BMA4723 VEHICLE DYNAMICS

Ch5 Braking Performance

by
Mohamad Heerwan Bin Peeie
Faculty of Mechanical Engineering
mheerwan@ump.edu.my

Chapter Description

- Aims
  - Explain the mechanism of brake system (How it works)
  - Explain the braking force
  - Explain the tire road friction
- Expected Outcomes
  - Students are able to determine the braking performance at the certain conditions.
- References
  - M.Abe, Vehicle Handling Dynamics Theory and Application, Second Edition, Published by Elsevier Ltd, 2015
  - Thomas D.Gillespie, Fundamental of Vehicle Dynamics, Published by Society of Automotive Engineers

Outlines

- 5.1 Braking System
- 5.2 Factors Governing Braking

5.1 Braking System

- The purpose of a brake system is to slow the motion of a vehicle.
- During braking, the friction of the tires against the road → slow down or stop the rotation of the wheels.
- The brake system converts the momentum of the vehicle into heat by slowing or stopping the vehicle's wheels.
- This is done by causing friction at the wheels.
- The application of the friction units is controlled by a hydraulic system.

5.1 Braking System

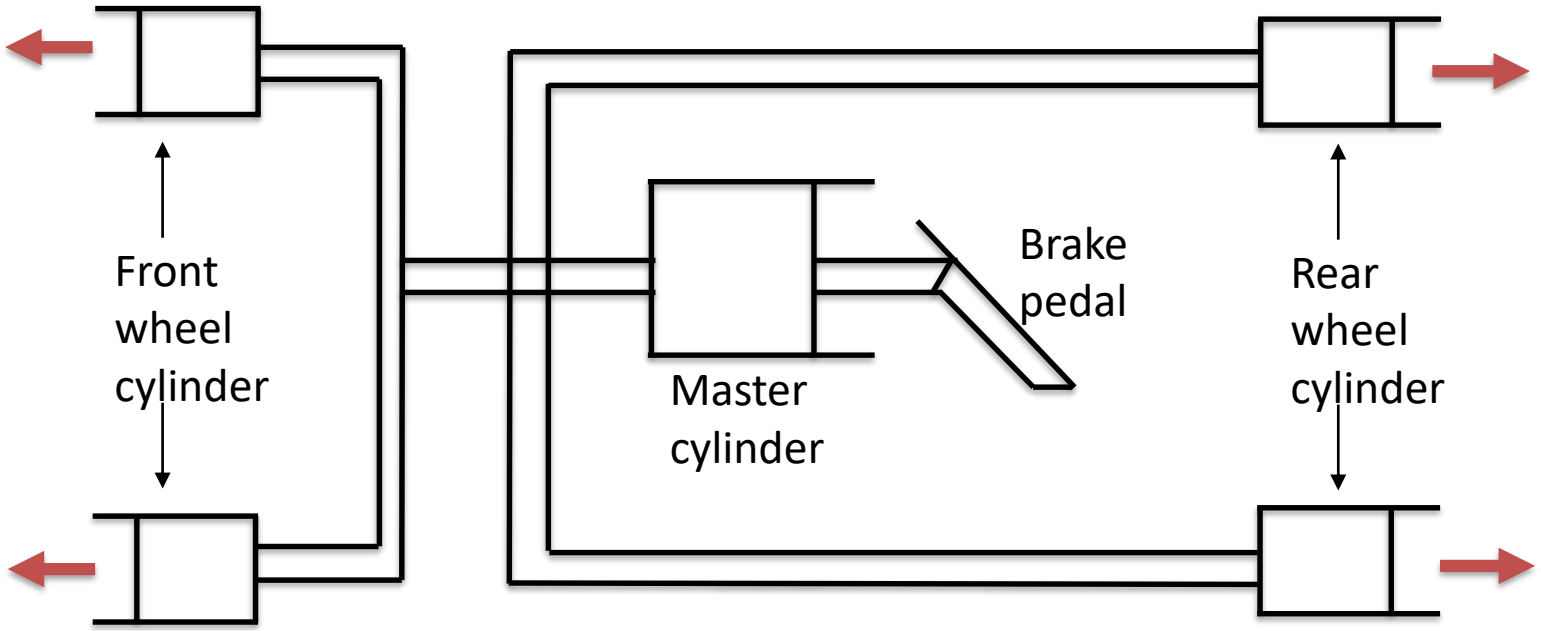

Figure 1 Mechanism of Hydraulic Brake System

5.1 Braking System

- Figure 1 shows the basic components of hydraulic brake system.
- When the driver push the brake pedal, the force from the brake pedal is transmitted to the master cylinder.
- The piston in the master cylinder will push the hydraulic fluid in the brake piping.
- In the brake piping, a brake fluid is used to transfer pressure from the master cylinder → pads or shoes.
- Pressure applied to fluid in a closed system is consistent (Liquids are not compressible).
- Pressure applied to a liquid in a closed systems is transmitted by that liquid equally to every other part of that system.

5.1 Braking System

- Although the fluid in the brake piping is in a closed system, the braking force at the brake pad and shoes can be increased by changing piston sizes.
- Force can be increased at output (wheel) by increasing the size of the wheel's piston.
- Example : to double the output force of the 35kPa at the master cylinder to 70kPa at the wheels, simple use a wheel cylinder piston with a surface area of 2 square inch.

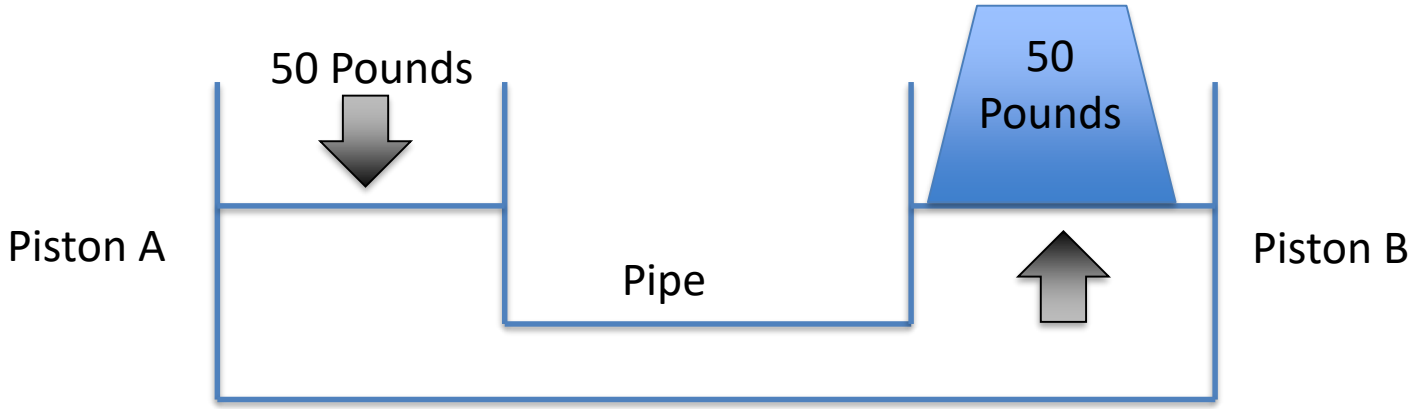

Figure 2 Basic concept of closed system

5.1 Braking System

- From the braking system and the components, the equation of braking force at the brake pads and shoes can be written as below:

Braking force, B_f = Pressure (Master cylinder) x Area (Wheel cylinder)

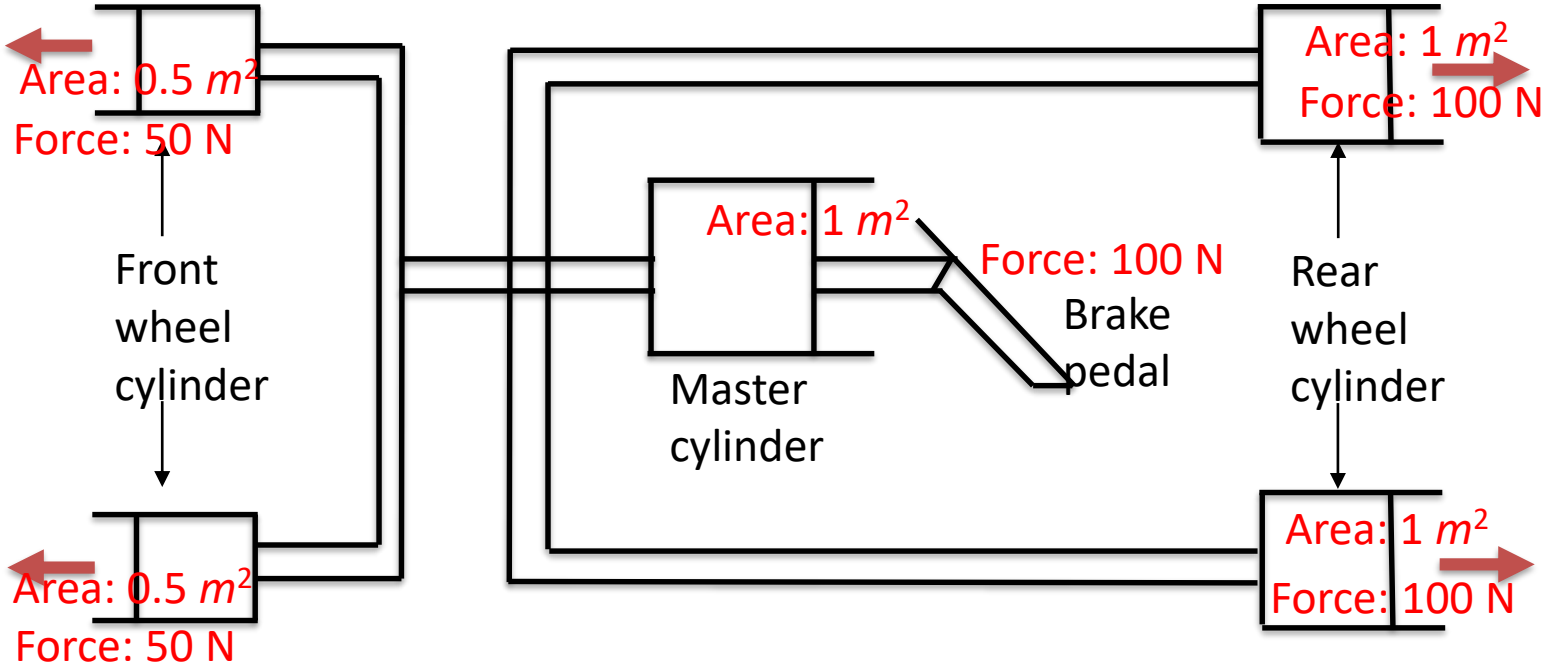

Figure 3 Brake system with different size of wheel cylinder

5.2 Factors Governing Braking

- Four basic factors determine braking power.
- The first three govern the generation of friction:
  - Pressure
  - Coefficient of friction
  - Friction contact surface

The fourth factor:

- Heat dissipation

Additional factor influences how well a vehicle will stop:

- Weight transfer

5.2 Factors Governing Braking

Pressure

- The amount of friction generated depends on the pressure applied to the friction surfaces.
- Hydraulic systems provide the pressure.
- Hydraulic force is used to move brake pads or brake shoes against spinning rotors or drum mounted on the wheels.

5.2 Factors Governing Braking

Coefficient of Friction (COF)

- COF →The amount of friction generated between two surfaces.

$$COF = \frac{the\ force\ required\ to\ pull\ an\ object}{weight\ of\ the\ object}$$

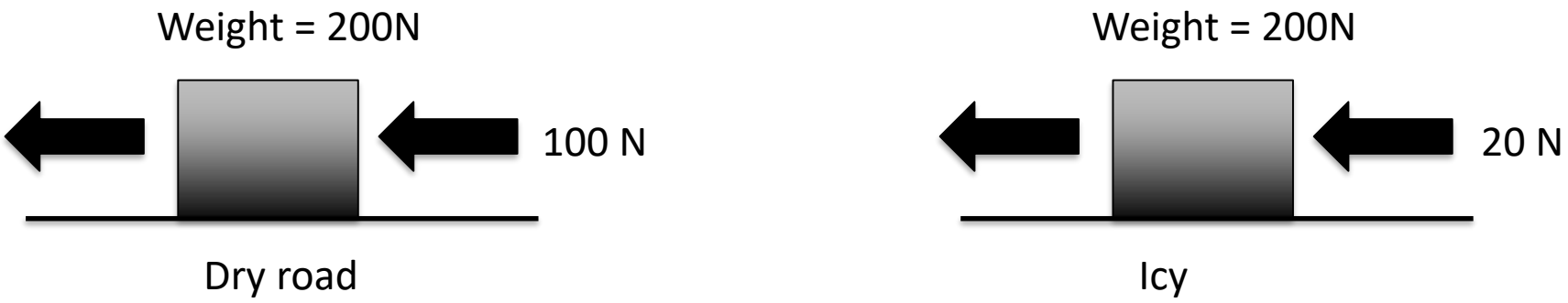

Figure 4 Box on the different road surface

5.2 Factors Governing Braking

- For automotive brakes, the COF expresses the frictional relationship between the brake pads and rotors or shoes and drums.
- Most brake friction materials are between 0.25 and 0.55.

5.2 Factors Governing Braking

Frictional contact surface

- Bigger contact surface stop a car more quickly than smaller brakes.
- The greater surface areas of the wheel brake units, the faster heat can be dissipated.

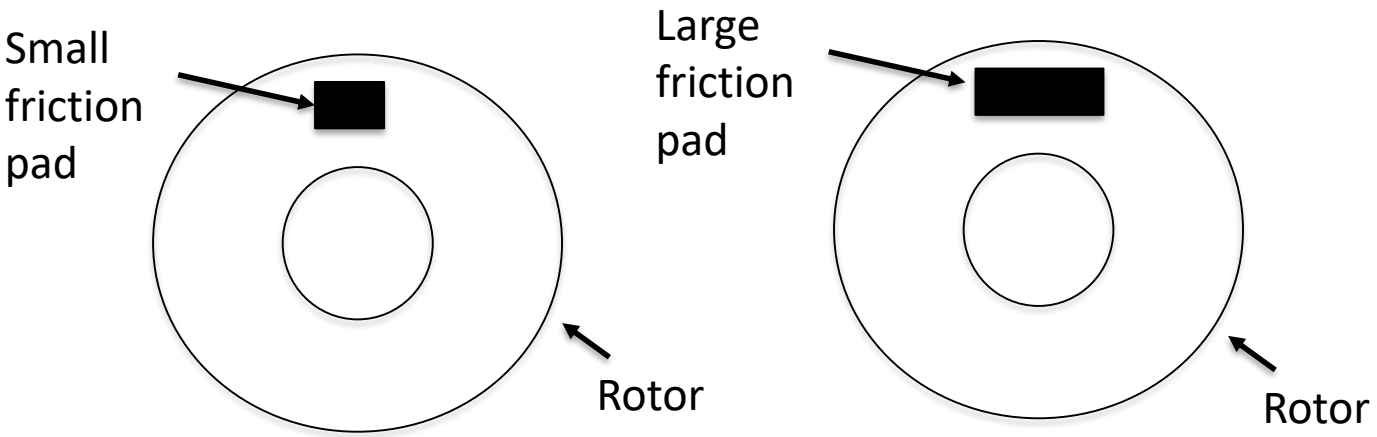

Figure 5 Different size of brake pads at the rotor

5.2 Factors Governing Braking

Heat dissipation

- Heat must be conducted away from pads/rotor or shoes and drum.
- Inadequate heat dissipation can cause brake fade.

Conclusion of the Chapter 5

- Conclusion #1
  - Brake fluid is used in the brake piping, and the system is closed loop system.
  - The braking force at wheel cylinder can be increased/decreased by changing the area of the wheel cylinder

- Conclusion #2
  - The coefficient of friction of the brake pads can affect the braking performance.
  - During braking, load transfer also can affect the braking performance.

Vehicle Dynamics

Chapter 5

Dr Mohamad Heerwan Bin Peeie