Constructing Excellence Forum

Hammersmith Flyover Strengthening Phase 2

11th February 2015

Constructing Excellence Forum

Andy Bannister: Costain Project Manager
Simon Lewis: Costain Construction Manager
Paul Hamid: TfL Project Manager

History of the Flyover

Construction of the bridge 1959-1962

Designed by G. Maunsell and Palmers

Built by Marples Ridgeway and Partners

Cost approximately £1.2M

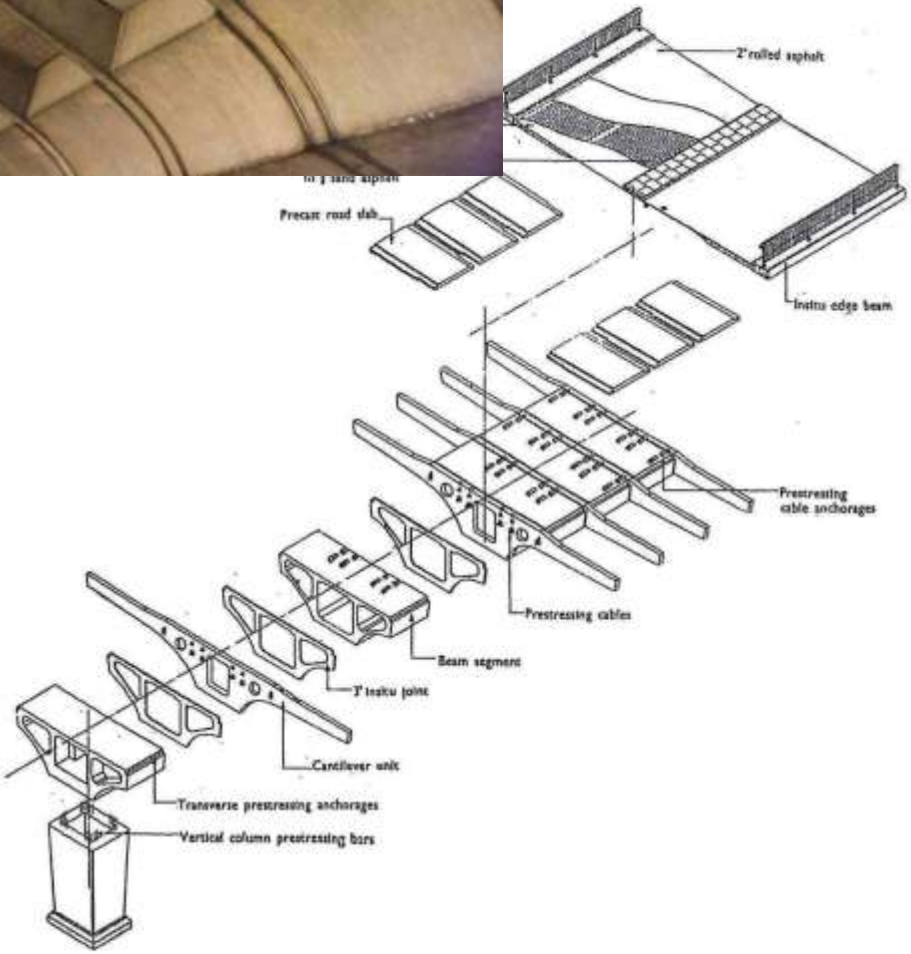
Elevated length 16 spans - 622.7 metres

Length with approach ramps is 862.9metres

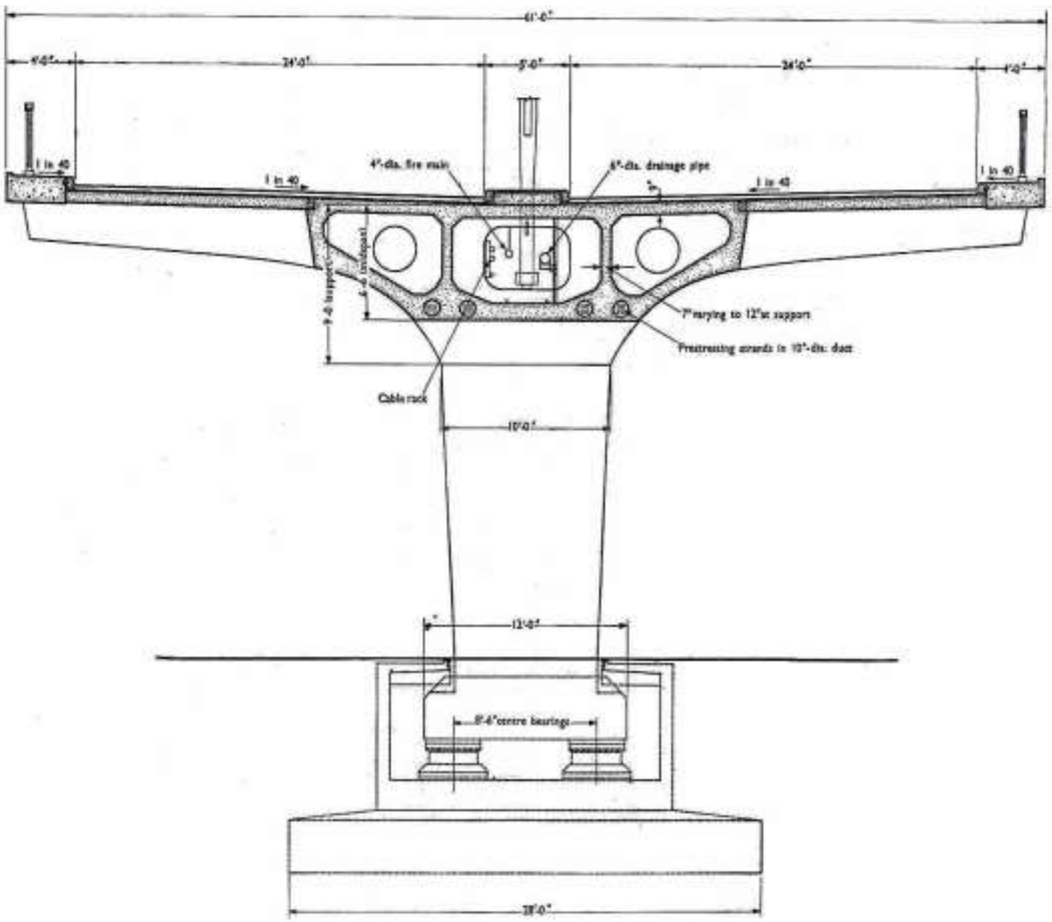
Dual 2 lane carriageways

Overall width 18.6 metres

History of the Flyover



- Comprises 16 spans of post tensioned segmental construction
- Each span tensioned by longitudinal tendons -four clusters, 19no, 29mm steel cables



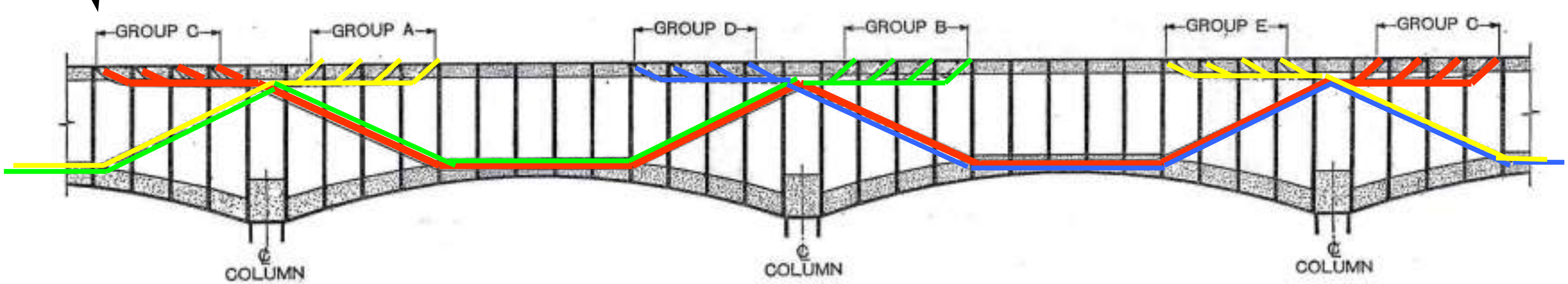
- Each span of 42m sits on top of 2 roller bearings

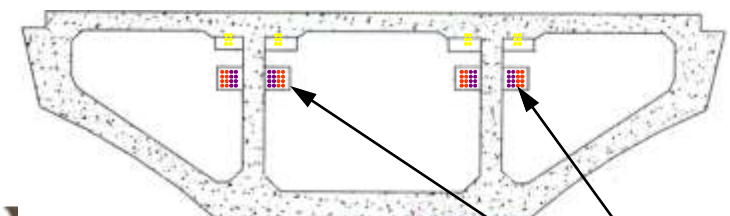
The Problems

Construction of the Flyover

Tendons anchored in deck slab adjacent to piers

Each tendon group continuous over 2 spans (3 piers)





Tendons encased in grout boxes ‘external’ to box section

Schematic diagram of post – tensioning tendon arrangement

Extensive water leakage

- This ingress of water, over a number of years, has led to corrosion of the existing post tensioning system

- Continuous acoustic monitoring has identified wire breaks at various locations and from this deterioration dates for each pier have been calculated

Hammersmith Flyover
Projected Date Calculations Summary

Prepared By :	EGB
Checked By :	CS
Approved By :	PS

Report Date: 28/01/2015

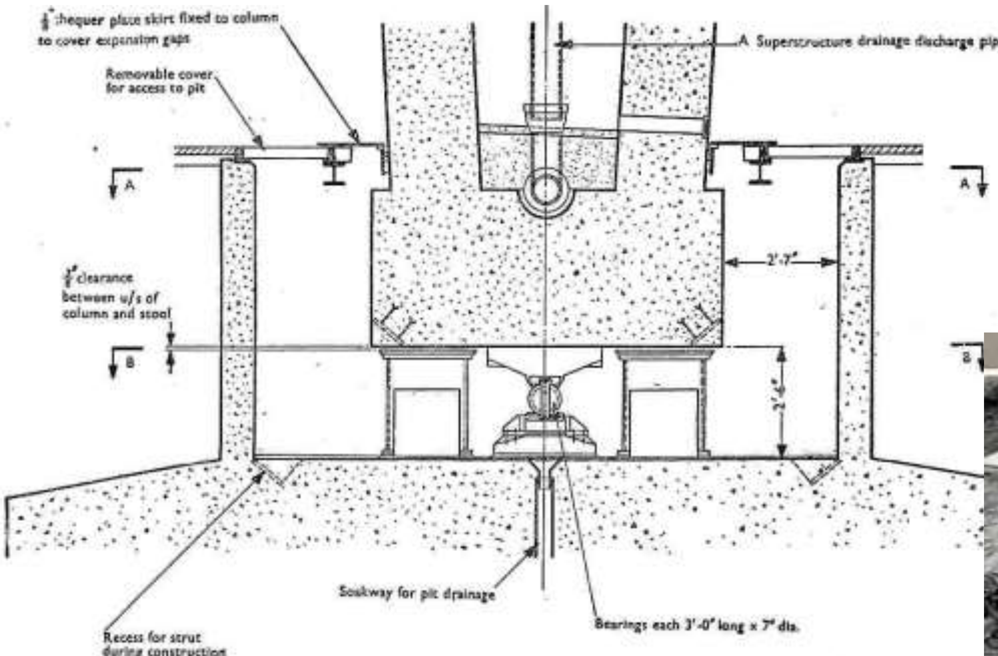
West Structure Piers

Report Number	Report for Week Ending	Report Issue Date	Pier ->	B	C	D	E	F	G
1	18/01/2015	28/01/2015	Wire breaks in December 2014	3	1	2	0	0	0
			Spare wires remaining to reach zero spare capacity	124	190	206	244	297	181
			Deterioration rate	3	3	5	1	2	3
			Time left from end of December (years)	3.4	5.3	3.4	20.3	12.4	5.0
			Projected Critical Date	Jun 18	Apr 20	Jun 18	May 35	May 27	Jan 20

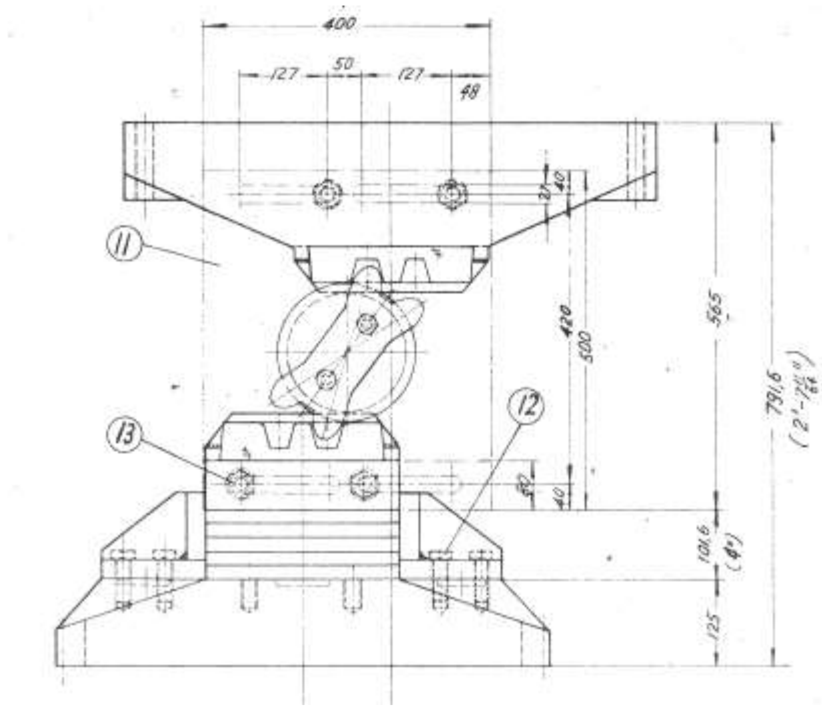
East Structure Piers

Pier ->	H	I	J	K	L	M	N	O	P
Wire breaks in December 2014	1	0	1	1	0	1	1	2	1
Spare wires remaining to reach zero spare capacity	312	74	46	1295	1084	851	1159	1076	50
Deterioration rate	2	3	2	6	4	5	6	5	2
Time left from end of December (years)	13.0	2.0	1.9	18.0	22.6	14.2	16.1	17.9	2.1
Projected Critical Date	Dec 27	Jan 17	Nov 16	Dec 32	Jan 37	Mar 29	Feb 31	Dec 32	Feb 17

- **Existing Bearing Pits**



- **Existing Bearings**



- 2 bearings per pit
- 15 pits
- Each bearing weighing a total of 2.2T
- Total available travel on a bearing +/- 130mm
- Some bearings are at their maximum travel
- At 2 locations the pier is sat on the failsafe stools

- Corrosion of stools has led to steel shim expansion and thus spalling of concrete, failure of drainage system has led to bearings being immersed in water over a period of time with extensive corrosion

- The Solutions

ECI

Working together

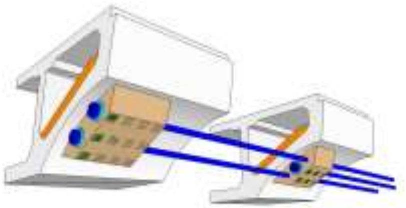
Early contractor Involvement (ECI):

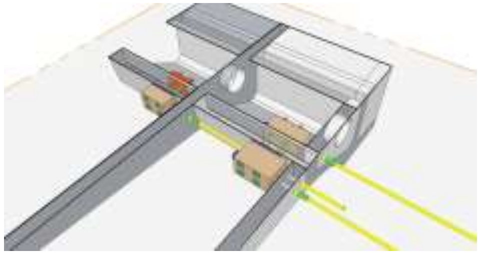
Early involvement and co-location of Costain with Transport for London and Ramboll & Parsons Brinkerhoff

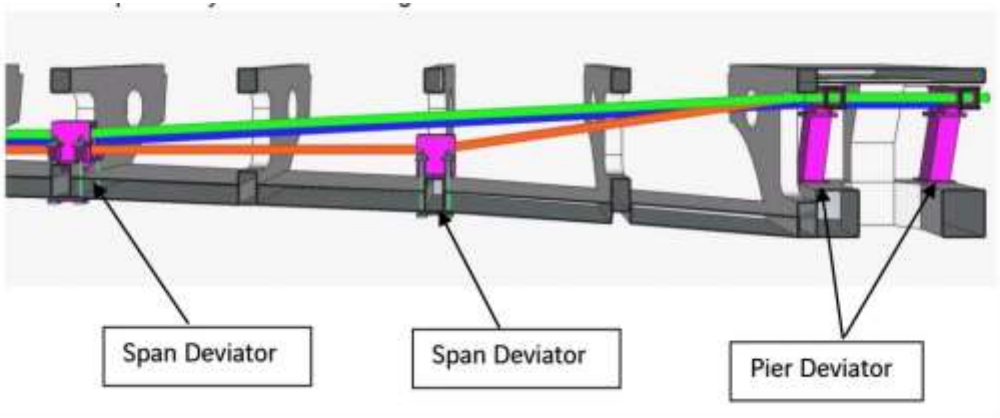
Working and cooperating with local authorities

- **SOLUTION 1: Replace the existing Post Tensioning with a series of new blisters and tendons that are both internal and external**

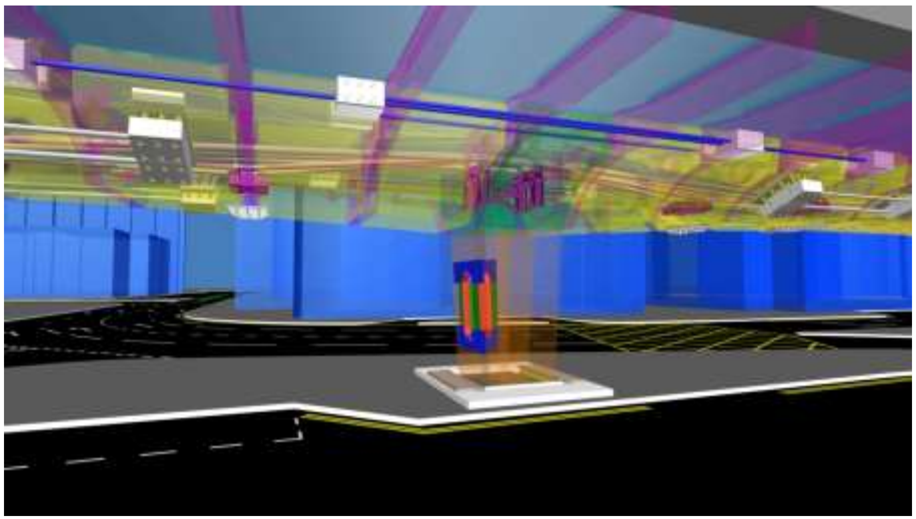
- Initial concepts were developed during the ECI phase

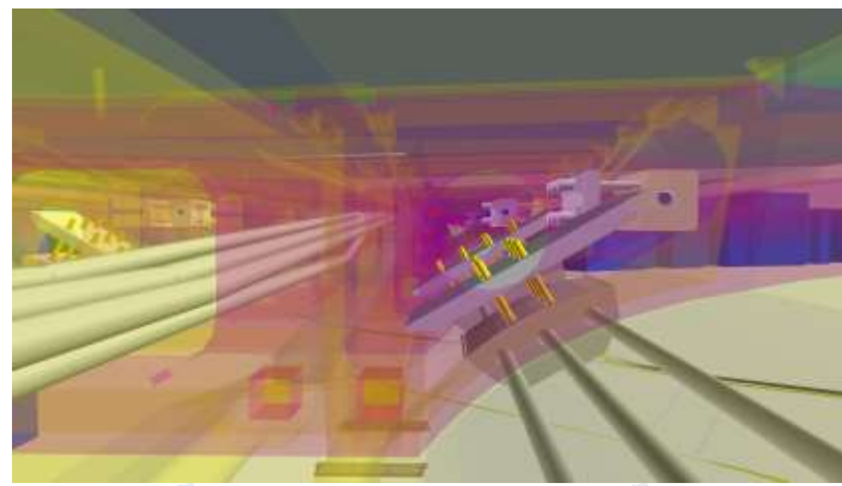




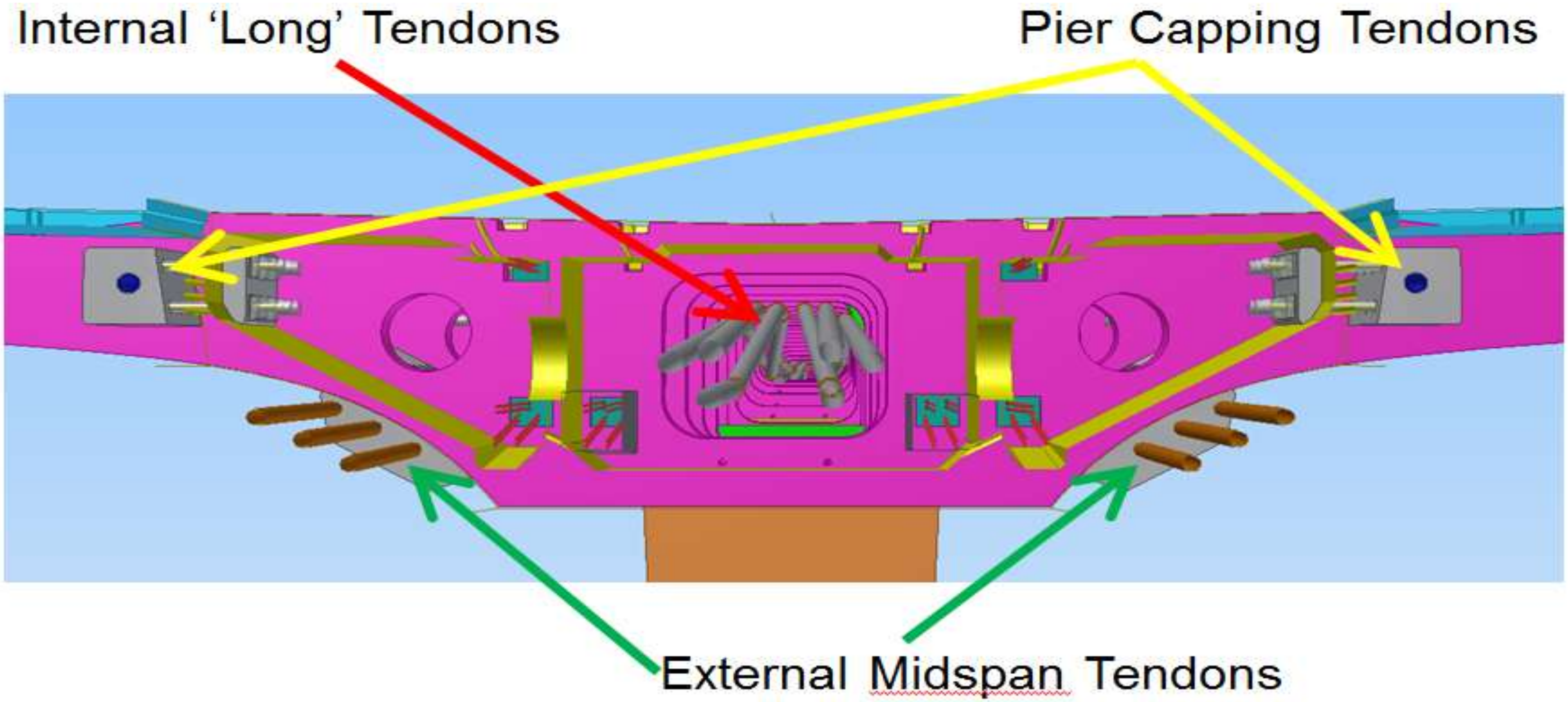


- Concepts from the ECI phase were detailed and installed into the 3D model so that checks could be made both locally on each segment of the bridge and globally on the whole structure itself





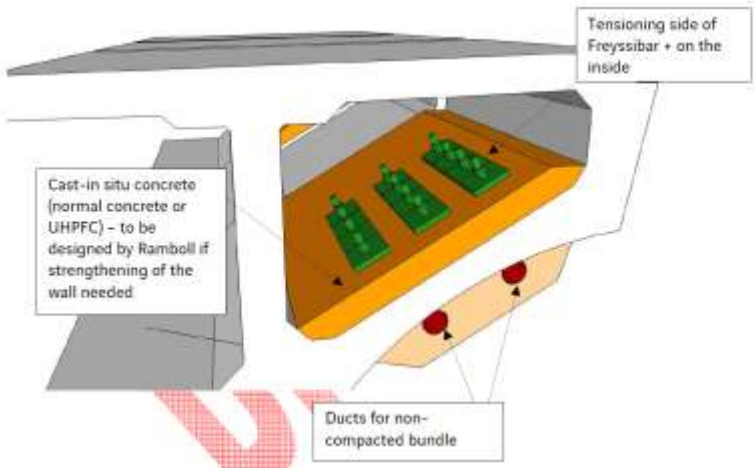
- These concepts were amended a number of times until a final workable solution was achieved via a number of new tendons



- Each pier capping tendon and mid span tendon is attached to an anchorage or "blister" which in turn is attached to the structure via a series of stressed bars
- Ultra High Performance Fibre Reinforced Concrete
- Each blister weighing in excess of 2T

- The challenge was then to attach these “blisters” to the structure

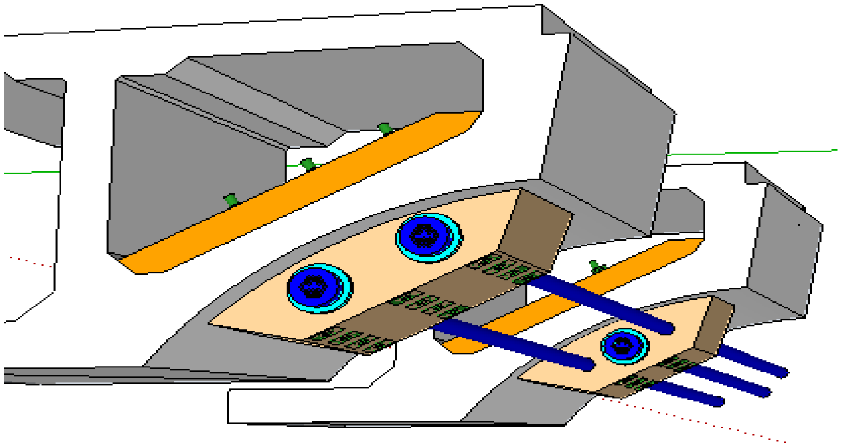
Challenge 1: In-situ backing slabs to transfer loads

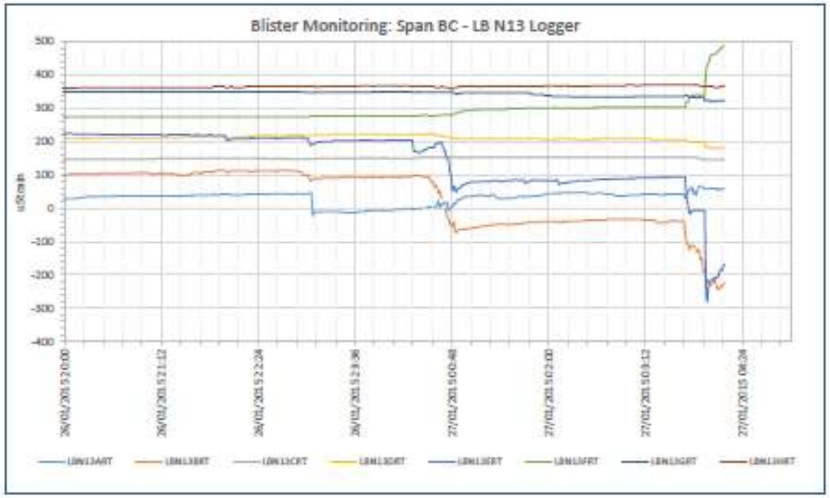


Challenge 2: Delivery of concrete for in-situ backing and space constraints

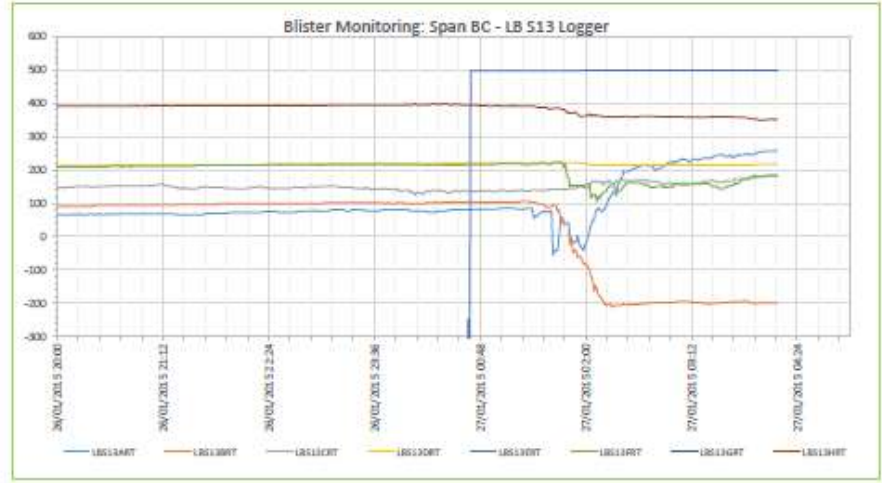
Challenge 3. Bespoke lifting equipment

- Mid-span Tendons consist of 22 strands in each tendon.
- Galvanised and individually sheathed in a polyurethane protection coat
- Stressed to 460T, 21T in each strand

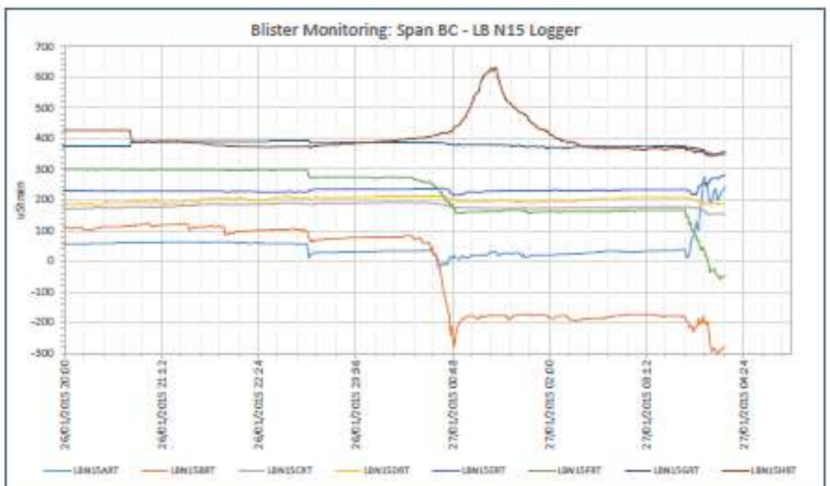




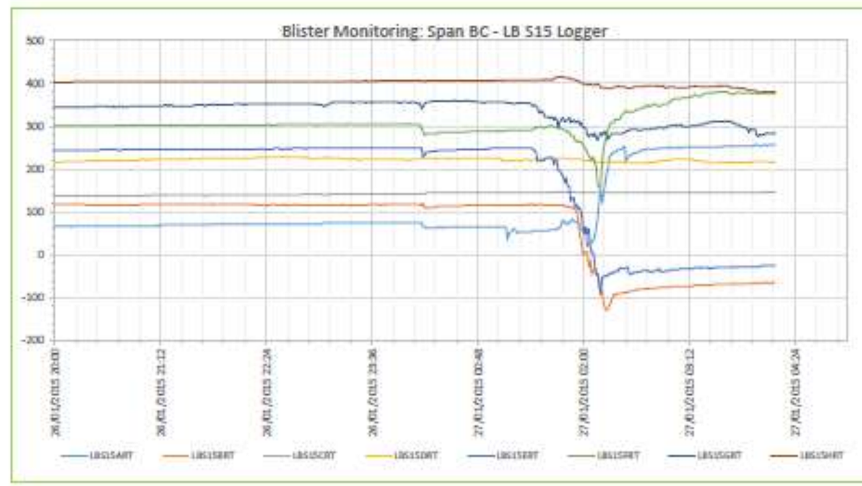
Blister Monitoring: Span BC - LB N13 Logger
500
400
300
200
100
0
-100
-200
-300
-400



Blister Monitoring: Span BC - LB S13 Logger
600
500
400
300
200
100
0
-100
-200
-300

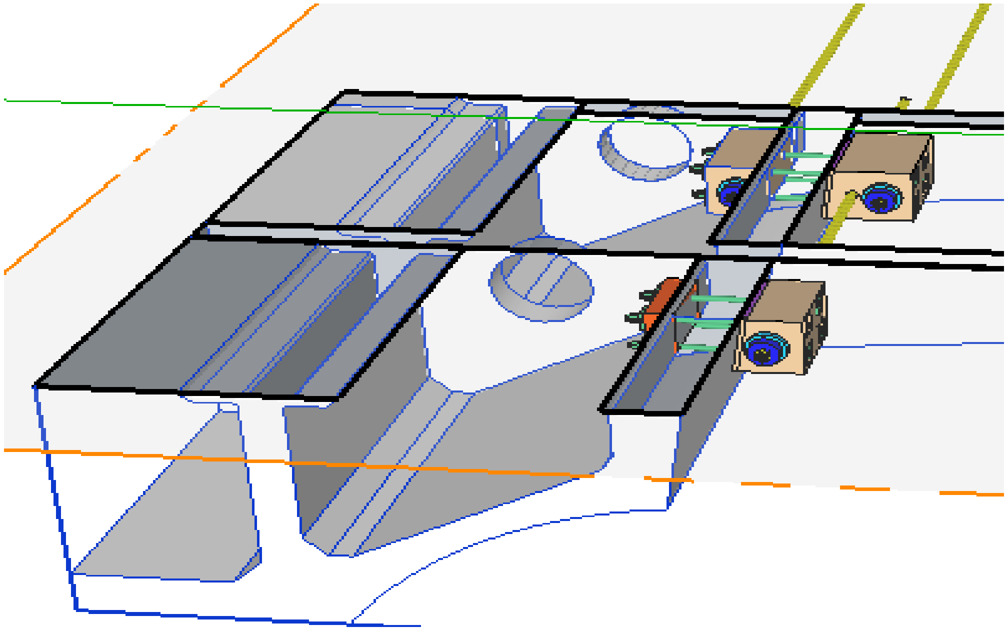


Blister Monitoring: Span BC - LB N15 Logger
700
600
500
400
300
200
100
0
-100
-200
-300

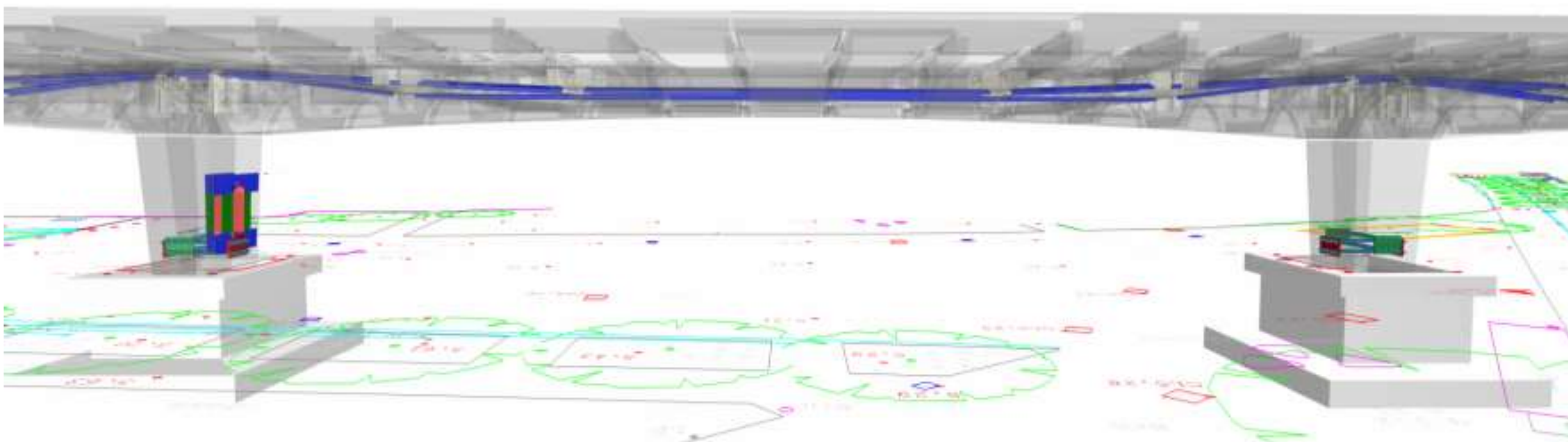


Blister Monitoring: Span BC - LB S15 Logger
500
400
300
200
100
0
-100
-200

- Pier Capping Tendons similar to the external mid-span tendons
- 13 strands per tendons stressed to 270T
- Pier capping tendons are both internal and external

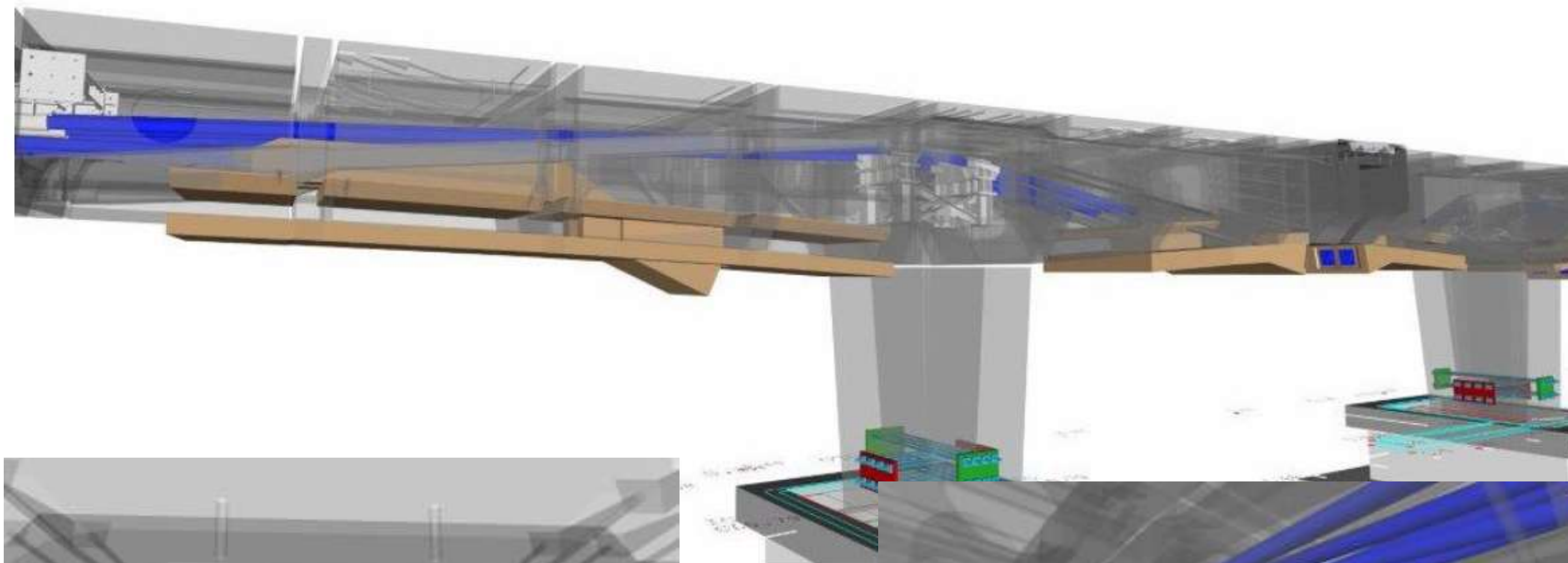


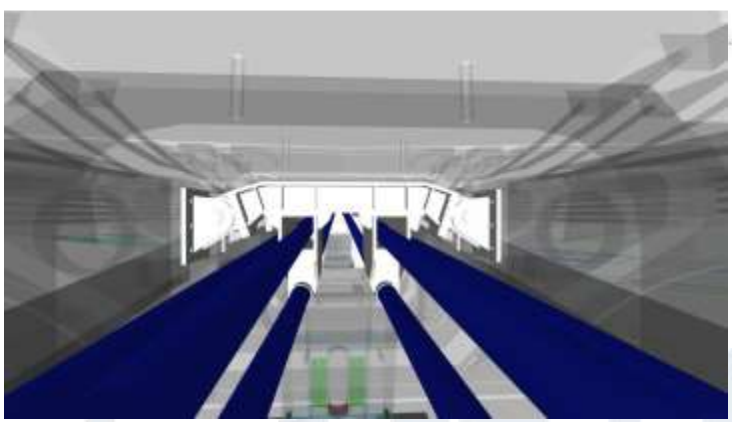
- Internal ‘Long’ Tendons consist of in HDPE ducts, running from each abutment to the expansion joint
- Start Installation March 15

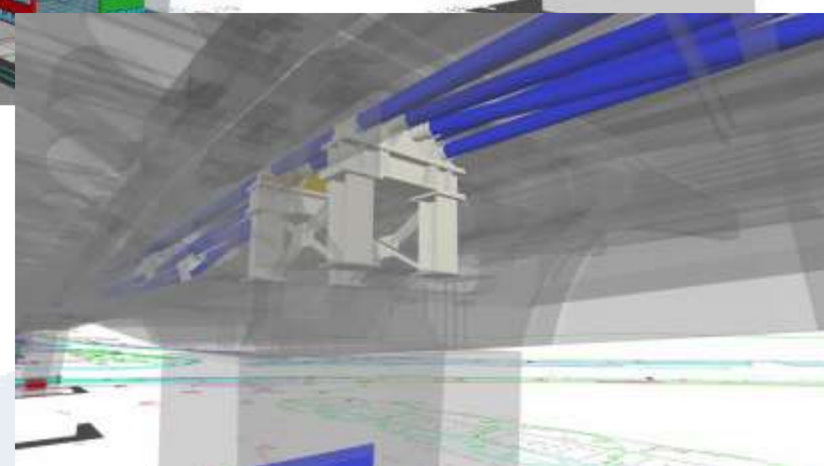


- Internal ‘Long’ Tendons consist of 6 number HDPE ducts, 620m long containing 37 no 16mm diameter galvanised steel strands
- Each Tendon stressed to 770T (21T per strand)
- Strands are covered in a wax, injected into the HDPE duct
- External Mid-span Tendons consist of 22 steel strands, galvanised, individually waxed and sheathed in a MDPE protection coat. Stressed to 460T, (21T per strand)
- Pier Capping Tendons 13 strands per tendons stressed to 270T
- Pier capping tendons are both internal and external

- Series of internal deviators and restraints with fixed anchors



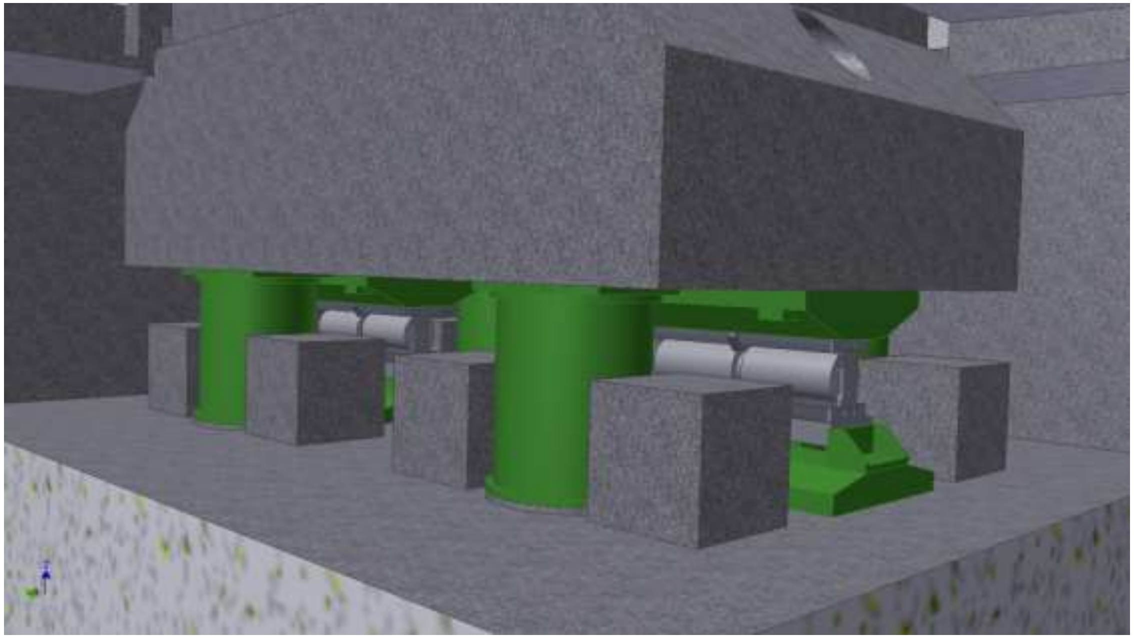




Below Deck – Post Tension Works

Long tendon anchorage works

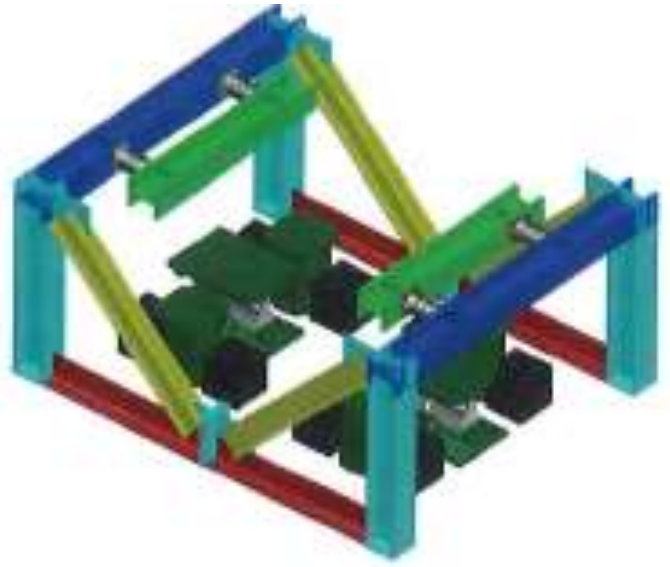
- <u>SOLUTION 2: Replace the existing roller bearings</u>



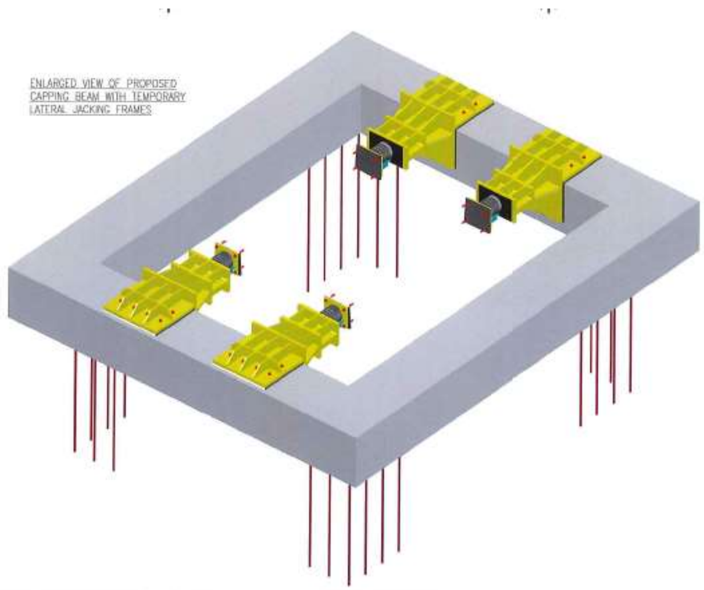
- Run out of travel
- Height constraint
- Sourcing bearing
- Increased loads

Considerations for Installation of new bearings

- Temporary Works Solution

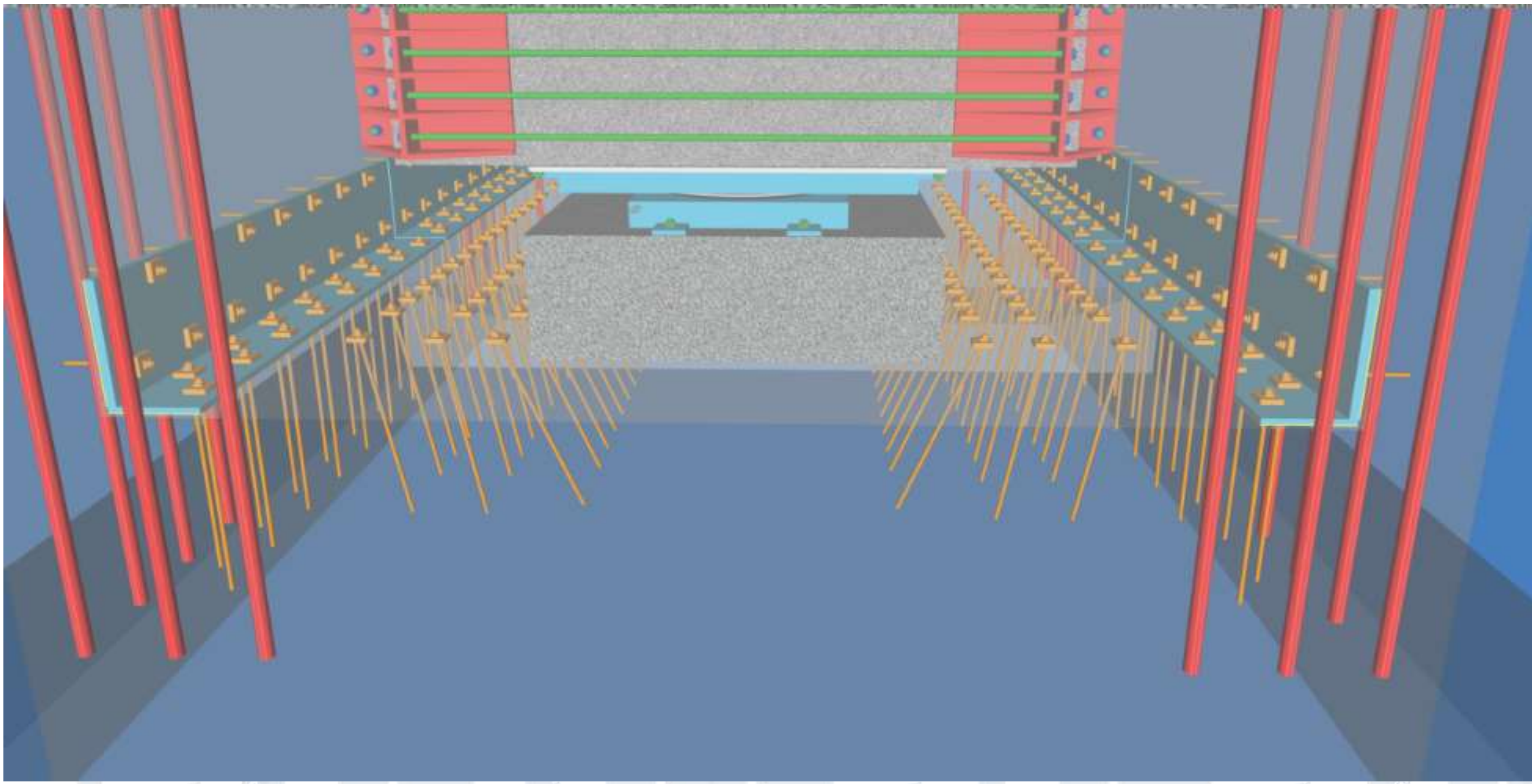


Initial concept



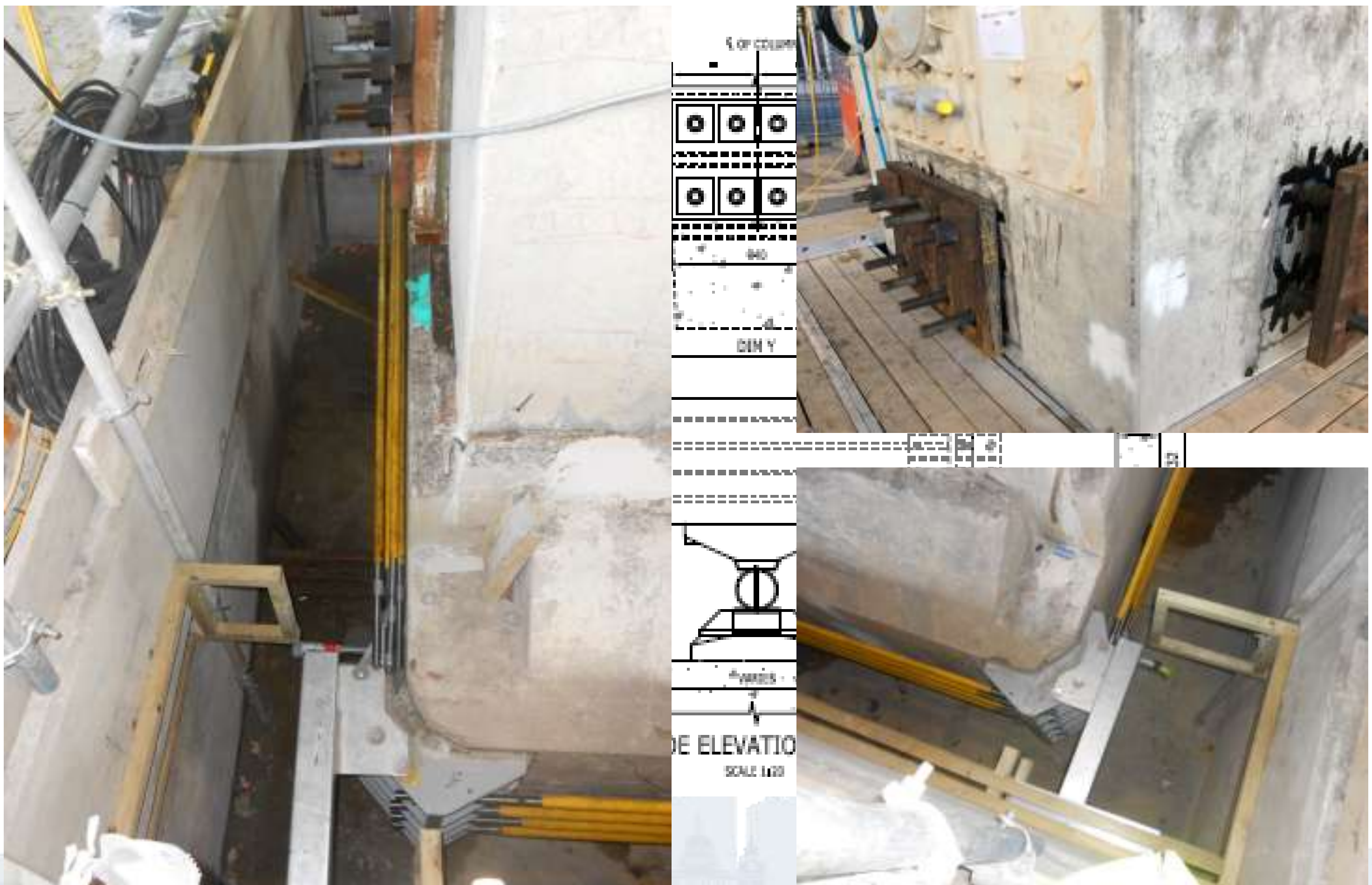
Final Design: Wall strengthening and capping beam

- Honeycombed pit base concrete - design solution



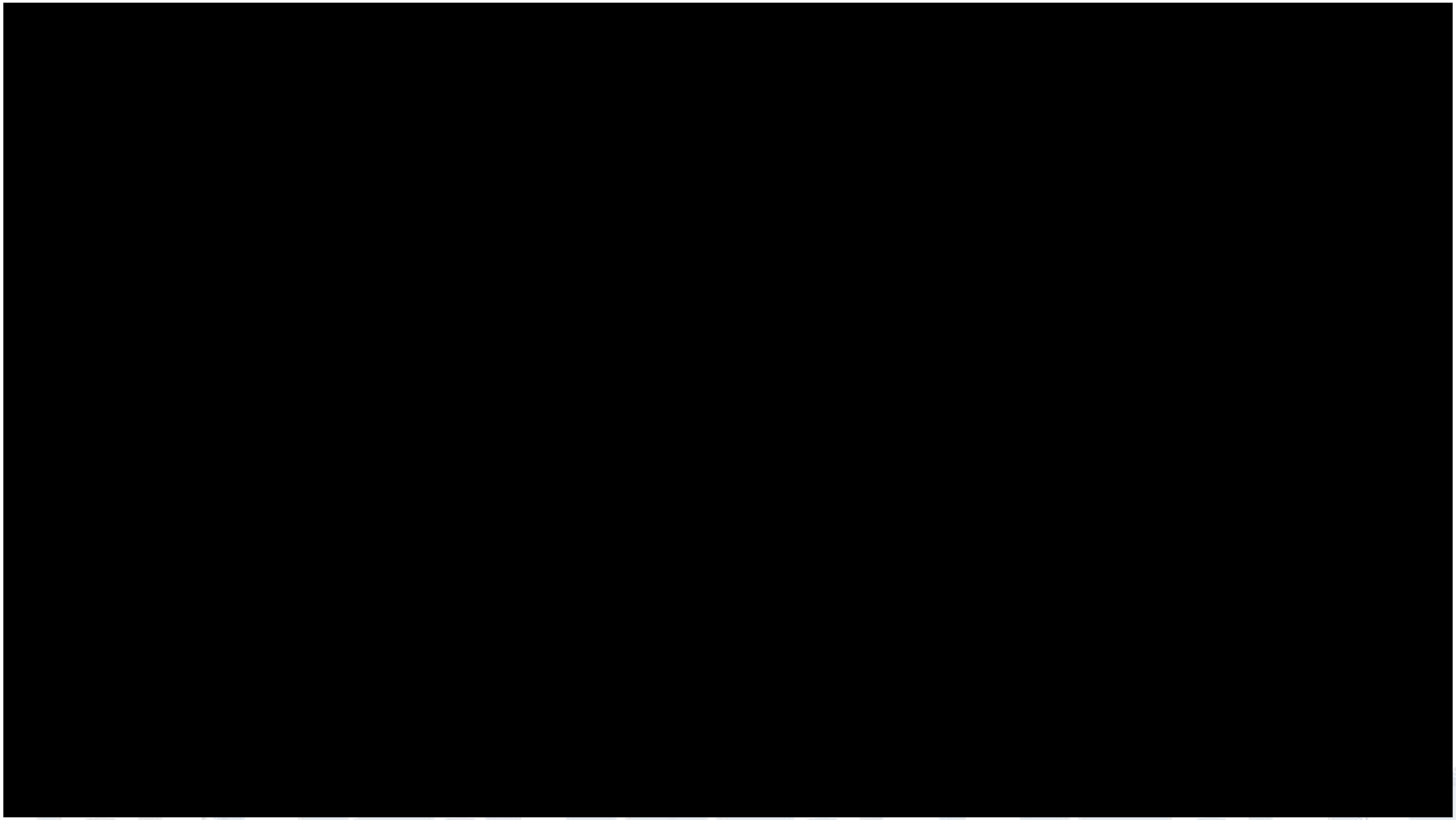
- Honeycombed pit base concrete – implementing solution

- Strengthening of the pier bases to resist bursting forces



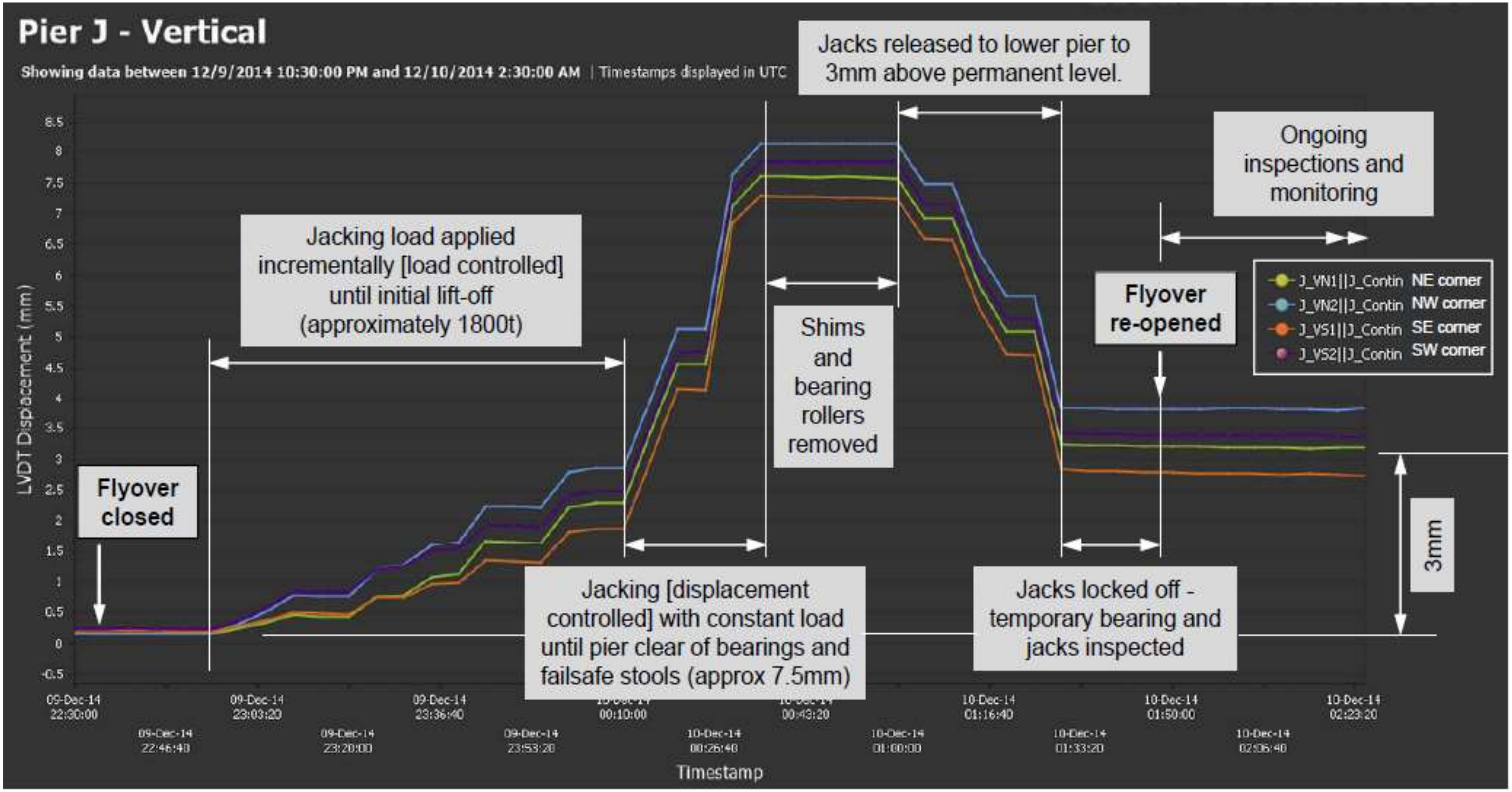
PARSONS BRINCKERHOFF STREETS RAMBOLL COSTAIN

- Lifting piers solution

- Bearing Replacement

- Monitoring



09–10 Dec 2014 – HAMMERSMITH FLYOVER – Record of Jacking Pier J (levels taken on each corner of pier base)

New ways of working

Community engagement

27 Apprenticeships offered:

11 directly by Costain, the rest through the Prince’s trust/TfL routes

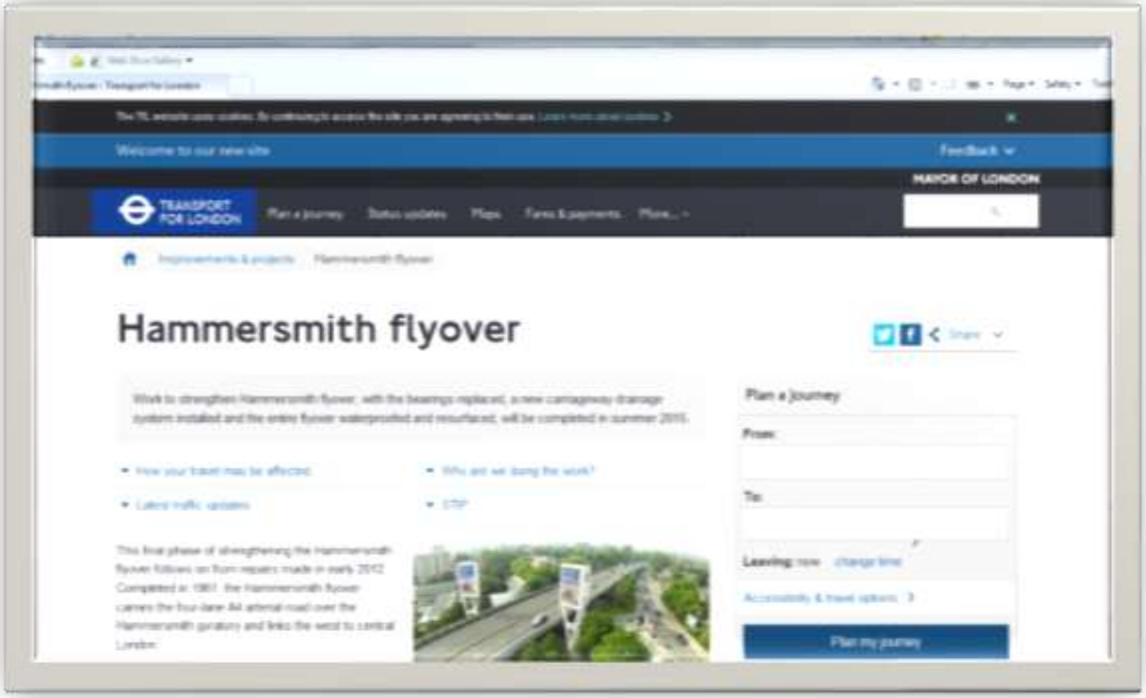
Responsible procurement embedded within the contract

Engaging with Communities:

St Paul’s Catholic School’s drawing competition

New ways of working

Keeping stakeholders and the local community informed



- Online updates of planned works.
- Open Consultations on Wednesdays and Thursdays
- Clear and easy contact information
- Working with customers and the local community

Hammersmith Flyover Final Phase