Immortus racing

University institute of engineering and technology
Panjab University, Chandigarh

Design report

Abstract

The report explains the viability and methodology of designing a go-kart, which should be durable, economical, comfortable, and should provide fun ride experience. The modeling is done on cad software (Solidworks, AutoCAD). Analysis and simulation is done on ansys software.

The team focuses on sound engineering practice to fabricate a viable kart .The process of work include design--calculation--simulation--fabrication--testing--repair. Designing is done by keeping the safety and comfort of the driver as prime importance.

Introduction

The go-kart is low ground clearance vehicle for its higher stability. The design process requires iterative procedure for final refined design. The kart is modeled on solidworks software and simulated on ansys software. Based on simulation design is modified and re-simulated for final design.

Design process includes:-

. Research on respective project and vehicle needs.

. Reverse engineering of product, market viability and cost comparison.

. Block diagram of different elements of design.

. Sketching of different elements to get rough image of design compactness.

. Modeling of chassis on cad software with proper dimensions.

. Modeling of different element with proper dimensions.

. Material addition for chassis and all elements.

. Force and torque analysis of chassis and different elements for simulation.

. Modification of model based on simulation.

. Assembly of different components and chassis to get a complete look of kart.

. Weight and centre of mass consideration.

Design parameters

1. Driver safety and comfort.
2. Cost effectiveness.
3. Less number of nodes (welding joints).
4. Less number of bending.
5. Compactness of vehicle.
6. Adequate clearance between members and drive body.
7. Prime importance to ergonomics.
8. Low weight vehicle with good strength.
9. Least track width and wheelbase keeping rule in compliance.
10. Aesthetics is also kept in mind.

Sub departments of design is divided for brake disc mount, knuckle, steering geometry, paddle, mounting.

Material selection

According to rule book we were required to select seamless pipes .We came across three materials i.e. AISI1018, AISI1020, AISI1026 and AISI4130. On chemical, cost and physical comparison we decided to use AISI1018.

Materials	Yield strength (MPa)	Percentage elongation at break	Cost per m in(₹)
AISI 1026	260-440	17-27%	345
AISI 4130	435-979	18-26%	735
AISI 1020	230-370	18-28%	315
AISI 1018	270-400	18-29%	300

AISI 1018 has good machinability, weld-ability, as well as good weight to strength ratio as compared to AISI4130.

The reason to reject AISI1020 as it has high cost though its material properties are equivalent to aisi1018. AISI4130 is rejected for its high cost and high carbon content.
Thus on a whole AISI1018 provide good balance of strength, elastic strength, machinability and weld ability.

Chemical composition of AISI 1018

ELEMENT CONTENT
Carbon (C) =0.14-0.20%
Sulphur, (S) <=0.050%
Iron, (Fe) =98.81-99.26%
Manganese, (Mn) = 0.60-0.90%

Phosphorous, (P) <=0.040%

Physical properties of AISI 1018

PROPERTIES VALUE (Metric)
Density =7.87g/cc
Yield tensile strength= 370 MPa
Elongation at break (in 50mm) =15%
Poisons ratio =0.29
Modulus of elasticity= 200GPa

ERGONOMICS

The ergonomics of the driver is designed in such a way to keep Driver in a comfortable zone and to have ability to perform a quick escape (within 5 Seconds) from the kart during fire accident. The design of seat used in the Go-Kart is bucket model, which can carry a single person in the vehicle.

- Distance of pedal from H-Point = 34.5 inches
- Distance (vertical) of Steering Wheel = 18 inches
- Distance (horizontal) of Steering Wheel from Vertical Line from H-Point = 14.3 inches

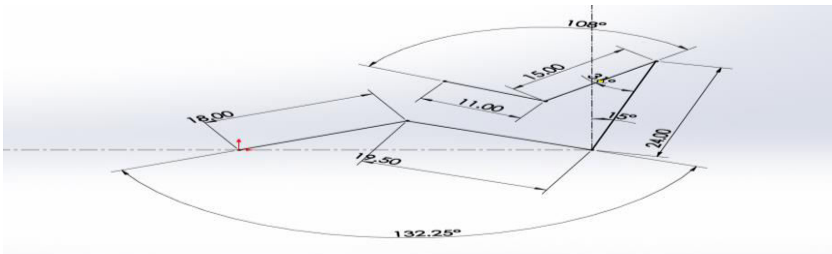
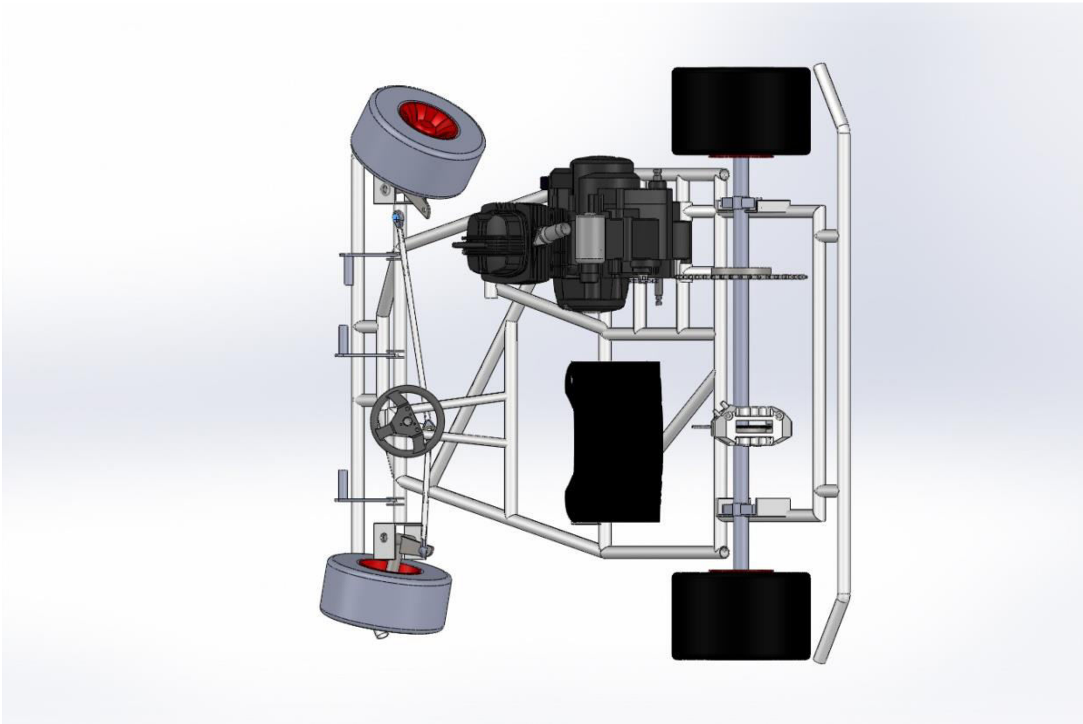


Fig: - **Ergonomics calculation**

VIEWS OF THE GO-KART

Three different views are displayed below:-

Top view



Side view

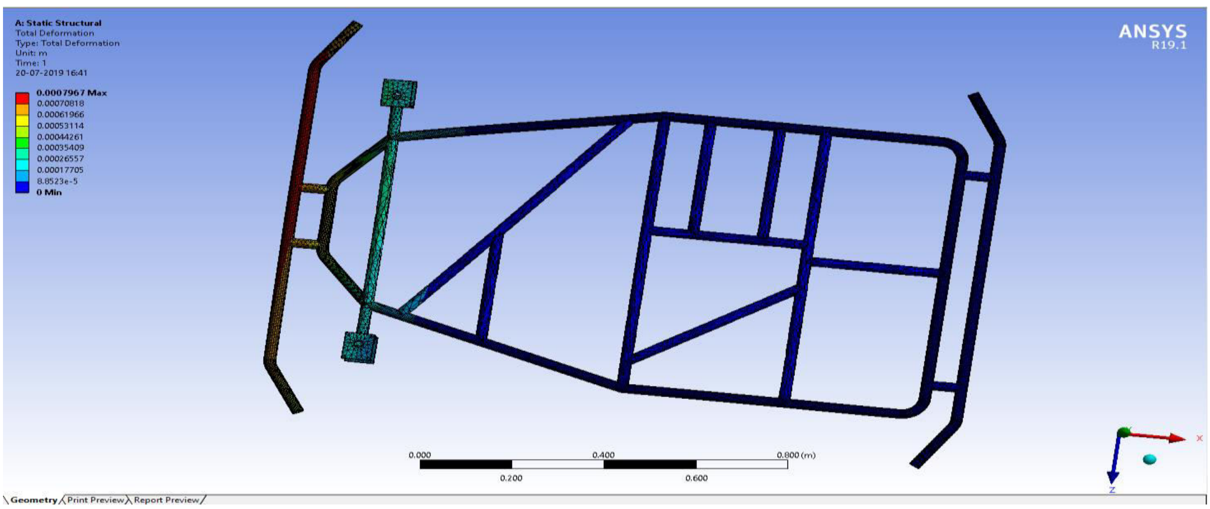
Isometric view

Wheelbase- 42inches
Track width -40inches
Ground clearance- 2.5inches

Frame analysis

Chassis force analysis has been done on ANSYS R19.1 software

Front impact

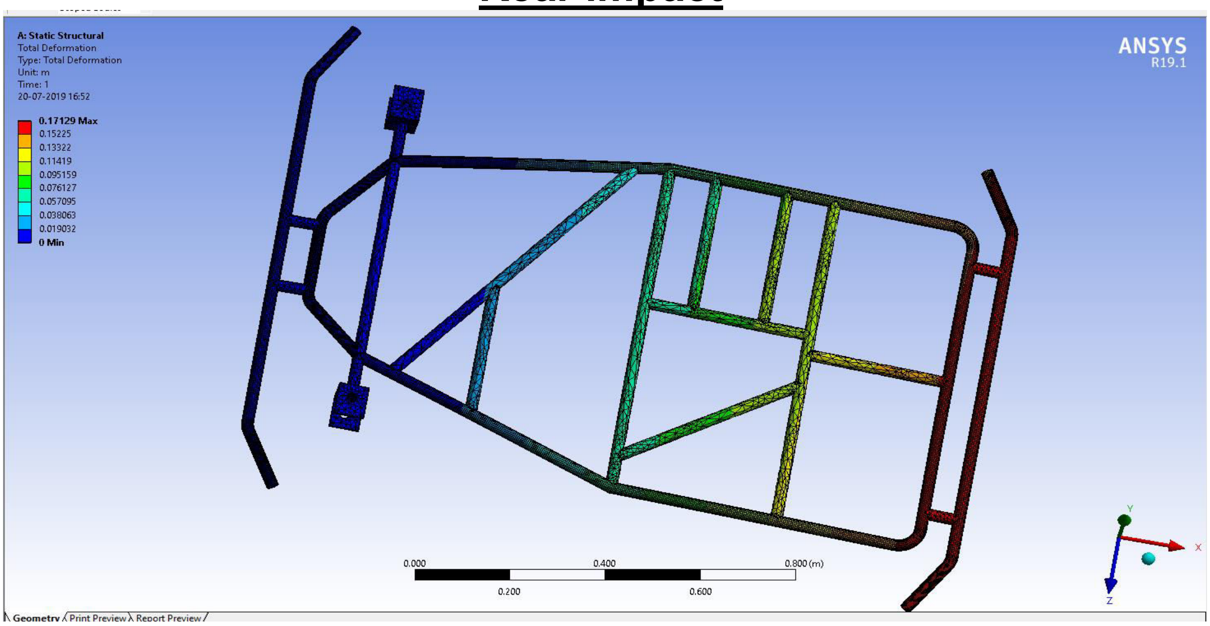


A force of 10,000 N is applied to get factor of safety 2.51

FOS =Yield Strength of AISI 1018/Von − Mises Stress.

Yield strength = 370MPa, Von- Mises stress -147.4MPa

Rear impact



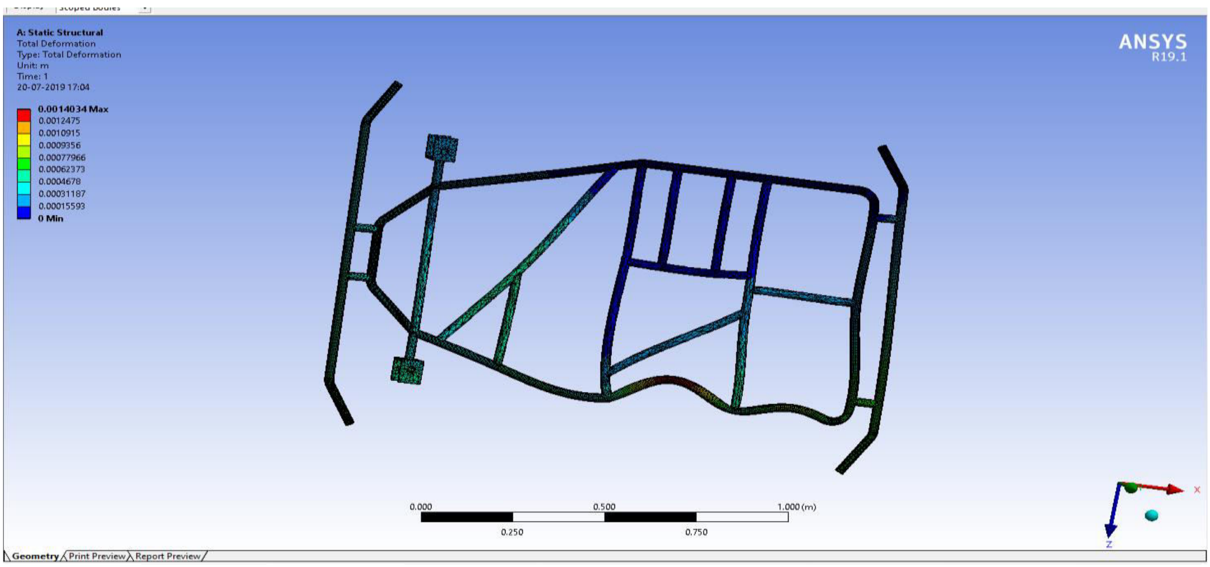
Force = 10,000 N

FOS=1.83

Yield strength=370MPa

Von-Mises stress=201.25MPa

Side impact



Force = 8000N

FOS=1.62

Yield strength=370MPa

Von-Mises stress=228.4MPa

Thus our FOS lies above 1.5 thus our kart is safe in impact test.

STEERING SYSTEM

Introduction: - The steering system is important part of the dynamic design of any automobile to facilitate a smooth change of direction (maneuvering of vehicle) and to make use of the tires' ability to generate lateral forces to the highest extent. A driver's sensory inputs supply visual, tactile, and inertial information used in developing a "feel" for car handling and performance. This feedback is necessary in enabling the driver to extract maximum performance from the race car. Hence, the steering is an important feedback mechanism giving the driver information on stability and directional control.

OBJECTIVES:

- To enable smooth and stable maneuvering of the vehicle.
- To provide feedback to the driver.
- To optimize the steering effort.
- To provide adjustability for parameters such as caster angle and toe.
- To select and implement the best mechanism that suits the purpose.
- To reduce the unwanted play in steering linkages so as to reduce the power transmission loss.
- To give directional stability to the vehicle by applying self-centering force during cornering.

SYSTEM USED WITH ADVANTAGES: Pitman Arm Steering Mechanism (Based on Ackermann Geometry)

- 1:1 Steering Ratio provides sensitive steering to the vehicle.
- Negative Camber of 2 degrees for greater turning stability and directional stability by increasing contact patch (traction) during cornering.
- Kingpin Inclination of 8 degrees for zero scrub radius (Zero scrub radius provides smooth steering as well as counters over-steering as it works as centre-point steering).

- Positive Caster of 3 degrees for ease of steering as tire centre line follows the steering axis.

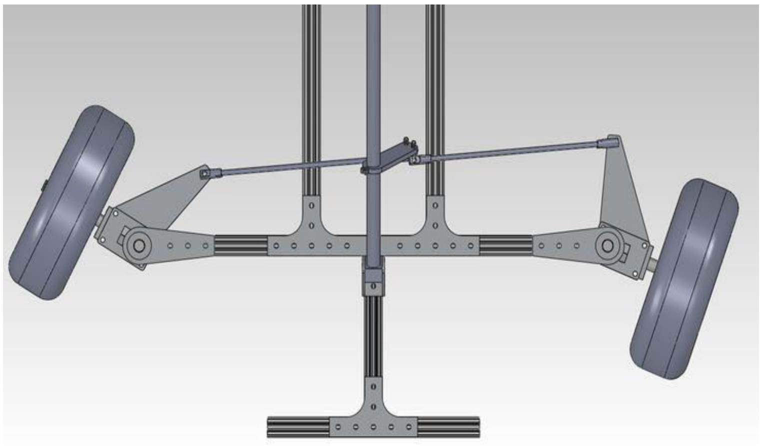


Fig: - Pitman arm type steering

STEERING COMPONENTS AND CALCULATIONS :

We are using Elliot Type steering bush and quarter for which the calculations are as follows :

- Track Width = 1.016 m = 40 inches
- Wheel Base = 1.067 m = 42 inches
- Ackermann Angle (α) = $\tan^{-1}$(0.5 × Track Width / Wheel Base) = $\tan^{-1}$(0.5 × 40 / 42) = 25.46^0
- Turning Radius = 2.5 m
- γ = (a+b)/2 ; a is outer wheel steering angle and b is inner wheel steering angle
- Average Steer Angle (γ) = $\sin^{-1}$[Wheel Base / {Turning Radius – (Track Width/2)}] = $\sin^{-1}$[1.067 / {2.5 – 0.531}] = $\sin^{-1}$[0.5418] = 32.81^0
- Kingpin Inclination = 8^0
- Caster Angle = 3^0
- Camber Angle = 2^0

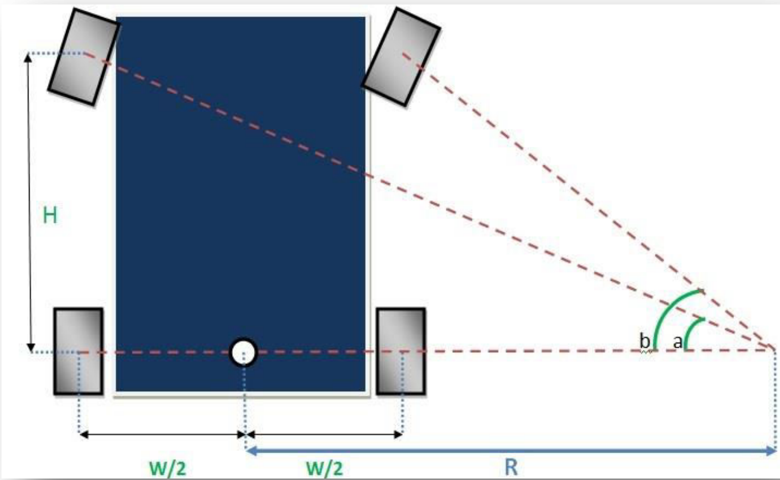


Fig: - **Turning radius calculation**

TRANSMISSION AND ENGINE

INTRODUCTION

Transmission is a mechanism that consists of power source and power transmission system, which provides controlled application of the power. Often the term transmission refers simply to the gear box that uses gears and gear trains to provide speed and torque conversion from a rotating power source to another machine device.

OBJECTIVE

- Achieve maximum possible torque
- Achieve maximum speed
- Minimize the power loss
- Maximize the efficiency

ENGINE USED WITH ADVANTAGES

As per following comparison of other available variety of engines having 125 cc capacity , Honda Shine's engine suites best regarding to the specifications.

ENGINE REQUIREMENT	OUR ENGINE
SINGLE CYLINDER 4 STROKE	SINGLE CYLINDER 4 STROKE
PETROL	PETROL
125CC(MAX.)	124.73CC
ELECTRIC START	ELECTRIC START
AIR COOLED	AIR COOLED

DISCOVER	HONDA SHINE
SINGLE CYLINDER FOUR STROKE	SINGLE CYLINDER FOUR STROKE
124.5CC	124.73CC
8L FUEL TANK	10.5L FUEL TANK
11 PS POWER	10.30 PS OF POWER

82.4 KMPL	65 KMPL
PICK UP (LOW)	PICK UP (HIGH)
PUMP MODULATION (MISSING)	PUMP MODULATION (PRE INSTALLED)

DRIVE: The drive used in our go kart is chain drive with the sprocket used on engine comprising of 14 teeth.
(T_2 = 14)

- Engine RPM = 5000 = 2 × 3.14 × 5000 /60= 523.33 rad/s
- Radius of Rear Tire = 5.5 inches = 0.1397 m
- Required Speed = 90 Km/h = 25 m/s
- Required Axle Rotation Speed = 178.9 rad/s
- T_1 = 14 × 523.33 / 178.9 = 41 teeth

Hence required number of teeth on axle is 41.

- Length of Chain (l) = $2x + (T_1 + T_2)/2 + (T_2 - T_1)^2 / 2\pi x$; x = 8.5 inches = 47 inches
- Diameter of Rear Sprocket = 6 inches
- Pitch of Chain = 0.50 inches

REAR AXLE: The diameter of rear axle will be 2.54 cm and its mounting will be done by flange Bearing, nuts and bolts.

ENGINE MOUNTING: Engine mounting will be done by proper welds, nuts and bolts as showcased in the design near the driver's seat.

GEAR RATIOS:

- No. of gears = 5

First = 27.64
Second = 16.07
Third = 11.68
Fourth = 9.58
Fifth = 8.23

- Primary Reduction = 3.136
- Drive Axle (Front / Rear / All) = 2.866 (Final Reduction)

TYRES

INTRODUCTION: The importance of wheels or tires used in automobiles is obvious. Without the engine, the car may be towed, but even that is not possible without the wheels. The wheel along the tire has to take the vehicle load, provide a cushioning effect and cope with the steering control.

TYRES USED IN GO - KART : Slick Tires are used in our Go – Kart as they have a smooth tread that is mostly found in auto racing and offers better traction .

- Specifications of Tires

Slick Front Tires

- Diameter = 10 inches
- Width = 4.5 inches
- Diameter of Rims = 5 inches

Slick Rear Tires

- Diameter = 11 inches
- Width = 7.1 inches
- Diameter of Rims = 5 inches

BRAKE SYSTEM

INTRODUCTION: A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for de-accelerating or stopping a moving vehicle and it is accomplished by friction. Brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed.

OBJECTIVES:

- To design a braking system that is simple and ensures safety of the driver.
- To design a braking system, that takes least time to bring the vehicle to stop.

BRAKE SYSTEM USED WITH ADVANTAGES: Disc Brake (Hydraulic Mechanism)

- Disc brake contributes for reduction in overall weight of the vehicle.
- More braking torque needs to be generated by the Rear brake even after weight transfer, because a single brake has to manage the braking torque requirement of the entire rear driveshaft.

As per following comparison of the available varieties of brake systems, Apache RTR 160's brake system suites best regarding to the specifications as

- Thickness (6 mm) is not too high
- Outer diameter (200 mm) is in accordance with our required design.

S.No.	Disc	Outer Diameter (mm)	Thickness (mm)
1	Pulsar 150	240	6
2	Pulsar 220	230	8
3	Apache RTR 160	200	6

S.No.	Caliper Brand	No. of pistons	Arrangement of Pistons	Diameter of Piston Front
1	Apache 160 RTR	2	Single Side	24.5 mm
2	Pulsar 200 NS Rear	2	Single Side	40 mm
3	Honda Active 125	1	Single Side	26 mm
4	Bajaj	1	Single Side	28mm

CALCULATIONS

:-Weight Distribution Ratio (Front: Rear) = 2:3
:-Static Front Weight = (40 / 100) × W = 627.84 N
:-Static Rear Weight = (60 / 100) × W = 941.76 N
:-Dynamic Front Weight = W (Static Front Weight) + W × a/g × h/l = 1316 N
:-Dynamic Rear Weight = W (Static Rear Weight) - W × a/g × h/l = 250.645 N
:-Gross Weight of Vehicle = g × Weight of Vehicle (with Load Condition in Kg) = 9.81 × 160 = 1569.6 N
:-Brake Line Pressure P = Force on Brakes / Area of Master Cylinder (Assume Normal Force to the Pedal = 350 N)
:-Force on the brakes = Pedal Ratio×Force on the Pedal (Pedal Ratio=4:1) =4 × 350 / $(0.01)^2$ = 17.8343 MPa
:-Clamping Force =Brake Line Pressure×Area of Calliper= 17.834×1000000×π/4× $(24.5\times10^{-3})^2\times2$ = 16806.9105 N

:-Rotating Force =Clamping Force×No of Pistons× Coefficient of Friction of Brake Pedal=16806.9105×2× 0.3=10084.146 N
:-Braking Torque=Rotating Force*Effective Disc Radius×2=1008.4146 Nm
:-Braking Force = (Braking Torque / Tyre Radius) × 0.8 = (1008.4146 / 0.1375) × 0.8 = 6352.2180 N

Deceleration

F = ma (Negative Sign Indicates Force in Opposite Direction)
a = Braking Force / m=6352.2180/160= 39.701 m/s^2

Stopping Distance

$v^2 - u^2 = 2as$
$s = u^2 / 2a= (13.5)^2 / (2 \times 39.701) = 2.2953$ m.

ELECTRICAL

BATTERY: The battery is used to power the starter motor, the headlights, the brake lights and all the kill switches. Its objectives are:

- Should have long life and less weight
- Should provide the required power continuously for longer period
- Should be charged easily and quickly after discharging
- Cost effective and safe to use
- 12 V and 42 A should be given out of each battery
- Non – toxic , compact and low weight in size
- Easily available , replaceable , repairable

CDI BOX: This component is used to time the spark plugs spark correctly with the end of 2nd stroke of the engine. For the below reasons, we favored and used a DC CDI box in our Go – Kart

PARAMETERS	LEAD ACID BATTERY
Cost	Rs. 1000 - 1500
Weight	1.5 Kg
Amp Hr	3 Ah
Overcharge Tolerance	Moderate

PARAMETERS	DC CDI	AC CDI
Size	Slightly Bigger	Slightly Smaller
Ignition Timing	More Precise	Less Precise
Engine Compatibility	Suitable for Bigger Engines	Suitable for Smaller Engines
Ease of Starting the Engine	Easily Starts a Cold Engine	Harder to Start a Cold Engine

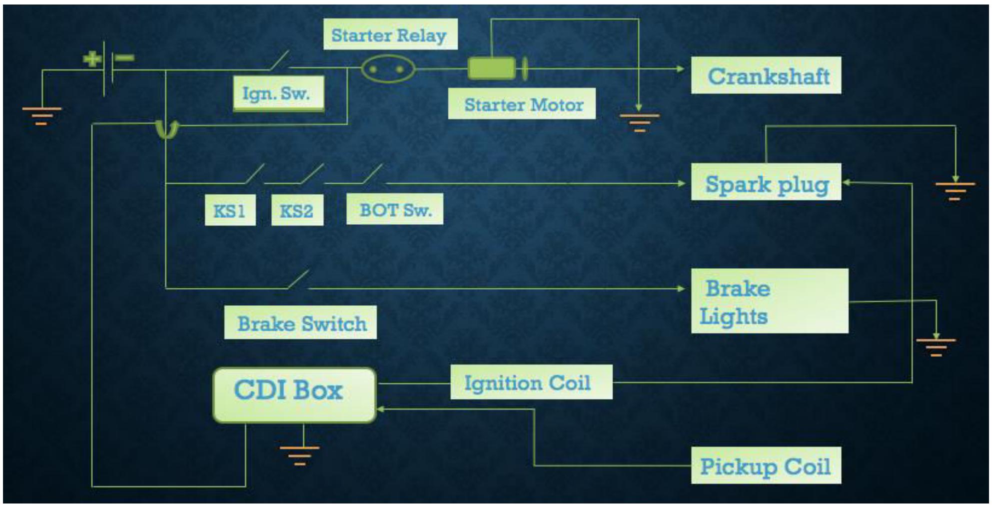


Fig:-Basic schematic diagram

Conclusion

We went through several designs for chassis on solidworks and simulated on ansys and rendered modification as per requirement. The final design was thereafter selected, which met all requirements and hard points covering all the safety and comfort factors.