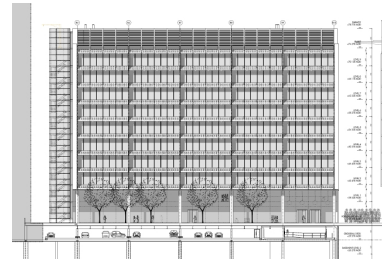


Case Study:

**12-storey Office Building
Kingdom Street, Central London**

Contributed by Ramboll SAFE

Building elevation



Basic facts

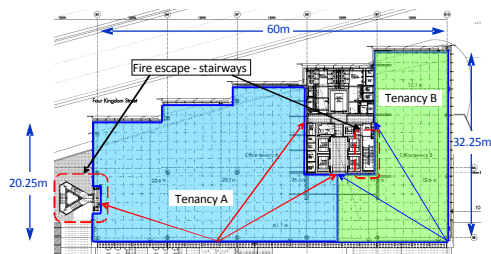
- 12-storey office building.
- Floor plate 60m x 32.25m max (20.25m min).
- Top floor level 36.6m.
- Basement car park providing a podium at ground level; 9 office levels of composite steel-framed design above ground. Open plant space at roof level.
- Facades have high proportion of glazing, non-fire-rated elements.
- Central concrete core containing services and escape stairs.
- Currently being constructed in central London.



Fire requirements and provision

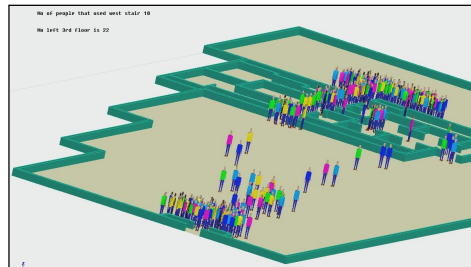
- England Building Regulation Approved Document B (ADB) requires 120 minutes' prescriptive standard fire resistance (R120) if top floor level over 30m.
- ADB also permits a performance-based fire engineering approach to achieve equivalent safety.
- Building is fully sprinklered.
- Phased fire evacuation strategy: fire floor first, then two floors at a time.
- Two fire-fighting shafts, with one fire-fighting lift. All areas within 60m.
- Fire-fighting lobbies are ventilated, rooms opening into fire access corridor preceded by protected corridor.
- High-risk rooms preceded by a lobby with >0.4m² permanent ventilation.

Tenancies and means of escape



Evacuation modelling (STEPS)

Worst case total occupant load of 235 is assumed based on 1 person/6m² occupant density for office use (ADB, 2006 Edition).



Structural Fire Engineering strategy

cost

- Structural Fire Engineering strategy adopted to optimise fire protection.
- Equivalent time of fire exposure based on a sprinklered building
 - reduced fire load density from EN1991-1-2 Annex C.
 - Risk factor 2.0 for building >30m height.
$$t_{e,d} = (q_{f,d} \cdot k_b \cdot W_f) k_c$$
 - Gives time equivalent < 60 minutes.
- Standard fire used as design fire scenario.
- All columns given 60 minutes' fire protection.

7 **cost TU0904: Integrated Fire Engineering and Response**

Structural subframe model 1

cost

Concrete core

Model 1

60m

20.25m

32.25m

8 **cost TU0904: Integrated Fire Engineering and Response**

Protected beams in Model 1

cost

Concrete core

Model 1

60m

20.25m

32.25m

9 **cost TU0904: Integrated Fire Engineering and Response**

Main points

cost

- 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.

10 **cost TU0904: Integrated Fire Engineering and Response**

Vulcan Model 1

cost

Protected beam B1

Protected beam B2

Slab S3

Slab S2

Slab S1

11 **cost TU0904: Integrated Fire Engineering and Response**

Model 1 deflection results

cost

Time [min]

Deflection [mm]

Protected beam B1

Protected beam B2

Slab S1

Slab S2

Slab S3

Span/30 (S2)

12 **cost TU0904: Integrated Fire Engineering and Response**

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.