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Retraction

Retracted: Retrospection of the Optimization Model for Designing the Power Train of a Formula Student Race Car

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] M. N. Kumar, V. Jagota, and M. Shabaz, "Retrospection of the Optimization Model for Designing the Power Train of a Formula Student Race Car," *Scientific Programming*, vol. 2021, Article ID 9465702, 9 pages, 2021.

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Research Article

Retrospection of the Optimization Model for Designing the Power Train of a Formula Student Race Car

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This article describes the power train design specifics in Formula student race vehicles used in the famed SAE India championship. To facilitate the physical validation of the design of the power train system of a formula student race car category vehicle engine of 610 cc displacement bike engine (KTM 390 model), a detailed design has been proposed with an approach of easing manufacturing and assembly along with full-scale prototype manufacturing. Many procedures must be followed while selecting a power train, such as engine displacement, fuel type, cooling type, throttle actuation, and creating the gear system to obtain the needed power and torque under various loading situations. Keeping the rules in mind, a well-suited engine was selected for the race track and transmission train was selected which gives the maximum performance. Based on the requirement, a power train was designed with all considerations we need to follow. Aside from torque and power, we designed an air intake with fuel efficiency in mind. Wireless sensors and cloud computing were used to monitor transmission characteristics such as transmission temperature management and vibration. The current study describes the design of an air intake manifold with a maximum restrictor diameter of 20 mm.

1. Introduction

SUPRA SAE India is an annual national level Student Formula Category car competition conducted by Society of Automobile Engineers India (SAE India) with support from Maruti Suzuki. It is a global platform for undergraduate and postgraduate students to demonstrate their technical skills and talent by applying their engineering skills and competing with other institute participants in developing a student formula category vehicle according to defined instructions and safety precautions. The vibration decoupling rate and frequency of the powertrain mounting system are investigated utilizing rigid body dynamics and energy techniques to improve the powertrain mounting system's vibration isolation capabilities, with the powertrain of a front wheel drive car as the research object [1, 2]. The subsystem transmits the power developed by the engine or motor of automobiles to the wheels of the motor vehicle to move the motor vehicle forward or backward. Power train is also called drive train/transmission. It consists of a group of components in a vehicle that delivers power to the driving wheels. Components present in the motor vehicle are engine, clutch, gear box, drive shaft, differential, axles, and cooling system. Connection of these components involves physical linking which may be present between the two ends of the vehicle, so it requires long drive connections (propeller shaft/drive shaft). The speed of the engine and wheels are different, so it must be matched with the appropriate gear ratio. A vehicle could be front wheel drive (FWD) or rear wheel drive (RWD) depending on which axle is given power from the engine. It impacts the BHP and torque figures according to different conditions [3, 4].

The vehicle's reliability was improved as a result of the power train simulation in this study. After knowing the requirements of the power train system, looking at both advantages and disadvantages of different parts, with the careful selection of the engine platform, KTM 390 was selected. Fuel efficiency is also a key role in racing events for that design of air intake with the restrictor diameter of 20 mm. The purpose of designing the power train without compromising the driver safety precautions is achieved and the power train of formula student race cars has been designed by following the SAE International rules. The sequence of design procedure followed for the same is given in Figure 1.

2. Design Considerations of Engine

The heart of a vehicle is the engine, which converts chemical energy (fuel energy) into mechanical energy [5]. According to the competition regulations, the engine used to power the automobile must be a four-stroke cylinder with a displacement of no more than 610 cc per cycle. If more than one engine is utilized, each engine's displacement must be less than 610 cc, and all engines' intake air must flow via a single air intake restrictor. Two-wheeler motorcycle engines such as the KTM390, CBR600, and Royal Enfield 350 are available for engine choice.

In the proposed paper for the design of power train, various parameters were taken into consideration. As per the rules of SAE, engine was selected on the basis of high-power output under 610 cc segment considering less about the torque Figure 2. Speed transmissions have been selected for the gear, train, and RPM and torque was evaluated for different gears and accordingly. There are multiple mechanisms available like belt, pulley drive, direct mesh gear system, and chain drive. Various drags such as aerodynamic drag as well as friction resistance were taken into consideration and their empirical relations according to the aerodynamics of the vehicle were evaluated. Apart from torque and power, the fuel efficiency factor was considered and the air intake runner was designed accordingly.

2.1. Comparison of Engines

2.1. Comparison of Engines. The comparative details and specification of the various engines have been presented in Table 1 above.

Although these two engines have more power compared to other engines, the performance of engines purely depends on air-fuel mixture, so the design of air intake could definitely affect the performance. As a first time participating in Race Events (SUPRA SAEINDIA and Formula Bharath), we did not make complications. Yamaha YZF R6 contains 4 cylinders arranged in a line, we have ruled that air should go through a single intake and that the diameter should be within 20 mm. Keeping this in mind, making an air intake with four runners is complicated. Moreover, for Yamaha YZF R3, it consists of 2 cylinders, and the design of a single air intake with two runners is complicated. Another factor is considering the availability cost of the engine, we did not opt for these two engines. We know that Royal Enfield will produce more torque than power, but for racing events we need more power than torque. Engine displacement is more compared to the remaining three engines, but the output power is low when compared to KTM RC390. Honda CBR250R &Yamaha WR250R, these two engines contain a single cylinder, but the output power and torque are low compared to KTM RC390.

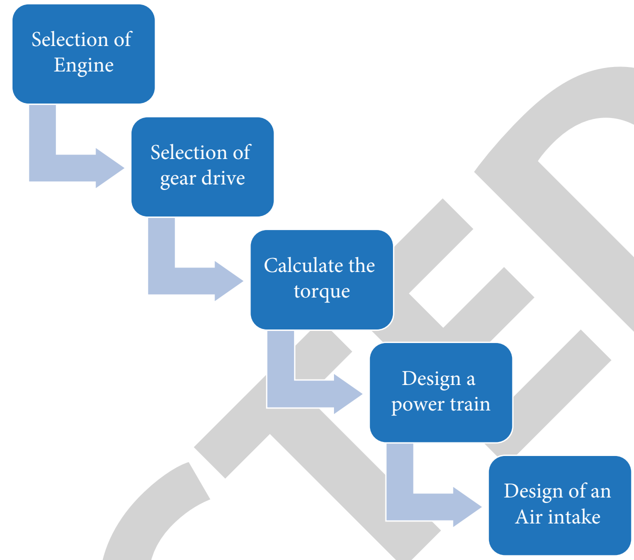

Figure 1: Block diagram for the design procedure for power train.

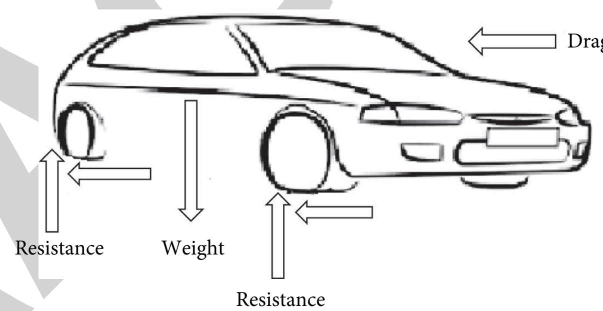

Figure 2: Total tractive force acting on the vehicle.

2.2. Reasons behind Selection of KTM RC 390. By considering the budget and availability of spare parts for better maintenance of the engine, the engine displacement is under 610 cc, which will satisfy the rule. It contains a single cylinder, so it may not be that much complicated in the design of air intake. KTM390 cc engine is an oversquare engine, so it produces more power compared to the torque which is required in racing conditions. The KTM RC 390 model is a sports bicycle made by KTM. In this form, sold from the year 2020, the dry weight is 149.0 kg (328.5 pounds) and it is outfitted with a single-chamber, four-stroke engine. The motor delivers the extreme pinnacle yield force of 44.00 HP (32.1 kW)) and a greatest force of 35.00 Nm (3.6 kgf-m or 25.8 ft. Lbs). With this drive train, the KTM RC 390 is equipped for arriving at the extreme maximum velocity of. About case attributes, liable for street holding, taking care of conduct and ride solace, the KTM RC 390 has a steel lattice outline, and powder covered edges with front suspension being WP topsy turvy Ø 43 mm and at the back, it is outfitted with WP Monoshock. Stock tire sizes are 95/75-R17 on the front and 115/75-R17 on the back. Concerning the halting force, the KTM RC 390 stopping mechanism incorporates single plate; ABS; four-cylinder callipers; size 320 mm (12.6 inches) at the front and single circle; ABS; coasting plate; single-cylinder calliper; size 230 mm (9.1 inches) at the back. KTM RC390 engine specifications as per manufacturer have been given in Table 2.

Table 1: Comparative analysis of various combustion engines.

Year	2020	2015	2014	2011	2010	1989
Engine model	Yamaha YZF R6	Yamaha YZF R3	KTM RC390	Honda CBR250R	Yamaha WR250R	Royal enfield 500
No. of cylinders	Inline 4	2	1	1	1	1
Displacement	599 cc	321 cc	373.3 cc	249.66 cc	249 cc	499 cc
Stroke	42.5 mm	44.1	60	55 mm	53.6 mm	90 mm
Bore	67 mm	68	89	76 mm	77 mm	84 mm
C.R	13.1 : 1	11.2 : 1	14.5 : 1	10.7 : 1	11.8 : 1	8.5 : 1
Transmission	6 speed	6 speed	6 speed	6Speed	6 speed	5 speed
Torque	61.7 Nm @10500 rpm	29.6 Nm @9000 rpm	35.3 Nm @7000 rpm	22.9 Nm @7000 rpm	23.7 Nm @8000 rpm	41.3 Nm @4000 rpm
Power	63.9 kW @14500 rpm	42 kW @10750 rpm	32 kW @9500 rpm	19.4 kW @ 8500 rpm	22.6 kW @10000 rpm	20.2 kW @5250 rpm
Cooling system			Liquid cooling			Air cooled
Fuel supply			Fuel injection			

Table 2: KTM RC390 engine specifications as per manufacturer.

Model	KTM RC390
Engine	Four-stroke, single cylinder
Capacity	373.4 cc
Bore × stroke	89 × 60 mm
Cooling system	Liquid cooled
Spark plug	Bosch VR 5 NE
Ignition	Fully electronic ignition system
Starting	Electric
Maximum power	32 kw/43.5 HP @9500 rpm
Maximum torque	35.3 Nm/26 ft-lb @7000 rpm
Clutch	Wet multidisc clutch

2.3. Selection of Gear System and Drive System. We selected KTM 390 cc engine in which the gear box is inbuilt with 6 speed transmission. There are multiple mechanisms available like belt, pulley drive, direct mesh gear system, and chain drive. The transmission system has been integrated with temperature and vibration sensors for monitoring purposes. These sensors wirelessly transfer real-time data of the transmission sections, temperatures, and vibrations monitored by a mobile-based app during the transmission operations. Nowadays, the use of sensors in automobiles has grown from the safety point of concern of the driver [6, 7].

2.4. Comparison of Different Drive Systems. Drive system is critical from the design point of view. The comparative details of the different drive systems have been presented in Table 3.

By observing from Table 3, the chain drive has been selected to make our transmission more efficient and reliable, i.e., driver sprocket, driven sprocket, and a chain.

3. Design and Results

3.1. Calculation of Forces. Let us assume the mass of the vehicle(M) is 350 kg (total weight of the vehicle including driver), wheel radius is 0.26 m, velocity of the vehicle (v) is 60kmph (assumption), and rolling resistance coefficient (f_r) is 0.02, this varies based on the type of road and tire, gradient angle (α) is 25° (maximum gradient angle in Formula Race Tracks) depends on the road, drag coefficient (C_d) is 0.7 (typical values for formula 1 car in range 0.7–1.1) depends on the car, frontal area (A) is 0.617 m^2 (calculate from design), density of air (ρ) is 1.225 kg/m^3, and gravity (g) is 9.81 m/s^2. Typical values of rolling resistance coefficient have been presented in Table 4.

3.1.1. Forces Calculation. We know that in a vehicle several forces are pulling on it. The vehicle motion can be completely determined by analyzing the forces acting on it. The different powers pulling up on a vehicle are shown in Figure 3.

3.1.2. Aerodynamic Drag. When a vehicle is travelling at a particular speed, the forward motion of a vehicle encounters an air force opposing its motion [8, 9]. This force is called aerodynamic drag. Observe Figure 3. Streamlined drag majorly affects the consistent state Vmax execution as it is the significant power to defeat at extremely high velocity and it is for the most part seen to be correspondingly significant for forceful track driving. The outcomes show that, for a 10% increment in drag coefficient, the warm impact around the Nurburgring is irrelevant with an expansion of just 0.2°C in liquid temperature and 0.5 s for lap time. There are two purposes behind this. Initially, the normal speed around the Nurburgring for the vehicles considered is around 85 mph and there are not many spots where the speed surpasses 120 mph. Indeed, even on the long straight where the drag turns out to be considerable, the speed is typically restricted (not by drag) to 155 mph. Furthermore, the vehicles are considered to have up to 500 hp accessible, so the drag power at the normal speed requires just a little extent of force accessible (around 10–15%), a large portion of which is utilized to defeat vehicle inactivity power during the speed increase. For lower fueled vehicles, which would spend a substantial extent of the lap at a speed restricted by drag, the impact would be a lot more noteworthy. Figure 4 shows how the drag force effects the motion of vehicle.

Aerodynamic drag force can be defined mathematically F_d: $1/2 * C_d * A * \rho * v^2 = 73.424$ N, whereas C_d is the coefficient of drag, A is the frontal area (m^2), ρ is the density of air (kg/m^3), and v is the speed of vehicle (m/s).

Table 3: Comparison of different drive systems.

S. No	Belt drive	Gear drive	Chain drive
1	Main element are pulleys and belt	Main element gears	Main element sprockets, chain
2	Chances of slip	No-slip	No-slip
3	Used for large centre distance	Used for the short centre distance	Used for the moderate centre distance
4	More space required	Less space required	Moderate space required
5	Simple in design and manufacturing	Complicated in design and manufacturing	The simplest in design and manufacturing
6	Failure in belt does not damage machine	Failure in gear may cause serious break down in the machine	Failure in a chain may not seriously damage the machine
7	Life time is less	More life time	Moderate life time
8	Lubrication not required	Requires proper lubrication	Lubrication required
9	Mainly used for low-velocity ratio	Mainly used for high velocity ratio	Mainly used for moderate velocity ratio
10	Low installation cost	High installation cost	Moderate installation cost

Table 4: Rolling resistance coefficient.

C- rolling resistance coefficient value for different conditions	
0.006–0.01	Truck tire on asphalt
0.01–0.015	Ordinary car tires on concrete, new asphalt, cobbles small new
0.02	Car tires on tar or asphalt
0.02	Car tires on gravel-rolled new
0.03	Car tires on cobbles-large worn
0.04–0.08	Car tire on solid sand, gravel loose worn, soil medium hard
0.2–0.4	Car tire on loose sand

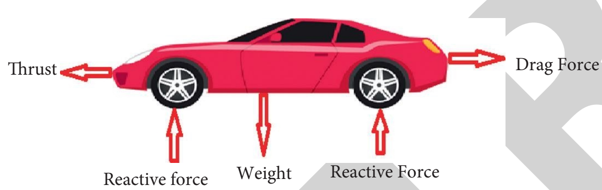

Figure 3: Different forces on the vehicle.

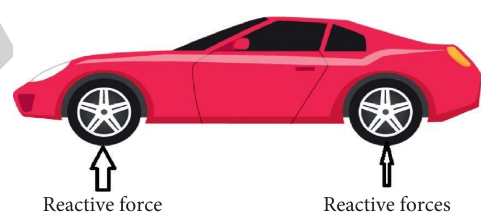

Figure 5: Gradient forces effect motion of vehicle.

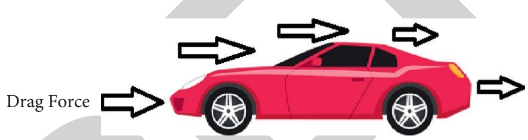

Figure 4: Drag force effects on the motion of the vehicle.

3.1.3. Gradient Force. The resistance force acts on a vehicle when a vehicle drives over gradient. It depends on the weight of the vehicle and the angle of road inclination. It always acts towards down. Observe Figure 5 to see how the gradient forces effect the motion of vehicle.

In short, moving obstruction is the power needed to keep your vehicle's tires moving at a given speed. Tire makers evaluate it by moving a tire against a considerable tube-shaped drum and estimating the power in question. The outcome is the tire's moving opposition coefficient (RRC). Tires change shape as they pivot, and the piece of the tire in touch with the street is distorted before it gets back to its casual state. The energy needed to misshape a tire is more noteworthy than what has expected to return it to its unique shape: a wonder known as "hysteresis." This energy is disseminated as warmth, and this warmth assumes a significant part in the moving opposition. In the event that you have at any point when accelerating a bike on an underinflated tire, you have first-hand involvement in hysteresis. To voyage at a consistent speed, you need to place more mechanical energy into the framework, accelerating more earnestly than if the tire had been expanded to its legitimate level. That is on the grounds that underinflated tires have heaps of hysteresis, making seriously moving opposition. Things being what they are, with the chance that underinflated tires have high moving obstruction, why not just overinflate them to decrease their moving opposition? If that works, however, there is a cost to pay. For a certain something, the ride quality endures, turning out to be progressively cruel as tire pressures rise. All the more critically, the higher the pressing factor, the more modest the "impression," which is the contact fixed between your tires and the street surface. A more modest contact fix can mean less foothold, which means diminished slowing down and cornering execution, particularly on wet surfaces.

Gradient force can be defined mathematically F_g: Mg $\sin\alpha = 1451.05$ N, whereas M is the mass of the vehicle (kg), g is the gravity (m/s^2), and α is gradient angle.

3.1.4. Rolling Resistance. The force resisting the motion of the vehicle when it is moving on a road is called rolling resistance. Rolling resistance is also called rolling friction. Observe Figure 6 to see how the rolling friction acts on tire.

Rolling resistance can be defined mathematically F_r: f_rMg = 68.67 N, whereas f_r is the rolling resistance coefficient, M is the mass of the vehicle (kg), and g is the gravity (m/s^2).

Mathematical formulas used to calculate the forces are:

Drag force: $F_{d:}$ $1/2 * C_d * A * \rho * v^2$.

Drag force is the force acting on the front side. A is the frontal area on which air drags, ρ is the air velocity, and v is the velocity of air. All factors depend on each other.

Gradient force F_g: Mg sinα.

Gradient force is depending on the road angle. M is the mass of the vehicle, α is the gradient angle, and g is the gravity. Every factor is related to others.

Resistance force F_r: f_rMg

Resistance force is the force between tires and road. Mass of the vehicle and gravity are related to road.

With the addition of all forces, we will get all forces acting on the vehicle.

3.1.5. Total Tractive Force. The amount of total force applied by the drive wheels to the ground is called total tractive force and has been shown in Figure 2.

Total tractive force is defined as the sum of all forces $F_d + F_g + F_r = 1593.144$ N.

Torque at the wheels can be calculated by using the below mathematical formula.

Torque at wheels = total tractive force ∗ wheel radius ∗ resistance factor = 463.92 Nm.

3.2. Gear Ratio Calculation. Gear ratio helps us to find the desired output of power and torque [10, 11]. By considering each primary drive ratio in the engine gear box from the manufacturer and the secondary drive ratio (chain gear ratio), we calculated the torque and power.

Primary drive ratio: 30 : 80 = 2.66 : 1.

Secondary drive ratio: 15 : 45 = 3 : 1.

Overall gear ratio = secondary drive ratio ∗ primary drive ratio ∗ individual gear ratio.

3.2.1. Overall Gear Ratio. In Table 5, we mentioned the individual and overall gear ratio for different gears. With the help of the below equation, we will find the overall gear ratio.

Overall gear ratio = primary drive ratio ∗ secondary drive ratio ∗ individual gear ratio.

3.2.2. RPM and Torque at Different Gear Ratios. Below the comparison of RPM and torque are the actual engine crankshaft RPM (engine speed) and torque. Output RPM here is an engine RPM not vehicle RPM. Usually, the engine torque increases with the increase of RPM. This torque can be compromised with speed by shifting gears. In the 1st gear, we get RPM around 2648, whereas the torque is 93.3 N-M, and RPM increases from 1st gear to 6th gear, whereas the torque increases from 1st gear to 2nd gear and decreases from 3rd to 6th gear. You can clearly observe this relation in Figure 7. In Figure 7 we can observe clearly that the torque increases from gear 1 to gear 2 in addition to a gradual decrease from gear 2 to gear 6. We know that the torque at 2 ng gear is more when compared to all gears. Torque and RPM were inversely proportional. If we clearly observe between gear 1 and gear 2, there is a sudden decrease in the RPM and a sudden increase in torque. From gear 2 onwards, there is a gradual increase in RPM and a gradual decrease in torque. By observing this, we can clearly understand that there is an inverse proportion between torque and RPM.

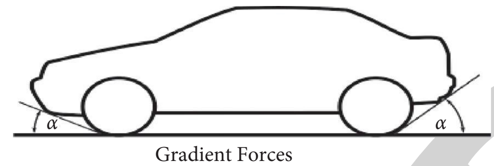

Figure 6: Rolling friction acts tire.

Table 5: Individual and overall gear ratio at different gears.

Gears	Individual ratios	Overall gear ratios
1st	2.6666	21.22
2nd	1.8571	14.81
3rd	1.4211	11.34
4th	1.1428	09.11
5th	0.9565	07.63
6th	0.8400	06.70

Torque for each individual gear can be calculated by using the below mathematical formula.

$$\text{Torque} = \text{maximun engine torque} * \text{Overall gear ratio}. \quad (1)$$

After calculating the torque from the above equation, at 1st gear, the torque is high whereas moving towards higher gear torque reduces. In the 1st gear, the torque is around 750 N-m and in the 6th the gear is around 240 N-m. Observe the comparison to see how the torque decreases when we move towards the higher gear in Figure 8.

Revolutions per minute can be calculated for each gear by using the following mathematical formula:

$$\text{RPM} = \frac{\text{Engine rpm}}{\text{overall gear ratio}}. \quad (2)$$

Vehicle RPM is low at the 2nd gear because we get more torque at the 2nd gear, the RPM of the vehicle gradually increases from 2nd gear to the final gear, but it decreases from 1st gear to 2nd gear. You can see the theoretical values from Table 6. Theoretical values for Engine RPM. Overall gear ratio and gear RPM.

3.2.3. Acceleration Calculation. We can calculate the acceleration for each gear by using the following mathematical formula:

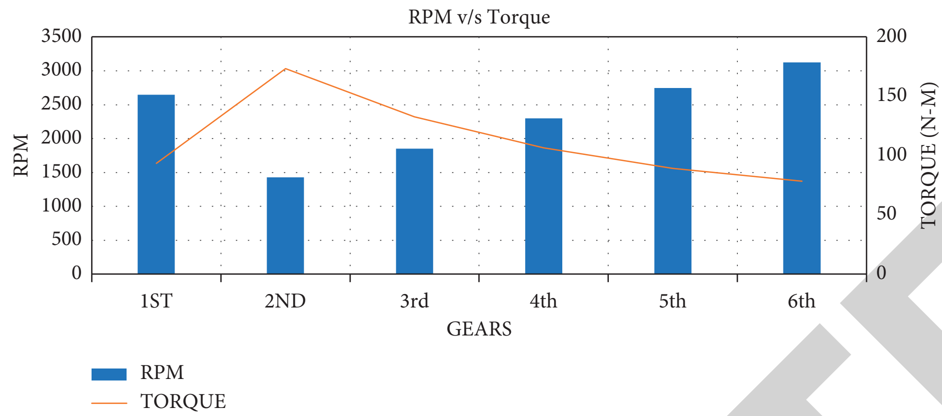

Figure 7: The RPM and torque values for differential gear.

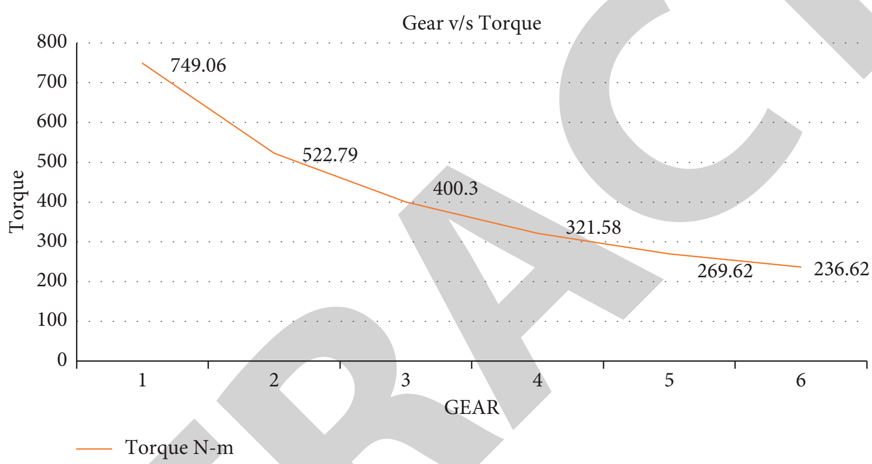

Figure 8: Torque ratios for differential gear systems.

Table 6: Theoretical values for engine RPM. Overall gear ratio and gear RPM.

Engine rpm	Overall gear ratios	Gear rpm
2625	21.22	123
1413	14.81	95
1849	11.34	163
2297	09.11	252
2745	07.63	359
3126	06.70	466

$$\text{Acceleration} = \frac{\text{torque}}{(\text{wheel radius} * \text{mass of vehicle})}. \quad (3)$$

Acceleration is decreasing when we start shifting to higher gears and at 1st gear acceleration is 8.231 m/s^2 whereas at top gear it is 2.6 m/s^2. Observe the relation between torque v/s acceleration at different gears given in Figure 9. From Figure 9, we came to know the relation between the torque and acceleration. With the help of the diagram, we can observe that at initial gear both torque and acceleration are more. With the increase of gears, both torque and acceleration are decreases. Least torque and acceleration at top gear and more torque and acceleration are available at the 1st gear.

From Figure 10, we can observe how the acceleration decreases while we are moving towards higher gear.

3.3. Transmission Design

3.3.1. Sprocket Calculations. By taking consideration of the gear ratio 3 : 1 and the sprocket of the KTM390 engine with (driver sprocket) 15 teeth, the number of teeth in the rear sprocket (driven sprocket) is

$$3 * 15 = 45 \cdot \text{teeth}. \quad (4)$$

Sprocket diameter is calculated by the standard diameter of roller chain sprockets [12]. Details of driver and driving sprocket are given in Table 7.

3.3.2. Differential Specifications. Usually in such competitions it is preferable to use a chain differential as the power is transmitted to the axles by chain drive. We manufacture a sprocket made of 7075 aluminium and die steel with teeth of 45. The real-time monitoring of temperature and vibration data by cloud computing and mobile platform app has shown that during the transmission operations the temperature and vibrations were well between the safe limits of operation.

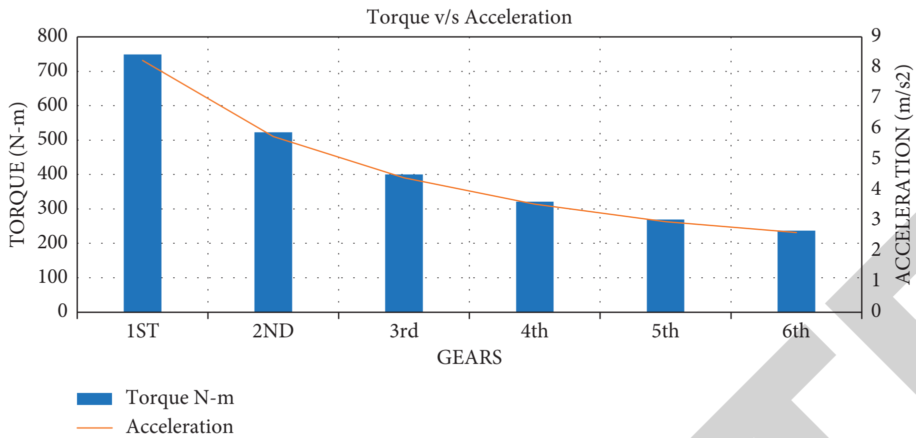

Figure 9: The relation between torque v/s acceleration at different gears.

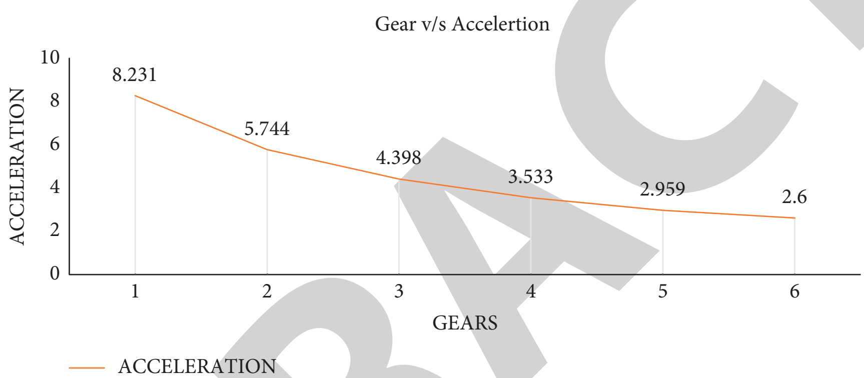

Figure 10: The relation between acceleration and different gears.

Table 7: Details of driver and driving sprocket.

Sprocket	Number of teeth	Outside diameter	Pitch diameter	Calliper diameter
Driver sprocket	15	3.315	3.006	2.590
Driven sprocket	45	9.313	8.960	8.554

3.4. *Design of Air Intake*

3.4.1. Consideration of Rules for Air Intake. Design of power train involves a lot of observations like to implement a system which moves the vehicle. The torque delivered by the engine is not sufficient to move the vehicle because the engine is designed for two-wheeler, while it is used for 4-wheeler. We will calculate the torque required to move our vehicle. Torque required is more when compared to the torque delivered by engine. Power train is designed to match the torque that requires moving the vehicle. To pass air into the cylinder, we design the air intake with the restrictor diameter of 20 mm. While designing the air intake, we need to be careful in the design of plenum and runner because the air intake is the combination of restrictor, runner, and plenum. Design of one part affects the dimensions of other parts.

A rarefaction wave flows upstream from the intake valve to the intake runner because there is low pressure downstream when it opens. From the open end, this wave reflects as a compression wave and returns to the pipe. When the intake valve opens, the rarefaction wave begins, and the compression wave must arrive precisely before the valve closes [13]. Maximum restrictor diameter is 20 mm, any portion of the air intake should be covered for side and back sway crashes, and any piece of the air consumption framework that is under 350 mm (13.8 inches) over the ground. The whole intake runner (Figure 11) has been divided into three pieces, two of which are located within the engine block and one of which is constructed. The fabricated intake portion goes within the engine block from upstream to downstream [14].

3.4.2. Restrictor. Given that the diameter of the restrictor (Figure 12) is maximum 20 mm, the diameter at the inlet portion is 46 mm, which is the diameter of the throttle body of KTM 390 cc, and the diameter at the outlet is depending on our design of plenum, converging, and diverging angles of the restrictor, if we observe the restrictor clearly, we have two sections named as converging section and diverging section. Mostly used converging angle is 12 degrees whereas diverging angle is 6 degrees.

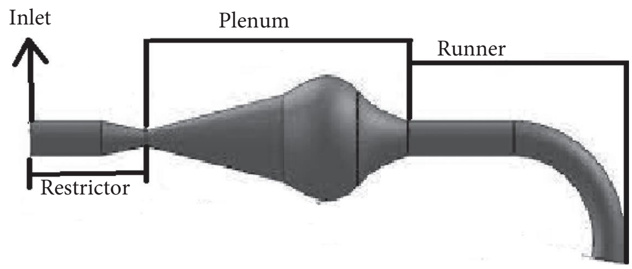

Figure 11: Diagram of intake runner.

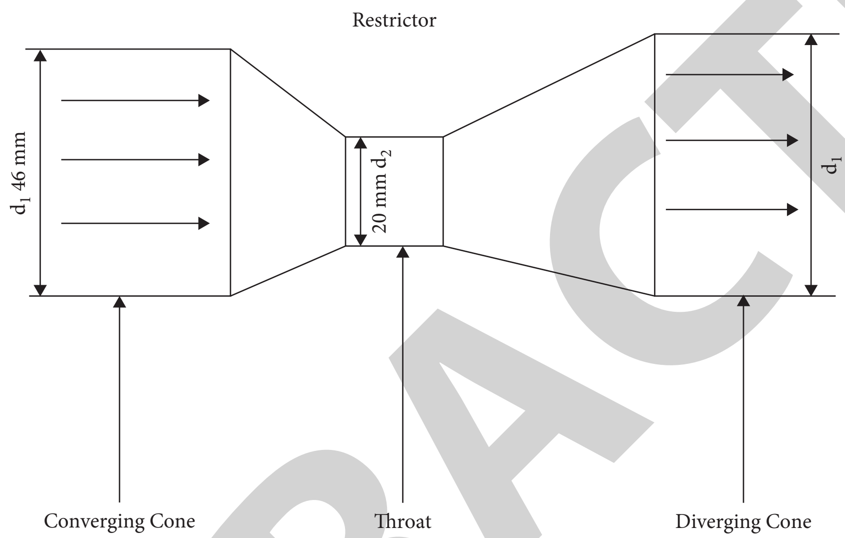

Figure 12: Diagram of restrictor.

3.4.3. Plenum. Plenum is a large cavity at the top of runner. It acts as a reservoir and stores air until it is ready to send to the cylinders. The main advantage over the usage of the plenum is evenly distributing the air into the runner. It is mostly preferable for Multi cylinder engines [15]. The volume of the plenum is almost 3 times the volume of the engine. Engine performance impact is based on the volume of the plenum.

3.4.4. Runner. Runner is the connection between the plenum and the engine cylinder. If the engine contains more than one cylinder, then runners are used to equally distribute the air into the plenum. The length of the runner is depending on the speed of the pressure wave and the cam duration, and the bending angle of the runner depends on the pressure wave.

3.5. Analysis. The method which was used while designing the power train is a conventional method, but all selections from engine selection to final drive follows certain technical rules, economically low, efficient and our availability. In any project one need to consider initially technical ways then efficient is important after that it should be economical cheaper then finally the part should be available. A power train was designed for formula student vehicle with KTM 390 engine. The final gear drive ratio is 3 : 1 (Driven: Drive) and chain differential was selected, because in FSAE Competitions we will transfer power through chain drive. To pass air into the engine we used air intake with restrictor diameter of 20 mm and plenum volume should be three time the engine volume. The diameter of air intake at engine end should be 46 mm because the diameter of KTM 390 engine throttle is 46 mm.

4. Conclusion

The vehicle's reliability was improved as a result of the powertrain simulation in this study. Most of the engineering student has a dream of designing powertrains with less weight-to power ratio. Selection of engine plays a major role in the power train; a square engine which produces more power compared to torque was selected. Power is the main important for race cars when compared to torque. After knowing the requirements of the power train system, look both advantages and disadvantages of different parts. With the careful selection of the engine platform, KTM 390 was selected as the best engine in the segment. It is certainly due to that the power required is more compared to the torque. Power is the main important for race cars when compared to torque. Along with the power, fuel efficiency also matters along with the medium to transfer the power. Power loss is reduced by selecting the chain drive. It appears sensible to continue research into improving the car's reliability and finding a method to minimize weight. We have achieved the purpose of designing the power train without compromising the driver safety precautions and the power train was designed for formula student race cars by following the SAE International rules.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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