Oxagon Port, Saudi Arabia - Sustainable port construction & New standard EN 10248-1: 2023

João MARTINS
ArcelorMittal Sheet Piling – Luxembourg

Dansk Spuns- & Rammedag 2023
Copenhagen
October 12, 2023

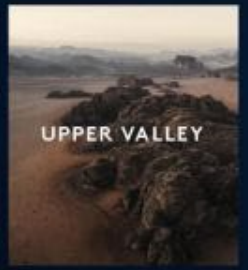
THE LINE
PRESERVING NEOM'S ENVIRONMENT

170KM LONG, IT CROSSES THREE DISTINCT REGIONS, EACH WITH THEIR OWN DIVERSE ECOLOGIES THAT MAKE THEM IDEAL FOR DIFFERENT PURPOSES.

170 KM
TOTAL LENGTH OF THE LINE

3 REGIONS
DIVERSE ECOLOGIES

95%
NATURE PRESERVED



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THE LINE
REVOLUTIONARY URBANISM

THE LINE IS COMPRISED OF A SERIES OF INTERCONNECTED MODULES, REACHING 500M HIGH.

THE CORE ELEMENTS OF EVERY MODULE ARE STANDARDIZED TO MAXIMIZE COMPATIBILITY AND DRIVE DOWN CONSTRUCTION COSTS.

170 KM
LENGTH OF THE LINE

500 M ABOVE SEA-LEVEL
HEIGHT OF THE LINE

200 M
WIDTH OF THE LINE

34 SQ.KM
FOOTPRINT OF THE LINE
2% OF CONVENTIONAL CITIES

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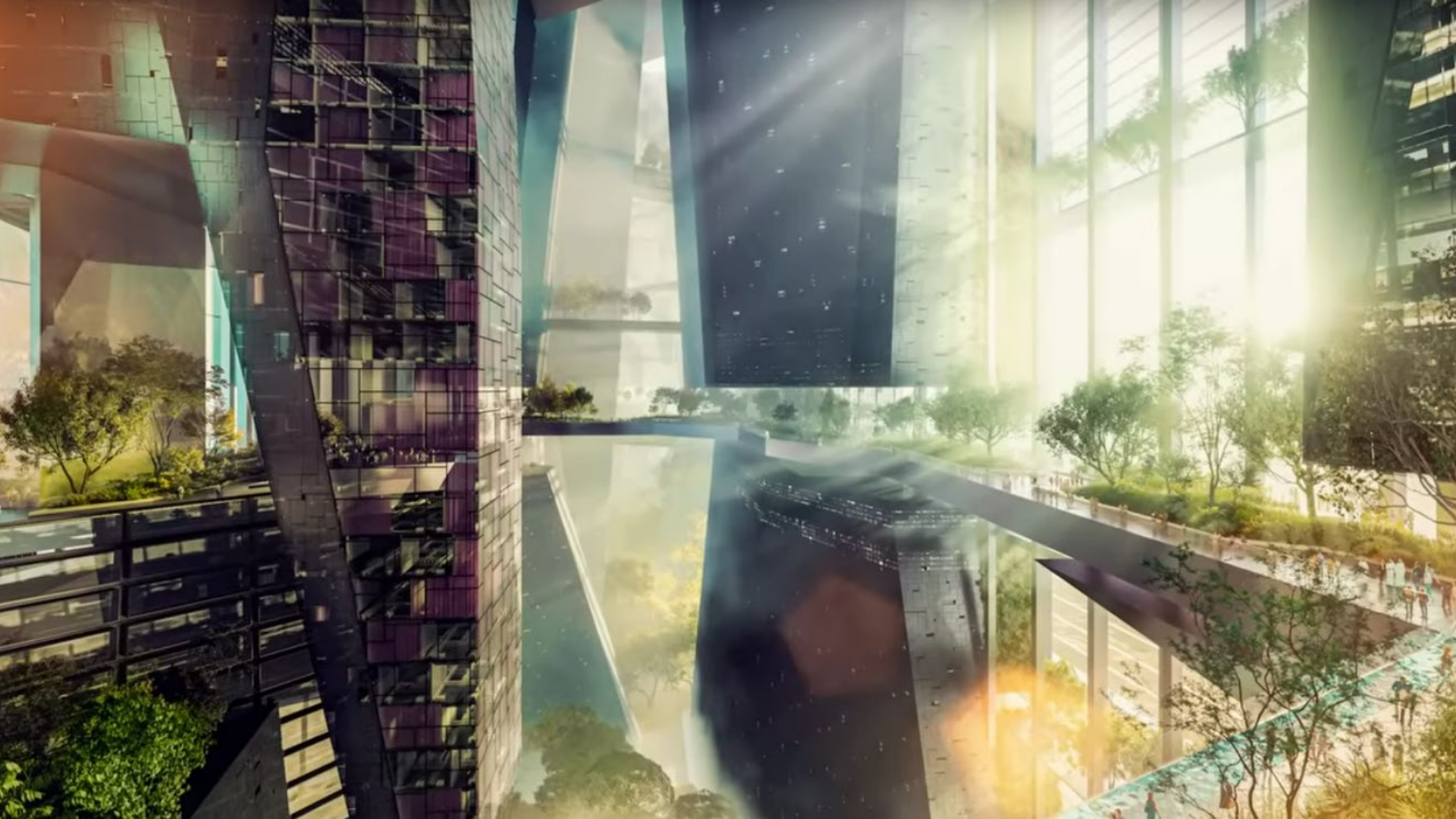
100% RENEWABLE ENERGY
Energy and water supplies
are 100% renewable.



WHAT IS OXAGON?

OXAGON is NEOM's economic and industrial engine, driving innovation in industry and technology whilst offering exceptional livability. Designed to attract global talent and breathe new life into manufacturing, this is the place where ideas can change the world.

13%
OF GLOBAL TRADE PASSES THROUGH THE SUEZ CANAL

LARGEST
FLOATING STRUCTURE IN THE WORLD

100%
CLEAN ENERGY

48km²
OXAGON CORE DEVELOPMENT AREA

PORT WITH:
3.5m
TEU CAPACITY (TWENTY FOOT EQUIVALENT UNITS)

OXAGON

NEOM.com

Port development

1st phase of the port's transformation is underway with renowned **design and engineering company Jacobs** appointed as the main design consultant for Terminal 1, set to open in 2025.

The dredging and quay wall construction for the first phase was awarded to a consortium of companies – **Modern Building Leaders, BESIX and Boskalis**.

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NEOM in Progress - January 2023
OXAGON
and our center for advanced industries Oxagon.

Stage 1: Marine Works. Channel deepening at -18.5 m

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Stage 2: Marine Works. Basin dredging at -18.5 m

New quay walls ≈ 3.2 km

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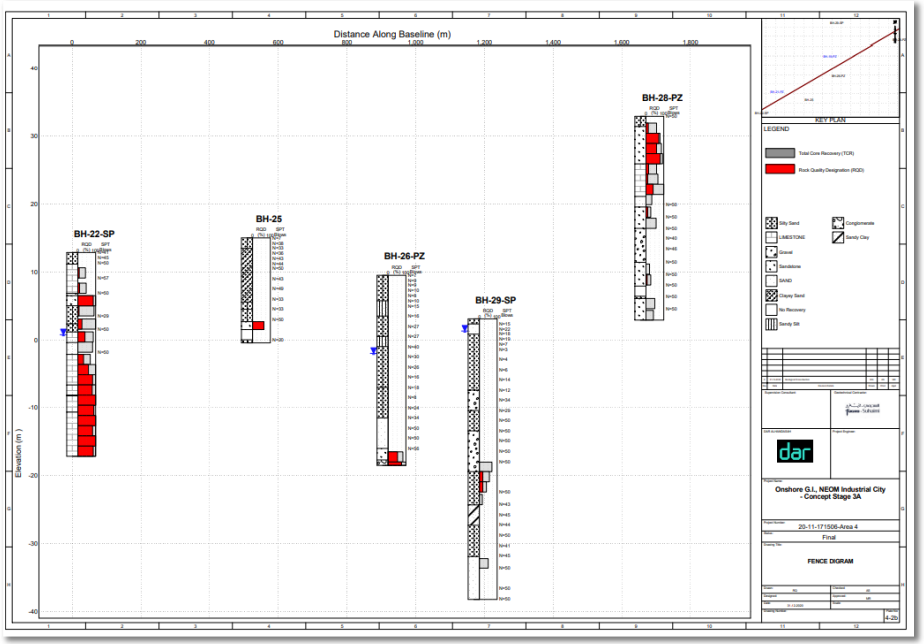
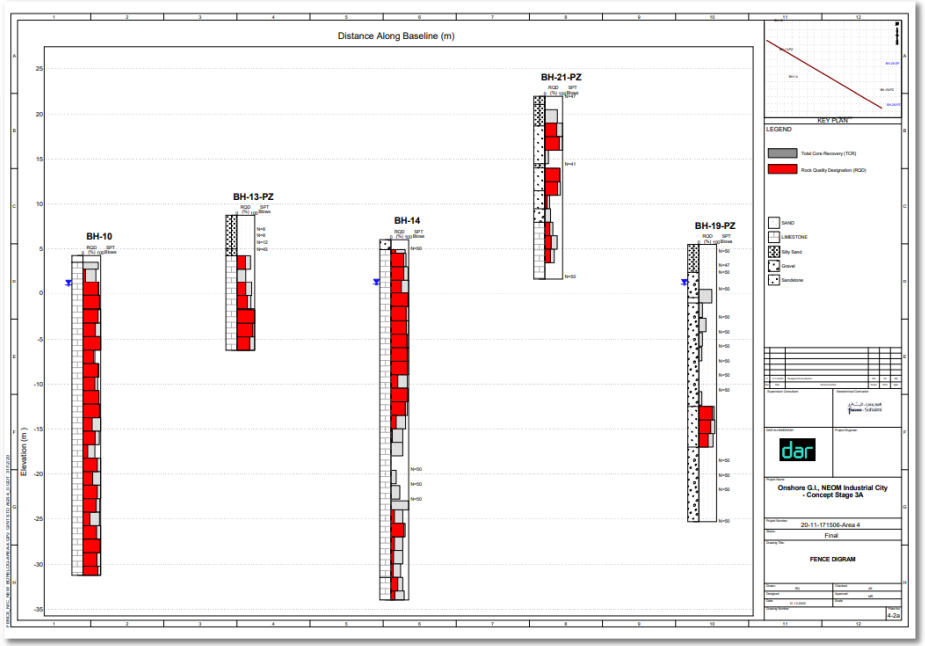
Soil conditions – boreholes

- mainly silty sand, limestone, sand,… with SPT > 50 in some locations / layers
- seismic conditions: $k_h = \approx 0.28$ g





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Cross section – Terminal T1 (& extension)

HZ-M/AZ combi-wall

anchored

to an AZ wall

900 m long

dredge level: -18.5 m

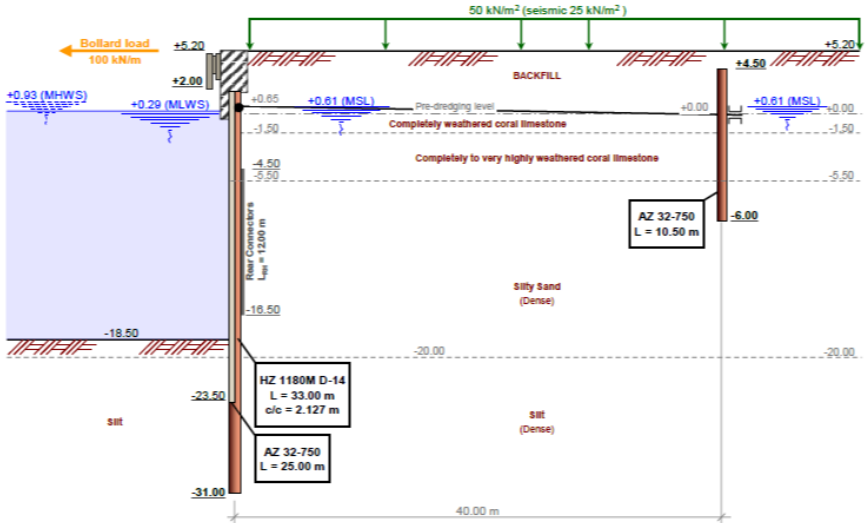
Conceptual Design Sheet

ArcelorMittal
Commercial RPS
Sheet Piling

Project: Oxagon Project
Project-nr.: SA22002
Destination: Saudi Arabia
Engineer: L. REISER
Date: 2022-05-12

sheetpiling@arcelormittal.com

TERMINAL T1 & EXTENSION: est. total quay wall length 900m



ArcelorMittal

Cross section – ‘Flexible’ berth

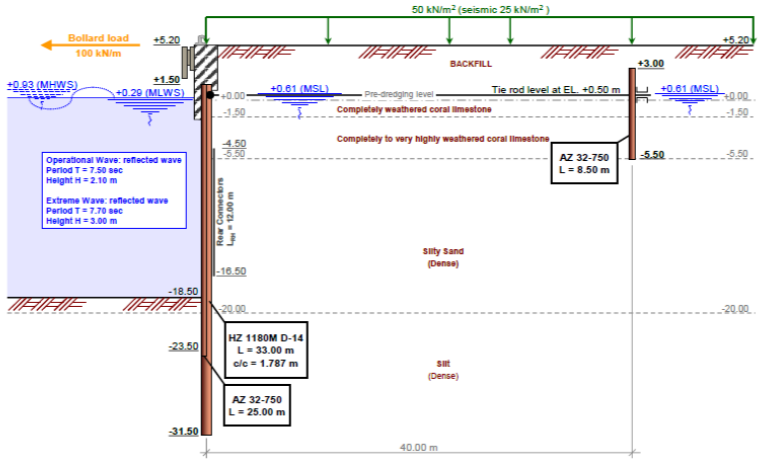
Conceptual Design Sheet

Project: Oxagon Project
Project-nr.: SA22002
Destination: Saudi Arabia
Engineer: C. ESCH
Date: 2022-05-12

sheetpiling@arcelormittal.com

ArcelorMittal
Commercial RPS
Sheet Piling

FLEXIBLE QUAY: est. total quay wall length 268m



HZ-M/AZ combi-wall
anchored
to an AZ wall

270 m long
dredge level: -18.5 m

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Cross section – Marine services berth

AZ head wall
anchored
to an AZ wall

Section 1
600 m long
dredge level: -10.0 m

Section 2
300 m long
dredge level: -18.5 m

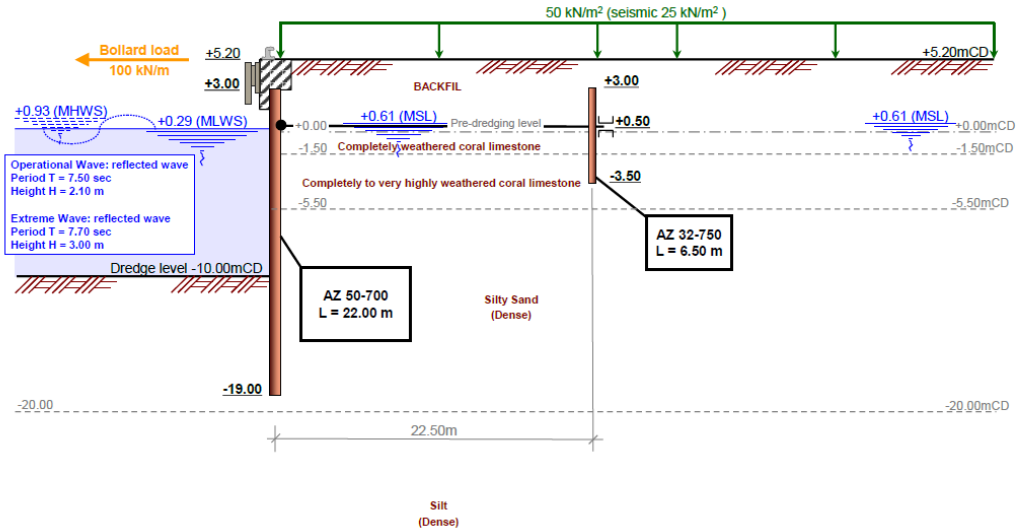
Conceptual Design Sheet

Project: Oxagon Project
Project-nr.: SA22002
Destination: Saudi Arabia
Engineer: D. NETO
Date: 2022-05-12

sheetpiling@arcelormittal.com

ArcelorMittal
Commercial RPS
Sheet Piling

MARINE SERVICES BERTH: est. total quay wall length 900m



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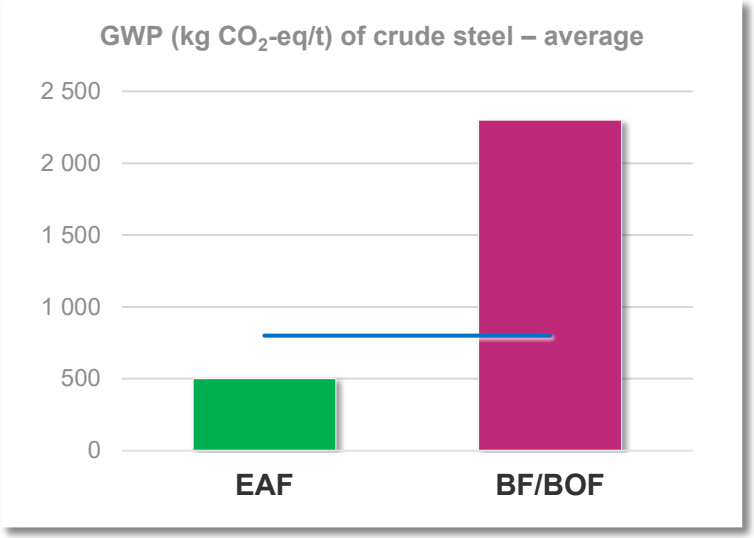
Environmental criteria

Carbon footprint for steel products: steel sheet piles, sections and merchants bars, tubes,…

max. 800 kg CO_2-eq/t

Reasonable & clear?

- per element or on average for overall solution?
- no optimization of solution?
- only EAF steel allowed?



Life Cycle Assessment

based on EPDs (Environmental Product Declaration)

according to EN 15804+A2:2019

EAF: Electric Arc Furnace
BF/BOF: Blast Furnace / Basic Oxygen Furnace

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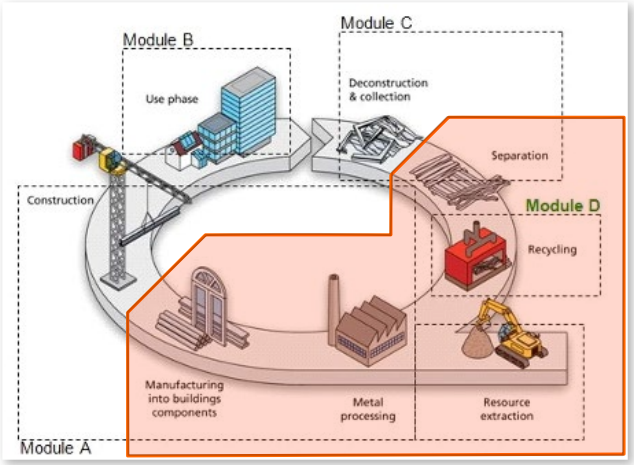
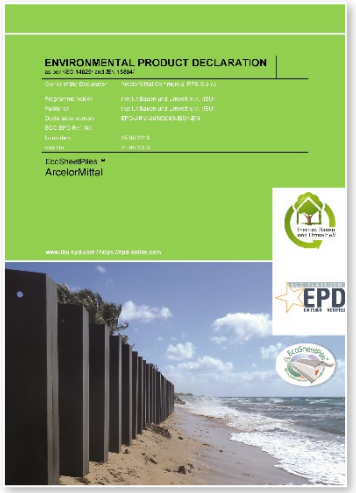
Environmental Product Declaration (EPD) – *EcoSheetPile*™ – IBU (DE) – 2018

Product specific: steel sheet piles from EAF produced in Belval & Differdange (LU)

Covers HZ-M & AZ sections, **S 240 GP to S 460 AP**

Global Warming Potential [kg CO_2-eq / t] IBU (DE) – indicators EN 15804+A1	
Module(s)	EcoSheetPile™
(A1 – A3)	**520**





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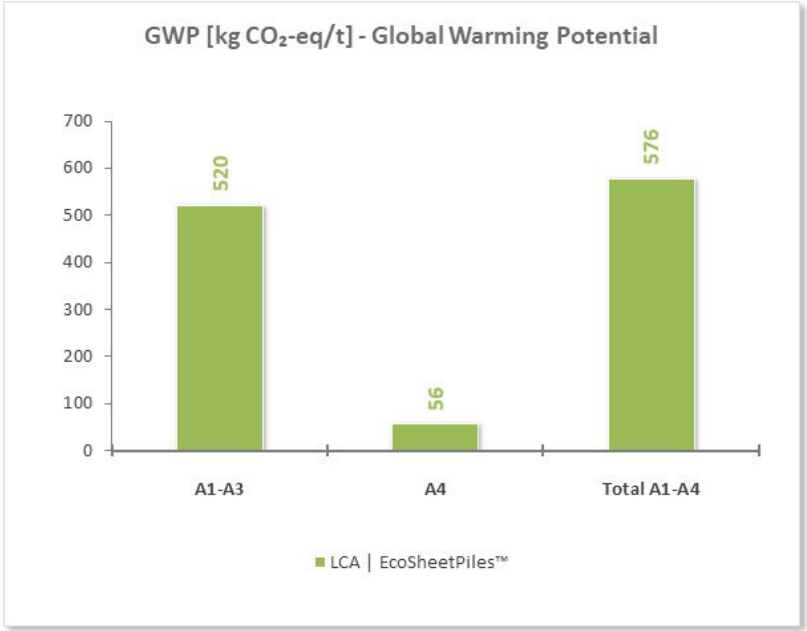
Carbon footprint of 1 tonne of steel sheet piles – Production & transport (A1 - A4) 07/2022

Solution: HZ-M/AZ combined wall system & AZ sections

- LCA based on EPD "***EcoSheetPile™***" with modified assumptions: 99 % recycling / 1 % landfill
- Products: HZ-M & AZ sections (mills Belval & Differdange)
- Delivery: Port of Duba (SA)
- Transport: 12 640 km
  - Rail (diesel): Belval / Differdange mill (LU) – Port of Mertert (LU): 60 km
  - Water (inland): Port of Mertert (LU) – Port of Antwerp (BE): 600 km
  - Water (sea): Port of Antwerp (BE) – Port of Duba (SA): 11 980 km



Module A1-A3 production (cradle to gate)
Module A4 transport (gate to job-site)

Transport

The calculation is based on data from the GaBi-database (developed by thinkstep AG) to quantify the environmental impact of transport processes. This is consistent with the EPD (see "Background data" within section 3 of the EPD).
See also http://documentation.gabi-software.com

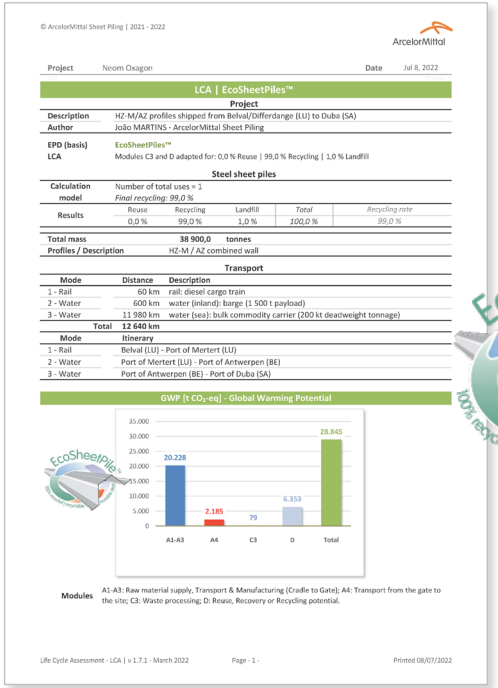
Transport modes	Lifecycle GHG emission [g CO_2-eq/t/km]
rail: diesel cargo train	25,5
water (sea): bulk commodity carrier (200 kt deadweight tonnage)	3,7
water (inland): barge (1 500 t payload)	17,4

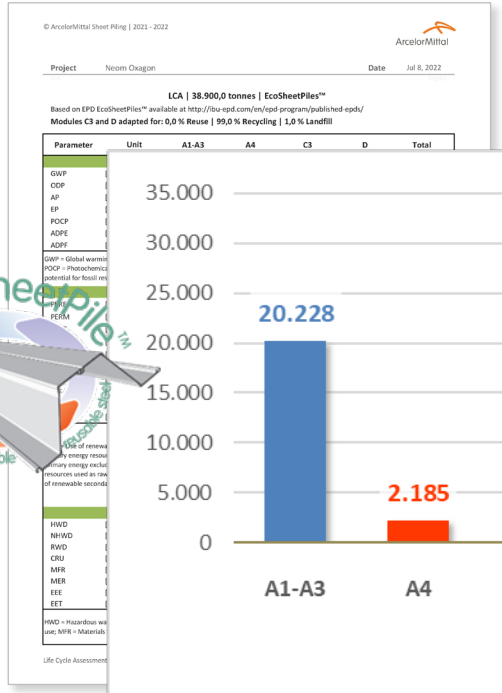
ArcelorMittal

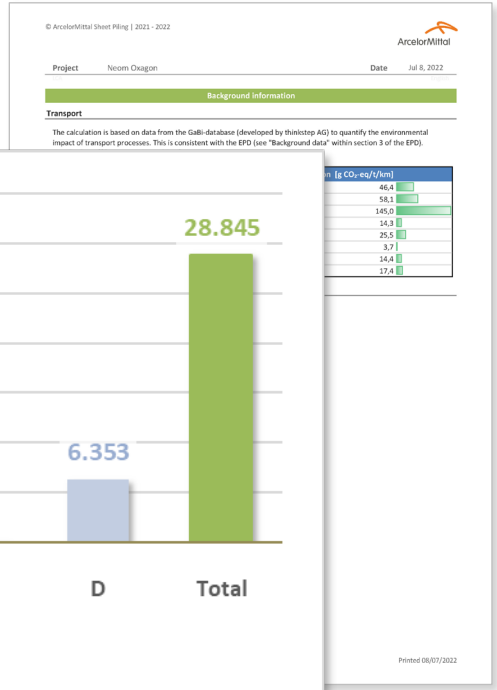
Life Cycle Assessment (LCA) for 38 900 tonnes of steel sheet piles – Modules A1 – D

07/2022

LCA based on EPD "***EcoSheetPile™***" with 99 % recycling / 1 % landfill / 0 % reuse, shipped from Luxembourg to Duba (SA)







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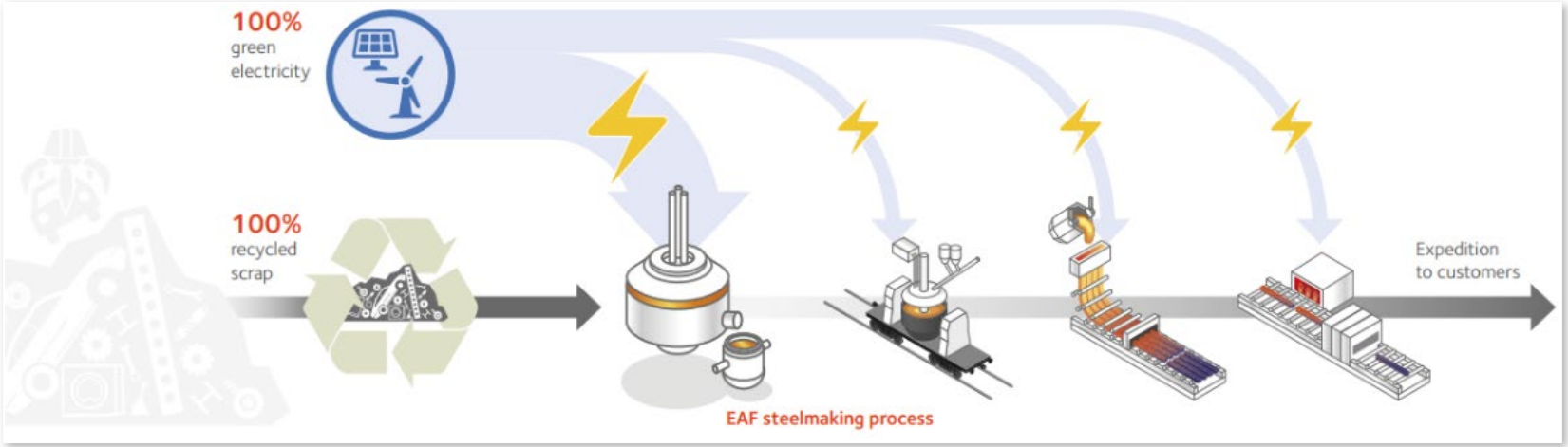
ArcelorMittal's XCarb® *recycled and renewably produced*

steels produced in an **electric arc furnace (EAF)** using high levels of **scrap** and **100 % renewable electricity**. The electricity used comes from renewable sources such as **wind and solar**, and is supplied via a recognised *Guarantee of Origin* (GoO) scheme.



ArcelorMittal

EPD *EcoSheetPile™ Plus* – MRPI (NL) – 2022 – draft version

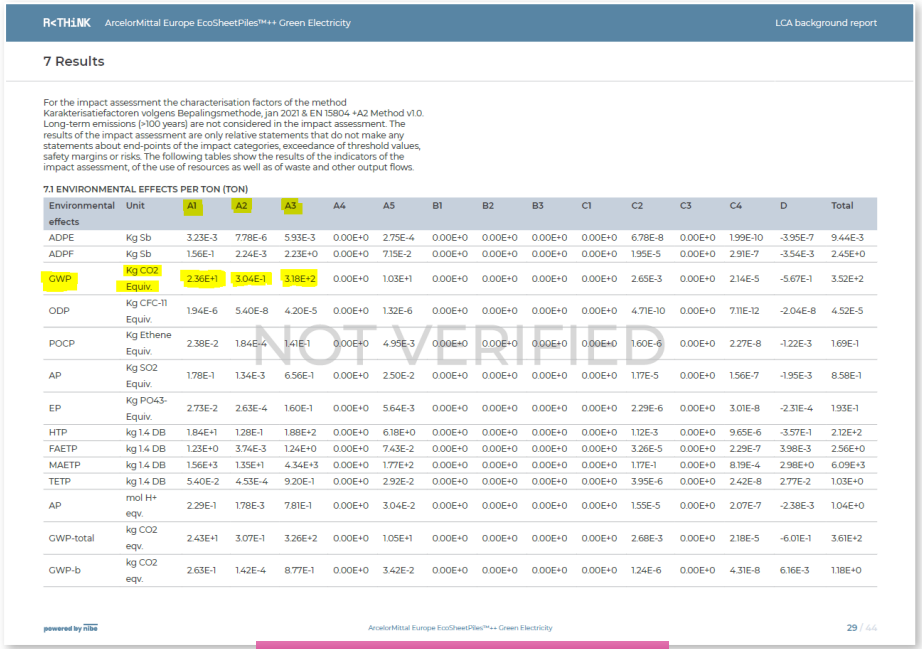
XCarb®
Recycled and renewably produced

Product specific: steel sheet piles from EAF produced in Belval & Differdange (LU)

with 100 % renewable electricity

Covers HZ-M & AZ sections, **S 240 GP to S 460 AP**

Global Warming Potential [kg CO_2-eq / t] MRPI (NL) – indicators EN 15804+A1	
Module(s)	EcoSheetPile™ Plus
(A1 – A3)	**347**



R<THiNK ArcelorMittal Europe EcoSheetPiles™++ Green Electricity — LCA background report

7 Results

For the impact assessment the characterisation factors of the method Karakterisatiefactoren volgens Bepalingsmethode, jan 2021 & EN 15804 +A2 Method v1.0. Long-term emissions (>100 years) are not considered in the impact assessment. The results of the impact assessment are only relative statements that do not make any statements about end-points of the impact categories, exceedance of threshold values, safety margins or risks. The following tables show the results of the indicators of the impact assessment, of the use of resources as well as of waste and other output flows.

7.1 ENVIRONMENTAL EFFECTS PER TON (TON)

Environmental effects	Unit	A1	A2	A3	A4	A5	B1	B2	B3	C1	C2	C3	C4	D	Total
ADPE	Kg Sb	3.23E-3	7.78E-6	5.93E-3	0.00E+0	2.75E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.78E-8	0.00E+0	1.99E-10	-3.95E-7	9.44E-3
ADPF	Kg Sb	1.56E-1	2.24E-3	2.23E+0	0.00E+0	7.15E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.95E-5	0.00E+0	2.91E-7	-3.54E-3	2.45E+0
GWP	Kg CO2 Equiv.	2.36E+1	3.04E-1	3.18E+2	0.00E+0	1.03E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.65E-3	0.00E+0	2.14E-5	-5.67E-1	3.52E+2
ODP	Kg CFC-11 Equiv.	1.94E-6	5.40E-8	4.20E-5	0.00E+0	1.32E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.71E-10	0.00E+0	7.11E-12	-2.04E-8	4.52E-5
POCP	Kg Ethene Equiv.	2.38E-2	1.84E-4	1.41E-1	0.00E+0	4.95E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.60E-6	0.00E+0	2.27E-8	-1.22E-3	1.69E-1
AP	Kg SO2 Equiv.	1.78E-1	1.34E-3	6.56E-1	0.00E+0	2.50E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.17E-5	0.00E+0	1.56E-7	-1.95E-3	8.58E-1
EP	Kg PO43- Equiv.	2.73E-2	2.63E-4	1.60E-1	0.00E+0	5.64E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.29E-6	0.00E+0	3.01E-8	-2.31E-4	1.93E-1
HTP	kg 1.4 DB	1.84E+1	1.28E-1	1.88E+2	0.00E+0	6.18E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.12E-3	0.00E+0	9.65E-6	-3.57E-1	2.12E+2
FAETP	kg 1.4 DB	1.23E+0	3.74E-3	1.24E+0	0.00E+0	7.43E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.26E-5	0.00E+0	2.29E-7	3.98E-3	2.56E+0
MAETP	kg 1.4 DB	1.56E+3	1.35E+1	4.34E+3	0.00E+0	1.77E+2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.17E-1	0.00E+0	8.19E-4	2.98E+0	6.09E+3
TETP	kg 1.4 DB	5.40E-2	4.53E-4	9.20E-1	0.00E+0	2.92E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.95E-6	0.00E+0	2.42E-8	2.77E-2	1.03E+0
AP	mol H+ eqv.	2.29E-1	1.78E-3	7.81E-1	0.00E+0	3.04E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.55E-5	0.00E+0	2.07E-7	-2.38E-3	1.04E+0
GWP-total	kg CO2 eqv.	2.43E+1	3.07E-1	3.26E+2	0.00E+0	1.05E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.68E-3	0.00E+0	2.18E-5	-6.01E-1	3.61E+2
GWP-b	kg CO2 eqv.	2.63E-1	1.42E-4	8.77E-1	0.00E+0	3.42E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.24E-6	0.00E+0	4.31E-8	6.16E-3	1.18E+0

NOT VERIFIED

powered by nibe — ArcelorMittal Europe EcoSheetPiles™++ Green Electricity — 29 / 44

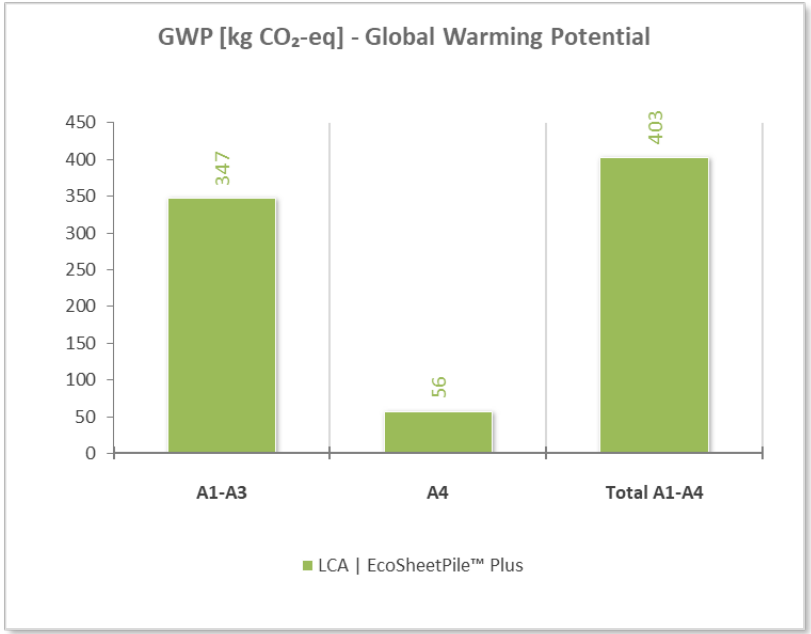
Background report (confidential)

ArcelorMittal

Carbon footprint of 1 tonne of steel sheet piles – Production & transport (A1 - A4)

10/2022

- Solution: HZ-M/AZ combined wall system & AZ sections
- LCA based on EPD "***EcoSheetPile™ Plus***" from the Dutch insititute MRPI. Assumptions: 99 % recycling / 1 % landfill
- Products: HZ-M & AZ sections (mills Belval & Differdange)
- Delivery: Port of Duba (SA)
- Transport: 12 640 km
  - Rail (diesel): Belval / Differdange mill (LU) – Port of Mertert (LU): 60 km
  - Water (inland): Port of Mertert (LU) – Port of Antwerp (BE): 600 km
  - Water (sea): Port of Antwerp (BE) – Port of Duba (SA): 11 980 km



Module A1-A3 production (cradle to gate)
Module A4 transport (gate to job-site)

Transport

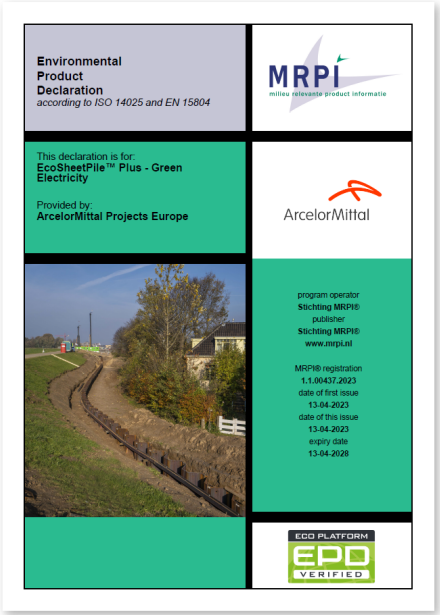
The calculation is based on data from the GaBi-database (developed by thinkstep AG) to quantify the environmental impact of transport processes. This is consistent with the EPD (see "Background data" within section 3 of the EPD).
See also http://documentation.gabi-software.com

Transport modes	Lifecycle GHG emission [g CO_2-eq/t/km]
rail: diesel cargo train	25,5
water (sea): bulk commodity carrier (200 kt deadweight tonnage)	3,7
water (inland): barge (1 500 t payload)	17,4

ArcelorMittal

EPD *EcoSheetPile™ Plus* – MRPI (NL) – 2023 – final submission

XCarb®
Recycled and renewably produced



EAF fed with 100% renewable electricity

- declared unit: 1 t (metric tonne)
- cradle-to-grave: A - D
- End-of-Life scenario: 30 % used 5 times
  - 60 % recycling ,
    25 % reuse ,
    15 % landfill .

⇒ **85 % recycled** at the end of life

Global Warming Potential [kg CO_2-eq / t] MRPI (NL) indicators EN 15804+A2:2019	
Module(s)	EcoSheetPile™ Plus
(A1 – A3)	**368**

ArcelorMittal

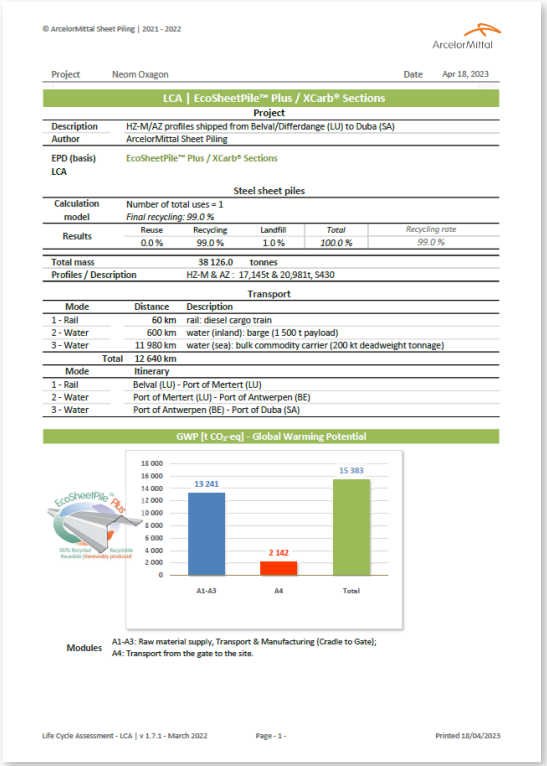
Carbon footprint – Production & transport (A1 - A4) – final submission

04/2023

LCA based on EPD "***EcoSheetPile™ Plus***",
shipped from Luxembourg to Duba (SA)

Modules (A1-A3) + A4

Global Warming Potential [t CO_2-eq.]		
	Initial assessment Standard mix electricity	*Final assessment* Renewable electricity
Module(s)	**EcoSheetPile™** IBU (DE)	**EcoSheetPile™ Plus** MRPI (NL)
A1 – A3	20 228	13 241
A4	2 185	2 142
Total	**22 413**	**15 383**
Difference	**+ 46 %**	reference



ArcelorMittal

Project	Neom Oxagon	Date	Apr 18, 2023

LCA | EcoSheetPile™ Plus / XCarb® Sections

Project

Description	HZ-M/AZ profiles shipped from Belval/Differdange (LU) to Duba (SA)
Author	ArcelorMittal Sheet Piling
EPD (basis) LCA	EcoSheetPile™ Plus / XCarb® Sections

Steel sheet piles

Calculation model	Number of total uses = 1 *Final recycling: 99.0 %*					
Results	Reuse	Recycling	Landfill	*Total*	*Recycling rate*	
	0.0 %	99.0 %	1.0 %	*100.0 %*	*99.0 %*	
Total mass	38 126.0 tonnes					
Profiles / Description	HZ-M & AZ : 17,145t & 20,981t, S430					

Transport

Mode	Distance	Description
1 - Rail	60 km	rail: diesel cargo train
2 - Water	600 km	water (inland): barge (1 500 t payload)
3 - Water	11 980 km	water (sea): bulk commodity carrier (200 kt deadweight tonnage)
Total	12 640 km	

Mode	Itinerary
1 - Rail	Belval (LU) - Port of Mertert (LU)
2 - Water	Port of Mertert (LU) - Port of Antwerpen (BE)
3 - Water	Port of Antwerpen (BE) - Port of Duba (SA)

GWP [t CO_2-eq] - Global Warming Potential

Modules: A1-A3: Raw material supply, Transport & Manufacturing (Cradle to Gate);
A4: Transport from the gate to the site.

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Phase 1 – 4.2 km of quay walls | ≈ 39 000 t of steel sheet piles

≈ **19 500 t** of **HZ-M** – **S 460 AP** – up to **33 m** long

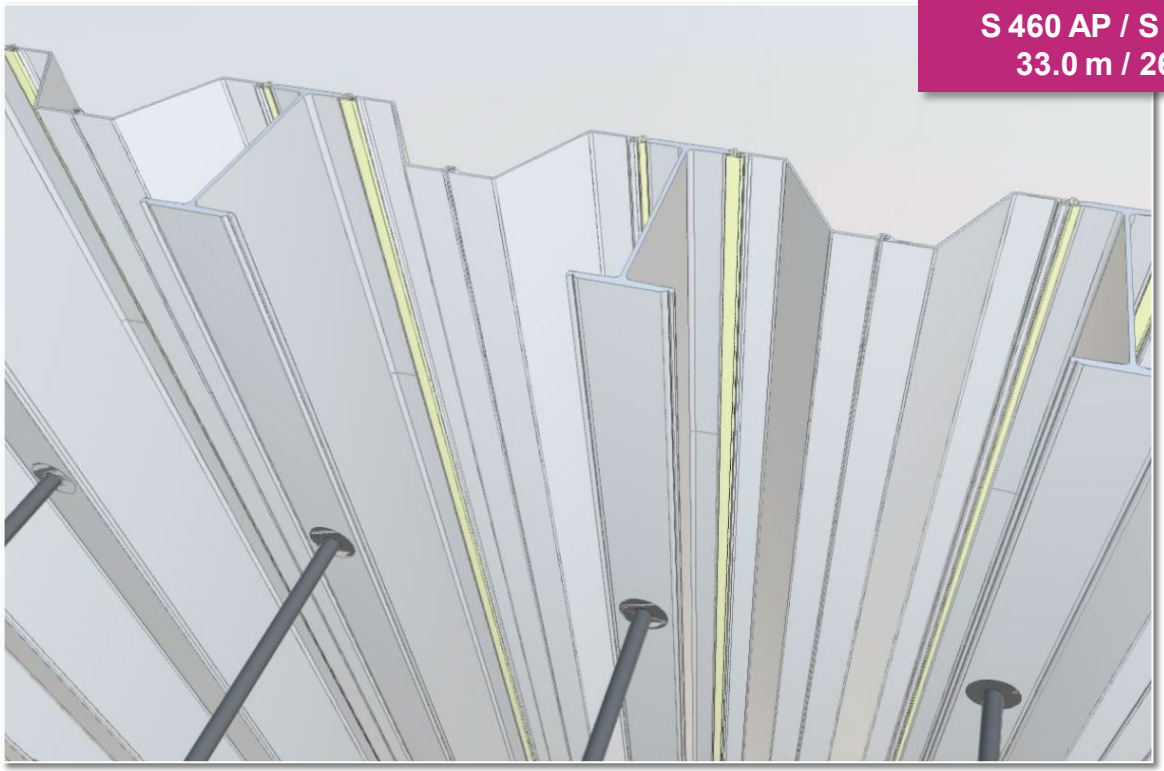
≈ **19 500 t** of **AZ** sections, **S 430 GP** & S 355 GP – up to **26 m** long

09/2023: 1st lot of HZ-M on its way to Duba port (SA)

ArcelorMittal

Besix – BIM model – quay T1 Upgrade Zone C/D

HZ 1180M-D14 / AZ 32-750
S 460 AP / S 355 GP
33.0 m / 26.0 m



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Oxagon Phase 2 – New quay walls (2023)

LCA submitted by BESIX in tender – with EPD *EcoSheetPile Plus* (MRPI, NL, 2023)

Functional unit: 1 m of wall

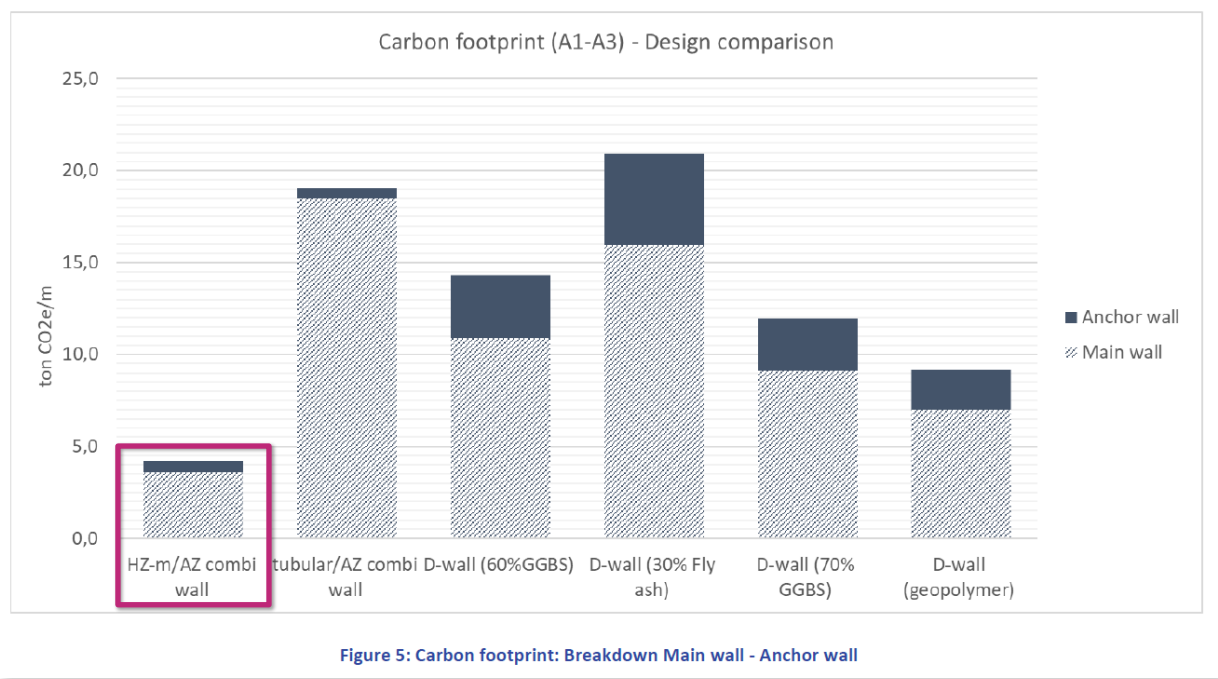

Figure 5: Carbon footprint: Breakdown Main wall - Anchor wall

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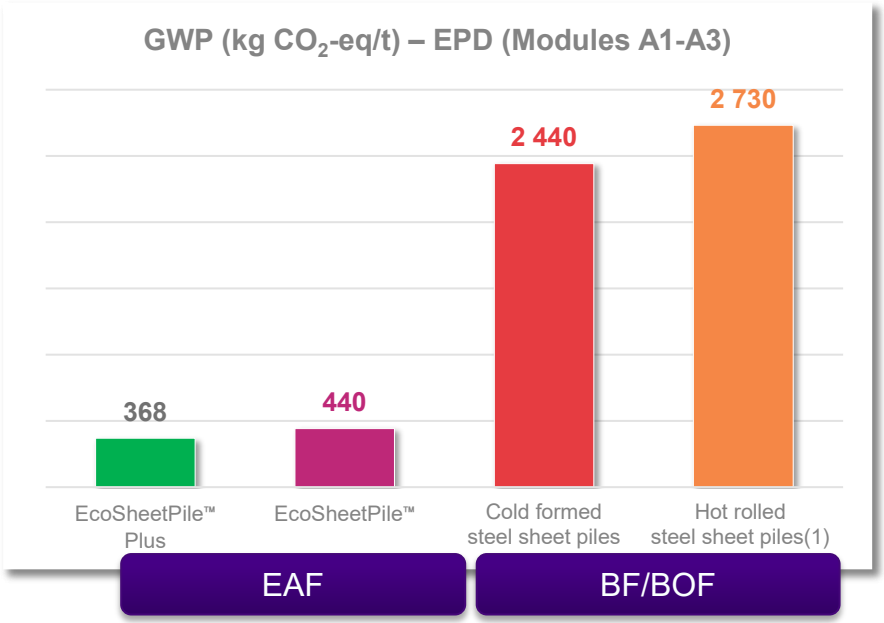
Miscellaneous

Global Warming Potential – summary

Program Operator EPDs

- EAF: MRPI (NL) – 2023
- BF/BOF: IBU e.V. (DE)



EAF vs BF/BOF
⇒ reduction of GWP factor ≈ 7

EAF = Electric Arc Furnace
BF/BOF = Blast Furnace / Basic Oxygen Furnace
GWP = *Global Warming Potential* according to an **EPD** (Environmental Product Declaration) from *IBU e.V.* Values for **Modules A1 – A3** (Production)
(1) Background report "*EPDs of ArcelorMittal construction steel products – Sheet Piling*". Thinkstep AG, Nov. 2016 (Confidential, unpublished)

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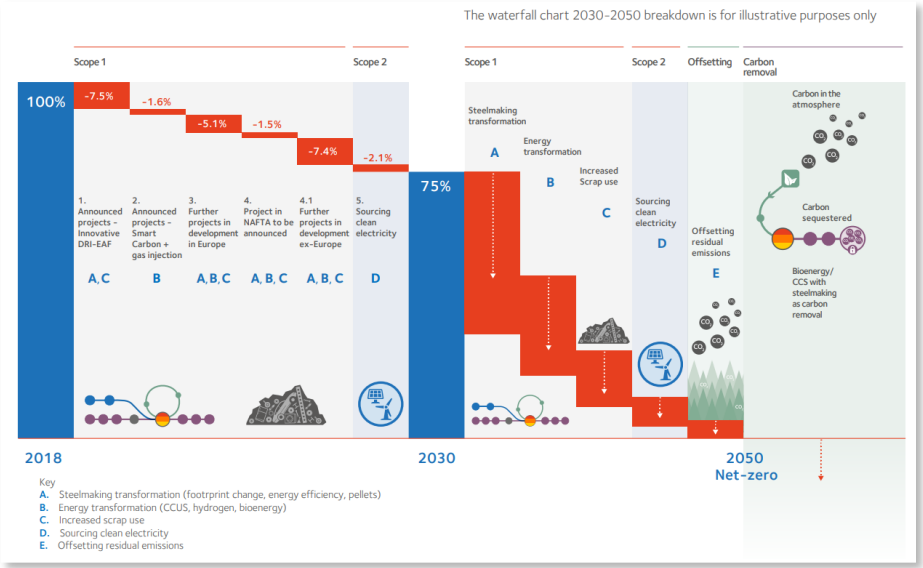
ArcelorMittal's goals

- steadily reduce its carbon footprint until reaching
  carbon neutrality by 2050
  (net-zero – scope 1 & 2)

- undertaking **extensive research and pilot programs** within our operations, as well as evaluating the opportunity from off-setting

- interim target for ArcelorMittal Europe
  -35 % CO_2 by 2030

- interim target for ArcelorMittal Group: **-25 % CO_2 by 2030**



More information: https://corporate-media.arcelormittal.com/media/yw1gnzfo/climate-action-in-europe.pdf

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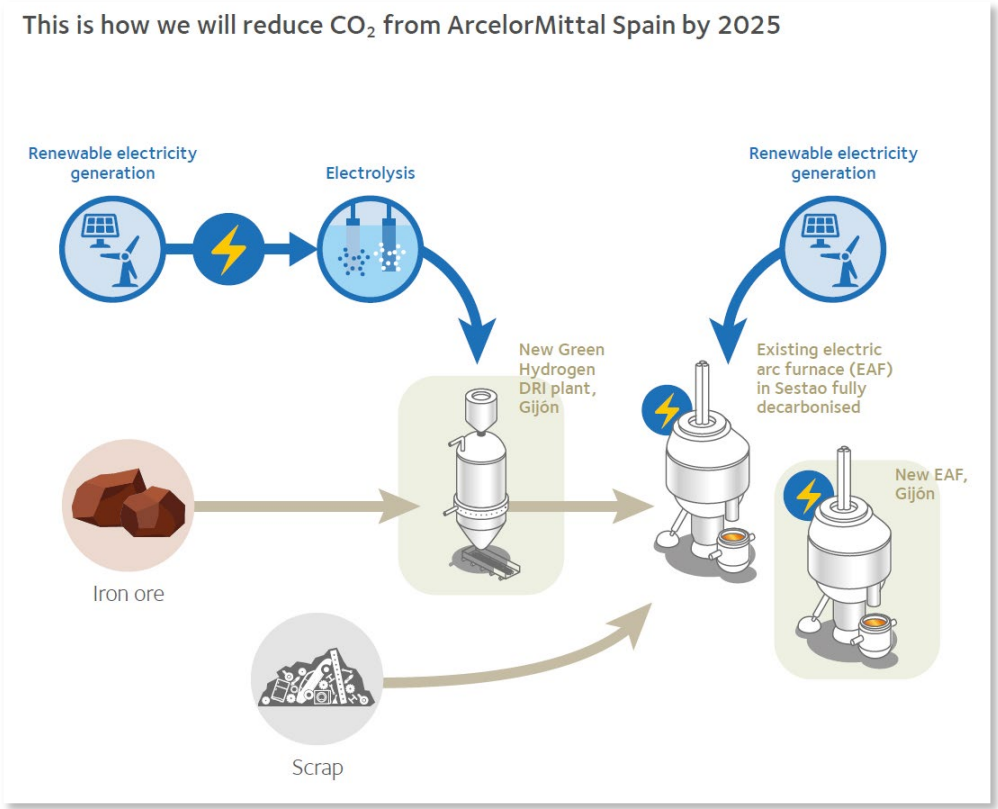
Future technologies – DRI (produced with H_2) / EAF



Full **decarbonisation only achievable if**

"green" hydrogen

(produced with renewable energies) available

- **in sufficient quantities**
- **at a reasonable cost**

⇒ new infrastructure

DRI: Direct Reduced Iron

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Circular economy

REDUCE

Lighter sections (AZ-800)

High strength steel

REUSE

- rental
- sales with buy-back option
- sales of second hand

RECYCLE

steel is **100 %** recyclable

&

ssp out of **100 %** recycled steel

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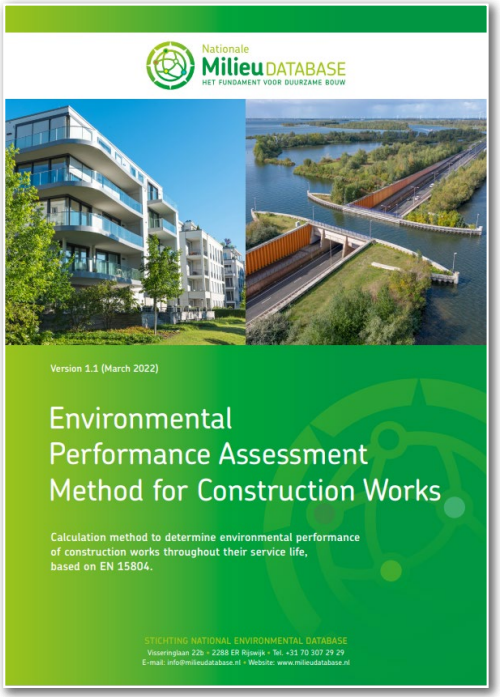
"*Environmental Performance Assessment Method for Construction Works*"
Stichting National Environmental Database (NL) – (03/2022)



- national environmental database with 4 product information categories
  - data from Cat. 3 (generic data, not verified according to SBK Verification Protocol) submitted to a **multiplication factor set to 30%!**
- **monetization** based on the '***shadow pricing method***':

Table 8: Weighting factors (for the environmental impact categories)

Environmental impact category	Equivalent unit	Weighting factor [€ / kg equivalent]
Depletion of abiotic raw materials (excluding fossil energy carriers) - ADP	Sb eq	€0.16
Depletion of fossil energy carriers - ADP	Sb eq[10]	€0.16
Global warming - GWP 100 years.	CO_2 eq	€0.05
Ozone layer depletion - ODP	CFK-11 eq	€30
Photochemical oxidant-formation - POCP	C_2H_4 eq	€2
Acidification - AP	SO_2 eq	€4
Eutrophication - EP	PO_4 eq	€9
Human toxicity - HTP	1.4-DCB eq	€0.09
Freshwater aquatic ecotoxicity - FAETP	1.4-DCB eq	€0.03
Marine aquatic ecotoxicity - MAETP	1.4-DCB eq	€0.0001
Terrestrial ecotoxicity - TETP	1.4-DCB eq	€0.06

Raw materials
Emissions
1-point score

CO_2-eq: 50 € / t

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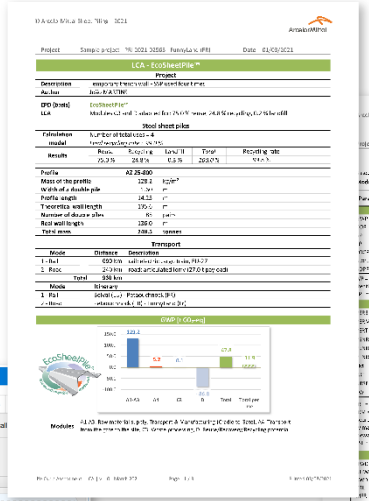
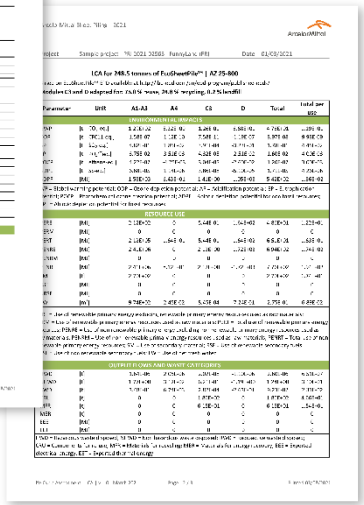
Simple assessment of the environmental indicators – LCA tools: Excel / Durability 4.1

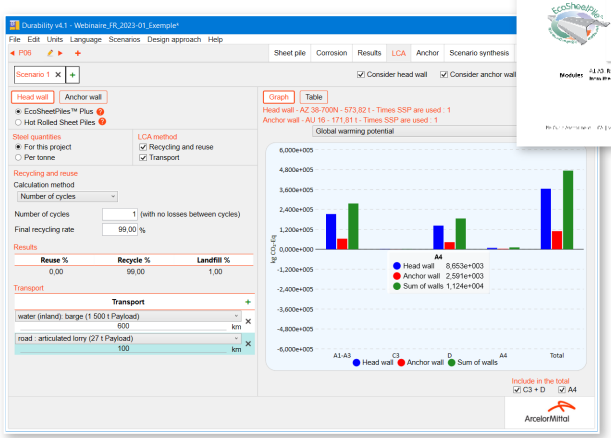
simple (macro) Excel file

- flexible
  - can **adapt recycling rates / reuse rates** to match specific project requirements
  - transport is an option
  - 3 different models for LCA, 2 specific for reuse
- no need to be an expert in LCA, but follow simple predefined steps or enter project specific data

new “LCA” tool of the
new version of software *Durability (4.1)*







it is a correct *statement*, to inform the stakeholders about a fact,
but without any guarantee or legal binding

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Take-aways

Take-aways

- environmental criteria in tenders
  - incentive for manufacturers & contractors to reduce the carbon footprint of infrastructure
  - need to be fair, transparent, specific, measurable, achievable, relevant

⇒ allow value engineering / optimisation

- LCA based on product specific EPDs should be preferred

- steel production: renewable electricity in EAF can **reduce** significantly the CO_2-eq emissions, i.e. approx. **20 %** for steel sheet piles!

- solution with lowest environmental impact is rarely the cheapest:
  ⇒ incentives through credits / **bonus** for lowest environmental impact such as the **"*shadow price method*" in NL** (*most advantageous economical tender*)

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New EN 10248-1: 2023
Hot rolled steel sheet piles.
Technical delivery conditions

Main changes – Overview

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EN 10248-1: 2023. Hot-rolled steel sheet piles. Technical delivery conditions. March 2023

Non ***harmonised*** standard! ⇒ no CE marking yet!

EUROPEAN STANDARD **EN 10248-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM March 2023

ICS 77.140.70 Supersedes EN 10248-1:1995

English Version

Hot-rolled steel sheet piles - Part 1: Technical delivery conditions

Palplanches en acier laminées à chaud - Partie 1 - Conditions techniques de livraison

Warmgewalzte Spundbohlen aus Stahl - Teil 1: Technische Lieferbedingungen

This European Standard was approved by CEN on 17 January 2023.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations v

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 CEN-CENELEC Management Centre has the same status as the official versions.

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

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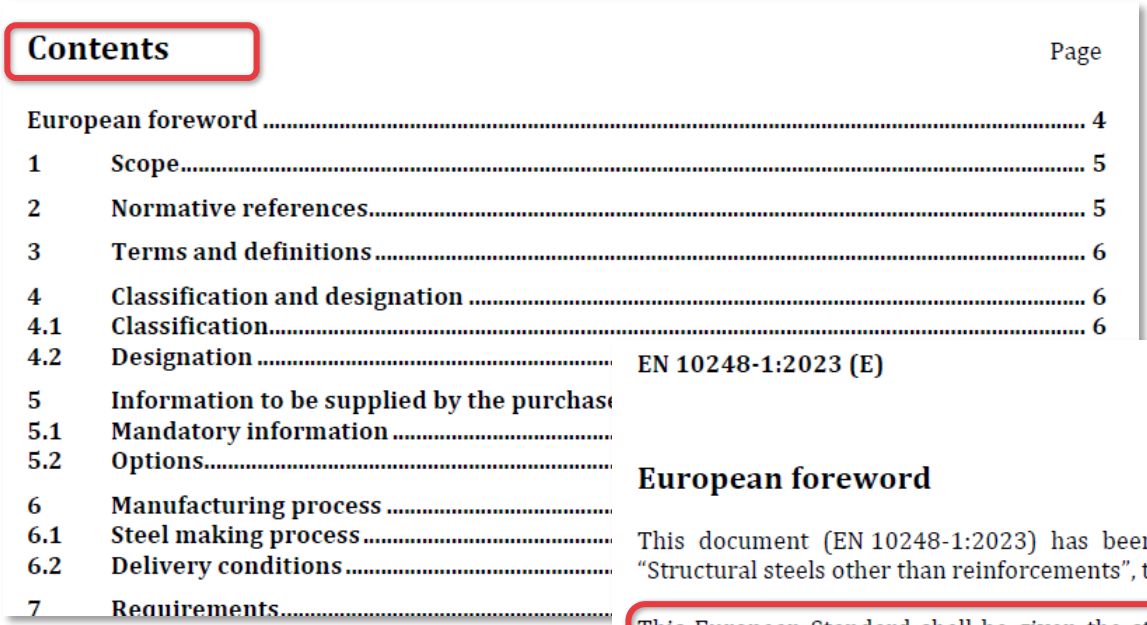
EN 10248-1: 2023. Hot-rolled steel sheet piles. Technical delivery conditions

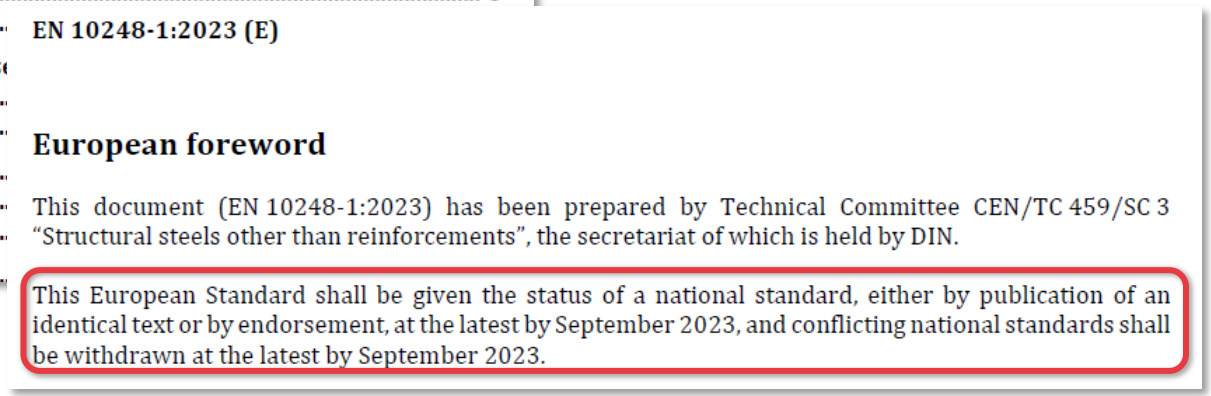


Contents

Page

Compared to prEN 10248-1: 2006, the **structure** of the standard changed.

It **follows EN 10025-2: 2019**. Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels



EN 10248-1:2023 (E)

European foreword

This document (EN 10248-1:2023) has been prepared by Technical Committee CEN/TC 459/SC 3 "Structural steels other than reinforcements", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2023, and conflicting national standards shall be withdrawn at the latest by September 2023.

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Main changes

This document supersedes EN 10248-1:1995.

In comparison with the previous edition, the following technical modifications have been made:

a) Document was restructured;

b) Normative references were updated;

c) Grades S460 and S500 in quality GP were introduced;

d) Modification concerning the maximum values for the chemical composition;

e) Addition of 7.4.3 dedicated for hot-dip zinc-coating and 7.8 for load bearing capacity;

f) New wording for Clauses 8, 9 and 10 for inspection and testing;

g) Addition of Clause 12 on the complaints;

h) Removal of the former Annexes B and C on Eurono

i) Addition of the Annexes B, C, D and E.

EN 10248 consists of the following parts, under the general title *Hot-rolled steel sheet piles*:

— *Part 1: Technical delivery conditions*

— *Part 2: Tolerances on shape and dimensions*

A further standard prEN 10375 with the title *Hot-rolled steel sheet piles – General (Characteristics, evaluation of conformity and marking)* is in preparation and can be used together with EN 10248 after publication.

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Main changes – new steel grades

4.1 Classification

4.1.1 Main quality classes

The steel grades specified in this document shall be classified as non-alloy quality steels according to EN 10020.

4.1.2 Grades and qualities

This document specifies eight steel grades S240, S270, S320, S355, S390, S430, S460 and S500 on the basis of the minimum specified yield strength at room temperature.

The eight steel grades are supplied in quality GP.

4.2 Designation

4.2.1 For the steel grades covered by this document in Table 1 the steel names shall be allocated in accordance with EN 10027-1; the steel numbers shall be allocated in accordance with EN 10027-2.

4.2.2 The designation of the steel grade shall consist of:

— the number of this document (EN 10248-1);

— the steel name or the steel number.

EXAMPLE Steel sheet piles in accordance with EN 10248-1 made of structural steels (S) with a specified minimum yield strength at room temperature of 430 MPa, followed by GP for steel sheet piles:

EN 10248-1 – S430GP

or

EN 10248-1 – 1.0523

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Main changes – weldability (carbon equivalent)

7.2.2 The upper limits applicable for the product analysis are given in Table 2.

For elements not specified in tables for the chemical composition for product analysis, limit values of Table 1 of EN 10020:2000 shall apply as maximum values.

7.2.3 The maximum carbon equivalent values for the grades based on the heat analysis given in Table 1 shall apply.

The maximum carbon equivalent values for the grades based on the product analysis given in Table 2 shall apply.

For determining the carbon equivalent value, the following IIW (International Institute of Welding) formula shall be used:

EN 10248-1:2023 (E)

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \qquad (1)$$

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Main changes – impact properties (Charpy V-notch test)

7.3 Mechanical properties

7.3.1 General

Under the inspection and testing conditions as specified in Clauses 8, 9 and 10, the mechanical properties shall comply with the values given in Table 3.

7.3.2 Impact properties

The impact properties shall be verified by test at the temperature given in Table 3, unless otherwise agreed upon at the time of the order.

Using test pieces of width less than 10 mm, the minimum values given in Table 3 shall be reduced in direct proportion to the cross-sectional area of the test piece.

See ***Option*** *4*, Clause 13, (Verification of impact energy).

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Main changes – “load bearing capacity”

7.8 Load bearing capacity

7.8.1 General

The design of steel sheet pile structures requires d
example the earth pressure, the water pressure, t
resistances. The actions will give rise to effects all o
moments, stresses, strains and displacements. Additio

7.8.2 Interlock resistance of straight web sheet piles

The interlock resistance of straight web sheet piles shall be agreed at the time of enquiry and order, and shall be tested according to the conditions as specified in 9.2.4.

7.8.3 Resistance of crimped points of U-shaped sheet piles

Crimped points can be used to enhance the shear force transmission in the interlocks of U-shaped sheet piles.

If crimped points are used to enhance the shear force transmission in the interlocks of U-shaped sheet piles, the resistance shall be agreed at the time of enquiry and order, and shall be tested according to the testing procedure specified in 9.2.5.

If agreed at the time of enquiry and order, the manufacturer can replace the crimping of interlocks by intermittent welding of interlocks that achieves the same shear force transmission.

EXAMPLE Triple U-shaped sheet piles delivered with one common interlock crimped and one common interlock partially welded.

See ***Option 7***, Clause 13, (Welding of common interlocks).

7.8.4 Interlock performance criteria

The interlock performance criteria shall comply with the requirements of 9.2.6.

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Main changes – options

13 Options

The following options (see 5.2) apply for this document:

1 The steel making process of the relevant quality shall be indicated (see 6.1).

2 An alternative delivery condition to as-rolled is required (see 6.2).

3 A copper content between 0,20 % and 0,35 %, or between 0,35 % and 0,50 % on the heat analysis is required (see 7.2.4).

4 The impact energy for the grades S240GP, S270GP and S320GP shall be reported (see 7.3.2 and 8.3.2).

5 The product shall have a chemical composition required for hot-dip zinc-coating (see 7.4.3).

6 The permissible surface discontinuities and for the repair of surface defects by grinding and/or welding another class than class C, subclass 1 of EN 10163-3 applies (see 7.5).

7 Replacement of crimping of interlocks of U-shaped sheet piles by equivalent intermittent welds (see 7.8.3).

8 Product analysis shall be carried out; the number of samples shall be as agreed upon (see 7.2.2 and 8.3.2).

9 Purchaser wishes to carry out inspection of surface conditions and dimensions (see 8.3.3).

10 The type of marking required (see Clause 11).

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Main changes

Table 1 — Chemical composition of the heat analysis for hot rolled steel sheet piles [a]

Designation		Chemical composition in % by mass max.								
Steel name	Steel number	C	Mn	Si	P	S	N [b]	Cu	Other [c, e,f]	CEV
S240GP	1.0021	0,17	1,40	-	0,040	0,040	0,012	0,55	-	0,35
S270GP	1.0023	0,18	1,50	-	0,040	0,040	0,012	0,55	-	0,40
S320GP	1.0046	0,20 [d]	1,60	0,55	0,040	0,040	0,012	0,55	-	0,42
S355GP	1.0083	0,20 [d]	1,60	0,55	0,040	0,040	0,012	0,55	-	0,47
S390GP	1.0522	0,20 [d]	1,70	0,55	0,035	0,035	0,012	0,55	-	0,48
S430GP	1.0523	0,20 [d]	1,70	0,55	0,035	0,035	0,012	0,55	-	0,52
S460GP	1.9524	0,20 [d]	1,70	0,55	0,035	0,035	0,012	0,55	-	0,46
S500GP	1.9525	0,20 [d]	1,70	0,55	0,035	0,035	0,012	0,55	-	0,49

[a] See 7.2.

[b] The maximum value for nitrogen does not apply if the chemical composition shows a minimum total Al content of 0,020 % or alternatively min. 0,015 % acid soluble Al or if sufficient other N binding elements are present. In this case the N binding elements shall be mentioned in the inspection document.

[c] If other elements are added, they shall be mentioned in the inspection document.

[d] For nominal thickness > 30 mm: C = 0,22 % max.

[e] The steel may show a Nb content of max. 0,05 %, a V content of max. 0,13 % and a Ti content of max. 0,05 %.

[f] For elements Ni, Cr and Mo the maximum value (%) is limited to Ni = 0,42; Cr = 0,29 and Mo = 0,11.

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Main changes

Table 3 — Mechanical properties for hot rolled steel sheet piles [a]

Designation		Minimum yield strength	Minimum tensile strength	Minimum elongation on a gauge length of $L_0 = 5,65\sqrt{S_0}$	Minimum impact energy [b] KV_2	
Steel name	Steel number	R_{eH} MPa	R_m MPa	A at fracture %	Testing temperature °C	J Joules
S240GP	1.0021	240	340	26	20	27
S270GP	1.0023	270	410	24	20	27
S320GP	1.0046	320	440	23	20	27
S355GP	1.0083	355	480	22	0	27
S390GP	1.0522	390	490	20	0	27
S430GP	1.0523	430	510	19	0	27
S460GP	1.9524	460	530	17	0	27
S500GP	1.9525	500	580	15	0	27

[a] The values in the table apply to longitudinal test pieces.

[b] For subsized specimens the minimum values shall be reduced in direct proportion to the cross-sectional area of the test piece.

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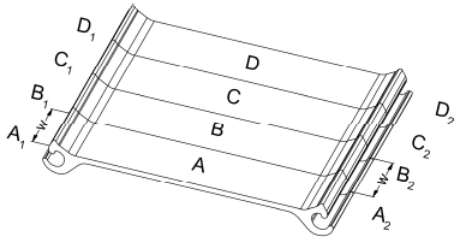
Main changes – Annex C – Interlock resistance of flat sheet piles (i.e. AS 500)

C.2 Test specimen

The test specimen shall be cut from the pile perpendicular to the rolling direction as shown in Figure C.1.

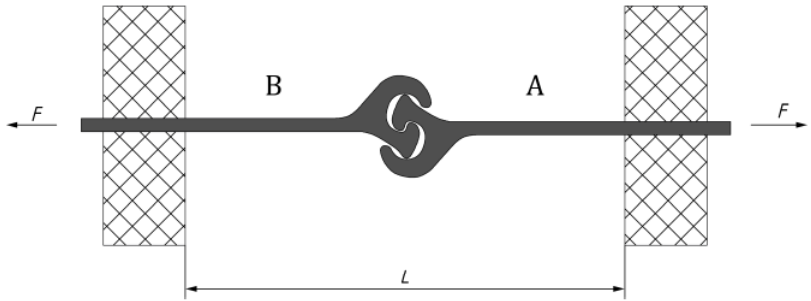
The width w of the specimen shall be 100 mm.



Key

A, B, C, D	specimen cut from the sheet pile
w	width of the specimen

The distance L between the grips shall satisfy: 350 mm ≤ L ≤ 500 mm



Key

A, B	samples
F	tensile force applied by the testing machine
L	distance between grips

Figure C.2 — Test set-up

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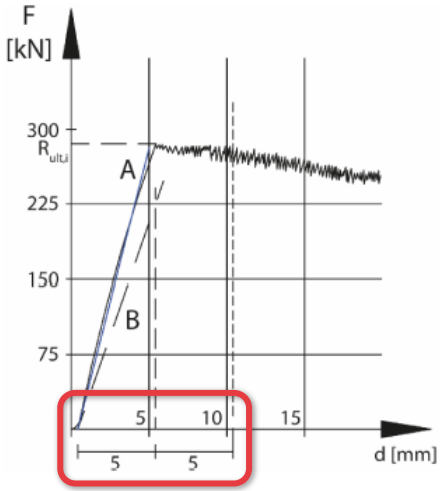
Main changes – Annex D – crimped points of U-shaped sections

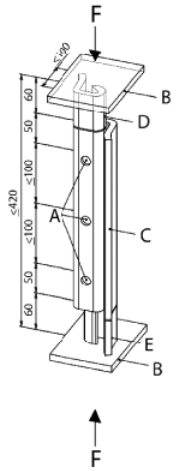
Regarding the number of tests to be carried out and the evaluation of the test results in order to obtain the characteristic value R_k reference shall be made to Annex D of EN 1990:2002.



Key

F measured force
d measured displacement of the cross-head
A linearisation of load displacement curve
B minimum required stiffness line

Figure D.3 — Resistance from load-displacement curve of triple crimps



Key

A crimped points
B end plates
C specimen taken from double pile
D, E interlock welded to specimen

Figure D.1 — Specimen for compression test

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Main changes – Annex E – Interlock performance criteria

Annex E
(normative)

Interlock performance criteria

E.1 General

The following provisions are given for ensuring load-bearing capacity as well as the integrity of the sheet pile wall. Examples of interlock types which have been proven to satisfy these provisions are given in EN 10248-2. For interlock types not covered in EN 10248-2, the assessment of the following criteria shall be part of the testing. Tests shall be carried out on at least five samples per interlocking geometry, with a maximum of one test per test unit.

The following criteria shall be fulfilled:

— the interference criterion according to EN 10248-2 and

— the declutching criterion and

— the tensile interlock resistance.

In case one of the following criteria is not fulfilled, the related design resistance should be determined by testing in accordance with EN 1993-5:

— the interlock stiffness criterion and

— the resistance of the interlock of U-shaped sheet piles in case of local load introduction.

Dimensions in millimetres

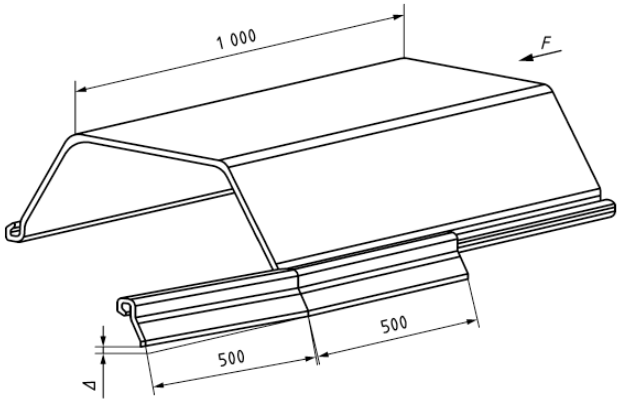

Figure E.1 — Schematic declutching test, aberration caused by Δ

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Thank you for your attention

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