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Three Way Dumper by Using Electric Mechanisms

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ABSTRACT:

A 3-way dumper is a type of dumping mechanism that can dump material into three separate locations or containers. It is commonly used in industrial and agricultural settings where large quantities of materials need to be transported and unloaded efficiently. The 3-way dumper is a mechanism used in industries to dump materials in three different directions. This mechanism is generally used in mining, construction, and agriculture industries to unload materials from trucks or carts. The traditional 3-way dumper mechanism is operated manually, which requires a lot of labor and time. To reduce the manual work, an electric mechanism can be used to automate the process.The electric 3-way dumper mechanism is designed to operate with the help of an electric motor. The electric motor is connected to the gear system, which rotates the dump bed in three different directions. The mechanism is designed to be controlled with the help of a switch.The electric 3-way dumper mechanism offers several advantages over the traditional manual mechanism. It reduces the manual work and time required to dump the materials. It also increases the safety of the workers as they do not need to be physically present near the dumper. The electric mechanism is also more efficient and can dump larger amounts of materials in a shorter time. In conclusion, the electric 3-way dumper mechanism is a more efficient, safe, and time-saving way to dump materials in three different directions. It can be used in various industries to increase productivity and reduce manual labor.

Key Words: Whiper Gear DC Motor system, DC Motor, Trolley.

1.INTRODUCTION :-

A 3-way dumper is a type of dumping mechanism that can dump material into three separate locations or containers. It is commonly used in industrial and agricultural settings where large quantities of materials need to be transported and unloaded efficiently. A three-way dumper is a machine used for unloading bulk materials from trucks or other transport vehicles. It is called a three-way dumper because it can tip the load in three different directions: to the left, to the right, or straight back. In this design, an electric motor is used to power a connecting linkage mechanism that controls the movement of the dumper bed. An electric 3-way dumper typically consists of an electric motor, batteries, a control panel, and a connecting rod. The batteries provide the electric motor with the necessary power to operate, and the control panel enables the operator to control the direction and speed of the dumper. The electric mechanism provides several advantages over traditional manual or hydraulic dumpers, such as lower noise levels, reduced maintenance requirements, and improved efficiency. One of the advantages of using an electric motor and connecting linkage mechanism in a three-way dumper is that it provides more precise control over the motion of the dumper bed. This can be particularly useful in situations where the load needs to be dumped in a specific location or with a specific orientation. In conclusion, the use of an electric motor and connecting linkage mechanism in a three-way dumper can provide several advantages over traditional hydraulic systems. This design offers more precise control, a more compact machine size, improved efficiency, and lower maintenance costs.

2. PROBLEM STATEMENT:

A three-way dumper is a mechanical device used for unloading materials from a truck or other similar vehicle. The device typically consists of an electric mechanism that allows the dumper to tilt in three different directions.

The problem statement for designing a three-way dumper using an electric mechanism could include the following:

1. Designing the electric motor system to provide sufficient power and torque to lift and tilt the dumper in all three directions.
2. Developing a linkage mechanism that allows the dumper to tilt in three different directions while maintaining stability and balance.

3. Ensuring the overall system is safe and reliable, with appropriate fail-safes to prevent accidents or injuries.
4. Optimizing the design for cost-effectiveness, ease of maintenance, and durability.
5. Considering the specific application and requirements of the dumper, such as the types of materials to be unloaded, the size and weight of the vehicle, and any environmental or regulatory constraints.

3. OBJECTIVE :

The objective of a 3-way dumper using an electric mechanism is to provide a means of unloading material from a container or hopper in three different directions: left, right, and center.

To achieve this objective, the system would involve the following components:

1. Electric motor: This would be the power source for the dumper, providing the necessary torque to operate the mechanism.
2. Linkage mechanism: This would be a system of connecting rods and pivots that would translate the rotational motion of the motor into the desired linear motion required to dump the material in the desired direction.
3. Dumping bed: This would be the container or hopper that would hold the material to be dumped. It would be designed with three openings, one on each side and one in the center, to allow the material to be discharged in the desired direction.
4. Control system: This would be the interface between the operator and the dumper, allowing them to select the desired dumping direction and operate the motor accordingly.

The basic operation of the system would involve the operator selecting the desired dumping direction using the control system. The electric motor would then rotate, causing the linkage mechanism to move and position the dumping bed in the desired direction. Once in position, the material would be discharged from the corresponding opening in the dumping bed.

Overall, a 3-way dumper using an electric mechanism provides a flexible and efficient means of unloading material from a container or hopper in multiple directions, making it a valuable tool for a variety of industries.

Fig. 1 model of 3 way dumper

MODIFICATIONS :

The above all papers which we have studied have used either hydraulic system or pneumatic system for their prototype but we are using motorise system for lifting dumper because of following advantages :-

Advantages :-

- Increased Efficiency: Electric motors are known for their high efficiency compared to other types of motors. Using an electric motor to power the dumper can result in significant energy savings compared to hydraulic or pneumatic systems.
- Increased Precision: Electric motors can be controlled with a high degree of precision, allowing for more accurate and consistent dumping. This is especially important when handling delicate or sensitive materials.

- Reduced Maintenance: Electric motors are generally more reliable and require less maintenance than hydraulic or pneumatic systems. This can result in lower operating costs over the lifetime of the dumper.

- Quieter Operation: Electric motors operate more quietly than hydraulic or pneumatic systems, which can be an important consideration in some settings.

- Improved Safety: The connecting linkage mechanism can provide a more stable and secure dumping process, reducing the risk of accidents or injuries. Additionally, electric motors do not pose the same fire or explosion risks as hydraulic or pneumatic systems.

Disadvantages of Hydraulic

- Potential for leaks: Hydraulic systems use high-pressure fluid to transmit power, and any leaks in the system can cause a loss of pressure and a reduction in efficiency.
- High maintenance costs: Hydraulic systems require regular maintenance to prevent leaks and ensure that all components are functioning properly. This can result in high maintenance costs over time.
- Complex design: Hydraulic systems are often complex in design, with many different components and moving parts. This can make them difficult to design, install, and maintain.
- Noise: Hydraulic systems can be noisy, especially when pressure is released or when there are problems with the system.
- Environmental concerns: Hydraulic systems use fluid to transmit power, and if this fluid leaks or is disposed of improperly, it can have negative environmental impacts.
- Limited temperature range: Hydraulic systems are typically designed to operate within a certain temperature range, and extreme temperatures can cause problems with the system.
- Limited speed range: Hydraulic systems are not suitable for high-speed applications, as the fluid cannot be transmitted quickly enough to keep up with the required speeds.

Disadvantages of Pneumatic:

- Limited Power: Pneumatic systems are not suitable for heavy-duty applications. They are limited in power compared to hydraulic or electric systems.
- Noise: Pneumatic systems generate a lot of noise due to the escaping air from the system.

- Leakage: Pneumatic systems can experience air leaks which can reduce the efficiency of the system.
- Limited speed control: Pneumatic systems do not have the ability to provide precise control over the speed of the system.
- Compressed air quality: Pneumatic systems require clean and dry compressed air to function properly. Any contamination in the air can damage the system and reduce its efficiency.
- Maintenance: Pneumatic systems require regular maintenance, including checking for leaks, replacing filters and lubricating moving parts.
- Cost: Pneumatic systems can be expensive to install and maintain, especially when compared to electrical systems.

DESIGN CALCULATION :

Material used Mild steel, C-45 used for frame chassis

Reasons:

- Strength: Both mild steel and C-45 are strong and durable materials, which are essential properties for a frame chassis. They can withstand the stress and pressure from the weight of the vehicle and the forces generated during acceleration, braking, and turning.
- Weldability: Mild steel and C-45 are also easy to weld, which is important in manufacturing a frame chassis. Welding ensures that the chassis is rigid and strong, and that there are no weak points that can compromise safety.
- Cost-effectiveness: Mild steel and C-45 are relatively inexpensive compared to other materials like aluminum or titanium. Using these materials can help keep the cost of the frame chassis low, making it more accessible to consumers.
- Availability: Mild steel and C-45 are widely available materials, making them easy to source for manufacturers. This can help ensure a steady supply of materials, which is important for efficient production.

- Machinability: Both materials are also easy to machine, which allows for precise cuts and shapes to be made in the manufacturing process. This can help ensure that the frame chassis is of high quality and meets the required specifications.

Properties of Mild Steel:

- Strength: Mild steel is relatively strong and durable, making it suitable for use in construction and manufacturing applications.
- Ductility: Mild steel is highly ductile, which means it can be easily formed into various shapes and sizes without breaking.
- Weldability: Mild steel is easy to weld, making it a popular choice in fabrication and construction industries.
- Corrosion resistance: Mild steel is not very resistant to corrosion and rust, so it requires regular maintenance to prevent degradation.
- Density: The density of mild steel is relatively low, making it a lightweight material that is easy to work with.
- Magnetic properties: Mild steel is magnetic, which makes it suitable for use in magnetic applications such as electric motors and generators.

Mild steel serve the purpose and was hence was selected because of the above purpose.

EN 10083 C45 steel carbon steel

EN 10083 C45 steel is a medium carbon steel with a carbon content of 0.42-0.50%. It is a popular material used in a variety of industrial applications such as gears, axles, shafts, and forged parts. Here are some of the properties of EN 10083 C45 steel:

- Strength: EN 10083 C45 steel is relatively strong and can withstand high stress and heavy loads.
- Hardness: EN 10083 C45 steel can be hardened by heat treatment and has a typical hardness range of 170-210 HB.

- Toughness: EN 10083 C45 steel has good toughness and impact resistance, which makes it suitable for use in heavy-duty applications.
- Machinability: EN 10083 C45 steel has good machinability and can be easily shaped and formed using conventional machining techniques.
- Weldability: EN 10083 C45 steel can be welded using conventional welding techniques, although preheating and post-weld heat treatment may be required in some cases.
- Corrosion resistance: EN 10083 C45 steel is not very resistant to corrosion and rust, so it requires regular maintenance to prevent degradation.

Properties of steel C45 (1.0503)

Weldability: Due to the medium-high carbon content it can be welded with some precautions. Hardenability: It has a low hardenability in water or oil; fit for surface hardening that gives this steel grade a high hardness of the hardened shell.

For material = C 45 (mild steel)

Take fos 2.5

From PSG 1.9

$\sigma t = \sigma b = 675/fos = 270$ N/mm²

$\sigma s = 0.5\ \sigma t$

$= 0.5 \times 270$

$= 135$ N/mm²

Why Mild steel C-45 is selected in our project.

- Easily available in all sections.
- Welding ability
- Machinability

- Cuttingablity
- Cheapest in all other metals.

Power of Shaft = P = 20 watt

Power transmitted by shaft,

$$P = \frac{2\pi N T}{60}$$

Where, N→ Rpm of motor shaft = 30

T →Torque transmitted

$$20 = \frac{2\pi \times 30 \times T}{60} \times 103$$

$T_1 = 6.36 \times 103$ N-mm

$N_1 = 30$ rpm

No. of teeth (Gear), $N_2 = 40$ and module = 2.54 mm

No. of teeth (sprocket) , $N_1 = 8$

Ratio = R = 1: 5

Torque on big gear $T_2 = 5 \times T_1 = 31.83 \times 103$ N-mm

$N_2 = N_1 / 5 = 6$ rpm

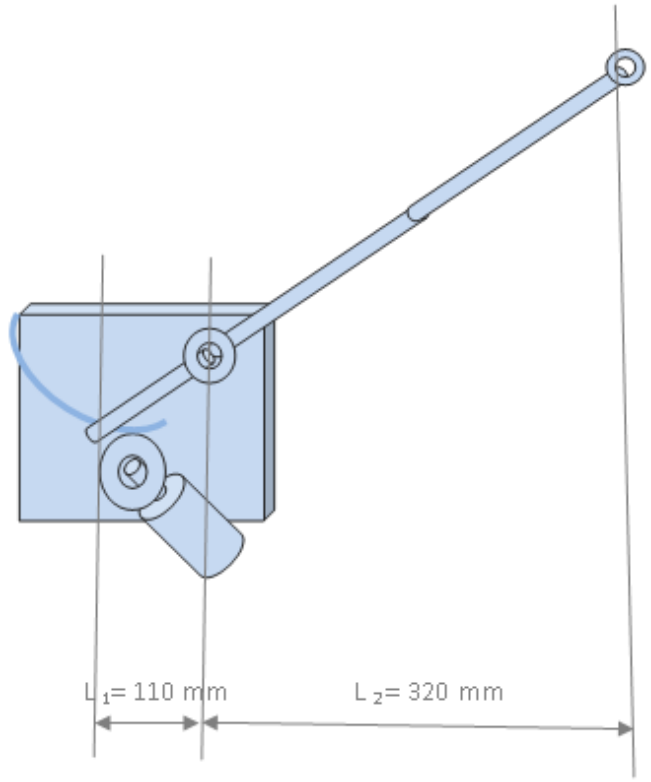
D = M ×Teeth = 2.54×40 = 101.6 mm

Torque = force x radius

$F = T_2 / R$

$F = 31.83 \times 103 / 50.8$

F= 626.59 N = 63.87 KG



$L_1 \times F_1 = L_2 \times F_2$

$110 \times 63.87 = 320 \times F_2$

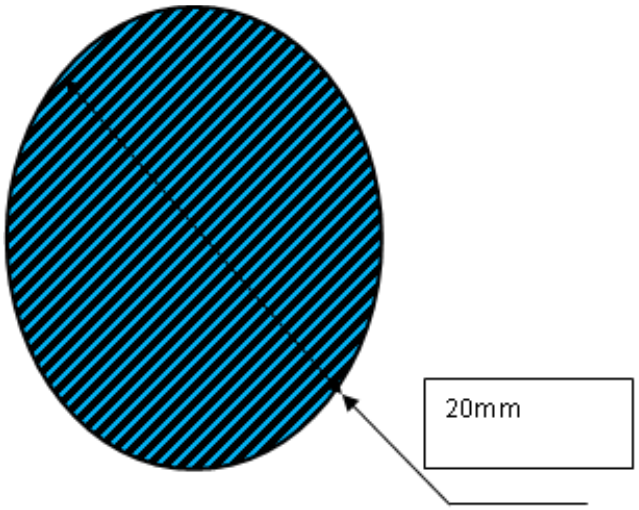
$F_2 = 21.95$ kg

Hence 21.95kg load will be lifted by our motor for single side.

Weight of dumper on be30 kg = 295 N say.

W=295 N

M= W × L / 4



M = 295 × 440/4 = 32450 N-mm

Section of modulus

$Z = \pi/32 \times d_3$

$Z = \pi/32 \times 203$

$Z = 785.3mm^3$

σb (induced)= M/Z = 32450/785= 41.33 N/mm²

As induced bending stress is less then allowable bending stress i.e. 135 N/mm² design is safe.

But we are using 20mm shaft, therefore our shaft design is safe.

For 20mm Shaft diameter we take standard breaking no. P204

Fig. 2 pedestal bearing

P=pedestal bearing

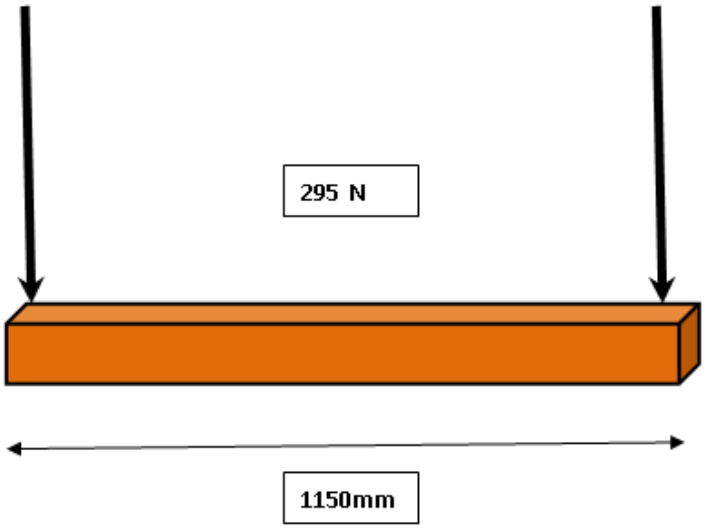
2=spherical ball or deep groove ball bearing

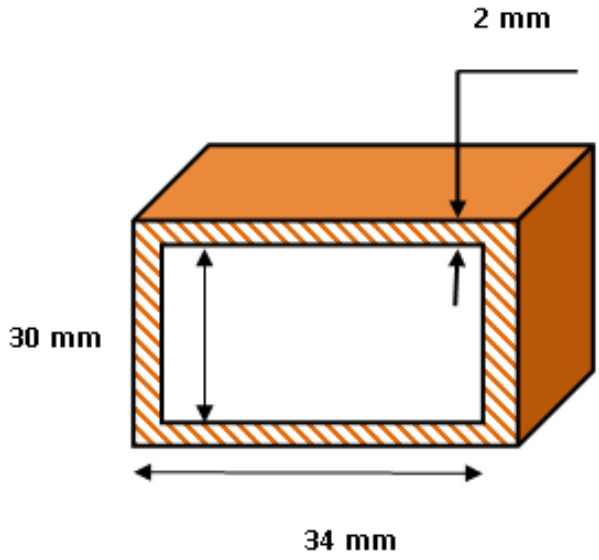
=04=5 × 4 = 20mm

Bore diameter of bearing.

bo× pipe used under belt is subjected to fail under bending,

Consider weight of 30 kg = 295 N





M = W L / 4 = 1150 × 295/ 4 = 84525 N/mm

$Z = B_3 – b_3 / 6 = 343 - 303 / 6 = 2050.7$ mm³

σ b = M / Z

σ b = 84525 / 2050.7 = 41.21 N/mm²

σ b INDUCED < σ b ALLOWED

41.21 N/mm² < 270 N/mm²

Hence our design is safe.

Design of bolt:-

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 kg/cm² . Std nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm

Fig. 3 design of bolt

Let us check the strength:-

Bolt is used as a pivot joint.

P = 63 kg is the value of force

P = 630 N

Also, $P = \Pi /4\ dc^2 \times \sigma$

$$\sigma = \frac{630 \times 4}{3.14 \times (8)2} = 12.53\ \text{N/mm}^2$$

the calculated σ is less than the σtensile and σshear hence our design is safe.

Design of transverse fillet welded joint.

Fig. 4 design of transverse fillet welded joint

Hence, selecting weld rod size = 3.2mm

Area of Weld = 0.707 × Weld Size × L

= 0.707 × 3.2 × 25

= 56.56 mm²

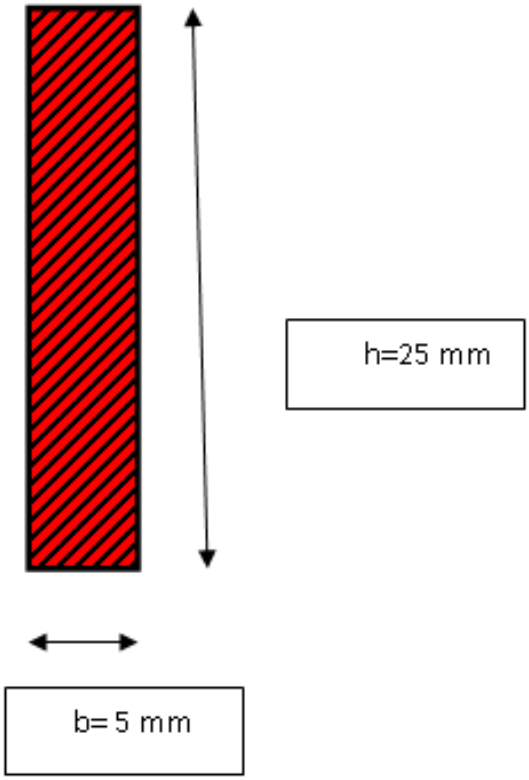
Force exerted = ---N

Stress induced = Force Exerted / Area of Weld

21 = F / 56.56

F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = 21 N/mm²



MANUFACTURING :

The process of conversion of raw material in to finished products using the three resources as Man, machine and finished sub-components.

Manufacturing is the term by which we transform resource inputs to create Useful goods and services as outputs. Manufacturing can also be said as an intentional act of producing something useful.

It's the phase after the design. Hence referring to the those values we will plan

The various processes using the following machines:-

i) Universal lathe
ii) Milling machine

iii) Grinding machine

iv) Power saw

v) Drill machine

vi) Electric arc welding machine

PROCESS SHEET :

1. CHASIS FOR THREE WAY DUMPING TIPPER

MATERIAL:- MILD STEEL C-45

QUANTITY : - 20kg

For our project first we bought a mild steel square pipe available in steel mart.

Fig. 5 3 way dumper tipper

First we mark the dimension according to our usage and cut the square pipe with the help of hacksaw machine. After that we have done grinding process and fixed them in the form of a chassis with the help of welding machine.

Here we are making a provision for mounting of chassis

Sr No.	Description Of Operation	Tool Used
1	Cutting operation with the help of abrasive cutting machine	Abrasive disc tool
2	Grinding operation	Grinding machine
3	Welding operation	Welding machine

2. WHEEL MOUNTING

QUANTITY –4

We have purchased four wheel of 100mm diameter. 2 hollow shaft has been used to mount 4 wheels. To fix the wheels we have used 4 washers and weld it with the hollow shaft. It will help the wheel not to move sideways. To fix chassis and the

axle of the body we have used a U shaped flat steel. We have used bending machine to bend the flat steel into a U shaped plate.

Fig. 6 Wheel Mounting

So operations are given below.

Sr no.	Description	Tool Used
1	To fix the Wheels With the help of nut bolt	-
2	U shaped steel	Bending Machine
3	Hollow shaft	Cutting Machine

3. CABIN OF TIPPER

MATERIAL:- SHEET METAL

QUANTITY : 2SQM

A sheet metal has been used and cut it according to our dimension to make a cabin of tipper. We have weld the sheet using spot welding operation. After that the sheet metal cabin has been welded on the chassis.

Fig. 7 cabin of tipper

Sr No.	Description	Tool Used
1	Sheet metal cutting , welding as per cabin shape	Shearing and welding machine

4. MAKING AND MOUNTING OF TROLLEY ON THE CHASSIS

MATERIAL -- SHEET METAL

QUANTITY – 1

We have used sheet metal to make a trolley. According to our dimension we have cut the sheet metal. We have made 4 side of trolley and one base for the trolley of sheet metal. We have fixed them with the help of nut and bolt with the frame. Mounting of trolley on the chassis.

Fig. 8 mounting of trolley

Sr No.	Description	Tool Used
1	Cutting the sheet metal (5 piece of sheet metal)	Shearing machine
2	Making frame for trolley	Hacksaw and Welding machine

5. FITTING THE PMDC GEAR MOTOR

MATERIAL -- STD

QUANTITY – 2

First we have purchased 2 standard PMDC gear motor from market. It has 2 parts, one which is stationary which is fitted on the chassis with nut and bolt and the other part if fitted to the trolley. The power of motor is 30W.

Fig. 9 PMDC gear motor

CONCLUSION :

The developed prototype exhibits the expected results. Further modifications and working limitations will put this work in the main league of use. The use of an electric mechanism in a three-way dumper provides several benefits over traditional hydraulic systems. An electric mechanism is more efficient, requires less maintenance, and is more environmentally friendly than hydraulic systems. It also allows for precise control over the dumping process, improving safety and reducing the risk of accidents. Additionally, the use of an electric mechanism can improve productivity by reducing downtime and increasing the speed of the dumping process. Overall, a three-way dumper with an electric mechanism is a reliable and cost-effective solution for handling bulk materials in a variety of industries. 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.

FUTURE SCOPE :

A 3-way dumper is a type of material handling equipment used to dump materials in three directions - left, right, and rear. This equipment has a wide range of applications, including construction, agriculture, and mining industries. Here are some potential future scopes of 3-way dumpers:

- Automation: With advancements in automation and robotics, there is a possibility of developing self-driving 3-way dumpers that can be remotely controlled or operate autonomously. This would improve safety, efficiency, and reduce the need for human labor.

- Integration with IoT: The integration of IoT (Internet of Things) technology into 3-way dumpers can help in remote monitoring, real-time tracking, and maintenance. This would enhance the safety and performance of the equipment and enable predictive maintenance.

- Electric power: Electric power is gaining popularity in the transportation industry. The development of electric-powered 3-way dumpers can significantly reduce carbon emissions, noise pollution, and improve energy efficiency.

- Lighter weight and greater capacity: The continuous development of new materials and fabrication technologies can lead to the creation of lighter-weight and high-capacity 3-way dumpers. This would enable more efficient transportation of heavier loads and reduce fuel consumption.
- Versatility: 3-way dumpers can be modified to serve various applications such as fire fighting, emergency rescue, and military logistics. This would expand the scope of the equipment beyond traditional material handling applications.

REFERENCE :

1] Strength of material for the shape and size of various structures are designed by knowing the strength of materials by R.S. Khurmi.

[2] Shinde, G., Tawele, P., & Raut, L. (2014). Design and development of 3-way dropping dumper. Int. J. Emerging Tech. and Adv. Engineering.

[3] Prasath, N.E. , Shanmugam, S., Sundaram, C. M., & Vembathu Rajesh, A. development of three axes lifting modern trailer.

[4] Design and fabrication of modern three way dumping trolley mechanism P. Shashidarl, P. Laxminagaprasad, U. Anil Kumar.

[5] Gaikwad, H. A., &Awate, N. P. Design of Multiside Tipper Tilting Mechanism.

[6] Khurmi Gupta, 2008, Degree of freedom, Theory of machine, S chand & Company Ltd; (2008).