# BTN 033
# Structural Requirements for Reinforced Concrete Drainage Pits

**30 March 2023**
**Version 1.0**

## 1. Scope and Application

Bridge Technical Note (BTN) 033 – Structural requirements for reinforced concrete drainage pits – states Department of Transport and Planning's (DTP) requirements for the design and construction of precast and cast in-situ reinforced concrete stormwater drainage pits on DTP's network.

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

This document is to be read in conjunction with the following DTP Standard Specification, Austroads Guideline and Australian Standard:

- Standard Specification 701
- Standard Specification 705
- Standard Specification 610
- Standard Specification 611
- Standard Specification 689
- Austroads Guide to Road Design Part 5: Drainage – General and Hydrology Considerations
- AS 3996 – Access covers and grates
- AS 3850.3 - Prefabricated Concrete Elements – Civil Construction
- AS/NZS 4680 - Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
- AS 1657 - Fixed platforms, walkways, stairways, and ladders—Design, construction and installation
- AS 5100 – Bridge Design

Other than as stated in this document and the relevant DTP Standard Specifications, the provisions of AS 5100 must apply. Where this document differs from AS 5100, its requirements override those of AS 5100.

The requirements of this BTN do not apply to subsurface drainage pits.

DTP was formerly known as Department of Transport (DoT) and VicRoads. DTP documents include the relevant DoT and VicRoads documents which must also be complied with.

## 2. Definitions

**Drainage Pit:** A reinforced concrete chamber constructed or installed below ground, which is designed to receive water from the surface and from connected upstream underground stormwater drain(s) and facilitate its discharge into a connected downstream stormwater drain.

**Small Concrete Drainage Pits** are pits that are less than or equal to 2 m deep and have internal dimensions up to 1.8 m in any direction.

**Large Concrete Drainage Pits** are pits that are deeper than 2 m or have internal dimension of more than 1.8 m in any direction. Where multiple units are used to form a deeper pit or a wider pit then each unit is defined as a large concrete drainage pit.

**Fibre Reinforced Concrete Drainage Pits** are pits with a concrete mixture containing uniformly dispersed and randomly oriented fibres.

**Unhaunched Pits** are pits with straight vertical walls with a constant width from top to bottom on all sides.

**Haunched Pits** are pits with risers or shafts that typically have a narrower width towards the top of the pit than the main section of the pit (the width of the pits wall varies from top to bottom).

**Side Entry Pits** are pits that collect water run-off from the road pavement, located at the kerb and channel location.

**Junction Pits** are pits connecting pipes without a surface inlet.

**End Entry Pits** are pits similar to junction pits but have a side entry point(s).

**Grated Pits** are pits similar to junction pits but consist of a top opening covered by a grate.

* Drainage Pits can be constructed using a combination of inlets, e.g. a Grated Side Entry Pit.

# 3. Materials

## 3.1. Concrete

Concrete must be provided in accordance with Standard Specification 610 and 705. The minimum concrete grade for all drainage pits must be VR 450/50.

An approved DTP self-compacting concrete (SCC) mix design may be used in accordance with the minimum concrete cover requirements of AS 5100.5 Table 4.14.3.2.

Fibre reinforced concrete must be in accordance with Standard Specification 705. The minimum concrete grade must be VR 450/50.

## 3.2. Steel Reinforcement

Steel reinforcement must be in accordance with Standard Specification Section 611.

Where low ductility Class L reinforcement is proposed to be used in design for flexural strength, the pit must be designed using the capacity reduction factor below:

**Table 1: Capacity Reduction Factor for Class L and N reinforcement**

| Reinforcement | Capacity Reduction Factor ($\Phi$) |
|---|---|
| (a) For members with Class L reinforcement | 0.65 |
| (b) For members with Class L and Class N reinforcement | 0.65 |
| (c) For members with Class N reinforcement | AS 5100.5 Table 2.3.2 |

## 3.3. Fibres

Fibre reinforcement must be in accordance with Standard Specification Section 705.

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

## 3.4. Steel Grates/Covers

Steel grates, covers and frames must be hot dip galvanised to AS/NZS 4680.

# 4. Structural Design Requirements

## 4.1. Design Life

Small concrete drainage pits must have a design life of not less than 50 years and must comply with the additional requirements specified in this document.

Large concrete drainage pits must have a design life of not less than 100 years and must comply with the additional requirements specified in this document.

## 4.2. Durability

Concrete drainage pits must be manufactured, delivered, sampled, and tested, placed, compacted, finished, and cured in accordance with the requirements of Standard Specification Section 610.

The minimum exposure classification for reinforced concrete drainage pits must be B1. Where the exposure classification of the site is different, the concrete drainage pits are to be designed in accordance with the requirements of AS 5100.5 for both small and large concrete drainage pits.

The minimum concrete cover must be as specified in AS 5100.5 and in conjunction with Standard Specification 610 for the appropriate exposure classification unless specified otherwise.

All dimensional tolerances must comply with the requirements of Standard Specification Section 610.

## 4.3. Design Loads

### 4.3.1. Traffic Loads

Concrete drainage pits must be designed in accordance with AS 5100.2 to accommodate the worst load effect of W80, A160, SM1600 and where required for HLP400, if any part of the drainage pit is located at the following locations:

- Under road traffic;
- Within two metres of the back of kerb;
- Within two metres of vehicle turning swept path;
- All other areas that may be subjected to road traffic loadings over their design life, including provision for future road widening.

Where concrete drainage pits are located within the railway corridor (defined by the VicTrack boundary), the pits must be designed in accordance with AS 5100.2 to accommodate the load effect of 300LA or as nominated by the relevant Accredited Rail Operator.

Where concrete drainage pits are located outside the locations specified above or behind traffic barriers and where the pits will not be subjected to road traffic loadings, the pits must be designed in accordance with AS 5100.2 to accommodate W80 vehicle loading.

Where concrete drainage pits are located outside the locations specified above or behind traffic barriers and where the pits will not be subjected to road traffic loadings, the pits must be designed in accordance with AS 5100.2 to accommodate Class C pit cover loadings as specified in Table 3.1 of AS 3996 that being 100 kN for Serviceability design load and 150 kN for Ultimate limit design load.

### 4.3.2. Soil and Groundwater Loads

All concrete drainage pits must be designed for lateral soil pressure and groundwater loads in accordance with AS 5100.2 and AS 5100.3.

All concrete drainage pits must be designed for hydrostatic pressure on pit walls and base slab and the drainage pit in its empty condition.

### 4.3.3. Surcharge Loads and Construction Load

Surcharge loads from road traffic must be determined in accordance with AS 5100.2.

Concrete drainage pits that are not subjected to road traffic must be designed for surcharge load of 10 kPa.

Concrete drainage pits that are within the railway corridor must be designed to rail traffic surcharge load as per AS 5100.2.

All concrete drainage pits must be designed for construction loads in accordance with AS 5100.3.

### 4.3.4. Handling

Provision must be made for lifting and handling the concrete drainage pit units in accordance with AS 3850.3.

### 4.3.5. Vertical Bearing Pressure

The total bearing pressure imposed by the drainage pit onto the ground under the base slab of all pits must be checked and be specified on the drawings.

## 4.4. Minimum Reinforcement

All steel reinforced concrete drainage pits must have minimum reinforcement for controlling of shrinkage and thermal effects as detailed below:

- Small concrete drainage pits: no less than 227 $mm^2/m$ in both the vertical and horizontal direction.
- Large concrete drainage pits: no less than 454 $mm^2/m$ in both the vertical and horizontal direction.

Fibre reinforced concrete drainage pits must be designed in accordance with Section 7.

## 4.5. Minimum Wall Thickness and Pit Depth Measurement

For concrete drainage pits up to 2 m deep, the minimum wall and base thickness must be 100 mm. For concrete drainage pits more than 2 m deep, the minimum wall and base thickness must be 150 mm or thicker if required.

Where the depth of the concrete drainage pit exceeds 2 m there may be a need to adopt two different wall thicknesses in the construction of the complete pit. The wall thickness at the bottom will need to be a minimum of 150 mm thick whilst the wall thickness of the riser must be a minimum of 100 mm thick.

For clarity the lowest section of a drainage pit is considered as the main drainage pit consisting of the concrete base and concrete sides while the sections above this are to be considered as risers consisting of concrete perimeter walls with no base.

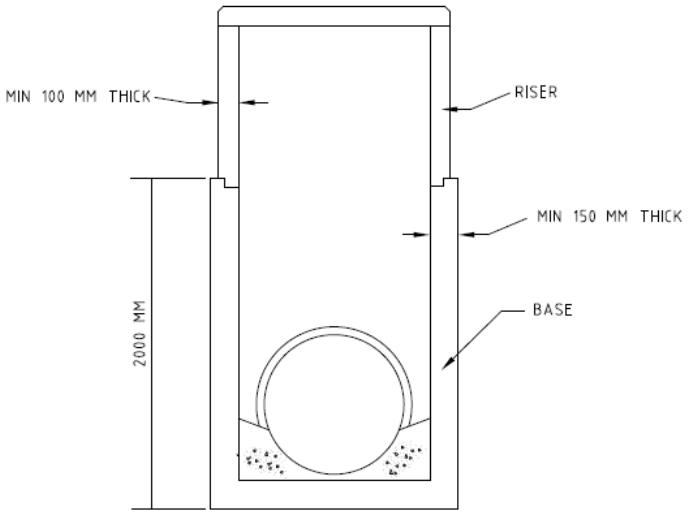


**Figure 1: Typical precast drainage pit >2000 mm deep with multiple sections**

The depth of drainage pit must be measured from the bottom of the pit towards the surface. The bottom 2 m must have 150 mm minimum wall thickness.

Where the depth of the drainage pit is over 2 m in height then it is acceptable to construct the complete pit as one section with 150 mm wall thickness.

Where the depth of the drainage pit is greater than 4 m, the wall thickness and reinforcement requirements must be structurally designed and Proof Engineered, but not less what has been specified under Section 5 for unhaunched concrete drainage pits up to 4 m in depth.

Where a drainage pit is manufactured in multiple sections with different wall thicknesses, the internal wall face must be vertically aligned, and the step in the wall thickness is to be located on the outside face of the pit. Joints must be sealed with cement mortar to provide watertight joints. No bonded anchors to be used for the construction of the drainage pits.

## 4.6. Access to Pits

Drainage pits greater than 1 m deep must be fitted with permanent access such as step irons or ladders. The step irons or ladders must comply with the requirements of Standard Specification 705 and to be designed in accordance with AS 1657.

For drainage pits greater than 3.5 m deep, in addition to the requirements outline in the paragraph above, a harness-based fall-arrest system and other fall protection measures must be implemented in accordance with Appendix H of AS 1657.

Drainage pits greater than 4 m deep are not to be provided unless unavoidable. Drainage pits greater than 4m deep also require the approval of the Chief Engineer Roads prior to construction/manufacture.

Further to the above, the Designer must consider the additional safety access requirements to ensure that inspection and maintenance activities can be performed safely in the future, including fall protection and confined space safety measures.

## 4.7. Modification of Existing Drainage Pits

### 4.7.1. Condition of Existing Drainage Pits

Where an existing drainage pit is to be modified, the existing condition of the drainage pit must be assessed. An engineering detailed inspection by a Registered Professional Engineer in Victoria in the Structural discipline must be conducted before any modifications can be made.

The inspection must include a structural assessment to confirm the pit does not have any defects such as spalling, concrete cracking in excess of 0.3 mm, rust stains etc. If any such defects are present, then the existing drainage pit must be replaced.

### 4.7.2. Extension of Existing Drainage Pits

If any modification to an existing drainage pit requires the height to be increased, both the extension and the existing pit must be checked and designed in accordance with the requirements of this BTN. The design of the drainage pit extension must be Proof Engineered by an Engineer who is pre-qualified at the Proof Engineering level, in accordance with the DTP's scheme for prequalification of consulting engineers.

### 4.7.3. New Pipe Connection of Existing Drainage Pits

Where an existing pit wall is required to be opened to facilitate the connection of a new stormwater pipe , the opening must be neatly saw cut or cored to the required size. The new opening must not be created using a jack-hammer or similar percussion or manual (e.g. sledge hammer) type tool.

Reinforcement exposed by the cutting of holes must be coated with an approved epoxy treatment to prevent corrosion prior to application of a repair mortar around the pipes in accordance with Section 689.

### 4.7.4. Conversion of Existing Drainage Pits

It is desirable that all existing drainage pits that would be located in a traffic lane following a road widening or similar be removed. Retention of drainage pits in these locations creates ongoing operational and maintenance issues. If removal of drainage pits in these locations is impractical or cost prohibitive, consideration to be given to capping the drainage pit and burying it under the pavement, unless ongoing access is required. The design of the new pit cover to meet the loading requirements of Section 4.3. Detailed location information of the buried asset including geographic coordinates and depth from finished surface level must be captured on the As-Built drawings. Where the pit is retained as a junction pit, the cover must meet the requirements outlined in Table 7.

# 5. Design of Unhaunched Pits

For unhaunched pits, the pits must be designed to meet the following minimum requirements.

The standard unhaunched pit sizes are provided in Table 2.

**Table 2: Standard unhaunched pit sizes**

| Depth (mm) | Internal Dimensions (mm) | |
|---|---|---|
| | Pits under direct traffic load | Pits in other locations |
| 0 - 1200 | 750 x 750 | 750 x 750 |
| Greater than 1200 | 750 x 750 | 750 x 1000 |

Subsurface drain holes must be sealed if not used.

Weep holes of 50 mm diameter must be provided in those walls which have openings for pipes; and must be placed half way between the top of the drainage pit and the centre of the opening for pipe.

The weep holes must be encapsulated by a non-woven geotextile, minimum size of 300 mm x 300 mm, securely attached to the outside face of the drainage pit's wall.

## 5.1. Unhaunched Pits Minimum Design Requirements

The minimum reinforcement requirements for typical precast unhaunched pits for up to 4.0 m deep and 2.4 m length or width are provided in Table 3, 4, 5 and 6 below.

Typical unhaunched pit is shown in Figure 2.

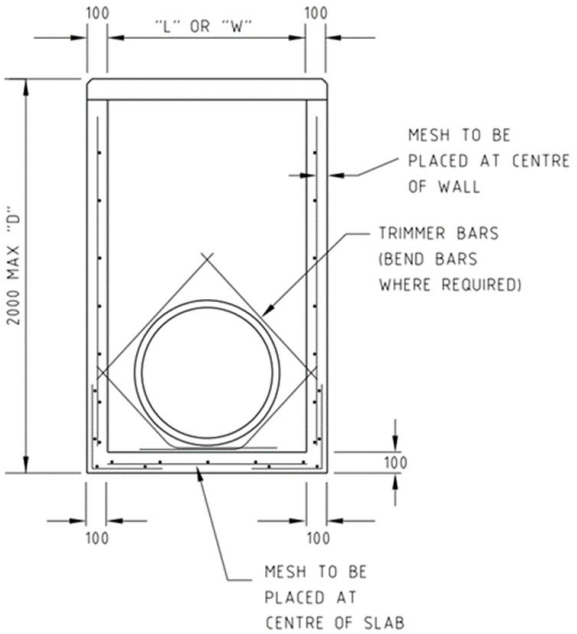


**Figure 2: Typical precast unhaunched pit up to 2000 mm deep**

Larger unhaunched pits outside Table 3, 4, 5 and 6 must be designed in accordance with the requirements of Section 3 and 4 of this document and other requirements of AS 5100.5.

**Table 3: Minimum reinforcement requirement for precast unhaunched pits up to 2 m deep and 2.4 m length or width that are subjected to road traffic loadings**

| Pit Depth (D) (mm) | Pit Length (L or W) (mm) (1) | Reinforcement | |
|---|---|---|---|
| | | Wall (100 mm thick) | Slab (100 mm thick) |
| Up to 1000 | Up to 1200 | SL82 | SL82 |
| | 1201 - 1800 | SL92 | SL82 |
| | 1801 - 2400 | RL818 + N10@200 (V) | SL81 |
| 1001 - 2000 | Up to 1200 | SL92 | SL82 |
| | 1201 - 1800 | RL1018 | SL82 |
| | 1801 - 2400 | RL1218 + N10@200 (V) | SL81 |

**Table 4: Minimum reinforcement requirement for large precast unhaunched pits up to 4.0 m deep and 2.4 m length or width that are subjected to road traffic loadings**

| Pit Depth (D) (mm) | Pit Length (L or W) (mm) (1) | Reinforcement | |
|---|---|---|---|
| | | Wall (150 mm thick) | Slab (150 mm thick) |
| 2001 - 3000 | Up to 1200 | SL81 | SL81 |
| | 1201 - 1800 | RL918 + N10@200 (V) | |
| | 1801 - 2400 | RL1118 + N10@200 (V) | |
| 3001 - 4000 | Up to 1200 | SL81 | |
| | 1201 - 1800 | RL1118 + N10@200 (V) | |
| | 1801 - 2400 | RL1218 + N10 @ 200 (H & V) | |

**Table 5: Minimum reinforcement requirement for precast unhaunched pits up to 2 m deep and 2.4 m length or width that are not subjected to road traffic loadings**

| Pit Depth (D) (mm) | Pit Length (L or W) (mm) (1) | Reinforcement | |
|---|---|---|---|
| | | Wall (100 mm thick) | Slab (100 mm thick) |
| Up to 1000 | Up to 1200 | SL82 | SL82 |
| | 1201 - 1800 | SL92 | SL82 |
| | 1801 - 2400 | RL818 + N10@200 (V) | SL81 |
| 1001 - 2000 | Up to 1200 | SL92 | SL82 |
| | 1201 - 1800 | RL918 | SL82 |
| | 1801 - 2400 | RL1118 + N10@200 (V) | SL81 |

**Table 6: Minimum reinforcement requirement for large precast unhaunched pits up to 4.0 m deep and 2.4 m length or width that are not subjected to road traffic loadings**

| Pit Depth (D) (mm) | Pit Length (L or W) (mm) (1) | Reinforcement | |
|---|---|---|---|
| | | Wall (150 mm thick) | Slab (150 mm thick) |
| 2001 - 3000 | Up to 1200 | SL81 | SL81 |
| | 1201 - 1800 | RL818 + N10@200 (V) | |
| | 1801 - 2400 | RL1018 + N10@200 (V) | |
| 3001 - 4000 | Up to 1200 | SL81 | |
| | 1201 - 1800 | RL1018 + N10@200 (V) | |

***Notes:***

1. *The minimum reinforcement requirements are also applicable for rectangular pit with different length and width. The larger dimension of the length or width is to be used for the selection of the steel reinforcement to be adopted.*

Please note, Tables 3, 4, 5 and 6 are based on the following assumptions, and are not applicable when these conditions cannot be met:

a. Road traffic loadings W80, A160, SM1600 and HLP400;
b. Top of the pit is at the ground level;

c. Rectangular steel reinforcement mesh with the main bars positioned horizontally and to be centrally placed in the pit walls and base;
d. Exposure classification B1;
e. The minimum concrete cover to reinforcement is 30 mm;
f. Where the reinforcement is lapped then the lapped reinforcement must be the same size with the main reinforcement and be symmetric around the centre axis of the wall and base;
g. N12, N16 and N20 trimmer bars must be provided around the openings for pipes with diameter of less than 600 mm, 600mm -1200 mm and 1200 mm – 1800 mm respectively;
h. The concrete strength to be used is VR 450/50;
i. The reinforcement lap lengths to be a minimum of 400 mm;
j. Intense compaction of the concrete is to be carried out as per AS 5100.5 Table 4.14.3.3;
k. 50 years design life for small pits, 100 years design life for large pits along with the additional requirements specified in this BTN.

It should be noted that for cast in situ drainage pits and self-compacting concrete precast drainage pits, the minimum wall thickness will need to be increased to comply with the minimum concrete cover requirements of AS 5100.5 Table 4.14.3.2.

For drainage pits that are located in batters where the fill on one side of the pit is higher than the top of the pit, the lateral soil pressure is higher than the depth of the pits. Such pits must be designed in accordance with the requirements of Section 3 and 4 of this document.

Where the exposure classification is more severe than a B1 environment, the requirements of AS 5100.5 and Standard Specification 610 must be satisfied.

## 6. Design of Other Drainage Pits

For side entry, end entry, junction pits and all other unhaunched drainage pits, the pits must be designed in accordance with the requirements of Section 5 of this document.

For haunched drainage pits, the pits must be designed in accordance with the requirements of Section 3 and 4 of this document and other requirements of AS 5100.5 and other relevant Standard Specification Sections.

## 7. Design of Fibre Reinforced Concrete Drainage Pits

Fibre reinforced concrete drainage pits must be designed with design loads specified in Section 4.3 above and in accordance with AS 5100.5 and Standard Specification 705.

Fibre reinforced concrete drainage pits must not be located under or adjacent to traffic lanes or shoulders of roads.

Where synthetic fibres are to be used, the performance of fibre reinforced concrete drainage pits must be demonstrated through prototype testing in accordance with Standard Specification Section 705 and AS 5100.5 Appendix A.

## 8. Proof Engineering Requirements

Designs of steel and fibre reinforced concrete drainage pits must be Proof Engineered by an Engineer that is pre-qualified at Proof-Engineering level in accordance with DTP scheme for prequalification of consulting engineers, except the following:

- the drainage pits designed by DTP specified in Table 3, 4, 5 and 6 in Section 5 above for unhaunched drainage pits do not require Proof Engineering.

## 9. Pit Identification Information

Design information for the exposure classification and the identification of pits that are going to be used in road, railway or other environment must be permanently and clearly marked or printed on both inside and outside wall of all precast pits for identification purposes.

## 10. Pit Access Covers

Drainage pits access covers and grates must be designed in accordance with AS 3996 and Table 7 below.

Prior to installation of all pit access covers, a Certificate must be provided to the Superintendent certifying that the pit access cover has been tested and certified by an Australian NATA accredited laboratory as complying with AS 3996 requirements.

Minimum load classification for pit access covers must be determined in accordance with Table 7 below and AS 3996.

**Table 7: Load classifications of pit access covers**

| Load classifications of pits access covers | | | | |
|---|---|---|---|---|
| **Location** | **Rural arterial roads (<80km/h)** | **Urban arterial roads** | **Rural arterial roads & highways (≥80km/h)** | **Urban Freeway / Motorway** |
| Traffic lane with high volume / high %CV | D | E | E | E |
| Traffic lane | D | D | E | E |
| Shoulders | D | D | D | D |
| Median / Verge | C | C [(2)] | C[(2)] | D |
| Behind kerb | C | C[(2)] | C[(2)] | C[(2)] |
| Behind safety barrier | C | C | C | C |

***Notes:***

2. *Load classification 'D' to be used when located within a vehicle swept path, or 20m of an intersection and within 2m from back of kerb. If turning lane is exclusive, extend distance to 10m beyond the full extent of the turning lane.*

3. *Load classification 'D" to be used for pit access covers in rest areas*

4. *Load classification 'C" to be used for pit access covers in car park areas*

For Class C pit access cover requirements, light weight material must be used for drainage pit access covers. Maintenance safety lock must be provided on the cover for access security.

## Contact Details

For further information please contact:

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

## Document Control

This document is subject to periodic review and may be superseded. The revision date is listed in this 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 DTP.

| Version | Description | Revision | Approved by |
|---|---|---|---|
| 1.0 | Original Publication | 30 March 2023 | Chief Engineer - Roads |