

Code of Practice Foundations

1. Scope and application

BTN023 Foundations states VicRoads' requirements for the design and specification of driven pile foundations for road structures. It states requirements for the design of precast concrete piles and steel piles (H-section and shell piles).

Bridge Technical Notes are a Code of Practice. Compliance with Bridge Technical Notes is mandatory.

BTN023 Foundations is to be read in conjunction with the following documents:

- AS2159 Piling – Design and installation
- VicRoads Standard Specification 610

Other than as stated in this document and relevant VicRoads standard specifications, the provisions of AS5100:2017 and AS2159 shall apply. Where this document differs from AS5100:2017 and AS2159, its requirements override those of AS5100:2017 and AS2159.

2. Materials

2.1. General

Reference shall be made to AS 5100, AS 2159, VicRoads Standard Specification and other relevant Australian Standards to determine the material properties to be used for design and manufacture of driven steel and precast concrete piles.

2.2. Other materials

Other materials shall comply with the appropriate Australian Standard or if no standard exists, the specification shall be approved by the Superintendent.

3. Ground investigations

3.1. Extent of investigations

Further to AS5100.3 Cl. 1.6.2, the minimum number of bore holes for bridges and major culverts shall be one borehole at every pier and abutment, with an additional borehole for each 10m of bridge width or part thereof.

High mast lighting poles shall have one bore hole per lighting pole. Gantries shall have one bore hole per leg of the structure.

For other structures (e.g. culverts, retaining walls, noise attenuation walls and similar), the minimum number of bore holes shall be one at each end and at intermediate locations at not more than 30m intervals.

The above are minimum requirements which may be increased depending on ground conditions subject to approval by the Superintendent.

4. Pile design

4.1. Concrete piles

Concrete Strength Grade

The minimum concrete strength grade for reinforced and prestressed concrete piles shall be VR400/40 in accordance with VicRoads Standard Specification 610.

Concrete Cover

Minimum concrete cover shall comply with the requirements specified in AS 5100.5 for the relevant exposure conditions, method of manufacture and concrete strength grade, except where specified otherwise in Table 1 below.

Table 1 Minimum cover to reinforcement

Exposure Classification as per AS 5100.5	Concrete Strength Grade		
	VR400/40	VR450/50	VR470/55
(a) For piles cast in rigid formwork and intense compaction			
B1	45mm	40mm	40mm
B2	60mm	50mm	50mm
C1	NA	70mm	70mm
C2	NA	NA	80mm
(b) For piles manufactured by spinning or rolling			
B1	30mm	30mm	30mm
B2	35mm	30mm	30mm
C1	NA	40mm	40mm
C2	NA	45mm	45mm

4.2. Durability

Specific reference shall be made to the requirements of AS 2159, AS 5100.3, AS 5100.5 and AS 5100.6.

If steel, composite or jointed piles are used, the designer shall ensure that the geotechnical information includes a report on soil reactivity and ground water movement.

The following factors may influence durability of steel, composite or jointed piles and shall be assessed by the designer:

(a) Sites with possible electrolytic action due to stray currents, very low soil resistivity, high soil permeability or soils with very high or low pH

(b) If there is a proven occurrence of Sulphate Reducing Bacteria (SRB) or where soils have a pH-value above 9.5 or below 4.0.

Precast monolithic piles or individual segments of jointed piles shall be classified as members in water for the purpose of determining the exposure classification unless it is proven by geotechnical investigation that no part of the member is below the permanent water table.

4.3. Pile toe protection

Pile toes shall be protected to ensure that piles can be driven through hard materials without damage. The pile toe shall comprise a rock shoe, cast iron shoe, cruciform driving shoe or welded steel plate.

Welded steel plates shall not be less than 6mm thick.

4.4. Pile driving ring or head band

Pile driving rings shall be used to prevent splitting or bursting of the top of precast concrete piles during driving. Pile driving rings or head bands shall be fabricated using full penetration butt welds and backing plates.

4.5. Scour and pre-boring

If piles are located in a stratum that is at risk of scour damage, the potential effects of scour shall be included in the design of the foundations.

Unless a rigorous analysis is used, a minimum local scour allowance of 1.0m shall be used in addition to the general scour allowance.

When conducting a pile test to determine the loss of capacity due to scour, pre-boring to a level below the estimated scour depth shall be specified.

5. Axial capacity of driven piles

5.1. Acceptance criteria for pile driving

Dynamic testing and wave-equation analysis shall be used for all pile driving except if otherwise approved by the Superintendent.

Use of the Hiley formula to prove pile capacity may be permitted by the Superintendent for bridges of low significance (i.e. low traffic volume and small structures), if soil types are suitable and dynamic testing is not economically justifiable. If the Hiley formula is to be used, a geotechnical reduction factor of 0.4 shall be adopted irrespective of the requirements specified in AS2159.

Reference shall be made to VicRoads Standard Specification Section 605.

6. Mechanical joints

Mechanical joints for precast reinforced concrete piles shall comply with the requirements of AS 5100.3.

Mechanical joints shall not be located within 5 metres of the underside of a pile-cap or in aggressive groundwater – refer to Cl.4.2 of this BTN. If aggressive groundwater is present, the location of splices shall allow for potential rise in water table due to seasonality.

The designer shall specify the allowable range of depths for the mechanical joints on the drawings.

7. Information required on drawings

7.1. Concrete piles

The following information shall be shown on the drawings for precast concrete piles:

- minimum characteristic concrete strength grade
- minimum concrete strength for lifting and handling
- minimum concrete strength for driving
- minimum cover and exposure classification.

7.2. Pile test loads

The designer shall determine the pile ultimate limit state design loads based on structural requirements and site conditions. Test pile or representative pile locations and the values of N and N^* shall be shown on the drawings as illustrated in Table 2.

Alternatively, within the limitations specified in Cl. 4 of this BTN, appropriate values for use with the Hiley formula may be specified on the drawings.

Table 2 – Pile Ultimate State Axial Design and Test Loads

Pile Axial Loads			
Pile Location	Ultimate Limit State Design Axial Load / Pile $N^*(kN)$	Pile Test Loads $N (kN)$	
		PDA Testing & Signal Matching	Hiley Formula*

*Include where applicable (refer to Clause 4 of this Technical Note)

Geotechnical reduction factor Φ_g and values for associated design assumptions shall be shown on the drawings as specified in Table 3.

Table 3 – Geotechnical Reduction Factor and Values for Design Assumptions

Geotechnical Reduction Factor Φ_g	
Basic Geotechnical Reduction Factor Φ_{gb}	
Intrinsic Test Factor Φ_{if}	
Testing Benefit Factor K	
Percentage of pile to be tested P^*	

* Refer AS 2159 Clause 4.3.1.

7.3. Pile joint loads

If it is proposed to use mechanical pile joints, the designer shall specify the allowable range of reduced levels for the joint on the drawings (refer Table 4).

The strength of the joint, as specified by AS 5100.3, shall be not less than that of the lengths of pile being joined.

Table 4 – Pile Joints

Pile Location	Joint Minimum Reduced Level (m)	Joint Maximum Reduced Level (m)	Description of Environmental Aggressiveness

7.4. Pile toe levels

Pile toe levels shall be shown on the drawings, based on levels determined during design.

7.5. Foundation settlement

The values of serviceability limit state loads, settlements and differential settlements, used in the design shall be shown on the drawings.

7.6. Concrete pile handling diagrams

Diagrams specifying the allowable methods for handling the piles shall be included on the pile drawings.

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Bridge Technical Notes are subject to periodic review and may be superseded.