International Journal of Innovative Studies in Sciences and Engineering Technology
ISSN 2455-4863 | Open Access | Volume 7, Issue 3, 2021
DOI: https://doi.org/10.20431/2455-4863.070302

Design and Development of Adjustable Ground Clearance In Vehicle Using Pneumatic Lifting

R.S.Patil[1], R.D.Patil[1], P.J.Rendalkar[1], A.S.Patil[1], A.N.Shinde[1], S.S.Javir[1], V.S.Gondkar[2]

[1]Student, Mechanical Engineering, ADCET, Ashta, Maharashtra, India
[2]Assistant Professor, Mechanical Engineering, ADCET, Ashta, Maharashtra, India

ABSTRACT

The handling of a vehicle depends upon the various parameters, centre of gravity of the vehicle is one of them. For better handling of the vehicle we need to keep the centre of gravity as low as possible. For sport cars it is always kept low but for the passenger cars it compromises with its ground clearance. The designers prefer to maintain fixed ground clearance and design the system to acquire requisite suspension parameters. For different types of tracks, the ground clearance of vehicles is designed accordingly and that is why this is a subtle reason which also differentiates the vehicles as on-road (Sedan/Hatchback cars) and off-road (Sports utility vehicles (SUV)). Off-road vehicles have to face the rough terrain, where we need the high ground clearance of the vehicle, on the other hand we run the same vehicle on a road where high ground clearance is not necessary.

Whereas a sedan car or hatchback has to run on smooth roads as well as on rough terrains sometime with its fixed lower ground clearance which tends to create dents on the bottom portion of the car. In both cases we need an adjustable ground clearance system in the vehicle to have optimum performance.

Keywords: SUV, Off Road, Hatchback, sports utility

INTRODUCTION

Road conditions are not similar at all places, it changes with application, environment and climate. In city at different sectors like school, hospital there are speed breakers of different dimensions. At certain condition road goes straight without any pits else we found irregularity. Most of the people buy only one four wheeler which they use that at all this condition. Hence it's necessary to give some standard ground clearance to the vehicle. But still there are some obstruction while driving the car on highway and in city.

Due to the difficulty of operating automobile jacks, various forms of electric jacks have been proffered. With the development of such electric jacks has gradually come an understanding of some of the problems associated therewith. Due to the torque needed to lift something as heavy as most automobiles, as a severe mechanical advantage must be utilized. Jacks that are built into an automobile have not been accepted due to expense and the need to at least lift each side of an auto, if not all corners individually. To reduce the human effort for operating any kind of jack separately. This will most appropriately benefit senior citizens to provide a safe and simple automatic pneumatic jacking system without manual effort. To provide a novel jacking system that can be operated from within the vehicle by means of a valve control. There are certain mechanisms already available for the same purpose which has a definite capacity to lift the car wheels viz.

LITERATURE REVIEW

Hrishikesh V Deo& Nam P Suh [1] introduced that how the comfort and handling are interrelated with centre of gravity of the vehicle. They designed the suspension system which varies its height and stiffness according to speed. The researchers used short long arm suspension system which is widely used in front wheel suspension. For controlling the height and stiffness, it can be achieved by making the lower spring pivot movable along the lower control arm. For moving the pivoted point and achieve desired position electric motor is used to actuate the actuator. But there are some limitation which we come across, that is about less quick response. In this paper they also described about active and semi-active suspensions limitations and how it can be overcome with adaptive control with variable height. P.E. Uys, P.S. Els, M. Thoresson [2] presented the suspension settings for optimal ride comfort of off-road vehicles travelling on roads with different roughness and speeds. In this they vary the suspension settings for different roads roughness and

vehicle speeds and results achieved for comfort level. Simulation is performed on a Land Rover Defender 110 model in MSC.ADAMS software for speeds ranging from 10 to 50 km/hr. Tests were performed on 100m Belgian paving and also ISO 2631-1, BS 6841 and VDI 2057 at different speeds. Correlation between measured and simulated results is very good, especially with respect to vertical acceleration. There are number of applications related to ground clearance and their consideration is designer need. To give the information about vital role of ground clearance. Debojyoti Mitra [3] presented design optimization of ground clearance of domestic cars. Stability and performance is also parameter of ground clearance. If we allow the vehicle for the low ground clearance then it helps to give less drag force simultaneously it consumes less fuel resulting less pollution. The experiment is carried out in wind tunnel with the help of notch back car model. The result shows that the positive lift force reduces with increasing height of ground clearance. Hence the optimized value of h/b ratio has to be taken in to consideration of clearance design. With the help of spoiler the lift force problem can be solve. The active suspension system is very essential for handling and giving comfort. These days this system is used in different type of vehicles like hybrid vehicles. Morteza and Mahdi [4] presented active suspension system in parallel hybrid electric vehicles. In this they compare the conventional and hybrid vehicle with active suspension. For conventional the power is taken from the IC engine hence gives little lag in actuation while in hybrid electric vehicle it is direct, resulting less fuel consumption and less emission. Guangqiang Wu, Guodong Fan, and JianboGuo[5] presented ride comfort evaluation for road vehicle based on rigid flexible coupling multibody dynamics. Spectrum of vibrations occurs in the vehicle due to various speeds. There are different road profiles and roughness therefore occupants are subjected to accelerations in different directions, which caused discomfort.

Proposed Method

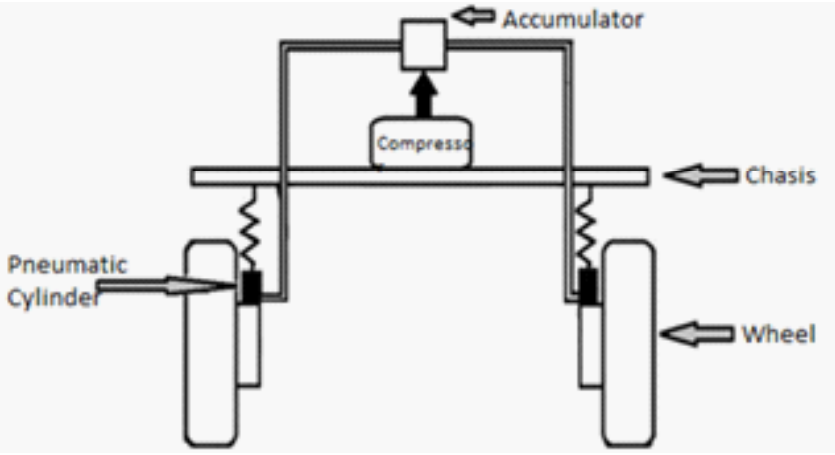

Figure1. Proposed Schematic Diagram

The entire lifting mechanism functions as an active suspension system, consisting of four pneumatic cylinders, which are installed in each wheel assembly and passive suspension system between, so that the cylinder looks upwards and the inner dead point looks downwards. The intake port of each cylinder is connected to the accumulator through an air pipe. The accumulator is connected to the outlet of the reciprocating compressor through an air pipe, which is installed on the frame at a fixed position. The electric motor uses battery power charged by the electric motor to drive the reciprocating compressor. There are two button systems on the dashboard, one for starting the engine and one for opening the cylinder outlet to release high-pressure gas. When driving on smooth and uneven roads or rough roads, people driving on flat roads can choose to connect the engine by simply pressing the button assigned to the engine, thereby increasing the ground clearance. As the rough terrain ends, the vehicle driver can open the exhaust valve of the pneumatic cylinder by pressing another assigned button to release high-pressure air into the atmosphere, resulting in all the elevated pistons of the pneumatic cylinder, thereby lowering Chassis height. Lower to an internal neutral position. Releasing the pressed button ensures that the outlet valve of the cylinder is closed. Similarly, the driver can have the car's standard ground clearance so that it has an appropriate centre of gravity to take full advantage of the acceleration potential.

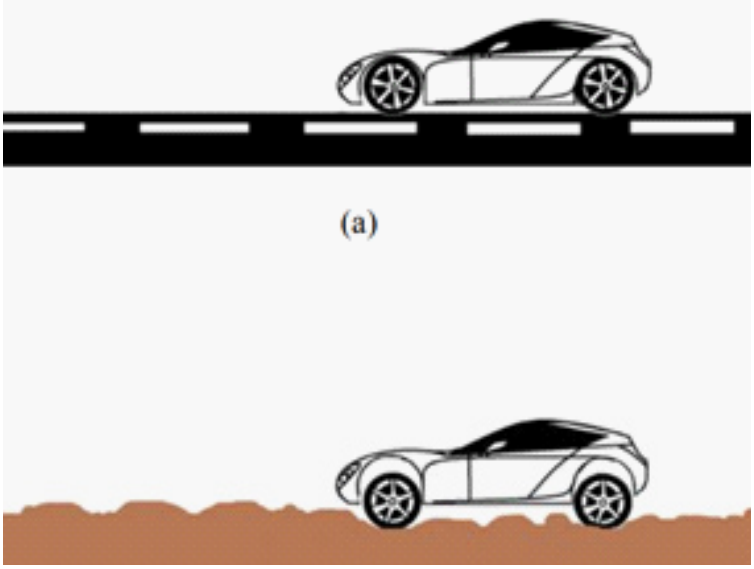

Figure2. Vehicles performance on Smooth & Rough road

The prototype of the project includes a four-wheel chassis with axles, a reciprocating compressor, four electric motors, a DPDT controller and other design accessories. The prototype car is powered by an electric motor, and the compressor runs on a battery to generate aerodynamic lift in each car to increase the car's ground clearance. The controller is used to operate the compressor and the motor to operate the mechanism.

DESIGN

Frame Size = 600 mm x 300 mm Material= Mild Steel

- Total Load = Weight of cylinder + Weight of Frame + Weight of accessories
- Weight of each cylinder = 0.6 kg
- Weight of Frame = 5 kg
- Weight of another accessories = 15 kg
- Total weight = (0.6 x 9.81) N + (4 x 9.81) N + (15 x 9.81) = 219.744 N
- Each wheel has individual cylinder, so total weight to be considered of frame and assembly is divided.
- Therefore, to lift each wheel, the cylinder to be designed should be able to lift minimum of 1/4th of total weight.
- Total weight = 220 N
- 1/4th of total weight = 220/4 = 55N.
- Minimum 55 N of weight should be lift by individual cylinder.
- Considering accessories and frame design structure,
- We will calculate the cylinder design for 70 N as a factor of safety.
- The formula used by this calculator to determine the piston cylinder force from pressure and diameter is:

$r = D/2$ $A = \pi \cdot r2 = \pi \cdot (D/2)2$

$F = P \cdot A$ $F = P \cdot \pi \cdot (D/2)2$

Symbols

- F = Force
- P = Pressure

• π = Pi = 3.14159…

• r = Circle radius

• Ø = Circle diameter

• A = Circle area

1. Applied Pressure = 3 bar

2. F = 70 N.

3. P = Consider pressure of 3 bar.

4. A = (D/2)2 = D2 / 4

Therefore,

D = 5.45 x 2 = 10.90

Hence, minimum of 11mm dia. cylinder should be selected.

Table1. Air Consumption Details

FORCE, AIR CONSUMPTION FOR DOUBLE ACTING CYLINDER

Double acting Cylinder			Force (N)									
Ø	Ø		Pressure (bar)									
Bore	Piston Rod		1	2	3	4	5	6	7	8	9	10
8	4	⇆	5 3.7	10 7.5	15 11.3	20 15	25 18.8	30 22.6	35 26.3	40 30.1	45 33.9	50 37.7
12	6	⇆	11.3 8.4	22.6 16.9	33.9 25.4	45.2 33.9	56.5 42.4	67.5 50.8	79.1 59.3	90.4 67.8	101.7 76.3	113 84.8
16	6	⇆	20.1 17.2	40.2 34.5	60.3 51.8	80.4 69.1	100.5 86.3	120.6 103.6	140.7 120.9	160.8 138.2	180.9 155.5	201 172.7
20	8	⇆	31 26	62 52	94 79	125 105	157 131	188 158	219 184	251 211	282 237	314 263
25	10	⇆	49 41	98 82	147 123	196 164	245 206	294 247	343 288	392 329	441 371	491 412

Stroke length should be selected such that it would lift wheel for at least 60 to 80 mm. So, considering length of cylinder arrangement and the wheel lift length, we required the stroke of 75mm.

Table2. Standard Stroke

STANDARD STROKE

DOUBLE ACTING (D)

BORE (mm)	STANDARD STROKE (mm)	MAX. STROKE (mm)
8	25, 50, 75,100	100
12	25, 50, 75,100	100
16	25, 50, 75,100	200
20	25, 50, 75,100, 150, 200	1000
25	25, 50, 75,100, 150, 200, 250, 300	2000

Selection from standard details

We have to select the cylinder of 25mm diameter and 75 mm stroke.

Conclusion

Pneumatics actuators can act efficiently. The air required for the operating of the actuators is easily available in the nature. Cost of the project is not high compared with other systems as compared with hydraulic. As our actuators are inbuilt the fatigue is less. If made in the lot the cost could be less. It serves better than hydraulic.

The benefit behind this project results in avoiding the obstacle which can directly impact to chassis from below. Due to automatic adjustment, it is help for preventing the vehicle in off-road conditions.

REFERENCE

1. Hrishikesh V Deo, Nam P Suh —Axiomatic Design of Customizable Automotive Suspension‖ The Third International Conference on Axiomatic Design Seoul, June 21-24, 2004
2. Shivaraj Chandrakant Patil- A review on adjustable ground clearance mechanism, December 2016
3. P.E. Uys, P.S. Els, M. Thoresson, —Suspension Settings for Optimal Ride Comfort of Off-road Vehicles Travelling on Roads with Different Roughness and Speeds‖ Journal of Terr mechanics 44 163– 175, 2007
4. Debojyoti Mitra —Design Optimization of Ground Clearance of Domestic Cars‖ International Journal of Engineering Science and Technology Vol. 2 (7), 2678-2680, 2010
5. Morteza Montaner- Gh, Mahdi Soleymani Morteza Montazeri-Gh& Mahdi Soleymani —Active Suspension System in Parallel Hybrid Electric Vehicles‖ IUST International Journal of Engineering Science, Vol. 19, No.5-1, Page 97-104, 2008
6. Wikipedia(www.wikipedia.com),YouTube (www.youtube.com) and other internet articles

Citation: *R.S.Patil, R.D.Patil, P.J.Rendalkar, et.al. Design and Development of Adjustable Ground Clearance In Vehicle Using Pneumatic Lifting. Int J of Innovative Studies in Sciences and Engineering Technology. 2021; 7(3): 8-12. DOI: https://doi.org/10.20431/2455-4863.070302.*