



ISSN NO. 2320-5407

Journal homepage: <http://www.journalijar.com>
Journal DOI: [10.21474/IJAR01](https://doi.org/10.21474/IJAR01)

INTERNATIONAL JOURNAL
OF ADVANCED RESEARCH

RESEARCH ARTICLE

DESIGN AND FABRICATION OF MULTI-DIRECTIONAL LIFTING DUMPER.

Shubham S. Ganar¹, Akshay D. Kakde¹, Rahul R.Pali¹, Shubham D. Kolhe¹, Mr. A.S Deshmukh².

1. UG Scholar, Department of Mechanical Engineering, DBACER, Nagpur.
2. Assistant Professor, Department of Mechanical Engineering, DBACER, Nagpur.

Manuscript Info**Manuscript History:**

Received: 11 February 2016
Final Accepted: 26 March 2016
Published Online: April 2016

Key words:

Design Optimization of Chain drive, Pneumatic Cylinder, Flow Control Valve.

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 180° as per requirement. The Multidirectional dumper is developed and tested for its movement in all 180° possible angle to unload the materials in the tipper trolley and monitor the inclinations for its gradualism (linearity).

***Corresponding Author**

Shubham S. Ganar.

Copy Right, IJAR, 2016. All rights reserved.

Introduction:-

Material handling in construction and civil works is one of the basic necessities. The material supply to civil and construction is provided through trucks, dumper etc. The material should be 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. The 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 transportation time to reach its location.

The dumper unloads the material in only one direction. But this incapability can be full new method mechanism as the Multidirectional dumper. Gothic mechanism is an approach to reduce the idle time to settle the dumper. The material is unloaded in any direction and hence can be boldly stated as "Multidirectional Dumper." The major outcomes of Multidirectional dumper has overcome space requirement which often result in road blocking. Hence, we have inversion in the existing mechanism providing the unloading in 180 rotations. This mechanism prevents blocking of road, saves time and enhances productivity at lowest cost.

The automotive sector is fast booming section in India. There are variable in automotive industry light and heavy motor vehicle. Heavy duty vehicle support as the backbone and confront to the working. A dumper whose material can easily be unloaded in one direction that is mostly to its rear end. These inefficiency is been overcomes by the Multidirectional dumper.

Basic idea:-

This idea was came from the visited a constructional site few days ago. There we found that a dumper was unloading loose material such as sand, gravel, and dirt. A dumper is an integral part of any construction work and hence its role is important for completion of work on site. Typical dumper trucks can generally unload material only exactly of its back side. One thing was remarkable that on complicated locations such as on angular sides and

directional sides (left and right) of dumper the unloading of material became quite difficult. In such conditions dumper truck remained ideal. It consumed extra.

Dumpers are also the most common cause of accidents involving construction site and plant also. A typical dump truck is equipped with a pneumatically 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.

One of the problems is cited with dumper in the time & energy for operating the huge dumper in the proper direction to dump the material carrying in it hence the need of project work riser was is about Multidirectional 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.

Literature review:-

Pneumatic Dump Bodies:-

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 truck's engine or an independent steam engine[3]. Alley & McClellan of Glasgow developed another early pneumatic dump body in 1907 that was power-driven by s

Types of Dump Truck:-

1. Standard Dump Truck: Another kind of 8x4 dump truck: three rear axles (two powered one lift)
2. A standard dump truck is a truck chassis with a dump body mounted to the frame. The bed is raised by a pneumatic ram mounted under the front of the dumper body between the frames, and the back of the bed is hinged at the back to the truck. The tailgate can be configured to swing on hinges or it can be configured in the "High Lift Tailgate" format wherein pneumatic rams lift the gate open and up above the dump body.

Design and Development of 3-Way Dropping Dumper:-

Ganesh Shinde¹, Prachi Tawele², Laukik Raut³

International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 9, September 2014)

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.

Development of three axes lifting modern trailer:-

N.Eswara Prasath¹, S.Shanmugam², C.Mathalai Sundaram³, A.VembathuRajesh⁴

International Journal of Emerging Technology and Innovative Engineering Volume I, Issue 5, May 2015 (ISSN: 2394 – 659)

Trailer has lots of applications in today's world. In industrial and domestic considerations, tippers can pull a variety of products including gravel, grain, sand, fertilizer, heavy rocks, etc. By considering wide scope of the topic, it is necessary to do study and research on the topic of tipper mechanism in order to make it more economical and efficient. In existing system, tipper can unload only in one side by using pneumatic jack or conveyor mechanism. By this research it is easy for the driver to unload the trailer and also it reduces time and fuel consumption. For making tipper mechanism with such above conditions pneumatic jack mechanism can be used.

Design and Fabrication of Unidirectional Dumper:-

Prof. Mrs. R. S. TupkarAditya R. MalewarRohit A. Ramteke IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015

The prototype of unidirectional dumper is thoroughly based on pneumatic system for light weight load and for heavy weight load pneumatic system is suitable. This prototype model consists of Air compressor, air reservoir, Pressure gauge, 5/3 solenoid valve, pneumatic cylinder, DPDT (Double pole double throw), etc.

Material used &it’s technical specification:-

Chassis - Mild Steel

Mechanical Properties:-

Hardness, Brunel	126	126
Hardness, Rockwell	71	71
Tensile Strength, Ultimate	440 MPa	63800 psi
Tensile Strength, Yield	370 MPa	53700 psi
Elongation at Break (In 50 mm)	15.0 %	15.0 %
Reduction of Area	40.0 %	40.0 %
Modulus of Elasticity	205 GPa	29700 ksi
Bulk Modulus (Typical for steel)	140 GPa	20300 ksi
Poisson’s Ratio (Typical For Steel)	0.290	0.290
Machinability	70 %	70 %
Shear Modulus (Typical for steel)	80.0 GPa	11600 ksi

Design of model:-

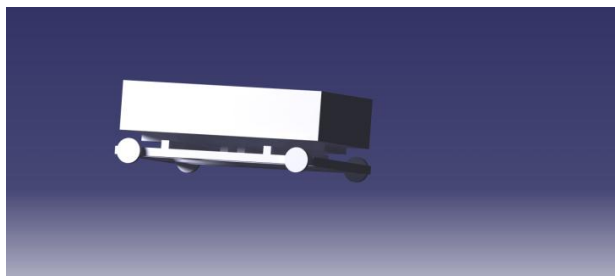


Fig.1.1

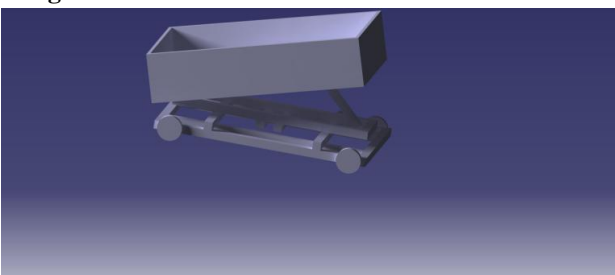


Fig.1.2

Calculation:-

V= 12 V

I= 1 A

P = V x I

= 12 x 1

= 12 = W

Chassis dimension consider a rectangular are a

650 x 450 mm²

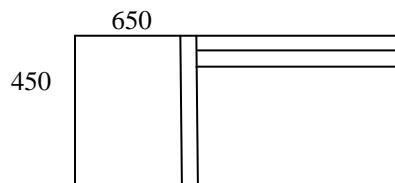


Fig1.2: Middle Part.

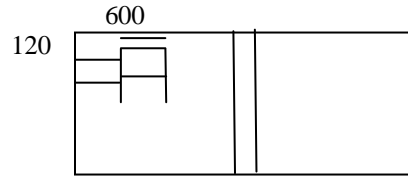


Fig1.2: Upper Body (dumper).



Fig1.3 3: D view of tipper.

Design to rotate a load of 25 kg.

Let,

Load = 25 kg.

To find: - Power

Assume

Velocity = 0.05 m/sec

$V = 0.05$ m/sec

Power = weight \times velocity

$$= 25 \times 0.05$$

Power = 12.2625 N-m/sec

[Power = 12.26 Watt]

Take a 12W D.C. motor to rotate the dumper.

Motor running at 50 rpm

$N = 50$ rpm

Velocity ratio = 5

$$\frac{N_1}{N_2} = 5$$

$$\frac{N_1}{5} = N_2$$

[$N_2 = 10$ rpm]

Now,

$P = 12$ W, $N_1 = 50$ rpm, $N_2 = 10$ rpm

$$\text{Torque} = \frac{P \times 60}{2\pi \times N_1}$$

$$T = \frac{12 \times 60}{2 \times \pi \times 50} = 2.29 \text{ N-m}$$

Design of Chain Drive

1] Design Power

$$P_d = P_R \times K_L$$

K_L – load factor

$K_L = 1.4$ (heavy load 10 hr/day)

[From D.B. Pg. 150 T-XIV]

$$P_d = 12 \times 1.4$$

[$P_d = 16.8$ W]

$$= \frac{16.8}{746} \text{ HP}$$

$$= 0.0225 \text{ HP}$$

2] Selecting Chain for $P_d = 0.0225$ HP and $N_1 = 50$ rpm

[From Data Book Pg. no. 152]

Select chain no. 25.

Pitch = 6.25 $T_1 = 17$

$$Dp_1 = \frac{P}{\sin\left(\frac{180}{T_1}\right)} = \frac{6.25}{\sin\left(\frac{180}{17}\right)}$$

$$[Dp_1 = 34.01 \text{ mm}]$$

$$Vp = \pi \times Dp_1 \times N_1$$

$$Vp = \pi \times \frac{34.01}{1000} \times 50$$

$$[Vp = 5.34 \text{ m/min}]$$

$$\text{For } Dp_2 = \frac{P}{\sin\left(\frac{180}{T_2}\right)}$$

$$\text{Since } \frac{N_1}{N_2} = \frac{T_2}{T_1}$$

$$\frac{50}{10} = \frac{T_2}{17}$$

$$[T_2 = 85]$$

$$Dp_2 = \frac{6.25}{\sin\left(\frac{180}{85}\right)} = [169.14 \text{ mm}]$$

3) Power capacity

$$P = \left[\frac{V}{104} - \frac{V^{1.14}}{526} \right] (26 - 25 \cos\left(\frac{180}{T_1}\right)) \times K_c$$

$$P = 6.25$$

$$V = 0.089 \text{ m/sec}$$

$$T_1 = 17$$

$$K_c = 1$$

$$[P = 29.90 \text{ KW}]$$

4) No. of chain / stand

$$\text{No. of stand} = \frac{16.8}{29.90} = 0.56$$

$$\text{No. of stand} = 1$$

5) Length of chain in pitches

$$L_p = \frac{T_1 + T_2}{2} + \frac{2C}{P} + \frac{P(T_1 - T_2)^2}{40 \times C}$$

$$L_p = \frac{21 + 61}{2} + \frac{2C}{P} + \frac{6.25(85 - 17)^2}{40 \times 186.145}$$

$$\text{Where } C = Dp_2 + \frac{1}{2} Dp_1$$

$$C = 169.14 + \frac{1}{2} \times 34.01$$

$$[C = 186.145]$$

$$[L_p = 114.44 \text{ mm}]$$

Standard roller chain sprocket dimension

[From Data Book Pg. no. 154]

a) Width of sprocket teeth

$$1) \text{ For single stand chain} = 0.58 \times P - 0.15$$

$$[t_0 = 3.475]$$

2) Transverse pitch for multiple stand chain

$$A = 1.1525 \times P$$

$$= 1.1525 \times 6.25$$

$$[A = 7.20 \text{ mm}]$$

3) Corner relief, $e = 0.125 \times P$

$$e = 0.78$$

4) Chamfer radius, $r = 0.54 \times P$

$$r = 3.375 \text{ mm}$$

5) Outside diameter

$$D_0 = P \left[0.6 + \cot\left(\frac{180}{T_1}\right) \right]$$

$$[D_0 = 37.18 \text{ mm}]$$

6) Root or Bottom diameter

$$D_r = D_p - 0.625 \times P$$

$$= 34.01 - 0.625 \times 6.25$$

$[D_r = 30.10 \text{ mm}]$

Assume a Area for 25 kg of load.

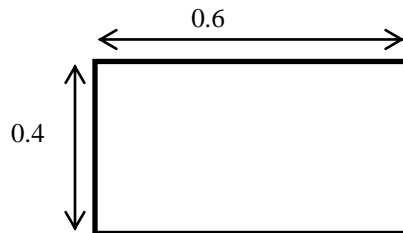
Take, $A = 0.6 \times 0.4$

Material = steel

Length = 0.6 m

Breath = 0.4m

Height = 0.018m



Density of steel = $\frac{M}{V}$

Density of steel = 7750 kg/m^3

$$7750 = \frac{M}{V}$$

$$7750 = \frac{M}{L \times b \times h}$$

$$M = 7750 \times 0.6 \times 0.4 \times 0.18$$

$$[M = 33.48 \text{ kg}]$$

Therefore this area for load 25 kg is fulfilled the condition.

Construction:-

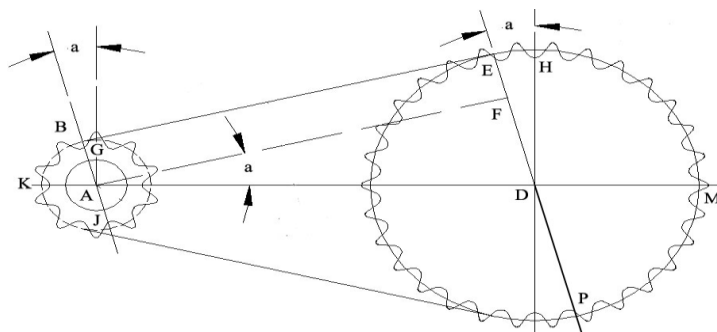
This machine is constructed using various materials like chain drive mechanism , MS Sheet, MS Square Pipe, Polished Rod, Double Acting Pneumatic Cylinder, Universal Joint, Pneumatic Pipes, Directional Control Valve, Pneumatic Fluid, Pneumatic Pump, and Reservoir. First of all a base frame structure is 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 hole load carrying structure.

Main components:-

Chain Drive Mechanism:-

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain known as the drive chain or transmission chain,^[1] passing over sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain



Pneumatic Cylinder:-

Pneumatic cylinders (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like pneumatic 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. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage.

Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tike Room, pneumatics is used to prevent fluid from dripping onto people below the puppets.

Motor:-

A **DC motor** is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

**Compressor:-**

An **air compressor** is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and repressurizes the tank.

Types of pneumatic 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.

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.

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

Other Types:-

Although SACs and DACs are the most common types of pneumatic cylinder, the following types are not particularly rare:^{[1]:89}

- ❖ Through rod air cylinders: piston rod extends through both sides of the cylinder, allowing for equal forces and speeds on either side.
- ❖ Cushion end air cylinders: cylinders with regulated air exhaust to avoid impacts between the piston rod and the cylinder end cover.
- ❖ Rotary air cylinders: actuators that use air to impart a rotary motion.
- ❖ Rod less air cylinders: These have no piston rod. They are actuators that use a mechanical or magnetic coupling to impart force, typically to a table or other body that moves along the length of the cylinder body, but does not extend beyond it.
- ❖ Tandem air cylinder: two cylinders are assembled in series in order to double the force output.

Future modification:-

As the world progressing at faster rate we meet mover and mover huge construction which head to be dig big and big amount of the earth and thus more efficiently working equipment's are to be required and hence the Development of Three Axis Lifting Modern Pneumatic trailer may be used more than the two way or one way. India is progressing at higher rate and hence infrastructural development is on its high. Hence the future of this project work seems promising.

The project work can be modified further more on following basis:-

- ❖ Dual stage cylinders can be used.
- ❖ Oil pump can be used instead of powered cylinder.
- ❖ Capacity can be increased.
- ❖ Wheel steering can be adopted for avoiding the lifting of vehicle along with trailers.

Advantages& disadvantages:-

- ❖ Increased moving ability: Thus, it does not become tiresome to perform the job.
- ❖ Can be used in very compact places : Where reversing & turning of vehicle is difficult.
- ❖ Accommodate on dam site working.
- ❖ Saves time & energy.
- ❖ Increased complexity: It requires complex mechanism for getting desired output.

Conclusion:-

The developed prototype exhibits the expected results. Further modifications in this developed setup will put this work in the main league of use. This concept saves time & energy which leads to efficient and effective working. This further line should be modeled using equations and an experimental agreement. The constructional work or the infrastructural work demands efficient and user friendly machinery which will lead to more and more use of three way dropping dumper.

References:-

1. www.shanafelt.com/material-handling-containers.htm
2. www.lislesurplus.com/.../8-x-14-x-2-bumper-pull-dump-trailer-drop-sides-7-ton/
3. www.northpoitauto.com/np/LinkClick.aspx?file=ticket...tabbed=40
4. www.racingjunk.com;3-Way-Dump-Trailer-Dumps-Left-Right-amp-Ba.html
5. [www.4cstrailersdirect.com/products.php?product=2011... – Canada](http://www.4cstrailersdirect.com/products.php?product=2011...)
6. www.tradekey.com > Products
7. www.tractorbynet.com > ... > Trailers & Transportation.
8. R.K.Bansal, Pascal, Fluid Mechanic, Laxmi Publication LDT.
9. Khurmi Gupta, 14th Edition. Stress Strain Analysis, Machine Design, S. Chand & Company Ltd.
10. Khurmi Gupta, 2008, Degree of freedom, Theory of machine, S chand& Company Ltd; (2008)
11. Ganesh Shinde, PrachiTawele, LaukikRaut, Designs and Development of 3-Way Dropping Dumper [1]. International Journal of Emerging Technology & Advanced Engineering, (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 9, September 2014) 766, Student M. Tech CAD/CAM, GHRCE, Nagpur-440016, MH, India.
12. P. Manasa, C. VijayaBhaskar Reddy Modeling and Analysis of Tractor trolley Axle using Antsy
13. Design and Fabrication of Unidirectional Dumper (IJSRD/Vol. 3/Issue 2/2015/162) All rights reserved by www.ijsrd.com 646[2]. IOSR Journal of Mechanical and Civil (IOSR-JMCE) E-ISSN-2278-1684-ISSN-2320-334X, Volume 6 Issue 5 (MAY-JUNE) PP 88-92
14. Wood, Donald (2001). Dump Trucks [3]. 729 Prospect Ave. Osceola, WI 54020: MBI Publishing Company. pp. 6–9. Wood, Donald (2001). Dump Trucks. 729 Prospect Ave. Osceola, WI 54020: MBI Publishing Company. pp. 11–30
15. AmbojiSudhakar R.1, Humane Yogesh A.2 ,ChavanRohan R.3 ,PatilJyotsna C.4 , KshirsagarPrashant R. Design and fabrication of 3 way tipper mechanism [4]. International journal of researching advanced technology vol, No.4, April 2014 E ISSN 2321-9637 Mechanical engg. Department RMCET, Ambav, Ratnagiri India.
16. Padmanabhan. S., Chandrasekaran.M.andSrinivasa Raman. V. Design Optimization of Worm Gear drive International Journal of Mining, Metallurgy & Mechanical Engineering (IJMMME) Volume 1, Issue 1 (2013) ISSN 2320–4060

Books:

1. Design of Machine Element ByBhandari.
2. Machine Design By R.S. Khurmi, J.K. Gupta.
3. Design Data book By B.D. Shiwalkar.