METROLINK

Integrated Transport. Integrated Life.

A5.14 TBM Consumables

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List of Abbreviations

Acronym	Meaning
EIAR	Environmental Impact Assessment Report
EPB	Earth Pressure Balance
MM-TBM	Multi-Mode Tunnel Boring Machine
MPV	Multi-Purpose Vehicle
TBM	Tunnel Boring Machine

1. Introduction

The proposed Project alignment through Dublin Airport and the City is achieved through two bored tunnel sections. It is proposed to construct two single-bore tunnels using a Tunnel Boring Machine (TBM). The tunnel alignments, associated construction areas and operation of the TBM are described in Appendix 5.13A of this EIAR. This Appendix describes the various chemicals (consumables) used in the operation of a TBM that are either left in the ground or removed with the spoil.

It does not cover consumables in the form of pre-cast concrete segments, packers, dowels or gaskets, electrical power, water for cooling or compressed air, or any grouting that may be required to launch or recover a TBM.

2. TBM Consumables

TBM consumables typically comprise the following:

- Annulus grouting;
- Spoil conditioning additives for Earth Pressure Balance (EPB) TBM or a Multi-Mode TBM (MM-TBM) in EPB mode;
- Main bearing grease;
- Main bearing labyrinth seal grease;
- Tail seal grease;
- Bentonite slurry for a slurry TBM or slurry mode on a MM-TBM; and
- High density slurry in high density mode on MM-TBM.

The materials are manufactured by various suppliers with examples given in Table 2.1 below. Material Safety Data Sheets are provided in Appendix A. Usage rates stated in Table 2.1 are typical but will vary with ground conditions and will be adjusted to suit.

Table 2.1: Consumables and Typical Usage Rates

Consumable	Product	Purpose of product	Usage rate (per metre of tunnel)	Manufacturer
Annulus grout, Part A	Cement and water	A mix of water, cement, powdered limestone and additives to produce a void filler which when cured forms a solid mortar-like material.	$7m^3$ – $9m^3$ depending on TBM design	More than one, see below.
Annulus grout cement	Ordinary Portland Cement	Cementitious part of the grout to produce a mortar-like solid	200kg – 350kg per cubic metre of grout. 1,400kg if 200kg at $7m^3$ of grout	Tarmac
Annulus grout Limestone powder	Ground limestone	A cement replacement material used to reduce the amount of cement. Other products such as pulverised fuel ash (PFA) or ground granulated blast furnace slag (GGBS) can also be used.	800 – 1,200kg per m^3 of grout 5,600kg if 800kg at $7m^3$ per metre of tunnel	Various
Annulus grout	TamCem HCA	Additive that extends the workable life of the grout and reduces water usage.	4 – 6 litres per m^3 28 litres if four litres at $7m^3$ per metre of tunnel	Normet
Annulus grout accelerator, Part B	TamShot 10SS	Accelerator added to the grout at point of injection to make the grout set quickly.	2 – 4% by weight of cement. For 200kg of cement, 4kg of TamShot at 2% 28kg if 200kg cement at $7m^3$	Normet
Spoil conditioning	MasterRoc SLF 30	A foaming agent added to the spoil in the cutter head to reduce friction and helps create a pressure plug in the screw conveyor.	100 – 150 litres	BASF

Consumable	Product	Purpose of product	Usage rate (per metre of tunnel)	Manufacturer
Main bearing grease	TamGrease BL11	Main bearing lubrication grease	2kg – 3kg	Normet
Labyrinth seal grease	TamGrease BS1	Grease that fills the bearing seal under pressure to prevent debris entering the bearing's moving parts.	2.5kg – 3.5kg	Normet
Tail seal grease	TamSeal TG12 & TG11	Pumped into the wire brush seals to create an impermeable seal at the back to the machine preventing water ingress.	35kg – 40kg	Normet
Bentonite	Bentonite	Reduces wear in the cutter head and in pumps. In certain cases, helps maintain pressure in the head. Added to the slurry but in variable rates depending on ground conditions.	15kg of which 10% remain or is lost in the ground, 1.5kg	Tarmac

2.1 Annulus Grouting

The cut diameter of the tunnel is larger than the outside diameter of the tunnel lining by approximately 120mm in radius. This gap allows the lining to accommodate any curves along the alignment and allows the lining to be built in the form of segmental rings, inside the TBM.

As the TBM pushes forward, this gap must be filled as soon as possible to prevent settlement and to support the ring as it leaves the tail can of the machine. This process is called annulus grouting and is performed by pumping a grout material into the annulus as the machine moves forward. This operation is interlocked with the TBM shove rams so the machine cannot mine forward without grout being pumped into the annulus.

The grout consists of water and ordinary Portland cement, mixed together to produce a flowable grout material. Additional additives are used to stabilise the grout and prolong the working time. Once set, the grout compressive strength is in the region of 5 to 10MPa.

The grout is pumped through pipes built into the tail skin of the machine, see Diagram 2.1 and Diagram 2.2. An accelerator is added to the grout just before the end of the tail can. This is called two-part grouting, Part A the grout, and Part B the accelerator. The accelerator makes the grout gel quickly to provide support to the tunnel ring and prevent it from settling.

Diagram 2.1: TBM Tail Can with Built-in Grout Tubes

To prevent a blockage in the grout pipe with accelerated grout, the pumping of the accelerator stops before the end of the advance to allow the Part A grout to flush the pipe out. The unaccelerated grout can be designed to have a workable life of several hours. During any planned stoppage, the grout pipe is jet-washed clean with water.

Grout is mixed on the surface in a batching plant and pumped to a holding tank. From here it is pumped to the tunnel and into a grout car on a tunnel multi-purpose vehicle (MPV), see Diagram 2.3. The grout car is delivered to the TBM where it is offloaded at a designated location on the backup gantries and lifted clear to allow other MPV movements. The grout car is connected to the grout pumping system ready for the next advance. The size of the car must be sufficient to allow for a full advance, including an extended advance to expose tail seal brushes for repair, see Section 2.4. Flap seals at the rear of the tail can prevent the grout from flowing over the machine and into the head, see Diagram 2.9. No grout is lost to the ground, all remains in the annulus between the cut ground and the outside diameter of the tunnel lining.

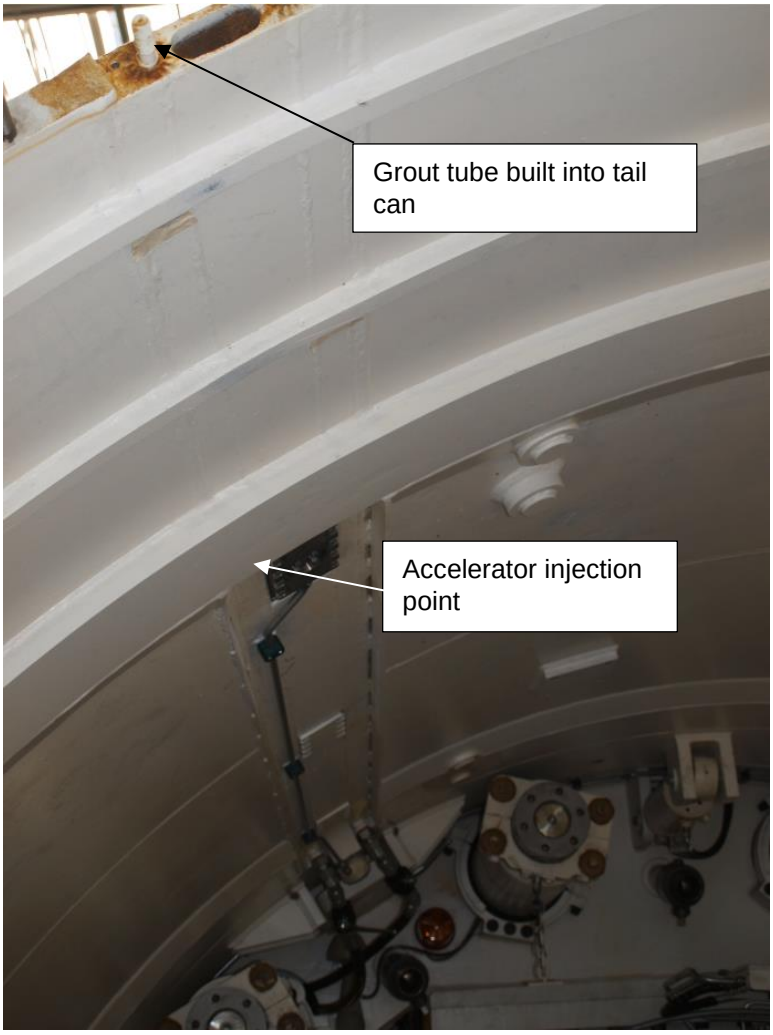

Diagram 2.2: Detail View of Grout Tube

2.2 Spoil Conditioning

Spoil conditioning additives are used when the TBM is in closed or EPB mode to make the cut ground more consistent and easier to handle. There is also a reduction in the friction in the cutterhead, leading to a reduction in tool wear and cutter head torque, reducing the power required to turn the cutter head. In addition, additives can help by allowing the spoil to form a pressure plug in the screw conveyor which is fundamental to the operation of an EPB TBM and its ability to maintain face pressure. They generally consist of a liquid foam agent that is mixed with water in foam generators on the backup gantries to produce a thick shaving-like foam that can be injected into the chamber in front of the bulkhead. In addition to the foam, polymers can be added to reduce the clogging (stickiness) of clay. These are often supplied pre-mixed with the detergent but can be injected separately. Injection ports can be on the bulkhead, on the front face of the cutter head itself and on the mixing arms behind the cutter head. The latter two are restricted in number by having to pass through the rotary coupling which also carries electrical cables for tool wear indicators and pressure sensors, plus hydraulic pipes if an adjustable copy cutter is used. Injection ports can also be used on the screw conveyor to reduce wear and torque if required.

The foam has a life of a few hours to a few days and breaks down in the spoil pile. There are many different brands of soil conditioning foam agent. All brands are biodegradable with no harmful residual chemicals.

The material is delivered to site on normal road lorries in Intermediate Bulk Containers (IBCs) and off-loaded by fork-lift or crane. Storage areas are bunded and covered to prevent a buildup of rainwater in the bund. Heating will be required to maintain the correct temperate range in cold weather. Loaded onto the tunnel transport MPV, they are delivered to the TBM and offloaded by a hoist or winch and stored in a purpose-made area. The delivery pipes are connected to the IBC and the foam is ready for use. Empty IBCs are brought out on the same MPV and are usually collected by the manufacturer for re-use.

Diagram 2.3: Tunnel MPV

2.3 Main Bearing Grease

The main bearing on a TBM is a complex structure and operates a constant loss lubrication and sealing system. Two different types of grease are continually pumped into the bearing from drums positioned on the backup gantries. Pipes carrying the grease run from the pumps to the bulkhead and into the bearing.

One grease provides the lubrication for the bearing and the other fills the labyrinth seal and prevents spoil from getting into the roller bearings. Both greases are ‘lost’ in the spoil and removed with the arisings and both are biodegradable. Under constant positive pressure, the greases are injected into the bearing, which prevents the pressurised slurry (spoil) in the mixing chamber from getting into the bearing.

The grease drums come in a variety of sizes to suit the TBM and method of handling but usually in 205-litre drums. They are delivered to the TBM and offloaded using a purpose-made hoist for drum handling. The drums are placed in position at the pumps and connected. By using additional hoists, it is possible to put the drums in position with no manual handling. Empty drums are returned by the same means and taken to the surface for disposal.

Bearing-grease drums go back to the manufacturer, who recovers any residual quantity left inside, cleans the drum, checks its shape, and refills it for reuse.

Diagram 2.4: Main Bearing and Labyrinth Grease on a TBM

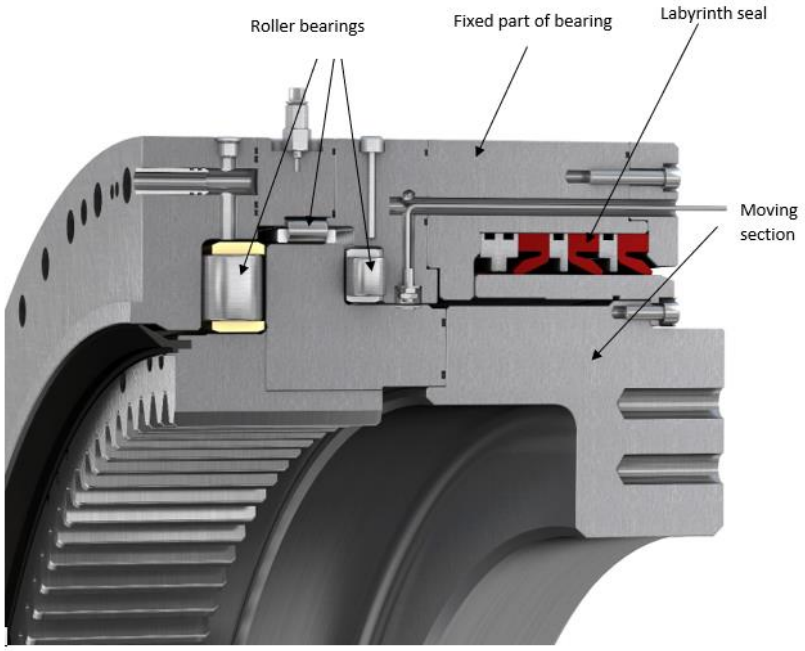

Diagram 2.5: TBM Main Bearing

2.4 Tail Seal Grease

The third grease used in bulk on a TBM is tail seal grease. This is a thick paste-like material that is continuously pumped into the tail seal brushes located in rows in the tail can. These are wire brushes welded or bolted in place to form a complete circle around the inside of the tail can, usually in three or four rows. The grease and wire brushes provide the seal at the rear of the TBM, preventing water and the annulus grout from getting into the tail can. Flap seals rubbing on the cut ground on the outside of the TBM prevent the grout from running over the TBM shield.

Diagram 2.6: Tail Seal Grease

Tail seal grease comes in two grades, hand pack and pumpable. The hand pack grease is thicker and used to fill the wire brushes of the tail seal prior to launching of the TBM. It is applied using a powerful pump and injector tool to reach the base of the wire brushes. The pumpable grease is used as the TBM advances in the same fashion as the main bearing grease. The material comes in 205-litre drums and is handled the same way as the main bearing grease. The tail seal grease does not come into contact with the ground when the TBM is mining. As the TBM pushes forward, the tunnel rings are exposed at the end of the tail can but are immediately covered by the annulus grout.

Tail seal grease drums go back to the manufacturer who recovers any residual quantity left inside, cleans the drum, checks its shape, and refills it for reuse.

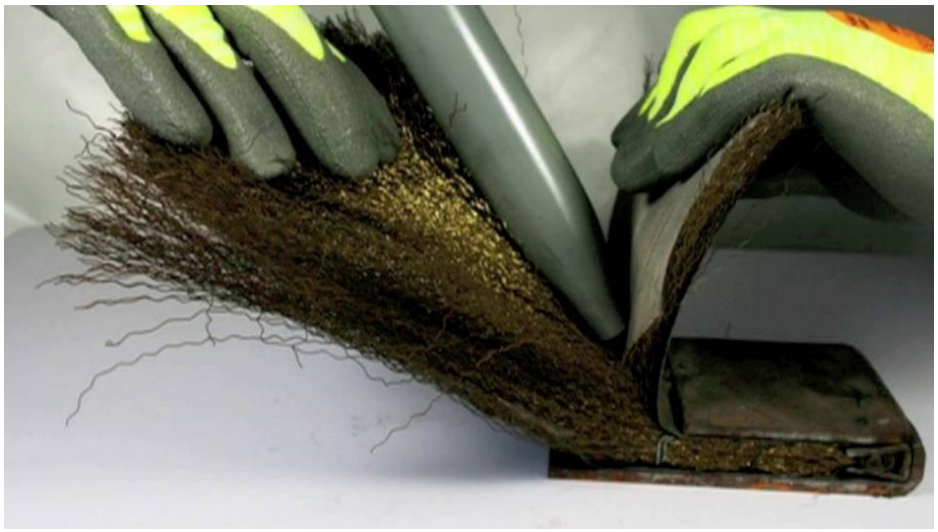

Diagram 2.7: Single Tail Seal Brush with Hand Packing Injector Tool

Diagram 2.8: Two Rows of Tail Seal Brushes

Diagram 2.9: Tail Seal Grease on the Outside of a Tunnel Ring

2.5 Bentonite

On a slurry or MM-TBM, a slurry of excavated material and water is formed in the head of the TBM. This slurry is used as a transport medium to remove spoil from the TBM. Bentonite can be added to this slurry to help in reducing wear in the cutting head and slurry pumps but is not always needed. A bentonite slurry will be used to launch the machine before any ground is mined. The slurry is generally bulk manufactured on the surface in a slurry plant and pumped to the TBM.

Bentonite is blended from naturally occurring materials and is non-hazardous. A material data sheet is provided in Appendix A. It is typically supplied in powder form and mixed with water.

Bentonite can also be added to the slurry to help form a cake over the cut ground to maintain face pressure in certain ground conditions such as loose or fractured ground and in sandy clays.

Polymers are often added to the slurry to prevent the mix flowing to the ground under the pressure inside the head, and to help prevent the mix sticking to metal surfaces. As with the slurry itself, very little is left in the ground as it is continuously re-cycled and mixed with fresh slurry as the tunnel and pipelines are extended.

High density slurry contains a higher amount of bentonite to deal with high water pressure and/or poor ground.

Bentonite slurry can also be used in smaller quantity for injecting around the TBM shield during long stoppages to help prevent ground closure, and into the cutter head in certain ground conditions when in EPB mode. The material will be batched on the surface and delivered to the TBM in a purpose-made tank which will be offloaded in a dedicated location and connected to the pumps for placing.

Slurry will be pumped back to the surface to a treatment plant that separates the excavated material from the bentonite. The treatment process separates the excavated material by size and a number of stockpiles are produced before removal from the site. The screening technology includes hydro-vacuum cyclones, vertical separators and centrifuges to ensure that fine particles are removed. The separated bentonite slurry is held in storage tanks and then pumped back down to the TBM for re-use.

On completion of all tunnelling works, the bentonite slurry will be disposed of to a designated waste disposal site. During tunnelling, spent bentonite that is no longer suitable for reuse will also need to be disposed of on occasions. Transport of the bentonite slurry will be by road tanker. Under Irish regulations it is classified as a non–hazardous waste. It will not be possible to reuse, recycle or recover this waste further and disposal to a licenced landfill may be required.

Detailed description on resource and waste management and potentially suitable destinations for spoil and bentonite slurry transported by road are discussed in Chapter 24 (Resource & Waste Management) and in the Excavated Materials Management Strategy (Appendix A24.1) of this EIAR.

Appendix A. Material Data Sheets

TARMAC
A CRH COMPANY

Uniclass L621
/ Cl/SfB / / Yq2 / /
September 2018

SAFETY INFORMATION

EN 197-1 COMMON CEMENTS

Health and Safety Information In accordance with Regulation (EC) No 1907/2006 (REACH) as amended by Regulation (EU) No 453/2010

SECTION 1: IDENTIFICATION OF THE MIXTURE AND OF THE COMPANY

1.1 Product identifier			
Product Name	EN 197-1 Common cements		
Substance	EINECS	CAS	
Portland cement clinker	266-043-4	65997-15-1	
Trade Name(s)	PCRM PCCP PC Ferrocrete Snowcrete Microcem	Phoenix Eco-Phoenix PLC Cemergi	Procem Mastercrete General Purpose Sulfacrete

1.2. Relevant identified uses of the mixture and uses advised against

Common cements are used in industrial installations to manufacture/formulate hydraulic binders for building and construction work, such as ready-mixed concrete, mortars, renders and grouts, as well as precast concrete. Common cements and cement containing mixtures (hydraulic binders) are used industrially, by professionals as well as by consumers in building and construction work, indoor and outdoor. The identified uses of cements and cement containing mixtures cover the dry products and the products in a wet suspension (paste). See section 16.2 for more information regarding use descriptors and categories.
Any uses not mentioned above, are advised against.

1.3 Details of the supplier of the safety data sheet

Tarmac Cement and Lime Ltd,
Portland House, Bickenhill Lane,
Birmingham B37 7BQ
Technical helpdesk: 0845 812 6232
Email: info-cement@tarmac.com

1.4 Emergency telephone

Emergency telephone number available during office hours
(08:30 – 16:00): Tel +44 (0)845 812 6232
(English Language only)
Emergency telephone number available outside office hours: None

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the mixture

2.1.1 According to Regulation (EC) No 1272/2008 (CLP)		
Hazard class	**Hazard category**	**Hazard statements**
Skin irritation	2	H315: Causes skin irritation
Serious eye damage/eye irritation	1	H318: Causes serious eye damage
Skin sensitisation	1	H317: May cause an allergic skin reaction
Specific target organ toxicity single exposure respiratory tract irritation	3	H335: May cause respiratory irritation

2.2 Label elements

According to Regulation (EC) No 1272/2008 (CLP)

Hazard pictograms

Signal word

Danger

Contains Portland cement clinker.

Hazard statements

H318 Causes serious eye damage.
H315 Causes skin irritation.
H317 May cause an allergic skin reaction.
H335 May cause respiratory irritation.

Precautionary statements

P102 Keep out of reach of children.
P280 Wear protective gloves/protective clothing/ eye protection/face protection.
P305+P351+P338+P310: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a doctor/physician
P302+P352+P333+P313: IF ON SKIN: Wash with plenty of soap and water. If skin irritation or rash occurs: Get medical advice/attention
P261+P304+P340+P312: Avoid breathing dust/fume/ gas/mist/vapours/spray. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a doctor/physician if you feel unwell.
P501 Dispose of contents/container to: Harden by application of water and dispose of as concrete waste

Supplemental information

Skin contact with wet cement, fresh concrete or mortar may cause irritation, dermatitis or burns. May cause damage to products made of aluminium or other non-noble metals

2.3. Other hazards

Cement does not meet the criteria for PBT or vPvB in accordance with Annex XIII of REACH (Regulation (EC) No 1907/2006). When cement reacts with water, for instance when making concrete or mortar, or when the cement becomes damp, a strong alkaline solution is produced.

Due to the high alkalinity, wet cement may provoke skin and eye irritation. Cement is either naturally low in soluble chromium VI or reducing agents have been added to control the levels of sensitising soluble chromium (VI) to below 2 ppm (0.0002%) of the total dry weight of the cement ready for use according to legislation specified under Section 15.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

Not applicable

3.2. Mixtures

Contains less than 1% crystalline silica

Information on ingredients

Substance	Concentration range (%by wt in cement)	Registration No	EINECS	CAS	Classification Regulation (EC) 1272/2008	
					Hazard Class Category	Hazard Statement
Portland cement clinker	5-100%		266-043-4	65997-15-1	Skin irritation cat 2. Serious eye damage/ eye irritation cat 1. Skin sensitisation cat 1. STOT SE respiratory tract irritation cat 3.	H315: Causes skin irritation H318: Causes serious eye damage H317: May cause an allergic skin reaction H335: May cause respiratory irritation

KILWAUGHTER CHEMICAL
COMPANY LIMITED

PRODUCT SAFETY DATA SHEET

(In accordance with Annex II of REACH regulation)

1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

1.1 Identification of the substance/preparation

Product Range **LIMESTONE (Calcium carbonate)**
Data sheet applies to: **Limestone Whiting** **Limestone Coarse Whiting** **Mastic Filler Grade**
Asphalt Filler **Limestone Sands** **Limestone Fine Granular**
Limestone Grits **Limestone Chips**
Limestone Feed Material 38% Calcium

1.2 Use of substance/preparation

Bagged or bulk limestone for use in various applications within the building industry, animal feed stuffs and use as a neutralising agent in agriculture and horticulture.

1.3 Company/undertaking identification

Kilwaughter Chemical Company Limited

9 Starbog Road
Larne
Co. Antrim
Northern Ireland
BT40 2TJ

Tel **+44 (0)28 2826 0766**
Fax **+44 (0)28 2826 0136**

e-mail Sales@Kilwaughter.com
web www.Kilwaughter.com

1.4 Emergency telephone

Available during office hours **+44 (0)28 2826 0766**
European emergency number **112**

2 HAZARD IDENTIFICATION

Xi Irritant

Risk Phrases

R36 Irritating to the eyes
R37 Irritating to the respiratory system

Under normal use this product is not expected to be harmful to the environment

3 COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Naturally occurring mineral limestone from geological origin

consisting of: approximately 98% calcium carbonate
approximately 2% silicon dioxide (as flint)
may contain naturally occurring trace metals

3.2 Limestone CAS No. 1317-65-3 Xi **R36 R37**
see section 16

TamCem HCA

Liquid Admixture for Controlled Concrete Hydration

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamCem HCA is a liquid additive for all fresh concrete and grout mixes where extended "open-time" becomes a crucial requirement for the construction process time frame. The product is designed to efficiently control cement hydration to allow for extended waiting times or delays on site, or readymix concrete transportation times. TamCem HCA eliminates the amount of rejected concrete due to loss of workability and helps contractors to stay within or even reduce the initially calculated material budget.

TamCem HCA is a high performance hydration control admixture for all wet sprayed concrete. It can be used in tunnelling applications where low rebound and high performance in combination with TamShot alkali-free accelerator is needed.

By adjusting the dosage, setting times of fresh concrete can be extended, giving an open-time typically in the range of 4 to 8 hours, but can be extended up to 2 days if required.

TamCem HCA meets EN 934-2 requirements for set retarding admixtures, EN 934-5 requirements for consistence control admixtures and ASTM C-494 requirements for Type B, retarding and Type D, water reducing and retarding admixtures.

KEY BENEFITS

- Controlled extended life of concrete or grout mix allowing increased flexibility on site
- Allows city centre job sites to stockpile fresh concrete and grout mixes during day shifts to negate need for night time batching
- Significantly reduces disposal of rejected / returned mixes
- Enhances performance of sprayed concrete set accelerators
- Beneficial in high temperatures and high humidity application environments

TYPICAL APPLICATIONS

TamCem HCA reacts with all commonly used Portland cement types and can be used to control hydration of all cement based grouts or concrete types. Typically, TamCem HCA is used in the mining and underground construction industry for applications such as:

- Sprayed concrete
- TBM Backfill grouts
- Pre-excavation grouting using TamCrete MFC grouts
- All concrete and cement grout applications where extended mix life is required

TECHNICAL DATA

TamCem HCA	
Colour and Form	Clear green liquid
Density (ISO 758) kg/dm³	1.08 ± 0.02
pH value (ISO 4616)	1.0 ± 0.5
Na_2O-equivalent (EN 480-12), %	< 0.1
Chloride content (EN 480-10), %	< 0.1
All at 20°C	

All technical data stated herein is based on tests carried out under laboratory conditions.

TamCem HCA

Liquid Admixture for Controlled Concrete Hydration

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

APPLICATION GUIDELINES

Refer to our Technical Department for detailed information on the application of TamCem HCA.

TamCem HCA should be added directly at the batching plant or truck-mixer at a suggested dosage of 0.3% to 2% of the cement weight in the concrete mix. TamCem HCA should always be added at the end of the batching process after all the concrete is thoroughly wetted out.

In all cases, it is recommended to carry out prior testing involving all components such as cement, fly ash, micro silica, sand, aggregates, in order to optimise the dosage required to maintain mix workability with TamCem superplasticising admixtures.

All testing should be in accordance with EN, ASTM, DIN or EFNARC standards to evaluate the best performing mix-design against economical considerations. Please always involve your local Normet representative for support.

PACKAGING

TamCem HCA is supplied in IBCs, drums and bulk containers. Packaging size may vary subject to local regulations and requirements, please contact your local Normet representative for more details.

STORAGE

TamCem HCA should be stored at room temperature (min 0°C and max 38°C), kept in closed containment in a cool, ventilated place out of direct sunlight until used. If these conditions are maintained and the product packaging remains sealed, then a shelf life of one year can be expected.

Due to the products acidic pH, TamCem HCA must be stored in stainless steel or plastic containers. Storage tanks made of mild (carbon) steel must not be used. Furthermore, all admixture pumps and delivery lines should be made of similar, anti-corrosive materials.

TamCem HCA will freeze at approximately -2°C but will return to full functionality after thawing and thorough mild mechanical agitation.

HEALTH & SAFETY

TamCem HCA should only be used as directed. We always recommend that the Safety data sheet (SDS) is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety data sheet is available upon request from your local Normet representative.

TamShot 10SS

Sprayed Concrete and Annulus Grout Accelerator

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamShot 10SS is used in sprayed concrete and annulus grouting applications which enables fast setting and/or where high early strength are required.

KEY BENEFITS

For sprayed concrete:
- Increased durability
- High final strengths
- Improved sprayability
- Increased bonding
- Increase strength due to reduced fibre rebound and better fibre orientation
- Reduced rebound
- Improved working environment
- Quicker work progress

For annulus grouting:
- Quick gel and setting times for segmental ring support
- High early strength development for segmental lining stability

TYPICAL APPLICATIONS

TamShot 10SS is suitable for all applications in wet shotcreting where large thickness layers and early and simultaneously high final strengths are crucial. TamShot 10SS is specially designed for use with wet sprayed, steel fibre reinforced shotcrete.
- Tunnels
- Galleries
- Mining
- TBM backfill grout
- Slope stabilisation
- Pit protection

TECHNICAL DATA

TamShot 10SS	
Form	Viscous Liquid
Colour	Clear to cloudy
Solubility	Complete
Density (kg/dm³)	1.35 ± 0.05
pH value	11 - 12.5
Initial Set	< 10 mins
Final Set	< 60 mins
Gel time	< 30 secs
All at 20°C	

All technical data stated herein is based on tests carried out under laboratory conditions.

APPLICATION GUIDELINES

Mixing
TamShot 10SS is dosed through a proportioning pump or pressure tank and added at the nozzle for sprayed concrete or injection port for grouting applications.

Application
For overhead applications the maximum thickness per layer applied is 80 – 140 mm.

Consumption
For sprayed concrete:
The dosage of TamShot 10SS generally varies between 1 - 7% by weight of cement. The required setting time and the necessary dosage of TamShot 10SS are determined by the type of substrate. Dosage is also influenced by the temperature of the substrate and of the gunned material, as well as by the type of cement used.

For annulus grouting:
Consumption varies greatly and is largely dependent on the w/c ratio, cement content, ambient and material temperatures, desired gel times as well as several other specific job conditions.

In special cases, other dosages may be recommended according to specific job conditions. Please contact your Normet sales representative for guidance on dosage recommendation.

TamShot 10SS V2WW16 – 2016.9.28

www.normet.com

TamShot 10SS

Sprayed Concrete and Annulus Grout Accelerator

CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

PACKAGING

TamShot 10SS is supplied in IBCs, drums and bulk. Packaging size may vary subject to local regulations and requirements, please contact your local Normet representative for more details.

STORAGE

TamShot 10SS is supplied in IBCs, drums and bulk. Packaging size may vary subject to local regulations and requirements, please contact your local Normet representative for more details.

HEALTH & SAFETY

TamShot 10SS should only be used as directed. We always recommend that the Safety Data Sheet (SDS) is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety Data Sheet is available upon request from your local Normet representative.

TamShot 10SS V2WW16 – 2016.9.28

www.normet.com

BASF
The Chemical Company

MasterRoc® SLF 30

Formerly MEYCO SLF 30

Soil conditioning foam for Tunnel Boring Machines (TBM)

Product description

MasterRoc SLF 30 is a foaming agent especially designed for soil conditioning in shielded tunnel boring machines.

Fields of application

- Soft ground tunneling

Features and benefits

- Improved soil behavior.
- Easier 'mucking'.
- Reduced permeability and increased sealing at the face.
- Creation of plastic deformation properties in the soil, which provides an even and controlled support pressure and increased face stability.
- Lower inner friction and lower abrasiveness of the soil at the cutterhead through to the screw conveyor and conveyor. This reduces power consumption, enables soil extraction and conveyance, as well as reducing wear costs.
- Reduced stickiness in certain soils, which would lead to blockage problems.

Packaging

MasterRoc SLF 30 is available in standard 1000 liter IBCs.

Technical data

Form	Liquid
Color	Clear colorless
Density [kg/m^3] 20°C	1035 -1045
Viscosity [mPas] 20°C	100
pH (5% solution) 20°C	6.5 – 7.5
Solubility in water	Total

Application procedure

An aqueous solution of MasterRoc SLF 30 can be expanded with air to produce a stable foam. The foam expansion and the foam injection rate onto the face, into the working chamber or screw conveyor will depend on the soil conditions encountered.

Consumption

Typically, MasterRoc SLF 30 is used at 2 to 3% (range 1.5 – 4%) in water to make a solution.
MasterRoc SLP 1 or MasterRoc SLP 2 polymers (see separate data sheets) can be jointly used with MasterRoc SLF 30 to strengthen the foam or adjust the properties of the excavated soil. For the first use and combination with other soil conditioning agents, please contact your local BASF representative.

Foam equipment

MasterRoc SLF 30 can be used with standard TBM dosing and foaming equipment.

Handling

Do not mix pure MasterRoc SLF 30 with any other pure soil conditioning additives as this may cause immediate gel formation. If several foaming products or polymers are used on the TBM, it is preferable to reserve a specific transfer or dosing pump for MasterRoc SLF 30. If a transfer or dosing pump is being used for more than one product, it is recommended to clean the pump with water before switching to other products.

Storage

MasterRoc SLF 30 must be stored between 5°C and 40°C. If stored in original tightly closed containers, it will have a shelf life of 12 months. Do not allow the product to freeze. Please contact your local BASF representative prior to the use of any product that has frozen.

Safety precautions

MasterRoc SLF 30 contains no hazardous substances. However, standard precautions for handling chemical products should be observed. Avoid eye and skin contact and wear rubber gloves and safety glasses. If contact occurs, rinse with plenty of water. In case of eye contact seek medical advice. For further information, refer to the Material Safety Data Sheet.

MASTER® BUILDERS SOLUTIONS

TamGrease BL11

Multi-purpose EP2 Grease for TBMs

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamGrease BL11 is a multi-purpose EP2 grease for tunnel boring machines, designed to lubricate the main bearing and the screw conveyor drive.

TamGrease BL11 is a high quality multi-purpose grease for both industrial and automotive applications and is suitable for a wide range of plain and rolling bearings.

KEY BENEFITS

TamGrease BL11 is a lithium thickened EP2 grease containing anti-oxidants, corrosion inhibitors and EP/AW additives.

- Excellent lubricating and pumping properties
- Good washout properties
- Good adhesion to metal surfaces

TYPICAL APPLICATIONS

EP2 grease can be used for the following tunnel boring machines:

- EPB TBMs
- Slurry TBMs
- Hard Rock TBMs

TECHNICAL DATA

TamGrease BL11	
Appearance	Homogeneous paste, yellow-brown
NLGI grade	2
Density (20°C) kg/m³	approx. 950
Consistency (ISO 2137)	265 - 295
4-ball-wear (DIN 52350:5) mm	< 0.5
Water spray-off (ASTM D4049) %	< 15 @ 25°C

APPLICATION GUIDELINES

The TBM supplier indicates the consumption of the EP2 grease. This indication has to be followed thoroughly.

PACKAGING

TamGrease BL11 is supplied in 180 kg drums design to fit the TBM press plate system.

STORAGE

TamGrease BL11 should be stored in unopened, original drums, preferably at 5 - 35°C. If these conditions are maintained and the product packaging is unopened, a shelf life of one year can be expected.

HEALTH & SAFETY

TamGrease BL11 should only be used as directed. We always recommend that the Safety data sheet is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety data sheet is available upon request from your local Normet representative.

TamGrease BL11 V1WW17 – 2017.3.21

www.normet.com

TamGrease BS1

Main Bearing Sealing Grease for TBMs

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamGrease BS1 is a main bearing sealing grease (excluder grease) for tunnel boring machines. It effectively protects the main bearing by preventing the ingress of soil, water or dust through the main bearing sealing.

TamGrease BS1 resists high water and ground pressures, has excellent sealing capacities and good lubrication and pumping properties. It is partly based on renewable raw materials.

KEY BENEFITS

- Excellent adhesion to metal surfaces
- Excellent cohesion and washout properties
- Good pumping and lubricating properties

TYPICAL APPLICATIONS

Excluder grease for the following tunnel boring machines:

- EPB TBMs
- Slurry TBMs
- Hard Rock TBMs

TECHNICAL DATA

TamGrease BS1	
Appearance	Homogeneous paste, black, fibrous
Odour	none
Density (20°C) kg/m³	1154 ± 50
Consistency (ISO 2137)	255 ± 20
4-ball-wear (DIN 52350:5) mm	< 0.90
Water spray-off (ASTM D4049) %	< 7

APPLICATION GUIDELINES

The TBM supplier indicates the consumption of the excluder grease. This indication has to be followed thoroughly.

PACKAGING

TamGrease BS1 is supplied in 230 kg drums design to fit the TBM press plate system.

STORAGE

TamGrease BS1 should be stored in unopened, original drums, preferably at 5 - 35°C. If these conditions are maintained and the product packaging is unopened, a shelf life of one year can be expected.

HEALTH & SAFETY

TamGrease BS1 should only be used as directed. We always recommend that the Safety data sheet is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety data sheet is available upon request from your local Normet representative.

TamGrease BS1 V1WW17 – 2017.3.21

www.normet.com

TamSeal TG12

1st fill Tail Sealant for TBMs

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamSeal TG12 is a special first fill grade tail sealant to be used on shielded tunnel boring machines (TBM). Together with the wire brushes, the sealant forms an impermeable barrier between the tail shield of the TBM and the concrete segments to effectively seal off any ingress of water, muck and backfill grout back into the TBM invert.

KEY BENEFITS

- Excellent interaction with the brush seal due to new fibre generation
- Excellent resistance to water
- Not mixable with annulus grouts
- Protects the brushes against wear

TECHNICAL DATA

TamSeal TG12	
Odour	None
Colour	Off-white
Form	Homogenous paste
Density (g/cm³)	Approx. 1.50
Consistency (1/10mm)	220 - 230
Matsumura Water pressure test	Pass at 34.5 bar
Flammability	Self-extinguishing

All technical data stated herein is based on tests carried out under laboratory conditions.

APPLICATION GUIDELINES

Application
TamSeal TG12 can be pumped by the TBM press plate system, if the pump is placed at the TBM shield (hose length as short as possible).

Consumption
The consumption of the first fill sealant can be calculated with 16.5kg per linear meter of brush row.

PACKAGING

TamSeal TG12 is supplied in 250 kg and 70 kg metal drums, being suitable for the standard press plate pumping system installed in TBMs. Other packaging may be available upon request.

STORAGE

TamSeal TG12 should be stored at room temperature (min 5°C and max 40°C), kept dry and out of direct sunlight. If these conditions are maintained and the product packaging is unopened, then a shelf life of one year can be expected.

HEALTH & SAFETY

TamSeal TG12 should only be used as directed. We always recommend that the Safety Data Sheet (SDS) is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety Data Sheet is available upon request from your local Normet representative.

TamSeal TG11

Tail Sealant for TBMs

normet
CONSTRUCTION CHEMICALS
TECHNICAL DATA SHEET

DESCRIPTION

TamSeal TG11 is a driving grade tail sealant to be used on shielded tunnel boring machines (TBM). Together with the wire brushes, the sealant forms an impermeable barrier between the tail shield of the TBM and the concrete segments to effectively seal off any ingress of water, muck and backfill grout back into the TBM invert.

TamSeal TG11 performs best when used in conditions with an ambient temperature above 15°C.

KEY BENEFITS

- Excellent interaction with the brush seal due to new fiber generation
- Excellent resistance to water
- Excellent adhesion properties
- Excellent pumpability
- REACH compliant

TECHNICAL DATA

TamSeal TG11	
Odour	None
Colour	Off-white
Form	Homogenous paste
Density	Approx. 1.50 (g/cm^3)
Consistency	250 - 260 (1/10mm)
Matsumura Water pressure test	Pass at 34.5 bar
Flammability	Self-extinguishing

All technical data stated herein is based on tests carried out under laboratory conditions.

APPLICATION GUIDELINES

Consumption
Consumption depends on various parameters like TBM-diameter, brush conditions, grout or water pressure and tunnel alignment.

Typical consumption rates are 0.8 - 1.2 kg/m^2 segment surface.

PACKAGING

TamSeal TG11 is supplied in 250 kg and 70 kg metal drums, being suitable for the standard press plate pumping system installed in TBMs. Other packaging may be available upon request.

STORAGE

TamSeal TG11 should be stored at room temperature (min 5°C and max 40°C), kept dry and out of direct sunlight. If these conditions are maintained and the product packaging is unopened, then a shelf life of one year can be expected.

HEALTH & SAFETY

TamSeal TG11 should only be used as directed. We always recommend that the Safety Data Sheet (SDS) is carefully read prior to application of the material. Our recommendations for protective equipment should be strictly adhered to for your personal protection. The Safety Data Sheet is available upon request from your local Normet representative.

JACOBS IDOM

TARMAC
A CRH COMPANY

TECHNICAL DATA SHEET
Bentonite
Ver. September 2016

TECHNICAL INFORMATION

BENTONITE

Product Data Sheet: Tunnelling Grouting Materials

DESCRIPTION

Bentonite is blended from naturally occurring materials designed to provide high gelling, lubricate and suspension properties in grouts or slurries.

The product is supplied in a fine powder form and is off white/yellow in colour with a flour type appearance.

USES

Bentonite is used either as a pipe jacking and tunnel shield lubricant or as a gelling material in grouts that need thixotropic properties.

Bentonite is used to create cut offs in diaphragm walls, for piling and also as a drilling mud.

MIXING AND LAYING

Water used in the preparation of slurries and grouts should be in compliance with BS EN 1008. Sea water is not recommended due to the possible saline imbalance.

It is essential to utilise the correct mixing and pumping equipment to realise the true characteristics of **Bentonite** grouts or slurries.

Mixers that impart energy (often known as high shear mixers) are required. Recirculating mixers can be used but will limit the potential for thorough gel formation.

Positive displacement pumps including diaphragm and piston pumps must be used to convey the material to the point of use

QUALITY CONTROL

All Pozament products are factory blended, tested and packaged to quality control procedures in accordance with BS EN ISO 9001.

PHYSICAL PROPERTIES

Appearance:	Cream, free flowing powder
Fineness:	95% passing 150µ sieve
Odour:	none
PH:	9-10
Bulk Density:	800-950kg/m^3

WORKABILITY

When prepared as a slurry and after the gel hydration has taken place the material will need to be reworked to restart flow. When used in grouts the other ingredients that may be used in the grout formulation will have an impact on the gel or flowing behaviour. Trial mixes should be carried out to establish properties before use.

CLEAN UP AND SPILLAGES

Dry powders should be swept up and disposed of in accordance with the Local Authority.

PACKAGING AND STORAGE

Bentonite is available in nominal 25kg sacks, palletised and shrink wrapped. **Bentonite** can also be supplied in Intermediate Bulk Containers or in Bulk Powder Tankers.

Palletised **Bentonite** should be stored in cool dry areas clear of the ground, sheeted or under cover and stacked not more than two pallets high.

The product should be used on a first in – first out basis.

Shelf life is minimum 3 months when properly stored but could be in excess of 6 months subject to temperature and humidity.

TECHNICAL DATA SHEET
Bentonite
Ver. September 2016

TARMAC
A CRH COMPANY

SLURRY CHARACTERISTICS

	After Mixing				Aged 1 hour			
Concentration in Water (kg/m^3)	50	60	70	80	50	60	70	80
Viscosity (Centipoises)	7.5	12.5	19	28	11	17.5	30.5	49
Yield Value (N/mm^2)	1.4	2.4	6.7	11.5	1.9	6.2	14.9	25
Bulk Density of Slurry	1026	1031	1036	1041	1026	1031	1036	1041

INFORMATION, PRICES & ORDERING

For technical information, pricing and to place orders contact our Sales Office on the following:

Telephone: **03444 630 046**
Email: **pozament@tarmacbp.co.uk**
Visit our website: **pozament.co.uk**

Tarmac Building Products Ltd.,
Swains Park Industrial Estate, Park Road, Overseal,
Swadlincote, Derbyshire, DE12 6JT

HEALTH & SAFETY

Health and safety advice, which must be followed, can be found on the Material Safety Data Sheet. Users are advised to wear face mask, goggles, gloves and overalls when handling, mixing and applying cementitious products.

Contains Portland Cement Contains Chromium (VI), which may produce an allergic reaction. Clothing contaminated by wet cement should be removed immediately and washed before reuse. R38 - Irritating to skin. R41 - Risk to serious damage to eyes. S26 - In case of contact with eyes, rinse immediately with water and seek medical advice. S37/39 - Wear suitable gloves and eye/face protection. S2 - Keep out of reach of children.

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BASF
We create chemistry

MasterRoc® SWA 710

Strong Thickener for Soil Conditioning in Tunnel Boring Machines (TBM)

DESCRIPTION

MasterRoc® SWA 710 is a liquid polymer, which is specifically designed for its use in ground and slurry conditioning. **MasterRoc® SWA 710** works as a binding agent restructuring the soil with a poor grading and low fines content, increasing its plasticity and cohesion, which helps to improve the balance of pressure in the working chamber, leading to better ground stability and soil extraction. **MasterRoc® SWA 710** can be used to enhance the performance of **MasterRoc SLF** foams and ACP soil conditioning products in difficult ground conditions, for example, in coarse soil with low fine content, or saturated soil with high water pressure. **MasterRoc® SWA 710** is also suitable to use for an adequate sealing of the excavation face during hyperbaric interventions in combination with the injection of bentonite or filler slurries.

FIELDS OF APPLICATION

- EPB and Slurry TBMs
- High ground water pressures, poorly graded or ground containing low amount of fine particles, water saturated ground, and
- Bentonite slurry modification in case of high soil porosity or saline water conditions.
- Improving the yield and filter cake properties of bentonite and filler slurries.
- Lubricant for pipe jacking.

FEATURES AND BENEFITS

- Structuring the soil, particularly effective in, coarse, clean sands and gravels below groundwater.
- Reducing soil permeability.
- Creation of plastic deformation properties in the soil providing an even and controlled support pressure and increased face stability.
- Lowering the inner friction and abrasiveness of the soil. Increasing cohesion of coarse sands and gravels.
- Improves the yield and filter cake properties of bentonite slurries.
- Ready to use - no mixing equipment required.

PACKAGING

MasterRoc® SWA 710 is available in 1000 liter IBC's.

Technical data	
Form	Liquid
Color	White
Density [kg/m³] 20°C	1.05
pH 20°C	7
Viscosity (DIN EN ISO 3219, 23°C, 250 1/s)	750 mPa.s
Solubility in water	Miscible

APPLICATION PROCEDURE

MasterRoc® SWA 710 should be used independently, in which case it is injected directly to the working chamber or the screw conveyor.

The quantity of **MasterRoc® SWA 710** polymer needed depends on the soil conditions.

For the combination with other soil conditioning agents, please contact your local BASF representative.

CONSUMPTION

Trials should be conducted to determine the optimum concentration of polymer. The dosage depends on the application field and the amount of water content in slurry or excavated ground – please consult your local BASF representative.

STORAGE

The storage temperature of **MasterRoc® SWA 710** is between 5°C and 35°C. If stored in original, tightly closed containers under the above conditions, it will have a shelf life of 6 months. Do not allow the product to freeze. Please contact your local BASF representative prior to the use of any product that has frozen.

MASTER® BUILDERS SOLUTIONS

MORRISON MUD
A division of MUDTECH LTD

CEFAS REGISTERED

MX POLYMER for tunnelling, drilling and geotechnics

Thixotropic, biodegradable, safe, ultra high performance mud for bentonite-free slurry. particularly effective in granular soils.

Background

MX POLYMER meets the requirement for clean, bentonite-free biodegradable slurry. MX POLYMER is effective in all ground types and is highly recommended for granular face. Formulation for most conditions would be 3 to 5 kg/m3 water.

Specific benefits

- Easy to mix and store - effective at less than 0.4% solution
- 100% biodegradable and non-toxic
- The No. 1 choice for sands/gravels/ cobbles
- Ideal for weak ground, shallow cover, and environmental breakout risk
- Highly effective in fresh or salt water
- Excellent face stabilisation and carrying capacity in sands and gravels
- Highly effective at low pumping rates
- Easily strippable with MX Breaker
- Excellent suspension properties when static or moving
- Excellent H & S profile compared with traditional bentonite
- Shear thinning: Superb carrying capacity - yet easy to pump

Packaging

- 25 kg sacks

Use

MX POLYMER was first developed to provide a superior replacement to overcome the limitations of bentonite slurry in mix soil conditions.

Physical characteristics

Granular powder, cream/ white.

Health and Safety/ Environmental Protection

MX POLYMER has been specifically manufactured for safety in use, and is a very low-hazard formulation requiring no special labelling. Please refer to MSDS (Material Safety Data Sheet) for this product. CEFAS registered as safe for use.

Compatible with:

- SLOOP face sealing agent
- TK60 lubricant and clay inhibitor
- Saline and fresh wate

Availability

Worldwide

For further guidance, and specific recommendations and costings for your project, kindly contact:
Mudtech Ltd - Morrison Mud Division,
Wyburn House, 1 Crab Lane
STAFFORD ST16 1SB United Kingdom
sales@mudtech.co.uk www.mudtech.co.uk
Tel: 0121 360 7669 Fax: 44 1929 554 361
Rev 02/03/2015

MX The super-premium biodegradable polymer. Powerful, versatile, and safe

Cefas REGISTERED