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Tire Inflation Pressure Influence on a road grip and braking force

1st Eng. Abdullah Kh Alfalah, 2nd Eng. Tariq Alnukhailan, 3rd Dr. Khaled Alawadhi

1stAutomotive Department, Industrial Institute at Sabah Alsalem, The Public Authority for Applied Education and Training, Sabah Alsalem, 70654 Kuwait, Kuwait

Email : ak.alfalah@paaet.edu.kw

2ndMecanical department Construction training Institute, The Public Authority for Applied Education and Training, Kuwait

Email :Tariqalnukhailan@gmail.com

3rdDepartment of Automotive and Marine Engineering Technology, College of Technological Studies, The Public Authority for Applied Education and Training, Shuwaikh, 70654 Kuwait City, Kuwait

Email :ka.alawadhi@paaet.edu.kw

Abstract:
The protection of one's health and the safety of others on the road is now a top priority. The authors address tire adhesion issues resulting from ground contact during vehicle braking. Tire pressure is only one of many parameters that affect road grip and braking force. The article discusses how tire pressure affects road grip and braking force. It was put to the test in two likely under pressure and two likely over pressure scenarios.

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I. Introduction

Wheels and tires are components that link the tire tread with the vehicle. The evaluation of numerous variables that influence the effect of wheel components on the vehicle running condition [1] is possible.

In conjunction with the track, the tire's duty is to bear the vertical loads and generate tangential forces to accelerate or decelerate the vehicle, as well as side forces to guide it. The wrong tire pressure reduces the tire's capability to provide suitable traction. This will lead to asymmetrical and excessive tire wear and will also have a significant influence on the tire, potentially posing a hazard, particularly in high-speed turns.

Two factors affect the contact patch between the road and the tire: tire pressure and wheel loads [2,3]. Based on the rim size, tire size, and load on the wheel, the manufacturer recommends appropriate pressures for the vehicle's front and rear tires [4]. When the tire pressure is low, the larger the contact surface between the tire and the road, the greater the rolling resistance. This has a detrimental effect on the tire, resulting in increased heating and wear [5]. When the tire pressure is too high, the center portion of the tire wears out faster, and when the pressure is too high, the tire blows out.

An automated technical inspection is made up of various tests. The braking systemis the most crucial mechanism of a vehicle's safety system and helps to reduce fatalities and financial losses. The braking system's performance has a significant impact on vehicle safety, handling, and dynamics [7]. The significance of braking efficiency increases in cases where certain drivers react slowlyin taking emergency braking decisions. They could be frightened or distracted and not braking hard enough to bring the car to a stop [8]. Other research, some of which are listed below, have investigated the significance of car brakes and related issues. [9,10,11,12].

The braking acceleration is measured with a roller brake tester at a technical inspection facility. The rate of deceleration of the vehicle per unit time when braking is known as braking acceleration. Newton's second law and Equation 1 [13] are used to calculate the braking acceleration:

$F=ma \rightarrow a=F/ (1)$

Where a represents the braking acceleration, F represents the sum of the braking forces, and m represents the vehicle's entire mass. The braking acceleration, on the other hand, is computed using Equation 2 [14]:

$a=(v^2-v_0{}^2)/2d (2)$

Where a represents the braking acceleration, v represents the final velocity, v0 represents the initial velocity, and d is the stopping distance. The stopping distance is the thinking distance (response time) plus the braking distance, although in this article, the braking distance is considered the same as the stopping distance due to the driver's mental preparation to brake in a specific location. The braking efficiency is also obtained from Equation 3 [15, 16]:

$E = F/mg \rightarrow E = a/ (3)$

Where E represents braking efficiency, a represents braking acceleration, and g represents gravity acceleration.
We get the following results from Equations 1, 2, and 3:
A) Braking force and stopping distance are inversely proportional.
B) Brake efficiency and braking acceleration are inversely proportional.

II. MEASURING DEVICE

Test has been run on the break tester rolling stand which is endowment by the public authority of applied education and training (PAAET) in Kuwait withRoller Set With precise strain gauge sensors for brake testing of passenger cars, overdrive load up to 4,0 to ¾, testing load=3,5 t ≈ 7,5 kN, braking force/wheel ¾ Brake roller: Ø 205 mm, axle distance 381 mm, silicon-sand surface, super elevation of rear rollers over front rollers 25 mm ¾ for track width up to 2200 mm.[17]

III. MEASURING CONDITION

The recommended pressure for the 235/60 R18 tire type with full loaded driver and his luggage is 33 PSI for the wheels of both axel pressure was measured [18] using DIYCO D1 Digital Tire Pressure Gauge with accuracy of +/-1% PSI.
The pressure in the tires of front wheels was changed from the nominal value of 33 PSI downward to 17 PSI and 25 PSI and upward to 33 PSI to 41 PSI and 49 PSI respectively. For each pressure value, 6 tests were performed total of 30 samples.
The test is applied on:
Type size and model: continental 235/60 R18
Power train: All wheel drive (AWD) SUV 5 speed Automatic Gear Box
Power unit: V6 3.5 L petrol compression-ignition engine.
Prior to performing tests, the condition of the components of the braking system, particularly brake discs and pads is evaluated by technicians of the official representative of the automobile manufacturer. Being critical components of the braking system, they transmit braking energy to the axle and tires, allowing the vehicle to reduce speed or stop. Experts from authorized representatives of the vehicle manufacturer also examine the roller brake tester's calibration.

IV. TEST PERFORMANCE AND RESULTS

Test is performed by increasing and decreasing the pressure in 2 stages and the results are recorded for front axle in both right and left side for road grip and braking force changes.

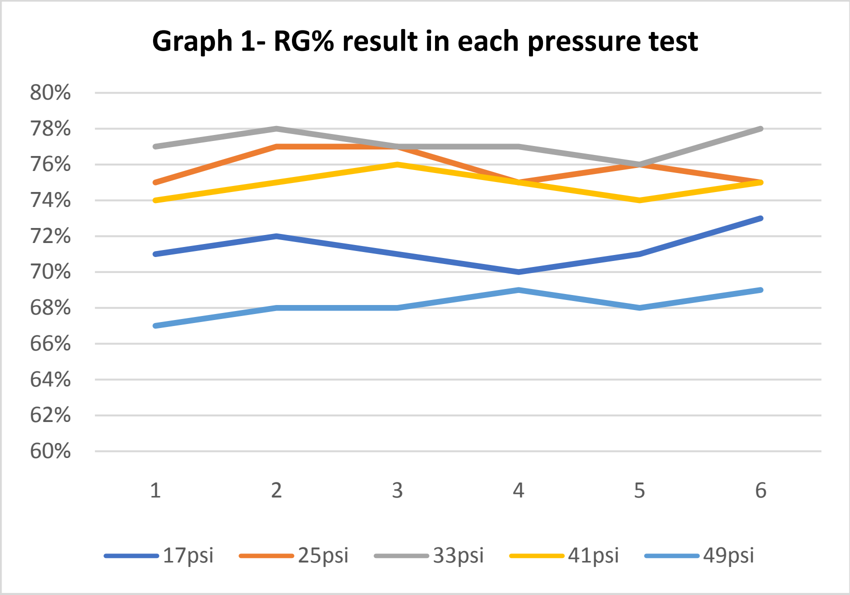
- **Road grip (RG)**

1	2	3	4	5
17psi	25psi	33psi	41psi	49psi
71%	75%	77%	74%	67%
72%	77%	78%	75%	68%
71%	77%	77%	76%	68%
70%	75%	77%	75%	69%
71%	76%	76%	74%	68%
73%	75%	78%	75%	69%

Table 1 – RG% in front axle, left side

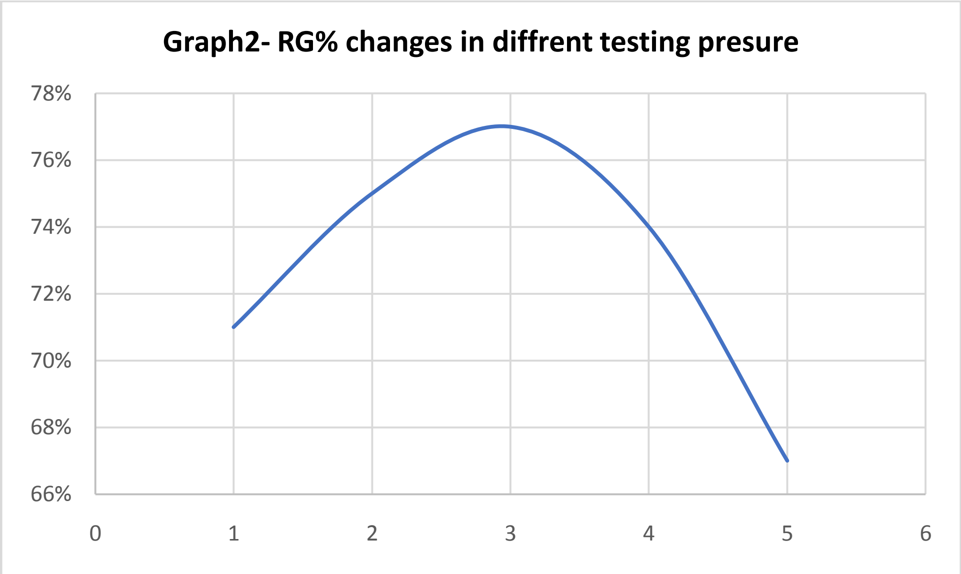
1	2	3	4	5
17psi	25psi	33psi	41psi	49psi
71%	74%	78%	73%	66%
71%	76%	78%	75%	66%
73%	75%	77%	73%	67%
72%	76%	76%	74%	66%
70%	75%	77%	73%	68%
71%	75%	76%	75%	67%

Table 2 – RG% in front axle, Right side

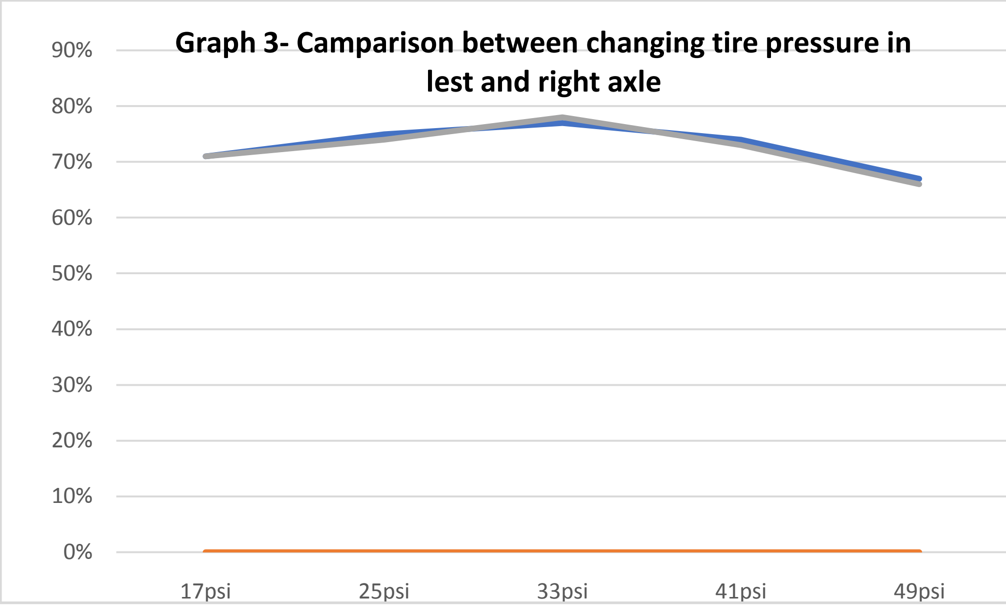


The graph 1 shows while the road grip is maximum level in nominal pressure which is suggested by car manufacturer, both decreasing or increasing of pressure by 8 psi will deduct road gear percentage proportionally from 2% to 4%

By decreasing or increasing the pressure by more 8 psi the drop in decreasing of road gear is more tangible from 6% to 10%.



Graph 2 shows the relation between changing the inside pressure with changing of road grip is an exponential function. While inflation of tire has more effect on decreasing the road grip than being under pressure.



The graph shows changing of the inside tire has a similar effect on road grip of left and right axle.

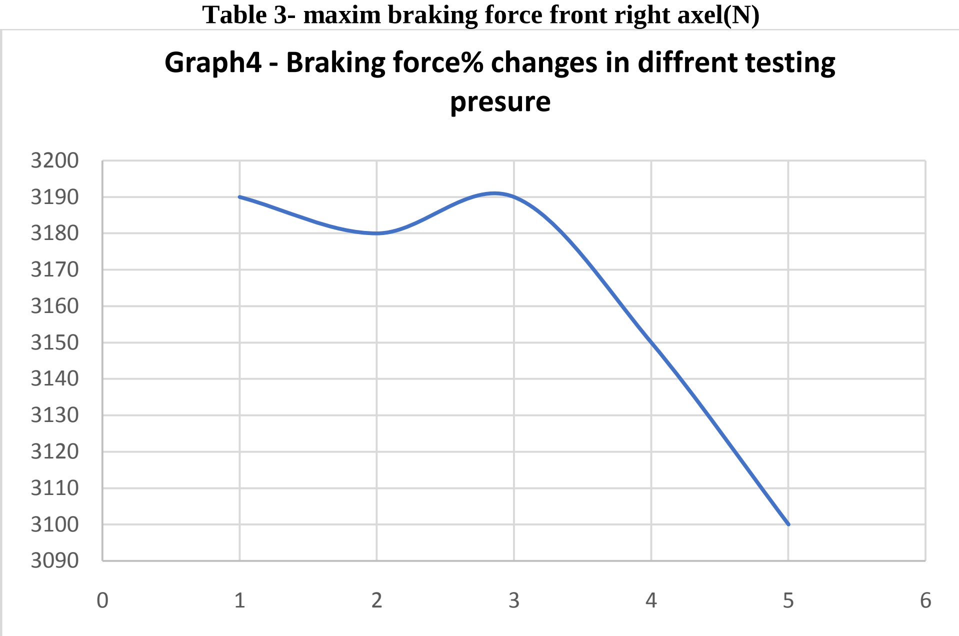
- **Braking force**

1	2	3	4	5
17psi	25psi	33psi	41psi	49psi
3190	3180	3190	3150	3100
3190	3190	3210	3170	3220
3170	3110	3190	3190	3150
3100	3100	3190	3100	3200
3150	3190	3100	3190	3190
3190	3190	3170	3160	3150

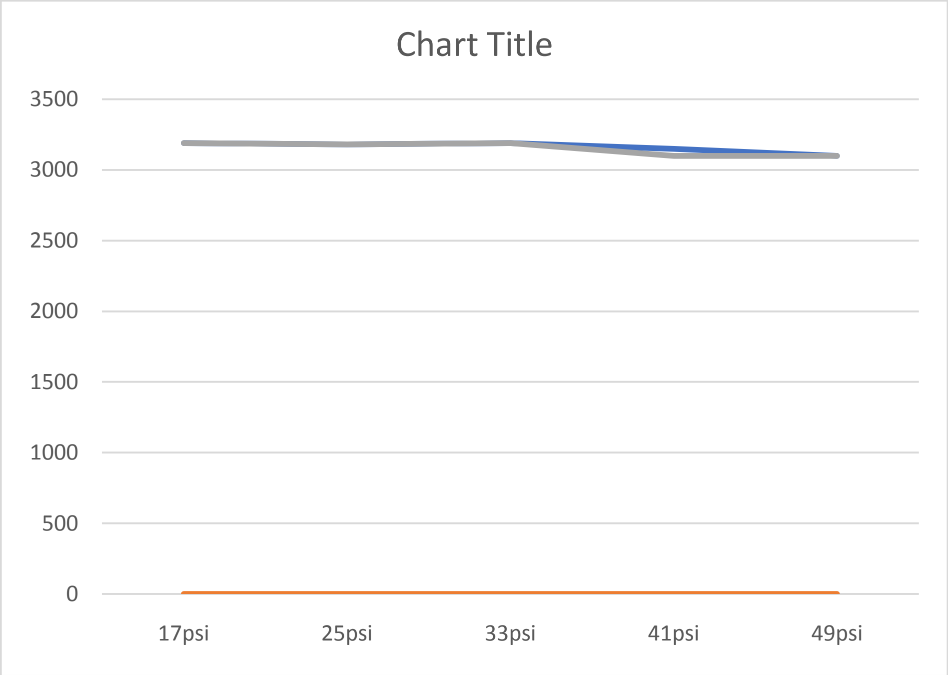
Table 3- maxim braking force front left axel(N)

1	2	3	4	5
17psi	25psi	33psi	41psi	49psi
3190	3180	3190	3100	3100
3190	3190	3200	3110	3120
3170	3150	3200	3190	3150
3100	3140	3180	3120	3100
3050	3100	3190	3170	3160
3090	3120	3180	3180	3150

Table 3- maxim braking force front right axel(N)

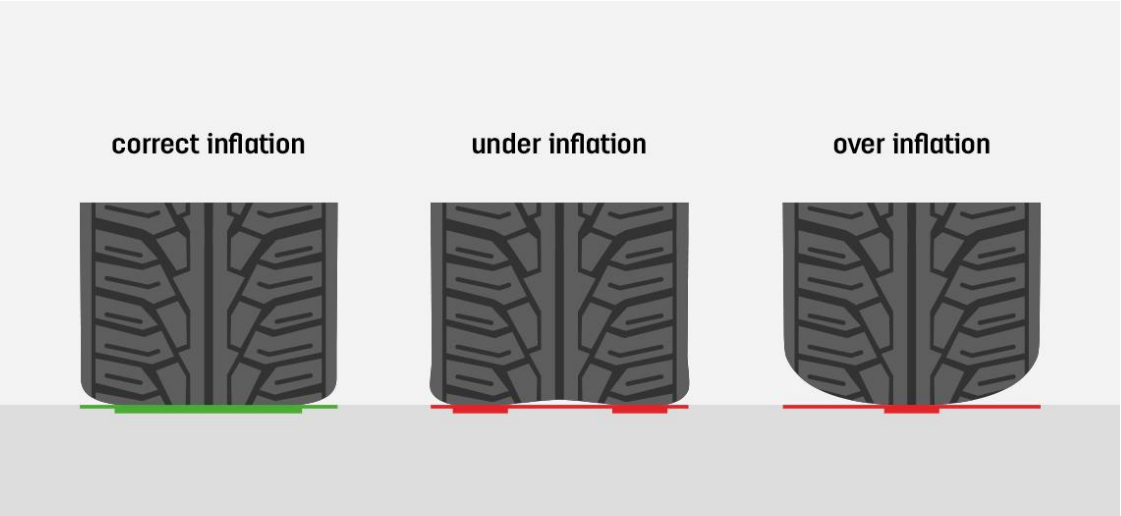


Graph 4 shows the relation between changing the inside pressure with changing of braking force is an exponential function. While inflation of tire has a negligible effect on decreasing braking force.



The graph shows changing of the inside tire has a similar effect on braking force of left and right axle.

V. CONCLUSION



In the case of inflation, the tire profile, which is consistent with the above-mentioned data, reveals less tire contact with the earth, resulting in reduced road grip and braking force.

Maintaining proper tire inflation pressure is important for vehicle handling and braking, as well as tyre life. It can also avoid tread separations and tyre blowouts, which can result in a vehicle's loss of control and serious crashes like rollovers.

Changing the tire inflation pressure has a considerable impact on the corresponding wheel's road grip, indicating an exponential link between the two parameters. As a result, if the test is conducted at a pressure that differs from the nominal value, the results may be inaccurate, meaning that the shock absorber is defective despite its good functioning condition.

When the tire inflation pressure is adjusted to 49psi, which is 50 percent above the manufacturer suggested pressure, the road grip difference (RGD) reaches a minimal value. This may have an impact on the vehicle's cornering characteristics.

When the tire inflation pressure is increased, the braking force reduces. When driving for an extended period of time, using a lower tire inflation pressure is riskier because it might lead to tire overheating, which has more bothersome implications.

The experimental results showed that when altering the tire pressure, which is usually approximately 3%, the maximum braking forces do not change much.
The pressure imbalance between the front axle's braking forces is nearly constant.

REFERENCES:

[1]. Varga B O, Mariaşiu F, Moldovanu D and Iclodean C 2015 Electric and Plug-In Hybrid Vehicles – Advanced Simulation Methodologies © Springer International Publishing Switzerland ISBN: 978-3-319-18638-2 524

[2]. Guan D, Shang Jin, Yam L H 2002 Study on Tire Dynamic Cornering Properties using Experimental Modal Parameters, Vehicle System Dynamics, 37 129-144. CAR-2017 IOP Publishing IOP Conf. Series: Materials Science and Engineering **252** (2017) 012011 doi:10.1088/1757-899X/252/1/012011

[3]. Waluś K J, Wolniewicz R M, Olszewski Z, Drożyński M 2009 Analysis of pressure and load influence on geometric parameters of tire understatic conditions, 17th French-Polish Seminar of Mechanics, Lille, France, pp. 31-36

[4]. Polasik J, Waluś K J, Warguła Ł 2017 Experimental Studies of the Size Contact Area of a Summer Tire as a Function of Pressure and the Load, Procedia Engineering, Volume 177, Pages 347-351, ISSN 1877-7058,

[5]. Yam L H, Guan D H, Shang J, Zhang A Q 2000 Study on tire rolling resistance using experimental modal analysis, International Journal of Vehicle Design, 30, 251 – 262

[6]. Adetan D A, Oledajo K A, Fasogbon S K, 2008 Redesigning the manual automobile tyre bead breaker, Technology in Society, 30, 184-193

[7]. A. Rahman, M. Amysar, Development of a DC Motor Assisted Hydraulic Braking System for Automotive Use, IJAE, Vol.8, No2, (2018), pp.2672-2678.

[8]. J. Marzbanrad, E. Taheripour, Object Oriented Programming for Anti-lock Brake System in Different Pavements, In Proceedings of Asian Simulation Conference/The 6thInternational conference on system Simulation and Scientific Computing, (2005).

[9]. M. RouhiMoghanlou, H. SaeidiGoogarchin, Three-dimensional coupled thermo-mechanical analysis for fatigue failure of a heavy vehiclebrake disc: simulation of braking and coolingphases. Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, (2020).

[10]. M. Esfahanian, M. Saadat, P. Karami, Antilock Regenerative Braking System Design for a Hybrid Electric Vehicle. International Journal of Automotive Engineering, Vol.8, No.3,(2018), pp.2769-2780.

[11]. B. Shahin, S. Ziaei-Rad, M. Esfahanian, Alumped parameter model for disk brake squeal and its suppression through use of dither signals. International Journal of Vehicle Noise and Vibration, Vol.7, No.3, (2011), pp.195-211.[12] J. Sharifi, A. Amirjamshidy, Type-2 Fuzzy Braking-Torque Electronic Stability Control forFour-Wheel Independent Drive Electric

[12]. Vehicles. International Journal of AutomotiveEngineering, Vol.8, No.1, (2018), pp.2633-2649.[13] S. Pakdelbonab, A. Kazerooni, G. Payganeh, M. Esfahanian, Extracting Tehran Refuse Collection Truck Driving Cycle and Estimating the Braking Energy, International Journal of Automotive Engineering, Vol.10, No.1, (2020),pp.3149-3157.

[13]. Test at Vehicle Technical Inspection Centers Adjusting Tire Pressure Before Braking Test at Vehicle Technical Inspection Centers M. Ajami1*, H. Jannat2, M. Masih- Tehrani3, 1 Baran Vehicle Technical Inspection Center, Saveh, Iran

[14]. P. Bhatt, Icse Physics, Book 1 for class IX

[15]. Archives of Automotive Engineering, ArchiwumMotoryzacji, Vol.73, No.3, (2016)

[16]. A. Gomeza, B. Boada, M. Boada, E. Olmeda, S. Sanz, V. Diaz, Braking Efficiency Predictive Parameters, (2015), pp.20-24.

[17]. https://manualzz.com/doc/32399764/bsa-sdl

[18]. KIA owner manual

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