FACT FILE
Shipyard, Glasgow
Main client: **BAE Systems**
Architect: **Corstorphine & Wright**
Main contractor: **McLaughlin & Harvey**
Structural engineer: **Robert Bird Group**
Steelwork contractor: **Severfield**
Steel tonnage: **6,000t**

Shipyard expansion launched with steel

A series of 80m-long steel trusses form the necessary column-free internal space for a large manufacturing hall that will transform and enhance shipbuilding on Glasgow's River Clyde.

Structural steelwork is playing a leading role in the construction of a large ship build hall at one of BAE Systems' Glasgow shipyards. On completion, it will enable efficient and safe shipbuilding for decades to come.

The company has secured a contract with the Ministry of Defence to build a total of eight Type 26 frigates and new facilities that are needed. To this end, the new hall, which measures 170m-long × 80m-wide and stands 45m-tall will be big enough for two frigates to be constructed side-by-side.

The structure will include two 100-tonne cranes and a further two 20-tonne cranes. The facility is designed to accommodate up to 500 workers per shift.

The project will help sustain an important Glasgow industry that once employed tens of thousands of workers and built some of the world's fastest and biggest ships. It is estimated some 25,000 vessels were built on the River Clyde and its tributaries since the first yard was opened in the early 1700s.

The steelworks of Lanarkshire supplied the material for the shipyards to build some of the world's most famous ships, such as the QE2. So renowned was the workmanship, the term Clyde-built was coined and used as a badge of honour.

BAE Systems runs the two remaining shipyards on the upper Clyde – the former Yarrow works at Scotstoun and the Govan yard, which was formerly known as Fairfield.

"We are the proud custodians of shipbuilding on the Clyde and our talented teams are working hard to build on that legacy to secure Glasgow's status as a shipbuilding centre of excellence for generations to come," says Managing Director BAE Systems Naval Ships Simon Lister.

"This new hall will give us some of the best facilities in the world and completely modernise our approach to shipbuilding. It, alongside the investments already under way to digitise our processes, will ensure our endeavour continues to be something that the City of Glasgow can be truly proud of."

Forming a key element of a £300M modernisation and digitalisation of the BAE Systems' River Clyde facilities, the ship build hall is being constructed by McLaughlin & Harvey, with Severfield fabricating, supplying and erecting 6,000t of steelwork for the large frame.

However, before the steel frame could be erected, an extensive preparatory works programme had to be undertaken.

"We initially had to make sure our site is a self-sufficient enclave, with its own secure fence all the way around. We then had to construct our own infrastructure and entrance," explains McLaughlin & Harvey Operations Manager Jonathan Cole.

"This has ensured that our workers and materials are not subject to security checks, which they otherwise would be if they were to use the shipyard's existing entrance."

The steel-framed hall has been erected over an

▸ 20

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The completed ship build hall at the Govan yard.

Royal Navy's new ships

The Type 26 is one of the world's most advanced warships. It is designed for anti-submarine warfare and high-intensity air defence, but can adapt its role quickly to transport humanitarian aid and house medical facilities. Steel was cut on the fourth Type 26, HMS Birmingham in April 2023 and work on the first three ships is already well under way.

First-of-class HMS Glasgow is currently at BAE Systems' Scotstoun shipyard having complex systems installed, HMS Cardiff is currently being assembled and HMS Belfast is in its early construction phase.

All eight frigates will be built in Govan and Scotstoun with the work sustaining approximately 1,700 jobs in Scotland with a further 2,300 jobs across the wider UK supply chain. ■

Construction work, including the steel erection, is progressing within a secure site, which is separated from the rest of the shipyard.

A confined site, means that all of the steelwork is erected from within the building's footprint.

Steel erection began at the southern end of the hall, with work then progressing towards the riverfront.

▸18 existing basin, which was filled with water. A stone bund was built across the entrance, it was drained and then infilled with approximately 220,000m³ of material.

Speed is of the essence for the project and the entire construction programme is just 118 weeks. The infilling part of the works was impressively completed in 22 days.

Helping to form the hall's foundations, a six-month long piling package was then undertaken. With up to 11 rigs onsite, 6,800 precast piles were installed.

Once the steelwork erection began, Severfield had up to seven cranes onsite, meaning coordination between various trades has been a key element in keeping the project on schedule on this busy site.

A series of 35m-tall lattice columns form the two main elevations of the hall. Sat on two 10m-high concrete walls, the 3.8m-wide columns, where brought to site in three sub-assemblies, each weighing 10t. They were spliced together in situ, while being lifted into place.

The columns support 18 roof trusses that create the required open-plan interior of the hall. The trusses are up to 4.5m-deep and due to their size, they are brought to site in five pieces.

The erection procedure for the trusses requires two cranes, one lifting two spliced sections and the other lifting three pieces, one of which incorporates the roof's central pitched apex.

The two truss sections are held in place while the connections are made to the perimeter columns and a central connecting splice is completed.

As well as the columns and trusses, the steel frame also includes crane beams, that run the length of the hall and support the facility's two 20-tonne cranes. The larger 100-tonne cranes are standalone units, independent of the main frame.

The southern end of the hall will have a 16m-high mega-door, to allow materials and components into the facility. Meanwhile, the entire northern end of the structure, facing the river, will be dominated by a vertically-opening giga-door. With no central support, it will be one of the largest such doors in the world.

Summing up, BAE Systems Type 26 Programme Project Manager Stephen Charlick, says: "The investment and construction of the new ship build hall in the Govan shipyard will provide the capability to construct two Type 26 frigates within a controlled, weathertight facility. Quality will also be improved, and each ship will be more materially complete before moving across to the dry dock in Scotstoun for test and acceptance. All of this will culminate in a quicker delivery of the Type 26 frigates to the Royal Navy." ■

Lattice columns

Do you require very tall columns with no opportunity for restraint in the major axis? – the new BAE Systems manufacturing hall in Glasgow showcases lattice columns as the solution. David Brown of the SCI encourages designers to consider this form of member.

When designing columns, intermediate restraints are beneficial in reducing the buckling length. If the columns are on an elevation, restraints to the minor axis are often possible – but what happens when the column is so tall that major axis buckling becomes critical and no standard rolled section has sufficient resistance? The new manufacturing hall at the Govan shipyard demonstrates the use of laced columns to resolve that design challenge.

Lattice columns commonly use two rolled sections for the chords orientated so that the major axis of each chord section is aligned with the minor axis of the compound section, increasing the resistance to minor axis buckling between restraints. In the major axis of the compound section, the distance between the two chords provides the section with a high second moment of area.

Just like any other section, initial imperfections and second-order effects must be managed within the design process. If a member – even a laced column – has an initial imperfection, when axial load is applied a secondary moment is introduced, causing more eccentricity. In the major axis, each chord member must be verified between restrained positions for the combination of the axial load due to this moment and the axial compression. In ordinary members, the shear stiffness is so high that the contribution of shear deformation to the deflection of the member can be ignored. The "web" of a lattice column is simply the diagonal members, so the shear deformation can be significant – it varies with the specific lattice arrangement.

The design of laced compression members is covered within clause 6.4 of BS EN 1993-1-1, which gives an initial imperfection of L/500 – which produces a moment from the axial compression – and a formula (expression 6.69) to calculate the axial force in a chord, including second-order effects. The expression may look involved, but it is simply amplifying the moment in the compound member based on the level of axial load and the shear stiffness of the lacing members. The moment is divided by the lever arm between the chords and combined with half the applied compression. The resulting design axial force in the chord can simply be compared to the design resistance of the chord section.

The new manufacturing hall illustrates an appropriate use of laced columns – very tall members where rolled sections are simply not capable, or they are very heavy. Despite laced columns being relatively unusual, they are straightforward and should be part of a designer's portfolio of solutions. Further guidance was published in *NSC*, September 2021. ■