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Reuse of Steel and Composite Structural Members

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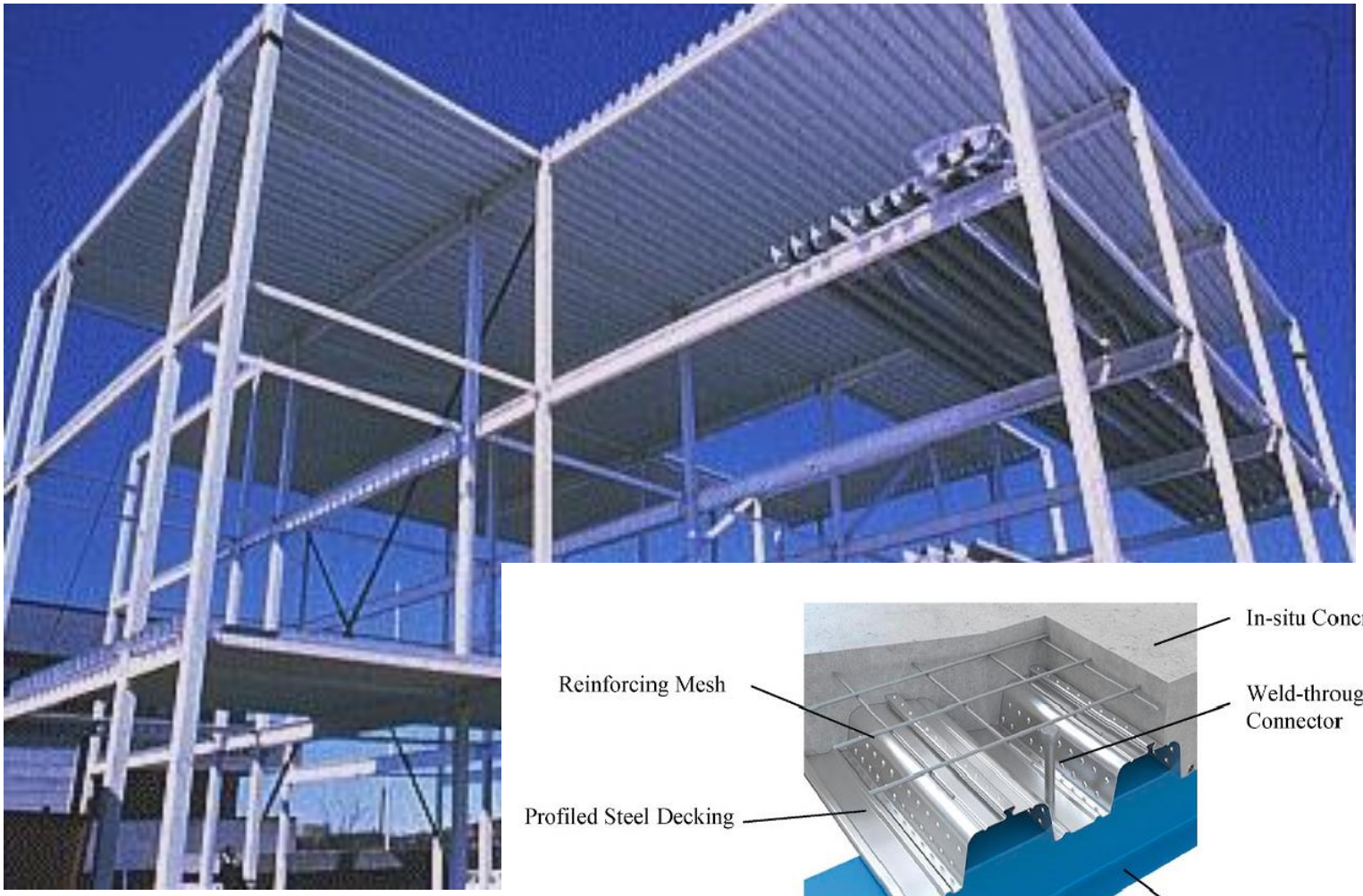
Reconmatic

Typical steel/composite structure



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Introduction contents of presentation

- Background context: the need to reuse
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Reuse of structures: a necessity – huge consumption of construction materials & legacies

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Effectiveness of dealing with legacy

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Options of reuse

- Whole structure reuse (repurpose)
- Structural member reuse

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Reusing structural members is challenging – turning bones of the dead to the live.

But it must be done.

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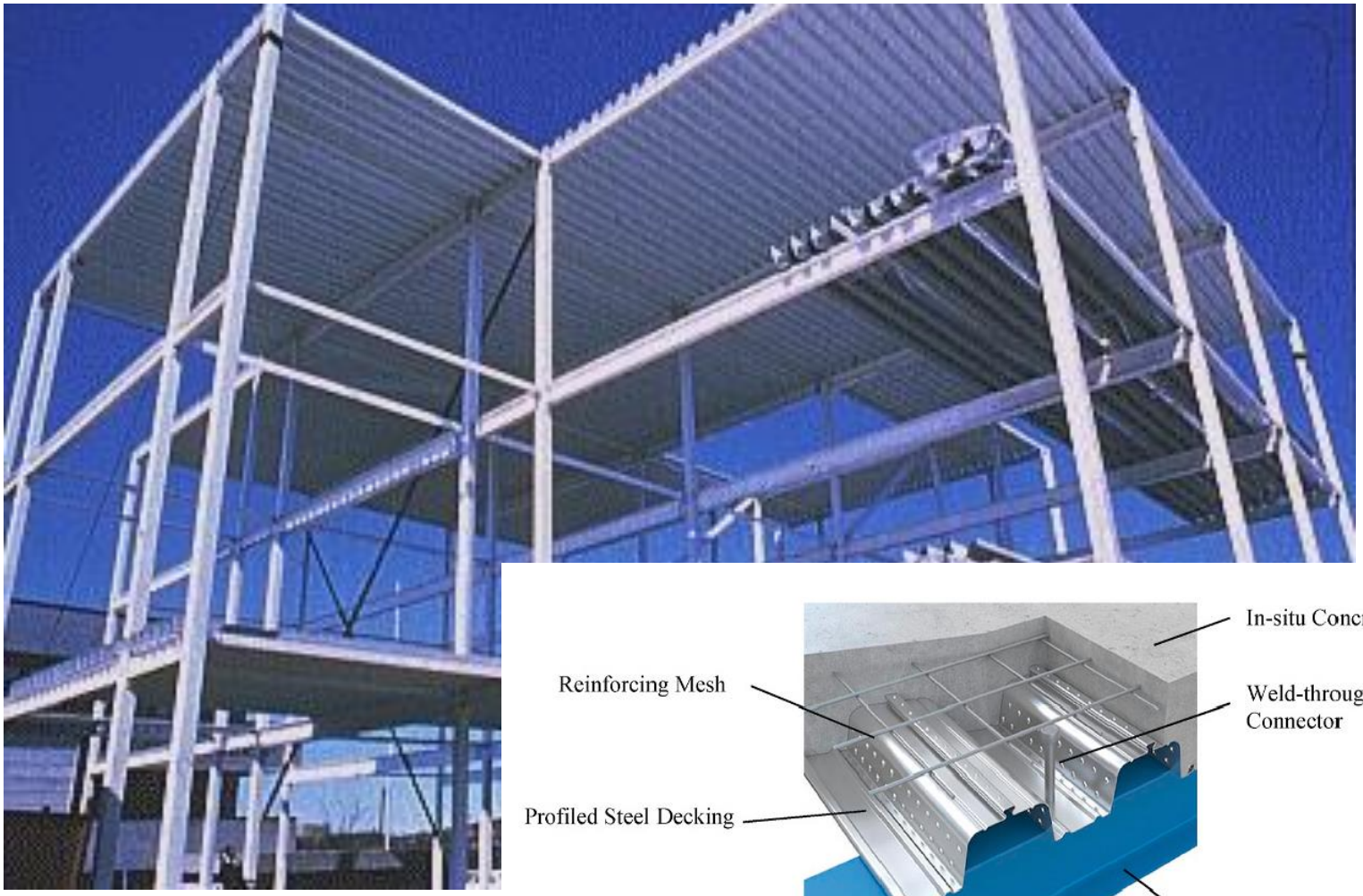
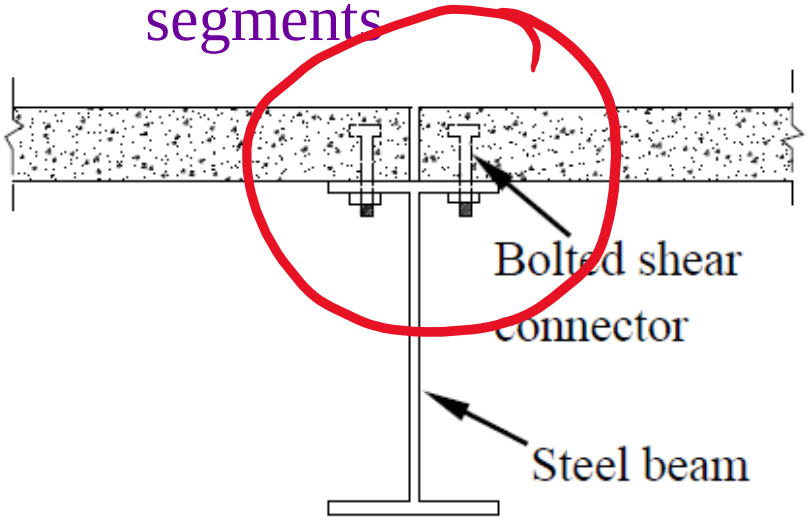
Typical steel/composite structure – problem with reuse



Solution: use demountable shear connectors & slab segments

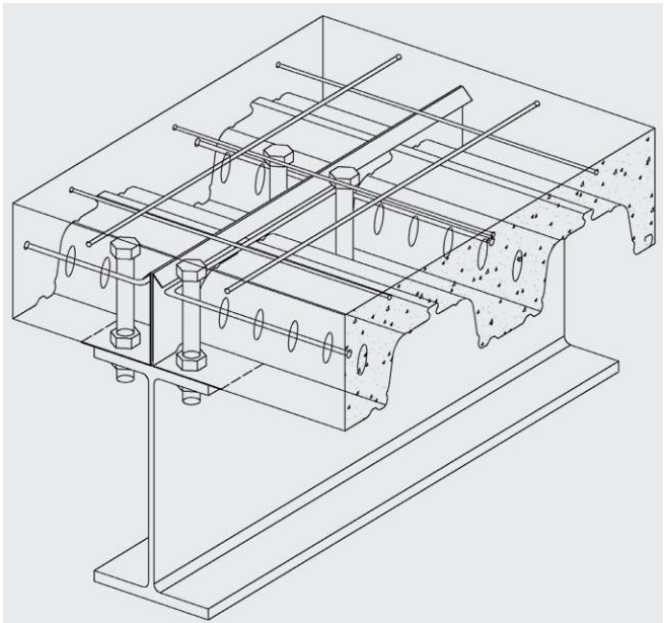
Main features

- Bolted shear connector
- Slab segments
- Grouting between slab segments



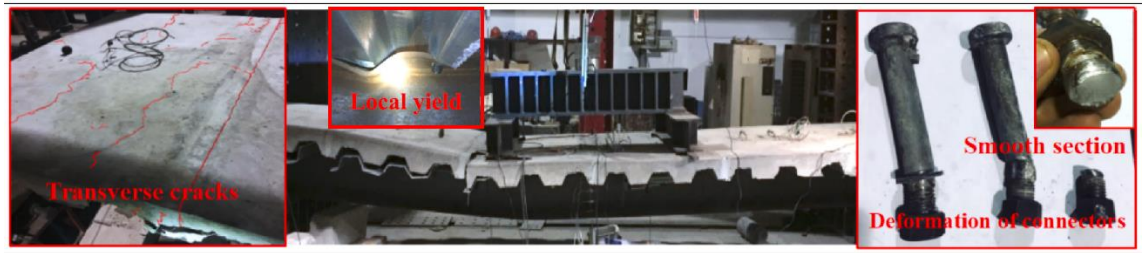
Design considerations

- Serviceability limit state
- Ultimate limit state
- Fire limit state



Experiments on static & fire performance of new construction

(a) Failure modes of SG1



(b) Failure modes of SG2

(c) Longitudinal crack in PG1 and PG2

(d) Destruction of mid–span grouting joint (PG1 and PG2)

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Main finding: little change behaviour compared to existing practice

Engineering Structures 295 (2023) 116887

Contents lists available at ScienceDirect

Engineering Structures

journal homepage: www.elsevier.com/locate/engstruct

Experimental, numerical and analytical investigation of bending performance of bolted demountable composite beams with profiled steel decking

Jiejie Long [a], Yongchang Wang [a,b], Guobiao Lou [c,*], Zhaohan Wen [c], Zhiyou Hu [c], Tao Yang [a], Lu Ke [a]

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An experimental investigation of the fire behaviour of demountable composite beams with profiled steel decking

Jiejie Long [a], Yongchang Wang [a,b], Guobiao Lou [c,*], Zhiyou Hu [c], Tao Yang [a], Qinghua Tan [a], Lu Ke [a]

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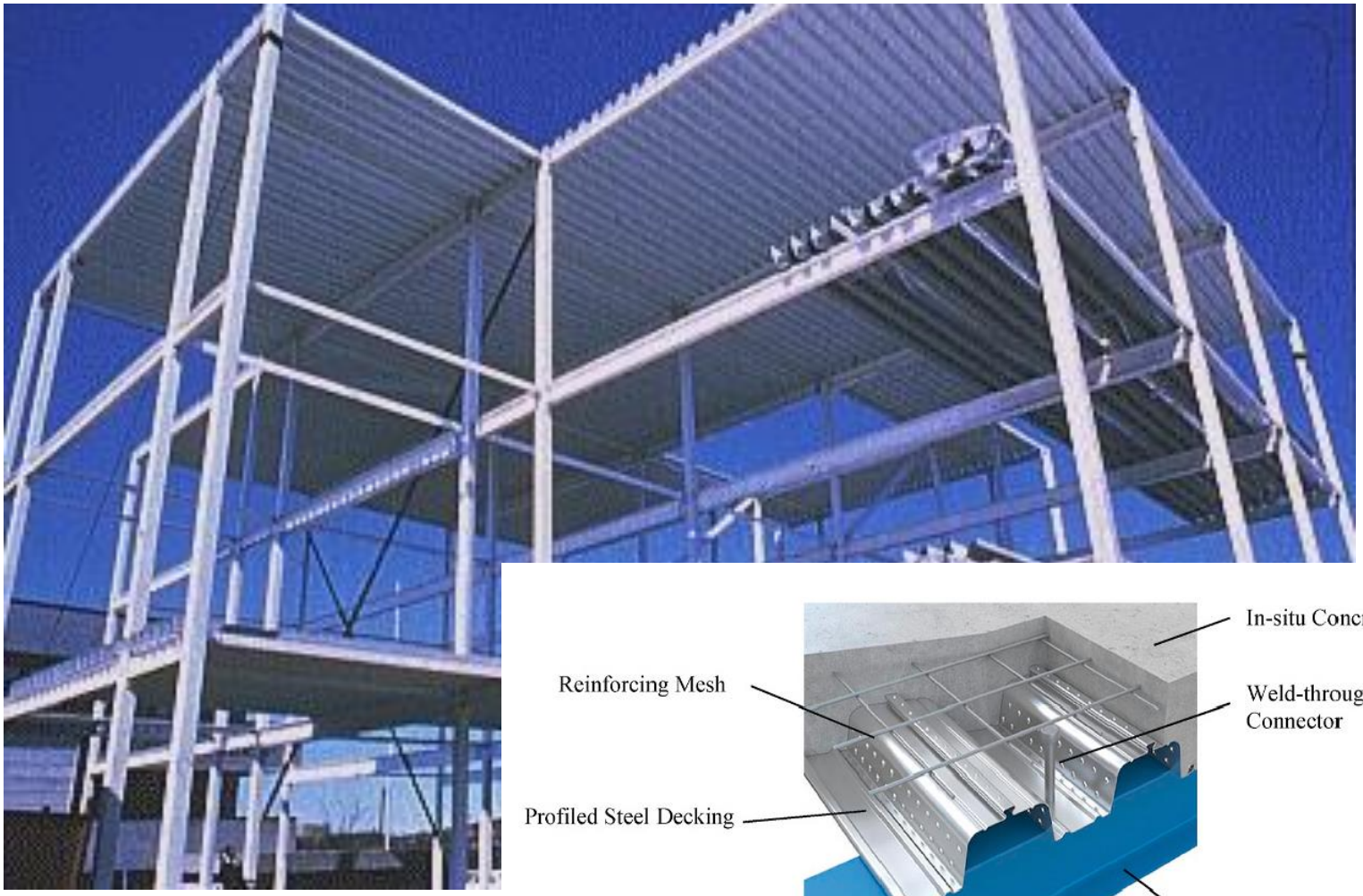
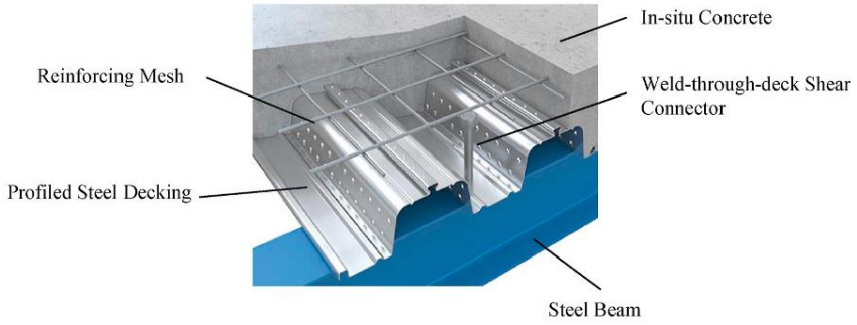
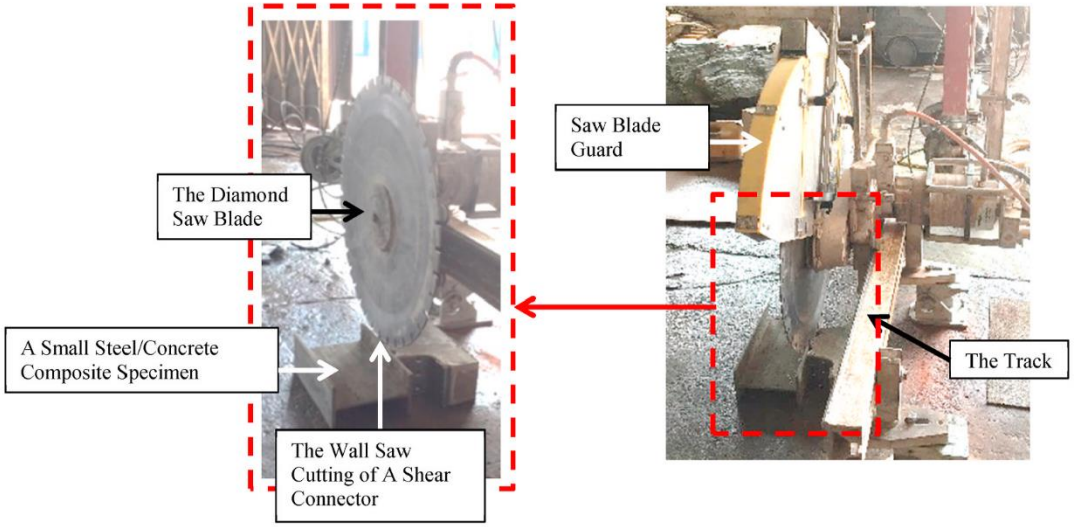
Reclaim – unbolting & cutting shear connectors



Separating steel from concrete





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Reclaimed steel members

Steel Construction Institute Guide: material quality assurance critical

All structures

- Yield & tensile strength
- Elongation
- Tolerance on dimensions & shape
- Impact strength/toughness
- Heat treatment delivery condition
- Stress reduction of area requirements
- Through thickness (Z-quality)
- Limits on internal discontinuities in welded zones

Welded structures

- Classification of materials grouping
- Carbon equivalent of steel, or,
- Declaration of chemical composition for calculation above

Destructive or non-destructive testing?

Consequence class	NDT	Minimum number of DT	Acceptance approach
CC1	All members to be subject to non-destructive tests to establish yield strength, ultimate strength and CEV	1	Non-statistical (maximum value of CEV)
CC2		1	Non-statistical (maximum value of CEV)
CC3		3	Statistical for yield strength, ultimate strength and elongation (maximum value of CEV)

Limitations of materials for reuse

- No effects of fatigue: e.g. not reclaimed from bridges/buildings with earthquake effects
- Not subject to significant strains, e.g. plastic hinges
- Without significant loss of section due to corrosion;
- Not been exposed to fire
- Used as plain members: existing connections removed/redundant (not reused).

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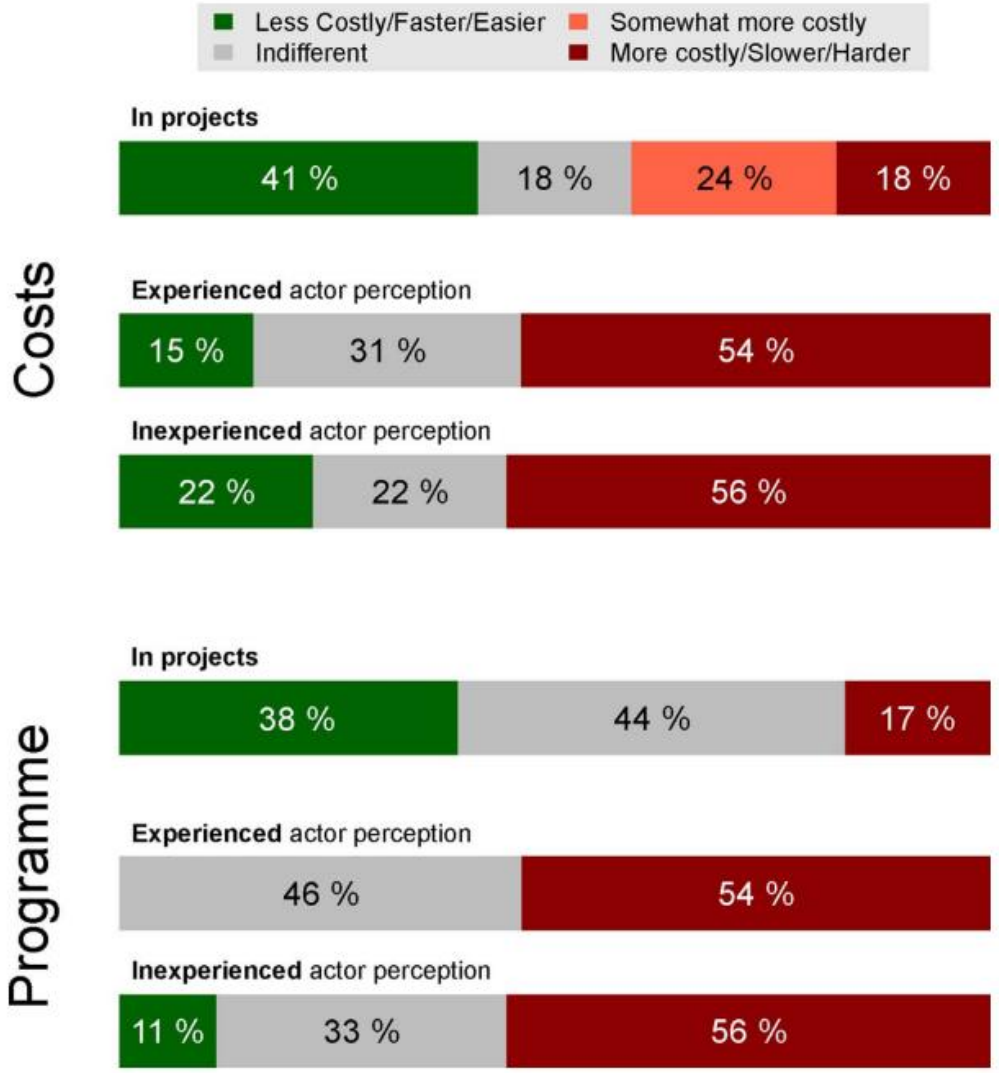
Perception worse than reality: results of a survey (2017)



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Resources, Conservation & R

journal homepage: www.elsevier.com/locate/resconrec

Real and perceived barriers to steel reuse across the UK construction value chain

Cyrille F. Dunant[c,*], Michał P. Drewniok[c], Michael Sansom[a], Simon Corbey[b], Julian M. Allwood[c], Jonathan M. Cullen[c]

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Advice on how to maximise reuse: Experiences of a pioneer in steel reuse

Some practical considerations to promote/ensure reuse

- Asset owner/agent: Set % target for reuse; holistic costing (including saving in embodied carbon); promote reuse design standard; prevent misunderstanding (e.g. insurers have no problem); accepting cosmetic defects (no difference as usually hidden)
- Demolition contractor: holistic costing (e.g. reclaiming more costly & taking longer time, but a small part of the overall project); Pre-demolition audit/specification; education of best practice;
- Stockholder: including saved carbon in costing; matching supply to demand (rather than cutting down length); multiple suppliers to multiple users; clear understanding of reuse market

- continued

- Engineer/designer: matching design to supply; widen tolerance (e.g. using trimmers) to enable more reuse; more design effort to check no clash between old and new steel members; clear specification of reuse steel.
- Fabricator: close interaction with designers to ensure no adverse effect on fitness for purpose; information & guidance on practical fabrication of old steel;
  coatings/attachments/holes: digital survey of old member & comparison with new requirements to minimise expensive work

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Summary

- Must find ways to reuse structural members: high embodied carbon.
- Steel structures: technically not difficult & existing businesses in operation.
- Demountable steel-concrete composite structures: technically possible, but not yet in practice.
- Advice about promoting & ensuring maximum reuse of steel structural members.

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THANK YOU
FOR YOUR ATTENTION

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