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Architect:	**Hodder Associates**
Structural Engineer:	**Ove Arup & Partners**
Steelwork Contractor:	**Watson Steel Ltd**
Main Contractor:	**Bovis Lend Lease Ltd**
Owner:	**Manchester City Council**

Corporation Street Footbridge, Manchester

Corporation Street's new footbridge is an important milestone in the rebuilding of Manchester City Centre, the original bridge having been severely damaged during the terrorist bomb blast of June 1996. The new bridge provides an enclosed link between the new flagship Marks & Spencer store and the greatly enhanced Arndale Centre, and is the result of a design competition devised by the City Council.

The bridge's tubular form represents a significant and exciting addition to the current trend in bridge design for ever more adventurous structural solutions, in that the outer steel lattice structure is both the primary spanning medium and the cladding support framework. There are no hidden main girders. The primary structure consists of a welded frame of nine perfectly straight 114mm diameter tubes with the curved hyperbolic paraboloid form being derived from the circular arrangement of these tubes around a central horizontal axis. This horizontal use is believed to be a first in footbridge design.

Alternating with the 114mm diameter tubes are an equal number of 28mm diameter tension rods which contribute to the overall stiffness of the bridge as a result of their prestress. The level of prestress has been set so that no design loading conditions result in a stress reversal in any of the rods. This again represents an innovative use of materials rarely seen in modern construction, and was made possible by the use of the advanced computer analysis techniques used in the design process. The alternate tube/rod/tube arrangement was in direct preference to the heavier and denser tube/tube/tube option, and has the advantage of added architectural interest to the overall form of the structure. Several alternative joint details were considered for the tube/tube connections of the primary grid. These included castings, welded/bolted end plates, and fin plates welded into slots cut longitudinally within the tube side walls. All of these carried significant cost implications when compared with a simple profile cut and welded joint.

At each end of the centre section of the bridge there is a braced, double hooped collar to act as an anchorage for the prestressing rods and to transfer the loads to the supporting building frames. A bolted connection detail was developed at the collar/centre section interface in preference to a fully welded arrangement as originally conceived. This design allowed the bridge to be shop fabricated in three separate transportable sections and simply bolted together on site.

The structure of the internal walkway deck consists of steel joists spanning longitudinally onto steel crossbeams coincident with hoop frames located at alternate node points of the primary structure. The level of this walkway deck varies by some 1200mm along the length of the bridge. This is cleverly accommodated within the confines of the primary structure that is, as stated earlier, horizontal. This change of deck level,

whilst maintaining a horizontal appearance was fundamental to the design brief set by Manchester City Council. The retail floor levels at each end could not be altered.

There are eight circular hoops (two in each collar and four in the centre section) which perform important roles in restraining the primary structure against buckling. Minimising the visual impact of the hoops was important in achieving the right visual hierarchy of bridge elements. The sympathetic answer was a value engineered H profile machined from a solid 75 x 75 steel billet.

The design brief required that the new bridge be fully enclosed in order to protect transient shoppers from the Manchester weather. This has been achieved by glazing the centre section and cladding the end collars with decorative ribbed open mesh grilles enclosing a weather tight membrane inner layer.

The principal cladding challenge lay with the centre glazed section. Here cast stainless steel discs have been fitted to the primary structure nodes. Each node supports an outer disc with a corresponding inner disc and central securing bolt. Between the two discs there is a 'sandwich' of six glass panel corners. The aesthetic key to this method of fixing was to ensure that the discs were not overly large leading to an overall 'polka dot' type appearance which would compromise the otherwise linear structural form. The problem was further complicated by the differing performance requirements for the glass above and below deck level. Above the deck the usual wind, snow and self-weight loading conditions governed the design. Below deck, access for maintenance introduced a further more onerous loading criterion. The solution in both situations was the use of silicon jointed laminated glass, with thicker, stronger panels for the below deck area. An additional requirement was that of inherent residual strength deemed necessary in the unlikely event of panel breakage. It was decided that from a health and safety perspective that an individual glass panel should not be allowed to drop out of its fixings. This was achieved by the innovative use of a drawn polyester interlayer developed originally for use in glazing designed to withstand flying debris during hurricane conditions. Projecting tabs of interlayer fabric have been designed and detailed to be clamped within the cast steel fixing plates. These provide a positive fail-safe fixing for each panel, even if the glass is completely fractured.

Corporation Street Footbridge has set new standards of structural and façade engineering in urban footbridge design. Innovative techniques range from the use of prestressed steel to form the hyperbolic paraboloid primary structure, to the incorporation of state of the art glazing materials used to ensure public safety in the event of glass panel failure.

Judges' comment:
A unique solution to provide pedestrian access across one of Manchester's busiest streets. With a combination of straight tubes and pre-tensioned rods meshing together to provide an elegant lightweight framing it appears to defy the misalignment between the linked buildings.