DANISH STEEL DAY | NOVEMBER 12, 2026

Towards Standardisation of Artificial Intelligence in Steel Structural Design

European Initiatives under Eurocode 3 and ECCS

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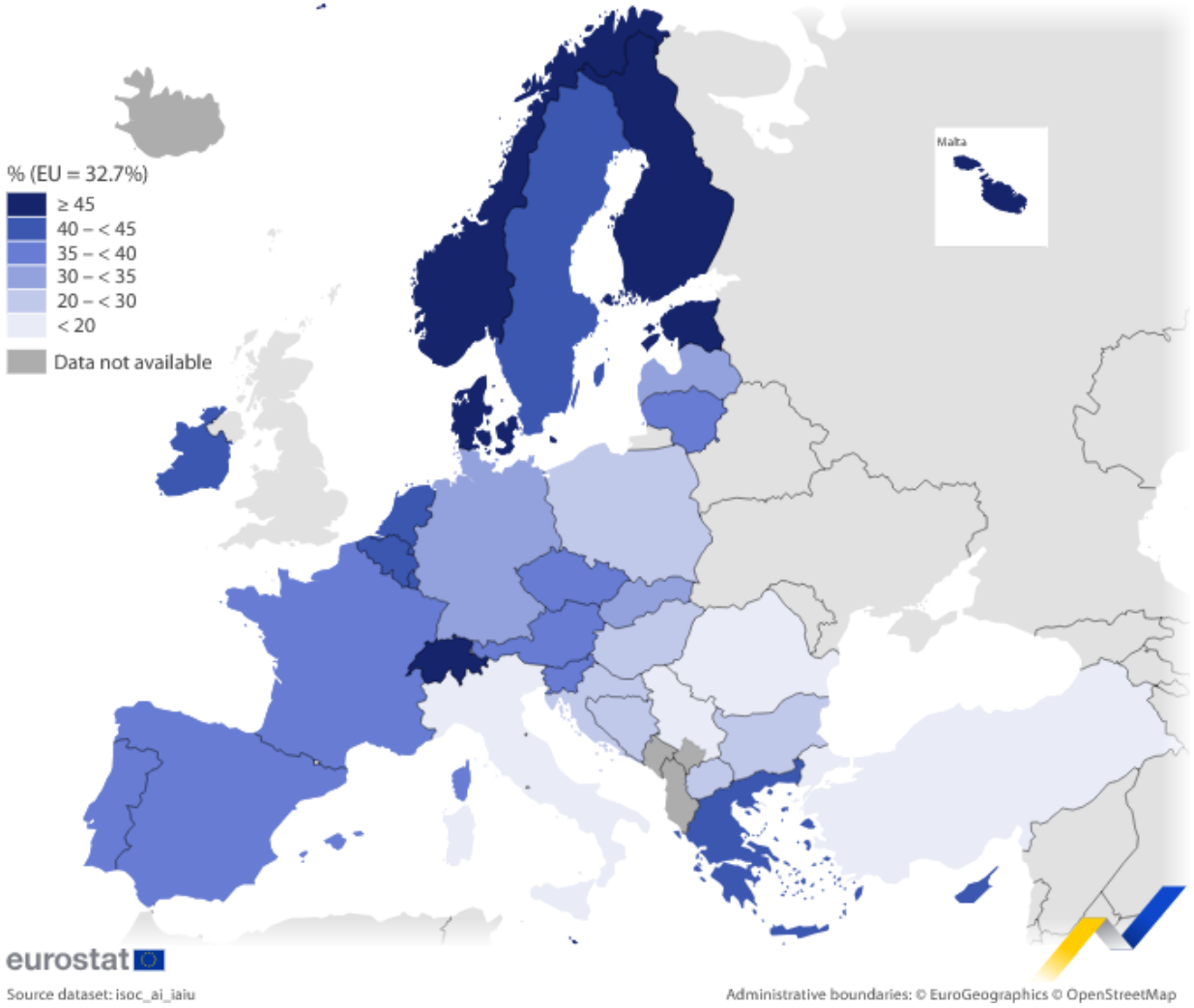
01

AI in engineering practice

Capabilities have expanded beyond prediction.

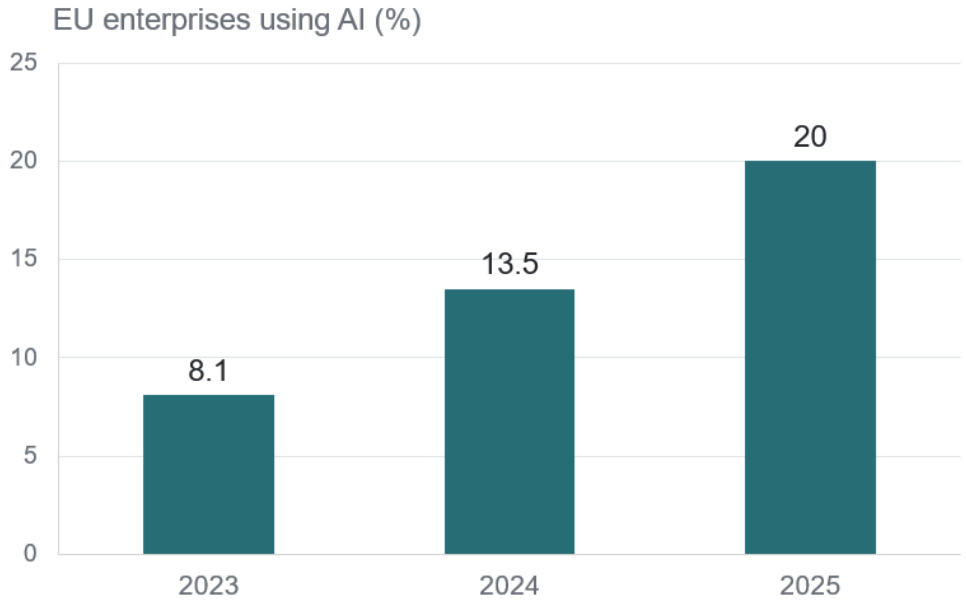


AI in Europe

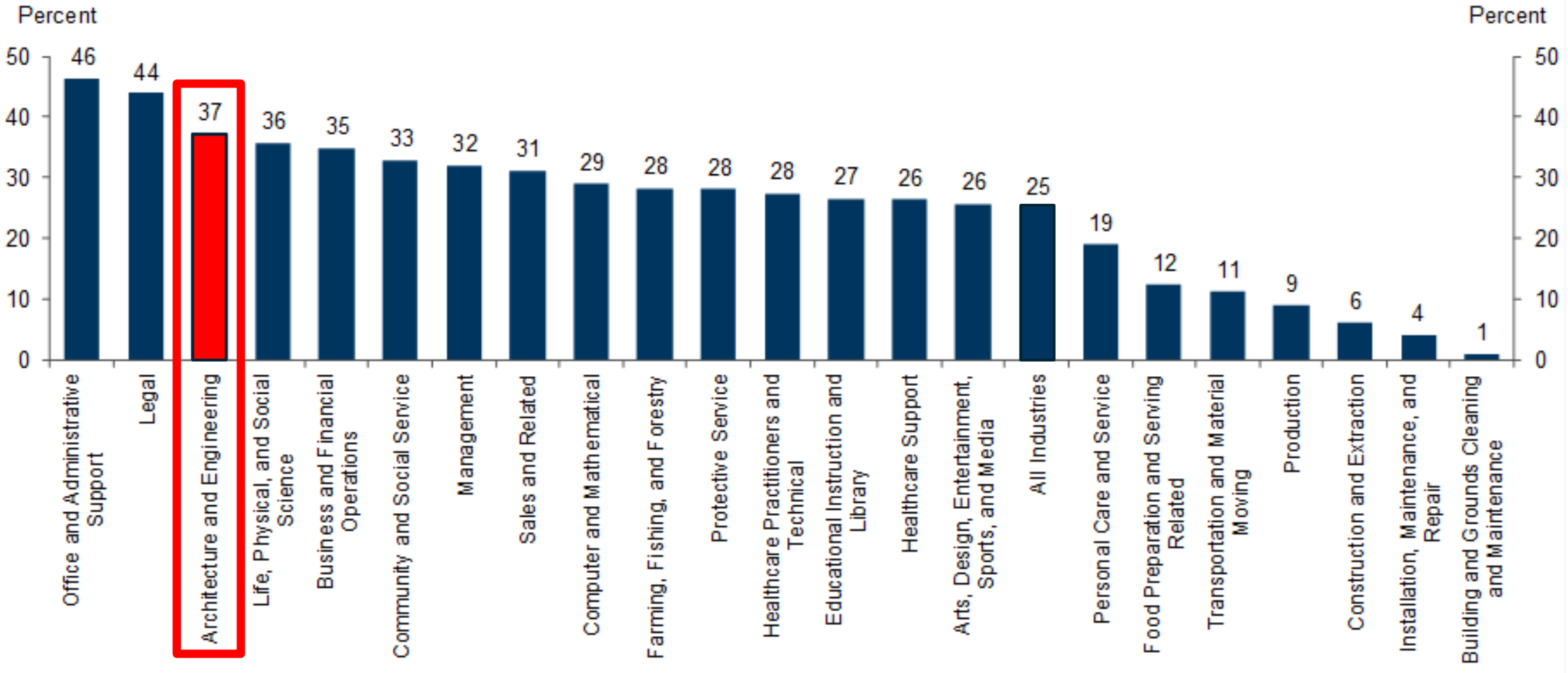


48%

of Danish enterprises used AI in 2025

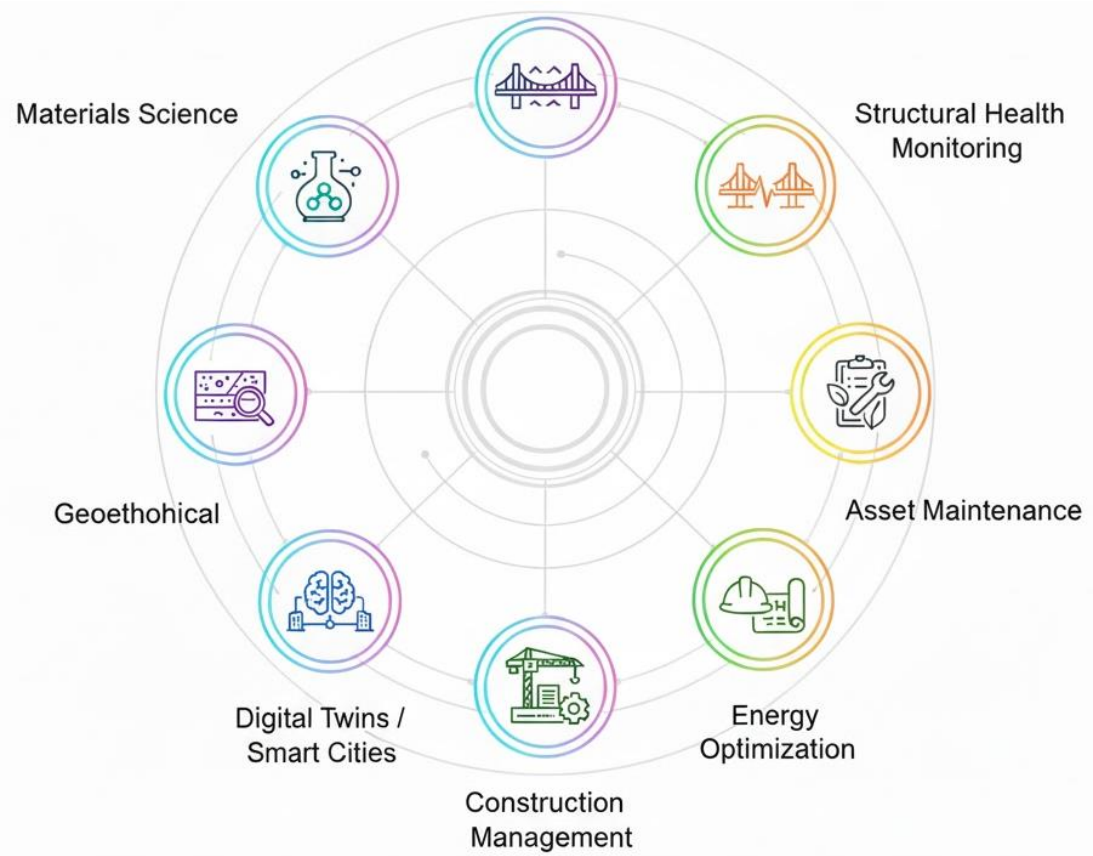


AI in civil engineering



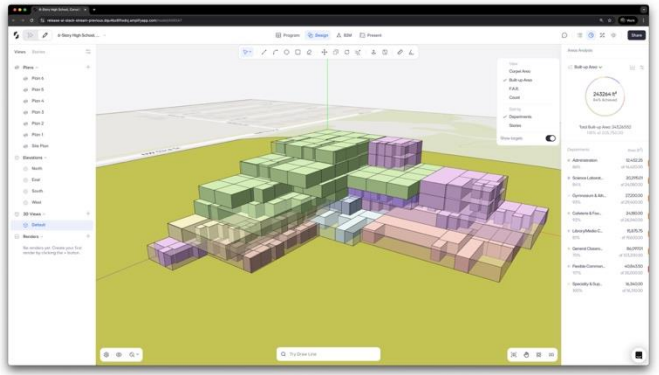
Source: Goldman Sachs Global Investment Research (2023)

AI in civil engineering











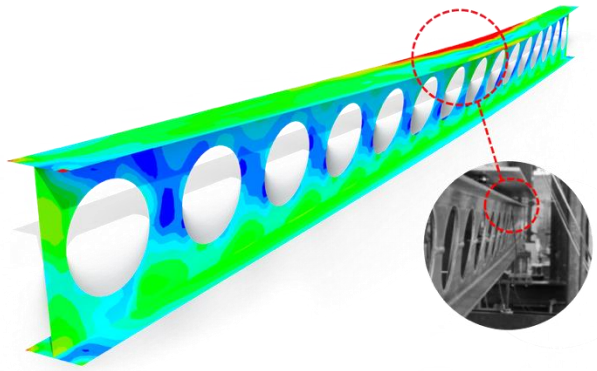
What about structural (steel) engineering?

Machine Learning

RF, SVR, XGBoost, ANN, CNN, RNN, PINN, TL,...

Prediction

Structural response
and surrogate models



$$M_{cr,0} = \frac{\pi}{L}\sqrt{EI_z GJ + \left(\frac{\pi}{L}\right)^2 EI_z EC_w}$$

$$M_{Rk} = \alpha_m \alpha_y M_{pl} \le M_{pl}$$

$$\alpha_m = \frac{\sqrt{3}M_{máx}}{\sqrt{\left[(M_A)^2 + (M_B)^2 + (M_C)^2\right]}} \le 2.5$$

$$\alpha_s = 0.6\left\{\sqrt{\left[\left(\frac{M_{pl}}{M_o}\right)^2 + 3\right]} - \left(\frac{M_{pl}}{M_o}\right)\right\}$$

$$M_o = \sqrt{\left\{\left(\frac{\pi^2 EIy}{l_e^2}\right)\left[GJ + \left(\frac{\pi^2 EC_w}{l_e^2}\right)\right]\right\}}$$

$$M_{Rd} = \frac{\chi_{LT} W_y f_y}{\gamma_{M1}}$$

$$\chi_{LT} = \frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \lambda_{LT}^2}} \le 1$$

$$\phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\lambda_{LT} - 0.2\right) + \lambda_{LT}^2\right]$$

$$\lambda_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

$$M_{cr} = C_b M_{cr,0}$$

$$\alpha_{LT} = 0.18\sqrt{\frac{W_{el,y}}{W_{el,y}}} \le 0.64$$

$$\alpha_{LT} = 0.25\sqrt{\frac{W_{el,y}}{W_{el,y}}} \le 0.64$$

$$M_{Rd} = k_{LB}\frac{\chi_{LT} W_y f_y}{\gamma_{M1}}$$

$$k_{LB} = \frac{1}{-0.01\lambda_{LT} + 1.05}$$

$$k_{LB} = \frac{min\left[\left(0.16\frac{A_f}{A_w} + 0.66\right), (1.0)\right]}{max\left[\left(-0.1\lambda_{LT} + 1.13\right), (0.9)\right]}$$

$$\phi_{LT} = 0.5\left[1 + \left(\frac{\lambda_{LT}^2}{\lambda_z^2}\right)\alpha_{LT}\left(\lambda_z - 0.2\right) + \lambda_{LT}^2\right]$$

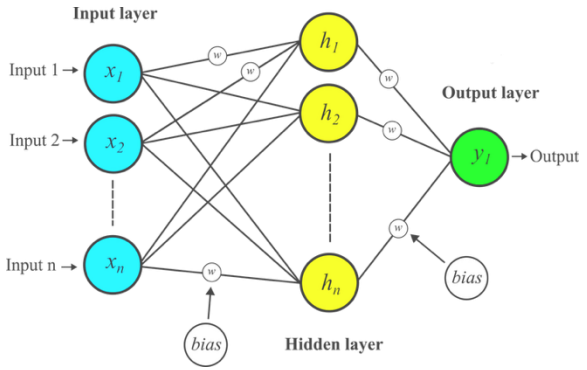
$$\chi_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

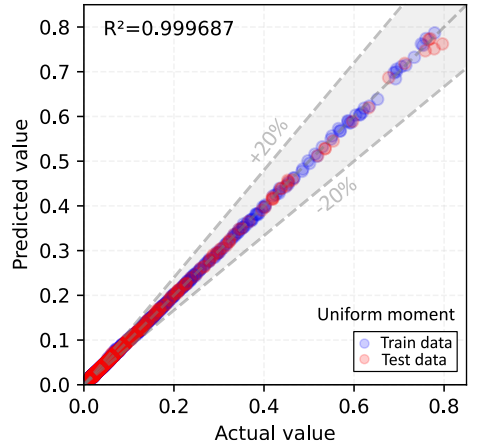
$$\lambda_z = \sqrt{\frac{Af_y}{N_{cr}}}$$

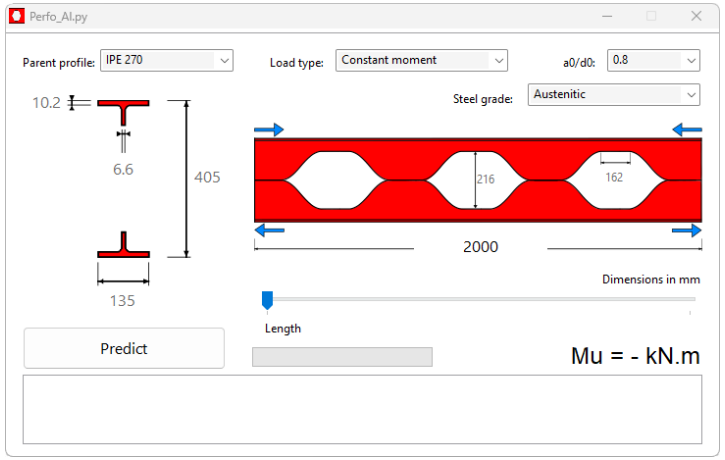
$$M_{cr} = C_1\frac{\pi^2 EI_z}{L^2}\left[\sqrt{\frac{C_w}{I_z} + \frac{L^2 GJ}{\pi^2 EI_z} + \left(C_2 z_g\right)^2} - C_2 z_g\right]$$

Eurocode

LTB Eurocode Formula (EC3 – Dense Math)



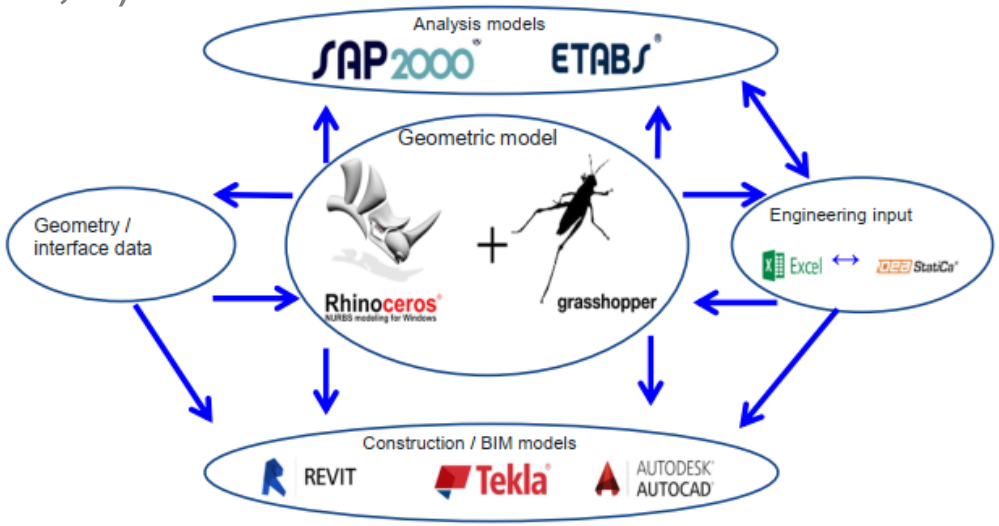




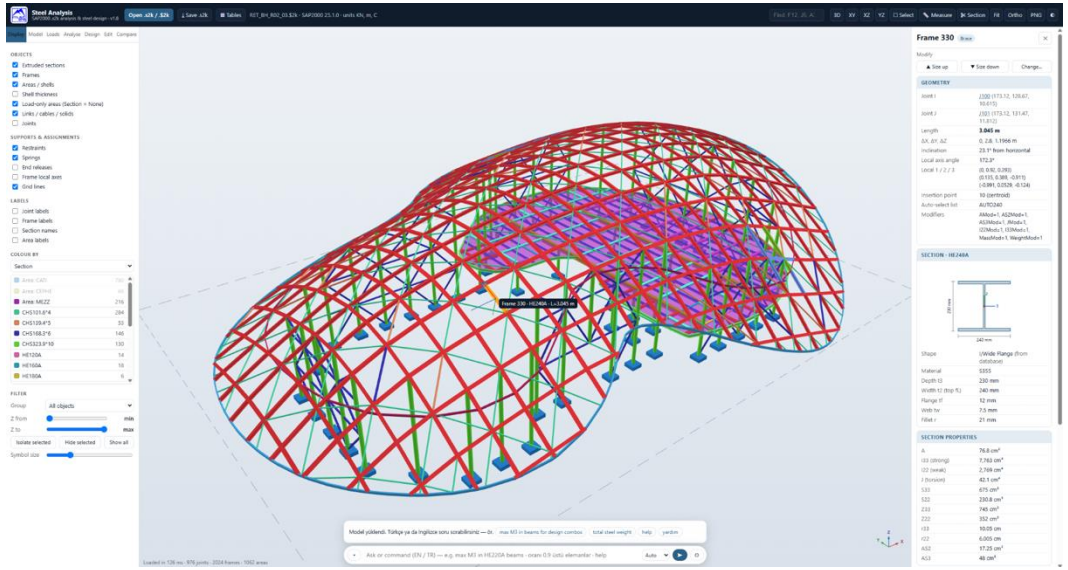
Tools → Workflows → Agents

LLMs orchestrate the software (RFEM, Dlubal, Sofistik,...)



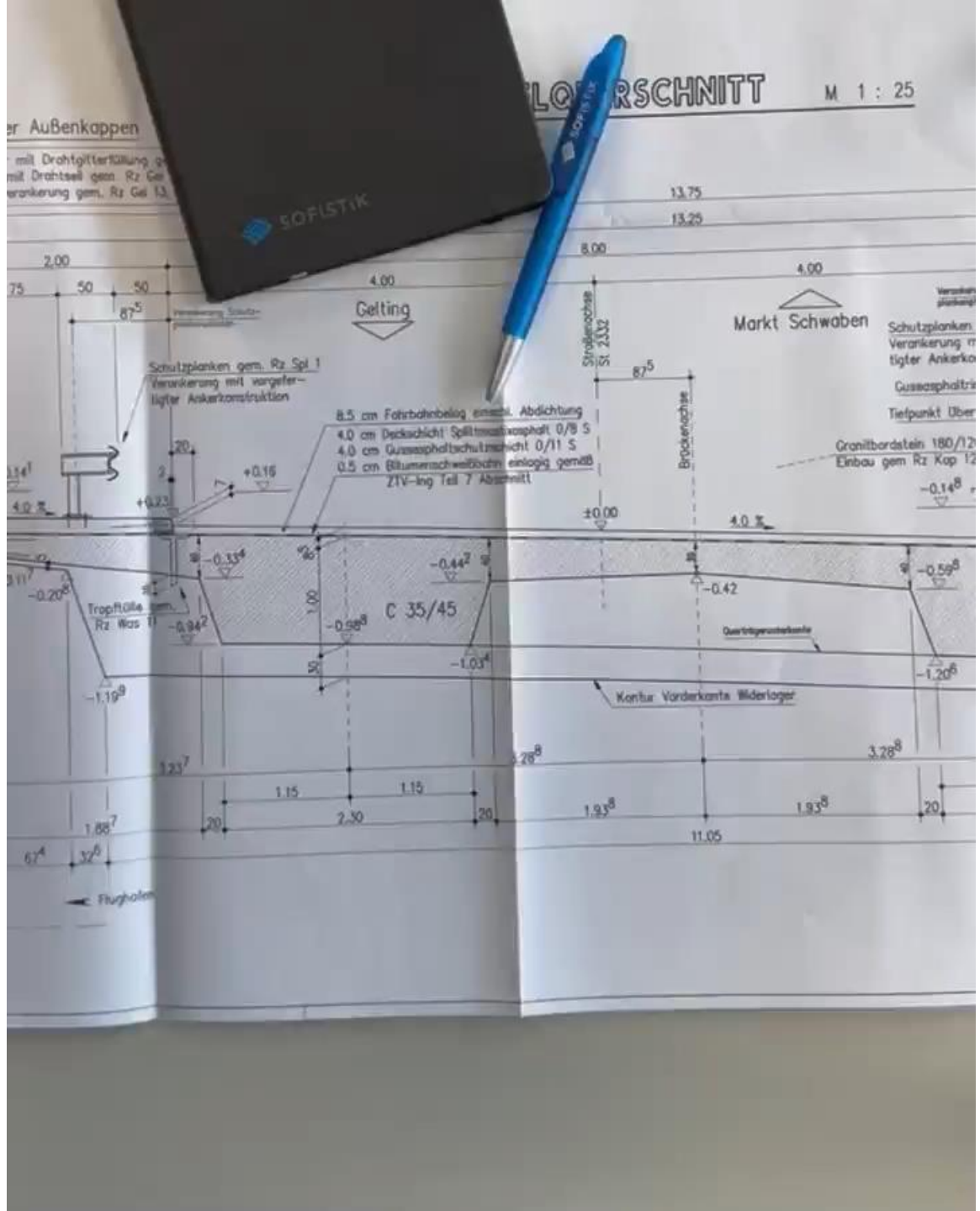


The calculations and the orchestration need different checks.



[Watch workflow demonstration ↗]

SOFiSTiK


SOFISTIK
SOFISTIK
M 1 : 25
Außenkappen
Gelting
Markt Schwaben
13.75
13.25
8.00
4.00
2.00
Schutzplanken gem. Rz Spl 1
Verankerung mit vorgefertigter Ankerkonstruktion
8.5 cm Fahrbahnbelag einschl. Abdichtung
4.0 cm Deckschicht Splittmastixasphalt 0/8 S
4.0 cm Gussasphaltschutzschicht 0/11 S
0.5 cm Bitumenschweißbahn einlagig gemäß
ZTV-Ing Teil 7 Abschnitt
Straßenachse
St 2332
Brückenachse
Granitbordstein 180/12
Einbau gem Rz Kap 12
Tiefpunkt Über
Gussasphaltsc
C 35/45
Tropfkante
Rz Kas 1
Querträgerunterkante
Kontur Vorderkante Widerlager
1.15
1.15
2.30
11.05
Flughafen

02

Trust and accountability

What evidence supports acceptance?



Industry is asking for justified trust





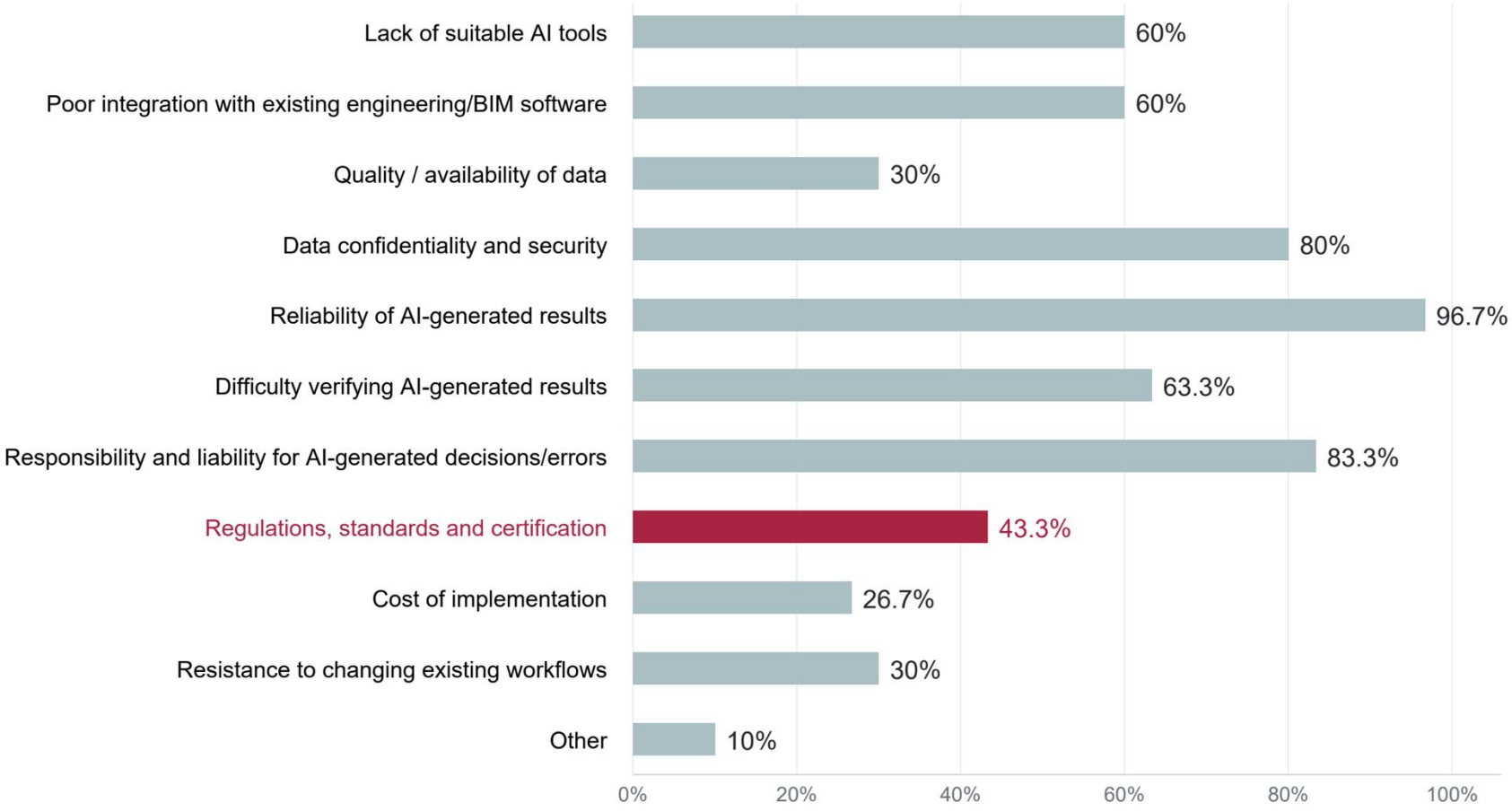
78%

use AI daily or
several times a week

AI IS ALREADY BEING USED WIDELY

The adoption question is no longer “if”. It is how to make usage **deliberate, reliable and scalable**.

The real barrier is engineering accountability



- Can I trust it?
- Can I verify it?
- Who is responsible if it is wrong?

ENGINEERS ARE NOT AFRAID OF AI

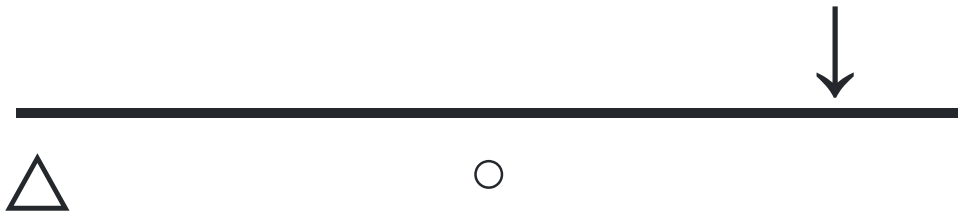
They are afraid of being wrong.

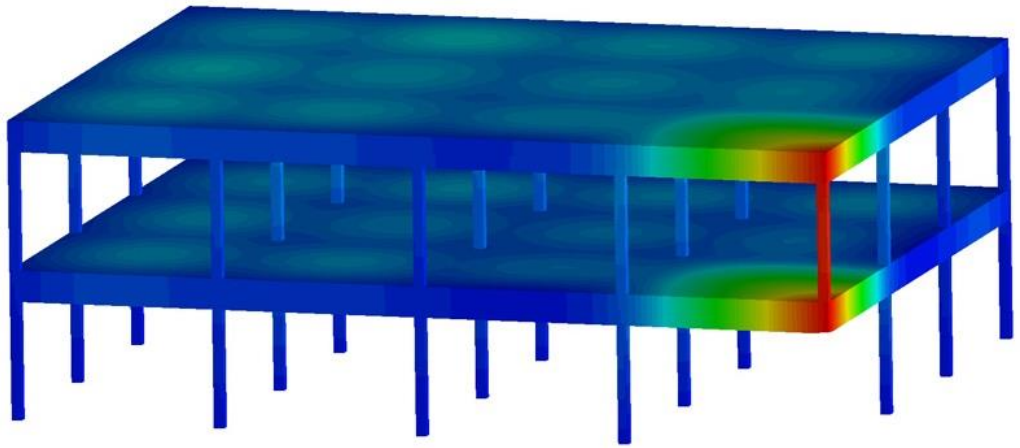
What if something goes wrong?

Requested model



Possible agent error





HUMAN CONTROL

Engineering judgement remains decisive

Accountability is a professional obligation!

AI Regulations in EU (“AI Act”)

Unacceptable risk	Prohibited practices
High risk	Requirements and oversight
Transparency obligations	Certain interactive / generated-content uses
Minimal or no risk	No additional AI Act requirements

Regulation (EU) 2024/1689

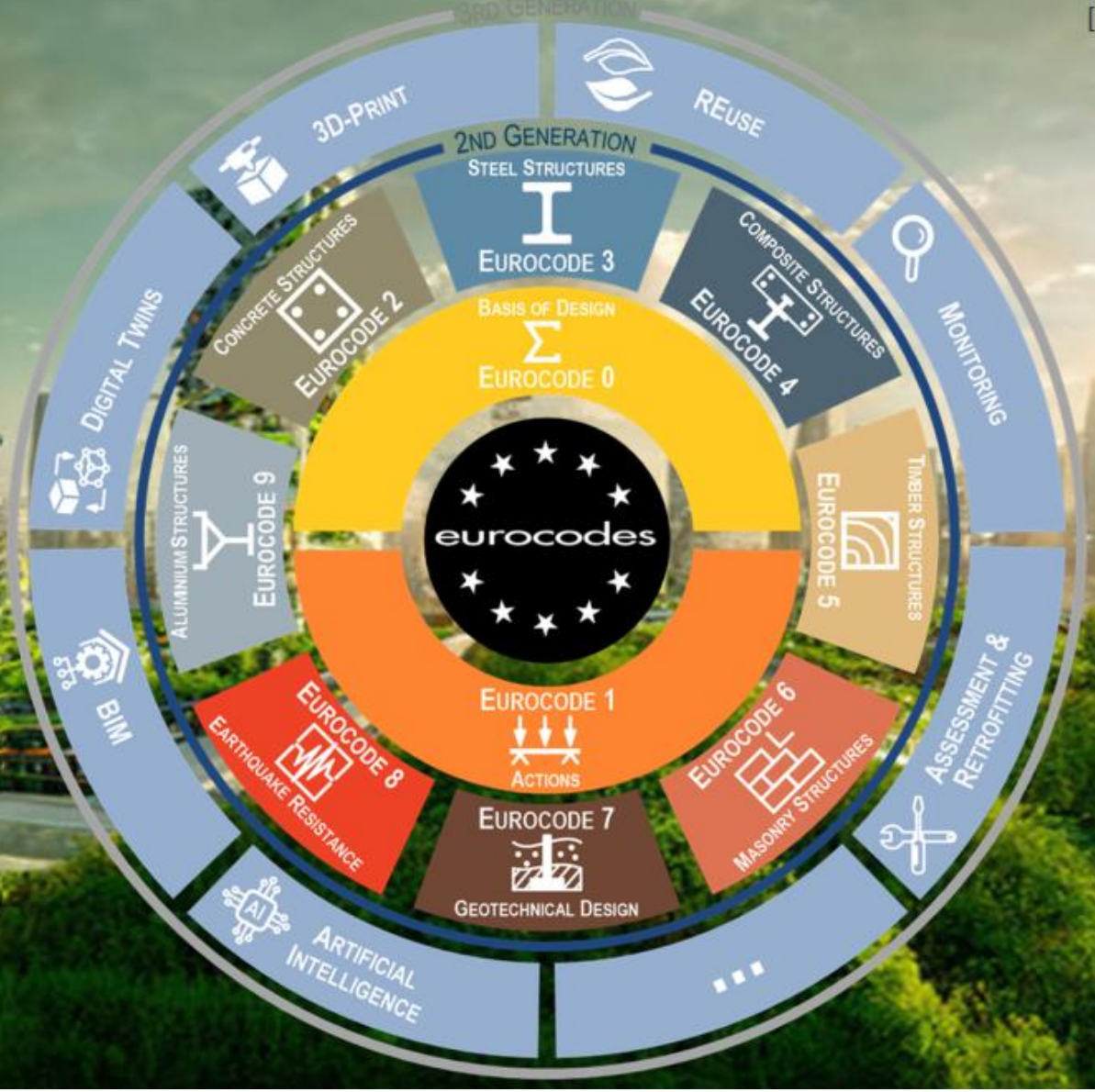
European Union regulation	
Text with EEA relevance	
Title	Artificial Intelligence Act[1]
Made by	European Parliament and Council
Journal reference	OJ L, 2024/1689, 12.7.2024
History	
European Parliament vote	13 March 2024
Council Vote	21 May 2024
Entry into force	1 August 2024



EU AI Act: Regulation (EU) 2024/1689, entered into force 1 August 2024. Legal classification is use-specific.

[16]

The development of the
3rd GENERATION OF EUROCODES must KEEP
PACE WITH THE (TECHNOLOGICAL)
PROGRESS of the modern world
and the NEED/S of well-educated engineers
IN PRACTICE.

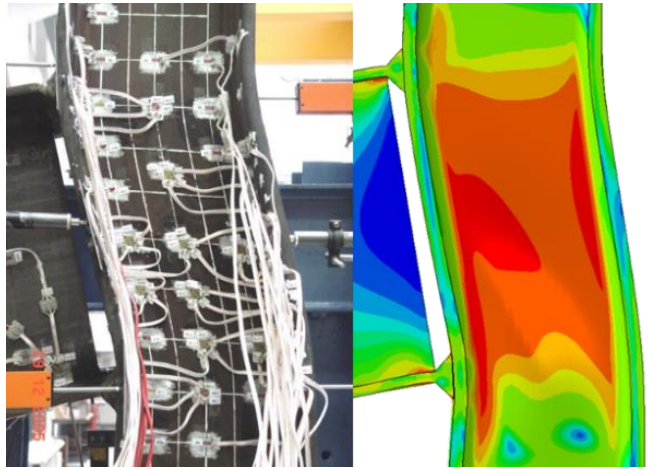


The aim is to provide normative guidelines for AI design of steel structures in EC3 in the future

Analogy with EN1993-1-14

EN 1993-1-14

Design assisted by
finite-element analysis



EN 1993-1-XX

AI-assisted design

Modelling assumptions · verification · validation
applicability limits · uncertainty · reliability

03

European initiatives

A coordinated route towards common guidance.



CEN/TC250/SC3 AHG5 & ECCS TC17

“AI design of steel structures”

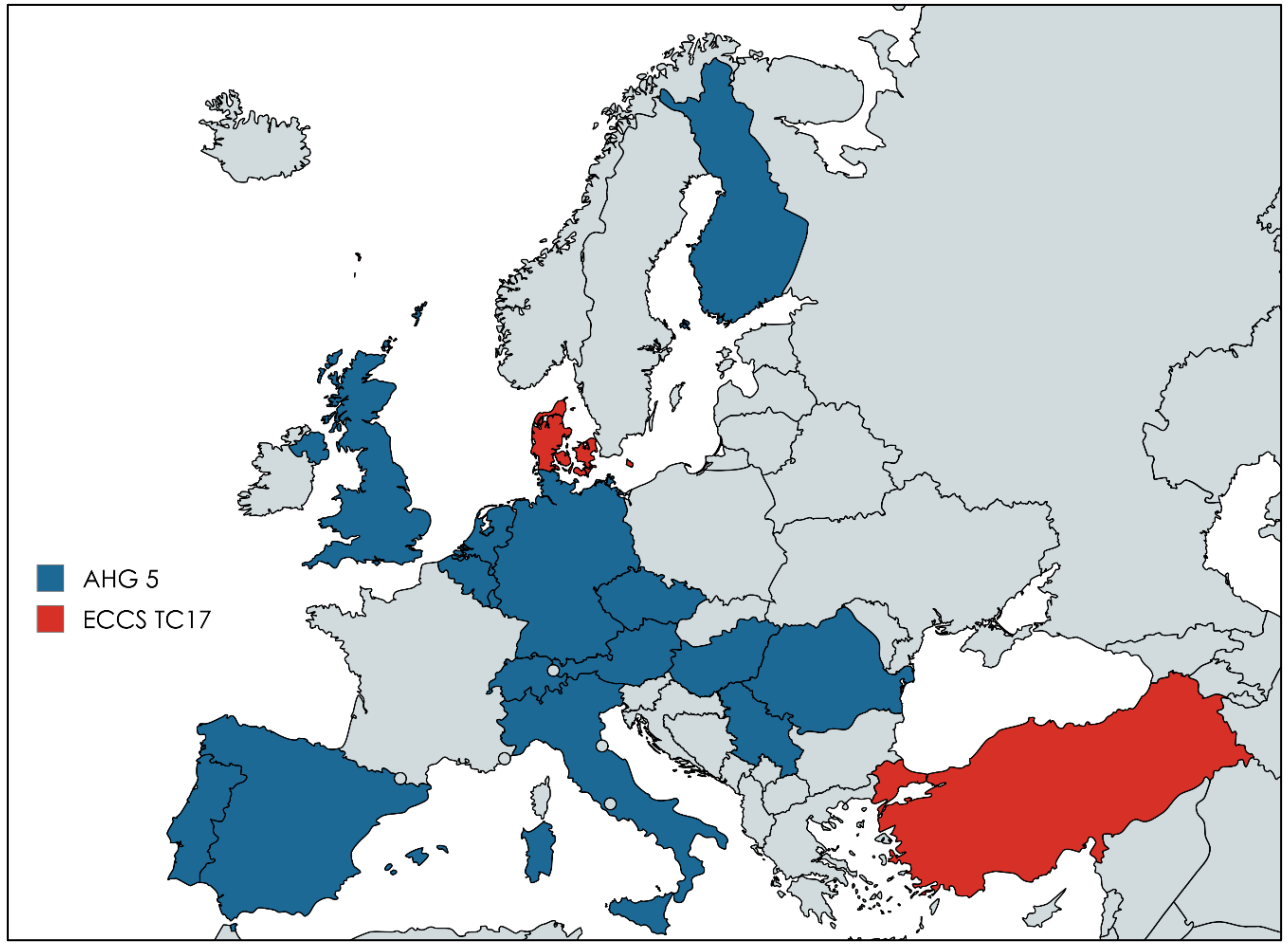
Established: April 2025

Chairman: Filip Ljubinković

Secretary: Adriano de Carvalho

Members:

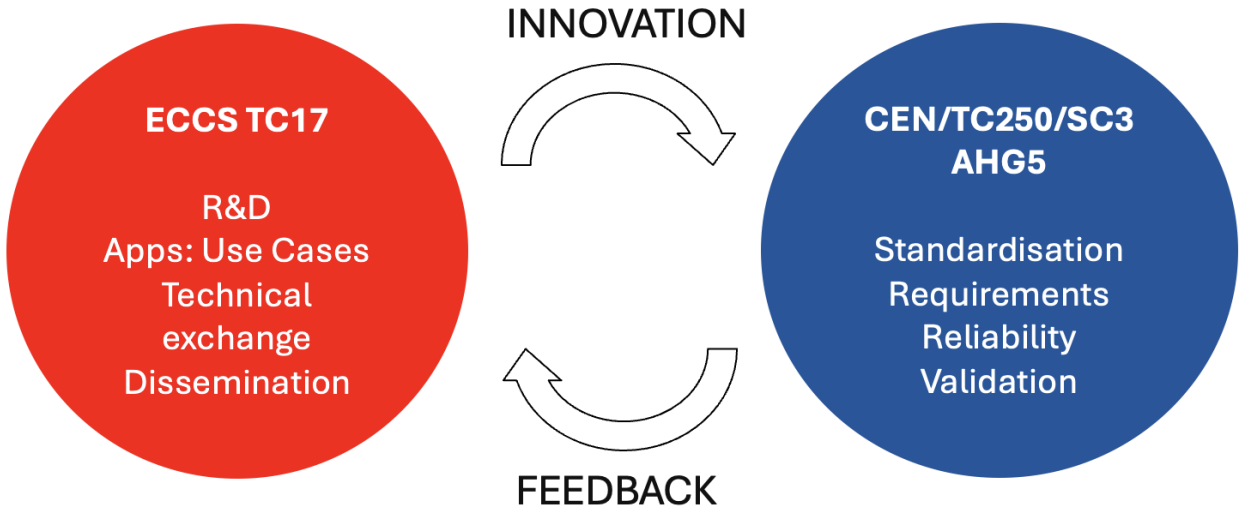
- 50 experts
- 17 EU countries
- Industry, Academia, Software



CEN/TC250/SC3 AHG5 & ECCS TC17
“AI design of steel structures”

Mission

- Develop normative guidelines - aligned with EU regulations (EN1990/EN1993; EU AI Act; Data Act,…)
- European forum for technical discussion, collaboration, and knowledge dissemination
- Technological integration and educational initiatives - training and certification



CEN/TC250/SC3 AHG5 & ECCS TC17

Meetings

Meeting	Date	Location	Participants	In-person
1 (AHG)	10 Oct 2025	Coimbra, Portugal	26	20
2 (AHG)	26 Feb 2026	Barcelona, Spain	34	22
3 (AHG + ECCS)	01 Oct 2026	Salerno, Italy	38	27
4 (AHG + ECCS)	04 Mar 2027	Delft, Netherlands		
5 (AHG + ECCS)	30 Sep 2027	Zurich, Switzerland		



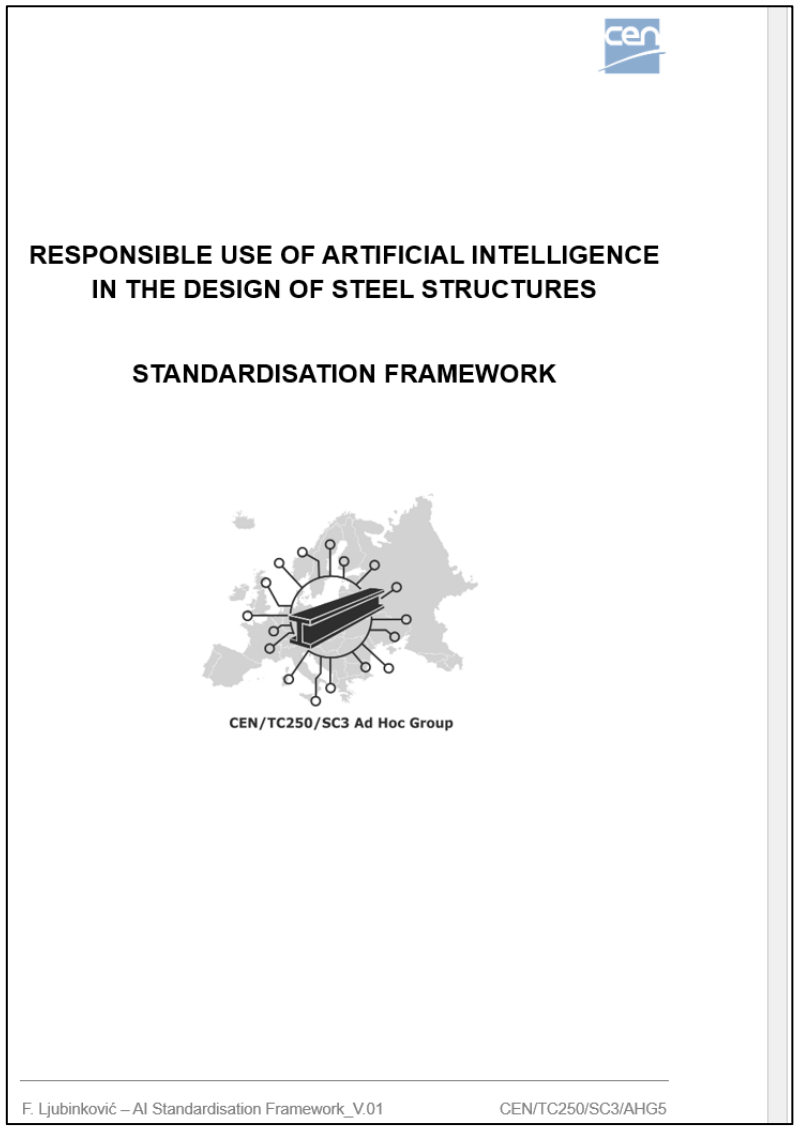


04

Standardistaion framework



Standardisation framework


RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE
IN THE DESIGN OF STEEL STRUCTURES

STANDARDISATION FRAMEWORK

CEN/TC250/SC3 Ad Hoc Group

F. Ljubinković – AI Standardisation Framework_V.01 CEN/TC250/SC3/AHG5

Evidence review → **Technical reports** → **Standardisation Framework**

Practices, patterns and limitations

Task-group findings and synthesis

Proposed process and requirements

≈ 300

papers, use cases, real examples
in a structured steel AI evidence review

The aim: turn research and practical experience into reviewable provisions.

Standardistaion framework

Purpose

To establish **general principles**, **requirements**, and **documentation provisions** to support the safe, reliable, transparent, traceable, and accountable use of AI in engineering applications related to steel structures.

Scope

AI systems supporting or performing engineering activities:

- conceptual and preliminary design;
- structural analysis and design verification;
- optimisation and generation of design solutions;
- inspection and structural monitoring

Audience

AI developers, structural engineers, software providers, reviewers, public authorities, researchers, and standardisation bodies

The framework breakdown

Structure

1 AI Classification → **2 Assess risk** → **3 Apply Requirements** → **4 Documentation**

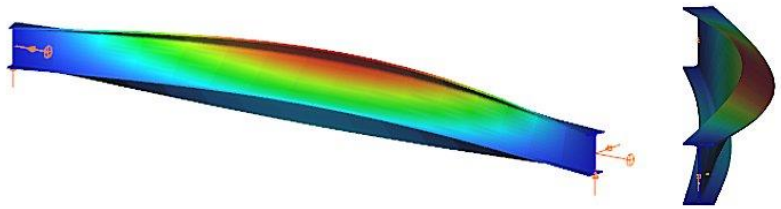
Define purpose and engineering role

Structural relevance and safeguards

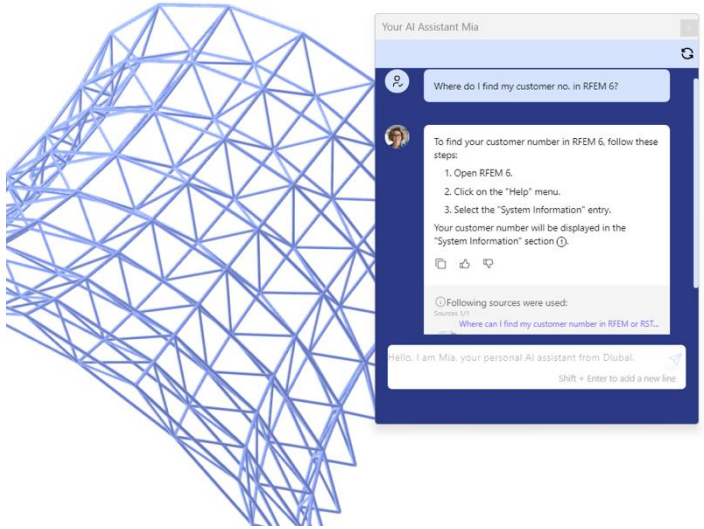
Lifecycle requirements and responsibilities

Basis for acceptance and continued use





+ EC3 design



Step 1: AI classification system

Engineering function

Action authority (autonomy)

Output behaviour

Independent verifiability

Transparency

Group	Classification dimension	Classes or indicative categories
CORE	Engineering use	ND – non-design; ID – indirect design; DD – direct design
	Engineering function (role)	F1 – advisory; F2 – prediction; F3 – classification; F4 – optimisation or generation; F5 – calculation or checking; F6 – orchestration or agentic operation
	Autonomy and action authority	A1 – informational; A2 – human-approved execution; A3 – automated predefined workflow; A4 – adaptive or agentic workflow
	Output behaviour	Deterministic; probabilistic or stochastic; non-deterministic
	Independent engineering verifiability	V1 – directly verifiable; V2 – verifiable through reference evidence; V3 – limited independent verifiability
	Transparency and interpretability	Transparent or interpretable; partially interpretable; opaque or of limited interpretability
SUPPLEMENTARY	Structural application domain	Lifecycle context; structural object; structural typology; engineering phenomenon or assessment
	Position within the engineering workflow	Concept or pre-design; input preparation; analysis; design verification; integrated design; execution; inspection or monitoring; reporting
	Operational input and knowledge sources	Engineering parameters; experimental or numerical data; monitoring data; documents; digital models; external knowledge; user input; hybrid sources
	Development provenance	Internally developed; adapted or fine-tuned; externally developed; hybrid
	Technical AI family	Machine learning; deep learning; physics-informed or hybrid AI; probabilistic AI; generative AI; language-model or agentic systems; other applicable families
	Generated output type	Numerical; categorical; recommendation; verification; design solution; digital or graphical; textual; data or software; action or workflow; hybrid

Step 2: Structural relevance and risk

1 AI Classification → **2 Assess risk** → 3 Requirements → 4 Documentation

Low	Information and administration	**Defined purpose and human review**
Moderate	Engineering support with established checks	**Application-specific validation**
High	Direct influence on safety or compliance	**Stronger evidence and workflow control**

Proportionality enables practical adoption.

Step 3: AI Lifecycle requeirments

1 AI Classification → 2 Assess risk → **3 Requirements** → 4 Documentation

AI Lifecycle

Stage 1: Planning

AI adoption strategy: Purpose, risk, roles and acceptance criteria

→ **Stage 2: Development**

Data, implementation and verification

→ **Stage 3: Use**

Engineering validation and operational control

→ **Stage 4: End-of-life**

Withdrawal, replacement or redevelopment

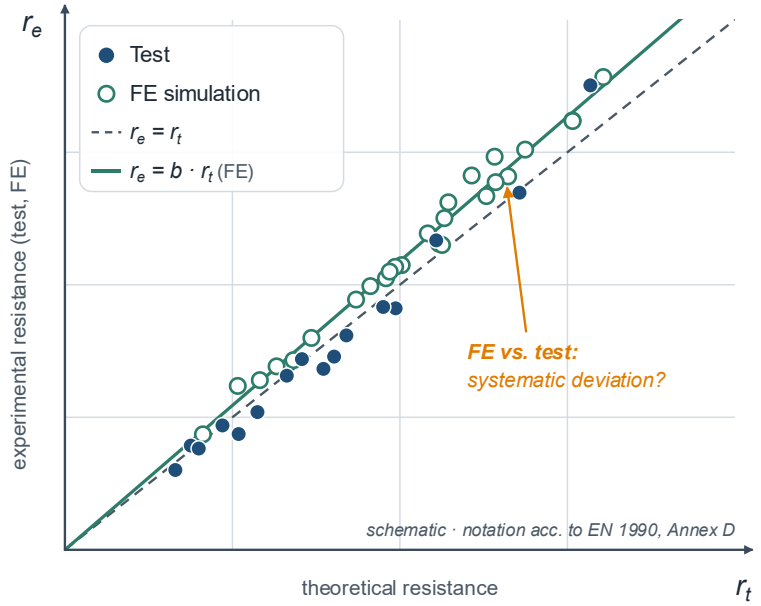
Significant changes can return the system to an earlier stage.

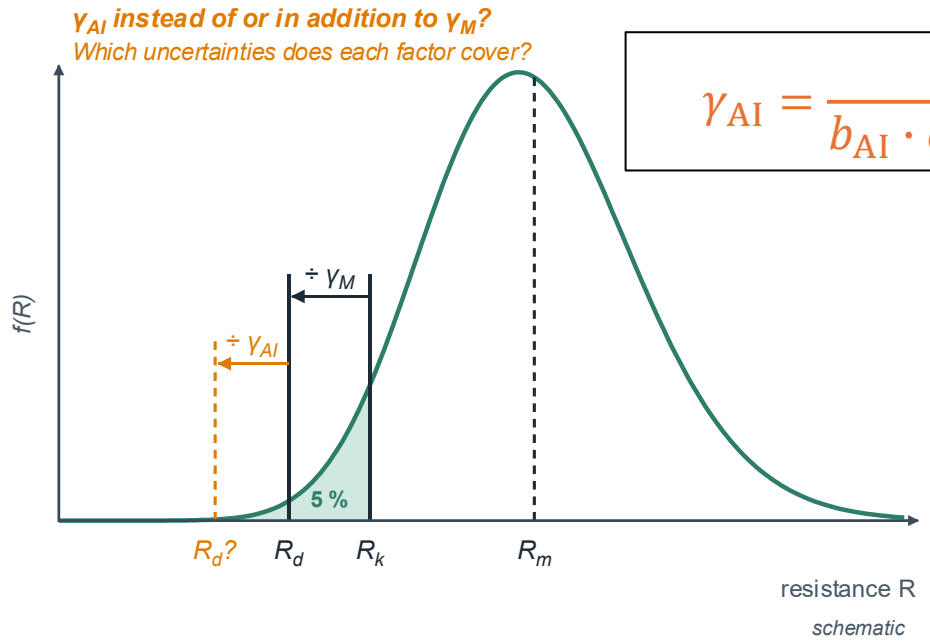
Validation and reliability

Representative benchmarks: experiments, validated FEM, analytical solutions

Engineering behaviour: physical consistency, sensitivity studies, limitations

For safety-related predictions: assess uncertainty and reliability (EN1990).



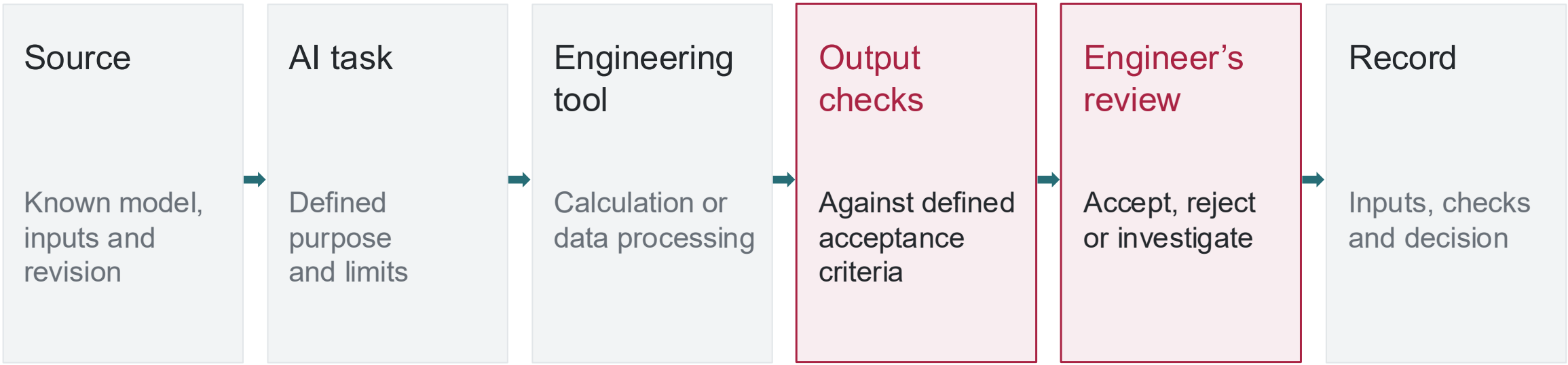


$$\gamma_{\mathrm{AI}} = \frac{1}{b_{\mathrm{AI}} \cdot exp(-k_{\mathrm{n}} \cdot \alpha_\delta \cdot Q_\delta)} \geq 1.0$$

γ_{AI}: indicative proposal for specific resistance predictions; calibration still needed.

Agentic workflows

How we make AI-assisted work checkable



Across every interface:

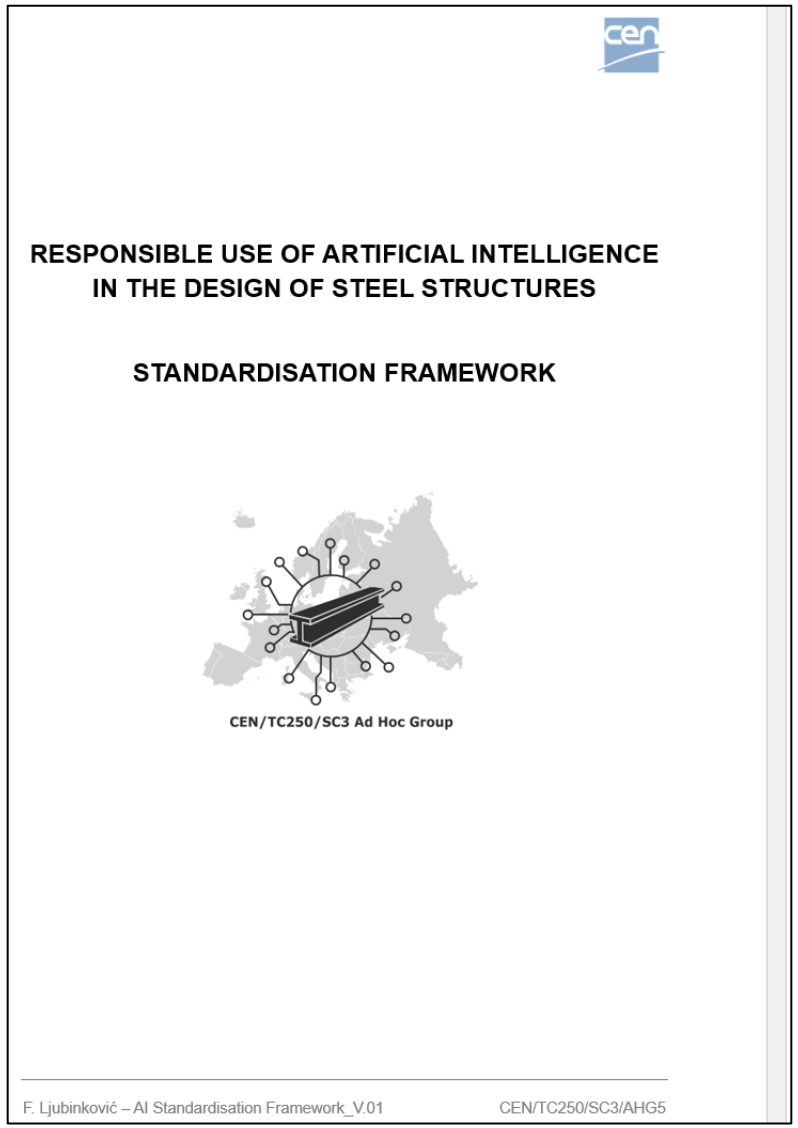
units · versions · action logs · permissions · intervention points

Step 4: Documentation makes acceptance reviewable

1 AI Classification → 2 Assess risk → 3 Requirements → **4 Documentation**

System	Version, configuration and permitted use
Evidence	Verification, validation and independent checks
Limits	Applicable domain, restrictions and uncertainty
Decision	Who reviewed, accepted or rejected the output
Change	Updates, incidents and reassessment

Pre-normative document: Standardisation framework



1 Define & classify → 2 Assess risk → 3 Requirements → 4 Documentation

Framework is:

- **Modular**: can be further detailed by inserting specific modules
- **Generic**: Can be used for AI applications beyond the design of steel structures (other materials, but also SHM, etc.)
- **"Timeless"**: It establishes a protocol control which is not specific to any AI family.

The next step is technical review and consensus

Evidence & drafts	→	2027 targets	→	Trial applications	→	Future guidance
Review research and working proposals		Synthesis, technical reports and review		Test requirements against real workflows		Consensus and formal standardisation decisions

- Submission to CEN in 2027: ECCS Publication
  - Ad hoc Group conversion to CEN Working Group
    - Techincal Specifications → EN1993-1-XX

05

Concluding remarks



Enable digital progress. Strengthen engineering accountability.

01

REMOVE FRICTION

repetitive work, transfer, documentation

02

AUGMENT JUDGEMENT

comparison, checking, optimisation

03

PRESERVE KNOWLEDGE

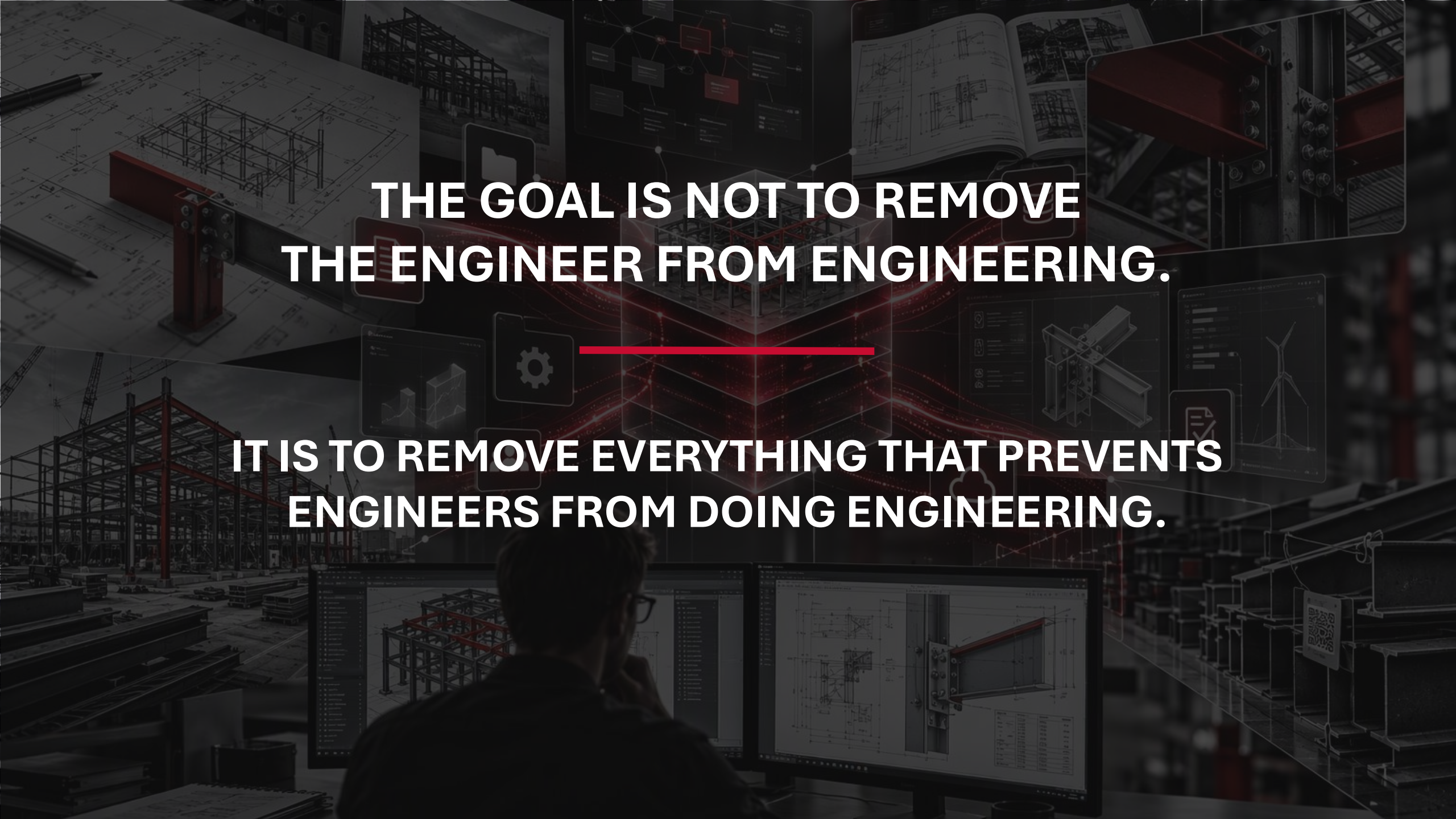
projects, lessons, engineering rationale

LESS PROCESS FRICTION. MORE ENGINEERING.



Industry · academia · standardisation bodies · international partners

Build the capability. Establish the evidence. Retain engineering judgement.


THE GOAL IS NOT TO REMOVE
THE ENGINEER FROM ENGINEERING.
IT IS TO REMOVE EVERYTHING THAT PREVENTS
ENGINEERS FROM DOING ENGINEERING.

THANK YOU

Let’s stay in touch

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Filip Ljubinkovic

University of Coimbra · ISISE
Convenor, CEN/TC250/SC3 AHG5 — AI Design of Steel Structures
Chairman, ECCS TC17 — AI Design of Steel Structures

TOWARDS STANDARDISATION OF ARTIFICIAL INTELLIGENCE IN STEEL STRUCTURAL DESIGN