Chapter 2: Literature Review

2.1 Dimensional Similarity

In order to gain accurate result from the wind tunnel test, the model of the vehicle must have similarities to the real world [1]. These similarities are the concept of a technique called Dimensional Similarity. Dimensional Similarity is introduced so that the test can be done on scale model rather than a prototype. This results in lower cost as well as shorter time. There are three conditions that are needed to complete the similarity which are:

- Geometric similarity - model has the same shape with the size being scaled
- Kinematics similarity - velocity at any point in the model flow must be proportional (scale in magnitude and same direction) to the velocity at the corresponding point in the prototype flow.
- Dynamic similarity - all forces in the model flow are scaled by a constant factor to the corresponding force in the prototype flow.

Numerous studies have been done on vehicle aerodynamic on passing maneuvers by other researchers. Noger et al. [2] stated that at each time two vehicles are driven in close proximity, they influence the flow field of each other, creating gust loads as additional forces on the vehicle, such as drag, lift, side force and the yawing moment, that could cause accidents.

2.2 Drag Force

Drag force is the force that a flowing fluid exerts on a body in the flow direction. Drag force act in the opposite direction of the movement of the body. Drag is usually an undesirable effect, a resistant to movement like friction, and it is minimize by all means. In automotive industry, drag is related to the performance and fuel consumption of a car, as well as the design of the car's body that gives value to style. The dimensionless quantity that describes the characteristic of the drag on a body is called the drag

coefficient. This project will focus more on the drag force as the results of the aerodynamic changes when two vehicles are in proximity to each other, using the windtunnel and scaled model to measure the force change.

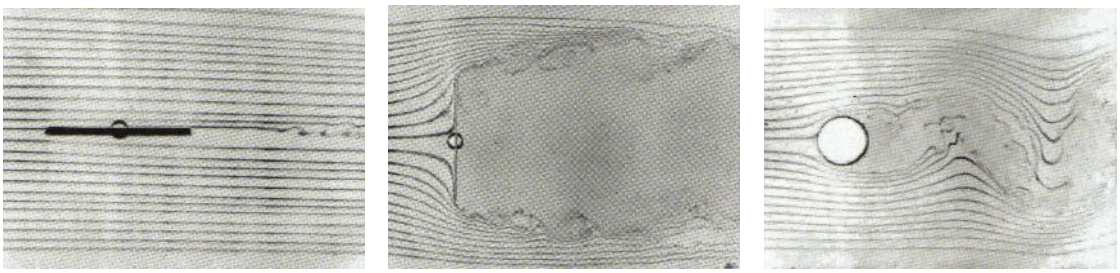

Figure 1: The visualization of the flow for different shapes. The drag is highest for a vertical plat and lowest for a horizontal plat.

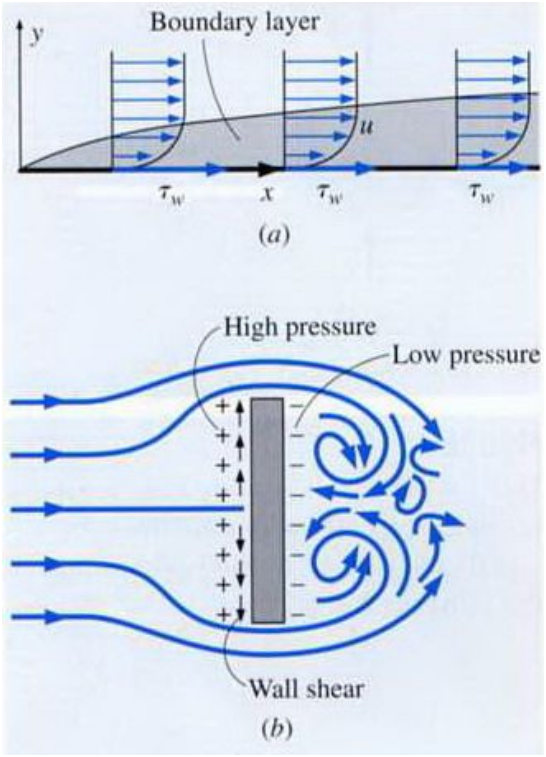

Figure 2: (a) The drag force acting on a flat plat parallel to the flow depends on the wall shear. (b) The drag force acting on a flat plat normal to the flow depends on the pressure.

2.3 Lift Force

Lift force is the force that a flowing fluid exerts on a body normal to the flow direction. Lift force are caused by difference in pressure acting on a body. Lift is usually related to aerofoil, used in aeroplanes design for upward force and spoiler design for more downforce. The dimensionless quantity that describes the characteristic of the lift on a body is called the lift coefficient.

For the experiment, the lift will not be considered as the wind tunnel testing will not be accurate as the lift is associated with the ground effect. However, there will be no 'ground' or 'road' in the experiment. The models of the vehicle will be supported by a metal rod, connecting it to the balance that will measure the forces acting on the model.

Figure 3: There is no 'ground' or 'road' for more accurate lift force measurement.