Reusing structural steel: what's in the new IStructE guide?

Robin Jones previews the guidance on reuse of structural steelwork that forms part of the Institution's forthcoming publication, *Circular economy and reuse: guidance for designers*.

As awareness of the climate emergency has grown in recent years, and the construction industry has begun to reorient itself towards a low-carbon future, there has been an increased focus on reuse of existing buildings. However, where a building cannot be repurposed or adapted, a circular economy approach is to view the building as a potential material bank, offering a source of construction materials for future projects.

Steel is already regarded as a 'circular material', with around 85% of steel recycled at the end of its first useful life globally[1]. However, with approx. 90% of scrap steel recycled in the EU, compared with only 5% reused[2], there is a clear opportunity to transition to greater reuse of steel. It is estimated that, in the UK, between 40–80% of steel section demand could be met using steel reclaimed from deconstructed buildings[3].

This article provides a brief introduction to Chapter 15 of the Institution's keenly awaited *Circular economy and reuse guide*, which focuses on reuse of steel.

What's in the guide?

Chapter 15 begins by examining the carbon and potential financial benefits of reusing structural steelwork, with reused steel having a carbon intensity as low as 50kgCO_2e/t[4], compared with a sector average of 1740kgCO_2e/t for new steelwork[5]. It also considers the nuances of balancing project and global emissions, noting that, as a rule of thumb, if reusing steel increases the total steel tonnage of a design by more than 30% compared with new steel, it may be better from a global viewpoint to recycle the steel.

The chapter then goes on to look at options for reusing structural steelwork and the guidance available. There are four options, presented in ascending order from lowest to highest processing and carbon requirements:

1) Reuse steelwork *in situ* within an existing building.
2) Reuse all or part of an existing steel-framed structure in a different location.
3) Reuse individual member(s) as is, without further processing.
4) Refabricate member(s).

Reuse *in situ* is covered elsewhere in the guide, with Chapter 15 focusing on options 2–4 which require reclamation of the steel.

Table 1: Available guidance relating to reuse of steel (adapted from Table 2 of Chapter 15)

Organisation	Document	Summary
British Construction Steel Association (BCSA)	*Model specification for the purchase of reclaimed steel sections*	Applies to suppliers of steel products placed on the market as reclaimed structural steel sections for the fabrication of structural steelwork
BCSA	NSSS Annex J – *Sustainability Specification*	Specifies general requirements and practices for achieving environmentally sustainable steel building construction
Steel Construction Institute (SCI)	Publication P427 *Structural Steel Reuse*	Protocol for reusing structural steelwork which provides a route to re-certification of reclaimed structural steelwork
SCI	Publication P138 *Appraisal of Existing Iron and Steel Structures*	Deals mainly with building structures in cast and wrought iron, and in steel up to 1968
UK Building Regulations	*Materials and Workmanship: Approved Document 7*	Existing materials can be reused if the material can perform the function for which it is intended
European Convention for Constructional Steelwork	*European recommendations for reuse of steel products in single-storey buildings*	Guidance for structural engineers relating to design using reclaimed steelwork and designing structures for future adaptability, demountability and reuse with an emphasis on single-storey industrial buildings
Institution of Structural Engineers	*Appraisal of existing structures* (3rd edition)	Guidance for structural engineers on appraising and testing existing structures for refurbishment

Available guidance
The chapter then looks at the guidance available in the UK for reuse of reclaimed steelwork **(Table 1)**. The principal guidance is SCI publication P427[6], which sets out a protocol for reusing steel produced after 1970 (although work is in progress to extend the guidance to cover steel produced earlier than this). However, which guidance is applicable will depend on how the steelwork is intended to be reused, and a flowchart guides readers through this.

Sourcing and recovering second-hand steelwork
Next, Chapter 15 examines the options for procuring second-hand steelwork (with further guidance provided in Chapter 11 Reuse of materials). The two main options are to:
- →| buy reclaimed steelwork from the market
- →| salvage steelwork from an existing building for use in a future construction project.

Current steel reuse projects tend to see clients sourcing steelwork early in the design process and designing with known sections for a new development. Structural engineers may therefore be involved in salvaging steelwork from an existing building. The chapter looks at the practicalities of deconstruction, including approaches to unbolting or cutting out steel sections, and how to minimise damage to reclaimed sections, noting that collaboration across the supply chain is key to establish the best approach.

Specification
The guidance discusses specification and acceptance criteria for steelwork sourced through the two routes set out in the previous section. Where steelwork is being procured from the market, it will need to be specified at tender that this should be sourced by the contractor. The structural engineer will need to specify on drawings and in a written specification the type of steel required, acceptable tolerances, provenance, aesthetics, etc.

Where steelwork is being salvaged from an existing building, the structural engineer will need to be involved in the deconstruction process, establishing acceptance criteria with the demolition contractor. The acceptance criteria should follow the SCI P427 protocol, as this is auditable and provides the fabricator with the required material properties, allowing them to certify the fabricated steelwork. Aesthetic considerations may also form part of the specification.

Assessment and testing
Chapter 15 then looks at the assessment and testing requirements for reclaimed steelwork, taking readers through the process set out in SCI P427. Salvaged steel will need to be cleaned and de-fabricated in line with project requirements.

The SCI protocol recommends 100% non-destructive testing of reclaimed structural members in combination with non-statistical or statistical destructive testing. Non-destructive testing of all reclaimed members establishes that a group of members can be represented by destructive test results from one or more representative members from a group.

Structural design
The chapter then takes the reader through the main fabrication and design issues the structural engineer needs to consider. For fabrication, these include:
- →| existing corrosion protection
- →| existing fire protection coatings
- →| bolt holes and welds.

For design, these include:
- →| ductility and residual strains
- →| global analysis
- →| cross-sectional resistance
- →| buckling resistance
- →| steel toughness and sub-grade
- →| thickness limits
- →| connection design.

Warranties and certification
Chapter 12 of the *Circular economy and reuse guide* looks in more detail at the legal considerations for reusing structural materials, but Chapter 15 also summarises these specifically for steel.

To comply with the Construction Product Regulation (CPR), which is a legal requirement in the EU and UK, all fabricated structural steelwork must be CE/UKCA marked, regardless of whether it is new (prime) steel or reclaimed.

Chapter 15 explains that structural components produced by fabricating reclaimed sections can be CE/UKCA marked by the steel fabricator. Unfabricated reclaimed steel sections cannot be CE/UKCA marked. Any steel produced before 2014 does not need to be CE/UKCA marked for it to be incorporated into a CE/UKCA marked structure. Hence, most second-hand steel sections would not need to be CE/UKCA marked, according to the CPR, and could be incorporated into a CE marked structure provided that their properties have been proven via testing.

Chapter 15 then goes on to briefly consider three types of warranty.

Carbon impact and case studies
Chapter 15 concludes with a more in-depth discussion of the carbon impact of reusing steelwork, including the emissions of the recovery, de-fabrication and remanufacturing processes, before presenting four case studies of steel reuse in practice.

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