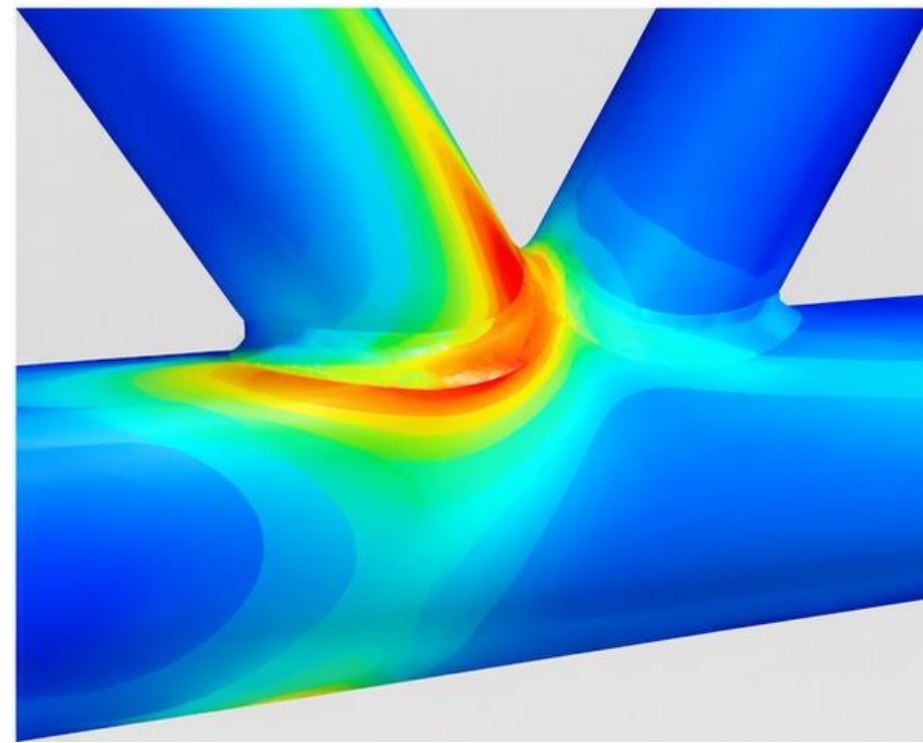
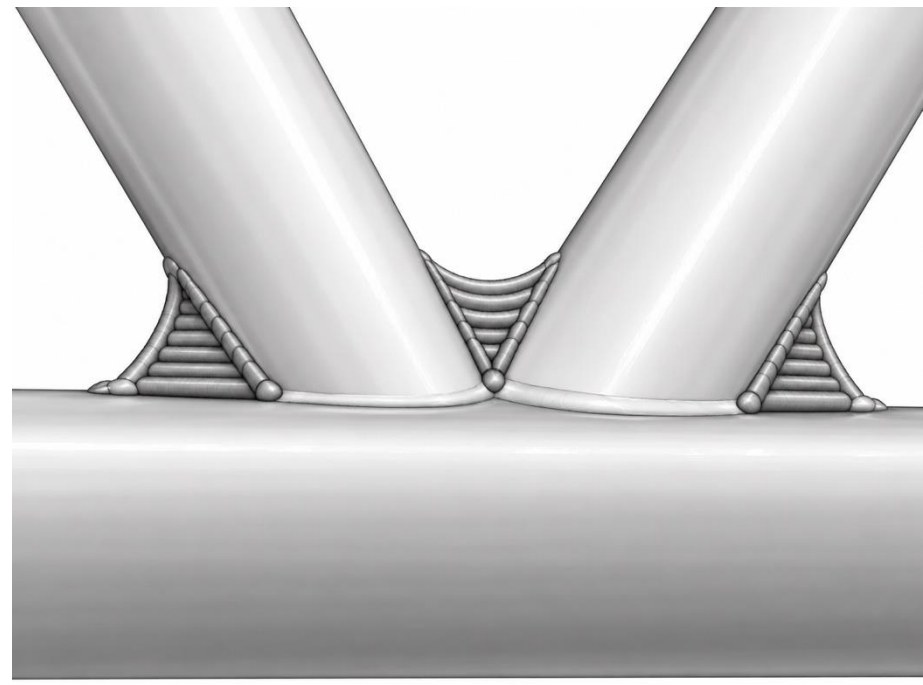






Wire Arc Additive Manufacturing









CE
EN 1090



EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM	EN 1993-1-8 May 2005 Supersedes ENV 1993-1-1:1992
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EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM	EN 1993-1-1 May 2005 Supersedes ENV 1993-1-1:1992
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ICS 91.010.30; 91.080.10

English version

Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings

Eurocode 3: Calcul des structures en acier - Partie 1-1:
Règles générales et règles pour les bâtiments

Eurocode 3: Bemessung und Konstruktion von Stahlbauten
- Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau

This European Standard was approved by CEN on 16 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

METAL 3D PRINTING

FROM MATERIAL → FULL SCALE

TRAYANA TANKOVA





IAMFat

Intelligent Additive Manufacturing for improved Fatigue strength of welded connections



Funded by
the European Union



Who?

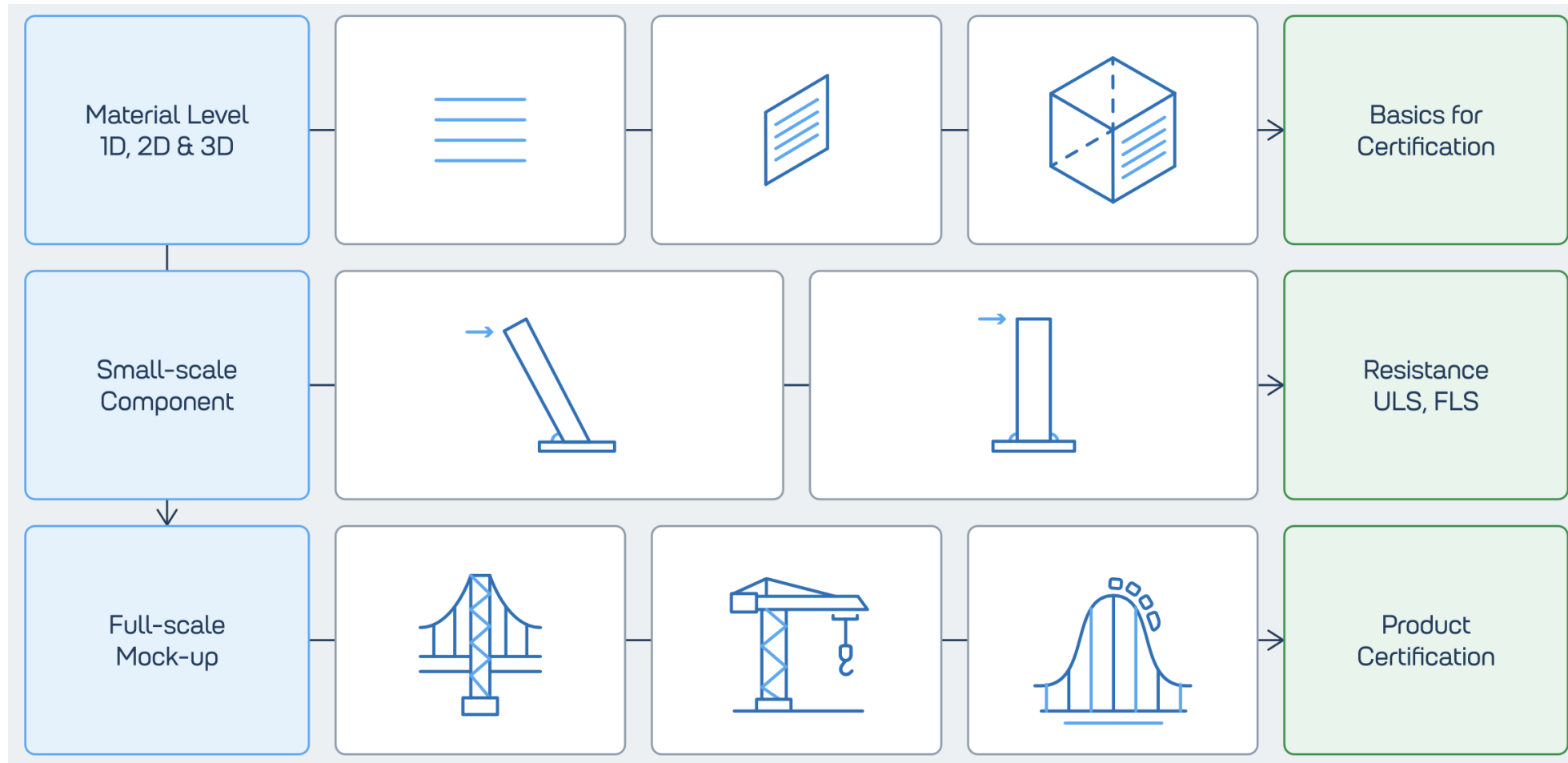
Partnership



Sponsor

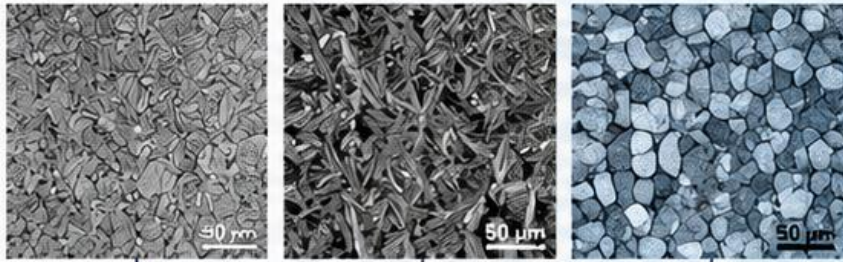


From material to full-scale



MATERIAL FREEDOM

ENGINEER THE MATERIAL



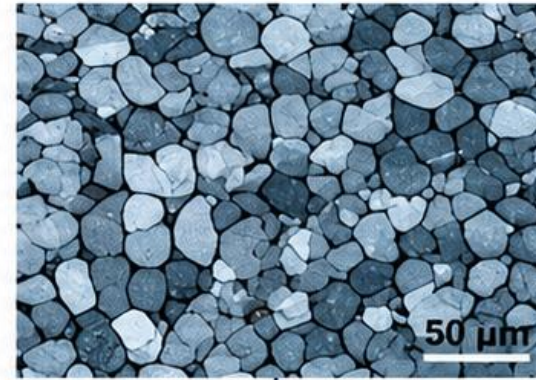
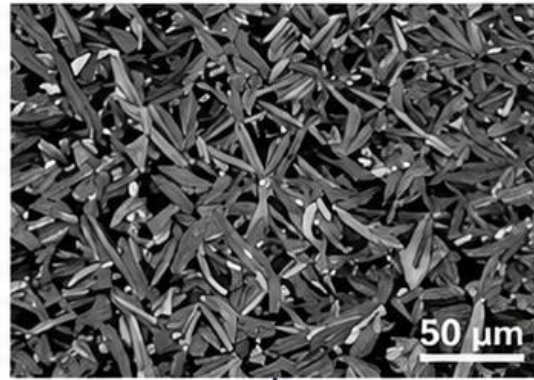
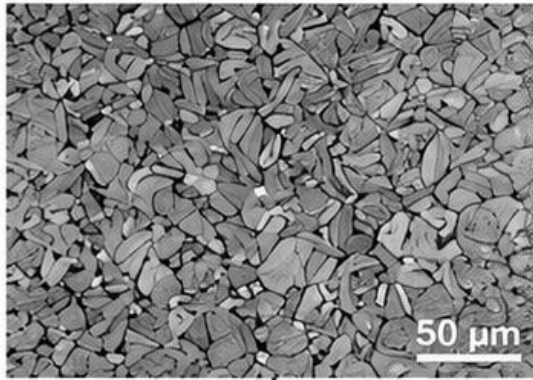
GEOMETRICAL FREEDOM

ENGINEER WHERE THE MATERIAL GOES



MATERIAL FREEDOM

ENGINEER THE MATERIAL



PROCESS SETTINGS

HEAT INPUT



TRAVEL SPEED

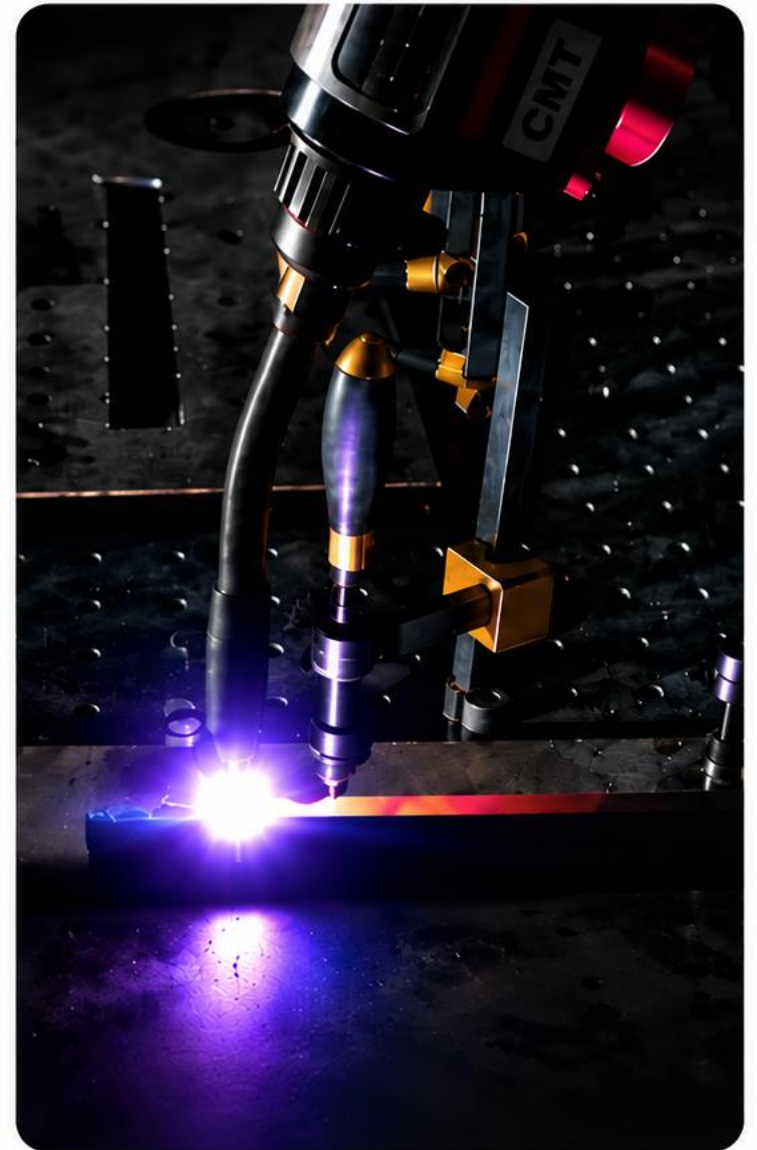


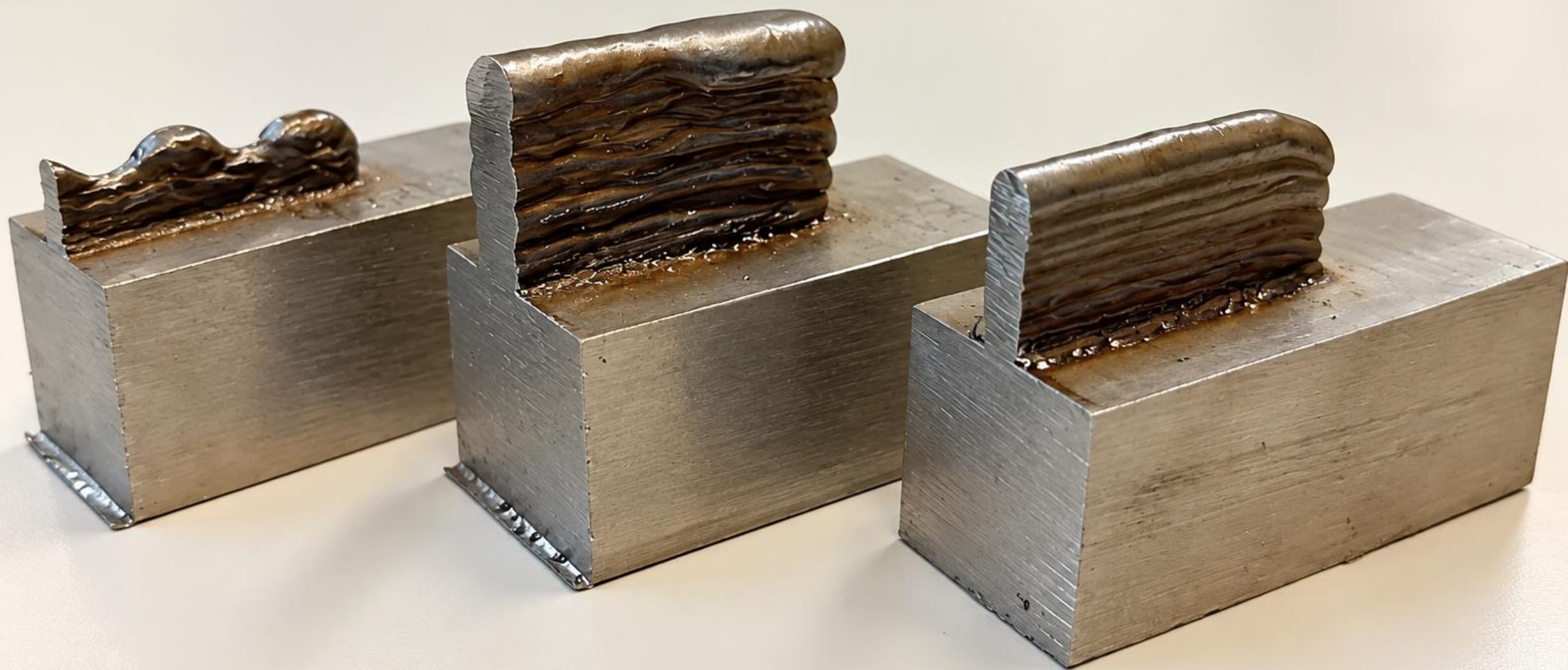
DEPOSITION PATH

UNIDIRECTIONAL

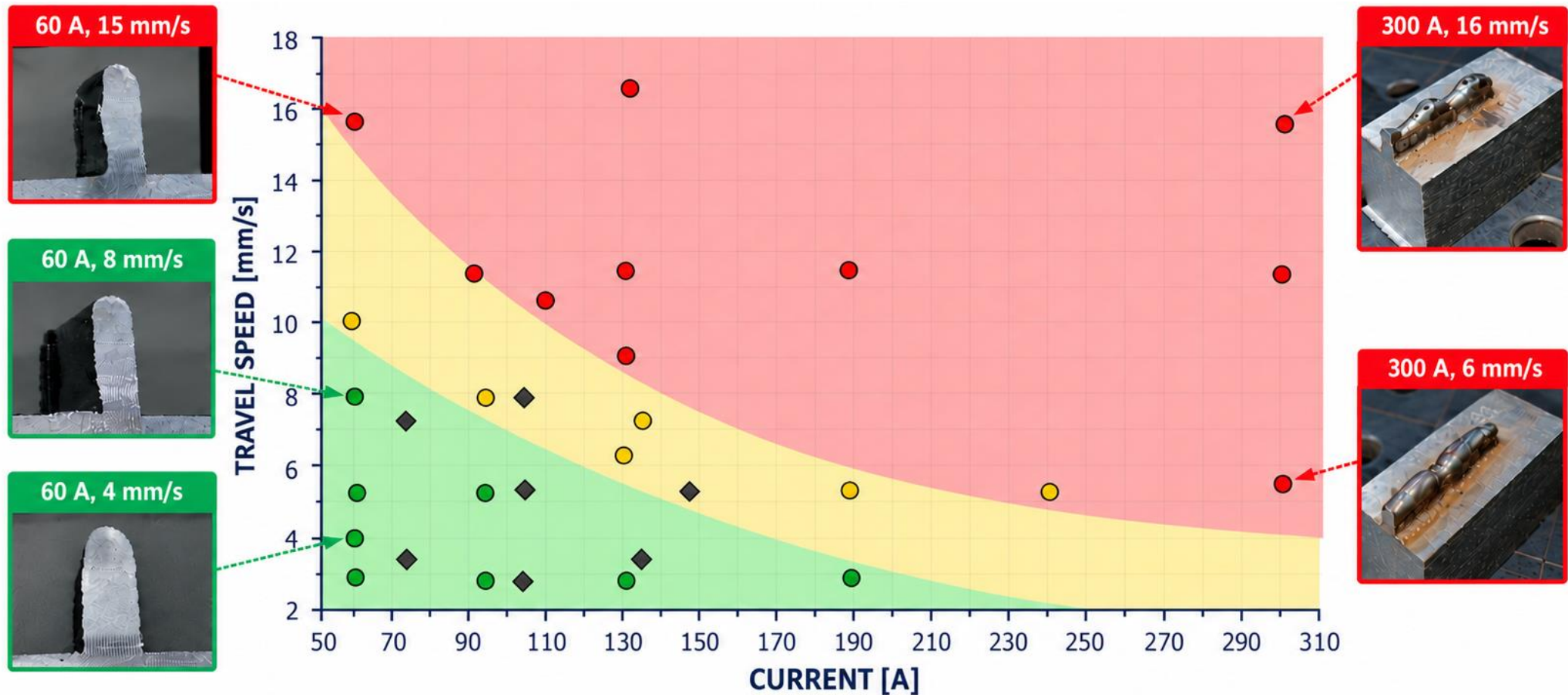


CONCENTRIC (SPIRAL)





Process Map

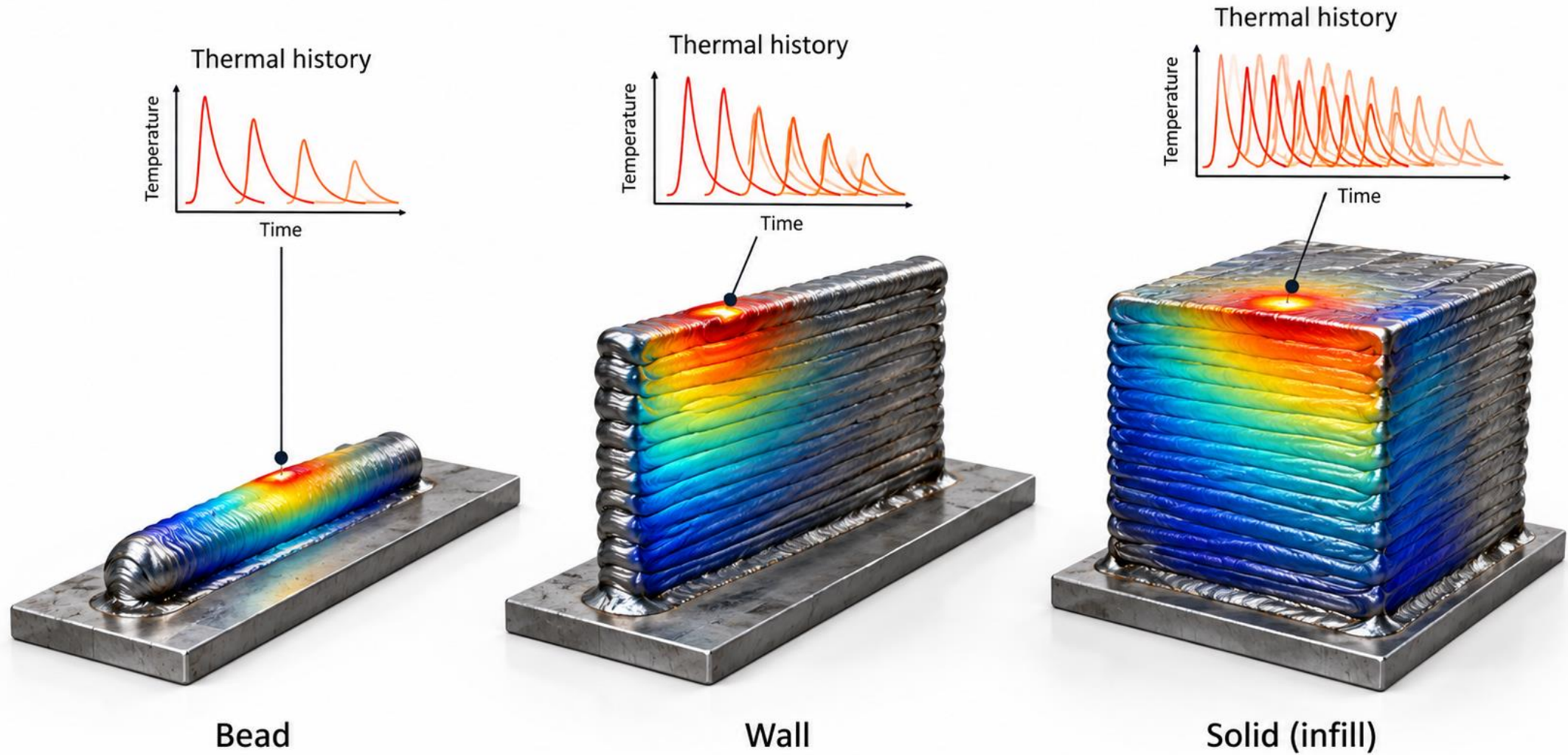


Material deposit

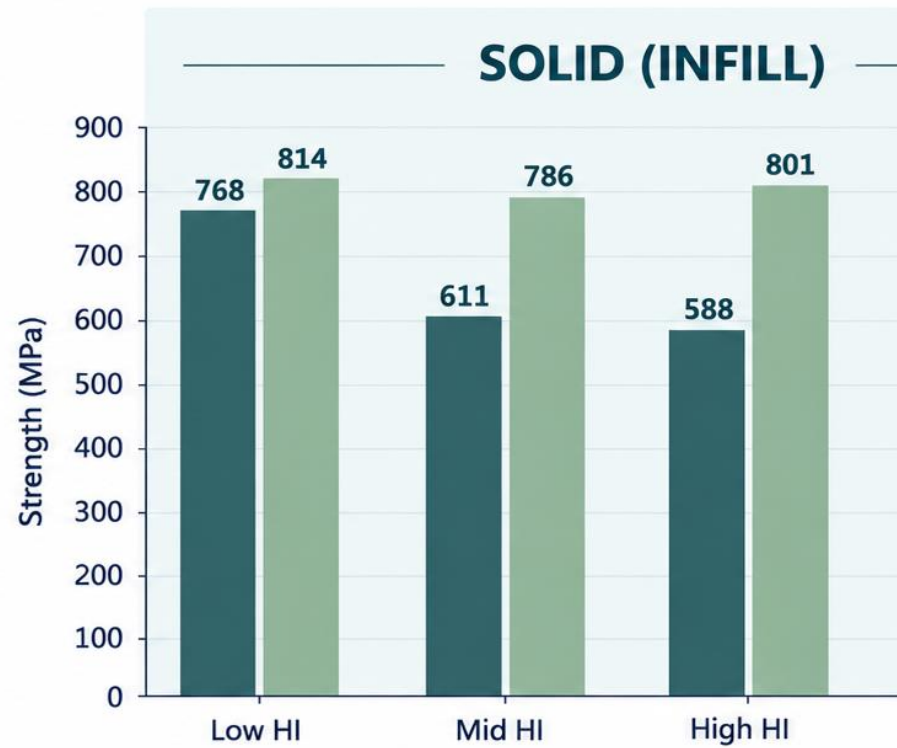


Bead

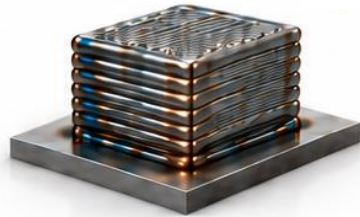
Thermal history



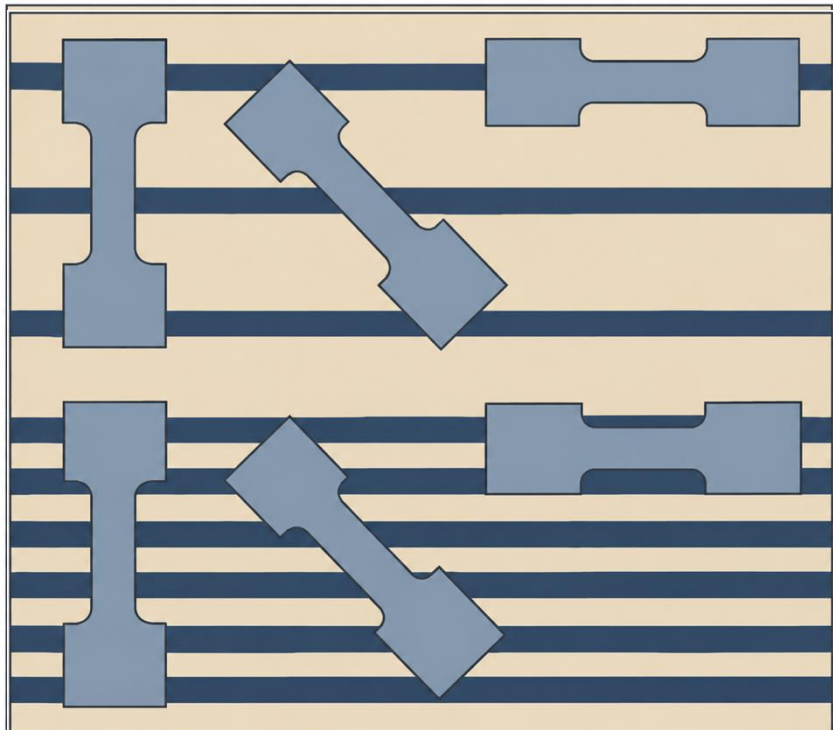
Material properties



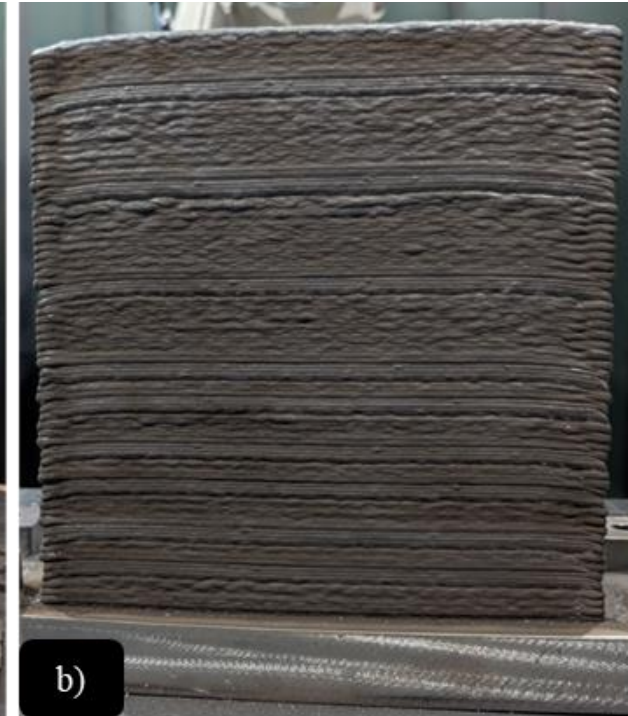
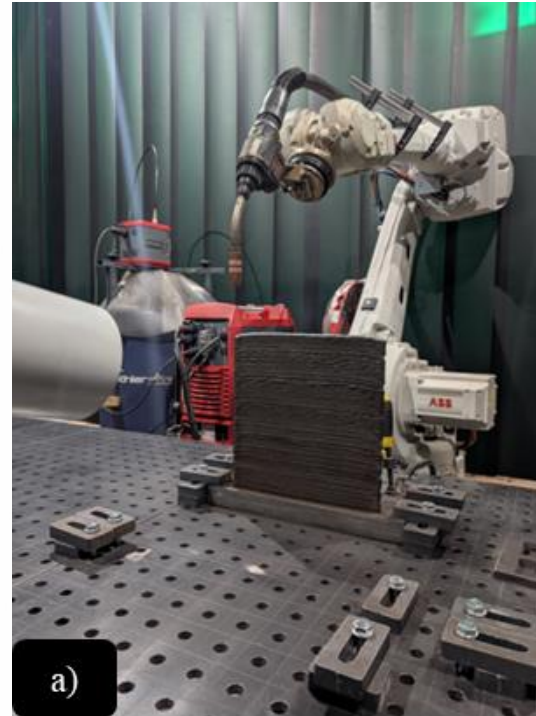
- Yield strength (f_y)
- Ultimate strength (f_u)



What can we do with these properties?

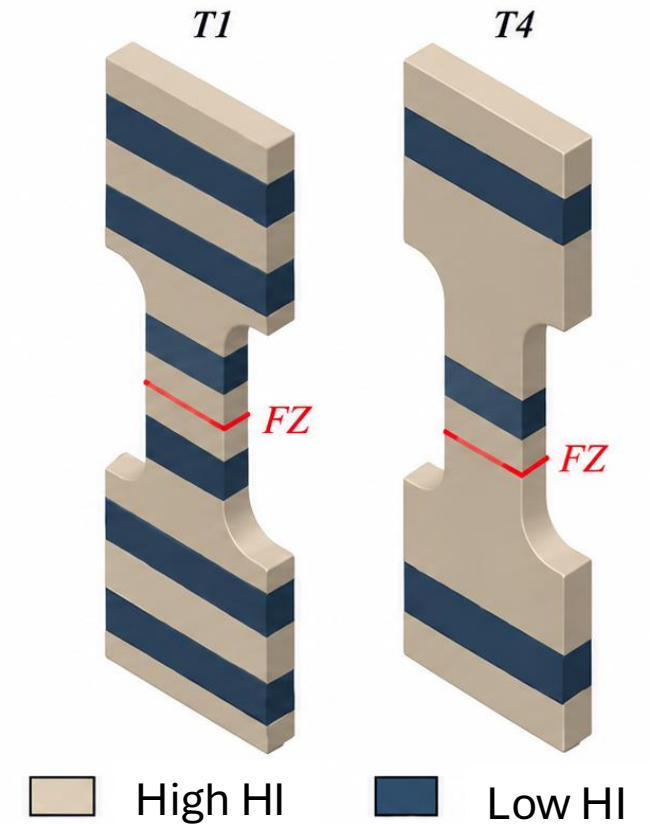
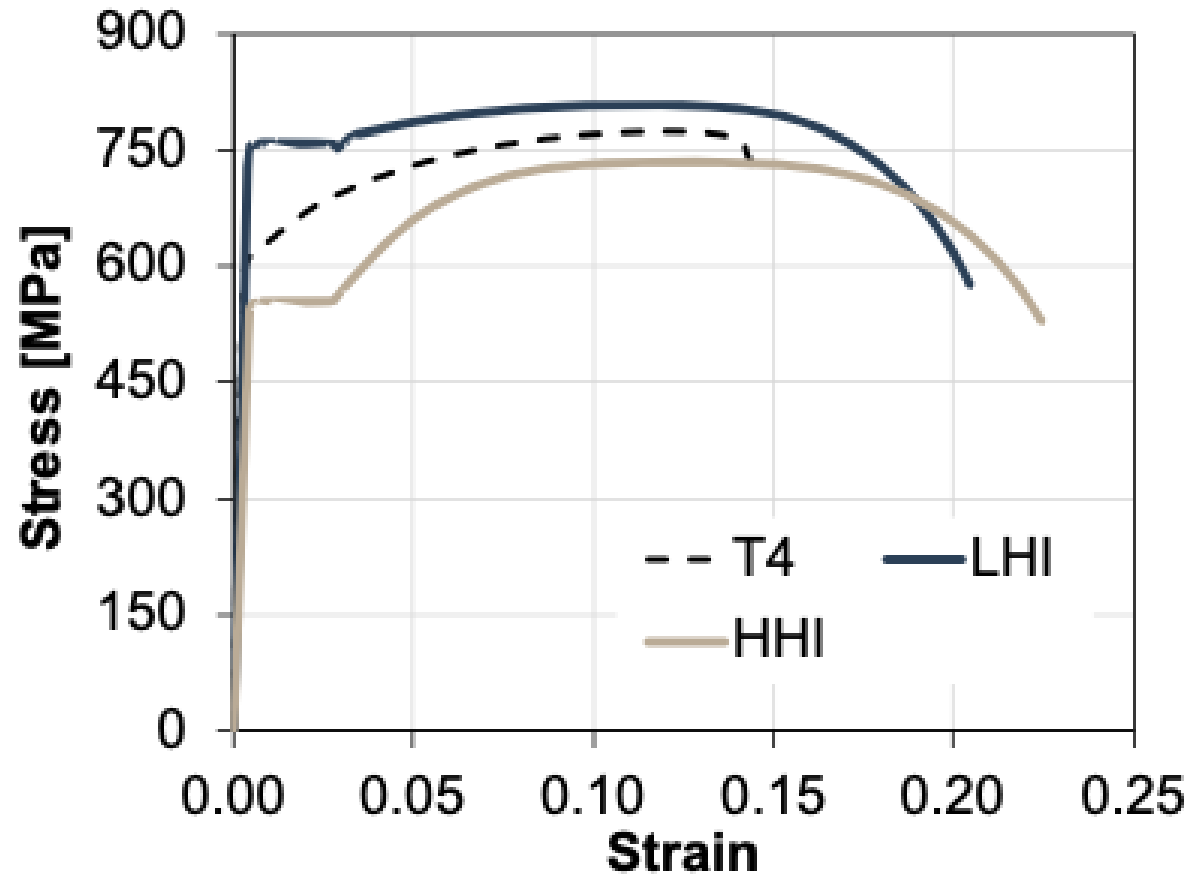


High HI Low HI



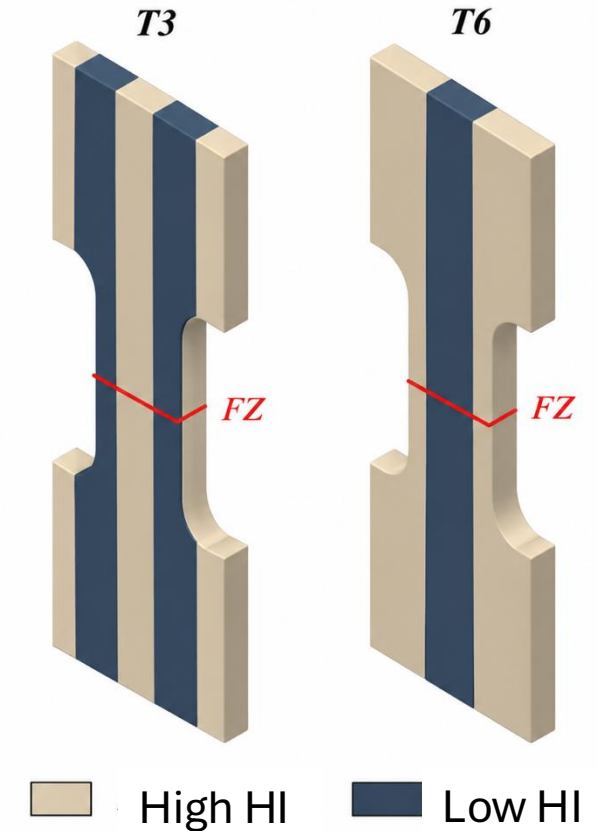
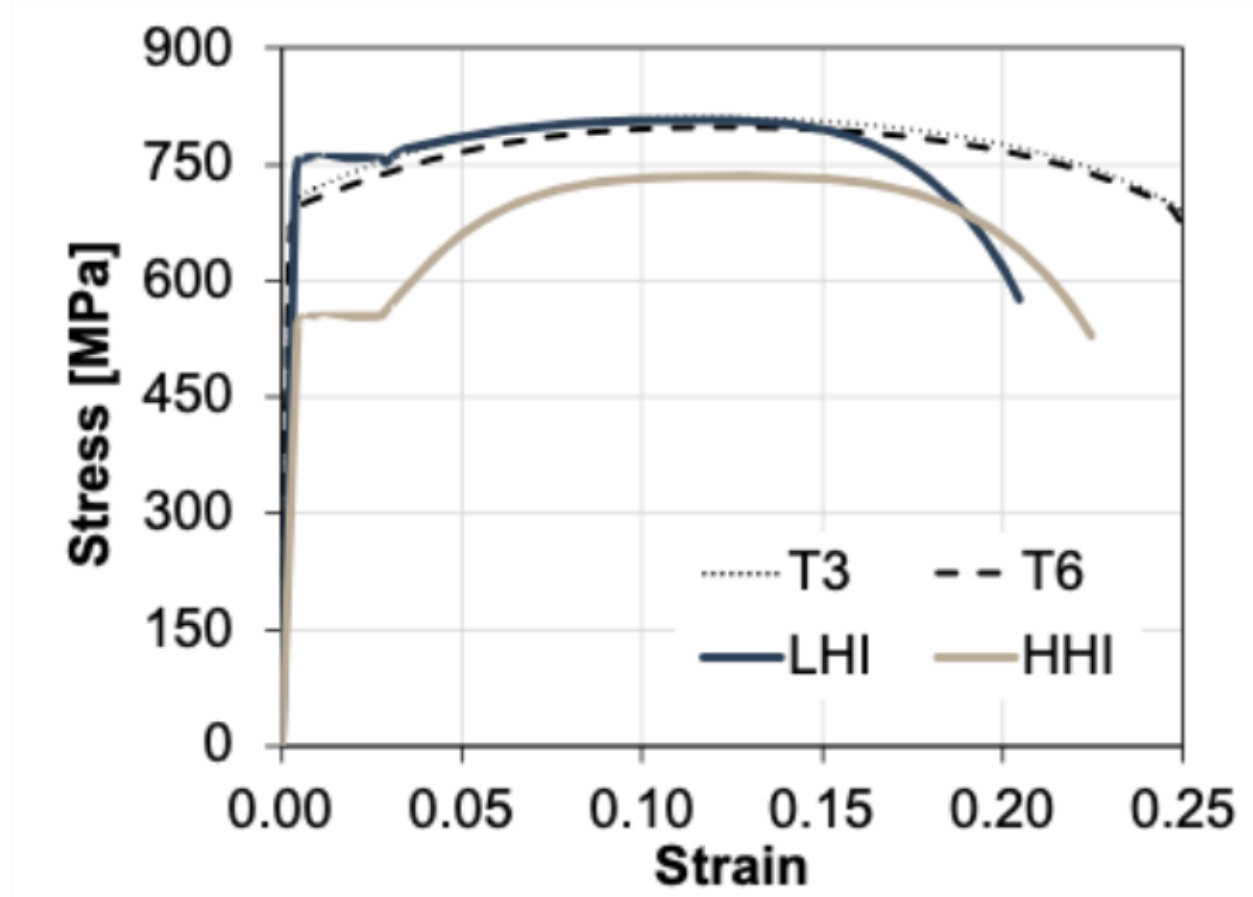
K. Monteiro, C. Zhu, D. Andrade, R. Branco, T. Tankova, L. Simões da Silva, (2027). *Functionally graded carbon steel produced by WAAM from a single wire*. Journal of Constructional Steel Research, 248,110687.

What can we do with these properties?

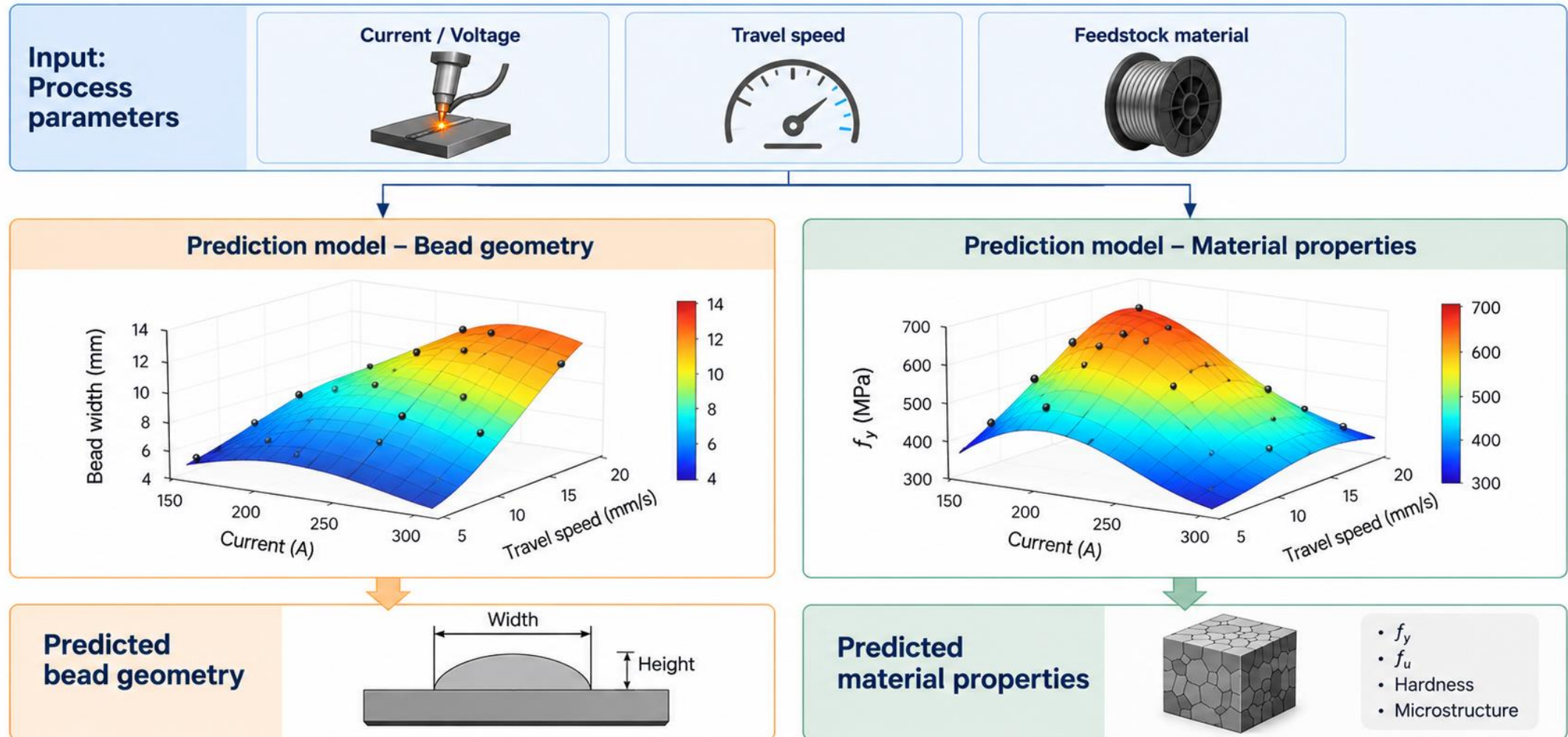


K. Monteiro, C. Zhu, D. Andrade, R. Branco, T. Tankova, L. Simões da Silva, (2027). *Functionally graded carbon steel produced by WAAM from a single wire*. Journal of Constructional Steel Research, 248,110687.

What can we do with these properties?



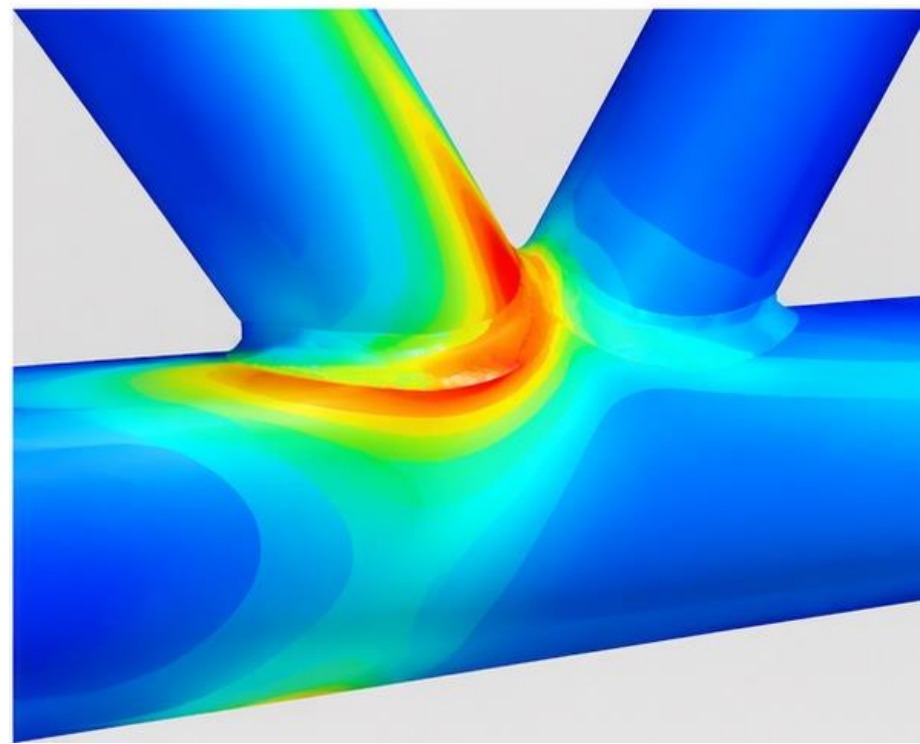
Prediction models



GEOMETRICAL FREEDOM

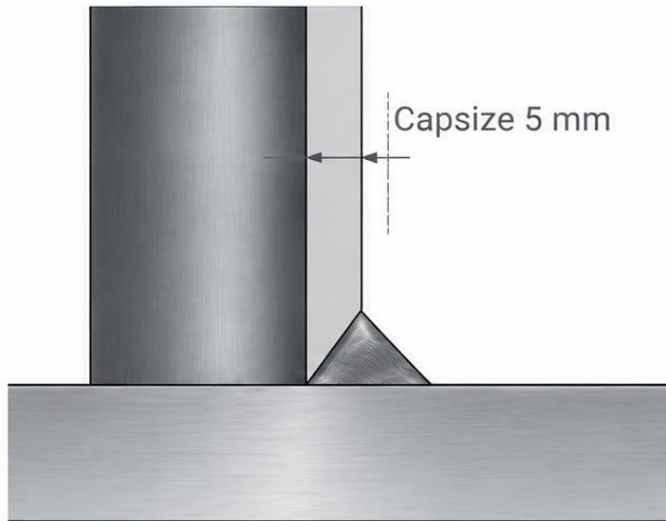
ENGINEER WHERE THE MATERIAL GOES



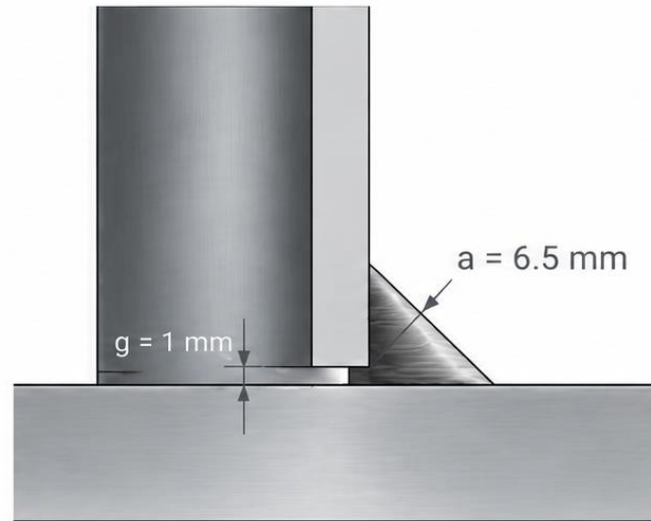


Optimizing geometry

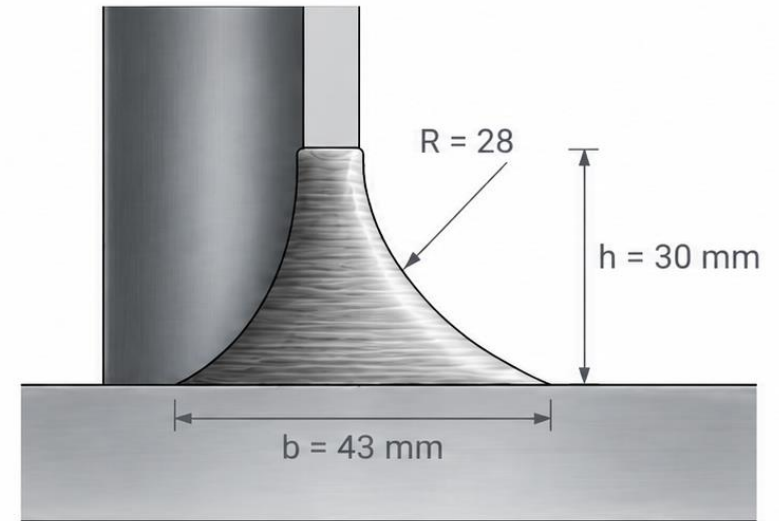
Butt weld



Fillet weld

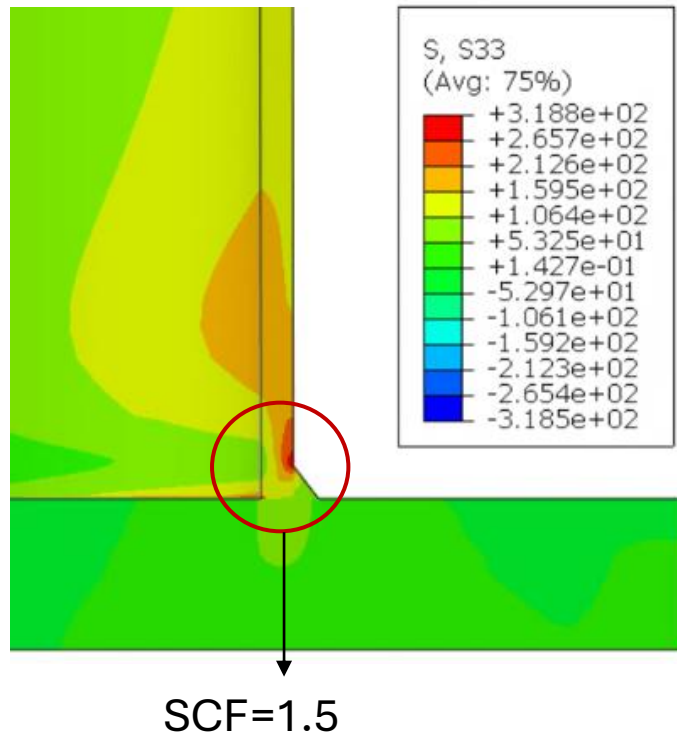


WAAM

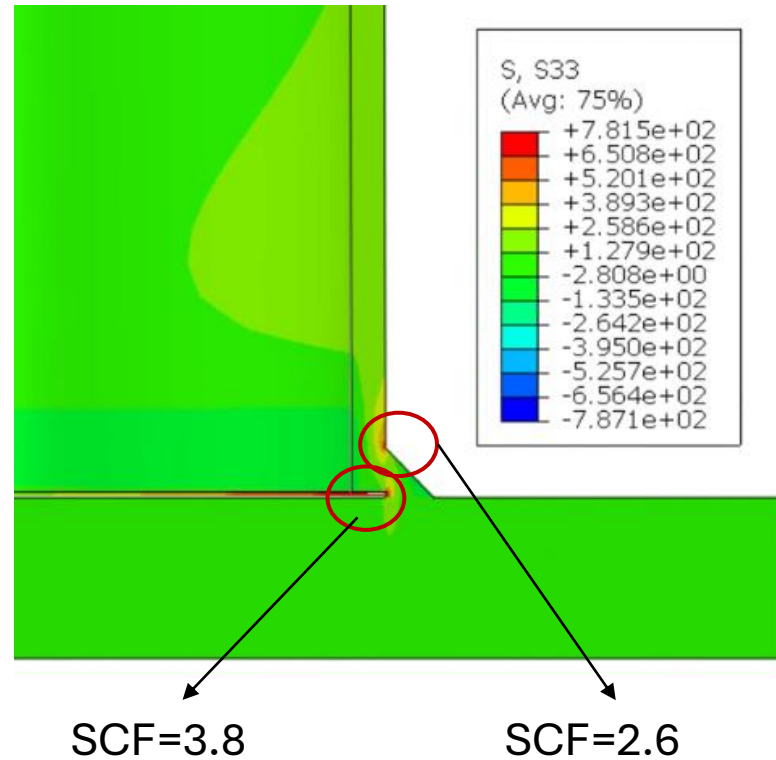


Optimizing geometry

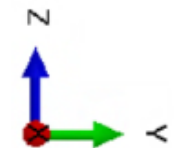
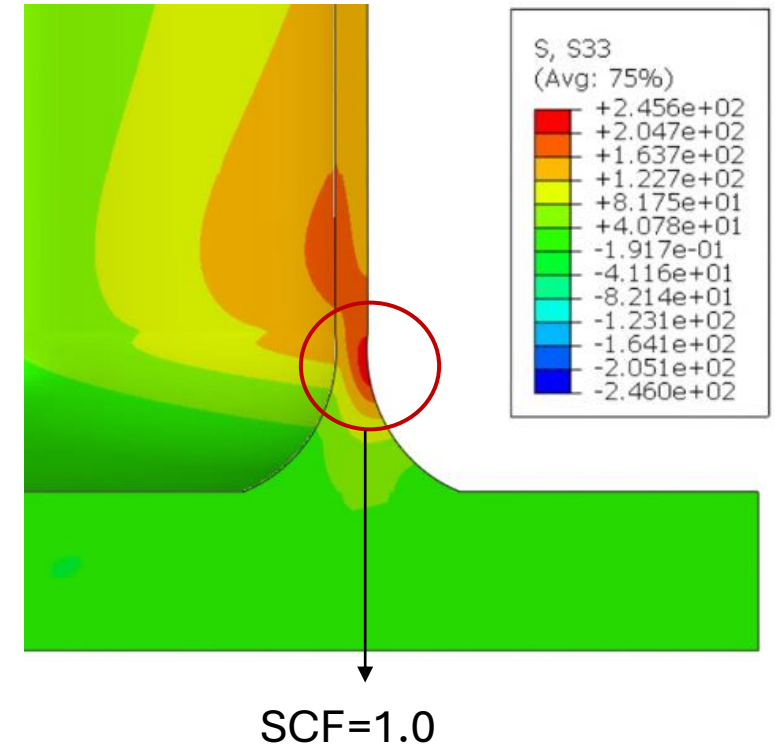
Butt weld



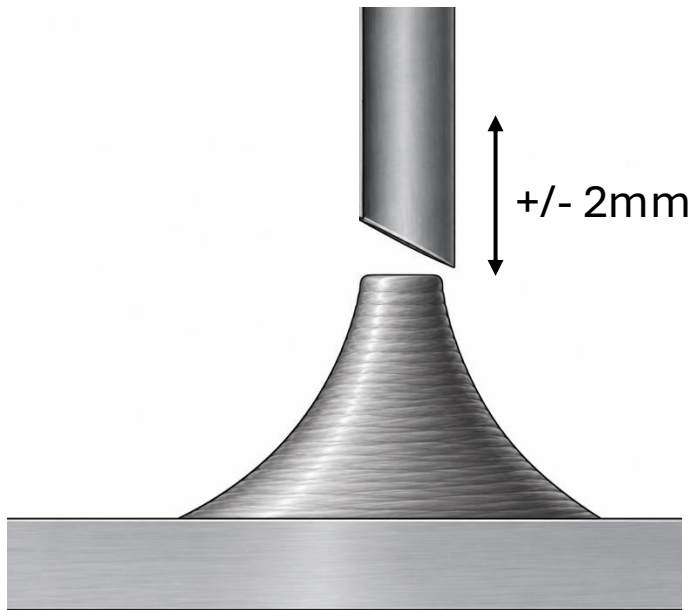
Fillet Weld



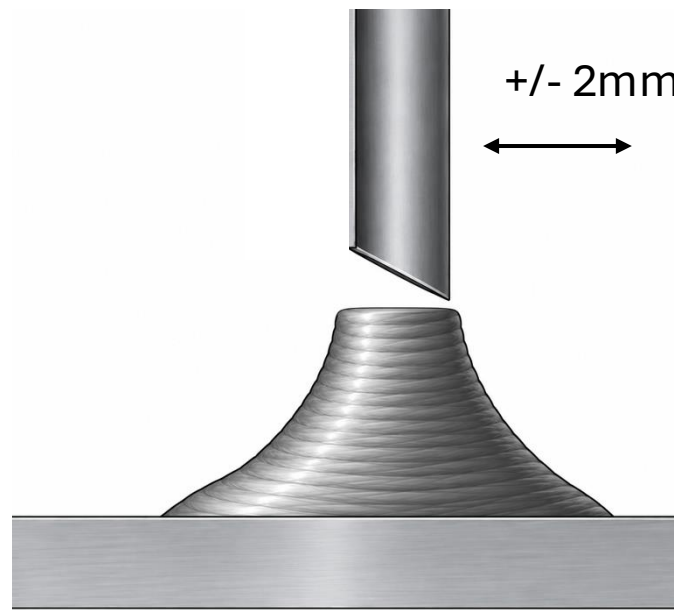
WAAM



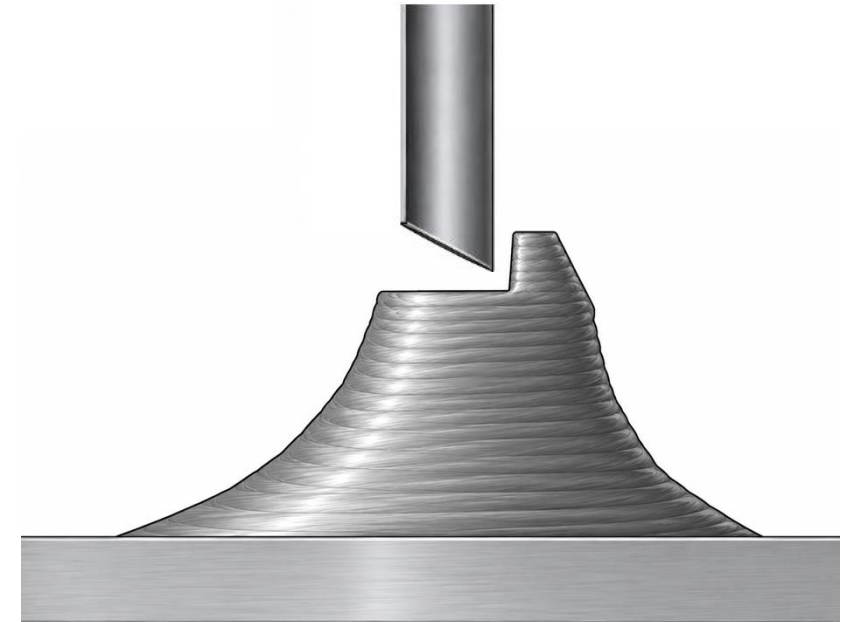
How can we produce it?



Vertical misalignment

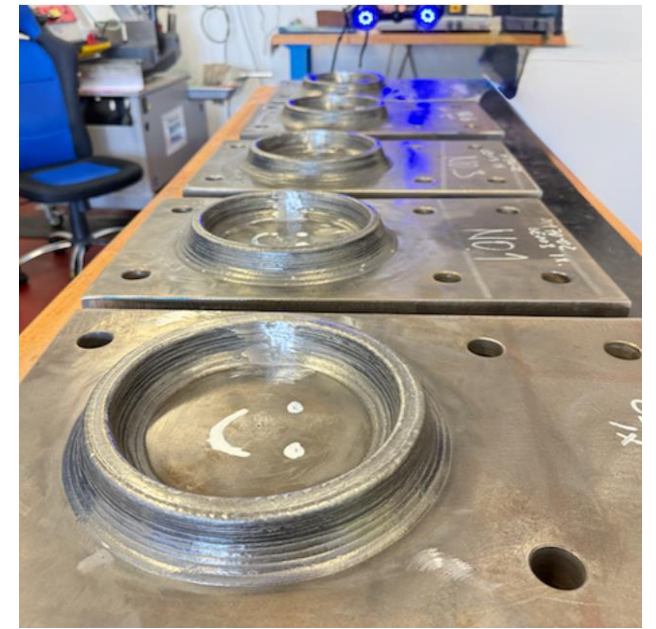
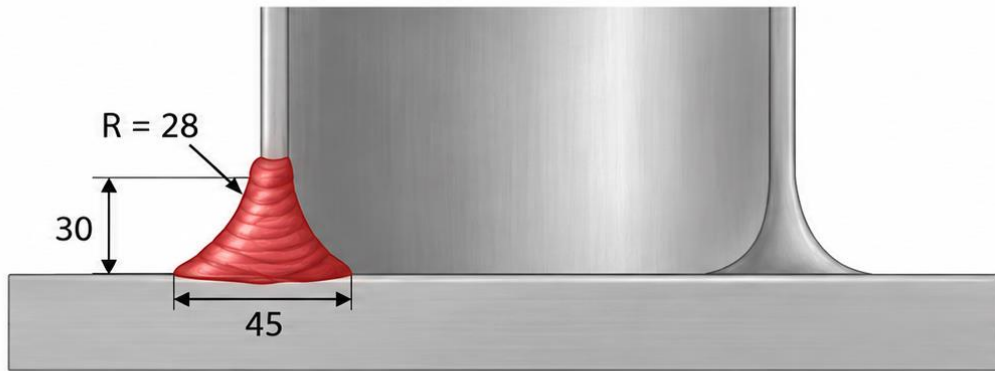


Tube diameter tolerance

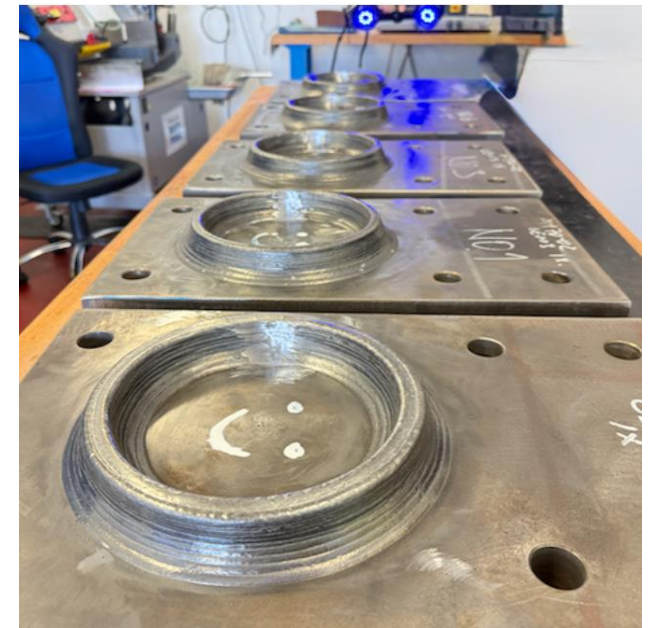


Root penetration

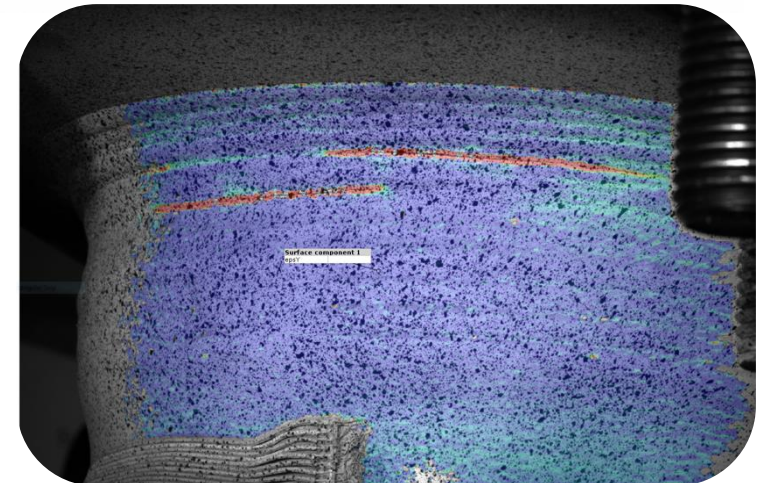
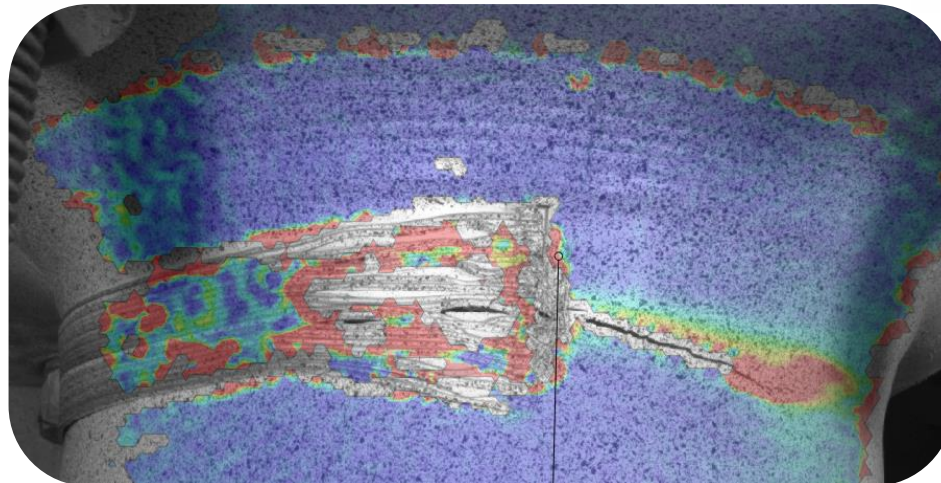
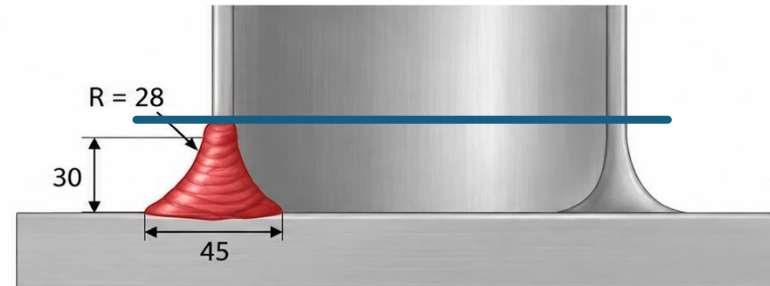
Optimizing geometry



Optimizing geometry



Optimizing geometry



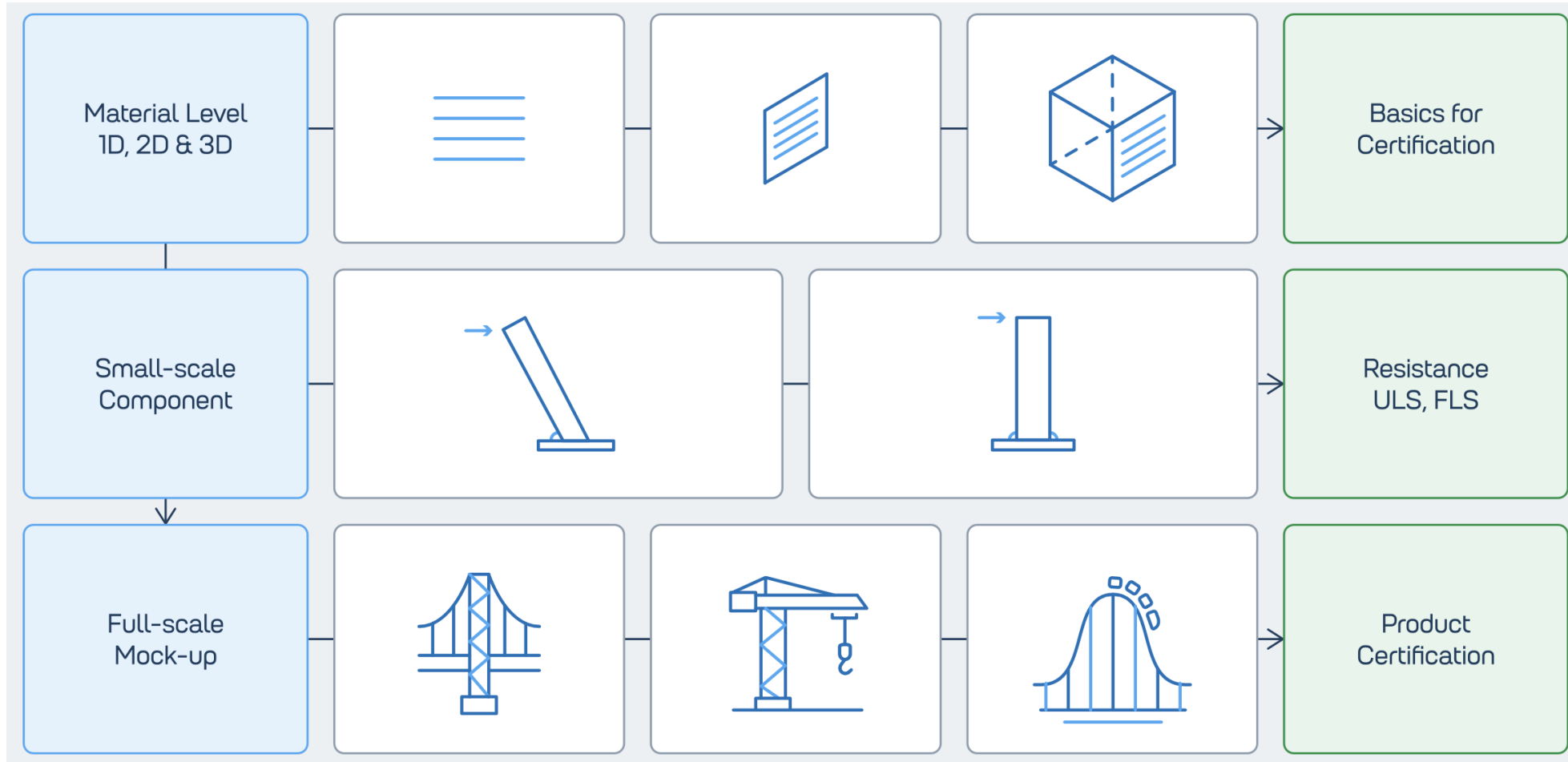
TO THE FULL SCALE



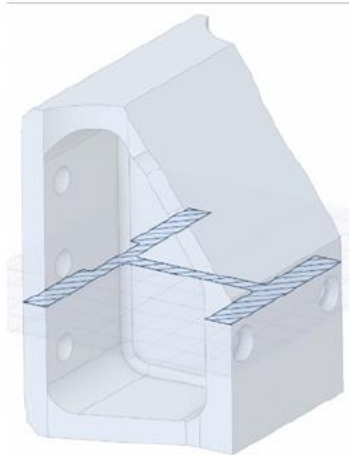
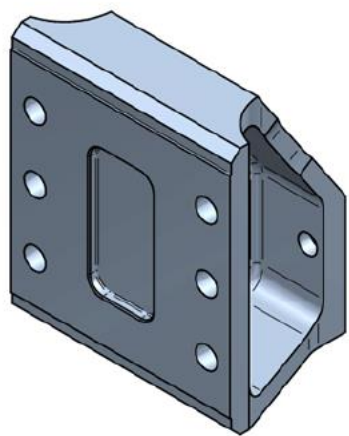
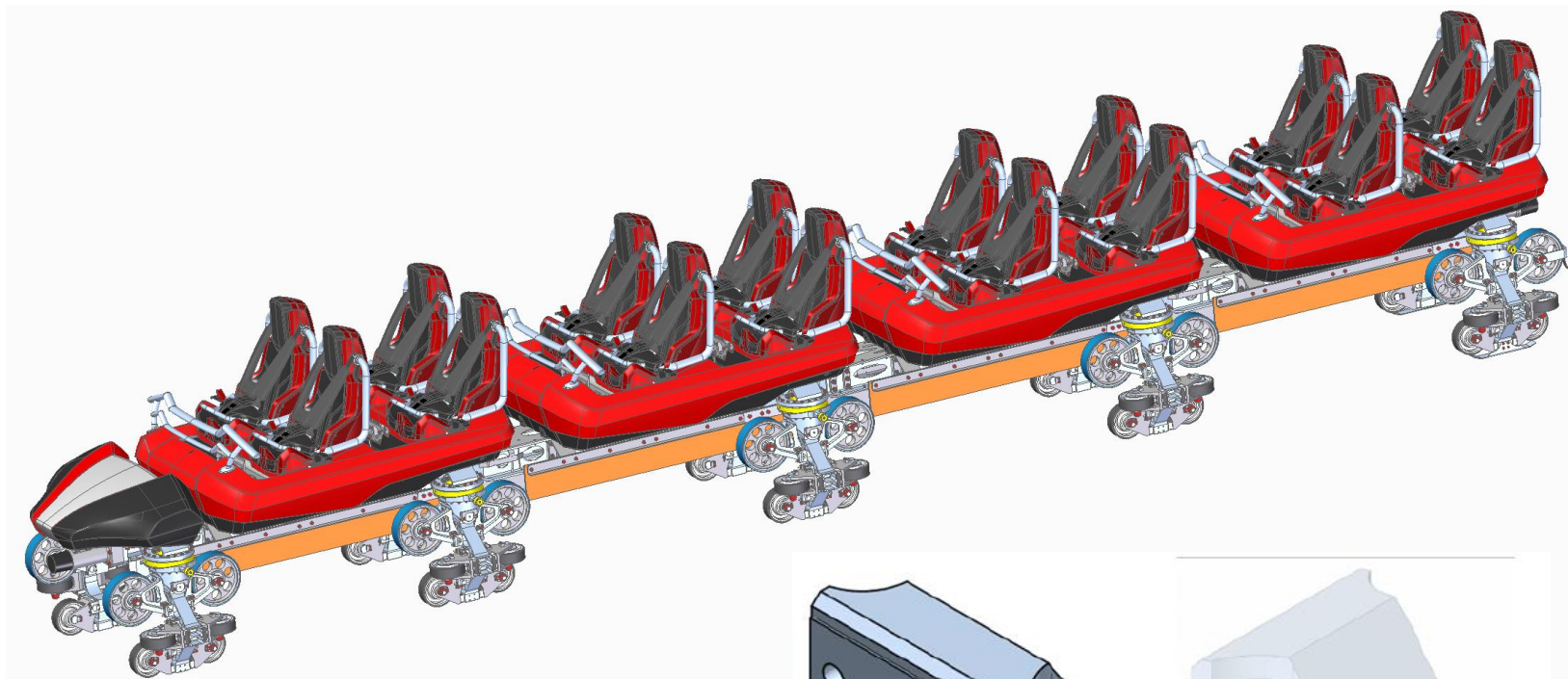
IAMFat



To full scale



The roller coaster



The roller coaster

1. Optimised component



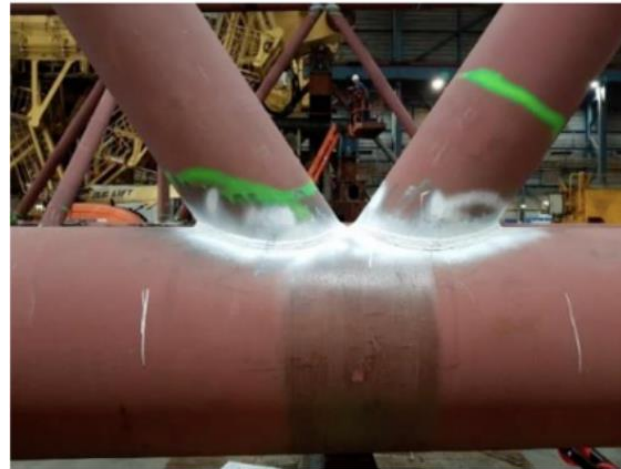
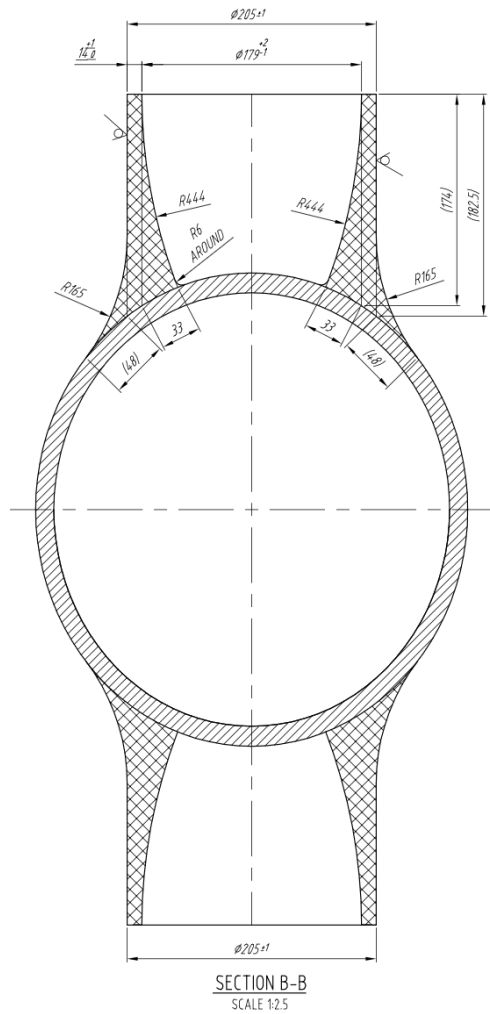
-30%

lighter



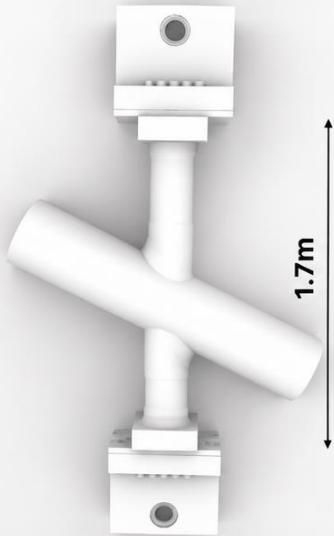
Design load validated

The Tubular Joint



The Tubular Joint

1. Optimised design

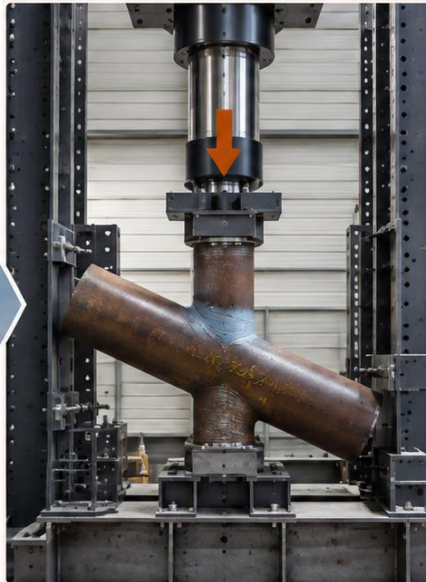


-40%
expected chord
thickness reduction

2. Fabrication



3. Full-scale validation

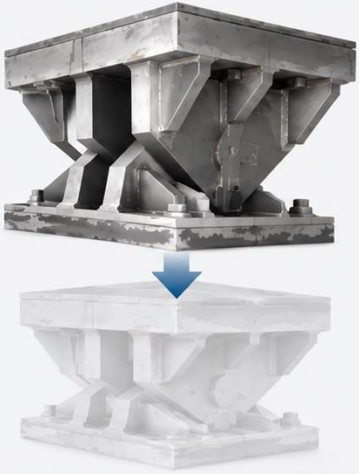


FULL-SCALE TEST
Structural validation



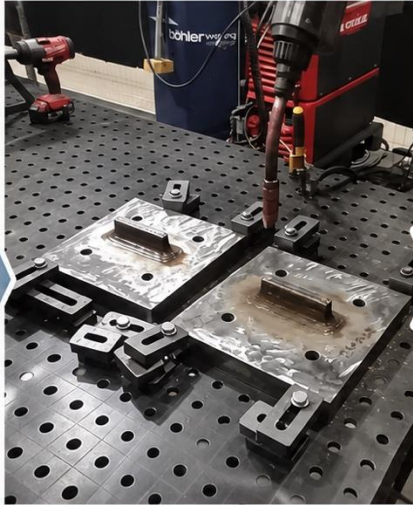
The bridge

1. Optimised design



-30%
material reduction

2. Fabrication



Fabrication
Manufacturing
of prototype

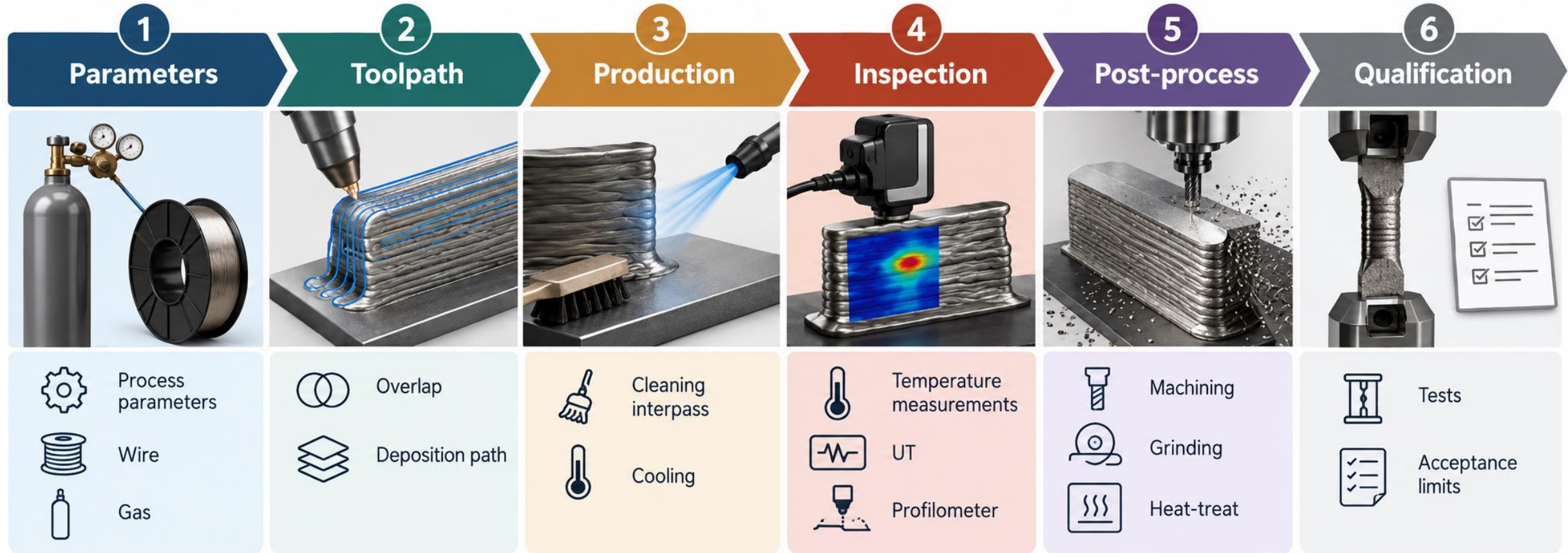
3. Full-scale validation



**Full-scale
testing**
Structural validation



The way forward...



The future is not 3D-printed structures.

**It is structures designed
without yesterday's fabrication constraints.**

