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## M74 Completion Project

### Old Coal Workings in Glasgow

#### Client

Glasgow City Council

#### Main Contractor

Interlink M74 JV

#### Consulting Engineer

Jacobs Atkins Design JV

#### Scope of Works

##### Consolidation Works:

- 678,867 linear metres drilled
- 16,484nr boreholes drilled
- 44,790t grout injected

##### Shaft Works:

- 4nr shafts grouted to completion
- 5nr shafts probed – subsequently not requiring grouting due to no influence on carriageway.



Cementation Skanska was involved in a significant ground engineering stabilisation scheme for Interlink M74 JV at the M74 Motorway Completion Project in Glasgow. The M74 Completion Project requires the construction of 8km of road which will continue the M74 motorway from Fullarton Road Junction to the M8 motorway west of the Kingston Bridge. The works also form part of the Clyde Gateway regeneration project which is one of the largest urban regeneration projects in Europe.

The project involves the construction of twelve significant bridges, including a bridge over the River Clyde and a 12-span 700-metre long steel composite launched bridge across the West Coast Main Line – the UK's busiest railway line. Also included in the development are major brownfield site remediation and ground improvements. These take the form of old coal mine workings consolidation, large diameter piling and the provision of intelligent transport systems – all in a constrained urban site.

The site is located in a derelict industrial area, with the nearest residential housing lying some 400m from the site. Sections of the proposed road are underlain by old coal mine workings which will require consolidation prior to construction of the new M74 motorway. Covering a combined area of some 203,000m<sup>2</sup>, the consolidation contract is restricted to and situated between the Fullarton Road Junction and the new Cambuslang Road Junction. Previous investigation at the site had identified the presence of former abandoned mine workings in the Glasgow Upper Coal seams as well as the underlying Ell, Main, Humph, Splint and Virgin Coal seams at greater depth.

The treatment of the old abandoned mine workings involved the drilling of 76.1mm diameter holes, both vertical and inclined, to the worked seam and the subsequent injection of a designed mix of pulverised fuel ash (PFA) and cement grout.

## Ground Conditions

The site is underlain by made-ground, with a total thickness in the range of 15m to 35m. The superficial natural soil deposits comprise thick beds of soft compressible clays and weak silts with intermediate layers of sands and gravel of the Clyde Alluvial sequence. The soil units present are well known within the Glasgow area and are a remnant of post-glacial conditions as the Clyde Basin passed from a marine phase, when it was inundated by the Clyde Sea Loch, through brackish conditions to freshwater as the ground surface rebounded following retreat of the ice sheet. The lower weak silt and fine sand deposits represent the marine phase, intermediate soft and firm clays comprise the brackish period, and the sand and gravels the late freshwater phase.

The drift overlies strata of the Middle Coal Measures which dip towards the south and south west. The geological maps confirmed the presence of shallow mine workings within 30m of rockhead in the Glasgow Upper Coal Seam.

As the site lies within the lower reaches of the Clyde Basin there are significant sub-artesian and sometimes artesian pressures within the bedrock which are often experienced when boreholes intersect bedrock. The presence of historical mining has acted to complicate the deep groundwater regime. Where previously there would have been mudstone or coal aquacludes these have been removed or bypassed by mining activities. The creation of drifts and shafts between and within workings has allowed for a connectivity of groundwater which did not previously exist.

In the past, there have previously been issues within this area with leaking artesian boreholes leading to piping of the weak alluvial sequence and subsequent subsidence at ground surface.

Up to nine abandoned mine shafts were also conjectured to lie beneath or immediately adjacent to the scheme. Four of the nine were stabilised following a detailed probing exercise, the remaining five were not treated as they were either outside the design zone of influence of the future road or had been previously stabilised.

The treatment of the old abandoned mine workings involved the drilling of over 16,000 boreholes,



Design route of the M74 link

both vertical and inclined, to the worked seam and the subsequent injection of a designed mix of 1:10 cement and pulverised fuel ash (PFA) grout. The total drilling depth was in the order of 675,000m with the average depth of each borehole being approximately 45m. The boreholes were drilled into the pavement of the old workings, including casing through overburden. The average depth to rock was in the region of 15m to 40m.

Almost 45,000 tonnes of the designed mix of pulverised fuel ash (PFA) and cement grout has been injected under pressure into the Upper Coal Seam. Grout injection to the boreholes is carried out until grout reaches the surface and is then pressurised as specified. Most importantly a verified, quality-assured programme of validation testing was rigorously applied, to confirm that grout flows and consolidation of the treated area met the specification in terms of design treatment.

## Summary

In association with our joint venture partner, up to 18nr rigs and 3nr site batch/mixer units were well managed and utilised leading to the works being successfully completed in 39 weeks, ahead of the agreed programme.

Our construction team overcame the many challenges presented by this project and provided the complete geotechnical solution using the company's wealth of ground engineering and design experience.