Compelete analysis of chasis design of automobile vehicle using finite element method

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Abstract - *Finite element stress analysis of chassis plays an important role during design stages. The paper focused on stress analysis of the chassis using finite element package ANSYS. The current work contains the load cases & boundary conditions for* ***the stress*** *analysis, deformation analysis of chassis.*

***Key Words*: stress analysis, deformation analysis of chassis,chasis design.**

Introduction-Chassis is a French term and was at first used to denote the frame components or Basic Structure of the vehicle. It's the rear bone of the vehicle. A vehicle without body is termed Chassis. The elements of the vehicle like powerhouse, gear, Axles, Wheels and Tyres, Suspension, dominant Systems like Braking, Steering etc., and conjointly electrical system components mounted on the Supra Chassis frame. It combines all the elements together with the body. Therefore it's conjointly known as Carrying Unit.

CHASSIS

- Cockpit Opening &Cockpit Internal Cross Section must be as per the **template**
- Any portion of frame which might be in contact with driver helmet must be padded.
- . Firewall &Floor Close-out must be of **suitable material** as per the rules.
- Restraints, its attachments and mounting must be strong enough to withstand a force of **890N.**

SUSPENSION & WHEELS

- The suspension system with shock absorbers must have minimum travel of 2 inches.
- The smaller track of the vehicle must be no less than 75% of the larger track.
- The wheels of the car must be 8.0 inches or more in diameter.
- The car must have a wheelbase of at least 1525 mm (60 inches).

BRAKING & SAFETY

- Brake pedal must be designed to withstand a force of **2000N.**
- The braking system must act on all four wheels and be operated by a single control.
- The vehicle must be equipped with two (2) master switches which form part of the shutdown system.

STEERING

- Allowable free play for the steering system is limited to 7 degree measured at steering wheel.
- The steering wheel must be mechanically connected to the wheels.

ENGINE

- Limitation of Engine displacement is set to below 610cc.
- The throttle must be actuated mechanically, i.e. via a cable or a rod system.
- Intake System Restrictor of 20mm must be used.
- The maximum permitted sound level from the vehicle is 110 dBA.

Table -1:

Parameters	IS 3074 CDS4	1018 Steel	4130 Chro moly	1020 DOM
Weight	4	2	4	4
Cost	3	4	1	3
Manufacturability	4	4	2	4
Strength	4	1	4	3
Total	**15**	**11**	**11**	**14**

- All the suspension, steering and engine mounting points are nodded.
- Inside out approach for cockpit design.
- All the analysis are done by taking engine as a structural member.
- Frequency Range: 12.7 - 31.875 Hz

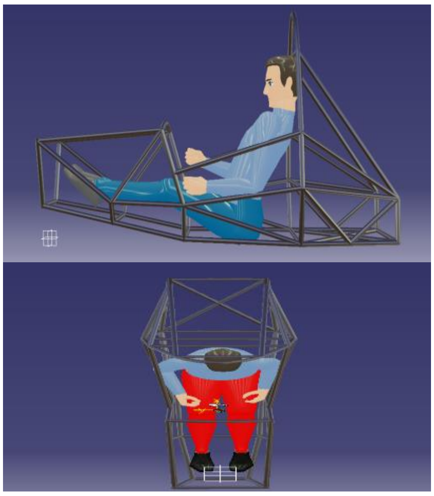


Fig – 1: ERGONOMICS & ANTHROPOMETRY

- Dashboard height = 596mm(5,4'')
- Reclined seating position with legs elevated
- Adjustable brake pedal(152.4mm)
- Seat thigh angle=27deg
- Quick release steering hub

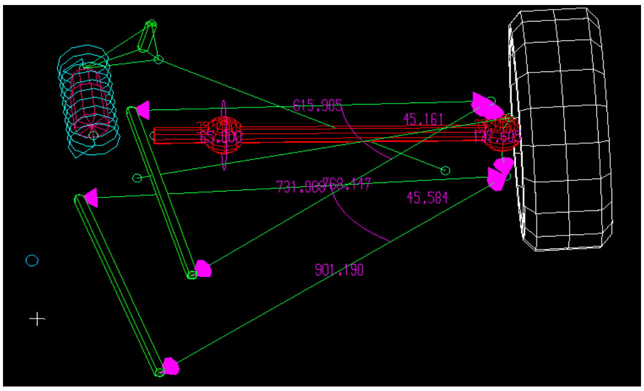


Fig-2: SUSPENSION

Table -2:

Design Considerations	
• Spring Stiffness	18N/mm(F) 27.5N/mm(R)
• Weight Ratio	40:60
• Wheel Frequency	3Hz
• Roll Centre	15 – 30 % of C.G Height
• Damping Ratio	Less than 1
• Roll Angle	0.124^0
• Motion Ratio	0.99FR 0.98RR

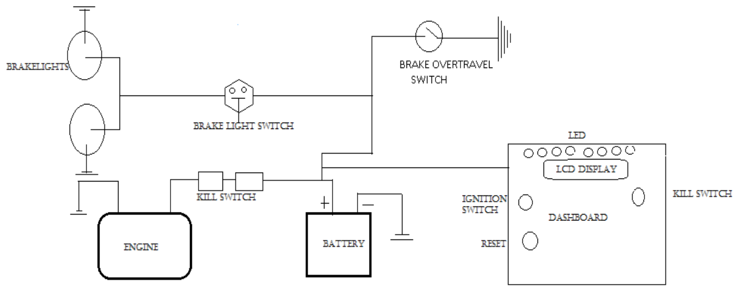


Fig – 3: ELECTRONICS

BATTERY 12V	BRAKE LIGHT 10W	DASHBOARD DISPLAY 10W	2 KILL SWITCH	1 BRAKE OVERTRAVEL SWITCH

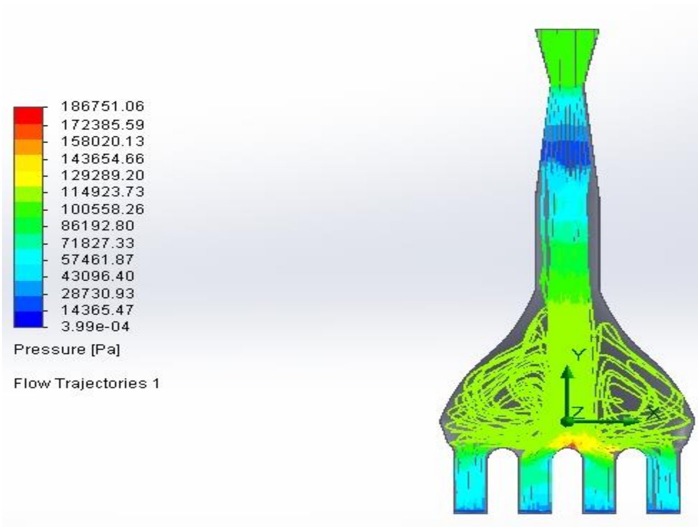


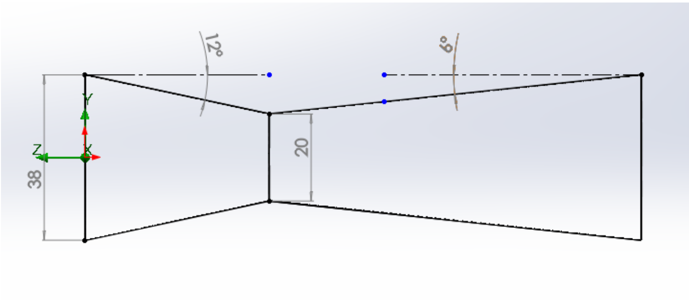
Fig – 4: INTAKE AND EXHAUST

Intake system

- Runner diameter = 38 mm

- Restrictor diameter = 20 mm
- Converging – diverging type nozzle

Maximum mass flow rate 0.0703 kg/s



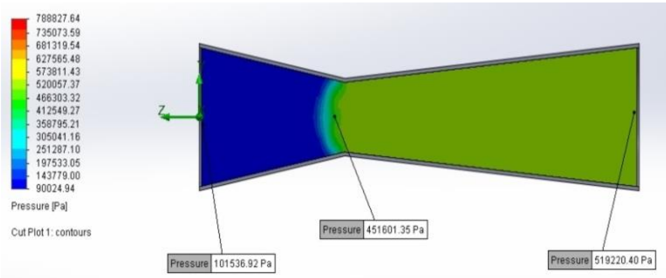


Fig – 5: Exhaust system

- 4-2-1 configuration for effective scavenging
- Sound level 110 db
- Analysis & Shape Optimization of Brake Pedal

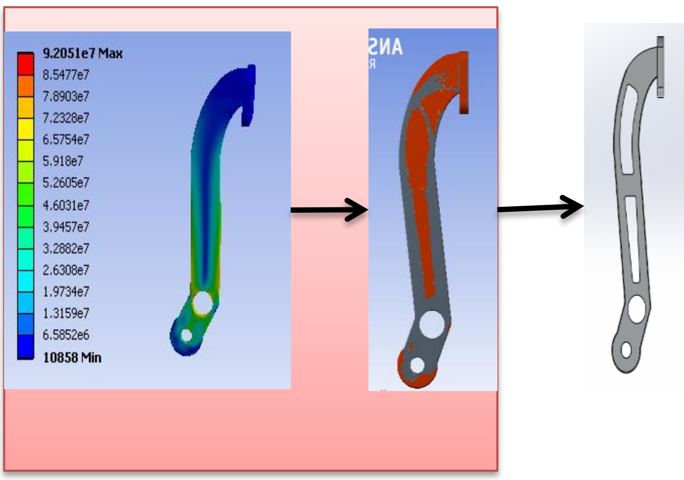


Fig – 6: ANALYSIS OF BRAKE PEDAL

Initial weight : 0.52 kg

Optimized weight : 0.40 kg

- Pedal Ratio – 6:1
- Max Stress – 92 N/mm²
- F.O.S – 2.98

- PEDAL TRAVEL- 92mm

System Specifications

- Independent Rear & Front Brake Circuit
- Outboard at Front & Inboard at Rear
- Balancing Bar used for brake biasing
- Y- Configuration Braking Circuit

ROTOR SPECIFICATION

- FRONT : 2 X 275 mm vented floating rotors
- REAR : 2 x 220 mm vented rotors

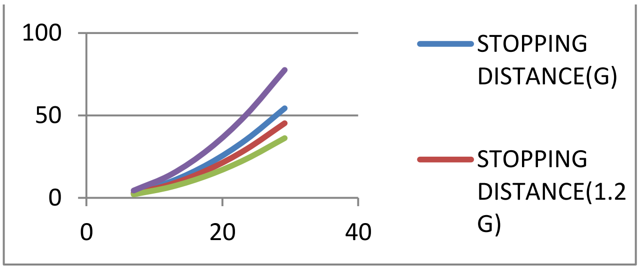


Chart-1: Stopping Distance

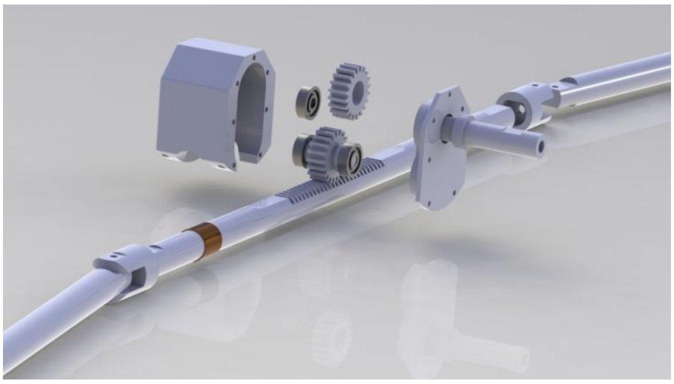


Fig –7: STEERING

Fig –8: STEERING DATA

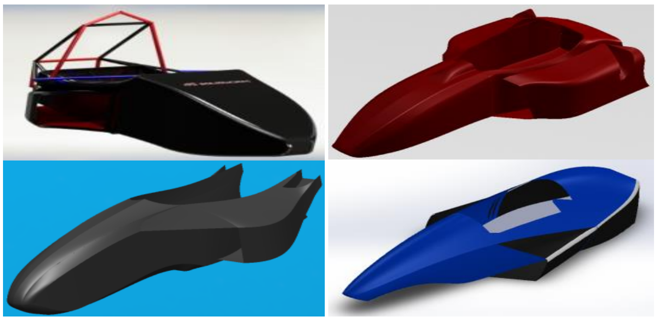


Fig –9: Material Selection for fairing

- Glass Fiber Reinforced Composite (GFRC)
- S- Grade Glass Fiber (0^0 & 90^0) (Plain Weave Twill)

Fig –10: final 3d design

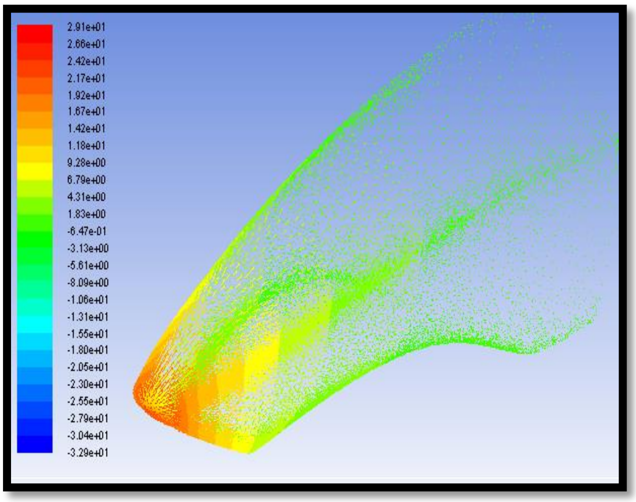


Fig –11: flow simulation around the nose

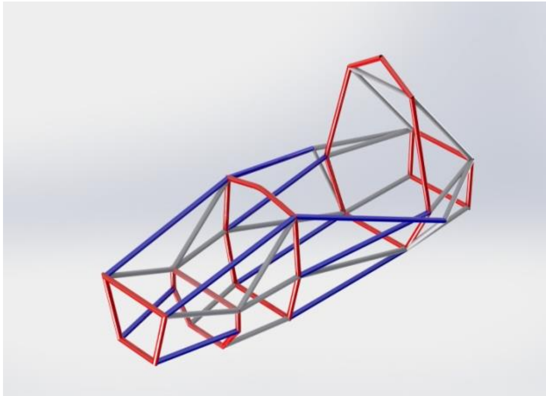


Fig –12: chasis frame design

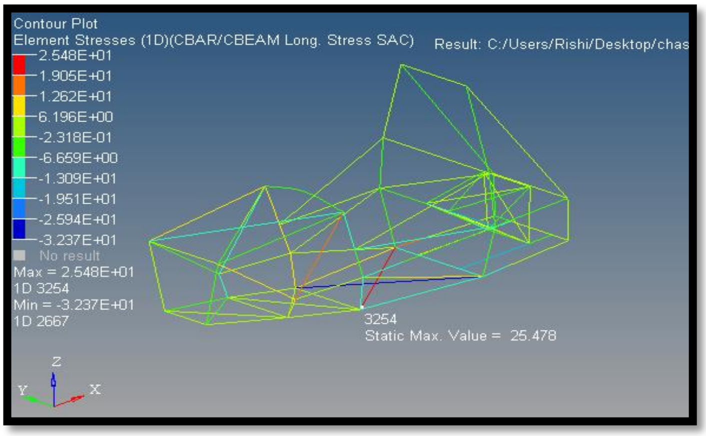


Fig –13: Stress analysis of chasis

- Loading condition : 4G
- Max. Stress : 25.478 Nmm^{-2}
- Max. Displacement : 5.576mm
- F.O.S. : 8.3

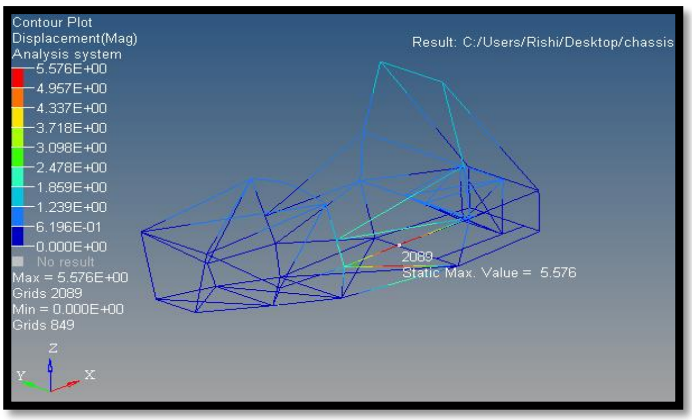


Fig –14: Displacement analysis

- Loading condition : 4G
- Max. Stress : 25.478 Nmm^{-2}
- Max. Displacement : 5.576mm
- F.O.S. : 8.3

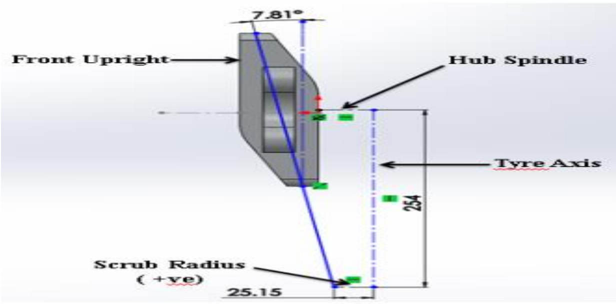


Fig –15: Front upright model

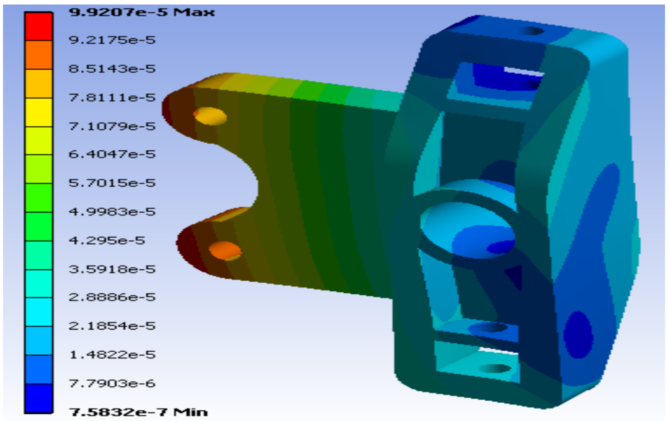


Fig –16: Front upright

- Material Used – Al 6061 (T-6)
- Stress Induced – 121 N/mm²
- Max. Deflection – 0.9 mm
- F.O.S – 2.4

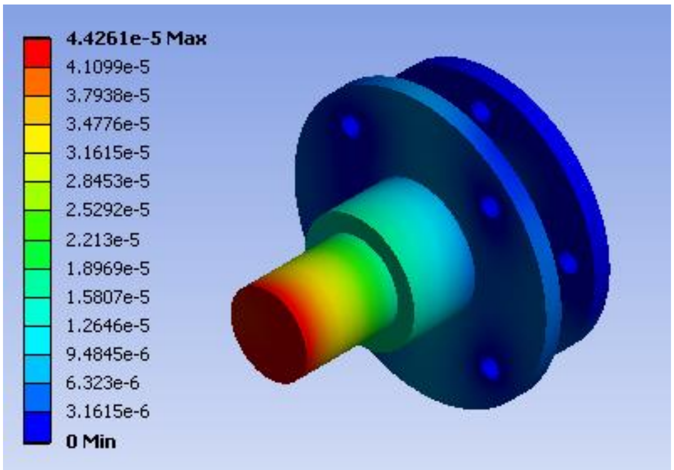


Fig –17: Wheel Hub

- Material Used – Al 6061 (T-6)
- Stress Induced – 50.4 N/mm²
- Max. Deflection – 0.044 mm
- F.O.S – 5.3

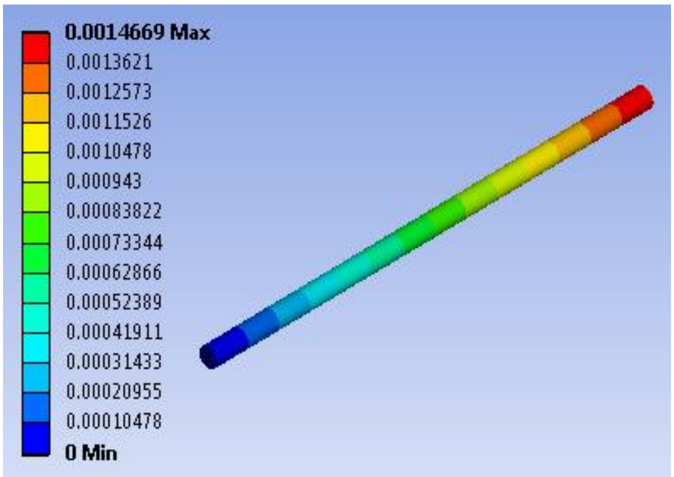


Fig –18: Rear Axle

- Material Used – AISI 4130
- Stress Induced – 286 N/mm²
- Max. Deflection – 1.4 mm
- F.O.S – 2.5

3. CONCLUSIONS

It is necessary to use the finite element model of the structure for analysis of the vehicle chassis. Here lot of work has been done before finalizing the boundary conditions & load cases are calculated, then checked. The finite component model has been tested to the experimental results. The same finite component model has been used for the fatigue analysis of the chassis. In this paper an attempt is made to analysis of SAE supra chassis frame.

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