ISSN 2229-5518

Design and Fabrication of Steering and Bracking System for All Terrain Vehicle

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Abstract—The project aimed at designing, analysing, fabrication and testing of steering and braking system for a student Baja car and their integration in the whole vehicle. The car has been designed and fabricated to the best of its possible. The primary objective of this project was to identify and determine the design the parameters of a vehicle with a proper study of vehicle dynamics. This project helped us to study and analyse the procedure of vehicle steering and braking system designing and to identify the performance affecting parameters. It also helped us to understand and overcome the theoretical difficulties of vehicle design.

Index Terms—All terrain vehicle, bracking, roll cage, steering system, suspension,transmission, vechicle

1 INTRODUCTION

BAJA STUDENT INDIA is a competition involving teams from all over the country wherein each team has a goal to design and build a rugged single seat, off-road recreational four-wheel vehicle intended for sale to a non-professional, weekend off-road enthusiast. An ATV is made for rough terrain whereas a Conventional Vehicle (CV) is made for a metal road or may be used on village roads. Hence, an ATV requires sturdy and stable design compared to any CV.The design analysis and fabrication of the various systems in the All-Terrain Vehicle (ATV) was divided amongst the 4 groups consisting of 4 members each.

Ou taskis the design and fabrication of steering and braking system of All Terrain vehicle. The design should follows certain rules specified in SAE Baja rulebook. Design should be within these set of rules and rules are common ton every team. So it is challenging task to design every components satisfying the rules. The design and analysis of the vehicle was first made using rough calculations and modelling in CAD, CATIA, and ANSYS and then applied into the practical field, by improvements and optimization. The general parameters and specifications of the vehicle is given in subsequent sections of this report, because we are well aware that steering and braking forms just a part of the unified whole, which we intend to portray as our project.

1.1 About all terrain vehicles (ATV)

The All Terrain Vehicle (ATV) was initially developed in the 1960‟s as a farm town vehicle in isolated, mountainous areas. During spring thaws and rainy seasons, steep mountainous roads were often impassable with conventional vehicles.

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It soon became a recreational vehicle however, providing transportation to areas inaccessible by other motorized transport. Royal Enfield CO built and put on sale a powered Quadra cycle in 1893 that worked in the same way as, and resembles, a modern quad-bike. ATVs were made in the United States a decade before 3- and 4-wheeled vehicles were introduced by Honda and other Japanese companies. During the 1960s, numerous manufacturers offered similar small off-road vehicles that were designed to float and were capable of traversing swamps, ponds and streams, as well as dry land.

The early ATV‟s were mainly used for agricultural purpose only. But now the definition of ATV is changing. Many coutries are allowing ATVs as commercial vehicle, though with the regulations on its use and safety. Now days, ATVs are generally used in defence and sports application redefining the ATV. Now the ATVs are also coming with durable roll cages, added safety of seat and shoulder belts and higher ground clearance making it more rugged vehicle. The rear cargo deck is more useful for hauling camping gear, bales of hay, tools and supplies making it suitable for exploring back country, riding sand dunes, hunting, fishing and camping. ATVs Sport models are built with performance, rather than utility, in mind. To be successful at fast trail riding, an ATV must have light weight, high power, good suspension and a low centre of gravity. These machines can be modified for such racing disciplines as motocross, woods racing, desert racing, hill climbing, ice racing, speedway, tourist trophy, flat track, drag racing and others.

1.2 Application of ATV's

Initially the ATVs were solely used for the transportation through the inaccessible areas, but now these vehicles have found their application in different areas as mentioned below:

a. In Defence Services like army and air force etc to carry and transport guns, ammunition and other supplies to remote areas of rough and varied terrain.

b. By railways during construction of railway tracks on mountain or on other rough terrain.

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c. By police force.
d. In sport also like golf for traveling one place to other place.
e. In Antarctic bases for research things where use of conventional vehicle is impossible
f. Now a days ATVs are also used in adventuring like mountaineering, in dirt and in snow.

1.3 Objective of the project

The objective of our project work was to study the Steering and braking system of an ATV by determining and analysing the dynamics of the vehicle when driving on an off road racetrack. Though, there are many parameters which affect the performance of the ATV, the scope of this project work is limited to optimization, determination, design and analysis of steering and braking systems and to integrate them into whole vehicle systems for best results.

a. To study different steering systems.
b. To understand the requirements.
c. To design steering system for an ATV.
d. To analyse the design.
e. To fabricate the system in the most possible economic manner
f. Implement the design into an atv and study the static and dynamic characteristics and also optimize the design based on result

2.STEERING SYSTEM

The steering system plays an important role for the vehicle as it is the "interface" between the driver and the vehicle. The driver turns the steering wheel which will rotate the steering column and give further movement in the steering rack. The motion is then transmitted to the wheels by the tie rods.

The design and type of the steering rack depends on the system chosen. The steering systems used are divided into power assisted and manual steering systems, each designed to help the driver to turn easily for optimal performance with different configuration of the vehicle. Since the steering system is directly operated by the driver it is essential to take human comfort into consideration while designing the steering. The effort required by the driver in handling the steering is an important factor.

2.1 Power assisted steering systems

Power assisted steering systems are used to amplify the turning moment applied to the steering wheels for heavier vehicles which might be hard to turn with a manually steering system at low speeds. This is practical when the car is at a standstill and the wheels have to be turned, i.e. when parking.

A power assisted steering system is supported by a hydraulic pump driven by the motor which directs pressurized oil, a boost, to the steering gear and helps to push or pull the rack in either of the directions. The boost is applied to the steering linkage or the steering gear. A flow control valve limits the fluid flow to the cylinder, and a pressure relief valve controls the pressure.

The system can also be electrical driven. This is more efficient as the electric power steering only needs to assist when wheels are turned and are not run constantly with the engine as the hydraulically driven system.

. It also works even if the motor is not running and by the elimination of the pump, hoses and fluids the weight is reduced. There is no leakage of fluids and it runs quieter as there is no pump.

The rack and pinion gear system is assisted by a pump connected to the engine and is run along with the engine. The pump is pumping fluid from a reservoir, through a controlling valve and into the system, as seen in figure 1.0

The rack contains a cylinder with a piston and two fluid ports. By applying pressurized fluid to one of the sides of the piston forces the piston to move, which will move the rack.

As the pump is connected to the engine it only works when the engine is running. This is the reason why it is hard to turn the steering wheel when the car is turned off.

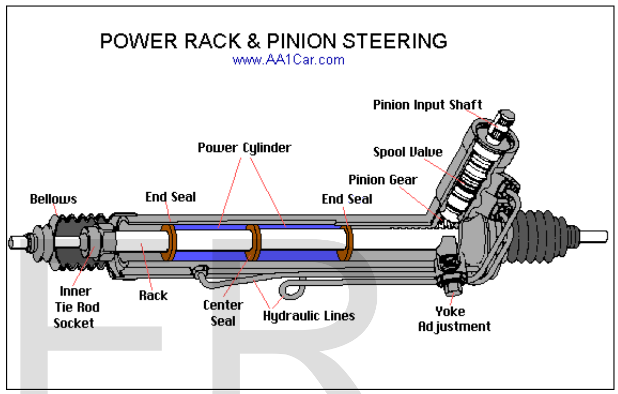

Fig. 1 Power assisted rack and pinion steering

2.2 Manual steering systems

The manual steering systems are used on light weighted vehicles, or vehicles which have the biggest distribution of mass on the rear wheels and can be easily turned with manual steering at low speed. The systems are fast and accurate and it provides a reliable design.

However, it will become more difficult to handle the vehicle at low speed if wider tires are used or more weight is distributed to the front wheels. These concerns play a big role when analyzing if manual steering should be used. There are different types of manual steering gear systems:

1. Worm and roller
2. Worm and sector
3. Worm and nut
4. Cam and lever
5. Rack and pinion

2.2.1 Worm and Roller

The worm and roller gear has a connection between the worm and the roller, and the roller is supported by a roller bearing. When the steering wheel turns the steering shaft, the worm is rotated which turns the roller. As a result of this motion, the sector and pitman arm shaft rotates.

The worm has a hourglass shape for variable steering ratio and better contact for the worm and roller. The variable steering ratio will result that the wheels turns faster at some positions than others. This will provide more steering control at

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the centre of the worm, and more rapid steering as the wheels are turned.

2.2.2 Worm and Sector

The worm and sector steering gear has a pitman arm shaft carries the sector gear. As the steering wheel rotates, the worm on the steering gear shaft rotates which rotates the sector and the pitman arm.

2.2.3 Worm and Nut

The worm and nut steering gear comes in different combinations where the recirculating ball is the most common type. The recirculation ball combination offers the connection of the nut on a row of balls on the worm gear to reduce friction. Ball guides returns the balls as the nut moves up and down. The ball nut is shaped to fit the sector gear. When the steering wheel is turned, the steering shaft rotates along with the worm gear fitted at the end of it. The recirculation balls starts to move, and this moves the ball nut up and down along the worm. This turns the pitman arm.

2.2.4 Cam and Lever

In the cam and lever gear, two studs are connected on the lever and engage the cam, figure 4-5. As the steering wheel is turned, the steering shaft will rotate and move the studs back and forth which move the lever back and forth. This will cause a rotation in the pitman arm. The lever is increased in angle compared to the cam, which will result in a more rapid move of the lever as it nears the ends, as in the worm and nut gear.

2.2.5 Rack and Pinion

In the rack and pinion gear, the rotating steering wheel and steering shaft rotates the pinion gear at the end of the steering shaft. The rack is fitted to the pinion and as the pinion rotates, the rotation motion is changed to transverse movement of the rack gear and moves it to one of the sides. The tie rods at the ends of the rack, which are connected to the wheels, are pushed or pulled which turns the wheels.

The teeth on the rack can be either linear or variable. With a linear rate there is the same amount of teeth over the whole area which makes the wheels to respond the same regardless of the angle. With a variable rate the rack has closely packed teeth at the center and the distance between the teeth widens towards the ends. The result is better adjustment when driving straight and bigger respond when doing sharp turning.

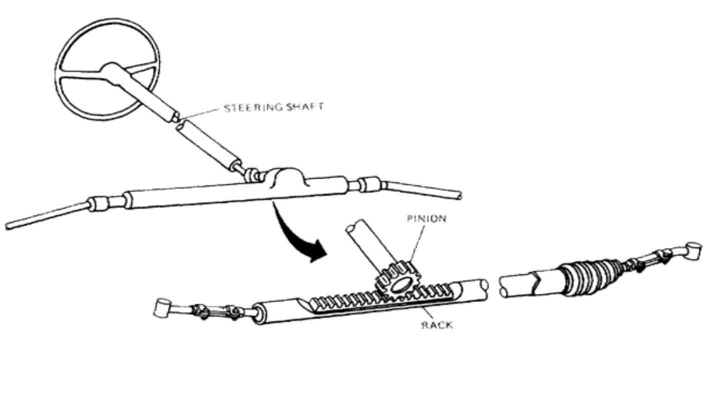

Fig. 2. General rack and pinion steering arrangement

2.3 Steering mechanism

There are two types of steering mechanism

1. Davis Steering gear
2. Ackermann Steering gear

2.3.1. Davis Steering Gear: The Davis Steering gear has sliding pair, it has more Friction than the turning pair, therefore the Davis Steering Gear wear out earlier and become inaccurate after certain time. This type is mathematically Accurate.

2.3.2.Ackerman Steering System: It has only turning pair. It is not mathematically accurate except in three positions. The track arms are made Inclined so that if the axles are extended they will meet on the longitudinal axis of the car near rear axle. This system is called Ackermann steering.

2.4 Steering geometry

It refers to the angular relationship between the front wheels and parts attached to it and car frame.

The steering Geometry includes

1. Scrub Radius
2. Steering axis inclination
3. Caster angle
4. Camber angle
5. Squirm

2.4.1 Scrub radius:

The scrub radius is the distance in the front view between the king pin axis and the centre of the contact patch of the wheel, where both would theoretically touch the road.

Large positive value of scrub radius, 4 inches/100mm or so, were used in cars for many years. The advantage of this is that the tire rolls as the wheel is steered, which reduces the effort when parking.

If the scrub radius is small then the contact patch is spun in place when parking, which takes a lot more effort. The advantage of a small scrub radius is that the steering becomes less sensitive to braking inputs, in particular.

An advantage of negative scrub radius is that the geometry naturally compensates for split braking, or failure in one of the brake circuits. It also provides centre point steering in the event of tire inflation, which provides greater stability and steering control in this emergency.

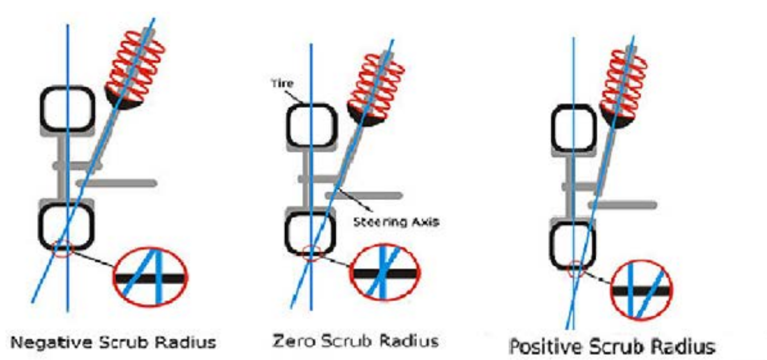

Fig. 3 Scrub radius

2.4.2Steering axis inclination:

Steering axis inclination is the angle between the centreline of

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the steering axis and vertivcal line from center contact area of the tire (as viewed from the front).OrIt is the angle between vertical line to the king pinaxis. The inclination tends to keep wheels straight ahead and make thewheels to get return to the straight position after completion of a turn. The
Inclination is normally kept 7º to 8º.

Effects of steering axis inclination

SAI urges the wheels to a straight ahead position after a turns. By inclining the steering axis inward (away from the wheel), it causes the spindle to rise and fall as the wheels are turned in one direction or the other. Less positive caster is needed to maintain directional stability.

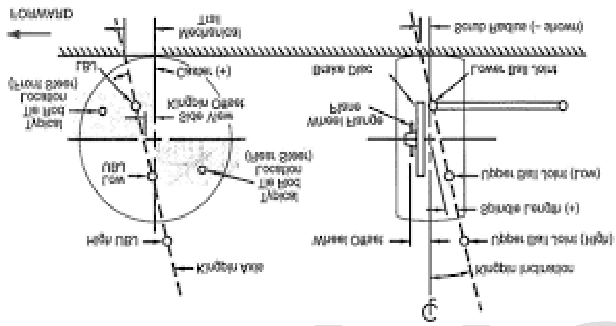
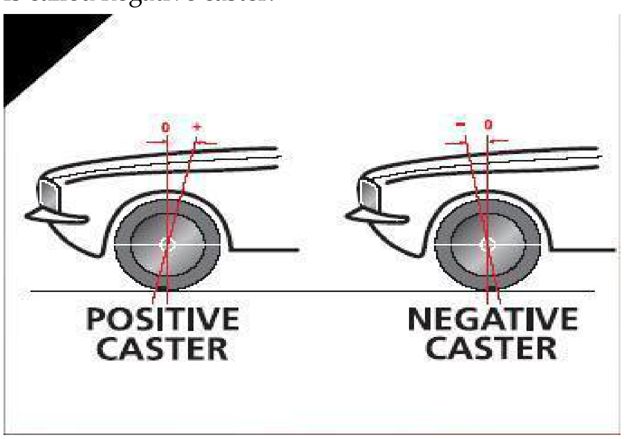


Fig.4 steering axis inclination

2.4.3 Caster Angle:

This is the angle between backward or forward tilting of the king pin from the vertical axis at the top. This is about 2º to 4º. The backward tilt is called as positive caster. The forward tilt is called negative caster.



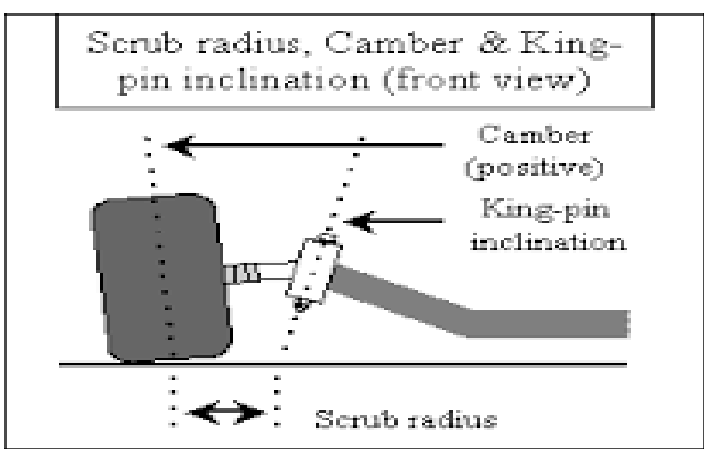


Fig. 5 Caster angle

2.4.4 Camber Angle:

The angle between wheel axes to the vertical line at the top is called Camber angle. It is approximately ½º to 2º.

Fig. 6 Camber Angle

2.4.5 Squirm:

Squirm occurs when the scrub radius is at zero. when the pivot point is in the exact center of the tire footprint, this causes scrubbing action in opposite directions when the wheels are turned. Tire wear and some instability in corners is the result.

2.5 Ackerman steering geometry

Ackerman steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radius. It has only turning pair. It is not
Mathematically accurate except in three positions. The track arms are made inclined so that if the axles are extended they will meet on the longitudinal axis of the car near rear axle. This system is called Ackermann steering.

2.6 Ackerman's law of correct steering

The law states that to achieve true rolling for a four wheeled vehicle moving on a curved path, the lines drawn perpendicular to the four wheels must be concurrent. However in Ackermann steering mechanism this condition is not achieved for all angular positions of the wheel. This condition is met only for a single angle of turn.

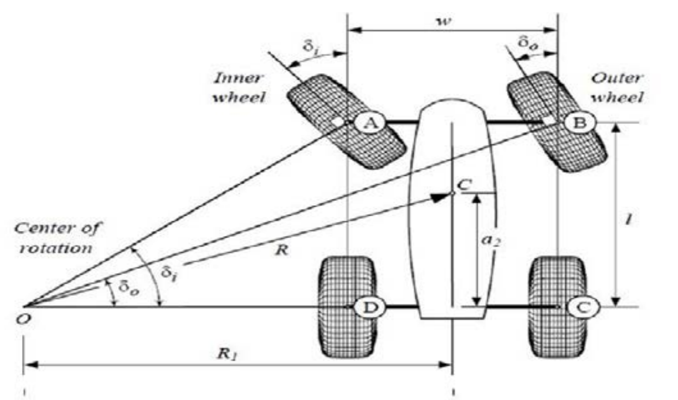


Fig.7 steering geometry

3. DESIGN OF STEERING SYSTEM

The steering mechanism used was Ackerman Steering mechanism. With the geometry drawn from the available data, we could obtain most of the desired values for a good steering.

3.1 Customization of a rack and pinion

For a single seated all-terrain vehicle as per student Baja India rule book, the steering rack and pinion should be centred in the neutral condition. Here arises the customization of an

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OEM part. The available rack and pinion in the market is designed for right handed vehicle. Direct use of this in our vehicle will be complicated. So the customization is required.

Fig 8 OEM right handed rack and pinion

The objective is to equalise the distance of the teeth length on the rack towards both sides of pinion when wheels are straight. For this a manual rack and pinion of Maruti 800 is purchased and it's to ends are cut to equalise the length from the centre of the teeth of the rack. Threaded portion of the rack at the both ends are also cut from the rack. Total rack length is 20mm.

Force acting on the rack will be large. To prevent failure of the welded joints an additional engineering practice is done on the rack. Beforewelding holes are drilled at the sides of the pieces which was cut. After drilling holes of 8mm, made a thread inside these holes for inserting M10 stud bolt. So the pieces are jointed and made into single piece without welding. Ends of the pieces are chamfered to make the double V butt joint. This is done because the clearance between rack and the steering box casing is very less. If the welded are projecting above the rack, it will affect the free motion of rack inside the casing. It will adversly affect the manuverability of the vehicle.

Fig. 9 Centred rack and pinion

3.2 STEERING FORCE CALCULATION

Let a force of 300N be acting upon the steering column and the steering is rotated at a speed of 18rpm. Let us assume the diameter of steering column be 30mm.The maximum tensile stress of cast iron pipe = 14N/mm².
The actual shear stress is within the limit, so design is safe. 30mm outer diameter cast iron pipe is selected as the steering column according to the design.

3.3 Ackerman geometry

The values used in Ackerman geometry development is as follows:
Wheel Base: 57 inch
Track Width: 52 inch
Determined rack length based on roll cage design: 20 inch

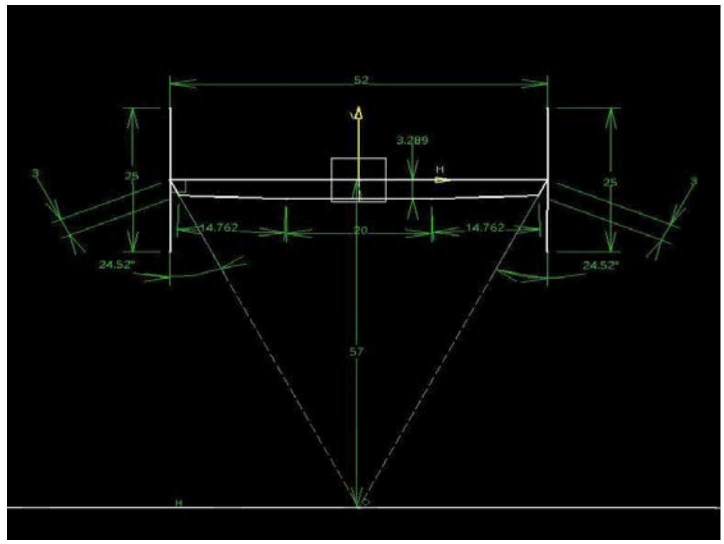

Fig. 11 Ackerman geometry

The following Values are obtained from geometry;
Tie rod length: 14.762 inch
Turning radius: 3.12m
Steering arm length: 3 inch
For Complete Ackerman, the following condition is to be satisfied; Cot (Φ) -
Cot (θ) = B/L
From Drawing we have,
Maximum turn angle of inner wheel $\theta = 45^0$
Corresponding turn angle of outer wheel $\Phi = 27.6^0$
Cot(27.6) - cot (45) = (52/57) = 0.99
Ackerman condition satisfied.

3.4 Steering wheel hub design

For the proper mounting of the steering wheel and the steering column, steering wheel hub is necessary. Steering wheel purchased consist of 6 Allen key bolt of diameter 6mm. The top surface of hub should have a provision to perfectly hold these bolts. And lower side should have a proper arrangement for connecting the other end of the steeringcolumn connected to U-joint further to the rack and pinion.

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Material selected for the manufacturing of steering wheel hub is cast iron because of its easy availability and cheapness in the cost.

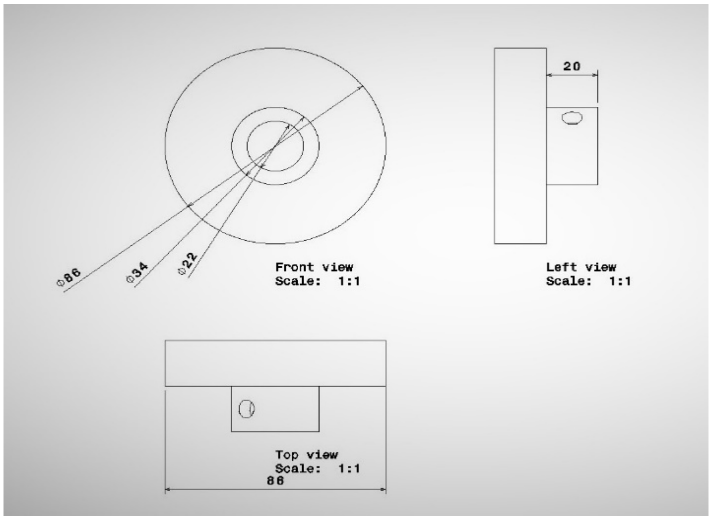
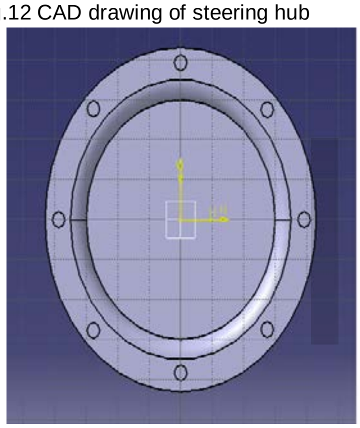


Fig.12 CAD drawing of steering hub



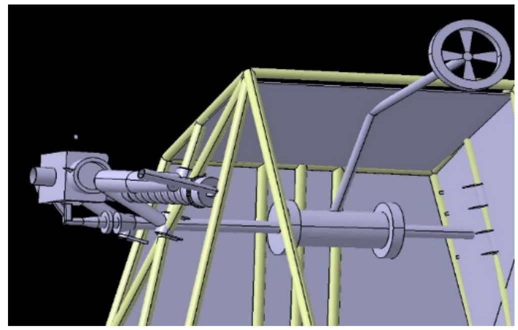
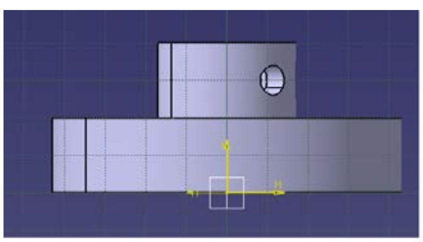


Fig. 14 CATIA generated assembly of steering



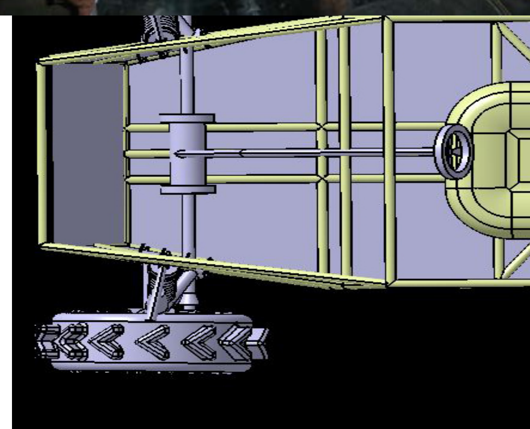


Fig. 13 CATIA generated assembly of steering system andassembled steering system

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WHEEL BASE	57 inches
TRACK WIDTH FRONT	52 inches
TRACK WIDTH REAR	50 inches
STEERING TYPE	ACKERMAN STEERING
ACKERMAN ANGLE	21 degrees
MAXIMUM OUTER WHEEL LOCK ANGLE	27.6 degrees
TURNING RADIUS	3.12 m
C-factor	66mm
STEERING RACK LENGTH	20 inch
TIE ROD LENGTH	14.76 inch
STEERING ARM LENGTH	3 inch m

Table. 1 Steering system specifications

4. BRAKING SYSTEM

All braking systems function on the basis of energy conversi sions. The basic function of braking systems is to convert the KE of motion of wheels into another energy source which could be dissipated. Usually all brakes employ conversion into heat. i.e, The Kinetic Energy of the vehicle is converted into Heat Energy by actuating brakes. We very well know that as the mass and velocity associated with a vehicle increases; its Kinetic Energy naturally increases as is clear from the Graph (Fig.4.1). So stopping a heavier vehicle moving at higher speeds require more force out of the brakes and would increase the stopping time.

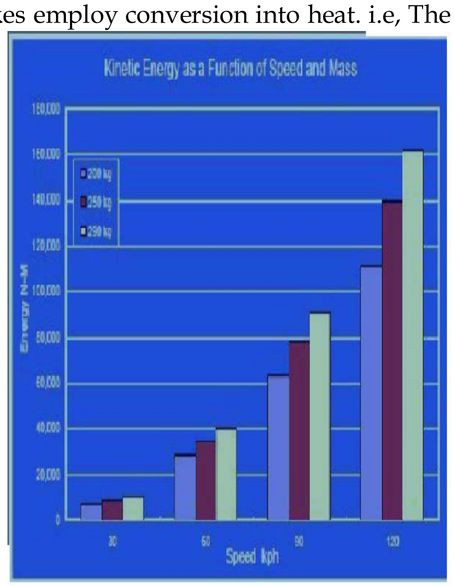

Fig. 15 Kinetic energy as function of speed and mass

4.1 Types of brakes

1. Mechanical Brakes
   - Disc brake
   - Drum brake
2. Hydraulic brakes
3. Power brakes
   - Air brakes
   - Air hydraulic brakes
   - Electric brakes
   - Vaccum brakes

4.2 Brake Component Function

Brake components are mainly divided into four sub-system

4.2.1 Four Sub-systems

- Actuation sub-system
- Foundation sub-system
- Parking brake sub-system
- ABS & ESP (electronic stability program) sub-system

4.2.1 Actuation Sub-system

Brake pedal: After laying out a proper hydraulic layout, it then is necessary to make the system functioning with brake hoses and brake pedal. The arrangement of brake pedal is as shown in the figure:

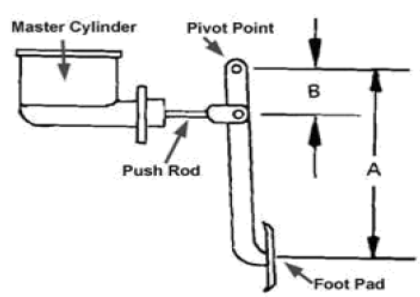

Fig. 16 brake pedal

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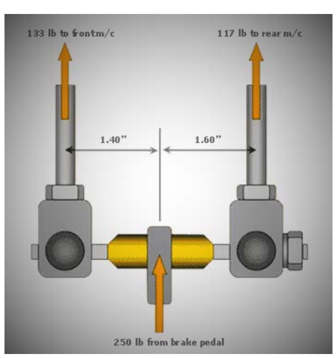
Here we design a brake pedal with a pedal: lever ratio of 6:1. We can easily make such leverage in the above figure if:
A/B = 6/1

Master Cylinder:
A tandem master or dual master cylinder is one of the most important safety devices in any vehicle. It operates a divided or split hydraulic system so that if one circuit fails the other wiil still operate. Systems can be split so that one circuit is connected to the front brakes and the other to the rear, or diagonally between front left and rear right and vice versa.

Fig. 17 master cylinder

Proportioning Valves:

Many proportioning valves are integral to the master cylinder housing. This reduces weight and complexity of the hydraulic piping. Alternatively they can be mounted separately. It provides balanced braking conditions by reducing the hydraulic pressure to the rear wheels. This helps prevent rear wheel lock-up.
The rear wheel requires less hydraulic pressure, hence the purpose of proportioning valves. Figure below shows the difference in the rear wheel brake pressure without using and with using proportioning circuits



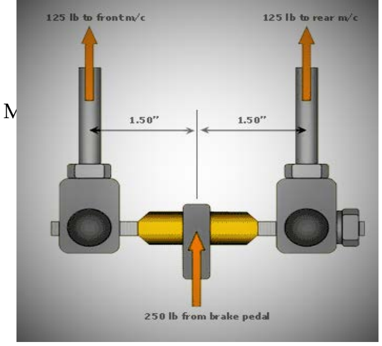


Fig .18 Non proportioning valves proportioning valve

Brake lines:
Double wall steel tubing (Bundy Tubing) is industry standard. The standard size is 3/16 inch outer diameter. Very robust, can take a lot of abuse. Use SAE 45° inverted flare (J533 and

J512) joints is most preferred.

Fig. 19 brake liner

Pressure Switches:
Pressure switches are widely used in automobiles for the purpose of glowing the brake light when the brake is applied. These units are connected to the brake lines using a T-junction and uses the pressure developed in the lines while applying the brakes to activate the connection between the battery and the brake light by closing the circuit.

Fig. 20 Pressure switch and brake line T-junction

Disc Brakes:

In a disc brake, the fluid from the master cylinder is forced into a caliper where it presses against a piston. The piston in turn squeezes two brake pads against the disc (rotor), which is attached to wheel, forcing it to slow down or stop.

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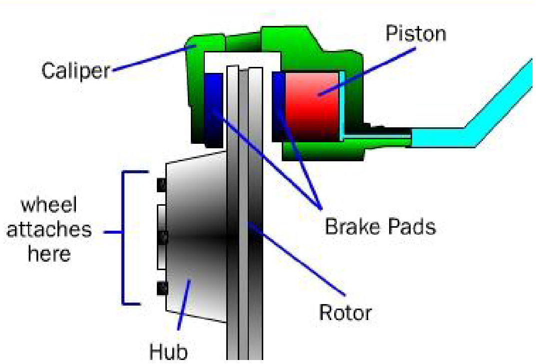

Fig. 21 Disk brake

The drum brake has a metal brake drum that encloses the brake assembly at each wheel. Two curved brake shoes expand outward to slow or stop the drum which rotates with the wheel.

4.3 HYDRAULIC SYSTEMS CONFIGURATIONS

There are basically two systems which we could employ in case of a hydrauliccircuit, they are:

1. Front/Rear Hydraulic Split
2. Diagonal Split

A front/rear hydraulic split system is as shown below:

Such a system is not adopted in our braking, because if one of the circuits fail,we lose complete braking on either the front or the rear side of our vehicle.
Rather, we employ a diagonal split system.

4.4 CALCULATIONS

Assumed Foot force = 200N
Total force on cylinder = F = 200x6 = 1200N
Pressure delivered by cylinder = Pc = F/A
= 1200/0.0003142 = 3819223.424 N/m² = 38.19 bar
Brake bias = 55:45
Front brake pressure, P (F) = 55% of 3819223.424
= 2100572.8835 N/m²
Rear brake pressure, P(R) = 45% of 3819223.424
= 1718650.5408 N/m²
Area of caliper = = 2/4 = x .0472 /4 = .00173494 m²
Front brake force = P (F) x Area of caliper
= 2100572.8835 x .00173494= 3644.37N
Rear brake force = 2981.755 N
Force applied on discs = No. of acting surfaces x F x coefficient of frictionof lining - disc Force on front disc, Fd (F)
= 2 x F (F) x 0.3 = 2186.622 N
Force on rear disc, Fd(R) = 2 x F(R) x 0.3 = 1789.05 N
Torque on front disc, T (F) = Fd(F) x Radius of disc = 218.66 Nm Torque on
Rear disc, T(R)
= Fd(R) x Radius of disc = 178.90 Nm

Force on wheels:
F (fw) = T (F)/Radius of wheel = 826.224 N
F (rw) = T(R)/Radius of wheel = 550.78 N

Net deceleration:
Let the acceleration = - μ g
Where μ is the co efficient of friction between road and tire
G is the acceleration due to gravity
So deceleration = 0.6x 9.81= 5.886 m/s²

Stopping distance:
We know by fundamental equations of dynamics, v2-u2=2as
Substituting,
V=final velocity=0 m/s2
U=initial velocity=11.11 m/s2 (40kmph)
A=deceleration=5.886 m/s2
Then s = 10.48 m

Stopping time:
We know v=u+at
V=0 m/s2
U=11.11 m/s2 (40kmph)A=deceleration=5.886 m/s2
From which we can get the time to stop, t=1.88 seconds

Average Brake Force:
BF avg = {Wtxu2}/ {2s}
Where,
Wt= weight of vehicle
U= velocity= 40kmph= 11.11m/s2
S= stopping distance
BF avg= {300x11.112}/{2x10.48m} = 1766.68N

DYNAMIC WEIGHT TRANSFER:
Front axle dynamic load = W1+(aWH)/gL
=1030+(5.886x2943x19)/9.81x57= 1602.57N
Rear axle dynamic load = W2 –(aWH)/gL

ISSN 2229-5518

=1913-(5.886x2943x19)/(9.81x57)=1340.42N

SPECIFICATIONS	VALUE
DISC DIAMETER	200mm
CYLINDER DIAMETER	19.05mm
PEDAL RATIO	6:1
PEDAL FORCE	200N (ASSUMED)
CYLINDER PRESSURE	38.19bar
BRAKE BIASING	55:45 (FRONT:REAR)
BRAKE TORQUE ON DISCS	218.66Nm/178.90Nm (FRONT/REAR)
AVERAGE BRAKING FORCE	1766.68N
DECELERATION	5.86 m/s^2
STOPPING DISTANCE	10.48m (At 40kmph)
STOPPING TIME	1.88 secs (At 40kmph)
DYNAMIC LOAD TRANSFER WHEN BRAKING	16020.57N/1340.42N (FRONT/REAR)

Table 2. BRAKE SPECIFICATION

Where,
W1 = Weight acting on front axle in static condition
W2 = Weight acting on the rear axle in static condition
W = Weight of vehicle = 300kg
H = Height of centre of gravity from ground = 0.4826m
L= Length of wheel base = 1447.8 mm
a = deceleration = 5.886 m/s
Distribution=55:45(F:R)

4.6 Braking system assembly

Fig.22braking system used components and assembly

PARAMETER	SPECIFICATION
ENGINE	BRIGGS & STRATTON 20S232-0036
MAX POWER	10 HP at 3600 rpm
MAX TORQUE	19 Nm at 2800 rpm
ENGINE DISPLACE-MENT	305cc
BORE	3.12 in
STROKE	2.44 in
LUBRICATION SYS-TEM	SPLASH
CHOKE CONTROL	MANUAL
IGNITION SYSTEM	ELECTRONIC
TOTAL MASS OF VEHICLE	266

Table. 3 Vehicle specifications

5.FINAL ASSEMBLED VEHICLE

Fig. 23 Final Assembled Vehicle on Track

6.1 CONCLUSION

The project aimed at designing, analysing, fabrication and testing of steering and braking system for a student Baja car and their integration in the whole vehicle. The car has been designed and fabricated to the best of its possible. The primary objective of this project was to identify and determine the design the parameters of a vehicle with a proper study of vehicle dynamics. This project helped us to study and analyse the procedure of vehicle steering and braking system designing and to identify the performance affecting parameters. It also helped us to understand and overcome the theoretical difficulties of vehicle design.

The entire designing and manufacturing period was a great experience for the entire team as we were introduced into the amazing world of automobile engineering. The events which the team participated in, the Baja Design Challenge held at Budha international circuit, Noida and the Baja Student India were milestones not just for the team but for the college. It was a learning experience in which we were the proud beneficiaries.

The Steering and braking system in particular functioned remarkably well and was tested all around during the Baja event and came out successfully, and performed without fail during our test runs.

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