

# Experimental Study of Brake System in Light Vehicles

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## ABSTRACT

In this experimental study, effect of increasing in brake disc temperature on braking performance was investigated. For this purpose, braking distance tests which the criteria of braking performance were carried out. The tests were conducted on a small-size commercial vehicle for different disc temperatures, pedal forces, the vehicle loads and for initial vehicle speeds. Test results of stopping (braking) distance were analyzed for the variation of disc temperatures. The results showed that the stopping distance is considerable increased when the disc temperature is increased for different vehicle speed and pedal forces. Typically, at the vehicle speed of 80 km/h and maximum pedal force for 63 °C disc temperature, 44.90 m stopping distance was measured. When the temperature is increased as 298 °C, stopping distance is increased as 52.71 m with the rate of 17.4% at road test.

**Keywords:** Brake system, pedal force, heating brake discs, commercial vehicle.

## 1. INTRODUCTION

The researches on traffic accidents generally refer to the driver faults beside that the vehicle and road defects have low proportion. The accidents caused by vehicles brake imperfections come immediately after tire puncture. [1].

The most important equipment for active safety in vehicles is brake systems. Along with developing technology the comfort and speed in today's vehicles with the load capacity of commercial vehicles are increasing continuously, so this case leads to need for effective and powerful braking systems. In order to provide direct stop for the moving vehicle, the brakes are effecting to the road safety directly. [2-3].

Braking efficiency and braking performance with the vehicle's stopping distance shows an important expression. The factors that effect on stopping performance are as follows: vehicle's weight, design of brake system, the hydraulic and mechanic parts state, the factors of environmental conditions, road conditions, tire state and the coefficient of friction between wheel and the road surface. [4-5].

The other factor that effects directly to the braking system performance is the temperature increasing of the braking system elements. Increasing temperature during brake, between the drum-lining (or disc-lining) may cause sudden friction (fading), premature wear, brakes liquid evaporation, thermal cracks and vibration. [6].

The brake of drum and disc temperature is a critical value for vehicles. This is a factor that directly affects the braking efficiency. Temperature effect is more important in overheating, and repeating this continuously causes reducing the friction coefficient between disc-lining (or drum-lining) and leads to dangerous results. This phenomenon, reducing brake effectiveness is defined as fading. [7-8].

In this research, road tests are studied during brake supply on a light vehicle and the effects of stopping distance with the change of disc temperature. In these tests; disc temperatures as well as vehicle speed, vehicle weight and applied pedal force variables were taken into consideration.

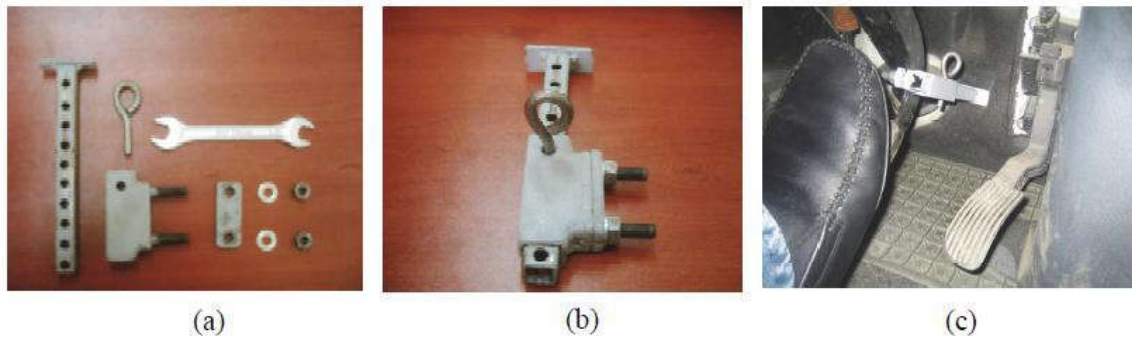
## 2. (MATERIALS AND METHOD)

Kia bongo light vehicle was used as a test vehicle. The purpose of this selection is to show that this problem (losing affectivity of brake by increasing temperature), is not happens only in heavy vehicles but also happens in light vehicles. Brake affectivity tests were carried out at a length of 1500 meters and 30 meter wide on dry asphalt road. Coefficient Friction of the road surface is assumed to be 0.6. [9]. During the tests, in order to check and control the disc temperatures whether reached the wanted temperature or not, infrared principle and remote non-contact temperature measurement (laser thermometer) is used. (Figure 1)



**Fig. 1: Laser thermometer**

To observe different pedaling force in brake activation test values that affect the stopping distance, a pedal force limiting apparatus has been developed (Figure 2-a, b). This apparatus being rigidly connected to the pedal holder, sliding holes on the mechanism and a pin to do tests at different stages (Figure 2-c).



**Fig. 2: Apparatus of the pedal force limiter and installation to the brake pedal**

Three different stages of the apparatus are used. Calibrating apparatus achieved with drum brake made with the aid of a test device and the supplied force values on the pedal are determined. These values are, 120 N in the first stage of the limiting apparatus, second stage 260 N and 450 N at the third force were applied.

To measure the force applied to the pedal, digital display with pedal force sensor (Figure 3-a), as well data collector unit (Figure 3-b) are used, to pick up the vehicle data such as speed, stopping distance, acceleration and time, which is collected and sent by optical sensors. Sensors that perceived vehicle speed, acceleration, stopping distance, pedal force etc. collected in electronic form and allows transferring these data to a computer (Figure 3-c).

To achieve different load conditions, each of 25 kg load materials are used. Although the path of the research has necessity to study in heavy conditions, this study aimed to review and examine the behavior in different load conditions.

According to the international safety conditions we chose three speed options for our vehicle 40, 60 and 80 km / h, with load (3220 kg) and without load (1745 kg), on three different pedal force levels 450 N, 260 N and 120 N consequently three different disc temperatures taken from the disc. A total of 60 stopping distances were tested.

Disc temperature values measured during tests and the data such as acceleration, speed, stop distance, etc. simultaneously recorded by the collection unit electronically.

The tests started with load options. According to the constructions of brake type approval tests if the disc temperatures below 100°C are referred to "Cold Brake" and if the temperatures above 100°C is called as "Hot Brake". Firstly beginning with cold brake; stopping distance tests were conducted for vehicle speeds 40-60 and 80 km/h at 3 different pedaling forces. Then carrying the brake discs were heated to an average of 180 ° C and tests were repeated. At last step, brakes discs heated to an average temperature of 300°C and stop distance tests were repeated again. Heating operation of brake discs, achieved by heavy stop-start of vehicle with maneuvers.