CASE STUDY: King Sheet Piling (KSP®)
A421 Improvements Junction 13 to Bedford - Marston Pumping Station

CONTRACT INFORMATION:

Sector type: *Infrastructure – roads*

Location: Midlands

Client: Highways Agency

Principal Designer: URS (Formerly Scott Wilson)

Principal Contractor: Balfour Beatty

Contract Value: £201M

THE PROJECT:

The A421 Improvements Scheme was the construction of 13.5 km of new dual carriageway, predominately green field. This ECI scheme was constructed between October 2008 and December 2010.

A large pumping station at Marston Junction, located at the bottom of a 7m cut with the East bound on slip immediately adjacent, was on the critical path for the project. It sat directly over a natural aquifer that created artificially high pore water pressures in the surrounding ground and potential base heave. This aspect was dealt with by the installation of vertical drains for the permanent solution. An alternative solution to the use of a contiguous piled wall that served both a temporary and permanent works function had to be found to save the project over-running by some 10 weeks.

THE BENEFITS:

The innovative KSP retaining wall system was adopted and incorporated in a re-design of the pumping station permanent works, saving £880,000 in direct costs and avoiding a 10 week programme over-run. Total cost saving to the Client was £2.7M and embedded carbon was reduced by 905 tonnes of CO_2e.

Propped KSP Walls

(Location of pumping station shown above)

THE PROCESS: Use of the KSP Sheet Piling System (GB2463079; Other Patents Pending)

Solutions for support of the East bound slip road developed at Target cost stage were a contiguous piled wall, an anchored sheet piled wall and soil nails. An anchored sheet piled wall was chosen, with the pumping station designed as a reinforced concrete structure.

By the time the scheme entered Phase 2, detailed design and construction, additional Ground investigation undertaken between agreeing the Target cost and commencement of detailed design had highlighted issues with high pore water pressures, base heave and high SPT N values which meant driveability of sheet piling was an issue. Dewatering and positive support to the sides of the pumping station excavation were deemed essential to manage the risk of base heave and overall instability of the excavation.

The final solution chosen was the construction of a conventional secant pile cofferdam around the pumping station and the use of soil nails to support the East bound on slip. The cofferdam piles were also needed to preclude a long-term failure of the cut slope passing beneath the pumping station. At this stage the Pumping station still remained a RC structure.

At this point the alternative of using KSP to minimise the risk of driveability was proposed to the project team, with the suggestion that the KSP walls be integrated into the permanent structure, removing the need to build RC walls to the Pumping station structure.

This option was explored with the Scheme's designers and the final solution chosen utilised KSP and integrated the two solutions.

Advantages

- Minimised the risk of sheet pile driveability refusal
- Avoided time-consuming and costly secant pile walls with a high embedded carbon content
- Removed the construction of RC walls
- Removed the need to extract the piles.
- Substantially speeded up the construction.
- Reduced the CO_2e construction footprint by 90%.

Method	Cost	CO2	Time	Comment
Contiguous Wall	£1m	1000t	12 weeks	TC Option
Sheet + RC	£300k	400t	10 Weeks	1st iteration
KSP + RC	£200k	155t	8 weeks	2nd iteration
KSP	£120k	95t	2 weeks	Final Option

KEY LEARNING POINTS / BEST PRACTICE

The ease with which KSP walls can be installed in hard ground opens up the potential for their use in a wide range of permanent works applications, saving cost and programme time as well as delivering substantial sustainability benefits through reduced embedded carbon.