



FEDERAZIONE NAZIONALE
INGEGNERIA CIVILE

L'economia circolare nell'ingegneria civile

10 luglio 2026

Facoltà di Ingegneria
La Sapienza Università di Roma



Il riutilizzo degli elementi strutturali in acciaio

Elena Mele



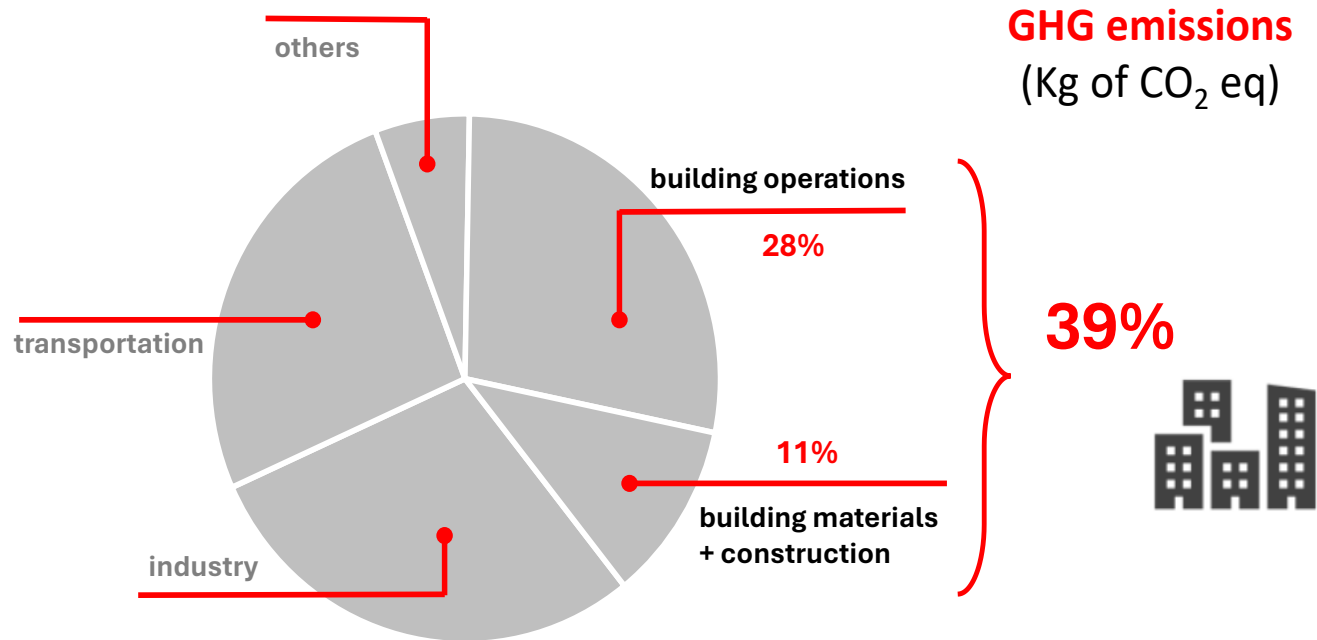
Università degli Studi di Napoli Federico II

Dipartimento di Strutture
per l'Ingegneria and l'Architettura



- reducing GHG emissions by 55% by 2030
- climate-neutral by 2050





United Nations Environment Programme (2021).
2021 Global Status Report for Buildings and Construction



reusing buildings



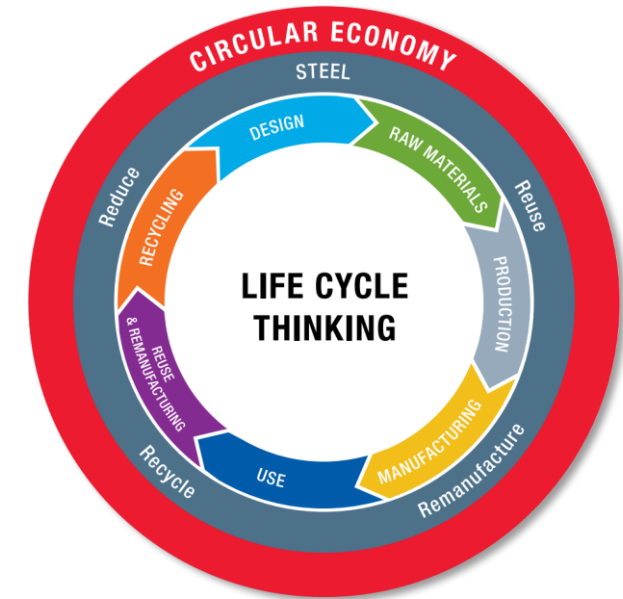
reusing steel structural elements



recycling steel from dismantled buildings



Urban Mining Design



preserve the value of products

- **direct reuse provides more environmental benefits (reduction GHG emissions) with respect to recycling**
- steel preserves indefinitely its mechanical properties and physical qualities
- when building reaches end of life cycle, much of steelwork components can be reused directly
- steel structures made of elements assembled through mechanical connections which facilitate dismantling and recovery

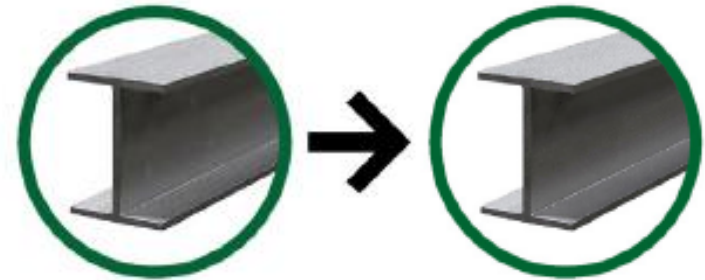
steel reuse

steel recycle



steel beam → scraps → steel element

steel reuse



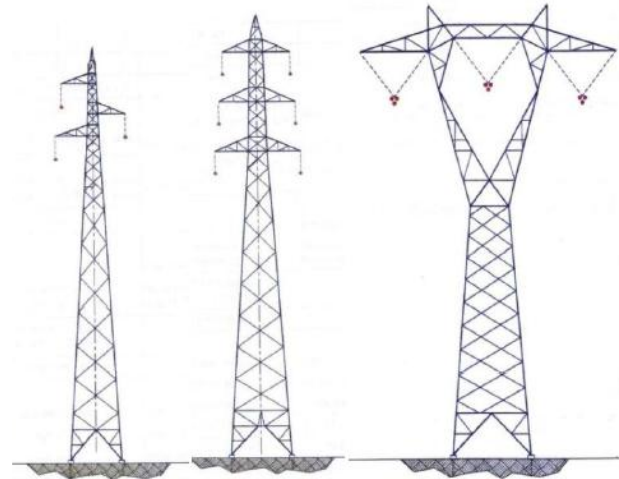
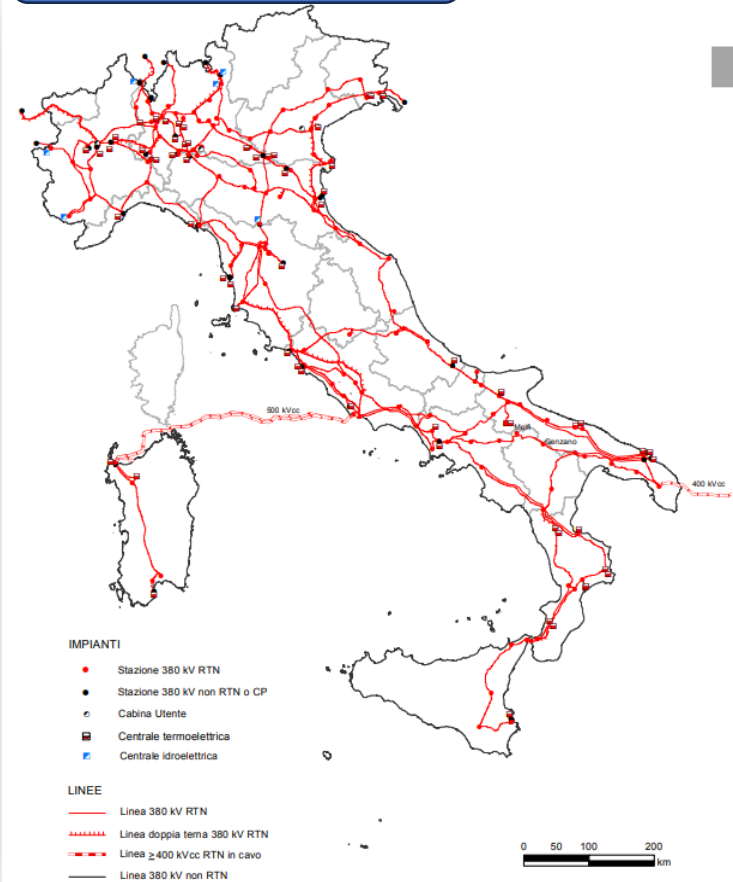
a steel beam remains a steel beam

<https://corporate.arcelormittal.com/about/making-steel>



ArcelorMittal

electric pylons



removing truss pylons



ecological
pylons



animal inspired
pylons



Austrian Power Giants



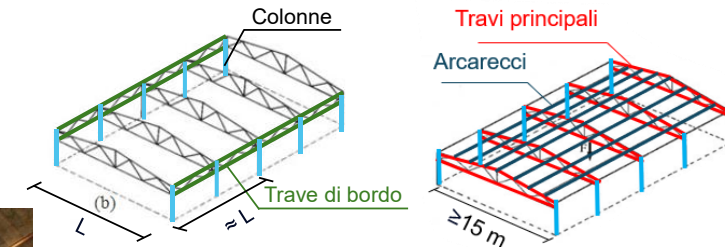
underground
cable power line



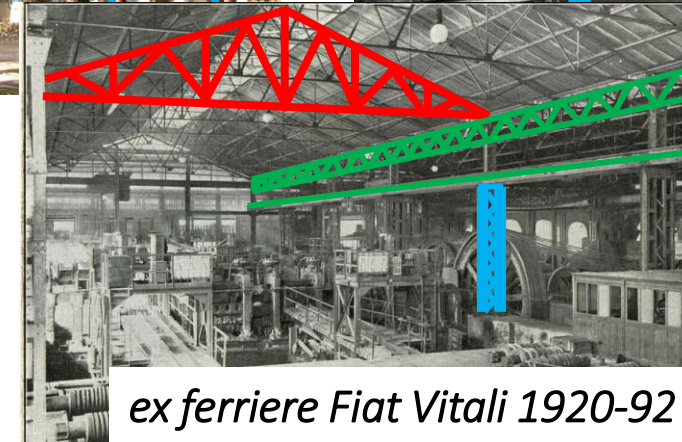
industrial sheds



*ex zuccherificio Eridania,
Parma 1899-68*

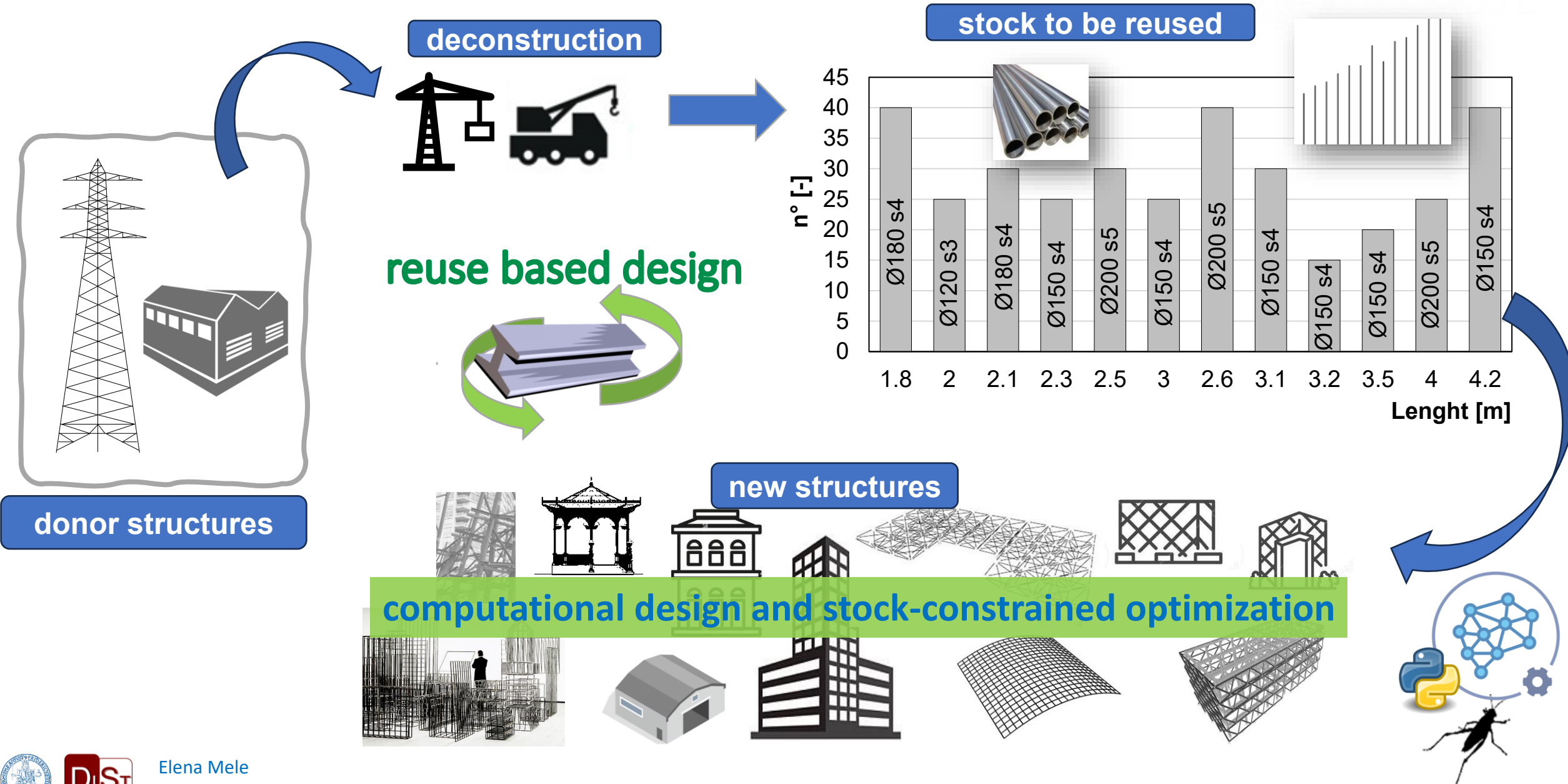


ex fonderie Limone 1921-77



ex ferriere Fiat Vitali 1920-92

obsolete industrial sheds and warehouses in abandoned areas (3%, 9000 km²)



barriers to reuse

- limited availability of **computational tools for designers** ✓
- lack of harmonised **design rules** for reused components
- uncertainty on **mechanical properties** of reclaimed members
- difficulty of assessing residual **geometric and structural characteristics**
- **stock definition** (temporal and regional variability) and design dependence

design

supply chain, connecting
donor structures, deconstruction companies,
reuse platforms, new design projects

additional barriers

- quality testing protocol
- certification / liability
- material passport / traceability
- inspection procedures
- economic feasibility
- stock management / reuse market

design rules and codes

Nederlandse technische afspraak

NTA 8713
(nl)

Hergebruik van constructiestaal

Reuse of structural steelwork



Handbok MVR BS04:2021
Återbruk av stål
i bärande konstruktioner
Del 1 - Vägledning
Del 2 - Krav- & Processbeskrivning



in this context, the European Union has undertaken a process for defining a harmonized regulatory framework at EU level, aimed at overcoming current national fragmentation and promote the systematic adoption of steel reuse practices in the construction sector

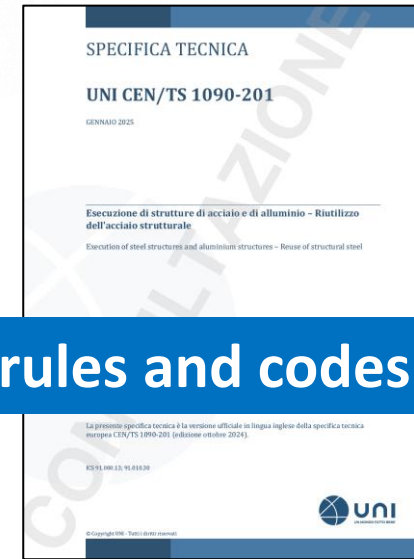
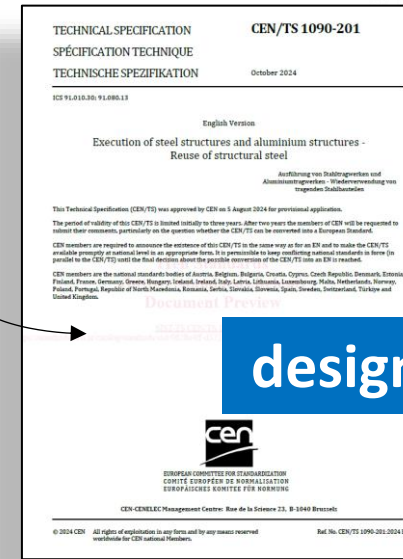
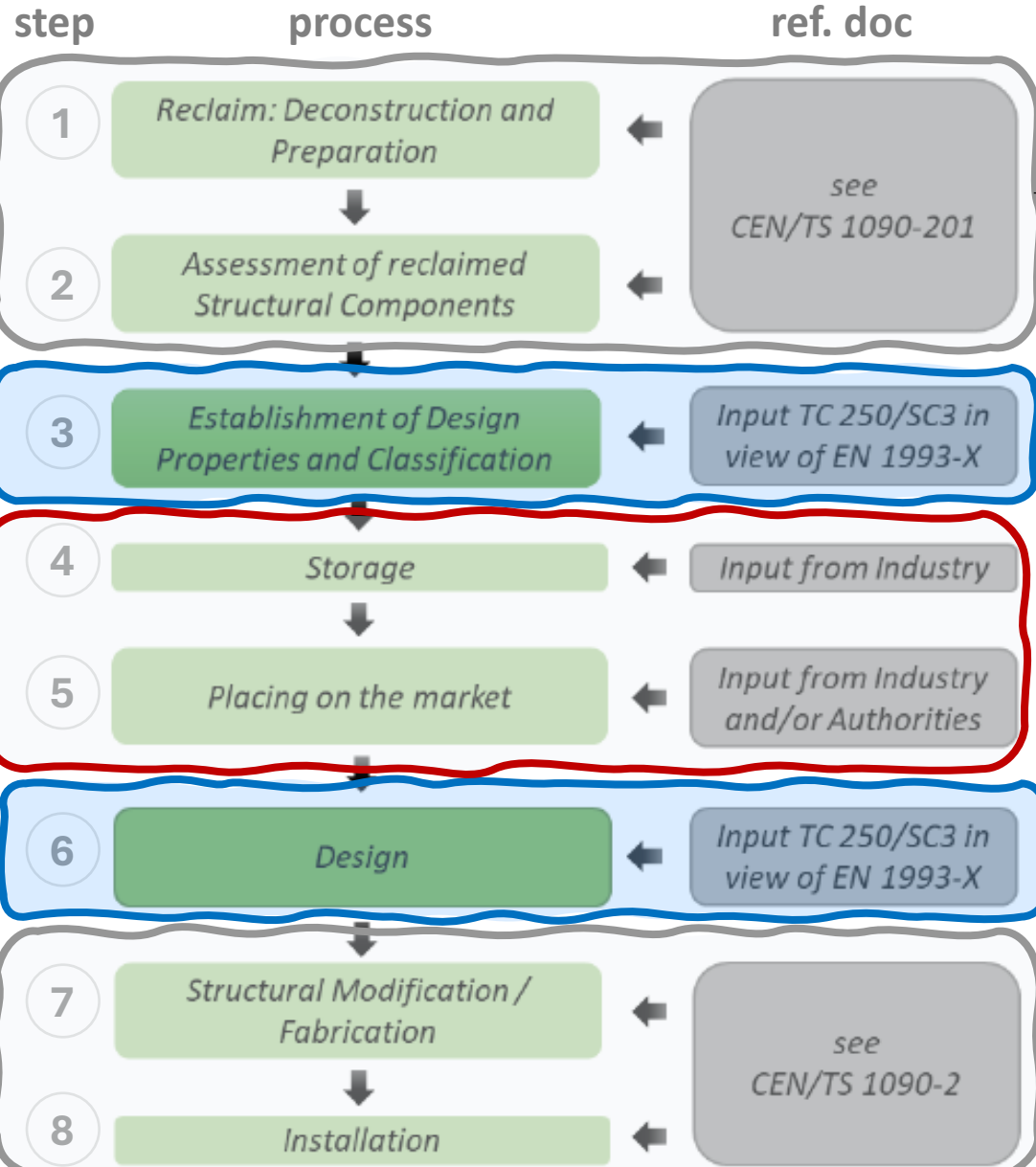
Fiche produit-application : éléments de structures en acier destinés à être réemployés dans des applications structurales
Mar 2021



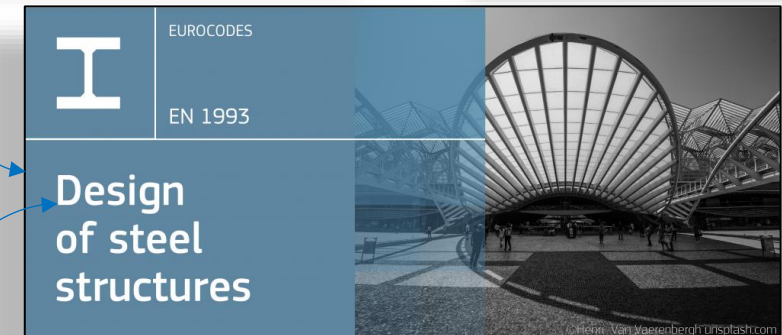
Wiederverwendung von Stahlbauteilen
(Wiederverwendung Stahl - 03.04.2022)

Inhaltsverzeichnis	
1. ANFORDERUNGEN	2
2. ANFORDERUNGEN AN KONSTRUKTIONSTEILE	4
3. ANFORDERUNGEN AN STAHL	4
4. ANFORDERUNGEN AN	4
4.1. Allgemeine Anforderungen	4
4.2. Anforderungen an Nachbearbeitung	4
4.3. Anforderungen an Lagerung und Transport	4
5. PLANUNG UND AUSFÜHRUNG	10
6. LITERATUR	11





design rules and codes



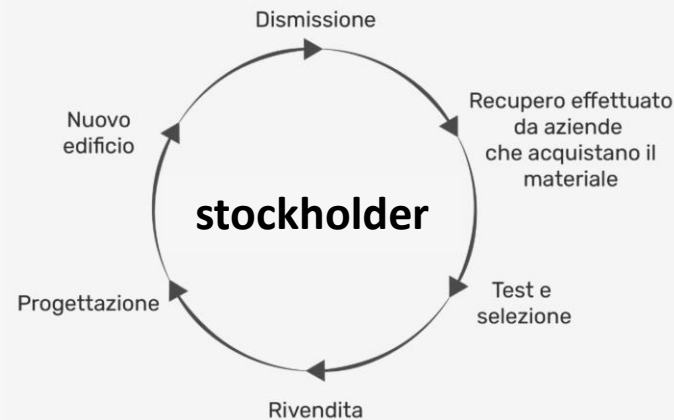


England

supply chain and business models



- management, testing, certification, marketing
- new declaration of performance DoP
- new CE marking



donor - recipient

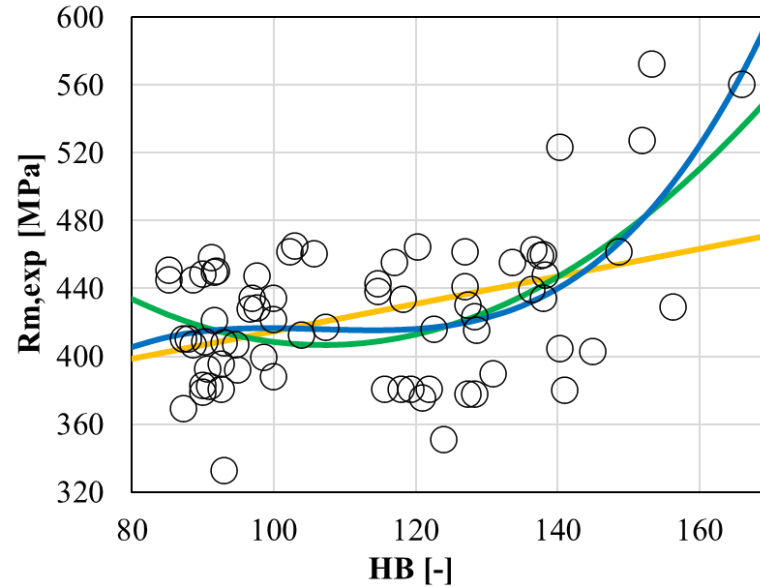
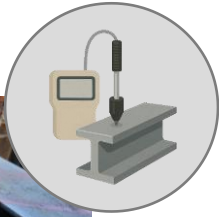


Netherlands

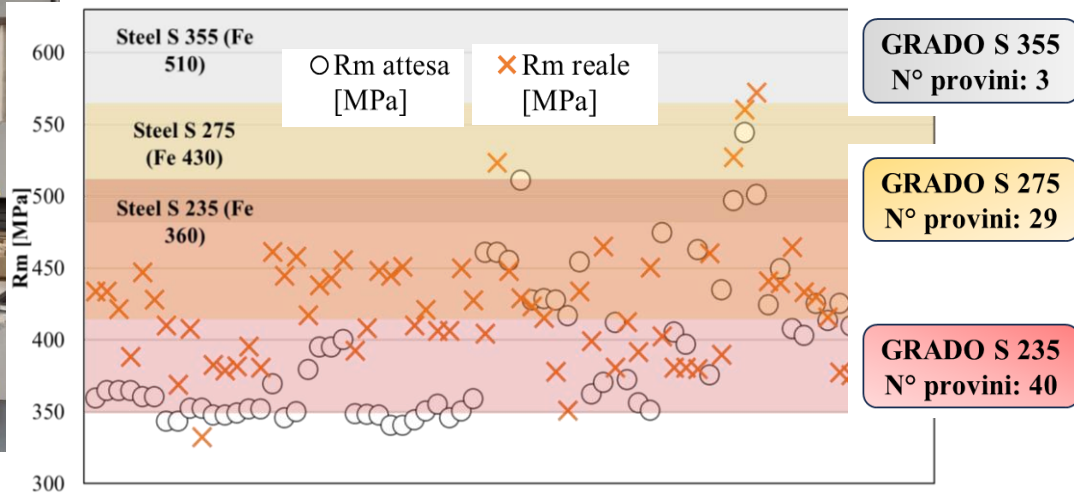
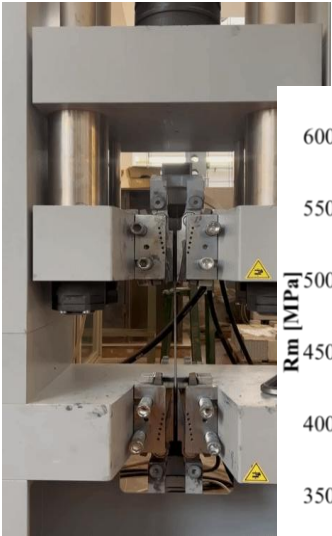


- single case studies
- no business model
- demolition companies

prove di durezza



prove di trazione

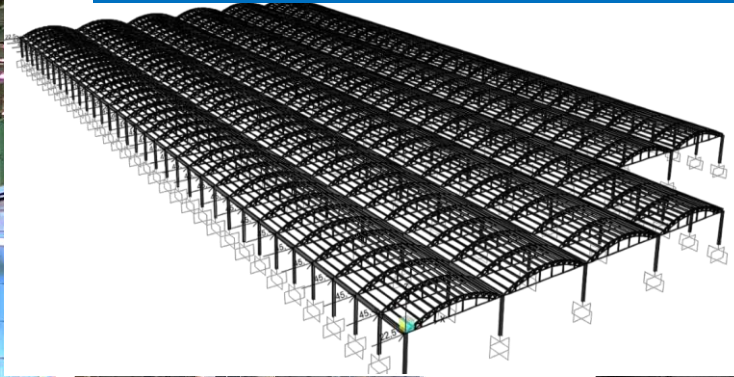


mechanical properties

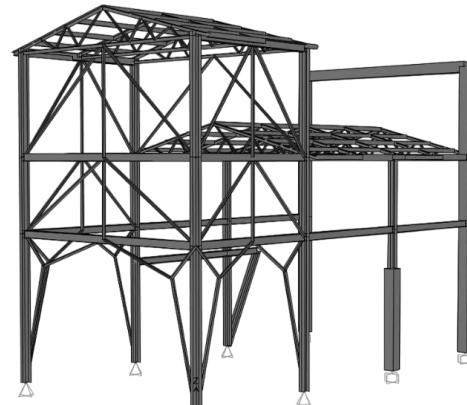
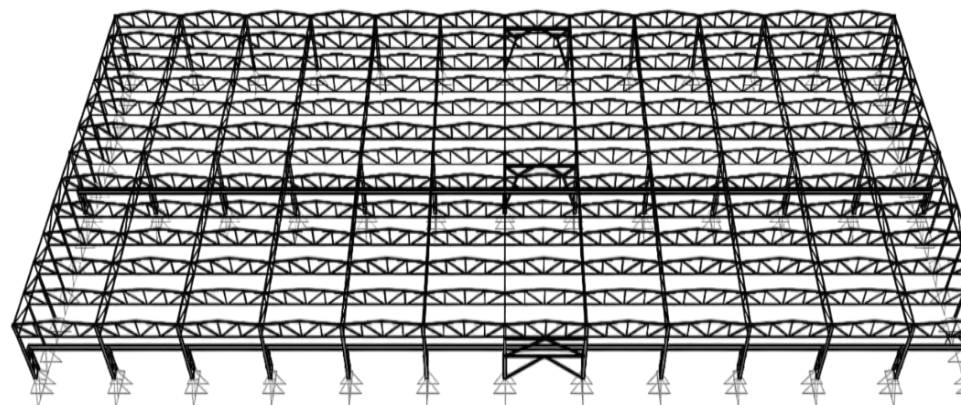
- extensive **hardness NDTs** combined with random check through limited number of **tension** tests
- definition of **testing procedure and protocol** for reclaimed steel (no. NDTs and tension tests, preparation of specimens, ...)
- conversion** of hardness into tensile strength values through existing **equations**
- analysis of large populations of NDT data and definition of **new equations based on data inference**

M. Riccardi - Tesi di Laurea Magistrale: Verso il riuso dell'acciaio: prove sperimentali e correlazioni empiriche tra durezza e resistenza meccanica

mechanical properties



working with students



availability of material does not automatically translate into actual reuse potential

- state of conservation of elements
- residual mechanical properties of material
- degree of corrosion and corresponding residual cross-section
- possible presence of fatigue damage
- connection systems
- expected losses due to dismantling operations

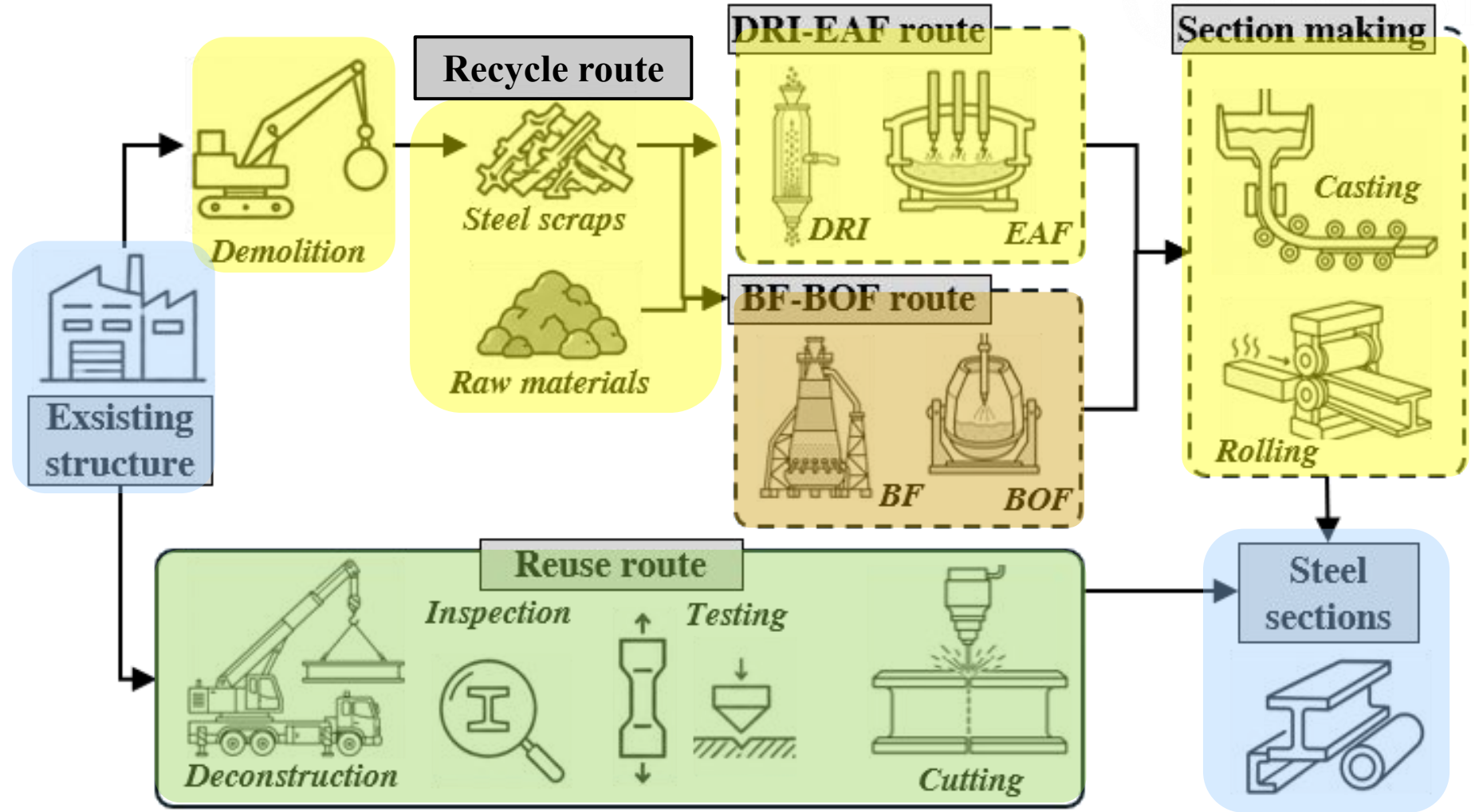
**technical feasibility:
pre-demolition audit**

economic impact of:

- selective deconstruction, transport, inspection
- possible cutting or reconditioning, protective treatments
- reuse potential in local markets

**economic feasibility:
logistics and supply chain**

all these factors strongly influence whether a stock of reclaimed steel members can be considered suitable, convenient, and reliable for future structural applications



special attention should be paid to the first crucial decision-making stage
whether an existing structure should be selectively dismantled for reuse or simply demolished and recycled

assessment of the stock: steel reuse as a decommissioning problem

conventional demolition vs selective deconstruction vs reuse vs recycling vs hybrid strategies

→ supported by **component-level and condition-aware information**

quantity, member typology, residual length, condition, economic feasibility, environmental benefit, and possible compatibility with multiple future applications

stock assessment: reuse strategy should be **technically feasible, economically convenient, and environmentally beneficial** under different damage, deconstruction, and future-use scenarios

Making Reuse Happen

European Green Deal

resource-efficient and competitive economy, with economic growth decoupled from resource consumption

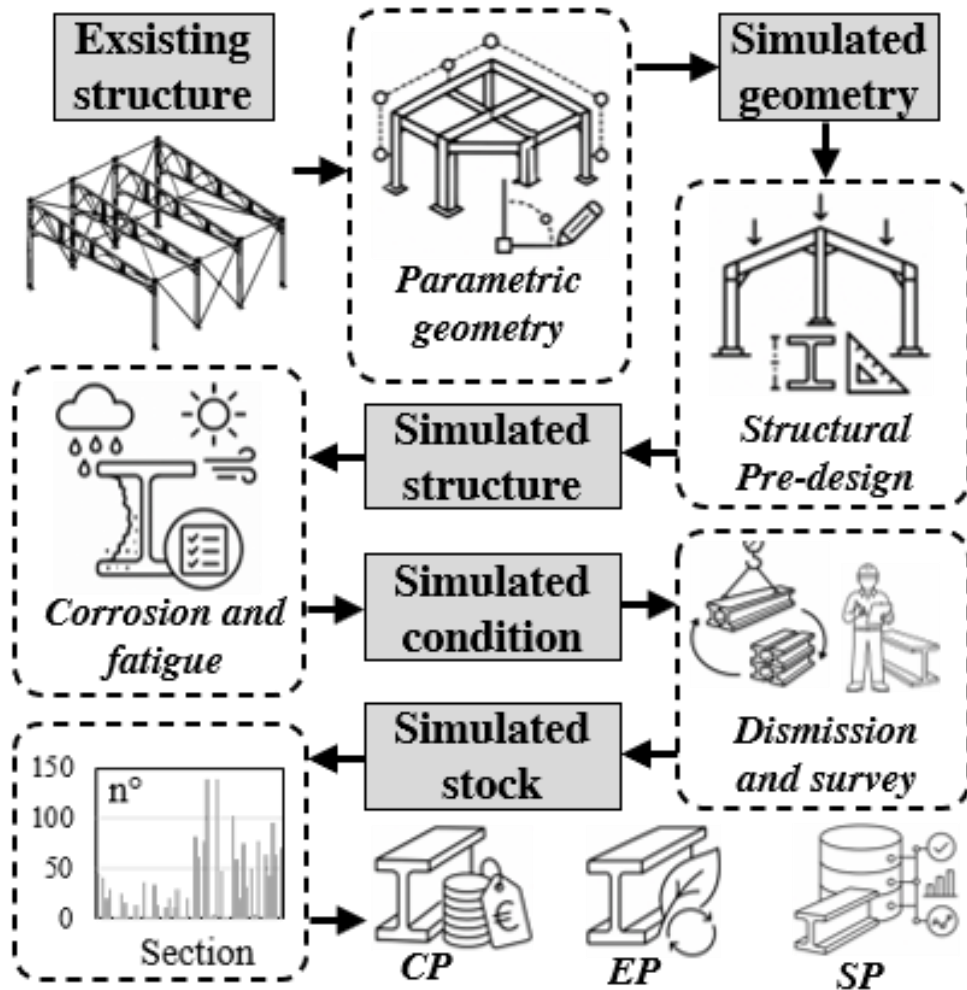


progettare per e con il riuso:

strumenti e metodi decisionali per la **valutazione economica e ambientale** di strategie strutturali circolari

PhD DISGRS, DiST, Università di Napoli Federico II
PR CAMPANIA FSE+ 2021/2027 Priorità 2 Istruzione e Formazione
Obiettivo Specifico ESO 4.7 – Azione 2.g.4.
A.A. 2025-2026 Ciclo LXI°



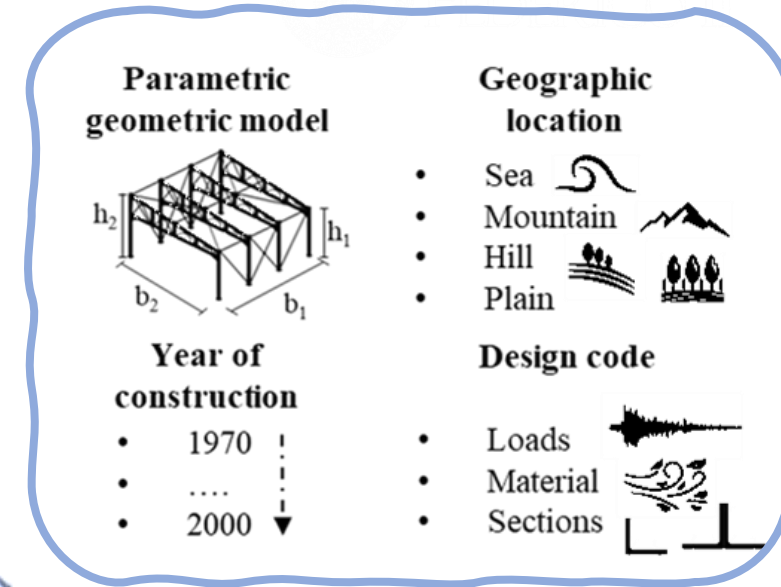
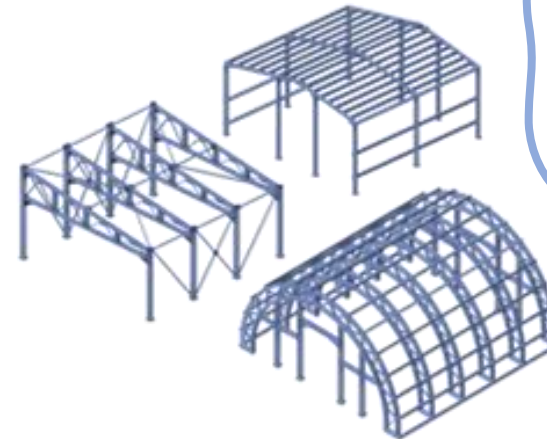
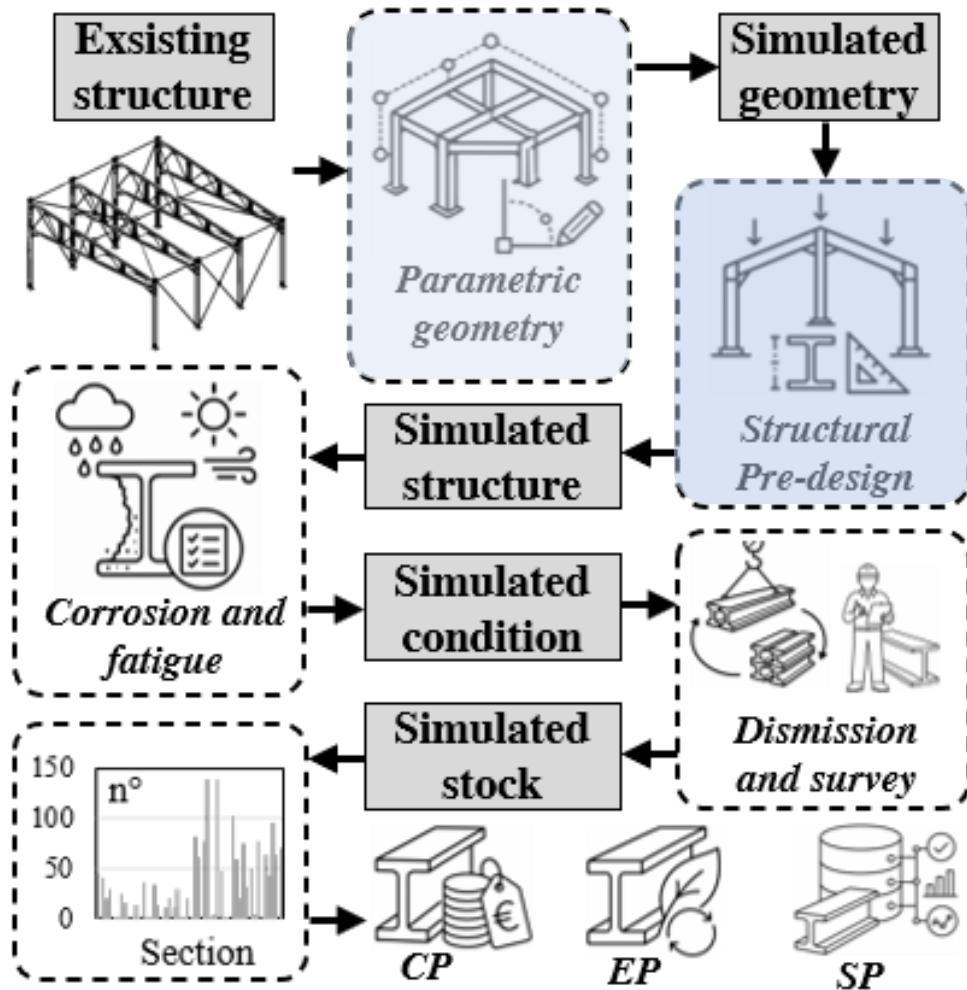


Real donor structures → drawings, information, design documents

Not real, but realistic structures, representative of specific construction periods, industrial typologies, locations and/or design practices

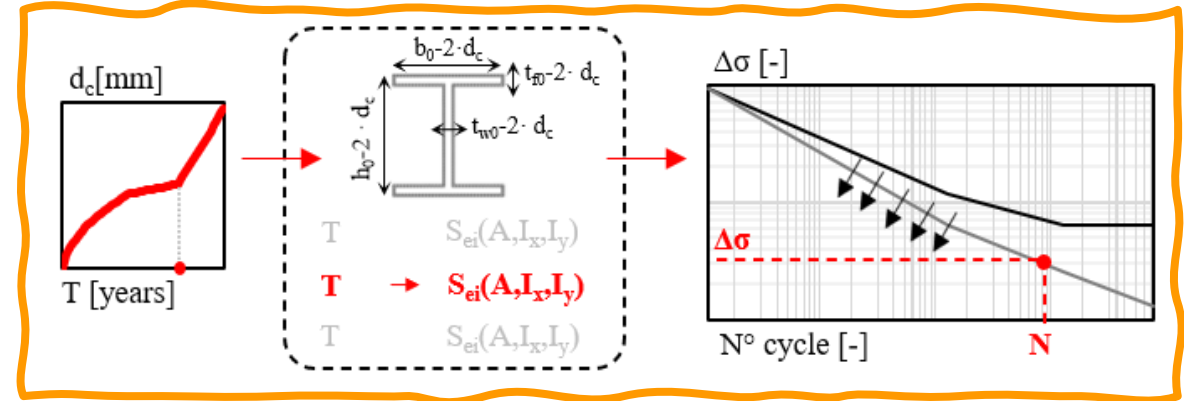
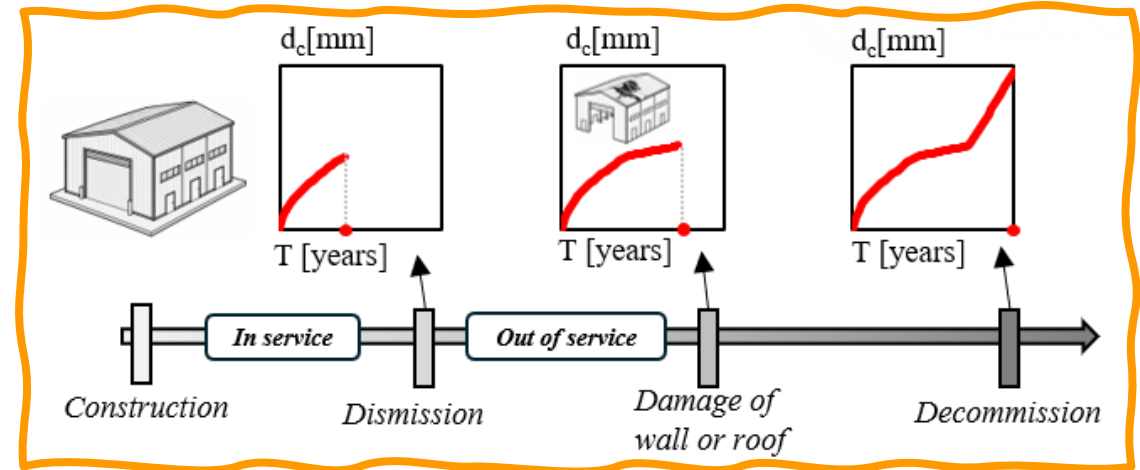
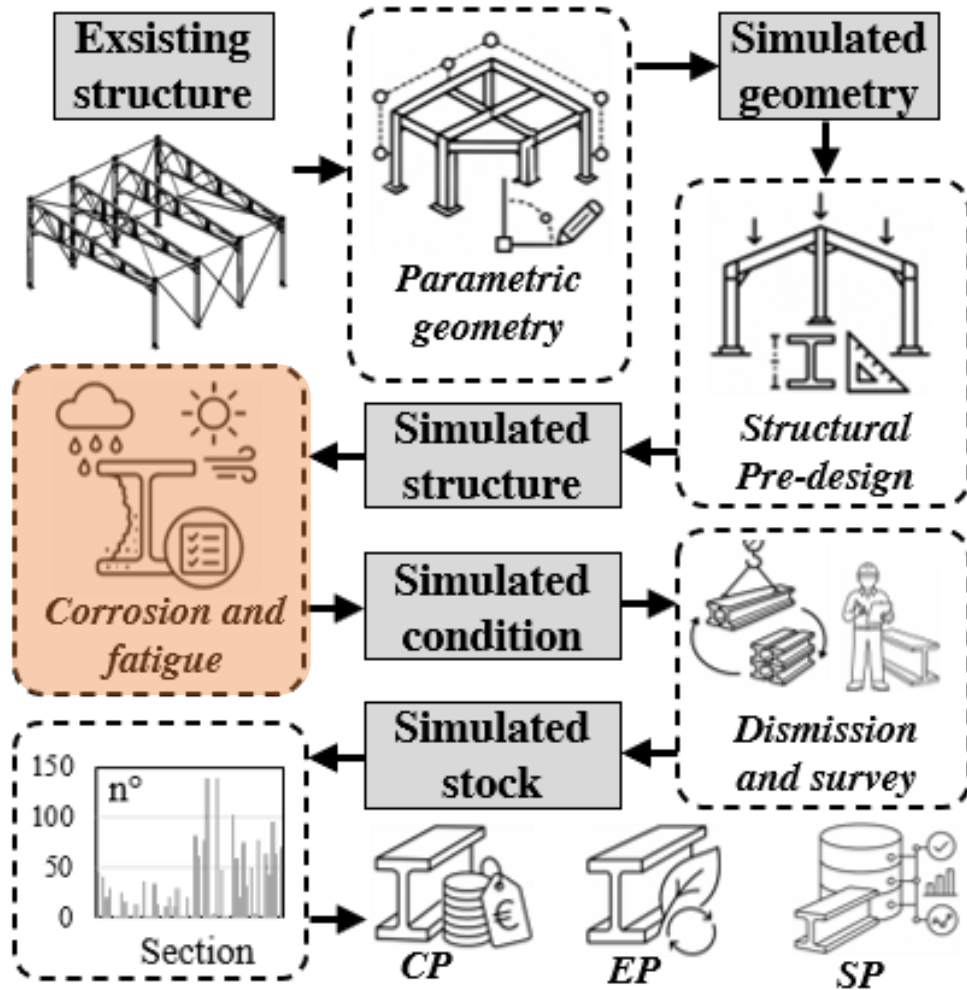
- preliminary reusability assessment and stock efficiency at large scale
- probabilistic analyses aimed at assessing potential benefits of steel reuse in various scenarios
- training and checking robustness of stock-constrained optimization algorithms

simulation-informed workflow for reusability assessment of reclaimed steel stock from industrial structures

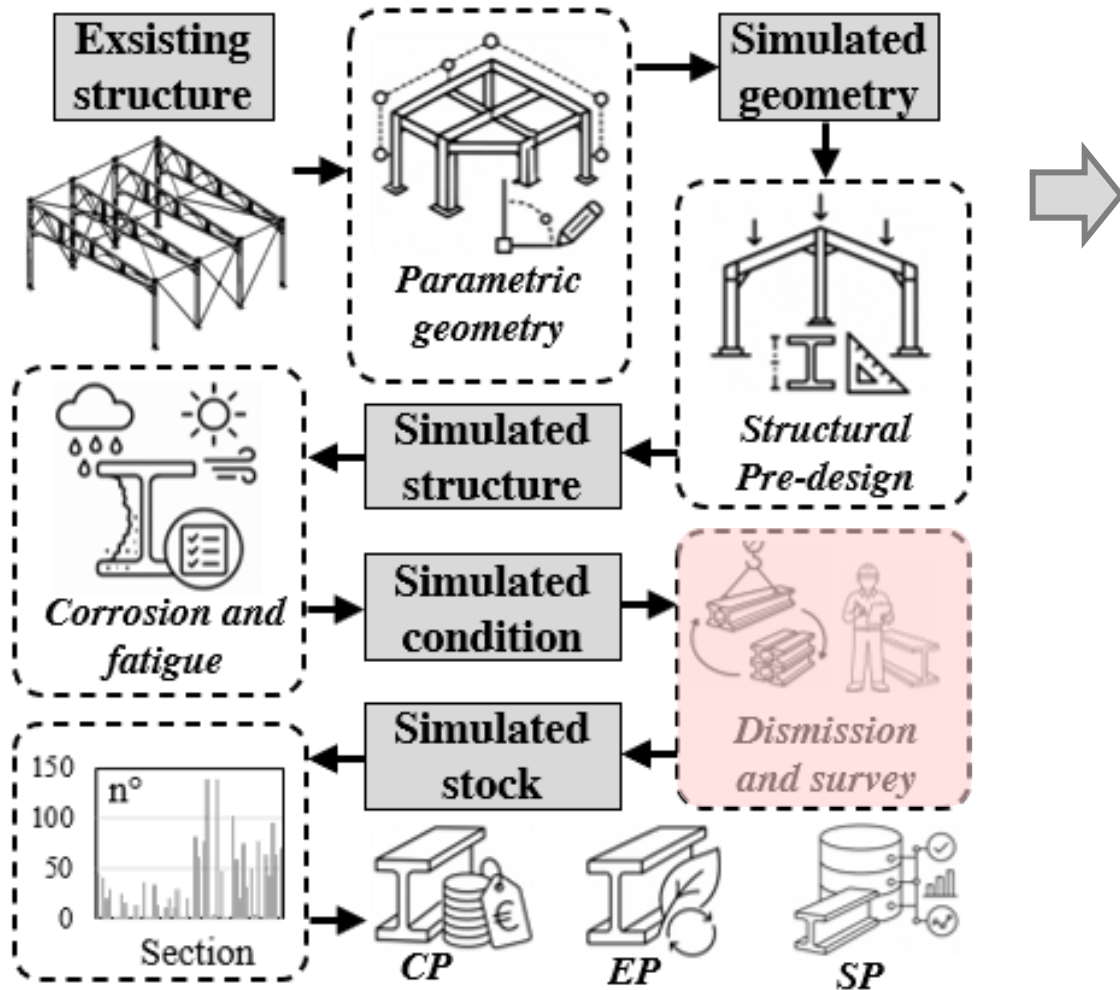


preliminary design
and member sizing

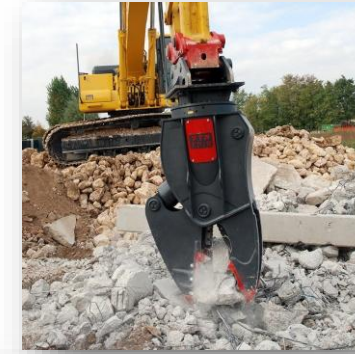
simulation-informed workflow for reusability assessment of reclaimed steel stock from industrial structures



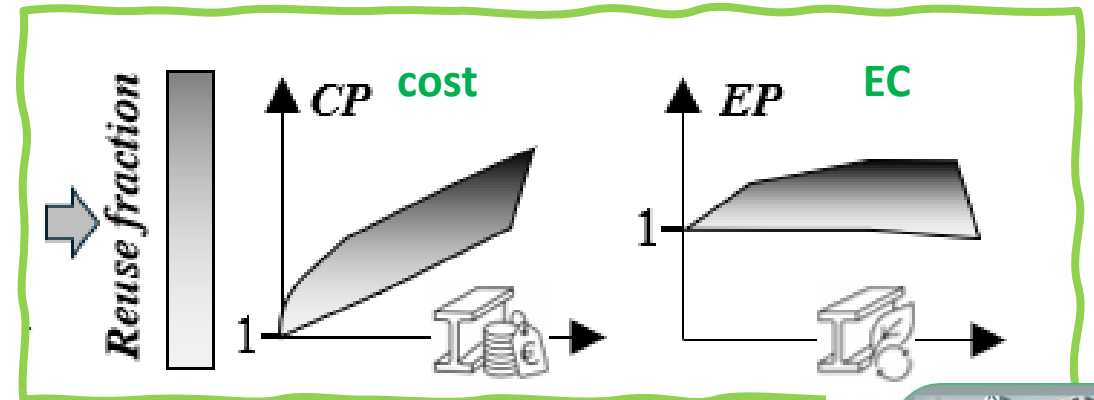
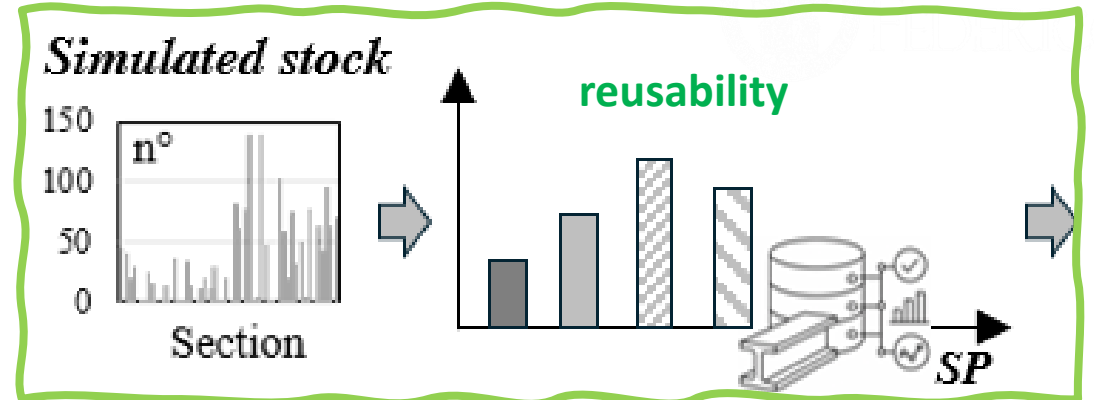
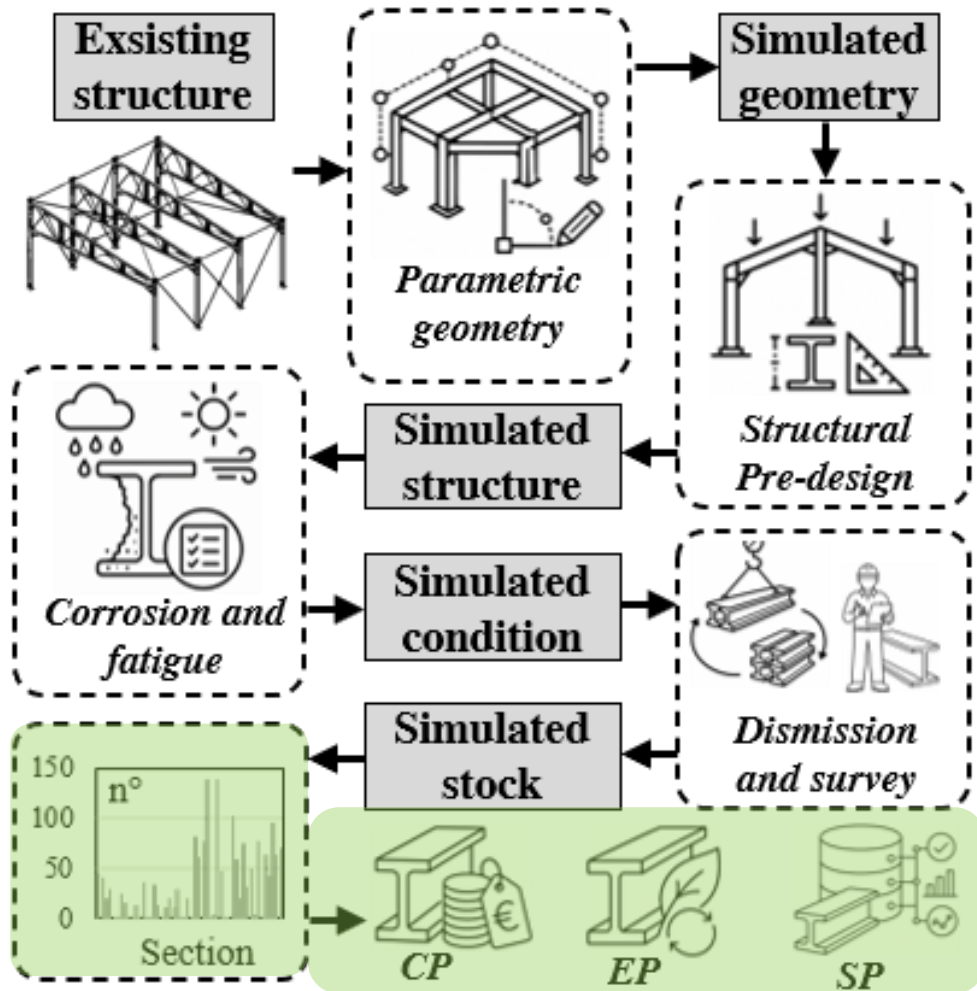
simulation-informed workflow for reusability assessment of reclaimed steel stock from industrial structures



cut mode
steel scraps
waste
.....



simulation-informed workflow for reusability assessment of reclaimed steel stock from industrial structures



performance of a reclaimed-stock as its general propensity to be reused in future applications in alternative scenarios



simulation-informed workflow for reusability assessment of reclaimed steel stock from industrial structures

reuse aesthetics: reuse and reassembly for new structures, new forms, new beauty



Here we come, Here we rise and Shine

Brent Cross Town Substation, London. Arup.

Wrap: 52-m-long, 21-m-high artwork.

London-based artist Lakwena and architects IF_DO



from public infrastructure to public art:
Bettina Pousttchi: Vertical Highways sculpture, NYC
steel guardrails become urban art at Rockefeller center

we can make a difference

it's a fantastic time to be a building designer – we are some of the few people on earth with the opportunity to make significant reductions in carbon emissions

Will Arnold

Head of Climate Action of The Institution of Structural Engineers