



# Dam foundation and cut off walls with Casagrande Hydromills

Authors: ing. G.Michelazzo, M.Rossit  
Casagrande S.p.a.  
Italy



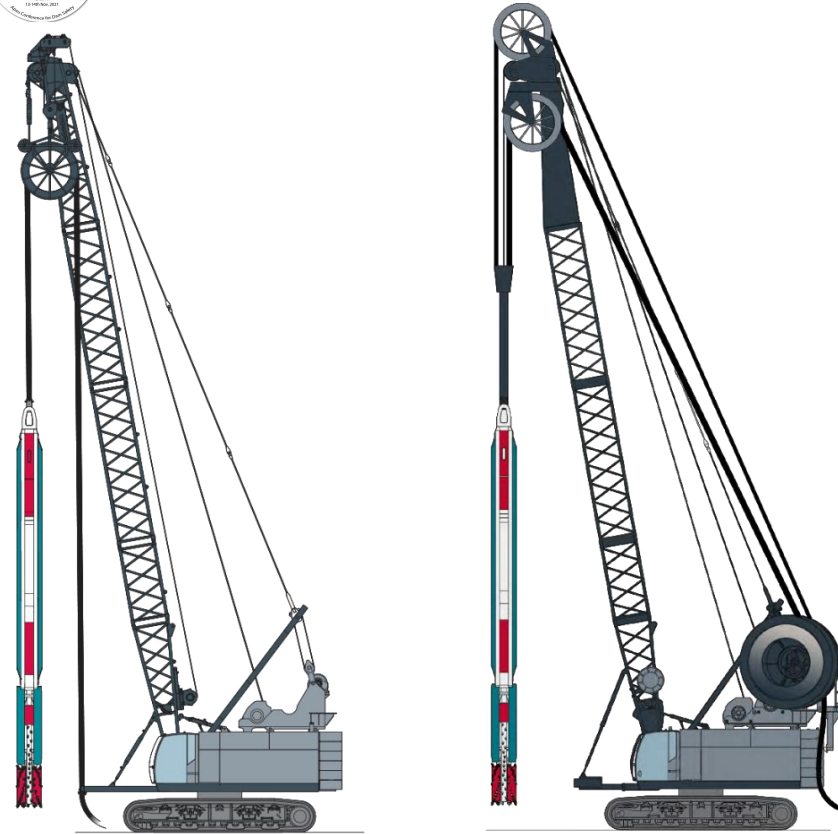


casagrande



# HYDROMILL FD70 on B470 xp-2

## Lattice boom arrangement



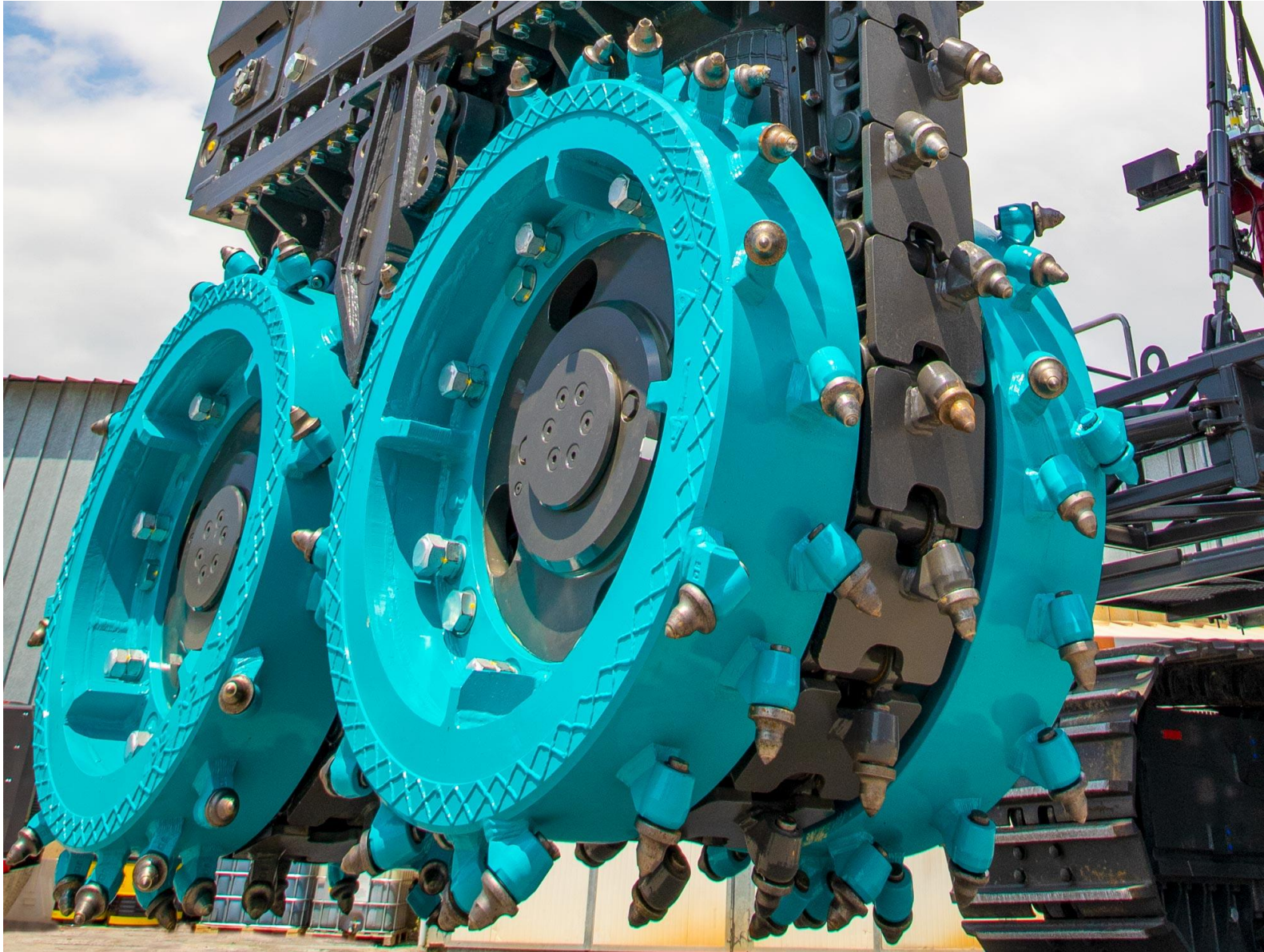
Hose tensioning system	Winches	Hose reels
<b>Depth</b>	<b>50 m</b>	<b>100 m – 120 m as option</b>
Boom length	30 m	27 m
Approx. Weight	180 t	190 t
Installed power	522 kW (Stage IIIA) / 563 kW (Stage V)	



# HYDROMILL FD70 on B470 xp-2

Lattice boom arrangement

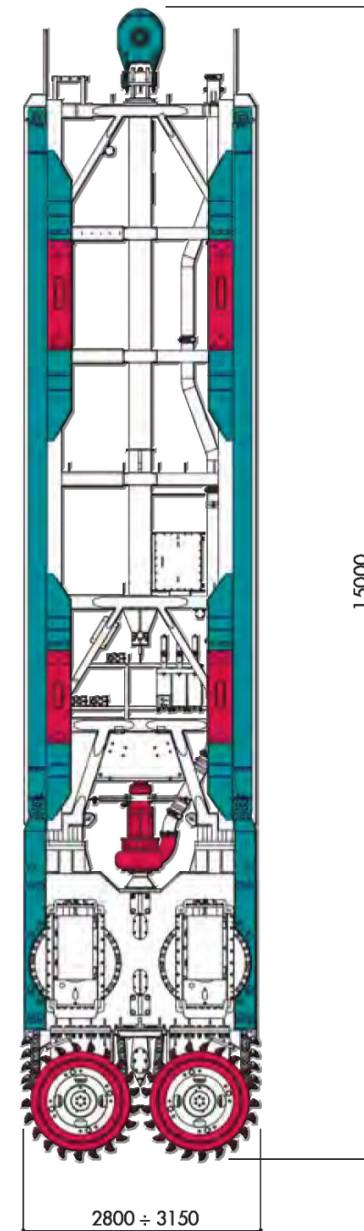






# HYDROMILL FD70

Length of trench	2800 ÷ 3150 mm
Width of trench	760 ÷ 1500 mm
Torque at wheel axle	2 x 100 kNm
Wheel speed	0 ÷ 30 rpm
Suction pump	450 m <sup>3</sup> /h
Verticality control	X-axis wheels + n°4 steering plates
	Y-axis n°8 steering plates
	Z-axis hydraulic rotation (as option)
Weight	45 ÷ 50 t





# CASE STUDIES

## CASAGRANDE HYDROMILLS





# CASE STUDY

## ➔ K3L HYDROMILL

REHABILITATION OF PAPAN DAM

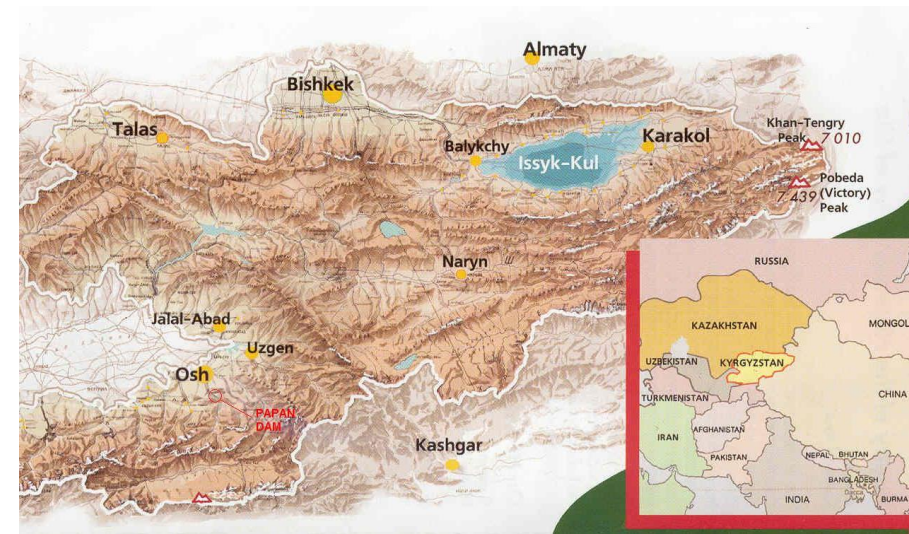
KYRGYZSTAN

2004





<p><b>Case study</b></p>	<p><b>K3L Hydromill Rehabilitation of Papan Dam, Kyrgyzstan, 2004</b></p>
<p><i>Project description</i></p>	<p>Construction of a plastic diaphragm wall through the core of the PAPAN. The dam was completed and impounded in 1975</p>
<p><i>Specialist Subcontractor</i></p>	<p>J.T.M.A. Co. of Iran with offices in 199/31 Tynystanov st, Bishkek, Kyrgyzstan</p>





# CASE STUDY

## ➔ PROJECT QUANTITIES AND GENERAL DATA

Wall excavation: 4254 m<sup>2</sup>  
Wall thickness: 1000 mm (30 in)  
**Wall depth: average 45 m – max 70 m**  
**Wall length: ~ 95 m**

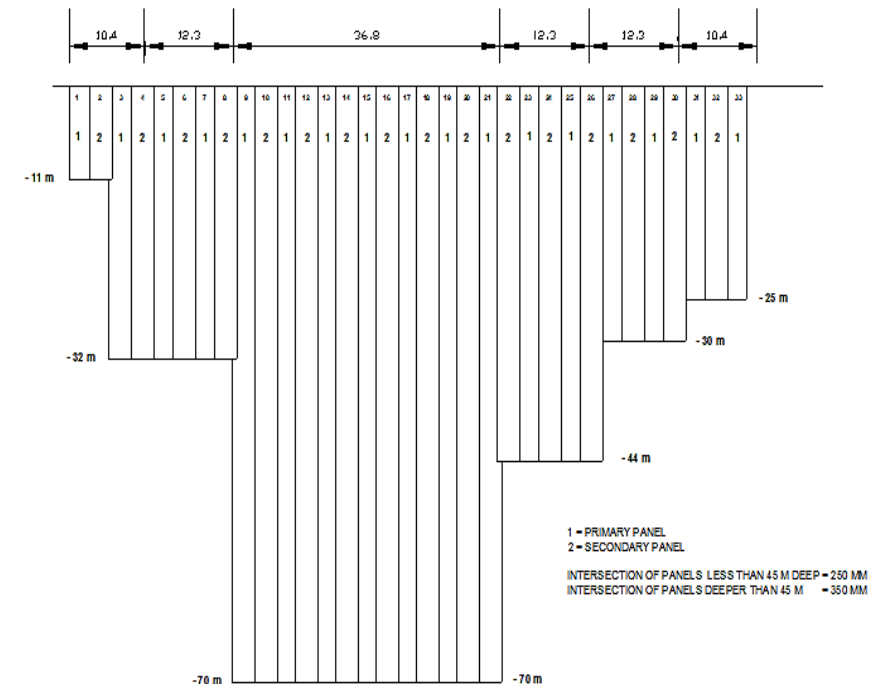
## ➔ PANEL DIMENSIONS

Primary panels: 3150 mm  
Secondary panels: 3150 mm  
Panel joints:  
milling 250 mm of each primary panel to 45 m  
milling 350 mm of each primary panel > 45 m  
Pre-excavation: using excavator up to 5 m

## ➔ GROUND CONDITIONS

0-5 m Dam body fill material, 5-55 m Sand and Gravel, 55-70 m Sand and Gravel – partly cemented, Rock socket

PAPAN DAM - LAYOUT OF PANELS



# CASE STUDY





# CASE STUDY

## ➔ K3L HYDROMILL

MISSISSINEWA LAKE INDIANA

USA

2002-2005





<b>Case study</b>	<b>K3L Hydromill Mississinewa Lake Indiana, USA 2002-2005</b>
<i>Project description</i>	Dam Foundation Remediation Cut Off Wall with Slurry Treching Works
<i>Specialist Subcontractor</i>	BENCOR – PETRIFOND, JV
<i>Owner</i>	U.S. Army Corps of Engineers





# CASE STUDY

## ➤ PROJECT QUANTITIES AND GENERAL DATA

Wall excavation: ~ 40700 m<sup>2</sup>  
Wall thickness: 762 mm (30 in)  
**Wall depth: 45 to 71 m**  
Wall length: ~ 800 m

## ➤ PANEL DIMENSIONS

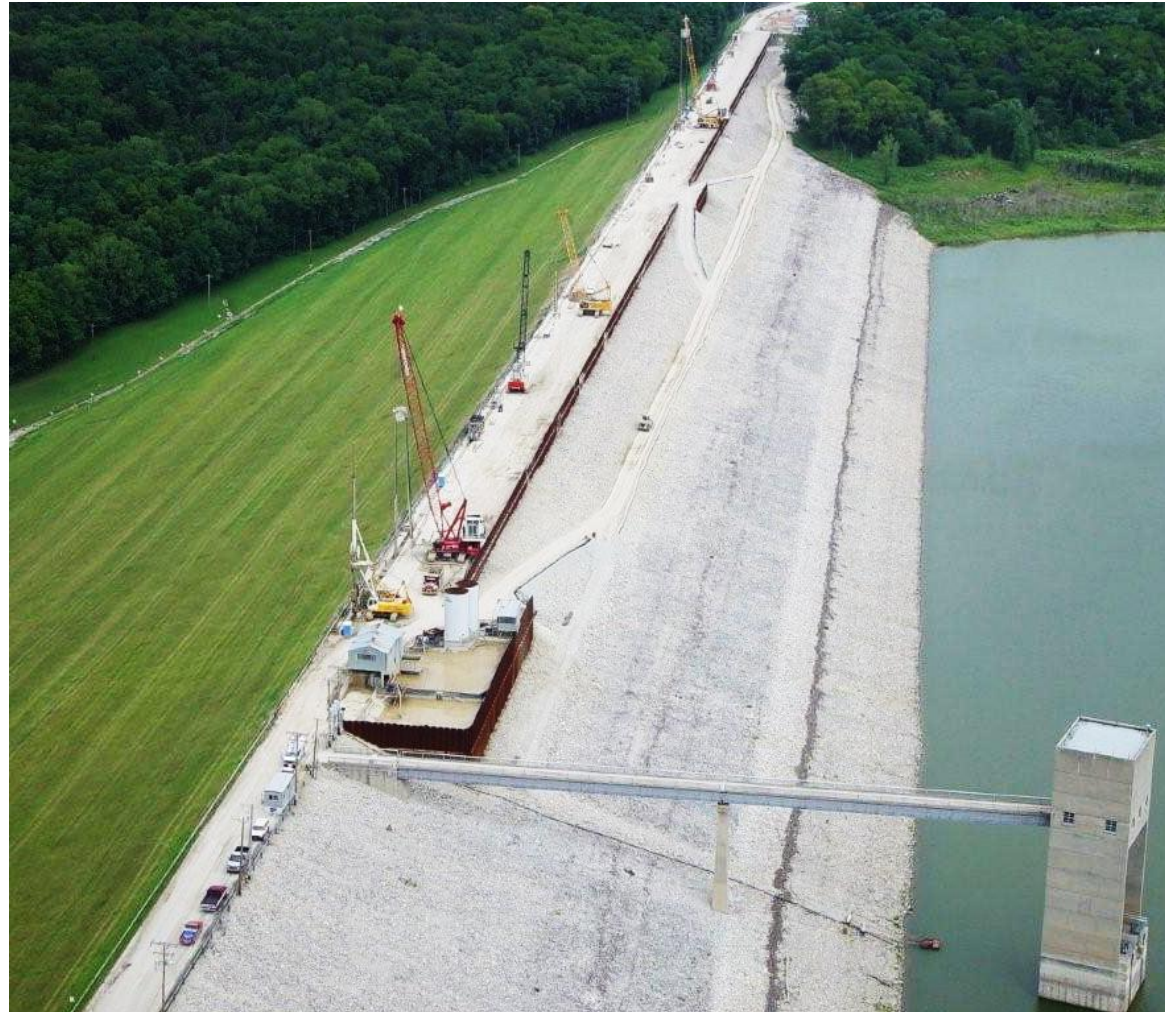
Primary panels: 7600-7900 mm  
Secondary panels: 3200 mm  
Pre-excavation: Using hydraulic clamshell up to 5 m

## ➤ GROUND CONDITIONS

Dam fill over karstic LIMESTONE (to max 170 Mpa) very permeable and jointed.



# CASE STUDY



# CASE STUDY



<b>Case study</b>	<b>FD60 Hydromill Sakarya Dogancay, Turkey - 2013</b>
<i>Project description</i>	Construction Cut Off Wall with Slurry Trenching Works





# CASE STUDY

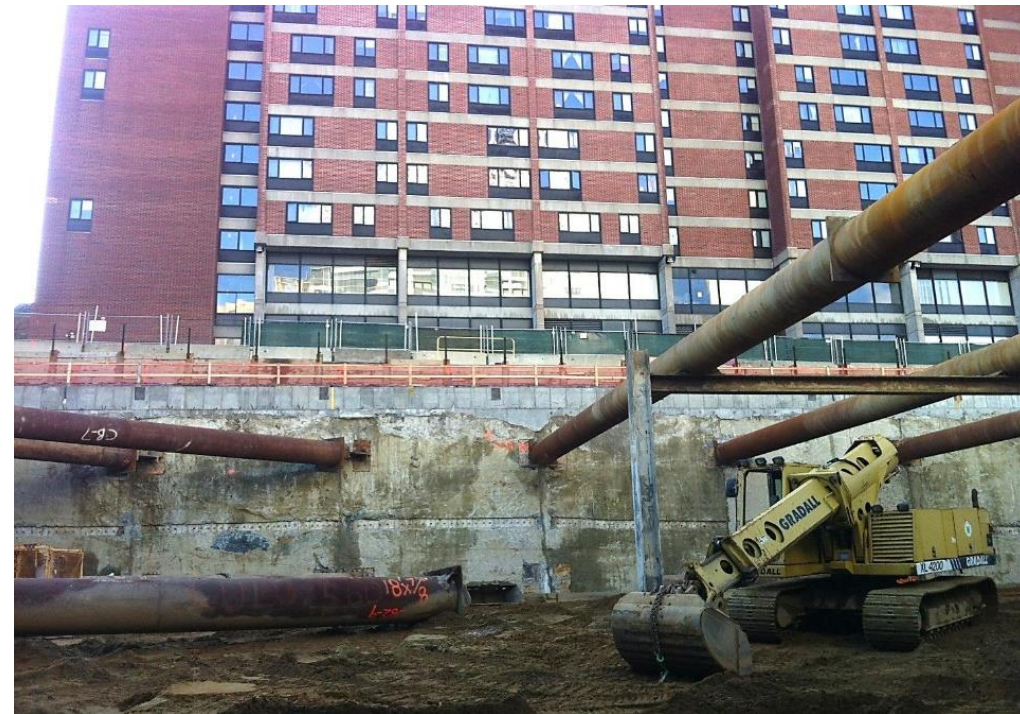
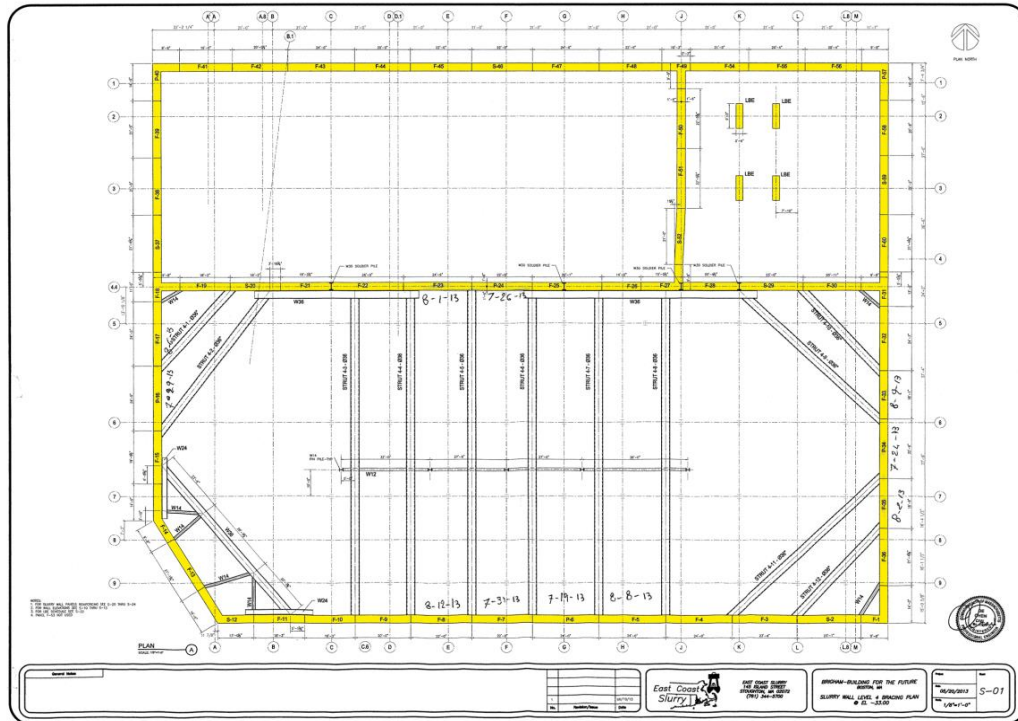
	<b>FD100 Hydromill Boston, USA</b>
<i>Project description</i>	BRIGHAM AND WOMEN'S HOSPITAL DW for a 5 level underground parking garage + LBE



# CASE STUDY

## ➔ PROJECT QUANTITIES AND GENERAL DATA

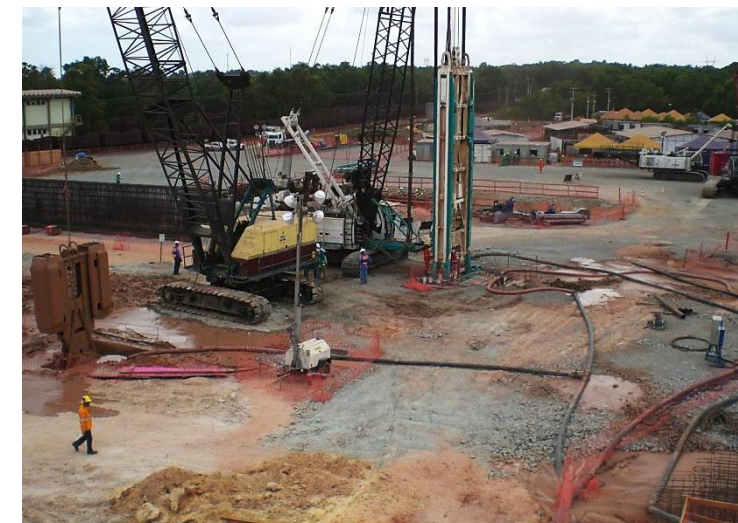
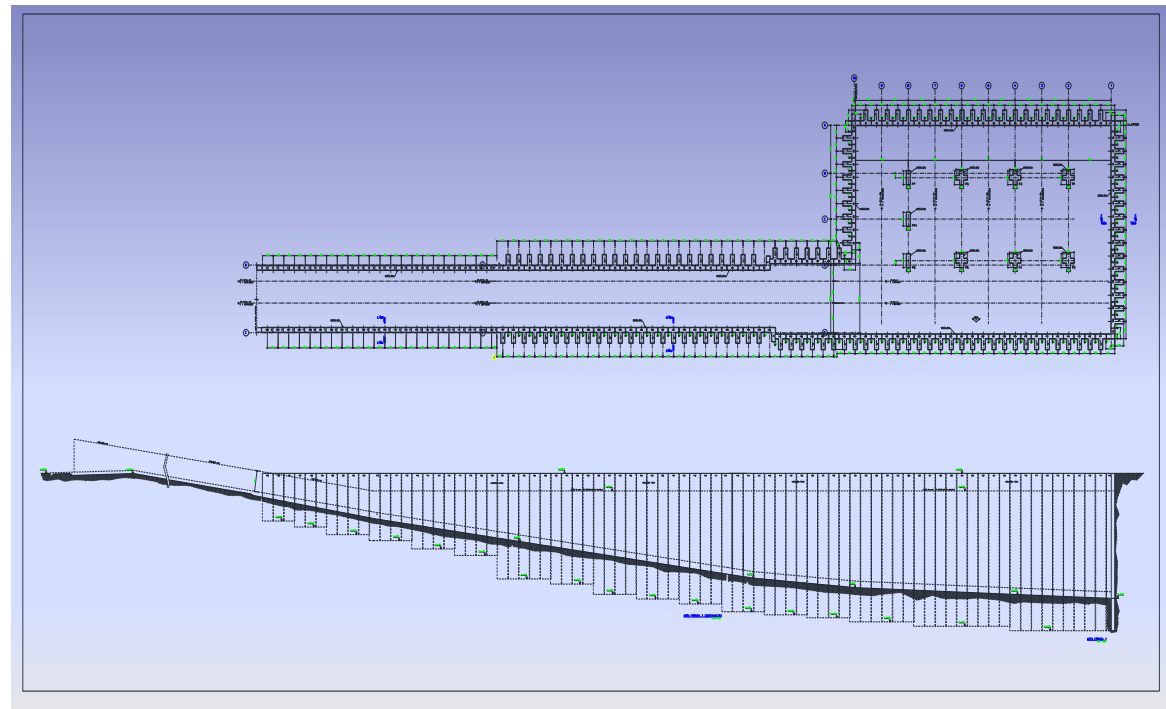
Wall excavation: ~ 9800 m<sup>2</sup>  
Wall thickness: 914 mm (36")  
Wall depth: 23-26 m  
Wall length: ~ 390 m



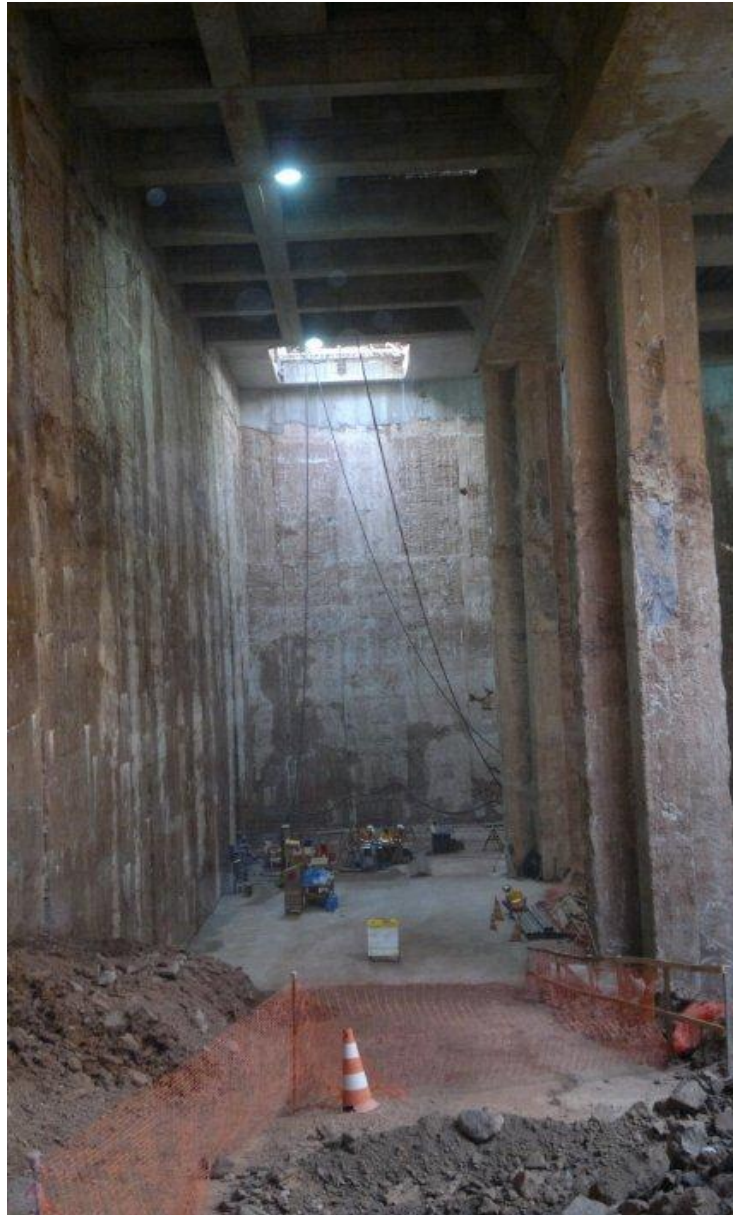


# CASE STUDY

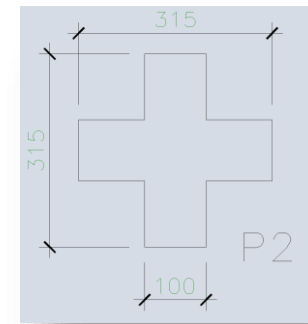
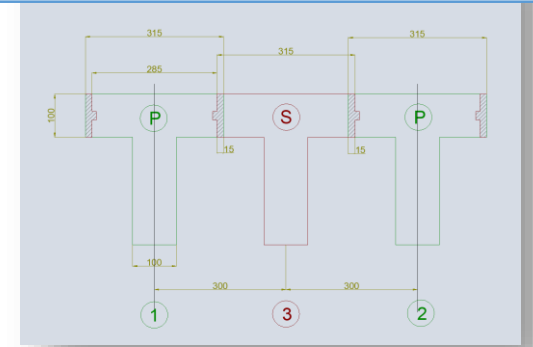
	<b>FD60 Hydromill</b> <b>Sao Luis, Brazil</b>
<i>Project description</i>	SHIPPING TERMINAL DE PONTA DA MADAIRA Onshore project Structural Diaphragm Wall for the underground iron ore wagons discharge terminal



# CASE STUDY



Wall construction sequence 1-2-3



Barrettes

Depth: 45 m



# CASE STUDY

	<b>FD60 Hydromill Abu Dhabi, U.A.E.</b>
<i>Project description</i>	TUNNELING SEWERAGE SYSTEM Diaphragm wall installation for n°10 access shafts





# CASE STUDY



## PROJECT QUANTITIES AND GENERAL DATA

N° of shafts:	10
Wall excavation:	21000 m <sup>2</sup>
Wall thickness:	800 and 1000 mm
Shafts depth:	50 m



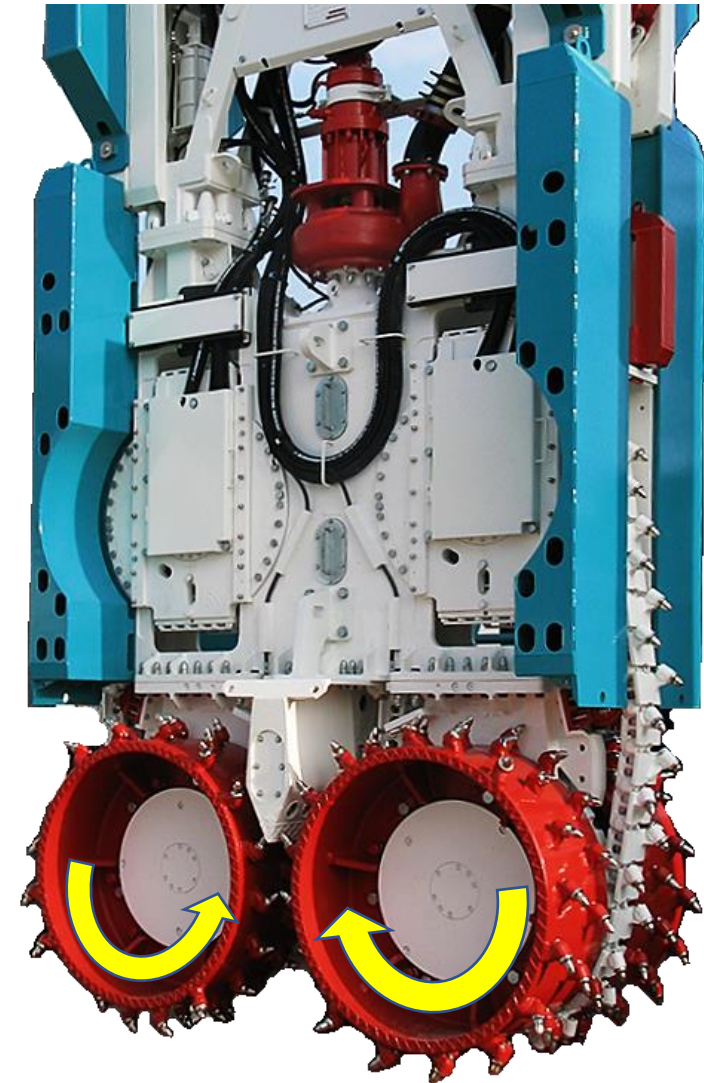


# CASAGRANDE HYDROMILLS CONCEPT AND SOLUTION





The equipment consists in  
a **heavy steel frame with  
two drive gears**  
(attached to its lower portion)  
which rotate in opposite directions  
around horizontal axes

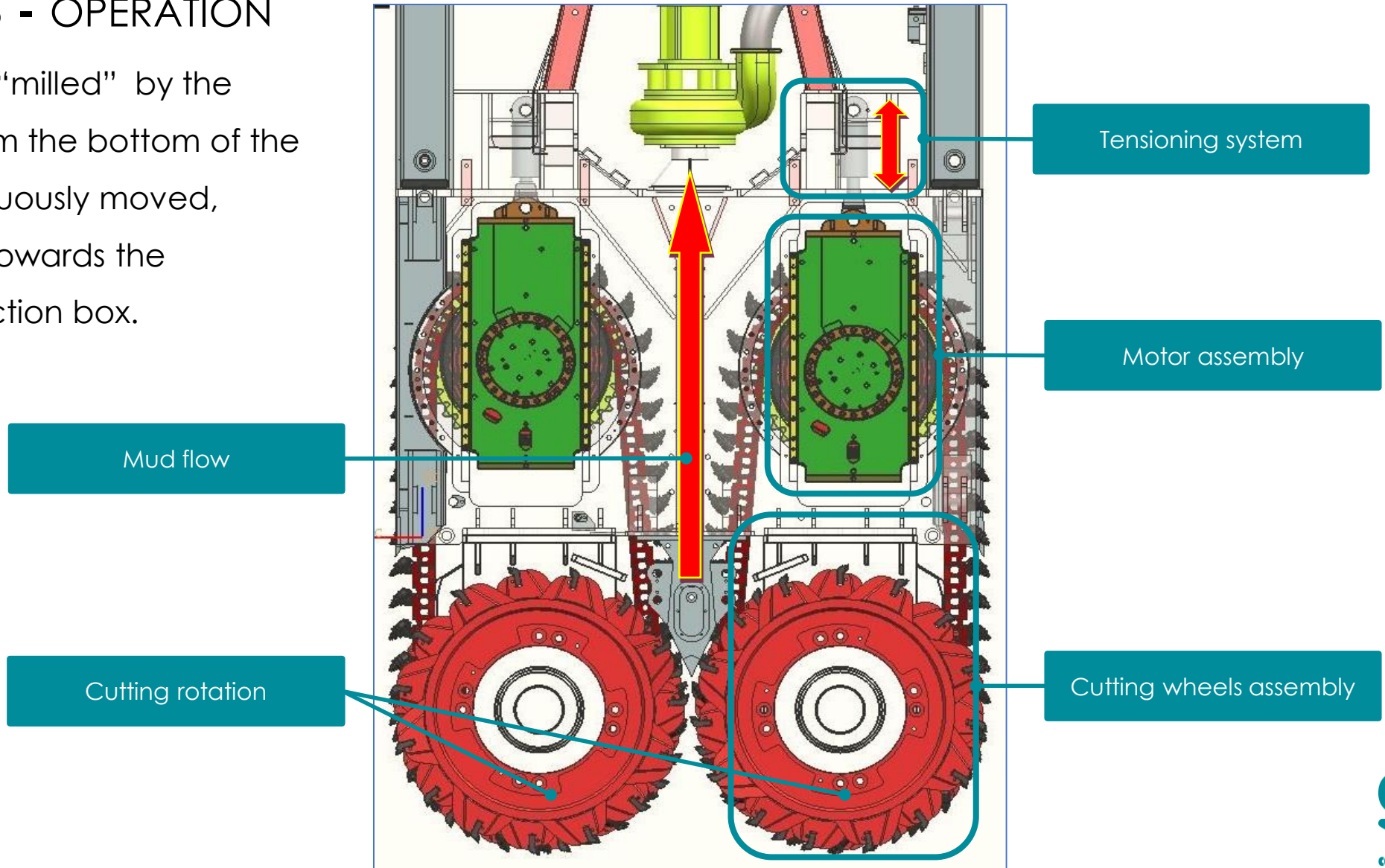






## HYDROMILLS - OPERATION

The soil, or rock, is “milled” by the cutting wheels from the bottom of the trench and continuously moved, mixed with slurry, towards the opening of the suction box.





# Advantages of the CHAIN DRIVE SYSTEM

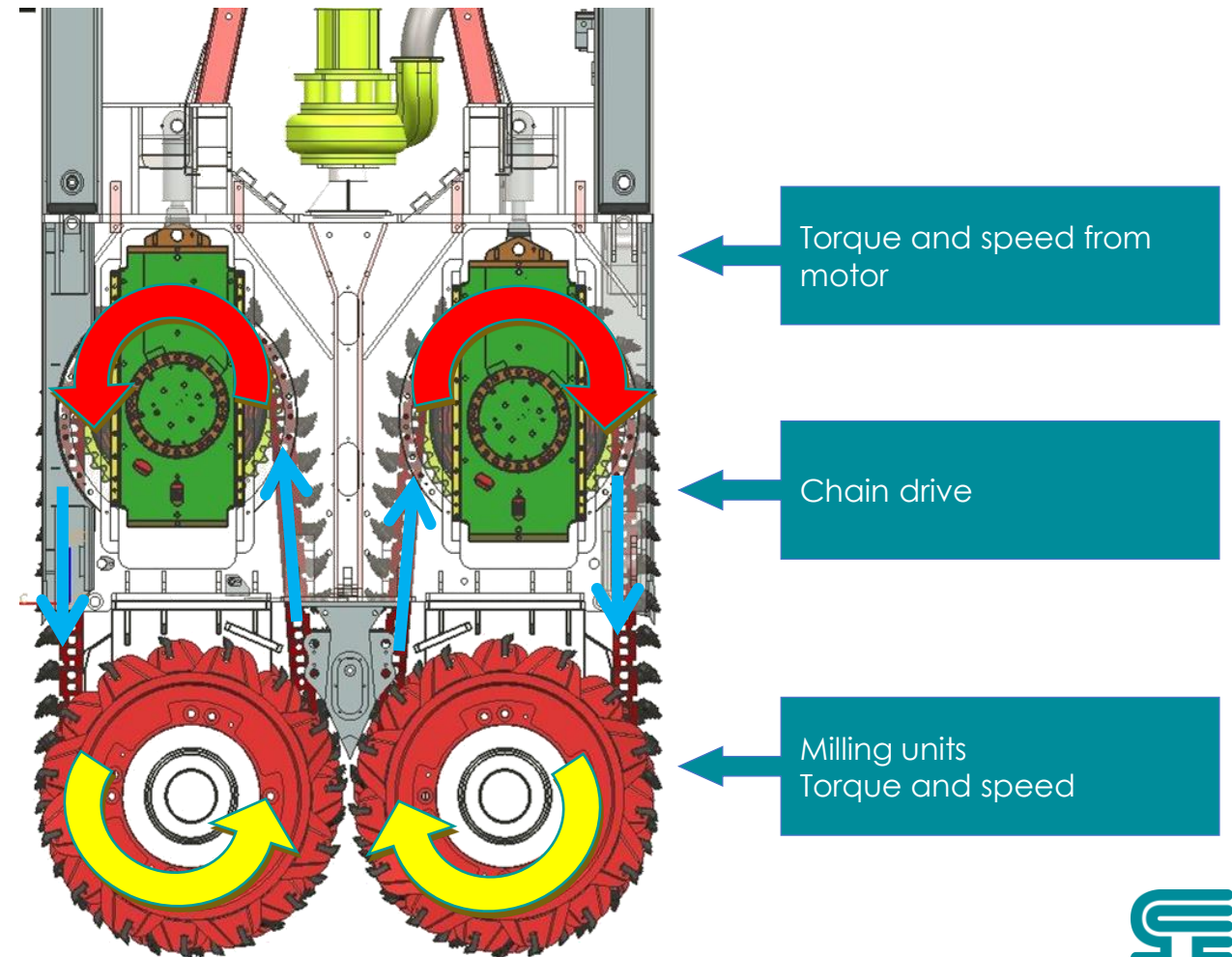




# HYDROMILLS - CHAIN DRIVE SYSTEM

**POWERFUL CHAIN PROVIDES HIGH TORQUE AND SPEED FOR THE CUTTING WHEELS**

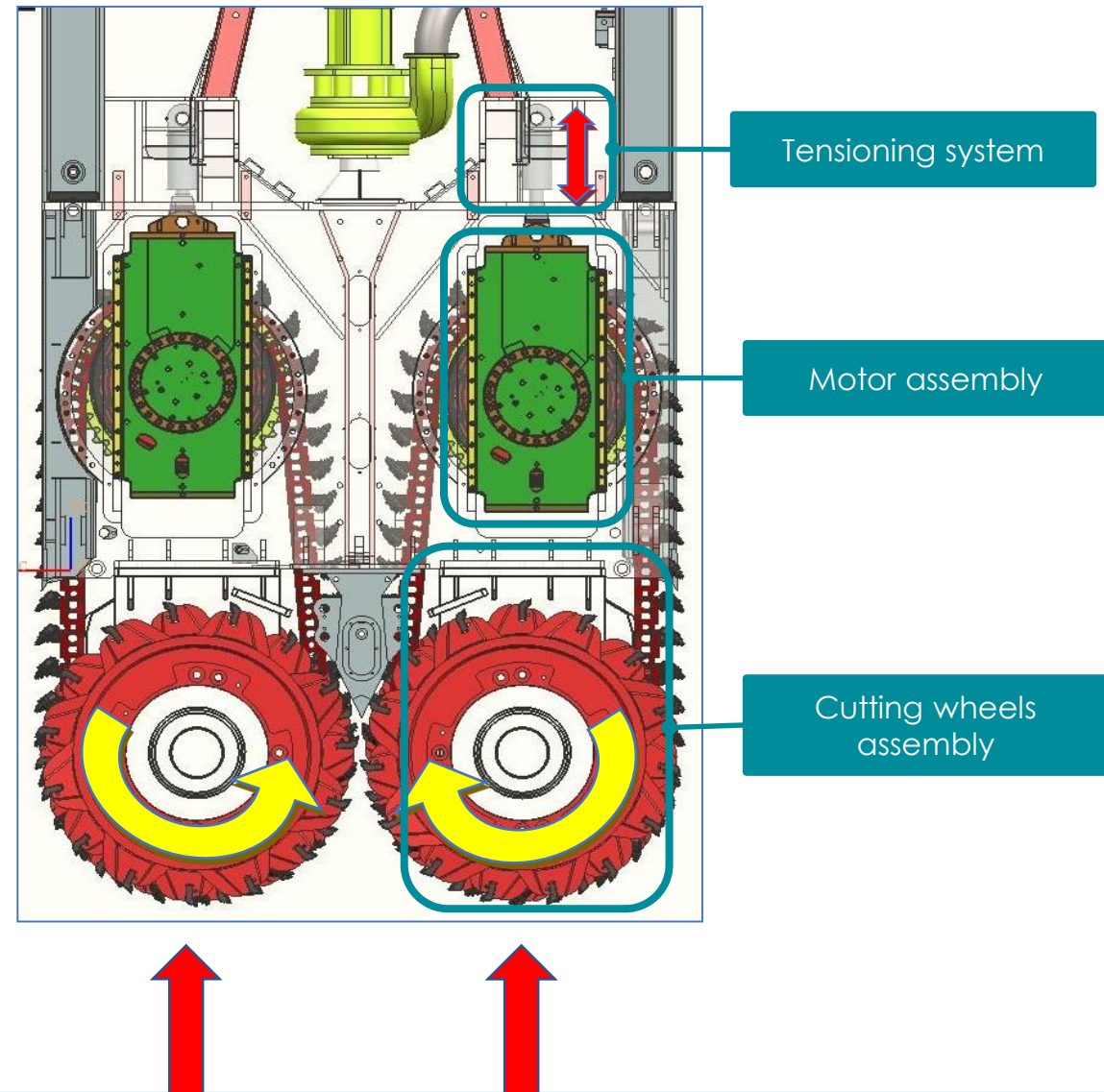
The chain transmits the rotation of the hydraulic motors to the milling units





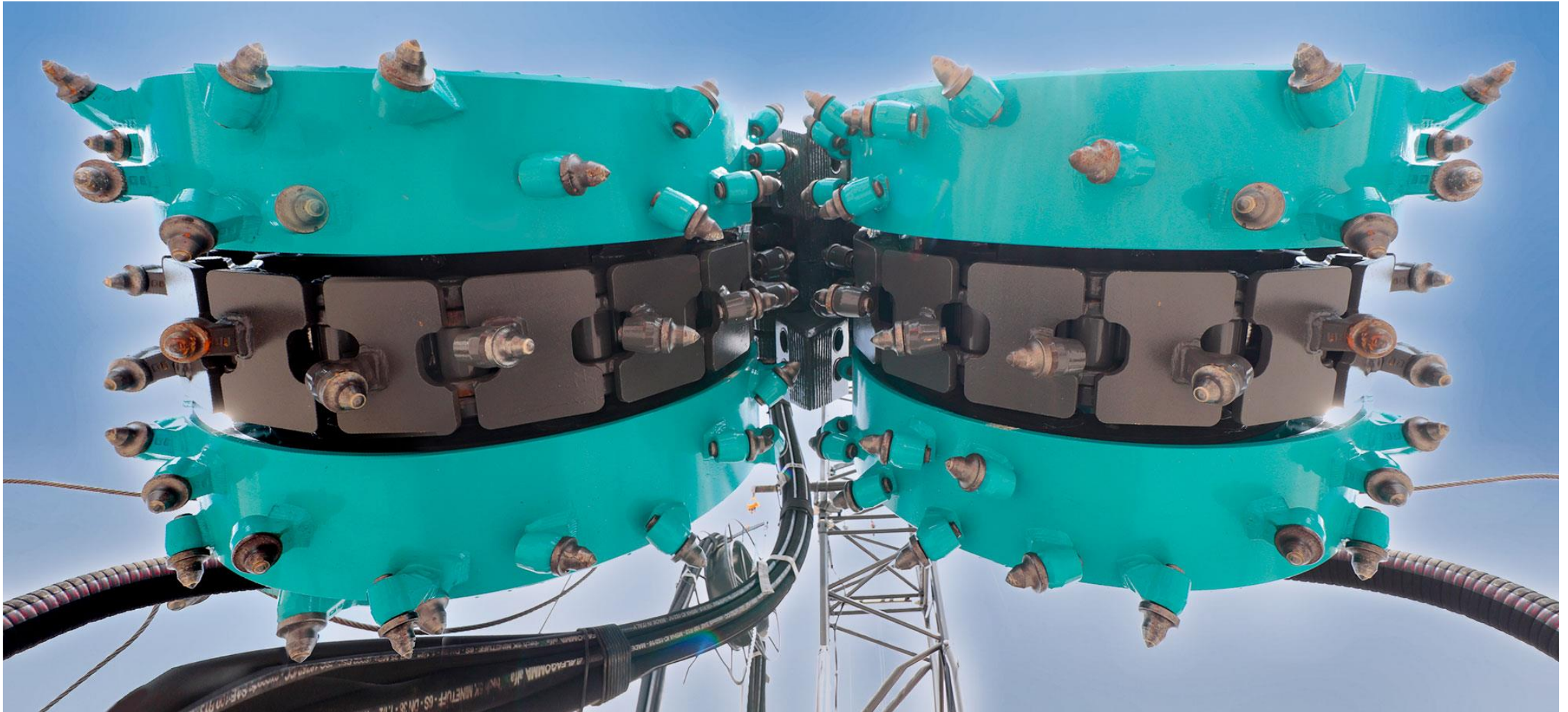
# HYDROMILLS - CHAIN AND TENSIONING SYSTEM

Shocks from excavation are on wheels and not on hydraulic components





## HYDROMILLS - "FULL FACE" EXCAVATION CASAGRANDE'S SYSTEM

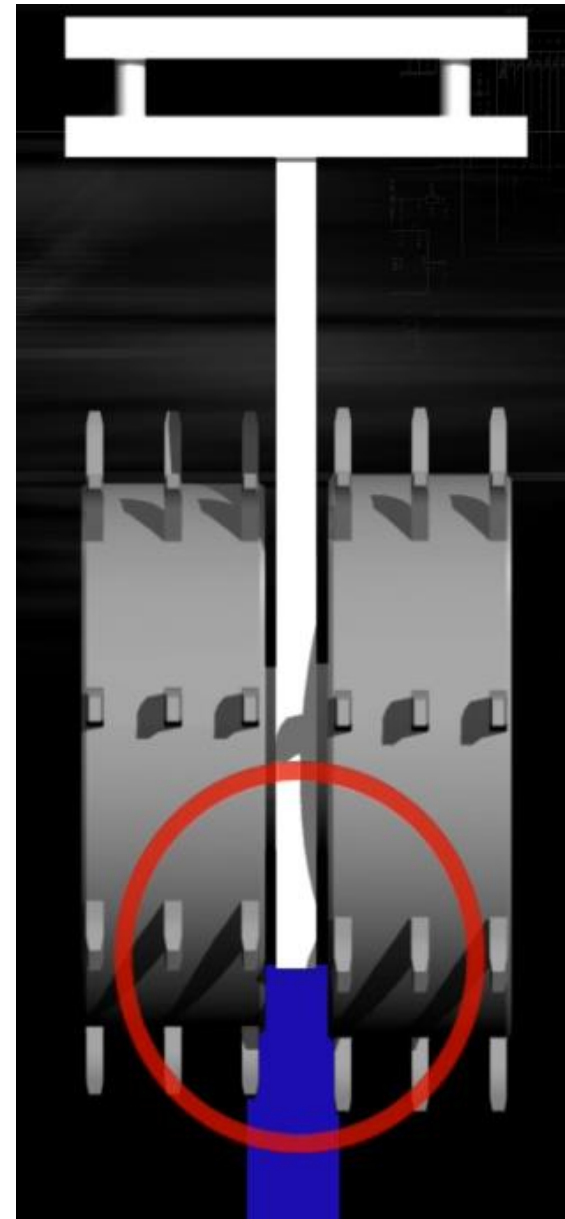
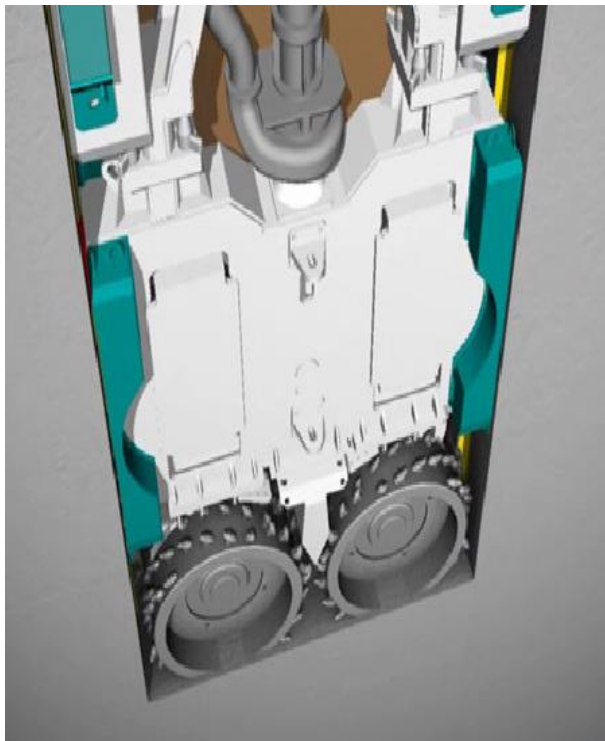




# HYDROMILLS - CHAIN DRIVE SYSTEM

## Motivation

Void area means a loss of productivity especially when excavating hard and difficult geological formations

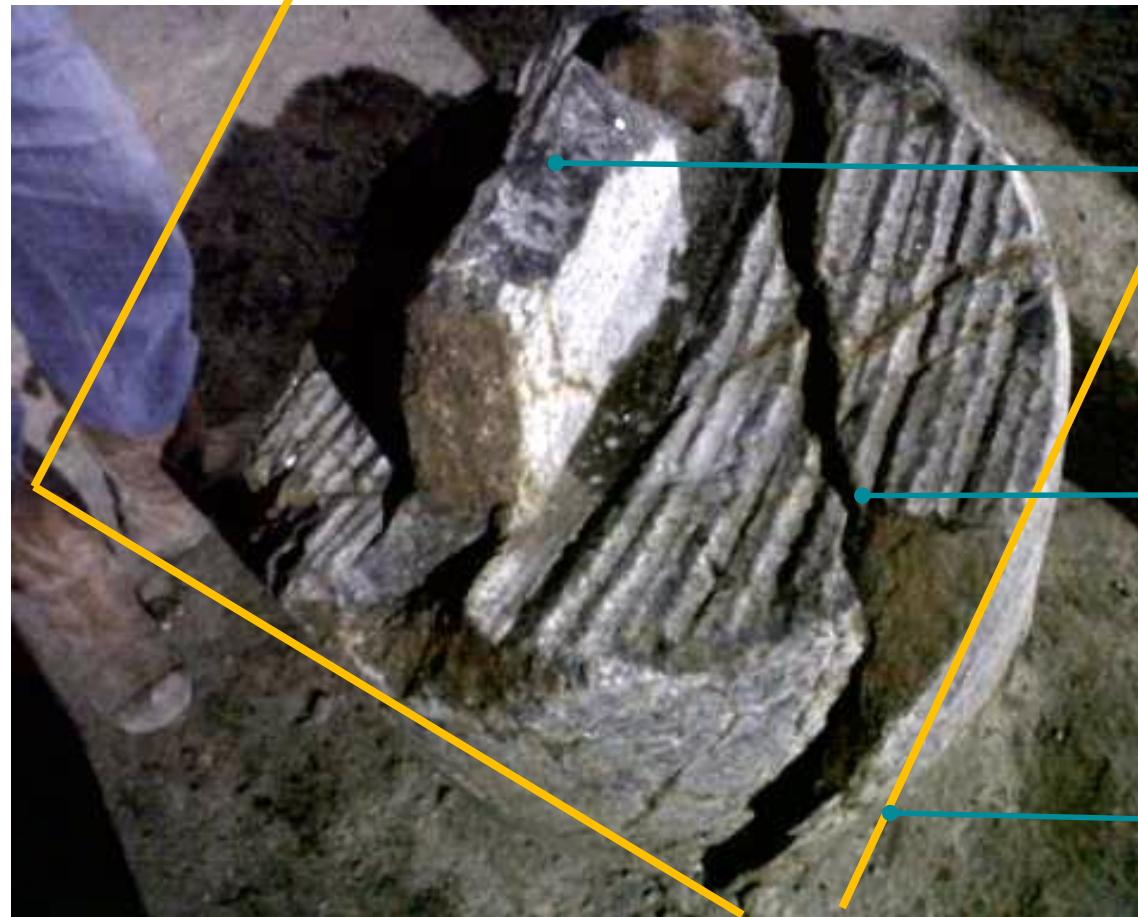




## HYDROMILLS - CHAIN DRIVE SYSTEM

### Typical section not fully excavated

Example of core removed from excavated section that shows an uncompleted cutting



Not excavated section of the trench

Cutting lines of the teeth of wheels

Shape of trench

Metro Station Chennai India 2012.  
Unconfined Compressive Strength UCS > 100 Mpa





## HYDROMILLS - CHAIN DRIVE SYSTEM

The chain system implements the special joint between primary and secondary panels.

With the chain system it's possible to make a **SPECIAL JOINT** that:

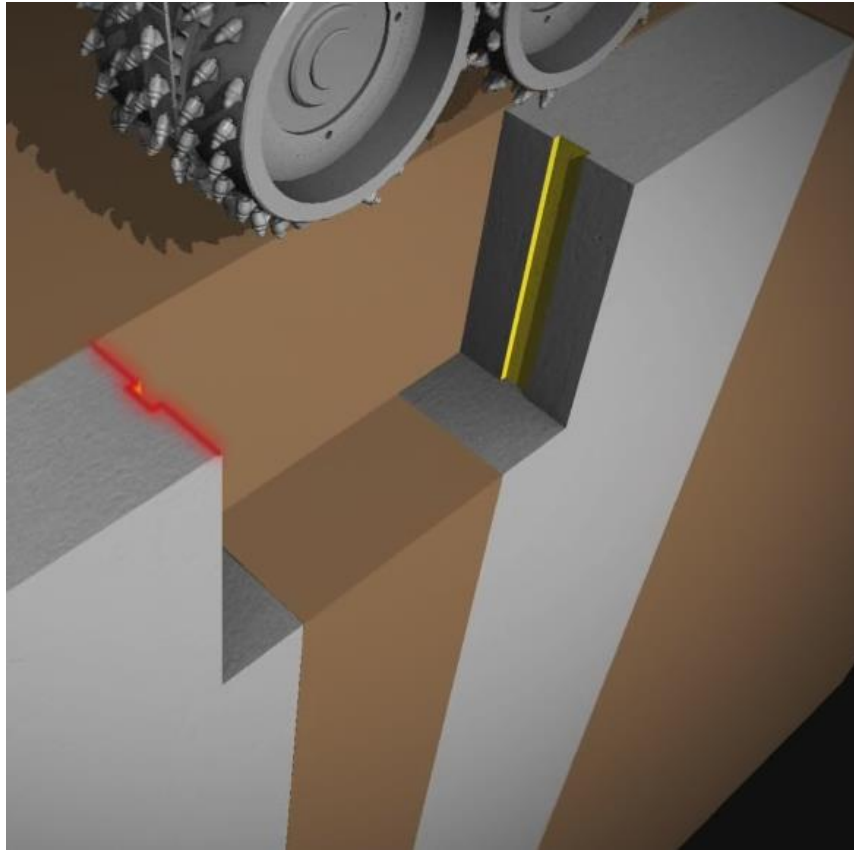
- Reduce the required overlapping → less concrete is excavated
- Create a “key” extended into the primary panel → better guidance of hydromill and seal of the joint



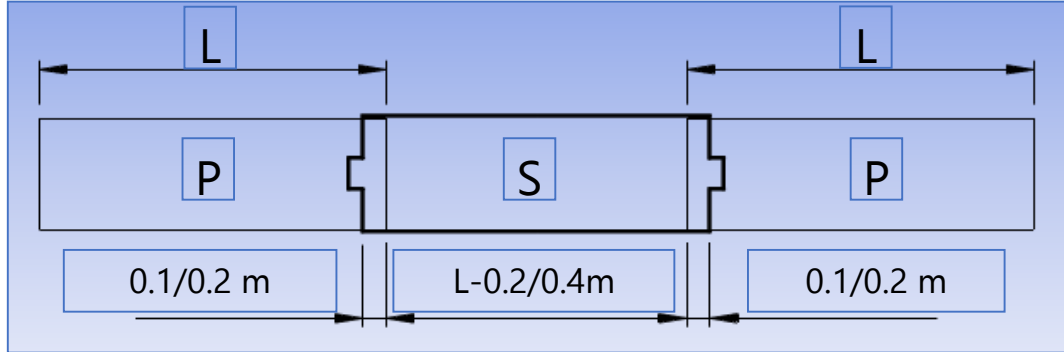




# HYDROMILLS - CHAIN DRIVE SYSTEM



Key joint between primary and secondary panels





# CASAGRANDE HYDROMILL

## HYDRAULIC TURNING JOINT +/- 100°

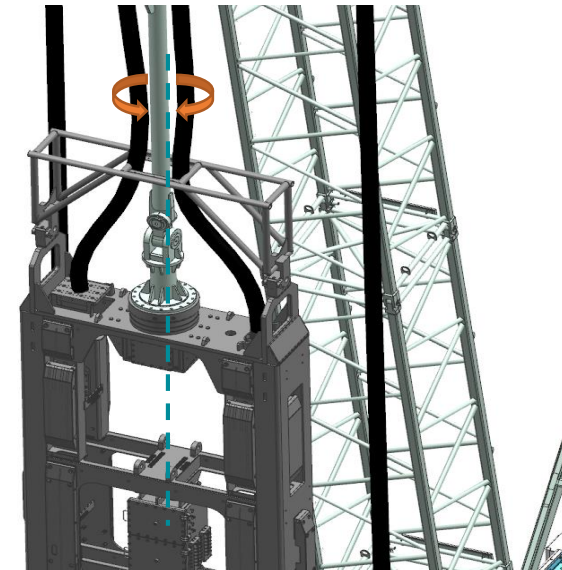




## HYDROMILLS - HYDRAULIC TURNING JOINT and CORNER PANELS

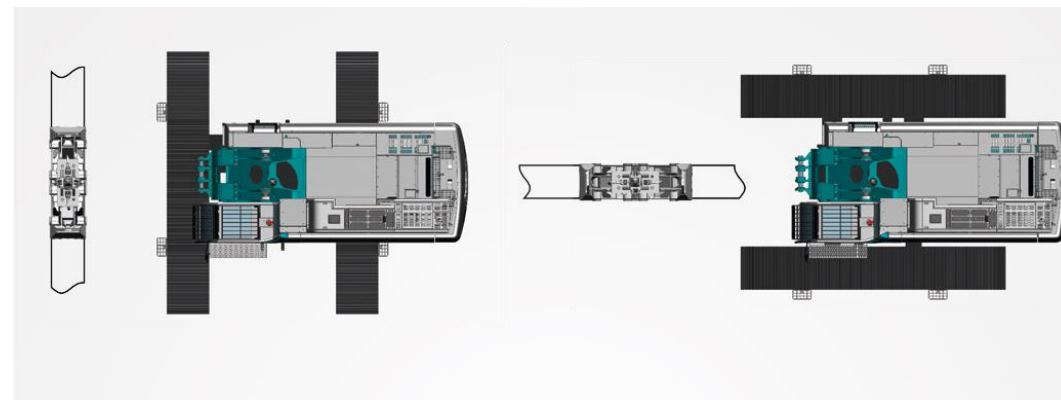
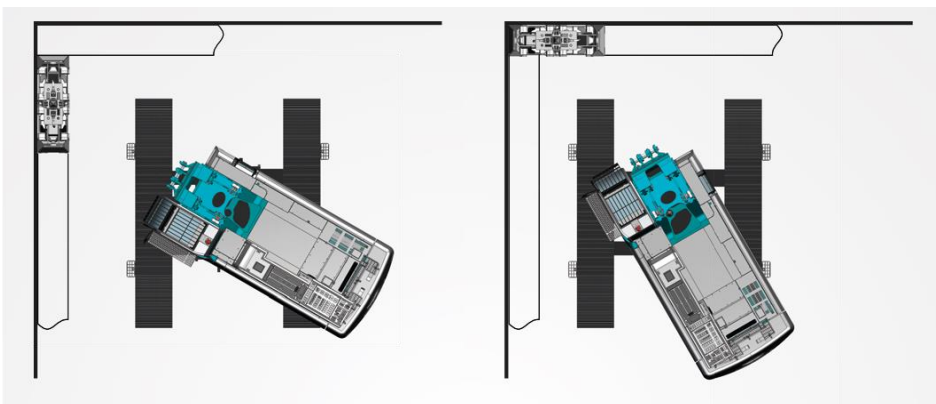
The **hydraulic turning joint** allows precise alignment of the hydromill with the trench and operation at various angles which is useful on limited working sites.

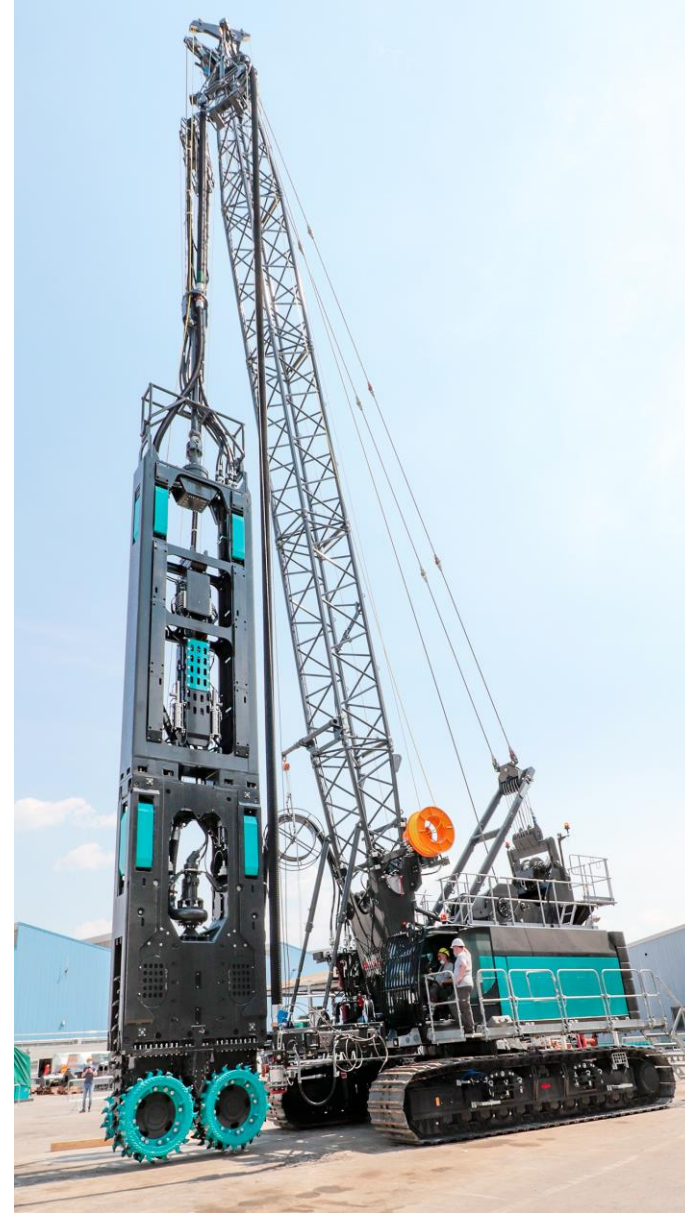
Complete rotation of the hydromill by +/- 100 degrees.



90° excavation option

Corner panels







# VERTICALITY CONTROL



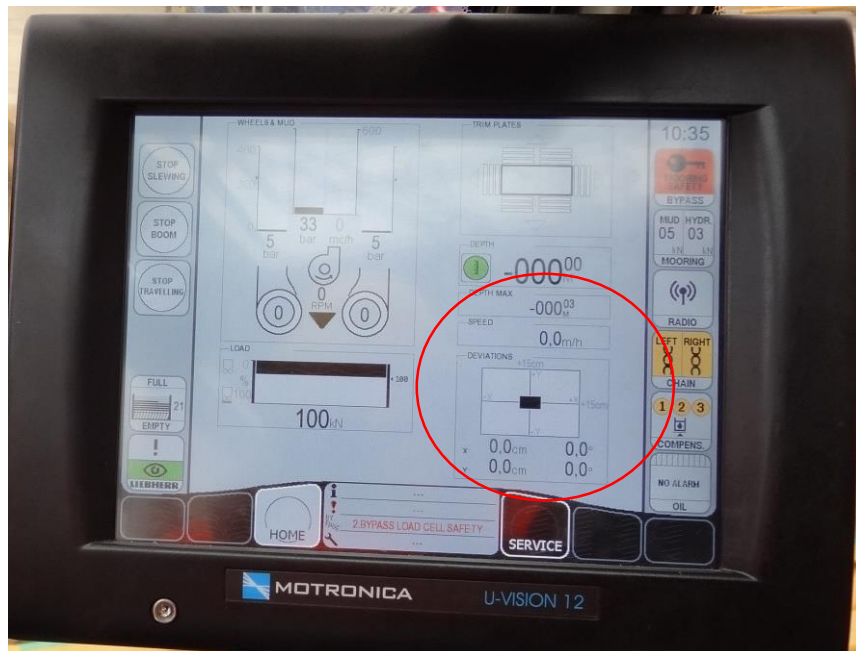


# HYDROMILLS - VERTICALITY CONTROL

The instrumentation constantly monitors the verticality of the hydromill.

**Instrumentation and full-face-excavation guarantee verticality precision of more than 0.1%**

e.g. For a 100 m deep diaphragm the deviation from the theoretical vertical is less than 100 mm

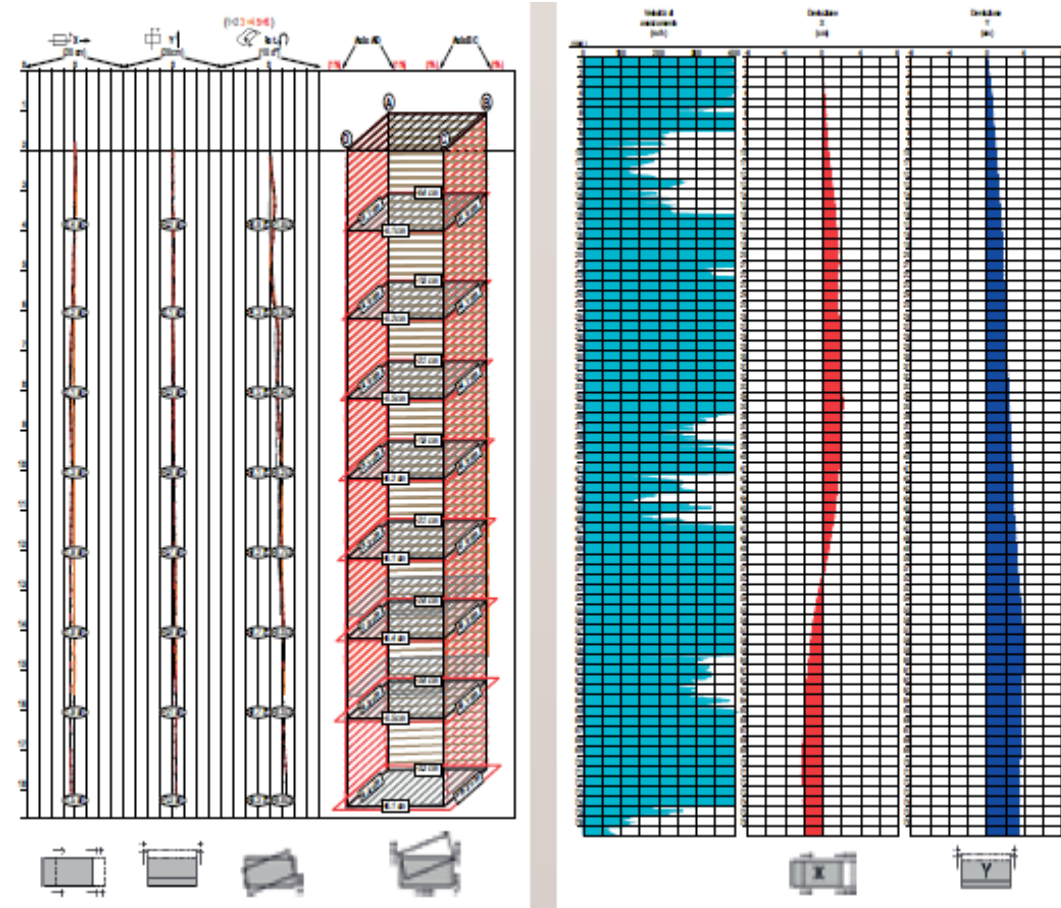


# HYDROMILLS - VERTICALITY CONTROL

All the data of the excavation are recorded for next download for post-processing operations.

List of measured and recorded data:

- Deviation axis X, Y, Z
- Depth of excavation
- Cutting wheel speed
- Press. cutting wheel
- Speed of suction pump
- Flow of suction pump
- Hydromill weight on ground
- Min./Max. oil level compensator
- Two press. switches for chain tensioner
- Hydraulic oil contamination sensors



Example of output record



## HYDROMILLS - STEERING PLATES

N° 6-upper + 6-lower hydraulically driven steering plates are available to correct verticality at the excavation stage.

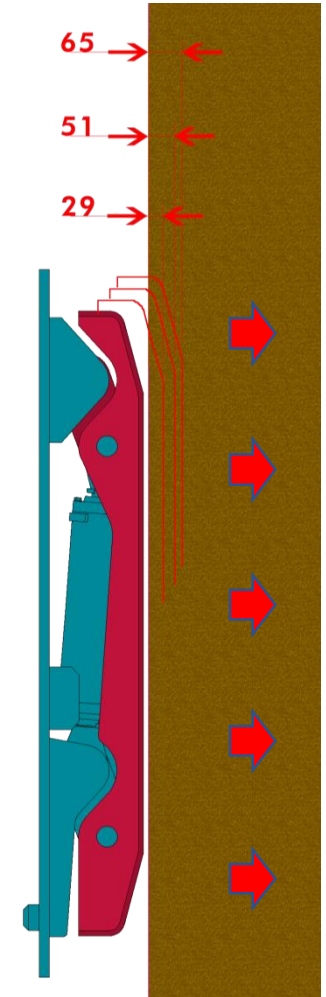
When activated they drive the hydromill to the required direction







# HYDROMILLS - VERTICALITY CONTROL DURING EXCAVATION



Steering plate. Detail



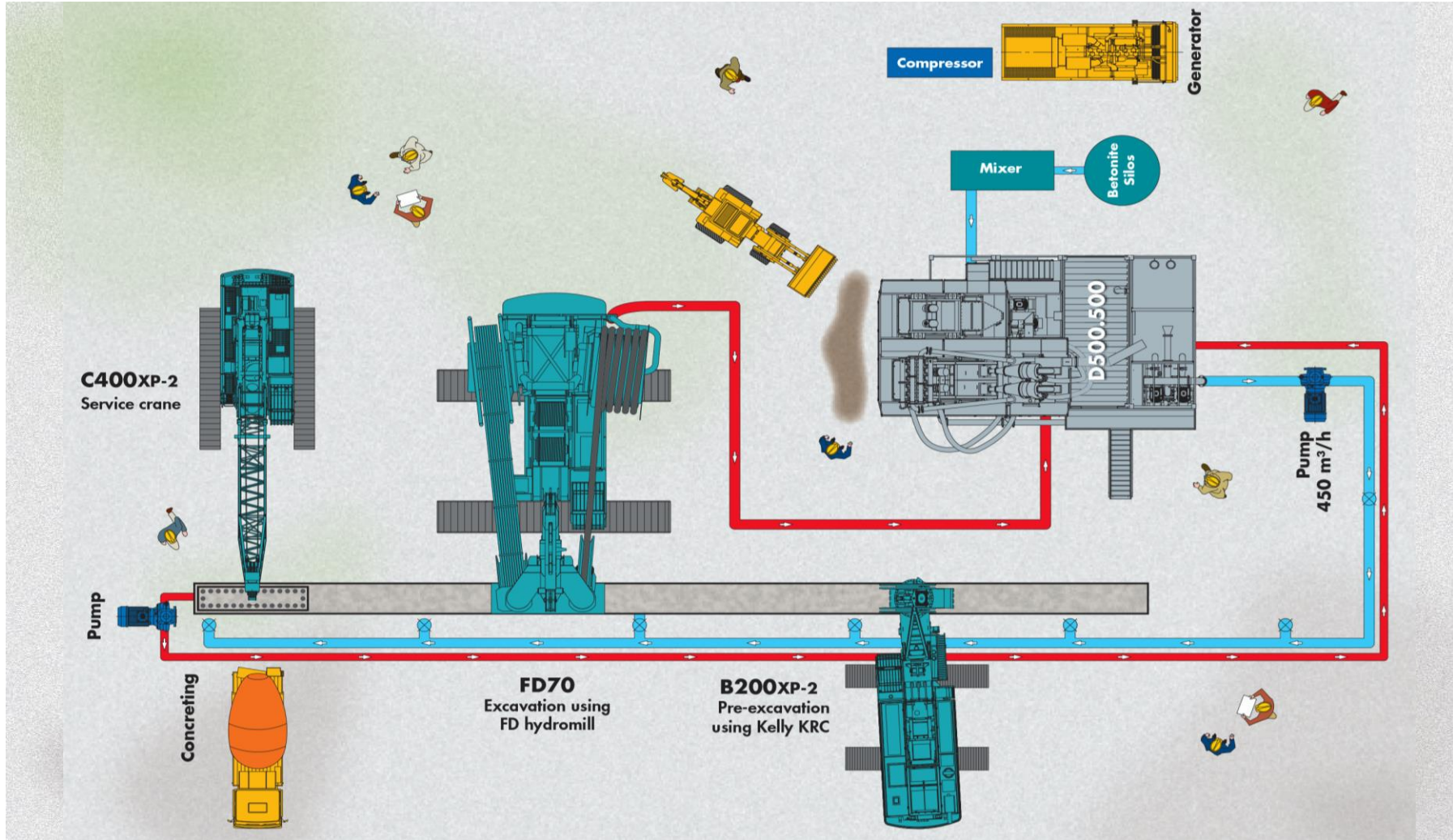


# **CASAGRANDE HYDROMILL OPERATION ... not only hydromill ...**





# HYDROMILLS – SLURRY WALL PLANT



Example of plant



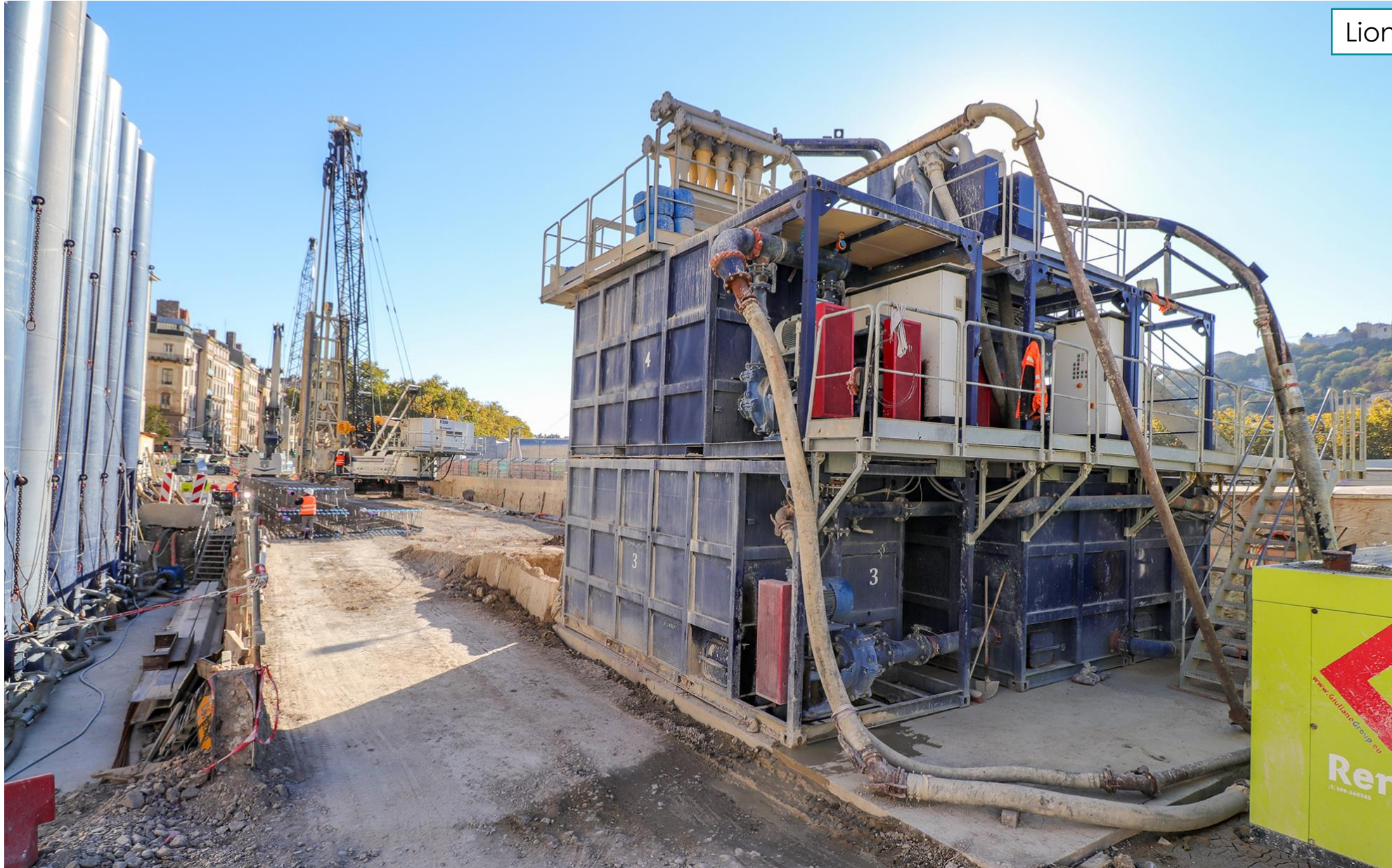


Lion - France





Lion - France





Lion - France





Brazil





Brazil







Thanks for your attention

Authors: ing.G.Michelazzo, M.Rossit  
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