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Retrofitting of Scooter using Electrical Power Pack

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Abstract: Mopeds that were factory-made in 2004 or before it reaching to be scrap in 2019 as RTO rule, therefore thanks to this reason we tend to modifying that in such some way that it'll run on road with zero emission. so as to sustain during this quick forward world we tend to should travel from place to position. It's important that point taking for motion ought to be less, additionally it ought to be economical and simply accessible. Taking all this into consideration, we must always shift aloof from typical fuels to renewable sources of energy. electrical mopeds plug-in electrical vehicles with 2 wheels which might be recharged from external supply of electricity provide, and also the electricity is hold on in a very reversible battery, that provides power to 1 or additional electrical motors to realize movement. The electricity is generated from associate degree external supply helps in acceleration of mopeds that causes no pollution .In This paper, we tend to victimisation recent mini-bike that having the Body and engine in it. BLDC Hub motor having the upper potency and wheel hub motor reduced size compared with brushed motor. It'll get power from Li particle and BMS. we tend to reaching to replaced engine with Wheel Hub Motor and controller and battery connected to wheel hub motor propel the vehicle.
Keywords: Electrical Vehicle, Battery, Hub Motor, Scooter,

I. INTRODUCTION

To retrofit the Moped into Electrical vehicle, it requires some changes in the chassis design of old vehicle. The vehicle should be electric powered and driven with the help of a powerful dc motor. it requires new design of a special swing-arm this carries enough strength as well as is light in weight. Due to this design becomes an eco-friendly, zero emission and low-cost . To select the battery or power pack, study of the Various Battery used in Electric Vehicle should be done carefully because we nned to follow some standards while dealing with electrical vehicle.

II. METHODOLOGY

Methodology includes Input Study- Deciding of geometry and material- Selction of motor- Selection of Controller and Bettery- Making CAD model of the vehicle- Structural analysis of the CAD model- Thermal analysis of the battery pack- Manufacturing phase- testing. Table no- 01 shows the wheel hub motor specifications selected .

A. Motor Selection

Table no- 01 Wheel Hub Motor specification

Sr. No.	Specification	Value
1.	Construction	Brushless Gearless Hub motor
2.	Rated Voltage (DCV)	48V
3.	Rated Power	1000W
4.	Weight	7.9 Kg
5.	Rated Efficiency	>80%
6.	Application	Electric Scooter
7.	Rim Size	10 Inch
8.	RPM At No Load	400 RPM -600RPM
9.	Tyre: F/R	3.00-10
10.	Torque	37 Nm
11.	Max Torque	72 Nm
12.	Max Carrying Capacity	200

B. Cell Selection

1) Model:15S for 3.2V Rated LiFePO4
2) 15S 48V 50A bms is used for 15 series 48V battery pack
3) Common Version : common port for charge/discharge
4) constant discharge current: 50A
5) Charge Current: 40A
6) Extreme low power consumption. The consumption of the whole device is less than 50uA.

Table no: 02 Comparision of Batteries for the Selection

Parameter	Lead Acid	Nickel Cadmium	Nickel Hydrogen	Nickel Metal Hydride	Nickel Zinc	Lithium Ion	Zebra	Nickel Iron
Specific Energy (Whr/Kg)	35-50	30-60	50	60-80	70-100	80-180	90-120	50-60
Specific Power (W/Kg)	150-400	80-180	220	200-300	170-260	200-1000	130-160	80-150
Cell Voltage	2.1	1.2	1.4	1.2	1.6	3.05-4.2	2.58	1.2
Cycles (N)	250-1000	1000-50000	1300-6000	300-600	Upto200	3000	>500	2000
Life (Years)	5	10-15	15	2-5	-	5	-	30-50
Max. Depth of Discharge (%)	20-80	60-80	-	-	100	100	-	80
Self-Discharge Rate / Month (%)	20-30	15	High	15-25	20	10	-	20-40
Efficiency (%)	75-85	60-70	-	-	-	-	-	65
Operating Temperature (°C)	Poor Performance At Low Temp.	-40-80	-	Ambient Temp.	-	49	270-350	-40-46
Safety	Good	Less	-	Average	-	Average	Good	-
Recharge Time(Hr.)	8	1	15	1	2-3	2-3	8	8

III.DESIGN

A. Powertrain Calculation

Vehicle Calculations:
Tyre size= 10”
Coefficient of Rolling = 0.015
Coefficient of drag = 0.5
Air Density = 1.27 kg/m3
Frontal Area = 0.6m2

For Maximum Speed

Maximum Speed = 70 Kmph = 17.44 m/sec
Weight of the Vehicle with two people,
(Gross weight)= 220kg
Range= 80Km/charge @ speed of 70kmph
Peak power= (Gwgt × 9.81×V × Cr) + (1/2 ρ×A×Cd×V3)
= (220×9.81×19.44×0.015)+ (1/2 1.27×0.6×0.5×19.443)
Peak power=2.028 KW (at top speed)

For Nominal Speed
At speed of 50kmph (i.e., V= 13.88 m/sec)
Peak power at 50kmph = 1.165 kW
≅ 1.2 kW
Rolling Resistance (Rr)
= 0.015× Gwgt×9.81
= 0.015×220×9.81
=32.373 N
Air Drag (Ra) =1/2×ρ ×A×V2×Cd
= 1/2×1.27 ×0.6×19.442×0.05
= 71.99
Total Resistance = Rr+Ra
= 72+32.373
= 104.36
Torque,
T= 13.25 N.m
N= (13.25*60*10^3)/(π*254)
N= 996.6 RPM
At Gradient Speed of the Vehicle= 25kmph
Rr = 32.373
Ra = 1/2×ρ ×A×V2×Cd
= 1/2×1.27 ×0.6×6.942×0.5
Ra = 9.186
Gradient Force (Rg) = w*9.81*Sin ∝
Gradient Angle (∝) =10°
Rg= 374.76 N
Total Resistance =
= Rr+ Ra+Rg
=374.76+9.186+32.373
= 416.32N
Torque Required= 416.32*0.127
= 52.87N.m

B. Motor Selection

Normally, Brushless DC (BLDC) motor is used in all electric portable vehicles due to its speed torque characteristics and also it gives maximum starting torque.
Torque decreases with increasing speed so no external reduction gearbox is required.
Also available in wide power ranges while not being expensive.

C. Battery

Range = 70 Km @ Speed 45Kmph
Power/ Km = 1000/45 = 22.22 W.hr /Km
For, 70 Km =22.22× 70 = 1555.55 W.hr
Capacity of Battery Pack = 1555.55/48 = 32.40 A ≅ 40A
Battery Pack capacity = 40A, 48V
Battery pack
Lithium ion 18650,
Voltage = 3.7V, Current= 2.6A
Series cell = 13
Parallel cell =16
Total No. of cell = 208

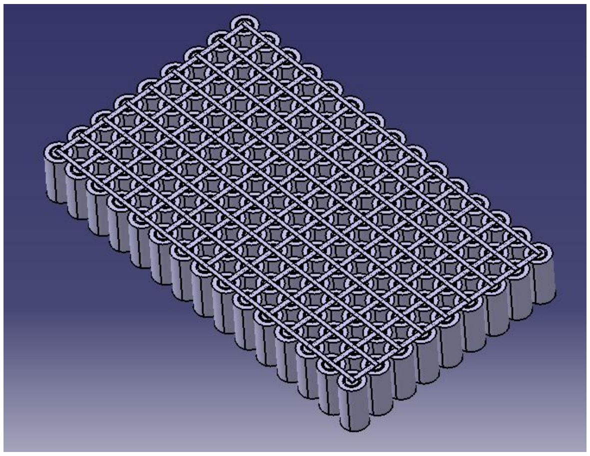

Figure 01: Battery Pack

D. Charger Selection

Specification of battery = 48V, 40Ah

Practically, 40% loss of current during battery charging

Then,

Loss= 40×40/100 = 16Ah

Total current= 16+40= 56Ah

Charger 48V, 3Ah

Charging time = (total current)/(charging current)

= 56/3 = 18.66 Hr.

Charger 48V, 24Ah

Charging time = (total current)/(charging current = 56/24 = 2.33 Hr.

Charger 48V, 20Ah

Charging time = (total current)/(charging current)

= 56/20 = 2.8 Hr.

4.4 Heat Dissipation

The battery heat is generated in the internal resistance of each cell and all the connections.

Total no. of cell= 208

Nominal current capacity for each cell= 6000mah

Internal resistance of cell= 10mΩ

Power dissipated by each cell= R×I2

= 10×10-3×62

P= 0.36

Total power dissipated by battery= P× Total no. of cell

= 0.36×208

= 74.88

E. Swing Arm

Material Used

General Characteristics of 4130 Alloy Steel

1) AISI or SAE 4130 grade is a low alloy steel containing chromium and molybdenum as strengthening agents.
2) Its chemical composition is as follows:

Material	iron	carbon	silicon	chromium	molybdenum	manganese
4130	97%	0.81%	0.25%	0.80%	0.20%	0.80%

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Figure 02: Activa Swing Arm

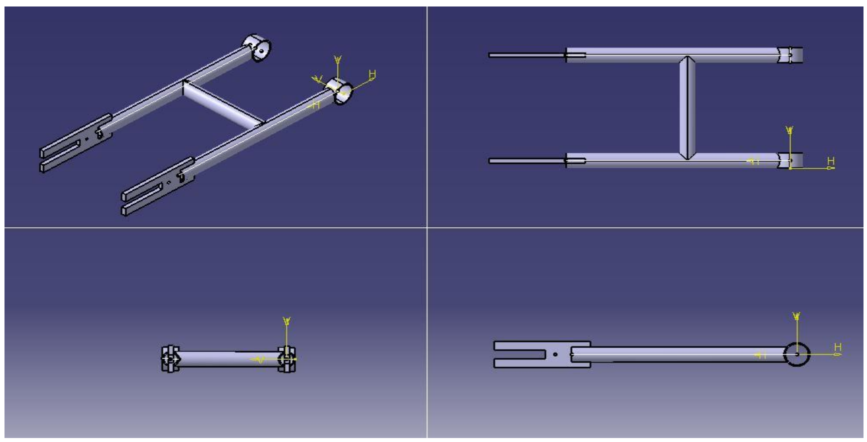

Figure 03: CAD model of Swing Arm

F. Analysis of Swing Arm

Inspire software is used for the Analysis of Swing Arm. Displacement, Factor of Safety , yielding is calculated on Inspire software. Table noo- 03 represents the analysis results of swing arm.

Table no 03- Analysis Results

Sr. No.	Result	Values
1.	Displacement	12.7 mm
2.	Stress	120.4 MPa
3.	Factor of Safety	1.08e+8
4.	Percentage of Yielding	334.12%

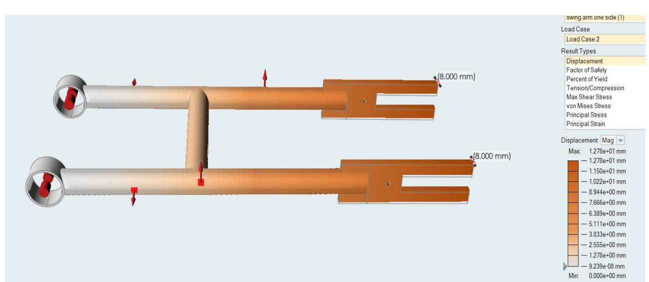

Figure no-04 Displacement results

G. Design Calculation for Helical Coil Spring of the Shock Absorber

Material: Spring Steel (modulus of rigidity) G = 78600N/mm2
Mean diameter of a coil, D=27.375 mm
Diameter of wire, d = 9.375 mm
Total no of coils, n1= 17
Height, h = 210mm
Outer diameter of spring coil, D0 = D +d = 36.75 mm
Hence Square and ground end=number of active turn
= (n1 -1)
= (17-2)
No of active turns, n= 15
Weight of bike = 118 kg
Let weight of 1person = 100Kg
Weight of 2 persons = 100×2=200Kg
Weight of bike + persons = 338 Kg
Considering dynamic loads it will be double
W = 338 Kg = 3315.78N
We know that, compression of spring,
$\delta=(8WD^3 n)/(Gd^4)$
$\delta=(8\times3315.78\times 〖27.375〗^3\times15)/(78600\times 〖9.375〗^4)$
$\therefore\ \delta=23.44$ mm
C = spring index
$\therefore\quad D/d=36.75/9.375=3.92$
Solid length, Ls =n1×d=17×9.375= 159.375 mm
Free length of spring,
Lf = solid length + maximum compression + clearance between adjustable coils
= 159.375 + 13.44 + (13.44 ×0.15)
= 174.831 mm
Spring Rate=K
3315.78/13.44
=246.70 N-mm
$E= 1/2\ \times W \times \delta$
E = strain energy stored in spring (N-mm)
E=22,282.04 N-mm
Stresses in helical spring: maximum shear stress induced in the wire
$\tau = K_s \times 8WD/(\pi.d^3)$
$k_s=(4C-1)/(4C-4)+0.615/C$
KS = 1.41373
$\tau=1032.39\ N/〖mm〗^2$
For Series combination,
$1/k= 1/k_1 + 1/k_2$
k1=k2 = 246.70
k= 123.35 N-mm
Pitch=p
$(l_f-l_s)/n_1 +d$
= (174.831-159.39)/17+9.375
p = 10.28 mm
Crippling load under which a spring may buckle KL = 0.1 (for hinged end spring)

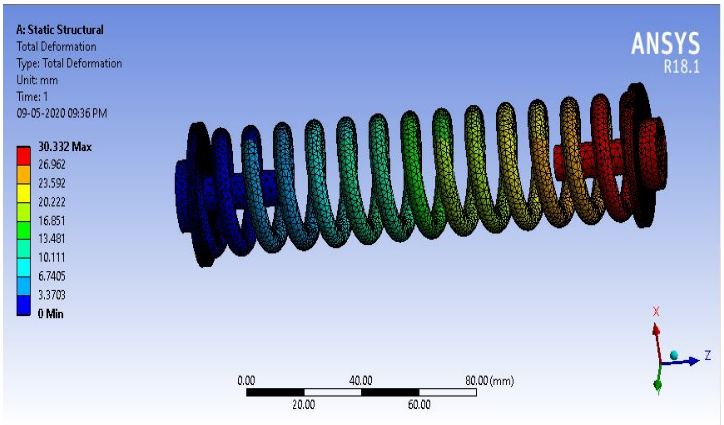

Figure no- 05 Spring Analysis

IV. RESULTS

After manufacturing the Vehicle, it gives Satisfactory driving experience to rider. Cost required for the retrofitting of old Activa into Electric vehicle is near about INR 22000. Average Charging cycle is for after 18 hours.

V. CONCLUSION

It is concluded from the design and study of research papers, the motor power required for Retrofitting vehicle is much low due to less rated torque and heavy weight. The brushless DC motor is selected for this vehicle is suitable and easily available at cheaper cost. Also torque at standstill is sufficient to propel the vehicle with 150 kg weight. Selected battery type is cobalt based lithium ion battery pack. The li-on cell has maximum specific energy and Amp-hr capacity than any other type of batteries. The single cell of various capacities is easily available in market with affordable cost.The Swing arm is the most critical part and it is made up of steel with Circular cross section. It has good Strength and provide safe riding experience on bump road, so Retrofittment of this vehicle reduces cost also it reduce pollution.

VI. ACKNOWLEDGMENT

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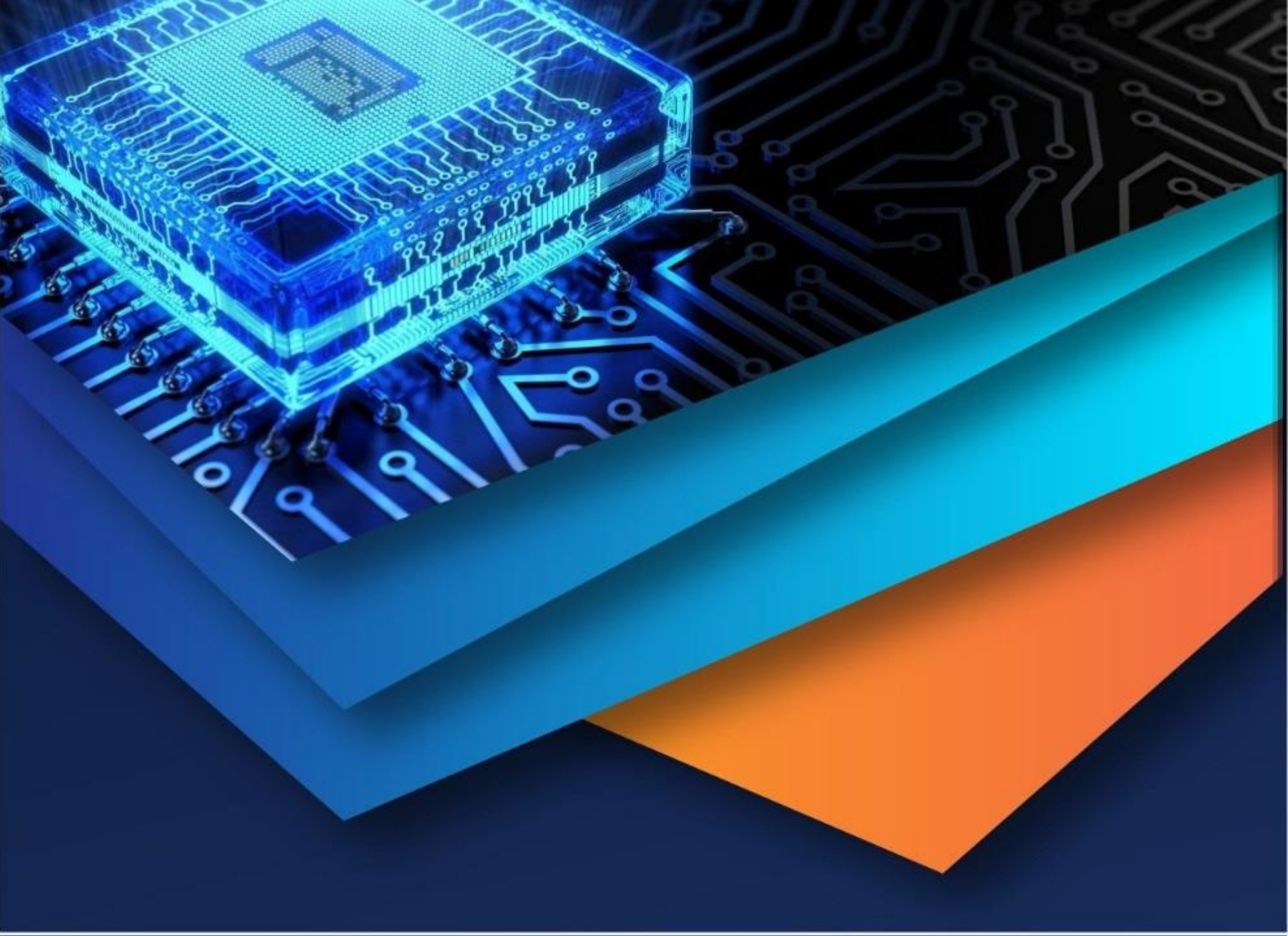

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