Design of a Rubber Sandal Press for Loisaba, Kenya

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Introduction

In Kenya 56 percent of the population lives in poverty, surviving on less than a dollar a day. Walking is the main mode of transportation and the majority of Kenyans can only afford second hand shoes that wear out easily on the unpaved roads. The purpose of this project was to develop an inexpensive manual cutting machine to cut sandals out of recycled tires and industrial belt allowing poor Kenya villages to produce their own sandals that are durable enough to survive the rough terrain. In developing this machine the goal was to make an efficient machine that was affordable enough for a company in Kenya to make and sell to local villages who could in turn use this machine to make a profit selling affordable shoes. In the design of this machine special attention was paid to the materials and tools available to manufacture this press.

Design Criteria

- **Affordable** – retail price less than a couple hundred dollars and provide a quick return on investment.
- **Energy-Efficient** – this machine is a human powered design so must be extremely efficient at converting human power to mechanical power.
- **Portable** – the press must be small and light enough to carry home by foot, bike or minibus.
- **Easy to use and set-up** – should not require training to use and must not require additional tools.
- **Durable** – machine must last years and be able to withstand abuse because it represents a large investment

Design Work

The machine design had to work manually and provide significant mechanical advantage to cut through the vulcanized rubber. Exploring different design options for the mechanism, the use of linkages was selected as the best method based on the design criteria.

Three toggle linkage designs in particular were analyzed based on mechanical advantage and stress analysis. A stone crusher six bar, double toggle linkage was chosen to mechanize the press. This linkage had a calculated mechanical advantage of 3.75, which increased as the links approached a toggle position.

The linkage design was simulated in SolidWorks with three different materials: two metals, stainless steel and cast iron, and one wood, pine, to compare the minimum factors of safety when subjected to a 500N force. Pine had the lowest minimum factor of safety with 1.82 but the design did not fail so a pine prototype was built to test the simulation results and the cutting capabilities.

A couple die blade prototypes were made with varying blade thickness and different cutting angles to test the cutting capabilities of the design. In actual building of the design a few characteristics were modified like the linkage mounting brackets to minimize the required machining and parts.

Results

The press linkage mechanism and blade were able to successfully cut through a rayon-belted tire sample. Design testing of the prototype with pine linkages did not result in failure supporting the SolidWorks stress simulation. The overall cost of the prototype was roughly $75 in materials and the final weight of the design about 30 lbs with pine and stainless steel components.

Conclusions

The design has some flaws that could be addressed to improve the fluidity of the motion and stability of the slider but when it comes down to it, this design gets the job done. Some further testing of the design durability may prove that metal linkages to be more desirable but at the expense of portability and higher costs. Also while the design was initially intended to be actuated by a single person, the opposing orientation of the two drive links which was to ensure the design stability make the machine a two person job. A test cutting a full shoe from the industrial belt still needs to be completed to get a final stamp of approval but the success in cutting a sample with the die, proves that this machine provides some serious mechanical advantage.

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Further Information

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