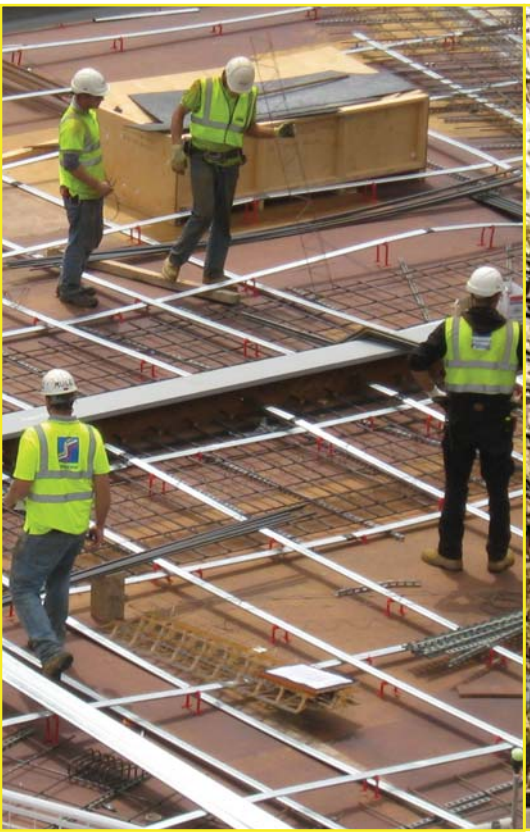
StrongForce

Post Tensioning Awards 2009



Project Summary

Type of structure	Residential with leisure suites including Swimming pool, Cinema, Virtual Golf, Wine Cellars, and Parking accessed via 2 car lifts
Location	Knightsbridge, London
Architects	Roger Stirk Harbour + Partners
Structural Engineer	Ove ARUP & Partners
Total no of apartments	86
Total project cost	Value - £500m (approx)
PT system	Ground floor & beams; Bonded Multi-strand system (19 x 15.7mm) & Mono-strand (15.7mm) For superstructure Bonded Flat Duct Mono-strand system (12.9mm)
Scope of PT	**Ground floor -** 15.7mm • Multi-strand beams – 17 in total (2 x 19 strand tendons per beam) • Mono-strand **Superstructure –** 12.9mm • Pavilion A – Level 1-10 • Pavilion B – Level 1-12 • Pavilion C – Level 1-14 • Pavilion D – Level 1-12
PT Tonnage	Ground floor – 10MT Superstructure – 225MT
Key Facts	• 70,000m^3 of Excavation; • 21,000m^3 Concrete; • 4300MT steel;

One Hyde Park

The most luxurious residential apartments in London, One Hyde Park is created on the site of the former 1950's building Bowater House in Knightsbridge.
Designed by architect Richard Rogers, the development consists of eighty-six apartments and three exclusive boutiques within four pavilions of between ten and fourteen storeys above a four level basement.

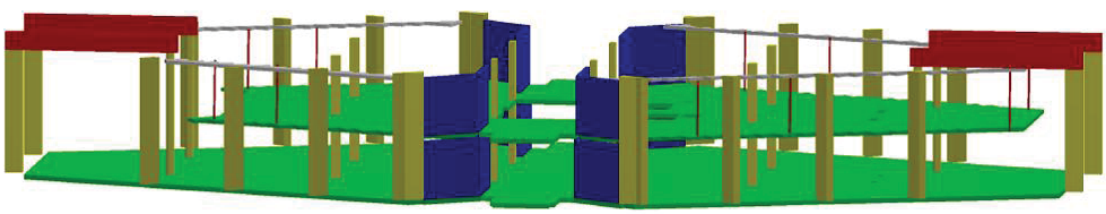
The feature elements of structural steelwork and
architectural quality precast concrete make this project stand out as a rare development.

Post-tensioning

A total of 235 tonnes of post-tensioning strand was installed in this iconic structure over the course of 56 weeks. Multiple post-tensioning (PT) applications were utilised to achieve an efficiency of design, materials and labour.

Ground Floor

The ground floor is a mixture of reinforced and post-tensioned beams and slabs using bonded (15.7mm) PT. PT transfer beams were located at ground level and are accommodated within the B1 storey height. The use of 1200mm deep x 2400mm wide transfer beams with multi-strand PT simultaneously minimised the depth of the beams hence reducing the depth of excavation in the basement. The PT arrangement was required to reconcile the trapezoidal superstructure column layout with the substructure column grid. (Refer SF-PTA-2009-SK-1). Each beam contained two 19strand 15.7mm tendons.



Typical Floor Slabs

Both conventionally reinforced and PT options were evaluated. The PT slabs were considered more suitable on the basis of efficiency under the high superimposed dead loads from heavy-weight partitions and luxury finishes, reduction in building mass and material and for speed of construction. The PT solution provided the advantage of structural efficiency, spans (greater than 8.5metre), whilst maximising the floor to floor height within apartments given the planning constraints on the overall building height. (Refer SF-PTA-2009-SK-2, 3 and 4).

Various vibration sources such as London Underground's (within the basement) Piccadilly line, Edinburgh traffic Gate, HGV Lift and vehicle lift structure made acoustics one of the key factors in determining slab thickness. This coupled with the floor finishes and ceiling build-up meant a minimum slab thickness of 280mm for roof slabs and 250mm for other superstructure levels were selected to provide the most efficient solution when evaluated in relation to vibration, acoustics, punching shear, stair and service penetrations.

Penthouse and Roof

A consistent slab thickness was used on typical floors of all Pavilions in order to maintain repetition of detail in structure, façade, formwork and finishes. The geometry of the upper penthouse level comprises triangular recesses on the long side to give saw-tooth slab edges. Hangers were provided from the roof slab above to support the re-entrant corners and assist the edge columns with slab support. (Refer SF-PTA-2009-SK-6)

The roof slab is a post-tensioned slab spanning between internal precast concrete upstand beam edge beams and columns. Whilst incorporating these precast elements the roof slab design needed to control crack widths to remain watertight whilst accommodating the gantry loadings onto the precast.

The slab depth increased at roof level from 250mm to 280mm in order to accommodate the loads imposed on the slab by the architectural beams, cleaning cradle and the additional loads imposed through the hangers at the perimeter. The mezzanine slab of the penthouse level on each pavilion was suspended from the roof slab by steel rod hangers, where slab edges are irregular and recessed from upper columns. Furthermore, this slab was able to accommodate a series of smaller penetrations and larger openings at mid span on both ends of the slab. (Refer SF-PTA-2009-SK-7, 8 and 9)

Design Challenges

The PT layout needed to be co-ordinated with façade and glazing works, precast columns, precast spandrels, mezzanine hangers and structural steel items as well as late alterations to site logistics and construction sequence.

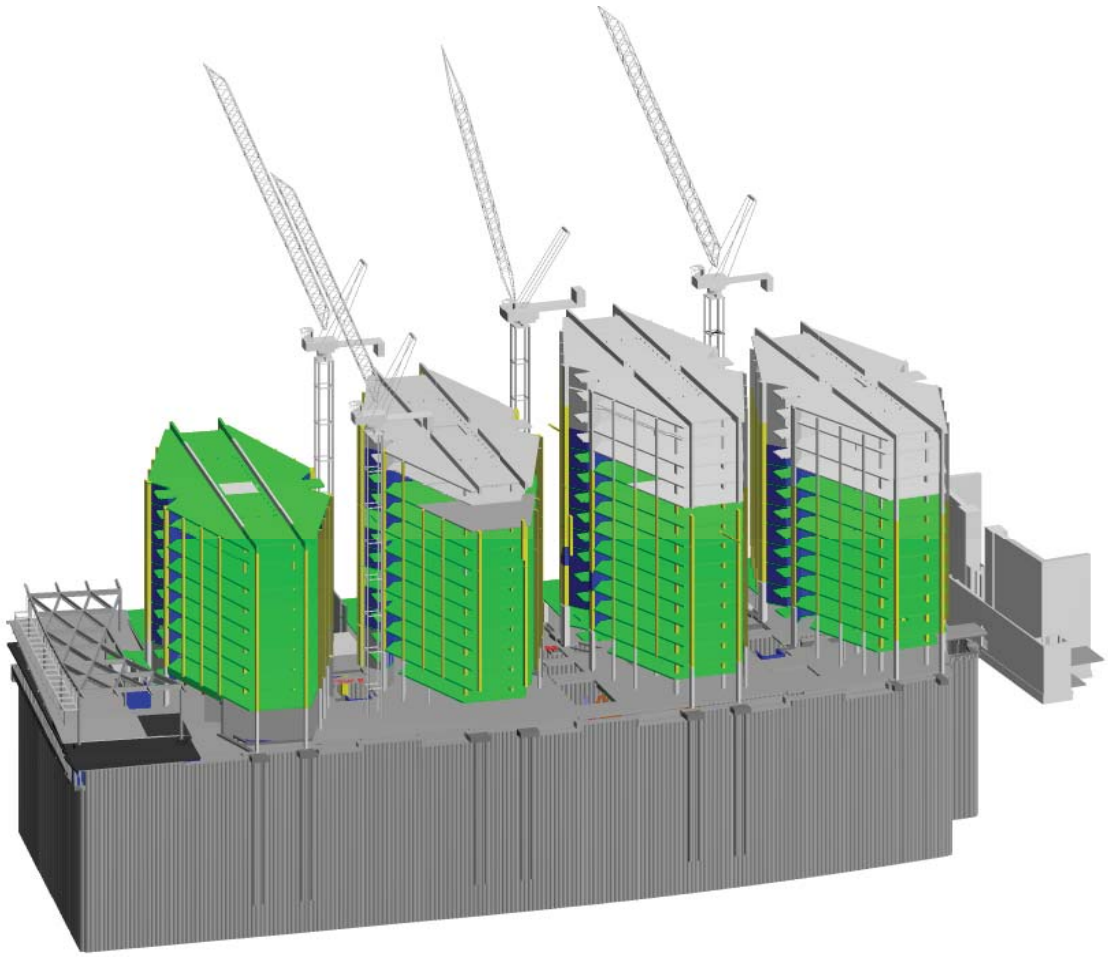
A late request by Transport for London (TFL) for an area of the site to be used for traffic management during their roadwork's at the busy Knightsbridge intersection required the end thirds of two pavilions to be delayed behind the rest of the structure. Hence an additional pour strip was introduced along the southern edge of Pavilion's B and C (Refer SF-PTA-2009-SK-2, 3 and 4).

An innovation on this project was incorporation of the steel transfer truss with the PT slabs. On Pavilion A level 2 a steel transfer truss was sought as best solution to overcome column restrictions imposed by the reception drop off space and access to the basement parking lift. The slab was designed as post tensioned which required the tendons to pass through the steel truss. The setting out for the PT and reinforcement were co-ordinated with the truss fabricator and voids were then formed in the truss for the PT ducts to pass through fabrication. (Refer SF-PTA-2009-SK-5)

Feature steelwork was also used to help provide stability to the pavilions. The stability frames as shown on section 21 of sketch SF-PTA-2009-SK-2 have been proportioned on a two storey module to align with the façade. The stability system relies on the coupling of steel frames with the internal reinforced concrete shear walls braced with the PT slabs.

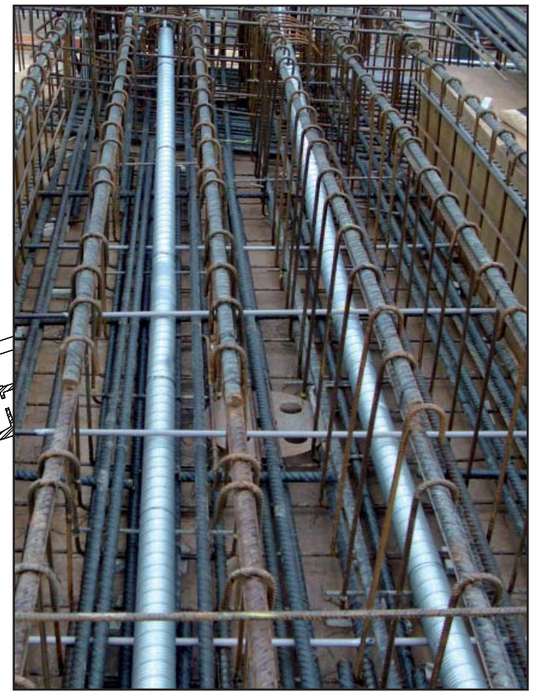
Sustainability

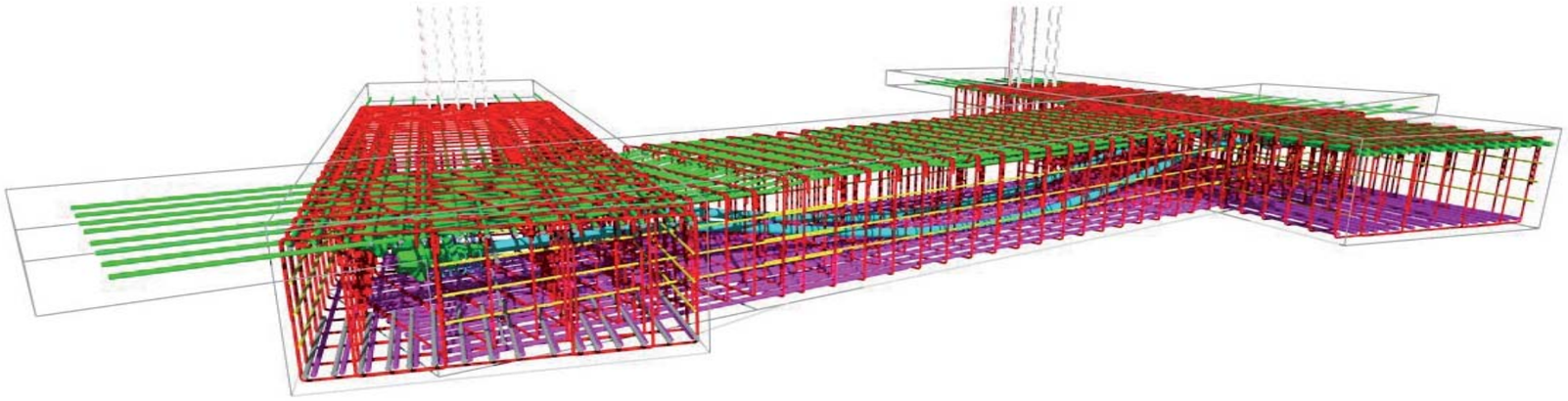
All the building materials used on site conform to 'Ecohomes 2006 – The environmental rating for homes'.



GROUND FLOOR TRANSFER PT BEAMS CARRY THE SUPERSTRUCTURE LOAD.
THESE BEAMS COMPRISE 19s–0.6" MULTISTRAND TENDONS.

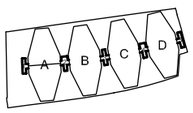
TEMPORARY OPENING FOR STRESSING ACCESS.





ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

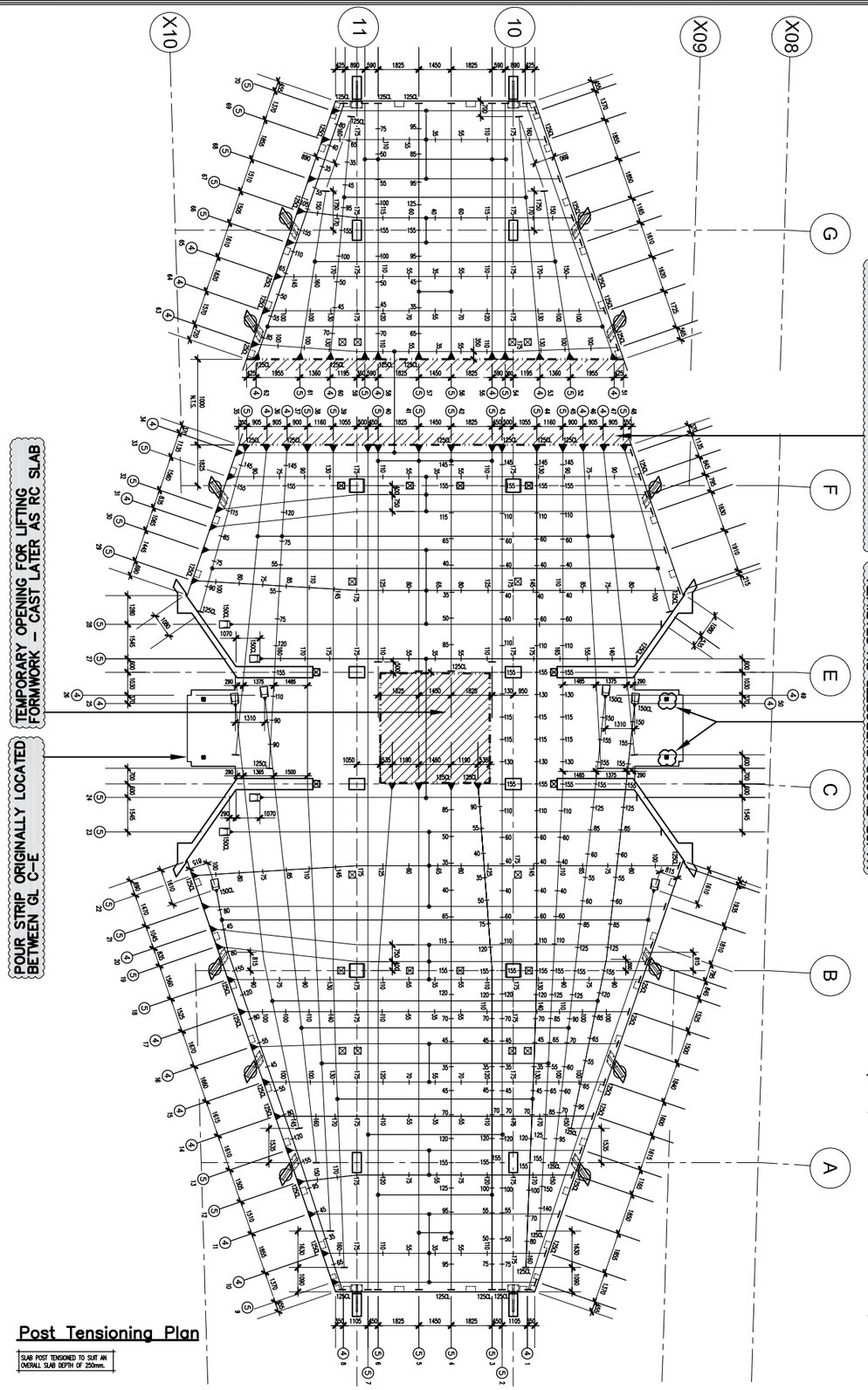
Project

One Hyde Park
Knightsbridge

Drawing

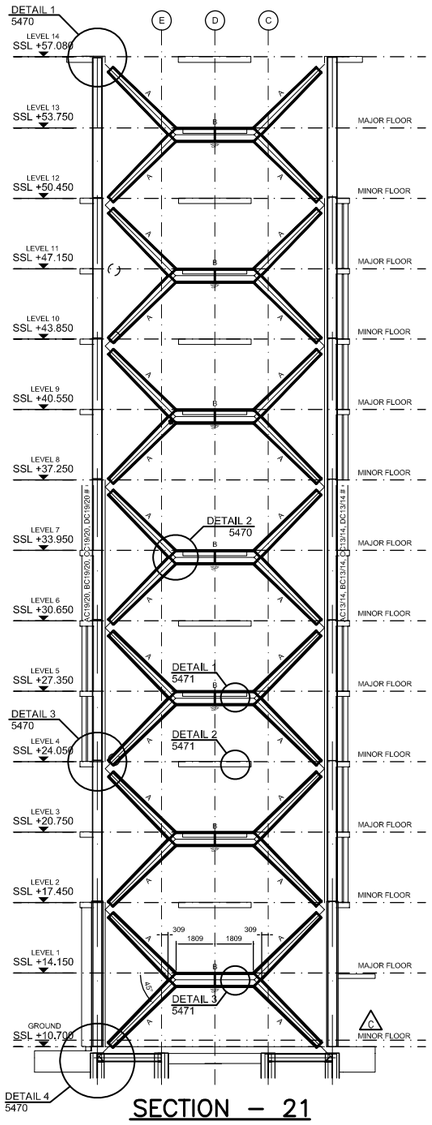
Transfer PT Beam
Plan At Ground Floor

SF–PTA–2009–SK–1



Post Tensioning Plan

SLAB POST TENSIONED TO SUIT AN OVERALL SLAB DEPTH OF 250mm.



SECTION – 21

POST TENSIONING NOTES.

1. FOR ALL GENERAL AND CONSTRUCTION NOTES, AND ALL ANTIBURST REINFORCEMENT DETAILS REFER TO DRAWING No. 2350_SW_AL_GN_0001.
2. FOR ANTIBURST REINFORCEMENT FOR POST TENSIONING AT THIS LEVEL REFER TO THE FOLLOWING BENDING SCHEDULE.
   SCHEDULE No. 01.
   DRAWING No. 2350_PC_03_PT_0300
   CONTRACT No. F1922

   NUMBER OF ANTIBURST HELIX TO BE SCHEDULED (Insitu Concrete Only)
   (PANNED LIVE END ANTIBURST REPEAT ALL AS TYPICAL LIVE END)

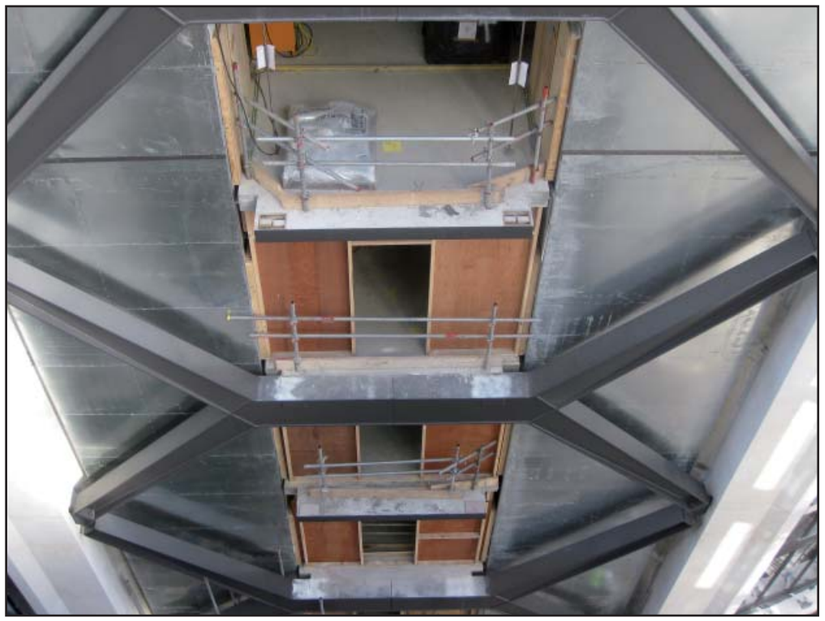
   2 + 3 Strand
   LIVE ENDS – 0
   DEAD ENDS – 0 — Bar Mark "500"

   4 + 5 Strand
   LIVE ENDS – 60
   DEAD ENDS – 70 — Bar Mark "501"

   PANNED END – 10 — Bar Marks "502, 503, 504"
   (Trimmer Bars)
3. POST TENSIONING ANTIBURST REINFORCEMENT NOT SHOWN ON PLAN. REFER TO TYPICAL DETAILS ON DRAWING No. 2350_SW_AL_GN_0001.

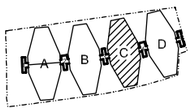
Bar Chair Quantities

Chair Height	No. Off	Chair Height	No. Off
35	43	110	82
40	36	100	52
45	32	115	24
50	24	120	42
55	77	125	30
60	40	130	34
65	28	140	6
70	34	145	30
75	48	150	16
80	36	155	84
85	37	160	16
90	38	165	2
95	18	170	14
		175	66



ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

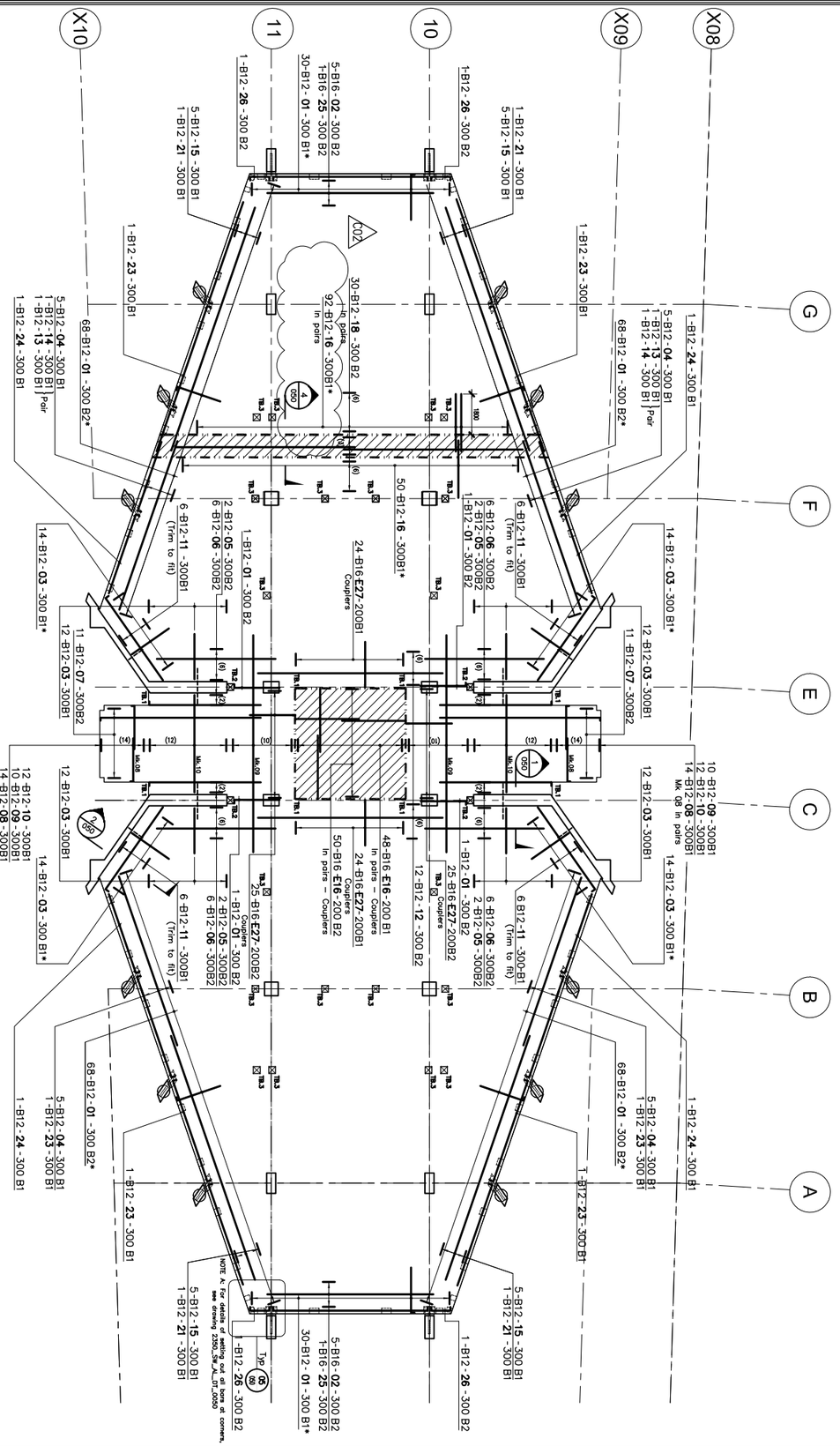
Project

One Hyde Park
Knightsbridge

Drawing

Post Tensioning Plan
Pavilion C, Level 3
Pours 1 & 2

SF–PTA–2009–SK–2



1 -B16-301- 75 B3

TYPICAL TRIMMER BAR ARRANGEMENT 'TB.1'

8 NUMBER OFF

2 -B16-302- 75 B1
2 -B16-301- 75 B3
4 -B16-302- 75 B2

TYPICAL TRIMMER BAR ARRANGEMENT 'TB.2'

4 NUMBER OFF

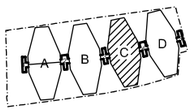
4 -B16-302- 75 B2
4 -B16-302- 75 B1

TYPICAL TRIMMER BAR ARRANGEMENT 'TB.3'

20 NUMBER OFF

ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald

Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom

Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce

Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

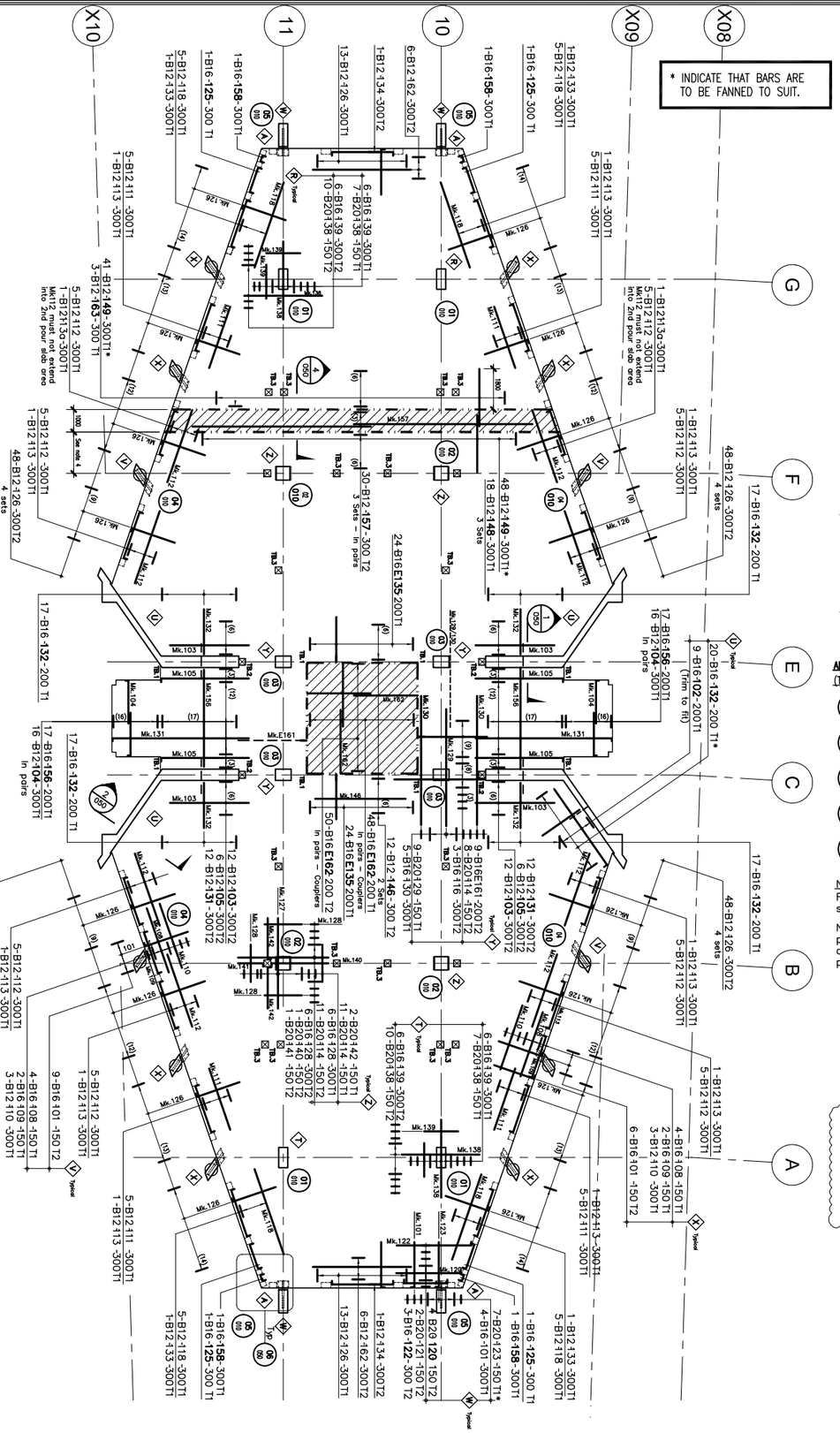
Project

One Hyde Park
Knightsbridge

Drawing

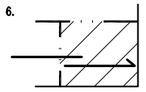
Bottom Reinforcement Plan
Pavilion C, Level 3
Pours 1 & 2

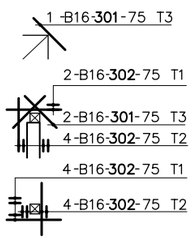
SF-PTA-2009-SK-3



REINFORCED CONCRETE NOTES.

1. FOR ALL GENERAL AND CONSTRUCTION NOTES, AND ALL ANTIBURST REINFORCEMENT DETAILS REFER TO DRAWING No. 2350_SW_AL_GN_0001. FOR STANDARD SECTIONS REFER TO DRAWING No. 2350_SW_AL_DT_0050.
2. FOR SLAB REINFORCEMENT AT THIS LEVEL REFER TO THE FOLLOWING BENDING SCHEDULES.
   SCHEDULES No. 01-05
   DRAWING No. 2350_PC_03_RC_0302
   CONTRACT No. F1922
3. CRANKS INDICATED IN B12 BARS ARE INDICATIVE ONLY. THESE BARS WILL BE SCHEDULED AND SUPPLIED STRAIGHT TO SITE. DRAPE BARS AS PER INDICATED ON PLANS.
4. FOR SETTING OUT OF POUR JOINT SEE DRAWING 2350_PC_03_PT_0300.
5. **'T.B'** DENOTES LOCATIONS OF TRIMMER BARS LOCAL TO PENETRATIONS. LOCATIONS TO BE TRIMMED USING THE FOLLOWING BAR ARRANGEMENT AND BARS CLASHING WITH PENETRATIONS TO BE CURTAILED AT PENETRATION RATHER THAN BUNDLED EACH SIDE OF PENETRATION. (BARS TO EXTEND MINIMUM 600mm PAST FACE OF PENETRATION)

   ALL OTHER PENETRATIONS UNLESS NOTED OTHERWISE OR INDICATED TO HAVE BARS SHOWN LOCAL TO PENETRATIONS DISPLACED MINIMUM EACH SIDE OF PENETRATION – DO NOT CUT BARS.
6. 
   AREAS SHOWN THUS ARE TO BE CAST AT THE DISCRETION OF THE FRAME CONTRACTOR, BUT AFTER THE STRESSING CERTIFICATE HAS BEEN ISSUED. BACKPROPPING AND TEMPORARY WORKS REMAIN THE RESPONSIBILITY OF THE CONCRETE FRAME CONTRACTOR.



TYPICAL TRIMMER BAR ARRANGEMENT 'TB.1'
8 NUMBER OFF

TYPICAL TRIMMER BAR ARRANGEMENT 'TB.2'
4 NUMBER OFF

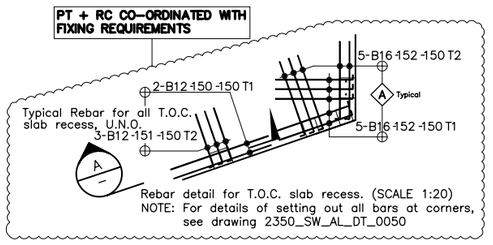
TYPICAL TRIMMER BAR ARRANGEMENT 'TB.3'
16 NUMBER OFF

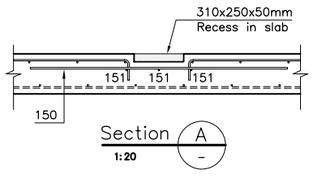
ADDITIONAL SHEAR TIE BARS
(Total number of bars at EACH detail)

01 / 010	36 B8.401 – Located to suit. 4 B8.410.150 B2	4 No. Off
02 / 010	92 B8.401 – Located to suit. 8 B8.410.150 B2	4 No. Off
03 / 010	40 B8.401 – Located to suit. 5 B8.410.150 B2	4 No. Off
04 / 010	21 B8.401 – Located to suit. 1 B8.410.150 B2	4 No. Off
05 / 010	20 B8.401 – Located to suit. 1 B8.410.150 B2	4 No. Off

NOTE
For details of set out of additional shear ties refer to drawings 2350_PB_AL_DT_0010.

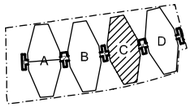
Nominal displacement of top reinforcing bars is permitted up to a maximum distance of 25mm where, clash occurs with bar marks '401' etc. and post tensioning duct.





ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

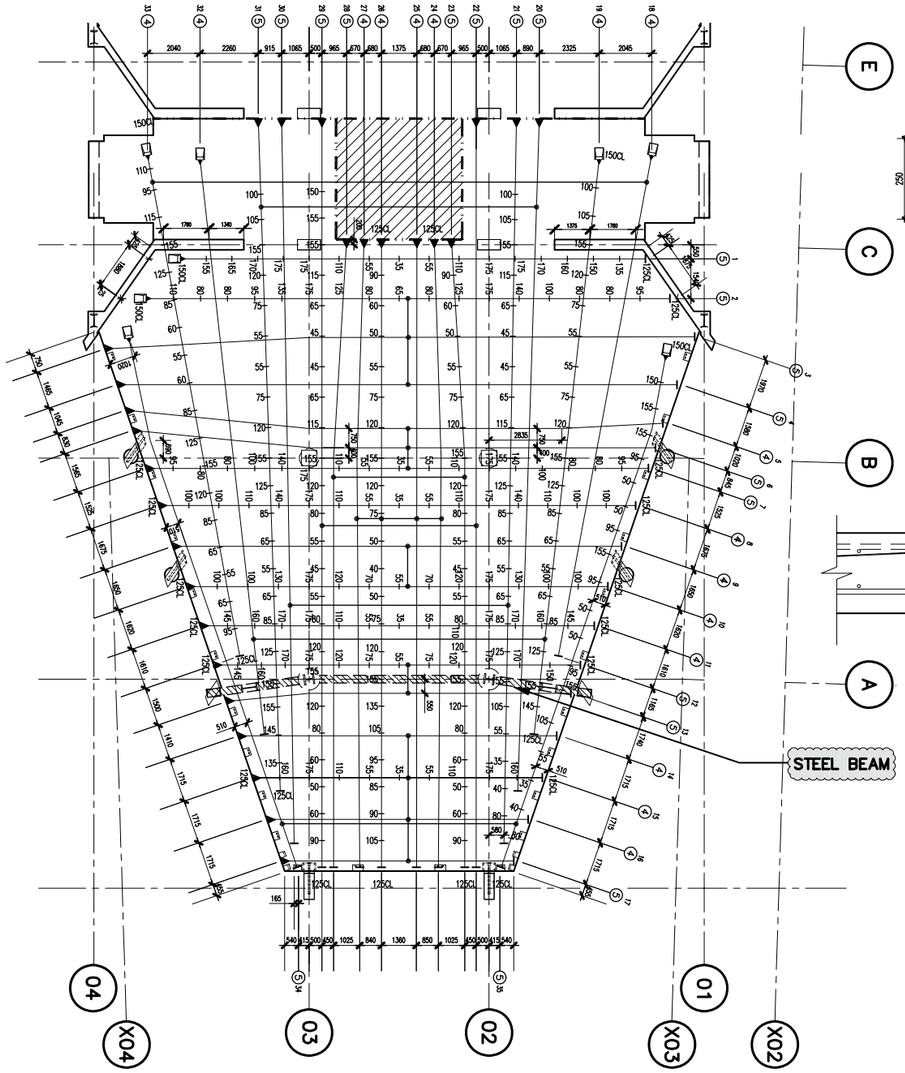
Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

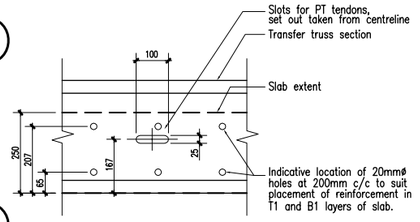
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788
StrongForce

Project
One Hyde Park Knightsbridge

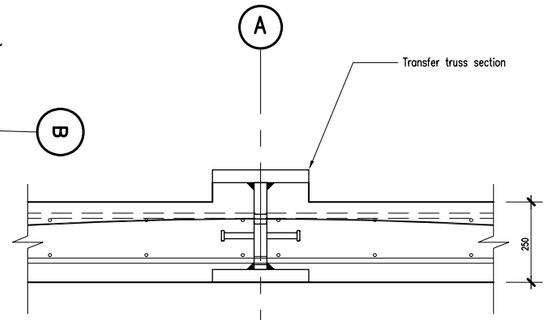
Drawing
Top Reinforcement Plan Pavilion C, Level 3 Pours 1 & 2

SF-PTA-2009-SK-4

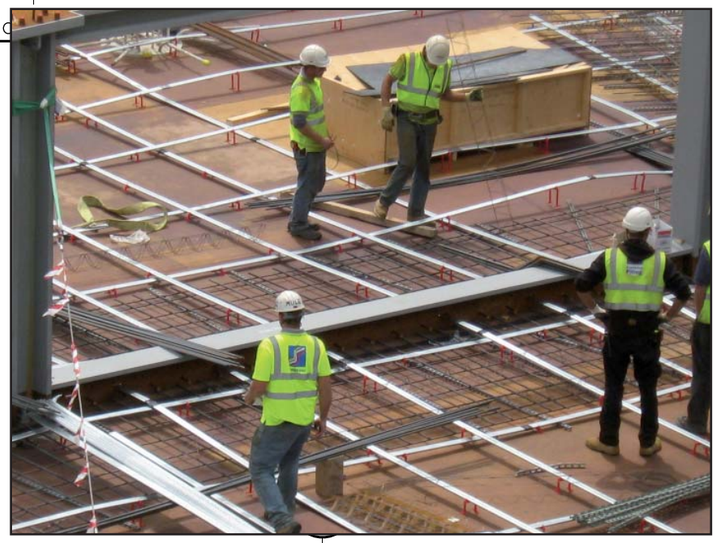


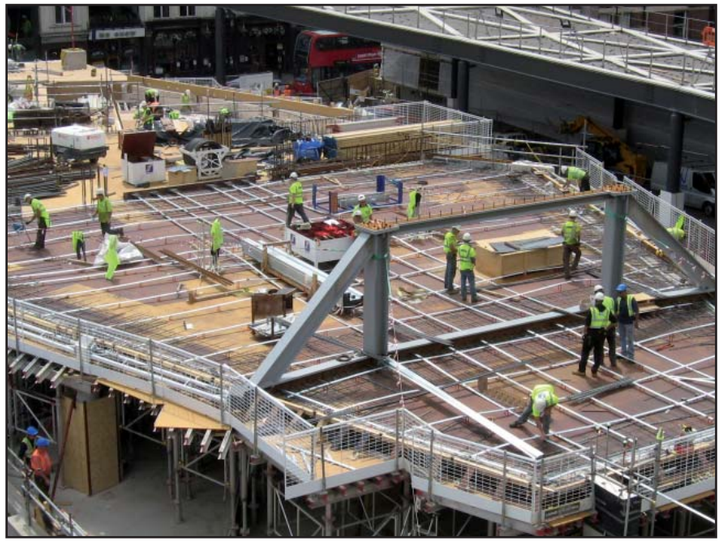


Detail 1 / 1:10



Section A / 1:10



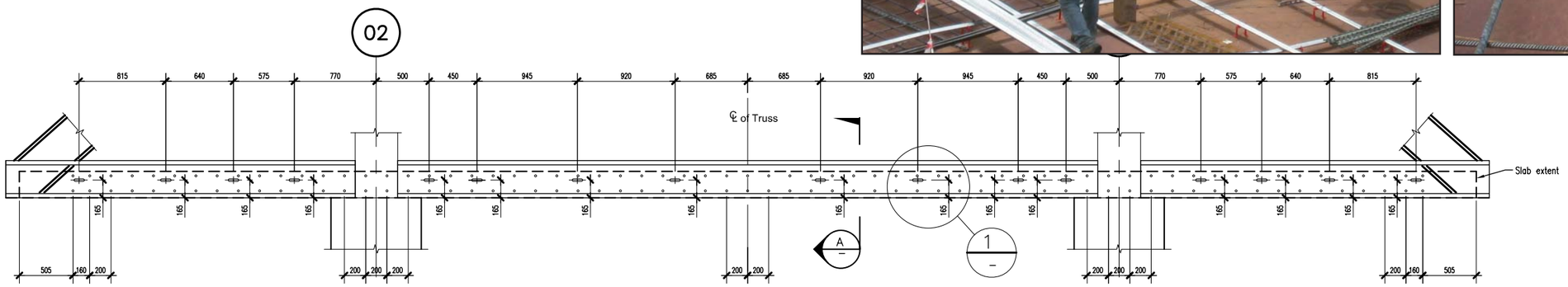


Post Tensioning Plan

SLAB POST TENSIONED TO SUIT AN OVERALL SLAB DEPTH OF 250mm.

X=150 FOR ALL PANNED ENDS

NOTE: ALL HOLES THROUGH STEEL TRUSS PRE-CUT TO ALLOW INSTALLATION OF PT & REINFORCEMENT



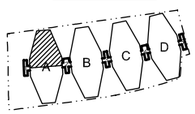
Beam on Grid Line A (Elevation faced along ℄ of beam)

Scale 1 : 25

Note:
All 20mmø holes through truss beam for slab reinforcement is at 200mm centres U.N.O.

ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce

Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

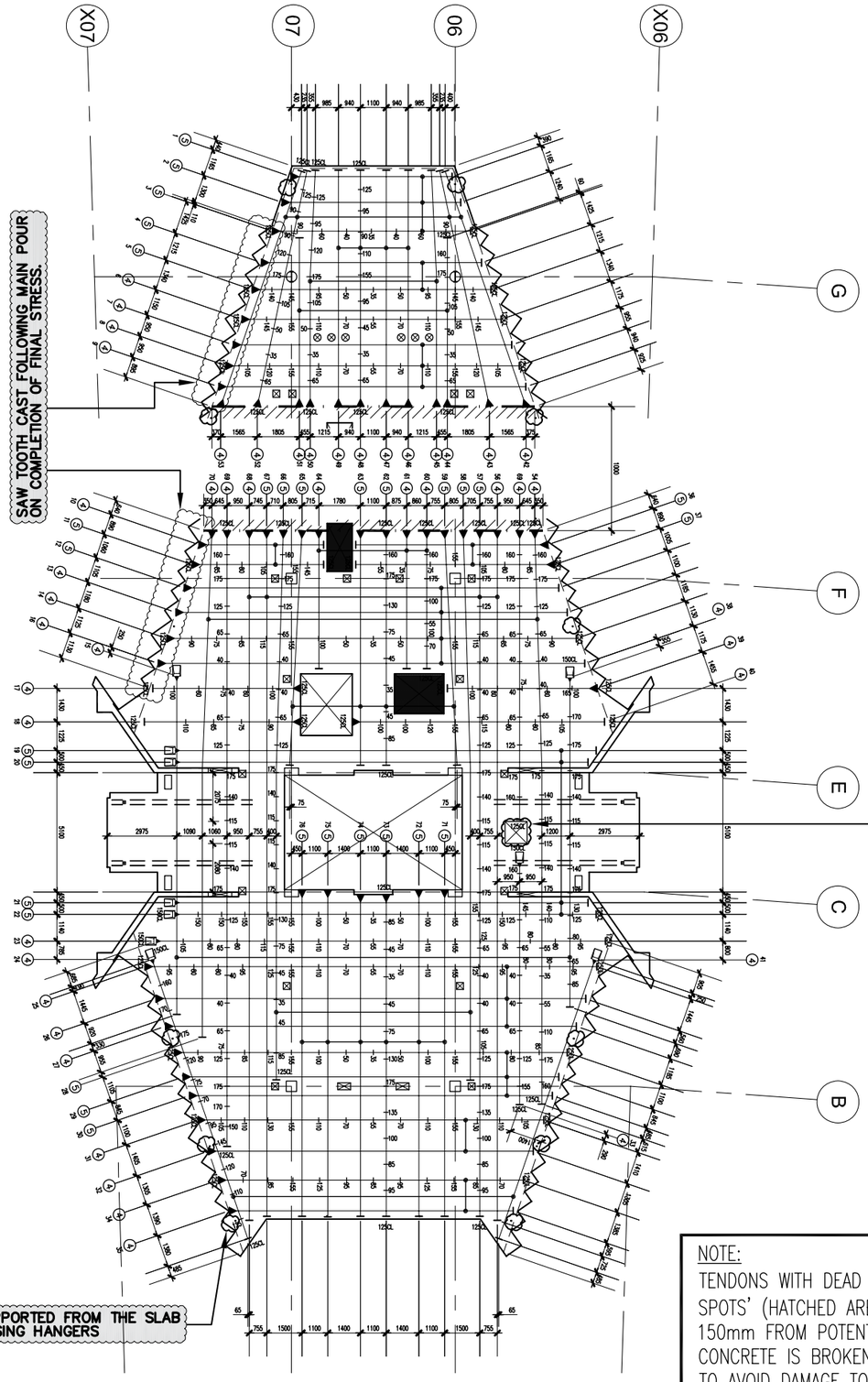
Project

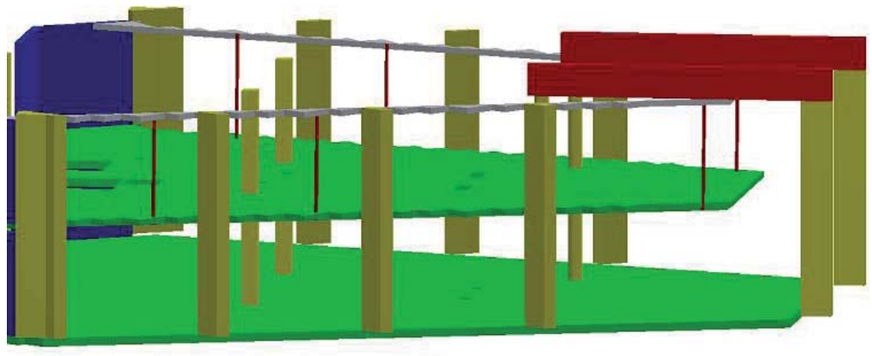
One Hyde Park
Knightsbridge

Drawing

Post Tensioning Plan
Pavilion A, Level 2
Pour 1

SF-PTA-2009-SK-5





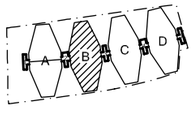
NOTE:
TENDONS WITH DEAD ENDS ADJACENT TO 'SOFT SPOTS' (HATCHED AREA) MUST BE A MINIMUM OF 150mm FROM POTENTIAL SLAB EDGE. WHEN CONCRETE IS BROKEN OUT CARE MUST BE TAKEN TO AVOID DAMAGE TO DEAD ENDS.

Post Tensioning Plan

SLAB POST TENSIONED TO SUIT AN OVERALL SLAB DEPTH OF 250mm.

ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

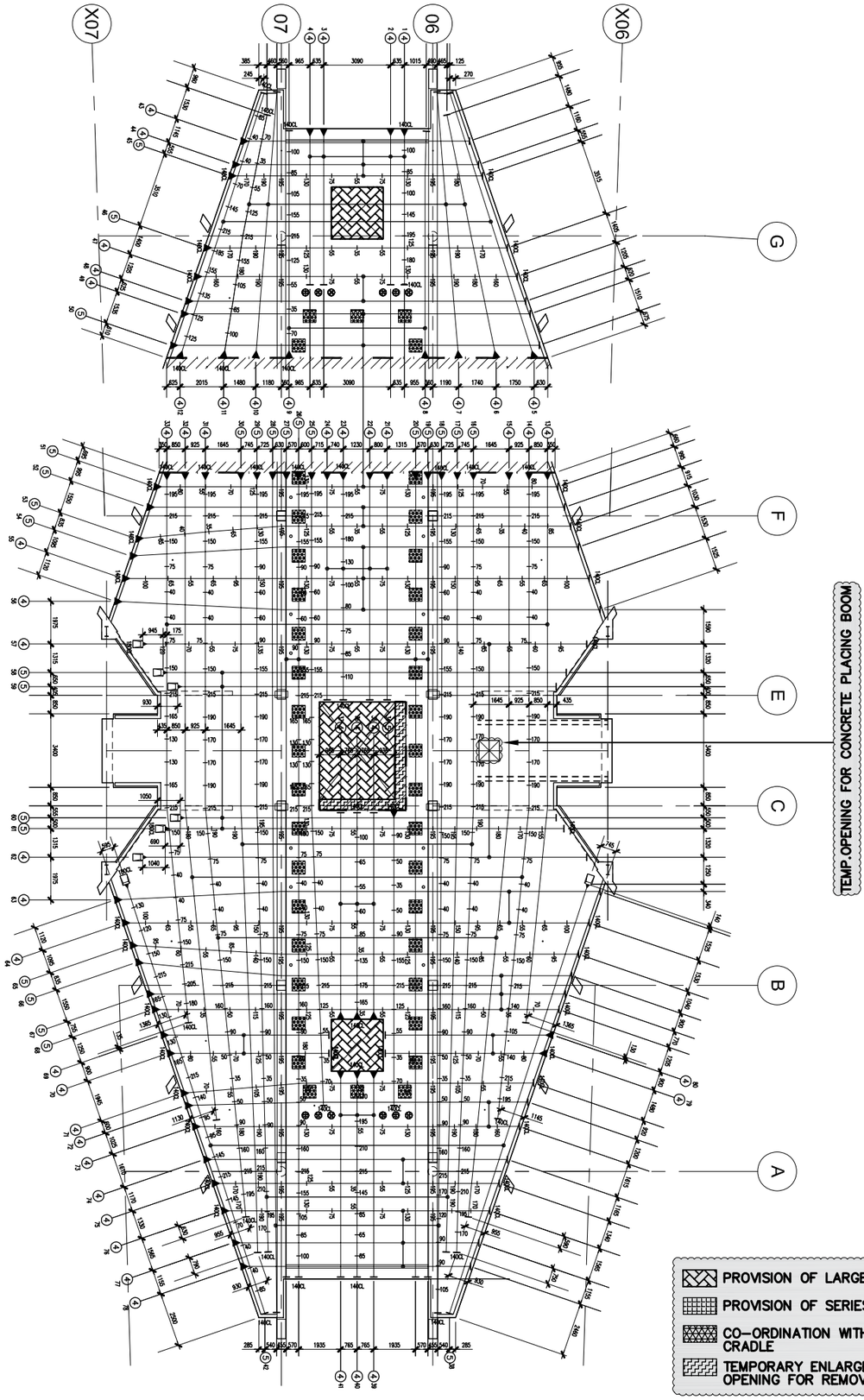
Project

One Hyde Park
Knightsbridge

Drawing

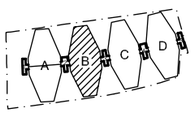
Post Tensioning Plan
Pavilion B, Level 11
Pours 1 & 2

SF-PTA-2009-SK-6



ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

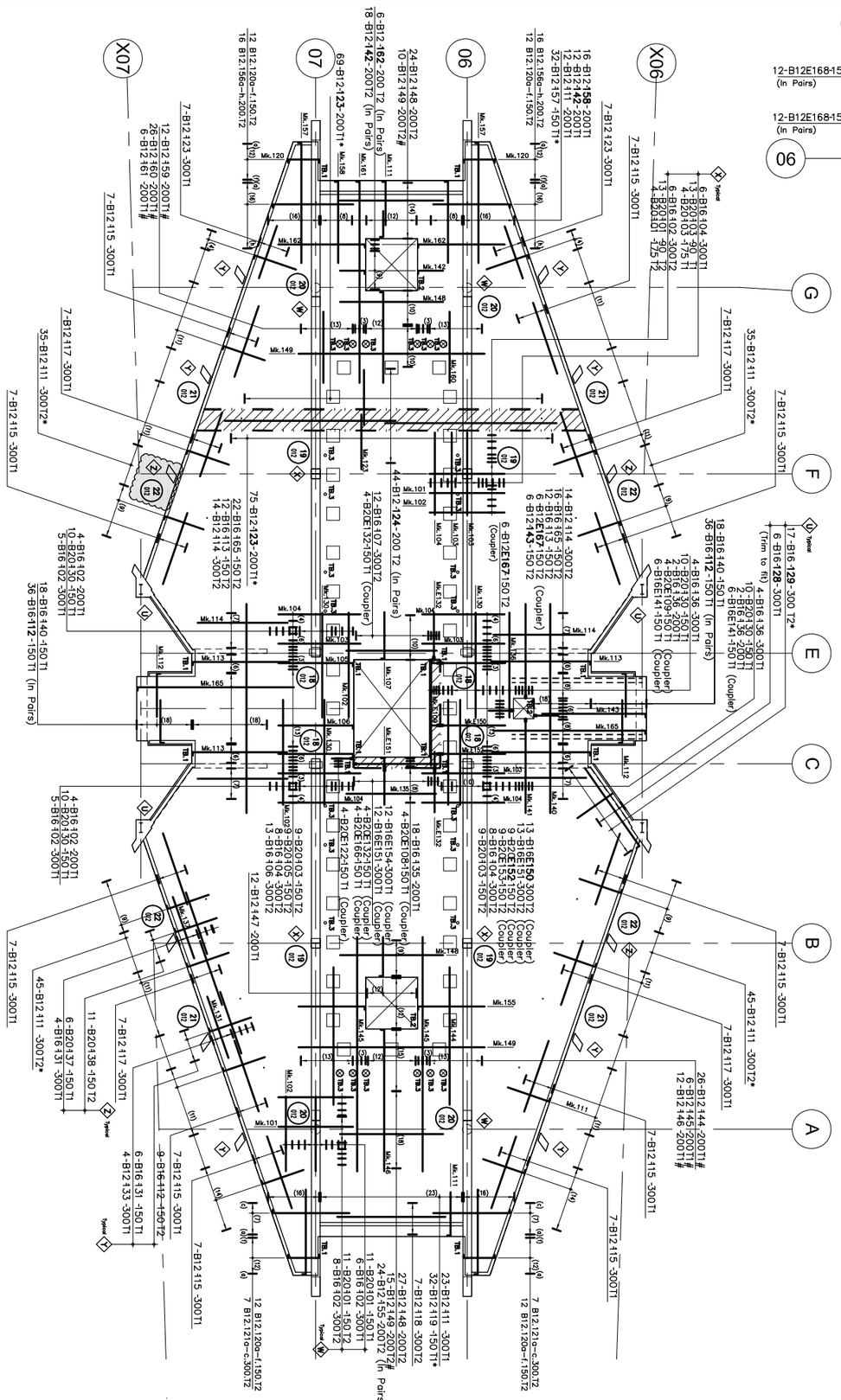
Project

One Hyde Park
Knightsbridge

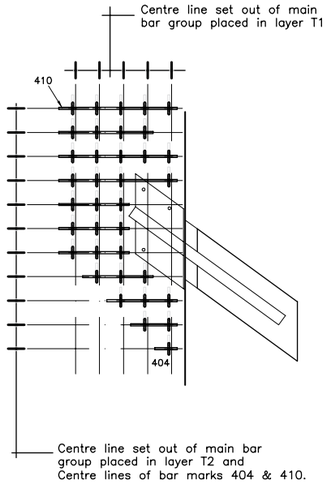
Drawing

Post Tensioning Plan
Pavilion B, Level 12
Pours 1 & 2

SF-PTA-2009-SK-7



NOTE:
ALL HOLES CUT INTO SLAB FOR INTERNAL PLINTHS AND DELAY POUR UPSTANDS MUST BE DRILLED A MIN OF 100mm AWAY FROM CENTERLINE OF TENDON.



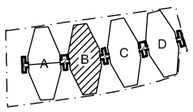
DETAIL 22
PLAN

ULT. Vt = 540kN (B20–150).

Red Chairs used for identifying duct locations

ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald

Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce

Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

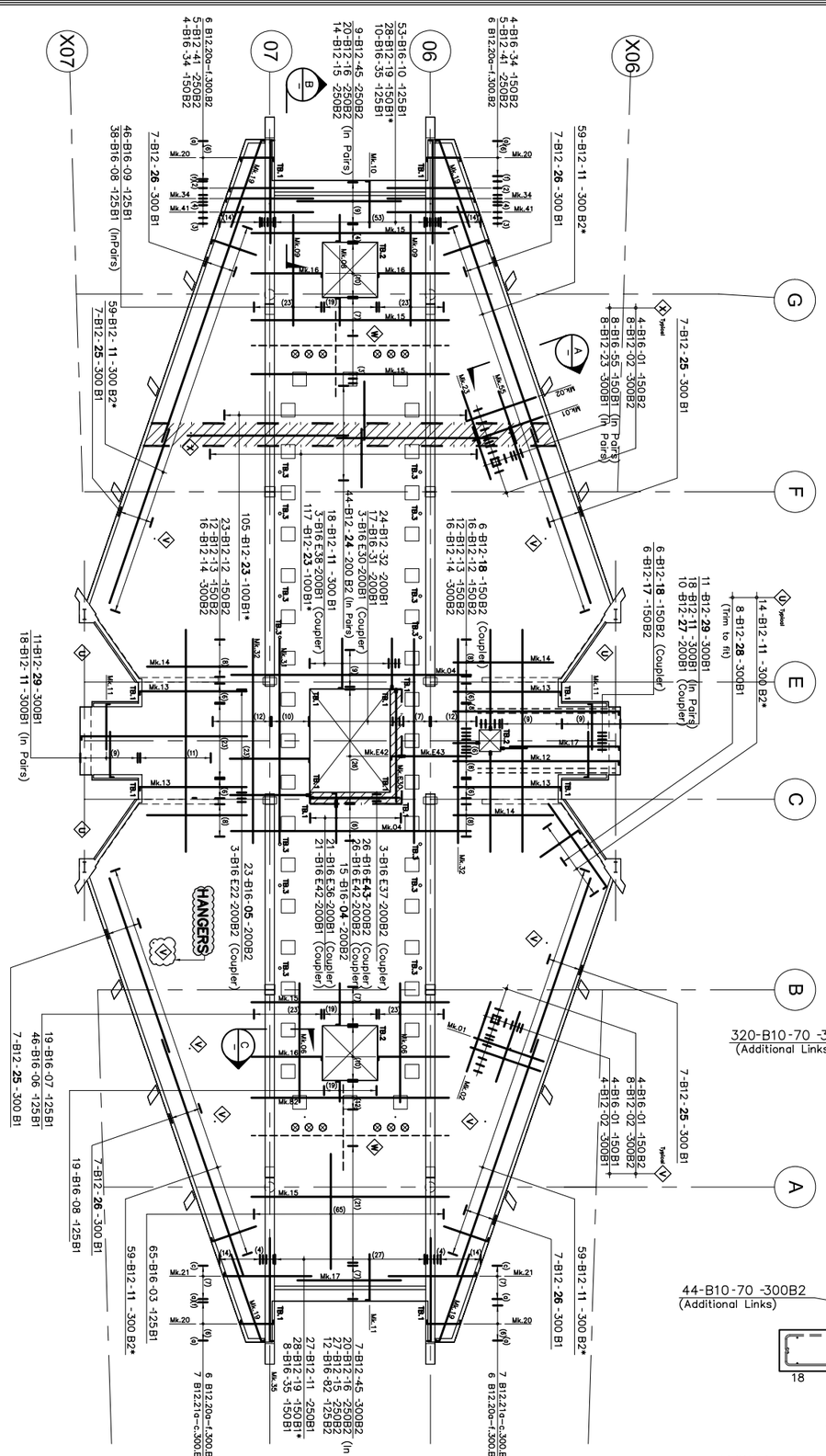
Project

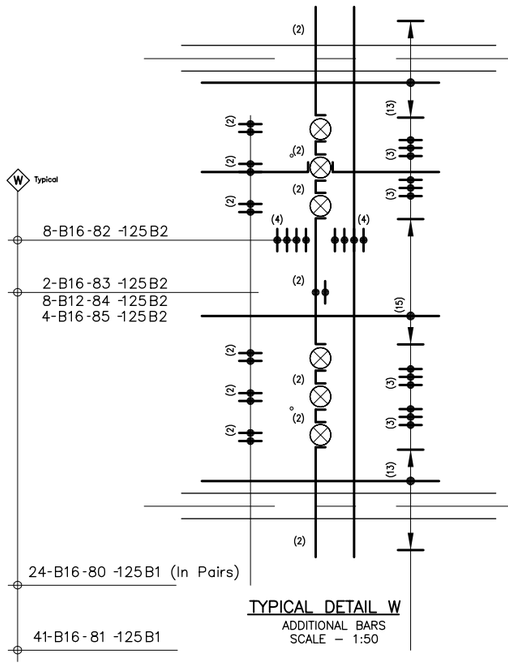
One Hyde Park
Knightsbridge

Drawing

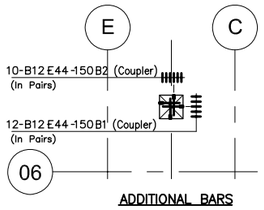
Top Reinforcement Plan
Pavilion B, Level 12
Pours 1 & 2

SF-PTA-2009-SK-8



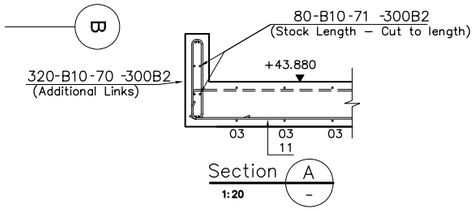


TYPICAL DETAIL W
ADDITIONAL BARS
SCALE – 1:50

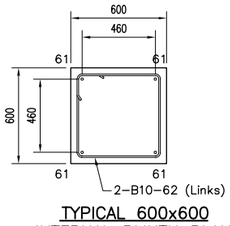


ADDITIONAL BARS

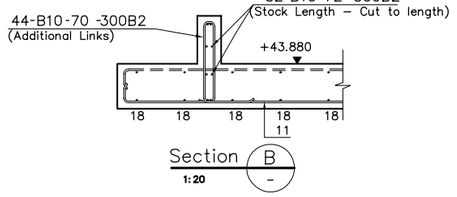
Post-tensioned roof slab can accommodate any services



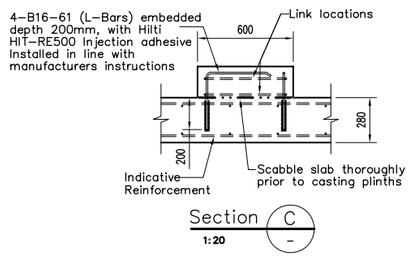
TYPICAL EDGE UPSTAND
ADDITIONAL BARS



TYPICAL 600x600
INTERNAL PLINTH PLAN
ADDITIONAL BARS
SCALE 1:20



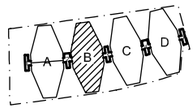
TYPICAL 200 x 300 INTERNAL UPSTAND
ADDITIONAL BARS



TYPICAL SECTION THROUGH INTERNAL PLINTH
ADDITIONAL BARS

ADAPTED FOR PTA SUBMISSION 2009

KEY PLAN



Project Consultant

ARUP

13 Fitzroy Street
London W1T 4BQ
Tel +44(0)20 7636 1531 Fax +44(0)20 7580 3924
www.arup.com

Mott MacDonald
Canterbury House
85 Newhall Street
Birmingham B3 1LZ
United Kingdom
Tel +44 (0)21 237 4000
Fax +44 (0)21 237 4001
Web www.mottmac.com

StrongForce
Strongforce Engineering Ltd.,
Bridge Place, Anchor Boulevard, Admirals Park,
Dartford, Kent. DA2 6SN
Telephone (01322) 317055
Fax (01322) 317788

Project

One Hyde Park
Knightsbridge

Drawing

Bottom Reinforcement Plan
Pavilion B, Level 12
Pours 1 & 2

SF-PTA-2009-SK-9