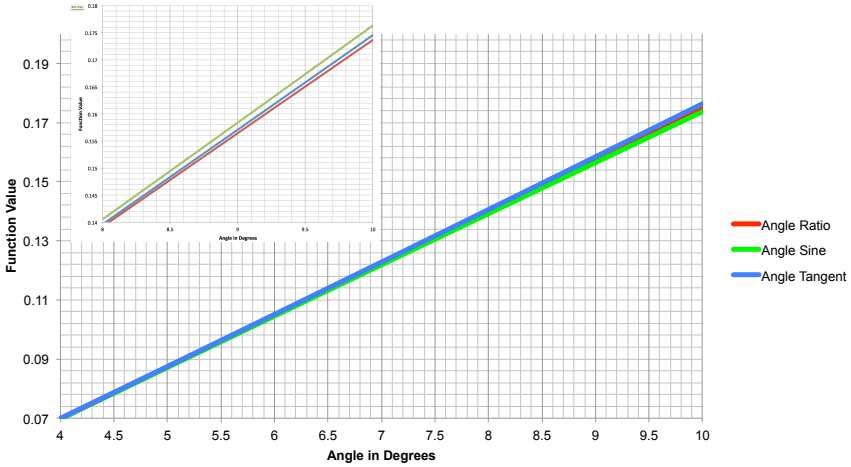
Mechanics of Materials
CIVL 3322 / MECH 3322
Thermal Strain

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Function Variation at Small Angles



THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- Thermal strains are strains that develop when a material is heated or cooled
- They can be the bane of an engineer's existence if they are not considered
- Materials that fit perfectly at one temperature can rupture or fall out when their environmental temperature changes

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- The problem can be made even worse when a combination of thermal strain and strains induced by loadings are combined
- Strains caused by thermal changes and strains caused by loadings are additive

Thermal Strain

- Thermal strains are typically linear in nature
- A uniform change in strain will occur for every degree change in temperature no matter where on the temperature scale it starts from
- Of course near the melting point this is severely violated

Thermal Strain

- The linear relationship for thermal strain is shown as

$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- The subscript on the strain denotes that it is developed because of a thermal change
- α is a linear coefficient relating the rate at which strain changes with respect to a unit change in temperature
- ΔT is the change in temperature in degrees

$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- Take care which unit system you are working in, degrees F or degrees C
- Different α values will be used in each system
- Tables D.1a and D.1b show some typical coefficients of thermal expansion

$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- Notice that the values are very small
- Don't expect really large strains to be developed through thermal changes

$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- Thermal strains are always axial strains
- No shear strains are developed in a single material because expansion or contraction takes place in all directions at once
- There are not forces developed between layers

$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Thermal Strain

- Because the material expands in all directions in the same way, thermal strains will appear in every direction

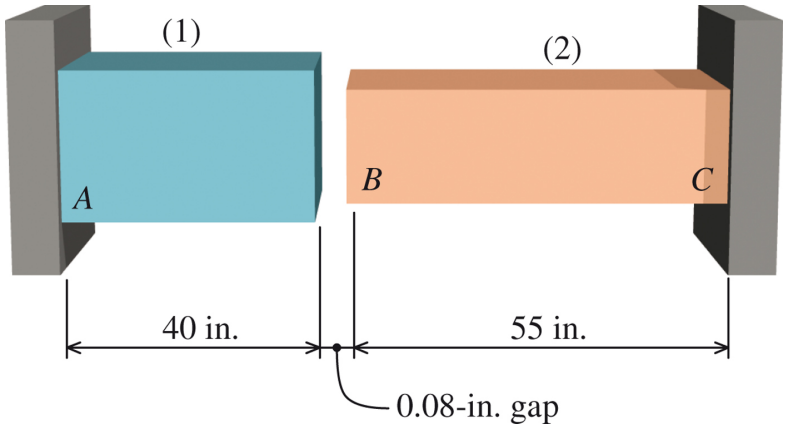
$$\varepsilon_T = \alpha \Delta T$$

THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

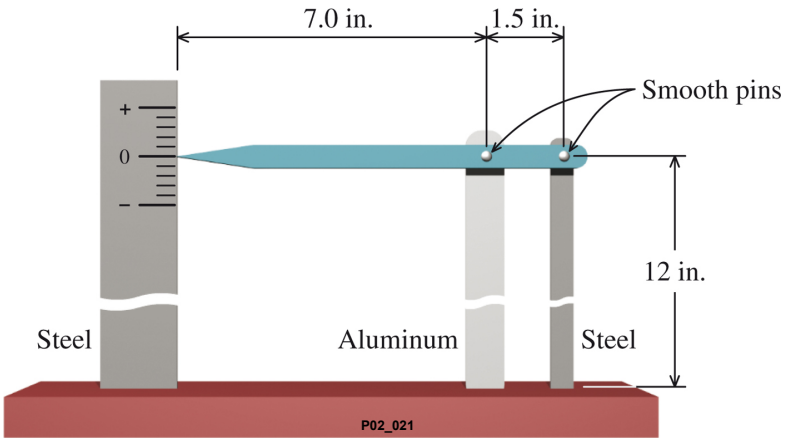
Problem P2.16

- A large cement kiln has a length of 400 ft and a diameter of 20 ft.
- Determine the change in length and diameter of the structural steel [$\alpha_s = 6.5 \times 10^{-6}$/°F] shell caused by an increase in temperature of 350°F.

Problem P2.18



Problem P2.21



THE UNIVERSITY OF MEMPHIS
Department of Civil Engineering

Homework

- P 2.19
- P 2.20
- P 2.22