

**COMPANY OVERVIEW**



COMPANY WEBSITE  
www.graham.co.uk

The company works on building, civil engineering, and fit-out projects for both public and private sector clients across the UK and Ireland and is currently delivering more than 100 projects. GRAHAM has offices in Dublin, Belfast, London, Edinburgh, Glasgow, Manchester, Leeds, Birmingham, Hillsborough, Aberdeen, Dumfries, Durham, Cambridge, St Albans, and Bristol. To align with our guiding principle of “delivering lasting

impact”, along with our culture of finding a better way we are focused on improving productivity, reducing error and embracing modern methods of construction to create a business which has a positive influence on the planet. We have delivered a number of iconic projects in Ireland including the Samuel Beckett bridge over the River Liffey in Dublin. GRAHAM currently employ over 2000 employees across the business.

**OVERVIEW & BACKGROUND TO THE LEAN INITIATIVE**

**AUTHORS**



Katie Jones



Luke Kolakowski

GRAHAM’s *Travis Brow Link Road* project has been described by Tim Lawton, TCAP Project Director, as “probably the single most important new strategic highways connection in Stockport”. Awarded through Highways England’s Collaborative Delivery Framework, this GBP£8Million project has delivered a new 400-metre long link road including retaining walls supporting the Grade II listed Stockport Viaduct dating back to the 1840s that carries the West Coast railway line.

*Year Award* which stood out due to GRAHAM’s intelligent design solution enabling a two-lane dual-carriageway to be formed through a single arch, and significantly improved access to and around Stockport, to the M60, the railway station, and to key sites within the town centre. It includes a series of highway improvement works along Travis Brow, George’s Road, and Wellington Road North. This Project’s major works included road cutting up to 12m deep with various geotechnical structures including soil nailed 1V:1H slopes, concrete gravity retaining walls, cantilevered and anchored contiguous piled walls to 8m in height, and pre-stressed rock anchors.



**Figure 1. Project Scheme**

The project received the CIHT (Chartered Institution of Highways and Transportation) *Northwest Project of the*

The soil nailing became a critical path activity due to dependencies on other contractors’ ability to mobilise and start work on time or early within their retrospective sections. Lean work studies were conducted to improve the productivity of soil nailing which projected the programme and provided further efficiencies.

**LEAN INITIATIVE UNDERTAKEN – LEAN THINKING, TOOLS, TECHNIQUES**

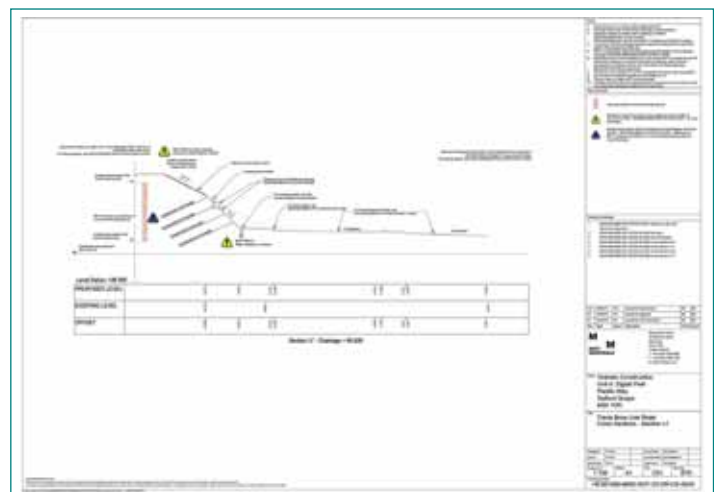
Soil nailing is an efficient construction solution to prevent horizontal movement in unstable soil slopes and retain earth that will steepened. The technique utilises hollow bars which are drilled and grouted simultaneously by the use of a sacrificial drill bit and by pumping grout down the hollow bar as drilling progresses.

*Equipment Used*

The equipment used was a drilling rig excavator mounted feedbeam and telehandler used to deliver the soil nails to the works area. The Travis Brow soil nailing design consists of 555 soil nails varying from 3m to 7m in length. The maximum height from ground level is 6m.

*Lean Methodology*

The Lean soil nailing work study followed the DMAIC



**Figure 2. Drawing of Soil Nailing Requirements**

(Define, Measure, Analyse, Improve, Control) methodology in Lean.

**Define** – The define stage of DMAIC established opportunities for improvement, current problems, and the main aims and objectives of the process. We defined that, at a critical phase in the scheme programme, the soil nailing was affecting other contractors mobilising and starting work on their respective works. The goal was to improve production from original planned average of 23 soil nails per day to an average of 30 soil nails per day to deliver programme benefits for other work activities.

- **Stakeholders & Benefits** – The customers of the process included the principal contractor, sub-contractor, and client. For Lean to be successful, all parties need to see the value and benefit of the initiative. As principal contractor, GRAHAM sought to improve the programme that allows the next dependencies to start earlier, protecting the programme, promoting success, and enhancing the reputation of the project. Additionally, the Sub-Contractor, Aarsleff, had the opportunity to develop a more efficient process to replicate on other schemes. Due to their sub-contract being a lumpsum, financial incentives were negotiated for delivering a certain rate of productivity. Removing waste from repetitive work also allowed Aarsleff to move on to the next project much sooner. Finally, the client gained confidence that the programme would be delivered on time or earlier.
- **Deliverables** – The deliverables of the project were: live footage of the process in action; data collection sheets; KPIs; a new best practice process and standard operating procedure for the sub-contractor.
- **Measures of Success** – The Lean Team measured their success by reducing planned programme, maintaining zero incidents, and developing increased sub-contractor engagement from both management and operatives.

**Measure** – The measure phase entailed data collecting to provide real evidence of production and performance.

- **Data Collection** – Data collection sheets were developed for the gangs to collect the respective output rates.

COMPANY: GRAHAM		DATE: 06/04/18		WORK STUDY SHEET					
PROJECT: Travis Show		OBSERVER: Luke Kulkowski							
OPERATION: Soil Nailing									
No.	Activity / Element	Activity Time (min)	Current Time (min)	Time Analysis	Improvement Idea	Estimated Time Saving			
1	Drilling soil nail	01	00:45	01					
2	Connecting MEWP	01	00:45	01	MEWP overloaded, check SWL prior to use	01			
3	Moving MEWP into position	02	00:45	02	Reposition to guide MEWP closer				
4	Connecting second bar	01	00:45	01					
5	Drilling soil nail	01	00:45	01					
6	Drilling soil nail	01	00:45	01	Note - used to extract for the next soil nail				
7	Setup for the next bar	01	00:45	01	Note - used soil directly used to previously installed				
8									
9									
10									
TOTAL:		06	01:11	06			TOTAL SAVING: 01		
		%	78.6%	4.2%	21.7%		% IMPROVEMENT: 16.8%		

Figure 3. Data Collection Sheet for Production Rates

From these data collection sheets, the ‘as is’ data was collected for week 1 to understand planned versus actual output rated of the soil nailing activity (see Table 1).

Table 1. Production Rates Prior to Lean Analysis

Soil Nailing – Week 1 Data Collection				
Date	Soil Nails Drilled (Planned)	Soil Nails Drilled (Actual)	Number of Operatives	Process Efficiency (Actual/Planned*100)
05/11/18	0	0	4	0
06/11/18	20	0	6	0
07/11/18	25	21	5	84%
08/11/18	25	30	5	120%
09/11/18	20	19	5	95%

- **Gemba** – This is the Japanese word, made popular by Toyota, for visiting the place of work and productivity. During the Gemba visit the process was documented, photographs were taken, and the activity was filmed. During the go-look-and-see activity, a typical working day was documented as follows:
  - o 07:30 – 08:00: Arrive on site & briefing
  - o 08:00 – 08:30: Set up plant, prime lines, load out materials
  - o 08:30 – 09:30: Installing soil nails
  - o 09:30 – 09:45: Wash out grout plant ready for break
  - o 10:00 – 10:30: Break
  - o 10:30 – 11:00: Set up plant, prime lines, load out materials
  - o 11:00 – 12:30: Installing soil nails
  - o 12:30 – 12:45: Wash out grout plant ready for lunch
  - o 13:00 – 13:30: Lunch
  - o Repeat above until finish at 16:00
  - o Week 1 average installation = 23 nails per day

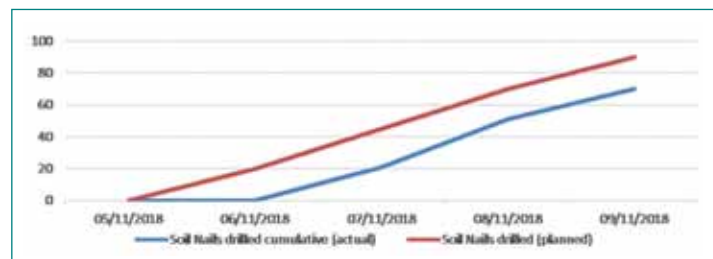


Figure 4. Soil Nailing Tracker Week 1

**Analyse** – During the analyse phase, a number of graphs were produced. The below shows the cumulative actual versus planned. We knew from calculating the process efficiency that we were more often than not losing 10% on wasteful activity. It was found that 1 cycle was 5-minutes 23-seconds and that there were no real improvements within the cycle other than Mobile Elevating Work Platform (MEWP) was initially overloaded which could have saved approx. 40-seconds. This meant the slow productivity for the day was elsewhere outside the actual value adding activity, that is the drilling installation. In order to understand where the missing productivity had gone, the team looked to understand the root causes of the waste. It was found that the root cause of delays included:

- **Soil Nailing Materials** were stored approximately 300m away from work area.

- Access to the work area was single traffic only which meant other activities working nearby delayed material delivery.
- Gangs were not working together, the MEWP operator un-

wrapped plastic around soil nails and placed the nails in the basket himself. This sometimes took as long as 10-minutes to load whilst the drilling rig was idle waiting.

## LEAN INITIATIVE IMPROVEMENTS & IMPACT

**Improve** – An improvement workshop was held and a number of improvement ideas were suggested, including:

- GRAHAM could assist loading out material at the end of each shift by staying later so the sub-contractor was prepped in the morning.
- Other less critical activities were stopped and moved to other sections of the site to remove delays during material deliveries.
- The washing out of grout plant at break times was stopped and moved to only lunch and end of shift.
- Telehandler driver assisted with loading MEWP and placed nails closer to working area so less carrying by hand.

The improvements were implemented and tracked using a continuation of data collection recording planned versus actual output rates. This enabled the team to understand and control the effects of the improvements.

**Control** – From direct observations following implementation of improvements, there were two nights where the grout plant broke down due to not being washed out correctly which resulted in the gang only installing 10 nails in 2 days. The drilling could have been completed much quicker. The findings, once the improvements were implemented and reviewed, were an improvement from 23 nail installations per day during week one to an average of 34 installations per day in weeks 2-4. Figure 5 illustrates the gradual increase in improvement, with the maximum number achieved being 50 soil nails per day. The average was 34 per day, which meant that this programme provided a significant improvement.

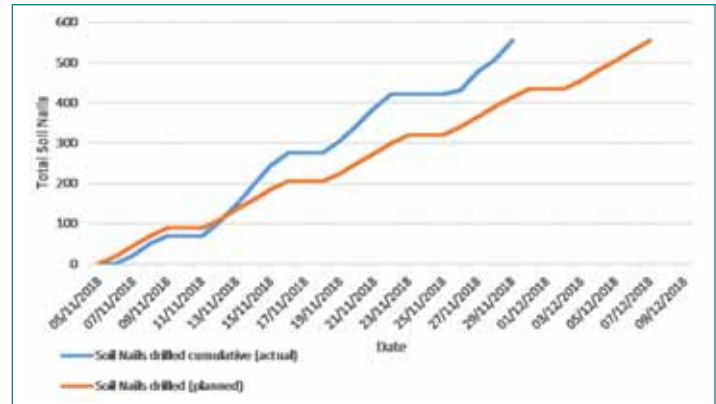


Figure 5. Soil Nailing Progress Tracker

### Benefits from Lean Deployment

The deployment of Lean on the project resulted in many benefits, including improved engagement and collaboration amongst the team. This enabled smoother and more efficient working towards an aligned goal which was to beat the existing programme. The benefits from deployment of Lean included:

- There were zero incidents during this project.
- The client was delighted with the programme improvements.
- The Lean initiative contributed to winning the CIHT *Northwest Project of the Year Award* – a great achievement and recognition for the whole project team.
- GRAHAM has benefitted reputationally with this success, thus contributing to winning more work.
- The sub-contractor exceeded targets and was rewarded through financial incentives and now has a new best practice process to work towards on its next projects.

