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Design and Development of 360^0 Rotating Dumper

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ABSTRACT: Normal dumper vehicle unload materials only in one direction that to only at the backside of the tipper by using various powerful pneumatically operated cylinder, which may cause the problems of blockage when the work area is limited. The Multidirectional dumper overcomes the problem of unloading the vehicle on side way by using Pneumatic cylinder in our prototype but pneumatic cylinder are going to be used in main vehicle .By using cylinder and chain drive the material can be unloaded in 360^0 as per requirement. The Multidirectional dumper is developed and tested for its movement in all 360^0 possible angle to unload the materials in the tipper trolley and monitor the inclinations for its gradualism by using Geneva mechanism.

Keywords: Geneva Mechanism, Dumping Vehicle, 360^0 dumping.

1. INTRODUCTION:

In daily uses the transport of material from one place to another place, so many methods are adopted in such application. The pneumatically operated rotating trolley will overcome the previous problem of rotation of the trolley. The main problem in the existing trolleys is that the material is dump towards back side only; this requires more man power to scatter the material drained. Such types of difficulties are overcome, if we use a rotating trolley which can rotate and enables to deliver the material towards all sides. It consumed extra time for complete material unloading process. Dumpers are also the most common cause of accidents involving construction site and plant also.

A typical dump truck is equipped with a hydraulically operated open box dead hinged at rear. The front of which can be lifted up to allow the contents to be deposited on the ground behind the truck at side of delivery. Nowadays dumpers with swivel skips could be rotated to sideways (3 directional dumper) which become popular, especially for working in narrow sites such as road works. But still this technology is insufficient for fulfilling our requirement for complete unload. This technology concerns only on solving the problem of unloading on directional sides of dumper. A pneumatically operated rotating trolley has three directions. This can be operated with the help of air pressure. The solenoid valves are used in order to regulate the air pressure, so that the trolley can rotate, by rotating the spur gear over the rack gear. At the required position it is stopped.

The cylinder piston arrangement is used to lift the trolley with the help of air pressure; so as to set the trolley in inclined position and the material inside is dropped down. The proper direction to dump the material carrying in it hence the need of project work riser was is about unidirectional dropping dumpers which dump the material in any direction with moving trolley in any direction. With rise of chances in technology, it is become essential to find a viable alternative to 3 way dumper system. This concept saves time & energy which leads to efficient working.

Different Type of Cylinders:

Although pneumatic cylinders will vary in appearance, size and function, they generally fall into one of the specific categories shown below. However there are also numerous other types of pneumatic cylinder available, many of which are designed to fulfill specific and specialized functions.

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A. Single Acting Cylinders:
Single-acting cylinders (SAC) use the pressure imparted by compressed air to create a driving force in one direction (usually out), and a spring to return to the "home" position. More often than not, this type of cylinder has limited extension due to the space the compressed spring takes up. Another downside to SACs is that part of the force produced by the cylinder is lost as it tries to push against the spring.

B. Double Acting Cylinders:
Double-acting cylinders (DAC) uses the force of air to move in both extends and retracts strokes. They have two ports to allow air in, one for outstroke and one for in stroke. Stroke length for this design is not limited; however, the piston rod is more vulnerable to buckling and bending. Additional calculations should be performed as well

2. LITERATURE REVIEW:

Pneumatics was being incorporated into truck mounted dump bodies relatively early on, in which record shows one of the first pneumatic dump bodies was the Robertson Steam Wagon with a pneumatic hoist that received power from the trucks engine or an independent steam engine. Alley &McClellan of Glasgow developed another early Pneumatic dump body in 1907 that was power-driven.

Modern 3 ways dropping dumper" has been conceived by observing the difficulty in unloading the materials. The survey in this regards in several automobile garages, revealed the facts that mostly some difficult methods were adopted in unloading the materials from the trailer. This paper has mainly focused on above difficulty. Hence a prototype of suitable arrangement has been designed. The vehicles can be unloaded from the trailer in three axes without application of any impact force [1].

The older dropping dumper has been conceived by observing the difficulty in unloading the materials. The survey in this regards in several automobile garages, revealed the facts that mostly some difficult methods were adopted in unloading the materials from the trailer. This paper has mainly focused on above difficulty. Hence a prototype of suitable arrangement has been designed. The vehicles can be unloaded from the trailer in three axes without application of any impact force. The Direction of the mechanism can be control with the help of ball and socket joint which attached the ram of the hydraulic cylinder which lifting the trailer cabin in require side. Further modifications and working limitations will put this work in the main league of use. This concept saves time & energy which leads to efficient working [2].

Existing trailers requires more space, time and fuel. So to overcome these problems we have introduced a three way tipper mechanism that would be economical and efficient. This tipper mechanism can do a great job by unloading the goods in three directions. This concept generally relates to hydraulic jack and ball socket joint for unloading material from trailer in left side, right side and back side[3]. A hydraulic jack is a powerful lifting or pushing tool designed to provide effective lift over greater distance than basic mechanical jack. Hydraulic jacks use a plunger mechanism and non-compressible fluid, typically a hydraulic oil, to create required pressure and thus resulting in greater lifting capability[4].

In this project the hydraulic jack is attached below whole setup to lift the trolley for unloading. This tipper mechanism can be applied to both domestic as well as industrial areas. The proposed mechanism used for unloading purpose is safe and efficient and could be used safely in different areas. This type of system is specially designed for easy unloading of goods in congested space without wasting time and fuel consumption. In traditional tipper, it is capable to lift the load only in one direction i.e. in backward direction. It requires very skilled driver, increases fuel requirement. In this type of system, hydraulic jack of 2 Tone capacity and ball socket joint plays very vital role. The ball socket joint is able to rotate in 360 degree direction.

The plunger of jack will pump the hydraulic oil at very high pressure. Due to oil pressure the piston start rising in the cylinder. The end portion of the piston is attached to ball socket joint. This end easily rotates in ball socket joint. Socket is provided below the carrier. Hinge pin will be provided at the each corner of the frame and on the chassis also.

If we want to unload the goods on left side then, fixed left side hinge with pin and remove the pins of other two sides and start the raising the hydraulic jack. During this process, the end of the piston which is in contact in the socket start sliding to the left side. Same process is done in case of tilting of trolley to right side by fixing the right side hinges and removing the pins of other two sides to unload the goods.

3. METHODOLOGY:

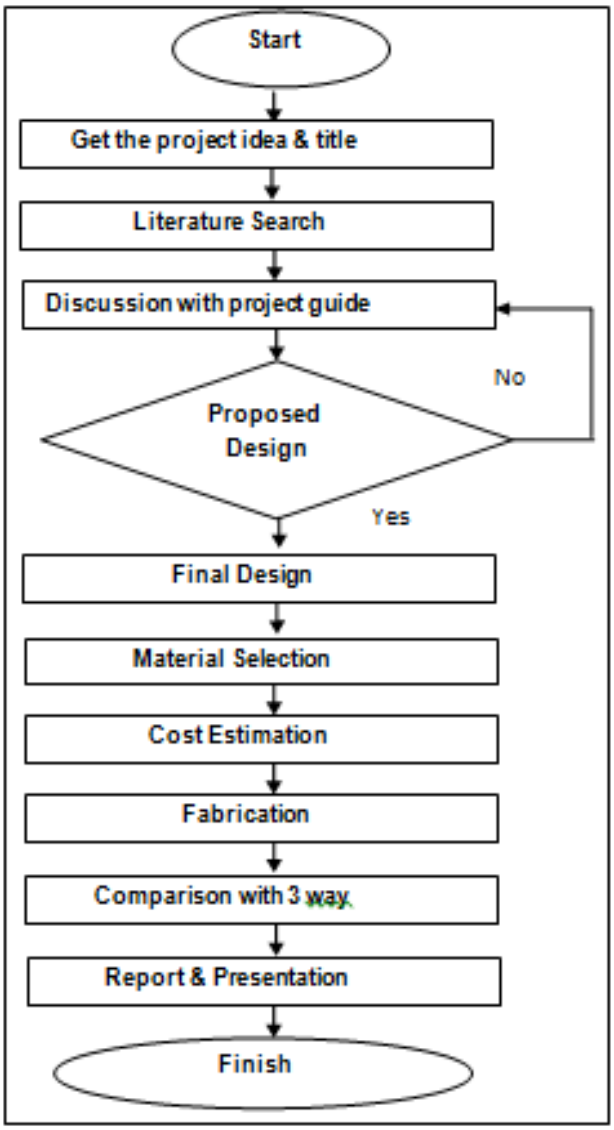

Fig. 1 Methodology

4. DESIGN:

DOUBLE ACTING CYLINDER CALCULATOR FOR OUTPUT STROKE-

The force exerted by a double acting pneumatic cylinder can be expressed as;

$F = p A$

$F = p \pi d^2/4$ (1)

where,

F = force exerted (N)

p = gauge pressure (N/m^2, Pa)

A = full bore area (m^2)

d = full bore piston diameter (m)

DOUBLE ACTING CYLINDER CALCULATOR FOR INPUT STROKE:

The force exerted by double acting pneumatic cylinder on outstroke can be expressed as (1).

The force exerted on in stroke can be expressed as

$F = p \pi (d_1^2 - d_2^2) / 4$ (2)

where

d_1 = full bore piston diameter (m)

d_2 = piston rod diameter (m)

FORCE CALCULATIONS:

Pressure of the cylinder = 200kpa

Diameter of the cylinder = 25mm

Diameter of the piston rod = 10mm

CALCULATION FOR DOUBLE ACTING PISTON OUTSTROKE:

The force exerted by a single acting pneumatic cylinder with 1 bar (105 N/m2) and full bore diameter of 100 mm (0.1 m) can be calculated as

$F = p \pi d^2 / 4$

$= [(2*105)* \pi * (0.025)^2]/ 4$

F = 98 N

CALCULATION - DOUBLE ACTING PISTON IN-STROKE:

The force exerted from a single acting pneumatic cylinder with 2 bar (105 N/m2), full bore diameter of 25 mm (0.025 m) and rod diameter 10 mm (0.01 m) can be calculated as

$F = p \pi (d_1^2 - d_2^2) / 4$

$= (2*105) \pi [(0.025)^2 - (0.01)^2] / 4$

F = 82 N

In-stroke capacity is reduced compared to outstroke capacity due to the rod and reduced active pressurized area. Through the pressure of 2 bar itself we could attain the desired required operation so through a mini compressor that could be fitted into our car we can achieve our purpose.

5. DESIGN OF CAD MODEL:

Layout of Pneumatic system used in Project:

Advantages of pneumatic systems:

Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machines. Pneumatic systems have a lot of advantages.

- **High effectiveness**

Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes. After use, compressed air can be released directly into the atmosphere without the need of processing

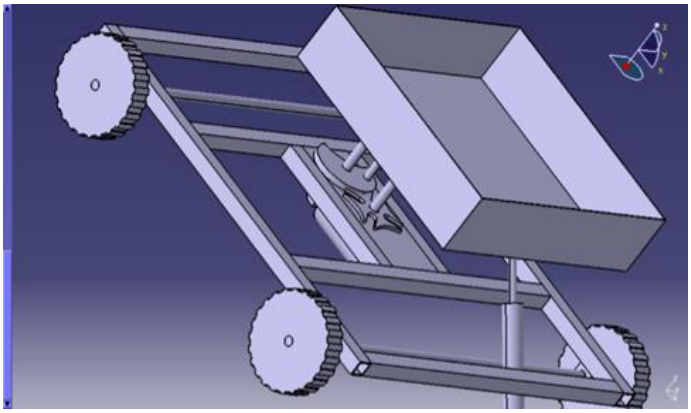

Fig. 2 CAD model of Geneva Mechanism

- **High durability and reliability**

Pneumatic components are extremely durable and cannot be damaged easily. Compared to Electromotive components, pneumatic components are more durable and reliable.

- **Simple design**

The designs of pneumatic components are relatively simple. They are thus more suitable for use in simple automatic control systems.

- **High adaptability to harsh environment**

Compared to the elements of other systems, compressed air is less affected by high temperature, dust, corrosion, etc.

- **Safety**

Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded.

- **Easy selection of speed and pressure**

The speeds of rectilinear and oscillating movement of pneumatic systems are easy to adjust and subject to few limitations. The pressure and the volume of air can easily be adjusted by a pressure regulator.

- **Environmental friendly**

The operation of pneumatic systems do not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

- **Economical**

As pneumatic components are not expensive, the costs of pneumatic systems are quite low.
Moreover, as pneumatic systems are very durable, the cost of repair is significantly lower than that of other systems.

6. CONCLUSIONS:

This machine is constructed using various materials like chain drive mechanism , MS Sheet, MS Square Pipe, Polished Rod, Double Acting Pneumatic Cylinder, Universal Joint, Pneumatic Pipes, Directional Control Valve, Pneumatic Fluid, Pneumatic Pump, and Reservoir. First of all a base frame structure is prepared using MS Square Pipe. The Trailer body is prepared using MS Sheet. The universal joint is attached with the frame using welding process.
Another universal joint is attached on Bottom of the Trailer Body. A Double Acting Cylinder connects both the universal joint. Pneumatic pipes are connected to the Double acting Pneumatic Cylinder. Another Side of the Pneumatic pipe is attached to the Directional Control valve. Pneumatic fluid is filled in the Reservoir Tank. Another side of the Pneumatic Pump is connected to the Directional control valve. This assembly is attached with pneumatic cylinder that operates the trailer and finally the chain drive mechanism has been welded with the main frame of the dumper so that it can rotate the whole load carrying structure.

Fig. 3 Actual Model

It is mainly based on rotation of trolley and divided in two parts Rotation and Dumping. For rotation of trolley, we used Geneva mechanism. With the help of Geneva mechanism we control the rotation of the trolley, by making the pneumatic cylinders and Geneva mechanism to work together in order to make everything work

efficiently. 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.

7. CONCLUSIONS:

Further modifications and working limitations will put this work in the main league of use. This concept saves time & energy which leads to efficient working .The constructional work or the infrastructural work demands efficient and user friendly machinery which will lead to more and more use of unidirectional trolley.

We have obtained most of the objectives and goals that we set for ourselves at the start of our project. We have been able to increase the easiness in unloading trolley. Problems occurred at the time of unloading the trolley in critical areas are eliminated. And thereby reducing overall time and fuel required for unloading the trailer.

8. ACKNOWLEDGMENT:

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