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# DESIGN AND DEVELOPMENT OF MULTIDIRECTIONAL DUMPING SYSTEM

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**Abstract** – Conventional dumpers unload exclusively from the rear using pneumatically operated cylinders, causing blockages in confined spaces.The Multidirectional Dumper, employing pneumatic cylinders and a chain drive, achieves 180-degree material discharge. Prototype tests demonstrate lateral unloading, overcoming unidirectional constraints. Rigorous testing confirms controlled discharge within a 180-degree range, with incline angle monitoring. The Multidirectional Dumper integrates a mobile app and lever mechanism for flexible control, enhancing safety and precision. This innovative design redefines dumper efficiency, offering control, safety, and productivity during material unloading, while addressing challenges. In sum, it advances dumpers, providing versatile solutions for diverse scenarios.

**Key Words**: Material Loading, Multi-Directional Dumping Trailer, Working Enhancement, Arduino, Material Selection, Comprehensive Testing, Solenoid Valve, Internet of Things.

## INTRODUCTION

The conventional dumping trucks are very important and crucial factor when it comes to transporting material for construction or mining field. As we used this truck of conventional dump system there are various problems one of them is to dump the material that may be sand in specific direction by setting the location of dump of the truck in construction site and in this case too much time consumption as well as energy is there and also in addition to this limited space of working challenges for the goods for unloading. In this case we didn't know the need of dumping system vehicle that can dump the material in any form in any direction. And for that multi-directional dumping system can help the workers working on construction site for various operation such as material transfer, collection of waste, also sand material and gravel. By using this multi-directional type of dumping truck there are benefits such as it reduction in power of vehicle and consumption of fuel when the truck dump material in more than one direction at a time. Advantage by using this type of

system is it will improve the efficiency also it provides the flexibility to worker with it's advance feature. The various types of trucks, or trolley are used for dumping heavy weight materials from one site to another site in construction site as well as sector of mining or in automobile industry also to fill the requirement of that particular place. With the help of advance feature like IOT the working of system will be more effective and one can operate automatically from mobile with the help of Bluetooth sensor system. In this study we evaluates the multi-directional systems solution in advance way as we integrate the IOT system in it that improves overall efficiency of truck or system.

**Modern multi- dumping truck**

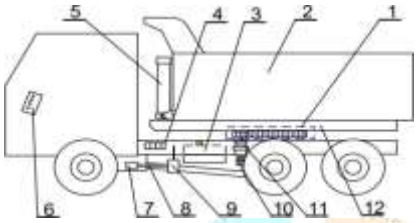



Fig. 1. diagram of multi-direction dumping truck

In the multi-directional type of dumping truck there are some complicated components assembly and they all are combined together as shown in figure. In this truck the cylinder (Hydraulic type) is there which is acts as a lifting mechanism for the dumping truck. Then there is operating system to operate the truck.

## Prospective Application

**Working Enhancement:** In the conventional dumping system there is limitation for working of mechanism and there's also many drawbacks of that but in multi-directional dumping system the limitations will be achieved and and it helps in Enhancement of working of the dumping trailor.

**Reduction in Accident:** In the mining sector there is risk of workers life during operating the conventional dumping system integrated in truck leading to severe accidents of workers but by using multi-directional dumping system with the help of IOT system provides worker safety.

**System's Flexibility :** The multi-directional dumping system provides flexibility as it will rotate $360^0$ and it reduces working time and it will help in material handling process.

## PROBLEM STATEMENT

The existing material handling industry faces inefficiencies and safety concerns due to the exclusive use of unidirectional dumpers that unload solely from the rear, leading to blockages and operational limitations in confined space.

## OBJECTIVE

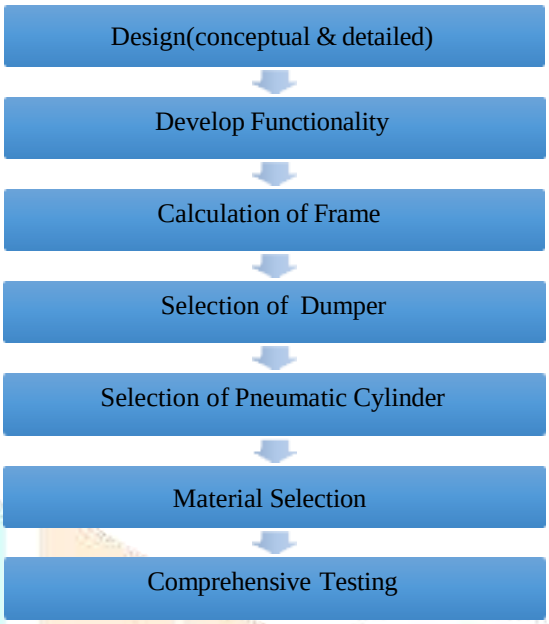
- To Develop a Multi-directional Dumper System.
- Integrate mobile control for operator flexibility and safety.
- Validate the system's efficiency and reliability through testing.
-

## SCOPE

- As our world continues to advance rapidly, we're seeing massive construction projects that require moving vast amounts of earth efficiently. This means we need more advanced equipment to get the job done effectively. That's where multi-directional dumping trailers come in. Unlike traditional two- way or one-way trailers, these versatile trailers can move in multiple directions, making them incredibly useful on busy construction sites. They're like the Swiss Army knife of earth-moving equipment, helping construction crews tackle challenges with ease..
- This device opens up a world of possibilities for tweaking, enhancing, and making it even more efficient. That means it can become a hot commodity in the market, appealing to both manufacturers and farmers alike. With its potential for upgrades and improvements, it's sure to find a welcome place in various industries. It's like giving a toolbelt to a superhero—it becomes even more capable and appealing as it evolves.

## METHODOLOGY AND PROCESS

The method of creating dumping system is categorized in following different steps:




### 2D & 3D Design of Model

First we have to design a 2D drawing of our prototype and we have to design as per our requirement.For the 2D drawing of prototype there are various design software's available and as per our comfort choose one software and we choose the solidworks software for designing the model and after that draw isometric views and other views such as side view, front view & top view for better understanding of prototype**.** After that to draw 3D view of prototype this software also used.

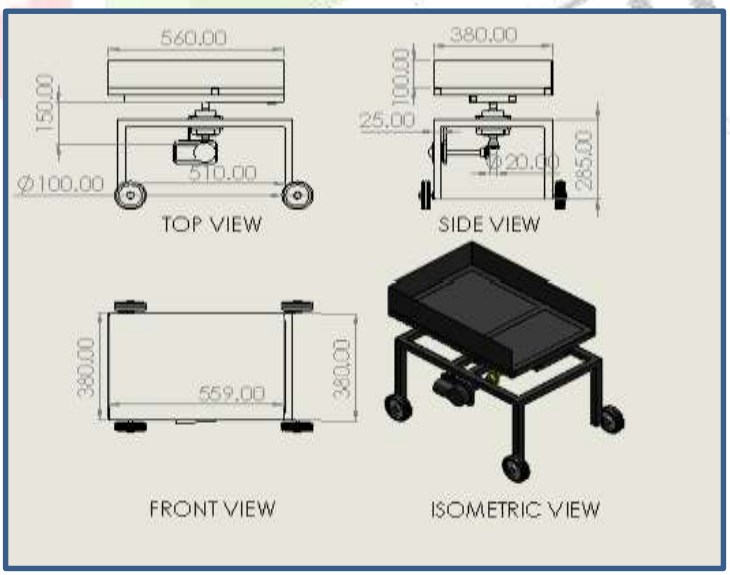



Fig. 2 2D design of Dumping Model

After the 2D design of prototype for better visualization draw 3D Design of prototype and for that we use solidworks software which is comfortable and flexible as it has various advance feature for drawing 3D model of prototype and in that we can see our complete prototype and make changes as required. Following are the 3D view of prototype.

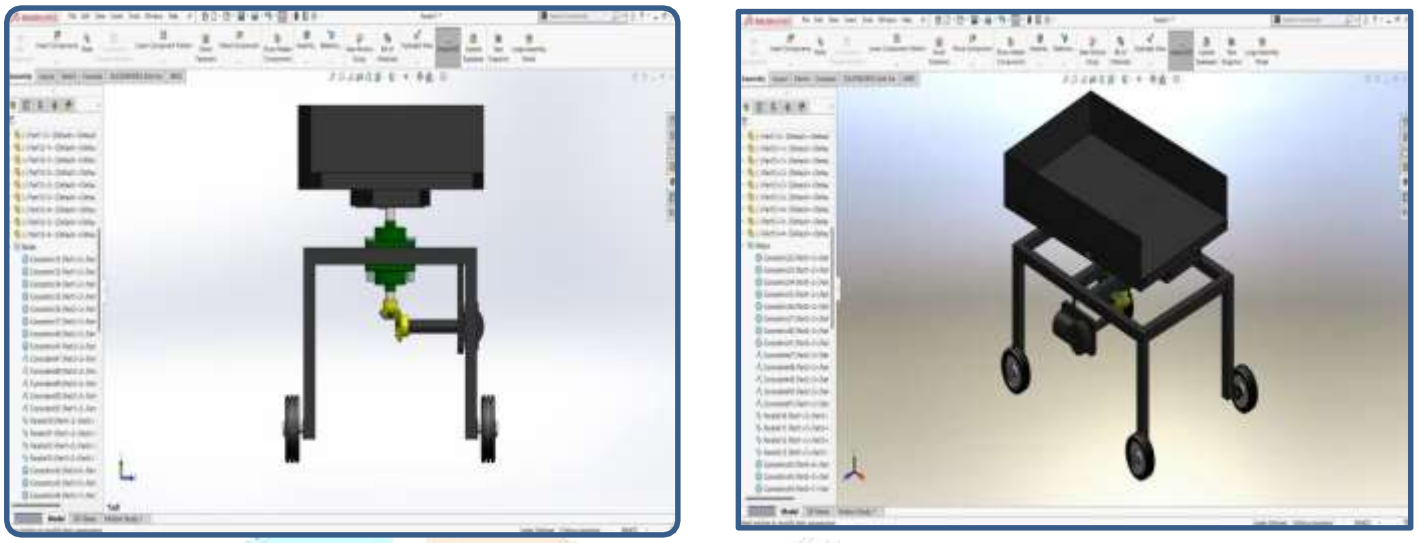
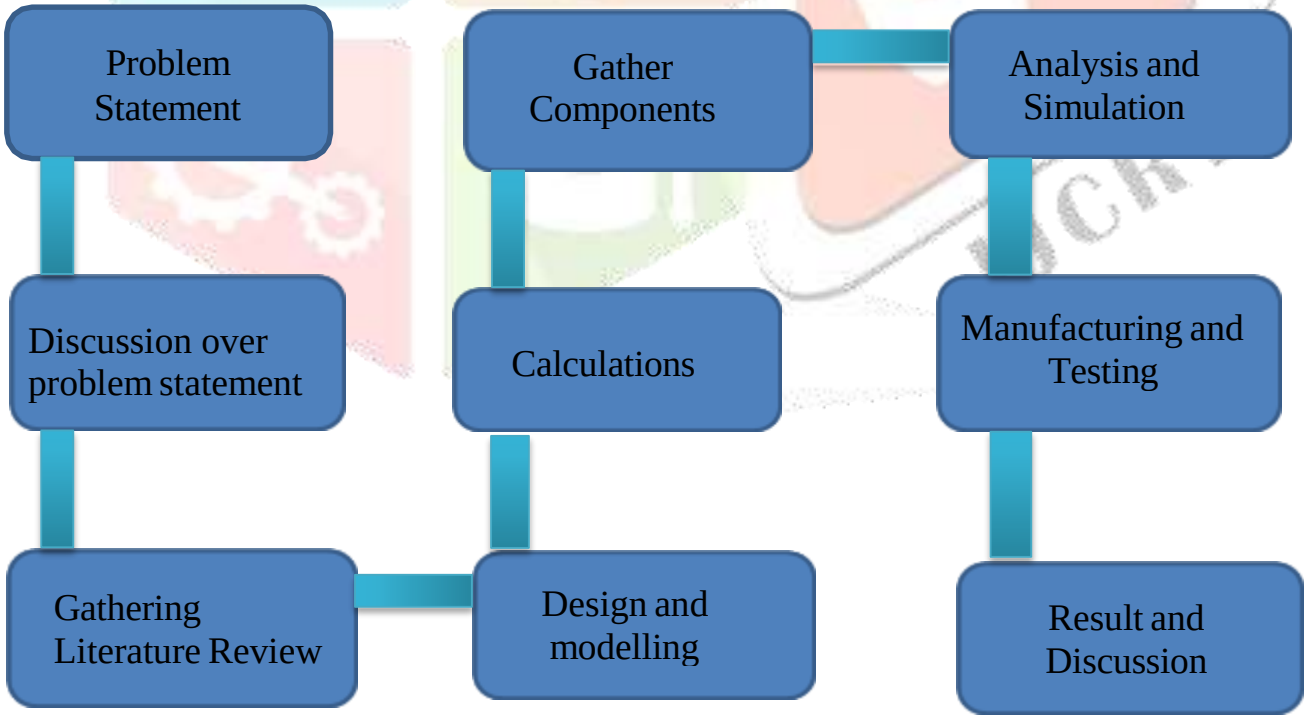


Fig. 3 3D design of Dumping Model

## Design Process



## Material selection

### Material Table

| Sr.No. | Component | Material |
|---|---|---|
| 1 | Bevel Gear | Carbon steel |
| 2 | Metal Frame Structure For Dumper | MS |
| 3 | Wheel | Rubber |

## CALCULATIONS

1. **Capacity of dumper**

Length: 560 mm =0.560 m

Width: 380 mm =0.380 m

Height: 100 mm =0.100 m Volume = L×W×H

= 0.56×0.38×0.10

= 0.02128 $m^3$

2. **Selection of pneumatic cylinder:**

Inlet Pressure (P) = 2 Bar = 2 x $10^5$ $N/m^2$

Full Bore Diameter (D) = 50 mm = 0.050 m Piston Rod Diameter (d) = 10 mm = 0.010 m Force Exerted while Outward Stroke = F1 Force Exerted while Return Stroke = F2

$$F1 = \frac{P \times \pi \times D^2}{4}$$

$$F1 = \frac{2\times10^5 \times \pi \times 0.05^2}{4}$$

F1 = 392.699 N

2. Force Exerted by Double Acting Cylinder in Return Stroke $F2 = \frac{P \times \pi \times (D^2-d^2)}{4}$

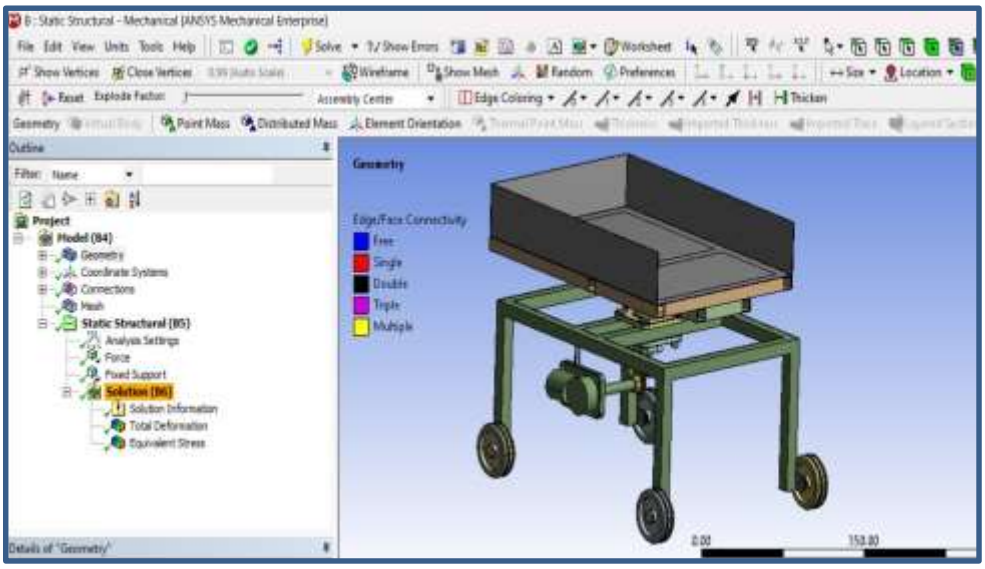
F2 = 376.991 N

So we are selected the 50 X 100 pneumatic cylinder

## Analysis of Dumping Trailer

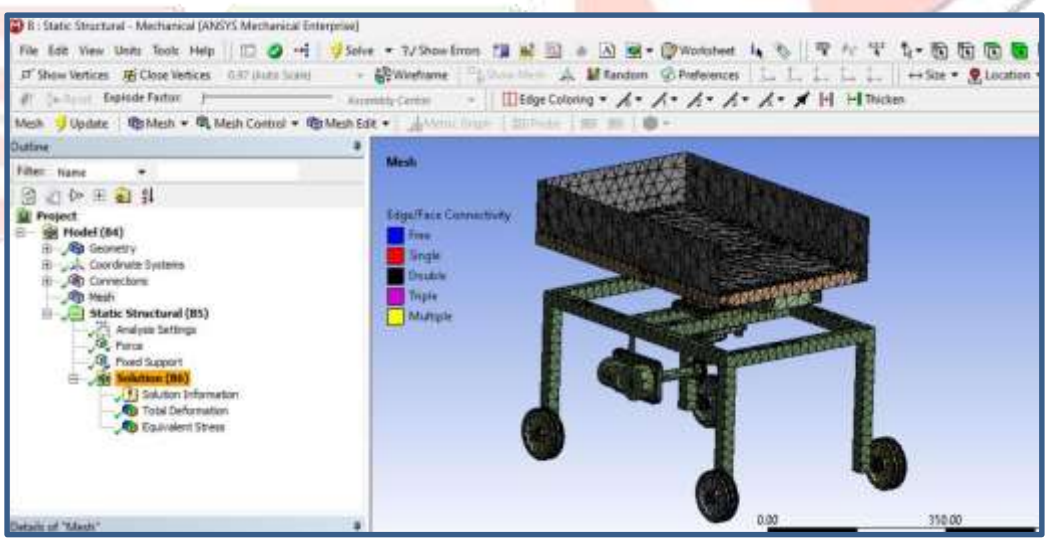
The Dumping trailer of the dumping system were analysed and simulated for practical implication of the experiment. In this analysis various parameters were analysed and simulation of whole model was done. Also we apply boundary condition to the dumping trailer and we calculate various values and stresses impact on the model.

## Geometry



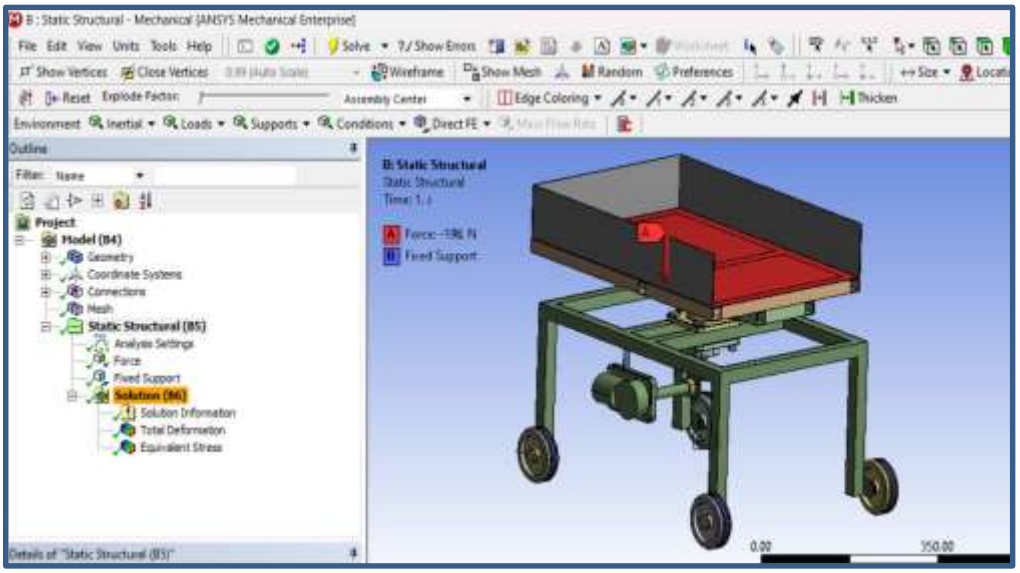

## Meshing

The meshing is very important and essential step for any model analysis. In FEA (finite element analysis), there is grid division in it that can reflect better finite element idea. Also there is a website that not only affects the analysis results accuracy which we calculate but also affects the model analysis efficiency and because of this without affecting calculated result accuracy it is possible to save calculation time by selecting method of mesh dividing.



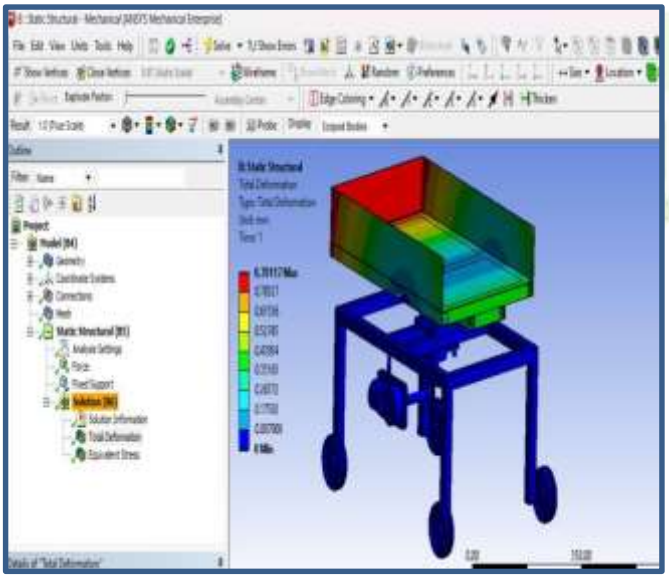

## Boundary Condition

A triangular or we can say tetrahedral mesh which can be created with the help of far fever cells that mesh of equivalent consisting quadrilateral or hexahedral elements when the geometries of the model are complicated or the length scale range of the flow is very large.

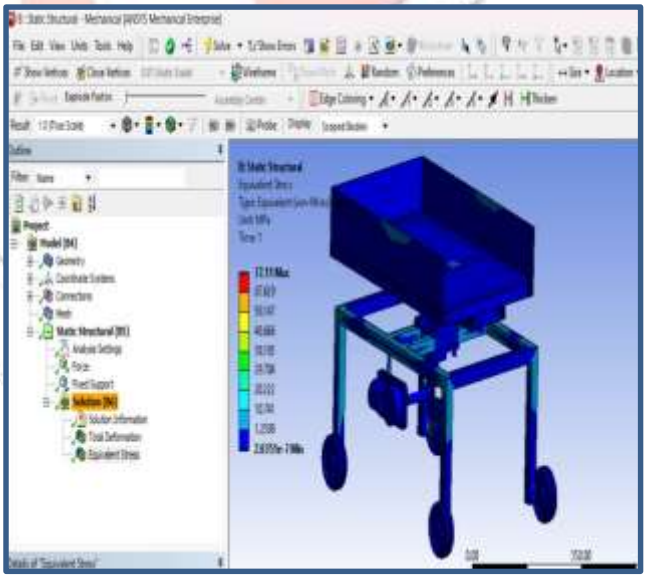


## RESULT AND DISCUSSION

### 1 Total Deformation



### 2 Equivalent Stress



## DISCUSSION

After all the process of model from design and material selection to the actual manufacturing and testing the final result the trolley is set to work in industry for material handling and with advance feature like IOT it will be more effective and the operation will be smooth and it eliminated all the drawbacks of the conventional dumping system.

The IOT helps to operate trolley through mobile and it will reduce the time that means time consumption achieved in it. The flexibility of the system enhance the overall working of the model or trolley. It will help

worker to work safe in the industry or in mining sector thus it ensures the workers safety during the operation of loading and unloading of material.The pneumatic cylinder is used as a lifting mechanism and the pressure in cylinder control by the solenoid valve. Bluetooth sensor is attach with that operator operates the trolley or dumping system.

The different types of material will be consider for manufacturing but only cost effective material selected for the manufacturing.There were huge scope of project in agricultural sector and modification would be done in that.

## CONCLUSION

In various industries and consideration of domestic, this dumping trolly can rotate in 360 way.The difficulties in unloading material and handling that were found in conventional dumping system "THE MULTI-DIRECTIONAL DUMPING SYSTEM" which is the mechanism of lifting in automobile sector in three or more than two direction and in this lifting system or mechanism there is a cylinder which is pneumatic type of cylinder and with that on Industry 4.O component which is also called as Internet of Things device is there in industry of automobile. The material loading and unloading will be easy in industry. Also in critical situation or in critical case the problem of unloading the trolley will be easily eliminated using this. That means it will fuel which is required for that as well as the time of operation.

There is system of operating which is quite simple and this make this system user-friendly that means other than operator anyone can be able operate the system without difficulties. The parts of dumping truck's were successfully reviewed and also for various manufacturing as well as various agricultural industry this type of modern system is applicable and have a great growth.

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