Volume 3, Issue 2, February-2016, pp. 70-75 ISSN (O): 2349-7084
IJCERT International Journal of Computer Engineering In Research Trends
Available online at: www.ijcert.org

Automotive Tyres: Study on Vehicle Computerized Wheel Alignment"

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Abstract:- Buying high quality tyres, buying the proper size for any automobiles, buying from a reputable tyre retailer, are of all these things are importance for tyre safety, long tyre life and driving satisfaction. While alignment is that aligning the front wheels relative to each other. Setting of castor, camber, toe-in or toe-out and king pin inclination. Computerized wheel alignment, a series of tests and adjustments to ensure that wheels and tyres are properly positioned on the vehicle. There are two types of wheel aligners, i.e. Mechanical types, which is attach to the wheel spindle and some have light beams that display the measurement on a computer screen and others are electronic that indicate the measurements on meter, display or printouts.

Many vehicles today are equipped with a rear suspension design that allows adjustments for rear wheel alignment or with a design that requires a rear wheel check. When a rear suspension is not in alignment, it may create problems for the front as well as the rear wheels problems like an apparent crooked steering wheel, camber or toe induced front tyre wear and directional pull or lead. Vehicles have changed the suspension , steering and drive train design all require a total vehicle i.e. four wheels approaches to alignment for proper performance of today's vehicles.

Key words: Conventional Tube Tyre, Noise and Balance, Piles., Tyre Threads, Tubeless tyres, Wheel Alignment etc

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2. Introduction:

The requirements of tyres are consisting by Load Carrying, Cushioning, Uniform Wear, Non-skidding, Power consumption, noise and Balance.

Load Carrying, the tyre should be able to carry the weight of the vehicle and its occupants without distortion. Cushioning should absorb the shock loads caused due to road irregularities and damp the vibration fast. Uniform wear, the tyre should not develop skidding even on wet roads and uniform wear reduces tyre skid and vibrations due to road irregularities. Non – skidding, the tread pattern design such that the tyre may not skid much on wet road, because the rubber have a co-efficient of friction. Power consumption, the tyre must have a low rolling resistance and therefore, must consume least of the engine power. Noise, which are depending threads pattern and type of road balance, the tyre should be statically and dynamically balanced.

Pneumatic tyres are two types:

2.1. Conventional tube tyre:

Conventional tube tyre, it comprises an inflated rubber tube placed inside the rubber tyre.

2.2. Tubeless tyres :

This tyre does not use an inner tube. The tubeless tyre is mounted on the wheel rim so that the air is retained between the rim and the tyre. The inside of the casing is lined with a soft rubber lining which forms an air tight seal with the rim.

Tyre casings and tubeless tyres are made in about the same and layers of cord is called plies and made by rubber.

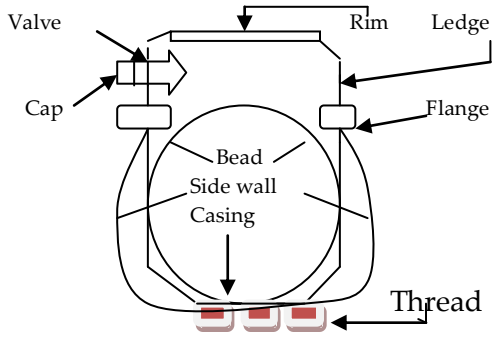

Fig: 2(a) Tubeless tyre bead rests between the ledges and flanges.

3. Literature Review:

The inflation Pressure:

The inflation pressure depends upon tyre size, tyre type, Speed and load. The inflation pressures are recommended by the vehicle manufactured and some questions are the following about on inflation:

3.1. Questions:

How much air should put in tyres?

Answer: Tyres should be inflated to the pressure recommended by the manufacture. The most important part of tyre care is Air.

Under-inflation:

The worst enemy a tyre can have is too little inflation pressure. An under inflation tyre generates excessive heat which reduces fuel economy and increased tread wear in the maximum inflation pressure specified on the tyre side wall can improve fuel economy and extend tyre life. Over and above, under-inflation causes the following defects.

3.1.1. Lack of directional stability,

3.1.2. Increased rolling resistance leading to increased fuel consumption,

3.1.3. Excessive flexing of side walls cause excessive build up, etc.

However, to check tyre inflation at least ever two weeks and before any long trips. Radial tyres their normal shape has a slight side well bulge, radial tyres require even more careful inflation checks. In terms of vary inflation with load, vehicle carrying extra weight a little additional air should be added to the tyres. Therefore, it is going to recommended increase the air pressure 4 pounds over the vehicle manufactures recommended cold tyre pressure-but not over the maximum inflation limit shown on the tyres side wall.

For example: Determine the maximum shaft diameter for an automobile engine developing a maximum torque of 17:15 kg/m. Constant ratio of different being 4.5 and bottom gear ratio of gear box = 3.0 . Efficient wheel diameter 0.65 m and the co-efficient of friction between the tyre and the road surface is 0.6. The permissible shear stress is 3300 kg/cm². Calculate the maximum load permissible on each wheel.

Answer:

Overall gear ratio = $3 \times 4.5 = 13.5$

Torque to be transmitted = 17.15×13.5

= 232 kg/m

= 23200 kg/cm

Using the relation $\frac{T}{(J)p} = \frac{(f)s}{Y}$

Or, $\frac{23200}{\frac{\pi}{32}(d)4} = \frac{3300}{(d)2}$

Where, d = maximum diameter of the shaft,

Or, $d^3 = \frac{16 \times 23200}{(\pi)T \times 3300}$

= 35.8

$\therefore$ d = 3.3 cm

Since same amount of torque is transmitted to each wheel,

Tractive effort = $\frac{23200}{32.5}$ = 715 kg.

Hence load on each wheel = $\frac{715}{0.6}$

= 1: 80 kg.

4. Methodology:

Vehicle Alignment:

Proper alignment is mandatory for even tread wear and for precise steering. Front and rear tyres should be checked periodically for signs of uneven wear. Any changes in handling on steering response can also indicate misalignment. The moderate cost of having

vehicles alignments checking have to more than pay to for itself in tyre mileage, performance and comfort. A vehicle is said to be properly "aligned" when all suspension and steering components are sound and when the tyre and wheel assemblies are rolling straight and true. Because, the system is flexible involving moving part, some wear of the steering and suspension components is normal and can be expected. And as the parts wear, misalignment occurs. This increase the imposed loading and rate of wear. The result is that the tyre may not roll as straight and free as they should causing scuffing and uneven, sometimes rapid tread wear.

Example: Calculate the maximum bending moment and maximum section modules assuming the following particulars.
Wheel base: 180 cm
Overall length: 360 cm.
Equal overhang on either side:
270 kg acting at C.G. of load 45 cm in front of front axle.
!80 kg acting at C.G. of load 45 cm behind front axle.
180 kg acting at C.G. of load 45 cm in front of rear axle.
67.5 kg acting at C.G. of load 45 cm behind the rear axle.
In addition there is a uniformly distributed load of 1.75 kg per cm run over the entire length of the chassis.
Assume dynamic stress = Twin the static stress induced.

Solution:

Taking run of the moments of all the forces at B and equating them to zero.

$R_A \times 180 = 67.5 \times 225 + 180 \times 135 + 180 \times 45 - 270 \times 45$

$= 47587.5 - 12150$

$= 33437.5$

$R_A = \frac{35437.5}{180} = 197$ kg.

And, $R_B = 270 + 180 + 180 + 67.5 - 197$

$= 500.5$ kg.

From the given figure:

Maximum moment = 12150 + 7088

= 19.238 kg/cm

B.M = f.z, where f= allowable stress,

= 600 kg/cm²

Z= Section modules.

Given, maximum bending moment due to dynamic force is twice that due to static force.

$Z = \frac{2 \times 19.238}{600}$

= 64.1 cm²

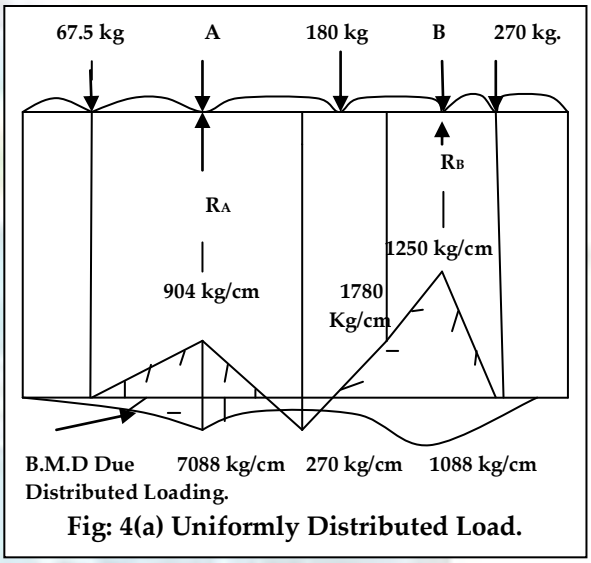

Fig: 4(a) Uniformly Distributed Load.

suspension design that allows adjustments for wheel alignment or with a design that requires a rear wheel check. When a rear suspension is not in alignment, it may create problems for the front tyre wear and directional pull or lead. However, suspension, steering and drive train design all require a total vehicle, four wheel approach to alignment for proper performance of today's vehicle.

Computerized Vehicle wheel alignment, usually involves three terms i.e. Caster, Camber and Toe (Toe in and Toe out) respectively. Therefore, the measured distance between the front of the two tyres on the same axle as compared with the distance between the rear of the same two tyres. The objective of proper toe is to make the tyres roll essential

parallel to each other with the treads true and flat against the road and to compensate for steering linkage under torque.

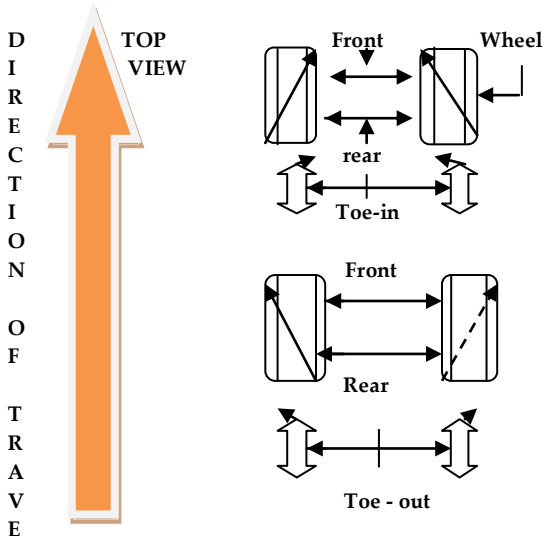

Fig: 4(b) Directional Travels (Toe-in, and Toe-out).

The above diagram, looking down on the vehicle, illustrates positive toe, often called toe-in with the front of the tyres measuring closer together than the rear of the tyres. A small amount of toe-in is required for optimum vehicle handling and to prevent steering "wander". Excessive tor-in, however, causes a feather –edging type of wear of wear on the outside edges of the tyre tread. Too much toe-out causes the reserve-feather edging of the inside edges. Radial tyres may show still other types of wear as a result of improper toe-sometimes spotty and irregular, sometimes a diagonal, wiping type of wear across the tread.

In correct toe on rear wheels also causes irregular wear. In addition, incorrect rear wheel toe can cause the vehicle, causing trickling problems as well as problems with the front tyres.

5. Discussion:

Tubeless tyre, the material and design of the carcass and the tread remain similar to the tube type of tyre. The inside of the casing is lined with a soft rubber lining which forms an air-tight seal with the rim. This lining retains the air and seals itself on being punctured, because such tyre easily mounted on rims.

5.1. Caster:

Caster means: It is the tilting of the steering axis forward or backward to provide directional steering stability. The front fork on which the front wheel is mounted is almost always titled back, giving the front wheel positive caster.

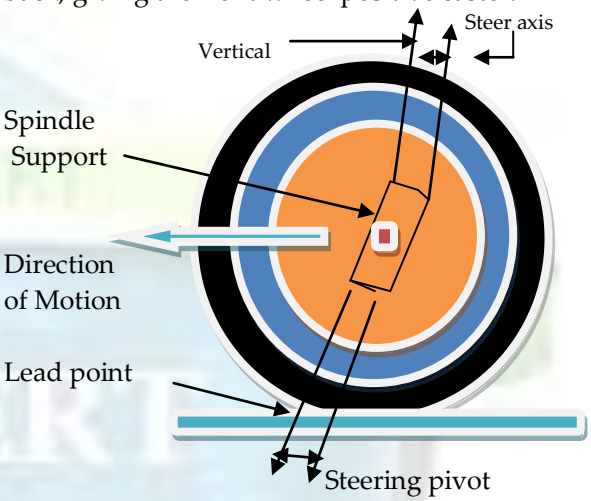

Fig: 5(a) caster.

The basic purpose of caster is to maintain directional control, give more on centre "feel" to steering and return the vehicle to a straight ahead position when exiting a turn.

Insufficient caster causes wander, road shock and a light feeling in the steering. Excessive positive caster can cause hard steering; shimmy and tyre wear in extreme cases. Unequal caster causes the vehicle to pull or lead toward the side having the least positive caster. When caster is out of manufactures specification range, tyre wear may occur as a result of incorrect camber on turns. However, loose or worn steering or suspension parts that would produce an incorrect caster angle would also affect camber and toe, which would also cause tyre wear.

5.2. Camber:

Camber, it is the tilting of the top of the wheels from the vertical. If the tilt is outward camber is said to be positive.

Camber can be positive on one wheel and negative on the other wheel on the same axle , or

it can be negative or positive on both wheels on the same axle.

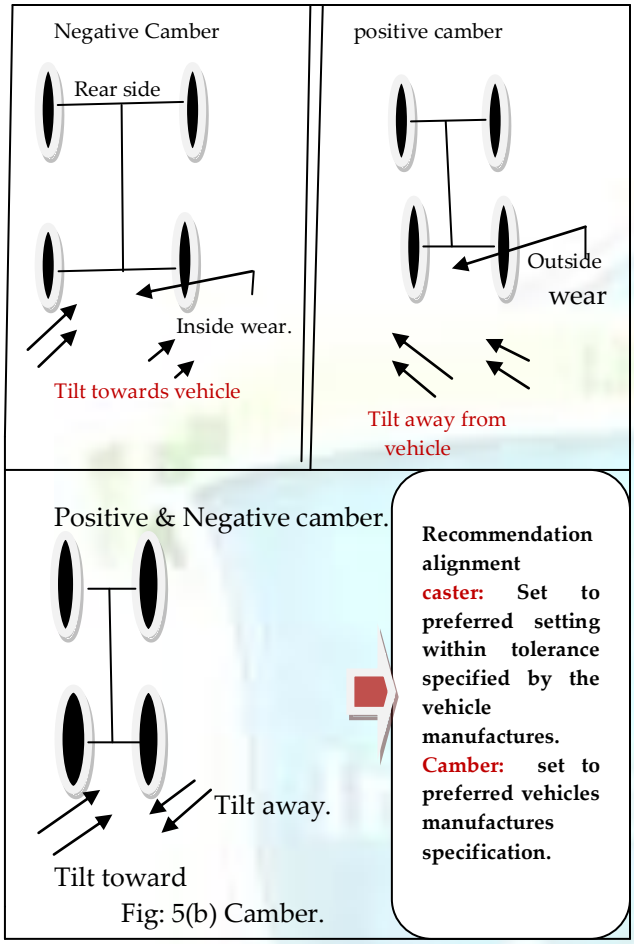

Fig: 5(b) Camber.

In some cases, unequal camber can cause a vehicle to lead or pull toward the side having more positive camber.

Fig. 5(a) Wheel alignment procedure.
(Source: www.platinumautoservice.com)

6. Type of Data:

(From Good Year India Ltd.)

For the maintenance and Driving habits , the following Five questions are helpful tips:

Question 1. What type of car maintenance helps increase tyre life?
Answer: Correct vehicle alignment is a must and should be checked periodically . Improper alignment not only can cause excessive tyre wear , it also can increase the car's fuel consumption . Tyres and wheels should be balanced dynamically rear wheels as well as fronts, and therefore, Goodyear India Ltd, had strongly recommended " off the car" computer balancing.

Questions No.2: What should I do if I notice a vibration?
Answer: Vibration is an indication that a car has something that needs attention . The tyres should be checked for any irregular wear to help determine the possible cause and correction of the vibration. If left unattended the vibration if caused by tyres and suspension wear. It could d even be dangerous.

Question No 3. Can the driving habits effect the life of tyres?
Answer: To increase the tyre life , have to avoid bad driving habits. Driving at high speeds, as a result , excessive heat is generated from the flexing of the tyres carcass when driven at high speeds. This heat increase the rate of tyre wear and reduces the tyre's durability. Fast turns on curves and around corners. Fast starts and panic stops. Riding on the edge of pavement . Driving over curbs, chuckholes or other obstructions.

Question No.4: It is safe to repair a tubeless tyre?
Answer: There are three types of repairing holes in tires:
4.1. Rubber plug Method: Rubber plugs , the repair is made from inside the tyre and the inside area around the puncture is buffed and cleaned.
4.2. Cold Patch method:

For this method , at first have to clean and buff the inside around the puncture and allow it to dry for 10 minutes .

4.3. Hot Patch Method:

The hot patch method that heat is applied after the patch has been put into place over the area.

Question No. 5: Where should store extra tyre?

Answer: Be sure to stack stored tyres on a smooth , oil free floor and don't store tyres with or near electric motors. Because motors generates a rubber damaging gas that could affect tyres.

The over and above, tubeless tyres repair vulcanize machine SV604 ,and it adopts press lead screw tightly, auto constant temperature and Control temperature by manually .

Fig. 6(a) vulcanize machine.

(Source: Scape Vehicle Spar Parts Ltd.)

7. Additional Approach:

(Tyre Rotation and Wear)

The purpose for regular tyre rotation is to achieve more uniform wear all of the tyres on a vehicles. Before rotate the tyres, the owner's manual for the specific vehicle should be consulted for the manufactures rotation recommendations. If no rotation period is specified tyres should be rotated every 6,000 to 8,000 miles. The first rotation is the most important.

Sometimes, few vehicles are not equipped from the factory with necessary hardware to make all alignment towards adjustments and the following procedure may make it.

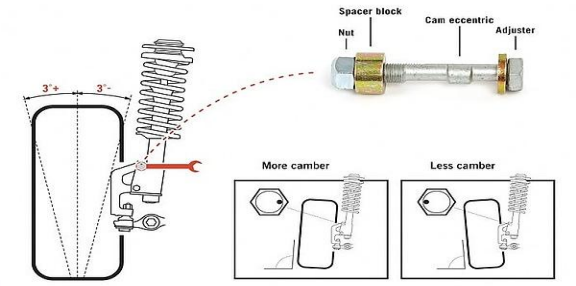

Fig: 7(a) Alignment adjustment procedure:

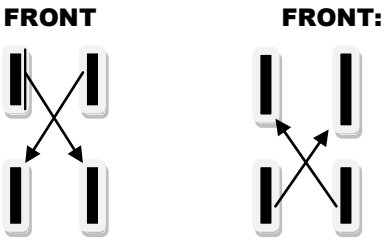

Fig : 7(b) Rotation Patterns
(Alternative patterns for all vehicles)

7. Conclusion:

Computerized wheel alignment is important, because after completion of wheel alignment do not wear prematurely. A proper alignment , as a result steering and suspension system found OK and less wear and tear. In its most basic form, a wheel alignment consists of adjusting of angles of the wheels so that they are perpendicular to the ground and parallel to each other.

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[4] Automobile Design Problems, by K M Agarwal, New Delhi. Edition 1995.

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