ENGINEERS AUSTRALIA

PRESENTATION 5
27TH JULY 2015
EA NEWCASTLE DIVISION OFFICE

Teacher Development Program
Bringing schools and Engineering together

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Bringing schools and engineering together

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- **Welcome & Introduction**

- **Braking Systems– Preliminary HSC Module 3**
- Historical and Social Influences
- Engineering Mechanics and Hydraulics
- Engineering Materials
- Communications

- **Exam questions Q and A**

- **Refreshments**

- **Q + A and Networking**

- **Close**

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- Introduction:

Paul Reynolds – BEng (Mechanical), Chair of Education Subcommittee for EA

- EA to be your link with the Engineering Profession / Industry
- These forums to provide important networking opportunities with other teaching professionals
- We want to assist in providing exciting ways of presenting concepts with real world examples and applications.
- We encourage a link of support with exam assessors
- We would like to make clear the pathways to engineering that exist for all students- Professional, Trades, VET
- **WE AIM TO BE A FACILITATOR IN SUPPORTING YOU.**

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Engineering Studies 2015 Teacher Development Program					
Term	Week	Date (week beginning)	Year 11 Preliminary Modules	Year 12 HSC Modules	Venue
1	3	Feb-09	Engineering fundamentals		Merewether High school
	7	Mar-09		Civil structures	HVGS
2	3	May-04	Engineering products		Division Office
	7	Jun-01		Personal and public transport	St Phillips Christian College
3	3	Jul-27	Braking systems		Division Office
	7	Sep-04		Aeronautical engineering	TBA
4	3	Oct-19	Biomedical engineering		TBA
	7	Nov-16		Telecommunications engineering	TBA

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Dropbox

- Creation of the **"ENGINEERING STUDIES RESOURCE CENTRE"** on Dropbox.
- Teachers and Engineers Australia to share and communicate useful resources.

Preliminary Modules

- 1, Engineering Fundamentals
- 2, Engineered Products
- 3. Braking Systems
- 4. Biomedical Engineering

HSC Modules

- 1. Civil Structures
- 2. Personal and Public Transport
- 3. Aeronautical Engineering
- 4. Telecommunications Engineering

BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

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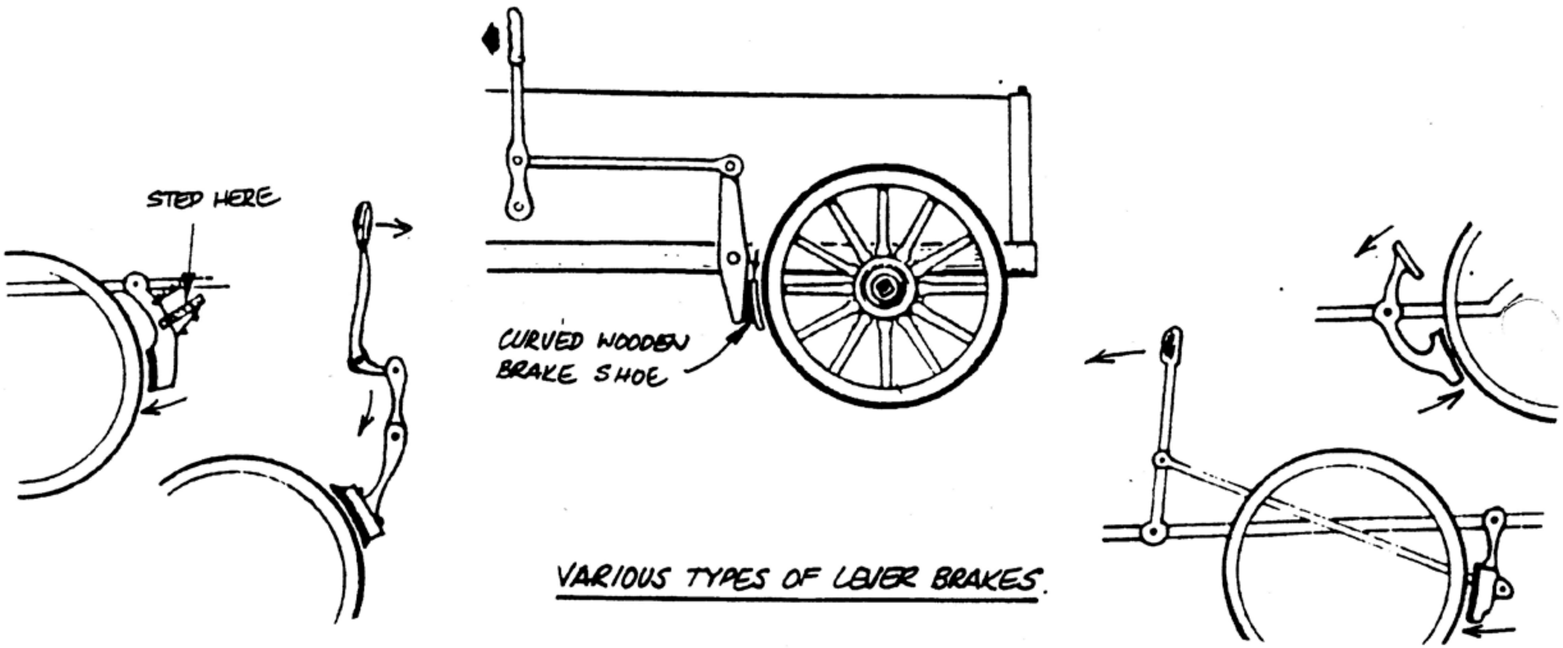
BRAKES:

- A brake is a mechanical device which produces frictional resistance against a moving machine member, in order to slow down the motion of a machine.
- In the process of performing this function, the brake absorbs the kinetic energy of the moving member and potential energy of a lowering member.
- The energy absorbed by brakes is typically released in the form of heat however other forms of energy conversion may be employed i.e. regenerative braking which converts energy in to electrical energy.

BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

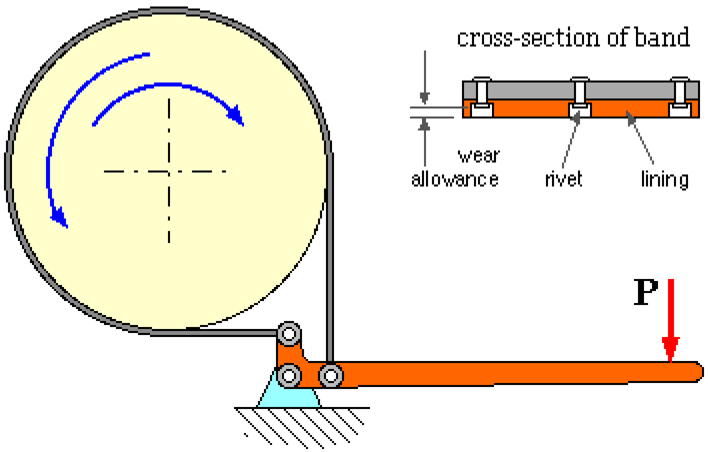
TYPES OF BRAKES: External Shoe Brake (aka. Block or Lever)

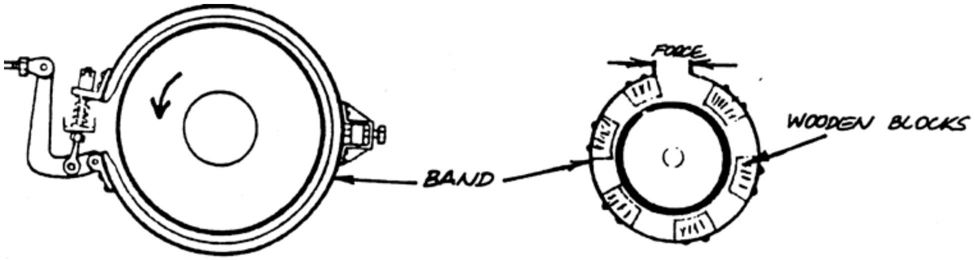


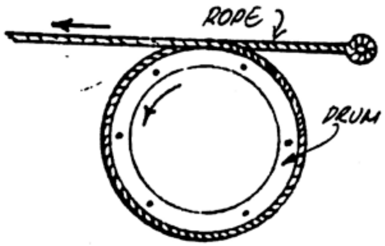
BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

TYPES OF BRAKES: Contracting Band Brake

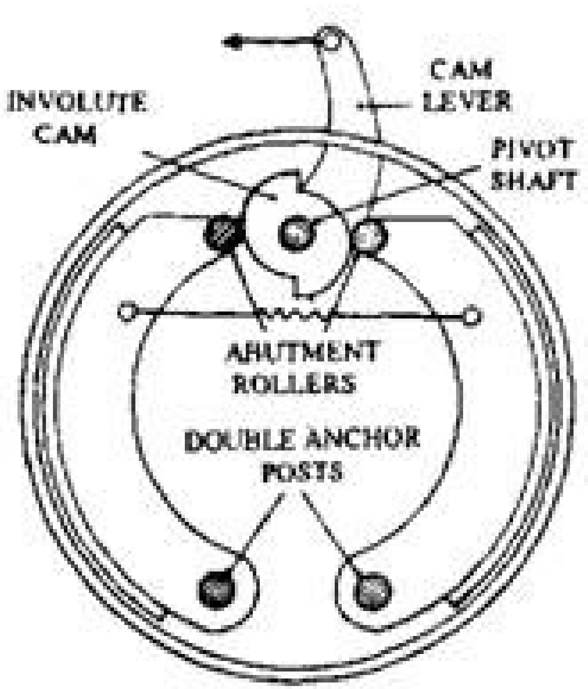






HISTORICAL & SOCIAL INFLUENCES

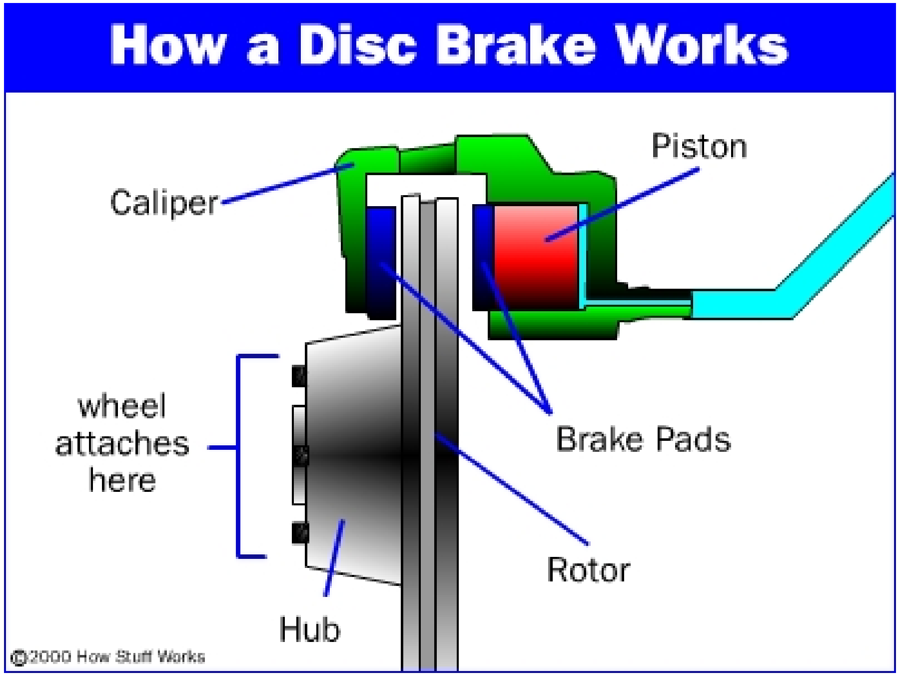
TYPES OF BRAKES: Drum Brakes

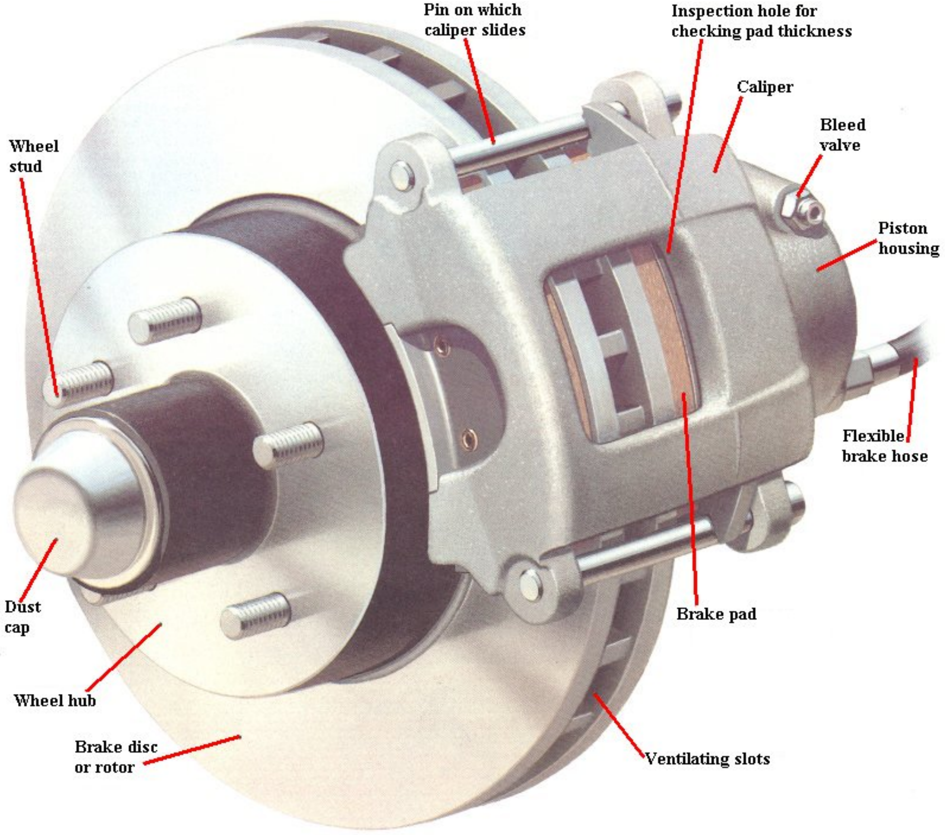


BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

TYPES OF BRAKES: Disc Brakes





BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

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BRAKE SYSTEM	OPERATION	ADVANTAGES	DISADVANTAGES
External Shoe Brake	- Hand operated by lever. - Uses linkages. - Pressure applied to shoe, forced against metal rim. - Mainly used as a parking brake. - Supplemented the horse.	- Appropriate for horse-drawn vehicle. - Cheap to produce. - Simple technology available. - Materials cheap and easy to obtain.	- Needed a large force to operate. - Worked only as a supplement to the horses. - not effective in wet and dusty conditions. - Safety problem due to exposed linkage. - Required a metal rim wheel.
Contracting Band Brakes	- Contracting band acted on hub. - Hand operated. - Worked only in forward motion.	- Appropriate for early model cars with rubber tyres. - New technology over the shoe brake was needed. - Use of the developing steel industry.	- Would not operate in reverse. - Not effective in wet and dusty conditions. - Not effective as a parking brake. - Heating of hub would cause expansion and engagement of brakes when not required.
Drum Brakes	- Internal expanding shoes. - Mechanically/hydraulically operated.	- Operated in all types of weather. - Servo-assisted (self-energising. - Allows for two independent systems.	- Brake fade. - Heat dissipation problems.
Disc Brakes	- Callipers force pads against the rotating disc. - Hydraulically operated with power assist. - Special design is required to operated the disc brake as a hand brake.	- More efficient. - improved heat dissipation. - Lighter weight. - little or no fade. - Easier maintenance.	- Special design required to operate at a parking brake. - Power assistance required. - More expensive. - Not self-energising.

BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

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EVOLUTION OF BRAKES:

Block Brake (1800's) → Contracting Band Brake (1890's) → Drum Brake (1900's) → Disc Brake (1960's)

Drivers of Change: *"Necessity is the mother of invention"*

- Social Change – evolution in modes of transport with horse drawn carts to bicycles through to the first cars. Safety and driver conform requirements have also increased with time.
- Material Advancements – emergent of the steel industry, advancement in material processes and the use of composite materials including engineered materials.

HISTORICAL & SOCIAL INFLUENCES

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FURTHER ADVANCES IN BRAKING SYSTEMS :

Hydraulic braking systems:

In 1904, the Mutton Car Company heralded a revolution in braking technology when a hydraulic system was introduced to operate the rear brakes.

By 1910 most motor vehicles were using two independent and separate brake operating mechanisms on the rear wheels; the first a hand operated lever system, the second either a pedal operated mechanical system or a pedal operated hydraulic system.

Front wheel brakes:

Around this time front wheel brakes also began to appear. The advantages of having brakes on all four wheels was that the stopping distance could be reduced. When brakes are applied on a motor vehicle, much of the weight force of the vehicle is thrown forward onto the front wheels, leaving the rear brakes relatively ineffective.

HISTORICAL & SOCIAL INFLUENCES

FURTHER ADVANCES IN BRAKING SYSTEMS :

Anti-lock braking systems (ABS):

A major development in recent years is the anti-lock braking system, (ABS). This system prevents wheels from locking during emergency braking situations, enabling drivers to steer the vehicle while stopping.

ABS uses wheel speed sensors to detect rapid deceleration. An electronic control unit constantly monitors the wheel speed information, and when an emergency situation is detected, it activates a hydraulic unit with solenoid valves which build up and release pressure, ‘pumping’ the brakes much more effectively than a driver can, to prevent the wheels from locking.

BRAKING SYSTEMS:

HISTORICAL & SOCIAL INFLUENCES

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THE FUTURE IN BRAKING SYSTEMS :

Electronic Braking systems (EBS):

- Electronic control replaces pneumatic control;
- Wires replace air control lines (air can be the backup)
- Actuation of the brakes still occurs through hydraulics.
- EBS provides the antilock function as well as a whole range of new functions.
- Economic benefits — Improved brake wear, less downtime, reduced tire wear and self-diagnosis;
- Safety — Shorter stops, better brake balance, improved stability/control and reduced rollover;
- Diagnostics — EBS can measure foundation brake performance and quickly identify problem wheel ends and maintenance requirements; and
- Driver Comfort — The relationship between pedal feel and pedal force v.s deceleration is improved and constant, regardless of loading.

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The Hydraulic Brake System:

- Originally, motor car brakes were operated by mechanical means (i.e. rods, linkages, cables and levers) and became know and ‘Mechanical Brakes’.
- These mechanical means had distinct disadvantages in that they:
  - Required constant attention to keep in good working order.
  - Subjected to wear.
  - Exposed to the weather.
  - Difficult to maintain equalising force on each wheel.
- Most of these disadvantages were overcome with the introduction of the hydraulic braking system .

ENGINEERING MECHANICS & HYDRAULICS

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The Hydraulic Brake System CONTINUED………

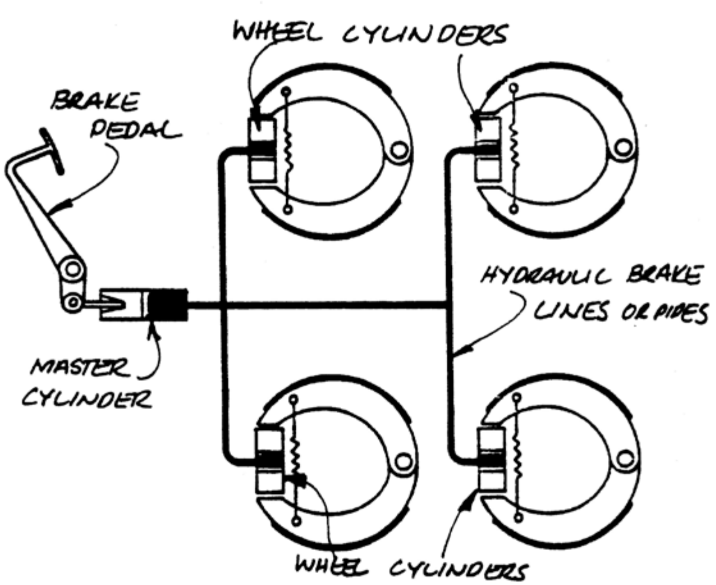

Fig: *The Hydraulic Brake System*

Hydraulic Brakes have the following features:

- Make use of the fact liquids can not be compressed by any appreciable degree.
- The pressure applied at the master cylinder will be equally transmitted throughout the system using Pascal's Principle.
- The master cylinder has a single piston whilst each wheel cylinder has two opposed pistons.
- All pistons have rubber O-rings to maintain pressure and prevent loss of fluid.
- On releasing the brake pedal the retraction springs release the brake shoe and forces the liquid back into the brake fluid reservoir.
- By having larger diameter cylinders for the front wheels one can increase the braking force applied.

ENGINEERING MECHANICS & HYDRAULICS

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Pressure:

Pressure (symbol: *p* or *P*) is the **force** applied perpendicular to the surface of an object per unit area over which that force is distributed

$$P = \frac{F}{A}$$

P = Pressure (Pa)
F= Force (N)
A = Area (m^2)

Hydrostatic Pressure: In a fluid at rest, all frictional stresses vanish and the state of stress of the system is called *hydrostatic*. During this condition the gradient of pressure becomes a function of body forces only i.e. a fluid at equilibrium becomes a function of force exerted by gravity.

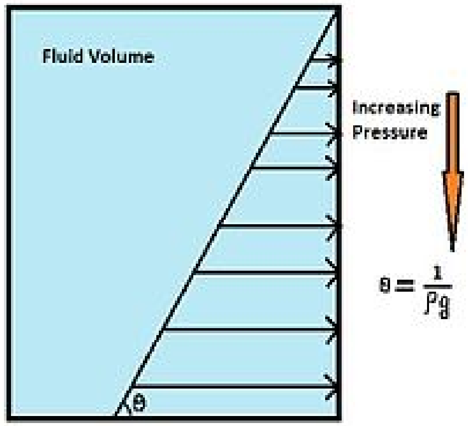


Fig: ***Pressure Prism***

$$P = \rho g d$$

P = Pressure (Pa)
ρ= Density (Kg/m^3)
g= Gravity (N/kg)
d = Depth (m)

BRAKING SYSTEMS:

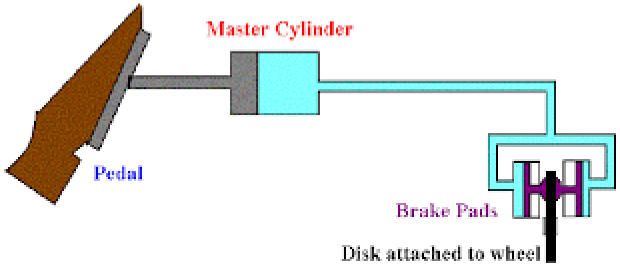
ENGINEERING MECHANICS & HYDRAULICS

Pascal's Principle:

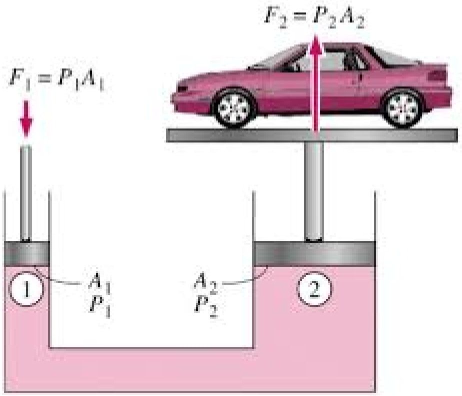
Pressure exerted at any point on a confined liquid is transmitted undiminished in all directions

Some applications of Pascal's Principle:

Brakes:



Hydraulic Jacks:



Essential Services:

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Pressure in Liquids - Open container:

A liquid at rest in an open container exerts a pressure due to its different weight at various depths.

1. Drill, or pierce, three small holes along the side of a large PET drink bottle at various heights – one near the bottom, middle and top.
2. Fill the container with water and observe the result.

You should observe that the:

i: pressure on the water in the open container varies with the depth; the greater the amount of water above the hole, the greater the pressure.

ii: pressure exerted by the liquid is always perpendicular to the surface it contacts.

iii: pressures are the same at all points on the same horizontal level in a liquid at rest.

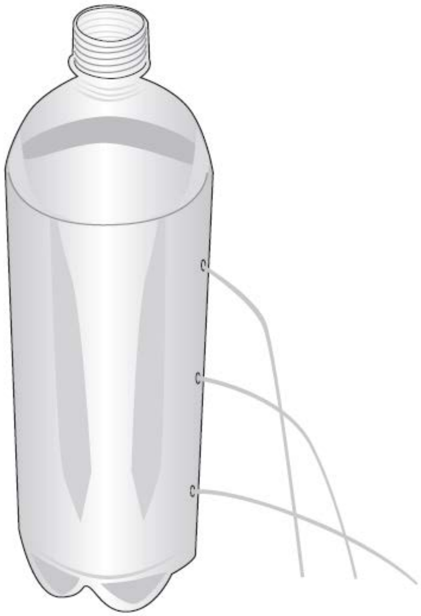

Fig: ***Water flow from a open container.***

ENGINEERING MECHANICS & HYDRAULICS

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Pressure in Liquids - Closed container:

Now consider the pressures in a closed or sealed container.

Any pressure that is applied from outside a sealed container full of liquid can exert an equal and undiminished pressure to all other portions of the liquid and to the walls of the container.

1. Attach the PET drink bottle used in the previous activity to another intact PET drink bottle so the two join at the neck.
2. Fill the bottles with water, connect and squeeze the container without holes and observe the result.

You should observe that the pressure on the water in the sealed or closed container is the same for each of the holes.

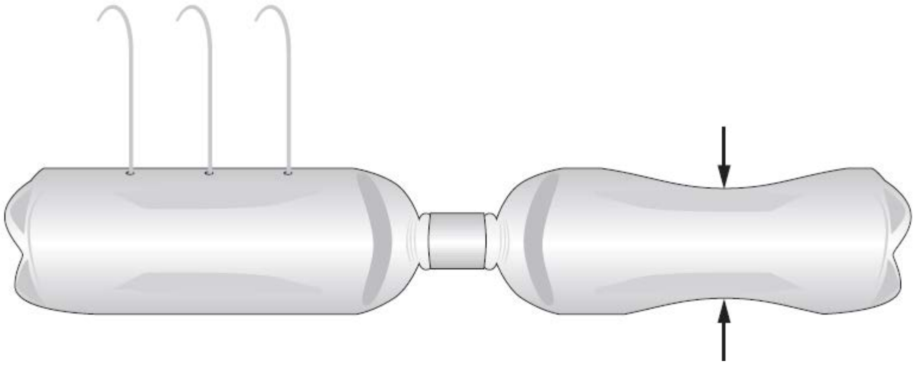

Fig: ***Water flow from a closed container.***

MATERIALS

Material Selection:

Often it can become overwhelming in how one might approach the selection of a certain material:

One learns many tools to assist in the selection process but a lot comes down to the experience and understanding of when to make appropriate trade offs on selection criteria.

- Experience; this can be knowledge gained through the learnings and outcomes obtained by an individual or drawing of the knowledge of others.
- Trade offs; often an engineer finds themselves in a situation in which the best material for a job is not the most suitable, especially when one takes into account dollars, time and customer requirements.

BRAKING SYSTEMS:

MATERIALS

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When things go wrong :

Unfortunately by there inherent purpose if there is a failure in the braking system then the results can be catastrophic.

Waterfall Train Crash – 2003

The train operator suffered a heart attack and “dead-mans brake” did not engage resulting in a number of fatalities.

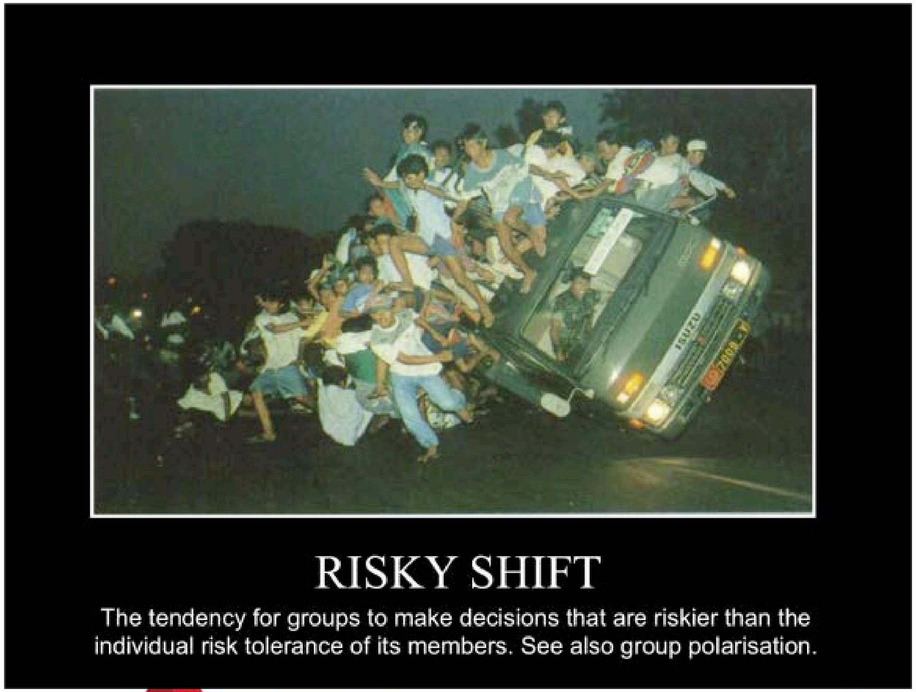
BRAKING SYSTEMS:

MATERIALS

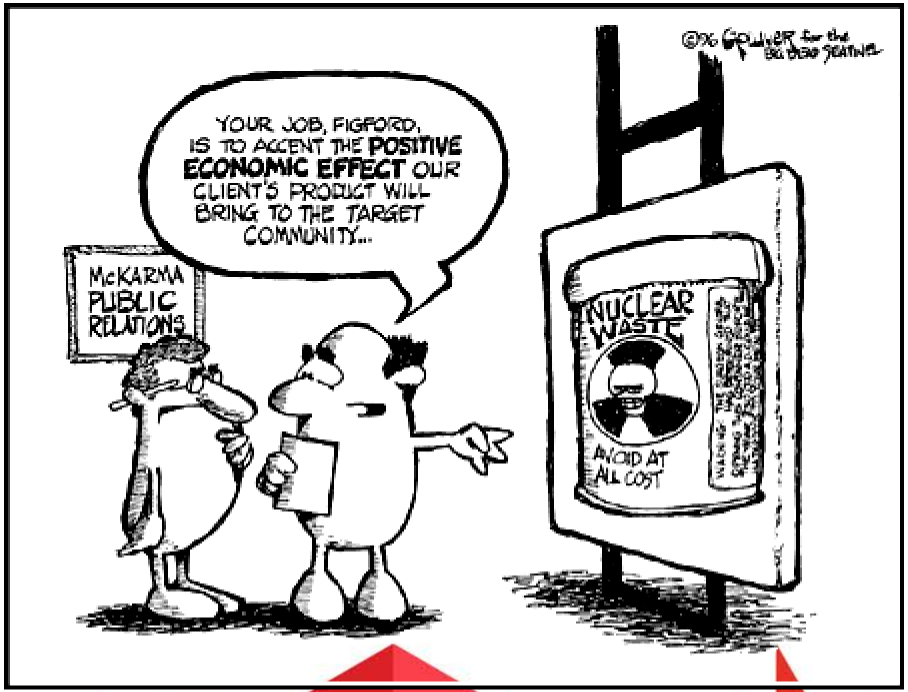
When things go wrong CONTINUED……….

Along with all the technical, material and design consideration - Engineers need to also consider and factor in a number of more human elements:

Human error



Customer Expectations

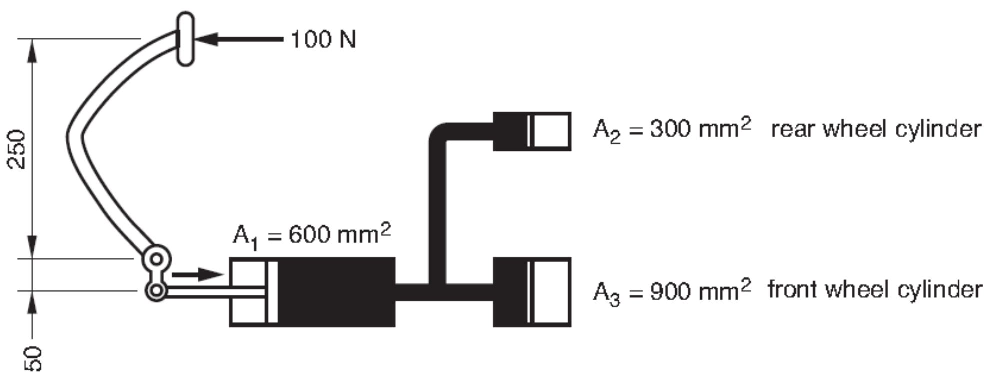


BRAKING SYSTEMS:

EXAM QUESTIONS

Example:

Below represents a sealed hydraulic braking system. A force of 100 N is applied to the brake pedal as shown. Size details of the pedal, master cylinder, and front and back wheel cylinders are given on the diagram.
Determine the thrust (force) delivered by each of the wheel cylinders.



$\sum M_{Pivot}$ (+ve ↻) $100 \times 250 = 50 \times R$

$\therefore R = 500N$ $M.E = 5$

Pressure due to 'R' $= \frac{F}{A} = \frac{500}{600 \times 10^{-6}}$

$= 833$ KPa

Thrust @ Rear Wheel $= PA$

$= 833 \times 10^{3} \times 300 \times 10^{-6}$

$= 250N$

Thrust @ Front Wheel $= PA$

$= 833 \times 10^{3} \times 300 \times 10^{-6}$

$= 750N$