BAJA SAE INDIA 2013
Virtuals Presentation

SAEINDIA The Engineering Society For AdvancingMobility Land Sea Air and Space
SOCIETY OF AUTOMOTIVE ENGINEERS INDIA

Mahindra Presents BAJA SAEINDIA 2013

The Road Runners

Team ID : 91636

VIT University, Chennai

VIT UNIVERSITY (Estd. u/s 3 of UGC Act 1956)
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Chennai - 600 048, Tamilnadu, India

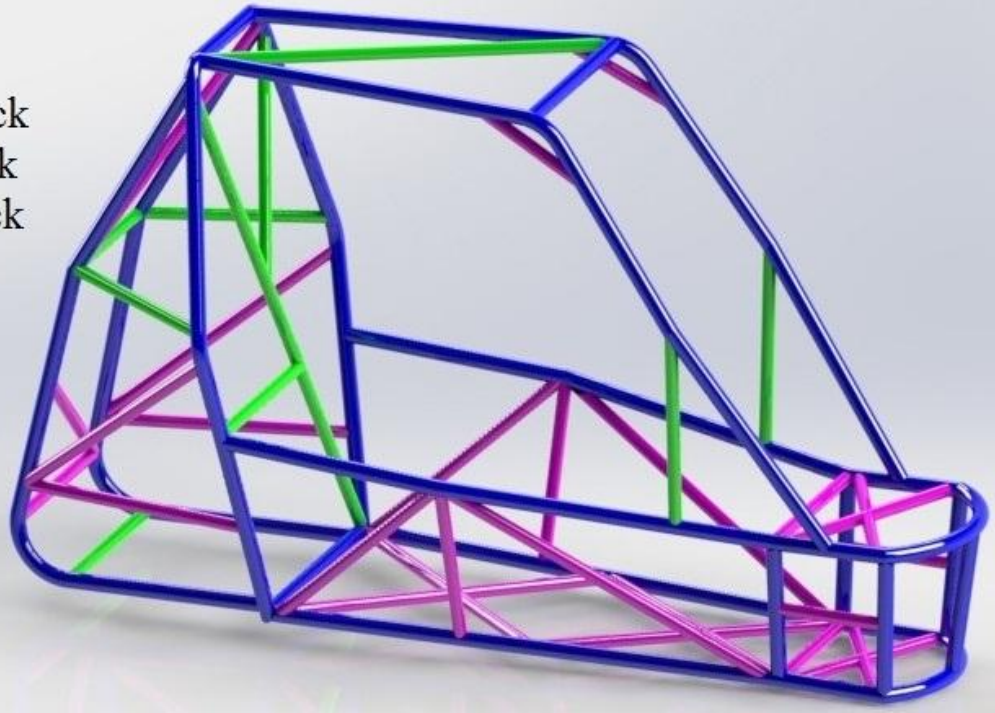
THE ROADRUNNERS

Material selection

Parameter	AISI 4130	AISI 1018	AISI 1020
Tensile Strength, Ultimate	731 MPa	450 Mpa	445 Mpa
Tensile Strength, Yield	460 MPa	310 Mpa	346 Mpa
Elongation at Break	25.10%	20%	39.30%
Cost (in Rs per meter)	2200	780	2500

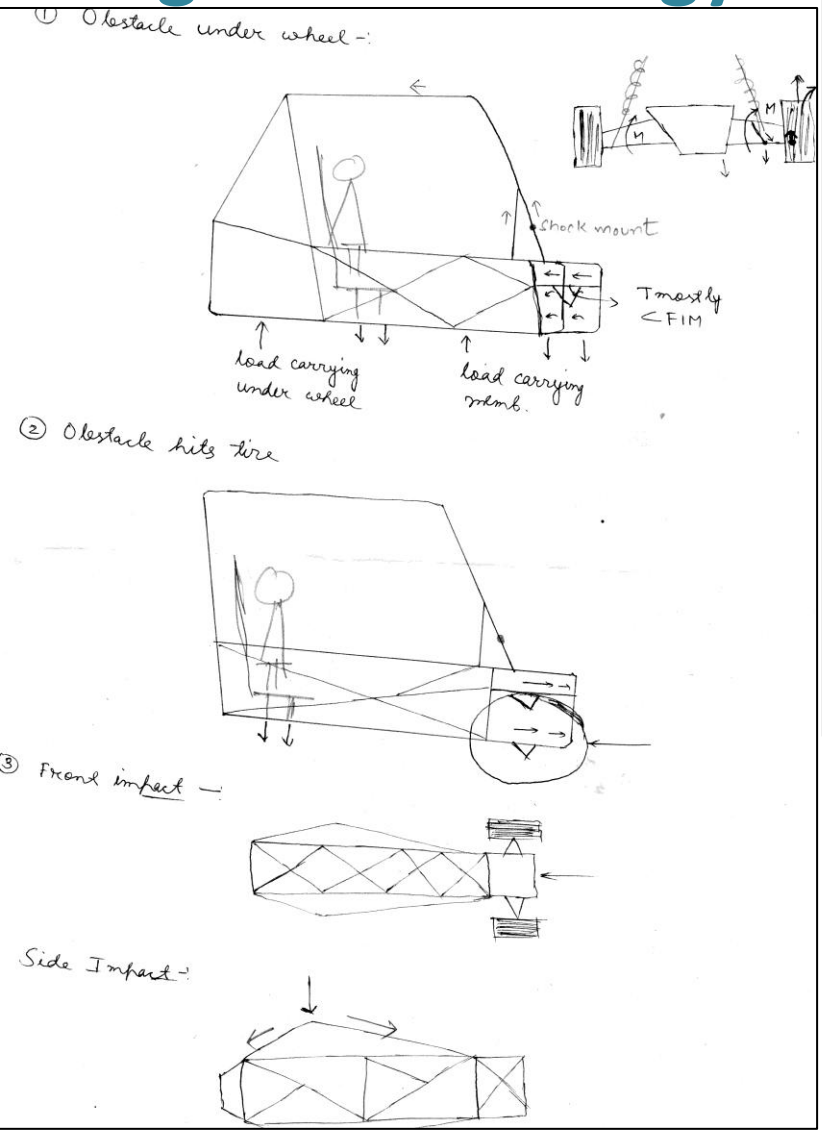
	Diameter (m)	Wall thickness(m)	Area MI	Bending strength	Bending stiffness	Weight(kg/m)
AISI 1018	0.025	0.003	1.277E-08	0.058	2618.09	6.52
AISI 4130	0.038	0.0016	3.035E-08	0.265	6220.94	5.74
AISI 4130	0.031	0.002	1.924E-08	0.137	3943.47	5.72
AISI 4130	0.031	0.0016	1.601E-08	0.114	3281.25	4.64

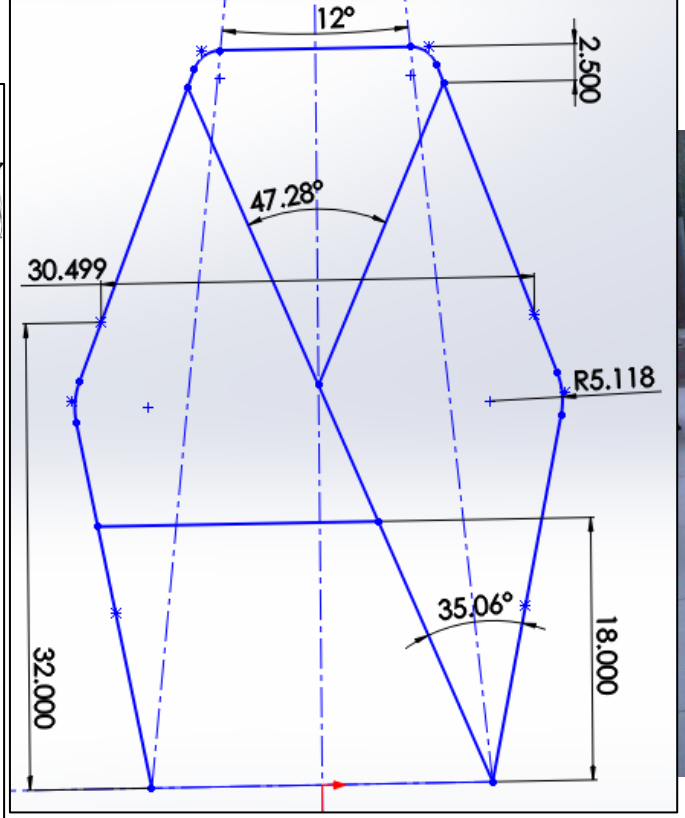
Blue: 38mm OD, 1.6mm thick
Green: 31mm OD, 2mm thick
Pink: 31mm OD, 1.6mm thick

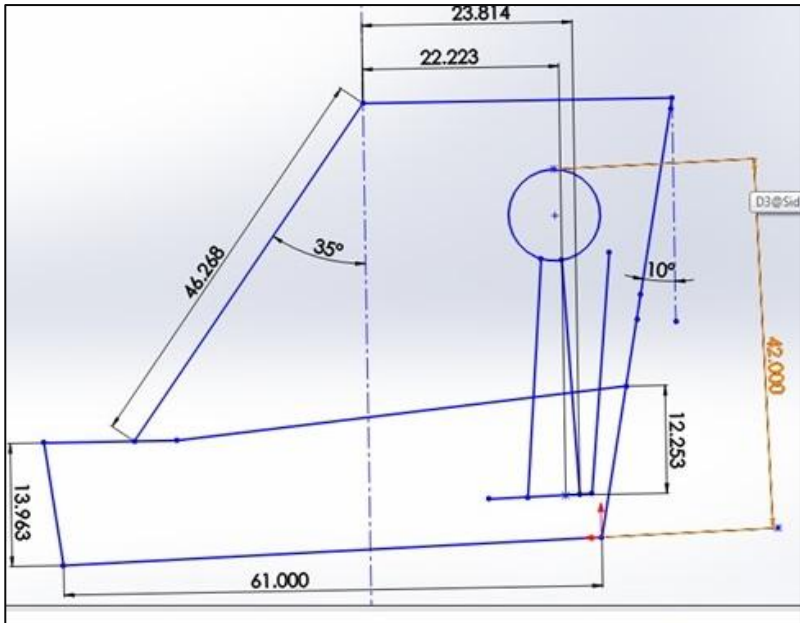


Net weight: 53.8kg

Design Methodology





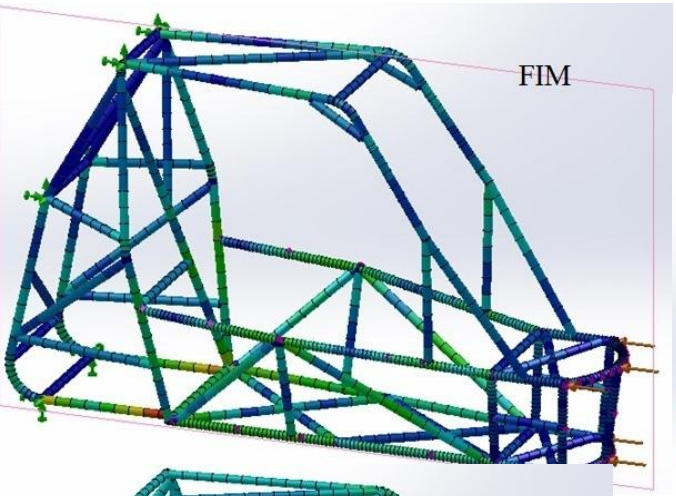


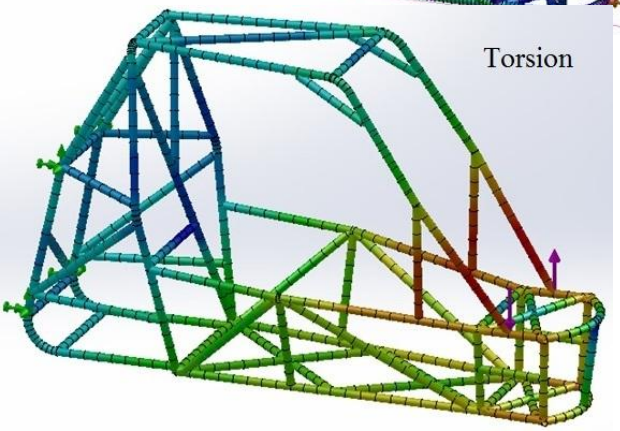
No. weld joints: 86

FEA

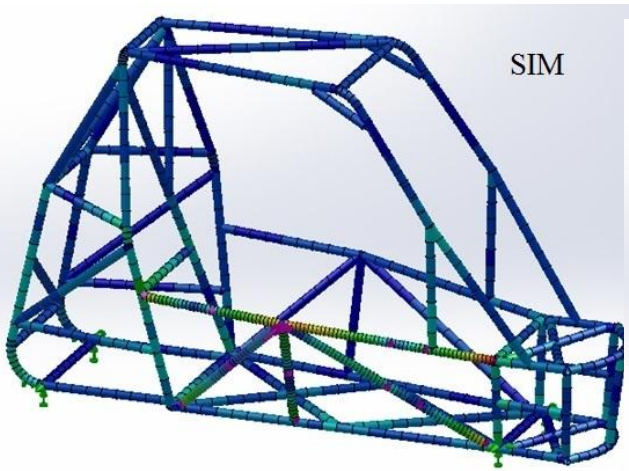
- Dynamic analysis, time of impact: 100ms

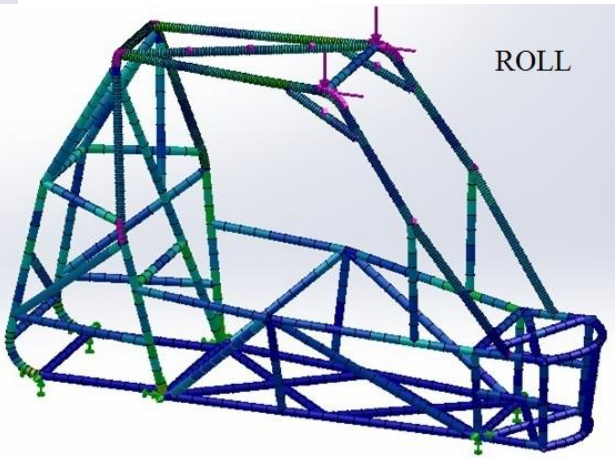
Test	Load(N)	Fixture	Max Stress(MPa)	Max Deform.(mm)	FOS
FIM	27,097	Rear	133.5	1.9	3.44
SIM	12,862	Rollcage base	568.6	10.38	1.28
ROLL	12,862	Rollcage base	526.3	9.13	1.39





Torsional stiffness: 2234.25Nm/deg





Source: NCVA, Auburn University

DFMEA

Potential Failure	Effect	Cause	Chance of occurrence	Control method
Brackets	Part malfunction	Excessive loading & improper welding	Unpredictable	Trained welder
Steering column rotation	Difficulty in steering	Gear jam, Insufficient spacing	Low, detectable during manufacturing	Proper spacing during CAD modelling
Drive shaft splines	No movement	Improper matching	High	Proper matching during buy
Engine mounts	Excessive vibrations	End of life	Low	Change in due time
Driveshaft axial stress failure	Breakage of shaft	Excessive axial stress	High	Plunging CV joints on inside
Pressure for normal secondary piston	Pressure difference	Lack of lubrication in master cylinder	Low	Pressure sensor in the lining
Steering arm	Failure of system	Bump steer	High	Steering geo adjust & FEA of upright

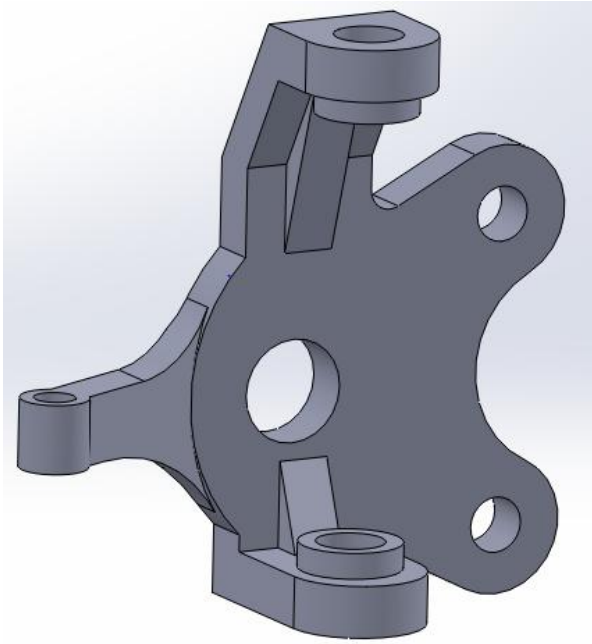
Suspension System

- Front suspension : Double A arm type
- Rear suspension : Modified Double A arm type
- Ground clearance : 280 mm
- Roll center calculation and graphical representation.
- Upright design according to given specifications from steering and brakes department.
- FEA analysis on uprights and double A arms.
- Selection of shocks (piggyback fully adjustable coil over shocks 2.5”)

Front and Rear Suspension System

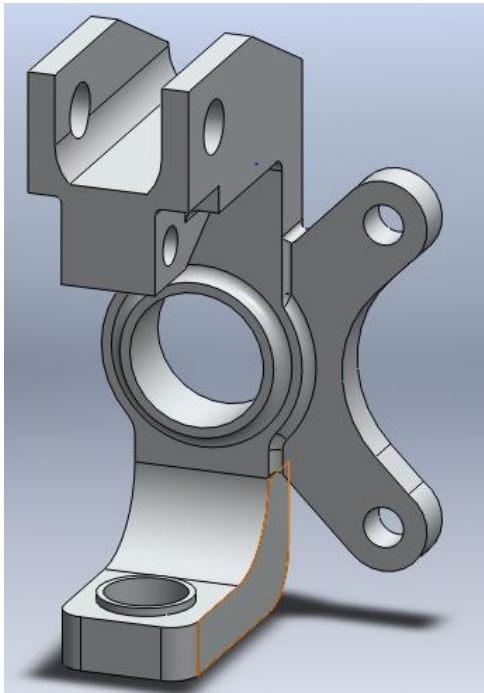
Description	Values (Front)	Values(Rear)
Total wheel travel	356 mm	254 mm
Jounce (mm)	204 mm	152 mm
Rebound (mm)	152 mm	103 mm
Track	58 inches	56 inches
Roll Center	90 mm	330 mm
Droop percentage	42%	40%
Camber angle	-2 deg	-1 deg
Motion Ratio	0.63	0.9
Ride frequency	1.29 Hz	1.55 Hz
Scrub radius	25.4 mm	146 mm
Spring rate	11380 N/m	9650 N/m

Front Upright



Material : Al 6061 T6

Rear upright



STEERING

FLOW OF CALCULATIONS

- C-factor
- Steering arm length
- Steering ratio
- Average steer angle
- Ackermann angle

TIE ROD MATERIAL

AISI 4130 Steel

DESIGN METHODOLOGY

Choice of steering system :

central rack and pinion

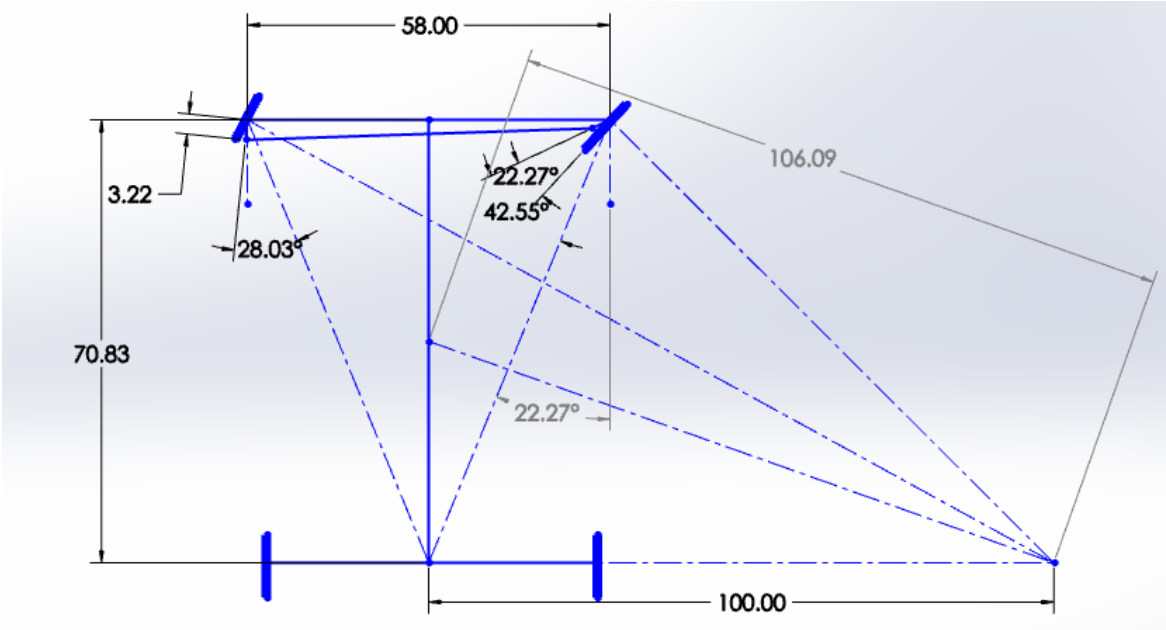
Justification : economical for low loads, easily available.

Choice of steering geometry : Ackermann

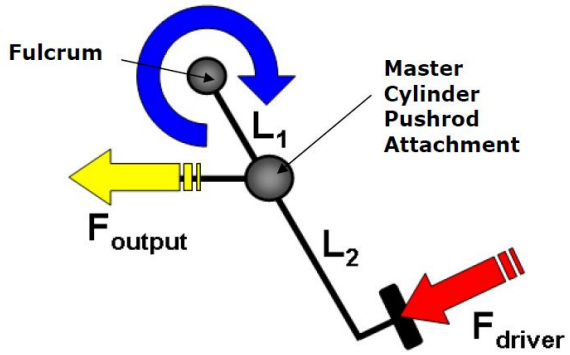
(photo)

Justification : reduced wear rate of tyres , ease in manoeuvrability

PARAMETER	SPECIFICATION
Ackermann angle	22.27 ^{0}
rack length	375.92 mm
steering ratio	6.1:1
Wheel turn angle	70 ^{0}
Toe out	8 ^{0}
Steering Effort	63.39 Nm
Minimum Turning radius	2694.69 mm
Tie Rod Length	431.8 mm
Steering Arm Length	81.782



Brakes



Config: 4 disk brakes, Split system
Biasing(Proportionating valve) : 60:40

For safety, pressure sensor in pipe lines

Specifications

Parameter	Value
Braking effort	10kgf
Pedal Ratio	6:1
Tandem Master Cylinder bore diameter	19.05 mm
Brake line diameter	9.525 mm
Brake line pressure	2.0644 M Pa
Rotor diameter	182.88 mm
Braking Force	2092.09384 N
Braking Torque	1991.301067 N--m
Stopping Distance	13.27 m
Deceleration	0.6g

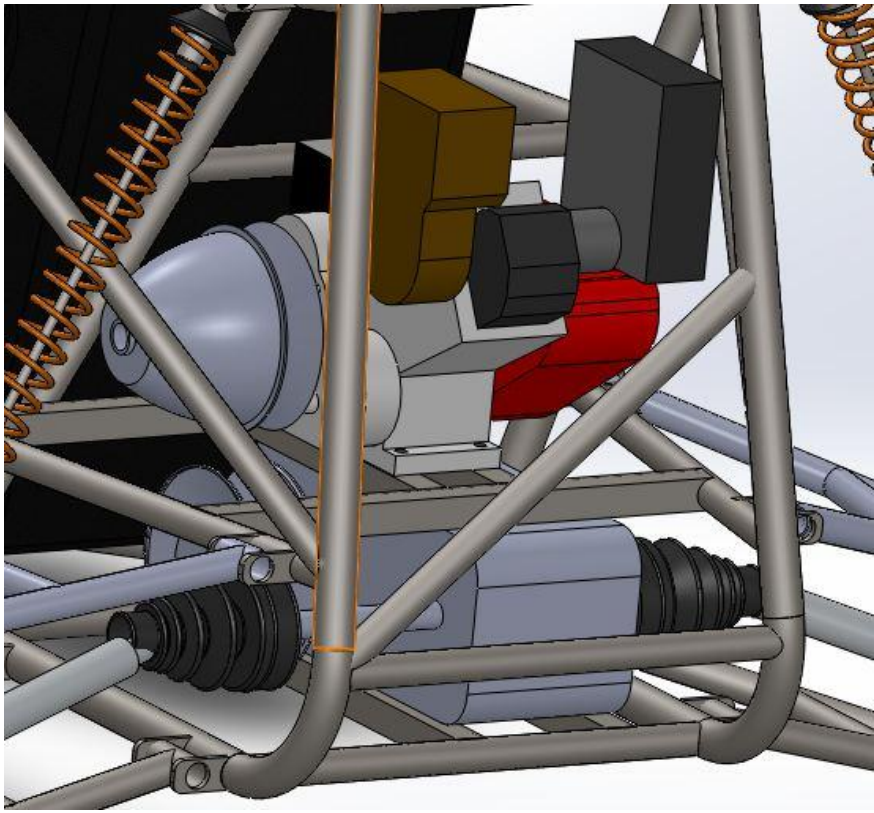
Innovation

- Electronic Parking Brakes
  - Solenoid valve(Brake fluid control)
  - In ON state normal braking action
  - After brake pedal floored switch on control button
  - Valve closes & brake fluid locked in place
  - In front 2 wheels

Engine Specifications

Engine: Briggs & Stratton ,10 HP,305 cc

Description	Value
Maximum rpm	3800
Maximum torque	18 N.m
Maximum power	10 HP



- Exhaust system will contain a muffler.
- CO_2 absorber will be connected to exhaust output.

CVTech-IBC

Description	Driver	Driven
Inner radius	27.12mm	21.4mm
Outer radius	192.5mm	198mm

Description	Description
Min.Ratio	3:1
Max Ratio	0.43:1
Efficiency	93%
Engagement rpm	2600
C-C distance	242 mm

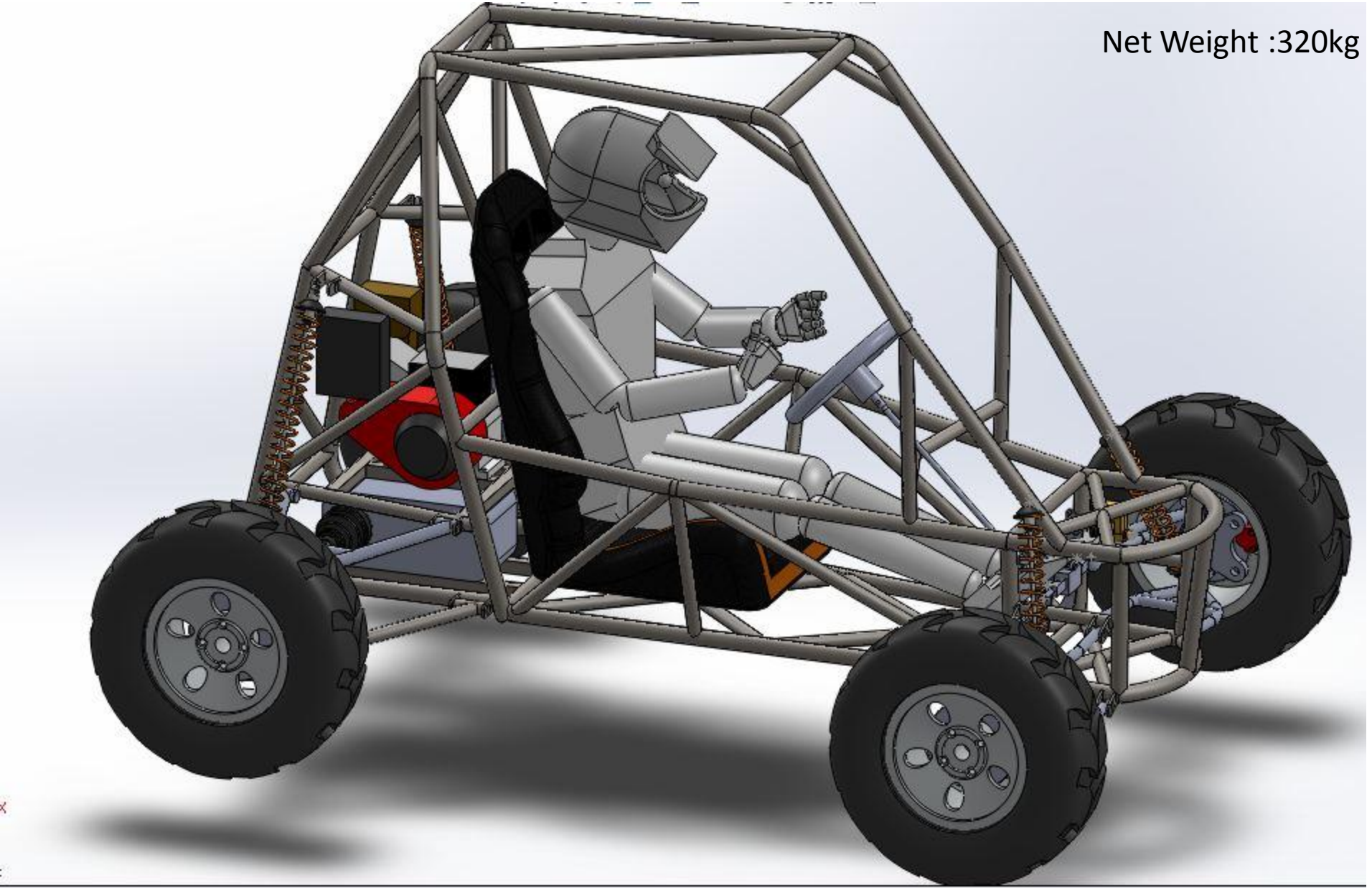
Final Drive Train Values

Discription	Value
Over all reduction ratio	7.7:1
Tire diameter	25 inch
Max speed	58 kmph
Max acceleration	4 m/s2
Output torque	11 N.m
Traction force	311.3 N
Gradability	41^0

FNR Gearbox

Position	Ratio
Forward	18:1
Neutral	0
Reverse	36:1

Vehicle 3D view



PLAN

Project Plan

Task name	Start	Durati	Finish
Team selection	03-02-2012	11	14-02-2012
Literature review	15-02-2012	29	15-03-2012
Preliminary design	15-03-2012	46	30-04-2012
Rollcage	20-05-2012	49	08-07-2012
Suspension	25-05-2012	37	01-07-2012
Power train	21-05-2012	50	10-07-2012
Steering	25-05-2012	36	30-06-2012
Brakes	30-05-2012	36	05-07-2012
Electrical Systems	25-05-2012	37	01-07-2012
Overall assembly	12-07-2012	31	12-08-2012
Procurement	25-09-2012	35	30-10-2012
Fabrication	01-10-2012	75	15-12-2012
Manufacturing upright	05-10-2012	10	15-10-2012
Engine and transmission	05-10-2012	54	28-11-2012
Suspension Installation	05-10-2012	51	25-11-2012
Wheel Assembly	15-10-2012	41	25-11-2012
Brakes and Steering System	15-10-2012	36	20-11-2012
Seat and other assemblies	22-11-2012	18	10-12-2012
Testing	15-12-2012	41	25-01-2013
Improvement	22-01-2013	19	10-02-2013
Competition	10-02-2013	3	13-02-2013

Team Organisation

Department	Assigned
Rollcage & analysis	3
Suspension	5
Powertrain	4
Brakes	3
Steering	4
Electrical	1
Non-technical	1

Cost Estimation

Parts	Cost(Rs)
Structural elements	70,000
Powertrain	60,000
Brakes	35,000
Suspension	59,000
Steering	20,000
Electrical, Accessories	40,000
Total	2,84,000

Post-Fab. Design Validation Plan

Test name	Test method	Acceptance criteria
Material quality	UTM loading	Meeting AISI standards
Weld quality	Liquid penetrant test	Stain free developer screen
	Radiography	Discontinuity free images
	Ultrasonic	No drop in intensity of received beam
Weld joint strength	UTM loading,Charpy & Izod test	Impact strength
Torsion	Torsion rig	Result matching FEA within experimental error
Anti-vibration	Accelerometers	Absorption of more than 75 % vibrations
Alignment of pipes	Gyroscopic	No change in calibrated spirit level
Upright quality	Ultrasonic	No drop in intensity of received beam
Stiffness of spring	UTM loading	As required
Exhaust	Flow measurement	Closeness to analysis in CFD
Load	Varying load on suspension anchor points using load cells	Closeness to FEA
Brake pressure	Pressure kit	Desired pressure on rotor
PUC	PUC kit	Less than prescribed environmental limits