Humes

Strength. Performance. Passion.

Box culverts

Issue 3

Contents

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Introduction

This brochure provides general information for both the specifier and user with only nominal dimensions shown. Specific dimensions of box culverts vary from state to state in Australia. When designing projects, reference should be made to the separate box culvert dimensions chart which is distributed by Humes in each state.

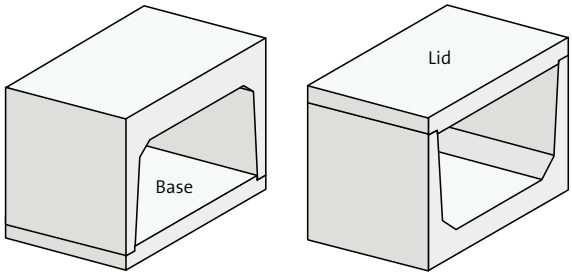
Box culverts are available either as an inverted U on a concrete base foundation (crown unit) or as a U shaped trough with a lid (invert unit), see Figure 1.

Humes designs and supplies precast bases and lids to suit individual culverts as well as Link Slab® units for multi-cell installations.

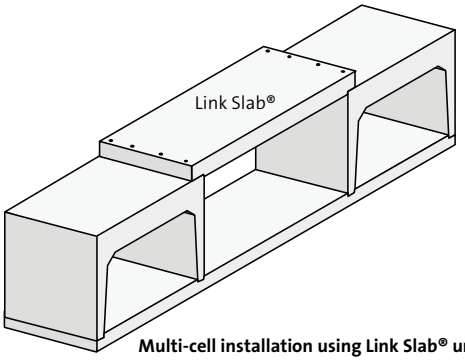
Humes also manufacture Uniculvert® modules where the crown and the base are cast integrally minimising site work and construction time.

Following recommendations given in the Australian Standard, large box culverts are specified by size class and load class ie: a 2,700 mm span x 1,500 mm leg used under 2 m of fill and AUSTROADS vehicle loading is specified as class 2715/2-A.

Figure 1 – Box culvert terminology



Crown unit **Invert unit**



Multi-cell installation using Link Slab® unit

Bottom:
Precast concrete box culverts and Link Slab® units

Applications

Box culverts are ideal for the following applications:

- **Instant bridging**
  Humes box culverts are designed to support the SM 1600 road traffic loads as defined in AS 5100 even when there is no overfill in place. Manufactured under quality assurance procedures, precast box culverts provide instant bridging with minimum traffic disruption.
- **Drainage structures with limited fill height**
  The shape and sizing of box culverts makes them ideal for drainage structures, in applications where cover to finished surface level is limited.
- **Pedestrian, fauna and stock crossings**
  Apart from hydraulic applications, the shape and sizing of precast box culverts means they are also eminently suitable as pedestrian subways and fauna/stock crossings under road and rail applications.
- **Industrial applications**
  Humes box culverts have been extensively used as ducting for electrical cabling, steam, air, hot water and oil as well as emergency/fire exits.

Benefits of precast box culverts

- **Wide flows with low head**
  Box culverts are ideal for flows where hydraulic head is limited. For an equivalent waterway area to circular pipes, box culverts can be configured to have less impact on upstream water levels and downstream flow velocities than equivalent pipe structures.
- **Instant bridging**
  Precast construction means that traffic may use the installation immediately after placing and backfilling whereas in-situ construction will require a period for curing prior to stripping forms ready for use. Due to their ability to tolerate heavy wheel loads even with no overfill in place, precast box culverts are superior to most alternative systems which require compacted overfill in place before loading is applied.
- **Difficult site conditions**
  When site conditions are difficult, particularly where excavation is in rock, installation of a box culvert requires minimal excavation and backfill.

Bottom:
High specification box culverts for a high overfill application

Design information

Hydraulic design

Box culverts are commonly used as a conduit under roadways or railways. Hydraulic designs of such structures involve:

- evaluation of peak design flow rate
- selection of culvert shape
- determination of operating condition of culvert, that is whether flow through the culvert is controlled by inlet or outlet conditions
- check of outlet velocity (erosion or siltation conditions).

The Concrete Pipe Association of Australasia (CPAA) manual, "Hydraulics of Precast Concrete Conduits" has been prepared to assist professional engineers with the hydraulic design of precast concrete conduits.

It is recommended that this CPAA manual be used when determining waterway areas for specific flow conditions.

Structural design

While some authorities have their own specific structural requirements for box culverts, the minimum design standards for box culverts are contained in Australian Standard AS 1597 Part 1, for culverts up to and including 1,200 mm span and AS 1597 Part 2 for culverts from 1,500 mm to 4,200 mm span.

Box culverts are normally designed for the standard highway vehicle loads or railway load requirements of the AS 5100 bridge design code, as appropriate for the application. However they can also be used in many non-standard applications and can be designed to carry loads well in excess of normal highway loading. It is important to note that construction considerations on site may require that heavy equipment must travel over box culverts before soil cover is placed. This can result in loading conditions more severe than those expected in service.

The design must satisfy construction conditions or provision must be made to support units during construction. Refer to AS 1597 Part 2 for minimum depths of fill for construction vehicle axle loads.

Table 1 – Small box culvert size range

Leg height (mm)	Span (mm)					
	300	450	600	750	900	1,200
300	■	■	■	■	■	■
450		■	■	■	■	■
600			■	■	■	■
750				■	■	■
900					■	■
1,200						■

Notes:
1. Nominal standard sizes are shown as: ■
2. Box culverts are generally available in standard lengths of 1.22 m and 2.46 m (or 1.2 m and 2.4 m in QLD).
3. The size range of Humes standard box culverts up to 1,200 mm span are those included in Australian Standard 1597 Part 1.
4. In many cases Humes has the facility to manufacture larger span and leg heights beyond those indicated in the Australian Standards. Our design team can customise culvert designs to suit various applications and site conditions.

- Not typically supplied.

Multi-cell installations

Top:
Multi-cell installation of box culverts

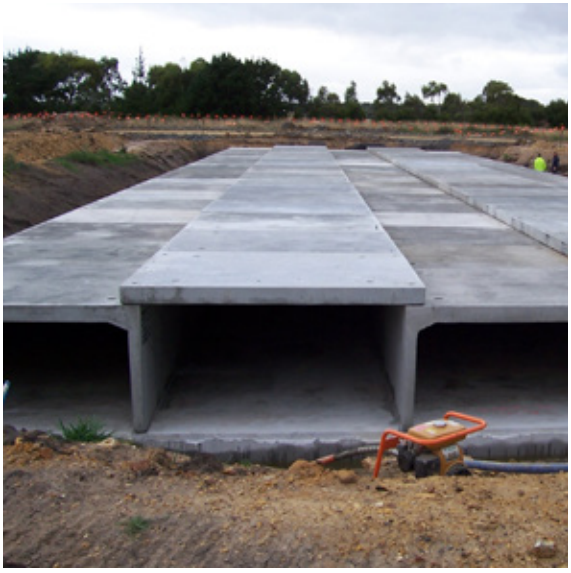
Bottom:
Multi-cell installation using LinkSlab® units

Where box culverts are laid side-by-side in multi-cell installations, they may be placed either touching or with a gap up to 25 mm which should be grouted.

Actual requirements vary and are generally governed by the size of the culvert, site conditions and the standard adopted by the particular authority. The gaps should be grouted with a sand-cement mortar or equivalent for a minimum depth of at least the crown thickness as detailed in the Australian Standards for box culverts.

Care must be taken with long leg culverts not to use excessive compaction, as forces may induce a loading in excess of normal design loading.

Link Slab® units



Linkslab® units spanning between two box culvert crown units are a cost effective solution for installations of three cells and above.

Using Link Slab® units also provides a greatly increased waterway area by enabling less restriction to water entering the culvert than is the case with multiple crown units side-by-side.

A Linkslab® unit usually has the same span as the supporting crown unit but Humes can design greater spans where required.

When depth of fill is minimal, a Linkslab® unit can be designed to sit flush with the top of the crown unit.

Figure 2 – General layout of a multi-cell installation using Link Slab® units

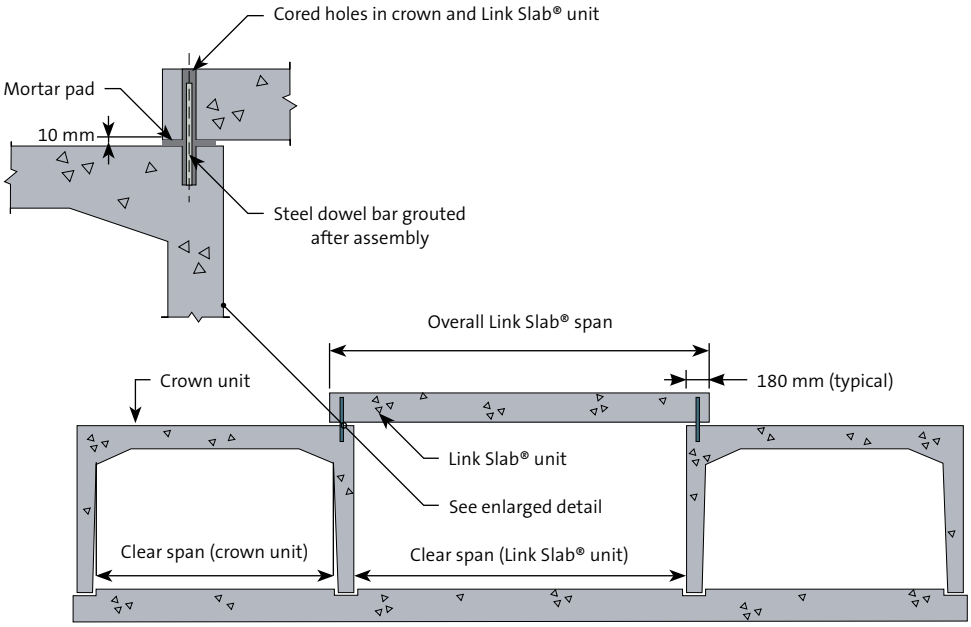


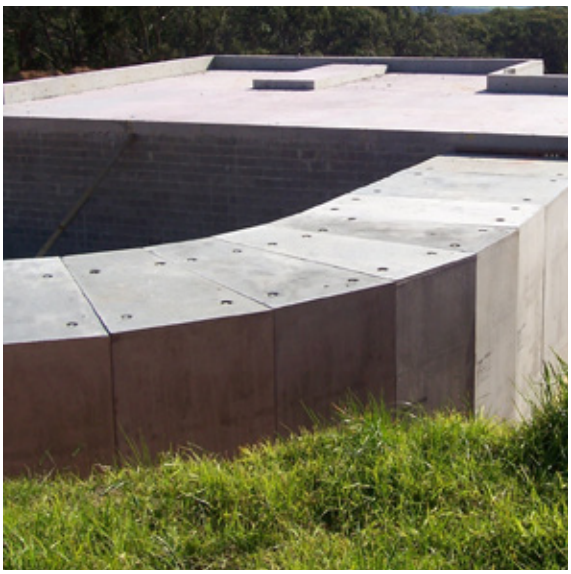
Table 2 – Large box culvert size range

Leg height (mm)	Span (mm)							
	1,500	1,800	2,100	2,400	2,700	3,000	3,300	3,600
600	■	■	■					
900	■	■	■	■	■			
1,200	■	■	■	■	■	■	■	■
1,500	■	■	■	■	■	■	■	■
1,800		■	■	■	■	■	■	■
2,100			■	■	■	■	■	■
2,400				■	■	■	■	■
2,700					■	■	■	■
3,000						■	■	■
3,600								■

Notes:
1. Nominal standard sizes are shown as: ■
2. Box culverts are generally available in standard lengths of 1.22 m and 2.46 m (or 1.2 m and 2.4 m in QLD).
3. The Humes large box culvert size range includes those sizes greater than 1,200 mm span and up to 4,200 mm span covered by Australian Standard 1597 Part 2.
4. In many cases Humes has the facility to manufacture larger span and leg heights beyond those indicated in the Australian Standards. Our design team can customise culvert designs to suit various applications and site conditions.

- Not typically supplied.

Splayed (skewed) box culverts



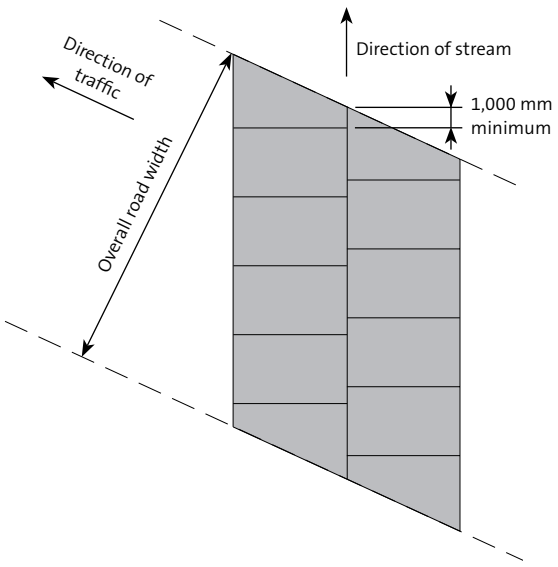
Right:
Splayed box culverts

Splayed units are normally used in the following situations:

- where a box culvert line passes under a road or railway at skewed angles from 15° to 25°
- where a box culvert line changes direction.

In each situation, minimum length of the splayed unit is 1,000 mm. There are a number of possible plan layouts which can be adopted depending on culvert size, number of cells, road (or railway) width and skewed angles, see Figure 3. Splayed units are non-stock items; contact a Humes representative regarding availability.

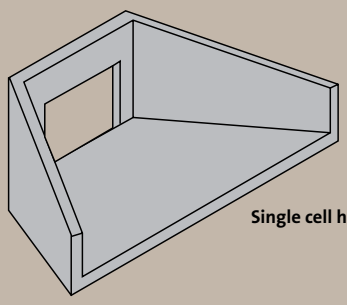
Figure 3 – Typical two cell box culvert layout of skewed angles up to 25°



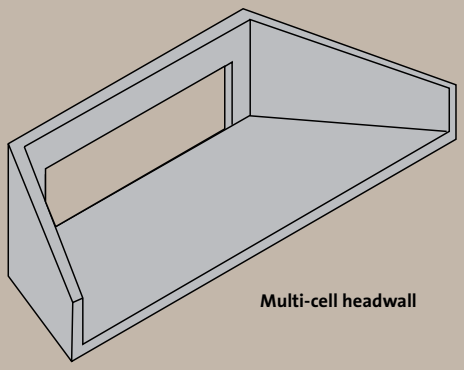
Precast headwalls

Precast concrete headwalls can be manufactured to suit site requirements and offer significant advantages over in-situ concrete, including:

- reduced installation time
- fewer people on site
- no premix concrete required so remote sites are not an issue
- concrete is at strength when delivered.



Single cell headwall



Multi-cell headwall

Handling and installation

Jointing

Joints between box culverts used in stormwater drainage conditions do not normally require a watertight seal. Box culverts are usually made with plain ends giving a butt joint with the joint gap nominally 10 mm.

Base rebates

Box culvert bases must have rebate connections between bearing surfaces of the culverts and base slabs to ensure pinned connections. This prevents sliding and the possibility of the legs being forced inwards by consolidation of the fill material beside the culvert.

In determining the width and location of rebates, adequate allowance must be made for grout packing and construction tolerances.

Handling of culverts

All units are provided with cast-in lifting anchors for ease of handling.

Lateral sliding of the box culverts should always be avoided. Culverts should be lifted clear off the ground, not dragged, to avoid any lateral forces at the bottom of the legs.

If the box culverts are to be stored on site, they should be placed on timber bearers and on firm level ground. In the case of invert units, supports should be placed directly beneath legs, not towards the centre of the slab.

Placing and backfilling

Large box culverts should be installed in accordance with AS 1597 Part 2.

The excavation, foundation preparation, placing of units, compaction and backfilling are all to be carried out in accordance with the relevant authority specification document or box culvert Australian Standard. Sound engineering judgement should always be used.

Backfilling around units should be done in layers on both sides simultaneously. Care must be taken to prevent wedge action against surfaces during backfilling. This is especially important for large box culverts, long leg lengths and LinkSlab® culvert structures, to ensure the units are not displaced during backfilling.

Construction loadings on box culverts should be limited to vehicles with axle loadings no heavier than normal vehicles permitted on public roads. The exception is where the culverts are designed for specific heavy construction vehicle loadings, or the permissible minimum heights of fill are achieved prior to application of construction loads in accordance with the relevant box culvert Australian Standards.

Precast solutions

Top:
Rubber ring jointed pipes

Middle:
Precast arches

Bottom:
Segmental shaft

Stormwater solutions
Stormwater drainage
Stormwater treatment
Detention and infiltration
Harvesting and reuse

Sewage transfer and storage solutions
Sewage transfer
Corrosion protection for sewage system components
Storage, overflow and pump stations
Inspection and maintenance

Bridge and platform solutions
Traffic bridges
Pedestrian crossings
Wharf structures

Tunnel and shaft solutions
Access, pipe jacking and ventilation shafts
Mine portals and reclaim tunnels
Traffic and utility tunnels
Escape tunnels and shafts

Walling solutions
Earth retaining walls
Wall panels

Potable water supply solutions

Traffic management solutions

Cable and power management solutions

Rail solutions

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