

FIGURE 2.1 Vehicle tire in motion.

wheel in (b) is said to have side slip. The angle between the wheel traveling direction and the rotational plane, or its heading direction, is called the side-slip angle.

The wheel is also acted on by a traction force if the wheel is moving the vehicle in the traveling direction, or braking force if braking is applied. Also, a rolling resistance force is always at work. If the wheel has side slip, as in (b), a force that is perpendicular to its rotation plane is generated. This force could be regarded as a reaction force that prevents side slip when the wheel produces a side-slip angle. This is an important force that the vehicle depends on for its independent motion. Normally, this force is called the lateral force, while the component that is perpendicular to the wheel rotation plane, is called the cornering force. When the side-slip angle is small, these two are treated as the same.

This force corresponds to the lift force, explained in fluid dynamics, which acts on a body that travels in a fluid at an attack angle, as shown in Fig. 2.2.

There are many kinds of wheels, but all produce a force perpendicular to the rotation plane, when rotated with side slip. Figure 2.3 shows the schematic comparison of the lateral forces, at small side-slip angles, for a pneumatic tire wheel, a solid rubber-tire wheel, and an iron wheel.

From here, it is clear that the magnitude of the force produced depends on the type of wheel and is very different. In particular, the maximum possible force produced by an iron wheel is less than 1/3rd of that produced by a rubber-tire wheel. Compared to a solid rubber-tire wheel, a pneumatic tire wheel produces a larger force. For independent motion of the vehicle, the force that

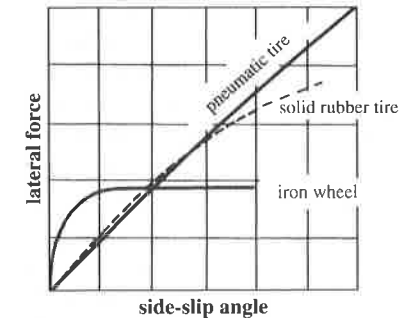
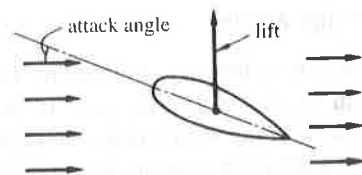


FIGURE 2.3 Lateral forces for several wheels.

acts on a wheel with side slip is desired to be as large as possible. For this reason, the traveling vehicle that is free to move in the plane, without external restrictions, is usually fitted with pneumatic tires. These are fitted for both the purpose of vehicle ride, and for achieving a lateral force that is available for vehicle handling.

In the following chapter, the pneumatic tire is called the tire, and the mechanism for generating a lateral force that acts on a tire with side slip is explained.

## 2.2.2 Deformation of tire with side slip and lateral force

Generally, forces act through the contact surface between the tire and the road. A tire with lateral slip, as shown by Fig. 2.4, is expected to deform in the tire contact surface and its outer circumference: (a) shows the front and side views of the tire deformation; (b) shows the tire contact surface and outer circumference deformation viewed from the top.

At the front of the surface, the deformation direction is almost parallel to the tire's traveling direction. In this part, there is no relative slip to the ground.

