



ArcelorMittal

Watertight retaining wall

University Campus P2
Trondheim | Norway



In order to unify the campus of the Norwegian University of Science and Technology (NTNU) in Trondheim, several departments and institutes will be relocated, and new buildings will be built. One of the first new buildings of the campus is dedicated to the Department of Materials Science and Engineering. Here, researchers, students and industry partners will come together with the aim to develop and test future-ready materials and solutions. Each year, around 50 students graduate from the only Masters-program in Materials Technology in Norway. One of the main aspects of the research done in Trondheim is materials with lower emissions and more efficient use of resources.

ArcelorMittal shares these ambitions and developed with the R&D department and external partners a new sealant system that is environmentally friendly and has similar performance as the well-known bituminous sealant Beltan® Plus.

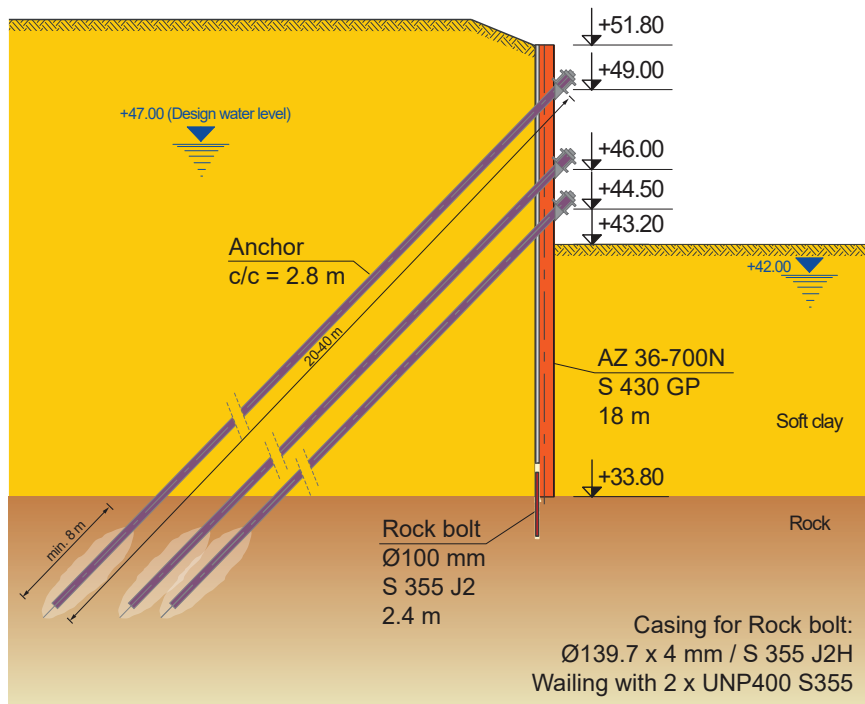
Seline®, the new sealant, is made of a renewable raw material: balsam resin (also known as colophony or gum rosin).

The resin is a natural raw material that was already used by the ancient Romans and Egyptians. The tree resin is mainly obtained from pine trees by scratching the tree and collecting the balsam that drips out.

Seline is free from any substances that would need to be listed in accordance with Regulation (EC) No. 1907/2006 (REACH). The new sealant was tested by the German *Hygiene-Institut des Ruhrgebiets*, which concluded that the use of Seline can be assessed as ecotoxicologically harmless.

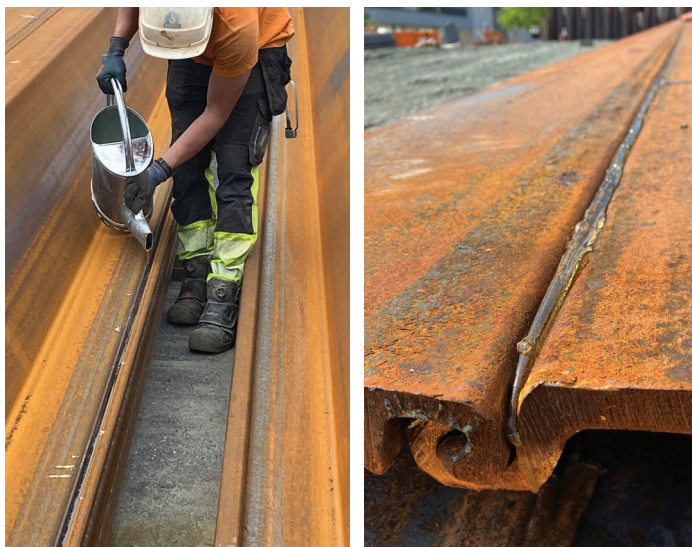
A **permanent retaining wall** for the P2 project in Trondheim is one of the first projects where Seline is used. The contractor, GEO fundamentering & bergboring AS, is in charge of the foundation works. The mainly consist of a permanent sheet pile retaining wall and drilled steel pile foundations, which take the vertical loads of the future building.

Typical cross-section of the retaining wall



The project presents classic inner-city challenges with restrictions on available space, noise, dust, vibrations and deformations. To start the project, the contractor, GEO fundamentering & bergboring AS had to deliver a **watertight retaining wall** that withstands the earth and water pressure as well as the loads from an existing nearby building. This retaining wall was **initially designed in drilled pipes** but was switched to a sheet piling solution for faster execution, better control on watertightness, smaller footprint and improved cost-efficiency. Especially, on a technical note, the sheet pile alternative is more efficient than the drilled pipe solution, as it avoids the risk of a potential pore pressure build-up from drilling of the tubular piles.

The deflection of the nearby building was monitored closely during the works as the entire area consists of **soft clay**. Quick clay inclusions on some parts of the project ask for even higher vigilance in the design and execution phase.



Application of Seline®.

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Project owner	Norwegian University of Science and Technology
Designer	Ramboll
Contractor	GEO fundamentering & bergboring AS
Steel sheet piles	AZ 36-700N 13.0 - 21.5 m S 430 GP 391 t

Buildings are generally founded on the underlying bedrock, as it is the case for the P2 project. The sheet pile wall consists of **AZ 36-700N profiles** in varying lengths from 13.0 to 21.5 m. They were manufactured in S 430 GP and delivered as uncrimped double pile. The contractor chose to get the sheet piles uncrimped to gain higher flexibility during installation. It allows to closely follow the inclined bedrock horizon. Due to the weak soil characteristics of the soft clay and limited thickness of the soil layer, insufficient passive earth pressure could be generated to have a stable retaining wall. Hence, the contractor installed **rock bolts on each double pile** to anchor the sheet piles securely in the underlying rock layer. The longer sheet piles were even equipped with 2 casings/rock dowels per double pile. The retaining wall has 2-3 anchor levels, with inclined anchors reaching up to 40 m. The contractor managed to deliver watertight anchor heads by precise welding and filling of the heads with a wax-like material that prevents eventual water leakages. After completion, the sheet pile wall was covered entirely with a discreet textile, to reduce the thermal transfer through the steel into the ground that could cause frost heave in winter and cause damage to the structure itself and building nearby. In order to handle small water flows around the sheet pile toe, some dewatering pumps were installed during the installation phase, leading to a water level at excavation side of around +42.00 m, while the design water level at the earth side is at +47.00 m.

The installation of the sheet piles was smooth, with a performance of **8-9 double piles per day**. The chosen equipment was a free hanging vibro ICE 18 RF TS with a maximum centrifugal force of 1,044 kN and a maximum centrifugal moment of 18 kgm.

To ensure the watertightness of the wall, Seline® is used for one half of the sheet piles and Beltan® Plus for the other half. This allows for the short- & long-term comparison of performance of the two sealants, which were put in the interlocks on the jobsite. The ease of workability of Seline, initially established through laboratory testing, was confirmed on site. The contractor prepared the sheet piles according to ArcelorMittal's recommendations in order to guarantee a good performance of the sealant. The end-result is very satisfying with no substantial leakages observed.

