COMPONENT SELECTION OF IMPACTOR BARRIER FOR FRONT CRASH TEST

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ABSTRACT: This paper attempts to compose a collision barrier to carry out the collision test as per directions. For evaluating vehicle safety in frontal collisions, the collision compatibility within the colliding vehicles is critical. Vital actions in frontal protection, such as the cab's dynamic testing, are known as Front Impact Test. A frontal result is the most common type of crash, resulting in fatalities. The impactor should be able to handle varying impact energies. Moreover, it should have a quick-release mechanism. The impactor should be capable of handling minimum force energy of 30 KJ. It would then be possible to determine the amount of force absorbed by the component (cab) by knowing its displacement or deformation. The primary goal of this work is to develop an impactor.

***Keywords*: Front Crash test, Impact test.**

1 Introduction

Jacobo Antona-Makoshi and Koji Mikami's study assessed the rate and danger of Moderate-to-Maximal awful mind wounds passed on by travelers in engine vehicle crashes in the US. Public Automotive Sampling System - Crashworthiness Data System crashes in years 2001–2015 with light vehicles delivered 2001 The outcomes indicated that Moderate blackouts represent 79% of all MAISbrain2+ wounds. Belted tenants were at lower chances than unbelted inhabitants for most cerebrum injury classifications, including blackouts. Received tenant insurance systems seem, by all accounts, to be lacking to essentially diminish the danger of dangerous mind wounds and blackouts for all vehicle inhabitants. Further exertion to create inhabitant and injury-explicit methodologies for the avoidance of cerebrum wounds is required. This examination proposes that these techniques consider organizing perilous cerebrum vasculature wounds, especially in old tenants, and blackout wounds, especially in female inhabitants.

Kristian Holmqvist, Mats Y. Svensson's point of the examination was to decide the human chest's reaction in many reenacted guiding wheel impacts. In this investigation, a gathering of little bar impacts was aimed at different chest statures, traversing roughly 120 mm around the fourth intercostal space. The examined outcomes comprise reactions, estimated concerning contrasts in the affecting shape and effect statures on pressure and gooey standards chest injury reactions. The results indicated that the bar impacts reliably delivered lesser scaled chest compressions than the center; the Middle bar reactions were around 90% of the center reactions. A predominant bar sway gave more optional chest pressure; the typical response was 86% of the Middle bar reaction. The chest pressure reaction was 116% of the center's chest pressure for second rate bar impacts.

Majbah Uddin, Nathan Huynh, researches factors influencing injury seriousness of accidents, including trucks for various lighting conditions on local and metropolitan streets. It utilizes 2009–2013 Ohio crash information from the Highway Safety Information System. The logical components incorporate the inhabitant, vehicle, crash, roadway, transient and ecological qualities. Six separate blended logit models were created considering three lighting conditions (sunshine, dim, and dim-lit) on two-zone types (provincial and metropolitan). A progression of log-probability proportion tests led to the approval that these six separate models by lighting conditions and territory types are justified. The model outcomes propose significant contrasts in both the mix and the extent of the effect of factors remembered for each model. A few factors were huge just in one lighting condition yet not in different situations. Also, a few elements were discovered to be huge in one region type; however, not in other zone types. These distinctions show that the diverse lighting conditions and zone types do, in reality, have various contributing consequences for injury seriousness in truck-included accidents, further featuring the significance of inspecting crashes dependent on lighting conditions on rustic and metropolitan streets. Age and sex of inhabitant (who is the most seriously harmed in an accident), truck types, AADT, speed, and climate conditions were discovered to be factors that have fundamentally various degrees of effect on injury seriousness in truck-included accidents.

Ediriweera Desapriya, Ian Pike's study inferred that As inhabitant insurance offered by new traveler vehicles has improved, there has been developing worry about the damage that some vehicle plans may deliver on tenants of different vehicles with which they impact. Going before examinations of crash measurements has exhibited the similarity between traveler car vehicles (PS) and get trucks (PU) associated with side effect crashes in British Columbia. A correlation of light truck and traveler vehicle crashes in past writing uncovers that light truck vehicles perpetrate more prominent mischief than traveler vehicles for various reasons, including their more substantial weight, stiffer structure, and higher ride stature. These highlights place tenants of traveler vehicles off guard should they be engaged with an impact with a light truck vehicle. The injury hazard for traveler car vehicle tenants is more prominent than the danger for getting truck inhabitants in two-vehicle crashes (Odds Ratio (OR) 1.87; 95% Confidence Interval (CI) 1.38-2.52). Furthermore, the threat of vehicle harm seriousness was expanded for traveler vehicles contrasted and get by actualizing proof-based approaches to lessen injuries because of traveler car vehicles and get trucks engaged with side effect crashes in the region of British Columbia.

A.I. Radu, C. Cofaru This paper considers the sorts of crash tests led in the current day by various appraisal programs. The categories of impact utilized in different circumstances and the kinds of life-size test models used to recreate the human tenant and additionally typical, and the obstruction type utilized. All appraisal programs fundamentally utilize the principle three sorts of crash tests, frontal effect, side, and back effect. Additionally, the most generally used fakers in these sorts of tests are the Hybrid III sham, male and female. The decision was that A vehicle's crashworthiness is controlled by ensuring it's tenant if there should arise an impact with another vehicle or obstruction. This is evaluated in the aftereffects of effect tests. Practically all tests depend on crash life-sized models to decide the wounds that can happen to both the inhabitants of the vehicle or the people on foot.

2 Objectives:-

- To design a safe, stable and an appropriate impactor capable of handling varying impact energies.
- All the components selected are to be ISO compliant.
- All the components selected are to be able to withstand various forces such as the impact force developed during the testing process.
- The angle of impact must be according to the regulations prescribed by UNECE.
- Test rig should be adaptable to the existing design on site.
- To design and manufacture a Front Pillar Impact Test Rig for testing of Heavy Commercial Vehicles with a minimum capacity of 30 KJ Impact Energy, which has a Quick Release Mechanism.

3.1 Component Selection

The impactor has been designed in accordance with the AIS029 and ECE R29 standards. Upon extensive research and studies, the components identified include:-

1. Cylinder

2. Arms

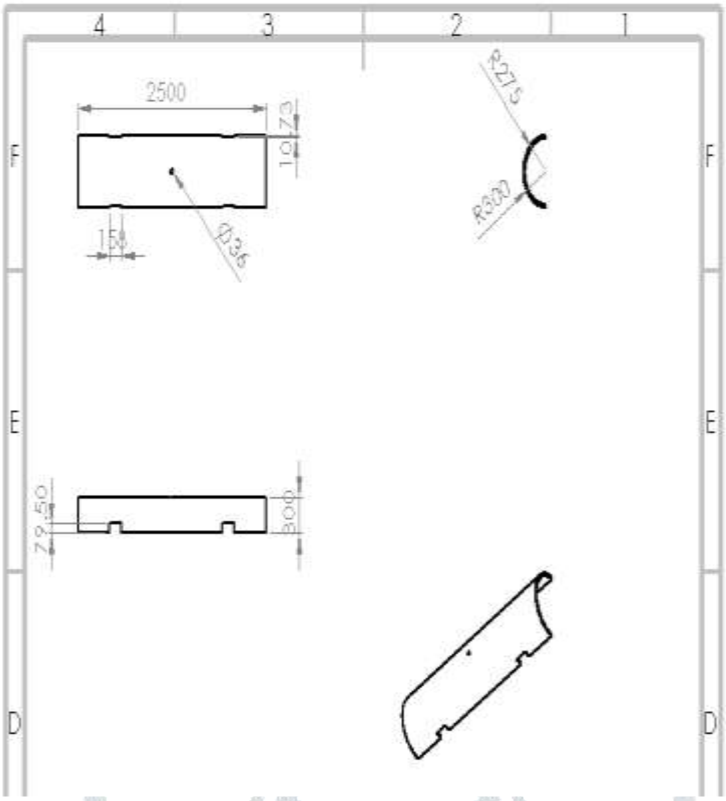
3. Reinforcements

4. End Plates

3.1.1 Cylinder:-

The cylinder being the main impacting component of the test rig must be sufficiently rigid to absorb the force of impact without distortion. The size and weight of cylinders has been selected in a such a way that it gives more rigidity and strength to withstand the impact loads and preclude the possibility of deformation which may lead to misalignment of loads during testing.

Fig. 3.1: Cylinder



3.1.2 Arms:-

The cylinder is suspended using two arms of square cross-section, selected as per the JINDAL Steel Standards. The arms should have sufficient strength and stiffness to withstand the weight of the cylinder as well as absorb the impact energy. To achieve the required stiffness, the arms have been fitted with reinforcements on all sides over the areas which are in contact with the cylinder.

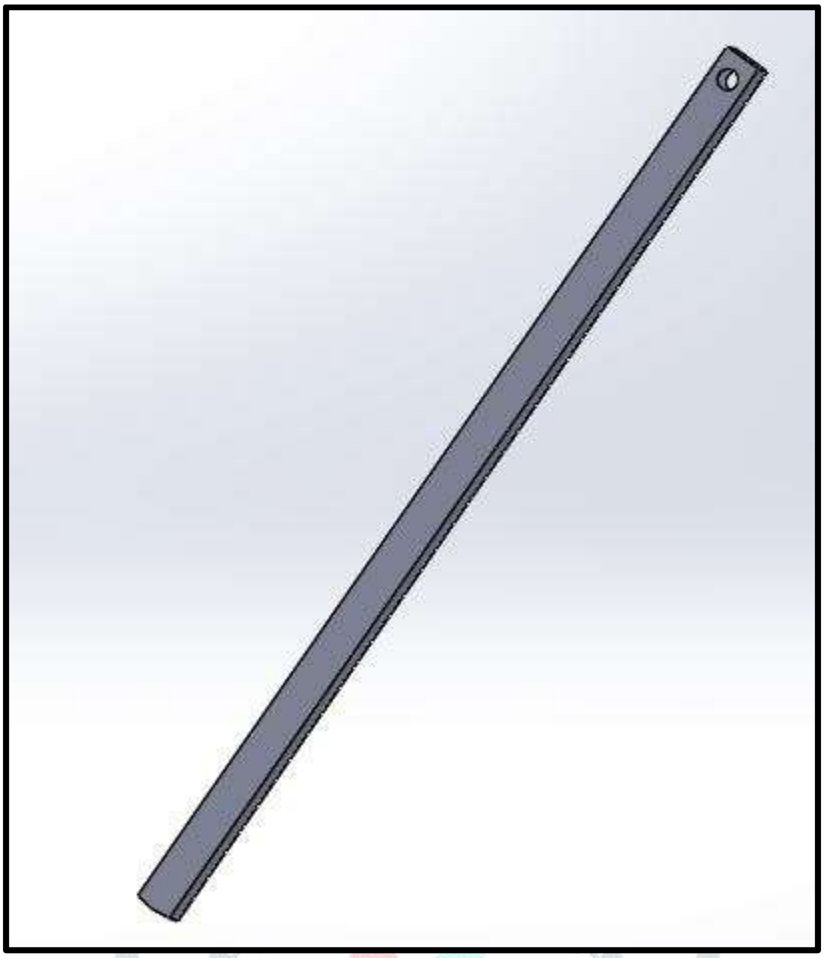


Fig. 3.2: Arms

3.1.3Reinforcements:-

The type of reinforcements has been selected after studying previous designs by different engineers and selecting the optimum reinforcement for the Arm and Cylinder assembly. The reinforcements should provide with the required stiffness to absorb the energy after impact. Two main types of reinforcements are used in the assembly:-

1. Angle

2. Ribs

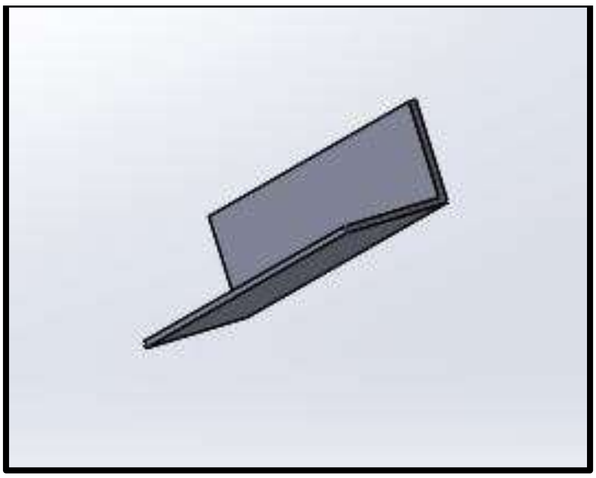


Fig. 3.3: Angle Reinforcement

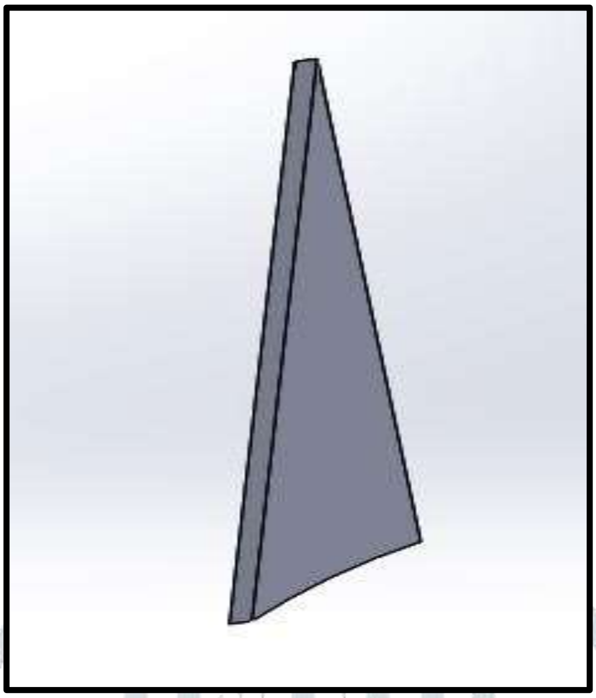
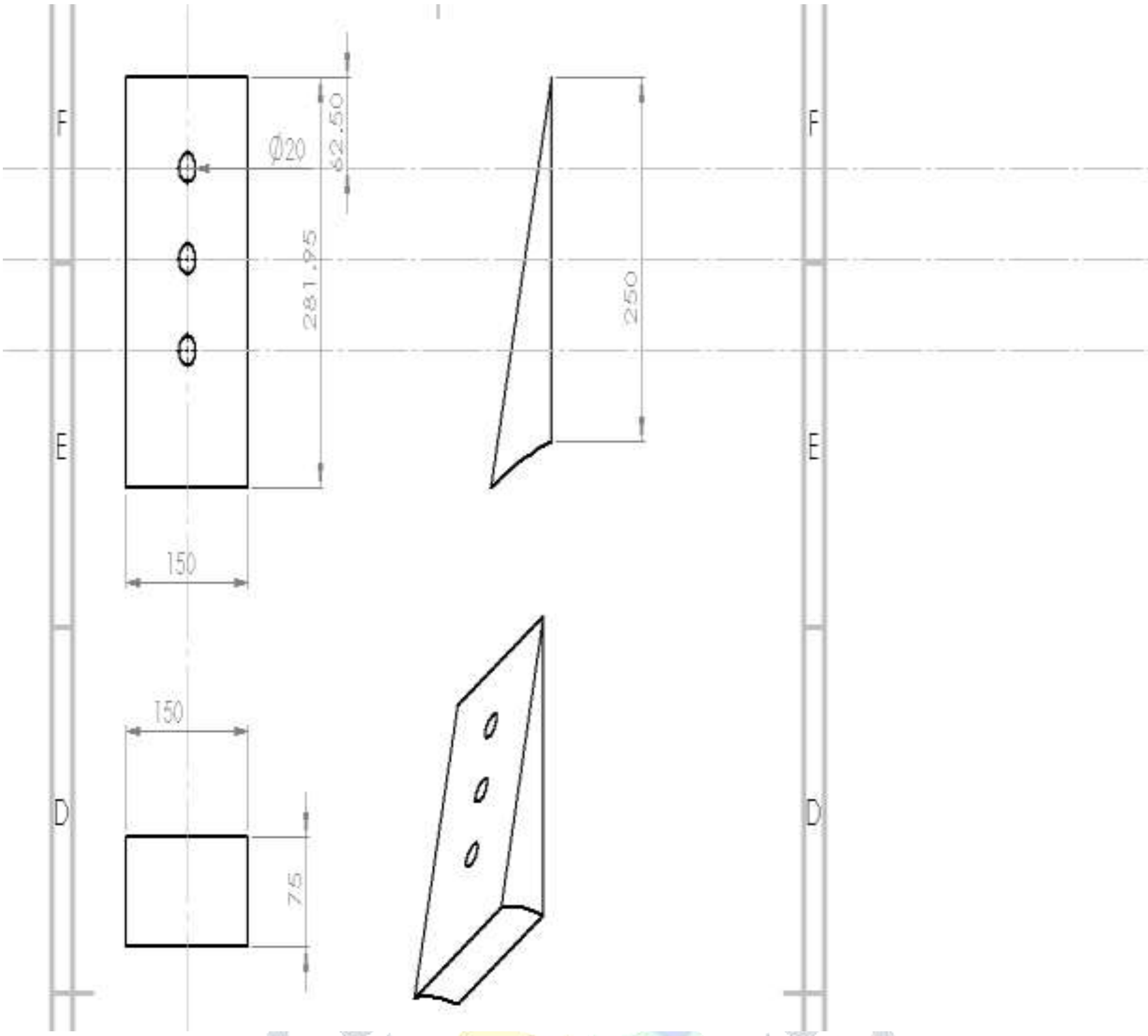


Fig. 3.4: Rib Reinforcement



3.1.4 End Plate:-

In order to cover the cylinder from both sides, a circular plate equal to the outer diameter was bolted to the cylinder. The primary reason for use of bolted joint was to make the cylinder accessible for maintenance.

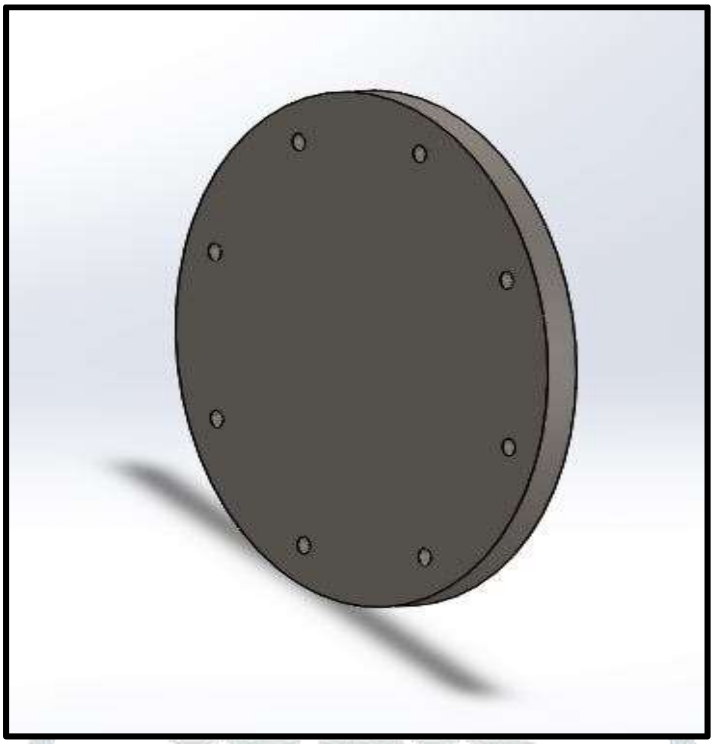
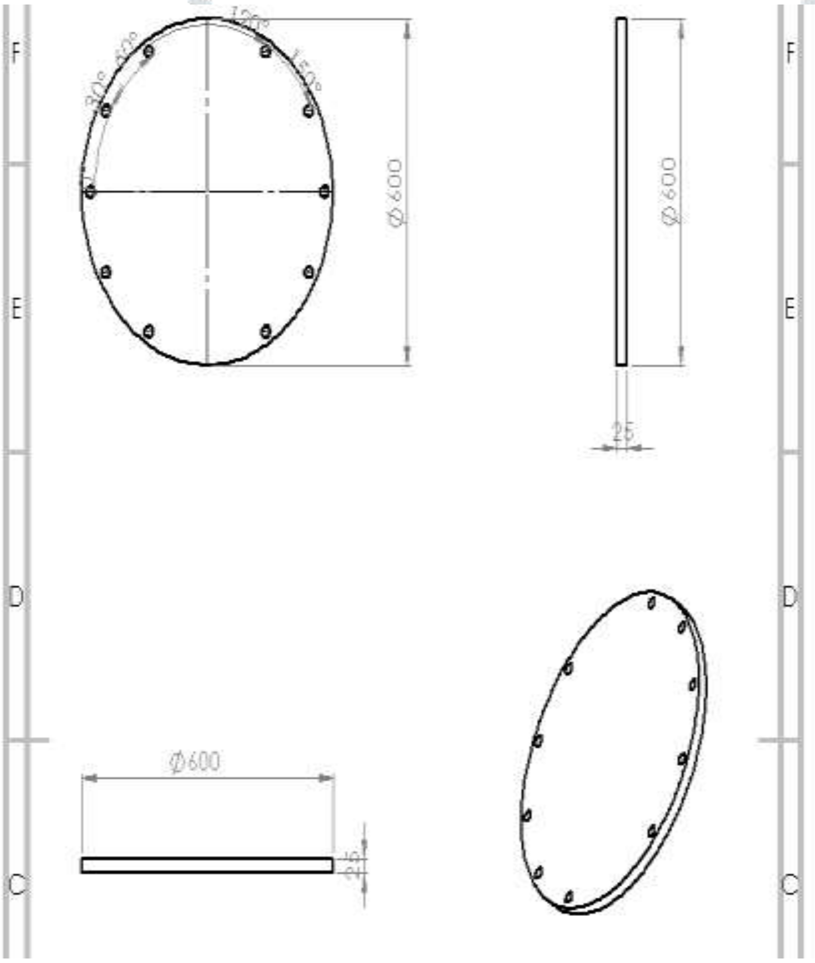


Fig. 3.5: End Plate



3.2 Mechanism used for impactor

Quick Release Mechanism:-

The quick release mechanism used is an Electromagnetic Quick Release having a capacity of 2500 kg. Powerful electromagnets like the ones used in cranes would be beneficial for this purpose. These magnets are to be given a supply while lifting loads and cut off when the load is to be released.

The electromagnet coupled with a hoist would enable easy lifting of the assembly. Hoists ranging from a few kilograms to a few tones are available.

A plate was added on the outer surface of the cylinder to lift the impactor using magnetic energy. No considerations were made for this component as it was readily available at site.

3.3 Sub-Assemblies:-

To facilitate manufacture and assembly, the complete assembly has been divided into a number of sub-assemblies. This assembly will then be combined to obtain the final assembly. The sub-assemblies include:-

1. Arm Reinforcement Assembly

2. Impactor-Arms Assembly

3. Arms-Horizontal Pipe Assembly

4. End Plate Assembly

3.3.1 Arm Reinforcement Assembly:-

Four angle reinforcements are welded to the arms at right angles. The size of he reinforcements has been selected according to IS 2062 standards.

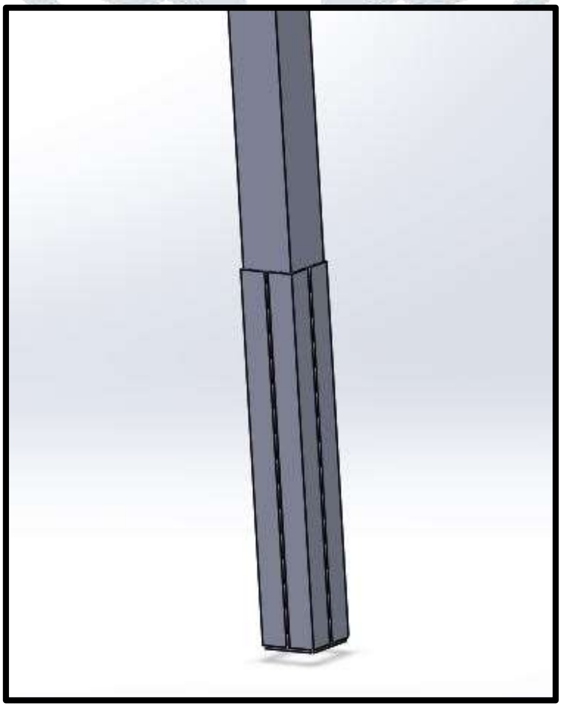


Fig. 3.6: Arm Reinforcement Assembly

3.3.2 Arms-Horizontal Pipe Assembly

A horizontal pipe has been connected between the two arms using C-Channels. The arms served two purposes - It acts as reinforcement and helps maintain the parallel distance between two arms. It has an eye bolt which will be useful in lifting the impactor when it is not used for testing.

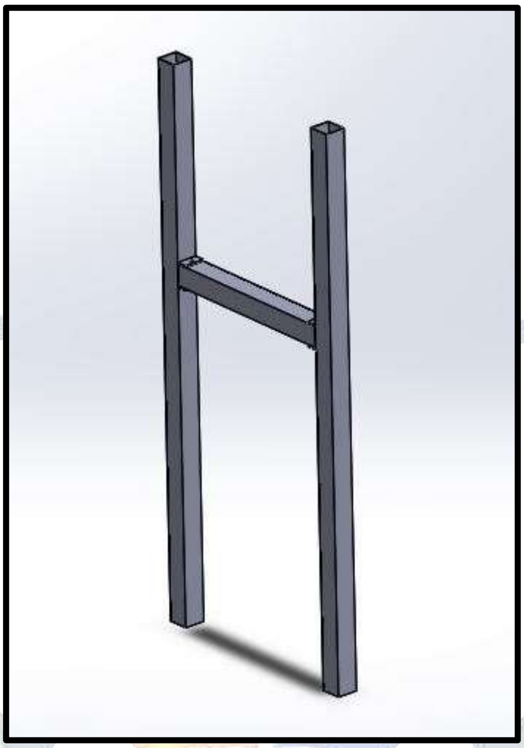


Fig. 3.7: Arms-Horizontal Pipe Assembly

3.3.3 Impactor-Arms Assembly

The arms after fitting with reinforcements will be welded to the impactor. Additional reinforcement will be provided using the Rib reinforcements, which will be welded between the arm and the cylinder. This will help transfer the energy of impact to the arms, thereby helping in absorbing the impact force.

Fig. 3.8: Impactor-Arms Assembly

3.3.4 End Plate Assembly:-

The end plates will be bolted to the cylinder using a ring. The ring will be welded to the inner surface of the cylinder. The purpose of bolting is to make the inner surface of the cylinder accessible for periodic coating of red oxide during maintenance.

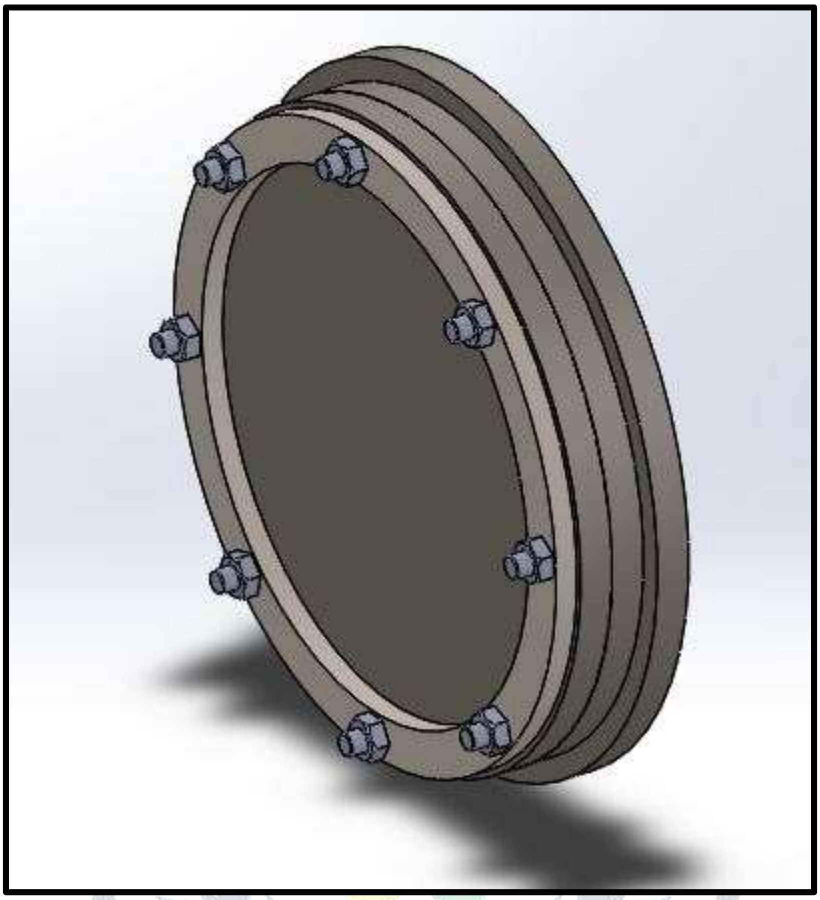


Fig. 3.9: End Plate Assembly

3.4 Full Assembly

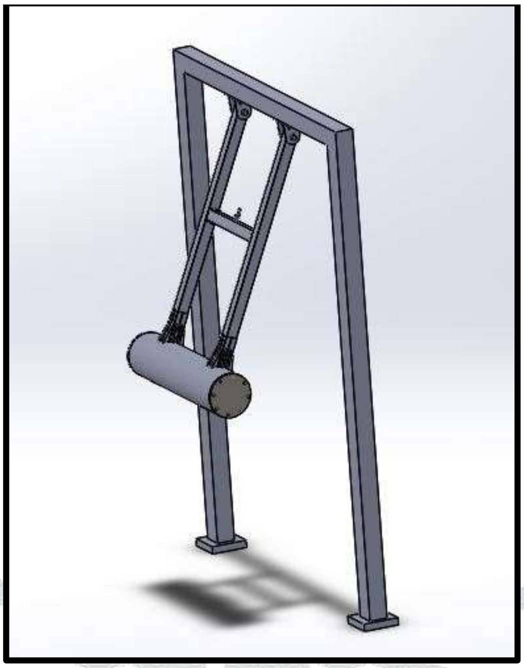


Fig. 3.10: Isometric View

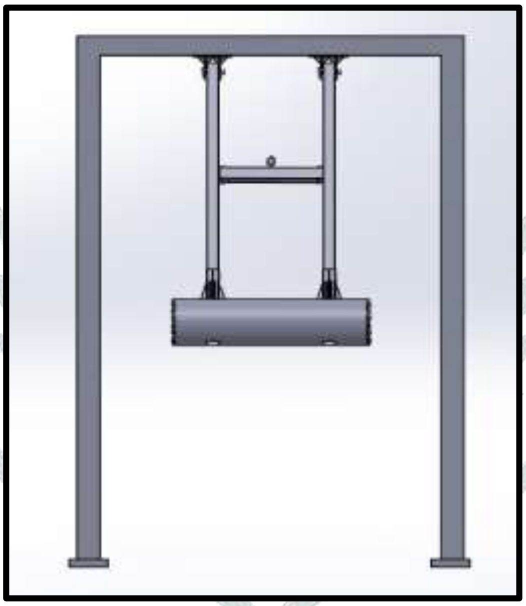


Fig. 3.11: Front View Of Assembly

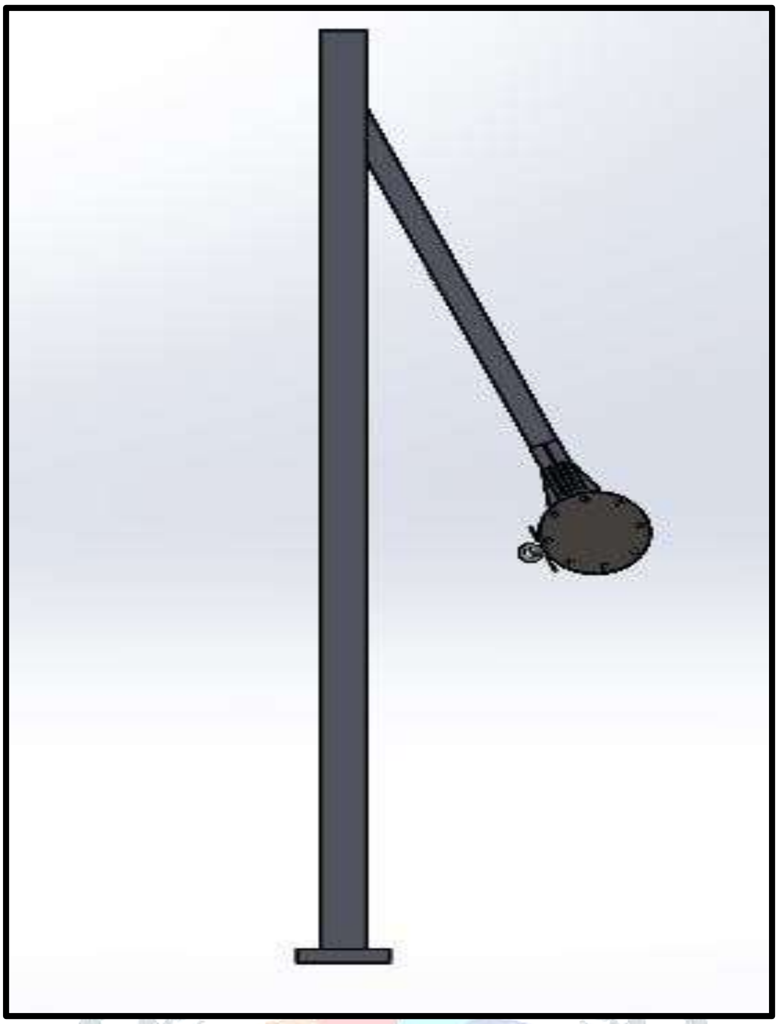


Fig. 3.12: Side View Of Assembly

4.1 Length:-

Average (μ) :-

$$\mu = \frac{2504+2503+2504+2504+2504+2503+2504+2504+2503}{9} = \textbf{2503.667 mm}$$

Now, to calculate Variance (σ^2)

$$(2504-2503.67)^2 = 0.1089$$
$$(2503-2503.67)^2 = 0.4489$$
$$(2504-2503.67)^2 = 0.1089$$
$$(2504-2503.67)^2 = 0.1089$$
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$$(2503-2503.67)^2 = 0.4489$$
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$$(2503-2503.67)^2 = 0.4489$$

Variance (σ^2) $\frac{0.1089+0.4489+0.1089+0.1089+0.1089+0.4489+0.1089+0.1089+0.4489}{9} = 0.222$

Standard Deviation (σ) :-

$\sqrt{0.222} = 0.4714 \approx \mathbf{0.5\ mm}$

4.2 Outer Diameter

Average (μ) :-

$$\mu = \frac{601+601+601+600+600+601+601+601+600}{9} = \mathbf{600.667\ mm}$$

$(601-600.667)^2 = 0.1043$

$(601-600.667)^2 = 0.1043$

$(601-600.667)^2 = 0.1043$

$(600-600.667)^2 = 0.4449$

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$(601-600.667)^2 = 0.1043$

$(600-600.667)^2 = 0.4449$

Variance (σ^2) :-

$$\frac{0.1043+0.1043+0.1043+0.4449+0.4449+0.1043+0.1043+0.1043+.4449}{9} = \mathbf{0.2178}$$

Standard Deviation (σ) :-

$\sigma = \sqrt{0.2178} = 0.47 \approx \mathbf{0.5\ mm}$

4.3 Inner Diameter

Average (μ) :-

$$\mu = \frac{559+559+560+560+560+560+560+559+560}{9} = \mathbf{559.667\ mm}$$

$(559-559.667)^2 = 0.4448$

$(559-559.667)^2 = 0.4448$

$(560-559.667)^2 = 0.1109$

$(560-559.667)^2 = 0.1109$

$(560-559.667)^2 = 0.1109$

$(560-559.667)^2 = 0.1109$

$(560-559.667)^2 = 0.1109$

$(559-559.667)^2 = 0.4448$

$(560-559.667)^2 = 0.1109$

Variance (σ^2) :-

$$\frac{0.4448+0.4448+0.1109+0.1109+0.1109+0.1109+0.1109+0.1109+0.4448+0.1109}{9} = \mathbf{0.2222}$$

Standard Deviation (σ) :-

$$\sigma = \sqrt{0.2222} = 0.4713 \approx \mathbf{0.5\ mm}$$

4.4 Arms Centre Distance

Average (μ) :-

$$\mu = \frac{1500+1500+1500+1500+1500+1500+1500+1501+1501}{9} = \mathbf{1500.222\ mm}$$

$(1500-1500.222)^2 = 0.0484$

$(1500-1500.222)^2 = 0.0484$

$(1500-1500.222)^2 = 0.0484$

$(1500-1500.222)^2 = 0.0484$

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$(1500-1500.222)^2 = 0.0484$

$(1500-1500.222)^2 = 0.0484$

$(1501-1500.222)^2 = 0.6084$

$(1501-1500.222)^2 = 0.6084$

Variance (σ^2) :-

$$\frac{0.0484+0.0484+0.0484+0.0484+0.0484+0.0484+0.0484+0.6084+0.6084}{9} = \mathbf{0.1728}$$

Standard Deviation (σ) :-

$$\sigma = \sqrt{0.1728} = 0.4357 \approx \mathbf{0.45\ mm}$$

4.5 Pivot To Bob Distance :-

Average (μ) :-

$$\mu = \frac{3500+3501+3500+3501}{4} = \mathbf{3500.5\ mm}$$

$$(3500-3500.5)^2 = 0.2500$$
$$(3501-3500.5)^2 = 0.2500$$
$$(3500-3500.5)^2 = 0.2500$$
$$(3501-3500.5)^2 = 0.2500$$

Variance (σ^2) :-

$$\frac{0.2500+0.2500+0.2500+0.2500+}{4} = \mathbf{0.2500}$$

Standard Deviation (σ) :-

$$\sigma = \sqrt{0.2500} = 0.1581 \approx \mathbf{0.25\ mm}$$

4.6 Weight

Average (μ) :-

$$\mu = \frac{1038+1038+1038}{3} = \mathbf{1038\ kgs}$$

$$(1038-1038)^2 = 0$$
$$(1038-1038)^2 = 0$$
$$(1038-1038)^2 = 0$$

Variance (σ^2) = 0

Standard Deviation (σ) = **0**

Item	Material	Dimensions (mm)
M.S Square Pipe	IS 4923 YST 310	150 x 150 x 5
L Section	IS 2062 E350 A	75x75x5 Length : 1000mm
Channel Section	IS 808	175×75×6×10.2
Cylinder	API 5L Grade B X60	OD- 610 Length -2500
End Plate	IS 2062 E350 A	OD-600
End Plate Ring	IS 2062 E350 A	OD-549 , ID-469
Re-enforcement Ribs	IS 2062 E350 A	FRONT Thickness : 16 mm Length : 250mm SIDE Thickness : 16mm Length : 250mm INNER Thickness : 16mm Length : 250mm
Electromagnetic Plate	IS 2062 E350 A	700×350×10

Table 4.1: Final Component Selection

5 Conclusion:

The fundamental point of the undertaking was to plan and approve the vertical effect drop test rig. The parts were chosen by usefulness endorsed in the guidelines and remember the underlying expense, and the last expense of gathering. The basic counts were not considered since the current structure was fit for supporting the broad scope of burdens. The figuring for the equivalent couldn't be uncovered because of privacy reasons. The test rig was planned to utilize standard measured chambers and box segments. The Impact Test Rig will be utilized for the frontal effect testing of Heavy Commercial Vehicles, accordingly accomplishing vehicles' latent security and guaranteeing expanded tenant wellbeing. The testing technique can be additionally adjusted to give a climate near the real mishap zone. It will forestall different tests and yield exact outcomes with no intricacies. The effect edge and tallness can be altered, so changing effect energies can be applied.Testing results can assist the plan with bettering fold zones and inflexible cells of the vehicle, accordingly diminishing the harm and injury if there should arise a head-on sway occurrence.

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