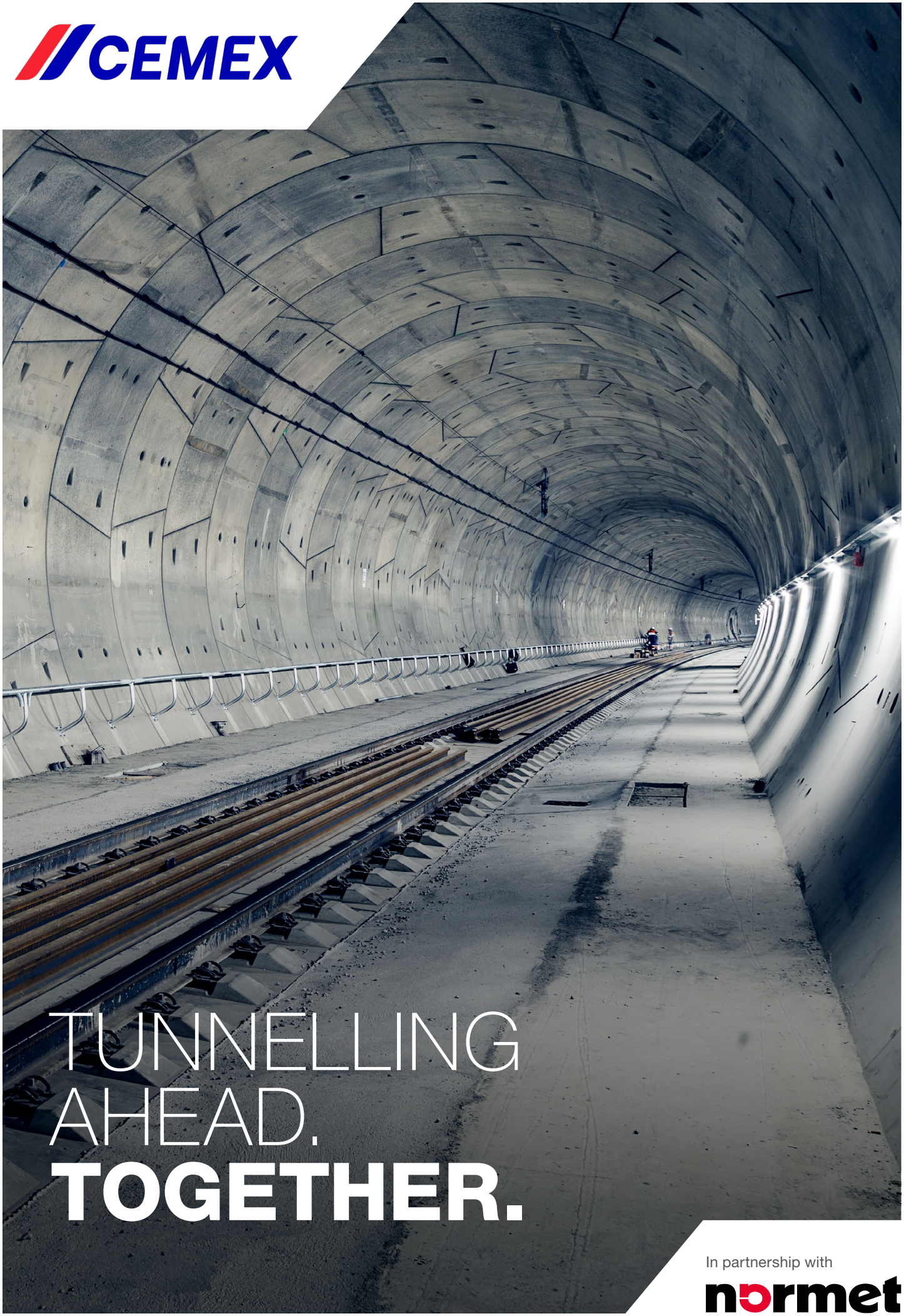
CEMEX



TUNNELLING AHEAD. **TOGETHER.**

In partnership with

normet

FUTUREPROOFING
TOMORROW'S CITIES

Urbanised cities are becoming denser and open spaces are becoming increasingly unavailable, in part due to continuous population growth.

Tunnelling and underground infrastructure is therefore instrumental in creatively using space available to develop sustainable urbanised landscapes.

TUNNELLING PLAYS A KEY ROLE IN THE SET-UP OF URBAN ENVIRONMENTS BY:

- Connecting communities through people-orientated transportation systems and infrastructure
- Supporting clean water systems by facilitating sewage treatment in older cities
- Futureproofing the resilience of cities from the impact of climate change
- Reducing visual, environmental and noise impacts by minimising disturbance to surfaces

CONTENTS

SUCCESSFULLY NAVIGATING TODAY'S CHALLENGES

Tunnelling is an extremely specialist and performance-critical industry. Along with the importance of identifying the correct concrete mix and equipment, the nature of tunnelling in high-profile environments comes with its own set of unique challenges, requiring complex and well-planned solutions.

PROXIMITY TO THE PUBLIC

Projects in major cities can mean construction activities take place in close proximity to the general public. Ensuring maximum health and safety concerns are addressed, while preventing escaped dust, is vital.

NOISE AND DISRUPTION TO EVERYDAY LIFE

With jobsites in highly pedestrianised residential and commercial areas, there is a growing pressure to find solutions that minimise the impact construction has on everyday life, for example, disrupting transport and blocking roads.

WORKING ENVIRONMENTS WHERE SPACE IS AT A PREMIUM

Compact workspace presents challenges for the delivery of materials and the equipment used during the construction process.

SUSTAINABLE CONSTRUCTION

There is a requirement to reach carbon neutrality by 2050. Contractors need to consider their materials and approach in maximising sustainable opportunities.

THE EFFICIENCY OF YOUR TUNNELLING PROJECT CAN DEPEND ON THE RIGHT APPROACH TO THESE CHALLENGES FROM THE ONSET

Project completed by our partner Normet

INNOVATION **THROUGH COLLABORATION**

At CEMEX, we're committed to developing reliable, efficient and more sustainable solutions that put the needs of our customers, contractors and the public at the heart of what we do.

To deliver our unrivalled solutions, we partner with Normet, a Finnish-based company that operates globally with over 43 locations in 28 countries worldwide.

Normet specialise in technologies and solutions for underground mining and tunnel construction, providing customers with safe, high-quality equipment and construction chemicals, sprayed concrete and underground construction.

The partnership focuses on innovation through collaboration, capitalising on multiple areas of expertise across both companies. This means we can support your projects with a truly end-to-end approach across all phases of underground construction.

We work closely with you to fully understand your requirements and project landscape. This approach enables us to determine the best concrete mix design, silo solution and equipment to enable you to deliver your project successfully.

WE SUPPORT YOU WITH A TRULY END-TO-END PARTNERSHIP SOLUTION THAT COVERS MANY PHASES OF THE TUNNELLING PROCESS

OUR END-TO-END APPROACH FOCUSES ON DOING THINGS AS EFFICIENTLY AS POSSIBLE FOR YOU

- We only batch the material you need, reducing unnecessary waste
- We work with you on planning logistics and single delivery to prevent constant disruption and multiple truckloads
- The performance of our product removes the need for additional accelerators
- We've introduced our lower carbon sprayed concrete with ambitions to continuously develop this further
- Our partner **Normet** provides the spraying equipment for you to build safely and improve energy efficiency in the construction process stage

Southam Tunnel - Lower Carbon Spray

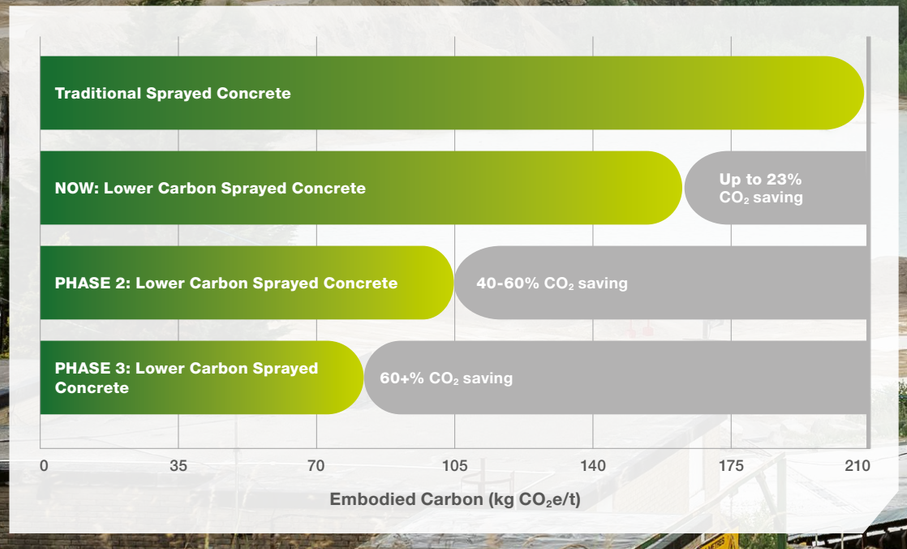
LOWER CARBON **SPRAYED CONCRETE**

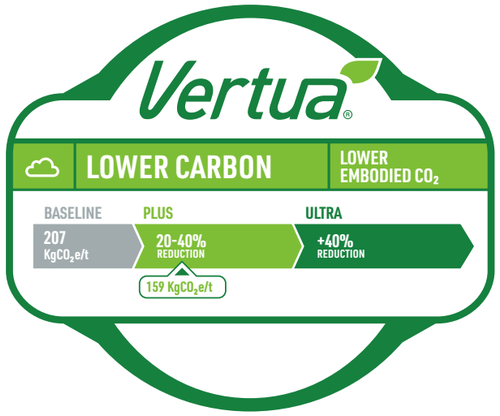
Our lower carbon sprayed concrete, part of our family of Vertua products and solutions, has a **carbon embodiment of 23% below** our industry renowned “Bank Mix” Silo Sprayed concrete, making it an ideal solution for constructors of large-scale tunnelling projects where the necessity of developing new infrastructure needs to be balanced against the environmental impact.

The new lower carbon product has identical performance in the plastic and hardened states, while utilising cement replacement materials and fibres with an element of recycled material.

LOWER CARBON SPRAYED CONCRETE ROADMAP

The CEMEX Specialist Solutions Lower Carbon Sprayed Concrete is only the first step in our ambitious aim to supply the tunnelling industry with more sustainable products. The introduction of our lower carbon sprayed concrete as our core product achieves the first phase objective. Our next aim is to produce a sprayed concrete with a target carbon embodiment reduction of up to 40%.





Vertua is a CEMEX Group trademark that highlights specific characteristics of CEMEX Group products regarding environmental impact as described in the corresponding Fact Label. The Vertua label is not intended as a certification. The data label is defined on the traditional (CEM I) sprayed concrete mix. The data in this label is based on operational performance and emissions taken from actual figures. This is subject to change and will be reviewed and updated annually.

For more information on **CEMEX’s commitment to sustainability,** see page 28

Doveholes Quarry, Derbyshire

TECHNICAL INFORMATION

CEMEX Specialist Solutions Sprayed concrete is designed to meet the requirements of controlled specifications across a range of application and projects.

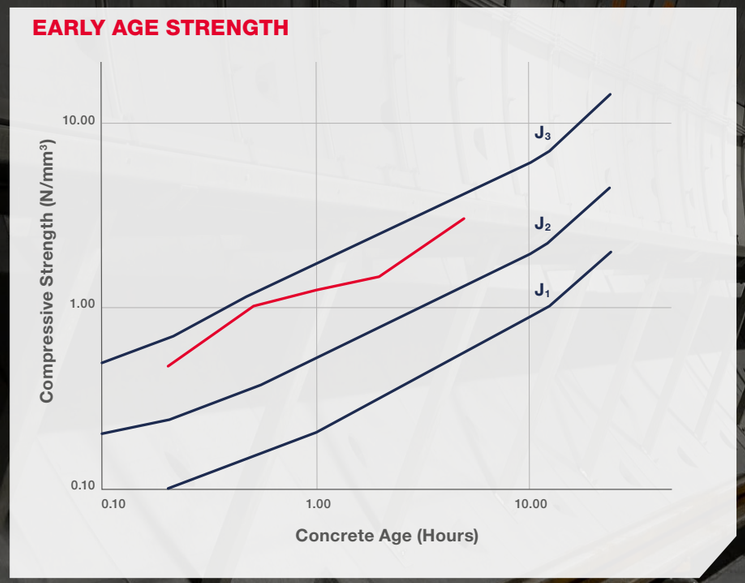
SPRAYED CONCRETE DESIGN AND PRODUCTION

We have developed a sprayed concrete solution provided via a dry silo system.

The blend of separately controlled coarse and fine aggregates provides a finished product with an ideal grading curve that improves rheology, pumpability and minimises rebound.

All raw materials, CEM I, additions, microsilica, aggregates, steel fibres and admixtures are produced through a batch weighed process. This production process can provide autographic records for each batch and load delivered.

EARLY AGE STRENGTH



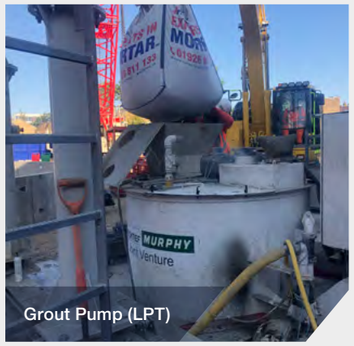
The technical attributes of the material can be divided into plastic and hardened properties. Performance from recent type testing trials is summarised below:

PLASTIC AND HARDENED PROPERTIES	
FLOW (BS EN 12350-5) By utilising selected hydration control admixtures flow retention has been extended to over 8 hours	TARGET 650mm (TYPICAL RETENTION OF 90 MINUTES)
EARLY AGE STRENGTH	MODIFIED J_2, COMPLIANT @ 10, 30 AND 60 MINUTES – 3, 6, 9, 12 AND 24 HOURS
COMPRESSIVE STRENGTH (BS EN 12390-3) Base mix sampled prior to pumping	28 DAYS > 50N/mm²
CORE COMPRESSIVE STRENGTH (BS EN 12504-1)	28 DAYS > 50N/mm²

Typical set-up for trials

TUNNELLING APPLICATIONS

Bank Station, London



Grout Pump (LPT)

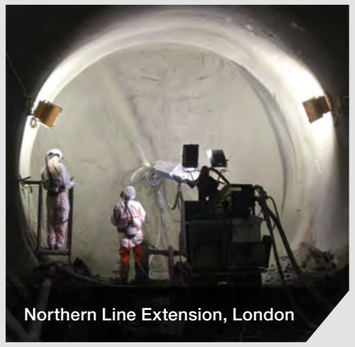
GROUTS

We have engineered a range of special grouts for a variety of tunnelling applications. We have also conducted research and trials utilising a variety of alternative fillers. Our grouts are designed and tested to achieve the required:

- Viscosity and open life
- Stability
- Compressive strength
- Gel/reaction time
- Initial set

APPLICATIONS

- Ground settlement compensation grouts - suitable for stabilisation
- Piling - for primary and secant piles


Northern Line Extension, London

In addition to sprayed concrete primary lining solutions, we have extensive experience in designing, producing, and delivering concrete across all tunnelling related structures including:

- Sprayed and cast secondary linings
- Shaft construction
- Piling
- Shaft annulus infill
- TBM annulus grouts

ADMIXTURES FOR SPOIL TREATMENT

ISOFINES SERIES

An effective treatment enabling a safe and secure removal of tunnelling sludge and spoil from jobsites, maximising transportation safety in busy urban environments.

Using a special blend of recycled material, **ISOFINES** absorbs high amounts of the water contained in any type of tunnelling mud, spoil or sludge, providing a quick method of stabilisation to transport waste.

- Quick and capable treatment for spoil
- Can help reduce pollution and minimise environmental impact
- Easier to finish
- Safe transportation of materials


Bank Station, London

PRIMARY AND SECONDARY LINING

We have proficient experience and capability in providing sprayed lining solutions. We can produce both cast in-situ or sprayed concrete products delivered in a pre-blended dry silo.

We can design concrete solutions to meet your project requirements including the following parameters:

- Flow retention
- A range of flexural and residual strengths using high-performance fibres
- Early age and durable long-term strengths
- Pumped and transported long distances
- New, reduced embedded carbon concrete solutions

TUNNEL WATERPROOFING

TAMSEAL 800/900

A high-performance polymer waterproofing membrane.

Provides a tough and durable, seamless waterproofing membrane for many tunnel structures.

- The DSM mix provides a suitable substrate for spray membranes and negates the need for separate sprayed mortar regulating layers, simplifying and speeding up the lining
- Fast and easy application particularly for complex underground geometries
- Supports the design of more efficient, thinner and low carbon tunnel linings
- Waterproof: zero penetration beyond membrane when tested in accordance with BS EN 12390-8:2000
- Fast curing to speed up construction processes

QUALITY TESTING...
RELIABLY DELIVERED BY TUNNELLING EXPERTS

All specialist technical support and laboratory testing is performed by our team of technical experts at our UKAS accredited National Technical Centre laboratories. Our centrally located facility enables nationwide site testing for specialist tunnelling concretes.

Our tunnelling partners can benefit from the wider resources and technical expertise of the global CEMEX business through **LabExperts.**

We offer an unrivalled comprehensive solution for all your testing requirements, from approval to continuous compliance and investigations.

Our dedicated team provide exceptional service through our three commitments.

1.

QUALITY

HIGH-QUALITY AND AVAILABILITY OF TEST REPORTS PROVIDING **CLEAR AND CONCISE TEST INFORMATION**

2.

RELIABILITY

CONSISTENT STANDARDS AND REPORTING BASED ON CUSTOMER REQUIREMENTS – WE'LL BE UPFRONT WITH TURNAROUND TIME COMMITMENTS

3.

RESPONSE

WE'LL DEVELOP A BESPOKE CUSTOMER EXPERIENCE BASED ON YOUR NEEDS, AND **ALL CLIENT ENQUIRIES WILL BE RESPONDED TO IN A TIMELY MANNER**

In addition to maintaining CEMEX's high standards of health and safety we have established these three commitments that together ensure we provide our customers with robust testing and superior technical service.

This sets CEMEX **LabExperts** apart in the industry through the ability to deliver a bespoke and consistently high-quality service.

For more information on **CEMEX LabExperts,** visit **cemex.co.uk/lab-experts** or scan this QR code

Please note: not included in our standard service pricing

LABeXperts
Construction materials testing

PRODUCTION SET-UP AND SUPPORT

OPTIMISE YOUR PROJECT DELIVERY

We understand your projects can be time critical. We leverage our unrivalled expertise in CEMEX Specialist Solutions to build a close understanding of your jobsite location and identify challenges to collaborate with you on developing a process that minimises delays and optimises your project delivery.

We provide a free site inspection service considering:

- Material quantity and programme requirements
- Site restrictions
- Pump locations and distances
- Control panel location and its ease of use
- Vehicle access and turning points
- Delivery processes

PROXIMITY TO THE PUBLIC

Bank Station, London

WORKING ENVIRONMENTS WHERE SPACE IS AT A PREMIUM

Thames Tideway Scheme, London

SILO LAYOUT

Expert direction on a silo site set-up that works for your precise project requirements, utilising our vast experience to guide you on best practice.

This includes our state-of-the-art gigamixer capable of producing up to 9m³/hr of sprayed concrete as a single unit, and up to 18m³/hr when used as a pair.

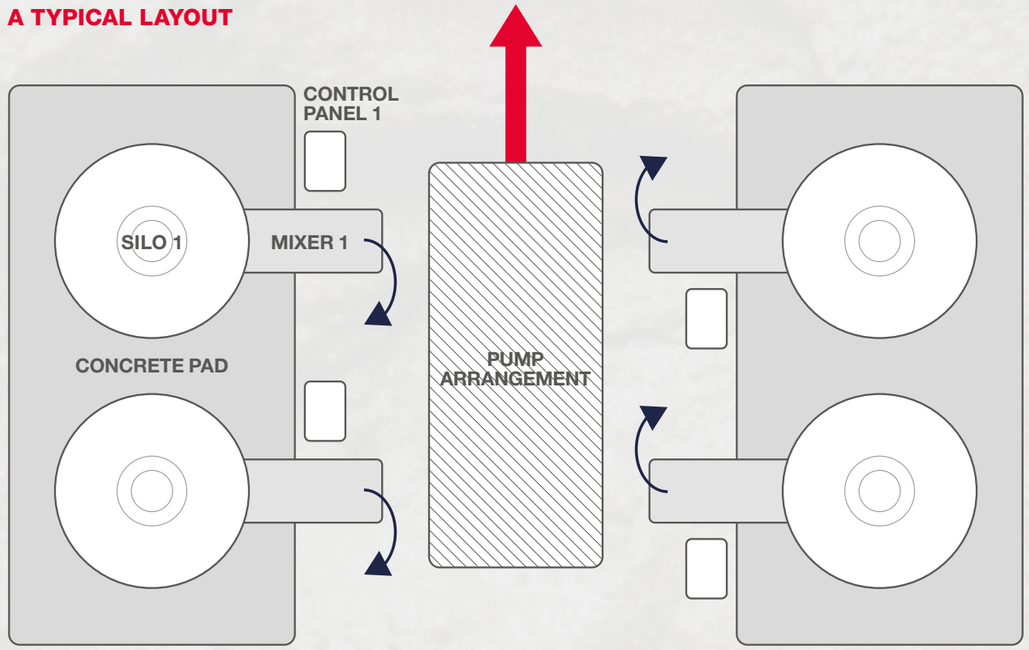
Our state-of-the-art Gigamixer

Silo set up in practice

Control panel set-up

Silo set-up from ground level

A TYPICAL LAYOUT



A user-friendly working area where everything is on the same level.

The control panels, water and rotary valve switches have been moved to the edge of the pad, which is also a good height for the staff to use.

A protective cover over the control panels can be used to keep them clean.

The chambers are about 200mm away from the pump, which allows the chambers to be opened without hitting the pump.

You will need a small chute from the chamber to the hopper. These measurements are approximations for the use with a typical pump arrangement.

SILO SET-UP BEST PRACTICE

- Equipment situated on an even level
- Ease of access to the control panels, water, and rotary valve switches
- Protective cover over the controls, which can be used to clean them
- Chamber can be opened without hitting the pump

SILO DESIGN

SUPPLY OF A STANDARD POCKET OR HOOK LIFE SILO, WHICH HOLDS APPROXIMATELY 40 TONNES

(100 TONNE SILO FOR DIFFICULT QUICK-MOVING SITES ALSO AVAILABLE)

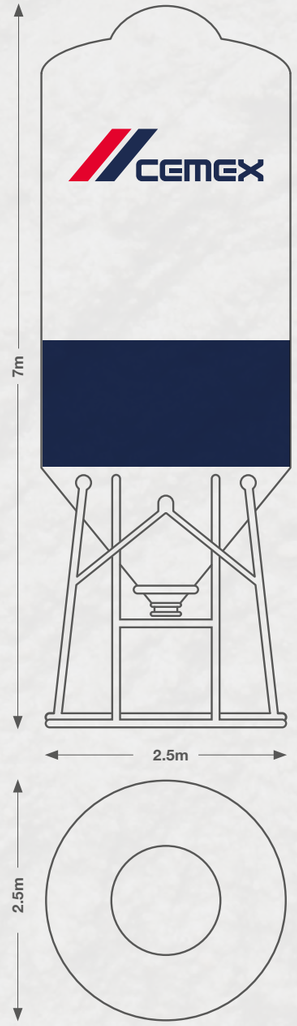
- Fitted with bottom fill and vent pipes and incorporated with a pressure relief valve
- Set up on a pad to withstand 44 tonnes
- Air pads to aid the free movement of material, which are enabled by snap fitting to an on-site compressor

SILO SIZE

- 22m³
- 7m high
- 2.5 x 2.5m²

MATERIAL LEVEL MONITORING

- Radar monitoring sensor



IMPROVING YOUR SET-UP

SILO MONITORING SYSTEM	SILO SAFETY SYSTEM (100 TONNE SILO ONLY)	REVERSE AIR JET
Prevent disruption to weekend and night-time operations	Minimise overfilling or excess pressure in the silo	Ideal in an environmentally sensitive working area and/or with close proximity to the public
Accurately measure your material levels and plan for continuous out-of-hours operations without the risk of a material shortage	High level safety alarm, when activated will automatically shut the pinch values	A better option for the environment vs traditional filter stock systems, dust flow is reversed and prevented from being released in the air

Please note: not included in our standard service pricing

DELIVERY

Benefit from access to a substantial fleet with the ability to move significant volumes of material quickly and act as a storage back up to ensure continuity of sprayed concrete supply.

Our dedicated team of specialists will expertly advise on orders, haulage and technical solutions.

- Local breakdown response service
- Partner hauliers are FORS and CLOCS approved
- CEMEX service fleet is FORS approved

	SILOS	CAPACITY	DELIVERIES	TOTAL QUANTITY (TONNES)
BANK	4	100 TONNES	2,178	58,675
THAMES TIDEWAY (7 SHAFTS)	36	40 TONNES	1,364	37,932
	2	100 TONNES		
NORTHERN LINE	14	40 TONNES	618	17,167

HEALTH AND SAFETY

We place the well-being of employees, customers and the wider public at the forefront of every decision we make when supplying solutions.

SILO OPERATIVE TRAINING

We developed and offer a certified training course for operatives of our silos and mixing equipment, with the option to maximise capabilities through our online training guidance.

PARTNER IN SAFETY AWARD

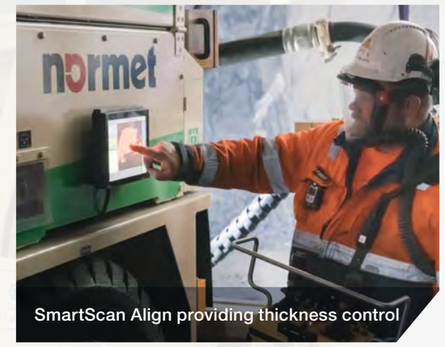
We work with partners who share the same commitment and values to health and safety as CEMEX and **Normet,** where we see 'good practices' we recognise this by awarding our 'Partners in Safety' Award to those demonstrate their commitment.

WE'VE MADE OVER **4,000 DELIVERIES** IN HIGHLY PEDESTRIAN ENVIRONMENTS AND AREAS WITH VULNERABLE ROAD USERS WITH **ZERO INCIDENCES OVER A 4 YEAR PERIOD**

SPRAYING **EQUIPMENT**

In partnership with

normet



SmartScan Align providing thickness control

Full electric, zero emission Spraymec 8100 SD

High quality, low pulsation spraying

ELECTRIC VEHICLES

Our strong partnership with Normet secures your projects with the leading tunnelling and spraying robots.

Together we focus on being process-efficient, coupled with supporting the need to switch from fossil fuelled tunnelling equipment. As part of our tunnelling solution partnership, **Normet** work with clients to reduce carbon and costs and enhancing the safety of the sprayed concrete process from batching to nozzle tip.

NORMET SMARTDRIVE®

A modular Battery Electric Vehicle (BEV) architecture designed to optimize energy consumption and performance in tunnelling applications.

Introducing SmartDrive® into your projects, you will benefit from:

- Higher productivity
- Lower operating costs
- Zero local emissions

SMARTDRIVE® TUNNEL SPRAYING ROBOTS

Normet Spraymec SmartDrive®

Aliva 520

WHEN POWERED BY RENEWABLE ENERGY, SMARTDRIVE® REPRESENTS THE LATEST CARBON NEUTRAL-READY SOLUTION.

LOCAL SERVICE TEAMS MAINTAIN THE EQUIPMENT GUARANTEEING PERFORMANCE AND SAFETY.

SMARTSCAN ALIGN

SmartScan Align georeferences the 3D scans to enable profile control in the future as well as thickness control.

SmartScan Align provides a valuable digital twin of the excavation surfaces and final as built data of the sprayed concrete linings, ideal for information exchange between interested parties on the project.

VR SPRAYING SIMULATOR

State-of-the-art sprayed concrete training endorsed by EFNARC C2 certification scheme.

The simulator encourages safe, sustainable ways of spraying and highlight areas for improvements, contributing to trainees developing the right attitudes and practices needed in the real underground space.

The VR Spraying Simulator is to includes carbon saving metrics during the session, driven by efficient spraying techniques and applying the correct thickness of concrete.

VR Simulator

NEW

THE IDEAL SPRAY PARTNERSHIP

For small tunnels and shafts the Minimec M2 and the Norstreamer 30 V trailer concrete pump work together as a pair to automate access to small spaces.

Norstreamer 30 V

Minimec M2

PROJECT PROFILES

1. BANK STATION CAPACITY UPGRADE, LONDON

Transport For London/Dragados

PROXIMITY TO THE PUBLIC

THE PROJECT

Bank station is one of the largest underground railway complexes on London's underground network, used by 300,000 passengers on a normal day and liable to high congestion.

The ongoing Bank Station Capacity Upgrade project aims to solve the problems of the third most congested interchange complex within the London Underground Network.

We were asked to supply high-quality primary lining spray concrete for use in the construction of shafts, tunnels and cross passages.

CHALLENGE

The project presents challenges because of its location in a very busy area of London, while the station itself is remaining operational throughout construction. Deliveries must be booked in advance and precisely timed, following pre-agreed routes through the City of London. Many pedestrians, cyclists and other vulnerable road users use the area around the clock, presenting a considerable risk that must be carefully managed.

APPROACH

We were contracted to provide high-quality primary lining spray concrete for the construction of the shafts, tunnels, and cross-passages, with 100-tonne silos on site for storage.

We worked closely with Dragados to design a site layout which allows regular deliveries of dry-silo materials while minimising disruption to traffic or pedestrians.

The project involved a coordinated approach with input from our plant, silo, supply chain and booking team deploying a dedicated strategic management approach to ensure the product is produced to meet the customer's requirements and delivered safely and to schedule.

SOLUTION

We supplied a bespoke design to give a high strength of +60N/mm^2, a 600mm flow, and a flow retention of 90 minutes. This mix, manufactured at our dedicated spray concrete plant, has been used on several high-profile London projects over the last seven years, including the Northern Line Extension and Thames Tideway.

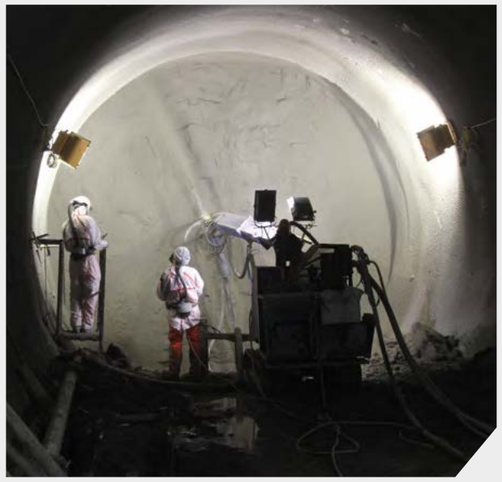
KEY TAKEAWAYS

- **PRE-BLENDED DRY SILO SOLUTION**
- **LINING A MULTITUDE OF TUNNELS, CROSS PASSAGES AND ESCALATORS**
- **MORE THAN 50,000 TONNES OF SPRAYED CONCRETE**
- **DEMANDING SPECIFICATION MET WITH COMPLEX MIX DESIGN**

2. NORTHERN LINE EXTENSION, LONDON

Transport For London/FLO

WORKING ENVIRONMENTS WHERE SPACE IS AT A PREMIUM



As part of the TFL Northern Line Tube Extension project, a new tunnel and 2 new stations were to be constructed between Kennington and Battersea.

CEMEX were awarded the primary lining element of the works by contractor FLO. As the project was taking place in a busy urban environment, CEMEX proposed to use a fully pre-blended dry silo solution to limit both the noise and construction traffic. At the start of the project we established six 40 tonne silos and Gigamixers between two locations to store and produce the product.

OVERVIEW

- Pre-blended solution
- Lining of **2 shafts** and **connecting tunnel**
- 13,000 tonnes of sprayed concrete
- Establishment of six **40 tonne silos onsite**
- Designed to modified J2 curve

3. LONDON POWER TUNNELS

National Grid/ HOCHTIEF Murphy JV

WORKING ENVIRONMENTS WHERE SPACE IS AT A PREMIUM

The second phase of the London Power Tunnels programme is the largest upgrade to the national electricity transmission system since the 1960s.

The £1bn National Grid-led project, which will rewire South London, is being constructed by HOCHTIEF Murphy JV and is vital to meet increasing electricity demand and in helping to keep Londoners connected to safe and reliable electricity supplies. The huge project involves the construction of tunnels and shafts deep under the busy road network in some of the most congested parts of the capital. We were involved from an early stage to identify that CEMEX Specialist Solutions sprayed concrete and grouts was the perfect solution to the logistical and working practice requirements of the complicated build. Each shaft was constructed with spray concrete and segments backfilled with a low shrink grout.

OVERVIEW

- **13k tonnes** of spray concrete & grouts supplied
- Complicated working patterns necessitating 24/7 product availability
- Tight site access

ON TARGET FOR A CLEANER TOMORROW

Our purpose is to build a better future and to do that we must reduce our impact on climate change. As one of the world's largest building solutions providers, climate action has been a priority for CEMEX for many years.

We continually invest and innovate to become a more environmentally friendly, sustainable leader – enabling a lower-carbon and resource-efficient circular economy.

CEMEX's Future in Action strategy sets our clear objective: **to become a net-zero CO_2 company by 2050,** not limited to the production process but the entire life cycle of our products, as well as transforming the industry's value chain.

In addition, CEMEX has set targets for 2030 to reduce emissions by approximately 47% in alignment to with the Science Based Targets initiative (SBTi) 1.5oC scenario.

We joined the United Nations' 'Race to Zero' campaign, and as of November 2021 we are a founding member of the First Movers Coalition, an initiative of the World Economic Forum to create market demand for zero carbon solutions. Building equals progress. But not at any cost – it must be done as efficiently and responsibly as possible.

We are committed to sustainable development and recognise that our success depends not only on the quality of our products, service and financial performance, but also on the way we meet our health, safety, environmental and social responsibilities. CEMEX's environmental record is one we are proud of as we continue to develop ways to further enhance our commitment to sustainable development.

Each year the CEMEX Group produces a global integrated report detailing past and present initiatives and successes, as well as setting future challenges.

Across the UK, CEMEX is committed to ensuring actions and decisions taken today, do not adversely affect the generations of tomorrow.

FUTURE IN ACTION

COMMITTED TO NET-ZERO CO_2

For more information on **Future In Action,** visit **cemex.co.uk/future-in-action**

OUR COMMITMENT TO RESPONSIBLE SOURCING

BES 6001
Responsible Sourcing

All CEMEX products have achieved BES 6001 Responsible Sourcing accreditation.

BES 6001 accreditation means that all our sprayed concrete is responsibly sourced, to an independently verified standard that addresses the social, economic and environmental impacts across the entire supply chain.

CEMEX's commitment to sustainable development and ethical and responsible sourcing has been formally recognised through this official accreditation.

By using CEMEX UK material products in line with the BES 6001 certification requirements our customers can score more credits under BREEAM, the most widely used environmental assessment method for business.

The BES 6001 certification complements a range of other ongoing initiatives at CEMEX UK to reduce waste, water, energy use and CO_2 emissions, while increasing the use of alternative fuels and by-products in the manufacturing of building materials.

As a global company, ecologically responsible construction is a priority for CEMEX and it is fully committed to the United Nations Sustainable Development Goals, of which five are directly related to our company's business. Furthermore, the United Nations established 2030 global goals have been embedded into our business model and inform the decisions we make and the work we do every day.

We understand and agree with the need for production of cement and concrete to be as sustainable as possible and are committed to contributing to a net-zero carbon society. It is important to remember that while global cement production (of which over half takes place in China) is responsible for 7% of global CO_2 emissions, UK cement emissions are amongst the lowest in the world at less than 1.5% of all UK emissions; testament to the dedication of the industry to decreasing its impact on the environment.

Climate change has been a priority for CEMEX for many years. The company's efforts have brought significant progress to date, but there is a need to do more and faster. This is why CEMEX has also recently announced a more ambitious global target for CO_2 emissions by 2030: a carbon reduction of 35% for concrete vs the baseline to ensure alignment with the Paris Agreement commitments. This is in addition to the ambition of becoming a net-zero company by 2050.

However, in the UK we have already achieved the following across our full operations:

20%
reduction in our CO_2 emissions since 2010

All our operations are certified to the ISO14001
standard for Environmental Management Systems

486
times more waste consumed
than we produce in our operations

Over 1,000 hectares
of priority biodiversity habitat
created and maintained

Implemented Energy Reduction Programmes in all our operations
with the most energy-intensive being certified to ISO50001

Supplied our operations with
100%
renewable electricity

A– rated for climate transparency and strategy by the **Carbon Disclosure Project (CPD) in 2019**

Established partnerships with organisations such as the RSPB
to ensure we maximise all opportunities for better and more sustainable working

For technical services and product support,
contact our **Product Support Helpline**
on **0800 667827**
or visit **cemex.co.uk/concrete-for-tunnelling**
Email: **gb-drysilomortar@cemex.com**

CEMEX

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