

# AS5100 Part 3: Foundation and Soil-Supporting Structures

**BTN 023**

Version 1.1

5 May 2022

## 1. Scope and Application

Bridge Technical Note BTN 023 – AS5100 Part 3: Foundation and Soil-Supporting Structures states Department of Transport's (DoT) requirements for the design and specification of foundations for structures.

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

This document is to be read in conjunction with the following documents:

- AS2159 Piling – Design and installation.
- DoT/VicRoads Standard Specifications.

Other than as stated in this document and relevant DoT/VicRoads Standard Specifications, the provisions of AS5100:2017 must apply. Where this document differs from AS5100:2017, its requirements override those of AS5100:2017.

## 2. Materials

### 2.1. General

Reference must be made to AS5100, AS2159, DoT/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 must comply with the appropriate Australian Standard or if no standard exists, the specification must be approved by the Superintendent.

## 3. Ground Investigations

### 3.1. Extent of Investigations

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

High mast lighting poles must have one bore hole per lighting pole. Gantries must 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 must be one at each end and at intermediate locations at not more than 30 m intervals.

Further to the above and subject to the approval by the Superintendent, the spacing of the boreholes may be increased where consistent ground conditions are encountered.

## 4. Pile Design

### 4.1. Concrete Piles

#### Concrete Strength Grade

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

#### Concrete Cover

Minimum concrete cover must comply with the requirements specified in AS5100.5 for the relevant exposure conditions, method of manufacture and concrete strength grade, including the additional cover requirement when curing compounds are used.

### 4.2. Durability

Specific reference must be made to the requirements of AS2159, AS5100.3, AS5100.5 and AS5100.6.

If steel, composite or jointed piles are used, the designer must 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 must 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 must 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 must be protected to ensure that piles can be driven through hard materials without damage. The pile toe must comprise a rock shoe, cast iron shoe, cruciform driving shoe or welded steel plate.

Welded steel plates must not be less than 10 mm thick.

### 4.4. Pile Driving Ring or Head Band

Pile driving rings must be used to prevent splitting or bursting of the top of precast concrete piles during driving. Pile driving rings or head bands must 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 must be included in the design of the foundations.

Unless a rigorous analysis is used, a minimum local scour allowance of 1.0 m must 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 must be specified.

### 4.6. Pile Chamfer

All square corners must have a 25 mm chamfer, except that chamfers on the top longitudinal corners of the precast pile as cast can be omitted provided:

- the exposure classification for the installed pile is B2 or better; and
- the geotechnical investigation results in the vicinity of the piles (less than 10 m measured in plan from the pile) confirm that the medium in which the pile is to be driven into does not include cobbles, boulders or obstructions of similar size.

## 5. Axial Capacity of Driven Piles

### 5.1. Acceptance Criteria for Pile Driving

Dynamic testing and wave-equation analysis must 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 must be adopted irrespective of the requirements specified in AS2159.

Reference must be made to DoT/VicRoads Standard Specification Section 605.

## 6. Mechanical Joints

Mechanical joints for precast reinforced concrete piles must comply with the requirements of AS5100.3.

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

The designer must 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 must 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 must 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  $N^*$  must be shown on the drawings as illustrated in Table 1.

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

**Table 1 – 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 Section 4 of this BTN)

Geotechnical reduction factor  $\Phi_g$  and values for associated design assumptions must be shown on the drawings as specified in Table 2.

**Table 2 – Geotechnical Reduction Factor and Values for Design Assumptions**

Geotechnical Reduction Factor $\Phi_g$	
Basic Geotechnical Reduction Factor $\Phi_{gb}$	
Intrinsic Test Factor $\Phi_{tf}$	
Testing Benefit Factor $K$	
Percentage of pile to be tested $P^*$	

\* Refer AS2159 Clause 4.3.1.

### 7.3. Pile Joint Loads

If it is proposed to use mechanical pile joints, the designer must specify the allowable range of reduced levels for the joint on the drawings (refer Table 3).

The strength of the joint, as specified by AS5100.3, must be not less than that of the lengths of pile being joined.

**Table 3 – 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 must 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 must be shown on the drawings.

### 7.6. Concrete Pile Handling Diagrams

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

## Contact Details

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

# Document Control

This document is subject to periodic review and may be superseded. The revision date is listed in this BTN.

Note that for projects tendered prior to the revision date of this document, there are no retrospective implications of this document unless agreed otherwise with DoT.

Version	Description	Revision	Approved by
1.0	Document Created	14 December 2017	Principal Bridge Engineer
1.1	Revision of Section 4.1 for concrete cover requirements for curing compounds. Section 4.6 added to cover for pile chamfer requirements.	5 May 2022	Chief Engineer – Roads