



## HANDGRIP PRESSURE STUDY ON PERODUA CAR'S STEERING WHEEL AMONG MALE DRIVERS

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### ABSTRACT

High gripping pressure on steering wheel can cause discomfort to a driver while driving a car for a long period of time. The purpose of this project is to study the differences of handgrip pressure on steering wheels for two types of Malaysian national cars while identifying factors that can affect the handgrip pressure. The experiment was done on a standard Perodua Myvi and Perodua Alza. A group of five male drivers were gathered as respondents. They were required to drive on a selected highway route in Malaysia for a specific time period. The force measurement responses were taken and evaluated by using the Tekscan tactile grip and pressure measurement (Grip System) device. The study surprisingly finds that the average handgrip pressure for Perodua Alza's steering wheel is lower than the average handgrip pressure for Perodua Myvi's steering wheel. For both vehicles, most of the right hand average pressure is higher than left hand average pressure. Three factors that affect the results were the road surface condition, curvy road, and the traffic environment. The results can be used as a guideline for future studies, that primarily in solving the driving fatigue problem among the Malaysian's drivers.

**Keywords:** handgrip pressure force, steering wheel, Tekscan tactile grip and pressure measurement system, Perodua.

### INTRODUCTION

Driver fatigue has been famously identified as one of major causes of road accidents in any part of the world today. A significant cause of fatigue-related accidents on motorways or major roadways is the long duration of driving. Driving for extended periods can cause fatigue and can impair driver alertness and performance, which then can compromise vehicle's safety (P. Ting *et al.*, 2008). It has been well known that driver fatigue is related to driver discomfort ability while driving. A previous study has concluded that driving experiences, aging, weight and height of the drivers can influence the discomfort ability while driving in the different kind of road (Seri Rahayu *et al.*, 2013). The types of gripping while holding objects are also play an important role to accelerate the muscle fatigue (Augurelle *et al.*, 2003, Hagberg, M., *et al.*, 1995). The fatigue's level can be measured by the force that applied at the steering wheels. Types of road (M., Eksioglu & K., Kizilaslan, 2008), driving experience (P., Gershon *et al.*, 2011), and age of the drivers (D., Clarke *et al.*, 1998) also have related with the fatigue factor experience.

Handgrip, which also generally identified as the strength of the hand, is described as the force of the hand to pull, push or hold from the objects. In this study, the subjects need to grasp and grip the steering wheel using their hand to control the steering wheel while driving. The pressure gained from the steering wheel gripping can be measured and evaluated using tactile grip and pressure measurement system, which uses a thin, high-resolution sensor that can be used directly on a hand or built into a glove.

A previous study shows that the steering grip force decreases when the driver is losing concentration as the driver's muscle are becoming increasingly relaxed (Chieh, T. C., *et al.*, 2003). Using a normal probability distribution function, a significant change in steering grip force data has been detected in this study. Furthermore, a previous research studied the relationship between the gender, type of road conditions and the speed of the car with the steering grip force (Eksioglu, M., & Kizilaslan, K., 2008). This study concluded that the road conditions and the speed of the car would influence the steering grip force. Another study concluded that driving through the winding road can make the drivers become fatigue as highest muscle activity and hand grip pressure force produced (Seri Rahayu *et al.*, 2016).

In particular, no extensive investigation has been made on the handgrip pressure study on Malaysian national car. Therefore, the aim of this work is to study the differences of handgrip pressure on the steering wheels for two types of Malaysian national cars, which in this study, is focused on Perodua car models. The work is also aim to identify factors that can affect the driver's handgrip pressure for both right and left hand while driving on a road in Malaysia.

### METHODOLOGY

A 1.3L Perodua Myvi and a 1.5L Perodua Alza was chosen for this experimental study for Perodua vehicles. The steering wheels are physically different in design as shown in Figure-1. Perodua Myvi's steering wheel has bigger gripping area compared to Perodua Alza's steering wheel. Both models were equipped with auto transmission gear. A group of five males were selected, among the Faculty of Technology of Engineering



(FTK) students aged 20 to 28 years old, to be the driver of the cars. The test was conducted using 9 and 3 o'clock hands positions.



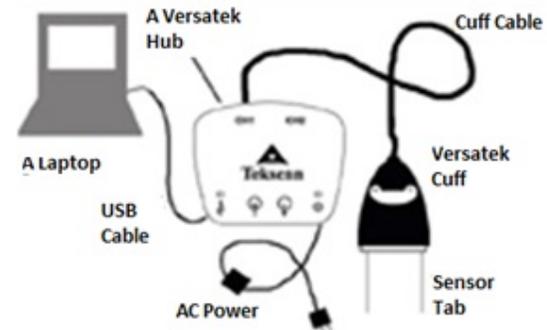
**Figure-1.** A Standard Perodua Myvi (left) and Perodua Alza (right) steering wheels.

During this stage, a Tekscan grip and pressure measurement device was used. This was to determine the gripping pressure mapping result while driving a car. Each sensor has eighteen sensing regions that can be individually positioned over important anatomic sections of the fingers and palm. In this study, the sensors were attached to a pair of glove as shown in Figure-2. The sensors were used to catch the dynamic pressure data while gripping the steering wheel.



**Figure-2.** An example of sensors attached to gloves.

The sensors were basically a part of the tethered, wired system that was needed to connect to a laptop as shown in Figure-3. The sensors for each hand were attached to a pair of Versatek cuff which was then connected to a Versatek hub with a pair of cuff cables. This hub was connected to a portable laptop using a USB cable. The sensors, together with the cuff were attached to the hand of the driver as in Figure-4. The portable battery was used to supply power for the whole system setup.



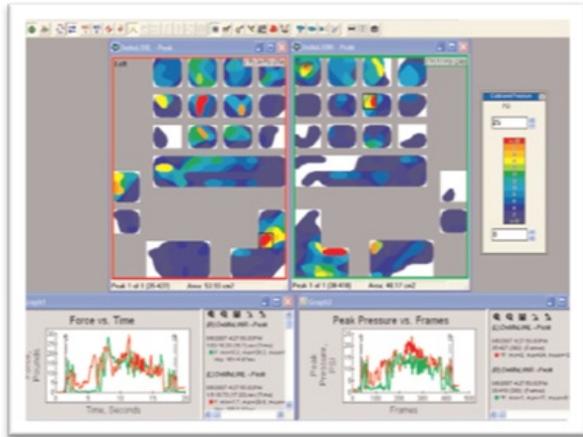
**Figure-3.** A Tekscan handgrip system attached to a laptop.



**Figure-4.** Gloves with sensors and cuffs attached to the driver's hands.

The gripping force result was displayed directly on the laptop's monitor in a form of pressure mapping graphic and graphs as shown in Figure-5. Each of the drivers was required to drive the car through PLUS Highway in Malacca and Johor, started from Ayer Keroh Toll exit (in Malacca) until the Tangkak Toll exit (in Johor). The time taken for each driver is about 20 minutes to complete the driving session. While driving, they were also required to drive by maintaining a speed at 80km/h as closely as possible. A video was recorded by using an action camera to observe each driver's behavior while driving to detect any condition that may contribute to irregularities that might occur during the experiment. All the data that have been gathered were studied and compared for both cars to help in understanding of the driving style and patterns among the respondents. The dynamic handgrip pressure is then analyzed by studying the average handgrip pressure for each hand by using the following formula:

$$\text{Average Pressure} = \frac{\text{Total Handgrip Pressure While Driving}}{\text{Quantity of Handgrip Pressure Data}}$$



**Figure-5.** An example of results gained from tekscan handgrip system.

## RESULTS AND DISCUSSION

Table-1 shows the results gained from the experiment for each Perodua car model. Each model shows the average handgrip pressure for left hand and right hand of each male driver.

**Table-1.** Results of the experiment.

	Perodua Myvi		Perodua Alza	
	Right (kPa)	Left (kPa)	Right (kPa)	Left (kPa)
Male 1	60	50	59	29
Male 2	46	40	47	29
Male 3	96	53	48	38
Male 4	65	67	36	17
Male 5	97	117	95	65

### Perodua Myvi pressure results

From Table-1, the average right handgrip pressure is higher compared to average left handgrip pressure for Male 1, Male 2, and Male 3. The result is a bit different for Male 4 and Male 5. From the visual observation, the route used by Male 4 is quit bumpy compared to other male respondents although their using the same highway. Thus, this condition suspected to affect the result. As for Male 5, the data value is very high compared to other male drivers due to he has the smallest hand among the group. Thus, the size of his hand occupied the surface of the Perodua Myvi steering wheel which can caused higher average pressure compared to other respondents. Overall, the average right hand grip pressure is higher than the average left hand grip pressure for Perodua Myvi.

### Perodua Alza pressure results

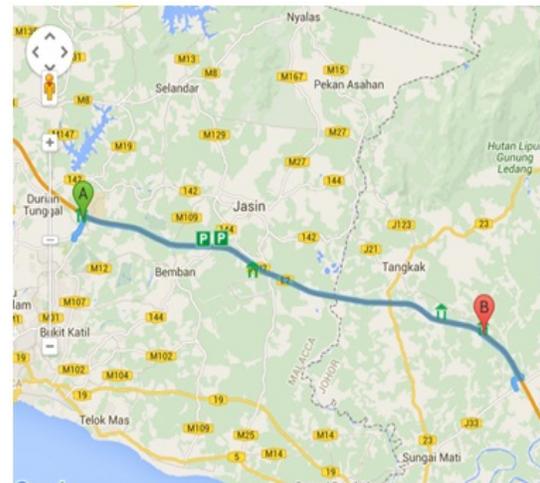
Perodua Alza's results shows the same behavior as Perodua Myvi results, where the average right hand pressure is higher compared to the average left hand pressure for each male driver. In this experiment with Perodua Alza, Male 5 is also having highest pressure for both hands among the male drivers due to his hand size are the smallest in the group. This condition requires him to grip the steering stronger. Overall, the average right

hand grip pressure is higher than the average left hand grip pressure for Perodua Alza.

## Environment factors

For both cars, it has been discovered that the handgrip pressures for both models can increased or decreased dramatically due to several factors:

- (i) Road condition where the Ayer Keroh-Tangkak highway has several bumpy roads, and cornering roads. These conditions tends to make the pressure increase dramatically due to the vibration effect on bumpy road and the high grip from the drivers while passing the flyover and cornering.
- (ii) From the visual observation for each driver, all of them have the tendency to steer the steering wheel to the left. This is due to their driving environment where the road has several left cornering area on the highway as shown in Figure-6. Thus, this can cause their right hand to automatically gripping stronger than their left hand for each driver.
- (iii) Traffic conditions where some of the drivers tend to overtake other vehicles on the road. This also caused the handgrip pressure to increase for both side of the driver's hand.



**Figure-6.** Ayer Keroh to Tangkak route on north south highway.

## CONCLUSIONS

Overall, the average handgrip pressure for Perodua Alza's steering wheel is lower than the handgrip pressure for Perodua Myvi's steering wheel, with right hand average pressure is higher than left hand average pressure. This result proves that design of Perodua Alza's steering has been able to reduce the average handgrip pressure better than Perodua Myvi's design. With lower handgrip pressure, the muscle activities on the hand are decreased. Thus, it can contribute to comfort ability while driving. Both have the same gripping feature on their steering wheel. The main difference between them is the



size of the gripping area diameter for Perodua Alza is smaller compared to Perodua Myvi, and helps to reduce contact stress area on the hand.

This experimental study also helped to identify clearly some of the significant causes can contribute to the dramatically changes of handgrip pressure reading on Perodua car's steering wheel while driving on Malaysian roads.

There were differences in terms of pressure consistency between both sides of the hands which need more studies in the future for clarification.

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