AWARD

The Imperial War Museum Extension

For: The Trustees of The Imperial War Museum

Arup Associates were appointed by the Property Services Agency in 1983 to prepare 'a detailed Feasibility Study for the redevelopment of the main building of the Imperial War Museum in Southwark, and to include recommendations for phasing to allow the existing building to continue in use throughout the work'. The purpose was to provide more exhibition space with room for study galleries and improved administration areas.

The building which currently houses the Museum was designed in 1815 by James Lewis as the Bethlem Royal Hospital or 'Bedlam'. The dome was added in 1846.

The Imperial War Museum took over the building in 1936. It is dedicated to exhibits of the First World War and all subsequent conflicts involving British forces.

The building is a Crown Property and is listed as grade 2.

One of the main objectives for the new development was the creation of a memorable central space, strongly articulated by its enclosing structure. The project is phased into three stages, and the roof to the main space provides a strong visual link between them like a continuous spine through the length of the building. The supporting steel structure is exposed and detailed to emphasise this.

The heaviest exhibits will be housed on the lowest levels, A and B, which are in reinforced concrete. The steel structure above level B consists of two storeys of galleries (level C and D), plus a level E over these, totally dedicated to services. The central area has a clear span of 22.7m, with a maximum height of 23.4m to the crown of the barrel vault. This will be used for large exhibits such as aeroplanes and rockets.

A site investigation was completed in August 1985. The lowest exhibition slab level was lowered 1m from the existing ground level, bearing directly onto compacted fill. Reinforced concrete pad footings bearing onto gravel were the natural choice for the foundation system. It was part of the brief that the main exhibition halls at levels A and B would be required to carry heavy armoured vehicles up to 65 tonnes. Because of that, an early decision was taken to design them in concrete, using a two-way waffle slab on reinforced concrete columns.

From level B upwards there is a steel structure on three sides of the courtyard, which had to give a feeling of clarity while fulfilling its structural functions. To this effect many of the joints are clearly expressed and articulated, the columns are twin tubes, and the primary beams frame into them to form a pure skeletal frame.

The secondary beams are located on top of the primaries rather than into their web, as would be more conventional. This adds to the overall sense of clarity.

These secondary beams are designed as composite with the in situ reinforced concrete slab, the latter being laid on a galvanised metal decking.

Twin tubular columns at 7m centres rise up from the floor of the large exhibit hall to form the spring point for the crane jib frame at plant room level which supports the roof barrel. The projection of the jibs is 5,5m and the clear span of the barrel is 12m. This gives a central space 23m wide x 40m long by about 23m high at the top of the barrel.

The overall stability of the new building is achieved using reinforced concrete service cores extending from foundation to level E, above which steel bracing is used.

The steel frames were analysed in a conventional manner. The columns were fabricated to the full length and were designed for combined axial and bending effects.

The central space of the courtyard between the cantilever jibs is 12m wide x 40m long. It was felt from an early stage that a single layer membrane would be the right structural and visual form to span it.

The barrel vault was analysed as a complete spaceframe supported on the cantilever jib frames which were modelled as springs. Aluminium glazing bars are attached to pre-welded lugs from the barrel tubes, the detail making allowances for thermal and load generated movements. A cellular polycarbonate sheet covering was used as a roofing material.

One size of tube was adopted for all internal members with a larger diameter for the perimeter. The analysis was carried out using a proprietary finite element computer program accessed through a desktop microcomputer.

The general imposed loading was taken as 0.75kN/m² with aircraft weighing up to 75kN (the heaviest being the World War II twin-engined Mosquito) to be suspended from the lower boom of the barrel. The effect of their components in space, combined with symmetrical and asymmetrical live load and wind, produced a total of seven loadcases.

A temperature change of 25°C was also considered.

Wind load was calculated using the current British Standard CP3: Chapter V: Part 2, while pressure coefficients for transverse and longitudinal wind were derived from recommendations in the 'Wind loading handbook' by Newberry and Eaton.

The member sizes selected were 139.7 x 10 CHS internally and 219.1 x 12.5 CHS for the perimeter members, Grade 50 steel being used throughout. The average level of stress within the internal members was approximately 60% of the maximum permissible and the maximum deflection horizontally approximately 40mm.

It was important to have these low stress levels as many of the welds would be carried out on site and as tubular members were being used, only partial penetration butt welds could be achieved.

It was of considerable importance that the components should be fabricated to very close tolerances and that assemblies be constantly checked for accuracy. In parallel with this requirement was that of appearance: it was essential that the workmanship be of the highest order. To this effect trial assemblies were made and checked for both quality and accuracy.

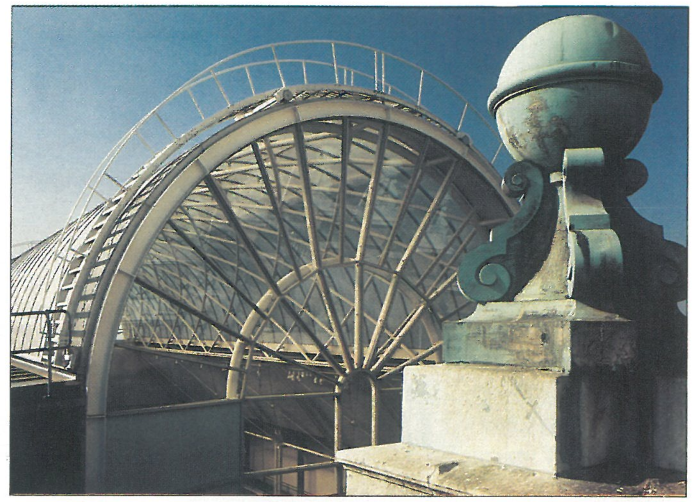
This was particularly difficult with the barrel vault, which was made in 12 pieces for ease of transportation. In order to ensure that problems of lack of fit did not occur on site, the vault was fully trial-assembled at the works prior to shipment to site.

Several purpose-made jigs were used by the fabricator and his subcontractor, and full-time inspectors were employed at both their factories during the fabrication and assembly processes. There was an extensive programme of non-destructive testing for the welds both on and off site.

The fabricator had decided at an early stage that he would use castings for the nodes of the barrel. There were some initial difficulties with surface quality but these were soon overcome, and the use of the castings proved very successful, particularly from the visual aspect.

Judges' Comments

The challenge of infilling a large, gloomy courtyard of an old building has been met most successfully, thus creating a light and lively atmosphere. The glazed roof, the additional gallery and accommodation for services have been well co-ordinated and integrated into the original fabric. The careful detailing and execution are exemplary.



Architects:
Arup Associates

Structural Engineers:
Arup Associates

Steelwork Contractor:
Robert Watson & Co (Constructional Engineers) Limited

Main Contractor:
Taylor Woodrow Management Contracting