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A INNOVATON: DESIGN OF TWIN (DUAL) SUSPENSION FOR ALL TERRAIN VEHICLE

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Abstract—: The paper describes design of new twin suspension and by these suspension system cost will be decrease with same amount of travel. The suspension design is important part when you design it for ATV (OFF ROAD VEHILCLE), Because stability, prevent rollover, motto of driver safety is more required while we were driving ATV on the off road, and It will be possible by if we are able to get same amount travel from front & rear suspension system. We can easily get high travel from front suspension system, but for the rear suspension system it will be bit difficult. So twin (dual) suspension is designed only for the rear suspension system and by using of KTM DUKE 200 bikes two shock absorbers & lever with adjustable & variable amount of 10 stiffness. So, we can adjust our rear suspension system with possible 100 variable stiffness. Using of these system, we can get up to 8 inches travel which is equal to travel by using costly FOX suspension FLOAT 3 EVOL RC 2. if we comparing cost and availability then twin suspension is less costly then FOX suspension system and availability is high while we have to purchase FOX suspension from foreign with paying extra custom duty. While Manufacturing of ATV that time mounting process is little bit difficult in twin (dual) suspension system.

Keywords: stability, travel, twin suspension system, ATV, adjustable & variable stiffness, FOX suspension system.

I. INTRODUCTION

All good engineering design starts with a clear understanding of the project's requirements, goals, availability of budget, material constraints, performance and criteria for judging the effectiveness and success of the final product. Once all of these design specifications are clearly understood, the process of actually designing the product may begin. we should have taken count the all parameter which would affect the product and its performance.

This new innovation we were applied in SAE BAJA 2016 ATV Championship, and it is very helpful because in this national/international event 400plus team were going to participate. And there is good chance to clear the first round of these event which is VIRTUAL ROUND. So new innovation things were able to get you more marks and help to clear the first round.

But behind this innovation our main aim was to get enough travel from front and rear suspension system so our ATV will give better performance in endurance test (Continuous race without stop The ATV expecting the fuel refueling).

By introducing twin suspension, we reduce cost of rear front suspension because 8inch travel is only we get by FOX FLOAT 3 EVOL RC 2 and also cost of FOX suspension pair is high and not available easily.

II. BASIC DESIGN & DEVELOPMENT

While we designing suspension system for ATV (all-terrain vehicle) that time weight of vehicle and how much travel we want for track are more important. Due to bad suspension design there are chances to roll over, less traction into muddy & hilly area and also it will be not able to absorb vibration, so in that case ATV is not able provide driver safety.

When we design ATV that time we know about track because every time in SAE BAJA they prepared something new and challenging for all teams. So, racing tracks are going to be full of uneven surfaces, mud pull, hilly area with some fine sands, so many uneven speed barkers are there and due to that we want to required good suspension, good traction with powerful transmission system. Variable stiffness is required when we competing in this type of races for surviving in tracks.

There are so many types and having differences mechanism having suspension system are available for front & rear suspension which are given below:

A. Front suspension system
   1) Solid I-beam
   2) Twin I-beam
   3) MacPherson strut
   4) Short-long arm

B. Rear suspension system
   1) Non independent rear leaf springs
   2) Non independent rear coil springs
   3) Trailing arm
   4) Beam

We are going to use short -long arm suspension and trailing arm with twin suspension for front and rear suspension system. Reason for choosing this suspension system are given below

Front suspension system:

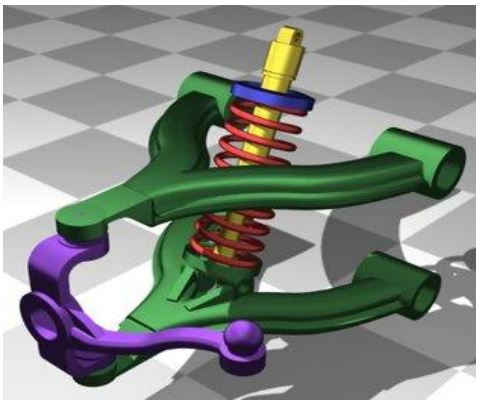

Fig 1 short-long arm type suspension system

Camber is change throughout the suspension travel and due to that we have to fix the value of it as per our requirement. There are two types are camber static and dynamic camber. Camber angle with loaded vehicle not in motion and loaded vehicle while in motion (i.e. breaking, cornering, launching) respectively. We are going to use unequal length arm and double wishbone suspension having system for better camber gain & better load distribution.

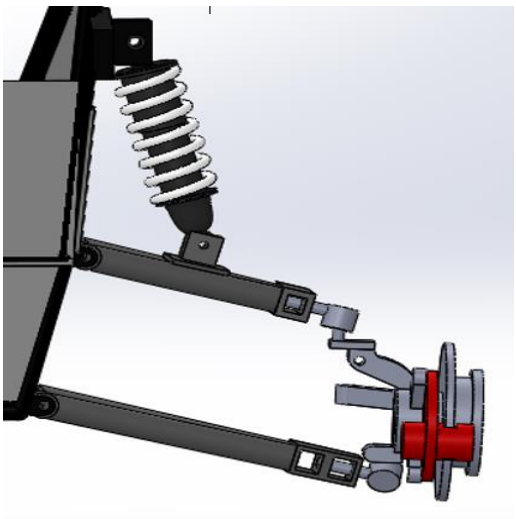

Fig 2 3-D modelling of front suspension system

Rear suspension system:

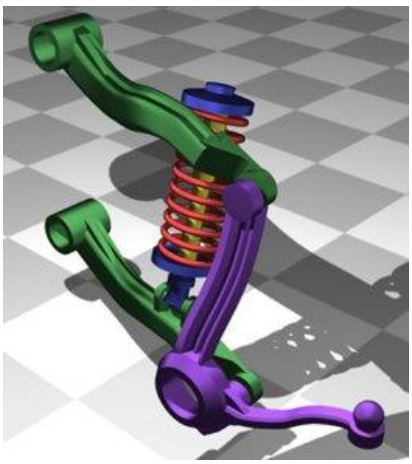

Fig 3 Trailing arm type suspension system

We choose trailing arm suspension system over others because its maintain same camber and toe over travel, but manufacturing is difficult because we have to set camber as per requirement and after actual angle required between arms. Due to involving twin suspension we have to use trailing arm for better travel and driver safety.

Fig 4 3-D modelling of rear suspension system with lever

For calculating acting total load on each suspension of front and rear suspension system we have make some assumptions value which is nearby to actual. So, below some assumptions and fix values for ATV are given which must be required for further calculations:

1) Sprung weight of vehicle W = 300 kg
2) Wheel base L = 1.7272 m
3) Wheel track for front and rear Tf &Tr = 1.32 m
4) Distance from front axle to CG Ax = 0.7*L = 1.20 m
5) Acceleration a = 6.27 m/s^2
6) Acceleration in X-direction = a/gravity = 0.639
7) Gravity g = 9.81 m/s^2

8) Height of CG from road = 0.634 m
9) Lateral acceleration Ay = 1.82
10) Front and rear wheel track Tf & Tr = 1.32 m

Calculations:

- Load due to Acceleration on rear suspension = Wa = (W(B/L) + (Ax*H)/ (g*L) = 217.18 kg
- Load due to cornering on front wheel = Wcf = (W*Ay*H)/Tf = 262.5 kg
- Load due to braking = Wb = (W*Ax*H)/L = 70.50 kg
- Load due to cornering on rear wheel = Wcr = (W*Ax*H)/L = 262.5 kg
- Total load on each front suspension = Wf = (0.15W) + Wcf/2 + Wb/2 = 211.49 kg
- Total load on each rear suspension = Wr = 0.35W+Wa/2+Wcr/2 = 344.84 kg

By the using of all value from the calculation we can obtain total acting load on suspension system

- Total load = Wa + Wcf + Wcr + Wb = 812.79 kg

In twin suspension we are using KTM DUKE 200 shock absorbers so below down 3-D modelling and specifications of shock absorber are given:

Fig 5 3-D modelling of KTM DUKE 200 shock absorber

Fig 6 shock absorber in KTM DUKE 200

When we talk about twin suspension that time very important part we have to design is lever. In twin suspension lever plays very important role because by using of leverage mechanism we can get high tire travel and twin suspension also provide good driver comfort during the race. So, design of lever is given below:

1) Caster angle θ = 0 .122
2) Arm length L = 863.2 mm
3) Distance between two ends of ball crank lever x = ((L/2) – (2*(13*Sine θ)))) = 351.43 mm
4) Shorter arm l = 76.2 mm
5) Longer arm 2*l = 152.4 mm
6) Effort P= 2*Wr = 6765.81 N
7) Reaction at fulcrum pin R = (P^2 + Wr^2) ^0.5 = 7564.42 N
8) Allowable bearing pressure p = 10
9) Diameter of fulcrum pin d1 = (R/2*p) ^0.5 = 19.44 mm
10) Length of fulcrum pin l 1 = 2*d1 = 38.89 mm

By using all the values from above we get final values of shear & bending stress and bending moment value which are given below:

- Shear stress = R/1.57*d1^2 = 12.73 N/mm^2
- Bending moment Mb = p*l = 51555.392 N*mm
- Bending stress σb = 400 N/mm^2

This is required calculation for rear suspension by this value we can get idea which type of manufacturing process we have to carried out and how much stiffness required at each level of racing track. At below KTM DUKE 200 shock absorber specifications are given:

KTM DUKE 200 Shock absorber	Properties
Type	Monoshock type
Model	Alloy swingram (WP suspension 4618 EM)
Rear wheel travel	150 mm
Body	Fully Al body
Big Damper piston	40 mm
Piston rod	14 mm
Hydraulic pre load option	Yes
Nitrogen charges	Yes
Ride height /length	Adjustable

Table 1: specifications of KTM DUKE 200

Lever design:

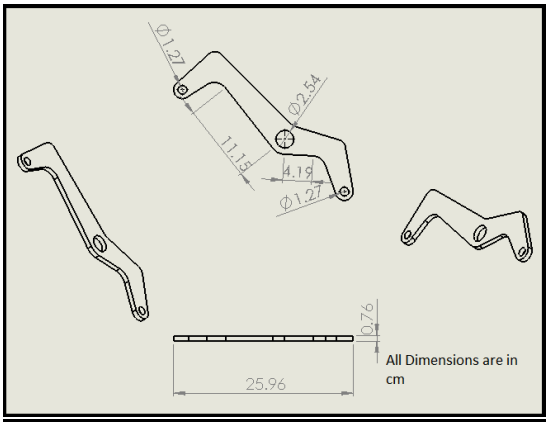

Fig 7 manufacturing sketch of lever

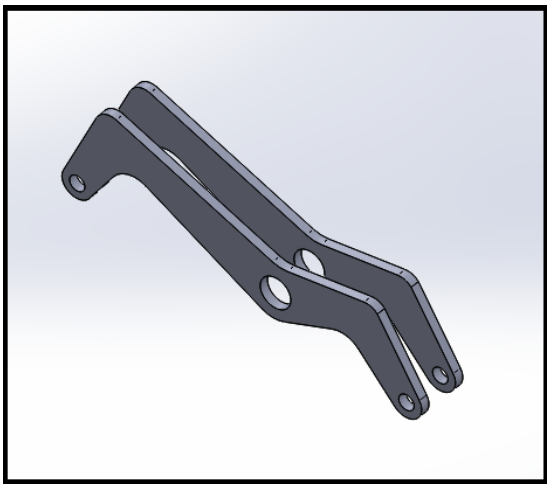

Fig 8 3-D modelling of lever mechanism in twin suspension

Actual front suspension after manufacturing:

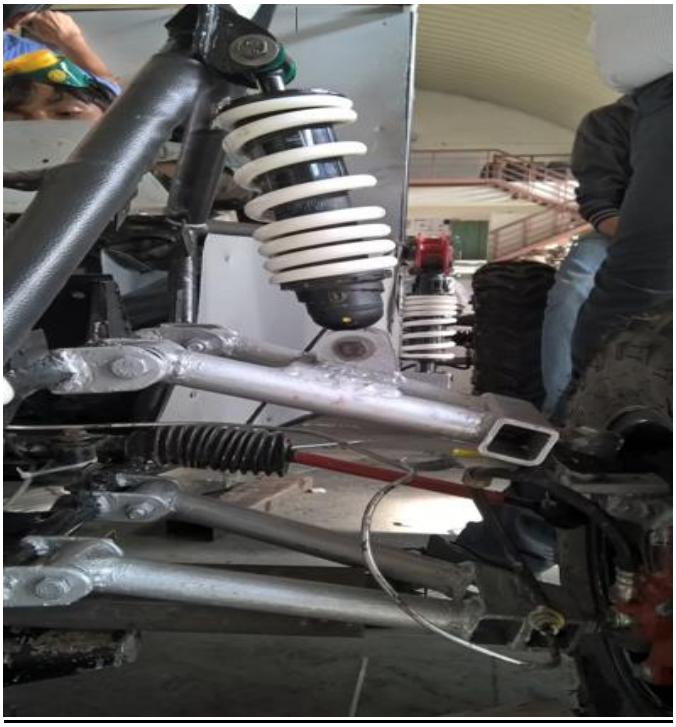

Fig 9 Actual ATV with double wishbone (short & long arm) Suspension system

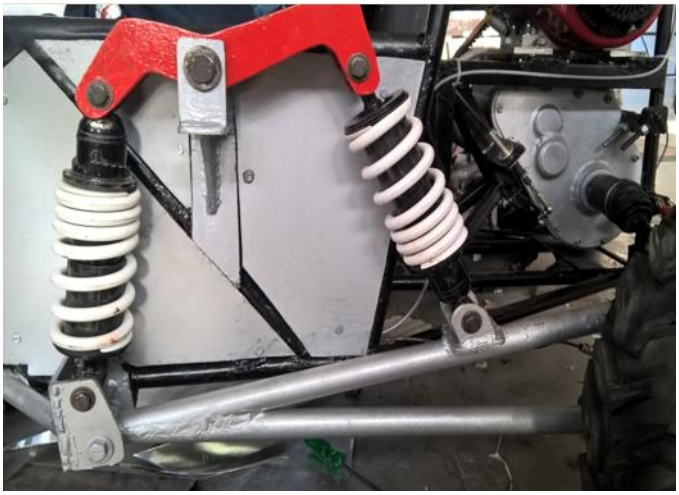

Fig 10 Actual ATV with trailing arm (twin suspension) system

These is the whole design of front & rear suspension for ATV And by using these suspension systems we able to get good comfort of driver, good traction, high wheel travel with better load distribution. Below down front & side view of whole ATV with both suspension system:

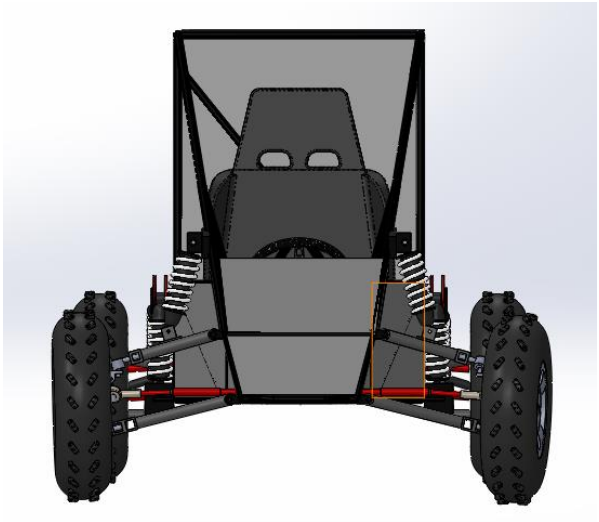

Fig 11 Front view of ATV

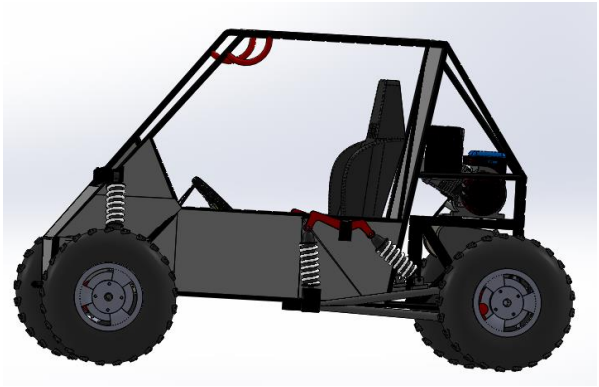

Fig 12 side view of ATV

III. CONCLUSION

If we want take summary of these paper so we can say using double wishbone with having short and long arm type suspension system for front and twin (dual) suspension system with KTM DUKE shock absorber for rear, we are able to get enough travel and good driver comfort during race on OFF ROAD TRACK. Important fact is that we get this much good suspension system with low budget, because as we all know that much amount of travel and good comfort with good severity we can get by using only FOX FLOAT 3 EVOL RC 2. But these shock absorbers are very costly and not easily available in India, and for these shock absorber we have to purchase from foreign by paying high value of it.

REFERENCES

[1] Motorbike Suspensions Modern design and optimization 2013 by Dario Croccolo, Massimiliano De Agostinis.

[2] Engineering Design Handbook Automotive Series Automotive Suspensions AMC PHMPHLET 1967 by US ARMY major general, acting chief of staff.

[3] VIBRATION CONTROL IN PITCH-PLANE SUSPESNSION MODEL WITH MR SHOCK ABSORBERS by BOGDAN SAPINSKI & PAWEL MARTYNOWICZ from journal of theoretical and applied mechanisms 2005.

[4] The shock absorber handbook second edition by John C. Dixon from the open university, Great Britain 2007.

[5] ROBUST SUSPENSION SYSTEM DESIGN by John E. Beard And John W. Sutherland from ASME VOLUME 1 1993.