Solutions for Underground Construction

Injection

MASTER BUILDERS SOLUTIONS

BASF
The Chemical Company
Introduction

Master Builders Solutions – connecting innovation and reliability for a sustainable future

The Master Builders Solutions brand brings all of BASF’s expertise together to create chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than a century in the construction industry.

The know-how and experience of a global community of BASF construction experts form the core of Master Builders Solutions. We combine the right elements from our portfolio to solve your specific construction challenges. We collaborate across areas of expertise and regions and draw on the experience gained from countless construction projects worldwide. We leverage global BASF technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make you more successful and drive sustainable construction.

Global Underground Construction Team

BASF, with its global underground construction team, is a world leader in the provision of reliable, customer-oriented product solutions focused on your needs in the tunneling and mining industries. We recognise that your success is underpinned by our ability to deliver solutions that meet or exceed your critical needs. By accompanying you from the start of your project and understanding the issues that are important to you, we can contribute to your success.

Avoid the Unexpected

Unexpected water ingress and poor ground conditions during underground construction and mining usually escalate costs, can severely influence the environment, and inevitably cause significant delays. To counteract these risks, an economical approach is to pre-inject the ground ahead of the advancing face to avoid water ingress occurring, or to use post-injection techniques as a water stopping measure, for which a broad range of products and technologies are available. In light of the modern world’s focus on stricter legislation covering the environment and workers’ health and safety, stabilization of sands and soils requires both durable and safe mineral grouts and microcements. BASF offers a complete range of injection products suitable for all projects, including new and existing tunnels, mines and large civil engineering projects such as dams.
**Water Ingress Reduction and Ground Consolidation**

The pre-injection method can solve difficulties ahead of the tunnel face – a simple and cost-effective approach. Microcements and mineral grouts, the latter known as colloidal silica, are used in such cases. They improve working safety with minimal environmental consequences.

**Rapid Ground Consolidation**

Quick reacting post-injection systems can immediately stabilize poor ground and be used to fill voids as a result of cave-ins. The polyurethane and polyurea silicate systems are approved for use in coal mining and are also used widely in hard rock mining and tunneling.

**Rapid Water Ingress Reduction**

The post-injection polyurethane and polyurea silicates, also known as resins, can be used to combat large water ingress quickly and effectively. For particularly difficult cases the solution is a combination of drainage and the injection of a rapid reacting foaming resin.

**Rehabilitation of Tunnel Linings**

This post injection method can be used for rehabilitation injection for cast concrete, segment lining and brick & masonry lined tunnels. The range of acrylate resins are particularly suitable for durable structural concrete crack injection, as well as the polyurethane resin MasterRoc® MP 354 CE for concrete repair.
Fast Setting, Fast Cycle

MasterRoc MP RHEOCEM® microcements are a range of superfine portland cements specially made for injection into rock and soils. Due to their fineness they provide extremely effective penetration into fine cracks in rock and fine grained soils to give efficient water tightness, stability and durability. They represent a significant technological advantage in cementitious injection. Their unique feature is rapid and controlled setting, allowing uninterrupted blasting rounds or continued injection sequences, thereby enhancing productivity considerably.

MasterRoc MP RHEOCEM microcements are also available as sulphate resisting versions and in different grades relating to the maximum particle size as given by the D95 values illustrated in the image on page 5.

Stable Penetrating Grout

Features and benefits:

- Reduced time for a given result – less drilling and less pumping, with no waiting time for the cement to set
- Improved quality of work due to fast grout without bleeding (w/c=1)
- Further reduced setting with the in-line addition of alkali-free set accelerators
- Excellent grout stability under high pumping pressure ensuring efficient penetration into rock and soils
- Very good penetration into small cracks and inter-granular spaces
- Better working environment as MasterRoc MP RHEOCEM contains no toxic products
- High durability
- Economical solution
- Standard cement injection equipment can be used.
Controlled Accelerated Setting of Microcement Suspensions

The setting of grout suspensions based on MasterRoc MP RHEOCEM microcements can be accelerated with a controlled dosage of alkali-free accelerator. Using this method, the open time of the grout suspension can be controlled from 1-2 minutes up to approximately 20 minutes, before it sets and becomes solid.

The main technical properties which can be achieved with this injection technology are:

- Controlled injection with limitation of grout spread in very permeable rock masses and soils.
- Controllable injection with fast setting in cold groundwater conditions, where conventional cements and microcements would only cure over a long time frame (several days).
Polyurethane and Polyurea Silicates

Water Stopping
- The MasterRoc MP 350 series of polyurethanes and the fire resistant (according to DIN4102-B2) MasterRoc MP 360 series of polyurea silicates are designed for water stopping and sealing, strata stabilization and cavity filling in mining and tunneling applications, meeting the modern day demands of the tunneling and mining industry.
- The range varies from a convenient 1 component PU for small water sealing jobs to specialist robust 2 component systems to effectively stop massive water ingress problems.

Consolidation and Cavity Filling
- MasterRoc also provides advanced tailor-made resins for cavity filling and ground consolidation in the demanding coal mining industry.

Tailor Made for Underground Use
Features and benefits of MasterRoc MP injection resins:
- All polyurethane and polyurea silicate products are solvent free and build closed cell foams.
- Many of the products for preventing water ingress in tunneling can be adjusted on site to give varying performance properties to suit the conditions using different accelerators.
- The polyurea silicate range has been developed to provide fire resistant properties for increased safety underground with better performance.
- All MasterRoc MP polyurethane and polyurea silicates have been tested and certified by external institutes in terms of technical properties and health and safety aspects.
<table>
<thead>
<tr>
<th>Product</th>
<th>Reaction time at 20°C</th>
<th>Foam factor</th>
<th>Applications</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MasterRoc MP 350 1 component PU + accelerator</td>
<td>30 – 100s Separate accelerator provided to adjust reaction time</td>
<td>to 8</td>
<td>For permanent structural crack sealing of concrete and masonry structures, filling of dry and water bearing fissures.</td>
<td>1-component pump</td>
</tr>
<tr>
<td>MasterRoc MP 354 CE 2 component PU</td>
<td>160 – 250 mins</td>
<td>1</td>
<td>CE certified resin, especially designed for concrete repair. Can react with stronger expansion in presence of water.</td>
<td>1 and / or 2 component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 355 1K 1 component PU + accelerator</td>
<td>10 – 120s Separate accelerator provided to adjust reaction time</td>
<td>20 to 30</td>
<td>To stop water ingress in tunnels. Consolidation of gravel. Sealing cracks in concrete structures.</td>
<td>1-component pump</td>
</tr>
<tr>
<td>MasterRoc MP 355 1K DW 1 component PU + accelerator</td>
<td>15 – 130s Separate accelerator provided to adjust reaction time</td>
<td>20 to 30</td>
<td>To stop water ingress in tunnels. Consolidation of gravel. Sealing cracks in concrete structures. DW = potable water approval.</td>
<td>1-component pump</td>
</tr>
<tr>
<td>MasterRoc MP 355 2 component PU</td>
<td>No Accelerator 60 – 70s Accelerator 10 40 – 60s Accelerator 15 90 – 120s Accelerator 25 20 – 60s</td>
<td>to 10</td>
<td>Ground consolidation and rapid water stopping in underground structures. Should not be used in coal mines due to too high reaction temperatures. Reacts with and without water. Use of Accelerator 10 allows increased foam factor and faster reactions to deal with major water ingress situations. Use of Accelerator 15 provides stiffer foam allowing more effective ground improvement properties. Use of Accelerator 25 combines the functions of Accelerators 10 and 15.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 355 TIX Highly reactive 2 component PU</td>
<td>The accelerators used for MP 355 may also be used (similar reaction times)</td>
<td>2 to 3</td>
<td>Fast reacting, thixotropic PU resin, used for very demanding water stopping conditions where the dilution of PU is likely. The resin provides immediate structural strength.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 358 SC 2 component PU</td>
<td>30 – 70s</td>
<td>to 3</td>
<td>High quality foam for ground consolidation in coal mines and civil projects. Consolidation of fractured rock in tunnels, shafts and longwall operations. Sealing against gas and quasi-static water. Less sensitive to water than usual polyurethanes.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 358 GS 2 component PU</td>
<td>30 – 70s</td>
<td>&lt; 1.5</td>
<td>Permanent consolidation of broken rock and coal in tunnels, shafts and longwall operations. Sealing against gas and quasi-static water. Extremely high compressive and bonding strength. Less sensitive to water than other polyurethanes.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 364 Flex 2 component solvent free urea silicate, fire resistant resin</td>
<td>90 – 120s</td>
<td>1</td>
<td>Dense glue-like resin, with good penetration properties for very effective ground consolidation of coal measures, fractured rock and gravels. No foaming in contact with water. Can be used for injections under water.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 367 Foam 2 component solvent free urea silicate, fire resistant resin</td>
<td>10 – 60s</td>
<td>2 to 30</td>
<td>Void and cavity filling in underground construction, tunneling and mining to avoid water or gas accumulation. Consolidation of fractured rock, sand, gravel and coal. Stabilization of cavities in tunnels. Expands without water.</td>
<td>2-component pump with static mixer</td>
</tr>
</tbody>
</table>
Water can flow in every direction, before and during injection.

**Goal of injection:**
to section and create barriers, subsequently removing water.

**Strong Durable Gels for Permanent Crack Sealing**

The MasterRoc MP 300 series is a range of high performance acrylic resins for underground use. They can strengthen weak soil and sand immediately and seal off water. Where water ingress must be avoided they can permanently seal the finest cracks instantly and even accommodate limited movement due to their flexibility and swelling capability. This makes them ideal products for curtain injection behind leaking tunnel linings and diaphragm walls. They are also widely used in major infrastructure projects such as power stations’ generator housings for the permanent waterproofing of concrete defects.

**CE Certification**

The CE certificate specifies requirements and conformity criteria for the identification, performance (including durability aspects) and safety of injection products for the repair and protection of concrete structures.

Two of our latest acrylics, MasterRoc MP 303 CE and MP 307 CE have CE certification for the “swelling fitted filling of cracks, voids and interstices in concrete”.

**Crack injection in tunnel linings**

Possibly leaking joints
Mastering underground construction challenges requires the right partner. Continuous innovation and customized solutions ensure that customers using Master Builders Solutions operate successfully, and to the highest safety standards.

<table>
<thead>
<tr>
<th>Product</th>
<th>Reaction time at 20°C</th>
<th>Viscosity</th>
<th>Features &amp; Applications</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MasterRoc MP 301</td>
<td>1 – 12 min</td>
<td>7 mPa·s</td>
<td>Highly reactive acrylic resin with good adhesion to wet surfaces. Flexible gel to accommodate ground movement. Designed for stabilization of soil and heavily broken rock, including micro cracks and capillary pores of soil.</td>
<td>1 and / or 2 component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 302</td>
<td>3 – 45 min</td>
<td>3 mPa·s</td>
<td>Solvent free, very low viscosity acrylic resin with good adhesion to wet surfaces. Flexible gel to accommodate ground movement. Low swelling pressure and non-corrosive due to low pH value. Suitable for deep penetration into fine cracks, rock fissures and soils.</td>
<td>1 and / or 2 component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 303 CE</td>
<td>10 sec – 3 min</td>
<td>5 mPa·s</td>
<td>Economic acrylic resin with good penetration into fine fissures, suitable for crack injection, concrete repair etc. Good adhesion to wet and damp surfaces. Can swell up to 200% of initial volume and is re-swellable. Very flexible: structural stability low. Stable against acidic and alkaline solutions.</td>
<td>2-component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 307 CE</td>
<td>4 – 17 min</td>
<td>7 mPa·s</td>
<td>Due to the special latex emulsion of part B, the cured system is rubber-like, strong and very flexible. Withstands high water pressure and balances ground movements. Can be used in “living cracks”. Cured material is not sensitive to water and stays close to its original shape (only small shrinkage or swelling). Good chemical resistance against acids, bases, solvents, fuels, etc.</td>
<td>1 and / or 2 component pump with static mixer</td>
</tr>
<tr>
<td>MasterRoc MP 308</td>
<td>10 – 60 min</td>
<td>40 mPa·s</td>
<td>Solvent free acrylic resin designed as a permanent water sealing resin for cracks. Suitable for injection in damp areas with excellent bonding to wet surfaces. Can swell up to 150% of its initial volume. Swelling is reversible. Resists permanent water pressure and allows for structural movement.</td>
<td>1-component pump</td>
</tr>
<tr>
<td>MasterRoc MP 309</td>
<td>45 sec – 8 min 30</td>
<td>13 mPa·s</td>
<td>Fast setting super strong acrylic resin with good adhesion to wet rock and concrete surfaces. It has good chemical resistance against acids, bases and fuels. It is a product to be used for special needs, such as consolidation in silty and sandy strata (where PU is too high in viscosity). It neither shrinks nor swells. Not suitable for bigger voids.</td>
<td>2-component pump with static mixer</td>
</tr>
</tbody>
</table>
Entirely Natural Ingredients

The MasterRoc MP 320 products (MP 320 and MP 325) are colloidal silica gels, referred to as a “mineral grouts”. These are not chemical grouts and consist only of natural ingredients, making products non-hazardous and ecologically friendly. They are made of a stable liquid dispersion of discrete, nanometric spherical particles composed of 100% amorphous silicone dioxide.

Due to their very low viscosity, they penetrate finer fissures than any cement based products and ensure unrivalled penetration and permanent stabilization of fine, silty sands.

The MasterRoc MP 320 products are used in jointed rock and fine grained soils as a supplement to microcement injections to achieve the final required result and where durable long-term solutions for water sealing and ground stabilization are required.

Effective Penetration

Features and benefits:

- Colloidal silica is environmentally friendly and durable, as it is simply composed of quartz sand, water and salt.
- Having a viscosity similar to water, it penetrates soils and fine rock fissures very easily.
- The gel time can be adjusted with the addition of salt water, and can be controlled to between 10 minutes and 2 hours.
- Unlike waterglass (sodium silicate) based products, colloidal silica is durable and continually gains strength over time.
- It is extremely user-friendly as standard cement grout equipment can be used, which is easily cleaned with water.
- More cost-effective solution than chemical grouts.
Training and Education

BASF provides technical injection training courses on a frequent basis centrally located in the Hagerbach underground facility in Switzerland. In addition, tailored training is organized on large projects for customers when required.

Technical training is organized both as demonstration workshops in realistic underground settings and as practical injection operators’ training.

The demonstration workshops are organized as practical “show-and-tell” sessions and aim to visualize and explain the possible types of application and the technical performance of our injection systems.

The practical injection operators’ training is offered exclusively to injection customers who are working with BASF injection systems. At this training the participants are given the chance to work in small groups, taking part in hands-on exercises under the supervision of experienced instructors. The main objective is to gain practical skills for the correct application and execution of injection works.

More brochures on our underground construction solutions are available at www.ugc.basf.com

Technical Services

BASF provides more than simply a supply of products. Assisting customers in selecting the right injection system and setting out the injection method, as well as providing initial supervision and site training of the customer’s personnel, is an essential part of our concept. BASF works together with suppliers of equipment and injection accessories to provide the best, most cost-effective and complete technology solution.
Master Builders Solutions from BASF for the Construction Industry

MasterAir®
Complete solutions for air entrained concrete

MasterBrace®
Solutions for concrete strengthening

MasterCast®
Solutions for the manufactured concrete product industry

MasterCem®
Solutions for cement manufacture

MasterEmaco®
Solutions for concrete repair

MasterFinish®
Solutions for formwork treatment

MasterFlow®
Solutions for precision grouting

MasterFiber®
Comprehensive solutions for fiber reinforced concrete

MasterGlenium®
Solution for hyperplasticized concrete

MasterInject®
Solutions for concrete injection

MasterKure®
Solutions for concrete curing

MasterLife®
Solutions for enhanced durability

MasterMatrix®
Advanced Rheology control solutions for self-consolidating concrete

MasterPel®
Solutions for water tight concrete

MasterPolyheed®
Solutions for high performance concrete

MasterPozzolith®
Solutions for water-reduced concrete

MasterProtect®
Solutions for concrete protection

MasterRheobuild®
Solutions for superplasticized concrete

MasterRoc®
Solutions for underground construction

MasterSeal®
Solutions for waterproofing and sealing

MasterSet®
Solutions for retardation control

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