Technical Note 124

Durability issues of Reinforced Concrete Driven Piles

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1 Purpose

The purpose of this technical note is to document the basis of the Department of Transport and Main Roads policy that reinforced concrete driven piles are not an acceptable substitution for prestressed concrete driven piles for departmental bridges and other structures.

2 Background

In recent projects, Transport and Main Roads has specified only octagonal Prestressed Concrete (PSC) driven piles where a driven pile foundation is required. Driven Reinforced Concrete (RC) piles are listed as "*not acceptable pile type*" in current *Design Criteria for Bridges and Other Structures*. Recent "design and construct" projects or alliance teams have raised the issue that RC driven piles offer some savings in initial costs and request Transport and Main Roads to accept RC piles as a substitution for PSC piles. The department has rejected these arguments consistently and the logic for this decision is documented in this technical note.

3 Referenced documents

Table 3 below lists referenced documents in this technical note.

Table 3 – Referenced documents

Reference	Title
Transport and Main Roads manual	*Design Criteria for Bridges and Other Structures*
AS 5100.3	*Bridge Design: Foundation and soil-supporting structures*

4 Durability

Durability is a key concept that has to be accepted by all stakeholders to ensure value for money.

Transport and Main Roads has identified that piles are a key structural element and shall have the highest durability to achieve the intended design life requirements for the whole structure.

PSC piles have built in compressive stresses in the order of 7.0 MPa along the full length of the pile (1756 kN axial compressive force) due to the prestress force applied during pile casting. This built in compressive stress provides PSC piles greater resistance to cracking due to tensile stress resulting from stress waves generated during pile driving, driving eccentricity, handling, transport and in service resulting higher durability compared to RC piles.

The prestress in PSC piles enables fine cracks to self-heal and high resistance to moisture penetration. In comparison, RC piles tend to develop wider cracks during driving which do not self-heal. Therefore, RC piles are more vulnerable to cracking during driving than PSC piles. These cracks in RC piles will widen further due to service bending moment created by bridge lateral loads such as creep and shrinkage effects, variation of bridge temperature, braking loads, flood, wind, lateral impact loads, and so on leading to long term durability issues. Therefore, when these wider cracks form in piles, oxygen, water and chlorides (if present) have access to the reinforcing steel at cracks and will initiate corrosion.

This departmental decision for not recommending RC piles as a substitution for PSC piles in Transport and Main Roads structures is to ensure the value for money without compromising durability of the piles during its design life of 100 years. From a "*whole of life*" perspective, there are significant cost

savings due to reduced maintenance if PSC piles are used. Cracked piles are usually “sleeved” and concreted at very high cost.

5 Pile splicing

AS 5100.3 states that *“the use of pile splices shall be limited to situations where their use is unavoidable”*. Pile splicing is the weakest and most vulnerable location for compromising durability and pile capacity. Pile splices are generally not recommended for significant bending moment transfer and for this reason splices need to be located away from the area of the maximum bending moment region. PSC piles can easily meet this requirement. Typically RC pile splices are less robust.

6 Conclusion

Piles are a key structural element that needs higher durability to ensure the robustness and achieve intended service life of the structure. Pile installation to the designed penetration to achieve required structural fixity and geotechnical capacity is a key challenge when driven piles are used for a structure foundation.

- PSC driven piles have much greater resistance to cracking compared to RC driven piles due to the presence of built in compressive stresses. There is higher possibility to open up cracks in RC piles during pile driving resulting in long term durability issues.
- PSC driven piles are more durable and will provide lower whole of life cost for Transport and Main Roads structures compared to RC driven piles. PSC driven piles are better value for money.
- Pile splices are the weakest and least durable element in driven piles and cannot be located in the maximum bending region. The objective is to minimise the number of pile splices due to their weak structural capacity and “down time” to install the pile splice resulting in increased costs. Longer PSC driven piles can easily meet this requirement.
- To substitute PSC driven piles with RC driven piles, the number of RC piles required may be increased substantially to meet structural and geotechnical requirements. The increase in number of RC piles results in increased cost for integrity testing, pile driving and traffic control. By comparison; use of PSC piles has significant cost saving to Transport and Main Roads projects due to less time required for pile driving, resulting in less cost for traffic control, and so on.

Consequently, Transport and Main Roads does not accept RC driven piles as an acceptable substitution for PSC driven piles in departmental structures.