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Industry CPD

Structural steel and the circular economy

This CPD module, sponsored by Steel for Life, examines a number of steel's credentials specifically on its ability to be reused, recycled and multi-cycled, its structural efficiency as a construction material, and its alignment and application to circular economy principles.

Continuing professional development (CPD) ensures you remain competent in your profession. Chartered, Associate and Technician members of the Institution must complete a specified amount each year. All CPD undertaken must be reported to the Institution annually. Reading and reflecting on this article by correctly answering the questions at the end is advocated to be:

1 hour of verifiable CPD

The construction industry continues to set itself ambitious targets for reducing its carbon footprint and environmental impact as a sector; key to this approach is the adoption and implementation of circular economy principles.

A circular economy aims to design out waste and pollution, maximise the service life of products and materials and avoid sending materials to landfill after their first-life use. It signals an end to the 'take-make-dispose' attitudes that have contributed to the climate emergency.

Circular economy principles

Client demand, as well as legislation, are key drivers of the increasing focus on the circular economy; one in which resources including construction materials are used long enough to ensure the maximum societal value is gained from them. At the end of the useful service life of a building or other structure, products and materials used in the original construction, and those added to accommodate changing uses, will be recovered and regenerated by being recycled and/or reused.

Another distinction to be understood is that there are different types of recycling that deliver different circular economy benefits. With true, or closed-loop, recycling, products are recycled into new products with exactly the same material properties. An example would be reprocessing steel through a steelworks, which could be called upcycling.

On the other hand, downcycling describes the process of converting materials into materials of lesser quality and reduced functionality. Examples of downcycling in construction include crushing concrete to produce aggregates for fill and chipping timber to produce chipboard. Although landfill is avoided, production of new concrete and timber is not avoided.

↑**FIGURE 1:** Forth Rail Bridge (1890) – example of durable steel structure

How steel enables the circular economy

Steel has excellent circular economy credentials: it is valued as a strong, durable **(Figure 1)**, versatile material that provides structural framing systems that are lightweight, flexible and adaptable, as well as reusable.

Its high strength-to-weight ratio means other sustainability benefits can be created, such as lighter and smaller foundations. Steel's combination of strength, recyclability, availability, versatility and affordability makes it unique.

Maintaining products at their highest utility and value for as long as possible is a key component of the circular economy, as the longer a product lasts, the less raw materials will need to be sourced and processed and less waste generated.

Steel-framed buildings are adaptable and flexible assets a business can invest in. The steel frame itself can be easily adapted **(Figure 2)**, with parts added or taken away, and its light weight means that extra floors can often be added without overloading existing foundations, as frequently seen in inner-city projects. This can add many years to the useful life of a building.

Steel structures are commonly used to renovate buildings, e.g. behind retained facades. This allows the historic value, character and resources of the facade to be retained, and the building structure can be reconfigured to create open, flexible internal spaces that meet modern client requirements and maximise net lettable floor area.

Circular Economy Action Plan

The EU has adopted a Circular Economy Action Plan[1], one of the main strands of the European Green Deal, the EU's new agenda for sustainable growth.

It refers to the Levels study[2], which recommends the whole-life carbon approach, i.e. including building end-of-life impacts (Module C) and benefits from reuse and recycling (Module D).

The Action Plan incorporates initiatives throughout the lifecycle of products, targeting their design, promoting circular economy processes and promoting sustainable consumption, with the aim of ensuring that the resources used are kept in the EU economy for as long as possible.

Among other things, the aim is to make sustainable products the norm in the EU, focusing on the sectors that use most resources and where the potential for circularity is high, which includes construction and buildings.

Even post-Brexit, such a plan must surely be welcomed and reflects a growing appreciation here in the UK of the need to include Modules C and D as part of a robust, whole-life carbon assessment. Limiting the scope to just Module A equates a 100% recyclable building to one which is 100% landfilled when it is demolished.

Landfill avoidance through downcycling construction materials is unsustainable and if we are going to deliver a truly circular, zero-carbon built environment, then we have to move up the waste management hierarchy and reuse our buildings and their constituent parts.

While reducing 'upfront' carbon emissions is a short-term priority, this has to be achieved in tandem with longer-term, smarter thinking that is compatible with broader sustainable development objectives.

↘FIGURE 2: Redevelopment of former Royal Mail sorting office made use of significant elements of its existing frame

History of steel recycling

Since steel was first mass produced in the 1880s, it has always been highly recycled **(Figure 3)**. This is principally because:

- →| steel has a relatively high economic value – the price paid for UK scrap structural steel (grade OA) is currently £230–240 per tonne
- →| the versatility of steel means that it can be easily recycled or remanufactured into new applications as demand dictates
- →| steel's magnetic properties mean that it can be efficiently segregated from mixed waste streams.

> **"THE VERSATILITY OF STEEL MEANS THAT IT CAN BE EASILY RECYCLED OR REMANUFACTURED**

↘FIGURE 3: There are considerable savings to be made from recycling steel as landfill is no longer considered to be an option for construction products and materials

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Steel is available in thousands of different compositions (grades), each tailored to specific applications in sectors as diverse as packaging, engineering, white goods, vehicles and construction. This versatility promotes recycling since steel scrap can be blended, through the recycling process, to produce different types of steel (different grades and products) as demand changes.

Steel recycling in the construction sector

Steel has a unique characteristic as it can be reused and recycled repeatedly without losing its qualities as a building material.

All steel used in today's construction projects has some recycled content. The constructional steelwork used in the UK contains an average of 60% recycled content. Current recovery rates from demolition sites in the UK are 99% for structural steelwork and 96% for all steel construction products.

FIGURE 4: Surplus large-diameter steel tubes repurposed for bridge repair at Grinton Moor

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Steel is routinely recovered for recycling, and a highly sophisticated global infrastructure has developed to take advantage of this.

Steel reuse

As well as recycling, there is a growing trend towards the reuse of structural steelwork **(Figure 4)**, as there are significant savings to be made if a new project simply uses steel sections obtained from an older demounted or disassembled structure.

Structural steel sections are inherently reusable. Reuse, as opposed to the current, common practice of recycling structural steel by remelting, offers significant potential in terms of resource efficiency and carbon emission savings, which support the construction industry's ambitious carbon reduction targets as the industry moves towards net-zero.

Currently, there are many steel-based temporary works systems which are highly reused; the next step is to develop permanent works systems that are similarly reusable.

Steel reuse generally happens in three main ways:

- ***In situ*** reuse sees the structural frame reused, with or without alterations, *in situ*. This is generally associated with refurbishment projects and it is currently the most common way of reusing structural steel in the UK.
- **Relocation reuse** involves deconstruction of an existing steel frame, which is then transported and re-erected, generally in its original form, at a different location for the same or similar purpose.
- **Component reuse** involves careful deconstruction of an existing structure where individual structural steel members are reclaimed and used to construct a new permanent structure.

> **"THERE IS A GROWING TREND TOWARDS THE REUSE OF STRUCTURAL STEELWORK**

Reuse advice for designers

To facilitate greater reuse, it is important that designers do what they can to optimise future reuse. Steps that the designer can take to maximise the opportunity for reusing structural steel include:

- using bolted connections **(Figure 5)** in preference to welded joints to allow the structure to be dismantled during deconstruction
- using standard connection details including bolt sizes and the spacing of holes
- ensuring easy and permanent access to connections
- where feasible, trying to ensure that the steel is free from coatings or coverings that will prevent visual assessment of the condition of the steel
- minimising the use of fixings to structural steel elements that require welding, drilling holes, or fixing with Hilti nails; using clamped fittings where possible
- identifying the origin and properties of the component, e.g. by bar-coding or e-tagging or stamping and keep an inventory of products
- considering using long-span beams as they are more likely to allow flexibility of use and to be reusable by cutting the beam to a new length – bearing in mind the increased steel weight associated with this.

FIGURE 5: Reuse advice for designers includes suggestion of using bolted connections in preference to welded joints to allow structure to be dismantled during deconstruction

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REFERENCES

1) European Union (2020) *Circular Economy Action Plan: For a cleaner and more competitive Europe* [Online] Available at: https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf (Accessed: February 2021)

2) European Commission (s.d.) *Level(s): European framework for sustainable buildings* [Online] Available at: https://ec.europa.eu/environment/topics/circular-economy/levels_en (Accessed: February 2021)

Questions

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1. What was the value of 1t of UK structural scrap steel in 2020?

☐ £230–240
☐ £105–150
☐ £50–100
☐ £25–50

2. What is the average recycled content of structural steel in the UK?

☐ 20%
☐ 40%
☐ 60%
☐ 80%

3. What are the current recovery rates from demolition sites in the UK for structural steel?

☐ 29%
☐ 49%
☐ 89%
☐ 99%

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4. Which of the following modules should be included as part of a whole-life approach to carbon assessment?

☐ Module A (product and construction stages)
☐ Module C (end-of-life stage)
☐ Module D (reuse, recovery, recycling)
☐ All of the above

5. In what ways does steel enable a circular economy? (Select all that apply.)

☐ Its strength and durability enable long-lasting structures when well maintained
☐ A steel frame is flexible and can easily be adapted
☐ Scrap steel is difficult to recycle or remanufacture
☐ Structural steel sections can often be reused *in situ* or in new or relocated structures

6. Which of the following can designers do to maximise the opportunity to reuse structural steel?

☐ Use bolted connections in preference to welded joints
☐ Consider using long spans
☐ Use standard connection details
☐ All of the above