

# Resin injection ground strengthening historic building



## INDUSTRY

Commercial

## STRUCTURE

Heritage

## PROBLEM

Subsidence

## LOCATION

Chester, UK

## DURATION / YEAR

13 days, 2023

## TECHNOLOGY

Teretek

## BUSINESS UNIT

Mainmark UK

A resin injection ground strengthening system was used to treat ongoing subsidence to a Grade II listed building in the heart of the historic town of Chester. The historic building, formally a branch of the Halifax bank, was built in 1935 and had been suffering from a progressive downward movement, known as subsidence, since 2012. Saint Werburgh Street, where the building is situated, is opposite Chester Cathedral and its existence can be traced back as far as 1745. The street sits over the site of an old sandstone quarry excavated around 500 years ago for a cathedral rebuilding program.

Several reports had been commissioned to investigate the cause of the subsidence and to find an appropriate solution. The investigations linked the subsidence to material instability within the ground used to infill the quarry. Results from probes used during a survey carried out in 2020 showed that between 18 to 20 metres of the ground below the building consisted of poorly consolidated quarry infill. This consisted of granular materials, such as sand, stone and ash, as well as softer cohesive soils in the form of clay or silt. Poor drainage is a likely contributory factor that further undermined the ability of the ground to provide support to the buildings and road above. The road has been sinking for the last 40 years and water run-off from the road surface plus vibrations from passing traffic are likely to have exacerbated the subsidence issues.

## Why was resin injection chosen over traditional underpinning?

Mainmark's Teretek® resin injection solution was chosen over traditional underpinning due to its ability to meet the challenges posed by the listed building's construction and location, along with the vast depth of the ground requiring strengthening. The building comprises of a basement, ground, first and second floor. Traditional underpinning would require piling down to the rock head some 18 metres or more below the building. The base slab of the basement floor would need to be strengthened to transfer the

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loads into the piles and the restricted headroom within the basement would add to the difficulties when using traditional piling equipment.

The old Halifax bank is right next to a busy main road in a historic part of Chester with no off-road parking and the introduction of specialist piling machinery to underpin the building would have a significant disruptive effect on traffic flow and local businesses.

Using the Teretek® resin injection system consolidated the infill soil and filled any voids present to strengthen the ground. This process caused minimal disruption and removed the need to separately strengthen the basement floor. All resin injection was done from within the ground floor and basement areas of the building despite the limited access and headroom available. The geopolymer expanding polyurethane resin was injected at appropriate depths across selected areas of the site to strengthen the ground so it would bear the weight of the building.

## How does the resin injection process tailor itself to tackle historic buildings?

The Teretek resin injection is an effective alternative to traditional underpinning that allows a precise and engineered approach to be taken on all projects, including those involving historic and listed buildings. Mainmark worked closely with the client to come up with a detailed project plan. This was helpful in addressing all concerns around access to the site and disruption to the building. Mainmark provided a detailed plan of work to strengthen the ground using controlled geopolymer injection technology that was required in each section of the building to stop further subsidence.

To ensure that the soils underlying the building were treated appropriately, Mainmark undertook a survey and penetrometer testing to validate the previous reports and investigations. In doing this we were able to reduce the depths of treatment in some areas from 12 to 8 metres, ensuring the most cost-effective solution for the client.

The work to stabilise the ground using resin injection

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consisted of drilling a series of 40mm diameter holes, around 1m deep, through the solid concrete slab across the building in a grid pattern around 1.5m apart. This enabled the whole site below the building to be treated as a homogenous mass to support the existing floors and any foundations beneath perimeter and separating walls.

Several metal tubes, 1m in length, were placed in each hole and vibrated into positions to the required depth in each location. The metal tubes were then extracted and replaced with 1m long injection tubes. The required amount of resin was injected through the injection tubes, starting with the deepest tube first. This tube was then extracted, and the process repeated with another injection tube 1m nearer to the surface, until the ground had been strengthened to the required depth and amount in that location. This was repeated at the other holes until the entire grid had been treated and the ground under the site had been strengthened by the expanding resin.

The whole ground strengthening process was carried out with minimal disruption over just 14 days and, although it was not a requirement of the project, it did achieve lift in the building in some areas, to the benefit of the structure.

## What reassurance is available for clients when using resin injection to stop subsidence?

The controlled process of resin injection to strengthen ground beneath the building was validated by post-treatment penetrometer tests carried out by Mainmark. These tests gave reassurance to the client that the ground in each area had been strengthened to the required bearing capacity. For further peace of mind, the project was backed by Mainmark's 20-year materials and workmanship warranty plus an additional 10-year insurance-approved guarantee.

If you would like to see how the non-intrusive Teretek® resin injection technology could help solve a subsidence challenge on your project, please get in touch with our technical team who will be happy to help.