

COLNE VALLEY VIADUCT



SUSTAINABILITY AND REGENERATIVE DESIGN CASE STUDY

The Colne Valley Viaduct is a key landmark structure on the High Speed Two (HS2). The design for the 3.4km-long viaduct celebrates the architecture of engineering with a structure that is expressive of power, speed and function. The viaduct has been designed to meet demanding technical, environmental, and operational requirements.



Grand Union Canal View ↑

Location: Colne Valley, UK
Completion: 2025
Client: HS2 LTD
Contractor: Align JV (Bouygues, Sir Robert McAlpine, and Volker Fitzpatrick)

Design Team: Align-D
Rendel/Ingerop (Structural Engineers), Jacobs (Engineers) Grimshaw (Architect), LDA Design (Landscape Architect)

HS2 is a new high speed railway linking London, the midlands and the north, the Colne Valley Viaduct will be a key landmark of HS2 Phase 1 connecting London and Birmingham. It is located in both South Bucks District and the London Borough of Hillingdon, crossing through the Colne Valley Regional Park and continuing into a tunnel under the Chilterns. Construction of the viaduct was completed in 2025 and ultimately, is planned to be operational from 2029.

The Colne Valley Viaduct is highly responsive to the character of the Colne Valley. Structural spans and pier forms vary as the viaduct passes through a mosaic of lakes and woodland. Over water, extended structural spans of 80m open up the space below the structure, enabling panoramic long-distance views to the landscape beyond. The viaduct requires fixed buttresses to transfer train braking loads into the ground and portals to allow thermal expansion at regular intervals. These have been strategically located at key site features within the Colne Valley. Great care has been taken to express these essential buttresses and portals as visibly special structures, unique to their function and location.

Structural Efficiency:

High speed trains travelling at up to 320 kmh generate substantial structural loads. A key challenge for the viaduct design has been to accommodate challenging engineering demands while minimising the scale of the structure and reducing impact on the local environment. The design has sought to minimise the quantum of concrete and steel by optimising structural efficiency and using faceted forms to shape the structure. The common design language of faceted forms has reduced the volume of concrete required to support the deck above. As a result, embodied carbon has been reduced by over 60%, from a baseline of 195,194 tCO₂e to 77,006 tCO₂e at completion. The structure has been designed to achieve a 120 year design life. To achieve this, all materials specified are self-finished to maximise robustness and durability, while avoiding the requirement for long term maintenance or replacement.

Optimised Construction:

The Colne Valley is a sensitive landscape which has significant environmental considerations including Ancient Woodland, SSSIs, and multiple water-bodies. As such, a variety of sustainable design strategies have ensured impacts on local communities and the environment are minimised.

A key design focus has been to reduce the width of the structure and its construction corridor as far as possible in order to minimise land take. This has limited the impacts on the local environment, substantially reducing tree loss including the avoidance of nearby Ancient Woodland. The construction methodology for the viaduct has been developed in parallel with the design, ensuring buildability is optimised and impacts on the local environment are minimised. Precast concrete deck segments are transported and installed from north to south using a launching girder, minimising construction traffic on local roads and the required construction area. A cantilevered construction method allows the deck to be installed at high level between each pier, reducing disruption to local roads and waterbodies that the structure crosses.

Improving Local Accessibility:

The landscape design meets strategic place making objectives by responding positively to the character of the area and contributing to local distinctiveness. A key design strategy has been to increase accessibility to the Colne Valley Regional Park, promoted through enhanced recreational routes and the introduction of new footpaths. The landscape and ecology proposals conserve as much of the most sensitive habitats close to the viaduct as possible. The design establishes new landscape and wetland features, introducing habitats which have been lost in the Colne Valley.

Designing for Resilience:

Large areas of the Colne Valley are within flood zones. The viaduct design response respects the watercourses, providing a railway that is resilient and does not increase the risk of flooding to other locations. Significant flood attenuation areas have been incorporated within the landscape design, creating substantial wetland areas that contain numerous ephemeral waterbodies, wet grassland, and larger balancing ponds.

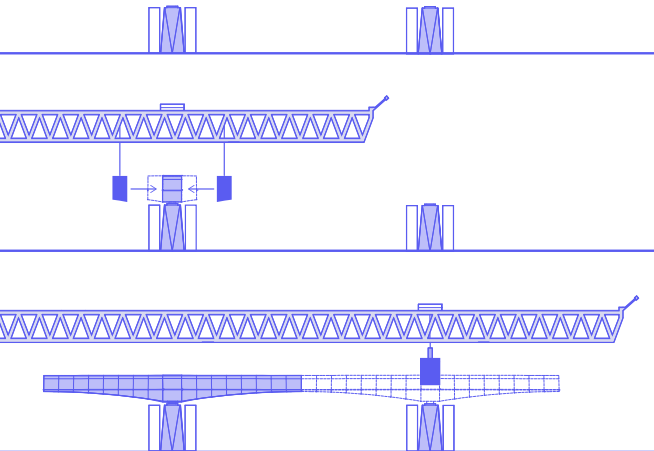
Effective Stakeholder Engagement:

Throughout the design process we worked closely with key stakeholders to seek views and ideas to inform design of the viaduct and associated landscape. Align held, a programme of public events which engaged with the local community early in the design process up until the Schedule 17 requests for approval were submitted.



Faceted Form and Family of Components ↑

All components have been designed using a common design language to ensure the viaduct is recognisable as a single, coherent structure wherever it is experienced in the Colne Valley. Curvature is only used in the haunched deck profile, where as all other structural components are characterised by faceted forms and defined edges. These folded planes and straight edges characterise the form, alongside textured concrete has been selectively applied to locations where the structure meets the ground.



6 ↑ Precast Deck Cantilever Construction Method

Key Sustainability Facts

PROJECT SITE

> Colne Valley Regional Park, Multiple SSSIs and Nature Reserves

EMBODIED CARBON

- > Embodied carbon reduction of more than 60%, cutting emissions from 195,194 tCO₂e to 77,006 tCO₂e. Total saving of 118,188 tCO₂e.
- > Construction methodology - 70% reduction of 480 tCO₂e.
- > Sustainable construction materials - 46% reduction of 35,166 tCO₂e.
- > Deck segment redesign - 34,361 tCO₂e reduction.
- > Noise barrier redesign - 29,610 tCO₂e reduction.
- > Piling optimisation - 5,855 tCO₂e reduction.
- > Additional design refinements - 27,694 tCO₂e reduction.

CERTIFICATION

- > **BREEAM Excellent*** for Infrastructure
*Achieved Excellent rating under the BREEAM Infrastructure Pilot Scheme, with an interim assessment already achieving an Excellent score of 78.7% and a potential final score of 97.93% expected to be confirmed in 2027.

Alignment with UN Sustainable Development Goals



SDG 3 GOOD HEALTH AND WELLBEING
The landscape design delivers distinctive and accessible green spaces that encourage pedestrian access.



SDG 9 RESILIENT INFRASTRUCTURE
The Colne Valley Viaduct has been designed to last at least 120 years and to withstand future climate change.



SDG 13 CLIMATE ACTION
Carbon footprint has been reduced through concrete efficiency and cement replacement restoration.



SDG 15 SUSTAINABLE ECOSYSTEMS
An integrated landscape and ecological design optimises biodiversity through nature conservation, recovery and habitat creation.



Axonometric diagram ↑

- Optimised Structural Efficiency** – A fundamental design principle for the viaduct has been to reduce the volume of concrete required wherever possible by maximising structural efficiency. The variable depth box girder deck locates the majority of structure directly below the track, resulting in a more direct transfer of load to structure below. By optimising structural efficiency, less concrete is required within the viaduct deck, resulting in a structure with less visual mass at deck level and a reduced deck width.
- Alternative Materials** – The weight of the deck has been further reduced using lightweight ultra high performance concrete (UHPC) parapets and a noise barrier system comprising aluminium acoustic cassette and transparent acrylic panels.
- Faceted Form** – Concrete forms have been carefully crafted and faceted to reduce visual bulk to achieve a refined and elegant profile. This common language has minimised the volume of concrete required to support the deck above
- Re-use** – The pier geometry was designed to enable the reuse of formwork, significantly minimising material usage. Furthermore the constructed haul roads will be re-used (including retention of base course materials) to provide multi-functional maintenance and recreational routes along the viaduct.
- Comfort / Natural Daylight** – When travelling between London and Birmingham, opportunities for natural daylight and long distance views for train passengers are limited. Therefore, wherever possible, transparent acrylic panels have been incorporated within the 4m noise barriers to allow passenger views over the landscape. To enable the use of transparent panels, the noise mitigation performance of the barrier is optimised wherever possible. To mitigate the risk of bird and bat collision with trains, the noise barriers provide effective enclosure whilst the transparent panels incorporate black lines to ensure they remain visible to flying birds.
- Construction Methodology** – In order to minimise the impact on local communities and the environment, the precast deck segments will be cast on site and transported via a launching girder from the north of the site. They will be constructed piece by piece from high level using a cantilever construction method, resulting in less impact on the local environment. The impact on local roads is also reduced with the equivalent of approx. 4000 lorries diverted from local roads via a designated construction corridor including four jetties and haul road. This construction method also enables the structure to be built over rivers and roads without major impact.
- Sustainable Construction Materials** – The design team have reduced the carbon footprint of the Colne Valley Viaduct through the replacement of cement with ground granulated blast furnace slag (GGBS). This resulted in a 46% carbon reduction to 35,166 tCO₂e. Where possible, the aggregate used in the concrete mix is locally sourced to minimise carbon impact associated with transporting materials.
- Accessibility** – This will include provision of 3.5km of new active travel routes which are fully connected to the surrounding rights of way network and opportunities to interact with nature within a range of environments. The network of new recreational routes will open up previously inaccessible areas of the Colne Valley Regional Park to the local community.
- Enhanced Landscape and Ecology** – Strategies have been integrated to enhance the ecological baseline of the site. Through localised reversion of species-poor agricultural pasture to a mix of wetland, rich grassland, scrub and woodland. All site soils and substrates have been reused with profiles matched to the target habitat types. The ecological design optimises habitat creation to help deliver local nature conservation objectives.