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 REVOLUTIONARY URBANISM

NEOM

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

200 M



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.



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.





NEOM in Progress - January 2023

and our center for advanced industries Oxagon.

AGON

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





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







Soil conditions – boreholes

• mainly silty sand, limestone, sand,... with SPT > 50 in some locations / layers





Distance Along Baseline (m)

ArcelorMittal

Cross section – Terminal T1 (& extension)





Cross section - 'Flexible' berth



ArcelorMitta

Cross section – Marine services berth





Environmental criteria

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

max. 800 kg CO₂-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



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				





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
- •
- Delivery: Port of Duba (SA) •
- Transport: 12 640 km •
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Transport	
The calculation is based on data fro environmental impact of transport p section 3 of the EPD). See also http://documentation.gabi-	m the GaBi-database (developed by thinkstep AG) to quantify the rocesses. This is consistent with the EPD (see "Background data" within software.com
Transport modes	Lifecycle GHG emission [g CO ₂ -eq/t/km]
rail: diesel cargo train	25.5

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)





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.





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



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				

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7 Results															
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1 ENVIRONMEN	TAL EFFECTS	PER TON (TON)	_											
Environmental effects	Unit	AI	AZ	A3	A4	A5	BI	82	B3	CI	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
powered by nibe					Ar	celorMittal Eur	ope EcoSheetPi	lles ^{tut} ++ Green E	lectricity						29 / 44

Background report (confidential)



Carbon footprint of 1 tonne of steel sheet piles – Production & transport (A1 - A4) 10/2022

- Solution: HZ-M/AZ combined wall system & AZ sections •
- I CA based on EPD "FcoSheetPile "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 _



ArcelorMitte

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 Lifequela CUC amission [a CO an h/h

Transport modes Lifecycle GHG emission [g CO2-eq/t/kmj
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

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





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 .
 - \Rightarrow 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					



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.]					
	<i>Initial assessment</i> Standard mix electricity	<i>Final assessment</i> 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			

ICA_1 EcosheetPiller Pilar / XCanP Sections Project Description H2-MA2 profiles shoped from Belvy(Differdinge (U) to Duba (SA) Author Accelentities Shoped from Belvy(Differdinge (U) to Duba (SA) EcoSheetPiler" Plus / XCarb* Sections ICA Steel sheet piles Calculation Number of total uses = 1 model Total Recycling Total mass 38 126.0 Total Recycling Total mass Total mass 38 126.0 Total mass Total mass S8 126.0 Total mass Total mass Total mass </th <th></th> <th></th> <th></th> <th></th> <th></th> <th>Dute</th> <th>Apr 10, 2023</th>						Dute	Apr 10, 2023
Description H2-MJA2 profiles shipped from Belvi/D/Britdarge (LU) to Duba (SA) Aution Accion/Mital Sheet Plang EVD (basis) LCA EVD (basis) LCA Steel sheet piles Colouidion Number of total uses = 1 model Find recycling; SB 0.5 Results 0.035, 99 0.5, 1.03, 0.5, 1.00, 0.5, 1.00, 0.5, 9 Total mass Results 0.035, 99 0.5, 1.05, 1.00, 0.5, 9 Total mass Results 0.035, 99 0.5, 1.05, 1.00, 0.5, 9 Total mass Results 0.035, 99 0.5, 1.00, 0.5, 1.00, 0.5, 9 Total mass Results 0.036, 99 0.5, 1.00, 0.5, 1.00, 0.5, 9 Total mass Results 0.036, 99 0.5, 1.00, 0.5, 1.00, 0.5, 9 Total mass Results 0.036, 99 0.5, 1.00, 0.5, 1.00, 0.5, 9 Total mass Node Total 12 640 km Mode Node 1.04, 1.05, 0		LCA	EcoSheet	Pile™ Plus /	XCarb® Section	ons	
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See I heet piles Calculation Number of total uses = 1.1 mode Final recycling: 98.0 %. Total Total Ancomposition Results 0.0 %. 99.0 %. 1.0 %. 10.0 %. 95.0 %. Total mass 39.13.6.0. tomes 7.00 %. 95.0 %. 95.0 %. Total mass 1.0 %. 1.0 %. 1.0 %. 1.0 %. 95.0 %. Total mass 1.0 %. 1.0 %. 1.0 %. 1.0 %. 95.0 %. Mode Description H2.M & A.2. / 1.0 % and (see Large train) 1.0 %. </td <td>EPD (basis) LCA</td> <td>EcoSheetPile"</td> <td>" Plus / XCarb®</td> <td>Sections</td> <td></td> <td></td> <td></td>	EPD (basis) LCA	EcoSheetPile"	" Plus / XCarb®	Sections			
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Index Participation 2010 /r Results 0.05% 99.0 % 1.0 % 1.0 % Accy Total mass 98.12.6.0 1.0 % 1.0 % 2.0 0 % 9 Total mass 98.12.6.0 1.0 % 1.0 % 2.0 % 9 Profiles / Description H2.44.8.4.2. 1.1 Ack 2.0 (20.1 %) 9 - Nater 6.00 m water (relation) barge (1.5 0.01 par/oad) 3	Calculation	Number of tot	al uses = 1				
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Total mass 38 126.0 tonnes HoMa A.2. 17,145 & 20,9811,5430 Tonsport Mode Distance Description 1-Rail 2-Water 600 km water (inland): barge (1500 t payload) 3-Water 11980 km, water (inland): barge (1500 t payload) 3-Water 11980 km, water (inland): barge (1500 t payload) Total 12 640 km Mode Inferenzy 1-Rail Belvai (LU)- Port of Metter (LU) 2-Water Port of Metter (LU)- 3-Water Port of Metter (LU)- 3-Water 10 balance (LU)- Port of Anterespen (BE) 3-Water Dot of Metter (LU)- 4-Water Dot of Metter (LU)- 15 Mass Anterpen (BE)- Port of Duba (A) 15 Mass Anterpen (BE)- 1000	Results	0.0 %	99.0 %	1.0%	100.0 %	99.	0%
Profiles / Description H2-M & A2: 17,1451 & 20,9811, 9430 Transport Transport Mode Distance Description 1 - Rul 60 km rait. devel cargo train 2000 2 - Wate 1000 m rait. devel cargo train 2000 rait. devel cargo train 3 - Wate 1000 m wate (sal); build, commodity carrier (200 kt deadweight ton 3 - Wate Total 12 640 m wate (sal); build, commodity carrier (200 kt deadweight ton 1 - Rul Belvia (LU) - Port of Mertert (LU) 2.000 m rait. developen (RE). 2 - Water Port of Mertert (LU) - Port of Antwerpen (RE). 2.000 m rait. developen (RE). 2 - Water Port of Antwerpen (RE) - Port of Duba (SA). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 3 - Water Port of Antwerpen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 1 1 000 m rait. developen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 1 000 m rait. developen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE). 1 000 m rait. developen (RE). 1000 m rait. developen (RE). 1000 m rait. developen (RE)	Total mass		38 126 0	tonnes			
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<u>3- Water</u> <u>11 980 km</u> water (sea): bulk commodity carrier (200 kt deadweight ton Total 2 640 km <u>Mode</u> <u>1- Reiil</u> <u>2- Water</u> Port of Metrert (U) <u>2- Water</u> <u>2- Water</u> Port of Metrert (U) <u>2- Water</u> <u>2- Water</u> Port of Metrert (U) <u>2- Water</u> <u>2- Water</u> <u>2- Water</u> Port of Metrert (U) <u>2- Water</u> <u>2- Water</u> <u>2-</u>	2 - Water	600 km	water (inland)	barge (1 500 t	pavload)		
Total 12 640 km Mode Interary 1-Rail Belval (UJ)-Port of Mettert (UJ) 2-Water Port of Mettert (UJ)-Port of Antwerpen (BE) 3-Water Port of Antwerpen (BE)-Port of Duba (SA) COVP (ECOp-eq) - Global Warming Potential	3 - Water	11 980 km	water (sea): bu	Ik commodity	carrier (200 kt de	adweight tonna	ge)
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2 - Water 3 - Water 9 - Word of Antwergene (BE) 5 - Water 9 - Word of Antwergene (BE) - Port of Duba (SA) CWP (t CO,- eq) - Global Warning Potential 0000 - 13 - 24 000 - 13 - 24 000 - 24 - 24	1 - Rail	Belval (LU) -	Port of Mertert	(LU)			
3- Water Port of Antwerpen (BE) - Port of Duba (A) CWP (COp-cq) - Global Warming Potential	2 - Water	Port of Mert	ert (LU) - Port o	f Antwerpen (B	E)		
CHOP (CCp.eq) - Global Warning Potential	3 - Water	Port of Antw	erpen (BE) - Po	rt of Duba (SA)			
Strating of the second		G	WP [t CO _z .eq]	- Global War	ming Potential		
AL-3: Raw material apply, Transport & Manufacturing (Cracle to Gate);		18 000					
ALA3 Raw meterial lappin, Transport & Manufacturing (Cradie to Gate);		16 000			15 383	_	
AL-3, Raw material apply, Trapert & Manufacturing (Cradie to Gate);	also and the se	14 000	13 241				
2 Module:	ECOSNEELINIE A	12 000	-				
AL-A3 A4 Total		10 000					
AL-A3 A4 Total Module: AL-A3 Raw material supply, Transport & Manufacturing (Cradie to Gate);		\$ 000				-	
Modules A1-A3: Raw material supply, Transport & Manufacturing (Cradie to Gate);		5 000					
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Modules A1-A3: Raw material supply, Transport & Manufacturing (Cradle to Gate);							
Modules A1-A3: Raw material supply, Transport & Manufacturing (Cradle to Gate);							
A1-A3: Raw material supply, Transport & Manufacturing (Cradle to Gate); Modules							
	Modules A1	-A3: Raw materia	al supply, Transpo	rt & Manufactur	ing (Cradle to Gate	e);	
A4: Transport from the gate to the site.	A4	: Transport from	the gate to the s	te.			



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

 \approx **19 500 t** of **HZ-M** − **S 460 AP** − up to **33 m** long \approx **19 500 t** of **AZ** sections, **S 430 GP** & S 355 GP − up to **26 m** long







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



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



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)



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 % CO₂ by 2030
- interim target for ArcelorMittal Group: -25 % CO₂ by 2030



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



Future technologies – DRI (produced with H₂) / EAF

This is how we will reduce CO₂ from ArcelorMittal Spain by 2025



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



Circular economy





rental
sales with
buy-back option

• sales of second hand

RECYCLE steel is 100 % recyclable

&

ssp out of **100 %** recycled steel



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

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



ersion 1.1 (March 2022)

Environmental Performance Assessment Method for Construction Works

Calculation method to determine environmental performance of construction works throughout their service life, based on EN 15804.

> TICHTING NATIONAL ENVIRONMENTAL DATABASE Asseringlaan 22b - 2288 ER Rijswijk - Tel. +31 70 307 29 29 mail: Info@mileudatabase.nl - Website: www.mileudatabase.nl

- 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':

		,			
	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	— Raw materials —	
	Global warming - GWP 100 years.	CO ₂ eq	€0.05	ore	
1	Ozone layer depletion - ODP	CFK-11 eq	€30	it sc	
	Photochemical oxidant-formation - POCP	C_2H_4 eq	€2	poin	
	Acidification - AP	SO ₂ eq	€4	t.	
	Eutrophication - EP	PO ₄ eq	€9	- Emissions	
	Human toxicity - HTP	1.4-DCB eq	€0.09		
	Freshwater aquatic ecotoxicity - FAETP	1.4-DCB eq	€0.03	CO.	ea: 50 €
	Marine aquatic ecotoxicity - MAETP	1.4-DCB eq	€0.0001		09.00 C
	Terrestrial ecotoxicity - TETP	1.4-DCB eq	€0.06		
				-	



/ t

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
- \Rightarrow allow value engineering / optimisation
- LCA based on product specific EPDs should be preferred
- steel production: renewable electricity in EAF can reduce significantly the CO₂-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)





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

Main changes – Overview



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

Non *harmonised* standard! \Rightarrow no CE marking yet!

EUROPEAN STANDARD	EN 10248-1	
EUROPÄISCHE NORM	March 2023	
ICS 77.140.70	Supersedes EN 10248-1:1995	
English Version Hot-rolled steel sheet piles Conditions	t 1: Technical delivery	
Paipianches en acter laminees a 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 Regu	This European Standard exists in thre translation under the responsibility o lations v Centre has the same status as the office	e official versions (English, French, German). A version in any other language made by F a OEN member into its own language and notif ied to the CEN-CENELEC Management rial versions.
	CEN members are the national standa Finland, France, Germany, Greece, Hu Poland, Portugal, Republic of North M United Kingdom.	rds bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, ngary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, acedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and



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

Contents		Page				
European for	eword					
1 Scope.						
2 Norma	tive references					
3 Terms	Terms and definitions					
4 Classif 4.1 Classif 4.2 Design	ication and designation ication					
5 Inform 5.1 Manda 5.2 Option	nation to be supplied by the purchase atory information 15	European foreword				
6 Manuf 6.1 Steel r 6.2 Delive	acturing process naking process ry conditions	This document (EN 10248-1:2023) has be "Structural steels other than reinforcements"				
7 Requir	rements	This European Standard shall be given the				

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

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.



Main changes

Th	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)	rmative references were updated; ades S460 and S500 in quality GP were introduced; odification concerning the maximum values for the chemical composition; dition of 7.4.3 dedicated for hot-dip zinc-coating and 7.8 for load bearing capacity; w wording for Clauses 8, 9 and 10 for inspection and testing; dition of Clause 12 on the complaints:						
f)	New wording for Clauses 8, 9 and 10 for inspection and testing;						
g)	Addition of Clause 12 on the complaints;						
h)	A further standard prEN 10375 with the title <i>Hot-rolled steel sheet piles – General (Characteristics,</i> Removal of the former Annexes B and C on Eurono <i>evaluation of conformity and marking)</i> is in preparation and can be used together with EN 10248 after						

publication.

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



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



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)

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



(1)

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).



Main changes – "load bearing capacity"

7.8 Load bearing capacity 7.8.1 General 7.8.2 Interlock resistance of straight web sheet piles The design of steel sheet pile structures requires d example the earth pressure, the water pressure, The interlock resistance of straight web sheet piles shall be agreed at the time of enquiry and order, and resistances. The actions will give rise to effects all o shall be tested according to the conditions as specified in 9.2.4. moments. stresses. strains and displacements. Additic 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.



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).



Main changes

	Table	1 — Chemical	compositio	n of the hea	at analysis f	or hot rolle	d steel shee	t piles ª			
Designation		Chemical composition in % by mass max.									
Steel name	Steel number	С	Mn	Si	Р	S	N ^b	Cu	Other ^{c,} e,f	CEV	
S240GP	1.0021	0,17	1,40	-	0,040	0,040	0,012	0,5 <mark>5</mark>	-	0,35	
S270GP	1.0023	0,18	1 <u>,</u> 50	-	0,040	0,040	0,012	0,55	-	0.10	
S320GP	1.0046	0,20 d	1,60	0,55	0,040	0,040	0,012	0,55	-	-9.47	
S355GP	1.0083	0,20 ^d	1,60	0,55	0,040	0,040	0,012	0,55	-	5.47	
S390GP	1.0522	0,20 d	1,70	0,55	0,035	0,035	0,012	0,55	-	0,45	
S430GP	1.0523	0,20 d	1,70	0,55	0,035	0,035	0,012	0,55	-	9.39	
S460GP	1.9524	0,20 ^d	1,70	0,55	0,035	0,035	0,012	0,55	-	0,25	
S500GP	1.9525	0,20 d	1,70	0,55	0,035	0,035	0,012	0,55	-	6,49	

^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.

° If other elements are added, they shall be mentioned in the inspection document.

 $^{\rm d}$ For nominal thickness > 30 mm: C = 0,22 % max.

* 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.



Main changes

rable 5 — Mechanical properties for not roned steer sneet pres "										
Design	ation	Minimum yield strength	Minimum tensile strength	Minimum elongation on a gauge length of	Minimum im	pact energy ^b				
				$L_0 = 5,65\sqrt{S_0}$	KV2					
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				
\$430CP	1.0523	430	510	19	0	27				
S460GP	1.9524	460	530	17	0	27				
S500GP	1.9525	500	580	15	0	27				

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

^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.



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





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



Key

С

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

Figure D.1 — Specimen for compression test

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







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.





Thank you for your attention



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