SUSPENSION REPORT

Why suspension?

Suspensions are very essential for a vehicle irrespective to the road conditions. When the vehicle is about to turn for certain degrees, the wheel on the inner side while turning experiences the maximum load than the outer side. This load might damage the wheels, frame etc. To avoid this or to minimise this, the suspensions are used. They are mainly used to enhance the comfort of the passengers but it also helps in reducing the direct load to the frame.

What is a suspension?

A suspension is component used in the automobiles that reduces the vibration caused due to the ups and downs of the road. It consists of a spring and a damper inside it. The damper inside the spring is very essential for a comfortable ride. Consider a suspension without a damper being mounted on the vehicle. When it is run on the road the ups and downs cause the spring to absorb it. But the spring does not dissipate that energy. It stores it in the form of compression and releases the same energy during expansion giving an uncomfortable feeling to the passengers. So in order to dissipate the energy stored in the spring, a damper is provided inside the spring. The damper may be gas filled or liquid filled. The oscillating vibrations are absorbed by the spring and the spring movement is controlled by the damper. This is the build structure of a damper.

FRONT TRACK WIDTH:

The front track width of the car is an important criterion as it the amount of resistance offered to the overturning moment at the Center of Gravity due to the inertial force and at the tires due to lateral weight transfer. Considering these points and the design restrictions we have decided to keep a front track width of **65 inches**.

WHEELBASE

Wheelbase is determined early during the time of design as it influences two things importantly. One, it decides the longitudinal weight transfer during braking and acceleration and Two, we get to know about the packaging of the components in our vehicle. So we have decided to keep a wheel base of **71 inches**.

TIRE AND WHEEL

The next step in the design consideration would be of tire and wheel only. Tire is such an important aspect as it generates the cornering force necessary during the turns. During the selection process the designers must consider how the tires will influence the performance of the entire package. We need to have the best traction and grip of the tire and many other factors like load etc,. matter.
Keeping in mind the necessary points along with the cost involved in the tires, there should be an optimal selection. So, according to our design

FRONT- Tyres of scooty pep
REAR- Tyre of YO Speed bike
for our vehicle would be optimum. The average pressures of the tires are **25psi** at the front and **32psi** at the rear.

POSITION OF SUSPENSION:
Position is common for both Left and Right.

LOCATION	X	Y	Z
Upper ball joint	25.71	12.43	0
Upper frame pivot.front inch	20	15.5	-4.235
Upper frame pivot.rear.inch	20	15.5	4.235
Lower ball joint.inch	28.61	3	0
Lower frame pivot.front.inch	20	3.5	-4.235
Lower frame pivot.rear.inch	20	3.5	4.235

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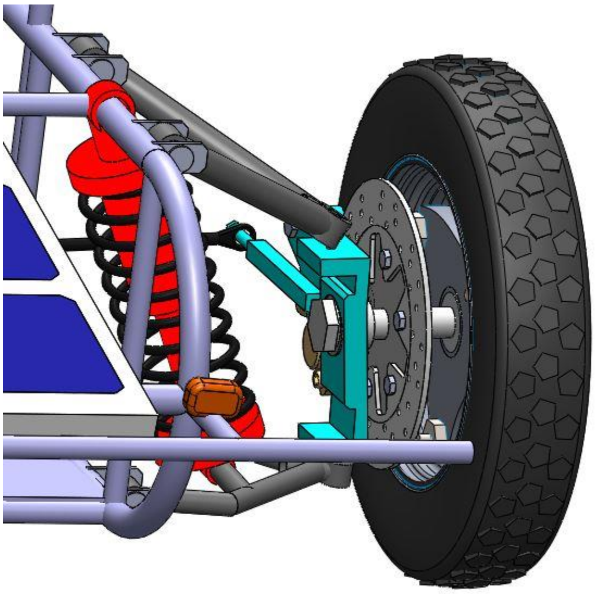
Tie rod on rack.inch	5	8	8
Tie rod on spindle.inch	28.6	8	8
Upper spring pad.inch	20	15.5	0
Lower spring pad.inch	25.06	3.38	0



SELECTION OF SUSPENSION

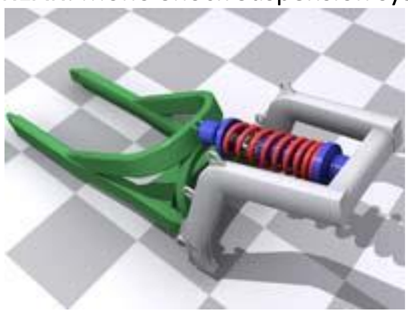
FRONT: Double wishbone Suspension system

We choose the suspension of Honda Shine 125, which is 2.5kgs each and we are using two suspensions on either side. The suspensions are mounted between the wishbones with suitable parameters.

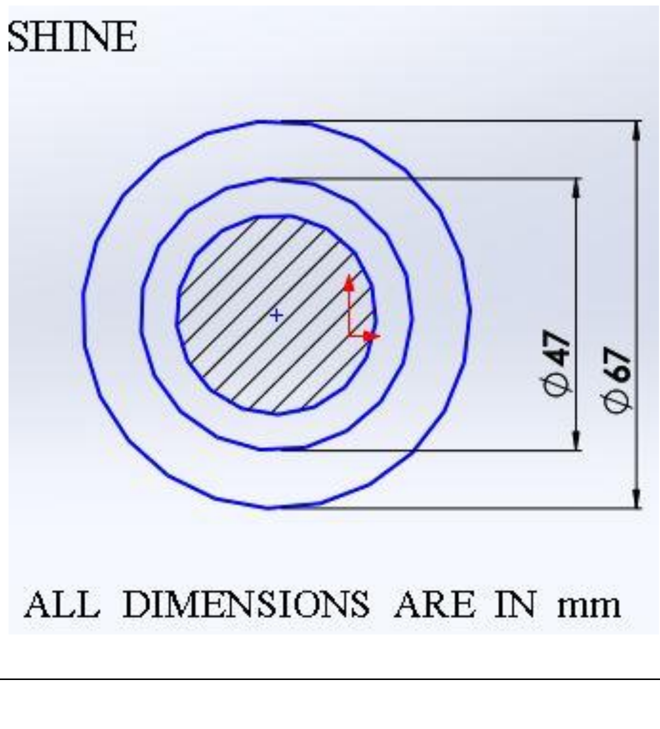
ADVANTAGES:

1. Double wishbone provides us with more free parameters than many of the other suspension systems.
2. The kinematics of the suspension can be tuned easily and the wheel motion can be optimized.
3. The double suspension system is much more rigid and stable than other suspension systems, thus you would realize that your steering and wheel alignments are constant even when undergoing high amounts of stress.
4. The setup of this suspension is a bit easy as compared to some of the other suspensions.
5. Double wishbones are usually considered to have superior dynamic characteristics as well as load-handling capabilities.
6. It is also economical.
7. This suspension system also provides least camber change during the bump and rebound condition.

REAR: Mono Shock Suspension system.



With a mono-shock rear suspension, a single shock absorber connects the rear swing arm to the motorcycle's frame. Typically this lone shock absorber is in front of the rear wheel, and uses a linkage to connect to the swing arm. Such linkages are frequently designed to give a rising rate of damping for the rear. Mono-shocks are said to eliminate torque to the swing arm and provide more consistent handling and braking.



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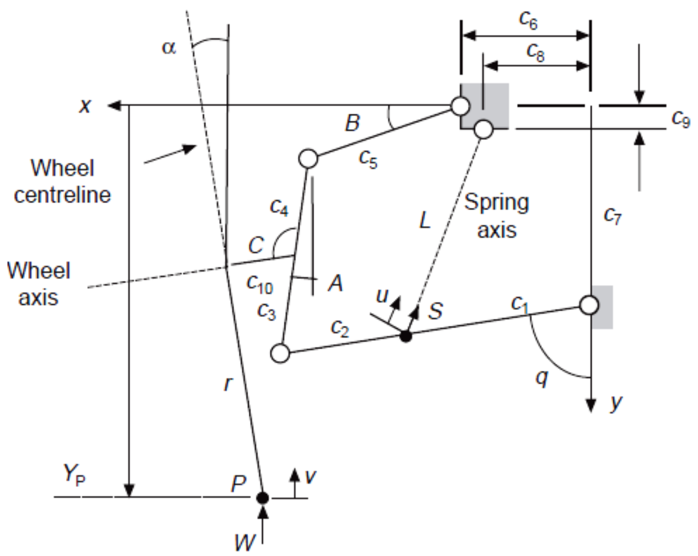
WISH-BONE CALCULATIONS AND ANALYSIS:



C_1= 131 A- Kingpin inclination.

C_2= 80 B- Upper arm inclination.

C_3= 133 C- Wheel axis inclination.

C_4= 142 q- Lower arm inclination.

C_5= 140 α- Camber angle.

C_6= 1 L- Length of spring.

C_7= 305

C_8= 1

C_9= 5

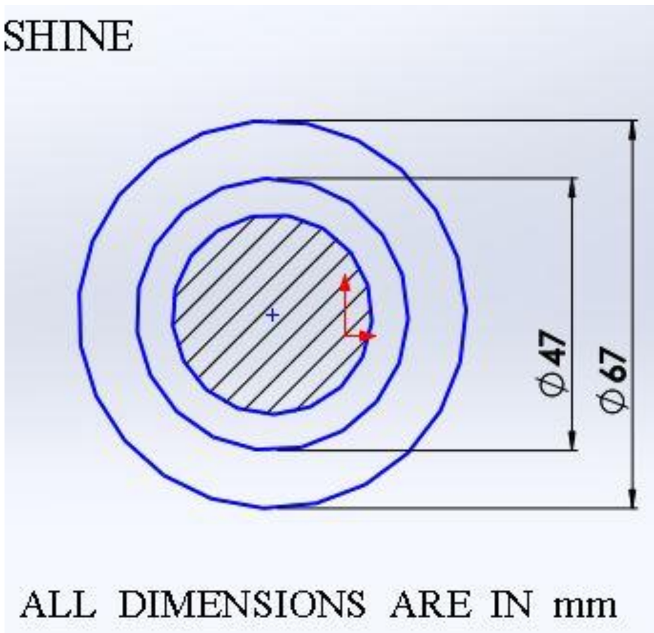
C_{10}=96

ALL DIMENSIONS ARE IN mm.

KINEMATIC ANALYSIS OF DOUBLEWISHBONE SUSPENSION:

FOR DIVE	CHANGE IN ANGLE A	CHANGE IN ANGLE B	CHANGE IN ANGLE C	CHANGE IN ANGLE q	Variation in LENGTH L
-1	7	7.5	88	80	14
-0.7	10	13.5	88	85	13.6
-0.2	12	21	88	90	12.9
0.15	14	30	88	95	12.6
0.7	16	41	88	100	11.9

The dimensions of the Spring are shown



These values were obtained from Diagrammatic representation of the wishbones as drawn below.

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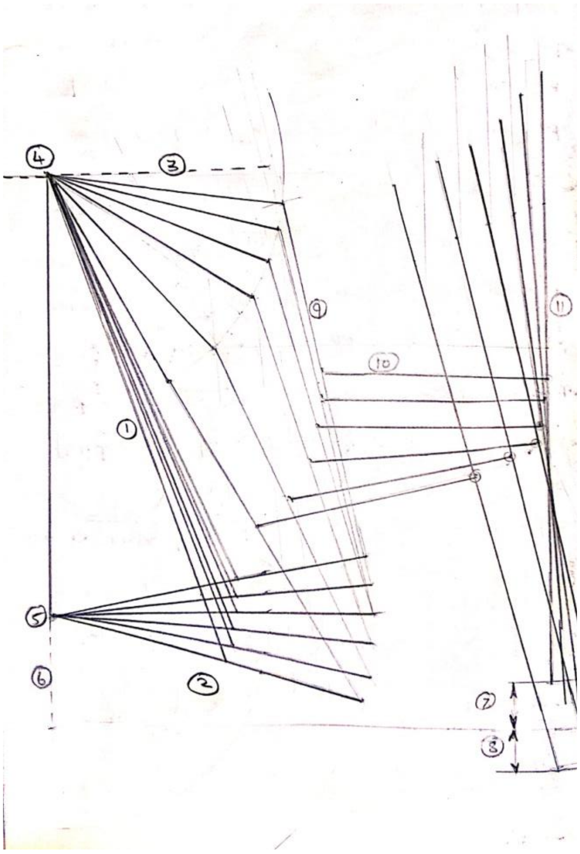
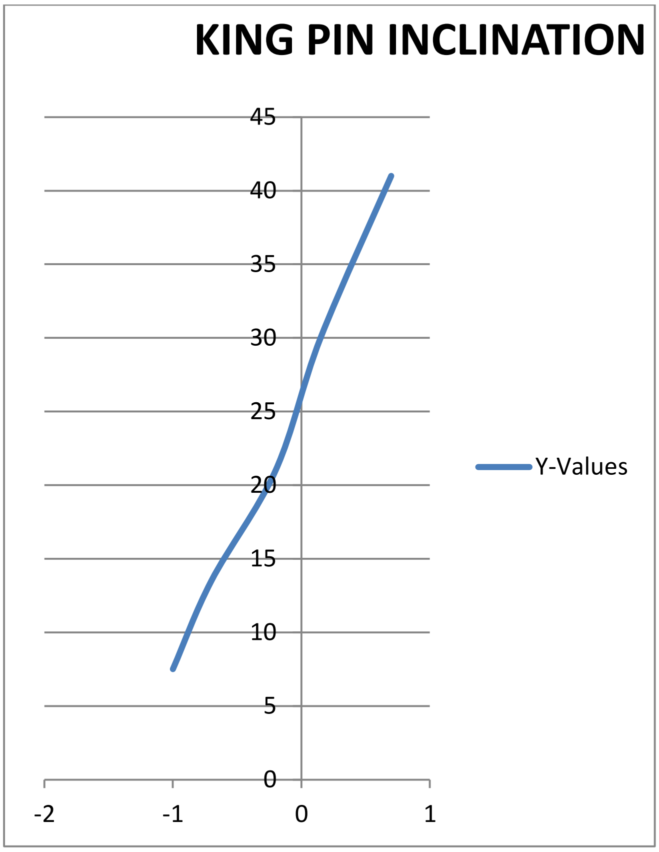




LEGEND:

1-Spring length

2-Lower A Arm

3-Upper A arm

4-Upper Frame mount

5-Lower Frame mount

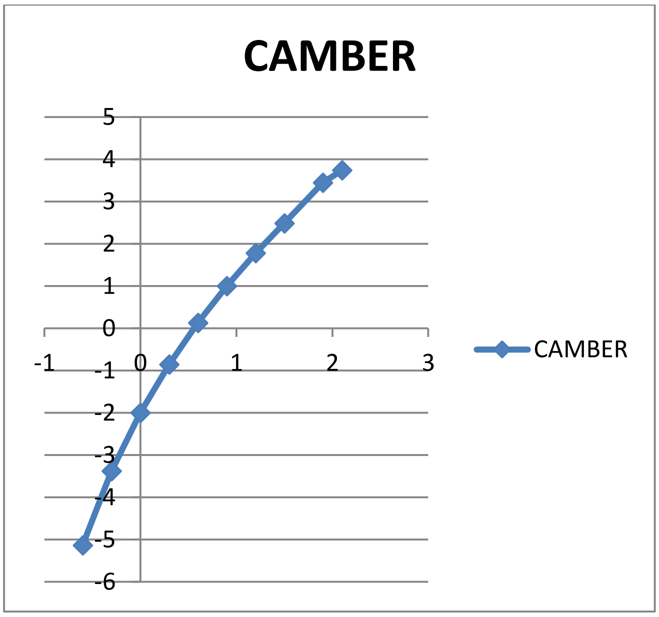
6-Clearance

7-Wheel up travel

8-Wheel down travel

9-King Pin

10-Wheel Shaft



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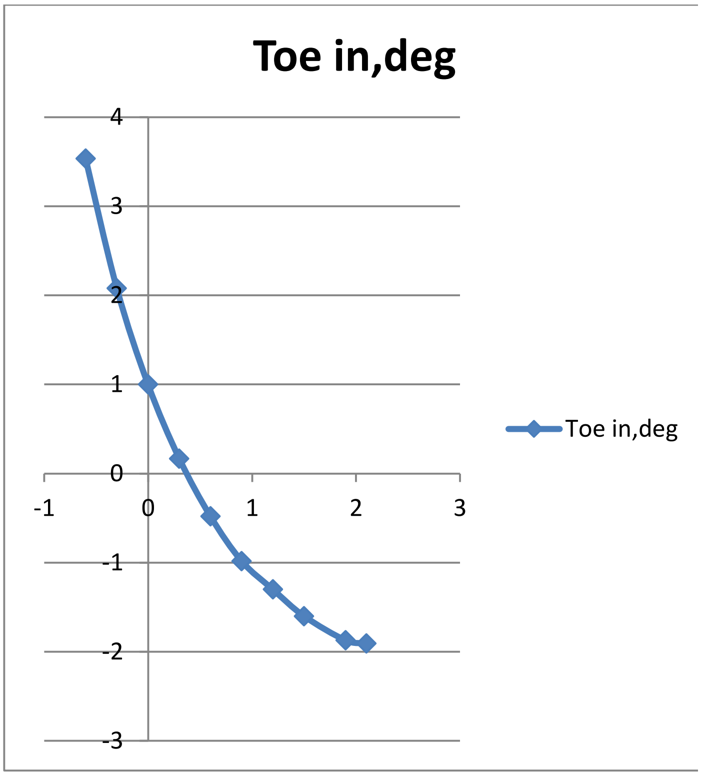


CAMBER:

We are using a negative camber of 2 degrees.

Since this is a three wheeled vehicle, during cornering it may drop down its handling characteristics. To maintain the handling capabilities and also to reduce the tire wear we are using a negative camber of 2 degrees.

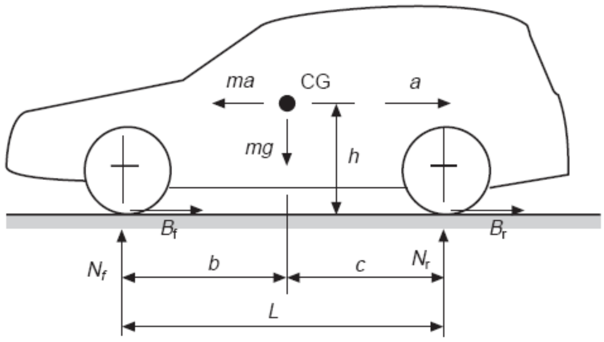
TOE IN:

We are using a Positive Toe in of about 1 degree.

The reason for using a positive Toe in of about 1 degree is,

As this is a three wheel vehicle there are lot of factors to be considered to maintain the stability. This positive toe in increases the stability of the vehicle.

WEIGHT TRANSFER:



Lateral weight transfer during left turn:

W_r x t = W x A x h

Where,

W_r - weight transferred on wheel.

T- TrackWidth

W- kart weight

A-Acceleration

h- Height of C.G

so, W_r= 165.80 N.

ANTI-DIVE:

%Antidive = (%Front brake bias x wb/h x SVSA ht)/ SVSA lg.

FRACTIONAL WEIGHT TRANSFER:

FLT= A X h/t

FLT- Fractional Load Transfer.

ROLL MOMENT:

Roll moment = Sprung Mass x (Dist b/w roll centre and C.G)

Roll moment = 197226.2769N

ROLL CENTRE HEIGHT:

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The roll centre is placed below the ground level with a value of -5.31 inches. The reason for negative value of the roll centre is that during cornering the rolling force is very minimal when the roll centre is negative.

Also the steering used here is Ackerman's steering which is very sensitive. This roll centre height compensates the sensitivity of the steering control..

DAMPERS:

Density

The density of light mineral oil is given by

$$\rho = m/v$$

where m is the mass of the fluid

v is the volume of the fluid

The approximate density of light mineral oil is 860 kg/m^3

Thermal Expansion

The thermal expansion of the fluid is given by

$$\rho=\rho 1\ (1-\gamma[t-t_1])$$

Where

ρ_1 - density of the fluid ~ 860 kg/m^3

T- temperature

T_1 - ambient temperature ~ 30°C

γ ~ 0.001 K^{-1}

1) If T= 40°C

$$\rho=851.4 \text{ kg/m}^3$$

2) If T= 50°C

$$\rho=842.8 \text{ kg/m}^3$$

3) If T= 60°C

$$\rho=834.2 \text{ kg/m}^3$$

Compressibility

$$\rho=\rho 1(1+\beta[P-P_1])$$

P_1 - atmospheric pressure ~ 101325 Pa

β ~670*10^{-12}

1) If P= 5MPa

$$\rho= 862.82 \text{ kg/m}^3$$

2) If P= 6MPa

$$\rho= 863.39 \text{ kg/m}^3$$

3) If P= 7MPa

$$\rho= 863.97 \text{ kg/m}^3$$

Viscosity

The viscosity of the fluid is given for mineral oil by

$$\gamma = u/\rho$$

The approximate viscosity of the fluid is 40.

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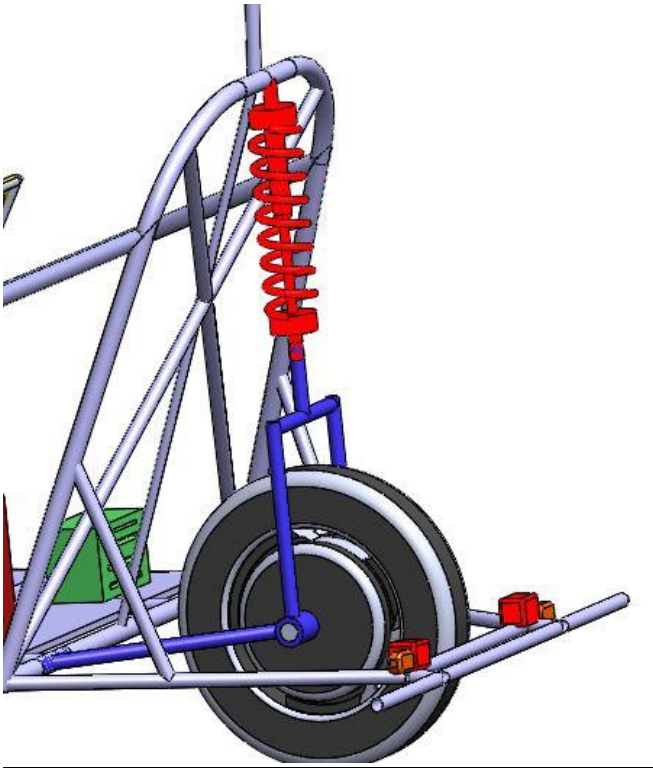
REAR SUSPENSION

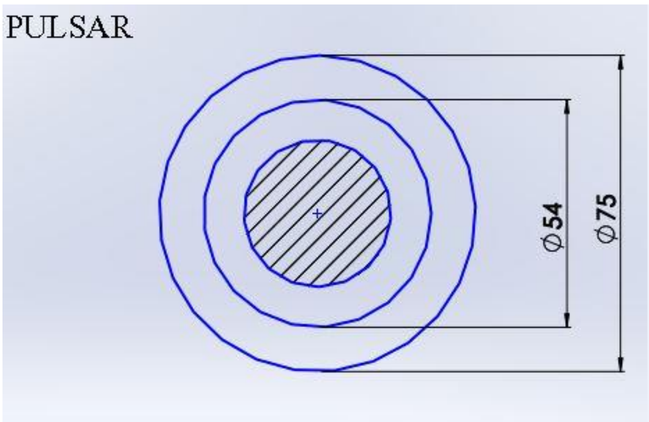


Output Parameters	
Leverage Ratio (Travel/Stroke)	0.71
Calculated Spring Rate (lbs/in)	103
Suggested Spring Rate (lbs/in)	100
Suggested Spring Rate Preloaded Sag (%)	19.0

Optional Spring Rates		
Spring Rate (lbs)	Shock Sag (%)	Shock Sag (in)
-100	0-19.0	-0.93
-50	0-38.1	-1.87
0	na	na
50	19	1.87
*** 100 ***	*** 19.0 ***	*** 0.93 ***
150	12.7	0.62
200	9.5	0.46
250	7.6	0.37

SPRING RATE CALCULATION

INPUT PARAMETERS	
Total Riding Weight (lbs)	441
Rear Weight Bias (%)	40
Rear Wheel Travel (in)	3.54
Shock Stroke (in)	4.92
Shock Sag (%)	25
Preload Adjuster (n.n)	14
End Coil Effect (%)	60



ANTI- SQUAT:

$W_{ACC} = W \times A \times h/wb$

CONCLUSION:

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Thus from the above seen calculation we are concluding with the final values that are stated in the Technical specification.

TECHNICAL SPECIFICATION:

S.no	Parameter	Front	Rear
1	Tyre pressure	25psi	32psi
2	Anti-Dive	35%	NA
3	Anti-squat	NA	64.6%
4	Sprung weight	Right: 132 pounds left: 132 pounds	176 pounds
5	Unsprung weight	102.2lbs	76lbs
6	Spring rate	115lbs/inch	103lbs/inch
7	Suspension travel	2.1 inch.	2.1 inch.
8	Roll centre height	-5.31	-
9	Length of lower A arm	8.6 inch	NA
10	Length of upper A arm	9.025 inch	NA
11	Spring rate	115lbs/inch	103 lbs/inch
12	camber	-2 degrees	
13	caster	0	0
14	Toe in	1 degree	0
15	Damping oil	Light mineral oil	Light mineral oil
16	viscosity	40	40
17	density	863 kg/m^3	863 kg/m^3