# Design and Analysis of Smart Automobile

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**ABSTRACT**

As the technological advancement are made keeping in mind sustainable manufacturing and environmental concern there is need for a car which is eco-friendly as well as having better safety measures. Automobile engineers have undertaken various measures and improvements which are done, but one of the aspect which is not given that much importance is tyres .The conventional tyres are rubber made which results in pollution in both making and decomposing. So we are trying to make Honeycomb structured Non-pneumatic Tyres (NPT) using Thermoplastic polyurethane (TPU), which are eco-friendly at the same time doesn't compromise with the properties of the tire. As well as to reduce the weight of vehicle the chassis is made from Chromoly Steel which is stiffer than normal steel but at same time light weight. With these the smart automobile model is incorporated with features such as Vehicle-to-everything (V2X) communication to communicate with other vehicles and road infrastructure to assist driver, cruise control system which controls speed of vehicle, ambient intelligence system which will detect drivers state(stress, fatigue, inattention) to improve drivers safety, solar panels to power the motors.

**Keywords-** Eco-friendly , Vehicle-to-Everything, Cruise control, Solar panel,will wood,TCR.

## INTRODUCTION

Growing concerns about public health, global warming and economic safety are calling for sustainable road transport technologies. Electric vehicles (EV), due to their zero local and potentially minor greenhouse gas emissions, are considered the cleanest option. Of even higher concerns are the opportunities EVs provide in terms of efficiency and flexibility in the use of energy.

This automobile is a combination of solar power, NPT, hydrogen fuelled engine and a rigid roll cage chassis all analyzed tentatively with a CAE software. The sole purpose is to make such a car that will be eco-friendly, safe and comfortable without burning a hole in the pocket of common people. The material used for Honeycomb structured tyre is Polyurethane which is a polymer made from Carbamate which is formed by reacting di-or poly-Isocyanate with polyol. For chassis the material used is AISI4130 chromyl steel which is an alloy of chromium and molybdenum.

In order to achieve the required voltage, the Photo Voltaic (PV) Module may be connected either in parallel or series, but it's costlier. Thus to make it cost effective, power converters and batteries are been used. The electrical charge is consolidated from the PV panel and directed to the output terminals to produce low voltage (Direct Current). The charge controllers direct this power acquired from the solar panel to the batteries. According to the state of the battery, the charging is done, so as to avoid overcharging and deep discharge.

Autonomous or Adaptive Cruise Control (ACC) is mostly used intelligent system for smart car controlling. Normally a radar or laser setup is used that allows the vehicle to slow when the front vehicle is slowing down and speed up to the preset speed that the traffic allows when no vehicle is in front. But these systems can only take control or take decision in straight roads where there is no possibility of taking decision about changing the route.

Park Distance Control (PDC) uses sonar sound waves and high-tech electronics to guide you in tight parking situations. Park distance control helps you park by audibly indicating when you are near an object, typically a parked car.

## LITERATURE SURVEY

S.Sarip [1], Further reduction in thickness or changing the material which is light weight vedant Kulkarni [2]To determine impact forces, loading points, convergence of node and mesh size dependence of generated stress

Sukumar.T[3] Observation shows that rim experiences maximum stress using ANSYS

Mahmood Hasan [4]Optimizing design of performance of disc brake using FEA.Evaluate performance under several braking condition from result of data service of long term stability is ensured.

Sangeeta malge[5] Performance design optimization of steering rod to nullify its function ability issue related with stress, deformation, vibration etc.Also suggest determination way for nullifying problem and cost by saving these material.

Ameer Fareed [6]Design is changed by giving holes to disc brake for more heat dissipation

B. Babu[7] Design of knuckle and perform load analysis and to find maximum stress area

Manik A. Patil [8] The FEA analysis of tie rod is carried out to check its natural frequency, maximum stress analysis and deformation

Chetan Dhuri [9] FEA of rack rod and pinion is carried out to check its properties.



**STEERING SYSTEM**

We have used Parallel Ackermann Steering geometry so as to get a low turning circle radius and optimum steer angles during dynamics.

Steering Dimensions:-

Wheelbase 61 inches Wheel track 50 inches Track Rod 38.3 inches Arm Length 3.5 inches Arm Base 2.8 inches Rack Lenth 24.5 inches Pivot Centre 45 inches Tie Rod Length 13.8 inches Steering Ratio 3:1 C-factor 0.06811 mm Toe-out 1(deg)

Camber 1.5(deg) KPI 3.5(deg) Caster 4.5(deg) Rack Travel 2.75 inches Value of outside lock 30 degree Value of inside lock 45 degree Turning Circle Radius of Outer Front Wheel , Rof 3.23meter Turning Circle Radius of Inner Rear Wheel, Rir 1.53 meter Turning Circle Radius of Inner Front Wheel, Rif 2.2 meter Turning Circle Radius of Outer Rear Wheel, Ror 2.7 meter Cornering force(braking) 30N Cf at accln 1.5g

TURNING CIRCLE RADIUS (TCR) CALCULATIONS:

1) Turning Circle Radius of Outer Front Wheel , Rof

$Rof = (b/\sin\phi)+(a-c/2)$

$Rof = 3.23$ meter

2) Turning Circle Radius of Inner Rear Wheel, Rir
$Rir = (b/\tan\theta)-(a-c/2)$ $Rir = 1.53$ meter

3) Turning Circle Radius of Inner Front Wheel, Rif
$Rif = (b/\sin\theta)-(a-c/2)$ $Rif = 2.2$ meter

4) Turning Circle Radius of Outer Rear Wheel, Ror
$Ror = (b/\tan\phi)+(a-c/2)$ $Ror = 2.7$meter

C- FACTOR CALCULATIONS:-

c-factor= rack travel(inch)/360(deg) pinion rotation

c-factor= $6.8611 \times 10^{-3}$ mm

STEERING RATIO:-

Steer ratio=sin^-1(c-factor×steering arm length)/360
Steer ratio=3.3 that is steering ratio is 3:1

STEERING EQUATIONS:-

Three factors affect the steering force in our application; vertical load, lateral force and tractive force. 1. Moment due to vertical load

$Mv=(Fzl+Fzr) \times d\sin(rollangle) \times \sin(steerangle)+(Fzr+Fzl) \times d\sin(castor) \times \cos(steerangle)$. =480.45N

2. Moment due to lateral force (braking)

$Ml=-(Fyl+Fyr) \times R\tan(castor)$ where R is Radius of tyre & Fy is lateral forces. Ml=-67851.30N

$Fy=Cf \times$mass of car/4

Cf= 1.5g

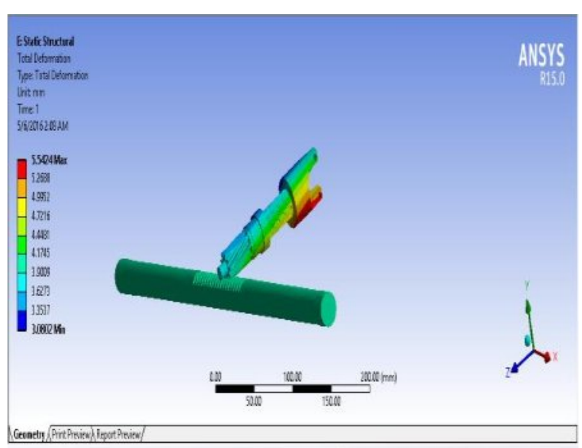


**Fig.1** Analysis of steering gear component

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**BRAKE SYSTEM**

Selection of Master Cylinder: Based on the above calculations willwood master cylinders were selected.

Selection of Disc: As summarized in the calculation a disc which could sustain 28906.56 N inch was required so we selected the Honda unicorn 220 mm disc of thickness 5mm. We reverse engineered it to analyze and validate its strength and we got satisfactory results.

Student Built Balance Bar: Different types of balance bars available in the market are very expensive but their construction is

Normal force on front caliper

Normal force on rear caliper

FNFCP = FFCP/μCP = 13119.85/0.6

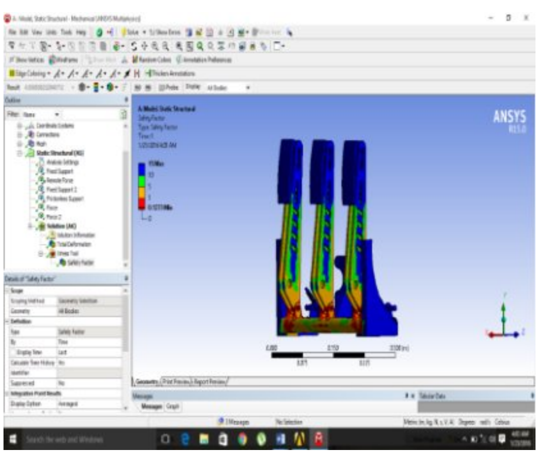
FNFCP =21866.42 N

FNRCP = FRCP/μCP = 4541.15/0.6

FNRCP =7568.58 N

comparatively simple, so the team decided to make our own balance bar. The balance bar can be adjusted for all the necessary bias.

**Fig.2** Pedal assembly



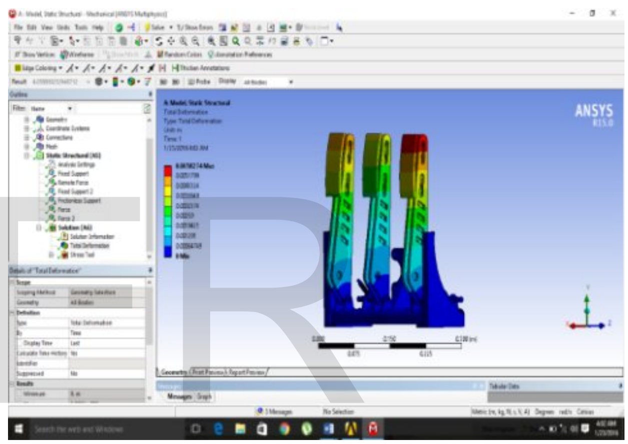




**Fig.4** Pedal Assembly: The pedal assembly was made from Al 6061 for light weight and high strength

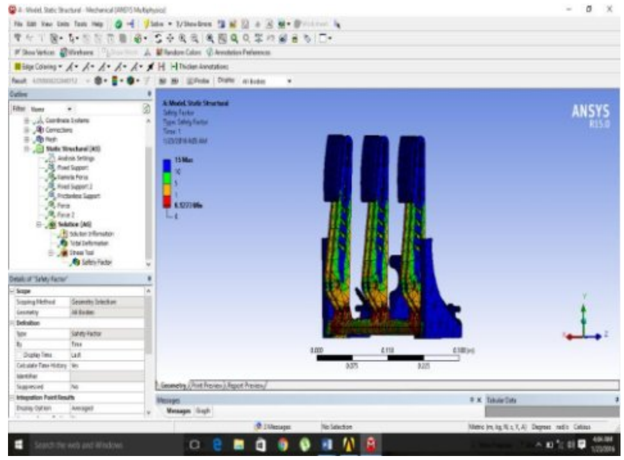



**TABLE.1**

**Geometric Properties**

| **Bounding Box** | | | | | |
|---|---|---|---|---|---|
| Length X | 4.e-003 m | 3.9999e-003 m | 0.10047 m | 0.3 m | |
| Length Y | 2.8497e-002 m | | 0.10182 m | 2.54e-002 m | |
| Length Z | 3.0033e-002 m | | 6.4138e-002 m | 2.54e-002 m | |
| **Properties** | | | | | |
| Volume | 1.8655e-006 m³ | | 1.0982e-004 m³ | 3.6399e-005 m³ | |
| Mass | 1.4644e-002 kg | | 0.86205 kg | 0.28573 kg | |
| Centroid X | 0.99521 m | 1.0212 m | 1.0087 m | 1.0095 m | |
| Centroid Y | 0.81681 m | | 0.84957 m | 0.79643 m | 0.79644 m |
| Centroid Z | 2.7153 m | | 2.7899 m | 2.7153 m | 2.7963 m |
| Moment | 1.5978e-006 | 1.5977e-006 | 9.0705e-004 | 4.4234e-005 | 3.4496e-005 |

| | | | | | |
|---|---|---|---|---|---|
| of Inertia Ip1 | kg·m² | kg·m² | kg·m² | kg·m² | kg·m² |
| Moment of Inertia Ip2 | 8.1102e-007 kg·m² | 8.0948e-007 kg·m² | 5.2223e-004 kg·m² | 2.1688e-003 kg·m² | 2.1572e-003 kg·m² |
| Moment of Inertia Ip3 | 7.8768e-007 kg·m² | 7.8611e-007 kg·m² | 1.1986e-003 kg·m² | 2.1656e-003 kg·m² | 2.1636e-003 kg·m² |
| **Statistics** | | | | | |
| Nodes | 352 | 355 | 1411 | 4057 | 4050 |
| Elements | 140 | 141 | 646 | 1996 | 1992 |
| Mesh Metric | None | | | | |

**TABLE.2**

**Structural Steel > Strain-Life Parameters**

| Strength Coefficient Pa | Strength Exponent | Ductility Coefficient | Ductility Exponent | Cyclic Strength Coefficient Pa | Cyclic Strain Hardening Expnt |
|---|---|---|---|---|---|
| 9.2e+00 | -0.106 | 0.213 | -0.47 | 1.e+009 | 0.2 |

**TABLE 3**
**Structural Steel > Isotropic Elasticity**

| Temperature C | Young's Modulus Pa | Poisson's Ratio | Bulk Modulus Pa | Shear Modulus Pa |
|---|---|---|---|---|
| | 2.e+011 | 0.3 | 1.6667e+011 | 7.6923e+010 |

**TABLE 4**
**Structural Steel > Isotropic Relative Permeability**

| Relative Permeability |
|---|
| 10000 |

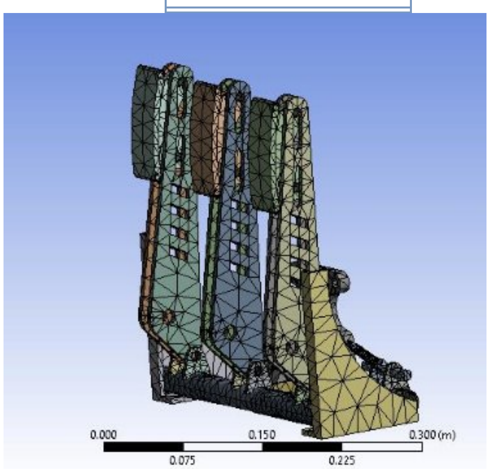



**Fig.5**

## Conclusion

The material selection is an important task as various factors such as strength, durability, aesthetics, mass etc. will be depending on the materials selected .Then analyzing the material and dimension for various parameters which will be acting on the Automobile while working.

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