ANNEX 3-B

Case study

BISHOP'S SQUARE
EXTENDS ITS SPAN

A new 12 storey office building close to London Broadgate demonstrates the best features of modern steel design to meet the client needs for an architecturally impressive and flexible building in use.

BISHOP'S SQUARE EXTENDS ITS SPAN

Modern design of commercial buildings requires the use of long spans, yet must minimise floor-floor zones to satisfy planning requirements. The Bishop's Square project near to London's Broadgate area met these challenges with a composite steel structure of 18 m span and only 650 mm depth. Added to this was the Architect's creation of an almost fully glazed façade, a 'green' roof space on three levels, and a client requirement for a paperless release of contract drawings and details.

The 12 storey building of close to 80,000 m^2 floor area was designed by the consultant Arup to a category A fit-out, which could be serviced by the client. Providing sufficient flexibility in service routing proved to be a major design issue, and eventually each 18 m long secondary beam was detailed with two large rectangular openings for major ducts and a series of circular openings. The 9m span heavily loaded primary beams also had large rectangular openings, and were also tapered in depth close to the concrete cores to allow for distribution of large ducts. The steelwork was fabricated by steelwork contractor Severfield Reeve from *X-Steel* electronic drawings and schedules of beam and opening sizes.

The 9,500 tonnes of steelwork was erected in only 30 weeks out of a 2½ year construction programme. Fire protection in the form of intumescent coatings was applied off-site in a single operation by the steelwork contractor, which speeded up the following trades.

The perimeter members were designed for tight deflections because of the glazing details, and no additional mullions were used. Tubular columns were used for architectural effect at the lower levels, and narrow 'fin' columns for the upper levels around the 'roof garden' and atria.

The highly glazed façade was also designed to the new Part L2 of the Building Regulations which led to the use of triple glazing with integral louvres. Interestingly, photovoltaic panels were installed on the roof to provide an energy source for lighting, thereby reducing running costs and CO_2 production.

Application Benefits

- Long span construction of shallow beam depth
- Off-site fire protection
- Glazing support without mullions
- Steel transfer beams at higher levels
- Speed of construction
- 'Green' roof at three levels

Project Team

Client:	Hammerson
Architect:	Foster & Partners
Structural Engineer:	Arup
Steelwork Contractor:	Severfield Reeve
Services Consultant:	Hoare Lea

Detail of tubular construction

Completed building

Construction Details

The floor grid consisted of 18 m span secondary beams and 9 m primary beams based on a 9 m × 9 m planning grid. The floor-floor height was only 3.9 m, which necessitated that Arup work to a beam depth of only 650 mm as part of a 1050 mm overall floor zone. Secondary beams were designed as fabricated steel sections with a series of 425 mm diameter circular openings for services and two rectangular openings of 425 mm depth × 750 mm length close to mid-span. An imposed load deflection limit of only 30 mm was specified, which was achieved by beams of only 138 kg/m weight with no stiffening.

Primary beams posed particular problems close to the cores and also had to meet the 650 mm depth limitation. Large rectangular openings were achieved by designing with a 18 mm steel web and using horizontal stiffeners to increase shear transfer close to the supports. Primary beams typically weighed 170 kg/m. The same approach was used for heavy transfer beams at 5th, 7th and 9th floors to support the 'green' roofs.

The perimeter beams were designed for a deflection limit of 12 mm under imposed and super-imposed dead loads in order that they could support the glazing directly. The overall steel weight was approximately 100 kg/m^2 gross floor area.

Two large slip-formed concrete cores provided the primary access and service routing, and two further smaller cores provided additional lifts.

The electronic use of *X-Steel* as the primary release of contract drawings was novel, but posed problems for the other trades and sub-contractors who were more used to paper-based information. Contractually, the steel structure design had to be 'frozen' at this point to avoid secondary problems in terms of revision not just for the steelwork contractor but also for specialist glazing and lift suppliers and services installers. Subsidiary programmes such as *Navisworks* identified 'clashes' in the services and structure, and *X-View* permitted specialists to download information for their use.