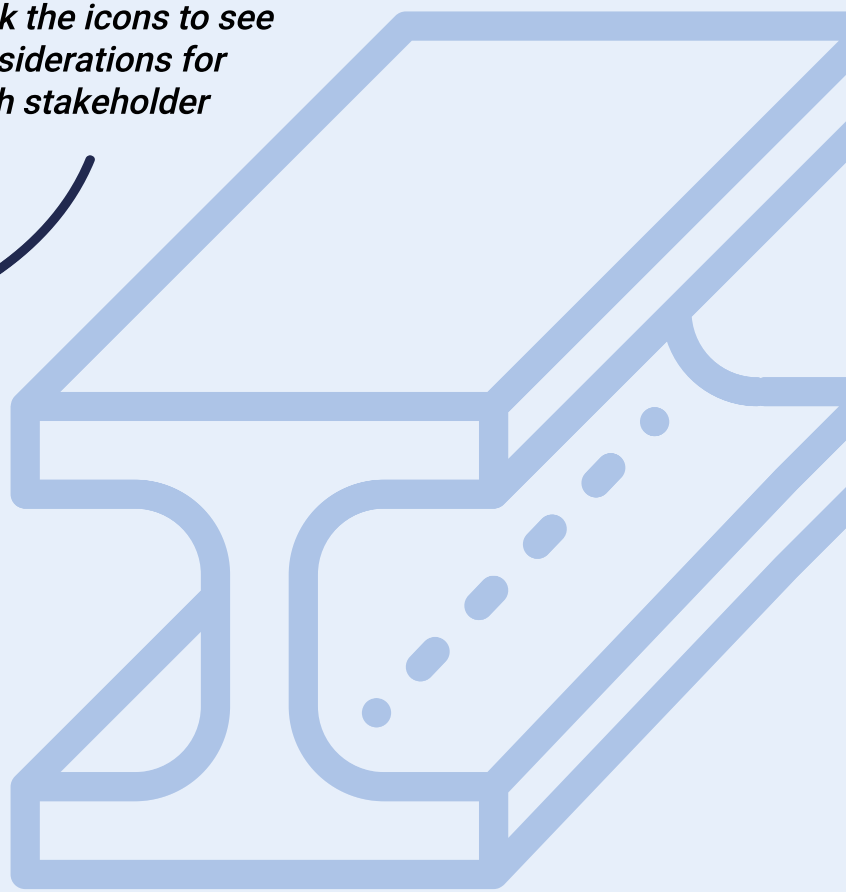
DISRUPT - Delivering Innovative Steel ReUse ProjecT

CONSIDERATIONS FOR STEEL REUSE

A set of business considerations has been developed for major supply chain stakeholders involved in steel reuse, ranging from demolition contractors to clients. These considerations cover technical, supply chain, economic, and carbon savings, as well as other benefits.

Click the icons to see considerations for each stakeholder

- **Demolition Contractor**
- **Stockholder**
- **Steel Contractor (Fabricator)**
- **Steelwork Erector**
- **Main Contractor**
- **Cost Consultant and Project Manager**
- **Designer**
- **Client**



Demolition Contractor

TECHNICAL

Pre-demolition audits (to ascertain which structural steel maybe suitable for reuse, the quantities, its condition and potential age)

Specifications/requirements from clients (to recover a certain amount of steel, in certain conditions and/or specific steel elements)

Demolition approach to recover steel sections

Ability to use existing demolition equipment to reclaim steel or utilise different equipment

Health and safety considerations (careful demolition/deconstruction may possess more injury risks)

SUPPLY CHAIN

Time constraints (it may take more time than usual although not necessarily as depends on the type of structure, the complexity of connections, composite materials and other factors)

Storage on site (might need to store large quantities of reclaimed steel on site)

Transportation of reclaimed steel elements

Demand for reclaimed steel (versus demand for scrap steel)

ECONOMIC

Potential cost increase in case of delays to the demolition programme (although not necessarily as this depends on the complexity of the project)

Payment for reclaimed steel (versus payment sent for recycling, and agreeing on the payment rate)

Potential increased labour costs (not necessarily as depends on the complexity of the project)

Potential increased machinery/ equipment cost (not necessarily as depends on the complexity of the project)

Cash flow (versus quick payment for steel scrap sent for recycling)

CARBON & OTHER

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Carbon savings and environmental benefits

Pre-demolition audits (to ascertain which structural steel maybe suitable for reuse, the quantities, its condition and potential age)

According to Protocol SCI P427 for assessment, testing and design principles for structural steel reuse, the following steel sections are acceptable for reuse:

- Steelwork no older than 1970;
- No built-up members (unless welds are tested);
- No spliced members (the individual lengths of a member with a bolted or welded splice can be disassembled/cut and reclaimed; otherwise, welds need to be tested);
- No significant section loss due to corrosion (loss exceeding 5% of the element thickness is considered significant);
- No signs of fire exposure;
- No evidence of plasticity observed in the steel surface or corrosion protection;
- Members must meet the geometric tolerances of BS EN 1090-2 (straightening can be performed if tolerances are not met). Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

An updated version of SCI P427 has been drafted and is currently under review by the BCSA's Steel Reuse working group. This revised version is expected to be launched in April or May of 2023 and will enable the reuse of steel sections dating back to 1932.

Furthermore, a project led by Heyne Tillett Steel is currently underway to explore the potential for reusing concrete encased steel structures built prior to the 1970s. It is estimated that approximately 50% of steel in London is encased in concrete, which means that the outcomes of this project could stimulate the reuse of a significant amount of steelwork in the capital. More information: https://www.istructe.org/resources/blog/reuse-of-1950s-concrete-encased-steel-at-cundy-str/

Greater London Authority requires conducting pre-demolition audits for major developments in London. The audit should be undertaken by a third-party independent specialist with expertise in reclamation of materials. The pre-demolition audits should be accompanies with: justification for demolition, summary of the key components and materials in the existing buildings and whether they are suitable for reclamation, and Circular Economy Statements demonstrating how building materials/components and products will be disassembled and reused at the end of their life. Reference: https://www.london.gov.uk/sites/default/files/circular_economy_statements_lpg.pdf

BREEAM targets require that a third-party independent of the project conducts the pre-demolition audit.

NFDC provides guidance for demolition contractors on conducting pre-demolition audits through the Demolition & Refurbishment Resource Protocol DRG116:2019. Reference: https://demolition-nfdc.com/wp-content/uploads/2022/07/DRG116_Demolition_and_Refurbishment_Resource_Protocol_2019-1.pdf

When measuring steel during the pre-demolition audit, it is important to consider that the recovered steel will be shorter in length. Typically, cutting off the steel at the ends is the most efficient way to reclaim steel. In this case, approximately 70% of the yield is usually recovered. Around 15% of the steel, in terms of weight, is typically found in the connections, and will be cut off.

Demolition Contractor

Specifications/requirements from clients (to recover a certain amount of steel, in certain conditions and/or specific steel elements)

In Enfield Council's Meridian Water project, a formal agreement between donor and recipient projects and deconstruction specifications were put in place. Specifications for the demolition contractor included requirements to exclude end plates and connections of steel elements, requirements to the length of steel elements (above 3m and not exceeding 12m), and condition of steel (undamaged from a structural perspective, such as not being bent and not subject to dynamic loading).

Demolition Contractor

Demolition approach to recover steel sections

Compared to BAU, a slightly different demolition approach might be required to reclaim steel from a building. For example, under BAU conditions, one strategy for demolition is to cut steel into small sections and drop them down a lift shoot. However, this approach is not appropriate for steel reuse, as the recovered steel elements should not be bent or structurally compromised.

Deconstruction is commonly associated with unbolting steel sections, which can be unproductive since connections tend to be highly individual and it is unlikely an identical connection will be used on the new building. Instead, cutting the section 1 metre away from the connections (and recovering the middle parts) can be more efficient.

As steel sections are usually cut off at the ends when recovered, it is important to consider that the recovered steel will be shorter in lengths. Around 15% of the weight of steel is in connections which, which will be cut off. On average, a 70% yield is expected when recovering steel from a building.

As projects vary, different demolition approaches might be required. For example, in the Holbein Gardens project, the steel sections from the Bermondsey site had simple bolted connections that were easy to dismantle. Therefore, the steel sections were unbolted during the demolition process.

Demolition Contractor

Ability to use existing demolition equipment to reclaim steel or utilise different equipment

Demolition contractors can use their existing equipment to reclaim steel elements. However, they may need to use additional of different types of equipment such as additional mobile cranes, mini spider cranes, or additional road closures.

A demolition contractor interviewed are developing an innovative robotic approach to assist and improve reclamation of steel from buildings.

Demolition Contractor

Health and safety considerations (careful demolition/ deconstruction may possess more injury risks)

Additional health and safety considerations due to deconstruction/ careful demolition include increased exclusion zones, additional lifting operations and access requirements.

For example, in the Holbein Gardens project, health and safety factors had economic implications. In this project, steel had to be supported on scaffold towers before being unbolted, which added significant costs. It is important to note that in this particular instance, steel sections were unbolted, whereas cutting off steel at the ends could have fewer implications.

There is also an argument that whilst health and safety is a consideration, it may not be a primary concern. The maturity of the industry should be such that health and safety is engrained into current practices, and demolition processes are highly automated. Therefore, health and safety is likely a perceived risk but not necessarily something that would affect the project.

NFDC provides the following recommendations for recovering steel sections:

- Use correct protective equipment for removing bolts and mortar.
- Wear gloves when handling steel sections with damaged edges, galvanised or coated in fire retardant paints to prevent irritation, cuts and splinters.
- Wear eye protection when using hand tools.
- Do not walk on wet and slippery steel.
- Only use harness protection at height as a last resort.
- Only use 360 plant, attachments or cutting tools if properly trained.
- Use appropriate respiratory protection equipment with a cutting torch.

Reference: http://nfdc-drids.com/drid/metal/m1-steel.html

Demolition Contractor

Time constraints (it may take more time than usual although not necessarily as depends on the type of structure, the complexity of connections, composite materials and other factors)

It is important to understand the program implications of steel reuse and time constraints.

For example, the idea of recovering steel from the original building and incorporating it into the new building on the same site was explored at the Holbein Gardens project. This would have required recovering the steel during demolition in a controlled manner, transporting the steel sections to testing facilities, sorting, inspecting, and cleaning the steel, and then refabricating it. These processes would have taken around 6 to 8 weeks, which the program did not allow for. Therefore, the recovered steel elements were reused in the client's other projects, whereas reclaimed steel sections from other buildings which were available were incorporated.

In one of the case studies, there was a marked increase in the programme time required to facilitate the demolition of the steel frame by dismantling. However, the additional demolition costs are expected to be compensated by the reduced material costs for the new building.

Storage on site (might need to store large quantities of reclaimed steel on site)

Storage is managed usually in two ways:

- Agreeing upon a rate with a stockholder and moving steel sections off-site as quickly as possible, to avoid storing the material on-site.
- storing material on-site when there is available storage space, such as in projects involving partial demolition. However, on-site storage can be very limited, especially in central London projects.

In the Meridian Water project, an additional cost of £40 per tonne was estimated for the demolition contractor to place primary steels in the holding area for collection.

Demolition Contractor

Transportation of reclaimed steel elements

Depending on the length of reclaimed materials, standard-length lorries might not be suitable, and extendable trailers might be required for transportation.

Depending on the project location, if space is an issue, more attention to route planning might be required, including issues such as parking on-site, SWEEP path analysis (evaluation of the space required when a vehicle makes turning manoeuvres), etc.

Demolition Contractor

Demand for reclaimed steel (versus demand for scrap steel)

Recycling is an established route, and there is a clear demand for scrap steel. However, presently, there is also high demand for reclaimed steel for reuse, and payment for reusable steel can be the same or higher than that for scrap steel, notwithstanding carbon and other benefits.

Demolition Contractor

Payment for reclaimed steel (versus payment sent for recycling, and agreeing on the payment rate)

The value of reclaimed steel for reuse is higher than the value of scrap sent for recycling.

In the client driven steel reuse model, demolition contractors do not get paid specifically for the recovered material, as the clients retain ownership over the reclaimed steel. However they will still need to be paid for the resources required for deconstruction.

In the stockholder driven steel reuse model, demolition contractors own the recovered materials and sell them to a stockholder at an agreed rate, which might depend on the length of the recovered sections, condition, available information, and other factors. This model can be profitable.

Payment estimations for recovering steel are not clearly established as it is not a widespread practice. This might depend on the complexity of works, any additional time added to the demolition programme, extra equipment needed, and additional labour required for recovering steel from a building.

Companies with no prior experience in reclaiming steel may perceive it as high risk and charge a premium, while those with experience or a thorough understanding of the process may minimise perceived risks and not charge extra.

Demolition Contractor

Potential increased labour costs (not necessarily as depends on the complexity of the project)

Depending on the conditions of each project, more planning and labour might be required. Additionally, more training of operatives might be necessary to ensure that the recovered steel is in an acceptable condition compared to business as usual.

Demolition Contractor

Competitive advantage

There is a high demand for steel reuse in the industry, but a lack of supply, so 'early adopters' will benefit.

Demolition Contractor

Carbon savings and environmental benefits

A key consideration to drive steel reuse is incentivising asset owners to encourage demolition contractors to recover steel from demolished buildings.

Currently, clients or asset owners are driving the demand for reuse in the market. However, the supply chain is not yet well-established or adequately stocked. Consequently, prominent asset owners are retrieving steel from their own buildings for reuse in their projects. This is further incentivised by the fact that most of the carbon benefit is credited to the recipient building, while the environmental benefit for the demolished building is relatively insignificant.

In sustainability assessments of construction works, steel reuse is included in Module D. Module A involves sourcing and production of the construction products and their assembly into buildings Module B involves the use of the building over its design life. Module C involves the end-of-life of the building including demolition and disposal of the demolition waste. Module D is a supplementary module that includes the reuse and recycling potentials of materials recovered from the end-of-life of buildings.

There is a view that steel reuse should be included in Module A or similar to Module A, specific targets should be established for Module D.

Including steel reuse in Module A, which is currently prioritised, would incentivise asset owners to increase the recovery of steel from demolition sites.

More information: https://steelconstruction.org/resources/sustainability-faqs/what-is-module-d-and-how-do-i-use-it/
https://www.ukgbc.org/news/steel-reuse-challenges-and-opportunities/

Stockholder

TECHNICAL

Reclaimed steel condition and sizes

Initial processing of reclaimed steel (this includes removing existing fittings, fixing holes, removing coatings and paints)

Testing and quality assurance (arrangements with testing laboratories)

Material information (including drawings from the demolished building, original certificates, grade and properties of steel sections, etc. Having material provenance is crucial since steel from certain sources may not acceptable for reuse. Having information on steel sections facilitates the testing and certification process)
spark test to identify chemical compositions)

SUPPLY CHAIN

Limited availability of reclaimed steel for reuse

Storage (large stockyards and inventory)

Lead times (turnover of reclaimed steel is slower than new steel)

Additional equipment for reconditioning reclaimed steel (such as sandblasting equipment to remove paintings and coatings)

Product liability insurance

Possibility to invest in non-destructive testing technologies (to identify material properties quickly at low cost on site, such as hardness test and electric spark test to identify chemical compositions)

ECONOMIC

Material costs (purchasing reclaimed steel)

Cost of product types/ applications (selling reclaimed steel)

Selling cycle (short selling cycle versus long selling cycle)

Cost of testing

Contracts (for reserving materials or agreeing on the process route for materials. This could include deposits and storage fees)

Storage fees

CARBON & OTHER

Reporting and carbon savings

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Environmental Product Declaration (EPD)/LCA (Life Cycle Assessment)

Reclaimed steel condition and sizes

Reclaimed steel sections can come in a variety of conditions. It is important that the reclaimed steel is structurally compliant, for example, it should not be twisted or have plastic deformation.

To distinguish between the different types of reclaimed steel, Elliott Wood and Cleveland Steel and Tubes have proposed a grading system. Reference: https://www.ukgbc.org/news/reusing-steel-how-do-you-know-what-your-second-hand-steelwork-is-going-to-look-like/

When considering reclaimed steel, longer length sections are generally preferable over shorter ones as steel sections tend to get shorter after being recovered from the building. Additionally, irregular size sections are less desirable.

An updated version of SCI P427 has been drafted and is currently under review by the BCSA's Steel Reuse working group. This revised version is expected to be launched in April or May of 2023 and will enable the reuse of steel sections dating back to 1932.

Furthermore, a project led by Heyne Tillett Steel is currently underway to explore the potential for reusing concrete encased steel structures built prior to the 1970s. It is estimated that approximately 50% of steel in London is encased in concrete, which means that the outcomes of this project could stimulate the reuse of a significant amount of steelwork in the capital. More information: https://www.istructe.org/resources/blog/reuse-of-1950s-concrete-encased-steel-at-cundy-str/

Stockholder

Initial processing of reclaimed steel (this includes removing existing fittings, fixing holes, removing coatings and paints, etc.)

The level of processing depends on the aspirations of the clients and architects in terms of what the final product is going to look like, and whether the steel will be exposed or enclosed in a building.

Reclaimed steelwork may have holes and marks from previous use. Retaining the original holes would be economically beneficial, since less rework is required. However, grinder marks will remain on the steel permanently and can transmit through the paint. If the steel is going to be exposed, it is necessary to reach an agreement with clients on what can be accepted aesthetically.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Stockholder

Testing and quality assurance

Stockholders typically oversee the testing of reclaimed steel. Protocol SCI P427 outlines the principles for assessing and testing structural steel reuse. Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

Testing is conducted by independent accredited laboratories.

The testing process can usually be completed within a week, depending on the arrangements with testing laboratories and other factors.

Stockholder

Material information (including drawings from the demolished building, original certificates, grade and properties of steel sections, etc. Having material provenance is crucial since steel from certain sources may not acceptable for reuse. Having information on steel sections facilitates the testing and certification process)

According to Protocol SCI P427 for assessment, testing and design principles for structural steel reuse, the following steel sections are acceptable for reuse:

- Steelwork no older than 1970;
- No built-up members (unless welds are tested);
- No spliced members (the individual lengths of a member with a bolted or welded splice can be disassembled/cut and reclaimed; otherwise, welds need to be tested);
- No significant section loss due to corrosion (loss exceeding 5% of the element thickness is considered significant);
- No signs of fire exposure;
- No evidence of plasticity observed in the steel surface or corrosion protection;
- Members must meet the geometric tolerances of BS EN 1090-2 (straightening can be performed if tolerances are not met).

SCI P427 outlines the material information that should be recorded and associated with each structural member, including the building age, drawings of the original building, steel grade, and mechanical properties. The document also lists the material properties that should be declared for reclaimed steelwork according to BS EN 1090-2.

Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

Stockholder

Additional equipment for reconditioning reclaimed steel (such as sandblasting equipment to remove paintings and coatings)

While shotblasting equipment is typically used by stockholders, in some cases, sandblasting equipment may be necessary to remove thick paints and coatings from reclaimed steel, as these can absorb shots and are difficult to remove. However, the use of sandblasting equipment is less common in comparison to shotblasting equipment.

Stockholder

Product liability insurance

As steel reuse is not yet common, there could be some ambiguities with warranties depending on the steel reuse model.

Overall, fabricators are expected to issue a manufacturing warranty for the reclaimed steel. They would look for product liability insurance from the reuse specialist (which could be a stockholder or stock owner). Additionally, a structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

More ambiguities could arise in the client driven steel reuse model. The clients retain ownership over the products throughout the entire steel reuse process and act as suppliers of steel. Some possible scenarios include:

The client might take PI insurance if the steel comes from one of their donor buildings, or they would insure the steel and fabricators would supply PI on the fabricated and erected element of it.

Stockholder

Limited availability of reclaimed steel for reuse

There are two types of reclaimed stock:

- overstock and steel sections from cancelled projects, for example, where the steel has already been fabricated for a project but the order has been cancelled. These steels may come in like-new condition, and

- steel reclaimed from buildings, which could have original paints, holes, and fittings from its previous use.

Stockholder

Storage (large stockyards and inventory)

The storage and inventory of reclaimed steel can be more complex since reclaimed steel does not come in standardised lengths. Inventories of steel stock should be up to date and made available to designers etc

Stockholder

Selling cycle (short selling cycle versus long selling cycle)

In traditional stockholding, steel is purchased and delivered within a short period of time, typically within a couple of months. However, in the steel reuse scenario, materials can be procured early in the project, such as at the design stage, and must be reserved and stored for a long time, often years, before they are delivered to the construction site.

Stockholder

Cost of testing

The costs of testing vary depending on the fees of each testing body. In the EU, testing fees tend to be three times higher than in the UK.

Stockholder

Storage fees

When reclaimed steel is reserved long in advance, storage fees may apply.

Additionally, storage fees are also a consideration when stockholders do not own the reclaimed steel but instead, provide storage and initial reconditioning services.

Stockholder

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

There is a lot of demand for steel reuse in the industry and a lack of supply, so ‘early adopters’ will benefit.

Stockholder

Environmental Product Declaration (EPD)/LCA (Life Cycle Assessment)

EMR has produced an EPD for their reusable steel. Reference: https://emrglobalstorage.blob.core.windows.net/sitemedia/uploads/reusable-steel-edp-2023.pdf

Cleveland Steel and Tubes have produced an LCA for their steel tubes recovered
and refurbished coated steel tubes. Reference: https://cleveland-steel.com/sites/default/files/2020-01/CST-life-cycle-analysis.pdf

John Lawrie have produced an LCA for their repurposed steel tubulars. Reference: https://uploads-ssl.webflow.com/612f56d40abf3fb6874ef134/614496ce7d750c22fdd43ec3_John%20Lawrie%20Tubulars%20Life%20Cycle%20Assessment%20Giraffe%20Innovation%20Ltd_CONDENSED%20VERSION.pdf

Stockholder

Steel Contractor (Fabricator)

TECHNICAL

Using existing equipment to fabricate reclaimed steel

Production line slowing down (reclaimed steel can take longer to fabricate)

Material information (such as age of structure, material properties, physical inspection records, tests conducted, CE mark)

Technical performance of reclaimed steel sections (inspection for damage such as a survey of existing bolts, and manufacturing tolerances)

Warranties

Surface condition (appearance of steel including surface imperfections)

SUPPLY CHAIN

Lead in times (processing reclaimed steel can take longer)

Limited availability of reclaimed steel for reuse

Procurement of reclaimed steel

Additional considerations:

Materials tagging (to increase traceability and facilitate steel reuse)

ECONOMIC

Payment for fabricating reclaimed steel elements

Additional cost (due to more time for fabricating and additional QA)

Risk profile (use of large quantities of reused steel on a project might be perceived to be riskier than new, particularly in the transition phase)

CARBON & OTHER

Reporting and carbon savings

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Using existing equipment to fabricate reclaimed steel

Generally, fabricators can use their existing equipment for processing reclaimed steel, provided that all the existing fittings and paints are removed, which is usually done by stockholders or fabricators themselves. Therefore, they would not need any additional specialised equipment.

Steel Contractor (Fabricator)

Production line slowing down (reclaimed steel can take longer to fabricate)

Most workshops are either semi-automated or fully automated now. However, processing a reclaimed section through an automated line can be more challenging due to the presence of original holes, stiffeners, and dents. This can lead to longer fabrication times for reclaimed steelwork.

The duration of the fabrication ultimately depends on the condition of the reclaimed steelwork and the level to which it was initially processed. Typically, stockholders conduct the initial processing, but fabricators can also do it. For example, steel in new-like conditions from cancelled projects would take very similar time to fabricate. However, steel with existing holes, stiffeners, and dents can take 15 to 20% longer to fabricate, according to two steel contractors with relevant experience.

It is important to note that the experience of fabricators may vary as there is a variety of fabrication equipment types. For instance, one steel contractor stated that they spend some time at the start of the fabrication process to ensure that the reclaimed steel does not damage the machinery. Another steel contractor mentioned that they would run the reclaimed steel through the production line at a slower speed to ensure that any protrusions beyond the envelope of the section do not damage the production capabilities.

Steel Contractor (Fabricator)

Material information (such as age of the structure, information on material properties, records of physical inspection, tests conducted, CE mark)

More details are in the technical guidance documents, namely:

- SCI P427 Structural Steel Reuse. Assessment, Testing and Design Principles.
Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

- BSCA Model Specification for the purchase of reclaimed steel sections. Reference: https://www.steelconstruction.info/images/7/70/BCSA_MS-Reclaimed_Sections.pdf

- Annex J of the National Structural Steelwork Specification.
Reference: https://steelconstruction.org/product/annex-j-sustainability-specification-pdf/#:~:text=The%201st%20edition%20of%20the,revised%20in%20its%208th%20edition

Steel Contractor (Fabricator)

Technical performance of reclaimed steel sections (inspection for damage such as a survey of existing bolts, and manufacturing tolerances)

Please refer to the following industy guidelines:

- SCI P427 Structural Steel Reuse. Assessment, Testing and Design Principles. Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

- BSCA Model Specification for the purchase of reclaimed steel sections. Reference: https://www.steelconstruction.info/images/7/70/BCSA_MS-Reclaimed_Sections.pdf

- Annex J of the National Structural Steelwork Specification. Reference: https://steelconstruction.org/product/annex-j-sustainability-specification-pdf/#:~:text=The%201st%20edition%20of%20the,revised%20in%20its%208th%20edition

There are manufacturing tolerances for rolled steel that new steel must comply with. However, when using reclaimed steel, there may be some deviations from these requirements, which could affect the design assumptions made in the original product.

For instance, if reclaimed steel is bent beyond the original manufacturer's specified tolerances, it could cause issues with design assumptions, as the design may have assumed that the steel was straight.

While requiring reclaimed steel to meet the same tolerances as new steel would be easier, it may result in missing out on a significant amount of usable reclaimed steel that deviates slightly from those tolerances. Therefore, it is crucial to understand what is acceptable in terms of tolerances for reclaimed steel to ensure that it does not undermine design constraints and decisions.

Steel Contractor (Fabricator)

Warranties

The steel fabricator can CE/UKCA mark structural components made from reclaimed steel sections. Pre-2014 steel does not require CE/UKCA marking to be used in a CE/UKCA marked structure. Therefore, as per CPR guidelines, second-hand steel sections mostly do not need to be CE/UKCA marked and can be used in a CE marked structure, subject to their properties being verified through testing.

More details: https://www.istructe.org/journal/volumes/volume-101-(2023)/issue-3/reusing-structural-steel-new-istructe-guide/

Fabricators are responsible for issuing a manufacturing warranty for the reclaimed steel.

They would typically seek product liability insurance from the reuse specialist, which could be either the stockholder or stock owner).

A structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

In the stockholder driven steel reuse model, warranty issues tend to be relatively straightforward since the products are tested and CE marked.

More ambiguities could arise in the client driven steel reuse model, where clients recover steel from their demolished buildings and incorporate it into new ones. Technically, the reusable steel sections do not have to be CE marked since they are not sold on the market. In this model, the clients retain ownership of the products throughout the entire steel reuse process and act as suppliers of steel. Therefore, they could take Professional Indemnity (PI) Insurance, or they could insure the steel while the fabricators would provide PI for the fabricated and erected element of it.

Steel Contractor (Fabricator)

Surface condition (appearance of steel including surface imperfections)

This can be a concern if steel is exposed, e.g. exposed ceilings and facades. Therefore, it is essential to establish a mutual understanding with clients or architects regarding their desired aesthetics for the final product.

However, surface imperfections can also be viewed as a reflection of the steel's origin and a celebration of its reuse.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Steel Contractor (Fabricator)

Limited availability of reclaimed steel for reuse

Currently, there is a demand for steel reuse, but a limited supply of reclaimed steel. This affects various technical, economic, and supply chain factors. However, as the market expands and more reclaimed steel becomes available, many issues related to steel reuse are likely to become more straightforward.

Steel Contractor (Fabricator)

Procurement of reclaimed steel

In the stockholder driven steel reuse model, reclaimed steel is procured from a stockholder who conducts initial processing of steel and coordinates testing and certification. There are two types of reclaimed stock:

- overstock and steel sections from cancelled projects, for example, where the steel has already been fabricated for a project but the order was cancelled. These steels may comes in like-new condition, and

- steel reclaimed from buildings, which could have original paints, holes, and fittings from its previous use.

In the client driven steel reuse model, reclaimed steel is supplied by the client, who recovers steel from their demolished buildings and incorporate into new ones.

Since it is difficult to predict the availability and type of reclaimed materials in advance, there are several approaches to procurement:

- Securing the reclaimed materials early on in the project so that the design is based on the available steel sections;

- Procuring appropriate steel sections based on the predefined design but allowing for design iterations;

- Combining the previous two approaches by reserving materials early in the project and maximizing steel reuse later when possible.

Payment for fabricating reclaimed steel elements

Payment for fabricating steelwork is usually estimated at expected fabricating hours depending on the tonnages, complexity of works, duplicated items and so on.

Payment for fabricating reclaimed steel sections ultimately depends on the condition of the reclaimed steel and the initial processing done to the steelwork.

However, since steel reuse is not a common practice, payment estimations for fabricating reclaimed steelwork is not yet established, and companies with little prior experience in steel reuse might charge premium for the perceived risk. As steel reuse becomes a more common practice, this will be mitigated.

Steel Contractor (Fabricator)

Additional cost (due to more time for fabricating and additional QA)

Fabricators may put more QA into reclaimed steel to make sure that certificates are in place and all the mechanical and chemical tests have been undertaken. These costs might plateau out as fabricators get used to steel reuse.

Steel Contractor (Fabricator)

Steelwork Erector

TECHNICAL	SUPPLY CHAIN	ECONOMIC	CARBON & OTHER
Assembly/fabrications guidance (in case there are spare holes or attachments) **Client support and requirements for steel reuse**	N/A	N/A	**Reporting and carbon savings** **Competitive advantage** (knowledge and experience of steel reuse could provide competitive advantage)

Assembly/fabrications guidance (in case there are spare holes or attachments)

The process of assembling reclaimed steelwork on site is similar to new steel, except of the cases where there are spare holes and attachments. In this case, additional precautions may be necessary during the assembly process to prevent accidents. This could include marking up the required holes to ensure they are not inadvertently used instead of the original holes.

Steelwork Erector

Client support and requirements for steel reuse

It is essential to establish a mutual understanding with clients or architects regarding their desired aesthetics for the final product.

Reclaimed steelwork might have signs of its previous use. However, these can also be viewed as a reflection of the steel's origin and a celebration of its reuse.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Main Contractor

TECHNICAL

Warranties (linked to the quality of steel)

Client support and requirements for steel reuse

SUPPLY CHAIN

Availability of reclaimed steel sizes and sections

Procurement of reclaimed steel

Lead in times (possibility of delays although not necessary)

Storage of reclaimed steel

ECONOMIC

Material costs (cost of reclaimed steel vs virgin steel)

Possibility of increased costs in case of delays (although not necessary, as this largely depends on how the material is being procured. If the material is readily available, procurement can be even quicker than new steel)

Contracts (for reserving materials or agreeing on the process route for materials. This could include deposits and storage fees)

CARBON & OTHER

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Carbon savings and environmental benefits

Warranties (linked to the quality of steel)

Warranty issues are one of the major factors for main contractors.

Main contractors rely on fabricators who issue manufacturing warranties. Also, they rely on structural engineers who provide their professional indemnity as a function of their services.

In general:

Fabricators are responsible for issuing a manufacturing warranty for the reclaimed steel.

They would typically seek product liability insurance from the reuse specialist, which could be either the stockholder or stock owner).

A structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

In the stockholder driven steel reuse model, warranty issues tend to be relatively straightforward since the products are tested and CE marked.

More ambiguities could arise in the client driven steel reuse model, where clients recover steel from their demolished buildings and incorporate it into new ones. Technically, the reusable steel sections do not have to be CE marked since they are not sold on the market. In this model, the clients retain ownership of the products throughout the entire steel reuse process and act as suppliers of steel. Therefore, they could take Professional Indemnity (PI) Insurance, or they could insure the steel while the fabricators would provide PI for the fabricated and erected element of it.

Main Contractor

Client support and requirements for steel reuse

It is essential to establish a mutual understanding with clients or architects regarding their desired aesthetics for the final product, steel reuse targets, and other issues related to steel reuse.

In terms of aesthetics, reclaimed steelwork might have signs of its previous use. However, these can also be viewed as a reflection of the steel's origin and a celebration of its reuse.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Availability of reclaimed steel sizes and sections

Currently, there is a demand for steel reuse, but a limited supply of reclaimed steel. This affects various technical, economic, and supply chain factors. However, as the market expands and more reclaimed steel becomes available, many issues related to steel reuse are likely to become more straightforward.

Main Contractor

Procurement of reclaimed steel

In the stockholder driven steel reuse model, reclaimed steel is procured from a stockholder who conducts initial processing of steel and coordinates testing and certification. There are two types of reclaimed stock:

- overstock and steel sections from cancelled projects, for example, where the steel has already been fabricated for a project but the order was cancelled. These steels may comes in like-new condition, and

- steel reclaimed from buildings, which could have original paints, holes, and fittings from its previous use.

In the client driven steel reuse model, reclaimed steel is supplied by the client, who recovers steel from their demolished buildings and incorporate into new ones.

Since it is difficult to predict the availability and type of reclaimed materials in advance, there are several approaches to procurement:

- Securing the reclaimed materials early on in the project so that the design is based on the available steel sections;

- Procuring appropriate steel sections based on the predefined design but allowing for design iterations;

- Combining the previous two approaches by reserving materials early in the project and maximising steel reuse later when possible.

Main Contractor

Lead in times (possibility of delays although not necessary)

This mainly depends on the procurement route.

Delays are more likely to happen in the client driven steel reuse model, as recovering steel from a building might result in additional time to the demolition programme.

For example, the idea of recovering steel from the original building and incorporating them into the new building on the same site was explored at the Holbein Gardens project. However, this would have required recovering the steel during demolition in a controlled manner, transporting the steel sections to testing facilities, sorting, inspecting, and cleaning the steels, and then refabricating them. These processes would have taken around 6 to 8 weeks, which the program did not allow for. Therefore, the recovered steel elements were reused in the client's other projects, whereas reclaimed steel sections from other buildings were incorporated.

Additionally, in one of the projects we reviewed, there was a marked increase in the programme time required to facilitate the demolition of the steel frame by dismantling. However, the additional demolition costs are expected to be compensated by the reduced material costs for the new building.

Main Contractor

Storage of reclaimed steel

This is linked to the issue of transfer of ownership over reclaimed steel, i.e. who owns steel and at which stage.

For example, in the stockholder driven steel reuse model, stockholders usually store the reclaimed steel until it is supplied to the construction site.

In the client driven steel reuse model, clients retain ownership over reclaimed steel throughout the demolition and new development. Reclaimed steel can possibly be stored at demolition/construction site. However, storage space can be limited, especially in central London projects. Another possibility is when stockholders store the material and also conduct initial processing and coordinate testing. In this case, storage fees may apply.

Main Contractor

Material costs (cost of reclaimed steel vs virgin steel)

The cost of reclaimed steel ultimately depends on the cost of new versus scrap steel, as well as the costs of recovering steel from a building, initial processing, testing, fabricating, and transportation. As a commodity traded product, the price of steel is subject to fluctuations, and the price of scrap steel is also affected by it.

In the stockholder driven steel reuse model, procuring/reserving reclaimed materials early in the project allows fixing the price so that estimated steel costs remain the same as actual.

In the client driven steel reuse model, steel from demolished buildings is incorporated into new buildings, so steel price fluctuations have no effect on the material costs.

In the Brent Cross Town Primary Substation project, reclaimed steel was reserved long in advance. Later on, the prices of new steel increased dramatically, but this did not affect the viability of the project as the price of the reclaimed steel was fixed and remained the same. This led to an economic advantage in this project.

Main Contractor

Possibility of increased costs in case of delays (although not necessary, as this largely depends on how the material is being procured. If the material is readily available, procurement can be even quicker than new steel)

In this steel reuse domestic refurbishment project, procuring reclaimed steel from the stockholder had only a 4-day lead time, which is significantly quicker than procuring new steel.

Main Contractor

Cost Consultant and Project Manager

TECHNICAL

Pre-demolition audits (to ascertain potential steelwork suitable for reuse their condition and quantities and age)

Warranties and insurance

SUPPLY CHAIN

Availability of reclaimed materials

Possible construction project delays (perceived complexities due to steel reuse being uncommon practice)

ECONOMIC

Consultant QS (unfamiliarity with the steel reuse process might lead cost consultants to price projects at higher rates, which discourages steel reuse)

Mitigating steel price fluctuations

Value engineering (considering embodied carbon along with cost factor)

CARBON & OTHER

Reporting and carbon savings

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Pre-demolition audits (to ascertain potential steelwork suitable for reuse their condition and quantities and age)

According to Protocol SCI P427 for assessment, testing and design principles for structural steel reuse, the following steel sections are acceptable for reuse:

- Steelwork no older than 1970;
- No built-up members (unless welds are tested);
- No spliced members (the individual lengths of a member with a bolted or welded splice can be disassembled/cut and reclaimed; otherwise, welds need to be tested);
- No significant section loss due to corrosion (loss exceeding 5% of the element thickness is considered significant);
- No signs of fire exposure;
- No evidence of plasticity observed in the steel surface or corrosion protection;
- Members must meet the geometric tolerances of BS EN 1090-2 (straightening can be performed if tolerances are not met). Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

An updated version of SCI P427 has been drafted and is currently under review by the BCSA's Steel Reuse working group. This revised version is expected to be launched in April or May of 2023 and will enable the reuse of steel sections dating back to 1932.

Furthermore, a project led by Heyne Tillett Steel is currently underway to explore the potential for reusing concrete encased steel structures built prior to the 1970s. It is estimated that approximately 50% of steel in London is encased in concrete, which means that the outcomes of this project could stimulate the reuse of a significant amount of steelwork in the capital. More information: https://www.istructe.org/resources/blog/reuse-of-1950s-concrete-encased-steel-at-cundy-str/

Greater London Authority requires conducting pre-demolition audits for major developments in London. The audit should be undertaken by a third-party independent specialist with expertise in reclamation of materials. The pre-demolition audits should be accompanies with: justification for demolition, summary of the key components and materials in the existing buildings and whether they are suitable for reclamation, and Circular Economy Statements demonstrating how building materials/components and products will be disassembled and reused at the end of their life. Reference: https://www.london.gov.uk/sites/default/files/circular_economy_statements_lpg.pdf

BREEAM targets require that a third-party independent of the project conducts the pre-demolition audit.

NFDC provides guidance for demolition contractors on conducting pre-demolition audits through the Demolition & Refurbishment Resource Protocol DRG116:2019. Reference: https://demolition-nfdc.com/wp-content/uploads/2022/07/DRG116_Demolition_and_Refurbishment_Resource_Protocol_2019-1.pdf

When measuring steel during the pre-demolition audit, it is important to consider that the recovered steel will be shorter in length. Typically, cutting off the steel at the ends is the most efficient way to reclaim steel. In this case, approximately 70% of the yield is usually recovered. Around 15% of the steel, in terms of weight, is typically found in the connections, and will be cut off.

Cost Consultant and Project Manager

Warranties and insurance

The project manager (PM) and quantity surveyor (QS) are often the ones most concerned about warranties.

In general:

Fabricators are responsible for issuing a manufacturing warranty for the reclaimed steel.

They would typically seek product liability insurance from the reuse specialist, which could be either the stockholder or stock owner).

A structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

In the stockholder driven steel reuse model, warranty issues tend to be relatively straightforward since the products are tested and CE marked.

More ambiguities could arise in the client driven steel reuse model, where clients recover steel from their demolished buildings and incorporate it into new ones. Technically, the reusable steel sections do not have to be CE marked since they are not sold on the market. In this model, the clients retain ownership of the products throughout the entire steel reuse process and act as suppliers of steel. Therefore, they could take Professional Indemnity (PI) Insurance, or they could insure the steel while the fabricators would provide PI for the fabricated and erected element of it.

Availability of reclaimed materials

Currently, there is a demand for steel reuse but a limited supply of reclaimed steel. This affects many technical, economic and supply chain factors. However, as the market expands and more steel becomes available, many issues with steel reuse will become more straightforward.

Cost Consultant and Project Manager

Consultant QS (unfamiliarity with the steel reuse process might lead cost consultants to price projects at higher rates, which discourages steel reuse)

If cost consultants do not fully understand the process or lack experience in steel reuse, they may price at much higher rates. Therefore, it is crucial that cost consultants are adequately educated, so they can accurately price for steel reuse. Additionally, obtaining a second opinion on price estimates is also an option.

In the Entopia Building project, the initial cost estimate for the project was a 25% premium, but the team agreed at stage 3 that this was unlikely. Steel reuse proved to be cost neutral in this project. The lack of similar projects to compare with, especially on stage 1, resulted in the discrepancy in the cost estimate.

Mitigating steel price fluctuations

The cost of reclaimed steel ultimately depends on the cost of new versus scrap steel, as well as the costs of recovering steel from a building, initial processing, testing, fabricating, and transportation. As a commodity traded product, the price of steel is subject to fluctuations, and the price of scrap steel is also affected by it.

In the stockholder driven steel reuse model, procuring/reserving reclaimed materials early in the project allows fixing the price so that estimated steel costs remain the same as actual.

In the client driven steel reuse model, steel from demolished buildings is incorporated into new buildings, so steel price fluctuations have no effect on the material costs.

In the Brent Cross Town Primary Substation project, reclaimed steel was reserved long in advance. Later on, the prices of new steel increased dramatically, but this did not affect the viability of the project as the price of the reclaimed steel was fixed and remained the same. This led to an economic advantage in this project

Value engineering (considering embodied carbon along with cost factor)

It is important to consider embodied carbon when conducting value engineering.

In the Brent Cross Town Primary Substation project, the design underwent changes, and the structure was value engineered purely on a weight and cost basis, so some of the pre-sourced reclaimed steel became irrelevant.

Cost Consultant and Project Manager

Designer

TECHNICAL

Material information (CE mark, material history, properties, original specification, information on steel condition, if steel was subject to dynamic loading, age of steel, etc.)

Pre-demolition audits (specifying and possibly conducting pre-demolition audits to ascertain what materials can be reclaimed and gather material information)

Design based on available steel sections and procurement route

Design efficiency (avoid using larger sections than required)

Design iterations (based on available reclaimed steel sizes and lengths)

Tolerances

SUPPLY CHAIN

Availability of reclaimed steel

Reclaimed steel sizes and lengths

Possibility of longer design times (particularly in case of design iterations)

Storage of reclaimed steel (considering whether clients have sufficient space on their site to store reclaimed steel or if it is necessary to involve stockists, etc.)

Aesthetics (particularly if steel is exposed. Also includes different section sizes, splicing details, connection details, etc.)

Client targets (help to achieve client targets, e.g. low carbon, circular economy, sustainability)

ECONOMIC

Cost of the construction project (with steel reuse versus BAU)

Possible increased design costs (additional design fees in case of design iterations, and more coordination and planning due to steel reuse being uncommon practice)

Contracts (for reserving materials or agreeing on the process route for materials. This could include deposits and storage fees)

Client support and requirements for steel reuse (client briefing and communication)

Professional Indemnity (PI) insurance

CARBON & OTHER

Embodied carbon reduction measurement (facilitated by the availability of EPD and LCAs on reusable steel)

Reporting (CSR and ESG)

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Design for reuse (including modular design, standardised sizes, using longer span beams, avoiding fabricated steel sections, avoiding composite materials such as steelfloor decks, and developing deconstruction plans as part of the design process)

Material information (CE mark, material history, properties, original specification, information on steel condition, if steel was subject to dynamic loading, age of steel, etc.)

Structural engineers may also require the original specifications, information on whether the steel has been exposed to external conditions, and its current condition to determine its strength and suitability for reuse. For instance, if the steel has been subjected to higher loads than originally anticipated, it may be less suitable for reuse.

Protocol SCI P427 outlines material information required for assessment, testing and design for structural steel reuse.
Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

Designer

Pre-demolition audits (specifying and possibly conducting pre-demolition audits to ascertain what materials can be reclaimed and gather material information)

Structural engineers tend to be involved more than usual with the demolition site on projects with steel reuse, where steel sections are reclaimed from buildings and incorporated into new developments (client driven steel reuse model).

When measuring steel during the pre-demolition audit, it is important to consider that the recovered steel will be shorter in length. Typically, cutting off the steel at the ends is the most efficient way to reclaim steel. In this case, approximately 70% of the yield is usually recovered. Around 15% of the steel, in terms of weight, is typically found in the connections, and will be cut off.

According to Protocol SCI P427 for assessment, testing and design principles for structural steel reuse, the following steel sections are acceptable for reuse:

- Steelwork no older than 1970;
- No built-up members (unless welds are tested);
- No spliced members (the individual lengths of a member with a bolted or welded splice can be disassembled/cut and reclaimed; otherwise, welds need to be tested);
- No significant section loss due to corrosion (loss exceeding 5% of the element thickness is considered significant);
- No signs of fire exposure;
- No evidence of plasticity observed in the steel surface or corrosion protection;
- Members must meet the geometric tolerances of BS EN 1090-2 (straightening can be performed if tolerances are not met). Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

An updated version of SCI P427 has been drafted and is currently under review by the BCSA's Steel Reuse working group. This revised version is expected to be launched in April or May of 2023 and will enable the reuse of steel sections dating back to 1932.

Furthermore, a project led by Heyne Tillett Steel is currently underway to explore the potential for reusing concrete encased steel structures built prior to the 1970s. It is estimated that approximately 50% of steel in London is encased in concrete, which means that the outcomes of this project could stimulate the reuse of a significant amount of steelwork in the capital. More information: https://www.istructe.org/resources/blog/reuse-of-1950s-concrete-encased-steel-at-cundy-str/

Designer

Design based on available steel sections and procurement route

The design process for projects involving steel reuse is not significantly different from BAU. The design depends largely on the available materials, including steel section sizes and lengths, and procurement route.

In the client driven steel reuse model, the design of new buildings is restricted to the steel sections available from the demolished buildings. This may lead to design inefficiencies, such as using larger sections than necessary due to limited availability or complications in accommodating existing openings or different openings in the reclaimed steel to put services through.

In the stockholder driven steel reuse model, there tends to be more flexibility in selecting steel sections and lengths.

Overall, the supply of reclaimed steel is currently limited. However, as the market expands, more steel sections will become available, simplifying the design process for steel reuse.

More information about design of buildings with reclaimed steel can be found in Circular economy and reuse: guidance for designers. More information: https://www.istructe.org/journal/volumes/volume-101-(2023)/issue-3/reusing-structural-steel-new-istructe-guide/

Steel that forms part of a tall building's main frame requires additional testing for CE marking, so reusing such steel might be less economic.

In the Elephant & Castle Town Centre Redevelopment project, a digital matching tool developed by WSP was utilised to facilitate the matching of available steel with design requirements.

A similar matching tool was also developed by Heyne Tillett Steel. More details: https://hts.uk.com/news/hts-reused-steel-stock-matcher/

Designer

Design efficiency (avoiding using larger sections than required)

When aiming to maximise steel reuse, it is important to consider design efficiency.

One argument suggests that steelwork that is underutilised by 30% or more should be avoided and used in other projects where it would be more appropriate. As steel reuse becomes more common and reclaimed stock becomes more available, designers will have a broader selection of suitable steel sizes and lengths to choose from.

Designer

Design iterations (based on available reclaimed steel sizes and lengths)

Design iterations may occur when additional materials become available after the final design has been completed, leading to a need to revisit the design in order to maximise the amount of reused steel.

Designer

Tolerances

Tolerances are a crucial consideration in the design process to ensure that the dimensions of the steel beams do not cause problems later on. When using new steel, steel beams can be designed to be the same size. However, when reusing steel, there may be variations in sizes (e.g. steel beam can be 10-20 ml deeper) that need to be accounted for. Therefore, the design team will need to discuss tolerances to ensure they accommodate the reused steel.

Also, there are manufacturing tolerances for rolled steel that new steel must comply with. However, when using reclaimed steel, there may be some deviations from these requirements, which could affect the design assumptions made in the original product. For instance, if reclaimed steel is bent beyond the original manufacturer's specified tolerances, it could cause issues with design assumptions, as the design may have assumed that the steel was straight.

Therefore, it is crucial to understand what is acceptable in terms of tolerances for reclaimed steel to ensure that it does not undermine design constraints and decisions.

Designer

Aesthetics (particularly if steel is exposed. Also includes different steel section sizes, splicing details, connection details, etc.)

This can be a major concern for architects, particularly if steel is external, e.g. exposed ceilings and facades. In this case, more coordination among architects, structural engineers and clients might be required.

However, surface imperfections can also be viewed as a reflection of the steel's origin and a celebration of its reuse.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Designer

Professional Indemnity (PI) insurance

A structural engineer would take some PI on specifying steel reuse. This is similar to BAU.

In general:

Fabricators are responsible for issuing a manufacturing warranty for the reclaimed steel.

They would typically seek product liability insurance from the reuse specialist, which could be either the stockholder or stock owner).

A structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

In the stockholder driven steel reuse model, warranty issues tend to be relatively straightforward since the products are tested and CE marked.

More ambiguities could arise in the client driven steel reuse model, where clients recover steel from their demolished buildings and incorporate it into new ones. Technically, the reusable steel sections do not have to be CE marked since they are not sold on the market. In this model, the clients retain ownership of the products throughout the entire steel reuse process and act as suppliers of steel. Therefore, they could take Professional Indemnity (PI) Insurance, or they could insure the steel while the fabricators would provide PI for the fabricated and erected element of it.

Designer

Additional considerations:

Design for reuse (including modular design, standardised sizes, using longer span beams, avoiding fabricated steel sections, avoiding composite materials such as composite steel floor decks, and developing deconstruction plans as part of the design process)

Industry guides commonly suggest designing new buildings with bolted connections instead of welded ones. However, connections tend to be highly individual for buildings, and it is unlikely that a new building would have identical connections to the donor building. Additionally, bolts are typically coated with spray, which can impact paint settings, making it time and cost-prohibitive to unbolt steel sections. Instead, cutting steel at the ends of connections during demolition/deconstruction might be a better solution. This means that unless connections are standardised, designing buildings with bolted connections would not necessarily facilitate steel reuse.

Longer steel sections are more likely to be reused than shorter ones because they have a higher residual value and can be cut further.

In terms of avoiding fabricated steel sections, openings in the sections to pass services through are usually designed bespoke, so that is quite limiting for steel reuse. Additionally, it can be more complex for architects to level office floors with terraces when using pre-fabricated steel sections.

Designer

Availability of reclaimed steel

Currently, there is a demand for steel reuse but a limited supply of reclaimed steel. This affects many technical, economic and supply chain factors. However, as the market expands and more steel becomes available, many issues with steel reuse will become more straightforward.

Designer

Reclaimed steel sizes and lengths

Reclaimed steel tends to be shorter than new steel. It gets shorter from the process of being reclaimed from buildings and after initial processing such as removing attachments.

Designer

Possible increased design costs (additional design fees in case of design iterations, and more coordination and planning due to steel reuse being uncommon practice)

If sourcing material during the design, a lot more surveying and on-site involvement may be required, especially in the client driven steel reuse model. This model involves designing a new building based on steel sections recovered from a demolished (donor) building. In such cases, designers can be more involved with the demolition process, such as conducting/commissioning pre-demolition audits and site visits

Designer

Embodied carbon reduction measurement (facilitated by the availability of EPD and LCAs on reusable steel)

EMR has produced an EPD for their reusable steel. Reference: https://emrglobalstorage.blob.core.windows.net/sitemedia/uploads/reusable-steel-edp-2023.pdf

Cleveland Steel and Tubes have produced an LCA for their steel tubes recovered and refurbished coated steel tubes. Reference: https://cleveland-steel.com/sites/default/files/2020-01/CST-life-cycle-analysis.pdf

John Lawrie have produced an LCA for their repurposed steel tubulars. Reference: https://uploads-ssl.webflow.com/612f56d40abf3fb6874ef134/614496ce7d750c22fdd43ec3_John%20Lawrie%20Tubulars%20Life%20Cycle%20Assessment%20Giraffe%20Innovation%20Ltd_CONDENSED%20VERSION.pdf

Designer

Embodied carbon reduction measurement (facilitated by the availability of EPD and LCAs on reusable steel)

EMR has produced an EPD for their reusable steel. Reference: https://emrglobalstorage.blob.core.windows.net/sitemedia/uploads/reusable-steel-edp-2023.pdf

Cleveland Steel and Tubes have produced an LCA for their steel tubes recovered and refurbished coated steel tubes. Reference: https://cleveland-steel.com/sites/default/files/2020-01/CST-life-cycle-analysis.pdf

John Lawrie have produced an LCA for their repurposed steel tubulars. Reference: https://uploads-ssl.webflow.com/612f56d40abf3fb6874ef134/614496ce7d750c22fdd43ec3_John%20Lawrie%20Tubulars%20Life%20Cycle%20Assessment%20Giraffe%20Innovation%20Ltd_CONDENSED%20VERSION.pdf

Designer

Client

TECHNICAL

Feasibility assessment of steel reuse (investigating what steel is available from demolished buildings or on the market, and whether this can be reused effectively in new developments)

Specifying steel reuse in new developments wherever practical or possible (this includes setting contractual requirements)

Demolition/deconstruction specifications (to recover steel from demolished buildings suitable for further reuse)

Warranties and technical assurances

Aesthetics (the appearance of reclaimed steel, especially if exposed)

SUPPLY CHAIN

Availability of reclaimed steel

Procurement of reclaimed steel

Possible construction project delays and demolition/ deconstruction delays (although not necessary, as this largely depends on how the material is being procured. If the material is readily available, procurement can be even quicker than new steel)

Storage of reclaimed steel

Additional considerations:

Requesting design for reuse for new buildings

ECONOMIC

Project budget

Costs in case of construction project delays and demolition/ deconstruction delays

Upfront investment for investigating what steel is available and whether it is feasible to reuse it, as well as deposits for securing steelwork

Mitigating steel price fluctuations

Contracts (for reserving materials or agreeing on the process route for materials. This could include deposits and storage fees)

CARBON & OTHER

Reporting (CSR, ESG and shareholder/funding requirements for sustainability, low carbon solutions and circular economy)

Competitive advantage (knowledge and experience of steel reuse could provide competitive advantage)

Incentives for clients to request recovering steel at the demolition stage

Feasibility assessment of steel reuse (investigating what steel is available from demolished buildings or on the market, and whether this can be reused effectively in new developments)

According to Protocol SCI P427 for assessment, testing and design principles for structural steel reuse, the following steel sections are acceptable for reuse:

- Steelwork no older than 1970;
- No built-up members (unless welds are tested);
- No spliced members (the individual lengths of a member with a bolted or welded splice can be disassembled/cut and reclaimed; otherwise, welds need to be tested);
- No significant section loss due to corrosion (loss exceeding 5% of the element thickness is considered significant);
- No signs of fire exposure;
- No evidence of plasticity observed in the steel surface or corrosion protection;
- Members must meet the geometric tolerances of BS EN 1090-2 (straightening can be performed if tolerances are not met). Reference: https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

An updated version of SCI P427 has been drafted and is currently under review by the BCSA's Steel Reuse working group. This revised version is expected to be launched in April or May of 2023 and will enable the reuse of steel sections dating back to 1932.

Furthermore, a project led by Heyne Tillett Steel is currently underway to explore the potential for reusing concrete encased steel structures built prior to the 1970s. It is estimated that approximately 50% of steel in London is encased in concrete, which means that the outcomes of this project could stimulate the reuse of a significant amount of steelwork in the capital.

More information: https://www.istructe.org/resources/blog/reuse-of-1950s-concrete-encased-steel-at-cundy-str/

Greater London Authority requires conducting pre-demolition audits for major developments in London. The audit should be undertaken by a third-party independent specialist with expertise in reclamation of materials. The pre-demolition audits should be accompanies with: justification for demolition, summary of the key components and materials in the existing buildings and whether they are suitable for reclamation, and Circular Economy Statements demonstrating how building materials/components and products will be disassembled and reused at the end of their life. Reference: https://www.london.gov.uk/sites/default/files/circular_economy_statements_lpg.pdf

BREEAM targets require that a third-party independent of the project conducts the pre-demolition audit.

NFDC provides guidance for demolition contractors on conducting pre-demolition audits through the Demolition & Refurbishment Resource Protocol DRG116:2019. Reference: https://demolition-nfdc.com/wp-content/uploads/2022/07/DRG116_Demolition_and_Refurbishment_Resource_Protocol_2019-1.pdf

When measuring steel during the pre-demolition audit, it is important to consider that the recovered steel will be shorter in length. Typically, cutting off the steel at the ends is the most efficient way to reclaim steel. In this case, approximately 70% of the yield is usually recovered. Around 15% of the steel, in terms of weight, is typically found in the connections, and will be cut off.

Client

Demolition/deconstruction specifications (to recover steel from demolished buildings suitable for further reuse)

In the Enfield Council's Meridian Water project, a formal agreement between donor and recipient projects and deconstruction specifications were put in place. Specifications for the demolition contractor included requirements to exclude end plates and connections of steel elements, requirements to the length of steel elements (above 3m and not exceeding 12m), and condition of steel (undamaged from a structural perspective, such as not being bent and not subject to dynamic loading).

Client

Warranties and technical assurances

In general:

Fabricators are responsible for issuing a manufacturing warranty for the reclaimed steel.

They would typically seek product liability insurance from the reuse specialist, which could be either the stockholder or stock owner).

A structural engineer would take Professional Indemnity (PI) insurance on specifying steel reuse.

In the stockholder driven steel reuse model, warranty issues tend to be relatively straightforward since the products are tested and CE marked.

More ambiguities could arise in the client driven steel reuse model, where clients recover steel from their demolished buildings and incorporate it into new ones. Technically, the reusable steel sections do not have to be CE marked since they are not sold on the market. In this model, the clients retain ownership of the products throughout the entire steel reuse process and act as suppliers of steel. Therefore, they could take Professional Indemnity (PI) Insurance, or they could insure the steel while the fabricators would provide PI for the fabricated and erected element of it.

Aesthetics (the appearance of reclaimed steel, especially if exposed)

The appearance of reclaimed steel can be a concern for some clients, particularly if steel is external, e.g. exposed ceilings and facades. In this case, more coordination with architects, structural engineers and steel contractors might be required.

However, surface imperfections can also be viewed as a reflection of the steel's origin and a celebration of its reuse.

In the Holbein Gardens project, the client was happy that the material had evidence of a previous life, and some beams with existing holes were left exposed.

Client

Additional considerations:

Requesting design for reuse for new buildings

The Greater London Authority encourages design for disassembly for major developments across London.

Reference: https://www.london.gov.uk/sites/default/files/circular_economy_statements_lpg.pdf

Client

Availability of reclaimed steel

Currently, there is a demand for steel reuse but a limited supply of reclaimed steel. This affects many technical, economic and supply chain factors. However, as the market expands and more steel becomes available, many issues with steel reuse will become more straightforward.

Client

Procurement of reclaimed steel

Currently, there are two major steel reuse models depending on the procurement route.

In the stockholder driven steel reuse model, reclaimed steel is procured from a stockholder who conducts initial processing of steel and coordinates testing and certification. There are two types of reclaimed stock:
- overstock and steel sections from cancelled projects, for example, where the steel has already been fabricated for a project but the order was cancelled. These steels may comes in like-new condition, and
- steel reclaimed from buildings, which could have original paints, holes, and fittings from its previous use.

In the client driven steel reuse model, reclaimed steel is supplied by the client, who recovers steel from their demolished buildings and incorporate into new ones.

Since it is difficult to predict the availability and type of reclaimed materials in advance, there are several approaches to procurement:
- Securing the reclaimed materials early on in the project so that the design is based on the available steel sections;
- Procuring appropriate steel sections based on the predefined design but allowing for design iterations;
- Combining the previous two approaches by reserving materials early in the project and maximising steel reuse later when possible.

Client

Possible construction project delays and demolition/ deconstruction delays (although not necessary, as this largely depends on how the material is being procured. If the material is readily available, procurement can be even quicker than new steel)

This is linked to the steel reuse model and procurement route:

In the client driven steel reuse model, steel is recovered from the client's demolished buildings and integrated into new developments. The challenge is that demolition should align with the new building development, and demolition delays may affect the construction process. Therefore, it is important to understand the program implications of steel reuse and time constraints.

For example, in one of the projects we reviewed, there was a marked increase in the programme time required to facilitate the demolition of the steel frame by dismantling. However, the additional demolition costs are expected to be compensated by the reduced material costs for the new building.

In two more projects, the 55 Great Suffolk Street and Holbein Gardens, steel reuse did not have implications on the project timeline. The reused material was sourced in advance of production requirements and was available when required.

In the stockholder driven steel reuse model, steel is purchased on the open market from steel stockholders. Depending on the available stock, the procurement process can be very quick.

For example, in this domestic refurbishment project, procuring reclaimed steel from the stockholder had only a 4-day lead time, which was significantly quicker than procuring new steel.

Client

Storage of reclaimed steel

This depends on the steel reuse model.

In the stockholder driven steel reuse model, steel is procured from stockholders who provide storage. Storage fees and contracts may apply.

In the client driven model, reclaimed steel from demolished buildings can be stored on site if possible, for example, in projects with partial demolition. Alternatively, reclaimed steel can be sent to stockholders for initial processing and storage. Storage fees and contractors may also apply.

Client

Project budget

Several projects reviewed within the DISRUPT project resulted in, or are expected to result in, economic savings from steel reuse. These projects are:

- Brent Cross Town Primary Station project
- Sloane Square House
- Steel reuse agricultural buildings
- Steel reuse domestic refurbishment project
- Steel reuse for offshore wind farm

Client

Costs in case of construction project delays and demolition/deconstruction delays

A major perceived barrier, particularly in the client driven steel reuse mode, is the additional programme time, which can cause the developers to lose out on income e.g. commercial rent.

Client

Mitigating steel price fluctuations

The cost of reclaimed steel ultimately depends on the cost of new versus scrap steel, as well as the costs of recovering steel from a building, initial processing, testing, fabricating, and transportation. As a commodity traded product, the price of steel is subject to fluctuations, and the price of scrap steel is also affected by it.

In the stockholder driven steel reuse model, procuring/reserving reclaimed materials early in the project allows fixing the price so that estimated steel costs remain the same as actual.

In the client driven steel reuse model, steel from demolished buildings is incorporated into new buildings, so steel price fluctuations have no effect on the material costs.

In the Brent Cross Town Primary Substation project, reclaimed steel was reserved long in advance. Later on, the prices of new steel increased dramatically, but this did not affect the viability of the project as the price of the reclaimed steel was fixed and remained the same. This led to an economic advantage in this project

Client

Reporting (CSR, ESG and shareholder/funding requirements for sustainability, low carbon solutions and circular economy)

In the 55 Great Suffolk Street project, the upfront embodied carbon of the building (modules A1-A5) was estimated to be 386kgCO2e/m2 owing to steel reuse, representing a 36% reduction compared to the LETI 2020 design target of 600kgCO2e/m2.

Client

Incentives for clients to request recovering steel at the demolition stage

Currently, clients or asset owners are driving the demand for reuse in the market. However, the supply chain is not yet well-established or adequately stocked. Consequently, prominent asset owners are retrieving steel from their own buildings for reuse in their projects. This is further incentivised by the fact that most of the carbon benefit is credited to the recipient building, while the environmental benefit for the demolished building is relatively insignificant.

Therefore, a key consideration is incentivising asset owners to encourage demolition contractors to recover steel from demolished buildings.

In sustainability assessments of construction works, steel reuse is included in Module D. Module A involves sourcing and production of the construction products and their assembly into buildings Module B involves the use of the building over its design life. Module C involves the end-of-life of the building including demolition and disposal of the demolition waste. Module D is a supplementary module that includes the reuse and recycling potentials of materials recovered from the end-of-life of buildings.

There is a view that steel reuse should be included in Module A or similar to Module A, specific targets should be established for Module D.

Including steel reuse in Module A, which is currently prioritised, would incentivise asset owners to increase the recovery of steel from demolition sites.

More information: https://steelconstruction.org/resources/sustainability-faqs/what-is-module-d-and-how-do-i-use-it/

https://www.ukgbc.org/news/steel-reuse-challenges-and-opportunities/

Client