

# Albion Wharf:

*a triumph for precast and in-situ construction*

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**A**lbion Wharf is in southwest London, on a brownfield site formerly used for industrial and warehousing units. Planning permission was granted in March 2001 to redevelop the site as a 10-storey riverside development of 190 flats. It also includes business units, shop, restaurant and leisure centre accommodation and a five-storey building at the rear containing 45 affordable flats with shops on the ground floor. One of the key architectural features of the development is the separation of the curved superstructure from the substructure with raking V-shaped columns (see Figure 1). Concrete works began in May 2001, following completion of piling. The single-level basement car park fills the whole of the site and has a secant piled wall around its perimeter; this is on an orthogonal grid whereas the main superstructure is radial with three different radii.

Key to the construction programme was completion of the interface between the substructure and superstructure. This included the ground-floor slab to allow V-column construction and then the second-floor transfer slab.



(Photo: Richard Beadle)

Figure 1: The V-columns separate the substructure from the superstructure.

## Concrete activities

### Basement works

Altogether, 40,000m<sup>3</sup> of spoil was excavated, including a significant quantity of waste contaminated with hydrocarbons in the gravel layer above the London Clay. Bearing piles with pile caps carry the main structure and cores. To support the V-column structure above, the basement contains 'jumbo' columns, for which a fine smooth finish was required. To achieve this, steel formwork was

used with a chemical release agent. The superplasticised mix contained graded limestone and had a 125mm slump.

The ground-floor slab prevents the eight rear pairs of raking V-columns from separating from the front columns. This called for radial reinforcement to be fixed between the orthogonal top and bottom mats of the slab. Some 250 tonnes of reinforcement were required, resulting in considerable congestion. The board pattern for the soffit of this slab was required to have joints accurately aligned in both directions, with recesses in the slab for tree pits above (see Figure 2).

### V-columns

There are 41 columns, with four main different shapes and configurations. The ground-floor slab slopes away from the river, and the underside of the second-floor transfer slab is horizontal. As the columns follow the radial pattern of the superstructure, each column is unique in profile. At the ends of the building, columns are vertical; front columns rake 75° to the horizontal, and intermediate columns 52.5°. Rear columns are in pairs, connecting the radial transfer beams above, and rake 41–45°.

Columns were originally intended to be smooth painted steel, filled with reinforced concrete. However, trials using the required 25mm plate failed to achieve the necessary finish, particularly



Figure 2: A plywood layout was used on the soffit to provide accurately aligned joints in the basement car park.

at the welded joints. There were also concerns that the hydrostatic pressure from a 6.5m head of concrete would distort plates, and welding stiffeners to overcome this would be likely to distort the plates. The decision to construct the columns from reinforced concrete created its own demands.

The development of the columns followed a number of phases:

- model the design to rationalise the number of formwork systems required and agree the design intent for procurement
- design formwork, taking into account surface finish, release agents and formwork pressures
- develop mix design with laboratory and batch trials
- stage full-scale trials
- manufacture and produce formwork and concrete columns at site.

Following design rationalisation, 16 sets of formwork were required. Three pairs of formwork were used to form eight unique pairs of columns (see Figure 3); column angle was adjusted by means of a fillet at the joint between each leg.

Access for internal poker vibrators was restricted by the angle of the form-



Figure 3: V-column formwork in position.

work and density of reinforcement. Self-compacting concrete was considered, and a series of trials were conducted to determine the most appropriate

mix. Concrete strengths and bond were excellent and arrisses sharp. With a steel formwork system, surface finish proved to be the most difficult obstacle: it was



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excellent on the circular underside of the columns but more difficult to achieve on the sloping top face.

A European research project led by University of Paisley into the testing of fresh properties of SCC confirms surface finish as a function of segregation. Tests are being developed to assess segregation, and interpretation of these results will help determine the suitability of the concrete. It was interesting that, when the SCC was cast using a more porous timber form or controlled permeability formwork, the surface finish was blemish-free.

For the V-columns, a modification of the 'jumbo' column mix with an increased sand content and slump of 250mm was chosen and, following further trials, placed using a combination of internal and external vibration (see Figure 4).

**Transfer slab**

Residential floors for levels 2–10 transfer loads to a deck consisting of wide radial beams connected by longitudinal perimeter beams and intermediate beams. Junctions between the beams are not at right-angles, and the raking column starter bars from below provide a complicated node arrangement. This effectively gave up to five layers of reinforcement at varying angles.

**Superstructure**

Above the second-floor transfer slab, construction of the 250mm-thick floor slabs followed a fairly conventional pattern. The only difficulty related to the shape of the front balcony and rear edges of the slabs and the tapering profile of each segment.

Concrete cores were not part of the critical path and were formed using the EFCO gang decking system formwork system. This provided a safe environment for working at height but required a large lay-down area at basement level for the internal panels following striking. Cycle times for the construction of the superstructure were typically eight to nine days for an average floor area of 400m<sup>2</sup>, and the optimum cycle time for core construction was eight days (see Figure 5).

**Building 1**

The construction of 45 apartments for low-cost housing at the rear of the scheme was a condition of planning permission. Also designed by Foster & Partners, this building was to be constructed using traditional in-situ concrete walling and slabs. However, John Doyle Construction, with assistance from the project team, pioneered the use of a precast/in-situ hybrid, using a precast con-



Figure 4: A high-quality finish was achieved on the concrete V-columns.



Figure 5: The core construction preceded the superstructure floors.

crete double wall and lattice girder floor slabs, with in-situ concrete to fill the walls and toppings. Although widely used in Europe, this is believed to be the first UK application for multi-storey construction. The five-storey building was completed in 11 weeks with an optimum cycle time of eight days for 450m<sup>2</sup> of flooring and 350m<sup>2</sup> of wall panels.

The system has the benefits of precast concrete quality combined with the structural stability of an in-situ concrete frame. It proved to be a practicable alternative to conventional construction and more flexible than alternatives such as tunnel-form or fully precast. The system has attract-

ed considerable interest and will be assessed for future projects.

**Conclusions**

The project presented a number of challenges to the construction team in terms of the finished concrete quality and geometrical complexity. It required a large volume of work to be completed in a tight programme to allow release to follow-on trades.

Client:	<b>Hutchinson Whampona</b>
Client's project manager:	<b>CM International</b>
Architect:	<b>Foster and Partners</b>
Consulting engineer:	<b>Ove Arup and Partners</b>
Construction manager:	<b>Exterior</b>
Concrete trade contractor:	<b>John Doyle Construction Ltd</b>
Ready-mixed concrete:	<b>London Concrete</b>
Falsework:	<b>SGB</b>
Steel formwork supplier:	<b>Formfab</b>