



Steel construction and the circular economy

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7th June 2016



Some definitions

- Reuse
 - Use again in same form; minor alterations
- Recycling
 - Process of converting waste into a new product
- Downcycling
 - Recycling to a lower value
- Recyclable



Steel in construction



Fundamental material
properties



Properties of structural
steel systems

Fundamental properties of steel

- Versatile 3,500 different grades
- Durable and strong
- Infinitely recycled (multi-cycled)
- No loss of properties
- Magnetic properties assist recovery & sorting
- Economic value ensures recovery
- Global infrastructure for trading scrap steel
- Energy/carbon intensive in production



Steel construction products



50%
Construction

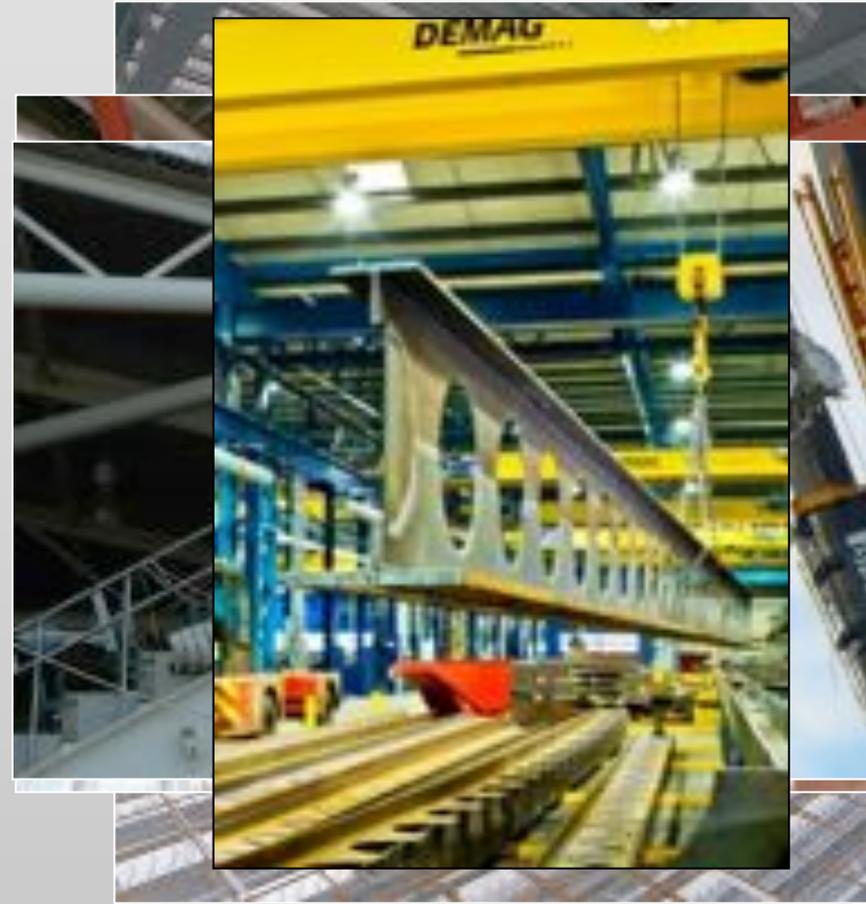


11%
Metal
products

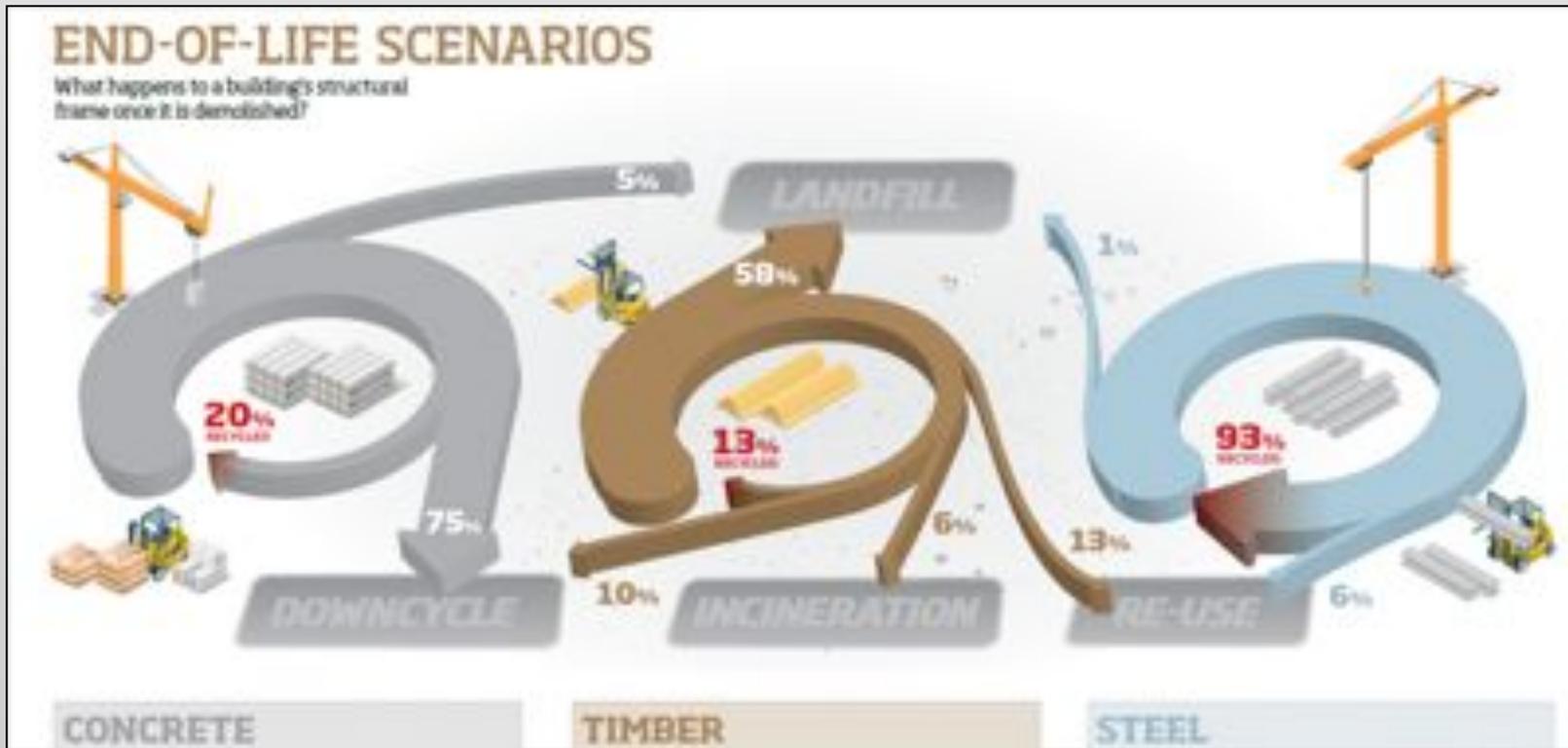


Fundamental properties of steel structures

- Structurally efficient
- Lightweight
- Manufactured off-site
- Fast, predictable programme
- Flexible & adaptable
- Theoretically reusable



All materials are not the same at EOL



All materials are not the same at EOL

Concrete



75% crushed
Landfill avoided
Primary aggregates saved
'Downcycling'

Timber



14% downcycled
23% incinerated
46% energy recovery
16% landfilled
- Decomposition CO_2 CH_4
- Landfill gas capture (51%)

Steel



99% recycled or reused
Landfill avoided
Primary steel saved
'True recycling'

Reuse and recycling rates

Product	% Reused	% Recycled	% Lost
Heavy structural sections/tubes	7	93	0
Rebar (in concrete superstructures)	0	99	0
Rebar (in concrete sub-structure or foundations)	0	99	0
Steel piles (sheet and bearing)	0	99	0
Light structural steel	0	99	0
Profile steel cladding (roof/facade)	0	99	0
Internal light steel (e.g. plaster profiles, door frames)	0	99	0
Other (e.g. stainless steel)	4	95	1
Average (across all products)	5	91	4



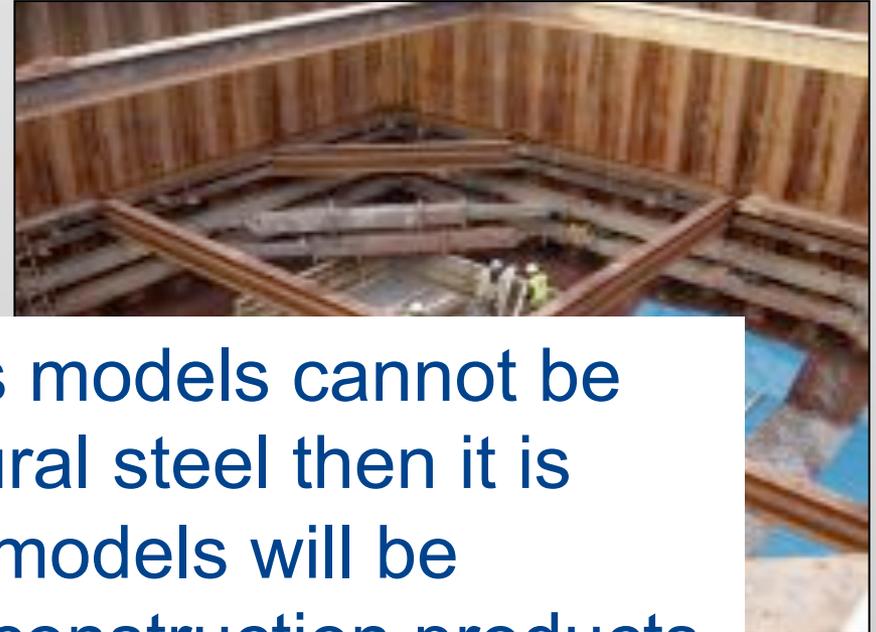
Survey of NFDC members, 2013

Why reuse?



- Move up waste hierarchy
- Save resources
- Reduce carbon emissions
- Save money
- Security of supply

Many reusable steel systems



If viable CE business models cannot be developed for structural steel then it is hard to see how CE models will be achievable for other construction products



Structural steel reuse

- In-situ or relocated
- All building or part of building
- Component or element

Warehouse refurbishment, UK



Before



After

Warehouse refurbishment, UK

- Portal frame raised by 3m
- Existing purlins, bracing and rafters reused
- New office block added (composite metal decking)
- Clad in steel sandwich panels



SEGRO relocation case study

- 3,180m² office and warehouse (2000)
- Relocated 1 mile away
- Slough trading estate



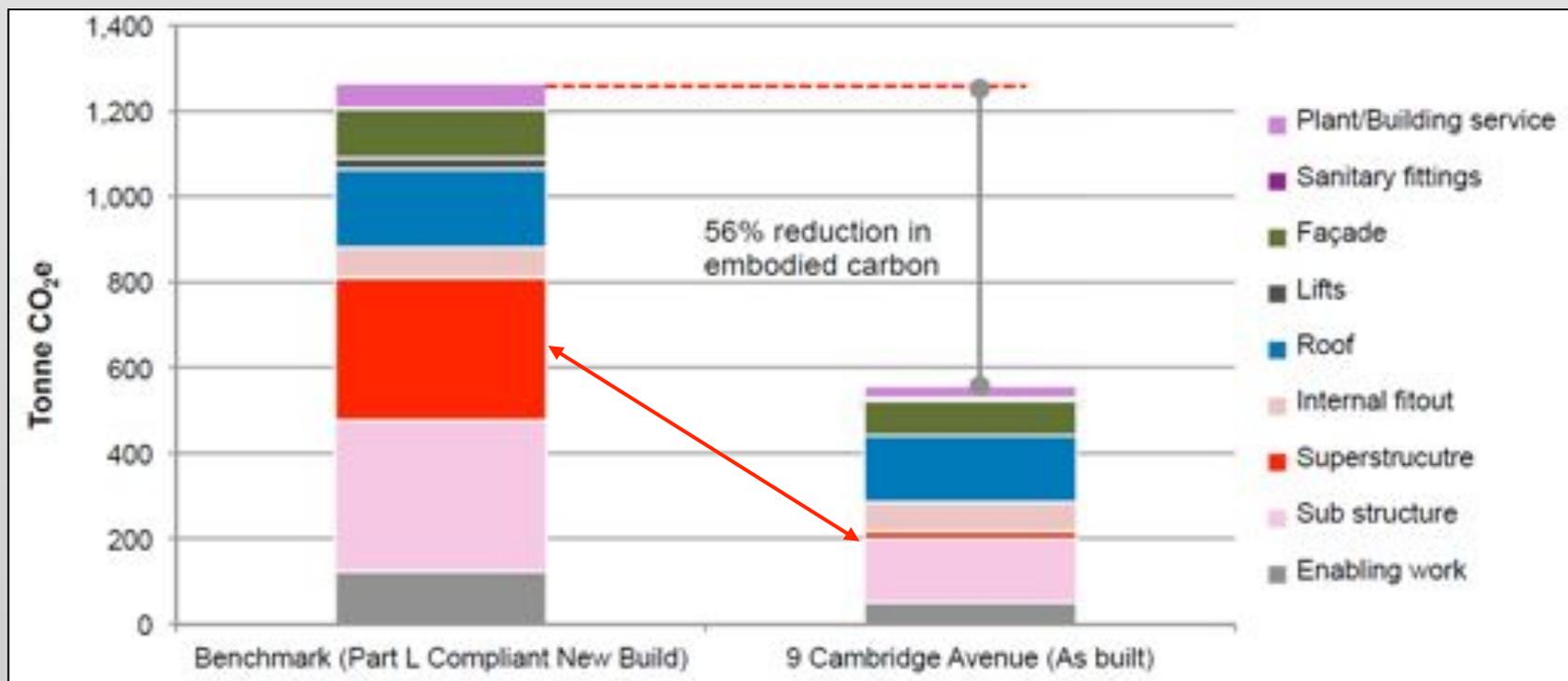
SEGRO relocation case study

Reused elements:

- Steel structure
- Plant/MEP
- Precast planks
- Curtain walling
- Raised access floor



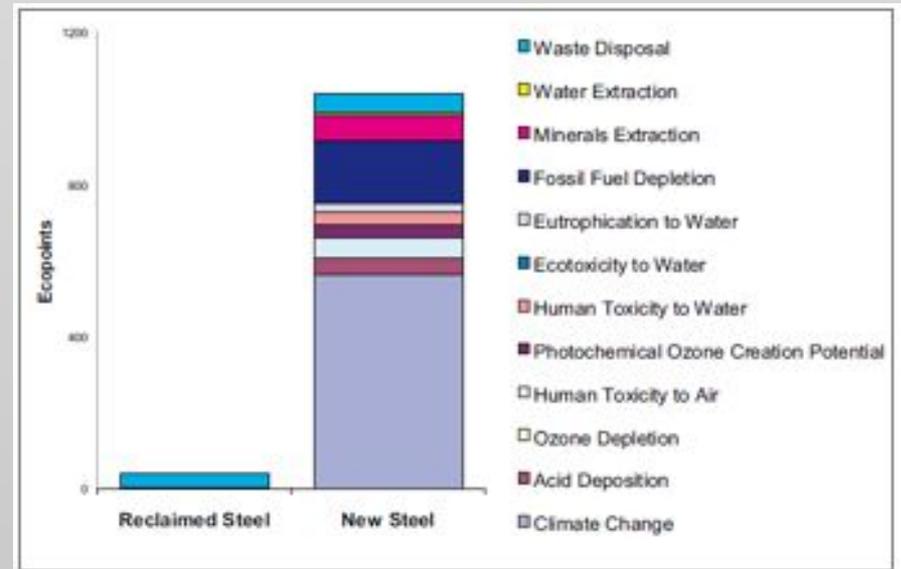
SEGRO relocation case study



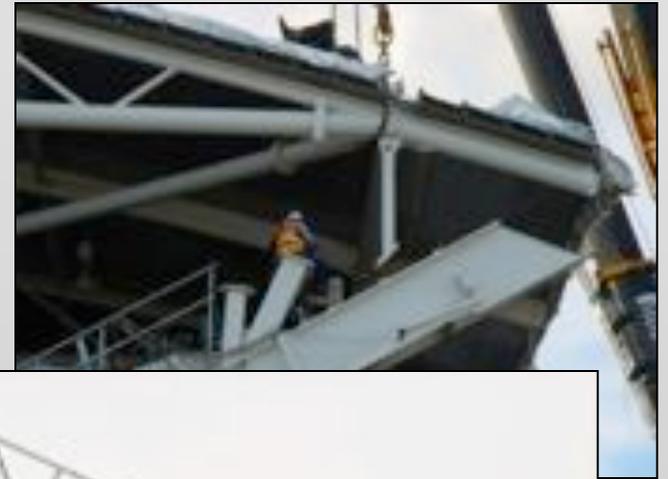
56% lower embodied carbon compared to an equivalent new build (Sturgis cp)

BedZed London

- 98 tonnes of reclaimed structural steel – temporary steel from Brighton station
- 96% saving on environmental impact (BRE)



Sydney Olympics aquatics stadium



London 2012 stadium



- 2,500 tonnes surplus tube from offshore pipeline
- Saved time and carbon

Carrwood Park, Doncaster

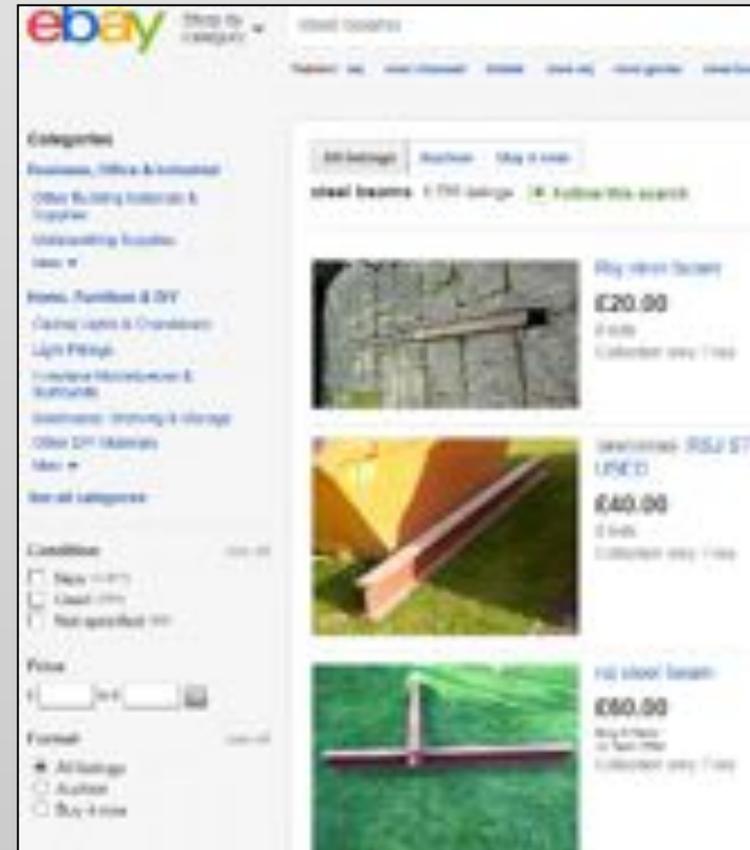


- Portal frame
- 1,800m²
- 82 t reused steel



ebay

- 'steel beams' returned 1,800 listings
- Small-scale sales but surprisingly high 'buy-now' price - £807 per tonne



From niche to mainstream

ebay **Steel Beams** 170 items

Buy Steel Beams £20.00

Used Buildings

2 No buildings 48.5m x 13.5m x 4m Galvanised with green composite roof

€45,000.00

These 2 buildings, 1No 47m in length, 1No 50 m in length are fully galvanised, they have 27 degree pitch roof making them very suitable for high snow loading and solar panels.

They are ideal for sub-dividing into industrial units.

RINSCOUGH METALS

STEEL STOCKISTS • INDUSTRIAL BUILDINGS • HEAVY MACHINERY • SECURE SITE CENTS

View and Check Steel Section Stock - Search

COT
CLEVELAND STEEL & TUBES LTD

SEARCH STOCKS

Viewing 1 to 6 of 6

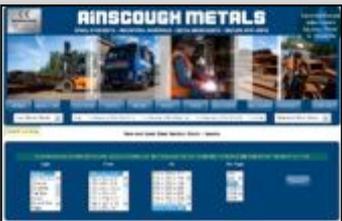
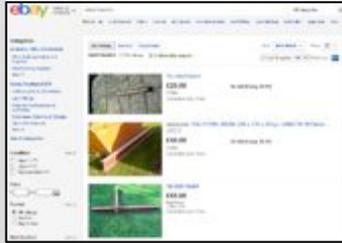
Any Outside Diameter

SELECT OUTSIDE DIAMETER TO SEARCH

In order to choose multiple sizes please hold your ctrl key and click the appropriate size.

Quantity you need	Outside diameter (mm)	Wall thickness (mm)	Weight (kg/meter)	Quantity in stock (meters)
<input checked="" type="checkbox"/>	40	3.2	4.48	50 to 100 metres available
<input type="checkbox"/>	40	4.0	5.52	100 to 500 metres available
<input type="checkbox"/>	40	4.5	6.75	100 to 1000 metres available
<input type="checkbox"/>	40	5.5	7.98	100 to 500 metres available
<input type="checkbox"/>	40	6.2	11.82	100 to 500 metres available
<input type="checkbox"/>	40	16.0	17.38	50 to 100 metres available

From niche to mainstream



Barriers to steel reuse

- Cost
- Availability & storage
- Lack of demand
- Traceability & CE marking
- Demolition time constraints
- Lack of supply chain integration

Supply chain integration

- Innovate UK funded feasibility study
- Supply-demand co-ordination tool for steel reuse



Construction supply chains

- Traditionally long, complex and linear
- Often end at completion/handover
- Long in-use phase
- Designers disconnected from demolition contractors



End of supply chain
25-100+ years



On-line portal

Designer requirements:

- Member size & grade
- Age and origin
- Location & availability

Demolition contractor:

- Pre-demolition audit
- Weight & value



Supporting guidance

- Specification and design of reused steel
- CE marking and other regulatory requirements for reused steel
- Pre-demolition surveys and audits
- Testing
- Contractual arrangements for sourcing and using reused steel
- Insurance and warranties
- Case studies of successful projects and quantification of the carbon savings

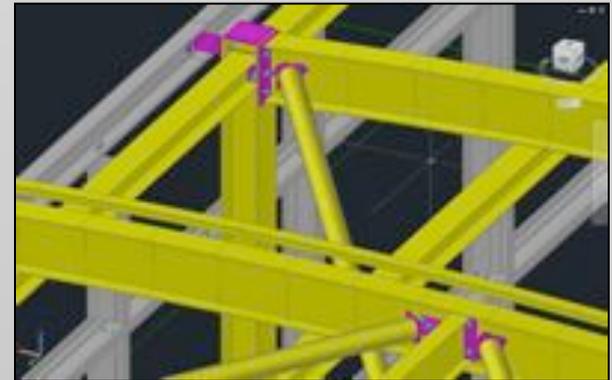
Demolition industry

- H&S and time biggest barriers to reuse
- Low steel price
- Current practice:
 - High-reach plant
 - Shearing of sections
 - No/poor structural info
 - Top-down construction in sensitive locations
- Significant extra cost to deconstruct



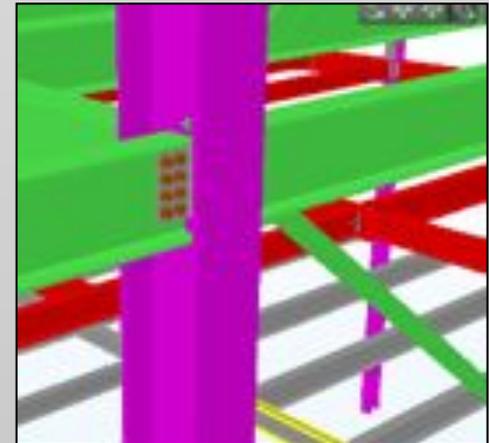
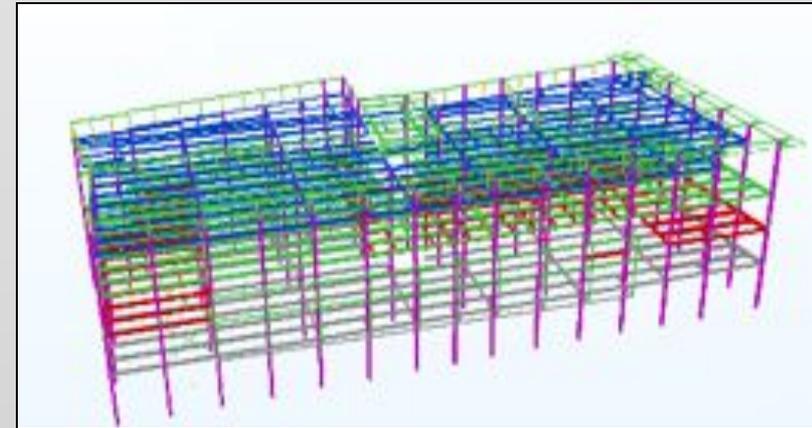
Steel reuse and BIM

- BIM theoretically overcomes many problems of traceability
- Steelwork contractors already BIM proficient
- Our prototype will explore this

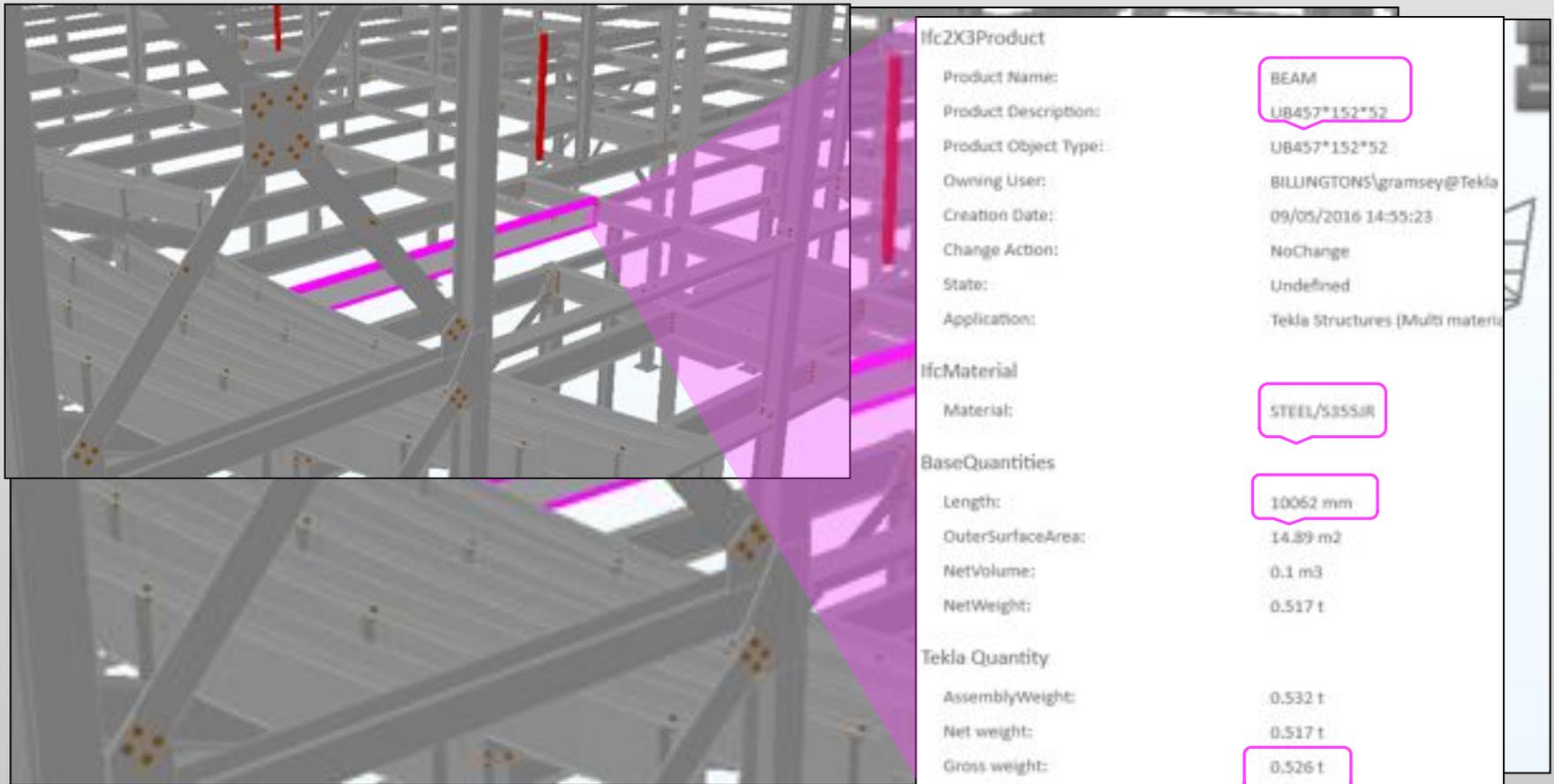


Future steel reuse

- Steelwork constructors have been doing 'BIM' for years
 - Tekla structures
 - StruMIS
- As-built IFC files provided on request
 - Simple to generate from Tekla
- Uploaded to a database to facilitate:
 - Refurbishment and extension
 - Reuse
 - Traceability and properties for optimising recycling



IFC file of steel structure



The image shows a 3D model of a steel structure with a specific beam highlighted in pink. A semi-transparent pink panel on the right displays the IFC properties for this beam. The properties are organized into sections: Ifc2X3Product, IfcMaterial, BaseQuantities, and Tekla Quantity. Several values are circled in pink, indicating key specifications.

Section	Property	Value
Ifc2X3Product	Product Name:	BEAM
	Product Description:	UB457*152*52
	Product Object Type:	UB457*152*52
	Owning User:	BILLINGTONS\gramsey@Tekla
	Creation Date:	09/05/2016 14:55:23
	Change Action:	NoChange
	State:	Undefined
Application:	Tekla Structures (Multi materia	
IfcMaterial	Material:	STEEL/S355JR
	BaseQuantities	
	Length:	10062 mm
	OuterSurfaceArea:	14.89 m2
	NetVolume:	0.1 m3
	NetWeight:	0.517 t
Tekla Quantity	AssemblyWeight:	0.532 t
	Net weight:	0.517 t
	Gross weight:	0.526 t

Maersk Triple-E ships

- Largest ship in the world
- 60k tonnes of steel
- Cradle-to-cradle passport
 - 3D model and database
- Separation for reuse:
 - High & low grade steel
 - Copper wiring
 - Hazardous waste



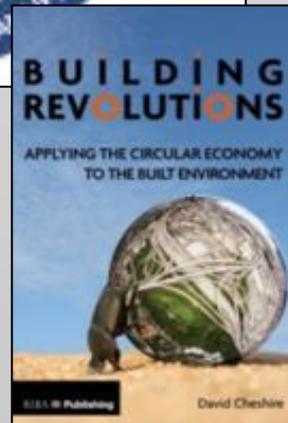
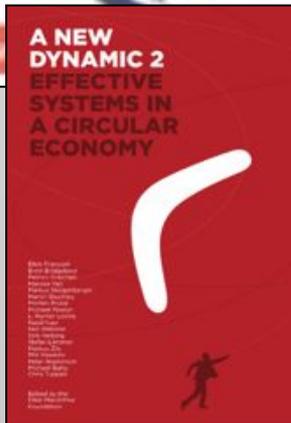
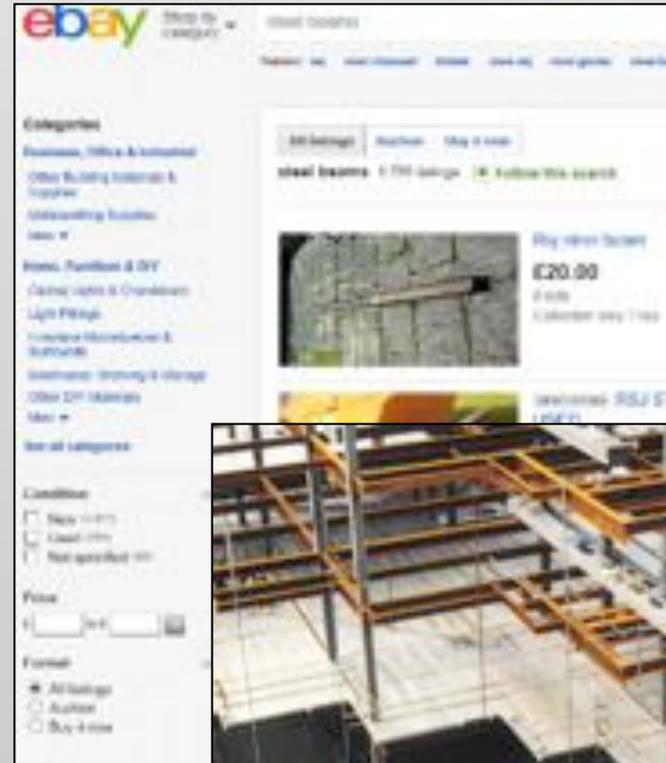
Conclusions

- Steel has excellent recycling credentials
 - ‘True’ recycling is the benchmark in CE
- Structural steel reuse today has many barriers
 - If no viable steel model, it will be difficult for other construction products
- Future reuse looks more viable with BIM
 - But will probably require legislative drivers
- Despite recent over-supply and falls in price, long-term resource scarcity, price volatility and environmental costs will require new CE construction business models

CE theory vs reality



VS





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