

SHOE TIGHTENING MECHANISM

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Abstract: *This Research titled Shoe Tightening Mechanism deals with the difficulties faced during the fastening of shoes. ill-fitting shoes can cause damage to your feet almost immediately. Poorly designed shoes, or footwear that doesn't fit properly, can cause a number of short and long-term health problems that affect various parts of our bodies, so it's important to be clued up on what you're putting on your feet. The research shoe tightening mechanism is concentrated in precise fastening of shoes and reducing difficulties, preventing accidental deaths due to tripping of shoes.*

Keywords: *Shoe tightening mechanism, accidental deaths, difficulties, health problems*

I. INTRODUCTION

Shoe Tightening Mechanism deals with the difficulties faced during the fastening of shoes. Ill-fitting shoes can cause damage to your feet almost immediately. Poorly designed shoes, or footwear that doesn't fit properly, can cause a number of short and long-term health problems that affect various parts of our bodies, so it's important to be clued up on what you're putting on your feet. This can be implemented in any shoe that is fastened with laces or a pair of lace-ups. The project shoe tightening mechanism is concentrated in precise fastening of shoes and reducing difficulties. This is done by mechanical means and not by using any sensors or other electronics. The laces can be fastened and locked with the help of special type of gear mechanism commonly known as a worm wheel. The laces are fastened by moving the wheel and self-locking properties of this gear helps in the locking to give the precise fastening. The design of the system is very simple and also very economical. Therefore, it can be implemented easily in the shoes. The space requirement for the installation is also very less. On an average, you might have to tie your shoes about 4 times a day, each time taking 30 seconds. If you live to be 85, but you don't tie your own shoes for the first 5 years, you will end up tying your shoes for 80 years which is 973 hours' worth of time. What a waste! Shoe Tightening Mechanism can save time for a minimum of 730 hours reducing the time from 973 hours to 243 hours in an individual's lifetime. Correctly fitting footwear should have little or no negative impact on our health. It can also eliminate accidents caused due to untied shoe laces. 3000 teens die from shoelace related accidents every year.

II. WHY BAD FITTING SHOES ARE PROBLEM?

Wearing ill-fitted shoes is more common than we may think, and can have significant negative consequences. These "side

effects" of improperly fitting shoes can range from corns and callouses, to foot deformities, to falls, and even loss of independence. Spending a day in those cute (or attractive) shoes may seem like a minor infraction, but could lead to serious and potentially ongoing foot problems. Yet even when people think they are wearing good and sensible shoes, they could be at risk. If you've experienced foot pain from your shoes, and even if you haven't, learn about how common it is for shoes to fit poorly, the potential consequences, and what you should know going forward.

2.1 Poor Shoe Fit Is Common

We will address some of the medical problems associated with ill-fitting shoes, but it's important to first talk about the scope of this problem. From research to date, it's thought that only around 25 percent of people are actually wearing shoes of the right length and width. This is especially alarming when the studies were looking at elderly people. Not only do many older people have diabetes (with the risk of diabetic foot ulcers from pressure and rubbing in their shoes), but they may be at risk for falls and more. That said, even young people who are healthy and free from other medical conditions can be at risk from poorly fitting shoes.

Michael Ratcliffe, Podiatrist at Carnation Footcare, United Kingdom, says that the three main functions of shoes are to protect our feet, enable us to walk wherever we want and provide comfort when we are on our feet for long periods of time. He says:

"Correctly fitting footwear should have little or no negative impact on our health. Poorly chosen and incorrectly fitting footwear can impact negatively on our feet. Shoes with higher heels, poor grip and inappropriate or absent fastenings have been linked to impaired walking, balance and falls, while foot constriction within shoes can create paresthesia (pins and needles) or temporary numbness. If footwear is incorrect then short term problems can become long term ones with an unwillingness to pursue activities such as walking or even affect the ability to work in a chosen occupation with consequent mental, emotional and physical implications."

2.2 Short-term problems

Ill-fitting shoes can cause damage to your feet almost immediately. Some of the more common conditions include: Corns

Corns are a 'plug' of hard, dead skin that occur over a bony prominence, like a joint. They are often caused by prolonged pressure to the specific area – usually from poorly fitting footwear.

"It usually has a punctate, discrete shape and can be very painful when pressure is applied to the site. Corns can be

hard or soft (and, where they exist between the toes, damp) and can contain blood vessels and/or nerve fibres. Long standing corns can be firmly attached to deeper soft tissues, which makes them hard to completely remove."

Shoes that are too loose can allow your foot to slide and rub, or designs that place excessive pressure on a certain area of the foot are the most likely contenders to cause corns.

Nail problems

Nail and fungal problems are extremely common in the UK, with an estimated 16% of all Europeans thought to be suffering from some form of infection. Ingrown toenails, caused when the sides of the nail pierce the surrounding skin, are a particular nuisance and can be painful.

"Wearing shoes and socks that do not fit properly and are too tight places pressure to the sides of the toes and can push the skin into the nail plate. Additionally, cutting your toenails incorrectly (neither straight across nor in a gentle curve) and cutting down the sides of your nail can place your toe at risk of an ingrowing toenail."

Additionally, fungal toenail infections cannot only be unsightly – causing discoloration and brittleness of the nail – but they can also affect self-esteem and (rarely) lead to further complications by which the infection is spread.

"Trauma, either a single episode or repeated minor episodes (caused by tight footwear), can lift the nail from the nail bed giving normal skin dwelling organisms a portal of entry into the nail bed and softer underside of the nail plate where they can thrive."

Avoiding wearing tight hosiery and footwear, which can damage the nail through repetitive trauma and create a moist environment in which the fungal spores can thrive, can help prevent fungal toenail infections.

Athlete's foot

Athlete's foot is caused by a dermatophyte – a fungal species living on the skin. It causes intense itching, inflammation and flaking of the skin, and is simultaneously unsightly, uncomfortable and extremely contagious.

"This condition affects the damp and sweaty areas of the foot, particularly between the toes and the toe webbing spaces (especially in tight fitting shoes which bring the toes in close proximity to each other for the duration of wearing those shoes) and often under the inner arch of the foot."

This condition can be spreadable and caught while walking barefoot in an area where others are also foregoing footwear. Good foot hygiene and use of an antifungal cream will help – it is important to treat this condition before it spreads to the toenails.

Blisters

If you suffer from these injuries, your shoes are rubbing on your feet and toes the wrong way. Often, this has been attributed to narrow and tight shoes. The pressure and friction that result from wearing narrow and/or tight shoes could easily lead to blisters and bunions.

2.3 Long-term problems

The wrong pair of shoes can cause permanent damage to your body further down the line, and resulting problems aren't just limited to your feet. Keep an eye out for:

Collapsed Arches

Collapsed or 'fallen' arches (more commonly known as 'flat

feet') is the term used to describe the instance when somebody's feet have low or no arches, and as a consequence press flat against the ground.

"This occurs when there is tightness in the Achilles tendon and the muscles at the back of the leg whilst walking. This can lead to strain in the ligaments that support the arch (the Spring Ligament), the Plantar Fascia and the tendon of the muscle (tibialis posterior), which also helps to support the arch. Prolonged strain to these soft tissue structures may result in damage and a lowering of the arches with consequent pain in the arch and heel area."

Wearing shoes that have no heel at all does not offer support to those people who have tight calf muscles and Achilles tendon.

Back Pain

There are number of potential problems that might arise from wearing improper footwear (especially heels) over a prolonged period of time, some of which target your back.

"Lumbar spinal muscle action can be exacerbated, leading to overuse with eventual stiffening and resulting in postural changes. Also, possible lumbar intervertebral disc compression (as a result of poor footwear) can lead to lower back pain."

Stick to low shoes where possible, and if you do wear high heels then make sure they are 'well made' and are not worn for too long.

Joint Pain

Prolonged overloading as a result of shoes that don't provide adequate support can ultimately cause all sorts of joint problems such as arthritis and also knee pain – especially in the case of high heels.

"The knees are forced to bend more to substitute for the reduced shock absorbing at the feet when the heel hits the ground during walking. Also as a result the muscles in the front of the thigh have to work harder to allow you to get a good push off during walking."

Ill-fitting footwear can also lead to deformities such as bunions and bony lip development around the larger foot joints. It has also been recently suggested that breathing and vocal cord health can be affected by shoe choice, as Helen Sewell, a leading voice and communication coach, told a parliamentary committee that wearing heels all day could lead to faster, shallower breathing and damage the vocal cords.

III. PAINFUL STATISTICS ON SLIPS, TRIPS AND FALLS

According to Occupational Safety and Health Administration (OSHA), most general industry incidents involve slips, trips, and falls. They cause 15% of all accidental deaths, and are second only to motor vehicles as a cause of fatalities. The OSHA standards for walking/working surfaces apply to all permanent places of employment, except where only domestic, mining, or agricultural work is performed.

I'd like to focus on slips, trips & falls today because they can happen anywhere in your operation. Slips and trips can result in falls, possibly disability or death. The results of these accidents can be extremely costly to employers and employees.

As reported in 2013 by National Safety Council, “fall from the same level” (\$7.94 billion) and “fall to lower level” (\$5.35 billion) were the second and third highest injury causes of disabling workplace injuries in 2011.

What are the leading causes of slips, trips and falls in the workplace? Slips can occur when floors or other working surfaces become slippery due to wet or oily processes. This includes floor cleaning, leaks, or from materials and debris left in walkways. Uneven floor or working surfaces can lead to trips. This may include protruding nails and boards, bunched floor mats or uneven carpeting, holes or depressions in working surfaces, and also step-risers on stairs that are not uniform in height. Both slips and trips can result in falls, which can occur when ladders are not maintained properly, and when stairways and elevated working surfaces are not designed properly.

According to the Center for Disease Control and Prevention (CDC) and the Bureau of Labor Statistics (BLS):

- 65% of fall-related injuries occur as a result of falls from same-level walking surfaces;
- The services, wholesale, and retail trade industries together accounted for over 60% of injuries that resulted from same level falls;
- The manufacturing sector alone accounted for 16 percent of injuries that resulted from same-level falls;
- Over 60% of all elevated falls are from a height of less than 10 feet;
- Over one million Americans suffer a slip, trip, and fall injury every year;
- An estimated 20 – 30% of people who experience a slip and fall will suffer moderate to severe injuries such as bruises, hip fractures, or head injuries;
- The most common fractures that occur from slip and fall accidents are fractures of the spine, hip, forearm, leg, ankle, pelvis, upper arm, and hand;
- Slip and fall accidents are the most common cause of traumatic brain injuries (TBI) and these account for 46% of fatal falls among older Americans;
- Slips, trips and fall accidents can also cause other complications including: Death, Incapacitation, Broken bones and fractures, Long-term medical complications, Head trauma and Spinal cord injuries;
- 1 in 6 of all lost-time work injuries result from slips, trips and falls;
- Slips, trips and fall injuries make up almost 20 percent of all job related injuries;
- It is estimated that these injuries result in an average of 11 days away from work;
- Approximately 19,565 people die in the U.S. annually due to injuries caused by unintentional falls;
- According to OSHA, slips, trips and falls cause 15% of all accidental deaths;
- Slips, trips and fall injuries account for between 12 and 15 percent of all Workers' Compensation expenses;

- Slips, trip and fall injuries cost employers approximately \$40,000 per incident
- 3000 teens die from shoelace related accidents every year.
- Shoelaces are banned in UK at workplace due to the accidents.

IV. SOLUTION TO THIS PROBLEM

The Shoe Tightening Mechanism deals with the difficulties faced during the fastening of shoes by locking the laces in the desired position without untying and tying the laces again. This mechanism does not require any special attention by the user wearing this footwear i.e. shoe.

This also eliminates the need to check the shoe laces by the person wearing it which saves both time, labour and ensures the safety and health of the person wearing the shoe.

V. PRINCIPLE AND WORKING

Shoe tightening mechanism can be very useful in eliminating the deaths caused by tripping due to untied shoelaces.

In this mechanism a special gear arrangement i.e. worm and wheel is used for the fastening of laces or strings in the shoe. It works on the principle of self-locking of the worm wheel.

Worm Wheel

Worm gears are usually used when large speed reductions are needed. The reduction ratio is determined by the number of starts of the worm and number of teeth on the worm gear. But worm gears have sliding contact which is quiet but tends to produce heat and have relatively low transmission efficiency.

As for the materials for production, in general, worm is made of hard metal while the worm gear is made from relatively soft metal such as aluminum bronze. This is because the number of teeth on the worm gear is relatively high compared to worm with its number of starts being usually 1 to 4, by reducing the worm gear hardness, the friction on the worm teeth is reduced. Another characteristic of worm manufacturing is the need of specialized machine for gear cutting and tooth grinding of worms. The worm gear, on the other hand, may be made with the hobbing machine used for spur gears. But because of the different tooth shape, it is not possible to cut several gears at once by stacking the gear blanks as can be done with spur gears.

The applications for worm gears include gear boxes, fishing pole reels, guitar string tuning pegs, and where a delicate speed adjustment by utilizing a large speed reduction is needed. While you can rotate the worm gear by worm, it is usually not possible to rotate worm by using the worm gear. This is called the self-locking feature. The self-locking feature cannot always be assured and a separate method is recommended for true positive reverse prevention.

Also there exists duplex worm gear type. When using these, it is possible to adjust backlash, as when the teeth wear necessitates backlash adjustment, without requiring a change in the center distance. There are not too many manufacturers who can produce this type of worm. The worm gear is more commonly called worm wheel in Japan.

Principle of Self-Locking Feature of Worm Gears

Self-locking means it is not possible to drive the worm using the worm wheel, and this feature is used in such things as reversing prevention systems and roll-up mechanisms.

A worm gear's self-locking tendency increases as the lead angle decreases (It becomes easier to self-lock).

As the lead angle gets larger, it becomes less self-locking.

Problem Areas of Self-Locking

Because it is relying on the coefficient of friction, self-locking lacks stability.

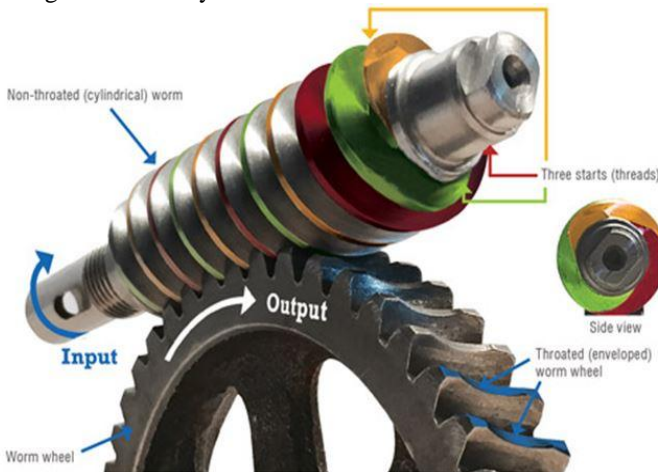


Fig 1. Worm Wheel

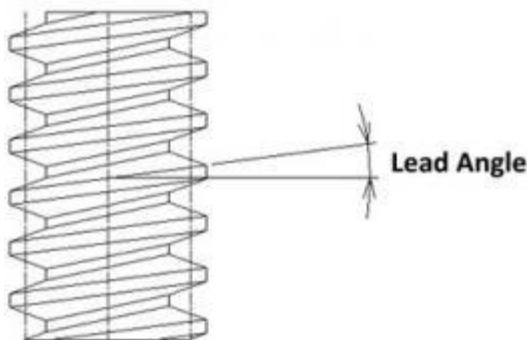


Fig. 2 Lead Angle

- Even with the same lead angle, it is difficult to self-lock with materials which have small coefficients of friction (μ)
 Example : Material Combination / Coefficient of Friction
 iron and iron / about 0.3
 Material Combination / Coefficient of Friction
 iron and aluminum bronze / about 0.2
 Material Combination / Coefficient of Friction
 iron and phosphor bronze / about 0.15
- Coefficient of friction changes with speed-
 When stationary, the static friction is high, but as the speed increases, it becomes dynamic friction, and the coefficient of friction decreases. When there is vibration, it is possible to reverse rotate.
- Coefficient of friction is smaller when the surface roughness is low
 It is difficult to self-lock with ground worms.

VI. COMPONENTS USED

Worm and wheel arrangement

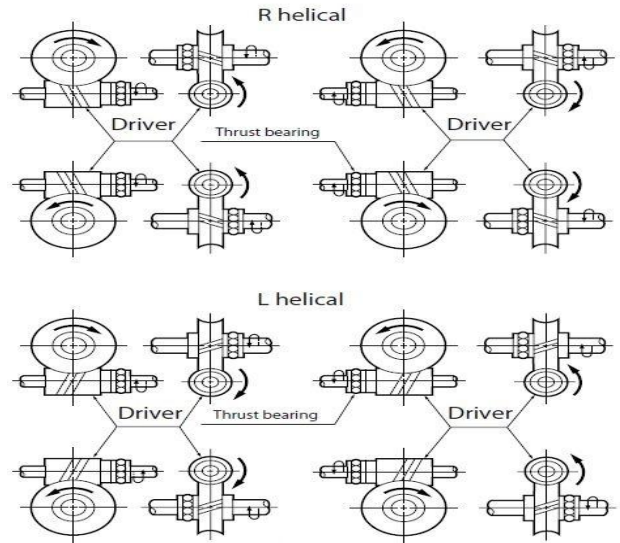


Fig. 3 Direction of Rotation

2. shoe
- 3.copper wire as shoelace or fastener

VII. CONCLUSION

Shoe tightening mechanism of this nature will make the shoe more expensive than the normal shoes in market however if we are making it in bulk then net cost of the whole equipment will be reduced. The mechanism is too easy to be fitted in a shoe that very high skilled labour is not required for the manufacturing of these shoes.



Fig.4 Figure showing ease of making
 The equipment is made of mechanical parts only without any electrical parts hence the mechanism is waterproof and there is no stress on user while wearing these shoes in the rainy season.

A lot of time can be saved by using this mechanism for the fastening of the shoe. Shoe Tightening Mechanism can save time for a minimum of 730 hours reducing the time from 973 hours to 243 hours in an individual's lifetime.

These shoes prevent the accidents from tripping of the user due to untied or loose. To be more accurate, around 3000 deaths can be cured every year. The precise tightening will also prevent the user from injuries that occur due to the bad fitting of the shoes.

These shoes are blessings for the paralyzed patients or physically handicapped people with only one hand working as these people will be able to fasten their shoes by themselves. As the tightening from this mechanism is more precise, many of injuries are prevented so these shoes will be recommended by the doctors too as a medical equipment to the injured patients.

Athletes will also be using these shoes as uncomfortable fitting or loosely tied shoes can be reason for losing a game at international level which is of great importance in life of athlete.

This mechanism can also be further automated by some organizations for the automatic tightening of the shoes which can be more upgraded level of this mechanism.

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