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Design and Analysis of Go Kart Chasis

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Abstract— The prior objective of this journal is to highlight the report of the Go Kart vehicle. Our primary objective is to build a cost effective Go Kart with maximum performance and safety. It should have a torsion free effective frame on which power train is mounted properly. The entire fabrication of the Go Kart is done by strictly adhering the competition rule. It is manufactured for consumer sale. Our Go kart meets all the objectives said in the rulebook. To give a more effective output, we've divided the team into different core groups headed by a leader and every group is monitored by the team captain.

Index Terms— Design, Analysis, Impact, Steering, Brake, Power Train, Wheels, Tyres, Body, Innovation

1 INTRODUCTION

Our Go Kart is designed in Solid Works and is analysed in ANSYS. We've divided the team into the following categories

- Frame Design and Analysis
- Steering System
- Brake and Wheels
- Power Train System
- Electrical System
- Body and Composites

Driver's comfort, safety , cost and efficiency are the main things we've focused on while making this GO Kart.

2 FRAME DESIGN

The frame is designed accordingly that meets all the rules given in the International Series of Karting 2016 Rule Book. The principal aspects concentrated in the time of frame design are driver's safety and performance of the vehicle.
The material used for the frame is ASTM A106 grade B as it has reasonable price and provide enough safety to the driver. The pipe is of 26.7 mm diameter having 3mm thickness. The physical properties of the pipe are as follows.

S. N.	PROPERTIES	VALUES
1.	Tensile strength	600 MPa
2.	Yield strength	350 MPa
3.	Bulk Modulus	87 GPa
4.	Shear modulus	69 GPa
5.	Young's Modulus	240 MPa
6.	Poisson's ratio	.30

The chemical composition of the pipe is as follows.

MATERIALS	PERCENTAGE
Carbon	.30
Manganese	.29 to 1.06
Phosphorous	.035
Sulphur	.035
Silicon	.1
Chromium	.4
Copper	.4
Molybdenum	.15
Nickel	.4
Vanadium	.08

3 PROPOSED DESIGN OF THE VEHICLE

The vehicle is modelled using Solid works 2011.The 3-D views of the completed vehicle are shown below.

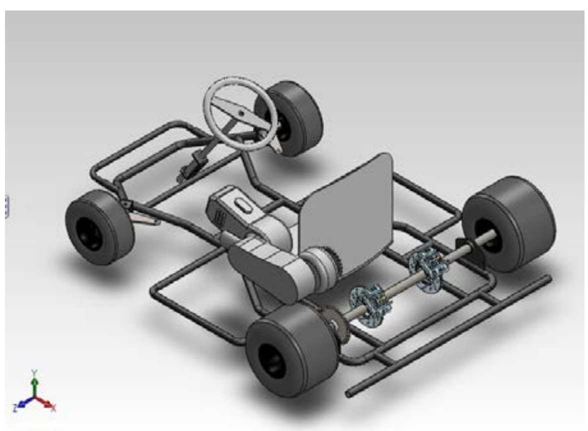

Fig. Isometric view of the vehicle

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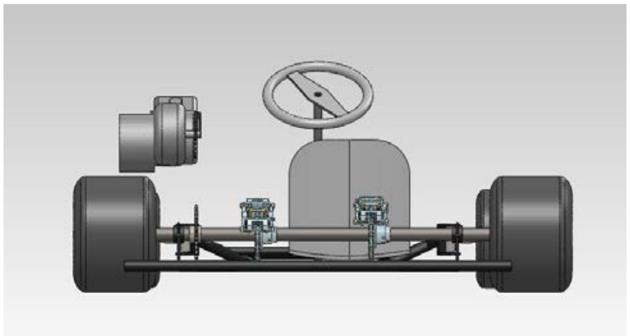

Fig. Rear view of the vehicle

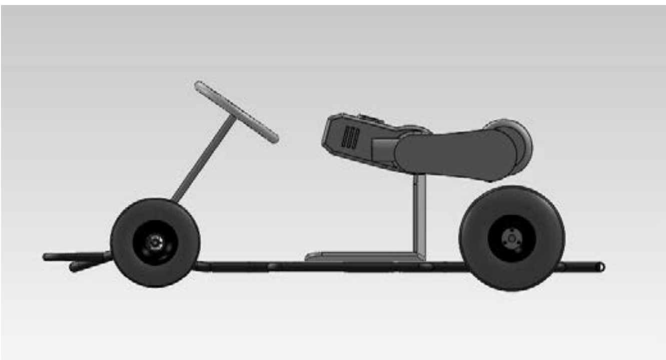

Fig. Side view of the vehicle

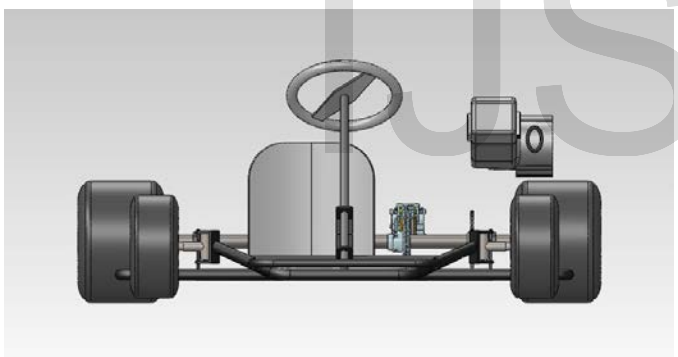

Fig. Front view of the vehicle

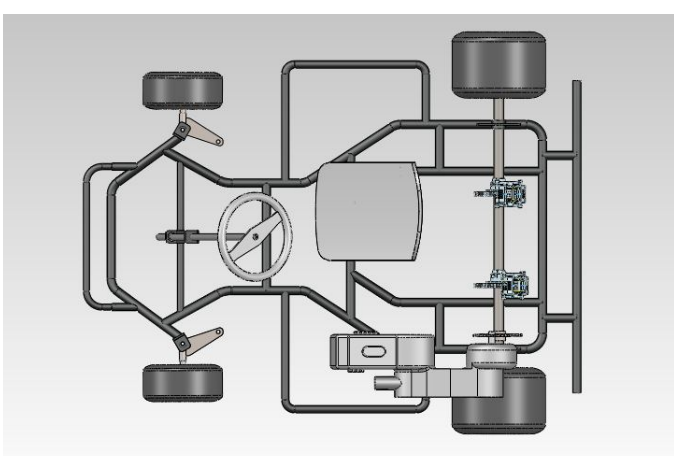

Fig. Top view of the vehicle

4 FRAME FEA SAFETY ANALYSIS

Aside from exceeding the minimum material requirement set by the discussion in team members. Standard values of the material are compared with the analysed result to verify the structural integrity of the frame. At critical points of the wireframe model of the frame, theoretically calculated loads are placed in order to stimulate the maximum force the vehicle can bear from its own weight and the driver in the event of collision. Frame analysis was conducted in ANSYS software. While meshing, the number elements was found to be 35955 with 70392 nodes. For the conduction of finite analysis of the frame an existing design of the frame is uploaded from the computer. Three different induced load cases are considered for the calculation of stresses. Three cases were frontal impact, side impact and rear impact. Impact test on the frame is conducted according to ENCAP (European New Car Assessment Programme). According to ENCAP, linear Velocity remains at 64 Kmph for frontal impact, 48 Kmph for side impact and 50 Kmph for rear impact.
The frame analysis calculations are done as follows.

4.1 FRONT IMPACT ANALYSIS

The front impact test is carried out as
Mass of the vehicle (estimated) M = 170 Kg
Velocity V = 64 Km/h = 17.8 m/s
From mass moment of inertia equation,
Frontal impact Force F = P x ΔT
where,
P = momentum
ΔT = duration of time = 1.1 seconds
P = M x V
= 170 x 17.8
= 3026 Kgm/s
F = P x ΔT
= 3026 x 1.1
= 3328.6 N

Now keeping the rear part fixed the calculated force is applied to the front part of the frame in ANSYS. The image below shows the results of deformation, Von-mises stress and safety factor respectively.

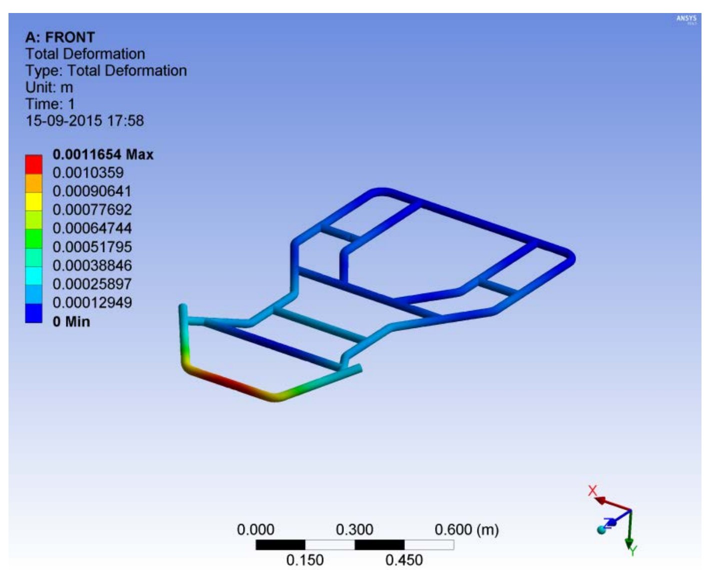

Fig. Deformation

The maximum deformation is found to be 1.16 mm which is very small and is within the safe value.

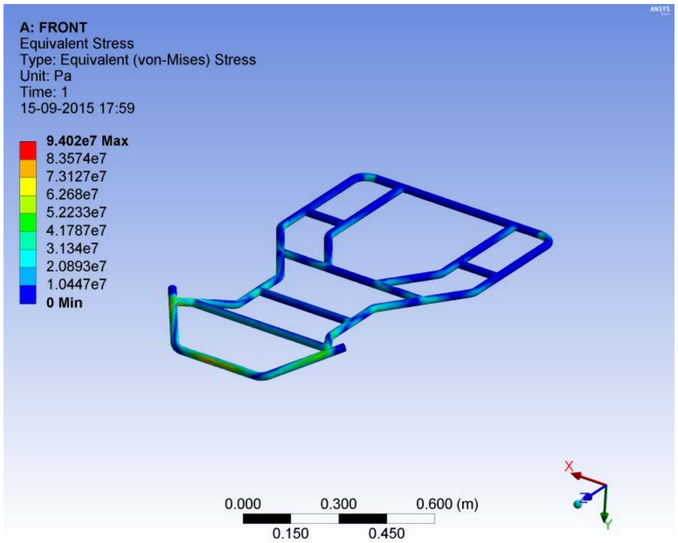

Fig. Von-Mises Stress

Maximum stress is found to be 9.4e7 Pa. It is a safe value.

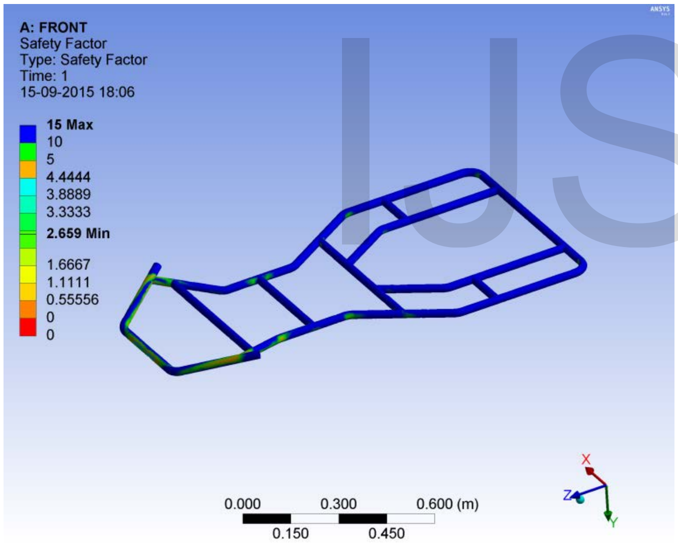

Fig. Safety Factor

From the analysis, safety factor is found to be not less than 5. So it is acceptable.

4.2 SIDE IMPACT ANALYSIS

Side impact Force $F = P \times \Delta T$
where $P = M \times V$
$M = 170$ Kg
$V = 48$ kmph $= 13.3$ m/s
$P = M \times V$
$= 170 \times 13.3$
$= 2261$ Kgm/s
$F = P \times \Delta T$
$= 2261 \times 1.1$
$= 2487.1$ N

Now keeping one side of the frame fixed the calculated force is applied on the other side of the frame in ANSYS.
The image below shows the result.

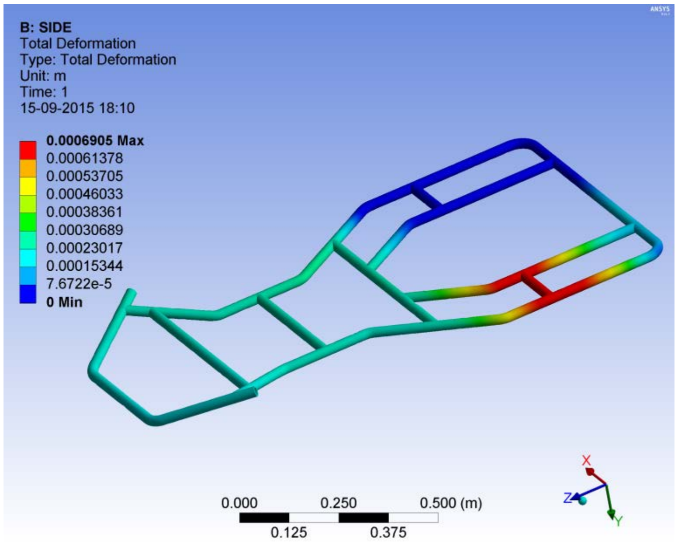

Fig. Deformation

The maximum deformation is found to be 0.613 mm which is very small and it is safer to use.

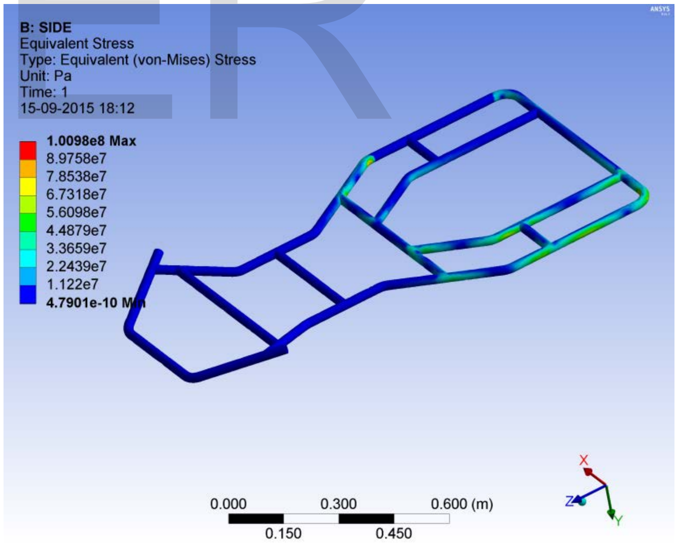

Fig. Von-Mises Stress

Maximum stress is found to be 1.0098e8 Pa. It is a safe value.

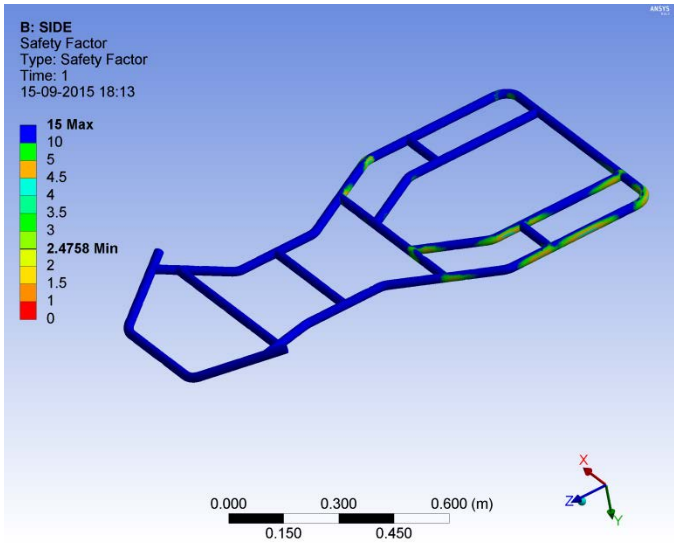

Fig. Safety Factor

From the analysis, safety factor is found to be not less than 5. So it is acceptable.

4.3 REAR IMPACT ANALYSIS

Rear impact Force F = P x ΔT
where P = M x V
M = 170 Kg
V = 50 kmph = 13.8 m/s
P = M x V
= 170 x 13.8
= 2346 Kgm/s
F = P x ΔT
= 2346 x 1.1
= 2580.6 N

Now keeping the front part fixed the calculated force applied to the rear part of the frame in ANSYS. The image below shows the result.

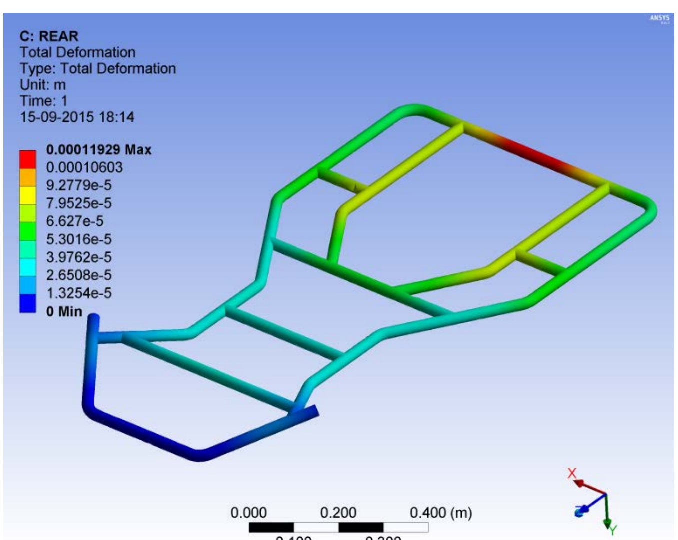

Fig. Deformation

The maximum deformation is found to be 0.119 mm which is very small and it is safer to use.

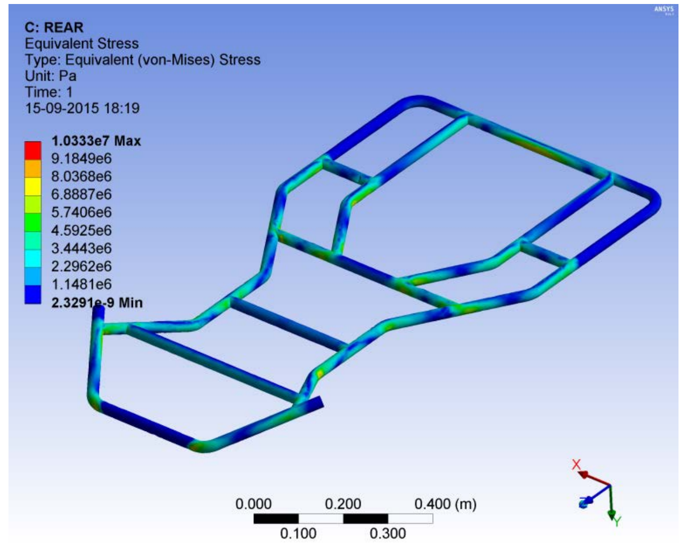

Fig. Von-Mises Stress

Maximum stress is found to be 1.0333e7 Pa. It is a safe value.

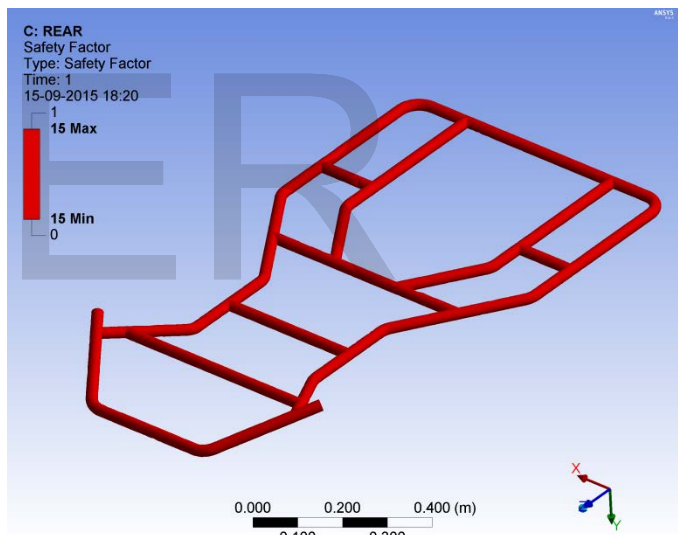

Fig. Safety Factor

From the analysis, safety factor is found to be 15. So it is acceptable.

4.4 CONCLUSION

Conclusion for the safety analysis is tabulated below.

FACTORS	FRONT	REAR	SIDE
Impact Force	3328.6 N	2580.6 N	2487.1 N
Stress Generated	10308.35 N/m2	1133.15 N/m2	3010.17 N/m2
Total Deformation	1.16 mm	0.119 mm	0.613 mm
F.O.S.	0.29	0.032	0.071

Factor of safety F.O.S. = Design Stress/Yield Stress

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5 STEERING SYSTEM

The steering system is the key interface between the driver and the vehicle. The main objective of the steering system is to provide directional control to the vehicle. It must be smooth, compact and light. It must also be precise and must also provide the driver a perfect control of the vehicle.

Our steering system is designed to provide easy manoeuvring with quick response and it follows Ackermann Design.

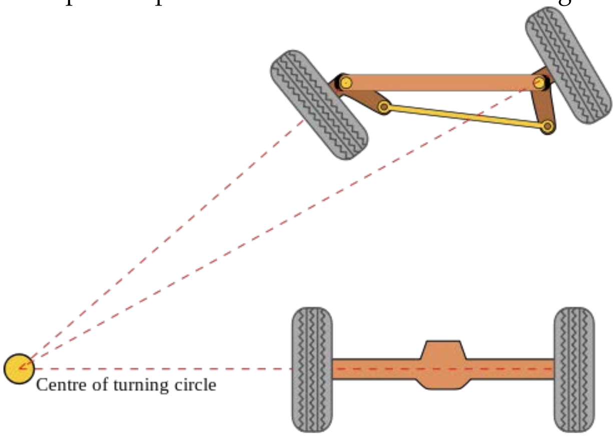

Fig. Basic Ackermann's steering design

5.1 CALCULATION

Track Width (a) = 1058 mm
Wheel Base (b) = 1020 mm
Pivot to pivot point (c) = 694 mm
Let outer turning radius Ro = 2400 mm

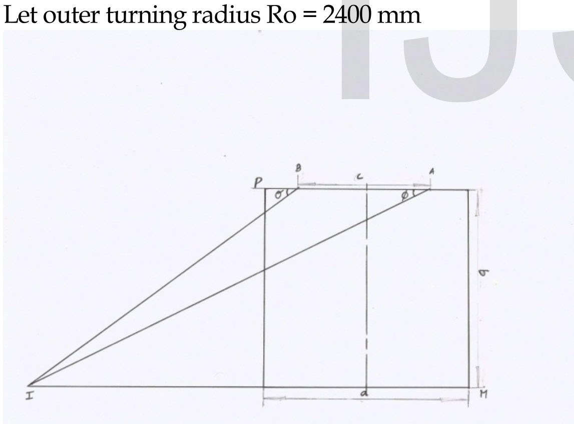

Fig. Graphical method

Consider Δ ABP,
$\cot\theta$ = BP/IP
= 1434/1024
□ = 35.42 □
Consider Δ IAP,
cotØ - cot□ = c/b
cotØ = 2.086
Ø = 25.61 □
Inner turning radius Ri = (b/sin□)/((a-c)/2)
= (1020/sin35.2)/((1058-694)/2)
= 1134mm
Ackermann angle = tanα =(c/2)/b
= (694/2)/1020
α = 18.7 □

The turning radius and turning angles are calculated graphically and arithmetically. It is found that the values from Graphical method and arithmetic method are approximately equal.

6 BRAKING SYSTEM

A disc brake is a wheel brake that helps to slow down the speed of the vehicle by the friction caused by pushing brake against the disc with a set of callipers. Discs are mostly made from cast iron. They are fixed on the axle. When brake calliper is forced mechanically, pneumatically or hydraulically against the both sides of the disc, friction occurs and thus the vehicle can be stopped.

The main objective of the brakes is to stop the vehicle safely and effectively.

No. of disc brake	2
Disc outer diameter	190mm
Disc inner diameter	30mm
Thickness	3mm
Brake pedal force	150N
Pedal ratio	3:1
Coefficient of friction pad	0.6
Stopping distance	4.89m
Stopping time	0.88s
Total brake force	2167.71 N

6.1 CALCULATIONS

At the time of braking, kinetic energy is converted into heat energy due to t he friction between calliper pad and rotor disc.

Kinetic Energy = $\frac{1}{2}mv^2$
= 170 x 11.112 /2
= 10491.73

Deceleration of the vehicle should not exceed 1.3G. μ = 0.6
Stopping distance of the vehicle is calculated by Newton Law's of motion.
v2 = u2 + 2aS
where,
v is the final velocity of the vehicle
u is the initial velocity of the vehicle
S is the stopping distance
S = v2-u2/ 2a
= 11.112/2x1.3x9.8
= 4.84 m
Braking force = K.E/S
= 10491.73/4.84
= 2167.71 N

7 POWER TRAIN

We're using the engine of Honda Activa. It's specifications are given below.

S. No.	Description	Type
1.	Displacement	109.2 cc
2.	Stroke	4 Stroke
3.	Cooling	Air Cooled
4.	Compression Ratio	9:5:1
5.	Max. Power	8.15bhp @ 7500 rpm
6.	Max. Torque	8.74 Nm @ 5500 rpm

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We're using continuous variable transmission as it gives more control on track than the manual transmission.

7 ELECTRICAL SYSTEM

8.1 KILL SWITCH

Kill switch is provided in our vehicle in order to provide safety to the driver. In case of any emergency the driver can push the kill switch so that the engine would stop functioning. The electronics are designed so that when the kill switch is depressed, power is disabled on primary ignition coil of the engine.

8.2 WHEELS

Wheels allow the vehicle to move smoothly on a surface. We're using go kart tyres having the dimensions 10X4.7X5 inches for the front wheel and 11X7.1X5 inches for the rear wheel.

9 BODY WORKS AND SEAT

We're using the Go Kart seat and body works provided by the Atelier Motors. Go kart seat gives extra safety to the driver when compared to the normal seats. Body works give an exterior appearance and provide some safety.

10 INNOVATION

SELF RECOVERY SYSTEM

- Our GO-KART's innovation is a self recovery system.
- Two DC motors of high torque or moulded with the centre of the frame with two rubber wheels connected to it.
- The DC motors are then connected to the car battery in order to get the electrical input to the motor.

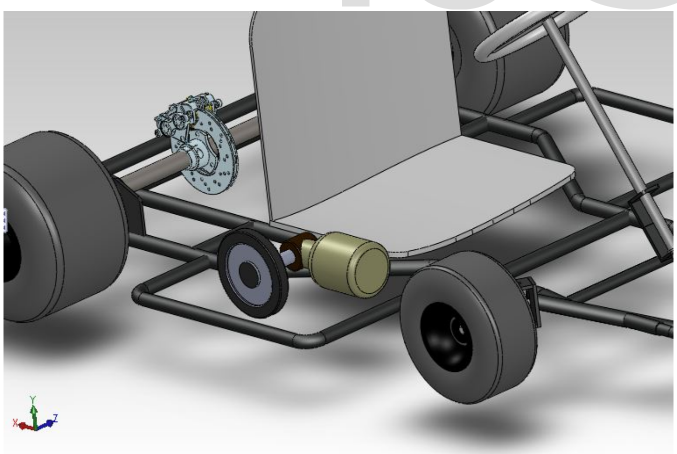

Fig: Position of DC motor

CONCLUSION

To achieve the set goals, we used the finite element for the evaluation, creation and modification of the best vehicle design. Our prior aim was to build a go kart with minimum cost without compromising the safety and performance of the vehicle. The final result is a desired Go Kart design meeting all the above factors.

ACKNOWLEDGEMENT

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