WE KEEP YOUR WORLD RUNNING
Geobear is a contractor with global presence who invented the concept of non-disruptive ground engineering by injecting expanding geopolymer. Its patented processes are used worldwide, with more than 100,000 projects completed in commercial, infrastructure and residential sectors.

With our high levels of technical expertise, combined with the quality of our work and more than 30 years’ experience, Geobear sets the standard for non-disruptive ground engineering. We are proud of our reputation and keen to preserve our market-leading position by continually developing ground engineering solutions which are both non-disruptive and durable over time. By increasing investment in research & development, we are providing our clients with quicker, less disruptive and more cost-effective solutions.
Richard Holmes – Managing Director

Our priority is to exceed customer expectations; Geobear is primarily chosen by customers because of the added value our solutions bring to geotechnical asset management. Our customers regularly report that the life span of a geotechnical asset has increased and operative maintenance costs significantly decreased after a Geobear solution has been applied.

Our highly qualified engineers are always available to assess a structure, provide advice and support the client at all life-cycle stages of the structure. In tandem with our own development, we have invested in the creation of a network of the best professionals (geo-technicians, building professionals, structural engineers) to whom we provide support and advice, ensuring that they receive suitable training throughout their career and that they can work as effective partners.

The aim of this brochure is to answer the question – why Geobear? It also details many of the projects we have already completed on a range of structures. We believe Geobear and the use of expansive geopolymer can be the ‘go-to’ ground engineering solution and also influence future design principles.
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The Geobear story began in Finland in the 1970s. In northern countries, recurrent periods of frost and thaw compromise the soil’s mechanical properties, leading to subsidence. In the 1990s, an engineer experimented with a revolutionary new method for treating sunken slab floors: an expanding geopolymer injection technology.

Over the years, and thanks to significant investment in R&D, Geobear has developed three new techniques for injecting expanding geopolymer. Since 1982, the company has filed for exclusive patents for several processes worldwide.

The most popular process is the ground improvement solution, which consolidates soils deep below the surface as a result of the injection of a high-density, highly expansive geopolymer which generates a very powerful expansive force. This innovative technique is used to stabilise buildings by increasing bearing capacity of the soil. This process offers an excellent alternative to traditional underpinning techniques.

Reasons why Geobear is a market leader:

- Recognised know-how and expertise in its sector
- Global reach
- Faultless support and monitoring of projects
- Engineers and geo-technicians trained in how to meet the requirements specific to each project.

As the inventor of these solutions, Geobear has already acquired more than 30 years of experience in the injection of expanding geopolymer, and masters this technology perfectly. This is why we present Geobear as the company “setting the standard” in this sector.
LOCATIONS

50
Countries worldwide

PROJECTS

+100,000
PROJECTS
Completed worldwide

HISTORY

2015
Presence in Belarus, Saudi Arabia, Baltic States.

2014
Presence in China.

2013
Presence in Russia.

2012
50 countries landmark.

2011
100,000 projects landmark.

2007
Introduction of structural support solution.

2004
Introduction of void filling solution.

1996
Geopolymer innovations for foundation stabilisation and ground improvement.

1980
First projects completed in Finland.
THE VALUES HELD BY GEOBEAR

CUSTOMER FIRST
As the inventor of the concept of underpinning by injecting expanding geopolymer, Geobear is recognised for the quality of its customer service and work in territories around the world.

Covering more than 50 countries around the world, our highly-qualified engineers and managers are available to apply their expertise to your project and support you through to its completion. We pride ourselves on being available to our customers whenever the need arises.

All the Geobear patented processes use geopolymers produced in accordance with a demanding specification by one of the best geopolymer manufacturers in the world. Each project is monitored individually and continuously to ensure the effectiveness of our work.

Geobear personnel embody professionalism and a willingness to deliver a great service.

PROFESSIONALISM
With more than 30 years' experience and more than 100,000 structures remediated around the world, Geobear is the market leader in the field of injection of expanding geopolymer for ground improvement.

We have developed unique expertise to problems which, up until now, have been treated using traditional techniques. We have developed several injection protocols for geopolymer which address all these issues perfectly, for home, commercial premises or major infrastructure projects.

Our specialist teams devote special care to ensure that our clients are satisfied, which is why we are committed to total transparency with regard to the technical feasibility and implementation of our processes.

ZERO HARM
Our core concern is zero harm whilst delivering our solutions.

Geobear are committed to a policy of zero harm for our employees, the public and the environment by having a high level safety-promoting culture and safety protocols in place. At Geobear, safety is everyone’s personal concern. We strive for zero fatalities, accidents and injuries. We are committed to: Elimination of risks and hazards - all Geobear companies will identify risks and establish zero harm design, management and behavioural protocols to eliminate them. Maintaining of zero harm on a daily basis - all Geobear companies will establish and maintain management, monitoring, review, audit and assurance systems geared towards zero harm. We keep a constant focus on the way we manage and control risk, making safe delivery habitual. Keeping the public and environment safe from harm - all Geobear companies will manage and maintain zero harm levels of separation, security, monitoring and stewardship to safeguard members of the public and environment from exposure to hazards. At Geobear safety is everyone's business.

GROWTH
At Geobear we are focused on growth. This doesn’t just mean growth of the business but more importantly it means growing our customer service, growing our solution offerings, growing our technical knowledge and our operational expertise. We understand that growth means progress and development on a continuous basis.
Ambitions
Our ambitions are:
- To be the primary solution for re-instating structural support
- To be the world’s market leader within our sector.

Proximity
Geobear have local teams in more than 50 countries worldwide and are committed to every project they work on. The teams utilise mobile workshop vehicles and carry out work on-site.

The ability to listen
Our teams are ready to support you with your project and to listen to your requirements. Whenever clients contact their nearest Geobear licensed contractor, an area manager is nominated as their dedicated contact person.

The warranties provided by Geobear
Technical warranties
The foundation and slab stabilisation processes are described in a set of precise and exacting requirements specifications. This approach has resulted in various external organisations officially recognising our work. CSTB technical investigation reports have reported favourably on our processes. Geobear also holds TÜV certification. This accreditation organisation issued a favourable opinion on the use of the Geobear ground improvement solutions. Geobear are also accredited with ISO 9001, ISO 14001 and OHSAS 18001 relating to standards in quality management, environmental management and health and safety.

Standards
The ground improvement process for the remediation of soils complies with standard BS EN 12715: “Execution of special geotechnical work – grouting”.

Environmental guarantee
In 2014, Geobear received several certifications guaranteeing the non-noxious nature of our resins in sensitive zones.

The Geobear guarantees
Geobear warranty
All Geobear solutions are covered by a warranty.

Public liability
The company has public liability insurance, with all the options covered.

BENEFIT FROM GEOBEAR’S EXPERIENCE
Geobear personnel are available to listen to your requirements and to propose a tailored solution.
KNOW-HOW
Our engineers work in the field and on site to study each project; they are skilled in different disciplines: civil engineering, geotechnical and structural engineering. They all share a common characteristic: unique know-how in their field that lets them propose the right solution. The engineering teams are complimented by our highly effective project managers who are experienced in handling the most complex projects.

WORK CARRIED OUT
Autonomous teams equipped with mobile workshops carry out work on-site.
OUR REGIONAL AGENCIES PROVIDING A LOCAL SERVICE

Do you need more information, or support?
CALL US ON +44(0) 20 3773 4866
Geobear utilises the expansion properties of a mix of unique structural geopolymers.

Geobear geopolymer components are mixed on site as a part of an injection process, this is called "polymerisation".

Initially, the geopolymer is a liquid and can easily penetrate the smallest crack or crevice.

As the chemical reaction progresses the geopolymer expands, its volume can increase by a factor of up to 30 depending on the degree of confinement. The expanding geopolymer compacts the ground, generating pressures as high as 10 MPa in the case of the ground improvement process.

Within a very short time period the geopolymer cures to a strong, stable and enduring matrix which is environmentally neutral.
THE PROPERTIES OF GEOBEAR GEOPOLYMERS

The characteristics of the geopolymer and its effects in the ground

Standard EN 12715, which governs the execution of special geotechnical work, covers all injection (also known as “grouting”) techniques. Most of the processes described involve injecting cement-based products. The standard also mentions the use of geopolymeric resin or of concrete containing resins.

Within this range of techniques, the Geobear technology occupies a special place since it combines an impregnation injection with hydraulic fracturing and compacting. The effects of the injection of expanding geopolymer are considered both in the category of injections “without ground displacement” and “with ground displacement”. Its characteristics are quite unusual.

GEOBEAR STRUCTURAL GEOPOLYMERS

- Rapid expansion for perfect control of the injection process
- High expansive force
- Strong in compression, tension, bending and shear.
The geopolymer has a high rate of expansion
The pressure exerted by the geopolymer as it expands is a key element of the technology. This pressure, which can exceed 10 MPa (about 1 000 000kg/m²), facilitates the penetration of Geobear geopolymer into fine soils and impermeable ground through a process of hydraulic fracturing. This action, combined with systematic, three-dimensional static compaction, significantly reduces the permeability of the in-situ soil structure. It thus limits any shrink-swell phenomena caused by repeated drying and rehydration.

The geopolymer does not increase the water content of soil
One of the key differentiating characteristics of the Geobear geopolymer is that it does not increase the water content of soil. Their state changes with variation in the water content. When water is added, some soils change from a solid to a plastic, and then to a liquid. Consequently, the absence of water in the geopolymer ensures that the injection does not cause any plasticisation of the soil. Shrinkage (a loss of volume) can affect most cement-based techniques (which contain water) as the ground dries out. The geopolymer hardens not by drying but by a process of polymerisation. Since it is also solvent-free, no shrinkage occurs during hardening.

The resin is a geopolymer
Unlike cement-based products, Geobear geopolymer tensile strength is excellent. The chains of molecules formed during polymerisation are extremely resistant to all forms of chemical attack or mechanical stress. Moreover, its compressive strength is remarkable, and much greater than the loading exerted by the structures above. Geobear geopolymer does not rot or biodegrade.

Expansion test: Increasing the expansion pressure as a function of unit weight of material.

Resistance test compression with free lateral expansion: Increased resistance depending on the specific weight.
GEOBEAR & THE ENVIRONMENT

With regard to resin-based processes, it is understandable to query their possible effects on the environment, and on health and safety. Since its inception, Geobear has adopted a strict policy on these subjects – both to safeguard the health of its technicians and clients, and to preserve ecosystems.

**Geobear geopolymer has no negative impact on the environment**

Studies conducted on the polymerised resin have shown that it does not contaminate the ground (refer to the table opposite). This absence of contamination is due to the fact that the multiple components, once mixed, form closed and very tightly bonded chains of molecules.

The quantities of geopolymer injected rarely exceed 2 to 4% of the volume in the treated area (0.2 to 1% by weight). The migration of the geopolymer away from the point of injection is limited (up to 2m) since polymerisation progresses very rapidly. 90% of remediation treatments are carried out near to the surface (at a depth of 3 to 4m).

**Carbon footprint**

The process generates very little carbon compared with traditional solutions. The drilling work is performed using electric drills with low electrical demand. Moreover, projects are completed quickly – between two and ten times faster than micro-piling.

Very little product is transported compared with concrete. Five tonnes of liquid geopolymer transported by tanker can expand underground to produce 70m³ of polymerised resin.

**Packaging**

The tankers are equipped with fixed stainless steel tanks which are filled from re-usable depot-based tanks. We do not therefore consume any packaging, and do not produce any waste.
IMPACT ON THE ENVIRONMENT

Presentation of the data obtained by analysing a sample of high-density geopolymer. This sample was made in accordance with the French standard defined by the French ruling of 15 March, 2006.

The original sample submitted by the requester in the form of compact cubes with a density of 240 kg/m³ was ground and sieved; the results for the solid in this form (table 2) were obtained by analysing the product when passed through a 4mm sieve. A leaching test was also performed on this product with a liquid/dry solid ratio of 10 l/kg, in accordance with French standard NF EN 12457-2; the eluate from the leaching test, with its inherent pH value, was subjected to the analyses presented in table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units of measurement</th>
<th>Value</th>
<th>Limit defined in appendix 2, table 1 of the French ruling of 15 March 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.001</td>
<td>0.06</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.01</td>
<td>0.5</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/kg of dry matter</td>
<td>1.43</td>
<td>20</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Total chromium</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.1</td>
<td>2</td>
</tr>
<tr>
<td>Mercury</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.001</td>
<td>0.01</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Selenium</td>
<td>mg/kg of dry matter</td>
<td>0.01</td>
<td>0.1</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/kg of dry matter</td>
<td>0.67</td>
<td>4</td>
</tr>
<tr>
<td>Fluorides</td>
<td>mg/kg of dry matter</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>Phenol index</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.1</td>
<td>1</td>
</tr>
<tr>
<td>DOC</td>
<td>mg/kg of dry matter</td>
<td>435</td>
<td>500</td>
</tr>
<tr>
<td>Soluble fraction</td>
<td>mg/kg of dry matter</td>
<td>200</td>
<td>4000</td>
</tr>
</tbody>
</table>

Legend: DOC: dissolved organic carbon

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units of measurement</th>
<th>Value</th>
<th>Limit defined in appendix 2, table 1 of the French ruling of 15 March 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOC</td>
<td>mgC/kg of dry matter</td>
<td>686000</td>
<td>30000</td>
</tr>
<tr>
<td>BTEX</td>
<td>mg/kg of dry matter</td>
<td>&lt; 2.2</td>
<td>6</td>
</tr>
<tr>
<td>PAH(*)</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.03</td>
<td>50</td>
</tr>
<tr>
<td>PCB(**)</td>
<td>mg/kg of dry matter</td>
<td>&lt; 0.01</td>
<td>1</td>
</tr>
<tr>
<td>Hydrocarbons (C10 – C40)</td>
<td>mg/kg of dry matter</td>
<td>&lt; 10</td>
<td>500</td>
</tr>
</tbody>
</table>


(*) The "PAH" parameter identifies a family of compounds for which the Italian standard sets limits for each compound and a limit for their sum. The French standard does not set a limit for each compound, but does set a limit for the sum. In the results presented above, and in test report No. 075/2009, the compounds considered are those listed in the regulatory decree of the Italian Republic 152/2006, section IV, heading V, appendix 5, table 1, and the sum of the concentrations of the said compounds was calculated.

(**) The "PCB" parameter identifies a family of compounds which is normally expressed as a sum of congeners; the French standard specifies that the family to be analysed should contain 7 congeners. In the presentation above, and in test report No. 075/2009, 12 congeners were considered. The "WHO (1998)-PCB-TEQ excl. (or incl.) LOQ" designation indicates a weighted sum based on the toxicity of the congeners.

Tables 1 and 2 reveal that the only value greater than the limit value set by the French standard is for the TOC parameter obtained by analysing the resin in its native form (table 2). However, the fitness for purpose of the resin is not compromised by this finding, since the limit value for the DOC, determined by measuring the eluate from the leaching test, complies (table 1). Parameter units of measurement value limit defined in appendix 2, table 1 of the French ruling of 15 March 2006.

Test reports Nos 75 and 76 are appended to this presentation. Padua, 3 September 2009, Analyst (Mrs. A. Sandon), Head of Department (Prof. P. Ruol).
Ground improvement, a unique, safe and fast stabilisation process with real-time verification of effectiveness.

THE VARIOUS STEPS

A prerequisite to proposing the ground improvement process is a thorough study of the soil.

A precise understanding of the ground to be treated establishes whether or not the remediation is feasible. On a more practical level, it is used to determine the depth of the treatment and the quantity of geopolymer needed.

Before commencing the drilling work, all the utilities (pipes and cables) passing through the work zone must be identified and located.

1 Drilling

During injection, the movements of the structure are monitored continuously using laser measurement systems. The detection of uplift at any time during injection provides real-time confirmation that the treatment has achieved its objective.

The work is conducted from outside the structure and it does not generate any vibration or dust and no excavation or demolition work is performed.

2 Insertion of tubes
THE BOUSSINESQ PRESSURE BULB

The injections are concentrated in the Boussinesq pressure bulb, i.e. in the volume of ground which bears the loads applied by downward loading from the building.

As it expands, the geopolymer spreads up to 2 metres away from the point of injection. The geopolymer then solidifies quickly, resulting in almost immediate consolidation of the ground.
SOIL IMPROVEMENT TESTS

The test results clearly demonstrate the positive effect of the injection of expanding geopolymer on the deformation behaviour and bearing capacity of the ground studied.

Three types of ground were tested: non-cohesive soil (Leitha limestone) and two cohesive soils, a clayey soil (Tegel) and a loamy soil (Loess).

The tests primarily involved performing plate loading tests and surveying with a penetrometer.

Details of the sensors
The bearing plates fitted with sensors provided useful information about the deformation under load of the various types of soil. This method was effective in enabling us to measure and compare the soil improvement work.

Non-cohesive soils
In non-cohesive soils, the injection of geopolymer achieved a marked reduction in settling. Inspection of the point of injection revealed that the geopolymer completely filled the voids and produced a soil structure with all the characteristics of a conglomerate: i.e. with a very significant improvement in the cohesion.

Cohesive soils
In fine soils, injection again achieved a significant reduction in the settling induced by the loads. The resin penetrates the weak zones and forms a network of strips. This sheet-like structure both significantly reduces the permeability of the soil and increases its compaction.

All the results of the research work conducted in Austria are available on request.
Diagram of the plate loading tests

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Loads / Displacements</th>
<th>Light dynamic penetrometer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TYPE OF SOIL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NON-COHESIVE SOILS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravels</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
</tr>
<tr>
<td><strong>COHESIVE SOILS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clays</td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
</tr>
<tr>
<td>Loams</td>
<td><img src="image5.png" alt="Graph" /></td>
<td><img src="image6.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

- With Geobear geopolymer
- Reference ground without geopolymer
THE IMPACT OF DRY GROUND ON BUILT STRUCTURES

Hot weather and periods of drought reduce soil moisture levels both near the surface and at deeper levels. Clay soils are particularly sensitive to variations in water content. The degree to which their volume changes depends on their mineralogical composition, and these soils are also more susceptible to shrink-swell phenomena.

Underneath buildings, the water content may vary from one point to another, resulting in differential settling which can have particularly adverse consequences.

Cracks may appear, the severity of which depends on the rigidity of the structure.

The Geobear ground improvement process is particularly well suited to addressing dry soil-related phenomena.

As demonstrated by a number of research projects (see below), the patented Geobear ground improvement process slows down and restricts the seasonal cycles of hydration/dehydration of the treated soils and thus reduces the shrink-swell cycling observed in clay soils. The recommended applications for the Geobear ground improvement process have been formally identified in our requirements specification, which has been approved by SOCOTEC.

**Atterberg limits**

They provide an indication as to the state of the finest fraction of the soil, which changes from a solid to plastic to liquid as a function of its water content. The plasticity index (lp) is the difference between the liquid limit and the plastic limit.

The methylene blue value (VBS) gives an indication as to the mineralogical composition of the clay fraction of the soil, and of the ability of the layers of clay to absorb water.
Subsidence affecting a slab

An external crack

A "SAUGNAC" gauge used to monitor cracks

A crack more than 1 cm wide
The Effect of the Geopolymer in Clay

Tests have been conducted in Italy to determine the effects of the injection of a high-expansion geopolymer into a clay soil. The higher density of the soils compressed by the injection of Geobear expanding geopolymer reduced the probability of large variations in volume occurring in the future. By replacing the water in the soil with a geopolymer, the water content is reduced, and thus there is less chance of settling occurring due to further losses of water.

Treatment with Geobear expanding geopolymer:

- Increases the soil’s dynamic resistance
- Saturates the ground with the geopolymer, which reduces the natural water content (Wnat).

These effects correspond precisely to those observed following periods of very dry weather, with the geopolymer restricting the shrinkage experienced by a clay soil.
Comment: Diagram 2 shows the effect of a single, one-off injection, 2.80m deep. In practice, when treating the ground under a foundation, a number of injections are made which have effects over the entirety of the treated height, which combine with the effects of grouped injections.

As part of the study, a calculation method was used to assess the reduction in settling resulting from the RPE treatment: The study considers a private home in Antibes (southern France) which suffered the effects of dry weather (Ip = 39): Since the volume of geopolymer injected into the ground equates approximately to:

$$RV = \frac{V_r}{V} = \frac{40}{1000} = 0.04 = 4.0\%$$

and since the formula used to determine the volume of water replaced by the resin is:

$$w = \frac{V_w}{V} \cdot \frac{\gamma_w}{\gamma_d} = 0.04 \cdot \frac{10}{17} = 0.023 = 2.3\%$$

then this shows that injecting Geobear expanding geopolymer down to a depth of 3.00 m:

The plot of the shrinkage test indicates that the future reduction in settling due to further loss of water is approximately 35mm.
TREATING CLAY SOILS

Geobear is active in Australia and has conducted research in conjunction with Olivier BUZZI, a French researcher at the University of Newcastle.

This work has particularly focused on the behaviour of expansive clay soils treated with expanding geopolymer.

The filling of voids under the structure's foundation restores the continuous contact between the ground and the structure. This treatment re-establishes the original equilibrium for which the foundation was designed.
The main conclusions drawn from the research are:

1. The geopolymer penetrates very fine cracks in the soil just 0.1 mm wide. Even though on a molecular level the geopolymer does not penetrate the clay, it freely penetrates a mass of clay soil.

2. The bond between the geopolymer and the clay is very strong since the inter-penetration of the two materials occurs across a layer 1 to 3 mm thick.

3. The geopolymer drastically reduces the permeability of the soil structure. This is important as it ensures that any future rehydration and potential risk of swelling will be significantly reduced.

4. The filling of the voids under the foundations means that the soil can once again perform its intended role in supporting the structure. This void filling also makes the zone more impermeable, which further reduces its sensitivity to variations in water content.

The pressure applied by the expanding resin after filling reduces the tensions in the structure.

Penetration of the geopolymer into the clay. The geopolymer does not penetrate between the layers, but rather into the soil structure itself by filling even the smallest voids and by fracturing the weakest zones.

Microscopic examination reveals that the clay is penetrated by the geopolymer over a layer 1 to 3 mm thick.
GROUND IMPROVEMENT SOLUTIONS

SOIL CONSOLIDATION
BY INJECTING EXPANDING GEOPOLYMER

CUSTOMER FIRST / PROFESSIONALISM / ZERO HARM / GROWTH
The ground improvement solution process involves injecting an expanding geopolymer into the ground to improve the soil’s mechanical properties. Initially, the geopolymer penetrates the soil by impregnation, with or without fracturing. During a second phase, and as a result of the pressure generated as the geopolymer expands, the product compacts the ground.

The expansion force is sufficient to raise the height of the buildings supported by the remediated soil. Each millimetre of uplift is detected by laser levels. This continuous monitoring ensures that optimal levels of ground remediation is achieved in terms of soil properties. The ground improvement solution process is frequently used when serious damage has been caused by subsidence under the foundations or slab. It is also used to increase the bearing capacity of a soil as part of a renovation project. This technique is well-suited to the stabilisation of all kinds of building, regardless of the type of foundation: individual houses, apartment blocks, historic structures, old buildings, churches, factories, roads and railways. Our techniques make it possible to improve almost all soils, even clay soils.

**THE WORK INVOLVED**

**Drilling**
Holes as small as 16mm in diameter can be drilled through the foundations to reach the volume of soil to be treated with precision. Tubes are then inserted into the drilled holes to transfer the geopolymer into the ground.

**Injecting**
The geopolymer is injected in liquid form. In this state, it penetrates and diffuses through the soil before starting to expand. During the expansion phase, the expansion force generated can be 10,000kPa or more, depending on the confinement and the loading exerted by the building being stabilised.

**Uplift and consolidation**
The geopolymer continues to expand until the ground cannot take any further radial compression. The geopolymer then expands in the direction of least resistance – upwards – to lift the building. Laser receivers are installed in the building and detect the first signs of any uplift. If uplift does occur, the injection at this point can be halted since this movement provides evidence that the bearing capacity has increased.

**STRENGTHS**

- No damage to the structure of the building as the work is limited to drilling and injecting through the foundations
- Option to limit work to specific, localised points
- Minimal vibration
- No excavation work, or support structures
- Quick and immediately effective
After inventing the technology and filing the patents it has now perfected the execution of the processes.

**Individual houses**

The Geobear technique is frequently used to stabilise the foundations of private homes. The most common causes of settling are the drying-out of the soil, leaks from pipework and shallow foundations.

**Apartment blocks**

The force exerted by the expanding geopolymer is sufficient to stabilise apartment blocks a few floors high. The occupants do not generally have to move out during the work. The remediation is often carried out externally or via the basement. Stabilisation of load-bearing walls is straightforward.

**Period properties**

The ground improvement process is well suited to the ground under old buildings. No excavation or demolition work is required. Since grade beams don’t have to be laid, the cost of stabilising using this technique is less than traditional solutions.

**Infrastructure**

Geobear ground improvement solutions can be used to increase the bearing capacity of soils in various types of infrastructure. It works ideally to treat subsidence, for example under rigid or flexible pavements, and is often chosen over traditional methods because of its minimal disruption and longevity under dynamic loading.

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**TECHNICAL DATA**

- **Pressure of up to 10 MPa**
- Increases the bearing capacity of the soil prior to further renovation using traditional techniques
- Stabilises all types of buildings
- Improves almost all soils, including clay soils.

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**THIS SOLUTION IS RECOMMENDED:**

- For remediation after subsidence under the foundation or slab
- As a preventative measure, when renovating a building on unstable ground.
STABILISATION SOLUTIONS

SOIL CONSOLIDATION
BY INJECTING EXPANDING GEOPOLYMER

CUSTOMER FIRST / PROFESSIONALISM / ZERO HARM / GROWTH
Our ground, earth and soil stabilisation solution is a specifically controlled process whereby resin is injected into the ground to prevent movement, whilst not raising any of the existing slabs or structures.

We achieve this precision control through the specific selection of slow expanding resins depending on the ground type and we set up multiple monitoring systems to ensure we achieve no more than 250 microns of resistance on the concrete slab. Fundamentally, this precision measures a lateral lift too small for the eye to see, which indicates the ground beneath has been stabilised.

The stabilisation process has resins injected at points beneath a slab, pad or foundation where it expands to fill any voids in underlying soils and compact any existing made ground.

This method is widely used on the UK road and rail network, together with airports. Where an asphalt surface is cracking or potholes appear, the cause is typically ground movement beneath, Geobear injects resins under the concrete to prevent any further movement. This process is used before a new surface layer is applied to a road or airfield.

In the rail sector Geobear is the fastest method to treat track beds where underlying ground movement is reducing line speed. We inject beneath the slab to ensure the sub-base is fully stabilised, we verify this using Network Rail monitoring and the line can be returned to full operation use.

**The benefits of our stabilisation process:**

- Preventing slab rocking
- Preventing surface failure
- Preventing lateral movement of rail

**WORK PHASES**

Once the area to be treated has a works programme agreed, our teams identify underground pipes and cables and the position of gas mains, electricity cables, drains, etc. is determined.

**Drilling**

The holes are generally drilled with 6-12 mm diameter at depths depending on slab size or amount of weak ground.

**Insertion of the injection tubes**

The tubes are placed in each drilled hole to the required depths, we treat at multiple depths where necessary.

**Injection**

Geobear geopolymer components are mixed on site as a part of the injection process, the chemical reaction takes place underground at varying speeds depending on ground type and the material we use.

**Stabilisation**

The geopolymer penetrates the voids under the asset and compacts the bearing layer. Stabilisation is controlled through laser monitoring and post process measurement.

**PROCESS OVERVIEW**

The geopolymer is injected in liquid form. In this form, it is able to penetrate all the voids under the assets before transforming firstly into a gel and then into a solid.

The chemical reaction causes the geopolymer to expand. It is not the pressure applied during injection which stabilises the ground, it is the expansion pressure generated by the polymerisation (or curing) of the geopolymer and the hardening of the material within the soils or made ground.
STRENGTHS

- Fast, localised teams to prevent disruption to normal operations
- No excavation work, or support structures required
- The asset or facility can be brought back into use within 30 minutes.

TECHNICAL DATA
- Maximum expansion pressure: 10 MPa
- Geopolymer density: varies from 45 to 120 kg/m³ (occasionally higher)
- Uplift: up to 30cm
- Expansion capacity of the geopolymer: up to 30 times the initial volume (depending on containment)
- Various geopolymers can be injected in wet conditions

THIS SOLUTION IS RECOMMENDED:
- For stabilising ground beneath roads and rail
- Preventive treatments, e.g. when renovating buildings standing on unstable ground
- Stabilising rocking slab problems

RAIL
The Geobear solution is applied beneath rail slab track to provide a solid footing and prevent movement. Lateral movement can be completely prevented by injecting resin in very short possession times, meaning line speeds restrictions can be removed.

AIRPORTS
Geobear re-level major airport runway and taxiways and slabs around ports, the fast overnight works mean normal operation is not affected and the surfaces can be used in hours.

COMMERCIAL AND INDUSTRIAL PREMISES
The stabilisation process causes almost no disruption. The work is completed quickly and generally with ‘business as usual’. It offers the perfect solution for stabilising slabs.

ROADS
The key benefit of Geobear is extending asset life. Our solutions future proof roads against degradation of the surface as a result of the weakened ground beneath. The long-term cost benefit of future proofing a surface can run into millions of pounds.
RE-LEVELLING SOLUTIONS

LIFTING & STABILISING FLOOR SLABS
BY INJECTING EXPANDING GEOPOLYMER

CUSTOMER FIRST / PROFESSIONALISM / ZERO HARM / GROWTH
Injecting expanding geopolymer under floor slabs

The re-leveling process stabilises and raises sunken slabs. Our geopolymer is injected into the bearing layer under the slab. During the hardening phase, as the geopolymer expands it consolidates the bearing layer before raising the level of the slab.

This uplift, which may be as much as several centimetres, is monitored continuously using laser levels. The re-leveling process can be used in residential properties to remediate sunken slabs. In industrial facilities, the re-leveling process can resolve several problems:

- Lifting sunken floor slabs
- Ensuring continuity of business operations
- Neutralising slab rocking phenomena.

The work may be consolidated by the additional injection of geo-polymer at depth, in accordance with the ground improvement process.

WORK PHASES

Identification of underground pipes and cables. The position of gas mains, electricity cables, drains, etc. is determined.

Drilling

The holes are generally drilled with 6–12 mm diameter bit.

Insertion of the injection tubes

Placed in each drilled hole, the Geobear expanding geopolymer is injected through these tubes.

Injection

Geobear geopolymer components are mixed on site as a part of the injection process.

Lifting

The geopolymer penetrates the space under the slab and compacts the bearing layer. The uplift is controlled so that only those zones which need to be lifted are lifted.

Laser monitoring

A laser level system is used to monitor, continuously and precisely, the uplift produced.

PROCESS OVERVIEW

The geopolymer is injected in liquid form. In this form, it is able to penetrate all the voids under the slab before transforming firstly into a gel and then into a solid.

The chemical reaction causes the geopolymer to expand. It is not the pressure applied during injection which creates the uplift, it is the expansion pressure generated by the polymerisation (or curing) of the geopolymer.

This pressure is capable of lifting very heavy items such as machines or loaded storage racks. The geopolymer is NOT biodegradable and will last for decades.

STRENGTHS

- Effective compaction of the bearing layer
- Slab can be lifted by a few millimetres... or even a few tens of centimetres
- Laser level monitoring systems ensure millimetric lifting precision.
- No disruption to commercial or industrial activity
- Clean and dust-free
- Work is completed very quickly
Airports, Ports
Geobear re-level major airport runway and taxiways and slabs around ports, the fast overnight works mean normal operation is not affected and the surfaces can be used in hours.

Commercial and industrial premises
The re-levelling process causes almost no disruption. The work is completed quickly and generally with “business as usual”. It offers the perfect solution for slab rocking problems.

Facilities open to the general public
The work does not require any demolition and does not endanger public safety. The treated buildings do not have to be closed, and in general the facility can continue to be used normally.

Roads, walkways, pedestrian zones
The process can be used to stabilise roads and transfer slabs. The geopolymer’s very fast hardening time means that the structure can be opened to traffic almost immediately.

TECHNICAL DATA
- Maximum expansion pressure: 10 MPa
- Geopolymer density: varies from 45 to 120 kg/m³ (occasionally higher)
- Uplift: up to 30cm
- Expansion capacity of the geopolymer: up to 30 times the initial volume (depending on containment)
- Various geopolymers can be injected in wet conditions

THIS SOLUTION IS RECOMMENDED:
- Re-levelling sunken floors, roads, walkways, etc.
- Preventive treatments, e.g. when renovating buildings standing on unstable ground
- Stabilising rocking slab problems
STRUCTURAL SUPPORT SOLUTIONS

STRUCTURAL SUPPORT
BY INJECTING GEOPOLYMER PILLARS

CUSTOMER FIRST / PROFESSIONALISM / ZERO HARM / GROWTH
A unique patented ground stabilisation technology, PowerPile geopolymer pillar is suitable for treating subsidence and strengthening very weak ground. Narrow diameter pillars typically incorporating a casing are inserted underground via small, typically about 50mm, drill holes. A highly expansive geopolymer is injected inside a geotextile capsule creating a pillar of up to 340mm in diameter, which hardens almost immediately. PowerPile eliminates the need for costly and disruptive traditional underpinning/piling, resulting in minimal mess and disruption.

Usually PowerPile geopolymer pillars are installed directly below foundations, but if needed they can be used to support soil below the foundations. There is no need for additional load transfer structures. Conditions on different sites of course vary but the normal installation speed is 5 – 10 pillars a day. The installation site causes little if no disturbance in the surrounding area. PowerPile installation does not require excavation and so produces no waste. The silent installation process is clean and fast.

All equipment needed for PowerPile installation is delivered to the site in one vehicle designed for this purpose. Installation is performed by a team of two technicians.

The actual installation device moves on rubber tires as easily as a hand truck and only one technician is required to move the pillar elements. The longest elements available are 6 meters in length.

Described briefly, the installed PowerPile is a geotextile capsule, which is filled with chemically expanding geopolymer. With high density geo-polymers, compressive strength can be up to 15 MPa. The material used in the process is selected based on the geotechnical information and the amount is controlled by a computer.

Because the geotextile capsule is filled with expanding geopolymer from bottom to top, the surrounding soil compacts and is partially displaced. The material hardens fast and the new composite structure is supportive immediately.

The shape of the pillar usually depends on the form of the surrounding soil and density fluctuations inside the pillar.
TECHNICAL DATA
- Compressive strength up to 15 MPa
- Gives support to all types of buildings
- E-modulus: 10.0 MPa – 80 MPa
- Improves almost all soils, including clay soils.

THIS SOLUTION IS RECOMMENDED:
- Treating subsidence and strengthening very weak ground
- Suitable for remedial treatment

Individual houses
The structural support solution is frequently used to stabilise the foundations of private homes. The most common causes of settling are the drying-out of the soil, leaks from pipework and shallow foundations.

Industrial Buildings
The structural support solution is well suited to supporting the structures of industrial buildings. No excavation or demolition work is required. Therefore the business can keep running and there is no need to shut down production.

Infrastructure
In different types of infrastructure such as highways, railways and ports the structural support solution is ideal. As in most cases it is impossible to close highways, railways and ports from traffic.

Historic structures
The technique is suitable for old and relatively weak buildings such as historic structures. The cost of supporting historic structures is very competitive compared with traditional techniques.
Our water sealing solutions are becoming increasingly commonplace in the UK. The increase in flooding in recent years has seen a demand for a preventative measure for water ingress and also a permanent barrier in already saturated environments.

The process we use follows the core principles behind our resin injection methodology. The materials we use are closed cell and impermeable, meaning the injection and subsequent expansion of the materials forms a sealed barrier against any liquids.

We use our water sealing techniques on work sites where a barrier needs to be created to facilitate construction or where structures are already below the water line and the integrity is compromised by water migration.

Our specialist engineering department will design a package of works dependent on the objective of the works, taking into account any environmental considerations. The materials we use are all environmentally friendly.
VOID FILLING SOLUTIONS

Geobear void filling solutions can be used to fill any size void. Using our vast wealth of void filling experience it is clear that one product/system cannot be used to fill all voids, as such we offer a portfolio of void filling systems to allow us to fill the majority of voids. Our systems are ideal for filling mine shafts, tunnels, basements, caves, pipelines and conduits.

We specialise in the application of a range of materials to fill voids depending on size and location. Our solutions prove a super fast alternative to conventional void filling and our process avoids numerous deliveries to site therefore reducing disruption. All our materials are recyclable, so if at a later date the void needs to be accessed the resin can be removed.

Where required, we also provide a specialist load bearing void fill solution that can be applied directly and through expansion result in lift of overlying structures.
If we hadn’t used geopolymer injection, the warehouse would have had to have all the mobile racking dismantled and taken away. I could imagine there would have been four months or more for each of the warehouses to be without storage facilities in half their areas, which wouldn’t have been acceptable.

Geobear teams first tackled ‘hot spots’ in the flooring, to enable the racking system to work on a temporary basis. This provided enough time to plan for a wholesale lifting of two sections of the warehouse floors to achieve a very tight tolerance across any diagonal in any particular bank of racks.

The Geobear team took about 40 days in total for the complete work, but were able to move from section to section leaving the rest of the warehouse operating normally.

“Replacing a warehouse floor slab is incredibly expensive anyway, but this would have been double the cost because of having to include a new set of rails for the racking, which was incorporated into the slab.” - Chris Rhodes, engineer with Gifford Consulting who oversaw the project.

Geobear processes have been used to stabilise and correct settlement in warehousing facilities throughout the world for the past 30 years.
Case Study

**RED HOUSE FARM / UK INDUSTRIAL**

**GEOBEAR ENABLED CONTINUED BIO-ENERGY PRODUCTION BY RE-LEVELLING HEAVY TANKS**

**SUMMARY**

The land owner had constructed two large tank facilities as part of a scheme to create a bio-electric plant on his farm. The plant would provide sustainable generation to power the farm. The primary structures for the bio-electric plant were two tanks, one for storage and one for digestion of the biomass materials. Following the installation of the tanks and the commencement of operations both tanks started to sink on one side. The drop of the structures was up to 230 mm at the lowest point. The tanks were built with concrete sections connected by steel wire, however the sinkage had compromised the structural integrity with additional load stresses on the walls around the area of the drop. Geobear was approached to lift the structure back to its original level without compromising the existing concrete shell further.

**TECHNOLOGY APPLIED**

The client had to remove all the waste contents and clean the facility before it was safe for Geobear technicians to begin the lift. Our solution required injections of expansive resins underneath the tanks at a depth of up to 3 metres. The injections were made at critical points beneath the dropped area of the structures. Using precise laser measurement, we injected resins to raise the structure in 20mm increments to ensure the tanks’ integrity.

**OUTCOME**

Following a process which took four weeks to complete the tanks were lifted back to their original installation level and could continue operating.

**REASONS TO CHOOSE GEOBEAR**

A fast solution delivered without interruption to the company’s business activities.
KILGARVAN WINDFARM REMAINED OPERATIONAL AFTER BEING STABILISED BY GEOBEAR

**Summary**
Geobear was contacted by Danish wind company Vestas to help stabilise one of their wind turbine structures at Kilgarvan in South West Ireland. The turbine base was built on an area of 50% rock and 50% fill; following several months of operation the forces generated by the turbine began to affect the fill area beneath the structure, making the entire tower rock on its base.

**Objectives**
We were brought in to stabilise the ground under the footing of the tower using expansive geopolymer injection.

**Technology Applied**
Following a site visit, a programme of work was designed that would take Geobear one week to deliver. Ground improvement solutions were applied whereby the team on site could inject expansive geopolymer below the 2.4 metre concrete slab to fill any voids and stabilise the existing fill area. The technical teams methodically injected at calculated points underneath the footing and used laser monitoring to control the stabilisation process.

**Outcome**
We completed the programme of work on time, stabilising the structure and ensuring its continued operation for decades to come.

**Reasons to Choose Geobear**
The earlier the remediation is done, the less damage will be caused by subsidence – resulting in direct cost savings.
KILLARNEY/IRELAND
WATER SEALING
Duration: 15 days

GEOBEAR GEOPOLYMER INJECTION
SAVES THE DAY AT KILLARNEY HOTEL

THE PROBLEM
During excavation work for the construction of a new hotel in Killarney the developers experienced excessive water being released into the cavity. The water table in the area is approximately 1 metre below ground and as the excavation extended down 6-7 metres, there were continuous problems with flooding. The flooding continued despite the action of submersible pumps, secant piling around the site perimeter and pumped concrete placed behind the piling.

“There were significant gaps between the piles, and because of the high water table, as we were digging, water was coming in. We tried sealing the excavation with concrete cement grout, but that didn’t work too well - it was being washed away.”

THE SOLUTION
Geobear used specialised hydro-insensitive geopolymer injected at 1 metre intervals behind the pile face and 2 metres from the base of the piling. Post injection, the liquid geo-polymer sets off within seconds, forming a closed cell impermeable barrier which successfully sealed the gaps between the piles. Our team was on site for 15 days and the strategy was successful in stopping water flow into the excavation, allowing construction to proceed.

“While we had to stop digging because of the volume of water that was ingressing, and if we hadn’t come across Geobear, I honestly don’t think we would have been able to physically get down to the level required for the basement. We’re very pleased with how it’s gone, it’s worked a treat for us. If anyone ever had a similar problem again, I would seriously recommend this. It’s very good stuff.”

- Sean O’Callaghan, site manager for Sean Clifford Contractors.

REASONS TO CHOOSE GEOBEAR
Geobear expanding geopolymer is suitable for all types of material: brick, stone, concrete etc.
**STABILISING A BUSY ROAD IN READING**

**SUMMARY**
Northumberland Avenue in Reading is a busy strategic route to schools, residential and commercial properties, but through years of damage to the concrete slab and the increased heavy vehicle use, the surface of the road was saturated in fretting and potholes. The concrete slab had been badly damaged by utility trenches and ducting that had been installed within the road over the last two decades and due to the unfavourable ground conditions, there was differential settlement of the slabs. This resulted in cracking and potholes reflecting through the slab to the surfacing course. The council were committed to preventing these problems rather than treatment, and so wanted a longer term solution without the need to reconstruct the road at considerable delay and cost on a strategic route.

**OBJECTIVES**
The council approached Geobear to look at the viability of treating the ground beneath the concrete. Firstly, in order to fully understand the extent of the issue a GPR survey was completed to analyse the composition of the ground. The results highlighted significant voiding and a soft base layer, meaning throughout a 400 metre stretch of road the integrity of the concrete slabs was being compromised by weak ground. The weakened ground had to be stabilised or a resurface would suffer similar accelerated deterioration; as the ground moves the concrete base also moves, meaning the asphalt surface is more prone to distress.

**TECHNOLOGY APPLIED**
Geobear drilled through the road and sub-surface to inject geopolymer resins that expand to fill voids and mix with the existing elements to harden, forming a solid base under the concrete. The procedure for the work was to drill at measured intersections into the road and inject a formula of expansive resin into the ground beneath the concrete at depths of 1 metre and 3 metres. Different resin compositions are used depending on soil condition and vary in terms of expansive force and the time it takes to harden. The technical teams on site use laser monitoring to observe fine movement in the ground level and once a movement limit is reached the resin is injected at the next interval.

**OUTCOME**
The stretch of road in Reading took the Geobear project team two weeks to complete. A contractor was subsequently employed to resurface the treated sections. Reading Borough Council was pleased with the outcome, highlighting that when you consider the economics, they are accruing long term savings by investing in the future of roads. Their strategy is to consider all the options available and ensure our programme of work delivers the best possible outcome to the local community. Geobear has worked with the council on a number of schemes and our methods have consistently proved successful. Sam Shean, Streetcare Manager at Reading Borough Council was pleased with the results, stating, "We’ve worked with Geobear on a number of schemes and their methods always deliver for us".

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**CASE STUDY**

**TREATED ZONE: 300m$^2$**

**READING/UK INFRASTRUCTURE**

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**Section 3**

<table>
<thead>
<tr>
<th>Key: Injection Point</th>
<th>10kg/vertical metre</th>
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<tbody>
<tr>
<td>314m</td>
<td>7m</td>
</tr>
<tr>
<td>51 Rows in this section (255 Holes)</td>
<td>390m</td>
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SUMMARY
As part of the Crossrail development, the Ilford rail depot was refurbished, and required its foundations upgrading to withstand increased loading. An investment of £50M was being undertaken by Volker Fitzpatrick to upgrade existing facilities to create 10 new sidings for Crossrail trains. Geobear’s task was to improve the bearing capacity of the ground beneath the mainframe foundations and perimeter walls. Techniques such as mini-piling would have been the conventional solution to overcome the problems but once time, disruption and ownership issues were factored in, it was not considered a viable solution. Volker’s consultant RPS proposed working with Geobear to use a geopolymer injected system to overcome the challenges in dealing with the steel framed workshop building. One of the main benefits of the Geobear system was that no excavation was needed and work could be carried out where there was minimal access.

OBJECTIVES
Ground investigations undertaken by ESG showed that ground conditions were inadequate for the proposed redevelopment, with around 5m of made ground over sands and clays. It was believed that the existing foundation design did not have the capacity that was required and would not support the increased loads of 350 kN/m² that the refurbishment would place on the foundations. Initial calculations ahead of both the testing and treatment suggested that total settlement of the pad foundations, which are 9m apart, would be 5mm. The analysis also showed that differential settlement between columns would be less than 10mm.

TECHNOLOGY APPLIED
Geopolymer injection was used for increasing the bearing capacity. 2 load plate trials were conducted to confirm our design.

OUTCOME
The treatment itself involved four 52mm diameter, 5m deep injection points per 3m by 3m pad foundation – two were drilled vertically and two were inclined through the foundation itself. In total there were 19 pad foundations to be treated and each 5m injection was completed in just 10 minutes. For the strip footings, the whole 168m length of the building under Crossrail ownership was treated by injecting at 1.5m centres along the walling. The maximum total settlement of any pad foundation was to be 25mm. Before injecting, tests with loads of 252kN and 378kN were made. When a load of 252kN was tested the settlement was 13.06mm and 33.97mm with 378kN. After the injections the results were 2.53mm with 252kN and 4.83mm with 378kN. The injection increased the settlement potential more than 7 times when testing with the heavier load. Geobear completed the works on time despite a compromised work site. Work took 10 days to complete with four teams from Geobear working on the site simultaneously.

Laser monitoring was used to measure the accuracy of the injections to within 3mm.
CASE STUDY

REASONS TO CHOOSE GEOBEAR
Geobear expansive geopolymer is the fast and non-disruptive solution for railways.

SUMMARY
Settlement to base slabs at a rail depot in Farnham, near London, threatened to disrupt rail operations in south-east England. The 60-year-old slabs had been gradually settling for many years due to compaction of fill material, drainage & washout problems, and the increased weight of modern rolling stock. The problem had reached a point where a crucial, 6,000 sq metre maintenance shed, vital to timetable operations, was at risk of closure due to unsafe ground. Geobear was contracted to solve the problem without disruption to timetables.

OBJECTIVES
To stabilise base slabs over 6,000 sq metres and raise the rails to level. Settlement of the slabs had led to speed restrictions for the locomotives, and fears of derailment. Adding ballast would have only been a temporary solution, and was unable to be completed quickly enough. Piling was ruled out due to cost. Breaking out and replacing the slabs was rejected due to the large area to be treated.

TECHNOLOGY APPLIED
Geobear's geopolymer injection process was applied to the 6,000 square metres of slab.

OUTCOME
Within a 5 week period, 6,000 square metres of slabs were stabilised and lifted to tolerances of +/- 10 mm over 10 sq metres, with no disruption to the operations of the shed.

BEFORE Geobear treatment

AFTER Geobear treatment

FARNHAM/UK INFRASTRUCTURE
Treated zone: 6,072m²

STABILISE BASE SLABS OVER 6,000m² AND RAISE TO LEVEL
GLASGOW/UK

RESIDENTIAL

Treated zone: 970m²

38 FAMILY HOMES TREATED - NO ONE HAD TO VACATE THEIR PREMISES

SUMMARY
38 properties situated within a large residential housing estate in South Glasgow, constructed across a former limestone quarry. Properties were identified by the engineers as showing cracking/distortion in excess of 15mm. Geobear were contacted to provide a solution to the problem that would result in minimal disturbance to the residents.

OBJECTIVES
In total over 900 linear metres of walling (both internal and external) were treated to a depth of 4.00m below ground level. Pre and post treatment dynamic penetrometer testing was completed at 5.00m intervals along all the walls, with the on-site engineer signing off properties when an increase in bearing capacity of the treated soils had been achieved. The ground conditions encountered were made ground/in-filled materials to in excess of 20m below ground level. Due to the partial treatment depth this work was undertaken with no guarantees.

OUTCOME
All post-treatment dynamic cone penetrometer tests recorded an increase in bearing capacity allowing all properties to be signed off as completed within the 16 week deadline. The client chose to use the Geobear systems due to the minimal disruption that would be caused to the elderly residents by our works, to the elderly residents along with the speed at which the properties could be successfully treated.

REASONS TO CHOOSE GEOBEAR

The residents are able to live in their homes during the work.

TECHNOLOGY APPLIED
Geobear geopolymer injection was the appropriate method to stabilise the shallow soils and improve the bearing capacity. The Geobear ground stabilisation works took 16 weeks to complete and were carried out without the need for the tenants to move out of their properties.

The soils were stabilised beneath all the houses in 16 weeks.
CASE STUDY

YORK/UK
HISTORIC BUILDINGS
Treated zone: 65m²

SETTLEMENT IN A VICTORIAN CITY CENTRE BUILDING

SUMMARY
Differential settlement of a Victorian city centre building caused headaches for York City Council recently – and they turned to Geobear for a solution because of the company’s track record in keeping disruption to a minimum. Geobear installed their new PowerPile system, which injects expanding resins into geotextile tubes to improve bearing pressure and strengthen the ground beneath subsided foundations. Archaeological considerations were another factor, with concern to minimize disturbance to the ground under the building.

OBJECTIVES
In the 1930s the building was converted into an electricity substation, containing very heavy transformers and electrical switchgear. Although this has now been decommissioned and the equipment removed, the heavy weight was possibly an exacerbating factor increasing the settlement, says Mark Whitelock, Senior Engineer for York Consultancy, consulting engineers for the City Council. The building was only on brick spread footings, which were relatively shallow, and these were resting on soft ground.

The original ground level is approximately 5–6 metres below the current ground level, and the intervening ground is Roman and medieval fill which can be extremely soft organic material.

“Subsidence has been occurring for at least 15–20 years, but in recent years has accelerated. So we were faced with the problem of having to underpin and stabilize the building.”

York Consultancy chose Geobear because, says Whitelock, “the alternatives were just too problematic, using mini piles, or needles, or lintels under the walls. Geobear’s process was quieter, and easier on site – there are no excavations, so there isn’t lots and lots of spoil coming to the surface. Plus it’s quicker. This work took about 4 weeks, but with traditional methods it would have been more like 3–4 months with a lot more disruption, a lot more dirt, a lot more noise, and a lot more cost. Everything was stacked against putting in a traditional system.”

Archaeological factors led Geobear to recommend the use of the PowerPile system as it would constrict the spread of resin. At the request of York Archaeological Trust, two test piles were installed before the go-ahead was given for the project.

TECHNOLOGY APPLIED
PowerPile geopolymer pillar.

OUTCOME
PowerPile is ideal for use in weak ground, as it contains and precisely locates the expanding polymer resins in geotextile tubes and can produce an up to 600% increase in ground bearing pressure without excavations. Whitelock is impressed with the results. “When we excavated the test piles, I was expecting to be able to push my finger into the resins, but they were like concrete. It was remarkable. Being constricted by the tubes gives the resins a greater density.”

The PowerPile method is suitable for treating subsidence and strengthening very weak ground.
DUNBARTONSHIRE/UK
HISTORIC BUILDING
Treated zone: 20m²

DUMBARTON CASTLE STABILISED
WITHOUT ROAD ACCESS

SUMMARY
The French Prison built in 1790 on the Dumbarton Castle grounds had moved 15mm since 1989 but the wall was actually 145mm from vertical. The stone structure was constructed on a foundation of stone that lies just 1.2m below ground level. The rear wall and south gable are close to bedrock and the other walls stand on clay fill material up to 4m deep. These factors plus water draining off the rock face onto the rear and the roof of the building had caused differential settlement.

OBJECTIVES
Stabilise the structure without repositioning due to previous works which may compromise the other parts of the structure. Complete the works despite no road access.

TECHNOLOGY APPLIED
The biggest challenge was pumping the material over 200m from the truck - the furthest distance and height that we had to pump over. 23 injection points externally and 3 points internally at varying depths of between 3.7m and 4.2m were drilled and pumped using Geobear geopolymer.

REASONS TO CHOOSE GEOBEAR
A safe solution for historic buildings.

The entrance to the prison which could safely open to the public after Geobear treatment.

Technical drawing
SUMMARY
The A153 is a busy road Honnington to Sleaford in Lincolnshire. Over the years an increase in traffic numbers and the increasing weight of vehicles has put the road under considerable pressure; the forces are shifted downwards through the road surface into the subsurface and further below.

One section of the road, Donna’s corner, has been particularly affected. This section was originally constructed on poor ground meaning over time subsidence has taken effect. Voiding and compression within the sub base has resulted in a very irregular surface for 400 metres.

Lincolnshire County Council’s maintenance contractor Kier contacted Geobear to provide subsurface stabilisation works prior to resurfacing.

OBJECTIVES
Geobear are the common choice for ground stabilisation works as the disruption and timescale of the processes minimise the inconvenience to road users. The solution is long term and allows resurfacing to be future proofed against further failure.

For this section of road, the council wanted to minimise closures, so Geobear worked overnight for two weeks to stabilise a stretch of 375 metres full width and 40 metres half width.

TECHNOLOGY APPLIED
The process involved drilling holes in a designed pattern across the sections of road to a depth between 0.5 and 0.9 metres; a tube is then inserted into the hole and Geobear geopolymer is injected. The expansive force of the geopolymer fills any voids and eliminates any water from the sub base, depending on the ground beneath in some areas it was possible to actually lift the road to reduce the irregularities.

OUTCOME
The road at Donna’s corner is now fully stabilised which means any further subsidence has been prevented and a new black top is future proofed against fracture and potholing.

REASONS TO CHOOSE GEOBEAR
We deliver localised solutions, meaning the traffic can still flow and roads are not fully closed.
SUMMARY

Bristol Royal Infirmary is a large teaching hospital based in south west England. The structure was undergoing some redevelopment work in 2015 which, following a specialist radar survey, revealed a void under an area of slab. The redevelopment necessitated an additional load to be placed on the existing slab but following load tests the void would compromise the slab integrity to withstand additional loads.

Geobear was contacted to propose a solution which required filling the void with specialist geopolymer material with the compressive strength to withstand additional forces.

OBJECTIVES

The void was identified as a 280m³ area beneath one of the main concrete slabs. The project was made particularly complicated by the presence of asbestos in the original construction.

Geobear proposed the use of a specialist high expansive geo-polymer that could be injected into the area, which subsequently solidifies and fills the void whilst creating additional load bearing strength.

TECHNOLOGY APPLIED

In order to inject the geo-polymer over 70 16mm holes drilled through a timber sub-floor of 50mm over a reinforced concrete slab, Geobear could then phase the geopolymer injections across the site working from the furthest point back to entry.

During the injection process the geo-polymer expands up to 45 times its liquid volume and exerts an expansive force as it quickly fills the void. To ensure an even coverage and fill of the void, the holes were injected in several passes, the number of passes being dependent on how big the void is at each particular hole.

The void was injected in several passes over the whole area until resin emerged from the injection holes providing the visual verification that the void has been filled. In addition to visual monitoring of the geo-polymer injection, we also monitored for possible movement of the floor slab with eye safe lasers. The laser was set up on a tripod close to the hole being injected and sensed any slab movement to within 0.5mm. Following the injection process the drill holes were filled in with Fosroc cement.

OUTCOME

The project was completed within 10 days, and the Geobear teams fully complied with regulatory health and safety for working in asbestos zones.

REASONS TO CHOOSE GEOBEAR

Our void filling solution can be pumped 100 metres from the vehicle, meaning we can reach difficult to access areas.
WAREHOUSE RE-LEVELLING AND STABILISATION, ENFIELD

SUMMARY
A major warehouse based in Enfield, Middlesex required remedial ground improvement works to enable its future as an operational facility. The site was constructed in 1997 and houses 14,000m² of warehouse space; the building was constructed on made ground of up to 3.5m and is a 3-span steel framed structure featuring piled foundations with a ground bearing floor.

In 2014 a site investigation was conducted that included a survey of the warehouse floor slab. This indicated that at least 60% of the warehouse floor had settled beyond its original design tolerance, in places up to 105mm were recorded. A further investigation revealed that original ground improvement works were ineffective which allowed settlement within the soil strata.

The conclusions necessitated remedial ground improvement works to lift the floor slab back to within its original tolerance, with repeated treatments where necessary to maintain adequate surface tolerance.

Critically, assessments showed steep floor gradients which would impact any use of the site as a warehouse in terms of efficiency and safety. Geobear was contracted to use its geopolymer injection processes to bring back the tolerances in line with the Concrete Society TR34 requirements.

OBJECTIVES
Geobear’s specialist engineers designed a programme of works for the site that could stabilise and lift the floor, enabling the site to be returned to use safely.

The ground survey data enabled us to identify the areas where the settlement was occurring and the extent of treatment that was necessary. Once the programme of works was established the Geobear technical teams could mobilise on site to perform the ground improvement and stabilisation treatment.

TECHNOLOGY APPLIED
The scale of the facility required Geobear to set-up multiple injection points at 1m centres throughout the affected areas. Geobear’s geopolymer was injected at over 100 points in accordance with the programme and laser monitoring was used to measure the required lift across all the injection points. We monitored the stabilisation and lift to within 1mm of the desired tolerance.

OUTCOME
The works package was delivered by Geobear within five weeks and the floor has been brought back to the required levels. Full level survey and TR34 flat floor surveys were carried out before and after works to illustrate compliance and improvement.

Due to the existence of alluvial and organic clay soils, compression is likely to continue once the flooring comes back into use. However, the Geobear method means that the site can remain fully operational as future treatments are made to the floor.

REASONS TO CHOOSE GEOBEAR
Our solutions provide a lift to warehouse slabs on any scale, ensuring premises are fit for purpose.
SUMMARY
A private residential home owner based in the royal city of Windsor was completing some extensive renovations to his property when the contractors completing the work discovered an abandoned culvert beneath the flooring.

In order for the renovations to be completed the culvert needed to be filled with a load bearing material as the floors were required to hold an additional weight.

OBJECTIVES
Geobear were contacted to provide a void filling solution to the homeowner. Our solution would be to use our specialist void fill material to fill the culvert and create a load bearing foundation.

The culvert to be filled was 30m in length and had a diameter of 600mm running under the length of the property. The culvert was capped at one end and collapsed at the other, so access had to be dug in four separate places and the pipe broken into for access.

TECHNOLOGY APPLIED
To fill the void we used our specialist structural geopolymer which, upon injection, expands rapidly filling any voids. To confirm the void was completely filled we used drainage cameras to visually inspect the process and ensure all parts of the culvert were filled.

OUTCOME
Geobear was able to complete the void fill in one day and the nature of our technology meant there was minimal disruption to the homeowner and other works taking place. The additional load bearing capacity that our geopolymer provides has now enabled the homeowner to proceed with the full renovations of their property.

REASONS TO CHOOSE GEOBEAR
Our void filling materials provide additional load bearing strength, transforming a site and enabling a change of use.
SUMMARY
Scribers Lane in Birmingham is a road that first came into use in the 17th Century. Historically, the end of the road led to a farm and there was a sizeable pond adjacent to it. Over years of development the road and land around it was turned into a modern street with houses on either side. The area where the pond once stood was reclaimed and a block of flats was built. Due to the geology of the ground and the heavy tree-lined area, the flats had become subject to subsidence. Geobear was asked to find a solution.

OBJECTIVES
The block of six flats was sinking into the ground on one side. This led to the entire structure’s integrity being compromised; serious cracking could be seen all around the perimeter of the building so a permanent solution to stop the subsidence was required. Geobear designed a solution that would require treating the ground with geopolymer resins to form a stable base for the property.

TECHNOLOGY APPLIED
In order to achieve these objectives, Geobear utilised a geopolymer resin specifically designed to be used in areas of ground subsidence which would strengthen the soils and prevent further subsidence.

Geobear's expansive geopolymer resins were injected at points beneath 101 linear metres of the structures load bearing walls. Tubes were placed in holes drilled to depths of between 2-3 metres and the resin was injected and expanded underneath the structure, forming a solid base for its future use.

OUTCOME
The work was completed within two weeks. Throughout the course of the project none of the residents needed to leave the property which is a significant benefit of using the ground injection process.

The ground beneath the property was strengthened and the integrity of the structure secured.

REASONS TO CHOOSE GEOBEAR
We perform our work whilst home owners or tenants remain in the property. This saves upheaval and cost of re-homing.
Void filling
Zero Harm
Ground Improvement
Customer First
Structural Support
Re-leveling
Growth
Professionalism
Stabilisation