Design & Analysis of Front Suspension for Light Duty Vehicle

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Abstract— Suspension unit is the term given to the system that consists of springs, Shock Absorbers and Linkages that connects a vehicle body to its wheel. Suspension unit has many purposes which are vehicle handling, passenger's comfortable, avoiding noise and bumps to the vehicle, etc. Independent suspension typically offers better ride quality and handling characteristics, due to the ability of each wheel to address the road undisturbed by activities of the other wheel on the vehicle. Independent suspension requires additional engineering effort in development versus a beam or live axle arrangement. Introducing Independent Suspension in Commercial Passenger Vehicles will increase the comfortable in long journey. Existing suspension units in the commercial passenger vehicles have only the leaf springs which are connected between the vehicle chassis and wheels. So the movement on one side will affects the wheel on the other side and whole body will affected by the shock. Therefore by designing Independent front suspension unit for heavy commercial passenger vehicle will result in absorbing the most part of the shocks by the suspension unit and also the independent movement of wheels. Here the existing model was studied and new design on independent suspension was created for front suspension unit of commercial passenger vehicles. The prototype Model of the design work was created with the help of Pro/Engineer Wildfire 2.0 and Solid Works 2008 3D CAD Design Software's and COSMOS Simulation Package was used to undergo the analysis operation.

Key words: Prototype, 3D CAD Design, COSMOS Simulation, Suspension

I. INTRODUCTION

Automobiles were initially developed as self-propelled versions of horse drawn vehicles. However, horse drawn vehicles had been designed for relatively slow speeds and their suspension was not well suited to the higher speeds permitted by the internal combustion engine. The year 1886 is regarded as the birth of the modern automobile with the Benz Patent Motorwagen, the German inventor Karl Benz. In 1901 Mors of Germany first fitted an automobile with shock absorbers. With the advantage of having a damped suspension system in his 'Mors Machine'. In 1901, British inventor Frederick William Lanchester patented the disc brakes. In 1920, Leyland used torsion bars in a suspension system. In 1922, independent front suspension was pioneered on the Lancia Lambda and became more common in mass market cars from 1932. The Hotchkiss drive invented by Albert Hotchkiss was the most popular rear suspension system used in American cars from the 1930s to the 1970s. In 1893, the first running, gasoline-powered American car was built and road-tested by the Duryea brothers of Springfield, Massachusetts. The first public run of the Duryea Motor Wagon took place on 21 September 1893, on Taylor Street in Metro Center Springfield. The Studebaker Automobile Company, subsidiary of a long-established wagon and coach manufacturer, started to build cars in 1897 and commenced sales of electric vehicles in 1902 and gasoline vehicles in 1904. In Britain, there had been several attempts to build steam cars with varying degrees of success, with Thomas Rickett even attempting a production run in 1860. Santler from Malvern is recognized by the Veteran Car Club of Great Britain as having made the first petrol-powered car in the country in 1894 followed by Frederick William Lanchester in 1895, but these were both one-offs. The first production vehicles in Great Britain came from the Daimler Company, a company founded by Harry J. Lawson in 1896, after purchasing the right to use the name of the engines. Lawson's company made its first automobiles in 1897, and they bore the name Daimler. Therefore In this paper the independent front suspension design will be explained. First the suspension ride, the suspension handling and the suspension geometry design objectives are summarized. According to these objectives the final design of the independent front suspension for commercial passenger vehicle will present. Before an independent front suspension can design, first the design objectives must clearly state. The design objectives define the most important suspension characteristics. Regarding to those objectives the best design decisions can make. Looking back to the objectives, during the development period prevents losing the main design points out of sight.

II. DESIGN ANALYSIS PROCEDURE

A. Independent Front Suspension Design

The Independent Front Wheel Suspension unit for commercial passenger vehicle using pair of twin tube shock absorber with heavy coil spring is shown in the figure 1. Here the part model and assembly was created by using Pro/Engineer Wildfire 2.0 (3D CAD Modelling Software).

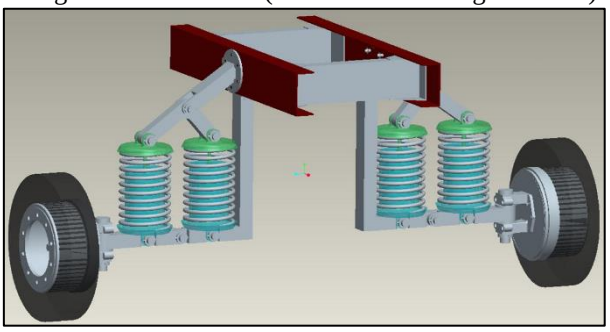

Fig. 1: Independent Front Wheel Suspension Unit Assembly

Independent suspension typically offers better ride quality and handling characteristics, due to lower un sprung weight and the ability of each wheel to address the road undisturbed by activities of the other wheel on the vehicle. Independent suspension requires additional engineering effort and expense in development versus a beam or live axle arrangement.

B. Coil Spring

A Coil spring, also known as a helical spring, is a mechanical device, which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded. Coil springs are a special type of torsion spring: the material of the spring acts in torsion when the spring is compressed or extended. Metal coil springs are made by winding a wire around a shaped former a cylinder is used to form cylindrical coil springs.

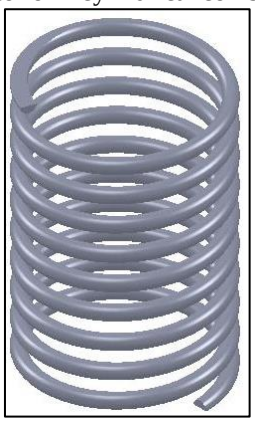

Fig. 2: Coil Spring

A coil spring, also known as a helical spring, is a mechanical device, which is typically used to store energy due to resilience and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded

C. L – Bent & Arm Bar

L – Bent and Arm Bar are newly designed to support the Shock Absorber and the Helical Spring Assembly. L – Bent is linked to the one end of Arm Bar with the help of pin, collar and taper pin. Another end of the Arm Bar is connected to the Axle Arm. Also the top flat portion of the L – Bent is fixed to the chassis of the vehicle body. L – Bent and Arm Bar are shown in the figure 3.

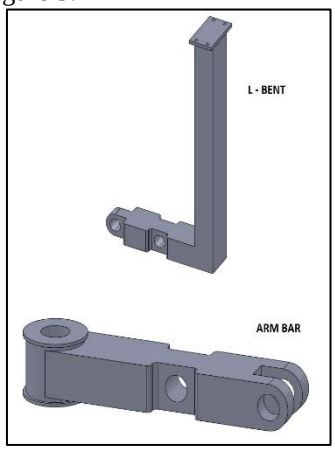

Fig. 3: L - Bent & Arm Bar

D. Universal Joint & V Bent

Universal Joint and V Bent are also newly designed to support the Shock Absorber and the Helical Spring Assembly. Universal joint is linked to the Chassis Frame with the help of fasteners. Another end of the Universal Joint is connected to the V Bent. Both sides of V Bent are connected to the Shock Absorber and Helical Spring Assembly. Universal Joint and V Bent are shown in the figure 3 .A universal joint, universal coupling, U-joint, Cardan joint, Hardy-Spicer joint, or Hooke's joint is a joint or coupling in a rigid rod that allows the rod to 'bend' in any direction, and is commonly used in shafts that transmit rotary motion. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft.

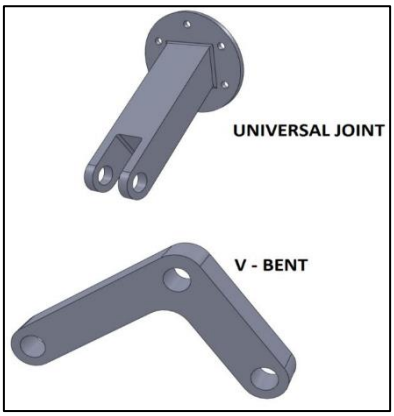

Fig. 4: Universal Joint & V Bent

E. Axle Arm

Axle Arm is the main part that connects the axle and Wheel & Wheel Hub assembly. It is mainly used with the dead axle of front suspension unit. Here we use the same existing part that was available in the existing design. Here is connects the Arm Bar and other side is connected to the wheel and wheel hub assembly as same like the existing model. Axle Arm is shown in the above figure 5.

F. Analysis of Independent Front Suspension

Analysis of Independent Front Wheel Suspension unit for commercial passenger vehicle takes main part in this project. Here assembly for imported to the simulation package and also sub-assemblies are used for easy of simulation. Solid Works Simulation Express and COSMOS Works Simulation Software bolster the depth of Simulation with additional capabilities, including a powerful set of tools for simulating with different materials and with different loading. Static and Dynamic loading is fully supported. No matter the material or use environment, Solid Works Simulation will provide valuable insight to improve product reliability in the most cost effective manner. Analysis results have been shown in the following figures with different load conditions, stress and deformations.

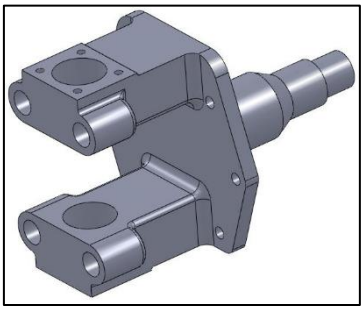

Fig. 5: Axle Arm

III. SPRING ASSEMBLY ANALYSIS MODEL 1

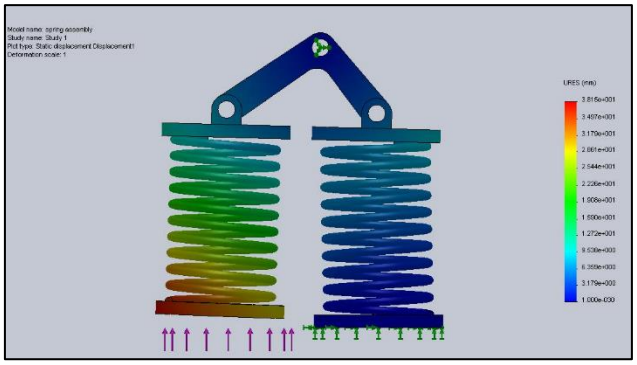

Fig. 6: Spring Assembly Analysis Mode 1: Static Displacement

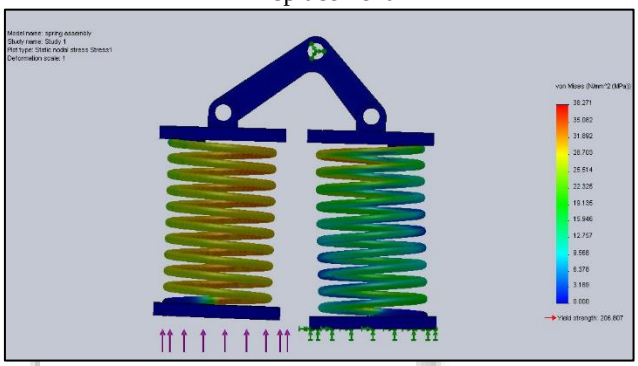

Fig. 7: Spring Assembly Analysis Mode 1: Static Nodal Stress

IV. SPRING ASSEMBLY ANALYSIS MODE 2

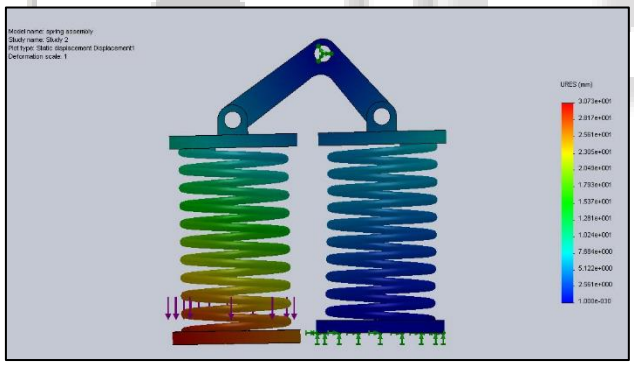

Fig. 8: Spring Assembly Analysis Mode 2: Static Displacement

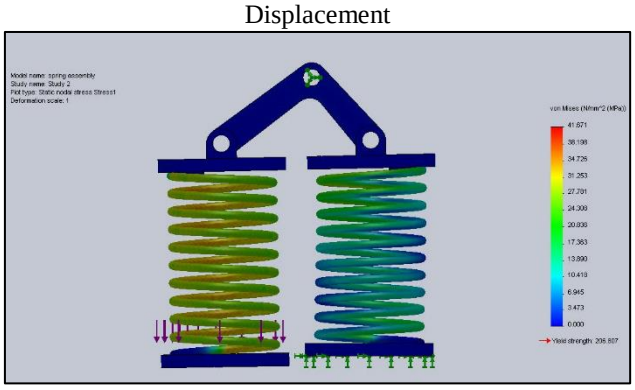

Fig. 9: Spring Assembly Analysis Mode 2: Static Nodal Stress

V. SPRING ASSEMBLY ANALYSIS MODE 3

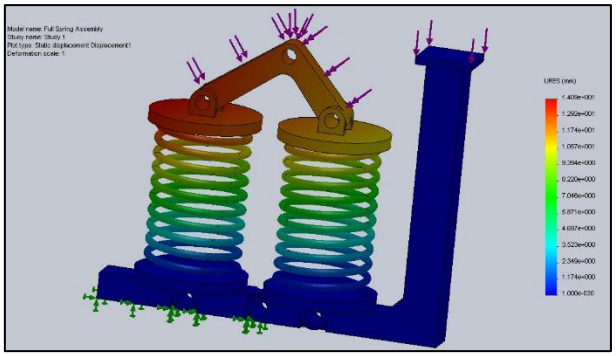

Fig. 10: Spring Assembly Analysis Mode 5: Static Displacement

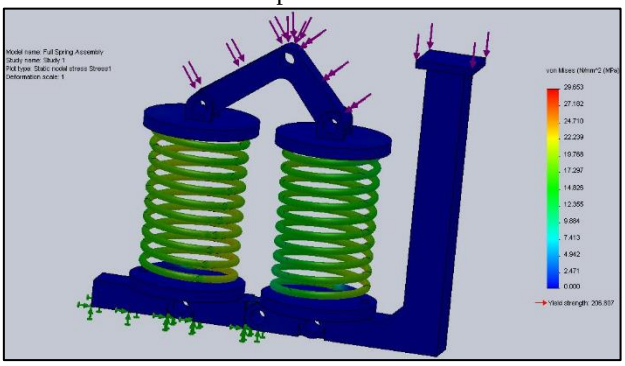

Fig. 11: Spring Assembly Analysis Mode 5: Static Nodal Stress

VI. CONCLUSION

An Independent Front Wheel Suspension is evaluated using a pair of Twin Tube Shock Absorber with Heavy Coil Spring. According to the design and analysis conducted, new concept of Independent Front Suspension unit for commercial passenger vehicle will works smoothly while carrying normal load and absorbs heavy shocks without passing them to the vehicle body parts and to the passenger compartment. Also it operates in maximum load condition, but it came to know that life of the moving part will be reduced when load condition exceeds the limit. As comparing with the imported model of suspension unit, this design will reduce the cost of luxurious vehicles and fit to the mid-range commercial passenger vehicles. The expected ride comfort improvement originating from an independent front wheel suspension was obtained using this design and analysis. Adding an extra spring damper mass body which act as air suspended driver seat will give more ride comfort simulation. An interesting future study might involve testing the independent front wheel suspension unit at different load condition and also extending the design concept to the rear wheel suspension unit. Also it can be developed and fitted to heavy commercial vehicles where there are only dependent suspension unit are possible.

REFERENCES

[1] John C. Dixon and Chichester Wiley, (2007) 'The Shock Absorber Handbook, 2 n d Edition', ISBN 978-0-470-51020-9. R.S.Khurmi and J.K.Gupta, (2005) ' A Textbook of Machine Design, 14th Edition'.

[2] Heinz Heisler, (2002) 'Advanced Vehicle Technology', Second Edition, ISBN 0-
[3] Jornsen Reimpell, Helmut Stoll and Jurgen W. Betzler, (2001) 'The Automotive Chassis: Engineering Principles', Second Edition, ISBN 0-7506-5054-0
[4] Dr.Kirpal Singh, (1999) 'Automobile Engineering – Vol.1 (Automobile Chassis and Body excluding Engine)', Eight Edition ISBN 81-86308-25-3
[5] Dr.Kirpal Singh, (1999) 'Automobile Engineering – Vol.2 (Automobile Engines Including Electrical)', Eight Edition ISBN 81-86308-25-3
[6] Soundarrajan, M., V. R. Srinivasan, M. Maniyarasan, and K. Venkatesh. "Design and Modeling of Advanced Welding System for Thermoplastics." IJSRD-International Journal for Scientific Research & Development 2, no. 09 (2014).
[7] Soundarrajan, M., S. M. Venkatesh, P. Shankar, C. Sonu Kumar, A. Siva Soorian, M. Soundarrajan, S. M. Venkatesh, P. Shankar, C. Sonu Kumar, and A. Siva Soorian. "Design and Fabrication of Novel Cutter for Timber and Sheet Metal." International Journal for Innovative Research in Science & Technology,4: 91-94.
[8] Srinivasan, N., M. Soundarrajan, K. Venkatesh, P. Ramesh, and K. Pasupathi. "Energy Efficient Air Conditioning System Design And Equipment Selection For Building." IJREAT International Journal of Research in Engineering & Advanced Technology 2, no. 6 (2015).
[9] Palanisamy, S. "SD Denesh kumaar." Stress Analysis of Washing Machine Drum." International Journal of Innovative Research in Science, Engineering and Technology (2015): 610-614
[10] Palanisamy, S., A. Amarnath, P. Ashok, S. Gokul, and M. GOWTHAM. "Design and Fabrication of F1 Race Car Chassis Frame." Imperial Journal of Interdisciplinary Research 3, no. 4 (2017)
[11] R. Ramesh and S. Sundaram A. Kalaiyarasan, S. Palanisamy, Re-engineering of Suspension Control Arm using Aluminium Alloy (AL6065) and Validation using FEA/FEM, International Journal of Mechanical Engineering Research (IJMER) , pp 21-33, 2017.
[12] J.Prabakaran Ranjithkumar A, Sankar S, Sridar S.S, Fabrication of Pneumatic Vehicle By Using Inversion of Slider Crank Mechanism, 1623-1629, International Journal of Innovative Research in Science, Engineering and Technology (2015).
[13] M.Soundarrajan, K.Pasupathi, N.Srinivasan, M.PrasannaVengatesh,"Experimental Investigation of Resistance Spot Welding of Duplex Stainless Steel " International Journal of Applied Engineering Research Volume 10, Number 9, 2015.

