8.4.2 Design for temporary works

Consideration shall be given to the design of temporary works, including required temporary road plates and provision of access.

Temporary road plates shall be designed for the specified repair design loads, anticipated traffic conditions and the extremes of thermal bridge movements possible during the repair period.

The structural integrity of bridge members and the bridge shall be maintained during repair work and in a condition suitable for vehicle and pedestrian use.

Where it is not feasible to provide sufficient load-carrying capacity for the temporary works, consideration shall be given to reducing traffic loads by—

(a) applying load limits;

(b) applying speed limits;

(c) moving lanes;

(d) reducing the number of lanes; or

(e) closing the bridge.

8.5 REPAIR DESIGN OUTPUT

8.5.1 General

Design output shall include a repair design report, deck joint repair drawings and the provision of a relevant technical specification.

8.5.2 Deck joint repair design report

The report shall include—

(a) design assumptions and loads;

(b) design calculations for joint movement range and anchorage requirements; and

(c) evidence of design verification.

8.5.3 Deck joint repair drawings

Drawings of the deck joint repair design shall be in sufficient detail for carrying out the repair and shall include the following:

(a) Relevant authority's plan registration number.

(b) General arrangement showing bridge articulation and bridge joints.

(c) Set-out information, tolerances and clearances.

(d) Location of utilities and any required adjustments.

(e) Joint gap widths with installation temperature corrections.

(f) Details of temporary works.

(g) Details of deck joint repairs.

(h) Sequencing of the repair work.

(i) Traffic management for each stage of the repair work.

8.5.4 Deck joint repair specification

A technical specification for the deck joint repair work shall include the following:

(a) Relevant legislation, regulations, Codes and Standards.

(b) Replacement joints and relevant authority specifications.

(c) Joint anchorages and protective treatments.

(d) Applicable authority technical specifications.

8.6 DECK JOINT REPAIR WORK

8.6.1 General

The deck joint repair work shall be carried out in accordance with the approved deck joint repair design report, drawings and specification, and shall include the requirements of Clauses 8.6.2 and 8.6.3.

8.6.2 Removal and replacement of deck joints

Existing bridge members shall not be removed, demolished, dismantled, cut, drilled or otherwise disturbed except as detailed in the repair design report or on the deck joint repair drawings.

8.6.3 Deck joint installation

Deck joints shall be installed in compliance with the repair design report, the deck joint repair drawings and the deck joint repair specification.

On completion of the joint repairs, the work site shall be reinstated including any damage to bridge members and any disturbance to utilities. Work-as-executed drawings shall be prepared showing all changes to the bridge, including deck joints, using the original bridge design drawings and the deck joint repair drawings, as appropriate.

SECTION 9 BARRIERS

9.1 GENERAL

This Section sets out requirements for the inspection, assessment and repair of existing bridge barriers. It also provides for the assessment of barrier performance levels, to be used in the consideration for the design of replacement traffic barriers.

NOTE: Barriers may require repair because they are deteriorated, or damaged by accidental vehicle impact.

The barrier repair design shall take into account the methods available for repairing or replacing damaged barriers.

9.2 REPAIR DESIGN

9.2.1 Minor repairs

Minor repairs generally comprise the following:

(a) Repainting steel and, where appropriate, timber barriers.

(b) Corrosion protection to spot areas of painted steel or galvanized barriers.

(c) Corrosion protection to reinforcement contained in reinforced concrete barriers.

(d) Replacement and retightening of loose fasteners.

(e) Repairs to grout and mortar pads supporting steel posts.

(f) Pressure washing of barriers to remove salt and other contaminants.

9.2.2 Major repairs

Major repairs generally comprise the following:

(a) Emergency temporary repairs required to make safe traffic accident damage to the barrier.

(b) Replacement of damaged steel barrier elements. All elements that have undergone structural damage shall be replaced. Steel elements that have undergone plastic deformation shall be removed and not re-used. Damaged anchor bolts shall be replaced.

(c) Replacement of damaged reinforced concrete elements.

9.3 INSPECTION AND CONDITION ASSESSMENT

Barriers shall be visually inspected for deterioration as part of scheduled regular bridge inspections carried out by the relevant authority. The condition state of the barriers shall be reported in accordance with the relevant authority's bridge inspection and condition rating system.

Barriers that have sustained damage from accidental vehicle impact shall be reported as soon as practicable to the relevant authority for action, and shall be made safe until a permanent repair can be effected.

For barriers that have deteriorated, the causes of deterioration shall be identified, and proposals provided for arresting and preventing further deterioration.

9.4 REPAIR OPTIONS

For barriers assessed as requiring repair, options for the repair design shall be prepared taking into account the level of deterioration, constraints on the execution of the repair and the cost for each option, with higher levels of detail provided for complex repairs.

When developing the repair options the following shall be considered:

(a) Rehabilitation or replacement of the barriers.

(b) For replacement, use of the same or upgraded barrier performance level.

(c) Options for on-site or off-site rehabilitation of barrier components.

(d) Timing of the repair work.

(e) Traffic management and disruptions during repairs.

Sketches shall be used to detail the scope and key features of the repair options, including whether to repair by rehabilitation or refurbishment, replacement barrier types, temporary works required, methods of executing the repair and management of traffic whilst carrying out the repair.

A report shall be provided to the relevant authority comparing the merits and cost of each option for the barrier repair.

NOTE: The report should include a recommendation with justification of the preferred option for the repair design.

9.5 FULL BARRIER REPLACEMENT OR MAJOR UPGRADE

Where a bridge is being widened, or substantially rehabilitated, full barrier replacement shall be undertaken in accordance with AS 5100.1 and AS 5100.2.

Where considered necessary by the relevant authority, the need to upgrade or replace the barriers on a particular bridge shall be assessed using an appropriate risk assessment process.

NOTE: Guidance on the risk assessment process is given in Appendix C.

The performance level of a replacement or upgraded barrier shall be indicated on the drawings. Where the performance level of a replacement or upgraded barrier meets the geometric requirements of a performance level in AS 5100.2 but does not achieve the strength requirement, its performance level shall be indicated as a percentage of the performance level strength in AS 5100.2 (e.g. 60% medium performance level).

SECTION 10 CULVERTS

10.1 GENERAL

This Section sets out minimum requirements for the repair, rehabilitation and strengthening of concrete, corrugated steel and corrugated aluminium culverts, including arches, with clear spans (or design diameters) extending from 1800 mm and up to 6000 mm. Spans in excess of 6000 mm shall meet the requirements of concrete and steel structures outlined in other Sections of this Standard, unless otherwise noted in this Section.

NOTE: For masonry culverts, see Section 6.

This Section applies to pipes, arches and box culverts manufactured using a variety of materials including reinforced concrete, aluminium and steel.

These culverts are buried structures subject to fill loading and live loads from road and rail traffic.

Requirements cover—

(a) drainage (not under pressure);

(b) pedestrian access;

(c) vehicular access;

(d) fauna crossings; and

(e) grade separation

10.2 CONDITION ASSESSMENT CRITERIA

10.2.1 General

A wide application of buried structures is covered within the generic term culverts, which range from circular and other shaped pipelines to reinforced concrete box culverts to reinforced concrete and steel arches. Clauses 10.2.2 to 10.2.6 outline criteria that shall be considered in assessing the existing condition of these buried structures.

10.2.2 Strength and serviceability

10.2.2.1 *General*

Culvert installations support the weight of the embankment or fill covering a buried structure and live load resulting from vehicular or rail traffic traversing the culvert.

A review of previous inspection reports and as-built drawings shall be undertaken in conducting a condition assessment of an existing structure. In addition and where available, calculations undertaken to design the original structure (and modifications thereto) shall also be considered. Where as-built drawings are not available, design drawings shall be reviewed and dimensions and properties compared to the installed culvert.

When assessing condition, and unless otherwise directed by the relevant authority, loads shall be determined in accordance with AS 5100.2 and their distribution through fill as outlined in the respective product design Standard where applicable.

NOTE: Distribution of live load through embankment and fill conditions is contained in AS/NZS 2041.1, AS/NZS 2566.1, and AS/NZS 3725. AS 5100.3 also outlines distribution through fill that may apply where no other product-related Standard is available.

10.2.2.2 *Reinforced concrete culverts*

Reinforced concrete arches, box culverts, link slabs and base slabs shall be assessed for strength by calculation in accordance with the AS 1597.2 and the relevant parts of AS 5100, as appropriate. Crack orientation and crack width shall be taken into account when assessing the strength of the culvert (see also Clause 3.2.10).

10.2.2.3 *Metal culverts*

Corrugated metal structures of circular and other shapes (including metal arches) shall be assessed for strength in accordance with AS/NZS 2041.1. Deflected shape, seam condition and structural base metal thickness after metal loss due to corrosion shall be taken into consideration when assessing the strength of the culvert. The structural base metal thickness shall be based on measured wall thickness.

Helical seams shall be inspected for cracking and separation. Plate joints shall be inspected for open seams, cracks at bolt-holes, plate distortion and bolt tipping. Dents and localized wall damage shall also be inspected as they can impair the ring compression or result in open joints and seams.

Corrosion of steel shall be assessed with respect to the metal thickness, any protective applied coating, the existing environment both within the culvert and outside side support material and the remaining required in-service life. Abrasion shall also be investigated as it can accelerate corrosion, particularly when the culvert is routinely subject to high flow rates and bed load.

NOTE: Uncontrolled corrosion will result in wall perforations and potential seepage of backfill material into the culvert, resulting in failure of side support and loss of culvert shape. Corrosion will produce structural failure if the culvert wall material is extensively removed.

10.2.2.4 *Masonry*

Assessment of masonry condition shall be in accordance with Section 6.

10.2.2.5 *Concrete pipes*

Concrete pipes shall be designed and manufactured to AS/NZS 4058 by performance-based testing.

Assessment of strength in service of concrete pipes shall include visual inspection and identification of the pipe size and load class for the respective installation condition, as outlined in AS/NZS 3725. Crack orientation and crack width shall be taken into account when assessing the strength of the pipe.

NOTE: For crack width, see Clause 3.2.10.

10.2.3 Hydraulic performance

The hydraulic performance of the culvert shall be determined by its size, shape, wall material and profile, slope, inlet and outlet treatments.

Performance of an existing culvert shall be assessed taking into consideration—

(a) changes in landform activities and watercourse alignment upstream that may increase flow discharge and flow velocity;

(b) changes in landform activities and watercourse alignment downstream that may retard discharge from the culvert;

(c) debris blocking in part or completely the culvert inlet structure;

(d) scour at the inlet and outlet structure and adequacy of the protection;

(e) piping at inlet structures and along the culvert (noticeable at joints);

(f) sediment build-up both outside and within the culvert;

(g) joint damage within the culvert; and

(h) abrasion of the culvert surface.

When an existing culvert is being refurbished, rehabilitated, strengthened or extended, the design flows and hydraulic methodology shall be undertaken to the latest Code or Standard, unless otherwise directed by the relevant authority.

10.2.4 Embedment

Materials for embedment and compaction levels for culvert installations are outlined in the relevant product installation Standards. A flexible culvert (manufactured from corrugated metal) is a composite structure involving an interaction with the culvert and the surrounding supporting soil.

Flexible culverts typically have relatively low stiffness in comparison to a rigid concrete culvert.

The load-carrying capacity of rigid concrete culverts is essentially provided by the structural strength of the culvert; however, the surrounding soil does still contribute to resisting vertical load.

Irrespective of the culvert type, an investigation including the following criteria shall be reviewed in any condition assessment of buried infrastructure:

(a) Minimum cover of fill over the buried existing structure as required by the relevant product installation Standard.

(b) Level of side support provided by the embedment zone (that is, bedding) and native soil in the installation and to the required compaction level, considering both material quality and compaction levels.

(c) Trench widths are in accordance with the specified width on work-as-executed drawings.

(d) Foundations are capable of providing uniform and stable support.

Construction loads applied during installation shall also be assessed where works-as-executed drawings and other relevant information is available.

NOTE: Embedment material and compaction requirements for flexible culvert installations are covered in—

(a) AS/NZS 2041.2 for corrugated metal circular and other shape culverts, and

(b) AS/NZS 2566.2 for metallic large diameter pipes;

and for rigid culverts in—

(c) AS 1597.2 for precast reinforced concrete box culverts, and

(d) AS/NZS 3725 for concrete pipe.

10.2.5 Other criteria

Other criteria that shall be assessed in determining the condition of a culvert include the following:

(a) Recorded settlement in the pavement over the culvert (possibly resulting from insufficient embankment compaction or loss of embankment support).

(b) Debris collection and other visual evidence upstream and downstream indicating the water level (compared to design).

(c) Visibility for safety and security within the culvert where used by pedestrians and any need for lighting.

(d) Vertical and horizontal clearance to the underside of the culvert and the need to signpost.

(e) Leaking joints and perforations resulting from faulty installation or corrosion.

(f) Floor grade that can limit usage and functionality (particularly where settlement has occurred).

(g) The treatment of the culvert surface for removal of graffiti.

(h) Measures required to ensure safety of members of the public and inspection and maintenance personnel.

(i) Impact of fencing at culvert inlets with respect to flooding and debris build-up.

10.3 REPAIR, REHABILITATION AND STRENGTHENING OF STRUCTURES

10.3.1 General

The repair, rehabilitation and strengthening of culvert structures includes the lengthening of existing culverts. This covers provisions for upgrading the existing culvert to provide the required hydraulic and structural capacity.

10.3.2 Reinforced concrete culverts

Concrete elements shall be remediated in accordance with Section 3, using suitable repair and protection procedures.

Dents, bulges, chips and spalls in the order of 200 mm in diameter (and blowholes up to 20 mm) and not more than 12 mm in depth may not require further investigation unless there is evidence of rust staining.

NOTE: Strengthening of reinforced concrete culverts may require one or a combination of the following:

(a) Additional wall at midspan.

(b) Composite steel plate or FRP.

(c) Local concrete thickening and additional reinforcement to the base.

(d) Local concrete thickening and additional reinforcement to the crown.

(e) Installation of steel struts.

(f) Slip lining.

Strengthening of culverts shall consider possible reduction in hydraulic capacity.

10.3.3 Metal culverts

Repair and rehabilitation measures for metal culverts shall include one or a combination of the following:

(a) Installing a reinforced concrete invert to repair or replace a deteriorated invert of a corrugated metal pipe.

(b) Installing a new lining internal pipe or lining inside an existing pipe.

(c) Spot patching and repairing.

(d) Installation of a cathodic protection system to prevent further corrosion.

(e) Applying internal bands or similar repairs to problem joints.

(f) Shotcrete lining.

(g) Sandblasting and repainting or recoating.

(h) Stabilizing or filling voids in the embedment surrounding the culvert.

(i) Excavating, realigning and replacing.

10.3.4 Lengthening of existing culverts

Where lengthening is required, the existing culvert shall be assessed to provide the required hydraulic capacity and for compliance with the AS(AS/NZS) 5100 series and upgraded as required by the relevant authority.

The interface between the old and new sections of the culvert shall be designed and detailed to avoid blockage of the culvert by trapped debris.

Consideration shall be given to one or a combination of the following:

(a) Design of connection between new and existing structures.

(b) Use of similar materials to simplify connection and minimize differential movements.

(c) Upgrading inlet and outlet protection.

(d) Hydraulic performance of the lengthened culvert:

  (i) Provision of additional culvert(s).

  (ii) Enlarging diameter at outlet.

  (iii) Tapered inlets.

  (iv) Lining of culvert to improve water flow.

10.3.5 Hydraulic performance

Damage to concrete headwalls and wing walls shall be—

(a) repaired or rehabilitated in accordance with Section 3; or

(b) reconstructed.

Consideration shall be given to the protection of the inlets and outlets to withstand hydraulic forces generated during peak flows (see Note 1).

Seepage along the outside of the culvert cell shall be blocked to prevent the development of piping and the removal of the embedment material providing support to the culvert (see Note 2).

NOTES:

1 Inadequately protected inlets and outlets may be subject to damage due to hydraulic forces generated during peak flows and damage to surrounding property and washout of the roadway or railway may result.

2 Seepage may be eliminated by modifications to the inlet structure, such as extending the concrete apron and the wing walls deeper into the soil.

10.4 DESIGN REQUIREMENTS

10.4.1 Reinforced concrete culverts

Rehabilitation and strengthening design of reinforced concrete culverts shall be in accordance with AS 5100.5.

10.4.2 Metal culverts

Rehabilitation and strengthening design of corrugated metal culverts of circular and other shapes (including metal arches) shall be in accordance with AS/NZS 2041.1.

Reinforced concrete elements shall be designed in accordance with AS 5100.5.

10.5 TESTING

Testing (other than load testing) of culvert units shall be undertaken in accordance with Section 3.

Load testing of an existing buried concrete structure to determine strength and serviceability criteria shall be undertaken in accordance with the provisions of AS 5100.5.

SECTION 11 WORK, HEALTH AND SAFETY AND QUALITY REQUIREMENTS

11.1 GENERAL

Health and safety shall be considered at all times during all maintenance or rehabilitation repair operations. Rules and regulations for the health and safety of personnel as well as safety for traffic and the bridge shall be adhered to when handling or applying the various types of proprietary or specialized materials.

A site safety plan detailing all site-specific safety risks associated with repair, maintenance and assessment work, shall be developed to ensure compliance with all relevant Work, Health and Safety Legislation.

The relevant government authorities shall be consulted to obtain updated regulations and codes of practice. Where required, relevant personnel shall comply with the provisions of Work, Health and Safety Legislation, including—

(a) scaffolding and access requirements;

(b) confined spaces;

(c) working at heights;

(d) use and maintenance of personal protective equipment;

(e) inspection, testing and tagging of electrical equipment;

(f) use of life jackets whilst in boats or over water; and

(g) safe design of structures.

11.2 HANDLING PRECAUTIONS

The materials and products in their uncured state may cause skin irritation, or sensitization or other injuries or diseases. Manufacturer's safety data sheets and labels for use, handling, storage and disposal of repair materials and products shall be followed.

Suitable personal protective equipment shall be utilized at all times in order to ensure protection of personnel. Personnel utilizing various repair materials and products shall be suitably trained and instructed of potential hazards, and the correct use of equipment and working procedures shall be enforced during repair operations.

11.3 FIRST AID

Health and safety plans shall provide procedures that consider first aid for eyes, skin, inhalation, ingestion and fire.

11.4 CLEANING UP

Any leaks or spillages, tools and equipment shall be cleaned up in a timely manner and waste shall be disposed of in line with environmental legislation.

11.5 QUALITY REQUIREMENTS

Detailed quality, inspection and sampling and testing procedures shall be prepared as part of the overall pre-planning for the works, including concrete repair, rehabilitation, strengthening and protective systems. This shall include procedures for satisfying Work, Health and Safety Legislation and environmental requirements (including waste control and disposal).