

Journal of Automobile Engineering and Applications
(Vol.12, Issue:3)2025
eISSN: 2455-3360

Received Date- 07 August, 2025
Accepted Date- 04 September, 2025
Published Date- 16 September, 2025

Article type- Research

Development of Lightweight Chassis and Efficient Drivetrain for Formula Student Applications

Aamir chaudhary¹, Manan Garg², Nitin Pandey³, Sarthak Sikka⁴, Sushant Bharadwaj⁵, Rakesh Chander Saini^{*6}

¹⁻⁵Student, Department of Mechanical Engineering, Maharaja Agrasen Institute of Technology, New Delhi, India

⁶Assistant Professor, Department of Mechanical Engineering, Maharaja Agrasen Institute of Technology, New Delhi, India

*Corresponding Author: Rakesh Chander Saini, Email: - rakeshsaini@mait.ac.in

Article Info

**Keywords:- Chassis Design,
Drivetrain Optimization,
Structural Analysis, AISI 4130
Steel, Formula Student Vehicle**

ABSTRACT

The chassis and drivetrain of a Formula Student vehicle are designed, analyzed, and optimized in this research study with an emphasis on manufacturability, performance, and safety. The project emphasizes the use of advanced engineering tools such as SolidWorks for computer-aided design (CAD) and ANSYS for structural analysis to evaluate the chassis under various dynamic conditions. The primary objective is to ensure that the driver remains safe inside the cockpit while maintaining a lightweight, rigid, and ergonomically efficient structure that can house all necessary components.

The study is divided into two major objectives. The first involves designing, manufacturing, and testing the Formula SAE race car chassis by considering critical factors such as vehicle dynamics, torsional rigidity, component packaging, ergonomics, and overall driver safety. Special focus is given to optimizing the chassis for structural strength while minimizing unnecessary weight. The second objective emphasizes the design and optimization of the drivetrain, including chain, sprockets, axles, and differential systems, to achieve maximum efficiency and smooth power transmission. References from SAE research papers and standard textbooks were extensively utilized to validate calculations and improve design accuracy.

The CAD models were developed in SolidWorks 2020–21, followed by 2D and 3D structural simulations in ANSYS 2021 to evaluate the chassis against frontal, side, and torsional loads. Fabrication was carried out in-house using TIG and arc welding, supported by jigs and fixtures to ensure accuracy. The high strength-to-weight ratio, weldability, and availability of AISI 4130 chromium-molybdenum alloy steel made it the material of choice for the chassis.

The final outcomes demonstrate that the optimized chassis and drivetrain not only meet competition rulebook standards but also enhance driver safety, performance reliability, and structural durability. These results serve as a valuable contribution to the ongoing development of cost-effective and efficient Formula Student vehicles.

adhering to safety and performance standards set by the rulebook [3]. Using CAD and CAE tools, the study investigates torsional stiffness, crashworthiness, and drivetrain efficiency, followed by fabrication and validation.

Nomenclature

Z_p	No. of teeth of pinion
Z_g	No. of teeth of gear
m	module
b	face width
$P(\text{kW})$	power of engine
$N_p(\text{RPM})$	Speed of pinion
γ	pitch angle
α	pressure
M_T	module estimation

1. Introduction

Students must design, construct, and compete in a formula-style race car as part of the SAE Formula Student competition, a prestigious worldwide engineering challenge. Among the critical subsystems of such vehicles, the chassis and drivetrain play central roles in determining safety, handling, and overall performance. The chassis functions as the skeletal structure of the car, supporting loads, resisting stresses, and providing mounting points for other systems [1]. In the meantime, the drivetrain makes sure that power is transferred smoothly from the engine to the wheels, which has a direct impact on speed, acceleration, and dependability.[2].

This paper focuses on designing and optimizing both the chassis and drivetrain of a Formula Student vehicle, while

R_M	radius of pinion
Q	ratio factor
D_P	diameter of pinion
K	material constant
D_G	diameter of gear
C_S	service factor
Y_P	Lewi's form factor (pinion)
P_d	dynamic load
A_0	cone distance
V	Pitch line velocity
e	Error according to class
C	Deformation factor

2. Literature review

The role of CAD and CAE integration in vehicle design has been highlighted across numerous studies. Simulation-based methods reduce costs, enhance safety, and allow engineers to refine prototypes virtually. Seward demonstrated how CAD-assisted simulation improves early design decision-making. The Efficycle and Supra SAE rulebooks [4] provide essential guidelines for structural strength, driver protection, and component packaging.

Past works demonstrate the relevance of simulation-driven optimization. Grover et al. used CAE to evaluate lithium-ion battery systems, while Jindal et al. validated BAJA chassis torsional stresses using gyroscopic sensors. Similarly, Saini and Rana highlighted CAE's role in Formula SAE suspension analysis. Upadhyaya et al. optimized brake calipers using FEA, while Sharma et al. applied simulation methods to Efficycle chassis.

Collectively, literature confirms that CAE not only reduces prototyping costs but also ensures compliance with safety standards, which this study builds upon [5].

2.1 Chassis

The primary support structure of the car is the chassis, sometimes referred to as the "Frame." It withstands all of the stresses placed on the vehicle in both static and dynamic situations. It's like a living creature's skeleton within a car [6].

The French language is where the word "chassis" first appeared. Every vehicle, be it a car, truck, three-wheeler, or two-wheeler, has a chassis or frame [7]. Its shape clearly differs depending on the type of vehicle, though. The following are the functions of the chassis. It:

- Provides room and a mounting area for different vehicle components;
- Supports or bears the weight of the vehicle body.
- Supports the weight of various systems of the vehicle such as engine, transmission etc.
- Supports a load of passengers as well as the luggage.
- Withstands the stresses arising due to bad road conditions.
- Withstands stresses during braking and acceleration of the vehicle.

According to our rulebook, our chassis is divided into three parts; FRONT BULKHEAD, COCKPIT and REAR.

2.2 Drivetrain and its components

A vehicle's drivetrain is a system that distributes power throughout it and uses engine power to turn the wheels and move it.

Transferring power from the engine to the driving wheels, which use the mechanical force to spin the axle, is the responsibility of the drivetrain [8].

In contrast, the engine, drivetrain, and/or motor or motors are considered to be a part of the powertrain. Through Derek Seward, we learnt about the drivetrain and transmission system of a formula-3 vehicle. The rulebook gave us the rules and regulations for designing and manufacturing our drivetrain system [9].

2.3 Chain and sprocket

Usually connected by a chain or belt, a sprocket is a wheel with teeth around the rim that transfers power and rotation from one device to another. Bicycles, motorbikes, and other mechanical systems frequently employ sprockets to transfer motion and power between various parts. The teeth of a sprocket engage with the links of a chain or belt to enable a smooth and efficient transfer of power [10-11]. Sprockets come in a variety of sizes and styles and can be made from a variety of materials, including steel and aluminum.

2.4 Differential

In order to allow the inner wheel to rotate more slowly than the outer wheel when cornering, the differential transfers power from the gearbox to the driven wheels [12]. The engine power and torque are transmitted and divided into two flows between the wheels on the same axle by the differential. If one of the wheels has poor road grip, this reduces tire wear by allowing the wheels to rotate at separate speeds, increasing stability and preventing sliding [13-15]. We were able to comprehend the differential gear calculations thanks to the book V.B. Bhandari.

2.5 Axles

The drive axle's job is to transfer power from the engine to the wheel.

One end of the driving axle is connected to the wheel, and the other end is connected to the differential [16]. Torsional and bending stresses are applied to the drive axle of the majority of automobiles on the road. Splines on both ends of the components transfer torque to and from the half-shaft. The books N.K. Giri and V.B. Bhandari helped us to understand the concepts and calculations related to axles.

Types of differentials

Open differential – The open differential, one of the more popular kinds of differentials, divides engine torque in half and permits the wheels to spin at different speeds. It is used in the majority of family sedans and budget vehicles. A locking differential, sometimes referred to as a welded differential, joins the wheels to ensure that they travel at the same pace [17-18]. It was a little harder to turn because of this. This kind of differential is seen in the majority of full-sized trucks.

Sports cars often use limited-slip differentials, which by default function similarly to an open differential. To increase grip and control on the road, a wheel that has lost traction switches to function as a locking differential. Torque-vectoring differential: The torque-vectoring differential can adjust the amount of torque applied to each wheel by adding more gear trains [19-21].

3. Methodology

The following flowchart of figure 1-7 depicts the flow of our

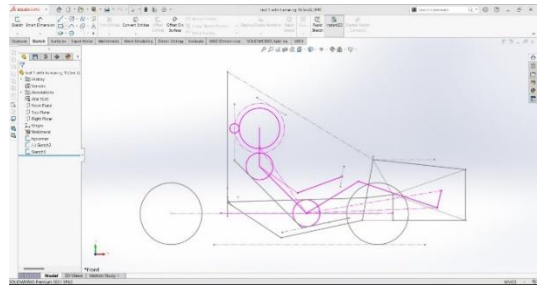


Fig 4 CAD MODELLING



project work:

Fig. 1 PROTOTYPE

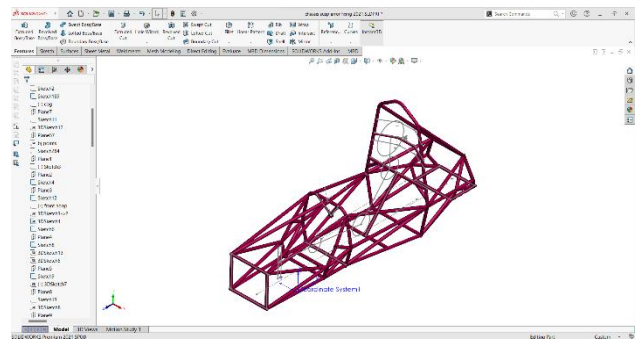


Fig 5 FINAL CAD MODELLING



Fig 2 DATA COLLECTION

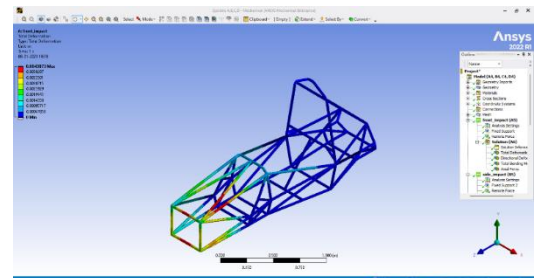


Fig 6 ANALYSIS

	Unit	Bending Strength Nm	Bending Stiffness Nm ⁴
Material-1	AISI 1018		
Cross Section	A=25.4 B= 21.4 T = 2	291.331	2078.031
Material-2	AISI 1018		
Cross Section	A= 25.4 B= 23.4 T =1	164.144	1170.824
Material-3	AISI 1018		
Cross Section	A= 28 B=24 T =2	211.073	2845.154
Material-4	AISI 4130		
Cross section	A=25.4 B= 21.4 T = 2	353.368	1960.18
Material-5	AISI 4130		
Cross section	A= 25.1 B=23.4 T =1	97.812	1085.154
Material-6	AISI 4130		
Cross section	A= 28 B=24 T =2	431.234	2636.972

Fig 3 CALCULATIONS



Fig 7 FABRICATION

4. Numerical analysis

4.1 Chassis

Torsional Stiffness Calculation:

Maximum Deflection front (Z1) = 9.9mm = 0.0099m (from FEA)

Maximum Deflection rear (Z2) = 7.6mm = 0.0076m (from FEA)

Track width (L) = 0.9915m
 Cornering force upward on wheel for front (F1) = 1828.5N
 Cornering force upward on wheel for rear (F2) = 1598.59N
 Torsional stiffness = C

For Front:

$$T1 = \text{torque} = F1 \times L = 1812.95775 \text{ Nm} \quad \dots (1)$$

$$\Theta1 = \text{Angle of deflection} = \arctan (Z1 \div L) = 0.572 \text{ deg} \quad \dots (2)$$

$$C1 = T1 \div \Theta1 = 3169.5 \text{ Nm/deg} \quad \dots (3)$$

For Rear:

$$T2 = \text{torque} = F2 \times L = 1585.001985 \text{ Nm}$$

$$\Theta2 = \text{Angle of deflection} = \arctan (Z2 \div L) = 0.439 \text{ deg}$$

$$C2 = T2 \div \Theta2 = 3610.48 \text{ Nm/deg}$$

$$\text{For torsional stiffness of chassis} = (C1 + C2) \div 2 \quad \dots (4)$$

So, torsional stiffness of chassis is 3390 Nm/deg

Minimum Fos = 2.73

Impact force calculation:

$$\text{Impact force (F)} = \text{Mass of vehicle with driver (M)} \times \text{Acceleration of vehicle (A)} \quad \dots (5)$$

$$F = M \times [\text{change in velocity } (\Delta v) \div \text{change in time } (\Delta t)] \quad \dots (6)$$

$$M = 350 \text{ kg (assume)}$$

For frontal impact:

$$U = 0 \text{ m/s } V = 120 \text{ km/h} = 33.33 \text{ m/s } \Delta t = 0.2 \text{ sec}$$

$$F = 350 \times [(33.33 - 0) \div 0.2] = 58327.5 \text{ N}$$

For side impact:

$$1) U = 0 \text{ m/s } V = 100 \text{ km/h} = 27.77 \text{ m/s } \Delta t = 0.2 \text{ sec}$$

$$F = 350 \times [(27.77 - 0) \div 0.2] = 48597.5 \text{ N}$$

$$2) U = 0 \text{ m/s } V = 60 \text{ km/h} = 16.66 \text{ m/s } \Delta t = 0.2 \text{ sec}$$

$$F = 350 \times [(16.66 - 0) \div 0.2] = 29115 \text{ N}$$

MATERIAL SELECTION

MATERIAL -1 (AISI4130)

FOR AISI 1018 WITH CARBON % 0.18

1.1 OUTER DIAMETER -25.4mm and THICKNESS – 2mm

BENDING STRENGTH

$$M = Sy \times I \div c \quad \dots (7)$$

$$C = 25.4 \div 2 = 12.7 \text{ mm}$$

$$SY = 365 \text{ MPa}$$

$$I = \pi ((O.D)^4 - (I. D)^4) \div 64 \quad \dots (8)$$

$$= \pi ((25.4)^4 - (21.4)^4) \div 64 = 10316.74 \text{ mm}^4$$

$$M = (365 \times 106 \times 10316.74 \times 10^{-12} \times 2) \div 25.4 \times 10^{-3} = 291.331 \text{ Nm}$$

BENDING STIFFNESS:

$$E = 205 \text{ GPa}$$

$$I = 10316.74 \text{ mm}^4$$

$$EI = 2078.031 \text{ Nm}^4 \quad \dots (9)$$

1.2 OUTER DIAMETER-25.4mm and THICKNESS-1.6mm

BENDING STRENGTH

$$M = Sy \times I \div c$$

$$C = 25.4 \div 1.6 = 15.875 \text{ mm}$$

$$SY = 365 \text{ MPa}$$

$$I = \pi ((O.D)^4 - (I. D)^4) \div 64 = \pi ((25.4)^4 - (22.2)^4) \div 64 = 8504.50 \text{ mm}^4$$

$$M = (365 \times 106 \times 8504.50 \times 10^{-12} \times 1.6) \div 25.4 \times 10^{-3} = 195.536 \text{ Nm}$$

BENDING STIFFNESS:

$$E = 205 \text{ GPa}$$

$$I = 8504.50 \text{ mm}^4$$

$$EI = 1743.42 \text{ Nm}^4$$

MATERIAL -2 (AISI 1018)

FOR AISI 4130

OUTER DIAMETER -25.4 and INNER DIAMETER- 21.4MM Thickness –2mm

BENDING STRENGTH:

$$M = Sy \times I \div c$$

$$C = 25.4 \div 2 = 12.7 \text{ mm}$$

$$SY = 435 \text{ MPa}$$

$$I = \pi ((O.D)^4 - (I. D)^4) \div 64$$

$$I = 10316.74 \text{ mm}^4$$

$$M = (435 \times 106 \times 10316.74 \times 10^{-12} \times 2) \div 25.4 \times 10^{-3} = 353.368 \text{ Nm}$$

BENDING STIFFNESS:

$$E = 190 \text{ GPa}$$

$$I = 10316.74 \text{ mm}^4$$

$$EI = 1960.18 \text{ Nm}^4$$

4.2 Drivetrain

The torque and speed are calculated for each gear by considering the primary driver ratio (Gear ratios in stock engine gearbox from the manufacturer) as well as secondary drive ratio (chain gear reduction) (table 1-4).

$$\text{Primary Drive ratio} = 30:80 = 2.66:1$$

$$\text{Secondary Drive ratio} = 48:15 = 3.2:1$$

$$\text{Overall gear ratio} = \text{Primary drive ratio} \times \text{Secondary drive ratio} \times \text{Individual gear ratio} \quad \dots (10)$$

Table 1- GEAR RATIO

Gears	individual ratios	overall gear ratio	Engine torque
1 st	2.6666	22.6980992	26
2 nd	1.8571	15.8076352	30.5
3 rd	1.4211	12.096432	33.02
4 th	1.1428	9.725136	26
5 th	0.9565	8.141728	25
6 th	0.84	7.15008	25

The Torque values at each individual gears can be obtained by Torque = Maximum engine torque × Overall gear ratio ... (11)

The Rotation per minute can be calculated at each gear by the formula

$$\text{RPM} = \text{Engine rpm} / \text{Overall ratio} \quad \dots (12)$$

Table 2- FINAL RPM CALCULATION

Engine RPM	overall gear ratio	Final RPM
4000	22.6980992	176.2262
6000	15.8076352	379.5634
8000	12.096432	661.3536
10000	9.725136	1028.012

10000	8.141728	1228.24	Hence, 2.46249 wheels needs 5.73 rotation to complete one revolution on circular trajectory.
10000	7.15008	1398.586	Ratio (B/A) (E) = 15.7/1.43 = 10.98 ... (21)

Radius of wheel = 9 inch = 0.2286m
 Force = Torque/ Radius of wheel ... (13)

Force required overcoming rolling resistance could be calculated as follows:

Rolling resistance, Fr = fmg ... (14)

Where f = coefficient of rolling resistance = 0.015

Acceleration due to gravity, g = 9.81m/s²

Mass of vehicle, m = 300kg

Fr = 0.015 × 300 × 9.81

Fr = 44.145N

Force available = Force delivered - Rolling resistance ... (15)

Acceleration = Force available/weight

Table 3- FINAL ACCELERATION CALCULATION

Gears	Final torque	wheel radius (m)	Force delivered (N)	ACCEL ERATIO N
1	590.1505 792	0.2286	2581.58 6	8.458137
2	482.1328 736	0.2286	2109.06 8	6.883076
3	399.4232 337	0.2286	1747.25 8	5.677044
4	252.9153 536	0.2286	1106.36 6	3.540738 8
5	203.5432	0.2286	890.390 2	2.820817
6	178.752	0.2286	781.942 3	2.459324

Speed of the vehicle at each gear is, Speed = RPS × 2π × 3.6 ... (16)

Table 4- Speed Calculation

Gears	RPS	speed (km/h)
1	2.935929	15.17343
2	6.323526	32.68118
3	11.01815	56.94389
4	17.12668	88.51391
5	20.46249	105.754
6	223.30044	120.4211

4.3 Differential

Circumference of wheel = 2 × π × R = 2 × 3.14 × 0.2286 = 1.43m ... (17)

Circumference of outer wheel trajectory = 3.14 × D2 = 3.14 × 5 = 15.7m ... (18)

Circumference of inner wheel trajectory = 3.14 × D1 = 3.14 × 2.62 = 8.2m ... (19)

Ratio (C/A) (D) = 8.2/1.43 = 5.73 ... (20)

Hence, Outer wheels needs 10.98 rotation to complete one revolution of circular trajectory.

Ratio (E/D) = 10.98/5.73 = 1.92 ... (22)

Hence outer wheel rotates 1.92 times faster than inner wheel.

Reduction between spider gears and side gears = 1.92

1.20 (Considering available module)

Z_P = 14 Z_G = 28

Pitch angle: Alpha (α) = tan⁻¹ [Z_P / Z_G] = tan⁻¹ [14/28] = 26.56degree ... (23)

Bending strength = Sut/3 = 1100/3 = 366N/mm² ... (24)

Lewi's form factor (Yp) = 0.487 - 2.87/14 = 0.282 ... (25)

Power = Torque × (R.P.M)/5252 = 590.15 × 176.23/5252 = 14.76kw ... (26)

Speed of pinion (RPM) Np = 1398.586 Rpm

MODULE ESTIMATION

MT = Torque transmissible
 MT = (60 × Power) / (2 × 3.14 × Np) × 10⁶ ... (27)

MT = 100872.037 Nmm

TANGENTIAL LOAD (PT): PT = 2 × MT / DP

PT = 2 × 100872.037

PT = 8762.28m

WE HAVE

b = 10 m or b = A0 / 3 (whichever is smaller)

b = face width, A0 = Pitch cone distance

BEAM STRENGTH(Sb)

Sb = m × b × Sb × Yp [1 - (b/Ao)] ... (28)

Sb = m × 14m × 366 × 0.2 × [2/3]
 Sb = 340m²

PITCH LINE VELOCITY(V)

V = π × D_p × N_p ÷ 60 × 10³ ... (29)

V = 3.14 × 56 × 1398 ÷ 60 × 10³

V = 3.713m/sec

DYNAMIC LOAD (P_d)

C = 11400N/mm²

P_d = 21 × v × (c × e × b + Pt) ÷ 21v + (c × e × b + Pt)^(1/2) ... (30)

P_d = 21 × 2.926 × ((11400 × 0.0125 × 17 + 5043.60) ÷ 21 × 2.926 + (11400 × 0.0125 × 17 + 5043.60)^(1/2))

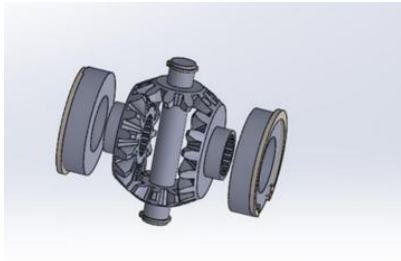
P_d = 2390.63N

Effective load (P_{eff}):

P_{eff} = C_s × P_t + P_d ... (31)

= 1 × 2009.07 + 2390.63
 = 4399.708 N

F.O.S =



$$S_{b/P_eff} = \dots (32) = 5445.75 / 4399.708 = 1.02$$

5. Cad model and CAE analysis

There are various figures which show the mechanism of the workflow.

5.1 Chassis

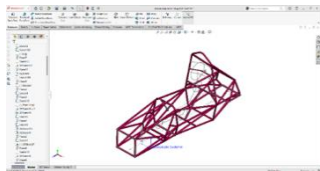


Figure 8-12 shows the various views of chassis CAD model, front impact, side impact, rear impact (a) axial (b) directional, torsional (a) procedure (b) directional respectively.

Fig 8 VARIOUS VIEWS OF CHASSIS CAD MODEL

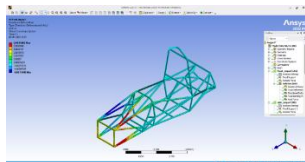


Fig 9 FRONT IMPACT a) AXIAL b) DIRECTIONAL

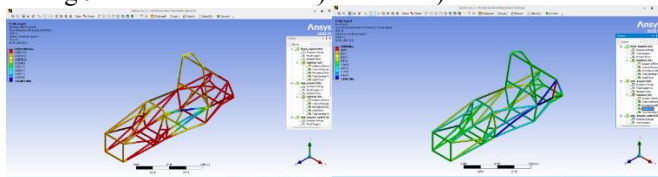


Fig 10 SIDE IMPACT a) AXIAL b) DIRECTIONAL

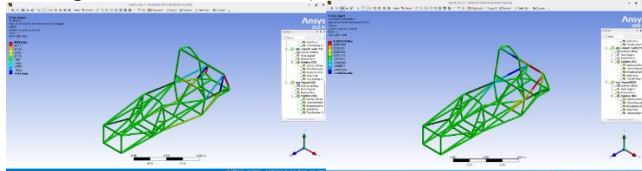


Fig 11 REAR IMPACT a) AXIAL b) DIRECTIONAL

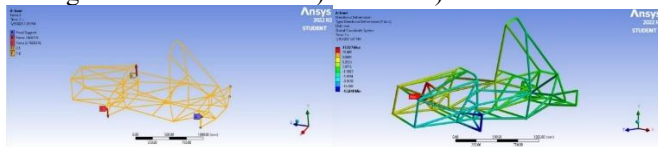


Fig 12 TORSIONAL a) PROCEDURE b) DIRECTIONAL

5.2 Drivetrain

Figure 13-16 shows the differential, assembly, sprocket, gears (a) mesh (b) result respectively.

Fig 13 DIFFERENTIAL

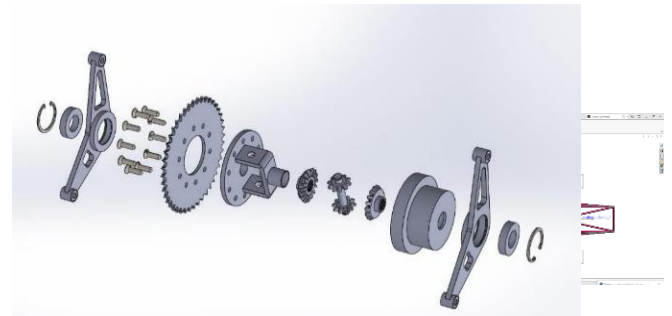


Fig 14 ASSEMBLY

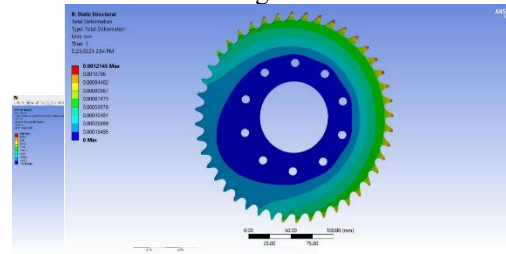


Fig 15 SPROCKET

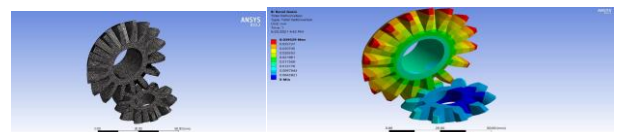


Fig 16 GEARS a) MESH b) RESULT

6 Result

The figure 17 shows the manufactured chassis and drivetrain which shows a fully completed vehicle.



Fig 17 MANUFACTURED CHASSIS AND DRIVETRAIN

6.1 Chassis

The final cad model of chassis was designed after incorporating the results from analysis. Then the chassis was manufactured from material AISI-4130 (figure 18).

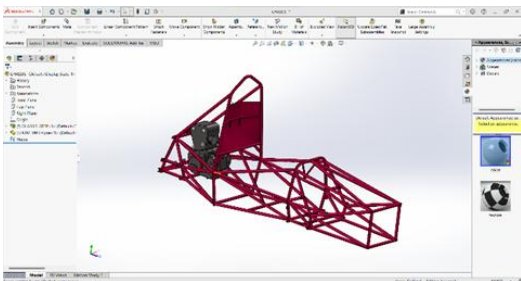


Fig 18 FINAL CAD MODEL

6.2 Drivetrain

The final cad model of differential was designed after incorporating the results from analysis. Then the differential was manufactured from following material:

Bevel Gears= EN24

Casing= Aluminum 6061 T6

Axles= En8

Mountings= Mild steel (8mm)

The following data was also found after the final calculations:

The maximum speed is 120.42km/h

The maximum acceleration will be 8.46 m/s^2

7. Conclusion

This study successfully demonstrates the design and optimization of the chassis and drivetrain of a Formula Student vehicle using CAD and CAE tools. The integration of SolidWorks modeling with ANSYS analysis enabled accurate evaluation of structural strength, torsional rigidity, and crashworthiness. AISI 4130 steel proved to be the most suitable material due to its strength-to-weight ratio and weldability. The fabricated prototype met all competition safety and performance requirements, ensuring driver

protection while maintaining efficiency. Future work may involve fatigue analysis and dynamic load testing.

8. References

1. Automobile Mechanics, N.K. GIRI, Khanna Publications, 8th edition
2. Race car design, DEREK SEWARD
3. V.B. Bhandari, (1999), Design of Machine Elements, 8th edition, Wiley
4. SAE, "Supra Saeindia rules and regulations", SAE [online]
5. Mechanical Engineering Design by- Budynas Richard, J. Keith Nisbett. 2008, London: McGraw-Hill, ISBN: 978-0-0731-2193-2
6. Automotive Mechanics: Fundamentals by- Stockel Martin, James Duffy. 1998.. City: Gregory's Automotive, Haynes Manuals Inc. ISBN: 978-0-8556-6626-2
7. Practical Gear Design Handbook by- Dr. Stephen P. Radzavich
8. Design, optimization& fabrication of FSAE spaceframe chassis by- Rishi Desai, IISRT 2456-2165
9. Grover, D., Bansal, S., Ishan, & Saini, R. C. (2019, December 1). Smart Locked Lithium-Ion Batteries for Electric Vehicle. 2019 IEEE Transportation Electrification Conference, ITEC-India 2019. <https://doi.org/10.1109/ITEC-India48457.2019.ITECIndia2019-55>
10. Saini, R. C. (2018). Optimization of Process Parameters of EDM Drill for Metal Removal Rate (MRR) and Tool Wear Rate (TWR) Sambhav Mehta. <https://www.researchgate.net/publication/338501120>
11. Saini, R. C. (n.d.). STUDY AND DESIGN OF SUSPENSION KINEMATICS FOR A FORMULA STUDENT VEHICLE. www.ijmer.in
12. Saini, R. C. (n.d.). Design, Analysis, Manufacturing and Testing of Plastic Compound Brake Master Cylinder. www.ijmer.in
13. Grover, D., Bansal, S., & Saini, R. (n.d.). ECONOMIC ANALYSIS OF BATTERY SWAP STATION FOR ELECTRIC THREE WHEELED VEHICLE.
14. Jindal, R., Arora, R., Papney, R., Patel, M., Chander Saini, R., & Rana, R. (2022). Torsion test for a BAJA chassis using gyroscopic sensor and validation of CAE results. Materials Today: Proceedings, 56, 3774–3779. <https://doi.org/10.1016/j.matpr.2022.01.019>
15. Chander Saini, R., Mahendru, H., & Aidhi, R. (2020). Dual-Stage Emission Reduction System Using Cu-Zeolite and Cobalt Oxide. In www.ijmer.com | (Vol. 10, Issue 5). <https://www.researchgate.net/publication/344013058>
16. Saini, R. C., & Rana, R. (2020). Designing and Analyzing the Suspension System of the Formula SAE. INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING, 5(2), 79–89. <https://doi.org/10.35121/ijapie202004250>
17. Upadhyaya, S., Saini, R. C., & Rana, R. (2020). Design optimization and FEM Analysis of a Floating Caliper for BAJA ATV Vehicles. INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING, 5(2), 30–39. <https://doi.org/10.35121/ijapie202004244>

18. Bhardwaj, V., Dayal, N., Sharma, H., Aidhi, R., & Saini, R. (2022). Validating the Design of CV Axle for BAJA SAE ATV. SAE Technical Papers, 2022. <https://doi.org/10.4271/2022-01-0644>
19. Mahendru, H., Aidhi, R., & Chander Saini, R. (2020). Dual-Stage Emission Reduction System Using Cu-Zeolite and Cobalt Oxide. In *www.ijmer.com* | (Vol. 10, Issue 5). www.ijmer.com
20. Upadhyaya, S., Raj, D., Gupta, K., Saini, R. C., Rana, R., & Lal, R. (2020). Designing and Analyzing the Brake Master Cylinder for an ATV vehicle. *INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING*, 5(1). <https://doi.org/10.35121/ijapie202001143>
21. Sharma, M., Saini, R. C., & Rana, R. (2020). Design and Optimization of Suspension and Steering System of Efficycle – Human Powered Hybrid Tricycle. *INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING*, 5(1), 64–79. <https://doi.org/10.35121/ijapie202001148>