BETTER PIPING SOLUTIONS

zeroULTRA ONE – NEW UHPFRC-COMPONENTS

FOR TUNNEL AND INFRASTRUCTURE CONSTRUCTION:
LIGHTWEIGHT, DURABLE, COST-EFFECTIVE

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SUCCESS HAS THREE LETTERS: ACT
JOHANN WOLFGANG GOETHE

Our innovative ultra-high-performance fibre-reinforced composite (UHPFRC) MAUDERLI zeroUltra$_{one}$ is the result of an idea, research, discussions with experts and a lot of determination

We use it to produce individual and tailor-made system solutions for tunnel and infrastructure construction. According to the Chamber of Industry and Commerce of Central Switzerland, which awarded MAUDERLI AG its 2024 Innovation Prize for this new material, «This innovation has the potential to transform the construction industry sustainably and long term.» –

This award confirms that we can make our visions a reality if we work diligently and consistently on implementing them. We are delighted to be recognised for a product that offers huge benefits for sustainable infrastructure construction.

Find out more about our new system solutions and the opportunities they are opening up, as well as the construction projects where they have already been used. Remember: whatever your new ideas in civil engineering or beyond, we can make them happen!

Happy reading!

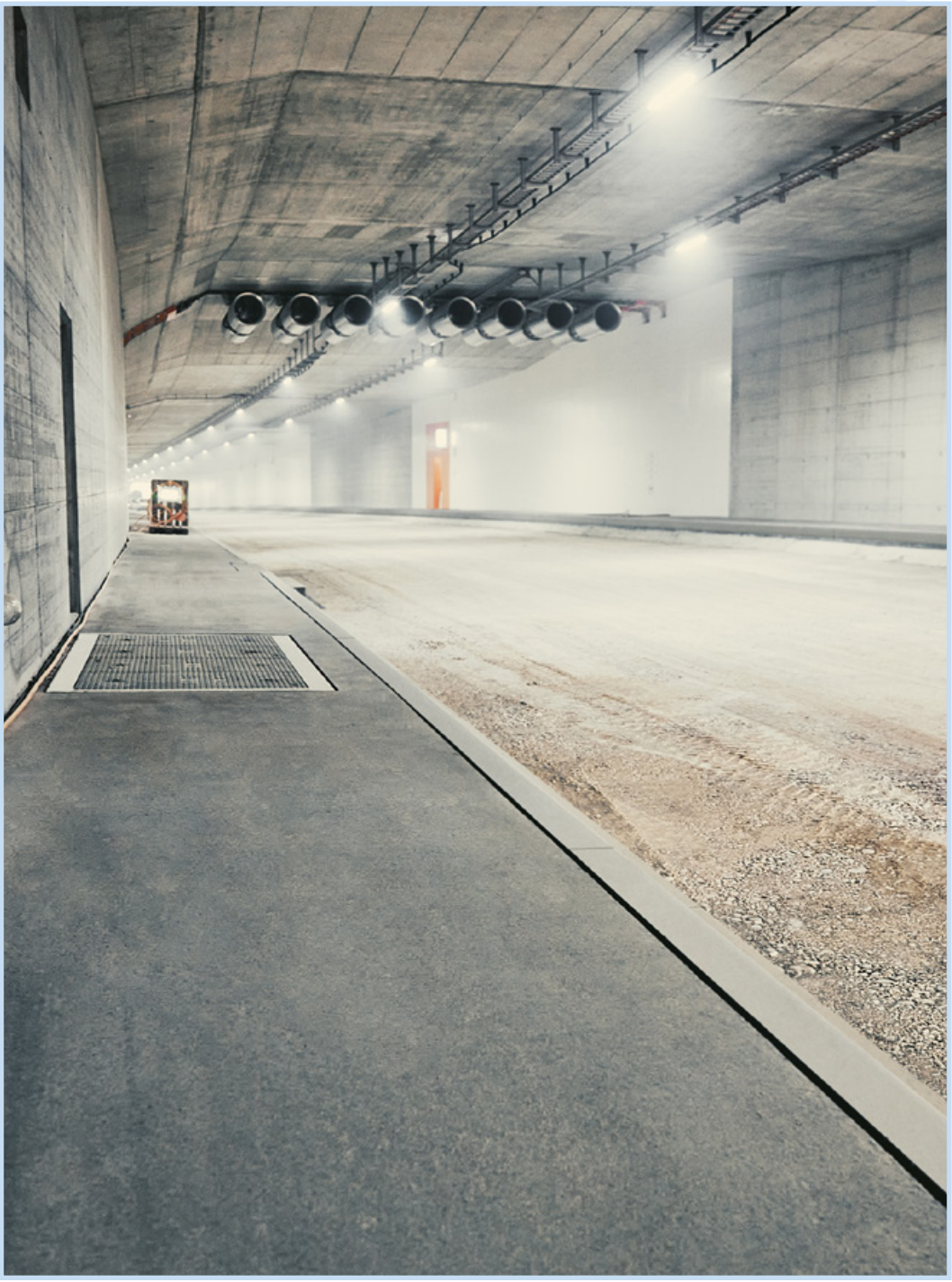
Christoph Mauderli

1. MAUDERLI AG

Company mission statement

MAUDERLI AG in Schachen, Lucerne, is a Swiss family business that combines tradition with innovation. We are an established manufacturer and supplier of plastic pipes, ducts and retention systems and have been operating in Switzerland, Austria and the rest of Europe for over 50 years. We are visionary in our thinking and do everything we can to offer our customers outstanding products and services.

Every day, we see how the ideas we develop with our customers ensure smooth processes on construction sites. Hence, we aim to offer functional and durable individual system solutions for construction projects in the areas of drainage, water retention, cable protection and beyond. This brings benefits for builders, planners and construction companies. That's why there was one particular idea we couldn't get out of our heads: producing prefabricated UHPFRC components for civil engineering and using them to develop economical system solutions.



2. VISION

The problem

Always on the lookout for innovative solutions in civil engineering, we maintain dialogue with our customers and partners on alternative products and materials. In doing so, we noticed similarities in the way we think about and work with plastic and UHPFRC. Previously, UHPFRC was mainly used in architecture and bridge construction; but never considered for use in civil engineering. We approached this challenge by changing our perspective and looking at the essential requirements rather than the maximum possibilities of the material.

Timeline

In 2018, discussions with Professor Eugen Brühwiler from the EPFL Lausanne confirmed to us that UHPFRC could be of great importance for prefabrication in civil engineering. Together with Holcim, we then developed a new type of UHPFRC building material, had it certified according to SIA guideline 2052 and called it zeroUltra$_{one}$. UHPFRC is highly impermeable, strong, ductile, abrasion and chemically resistant. zeroUltra$_{one}$ can also be cast extremely thinly, offers qualitative advantages over conventional concrete and polymer concrete and thus enables the production of cost-effective prefabricated components for a broad market.

In 2018, we presented our planned range of prefabricated slot drains, kerbs, siphon and cable shafts made of UHPFRC to the Federal Roads Office (FEDRO). These were immediately included in the FEDRO technical manual. Within four weeks, MAUDERLI AG commissioned a new concrete mixing plant and a production facility for UHPFRC components at the Schachen site and set up a new team. Today, around 25 of its more than 100 employees work on the development and production of prefabricated UHPFRC elements.

The Schwamendingen enclosure was the first construction site to be supplied with our innovative system solution, with UHPFRC components individually tailored to the site. The same year saw the renovation of the Lake Brienz Tunnel and the six-lane extension from Bern to Thun. MAUDERLI now supplies prefabricated UHPFRC components to infrastructure projects throughout Europe, including the Brenner I and Gotthard Base Tunnel, Bern RBS railway station and Zurich Airport.
-Tunnel, den RBS-Bahnhof Bern oder den Flughafen Zürich.

Future prospects

Prefabricated elements made of UHPFRC are gaining ground in the highly competitive civil engineering market. Since 2019, we have supplied more than 30,000 metres of slot drains, 30,000 metres of kerbs, around 1,000 siphon shafts and over 4,000 cable shafts to satisfied customers and clients. Our prefabricated UHPFRC elements keep pace with the times. They offer completely new options for installation planning, significantly reduce life cycle costs and can be fully recycled.

New product ideas are added almost every day in dialogue with our customers. In our traditional field of activity, these include prefabricated drainage channels, formwork elements and culverts. zeroUltra$_{one}$ can also be used for applications in landscaping, interior design, building envelopes, outdoor kitchens, art and explosion protection. With our system solution, every idea can become a reality – one at a time!

3. MATERIAL SELECTION

UHPFRC

The development of UHPFRC zeroUltra$_{one}$ is progressing rapidly. In the SIA 2052 guideline revised in 2016, UHPFRC was still referred to as ultra-high-performance fibre-reinforced concrete. Today, it is referred to as a ultra-high-performance fibre-reinforced cementitous composite and a distinction is made between three different types of UHPFRC: U0, UA and UB. In civil engineering, U0 is the most economical.

Polymer concrete

In the past, tenders were often advertised for products made of polymer concrete. During discussions with FEDRO in 2018, it was discovered that the properties of the prefabricated polymer concrete elements used at the time were not defined at all. As a result, it was impossible to determine an «equivalent» product. This has been corrected in the new editions of the FEDRO technical manuals.

Equivalence UHPFRCC polymer concrete

Professor Brühwiler of the Swiss Federal Technology Institute of Lausanne (EPFL) takes the view that the properties of UHPFRCC are sufficiently well known and superior to those of polymer concrete. According to his expertise, today's UHPFRC products more than meet all the requirements of polymer concrete.

UHPFRC test results

The new UHPFRC type U0 developed by MAUDERLI AG is certified as MAUDERLI UHPFRC zeroUltra$_{one}$. It has the following characteristics:

- Characteristic value of elastic boundary strength f_{Utek} 7.5 N/mm²
- Characteristic value of centric tensile strength u_{tuk} 8.5 N/mm²
- Ratio of char. tensile strength to char. ultimate boundary strength f_{Utuk}/f_{Utek} 1.14
- Characteristic value of cube compressive strength (5% fractile) f_{Uck} 123 N/mm²
- Bending tensile strength R_f 29.1 N/mm²
- Very high resistance to the penetration of gases and liquids. At around 60 g/m²h0.5, the UHPFRC sorption coefficient is more than three times lower than that of high-quality concrete.
- It has such high resistance to salts and sulphates that no values can be determined using the current measurement method for concrete (chloride migration coefficient according to EN 12390-18).

Further information can be found in the data sheets.

PRODUCT DATA SHEET

Manufacturer's declaration

MAUDERLI UHPFRC zeroUltra$_{one}$

Ultra High Performance Fibre Reinforced sComposite (UHPFRC) Grade U0

18/03/2025

COMPONENTS

MAUDERLI UHPFRC zeroUltra$_{one}$ consists of a custom cement from the Holcim 250 cement range, natural aggregates, admixtures and additives. The custom cement contains cement according to SN EN 197-1 and silica dust according to SN EN 13267.

AREAS OF APPLICATION

MAUDERLI UHPFRC zeroUltra$_{one}$ ultra-high-performance fibre-reinforced concrete corresponds to grade U0 according to SIA data sheet 2052:2016 and corrigendum C1:2017. Particularly suitable for the production of prefabricated components with high resistance to wear and chemical attack (XA3s, XAA). Has high flowability and corresponds to building material class A1 (non-combustible).

COMPOSITION

- Custom cement range Holcim 250
- Natural aggregate D_{max} 4
- Fluxing agent
- Fibres

ADDITIONAL POSSIBLE ADDITIVES

- Microplastic fibres (PP)
- (resistant to spalling in case of fire)
- Deaeration aid
- Shrinkage-reducing agent

MECHANICAL CHARACTERISTICS

		Grade U0		Limit values
Characteristic value of elastic boundary strength	f_{utek}	8.5	N/mm²	≥ 7.0
Characteristic value of centric tensile strength	f_{utuk}	7.4	N/mm²	
Ratio of char. tensile strength to char. boundary tensile strength	f_{utuk}/f_{utek}	0.87	-	> 0.7
Hardening	e_{Utu}	-	‰	No req.
Characteristic value of cube compressive strength (5% fractile)	f_{uck}	124	N/mm²	≥ 120
Modulus of elasticity (tension/compression)	E_U	44,800	N/mm²	No req.
Bending tensile strength (SN EN 196-1)	R_f	29.1	N/mm²	No req.

OTHER CHARACTERISTIC VALUES, DURABILITY

Processability	Section C.4	self-compacting, slump flow	750 - 820		
Leak-tightness	SN EN 13057	Sorption coefficients	42.8	g/m²h$^{1/2}$	≤ 100
Slope stability	Section C.5		none		
Shrinkage	SN EN 12390-16	after 182 days	-0.39	‰	
Shrinkage	ASTM C 1698-09, up to 21 d		-0.58	‰	
Creep	SN EN 12390-17	Creep coefficient, after 182 days	0.79		
Bulk density			2,530	kg/m³	
Frost and de-icing salt resistance	SIA 262/1 Annex C	Limit value for XF4	10	g/m²	≤ 200
Chloride resistance	SIA 262/1 Annex B		3.5	m²/s*10^{-12}	≤ 10
AAR resistance	SIA MB 2042 and SIA 262/1:2019		AAR resistant (after 20 weeks)		
Sulphate resistant	SIA 262/1, Annex D, ÖNORM B 3309-1,	Change in length ΔlS Annex B; Bending tensile strength criterion	0.31 94	‰ ‰	≤ 1.0 ≥ 85
Wear resistance	DIN 52108SN SIA 252	Wear resistance according to Böhme Wear resistance class	64 A6	cm³/50cm²	

4. PRODUCTS USED

Shaping

UHPFRC can be used to create allows a wide variety of shapes. The limiting factor is usually the transport dimensions and not the material weight or stability.

Products used

4.1 Heavy-duty gutters and flushing openings

At the request of various regional units, we have developed and produced several types of heavy-duty gutters that do not require transverse ribs or bars for reinforcement. They ensure uninterrupted flushing during operation throughout the entire service life. Monolithic edge protection made of UHPFRC eliminates the need for the stainless steel edge protection still in use today. Thanks to its low weight, it can also be installed safely within confined spaces using small construction machinery. In an effort to increase traffic safety, MAUDERLI developed anti-slip surfaces and had them tested by IMP Bautest AG. These are abrasion-resistant and significantly reduce the risk of slipping on the slot drains, shaft covers or edges when changing lanes.

F900 heavy-duty gutter without bar/cross rib on the Yverdon motorway

Anti-slip surface on heavy-duty gutter with integrated flushing element

4.2 Shaft inlets

Experience shows that connecting a gutter to a drainage shaft is difficult and often causes problems. Suitable transition pieces and preparations made in the shafts can eliminate this. The strength of zeroUltra$_{one}$ now allows the direct integration of flushing openings and drains into the drainage channel.

FORCEDRAIN airport drainage channels at Zurich Airport

4.3 Tunnel slot drains and kerbs

MAUDERLI AG has developed and produced several types of slot drains. Experience has shown that when these are manufactured with UHPFRC, they can have significantly thinner wall thicknesses than polymer concrete gutters with the same load class. This results in the same discharge volume within smaller dimensions. The ductile properties of UHPFRC also make the drains significantly less susceptible to damage during handling, installation on the construction site, operation or surface renovation.

Installation and backfilling of slot drains in the Schwamendingen housing project, 2023

Slot drains, kerbs and siphon shafts, T5 Bözingenfeld

Slot drains, kerbs and siphon shafts in the Bad Zurzach tunnel

4.4 Inlet shafts

For a complete system solution, suitable monolithic inlet and siphon shafts are also manufactured from UHPFRC. The connections to the drainage system are inserted directly into the shafts. This removes the need to fill and seal the openings afterwards, which is often done using inferior-quality materials. Installation becomes faster and easier.

Siphon shaft enclosure in Schwamendingen.
Inlet of slot drain(top right) and main drainage opening below.

4.5 Cable shafts

Using UHPFRC, cable shafts can be produced according to FEDRO standard (A1, A2, A3, S2, S3) or to measure with thin wall thicknesses. The lower weight of these components simplifies the logistics, and the prefabricated connections, which are designed to meet customer requirements, make it quicker to install them. This speeds up the construction process. We can furthermore respond to companies' requirements by providing relevant specialised solutions, such as integrated drainage.

FEDRO A2 cable duct

Cable shaft housing in Schwamendingen

4.6 Shaft structures and drainage shafts

MAUDERLI has made a name for itself in the construction of shaft structures – from standard drainage shafts to very large shafts as an alternative to in-situ concrete solutions. Our concrete shaft floors with fully encased plastic channels combine the advantages of plastic and concrete. Plastic is resistant to abrasive waste water. In combination with high-quality concrete elements, the quality of the shafts – their durability, tightness and service life – is now many times higher than it used to be. The use of UHPFRC makes it possible to prefabricate shafts in dimensions that were previously only possible as in-situ concrete variants. This significantly simplifies handling and speeds up installation. UHPFRC shafts also have a significantly longer service life.

Berntorplatz Thun mixed water shaft

Prefabricated mixed water channel, Diessbach

Prefabricated mixed water channel, Diessbach

Prefabricated pump shaft, Bottmingen

4.7 Composite shaft covers

Shaft, surface and step covers often used to be made of cast iron, concrete or stainless steel. Our composite shaft covers according to EN124–5 are now used in all new motorway tunnels and on motorways at the request of maintenance services. In combination with frames made of UHPFRC, these also offer new possibilities that eliminate the need for additional frame constructions. The low SUVA-approved weight makes it possible to service and maintain the covers, which sometimes weigh more than 100 kg, without a crane. The composite shaft covers are chemically resistant, corrosion-free and can be opened effortlessly and without heavy equipment even years later. And they are not electrically conductive – a big plus in terms of occupational safety.

Installation of a cable access shaft with composite material in the Schwamendingen enclosure

Composite shaft covers, Bad Zurzach

Prefabricated canal elements, renovation of the Grenchen Aarmatten Canal

Made-to-measure composite shaft cover, Seelisberg Tunnel

5. CONCLUSION

MAUDERLI UHPFRC zeroUltra$_{one}$ has proven its worth in infrastructure and tunnel construction. The system solutions from MAUDERLI, coupled with the long service life of the material, minimise maintenance and repair costs over decades.

Combined with our individual system and special solutions, MAUDERLI UHFB zeroUltra$_{one}$ is the ultimate building material for every challenge: durable, easy to use and 100% recyclable. And, in terms of the life cycle of a building, it is always the most economical solution. Christoph Mauderli sums it up: «It's a win-win-win solution for clients, planners and construction companies.» We are happy to advise you and suggest ideas – from planning to engineering.

Collecting shaft, Kesswil

UHPFRC plant trough

WOULD LIKE TO TALK ABOUT YOUR CONSTRUCTION PROJECT?

Are you planning a tunnel or infrastructure construction project – or are already in the middle of one? Do you have a landscaping project or an idea for an unusual building envelope? Whether you're a public-sector or private client, we're your go-to partner. Get in touch!

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