2010 CONCRETE SOCIETY AWARDS

OVERALL WINNER

Strata SE1

LONDON

Strata SE1 is the first development in the UK by Brookfield Europe. The design brief was to produce a striking but cost-effective tall residential building on a small central London site, while striving to meet the Mayor of London's 10% renewable energy target.

(Photo: Gary Britton.)

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(Photo: Nicola Evans, WSP Group.)

The 36,600m^2 development consists of a 43-storey (147.9m-high) tower with three integrated 18kW 9m-diameter wind turbines and an adjacent five-storey pavilion building.

In-situ concrete was chosen as the structural material for the following reasons:

- a thin floor sandwich was achievable with a flat slab for typical residential floor spans – 3000mm structural floor-to-floor height; 2500mm floor-to-ceiling height to living rooms and bedroom; 200mm slab and 90mm floor finishes
- the curved floor plates could be formed easily and economically
- concrete offered good acoustic properties
- concrete offered the opportunity to produce an efficient lateral force-resisting system.

Sustainable concrete solutions

The structure makes use of 200mm-thick post-tensioned concrete floor slabs supported on an irregular arrangement of 300mm-wide high-strength blade columns. Post-tensioning reduces the slab thickness, saving over 2000m^3 of concrete and 1800 tonnes of CO_2. This CO_2 reduction is the equivalent of emissions from energy that the apartments will use over four years. The resulting 200mm slab thickness is the minimum thickness achievable with punching shear reinforcement in the UK. The intelligent positioning of columns combines shorter end spans with longer interior spans, which achieve deflections within the tight limits imposed by the cladding. The 300mm-wide C60 blade columns enable concealment within apartment walls and reduce in size at higher levels to achieve improved apartment layouts.

Innovative column strategy

To achieve the architectural vision of the tower narrowing over several steps towards the top and inwards at the base around the retail spaces a system of 'walking columns' have been used rather than conventional transfer slabs or beams, meaning standard storey heights can be maintained and the reinforced concrete used minimised.

The walking columns consist of virtual diagonal struts contained within standard and simple to construct vertical blade columns. The slabs at the top and bottom of the transfer act as struts and ties, transferring the resulting forces across the building or to the core.

Within each tie, headed reinforcement bars have been used for one of the first times in a building in the UK, enabling a compact and cost-effective connection to be made.

Architectural expression

Towards the top, at the front, the building is cut off in a diagonal line, which had the potential to leave unsupported slab edges. To avoid the need for transfer slabs and achieve the standard storey height, two pairs of unobtrusive diagonal circular columns were inserted in the corners of the apartments.

At even higher levels and to avoid a deeper structure, two pairs of diagonal tension columns are used to support the slab, which are in turn supported by the concrete core.

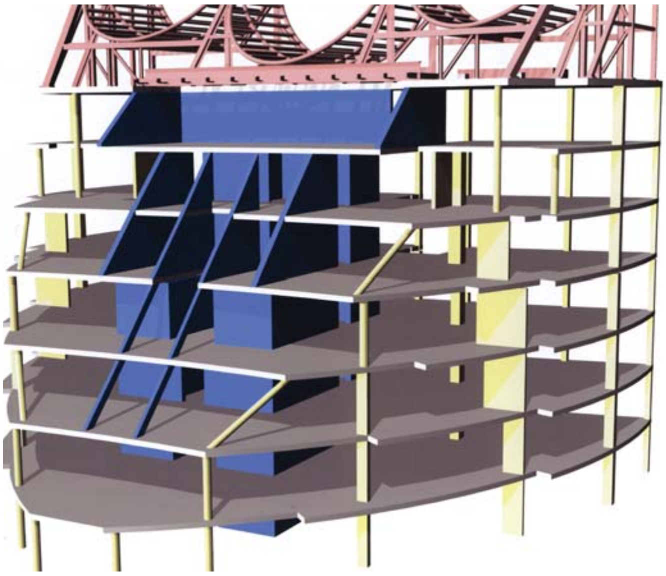
Maintaining stability

Lateral stability is achieved primarily through a rectangular 9m × 11m concrete core, supplemented by three wing walls on the lower 11 levels where they are

Right: View of floor slabs and core jump form during construction.

Below: Model of the top of the tower showing diagonal tension columns supported by core walls.

Right: Model of the core and wing walls.

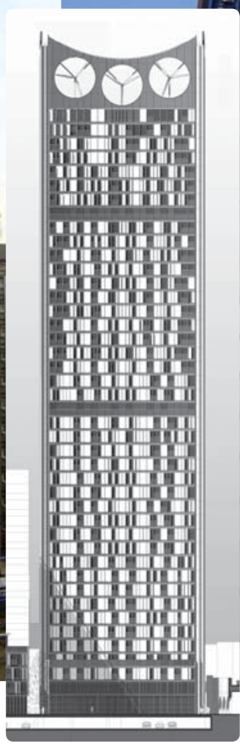


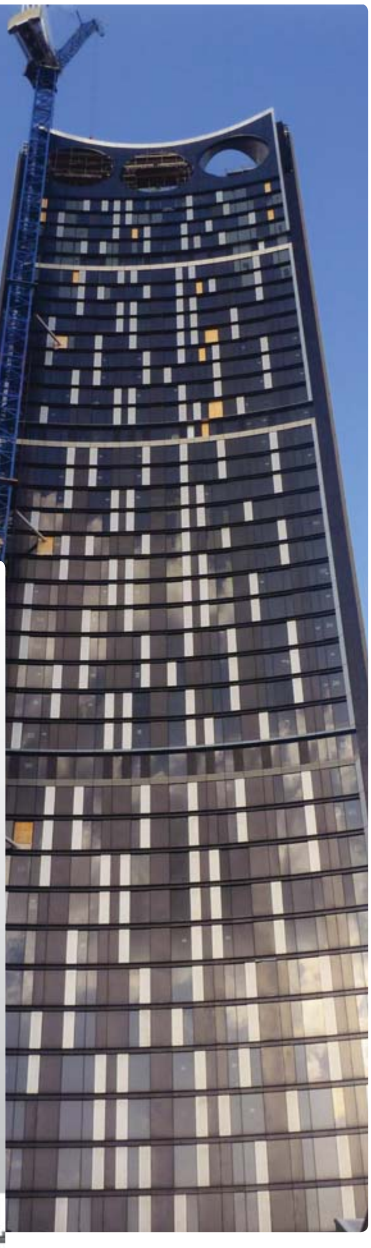
Concrete offered the opportunity to produce an efficient lateral force-resisting system.

Left: North elevation – artist's illustration and the completed north elevation.

Right: South elevation – artist's illustration and the completed south elevation.

Below: Strata SE1 taken in March 2009 as the external façade to lower floors is added.





Post-tensioning reduces the slab thickness, saving over 2000m^3 of concrete and 1800 tonnes of CO_2.

Right: The wind turbines at the top of the building.

concealed within apartment party walls. As well as providing stability to the building the core also contains all the common vertical services routes and on-floor metering room. Link beams (lintels) 525mm deep have been used over the three openings in the perimeter of the core at each level. This link beam depth gives sufficient space for services distribution, while being structurally acceptable.

This extra depth was achieved by stepping the floor slab up 80mm within the core with a finishes zone of 10mm compared with the standard 90mm and gaining 80mm depth of critical link beam, increasing the stiffness of the core and allowing a reduction in the core wall thickness. The wing walls increase the lateral stiffness of the core where it is needed most. In addition, the rear wing wall enables the load from the column sitting on the end of it to counteract the tension in the rear of the core caused by two pairs of walking columns at the front of the building.

Foundation stability

To reduce the need for excavation and temporary works the 3.5m deep pits for the high-speed lifts were formed by piercing rather than dropping the core pile cap.

To avoid the need for underpinning at the basement perimeter, an unusual system of placing single pile caps within rather than under the basement was used. To minimise the space lost within the basement the pile caps were circular and sized to allow for tolerance in the location of the piles.

Slab design issues

The post-tensioning of slabs with relatively long columns meant that the columns had to be designed for the additional moment and shear induced by the post-tensioning as well as the standard forces. In addition, where the columns act as walking columns, secondary moments and shears induced by the load transfer had to be allowed for.

To achieve the desired slab edge deflections while minimising slab thickness a maximum water:cement ratio of 0.40 was specified in order to reduce concrete creep and hence post-cladding deflections.

As is common for tall buildings, net and differential axial shortening between the core and columns had to be allowed for in the design and construction. In addition, the close spacing of some columns to the side core walls required adjustments in column size to reduce potentially problematic differential axial shortening in these locations and along the façade line.

Programme and budget

The concrete frame programme was 78 weeks and construction was completed in 66 weeks. The concrete frame budget was £8.9 million and the final cost was £8.9m. ●

Above: Strata seen in its context across south-east London.
Below right: The building nears completion.

Strata SE1, London

Owner	Brookfield Europe
Architect	BFLS
Consulting engineer	WSP Cantor Seinuk
Contractor	Brookfield Construction
Post-tensioning	CCL
Supplier/subcontractor	Modern Mix
Supplier/subcontractor	Buildstone (since ceased trading)

Judges' Comments:

It is difficult to see how a building of this design and height, apart from its sliced top in structural steel, could be built economically and practically in any other structural material than in-situ concrete. The three large circular openings for the propeller fans at the top make it very distinctive.

The use of in-situ concrete was fundamental to the design of the building. The post-tensioning of the floors reduced the slab thickness, saving an estimated 2000m^3 of concrete and 1800 tonnes of CO_2. The 200mm slab thickness is the minimum achievable with punching shear reinforcement in the UK.

The blade columns enable them to be concealed within apartment walls. Indeed one of the most impressive things about this structure is that you are not aware of the structure once inside the building. Towards the top of the building diagonal tension columns that support the slab are the only obvious evidence of any structural elements.

This building is innovative in developing luxury high-rise flats at the Elephant & Castle. It is striking architecturally, a considerable feat of construction on this restricted site and a very good use of concrete as a structural material.

The building has already become a striking landmark.