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Optimizing Revolution Development of Low Cost Sustainable Glide Shoe in Biodegradability Study in Compost Environment

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Abstract:- It has been proclaimed that the most advanced period for human empowerment and inventions has been the last few decades. As a result of innumerable technical and scientific advancements, humanity is advancing with unfathomable strength. All of these things are sufficient to prompt the question, "Is this actually happening? What's the catch, though? According to Newton's third law, every action has a corresponding and opposing response. In light of all these recent discoveries and technologies, what is the opposite response? Environmental degradation would be a straightforward explanation. This one phrase comprises countless issues for which man hasn't even attempted to find solutions. The components and materials used in the footwear industry contribute significantly to global warming.

I. INTRODUCTION

One of the most vital organs in the body, the foot is essential to many bodily processes. To truly comprehend this, one must practice appropriate foot hygiene and use only safe items. However, we are still a long way from coming to this awareness because we are unaware of the potential harm that the materials in our shoes might do to the environment and to ourselves. It is therefore necessary to develop a fully organic shoe that significantly lessens all the negative effects. Even though not all consequences may be felt right away, they all eventually manifest. And not only does this contribute to environmental preservation, but it also significantly lowers the cost of shoe preparation, making it affordable for everyone.

Some claim that the leather business is the second-oldest occupation in the world, having played a significant role in international trade for centuries. Today, it is without a doubt a significant multinational sector with significant economic impact; in just one year, 23 billion square feet of leather, worth almost 45 billion dollars, are produced (2007).Out of the entire leather industry, shoes/footwear constitute the biggest part that is 47% along with other leather goods having 12% and automobile industry having 17%. And as we all know, it is a huge process to cure raw hides into finished leather that is used for shoe making. Raw hides are not a threat to the society. But the numerous amount of chemicals and substances that are used in the process has adverse effects on the environment and slowly poisons the environment. It also makes the hides that was once degradable into a semi degradable substance. Other important constituents of a shoe are synthetic and rubber. Synthetic polymer materials, without even a doubt, play an important role in our everyday lives. Synthetic polymeric materials are rapidly replacing organic elements in footwear. Polymeric materials such as polyurethane (PU), ethylene vinyl acetate (EVA), thermoplastic rubber (TPR), and thermoplastic polyurethane (TPU), for example, are progressively displacing natural materials such as leather and natural rubber (NR). Now the aim of this present study is to design and develop an completely biodegradable shoe which can easily be degraded or recycled and is affordable to people of every profession.

II. MATERIALS & METHOD

- **Upper:** The main composition of the upper consists of leather. Natural leather is biodegradable since it is essentially formed of collagen cells from an animal's skin that have been treated by tanning to slow down or stop the decay process, but it will eventually rot if it is not cared for or is purposefully allowed to do so.But for increasing the physical properties and durability of the leather, various chemicals are used in the process of tanning which are bio degradable and a danger to the environment. Some of those chemicals are chromium, aldehydes and solvents. Hence these pose as a great threat to the environment.As a remedy for this, the process of vegetable tanning is incorporated along with the addition of anhydrous copper sulphate. The copper is added because just vegetable tanned leather poses a great threat for decomposing quicker than usual. And the presence of anhydrous copper sulphate is more prominent to the environment and is highly effective as well. As a result, we get leather products that are more readily biodegradable than before and contributes towards a pollution free environment
- **Insole:** The insole incorporated in GLIDE SHOES are blended insole. It's generally made form insole and shank board which are generally manufactured form vegetable wastes, wood pulp and other organic materials. The part under observation is the shank as it is usually made form metal and plastic. An even more environmentally friendly shank is implied in the insole making the entire component completely biodegradable and environmental friendly.

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The blended insole used in GLIDE SHOES is implied with specific many reasons. the first advantage is that the shank is placed outside which helps to distribute the pressure and force of the foot evenly and creates great comfort. Any type of foot including diabetic patients can use this as the weight is spread similarly. It also helps in easily understanding the gait pattern the shank helps us to measure the ground reaction force and design according to it.

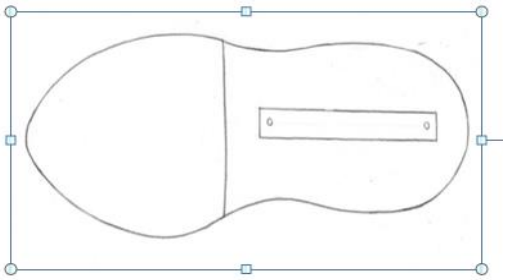

Fig. 1: Blended Insole with shank

- **Sole:** The sole is one of the most important part of a shoe and it requires strong and durable materials as it is in direct contact to the hard ground. As a result, it's essential that no quality compromises must be made in the sole. the sole used in GLIDE SHOES are a mixture of PU, TPR and EVA. And all these are made form already used and discarded materials which increases the sustainability of the product. The process of rejuvenating already used materials greatly help in controlling the non-disposable waste products and contributes to a major part of conserving the environment.

The sole is designed in a way that it gives maximum performance and is also soft for the user to wear. And the most important thing is that since the sole is made of a combination of TPR + PU+EVA +Clay materials, it has the combined properties of all the three materials. And as it is made from already used and disposed materials, the cost of it also greatly reduced as to make it available to every single person.

A mechanism called rocker mechanism is also employed in the glide shoes. With the application of Rockwell mechanism in the shanks and insoles of footwear it is found that they provide more strength and improve the safety in shoes. By applying its properties and process on the shank, its strength is increased which provides flexing resistance to the shoe and protects the wearers feet from any external damage.

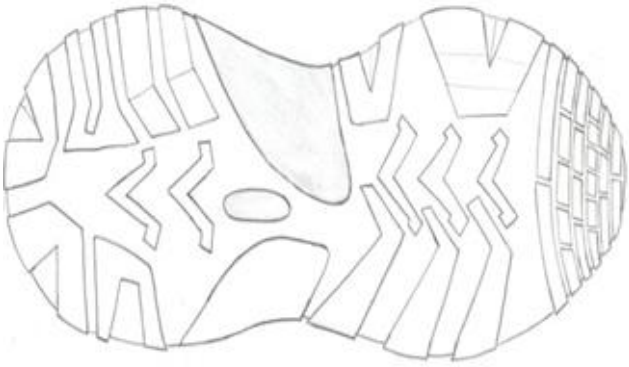

Fig. 2: Sole with rocker bottom

- **Shoe:** The entire shoe is designed in a way that it is light in weight and also durable in all perspectives. And also the most important part is that it is entirely bio degradable and poses no threat to the environment. It is also suitable for all age groups as it entirely made natural products and has no chemical side effects on the foot due to unwanted chemical reactions. The shoe also provides great comfortability and laces are used as to achieve a perfect fit.

Fig. 3: GLID shoe

III. METHOD

The first step is applied in the process of tanning of leather which is going to be used for making the glide shoe. Animal skin is turned into leather by the process of tanning, which involves soaking the skin in a solution containing tannic acid or other chemicals. And usually now a day the chemical compound Basic Chromium Sulphate $Cr_2(SO_4)_3$ is widely used for this operation. But studies show that Chromium VI is the most harmful type of chromium, and it can cause allergic reactions, skin rashes, nasal irritations and nosebleeds, ulsers, a weakened immune system, genetic material changes, kidney and liver damage, and even result in death. Not only does it affect humans but also has adverse effects on the environment. Cr toxicity in plants manifests as reduced seed germination, decreased growth, lower yield, suppression of enzyme activity, a lack of photosynthesis, nutritional and oxidant imbalances, and mutagenesis. Knowing this puts us in an advantage so the we could find a suitable replacement for such a toxic tanning agent. This is where glide shoes propose a new tanning agent.

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This invention is related to replacing (BCS) Basic Chromium Sulphate $Cr_2(SO_4)_3$ with (PCS) Pentahydrate Copper Sulphate $CuSO_4 \cdot 5H_2O$, as a substitute for chrome tanning which is continuously used for making leather from animal hides and skins. When compared to the highly harmful effects of chromium, Compared to chrome tanning, copper tanning is less dangerous and has strong chemical qualities that can enhance the physical properties of the leather. This discovery could improve leather quality while also addressing environmental problems brought on by chemical waste from tanneries.

Next the upper patterns are cut using our new and improved leather, and all the components are subjected to the process of upper making. Lining is given with normal cloth and so on. But it is made sure that each component is completely recyclable.

Blended insole is incorporated inside the shoe due to its various positive effects. And the sole is made up of a mixture of EVA, TPR and PU. All these are already recycled materials mixed-up to give maximum performance and durability.

IV. TESTING & CHARACTERIZATION

1st step to manufacture glide shoes are to obtain the Pentahydrate Copper Sulphate tanned leather instead of the usual chromium sulphate tanning. For this, certain steps are to be followed.

Firstly, an important step before starting pre-tanning operations. Curing (preservation of hide) it will be done by a chilling method which is an alternative of salt curing (NaCl) common salt is popularly used for preservation of hides and skins of the animals in Indian leather industry. Chilling is a short-term curing method of hides and skins. After 7 days' preservation ready for pre tanning operations. Soaking operation is necessary for rehydrating hides after preservation of hides in a blast chiller, and also helps to remove blood stains, insoluble protein, dirt and other unwanted waste. Liming operation also known as Unhairing operation which is done after Soaking operation to disrupt the hairs or epidermal layer also loosen the hair follicles and open-up the fiber bundles of the collagen. After Liming operation, Deliming operation is an essential process for removing excessive lime from the limed pelt and maintaining the pH level of the pelt as well as osmotic swelling.

Last pre-tanning operation is Pickling operation by which pH level of bated pelt has to be changed to desired pH level according to requirement for the tanning process. It also prevents pelt from several microorganisms and bacterial attacks and can be stored for about months.

Tanning process is done with pickled pelts for required properties like softness, suppleness, flexibility and durability. After pickling we removed 50% of pickled water, now we will add Tanning agent 4% of (PCS) PentahydrateCopper Sulphate ($CuSO_4 \cdot 5H_2O$) salt. Rotate drum at shrinkage temperature (T_S) 105-110°C for 30 minutes. After, rotate the drum for another 30 min in fresh water (H_2O) with 4% of PentahydrateCopper Sulphate ($CuSO_4 \cdot 5H_2O$) salt at optimum temperature 37°C.

Here Post-Tanning operation takes place after tanning, Sammying operation is removal of excess water of the leather has been reduced so we can execute all post-tanning operations easily.

And after this the remaining process are done to get the finished leather which has been successfully tanned with copper sulphate.

Next the leather is cut into components and the tightness and stretchiness of the leather are tested. Components like insole and soles are also tested to see if any complications may rise during placing the shank following the rocker mechanism.

In this way every single process is tested and any complications arising are solved immediately.

NOTE: all the above mentioned testing processes are only studied and recorded theoretically and is yet to begin practical testing.

- Conditions
  - Before performing biodegradability test
  - After the biodegradability test
- Physicochemical properties
  - Tensile strength
  - Hardness
  - Abrasion resistance
  - Scanning Electron Microscopy
  - Thermo Gravimetric Analysis
  - Differential Scanning Calorimetry
  - Attenuated Total Reflectance-Infrared spectroscopy
- Gait Analysis
  - Biomechanical analysis

V. FUTURE SALIENT OUTCOMES

- Light weight
- Antibacterial
- Good Slip resistant
- Breathable
- Odorless
- Low cost

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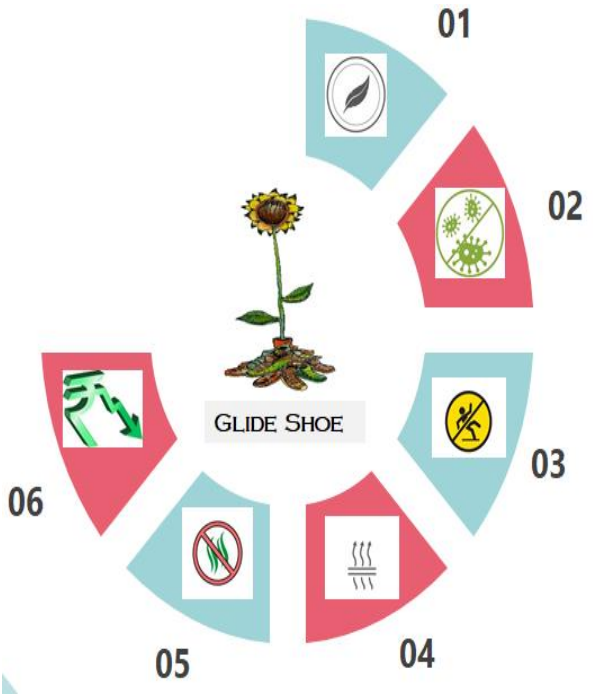

Fig. 4: Future Salient Outcomes

VI. CONCLUTION

Recent days, everyone are so concerned about saving the environment that they post and share posts regarding environmental awareness, and still continue to pollute without even knowing that their day to day activities cause so much damage. One of best examples of this is the waste management of shoes. Educating everyone might not be a simple job but making pollution free and recyclable shoes are now possible. Glide shoe's main emphasis is that an everyday necessity like shoes must not act as a pollutant to the environment. And another main feature is the availability of glide shoes. It is manufactured in a way that it is available to people of all professions without discrimination. To achieve this going to be huge milestone in the history of footwear and the environmental protection.

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Figure Captions
Figure 1:**Blended Insole with shank**
Figure 2:**Sole with rocker bottom**
Figure 3:**GLID shoe**
Figure 4:**Future Salient Outcomes**

BIO-BRIEF OF AUTHORS

Mr. T.Loganathan is presently working as junior faculty in Footwear Design and Development Institute, Ministry of Commerce and Industry, Govt.of India. He is having more than 8 years of association with Footwear and Leather industry since his Master Program (M. Tech, Footwear Science and Engineering Department of Leather Technology) in 2016.He is having 12 international publications and 3 Indian patent. He has received “Mecca Haaji Abdul Majid Sahib Endowment Best Project Award” from CSIR-CLRI, Chennai, India for the M. Tech academic project. He also received “Best visual presentation Award” from UITIC 19th International technical footwear congress, Chennai, India held during February 2016.