## 4. Zero waste

# Delivering steel's circular economy potential

**Steel reuse is now a viable low-carbon option for all parties to a project, as this article explains from the perspectives of contractor, steel producer, fabricator, engineer and client.**

## Introduction

Since Michal Drewniok's article in *The Structural Engineer* (March 2021) entitled 'Enabling steel's circular economy potential'[1], awareness of design solutions with lower embodied carbon has increased significantly.

Implementation of the proposed Part Z[2] of the Building Regulations would be a watershed moment for the UK construction industry, while the ongoing whole-lifecycle carbon assessment required under the London Plan[3] is driving significant embodied carbon benchmarking. In September 2021, the Department for Business, Energy & Industrial Strategy[4] dramatically increased the shadow pricing for government-funded project appraisals, with a central cost rising from £27/t to £248/t.

With the significant shift towards calculating and reporting embodied carbon, alongside significant utilisation of carbon shadow pricing to drive lower-carbon designs, formal taxation in one form or another is rapidly approaching.

Where reused steel can be utilised on site for temporary works or tested for utilisation in permanent works, dramatic emission reductions can be achieved. This article stress tests the technical guidance outlined in SCI P427 (*Structural steel reuse*)[5] and presents five perspectives on how a collaborative approach and joined-up supply chain can allow the carbon savings associated with reuse of structural steel elements to quickly become a reality within our industry.

## The contractor

**David Moylan (Erith Group)**

To save maximum carbon by ensuring the urban mine is comprehensively exploited, early engagement with all key stakeholders is imperative, especially the client and main contractor. This ensures that suitable time is programmed for the appropriate surveys and deconstruction process.

This process often takes the form of undertaking a detailed asset survey, and reviewing 'as built' information (including connection details) and the scope of the reuse aspirations from the asset owner. It allows a comprehensive understanding of the structure to be established and the maximum value of the existing asset to be realised through circular economy principles.

While Erith actively engages with consultants at the early stages, we also promote enhanced engagement from purchasers of reused steel, which will allow them to further understand both the opportunities for added value and the possible issues that may present themselves further down the line when considering dismantle-for-reuse options. This will allow purchasers to form a rounded view before making key directional decisions whether the reuse is for temporary or permanent works.

The reuse of steel elements within temporary works is starting to gain traction within Erith, where a dismantle/salvage-for-reuse option has been chosen for our temporary works scheme at 120 Fleet Street in London **(Figure 1)**. This involved establishing a fabrication workshop within the existing basement area and selecting suitable steels for deconstruction from the upper floors. The steel elements are then transported through the building via crane support, modified and certified to facilitate propping of the new retaining wall and gantry requirements.

The above amounted to a saving of 180t of imported steelwork to the project. In addition, a saving of 432t of carbon was realised compared with the fabrication of imported steel. Surplus steel sections from this structure are being used on other Erith schemes across London as plunge column, gantry and raking prop steel.

## The reusable steel producer

**Bill Firth (EMR)**

EMR has for many years supported the production of low-carbon steel through the manufacture and delivery of high-quality

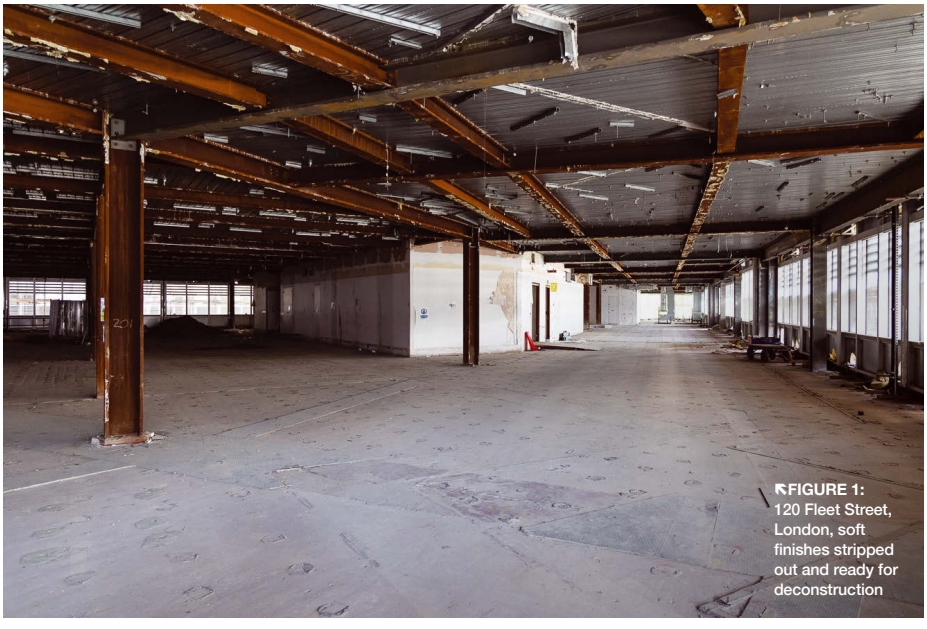


**FIGURE 1:** 120 Fleet Street, London, soft finishes stripped out and ready for deconstruction


FIGURE 2: Centre Block, Ottawa, Canada, during reconstruction following 1916 fire

secondary (scrap) metal for use by the steel industry. An important material flow has and continues to arise from the demolition sector and the firm works closely with its suppliers to deliver a service that enables approx. 99% of metals to be recycled from such schemes.

EMR has recognised there is an increased awareness and demand for reduced-carbon materials and, as such, has taken the decision to introduce a reusable steel service which integrates and complements its established metal recycling activities. This combined offer allows it to work with customers to proactively identify steel sections which have the potential to be reused and those which will be recycled prior to the building being taken down.

Working closely with engineers, developers and architects, EMR put in place a process that enables the potentially reusable sections to be carefully removed, whereupon they are delivered to its reusable steel facilities to be rigorously tested in accordance with the SCI Reusable Steel Protocol[6].

Those which meet the necessary standards become part of EMR's reusable steel stock, whereas sections that fail are transferred into normal recycling activities for sale to conventional steelmakers. The ability to undertake these evaluation processes away from the active (de)-construction site means that delays are minimised to the programme, providing time and space to thoroughly assess the materials at its reusable steel locations. This also allows the return of any additional value from the production of reusable steel sections back into the project to compensate for any increased costs of deconstruction and any redesign considerations, so barriers that can constrain the market for reusable steels are overcome.

Reusable steel sections are catalogued according to serial size and length before being shared with an ever-increasing number of customers, which include steel fabricators, developers, design professionals and, more recently, steel stockholders. EMR is aware that reusable steel activities could be considered disruptive to the established and mature constructional steels sector and has been working collaboratively with many of the organisations across the supply chain to enable all to benefit from the growth of a reusable steel market.

The carbon reductions that can be achieved through reusable sections are transformational and EMR's published Environmental Product Declaration (EPD)[7] indicates reused steel will be 97% lower than the World Steel Association blended average figure of 1850kg$CO_2$e/t of new steel products. However, reusable steels should be seen as part of the overall mix of suitable materials to be utilised within a construction project and reusable steels are already being incorporated as part of the steel work design alongside new products.

EMR is beginning to build a scalable reusable steel service and is keen to do this in collaboration with other partners, to ensure it becomes a mainstream option, which can take advantage of using reusable steels within current projects to dramatically reduce embodied carbon within the short, medium and longer term.

## The fabricator

**Nigel Moss (Bourne Group)**

As we transition to a net-zero world, through campaigns such as SteelZero and accreditation to Responsible Steel standards, steel producers will develop and deliver products with ever-decreasing embodied carbon levels. While new technologies and investments come on stream, steel will continue to support the circular economy through the longevity of the structures built, adaptability of those structures for repurpose or refurbishment, relative ease of deconstruction and reuse, or ultimately through 100% recyclability without loss of original properties.

Modern structural steel production embraces every facet of technology, from 3D design and detailing, building information modelling collaboration and electronic planning, to process recording, computer numerical-controlled (CNC) equipment and handling systems. Combined with one of the most refined stockholding and material supply chains in the world, steel production offers the epitome of a design for manufacture and assembly (DfMA) approach to construction, but with the flexibility to produce some of the most complex and varying structures on the planet. Simply varying the material input from prime new steel to selected reused sections is a change, but it is wholly deliverable.

As with any production flow, adding process may increase time and costs, but these should not be disproportionate to the prized carbon reduction gain. We have the tools – a *Model specification for the purchase of reclaimed steel sections*[8] to be used in conjunction with the National Structural Steelwork Specification along with SCI guidance[5] for the assessment, testing and design of those sections. Appropriately accredited fabricators applying their normal processes to reclaimed materials in accordance with these protocols should CE/UKCA Mark their products as per current legislation.

Collaboration through the whole value chain can create and sustain a supply system that economically harvests suitable steel, de-fabricates to an appropriate level, tests and delivers materials into the production process with almost zero embodied carbon. With some adjustments to the fabrication and checking regimes, production of reused sections to a certified stand is achievable today. Constraints will be limited to the availability of material, but these will ease over time as stocks grow.

## The engineer

**David Leversha (WSP)**

The role of the structural engineer in driving the successful implementation of reused structural steel cannot be understated. Some organisations may not be aware of the

opportunities available to save carbon through the reuse approach, while others may need to be convinced on safety and quality grounds. The recently published model specification[8] by the BCSA and SCI guidance[5] should provide absolute reassurance to all involved with regards to the safety associated with the reuse of steel elements.

Though greater stockpiles of reused steel are being generated, some flexibility on section sizes is required. WSP has developed a script to map existing stock from EMR against its Revit models to assess the potential opportunity for reused steel on a particular project in London.

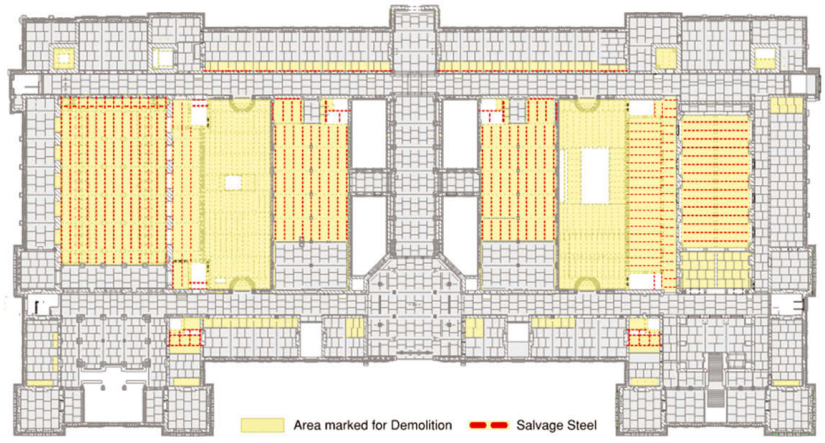
Like so many challenges with the climate emergency, the opportunity to flip a situation upside down is imperative to drive change. Where reused steel is exposed in the new project, there is a real opportunity to tell an honest story with regards to the reused nature of the sections by highlighting and celebrating web plates/bolt holes that remain in place, rather than extensive reworking that adds cost but no real value. Proposed guidance and a grading system is outlined in a recent UKGBC blog[9].

WSP currently has a number of active schemes in early stages of development where the client has expressed a desire to utilise reused structural steel elements. The Centre Block rehabilitation of the Canadian Parliament Buildings **(Figure 2)**, originally built in the 1920s, has identified over 4500 structural steel elements that needed to be removed as part of the extensive renovation works **(Figure 3)**.

While the SCI guidance places restrictions on steel produced prior to 1971, the National Building Code of Canada allows a yield strength of 210MPa to be utilised, which was a great starting point. Extensive testing for strength, plastic deformation and weldability was undertaken to validate that 210MPa is a suitable design strength, maximising the amount of steel for reuse in new-build areas of the project.

The current design has identified 1700 elements for reuse within the project, roughly 25% of the new build, with a projected saving of 750t$CO_2$e. In addition, the remaining elements will be triaged for potential reuse in another redevelopment project within the Parliamentary Precinct, an opportunity to save up to another 900t$CO_2$e.

**FIGURE 3:** Centre Block, Ottawa, Canada. Plan of anticipated demolition and salvage of steel for level 2




## The client

**Steve Gilchrist (Grosvenor Property UK)**

It is overly simplistic to think that what the client wants is what the client gets. Recent years have seen the client brief evolve rapidly. Once ambitious sustainability targets only ever seen on large poster projects are now commonplace across the industry. But things never stand still, and now we have successfully raised the floor in terms of industry understanding and ability to deliver sustainable buildings, we are turning our attention to the circular economy. This is an opportunity to dial up the performance of developments and also very easy to understand when you boil down the idea to first principles (not using new if existing is available).

Is it down to the clients to ask for 'circular design' in their briefs? In theory, yes, but in order to unlock this we need to tackle the challenge from all flanks. Clients must absolutely demand that buildings are designed to be as circular as possible; however, the wider project team and the industry need to show what it is possible and how viable it is.

Designers should look for opportunities to introduce circularity into their designs, whether this is through flexible zones, early interaction with the supply chain, influencing procurement routes or looking to the future with design for deconstruction. Grosvenor works with consultants who are brilliant and are learning how to show the organisation the benefits of reusing material, playing a crucial role in pulling information together to help make informed decisions.

The supply chain can help clients understand the information they need. Gaps in the market are appearing and some companies are looking to fill this with the offer of an inventory of tested, de-fabricated steel, essentially ready to go into a fabrication shop – just like new steel would.

Aside from clients setting a simple brief, they can do their bit too. Understanding that this part of the industry is going through some growing pains is important. It challenges the way clients procure works and how able they are to estimate and fix things like cost and programme.

## Conclusion

In conclusion, if all necessary procedures have been followed and the building cannot be refurbished, there are no technical barriers to deconstructing the asset and maintaining structural steel elements at their highest value state for utilisation in temporary or permanent works. This may also be possible for other materials, although the challenges may be greater. The cost gap between scrappage value and the purchase of new steel also provides a significant financial incentive leading to an overall cost-neutral position.

Testing and quality control procedures are clearly articulated within the BCSA specification and SCI reuse protocol, and structural engineers are suitably agile to respond to limited sizes that may be available in the short-to-medium term, while stockholders build their inventories.

While a building formed from 100% reused steel is the ideal, mixing and matching is perfectly reasonable, allowing fabricators to seek out the lower-carbon sections where available.

From today, any stakeholder on a project needs to collaborate and drive circular economy principles by:

- challenging and setting the brief early alongside engagement with the supply chain
- being flexible on programme, procurement and price – or the mechanisms behind these
- deconstructing – it's not just about buying materials but also putting them into the market
- focusing on the long term when making decisions
- sharing their experiences with the industry.

The cultural change required to think differently and break down perceived blockers is vital. With significant global price volatility and international supply chain uncertainty, the time is right to embrace the reuse of structural steel and to realise the significant embodied carbon savings available from our historic assets.

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