structural steel reuse

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Steel and the circular economy
The Building Centre, London
30 November 2016
the case for structural steel reuse
SUSTAINABLE MATERIALS
WITH BOTH EYES OPEN

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www.withbotheyesopen.com
global flows of steel

Global steel flows for 2008 in million tonnes

Cullen, Alwood, Bambach
... and energy inputs
the economic margin
availability of used structural steel

Structural steel scrap arising from demolitions - prediction

- Consumption of structural steel (sections, fabricated sections, hollow sections)
- Prediction of structural steel scrap arising from demolition (INPUT as sections, hollow sections, plates)
- Steel sections sent for recycling or reuse as 40% of metals sent for recycling of reuse - NFDC data - kt
successful reuse of structural steel

740 Rue Bel-Air
Montreal, Quebec

BedZED
London
successful reuse of structural steel

Carrwood Park, Doncaster

Blue Steel Building, Leeds
successful reuse of structural steel

Kings Science Academy, Bradford

University Technical College, Leeds
successful reuse of structural steel

9 Cambridge Ave
(Segro), Slough

Honda Warehouse,
Swindon
why is reuse not happening at scale?

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Reuse</th>
<th>Recycle</th>
<th>Landfill</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Steel Construction Institute</td>
<td>12%</td>
<td>93%</td>
<td>5%</td>
<td>Heavy sections</td>
</tr>
<tr>
<td>2006</td>
<td>Gorgolewski et al.</td>
<td>10%</td>
<td>90%</td>
<td>nil</td>
<td>Sections, Canada</td>
</tr>
<tr>
<td>2012</td>
<td>EUROFER</td>
<td>7%</td>
<td>96%</td>
<td>2%</td>
<td>Heavy sections</td>
</tr>
</tbody>
</table>

Reuse rates in the UK for structural steel are low and are falling
**hypothesis : current practice**

**Buyer**  
Wants reused steel for new building

**Small-scale local reuse**  
Reuse happens when the buyer and seller can easily communicate, or are the same entity

**Seller**  
Wants to sell a property or building

**Designer**  
(Engineer / Architect) designs building

Requests reused steel for project

**Fabricator**  
Frames incorporate reused steel sections

Designs for reused sections
hypothesis : where we would like to be

Buyer
wants reused steel for new building

Requests reused steel for project

Small-scale local reuse
Reuse happens when the buyer and seller can easily communicate, or are the same entity

Designer
(engineer/architect)
designs building

Generic design for new or reused steel

Seller
wants to sell a property or building

Sees value in extracting old steel from building

Demolition contractor
deconstructs building to recover steel

Delivers reused steel to stockist

Fabricator
frames incorporate reused steel sections

Full-scale reuse market
Steel stockist holds certified reused steel
Clients / designers not part of decision-making

Stockist
holds new and certified reused steel
hypothesis: a step along the way

Client
- wants reused steel for new building
- Requests reused steel for project

Small-scale local reuse
- Reuse happens when the buyer and seller can easily communicate, or are the same entity

Designer
- (engineer/architect)
- designs building
- Generic design for new or reused steel

Supply—demand website
- Linking demand and supply for reuse steel
- Regular updates of quantities and timing

Demolition contractor
- deconstructs building to recover steel
- delivers reused steel to stockist

Developer
- wants to sell a property or building
- Sees value in extracting old steel from building

Fabricator
- frames incorporate reused steel sections

Full-scale reuse market
- Steel stockist holds certified reused steel
- Clients/designers not part of decision-making

Stockist
- holds new and certified reused steel
the barriers to structural steel reuse
Building lifecycle and supply chain actors

- Client
- Architect
- Main contractor
- Demolition contractor

Concept → Design → Construction → Use → Demolition

- Structural engineer
- Fabricator
- Mill
- Stockist
- Recycling route
- Reuse route

Links between the actors is critical
Barriers to structural steel reuse identified in the literature

- **Profit opportunity/cost**
  additional cost and risk of reusing steel

- **Programme**
  disruptions causing delays to the project timeline

- **Quality/certification/traceability**
  certifying the properties of structural steel

- **Availability/Dimensions**
  difficulties sourcing the correct section sizes

- **Old/New perception**
  concerns that reused steel is inferior

- **Trust/Lack of communication**
  issues of trust and liability

- **Uncommon practice**
  reluctance to change current practices

- **Design for deconstruction**
  challenges in recovering sections from buildings
experience of steel reuse

38 interviewees from 30 semi-structured interviews
24 respondents to on-line surveys
Similar scores for the survey and interviews gives confidence in the results.
**Salience score**

*Salience* is the state or condition of being prominent

\[
\text{Salience score} = \frac{n_g}{N_g} \times \frac{N}{n_b}
\]

- \(n_g\) – number of mentions of barrier in group
- \(N_g\) – number of respondents in group
- \(N\) – total number of respondents
- \(n_b\) – number of mentions of barrier across all interviewees

A higher salience score indicates that a barrier is particularly important to that actor.
salience: barrier ranking, by actor

- Profit opportunity/cost
- Quality/certification/traceability
- Availability/Dimensions
- Uncommon practice
- Old/New perception
- Programme
- Trust/Lack of communication
- Design for deconstruction

Architects & Clients
Structural Engineers
Main Contractors
Fabricators
Stockists
Demolition Contractors
salience: actor ranking, by barrier

[Bar chart showing salience scores for various barriers, with different colored points representing different actor groups.]
perception of costs and programme

Perceptions taken from the on-line survey

- Green: Less Costly/Faster/Easier
- Indifferent
- Orange: Somewhat more costly
- Red: More costly/Slower/Harder
the costs of structural steel reuse
costs considered

- Transport and handling
- Storage/administration
- Price of steel elements
- Premium for uncommon sections
- Connection design
- Profit margin
- Fabrication operations
  recondition costs, cutting, welding, drilling, etc.
- Materials
  bolts, primer
- Erection
- Deconstruction
  as opposed to demolition
- Testing and certification
- Coating and fire protection

Costs were reconstructed from the information given in interviews
the cost structure for reuse

New Steel price -- Reconstruction from individual operation costings

Reuse steel price -- Reconstruction from individual operation costings

Legend

Other Costs
- Transportation/Handling
- Testing
- Paint

Steel cost
- Operating and profit margins of stockist
- Cost of steel

Fabrication Costs
- Bolts/Primer
- Connection design
- Administration
- Erection
- Cutting, drilling, welding, shotblasting

Recondition Costs
- Shotblasting
- Deconstruction
- Removing plates/welds

Examples of successful reuse case studies

Reusing steel elements
- Whole structure
- Reinforcing old structures

Baseline comparison between reuse and new steel
the cost structure for reuse

The cost of reusing steel at scale is at least as expensive as new steel.
successful reuse case studies?

three types of successful case study
Three types of successful reuse case studies

- minimal sourcing or stocking of steel required (grey)
- transport costs are minimised (black); testing or engineering judgement
- examples: BedZED, Carwood Park, 740 Rue Bel-Air
Three types of successful reuse case studies

- **Refurbishment of structure in situ (with strengthening)**

- testing costs are eliminated (grey), but onsite fabrication increases (pink)
- transport (black) and stocking (light grey) costs are reduced
- examples: Blue Steel, Kings Science, UTC
successful reuse case studies

Three types of successful reuse case studies

Relocation of entire structure to new site

- minimal sourcing or stocking of steel required (grey)
- testing required (blue), fabrication costs are reduced (pink)
- examples: Segro, Honda Warehouse, Portal Power
Conclusions

Motivation

• The economic margin and availability of old steel sections appear to favour reuse

• Several successful case studies of structural steel reuse exist
Conclusions

Findings

• Different barriers to reuse affect different actors along the supply chain

• Barriers are most salient for fabricators, stockists and demolition contractors

• Barrier perception and reality are not always aligned
Conclusions

Findings

• The costs of reusing structural steel at scale are at least as high as specifying new steel

• Successful examples of reuse can be explained by the elimination of one or more of the cost components

• Three types of successful case studies are identified:
  - Recovered sections reused in new design
  - Refurbishment of structure in situ (with strengthening)
  - Relocation of entire structure to new site
thank you

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