REIDsteel

Dual Cantilever Hangar at London Biggin Hill Airport

LONDON BIGGIN HILL AIRPORT

BOMBARDIER

Civils
Construction & Property Solutions

REIDsteel

PROJECT BACKGROUND

London Biggin Hill is the fastest growing business airport in the UK with major investment transforming it into a world-class centre of aviation.

The iconic airport's most ambitious and technically challenging development yet is a spectacular dual cantilever 'super-hangar' for occupation by aerospace giant Bombardier. It is the UK's largest dual cantilever hangar and follows the same design philosophy as the Lockheed Hangar in Georgia which originally featured in the Building With Steel Magazine in 1968 and later issues of New Steel Construction.

Bombardier's prestigious structure would have been impossible to build within budget in any other material than steel – and it was achieved at the peak of the pandemic with all steel fabricated and erected in 2020 to 2021.

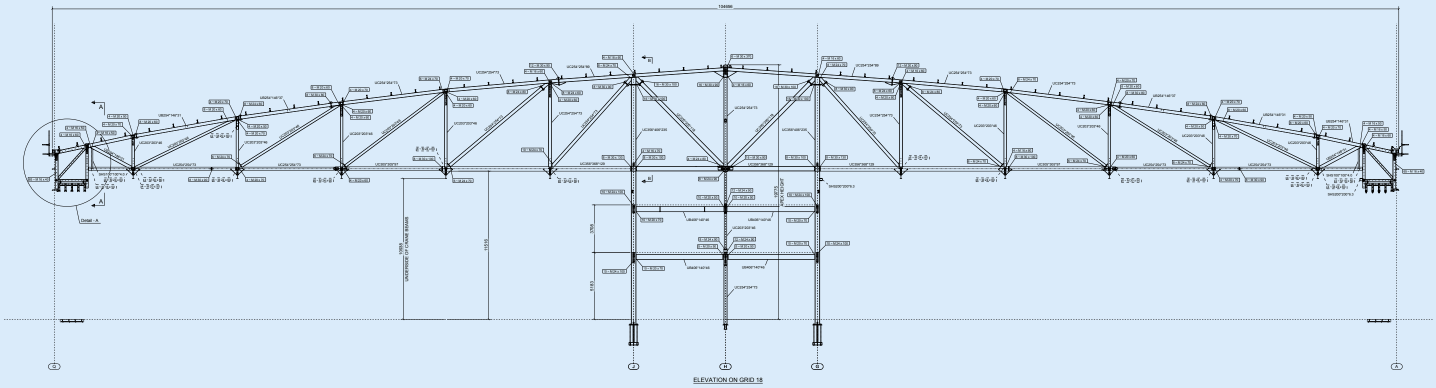
The Client's vision was for an advanced MRO hangar with two 160m clear span entrances and underslung cranes for servicing aircraft, along with offices and a VIP lounge.

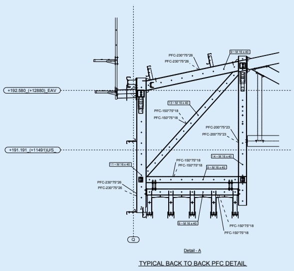
Early engagement of REIDsteel as the structural steel design and build fabricator, hangar door manufacturer and cladder was necessary given the need for elements to be erected and aligned on 45m cantilever trusses with requirements to accommodate complex hangar door head gear and underslung cranes – both of which required more stringent deflection criteria than usually anticipated on a large span structure.

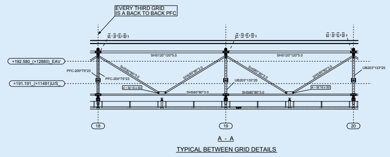
One year after celebrating 100 years in business, REIDsteel worked closely with Civils Contracting Ltd on the landmark development and were contracted to provide design, drawing, fabrication and installation of the complete steel frame, electrically operated hangar doors and underslung crane as well as the floor decking, cladding and glazing elements.

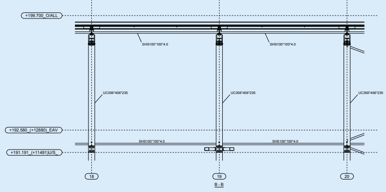
After investigating traditional hangar solutions, a cost-saving design was proposed which was highly efficient in its structural performance, with a cantilever truss design for the hangar, 'beam and stick' construction for the offices and an elegant, glazed lounge, which has minimal bracing by virtue of the diaphragm within its roof structure.

CANTILEVER DESIGN





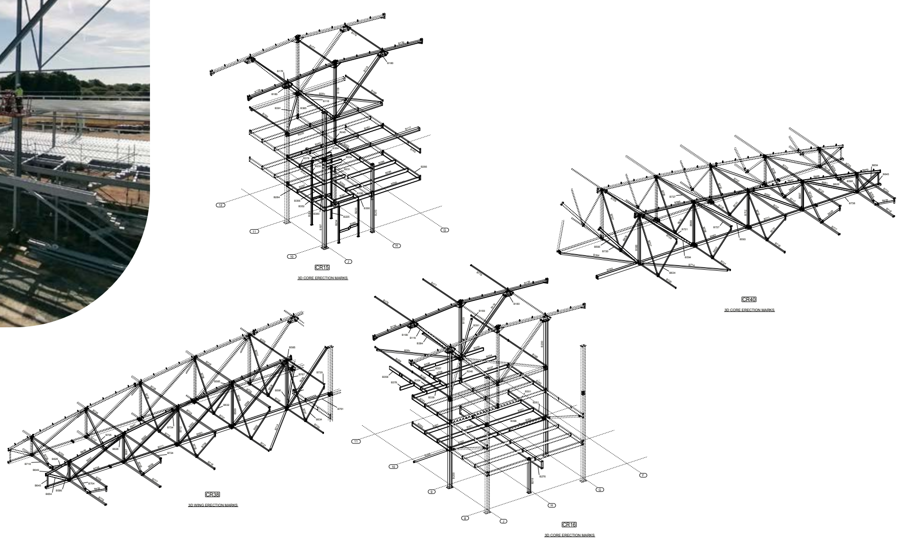




The value-engineered cantilever design, along with load sharing elements, allowed significant reductions in material use, producing a much lower tonnage than other concepts – eventually weighing 1,600 tonnes of steel for the structure overall compared with 2750T for more conventional designs.

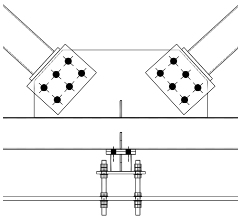
The design allowed the roof of the hangar area to safely span without support from internal columns to achieve the client's aspiration for two vast, unobstructed hangar floor spaces of 77,500 sq ft (7,200 sq m) each.

Long span cantilevers pose a unique set of technical difficulties - they are inherently vulnerable to disproportionate collapse due to the nature of the tension connections in the top chord. Furthermore,



the deflection limits were extremely tight on this project due to the presence of the underslung crane and bottom rolling hangar doors.

To alleviate this, load sharing trusses were put in place to ensure that each frame could be supported by its adjacent frames and to reduce differential deflections under crane and wind loads. This created a new issue, in that fabrication tolerances could cause a frame sitting higher than its neighbours to attract unacceptably excessive loads.



The solution to this lay in leaving the load sharing trusses 'loose' until all dead loads were applied. By using slotted HSFG connections to ensure that, under dead loads, the bracing in the load sharing trusses would be subject to zero initial axial load and not cause the previously erected frame to attract loads in excess of its capacity.

In addition, careful planning of the erection sequence and pre-cambering of the trusses was needed to take into account the temporary state where one side of the hangar was erected but not the other.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Through the design development process with the key stakeholders it was possible to provide additional floor area above the first floor offices which, although not part of the original brief, permitted additional space which has been used to good effect for all of the M&E equipment, plant and storage. As a result, the mass needed to counterbalance the cantilevers has been used for productive purposes rather than being buried in the ground as part of the mass foundations.

The office entranceway provided its own challenges. The brief called for raked, glazed façades on three sides with minimal bracing. To achieve this the roof was turned into a stiff diaphragm, transmitting forces back into the main structure. After this the only bracing required was some light stainless rods on one face to reduce deflections.

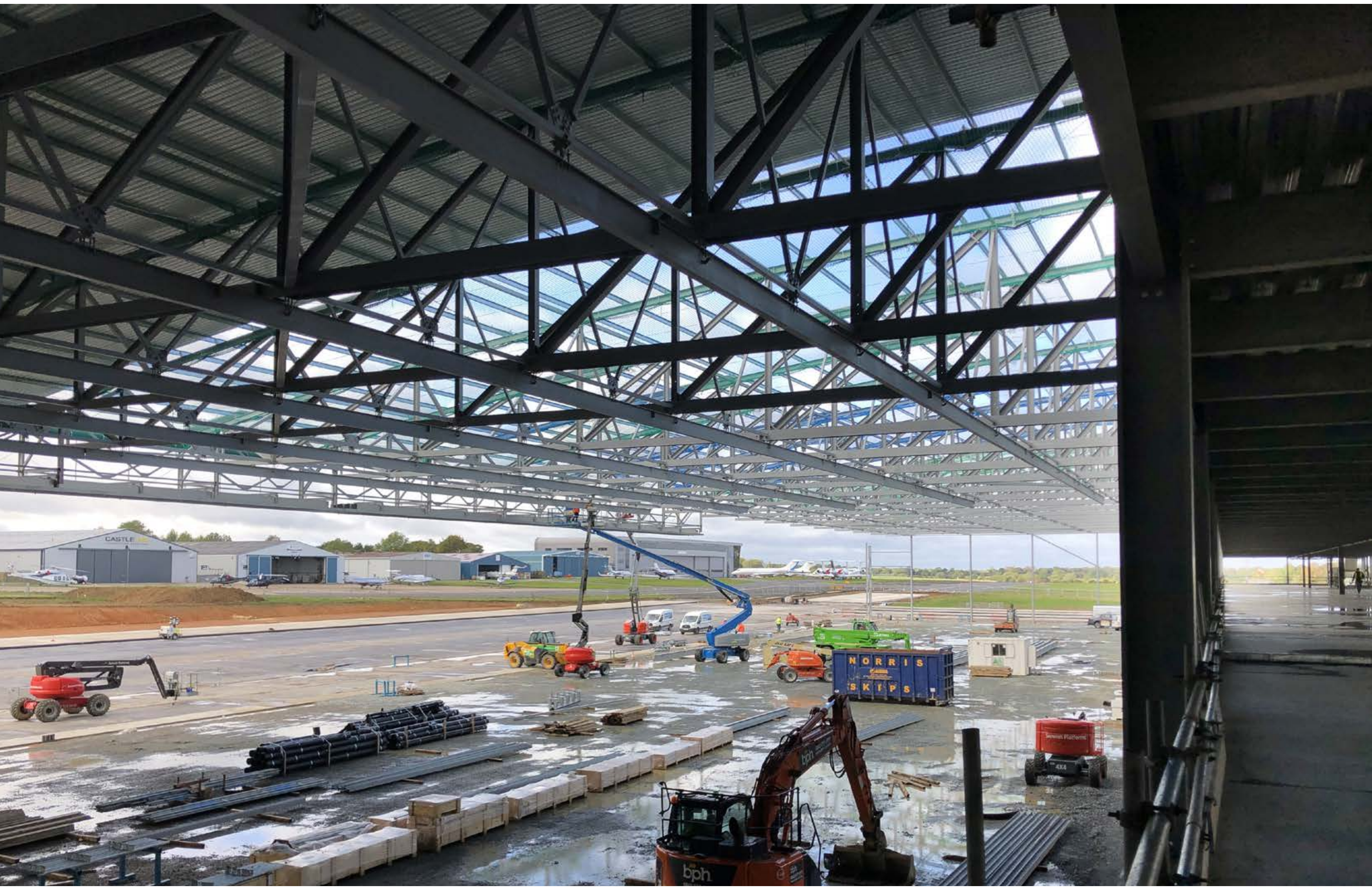
HANGAR DOORS AND INTERIOR

Being suspended from the five tie level beams, the roof's underslung crane required very tight tolerances in order to operate. Wind loads were checked with codes of practice, against full-scale testing and computational fluid dynamics to ensure that even with the 160m long rolling doors fully open the hangar would remain within tight deflection tolerances.

The client initially specified 50% coverage of one hangar for the underslung crane but, in accordance with the brief, REIDsteel's design caters for 100% coverage of both hangars, providing the future-proofing required by the end user.

Steel's durability, strength and flexibility as the ultimate construction material has given the super-hangar a 50 year design life as well as potential for life-extension, re-use or recycling. Because of its dual cantilever design, it can be extended to meet changing requirements.


AINSCOUGH
EXCLUSION ZONE


NORRIS
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LOGISTICAL CHALLENGES

Close co-ordination was required between London Biggin Hill, Civils and REIDsteel to ensure the steelwork was delivered efficiently and safely for assembly, which included the choice of opting for tandem lifts of the 45m rafter trusses to reduce jib heights from that required for a single crane. Logistical challenges to consider included operating in a live airport environment – including flight schedules and restrictions on lifting during poor visibility – as well as activities of other site users.

Whilst the design was innovative, a clear strength lay in the fact that it could be constructed using standard equipment. The tandem lift was achieved with two 55 tonne mobile cranes with a 40 tonne mobile used to infill between frames with the load sharing trusses and cold rolled steel purlins needed to ensure stability in the temporary state. While the rafter on one side of the core was being erected, the rafter on the other side was being assembled on trestles and cambers set, ready to be erected the following day.

The structure is the 11th aircraft hangar designed and erected by REIDsteel at Biggin Hill and is a testament to its long-term working relationships with its Clients and main contractors.

It looks outstanding as a statement building; both in terms of its structural steel and sleek appearance with cladding and glazing to create a striking and contemporary development which is a new benchmark for the highest quality MRO facilities in the 21st century.


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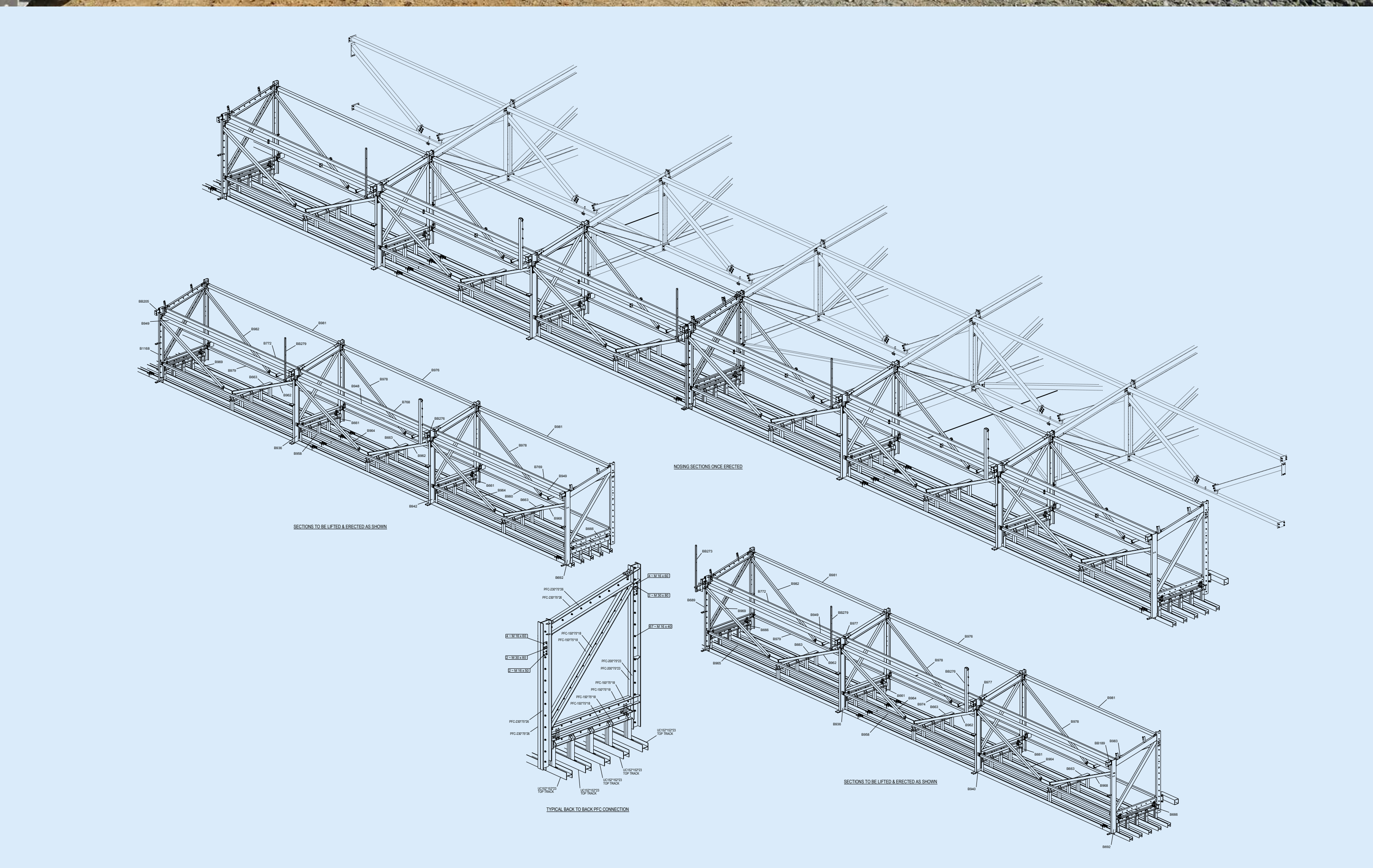

SECTIONS TO BE LIFTED & ERECTED AS SHOWN
NOSING SECTIONS ONCE ERECTED
TYPICAL BACK TO BACK PFC CONNECTION
SECTIONS TO BE LIFTED & ERECTED AS SHOWN

NOSING SECTIONS

In order to minimise the extent of working at height over the complicated door guides and hoods it was decided to pre-assemble the nosings at ground level in sections of three bays at a time.

Once the steel frame was assembled and the hoods fixed to the door guides, each three bay section was lifted into place and bolted to the ends of the cantilever rafters.

CARBON FOOTPRINT

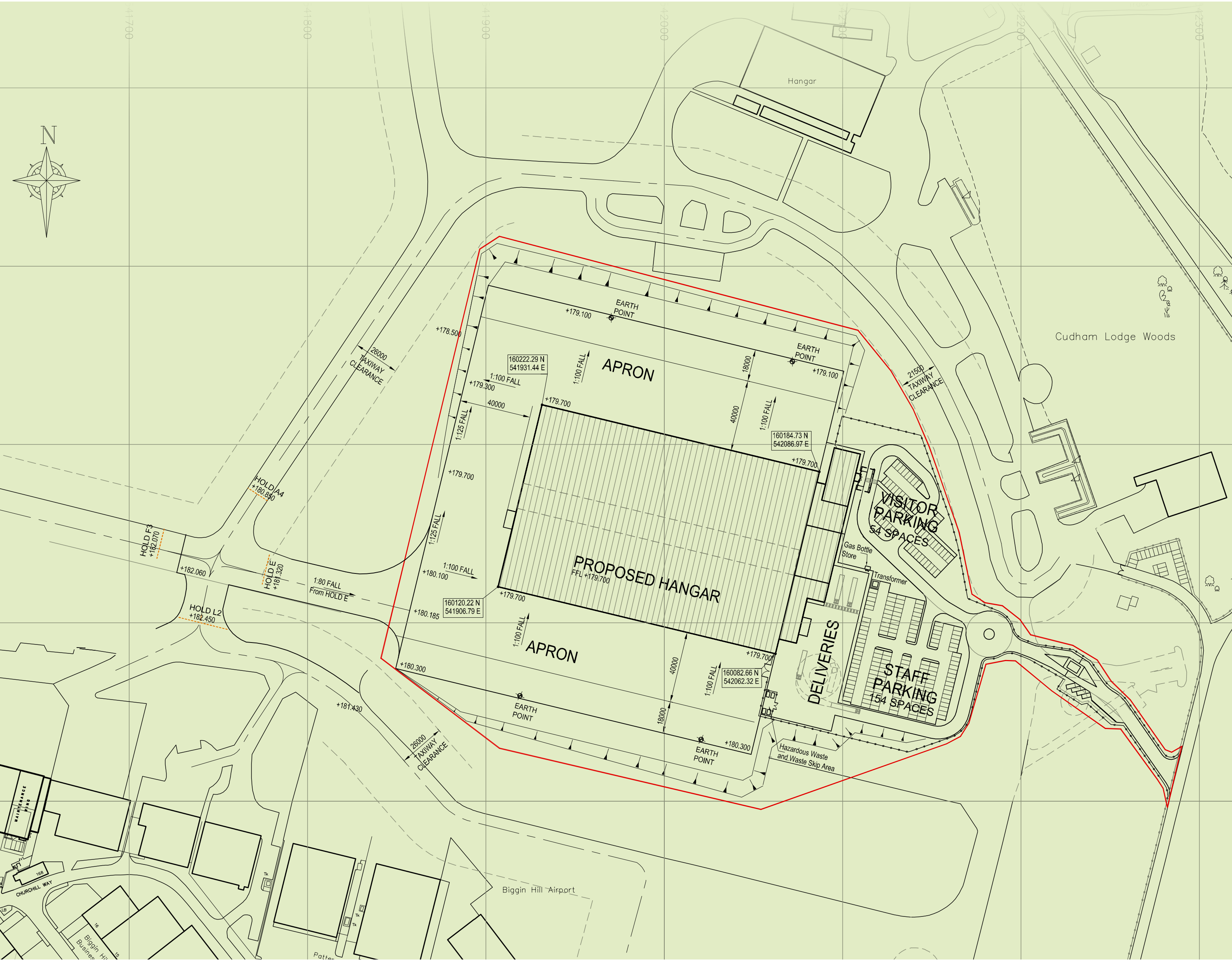
REIDsteel are committed to reducing our carbon footprint in line with the BCSA's Sustainability Charter. The Company is aware of the impact of its operations on the environment and is making this ambitious step to a more sustainable future for us all.

Value-engineering saved on steel, erection and fabrication time as well as environmental impact as sourcing of products domestically from British Steel substantially cut this project's carbon footprint.

We cannot emphasise enough the importance of weight reduction in the carbon calculation process.

With our early involvement we were able to consider several structural forms to achieve the 160m clear openings the client required. Amongst these were king trusses, traditional clear span and alternative cantilever arrangements.

For illustration, the clear span option would have weighed around 108kg/m2, where our final solution came in at under 85kg/m2. In real terms this saved around 460T of steel, or 850T of CO2 just in steel production terms, without the knock-on benefits to transport and erection.



The roof is also designed to take solar panels and assuming that the client achieves 50% coverage, this has the potential to save 300T of CO_2 per year.

The BCSA roadmap to decarbonised steel production calls for 17.5% reduction through design efficiency savings and 6.5% through grid decarbonisation.

This project clearly demonstrates that these savings can be realised by using innovative designs and early steelwork contractor involvement.

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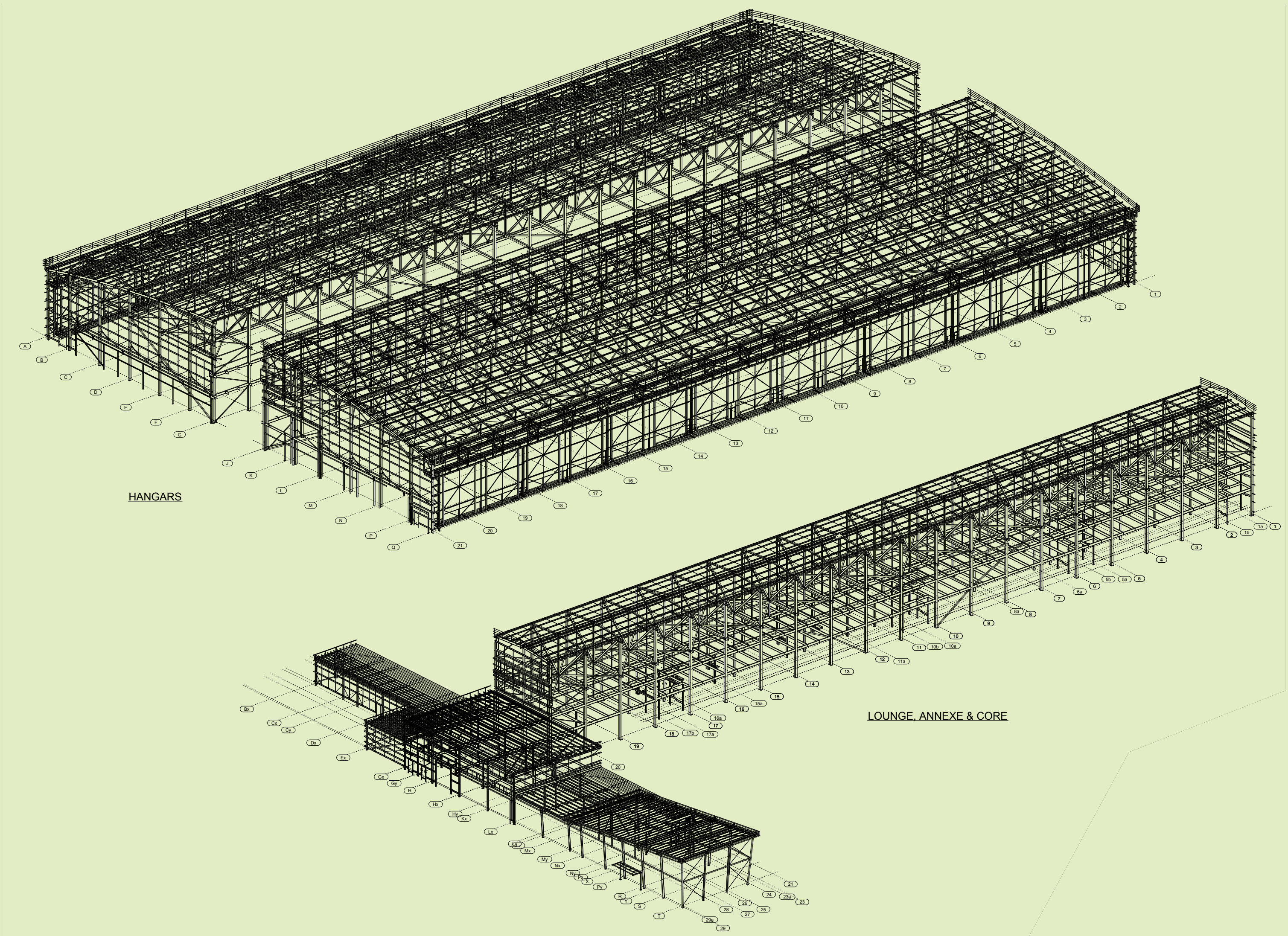

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FULLY CE COMPLIANT FOR EXECUTION CLASSES 1 TO 4 • BS EN ISO 9001:2015 • BS EN ISO 14001:2015 • BS EN ISO 45001:2018

JOHN REID & SONS (STRUCSTEEL) LTD trading as REIDsteel & REIDglazing • Company Registration No: 617773