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Design and Fabrication of All Terrain Electric Vehicle

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ABSTRACT: Electric vehicles (EVs) are becoming an increasingly important part of the automotive market. ATVs can also fabricate and equipped with electric power trains. This method of making ATVs on electric power will enhance the performance and reduce the fuel consumption cost. The pollution due to the vehicle will be reduced. There are several factors, methods and techniques need to be considered while designing electric ATVs. Design calibration and performance testing should be as equal or better than ATV with fossil fuels. As per the required load carrying capacity, power train and battery pack should be modified. Cost of fabrication and equipment is also a considerable issue. It must be cost effective.

In this paper the design and development of Electric ATVs is explained. We have selected to make ATVs on electric power train for our project. This article explains the step by step process of developing the electric ATVs.

KEYWORDS: Electric Vehicle (EV), ATVs, All Terrain Vehicle (ATV)

I. INTRODUCTION

Today's electric cars are described as "modern era production electric vehicles" to distinguish them from the series of false starts in trying to design an electric car based on existing production models of gasoline-powered cars and from "kit" cars or privately engineered electric cars that may be fun and functional but not production-worthy. From the 1960s-1980s, interest in the electric car was profound, but development was slow. The design roadblock of the high-energy demand from batteries could not be resolved by adapting designs. Finally, in the late 1980s, automotive engineers rethought the problem from the beginning and began designing an electric car from the ground up with heavy consideration to aerodynamics, weight, and other energy efficiencies.

The space frame, seat frames, wheels, and body were designed for high strength for safety and the lightest possible weight. This meant new configurations that provide support for the components and occupants with minimal mass and use of high-tech materials including aluminum, magnesium, and advanced composite plastics. Because there is no exhaust system, the underside is made aerodynamic with a full belly pan. All extra details had to be eliminated while leaving the comforts drivers find desirable and adding new considerations unique to electric automobiles. One eliminated detail was the spare tire. The detail of the rod-like radio antennae was removed; it causes wind resistance that robs energy and uses energy to power it up and down. An added consideration was the pedestrian warning system; tests of prototypes showed that electric cars run so quietly that pedestrians don't hear them approach. Driver-activated flashing lights and beeps warn pedestrians that the car is approaching and work automatically when the car is in reverse. Windshields of solar glass were also an important addition to regulate the interior temperature and minimize the need for air conditioning and heating.

Among the many other design and engineering features that must be considered in producing electric cars are the following:

Batteries that store energy and power the electric motor are a science of their own in electric car design, and many options are being studied to find the most efficient batteries that are also safe and cost effective. An electric motor that converts electrical energy from the battery and transmits it to the drive train. Both direct-current (DC) and alternating current (AC) motors are used in these traction or propulsion systems for electric cars, but AC motors do not use brushes and require less maintenance.



A controller that regulates energy flow from the battery to the motor allows for adjustable speed. Resistors that are used for this purpose in other electric devices are not practical for cars because they absorb too much of the energy themselves. Instead, silicon-controlled rectifiers (SCRs) are used. They allow full power to go from the battery to the motor but in pulses so the battery is not overworked and the motor is not underpowered.

Any kind of brakes can be used on electric automobiles, but regenerative braking systems are also preferred in electric cars because they recapture some of the energy lost during braking and channel it back to the battery system.

Two varieties of chargers are needed. A full-size charger for installation in a garage is needed to recharge the electric car overnight, but a portable recharger (called a convenience recharger) is standard equipment for the trunk so the batteries can be recharged in an emergency or away from home or a charging station. For safety, an inductive charger was created for electric cars with a paddle that is inserted in the front end of the car. It uses magnetic energy to recharge the batteries and limit the potential for electrocution.

II. DEVELOPMENT OF ELECTRIC ATVS

2.1 Rollcage Design

While designing Thickness, Outer diameter and carbon content of the roll cage material must be considered under the limiting dimensions as per SAE Baja rule book (2019). The product development process is lead to add value by improving usability, lowering production cost and developing more appealing product. Last time the design of the vehicle was little over engineered. Engine compartment was overloaded with much number of members due to this it create problem while assembly and dis assembly engine and gearbox. And this year design is easy to make and assemble, as well as delivering appropriate functionality and appearance. Cockpit was undesirably spacious as compare to new design where driver’s comfort and compactness is achieved simultaneously.

Table 1: Material Selection and Dimensions

Material	AISI 1018	AISI 4130	AISI 1018	AISI 4130
Outer Diameter (mm)	25.4	25.4	29.2	29.2
Wall Thickness(mm)	3	3	1.65	1.65
Bending Stiffness (Nm ²)	2758	2758	2787.51	2787.51
Bending Strength (Nm)	387	658.22	339.94	642.62

One of the major factor which is considered for the manufacturing of the roll cage is the material selection where the cost, availability and safety of vehicles. Various material of similar mechanical properties are to be compared and selected according to their result obtained. As we can observe in the above table that the AISI 4130 has major advantage of greater bending strength, bending stiffness and giving flexibility to use different geometric cross-sections.

2.2 Ergonomics

Driving comfort is a very essential part of designing a roll cage as drivers has to drive the vehicle for very long time on all kind of terrains. The basic strategy of a safe system approach is to ensure that in the event of a crash, it provides crash survivability design including injury-retardant interior materials for safety of driver.

Table 2: Parameters and Their Angles

Sr. No.	Parameters	Values
1.	Angle of Elbow	110 ⁰
2.	Seat back Angle	75 ⁰
3.	Angle of Knee	120 ⁰



Fig. 1: Fabrication of Roll-cage

To minimize the unsprung mass, the bulky wheel assembly is replaced by lightweight assemblies which reduces the 47% of unsprung mass. To overcome bending of ball joint, spherical ball joint is used which also helps in reducing weight.



Fig. 2: Design of Suspension and other components

2.3 Material Selection

To select the material first of all we have a clear idea about what we have to make, how we make and what is its purpose. After getting the idea we are done background research of various materials and in the research, we figure out the properties of material, machining on the material, cost, and availability of the material in market.

This system is configured in numbers 0 to 5 in which 0 is poor quality and 5 is given for best material. After given these numbers to different properties of different parameter the addition of numbers is done. The material which consists higher numbers is the best one for particular parts.



2.4 Welding

We have used the TIG welding. The TIG welding stands for Tungsten inert gas welding. In this welding, less noise is produced, less electricity consumption, and chips do not form. In the welding process, the non-consumable tungsten electrode (EN26848 WT20 ϕ 2.4*150mm) is used. The AWT FR-70S-2 filler metal of diameter 1.5mm is used, which has similar properties with the parent material and makes a small fillet radius, which tends to be good aesthetically, with less consumption of filler. In the welding process, the shielding gas used is such as Argon or Helium, which are inert in nature and do not affect the surroundings, as compared to CO₂, which is used in MIG welding.

2.5 Suspension System

With the help of CAD software, suspension geometry is drawn and study is done by synthesis of mechanism. Multiple iterations are done on "LOTUS SHARK" Suspension Analysis Software for optimal results. Parameters required are as follows: wheel base 56, track width of front is 54 and rear is 52, caster angle as 70° according to steering effort of driver, to improve straight-line stability; king pin inclination is set to be at 80°, to minimize scrub radius and camber gain, ground clearance 12" to easily overcome obstacles, weight distribution is taken 40:60. The stiffness, ride frequencies, spring rates and wheel rates are calculated from the result of Lotus software output and the mounting points are selected. Roll centre of front is higher than rear since it helps in over-steering. To overcome plugging of axle, camber gain is 0° at rear. Wishbones are inclined at 70°, at the same time, the caster is kept 70° to transmit forces on the wheel directly in suspension.

Table 3: Suspension System Parameters

PARAMETERS	VALUES	
	Front	Rear
Suspension travel in Jounce	5 inch	5 inch
Suspension travel in droop	3 inch	2 inch
Camber (static)	0 0	0 0
Toe (static)	0 0	0 0
Roll centre height	190 mm	170 mm
Motion ratio	0.55	0.65

2.6 Steering

Table 4: Steering System Parameters

Total rack length	16"
Rack travel	48mm
Module	1.5
No of teeth on pinion	20
No of teeth on rack	12
Scrub radius	44.35mm

We are using Ackerman steering geometry. Practically, it is not possible to achieve 100% Ackerman, so 99.43% is calculated. With the steering arm inclination, the geometry is perfect steer. Front and rear trackwidth is kept different because a larger track width at the front decreases the weight transfer during braking and cornering, which takes place diagonally, and rear wheels are kept closer as it helps in attaining traction. Wheelbase is kept minimum considering weight transfer and smaller wheelbase effect on a vehicle's turning radius (or turning circle) and steering angle (how sharply it turns). From Ackerman geometry, inner and outer angles are calculated as 44.98° and 27.50° respectively, having a turning radius of 2.053 m.

By keeping a minimum positive caster angle of 7° for straight line stability and providing good response to steering, king pin inclination is kept 8° for minimum scrub radius to increase returnability. Zero static camber is kept for even tire wear. Static toe is kept zero to avoid bump steer, as bump steer is defined as toe angle change with suspension travel. So our main objective is to reduce the bump steer by keeping tie rods parallel to wishbones, acquiring parallel geometry.



Fig. 3: Steering System Attachment on Rollcage

Rack and pinion steering mechanism is used.. By doing number of iteration rack position is decided from lotus shark suspension analysis.

By eliminating universal joint tilting type steering column is chosen to adjust according to driver's comfort. Steering wheel diameter is taken 10.5 "from calculation of steering effort. Shape of steering wheel is butterfly type to reduce weight.

2.7 Braking system:

The evaluation of model is done by calculation of braking torque & comparing it with required value. It is implemented, BAJA buggies require compact & light weight system which are reliable and provide satisfactory braking under tough condition. According to BAJA rule all wheels must be lock at a time at the speed of 45kmph. So the calculations are done at the speed of 45kmph. Total braking force is 1854N out of which 57% is act front due to weight transfer and 43% at rear. For compact wheel mounting 170 mm disc is taken at front and 160 at rear. due to smaller size of vents the heat dissipation was slow, which causes brake fading, brake squealing and crack formation. So this year we manufacture rotor with large size of vents. Materials used for rotor is SS 430. It is highly resilient to corrosion and wear and ready to be heat treated for increased wear resistant and good surface finish for antifade characteristic. Two master cylinder are use instead of one tandem master cylinder due to small in diameter it generate more pressure and two independent circuit . To generate more clamping force fix type caliper is use of bore diameter of 32mm and at rear 25mm is use. With the help of balance bar the driver pedal force is split in two master cylinder in ratio of 57:43. Normal driver force is taken 200N. to reduce driver effort the leverage ratio is kept 1:7. Pedal is mounted on the balance bar with the help of needle bearing. For brake biasing we used a F-R split for maintaining pressure difference between front & rear. The selected willwood pads can operate up to 8 MPa. In calculation maximum brake pressure has been set to 5.56 MPa. The convective cooling is optimised through effective ambient air flow and large cooling areas.



Fig. 4: Master Cylinder used for Breaking System

VI. CONCLUSION

Development of Electric ATVs is not yet cost effective but having major advantages that it works on green energy. Also, the Nowadays, Li-Ion batteries have the biggest market segment in equipping electric vehicles. Moderate energy consumption (14.7 kWh/100 km), continuous decline of the cost price, advanced manufacturing technology, increased cycle life, low weight and high energy storage potential make Li-Ion batteries an optimal choice in this field. In this paper the ATV (All Terrain Vehicle) is manufactured and successfully operated on 30 km/hr speed.





Fig 5. Different Views of ATEV after work

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