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| AUSTROADS TECHNICAL SPECIFICATION ATS2230 Supply of Small Box Culverts | A close up of a flag  Description automatically generated |

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# Scope

This Austroads Technical Specification ATS 2230 sets out the requirements for the supply of small precast reinforced concrete rectangular box culverts, up to 1200 mm wide and 1200 mm high, and associated link slabs. It excludes box culverts:

1. which are subject to internal hydraulic pressure;
2. which are placed under more than 2.0 metres of fill;
3. where conformity is demonstrated by design instead of strength load testing (refer AS 1597.2);
4. that are designated railway load class in accordance with AS 1597.1; or
5. that are U shape culverts as defined in AS 1597.1

Further to the provisions of Appendix A of AS 1597.1, the required size, load classes, exposure classification, culvert types and other information are as shown on the drawings or as specified.

Culvert Components must comply with the requirements of AS 1597.1 and as stated in this Specification.

# Definitions

In addition to the definitions in AS 1597.1 and AS 5100.5, the following definitions apply to this Specification:

Culvert Component: A reinforced concrete inverted U shape box culvert and/or link slab.

Professional Engineer: A Chartered Professional Engineer who:

1. is registered on the National Engineering Register (NER);
2. is registered on any scheme of registration of engineers prescribed by legislation in the applicable jurisdiction;
3. has at least 5 years’ experience in design of concrete structures; and
4. is appropriately registered or prequalified if the Principal has implemented an applicable registration or prequalification scheme.

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| For Culvert Components manufactured and/or installed in Queensland, the following additional requirement applies:The Professional Engineer must be a Registered Professional Engineer of Queensland (RPEQ). |

The following definitions apply to the lifting requirements:

Applied Load The dead weight of the precast concrete culvert multiplied by the sling

per Anchor: angle factor and the dynamic factor and divided by the number of effective lifting points used in the lift.

Dynamic Factor: A multiplying factor to account for dynamic effects during lifting.

Factor of Safety: The ultimate capacity (lower characteristic strength) of the lifting anchor divided by the applied load per anchor.

Lifting Anchor: A cast in, bolted on or otherwise attached device anchored to the precast culvert component at the lifting point, which is provided exclusively for lifting the precast concrete culvert.

Lifting Attachment: Lifting device used to attach a lifting anchor to the hoisting equipment.

Lifting Point: The designed location of a lifting device to be used for lifting a precast concrete culvert.

Rigging Diagram: Diagram showing the method for attaching hoisting equipment to the precast concrete culvert, the required sling angles and load sharing requirements.

Sling Angle Factor: The factor by which the tension in a sling increases according to the included angle between the slings.

Working Load Limit: The maximum load which may be applied to a lifting anchor, device or attachment.

# Referenced Documents

The following documents are referenced in this Specification.

**Austroads** (available from:<https://austroads.com.au/publications>)

AGBT T710–19 Austroads Test Method - Accelerated Mortar Bar Test - Alkali-Silica Reactivity of Aggregate

AGBT T771–19: Austroads Test Method - Alkali Aggregate Reactivity Assessment - Concrete Prism Test

ATS 5210 Supply and Placement of Steel Reinforcing

ATS 5340 Cementitious Patch Repair of Concrete

**Australian/New Zealand Standards**

AS 1012 Methods of testing concrete

AS 1379 Specification and supply of concrete

AS 1597.1 Precast reinforced concrete box culverts Part 1: Small culverts (not exceeding 1200 mm span and 1200 mm height)

AS 2193 Calibration and classification of force-measuring systems

AS 2350.2 Methods of testing portland, blended and masonry cements Chemical composition

AS 2425 Bar chairs in reinforced concrete – Product requirements and test methods

AS 2758.1 Aggregates and rock for engineering purposes - Concrete aggregates

AS/NZS 3582.1 Part 1: Supplementary cementitious materials - Fly ash

AS 3582.2 Part 2: Supplementary cementitious materials - Slag ‑ Ground granulated iron blast furnace

AS/NZS 3582.3 Part 3: Supplementary cementitious materials - Amorphous silica

AS 3610 Formwork for concrete

AS 3799 Liquid membrane‑forming curing compounds for concrete

AS 3972 General purpose and blended cements

AS/NZS 4680 Hot dip galvanized (zinc) coatings on fabricated ferrous articles

AS 5100 Bridge design

AS/NZS ISO 9001Quality management systems – Requirements

**Australian Technical Infrastructure Committee**

ATIC SP43 Section SP43 Cementitious materials for concrete

**ASTM International**

ASTM C295 Standard guide for petrographic examination of aggregates for concrete

ASTM C1202 Rapid chloride penetrability test

**National Transport Commission** (available from: [https://www.ntc.gov.au](https://www.ntc.gov.au/))

NTC Load Restraint Guide

# Quality System Requirements

The Culvert Components must be manufactured under a quality management system which is independently certified by a JAS/ANZ accredited organisation as fully complying with AS/NZS ISO 9001. Evidence of the certification must be provided prior to the commencement of the supply of Culvert Components to the site.

The Hold Points and Witness Points applicable to this Specification are summarised in Annexure A.

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| For Culvert Components to be installed in Queensland, the following additional requirements apply:Culvert Components must be manufactured by a Transport and Main Roads registered supplier.Cementitious materials, aggregates, concrete admixtures, steel reinforcement, bar chairs, curing compounds, cast in lifting anchors, repair grouts/mortars and crack injection epoxies must be a Transport and Main Roads registered product.Further details are available from: <https://www.tmr.qld.gov.au/business-industry/Business-with-us/Approved-products-and-suppliers> |

# General

Individual Culvert Components must be manufactured square and not skewed. Components must not be cut to shape.

Link slabs must be simply supported on mortar seatings on the top of the culverts. Four bar anchors per 1.2 m long slab section must be provided to locate the assembly. The bar anchors must pass through holes in the link slab and be grouted into holes provided in the legs of the culvert crowns.

# Materials Manufacture and Dimensioning

Further to AS 1597.1, the culverts must be manufactured in accordance with the additional requirements set out in this Clause 6.

## Reinforcement

(Refer AS 1597.1 Clause 2.3)

Steel reinforcement used in the manufacture of Culvert Components must comply with Austroads Technical Specification ATS 5210.

Reinforcement must be placed within a tolerance of ± 5 mm.

The placing of the reinforcement must be such as not to interfere with the location of lifting holes, lifting anchors, dowel bars or any other cast in items. The reinforcement may be displaced locally to obtain the required cover to these items.

Bar chairs and spacers must comply with ATS 5210. For Exposure Classification C2 and box culverts placed in saltwater, the bar chairs or spacers must be stainless steel or concrete.

## Cement and Supplementary Cementitious Materials

(Refer AS 1597.1 Clauses 2.4.1 & 2.4.2)

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| For Culvert Components to be installed in Queensland, the following applies:A cementitious blend which complies with Table 6.9 must be used. |

The cementitious material used in the manufacture of the Culvert Components may be up to 100% GP Cement only if:

1. the Culvert Components are to be installed in a B1 Exposure classification (as defined in AS 5100); and

b) the aggregates are classified as non-reactive when assessed in accordance with the following process:

1. The aggregates are assessed for any unstable silica minerals by petrographic examination in accordance with ASTM Test Method C295.
2. The potential alkali silica reactivity of all aggregates is determined using either AGBT T710 – 19: Accelerated Mortar Bar Test - Alkali-Silica Reactivity of Aggregate or AGBT T701 – 19: Alkali Aggregate Reactivity Assessment - Concrete Prism Test.

Aggregates which are classified as reactive may only be used if a cementitious blend in accordance with Table 6.9 is used.

For an Exposure classification which is more severe than B1 or where a cementitious blend for control of alkali silica reaction is required, the cementitious materials must comply with the criteria specified in Table 6.9 in with the combined total adding to 100%. The tolerances in Clause 4.2 of AS 1379 apply to Table 6.9.

Table 6.9: Cementitious materials content

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Blend no. | GP cement (%) | Fly ash (%) | Ground granulated blast furnace slag (%) | Amorphous silica (%) |
| 11 | 65 to 75 | 25 to 35 |  |  |
| 2 | 50 to 55 | 25 to 30 | 20 to 25 |  |
| 3 | 60 to 70 | 25 to 30 |  | 5 to 10 |
| 4 | 30 to 40 |  | 60 to 70 |  |

1. not permitted for Exposure Classification C, C1 and C2

Type High Early (HE) cement which also satisfies the requirements of Type General Purpose (GP) cement may be substituted for Type GP Cement in any of the blends.

Cementitious materials must:

1. comply with the requirements of ATIC‑SPEC SP43;

b) be registered under the Cementitious Material Registration Scheme (CMRS) in accordance with ATIC‑SPEC SP43; and

c) not be used in the manufacture of Culvert Components if they are more than 3 months old, unless they are re‑tested to demonstrate compliance with this Specification.

## Aggregates

(Refer AS 1597.1 Clause 2.4.3)

Aggregate for concrete must comply with the requirements of AS 2758.1 and the specifications listed in Table 6.12:

Table 6.12: Aggregate requirements

|  |  |
| --- | --- |
| Jurisdiction where the Culvert Components are to be installed | Applicable Specification |
| Queensland | Clause 7.5 of TMR [MRTS70 Concrete](https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Specifications/2-Bridges-Marine-and-Structures#MRTS70) |
| South Australia and Northern Territory | Clause 3.3 of DPTI [ST-SC-S7 – Supply of Concrete](https://www.dpti.sa.gov.au/__data/assets/pdf_file/0009/551457/MASTER_SPECIFICATION_-_PART_ST-SC-S7_-_SUPPLY_OF_CONCRETE.pdf) |
| Western Australia  | Clause 820.08 of MRWA [Specification 820 Concrete for Structures](https://www.mainroads.wa.gov.au/BuildingRoads/TenderPrep/Specifications/Pages/800Series.aspx) |
| New South Wales and ACT | Clause 2.4 of RMS [B80 Concrete Work for Bridges](https://www.rms.nsw.gov.au/business-industry/partners-suppliers/document-types/specifications/qa/bridgeworks.html#Concretemembers,B80-B170) |
| Victoria and Tasmania | Clause 610.11 of VicRoads [Section 610 Structural Concrete](http://webapps.vicroads.vic.gov.au/VRNE/csdspeci.nsf/) |

## Water

(Refer AS 1597.1 Clause 2.4.4)

The quality of water to be used in the concrete mix and for the curing of concrete must comply with the requirements of Clause 2.4 of AS 1379. However, for sources other than water drawn from a stable reticulated drinking water supply, the following applies when tested in accordance with the test methods listed in Table 2.3 of AS 1379:

1. chloride content must not be greater than 0.03% (300 ppm);
2. sulphate content (as SO4) must not be greater than 0.04% (400 ppm).

The total dissolved solids of any recycled water used in the concrete mix must not be greater than 700 milligrams per litre.

Any recycled or non-potable water must be sampled and tested to demonstrate compliance with the requirements of this Specification and AS 1379. The interval between testing times must not exceed one month.

## Restriction on Chemical Content

(Refer AS 1597.1 Clause 2.4.6)

The sulphate and acid soluble chloride ion content must be determined by either testing hardened concrete in accordance with Clause 6.18 or testing the individual components of the mix and calculating them in accordance with Clause 6.19. Tests are to be repeated yearly.

Notwithstanding Table 2.2 of AS 1379, for Exposure classification C, the acid soluble chloride must not exceed 0.4 kg/m³.

Where chloride ion content is determined by testing of hardened concrete, the testing must be in accordance with the following:

1. Sampling in accordance with AS 1012.8.1 with a minimum sample size of 1.2 kg;

b) Testing in accordance with AS 1012.20.1;

1. 2 portions (subsamples) must be tested; if either is non-conforming, a further three portions must be tested; and
2. The test report must include:
3. details as per AS 1012.20.1 Clause 9;

ii) individual chloride contents (by mass) from each sample;

1. average chloride content (by mass);
2. standard deviation of chloride content (by mass); and
3. average chloride content (kg/m³).

Where chloride ion content is determined by testing individual components and calculation, the process must be in accordance with the following:

1. Testing of individual components for chloride ion content must be in accordance with AS 1012.20.1 for aggregates and AS 2350.2 for cementitious materials; and
2. The total chloride content of concrete must be determined by the summation of the individual chloride contents of the mix components (cementitious material, aggregates, water and admixtures) in the same proportions as the quantities in the mix design.

## Admixtures

(Refer AS 1597.1 Clause 2.4.5)

Admixtures must be used in accordance with AS 1379.

Admixtures other than water reducing (WR, MWR, HWR), such as set retarding (Re), set accelerating (Ac), air-entraining (AEA), viscosity modifying admixtures or slump retention admixtures, or a combination of these (for example, WRRe) must not be used.

Sugar, independent from an AS 1478-complying admixture, must not be used as a set retarding agent.

The total alkali contribution (measured as Na2O equivalent) of all admixtures used in a mix must not exceed 0.2 kg/m3.

Admixtures in a single mix must be sourced from the one supplier, unless approved on the basis of satisfactory mix trials and evidence of performance.

Where air entrainment is used, the air content of the concrete used must have a maximum value of 6%, as measured by AS 1012.4, unless otherwise specified. The Contractor must provide an approved air content gauging device (which must operate in accordance with the manufacturer’s instructions) at the place of discharge of the concrete from the concrete agitator or on site batch plant (precast applications) so that the air content of the freshly mixed concrete may be accurately determined. In addition, the manufacturer must submit proof that the air content can be sufficiently controlled and that the compressive strength remains in compliance.

## Concrete Specification and Cover to Reinforcement

(Refer AS 1597.1 Clause 2.5)

The concrete mix design(s) used for the manufacture of box culverts must have been submitted to the Principal and approved by the Principal in the preceding 12 months.

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| **HOLD POINT 1.**  |
| Process Held | Supply of Culvert Components |
| Submission Details | Evidence that the manufacturer has submitted its concrete mix design to the Principal within the preceding 12 months must be provided at least 2 weeks prior to the delivery of the Culvert Components. |

The specified slump for conventional concrete must be in the range of 80 mm to 180 mm with acceptance tolerances in accordance with AS 1379.

Any superworkable concrete must comply with Table 6.28.

Table 6.28: Superworkable concrete

|  |  |
| --- | --- |
| Property | Acceptance limits |
| Spread: | 700mm with tolerance of ± 50 mm  |
| T500 time:  | ≤ 5 seconds |
| RCPT test value (tested in accordance with ASTM C1202): | Maximum 1000 coulombs at 56 days. |

The concrete mix design details must include the following:

1. Nominated range of applicable products
2. Mix identifier
3. Strength grade of concrete
4. Nominated slump or spread
5. Name of concrete supplier
6. Location of batch plant
7. Nominated source materials
8. Cementitious material (with ATIC reference)
9. Aggregates (with quarry details and appropriate test results)
10. Admixtures
11. Nominated cementitious blend
12. Chloride content test results (refer Clause 6.16 and AS/NZS AS 1597.1 Clause 2.4.6)

If recycled water is used, test results demonstrating that the water does not contain contaminates harmful to concrete and evidence of previous performance must be submitted with the mix design.

Concrete must comply with the requirements of AS 1379 and this Specification.

The Culvert Components must comply with Table 6.32, which replaces Table 2.3 of AS 1597.1.

Table 6.32: Concrete specification and nominal cover to reinforcement

|  |  |  |  |
| --- | --- | --- | --- |
| Exposure classification | Minimum cementitious material content | Maximum water/cementitious material (W/C) ratio | Required cover to steel reinforcement (mm) |
| Characteristic compressive strength (f’c) |
| **40 MPa** | **50 MPa** | **≥55 MPa** |
| B1 | 330 | 0.50 | 35 | 30 | 30 |
| B2 | 400 | 0.45 | 50 | 40 | 40 |
| C1 | 450 | 0.40 | Not Applicable | 70 | 70 |
| C2 | 470 | 0.36 | Not Applicable | Not Applicable | 70 |

The tolerance on concrete cover is -5 to +5 mm where a negative value indicates less cover than that specified.

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| For Culvert Components to be installed in Queensland, the following additional requirements apply:An Exposure classification less severe than B2 must satisfy the strength grade and concrete cover requirements for B2.For Culvert Components to be installed in Western Australia, the following additional requirements apply:The Characteristic Strength (f’c) must not be less than 50 MPa. If a Contractor has not previously supplied box culverts to Main Roads Western Australia, or has changed the concrete mix design of any culverts, in addition to providing the concrete mix design, the manufacturer must prepare a trial mix for the required class of concrete using the plant to be used for concrete in the works.Test results from the trial mix demonstrating compliance with the requirements of this Specification must be supplied to the Principal with the concrete mix design.  |

## Concrete Production, Placement and Curing

(Refer AS 1597.1 Clause 2.6)

Formwork must be rigid and constructed from metal. Timber formwork is not acceptable.

Culverts must be cast legs down or on end. Where a hole or void in the concrete is shown on the Drawings, the formwork or void former must be removed after casting.

The manufacturer must maintain a batch recording system that records the weight and volume of each component used in the concrete mix. These records must be made available to the Principal upon request.

Concrete must be deposited in horizontal layers in a manner to avoid segregation and displacement of the steel reinforcement or other embedded items or formwork.

Vibration must be by external form vibrators supplemented by internal vibration if required. External form vibrators are not required if Self-compacting concrete is used.

## Curing

(Refer AS 1597.1 Clause 2.6.3)

The concrete compressive strength for checking the adequacy of curing must be determined by test cylinders cured with and in the same manner as the concrete unit.

Curing must be carried out to meet the requirements of Table 6.44, which replaces Table 2.4 of AS 1597.1.

Table 6.44: Concrete curing requirements

|  |  |  |
| --- | --- | --- |
| Minimum characteristic concrete compressive strength (f’c) (MPa) | Required concrete compressive strength at completion of curing (MPa) | Required minimum concrete age (days) and minimum maturity (°C hrs) at completion of curing (whichever occurs first) |
| Moist | Membrane | Accelerated |
| Age(Days) | Maturity(°C hrs) | Age(Days) | Maturity(°C hrs) | Age(Days) | Maturity(°C hrs) |
| 40 | 28 | 7 | 3864 | 7 | 3864 | - | 550 |
| ≥ 50 | 35 |

Notes:

1. For concrete exposure classification U (as defined in AS5100.5), curing must in accordance with the drawings or as specified.
2. The required concrete compressive strengths at completion of curing are based on a compressive strength at completion of curing = 0.7 f’c. The Contractor may submit a proposal to the Principal to use partial accelerated curing followed immediately by membrane curing.
3. Any curing compounds must comply with the requirements of AS 3799. Two coats of curing compound at a minimum rate of 0.2 litres per m2 is required.
4. Accelerated curing must be conducted in accordance with the requirements in Appendix C of AS1597.1

## Internal Dimensions

(Refer AS 1597.1 Clause 2.8.1)

The actual internal cross sectional area must not be less than 95% of that specified by the nominal internal dimensions specified on the drawings.

The internal corners of the culverts must be finished with curved or straight fillets. The fillets must not reduce the waterway area by more than the amount specified in the previous clause.

## Tolerances

(Refer AS 1597.1 Clause 2.10)

End squareness must be measured on each end face across the unit section thickness. Verticality must be measured on each end and side face. The tolerances in Table 6.47 apply in addition to those listed in AS 1597.1 Table 2.7.

Table 6.47: Additional tolerances

|  |  |
| --- | --- |
| Measurement | Permitted tolerance from design |
| End squareness | ± 4 mm |
| Verticality | ± 20 mm |

## Storage and Handling (Refer AS 1597.1 Clause 2.11)

The manufacturer must a undertake a final visual inspection of the units prior to transport from the cast yard and include evidence of the inspection in the Conformance Report (refer Clause 8.1).

Culvert Components must be transported and handled in a manner which does not damage the Culvert Components and is in accordance with the NTC Load Restraint Guide.

During transportation, Culvert Components must be supported on bearers made of timber or other suitable material. Rubber strips must be placed between units, both laterally and longitudinally. All tie down straps and chains must have rubber protection strips over the box culvert edges.

Precast base slabs and link slabs must be transported in the as laid position.

Culvert Components to be stored must be placed on an even surface, stacked and supported in a manner that will avoid damage. Culvert Components may be stored in more than one layer. Timber or other suitable material which does not damage, mark or stain the culverts must be used as supports between the ground and the Culvert Components and separating each layer. For Culvert Components, the stack height must not be greater than either six metres or six culverts.

Lids or base slabs must be stored in separate stacks of identical units up to a maximum height of six units separated by suitable packers which do not stain, damage or mark the culverts in any way. The packers must be placed near the ends of the slab and directly above the supports of any lower layer.

## Provision for Lifting

(Refer AS 1597.1 Clause 2.11.2)

The design of the lifting mechanism must comply with the following:

1. Lifting anchors must fail in a ductile manner as evidenced by visible distortion prior to failure.
2. The minimum factor of safety for the design of the lifting points for both lifting anchor and concrete pull out capacity must be 4.0.
3. The minimum allowance for dynamic effects must comply with Table 6.54:

Table 6.54: Dynamic effects

|  |  |
| --- | --- |
| Situation | Allowance for dynamic effects |
| Gantry crane on steel rails (in precast yard) | 1.2 |
| Stationary hydraulic crane standing on outriggers | 1.2 |
| Tracked mobile lifting equipment travelling with the suspended load on a prepared even surface | 1.7 |
| Non-tracked mobile lifting equipment (including rubber tyred) travelling with the suspended load on a prepared even surface | 2 |
| All mobile equipment travelling with the load suspended on unprepared uneven surfaces | 5 |
| Any other case not listed above  | not less than1.5 |

The number of lifting points and the location of these points must be designed to provide stability at all stages of lifting, handling and installation, including the requirement to place the product at the required level during installation.

With the exception of small box Culvert Components with a mass less than 500 kg, a minimum of four lifting points must be provided, and no product must be lifted with less than two points.

The Contractor must ensure that the Professional Engineer who designed the lifting mechanism certifies that the lifting points and/or rigging diagram comply with this Specification. The certification must be included in the Conformance Report (refer Clause 8.1).

Culvert Components must be lifted using the lifting points provided, as shown on the drawings and/or rigging diagram.

If holes are provided instead of cast‑in lifting anchors, the manufacturer must supply tight‑fitting concrete or plastic plugs with each consignment to seal the holes. Alternatively, the holes can be filled with a cementitious repair grout.

Cover to reinforcement at the lifting anchor recess must be maintained in accordance with this Specification. Cover to the lifting anchor is not required if any recess is filled with a cementitious repair grout.

The lifting anchors must be made of:

Exposure Classification C2: Stainless steel

Less severe Exposure Classifications: Hot dip galvanised to AS 4680 or stainless steel.

All lifting anchors must be permanently marked or tagged by the manufacturer with the working load limit, which must be clearly visible.

Lifting anchors which are damaged must not be used without inspection and certification by a Professional Engineer.

## Workmanship and Finish

(Refer AS 1597.1 Clause 2.12)

The surface finish must comply with Class 2 to AS 3610.

## Defects

(Refer AS 1597.1 Clause 2.12)

A Culvert Component must not exhibit any of the following defects:

1. A crack or fissure wider than 0.15 mm.
2. An individual crack longer than 300 mm.
3. A cumulative crack length more than 500 mm.

Dents, bulges, chips and spalls of a depth or height not more than 3 mm in any direction are permitted, provided they do not extend over the surface for a distance greater than twice the wall thickness of the unit and provided that the required cover is maintained.

Crack widths must be measured at the surface and not with the feeler gauge method.

## Finishing and Repairs

(Refer AS 1597.1 Clause 2.14)

Unless specified otherwise in the Contract documents or approved by the Principal, units must not be coated with cement wash or any other preparation.

## Marking

(Refer AS 1597.1 Clause 2.15)

In addition to the requirements of AS 1597.1 Clause 2.15, the marking must include “ATS 2230”.

# Sampling and Testing

Further to AS 1597.1, the culverts must be sampled and tested in accordance with the additional requirements set out in this Clause 7.

## General

(Refer AS 1597.1 Clause 3.2)

Add the following to AS 1597.1 Clause 3.2.2 (a):

a) Changes to the maximum nominal aggregate size.

b) Changes to cover to reinforcement.

The testing machine used for load testing must meet the requirements of AS 2193 Class B and must be calibrated by NATA accredited laboratory. A jack and pressure gauge system may be used provided that calibration is carried out at not more than 12 monthly intervals.

## Required Tests

(Refer AS 1597.1 Clause 3.2.3)

Ultimate load testing is required for both routine and type testing.

The concrete cover to the steel reinforcement must be measured with a calibrated cover meter. One unit for concrete cover measurements from each 100 units of a batch or a maximum period of 3 months production must be selected for testing. The cover meter device must be capable of detecting the presence of reinforcement and indicating the depth from the concrete surface to the nearest point on the surface of the reinforcement with an accuracy of ± 2 mm at a depth of 25 mm.

Concrete Compressive Strength Testing must comply with the following:

1. The rate of sampling for concrete compressive strength testing must be one sample per 5 m3 of concrete where the manufacturer batches concrete, and one sample per truck where concrete is supplied as premixed concrete in trucks.
2. Each sample must consist of a minimum of 4 cylinders.
3. A minimum of one cylinder must be tested for compressive strength to prove that the curing requirements have been satisfied.
4. Where early stripping or lifting of the Culvert Component is proposed, a minimum of one cylinder must be tested for compressive strength to demonstrate that the concrete has attained at least 0.4 *f’c*.
5. A minimum of two cylinders must be tested for compressive strength as a matched pair at 28 days. The sample result must be the average of the two results except that the lowest result must be excluded if the two cylinder results differ by more than 2 MPa. It the test result is less than the specified characteristic strength the lot of culverts represented by the sample must be rejected.

## Type Testing

(Refer AS 1597.1 Clause 3.3)

When type tested in accordance with AS 1597.1 Clause 3.3, the culverts must satisfy the following additional requirements:

1. for culverts with a specified cover to reinforcement of greater than 50 mm, the crack widths must be the same as for culverts with 50 mm cover;
2. for ultimate load testing the coefficient of variation of the five recorded results must not be greater than 0.15;
3. testing of units must occur at 28 ± 5 days from the date of manufacture;
4. manufacture of the test units must be in accordance with this Technical Specification, including all materials;
5. for small culvert units with a nominal length of 2.4 m the design must have the same concrete thickness and distribution of reinforcement as a 1.2 m long unit; and
6. for testing of 2.4m long units, the test load only needs to be applied to one end of the unit.

The type testing must be witnessed by a Professional Engineer and the results certified and reported, in accordance with AS 1597.1 Clause G9.2. If requested, the test certificate and report must be made available to the Principal.

## Routine Sampling and Testing

(Refer AS 1597.1 Clause 3.4)

Both proof and ultimate load testing are required.

For testing of 1.2m and 2.4m long units, the test load only needs to be applied to one end of the unit.

A batch for proof load testing is defined as a maximum of 50 number units of the same size, and cover to reinforcement and manufactured and cured at the same casting yard within one calendar month.

If units are supplied from more than one source, or manufactured outside a one month period, these units are deemed to be more than one batch and the requirements of this Specification apply to each separate batch.

A batch for ultimate load testing is defined as a maximum of 150 number of units of the same size, and cover to reinforcement and manufactured and cured at the same casting yard within three calendar months.

If any sample element fails the respective test, that element will be rejected and the sampling regime specified in Table 7.14 must be implemented. Secondary samples will not be permitted during this time. The sampling frequencies specified in Table 7.14 must be in place for a minimum of six months, after which, if no further failures have occurred, a normal sampling frequency may be resumed.

Table 7.14: Tightened testing frequencies

|  |  |
| --- | --- |
| Test | Test frequency |
| Proof load | 1 in 10 or weekly1 |
| Ultimate load | 1 in 50 or monthly |
| Cover and dimensions | 1 in 50 or weekly |

1. Whichever gives the greater number of tests

## Acceptance

(Refer AS 1597.1 Clause 3.4.4)

Culvert Components will be accepted on the basis of full compliance with the requirements of this Specification and AS 1597.1.

The Sampling Plan for Routine Proof Load Testing and Ultimate Load Testing must comply with this Specification.

# Information to be Supplied by the Manufacturer

(Refer AS 1597.1 Appendix A3)

A Conformance Report must be supplied on, or prior to, delivery. This report must include:

1. Confirmation that the Culvert Components have been manufactured under a quality system certified to AS/NZS/ISO 9001 by a JASANZ accredited organisation.
2. Definition of the batch(es) that the report covers including:
3. Design (size, exposure classification, product code/drawing number)
4. Date range of manufacture

iii) Individual unit identifiers

iv) Batch size.

c) A Visual Inspection report issued prior to transportation from the casting yard.

d) Certification of the lifting mechanism from the Professional Engineer.

e) Report(s) of load testing in accordance with AS 1597.1 Clause 3.2.3, including:

1. Proving test load results
2. Ultimate load test results
3. Concrete compressive strength
4. Cover to reinforcement
5. Dimension accuracy checks
6. Steam curing charts.
7. A statement of whether the Culvert Component is defect free, has an acceptable defect or has been repaired/tested in accordance with Table 2.8 “Acceptability of Defects” of AS/NZS 1579.1.

With each batch of Culvert Components delivered to the site, a delivery docket must be supplied that provides traceability to the Conformance Report for the batch. The delivery docket must also state that the culverts supplied conform to the requirements of this Specification.

|  |
| --- |
| **HOLD POINT 2.**  |
| Process Held | Incorporation of Culvert Components into the Works |
| Submission Details | The Conformance Report and Delivery Docket must be provided at least 2 days prior to the incorporation of the Culvert Components into the Works. |

# Annexure A: Summary of Hold Points, Witness Points and Records

The following is a summary of the Witness Points/Hold Points that apply to this Specification and the Records that must be supplied by the Contractor to the Principal to demonstrate compliance with this Specification.

|  |  |  |  |
| --- | --- | --- | --- |
| **Clause** | **Hold point** | **Witness point** | **Record** |
| 6.26 | 1. Supply of Culvert Components |  | Evidence that the concrete mix design has been submitted to the Principal  |
| 8.2 | 2. Incorporation of Culvert Components into the Works |  | Conformance Report and Delivery Docket |

Amendment Record

|  |  |  |  |
| --- | --- | --- | --- |
| Amendment no. | Clauses amended | Action | Date |
| - | New specification | New | June 2020 |
|  |  |  |  |

|  |  |
| --- | --- |
| **Key** |  |
| Format | Change in format |
| Substitution | Old clause removed and replaced with new clause |
| New | Insertion of new clause |
| Removed | Old clauses removed |