

# ELECTRIC TWO WHEELER DESIGN CHALLENGE

**7<sup>th</sup> Edition**

## MASTER LAYOUT AND DESIGN REPORT

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TEAM CAPTAIN

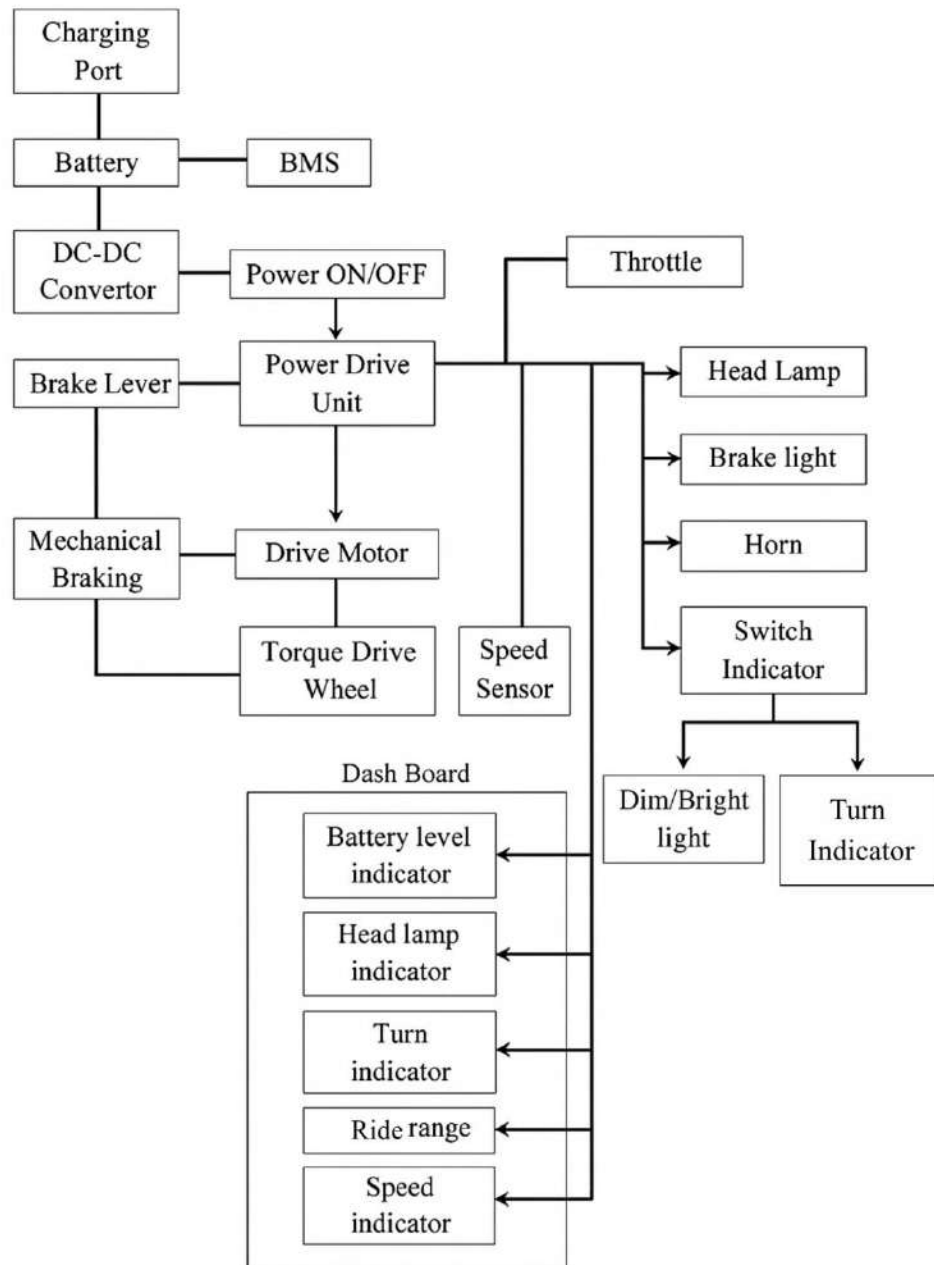


FACULTY ADVISOR

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## 1. VEHICLE WORKING LAYOUT



## 2. INTRODUCTION

The idea to develop an **electric two-wheeler** stemmed from its ability to address environmental challenges and reduce vehicular pollution. Powered entirely by electricity, this two-wheeled vehicle produces no harmful emissions, making it an eco-friendly option for everyday commuting and supporting the vision of green mobility. The design has been carried out in compliance with the **SAEISS ETWDC Rulebook 2025**, taking into account both static and dynamic conditions. Improvements were incorporated based on analysis results, ensuring reliability. The subsystems were designed to remain simple yet efficient, aligning with the overall purpose of building a practical and sustainable electric two-wheeler.

## 3. SELECTION & DESIGNING OF SUBSYSTEM

### 3.1 POWERTRAIN CALCULATIONS

Calculations:

Total weight = Vehicle weight + Rider weight

$$= 85 \text{ kg} + 70 \text{ kg}$$

$$= 155 \text{ kg}$$

#### 1. Aerodynamic Drag:

$$F_{ad} = \frac{\rho_a * C_d * A_f * (V_{bike} + V_{wind})^2}{2}$$

$C_d$  = Aerodynamic drag co-efficient = 0.65 Pa

$\rho_a$  = Density of air at sea level =  $1.225 \frac{\text{kg}}{\text{m}^3}$

$A_f$  = Frontal Area =  $0.65 \text{ m}^2$

$V_{bike} = 35 \text{ km/h} = 9.73 \text{ m/s}$

$$V_{wind} = 0.04 \text{ m/s}$$

Neglecting  $V_{wind}$  as it's very small compared to  $V_{bike}$

$$F_a = \frac{0.65 * 1.225 * 0.65 * (9.73)^2}{2} = 24.5$$

#### 2. Rolling Resistance:

$$F_{rr} = \mu_{rr} mg \cos \theta$$

$\mu_{rr}$  = Coefficient of rolling friction = 0.014

$m$  = Mass of the vehicle = 155 kg

$\theta$  = Angle made by the inclined plane with horizontal =  $4^\circ$

$$\cos \theta = 0.99 \approx 1$$

$$F_{rr} = (0.014) * (155) * (9.8) * (1) = 21.266 \text{ N}$$

#### 3. Grading force:

$$F_{gr} = mg \sin \theta$$

As  $\sin(4^\circ)$  is a very small value  $\approx 0.00698$ , we will consider it to be negligible.

$$F_{hc} = 155 * 9.8 * 0 = 0$$

#### 4. Angular Force:

$$F_{wa} = I \frac{G^2}{\eta_g r^2} a$$

$G$  = Gear Ratio = 1

$\eta_g$  = Efficiency = 0.98

$r$  = Radius of wheel =  $0.22 \text{ m}$

$m$  = Mass of motor & tire (rotating parts) =  $8.3 \text{ kg}$

$$\begin{aligned} I &= \frac{mr^2}{4} \\ &= \frac{8.3 * (0.23)^2}{4} \\ &= 0.10976 \end{aligned}$$

$$a = \text{Acceleration} = \frac{v - u}{t} = \frac{9.73}{15} = 0.6487$$

$$F_{wa} = \frac{0.1058 \times 1 \times 0.6487}{0.98 \times (0.23)^2} = 1.324$$

#### 5. Acceleration Force ( $F_{la}$ )

$$F_{la} = ma$$

$$= 155 \times 0.6487 = 103.792 \text{ N}$$

#### 6. Total Tractive Force ( $F_t$ )

$$\begin{aligned} F_t &= F_{ad} + F_{rr} + F_{hc} + F_{wa} + F_{la} \\ &= 24.5 + 21.266 + 0 + 1.324 + 103.792 \\ &= 150.882 \text{ N} \end{aligned}$$

#### MOTOR SELECTION

$$\begin{aligned} P_T &= F_T \times \text{Max.Speed} \\ &= 150.882 \times 9.73 \\ &= 1474.764 \approx 1500 \text{ W} \end{aligned}$$

#### TIME TAKEN TO ACHIEVE MAXIMUM VELOCITY

$$\begin{aligned} P &= \frac{W}{t} = \frac{\frac{1}{2} \times m \times v^2}{t} \\ t &= \frac{mv^2}{2P} = \frac{155 \times (9.73)^2}{2 \times 1500} = 5.05 \text{ sec} \end{aligned}$$

#### MAX ACCELERATION

$$a = \frac{v - u}{t} = \frac{9.73 - 0}{15} = 1.927$$

#### GRADABILITY

$$\begin{aligned} \theta &= \sin^{-1}\left(\frac{a}{g}\right) = \sin^{-1}\left(\frac{1.927}{9.8}\right) \\ &= \sin^{-1}(0.662) = 11.34^\circ \end{aligned}$$

#### TOTAL ENERGY OF VEHICLE:

$$E = (P \times \text{time}) \text{ J}$$

$$\begin{aligned} 1J &= \frac{1 \text{ KWH}}{36 \times 10^5} = 1000 \times 3600 \text{ J} \\ &= 10 \times 36 \times 10^4 \times \frac{1 \text{ KWH}}{36 \times 10^5} \\ &= 1 \text{ KWH} \end{aligned}$$

#### TORQUE:

$$\begin{aligned} T &= F_t \times \text{Radius of the Wheel} \\ &= 150.882 \times 0.2286 \\ &= 34.65 \end{aligned}$$

#### BATTERY PACK CALCULATIONS

$$E = V \times \text{Ah (Ampere Hour)}$$

$$1 \text{ KWH} = 48V \times \text{Ah}$$

$$= 1000 \text{ W} / 48 \text{ V}$$

$$= 20.84 \approx 21 \text{ Ah}$$

Usable energy = 80% of battery pack calculations

(According to Peukert co-efficient)

**- 48V, 25 Ah Rating -**

## SERIES-PARALLEL CONFIGURATION:

Each cell=3.7v

Capacity=2500 mAh (or) 2.5 Ah

$48/3.7 = 13$  cells in series

$25/2.5 = 10$  cells in parallel

13S10P Configuration

## 3.2 STEERING SYSTEM

Governing the electric two-wheeler's stability and maneuverability, the steering subsystem is a critical component for delivering a controlled and comfortable ride: Our team has designed it in such a way that it provides the rider with great handling and comfort, ensuring a smooth ride.

**Rake angle:** The rake angle refers to the angle between FRONT SUSPENSION the steering axis (an imaginary line passing through the steering head bearing down to the ground) and the vertical axis (a line perpendicular to the ground). This angle determines the stability, responsiveness and handling factors. Here we have taken the Rake Angle as  $25^\circ$ .

**Trail:** refers to the distance between the point where the weight and capability to absorb. It is also called as steering axis intersects the ground (called the "Contact Telescopic shock absorber point") and the point where the front tire contacts the ground (called the tire contact patch"). More specifically, it is the horizontal distance between these 1. two points when viewed from the side of the scooter. Trail obtained by fixing rake angle is  $53.7^\circ$ .

**Turning Angle:** It is the measurement of how far the handlebar and front wheel are turned away from the straight-ahead position. It determines the radius of the smallest circle that the vehicle can turn.

The turning angle affects the scooter's ability to negotiate tight turns and navigate in confined spaces, such as parking lots or city streets. It is calculated as  $45^\circ$ .

**Wheelbase:** The wheelbase of an electric two-wheeler is the horizontal distance between the centers of the front and rear wheels. The value of wheelbase is 1299.97 mm.

**Turning Radius:** The radius of the smallest circular turn that the vehicle is capable of making is defined as the Turning Radius. It is determined by the combination of several factors including the wheelbase (distance between the front and rear axles), the steering geometry (rake angle, trail, and turning angle), and the design of the vehicle's front wheel steering mechanism.

## Steering justifications

- 1) Rake angle: having an rake angle of  $25^\circ$ , is taken as it offers great balancing while not being too steep to compromise low-speed maneuverability. Designed for urban riding a  $25^\circ$  rake angle supports agile handling of the vehicle.
- 2) Trail: Most scooters have trail values between 40 mm and 90 mm. Ours having Lower trail value means quicker steering, less effort at low speeds, tuned for responsive urban handling without sacrificing too much straight-line stability.
- 3) Turning Radius: having the turning radius be 1.83 m allows our vehicle to make U-turns on narrow streets and easy navigation in tight spaces.

## 1. Rake Angle

Rake Angle =  $25^\circ$

Wheel Radius = 12 inches = 304.8 mm

## 2. Fork Offset

Fork Offset = 50

$$R = \frac{(304.8+2)81}{2} = 233.4$$

### 3. Trail

$$\begin{aligned} \text{Trail} &= (R \cos \theta - R / \sin \theta) \\ &= 233.4(\cos 65^\circ - 50) / \sin 65^\circ \\ &= 53.6 \text{ mm} \end{aligned}$$

### 4. Turning Angle

$$\begin{aligned} \text{Turning Angle} &= 45^\circ \\ \text{Head Angle} &= 90^\circ - 25^\circ = 65^\circ \end{aligned}$$

### 5. Wheel Base

$$\text{Wheel Base} = 1299.97 \text{ mm}$$

### 6. Turning Radius

$$\begin{aligned} \text{Turning Radius} &= \frac{\text{Wheel Base}}{\sin(\text{Turning Angle})} \\ &= \frac{1299.97}{\sin 45^\circ} \\ &= 1838.4 \text{ mm} \\ &= 1.83 \text{ m} \end{aligned}$$

## 3.3. SUSPENSION SYSTEM

### FRONT SUSPENSION

For our design, we opted for a telescopic suspension system instead of an upside-down (USD) suspension.

A telescopic suspension works on a hydraulic mechanism supported by internal coil springs. The forks function through hydraulic action, allowing the system to efficiently handle shocks. Because of its durability, lightweight nature, and strong absorption capacity, this suspension type is widely preferred. It

is also commonly referred to as a telescopic shock absorber.

### Key Benefits of Telescopic Suspension:

1. The fork has a very straightforward design.
2. Manufacturing and maintenance costs are comparatively low.
3. The chances of oil leakage are minimal.
4. It provides longer service life and consistent performance across various terrains.
5. Its lightweight design gives it an advantage over many other suspension types.

From our analysis, the spring constant of this suspension is estimated to be around **30 N/mm**.

### REAR SUSPENSION

Since the maximum allowable compression in the suspension is **42 mm**, the telescopic suspension chosen by our team is considered suitable and practical.

Dual suspension is incorporated to improve shock absorption and ensure superior ride stability.

### Assumptions for Calculation:

- All rods are treated as perfectly straight.
- Vehicle weight is taken as **85 kg**.
- Driver's weight is considered as **70 kg**.
- For simplification, springs are replaced with rigid rods during calculations, as this does not affect the final outcome.
- The spring is mounted on a rigid chassis component, which is assumed to behave like a fixed, motionless wall.

### FRONT SUSPENSION

#### Assumptions:

Spring constant = 30 N/mm

Vehicle weight = 85kg

Rider weight = 70kg

$$\begin{aligned}\text{Total weight} &= \text{Vehicle weight} + \text{Rider weight} \\ &= 85 + 70 \\ &= 155 \text{ kg}\end{aligned}$$

$$\begin{aligned}\text{Total force} &= \text{Total weight} * g \\ &= 155 * 9.81 \\ &= 1520.55 \text{ N}\end{aligned}$$

In static condition the weight distribution is  
(Front : Rear) = (40:60)

In dynamic condition (Hard braking) the weight distribution is  
(Front : Rear) = (70:30)

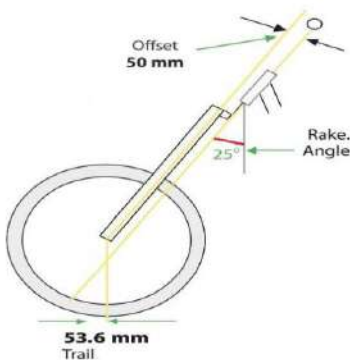
$$\begin{aligned}F &= \frac{70}{100} * 1520.55 \text{ N} \\ &= 1064.385 \text{ N (Both forks)} \\ &= 532.1925 \text{ N (For each fork)}\end{aligned}$$

Deflection for fork,  $F = k * x$   
X = compression of the suspension  
Suspension

$$\begin{aligned}F &= k * x \\ x &= F/k \\ x &= \frac{532.192}{30}\end{aligned}$$

$$x = 17.739 \text{ mm}$$

The maximum deflection possible is  
 $x = 17.739 \text{ mm}$



## REAR SUSPENSION

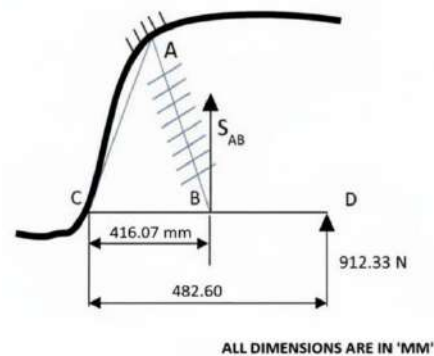
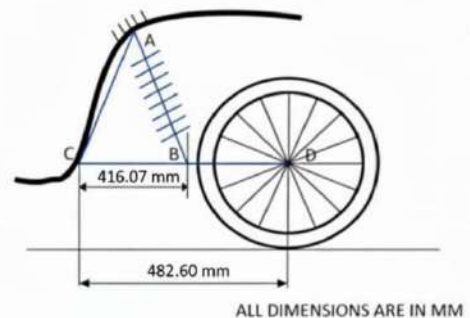
### Assumptions:

Vehicle Weight = 85kg  
Driver's Weight = 70kg

### Dimensions and Angles

AB=34.287cm  
AC=50.963 cm  
BC=41.607 cm  
 $\angle CAB=54.25^\circ$   
 $\angle ABC=83.77^\circ$

**Schematic diagram of the suspension system:**



As we assumed that 60% of the weight is on the rear wheel

$$60\% \text{ of } 155 = 93 \text{ kg}$$

The reaction from the ground on the wheel is  
 $(93) * 9.81 = 912.33 \text{ N}$

$$=R_w$$

The perpendicular force on the member AB be  $S_{AB}$   
Perpendicular to CD

Now, taking moments about point C

$$R_w * CD + S_{AB} * CB = 0$$

$$912.33N * (482.60) + S_{AB} * (416.07) = 0$$

$$(416.07) * S_{AB} = -440290.45$$

$$S_{AB} = \frac{-440290.45}{416.07}$$

$$S_{AB} = -1058.21N$$

The spring is inclined at an angle of  $83.77^\circ$   
Therefore force on the spring =  $S_{AB} * \sin(B)$

$$F_s = -1058.21 * \sin(83.77^\circ)$$

$$F_s = -1051.96 N$$

We are using 2 springs in parallel, each with spring constant

$$K = 46.5N/mm$$

Therefore,

$$K_{eff} = 93N/mm$$

$$F_s = K_{eff} * x$$

$$F_s = \text{Axial Force}$$

$$K_{eff} = \text{Effective spring constant}$$

$$x = \text{Compression in the spring}$$

$$x = F_s / K_{eff}$$

$$x = -1051.96/93$$

$$x = 11.311 \text{ mm}$$

Here x is the compression in the spring when a force of 1051.96 N or 1058.21 N of reaction force is applied on the spring.

$$X_{max} = 42mm$$

$$F_{max} = K * X_{max} \\ = 93 * 42$$

$$F_{max} = 3906 N$$

The relation between axial force on spring (F) & Reaction force on the wheel is linear ,

Therefore

$$\frac{F}{F_{max}} = \frac{R_w}{R_{wmax}}$$

$$R_{wmax} = \frac{(912.33) * 3906}{1051.96}$$

$$R_{wmax} = 3387.54N$$

### 3.4. WHEELS AND TYRES

#### FRONT:

Wheel diameter =18 inches

Wheel rim diameter =12 inches

#### REAR:

Wheel diameter =18 inches

Wheel rim diameter =12 inches

The rear wheel radius is chosen to have same breaking force and gives enough stability to the vehicle.

### 3.5. BRAKING SYSTEM

The front and rear wheels of the vehicle are equipped with different braking mechanisms to achieve optimal performance.

#### Disc Brake (Front Wheel):

Mechanical disc brakes function through a steel cable that links the brake lever to the caliper. When engaged, the brake pads press firmly against both sides of the rotating disc, creating friction that slows the wheel.

#### Advantages of Disc Brakes:

1. Offer greater stopping power with a higher mechanical advantage, reducing the hand effort required.
2. Superior at handling and dispersing heat during braking.

3. Lightweight, cost-effective, and simple to install and maintain.

### Drum Brake (Rear Wheel):

In a drum brake system, friction is created when brake shoes or pads press outward against the inner surface of a rotating cylindrical drum.

### Advantages of Drum Brakes:

1. Increased contact area provides longer service life compared to disc brakes.
2. Rear drum brakes generate less heat under normal operation.
3. Capable of delivering higher braking force when needed.

### Configuration Used:

Our setup incorporates a **disc brake at the front** for strong and responsive braking, while the **rear wheel uses a drum brake** to ensure durability and balanced braking performance.

## CALCULATIONS

### FRONT BRAKES

Maximum speed ( $v$ ) = 35 kmph = 9.72m/s

Vehicle mass ( $m$ ) = 155 kg

Rotor radius ( $r$ ) = 110 mm

Front Wheel radius ( $R$ ) = 9 inches = 0.2286 m

Coefficient of friction b/w disc & brake pad ( $\mu$ ) = 0.5

Area of brake pad ( $A$ ) = 1021 mm<sup>2</sup>

Pressure ( $P$ ) = 3.5 MPa

The force exerted by the brake pad on the rotor (Clamping force) will be  $F_e$

Number of contact surfaces ( $n$ ) = 2, since they are two brake pads

$$\begin{aligned} F_e &= P * A \\ &= (3.5 * 10^6) * (1021 * 10^{-6}) \\ &= 3574 \text{ N} \end{aligned}$$

The braking torque at the disc will be,

$$\begin{aligned} T_a &= n * \mu * F_e * r \\ &= 2 * (0.5) * (3574) * (0.11) \\ &= 393.14 \text{ N-m} \end{aligned}$$

Since the disc is fixed to the wheel hub, Torque at the disc is equal to the torque of the wheel (i.e.)

Torque of the wheel = Torque of the disc

$$T_{\text{wheel}} = T_{\text{disc}}$$

$$F_f * R = 393.14 \text{ N-m}$$

$$F_f * (0.2286) = 393.14$$

$$F_f = 1724 \text{ N}$$

Here,  $F_f$  the braking force on front wheel,

$$F_f = 1724 \text{ N}$$

### REAR BRAKES:

Force applied on the lever,  $F_{\text{lever}} = 200 \text{ N}$

Advantage offered by the hand lever,

$$Adv_{\text{lever1}} = 4$$

Advantage offered by drum lever,

$$Adv_{\text{lever2}} = 5.278$$

Cable efficiency,  $n=0.8$

Force applied at the cam,

$$F_{\text{cam}} = F_{\text{lever}} * \text{Adv}_{\text{lever1}} * \text{Adv}_{\text{lever2}} * n = 3377.92 \text{ N}$$

Coefficient of friction between shoe and drum,  
 $\mu=0.4$

Maximum force achieved by the brake,

$$F_{\text{max}} = 2 * F_{\text{cam}} * \mu = 2702.33 \text{ N}$$

Max braking torque,

$$T_{\text{max}} = \text{Drum diameter} \times F_{\text{max}}$$

$$= 0.13 \times 2702.33$$

$$= 351.30 \text{ N-m}$$

Since the disc is fixed to the wheel hub,

Torque at the disc is equal to the torque of the wheel (i.e.)

Torque of the wheel = Torque of the disc

$$T_{\text{wheel}} = T_{\text{disc}}$$

$$F_r * R = 351.30 \text{ N-m}$$

$$F_r * (0.2286) = 351.30$$

$$F_r = 1530 \text{ N}$$

Here,  $F_r$  the braking force on rear wheel,

$$F_r = 1530 \text{ N}$$

Therefore, average braking force,  $F_{\text{avg}} = 1625 \text{ N}$

Vehicle wheel base ( $L$ ) = 1300 mm = 1.3 m

Centre of gravity height ( $h$ ) = 13 in = 0.33 m

Distance of COG to front axle ( $x$ ) = 33.07 in = 0.84 m

Coefficient of friction b/w wheel & road ( $\mu'$ ) = 0.7

The deceleration of the vehicle braking is:

$$d = \frac{L * \mu' * F_f}{m(L * x - \mu * h)}$$

$$= \frac{1.3 * 0.7 * 1625}{115 (1.3 * (0.84) - (0.7) * 0.33)}$$

$$= 10.29 \text{ m/s}^2$$

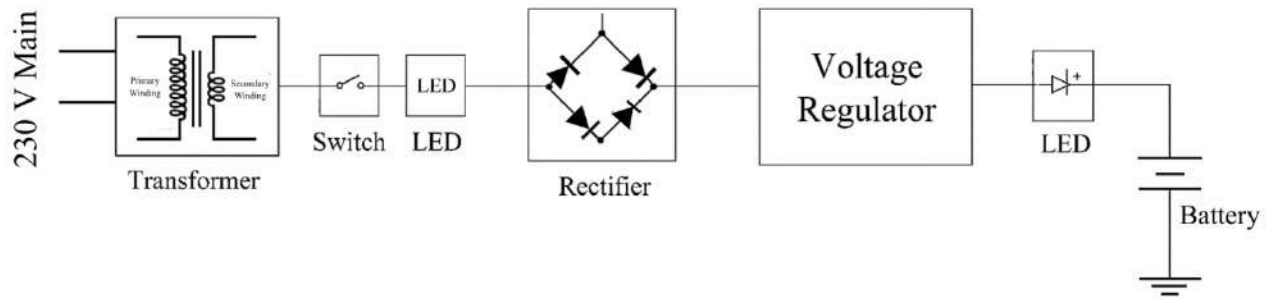
The stopping distance of the vehicle at the maximum speed will be,

$$D = V^2 / 2d$$

$$= (9.72)^2 / (2 * 10.29) = 4.59 \text{ m}$$

Therefore, the vehicle stops at a distance of 4.59 m from the point where brakes are applied.

### 3.6. ELECTRICAL SYSTEM



#### BATTERY AND CHARGING SYSTEM

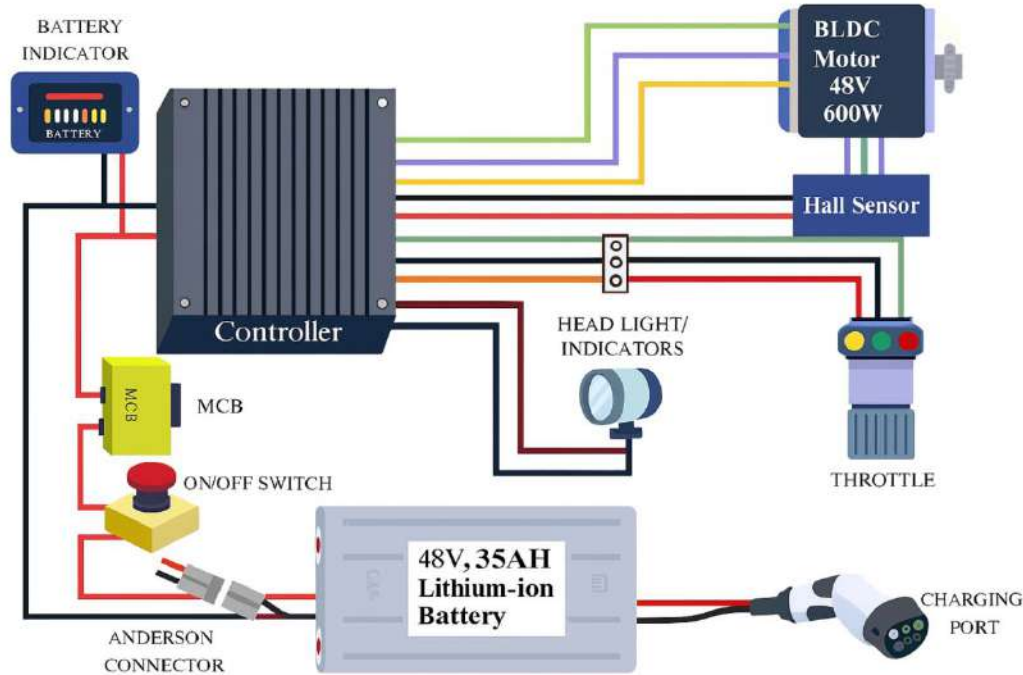
The battery is designed to be charged from a standard **230 V, 5 A, 50 Hz AC household supply**. Since the incoming power is in AC form, it is first rectified into DC and then regulated to the required voltage level before being delivered to the battery.

The system uses a **48 V Li-ion battery** rated at **34 A for 1 hour**. A **step-down transformer** lowers the input voltage to the necessary level, simultaneously increasing the current as per the battery's charging requirements.

To manage and control the charging process:

- **Power-rated switches** are incorporated, capable of handling the high current involved, and allow the user to connect or disconnect the battery unit from the supply.
- An **LED indicator** provides feedback on the battery's status, such as charging in progress or fully charged.
- A **bridge rectifier** converts the stepped-down AC output from the transformer into DC, ensuring compatibility with the Li-ion battery.
- A **voltage regulator** maintains the appropriate charging voltage, protecting the battery from overvoltage or unstable input.

## ELECTRIC DRIVE CIRCUIT



### BATTERY AND POWERTRAIN COMPONENTS

The vehicle is powered by a **Lithium-ion battery** (detailed specs on the next page).

- **Kill Switch:** Safety switch to cut off battery supply; usually kept ON except in emergencies.
- **MCB:** Protects the motor from overcurrent, similar to a fuse.
- **Motor Controller:** Acts as the vehicle's brain, regulating motor speed and accessories using inputs from the throttle and battery. It also provides speed output for the speedometer and shows battery charge level.
- **BLDC Hub Motor:** A 1000 W, 48 V, 13 A motor delivering 3000 rpm and 4.5 N-m torque.
- **Throttle:** Rider input device for speed control via the controller.
- **Hall Sensors:** Inside the motor, they detect rotor position for smooth operation.
- **Anderson Connector:** Ensures safe power connection between battery, controller, and other components.

## CONTROLLER DATA SHEET

Specifications	Value
Dimensions	177mm*84mm*41mm
Throttle Voltage	0.9–4.3V
Rated Current	35A
Rated Voltage	48V
Weight	0.64 kg

## MOTOR DATA SHEET

Specifications	Value
Dimensions	280mm*230mm*150mm
Power	Rated–1000W Peak–1500W
Current	Rated–13A,Peak–32A
Voltage	48V
Rated RPM	3000
Torque	Rated–4.5Nm, Peak–400% of rated power for 10 sec
Efficiency	~80% on full load and full RPM
Weight	4.60 kg

## BATTERY SPECIFICATIONS

S. No.	Nominal Voltage	48V	Nominal capacity	24Ah		
1.	Cell Model	3.72V, Ah, NMC Cell		Working temperatures > 45°C		
		4C Discharge 8A				
		1C Discharge2A				
2.	Battery Pack Dimensions (L*W*H) mm			210	165	180
3.	Battery Weight (kg)			8.75		
4.	Normal Capacity			1152		Wh
5.	Usable Capacity			1120		Wh
6.	Charge cut-off voltage			54.6	V	
7.	Discharge cut-off voltage			37	V	
8.	Continuous discharge current			30	A	
9.	Peak continuous discharge current			40	A	
10.	Discharge over-current protection			75	A	
11.	Charge time under standard charge current			5	hrs	
12.	Nominal charge current(A)			A	<7	Continuous charging
13.	Cooling System			Passive natural cooling		

## BMS TECHNICAL DATA SHEET

13	S	48	V	Details	Specs
Discharge				Nominal Continuous discharging current	10 A
				Peak discharging current	60 A
				Over current protection current	75 A
Charge				Charging voltage	55 V
				Charge current	6 A
Overcharge Protection				Over-charge detection voltage	$4.2 \pm 0.025$ V
				Over-charge detection delay time	0.55
				Over-charge release voltage	$2.9 \pm 0.05$ V
Cell balancing				Cell balancing detection voltage	4.18V
				Cell balancing release voltage	4.18V
				Cell balancing current	$35 \pm 5$ mA
Overdischarge protection				Over-discharge detection voltage	$2.8 \pm 0.05$ V
				Over-discharge detection delay time	0.55
				Over-discharge release voltage	$2.9 \pm 0.05$ V
Overcurrent protection				Over-current detection voltage	260 mV
				Over-current detection delay time	9 ms
				Over-current release voltage	Disconnect the load
Short Protection				Detection condition	Exterior short circuit
				Detection delay time	250 $\mu$ S
				Release condition	Disconnect the load
Temperature protection				65°C or 75°C	Cut-off
Internal resistance				MOSFET	$\leq 10$ m $\Omega$

## 4. SAFETY FEATURES OF THE VEHICLE

To prioritize driver protection, the vehicle's chassis has been carefully analyzed under various impact conditions such as front and rear collisions. Factor of safety values have been calculated to ensure structural integrity. In line with the rulebook, the vehicle will be equipped with ISI-certified helmets, a complete driver safety kit, and a fire extinguisher. Provisions for electrical safety are also fully incorporated.

## 5. ERGONOMICS AND COMFORT FEATURES

### Ergonomics

The design has been tailored to accommodate an adult driver of average build, equivalent to the 95th percentile male. The seat positioning mimics an armchair-style layout, allowing the driver to sit comfortably with sufficient legroom and relaxed posture for longer rides.

### Comfort Features

The onboard display system functions as an interactive user interface, providing real-time updates on:

- Vehicle speed
- Engine RPM
- Battery percentage
- Estimated runtime
- Distance traveled
- Integrated maps with GPS tracking

## 6. INNOVATIONS

### Proposed Innovations for Enhanced Safety and Performance

Our team has designed and integrated multiple concepts aimed at improving both safety and operational efficiency of the vehicle. While certain modules remain in the prototype stage and require further validation, each system contributes toward increased reliability and user protection. The vehicle also incorporates wireless connectivity with smartphones via the Internet, enabling an intelligent, interactive interface.

#### 1. Side-Stand Power Cut-Off

This mechanism prevents the vehicle from being operated while the side stand is deployed, thereby minimizing the likelihood of accidents due to unintentional movement.

#### 2. Smart Helmet with Alcohol Detection

The helmet is equipped with a Passive Infrared (PIR) sensor for human presence detection and an alcohol detection module. The system, controlled via Arduino, ensures that the vehicle ignition is enabled only when the rider is present and no traces of alcohol are detected, directly enhancing rider safety.

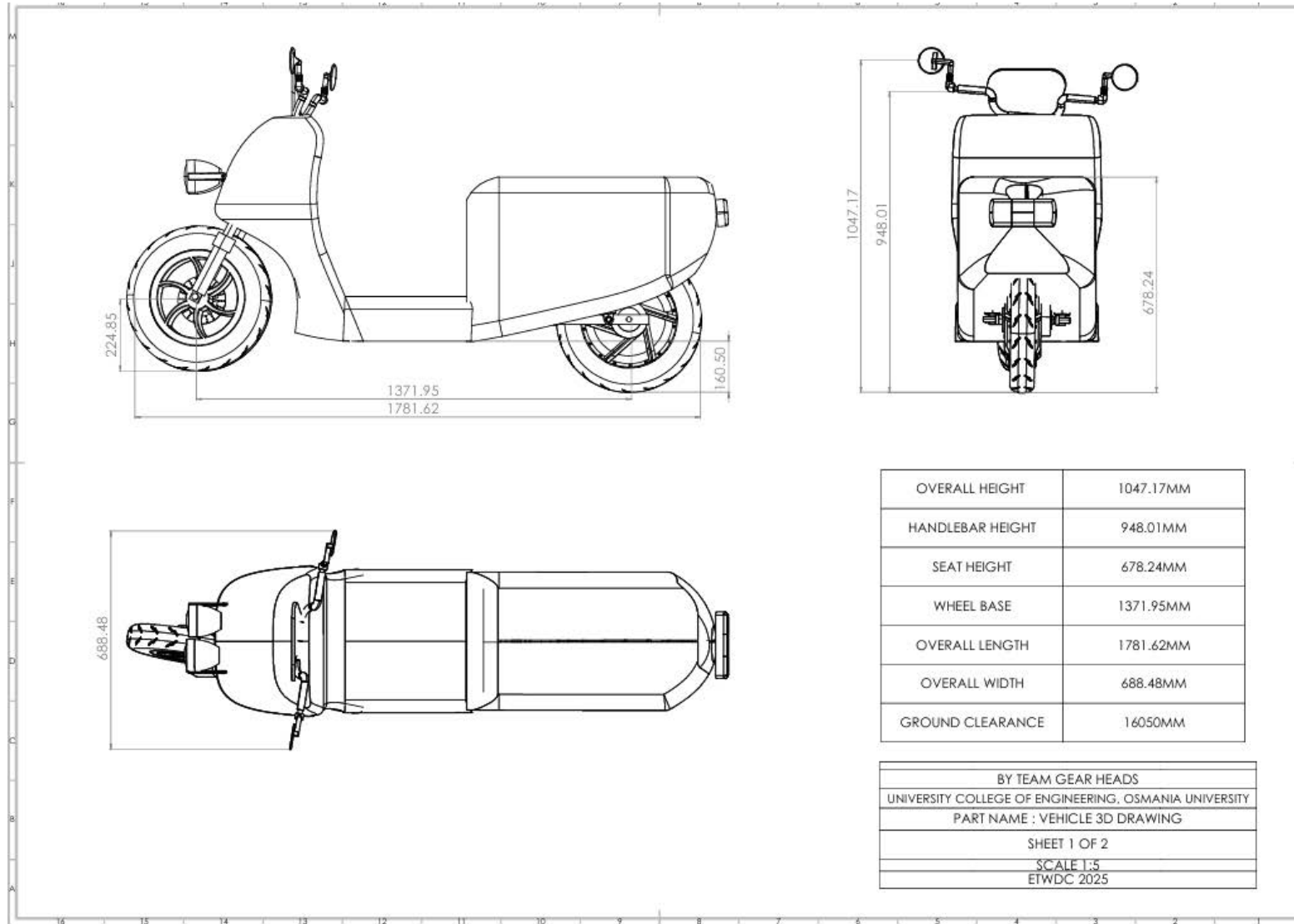
#### 3. Accident Detection and Alert System

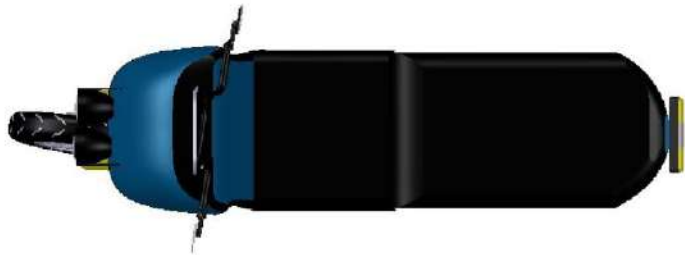
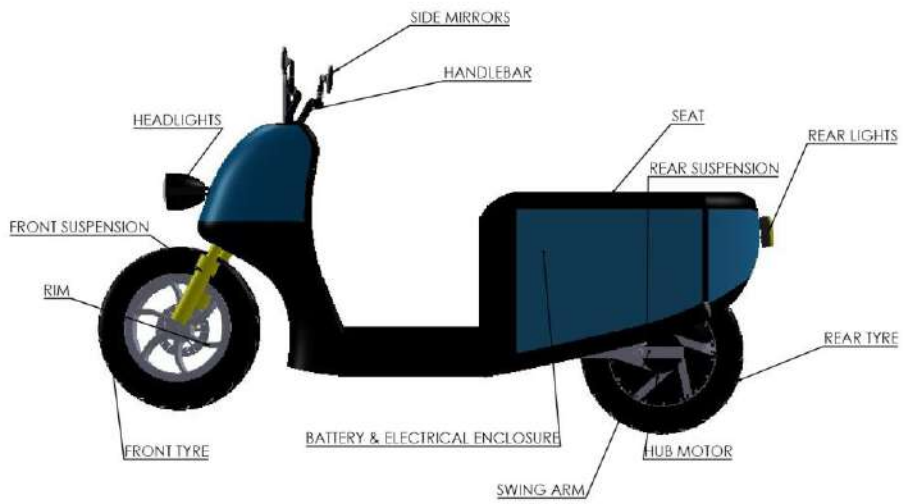
This module continuously monitors vehicle impact and GPS activity. In the event of a collision, the system triggers a buzzer, displays information on the LCD, records a timestamp, and automatically sends SMS and call notifications with GPS coordinates to predefined emergency contacts.

#### 4. Secondary Motor-Generator Integration

A supplementary 48V motor is mechanically coupled via belt or chain to operate as a generator. This unit provides auxiliary charging and system support, thereby improving overall energy efficiency and extending operational reliability.

## 7. VEHICLE 3D LAYOUT





BY TEAM GEARHEADS
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY
PART NAME : VEHICLE 3D DRAWING
SHEET 2 OF 2
SCALE 1:5
ETWDC 2025

# ELECTRIC TWO WHEELER DESIGN CHALLENGE

**7<sup>th</sup> Edition**

## CRITICAL DIMENSION CALCULATIONS AND POWERTRAIN SIMULATIONS REPORT

**Team ID : ETWDC2526023**

**TEAM NAME :** Team GearHeads

**INSTITUTION NAME :** University College of Engineering, Osmania University

**FACULTY ADVISOR :** Dr. E. Madhusudhan Raju

**TEAM CAPTAIN :** D. Nivas Reddy



TEAM CAPTAIN



FACULTY ADVISOR

## ETWDC2526023\_Team Gearheads\_Critical Dimension Calculation and Powertrain Simulations Report

### 1. CHASSIS DETAILS:

Material Details:	
Material	AISI 1020
Pipe Dimensions	1.25 inch OD, 2mm Thick

Material Quantity:	
AISI 1020 1.25 inch OD, 2mm Thick	7.8 m
Total weight of the frame	15 kg

#### Chemical Composition:

Element	% (in AISI 1020)
Carbon	0.18-0.23
Iron	99.19-99.44
Manganese	0.30-0.50
Phosphorous	0.030max
Sulphur	0.050max

#### Mechanical Properties (at 25° c):

Parameter	Value
Ultimate Tensile strength (MPa)	420.507
Yield Strength (MPa)	351.570
Modulus of elasticity (GPa)	200
Machinability %	70
Elongation %	22.37
Weldability	Post and pre heating are not required and is easily weldable.

We have AISI 1018 & AISI 1020 as our material options. Considering Weight, Price, Strength, Availability we have chosen **AISI 1020** as our final material for the frame.

## 2. FORK DETAILS:

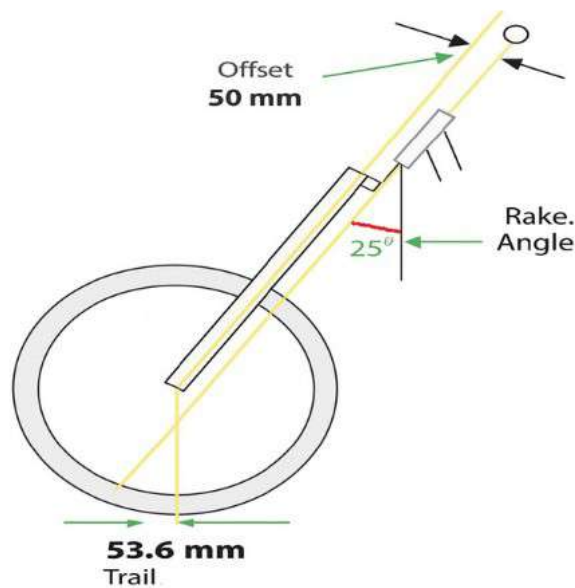
We have used telescopic suspensions over USD suspension.

Telescopic suspension is a type of hydraulic suspension system with internal coils. The telescopic fork operates hydraulically. It has fork tubes and sliders which contain the springs and dampers. It is highly successful due to its weight and capability to absorb. It is also called as Telescopic shock absorber.

Advantages of a telescopic suspension:

1. The telescopic fork is simple in design.
2. It is relatively cheap to manufacture and maintenance.
3. It has less oil leakage chances.
4. It has more life and better performance in any terrain.
5. It is lighter in weight compared toothers.

S. No	FORK DETAILS	SPECIFICATIONS
1.	Rake angle	25°
2.	Spring constant	30 N/mm
3.	Maximum compression	11.18 mm
4.	Fork offset	50 mm
5.	Trail	53.6 mm



# ELECTRIC TWO WHEELER DESIGN CHALLENGE

7<sup>th</sup> Edition

## CAE REPORT

**TEAM ID** : ETWDC2526023

**TEAM NAME** : Team GearHeads

**INSTITUTION NAME** : University College of Engineering, Osmania University

**FACULTY ADVISOR** : Dr. E. Madhusudhan Raju

**TEAM CAPTAIN** : D. Nivas Reddy



**TEAM CAPTAIN**

D. Nivas Reddy



**FACULTY ADVISOR**

Dr. E. Madhusudhan Raju

## 1. INTRODUCTION:

Computer aided engineering (CAE) is indispensable in the design process of electric two-wheelers as it enables engineers to simulate, analyze, and optimize designs comprehensively before physical prototypes are built. This results in improved design quality, reduced development time, and enhanced overall performance of the vehicle.

Our approach to the vehicle design was to ensure that it is aerodynamic and ergonomically designed. To provide a comfortable and safe cornering ride for the driver, both the front and rear suspension systems are chosen.

Considering the safety of the drivers, all the components and ground clearances are in accordance with the 2025 rulebook given by SAEISS. The software used to develop the 3D model is **SOLIDWORKS**, and to analyse the design is **AUTODESK FUSION 360**.

## 1. FRAME MATERIAL OPTIONS:

Using **Ansys Granta Selector 2025 R1**, a material selection strategy was performed that identified AISI 1018 and AISI 1020 as the top candidates. The following is a comparison to determine the better of these two materials.

### Mechanical properties:

PARAMETER	AISI 1018	AISI 1020
Ultimate Tensile Strength (MPa)	460	394.72
Yield Strength (MPa)	400	294.74

Modulus of Elasticity (GPa)	205	200
Density (kg/m <sup>3</sup> )	7870	7870
Poisson's Ratio	0.29	0.29

### Chemical properties:

ELEMENT	AISI 1018%	AISI 1020%
Carbon	0.14-0.20	0.17-0.230
Iron	98.81-99.26	99.08-99.53
Manganese	0.60-0.90	0.3-0.60
Phosphorous	0.04	0.04
Sulphur	0.05	0.05

### Material Selection:

Considering Weight, Price, Strength, Availability and other factors, we are choosing AISI 1020 as our material.

## 2. CALCULATION OF STRENGTH AND BENDING STIFFNESS:

Outer Diameter ( $d_2$ ) = 31.75 mm

Inner Diameter ( $d_3$ ) = 27.75 mm

Yield Strength ( $S_y$ ) = 400 MPa

C = Distance from neutral axis to extreme fiber  
= 15.875 mm

Second Moment of Area ( $I$ ) =  $\frac{\pi}{64} (d_2^4 - d_3^4)$

$$= (\pi/64) (31.75^4 - 27.75^4)$$

$$= 2.08 \times 10^{-8} m^4$$

Bending Strength (M) =  $(S_y \times I)/C$

$$= \frac{(400 \times 10^6 \times 2.08 \times 10^{-8})}{15.875 \times 10^{-3}}$$

= 523.43N·m

Bending Stiffness =  $E \times I$

$$= 200 \times 10^9 \times 2.08 \times 10^{-8}$$

= 4154.69 N.m<sup>2</sup>

### 3. CAE ANALYSIS OF VEHICLE FRAME:

A Frame is the main supporting structure of a vehicle to which all other components are attached.

The main functions of a frame in vehicles are:

- 1) To support the vehicle's mechanical components and body.
- 2) To deal with static and dynamic loads, without undue deflection or distortion.

These include:

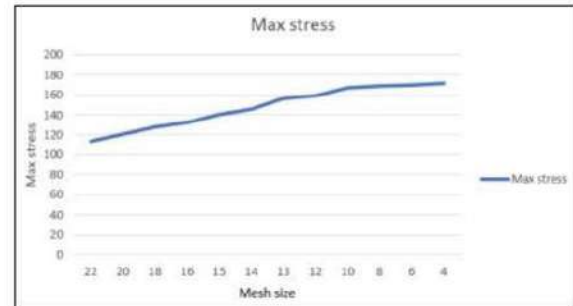
- Weight of the body, passengers, and cargo loads.
- Vertical and torsional twisting transmitted by going over uneven surfaces
- Transverse, lateral forces caused by road conditions, side wind, and steering the vehicle.
- Torque from the drivetrain components.
- Longitudinal tensile forces from starting and acceleration, as well as compression from braking.
- Sudden impacts from collisions.

Finite Element Analysis is a mathematical modelling technique used to determine the response of real structures to external and

internal loads. CAE Analysis on the frame is performed to evaluate the safety offered by the frame to drivers in case of any accident.

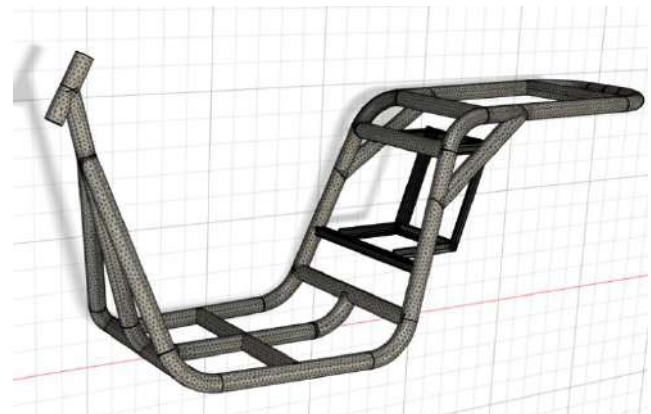
### 4.FRAME ANALYSIS:

#### MESH PARAMETERS



Maximum stress remains about the same after a mesh size of 10mm and the mesh size does not play a major role in the result. For the above reason, we decided to take a mesh size of 8mm, which was a good compromise between obtaining accurate results and computing time.

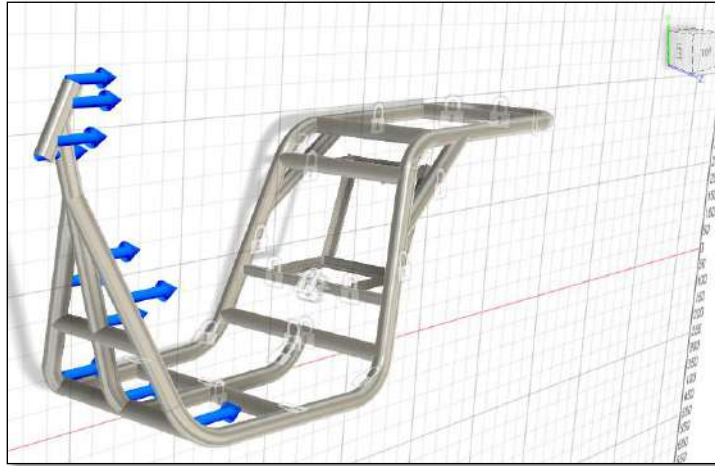
Mesh Size	8mm
Nodes	224055
Elements	111559



#### 4.1. FRONT IMPACT:

##### a) Assumptions & Considerations:

For boundary conditions, the suspension mounting of rear side of the frame is fixed and the front members of the frame will come across the applied load.



**Fig-1 Boundary Conditions**

For the calculation of the impact caused by a head-on collision, the vehicle of mass 155 kg is assumed to be travelling at a maximum speed of 35 kmph and collides with a rest wall with an impact time of 0.25s (assumed based on comparison with other automobiles).

##### b) Calculation of Impact forces:

Parameter	Symbol	Value	Unit
Vehicle Mass (with driver)	M	155	Kg
Velocity (pre-impact)	u	9.72	m/s
Final Velocity (post-impact)	v	0	m/s
Impact time	t	0.25	s

Work done = Change in kinetic energy  $W = 0.5 \times M \times (u^2 - v^2)$

$$= 0.5 \times 155 \times 9.72^2$$

$$= 7322.076 \text{ N-m}$$

Work done = Force x displacement =  $F \times s$  -- (1)

$$\text{Also, } s = u \times t = 9.72 \times 0.25\text{s} = 2.43 \text{ m}$$

From (1) we get,

$$F (\text{Impact force}) = \frac{\text{work done}}{\text{Displacement}} = \frac{7322.076}{2.43} = 3013.2 \text{ N}$$

c) Analysis Results:

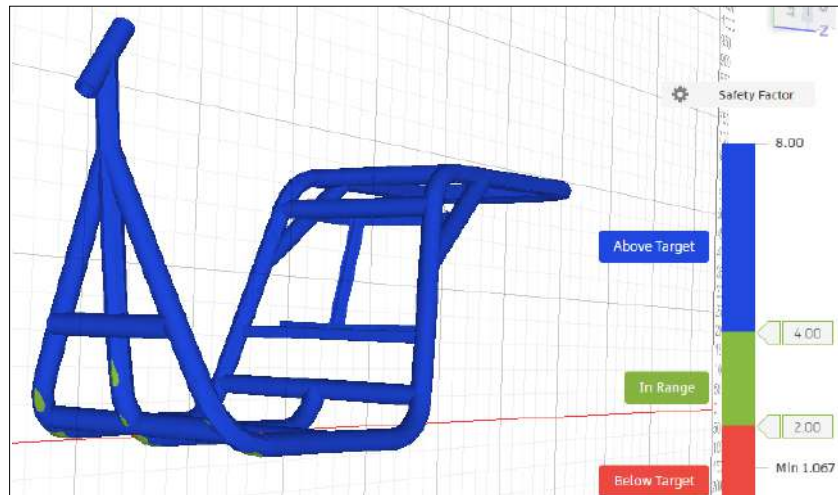


Fig-2 Factor of Safety

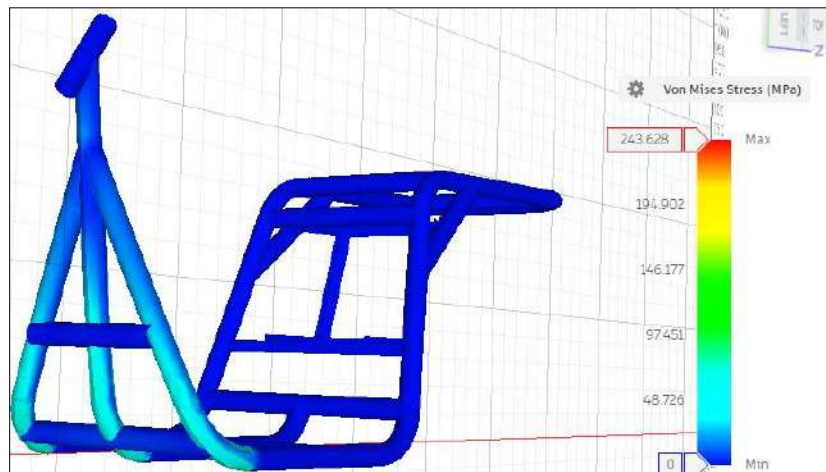


Fig-3 Von Mises Stress

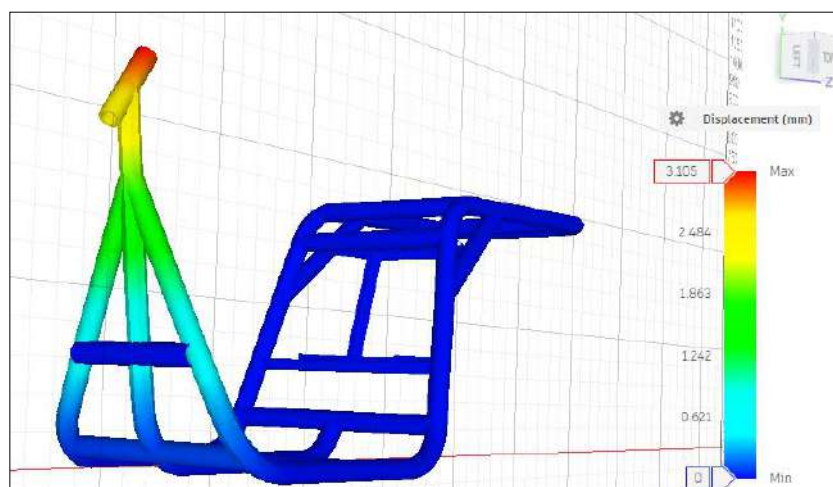


Fig-4 Total Deformation

Total Deformation	3.105 mm
Von Mises Stress	243.628 MPa
Factor of Safety	1.067

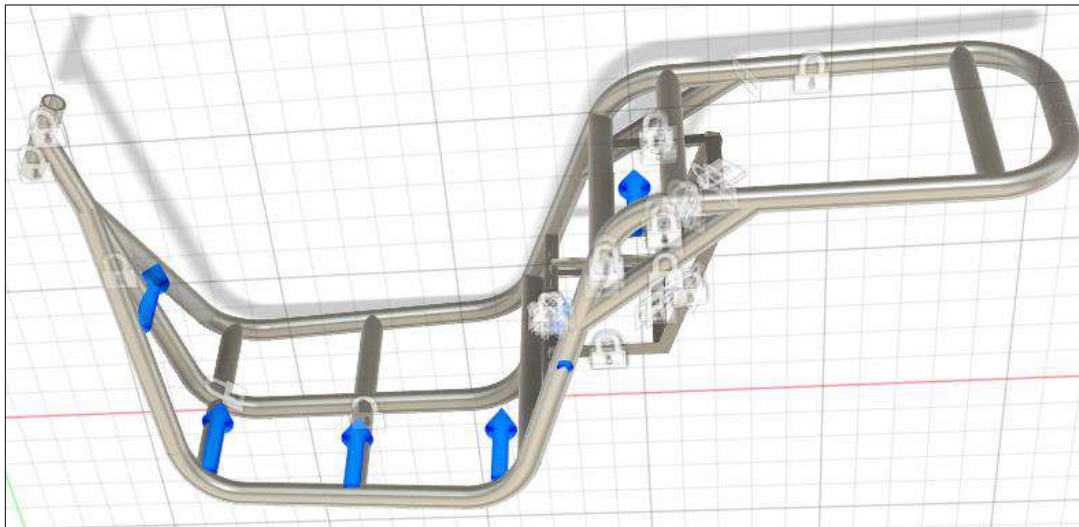
**d) Optimizations:**

The FOS is good enough; thus, no further optimization was required.

**4.2. SIDE IMPACT:****a) Assumptions & Considerations:**

For boundary conditions, the suspension mountings of both front and rear sides of the frame are fixed, and one of the left/right sides of the frame will carry the load. Analysis of any one side is enough due to the symmetrical design of the frame along the plane parallel to the side view and passing through the center.

For the calculation of the impact caused by a side collision, the vehicle of mass 155 kg is assumed to be at rest and is hit by another vehicle moving at a maximum speed of 35 kmph (perpendicularly and along one side), and assuming an impact time of 0.25 sec.



**Fig-1 Boundary Conditions**

### b) Calculation of Impact forces:

Parameter	Symbol	Value	Unit
Vehicle Mass (with driver)	M	155	Kg
Velocity (pre-impact)	u	9.72	m/s
Final Velocity (post-impact)	v	0	m/s
Impact time	t	0.25	s

Work done = Change in kinetic energy  $W = 0.5 \times M \times (u^2 - v^2)$

$$= 0.5 \times 155 \times 9.72^2$$

$$= 7322.076 \text{ N-m}$$

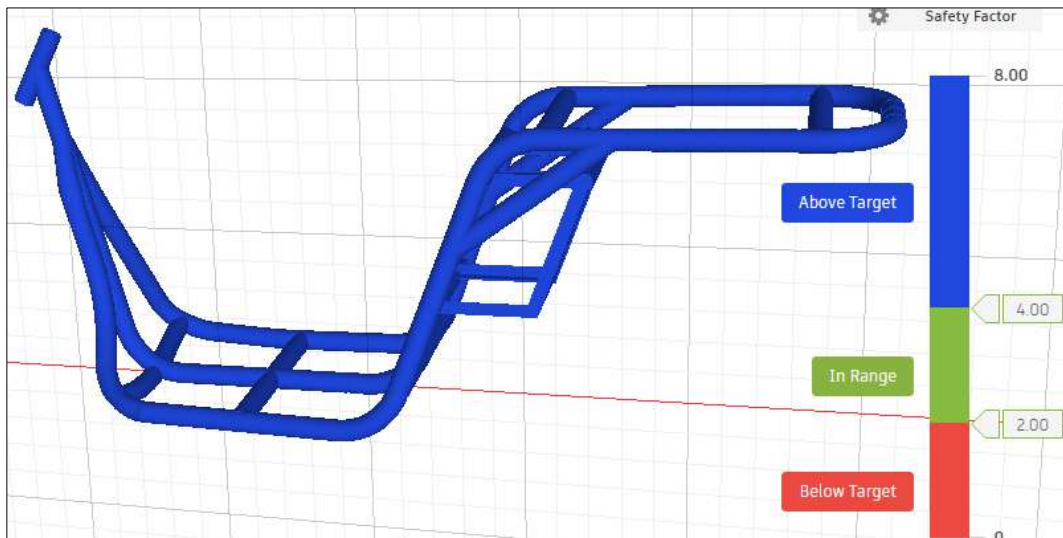
Work done = Force x displacement =  $F \times s$  -- (1)

$$\text{Also, } s = u \times t = 9.72 \times 0.25 \text{ s} = 2.43 \text{ m}$$

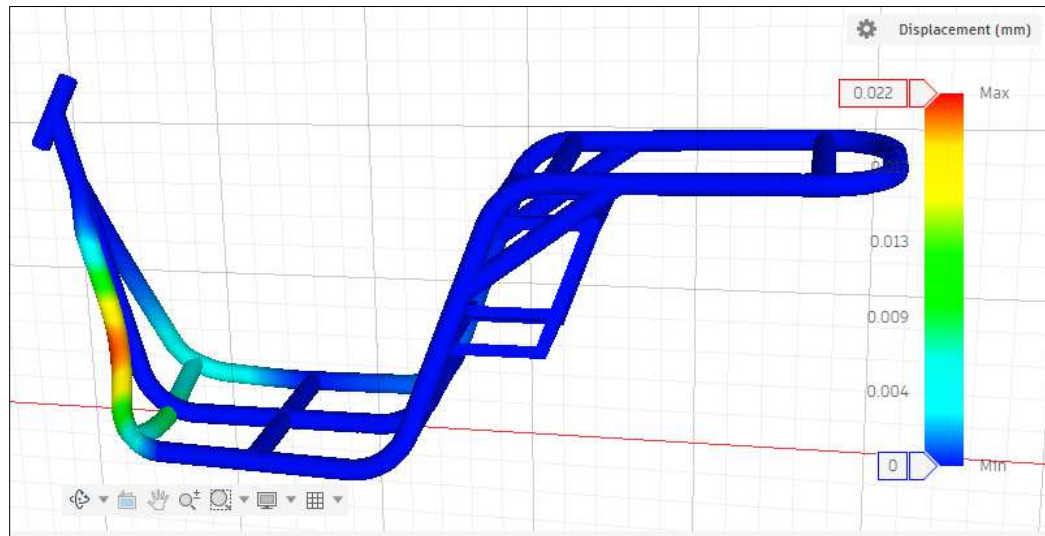
From (1) we get,

$$F (\text{Impact force}) = \frac{\text{work done}}{\text{Displacement}} = \frac{7322.076}{2.43} = 3013.2 \text{ N}$$

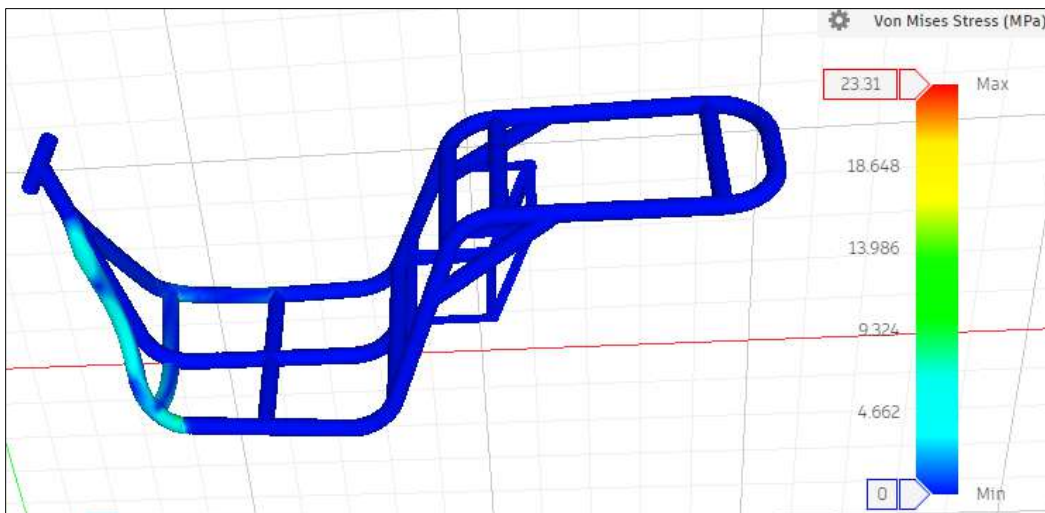
### c) Analysis Results:



**Fig-2 Factor of Safety**



**Fig-2 Total Deformation**



**Fig-4 Von Mises Stress**

Total Deformation	0.022 mm
Von Mises Stress	23.31 MPa
Factor of Safety	11.154

**d) Optimizations:**

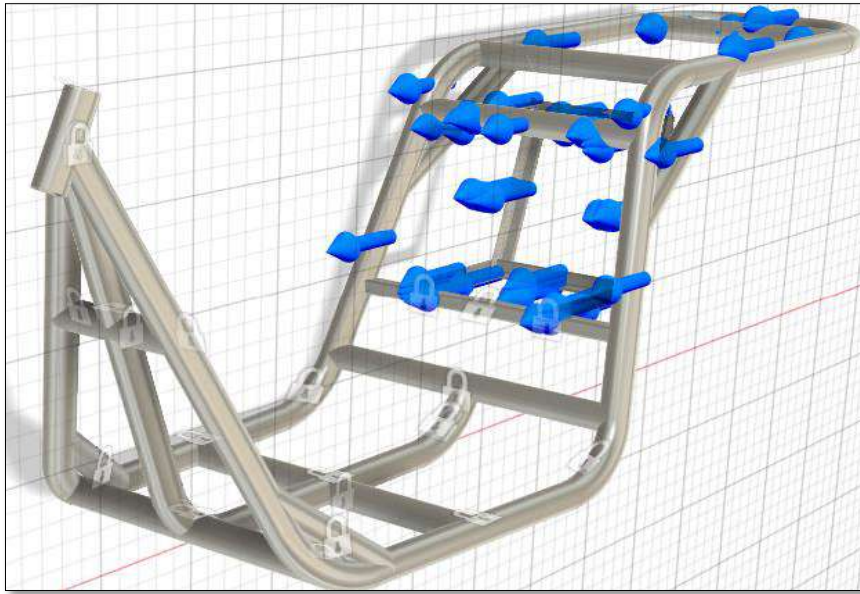
The FOS is good enough; thus, no further optimization was required.

#### 4.3. REAR IMPACT:

##### a) Assumptions & Considerations:

For boundary conditions, the suspension mounting of the front side of the frame is fixed, and the rear members of the frame will bear the applied load.

For the calculation of the impact caused due to rear collision, a vehicle of mass 155 kg is assumed to be travelling at a maximum speed of 35 kmph and collides with a stationary vehicle with an impact time of 0.25s (assumed based on comparison with other automobiles)



**Fig- 1 Boundary conditions**

##### b) Calculation of Impact forces:

Parameter	Symbol	Value	Unit
Vehicle Mass (with driver)	M	155	Kg
Velocity (pre-impact)	u	9.72	m/s
Final Velocity (post-impact)	v	0	m/s
Impact time	t	0.25	s

Work done = Change in kinetic energy  $W = 0.5 \times M \times (u^2 - v^2)$

$$= 0.5 \times 155 \times 9.72^2$$

$$= 7322.076 \text{ N-m}$$

Work done = Force x displacement =  $F \times s$  -- (1)

Also,  $s = u \times t = 9.72 \times 0.25s = 2.43 \text{ m}$

From (1) we get,

$$F (\text{Impact force}) = \frac{\text{work done}}{\text{Displacement}} = \frac{7322.076}{2.43} = 3013.2 \text{ N}$$

### c) Analysis Results:

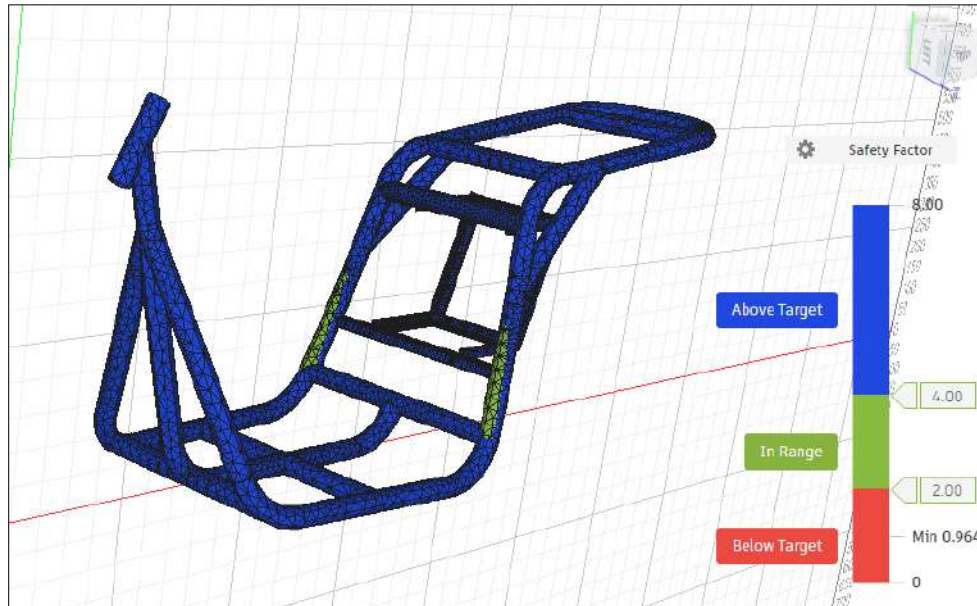


Fig- 2 Factor of Safety

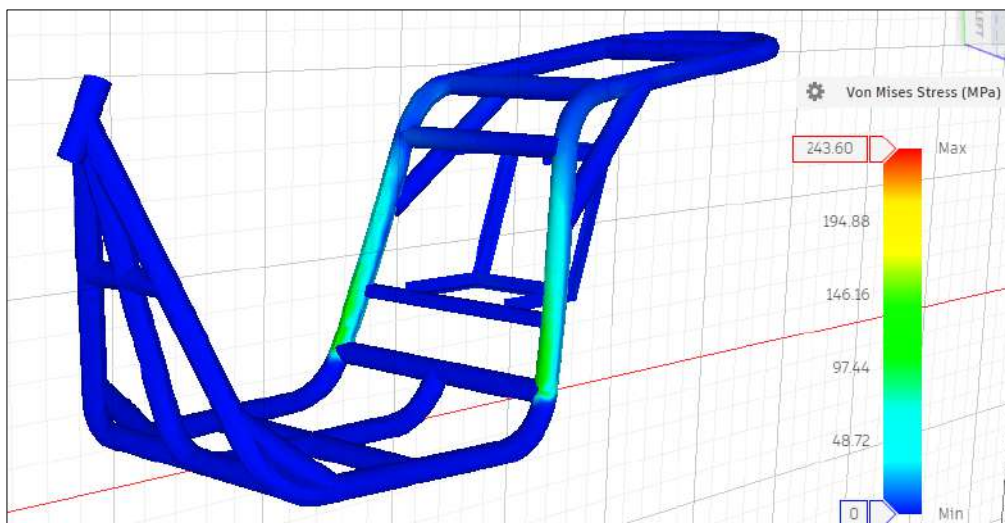
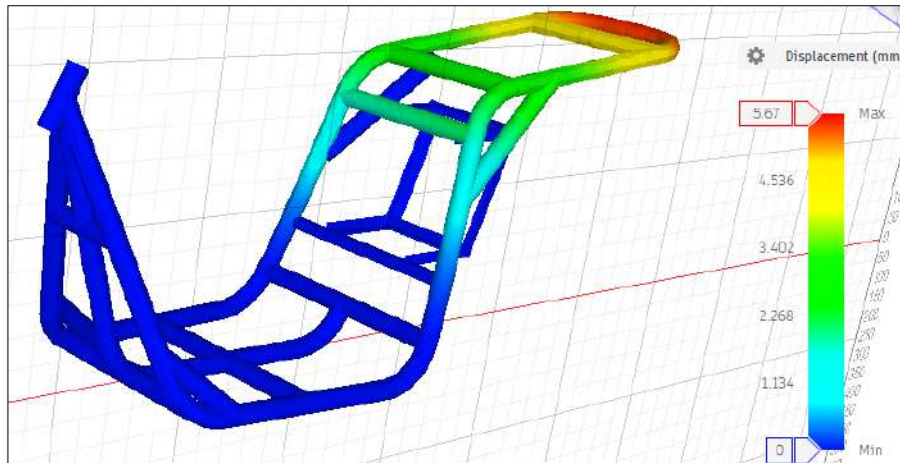


Fig-3 Von Mises Stress



**Fig-4 Total Deformation**

Total Deformation	5.67 mm
Von Mises Stress	243.60 MPa
Factor of safety	1.067

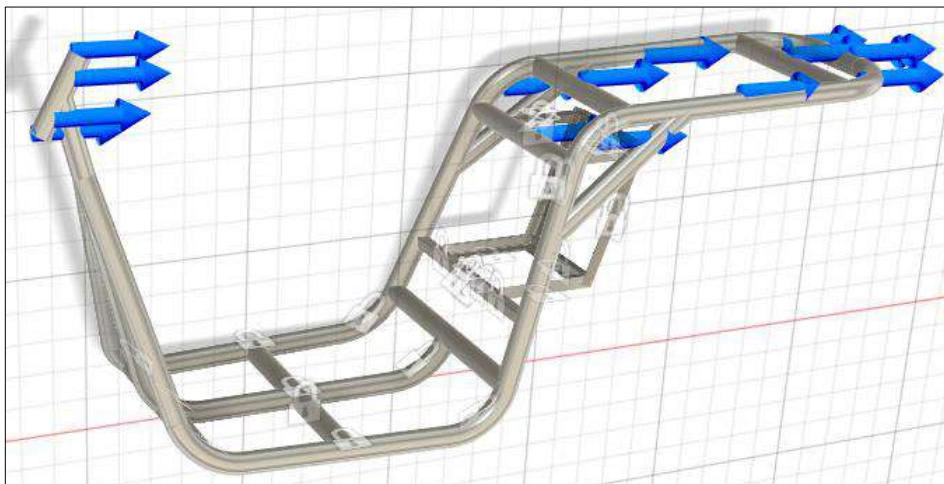
**d) Optimizations:** The FOS is good enough; thus, no further optimization was required.

#### 4.4. FRONT ROLLOVER:

##### a) Assumptions & Considerations:

For boundary conditions, the frame is fixed on the bottom sides, and the top members of the frame will come across the applied load.

For the calculation of the impact caused by front rollover, assuming the 2G force will be the worst-case scenario.



**Fig-1 Boundary Conditions**

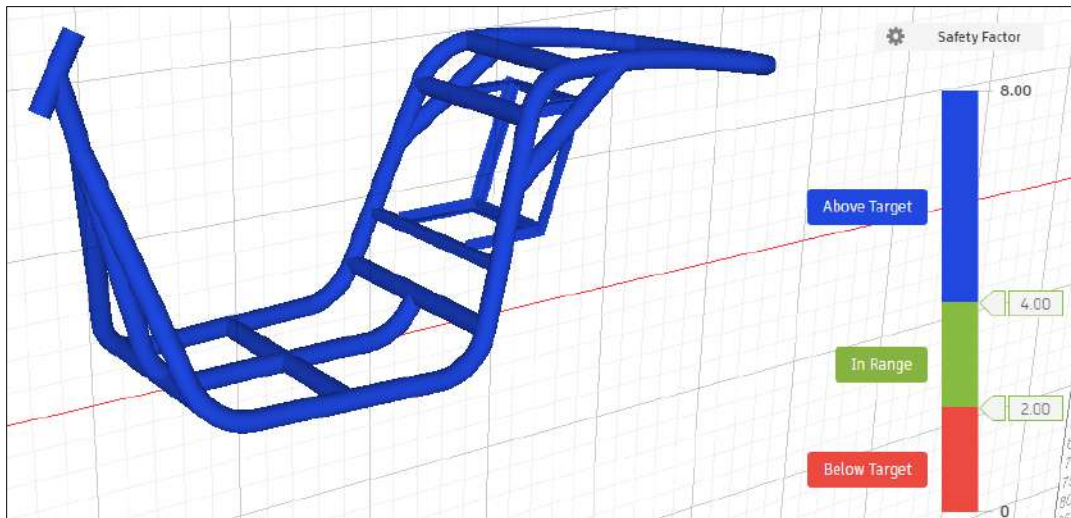
**b) Calculation of Impact forces:**

Weight of the Vehicle,  $M = 155 \text{ kg}$  (including driver)

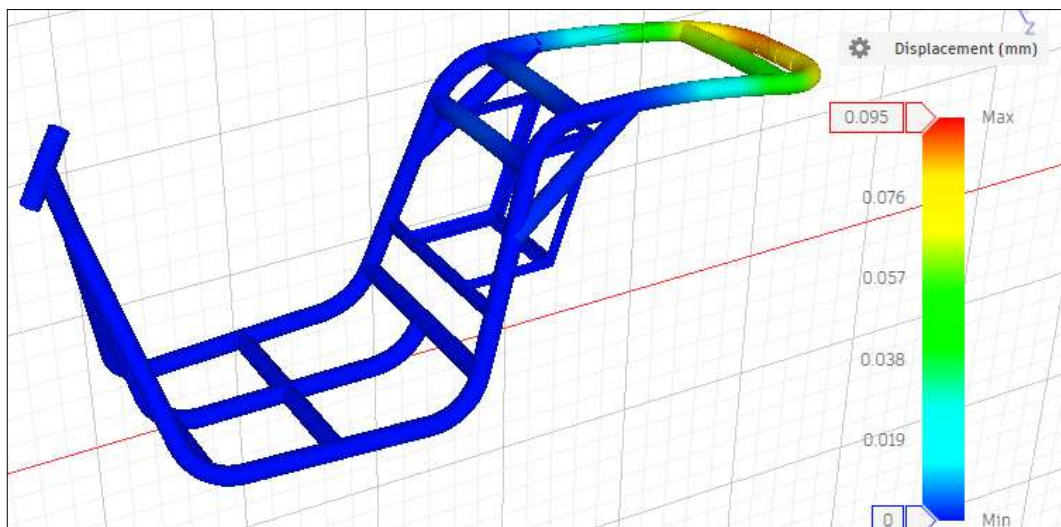
Acceleration due to gravity,  $g = 9.81 \text{ m/s}^2$  Force acting,

$$F = M \times G = M \times 2g = 155 \times 2 \times 9.81 \text{ N} = 3041 \text{ N} = 3041 \text{ N}$$

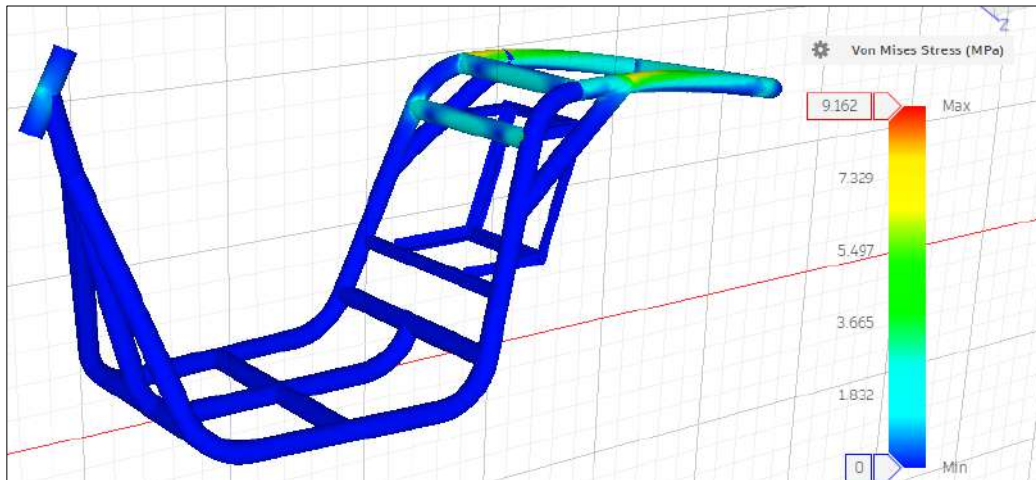
**c) Analysis Results:**



**Fig- 2 Factor of Safety**



**Fig- 3 Total Deformation**



**Fig- 4 Von Mises Stress**

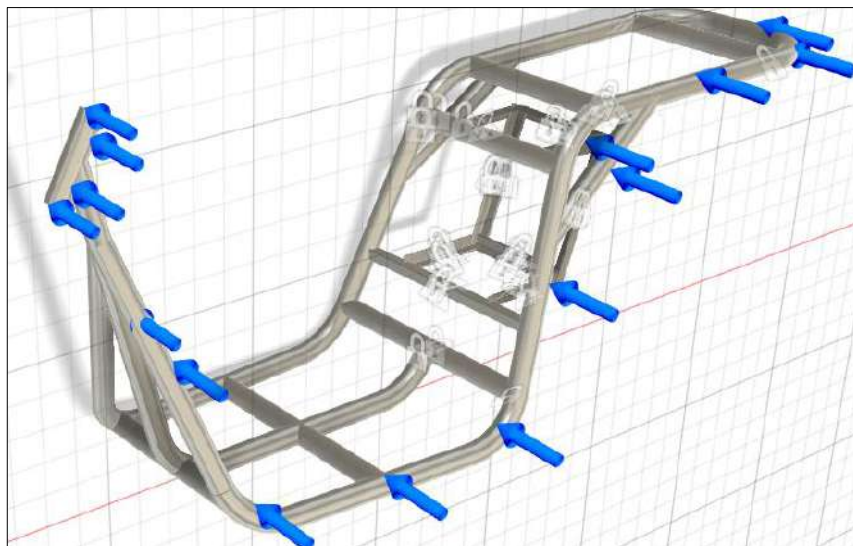
Total Deformation	0.095 mm
Von Mises Stress	9.162 MPa
Factor of Safety	15.00

**d) Optimizations:** The FOS is good enough; thus, no further optimization was required.

#### 4.5. SIDE ROLLOVER:

##### a) Assumptions & Considerations:

For boundary conditions, the frame is fixed from one of the right/left side and the other side members will come across the applied load. Analysis of any one side is enough due to symmetrical design of the frame along the plane parallel to side view and passing through centre. For calculation of the impact caused due to front rollover, assuming the 2G force will be the worst case scenario.



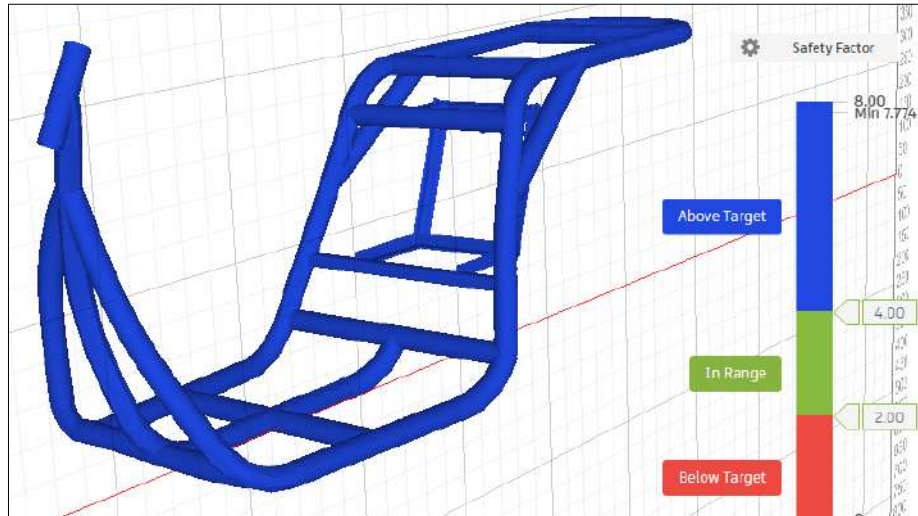
**Fig- 1 Boundary Conditions**

**b) Calculation of Impact forces:**

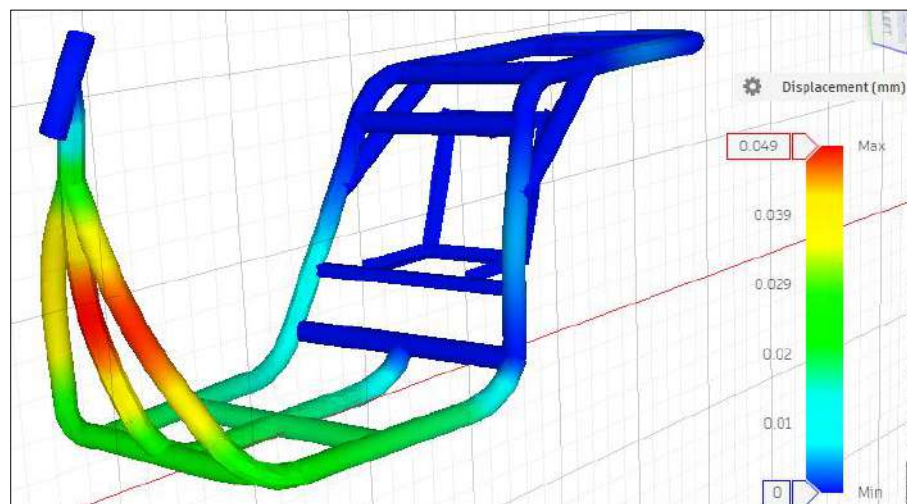
Weight of the Vehicle,  $M = 155 \text{ kg}$  (including driver)

Acceleration due to gravity,  $g = 9.81 \text{ m/s}^2$  Force acting,  $F = M \times G = M \times 2g = 155 \times 2 \times 9.81 \text{ F}$   
 $= 3041.1 \text{ N} = 3041 \text{ N}$  (approx.)

**c) Analysis Results:**

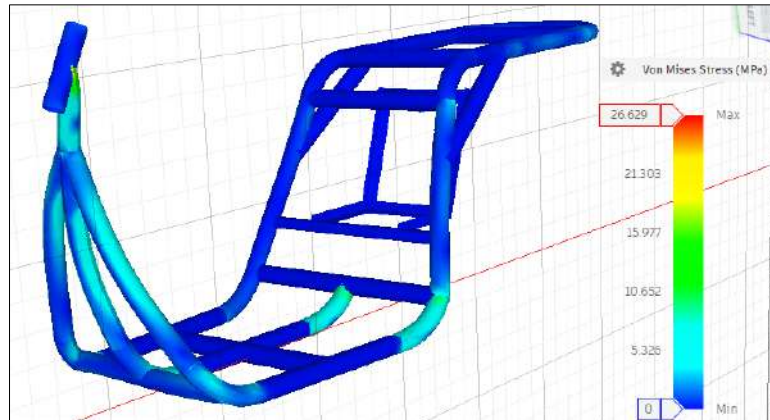


**Fig- 2 Factor of safety**



**Fig- 3 Total Deformation**

Total Deformation	0.049 mm
Von Mises Stress	26.629 MPa
Factor of Safety	7.774



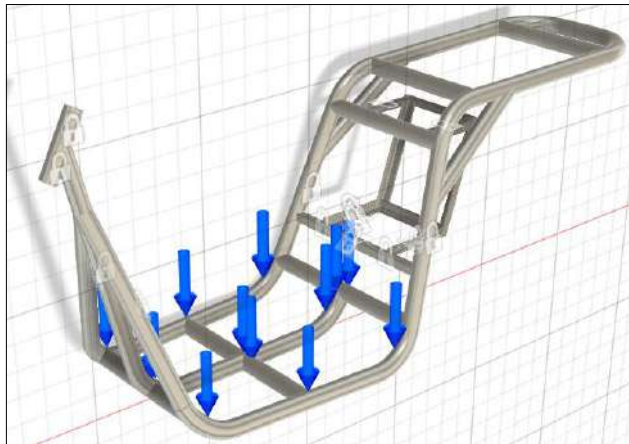
**Fig- 4 Von Mises Stress**

**d) Optimizations:** The FOS is good enough; thus, no further optimization was required.

#### 4.6. DROP TEST:

##### a) Assumptions & Considerations:

For boundary conditions, the top members of the frame are fixed, and the bottom members of the frame will carry the applied load. For calculations of impact caused by the drop test, the vehicle of mass 155 kg is assumed to be dropped from a height of 10ft above the ground (taking the worst case scenario)



**Fig- 1 Boundary Conditions**

##### b) Calculation of Impact forces:

Parameter	Symbol	Value	Unit
Vehicle Mass (with driver)	M	155	Kg
Velocity (pre-impact)	u	9.72	m/s
Final Velocity (post-impact)	v	0	m/s
Impact time	t	0.25	s

Work done = Change in kinetic energy  $W = 0.5 \times M \times (u^2 - v^2)$

$$= 0.5 \times 155 \times 9.72^2$$

$$= 7322.076 \text{ N-m}$$

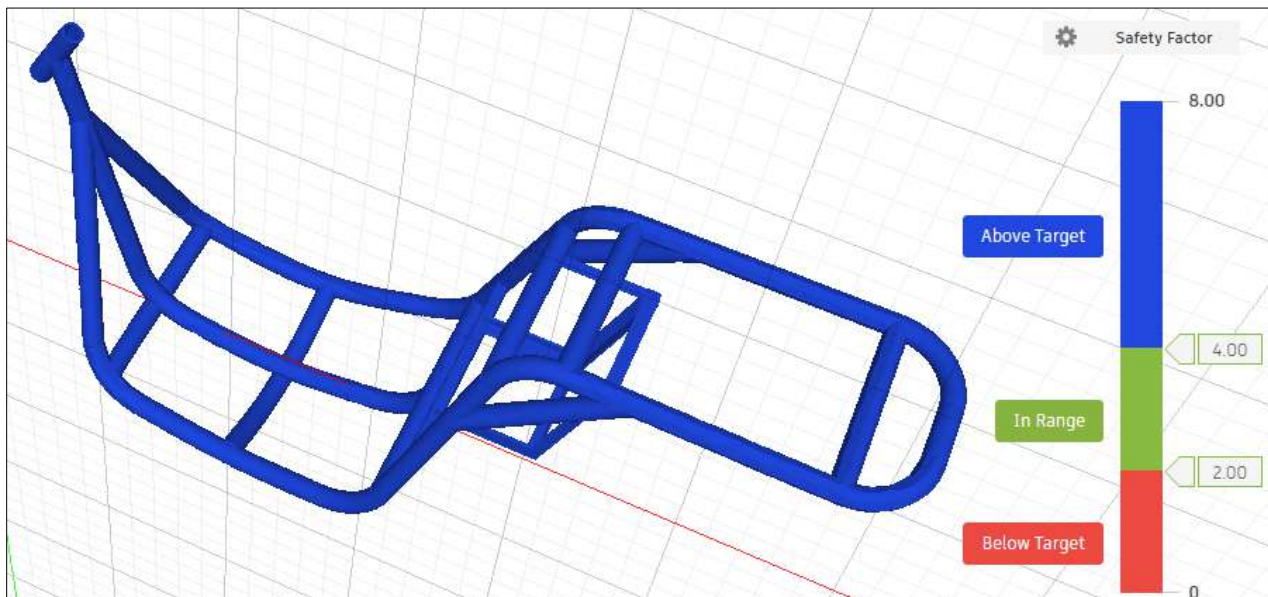
Work done = Force x displacement =  $F \times s$  -- (1)

$$\text{Also, } s = u \times t = 9.72 \times 0.25 \text{ s} = 2.43 \text{ m}$$

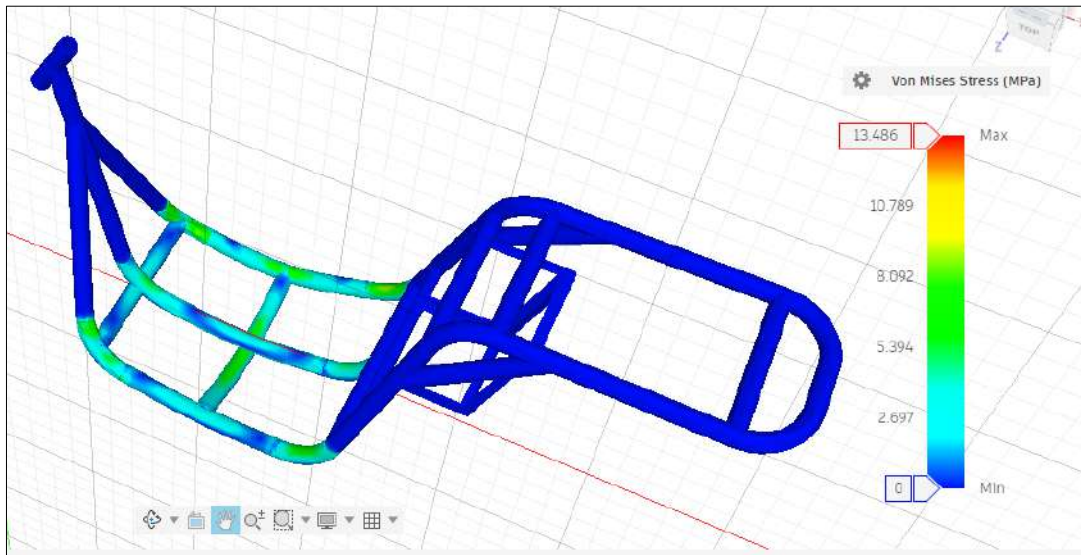
From (1) we get,

$$F (\text{Impact force}) = \frac{\text{work done}}{\text{Displacement}} = \frac{7322.076}{2.43} = 3013.2 \text{ N}$$

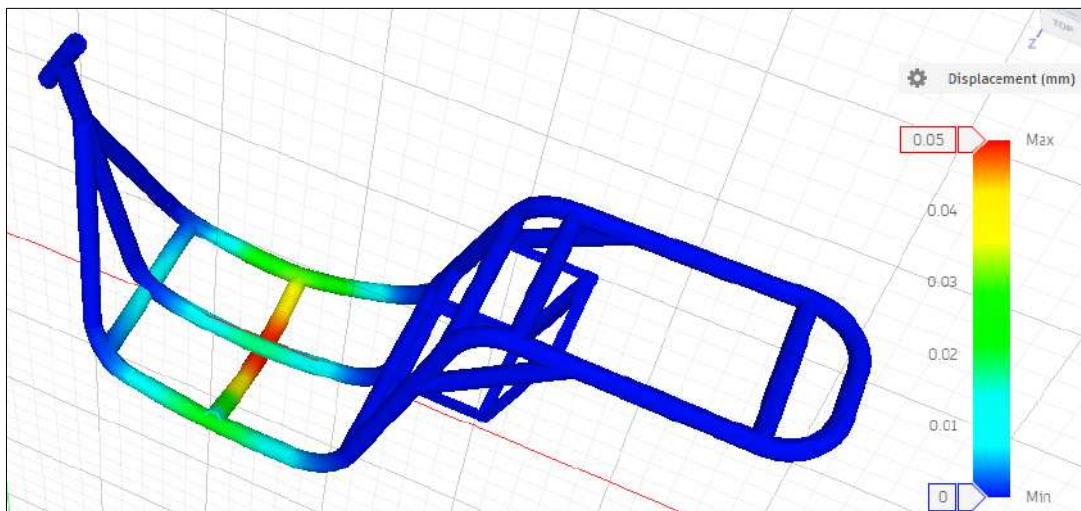
### c) Analysis Results:



**Fig-2 Factor of safety**



**Fig-3 Von Mises Stress**



**Fig- 4 Total Deformation**

Total Deformation	0.05 mm
Von Mises Stress	13.486 MPa
Factor of Safety	15.00

**d) Optimizations:**

The FOS is good enough; thus, no further optimization was required.

### 5.1. SEAT SUPPORT MEMBERS:

#### **For One Driver:**

##### **a) Assumptions & Considerations:**

For Boundary conditions, the suspension mounting of the frame is fixed, and the contact faces of the frame where the seat is attached will come into contact with the applied load. A few sections of the frame (where there is no effect) are suppressed to decrease the computation time.

##### **MESH PARAMETERS:**

A mesh size of 8 mm is used to analyze.

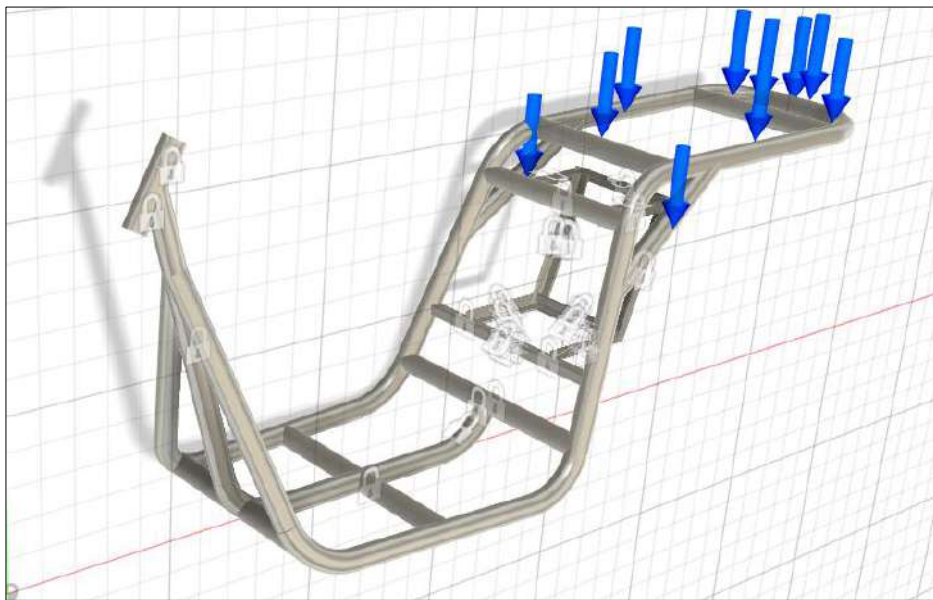
Mesh Size	8mm
Nodes	224055
Elements	111559

##### **b) Calculations of Forces:**

Weight of the driver = 70 kg

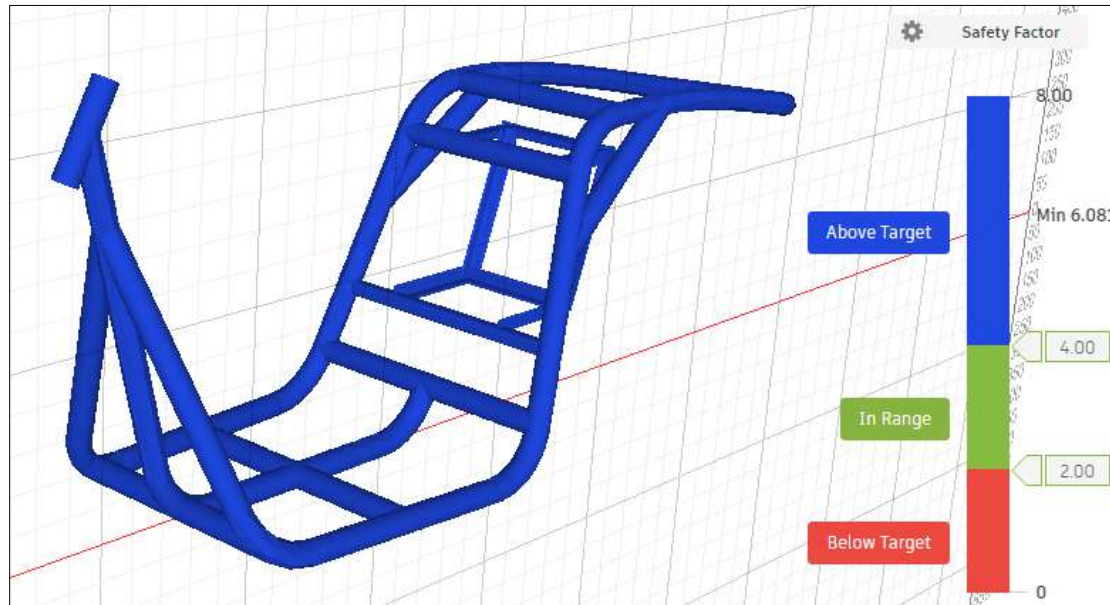
Force acting on the chassis due to driver  $F = 70 \times 9.81 = 686.7 \text{ N}$

$F \sim 690 \text{ N}$

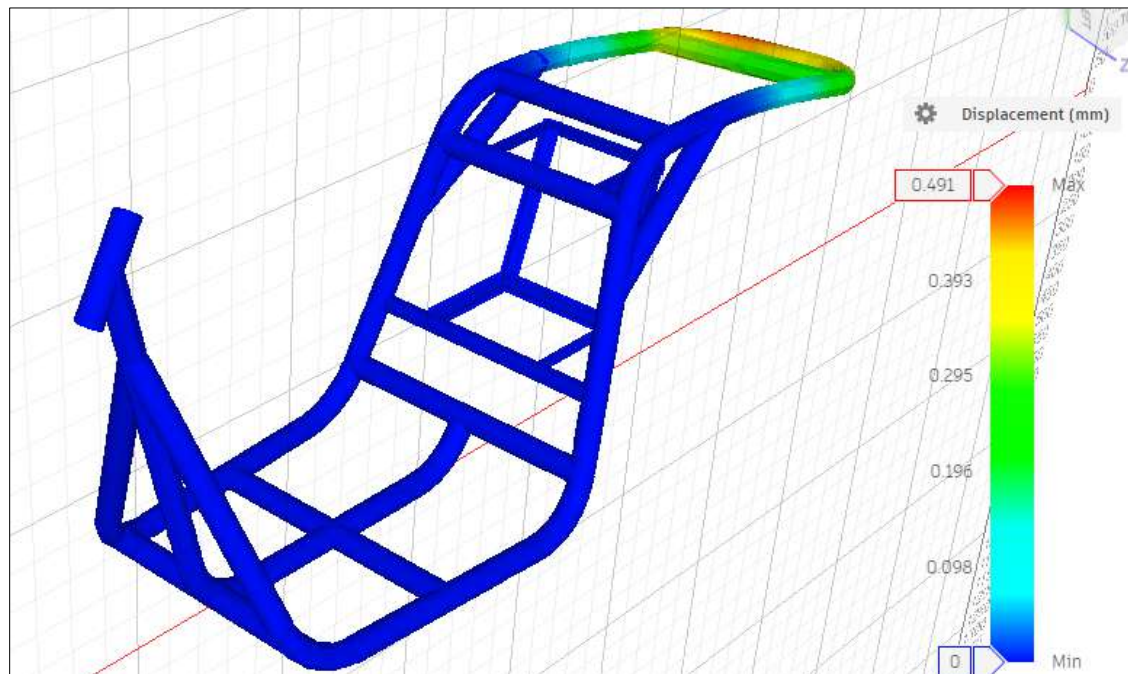


**Fig- 1 Boundary Conditions**

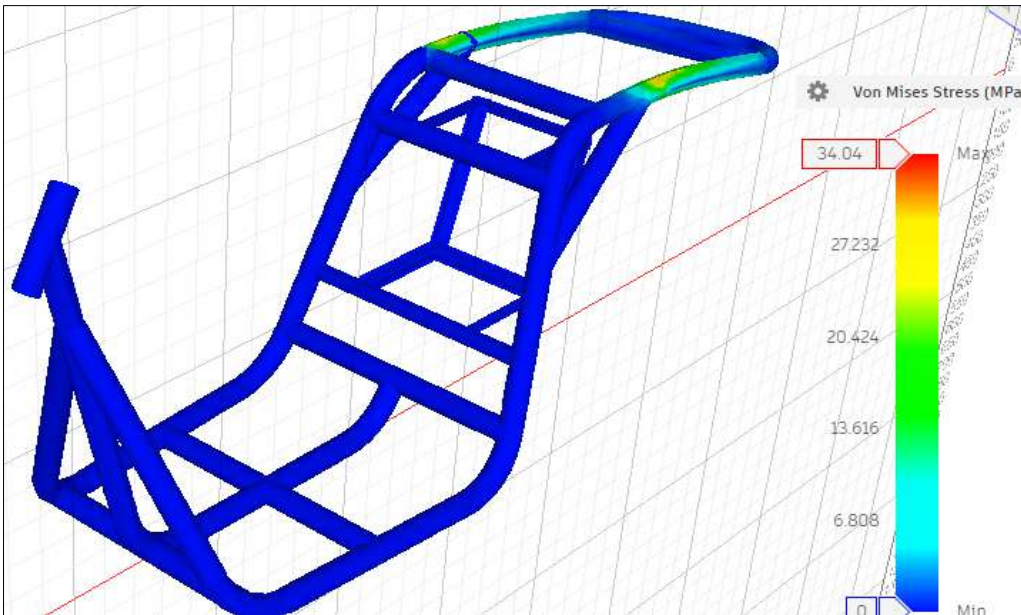
**c) Analysis Results:**



**Fig-2 Factor of safety**



**Fig-3 Total Deformation**



**Fig-3 Von Mises Stress**

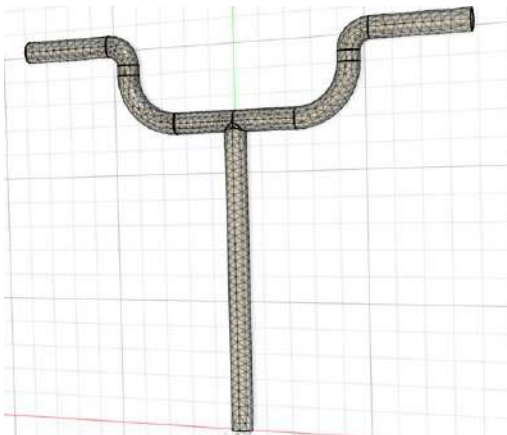
Total Deformation	0.491 mm
Von Mises Stress	34.04 MPa
Factor of Safety	6.081

**d) Optimizations:** The FOS is good enough; thus, no further optimization was required.

## 5.2. HANDLE BAR:

### a) Assumptions & Considerations:

**MESH PARAMETERS:** A mesh size of 8 mm is used to analyse.

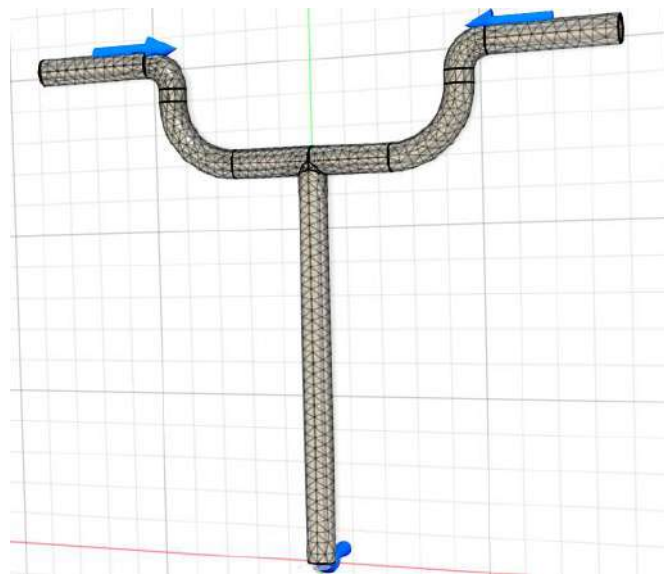


**Fig-a Mesh View**

Mesh	8mm
Nodes	13286
Elements	6487

### Boundary Conditions :

Setup	Location	Value	Direction / Axis
<b>Fixed Constrain</b>	Bottom Face of the Vertical Steering Tube	Fixed	N/A
<b>Vehicle weight force</b>	Bottom Face of the Vertical Steering Tube	456.165 = 460 N (approx)	Upwards +Z axis
<b>Rider Steering Force</b>	<b>Force A:</b> Left Hand Grip <b>Force B:</b> Right Hand Grip	200N (Assumption)	A: Sideways (+X Axis) B: Sideways (-X Axis)



**Fig- 1 Boundary Condition**

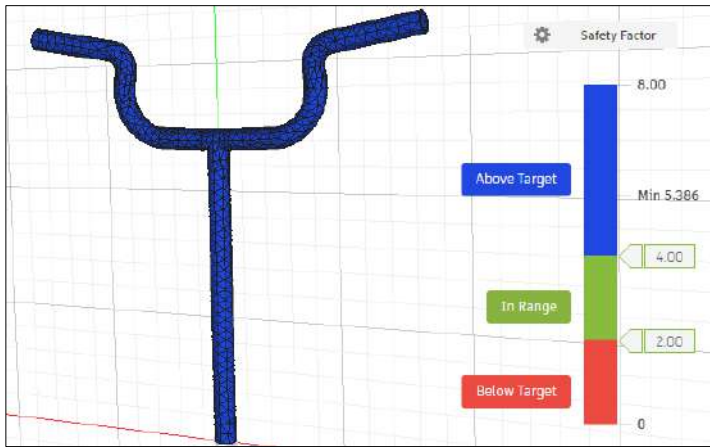
### b) Calculations of forces:

Force applied to steer the handlebar (assumed value) F-200 N

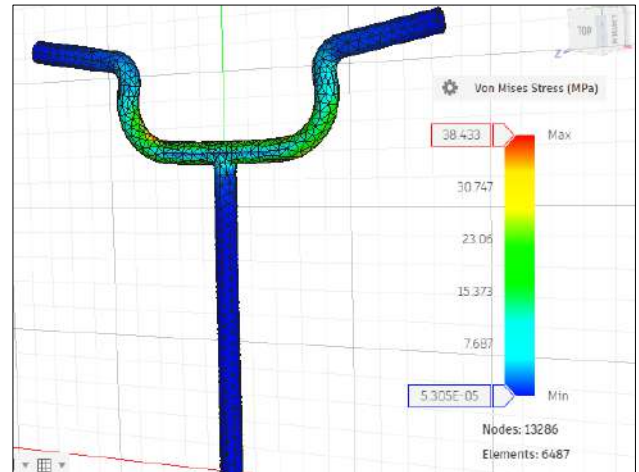
According to the weight distribution, 30:70, Force acting on the front of the vehicle = 456.165 N -500 N

Assuming that these forces are acting on the handlebar in the worst cases

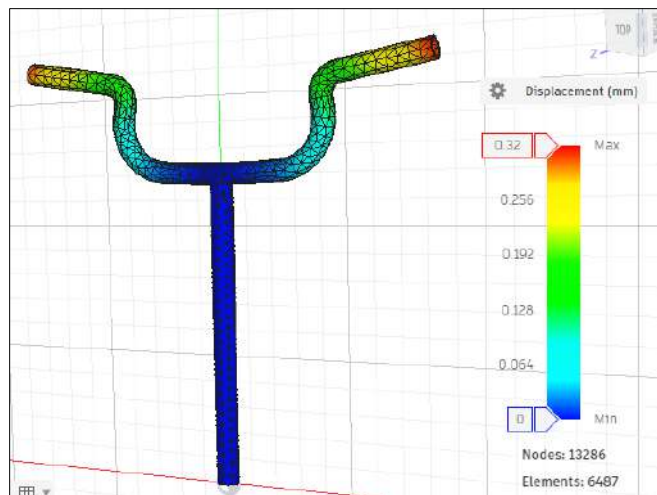
**c) Analysis Results:**



**Fig- 2 Safety Factor**



**Fig- 3 Von Mises Stress**



**Fig- 4 Total Deformation**

Total Deformation	0.32 mm
Equivalent Stress	38.433 MPa
Factor of Safety	5.386

**d) Optimizations:**

The FOS is good enough; thus, no further optimization was required.

### 5.3. SWING ARM:

#### a) Assumptions & Considerations:



Mesh size	8mm
Nodes	16401
Elements	8382

Fig- 1 Boundary conditions with component mesh view

#### Boundary Conditions

Setup	Location	Value
Fixed Constrain	Pivot Points	Fixed
Force 1	wheel mountings	Total : 1065 N (533 N each), Upwards
Force 2	spring mountings	Total : 1491 N (745 N each),Downwards

#### b) Calculations of Forces

$$F = M \times g = 155 \times 9.8m/s^2 = 1521N \text{ (Downward Force on vehicle)}$$

According to the weight distribution 30:70

$$\text{Force acting on the rear of the vehicle} = 1521 \times 0.70 = 1065N \text{ (Approx)}$$

$$\text{Spring force} = 1065 \times \text{leverage ratio} = 1065 \times 1.4 = 1419 N$$

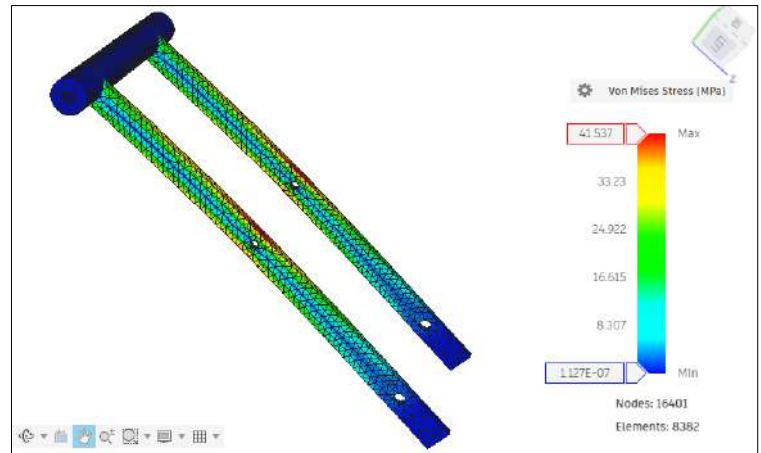
So, On each side Spring force = 745 N

$$\text{Force on each side of a Wheel Mountings} = \frac{1065}{2} = 533N$$

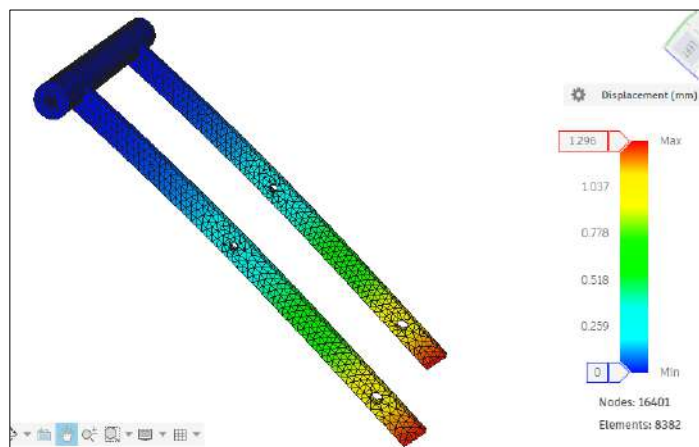
**c) Analysis Result**



**Fig- 2 Safety Factor**



**Fig- 3 Von Mises Stress**



**Fig- 4 Total Deformation**

Total Deformation	1.296 mm
Equivalent Stress	41.537 MPa
Factor of Safety	4.984

**d) Optimizations:**

The FOS is good enough; thus, no further optimization was required.

# ELECTRIC TWO WHEELER DESIGN CHALLENGE

7<sup>th</sup> Edition

## PART DRAWINGS AFTER CAE

**Team ID** : **ETWDC2526023**

**TEAM NAME** : **Team GearHeads**

**INSTITUTION NAME** : **University College of Engineering  
Osmania University**

**FACULTY ADVISOR** : **Dr. E. Madhusudhan Raju**

**TEAM CAPTAIN** : **D. Nivas Reddy**



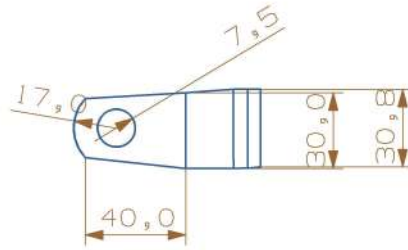
**TEAM CAPTAIN**


D. Nivas Reddy

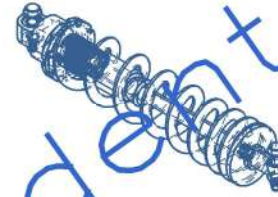
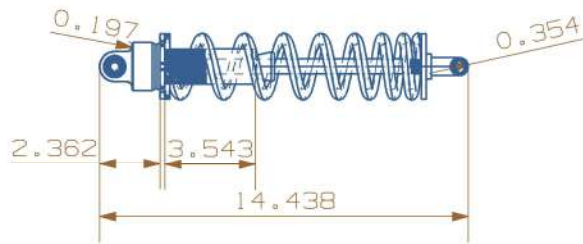


**FACULTY ADVISOR**

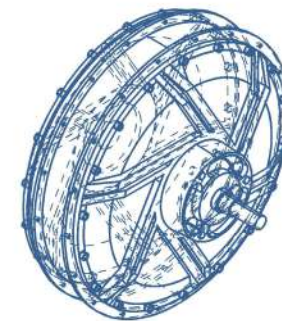
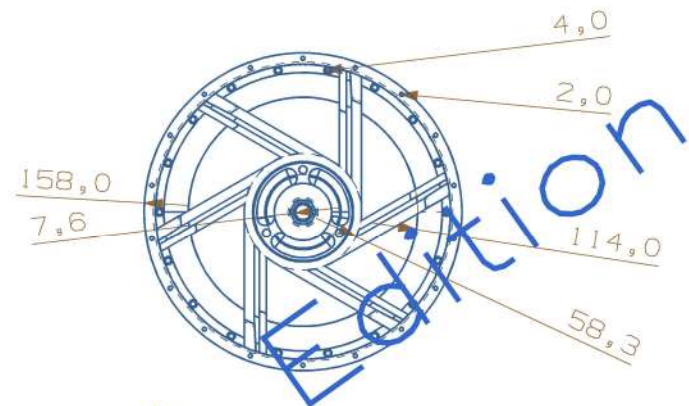
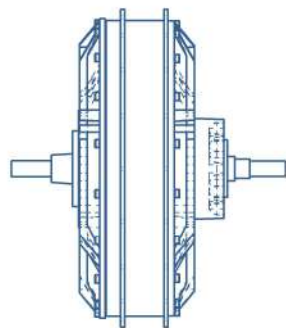
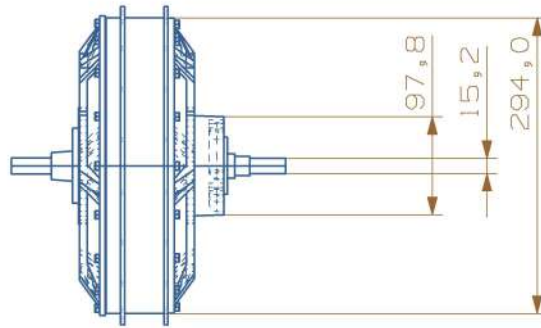
Dr. E. Madhusudhan Raju




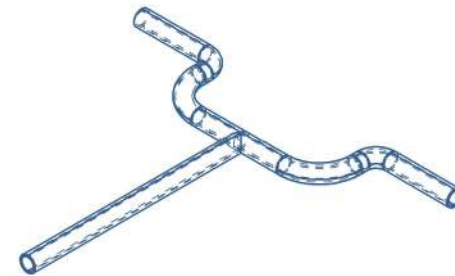
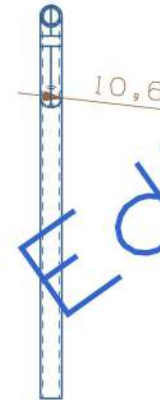
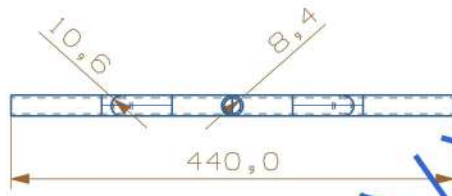
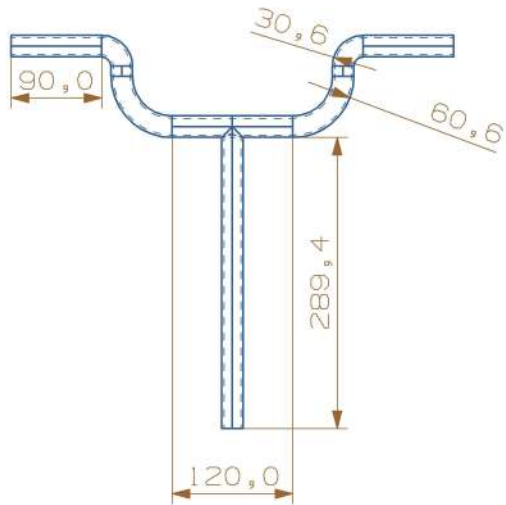
MATERIAL :	mild steel	SAE ETWDC 2025-2026		MASS :	0.5kg
HEAT TREATMENT :	annealing	DESCRIPTION :		SHEET :	1 of 11
SURFACE TREATMENT :	zinc plating	PART :	MOUNTING TAB		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	FRM-002		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					




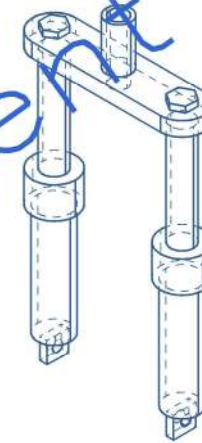
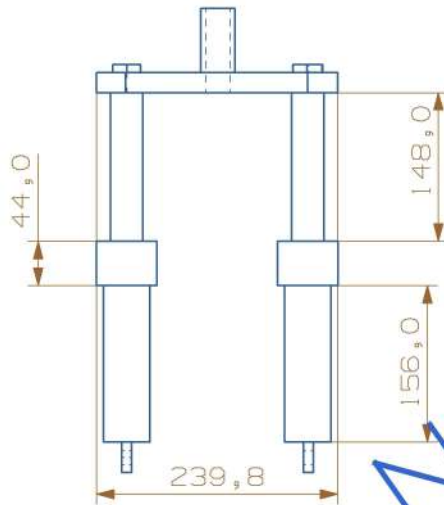
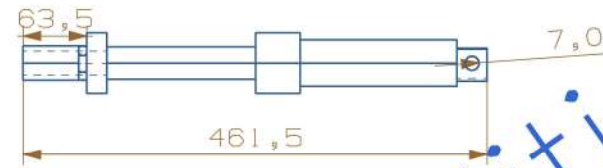
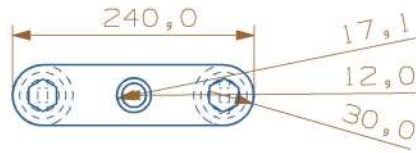
MATERIAL :	alloy steel	SAE ETWDC 2025-2026		MASS :	2.7kg
HEAT TREATMENT :	quenching and tempering	DESCRIPTION :		SHEET :	2 of 11
SURFACE TREATMENT :	nitriding, chrome plating	PART :	MONO SHOCK ASSEMBLY		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	SUS-001,2,3, 4,5,6,8,9,10		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					




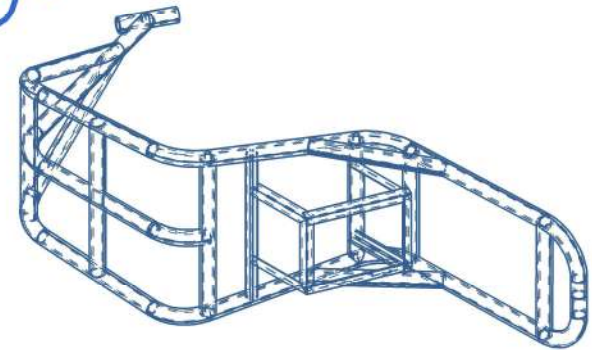
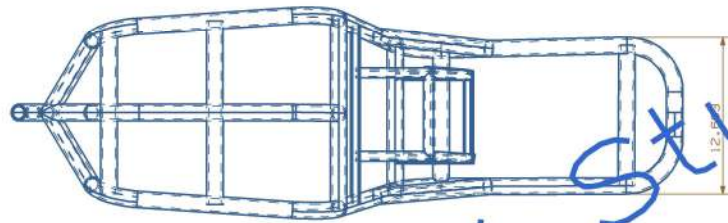
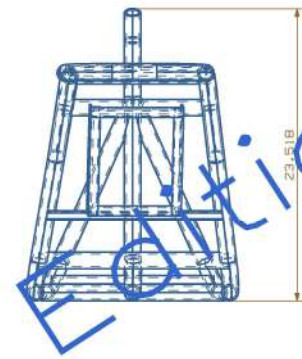
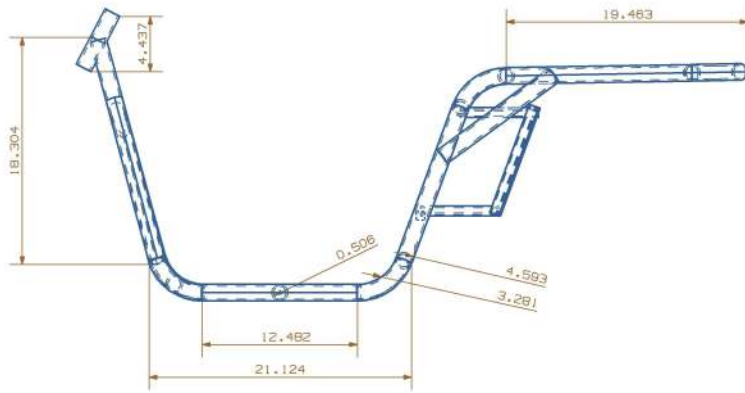
MATERIAL :	cast aluminium alloy	SAE ETWDC 2025-2026		MASS :	6.5kg
HEAT TREATMENT :	annealing	DESCRIPTION :		SHEET :	3 of 11
SURFACE TREATMENT :	anodizing aluminium, ferrofluid cooling	PART :	HUB MOTOR		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	ELS-007		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					



MATERIAL : mild steel HEAT TREATMENT : tempering SURFACE TREATMENT : painting, powder coating VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION <b>BY TEAM GEAR HEADS</b> UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY	SAE ETWDC 2025-2026		MASS :	1.5kg
	DESCRIPTION :		SHEET :	4 of 11
	PART :	HANDLE BAR		
	PART NO :	STR-001		
	SCALE :	1:5		

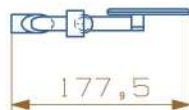
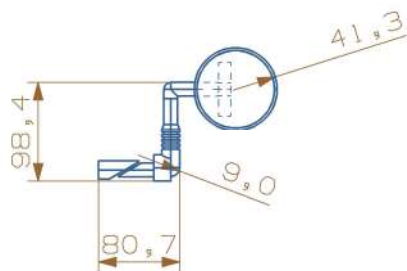



MATERIAL :	alloy steel	SAE ETWDC 2025-2026		MASS :	4kg
HEAT TREATMENT :	induction hardening, quench & temper	DESCRIPTION :		SHEET :	5 of 11
SURFACE TREATMENT :	chrome plating, anodizing	PART :	FRONT FORK		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	SUS-002,3,4		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					

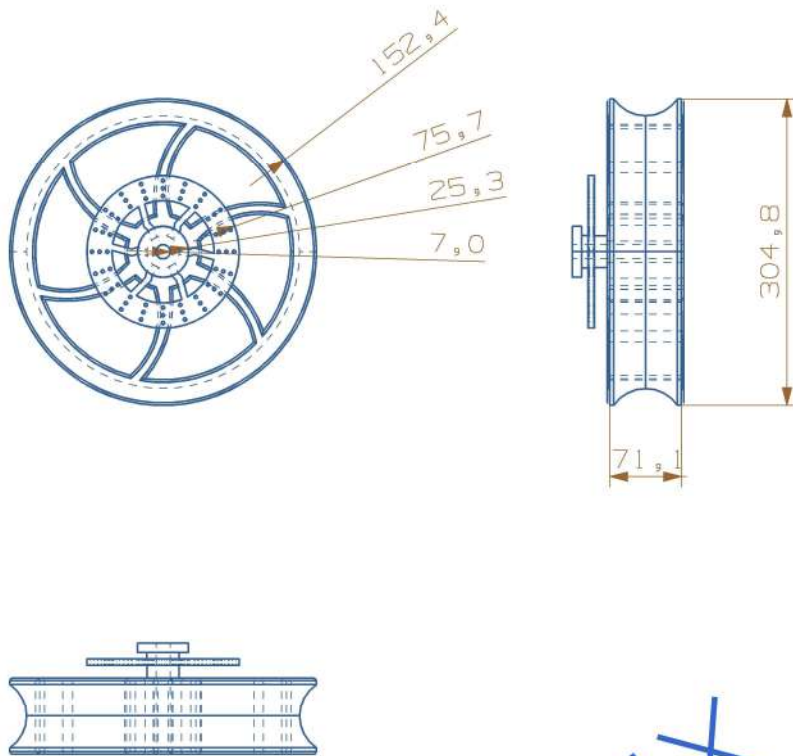



Created by NX Student Edition

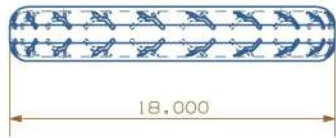
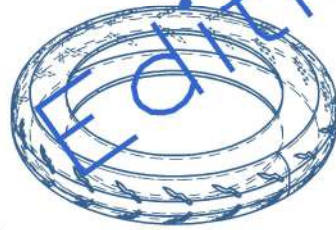
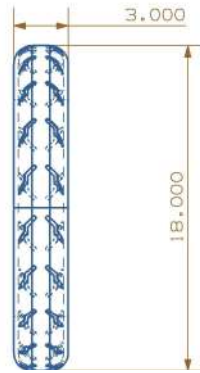
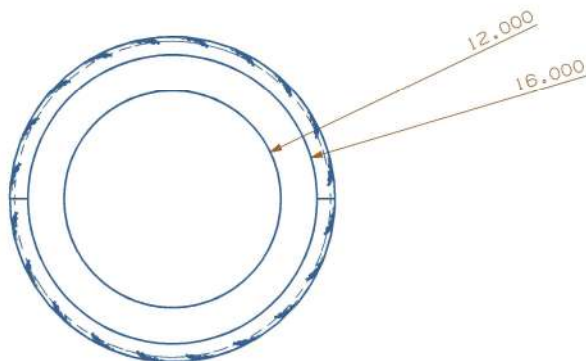
MATERIAL :	steel AISI 1020 107 HR	SAE ETWDC 2025-2026	MASS :	15 kg
HEAT TREATMENT :	normalizing, stress relieving	DESCRIPTION :	SHEET :	8 of 11
SURFACE TREATMENT :	anti-corrosion paint	PART :	FRAME	
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	FRM-001	
		SCALE :	1:5	
BY TEAM GEAR HEADS				
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY				



MATERIAL : HEAT TREATMENT : SURFACE TREATMENT : VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION	ABS plastic (casting + stem)	SAE ETWDC 2025-2026		MASS :	1.2 kg (0.6 kg each)
	none	DESCRIPTION :		SHEET :	7 of 11
	chrome plating, painting	PART :	MIRROR		
		PART NO :	ACC-007		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					



MATERIAL :	cast aluminium alloy	SAE ETWDC 2025-2026		MASS :	3kg
HEAT TREATMENT :	solution treating (aluminium)	DESCRIPTION :		SHEET :	8 of 11
SURFACE TREATMENT :	anodizing, polishing, painting	PART :	RIM		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	WHA-002		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					




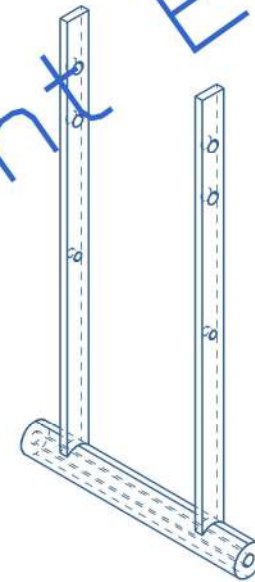
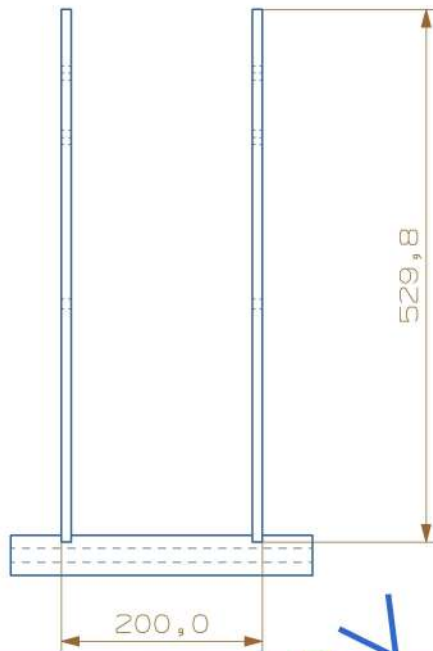
MATERIAL :	synthetic rubber	SAE ETWDC 2025-2026		MASS :	6kg (3kg each)
HEAT TREATMENT :	not applicable	DESCRIPTION :		SHEET :	9 of 11
SURFACE TREATMENT :	rubber vulcanization	PART :	TYRE		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	WHA-001		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					


10,0

190,0

220,0

MATERIAL :	alloy steel	SAE ETWDC 2025-2026		MASS :	0.8kg
HEAT TREATMENT :	quenching and tempering	DESCRIPTION :		SHEET :	10 of 11
SURFACE TREATMENT :	nitriding, case hardening	PART :	SPINDLE		
		PART NO :	STR-003		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		SCALE :	1:5		
<div></div>					
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					



MATERIAL :	mild steel	SAE ETWDC 2025-2026		MASS :	4.5kg
HEAT TREATMENT :	normalizing, solution treating	DESCRIPTION :		SHEET :	11 of 11
SURFACE TREATMENT :	anodizing, powder coating	PART :	SWING ARM		
VIEWS POSITIONED ACCORDING TO THIRD-ANGLE PROJECTION		PART NO :	SUS-007		
		SCALE :	1:5		
BY TEAM GEAR HEADS					
UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY					

# **ELECTRIC TWO WHEELER DESIGN CHALLENGE**

## **7<sup>th</sup> Edition**

### **E BOM**

**TEAM ID** : ETWDC2526023

**TEAM NAME** : Team GearHeads

**INSTITUTION NAME** : University College of Engineering, Osmania University

**FACULTY ADVISOR** : Dr. E. Madhusudhan Raju

**TEAM CAPTAIN** : D. Nivas Reddy



**TEAM CAPTAIN**

D. Nivas Reddy



**FACULTY ADVISOR**

Dr. E. Madhusudhan Raju

## ETWDC2025\_GEARHEADS\_EBOM

Sno.	Part No.	Part Name	Sub-system / Part Group	Quantity	Weight (kg)
E BOM					
1.	FRM_001	Chassis	Frame	1	15
2.	FRM_002	Mounting Tabs	Frame		0.5
3.	FRM_003	Hinges	Frame	3	0.3
4.	FRM_004	Fasteners	Frame		0.8
5.	STR_001	Handlebars	Steering	1	1.5
6.	STR_002	Steering stopper	Steering	1	0.2
7.	STR_003	Spindle	Steering	1	
8.	STR_004	Fasteners	Steering		0.1
9.	STR_005	Bushings	Steering		0.3
10.	SUS_001	Spring (F)	Suspension	2	0.9
11.	SUS_002	Slider (F)	Suspension	2	0.6
12.	SUS_003	Stanchion (F)	Suspension	2	2.5
13.	SUS_004	Triple Clamps with Steering Stem (F)	Suspension	1	1.2
14.	SUS_005	Spring (R)	Suspension	1	0.9
15.	SUS_006	Damper (R)	Suspension	1	1.8
16.	SUS_007	Swing arm (R)	Suspension	1	4.5
17.	SUS_008	Spring brackets (R)	Suspension	4	0.4
18.	SUS_009	Bushings	Suspension		0.2
19.	SUS_010	Fasteners	Suspension		0.6
20.	WHA_001	Tubeless tyre (F)	Wheels (Assembly)	1	2.5
21.	WHA_002	Alloy rims (F)	Wheels (Assembly)	1	3.0
22.	WHA_003	Axle (F)	Wheels (Assembly)	1	0.7

23.	WHA_004	Fasteners (F)	Wheels (Assembly)		0.4
24.	WHA_005	Tubeless tyre (R)	Wheels (Assembly)	1	2.5
25.	WHA_006	Axle (R)	Wheels (Assembly)	1	0.7
26.	WHA_007	Fasteners (R)	Wheels (Assembly)		0.4
27.	BRK_001	Disc	Brakes	1	1.2
28.	BRK_002	Calliper	Brakes	1	0.9
29.	BRK_003	Hydraulic line	Brakes	1	0.3
30.	BRK_004	Levers	Brakes	2	0.2
31.	BRK_005	Drum set	Brakes	1	2.5
32.	BRK_006	Brake cable	Brakes	1	0.2
33.	BRK_007	Fasteners	Brakes		0.4
34.	ACC_001	Seat	Accessories	1	4.0
35.	ACC_002	Side stand	Accessories	1	1.0
36.	ACC_003	Centre stand	Accessories	1	3.0
37.	ACC_004	Head light	Accessories	1	0.6
38.	ACC_005	Rear light (brake)	Accessories	1	0.15
39.	ACC_006	Side indicators	Accessories	4	0.1
40.	ACC_007	Sideview mirrors	Accessories	2	0.6
41.	ACC_008	Dashboard	Accessories	1	0.8
42.	ACC_009	Rubber Floormat	Accessories	1	1.2
43.	ACC_010	Horn	Accessories	1	0.3
44.	ACC_011	First aid kit	Accessories	1	0.3
45.	ACC_012	Hand Grips	Accessories	2	0.2
46.	ELC_001	DC-DC converter	Electrical System	1	0.6
47.	ELC_002	Junction Box	Electrical System	1	0.4
48.	ELC_003	MCB	Electrical System	1	0.4

49.	ELC_004	Wire Harness	Electrical System	1	2.0
50.	ELC_005	Ignition Key	Electrical System	1	0.05
51.	ELC_006	Charging Port	Electrical System	1	0.2
52.	ELC_007	48V 1000W BLDC Hub Motor Kit	Electrical System (Traction Battery)	1	6.5
53.	ELC_008	48V 24Ah Li Ion Battery	Electrical System	1	10
54.	ELC_009	Charger	Electrical System	1	1.2
55.	ELC_010	Kill Switch	Electrical System	1	0.05
56.	ELC_011	Dashboard	Electrical System	1	0.3
57.	ELC_012	Fasteners	Electrical System		0.2
58.	ACC_013	Body Panels	Others		6.0
59.	ACC_014	Mud Guards	Others	2	1.0
60.	ACC_015	Fire Extinguisher Tubes	Others	1	0.8
61.	ACC_016	Fasteners	Others		0.5
62.	ACC_017	Water Detecting Sensor	Others		0.05
63.	ACC_018	LED bulbs	Others	6	0.1
64.	ACC_019	Blank PCB	Others	1	0.05
65.	ACC_020	Arduino	Others	1	0.03
66.	ACC_021	Buzzer	Others	1	0.02
Total Weight (in kgs)					90.9

ETWDC 2025

# **ELECTRIC TWO WHEELER DESIGN CHALLENGE**

## **7<sup>th</sup> Edition**

### **E BOM COST ESTIMATE**

**TEAM ID** : ETWDC2526023

**TEAM NAME** : Team GearHeads

**INSTITUTION NAME** : University College of Engineering, Osmania University

**FACULTY ADVISOR** : Dr. E. Madhusudhan Raju

**TEAM CAPTAIN** : D. Nivas Reddy



**TEAM CAPTAIN**

D. Nivas Reddy



**FACULTY ADVISOR**

Dr. E. Madhusudhan Raju

# ETWDC E-BOM COST ESTIMATE

## ETWDC E-BOM COST ESTIMATE

S.No	Part No	Part Name	Part Group	Unit Price	Quantity	Total Price
MATERIAL COSTS						
1	SUS-001	SPRING(F)	FRONT SUSPENTION	150	2	300
2	SUS-002	SLIDER(F)	FRONT SUSPENSION	200	2	400
3	SUS-003	Stanchion(F)	FRONT SUSPENSION	120	2	240
4	SUS-004	Triple Clamps with Steering Stem(F)	FRONT SUSPENSION	280	1	280
5	SUS-005	SPRING(R)	REAR SUSPENSION	300	1	300
6	SUS-006	DAMPER	REAR SUSPENSION	400	1	300
7	SUS-007	Swing Arm(R)	REAR SUSPENSION	250	1	250
8	SUS-008	Swing Brackets(R)	REAR SUSPENSION	100	4	400
9	SUS-009	BUSHING	SUSPENSION			
10	SUS-010	FASTENERS	SUSPENSION			
11	STR-001	HANDLE BAR	STEERING	300	1	300
12	STR-002	STEERING STOPPER	STEERING	100	1	100
13	STR-003	SPINDLE	STEERING	50	1	50
14	STR-004	FASTENERS	STEERING			
15	STR-005	BUSHING	STEERING			

16	FRM-001	CHASIS	FRAME	1000	1	1000
17	FRM-002	MOUNTING TAB	FRAME			
18	FRM-003	HINGES	FRAME	75	3	225
19	FRM-004	FASTENERS	FRAME			
20	BRK-001	DISC	BRAKES	400	1	400
21	BRK-002	CAPILLERS	BRAKES	1000	1	1000
22	BRK-003	HYDRAULIC LINE	BRAKES	780	1	780
23	BRK-004	LEVERS	BRAKES	180	2	180
24	BRK-005	DRUM SET	BRAKES		1	
25	BRK-006	BRAKE CABLE	BRAKES	330	1	330
26	BRK-007	FASTENERS	BRAKES			
27	WHA-001	TUBELESS TYRE	FRONT/REAR WHEEL	1200	2	2400
28	WHA-002	RIMS	FRONT/REAR WHEEL	500	1	
29	WHA-003	AXLE	FRONT/REAR WHEEL	179	2	358
30	WHA-004	FASTENERS	FRONT/REAR WHEEL			
31	ACC-001	SEAT	ACCESSORIES	600	1	600
32	ACC-002	SIDE STAND	ACCESSORIES	180	1	180
33	ACC-003	CENTRE STAND	ACCESSORIES	995	1	995
34	ACC-004	HEAD LIGHT	ACCESSORIES	400	1	400
35	ACC-005	REAR LIGHT	ACCESSORIES	300	1	300

36	ACC-006	SIDE INDICATORS	ACCESSORIES	70	4	280
37	ACC-007	SIDEVIEW MIRRORS	ACCESSORIES	100	2	200
38	ACC-008	DASHBOARD	ACCESSORIES	1800	1	1800
39	ACC-009	FLOORMATS	ACCESSORIES	150	1	150
40	ACC-010	HORN	ACCESSORIES	200	1	200
41	ACC-011	BODY PANEL	ACCESSORIES			
42	ACC-012	MUD GUARDS	ACCESSORIES	300	2	600
43	ACC-013	KILL SWITCH	ACCESSORIES	150	1	150
44	ACC-014	FIRE EXTINGUISHER TUBES	ACCESSORIES	236	1	236
45	ACC-015	PCB	ACCESSORIES	55	1	55
46	ACC-016	AUDRINO BOARD	ACCESSORIES	300	1	300
47	ACC-017	LEDs	ACCESSORIES	10	6	60
48	ACC-018	FIRST AID KIT	ACCESSORIES	200	1	200
49	ACC-019	FASTENERS	ACCESSORIES			
50	ELC-001	DC-DC CONVERTER	ELECTRICAL SYSTEMS	2000	1	2000
51	ELC-002	JUNCTION BOX	ELECTRICAL SYSTEMS	900	1	900
52	ELC-003	MCB	ELECTRICAL SYSTEMS	700	1	700
53	ELC-004	WIRE HARNESS	ELECTRICAL SYSTEMS	750		750
54	ELC-005	IGNITION KEY	ELECTRICAL SYSTEMS	200	1	200
55	ELC-006	CHARGING PORT	ELECTRICAL SYSTEMS	800	1	800
56	ELC-007	48V 1000W BLDC MID DRIVE MOTOR KIT	ELECTRICAL SYSTEMS	5000	1	5000

57	ELC-008	48V 24A Li ION BATTERY	ELECTRICAL SYSTEMS	20000	1	20000
58	ELC-009	CHARGER	ELECTRICAL SYSTEMS	1000	1	1000
59	ELC-010	FASTENERS	ELECTRICAL SYSTEMS			
MATERIALS COST						47649
MANUFACURTING COST						
1	MFD-001	FRAME FABRICATION	MANUFACTURING	7500	1	7500
2	MFD-002	MACHINING	MANUFACTURING	800	1	800
3	MFD-003	PAINTING	MANUFACTURING	2500	1	2500
MANUFACURTING COST						10800
TOTAL COST:						58449



# E-COMMUTER

## TEAM GEARHEADS



# NEW URBAN RIDER

## E-COMMUTER

Made for city.  
Effortlessly.



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✉ Email ID: etwdc2526023@gmail.com



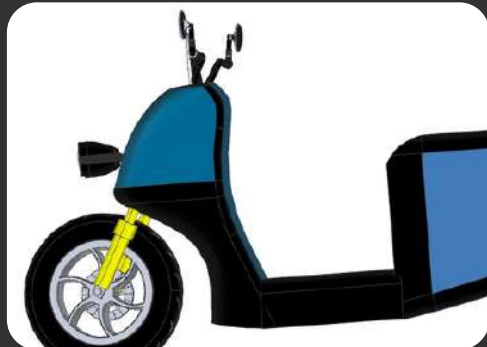
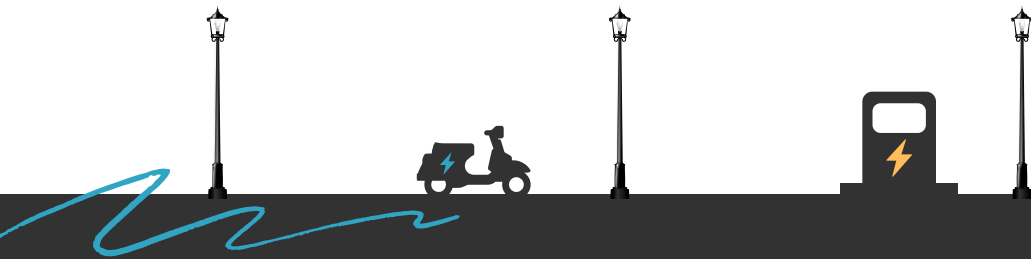
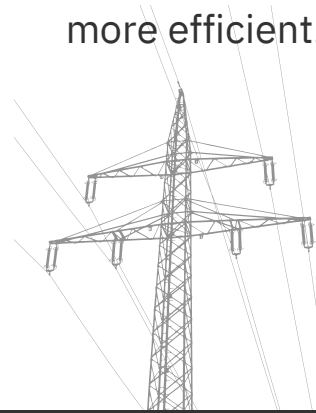
E-Commuter. Made for city. Effortlessly.

# ABOUT VEHICLE

Meet your perfect everyday companion on the road, a stylish, efficient and eco-friendly electric two-wheeler built for today's city life riders. Blending modernism with engineering to present you our E-Commuter. Designed while keeping in mind the comfort of an everyday ride. Whether you're navigating busy streets or cruising through your neighborhood, this ride is designed to keep you moving with ease and confidence.

## FEATURES

Packed with smart technology and rider-friendly design, this electric two-wheeler comes with features that make every ride smoother, safer and more efficient.



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