Constructing Excellence Forum

Hammersmith Flyover Strengthening
Phase 2

11th February 2015
Constructing Excellence Forum

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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 862.9 metres
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

Each tendon group continuous over 2 spans (3 piers)

Tendons anchored in deck slab adjacent to 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**

**Report Date:** 28/01/2015

<table>
<thead>
<tr>
<th>Report Number</th>
<th>Report for Week Ending</th>
<th>Report Issue Date</th>
<th>Pier -&gt;</th>
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<th>B</th>
<th>C</th>
<th>D</th>
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### West Structure Piers

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<th>Apr 20</th>
<th>Jun 18</th>
<th>May 16</th>
<th>May 27</th>
<th>Jun 29</th>
<th>Jul 20</th>
<th>Aug 17</th>
<th>Sep 18</th>
<th>Oct 18</th>
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### East Structure Piers

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<th>Nov 16</th>
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<th>Jan 30</th>
<th>Mar 10</th>
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• 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
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
• 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
• SOLUTION 2: Replace the existing roller bearings

• 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
• Lifting piers solution
• Bearing Replacement
• Monitoring

**Pier J - Vertical**

- Jacking load applied incrementally [load controlled] until initial lift-off (approximately 1800t)
- Shims and bearing rollers removed
- Jacking [displacement controlled] with constant load until pier clear of bearings and failsafe stools (approx 7.5mm)
- Jacks released to lower pier to 3mm above permanent level
- Ongoing inspections and monitoring
- Flyover re-opened
- Flyover closed

**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

Questions?