Coefficient of Linear Expansion

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- Metals expand and contract due to temperature variations.

- Different metals expand and contract by different amounts for the same change in temperature.

- However this expansion is a constant.

- For example:

- Say steel expands by 0.00004mm for every 1^O rise in temperature then:-

- If the temperature rises by 5° then the increase in length will be

$$5 \times 0.00004mm$$

$$= 0.0002mm$$

T

- The change in length of a solid bar when heated or cooled through a temperature change Δt is given by the experimental relationship

$$x = \alpha \text{ x } l \, \Delta t$$

- Where x is the amount of expansion l is the original length of the bar α is a constant known as the coefficient of linear expansion.

- Typical values of α are as follows:-

Substance		α
Aluminium		24×10^{-6}
Iron, carbon steel		12×10^{-6}
Cast iron		10×10^{-6}
Copper		17×10^{-6}
Brass, bronze		19×10^{-6}
Glass		8×10^{-6}

The Forth road bridge linking the Edinburgh side of the River Forth to Fife on the North side is 2,512 m long if the whole structure is made of steel and the total temperature difference seen across the year is 35 ^{O}C then the bridge will expand by an amount equal to

$$\Delta L = \alpha \times l \times \Delta T$$

$$\Delta L = 12 \times 10\text{-}6 \times 2512 \times 35$$

$$\Delta L = 1.055 \text{ m}$$

- (1) at the standard measuring temperature of 20° C, a steel gauge is 250mm long.
- What will its actual length be at 25° C?

Ans. 0.000015m or 0.015mm

- (2) A 50mm steel gauge block is accurate when checked in the laboratory at 15° C.
- What will its length be when used in the workshop at 25° C?

Ans. 0.000066m or 0.060mm

- (3) How much taller is the Eiffel Tower on the hottest day of the summer (25 ℃) than the coldest day of the winter (2 ℃)?

- The tower is 324 m tall measured from the top of the flagpole.

- Assume the tower is built of structural steel.

Ans 0.0894 m or 89.4mm

- (4) An aluminium tape measure measures 10.0 m at a temperature of 20°C.

- When a builder uses it on site at on a winter day at a temperature of -2^{O}C what is the actual length of the tape measure at this temperature?

Ans 10.0053m