FEDERATION OF PILING SPECIALISTS

Technical Note – Corrosion of Pile Reinforcement Cage

The main bars of pile reinforcement cages are often extended below the base of the required reinforcement cage to level as 'feet' to provide the required concrete cover to the main cage and to support the installed cage at the correct level giving some flexibility to the bore depth.

Not all piles are designed to require any resistance from base as they can generate the required resistance entirely from shaft friction.

It has been noted that there is a trend in infrastructure project clients requesting or querying that the extended bars should be protected against corrosion. This is not a requirement in either the ICE Specification for piling and embedded retaining walls[1], or the Specification for Highway Works Series 1600 Piling and Embedding Retaining Walls[8].

One example of the measures which contractors have been forced to implement as a method of protecting the steel is to apply galvanising paint spray to the lower 200mm of bar, fit a plastic mushroom cap to the base, and wrap in Denso tape. This has to be done once the cage is suspended vertically as these components would otherwise be damaged as the cage is lifted from horizontal to vertical. Such activities have a small impact on the time and cost of piling operations but more significantly pose a safety risk to the operatives carrying out the task.

Both water and oxygen are required for corrosion to take place. At the base of the concreted pile, in the vast majority of ground conditions, oxygen does not exist hence the environment is anaerobic and therefore corrosion does not occur[7]. There are some exceptions whereby in tropical soils and/or marine environments where bacterial corrosion can occur, and this should be a consideration when working in these ground conditions.

As steel which is sufficiently encapsulated in concrete does not corrode, most of the studies relate to steel piles where the steel is in direct contact with the environment. Within the ICE Specification[1], direct reference to corrosion of reinforcement cages is not made, but corrosion is referenced in section C8.5 where the following is stated:

'The corrosion rate applicable to steel piles installed into undisturbed natural soils tends to zero as both water and oxygen must be present for corrosion to take place. At depth there is little oxygen available, so the process ceases.'

This is further evidenced in a review of published data[2,3,9] addressing corrosion on steel bearing piles which states:

'The underground corrosion of steel piles has been studied extensively. A review of published data, outlining mainly overseas experiences, concluded that, unless the soils are strongly acidic (pH<4), the underground corrosion of steel piles driven into undisturbed soils is negligible, irrespective of the soil type and characteristics. The insignificant corrosion attack was attributed to the very low oxygen levels present in undisturbed soils.'

Guidance on the corrosion of steel bearing piles[2] concludes that:

'Guidance on corrosion allowances for piles in natural soils is given in BS 8002[4] where the maximum corrosion rate of 0.015mm/year/side is advised, and no other protection is required. This is within the range quoted by BS 8004[5] and consistent with the corrosion rates derived from Eurocode 3[6].'

In view of the information presented above corrosion protection of pile reinforcement cages is not required at the toe of the pile, unless installed in tropical soils and/or marine environments where bacterial corrosion can occur and therefore corrosion rate should be considered.

References

1. Institution of Civil Engineers: 'Specification for Piling and Embedded Retaining Walls', Third edition, Thomas Telford Ltd, 2017
2. Corus: 'A corrosion protection guide – For steel bearing piles in temperate climates', CC&I:CD:F:3000:UK:02/2005, Corus Construction & Industrial, 2005.
3. J. Morley: 'A Review of the Underground Corrosion of Steel Piling', Report T/CS/1114/1/78/C, British Steel Technical, Teesside Laboratories, 1978.
4. BSI: 'Code of practice for earth retaining structures', 4.4.4.4.3.1, BS 8002:1994
5. BSI: 'Code of practice for foundations', 10.3.5, BS 8004:1986
6. BSI: 'Eurocode 3 – Design of steel structures – Part 5: Piling', Table 4-1, BS EN 1993-5:2007
7. J P Tyson: 'Design of reinforcement in piles', Transport Research Laboratory, TRL Report 114, 1995
8. 'Specification for Highway Works', Volume 1, March 1998
9. D Rowbottom, D Baxter, S Cross: 'Durability of Steel Piling', SCI, P422, 2019