Design and Fabrication of Body Framing and Chassis
Development of Electrical Vehicle (ATV) With Simulation Analysis

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Abstract. Designing purpose of this electrical ATV is to manufacture an off-road vehicle that could help in transportation in hilly areas, farming field, military & border defence forces (while climbing mountains for attacking and war zone to move fast). Our perspective is designing ATV for the agriculture process with some major Agricultural operations to accomplish this task, different design aspects of electrical ATV. The vehicle was analyzed, and certain elements were chosen for a specific focus. There are many factors to an off-road electrical vehicle, such as the chassis, suspension, steering, drivetrain, power transmission, solid-state batteries, electronics driver (Acceleration, Regenerative Braking power calculus and Inputs and Outputs RPM and Efficiency) all of which require thorough design concentration. My part is to focus on where the chassis and body framing which includes steering and suspension aspects for designing. Most time and effort went into designing and implementing these components through FEA simulation and verifying the stability and efficiency of the ATV. In order to boost the edge of the ATV, it is important to pick a range of phases including content, collection, frame plan constraints, criteria for inquiry, iteration, evaluation and simulation. The above measures are critical to the unbending edge and ideal to give the driver the full protection along with enhanced road performance. The procedures are closely observed in this investigation and an attempt is being made in order that a case fit to be produced and an automobile improved that can be carried out in disagreeable environments. Due to the above proposed functionalities, a move confine must have some ideal properties and characteristics to such an extent that it is ready to withstand high anxieties created during vehicle activity just as holding fast to the prime target of giving security and solace to the inhabitant. An expanded concern concerning the move confines configuration has made the significance of recreation and investigation in this way anticipating disappointment methods of the casing. In the introduced report, we have utilized a demonstrating and reproduction programming to examine the reaction of the planned casing under different effects, reproduced based on genuine effect situations. The mimicked limit conditions and stacking application are done to anticipate the useful conduct of move confine during impacts, assisting with building up a casing plan which has adequate quality what's more, vital wellbeing principles.

Keywords: All Terain Vehicle, Modelling, Over All Design, Design and Analysis, Simulations, Material Selection, CAD, FEA, Optimization, Development, Chassis, Electric Vehicle
1. Introduction
Roll Cage can be called as the skeleton of a vehicle, other than its inspiration being seating the driver, giving security [1]. Move limits are exceptionally structured and created packaging worked in the voyager compartment of a vehicle to shield occupants from being hurt if there should be an occurrence of setbacks [3]. An ATV vehicle having moved over the protection system has been attempted coincidentally test to check whether it is alright for its occupants or shows that the front and posteriors of a vehicle have crushed anyway the move restrict demonstrates how solidified it is [2]. We can't thoroughly avoid incidents anyway we can decrease the number of fatalities amid these setbacks by taking prosperity exercises [5]. The objective of the examination is to structure and develop the move bind for All-Terrain Vehicle. Material for the move keep is picked subject to quality, cost, and openness. The move limit is planned to combine all the vehicle sub-structures [4]. An item show is set up in Solid work’s programming. Later the structure is attempted against all techniques for disilluishment by driving various generations and stress examination with the guide of ANSYS Software. Considering the result got from these tests the structure is modified in like way [6]. The vehicle is required to have a blend blueprint and move limit containing steel people. As weight is essential in a vehicle constrained by somewhat engine, evening out must be found between the quality and heap of the arrangement. To best upgrade this balance the usage of solid showing and constrained part examination (FEA) writing computer programs is to an extraordinary degree significant despite customary assessment [7]. The item shown is set up in Solid Works programming. Later the structure is attempted against the various types of frustration by driving diverse impact conditions and stress assessment with the guide of ANSYS Software. After viably arranging the move limit, it is set up for fabricating [9].

The ATV V1.0 is modeled in CATIA and SOLIDWORKS 2014 because of their greater flexibility and productivity for modeling different components. To test and validate the different models the ANSYS Workbench 16.0 is used [8]. The results were studied and remodeled and retested. Such iteration is repeated unless and until maximum possible weight reduction is achieved without any loss of structural stability and driver safety [10]. The Lotus suspension simulation programme performed the dynamics simulation. Theoretical efficiency measurements have also been conducted [11]. In order to increase efficiency without losing structural stability, comprehensive weights significant decrease strategies have been followed in each level. In terms of safety and cosmetic appearance, we constructed the roll cage [12]. These are all the two most important things that matter to us, and so they are taken seriously [13]. All work was performed following the SAE Baja guidelines to maintain the car’s eligibility for the competition [14]. The Figure 1 shows the sample design of tubular space (or) roll cage dimension design.

Main Factors Involved in Fabricating Of Ev Atv
- modelling or designing
- selection of frame
- selection of material for both base and body frame
- type of welding
- simulation analysis

2. Design Methodologies
Modelling: A wide assortment of programming, for example, CREO, CATIA, SOLIDWORKS, FEMPRO, ANSYS, and so forth are economically accessible and can be utilized to display and dissect the ATV outline. In this examination, Creo2.0 is utilized for displaying and ANSYS 14.5 is utilized as an apparatus for investigation. For the most part, utilized CAD and afterward changed over to 3d plan or two duplicates one in CATIA and another is in strong works for simple and better recreation and examination reason.
Figure 1: Sample design of tubular space (or) roll cage dimension design

*Design Factor:* Designing factor of ATV through a stepwise direction conceptual, developing of design through CAD software like Solid Works and CATIA, FEA analysis on all parts, fabricating the vehicle, and vehicle testing.

*Main design focus:* The vehicle’s main architecture is based on lightweight, stiffer ascetic frames, sturdy suspension architecture and a more compact train. In addition, the design of steering and braking with high safety and precision was aimed in order to achieve faster acceleration, it is also important to keep the rolling cage as low as possible and also to maintain the centre of gravity as wide as possible in order to prevent overthrowing. Mounting heavier parts directly on the frame, including the engine and the driver's seat, is one way to reach a low gravity centre.

*Design Considerations:* The goals for the roll cage design include. Increase comfort for the driver.
- Decreased weight, and overall length
- Improved packaging for subsystems
- Aesthetic considerations
- Attractive design
- Durable
- Lower C.G value
- Safety and Ergonomics
- Standardization and Serviceability
- Maneuverability
- Maximum control with suspension design.
- Optimize power efficiency
- Cost of the components
- Safe engineering practices

*Design Stage:* Many models of the roll cage were designed and modified to reach the design considerations. The frame was designed using CATIA and SOLIDWORKS packages and analyses were performed in ANSYS. The main steps to be followed while designing the frame of the vehicle are:
Proper clearances must be maintained. Figure 2 shows the design stage. Between the driver and the frame by taking the measurements of the common driver dimensions.

- Wheelbase and track width must be fixed
- Initially before designing the roll cage
- Proper leg room must be provided

Figure 2: Design stage

**Size Specifications of Material:** In order to reduce the weight of the roll cage, different sizes of the tubes were considered.

**Primary tubes:**
- Outer diameter—2INCHS
- Wall thickness— 0.5MM

**Secondary tubes:**
- Outer diameter— 1.5INCHS
- Wall thickness—0.3 TO 0.5MM

Outside Diameter >> Wall Thickness >> Bending Strength >> Bending Strength >> Weight Per Meter.

**Factors required designing of electrical vehicle (ATV):**

- Selection f Frames
- Types of frames Mostly used in ATV
- Backbone Frame
- Ladder Frame
- Monocoque Frame

Among these above frames Tubular Space Frame is suitable for ATV

- (Two Seating) And Advantages
- Safety Factor
- Light Weightiness (Usage of Alloy Materials)
- Torsional Rigidity
• Optimum Strength  
• Ability To Gain Speed at Less Time

**Tubular Space Frame** (Using Software CATIA): In a tubular chassis the rectangular segment tube uses thousands of circular locations in various directions provide the structural properties to motion. These tubes are welded and form a very complex structure. Tubular Space Frame is mostly used in the manufacturing of ATV. For the two-wheel drive in which connected only with Rear wheel Axial. so, the selected frame was efficient to the Transmission aspects. The load withstanding at the end of the body frame due to the Electrical motor is placed at the end.

**Frame Design:** The purpose of the chassis is to effectively and securely encapsulate all aspects of the automobile, including the driver. During construction and installation, key features of the frame include the safety of the driver, stability and integration of the drive train, structural rigidity, size and operator build quality. In chassis construction, driver safety was the number one concern. The figure 3 shows the CATIA ATV Model Design.

![Figure 3: CATIA ATV Model Design.](image)

3. Material Selections  
Material choosing as a whole has experienced strong development that ensures that all the products are well optimised, strength-to - weight tests, cost analyses and weight control are done together.

3.1 Selection of Material  
Material >> Roll Cage >> Pipe Diameter & Radius  
For Example: STEEL 4130  
**Materials**  
Steel 4130  
Outside Diameter >> 2.540cm  
Wall Thickness >> 0.304cm  
Bending Strength >> 3791.1Nm  
Bending Strength >> 467.4Nm  
Weight Per Meter >> 1.686Kg

- Any alloy or composite material which is light in weight and high load carrying capacity and factors like deformation and stability.
We choose the above-mentioned material through SAE Baja rule book of all the editions and analysed to get a good property in selection of material.
3.2 Weldments (Fabrication)
The soldering process of MIG and TIG uses an electric arc for the solder. The distinction is how the arc is used. The distinction. The soldering of MIG (metal inert gas) uses a feed wire that passes through the gun continually to generate a spark and melts into the weld. TIG soldering (tungsten inert gas) requires long rods to directly connect two metals. TIG welding is constrained in its performance on thicker work. More types of metals are ideal for use. It is possible to use MIG welding in the aluminum, in stainless steel and steel and all the heavy-duty concrete plates from 26-gauge sheet metal.

Tig Welding or Gas Tungsten Arc Welding: TIG is the most widely used stainless welding process for its high efficiency, flexibility and durability. This welding method produces a low input of heat, making it suitable for thin materials. Argon gas is also paired with other gases, depending on the requirements of the individual plant, such as oxygen, hydrogen and nitrogen. A one-sided welding process can be used to ensure inert gas back safety between inner and outer welds to avoid oxidation and to improve resistance to corrosion.

Resistance or Spot Welding: Welding intensity or "spots," as is often referred to, is one of the most inexpensive soldering styles. The RW machinery is exceptionally flexible that can be used on either medium or big projects. The RW is a highly versatile machine. RW uses electrical flow to heat and secure frayed metal edges. The welding type is particularly productive on steel with a limited melting point since it can be customized to avoid metal corrosion.

Mig Welding or Gas Metal Ac Welding: MIG welding is a semi-automatic process that creates a clear bond between two components of stainless steel when performed correctly. The argon-rich shielding gas and rigid wire electrode are used in this operation. MIG welding is common because it helps the welder to run a pulse current supply that makes it easier for complicated stainless-steel projects to solder the rough spots. The stabilization of arc and enhancement of the solder efficiency are commonly seen in additional mixed gases, including helium, oxygen and carbon dioxide. AISI4130 has good soiling potential for the material used.

Figure 4: Gas Metal Ac Welding

Both solders in the car are manufactured by a welding method MIG (metal inert gas). MIG welding generates an active arc to build the circuit with an anode fed constantly (+ cables) and a cathode-the (metal is welding). MIG is preferred because it provides the greatest thermal management in affected areas, while also reducing the internal tension of the preferred frame so that the weld can bend slightly and without fracturing. It offers the best soldering, speeds up welding and allows welding simpler simple and renewable. Among the above welding process both are best for two metal SSAISI 1018 and SS AISI
4130. Specially the TIG was suitable for all grade of stainless. Figure 4 shows the Gas Metal Ac Welding images.

4. Simulation Results

**Analysis:** The growth of the analysis is also significant, and numerous additional effect checks can be accomplished in the analysis.

**Front Effect:** In the front impact, we used energy in the front of the automobile and all pathways are needed at the front and back stabilization points. It has been agreed that the car has a front effect on some other stationary car since the Baja rulebook communicates our vehicle's highest speed of 60 mi/h.

**Back Effect:** In the Rear effect, the power is applied in the back piece of the vehicle and every one of the 4 suspension points is compelled toward all paths, the vehicle is expected stationary. Considering the other vehicle with the same detail is moving at its most extreme speed 60 Kph as expressed by the Baja rulebook and hit the principal vehicle from the back.

**Side Effect:** It is performed by applying the power on the side effect part and obliging the suspension focuses on all paths.

**Torsional Stiffness:** It is one of the most significant properties of the vehicle body. Lack of skeleton torsional firmness impacts the heap move appropriation. It is performed by considering. An arm and move confine as a solitary unit while evacuating revolute joint and compelling the back An arm vertex focuses on all path and applying the equivalent and inverse power on the front An arm vertex focuses.

**Front While Bump:** It is used to check if the frame transmits the heap if the suspension is disappointed. The absolute pressure is transferred from tyre to framework if it happens. It is done by obligation to suspend the control of the right front wheel for three haggles.

**Turn Over Analysis:** In turn, over the examination, we consider the most pessimistic circumstance where all the heap is moved to move loop overhead part and obliging the suspension focuses on all paths.

| Name             | Force (Pounds) | Stress (gpa) | Deformation (inches) | F.O.S. | Stress Analysis | Deformation Analysis |
|------------------|----------------|--------------|----------------------|-------|----------------|----------------------|
| Front Impact     | 3374.05 (4.8G) | 442496       | 0.418                | 1.50  |                |                      |
| Rear Impact      | 3374.09 (4.8G) | 40706        | 0.935                | 1.56  |                |                      |
| Side Impact      | 2240.59 (3.6G) | 36633        | 1.047                | 1.74  |                |                      |
| Rail Over Impact | 1986.81 (2.8G) | 60856        | 0.560859             | 1.04  |                |                      |

*Figure 5: Curb Weight Testing Results*

**Curb Weight Testing and Ground Clearance:** The weight in which the vehicle weight without all the loads and persons and analysis of torque and performance of the load in the vehicle. Land visibility is among the most common but very significant basic measurements for an automobile (also referred to as riding height). The gap between the underside of the engine block (or chassis) and the ground is defined as minimal. Figure 5 shows the curb weight testing results.
5. Results and Analysis

**Front Impact:** When the rear recovery points are reversed in the front and 5 G is used at the frontal nodes facing the collision. Measuring is carried out in 0.5 mm mesh size Figure 6 indicates the peak frontal stress produced at the rate of 300.76 MPa while the maxi deflection is 4.4 mm, shown in the figure 7.

![Figure 6: Maximum Stress in Front Impact.](image)

**Rear Impact:** When evaluating Rear Effect, front pickup points are set and 3 G force is applied at the rear nodes undergoing a collision. [16] The meshing size had been 0.5 mm and the maximal stress produced had been 224.65 MPa, as illustrated in figure 8 and 2.64 mm vertical displacement as in figure 9.

![Figure 7: Maximum Deformation in Front Impact.](image)

![Figure 8: Maximum Stress in Rear Impact.](image)
**Rear Impact:** When evaluating Rear Effect, forward pickup points are set and 3 G force is applied at the rear nodes undergoing a collision. The meshing scale was 0.5 mm and the maximum pressure, as seen in Figure 10, was 224.65 MPa. And in case of rear impact, display a maximum deformity of 2.64 mm as seen in figure 11.

**Side Impact:**
For Side Impact, at the most excellent node of Side Impact Member (SIM), the opposite selection notes which that stack is attached are fixed. The 2.5 G load is applied. The maximum stress was 435.7 MPa,
as shown in the figure 12, while the maximum distortions in case of side effect is 9.23 mm in Figure 13. [15] The fracture of 9.23 mm in this effect is maximal but not very significant as a 4 "SIM tolerance was involved in the design process. Figure 12 and figure 13 shows the maximum stress in side impact and displacement limit in side Impact.

![Figure 12: Maximum Stress in Side Impact.](image1)

![Figure 13: Displacement limit in Side Impact.](image2)

**Roll Over:** For rollers with a volume of more than 1.5 G, the front bracing member is extended through the 45° reference plane to the cartesian co-ordinate plane. In case of rotation, as seen in the figure 14 the stress distribution of 152.51 MPa is created. In roll-over, as the figure 15 shows a maximum deformity of 3.38 mm. Figure 14 and figure 15 shows the maximum stress in roll over and displacement limit in roll over.

![Figure 14: Maximum Stress in Roll Over.](image3)

![Figure 15: Displacement limit in Roll Over.](image4)
5.1 Advantages of AT
Motorbikes with four wheels are ATVs or all-terrain vehicles. Many people call them four-wheelers or quads. The great thing the about bike is that it fits the demand between those who want regular and simple bikes. ATVs can have the following advantages as a vehicle:

1. **Flexibility**: All-terrain ensures that virtually anywhere from concrete roads to pasturelands, deserted fields, and rocky terrain, the ATV can be used. Regardless of the road surface, the ATV can surely manage all the bumps and steep climbs needed in various places. The car itself is essentially built to be pushed anywhere, and this is the greatest advantage from ATVs.

2. **Driving Fun**: Since ATVs are everywhere when it comes to wanting fun and adventure it can be the perfect vehicle. ATV provides more flexibility and a distinct driving experience for motorcycle riders, making it a very enticing vehicle for people finding adventure. The accessible layout and flexibility of ATVs in rugged terrain for car lovers would also be able to appreciate.

3. **Usefulness**: ATVs are also tough to create that explains its ability to cope with the different pressures on the mountainous and rugged roads. As a rugged, durable and flexible vehicle, ATVs are a very good working vehicle for some people, particularly farmers and other agricultural workers. Motorbikes and cars may not be on rugged and muddy terrains when you tend your farm but growing can go smoothly with the ATV. All-terrain vehicles provide a friendly and useful alternative to more general vehicles. These can also be more valuable than a fun driving experience. Hard and durable constructed.

5.2 Advantages of Electrical Vehicle (ATV)
- Electric motors are operating slower than combustion engine motors. Electric cars have relatively low noise pollution. The rolling sound from the tyres at high speeds is the loudest.
- No toxic emissions or greenhouse gas emissions are emitted by electric vehicles while driving. The electric car will run CO2-free if the high-power capacitor is depleted from the renewable energy resources.
- We can only be permitted to travel through them with high-voltage cars in the immediate future, as extremely highly congested municipalities become pollution zones.
- The engine is extremely durable and needs no servicing. It is physically wearable only.
High performance of electric motor engines of up to 96 percent compared with 35 to 40 percent in-house internal combustion.

Electric drive engines have excellent torque and performance. The maximal torque is produced from standstill. This makes it much easier for an electric car than with a car that achieves the same performance from an internal combustion engine.

The configuration of the drive train is simpler, since there is no need for vehicle components such as engine, clutch, mufflers, particulate philtres, fuel tank, ignition, alternating and pulling plugs. The engine can also be used as a producing energy alternator while the car is braked and battery charges (regenerative braking).

You should charge the high-voltage battery at home, in a car park and using convenient connectors. The blue charge connector in the car is standardised in Germany and is used by every manufacturer at public charging terminals.

Just when the consumer wants the electricity is supplied. The electric drive engine never operates when the car stops at a red light, similar to traditional cars. In line and bumper-to-bumper traffic the electric drive motor is highly powerful.

In addition to the electric motor drives reducing gearbox, no lubricating oil is required for an autonomous motor.

5.3 Disadvantages of Electrical Vehicle (ATV)

- Based on battery capacity and structure, electric cars have a small range.
- Powering a high-tension battery, depending on the system load and power supply, will take some time.
- The charging point service is limited.
- The operator will have to schedule the trip because the target is outside the electric car. "Where can I recharge on the path my electric car?"

6. Conclusion

For the model roll cage, we measured frontal impacts, side effect, roll-over evaluation, rear reaction, bump evaluation and torsional evaluation. The load application relies on the race conditions of the ATV. Comparable stress values, overall deformity and protection factor have been shown to be smaller than the allowed maximum, hence the construction of a roller cage is better under all situations. The map among tension and the protection factor provides a good picture of the situation in different loading conditions of the rolling cage. For an increase in load, the protection factor reduces continuously. The findings of this study allow the roll cage to be optimised further. Case expects fundamental occupation in the Automobile to get together and should be mindfully organized. The coordinated research has begun with the arrangement of 3DCAD solid construed show as a multi-body structure, after that solid work will be made where each and every matched segment thought to be a marvelously unyielding and indistinct period of testing restricted part. The configuration of the rolling cage has been modified many occasions during the static review in order to reach higher FOS. A greater safety benefit guarantees the rolling cage ’s longevity under the toughest pressures and renders the rolling enclosure safe in manufacturing. The designing criteria involve all the testing and analysis conditions which are referred to in the SAE Baja rule book and the most important safety factor that involve in pre-riding safety techniques and momentum of the vehicle’s speed and matter distribution. As we are concentrated on electrical motor instead of an engine the weight of the vehicle reduces and changes in weight distribution for the center of gravity and analysis properties.
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