Stabilizacija betonskega vozišča strateško pomembne ceste z injektiranjem raztezne geopolimerne smole. Primer iz Velike Britanije

Astrid CORBATTO, mag. inž. geotehnol.
Alberto PASQUETTO, mag. inž. grad.
Uretek d.o.o.

Povzetek

Northumberland Avenue v mestu Reading v Veliki Britaniji je zelo obremenjena dvosmerna strateško pomembna cestna povezava. Cesta je skozi čas utrpela številne poškodbe. Zlasti v zadnjih dvajsetih letih so se na betonskem vozišču, zaradi vedno večjega števila težkih vozil, pojavile udarne jame in korozija betona. Vozišče je bilo hudo poškodovano tudi zaradi neugodnih pogojev zemljine ter neprimernega vgrajevanja različnih vodov in kanalizacije. Pojavili so se vse večji diferencialni posedki vozišča. Razpoke so se iz globljih slojev razširile vse do obrambne plasti voziščne konstrukcije. Mestna uprava je za strateško pomembno cesto iskala dolgoročno rešitev, pri tem pa so se želeli izogniti rekonstrukciji, ki bi bila draga in zamudna. Na celotnem odseku so bile izvedene geofizikalne raziskave z georadarjem s ciljem ugotavljanja prisotnosti anomalij pod voziščno konstrukcijo. Investitor se je na podlagi raziskav odločil, da sanacijo izvede z injektiranjem razteznih poliuretanskih smol v cestno telo. Poseg je omogočil zapolnitev praznin in utrditev obodne zemljine ob konstrukcijskih elementih vozišča.

Abstract

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 - so Reading Borough Council put plans in place to make the necessary repairs. 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, so wanted a longer term solution without the need to reconstruct the road at considerable delay and cost on a strategic route. A Ground Radar survey was commissioned in order to determine anomalies that may be detrimental to road stability. Based on the results of a survey it was decided to subsurface to inject geopolymer resins that expand. The treatment allowed to fill voids and mix with the existing elements to harden forming a solid base under the concrete.

1 Introduction

The damage to the integrity of the concrete has over the years allowed water to leach through and dissolve the materials below. Some movement of the slabs due to failed tie bars has compressed the materials below, then the slabs have moved back into place, and voids have formed so that the concrete is bridging probable long shallow voids. This bridging has at times caused the concrete to crack with the result that potholes have formed on the road surface. Subsequent repair work on the pot holes has not addressed the underlying causes and further problems have continued to occur. The road was scheduled for extensive resurfacing work and to prevent damage to this resurfacing it was decided to carry out some preventative measures in order to prolong the life expectancy of the road surface. The council approached the expanding geopolymer resins treatment to look at viability of treating the ground beneath the concrete.

Figure 1: Northumberland Avenue - Reading, UK; location of the treatment and of the Ground Penetrating Radar Survey.

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.

2 Technology applied and working time

The technical team drilled through the road and subsurface to inject geopolymer resins that expand to fill voids and mix with the existing elements to harden forming a solid base under the concrete. Different resin compositions are used depending on soil condition and vary in terms of expansive force and the time it takes to harden. 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. 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. The stretch of road in Reading took the project of technical team two weeks to complete and a contractor was subsequently employed to resurface the treated sections.

Table 1: Remediation treatment summary table.

SUMMARY
Category…….…….....STABILISATION
Focus……...…….…..….....ROAD
Location……..…….……READING, UK
Duration…….…….……..2 WEEKS
Technology….....GEOPOLYMER RESINS

3 Ground radar survey

A Ground Radar survey was commissioned. To seek to determine anomalies that may be detrimental to road stability. The GPR survey was to be conducted to determine the location of anomalies that may prove detrimental to the long term stability of the road. The GPR survey base line was established at the North side of the Canterbury Road Junction with Northumberland Avenue and five scan lines were carried out at approximately 1m separation along Northumberland Avenue to the Long Barn

Lane junction. All data scans terminate at the South end of this section of Northumberland Avenue. Cross scan lines were carried out at intervals along the Avenue to verify probable utilities etc., running along the avenue. The long scan data lines were processed and incorporated into a 3d software program which highlighted the range of anomalies both near-surface and to a depth of around 6.5 m.

Figure 2: Survey base line on the North side of the Canterbury road junction: the end line is the junction of Northumberland Ave and the junction of Long Barn Lane. This section of Northumberland Avenue is carries a cross section of traffic from regular bus services to delivery vehicles, cars and some HGV movements (Radar Team, 2014).

The GPR data was processed, analysed and interpreted after the survey. The data was then uploaded into a 3d software program that was set to show the layers and the length and breadth of the interpreted anomalies. Volumising was used in the 3d software to fill the gaps between the respective scan lines. Volumising was 50% of the surveyed area on a 6m wide road (kerb to kerb). The survey base line was the South side of the Canterbury Road junction.

3.1 Results of the GPR survey

The conductivity figure has been amended to give the correct depth of sewer. These data extracts are from a 390 m scan along the road C/L with data interpretation annotated. In the figure 3 is shown the data related to the area from 200 to 300 m. Problems clearly exist below the surface, due to poorly reinstated and leaking utility trenches, sewer laterals and sewer itself. The figure 3 and 4 shows utilities that run along the road.
After interpreting the long scan lines and the cross scan lines the data were incorporated into the 3d processing software. The criteria was areas of voiding and ground movement. Areas of voiding varying in size below the road deck slabs were annotated as dark and became lighter as the void size (depth) decreased. Less dark areas are where ground movement is interpreted that could lead to problems down the line.
The figure 5 is the start of the building a 3d and this is a plan view of the anomaly patterns. The darker areas are interpreted as requiring urgent remedial work to stabilize the road and prevent further break up. This

is however only the near surface problems down to around 1m depth. In the figure 6 there is the west elevation which shows the depth and extents of the remedial works required. The three views in figure 8 are from the 3d elevations and show that down to around 4m there are problems.

From the South Base line to 190 m North along the road required urgent action the width of the road. Then from 234 m to 294 m required urgent attention across half of the width. Finally action was required from 314 m to 390 m. The depth of injection should average 3.5 m to ensure good compaction above and below that point without compromising the sewer. Water leaking from utilities and trenches is exacerbating the stability problems below the slabs. The recommendation was that resin be injected to 2.5m depth and continue during rod extraction.

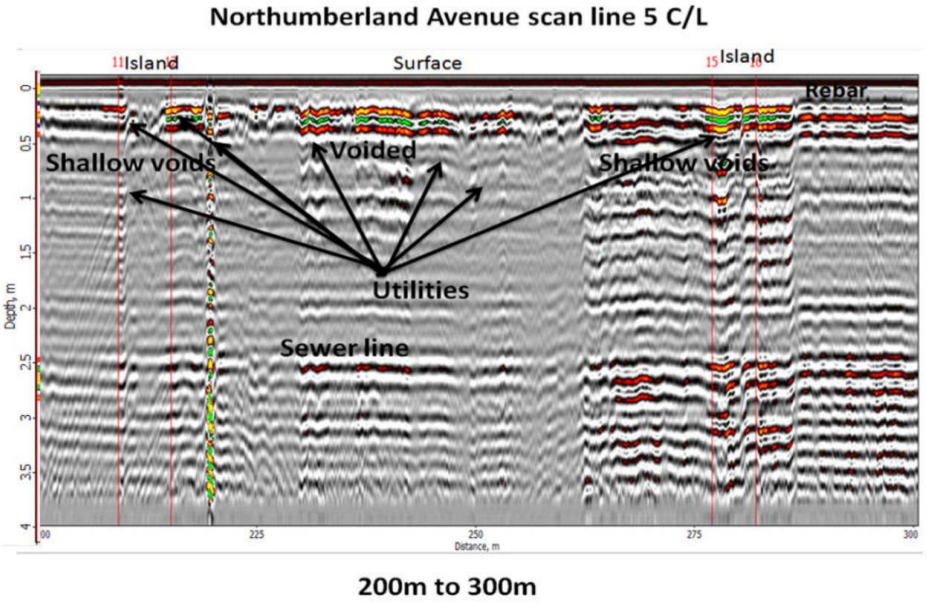

Figure 3: Processed data from Scan line 6 across Northumberland Avenue at the South end (from 200 m to 300 m); x-Distance (m): y-Depth (m) (Radar Team, 2014).

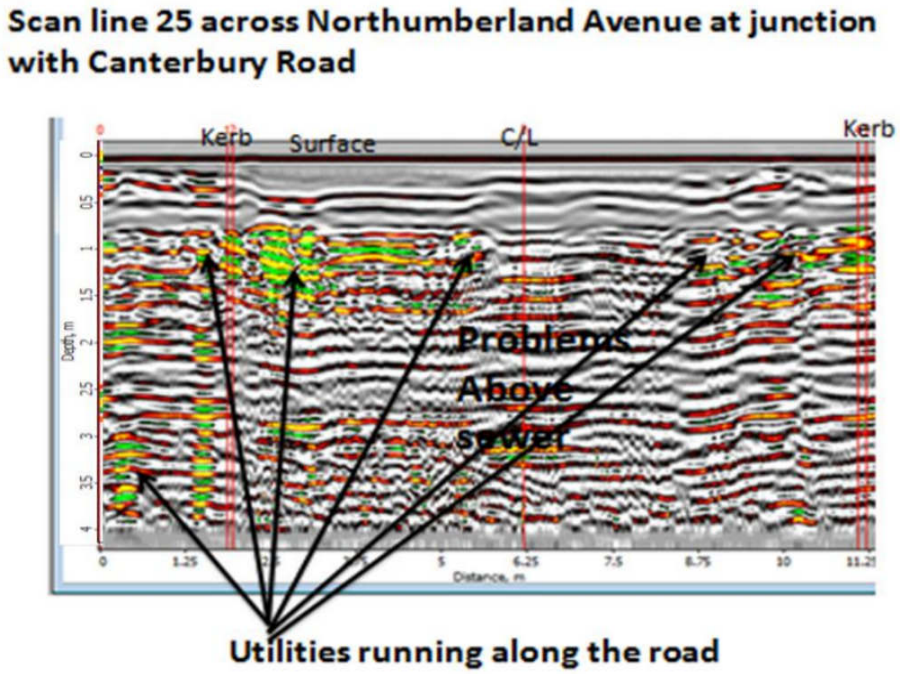

Figure 4: Utilities that run along the road. x-Distance (m): y-Depth (m) (Radar Team, 2014).

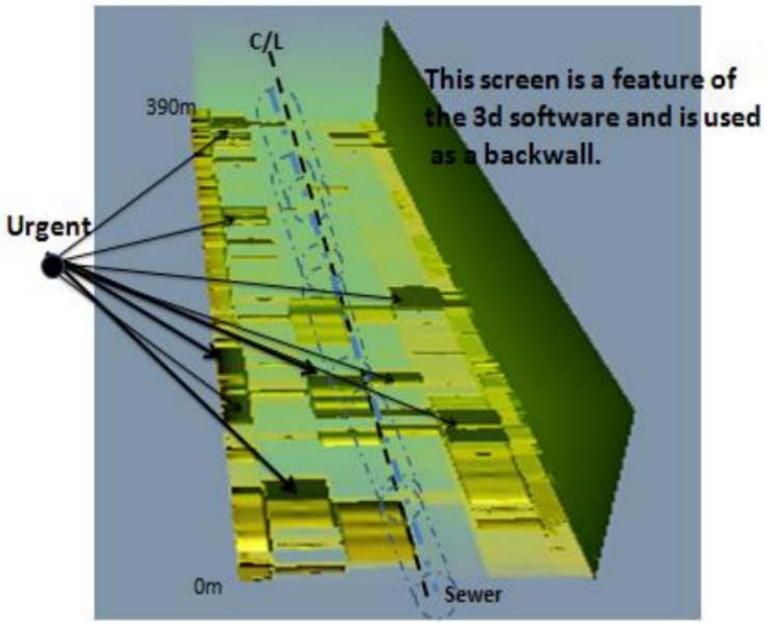

Figure 5: 3d data analysis of the 390 m scan along the road C/L - plan view of the anomaly patterns till 1 m depth (Radar Team, 2014).

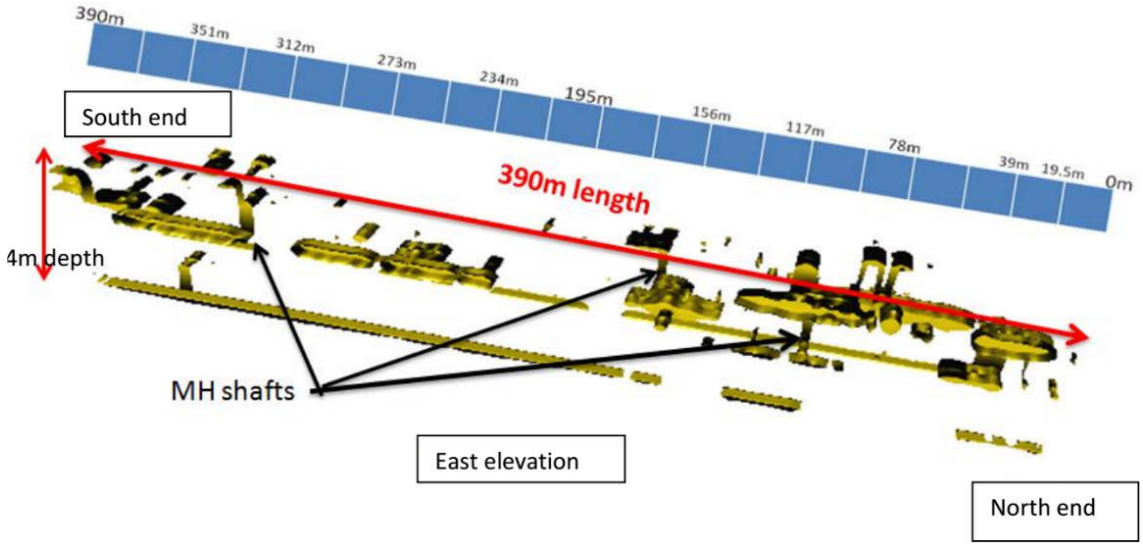

Figure 6: 3d data analysis of the 390 m scan along the road C/L - plan view of the anomaly patterns till 4 m depth (Radar Team, 2014).

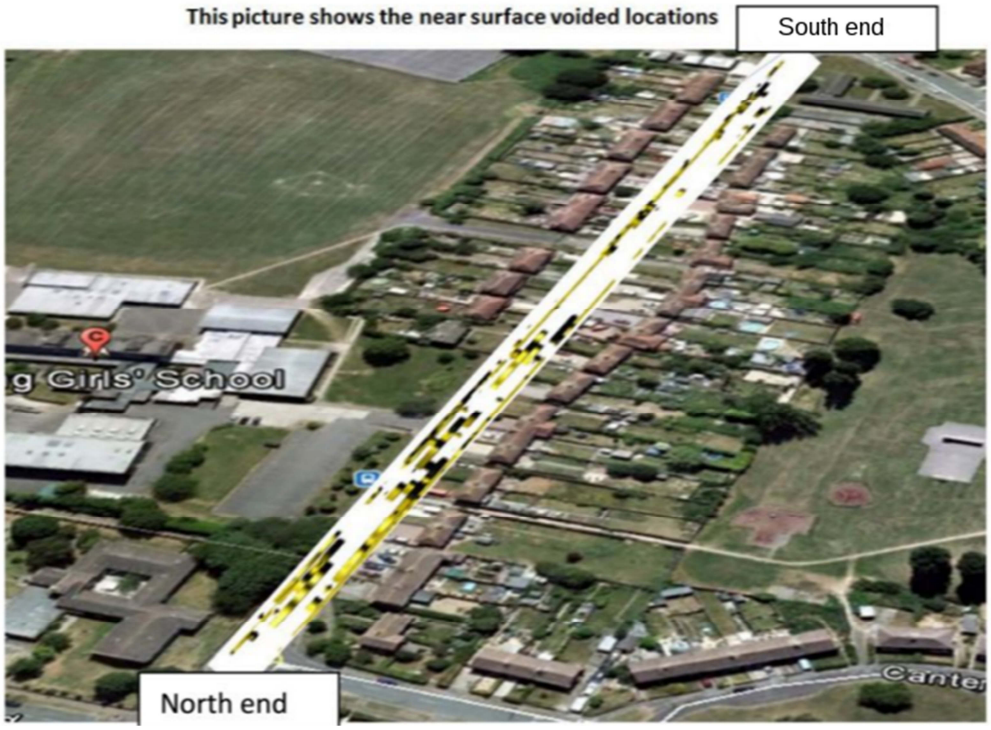

Figure 7: Near surface voided locations - high view on the surveyed area (Radar Team, 2014).

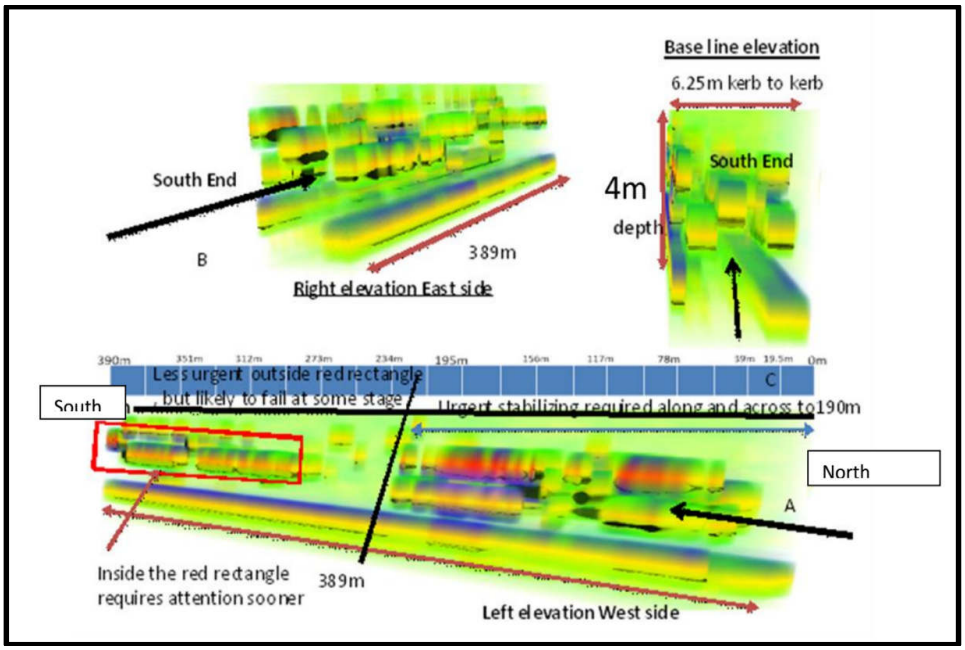

Figure 8: 3d data analysis of elevations of the 390 m scan along the road C/L - east, west and baseline elevation (Radar Team, 2014).

From the South Base line to 190 m North along the road required urgent action the width of the road. Then from 234 m to 294 m required urgent attention across half of the width. Finally action was required from 314 m to 390 m. The depth of injection should average 3.5 m to ensure good compaction above and below that point without compromising the sewer. Water leaking from utilities and trenches is exacerbating the stability problems below the slabs. The recommendation was that resin be injected to 2.5m depth and continue during rod extraction.

6 Conclusions

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. The council chose the expanding geopolymer resins treatment to look at viability of treating the ground beneath the concrete. The technical team has worked with the council on a number of schemes and the methods have consistently worked.

Bibliography

Radar Team working with Uretek UK LTD; GROUND PENETRATING RADAR SURVEY RESULTS; Along Northumberland Avenue Reading FOR Reading Borough Counci. Date of survey 27th October 2014.

Uretek UK LTD, 2016, Road stabilisation using resin injection. [online]. 28 Jan 2016. [accessed 1 June 2016]. Available from: https://www.youtube.com/watch?v=oxyk2Dv-mEU