CASE STUDY: King Sheet Piling (KSP®)
M4/M5 Managed Motorway

CONTRACT INFORMATION:

Sector type: *Infrastructure – roads*

Location: South West

Client: Highways Agency

Principal Designer: Atkins

Principal Contractor: Balfour Beatty

Contract Value: £89M

THE PROJECT:

The M4/M5 is a major crossroads which provides a strategic link between London, Wales, the South West and the Midlands, carrying over 140,000 vehicles per day. The motorway serves a vital part of the local and regional transport infrastructure. Sensors in the road will enable traffic and congestion to be detected. The speed and availability of lanes will then be managed via information signs to allow traffic to flow smoothly, helping to reduce congestion.

The scheme involves the installation of 32 super-span gantries between junctions 19-20 of the M4 and junctions 15-17 of the M5. These will house 196 electronic signs which will be used to inform drivers of the speed limit and lane use during peak traffic periods.

THE BENEFITS:

The use of the KSP retaining wall system allowed a change to a form of construction that simplified the construction process, substantially increased the safety of the workforce and minimised the removal of valued vegetation barriers that screen nearby residential communities. A conventional sheet pile retaining wall would not have been feasible in these locations because of the hard nature of the ground. The dramatic reduction of clutch friction between piles, a key feature of the KSP system, made a KSP wall possible in these conditions.

The change from gabions to KSP Piling was undertaken for the following benefits:

- Reduced risks to the safety of the workforce
- Reduced frequency of access and egress from the live traffic into the works
- Elimination of delivery and double handling (limited storage facility) of gabion stone within a restricted work area
- Reduced plant people interface risks associated with gabion construction
- Reduced spoil removal from site and the associated movements within a restricted working space alongside the live traffic
- Increased KSP productivity compared to gabions, a 140m long, 2.2m high KSP wall would take approx three weeks to construct (allowing for pre-augering) compared to eight to ten weeks for Gabions
- Substantial reduction in vegetation clearance required extremely close to nearby residents
- Reduced risk associated with weather conditions
- Reduced embedded carbon compared to a gabion solution

THE PROCESS: Use of the KSP Sheet Piling System (Patent Pending)

The M4/M5 Managed Motorway scheme requires the construction of numerous retaining walls to accommodate new overhead sign gantry sites and emergency refuge lay-bys. The retained height varies from one to three metres and the ground conditions consist predominately of fractured very weak to moderately strong mudstone, the stronger bands generally being more calcareous.

Construction works will take place within the confines of the hard shoulder only, resulting in a very narrow working environment. The control of people and plant interface is therefore vital in minimising associated risks. Initially, sheet pile retaining walls were considered an attractive solution because of their low construction footprint and hence reduced risk to safety, as well as their reduced impact on existing vegetation barriers. They were rejected because of the perceived impracticality of driving sheet piles into the weak rock with thin stronger rock layers. The preferred alternative, gabion walls, meant the loss of much vegetation and the exposure of the workforce to more risky operations adjacent to live traffic. A gabion solution also represented a logistical nightmare as traffic flow had to be maintained whilst also catering for the supply and stockpiling of materials and the removal of excavated spoil.

Due to the perseverance of the project's Engineering Manager, KSP retaining walls were examined further as a means of achieving the desired safety and environmental benefits.

During the initial stages of the design phase, on-site trials were undertaken to demonstrate that the KSP sheet pile system could be installed within the anticipated hard ground conditions utilising a planned pre-augering sequence. The trials were carried out with the assistance of the sheet piling supplier, ArcelorMittal, who supplied on loan the piles for the trial. Crucially, the limited intermediate pile lengths of the KSP pile system minimised the clutch friction between piles and rendered feasible the installation of sheet piled walls in the hard ground.

Following the successful outcome of the trials, the outline gabion wall designs within cuttings were changed to a KSP solution. The extra length of piles required at fill locations and the additional temporary works required for platforms to install the sheet piles led to the retention of the gabion wall solutions at fill locations. In cuttings, 10 retaining walls, with a total length of 550m, were converted to KSP piling. The installation cost comparison between Gabions and KSP was approximately cost neutral. A conventional sheet pile wall would not have been viable financially and installation would not have been feasible in the hard ground due to the additional clutch friction.

Following adoption of the KSP solution, further significant cost savings and sustainability benefits were realised by utilising surplus sheet piles from the completed M25 DBFO contract.

KEY LEARNING POINTS / BEST PRACTICE

The minimal clutch friction between sheet piles, inherent in the KSP retaining wall system, renders sheet pile walls feasible in a much wider range of ground conditions than previously considered possible. The logistical, environmental and safety benefits of sheet piling for motorway widening projects undertaken from the hard shoulder are considerable.