

Thermal Expansion

Thermal expansion is the phenomenon of expanding or shortening a material when it undergoes a temperature change. In the thermal expansion process shape and size of a structural member may change. Hence it affects the total volume or area of the structural member. Thermal expansion meaning can be understood properly by understanding the thermal expansion phenomena.

Thermal expansion means a material may expand or shorten when it is supposed to change temperature. If the working temperature exceeds the standard temperature, the expansion will occur in this case. But if the working temperature is less than the standard temperature, then shortening of the material will occur in such a case. These expansions or shortening amounts will depend on the coefficient of thermal expansion.

Coefficient of Thermal Expansion

The coefficient of thermal expansion is a coefficient that describes the effect of temperature on a material. It describes how the material dimension will change when the temperature of the material changes with the standard temperature. It can be defined as the fractional change in dimension with respect to its original dimension when it goes to a unit change in temperature.

The coefficient of thermal expansion also depends on the material properties of the structural element. The coefficient of thermal expansion of steel is 9×10^{-6} per degree celsius change in temperature. More value of the thermal expansion coefficient indicates more change in the structural element when it undergoes temperature change. The unit of thermal expansion coefficient is per degree celsius of temperature change.

Thermal Expansion Formula

The thermal expansion formula can be derived from its definition itself. The coefficient of thermal expansion shows the amount of change in dimensions when it is subjected to temperature change. The formula for thermal expansion can be described as follows:

$$\Delta L = \alpha L \Delta T$$

Where ΔL is the change in length of the structural member

α is the coefficient of thermal expansion

L is the length of the structural member

ΔT is the change in the temperature.

Application of Thermal Expansion

The concept of thermal expansion is used in the civil engineering design of structures and in mechanical engineering, chemical engineering, aeronautical engineering, etc. In the real world of designing structural elements, thermal expansion plays an important role. It has various uses and advantages in the design sector. For example, a structural member with less coefficient of thermal expansion is preferred when designed for an environment more prone to temperature change. Here a few applications of thermal expansion are listed below.

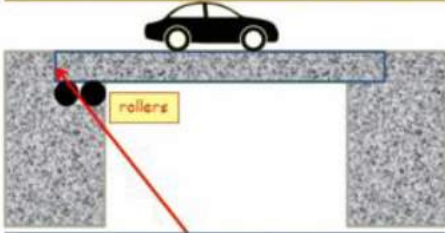
- Increase in the length of railway tracks during summer.
- Expansion of metallic joints in concrete bridges.
- Rise of mercury level in thermometer.
- Wings design in the jet plane.
- Cracking of glass when it is subjected to heat.

Thermal Expansion Examples


The concept of thermal expansion will be more clear by understanding it with the help of a few real-life examples. Thermal expansion applications can be seen in various domains like railway structures, highway structures, designing of airplanes, etc. Here are a few examples.

Thermal Expansion - examples

Girders in buildings and bridges are made with gaps at the ends.
Glass to be used in cooking has to be a low expansion type such as Pyrex otherwise it would shatter as it got hot.
Rivets are heated before they are put in place to hold two metal plates together.



Bridges have gaps to allow for expansion. Rollers may be used at one end so that movement can take place.



High-speed planes are warmed by air friction and so get longer.

Suspended overhead cables are left slack to allow for contraction that could happen on a very cold day.

