Steel supports over-station offices

The steel frame adjacent to the six-storey Crossrail box was one of the initial parts of the building to be erected.

Forming a bridge over underground railway assets, a series of large steel trusses are enabling the construction of a new City of London commercial development.

The market for new modern office space in the City of London shows no sign of abating and as available plots are at a premium, over-station developments (OSD) offer a solution.

Construction works associated with the recently completed Elizabeth Line have resulted in a number of opportunities for new offices, sited over ticket halls and station entrances.

A similar type of scheme is taking place at 1 Liverpool Street, where a 10-storey commercial building is under construction. It sits adjacent to the Elizabeth Line Station entrance, and spans over the Metropolitan and Circle Lines as they enter Liverpool Street Underground Station.

As well as these railway lines, the scheme also sits directly over the much deeper Elizabeth Line tunnels, wraps over a six-storey high Crossrail box (ventilation shaft), and has to span over various other contemporary and historic infrastructure.

1 Liverpool Street is the latest steel-framed building to be built in the area, complementing the ongoing and nearby Broadgate redevelopment.

With so much to build over and incorporate, what would ordinarily be a busy centre city project, is now a complex and challenging development.

Mace Project Director Jonathan Emmines, says: "On this scheme we have to bridge over live railway tracks, while also considering and protecting other subterranean assets, such as a ticket hall and service corridors. We are only able to achieve this via a series of large steel transfer structures."

Making sure no vibration is transferred from the live railway into the new office building is another important design criteria. This has been solved with a series of isolation bearings, placed under every column and truss at ground floor and level one.

Incorporating numbers 1-14 Liverpool Street and 11-12 Blomfield Street, early works for the development included the demolition of the existing buildings. This programme had to work around the ventilation shaft and a substation, with these structures remaining in place, as the new steel-framed building is being erected over and around them.

"As the new building abuts and spans over the ventilation shaft, it derives some support from the structure. Consequently, the design had to ensure the loads on the shaft were not exceeded," explains Robert Bird Group Operations Director Europe, Simon Cloherty.

Following on from the demolition and keeping the overall construction programme on schedule, an enabling works package, which is primarily forming a two-level basement along the north

FACT FILE
1 Liverpool Street, London
Main client: **Aviva Investors**
Architect: **Eric Parry Architects**
Main contractor: **Mace**
Structural engineer: **Robert Bird Group**
Steelwork contractor: **William Hare**
Steel tonnage: **4,000t**

side of the site (the ventilation shaft prevents this subterranean work on the south side) is taking place simultaneously with the steel erection.

To facilitate both packages happening at the same time, the site is divided in half, with the steel frame initially going up on the south side and enabling works proceeding on the north. One of the main challenges of the project was coordinating the permanent as well as temporary work design alongside the third-party interface coordination, given the location of the project.

A holistic design approach was adopted, with the structural steel developed to suit the crane strategy on the project. One tower crane sits on an existing London Underground foundation, while the team had to develop a cantilever grillage for another tower crane to avoid overloading the foundations and ensure structural stability of the new structure.

All site work had to progress in line with London Underground and City of London Corporation standards, with 24-hour monitoring of existing assets. More than 11,000 monitoring instruments were installed within the site.

Once the steel frame erection has reached level eight, the basement works will have been completed, and the steelwork team will be able to take possession of the north side. In this way, there will be no break in the steel package, and the erection will then proceed with the remainder of the structure.

With so many assets below the new building, designing the foundations has been another challenge. There are limited areas for new supporting foundations, but in some locations new piles have been installed, threaded between the various assets, down to a maximum depth of 46m.

As the new piles are not sufficient to support the new build on their own, some of the existing foundations from the previous structures are also being reused.

On such a busy and challenging site, removing the old foundations was not an option, so after an in-depth validation exercise, it was confirmed there was sufficient load capacity for some existing piles to be incorporated into the new scheme.

Even with the combination of new and existing foundations, the support points for the new building are still limited. The design solution for this, is a series of nine 4.5m-deep trusses, positioned at first floor level, that create a large bridge over the various assets and support the columns for upper floors of the office block.

As the site is surrounded by busy City of London roads, offering little room for manoeuvring large loads, the trusses have to be delivered in sections. The majority of them are then assembled on the ground, before being lifted into place as a complete piece.

However, as the site is confined and very busy, some of the trusses have had to be installed in sections, with the bottom chord installed first, and the rest of the steelwork fitted afterwards.

The trusses create useable first floor space, as within their depth they will accommodate offices and utility areas, including meeting rooms and a cycle store.

Working above live TfL infrastructure has also had a bearing on the construction programme and its working hours, as William Hare Project Director Francisco Loureiro, explains: "As some of the steelwork has been erected directly over the railway lines, this work had to be scheduled around when underground trains are not running and installed between 1am and 4am."

This overnight work has included the installation of a series of plate girders, measuring up to 15.4m-long, that span directly over the underground lines forming the floor of the lowest basement level. They also create a deck that allows work to proceed above the live railway.

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Above the first floor, there are three further trusses that form a 6.5m-long cantilever, starting at the underside of third floor, on the building's north east corner. This part of the structure cannot be supported by any columns because it spans over the aforementioned substation.

The southeast section/elevation of the building cantilevers over the Circle, Hammersmith and Metropolitan lines. This part of the building is supported by trusses installed at levels one and three.

Aside from the cantilever, the upper floors of the building are based around a regular column grid pattern. All levels are formed with cellular beams supporting metal decking and a concrete topping to form a composite flooring solution.

Adding some architectural interest to the building, at level eight, the structure steps in, forming a mansard with a series of sloping perimeter columns. Further steelwork forms two plant decks that top the structure.

Aiming to achieve a BREEAM 'Outstanding' rating, sustainability is at the forefront of the building's design. Fully electric in operation, 1 Liverpool Street is set to achieve significant energy and carbon savings throughout its lifespan – saving an estimated 110 tonnes of carbon per year.

Carbon savings will be achieved through a range of measures including meeting the building's heating and cooling demands through air source heat pumps, triple glazing, high-efficiency chillers and energy-efficient lighting.

The project is due to complete in January 2026. ■

A series of large steel trusses form a bridge over many of the underground assets that sit below the project.

The completed building will benefit from its proximity to the Elizabeth Line.