



Princess of Wales Conservatory

For the Trustees of the Royal Botanic Gardens, Kew

The plan and form of this glasshouse demanded an unorthodox approach compared to traditional steelwork and building design. All steelwork has been exposed which has meant that apart from being structurally adequate the frame had to be visually pleasing. The restrictions on the steelwork design imposed by the architects were as follows:

- no diagonal roof bracing
- no lattice members
- no trusses
- standardisation of steel section sizes and connections
- easy external access a major requirement for maintenance

The building has been designed as a permanent structure with the normal imposed loadings for snow and access.

- a. Wind. Overall shape and roof profile meant that the glasshouse could not be categorised within the wind load tables of BSCP3, Chapter V. Therefore a wind tunnel test analysis was performed by the Building Research Establishment which provided realistic loading categories.
- b. Temperature Effects. From an ambient temperature of 15°C the design accounted for temperature changes of down to 12°C and up to 47°C. The rafter forms a heat bridge between the inside and outside environments as the roof glazing was supported by the web just above the bottom flange.
- c. To eliminate bolted rafter connections, site welding was specified for the temporary joints.

Thermal stresses would be induced into the steelwork from the above points and it was considered prudent to specify a ductile steel, viz Grade 43E, for the majority of the steelwork. The multi-span pitch portal frames are tied together with Vierendeel tubes fixed to the top flange and purlins just above the bottom flange. East/West stability is achieved by frame action of the portals having rigid joints. North/South stability is achieved by Vierendeel frame action with the tubes rigidly connected to the rafter's top flange. Vierendeel frames span 'horizontally' from buttress to valleys, with the valley tubes and purlins transmitting the horizontal forces to rows of diagonally braced columns. The frames were fabricated in sections and temporary joints welded, flame sprayed with aluminium and painted on site.

The frames were analysed first as 'plane frames' and then three dimensionally with the Vierendeel tubes. Extensive use was made of the 'Stress' computer programme. To avoid glass breakage, mobile deflections from imposed loadings were restricted to approximately 20mm vertically and horizontally. Purlins of steel Grade 50D were precambered to between 10 to 15 mm.

There were no expansion joints specified in the steelwork as it was considered that thermal movement would cause articulation of the frame at each vertical gable. The structure was designed to withstand the stresses induced due to the effects of temperature.

All steelwork was pre-ordered from the British Steel Corporation with the requirement that the rolling tolerances should be half of those allowed in BS 4. This was fully met by BSC and 275 tonnes of structural steel were employed in the structure.

Due to the importance placed on the design for appearance and maintenance, a full size prototype of two bays was constructed at Kew, 18 months prior to the start of the main contract.

The corrosion protection system will dictate the life of the structure (100 year design life). The internal environment consists of hot, humid air, surfaces running with condensation and cleaning with high pressure water spray, i.e. more extreme internal conditions than external. Visible corrosion can be treated but unseen corrosion in crevices, corners etc could progress until major work discovers the deterioration. Hence the emphasis on details, 'clean' joints, no water traps etc, allowing inspections and access for re-painting, e.g. all gutters demountable, no hollow sections or internal corners difficult to paint. Following investigations and consideration of the problem, the system specified was: grit blasting, flame sprayed aluminium (100 microns) and chlorinated rubber paint (175 microns).

The general layout of the displays is a response to some stringent plant management requirements and to the constraints of the site. Also there is a need to accommodate 1 million+ visitors a year. Each zone has the optimum location for its temperature, humidity, ventilation and lighting requirements. The 2.1m wide path system caters for the disabled. The service area is central and is set partially into the ground. There are several levels, which are fully planted and have a number of water features and also special displays.

The project formally entered planning in November 1980. The contract was let to French Kier Construction in August 1983 and completed in August 1985. Partial opening to the public will commence in the summer of 1986 with a formal opening in 1987. The project cost was approximately £4M.

Architects: Property Services Agency, DoE
Structural Engineers: Property Services Agency, DoE
Steelwork Contractors: Blight and White Ltd.

Judges' comments:

Bold and imaginative use of a finely detailed external steel frame, makes this outstanding glasshouse a most attractive structure to view from the outside, whilst providing a perfect, uncluttered environment in which to study and enjoy the plants which it houses.