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DESIGN AND MANUFACTURING OF ELECTRIC BIKE WITH SWITCHABLE AWD TRANSMISSION

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Abstract - *Due to the revolutionary impact of electric technology automobiles have established a source of energy that is convenient than IC engines which are electric automotive. In this world about the majority of the population in automobiles is of motorcycles. As industry needs a motorcycle which is easy to use and can be used in any area as motorcycle goes in bad terrain such as sand, mud, rocks motorcycle losses it traction so the concept of Electric AWD (All-wheel drive) is introduced which is much lighter in weight and has good strength the main idea of AWD is to switch the power train from rear to front as per user need which gives the user to move freely in any area. Parts of Electric AWD motorcycle includes chassis(frame), Electric motors(BLDC motor), swing arm, Throttle(Accelerator), Switchable All-Wheel Drive system, Motor Controller, Battery storage, Battery Management System(BMS), Suspension system, Body panels, and other motorcycle parts(accessories).*

Key Words*: *Switchable All-Wheel Drive(AWD)_ Chassis(frame)_ Electric motors(BLDC motor)_Swing arm_Throttle(Accelerator)_Switchable All-Wheel Drive system_ Motor Controller_ Battery storage_Battery Management System(BMS)_Suspension system_Body panels_other motorcycle parts(accessories).

1. INTRODUCTION

In the Automobile industry due to the revolutionary impact of electric technology and electrical systems, automobiles have established a renewable source of energy that is far better than conventional IC Engines. Electric automobiles have its advantage and disadvantage so we are trying to minimize those errors which are in today's Electric Automobiles. In today's world, about 200 million motorcycles running on streets i.e 33 motorcycles per 1000 persons so by changing IC engine motorcycles we can create a huge impact and it will be more beneficial for Nature. A motorcycle is easy to use and used in any area so the automobile industry wants a motorcycle that has greater quality and stability which will move in any terrain as motorcycle moves in bad terrain motorcycle struggles for traction so to overcome this problem the concept of Electric AWD (All-wheel drive) is introduced which is much lighter in weight and has good strength the main idea of AWD is to switch the power train from rear to front as per user need whenever there is a loss in traction which gives the user to move freely in any area. Parts of Electric AWD motorcycle includes Frame(chassis), Electric motors (BLDC motor), swing arm, Throttle (Accelerator), Switchable All-Wheel Drive system, Motor Controller, Battery storage, Battery Management System (BMS), Suspension system, Steering, Body panels, Wheels and other motorcycle parts(accessories). So by a proper study, we designed an All-wheel drive switchable electric motorcycle using Solidworks and created a working prototype.

2. LITERATURE REVIEW

- K.Sivaramakrishnan 1) In this paper author has studied a different type of chassis frame structure and concluded that the most commonly used chassis frame used in an automobile is the double-cradle frame. So they designed and calculated a double-cradle frame and done analysis for loading conditions on which 200kg passenger load was implemented and with the study of different type of material which are stainless steel, aluminum alloy, carbon steel, titanium, and maximum stress and strain is calculated using ANSYS software From the result it is observed that the stresses are maximum in the joint location and also for all the materials the stress value are fewer values than that their permissible yields stress values. While comparing all four materials steel and aluminum are the cheapest but as for our result, the stress and deformation will be lesser in stainless steel and carbon steel. By using carbon steel which has less density compared to stainless steel materials and also is cheaper, so this is the best material suitable for chassis frame which provides very good strength with weight reduction.
- Srinivas Mutyala 2) In today's world to overcome the pollution produced by automobiles in urban areas author has studied and designed Electric motorcycles. In this paper, their main objective was to explore the acceleration of an electrically powered motorbike under Practical conditions and to review the current situation and effectiveness of electric motorbike researched by various researchers. Motorbike is made by using various components which area a) frame b) swingarm c) BLDC motor inbuilt controller d) lithium-ion battery pack e) power transmission f) steering g) wheels h) braking system. i) Dc-Dc converter j) accessories author has studied and designed components

according to their need. While designing the frame a mixture of single and double-cradle frame structure are used to have better storage capacity and stability the frame is designed in which battery, BLDC motor is fitted the other component which is swing arm with mono coil suspension in this mono coil or mono-shock suspension is used because it is more comfortable than double shock suspension and provides more stability. Then BLDC motor is fitted in the frame. A Brushless dc motor (BLDC) is the best choice for today's electric bikes as it has advantages such as High starting torque and is more reliable noise produced is comparatively less it has a longer lifetime than other motors. BLDC motor has a controller PIC16F72 that controls the electric motorbike systems which include current detection signal, motor speed control signal, capacity detection system. It is a very important part of the electric motorbike. The motor and other systems are powered by an electric battery it is a type of rechargeable battery the specifications are voltage is about 48V and the current capacity is about 40Ah. The power which is transmitted by a motor to the wheel is by a power transmission system that is connected by a chain. Tyre used is wet type tire 17 inches tubeless 90/90 front and 110/90 rear wet/rain tires are used which provide grip over slippery terrain which helps motorbike to attain better stability. A Steering system is made which consists of a handlebar and handle head the calculations are carried out and steering is under ergonomics calculations. Brakes which are one of the most important parts of the motorbike system are selected are disc-type brake disc is about 250mm with master cylinder strong brakes are selected so that while riding any problems occurs user can stop the vehicle quickly. A DC-DC type converter is used it is an electronic circuit or a type of electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high voltage power transmission) so the output of the lithium-ion battery pack is 48V the converter converts it into 12V for the functioning of accessories like headlights, horn, tail lights. Other accessories are added to the motorcycle in which body panels are of body reinforced which are lighter in weight and good in strength. This paper concludes the study of various components required to design and manufacture an electric motorbike.

- CH. Neeraja 3) In this the Author studied a different type of suspension frames which are 1. Single cradle frame, 2. Double cradle frame, 3. Backbone frame, 4. Perimeter frame, 5. Trellis frame. And designed CAD model for suspension frame and by using ANSYS structural and modal analysis is done by using different materials that are Alloy steel, Aluminium alloy A360, Magnesium alloy, Carbon reinforced polymer and the results which obtained conclude that for all the materials the stress values are less than their respective permissible yield stress values. So the design is safe. By comparing the results for all four materials, the stress obtained is the same and displacement is less for carbon fiber reinforced polymer than the other three materials. So its conclude that for the design, CFRP is a better material for suspension frames.
- Jeyapandiarajan 4) In 2017 Author has studied designed and analyzed the chassis for an electric motorcycle in this they created a design comfortable in every aspect. In this design, they have space for the battery as their availability. The structure of the chassis is analyzed and structural analysis is done by using different materials that are AISI 1020, Aluminium 6063, AISI 4340 in ANSYS software the total deformation for all the material are studied, and it concluded that AISI 4340 has the maximum factor of safety equal to 4.06. The deformation is also the least (0.5 mm) The weight of Aluminium 6063 is the least having factor of safety just in the safety range. If for motorcycle lightweight is an important factor in the frame, Aluminium 6063 can be used. But it should be noted that the manufacturing cost of the Aluminium 6063 frame will be significantly more than other cases since only TIG welding works for Aluminium which requires sophisticated machinery and skills. Hence, is recommended AISI 4340 as the material for mass manufacturing.
- Srihari Mallela 5) In 2017 the author studied the types of chassis suitable for a motorcycle they have studied a different type of materials that are Steel, Aluminium, Carbon fiber, Titanium, Composite then they created a model using Solidworks on Solidworks they perform load testing to analyze the deformation and perform structural analysis and it is concluded that Aluminium Metal Matrix (KS1275) shows the least stress and least deformation and have strain value on same static load condition. From the Modal analysis result tables, it is concluded that the Aluminium metal Matrix (KS1275) shows fewer deformation results for a given frequency. Hence for Structural Analysis Aluminium metal matrix (KS1275) (Composite), it is the best suitable material for a Motorbike frame.
- Vidya S.Visave 6) In this paper the author has studied and analyzed the Monoshock suspension of the Honda unicorn. Further, the spring of the suspension is taken and analyzed using ANSYS software FEA analysis is carried out and deformation is studied under various loading conditions and stress is studied and it concluded that as load increases at constant speed the transmissibility of the system goes on decreasing practically Monoshock suspension has more precise and better damping, which results in better handling. Monoshock suspension has more precise and better damping, which results in better handling.

- Er. Parminder Singh 8) In this paper Author have studied working and history of suspension systems author have studied a different type of suspension systems i.e Dependent suspensions, Independent suspensions, Semi-independent suspensions. From the study, it is understood that why it is important to have a suspension system in our vehicle. The study concludes that Vehicle's Suspension system is responsible for driving comfort and safety as the suspension carries the vehicle's body and transmits all the force between body and road. The suspension system provides safety for vehicle acting as a safety member by providing the desired height and cushioning against the bumps or irregularities present on the road surface
- Pratik G.Chute 7) In this author has studied about q different type of suspension in this they have to compare two mostly used suspension i.e a) dual shock suspension b) mono-shock suspension in this paper both systems are studied and which of them is most efficient for motorcycle is concluded by the study it has seen that mono-shock has very much advantage over dual shock suspension that is Mono shock eliminates torque to the swing arm and improve braking and handling of a vehicle. It is easier to adjust on the vehicle as there is only one shock to adjust. The linkage used to connect the shock to the swingarm is frequently designed to give a rising rate of damping for the rear. Mono-shock has better cornering ability Cornering is better and Weight of Vehicle decreases, It is easier to tune rather than dual shock which is hard to tune mono-shock suspension gives better Stability to vehicle. so it concluded that mono-shock suspension is best suitable for a motorcycle for better performance and stability.
- Morris Brenna 8) In 2015 author has studied lithium-ion batteries. A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium-ion as a key component in the electrochemical process. During a discharge cycle, lithium atoms present in the anode are ionized and then separated from their electrons. Li-ion batteries typically use ether as an electrolyte. During this study, they performed a test to study the battery properties and batteries' behavior over certain conditions. They perform a test to check the life cycle of the battery by charging and discharging the battery the rated capacity is 10000Ah and while the continuous discharge current is about 10C and Max 15C the battery operates under 0-60 degrees Celsius. The charging and discharging was test under different conditions to study the discharge rate at various conditions and the results, obtained from the analysis of the collected data, show that the aging of the Li-ion battery is correlated with the total electric charge that flows into the battery cells and in particular with the square root of the total moving charge. Then, it is possible to state that the duty cycle does not practically affect battery aging. It is worth noting that the life prediction does not take into account all the reactions that can occur when the voltage is close to the minimum or the maximum but it refers to the best use of the batteries in the linear region. In addition, a change in the degradation of the battery after a high number of cycles can be expected.
- Yen-Ming Tseng 9) Author has studied Lithium iron phosphate batteries (LiFePO4). It is a type of lithium-ion battery using lithium iron phosphate as the cathode material and a graphite carbon electrode with a metallic backing as the anode. The comparison between Lithium iron phosphate and other secondary batteries is studied which are lead-acid batteries pack, and lithium batteries such as lithium-cadmium batteries, nickel-metal hydride batteries, lithium cobalt batteries. Lithium iron phosphate battery Compared with other lithium family battery packs which LiFePO4 battery packs have high-efficiency energy conversion up to 95% and possess more life cycle up to 2000 times than the other lithium family battery pack life cycle about from 400 to 500 times. The relationship between the charging voltages and currents and dynamic internal voltage and equivalent inner resistance of the battery pack is studied and it concluded that o charge and discharge test obtained the battery pack voltage, resistance, and other parameters and to determine which each other dependency. And deduce the battery's internal dynamic resistance and to other applications before the lead operations. In the charging mode, when the charging voltage is fixed the result of the battery voltage, current and internal resistance are closely related to each other. In the discharge mode, the battery internal resistance and the battery potential can be approximated by the mathematical model of the third-order polynomial to the internal resistance of the battery pack and obtain its value. Lithium iron phosphate batteries have advantages such as high capacitance, low toxicity, and no pollution, high-temperature environment, and good circulation performance under heavy-duty charge and discharge mode. Thus lithium iron phosphate batteries are majorly used in industry due to their good characteristics.
- R. Babu Ashoka 10) In 2017 Mr. Babu study and analyzed Brushless DC motor for a different type of controllers Analysis of controller for BL-buck boost converter fed BLDC drive is performed and found that PI controller as shown eliminates forced oscillations and minimizes steady-state error but the integral mode harms speed of the response and overall stability of the system and PI fails when the controlled object is highly nonlinear and uncertain and it can be solved through Fuzzy Logic (FL) because FL adopts the logic of reasoning, provides an inexpensive solution for controlling ill-known

complex systems. The speed controllers such as PI, Fuzzy Logic & hybrid (PI+FLC) controllers are analyzed by author in paper. By performing tests under various conditi0ons for various controllers its concluded that the performance of the BLDCM is gradually increased with controller PI, Fuzzy and Hybrid except for the power factor where there is a marginal dip. The BLDC motor speed remains constant irrespective of the loads and simultaneously PF is also close to unity using a PI controller. The performance is marginally improved only in the hybrid controller. The design aspect and cost involved in the hardware implementation will be more. Hence it is concluded from the comparative analysis that the Hybrid controller is suitable for high power applications whereas the PI controller is a promising device only for low power applications.

- Amol S.Amrutkar 11) Author study about ergonomics and concluded that Motorcyclists experience discomforts while riding motorcycles for a specific distance majorly on the wrist, shoulder, lower back, neck, thigh, and calf leg. This discomfort will increase by increasing age and years of riding and may also depend upon the type of motorcycle whether it is cruiser type or sports type or tourer type.
- Prashant V.Thorat 12) By performing deep study about ergonomics author designed and concluded that Different sitting posture on a bike or bicycle has different roles. A committed posture of sports bikes gives more control to the vehicle whereas an upright posture of commuter and tourer bikes gives comfort to the rider and an adjustable handlebar can solve the problem whether we need to relax or get better control over the bike.
- Koumi Datta 13) By studying author concluded that an Awkward riding posture can cause physical, biological as well as psychological disturbances. It was found that motorcycle riders after a long time ride has more stress due to poor ergonomics and vibration. So motorized two-wheelers are stressful and require attention and revision by ergonomic intervention.
- Rathin Shah 14) By studying, designing, and analyzing brake caliper in Solidworks by author the conclusion Designing a fixed brake caliper considering different parameters are analyzed for performance and many studies were done including piston displacement, piston drag, and performance of caliper. The system was modified just to lower the cost of manufacturing, weight and increase stiffness for much more efficient braking performance.
- Sanket P.Golhar 15) Author studied a different type of brake and designed a brake caliper and concluded that the most crucial aspect to be considered is that the generated braking force should be always greater than the required braking force while braking. The calculated clamping force determines the diameter and also the number of pistons to use in the caliper. The piston retracts because the seal groove geometry is pivotal to the operation of the caliper after the clamping force is applied.

3. OBJECTIVE

The objective is to design and manufacture a cheap and reliable Electric motorcycle with having Switchable All Wheel Drive (AWD) transmission which overcomes the problem of traction control having a lighter and strong body frame with great power and having a greater range as it can move in any terrain freely in one full charge.

4. METHODOLOGY

4.1 COMPONENTS OF SWITCHABLE AWD ELECTRIC MOTORCYCLE

1. Chassis
2. Swingarm
3. Steering
4. Suspension system
5. BLDC motor
6. Wheels
7. Motor controller
8. Brakes
9. Switchable AWD system
10. ECU
11. Battery
12. Battery management system
13. Body panels
14. Accessories

4.2 WORKING METHODOLOGY

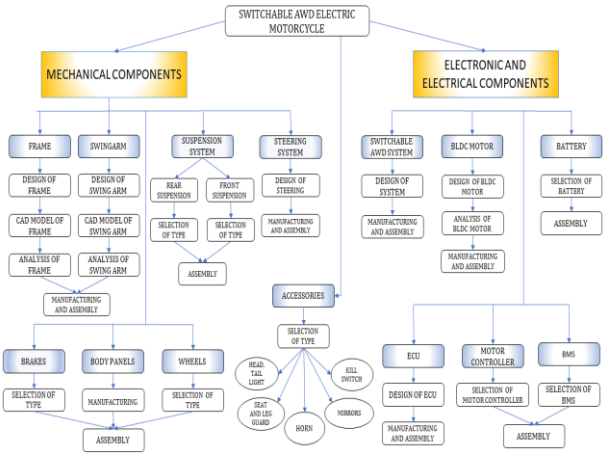


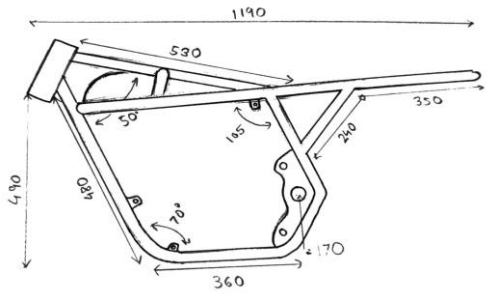
Figure (1) Working Methodology

4.3 WORKING PROCESS

4.3.1 FRAME

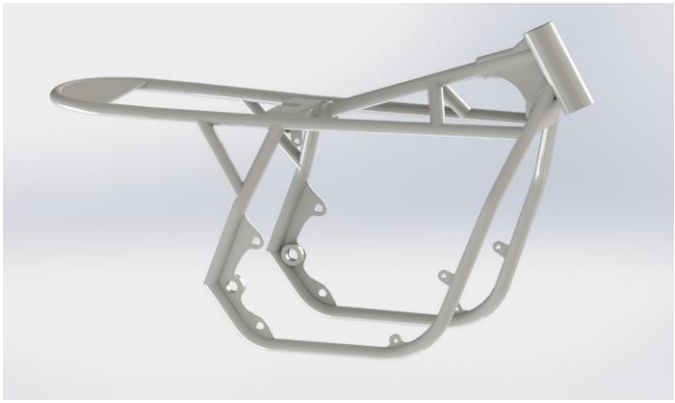
The Frame (chassis) which is called the backbone of the electric motorcycle, not only just affect the appearance of the electric motorcycle it provides safety and handling to the electric motorcycle, a frame is a skeleton where other parts are fitted so a type of modified mixture of the double-cradle and the twin-spar frame is used in designing the frame. A frame of electric AWD motorcycle should have very good strength to handle heavy loads accompanied while riding an electric AWD motorcycle

A) SKETCH OF FRAME



B) 3D MODEL OF FRAME (CHASSIS)

The model is made in Solidworks 2020 software



C) ANALYSIS OF FRAME

C.1) STRUCTURAL ANALYSIS

Structural analysis is performed by checking the total load on the frame and study is performed by using different types of material.
Materials:- 1) Plain Carbon Steel
2) Aluminium Alloy 6063

Load:- Consider passenger weight - 80 kg
Factor of safety - 5
Testing load with a factor of safety- 80*5 = 400 kg = 3922.66 N

1) PLAIN CARBON STEEL

Total Deformation

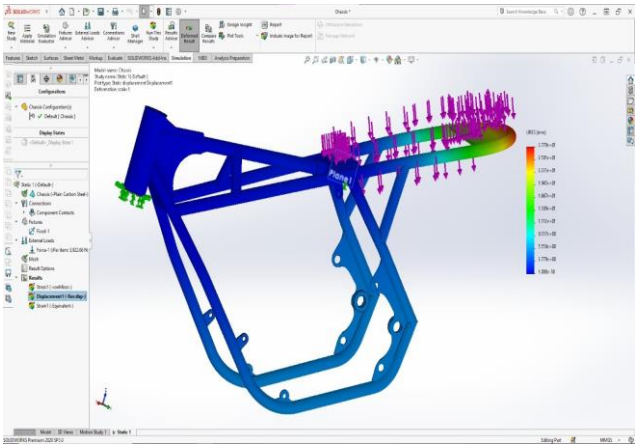


Fig No – 1 Total Deformation for Plain Carbon steel

Max Strain

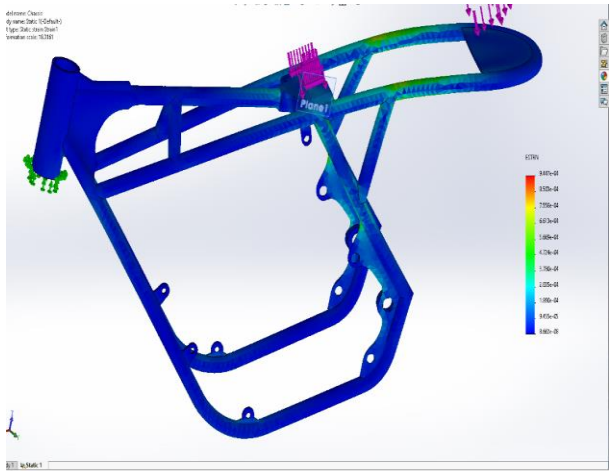


Fig No – 2 Max Strain for Plain Carbon steel

Max Stress

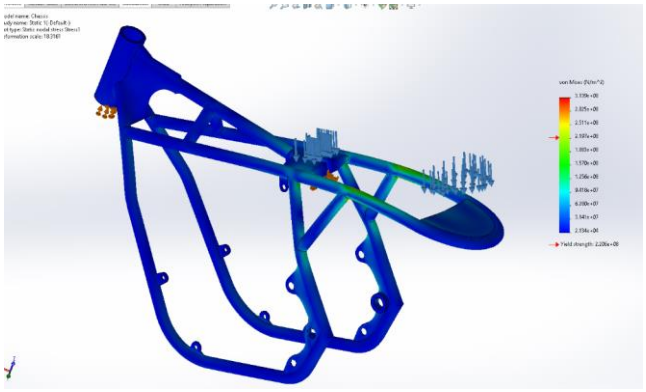


Fig No – 3 Max Stress for Plain Carbon steel

2) ALUMINUM ALLOY 6063

Total Deformation

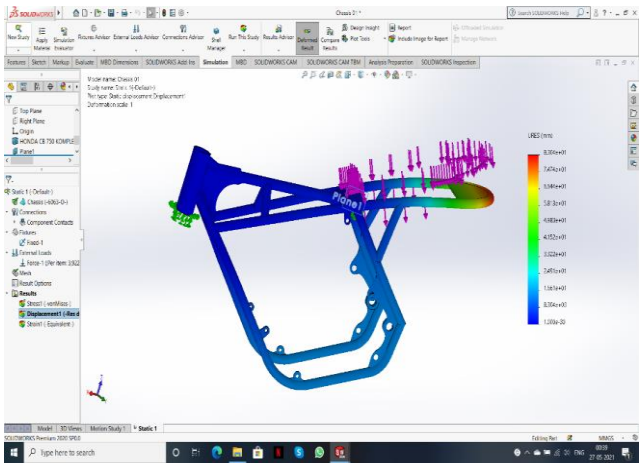


Fig No – 4 Total deformation for Aluminum 6063

Max Strain

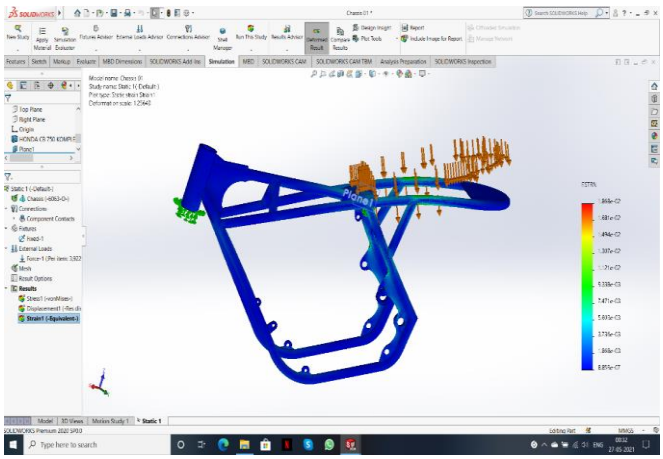


Fig No – 5 Max Strain for Aluminum 6063

Max stress

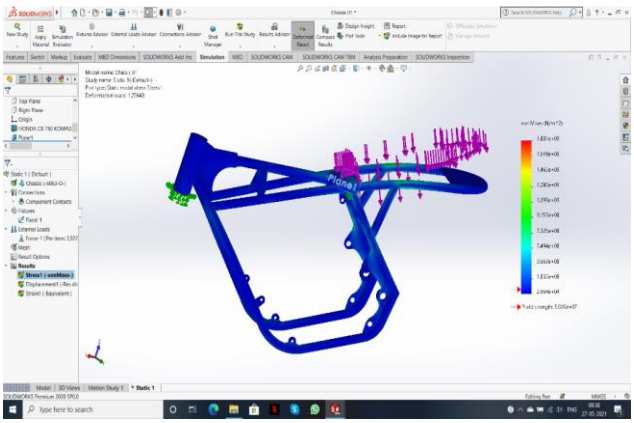


Fig No – 6 Max Stress for Aluminum 6063

C.2) Results

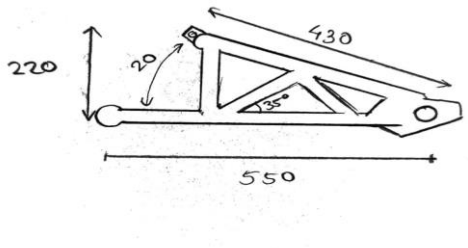
Sr. No	Material	Stress Mpa	Strain	Total Deformation mm	Weight Kg
1	Plain Carbon Steel	313	0.0009	27	40
2	Aluminum Alloy 6063	1831	0.0868	83	13.9

As frame holds the electric motorcycle together the material used for designing should have very good strength so material properties are studied and is selected that Plain Carbon Steel material is used it has very good strength and good density it can handle heavy loads so it is the best material to make the frame for AWD electric motorcycle.

4.3.2 SWINGARM

To make a Switchable AWD motorcycle that moves in every terrain each part should be designed carefully. So, in a motorcycle, a vital and most important part is the swingarm. A swingarm, or "swinging arm", originally known as a swing fork or pivoted fork, is the main component of the rear suspension of most modern Motorcycles. Swingarm supports the rear wheel and is attached to the frame of a motorcycle. The suspension at the rear side of a motorcycle is attached to the swingarm. The forces like cornering forces while taking a turn, the half weight of the bike, rider weight, vibrations, impact loads at bumps will be taken by the swing arm.

A) SKETCH OF SWINGARM



B) 3D MODEL OF SWINGARM

Model is created by using Solidworks 2020 software which is shown in figure Fig No – 1

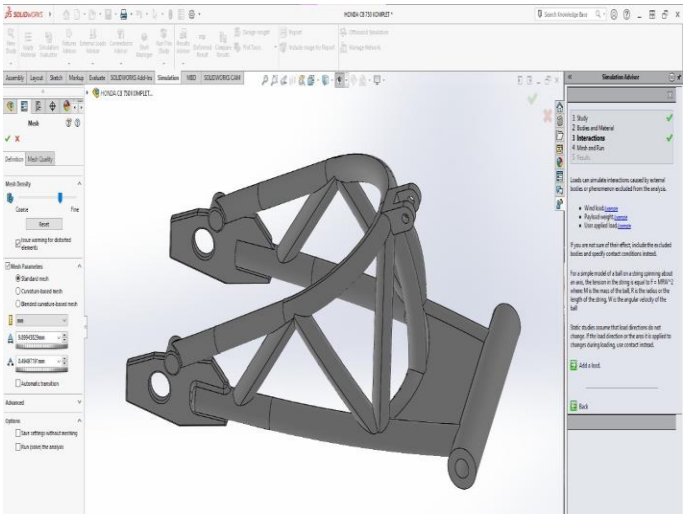


Fig No – 1 CAD Model of swingarm

C) ANALYSIS OF SWINGARM

Analysis of frame is done by using Solidworks 2020 software

C.1 STRUCTURAL ANALYSIS

Structural analysis is performed by checking the total load on the swingarm.
Considering one person is sitting on the bike. The total weight is 400 kg. In most two-wheelers, the distribution of weight on the rear axle is 58% to 65%.

For the model selected, the weight distribution is taken to be 60% on the rear axle. Thus, netload on swing arm can be calculated as,

Ls = [Ms+Mp]x0.6(1) = [320+80]x0.6 = 240
Ms = mass of Electric motorcycle
Mp = mass of person
The Weight of the motorcycle is 320kg. Considering the average weight of a person is 100 kg.
Ls=240 Kg = 2354 N

The loads are separated into vertical and horizontal components.

Vertical load – Lvs = Ls Sin θs = 240x9.81xSin 50° = 1803.57 N.
Horizontal load – Lvh = Ls Cos θs = 240x9.81xCos 50° = 1513.37 N.

The Longitudinal force acting on Swingarm, The maximum acceleration of the motorcycle is found to be = 5 m/s^2. Also, the total mass mT=400 kg.
Hence longitudinal force acting on the swing arm can be found as

FL= mT x a= 400 x 5=2000 N.
Static analysis study is performed by using different types of materials

Materials:- 1) Plain Carbon Steel
2) Aluminium Alloy 6063

Load:- Total load – 400 kg
60 % load – 240 kg = 2354 N

1) PLAIN CARBON STEEL

Total Deformation

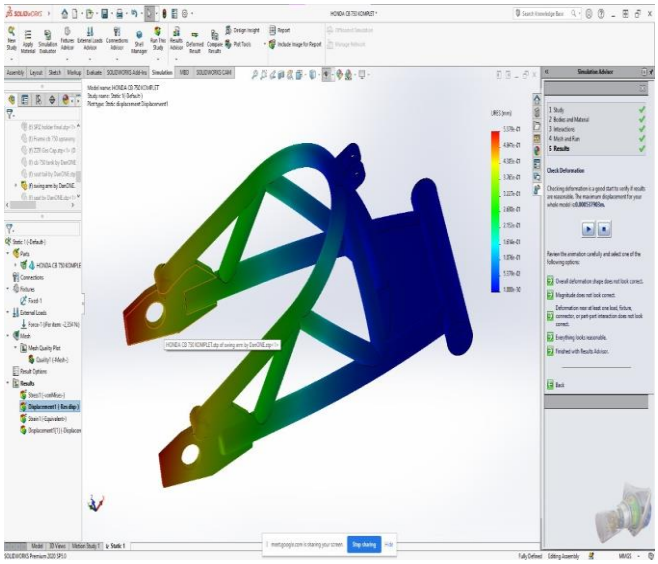


Fig No – 2 Deformation for plain carbon steel

Max Strain

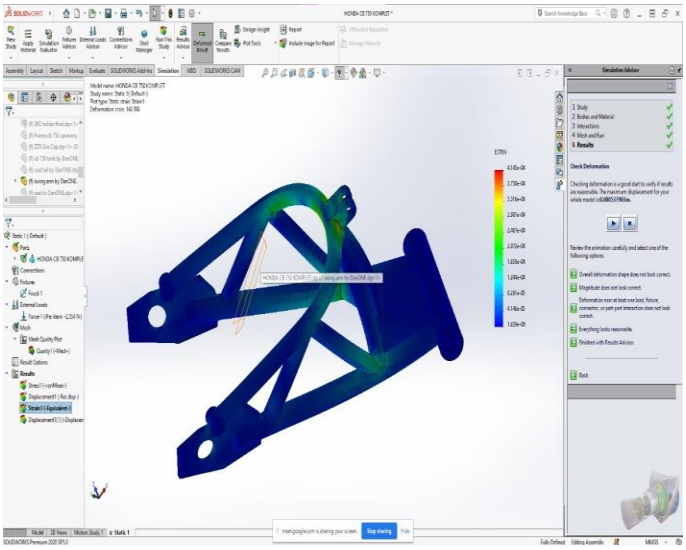


Fig No – 3 Max strain for Plain Carbon Steel

2) ALUMINUM ALLOY 6063

Total Deformation

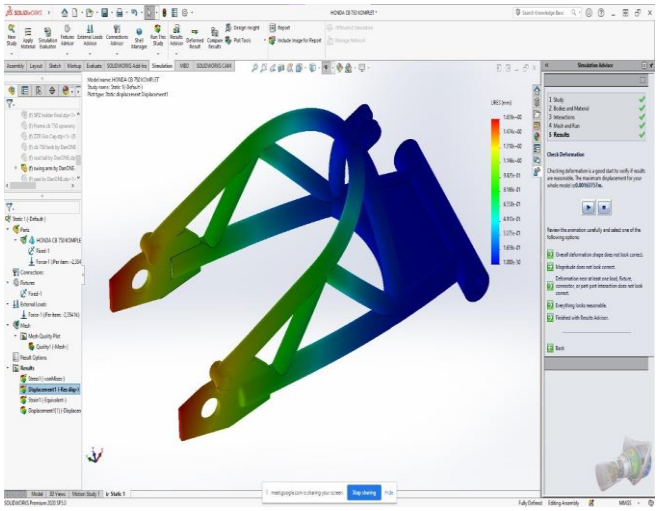


Fig No – 4 Deformation for Aluminium Alloy 6063

Max Strain

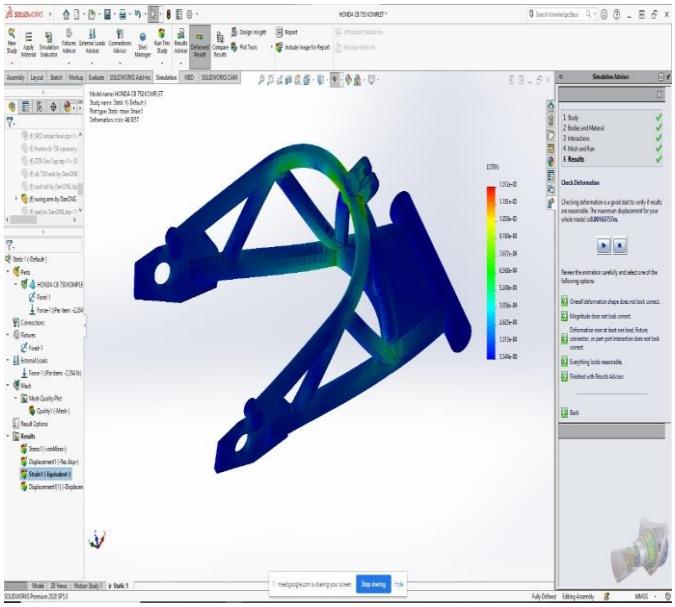


Fig No – 5 Max Strain for Aluminium Alloy 6063

C.2) RESULTS

Sr. No	Materials	Strain	Deformation mm	Material weight gm
1	Plain Carbon Steel	0.00041	0.5	17061.3
2	Aluminum Alloy 6063	0.00131	1.6	5905.84

Result table

4.3.3 STEERING

Steering is the part that moves the motorcycle without steering we cannot take turns and AWD moves in any terrain it is important that steering should be perfect for handling and should be more comfortable so it is very important to have a good steering system.

A) CALCULATION

Head tube angle	65^0
Rake angle	20^0
Offset	25.4 mm
wheelbase	1305 mm
Steering ratio	1:1

Table 1 Parameters

1) Trail

trail = Rw Sin(Aμ)- offset cos(Aμ)

= 228×Sin (20) - 25.4× cos (20)

= 50.008mm

Where, Rw = wheel radius =216mm

Aμ= Rake angle

Of= offset.

2) Turning radius

Turning radius= 2× (wheel base) × Sin (90-wheel lock angle)

= 2×1350×sin (90-20)

= 2452.59 mm

3) Wheel flip flop factor

Wheel flip flop factor (l) = b x sin (U) x Cos (U)

Where , U= Head angle;

b=Trail

I= wheel flip flop factor

l = 50 x sin (65) x cos (65)

I = 19.15

B) STEERING CALCULATIONS RESULTS

Trail value	50 mm
Turning radius	2453 mm
Turning radius	19.15

Table 2 Result

4.3.4 SUSPENSION SYSTEM

A Suspension system is one of the most valuable parts of an Electric motorcycle it absorbs the vibrations produced by the AWD electric motorcycle when moving in uneven terrain it reduces the impact of bumps on roads.

A) SELECTION OF TYPE OF SUSPENSION SYSTEM

a) REAR SUSPENSION SYSTEM:-

It is the suspension system that accompanies the majority of a load of an electric motorcycle so an excellent type of suspension is used for having better handling which is Monoshock suspension. Mono shock eliminates torque to the swing arm and improves braking and handling of a vehicle and it's is easier to adjust on the vehicle as there is only one shock to adjust. The linkage used to connect the shock to the swingarm is designed to give a rising rate of damping for the rear. Mono-shock has better cornering ability over another type of suspension which provides better stability on road.

4.3.4 Fig No – 1 Rear Monoshock suspension

b) FRONT SUSPENSION SYSTEM:-

It is the suspension system that accompanies the front load of the motorcycle it is connected to the front wheel and handlebar the system which is used is the USD suspension is fitted in an opposite direction than telescopic suspension. The handle yoke is connected to the damping unit and the sliders are connected to the wheel of the electric motorcycle. As our bike is an All-terrain Switchable AWD electric motorcycle that can move freely at high speed so to achieve the steering of the motorcycle needs to be agile as possible it cannot happen unless excess and unwanted load from the front wheel is taken off that is what upside-down forks do. With the heavy stuff all connected to the frame of the AWD electric motorcycle the wheel is very much free from movement and it becomes easier for the AWD electric motorcycle to be maneuvered and change direction at high speeds on uneven terrain.

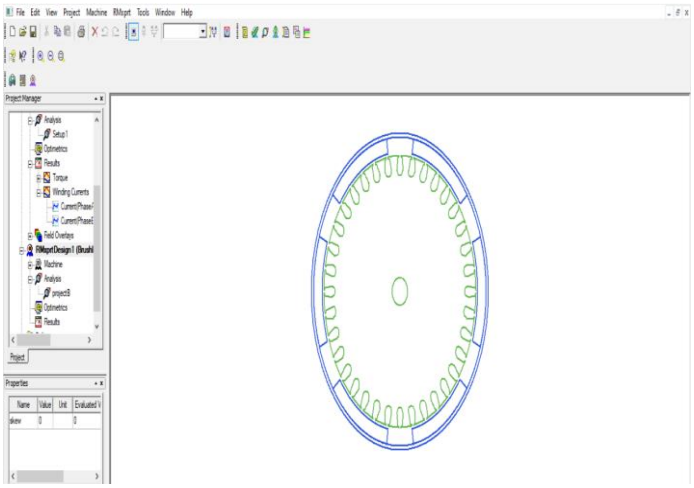
4.3.5 BRUSHLESS DC MOTOR (BLDC MOTOR)

The Motor is the power train of AWD electric motorcycle so a selection of motor types is a very important part. The motor is selected that is a hub-type electric BLDC motor. A Brushless dc motor (BLDC) is the best choice for today's electric bikes as it has advantages such as High starting torque and is more reliable noise produced is comparatively less it has a longer lifetime than other motors.

A) DESIGN OF BLDC MOTOR

The design of the motor is made to overcome the problems occurring of low power so an effective and reliable design is made by using Ansys maxwell software
Dimensions of motor:-

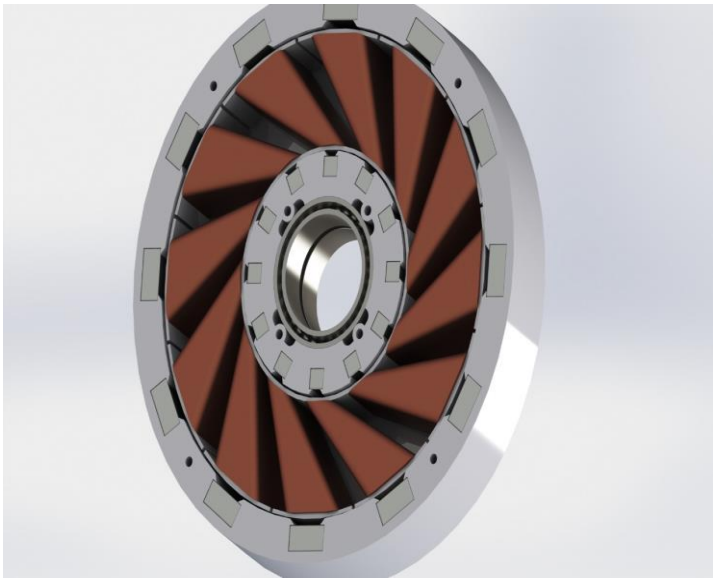
Motor dia - 250 mm
Motor length - 80 mm



3.3.5 Fig No – 1 Sketch of BLDC motor (ANSYS MAXWELL)

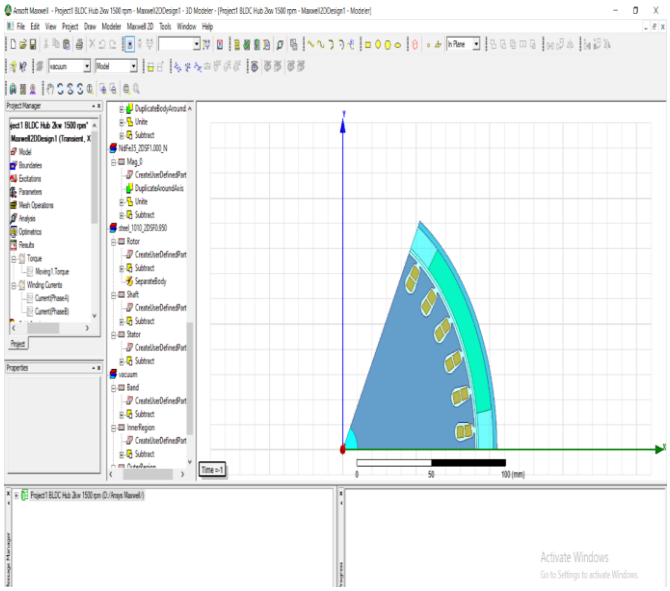
B) MODEL OF BLDC MOTOR

Model of BLDC motor in Solidworks

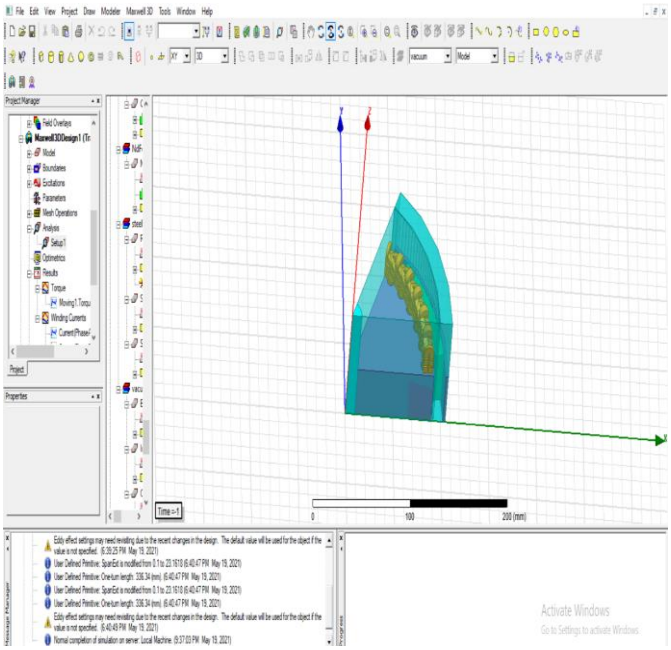


3.3.5 Fig No – 2 BLDC Motor

Model of BLDC motor is made by using software Ansys maxwell and Solidworks software



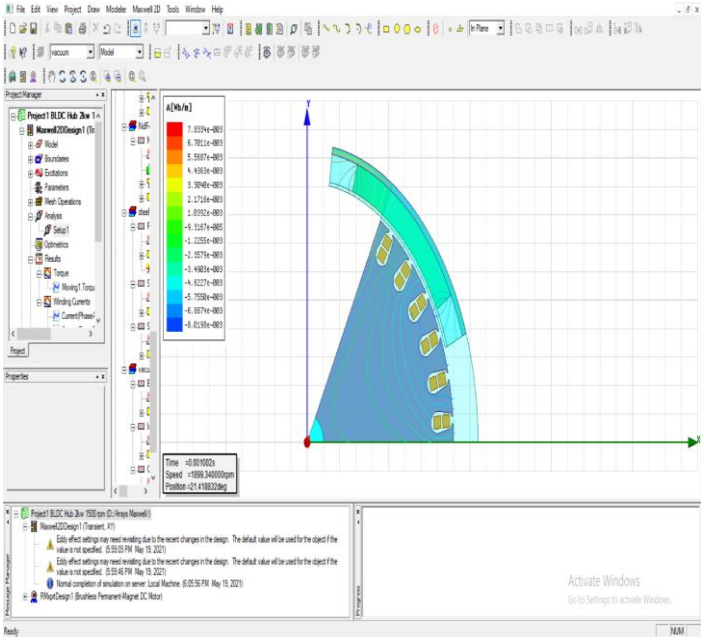
3.3.5 Fig No – 3 2D Design Part portion of a single magnet of BLDC motor(ANSYS MAXWELL)



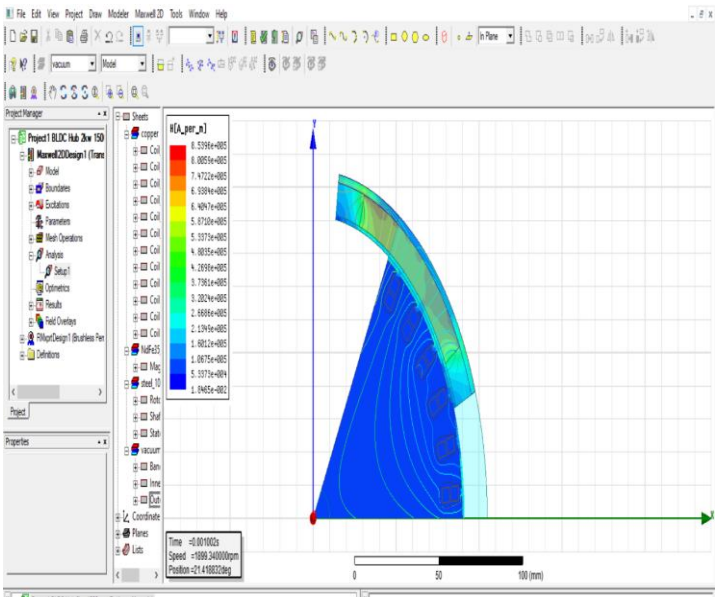
3.3.5 Fig No – 4 3D Design Part Portion of Single magnet of BLDC motor

C) ANALYSIS OF BLDC MOTOR

Magnet flux analysis and magnetic field strength analysis is performed to check the strength of the magnet and its magnetic field and movement of the rotor is studied at an initial stage in 0.001002 sec.



3.3.5 Fig No – 5 Flux lines at 0.001002 sec



3.3.5 Fig No – 6 Magnetic fields with flux lines at 0.001002 sec

When the current is on there is the magnetic field generated which makes the rotor rotate so by the analysis we came to know that for initiating the motor with 65 amps current rotor takes 0.001002 sec to move from its initial pole and start to rotate

4.3.6 WHEELS

Wheels are the one which handles the weight of an electric motorcycle it is the only part which is in contact with the ground while riding so the wheel should be strong and

capable to avoid slip during riding All-terrain type of tires are used they are designed for off-road riding and have deep grooves with bigger blocks on the tread these tires have a better grip on light sand, dirt, mud and rocks which makes it convenient to move in any area.

The rim where the tire fits are spokeless which has less weight and has good cornering stability rims are directly attached to the rotor casing of the BLDC hub motor.

3.3.6 Fig No – 1 Wheel with a hub motor

4.3.7 MOTOR CONTROLLER

A motor controller is a device that controls possibly every action of the motor

A 72 volt 65 amperes motor controller is used it is designed such as it controls every operation which includes speed control of the motor and Braking system. A Motor controller is the brain of the motor.

3.3.7 Fig No – 1 72 V 65 A Regenerative motor controller

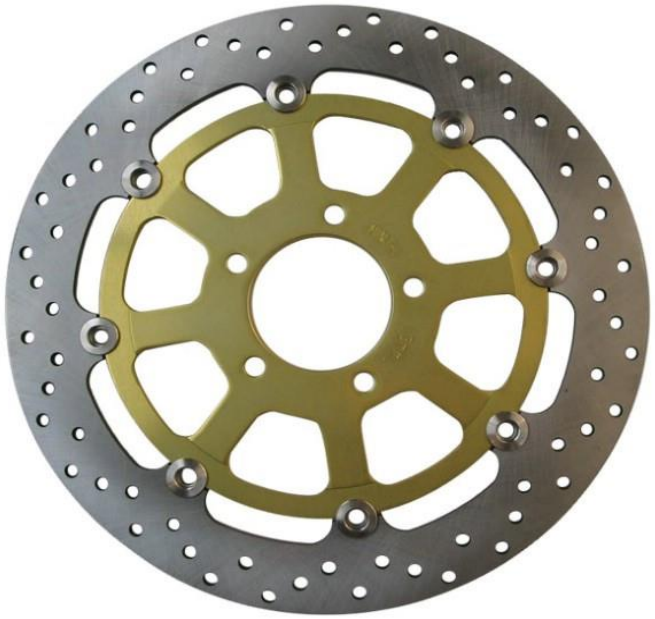
4.3.8 BRAKES

Brakes are used to stop a vehicle from moving in our AWD electric motorcycle brakes play an important role as the AWD electric motorcycle moves at high speed so in case of any unknown scenario brakes should be of a good type to stop the electric motorcycle and avoid accidents.

A) SELECTION OF TYPE OF BRAKES

The type of brakes used in AWD electric motorcycle is disc brakes which use a disc to stop the wheel the brake pad squeeze the rotor disc instead of the wheel. The brake components are shown below

- Disc
- Master cylinder
- Brake lever
- Caliper



3.3.8 Fig No – 1 Disc Plate

B. SPECIFICATIONS OF BRAKES

- Caliper-floating
- Number of the piston (front and rear) - 2 disc
- Front diameter - 260mm
- Rear disc diameter - 260mm
- Master cylinder - single pot, smaller dia for maximum pressure
- Brake hose-steel wired and rubber-coated hose

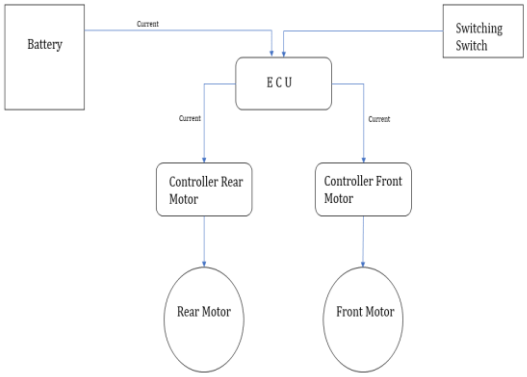
4.3.9 SWITCHABLE AWD SYSTEM

As the name says it is the most important component of a Switchable AWD motorcycle. A Switchable AWD system is the ability to switch between the two power trains (hub motors). The switching operation is carried out with the help of a switch which includes three modes

i. Switch rear to front
ii. Switch front to rear
iii. Intermediate switch

A. COMPONENTS OF SWITCHABLE AWD SYSTEM

1. Switching switch
2. ECU
3. Motor controller (Front and Rear)
4. BLDC Motor (Front and Rear)
5. Battery



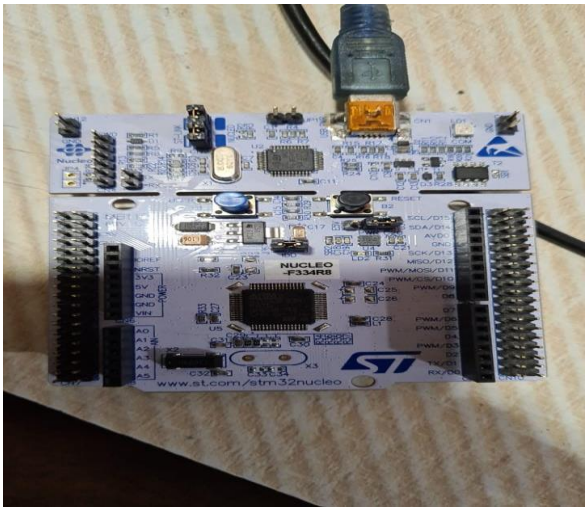
3.3.9 Fig No – 1 Switchable AWD system

B. WORKING

The switching operation is performed by a switch which is on the handlebar when the switching is done the signal is received to ECU then it calibrates the data and sends the signal further and the switch is performed, example- If we have to switch from front to rear then once the switching is done the signal is received by ECU and further send to controllers which analyze the signal an switch off the front motor and starts the functioning of rear motor. The whole system is shown in figure (3.3.9 Fig No - 1).

3.3.10 ECU (ELECTRONIC CONTROL UNIT)

ECU is called the brain of the electric motorcycle system ECU is the one that controls different components of electric motorcycles which include electronic screen display, Current regeneration, headlight control, and tail light control.



3.3.10 Fig No – 1 Smart ECU

Ecu is a smart device that includes a DC-DC converter inside a DC-DC converter. A DC-DC converter is an electronic circuit or electromechanical device that converts a source of direct current from one voltage level to another. It is a type of electric power converter. The power in lithium batteries vary from very low to very high our battery output is 72V it has to be converted to 12V as the power is to be used in other systems which operate at 12V such as headlights, indicator lights, horn, etc so this DC to DC converter is used.

MODEL NO - STM32F334R

3.3.11 BATTERY

The Battery is the powerhouse of an electric motorcycle so to make a Motorcycle design that has a very good range a rechargeable battery should be used as it can be recharged and used.

A) SELECTION OF BATTERY

A lithium iron phosphate battery is selected for battery in a Switchable AWD motorcycle. Lithium iron phosphate battery is a type of rechargeable battery. A lithium iron phosphate battery (LiFePO4) is a type of lithium-ion battery that uses lithium iron phosphate as the cathode material and a graphitic carbon material as an electrode with a metallic backing as the anode. It is one of the larger selling battery types in the industry. Compared with other lithium family battery packs which LiFePO4 battery packs have high-efficiency energy conversion of up to 95%. Lithium 3pollution, high-temperature environment, and good circulation performance under heavy-duty charge and discharge mode.

3.3.11 Fig No – 1 Lithium Iron Phosphate (72 V, 36 Ah)

Battery specifications

i. Battery type - lithium iron phosphate
ii. Voltage - 72 volts
iii. Amperes - 36 Ah
iv. Battery weight - 20 kg

3.3.12 BATTERY MANAGEMENT SYSTEM

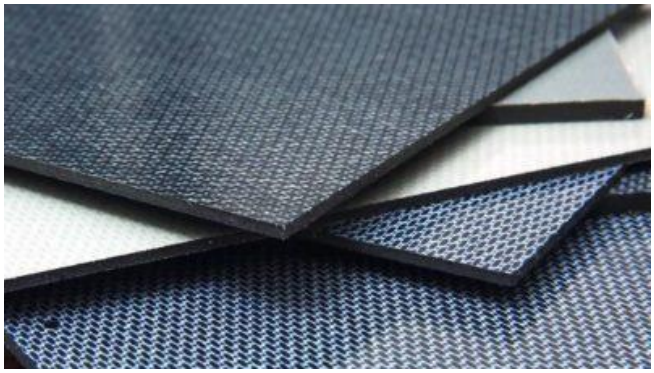
BMS module is an important part of a battery. In an electric vehicle (EV) or hybrid electric vehicle (HEV), the battery management system (BMS) monitors and controls the battery stack and manage features which include:

- Measuring the cells charge, voltage, temperature, and health
- Controlling the flow of battery coolant
- Diagnostics and protection for the battery
- Controlling the current among the cells to avoid overcharging or undercharging

3.3.12 Fig No – 1 AVID BMS

3.3.13 BODY PANELS

Body panels are the outer structure of the vehicle these covers the entire system insides such as frame, battery, motor controller, ECU, electrical wires, etc. thus the outer body of AWD electric motorcycle should be strong and as well as light so as the overall weight of AWD electric motorcycle should be less which makes it easy to move in any area. So to overcome these issues body panels are made of fiber-reinforced plastic. The composite material is made of polyester thermosetting plastic, epoxy resins. It is a composite material made of a matrix reinforced with fibers. FRP is a very light material and has very good strength to make the body panels we desired.



3.3.13 Fig No – 1 Fiber-Reinforced Plastic

3.3.14 Accessories

Accessories are the other parts of the AWD electric motorcycle all the remaining parts are also important it has their importance in electric motorcycle they include headlight, taillights, horn, rider seat, leg guard, brake lights, kill switch, mirrors. Headlights are designed according to our design with newly developed technology which is effective than conventional lights that are shown in figure (3.3.14 Fig No – 1). Taillights for indication of turns which are shown in figure 3.3.14 Fig No – 2). Legguards for vehicle protection and rider seat is for comfortable sitting riding maneuvrability for the rider. Kill switch is for an emergency stoppage to cut the power supply in case of emergency it is shown in figure (3.3.14 Fig No – 3). Mirrors are fitted for having visibility of behind vehicles mirrors are shown in figure (3.3.14 Fig No – 4). The Seat is attached to an Electric motorcycle so as the person will get comfort while riding seat is shown in figure (3.3.14 Fig No – 5)

3.3.14 Fig No – 1 Headlight

3.3.14 Fig No – 2 Tail Lights

3.3.14 Fig No – 3 Kill switch

3.3.14 Fig No – 4 Mirror

3.3.14 Fig No – 5 Seat

6. CONCLUSIONS

The main objective to produce a Switchable All-wheel drive(AWD) motorcycle that moves in uneven terrain without loss of traction that can be achieved by study and experiments results obtained. By these results we can make a Switchable AWD motorcycle which overcomes today's problems we experienced such as pollution from burning fossil fuels, stability of electric motorcycles, moving in uneven areas with greater range, etc. Our innovative idea can overcome these problems with excellence this is all result achieved by long study overcoming all the potential barriers in an electric vehicle.

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