

## ENHANCING SAFETY – Sheet Piling in Hydraulic Engineering

**Presenter: Ali Rasha**

**Firm : ArcelorMittal Projects**

**Country: Luxembourg`**



# ArcelorMittal

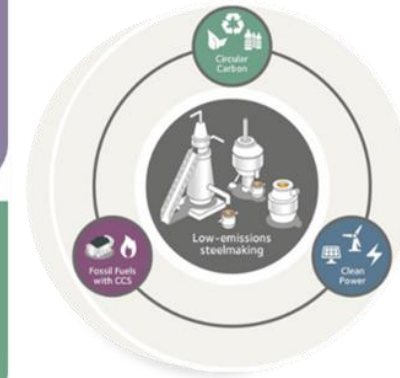


## Global R&D – facts & figures 2020



## Our commitment to sustainability

Making carbon neutral steel



- As the world's leading steel company, we are committed to the objectives of the Paris Agreement.
- Our target in Europe is to reduce our CO2 emissions by 30% by 2030 over 2018.
- Across our global portfolio our ambition is to significantly reduce our carbon footprint and to promote a sustainable & circular economy.

# ArcelorMittal Projects



ArcelorMittal Projects operates as a **global** one-stop solution shop.



We provide **complete, customized, safe** and **sustainable** steel solutions and services via 3 specialized and project related business lines:

- ❖ Energy Projects
- ❖ Foundation Solutions
- ❖ Solar Projects & Processing



We combine **regional presence** and knowledge with our **worldwide sources** and skills.



We believe that our customers benefit from **long-term partnerships**, the driving force of our business.

### Foundations Solutions

Efficient, cost effective & innovative foundation solutions for port, road and railway infrastructure, river and canal embankment and earth/ water retention.



All our solutions are supported by in house technical engineering based in Europe



## ArcelorMittal Projects Near East

...dedicated to Foundations Solutions

**PRODUCT RANGE**

<p><b>Hot Rolled Steel Sheet Piles</b></p> <ul style="list-style-type: none"> <li>NEW PRODUCTION</li> <li>STOCK (NEW &amp; USED)</li> </ul>	
<p><b>Tubular Pipes</b></p> <ul style="list-style-type: none"> <li>NEW PRODUCTION</li> <li>STOCK (NEW &amp; USED)</li> <li>ALL FOUNDATION TYPES</li> </ul>	
<p><b>Anchor Material &amp; Accessories</b></p> <ul style="list-style-type: none"> <li>TAILORED TO MATCH SPECIFIC SOLUTION</li> </ul>	

**TAILOR-MADE PACKAGE SOLUTIONS**

**Bending Resistant**

U - section

Z - section

Combined Walls

Tubular Pipe / AZ

**Gravity Structure: Resisting by interlock tension**

**Straight Web Sheet Piles AS500 Circular Cells**

- gravity structure
- deep wharfs, quays, breakwaters, cofferdams
- structures founded on rock
- no anchors

$M_{max} = S_y \cdot \sigma_y$

$T = p_z \cdot R$

**Hazards & Solutions**

**Environmental protection solutions**

Steel sheet piles are used as temporary and permanent retaining walls for landfill conversion, polluted soil remediation, needed clearing operations and pollution containment. Sealing solutions like AKILA® ensure the retaining walls are impervious, while suitable for contact with groundwater. Enclosures retaining contaminated soils can be created over leader with the unique 800 mm wide AZ-600 steel sheet piles. ArcelorMittal EcoSheetPiles™ have 55% less carbon footprint than steel sheet piles from other producers. EcoSheetPiles are the ideal solution to reduce the environmental impact of all retaining walls.

*Environmental Product Declaration by Sustainable Development (EPD) based on a life cycle analysis with lifecycle for each steel sheet pile.*

When faced with pollution risks, containment is vital

Fish pens at Sausserhorn power dam on river Rhine, France, allowing the restoration of the migration path of several fish and wildlife species. © Jean Robert

**Mobility infrastructure solutions**

Composite bridges with steel sheet pile abutments have up to 10% shorter construction time and up to 15% less economic impact on the community throughout their service life. The use of steel sheet piles on load-bearing impervious permanent retaining walls in underground car parks maximizes the available surface inside the building. Permanent steel sheet pile walls in underground car parks of 2 to 3 levels are up to 50% more cost-effective than alternative materials, with significantly shorter execution time. Silent and low vibration installation techniques minimize disruption in urban settings. Steel sheet piles can be reused several times and are recyclable, reducing the global environmental impact of projects.

*Study by Kuehner Institut für Technologie (KI), Germany (2019)*  
*Study by Dierig Technology (DT), Switzerland (2018)*

Efficient and reliable mobility infrastructures make your journey smoother and safer

Underground car park with permanent steel sheet pile walls at Maprock shopping center, Antwerp, Belgium

**Hazard protection solutions**

Dykes, flood and erosion protection barriers made with steel sheet piles are one of the most efficient ways of protecting against floods and rising sea levels. The design of reinforcements and upgrades of existing flood protection barriers with steel sheet piles can be optimized to bring potential savings of up to 30-40%. Requiring little equipment and manpower, steel sheet piles can be quickly installed with guaranteed quality, even in remote locations. AZ® 600 the widest sheet piles on the market, allow up to 14% less installation time. Inward on-site detaching detectors and AKILA® sensors ensure the integrity and imperviousness of the structures.

*Steel sheet pile wall, regularly inspected with AKILA® (www.arcormittal.com)*

Steel sheet piling solutions help safeguard our communities from natural disasters

Flood protection barrier protecting the city of St-Pierre de Gorbet, France

**Water transport solutions**

Build sustainable and durable maritime port and waterway infrastructures with our steel solutions. Quay walls made with steel sheet piles allow up to 20% faster construction and 15% lower cost\* when compared with alternative materials. Steel is also the material of choice for breakwaters, dolphins, locks and canals. The lifetime return on investment of ports built with ArcelorMittal AZ® steel sheet piles exceeds by 8% the financial result brought by concrete solutions. AMUCore® steel grades are up to 5 times more corrosion-resistant than standard steel grades, allowing optimized designs with service life of up to 100 years.

A specific Environmental Product Declaration based on comprehensive Life Cycle Analysis is available for ArcelorMittal steel sheet piles and EcoSheetPiles™ made of 100% recycled steel. With the natural ductility of steel, sheet piling solutions in conjunction with modern performance based design methods help design and optimise safe ports in seismic areas.

*\*Results from a study by Techint, Belgium (2015)*

Water based transport is essential to our global economy

Ship lock on river Main at Ebersheim, Germany

**Design software AMRetain™**

**Further support:** Local presence, After-Sales Service during installation, site visit, confcalls, to keep project in safe zone..



Excellent performance of sheet piles under earthquake loading

Steel sheet piles are widely used for the construction of a variety of structures: quay walls and breakwaters in harbours, bank reinforcements on rivers and canals, urban infrastructures such as underpasses, as well as global hazard protection schemes. Sheet piles are also used in seismic areas and have shown their good performance when undergoing an earthquake.

Chile is the country that suffered the biggest earthquakes in recorded history, of which the 8.8 magnitude Maule earthquake that hit the Pacific coast in 2010. Many of the earthquakes that hit Chile in the last decade caused severe damages to the concrete-based ports of the country. Port of Mejillones, that was constructed in 2003 using the HZ/AZ combined wall for the quay wall and AS 500 straight web sheet piles for the breakwater, suffered no damages throughout many heavy earthquakes with magnitude of up to 7.7. All the involved parties in this project (Port authority, consultant, contractor and technical university) agreed that this port is a perfect example of the effectiveness of flexible sheet pile structures under extreme seismic conditions.

Although steel sheet piles provide their performance under earthquake loading, a reluctance to use sheet piles in seismic areas remains among some designers. This concern may come from their experience of conventional design methods which do not favour flexible walls in seismic conditions. These design methods usually comprise of pseudo-static calculations using the Mononobe-Okabe theory (1931), based on the under-revision Eurocode EN 1998-5.

Seismic Design Brochure

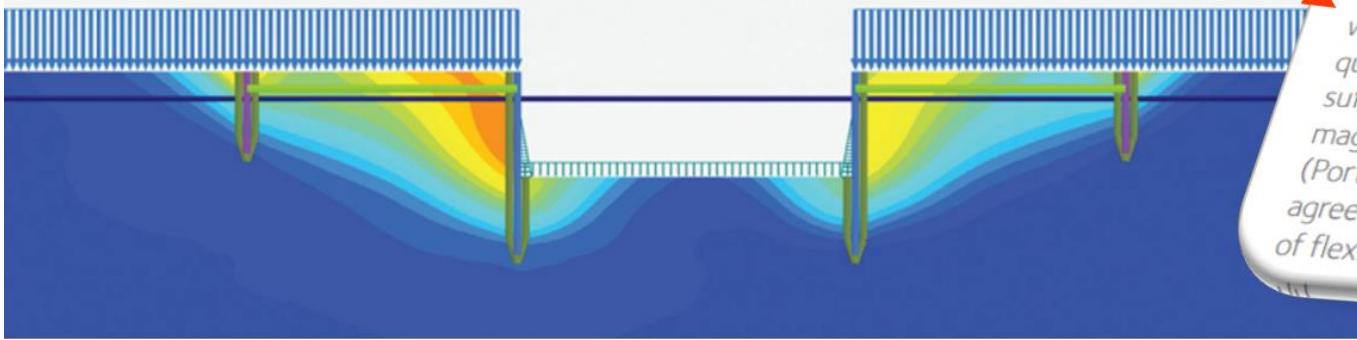
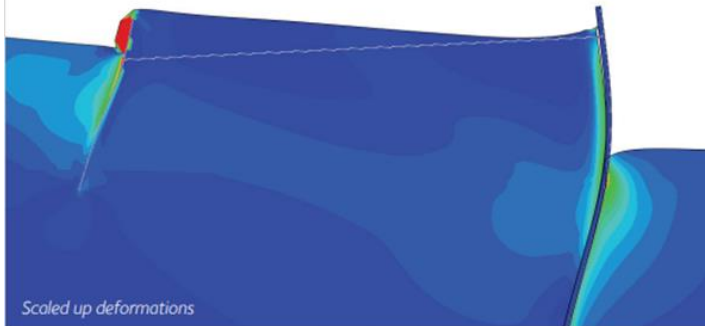
For more information on the seismic design of sheet piles, a more comprehensive brochure provides a guideline for the dynamic design of sheet piles using Finite Element Modelling (FEM). It highlights the different aspects to be considered: model geometry, seismic motion, hydrodynamic loads.

This brochure also gives detailed information on the comparative study presented in this flyer: assumptions, study cases, procedure, results and conclusions.

Technical experts are also available to assist you with the dynamic design of sheet piles using FEM.

"The wind does not break the tree that bends"

Tanzanian proverb



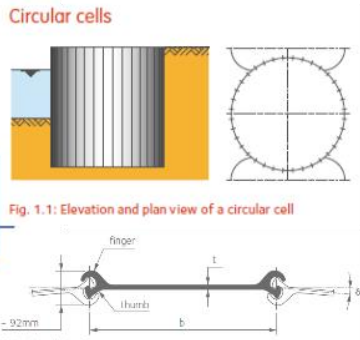
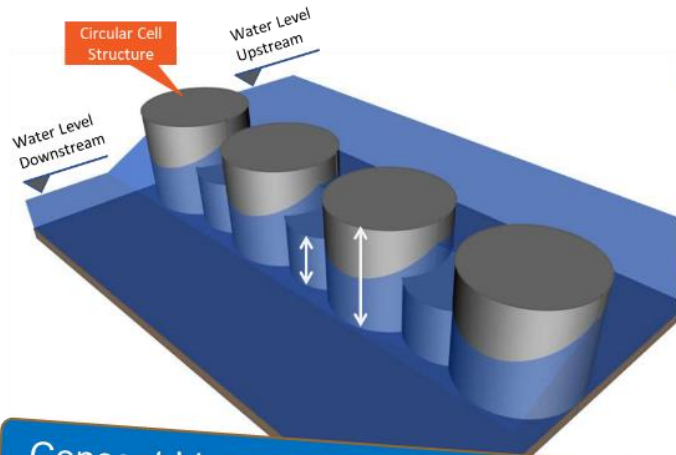
Steel is a highly ductile construction material which allows for major deformations before failure. This mechanism provides significant reserves for extreme load cases such as earthquake events!

their good performance when undergoing an earthquake. Chile is the country that suffered the biggest earthquakes in recorded history, of which the 8.8 magnitude Maule earthquake that hit the Pacific coast in 2010. Many of the earthquakes that hit Chile in the last decade caused severe damages to the concrete-based ports of the country. Port of Mejillones, that was constructed in 2003 using the HZ/AZ combined wall for the quay wall and AS 500 straight web sheet piles for the breakwater, suffered no damages throughout many heavy earthquakes with magnitude of up to 7.7. All the involved parties in this project (Port authority, consultant, contractor and technical university) agreed that this port is a perfect example of the effectiveness of flexible sheet pile structures under extreme seismic conditions.

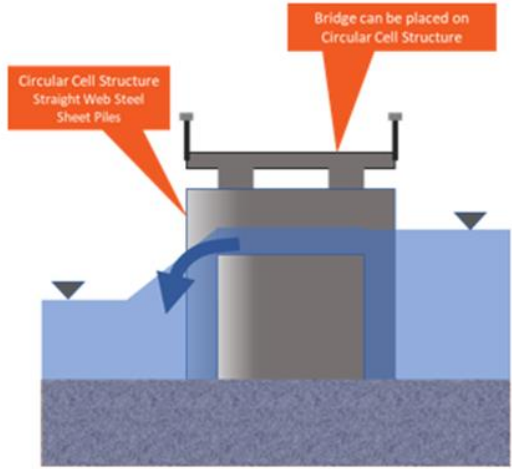


# Straight Web Steel Sheet Piling

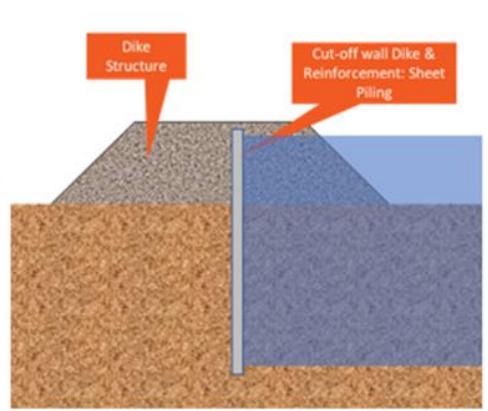
Quay Walls, Cofferdams, Breakwaters, Barrages, Lock Structures, Bridge Abutments, Dikes, ...



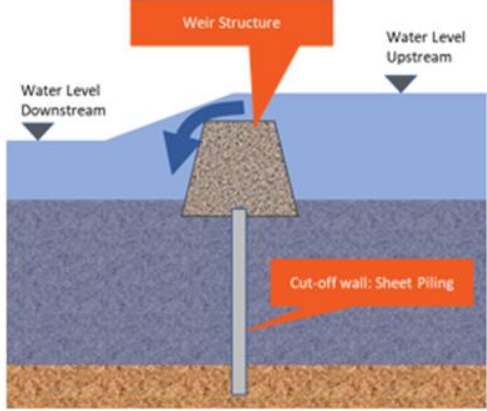
Concept Ideas for Barrages & Dikes



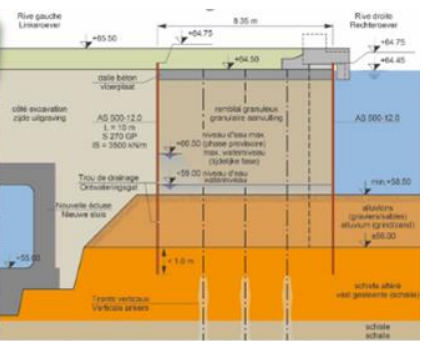
Circular Cells on impermeable soil



Reinforcement of existing earthen dikes/dams & "cut-off wall"



Concrete structure on permeable soils with "Sheet Pile "cut-off wall"





# Applications



## Waterfront structures



Quay walls



Jetties



Flood walls



Dolphins



Breakwaters



Dike reinforcements

## Underground construction



Building pits



Cofferdams



Underground car parks



Deep foundations



# References – Iraq initiative

## Shat Al Arab dam and lock solution





# References

## Hydropower Generation, Guatemala



ArcelorMittal







# References

## Flood Protection Walls



© VolkerStevin | UK



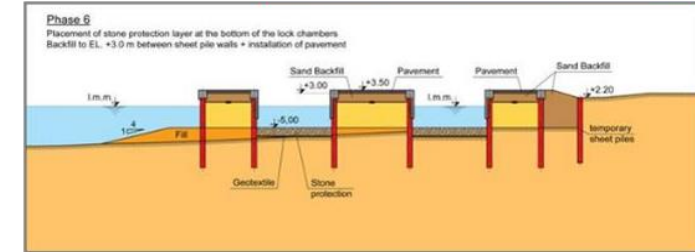
# References

## “M.O.S.E” - Project, Venice, Italy (2004-2009)



## Chioggia Lock Structure

- 120m long \* 16m wide \* 5m deep
- refuge basin
- abt. 14'000tons HZ975D-24 / AZ 26 & HZ975D-C23



## Dry Docks

- min. 10 m depth, to build prefab. concrete caissons; these will be floated to final position (placed between the HZ/AZ)
- after use as dry dock structure is **integrated into final structure** of the locks as a refuge basin / waiting harbour for ships
- regular AZ25 and HZ/AZ combi-walls
- abt 24'400tons



more than **100'000tons** of steel supplied by ArcelorMittal: HZ / AZ, Pipe / AZ, Pipe / PU (with lengths up to 49.00m)



# References

## Aquaduct Veluwemeer Harderwijk, Netherlands





# References



ArcelorMittal

## Underground Car Parks



Mercedes Gent, Belgium



Bristol, UK



Suresnes, France

## Aqueduct Veluwemeer Harderwijk, Netherlands

(1998 - 2002)

### waterway Structure

- 25 m long \* 9m wide \* 3m deep
- Waterway
- Section used AZ





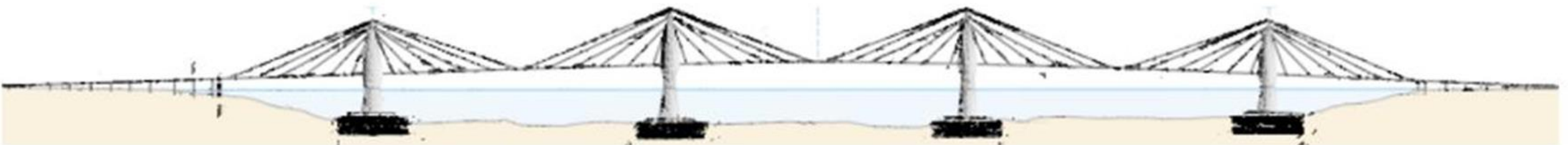
# References



## Rion – Antirion Bridge: Greece



Sheet Pile cofferdam is removed to open dock and swim out concrete bridge column afloat.





# References

## Bridge Piers



Ras Al Khor Bridge, Dubai



Seo-Hae Grand Bridge Korea



# References

## Grand Paris Express - L15 T2A - Strutting systems

(July 2018 – May 2019)



- Customer: Horizon
  - Joint venture Bouygues – Soletanche Bachy
  - Via AMCRPS
- Strutting systems for 3 stations:
  - Créteil l'Échat CLE (3 layers)
  - Les Ardoines ARD (3 layers)
  - Vitry Centre VIC (4 layers) (10 layers)
- Steel products: total **± 3300 ton** :
  - Tubes ± 2000 ton
  - Beams ± 650 ton
  - Plate material ± 650 ton
- Redesign in stock tubes (used and new)
- Including full prefabrication in struts and walings





# References

## Water Treatment Plant



Sewage Treatment Plant, Germany

- ✓ Sheet Piles for vertical support during excavation
- ✓ Sheet Piles as permanent perimeter wall of the structure
- ✓ HP-Piles prevent hydraulic uplift of the concrete slab



Spandau Lock, Germany

- ✓ Water tightness
- ✓ Reliable interlock
- ✓ Driveability
- ✓ Defined corner pile layout
- ✓ Corner Sections: C9, C14, Delta 13 & Omega 18







# References

## Underground Car Parks



Scheweningen, Netherlands



Mercedes Gent, Belgium



Delft, Netherlands



Bristol, UK



Suresnes, France



# Thank you for listening

We as **ArcelorMittal projects** are here **in Iraq** to support and develop infrastructure projects.

ArcelorMittal Projects

Iraq

Contact details:

Ali Rasha

**M:** +9637701587601

**E:** [ali.salahuddin@arcelormittal.com](mailto:ali.salahuddin@arcelormittal.com)