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Design of Manoeuvrable Trolley for Spool Transportation for Wire Manufacturing Industries

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Abstract—*This project aims at designing a maneuverable trolley for transporting spools across the different sections of industries. In a wiredrawing industry scenario, processed wires are wound on a spool. The spool is rolled along the floor which is a long and laborious task. In order to solve this issue, this project tries to design a trolley for carrying heavy spools (up to 1.5 ton) with less human effort compared to pushing the spool by hand. Most of the currently available trolleys might make it possible to transport an industrial hand trolley over shop floors or uneven terrains wherein reducing strain on user. But these trolleys are not able to accommodate heavy spools and faced difficulties in loading and unloading.*

Keywords—*Spool, wire drawing industry, trolley, human effort.*

Introduction

Material handling refers to moving goods and assembly components in a shop floor or in a storage area. The activity includes loading, unloading, palletizing and de-palletizing. Trolleys are commonly used for material handling purpose in both production and process industries. Many types of trolleys have been designed to transport different types of goods and to sustain different conditions. For example: folding trolley, pallet trolley, etc. In most of the wire drawing industries, the processed wire is wound on bobbins. The bobbins are moved to different sections of an industry by human pushing, which demands the full work of at least two labours. The labours, who carry out this task are also more prone to muscle strain and back pain. Conjointly, this traditional practice reduces productivity of an industry.

In our project, the trolley is provided with hydraulic jack that leads a way for lifting heavy bobbins. Disc brakes are provided to control speed of the trolley while moving over down slopes and for parking purpose. Additionally, bobbin-holder is equipped with rack and pinion mechanism which facilitates loading and unloading. This trolley is flexible in the view that it can handle a range of spool dimensions.

Literature Review

Shiwarkar etal. (2018)designed a trolley which will be useful to transport heavy weight materials over the stairs. The trolley can carry up to 150 kg with less effort from the user. They considered the failures of non - industrial trolleys while travelling in rough path and stairs. The results proved that the trolley can climb at an inclination angle of 44 degrees [1].

Bechts is et al. (2017) promoted Automated Guided Vehicles (AGVs) for sustainable material handling in the digital manufacturing systems. Their study mainly focused on the material handling in process industries. AGVs can eliminate accidents and promote safety in the sustainable material handling environments [2].

Garghate et al.(2015)developed a drum handling equipment that will be useful to industries where drum handling is done manually. They designed a vertical stand for holding the drum. They believe this equipment can reduce the risk of manual drum handling and reduce labour count in handling the drum[3].

Jayakrishnan et al.(2018)designed a portable pneumatic material handling equipment which will be useful in small scale industries. The results proved that the equipment can be

available at an affordable price to the small-scale industries [4].

Chan Yew Tow and Kam Wai Kuen (2015)evaluated the force required by the workers to push the supply trolley in a hospital.. They concluded that greater the amount of extension and flexion of arm to push or pull the trolleys will require greater amount of force[5].

Mit patel et al. (2016) in their work presented design procedures for disc brakes rotor and manual calculations for braking[6].

Objective

To design a manoeuvrable spool handling trolley, that enables a convenient transportation of bobbin among various sections of an industry which will reduce labour effort and may reduce the probabilities of operators getting injured.

COMPONENTS AND USES

Hydraulic bottle jack

A hydraulic bottle jack has a cylindrical body and neck. Hydraulic jacks are meant for lifting heavy loads with less human effort. It works on pascal's law. It provides both support and lifting force simultaneously. Being, the maximum load to be lifted is 1 ton, considering other forces acting on the hydraulic jack especially, weight of the structure, a hydraulic jack with 2-ton capacity has been chosen for this application.

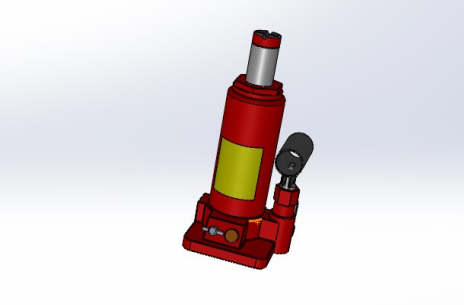

Fig. 1. Hydraulic jack

Rack and pinion

Rack and pinion is a gear arrangement which converts the rotary motion of gear into a linear motion of rack. In this project, this arrangement is used for loading and unloading of trolley. The rack and pinion assembly is connected with bobbin holder. Rotary motion needs to be provided by operator by rotating a rod that is attached with a lever. The rotary motion is transmitted to the bobbin holder as a linear motion, thereby achieving clamping and unclamping functions of the trolley.

Fig. 2. Rack and pinion

Steering system

The main function of a steering system is to alter the direction of a vehicle. Steering system converts the rotary motion of steering wheel, in the operator's hand into angular turn of wheels. Steering system is used in this project in order to change the direction of motion of the trolley easily.

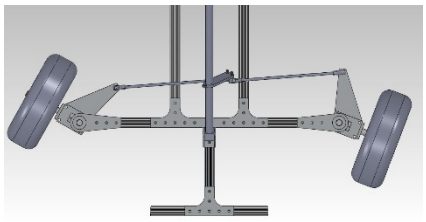

Fig. 3. Steering system

Wheels

Wheel is a component with circular shape, facilitates the movement of a vehicle. It bears the entire weight of a vehicle. It can be widely found in all the automobiles and other moving vehicles. Avariety of wheels are available in order to allow motion on different terrains.

Fig. 4. Wheel

Design

The model has been designed using Solid Works software.

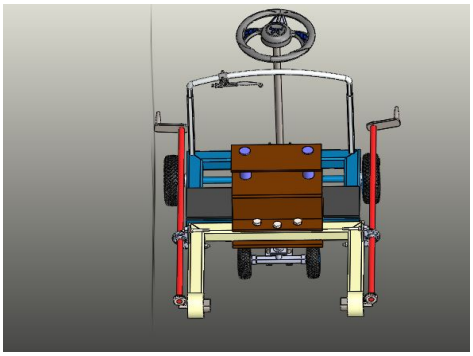

Fig. 6. Front view

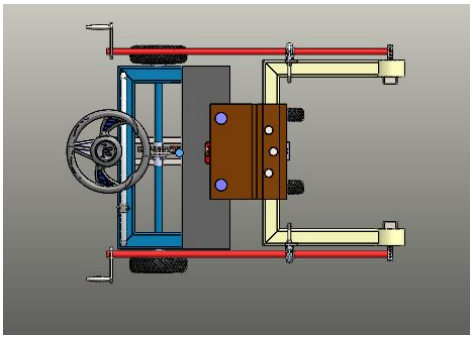

Fig. 7. Top view

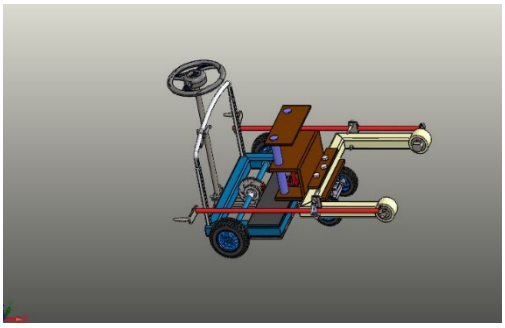

Fig. 8. Isometric view

Design calculations

Force required to move the trolley

Total weight of the trolley including the weight of the trolley = (1000×9.81) + (163×9.81) = 11, 409 N.

Total load is distributed to both rear and front wheels.

Load acting on rear wheels = load acting on front wheels

=5704.5 N

Force required = $\frac{(\mu \times N)}{R} N$

where,

μ = Coefficient of rolling friction per m

N = Normal reaction force in newton

R = Radius of wheel in m

Here, μ = 0.00038 m between tire and concrete

Rolling resistance, needs to be overcome by rear wheels (F1)

F1 = $\frac{(0.00038 \times 5704.5)}{0.1}$ = 21.73 N

Rolling resistance, needs to be overcome by front wheels (F2)

F2 = $\frac{(0.00038 \times 5704.5)}{0.05}$ = 43.46 N

Here 100 mm, 200 mm are the diameters of front and rear wheels respectively.

Now, total force required = F1+F2 = 21.73+43.46 = 65.19 N

Braking calculations

Disc brake is chosen for this application.

Total trolley mass = 1170 kg

Maximum speed = 5 km/hr = 1.39 m/s

Kinetic energy to be absorbed by the brake (KE),

$$KE = \frac{mv^2}{2} J$$

where,

M = Total mass of the trolley in kg.

v = velocity of trolley in m/s

Substituting the known values in the kinetic energy equation, we get

Kinetic energy to be absorbed by the brake = $\frac{(1170 \times 1.39^2)}{2}$

= 1130.28 J

$$\textit{Maximum friction force, } F = \mu \times m \times g$$

where,

μ = Coefficient of friction between disc brake rotor and the caliper

m = mass of the trolley in kg

g = acceleration due to gravity

Here, μ = 0.4

Therefore,

F = 0.4×1170×9.81 = 4591.08 N

Conclusion

A material handling trolley has been designed ergonomically to facilitate the material handling process that takes place in most of the wire drawing industries. A due consideration has been given for easy manufacture of this product. It is believed that, this work will make a positive change in the conventional

material handling process in wire drawing industries. Also, there is a plan to get this product equipped with automatic guidance system in future.

REFERENCES

[1] Shubham S. Shiwarkar, Sagar D. Pairag, Prof. Shailendra R. Zaveri (2018), "Design andFabrication of Easy Handling Trolley", International Research Journal of Engineering andTechnology (IRJET) Volume: 05 Issue: 05, May 2018.

[2] Dimitrios Bechtsis, Naoum Tsolakis, Menippos Vouzas, Dimitrios Vlachos, "Industry 4.0: Sustainable material handling processes in industrial environments", Volume 40, 2017, Pages 2281-2286, ISSN 1570-7946, ISBN 9780444639653

[3] Nilesh K. Garghate, Dr. S. K. Choudhary, A. P. Ninawe, "Design and Fabrication of DrumHandling Equipment- A Review", IJSRD - International Journal for Scientific Research &Development, Vol. 3, Issue 04, 2015

[4] Jayakrishnan N, Juhin Pradeep N, Athul VA, Amith Raj U, Nithin M, Harikrishnan G, "Design and manufacturing of a portable pneumatic material handling equipment", International Conference on Mechanical, Materials and Renewable Energy, IOP Conf.Series: Materials Science and Engineering 377 (2018) 012044

[5] Chan Yew Tow, Kam Wai Kuen, " Force evaluation and comparison for supply trolley in ahospital", 6th International Conference on Applied Human Factors and Ergonomics (AHFE2015) and the Affiliated Conferences, AHFE 2015, Procedia Manufacturing 3 (2015) 1861– 1864

[6] Mit Patel, Mansi Raval, Jenish Patel (2016), "Design of Disc Brake's Rotor, IJEDR-International Journal of Engineering Development and Research, Volume 4, Issue 4 | ISSN: 2321-9939