ANALYZE THE REAR SUSPENSION STRUCTURE FOR PASSENGER CAR

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ABSTRACT

The design of vehicle, suspension system is very important. The suspension system is including of the spring and the absorber. Suspension system is very important in optimum the driving in term of comfort and safety. Furthermore, it is important to identify the suitable suspension for the cars. Because of that the research is done in order to analyze the effect of number of coils to the stiffness and the forces require tending back the spring to the original position. In order to find the stiffness of the spring, manual calculation will be use. After the stiffness got, the value will be use in simulation which is cosmos motion software. Each coil has different values of stiffness. From simulation the different value of force will be get because of each spring with different coil will have different value of force. The analysis is done to identify the effect of the number of coils to the spring. With the different number of coils the stiffness of spring will be different and this research wants to identify whether the value of stiffness will increase or decrease due to different of coils. In this research the suspension of Proton Waja will be use because of the passenger car. The load that will be given in the simulation is 2000N, 3000N and 4000N. The numbers of coils that will be analyzed are 6 coils, 7 coils, 8 coils and 9 coils. The final results from calculation and simulation will be comparing according to the number of coils.

ABSTRAK

Dalam kenderaan, penyerap gegaran "*shock absorber and spring (suspension)*" adalah bahagian penting yang digunakan untuk mengoptimumkan pemanduan selesa dan keselamatan pemanduan. Oleh itu, ia adalah perlu untuk mengenalpasti kelakuan dan keadaan penyerap gegaran (suspension). Dengan itu, kajian dilaksanakan untuk tujuan menganalisis kesan pemotongan lilitan spring kepada stiffness atau kekuatan spring melalui cara pengiraan manual. Selepas pengiraan manual siap dan stiffnes diperolehi, nilai stiffness tersebut akan dimasukkan ke dalam software cosmos motion untuk menganalisa kesan stiffness kepada daya (force) yang bertindak untuk spring dan shock absorber kembali dalam keadaan asal. Analisis ini dilakukan untuk mengkaji adakah apabila lilitan spring dipotong menyebabkan stiffness meningkat atau menurun dan adakah apabila lilitan spring dipotong force meningkat atau menurun. Dalam kajian ini, suspension yang digunakan ialah suspension waja untuk 1600cc. Dalam kajian ini juga, berat yang dikenakan ialah 2000N, 3000N, dan, 4000N. Spring yang digunakan pula ialah dari 9 lilitan untuk asal hingga dipotong sampai tinggal 6 lilitan. Lilitan tersebut ialah 9, 8, 7, dan, 9 lilitan spring. Keputusan akhir daripada pengiraan dan analisa dari cosmos motion dibandingkan mengikut lilitan spring.

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LIST OF SYMBOLS

A	Amplitude of oscillation
A_p	Piston section area
A_r	Rod section area
c	Viscous damping coefficient
$F_{damping}$	Damping force
$F_{friction}$	Friction force
f_n	Natural frequency
k	Spring stiffness
m	Mass
P_c	Pressure from chamber
P_r	Pressure from rod
x	Displacement
$\dot{x}$	Velocity
$\ddot{x}$	Acceleration
ϕ	Angles
π	Mathematical constant in radians
θ	Angles
τ	Period/time
ω	Circular frequency

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, people are looking for the car with the best performance. In order to archive this desire, one should consider the whole part of the car system. The automotive system include of power plant, power train, steering system, breaking system, suspension system, and chassis. Out of many part, the suspension system is very important which is influence the performance of the car and provide safety and comfort for the driver and occupants. The suspension system includes the springs, shock absorber, struts, control arms and spindle or axle as well as the bushing that allow the necessary motions. These parts should hold the tire and wheel in correct alignment with the car and the road. (Birch, 1999)

Apart from the car's tire and seats, the suspension is the prime mechanism that separates the bum from the road. It also prevents the car from shaking itself to pieces. No matter how smooth the road is, it's a bad, bad place to propel over a ton of metal at high speed. So we rely upon suspension. In its most basic form, suspension consists of two basic components. Spring come in three types. These are coil springs, torsion bars and leaf springs. Coil springs are what most people are familiar with, and are actually coiled torsion bars. Leaf springs are what would find on most American cars up to about 1985 and almost all heavy duty vehicles. The main function of shock absorber is to dissipate the energy introduced in the vehicle by road irregularities and by driving situation. Shock absorber actually not to absorb shock but it is done by the spring. The

goal of the shock absorber is to dampen spring oscillation. In order to reduce spring oscillation, shock absorber absorbs energy. The shock absorber absorbs different amounts of energy depending on how fast the suspension is moving. So, shock absorber also could be call as the energy converter. Car manufacturers have set out to baffle use with the sheer number of different types of suspension available for both front and rear axles. The main groupings are dependant and independent suspension systems and divide into two types, front and rear suspension.

1.2 Project Title

Analyze the rear suspension structure for passenger car.

1.3 Project Objectives

1. To analyze the comparative study for stiffness of coil spring.
2. Study the current structure of rear suspension by using cosmos motion software.

1.4 Project Scopes

1. The passenger car investigate common type used in country
2. The passenger car used below 1600 cc vehicle capacity
3. Focusing on spring component.
4. Analyze and simulate the suspension system structure by using cosmos motion software.
5. The analysis of spring coils is between 6 to 9 coils

1.5 Problem statements

Shock absorber failure can happen due to fatigue and the actual life short of the shock absorber is difference according to force applied. The different of number of coils can be effect the performance of the suspension.

CHAPTER 2

LITERATURE REVIEW

2.1 Suspension system

The suspension system includes the springs, shock absorbers, struts, control arms and spindle or axle as well as the bushings that allow the necessary motions. These parts should hold the tire and wheel in correct alignment with the car and the road which also allow the tires and wheels to move up and down relative to the body over bumps and holes in the road surface. The tires can thus follow the road surface and maintain traction without transmitting the roughness of the road to the driver and passengers (Figure 2.1). When ridden in a vehicle with a solid suspension such as a farm tractor, bicycle, or forklift the value of a well adjusted suspension system can be found when went over the first bad bump. The solid suspension probably transferred most of the bump from the road.

For the car's chassis, the side-to-side distance between the center lines of the tires on an axle is called the track. The distance between the centers of the front tires and the centers of the rear tires is called the wheelbase (Figure 2.2).

In order to make the correct alignment, a tire should roll on a path that is parallel to the center line of the vehicle. This is called zero toe-in or toe-out. The tire should also be straight up and down or at a right angle (90°) to the road surface. This is called zero camber. If one or more of the tires is not positioned this way, it is out of alignment and will have to scuff or scrub sideways as it rolls down the road. This will cause tire wear and a loss in fuel economy since a scuffing tire

does not roll as freely as one that is aligned correctly. In actual practice, the tires are often aligned to have a slight amount of toe or camber to compensate for suspension travel and road forces (Figure 2.3).

The steering system allows the driver to control the direction the car travels. Turning the steering wheel will cause the front wheels to point in the direction the driver wants to go. The steering system consists of the steering wheel, steering gear, and tie-rods. (Birch 1999)

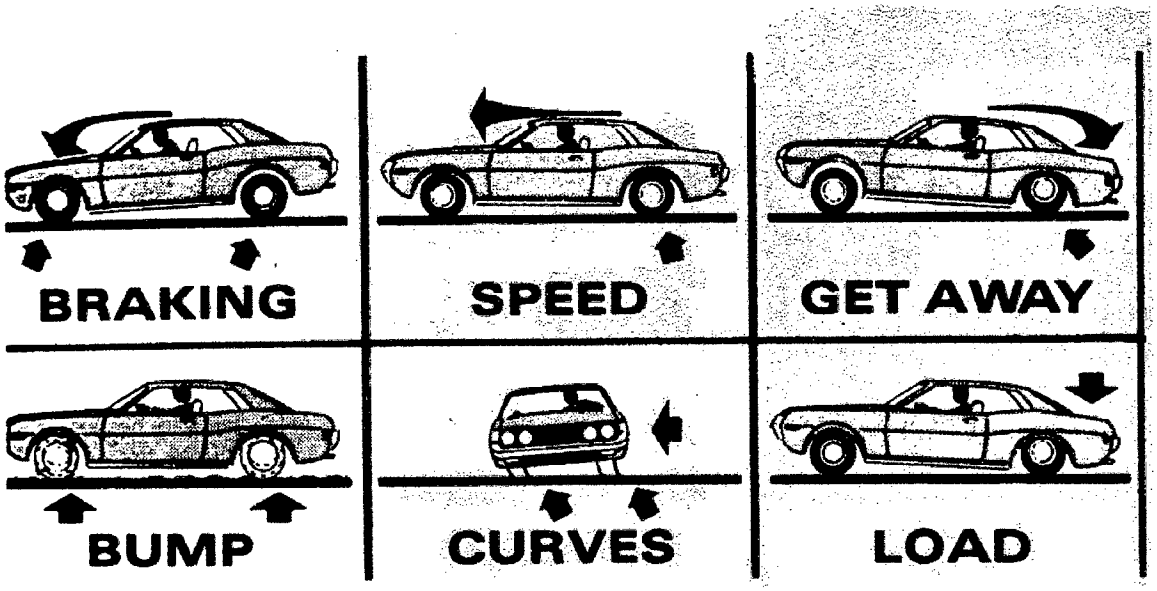

Figure 2.1: shows the cars suspension system allow the tires to maintain contact with the road when the car is operated under various conditions. The suspension system play important role in making the contact of tire is under control. (Thomas W. Birch 1999)

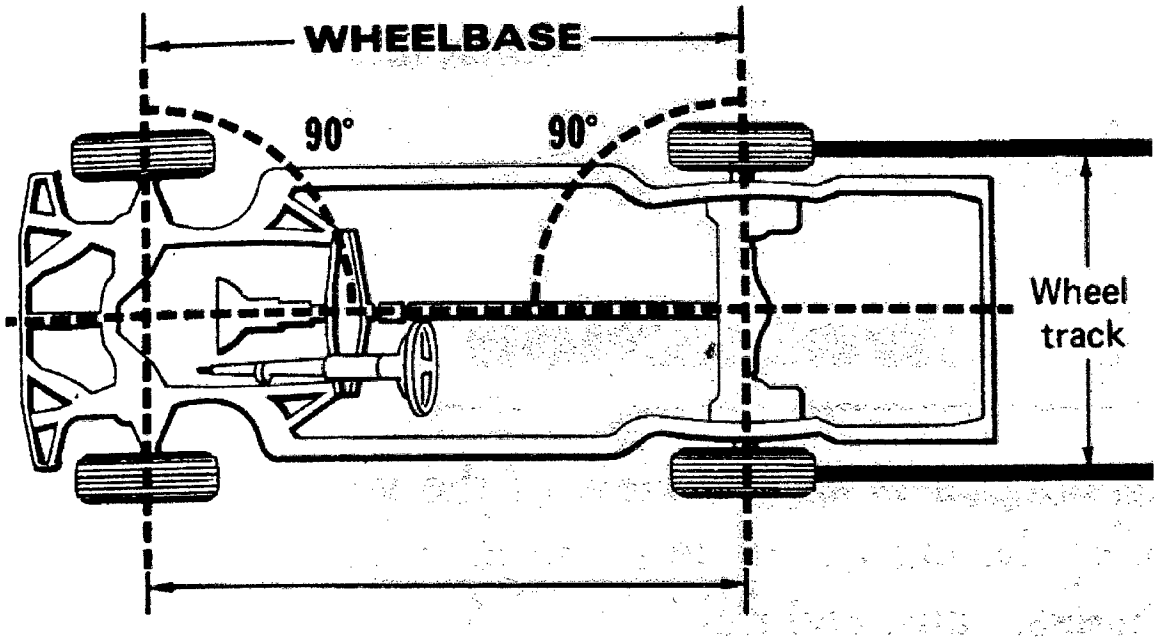

Figure 2.2: show the suspensions system that keeps the cars tires parallel to the center line of the car when it is going straight ahead. The lengthwise distance between the axles is called the wheelbase; the crosswise distance between two tires on an axle is called track. (Birch 1999)

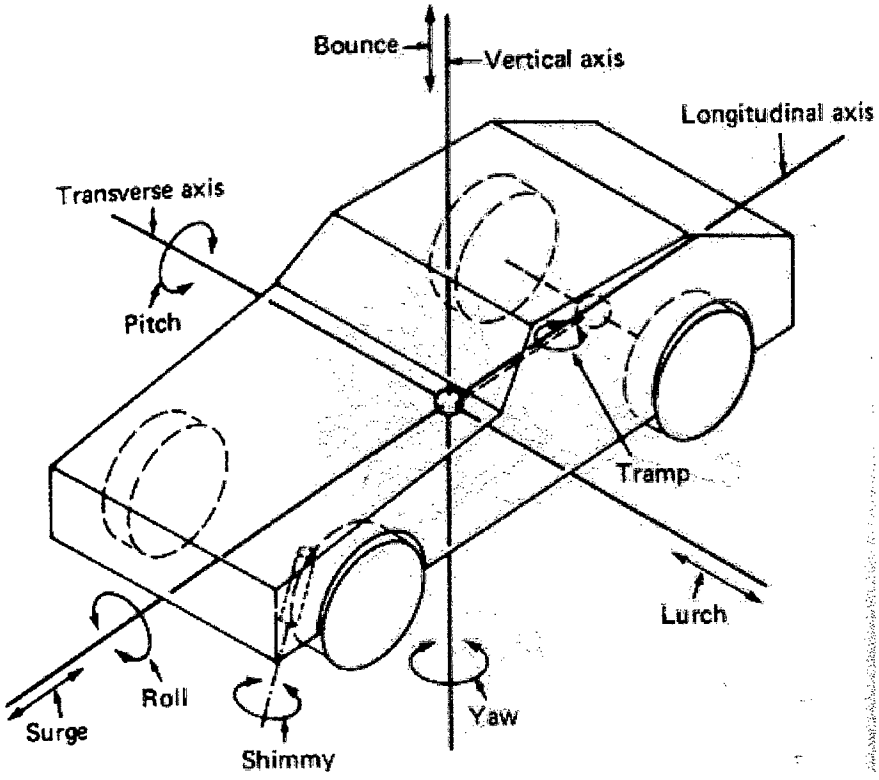

Figure 2.3: show the body and suspension members of a car can move in several different directions with several function. (Birch 1999)

2.2 Overview of suspension

The suspension system of a vehicle is present to prevent the variations in the road surface encountered by the wheels from being transmitted to the vehicle body. There are two main categories of suspension systems: independent and non-independent. An independent type has each wheel moving up and down without affecting the wheel on the opposite side of the vehicle. On non-independent systems movement of one wheel will affect the wheel on the opposite side of the vehicle. (Schwaler, 1999)

2.3 Rear suspension

The line between two rear wheels is called the thrust line. This thrust line should run down the middle of the car. The car's path during straight-ahead driving follows this thrust line. If the thrust line runs at an angle to the car's center line, the rear tires will not track or follow in direct alignment with the front tires. A rear tire and wheel thrust line that points to the right of the vehicle's center line (at the front) will cause the rear tires to steer to the right.

Rear suspension can divided into two types: no independent types and dependent types. Rear suspensions are very similar to front suspensions in allowing vertical tire movement. However, in most cases not allow steering, and in those cases where four-wheel steering (4WS) is used, the steering is very limited. 4WS is used to improve front steering characteristics. Rear tires and wheels are normally set at or near zero camber (straight up and down) and zero toes (straight forward). Excessive camber or toe would cause tire wear and, possibly, a car that dog tracks and goes down the road slightly sideways.

The front tires will have to be steered to the right in order to go straight down the road; and the rear tires will leave tracks to the right side of the tracks left by the front tires.

Rear wheel alignment on solid axles, camber, toe, and track, are controlled by the strength and length of the axle and axle housing. The rear wheel end of the wheelbase is controlled by the rear springs or control arms. (Birch 1999)

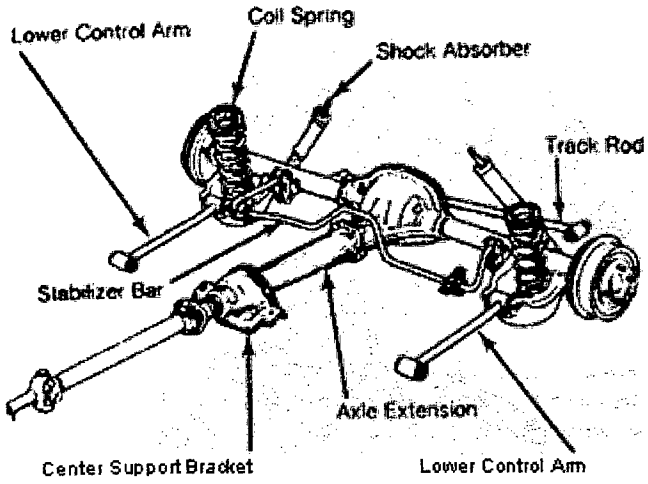

Figure 2.4: shows the center support bracket and the axle extension prevents axle rotation from acceleration or brake torque response. The driveshaft and axle extension are a type of torque tube driveshaft. (Birch 1999)

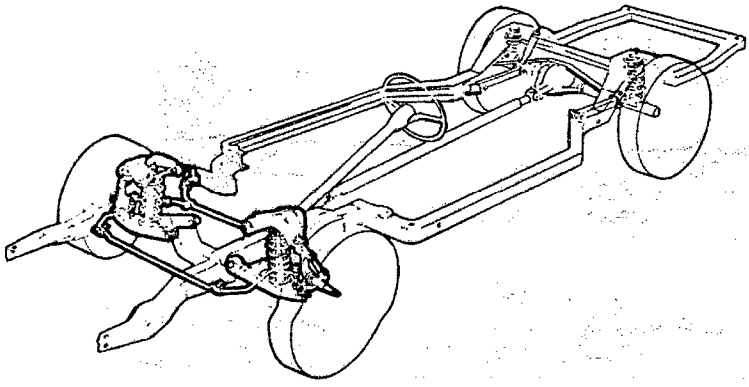

Figure 2.5: shows on most RWD cars, the rear axle assembly controls rear wheel camber and toe angles, the wheelbase and the crosswise position of the axle are controlled by the rear leaf springs or suspension control members. (Birch 1999)

In some systems the rear suspension is arranged to produce a steering effect when cornering. As the suspension deflected the road wheel toes-in due to the arc of movement of the semi-trailing link. This produces under steer on cornering and it gives a small degree of same direction rear-steer. (Schwaler, 1999)

2.3.1 Non independent suspensions

The suspension arms or axles connect the wheels and tires to the frame and allow the tires and wheels to move up and down relative to the frame and body. The different styles of suspensions fall into two general classifications, independent and no independent. In no independent suspensions, the front wheels are mounted on the same axle, and the rear wheels are mounted on another, single axle. Trucks and pickups use a solid front axle. Nearly all rear wheel drive (RWD), front-engine cars as well as trucks and pickups use a solid rear axle. Solid axles are strong and relatively inexpensive.

Besides simple and trouble-free, especially on drive axles, there are also several drawbacks with solid axles. First to make sure is heavy characteristic, it is because of their weight, the vehicle's unsprung weight will increase. This increase in unsprung weight will require more spring and shock absorber control to keep the tires in contact with the road. Also, when one tire of a solid axle goes over a bump, the other tire on that axle will have to change position and possibly lose traction. A car with solid axles will usually have a harsher ride than a car with an independent suspension. (Birch 1999)

2.3.2 Independent suspensions

Independent rear suspension (IRS) on rear wheel drive has been used only on cars of a luxury or sporty nature. IRS is more expensive to build and has more wear points than a solid axle but it provides better ride qualities and usually better camber and toe control of the rear tires.

Independent rear suspension is used on many front wheel drive cars. Independent rear suspension means that each rear wheel is independent in its

movement. This is much the same as the front suspension system. Although there are many designs for independent rear suspension, most systems include coil springs, control arms, struts, and stabilizer bars. (Bornick, 2005)

One reason for an improved ride is the reduction of unsprung weight. The housing and final drive gears, which include the ring and pinion plus differential, are mounted on the frame. Their weight is carried by springs, not directly by the tires and wheels. Reducing the unsprung weight allows better spring and shock absorber control of tire and wheel movement. Power is transmitted from the differential to the tires and wheels by a pair of driveshaft or half shafts, much like those on an FWD car.

It follows, that what can be fitted to the front of a car, can be fitted to the rear to without the complexities of the steering gear. Simplified versions of all the independent systems described above can be found on the rear axles of cars. The multi-link system is currently becoming more and more popular. In advertising, it's put across as '4-wheel independent suspension'. This means all the wheels are independently mounted and sprung. There are two schools of thought as to whether this system is better or worse for handling than, for example, Macpherson struts and a twist axle. The drive towards 4-wheel independent suspension is primarily to improve ride quality without degrading handling.

In independent suspension systems, each one of the front wheels, and sometimes the rear wheels, are mounted on separate spindles and control arms. Mounting the wheels separately allows them to travel up or down independently of the other wheel on the same axle. This usually reduces the unsprung weight and gives a softer ride with greater control of the tire and wheel position. However an independent suspension is a more complicated system with more parts and movable bushings. There will be more parts to wear out, possibly leading to misalignment of the tires. All passenger cars, many pickups, and a few trucks have independent front suspensions.a few RWD and some front wheel drive FWD cars will have independent rear suspension (Figure 1-9). (Birch 1999)