MWD on small diameter rigs

State of art

- Geotechnical drilling / soil investigation: Widely used in Europe, starting to be used in the US.

- Small diameter foundation drilling (anchors, tie-backs, micropile, etc): Widely used in Europe, barely used (or not used) in the US.

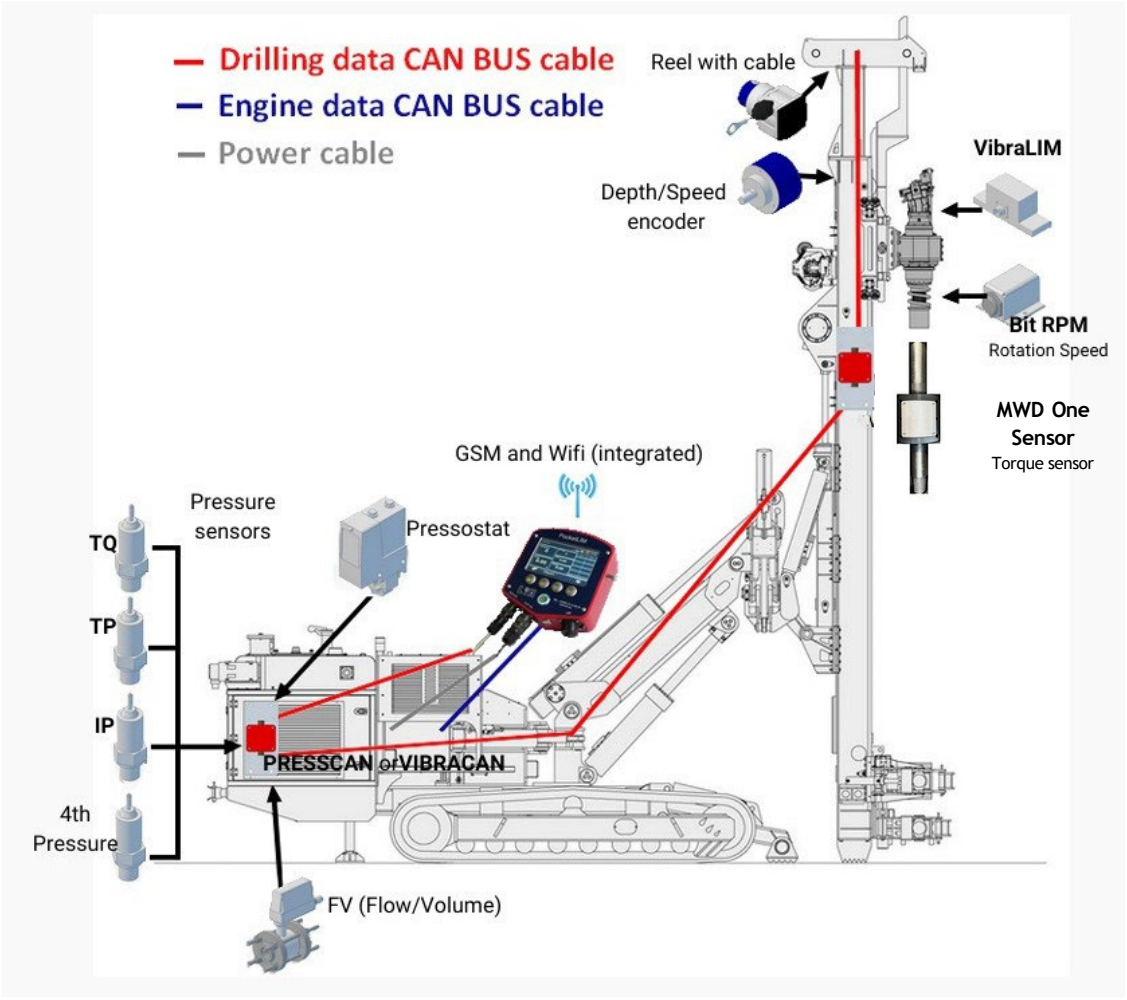




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MWD on small diameter rigs

Sensors overview



Here is a general set-up of the sensors on a small diameter drill rig. That is including geotechnical, micropile, anchors, tie-backs, etc.

Parameters that can be recorded Depth

- Penetration sensor;
- TQ: Torque pressure (hydraulic); TP:
- Crowd pressure;
- IP: Water pressure;
- Opt. VibraLIM (vibration sensor); Opt.
- RPM sensor (rotation speed); Torque
- sensor (mechanical);
- Opt. Flowmeter;
- Volume, flow and pressure of the grout.

Data can be transferred by with internet connectivity or USB.

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MWD on small diameter rigs

Set up

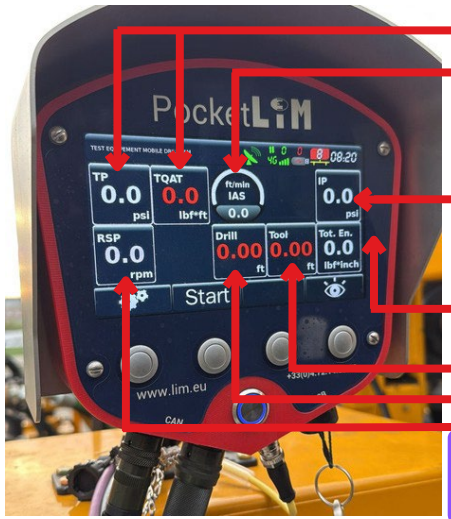


Depth encoder and Penetration sensor: This setup includes a reel with a 5m (16ft) steel cable.

RPM sensor: In the left picture, we find the RPM sensor. It is detecting the four corners of the kelly bar.



Pressure sensor with membrane separator: The sensor measures the pressure of the injected grout.
Electromagnetic flowmeter: It is measuring the flow and the volume of the injected grout.



Penetration Rate (ft/hr)

Feed pressure (psi) and True Torque (lb-ft)

Down the hole depth (ft)

Water Pressure (psi)

Tool tracking depth (ft)

Specific Energy (psi)

Rotation Speed (rpm)

Note also, the pressure sensors are installed behind the gauges.







Junction boxes: Sensors are connected to the different junction boxes: Feed, torque, and injection pressure, RPM, Depth sensor.

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MWD on small diameter rigs

Micropile report

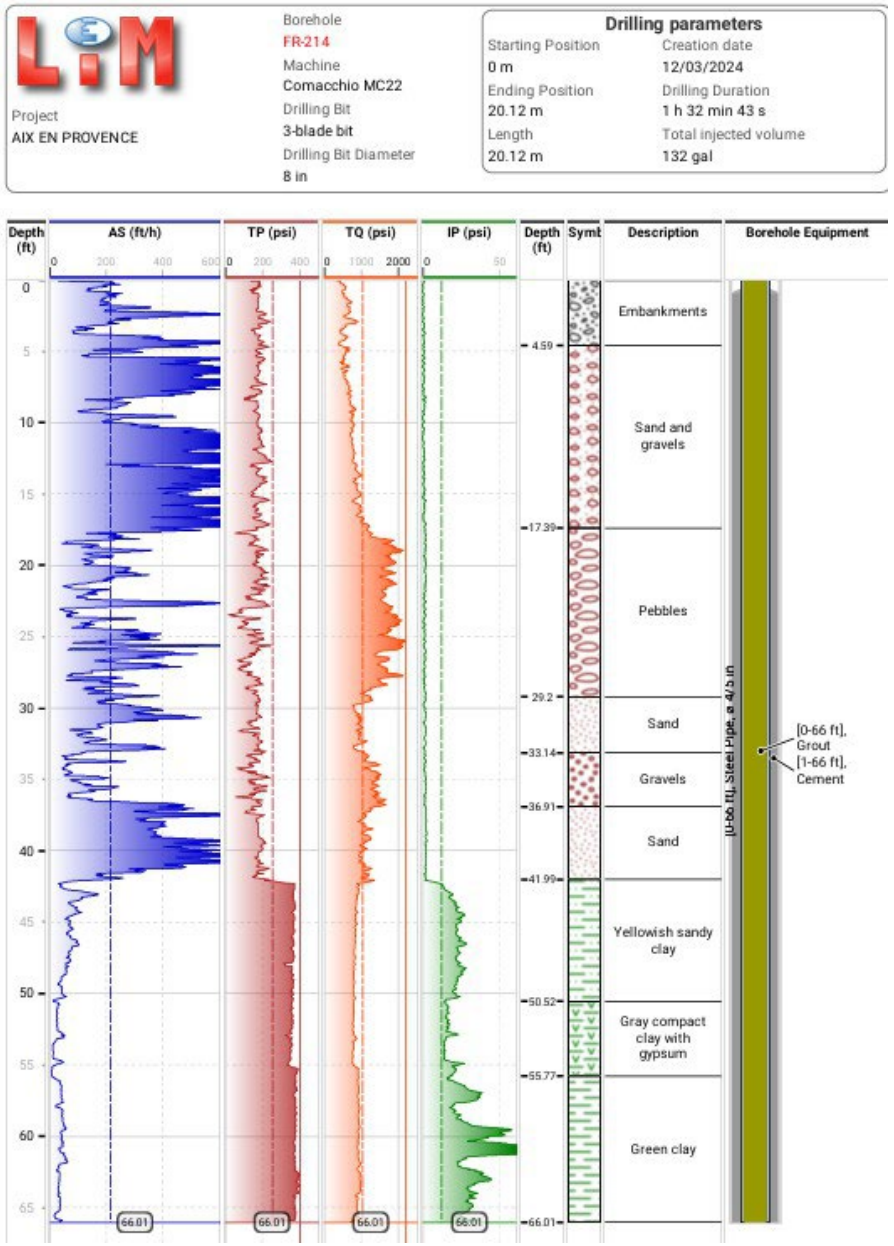
The report can be received in a real time. It can be used as proof for the contractor.

The header gathers the information info related to the drill rig (brand, tool, etc) and to the borehole itself (length, GPS location, time, grout volume, etc).

0-42ft: Heterogeneity in the ground; not very solid. It can be seen with variation in the different drilling parameters.

42-65ft: Homogeneity in this section. We are in the bedrock. The equipment is well anchored into the hardest part of the borehole.

On the right side of the report, we could create the lithology and equipment into the borehole. This is done manually with the software.



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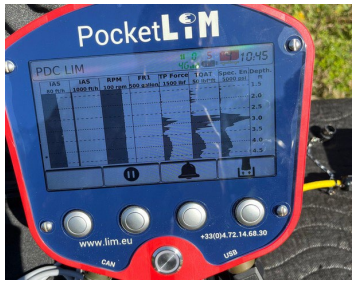
MWD on small diameter rigs

How to use the data?

- Geotechnical drilling / soil investigation:
  Drilling optimization for core recovery;
  Limit SPT test;
  Provide information when CPTrefusal;
  Correlate with in-situ test;
  Continuous log.

- Small diameter foundation drilling (anchors, tie- backs, micropile, etc):
  Check for geological concern;
  Make a decision on grout volume to be injected;
  Make sure the length of the equipment is well in place in the “bedrock”;
  Insure the work has been done correctly;
  Protect the contractor if there is a litigation









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MWD + Data Recording

Soil Mixing

MWD - What Data is Recorded?

Sensors located on tool / base carriers include:

	SCM / SCM-DH	MSM	CSM
Deviations ("X" and "Y" Directions)	-	-	+
Torque* (Calculated value based on oil pressure)	+	+	+
Mixing Speed (tool or cutting wheel)	+	+	+
Flow and Pressure of the Slurry	+	+	+
Hydrostatic Pressure (in the panel)	-	-	+
Machine Data (e.g., depth, crowd force, etc.)	+	+	+

MWD- Sensor Locations

Column Mixing



Mixing Speed
(rpm)

Mast Inclination
(Inclinometer)

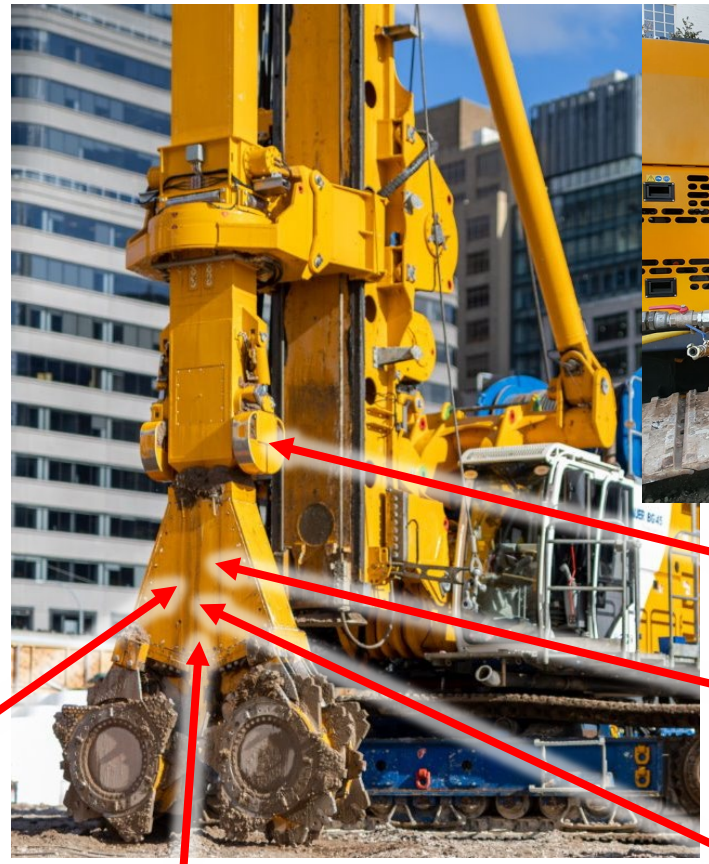
Depth
position measurement of the crowd sledge (Incremental encoder on the feed winch)

Crowd Force
(Hydraulic Pressure)

Winch Force
(Hydraulic Pressure)

Slurry Pressure
(Pressure Sensor)

CSM - Specific





Slurry Volume
(Flow Meter)

Steering Flaps
(Position Measurement)

Deviations
(Inclinometer)

Hydrostatic Pressure in Panel
(Pressure Sensor)

Mixing Wheel Rotation Speed / Direction
(Incremental Encoder)

MWD - Data Recording

B-Tronic Instrumentation System example CSM:

All data relevant to operation is displayed on the B-Tronic monitor for the machine operator and stored for evaluation.

Slurry/grout flow rate

Hydraulic pressure for “mixing wheel drive”

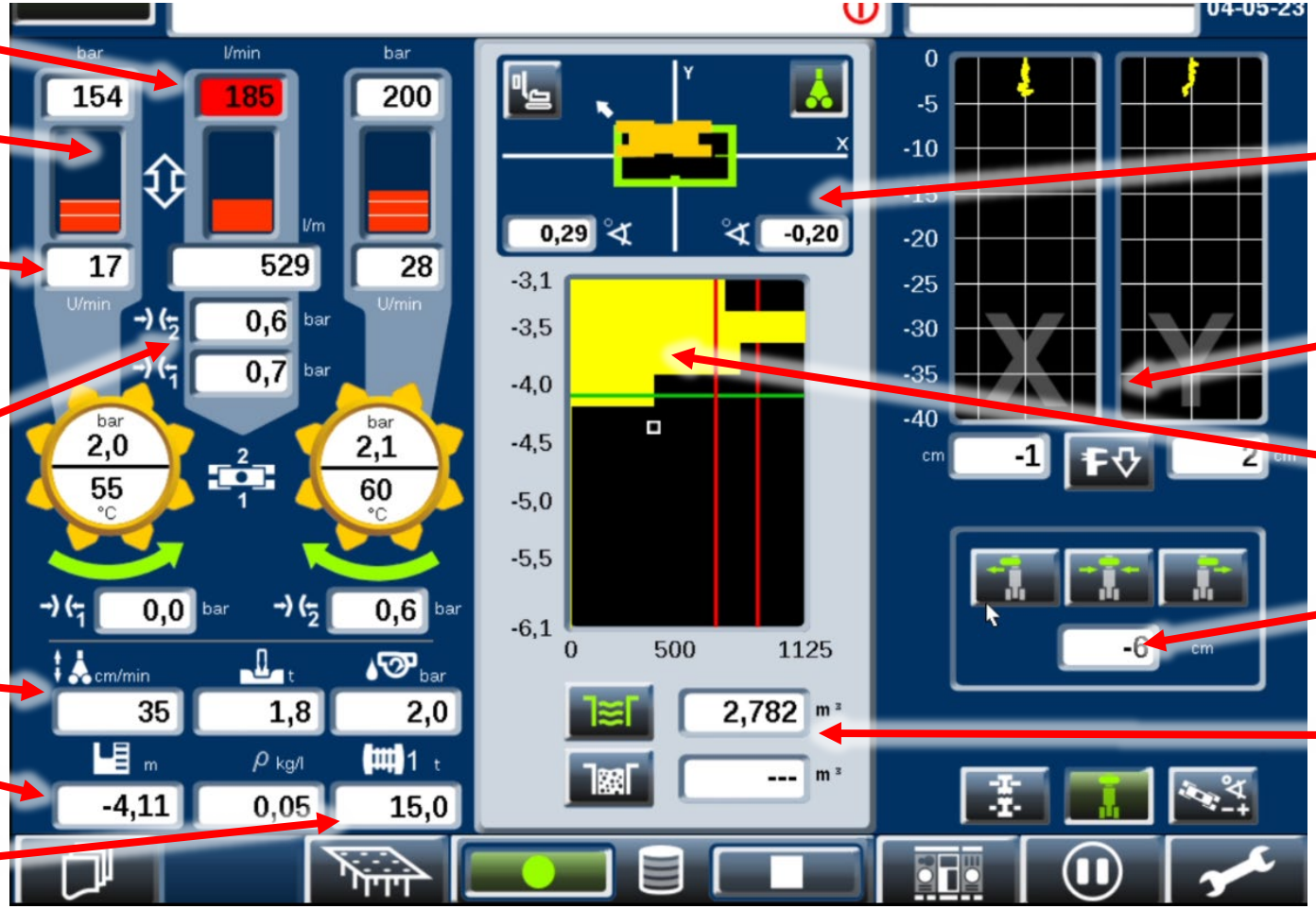
Rotation speed mixing wheels

Hydrostatic pressure inside the panel at actual depth

Penetration speed

Actual depth

Main winch pulling force



Measured values Inclinometer mixing head (BCM) and Mast

Deviation

Slurry/grout already injected, shown over depth

Position steering flaps

Volume pumped slurry/grout

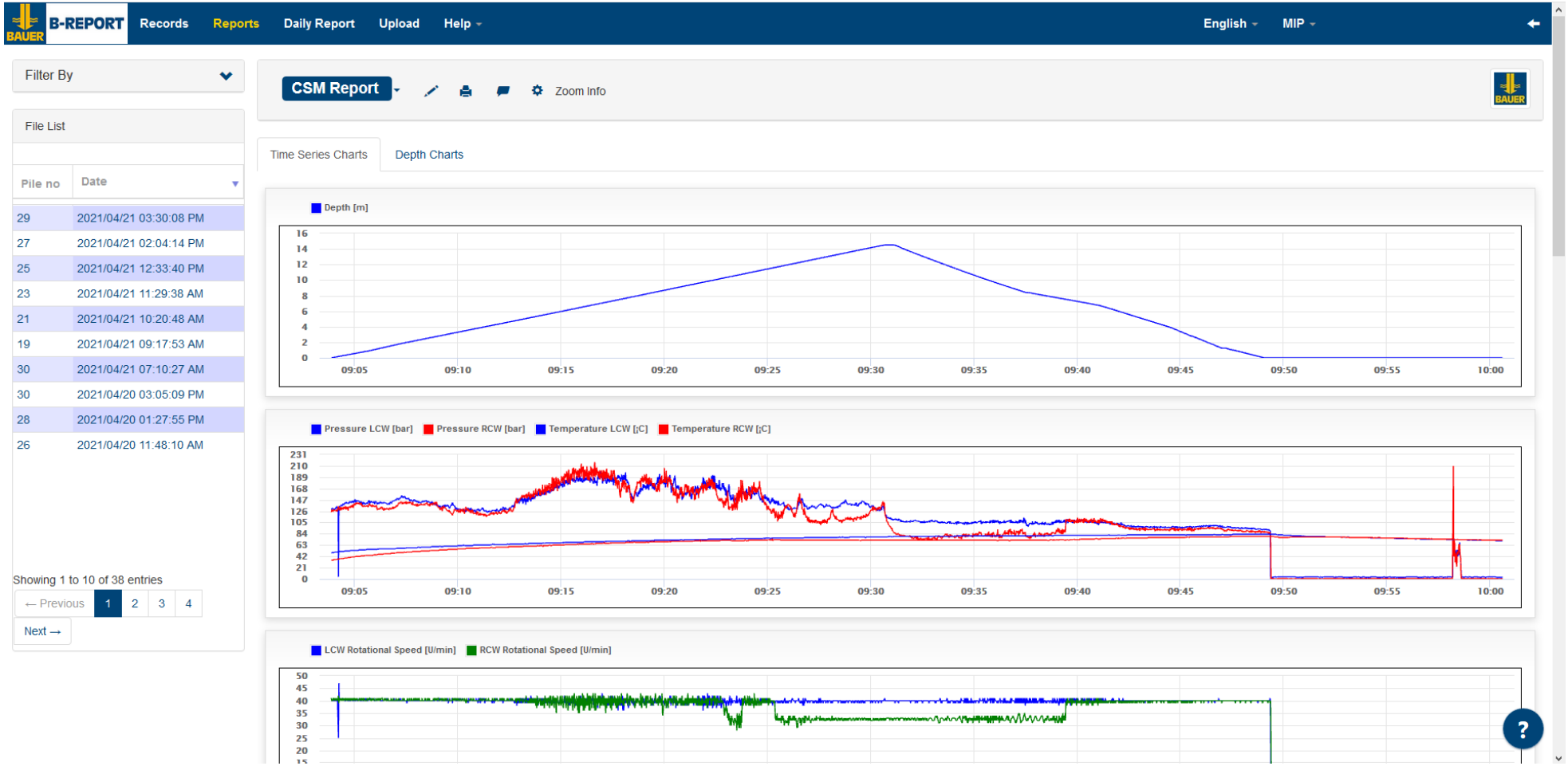
Soil Mixing Assistant System

MWD - Data Recording

Evaluation of production data with B-Report software

Depending on the method, up to 50 different data sets can be displayed.

Graphical representation over depth/time possible.

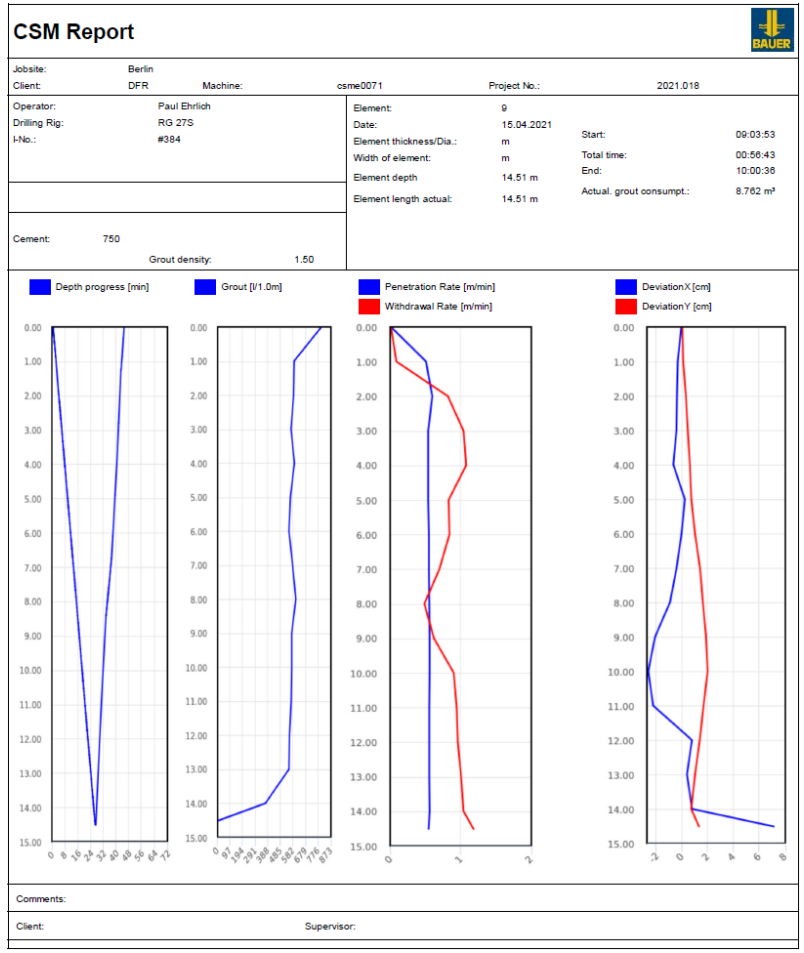


MWD - Data Recording

Mixing Logs for Clients

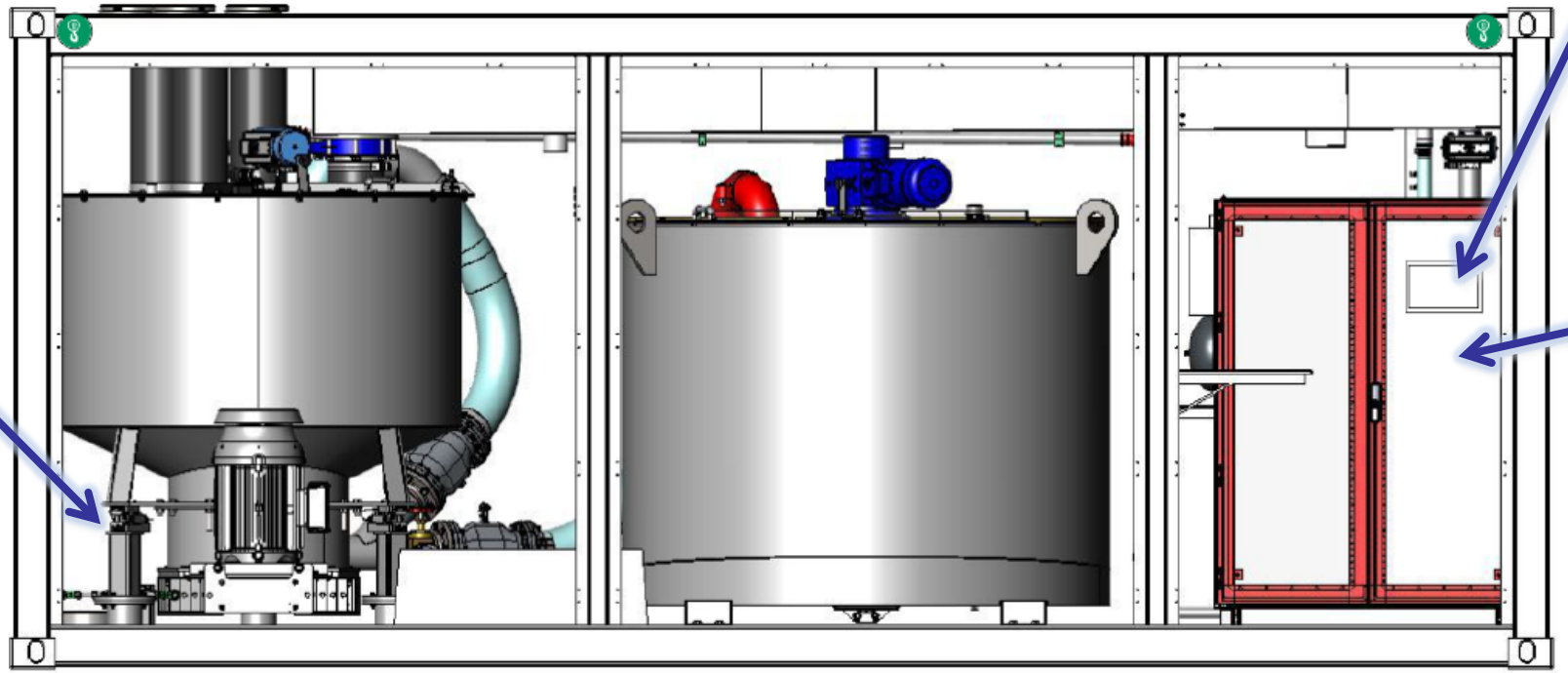
Logs with graphs over time or depth





MWD - Data Recording

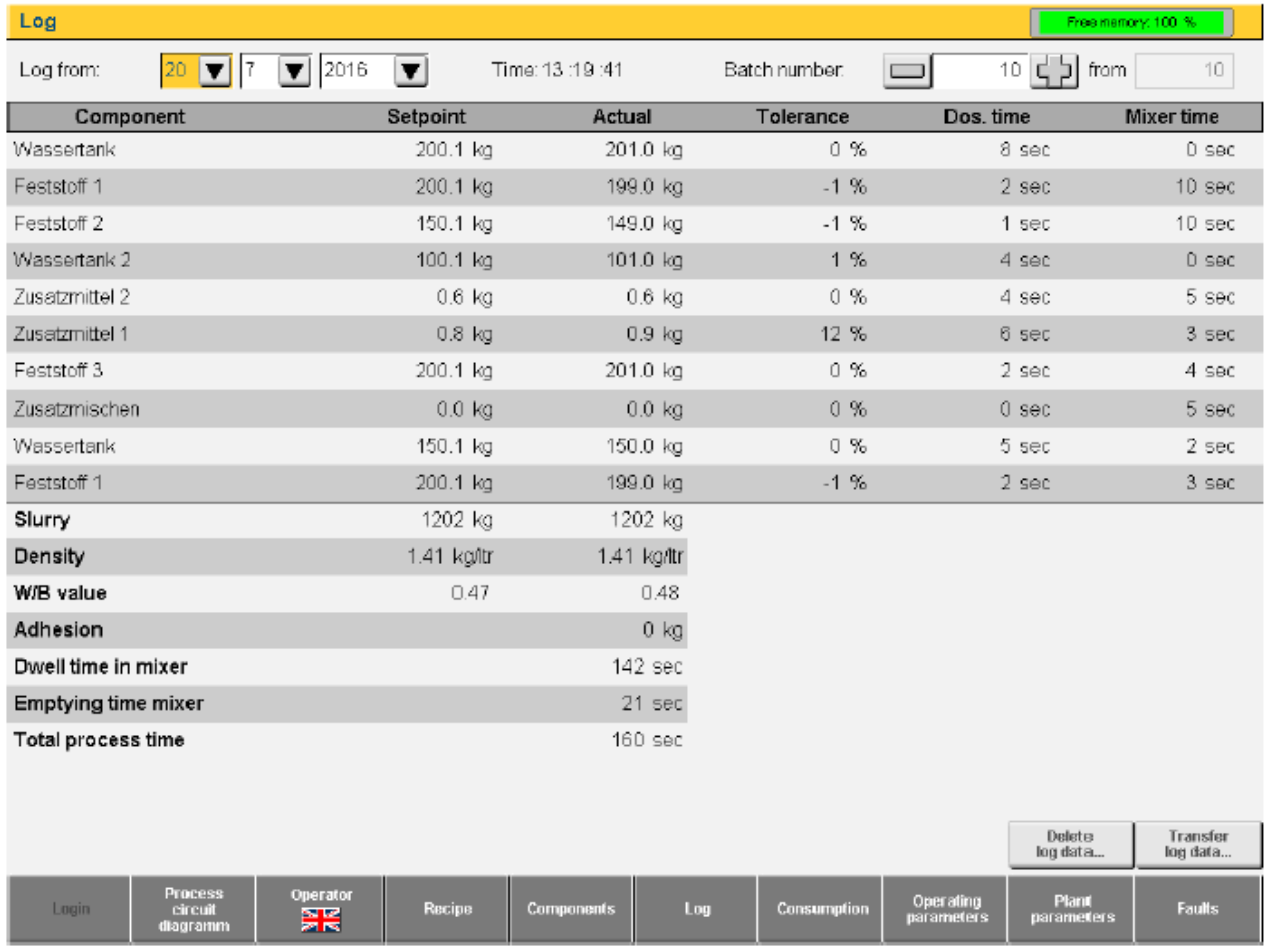
MAT CMS mixing plants are equipped with data recording



MWD - Data Recording

Slurry Recipe

Display of the quantities used on the tactile monitor



MWD - Data Recording

Stored data per mixed batch

- Sequential batch no.
- Recipe name
- Start date of batch
- Start time of batch

<u>For up to 8 recipe components:</u>

- Name of recipe component
- Target value for dosing quantity
- Actual value for dosing quantity
- Actual value for dosing deviation
- Actual value for dosing time
- Actual value for mixing time

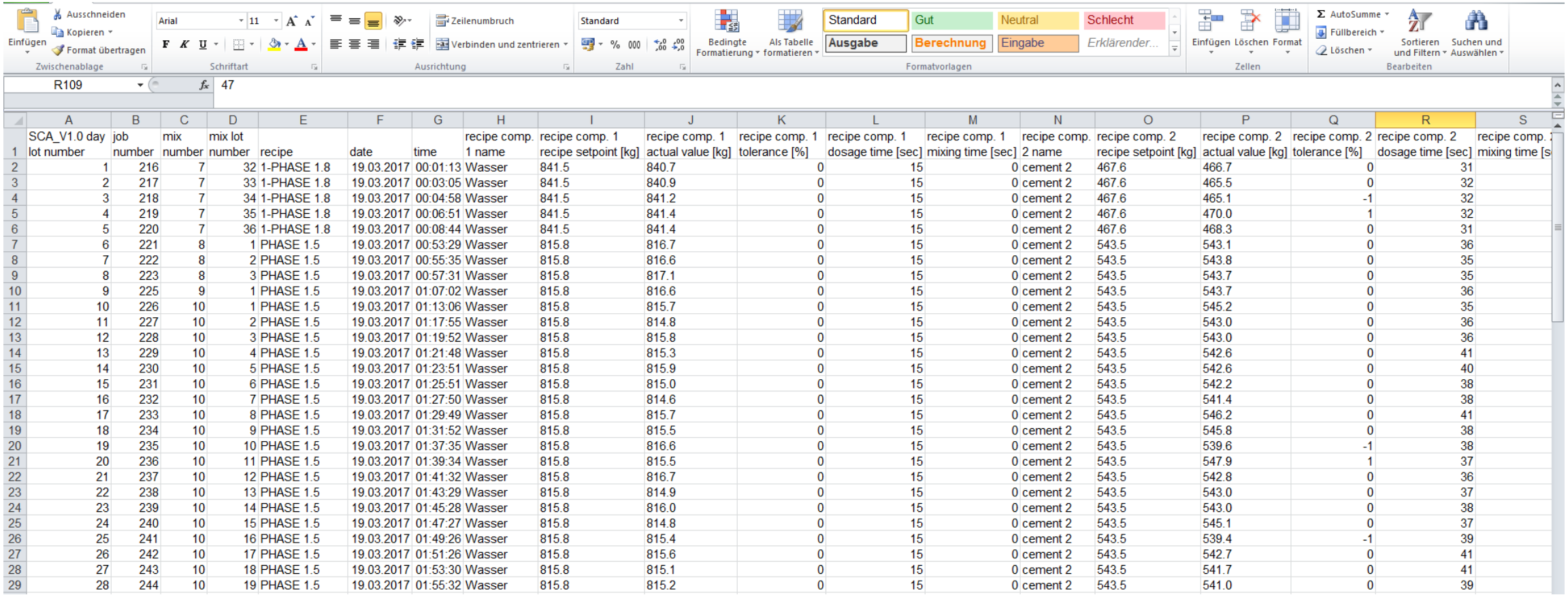
Additional Data fields:

- Retention time in the mixer
- Process time
- Target batch quantity
- Actual batch quantity
- Target density
- Actual density
- W/C target value
- W/C actual value
- Adhesion quantity

MWD - Data Recording

Data Interface

Stored data can be transferred to a computer via the USB interface and displayed there using Excel.



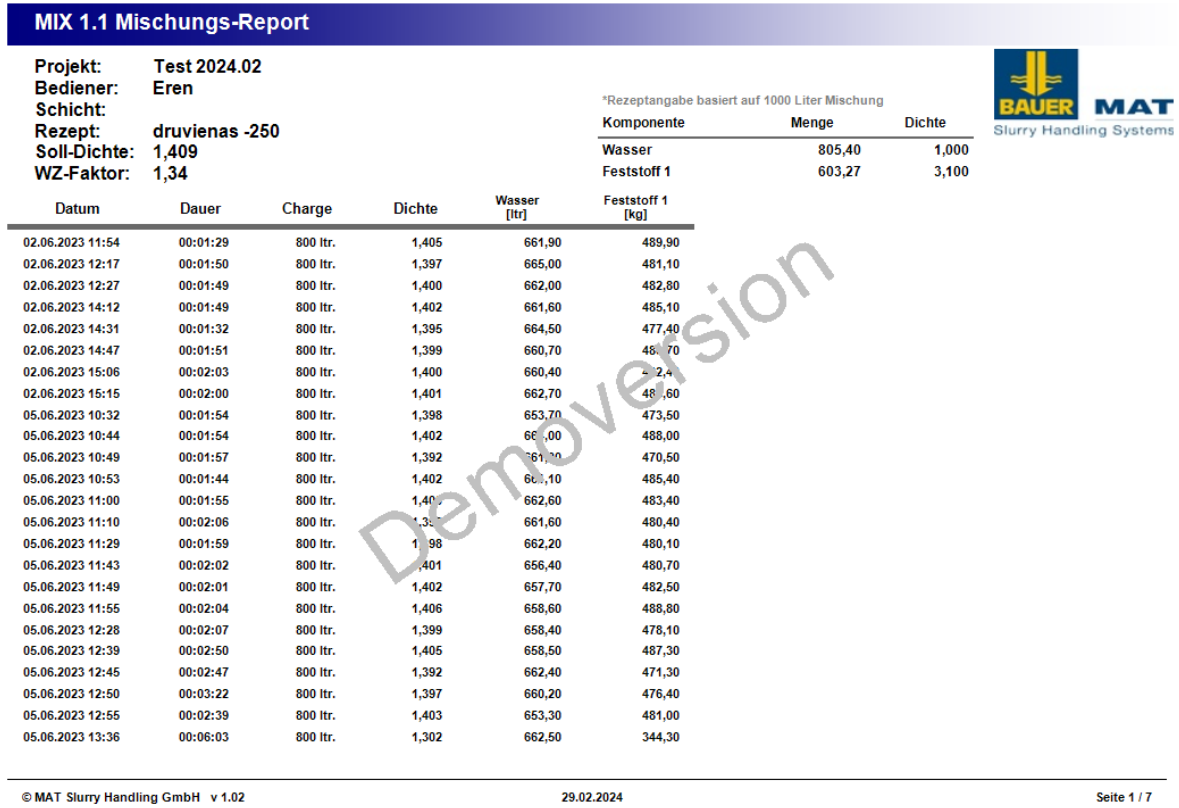
R109 | 47

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	SCA_V1.0 day lot number	job number	mix number	mix lot number	recipe	date	time	recipe comp. 1 name	recipe comp. 1 recipe setpoint [kg]	recipe comp. 1 actual value [kg]	recipe comp. 1 tolerance [%]	recipe comp. 1 dosage time [sec]	recipe comp. 1 mixing time [sec]	recipe comp. 2 name	recipe comp. 2 recipe setpoint [kg]	recipe comp. 2 actual value [kg]	recipe comp. 2 tolerance [%]	recipe comp. 2 dosage time [sec]	recipe comp. 2 mixing time [s
2	1	216	7	32	1-PHASE 1.8	19.03.2017	00:01:13	Wasser	841.5	840.7	0	15	0	cement 2	467.6	466.7	0	31	
3	2	217	7	33	1-PHASE 1.8	19.03.2017	00:03:05	Wasser	841.5	840.9	0	15	0	cement 2	467.6	465.5	0	32	
4	3	218	7	34	1-PHASE 1.8	19.03.2017	00:04:58	Wasser	841.5	841.2	0	15	0	cement 2	467.6	465.1	-1	32	
5	4	219	7	35	1-PHASE 1.8	19.03.2017	00:06:51	Wasser	841.5	841.4	0	15	0	cement 2	467.6	470.0	1	32	
6	5	220	7	36	1-PHASE 1.8	19.03.2017	00:08:44	Wasser	841.5	841.4	0	15	0	cement 2	467.6	468.3	0	31	
7	6	221	8	1	PHASE 1.5	19.03.2017	00:53:29	Wasser	815.8	816.7	0	15	0	cement 2	543.5	543.1	0	36	
8	7	222	8	2	PHASE 1.5	19.03.2017	00:55:35	Wasser	815.8	816.6	0	15	0	cement 2	543.5	543.8	0	35	
9	8	223	8	3	PHASE 1.5	19.03.2017	00:57:31	Wasser	815.8	817.1	0	15	0	cement 2	543.5	543.7	0	35	
10	9	225	9	1	PHASE 1.5	19.03.2017	01:07:02	Wasser	815.8	816.6	0	15	0	cement 2	543.5	543.7	0	36	
11	10	226	10	1	PHASE 1.5	19.03.2017	01:13:06	Wasser	815.8	815.7	0	15	0	cement 2	543.5	545.2	0	35	
12	11	227	10	2	PHASE 1.5	19.03.2017	01:17:55	Wasser	815.8	814.8	0	15	0	cement 2	543.5	543.0	0	36	
13	12	228	10	3	PHASE 1.5	19.03.2017	01:19:52	Wasser	815.8	815.8	0	15	0	cement 2	543.5	543.0	0	36	
14	13	229	10	4	PHASE 1.5	19.03.2017	01:21:48	Wasser	815.8	815.3	0	15	0	cement 2	543.5	542.6	0	41	
15	14	230	10	5	PHASE 1.5	19.03.2017	01:23:51	Wasser	815.8	815.9	0	15	0	cement 2	543.5	542.6	0	40	
16	15	231	10	6	PHASE 1.5	19.03.2017	01:25:51	Wasser	815.8	815.0	0	15	0	cement 2	543.5	542.2	0	38	
17	16	232	10	7	PHASE 1.5	19.03.2017	01:27:50	Wasser	815.8	814.6	0	15	0	cement 2	543.5	541.4	0	38	
18	17	233	10	8	PHASE 1.5	19.03.2017	01:29:49	Wasser	815.8	815.7	0	15	0	cement 2	543.5	546.2	0	41	
19	18	234	10	9	PHASE 1.5	19.03.2017	01:31:52	Wasser	815.8	815.5	0	15	0	cement 2	543.5	545.8	0	38	
20	19	235	10	10	PHASE 1.5	19.03.2017	01:37:35	Wasser	815.8	816.6	0	15	0	cement 2	543.5	539.6	-1	38	
21	20	236	10	11	PHASE 1.5	19.03.2017	01:39:34	Wasser	815.8	815.5	0	15	0	cement 2	543.5	547.9	1	37	
22	21	237	10	12	PHASE 1.5	19.03.2017	01:41:32	Wasser	815.8	816.7	0	15	0	cement 2	543.5	542.8	0	36	
23	22	238	10	13	PHASE 1.5	19.03.2017	01:43:29	Wasser	815.8	814.9	0	15	0	cement 2	543.5	543.0	0	37	
24	23	239	10	14	PHASE 1.5	19.03.2017	01:45:28	Wasser	815.8	816.0	0	15	0	cement 2	543.5	543.0	0	38	
25	24	240	10	15	PHASE 1.5	19.03.2017	01:47:27	Wasser	815.8	814.8	0	15	0	cement 2	543.5	545.1	0	37	
26	25	241	10	16	PHASE 1.5	19.03.2017	01:49:26	Wasser	815.8	815.4	0	15	0	cement 2	543.5	539.4	-1	39	
27	26	242	10	17	PHASE 1.5	19.03.2017	01:51:26	Wasser	815.8	815.6	0	15	0	cement 2	543.5	542.7	0	41	
28	27	243	10	18	PHASE 1.5	19.03.2017	01:53:30	Wasser	815.8	815.1	0	15	0	cement 2	543.5	541.7	0	41	
29	28	244	10	19	PHASE 1.5	19.03.2017	01:55:32	Wasser	815.8	815.2	0	15	0	cement 2	543.5	541.0	0	39	

MWD - Data Recording

Providing Batch Data to Clients

With ReportControl5, tabular summaries of the batches produced can be created as PDF files.



MIX 1.1 Mischungs-Report

Projekt: Test 2024.02
Bediener: Eren
Schicht:
Rezept: druvienas -250
Soll-Dichte: 1,409
WZ-Faktor: 1,34

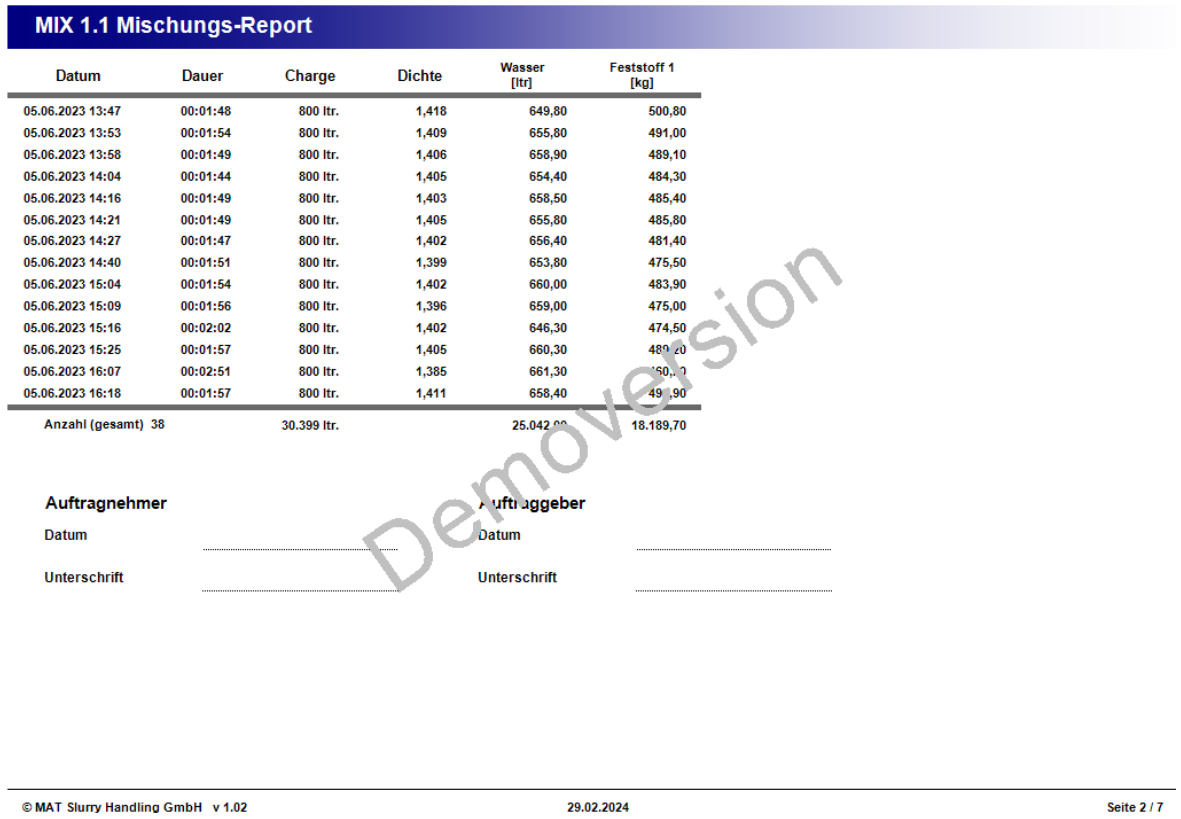
*Rezeptangabe basiert auf 1000 Liter Mischung

Komponente	Menge	Dichte
Wasser	805,40	1,000
Feststoff 1	603,27	3,100

BAUER MAT Slurry Handling Systems

Datum	Dauer	Charge	Dichte	Wasser [ltr]	Feststoff 1 [kg]
02.06.2023 11:54	00:01:29	800 ltr.	1,405	661,90	489,90
02.06.2023 12:17	00:01:50	800 ltr.	1,397	665,00	481,10
02.06.2023 12:27	00:01:49	800 ltr.	1,400	662,00	482,80
02.06.2023 14:12	00:01:49	800 ltr.	1,402	661,60	485,10
02.06.2023 14:31	00:01:32	800 ltr.	1,395	664,50	477,40
02.06.2023 14:47	00:01:51	800 ltr.	1,399	660,70	48[illegible]70
02.06.2023 15:06	00:02:03	800 ltr.	1,400	660,40	[illegible]2,4[illegible]
02.06.2023 15:15	00:02:00	800 ltr.	1,401	662,70	48[illegible]60
05.06.2023 10:32	00:01:54	800 ltr.	1,398	653,70	473,50
05.06.2023 10:44	00:01:54	800 ltr.	1,402	66[illegible]00	488,00
05.06.2023 10:49	00:01:57	800 ltr.	1,392	[illegible]	470,50
05.06.2023 10:53	00:01:44	800 ltr.	1,402	66[illegible]10	485,40
05.06.2023 11:00	00:01:55	800 ltr.	1,40[illegible]	662,60	483,40
05.06.2023 11:10	00:02:06	800 ltr.	1,3[illegible]	661,60	480,40
05.06.2023 11:29	00:01:59	800 ltr.	1,398	662,20	480,10
05.06.2023 11:43	00:02:02	800 ltr.	1,401	656,40	480,70
05.06.2023 11:49	00:02:01	800 ltr.	1,402	657,70	482,50
05.06.2023 11:55	00:02:04	800 ltr.	1,406	658,60	488,80
05.06.2023 12:28	00:02:07	800 ltr.	1,399	658,40	478,10
05.06.2023 12:39	00:02:50	800 ltr.	1,405	658,50	487,30
05.06.2023 12:45	00:02:47	800 ltr.	1,392	662,40	471,30
05.06.2023 12:50	00:03:22	800 ltr.	1,397	660,20	476,40
05.06.2023 12:55	00:02:39	800 ltr.	1,403	653,30	481,00
05.06.2023 13:36	00:06:03	800 ltr.	1,302	662,50	344,30

Demoversion



MIX 1.1 Mischungs-Report

Datum	Dauer	Charge	Dichte	Wasser [ltr]	Feststoff 1 [kg]
05.06.2023 13:47	00:01:48	800 ltr.	1,418	649,80	500,80
05.06.2023 13:53	00:01:54	800 ltr.	1,409	655,80	491,00
05.06.2023 13:58	00:01:49	800 ltr.	1,406	658,90	489,10
05.06.2023 14:04	00:01:44	800 ltr.	1,405	654,40	484,30
05.06.2023 14:16	00:01:49	800 ltr.	1,403	658,50	485,40
05.06.2023 14:21	00:01:49	800 ltr.	1,405	655,80	485,80
05.06.2023 14:27	00:01:47	800 ltr.	1,402	656,40	481,40
05.06.2023 14:40	00:01:51	800 ltr.	1,399	653,80	475,50
05.06.2023 15:04	00:01:54	800 ltr.	1,402	660,00	483,90
05.06.2023 15:09	00:01:56	800 ltr.	1,396	659,00	475,00
05.06.2023 15:16	00:02:02	800 ltr.	1,402	646,30	474,50
05.06.2023 15:25	00:01:57	800 ltr.	1,405	660,30	48[illegible]20
05.06.2023 16:07	00:02:51	800 ltr.	1,385	661,30	[illegible]0,1
05.06.2023 16:18	00:01:57	800 ltr.	1,411	658,40	49[illegible],90
Anzahl (gesamt) 38		30.399 ltr.		25.042,[illegible]	18.189,70

Auftragnehmer
Datum .....
Unterschrift .....

Auftraggeber
Datum .....
Unterschrift .....

Demoversion

MWD- Data Recording

Reporting Batch information for Clients

With ReportControl5, individual reports can be generated for each batch.



MIX-1.2 Detail-Report

Projekt:	Test 2024.02	Adhesion:	31 kg
Rezept:	druvienas -250	Gesamtzeit Mischer:	179 sek.
Jobnr.:	36	Gesamtzeit Prozess:	202 sek.
Chargennr.:	0	Entleerzeit Mischer:	37 sek.
Startdatum	05.06.2023	Ø Mischerstrom:	26,15 A
Startuhrzeit:	12:50:22	max. Mischerstrom:	30,04 A
Chargenmenge Soll:	800,0	Durchsatz:	14,50 m³/h
Chargenmenge Ist:	813,9	Anlagentyp:	CMS-30
Dichte Soll:	1,41 kg/ltr	Baunummer:	SC-0000550
Dichte Ist:	1,40 kg/ltr	Bediener:	Vadims Neverciks
W/F Soll:	1,34		
W/F Ist:	1,39		

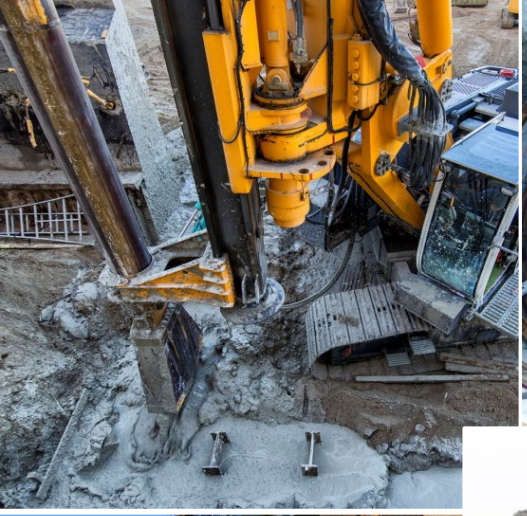
Nr.	Komponente	Soll (kg)	Ist (kg)	Toleranz (%)	Dosierzeit (s)	Mischszeit (s)
1	Wasser	644,30	660,20	2,5	9	0
2	Feststoff 1	482,60	476,40	-1,3	124	15

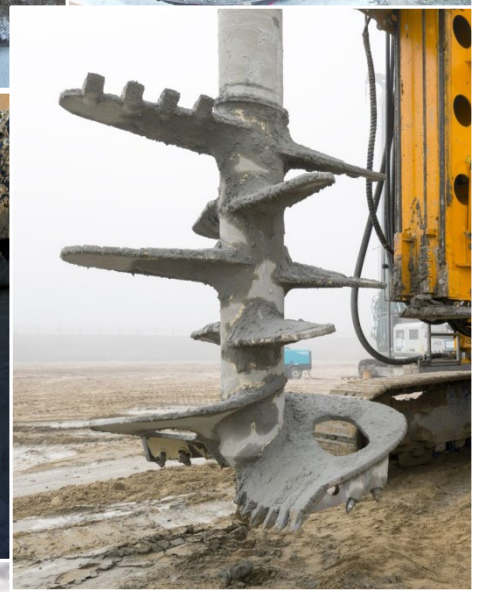
Nr.	Komponente	Total (kg)	Rohdichte	Bindemittelfaktor
1	Wasser	660,20	1,00	W
2	Feststoff 1	476,40	3,10	F

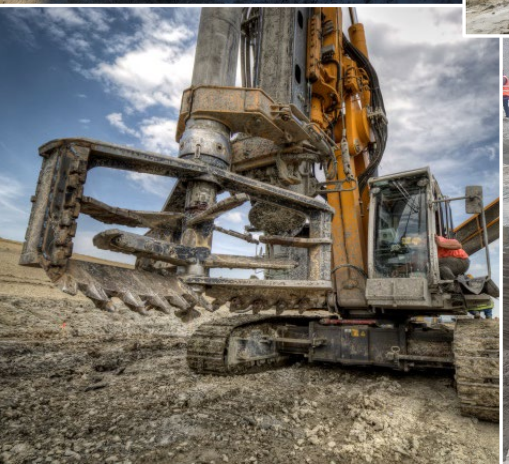
Demoversion

Auftragnehmer
Datum .....
Unterschrift .....

Auftragnehmer
Datum .....
Unterschrift .....








PASSION for PROGRESS

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MWD Panel Discussion

Michel Lariau
JEAN LUTZ North America
Canfield, Ohio

- Deliver monitoring/instrumentation for the Geotechnical industry for the United States and Canada
- Sensors, Data loggers, Software, Data management
- JEAN LUTZ SA data loggers and sensors plus customization for the North American market

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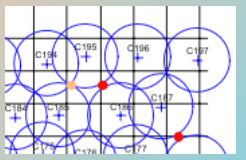


MWD and jetgrouting



- ***H***
  pc
  rp
- ***C***
  lift
- ***Q***

- ❖ **Verticality control and overlap**



- ❖ **Accurate positioning and as built recording (GPS)**

MWD and jetgrouting

- Real time depth of the tool bit
- RPM
- Uplift rate
- Grout Pressure
- Air flow

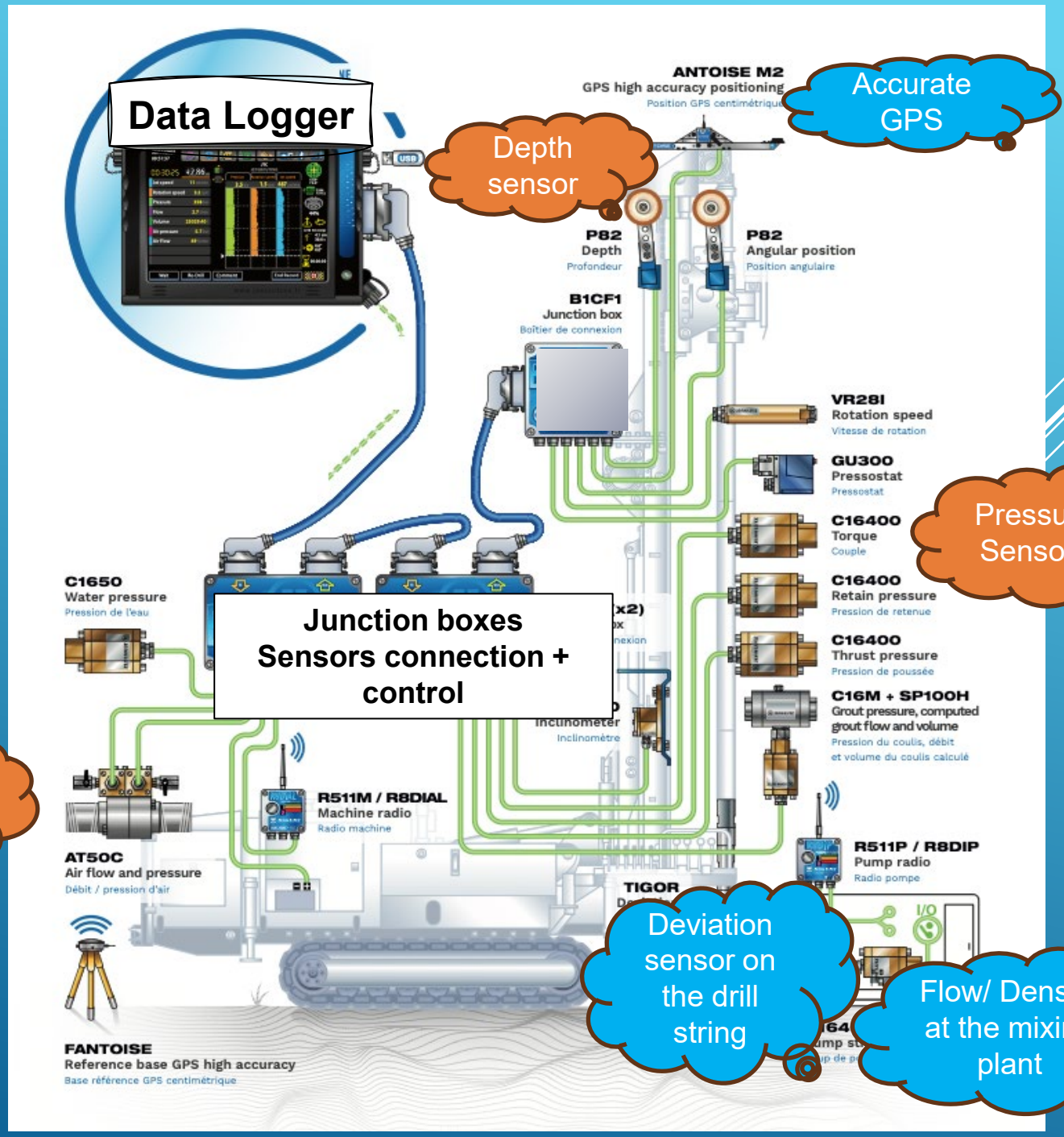
Grout Flow and volume, Air pressure, Inclination of the mast, torque

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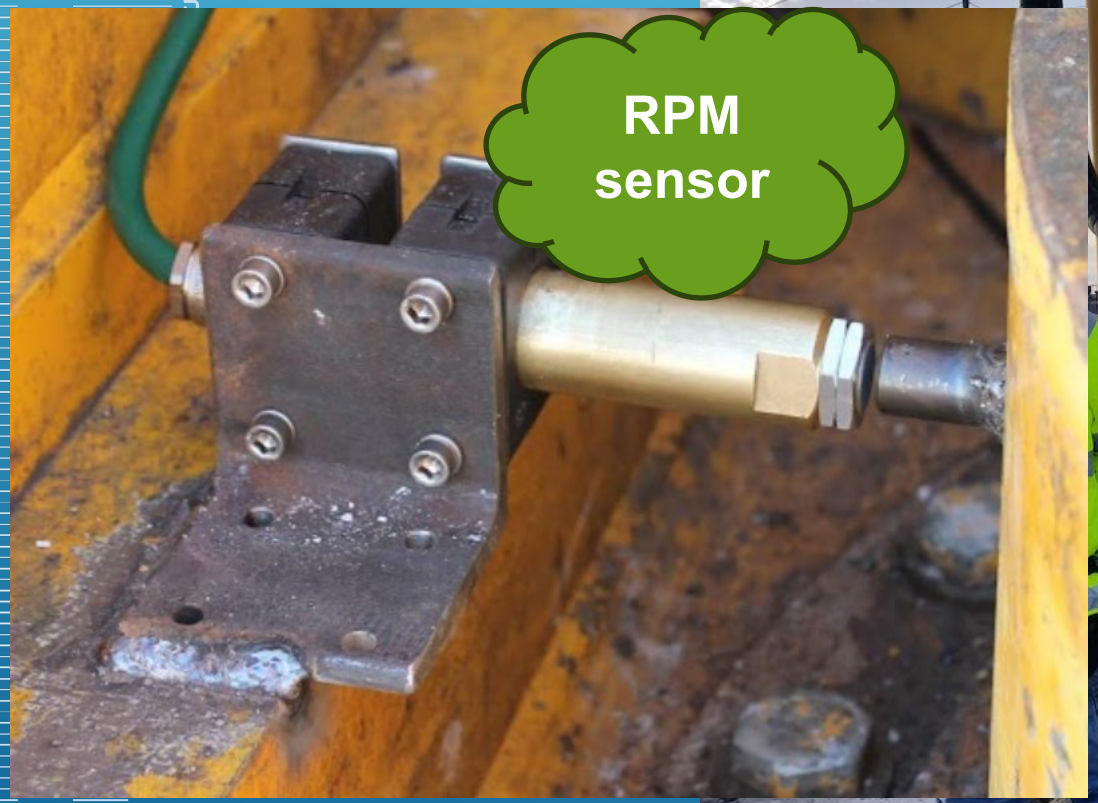
Density

Real deviation of the column

GPS positioning and as built record

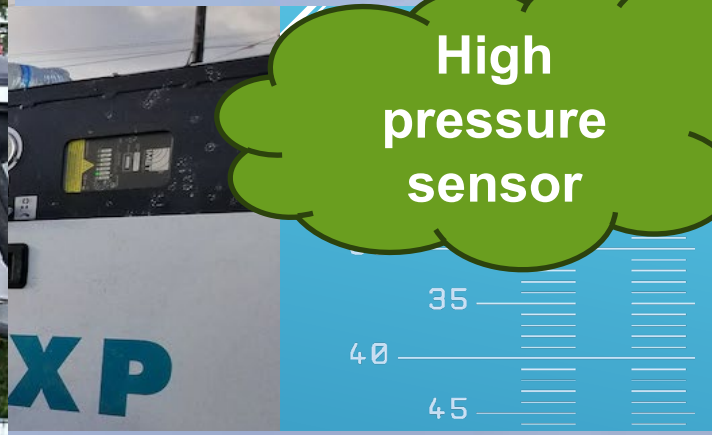

Data Logger
ANTOISE M2
GPS high accuracy positioning
Position GPS centimétrique
Accurate GPS
Depth sensor
P82
Depth
Profondeur
P82
Angular position
Position angulaire
B1CF1
Junction box
Boîtier de connexion
VR28I
Rotation speed
Vitesse de rotation
GU300
Pressostat
Pressostat
C16400
Torque
Couple
C16400
Retain pressure
Pression de retenue
C16400
Thrust pressure
Pression de poussée
C16M + SP100H
Grout pressure, computed grout flow and volume
Pression du coulis, débit et volume du coulis calculé
Pressure Sensors
C1650
Water pressure
Pression de l'eau
Junction boxes
Sensors connection + control
Inclinometer
Inclinomètre
R511M / R8DIAL
Machine radio
Radio machine
R511P / R8DIP
Pump radio
Radio pompe
AT50C
Air flow and pressure
Débit / pression d'air
Air pressure and flow
TIGOR
Deviation sensor on the drill string
Flow/ Density at the mixing plant
FANTOISE
Reference base GPS high accuracy
Base référence GPS centimétrique

MWD


RPM
sensor


Depth
sensor




High
pressure
sensor

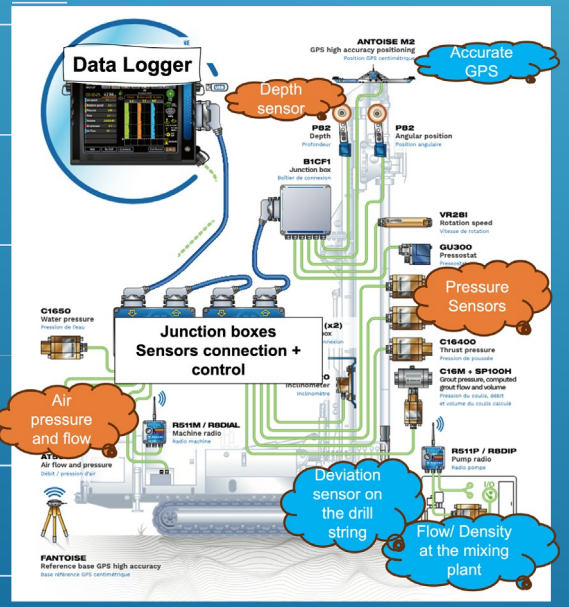

Air
pressure
and flow

MWD and jetgrouting

Flow and volume measurement

Flow + Nozzles = pressure

- No pressure without flow
- Direct relation between pressure and flow
- Pressure function or pressure stroke counter





- Flowmeter at the mixing plant (wireless when possible) with density option

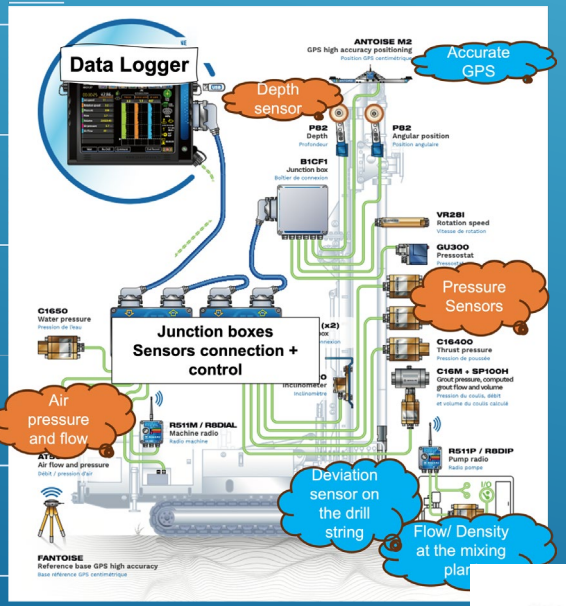
MWD and jetgrouting

Machine automation

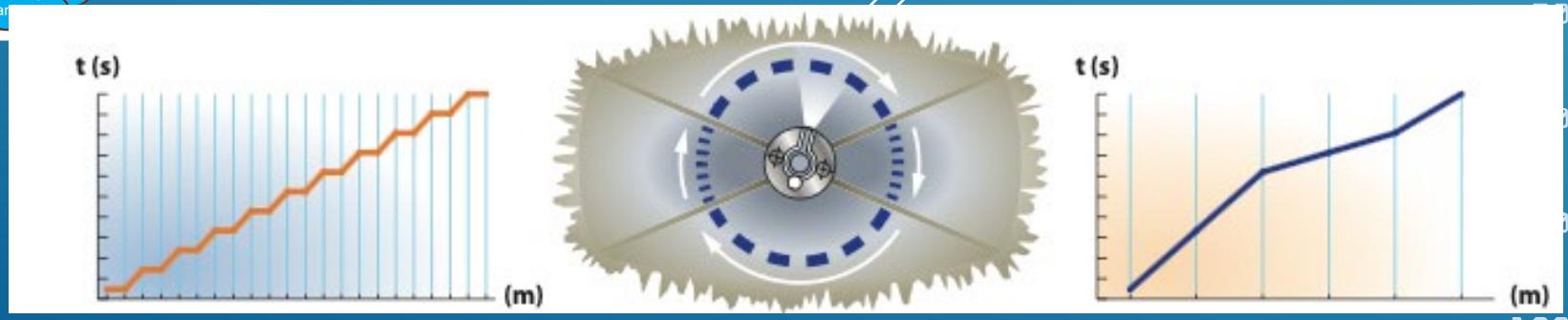
Automatic control of the pulling rate (mandatory):

- ❑ **Steps**
- ❑ **Continuous**

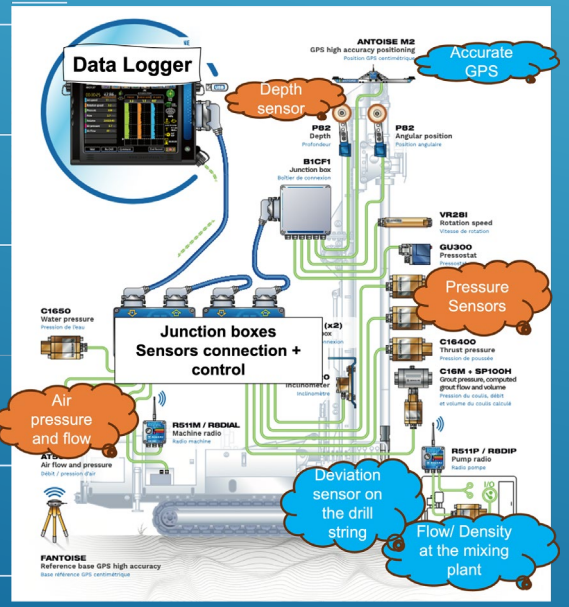
- ➢ **Rpm control (better quality)**
  Machine compatibility
- ➢ **Rpm for bow-tie candy jet**

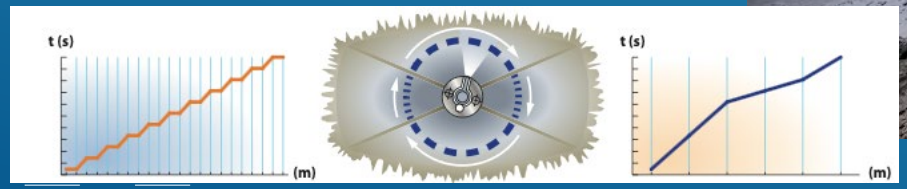




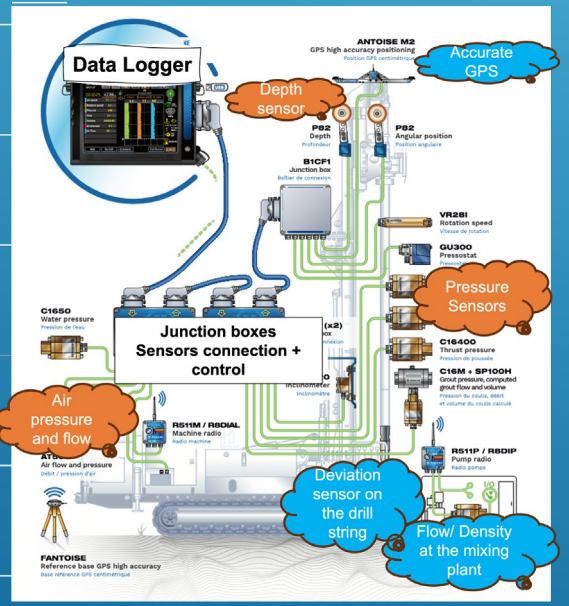


MWD and jetgrouting





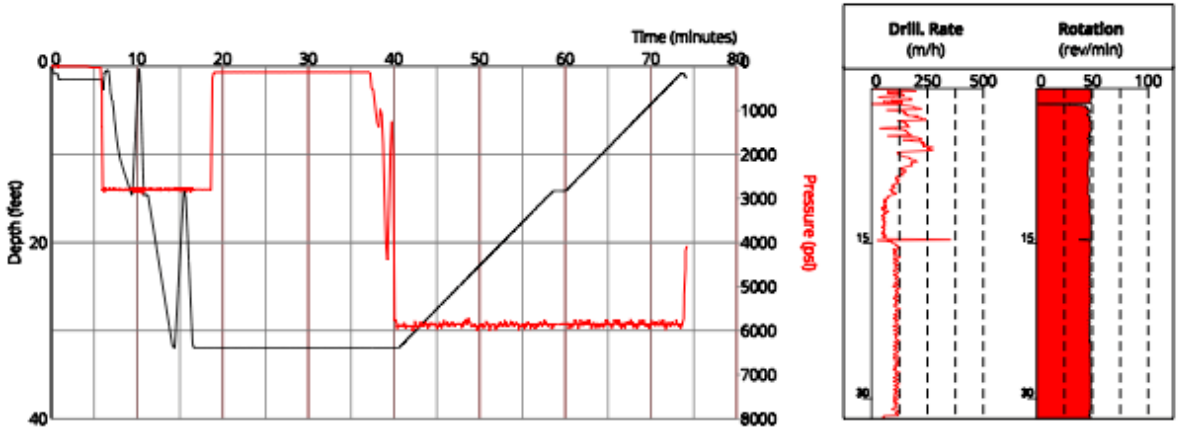


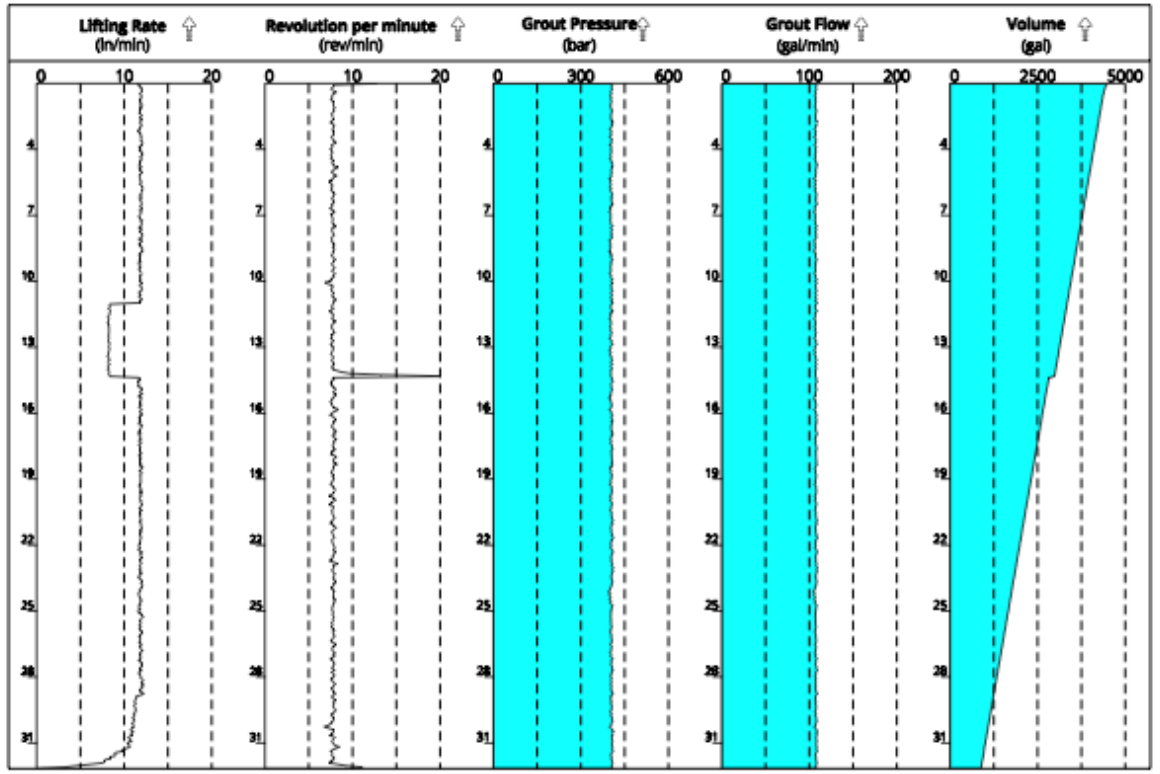


	ACUARELA PR Jetgrouting				(Job # MRD)
Date	: 06/14/2025	Machine	: MDT180B	Length	: 31.98 ft
Begin	: 01:47:33 PM	Drill Duration	: 40:14	Water Volume	: 847 gal
Jet	: 02:29:41 PM	Jet Duration	: 33:58	Volume	: 3643 gal
End hour	: 03:04:28 PM	Jet Length	: 31.17 ft	Volume by foot	: 144 gal/ft

Pile: ACUARELA JS-7

ADR 2.58/DialogMX 2951 6.6.29







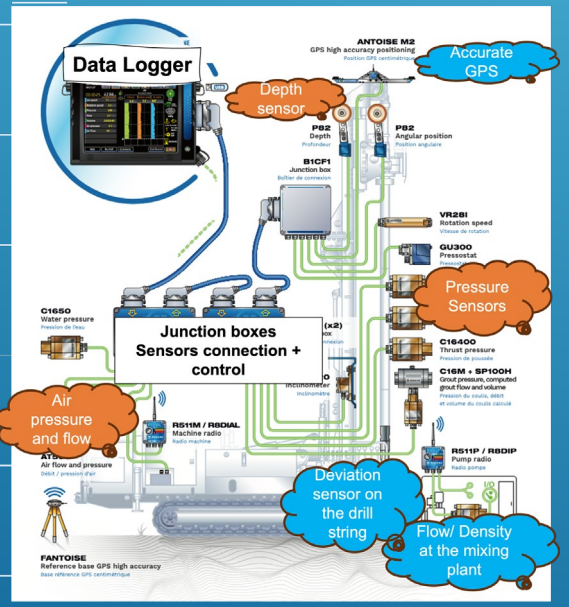
MWD and jetgrouting

Verticality monitoring/ Overlap

One of the existing solutions is to use a smart sensor installed just above the monitor







- ✓ Recording deviation (tilt) while drilling
- ✓ Collection of sensors managed by an internal microprocessor
- ✓ Internal memory to keep the data for further calculation
- ✓ Communication channels: Bluetooth

Jetgrout

Bottom plug

Sealing

MWD and jetgrouting

Thank you

Michel Lariau
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Manager of North American Operations

MWD for Single Pass Drilling

DFI S3 Conference

MWD Panel – Madison WI

LIEBHERR

Pierfrancesco Janes – LIEBHERR USA



PDE System: Single Pass Methods

DRILLING PHASE :

- Crowd Winch: Drum Position, Force on pulley
- Kelly Winch: Drum Position, Force on pulley
- Rotary: Rotational Speed, Hydraulic Pressure, Motor Displacement
- Leader: Inclination and vertical position
- Calculated Values: Drilling Depth, Crowd force, Drilling Pitch, Drilling Torque, Specific Energy



PDE System: Single Pass Methods

CONCRETING PHASE :

- Concrete swivel: Concrete Pressure 1
- Concrete line: Concrete Pressure 2
- Concrete Pump: Stroke Counter (Optional)
- Calculated Values: Pump strokes, Concrete volume and flow, Over Consumption



PDE System: Assistant Systems for Single Pass

- Drilling Assistant
- Concrete Assistant
- Screw Pile Assistant





Thank you.

Pile Dynamics, Inc.



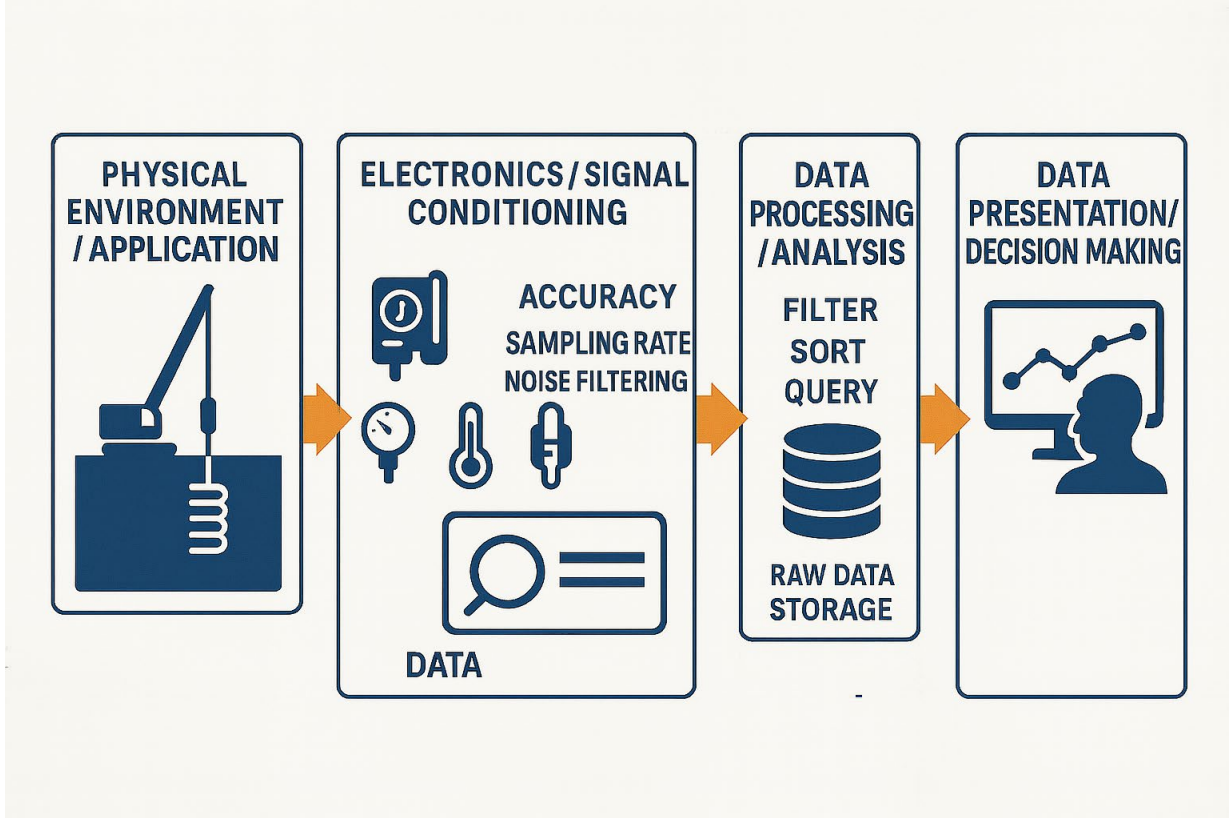
DFI S3: Slopes, Support and Stabilization

Organization and Presentation of Measurement While Drilling Data

Presented by: Wayne Dalton

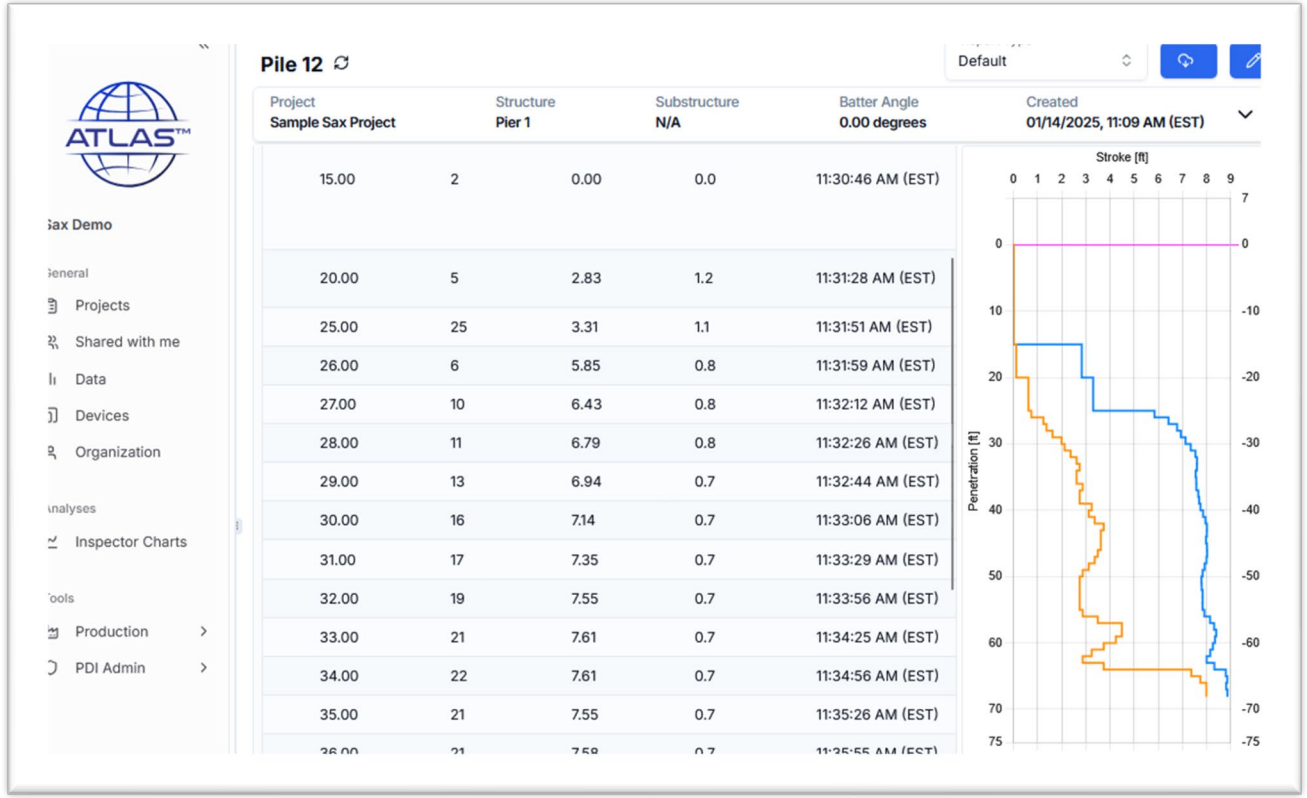
From Measurement to Meaningful Data

- Choosing the right sensors and electronics is the first step toward quality data
- Sensor accuracy and resolution must match the application's needs
- Electronic systems must preserve the fidelity of sensor data throughout the chain
- Poor data fidelity at the source cannot be fixed with downstream processing
- Over-sampling and excessive precision waste resources and complicate data management



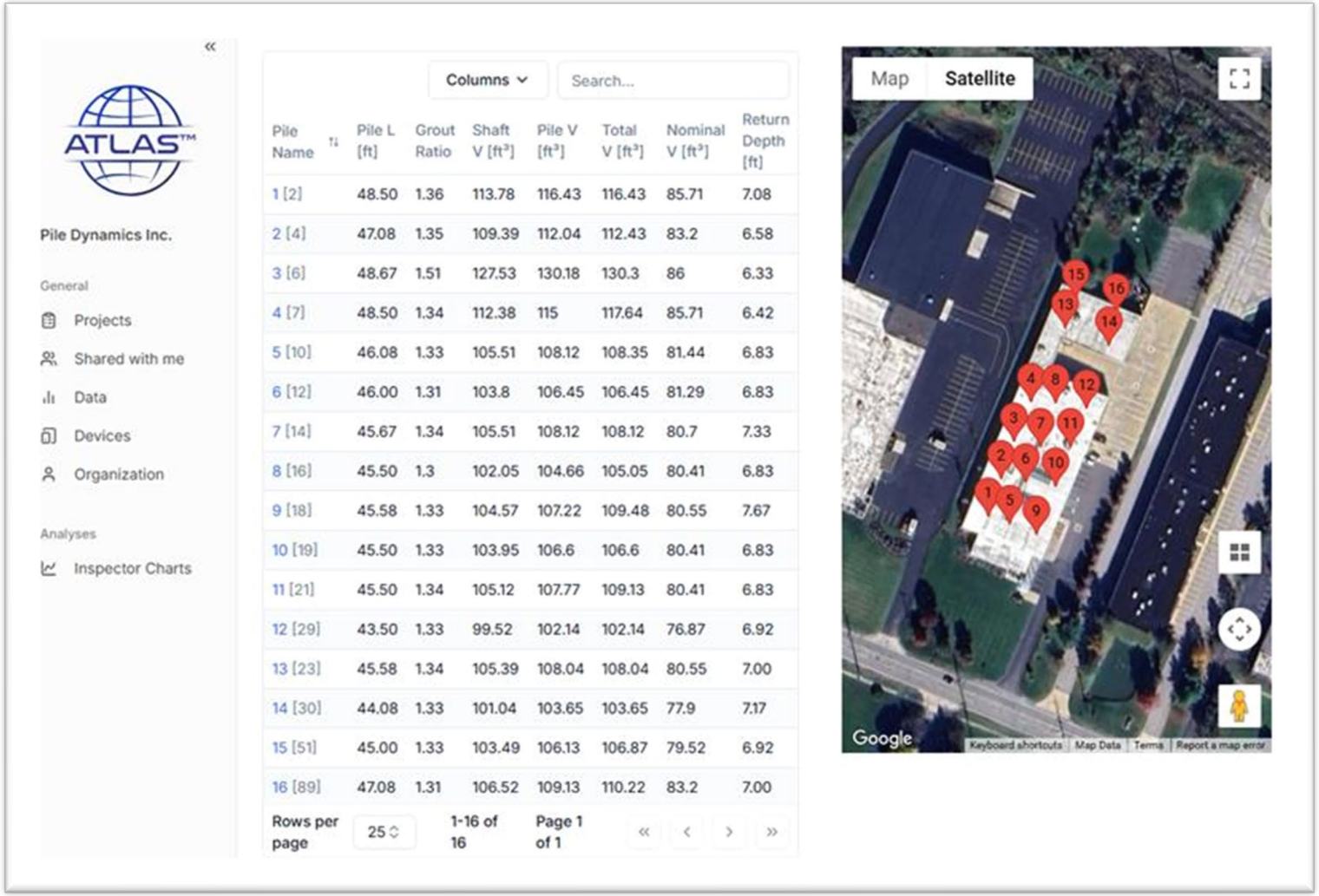
Data Storage: Preserving Integrity and Resolution of Data

- Stores complete raw measurement data
  - Enables deeper analysis, reprocessing, and extraction of new insights from raw data
  - Avoids information loss by preserving critical details and trends that summary data alone may overlook
- Uses a structured, queryable database to ensure reliable and efficient access to records and information
- Captures all available metadata with each data record
- Built for scalability, long-term accessibility, and efficient filtering across large datasets



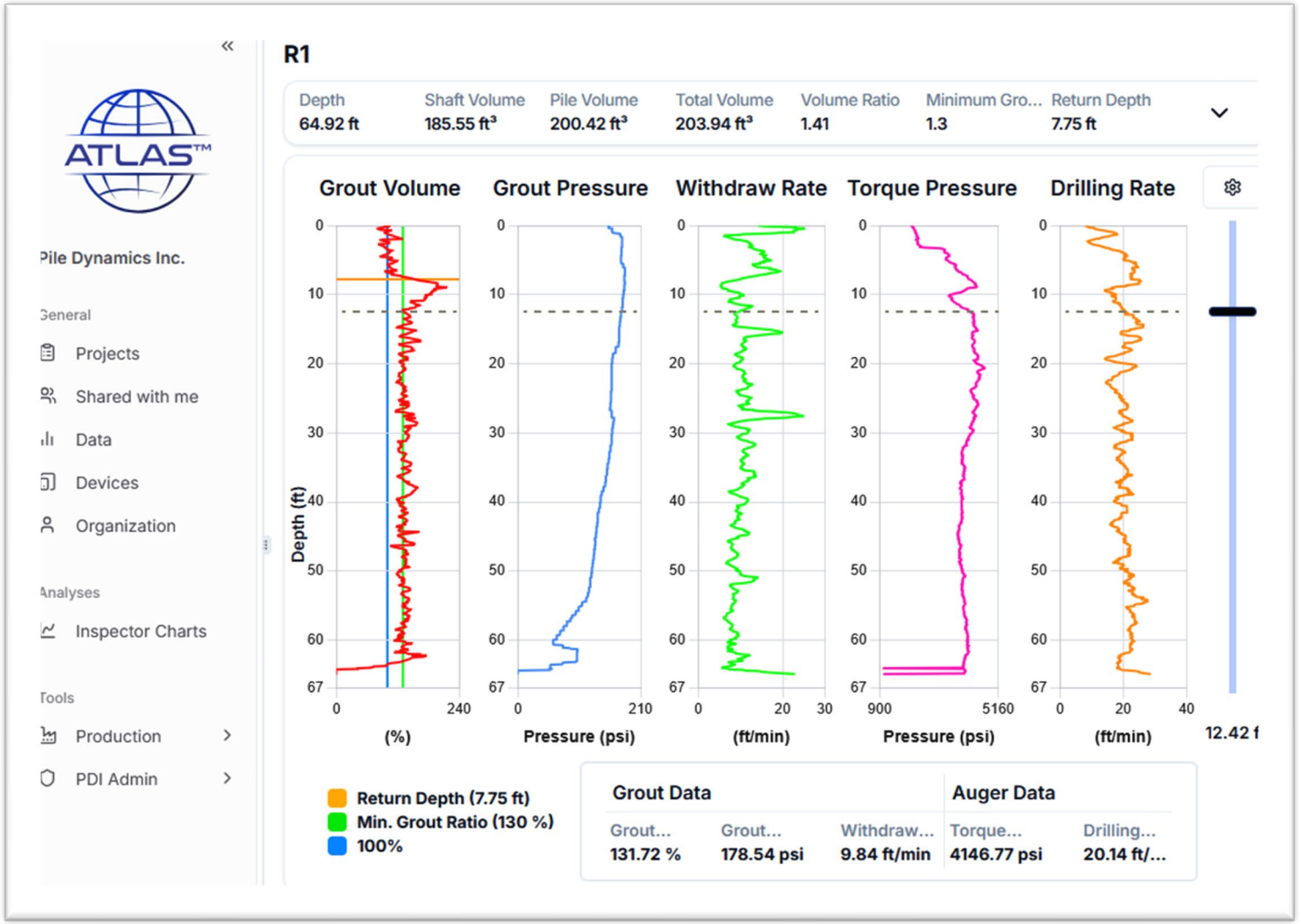
Data Organization: Structuring for Access and Insight

- Data is organizes as structured records for consistency and precision
- Each record includes complete raw measurements along with all available metadata
- Provides efficient filtering, sorting, and querying capabilities by key parameters, enabling quick identification of data outliers
- Utilizes a flexible schema that supports both current and legacy data types
- Relationships between datasets should be clearly defined and easy to interpret



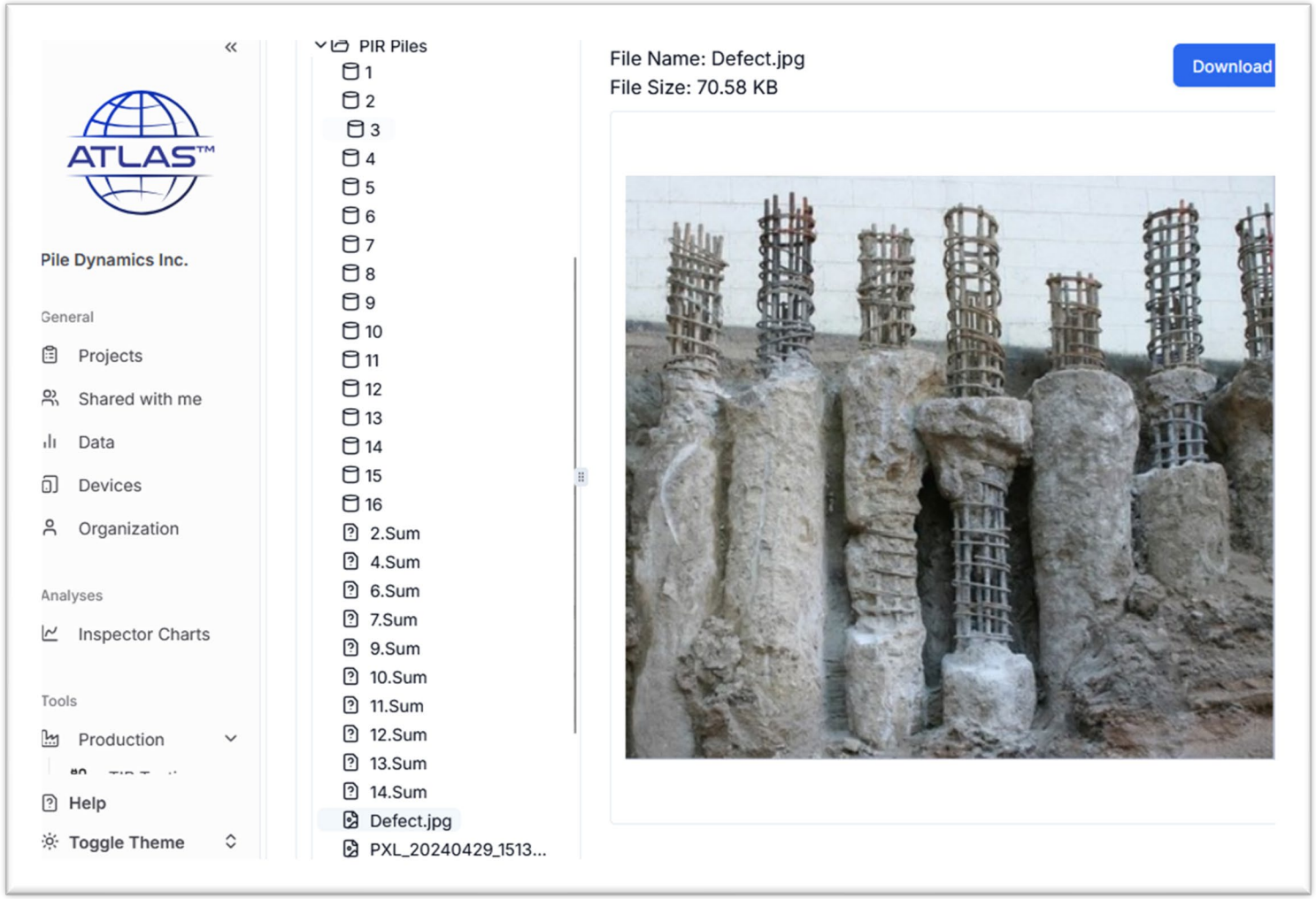
Data Visualization and Reporting

- Data is presented in a clear structured view based on project or sub-structure
- Dashboards provides actionable insights through charts, status indicators, and key metrics
- Built-in reporting tools support automatic and on-demand export of relevant information
- Ability for the user to drill down into the raw data for further analysis
- Reporting supports both graphical visualization and raw tabular data views



Complete Record Management

- Imports common file types and job-specific documentation into data records
- Centralizes all project data and related files in one interface
- Provides built-in viewing of common documents types, images, and videos
- Maintains a complete, traceable history of field activities
- Designed to scale with future needs, including support for additional or custom file formats



Pile Dynamics, Inc.

THANK YOU

www.pile.com | info@pile.com