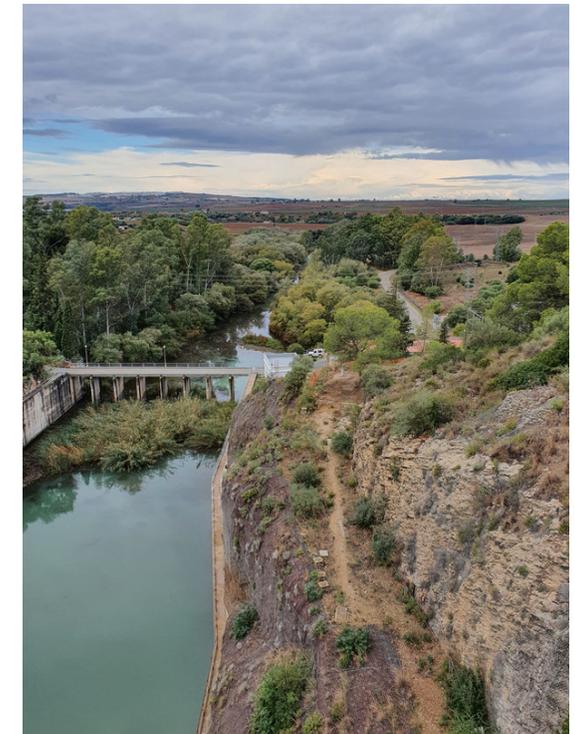


Table of contents :

- ✓ Specifications
- ✓ Sensors installation
 - ✓ Results
 - ✓ Outcomes



In this case, the **MiniLIM 5G** records and displays low-pressure grouting parameters. It controls the pump in volume and pressure. The installation took place on a dam in Sevilla, Spain, in September 2020. The depth of the boreholes is about 50 m.

The grouting method has been used here because the dam is critically deteriorating. Once injected, the grout will fill up the seams and consolidate the dam. This work needs to be done with extreme accuracy. We used common sleeves or “tube à manchette” (33 cm long) and a double packer to control the injection.

The injection automatically stops when it reaches a certain volume or pressure limit.

We also can regulate the grouting automatically with the GIN (Grouting Intensity Number), if the pump is equipped accordingly.



Parameters recorded during the grouting:
Volume, Pressure and flow of the grout vs Time.





Dam Installation: This is the different equipment on this project:

- drilling machine;
- pump;
- grout container;
- generator.

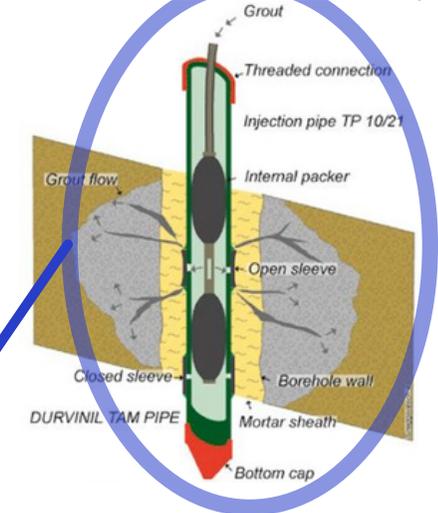
MiniLIM: Central unit recording and displaying the grouting parameters. It is installed on the pump. The system offers the option to automatically control the grouting phase by setting up the different equipment used (sleeves and packer) and also parameters. In this case, we only control one pump.



Electromagnetic flowmeter: It is installed on the injection pipe. It measures grout volume and flow.

Pressure sensor: It is installed on the same line just after the flowmeter. We are using a membrane separator in between the grout and the sensor to protect it.

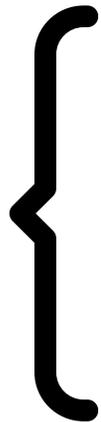
Double packer: Inside the borehole, we use a double packer with 33 cm sleeves (or "Tubes à Manchette") to inject the grout locally. The system can also be set up for a single packer or none. Parameters can be adjusted in the settings of the MiniLIM system



Results: 1. Stages report

The grouting report is divided into three parts. First, the software provides a sum-up of the whole borehole injection: stages report (see below). This is the most important report. It gives you general information about the grouting for each stage (depth, volume, flow pressure, stop cause, and more).

Our focus on
our next slide
(Depth Print-
Out)



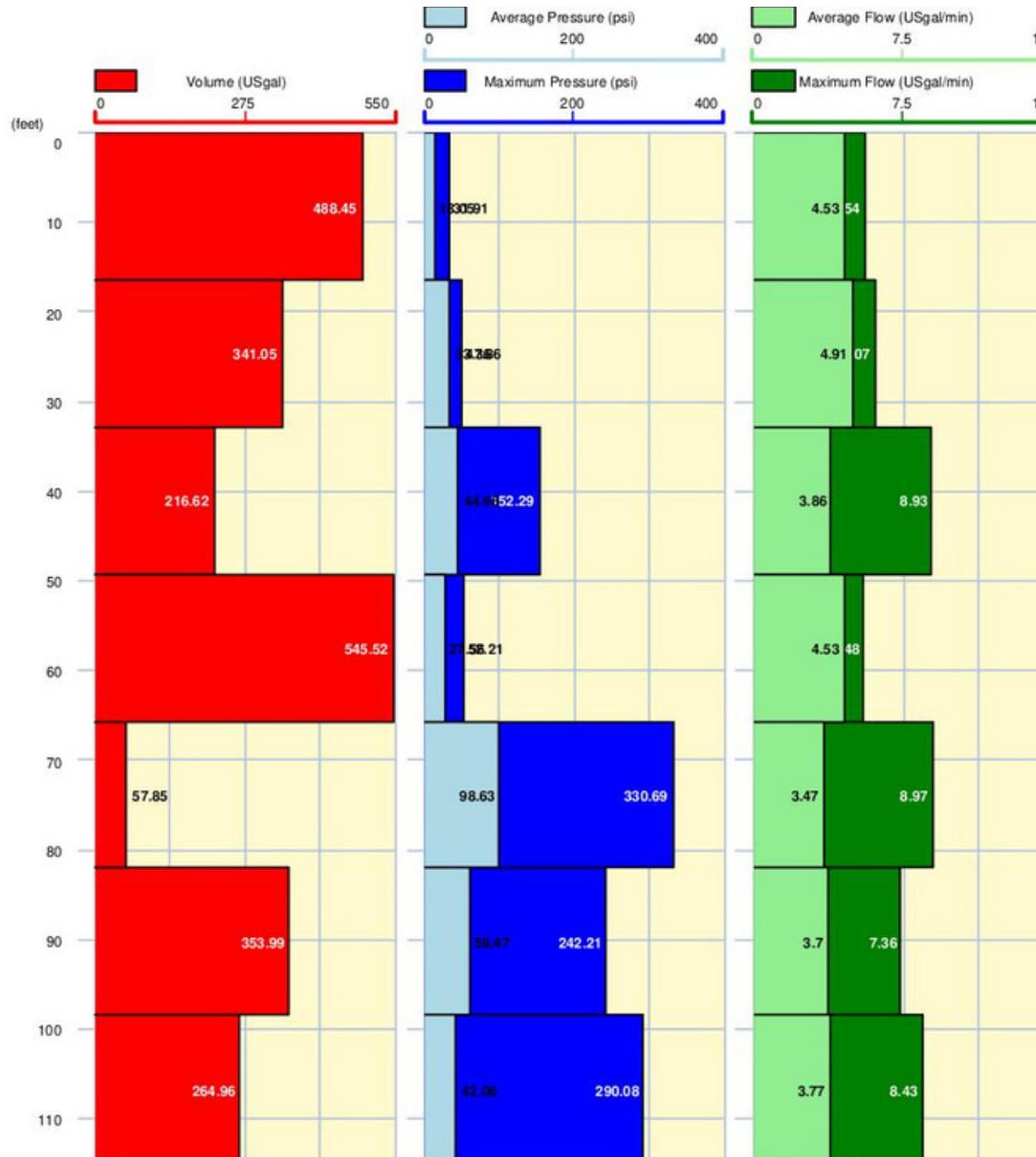
Accumulated Volume				2787.02 USgal		Grouting Duration				11:56:17			
Stage Number	Phase	Top (feet)	Bottom (feet)	Grout	Duration	Volume Stopping Threshold (USgal)	Grouted Volume (USgal)	Average Flow (USgal/min)	End Flow (USgal/min)	Pressure Stopping Threshold (psi)	Average Pressure (psi)	End Pressure (psi)	Stop Cause
14	L	0	16.4042	07	01:47:49	0	488.4541	4.534954	4.363242	72.51888	13.0534	31.9083	Manual
13	L	16.4042	32.8084	07	01:09:09	0	341.0461	4.9136	3.707214	72.51888	33.35868	44.9617	Manual
12	L	32.8084	49.2126	07	00:56:15	0	216.6211	3.861315	4.25317	145.0378	44.9617	94.27454	Manual
11	L	49.2126	65.6168	07	02:00:10	0	545.5153	4.526148	2.584483	145.0378	27.55717	36.25944	GIN
10	L	65.6168	82.021	07	00:17:00	0	57.85368	3.473862	5.239412	290.0755	98.62566	123.2821	Manual
9	L	82.021	98.42519	07	01:36:55	0	353.9905	3.702812	4.82114	290.0755	59.46547	18.85491	Manual
8	L	98.42519	114.8294	07	01:10:57	0	264.9646	3.768855	1.285637	290.0755	42.06095	91.37378	GIN
7	L	114.8294	131.2336	07	00:23:41	0	65.77884	2.716569	1.959276	290.0755	259.6176	304.5793	Pressure
6	L	131.2336	147.6378	07	00:02:33	0	4.490925	0	2.553663	290.0755	0	310.3808	Pressure
5	L	147.6378	164.042	07	00:56:16	0	183.0712	3.262525	2.201434	290.0755	147.9385	108.7783	GIN
4	L	164.042	180.4462	07	00:32:15	0	94.83777	2.998353	2.421577	290.0755	233.5108	210.3047	GIN
3	L	180.4462	196.8504	07	00:16:03	0	38.04078	2.232254	1.439738	290.0755	263.9687	303.1289	Manual
2	L	196.8504	213.2546	07	00:31:47	0	94.83777	2.927907	2.267477	290.0755	243.6634	205.9536	Manual
1	L	213.2546	229.6588	07	00:15:27	0	37.51243	2.3027	1.153551	290.0755	274.1213	288.6251	Manual

Results: 2. Depth Print-out

The second part of the report is the depth print out. Here you will find a sample of the report (injection parameters between 0 and 110 ft). This graph displays the volume (in red), average pressure and max. (in blue) and average flow and max. (in green) per stage vs depth.

The scale and units can be adjusted according to the customer's needs.

Our focus on the next slide (Graph per stage)



To go more into details, the stage between 50 and 65 ft needs more grout than the others, due to a bigger fault to fill in the dam (545 gal of grout injected). This is confirmed by a relatively low injection pressure and flow.

Those strata information could be verified with the drilling parameters if they have been recorded.

We can notice the difference between each stage on this example and the work needed on this dam.

Results: 3. Graph per stage

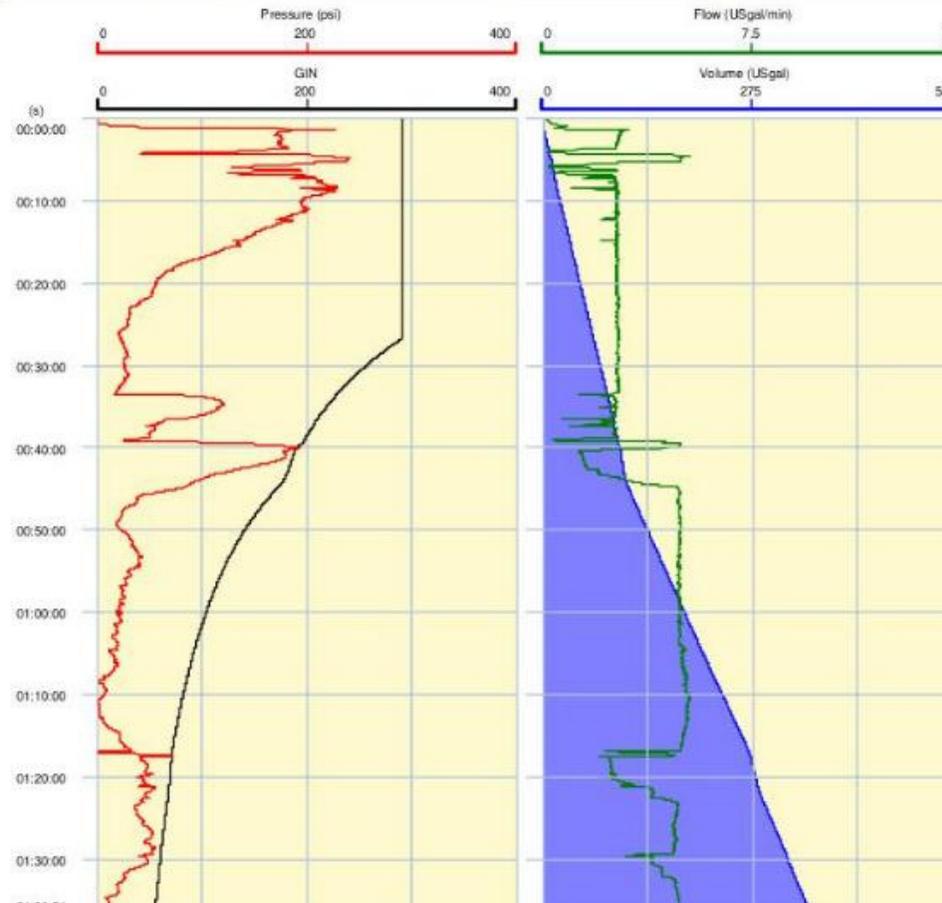
The third and last part of the report in the graph per stage. It goes into more detail about the stage injection.

It is generally used to verify the quality of the grouting. You will find a table with a sum-up of different injection parameters.

The graph displays the pressure (in red), the GIN (in black), the flow (in green) and the volume (in blue) vs time.

If the pressure goes over the GIN number, the pump is automatically stopped by the MiniLIM 5G.

Top	82.02 feet	Grouting End	28/09/2020 14:02:04
Bottom	96.43 feet	Stage Number	9
Phase	L	Grouting Duration	01:36:55
Pump	1	Grout	07
Residual Volume	5.55 USgal	Grouted Volume	353.99 USgal
Average Flow	3.70 USgal/min	Average Pressure	59.47 psi
Last 30s averaged Flow	4.84 USgal/min	Last 30s averaged Pressure	18.25 psi
End Flow	4.82 USgal/min	End Pressure	18.85 psi
Maximum Flow	7.36 USgal/min	Maximum Pressure	242.21 psi
Volume Stopping Threshold	0 USgal	Stop Cause	Manual
Strain Volume	1357.58 USgal	Pressure Stopping Threshold	290.08 psi
GIN Stopping Threshold	19157.46 psi USgal	Pressure Starting Threshold	0 psi
		Suspend Duration	00:00:05



We notice the quality of the grouting because the pressure has been well regulated by the GIN number.

When the volume reaches a certain value (about 50 gal here), the GIN number has to decrease to regulate the pressure.

If the pressure increases (at 40 min), the MiniLIM 5G can automatically control the injection, decreasing the pressure. This is a great example.

The grouting was very smooth here according to the regularity of the flow.

The MiniLIM 5G - Grouting version exceeded the customer's expectations. They could easily verify the work done to improve the consolidation of the dam.

- ➔ As explained here, the MiniLIM 5G can record and display in real-time the grouting parameters but also the drilling parameters (if you want to merge the data to verify the strata).
- ➔ We can easily see which area needs more work than others according to the volume injected into the soil. Critical parameters are the pressure and GIN number to verify the quality of the injection.
- ➔ The system offers the possibility to control the pump automatically, as we did here. You can also choose the manual option which also works perfectly.
- ➔ Data is recorded on a USB and uploaded to the software. The report is automatically generated when you upload the files to the software.
- ➔ The report is separated into three sections to allow a quick review of the work, but also gets into the details if something goes wrong or happens during the injection.