As with many other materials, as glass is heated, it expands. Thermally induced stresses, or thermal stresses, are generated when one region of a piece of glass expands more than another region. In the case of glazing within a frame, the generation of thermally induced tensile stresses at the edge will result from the central region of the glass being heated relative to the edges, which may be concealed within a framing system.

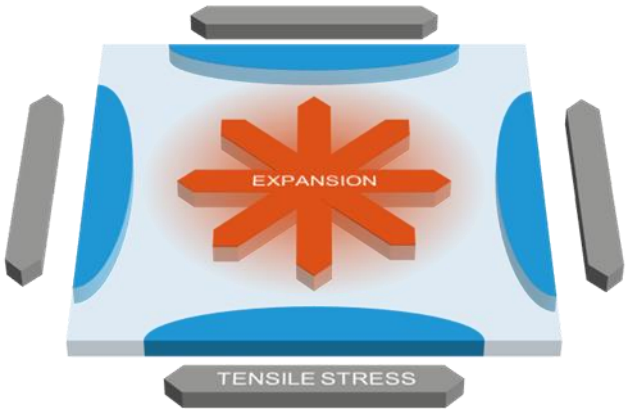

Figure 1 - Illustration of Thermal Stress Generation

As the central region expands relative to the cooler edges, tensile stresses are generated parallel to the edge of the glass. The amount of stress generated (σ) per ^{o}C rise in temperature is related to the coefficient of thermal stress (α) and the Young's modulus (E), by the equation;

$$\sigma = \alpha \cdot E \cdot \Delta T$$

This results in a stress of approximately 0.63 MPa/^{o}C. This means that for a temperature different of 15^{o}C, a stress of 9.45 MPa is being generated.

Should the amount of stress generated be great enough to overcome the strength of the glass at any point on the edge, then a fracture will occur. The strength of the glass is predominantly dependent upon edge quality, which will be discussed in a separate document.

THERMALLY INDUCED FRACTURES

As the tensile stress is generated parallel to the edge, the initial fracture will occur perpendicular to the edge, as the glass is effectively being pulled either side of the origin. Typically the edge of the glass will be concealed within a framing system until it is removed, and so breakage due to thermally induced stresses cannot be confirmed. However, if the edge is assessed the initial fracture can typically be easily identified, as through the thickness and relative to the edge, the fracture will be at 90^{o}, as illustrated below.

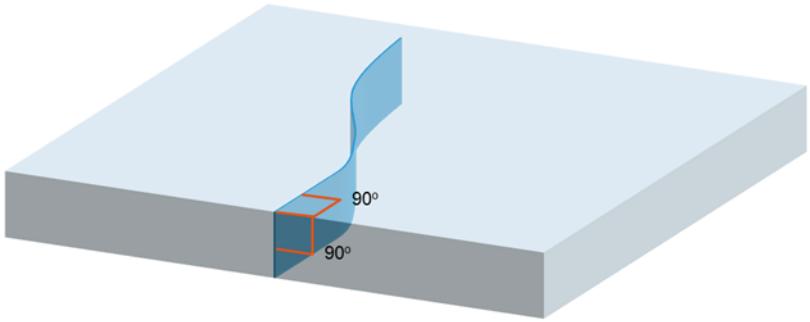

Figure 2 - Illustration of Thermally Induced Fracture

The subsequent fracture path can be dependent on the amount of energy causing the failure. Thermal stress fractures are typically low energy failures, and as such manifest as a single fracture moving through the glass. If a higher energy thermal breakage occurs, then the fracture may fork/split and propagate in different directions across the lite.

It should also be noted, that once an initial fracture has occurred, the glass will be weakened in this area, and more susceptible to other external loadings, such as wind or impact. Typically any additional stresses generated will have more influence where existing damage is present, and so, it is likely the original fracture would be extended further.

INFLUENCING FACTORS

Beyond the basic scenario of glazing within a framing system, other factors can influence the likelihood of failure to thermal stresses, including;

- Glass Absorption and Unit Configurations
- Shading
- Framing Systems
- Backups, Blinds and Internal Obstacles
- Internal Heating

These factors will be discussed in detail in separate documents.