




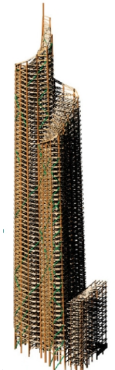


Case Study:
**The Pinnacle
London**

Contributed by Arup Fire


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Basic facts 




- 63-storey office building.
- Tapers linearly to Level 44, the floors cut back in sequence to form a spiral wrap.
- Highly irregular floor plates and beam layout.
- Height 288m.
- To be completed in 2014.

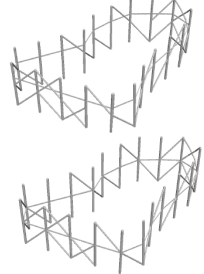
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Particular structural aspects 


- The organic shape of the floor plate means that beams are arranged in a highly irregular layout.
- Architects' requirements:
 - Large, clear spans with minimum internal columns to provide flexibility for tenants.
 - Perimeter columns to have circular cross-sectional profiles; filled with high-strength concrete.
- perimeter columns form part of the lateral load-resisting system of the entire building.
- To minimise inter-storey height, cellular beams with composite steel-concrete trapezoidal floor decks are used.
 - Cellular beams allow building services to pass through the beam webs.
 - Trapezoidal floor system reduces overall building mass.

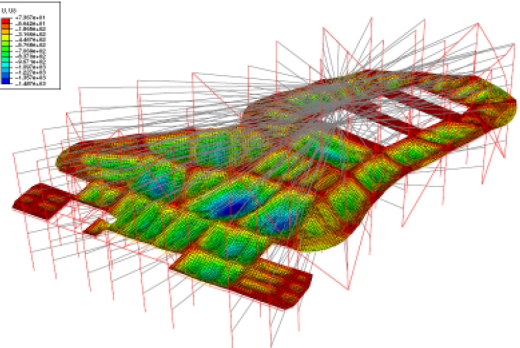
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Particular structural aspects 




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Structural subframe model 1 



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Protected beams in Model 1 

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Main points

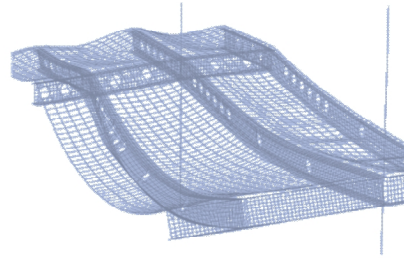


- The structural fire engineering strategy is predicated on failure of the sprinkler system. Relying on sprinklers alone does not give high enough reliability.
- Temperatures of unprotected beams are easily calculated using the EN1993-1-2 incremental method.
- Slab temperature distributions at 60 minutes are taken from EN1994-1-2, and an effective-depth flat slab is used with the correct offset from the beams.
- The prescriptive protection on columns keeps their temperature to about 550°C at 60 minutes of the Standard Fire. 60-minute protection on the protected beams keeps their temperatures to about 620°C.
- Temperatures of unprotected beams approach the ISO834 fire temperature (946°C) at 60 minutes.

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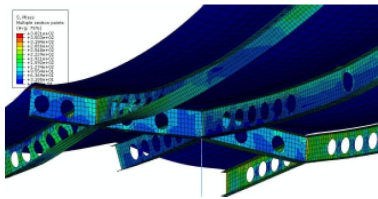
Vulcan Model 1



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Model 1 deflection results



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Main points



- Several similar design models were used to cover different typical floor areas – but the layout is very repetitive.
- There is no runaway deflection of beams or slabs by 60 minutes, and deflections stay within the $(span/30)$ limit used in furnace testing of individual members.
- A considerable saving is made on passive fire protection without compromising the fire safety of the building.
- In small local areas where there is little advantage to using non-linear slab deflection to carry loads it is not worth leaving steelwork unprotected.
- The main advantage is in large slab panels of reasonably square aspect ratio, and on buildings with a repetitive floor layout.

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