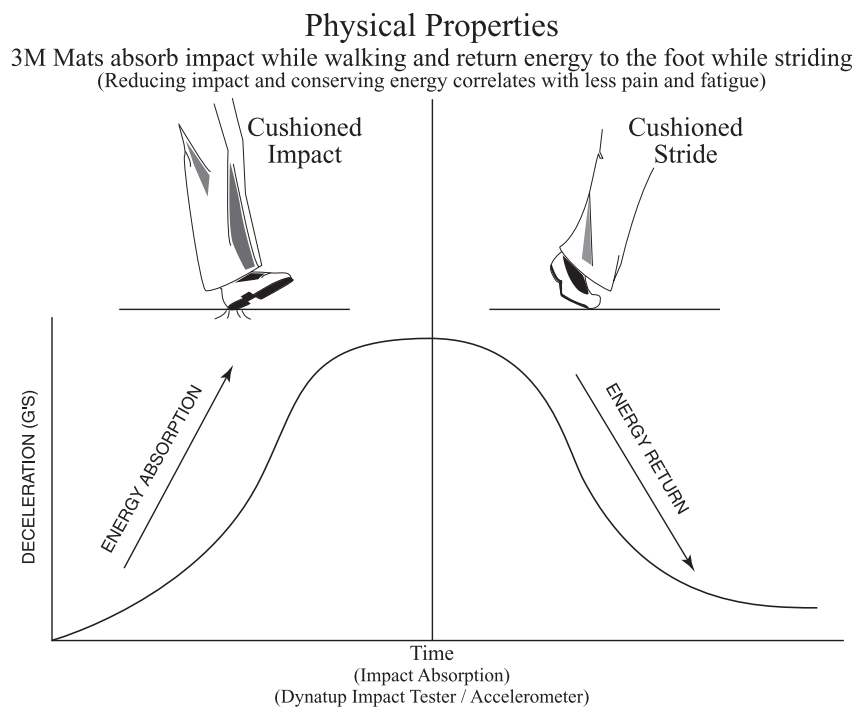


B. Softness With Walking Stability

Physical Properties

3M mats absorb impact while walking and return energy to the foot while striding.

(Reducing impact and conserving energy correlates with less pain and fatigue.)



C. Durable Cushioning

Physical Properties

3M mats retain strength and cushioning properties after extended use. This means anti-fatigue properties remain essentially unchanged.

Property	New	After 2 yrs of service	% Change
Tensile strength (lbs/in. of width)	32	34	6%
Compression Displacement (in.) @ 30 lbs/sq.in.	0.30	0.29	(3%)

PART III

3M Matting Technology

There are two technology platforms used in the unique construction of 3M mats. One technology utilizes a “coiled spring” polymeric construction to provide anti-fatigue properties. Empirical evidence from users indicates that it is the first choice of workers who must walk as well as stand while performing their duties. Constructions utilizing this technology are described below.

3M™ Safety-Walk™ Cushion Matting 5250

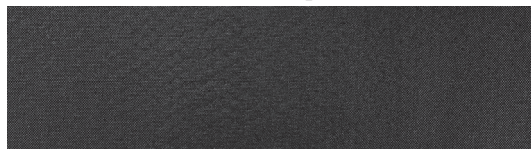
- Coiled spring design
- Open construction
- Allows liquids to pass through
- Traps soil and debris for later removal
- Keeps feet clean and dry



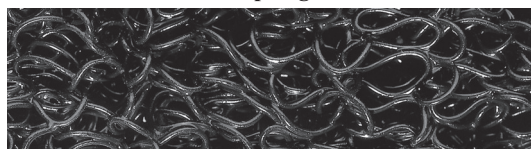
3M™ Safety-Walk™ Cushion Matting 5270

- Coiled spring design
- Textured solid top construction
- Improves traction and allows soil and debris to remain on top for easy cleanup

Solid Top



Coiled Spring Bottom

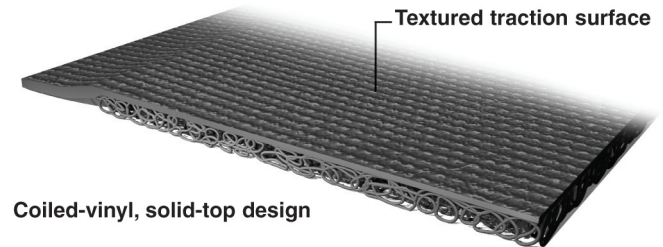


3M Matting Technology

The other technology platform utilizes a unique integrated “Z” polymeric closed cell foam design to provide the anti-fatigue properties. The closed cell foam provides cushioning and the integrated “Z” construction provides independent support across the bottom of the foot to keep the foot cushioned and stabilized while standing. This phenomenon is similar to air-filled tires and independent suspension on automobiles that provide a cushioned yet stable ride. Constructions utilizing this technology are described below.

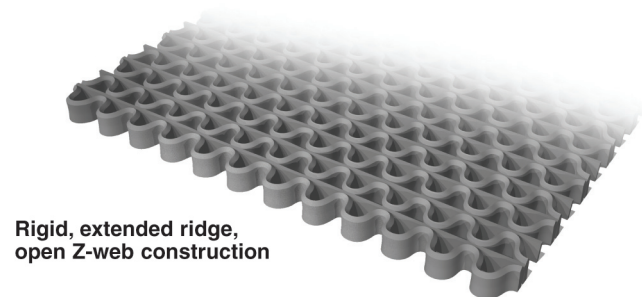
3M™ Safety-Walk™ Cushion Matting 3270

- Spring-coiled vinyl compresses uniformly and continually, providing greater comfort and less fatigue
- Textured top surface provides a high coefficient of friction to increase the security of footing
- Solid top allows debris to stay on top for easy cleaning
- Coils are permanently fixed to the top surface and will not delaminate or separate when wet like foam mats



3M™ Safety-Walk™ Cushion Matting 5100

- Rigid vinyl Z-web construction provides firm support and allows cart traffic for a multi-functional work area
- Extended ridge design provides increased traction in wet areas, helping reduce slips and falls
- Open Z-web design allows liquids and small debris to fall through to increase the security of footing



Conclusion

Workers have known for years that their workplace is a source of risk to injury – and they’ve also known their workplace can hold the key to reducing that risk.

Employers need to respond to their workers’ concern, but also be proactive and reduce the risks of workplace MSDs before it becomes a source of injury. It’s not just a good idea – it’s enforceable by OSHA.

Government, independent researchers and 3M all agree: Musculoskeletal disorders’ impact doesn’t end with the worker; the impact is felt on the employer’s bottom line, and is reflected in billions of dollars of workers’ compensation costs for the country as a whole.

3M is doing its part to bring solutions to employers. 3M is accomplishing this through research to understand the issues related to workplace MSDs and in developing innovative products that further improve workplace conditions.

With the development and implementation of many state OSHA ergonomics standards, workers and employers all serve to benefit by addressing MSDs proactively.

- ⁱ CDC/NIOSH Ergonomics and MSS Fact Sheet 1997
- ⁱⁱ OSHA, Ergonomics, FAQs
- ⁱⁱⁱ CDC/NIOSH Ergonomics and MSS Fact Sheet 1997
- ^{iv} The Biomechanical Basis of Ergonomics, E.R. Tichauer, Wiley-Interscience, New York 1978
- ^v OSHA, Ergonomics, Introduction, Chapter IV
- ^{vi} OSHA Pathogenesis and Pathophysiologic Evidence for WMSDs
- ^{vii} Mayo Clinic, Health Oasis
- ^{viii} OSHA, Ergonomic Proposal, Chapter III
- ^{ix} OSHA National News Release, November 1999
- ^x Federal Register #65:68261-68871,section;(j)(2),page 68340
- ^{xi} Federal Register #:65:68261-68870,section;(m)(2), page 68365
- ^{xii} Rys an Konz, Proceedings of the Human Factors Society 34th Annual Meeting
- ^{xiii} Effect of Flooring on Standing Comfort and Fatigue, by Rakie Cham and Mark S. Redfern, University of Pittsburgh

Important Notice:

This document is intended to be an introductory summary. The information provided is based upon typical conditions and is believed to be reliable; however, due to the wide variety of intervening factors, 3M does not warrant that the results will necessarily be obtained. All details concerning product specifications and terms of sale are available from 3M.



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