International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

Design and Optimization of Hydraulic Farm Tractor Trolley

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***Abstract*: The conventional trolley delivers the function such as lifts up to certain angle. Therefore, it has been considered by detecting the trouble in unloading the materials. Therefore, after surveying problems stage in unloading. It is use to carried Trolley modification with functions like rolling with hydraulic jack's arrangements. Thus problem of unloading is to be solved. Thus the idea about the modified trolley with rolling provides the multifunctional & contentment of the desire purpose. As a result, it saves time & energy which leads to efficient working.**

***Keywords*: hydraulic trolley, hydraulic jack, chassis, hydraulic cylinder, oil pump**

1. Introduction

A. Trolley

Trolley is used as a transport vehicle. To transport any goods from one place to another place. With the change of time there is also change in the trolley. In old time trolley it has very less capacity to transport materials, but now a day's modern trolley has capacity to transport materials up to 10 or more tones. It helps to easy in unloading the materials. The main components of the trolley are:

- Hydraulic jack
- Chassis
- Control valve
- Hose pipe
- Oil pump

The oil used for lifting purpose. With the help of pump, it gets pressurized and uses for lifting purpose. Some of the oil which are used in this system are: Hydraulic jack oil ISO32, Black jack oil, 8fl oz., etc.

B. Hydraulic Jack

Hydraulic jack is a device which is used for lifting heavy materials by the application of much smaller force. It based on Pascal's law, which states that intensity of pressure is transmitted equally in all directions through a mass of fluid at rest. Hydraulic jack used in trolley plays a vital role to lift & unload heavy materials. From figure 1.

C. Hydraulic cylinder

Reliability of a hydraulic mechanism system not only depends on the system design but also on issues such as element design and fabrication. This is correct while selecting cylinders too. A good number of hydraulic system fails may be recognized to defects in cylinder design.

D. Hydraulic Cylinder

A hydraulic cylinder is placed below the body of truck longitudinally at one end of the truck, and the piston end of the hydraulic cylinder is connected by the means of a pivot joint to the chassis of truck. In the forward stroke of the cylinder, it pushes the truck body upward thus gives necessary lift for tipping dumping. So, in the forward stroke of the cylinder the truck is unloaded. In the return stroke of the cylinder the body of the truck comes to its original position.

E. Hinge Joint

The other bottom end of the body of the truck is connected by a hinged joint with the chassis. So, when the hydraulic cylinder pushes the body in its forward stroke the entire body gets tilted about the axis of the hinged joint and the material gets unloaded and by the return stroke of the hydraulic cylinder body comes and seat to its original position with respect to the hinged axis. But in this types of tipper can unload materials only at the backside of the tipper. 3-way tipper can overcome this problem, as it can unload material on three sides.

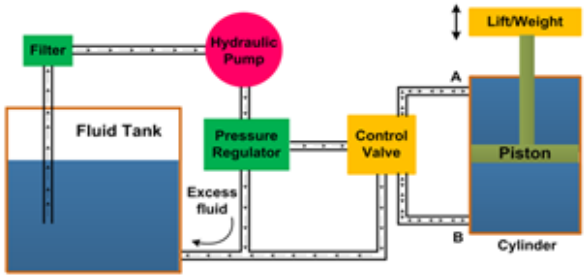

Fig.1. Mechanism of hydraulic jack

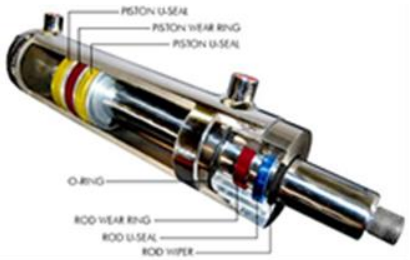

Fig.2. Hydraulic cylinder

F. Three Way Tipper Mechanism

As already stated, a 3-way tipper can unload goods in all 3 sides. To control the sides of tilting there needs to be compulsory one more pneumatic cylinder apart from the foremost hydraulic cylinder. Also we want special types of hinge joints.

2. Three axis hydraulic trolley

The project work is built using several material like MDF (Medium density fiber core hard wood plywood, 3/16 nuts & bolts, aluminum sheet, motors (DC), gearboxes, syringes, wheel screw, nuts, toggle switches, push buttons, battery etc.) First of all a base chassis construction is prepared using MDF 8mm sheet. The structure is 22 in length and 11 in width. This construction includes driving motor along with steering motor. These motors are fixed with a fixed decrease radio gearbox of 100:1 to increase torque and reduce speed of the motor. The wheel base is kept 14 while the track distance to the output slate of the gearbox which is related with the driving DC motor this motor and gearbox assembly is fixed in the wheel hub. This is attached with the chassis using aluminum attachment.

Fig. 3. Side opening of trolley

Fig. 4. Side opening of trolley rear view

Fig.5. Back opening of trolley

Fig. 6. Hydraulic trolley

A steering rod connects both the wheels which in the tractor is connected with a steering motor. At the end of this chassis a platform of 26 x 36 cm such these platforms are pivoted on each and off opposite sides. So as to four Z shaped. Each two platforms are linked using a plastic needle piston and cylinder assembly that forms the hydraulic piston and cylinder arrangement. Hydraulic fluid in this piston and cylinder arrangement that is pushed and pulled using a head screw arrangement. That is complete to run to a flow using gearbox and motor. For the appropriate guide ways and guide slides are used for the same thing. This assembly is made in three numbers as there are three number of hydraulic cylinder that functioned the trolley this power cylinder and piston arrangement is fitted in front of the trolley that is situated at the back of the chassis member.These motors are connected to the wired remote that incorporated toggle switches and push button by manipulating these buttons the entire project work can be demonstrated and made to work. When the operator pushes the push button the motor functioned the piston and cylinder arrangement that pushes the hydraulic fluid to the cylinder beneath. The trolley this piston gets out and thrusts the trolley to tilt by operating various cylinders the material can be dropped in 3 ways.

3. Design of hydraulic jack & methodology

A. Three axis modern trolley

- Load (W) = 06 ton (60kN)
- Operating pressure (p) = 25 M Pa
- Lift range (L) = 20 cm
- Man effort put on the handle (e) = 20 Kg
- Permissible tensile stress of mild steel (σt) = 120 N/mm2
- No. of strokes for lifting load (n) = 150
- Factor of safety = 5
- Permissible shear stress of mild steel (τ) = 20 N/mm^2
- Permissible compressive stress of mild steel (σc) = 20 N/mm2 Permissible compressive stress of cast iron (σCI) = 120 N/mm^2
- Permissible shear stress of cast iron (τCI) = 35 N/mm2

B. Design of ram cylinder

It is a cylinder in which produces a slide way to the ram. The ram cylinder is made up of mild steel with density of 7.868 gm/cc. It is mounted on the base plate Let,

- d = inner diameter of ram cylinder
- D = outer diameter of ram cylinder
- P = pressure acting on cylinder =25 Mpa
- W = load =60kN
- T = thickness of ram cylinder

C. Design of plunger cylinder

The plunger cylinder is made up of mild steel and is mounted on the base plate. It provides slide way to the plunger in order to build up the pressure. Let

- dp= inside dia of plunger cylinder = 8 mm
- Dp = outside dia of plunger cylinder
- tp = thickness of plunger cylinder

Assume the thickness of plunger cylinder (tp) = 5 mm Tensile strength of mild steel (σt) = 120 N/mm2. By LAME'S equation t = 5+ 5.0625(25 - 1) 126.5625 – 5.0625 +5.0625 = 126.5625 – 25 6.0625 = 101.5625 = 16.752 N/mm2. Hence the induce tensile strength of M.S. is less than permissible value. So, the design is safe. By using thickness and inside diameter, we can calculate the outer diameter of plunger cylinder Dp =dp + 2t = 8+2(5) = 18 mm Outer diameter of plunger cylinder (DP) = 18 mm.

D. Design of plunger

Let the plunger is made up of mild steel which reciprocates in plunger cylinder to increase the pressure of the oil. Let,

- W = load acting on plunger
- dp = diameter of plunger
- P = pressure developed in plunger cylinder from standard table inside diameter of plunger cylinder is fixed i.e. 8 mm. Load acting on plunger = pressure × area = 25×106 = 1256.63 N = 128.09 kg. We take Load acting on the plunger =130 kg

E. Plunger displacement

We know that Velocity ratio (V.R.) = Assume V.R. = 150
150 = 114.49 mm = 11.449 cm
Therefore, plunger displacement = 11.5 cm

F. Design of lever

A lever is made up of mild steel and is used to apply load on the plunger. It is attached to the plunger with the help of pivot. Assumptions,

- Effort put on lever by man = 20 kg
- Load acting on plunger = 130 kg

Velocity ratio of lever = 6.5
Required distance from fulcrum to load = 11.5 cm
Total length of lever = 6.5× 11.5 = 74.75 cm.
We take length of lever = 75 cm Lever is made up of mild steel. Permissible tensile strength of mild steel (σt) = 120 N/mm^2. Where M = maximum bending moment
I = moment of inertia = permissible tensile strength
Y = distance between outer most layer to neutral layer
Z = section modulus

Fig. 7. Design of hydraulic trailer

Fig. 8. Length of trolley

Ra + Rb = 130 kg
Ra + 20 = 130
Ra =130-20
Ra = 110 kg
Bending moment at C = 0
Bending moment at B = 20× 9.81× 0.635 = 124.58 N-m
Bending moment at A = (20× 9.81× 0.75) – (130× 9.81× 11.5) = 0
From the above calculation Maximum bending moment = 124.58 N-m
Where dl = diameter of lever = 0.0219
m = 21.9 mm we adopt diameter of lever = 25 mm

G. Design of reservoir

The volume of oil circulated in the system is 835c.c But, we take the volume of oil is 33% greater than the volume of circulated in the system.
Volume of oil in the reservoir = 835+ × 835 = 1110c.c
[× L]- = 1110 c.c
Where D = outer dia of ram cylinder
L = height = 119.89 mm
We adopt inner dia of reservoir = 122mm
Assuming thickness of reservoir = 4mm
Therefore, outer dia of reservoir (Dr) = = 122+(2×4) = 130mm

H. Design of base

Fix the dimensions of base plate as l× b × tb =200×150×25
Where l = length of base
b =width of base
tb =thickness of base
Base is made up of mild steel.
Permissible compressive stress of M.S (σc) = 20 N/mm^2
Compressive area of base =200×150 = 30000
Permissible shear stress of mild steel (τ) = 20 N/mm^2

Shearing area = π × d × tb = π × 71.5 × 25 =5615.59
Where d = inner dia of ram cylinder
tb =thickness of base plate
Load acting on base = 100.17 KN
Checking for compressive strength σc = 3.339 N/mm^2
Checking for shear strength τ =17.83 N/mm^2.

The induced shear and compressive stresses are less than permissible valve. Hence the design is safe.

4. Discussion

A. Advantages

- Lifting cost will be less
- Permitted from wear adjustment.
- Not as much of power consumption
- A smaller amount skill technicians is sufficient to operate.
- Installation is simplified very much.

5. Conclusion

This project used to perform the operation of lifting heavy weight materials. This project also studies the importance of hydraulic circuit system. Various parts of the modern trolley were studied and their performance was analyzed in terms of the work. Further review is made on the practical plastic model of project with analysis of working and with the help of hydraulic system lifting operations can be easily carried out without much effort and without outsourcing. Thus we have developed a modified trolley which helps to know how to achieve low cost automation. The operating procedure of this system is very simple, so any person can operate. By using more techniques, they can be modified and developed according to the application. It is to be concluded from the above project, the overall performance of the whole system is increased as compared to the conventional trolley. And also the overall capacities of the load on the trolley increased simultaneously as per the hydraulic jacks are added. Hence, looking to the entire project it is innovative and a desirable project.

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