

Editorial: Themed issue on reuse of foundations and structures

Dinesh Patel

Arup Fellow, Arup Geotechnics, London, UK

In a sustainable future, the built environment is key. Demolishing and rebuilding does not fit with reducing the whole life carbon footprint of buildings. It is unsustainable for buildings to be demolished well before the end of their design life, leaving ground congested with old foundations in dense urban cities.

The challenge then is to reuse existing foundations and repurpose structures. Engineers have a duty to change attitudes of clients and architects, to explore novel ways of reusing foundations and superstructure, and to ensure buildings have a longer design life with multiple usage. A significant proportion of embedded carbon, up to 40% of existing buildings is in the concrete substructure and foundations and therefore foundation reuse is a ‘no-brainer’.

Current planning policy in the London market (GLA London Plan 2014), requires developers to actively consider keeping existing buildings and foundations or incorporating them with any new developments, wherever possible, before planning approvals are granted. Long gone are the days when demolition and rebuild was taken for granted. Developers and their design teams now have to rethink and have special skills on how to design and construct buildings in dense urban cities for sustainability, incorporating reuse strategies within proposed, whilst still considering the clients commercial needs.

London is seen across Europe and USA as one of the leaders in restoration of buildings and foundation reuse – they are watching and learning, as their cities come under increasing pressures to become more sustainable and as planning policies mature in the future. That is why this themed issue is important as unlike traditional design methods, foundation reuse requires different engineering skills and knowledge by engineers as it is often based on a risk-based approach considering serviceability and the impact of movements on the combined new and old structure.

A total 6 papers were submitted and four have been selected in this themed issue following the standard of *Forensic Engineering* review process. A further four abstracts were submitted with authors producing papers which could not be included in this themed issue in time for publication. Either, these will be considered for a second volume on this themed issue or published individually in future *Forensic Engineering*. We would also encourage more authors to submit papers on this important topic. Case studies are an important part of understanding and educating engineers across the globe on how restoration and foundation reuse developments can be designed to be green, lean and faster in dense urban cities.

The first paper in this issue, by Berry *et al.* (2024) presents a comprehensive case study on how to design for ‘Green’, how to design ‘Lean’ which would result in ‘Faster’ construction on a prime site in London, significantly impacted by old foundations in the ground from past developments stretching back almost 120 years. There were significant steel grillage foundations from the 20th century, as well as modern reinforced concrete rafts and piled rafts from old printing presses and office developments in the ground. The restoration of the existing structure comprising, retrofitting parts of the existing structure and reuse of modern 1970’s foundations was crucial to unlocking this development. However, additional piles were also required combining with existing foundations to fill areas of new structure, but this required a specialist piling technique that could tackle one of the most challenging London sites known, full of obstructions from previous developments. The paper describes a unique piling solution that allowed specialist low headroom Pali Radice piling rigs to operate within confined spaces which could drill through dense reinforced concrete, steel grillages within shallow foundations and thick rafts, that most forms of traditional piling methods would be incapable of performing. This significantly reduced the need for enabling works which was hazardous. To derisk the commercial aspects of coring through these obstructions and ensure programme certainty, the authors explain how crucial it was to carry out on site core drilling trials. For foundation reuse, the authors showed that a risk-based design methodology was carried out using achieve data and a working stress approach, carrying out test piles to inform the design, rather than simply rely on a code-based design approach using Eurocodes. This was a game changer for the project as the approach was the least disruptive and efficient way to carry out a green and lean design, avoiding extensive enabling works prior to piling.

The second paper by Morrison and Ganesharatnam (2024) describes a low-rise building designed in the 1980’s that required additional floors to be added, reusing the original driven closed ended steel tube piles installed through the dock basin, within the London Docklands, UK. To justify foundation reuse, the authors had to justify an increase in working load of up to 67% on the driven piles, to make this project commercially viable. This could only be done after careful examination of 1980’s archive data, reinterpreting the original driving records and preliminary pile tests against the original 1980 pile capacity. The authors explain why this approach was the only way forward, as London Underground (LU) tunnels were constructed below the dock near the structure in the 1990’s, potentially restricting installation of new piles even

if it was possible to purchase additional land in the dock. It led to an overall solution, both sustainable and cost-effective de-risking the project for the client. Importantly, the authors explain that this lean design was only achievable as the building owner (Client) commissioned the original design firm that had carried out an 'engineer design' solution in the 1980s, who had also overseen the pile construction and still had resident engineer records and original design calculations. This paper shows the importance of designers keeping archive records from 1980's. Construction drawings alone, whilst useful, would not have provided the same result as without the rest of the archive data held internally by the original designer, the impact and capital costs of redevelopment would have been significant to the Client.

Following the theme of adding value to Clients by reusing existing foundations and considering serviceability performance, not just simply code based ultimate state design, Gasparre *et al.* (2024) describe an example of a 1999, 4 storey structure in London, UK that was doubled in height following a thorough review of the existing foundations and a desk study. The original building was supported on short (3-6m) displacement piles in Terrace gravels connected by ground beams. A review of archive data – integrity testing using the transient dynamic response method – showed no discernible pile defects and positive pile toe levels; a static load test also helped confirm the original safe working loads. Carefully devised intrusive investigations of 10% of the foundations provided further justification for the successful foundation reuse strategy adopted. To produce a cost effective and sustainable design without automatically resorting to the 'default' install additional piles syndrome, the authors describe how they used a risk-based design solution reusing existing piles combined with new strip footings bearing on the gravels. This required an evaluation of different load transfer mechanisms from the new structure into old and new foundations, an understanding of stiffness response and settlement response of the individual and combined foundation systems. The new strip foundations were there to enhance the FOS of the overall foundation solution and provide extra capacity without overloading existing piles. Sensitivity studies showed that even if the piles were

overloaded beyond the safe working loading the settlements would be less than 12 mm as proven by monitoring of the new build. This paper shows the importance of collaboration between geotechnical engineers and structural teams, can provide positive outcomes to Clients.

The final paper presents a case study of reuse of steel piles reused for a bridge in Ontario, Canada by Sangiuliano *et al.* (2024). The reuse strategy involved replacing the existing bridge deck but reusing the steel piles and extending its existing service life by 75 years with a new bridge deck. An assessment was required on the condition of the steel H-piles, estimation of pile lengths and geology at the bridge abutments, and estimating the load carrying capacity of the steel piles. From understanding the chemistry of the ground from lab testing of samples from boreholes, the potential for section loss of steel piles due to corrosion was made. Geophysical testing for pile toe, allowed an estimate of pile capacities for reuse purposes was checked against Canadian national codes for compliance. The paper provides a cost-benefit analysis of cost and programme savings, to demonstrate savings from foundation reuse can indeed be impressive and very effective for public clients.

REFERENCES

- Berry A, Patel D, Faber F *et al.* (2024) Managing piling obstruction risk intelligently for reinvention of a UK brutalist building. *Proceedings of the Institution of Civil Engineers – Forensic Engineering* **177**(3): 75–86, <https://doi.org/10.1680/jfoen.22.00028>.
- Gasparre A, Crilly M, Harland S and Atkinson G (2024) Strip footings for the extension of a piled building. *Proceedings of the Institution of Civil Engineers – Forensic Engineering* **177**(3): 95–103, <https://doi.org/10.1680/jfoen.22.00030>.
- Morrison P and Ganesharatnam L (2024) Driven pile foundation reuse in East London, UK. *Proceedings of the Institution of Civil Engineers – Forensic Engineering* **177**(3): 87–94, <https://doi.org/10.1680/jfoen.22.00033>.
- Sangiuliano T, Staseff D, Chatterji PK, Shi K and de Castro Jr R (2024) Reuse of steel pile foundations: Greenock Creek Bridge, Walkerton, Ontario, Canada. *Proceedings of the Institution of Civil Engineers – Forensic Engineering* **177**(3): 104–111, <https://doi.org/10.1680/jfoen.22.00025>.