BTN 028

January 2018

Code of Practice
Bridge rehabilitation and strengthening

1. Scope and Application

AS 5100.8:2017 covers the assessment of load capacity, rehabilitation, repair and strengthening of existing bridges.

BTN028 Bridge rehabilitation and strengthening, together with other relevant VicRoads technical documents, supplement AS 5100.8:2017.

Other than as stated in this document and other relevant VicRoads standard specifications and technical documents, the provisions of AS5100.8:2017 shall apply. Where the contents of this document and of VicRoads' other relevant documents differ from AS5100.8:2017, their requirements override those of AS5100.8:2017.

BTN028 Bridge rehabilitation and strengthening is to be read in conjunction with the following documents:

BTN005 FRP Strengthening

- standard Specification 688
- other relevant VicRoads technical documents as applicable.
- Bridge Technical Notes are a Code of Practice. Compliance with Bridge Technical Notes is mandatory.

2. Adoption

AS 5100:8 2017 is a general reference document that highlights certain aspects of bridge technology and identifies options for repair, rehabilitation and strengthening of highway structures.

VicRoads adopts the general principles stated in AS 5100.8:2017 Rehabilitation and strengthening of existing bridges as a framework for rehabilitation and strengthening of bridges and other highway structures.

To specify its detailed requirements, VicRoads makes reference to its technical documents as listed in Section 4 of this BTN and, except as specified below, adopts AS 5100:8 2017 as a source of information.

3. General

AS 5100.8:2017 comprises separate sections covering:

- concrete structures
- steel structures
- timber structures
- masonry structures
- bearings
- deck Joints
- barriers
- culverts

It includes normative appendices covering:

- the design and application of fibre reinforced polymer (FRP) strengthening
- cathodic protection of reinforced concrete structures
- the design of rehabilitation or strengthening of timber structures.

4. Supplement to AS 5100.8 2017

The following VicRoads documents provide specific requirements for the repair, rehabilitation, strengthening and inspection of existing highway structures and shall be read in conjunction with AS 5100 in its entirety.

- Standard Specification for Roadworks and Bridgeworks
- Bridge Technical Notes
- codes of practice, Technical Notes and Technical Bulletins for materials and material testing prepared by VicRoads Asset Services
- Road Structures Inspection Manual

5. BSALL loading

Proposals to evaluate and/or apply a Bridge Specific Assessment Live Load (BSALL) shall be determined by VicRoads on a bridge-specific basis.

If VicRoads specifies the requirement for a BSALL, the assessment methodology and resulting BSALL shall be subject to the approval of the Superintendent.

6. Design of fibre reinforced polymer (FRP) strengthening of existing concrete structures

FRP strengthening shall be designed in accordance with BTN005 and the associated references.

Materials, installation workmanship and testing of FRP strengthening shall be in accordance with Standard Specification 688.

7. Bridge widening and strengthening

Requirements for widening and/or strengthening of bridges shall be determined by VicRoads on a bridge-specific basis.

8. Fatigue cracking

8.1. Remediation of existing fatigue cracks

Fatigue cracking can occur where stiffening or bracing members are connected to principal load-carrying members rather than as a result of primary stresses in principal load carrying members. Fatigue cracks can result in a reduction in the capacity of principal load-carrying members.

AS 5100.8:2017 Section 4 provides advice on the causes of fatigue cracking and repair of fatigue cracks.

Contrary to AS5100.8 Cl4.5.4 (which requires that if a fatigue crack occurs, a hole is to be drilled through the tail of the crack to terminate it and evenly distributed the stress to a larger area), an investigation shall be conducted to understand the cause of the fatigue cracking before any remedial work is conducted. When the cause has been identified (commonly a stress concentration), a remediation solution shall be developed which may include modifications to alter load-paths and improve the flow of stresses.

8.2. Remediation of existing details

AS/NZS 5100.6:2017 includes more detailed provisions for assessment of fatigue life than are included in AS/NZS5100.6.

However, a calculation of fatigue life has a relatively high level of uncertainty.

Options for treating the cause of the fatigue cracking shall be identified and assessed. Such options can be compared by finite element analyses, adopting a suitable fatigue load spectrum and detail and, if necessary, by applying the hot spot stress method (ref International Institute of Welding document IIW-1823-07 and Eurocode 1993-1-9) which will provide an approximate estimate of fatigue life treatment. The order of magnitude by which the detail is improved, as measured by the improvement in fatigue life, shall be used to select the treatment option that provides the greatest improvement in fatigue life.

8.3. Assessment of existing details

The AS 5100.8 2017 approach to fatigue life assessment requires assumptions to be made regarding the fatigue load spectrum that will reduce the reliability of the result.

When assessing the fatigue life of an existing detail, the following approach may be used:

- conduct finite element analysis of the detail using a refined mesh at the detail of concern and applying a notional load of say 100kN
- using the Paris Law (which is based on linear elastic fracture mechanics) to determine the stress intensity factor (SIF) for the detail
- determine the fatigue strength for a notional number of cycles, e.g. 2 million cycles, using the SIF derived above
- instrument the bridge in a way that will provide the fatigue load spectrum for the detail concerned. This step may require a degree of extrapolation to determine the stress at the critical point
- derive an equivalent stress range of constant amplitude equivalent to the measured variable amplitude damage for the total number of actual stress cycles by application of the Miner's summation
- estimate the fatigue life using the fatigue strengths determined from the finite element analysis and the equivalent stress range derived from the recorded strains.

The foregoing analysis provides an estimate of fatigue life within an order of magnitude. It can be used to guide inspecting engineers where to look for the first signs of fatigue cracking.

For inspection purposes, consideration should be given to employing phased array ultrasonic methods rather than manual ultrasonic methods as a more robust, verifiable and reproducible method of non-destructive testing.

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