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1

This report will look into it active damping and how it can be used. Active damping will use electronics to change the characteristic of the damper meaning that the ride quality will change depending on what is required whether to provide the maximum available grip allowing for better handling or a luxurious smooth ride is required so the bumps are seen as soft. Dampers are a vital part of a suspension set up as they will control the energy being put into the vehicle and stop the vibrations that are put into the vehicle.

1.1

This report will use a range of different testing using both physical and theoretical testing in the form of CAD and CFA. Dampers will be physically tested using a rig with their results being critically evaluated to provide a specification of the qualities required of an active damper, an active damper will then be tested to see if it has the capability to be give both a luxurious ride and the handling qualities needed.

2

Suspension systems are a vital component to any vehicle, this is because the ability to control a vehicles wheels is key to the performance. Suspension characteristics will vary from vehicle to vehicle depending on what the vehicle will be used for, for example in a performance car the suspension system will need to be hard to ensure that the vehicle is in contact with the road for as much as possible to give the full amount of grip, whereas for a luxury vehicle suspension systems will be softer to ensure that there is a more comfortable ride for the user and passengers. This report will look at how implementing active dampers will allow a vehicle to have changing characteristics meaning it is possible to have different ride settings depending on what the user requires. Many companies have used active dampers with results being mixed as they need large amounts of testing and engineering to give a good ride quality, the costs of developing as well as the complexities of the systems often puts off smaller and cheaper cars from using active damping. Throughout this report various different dampers will be tested and plotted to show a range that required, an active damper will then be tested to see if that sort of range would be possible.

3

Suspension is used in vehicles as a way of controlling the wheel in relation to the cars body, this is done for two main reasons the ride quality and handling. Suspension has been used from as early as 1200BC as the Greeks used thin willow in their wheels with only four spokes to give a springy quality to the chariots used at the time, this was seen as a way of dealing with the rough grounds (Gordon, 1978). Suspension was later evolved as horse drawn carriages would attach the wheels to a frame and suspend the whole passenger structure to allow for a smoother ride, this allowed for more comfort but there was no way of controlling the frequency in which it moved at (The Editors of Encyclopaedia Britannica, 2013). Vehicles have used various different suspension systems with the early vehicles employing leaf springs in the early 1900's (Evans, 2018). Throughout time different systems have been brought in with coils springs appearing on vehicles as early as 1906 in the Brush Runabout. Today there are a range of different suspension set up systems with each system having its own advantage and disadvantage over others. Independent suspension is widely used in both the front and rear of modern vehicles and will allow for each wheel to act upon its own axis meaning it is not affected by what is happening at the other wheels (Bastow, 2004).

4

There is multiple different jobs the suspension must do for it to be considered successful. Suspension must be able to allow for vertical movement of the wheel as it will go up and down whilst going over uneven surfaces. The suspension must also be able to take the weight of the vehicle meaning that the wheels can spin freely and are not locked by the weight of the vehicle (SAE, 2001). There will be multiple different forces put into a cars suspension including the weight of the car moving down towards the ground with driving and breaking forces being applied whilst accelerating and deceleration in the longitudinal axis with cornering forces being applied to the lateral axis (Reif, 2014).

5

Coil sprung suspension systems will be made up of a series of different components including a top strut that will connect the suspension to the chassis of the vehicle (Reif, 2014). The suspension connection at the bottom differs depending on the type of suspension that is being used as can be straight to the hub or to a lower wishbone. The coil

springs are a vital component in modern suspensions, their job in the suspension will be to absorb the energy that is put into the wheels, with the only force that will be transmitted into the vehicle's structure is that causing the spring to compress raising the wheel over the bump (SAE, 2001). The characteristics of the spring will be decided by the size of the springs and the amount of coils contained, this is defined as a spring rate meaning the force needed to compress the spring. The other component is the damper, this is what the project will focus on in detail how they work.

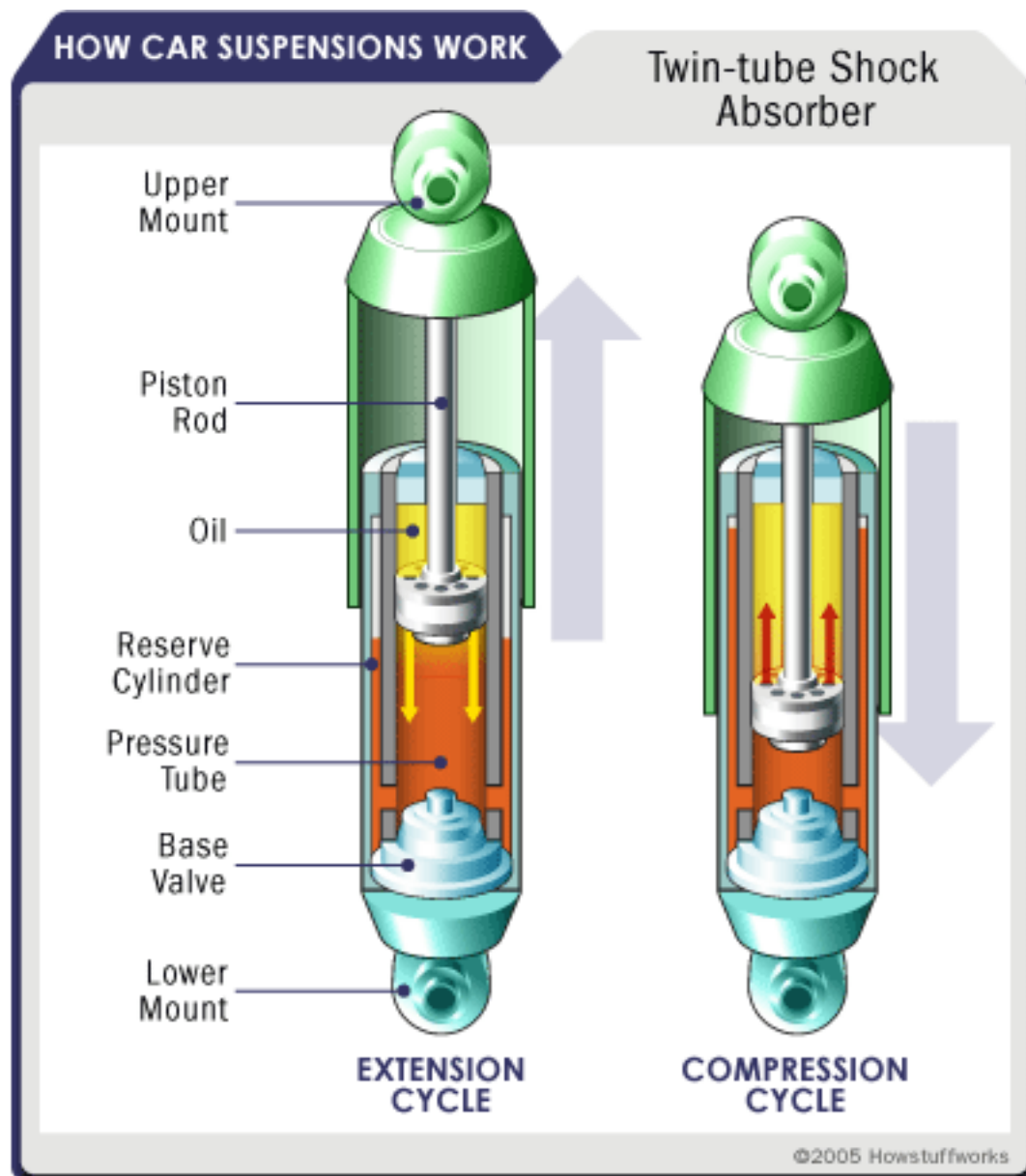
6

Dampers are used as a way to stop the vibration put into the suspension due to inconsistencies in the road surface, if dampers were not used the vibration would never stop (Harris, 2015). Dampers will control the amount of movement allowed in a spring, this will then allow for a more consistent ride as if the spring was left untreated the force would continue in the spring meaning it would be inconsistent and create a bumpy ride (SAE, 2001). Dampers will work as energy converters in converting kinetic energy into heat energy that will be spread throughout the fluid. Damping occurs in three different ways including air resistance, friction and viscous damping, Air resistance will be small compared to the force required to prevent movement in the suspension as the force applied with the sprung mass will be greater. Friction in suspension is harmful because the static force of the friction will need to be exceeded for there to be an effect leaving the suspension in a locked state meaning movement is not possible and then puts the force on to other parts in the suspension (Thyssenkrupp, 2018). This means the majority of the force will be dealt by the viscosity of the fluid in damper usually controlled hydraulically with the resistance in the fluid controlling the speed in which the damper moves.

6.1

Dampers will work in two different cycles the compression and the extension cycle of the damper. The compression cycle will happen when the piston moves downwards and to its closed state this will compress the fluid in the chamber below the piston, this will control the motion of the unsprung mass (Chahine, 2011). The Extension cycle will occur when the piston moves back to its open state and will compress the fluid in the chamber above the piston, this will have more resistance as it will be dealing with the force of the sprung mass (Chahine, 2011).

Figure 1



7

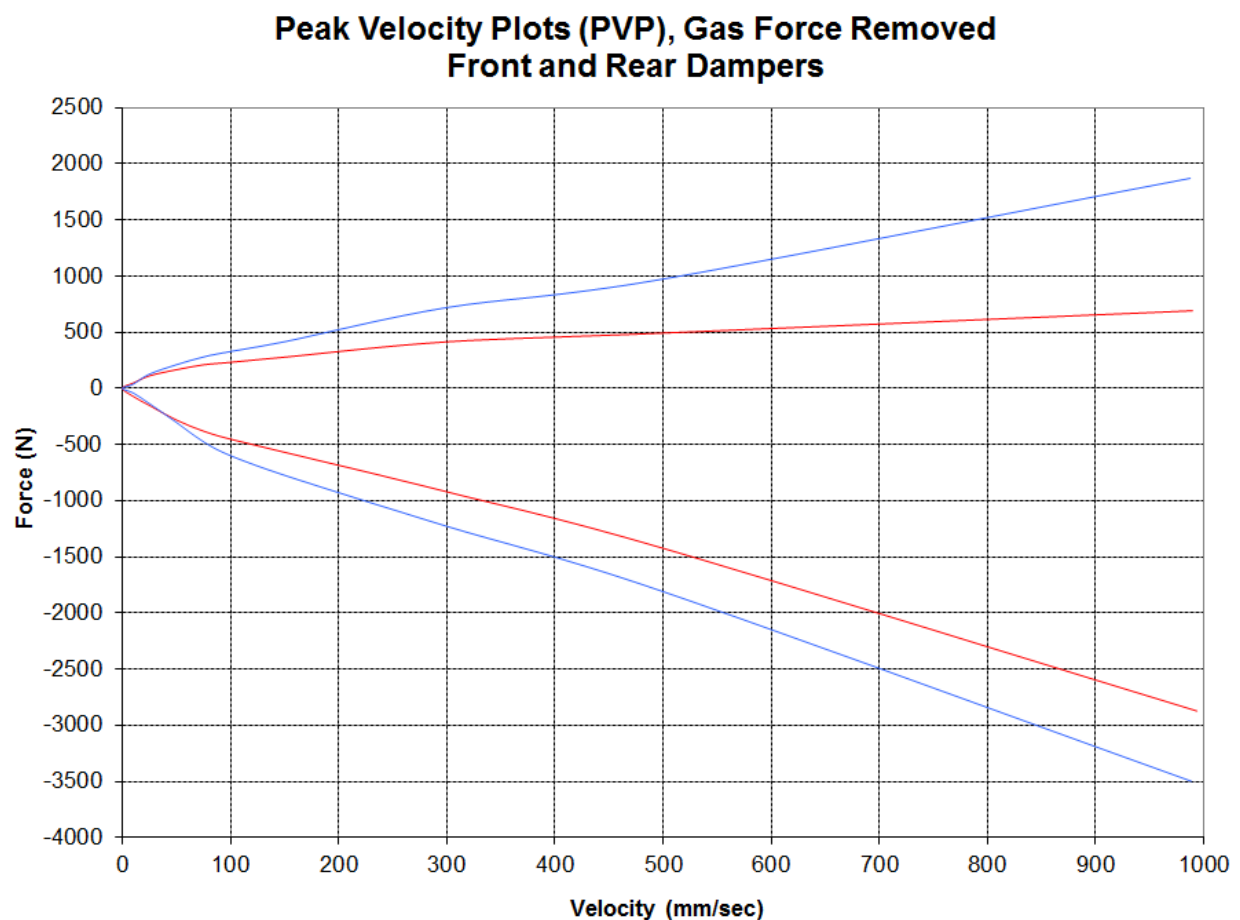
Active damping will control the vertical movement of the wheels relative to the vehicles body using an on-board system to control the oscillations instead of being controlled by the road conditions.

Magnetorheological dampers work by having a magnetorheological fluid in the cylinder, this fluid will then have a magnetic field applied to it using an electromagnet. A magnetorheological fluid is a type of smart material that when has a magnetic field applied to it will change its viscosity, it will have a carrier oil that will then contain magnetic particles (Bajkowski, 2007). By applying different power to the fluid, it will then give the dampers different characteristics by allowing the damper to move at different speeds in both the compression and extension cycle. Magnetorheological dampers adapt to different road conditions by having sensors throughout the vehicle, changes in dampers can occur as quickly as 60 milliseconds (Bajkowski, 2007).

8

Dampers can be tested and measured using a test rig, this will put the damper under multiple different loads and speeds with the results being plotted onto a computer for the results to be analysed. It will show the speed that the damper moves at depending on the load that is applied to it, it will plot this for both the bump and the rebound as shown in figure 2 (Ntityres, 2018).

Figure 2



9

Future plans in this project will include testing various different dampers from similar vehicles and show the capabilities of such and then this will include testing an active damper to see the range that is possible when different currents are applied. A damper will then be designed that is capable of the full range of capabilities with its charges that are required to achieve such calculated. Further research will be done into the user's needs and what is expected of the car whilst under different road circumstances, this will then allow the design of the system to what triggers different charges being applied to the damper.

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