Proceedings of the XVIII ECSMGE 2024
GEOTECHNICAL ENGINEERING CHALLENGES
TO MEET CURRENT AND EMERGING NEEDS OF SOCIETY

ISBN 978-1-032-54816-6
DOI 10.1201/9781003431749-394

ECSMGE 24
XVIII EUROPEAN CONFERENCE ON SOIL MECHANICS AND GEOTECHNICAL ENGINEERING

Activating decarbonisation in the piling supply chain

Activer la décarbonation dans la chaîne d'approvisionnement des pieux

C.A. Barker*
Arup, London, United Kingdom

J. Ly
Canary Wharf Group, London, United Kingdom

**chris.barker@arup.com*

ABSTRACT: Strategies to reduce embodied carbon for new developments have to date mostly been focused on the carbon emissions hierarchy of Build Nothing, Build Less, Build Clever and Build Efficiently from a developer/designer perspective. For some projects this approach can deliver significant reductions. However, for the many other projects, carbon reductions (if any) have been far more limited, and procurement processes have often not actively driven innovation for reduction of carbon. With a goal of reducing embodied carbon for all new developments at Canary Wharf, the role of carbon reduction within the piling supply chain was defined in the procurement approach. To actively decarbonise the piling contractor supply chain, direct engagement with piling contractors was done to measure and report embodied carbon consumption against a project target during construction. This paper shares the details of this carbon reduction supply chain engagement.

RÉSUMÉ: Jusqu'à présent, les stratégies visant à réduire le carbone incorporé pour les nouveaux développements se sont principalement concentrées sur la hiérarchie des émissions de carbone: Build Nothing, Build Less, Build Clever et Build Efficiently du point de vue du développeur/concepteur. Pour certains projets, cette approche peut entraîner des réductions significatives. Cependant, pour de nombreux autres projets, les réductions de carbone (le cas échéant) ont été bien plus limitées, et les processus d'approvisionnement n'ont souvent pas activement stimulé l'innovation en matière de réduction des émissions de carbone. Dans le but de réduire le carbone incorporé pour tous les nouveaux développements à Canary Wharf, le rôle de la réduction du carbone au sein de la chaîne d'approvisionnement des pieux a été défini dans l'approche d'approvisionnement. Pour décarboner activement la chaîne d'approvisionnement des entrepreneurs en battage, un engagement direct avec les entrepreneurs en battage a été réalisé pour mesurer et rapporter la consommation de carbone incorporé par rapport à un objectif du projet pendant la construction. Ce document partage les détails de cet engagement dans la chaîne d'approvisionnement en matière de réduction des émissions de carbone.

Keywords: Carbon; decarbonisation; sustainability; piles; construction.

1 INTRODUCTION

For many companies, supply chain-related emissions are their largest source of carbon emissions, and being outside their direct control, are the most challenging to reduce. Activating decarbonisation through supply chains is one of the most critical and effective pathways to reach net-zero (CDP, 2023).

However, with limited visibility and perceptions of limited influence on emission reduction measures, it can be challenging for many companies to bring the required change to their supply chain. Supplier engagement targets offer a way to influence decarbonization efforts within companies' supply chain when emissions data is challenging to track or unavailable.

Canary Wharf is forty hectares of land being progressively developed since the late 1980s on the site of the former West India Docks in East London, United Kingdom. It is the largest urban regeneration project in Europe containing commercial, retail and residential developments with many high-rise buildings and large basements.

In December 2020, Canary Wharf Group published its Net Zero Carbon Pathway, outlining its pathway for achieving net zero. A key aspect of the Pathway for new developments was supporting their supply chain in reducing carbon emissions and achieving their Science Based Targets.

This paper presents details of how the Pathway was implemented for the design, procurement and construction of new piled foundations for five new build projects.

2 DESIGN APPROACH

The five Canary Wharf projects presented in this paper are developments within a larger phased development. Foundation option selection process had determined piled foundations as the most suitable foundation solution. The subsequent carbon reduction approach during the design stages was one of reduction i.e. material selection and reducing material volumes. The principal ways this was achieved was through adopting lower partial factors in design permitted with preliminary and working pile load tests, which is further discussed in (Taggart and Barker, 2022) and by developing an efficient pile layout. This was achieved through maximising individual pile capacities within the capability of the piling industry while optimising the foundation layout through a geotechnical-structural iteration process to reduce the number of piles.

The scope of piling works was procured as contractor designed and for each of the five projects were:

Project A: comprised 500 No. 900mm and 1050mm diameter continuous flight auger (CFA) bearing piles with a typical pile length of 28m.

Project B: comprised 210 linear metres of 1200mm diameter hard-firm secant wall and 75 linear metres of 15m deep sheet pile wall and 7 No. 1500mm and 1800mm diameter rotary bearing piles with a typical length of 35m.

Project C: comprised 150 linear metres of anchored sheet piled dock wall and temporary cofferdam and capping beam with 26 No. 900mm diameter CFA anchor piles and 90 linear metres of 20m long 1200mm diameter hard-firm secant pile wall.

Project D: 300 No. 900mm diameter CFA bearing piles and 50 No. 900mm to 1800mm diameter marine piles.

Project E: comprised 120 No. 750mm CFA bearing piles typically 30m long, 80 No. 1050mm CFA bearing piles typically 32m long and 17 No. 1300mm rotary bearing piles with a typical length of 35m.

3 SUPPLY CHAIN ENGAGEMENT

With a goal of reducing embodied carbon in these new developments the role of embodied carbon was defined within the piling supply chain through the procurement process. Procurement, as shown in Figure 1, was historically on cost, quality and programme but for these projects embodied carbon was also now included.

To decarbonise the piling contractor supply chain, it was recognised that direct engagement with typically Tier 2 piling contractors was needed to calculate, measure and report embodied carbon consumption against a project target through the project delivery process, as shown in Figure 2.

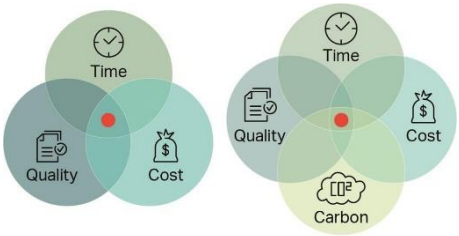

Figure 1. Historical and revised procurement values.

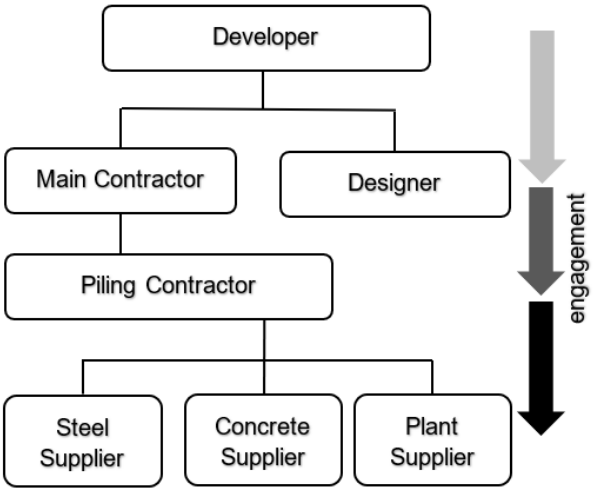

Figure 2. Supply chain engagement.

4 TENDER SPECIFICATION

To frame this approach new specification clauses were needed in the project piling specification. The two pages of new specification text (Barker, 2023) provide an aspirational embodied carbon target and requires all tendering piling contractors to use the free EFFC/DFI Carbon Calculator (EFFC and DFI, 2023) to estimate the embodied carbon in their tender design submissions. Concrete mix designs and any proposals for further embodied carbon reductions were also to be provided at tender. For the successful contractor, independently verified Environmental Product Declarations (EPD) were required for their construction materials and recalculating the estimated embodied carbon for their construction issue design was undertaken. Weekly reporting of embodied carbon consumption is provided by the contractor during construction. Also, at the end of construction, an as-built report is provided totalling the A1-A5 life cycle assessment modules (product and construction process stages) including waste emissions.

Table 1. Tender stage estimated embodied carbon (tCO2e).

	Project A	Project B	Project C	Project D	Project E
Target	*3000*	*2200*	*2600*	*4000*	*2160*
Contractor 1	2900	3300	3200	3300	2000
Contractor 2	3800	1300	-	3700	3800
Contractor 3	5800	1500	-	-	2400
Contractor 4	2500	-	-	-	2380
Contractor 5	-	-	-	-	2600

An EPD provides the independently verified carbon footprint of a product, e.g., concrete, diesel and steel reinforcement, in terms of Global Warming Potential (GWP) as measurable carbon dioxide equivalents (CO2e).

The calculation of embodied carbon consumption is easily undertaken during construction. Contractors are already routinely recording and reporting material volumes and resources. So, multiplying these quantities by a carbon factor is quite simple.

Table 1 presents the five separate contractor designed piling projects. The target embodied carbon was calculated and provided in the tender specification as an aspirational target assuming what a typical piling contractor was previously offering at tender. The remaining numbers are the calculated embodied carbon in contractor's tender returns. The piling industry's EFFC/DFI carbon calculator was specified as it was free, simple, easy to use and provided a common calculation method for all tenderers creating an equal tendering basis.

On the first project the range of estimates was quite large with a subsequent general trend of estimates reducing and the tender range narrowing.

5 CONSTRUCTION

Contractors were encouraged to engage with their suppliers to source low carbon materials and equipment. To drive beneficial changes in the supply chain, third party certified EPD carbon factors were preferred over published generic tables.

So as to not overburden construction administration, the weekly reporting format of carbon consumption during construction was decided by each contractor to best fit in with their established commercial monitoring processes. Typically, tables and plots were simply produced in Excel.

The principal areas of embodied carbon reduction are discussed below.

5.1 Concrete

Concrete is typically the most significant source of embodied carbon in piling. Typical piling tenders allow CEMIII/A with 40 - 50% GGBS (ground granulated blast furnace slag) cement replacement in piling concrete (210 kgCO2e/m^3). However, contractors can supply CEMIII/B piling concrete up to 70 - 80% GGBS cement replacement (163 kgCO2e/m^3). In unreinforced secant piles CEMIII/C can increase up to 95% GGBS cement replacement (49 kgCO2e/m^3).

While GGBS is an excellent supplementary cementitious material that helps displace clinker demand globally, it is a limited and constrained resource that is almost fully utilised globally. Therefore, whilst global supplies must continue to be fully utilised, locally increasing GGBS use at a project level is unlikely to decrease global emissions (Arnold *et al*, 2023).

Significant 52% carbon reduction shown in Table 2 were achieved in the secant wall on Project B, in part, through the use of high levels of GGBS in concrete mixes. This demonstrated the potential magnitude for carbon reductions in the future using new novel low carbon concrete mixes.

Tracking and reporting carbon consumption during CFA pile construction highlighted a +512 tCO2e increase over the target on Project A, the consequences, in part, of increased concrete wastage resulting from frequent concrete delivery delays.

5.2 Reinforcement cages

Suppliers of pile reinforcement source stock from steel mills both in the United Kingdom and the Europe Union and usually with high levels of recycled steel (>95%) which reduces carbon emissions. However, this may not always be the case, as on one project with two reinforcement suppliers their EPD showed significantly different values of 730 kgCO2e/t and 1100 kgCO2e/t steel. Adopting the circular economy principles in steel reuse is crucial.

5.3 Steel sheet piles

The introduction of an embodied carbon target in the Project C piling specification resulting in a tendering contractor to offer a 815 tCO2e saving by adopting 100% recycled steel sheet piles manufactured in an electric arc furnace (520 kgCO2e/tonne), for a cofferdam and new dock wall instead of more

Table 2. Measured as-built embodied carbon totals (tCO2e).

	Project A	Project B	Project C	Project D	Project E
Target	3000	2200	2600	4000	2160
Tender	2500	1300	3200	3300	2000
As-built	3512	1060	1400	tbc	tbc
Δ from target	+17%	-52%	-46%	tbc	tbc

typically procured steel sheet piles being source from blast furnace steel (2164 kgCO2e/tonne).

5.4 Fuel

A piling project at Canary Wharf (rigs, cranes, excavators, generators, pumps) can typically consume 80,000 to 150,000 litres of diesel (215 to 400 tCO2e).

Since 2012, Canary Wharf Group supply the estate and construction sites with certified renewable electricity being sourced from a mix of wind, thermal, solar and hydro. This enables the tendering process to engage contractors in transitioning piling plant and equipment from diesel fuel (2.68 kgCO2e/litre) to HVO biofuel (0.68 kgCO2e/litre) to renewable electricity (0 kgCO2e/kWh) or hydrogen.

5.5 Plant

Several of the projects have also achieved carbon reductions using electric crawler cranes, pumps and for site office power, HVO biofuel for plant as well as trialling electric piling plant. Contractors make significant capital investments in piling plant and the transition does benefit from active support in project procurement.

6 SUMMARY

Table 2 shows the five projects again but with the measured as-built embodied carbon total and difference from target. Projects D and E are still currently on site. The materials, fuel and plant carbon reductions achieved on Projects B and C illustrate what can be achieved from current 'normal' practice. The additional carbon consumed in Project A illustrates the significant additional carbon that can occur from concrete delivery delays.

7 CONCLUSIONS

Substantial embodied carbon reductions can be realised using currently available materials and methodologies and using the free the EFFC/DFI carbon calculator tool.

Activating decarbonisation in the piling supply chain can be readily achieved by specifying project embodied carbon targets for procurement followed by measuring and reporting embodied carbon consumption during construction. Such target setting is the step the industry now needs to take having identified baseline emissions and emission hotspots. Measuring and reporting data at a project level engages the whole supply chain: developer-consultant-contractor-suppliers and enables learning and continuous project improvements to be made by all parties.

Incorporating embodied carbon into the procurement and construction processes initiates a new level of engagement and learning for all parties. This is essential to drive change to enable the piling industry to capitalise on the coming opportunities in lower carbon materials and methodologies for a low carbon future.

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