Precast Concrete at Paddington Rail Station, London

By

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Member of *fib* Commission 6

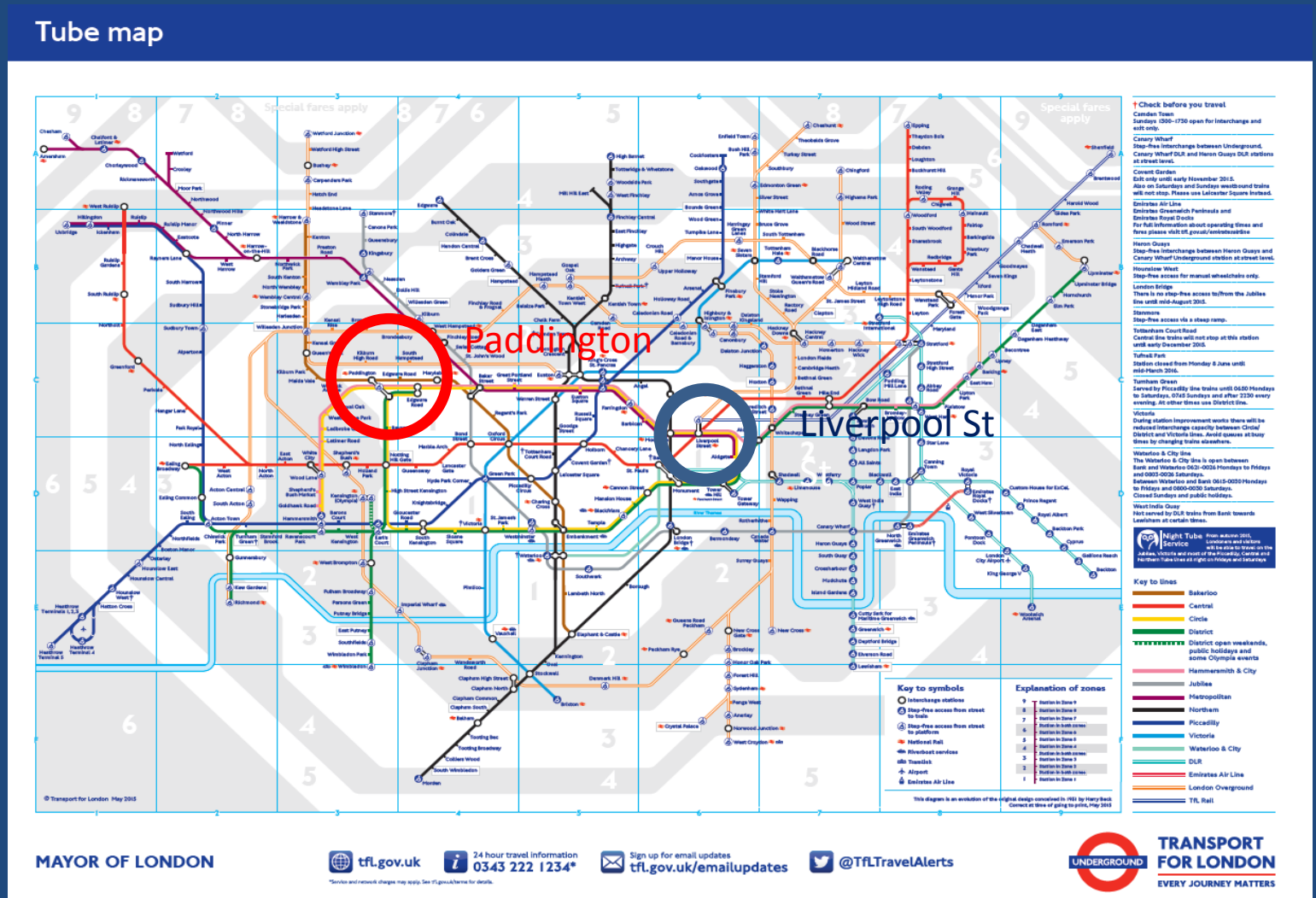
Precast Concrete
at
Paddington Rail Station

- Project background.
- Reasons for using precast concrete and its extent.
- 3D modelling of precast ceilings and element design.
- Precast installation and top down construction.
- End result of ceiling construction.
- Remaining precast to be installed.

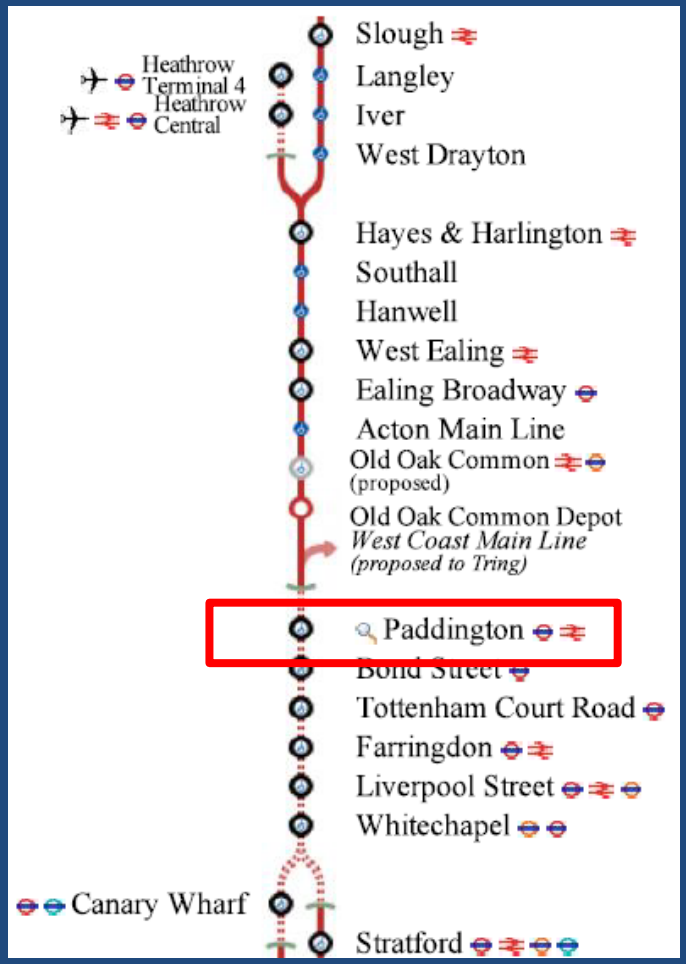
Paddington Rail Station and Crossrail

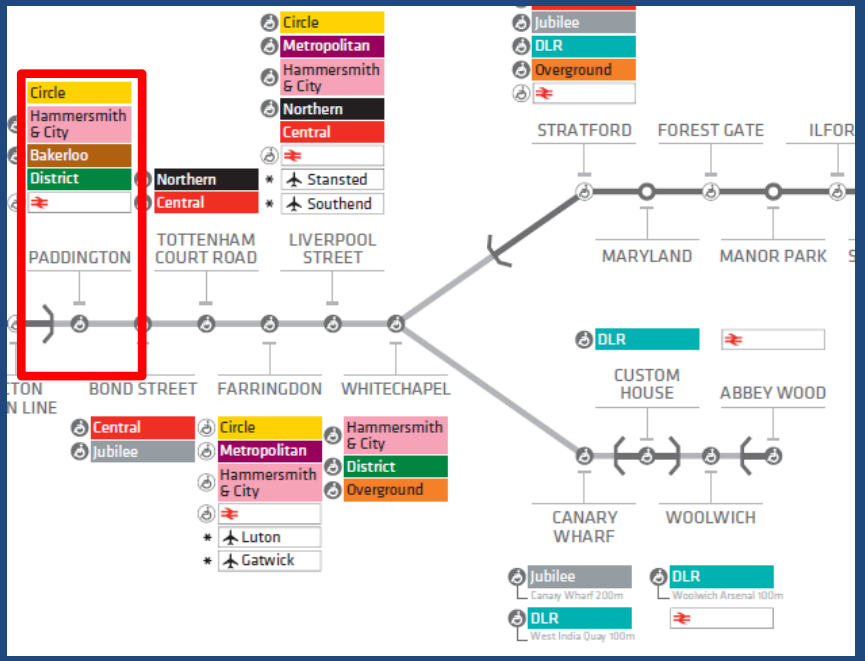
- Background:
- Mainline station at eastern end of Great Western Line, undertaken by Isambard Kingdom Brunel to link London and New York, opened 1854. Now served by four underground lines and is the London gateway for passengers from Heathrow.
- Initial proposals for tunnel to link Paddington and Liverpool Street main line stations in 1948
- Further proposals in 1974, 1991 and 2005. Royal assent received in 2008.
- Construction starts 2009, first passengers expected to use new station in 2018.

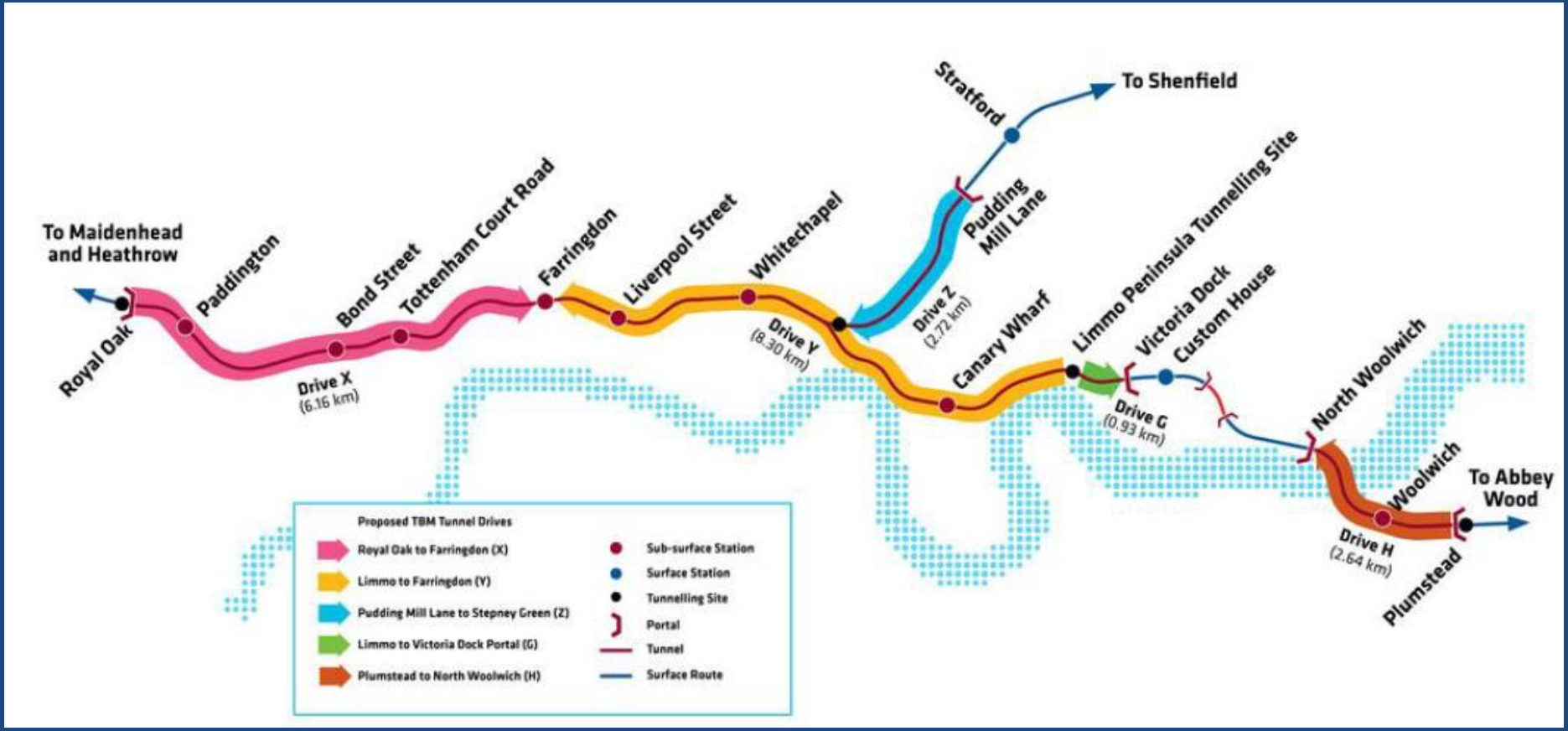
Familiar London Tube Map



Connections to Paddington







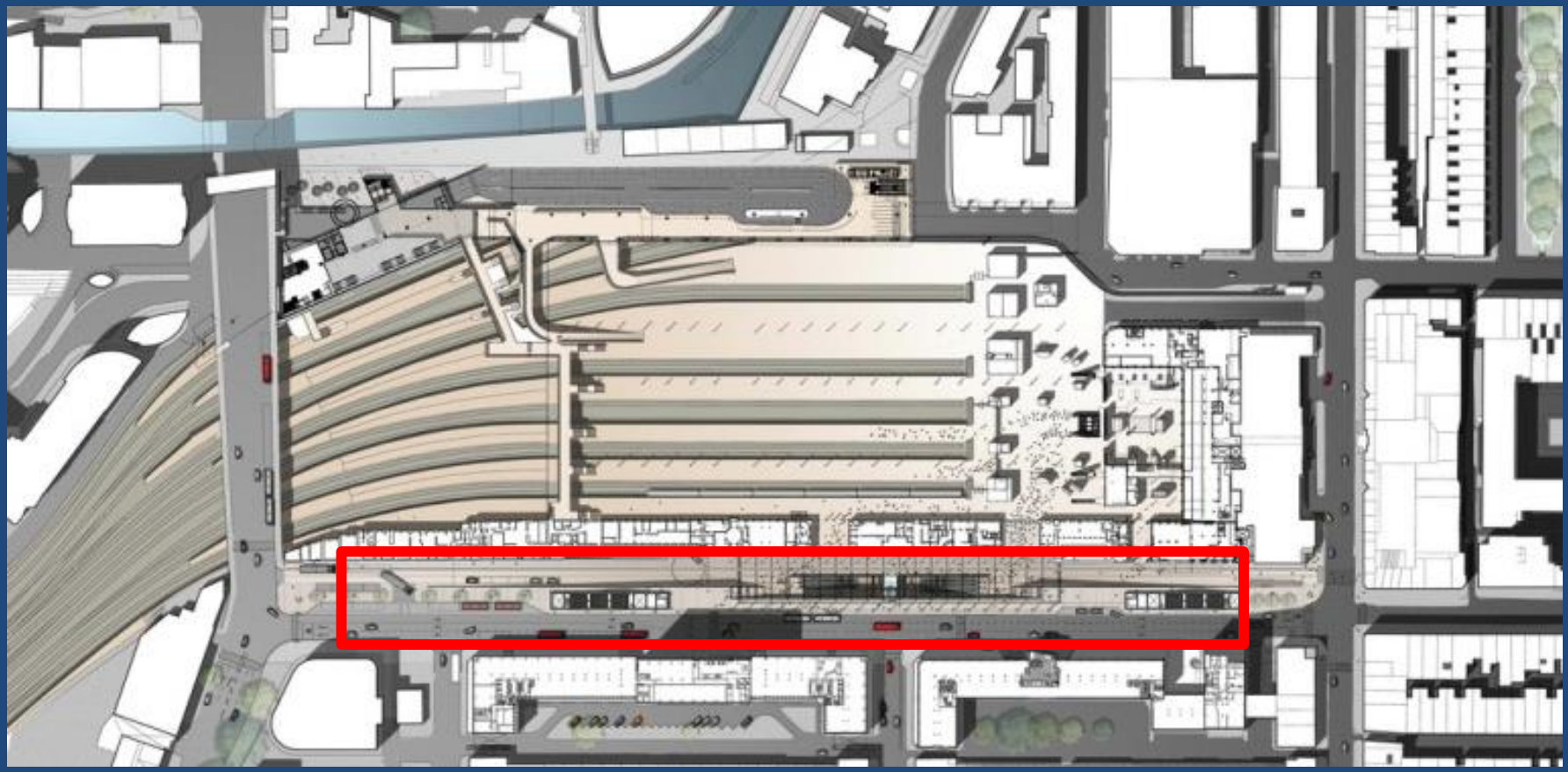
Crossrail: Key Figures

- 136 km of new line
- 42km of new tunnels
- 10 new stations
- £15.9 billion projected cost.

Crossrail

New Underground Station at Paddington

- New underground station for Hammersmith and City Lines
- Platform, Concourse, Intermediate and Ground Levels
- Platform length of 250m x 25m wide, and the new station box is 23m deep
- Construction will generate 160,000 cubic metres of excavation, 80,000 cubic metres of concrete and 15,000 tonnes of reinforcement.

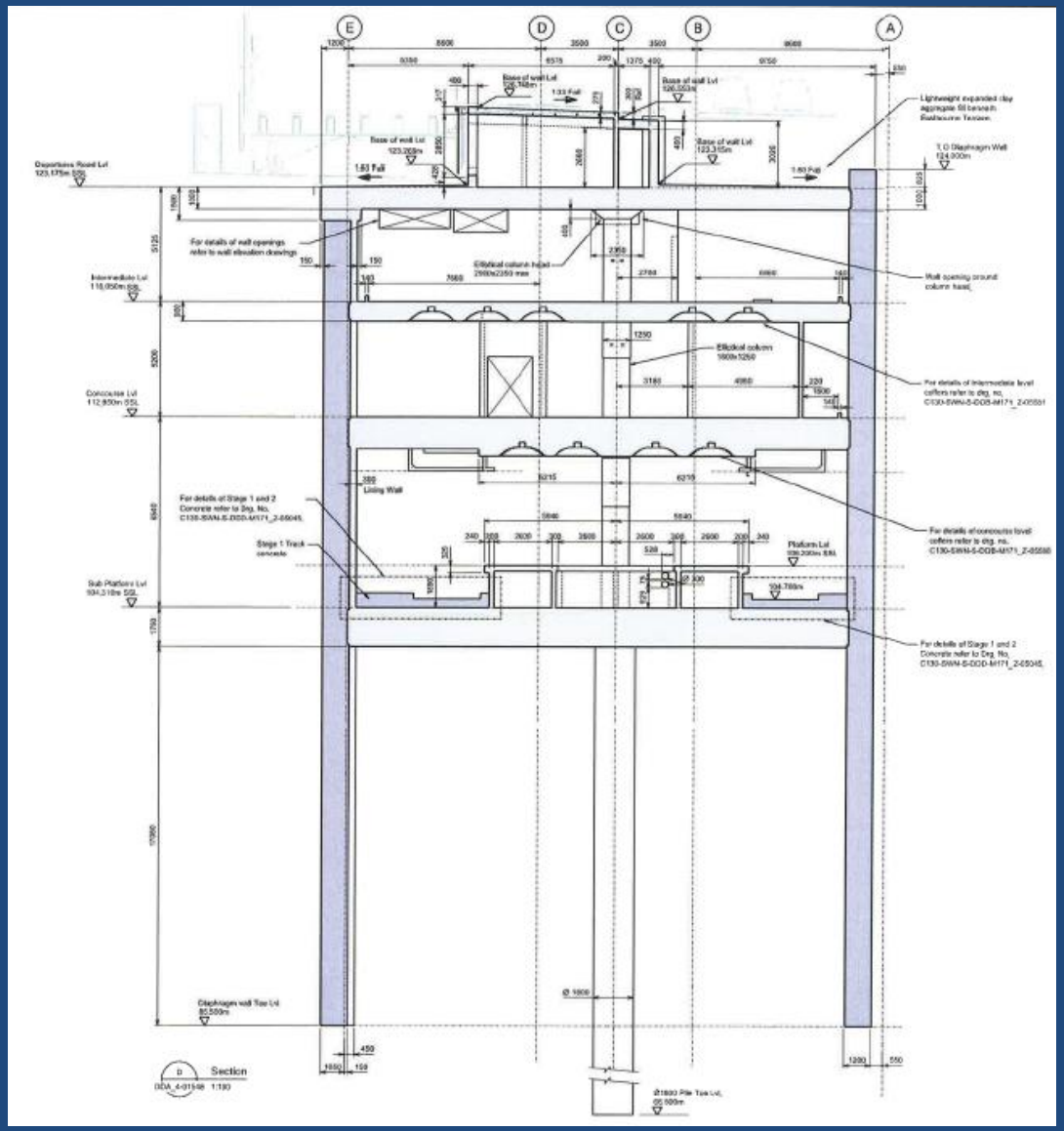


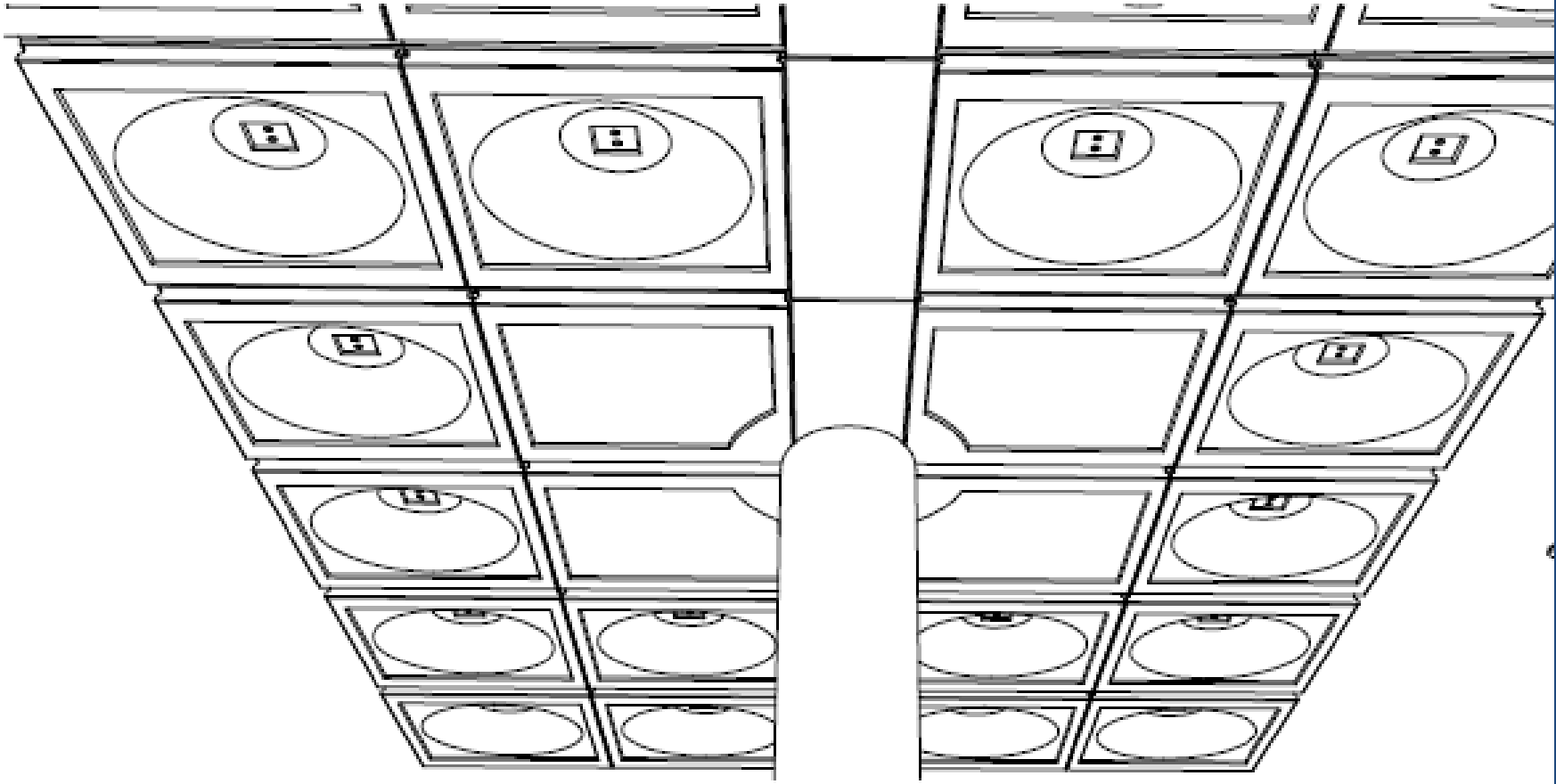
Location

The new station box will be located directly under Departures Road and Eastbourne Terrace.

Typical Section

- The station is made up of;
- D-Wall
- 4 main slabs;
  - Departures Road
  - Intermediate
  - Concourse
  - Sub-Platform
- Superstructure
  - Eastbourne Terrace slabs
  - 9 m Vent Walls
  - Eastbourne Terrace Retaining Walls
- Platform Walls and Slabs
- Architectural Elliptical Columns



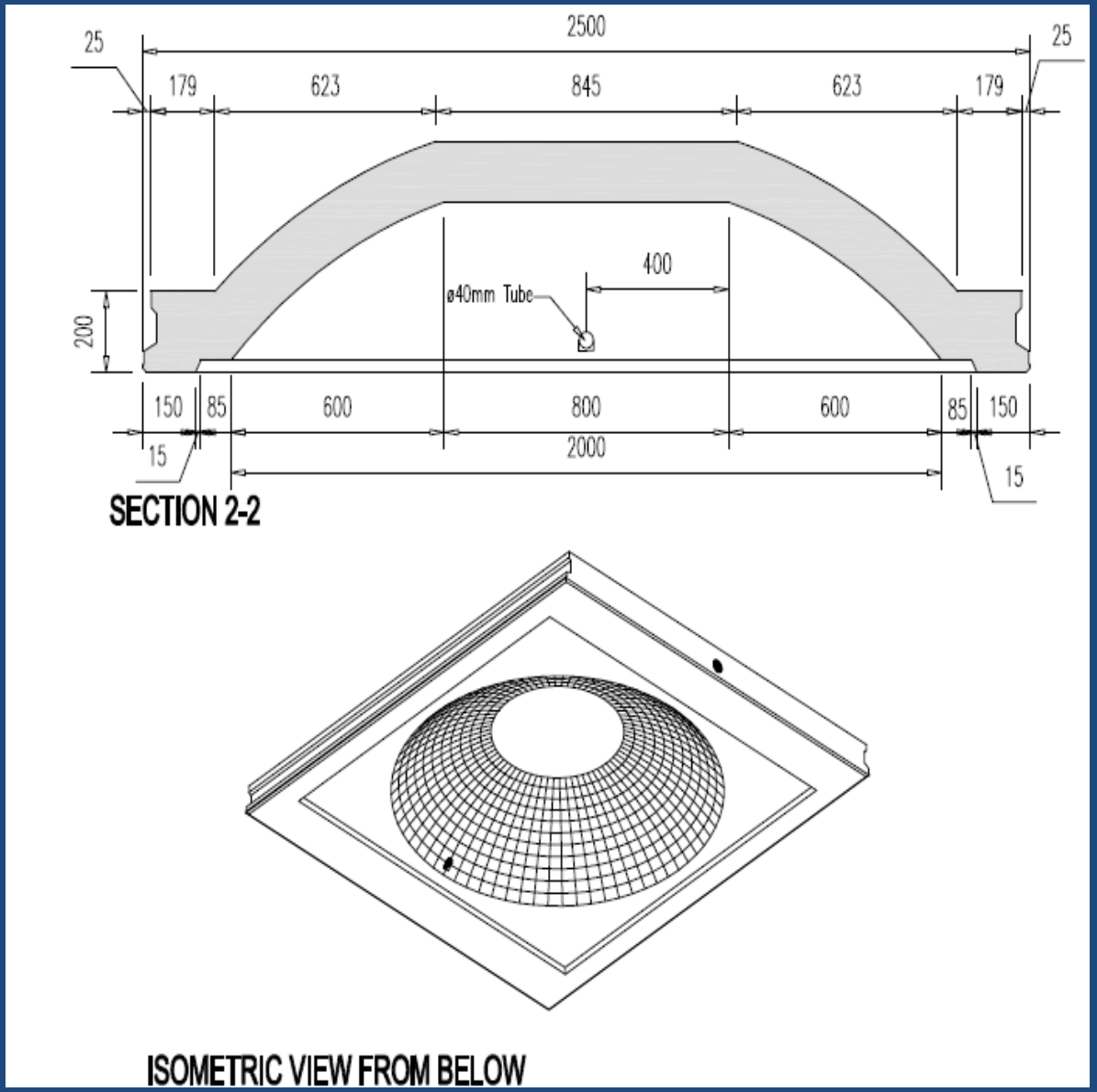


Coffered Concrete for Station Ceilings

- Curved coffers with lighting at top of curve
- Consistent profile set out in regular pattern-high repetition in 2.5m square modules
- Fair and consistent finish is a contract requirement

Coffered Modules: Reasons for choosing precast

- High repetition
- Mould efficiency: Four moulds used at precast factory compared to 180 required for cast in place alternative.
- Consistency of finish and geometry.
- Capability to produce elements in advance of construction and store off site.
- Precasting allows for accurate incorporation of cast in items for lighting and services
- Congestion of reinforcement in insitu construction would have led to increased delay risk.
- Ability to reject panels prior to site delivery.
- Choice of precast was subject to approval of finish by Architect. A full scale mock-up was prepared at the precast yard prior to production.

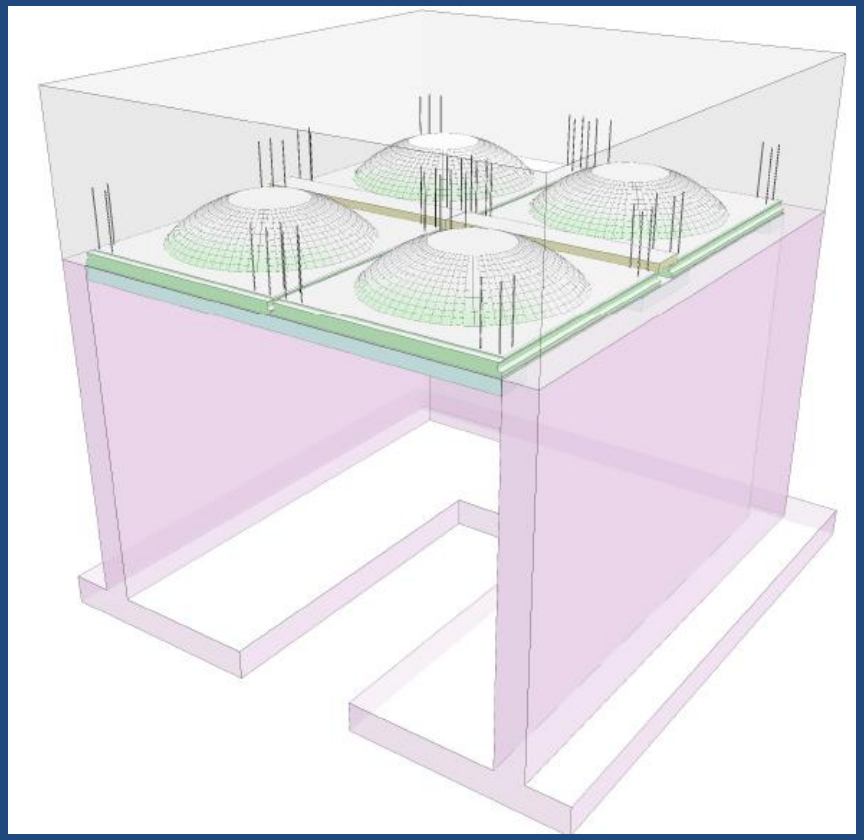


Precast Coffered Modules

Glass Fibre Mould

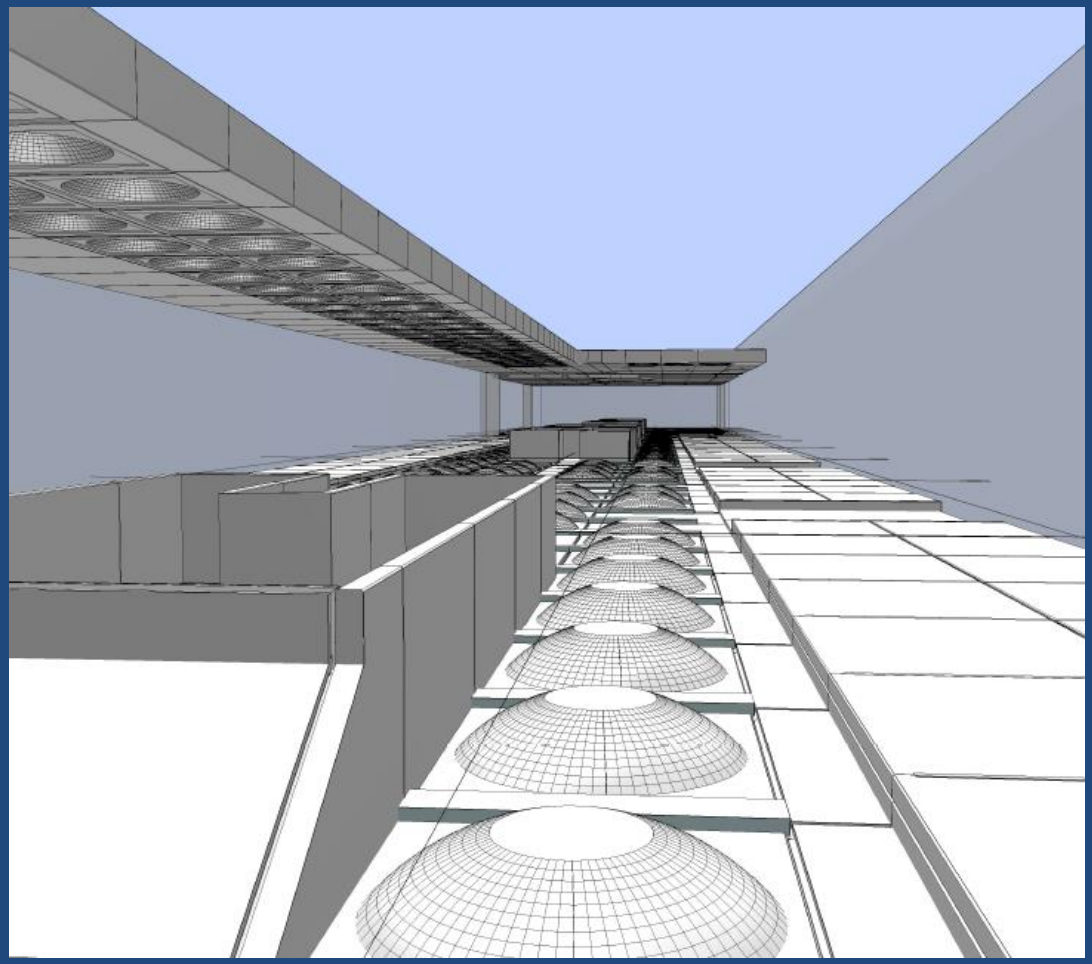
Precast Coffer Viewed from Below.

Coffered Ceiling Mock-Up



Coffered Ceiling Mock-Up

3D Modelling



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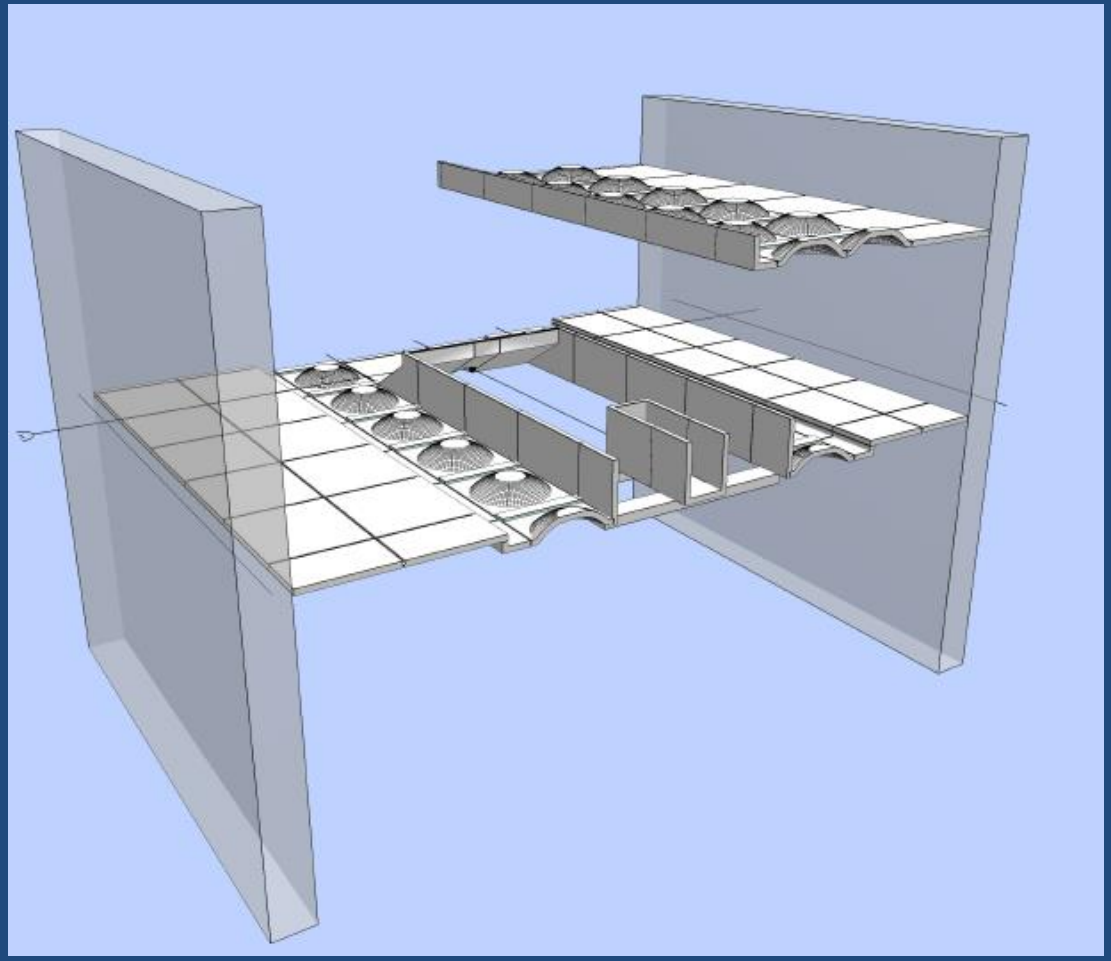
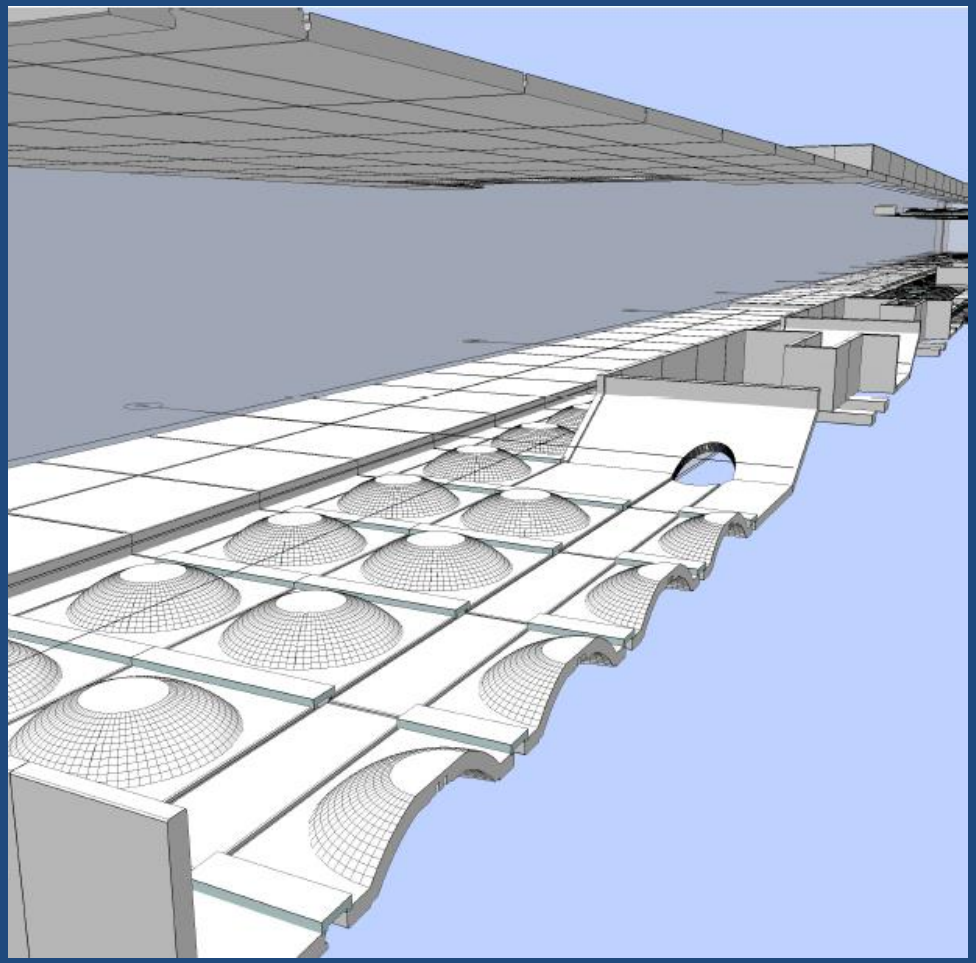
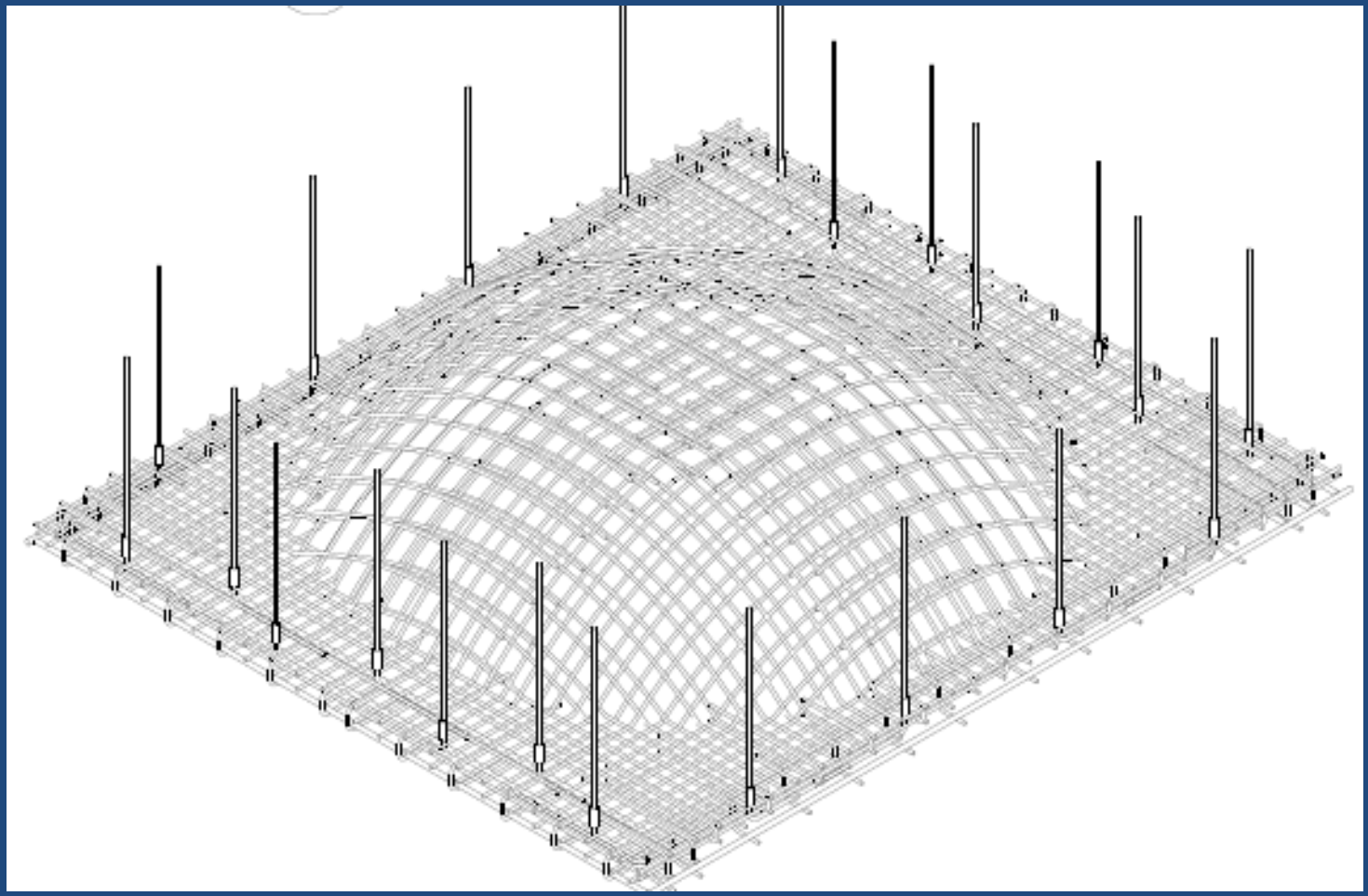


3D Modelling



3D Modelling: Reinforcement



Precast Element Design

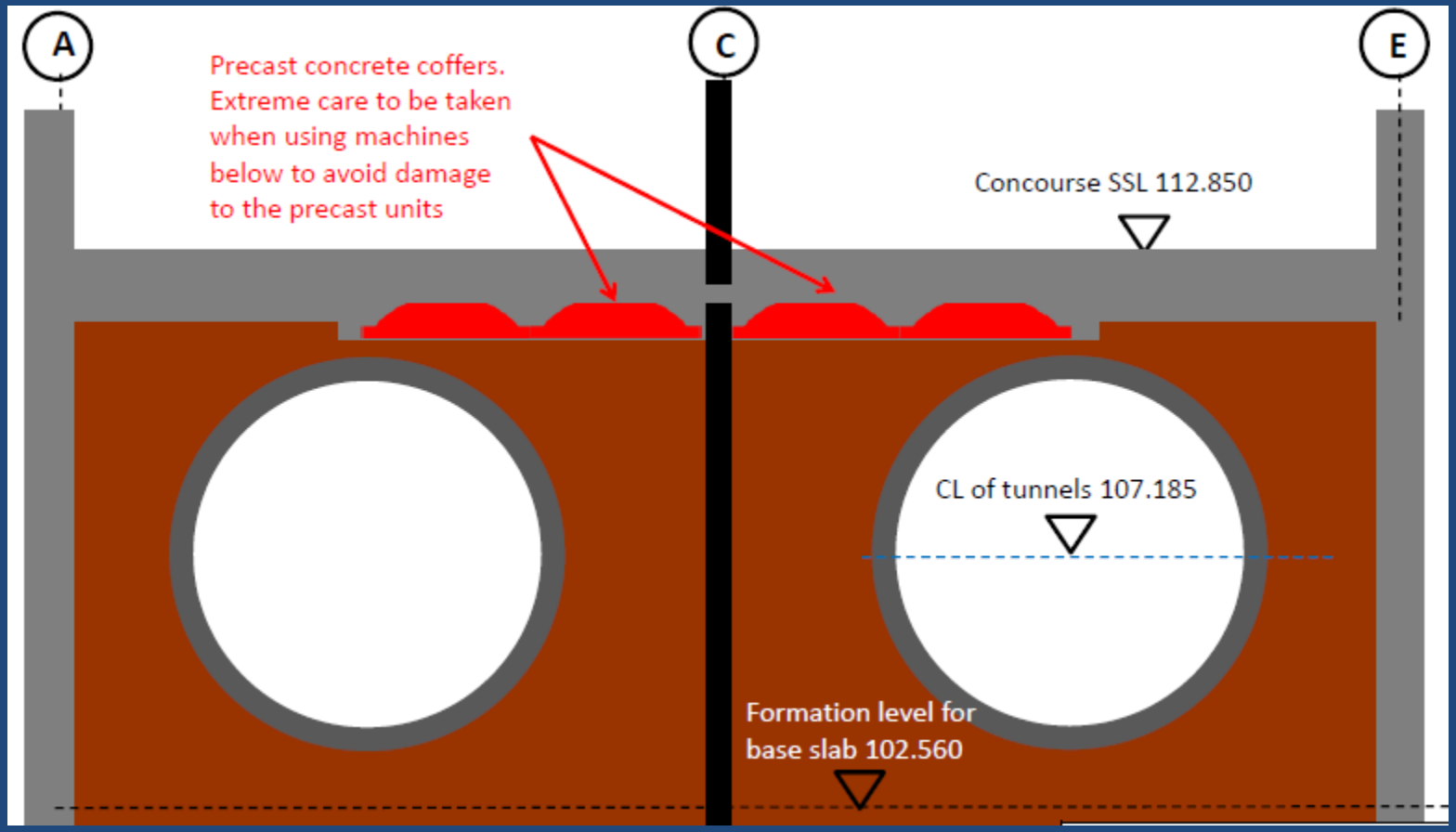
- Ceilings act as permanent formwork to support the structural slab self weight (Varies between 1200 and 1800mm deep).
- Have to resist blast loading.
- Analysed using finite element
- Subject to CAT3 check (Parallel design by another party using drawings only).

Construction

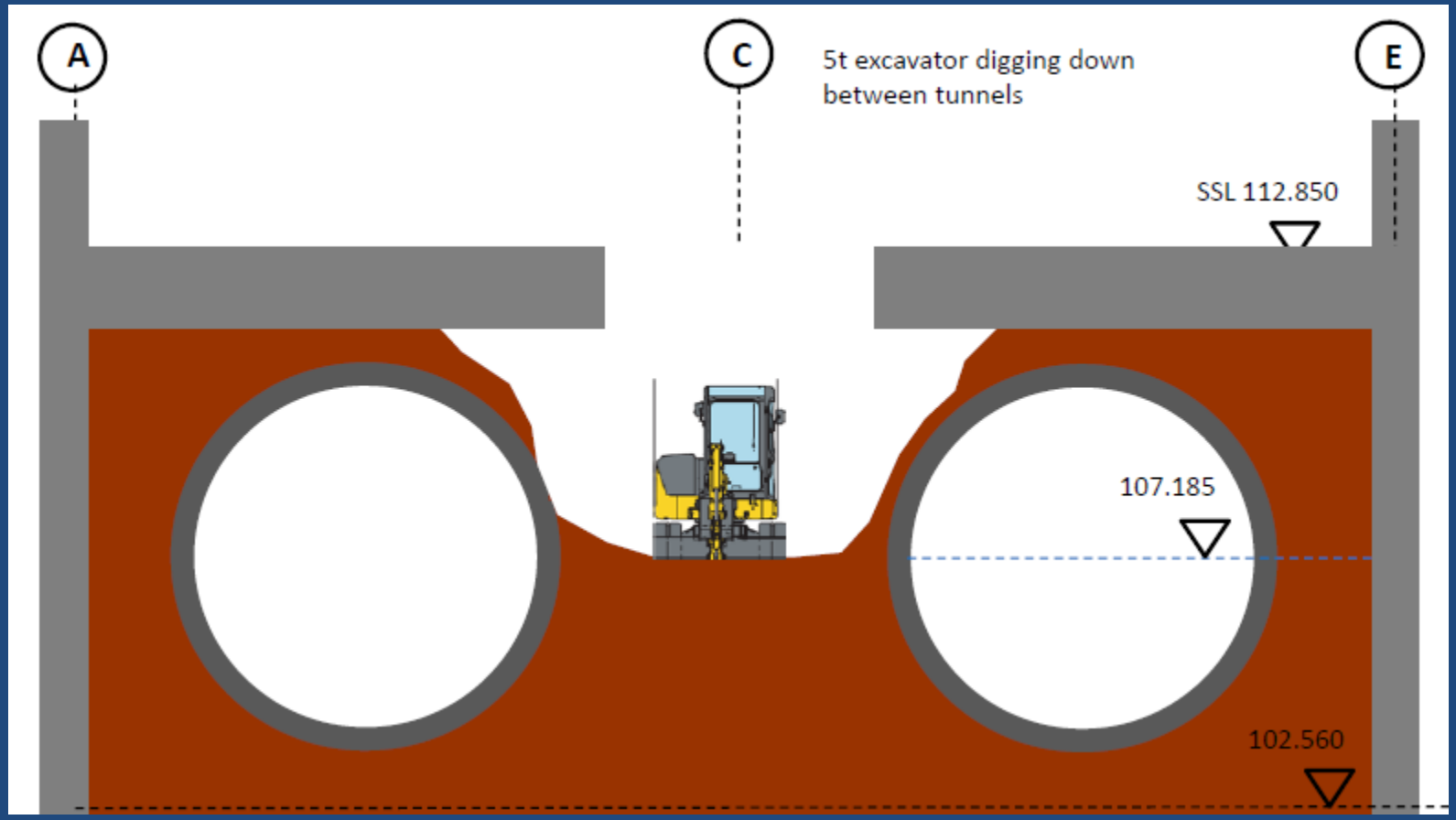
- **Top Down**:
- Construction commences at ground level: Precast elements are placed onto temporary bearing strips, the structural slab poured and the ground then excavated beneath the slabs. This sequence then repeats until track level is reached.

- **Distribution of Precast Units Below Ground Level**: Precast elements are lowered below ground level through “mole holes” and then distributed horizontally using a gantry crane system.

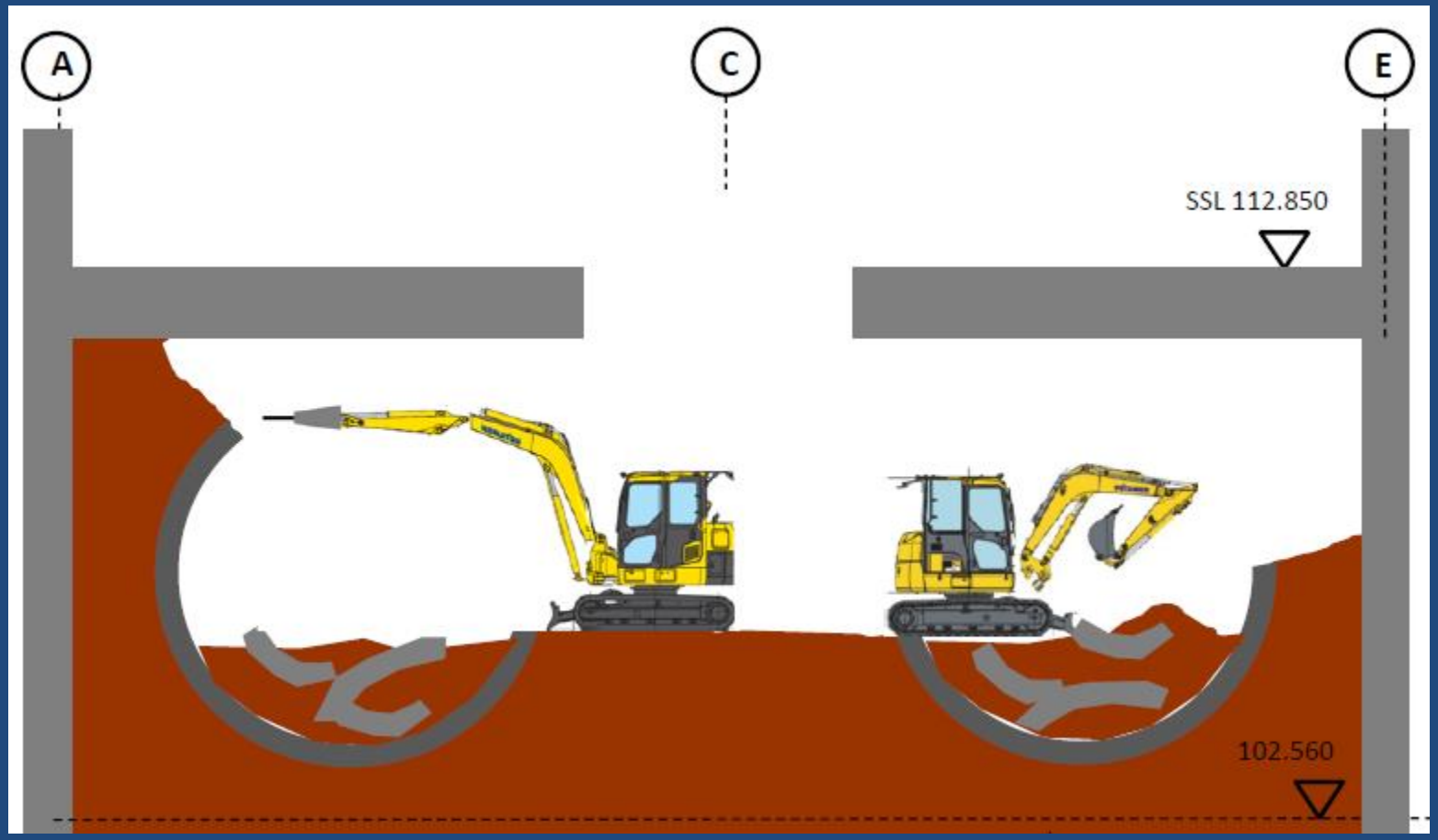
Top Down


A
C
E
Precast concrete coffers. Extreme care to be taken when using machines below to avoid damage to the precast units
Concourse SSL 112.850
CL of tunnels 107.185
Formation level for base slab 102.560

Top Down


A
C
E
5t excavator digging down
between tunnels
SSL 112.850
107.185
102.560

Top Down



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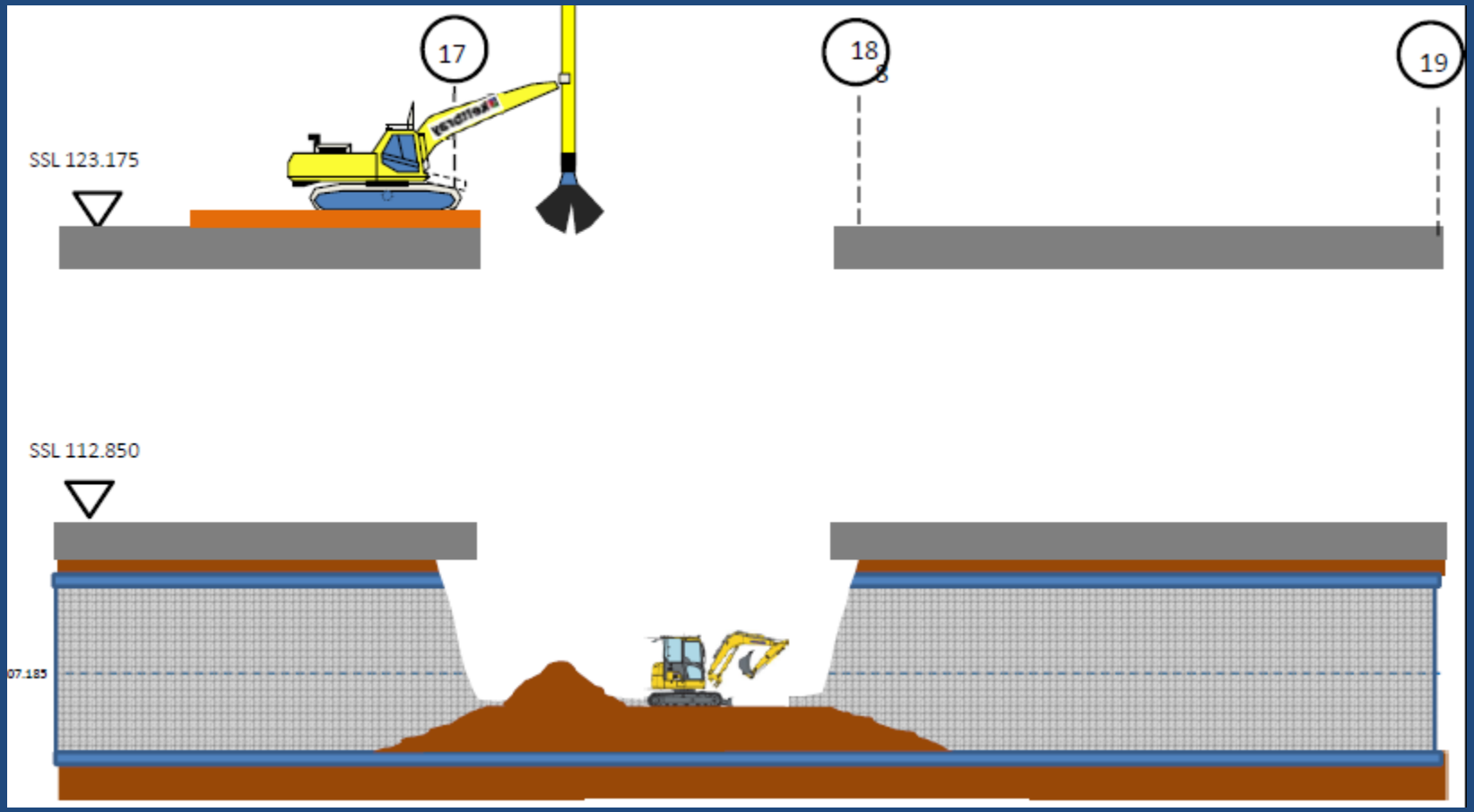
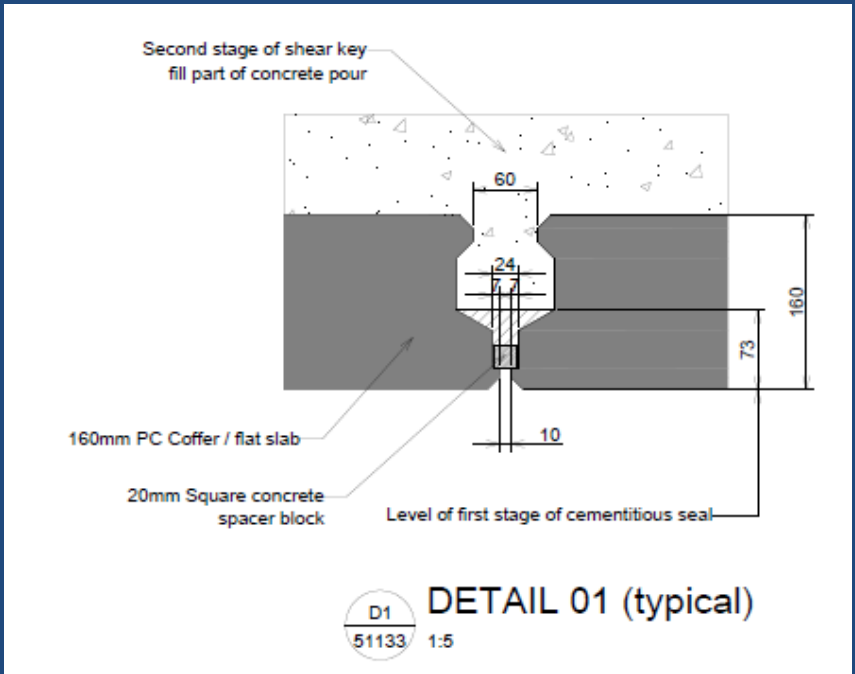


Lifting Coffer Elements

Precast Elements on Temporary Bearers

Panel Joints



Reinforcement Fix Over Coffers

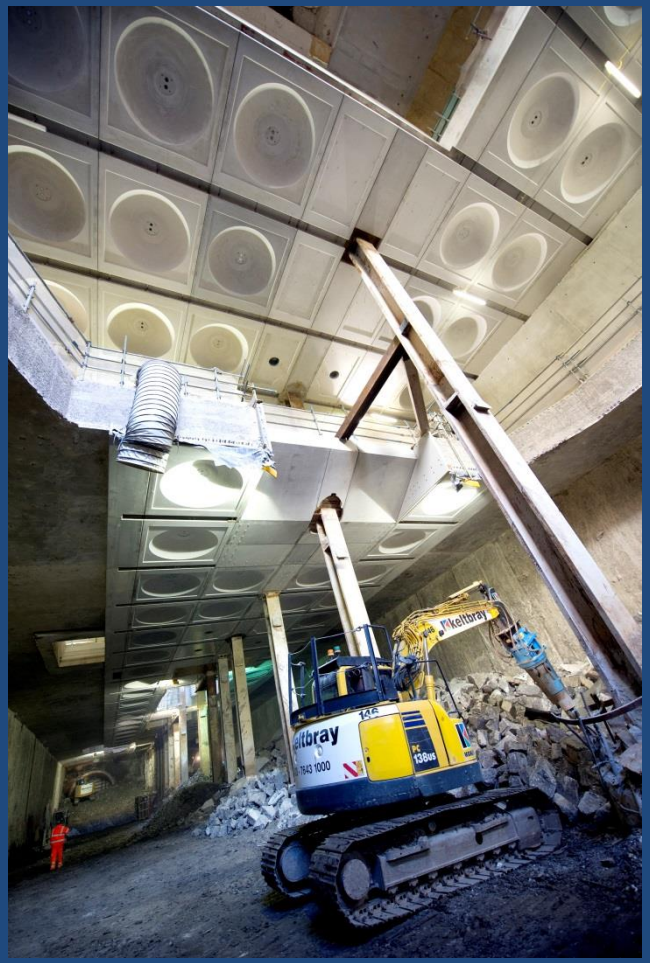
Reinforcement Fix Over Coffers

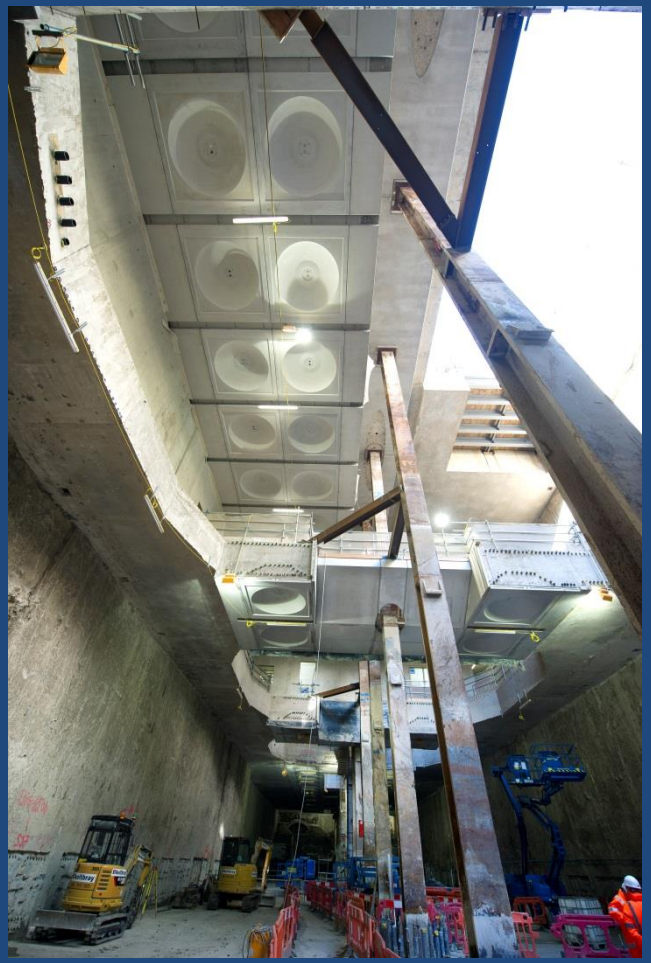
Excavation at Track Level

Three Levels of Precast Concrete Exposed

Exposed Coffers at “Mole Hole”

Concourse and Intermediate Ceilings Exposed





Remaining Precast Concrete

- Elements to close “mole holes”
- Platform permanent formwork
- Lift shafts and stair cores (Last items as built conventionally)