Case 2 - Load carrying device
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Introduction

Labors are carrying the load on their head at different places like construction sites, farm, etc to transfer the load from one place to another. We identified the problems of women working at the construction site. They are carrying bricks and MORTAR on their head. The weight of the bricks is around fifty kgs. They are getting huge pain in the neck and back which is very dangerous for their health. They get tired very easily. The load is concentrated on the head. The stress developed is very high. Therefore, we have tried to make a device so that the stress can be distributed over the body. Moreover, the energy loss in a day can be reduced.

First Brainstorming

In the first Brainstorming, we have discussed the different aspects of design like the load acting on the body, Balancing problem, Strength of the device and what are the different stakeholders who will be benefited with this device.
Literature Review

We have searched few papers and found some important information. How the stress developed in the body and the amount of energy consumption in a day when the load applied to different parts of the body. According to a paper, The load has applied to three different places of the body. And found out the energy consumption in each case. We should match the center of gravity of the device with the body so that the device will be balanced. There are two different posture of the body, One is when carrying the load and move on the horizontal surface and another is when moving on an inclined surface.
Carrying load on a back walking on (a) horizontal surface (b) Inclined Surface

According to this paper, The load should not apply away from the body. The energy consumption is less when the load is closer to the body. The device should be such that It’s easy to carry, Portable, Easy to handle, lightweight, Durable, Efficient, etc.

Field Visit

To get the better understanding of the problem, we went for the field visit at four different places. First, we went to the construction in Amrapur near Grambharti. Initially, we have observed the living condition and work of the laborers. They have made the tents and preparing the food outside. We have interacted with Khusbu. She is from Rajasthan. She is studying in ninth standard. Because of their low financial condition, She use to work in holidays. She is able to carry twelve-sixteen bricks on her head and transfer from one place to another. The weight of each brick is 3-3.5 kgs. She was able to carry around 50 kg load on her head. She uses a wooden plate to carry the bricks and cloths so that the impact of the load on the head should be less. First, the labourers use to load the bricks on their head one by one and then transfer to another place. During unloading, Either they throw the bricks on the ground one by one or all the bricks simultaneously. We have observed that when they through the bricks simultaneously, sometimes bricks break. But the time consumption is less in this case. However, If they unload the brick one by one then the bricks don’t break but the time consumption is large.
Khusbu is carrying sixteen bricks on her head

Wooden plate to carry the bricks

After all, we have also experienced to carry the bricks. It was very difficult to do. Mainly the balancing problem and pain in the neck. If the bricks won’t be properly kept then The labor can easily be get injured.
Anshuman is carrying the bricks on his head

For the next field visit, we went to inside campus of Gujarat University, Ahmedabad. That was the big construction site. People use to lift the bricks and mortar using machine for floor to floor. But for the shorter distance, they use to carry on their head. Here, they were using cement bricks which is more heavier than the clay bricks. The weight of this brick is 5 kg. We have measured the dimensions of the brick.
Measuring the dimensions of a brick

Then, we have interacted with a girl. She hails from Rajasthan. And she also came here to work in holiday because of poor financial condition. We have asked a lot of questions. He was very happy to answer. She was just 16 years old and able to carry so much weight.

Discussions with the workers

For the third field visit, we went to temporary bricks making factory for flooring. The were making two different types of bricks, one was 5 kg and another was 20 kg.
Rohit is experiencing the weight of a 20kg brick

For making the bricks, first they prepare the Mortar using the mixing machine and then put it onto the mold. After that they vibrate the the mold using a big vibrator. And after some the bricks is ready. So for making the mortar, they put all the raw materials in the machine. For that they have to transfer the raw materials from one place to another. They use a pan to carry the raw materials. Women use to carry the pan on the head. Men use to carry it on the shoulder and giving support with the hand and maintaining some distance between the pan and shoulder. Due to fatigue load, they use to get pain on the arm and hand.

And after making the bricks, they use to carry 4-5 small bricks on their head and big brick(20 kg) in front of them as shown in above figure.

A labour is carrying the load on the shoulder

Initially, we didn’t have any idea that on which type of load carrying, we should work on. Which is more important. So, went to Kalupur Railway Station. We met with Mr. Manoj. He is a coolie. He has given us the idea about the living condition and the working of a coolie. He wanted to become a clerk in the army. But unfortunately, He became collie. He is happy with his life. Collies are carrying the loads on different parts of the body like head, shoulder, and hand. They don’t have any problem while moving on
the horizontal surface because some collie has the trolley offered by the Indian Railway. But when they move on the stairs, then they have the problem of carrying the loads.

Re-Brainstorming

After Field visit, We thought about different design parameters. We again reviewed some paper. We thought about the specification of the device. What are the different manufacturing processes to make the prototype. The problems in the design of the previously made prototype. Reason for not implementing into the market product. Then we finalized one design.
Mind Map

Cardboard Prototype

A cardboard prototype shown below is not the mimic of actual device. We just made it in starting.
Cardboard Prototype

Cad model of proposed Solution

We have designed this model in order to keep in mind that the center of gravity of body should match with the center of gravity of the device. It has three different places where bricks or mortar in a Pan can be kept. The device can be adjusted according to the waist of the person. And the load is distributed to the shoulder. It also has the adjustable stand. If the bricks are kept on the ground. Then the labor can keep the bricks and then they can lift the device. The details specification are given below.

**Specification of the prototype**

Material Used : Mild Steel

Dimensions
All dimensions are in mm. Each part of the frame is drawn with dimensions written on each rod. Moreover, all the dimensions are in cm. All the rods are hollow square pipes. In addition, the thickness of all the pipes is 2mm. All the rods are welded together according to the above CAD drawing. Frame.
First, (4) is welded to the frame. (1) and (3) are welded together and fixed to (4). (2) can be adjusted on (1) through nut and bolt. Strips
The length of all the strips are 1m. And can be adjustable using buckles.

Buckles

Strips for comfort
All the parts were welded together. Strips were stitched with the frame. Final prototype is ready for the test.

**Manufacturing Processes**

![Cutting, Grinding, Welding, Bending images]

**Final prototype**
Weight of the prototype = 5.2 kg

User Testing and Feedback

We went to the field in Amrapur near Grambharti for the user test. We talked with the contractor and discussed about the device. One labor working has tried with this device. He was easily able to carry 14 bricks. This was the first time for the user. That’s why he felt little awkward but comfortable. We got some positive feedback. We have also tried with the Mortar and able to carry two pans of Mortar on both sides at a time. Labors use to carry only one pan of mortar on their head.
Anshuman is able to carry 16 bricks and Two pans of mortar

A labour is carrying 14 bricks on the device

We have also tried by keeping the back part of the frame in front. It was not comfortable. But loading and unloading is easy in that case.

Front configuration of the prototype
Finally, we talked with Prof. Anil Gupta. He was happy with the device. He has given many suggestions.

Make the side part of the prototype little incline so that the load will be distributed to both the shoulder and the waist. And the bricks also not fall.

**Future Scope**

Furthur stress analysis can be done for better understanding of the load acting on the device. For the lightweight and low-cost device, we can change the different parameters like the material.