

# Development and Fabrication of Three Directional Modern Trailer Using Pneumatic System

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**Abstract:** This project work titled "PNEUMATIC THREE AXES MODERN TRAILER" has been conceived having studied the various methods employed and difficulty in dumping materials. Conventional trailers unload materials only in one direction that is at the backside of the vehicle. This may cause the problems of blockage when the work area is limited. This Multidirectional dumper overcomes the problem of unloading the vehicle by using Pneumatic cylinder and worm gear arrangement through which the material can be unloaded in 180 degrees as per requirement. The three dumper is developed and tested for its movement in all possible angle (180 degrees) to unload the materials with the inclinations monitored and controlled.

**Keywords:** Tipper Mechanism, Valves, Pneumatic System, Trailer.

A Dumper trailer is a vehicle designed for carrying bulk material, often on building sites and construction works. They are normally diesel powered vehicles which can pull a variety of products including gravel, grain, sand, fertilizer, heavy rocks, etc.

The Dumper is an essential part of any construction work since Material handling in construction and civil works is one of its basic necessities. The material supply to civil and construction is provided through trucks, dumper etc. The material is properly loaded, managed, stacked, transported and unloaded. The dumper carries the material which is loaded from the site, where the material is initially stored. It is then loaded to the dumper and transported to the required site and then unloaded. Thus the dumpers role is important for completion of any constructional site. Modern dumpers have payloads of up to 10000 kg & usually steer by pivot steering.

## *Conventional Dumper Trailers*

The Traditional dumper unloads the material in only one direction generally in payloads of up to 10 tones and usually steer by articulating 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 ROPS (Roll over Protection) frame may be fitted over the seat to protect the driver if the dumper rolls over. Some dumpers have FOPS

(Falling Object Protection) as well. Lifting skips are available for discharging above ground level

The Existing system available unloads the material on one direction only that is, on the back side. One of the problem are cited with the conventional dumper in the time and energy for setting the huge dumper in the proper direction to dump the material As considering the mines space available is very less especially in countries like India, major issues raises over here, the incompatibility of the site with the fully loaded dumper causes a lot of settling time for the trolley to get the material properly arranged and transported to reach its location.

To overcome this problem 3 Axes tipper mechanism is employed which can dump the material in any direction except the frontal one without moving the truck in any direction. This mechanism can overcome space requirement which often result in preventing blocking of road, saves time and enhances productivity at lowest cost.

The Aim of our project is to develop the suitable arrangement keeping in mind the aforementioned problems and to ensure that the materials can be unloaded from the trailer in three axes without application of any impact force.

In real time application, the dumping process is achieved by pressing the Direction control valve activation switch. The compressed air is goes to the pneumatic cylinder through valve. The ram of the pneumatic cylinder acts as a lifting the trailer cabin. The automobile engine drive is coupled to the compressor engine, so that it stores the compressed air when the vehicle running. This compressed air is used to activate the pneumatic cylinder, when the valve is activated.

Automation of this dumper system can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation.

#### *Basic Idea*

This idea came after visiting various construction sites. The problem we observed there was that, the trailer only could unload the material (sand, gravel, dirt etc.) in only back side of the trailer. So if the construction site has narrow space and one wants to unload the material left or right side of the space then it is not possible. So for that there should be some mechanism so that the trailer can unload the material in all three possible directions and for that one can use three cylinder for three directions, But the controlling will be difficult and also the cost will be more. To overcome the above problems we can use one worm-wheel gear pair arrangement to rotate the dumper of the trailer in all three possible directions (right, left & back) and one cylinder to lift the dumper for unloading.

#### RELATED LITRATURE

##### *About pneumatic*

The word pneumatic derived from Greek word called 'pneuma' which means wind, and can be defined as study of air and other gases under pressure and application of that knowledge in design of mechanical components. The origins of pneumatics can be considered back to the 1<sup>st</sup> century when Greek mathematician Hero of Alexandria wrote about his inventions powered by wind. Later on German physicist Otto von Guericke invented the vacuum pump, which can take out air from any vessels. The compressibility of the air was first studied by Robert Boyle in 1662 and he concluded that product of pressure and volume of a particular quantity of gas remains constant

$$P * V = Constant \text{ (or) } P_1V_1 = P_2V_2$$

In this equation the pressure is in absolute pressure. So the pressure of gas can be increased by compressing it to smaller volume.

#### LITERATURE REVIEW

*Alley & McLellan[1]* studied how the hydraulics can be introduced in truck mounted dump bodies relatively early on, in which record shows the first hydraulic dump bodies was introduced in 1907 as Robertson Steam Wagon with a hydraulic hoist which received power from truck engine .

*Ganesh Shinde et al.[2]* studied the "Design and Development of 3-Way Dropping Dumper" which has been conceived by observing the difficulty in unloading the materials mainly at construction sites. Survey for this paper revealed the fact that most of the construction sites and garages use difficult method to unload the material, So by focusing mainly on the above difficulty they have designed a prototype of suitable arrangement to dump the material in three different direction by using hydraulic power. This concept saves time and effort to dump the materials. Further modification will make it more efficient of use.

*Prof.Deshmukh.S.A. et al.[3]* studied the "Three Axis Pneumatic Modern Trailer" which has been conceived having studied the difficulty in unloading the materials from the trailer. It is difficult to dump the material in all three directions and also dumping can not be done in small compact streets. In this project the above problems are rectified to unload the material in all three directions without any impact force. Further this can be modified and developed based on the required application.

#### WORKING PRINCIPLE

Three ways modern trailer will dump the material in all three possible direction. The dumping will be done by using pneumatic cylinder, the compressed air will pass from the compressor to the direction control valve which will control the compressed air according to the required action(forward or backward stroke) . The worm-wheel gear pair coupled with DC motor will help to rotate the trailer in all three possible directions.

#### CONSTRUCTION

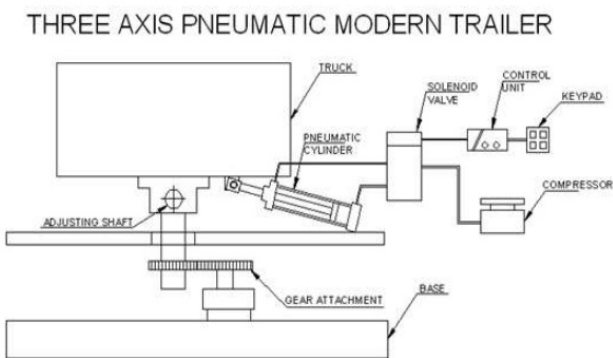
The major parts of 3 axis pneumatic trailer are as follows

1. Double acting Pneumatic cylinder

2. Air compressor
2. Worm gear arrangement
3. D.C Motor
4. Solenoid valve
5. Relay

Pneumatic cylinder is placed directly below the dumper body and is attached to the frame of a dumper which is hinged at one point to perform tipper mechanism. Air compressor is the component which provides air in the pneumatic cylinder for the working of trailer. Worm gear arrangement plays its role in rotating the dumper in different directions and is placed below the trailer so that everything can be rotated accordingly. Other important components includes D.C motor, Solenoid valve, and relay. The D.C motor helps the rotation of trailer body with its connection to gear arrangement which converts its rotary motion to linear motion and its capacity depend on the trailer size. Further solenoid valve which is an electromechanically operated valve with the relay operates the intake and release of air pressure inside the pneumatic cylinder. Other components used in the construction of 3 axis pneumatic trailer are polyethylene tubes, wheels, ball bearing, and mild steel. Model frame has been constructed using the mild steel rods and dumper is made up of mild steel sheets.

### CIRCUIT DIAGRAM



### CALCULATIONS

- Operating pressure of the compressor = 10 Bar
- Rated Power of the DC Motor = 30 W
- Force exerted by the cylinder rod

In forward stroke

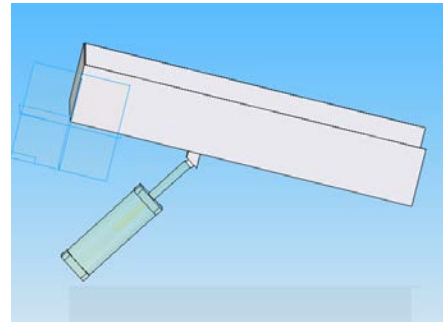
$$F_f = P * A = 10 * 10^5 * .25 * \pi * 0.032^2$$

$$= 804.247N$$

In backward stroke

$$F_b = P * A = 10 * 10^5 * .25\pi * (0.032^2 - .0032^2)$$

$$= 796.205N$$



- Torque produced by the motor

$$\text{Power Developed} = \frac{2 * \pi * n * T}{60}, \Rightarrow T = \frac{18 * 60}{2 * \pi * 30}$$

$$T = 5.72Nm$$

- Calculation of weight to be dump ( $F_c$ )

$$F_v = F_f * \cos\theta$$

$$= 804.24 * \cos 69.72 = 278.75N$$

$$F_h = F_f * \sin\theta$$

$$= 804.24 * \sin 69.72 = 750.34N$$

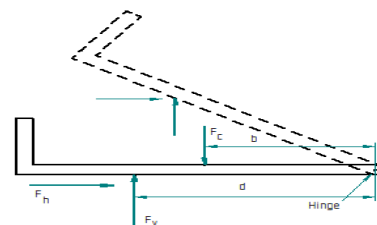
- Torque balance equation

$$F_v * d = F_c * b$$

$$278.75 * 180 = F_c * 215$$

$$F_c = 233.372N$$

$$F_c = 23.789Kg$$



Where,

P=Compressor Operating Pressure[Pa]

$A$ =Area of Piston[ $m^2$ ]

$F_f$ =Force exerted by the piston during forward stroke[N]

$F_b$ =Force exerted by the piston during backward stroke[N]

$n$ =Speed of DC Motor[rpm]

$T$ = Torque developed by the DC motor[N-m]

$F_v$ =Vertical Component of the Piston force[N]

$F_h$ =Horizontal Component of the Piston Force[N]

$\theta$  =Inclination of the Piston with respect to the Vertical [Degree]

#### APPLICATIONS

- 3-Directional dumper can be helpful for farmers, site construction, garbage collector as well for dumping gravel, sand etc.
- 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.
- 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.



#### FUTURE SCOPE

- Precision control over the positioning of the cylinder can be achieved by installation of proper sensor arrangement.

- Instead of one cylinder we can use two small cylinders of identical capacity to lift higher loads with better balancing.
- We can automate the whole system using microprocessors and transformer arrangement.

#### CONCLUSION

The developed model exhibits the required results. This concept saves time & energy which leads to effective working of model. The constructional work or the infrastructural work demands efficient and user friendly machinery which will lead to more and more use of modern three axis pneumatic trailer. 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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