TEAM JATAYU

TEAM ID :	18238
COLLEGE NAME :	MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY
OLD TEAM ID :	17129
CAR NO.	45
ENDURANCE SCORE :	323.8
TOTAL SCORE :	734.6
AWARDS :	1) SUSPENSION AND TRACTION RUNNERS UP 2) GO GREEN AWARD WINNER

LESSONS LEARNT

- VEHICLE PERFORMANCE IN MAIN EVENT :

- **CVT Overheating -** During the endurance , the cvt got overheated due to which there was an appreciable loss of acceleration.
- **Damage of rear kill switch –** The ATV toppled in the endurance due to which the rear kill switch broke and stopped working.
- **Shear of the Ball joint-** The ball joint stud got sheared because of the sudden change in cross section produced due to its machining and the arm got separated from the upright.
- **Rotational mass was high** resulting in higher acceleration time.

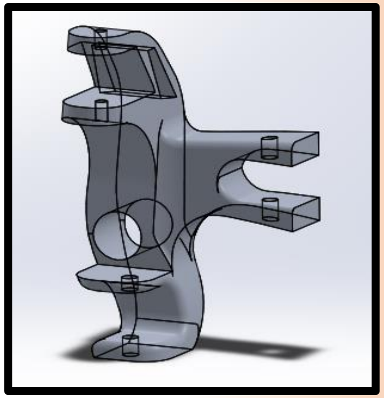
- BREAK DOWN / FAILURES :

- **Rack bending-** The rack got bended from the point of end of the rack casing.
- **Pedal deformation –** The brake pedal got deformed due to the improper analysis
- **Hub failure-** The hub got sheared during the testing because one of the disc bolt fell off and the disc got hit with the hub.
- **Upright failure-** The mounting point of the lower ball joint at the upright got sheared during testing.

LESSONS LEARNT

➢ AGGREGATES

- Reduction of the overall weight of the vehicle: carbon fibre driven shafts; overall chassis weight decreased; lesser gearbox weight by optimising gears.
- Sudden change in cross section should be avoided.
- Increase the length of the rack casing to minimize the chance of bending.
- Use of steel sleeves in Aluminium components.



➢ ROLL CAGE

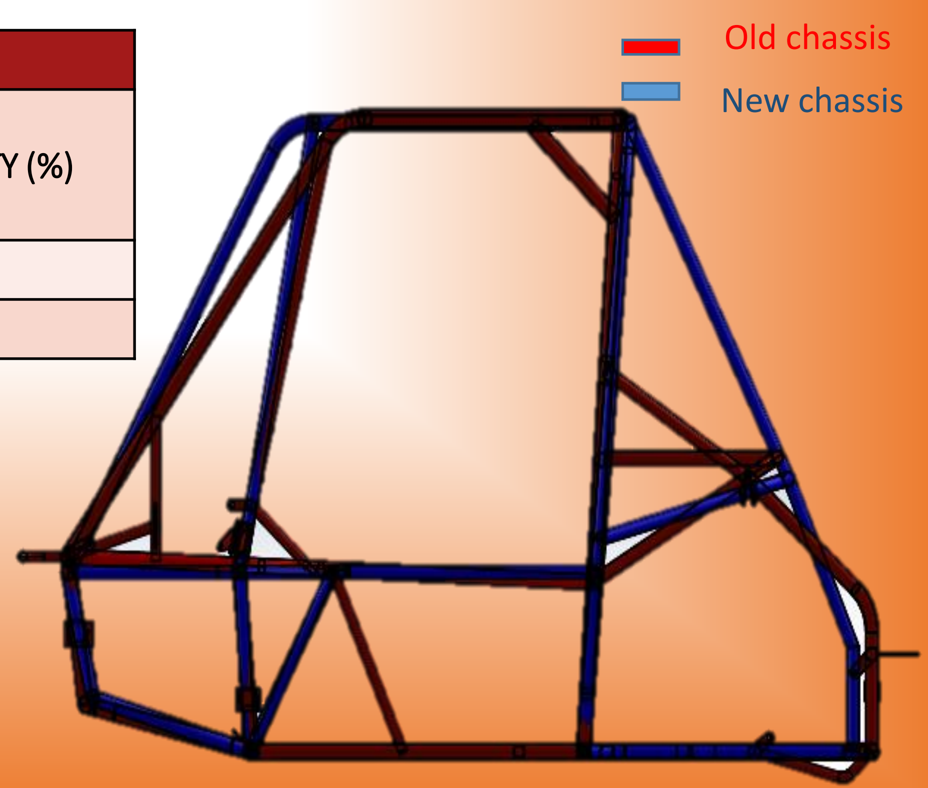
- Bending strength of AISI 4130 is high ; therefore for the same strength thinner cross section can be used.
- Use of CNC bending (availability of standard dies) for accurate bend angles.
- TIG welding to be used for higher strength.

SPECS COMPARISON – OLD VS PROPOSED

DIMENSIONS								
PROPERTIES	LENGTH	WIDTH	TRACK WIDTH		WHEEL BASE	GROUND CLEARANCE	FRONT	REAR
			FRONT	REAR				
Old chassis	70”	29.6”	53”	44”	57”	12”	22x7x10	22x7x10
New chassis	67”	33.2”	52”	46”	55”	13”	21x7x10	21x7x10

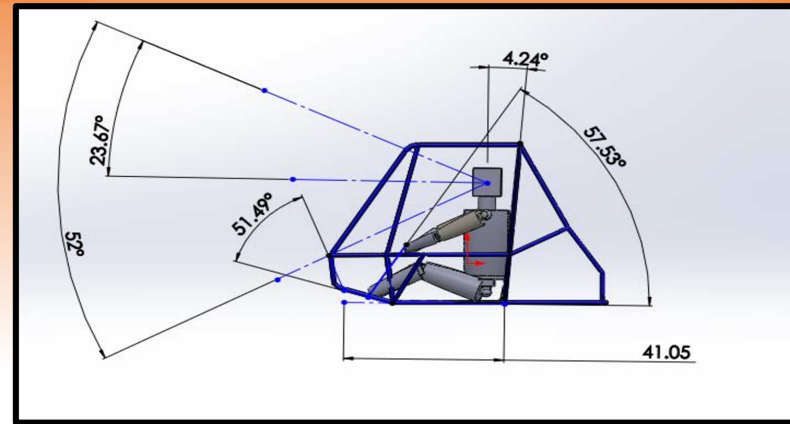
PERFORMANCE SPECS			
MAX SPEED (kmph)	MAX ACC.	STOPPING DISTANCE	GRADABILITY (%)
52	5.7m/s²	7 m	65
50	5.9m/s²	7 m	71

WEIGHT	
KERB (kg)	FAW/RAW
145	45/55
130	45/55

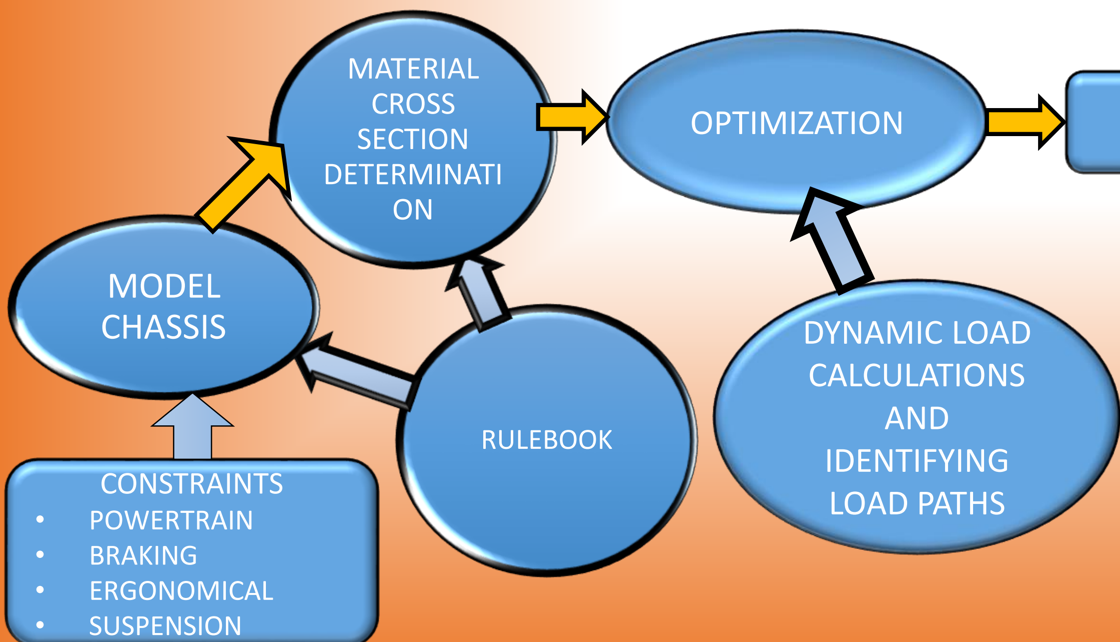


ROLL CAGE DESIGN PROCESS & ERGONOMICS

- Viewing angle :52^0
- Steering Inclination Angle :57.33^0
- Steering wheel height above thighs :8 “
- Distance b/w RRH and pedals :41.05”
- Driver’s Seat inclination :4.24^0 with vertical
- Brake Pedal Angle :51.49^0



	FRONT	SIDE	ROLLOVER	REAR
FORCES (N)	16000	8000	10000	12000



IMPACT FORCE CALCULATION

Change in Momentum=Mv_i-Mv_f

M = Mass of vehicle + driver=200Kg

v_i = max velocity = 13.88m/sec

Δt = impact time = 0.175sec

Force = mv_i /Δt

Hence Force = 16000N

COMPUTER AIDED ENGINEERING

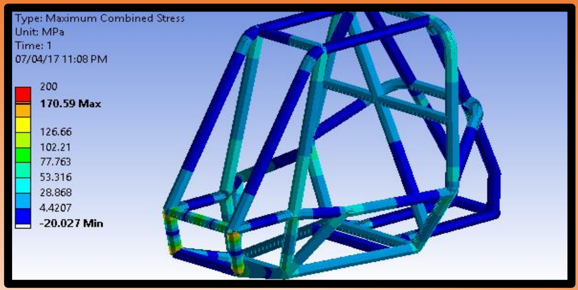
PROPERTIES	YIELD STRENGTH	UTS	ELONGATION
AISI 4130	619	731	25%

Selection Criteria : Maximise inertia & Minimise cross sectional area
Meshing size : 2mm
Proposed FOS : 2.7
Max Deformation : 2.64mm
Type of Mesh : Tetrahedron
Bending Strength of Primary : 576Nm

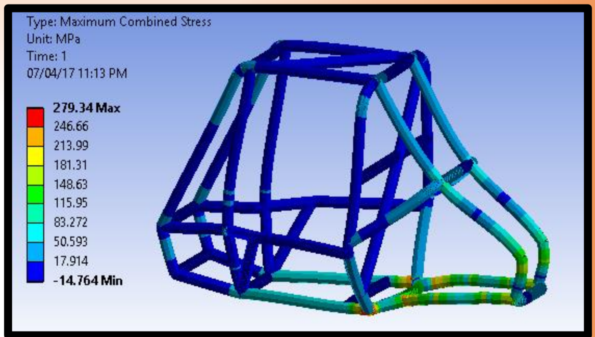
IMPACTS	FRONT	SIDE	ROLLOVER	REAR
Stress(N/mm^2)	170	214	265	280
Deformation(mm)	1.12	1.76	2.15	2.64
FOS	3.64	2.89	2.33	2.21

- **<u>Advantages</u>**
  Beam method used for spaceframe chassis
- **<u>Choosing solver</u>- Ansys**
- **<u>Constraints</u> – Suspension points, Rulebook**
- **<u>Chemical Composition</u> : Mn(.5) Cr(0.8) Si(.2) S(.04) P(.035) C(.30).**

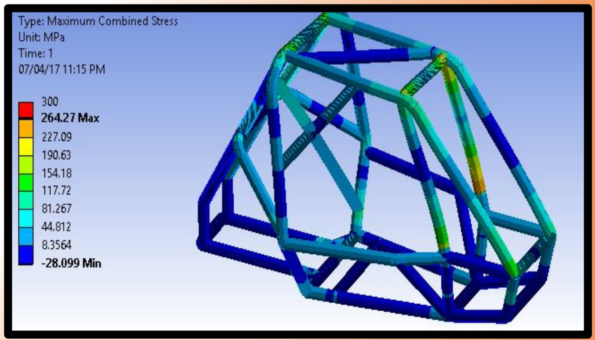
Weldability of 4130 is good, and the alloy may be welded using any commercial method



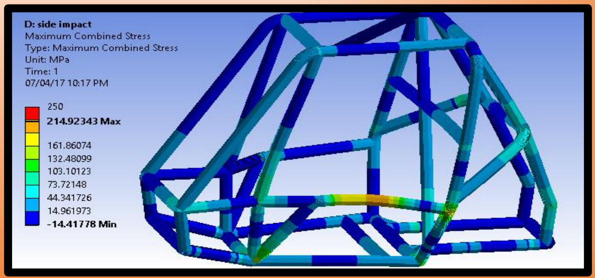
Front Impact



Rear Impact



Roll Over



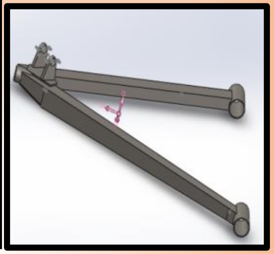
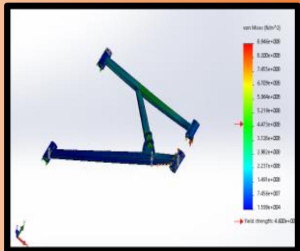
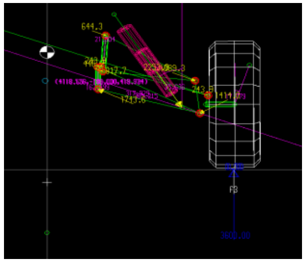
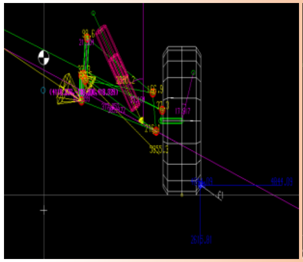
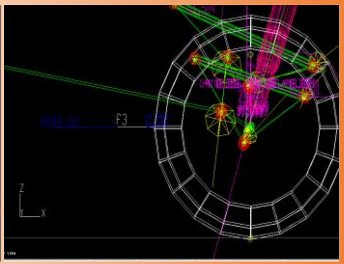
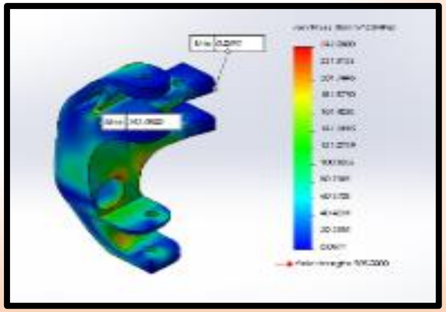
Side Impact

SUSPENSION

	FRONT	REAR
TYPE OF SUSPENSION	A-ARM	H-ARM
CG HEIGHT	20”	
GROUND CLEARANCE	13”	11.5”
ROLL CENTRE	13.77”	5.9”
MOTION RATIO	0.58	0.7
CAMBER (At kerb weight)	0.00°	0.00°
CAMBER (bump/droop)	-6°/1.9°	-3.2°/1.3°
CASTER ANGLE	5.47°	-
KINGPIN	7.21°	-
SCRUB RADIUS	3.74°	-
TOE IN/OUT	0.0°	0.0°
SPRUNG MASS	54kg	66kg
UNSPRUNG MASS	9kg	11kg
NATURAL FREQUENCY	1.16hz	1.8hz
SPRING STIFFNESS	8.9N/mm	13.7N/mm
BUMP/DROOP	6.8”/3.2”	6.1”/2.3”
RIDE RATE	2.96N/mm	6.5N/mm

FORCES
Bump : 3.6g
Lateral :4.8g Vertical :2.6g
Front impact : 6.6g

MATERIAL	
ARMS	AISI 4130
UPRIGHTS	AISI 7075


The 2018 model comes with :

- Increased motion ratio facilitating a better ride quality.
- Addition of Anti-Squat angle in the rear geometry for better performance.
- Introduction of anti-roll bar for better turning characteristics.

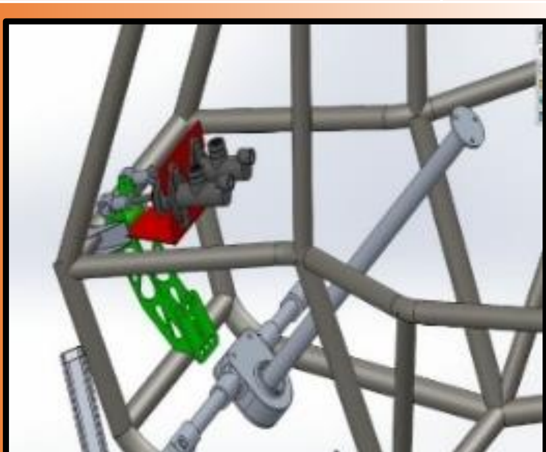
BRAKING

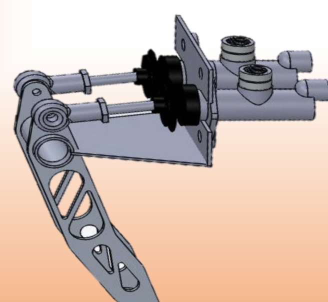
BRAKING CIRCUIT

System	Inboard at rear and outboard circuit in front
MC Bore size x stroke	5/8in x 1.12in ,3/4in x 1.12in (bore*stroke)
Disc Size	6in-front, 8in-rear
Brake caliper pistons	0.99in^2 x2 (area*count)
Brake caliper pad	2.00in^2 , 0.3in (area*thickness)
Brake fluid	DOT 4
Bleeding Method	Pump And Hold Method

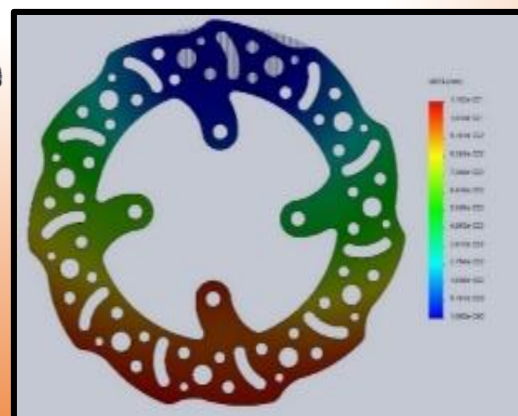
BRAKES PARAMETERS

Weight Transfer at 40kmph to 0kmph	70:30
Static Rolling Radius for Tyre	10.5in
Coefficient of friction for road	0.8
Brake torque required per wheel	205.12Nm
Stopping Distance	7m
Pedal Force	300N
Force required by caliper cylinder	14000N
Pedal Travel	50mm
Balance between two braking system (PRV)	Simultaneous Locking
Wheel Locking Order	All wheels simultaneously

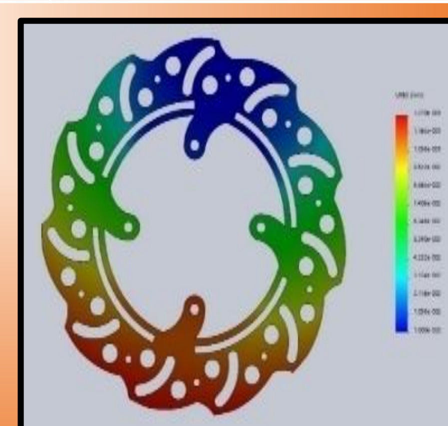




Pedal and MC mount



Front brake disc

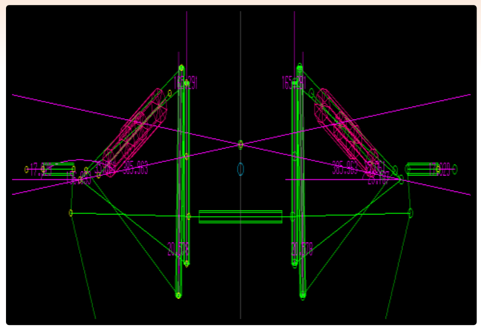


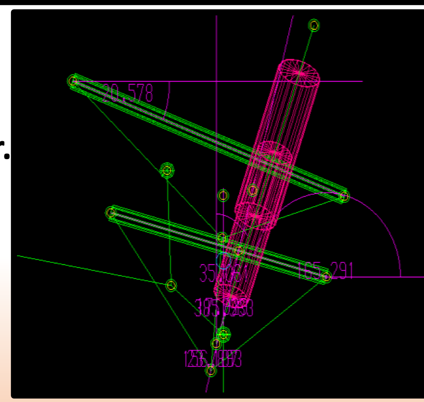
Rear brake disc

STEERING

STEERING SYSTEM	2017	2018
Oversteer	-0.024 deg/g	-0.027 deg/g
Ackerman	51.27%	75.23%
Steering Angle (Inside)	46.85˚	52.23˚
Steering Angle (Outside)	34.98˚	33.72˚
Turning Circle Radius	2m	1.75m

STEERING COLUMN	
Type	Non-Collapsible
Power Assist	No

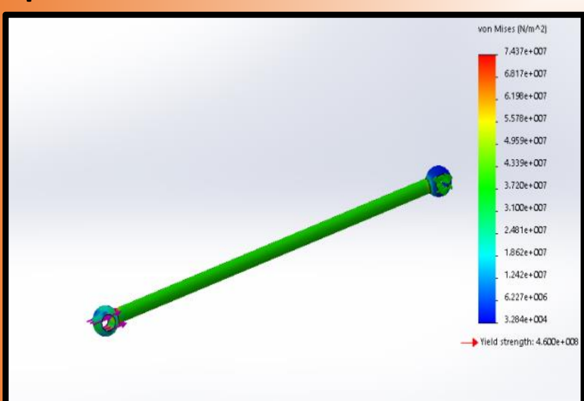


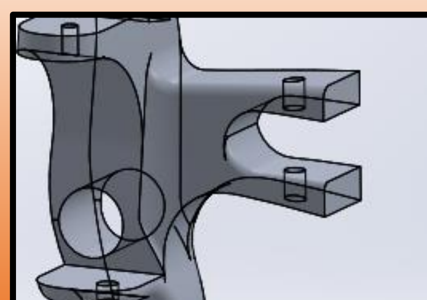


STEERING GEARS	2017	2018
Drive	Central	
Rack Travel (end to end)	90mm	82mm
Pinion Turns (lock to lock)	0.5 rev	0.5 rev
Steering Ratio	180 mm/rev	164 mm/rev
IBJ Centre Distance	380 mm	344 mm
OBJ Centre Distance	1082 mm	1130 mm
Length of Tie Rod	385 mm	417 mm

THIS TIME :

- Front mounted steering arm.
- Decreased steering effort for the driver.
- Planned better manoeuvring characteristics enhancing the performance.



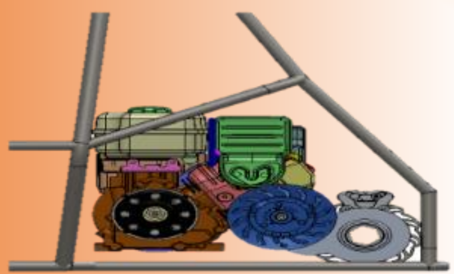


STEERING WHEEL		
Diameter	254 mm	254 mm
Torque	35 Nm	26.1 Nm

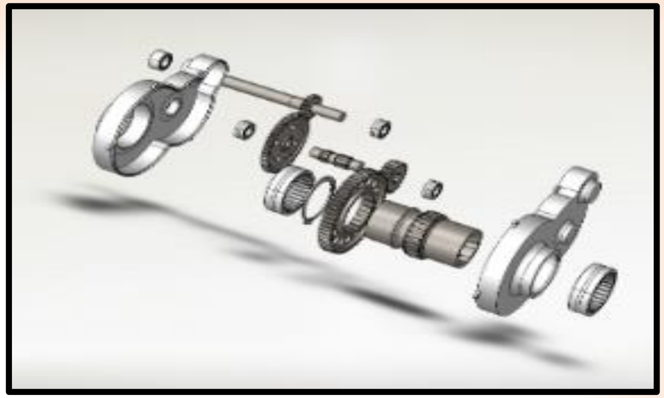
POWER TRAIN

MAX POWER	MAX TORQUE	OUTPUT RATIOS	ACCELERATION	GRADABILITY	TYRE SIZE
9.975 HP	19.6Nm	HIGH- 24.85 LOW- 7.1	5.9m/s²	70.7%	F – 21x7x10” R – 21x7x10”

Power Train Layout

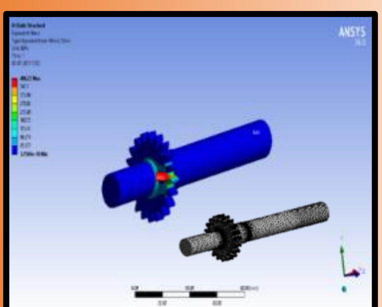


Engine → CVT → Gearbox → Wheels

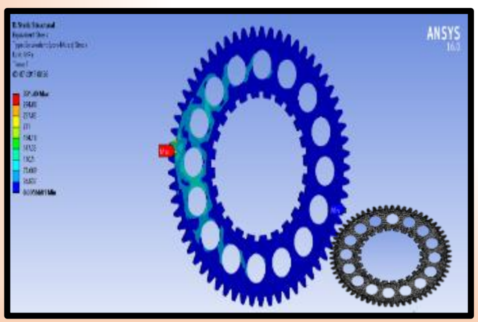


Exploded Assembly of Gearbox

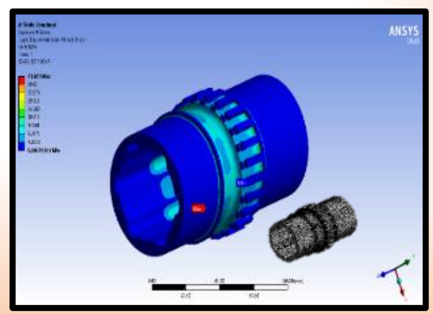
GEARBOX DATA	
GEAR RATIO	7.10
NO. OF REDUCTION STAGES	TWO
MODULE I STAGE	2mm
MODULE II STAGE	2.25mm
GEAR AND SHAFT MATERIAL	SAE 9310-Gear SAE 4340-Shaft
CASING MATERIAL	AL7075-T6



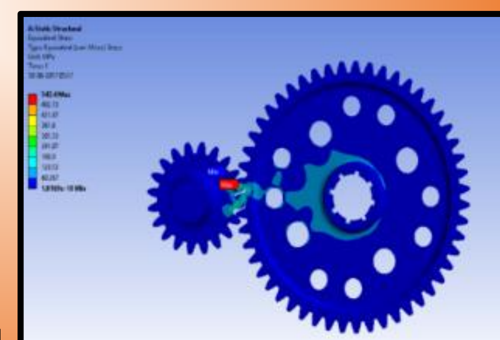
Input Shaft



Output Gear



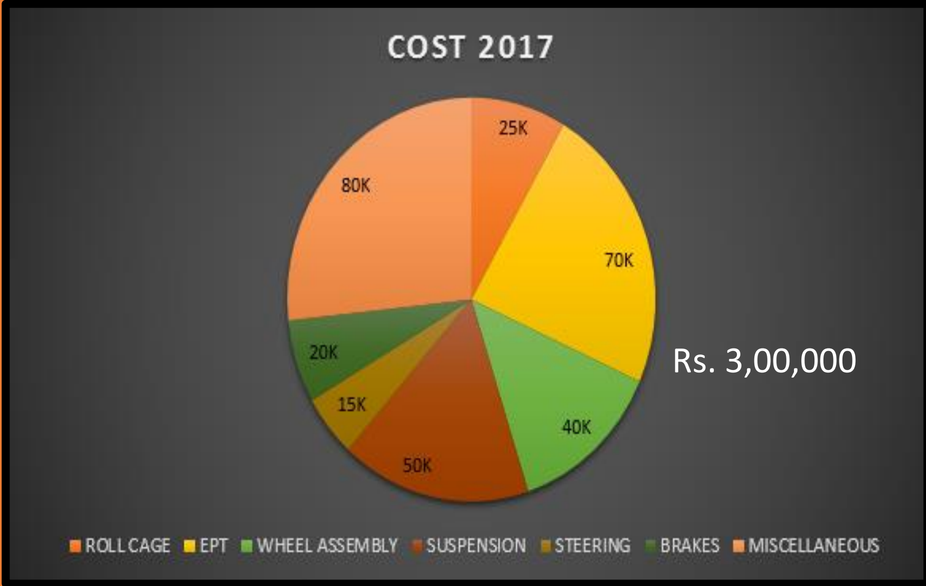
Output Shaft

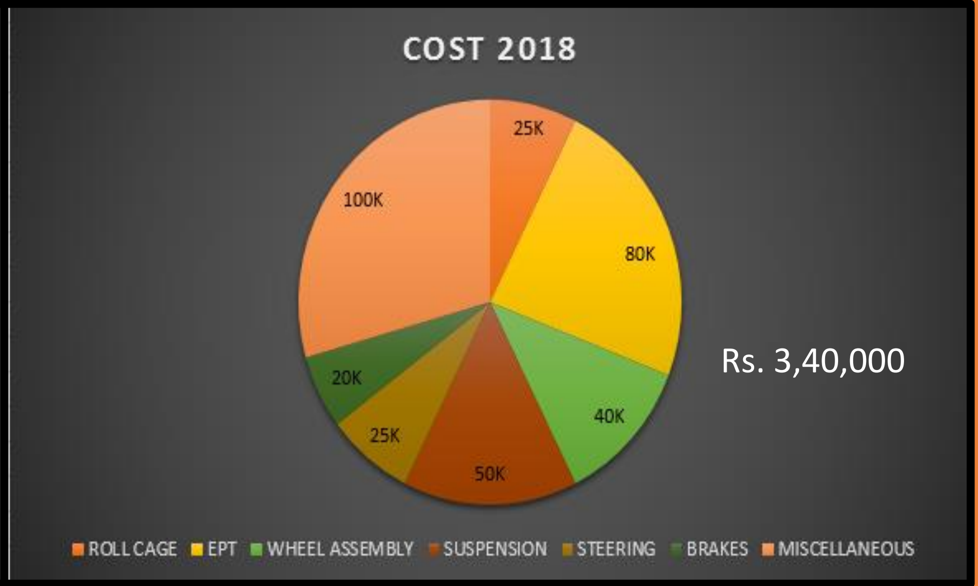


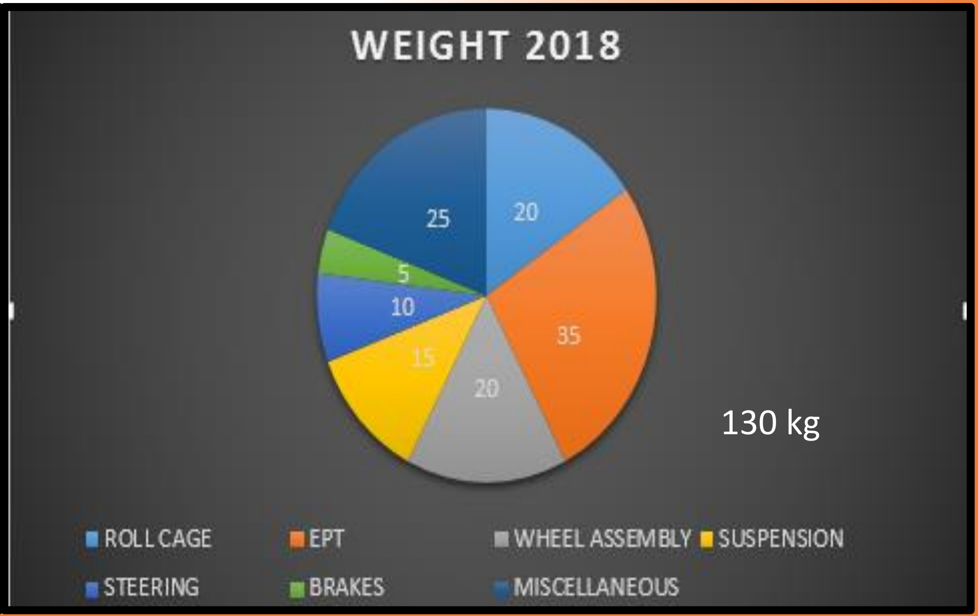
Stage 1

- Custom Integrated Gearbox With Gaged CVT- About 2.5 kg reduced by integrating the gearbox
- Engine and Gearbox coupled using a CVT with a V-Belt
- NVH considerations – Engine and Gearbox Mounted on same member; Engine mounted on cast nylon bushes to curb the vibrations.

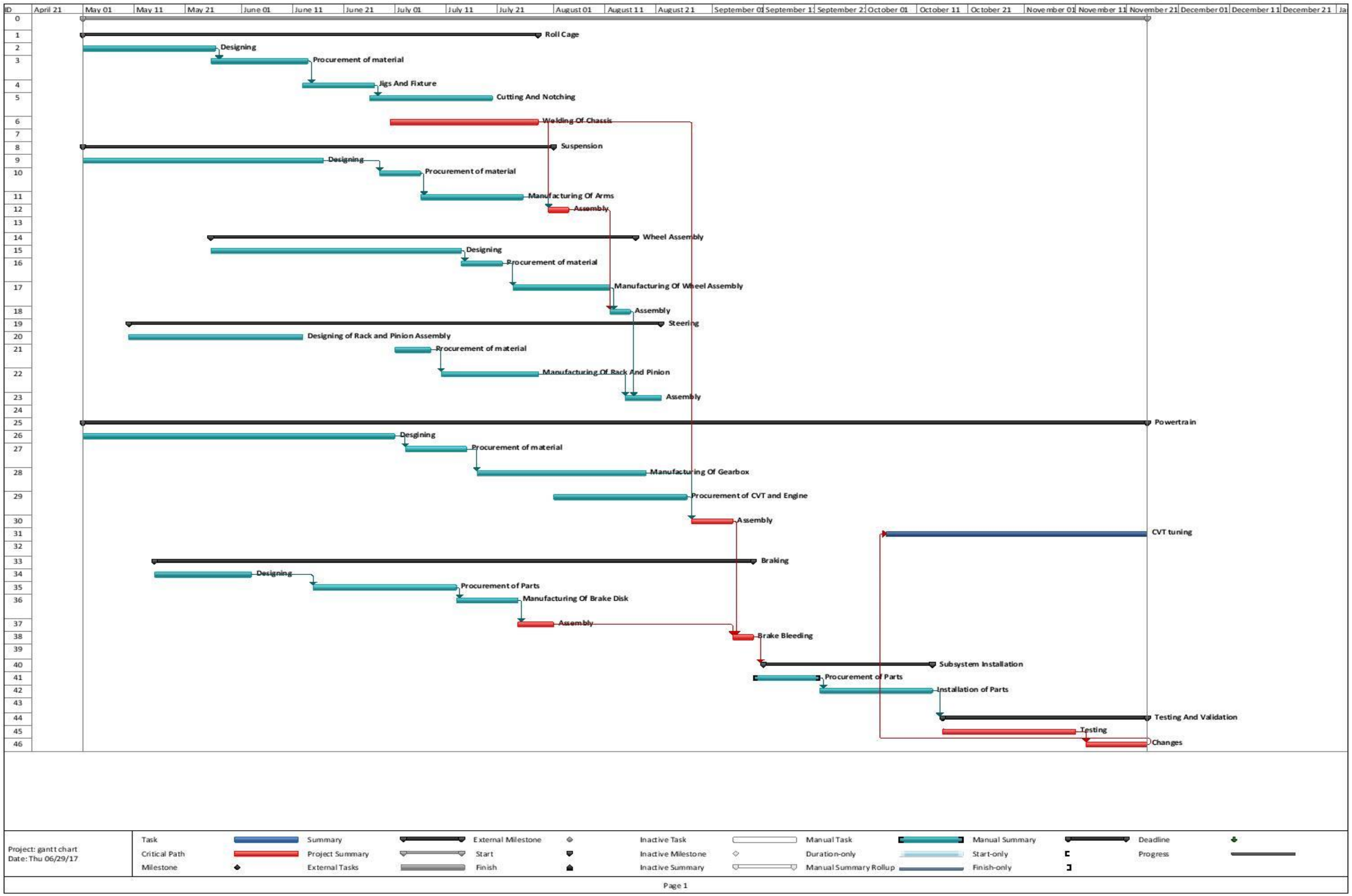
COST AND WEIGHT ANALYSIS







PROJECT PLAN



DFMEA

SYSTEMS	POTENTIAL FAILURE MODE	EFEFECT ON SYSTEM	Severity	POTENTIAL CAUSE(S)/MECHANISM(S) OF FAILURE	Occurrence	CURRENT DESIGN CONTROL	Detection	RPN	RECOMMENDED ACTION(S)	ACTION TAKEN	Severity	Occurrence	Detection	RPN
Roll cage	Structural damage	Bending of the members	8	Impact with other ATV	2	Proper analysis for forces	2	32	Keeping high fos for high structural rigidity	Adding a bracing to the bent member to cease the bending	8	2	1	16
Gear box	Crack development in gears	Failure of powertrain working	5	Improper hardening of the gears	4	Adequate face width of the gears	2	40	Keeping high fos as it is a critical component	Increasiing the Face width	5	2	1	10
Brake disc	Deformation of disc	Brake failure	9	Low heat discipation; loosening of disc bolts	2	Designing of disc for proper heat discipation	2	36	Heat analysis of brake disc	Improving the design for better heat dissipation	9	1	1	9
Hub design	Shear of hub	Loss of control	9	Sudden changes in cross section	3	Given fillet radius in the design	4	108	Increase thickness between mounting points & bearing casing	Giving a fillet between mounting points and bearing casing	9	2	2	36
Upright	Shear of steering arm	Steering control lost	8	Selection of wrong steering points; unidentified forces experience	5	Proper analysis for forces	2	80	Increase thickness of steering arm at the juntion of arm and upright	Integrating the steering arm with upright	8	2	2	32

PFMEA

PROCESS	POTENTIAL FAILURE MODE	EFFECT ON SYSTEM	SEVERITY	POTENTIAL CAUSE(S)/ MECHANISMS OF FAILURE	OCCURRENCE	PREVENTIVE ACTION	DETECTION	RPN	RECOMMENDED ACTION(S)
WELDING	Insufficient welding current	Weak weld	9	Less penetration	5	Sufficient current during welding for proper penetration	3	135	Proper display of current values and testing the weld penetration at various current values
HOBBING MACHINE	Failure of the gearing mechanism	Interface between gears	7	Incorrect module Incorrect tooth profile	4	Oiling of the machine; use of cutting fluid	3	84	Use of CNC gear hobbing increases accuracy
CNC	Electronics fail	Motor will not work or work improperly	7	Failure of connections	4	Servicing of the m/c	3	84	Installing Preventive maintenance measures

DESIGN VALIDATION PLAN

	Description	Acceptance Criteria	Responsibility	Test Resource	Report	Remarks
1	Weld Test	Welded joint remains intact	Ankit	UTM	The weld didn't show any kind of failure	Success
2	Spring Stiffness Test	Must confirm to the required specs	Vishal	UTM	The dampers showed the required specs	Success
3	Brake Test	The vehicle should stop within the calculated distance	Akshit	Driver slams on the brake when buggy is running at top speed	The ATV stopped within the required distance.	Success
4	Straight Line Stability	Vehicle with no obstruction should not deviate from a straight line while steering is at neutral condition	Anmol	Manual Observation	Test Successfully performed	Success
5	Turning Radius Test	Should be equal to the calculated value	Viraat	Measuring Tape	The turning radius is equal to the calculated value	Success
6	Bump Steer Test	The steering wheel must continue to be in neutral condition before and after bump	Rahul	Bump Steer Gauge	Negligible Bump Steer	Success

TEAM COMPOSITION & WORKSHOP FACILITIES

MANUFATURING FACILITIES AT COLLEGE

LATHE MACHINE- WIDTH OF BED:-260mm,SPINDLE BORE:-35 ,CHUCK DIAMETER:-160mm SPEED RANGE:-40-1800 rpm GUIDE

TIG WELDING- CURRENT RANGE:-10-200A, VOLTAGE RANGE: 220-230V, SHIELDING GAS:-Ar

TESTING FACILITIES

UTM- MAX. APPLIED FORCE:-300KN,
MAX. PISTON STROKE:-200mm ,
FORCE RANGE:-2-100% TEST SPACE,
TENSILE:550mm

PARKINSON'S GEAR TESTER- MAX. DIAMETER OF GEAR-200m , MAX. HELLIX ANGLE- up to 30, MAX. THICKNESS OF GEAR-30mm,

MANUFATURING FACILITIES OUTSIDE COLLEGE

CNC- MAX. HEIGHT-350mm, MAX. LENGTH-450mm ,MAX. DIAMETER-365mm,
SPINDLE SPEED-150-2500rpm MOTOR POWER-4kw

HYDRAULIC PRESS- MOTOR POWER-2.2W,BEND SPEED-8mm/sec
BENDING LENGTH-1250mm,MAX. STROKE-100mm
APPROACH SPEED-6mm/sec, RETURN SPEED-40mm/sec

Department heads	Members	Work Allocation
Mayank Pant (Design)	Arpit	Designing ,Rule book
	Jatin	Analyzing
■ Old members	Nikhil	Ergonomics
	Anmol	Manufacturing
Mrinal Gupta (Power Train)	Hiren	CVT Tuning
	Abhinav	Calculations
	Tejasva	Axle making
Raghvind (Suspension)	Vishal	Arm designing
	Shri Harsh	Hub Designing
Rahul (Steering)	Mayan	Rack and Pinion Design
Shivam (Braking)	Sidharth	Rotor Design
	Vinayak	Pedal Assembly Design
Ankit (Fabrication)	Viraat	Market Survey
	Asad	Jigs and Fixtures Design
	Ayush	Welding
Akshit (Marketing)	Ajay	Sponsor hunting
Vasu (Finance)	Neelesh	Account handling

Mr. Rakesh Chander Saini (Faculty Advisor)