

Tunnelling Credentials

Tunnel segments, sprayed concrete, grouts and mortars

What we can do

Hanson UK, a capable business

Hanson UK is part of the HeidelbergCement Group, employing 53,000 people across five continents. HeidelbergCement is the global leader in aggregates and a leader in cement, concrete and heavy building products (brick, block and precast concrete).

Hanson UK is split into five business lines offering the broadest range of products and services in the heavy building products market.

Hanson Aggregates produces sand, gravel and crushed rock from over 62 quarries in England and Wales and includes Hanson Aggregates Marine, Europe's largest producer of marine-dredged sand and gravel.

Hanson Concrete is one of the UK's biggest suppliers of ready-mixed concrete from a network of more than 200 fixed and site-based plants.

Hanson Asphalt and Contracting supplies and lays asphalt for road surfacing and provides a range of infrastructure services. Its civil engineering division specialises in the construction of wind farms and waste-to-energy plants.

Hanson Cement is a leading manufacturer of Portland cement, both in bulk and in bags, and produces ground granulated blastfurnace slag (GGBS) under the brand name Regen – a cement replacement in ready-mixed and precast concrete – and a range of bagged cementitious and aggregate products.

Hanson Building Products is split into three business units. Material Products produces clay bricks, Thermalite (aircrete) and aggregate blocks. Design Solutions manufactures bespoke precast concrete products and includes Formpave, a specialist in sustainable urban drainage systems and Bath and Portland stone, a leading supplier of natural stone masonry. Build Solutions draws on the skills within Hanson Structtherm, manufacturers of structural cladding systems and experts in new build and refurbishment products, and Irvine-Whitlock, a specialist brick and block laying contractor.



Aggregate dredger Arco Dart



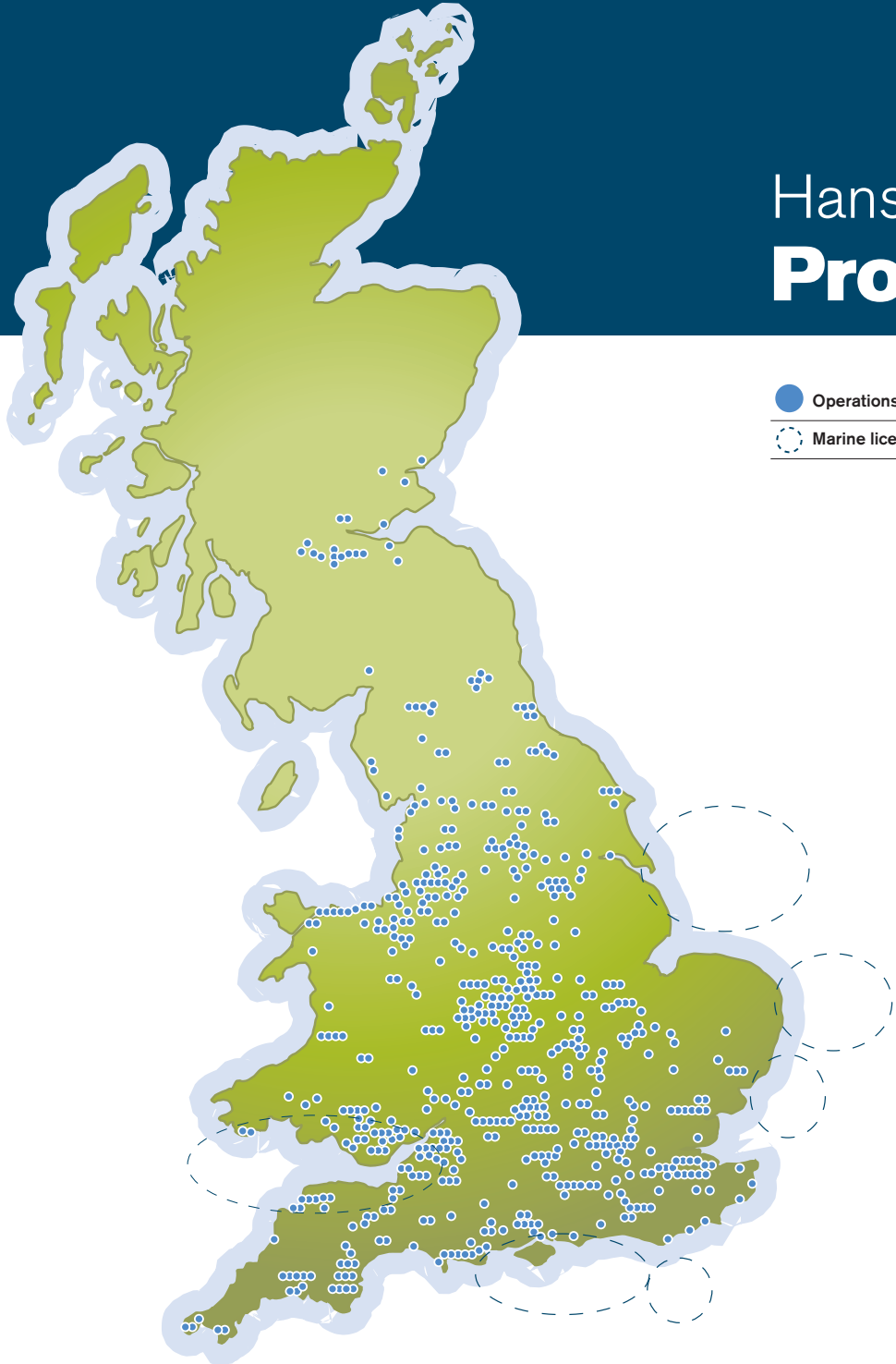
Ketton cement works in Rutland



Ready-mixed concrete delivery

Hanson UK

Production sites



Our UK operations

| | |
|--|------------|
| Quarries – sand and gravel | 32 |
| Quarries – crushed rock | 30 |
| Marine dredgers | 8 |
| Aggregates depots and wharves | 12 |
| Ready-mixed concrete plants | 191 |
| Site concrete plants | 17 |
| Asphalt plants | 36 |
| Recycling/landfill | 4 |
| Cement plants | 3 |
| Cement depots and wharves | 8 |
| Ground granulated blastfurnace slag plants | 3 |
| Bagged products plants | 14 |
| Precast concrete and flooring plants | 3 |
| Brick works | 9 |
| Aggregate/aircrete block plants | 5 |
| Block paving plants | 1 |
| TOTAL | 376 |

All our production sites are certified to ISO 14001 and ISO 9001

Hanson UK

Products and services

Concrete

- Ready-mixed concrete
- Ready-mixed mortar
- Dry silo mortar
- Screed

Aggregates

- Sand
- Gravel
- Crushed rock
- Recycled aggregates

Asphalt

- Hot rolled asphalt
- Stone mastic asphalt
- Asphalt macadams



Contracting

- Road surfacing and maintenance contracts, construction – wind farms, waste-to-energy, bridges

Bulk cement products

- Grey
- White
- Blends
- Regen (GGBS)



Packed products

- Cement
- Ready to use concrete, mortars, asphalt, aggregate and sand



Bricks

- Clay bricks and brick specials
- Clay pavers
- Bespoke clay products



Blocks

- Aircrete
- Aggregate



Precast concrete

- Floors
- Stairs
- Structural walls
- Basements
- Off-site solutions

Cladding and render systems

- Cladding and render systems



- Wonderwall
- Lockclad



Other products and services

- SUDS
- Geothermal



- Roofing
- Chimneys



- Brick and block laying contractors



Delivering product and technical innovation

Construction

- Hanson Ecohouse® – first Code 4 masonry house
- Stewartby commercial building – BREEAM excellent

Concrete

- High rise – leading concrete technologies and construction techniques in high rise construction
- Hanson Easypile® – innovation in concrete piling mixes
- Concrete solutions – post tensioned, high strength, low permeability, self-compacting and lightweight concretes
- Sustainable concretes – high Regen® (GGBS) mixes with recycled aggregates
- Power range – specific mix designs for the energy sector

Asphalt

- Hanson era® – low energy, high recycled content asphalt for all surface courses
- Hanson Tuffgrip® – low noise, reduced course thickness

Cement

- Regen® – the cement substitute GGBS
- Low CO₂ cement – introduction of aggressive alternative fuel and material programmes
- TioCem® – absorbs and reduces NO_x in the atmosphere

Building products

- Ecostock® – leading sustainable stock brick range
- Thermapave® – combined Geothermal and SUDs systems
- Off-site walling solutions – Quick build, Fast build
- Thermalite® thin joint masonry





▲ Sellafield – nuclear construction

▼ Clyde wind farm – onshore construction



▲ Crossrail – stations and tunnels

▼ Canary Wharf – high rise construction



▲ A40 – infrastructure and road surfacing

▼ Lawn House – Code 6 masonry house



Case Studies - UK

Hanson UK

Canary Wharf Box

Hanson UK is already involved in the development of the new Crossrail station at Canary Wharf.

Concrete mix design:

- Low heat and low carbon (ie CO₂) concrete.
- High usage of Regen (GGBS) (ie 70% replacement in piling).
- Low permeability and watertight concrete.
- Practical concrete for DC-4 (one of the highest) Aggressive Ground Conditions.

Application expertise:

- 70% of raw materials river-fed.
- Sizeable reduction in lorry movements.
- Further reduction in carbon footprint.
- Split shift to meet service/building requirements of LOR.
- Association with Canary Wharf over 10 years through high rise development.
- Maximised the use of quality and sustainable materials such as Regen (GGBS), which is described as 'excellent' within the current BRE Special Digest 1 for use within Aggressive Ground Conditions.



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Channel Tunnel Rail Link (CTRL)

Hanson UK was involved in the manufacture of the tunnel lining segments for CTRL 250, producing over 80,000m³ of concrete and sprayed concrete.

Specialist concrete:

- Developed specialist concrete for steel and polypropylene fibre reinforced segmental tunnel linings.
- Mix Design incorporating Regen (GGBS) to reduce micro-cracking and to better prevent the diffusion of chlorides and other aggressive agents.

Sprayed concrete:

- Sprayed concrete with cement from Ketton was used in various sections of the tunnel.
- Hanson UK was able to provide specialist supply chain solutions to maximise efficiency.

The CTRL 250 project demonstrated Hanson's expertise in:

- Dispensing polypropylene and steel fibres into the concrete mix using vacuum blowing and an Incite AB shaker system.
- Excellent supply chain management, including dedicated concrete trucks discharging directly into moulds.
- Prevention of freezing through use of steam generators in the aggregate bins.



Sprayed concrete capability

Hanson UK sprayed concrete with cement from Ketton

Hanson UK has 20 years of experience in producing sprayed concrete through its Hanson Cement and Hanson Quarry Products divisions. From its Ketton plant Hanson Cement manufactures a unique quality of cement that is used in sprayed concrete mixes. Hanson UK with HeidelbergCement has a technical product capability that has been proven in tunnelling projects worldwide. Hanson Cement and Hanson Concrete, together with our admixture partners, can ensure the final mixes for the primary and secondary coats deliver:

- Reduced bounce-back
- Minimal waste
- Time saving
- Rapid and successful adhesion
- Consistent best quality
- Specific mix designs

Case Studies – UK and Europe

Hanson UK and HeidelbergCement

Strood and Higham Tunnel Lining Project – UK

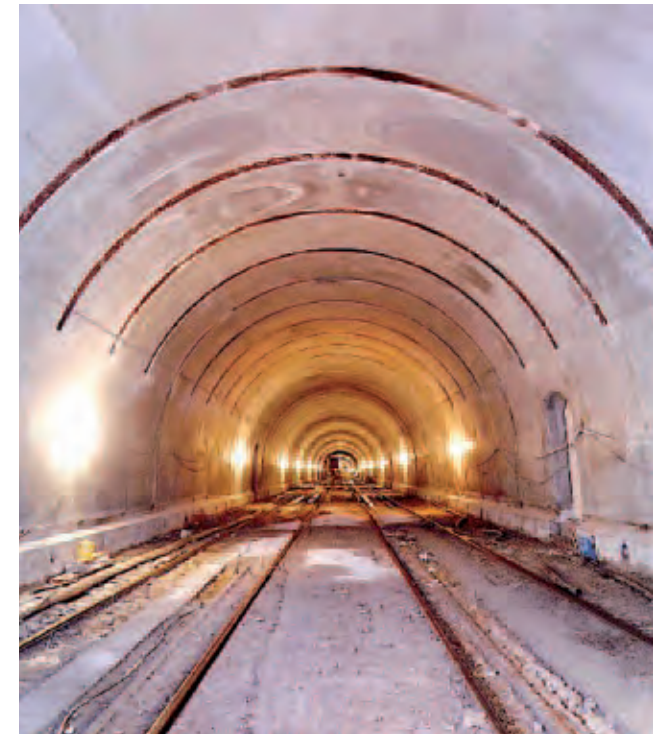
Hanson UK was chosen as the concrete supplier to line the 1,400m Higham tunnel and the 2,129m Strood tunnel on behalf of Network Rail.

Sprayed concrete mix design:

- Specific mix of C40 concrete, with a minimum cement content of 400kg/m³, a water/cement ration of 0.40, and the addition of plastic fibres.
- A special superplasticiser was also used to counter thermal issues and shrinkage.

Application expertise:

- The temperature variation within the tunnels required Hanson UK to provide a solution that ensured consistent quality and delivery times. This was achieved through varying the dosage of retarder applied in each area.
- This project used 900m³ of sprayed concrete, applied to a structural thickness of 200mm. Hanson UK's technical knowledge and ability to deliver in challenging conditions fulfilled the client's requirements.



Kulch and Lichtenholz Tunnel – Germany



The two-track Kulch Tunnel (1,331m long) and the two-track Lichtenholz Tunnel (931m long) in the Lichtenfels district, are part of the 107km long new railway line between Ebensfeld and Erfurt, comprising of 22 tunnels. The Kulch and Lichtenholz Tunnel construction uses classic tunnelling technology with sprayed concrete support and a lined watertight, in situ concrete inner shell. The excavated material is being reused for further building of the route and for improving the landscape. The tunnels were started in mid-October 2010 and will be completed in 2013.

Sprayed concrete mix design:

- HeidelbergCement supplies the cement and sprayed concrete mixes, developed in conjunction with the project engineers and contractors.
- It also supports the project on site with HeidelbergCement personnel from its R&D centre in Leimen.
- In the next phase HeidelbergCement will also be supplying the mix designs, cement and concrete for the final tunnel lining.



Remote controlled sprayed concrete application to stabilise upper bench

Case Studies – UK and Europe

Hanson UK and HeidelbergCement

Katzenberg Tunnel – Germany

The Katzenberg Tunnel is part of the upgraded high speed rail line between Karlsruhe and Basel, owned by Deutsche Bahn AG. The two parallel single track tunnels are designed to take trains travelling up to 250km/h. The tunnel is located between Bad Bellingen and Efringen-Kirchen with a total length of 9,385m, the two bored tunnels being 8,894m with a tunnel bore of 95m² and an interior diameter of 9.4m. The project began in 2003 and will be completed in 2012, when it will become the third longest tunnel in Germany. The tunnelling project had some difficult geological issues to resolve with drilling through soft rock strata such as clay, marl, limestone and sandstone plus four ground water stores. With two tunnels and 18 cross cuts the issue of water leakage was a major challenge.

Sprayed concrete expertise:

- HeidelbergCement worked to develop concrete mixes for the tunnel segments, grout and sprayed concrete that dealt with the geological challenges of this tunnel project.



Hindhead Tunnel – UK

Cement from Ketton was used in the sprayed concrete on the £371 million A3 improvement scheme at Hindhead in Surrey. This £3 million contract used ordinary Portland cement from Ketton. This cement was used to produce sprayed concrete to form the structural lining of the 1.8km twin-bore tunnel under the Devil's Punch Bowl.

Sprayed concrete mix design:

- The sprayed concrete was applied at high pressure to benches, roofs, floors and other structural shapes. Cement from Ketton was found to be best for the project, with minimum wastage and easier application.
- Hanson UK's involvement with the Hindhead Bypass continues with the remaining single carriageway of the A3, between London and Portsmouth.



Application of sprayed concrete after excavation



National grid upgrade – UK

London cable replacement tunnels will form part of National Grid's upgrade of the capital's electricity transmission network. The tunnel will be 33km long in total and construction is underway at Eade Road.

Sprayed concrete expertise:

- The project has benefited through the use of Hanson UK specialist sprayed concretes being supplied from the Hanson UK ready-mixed facility at King's Cross. Hanson Concrete was actively involved in site and plant trials to ensure that the correct material was developed.
- The King's Cross concrete plant benefits from the supply of Ketton cement into a cement depot on the same site.
- Sprayed concrete was used to facilitate tunnelling construction methods, as opposed to cut and cover, significantly reducing disruption and costs.

Grout capability

Over the last 15 years HeidelbergCement has developed in excess of 50 different grout variants for tunnel applications across Europe. Through the HeidelbergCement Technical Centre (HTC), a specialist department was created to develop grout formulations and work with engineers and contractors to deliver tailored solutions for individual projects where geological, logistical and formulation issues needed to be considered. These are:

- Pumpability of grout from batching plant to work location
- Setting time control
- Resistance to bleeding and segregation
- Reduced heat of hydration/low heat
- Durability
- Easy application through segment annulus
- Shrinkage compensation

Hanson UK with HeidelbergCement can supply formulations, material and expertise for grout used in concrete segment tunnel lining. This technical knowledge can be translated in the UK market through Hanson UK's:

- Asset base – three cement plants and depots
- Material supply – Cement, PFA, Regen (GGBS) Micro silica, Limestone and admixtures
- Knowledge – Hanson UK Concrete technologists
- UK based technical support and quality control
- Pumping expertise

Case Studies – Europe

HeidelbergCement

Düsseldorf urban rail line – Germany



Laboratory mortar drain test with soil sample

The first tunnel of the Düsseldorf urban rail line was completed in September 2010. This first phase of the new urban rail line was completed one month ahead of schedule by the main contractor with the tunnel boring machine finishing the 1.3km section between Elisabethstrasse and Kasernenstrasse in less than seven months. The tunnel lining was made up of around 870 segment rings which were installed during the course of the tunnelling work. With a total length of 3.4km, the underground rail line will replace several surface tram lines. The 300 million euro project will significantly reduce the burden on traffic in the inner city when it comes into service in 2015.

Grout expertise:

- HeidelbergCement was involved in the development and supply of tubbing mortar to grout the tunnel segments, and in the design and location of the on-site batching plant.
- For different applications of ground engineering HeidelbergCement delivered building materials for jet grouting, lifting injection and diaphragm walls.



Ems Tunnel – Germany/Holland

The Ems Tunnel is a 4km tunnel that goes under the River Ems from the West of the town of Emden at Knock in Germany to Borgsweer in Holland. The tunnel carries a 48-inch gas pipeline which will supply gas between the two countries. The tunnel is 4,016m long, with an interior diameter of 3m and was bored 11.5m below the river bed, with a maximum gradient of five per cent. The tunnel had many geological issues to overcome with ground deposits of sand, silt and clay being friable and soft, and water pressure issues because of the tidal nature of the river. A five segment concrete ring was used with steel reinforcing being replaced with steel fibres. Once the tunnel was complete and the pipeline laid, it was backfilled to stop future access to the external jacket of the pipeline.

Grout and segment expertise:

- HeidelbergCement was involved in the development and supply of the concrete for the tunnel segments and grout mixes.

Other Hanson and HeidelbergCement global tunnelling projects:

1. Brightwater project

Country: USA

Place: Washington State

Overview: Six miles of underground tunnels for sewage treatment in South Snohomish and North King counties. Construction of 14-foot diameter tunnel segments.

2. CSI tunnelling

Country: USA

Place: Ohio

Overview: Hanson work with JV partner CSI on tunnelling projects across the USA.

3. Eglinton & Sheppard Subways

Country: Canada

Place: Toronto

Overview: The Eglinton West subway was the East-West subway line in Toronto, using 60,000m³ concrete.

4. Barcelona Subway

Country: Spain

Place: Barcelona

Overview: Supplied concrete volume of 65,000m³ Tunnelling at a depth of 80m.

5. Madrid Railway Tunnel

Country: Spain

Place: Madrid

Overview: Supplied 350,000 tons of aggregate.

6. Blanka City Tunnel Project

Country: Czech Republic

Place: Prague

Overview: Supplied concrete volume of 800,000m³ for a 5km two-lane tunnel.

7. Vijenac Tunnel

Country: Bosnia and Herzegovina

Place: Vijenac, Kakanj-Drivuša

Overview: Supply concrete with a volume of 220,000m³ for a two-lane motorway tunnel.

8. Penchala Tunnel

Country: Malaysia

Place: Kuala Lumpur

Overview: The Penchala Tunnel is the widest highway tunnel in Malaysia. This 700m tunnel, located on the Sprint Expressway's Penchala Link, connects Sungai Penchala to Mont Kiara in the Klang Valley.

9. Clem 7 Tunnel

Country: Australia

Place: Brisbane

Overview: Supplied 280,000m³ of concrete for 38,000 tunnel lining segments, for a 4.8km twin two lane highway.

10. Brenner Base Tunnel

Country: Austria/Italy

Place: Brenner Pass

Overview: This will be the longest tunnel in Europe at 55km (34 miles). HeidelbergCement is involved in the enabling works.



Performance and sustainability highlights 2010

Key contacts

- ✓ Reportable and lost time injuries fell by **53 per cent**
- ✓ More than 500 energy-saving ideas were introduced during the year, reducing carbon emissions and saving more than **£1.5 million** a year in energy costs
- ✓ Over **300 managers** and supervisors received training in sustainability and responsible sourcing
- ✓ Use of both mains and controlled water has **fallen**
- ✓ Environmental complaints fell by **42 per cent**
- ✓ Use of GGBS as a cement replacement in our concrete remained at a high level of **35 per cent**

- ✓ We invested more than **£10 million** in a new business system for our aggregates, concrete and asphalt operations to improve efficiency and customer service
- ✓ The number of biodiversity and geodiversity action plans in place increased by **12**
- ✓ All our production sites are now certified to **ISO 14001** and **ISO 9001** systems
- ✓ We have exceeded our 2009 target of a **10 per cent** reduction in waste to landfill
- ✓ We are the largest building materials company to receive the **Carbon Trust Standard**

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