

# DEVELOPMENT OF THREE AXIS PNEUMATIC MODERN TRAILER

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**Abstract :** - Trailer has lots of applications in today's world. In industrial and domestic considerations, trailer can haul a variety of products including gravel, potatoes, grain, sand, compost, heavy rocks, etc. By considering wide scope of the topic, it is necessary to do study and research on the topic of trailer mechanism in order to make it more economical and efficient. In existing system, tipper can unload only in one side by using hydraulic jack or conveyor mechanism. In our project we will use 3 way trailer mechanisms, which will help the trailer to unload in 3 directions. We will use worm and worm gear, pneumatic system in which we use pneumatic cylinder and hand operated direction control valves for this project.

**Index Terms - Pneumatic system, Worm gear and Hand operated direction control valves**

## 1. INTRODUCTION

A trailer is a vehicle designed for carrying bulk material, often on building sites. They are distinguished from dump trucks by configuration: a dumper is usually an open 4-wheeled vehicle with the load skip in front of the driver, while a dump truck has its cab in front of the load. The skip can tip to dump the load; this is where the name Trailer comes from. Trailers are normally diesel powered. Trailers with rubber tracks are used in special circumstances and are popular in all over world. Early trailers had a payload of about a ton and were two-wheel drive driving on the front axle and steered at the back wheels. We used hand cranking for single cylinder diesel engine. Back wheels are moved by steering wheels. Having neither electrics nor hydraulics there was not much to go wrong. The skip was secured by a catch by the driver's feet.

One of the problem are cited with dumper in the time and energy for setting the huge dumper in the proper direction to dump the material it in carrying and hence the need of the project work riser which is about 3 way dropping dumper which can dump the material in any direction except the frontal one without moving the truck in any direction. A dump truck (or, UK, dumper truck) is a truck used for transporting loose material (such as sand, gravel, or dirt) for construction. A typical dump truck is equipped with a hydraulically operated open-box bed hinged at the rear, the front of which can be lifted up to allow the contents to be deposited on the ground behind the truck at the site of delivery. In the UK and Australia the term applies to off-road construction plant only, and the road vehicle is known as a tipper, tipper lorry (United Kingdom) or tip truck (AU)

Modern dumpers have payloads of up to 10 tones (11 short tons; 9.8 long tons) and usually steer by Particulating at the middle of the chassis (pivot steering). They have multi-cylinder diesel engines, some turbocharged, electric start and hydraulics for tipping and steering and are more expensive to make and operate. An A-frame known as a Roll-Over Protection frame may be fitted over the seat to protect the driver if the dumper rolls over. Some dumpers have Falling Object Protection as well. Lifting skips are available for discharging above ground level. In the 1990's dumpers with swivel skips, which could be rotated to tip sideways, became popular, especially for working in narrow sites such as road works. Dumpers are the most common cause of accidents involving construction plant. A dumper is an integral part of any construction work and hence its role is important for completion of any constructional site. One of the problem are cited with dumper in the time and energy for setting the huge dumper in the proper direction to dump the material it in carrying and hence the need of the project work riser which is about 3 way dropping dumper which can dump the material in any direction except the frontal one without moving the truck in any direction.

### 1.1 OBJECTIVE

Our aim in this project is to modify and fabricate the modern three axis trailer for industrial application. To give additional two directional motions to the trailer. To develop mechanism for reducing time of loading and unloading. To provide easier way dumping.

### 1.2 SCOPE

World progressing at faster rate which demands efficient working equipment's such as user friendly machinery and hence the three way dumper may be used more than the two way or one way. The work can be modified further more on following basis:- Electronic sensors can be used to make the operations easy. Oil pump can be used instead of Pneumatic cylinder. Capacity can be increased. Four wheel steering can be adopted for more movement ability.

## 2. METHODOLOGY

After going through various topics we have decided we select the topic of 3 way pneumatic dumper. We started the work of our project with literature survey. We went through many research papers. We sorted out some papers that were relevant to our topic. We got different ideas from different research papers. Thus we decided rough idea of how we are going to make our project. From this idea we have drawn a Rough model of our project and we came to know different components which we are going to

use for our project. From this drawing we started the design and calculation part of different component which will be required to manufacture.

From these calculations we have got some specifications of components. We have referred different design data books while doing the calculations. After getting the specifications we have again drawn a drawing.

### 3. WORKING AND PRINCIPLE

It is mainly based on rotation of tipper trolley and divided in two parts Rotation and Dumping. For rotation of tipper, we used worm and gear mechanism. Worm is directly coupled with electric motor which is at horizontal position. On the lower side of dumper, the spur gears are meshed with worm wheel and the axis of rotation of spur gear is vertical, which is directly attached to tipper trolley. The power supply is provided to the electric motor by using Double Pole Double Throw switch to complete the circuit of battery and motor. As a motor start rotating the worm is also rotated at same speed and spur gear which is connected to worm wheel. The vertical shaft which is connected directly to the center of tipper trolley, when worm complete its 1 rotation then 1 teeth of worm gear moves forward. Spur gear is having 40 teeth on its profile. When 10 teeth of spur gear are moved forward then trolley gets rotated by 90° from its initial position in 20 second. The rotating direction of trolley is changed or reversed by Double Pole Double Throw switch. When the trolley completes its required angle then material is dumped with the help of pneumatic cylinder. The compressed air is supplied by air compressor to cylinder. The air flow direction is controlled by solenoid valve. On the cylinder two forces are provided one on upper side & other on one side. For the upper movement of trolley air is supplied through the lower port and for downward movement of trolley air is released from the same port.

### 4. DESIGN & CALCULATIONS

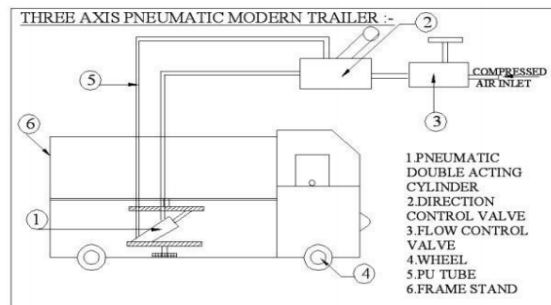


Fig-01: Three axis pneumatic trailer

#### COMPONENTS

- 1 Air Compressor
- 2 Pneumatic cylinders
- 3 Direction Control Valve
- 4 Worm & Worm Wheel gear
- 5 Vehicle model frame
- 6 Connecting hoses



#### PNEUMATIC CYLINDERS

Pneumatic cylinders are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.



Fig-02: Double acting Pneumatic cylinders

#### DIRECTIONAL CONTROL VALVES

A valve is a device that regulates, directs or controls the flow of a fluid (gases, liquids, solids, or slurry) by opening, closing, or partially obstructing various passageways. Valves are technically fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure.



Fig-02: Directional control valves

## WORM & WORM WHEEL GEAR

Worms and worm gears are gear sets that offer high gear reduction and torque multiplication with a small footprint. A worm drive is a cylindrical gear with a shallow spiral thread that engages the worm gear in a non-intersecting, perpendicular axes configuration.

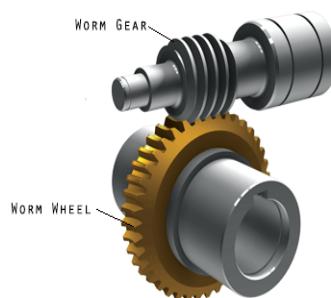


Fig-03: worm & worm wheel gear

## CALCULATIONS

### ➤ RPM :-

Motor is running on 40 rpm.

D1 = diameter of small sprocket

D2 = diameter of big sprocket

T1 = no. of teeth on driver member (small sprocket)

T2 = no. of teeth on driven member (big sprocket)

N1 = rpm of driver member

N2 = rpm of driven member

The rpm of driver member is same as motor rpm.

So, N1 = 40 rpm

By the relation of

$$D1/D2 = N2/N1$$

$$T1 * D1 = T2 * D2$$

$$\text{So, } D1/D2 = T1/T2 = N2/N1$$

$$14/40 = N2/40$$

$$N2 = 14 \text{ rpm}$$

Which is less rpm compare to the small sprocket

### ➤ TORQUE :-

Motor has power 90 w

And rpm of motor is 40 & 60.

Suppose motor is running on rpm of 40.

$$\text{Then torque} = (P * 60) / (2 * 3.14 * n)$$

$$= 21.5 \text{ Nm}$$

So, motor produced maximum torque 21.5 Nm.

### ➤ FORCE:-

The stroke length of double acting pneumatic cylinder is 160 mm.

The diameter of double acting pneumatic cylinder is 40mm, which is taken into m, = 0.040 m

The pressure p = 7 bar =  $7 * 10^5 \text{ N/m}^2$

- Forward Force = pressure \* area

$$= p * \{3.14 * d^2 / 4\}$$

$$= 7 * 10^5 * \{3.14 * 0.040^2 / 4\}$$

$$= 879.2 \text{ N}$$

Maximum mass = 89.62 Kg

So, the maximum force which is exerted by the pneumatic cylinder is 879.2N.

○ Ultimate stress

$$= \text{maximum force/area}$$

$$= 879.2 / (3.14 * 0.040 * 0.040) / 4$$

$$= 700000 \text{ N/m}^2$$

○ In aluminium alloy we use factor of safety = 1.5

So, Yield stress

$$= \text{ultimate stress / factor of safety}$$

$$= 700000 / 1.5$$

$$= 466666.66 \text{ N/m}^2$$

ALLOWABLE WORKING LOAD OR SAFE WORKING LOAD

Allowable working load

$$= \text{yield stress} * \text{area}$$

$$= 466666.66 * 3.14 * 0.040 * 0.040 / 4$$

$$= 586.13 \text{ N}$$

So, the safe load which is exerted by pneumatic cylinder is 586.13N

➤ THEORETICAL AIR CONSUMPTION CALCULATIONS:-

D = Diameter of cylinder bore 4 cm

L = Stroke length 16 cm

P = Air pressure 7 bar

d = diameter of piston rod 0.4 cm

● AIR CONSUMPTION FOR FORWARD STROKE:-

$$C = [3.14 * D^2 * L] / 4000$$

$$= 0.20096 \text{ LTR}$$

● AIR CONSUMPTION FOR RETURN STROKE:-

$$C = [3.14 * (D-d)^2 * L] / 4000$$

$$= 0.16277 \text{ LTR}$$

● ONE COMPLETE CYCLE OPERATION THIS CYLINDER TOTAL AIR CONSUMPTION :-

$$C = 0.20096 + 0.16277$$

$$= 0.36373 \text{ LTR}$$

**RESULTS:**

Table 4.1: Descriptive Statics

SR.NO	Output Variable	Measurement
1	Maximum mass	89.62kg
2	Maximum force	879.2N
3	Safe working load	586.13 N
4	Air consumption	0.36373 LTR
5	Motor torque	21.5Nm
6	RPM of big sprocket	14

**5. ADVANTAGES:**

1. Increased moving ability: Thus, it does not become tiresome to perform the job.
2. Can be used in very compact places: Where the reversing & turning of vehicle is difficult.
3. Can accommodate into pass on dam site working: Saves time & energy.

**DISADVANTAGES:**

1. Increased complexity: As it requires complex mechanism for getting desired output.
2. Cost increases: As more will be the complications to perform the operation, more will be the cost encountered with it.
3. Maintenance increases: More parts in working leads to more maintenance.

**APPLICATIONS**

1. 3-Directional dumper can be helpful for farmers, site construction, garbage collector as well for dumping gravel, sand etc.
2. Truck, tipper, dump truck are used to transport loose material from one place to another place at construction site in mines or in dump yards to accomplish the actual site requirement.
3. In a nutshell, in order to execute low scale engineering and mechanical tasks, pneumatic dumpers would be the best suited and a viable alternative over conventional hydraulic dumpers.
4. Packing: packing is that puts goods into boxes to protect them and to make them easier to carry while in transit. In this the required quantity of the material is loaded in trailer and can be unloaded at required direction.
5. Loading: In this, any bulk and unit load can be loaded, transported and unloaded at required place and required direction.
6. Dispensing: dispensing is distributed or weighted out in carefully determined portions. In which material is distributed at any three directional places.
7. Palletizing: In this the material is filled in pallets and these pallets are carried or supported by trailer and transported to required place by using forklift
8. Material dropdown: the finished products on machine is dropdown by using pneumatic trailer  
Pick & place: pick up and placement of all types of materials at required place

**6. CONCLUSION:**

The project work thus constructed exhibits the expected results. As this concept saves time & energy as well this may leads to efficient working, which helps in the early completion of project. The constructional work or the infrastructural work demands of efficient and user friendly machinery will lead to more and more use of the project work like three way dropping dumper. Thus we have developed a Modern Three Axis Pneumatic Trailer which helps to know how to achieve low cost automation. The operating procedure of this system is very simple, so any one can operate. By using more techniques, they can be modified and developed according to the applications.

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