**Hydromill**

Diaphragm
Wall System

**Cougar**
**Tiger**


Diaphragm
Walls

# Hydromill

soilmec
Drilling and Foundation Equipment


## A complete Range

Soilmec hydromills are designed and manufactured to meet the need for increased production and performance on the most challenging soil conditions and depths. The new equipment range can perform up to 250 m depth and torque of 143 kNm per cutting motor.

## Advanced verticality control

- 12 autonomous mobile flaps with 3 different position each
- Independent movement of the cutting motors as flipper teeth drums
- DMS Automatic Verticality Correction System
- 2-axis or 3-axis showed deviation

## High powerful engine and external power pack

Soilmec install large displacement engines, providing exceptional performance and reliability.

- High performance, availability and reliability by using tried-and-tested technology with high power-to volume-ratio. Cutter module power availability up to 1550 HP.
- The modern electronic injection system ensures low fuel consumption and therefore low operating costs.
- Low noise emissions, smooth running characteristics and durability.
- Meets exhaust emission regulations 2004/26/EU, Step III A and US-EPA Tier 3

## DMS & Floating Control

DMS is an innovative system, developed by Soilmec, which controls and monitors the operation of the machine. For ease of operation the system is controlled by a touch screen located in the cab. The system main function, is to enable the machine to perform different functions more efficiently.
The Floating Control operated by DMS enables the operator to control the correct weight on cutter and the drilling speed in order to obtain the maximum drilling performance.

## Ergonomic design

The cab is designed to be spacious, quiet and comfortable for the operator, assuring high productivity throughout the working day.
Controls are conveniently located for easy operation.

## The Soilmec advantage

- A real multifunctional machine, designed from scratch to give you the best drilling solution.
- Long life expectancy with a high residual value.
- Best price/performance ratio.
- Built with the customer in mind.


1 Undercarriage
2 Base machine
3 Cab
4 Power pack
5 Mud hose winder
6 Hydraulic hose winder
7 Lattice boom
8 Hydromill module
9 Cutting motors & drums

# HYDROMILL SYSTEM

## Introduction

**More than 25 years of experience of TREVI Group Companies *(enriched also by Rodio)* in the use of Hydromill technologies, have made SOILMEC able to engineer the most advanced fleet of Hydromill equipment and to provide the global foundation market with a complete range of models and accessories.**

Diaphragm walls are common practice in civil engineering as part of or as aids to the building of civil and hydraulic structures. Hence, they can be either temporary or permanent.
In the realm of structural diaphragm walls a distinction exists between retaining structures (earth and hydraulic) and foundations. The walls, for hydraulic purpose, can be sub-divided into impervious (cut off) and draining.
Basically, a trench is excavated in the ground, generally in the presence of a stabilising fluid, then back-filled with an appropriate material. The trench geometry (width, depth and length) is designed according to the characteristics of the structure to be built; these geometrical features and also the ground conditions determine the choice of best suitable trenching equipment.

A simple and rational method is trenching by means of jaw-grabs, which dig into the ground and replace it with an equal volume of slurry (bentonite or polymeric fluids) which stabilises the excavation.

It is generally found that when excavating diaphragm walls through soils with conventional grabs the maximum practical depth is 40-60 m. The amount of panel deviation from the vertical may be 0.5 to 2% depending on the ground conditions. Below such depths, the quality of the panel joints may be unacceptably low. The continuity and effectiveness of the whole diaphragm will therefore be compromised.
Conventional grabs are also severely limited in their ability to excavate bedrock; in such cases, the traditional method is “chiselling”, i.e. the dropping of a large and heavy sharp edged tool to fracture the rock for subsequent grabbing. This is usually a tedious and time consuming process and shows a very low production rate.

The Hydromill system is made up of three main components:
- **supporting crawler crane**
- **milling unit**
- **plant for mud preparation and processing.**

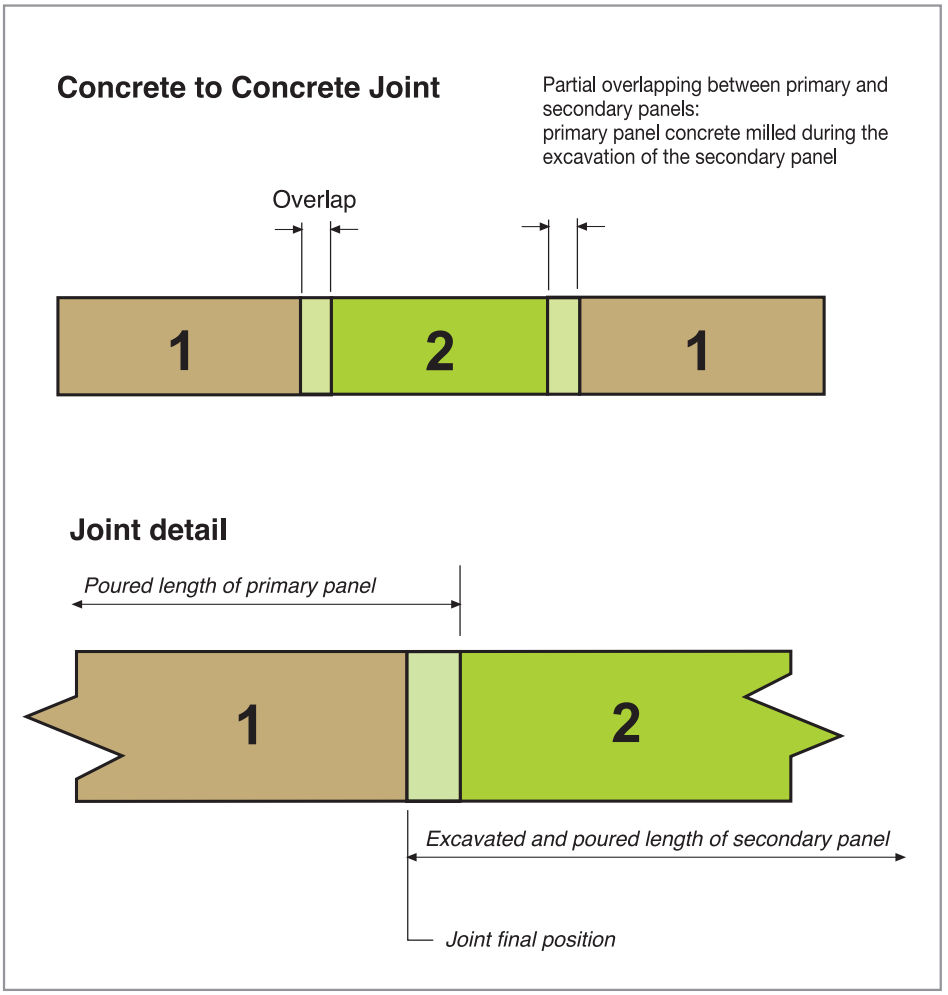
## Excavation phases and construction procedure

The hydromill allows the excavation of a panel in one single phase, since the excavation cuttings are continuously pumped away by the mud recirculation system.

Typically the procedure for the construction of a structure foresees a series of alternating primary and secondary panels:

- Excavation of a shallow pre-trench, for the suction pump start-up;
- Excavation of the primary panels; the panels can be individual or multiples, formed by 2 or more bites, followed by the wedge in between;
- Once the excavation is completed and the drilling mud is properly cleaned (the mud is regenerated until its characteristics in the trench, i.e. density, viscosity and sand content, comply with the technical requirements), the reinforcement cage is placed and concreting can start.
- Excavation of the secondary panel in a single bite. During the excavation a small portion of the concrete on each adjacent primary panel is removed by the hydromill cutter drums. The construction joint between the panels is a high quality "concrete-to-concrete joint". During the excavation of the secondary panels, the hydromill cutter drums creates a rough, clean contact surface on the ends of the primary panels. Shear resistance and water tightness is achieved without the use of conventional stop-ends or steel profiles.
- Again when the excavation is completed and the drilling mud is properly treated, the reinforcement cage is placed and concreting can start.

"Concrete-to-concrete joint" obtained by partial overlapping between primary and secondary panels.



## Job Site Layout

### Conclusions

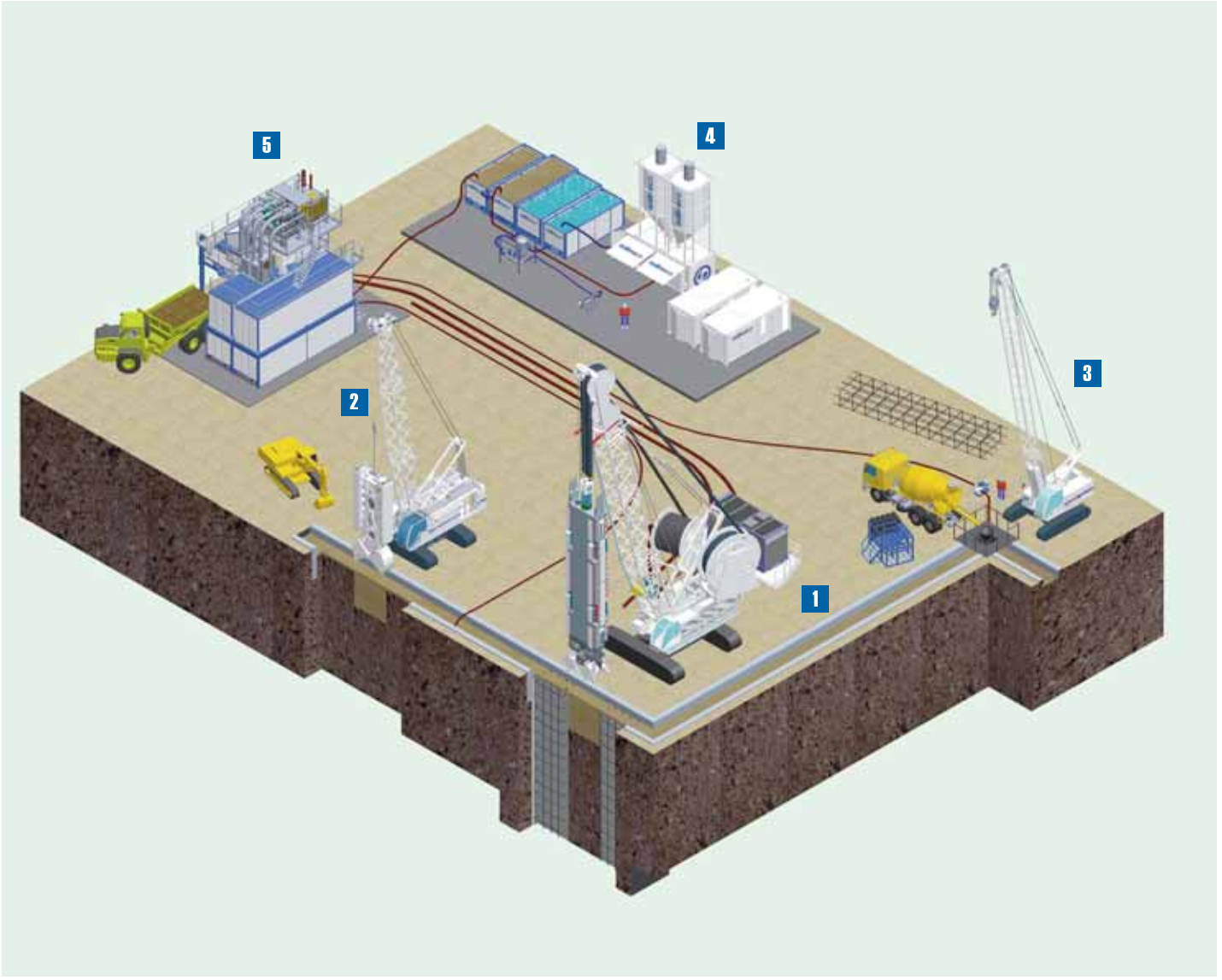
The Hydromill technology has been extensively applied to the construction of diaphragm wall, also in urban environment. The main features in respect to the traditional excavation techniques can be summarised as a **high quality product, in terms of joint contact and panels verticality.**

**In particular:**

- Concrete-to-concrete joint: when excavating the secondary, the mill cuts on both sides of the adjacent primaries; by concreting the secondary, a tight concrete to concrete joint is formed *(the contact surface is adequately rough)* which ensures a hydraulic tightness perfectly satisfactory.
- Real time verticality monitoring and guidance during the excavation: the hydromill is equipped with electronic systems (DMS) in order to continuously monitor the excavation parameters of the milling unit and its position. Special devices can be used to ensure the verticality correction, if necessary.
- Suitable in various types of soil and rock.
- Mitigation of the construction impact on the urban environment, since the level of noise and vibration induced during the excavation do not create any disturbance to adjacent structures and buildings.
- Clean site operations, as a result of the slurry reverse circulation system utilised for the transport and removal of the cuttings. The excavation material *(solid particles separated by the mud treatment plant)* can be reutilised as filling material, or easily transported to a disposal area.

**Job site layout proposal:**

1. SC-135 Tiger
2. SC-65 c/w GC-16
3. SC-20 service crane
4. Bentonite preparation plant
5. SMT-500 c/w SDM-35 desanding plant




soilmec

# HYDROMILL SYSTEM

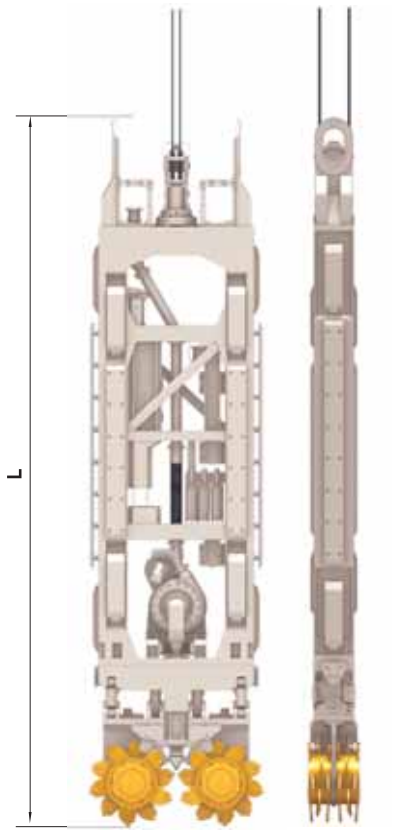
## Hydromill Module

The milling unit is constituted by a heavy steel frame on which are mounted two counter-rotating and independent milling drums. Drums with different torque and dimensions can be adopted in order to match the geometrical requirement; several Soilmec tooth types can be mounted on the milling drums, depending on the characteristics of soil to be excavated. The hydromill is lowered progressively into the trench, excavates and crushes the soil or rock.

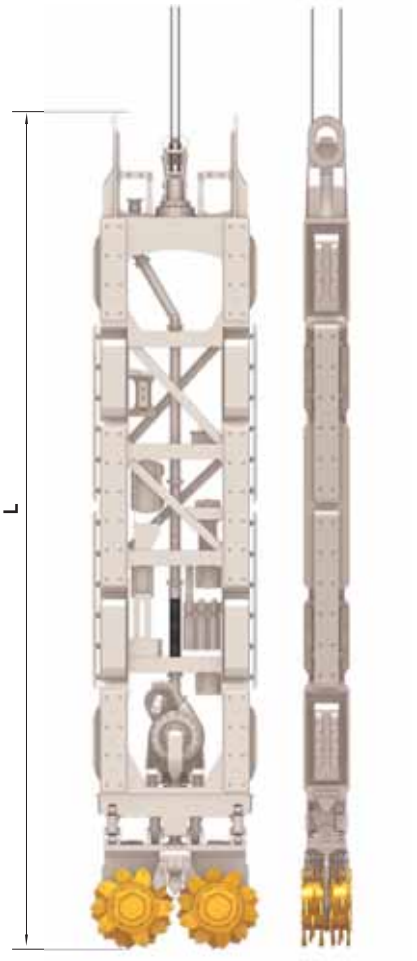
A powerful submerged mud pump *(with nominal output of 500 cubic metre per hour)*, located immediately above the cutter drums, creates a reverse circulation of the stabilizing fluid *(bentonite mud or water)*, which acts as a transport medium to evacuate the cuttings from the excavation, and delivers the cuttings-laden mud to a mud treatment plant.

The cuttings are removed from the stabilising fluid by means of vibrating screens or cyclones, depending on the size particles. Cleaned and fresh slurry is fed back into the top of the trench to maintain the slurry level and the trench stability.

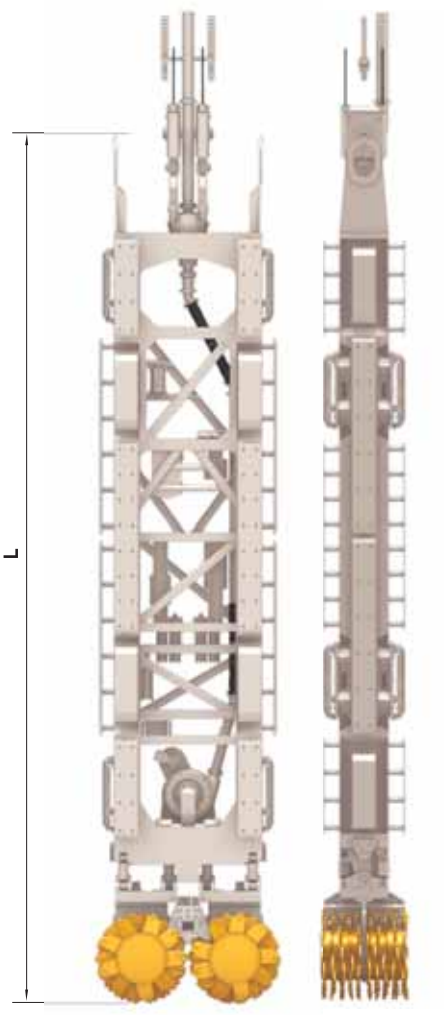
### SH-30




### SH-40




### SH-50




| HYDROMILL MODULE | SH-30 | | SH-40 | | SH-50 | |
|---|---|---|---|---|---|---|
| Body lenght (**L**)** | 11,3 m | 36.1 ft | 13,8 m | 42.6 ft | 15,5 m | 49.2 ft |
| Weight class | 30000 kg | 66139 lb | 40000 kg | 88185 lb | 50000 kg | 110231 lb |
| Panel lenght range | 2800/3000 mm | 110/118 in | 2800/3000 mm | 110/118 in | 2800/3200 mm | 110/126 in |
| Panel width | 650/1000 mm | 26/40 in | 800/1500 mm | 31/59 in | 1000/2000 mm | 40 /79 in |
| Indipendent mobile flaps | Standard * | Standard * | Standard | Standard | Standard | Standard |
| Module rotation system for T panel | Standard * | Standard * | Standard | Standard | Standard | Standard |

** not available for panel width lower than 700 mm (27.6 in)*

*** considering panel lenght of 2800 mm (110 in). In case of fixed plate this value may to be reduced of 0.8 m (31.5 in)*

## Hydromill Cutting Unit

## Suggested cutting unit application

| Panel width *(mm)* | 650 / 800 | 800 / 1000 | 1000 / 1200 | 1200 / 1800 | 1800 / 2000 |
|---|---|---|---|---|---|
| SH-30 | H-6 | H-7/8/10 HH-7 | | | |
| SH-40 | | H-7/8/10 HH-7 | HH-8/10/12 | | |
| SH-50 | | | HH-8/10/12 | HH-10/12/14 | HH-12/14 |

| CUTTING UNIT | H-6 | H-7 | H-8 | H-10 | HH-8 | HH-7 | HH-10 | HH-12 | HH-14 |
|---|---|---|---|---|---|---|---|---|---|
| Panel width | 650 / 800 mm *26 / 31 in* | 800 / 1000 mm *31 / 40 in* | 800 / 1000 mm *31 / 40 in* | 800 / 1000 mm *31 / 40 in* | 1000 / 1200 mm *40 / 47 in* | 800 / 1000 mm *31 / 40 in* | 1000 / 1500 mm *40 / 59 in* | 1000 / 1800 mm *40 / 71 in* | 1000 / 2000 mm *40 / 79 in* |
| Max torque | 58 kNm *42779 lbf*ft* | 73 kNm *53842 lbf*ft* | 87 kNm *64168 lbf*ft* | 102 kNm *75231 lbf*ft* | 81 kNm *69743 lbf*ft* | 72 kNm *53104 lbf*ft* | 101 kNm *74494 lbf*ft* | 123 kNm *90720 lbf*ft* | 143 kNm *105471 lbf*ft* |
| Max drilling speed @ 450 l/m | 42 rpm *42 rpm* | 30 rpm *30 rpm* | 25 rpm *25 rpm* | 21 rpm *21 rpm* | 26 rpm *26rpm* | 30 rpm *30 rpm* | 21 rpm *21 rpm* | 17 rpm *17 rpm* | 15 rpm *15 rpm* |
| Flipper tooth drums | Available | Available | Available | Available | Available | Available | Available | Available | Available |
| Simoultaneous or indipendent tilting cutters | Available | Available | Available | Available | Available | Available | Available | Available | Available |

# MONITORING CONTROL AND CORRECTION SYSTEM

## CORRECTION SYSTEM

In detail it is possible to correct hydromill verticality deviation:

### CORRECTION ON X-X PLAN

Correction in the X-X- plan can be achieved in two ways:

• **Adjusting the rotation speed of the milling drums.**
The rotation speed of one of the two drums can be adjusted in order to correct the X-X verticality deviation, so the different drum speed forces the hydromill module in the requested direction.

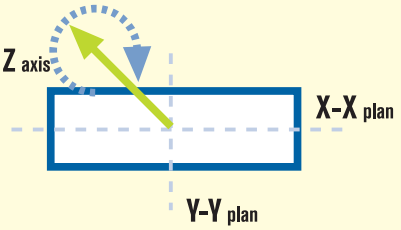
• **Moving the sides flaps.**

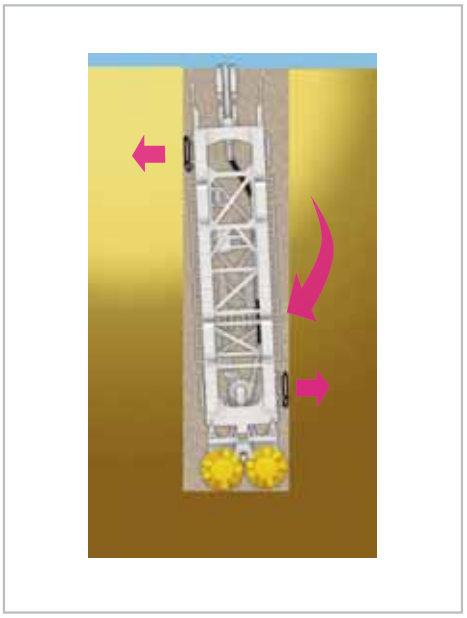
### CORRECTION ON Y-Y PLAN

Correction in the Y-Y- plan can be achieved in two ways:

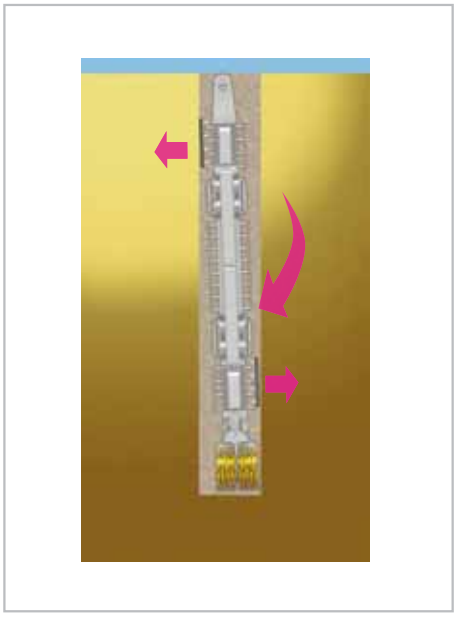
• moving faces flaps
• varying the inclination of the drums group respect to the main hydromill frame

**Hydromill orientation**
Reference scheme



MOVING SIDE FLAPS



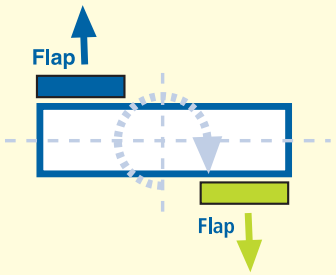
MOVING FACES FLAPS

MOVING SIDE FLAPS

VARYING INCLINATION OF DRUMS GROUP

## CORRECTION SYSTEM

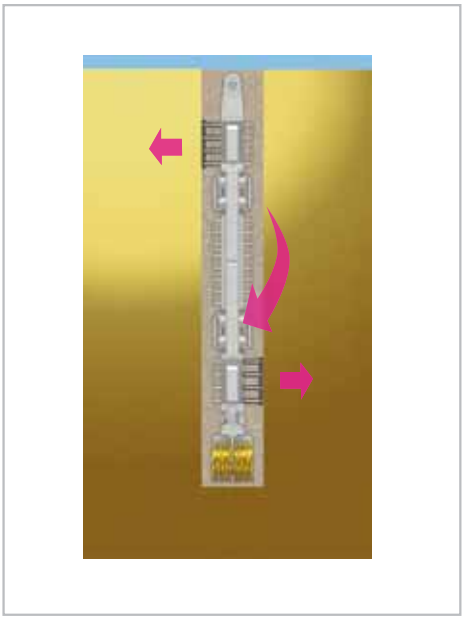
PLAN VIEW




### CORRECTION OF TWISTING ALONG Z AXIS

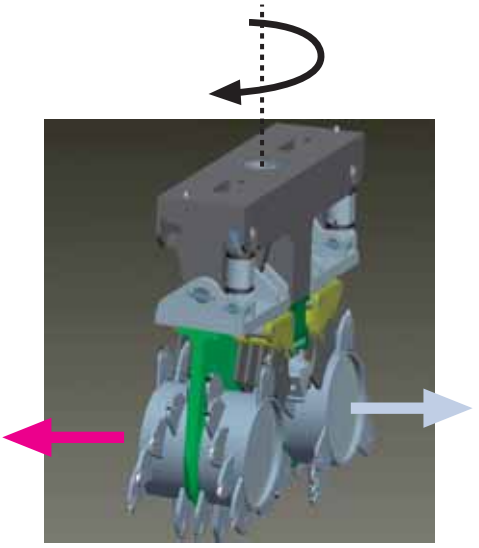
Correction of twisting along the Z axis can be achieved in two ways:

- **moving faces flaps**
- **moving separately each drums in respect to the main hydromill frame**



MOVING FACES FLAP

DIFFERENT INCLINATION OF EACH DRUMS



These inclination corrections are then progressively reduced until the complete correction of the verticality is achieved.
The operator can combine such actions in order to adjust the deviation and reposition the hydromill back to the vertical position, while excavation continues.
All correction operations are showed and controlled by the Soilmec DMS system.
The recorded data, graphically represented, will give a document proving the verticality of each excavated bite and panel.

**In normal operating conditions, the Hydromill models are capable of achieving depth up to 130-150 meters, with a vertical tolerance in the range of 0.2 - 0.4%, both in longitudinal and perpendicular direction.**

# DMS-PC SOFTWARE

## DMS - Drilling Mate System

The DMS allows a constant control, in real time, of all the excavation parameters. Moreover, the verticality is constantly monitored by means of sensors installed directly on the hydromill frame, allowing the operator to take corrective action at the slightest sign of deviation.

The Soilmec DMS system shows the following main parameters:

- **depth**
- **milling unit position on two or three axis, X** (longitudinal), **Y** (transversal) and **Z** (rotation).
- **rpm and oil pressure per each motor**
- **mud parameters:**
  - **suction pressure** (drilling hydrostatic pressure)
  - **downstream or output pressure**
  - **surface pressure** (mud hoses)
  - **flow rate**
- **hoist on drums**

### DMS-PC

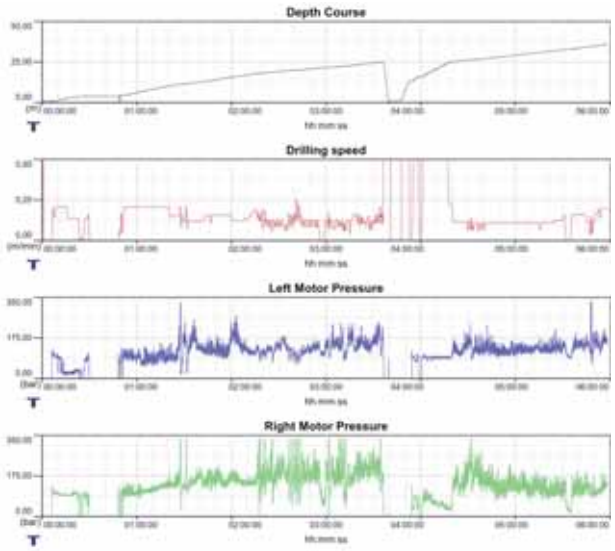
*DMS-PC is the software that allows to analyse the production data. It's possible to see the main digging parameters versus depth or versus time. The treated parameters are:*

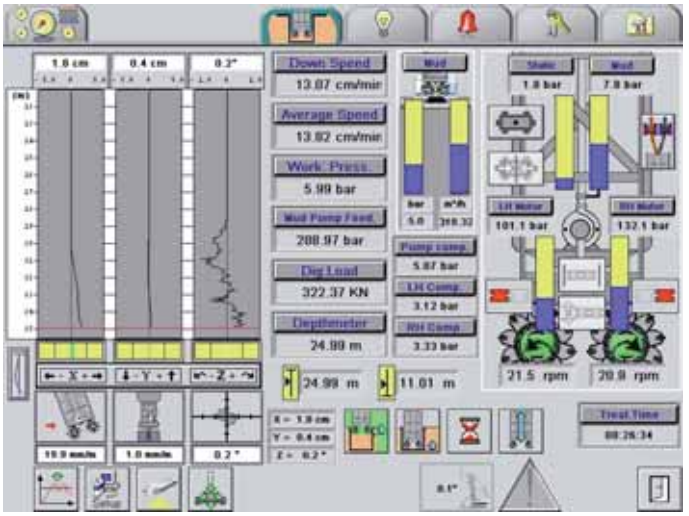
| DEPTH | TIME |
|---|---|
| drilling speed | *depth* |
| LH motor pressure | *drilling speed* |
| RH motor pressure | *LH motor pressure* |
| mud pressure | *RH motor pressure* |
| digging load | *mud pressure* |
| X deviation | *mud pump oil pressure* |
| Y deviation | *digging load* |
| Z deviation | *X deviation* |
| | *Y deviation* |
| | *Z deviation* |

*Matching these parameters it's also possible obtain other columns, i.e. % deviation tolerance columns vs time by means X deviation/depth (cm/m), Y deviation/depth (cm/m)*

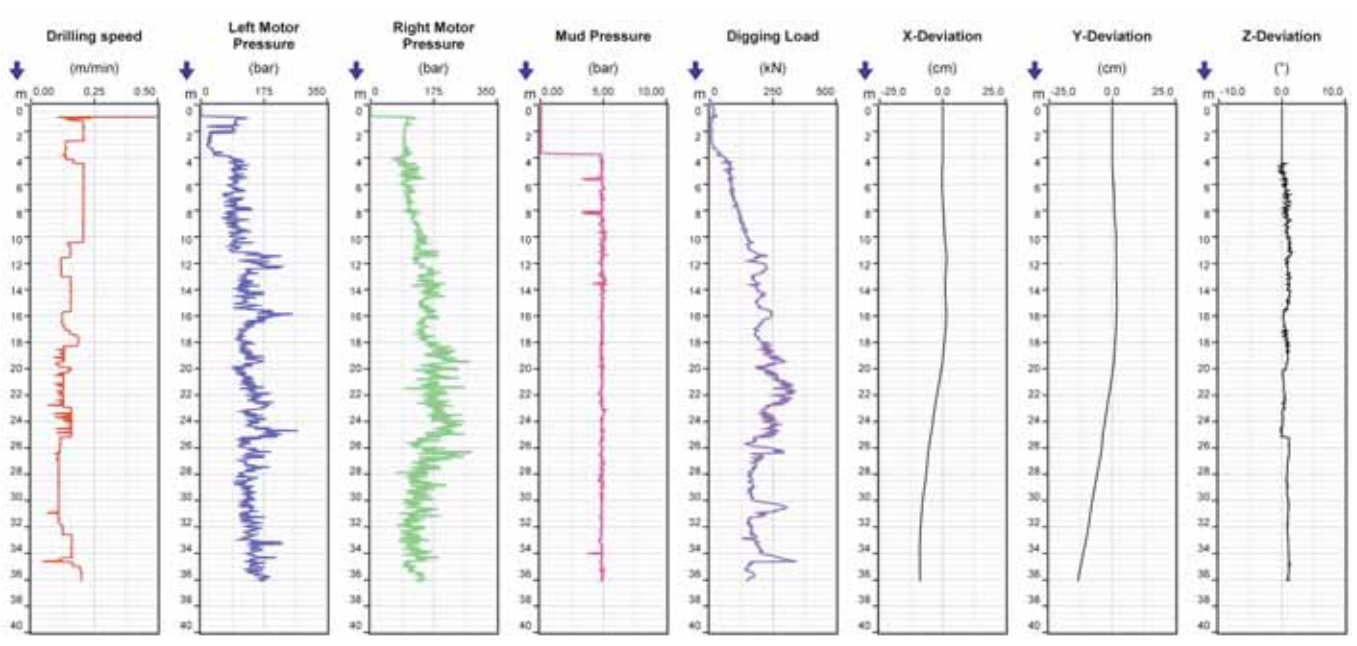
*With 3D option, DMS-PC can create a 3D view of the project to evaluate the quality of the joint and the whole structure deviations putting together the X, Y, Z displacements.*

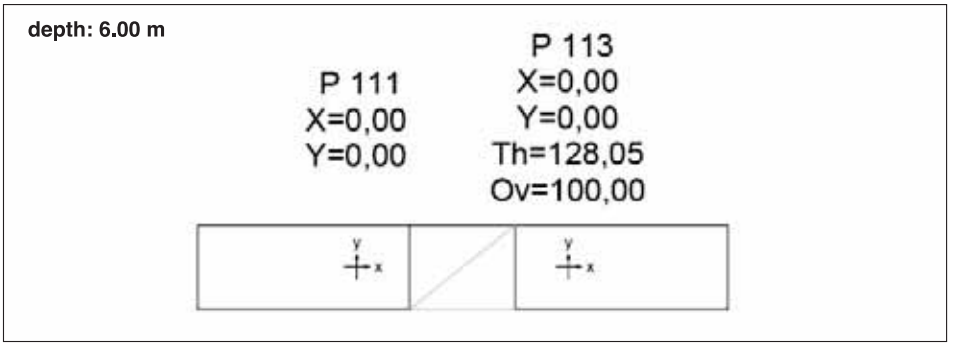
*The DMS system can monitor also the machine working parameters (engine data, alarms, etc), representing therefore a fundamental instrument to reduce intervention times on the equipment and to collect feedback on present rig status and on components average life.*
*For the first meters of excavation, the Hydromill is placed and maintained in the proper position by means of a guide frame fixed to the guide walls by hydraulic jacks.*

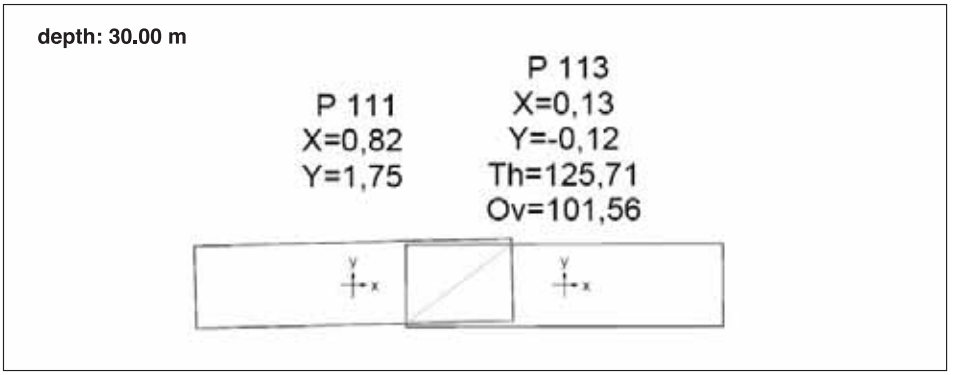


DMS General Control Board

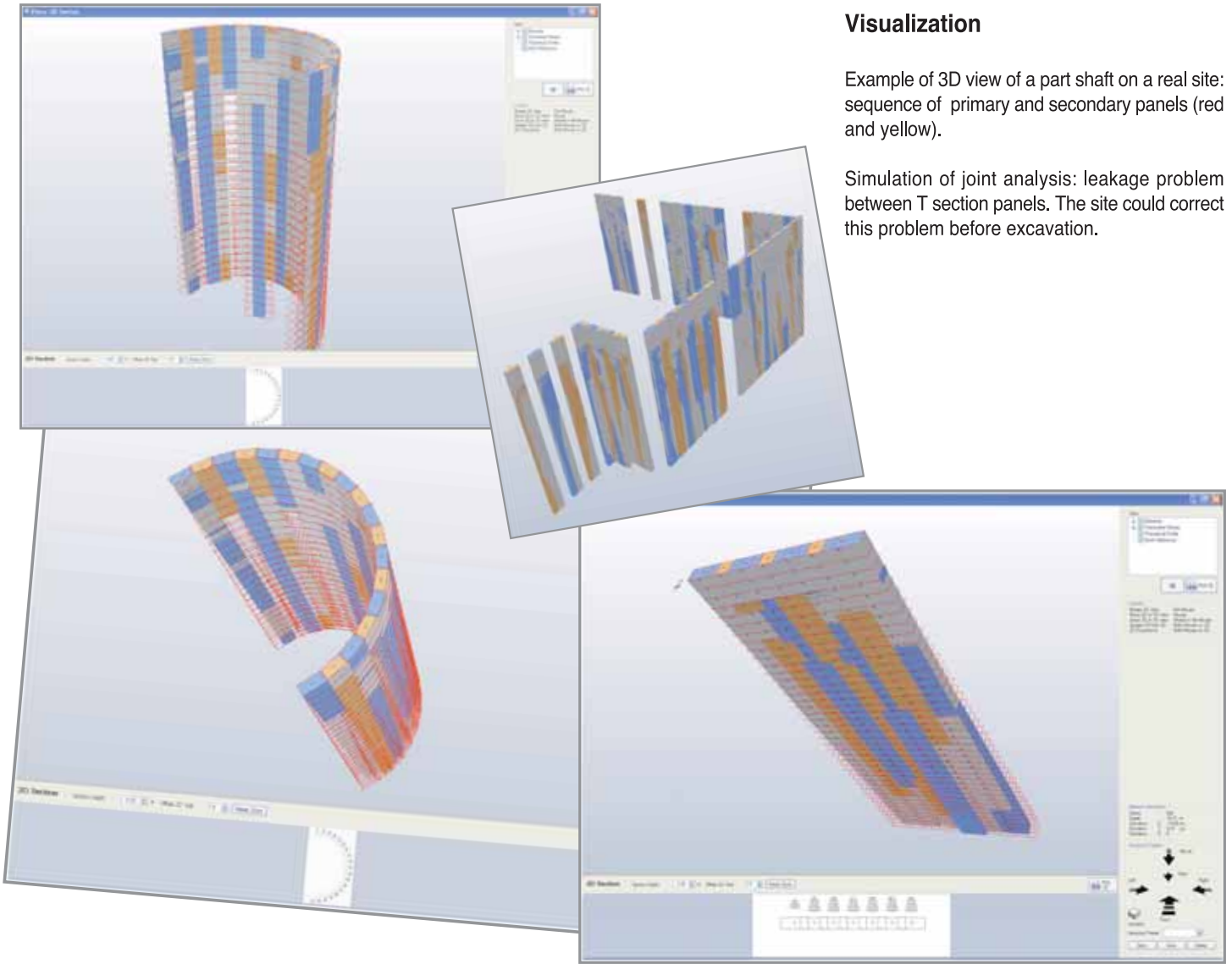





## OVERLAP ANALYSIS

DMS-PC 3D shows the cross section, at selected depth, of the contiguous panels writing their baricentric displacements and rotation *(X, Y and Z)* and the overlap area dimensions *(thickness and overlap)*. When thickness and overlap are out of the specified tollerance, they are highlighted in red by the software.



## Visualization

Example of 3D view of a part shaft on a real site: sequence of primary and secondary panels (red and yellow).

Simulation of joint analysis: leakage problem between T section panels. The site could correct this problem before excavation.

# DMS-MANAGER

## DMS - Drilling Mate System

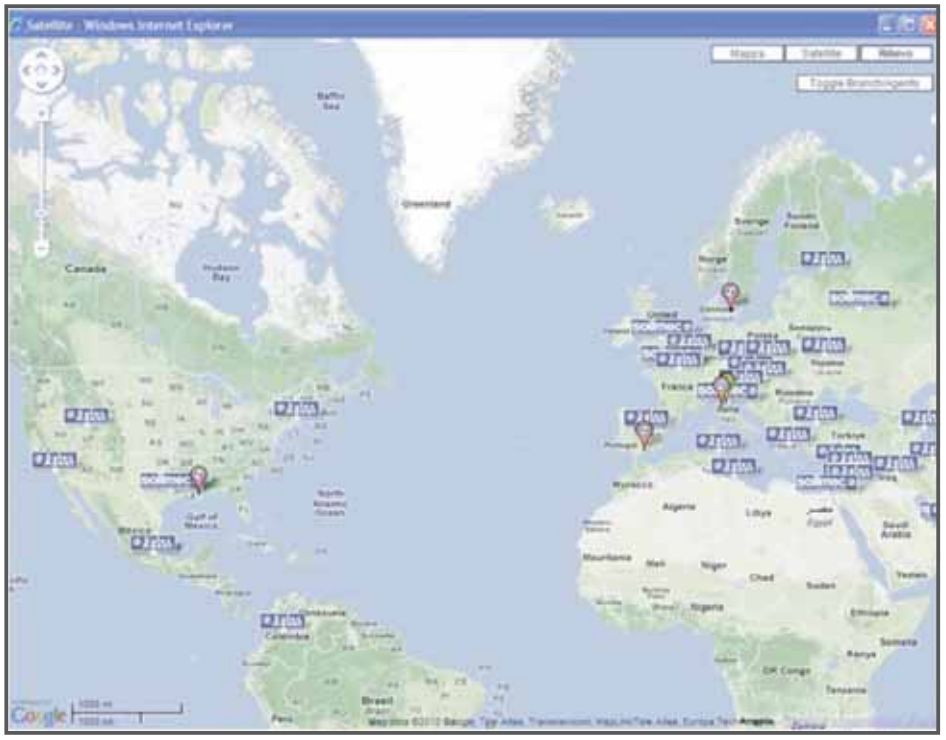
This software offers full monitoring of the entire DMS potential.

The main DMS Manager features are the following:

- history of alarms sent by the connected machines *(date and time)*
- machine alarm level
  *(standard, medium, severe)*
- storage of alarm signals for subsequent statistical analysis *(components reliability, event recurrence)*
- machine map positioning
- remote control
  *(real time connection with the rig)*

  This function allows:
  - helping the operator to configure DMS
  - improving the operator's technical knowledge on the machine from a remote location


**DMS MANAGER is a service that Soilmec offers to their customers. With DMS MANAGER Soilmec monitors the hydromill 24/7 around the world; having real time alarms on the rig, Soilmec can avoid delays to the site schedule.**




Soilmec

# CUTTER UNIT

## Soilmec Teeth Type

The milling unit drums are equipped with tooth holders suitable to mount all type of Soilmec teeth.

Different type of teeth are specially designed in order to tackle the characteristics of soil conditions (sharp for clayey material, crushing for gravel, boulders or rocks).
All Soilmec teeth are reinforced by tungsten carbide insert, in order to confer strength, hardness and life against abrasion and wear.

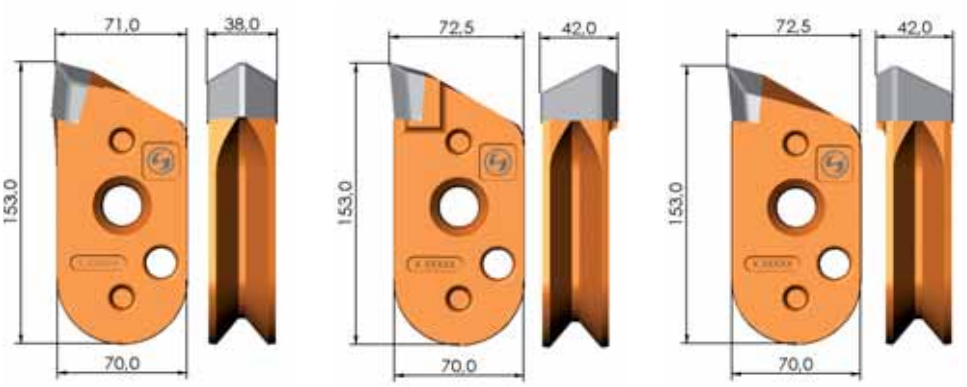
The main characteristic of Soilmec teeth are shown in the table below:

- **Body thickness:** **36 - 42 mm**
- **Body height:** **153 - 156 mm**
- **Teeth shape:** **Flat or Conical**
- **Available in right or left version**

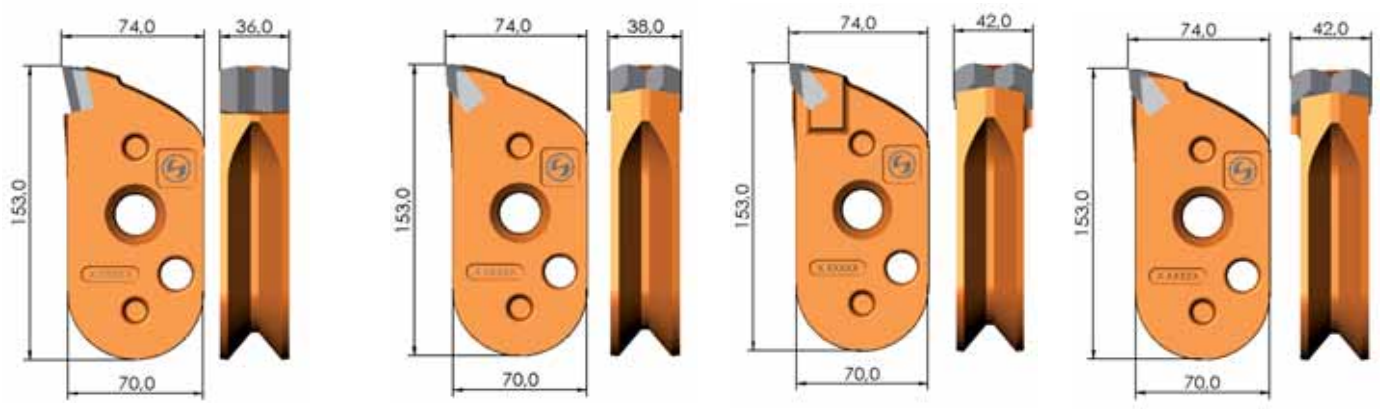
### Available flat teeth table

Multipurpose flat Soilmec tooth

### SM-SCT




### SM-DCT




### SM-PT

## Soilmec Teeth Type

### Available conical self sharpening teeth table

Conical self sharpening teeth

The shape of the teeth, function of soil conditions can be:

- Multipurpose flat tooth, with carbide plate, suitable for all type of soil (soft to medium stiff);
- Conical tooth, with carbide round insert, suitable for boulders and rocks;
- Conical self sharpening teeth can be supplied for hard rock applications.

### SM-TS *

### SM-BKS

### SM-TSX *

### SM-T3DD

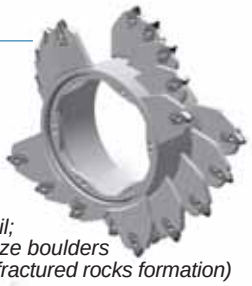
* The difference between **SM-TS** and **SM-TSX** is the tooth body surface treatment

# CUTTER UNIT

## Drums Charts

With the purpose to meet the most challenging soil conditions three different type of drums have been developed.For each drum type and dimension Soilmec have designed the relevant scrapers and mud inlet collectors and motoreducer body in order to optimize the spoil suction process and therefore to obtain the best drilling performance.

### Type 1 teeth drums



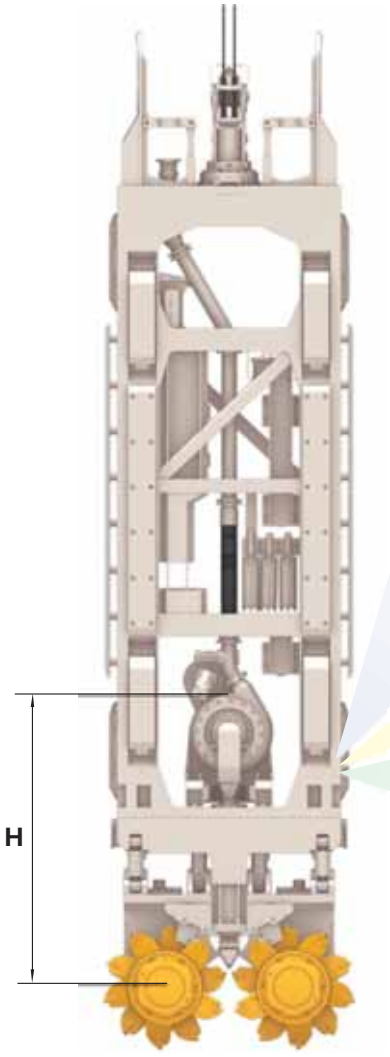
**Used in:**
*coarse and cohesive soil; alluvial soil with small size boulders soft rocks, medium-soft fractured rocks formation) and decompressed rocks.*

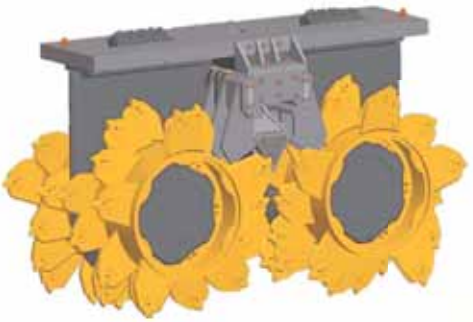
### Type 2 teeth drums

**Used in:**
*medium-hard fractured rocks and decompressed rocks.*

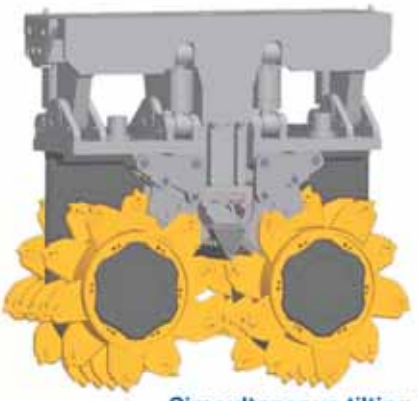
### Rock pick drums

**Used in:**
*low fractured medium and hard rock formation over 50 MPa.*

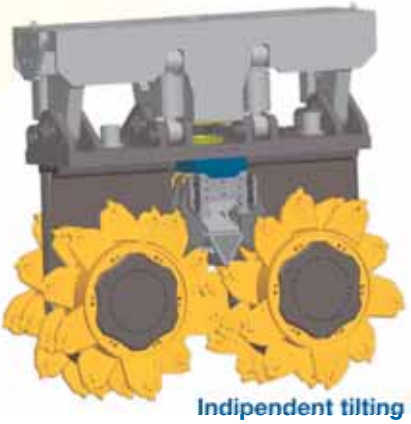


**Fixed plate c/w "flipper tooth"**
**H= 2.7 m (8.9 ft)**



**Simoultaneous tilting plate**
**H= 3.5 m (11.5 ft)**



**Indipendent tilting plate**
**H= 3.5 m (11.5 ft)**

**In according to the different customer requests and soil conditions Soilmec developed three different and easily interchangeable solutions for the connection plate of the cutting unit to the main module body.**

**1) FIXED PLATE**
The most simple and economic solution that has also the advantage to reduce of about 1 m. the height of the mud pump.

**2) SIMULTANEUS TILTING PLATE**
This solution, moving the cutting unit in front-back direction, helps during the cutting of the central ridge between the two drums and to correct the module deviation in the Y-Y axis. It is very precious in a not homogeneous rock layers.

**3) INDEPENDENT TILTING PLATE**
In this configuration the two "cutting wheels" can tilt independently in front-back direction. This solution has the same features of the simultaneous tilting plate but in addition it can correct the module rotation with respect of the vertical (Z-Z axe deviation). It is very helpful especially in not homogeneous soil and high depth panels.

HOSE WHEELS DESIGN

## “ Cougar ”

- **Hose wheels design (HWD)**, positioned below the cathead and free to follow the hydromill movements,with a tensioning and rewinding automatic system.

# EQUIPMENT

## COUGAR

| Carrier | SC-100 | | SC-135 | |
|---|---|---|---|---|
| Max height | 34 m | *112 ft* | 42 m | *138 ft* |
| Max cutting depth with *SH-30* | 52 m | *171 ft* | 67 m | *220 ft* |
| Max cutting depth *with SH-40* | - | - | 61 m | *200 ft* |
| Engine power | 563 kW | *755 HP* | 653 kW | *876 HP* |
| Machine class | 100000 kg | *220462 lb* | 135000 kg | *297624 lb* |
| Hydromill module | SH-30 | *SH-30* | SH-30 / SH-40 | *SH-30 / SH-40* |

**HDD (Hose Drums Design):**
Hydraulic and mud winders positioned on base carrier allows a compact unit and high depth drilling performance

HOSE DRUMS DESIGN
## “ Tiger ”

*The hydromill is cable-suspended to the supporting crane’s boom through a cathead and a motorized swivel, manufactured under Soletanche Fressynet license, located at the top of the hydromill frame*

# EQUIPMENT

## TIGER

| Carrier | SC-135 | |
|---|---|---|
| Height | 26,5 m | *86.9 ft* |
| Max cutting depth | 100 / 120 m | *328.4 / 393.7 ft* |
| Engine power | 653 kW | *876 HP* |
| Machine class | 135000 kg | *297624 lb* |
| Hydromill module | SH-30/SH-40/SH-50 | *SH-30/SH-40/SH-50* |

| **Carrier** | **SC-200 c/w P450/P700** | |
|---|---|---|
| Height | 30 m | *98,4 ft* |
| Max cutting depth | 250 m | *820 ft* |
| Engine power | 450 kW | *603 HP* |
| Ext. power pack | 450 kW / 708 KW | *603 HP / 950 HP* |
| Machine class | 200000 kg | *440924 lb* |
| Hydromill module | SH-30 / SH-40 / SH-50 | *SH-30 / SH-40 / SH-50* |

## T - Panels device

TIGER
*version 90°*

COUGAR
*version 90°*

In some panel layout the diaphragms can be positioned orthogonally as the picture on right shows.

Especially in little job sites the rig orientation change is a very difficult operation increasing in this way time loses and costs. In order to solve this limitation Soilmec develops a rotating module system which allows the module itself rotation. Here below, **either for Cougar or Tiger version**, the carrier/module 0°-90°configurations for T panels are presented in their limit positions. Thanks to this system the rig placing time in case of corner or t-panels can be reduced up to 50 %.

**All technical data are merely indicative and subject to change without notice**



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