AS 5100 Part 5: Concrete

BTN 025
Version 2.1 3 October 2022

1 Scope and Application

Bridge Technical Note BTN 025 – AS 5100 Part 5: Concrete – states the Department of Transport's (DoT) requirements regarding the application of AS 5100.5 to the design and assessment of reinforced and prestressed concrete structural members.

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

BTN 025 is to be read in conjunction with the following DoT/VicRoads Standard Specification:

- Section 610 – Structural Concrete
- Section 611 – Steel Reinforcement

Other than as stated in this BTN and the relevant DoT/VicRoads Standard Specifications, the provisions of AS 5100:2017 must apply. Where this document differs from AS 5100:2017, its requirements override those of AS 5100:2017.

2 Shear and Torsional Strength

2.1 Amendments to AS 5100.5

The Modified Compression Field Theory (MCFT) in accordance with AS 5100.5 must be used with the following amendments to determine the shear and torsional strength of reinforced and prestressed concrete members.

AS 5100.5 Equation 8.2.1.2(2)

Stress σ_{cp} is the compressive stress and must be determined for both reinforced and prestressed members. The value of that stress must be adjusted for stresses due to any external axial forces and the composite action effects stated in AS 5100.5 Clause 8.10. Axial tensile stresses to be taken as negative. Where vertical stresses exist, they must be taken into account in the calculation for Torsional cracking moment Tcr.

AS 5100.5 Clause 8.2.1.5:

The effective web width, b_v, must be taken as the minimum value within the effective shear depth, d_v.

AS 5100.5 Clause 8.2.3.1

The design shear strength must satisfy this expression:

$$\emptyset V_u \geq \boldsymbol{V}^*$$

AS 5100.5 Equation 8.2.4.3(2):

A_{ct} must be taken as the area of concrete from the mid-depth of the section on flexural tension side.

AS 5100.5 Equations 8.2.4.5(1), 8.2.4.5(2) and 8.2.4.5(3)

In these expressions, (V* - P_v) must be replaced with (V*) only.

2.2 Assessment of Shear Strength

The simplified method of AS 5100.5 Clause 8.2.4.6 must not be used for shear assessment of an existing section.

Capacity of an existing section is defined as the force at a section at the incidence of failure. AS 5100.5 relates shear design strength, ϕV_u, to the applied forces, V*, M*, N*, and T*, and determination of the section shear capacity therefore requires an iterative procedure to reach ϕV_u = V*. The Designer may refer to Caprani and Melhem's paper [1] for further reference.

3 Mechanical Splices

3.1 Design General

Mechanical splices for reinforcement must not be used where lapped splicing is possible.

Where lapped splicing is not possible, mechanical splices can only be used provided that:

- a proprietary connector is used; and
- the connector has appropriate dynamic capacity as specified in Section 3.2 of this document.

If the structure containing the coupler could be subjected to dynamic loads, the time dependant properties of the coupler system must be established by testing for the effects of cyclical loading specified in Section 3.2 of this document. The chosen coupler must

perform satisfactorily over the design-life of the structure.

The mechanical coupler system must be supported by objective documented evidence of independent testing and engineering certification of compliance to DoT/VicRoads Standard Specification Section 611.

3.2 Mechanical Splices for Tension Reinforcement

Mechanical splices can only be used to join tension reinforcement in structures provided that:

- ~~A~~ proprietary connector is used in accordance with the manufacturer's recommendations.
- The maximum design crack widths must not exceed 0.30 mm for Exposure Classifications A and B1, and 0.25 mm for other Exposure Classifications. The design crack widths must be calculated using Eurocode 2 Part 1 BS EN 1992-1-1:2004 [2].
- Ideally the mechanical splice must not be placed at the points of maximum bending stress. Where bars are spliced at points of maximum bending stress, the requirement for the mechanical splices used in potential plastic hinge zones in AS 5100.5 Clause 13.2.6 must be complied.
- The splices to be staggered so that not more than 50% of the total area of tensile reinforcement to be mechanically spliced at any one section. The minimum clear distance between staggered splices (D) to be equal to or greater than the clear spacing between reinforcement (S). Refer to Figure 1 for mechanical splices staggering detail.

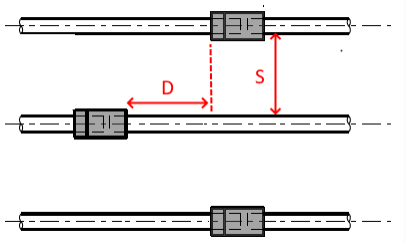

Figure 1 – Staggering detail for mechanical splices

The following factors must be considered when selecting a coupler:

- minimum yield stress – the coupler system must be strong enough to develop the characteristic yield stress of the smallest diameter reinforcing bar in the connection.
- dynamic capacity – if the structure containing the coupler could be subjected to dynamic loads, the coupler system must satisfy the requirements of ISO 15835-1 [3] for category F (fatigue). The chosen coupler must perform satisfactorily over the design-life of the structure.
- tensile strength / yield stress ratio – to maintain the ductility of the structure, the Tensile Strength / Yield Stress Ratio of the coupler system must not be less than 1.08, measured for actual stress across the full range of yield stresses (500 MPa to 650 MPa for a grade 500 N bar). Further consideration must be given to the tensile strength / yield stress ratio in designs for seismic conditions.
- uniform elongation – a minimum uniform elongation of 3.5% is required for mechanical splices in order to maintain the ductility of the structure. Care must be taken when locating couplers to ensure the ductility of the structure is not reduced below the requirements of the design.
- slip – slip in the coupler may lead to cracking in the concrete above the coupler. In order to limit the design crack widths in the concrete above the coupler, slip in the coupler must be limited to 0.10 mm at 60% of the yield load. The effects of shrinkage, creep and flexural cracking on the actual crack widths must be combined for this purpose.
- The designer must ensure that the performance of the selected coupler and the design of the reinforcement are consistent with the ductility of the reinforcement.

3.3 Cover To The Mechanical Splices

The minimum concrete cover from the outer surface of the coupler must satisfy the specified minimum concrete cover requirements for that component of the design.

4 Steel Fibre-Reinforced Concrete

Steel fibres may be used to improve the performance and capacity of reinforced and prestressed concrete structures in accordance with the provisions, design principles and limitations of Section 16 of AS 5100.5.

Steel fibre must not be used to replace conventional steel reinforcement or tendons for structural components with no redundant load paths, which will result in the total structure failure.

Steel fibre reinforced concrete must not be used in Exposure Classification B2, C1, C2 or U. Stainless steel fibres must be used for these Exposure Classifications.

Where steel fibres are used in accordance with AS 5100.5, the impact of steel fibres which may be partially exposed on the concrete surface thus leading to corrosion, formation of rust spots or surface staining, and the impact of steel fibres that may become partially or fully dislodged from the concrete in the in-service exposure conditions must be allowed for in the design.

A protective coating must be applied to all concrete surfaces where steel fibre reinforced concrete has been used and the coating applied must be applied in accordance with Section 686.

5 References

1. Caprani, C., and M. Melhem 2019. “On the Use of MCFT per AS 5100.5 For the Assessment of Shear Capacities of Existing Structures.” *Australian Journal of Structural Engineering* Sep. 2019.
2. EN 1992-1-1:2004. “Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings”.
3. ISO 15835-1:2018. “Steels for the reinforcement of concrete – Reinforcement couplers for mechanical splices of bars – Part 1: Requirements”.

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Document Control

This document is subject to periodic review and may be superseded. The revision date is listed in the 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	Effective Date	Approved by
1.2	General Amendments	November 2018	Principal Bridge Engineer
2.0	Revision of Section 2, Section 3 and Section 4 • Modified compression field theory for prestressed concrete member • Use of mechanical splices • Use of steel fibre reinforced concrete	23 June 2022	Chief Engineer – Roads
2.1	Minor amendment • Section 2.2 – The reference to the research paper was amended. • Section 4 – The treatment of exposed steel fibres amended.	3 Oct 2022	Chief Engineer – Roads