Low Carbon Steel
In Underground Projects

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Underground car park in Aalst, Belgium

Introduction

- Sustainability is an increasingly important design parameter
- Global goal for carbon neutrality -
- engineers shall consider the **environmental impact** of new structures and develop a method to determine the most *sustainable* solution ⇒ not always the low-priced solution.

- How can a sustainability be increased?
  - What is the state of the art?
  - Sustainable steel solutions
- How can sustainability of solutions be measured and compared?
  - How is this reconciled with other decision factors such as cost?
- Can steel provide a sustainable underground structure?

Sustainability

sustainable solutions will be achieved by:

- **Reducing** required quantities of natural resources
- **Reusing** some elements
- **Recycling**

Reduce - steel sheet pile required for retaining walls **by more than 50%** over the last 50 years

- use of higher *yield strength* steel and lower corrosion steels
- optimized *shapes* of sheet piles,
- better soil models and methods for the geotechnical design,
- Better installation methods

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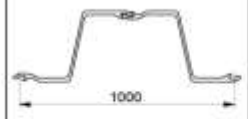
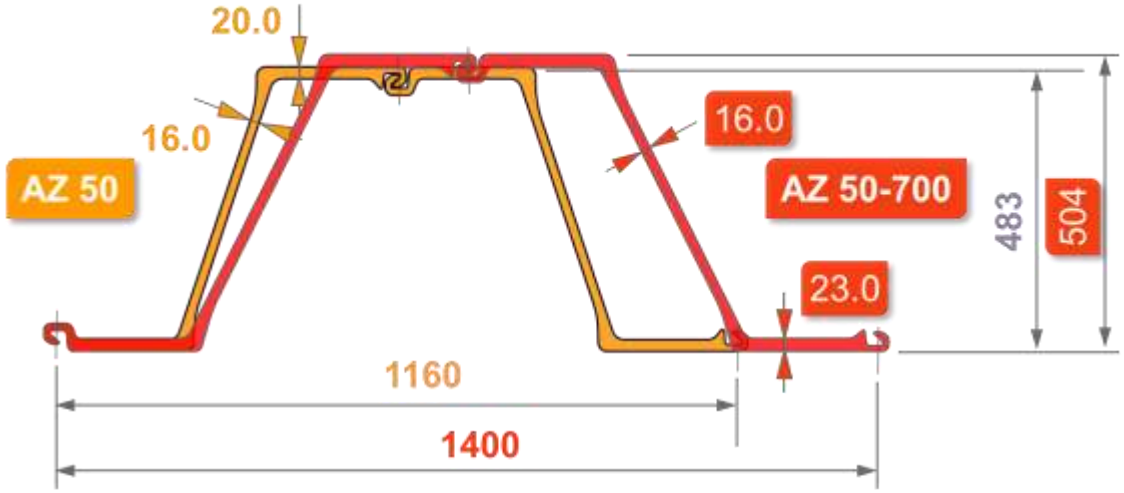
Reduce

Type	RANSOME 1911	BZ 1933	AZ 1990	AZ - 700 2004
Z				
Type	**TERRE-ROUGE 1912**	**LARSSEN 1914**	**PU 1988**	**AU 2000**
U				



	AZ 50	AZ 50-700
W_x (cm³/m)	5 015	4 955
mass (kg/m²)	252.9	**237.5**
Δmass (%)	0	**-6.1%**

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Reuse

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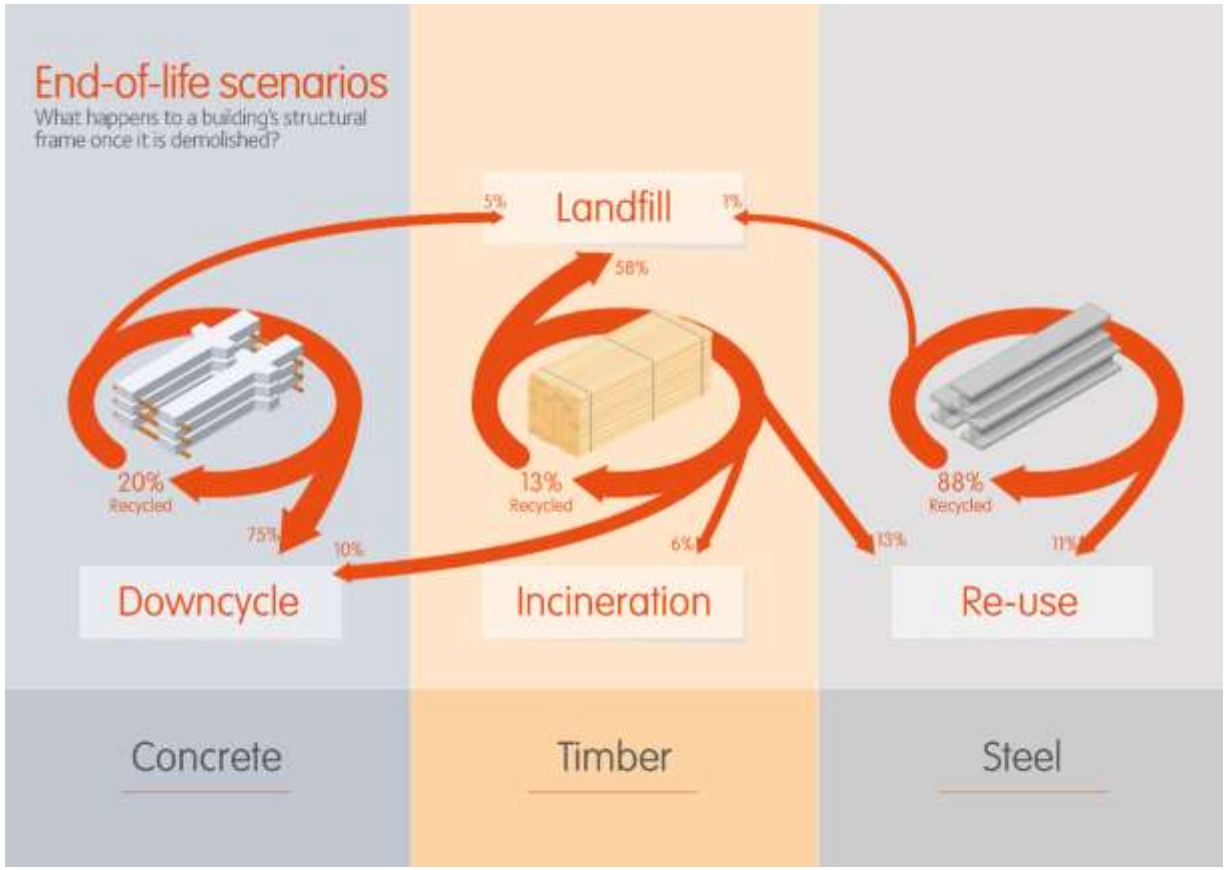
Recycle



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Recycled Steel

EcoSheetPile™ Plus

100% Recycled Recyclable
Reusable | Renewably produced

Responsible™ Steel | standards & certification

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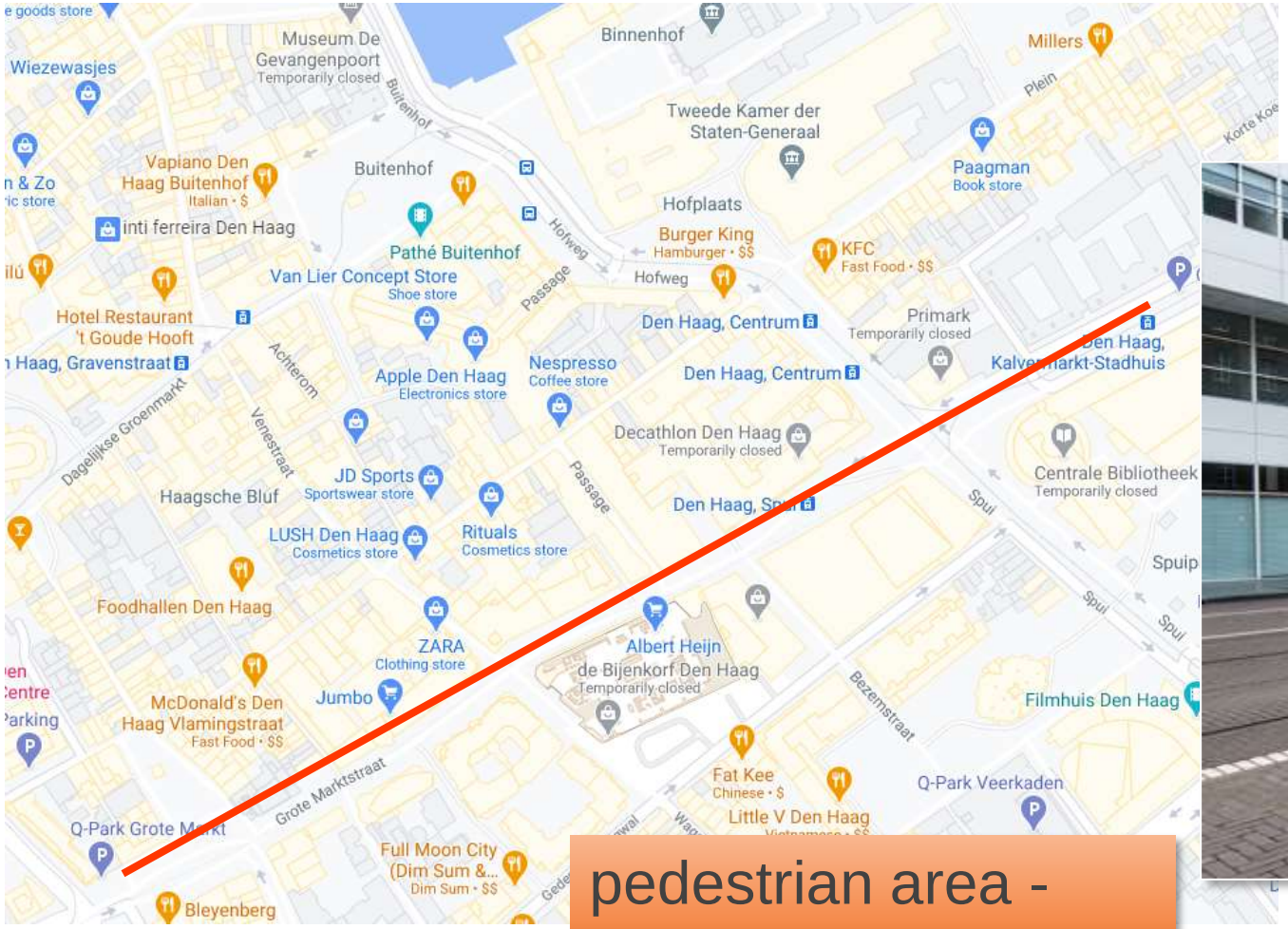
Den Haag – Grote Markt



pedestrian area - downtown

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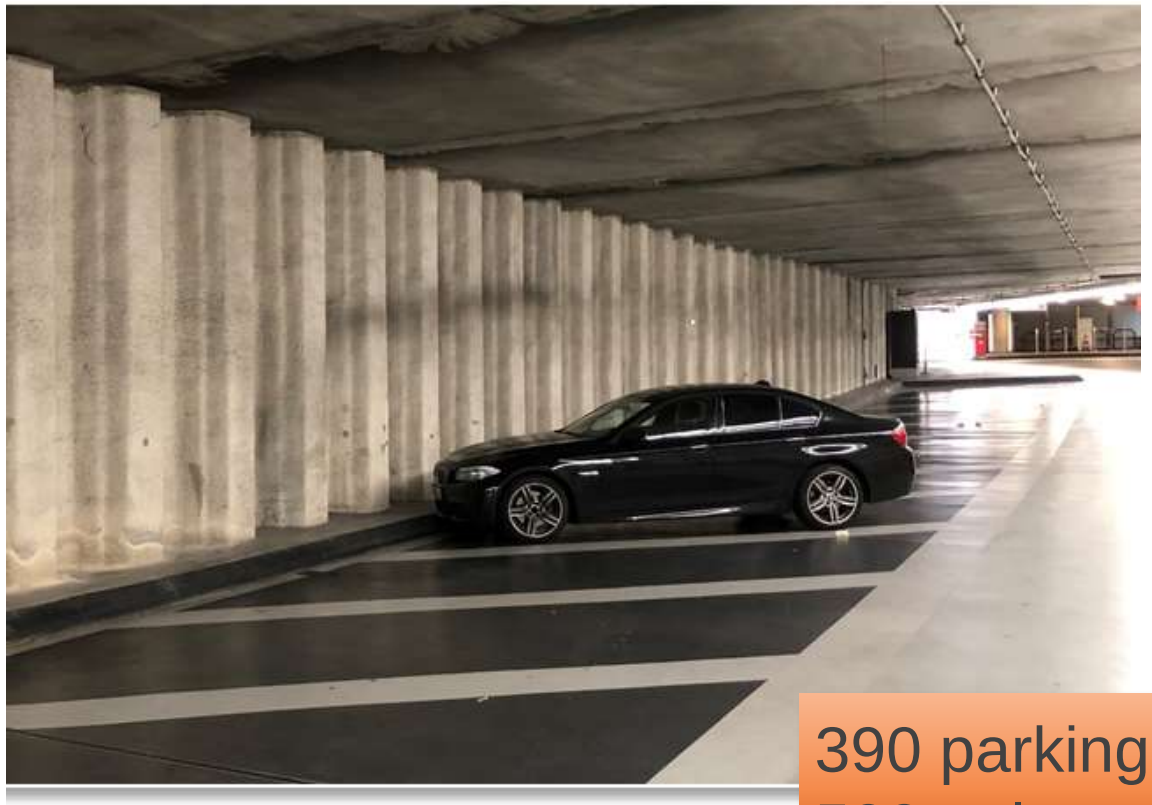
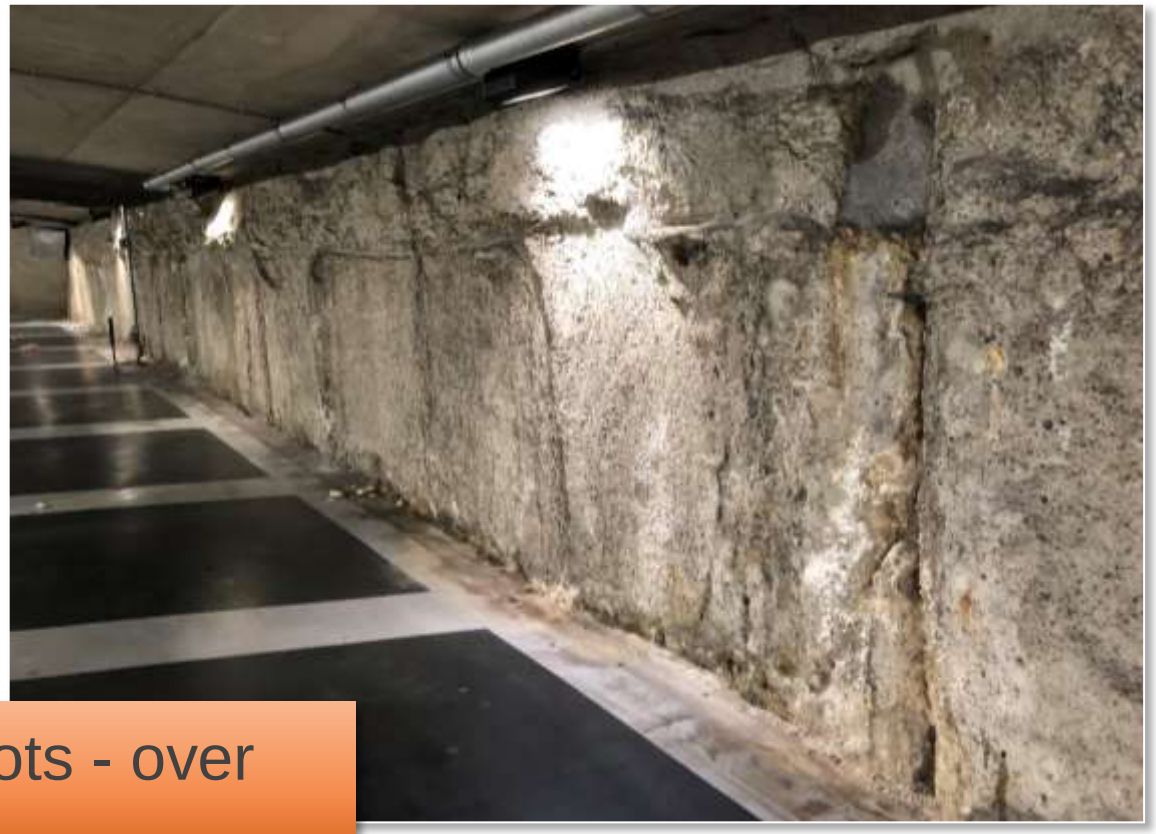
Den Haag – Grote Markt

Steel sheet piles



Slurry wall



390 parking spots - over 500 m long

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Market study on UCPs - Royal HaskoningDHV (NL – 2018) – focus on Dutch practice

Technical aspects

- design
- settlements
- watertightness
- fire safety
- vertical bearing capacity
- durability
- execution method
- …

Financial (cost)

- price
- speed of execution
- ROI

Environmental criteria

- CO_2-eq
- water consumption
- …

ROI – Return On Investment

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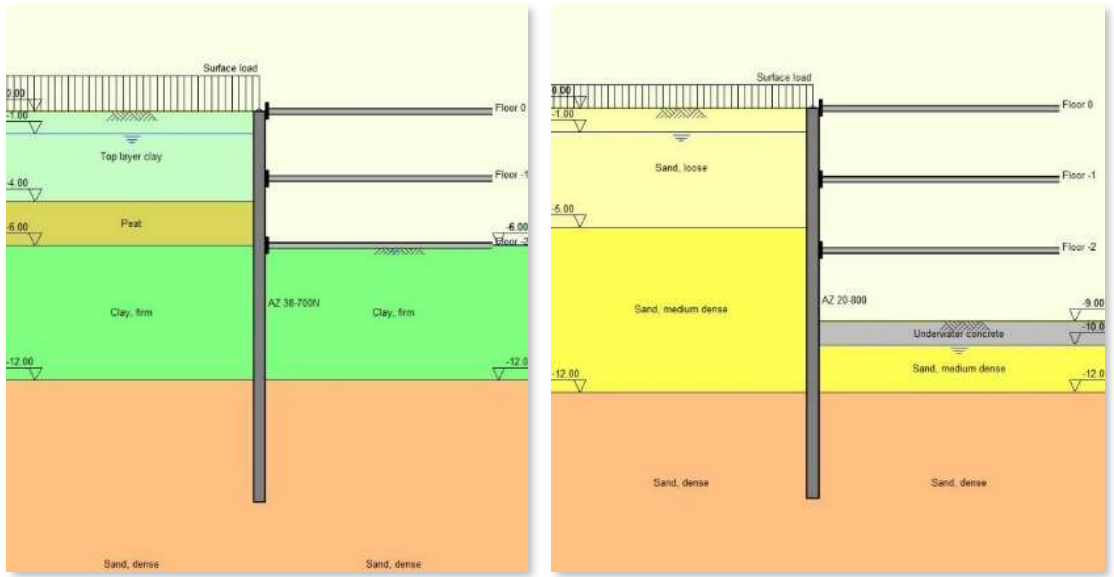
Market study on UCPs - Royal HaskoningDHV (NL – 2018) – focus on Dutch practice



- analysis of current practice
  - design, software, installation, risks,…
- comparison at higher level of alternative solutions - costs & installation
  - steel sheet piles,
  - secant piles,
  - slurry walls,
  - cutter soil mix (CSM) walls.
- 2 & 3 level carparks
- 2 typical soil conditions

Report from Royal Haskoning DHV "BF7258TPRP1812111356“ from 19/12/2018:
GUIDE BOOK: ‘Steel Sheet Piles for Underground Parking Facilities’

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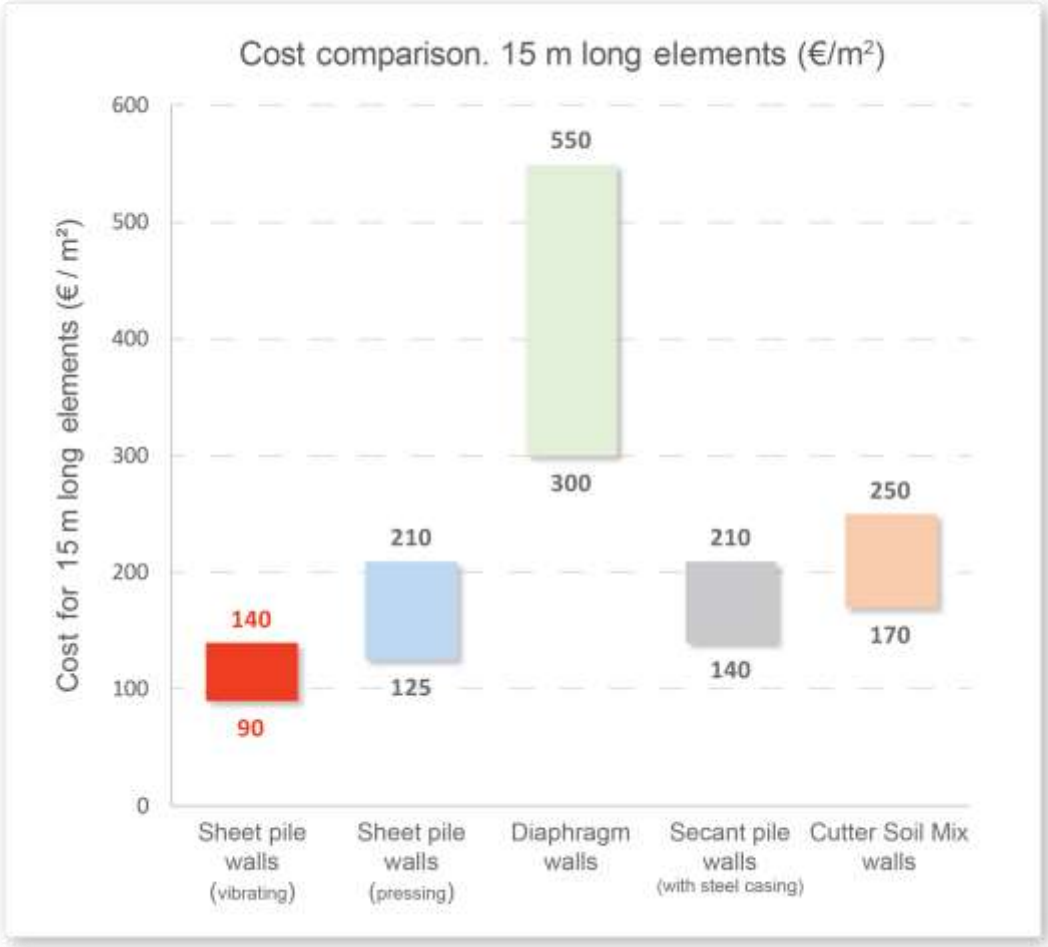
Market study on UCPs - Royal HaskoningDHV (NL – 2018) – focus on Dutch practice



installation of the steel sheet pile wall

2x faster

than secant pile wall

Base:
Guide book "BF7258TPRP1812111356“
Royal Haskoning DHV
19/12/2018

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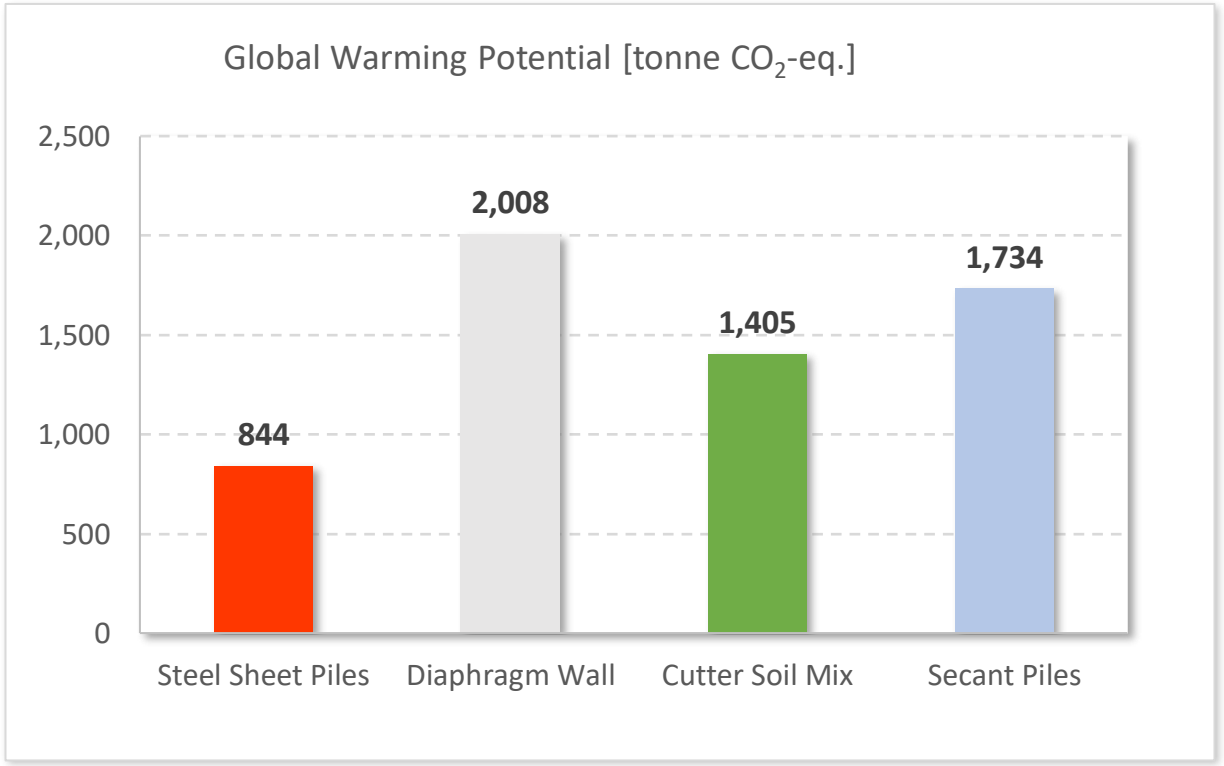
Comparison study by Witteven & Bos | NL (2020)

in-depth comparison of 4 alternatives – same 3 key indicators



LCA report by ArcelorMittal R&D – June 2020

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Determination Method
Dutch approach

Dutch approach

• consider **financial, environmental and social criteria** to choose the *most economically advantageous tender* (European directive 2014/24/EU)

Environmental criteria

• monetized (*shadow pricing method*) – 11 indicators

– ex. 1 t CO_2-eq = 50 €

• uses thresholds (min – max amount)

• based on “Dutch” EPDs (Environmental Product Declaration) or generic data from Dutch database (penalization of 30%)

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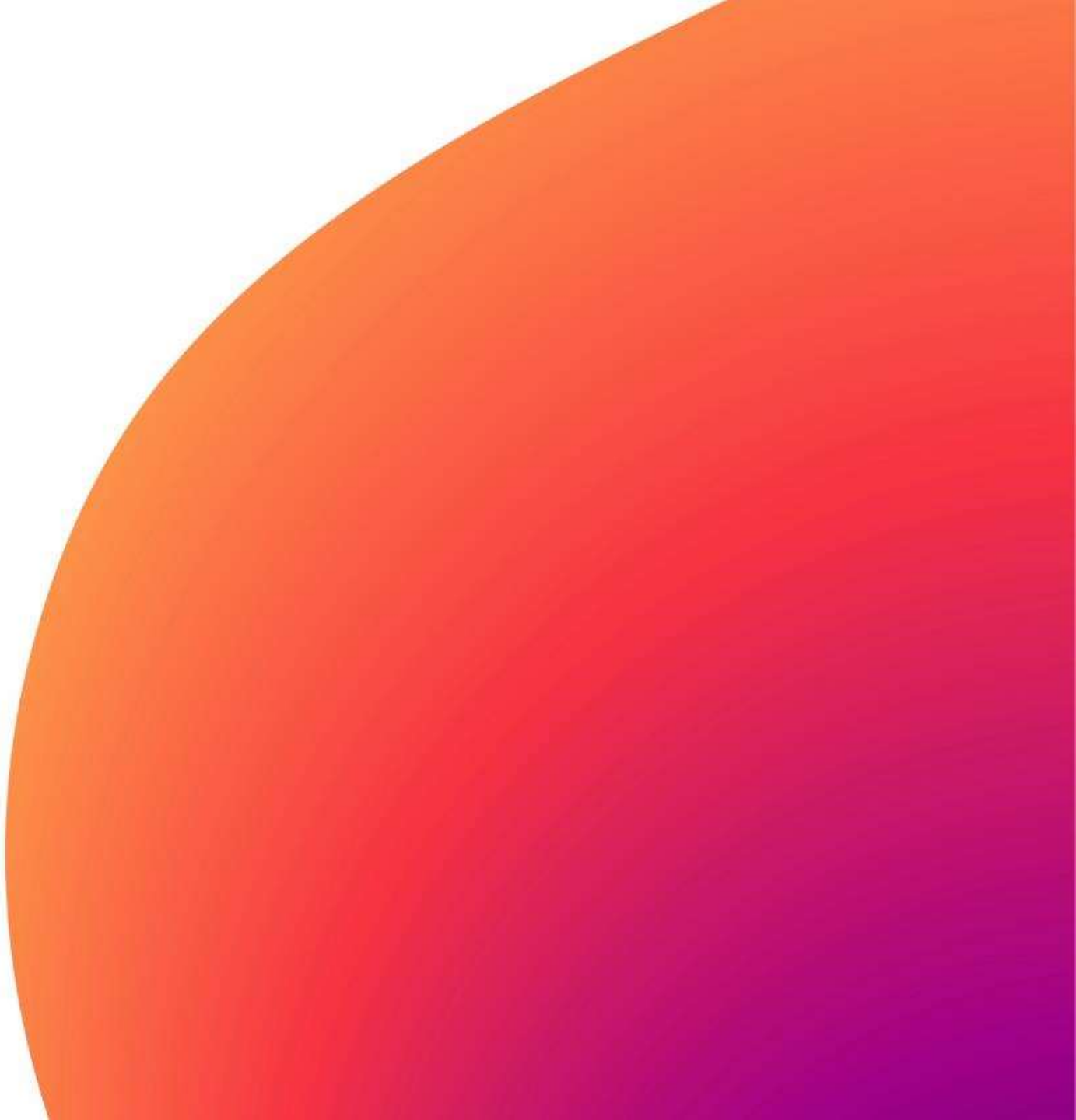
Not just sheet piles…



Parking Markthal | Rotterdam | NL

- 1,040 parking spaces
- 4 levels

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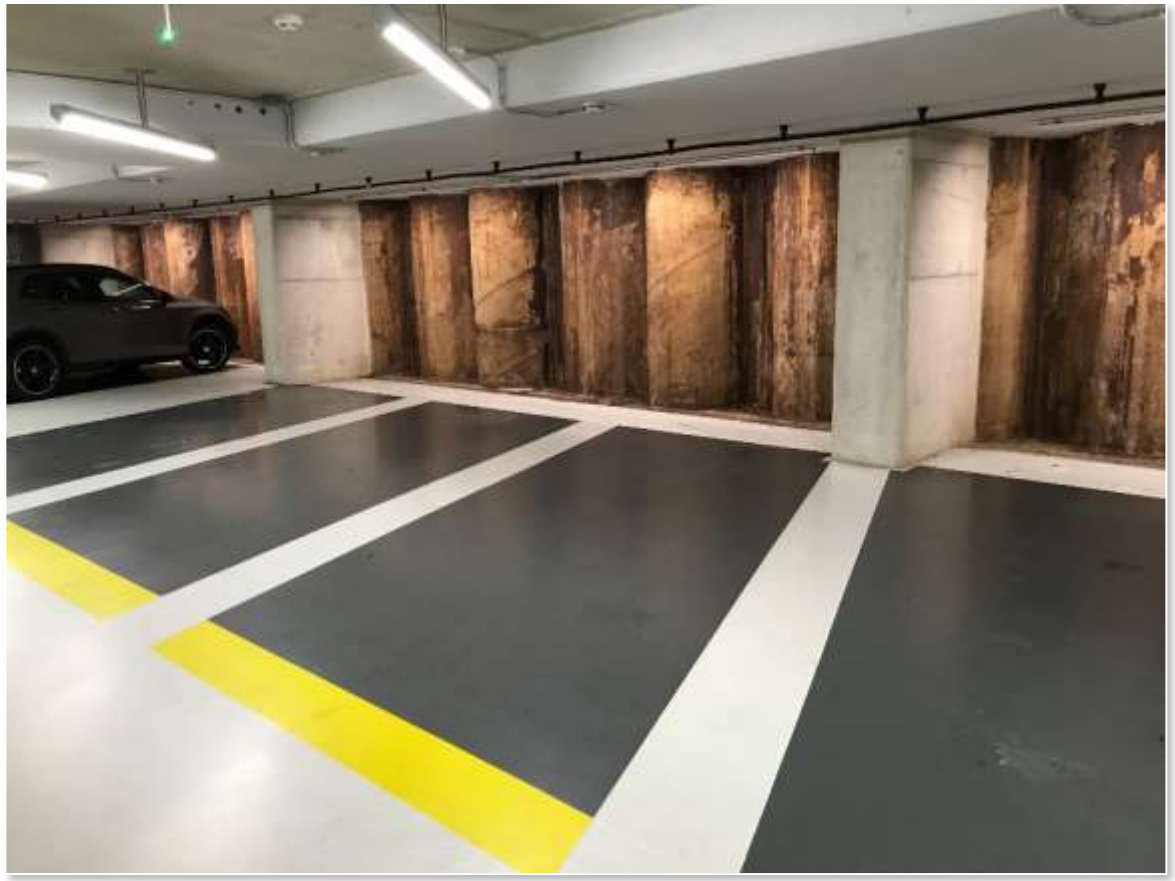
Parking Markthal | Rotterdam | NL



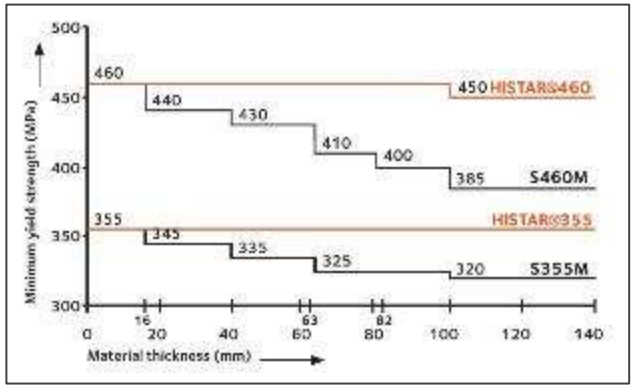
Bearing Pile and Plunge Columns

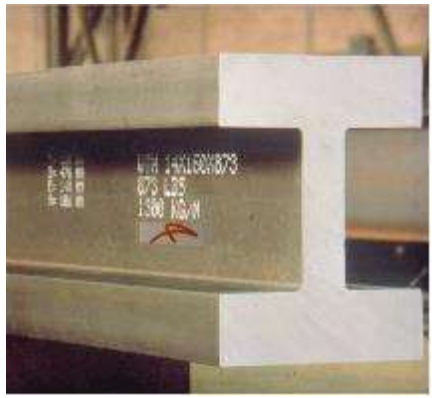
Bearing Piles (UBP) are a special “UC type” section where the flange and web have the same thickness.
Benefits include,

- Control of bearing capacity by measurement of refusal at driving,
- No limits to lengths, can be driven at close centres,
- Immediate load bearing after driving.
- Tend to be light weight (by comparison with plunge columns)
  - Available up to UBP 305 x 305 x 223

Plunge Columns – any rolled section thereby enabling greater capacity in basement and top down construction

- Sizes available up to UC 356 x 406 x **1299** and UB 920 x 420 x **1377**.
- Available in Histar 460 and XCarb Recycled and renewably produced (EPD = 333 kgCO2e/t, A1-A3).





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Orange Book gives
Histar 460 capacities

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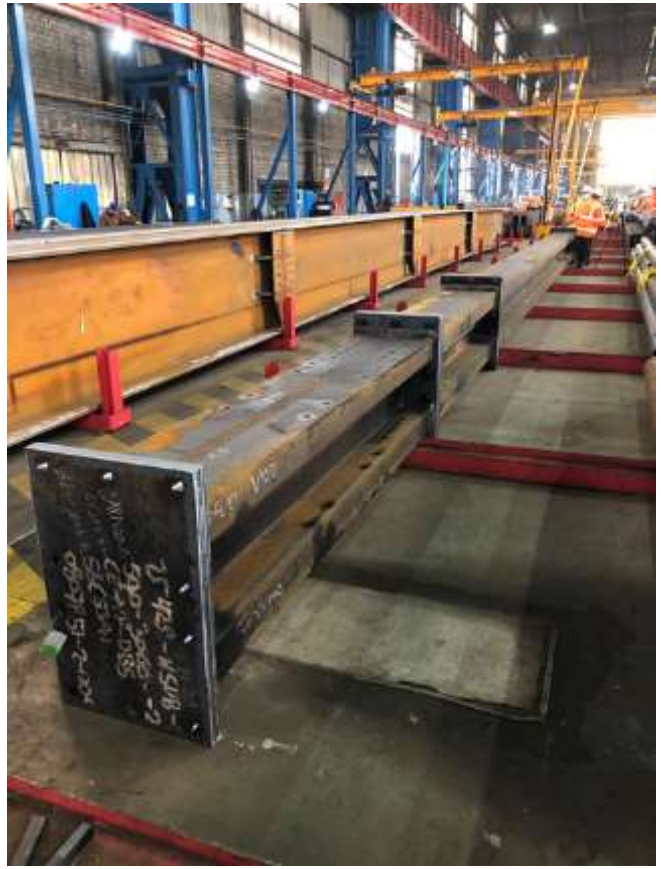
Plunge Columns

Station at Stade de France, Paris.



Sizes uti HD 400 x 1299
(UC 356 x 406 x 1399)

Fabricated at Steligence Fabrication Centre (SFC) Luxembourg.

Conclusions

- Sustainability is an increasingly important design parameter
- Global goal for carbon neutrality
- How to consider the **environmental impact** of new structures
  - a method to determine the most *sustainable* solution ⇒ not always the low-priced solution.
- Increasing sustainability
  - What is the state of the art?
  - Sustainable steel solutions
- steel can provide a sustainable underground structure