What is the feasibility of turning post-consumer shoe waste into a residential shingle?

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Textiles II

Introduction

What do you do with your shoes once you decide you no longer want them? For most people, the answer is throwing them away. What many consumers do not realize is that shoes can be recycled to have another lifecycle. Putting shoes in the landfill could be costing communities valuable building materials. Furthermore, the shoes that are thrown out into landfills take many years to degrade, causing many environmental issues.

Shoes already have several recycling applications. We specifically want to look at the rubber soles. There is a wide variety of information related to recycling other rubber-based materials into housing materials. However, there is currently a gap in academic research for the possibility of converting shoe soles into a residential shingle. Most information available is through tradesmen whose articles and reports have not been peer-reviewed.

Sustainability in common household items

Many people are approaching residential sustainability as an artistic outlet to personalize their home and prevent large items from reaching landfills. Upcycling is no longer viewed as just a DIY project that probably will not turn out correctly (Clarke, 2020). However, this approach is not necessarily preventing the creation of new products. Many consumers may think they are making the sustainable choice when buying products that boast recycled content, but in reality, it is a small fraction of what is actually in the material.When building or renovating a home, drywall is a frequently purchased item. Currently, most post-consumer recycled content in drywall refers to the paper used in facings, which comprises only 3-8% of the material's weight (Healthy Building Network, 2020).

An estimated 20 billion shoes are produced every year, and 300 million of them end up in a landfill. People simply throw away shoes that are too small, too worn, or sometimes those that

did not sell well enough. The decomposition of these shoes takes a long time. Rubber soles can take 80 years to break down. A common ingredient, Ethylene Vinyl Acetate, may take 1,000 years. (The Shoe Industry, n.d.) What if we found a way to use the long decomposition period as an advantage by using it as a building material?

Existing shingle materials

There are several shingle options available, such as tile, slate, metal, and the most popular, asphalt (Consumer Reports, 2021). They consist of a fiberglass or felt paper base that is coated with a waterproof layer of asphalt and then topped with ceramic granules. Although these shingles use recycled materials, they are not very eco-friendly because of the asphalt content (Guardian Roofs, 2015). Manufacturers are working to improve the technology behind rubber shingles. Post-consumer tires are ground into a powder. A liquid mixture is made from the powder and poured into a mold to form the shingles. Compared to those made from natural materials, the rubber shingles are less fragile and expensive, but more flexible and durable (Roof.info, n.d.).

Lifecycle of a shingle

Shingles are one of the most common building materials, one would expect them to be durable, however, traditional shingles do not have a long life expectancy. “It is estimated that between 8 million and 12 million t of roofing shingles are manufactured each year in the United States. […] 65 percent of these shingles is used for re-roofing” (Brock, 1990, as cited in Schroeder, 1994). Having to manufacture this amount of roofing shingles per year suggests these shingles aren’t meant to last an extended period of time. Majority of shingles will eventually be discarded in a landfill creating more environmental waste, “between 5 million and 8 million t of old waste shingles is produced annually” (Stroup-Gardiner, 1993, as cited in Schroeder, 1994).

Impact of discarded shoes

To understand the waste caused by shoes the materials to create them need to be discussed. There are many different types of shoe materials such as leather, suede, etc. Many know that the soles of shoes are created by some form of rubber compound. The compound of, "the soles of materials mainly include polyvinyl chloride (PVC), polyethylene (PE), thermoplastic polyurethane (TPU), etc" (Zhang, 2018, 2). How do these materials affect the environment? One study showed that after several years of degrading, shoes let off chemicals such as benzene, chlorine toxic gas, which seeped through the ground, water, and into the air, for humans and animals to breath/harm (Zhang, 2018, 3). Given that shoes are a necessity in life, almost everyone on the planet has at least one pair of shoes. For just one pair of running shoes, the carbon footprint is estimated to be 14 ± 2.7 kg CO2-equivalent (Cheah, 2013, 18). Multiplying that number by every person on the planet just once will leave an astronomically negative effect on the environment.

Provided that almost everyone has shoes, what happens when these shoes are deemed worn-out or unwearable? Majority will land in a waste field, as many people do not know of recycling options for shoes. "The annual production volume of global footwear exceeds 20 billion pairs, […] this number is still increasing annually, however, the loss of the use of shoes (the end of life cycle), and not timely recycling, most of which were sent to landfills or abandoned in the natural environment, resulting in a large number of waste production" (Zhang, 2018, 1). A study in the European Union showed for one year residents in the EU alone "estimated that the waste arising from post-consumer shoes will reach 1.2 million tonnes" (Rahimifard, 2007, 3). Once rubber has hit the landfill it will stay there for years, adding more

waste into the environment. “The major rubber waste source can take up to 80 years to naturally degrade” (Basik, 2021).

Existing shoe recycling options

Many consumers are not aware that shoe recycling programs are available to them. According to Vans representative Melanie B., “In April 2019, we launched a 6-month shoe recycling pilot program in 24 Van locations across Southern California in partnership with TerraCycle” (Melanie B., 2022). Shoe soles and tires are both made of rubber compounds, making them similar in the formation and degradation processes. There has been more research regarding tire conversion into housing materials. Many cities and universities are currently conducting studies to produce noise walls, retaining walls, poles, insulation, etc. from scrap tires (Schroeder, 1994). There are three ways to recycle used shoes: donating them (this option still creates a high likelihood of the shoes ending up in a landfill), recycling the materials, and to recycle shoes into energy/power (Rahimifard, 2007, 5).

Possible challenges

There are many restrictions for shoe soles to be recycled into shingles. There will be certain areas that will not be able to use this material. The temperature will need to be evaluated for each geographical region due to varying climates. Certain areas will be excluded due to their high or low average temperatures, as it can affect the properties of the rubber. The areas that will have the best advantage are the ones with optimal temperature, “the optimum temperature for rubber is 20 C” (reference.com).

Possible benefits

An advantage of recycling shoe soles, made from rubber compounds, is the resistance to lightning. Because rubber is a poor conductor of electricity, this material has the potential to save

homeowners money in the event that their house is struck by lightning. It can prevent their wiring from shorting throughout the whole house, which is an expensive repair. In a study for reclaimed rubber, it was found that reclaimed rubber into thermoplastic vulcanizates promoted processability, meaning the reclaimed rubber could be converted (Thitithammawong, 2019, 98-102). The results of this study show that the rubber compounds in shoe soles also have the ability to be converted.

Conclusion

There is a clear lack of information for residential applications on how post-consumer shoes can be utilized. Similar material types are already being used and benefiting consumers. With further research, companies can have a new material that can be reclaimed, which reduces the need to create new ingredients for these products. This will also redirect waste from landfills that can be used if properly understood.

All of this information leads us to a question: is it possible to turn post-consumer shoes into shingles in a residential setting? That is what we hope to determine with our research.

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