DESIGN, ANALYSIS AND MANUFACTURING OF MULTIUTILITY TRAILER

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE DEGREE OF

Bachelor of Engineering
In
Mechanical Engineering

Submitted By

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[2017-18]

Progressive Education Society's

Modern College of Engineering, Pune

CERTIFICATE

This is to certify that the project work (402046) report entitled

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Has Successfully Completed By

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Under the guidance of

PROF. R. M. THAKARE

During the Academic Year 2017-18

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Internal Examiner Seal **External Examiner**

SPONSORE'S PROJECT COMPLETION CERTFICATE

SANDVIK

Date: 28.05.2018 Ref: SMRTHR/INT/BP/004

TO WHOMSOEVER IT MAY CONCERN

This is to certify that, **Mr. Rahul Dhande,** student of **P.E.S. Modern College of Engineering, Pune** has completed in plant training & project titled "**Design, Analysis and Manufacturing of Multi-Utility Trailer**" in SMRT, Assembly Centre Unit, Pune under guidance of Mr. Raghavendra Bhatt & Mr. Nareshkumar Nekkanti for a period from **23rd June 2017 to 23rd March 2018** at Sandvik Asia Pvt Ltd., Pune.

During this period, his performance was excellent and we found him dedicated, hardworking and sincere.

We wish him all the success in his future endeavors.

Thanking You.

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Place: Pune

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NOMENCLATURE

M	Bending Moment (Nm)
I	Moment of inertia (cm^4)
σ	Bending Stress (MPa)
Y	Distance of farthest fibre from natural axis (mm)
H	Height of Beam (mm)
R_a	Reaction at point A (N)
R_b	Reaction at point B (N)
w	Weight of beam per unit length (kg/m)
B	Flange width of the beam (mm)
t_w	Thickness of web of beam(mm)
t_f	Thickness of flange of beam (mm)
r	root radius of the Beam (mm)
A	Cross-sectional Area of the beam (cm^2)
HSI	Horizontal Shaft Impactor
VSI	Vertical Shaft Impactor

ABSTRACT

For transportation of any kind of big machine or big equipment, trailer is required. Trailer has to withstand heavy loads of these things. As the cost of these machines and equipments is quite high, they have to be transported safely and carefully. The failure of any part of trailer can result in huge economical loss as well as loss of lives. So the trailer plays a role of link between production and distribution network.

Designing of trailer is the first step toward the successful operation of trailer. Each and every part of trailer should be designed or chosen according to loading conditions, type of load and operating condition of the trailer. The designed trailer has to pass the analysis test which is done on softwares like ANSYS.

The analysis software gives the critically stressed areas and maximum deflection of the trailer. The critically stressed areas can be reinforced with trusses. Again the upgraded design is tested again on software to test its safety. Once the design is certified as safe on analysis software, it is sanctioned for manufacturing.

In SANDVIK ASIA Pvt. Ltd., trailer from outside vendors is hired for transportation of machines from one assembly centre to another. The rent of hiring these trailers is quite high and it can be saved by manufacturing their own trailer. For saving of cost, company has decided to manufacture their own trailer.

1. INTRODUCTION

Trailer is a transportation means used to transport goods, machines, cars etc. There are many types of trailers which are used for different working conditions and different payloads. Trailer is basically an unpowered vehicle which is towed to a powered vehicle called as tug-master. There are various types of tug-masters available according to the various loading conditions. The amount of loads to be loaded are regulated according to the government norms.

This project is sponsored by ‘SANDVIK ASIA PVT. LTD’. Right now, SANDVIK ASIA PVT. LTD is hiring trailers from outside vendors to transport the payloads. They hire trailer to transport payloads to outside the company premises as well as between assembly lines within the company. They have to spend a large amount of money on these trailers. This money can be saved if they own a trailer for transportation. In any company, the money saved is same as money gained. So this project has great importance regarding the profit of this company. This trailer will be the one time investment for this firm which will help to save considerable amount of assets.

The machines to be transported by this trailer are three Jaw Crushers, three Vertical Shaft Impactors (VSI) and one Horizontal Shaft Impactor (HSI). The specifications of these machines are quite different from each other. Their loads as well as distribution of load is different. VSI will rest on four legs, that’s why its load will be point load acting along these legs, while Jaw Crusher has uniformly distributed load.

1.1 Organisation of Report:

The entire work has been presented through chapter 2 to chapter 8. The detail of each in brief are as follows

Chapter 2: Literature Review and Theory:-

This chapter details the literature review. In this literature the main information regarding the trailer design is discussed.

Chapter 3: Problem Definition, Objectives and Scope:-

This section of the thesis highlights the problem definition, the objectives to be achieved and the scope of the project. From this chapter we get the information about exactly which things are to be done in this project.

Chapter 4: Methodology:-

Methodology followed for completion of this whole project is discussed in this chapter. It gives the information about the sequence the steps performed for completion of this project.

Chapter 5: Design, Analysis and Manufacturing:-

The main part of this project regarding design, analysis and manufacture is covered in this chapter. All the aspects regarding this project can be studied in this chapter.

Chapter 6: Result and Discussion:-

This chapter specifies the result of the project obtained from analysis. Also it comments on the safety the trailer under different loading conditions. The results are obtained using ANSYS software.

Chapter 7: Cost Estimation:-

'Cost Estimation' chapter includes the cost of various components used in trailer as well as the cost of manufacturing of the trailer. It is represented in tabular form for the ease of understanding.

Chapter 8: Conclusion

This chapter includes the final conclusive remarks of the project. It discusses the change in scenario of the company after implementation of the project.

2 THEORY & LITERATURE REVIEW

2.1 Literature Review:

1] **“**Trailer Design Guidelines**”** Article:- STRENX Performance Steel PVT LTD.

Road transport vehicles, like trucks and trailers, can significantly benefit from improvements in both design and production methods. Material selection is strongly connected to these aspects, and affects the performance and the cost of these vehicles. This article deals with the design considerations of trailer. Article gives information about semi trailers , volume limited cargo, weight limited cargo.[1]

2] (1)Alexander R. Tusnina, (2)Milan Prokica, “Selection of parameters for I-beam experimental model subjected to bending and torsion”. Article :- Elsevier Ltd.,

I-Beams can be used efficiently in different conditions of bending and torsion. This research paper deals with the analysis of I Beam in bending and torsional loading condition. Beams generally carry gravitational forces but also be used to carry horizontal forces. The article emphasizes on different types of beams available in the market, various specifications and their standards. Technical specifications of I-beams, certifications and approvals have been mentioned.[2]

3] YTE Transport Ltd, Tata York Enterprise Ltd., Product Catalogue:- “KINGPIN”. Volume update (November-2012)

The selection of Kingpin is depending upon D-Value. D-value is calculated by considering weight of tug-master and total loaded weight of trailer. Weld ability of kingpin can improved by tightly controlling metallurgical composition. The catalogue gives information about features of kingpin, quality standards regarding YTE, various product specification, etc.[3]

4] “Trailer wheel & Tire facts”, Article:-Centreville, Maryland. Online based Centreville Trailer parts and components Pvt. Ltd

The article gives information about trailer wheels (Rims & Tire).Various technical terms like bolting pattern, pilot diameter, different styles of fitments of tires , material composition of rims, weight carrying capacity for different fitments of tire.[4]

5] Robert Lowdon, “Semi-Trailer Main Beam Design”, ENGR 446 Report, University of Victoria

The proposed beam design is optimized to reduce the overall weight of the trailer. The optimization is based purely on static loading using hand calculations and Finite Element analysis. Dynamic loads were not considered due to the difficulty of determining the dynamic loads.[5]

6] (1)Ashwini Bhoi, (2)L. P. Koushik, (3)Narendra Yadav, (4)Manas Patnaik, “Optimization of I-Section of a Flat Bed Trailer”, Research Paper: IJERA, vol. 2, Issue 3, March-April 2013, pp. 1149-1150.

Flat Bed trailers are employed in heavy automobiles to carry tonnes of loads safely. These trailers have a big role to play as far as the safety of the cargo loaded is concerned. With more and more industrialization the rate at which these trailers are fabricated are increasing. This work has been carried out on one of the major I-Beams carrying a larger load comparatively. In this paper work is carried out on flat bed trailer of a heavy automobile.[6]

2.2 Theory:

Trailer is the means of transportation for goods, machines, cars etc. There are many types of trailers which are used for different working conditions and different payloads. Different trailers have their own advantages and disadvantages. Also the designing methodology used for these trailers is also slightly different for different type. We have to choose the type of trailer according to our need.

2.2.1 Main Types of Trailers:

There are mainly two types of trailers. Those are Step-Deck Trailer and Flat Bed Trailer. Above trailers are discussed below briefly.

Step-Deck Trailer:

These trailers are Flat Bed Trailers with a step at front side. This step is given to increase the height of the front portion of deck so that the trailer can be attached to the Tugmaster. This type of trailer is useful for mounting the equipments having higher height due to the low level of deck. The low level of deck is also makes mounting task easier.

Fig 2.1 Step Deck Trailer

The disadvantage of this trailer is that the STEP portion of deck is not used for mounting. Due to this the length of trailer increases. Also the stress concentration in the region connecting the higher and lower deck is high, so we have to add more reinforcement in that region to avoid its failure.

Flat Bed Trailer:

Flat Bed Trailers are totally flat. They have same height as that of mounting point of the Tugmaster. To increase the height to that extent, another I-Beam frame at the back side of main frame is used. This small frame is fitted below the main frame at back side and leaf springs and axels are fitted under this frame.

Fig 2.2 Flat Bed Trailer

As the deck is totally flat without any steps, it can be used fully to load the loadings. Due to this the length of trailer decreases. Also there is not any stress concentration problem, so the failure possibilities are decreased.

Suitable Trailer for Our Application:

Flat Bed Trailer is quite appropriate for our application due to following reasons:

- The whole deck of the trailer can be used for the loading, due to which the length of the trailer decreases. Which makes the trailer compact.

- Reduction in length means there will be reduction in cost of the trailer.
- The designing and manufacturing procedure of this type of trailer is easy compared to other types of trailers.
- We can use standard beams for construction of trailer unlike ‘Flat Bed Trailer with Gooseneck’, which again decreases cost.
- There is no stress concentration problem in this type of trailers as the cross-section of beam is uniform throughout the length.

2.2.2 Loads and Stresses Generated in Trailer :

The loads acting on any trailer are of two types, one is static load and other is dynamic load. But while designing the trailer, only static load is considered because the dynamic loads are highly unpredictable and the designing procedure becomes highly difficult and complicated by considering dynamic loads. Also the dynamic loads are much less considering static loads.

The prominent type of stress generated in the trailer beams will be Bending Stress. The Shear Stress and Torsional Stress will be much lesser than Bending stress. So the design will be done according to the Bending Moment generated in the beam.

The straight beam subjected to a bending moment M_b is shown in figure. The beam is subjected to tensile stress on one side of the neutral axis and compressive stress on the other. Such a stress distribution can be visualised by bending a thick leather belt. Cracks will appear on the outer surface, while folds will appear on the inner surface. Therefore, the outside fibres are in tension, while inside fibres are in compression. The bending stress at any fibre is given by,

$$\frac{M}{I} = \frac{\sigma}{Y}$$

Where,

σ = bending stress at a distance y from the neutral axis(N/mm^2)

M = applied bending moment (N-mm)

I = moment of inertia of the cross-section about the neutral axis (mm^4)

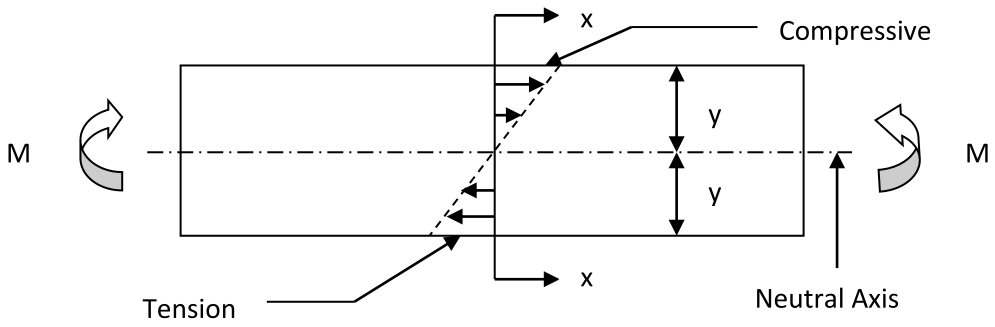


Fig 2.3 General Approach of Bending Stress in Beam

The bending stress is maximum in a fibre, which is farthest from the neutral axis. The distribution of stresses is linear and the stress is proportional to the distance from the neutral axis.

The above equation is based on following assumptions:

- The beam is straight with uniform cross-section.
- The forces acting on the beam lie in a plane perpendicular to the axis of the beam.
- The material is homogeneous, isotropic and obeys Hook’s law.
- Plane cross-section remain plane after bending.

The bending generated in the trailer will be positive bending i.e. sagging.

2.2.3 Types of Beams:

There are many types of beams having different types of cross-sections used in industry. Some of them are listed below:

- I-Beam: These steel beams are shaped like the capital letter ‘I’, just as the name implies. They are commonly used in industrial applications and have tapered flanges. I-shaped cross-section steel beams come in two different styles, one has a parallel flange surface (wide), whereas the other one has a slope on the inner flange surfaces (S-beam).
- W-Beam: These are similar to I-beams and they are also called as ‘wide flange’ beams. They have a straight flange and are most often used in residential construction.
- H-Beam: These are generally heavier and longer than I-beams. Appearing like the capital letter ‘H’, they have longer flanges. Often, the term is interchangeably used with I-beams, so this can be confusing at times. H-beams have webs and flanges that have the same thickness in many cases.
- Channel: Like one half of the I-beam, these have a C-shaped cross-section. The top and bottom part of the beam have sloped inner flange surfaces that come out only on one side of the beam. They are used in supporting lighter loads since they are not as strong as the other beam shapes.

Out of all these beams, I-Beam is appropriate for our application due to following reasons:

- I-section is more efficient in terms of material usage and hence in terms of cost.
- This type of beam has high moment of inertia compared to other beams having same cross-sectional area.
- The web resists shear forces, while the flanges resist most of the bending moment experienced by the beam.
- The I-shaped section is a very efficient form for carrying both bending and shear loads in the plane of the web.

3. PROBLEM DEFINITION, OBJECTIVE AND SCOPE

3.1 Problem Definition:

To design, analyse & manufacture the "Multi-Utility Trailer" to carry-transport the desired payload (maximum point load of 15 ton & Uniformly distributed load of 23 ton, taking factor of safety as 1.3) from one point to another and ensure smooth working environment .

3.2 Objectives:

- To manufacture a trailer that can cater to the company's need at all times.
- To eliminate the problem of dependability and reliability associated with the scene of hiring the trailer from outside .
- To maximize the working time by reducing the transportation time inside the company.
- To maximize the profits by cutting down the rents of the hired trailers.

3.3 Scope of Project Work:

- Thorough study of different types of trailer and there components and parts.
- To design the trailer for mounting all the 7 machines for their transportation for SANDVIK ASIA PVT. LTD, taking factor of safety as 1.3.
- To make the design of trailer in SOLIDWORKS for visual representation.
- Analyze the trailer in ANSYS software for getting information about stress and deflection occurred in trailer due to loading.
- To manufacture the trailer.
- Testing of the trailer in company premises for different loadings and transportation.
- Implementation of the project.

4. METHODOLOGY

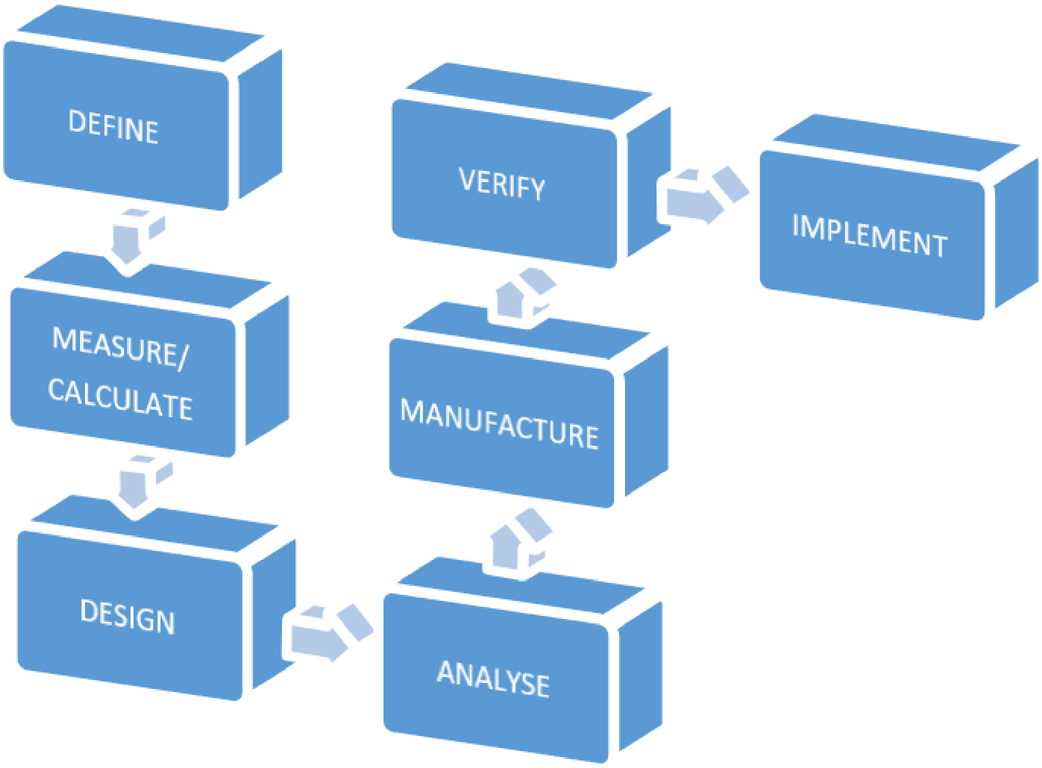


Fig.4.1 Methodology

<u>DEFINE</u>: -In define stage we started observing the machines that needed to be transported from one point to other. The trailer that were already employed to do so were rented and were not economic as well. In order to eradicate this an in-house Multi-Utility trailer was to be build. Hence we started searching for other data which could be useful for proper enhancing of our problem statement.

<u>MEASURE</u>: - In this stage we started collecting data related to different types of trailers and its components. This stage helped us to know what work has to be done in research and study in this topic and also what more development can be done in this topic.

DESIGN: - In design stage, all collected data obtained from measure stage was used to calculate various parameters and get pictorial view of trailer by designing on software. Gathering all information, we designed 3D parts and assembled these parts to obtain assembly fixture by using SOLIDWORKS software.

ANALYSE: - The design was analyzed for various stress and force conditions using ANSYS software, were in all the parameters of various force and stress conditions were taken care of, and the designed was approved for manufacturing.

MANUFACTURE: - The design which is done so far will be manufactured in manufacturing unit of the company.

VERIFY: - The manufactured trailer will be verified as par the standards to ensure safety.

IMPLEMENT: - This trailer will be used in company to replace the rental trailers for transportation.

4.1 Components and Parts Used in Trailer:

Following are the components and parts used in construction of trailer;

1. Beam: Beam is used in trailer as main load carrying and mounting part. It provides trailer its structural rigidity. Mostly I-beam is preferred due to its higher load carrying capacity than other beams.

2. Kingpin: Kingpin is used to join the trailer to pulling tug-master. Kingpin should be strong enough to withstand the shear force occurring due to pulling..

3. Leaf Spring Suspension System: Different suspension systems are there but Leaf Spring Suspension System is used in trailers because of its affordability and effectiveness.

4. Wheels: Wheels are selected according to our loading conditions and operating conditions.

5. Axel: Axels are used to mounting the wheels and suspension system. Number axels used depends upon the load to carry.

6. Landing Gears: Landing Gears are used to support the trailer when the tug-master is not attached.

7. Chequered Sheet: Chequered sheet is used to cover the main load carrying frame.

8. Nut and Bolts: Different sizes of nuts and bolts are used for mounting different component in trailer.

9. Trusses: Trusses are used to nullify the stress concentration in the frame.

4.2 Designing Methodology Used:

Methodology used while designing trailer is as follows:

1. Selection of material for I-Beam.

2. I-Beam selection according to the loading conditions.

3. Designing the frame as per the loading positions of different machines.

4. Calculating the D-value of kingpin and selecting the kingpin accordingly.

5. Selecting the wheels for given loading conditions.

6. Selecting the axel according to load carrying capacity.

7. Designing the Leaf Spring Suspension System.

8. Selection of landing gears according to load carrying capacity.

9. Designing different Trusses for different positions on the frame.

10. Selecting the Chequered Sheet for covering the upper side of the trailer frame.

5. DESIGN, ANALYSIS AND MANUFACTURING

5.1 I-Beam:

An I-beam, also known as H-beam, W-beam (for "wide flange"), Universal Beam (UB), Rolled Steel Joist (RSJ), or double-T, is a beam with an ‘I’ or H-shaped cross-section. The horizontal elements of the "I" are known as flanges, while the vertical element is termed the "web". I-beams are usually made of structural steel and are used in construction and civil engineering.

The web resists shear forces, while the flanges resist most of the bending moment experienced by the beam. Beam theory shows that the I-shaped section is a very efficient form for carrying both bending and shear loads in the plane of the web. On the other hand, the cross-section has a reduced capacity in the transverse direction.

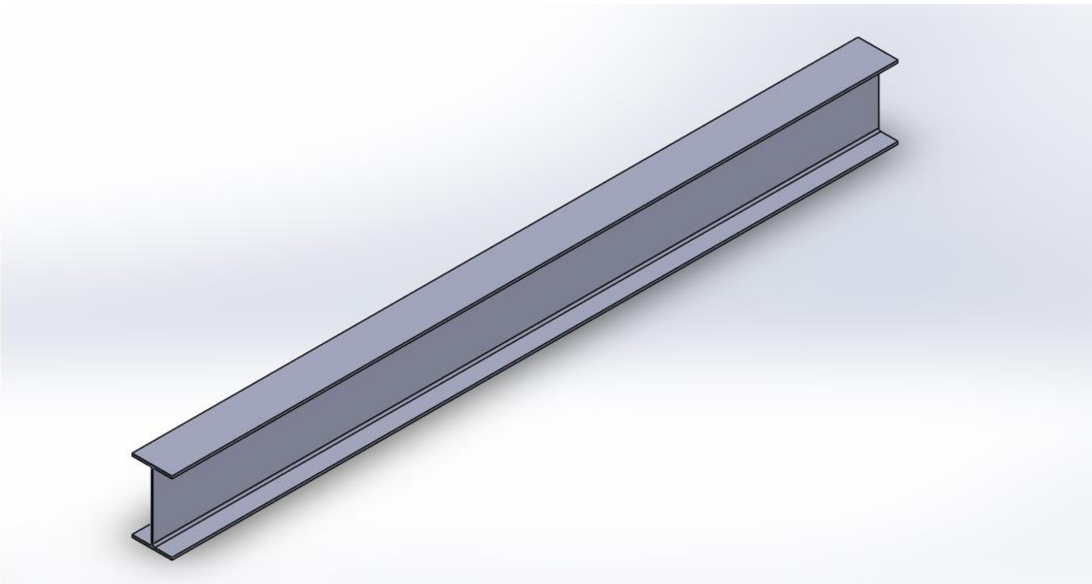


Fig.5.1: I-Beam Isometric View

Given Data and Initial Considerations:

The parameters related to 6 machines are as follows;

- **VSI CV229**: Weight= 15 tons
  Length = 3.470 meters
  Width = 1.930 meters
  Load Type = Point Load
- **VSI CV218:** Weight = 12 tons
  Length = 4 meters
  Width = 1.930 meters
  Load Type = Point Load
- **VSI CV217:** Weight = 10 tons
  Length = 4 meters
  Width = 1.930 meters
  Load Type = Point Load
- **Jaw Crusher CJ411:** Weight = 23 tons
  Length = 2.237 meter
  Load Type = Uniformly Distributed Load
- **Jaw Crusher CJ211:** Weight = 16.3 tones
  Length = 1.7 meters
  Load Type = Uniformly Distributed Load
- **Jaw Crusher CJ409:** Weight = 14 tones
  Length = 2.030 meters
  Load Type = Uniformly Distributed Load
- **HSI CI521:** Weight = 17 ton
  Length = 1.9 meters
  Load Type = Uniformly Distributed Load

Factor of Safety = 1.3

Length of the trailer = 6.7 meters

Here, we are taking two main beams to carry the load and cross beams in between these main beams for support and distribution of load. The whole load of the machine will be equally divided to two main beams. Also the reaction of King Pin and tyre-axel assembly will be equally divided to two beams.

The reaction of Kingpin is taken at 0.4 meters from front side and reaction of tyre-axel assembly is taken at 1.5445 meters from back side of trailer.

For I-beam, catalogue of 'Jindal Steels' is referred. We have used universal I-beam from that catalogue.

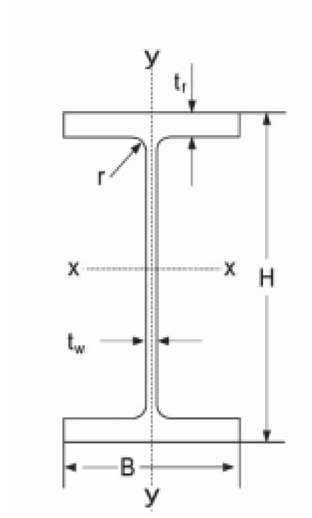


Fig.5.2: I-Beam Parameters

Different parameters of I-Beam are as follows:

w = Weight per meter H = Height

B = Width t_w = Thickness of Web

t_f = Thickness of Flange r = Root Radius

A = Cross-Sectional Area I_{xx} = Mass Moment of Inertia

The basic formula used here is;

$$\frac{M}{I} = \frac{\sigma}{Y}$$

Here,

M = Bending moment

I = moment of inertia

$\sigma =$ Bending Stress induced in beam

Y = H/2

H = Height of the beam

The material for the I-beam = IS2062 E250Br

Allowable Bending stress = 250 MPa

- **Calculations for Jaw Crusher CJ411:**

Weight = 23 tons

Load to be considered = 1.3*23 = 30 tons =294.1995KN

Length = 2.237 meters

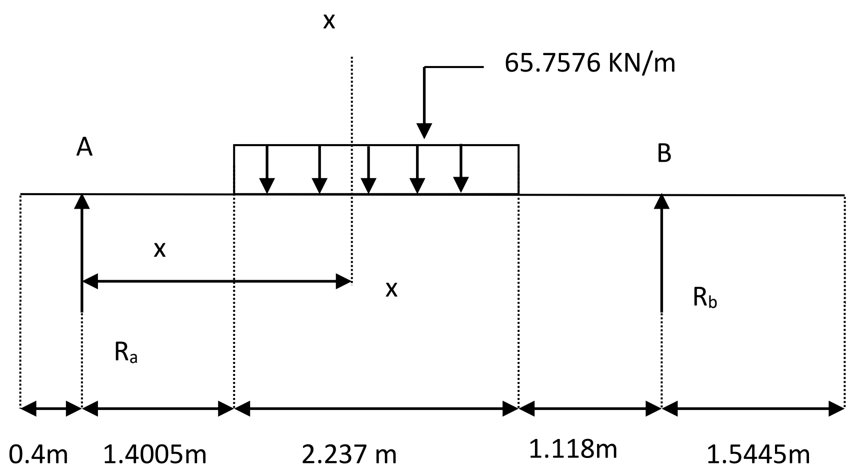


Fig 5.3: Loading diagram of Jaw Crusher CJ411

Load on single beam = 147.0998 KN

Load distributed on loading length = 147.09975/2.237 = 65.7576 KN/m

Now,

Moment at B = 0 = R_a*(AB)-65.7576*2.237*2.2365

0 = R_a*4.7555-147.0998*2.2365

Therefore**,**

Ra= 69.1807 KN

R_b = 77.9191 KN

Now, maximum bending moment will be at section x-x which is at distance x from point A. Bending moment will be maximum when shear force will be zero. So at section x-x, shear force is going to be zero.

Shear force = 0 = R_a-65.7576*(x-1.4005)

Therefore, x = 2.4526 m

Now, maximum bending moment is given as,

M = R_a*x-65.7576*$(x-1.4005)^2/2$

M = 69.1807*2.4526-65.7576*$(2.4526-1.4005)^2/2$

Therefore**,**

M = 133.2786 kNm

Now, from **JINDAL STEELS catalogue**,

Consider Universal I-Beam UB 305*165*40,[7]

w = 40.3 kg/m H = 303.4 mm

B = 165 mm t_w = 6mm

t_f = 10.2 mm r = 8.6 mm

A = 51.32 cm^2 I_{xx} = 8503 cm^4

Y = 151.7 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{151.7} = \frac{133.2786 * 10^6}{8503 * 10^4}$$

Therefore,

σ=237.779 < 250 MPa

This beam is suitable for this loading condition.

- **Calculations for Jaw Crusher CJ211:**

  Weight = 16.3 ton

  Length = 1.7 m

  Load to be considered = 1.3*16.3 = 21.19 ton = 207.8029 KN

  Load on single = 103.9015 KN

  Load distributed on loading length = 103.9015/1.7 = 61.1185 KN/m

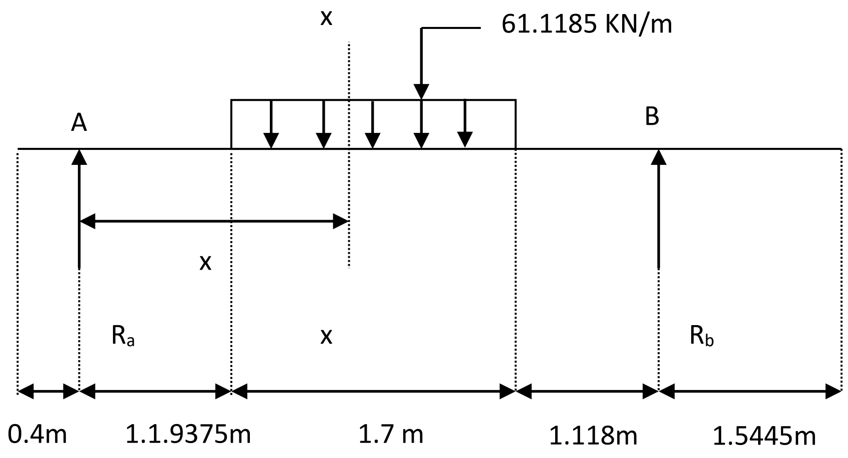


Fig.5.4: Loading diagram of Jaw Crusher CJ211

Now,

Moment at B = 0 = R_a*(AB)-103.9015*1.968

0 = R_a*4.7555-103.9015*1.968

Therefore**,**

Ra= 42.9982 KN

R_b = 60.9033 KN

Now, maximum bending moment will be at section x-x which is at distance x from point A. Bending moment will be maximum when shear force will be zero. So at section x-x, shear force is going to be zero.

Shear force = 0 = R_a-61.1185*(x-1.9375)

Therefore, x = 2.6410 m

Now, maximum bending moment is given as,

M = R_a*x-61.1185*(x-1.9375)^2/2

M = 42.9982*2.6410-61.1185*(2.6410-1.9375)^2/2

Therefore,

M = 98.4341 kNm

Now, from **JINDAL STEELS catalogue,**

Consider Universal I-Beam UB 254*146*37,[7]

w = 37.0 kg/m H = 256 mm

B = 146.4 mm t_w = 6.3 mm

t_f = 10.9 mm r = 7.6 mm

A = 47.17 cm^2 I_{xx} = 5537 cm^4

Y = 128 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{128} = \frac{98.4341 * 10^6}{5537 * 10^4}$$

Therefore,

***σ*=227 < 250 MPa**

This beam is suitable for this loading condition.

- **Calculations for Jaw Crusher CJ409:**

  Weight = 14 ton

  Length = 2.030 m

  Load to be considered = 1.3*14 = 18.2 ton = 178.4810 KN

  Load on single = 89.2405 KN

  Load distributed on loading length = 89.2405/2.030 = 43.9608 KN/m

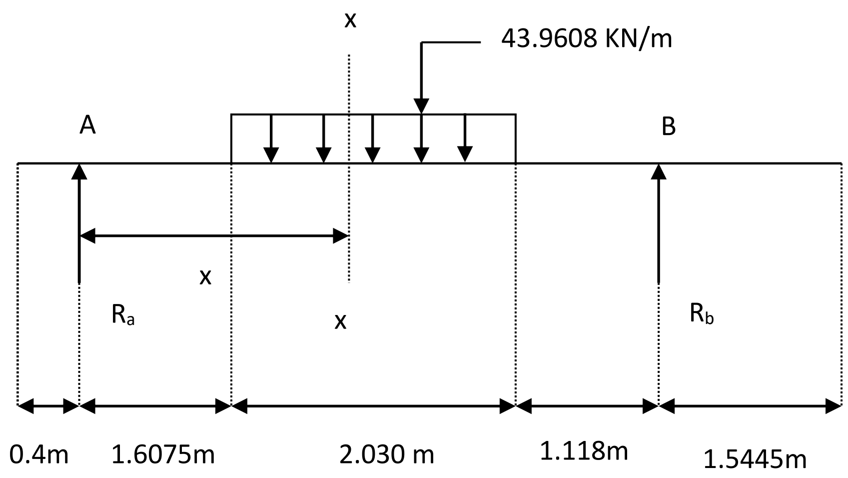


Fig 5.5: Loading diagram of Jaw Crusher CJ409

Now,

Moment at B = 0 = R_a*(AB)-89.2405*2.133

0 = R_a*4.7555-89.2405*2.133

Therefore**,**

<u>Ra= 40.0273 KN</u>

<u>R_b = 49.2132 KN</u>

Now, maximum bending moment will be at section x-x which is at distance x from point A. Bending moment will be maximum when shear force will be zero. So at section x-x, shear force is going to be zero.

Shear force = 0 = R_a-43.9608*(x-1.6075)

Therefore, x = 2.5180 m

Now, maximum bending moment is given as,

M = R_a*x-43.9608*(x-1.6075)^2/2

M = 40.0273*2.5180-43.9608*(2.5180-1.6075)^2/2

Therefore,

M = 82.5667 kNm

Now, from **JINDAL STEELS catalogue,**

Consider Universal I-Beam UB 254*146*31,[7]

w = 31.1 kg/m H = 251.4 mm

B = 146.1 mm t_w = 6 mm

t_f = 8.6 mm r = 7.6 mm

A = 39.68 cm^2 I_{xx} = 4413 cm^4

Y = 125.7 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{125.7} = \frac{82.5667 * 10^6}{4413 * 10^4}$$

Therefore,

***σ*=235.183 < 250 MPa**

This beam is suitable for this loading condition.

- **Calculations for HSI CI521 :**

  Weight = 17 ton

  Length = 1.9 m

  Load to be considered = 1.3*17 = 22.1 ton = 216.727 KN

  Load on single = 108.364 KN

  Load distributed on loading length = 108.364/1.9 = 57.033 KN/m

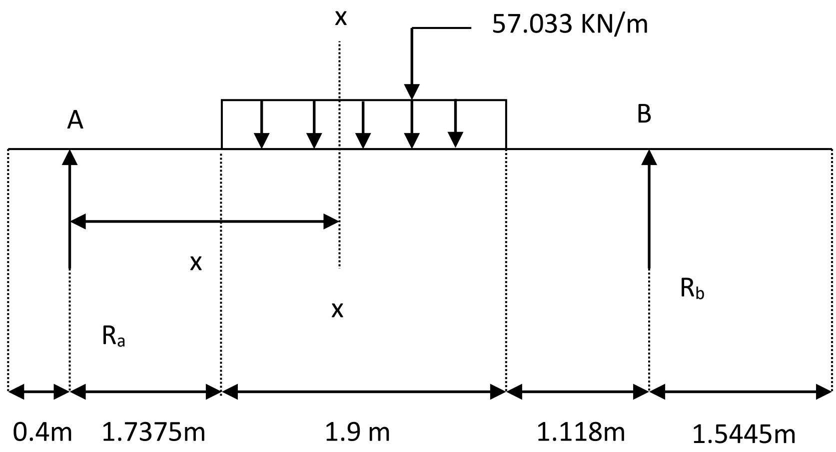


Fig.5.6: Loading diagram of HSI CI521

Now,

Moment at B = 0 = R_a*(AB)-108.364*2.068

0 = R_a*4.7555-108.364*2.068

Therefore**,**

<u>Ra= 47.1237 KN</u>

<u>R_b = 61.2403 KN</u>

Now, maximum bending moment will be at section x-x which is at distance x from point A. Bending moment will be maximum when shear force will be zero. So at section x-x, shear force is going to be zero.

Shear force = 0 = R_a-57.033*(x-1.7375)

Therefore, x = 2.5637 m

Now, maximum bending moment is given as,

$M = R_a*x-57.033*(x-1.7375)^2/2$

$M = 47.1237*2.5637-57.033*(2.5637-1.7375)^2/2$

Therefore,

<u>M = 101.3454 kNm</u>

Now, from **JINDAL STEELS catalogue,[7]**

Consider Universal I-Beam UB 254*146*37,

w = 37.0 kg/m H = 256 mm

B = 146.4 mm t_w = 6.3 mm

t_f = 10.9 mm r = 7.6 mm

A = 47.17 cm^2 I_{xx} = 5537 cm^4

Y = 128 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{128} = \frac{98.4341 * 10^6}{5537 * 10^4}$$

Therefore,

<u>σ=234.282 < 250 MPa</u>

This beam is suitable for this loading condition.

- **Calculations for VSI CV229 :**

  Weight = 15 ton

  Length = 3.470 m

  Load to be considered = 1.3*15 = 19.5 ton = 191.2298 KN

  Load on single beam = 95.6149 KN

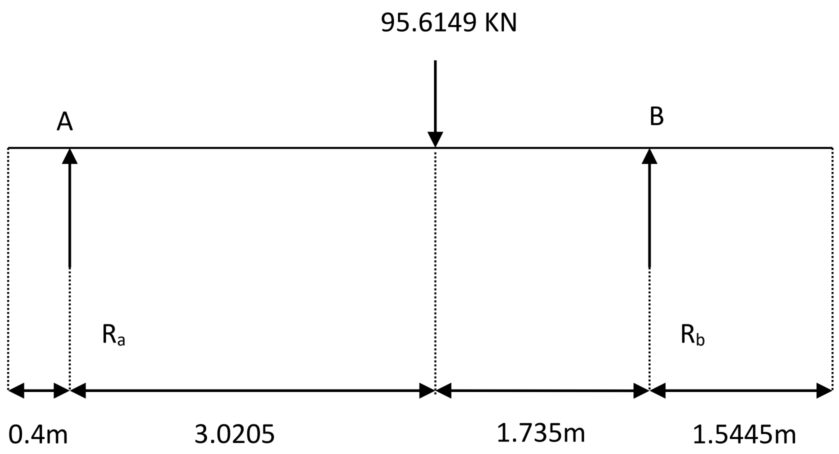


Fig.5.7: Loading diagram of VSI CV229

Now,

Moment at A = 0 = R_b*(AB)-95.6149*3.0205

0 = R_b*4.7555-95.6149*3.0205

Therefore,

R_b= 60.7307 KN

R_a = 34.8842 KN

Now, maximum bending moment is given as,

M = R_a*3.0205

M = 34.8842*3.0205

Therefore,

<u>M = 105.5678 kNm</u>

Now, from **JINDAL STEELS catalogue,**

Consider Universal I-Beam UB 254*146*37,[7]

w = 37.0 kg/m   H = 256 mm

B = 146.4 mm t_w = 6.3 mm

t_f = 10.9 mm   r = 7.6 mm

A = 47.17 cm^2 I_{xx} = 5537 cm^4

Y = 128 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{128} = \frac{105.5678 * 10^6}{5537 * 10^4}$$

Therefore,

<u>σ=244 < 250 MPa</u>

This beam is suitable for this loading condition.

- **Calculations for VSI CV218 :**

  Weight = 12 ton
  Length = 4 m
  Load to be considered = 1.3*12 = 15.6 ton = 152.9837 KN
  Load on single beam = 76.4918 KN

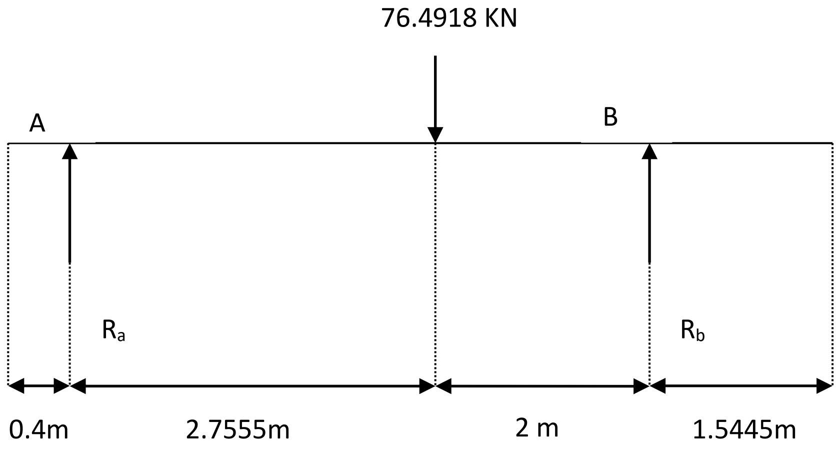


Fig. 5.8: Loading diagram of VSI CV218

Now,

Moment at A = 0 = R_b*(AB)-76.4918*2.7555

0 = R_b*4.7555-76.4918*2.7555

Therefore,

R_b= 44.322 KN

R_a = 32.1698 KN

Now, maximum bending moment is given as,

M = R_a*2.7555

M = 32.1698*2.7555

Therefore,

M = 88.6440 kNm

Now, from **JINDAL STEELS catalogue,**

Consider Universal I-Beam UB 254*146*37,[7]

w = 37.0 kg/m   H = 256 mm

B = 146.4 mm t_w = 6.3 mm

t_f = 10.9 mm   r = 7.6 mm

A = 47.17 cm^2 I_{xx} = 5537 cm^4

Y = 128 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{128} = \frac{88.6440 * 10^6}{5537 * 10^4}$$

Therefore,

σ=204 < 250 MPa

This beam is suitable for this loading condition.

- **Calculations for VSI CV217 :**

  Weight = 10 ton

  Length = 4 m

  Load to be considered = 1.3*13 = 13 ton = 127.4866 KN

  Load on single beam = 63.7433 KN

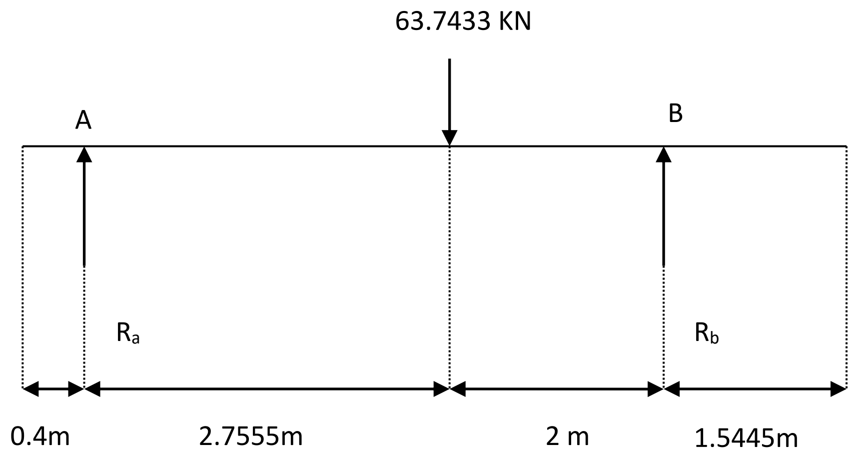


Fig. 5.9: Loading diagram of VSI CV217

Now,

Moment at A = 0 = R_b*(AB)-63.7433*2.7555

0 = R_b*4.7555-63.7433*2.7555

Therefore,

R_b= 36.9350 KN

R_a = 26.8082 KN

Now, maximum bending moment is given as,

M = R_a*2.7555

M = 26.8082*2.7555

Therefore,

M = 73.8701 kNm

Now, from **JINDAL STEELS catalogue,**

Consider Universal I-Beam UB 254*146*31,[7]

w = 31.1 kg/m   H = 251.4 mm

B = 146.1 mm t_w = 6 mm

t_f = 8.6 mm   r = 7.6 mm

A = 39.68 cm^2 I_{xx} = 4413 cm^4

Y = 125.7 mm

Now, $\frac{\sigma}{Y} = \frac{M}{I}$

$$\frac{\sigma}{125.7} = \frac{73.8701 * 10^6}{4413 * 10^4}$$

Therefore,

σ=210.4117 < 250 MPa

This beam is suitable for this loading condition.

NOTE: - According to the above calculations the most suitable I-Beam to be considered is **UB 305*165*40.**

5.2 Components Finalised For The Trailer:

5.2.1 I-Beam:

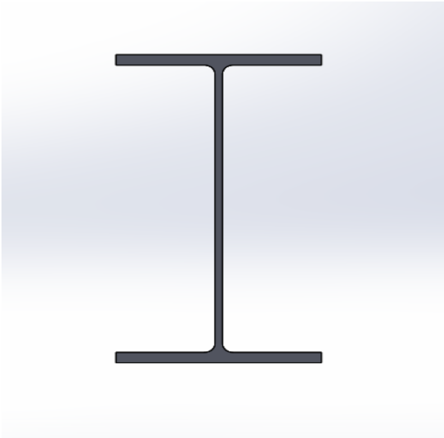


Fig.5.10: I-Beam Front View

I-Beam Selection: -

Type of beam	Parallel Flange beams(UB Series)
Sectional weight (w)	40.3 kg/m
Total Depth (H)	303.4 mm
Flange Width (B)	165 mm
Thickness of Web (t_w)	6mm
Thickness of Flange (t_f)	10.2 mm
Root Radius (r)	8.6 mm
Cross-Sectional Area (A)	51.32 cm^2
Mass moment of Inertia (I_{xx})	8503 cm^4

Table 5.1: I-Beam Specification

Reference: -

JINDAL STEEL & POWER

PRODUCT RANGE

Universal Beams & Columns, Channels and Rails

ANNEXURE - A

Description Beams	Sectional Weight	Total Depth	Flange Width	Thickness of Web	Thickness of Flange	Root radius	Area of section	Moment of Inertia		Sectional Modulus		Radius of gyration		Remarks
								X Axis	Y Axis	X Axis	Y Axis	X Axis	Y Axis	
	w	H	B	t_w	t_f	r	A	Ixx	Iyy	Zxx	Zyy	rxx	ryy	
	Kg/m	mm	mm	mm	mm	mm	cm^2	cm^4	cm^4	cm^3	cm^3	cm	cm	
PARALLEL FLANGE BEAMS; UB SERIES														
UB 203 x 133 x 25	25.1	203.2	133.2	5.7	7.8	7.6	31.97	2340	307.6	230.3	46.2	8.56	3.10	
UB 203 x 133 x 30	30.0	206.8	133.9	6.4	9.6	7.6	38.21	2896	384.7	280	57.5	8.71	3.17	
UB 254 x 146 x 31	31.1	251.4	146.1	6	8.6	7.6	39.68	4413	447.5	351.1	61.3	10.55	3.36	
UB 254 x 146 x 37	37.0	256	146.4	6.3	10.9	7.6	47.17	5537	570.6	432.6	78	10.83	3.48	
UB 254 x 146 x 43	43.0	259.6	147.3	7.2	12.7	7.6	54.77	6544	677.4	504.1	92	10.93	3.52	
UB 305 x 165 x 40	40.3	303.4	165	6	10.2	8.9	51.32	8503	764.4	560.5	92.6	12.87	3.86	
UB 305 x 165 x 46	46.1	306.6	165.7	6.7	11.8	8.9	58.75	9899	895.7	645.7	108	12.98	3.90	
UB 305 x 165 x 54	54.0	310.4	166.9	7.9	13.7	8.9	68.77	11700	1063	753.6	127	13.04	3.93	
UB 356 x 171 x 45	45.0	351.4	171.1	7	9.7	10.2	57.33	12070	811.1	686.7	94.81	14.51	3.76	
UB 356 x 171 x 51	51.0	355	171.5	7.4	11.5	10.2	64.91	14140	968.3	796.4	112.9	14.76	3.86	
UB 356 x 171 x 57	57.0	358	172.2	8.1	13	10.2	72.56	16040	1108	896	128.7	14.87	3.91	
UB 356 x 171 x 67	67.1	363.4	173.2	9.1	15.7	10.2	85.49	19460	1362	1071	157.3	15.09	3.99	
UB 406 x 178 x 54	54.1	402.6	177.7	7.7	10.9	10.2	68.95	18720	1021	930	115	16.48	3.85	
UB 406 x 178 x 60	60.1	406.4	177.9	7.9	12.8	10.2	76.52	21600	1203	1063	135	16.8	3.97	
UB 406 x 178 x 67	67.1	409.4	178.8	8.8	14.3	10.2	85.54	24330	1365	1189	153	16.87	3.99	
UB 406 x 178 x 74	74.2	412.8	179.5	9.5	16	10.2	94.51	27310	1545	1323	172	17	4.04	

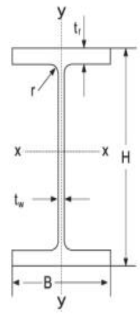


Fig.5.11: I-Beam JINDAL STEEL Catalogue

Material Composition: -

Steel Grade	IS2062
Allowable Stress (S)	250MPa
Yield Strength	250MPa
Young's Modulus(E)	200e3 MPa
Poisson's Ratio	0.3
Density	7850 Kg/m^3

Table 5.2: Material Composition of I-Beam

5.2.2 Axle:

An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle.

Axles are an integral component of most practical wheeled vehicles. In a live-axle suspension system, the axles serve to transmit driving torque to the wheel, as well as to maintain the position of the wheels relative to each other and to the vehicle body. The axles in this system must also bear the weight of the vehicle plus any cargo.

A tandem axle is a group of two or more axles situated close together. Truck designs use such a configuration to provide a greater weight capacity than a single axle. Semi-trailers usually have a tandem axle at the rear.

Axles are typically made from SAE grade 41xx steel or SAE grade 10xx steel. SAE grade 41xx steel is commonly known as "chrome-molybdenum steel" (or "chrome-moly") while SAE grade 10xx steel is known as "carbon steel".

Fig.5.12 Example of Square Beam Axle

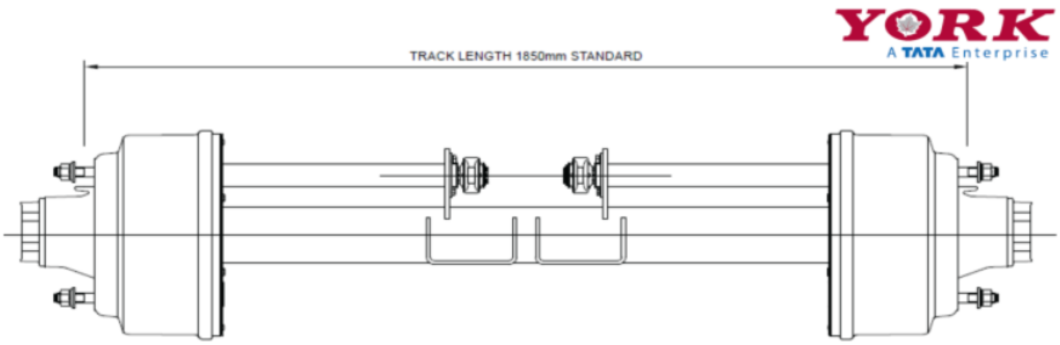


Fig.5.13 Square Beam Axle

Axle Selection: -

Manufacturer :- YORK – TATA Enterprise	
Axle Assembly. SP. CRS. 960 & W. T. 1850	2 SET
Double Axle Brake 7'' Spring Brake Chamber T 30/30 at Rear Axle & T30 at Front Axle.	1 SET
Individual Weight carrying capacity	12 Tonnes

Table 5.3: Axle Selection

Reference: - Drawing Sheet No. 701.0011-R4

5.2.3 Leaf Spring Suspension System:

A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times.

A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. In the most common configuration, the center of the arc provides location for the axle, while loops formed at either end provide for attaching to the vehicle chassis. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action.

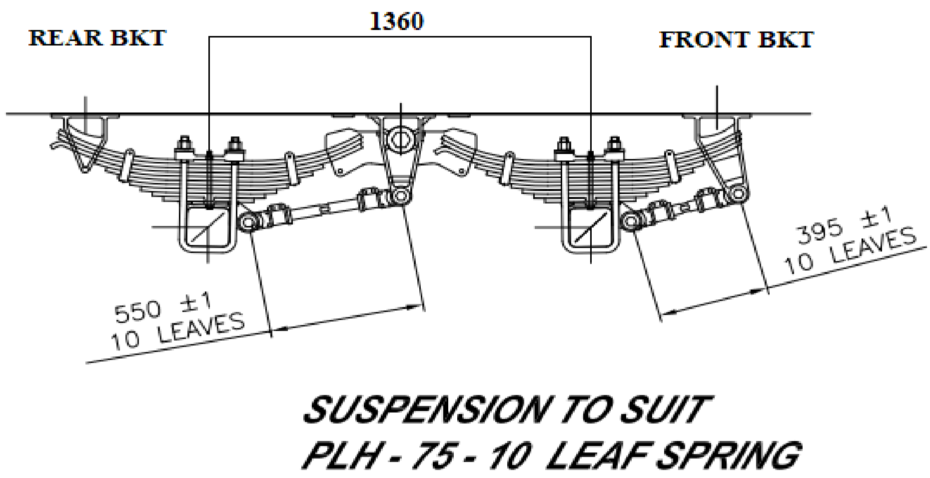


Fig.5.14: Leaf Spring Suspension System

Calculations: -

As per suggestion of company guide, the number of leaves used in leaf spring for heavy duty trailers are generally 10.

n = No. of leaf = 10

$2L_2$= overall length of spring of span length mm

= length of major leaf = 1080 mm

2L = effective length

l = distance between U-bolts =154 mm

Effective length (2L) = $2L_2$- (2/3)l

= 1080 – (2/3)*154

2L = 977.33 mm

Length of smallest Leaf = (2L/n-1) + l

= (977.33/ 10-1) +154

= 262.59 mm

Width: - 75 mm

Thickness: - 10 mm

Selection: -

PLH – 75 Double Axle Suspension with 10 Leaves – 1 SET

Manufacturer: - YORK – TATA Enterprise.

Axle Type: - Tandem Type

Leaf Spring Capacity per Axle:- 10 Leaf Spring / 15 Ton

Axle Spacing:-1360 mm

5.2.4 Wheels:

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labour in machines.

Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity or by the application of another external force or torque.

A Wheel comprises of ‘RIM’ & ‘TYRE’.

TYRE: - A Tyre is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface traveled over. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

The materials of modern pneumatic tires are synthetic rubber, natural rubber, fabric and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction while the body provides containment for a quantity of compressed air.

RIM: - The rim is the "outer edge of a wheel, holding the tire".It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles.

Diameter (effective): distance between the bead seats (for the tire), as measured in the plane of the rim and through the axis of the hub which is or will be attached, or which is integral with the rim.

Width (effective): separation distance between opposed rim flanges. The flange-to-flange width of a rim should be a minimum of three-quarters of the tire section width. And the maximum rim width should be equal to the width of the tire tread.

Material: Various metals can be used for the rim. Commonly seen are alloy (magnesium and aluminum), aluminum, and chrome. Teflon coatings are sometimes also applied for an extra layer of protection.

Wheel Selection: -

Wheel Rim	10 x 20 (10 Holes)
Material	Iron-Carbon Alloy
Quantity	8
Outer Dia. Of Wheel	106 cm
Tyre Material	Synthetic Rubber
Tyre Ply Rating	16
Type Of Fitment	Dual Fitment Tyre
Max load carrying Capacity	Single (3 Tonne) , Dual (2.65 Tonne)
Brand	CEAT or MRF

Table 5.4: Wheel Selection

5.2.5 Landing Gears:

When Tug-master is un-jacked from trailer end, the front end of trailer rests on the landing gears. They provide the required support to the trailer frame. They come in variety of weight carrying capacity. Their lifting and backstroke and be gearbox controlled or manual one.

Fig.5.15: LANDING GEAR

Selection: -

Manufacturer: - YORK – TATA Enterprise

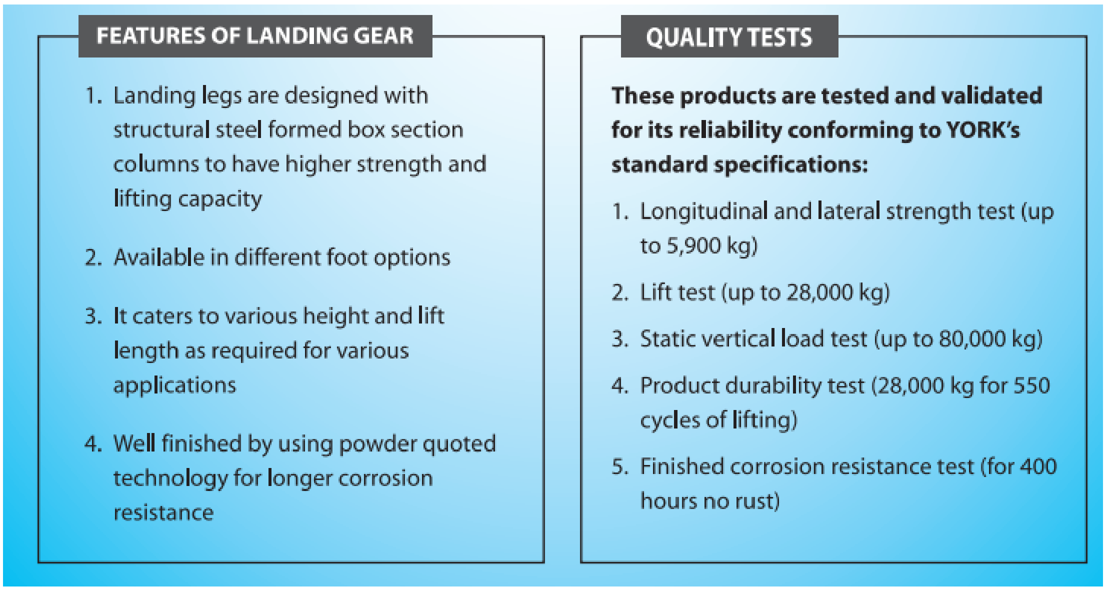


Fig.5.16: YORK Quality Standards

Product Specification: -

SPECIFICATIONS	YT-28A-2	YF-28A-2
Static Load(kg)	64000	64000
Lift Capacity(kg)	28000	28000
Max Travel(mm)	480	480
High Gear(mm)	5.42	5.42
Low Gear(mm)	0.72	0.72
Retract High(mm)	840	857
Standard Weight(kg)	110	110
Crank Force(kg)	22	22
Side Load Capacity(kg)	13000	13000

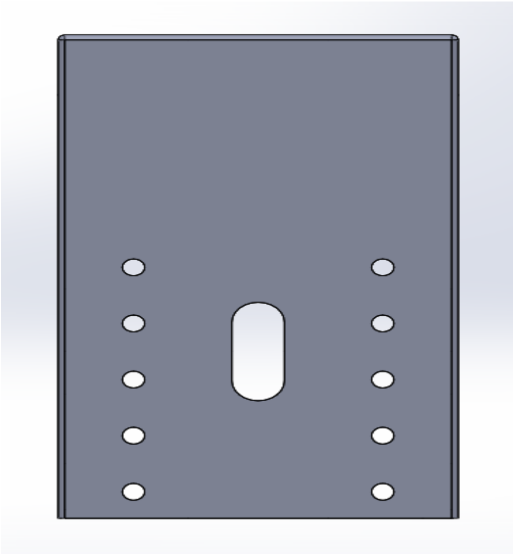
Table 5.5: Landing Gear Specifications

Reference: - http://www.yorktransport.com/brochures1.html

<u>Landing Gear Bracket: -</u>

It is the bracket link between the landing gear and the Main I-Beam.

It is made up of Mild Steel material.



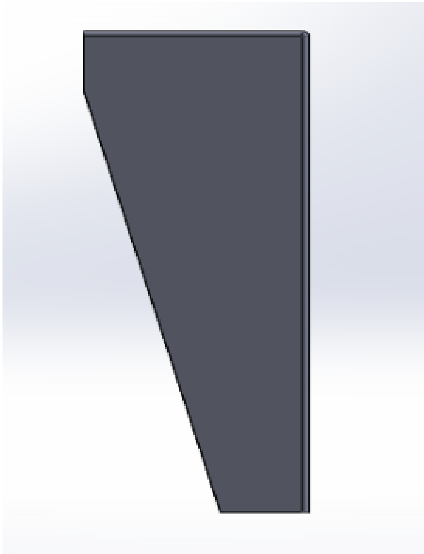


Fig.5.17: Bracket (Front view) **Bracket (Side View)**

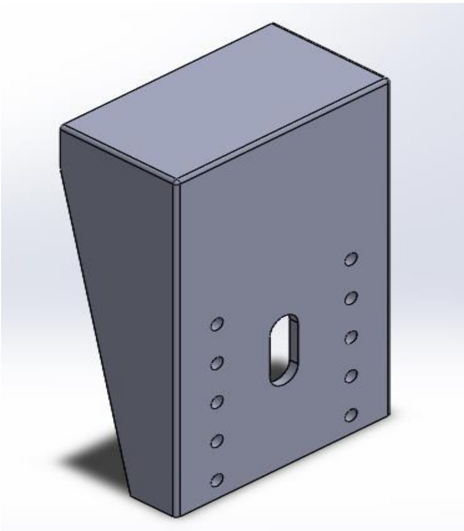


Fig.5.18: Bracket (Isometric View)

5.2.6 Kingpin:

The kingpin is the main pivot in the steering mechanism of a car or other vehicle.

The term is also used to refer to part of a fifth wheel coupling apparatus.

Features of kingpin:-

- Tightly controlled metallurgical composition achieved offers excellent welding characteristics for easy installation and replacement.
- Carefully controlled hardening process for maximum wear resistance.

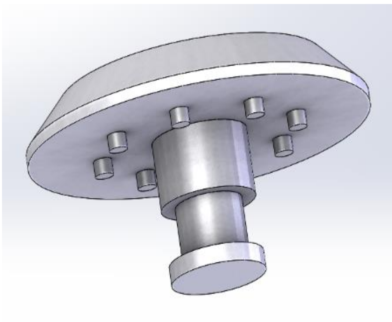


Fig.5.19: Kingpin

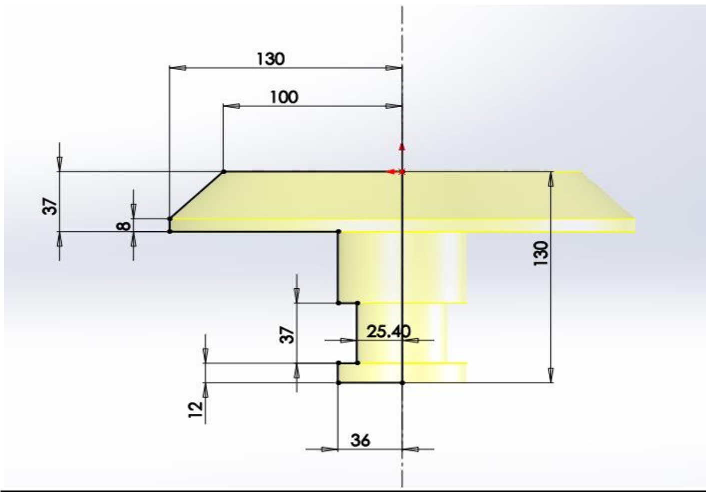


Fig.5.20: Kingpin Sketch

D value Calculations:

The D-value is defined as the theoretical reference force for the horizontal force between towing vehicle and trailer resulting from the permissible max. Masses of the towing vehicle and full trailer (with vertically adjustable drawbar).

T = permissible max. Mass of towing vehicle in tonne
R = permissible max. Mass of trailer in tonne

The permissible D-value of the trailer coupling must be greater than or equal to the calculated D-value.

T= 25 tonne

R= mass of trailer + load on trailer = 8 tonne + 30 tonne = 38 tonne

D(kN)=$\frac{T*R}{T+R}*9.81$

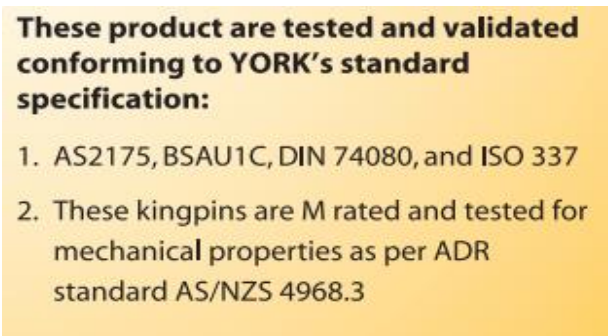
D=$\frac{25*38}{25+38}*9.81$ kN

D=147.9kN

Selection: -

Manufacturer: - YORK-TATA Enterprise.

YORK Quality Standard.

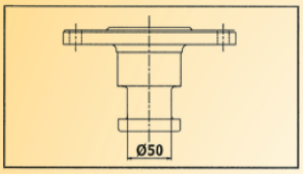


These product are tested and validated conforming to YORK's standard specification:

1. AS2175, BSAU1C, DIN 74080, and ISO 337
2. These kingpins are M rated and tested for mechanical properties as per ADR standard AS/NZS 4968.3

Fig.5.21: York's Standards

Product Specification: -



Bolt/Weld-In King Pin

SIZE	Trailer Rubbing Plate Thickness	M Rated		D Value	
2" / 50mm	10	105KN	YKZ50M10	150KN	Y-KP2100
	12	105KN	YKZ50M12		

Fig.5.22: Kingpin Specifications

5.2.7 Diamond/Chequered Plate:

Diamond plate, also known as chequered plate, tread plate and Durbar floor plate, is a type of metal stock with a regular pattern of raised diamonds or lines on one side, with the reverse side being featureless. Diamond plate is usually steel, stainless steel or aluminum. Steel types are normally made by hot rolling, although modern manufacturers also make a raised and pressed diamond design.

The added texture reduces the risk of slipping. Its non-skid properties mean that diamond plate is frequently used on the interior of ambulances and on the footplates of fire trucks. Additional applications include truck beds and trailer floors.

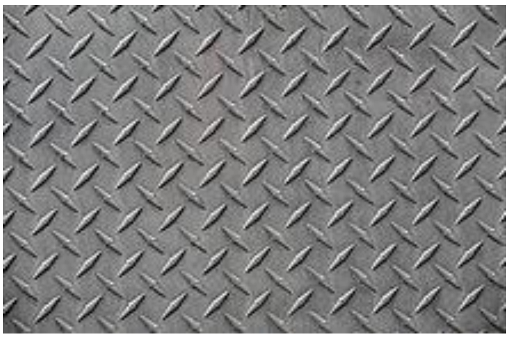


Fig.5.23: Chequered Plate

Selection: -

Material	Mild Steel
Size	6.5*2 m (L*B)
Thickness	5 mm
Total Weight	0.54 Tonne
Estimated Rate	41 Rs / Kg
Overall Estimated Cost	22,000 Rs /-
Model	S-275 jr

Table 5.6: Chequered Plate Selection

5.2.8 Nuts And Bolts:

A bolt is a form of threaded fastener with an external male thread.

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten multiple parts together.

Fig.5.24: HEX BOLT

Fig.5.25: Nylon/Lock NUT

Selection: - BOLT

Type of Bolt	Hex Bolt
Quantity	24
Size	M22
Material	High Grade Steel (EN ISO 4014)
Thickness of Head	14 mm (approx.)
Total Length	75-77 mm
Width across Corners	37.29 mm (approx.)
Width across flats	33-34 mm (approx.)

Table 5.7: Selection of Bolt

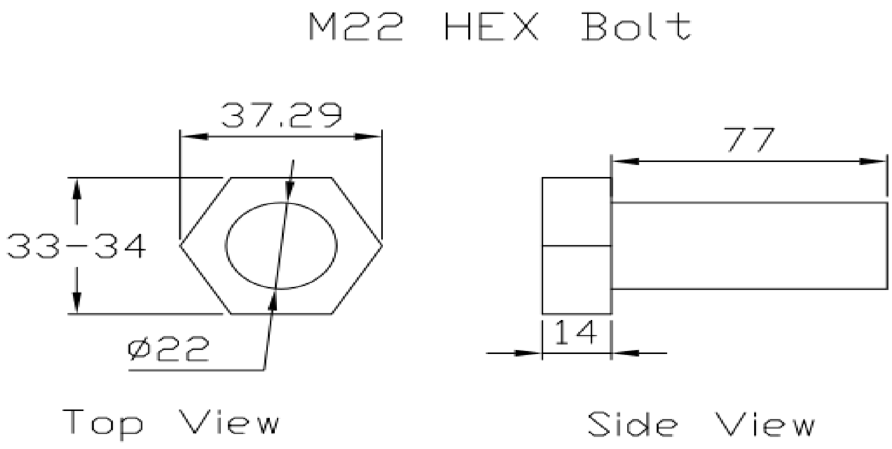


Fig.5.26: M22 Hex Bolt

Selection: - NUT

Type of Nut	Nylon / Lock Nut
Quantity	24
Size	M22
Material	High Grade Steel (Class 6 or 8)
Thickness of Head	19.80 – 21.10mm (approx.)
Width across Corners	37.72 – 39.30 mm (approx.)
Width across flats	33.3 – 34 mm (approx.)

Table 5.8: Nut Selection

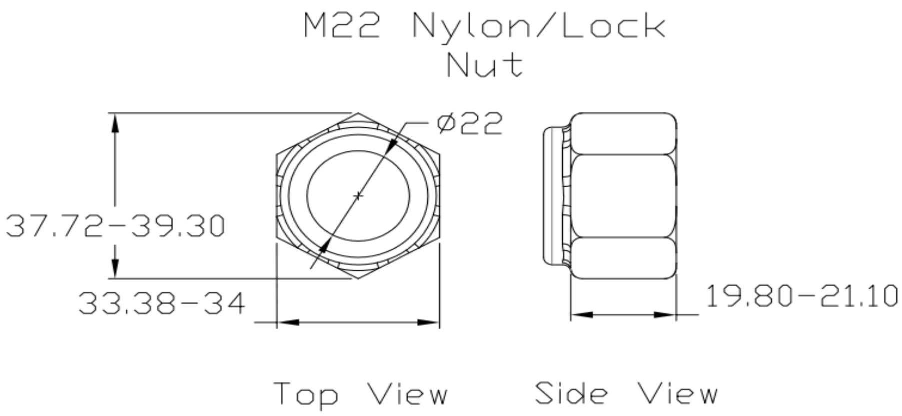


Fig.5.27: M22 Nylon/Lock Nut(Sketch)

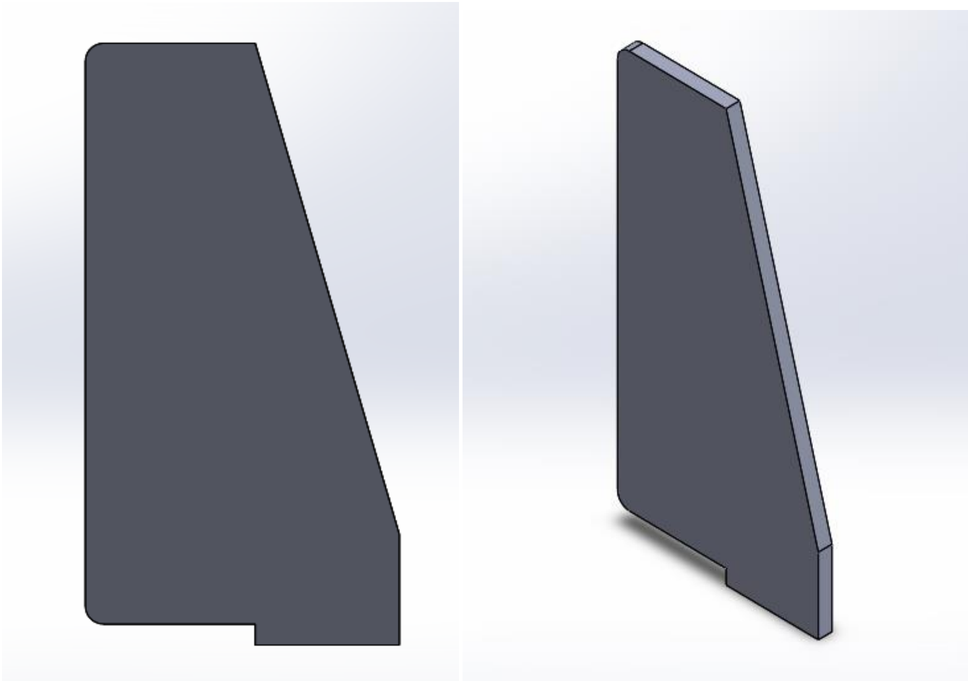
5.2.9 Trusses:

In engineering, a truss is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object". Trusses add to structural rigidity of the assembly. It makes the whole system strong.

In our Design we have incorporated 3 types of trusses, namely: -

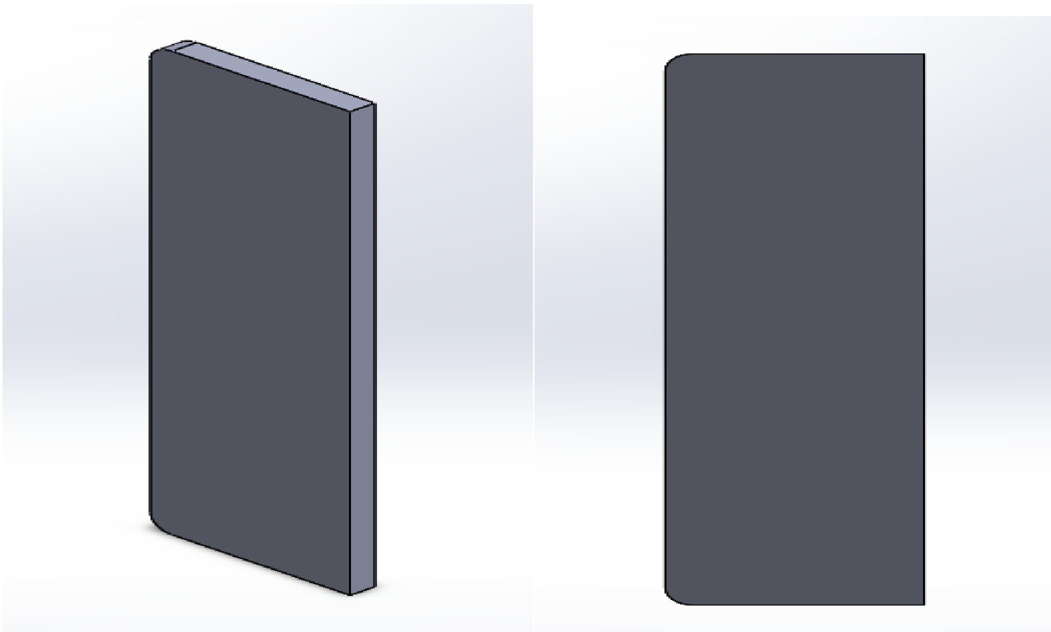
1. Bolt Plate Trusses
2. External Main I-Beam trusses
3. Lower frame Trusses

In our trailer, Bolt Plate Trusses are used in between upper and lower frame where bolting plate is used. External Main I-Beam trusses are used for structural rigidity of the main frame. Lower Frame trusses are used for structural rigidity of lower frame.



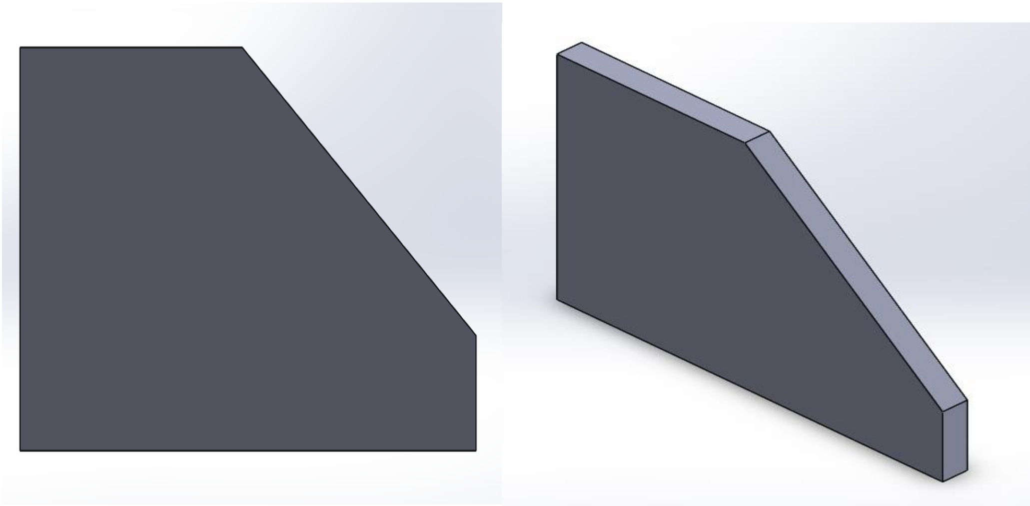
Front View Isometric View

Fig.5.28: Bolt Plate Trusses



Isometric View Front view

Fig.5.29: External Main I-Beam trusses



Front view Isometric View

Fig 5.30: Lower Frame Trusses

5.3 ANSYS Analysis Of Trailer Frame:

5.3.1 Analysis of Jaw Crusher CJ411:

AIM:-To find out stress and deformation on a trailer frame for maximum payload of 30 ton (CJ411).

- **Material :**

Parameter	Trailer Frame (Steel:IS2062)	UNIT
Allowable Stress (S)	250	MPa
Factor of Safety (Considered)	1.3	
Yield Strength	250	MPa
Young's Modulus(E)	200e3	MPa
Poisson's Ratio	0.3	
Density	7850	Kg/m3

Table 5.9: Material Selection

- **GEOMETRY:-**

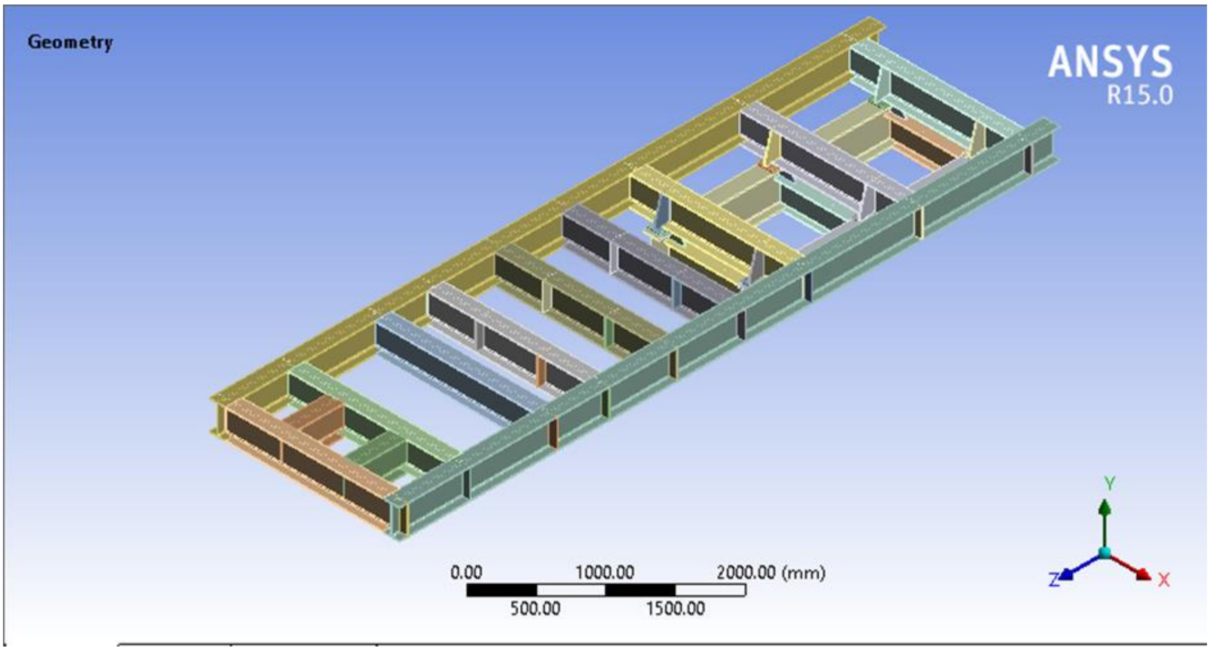


Fig 5.31: Geometry of Chasis (3D Model)

- **Meshing:-**

Total no. of Nodes= 72445

Total no. of Elements=207806

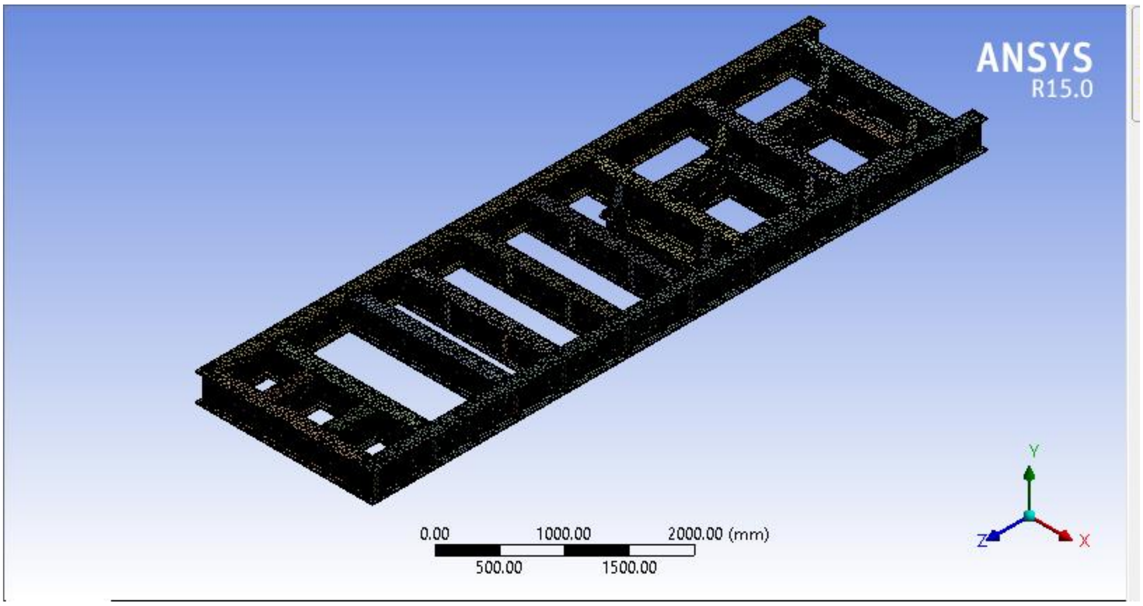


Fig 5.32: FEA mesh model of Chasis

- **Loading Conditions:-**

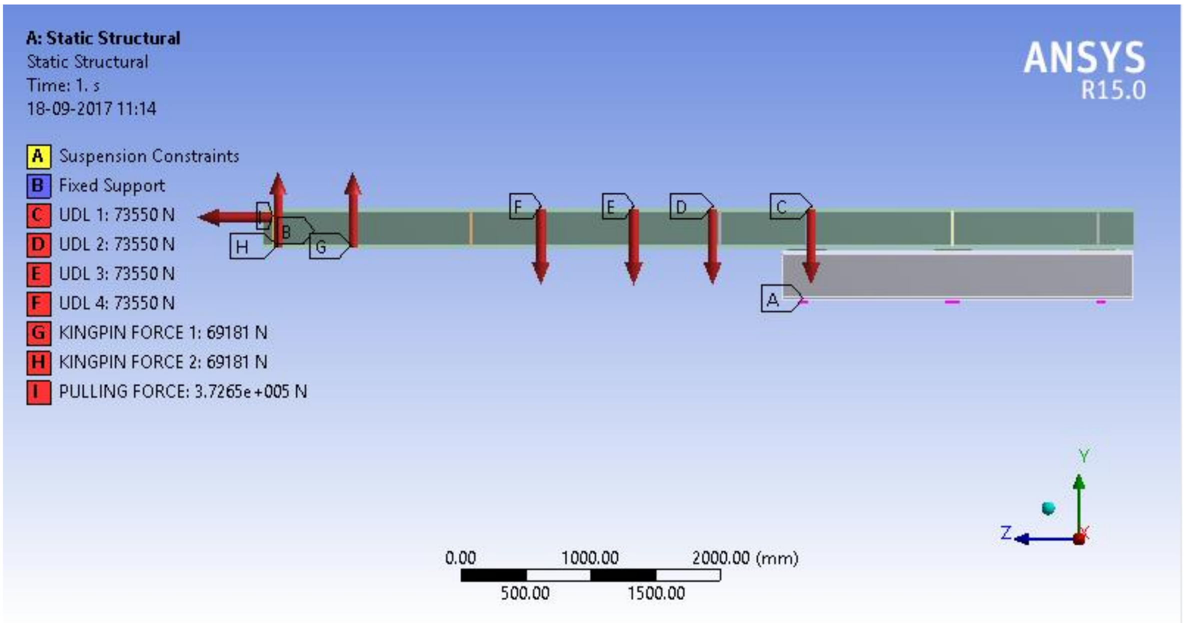


Fig. 5.33: Loading Conditions of Chasis

The Jaw Crusher CJ411 has 23 ton weight, which after considering the factor of safety 1.3 becomes 30 ton. This load is uniformly distributed over 4 cross members. This load is shown in figure as C, D, E and F. It is 73550N UDL on each cross member. G and H are representing reaction given by Kingpin. The pulling force is shown by I. the secondary frame has suspension constraints shown by A.

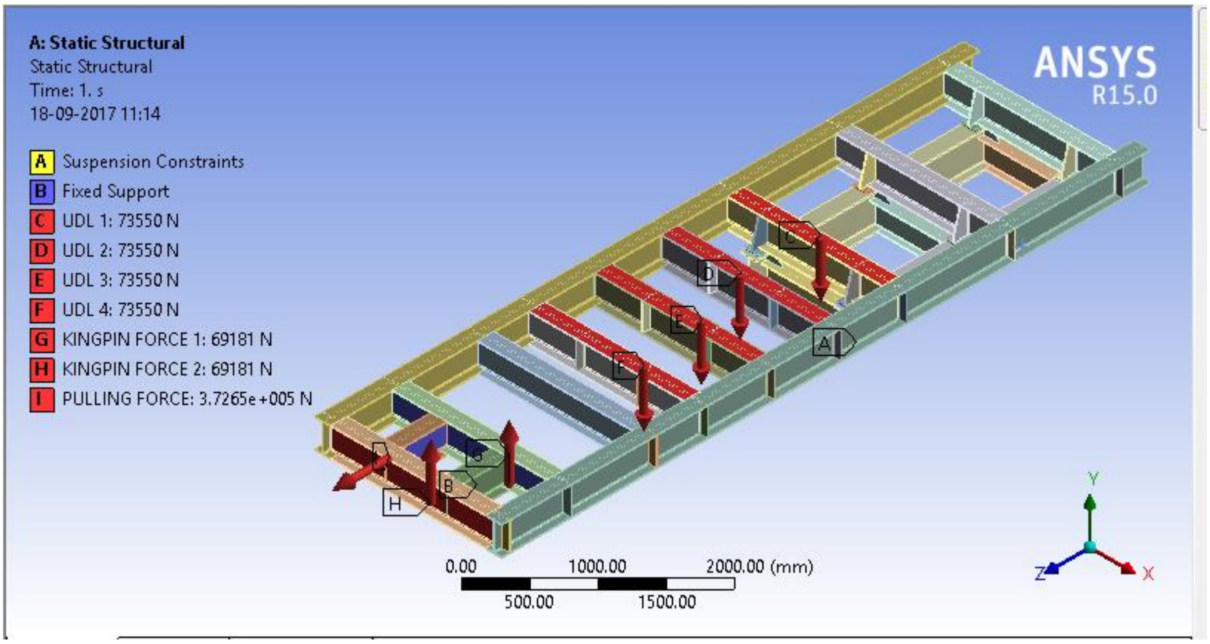


Fig. 5.34: Loading Conditions of Chasis (Isometric View)

Case 1:- Jaw Crusher CJ411

TOTAL DEFORMATION	2.51 mm

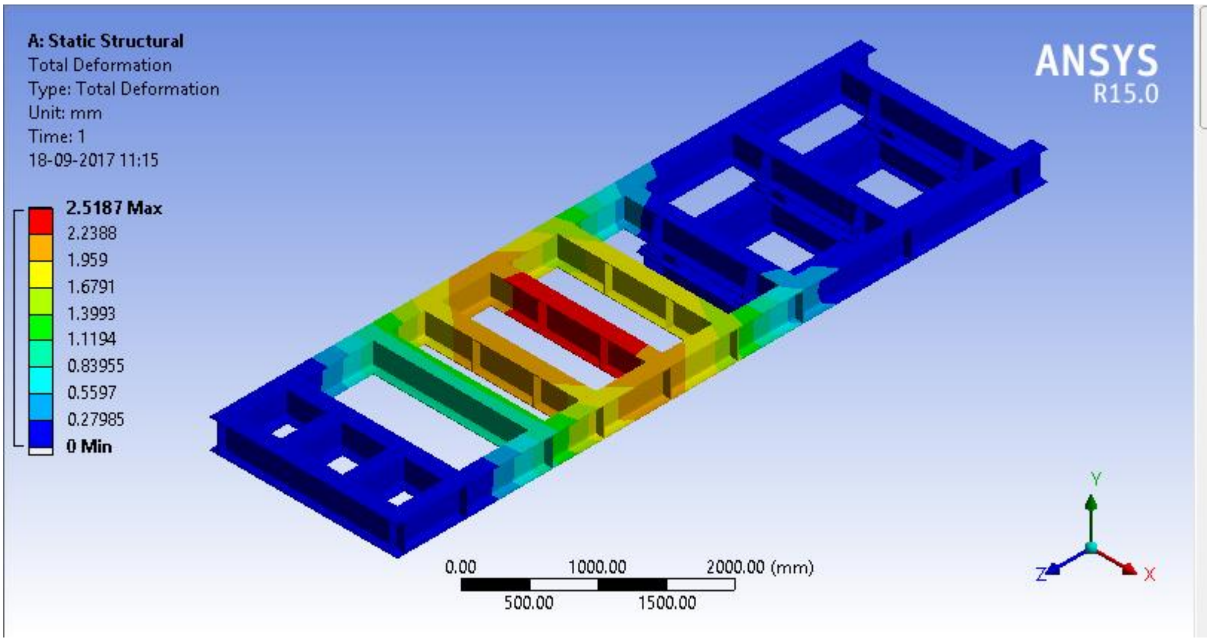


Fig. 5.35: Total Deformation of Chasis (Isometric View)

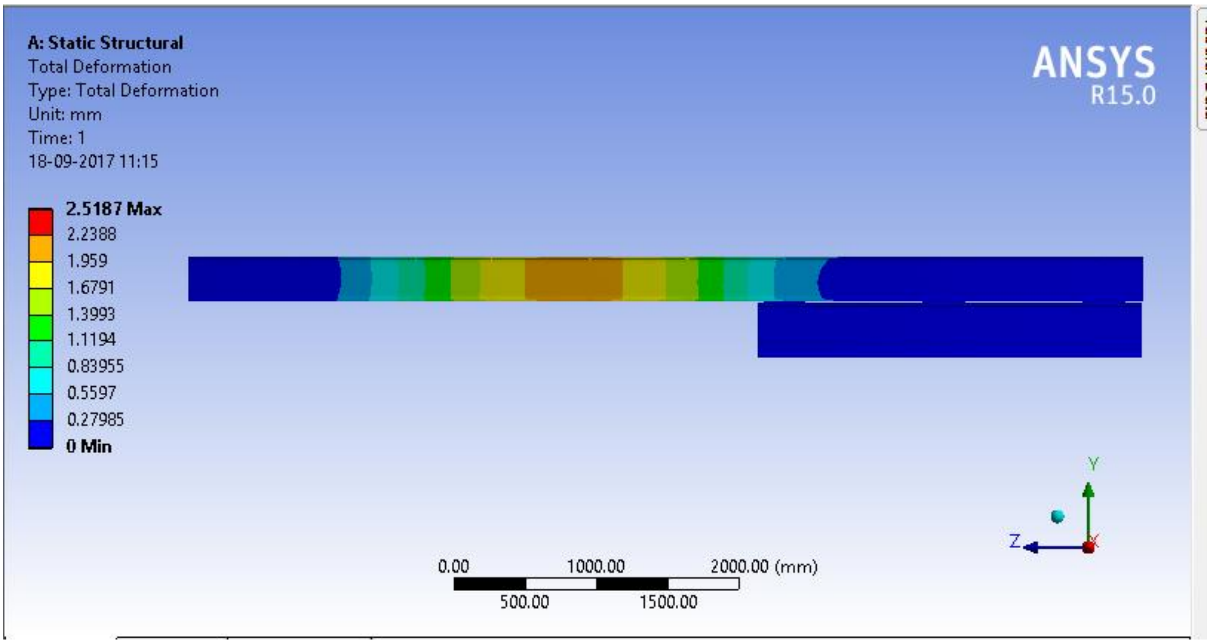


Fig. 5.36: Total Deformation of Chasis (Side View)

EQUIVALENT (Von-Misses) Stress	157.12 MPa

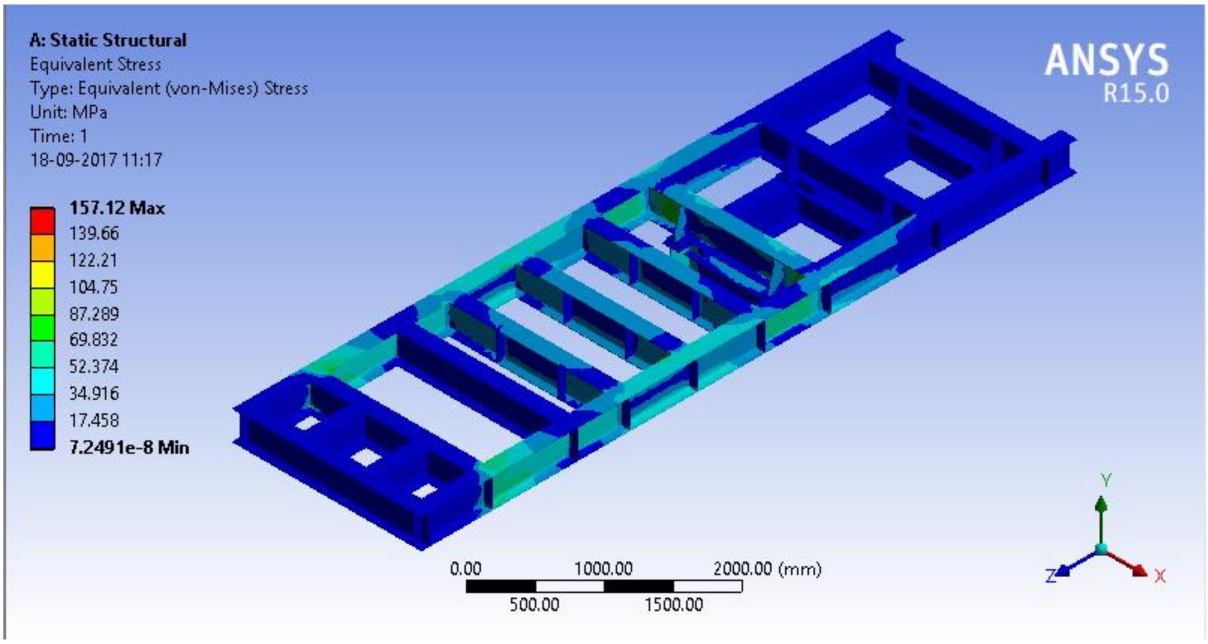


Fig. 5.37: Equivalent (von-Mises) Stress of Chasis (Isometric View)

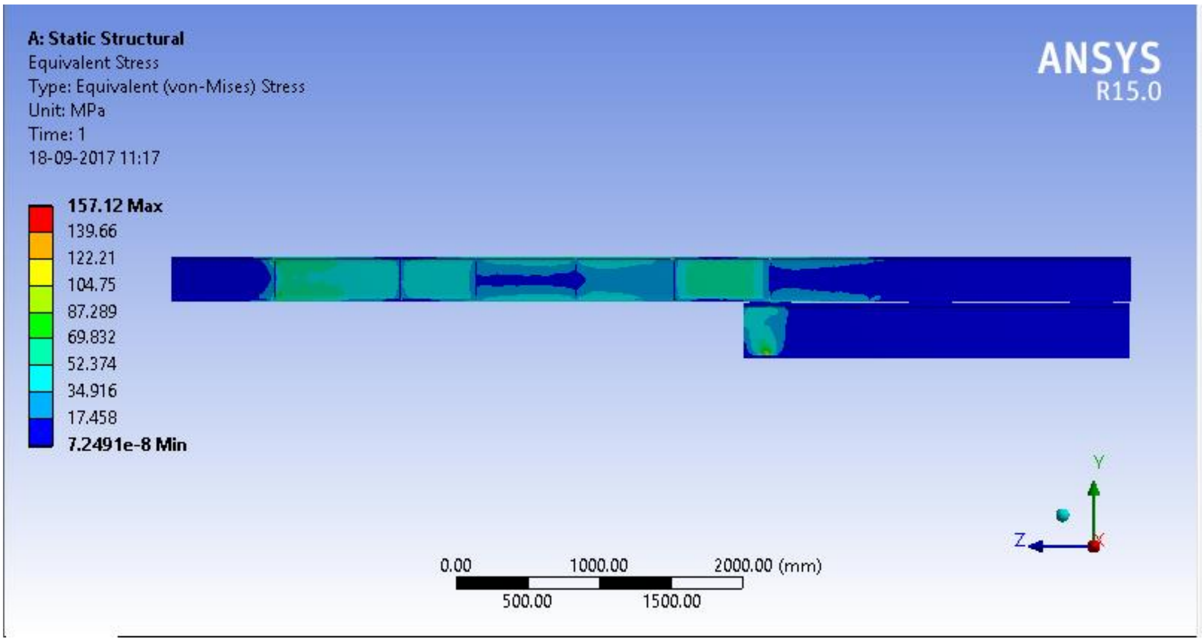


Fig. 5.38: Equivalent (von-Mises) Stress of Chasis (Side View)

5.4 Final Trailer Design:

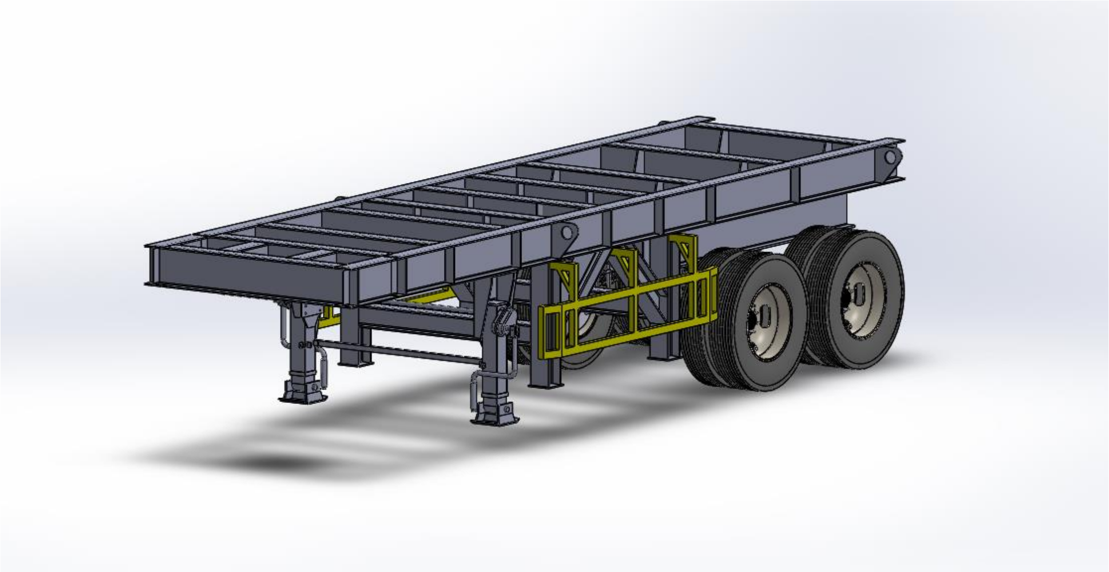


Fig.5.39: Isometric View of Trailer

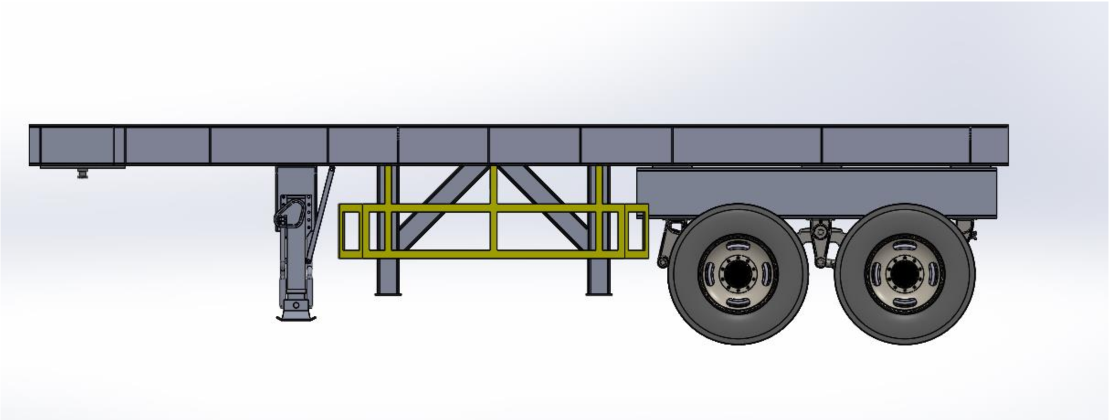


Fig.5.40: Side View of Trailer

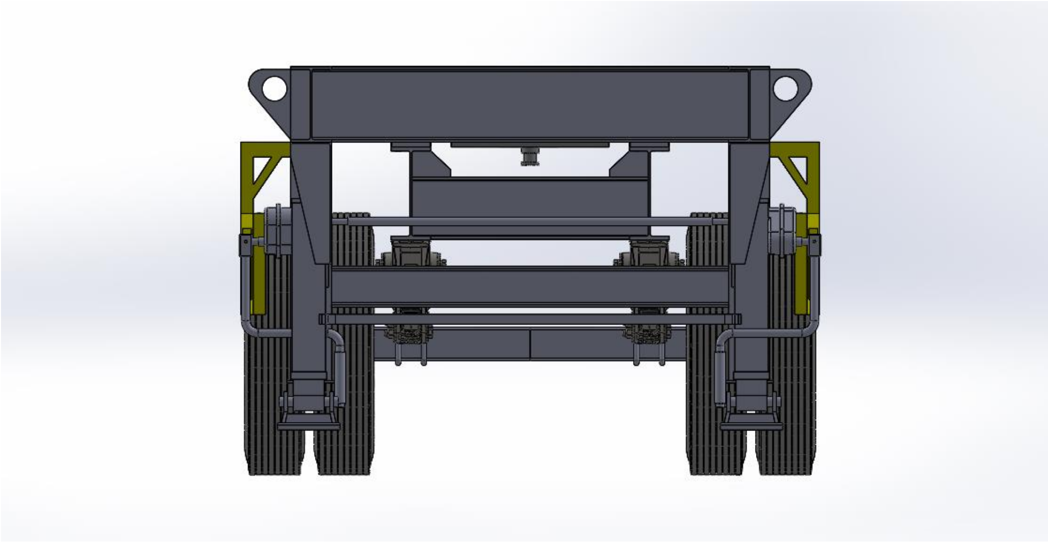


Fig.5.41: Front View of Trailer

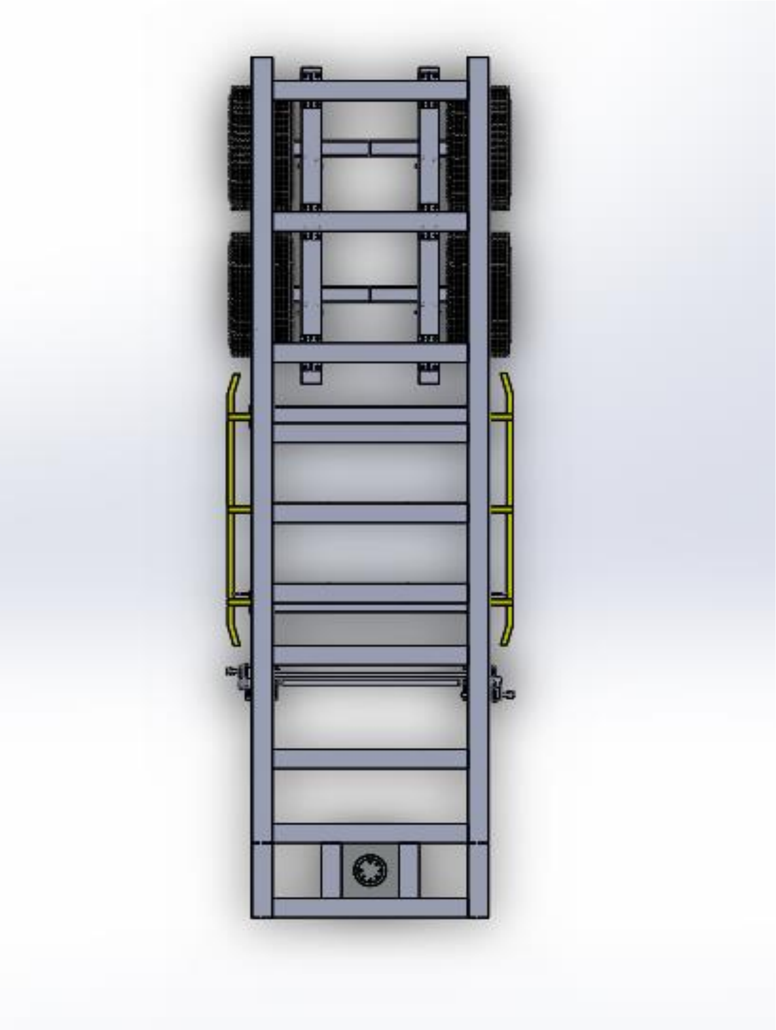


Fig.5.42 Top View of Trailer

5.5 Processes Followed For Manufacturing:

Manufacturing process involves processes like cutting, welding, Sandblasting and painting. Description of these processes used for manufacturing of trailer are given below:

5.5.1 Cutting:

Cutting process is used for the cutting of the I-beams, Trusses, various plates and other miscellaneous items.

Gas cutting (oxy fuel cutting) are processes that use fuel gases and oxygen to weld and cut metals, respectively. Pure oxygen, instead of air, is used to increase the flame temperature to allow localized melting of the work piece material (e.g. steel) in a room environment. A common propane/air flame burns at about 2,250 K (1,980 °C; 3,590 °F), a propane/oxygen flame burns at about 2,526 K (2,253 °C; 4,087 °F), an oxy-hydrogen flame burns at 2,800 °C (5,070 °F), and an acetylene/oxygen flame burns at about 3,773 K (3,500 °C; 6,332 °F).

In gas cutting (oxy fuel cutting), a torch is used to heat metal to its kindling temperature. A stream of oxygen is then trained on the metal, burning it into a metal oxide that flows out as slag. In oxy-fuel cutting, a torch is used to heat metal to its kindling temperature.

Fig.5.43 cutting torch to cut beam

5.5.2 Welding:

Welding is a material joining process. The entire chasis of the trailer was MIG Welded. For welding purpose we use flux coated MIG welding with filler material and 7018 arc welding for the main base foundation for sustaining load of 70000 PSI.

MIG (Metal Inert Gas) welding, also known as MAG (Metal Active Gas) and in the USA as GMAW (Gas Metal Arc Welding), is a welding process that is now widely used for welding a variety of materials, ferrous and nonferrous.

The essential feature of the process is the small diameter electrode wire, which is fed continuously into the arc from a coil. As a result, this process can produce quick and neat welds over a wide range of joints.

Equipment -

-DC output power source

-Wire feed unit

-Torch

-Work return welding lead

-Shielding gas supply, (normally from cylinder)

-Power Source

MIG welding is carried out on DC electrode (welding wire) positive polarity (DCEP). However, DCEN is used (for higher burn off rate) with certain self-shielding and gas shield cored wires. DC output power sources are of a transformer-rectifier design, with a flat characteristic (constant voltage power source). The most common type of power source used for this process is the switched primary transformer rectifier with constant voltage characteristics from both 3-phase 415V and 1- phase 240V input supplies. The output of direct current after full wave rectification from a 3-phase machine is very smooth. To obtain smooth output after full wave rectification with a 1- phase machine, a large capacitor bank across the output is required.

5.5.3 Sandblasting:

Sandblasting or bead blasting is a generic term for the process of smoothing, shaping and cleaning a hard surface by forcing solid particles across that surface at high speeds; the effect is similar to that of using sandpaper, but provides a more even finish with no problems at corners or crannies.Sandblasting is a form a surface preparation. Any action that prepares a surface for coatings can be considered surface preparation.

Anchor Profile:

One of the main reasons sandblasting is better than other surface prep methods is because sandblasting leaves an anchor profile. This means sandblasting leaves the steel with very small hills-and-valleys, giving the coating something to hang onto.

For E.g:-Just like your shoes have treads that give you traction, the anchor profile is going to give the paint a tread to stick to.

Advantages Of sand blasting:

Remove grime, rust or old paint from metal surfaces and repaint with an effective protective coating where appropriate.

Equipment used for sandblasting of Multi-utility Trailer:-

Blast Room:

A blast room is a much larger version of a blast cabinet. Blast operators work inside the room to roughen, smooth, or clean surfaces of an item depending on the needs of the finished product. Blast rooms and blast facilities come in many sizes, some of which are big enough to accommodate very large or uniquely shaped objects like rail cars, commercial and military vehicles, construction equipment, and aircraft.

Components that can be found in a typical blast room:

An enclosure or containment system, usually the room itself, designed to remain sealed to prevent blast media from escaping.

- A blasting system; wheel blasting and air blasting systems are commonly used
- A blast pot — a pressurized container filled with abrasive blasting media.
- A dust collection system which filters the air in the room and prevents particulate matter from escaping
- A material recycling or media reclamation system

Fig.5.44 Sandblast Room

5.5.4 Painting:

The trailer after sandblasting was given a coat of "Epoxy Finish Coat".

Epoxy Finish coat:

Two part epoxy coatings were developed for heavy duty service on metal substrates and use less energy than heat-cured powder coatings. These systems provide a tough, protective coating with excellent hardness.

Epoxy coatings are often used in industrial and automotive applications since they are more heat resistant than latex-based and alkyd-based paints.

5.5 Actual On-Site Photos:

Fig.5.45: Manufactured Trailer in SANDVIK ASIA PVT LTD.

Fig.5.46: Project Group with Manufactured Trailer

Fig.5.47 Trailer with Tug-Masster

Fig.5.48: Group Members with College Guide(Prof. R. M. Thakare) and Company Guide(Mr. Raghavendra Bhatt- Sr. Production Engineer)

6. RESULT & DISCUSSION

6.1 Results For Jaw Crusher CJ411:

CJ411	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	157.12	89.065	43.258	237.78	2.5187
Minimum	7.2491e-8	401781e-8	-65.153	0	0
Allowable		125		250	9

Table 6.1: Result for CJ411

- The Jaw Crusher CJ411 has Uniformly Distributed Load of 23 ton, which after considering factor of safety as 1.3 becomes 30 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 2.51 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.2 Results For Jaw Crusher CJ211:

CJ211	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	134.03	75.018	50.377	227	1.8623
Minimum	1.3812e-8	7.8977e-8	-51.507	0	0
Allowable		125		250	9

Table 6.2: Result for CJ211

- The Jaw Crusher CJ211 has Uniformly Distributed Load of 16.3 ton, which after considering factor of safety as 1.3 becomes 21.19 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 1.8623 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.3 Results For Jaw Crusher CJ409:

CJ409	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	82.416	46.256	26.680	235.18	1.48
Minimum	4.2229e-8	2.48e-8	-40.956	0	0
Allowable		125		250	9

Table 6.3: Result for CJ409

The Jaw Crusher CJ409 has Uniformly Distributed Load of 14 ton, which after considering factor of safety as 1.3 becomes 18.2 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 1.48 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly

4.4 Results For HSI CI521:

CI521	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (Mpa)	Bending Stress (MPa)	Deflection (mm)
Maximum	98.286	55.073	33.786	234.28	1.7973
Minimum	4.7061e-8	2.7169e-8	-48.482	0	0
Allowable		125		250	9

Table 6.4: Result for HSI521

The HSI CI521 has Uniformly Distributed Load of 17 ton, which after considering factor of safety as 1.3 becomes 22.1 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 1.7973 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.5 Results For VSI CV229:

CV229	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	22.489	12.76	6.2059	244	0.24805
Minimum	2.7078e-8	1.5639e-8	-8.7075	0	0
Allowable		125		250	9

Table 6.5: Result for VSI CV229

The VSI CV229 has point Load of 15 ton, which after considering factor of safety as 1.3 becomes 19.5 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 0.24805 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.6 Results For VSI CV218:

VSI CV218	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	15.974	9.0767	4.4227	204	0.1195
Minimum	2.6031e-8	1.5029e-8	-6.1713	0	0
Allowable		125		250	9

Table 6.6: Result for VSI CV218

The VSI CV218 has point Load of 12 ton, which after considering factor of safety as 1.3 becomes 15.6 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 0.1195 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.7 Results For VSI CV217:

VSI CV217	Von-Misses Stress(MPa)	Shear Stress (MPa)	Normal Stress (MPa)	Bending Stress (MPa)	Deflection (mm)
Maximum	12.884	7.3215	3.558	210.41	0.09675
Minimum	2.5886e-8	1.4945e-8	-5.1926	0	0
Allowable		125		250	9

Table 6.7: Result for VSI CV217

The VSI CV217 has point Load of 10 ton, which after considering factor of safety as 1.3 becomes 13 ton. This is the maximum loading condition for the trailer. It will generate the deformation of 0.09675 mm, which after removal of load, will disappear. So the trailer will regain its original dimensions exactly.

6.8 Overall Results :

- As it is being observed from the observations and analysis that we have taken in ANSYS Software the results generated for different loading conditions of trailer are as follows:

Machine	Loading conditions (Ton)	Von-Mises Stress (MPa)	Shear Stress (MPa)	Bending Stress (MPa)	Normal Stress (MPa)	Deformation (mm)
Jaw Crusher CJ411	30	157.12	89.065	237.78	43.258	2.51
Jaw Crusher CJ211	21.19	134.03	75.018	227	39.057	1.86
Jaw Crusher CJ409	18.2	82.416	46.256	235.18	26.686	1.48
HSI CI521	22.1	98.286	55.073	234.28	33.786	1.79
VSI CV229	19.5	22.489	12.76	244	6.2059	0.24805
VSI CV218	15.6	15.974	4.4227	204	4.4227	0.11995
VSI CV217	13	12.884	7.3215	210.41	3.5538	0.0967

Fig. 6.8 Overall Result Table

- Here the main design of the trailer is totally influenced by the loading of Jaw Crusher CJ411, as the stresses generated by loading of this machine are highest.
- From the result, we can clearly see that trailer is safe under all loading conditions.

7. COST ESTIMATION

SR.NO	PRODUCT	MATERIAL	SPECIFICATION	QUANTITY	APPROX.COST(Rs.)
1	Frame	IS2060 E250 Br	UB 305X165X40	3 X12m	59,500
2	Axle	MS	TQ and Round model no. 2021 10XM22X335	2	1,60,000
3	Tyre		MRF 10-20" Dual fitment	2 set of dual fitment for each axle resp.	1,28,000
4	King Pin	MS	Bolt/Weld-in king pin size-2" thickness-12mm	1	3000
5	Chequered Sheet	MS	6.5X2X5 mm	1	57,000
6	landing gears		YT-28A-2 Leg with foot gearbox	1 set	24,000
7	Leaf spring		Tandem over slung 8 leaf/12 ton	1 set	40,000
8	Manufacturing Cost (Labour + Machining + Welding + Sandblasting)				1,50,000
	Total				**5,81,000**

Table 7.1: Cost Estimation

8. CONCLUSION

Over the course of our project, we have come to the conclusion that the trailer when employed to use, satisfies it purpose efficiently and reliably. In order to surpass the performance of previous trailers our trailer must perform effectively and efficiently. Also the safety should not be neglected in any case. Neglecting safety in this case may result into the great economical loss due to damage happened to loaded machine as well as damage to human lives. Considering all these aspects, we have designed this trailer so that it will handle the desired payload without any failure. Safety has been given the utmost importance while designing. The addition of the trusses gives more strength to the trailer so that any slight load variation can be tolerated. The parts used in this trailer are from industry's leading and most reliable manufacturers, so the quality wise no compromise has been done.

The following conclusion are further withdrawn in the entire course of project:-

1. Earlier when machines were supposed to be moved from point A to point B, trailers were hired from 3rd parties, which was not economical and reliable such.
2. Over the long run by using the trailer for various transportation purpose, lot of capital can be saved.
3. After manufacturing the in-house trailer, the production rate as well as the efficiency of process has increased, resulting the beneficiary outcome of the company.
4. No time delays are there as the trailer is available at our disposal all the time.
5. The multi-utility trailer has also resulted in the fast transportation of the various machines and other miscellaneous products in less time.

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VISIT TO TATA DLT INTERNATIONAL

HISTORY: -

Established in 2006, TATA DLT trailers started their journey with single point aim of providing the best trailers to TATA Motors, after a series of successful years with TATA Motors, company expanded its journey to the open market with one agenda in its psyche to provide INDIA with the trailers of international quality. With so much experience in hand in the commercial vehicle industry TATA DLT emerges out as the first choice for all the trailer buyers throughout the country.

TATA DLT is well known for its trailer manufacturing. The company is located in outskirts of Pune in the Chakan district. We got a chance to visit the company on 27th JUNE 2017. The visit was extremely useful for us as we gained detailed knowledge about trailers, axles, wheels, landing gears, beams, manufacturing processes etc. We were guided by their production engineer. In addition to this he also answered to our various queries. Thus the visit was indeed successful as it was helpful for us to gain sufficient knowledge about trailers and further proceed to our project work.

Fig A: On-Site Photo of TATA DLT