A PROJECT REPORT

ON

"IMPROVEMENT IN DESIGN OF CHASSIS AND TRANSMISSION SYSTEM OF A FOUR WHEEL ELECTRIC SCOOTER FOR HANDICAP"

Submitted by

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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

PROF. ZIA MOMIN

DEPARTMENT OF MECHANICAL ENGINEERING

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NAVI MUMBAI – 410206

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KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE,

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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Submitted by

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In partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering, as prescribed by University of Mumbai approved.

(Internal Examiner) **(External Examiner)**

____________________ ____________________

Date: ___________

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

This report aims to model, simulate, perform the static and dynamic analysis of a four wheel electric scooter chassis consisting of square and rectangular beams. modeling and simulation are performed using modeling software that is AUTODESK INVENTOR and analysis on ANSYS.

The maximum deflection is determined by performing static analysis and dynamic analysis. As we had to customize scooter so it can be use for indoor and outdoor purpose both. Keeping that into mind we had design our chassis. Strength and light weight were our basic consideration through out the design of electric scooter.

Hence, AISI1018 was selected as an appropriate material fir design which is medium carbon steel with properties such as light weight, height tensile strength, higher machine ability, better weld ability etc.

All the impact and stresses were calculated manually by considering the severe working condition and then the design was analyzed on the software.

After the complete and the approval of design by inspecting it in all the modes of failure type design was finalized.

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Chapter 1

Introduction

Chapter 1, Section 1

1.1 Introduction

India is the 2nd country by population and has one of the busiest road networks. Because of the large population, accidents are frequent, and they are a major cause of death in the country.

Two-wheeler accidents account for more than a third of all road accidents. The frame of the bike is one of the most important parts to remember in order to minimize the risk of accidents on the rider.

A chassis of two wheeler's consists of the frame, wheels, and suspension. The frame determines the style of the two-wheeler. The frame is the vehicle's primary carriage structure. The frame serves as the skeleton upon which the engine and transmission are mounted. The frame may be made of aluminum, steel, or an alloy that will not buckle in the event of road undulations.

Furthermore, any distortion should not be transmitted to the human body, so the frame's torsion resistance should be high.

The frame also supports a variety of components such as the bench, bodywork, and accessories. The frame also houses the battery and Motor. The frame must be able to withstand vehicle shocks and impacts while also providing stiffness, shielding the consumer and critical vehicle components.

The transmission, steering, and suspension all have an effect on the frame design. The analysis depends on various factors. We have chosen to include impact and weight analysis among these variables.

In addition, a successful design must be cost-effective and stable under severe loading conditions

1.2 Problem Statement

- To Entirely change the chassis design because The old chassis design was overweight and over engineered.
- To only use BLDC motor to transmit power to rear wheels instead of hub motor.
- Currently the weight of chassis is 158Kg. we need to reduce it at least by 50Kg

Chapter 2

Literature Review

Chapter2, Section 1

2.1 Literature Review

According to a survey done by WHO it was found that around 7 lac accidents occur every year in India. Out of these 2.3 lac people becomes permanently disabled. Out of these permanently disabled peoples around 50% are disabled by lower limbs. The person with such a disability are laid on the bed for rest of their life. They cannot take part in any social activity. They are dependent on others for their needs. As time passes by they are isolated by the society. Due to which they starts feeling lonely, and eventually results in the death of the disabled person due to depression. This can be avoided by bringing them to their social life. In order to overcome this problem, the solution is a mobility scooter which can be used by the disabled person not only for outdoor purpose but also for indoor. This mobility scooter will help them to return to normal life. It will also make them independent.

An electric scooter is a battery-operated one-person capacity vehicle that is specially designed for people with low mobility. It is generally used by those who have difficulty walking or standing for long periods of time. Scooters are available in three common designs, those intended for indoor use, those for outdoor use, and those that are used for both. An electric scooter is different from a motorized wheelchair, in that the wheelchair is generally intended for indoor use and usually costs a great deal more. Some people are a little wary of purchasing an electric scooter because they fear it will be difficult to operate. In fact, the control console makes it quite simple once a person gets the feel for it.

2.2 Scooter Operation

Generally, there is several type of scooter. The way how to produce power for this kind of transport is depend on its want to use. High power scoter usually use small engine with gasoline. Another type is using electric motor operation whether dc or ac motor. This kind of bike usually use in small area and for recreation.

2.2.1 Engine Powered Scooter

This type of scooter usually use small capacity engine. Normally around 40 to 60 cubic capacities (cc). This kind of engine can be found whether four-stroke or two stroke engine. This small engine scooter usually looks like small super bike. It can speed up until 50 to 60 km/h. Safety clothes should be used for precaution safety while ride this type of bike. This kind of scooter usually can be found at place which already has their club track. The sound of this bike is little bit noise but it looks very nice.

2.2.2 Electric Motor Scooter

Generally, the source of power for the electric motor has been batteries, but development in fuel cell technology has created several prototypes. Some examples are: the ENV from Intelligent Energy, Honda's scooter using the Honda FC Stack, and the Yamaha FCAQEL. Also, petroleum hybrid-electric motorcycles are under development. Some examples are the E-cycle, and Yamaha's Gen-RYU. Figure 2.3 is example of scooter using electric motor with stand riding operation.

2.2.3 Mobility Scooter

This is a modified version of the electric scooter and is made for special people like the disabled and the aged people. These scooters are extremely stable, as they have more than two wheel or four wheel

Chapter 3

Methodology

Chapter 3, Section 1

3.1 Methodology

Flow of our work is as follows:

1. Literature Review

a. Make review on other model and type of scooters

b. Focusing on how to make it simple and relevance to the project title.

2. Design Calculation

a. Calculation of torque and power required to drive the vehicle.

b. Estimating wheel size

3. Design Layout

a. Designing of block/circuit diagram

b. Arrangement on chassis

4. Market Survey

a. As per our design calculation we visited few suppliers and as per the availability and cost - motor, battery, tire and controller selection is done

5. Modification Design

a. As per the parts available the design has been modified

6. Prototyping Development

a. Assemble all the part to the design.

7. Testing

a. Run the model

b. Tuning of prototype according to problem if any

8. Documentation

a. Preparing a report for the project

Chapter 4

Material Selection

Chapter 4, Section 1

4.1 Material Selection

AISI-1018 is used for the chassis. This material was chosen for its excellent combination of steel strength, ductility, and corrosion resistance, and comparative ease of machining and weldability.

The properties of material are presented in the

table 4. 1

PROPERTIES	VALUE
Modulus of elasticity	205 GPa
Hardness, Brinell	126
Ultimate stress	440 MPa
Elongation at break (in 50mm)	15.0%
Bulk modulus	140 GPa
Poisons Ratio	0.290
Shear Modulus	80 GPa

Table 4.1 Material properties

Chapter 5

Chassis Design

Chapter 5, Section 1

5.1 Chassis Design

The chassis is a important part of any vehicle. So the vehicles are either preferred to be made up of hollow pipes or super tubular cross section so as to make it light weight and shock absorbent.

Chapter 5, Section 2

5.2 Dimension of chassis

Overall Width : 19.03 inch

Overall length : 45.09 inch

Seat to floor height : 30 inch

Ground clearance : 8 inch at chassis

Weight : 102 kg

Material : AISI1018

As the design of vehicle is distributed in two groups we are working or Design of chassis and Transmission part and the other group is working on Suspension and steering. After we forward the dimension of chassis they will finalize the mounting of suspension and steering.

Chapter 5, Section 3

5.3 New chassis

According with these dimensions we have once again drawn the chassis in 2D Diagram on the sheet but this time we are using hollow square cross section of 1 inch diameter and the other rectangular cross section of 2×2 inch as the total weight of chassis is **102 kg**

Scooter is not having much height so there will be not much vibration and because the wheel track is also less therefore there is no need of differentials for power transmission.

Chapter 5, Section 4

5.4 Re-modification

- After providing the details of chassis to the team working on suspension and steering they found that they are facing problem in the mounting of suspension and steering.
- Now to fulfill their need of mounting of suspension on the vehicle we have to make modifications in the current chassis.
- So after they have decided the inclination angle of suspension and position we will design our chassis.
- As the other team has to make the suspension independent keeping that into mind we have to give mounting for the part they will be introducing.
- After a series of change in design. The new design of chassis is made on Autodesk Inventor 2017.
- The software helps a lot to visualize the design in both 2D and 3D to reduce the chance of error in fabrication.
- The main criterion in chassis was to make in light in weight without making in look over engineered and utilizing the space effectively.
- In the previous design there was no space for foot rest of the driver and the battery position was using excessive space.
- By utilizing the space available below the seat of driver we have successfully managed to give space for the foot rest.

5.5 Comparison Between Old and New

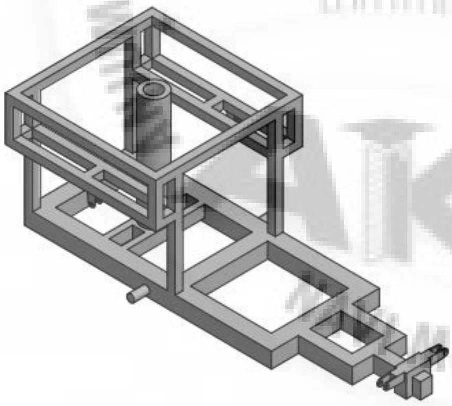
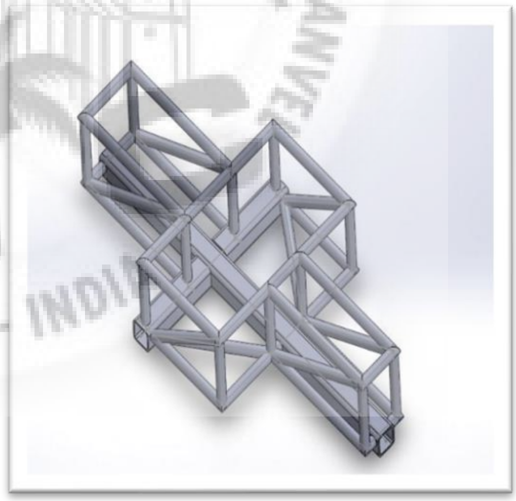
NEW	OLD
Dimensions:- Overall Width : 19.03 inch Overall length : 45.09 inch Seat to floor height : 30 inch Ground clearance : 8 inch at chassis Weight: 102 kg Material : AISI1018	**Dimensions:-** Overall Width : 24 inch Overall length : 48 inch Seat to floor height : 30 inch Ground clearance : 8 inch at chassis Weight: 158 kg Material : AISI1018
Resolved problems :- Weight Of chassis has been reduced to 101kg from 158kg **Model :-** 	**Problems :-** 1. Over Engineered 2. Inappropriate Battery position 3. Battery position **Model :-** 

Table 5.5

Chapter 6

Structural Analysis

Chapter 6, Section 1

6.1 Structural Analysis (ANSYS)

After finalizing our design on INVENTOR and paper work, we have to analyze our design, for that we have to use a software. Mathematically or on papers it is very difficult to find out different types of forces, deflection, failure, etc. on our designed vehicle. There are number of softwares available for analysis of design such like AUTODESK Inventor, ANSYS, etc. But the ANSYS was the software which was the suitable for us to use it also it gives the better results than AUTODESK Inventor.

The purpose for using ANSYS, the software used is:

1. To find static structural analysis.

2. To find torsional analysis.

3. To find various forces acting on each member and to study the failure of frame.

4. To study von-Mises Stresses.

5. To find the total deformation.

6. To evaluate elastic strength intensity.

7. To find the strain energy.

For completing the analysis on the specified software, we have to perform the following steps stated below as our model design is made by using a software as SOLIDWORKS.

1. Geometry cleanup

2. Selection of material and applying material properties in analysis

3. Importing '.ipt' file format to ANSYS

4. Definition of contacts and mesh formation

5. Defining forces and supports

6. Solution for given system using solver

7. Plotting the results

To perform the analysis on the given model in ANSYS, first of all we have to import our model into ANSYS, whereas in ANSYS, it requires '.ipt' file format.

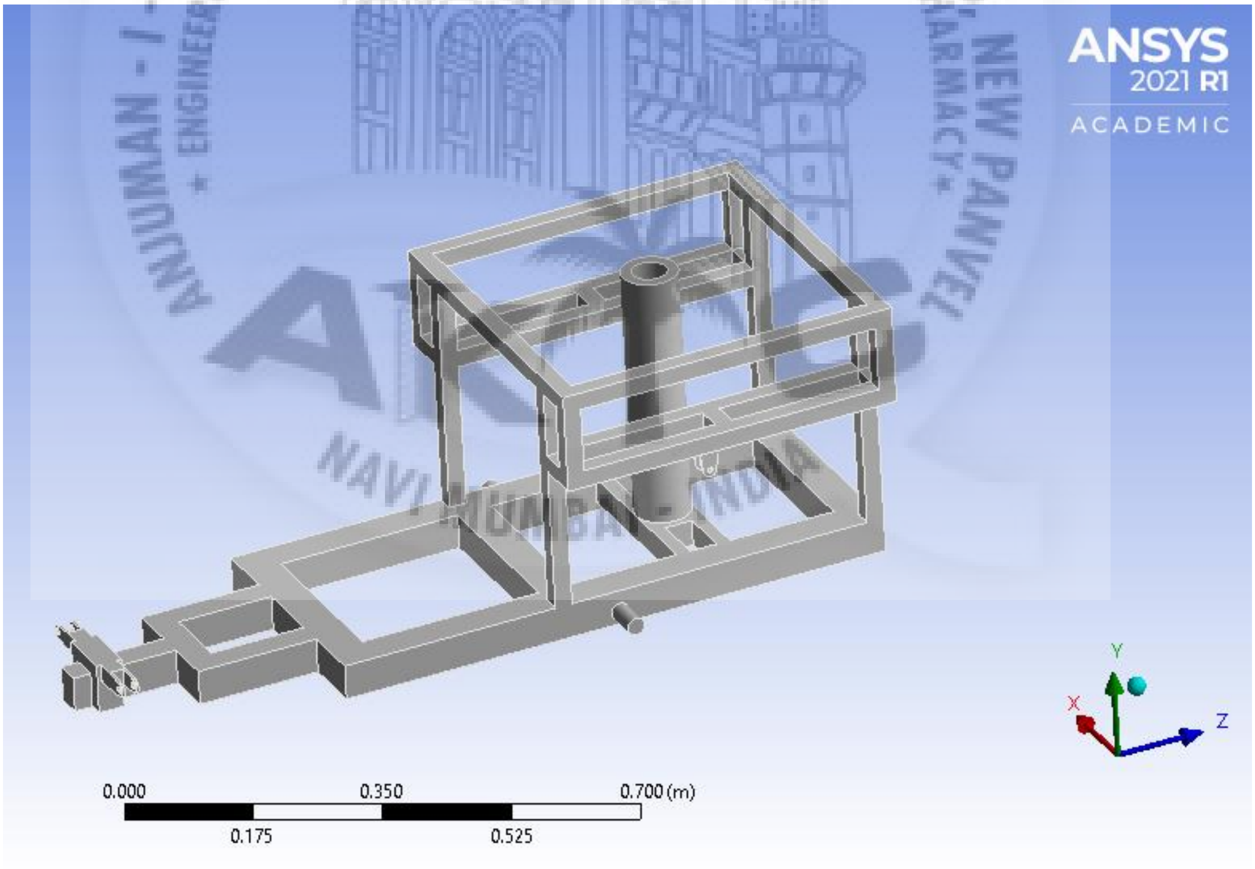


Fig. 6.1:Importing model from INVENTOR to ANSYS

Chapter 6, Section 2

6.2 Geometry Cleanup

Geometry cleanup is a task to clarify all the connections and joints of the model given. If we do not go for geometry cleanup, the software used ANSYS will not accept the model made as it will not be able to mesh it.

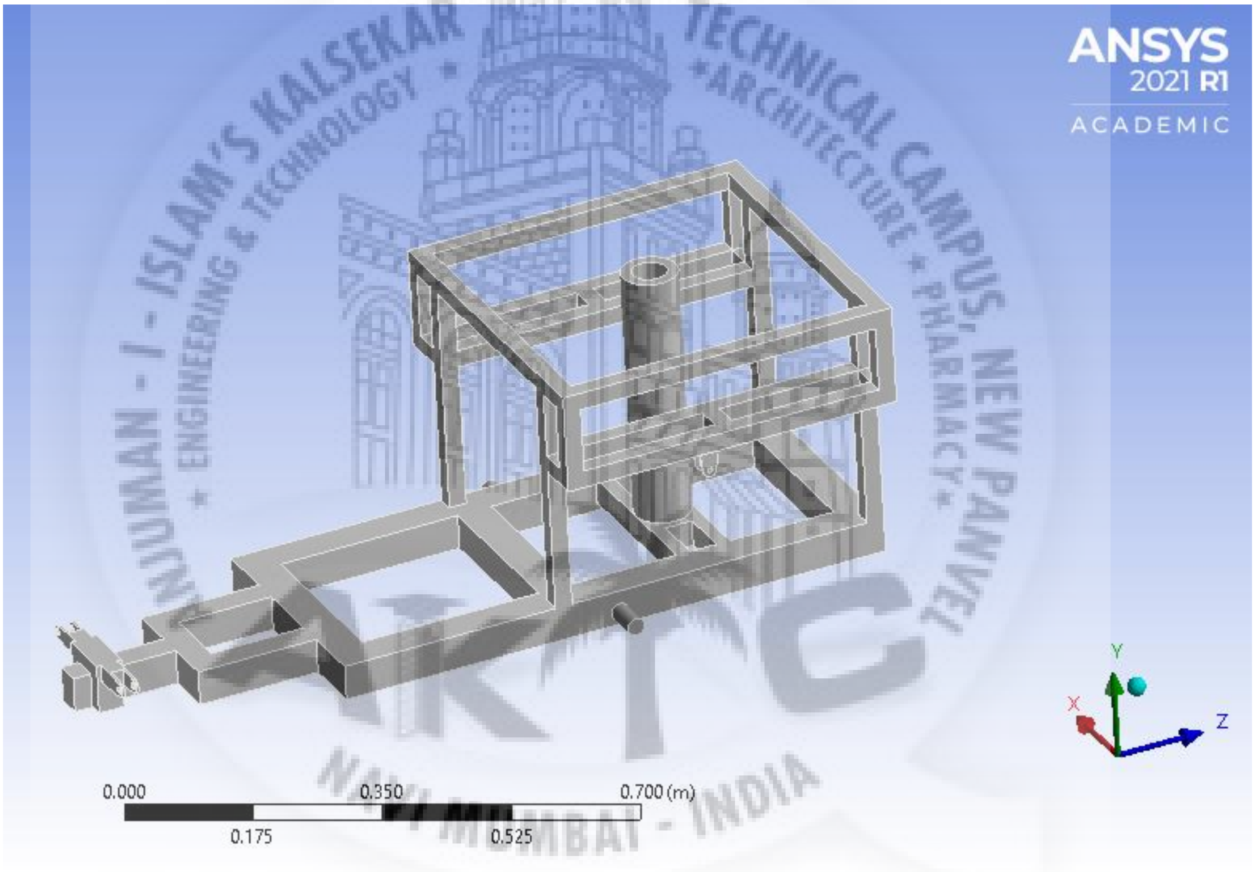


FIG 6.2. Geometry cleanup

6.3 Material Selection

In chapter 4 we studied a material AISI 1018. And on the basis of obtained by different resources' results, we selected the AISI 1018 as our vehicle material. We gone to the material library on our software i.e ANSYS but in that library we did not find our chosen material, therefore we made a new material there as AISI 1018 on the basis of our predefined material's standard properties.

When we assigned our made material to the model we found the different values of properties of our vehicle as given in the following table:

PROPERTY	VALUE
Density	7.87g/cc
Ultimate tensile strength	440 Mpa
Yield strength	370 Mpa
Modulus of elasticity	205 Gpa
Poisson's ratio	0.29

Table 6.3 Material Selection

Properties of Outline Row 3: AISI 1018

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	7.87	g cm^-3		
4	Isotropic Elasticity				
5	Derive from	Bulk Mo...			
6	Young's Modulus	2.05E+05	MPa		
7	Poisson's Ratio	0.29			
8	Bulk Modulus	1.627E+05	MPa		
9	Shear Modulus	79457	MPa		
10	Tensile Yield Strength	370	Pa		
11	Tensile Ultimate Strength	440	Pa		

Table 6.3 Material Selection

Chapter 6, Section 4

6.4 Import of Geometry

As explained in section 5.1 we have to import the INVENTOR'.ipt' file into '.IGS' file format and the IGS file is generated to ANSYS.

Chapter 6, Section 5

6.5 Connections and Mesh

6.5.1 Connections

Different Contacts As we imported the geometry, ANSYS has automatically identified the free geometry, single geometry and multiple geometry and we also identified the different types of connections.

6.5.2 Mesh

Meshing is probably the most important part in any of the computer simulations, because it can show drastic changes in results we get. Meshing means creating a closed geometry of some grid-points called 'nodes'. The results are calculated by solving the relevant governing equations numerically at each of the nodes of the mesh. The governing equations are almost always a partial differential equations and finite element method (FEA) is used to find solutions to such equations. The pattern and positioning of nodes also affects the solution, good meshing is very essential for a computer simulation to give better results.

In our model we also did the meshing after importing and identifying the connections in ANSYS software. There three types of meshing are available with this software as fine meshing, medium meshing and coarse meshing. We did the coarsemeshing.

The geometry of mesh can be of any shape as triangular meshing or quadrilateral meshing, etc. but here we did the triangular meshing as it was program controlled and we did not changed it. We can see that in table it is shown as program controlled.

Details of "Mesh"

Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Use Adaptive Sizing	Yes
Resolution	Default (2)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Fast
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Diagonal	1.3118 m
Average Surface Area	8.3329e-003 m²
Minimum Edge Length	2.e-003 m

Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Advanced	
Statistics	
Nodes	5940
Elements	2329

Table.6.5 Meshing

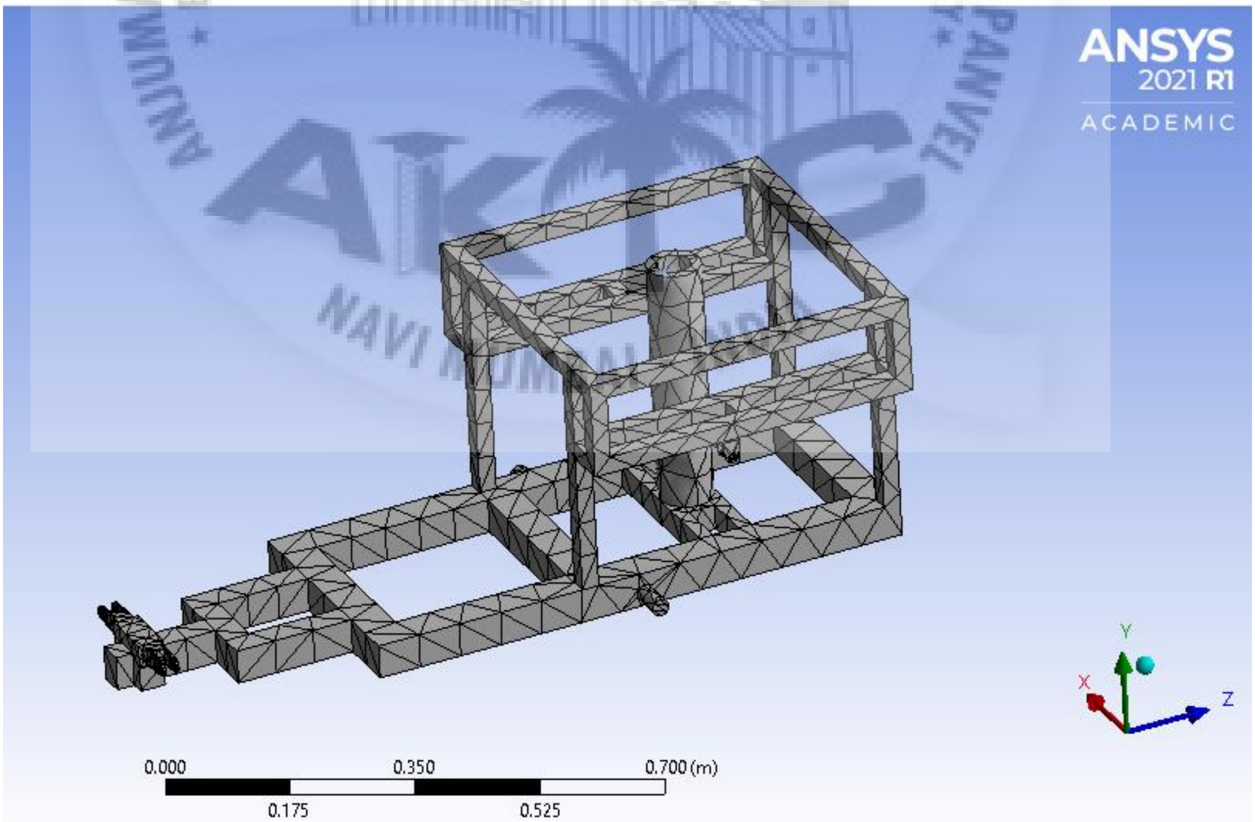


FIG 6.5 Mesh analysis

Chapter 6 , Section 6

6.6 Supports and Forces

6.6.1 Supports

To find out the magnitude of the forces, such like in mathematical problems we have to fixed the different types of supports such as fixed support, hinged support, roller support or pin support, etc. we have to defined it. Supports are thought of in terms of degree of freedom (DOF) available for the elements used. Supports, regardless of actual names, are always defined in terms of degree of freedom. Supports having a direction component can be defined in global or local coordinate system.

In our model we have fixed the two members linked with the forks of front and rear wheels as fixed supports such that a square horizontal bar with steering bar to which the front forks are joined and a horizontal square bar of main chassis frame to which the rear forks are attached. Since these are linked with the wheels that is they are resting or their loads are acting directly to the ground. The different loads are shown in fig below.

Details of "Fixed Support"

Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
Type	Fixed Support
Suppressed	No

Table 6.6.1 fixed support

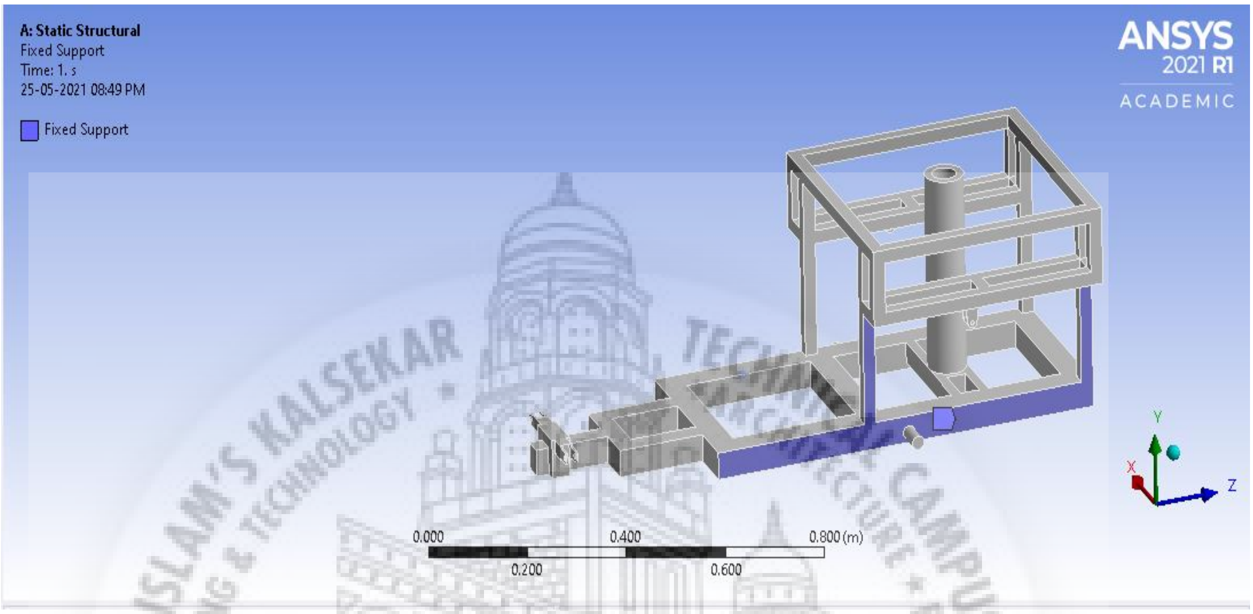


FIG 6.6.1.fixed support 1

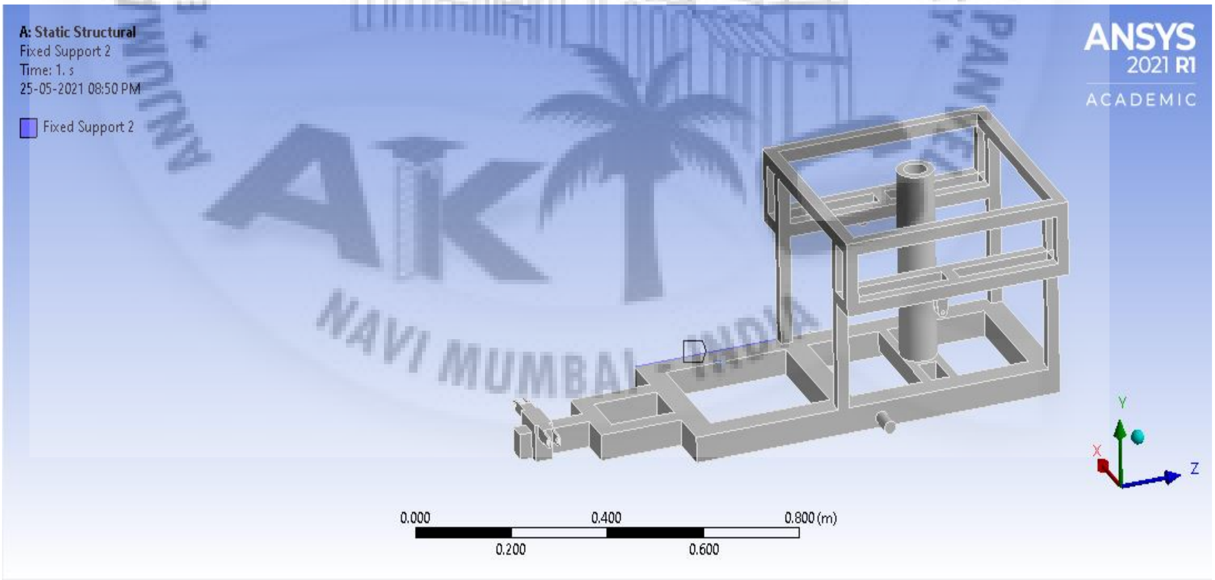


FIG.6.6.1 fixed support 2

6.6.2 Forces

(Loads) These are the actual reasons for the failure of any system. There are different types of loads acting on the entire system which are as follows:

1. **Inertial loads:** These loads act on the entire system where density is required for mass calculations and these are only loads which act on defined point masses
2. **Structural loads**: Forces or moments acting on parts of system.
3. **Structural supports:** Constraints that prevent movements on certain regions.
4. **Thermal loads:** The thermal loads which result in a temperature field causing thermal expansion or contraction in the model.

After analysing we have found the results as follows:

Load Magnitude= [(Person wt.=70kg)+(Accessories wt.=30kg)]=100kg=100*10=1000N

Type	Force
Define By	Components
Applied By	Surface Effect
Coordinate System	Global Coordinate System
X Component	0. N (ramped)
Y Component	-1000. N (ramped)
Z Component	0. N (ramped)
Suppressed	No

Table6.6.2.force

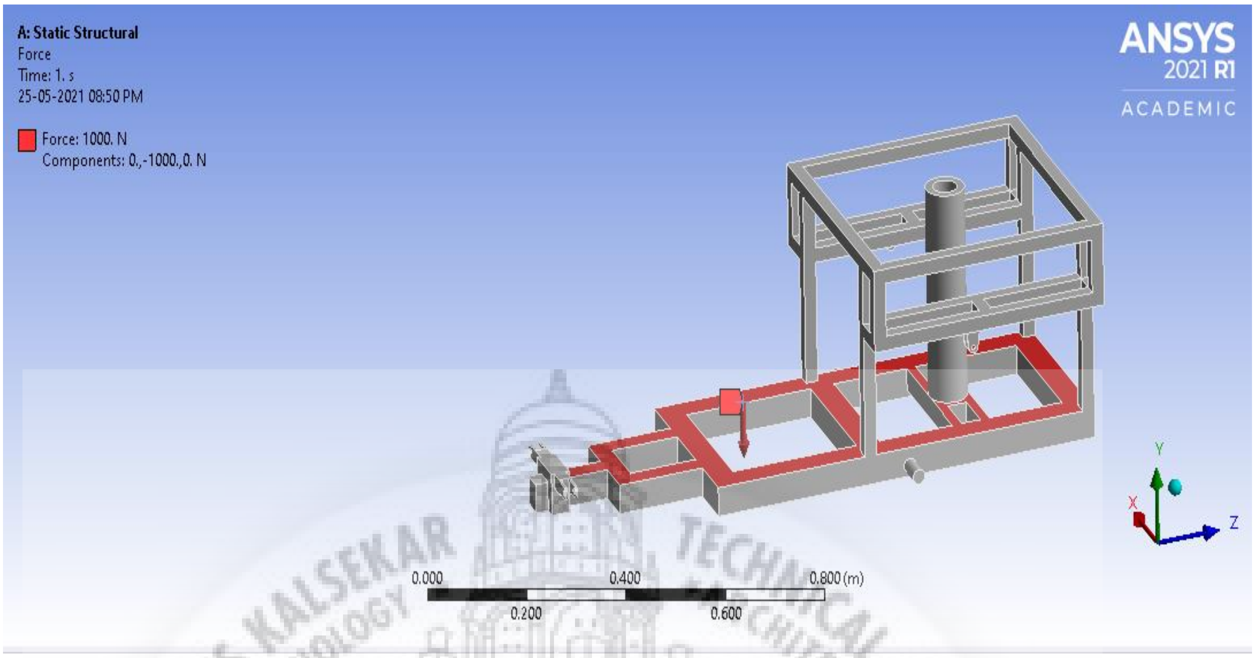


Fig .6.6.2 Force

Chapter 6, Section 7

6.7 Solution information

For solution we have selected results of analysis to display the different stresses, deformations, graphs (linear or non-linear) etc. But we have focused on these:

1. Von-Mises Stresses

2. Total deformation

3. Elastic strength intensity.

4. Strain energy These are shown in figures given below

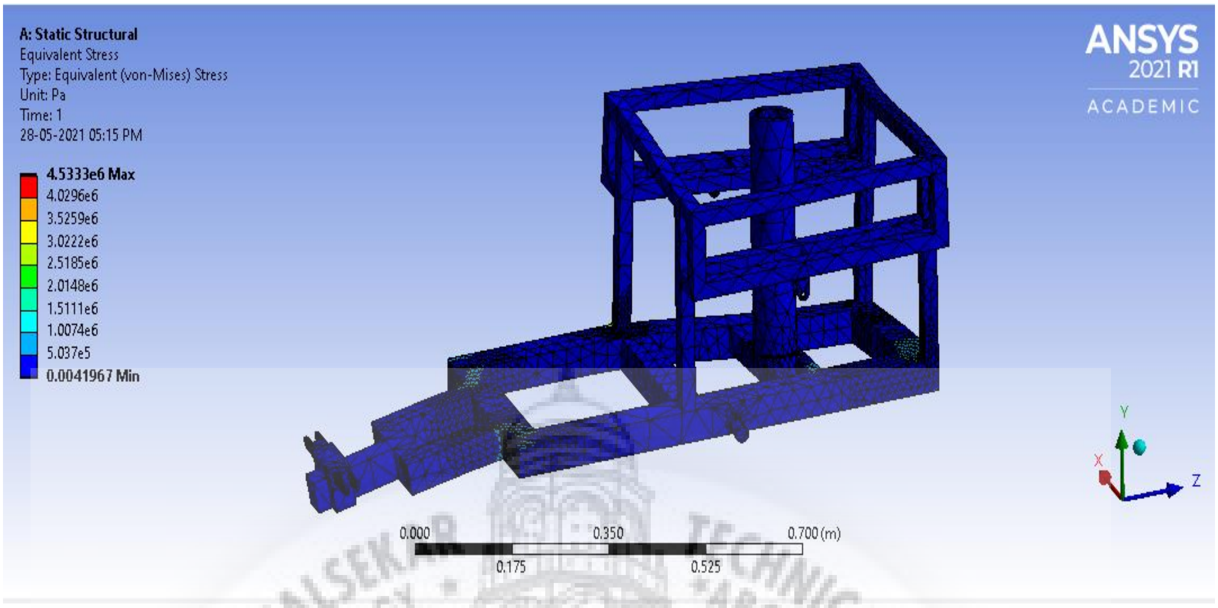


Fig.6.7.1 von-Mises Stresses

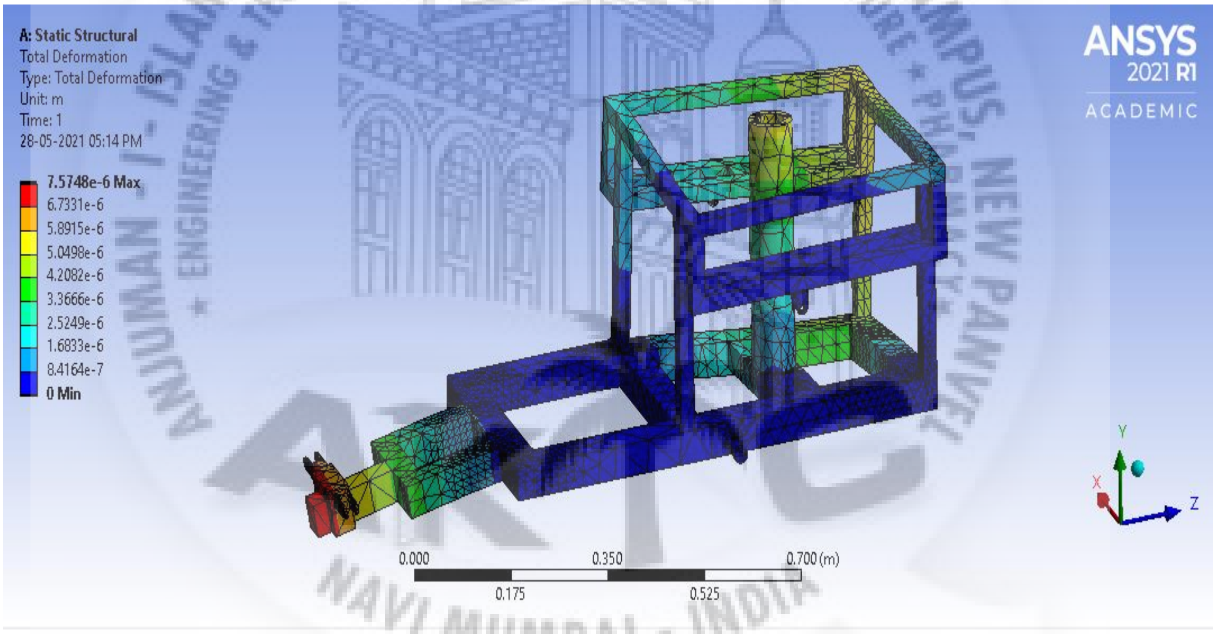


Fig. : 6.7.2 Total Deformation

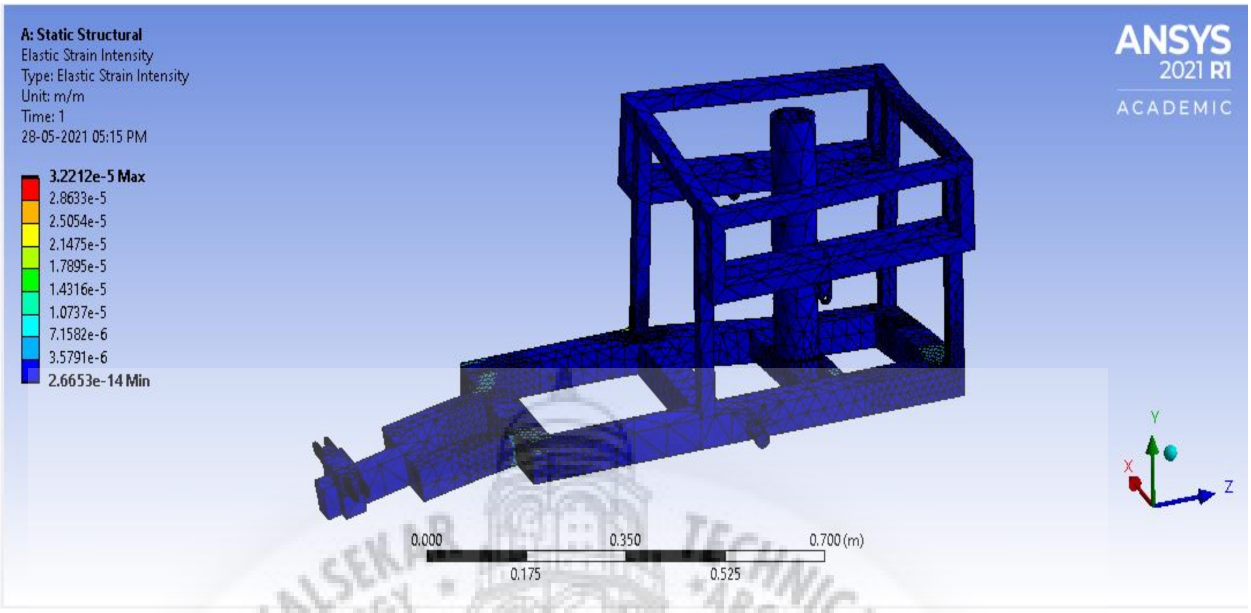


Fig.6.7.3 : Elastic Strain Intensity

Fig 6.7.4 : Strain Energy

Chapter 6, Section 8

6.8 Solution

By applying all the relative values and prerequisite to the solver of the software ANSYS we get all the values of stresses, total deformation, elastic strain intensity and strain energy that is the minimum and the maximum values of all these factor we got in tabular form such as given as follows:

Details of "Equivalent Stress"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Equivalent (von-Mises) Str...
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	4.1967e-003 Pa
Maximum	4.5333e+006 Pa
Average	1.5153e+005 Pa
Minimum Occurs On	SYS\Solid1
Maximum Occurs On	SYS\Solid1
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Details of "Total Deformation"

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Total Deformation
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Results	
Minimum	0. m
Maximum	7.5748e-006 m
Average	1.3807e-006 m
Minimum Occurs On	SYS\Solid1
Maximum Occurs On	SYS\Solid1
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Details of "Elastic Strain Intensity"

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Elastic Strain Intensity
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	2.6653e-014 m/m
Maximum	3.2212e-005 m/m
Average	1.0303e-006 m/m
Minimum Occurs On	SYS\Solid1
Maximum Occurs On	SYS\Solid1
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Details of "Strain Energy"

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Strain Energy
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Results	
Minimum	2.6339e-024 J
Maximum	3.8908e-006 J
Total	6.016e-004 J
Minimum Occurs On	SYS\Solid1
Maximum Occurs On	SYS\Solid1
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Table 6.8: Results obtained

Chapter 6, Section 9

6.9 Conclusion

By property of material AISI 1018 we know that the ultimate stress value as 440 MPa and from (Fig. von-Mises Stresses)we can see that the max stress value obtain is 4.5333 Pa, hence it is found as a safe selection of material and safe loading

Chapter 7

Vehicle specification

Chapter 7, Section 1

7.1 Vehicle Specification

Vehicle Model	Make Value
Wheel base	42 inch
Wheel track	27 inch
Overall length	60 inch
Overall width	30 inch
Rpm	300
Material	AISI 1018

Table 7.1 Vehicle specification

Chapter 8

Transmission

Chapter 8 , Section 1

8.1 Transmission

In the previous design of vehicle the transmission system consist of hub motor but as we have replaced the hub motor with bldc motor we have also introduced axle which is made with such an arrangement that motor will have spindles at both end.

Now as a result of connecting one wheel with the another it has made the suspension system dependent so by introducing C.V joint at both side in between motor and the wheel the suspension system will be independent.

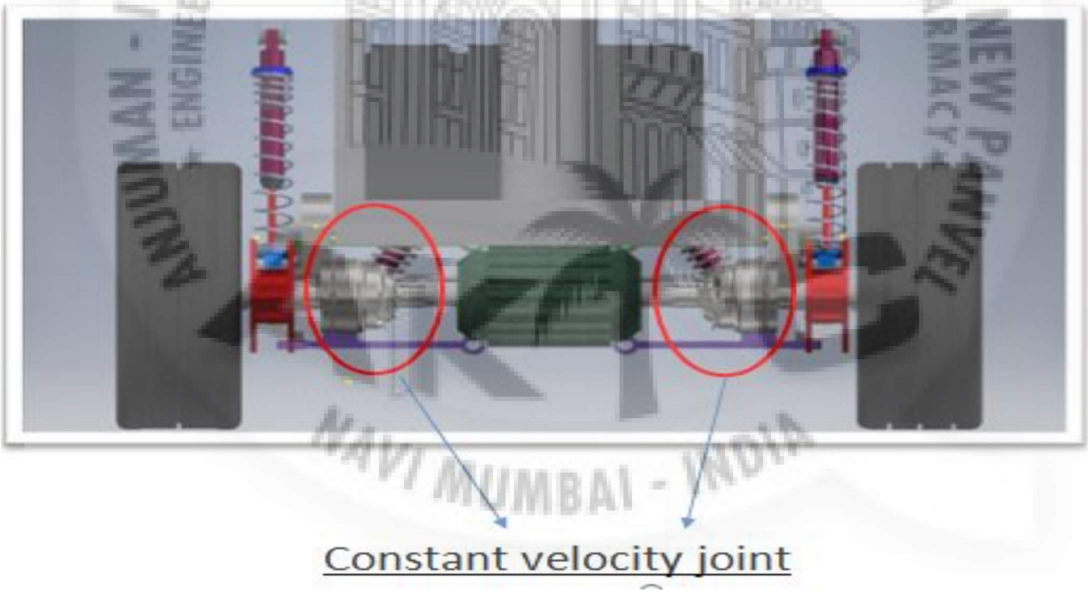


Fig 8.1 Transmission

Chapter 8, Section 2

8.2 Design Aspect

Max. Velocity (V) = 15 km/h

Wheel Diameter (D) = 16"
Therefore, Speed (N) = 200 (aprox.)

8.2.1 Power and Torque

Total vehicle weight (GVW) = 250 kg
Acceleration time = 6 sec

Maximum incline = 15 degree

i. Rolling Resistance (RR) = 1.25 kg
ii. Grade resistance (GR) = 51.97 kg

iii. Acceleration Force (FA) = 18 kg

iv. Total tractive Effort (TTE) = 71.22 kg

v. Torque on wheel (Tw) = 78.08 Nm

vi. Torque at motor= 6.02N-m

vii. Power (P) = 250 W

Chapter 8, Section 3

8.3 Motor Selection

Introduction of BLDC Motor:

Since the stator generates a magnetic field, and the rotor revolve at the same frequency, a BLDC motor is known as a synchronous form. One advantage of this setup is that BLDC motors don't have the "slip" that induction motor do, Brushless DC motors, as their name suggests, do not use brushes. Brush motors use brushes to deliver current to the coils on the rotor through the commutator. Instead of spinning, the rotor is a permanent magnet, and the coils are fixed in place on the stator.

Construction of BLDC Motor:

Like all other motors, BLDC motors also have a rotor and a stator. Similar to an Induction AC motor, the BLDC motor stator is made out of laminated steel stacked up to carry the windings. Windings in a stator can be arranged in two patterns; i.e. a star pattern (Y) or delta pattern (Δ)

Working of BLDC Motor:

The basic working principle for the brushed DC motor and for brushless DC motor are same i.e. internal shaft position feedback. ... Permanent magnets are used in BLDC to transfer the electromagnets from the rotor to the stator. Electromagnets for shaft turns are enabled by high-power transistors.

Chapter 8, Section 4

8.4 BLDC Motor Advantages over Hub Motor

TYPE	ADVANTAGES	DISADVANTAGES	APPLICATIONS	TYPICAL DRIVE
BRUSHLESS DC MOTOR	Long lifespan High efficiency Low maintenance	High initial cost requires a controller	Hard drives CD/DVD players Electric vehicles	Multiphase D.C
BRUSHED DC MOTOR	Low initial cost Simple speed control	High maintenance (brushes) limited lifespan	Treadmills exercisers automotive starters toys	PWM(pulse width modulation
HUB MOTOR	No interaction with the primary scooter chain required No additional transmission system required	Adds weight to wheels Torque factors can enter operational considerations	Electric bikes Electric bicycles	Direct

Table 8.4 Comparisons of different type of motors with advantages and disadvantages

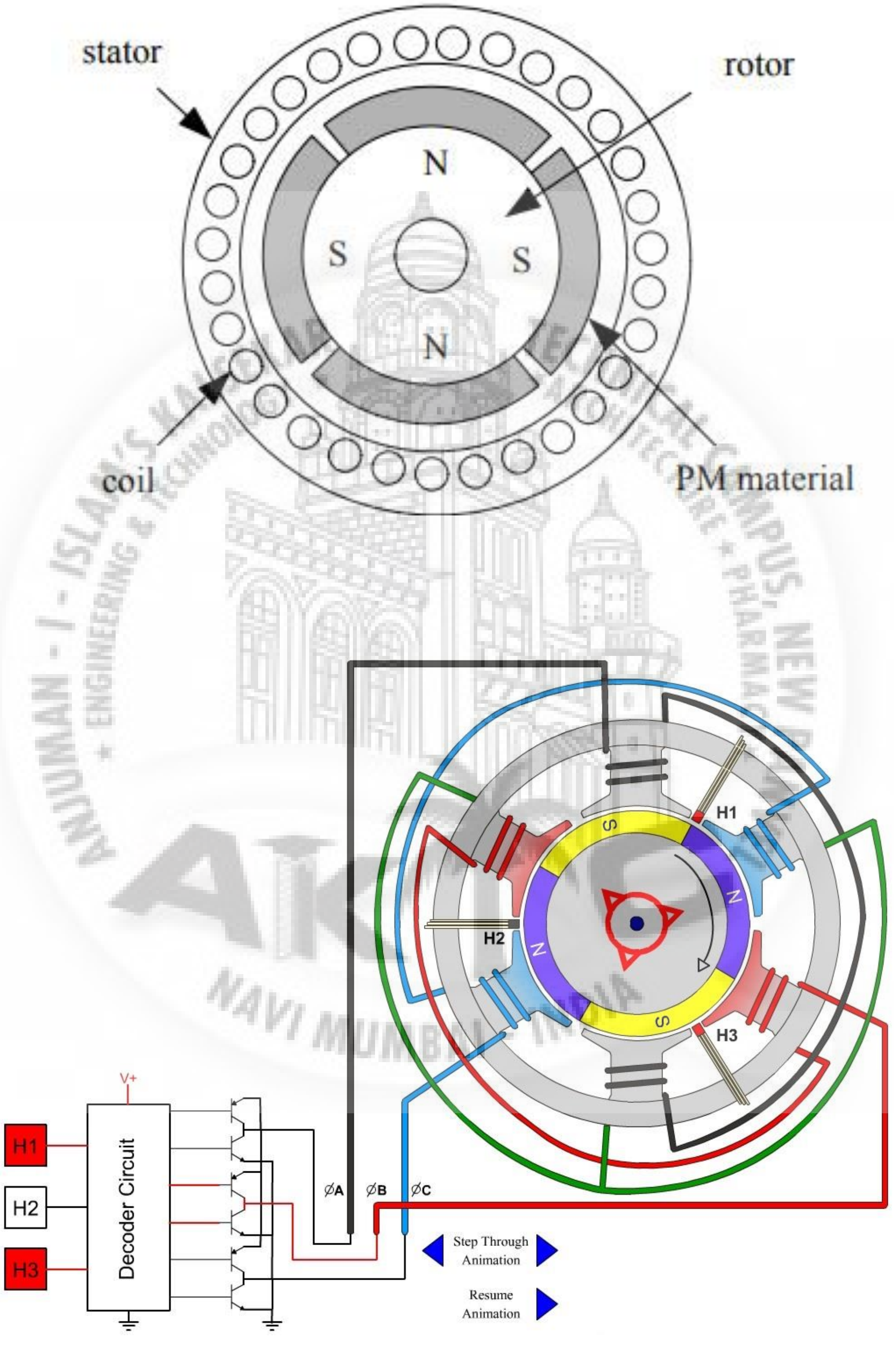


Fig 8.4 Construction of BLDC Motor

Chapter 8, Section 5

8.5 BLDC MOTOR SPECIFICATION

- Features & details 48 Volt 250 Watt Rated power: 250/W
- Voltage: 48v
- No-load current: ≤ 2.0 A
- No load speed: 3850 RPM
- Rated torque: 0.80N · m
- Rated speed: 3000 RPM
- Rated current: ≤ /13.4 / 9.0 A
- Motor efficiency: ≥ 78%
- Reduction ratio: 9.78:
- Dimensions22.6 x 19.8 x 13.4 cm; 2.49 Kilograms Manufacturer recommended age6 years and up
- Weight 2.490 kg

Fig 8.5.1 BLCD MOTOR

Fig8.5.2 CONTROLLER

Chapter 9

Battery selection

Chapter 9, Section 1

9.1 Battery selection

9.1.1 Sealed Lead Acid Battery

The lead acid battery consists of three or six cells connected in series is used in automobile, trucks, aircraft, or other vehicles. It chief advantage is it can deliver strong electrical current for starting an engine, however it runs down quickly. Figure shows the lead acid battery.

9.1.2 ADVANTAGES

i. Inexpensive and simple to manufacture

ii. Mature, reliable and well-known technology among the lowest in rechargeable

batteries.

iii. Low self-discharge—the self-discharge rate is among the lowest in rechargeable

batteries.

iv. Gel lead acid batteries can be used at any inclination.

v. The electrolyte is in the form of gel rather than liquid, due to which there is no spilling

of acid in case of battery breakage.

vi. Life cycle <= 3000 cycles <= 70000 km

9.2 Battery Specification

9.2.1 Description

Amptek - 12 Volt 24Amps Sealed Rechargeable Maintenance-Free Battery (BLACK GOLD) used for Electric Bike.

Let's look at what a battery is and what precautions a buyer can take:

1. The battery is a long-lasting power source. Otherwise, the battery will become completely discharged and damaged if it is not charged at least once every 15 days.

2. Charge the battery for a total of 6-7 hours. Overcharging for 10-12 hours would cause the battery to bulge, and the battery will eventually die.

3. Don't get too worked up if your battery isn't charging. Check your charger for a defective component; it should give you an indication.

9.2.2 Features & details Multipurpose Sealed Lead Acid Battery.

The battery is maintenance-free and spill-proof. Strong ABS with a rechargeable battery that can be installed in any place and prevents shocks and vibration

Wide Operating Temperature Range, Push type battery terminal. Used in Electronic Weighing Scales, Medical Equipment's & Electronic Test Equipment's , Emergency Lights & Rechargeable Fans, Communication Equipment .

Dimension: 18.0 * 8.0 * 17.5 IN cm. MADE IN INDIA Product information Brand Amptek Manufacturer AMPTEK Product Dimensions18 x 8 x 17.5 cm; 7.2 Kilograms Compatible Devices Fan, Automobile Number Of Items1Voltage12 Volts

Battery Cell Composition Sealed Lead Acid Manufacturer AMPTEK Country of Origin India Item Weight7 kg 200 g Dimensions LxWxH: 18 x 8 x 17.5 C

Fig 9.2Amptek Battery

Chapter 10

FUTURE SCOPE

Chapter 10, Section 1

10.1 FUTURE SCOPE

Electric cars are thought to be the way of the future. since it makes use of electricity as a source of energy Since non-renewable resources such as gasoline, diesel, and other fuels are depleting. There is a great need to develop a new energy source.

As a result, electric vehicles are ideal in this situation. While these electric vehicles have many benefits, they also have a number of drawbacks, such as the need for regular recharging and the disposal of these batteries.

To address these charging issues, we have used a suitable regenerative device in this project, which allows us to recover some of the used energy; however, the system's drawback is that we cannot recover all of the used energy.

As a result, a better alternative to solve these limitations must be sought.

Solar energy is one of the best options for charging the battery. This can be accomplished by altering the vehicle's configuration, as well as by using enough solar panels to meet the energy requirements. Making the car more effective for use while causing no pollution to the atmosphere.

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Photos

Photo

REFERENCES

Journal Paper

- D.Mohankumar, R. (2108). Structure And Modal Analysis Of Scooter Frame. ijpam.eu, 935-943.
- Prof. Firoz khan1, S. K. (2016). Design and Development of Light Weight Multi-Utility Electric Scooter using Hub Motor Transmission. International Journal of Engineering Research & Technology (IJERT), 2278-0181
- Prof.Kaveri.S Kadam, M. N. (2020). Design and Analysis of E-scooter Chassis Frame. IRJET, 7138-7146.
- Structural. (2019). Structural And Modal Analysis of Scooter Frame for Design Improvement. ELSEVIER, 1106-1116.

Books

- Singh, K. (n.d.). Automobile Engineeering Vol. I and II. Standard publisher Distributors,Delhi.
- R.K.Rajput. (n.d.). Automobile Engineering . Luxmi Publishing CO.

Websites

- Technical Guide: Electric Scooter Motors. (n.d.). Retrieved from electric-scooter.guide: https://electric-scooter.guide/guides/electric-scooter-motors/
- Shiffer, E. ,. (1954). Mobility scooter. Retrieved from WIKIPEDIA: https://en.m.wikipedia.org/wiki/Mobility_scooter