

Factsheet no. 1: NTS building, Thirsk, UK



Figure 1 Erection of the NTS building primary structure (summer 2017)

Project summary

Client:	National Tube Stockholders (NTS)
Original designer/fabricator:	Severfield plc/Fisher Engineering
Project manager and fabricator:	Cleveland Steel and Tubes (CST)
Structural engineer	BHD partnership
Fabrication drawings	Rapid consulting
Steelwork erector	WHL Building Services Ltd

Project description

CST's main business involves buying surplus steel pipe from the offshore oil and gas sector and supplying structural steel tube and piling into the UK construction market. CST holds approximately 65,000 tonnes of pipe stock at their facility in Thirsk, UK. In addition to stock holding, CST offers steelwork fabrication services. CST project managed this reuse project on behalf of NTS. CST has good experience of procuring previously used steelwork and is keen to promote the reuse of structural steel. CST was responsible for the overall management and coordination of this project.

This case study is unusual in that involves the reuse of part of a much larger steel-framed building that was originally designed and fabricated in 2008 but, as a consequence of the economic recession, the contract was cancelled before the structure was shipped or erected.

The original single-storey building (74,700 m²) was fabricated for the Irish company Quin Therm. The building, destined for Ireland, was to be a manufacturing facility for the production of PIR insulation for the construction industry.

The original building was designed and fabricated by Fisher Engineering (part of Severfield plc) at their Thirsk facility in the UK. Since the original order was cancelled in 2008, the fabricated structure was stored, outside, at Severfield's Thirsk site. Figure 2 shows the condition of the steel (fabricated in 2008) in 2017.



Figure 2 The original steelwork (fabricated in 2007-8) in September 2017

The design of the original building is shown in Figure 3. In 2013, the fabricated steelwork for the building was divided into four parts (lots) and sold at auction. NTS purchased one lot. The steelwork was to be erected as a new warehouse for NTS on their neighbouring site in Thirsk. It is understood that the other three lots were also sold at auction and were reused although no details are available.

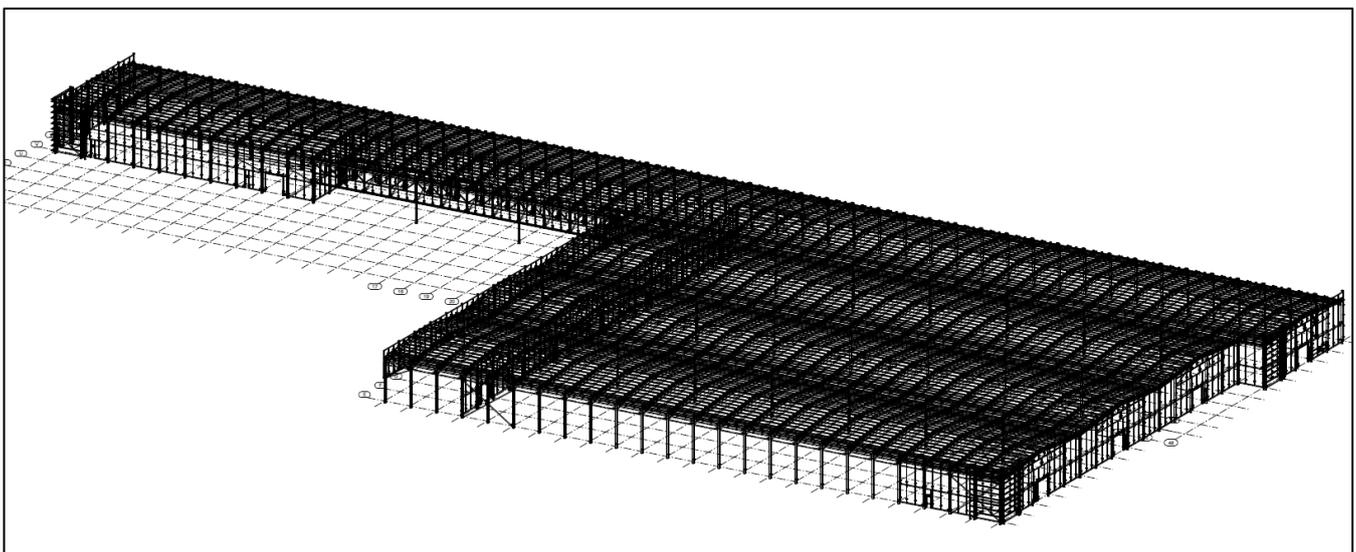


Figure 3 The structural model of the original building

Figure 4 shows the structure of the new (reused) part of the building. The new building measures 195m x 60m and comprises a double-bay portal-framed structure. Column spacing is 7.5m and the height to eaves is 11m. The total floor area is 11,700 m². The primary structure was erected by WHL Building Services in just three weeks during the summer of 2017. Figure 1 shows the structure during erection during the summer of 2017. The new building is configured with the long axis running NE to SW.

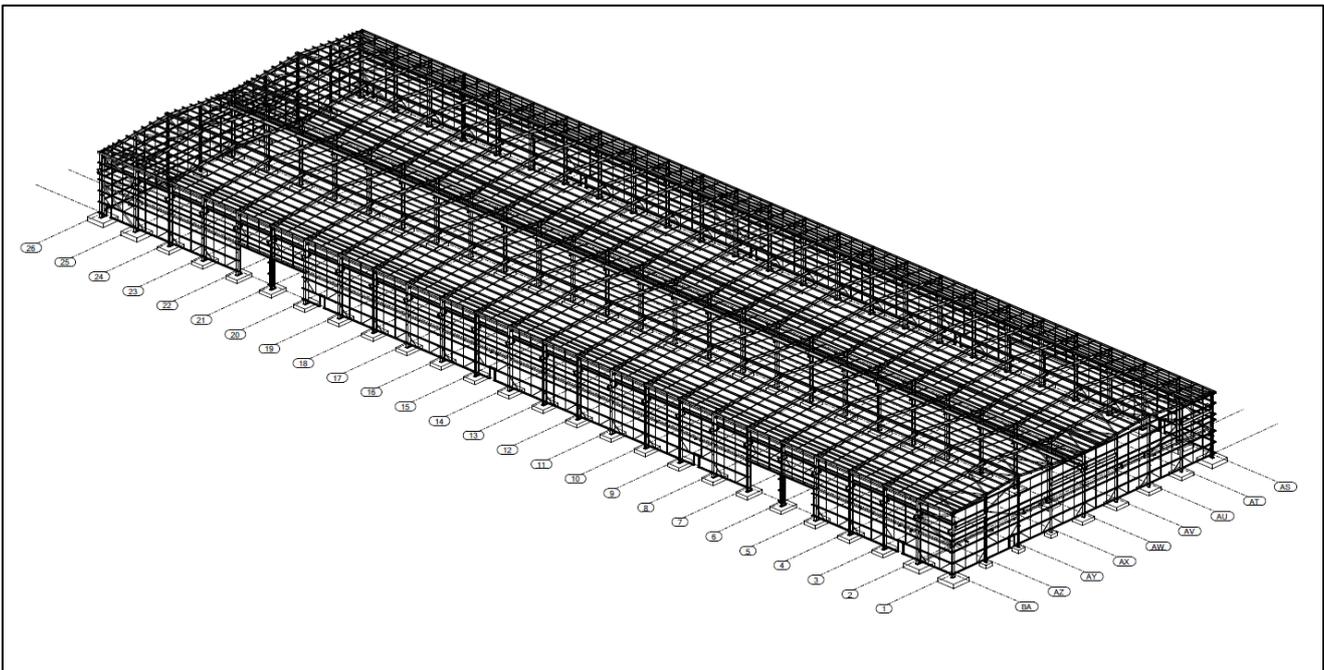


Figure 4 The structural model of the new NTS building

Key aspects

The following sections explain some of the key aspects of this building reuse case study.

Design information

The original design drawings and the structural model were obtained from Severfield. No structural calculations for the original design were available.

More than 200 drawings were provided by Severfield and it was difficult and time-consuming to identify all members and components from the drawings. Many members were hard-stamped which aided this process.

Most of the steel was grade S355 although there was also some grade S275 used for base plates and fittings, etc. No testing was required to establish the steel properties since full traceability to the original drawings was available.

Redesign

A number of elements of the new building required new or redesign. These included:

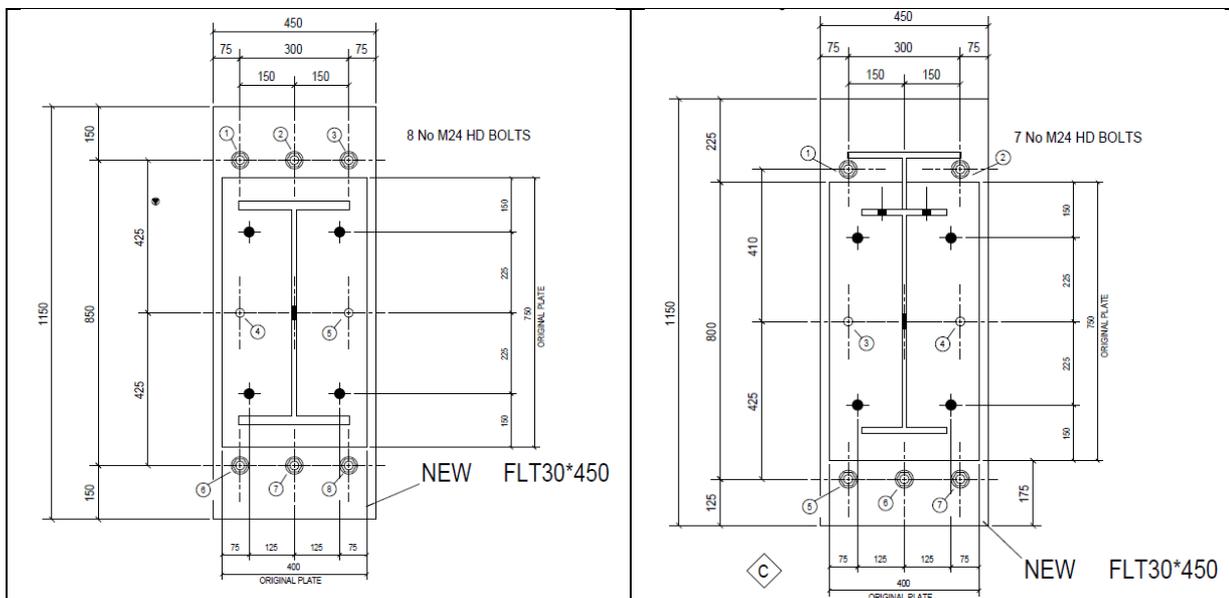
Strengthening the columns along the eastern column line

In the original building, the eastern column line of the new building (grid line BA in Figure 4) was an internal column line and therefore required stiffening to limit deflection tolerances in the new building configuration. This was achieved by welding a T-section (T 305x152x49 split from a UC) to all 26 columns (UB 610x229x101) on this grid line – see Figure 5.



Figure 5 Strengthening of the columns on grid line BA using a welded T-piece and the larger base plates

In addition, the base plates for the outer column lines AS and BA required redesign. The original base plate design (750x400x25) was retained for the central valley line (AW) however larger base plates were used for the two external column lines. The base plates and holding down bolt configurations are shown in Figure 6. The pad foundations for the external wall columns were 3.5x2.5x0.6m deep. The pads for the central (valley) line of columns was 2.8x2.0x0.6m deep.



Column line AS Column line BA
 Figure 6 New base plate and holding down bolt arrangement for the external column lines AS and BA

At the Southern end of the building (portal 26), the original gable wall was replaced with a portal frame to enable the building to be extended if required, in the future – see Figure 7.



Figure 7 Southern end of the building (grid line 26) showing the haunched portal and the vertical bracing in the end bay

Figures 8 and 9 show the design of the southern (grid line 1) and northern end (grid line 26) of the new building.

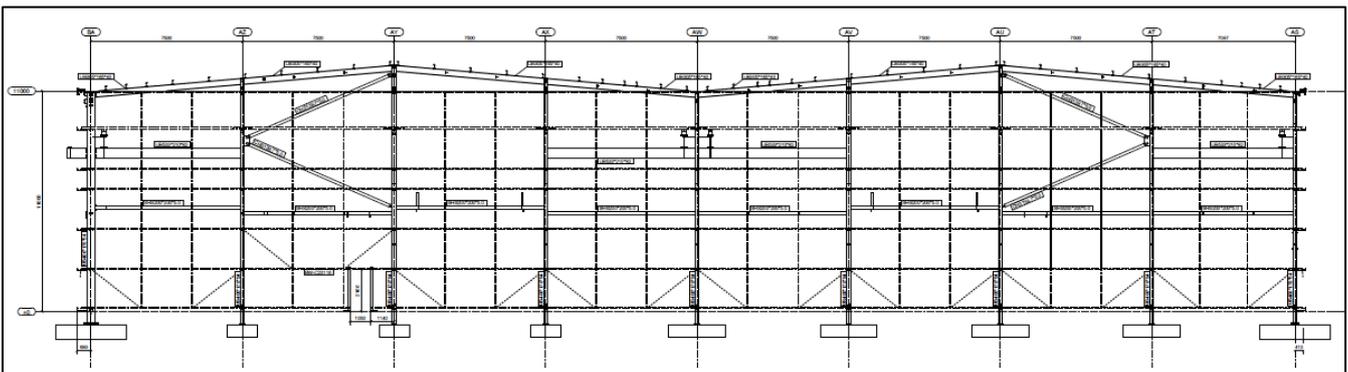


Figure 8 Elevation of the gable wall structure at grid line 1

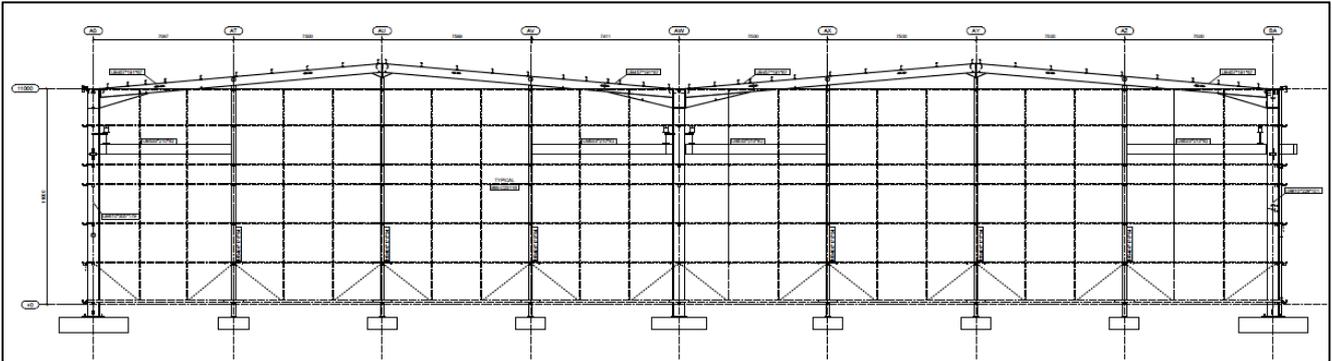


Figure 9 Elevation of the portal frame gable structure at grid line 26

New cleats were welded onto the columns to support the side rails. This was because the original cleats were for an unknown but non-standard wall cladding system and did not match the new Tata Steel Trisomet cladding. Some cleats were also missing. In addition, the original cladding was to be hung horizontally whereas on the new building, the cladding will hang vertically. The side rails are a single-span, sleeved system.

The rafters had been pre-drilled so that cleats can be bolted to them to attach the purlins. The new purlins are double-span with sleeves (heavy end bay).



Figure 10 New cleats to support the cladding rails (grid line AS)



Figure 11 Cladding rail fixed to one of the strengthened columns on grid line BA

Crane rails (UB 610x305x149) for 10 and 20 tonne EOTC (electric overhead travelling crane) are provided on all three column lines. In addition, to the east of the building (column line BA), steelwork has been provided to support an external gantry crane – see Figure 12.



On the central column line



Supports for an external gantry crane (grid line BA)

Figure 12 Crane rails

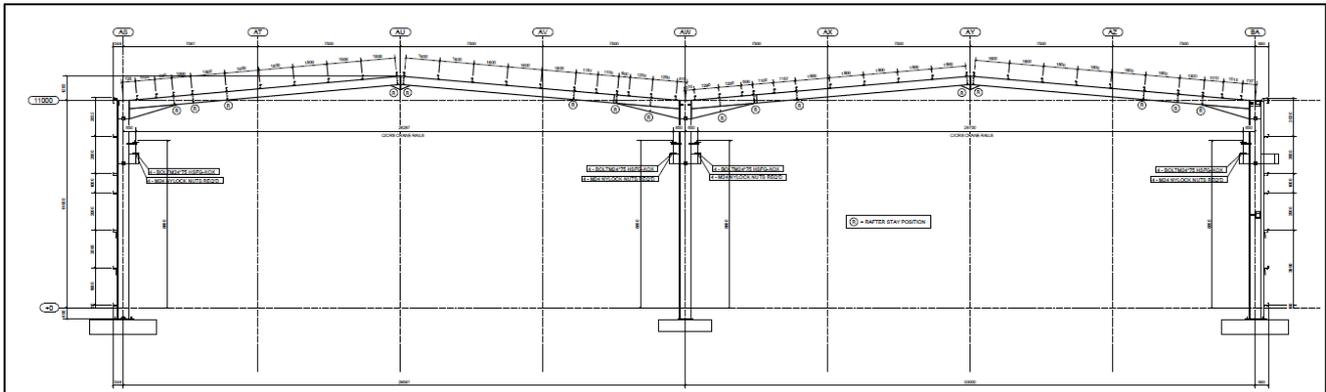


Figure 13 Crane rail locations

Coatings

The original coating on the steelwork was epoxy. Following fabrication in 2008, the structural members were left outside for around 10 years and showed significant deterioration, see Figure 2. The steelwork required shot-blasting to remove the loose and flaking paint and repainting before erection.

Difficulties were encountered passing the fabricated steelwork through the automated shot-blaster. This was due to:

- Difficulties with sections with fittings welded to them passing over the roller conveyor;
- Shot becoming trapped in the open sections (and carried out of the shot-blaster) particularly members with end or base plates.

As a consequence, around 50% of the structural sections were cleaned using the automated shot-blaster and the remainder manually shot-blasted.

Shot-blasting only removed the loose paint. Shot-blasting the paint on the welds caused problems since shot-blasting the welds did not remove the paint and when the new paint was applied to these areas it became 'soggy and blistered'. Consequently, the paint on the welds had to be manually scraped off.

CST were able to identify the original paint system and sought advice from a paint manufacturer about a suitable paint for over-spraying. A twin-pack epoxy was used to over-coat the original paint. This was done in CST's workshop.

Repainting the steelwork started in summer 2016 and, as shown in Figure 14, some of the repainted steelwork is already showing some deterioration (as at September 2017) and will be 'touched up' using a roller, on-site when the building has been clad and is water-tight.



Figure 14 Central column showing the haunched rafters, eaves struts (CHS), purlins and purlin stays. Note the condition of the repainted steelwork in September 2017

Cladding

No information on the design of the original cladding was available. Tata Steel Trisomet composite panels are to be used for both the roof and wall cladding of the new building.

The rafters had been drilled to fix the purlin cleats and these were used for the new purlins. The gutter support brackets were re-drilled to accommodate the different gutter system on the new building and new cleats fixed to the columns on grid lines AS and BA.



Figure 15 Fully erected structure as at September 2017

Missing and redundant steelwork

All tubular bracing members were missing from the lot as purchased and therefore had to be replaced with new members. API tubes were used; these were procured and fabricated by CST.

Planning and CE marking

A planning application (Hambleton District Council application 16/01953/DCN) was only made after the frame had been bought at auction. The application was made by NTS in February 2017. Permission was granted in September 2017.

Costs

Costs for this project have been provided by CST.

Item/activity	Cost (£k)	Notes
Steel frame cost (primary structure)	250	Bought at auction in 2013
Design work	10	New design work including the purchase of the original building model
Additional steel work	57.8	Substituting missing sections, additional fixings, etc.
Over-coating cost	33.9	Shot-blasting and re-coating existing steelwork
Secondary steelwork cost	114	Purlins and side rails; new cleats and bolts
Erection cost	140	Including primary and secondary steelwork
Cladding	750	Including rooflights
Site management costs	8.25	
Total cost	1,364	

Excluding the costs relating to the secondary steelwork, cladding and site management (shaded items in the table above), the total cost associated with the primary structure is £491.75k or £42/m².

By comparison, the indicative new build cost for a large span, high eaves portal frame structure as at Q2, 2017, is £82 to £112/m². Source www.steelconstruction.info/Cost_of_structural_steelwork

Conclusions and lessons learnt

This large-scale, case study demonstrates the economic savings that can be achieved through reusing structural steel. Factors that were important in the successful realisation of this project included:

- The knowledge and experience of CST in reusing structural steel and their commitment to deliver this project
- The proximity of the reclaimed steel to the site of the new building
- CST's in-house ability to fabricate, shot-blast and paint structural steel.

The age of the steelwork and the commercial relationship between CST and Severfield plc, meant that much of the original design information was available. In addition to the original design drawings, CST purchased the electronic structural model and this was issued to Rapid Consulting (RC) for them to produce and erection and cladding drawings, etc. According to CST, this actually caused a number of issues, including:

- 1) RC incorporated anything from the original structure that they weren't expressly asked to omit, and they redesigned from scratch anything that needed to be added. This did not buy into the ethos of reuse.

- 2) RC had a lot of issues with their new BIM software and had problems integrating the old model into the new software. This led to a lot of errors.
- 3) New drawings were often a mix of the original and the new drawings which made working with them difficult, e.g. identifying what work was necessary and where.
- 4) The new BIM software produced hundreds of parts drawings, most of which were not required.
- 5) Software incompatibility (between the original and the new building model) meant that the parts labelling on the original model did not transfer correctly to the new software. This required a lot of additional work to label the parts in the new model so that they correlate with the original model.
- 6) Rather than consider the redesign from first principles, RC focussed on amending specific parts of the original design in isolation rather than thinking holistically about the structural behaviour of the new building.

CST struggled to find a steelwork contractor/erector to work on this project. This is generally the response from steelwork contractors since they are reluctant to sacrifice production efficiency by dealing with reclaimed structural sections. This suggests that a different supply chain is required to support structural steel reuse rather than try to fit steel reuse within the existing structural steel supply chain.



Figure 16 Cladding of the building January 2018

Further information

The information in this case study is based on interviews with the following organisations involved in the project:

- CST
- BHD partnership
- WHL Building Services Ltd