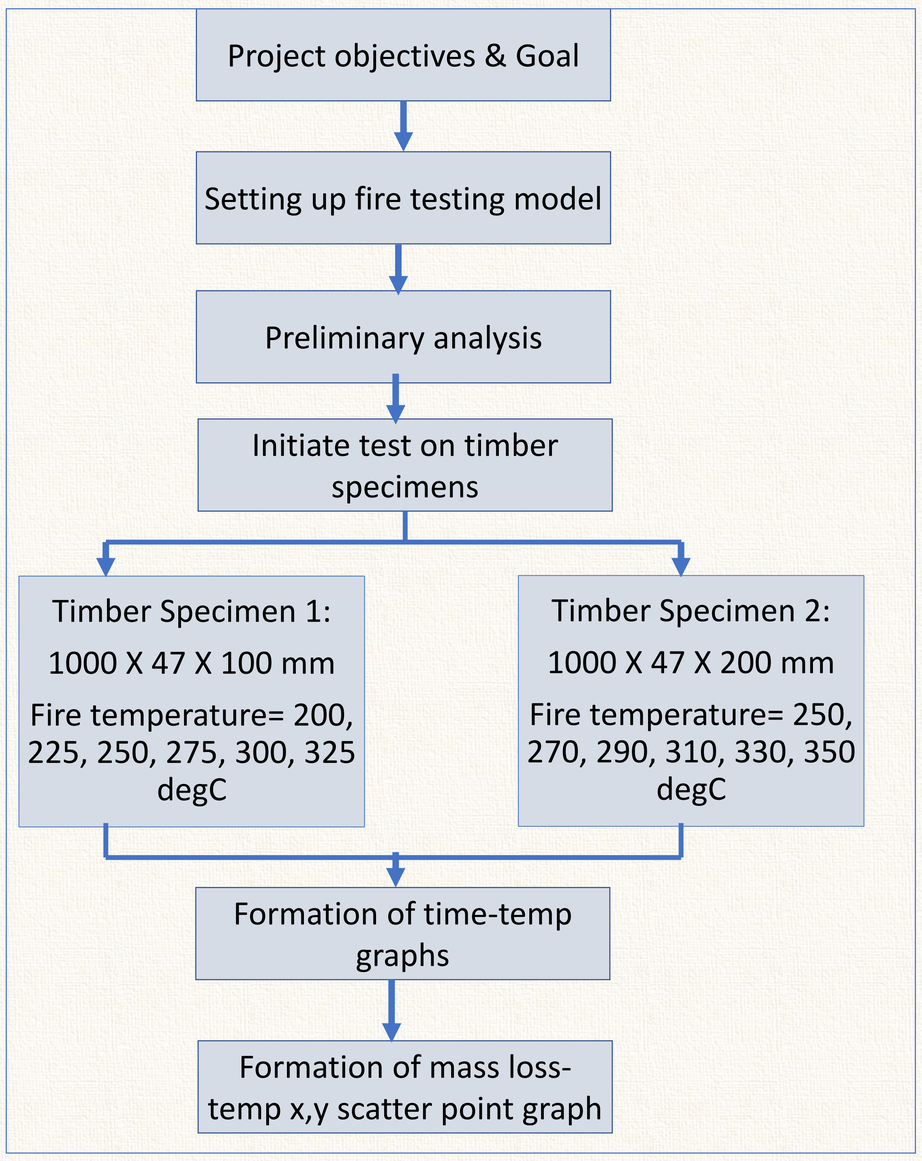
Fire Fuel Load Contribution of Timber Structural Engineering Products

Project Brief

As the requirement for substantial use of timber rises in the construction industry not only for architectural reasons but also to stimulate sustainability; there lies corresponding demand for design methods and models that can precisely sketch for the effect that timber may have on the behavior of an enclosure fire. Timber being a combustible substance in nature, various building regulations and codes limits its usage as a building material specially in tall buildings such as in the UK the timber framed buildings are limited up to a height of 11 meter. As all timber products are flammable fire engineering is a necessary condition for safe design and use and to accomplish net zero carbon goal.

Project Aim

The research aims to measure the thermal output of various timber products with increased temperature so that the fuel load contribution during pyrolysis can be ascertained, which then can be used to determine more accurate temperature-time curves for timber structural components. To fulfill this 36 fire tests have been conducted with two different timber specimens



Discussion & Observation

- Timber products endured a substantial amount of weight loss with increasing fire temperatures. The loss of weight is more for beams with 200 mm depth owing to greater surface area. This modification of weight before and after consumption of heat energy reckons to the fuel load contribution at elevated temperatures.
- The thermal expansion of timber beams broadened with temperature rise and split the surface of 100 mm depth timber beams at 325 degC and for 200 mm depth timber beams ruptured surfaces first appeared at 290 degC.
- Flashover phase of 200 mm depth timber beam was first observed once it reached 350 degC fire temperature. The loss of mass of timber rapidly increased to 441 g.

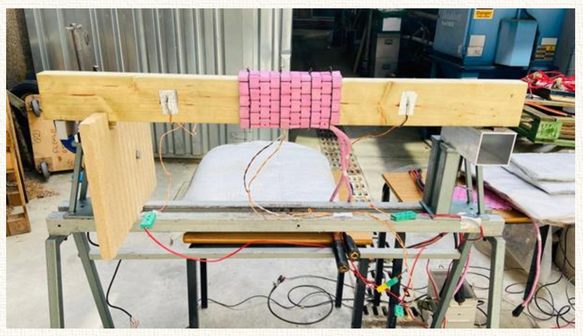
Methodology & Data Collection

1. Setting up a fiscal model with timber mounted on a platform placed with thermocouples to detect heat and a ceramic heating pad acting as a thermal load.

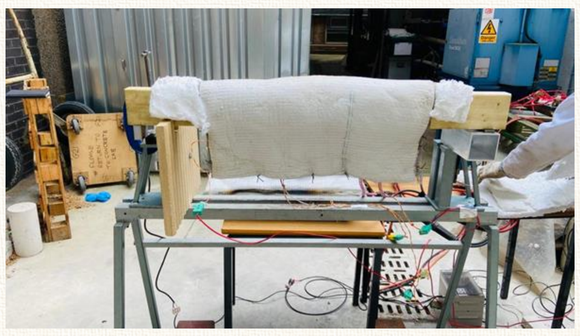
2. Insulation sheets wrapped on top of timber beam to entrap heat and restrain the entrance of oxygen which initiated the process pyrolysis.

3. Thermocouples and heating pad connected with data acquisition module software and inverter respectively produces time-temperature graphs with an increment of 10 degrees per minute.

4. The difference of the mass of the timber after fire testing accounts for the loss of the fuel load at different sets of temperatures.



Thermocouples and heating pad placed on timber beam



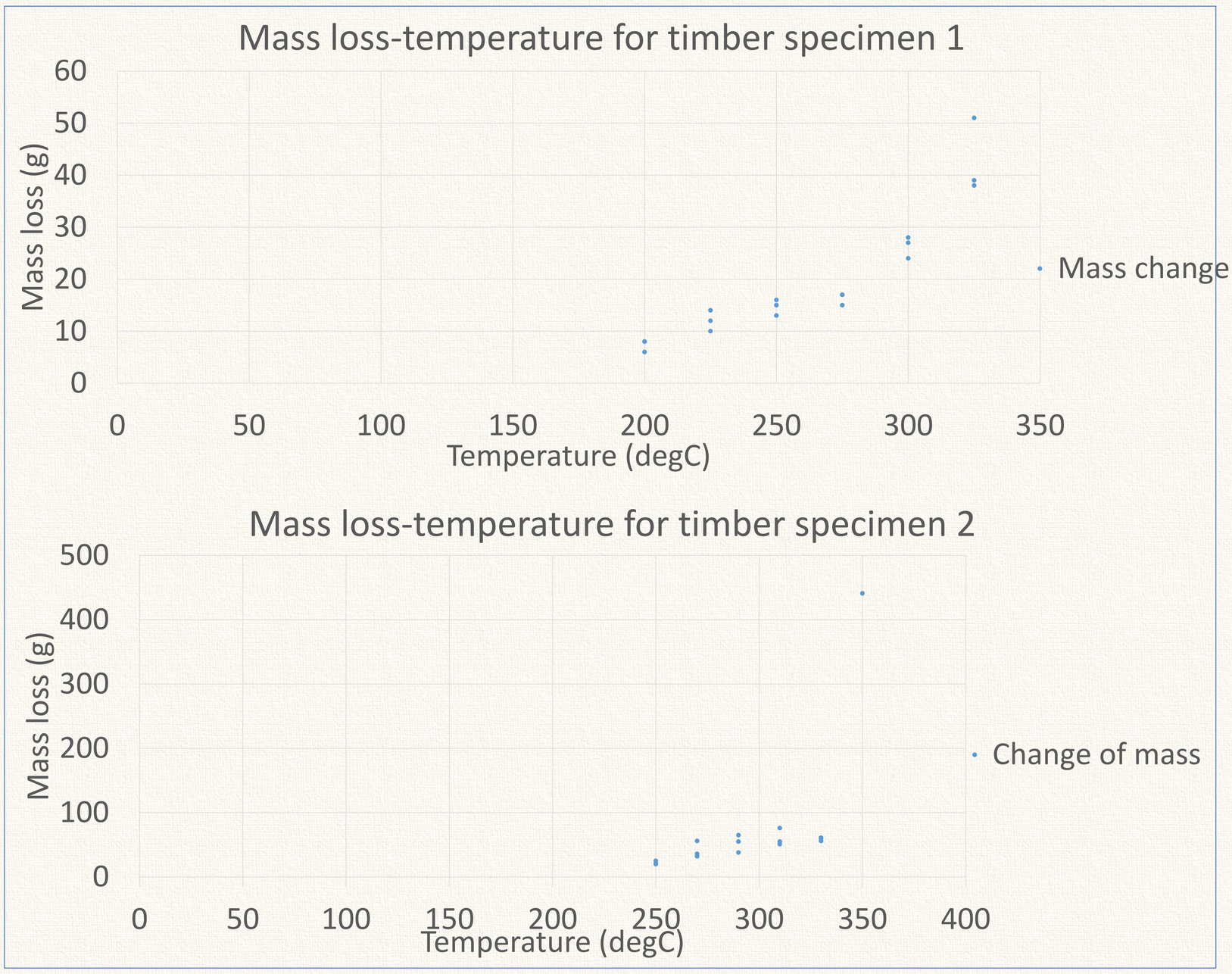
Insulation sheet wrapped on timber beam

Formation of rapid smoke with increased temperature

Formation of flamed charcoal at 330 degC

5. It has been observed that with the increase of heat the thermal expansion, charring, emergence of smoke and fissures & splitting of timber surfaces increase along with the rise of loss of mass. For timber beams with greater surface area the change of mass was more.

Statistical Data & Analysis



Future Research Scope

The utilization of ceramic heating pads as a source of heat and exertion of thermal load can be evaluated more to calculate the magnitude of compression load which then can be used to measure stiffness of timber products by finding out modulus of elasticity and strength decay of wood by quantifying modulus of rupture.