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Design and Fabrication of Rotating Hydraulic Tipper Trolley

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Abstract - *We are made a hydraulic system for rotating or tilting the trolley of a truck to any required angle (i.e., any angle in the range of 90^0 towards right or left from normal position horizontally) and lift it to dump or unload the material in instant position of trolley by hydraulic actuation with hand lever pumping. Prototype is constructed and in real conditions it is expected to use the engine power for hydraulic actuation.*

Key Words: Tipper trolley, hydraulic cylinder, sprocket, chassis

1. INTRODUCTION

Material handling involves the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. The focus is on the methods, mechanical equipment, systems and related controls used to achieve these functions. A material handling system can be simply defined as an integrated system involving activities such as handling, storing and control of materials. The word material has a very broad meaning, covering all kinds of raw materials, work in process, sub-assemblies and finished assemblies. The primary objective of using a material-handling system is to ensure that the material in the right amount is delivered to the desired destination at the right time and at the minimum cost. Material handling is an integral part of any industrial or commercial activity. The material handling cost component can form 10-80% of the total cost. Furthermore, the equipment is also prone to accidents. Thus it is imperative that the material handling system is properly designed from efficiency as well as safety point of view.

The aims of our project are:

- To design and fabricate the automobile base with drive mechanism being powered by DC motor and controlled by hand held buttons through wired control.
- To design and fabricate the trolley with rotating mechanism held on the rotary base on thrust bearing.
- To design and fabricate the pump and oil tank to exert the hydraulic pressure to rotate the rotary base of the trolley.
- To design and fabricate the direction control valve for two outlets and non-return valve.
- To design and fabricate the cylinder mechanism which by actuation will rotate the rotary base to the required angle as controlled by the pumping.
- To design and fabricate the lift mechanism being actuated by the hydraulic cylinder pivoted on the main chassis.

Presently material handling for shortest distance is done by carriers like trucks, tippers, tractor trailers etc. Long distance material transportation is done normally through railways which is the cheapest compared to this road transportation system. The material being loaded onto the trailer or the tipper by some mechanism like excavators or conveyors etc. Un-loading of the material from these trucks is again mechanized by using hydraulic lifter mechanism below the trolley which lifts the trolley from one side when pivoted at the other end. But the present system is having only one side lifting mechanism which may not be convenient which calls for the flexibility of the lifting mechanism.

Traffic and transportation in existing streets and highways and rail facilities no longer match the new demands created by recent population growth and new location patterns of economic activity. Besides increase in population, another problem is private automobiles overloading the network of highways and arterial streets.

2. WORKING PRINCIPLE

In the present work we are provided four wheel bases with the drive mechanism. The drive powered by the DC motor to the rear axle which is controlled by the buttons hand held and wired to the unit. The rotary base is made on which the trolley is mounted and the rotary mechanism held on the bearing and is having the cylinder hinged to the rotary mechanism driving the spur gear by the rack teeth on the ram of the cylinder. The pump is fixed in the cabin and has oil tank and hand lever. The pump connects to the non-return valve then to the direction control valve and to the respective cylinder. The lift mechanism for the trolley which is pivoted to the rotary top frame, pivoted at the rear end of the trolley, has second cylinder mounted on the rotary frame and the ram end is hinged to the trolley front portion and when cylinder actuated, will lift the trolley at the front side to be able to dump the material from the rear end.

The direction control valve has one inlet and two outlet ports and a lever is provided to be rotated to select the action we need either rotating or lifting. The pumping is done

when the direction control valve is rotated and then that cylinder receives the oil to push the ram out effecting the rotation or lifting as required.

The angle of rotation required, the pumping is stopped and then the selection of the lift by direction control valve (DCV) to change the oil to move to the lift cylinder. Once the end of the lift is achieved, then the release valve is opened by which the oil from the lift cylinder returns back to the pump and again the direction control valve is operated to return back to position.

In our project we used hydraulic oil of grade ISO 68 because of the following features:

- This unique blend maintains optimum viscosity characteristics over wide temperature, operating pressures and speeds range making it suitable for stationary and mobile hydraulic systems.
- ISO 68 hydraulic fluid is blended with a high quality hydro-cracked mineral base fluid and the latest high performance, thermally stable zinc anti-wear additives, along with anti-foam, anti-corrosion and oxidation inhibitors for sustained performance and protection.
- The unique stable anti-wear zinc additive reduces ware on components and protects working surfaces thus reducing equipment downtime.

Table -1: Properties of Hydraulic oil ISO 68

Hydraulic oil ISO 68				
Mineral based hydraulic oil				
Property	Value in metric unit		Value in US unit	
Density at 60°F (15.6°C)	0.880 *10³	kg/m³	54.9	lb/ft³
Kinematic viscosity at 104°F (40°C)	68.0	cSt	68.0	cSt
Kinematic viscosity at 212°F (100°C)	10.2	cSt	10.2	cSt
Viscosity index	135		135	
Flash point	204	°C	400	°F
Pour Point	-40	°C	-40	°F
Aniline Point	88	°C	190	°F
Color	max.7.0		max.7.0	

3. COMPONENTS USED

1) BEARING: We are used ball bearing of rolling contact type. These bearings are used for light loads.
Dimensions

i. Inner diameter: 15 mm
ii. Outer diameter: 35 mm.

2)WHEELS: Plastic readymade wheels are brought and centre bore is made to 12 mm. The outside diameter is 120mm and the width is 20mm. Total four number of wheel are used, two for front and two for rear side.

3)FRAME: This is made out of mild steel flat of 20mmx4mm thick cut for the required size. Angle of size 20mmx20mmx4mm is taken for the length of 700mm of 2nos cut and straightened by hammering and then joined with the flats being cut earlier to make the rectangular frame as per the sketch.

4)REAR AXLE: Round mild steel bar of diameter 20mm is taken for the length of 300mm and then it is turned on the lathe machine to make steps diameter of 16mm to suit the sprocket and 15mm to suit the ball bearing and the both ends 12mm to suit the plate washer which holds the plastic wheels.

5)MOTOR CLAMP: Mild steel flat is taken of size 25mmx5mm for the length of 225mm and it is bent to the circle to maintain the diameter of 75mm to hold the motor. Same size two number of motor clamp are made. It is welded at the end and m10 nut is welded on it after drilling on the circumference.

6)BEARING HOUSING: It is turned on the lathe machine for the diameter of 45mm outside and internal step bore is made to suit the ball bearing of diameter 35mm for the depth of 15mm and centre hole is made of diameter 15mm. The total length maintained is 20mm. It is face turned from the backside. The M10mm bolt is welded on the top circumference to hold the chassis on it.

7)WHEEL HOLDING PLATES: This is made out of mild steel round plate cut to the diameter of 75mm of thick 3mm and drilled to make the hole diameter as 12mm. Such four plates are made for holding the wheels.

8)FRONT AXLE: 20mm square bar mild steel is taken of length 85mm and turned on the lathe machine to maintain the step of diameter 12mm to suit the wheel bore diameter for the length 40mm and at the end. A cross hole of diameter 6mm is made to insert the lock pin after wheel is inserted. Two numbers are turned and fitted at both the sides. The mild steel flat of 20mmx3mmx40mm is welded to the front axle pin which is fitted to the rack gear of steering. The drill of 6mm is made at the end of this flat in which the rack gear end is pivoted.

9)HINGE BUSH: This is made out of mild steel round bar of diameter 25mm being cut for the length of 35mm and turned on lathe machine to make the diameter 20mm for the length of 30mm and drilling of 10mm is done to insert the hinge pin into it. Such two numbers of bushes are made for this project.

10)TRAY BASE: This is made out of mild steel flat being cut out of 20mmx3mm flat for the length of 495mm-2nos, 485mm-2nos and flattened by hammering and then joined to make the rectangular frame as per the sketch. In between another flat is cut and welded as per the sketch on which the lifting pivot bush is welded. The hinge bush is welded to this tray at the ends.

11)DCV CLAMP: A mild steel flat is taken of size 25mmx5mm for the length of 225mm and it is bent to the circle to

maintain the diameter of 75mm to hold the motor. Same size two number of motor clamp are made. It is welded at the end and m10 nut is welded on it after drilling on the circumference.

12)PIVOT BUSH: This is made out of mild steel round bar of diameter 25mm being cut for the length of 15mm and turned on lathe machine to make the diameter 20mm for the length of 10mm and drilling of 10mm is done to insert the hinge pin into it. Such one number of bushes is made for this project.

13)BEARING HOUSING: The bearing housing are made out of mild steel round bar of diameter 48mm being cut on the cutting machine and being turned on the lathe machine for the step diameter of35mm bore and the centre hole of 15mm to suit the bearing of internal diameter of 15mm and outside diameter of 35mm for the depth of 12mm. The total length is maintained is 16mm faced on the backside. Such housings are turned 4nos.

14)CYLINDER RAM: It is made out of C30 steel, round bar of diameter 25mm being cut for the length of 150mm and turned on lathe machine to make the diameter 24mm collar for the length of 6mm, 16.3mm at one side for the step of 6mm, and 22.4mm diameter for the length of 135mm with the end chamfer for the length of 3mm. This turned ram is then loaded on cylindrical grinding machine to maintain the diameter as 16mm to suit the PU seal, 22mm diameter.

15)CYLINDER: This is made out of C30 round bar of diameter 32mm cut for the length of 155mm and turned on lathe machine for the diameter of 30mm and drilled and bored for the internal diameter of 23.8mm. It is then threaded at both the ends for the size of M30x2mm pitch for the length of 25mm. It is then loaded on internal cylindrical grinding to grind the internal diameter for the size of 24mm to suit the sliding of the ram with PU seal.

16)CYLINDER HOUSING: This is made out of C30 steel round bar of diameter 65mm being cut for the length of 35mmm and then turned on lathe machine for the diameter of 64mm and then drilled, bored and then threaded for the size of M30mm, 2mm pitch to suit the cylinder threading, for the depth of 19mm. Cross drill is done from the circumference and tapped to suit the 1/8inch BSP threading and then taper drilling is done to match the centre hole.

17)CYLINDER GUIDE RAM: This is made out of C30 steel round bar of diameter 40mm cut for the length of 18mm and then turned on lathe machine for the diameter of 22mm and a groove of 25mm diameter for the width of 3mm. threading is done from the other side for the diameter of M30, 2mm pitch to suit the cylinder threading.

18)CYLINDER HOLDER CLAMP: It is made out of mild steel flat of 25mmx 4mm flat for the length of 100mm and a 'u' clamp is made to clamp the jack on the main frame of the chassis.

19)TUBULAR CONNECTIONS: It is being bought from the market for the required length and being gas welded to the requisite connectors and joined to the master cylinder and through the non-return valve to the jack and from there to the release valve to the tank.

20)VEHICLE COVER: Mild steel sheet of 1mm are used to cover the vehicle and it is made to shape as required.

4. FABRICATION

4.1. DESIGN OF CHASSIS:

The rectangular, usually steel frame, supported on springs and attached to the axles, that holds the body and motor of an automotive vehicle. The chassis design used in our project is shown below.

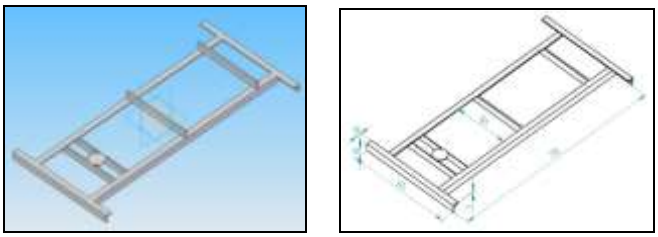

Fig -1 Chassis (3-D and 2-D model)

4.2 DESIGN OF ROTARY UNIT:

It consists of a sprocket with a shaft in mesh with a chain welded to a square bar. The square bar is connected to the double acting cylinder which produces rotary effect.

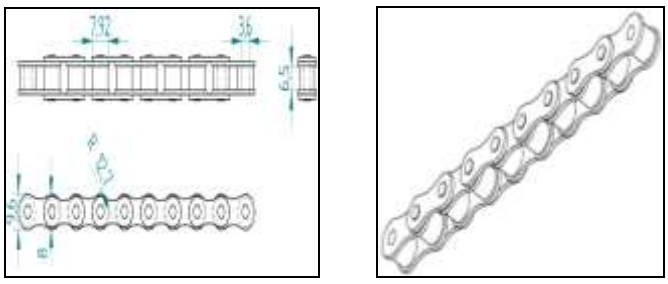

Fig -2 Chain 2-D model

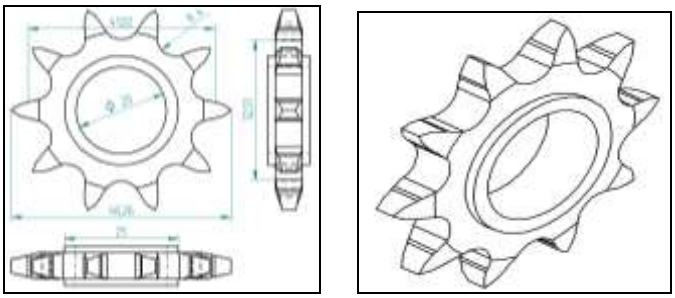

Fig -3 Sprocket 2-D model

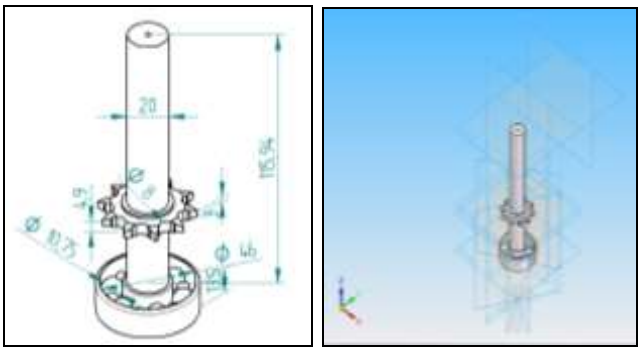

Fig -4 Rotating part

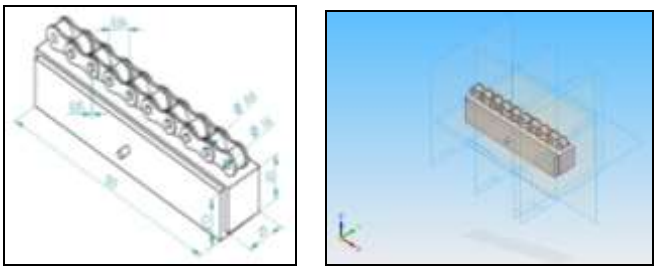

Fig -5 Chain-Ram

4.3 DESIGN OF LIFTING UNIT:

It consists of a single acting cylinder which is hinged to the tray. The tray provides the space for single acting cylinder for lifting action. The trailer is fixed to a frame which is hinged to the tray and is in contact with the single acting cylinder for lifting action.

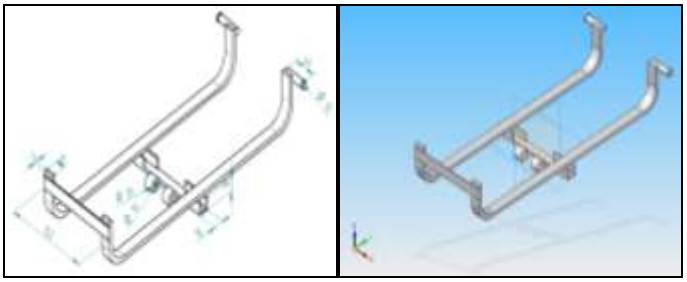

Fig -6 Hydraulic lift holding tray

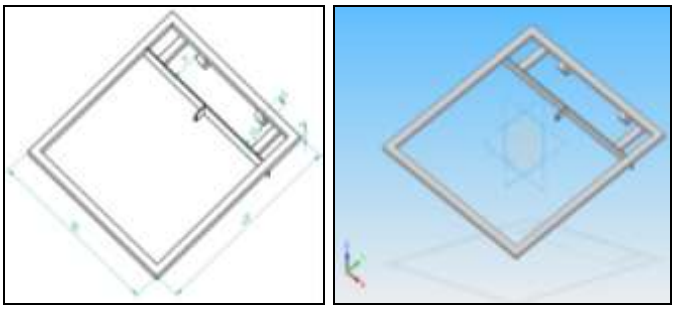

Fig -7 Trolley holding frame

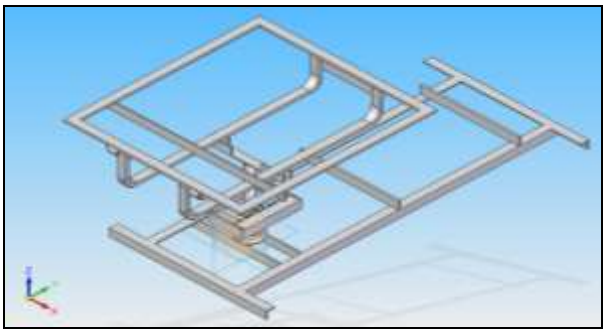

Fig -8 Assembly of parts

Fig -9 Final working model

5. SCOPE FOR FUTURE WORK

- Instead of rack and pinion arrangement with double acting cylinder, we can provide a motor which has less revolution per minute for the rotary effect.
- In order to distribute the entire load acting on the shaft when the trolley is loaded, we can provide a bearing at a certain height from the sprocket present on the shaft. The load can be transferred from this bearing to the chassis by means of rods or bars, welded to the bearing and chassis.
- Instead of using hand pump for pumping the fluid, we can have a gear pump which can pump the fluid at faster rate.
- Instead of using the manually operated flow control valves, we can write a program which operates these flow control valves at a touch of a button.
- In order to have more lifting force we can provide two single acting cylinders of same capacity or of capacity evenly distributed between the two single acting cylinders.
- We can also have the sleeve drive arrangement to achieve the rotary effect.

6. CONCLUSION

The present material handling automobiles are having the trailer which has the lifting system to dump the material towards one side i.e., rear side. For dumping the material at a particular point, the vehicle has to be positioned properly to affect the exact dumping point. At some places it will not be possible to position the vehicle according to the dumping point since the roads or the space might be congested. So the material is dumped in un-required place which again need some manpower to shift it.

In this present model an attempt made to make the hydraulic system for rotating or tilting the trolley to any required angle (i.e., any angle in the range of 90^0 towards right or left from normal position) and lift it to dump the material in that position all by hydraulic actuation by hand lever pumping in this model and use the engine power for hydraulic actuation in the actual vehicle.

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