Humes

Strength. Performance. Passion.

Segmental and one piece shafts Installation guide

Issue 1

Purpose of this guide

This document is a guide to the safe and efficient installation of Humes' segmental and one piece shafts which should be reviewed by supervisory personnel prior to installation.

The information in this guide is of a general nature only and is no substitute for professional engineering advice. This guide should be read in conjunction with project-specific documents including contracts and drawings. Where the contents of this guide differ from project specifications and drawings, supervisory personnel should consult a Humes engineer. Should the information in this guide conflict with local legislative requirements, the legislative requirements should take precedence provided safety or engineering requirements are not compromised.

For typical installation requirements, please refer to the general assembly standard drawings or project specific drawings supplied by Humes. The Humes drawings contained in this document are system assembly drawings only and do not constitute a site layout; the site layout should be specified in project documents provided by the consulting engineer who has been engaged by the asset owner.

It is the responsibility of the site owner or consulting engineer to determine the site's suitability for construction, including possible site access problems for plant and other issues.

Statements in this guide are not to be construed as representations, guarantees or warranties. Satisfactory adherence to this guide will not discharge the contractor from it's contractual and statutory obligations.

Contents

Segmental and one piece shafts

Applications

Humes' precast concrete shafts are an economical and safe solution for permanent and temporary underground structures. They are used for a variety of applications including:

- ventilation shafts
- escape shafts
- launch and receival shafts for pipe jacking applications
- storage overflow and pump stations (sewerage)
- water harvesting and reuse.

The shaft system suits a variety of soil conditions, and provides a soil and watertight solution.

Humes offer segmental shafts in partnership with Buchan Concrete Solutions Limited (UK).

Features and benefits

Precast shafts provide installation contractors with a number of benefits over traditional shaft construction methods including the potential for greater installation efficiencies, cost benefits, and a safer work environment. Humes' precast shafts can also help to reduce the environmental impact of construction.

Cost savings

- Installation time is significantly reduced as excavation and ring placement can be on a continuous cycle.
- The precast concrete segments provide a one-pass finished shaft, so no further concrete work is required to finish the structure.
- There is no requirement for specialist labour and a small team should be capable of managing the entire installation process.

Safer work environment

Humes' precast shafts can enable contractors to provide a safer environment for their workers as:

- the majority of work can be carried out above ground (caisson method)
- overhead service hazards are minimised as no large cranes are required
- the system has a built-in safety barrier created by the installation of the top ring.

Minimal environmental impact

An efficient design means shafts have minimal impact on project sites and the surrounding environment:

- Noise and ground vibration are virtually eliminated as no hammering is required.
- The excavation and site storage areas are minimal, as the precast units are relatively compact at less than 2.5 m wide.
- Shaft installation does not require the use of water or wet concrete (except for the base and collar).

Innovative design

- The shaft can be installed accurately due to the high degree of control over the rate and direction of installation.
- No bracing is required due to its structurally efficient circular shape. The shaft gains structural stability from the surrounding soil so tie-backs or ring-beams are not required to support the segments.
- The shaft is suited to a variety of soil conditions.
- The shafts provide a soil and watertight solution.
- The unique external fixing used to join the segments, eliminates the need for specialist trades, like welders, on site.
- There is an extensive diameter range with a full range of ancillary products.

Product range

Humes offer the following sizes in one piece and segmental shafts:

- 3 m one piece shaft
- 3.6 m one piece shaft
- 4.5 m segmental shaft
- 6 m segmental shaft
- 7.5 m segmental shaft
- 9 m segmental shaft
- 10.5 m segmental shaft
- 12.5 m segmental shaft
- 15 m segmental shaft
- Sizes up to 25 m are also available, please contact Humes for availability.

Bottom:
Caisson shaft installation

Safety

Safety is a priority at Humes. It is important for all parties to observe safety requirements and regulations during transportation, handling, storage and installation, including wearing appropriate personal protective equipment. It is the responsibility of the main contractor or installation contractor to produce a Safe Work Method Statement. The statement should comply with all relevant codes of practice, standards and safety regulations.

The precast concrete component should only be lifted using the correct lifting clutches and from the designated lifting points, which are shown in the project specific drawings and product drawings. Each precast segment or one piece shaft is fitted with a number of Swiftlift® foot anchors. All lifting equipment must be certified to lift the specific weight and approved for lifting heavy componentry. The weight of the segments or one piece shaft units vary and will be clearly marked on the precast units and in the relevant project drawings.

All lifting and placement must proceed with caution and strictly in accordance with all relevant occupational health and safety standards. Bumping of segments can cause damage or injury and should be avoided.

The advice in this publication is of a general nature only. Where any doubt exists as to the safety of a particular lift or installation procedure, seek advice from a professional engineer or contact Humes for assistance.

Construction methods

Caisson method

The caisson method is generally used in softer soils with or without the presence of ground water. In the caisson method, the precast concrete elements are erected at the surface and are then lowered into the ground whilst excavation progresses. Caissons are either installed as a 'wet caisson' where the water level inside the caisson is slightly higher than the external ground water level, or as a 'dry caisson' where the inside of the caisson is open to the atmosphere.

There are a number of features unique to Humes' caisson shaft systems which facilitate installation. These include:

- **In-situ cast concrete collars**
  These collars act as a guide ring to keep the caisson shaft vertical and, in larger diameter shafts, resist the force from the hydraulic jacks.
- **Hydraulic jacks (gallows)**
  These are installed to both steer the shaft and to add to the vertical force in addition to the self weight of the shaft lining (generally not required for one piece rings).
- **Excavation should be slightly larger in diameter than the precast concrete shaft**
  The annulus between the shaft and the excavated ground should be filled with suitable fluid (usually bentonite with additives as required to suit the ground conditions) which acts both as a lubricant but also supports the ground during installation.

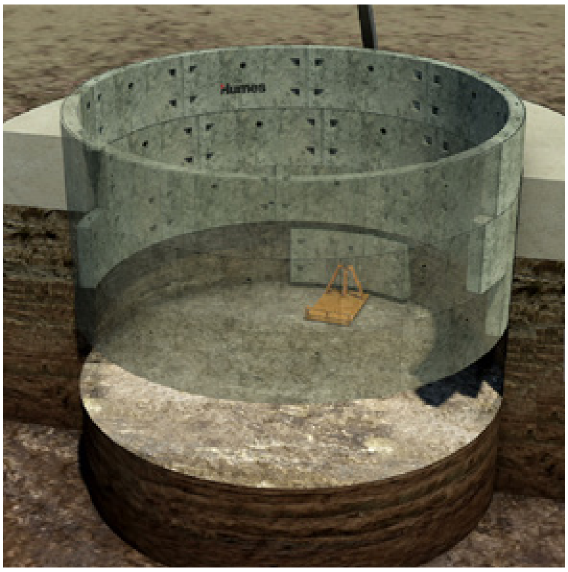
Left:
Caisson method

- **The bottom/choker ring is wider than the standard ring and the same diameter as the excavation**
  The choker ring is designed to provide a seal diameter between the shaft and excavated ground so that the fluid in the annulus above the ring is retained. The choker segments are also designed to bolt the steel cutting edge to the shaft and connect the underpin segment, (refer to the combination method on the following page).
- **A steel cutting edge underneath the bottom/choker ring**
  The steel cutting edge literally cuts through the ground. It also acts as a stiffener.
- **All caisson units are provided with grout fittings**
  This allows the exterior annulus to be filled with a cementitious grout at completion of the installation.

Top:
Underpin method

Bottom:
Combined method

Underpin method



The underpin method can be used in self supported soil where caisson installation is not possible. In this method, the precast concrete elements are progressively installed at the base of the excavation. Segmental rings are built and the annulus between their outside perimeter and the excavated ground is immediately grouted.

Combination of the caisson and underpin methods

A combination of both methods can be used if the soil condition varies. Installation commences with the caisson method (using a special choker ring) and then shifts to the underpin method when the hard soil ground is reached.

A special choker/transition ring must be used to enable the shift to the underpin construction method. Once the caisson rings have been completely grouted and the steel cutting edge removed. The underpin method can commence as previously described

Shaft segment handling

Humes precast segments are delivered to site on wooden pallets. Each pallet holds two segments which are separated by wooden strips to protect the units during shipping.

Before the segments are removed from the pallet the following steps are recommended in order to prevent damage and to ensure a safe work environment:

1. Use heat to apply the bitumen packing to one cross joint face of each segment.
2. Place rubber mats between the two segments; one in each corner and one in the middle (total of three).
3. Place the mats on the side opposite to where the Swiftlift® anchor is fitted.
4. Cut and remove the straps holding the two segments.
5. Hook the Swiftlift® clutches into the Swiftlift® anchors on the top segment. Each segment is provided with two 1.3 t x 120 mm long Swiftlift® foot anchors (supplied by Reid Construction Systems).
6. Once the segments are securely fastened to the anchors, start lifting and tilting the top segment according to safe precast concrete lifting procedures. Efforts should be made by the crane crew to prevent the top unit from swinging. For underpin installations, place the segment into the lifting frame as per Humes general method statement for use of the lifting frame.

Top:
Rubber mats placed between the two segments

Middle:
Hooking the clutches into the Swiftlift® anchors on the top segment; Lifting and tilting the top segment

Bottom:
Segment placed into the lifting frame (underpin installations)

Installation

Caisson method

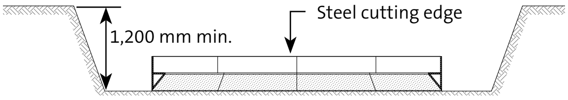
1. Excavate a circular area that is at least 800 mm wider (to allow for the collar) than the external diameter of the shaft and a minimum of 1,200 mm deep (refer to Figure 1). The actual width of the collar has to be determined by the shaft engineer but typically is no less than 800 mm.

   Once completed, level the base of the excavation using 50 mm of low strength concrete.

2. Accurately position the first steel cutting edge unit for both positioning and leveling. The joining of the cutting edge units should be carried out in accordance with project specific drawings.

3. Using heat, apply bitumen packing to one cross joint face of each bottom/choker ring segment. Check that the EPDM gasket is fitted into the gasket groove of each segment.

Figure 1 – Excavation and steel cutting edge



Step 2 – Completed steel cutting edge

Step 2 – Detail of steel cutting edge

4. Begin installing the bottom/choker ring on top of the cutting edge (refer to Figures 2 and 3) – all choker segments are ordinary (non-tapered) and of the same size. Segments are to be safely propped up making them stable until the first ring is complete. Where practical, the segments should be placed so that any inlet/outlet openings to the shaft avoid the vertical tie bars.

   Fixing the bottom/choker ring segments into the cutting edge has to be done in accordance with project drawings.

   Insert 2 x M16 curved bolts into the bolt hole recesses on the outside and inside of the choker segments, fix washers, gel grommets, and nuts and tighten to close the vertical joints; repeat procedure for each segment until the ring is complete.

   Ensure all joints are tightened and the ring diameter is within allowable tolerance.

Figure 2 – Bottom/choker ring in place

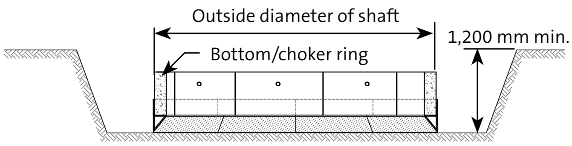
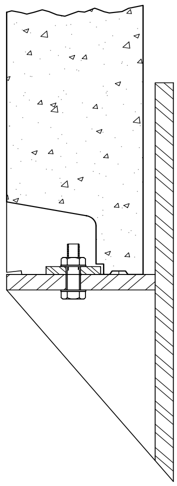


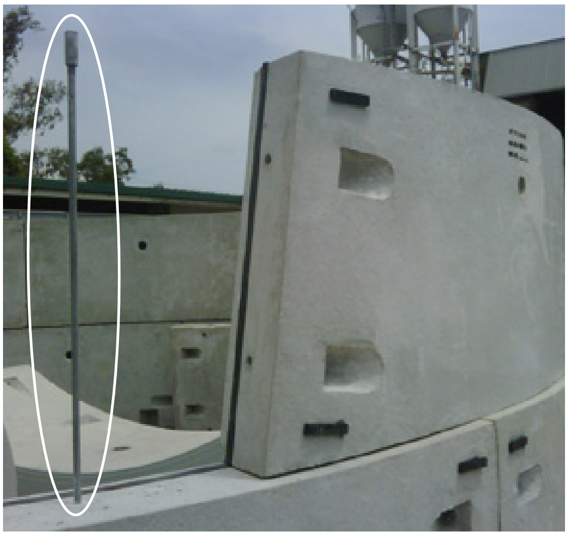
Figure 3 – Proposed connection of bottom/choker ring segments into the cutting edge



5. Fit the threaded M16 x 985 mm long tie bars to the M16 sockets in the top of the bottom/choker ring segments, screw in the thread to 25 mm.

6. Build the next ring on top of the bottom/choker ring (refer to Figure 4 below). Lift and position the first ordinary segment using the lifting chains and lifting clutches, lowering the segment over the vertical tie bars. The segment should be turned relative to the segment below to stagger the vertical joints by a third of a segment.

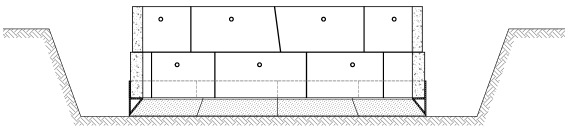
Step 5 – M16 socket in the top of bottom/choker ring segment



Step 5 – Threaded M16 x 985 mm tie bar fitted to M16 socket

Step 6 – Constructing first ring on top of bottom/choker ring segment

Figure 4 – The first ring on top of the bottom/choker ring



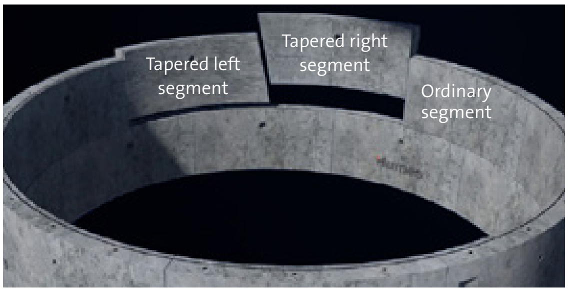
7. After the second ordinary segment is installed, insert 2 x M16 curved bolts through the bolt hole recesses on the outside of the segments. Fix the washers and nuts, then tighten the vertical joints to a torque of 100 N-m.

   Fix the grommets, washers and M16 x 70 mm long hexagonal couplers to the vertical tie bars located in the recesses on top of the segments and tighten using a socket wrench to a torque of 100 N-m.

8. Continue installing ordinary segments until the last two units which are the tapered segments. Position the tapered left segment first (this has the longer edge along the bottom face) then finally complete the ring with the tapered right segment, these segments are fixed using the same tie rods and curved bolts as the ordinary segments.

Step 7 – Making vertical joints using curved bolts

Step 8 – Installing the tapered segments



Step 8 – Installing the tapered segments

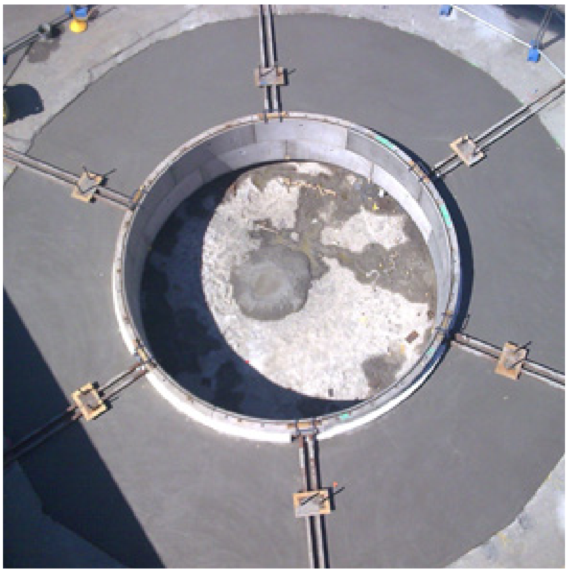
9. Surround the ring with 50 - 60 mm thick polystyrene sheet to create an annulus.

10. Fix the locations of the jacking gallow anchors then prepare and cast the base (concrete collar around the shaft).

    The area between the completed bottom/choker ring and the outer perimeter of the excavation should be filled with concrete (min. grade 20 mPa) to form a complete concrete collar; this provides permanent support to the shaft excavation, lateral resistance to jacking forces, and acts as a guide for the shaft sinking.

    Once the concrete has hardened the polystyrene can be dissolved using a suitable chemical solvent. The concrete is usually sufficiently hardened to allow shaft sinking to begin the next day.

Step 9 – Surrounding ring with polystyrene to create an annulus



Step 10 – Base casting complete

11. Install the jacking gallows.

12. Build two more rings above ground level, repeating steps 5 to 8. Ensure one complete ring always remains above ground to act as a safety barrier during shaft construction. As additional rings are constructed ensure that vertical joints are staggered.

Step 11 – Jacking gallow anchors in place

Step 11 – Jacking gallows in place

16.

Step 12 – Top ring acting as a safety barrier

13. The rings are sunk by excavation inside the shaft using a suitable hydraulic grab mounted on an appropriate excavator. The rings will sink under their own weight in very soft ground but in harder ground, pressure will need to be applied to the top ring using hydraulic jacks.

    The grout socket assembly in each segment can be used to introduce bentonite slurry into the annulus between the shaft and the soil, to lubricate and reduce friction force when jacking rings into the ground. The bentonite slurry is normally filled from the top of the shaft as the rings are being pushed down

    Check the sinking shaft level by using a spirit level or plumb line; adjustments can be made by applying pressure to the high point. Selective excavation of the ground will also help level sinking.

Step 13 – Excavation inside the shaft

14. Excavate and construct rings until the required depth is reached.

15. Grout the annulus on completion to create an intimate contact between the shaft and the ground to provide additional watertightness. Using the grout sockets begin grouting from the bottom rings and fill upwards (if the grouting starts near the top, it may 'go off' or block before it reaches the lower rings, which could form a void pocket, which could allow the rings to be pushed out of shape when internal or external loads are applied at a later period).

Underpin method

1. Excavate a hole of sufficient diameter to build a complete ring and collar (refer to Figure 5). The actual width of the collar has to be determined by the shaft engineer. Depth of the excavation will vary, depending upon ground conditions, but should be at least one ring deep. Fix the shaft centre position with a pin.

2. Using heat, apply bitumen packing to one cross joint face of each segment. Check that the EPDM gasket is fitted into the gasket groove of each segment.

3. Install the first ring on timber blocks. Insert 2 x M16 curved bolts into the bolt hole recesses on the inside of the segments, fix washers, gel grommets, and nuts and tighten to close the vertical joints.

   Ensure the ring is level, all joints are tightened and the ring diameter is within allowable tolerance.

4. Secure the first installed ring(s) by casting a concrete base around the outside of the ring(s) (refer to Figure 6) prior to excavating underneath them to construct the next ring. Shear connection may be required. Ensure the base edge of the ring is kept clean.

   It is recommended to install one extra ring above ground to act as a safety barrier, alternatively a guardrail can be used.

Figure 5 – Excavation with first two rings in place

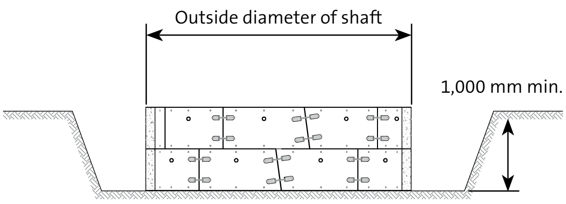
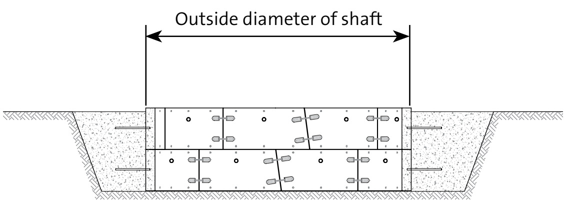


Figure 6 – Concrete collar cast around first two rings



Step 4 – Guardrails in place

5. Prepare to construct the next ring by excavating below the first ring – excavate the depth of a segment (refer to Figure 7) plus an additional 200 mm.

6. Place the first ordinary segment into the lifting frame and secure it via the grout socket assembly.

7. Use the lifting frame to lower the segment into place underneath the first ring (refer to Figures 8 and 9).

Figure 7 – Excavating for the next ring

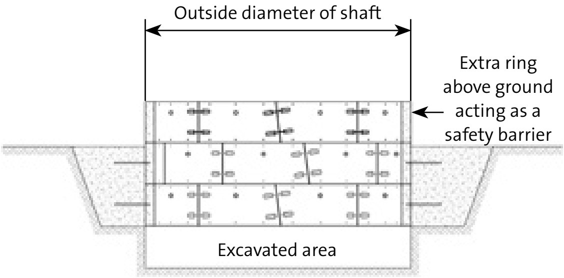


Figure 8 – Fixing a segment into the lifting frame

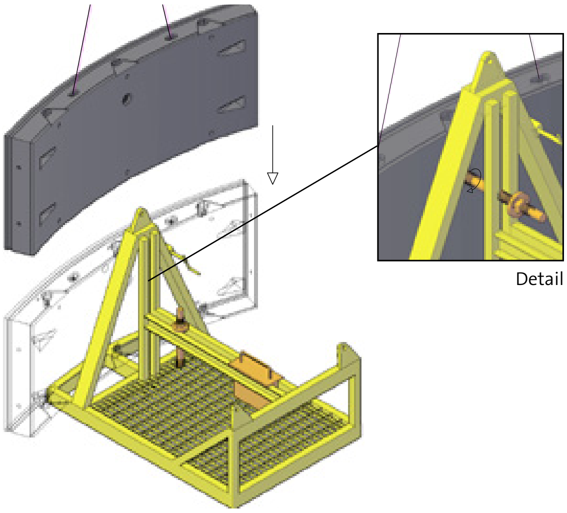
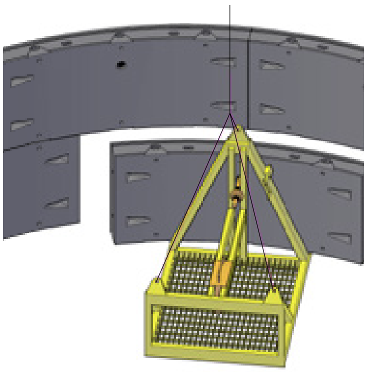


Figure 9 – Lowering the segment into place



8. Place eyebolts in the slots of the previously constructed ring and secure with sheradised dowels. The eyebolts should be hung with the notched end downwards (refer to Figure 10).

   Align the new segment so that the hanging eyebolts enter the slots on the horizontal and vertical joints. Correct positioning will automatically align the eyebolts, allowing the joints to be secured with sheradised dowels. If the dowel does not enter, check that the eyebolt slot has been adequately cleaned.

9. Tighten the joints with an open-ended spanner (refer to Figure 11).

Figure 10 – Eyebolts attached to installed segments

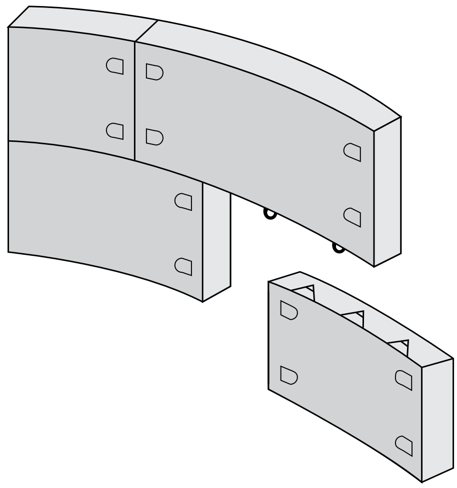
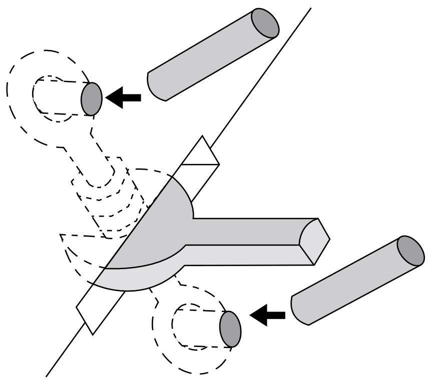


Figure 11 – Securing eyebolts using sheradised dowels and tightening using an open-ended spanner



Step 9 – Tightening the joints

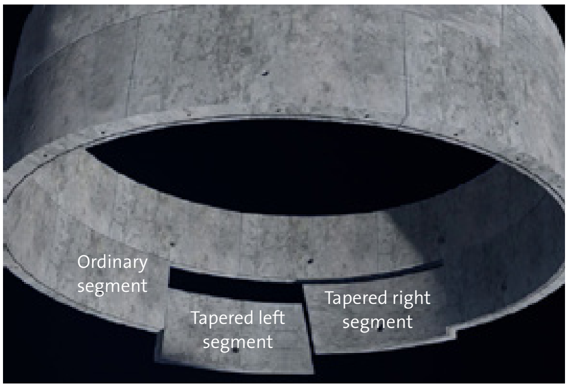
10. After the second ordinary segment is installed, insert 2 x M16 curved bolts through the bolts holes recesses on the inside of the segments, fix washers, gel grommets, and nuts and tighten to close the vertical joints.

11. Continue installing ordinary segments until the last two units which are the tapered segments. Position the tapered right segment first (this has the longer edge along the top face) then finally complete the ring with the tapered left segment.

12. Close the gap behind the bottom of the installed ring and grout the ring up (refer to Figure 12 below).

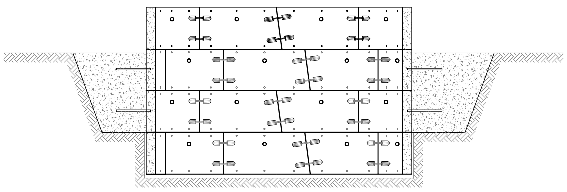
    Always excavate, install and grout one ring at a time. This reduces the risk of overloading the upper rings which could pull the whole ring build down due to lack of ground friction. Excavation of the following ring can commence once the grout reaches its recommended strength.

Step 10 – Fixing the curved bolts



Step 11 – Installing the tapered segments

Figure 12 – Complete ring installation before grouting



One piece shafts

1. Excavate an area at least 1 m deep and 200 mm greater than the external diameter of the shaft.

2. Position the cutting edge accurately and level inside the excavation (refer to Figure 13). Lift and fit the first one piece ring into the cutting edge. Where practical, the units should be positioned so that inlet/outlet openings to the shaft avoid the vertical tie bars. A common method of fixing the steel cutting edge to the first ring is by bolting it to the equally spaced M16 x 1,030 mm long tie rods.

3. Surround the base section (immediately above the cutting edge) with 10 - 15 mm thick polystyrene sheet to provide an annulus.

4. Fill the area between the first ring and the outer perimeter of the excavation with concrete (min. grade 20 mPa) to form a complete concrete collar; this provides permanent support to the shaft excavation, lateral resistance to jacking forces, and acts as a guide for the shaft sinking.

   Once the concrete has hardened the polystyrene can be dissolved using a suitable chemical solvent. The concrete is usually sufficiently hardened to allow shaft sinking to begin the next day.

5. Fit threaded tie bars into the hexagonal couplers on the top of the first ring (refer to Figure 14). Screw in the thread 25 mm. Clean the top surface of the ring and the rubber sealing strip positioned in the groove provided. Overlap the strip vertically by 50 mm at the ends.

Figure 13 – Proposed connection of first ring into cutting edge

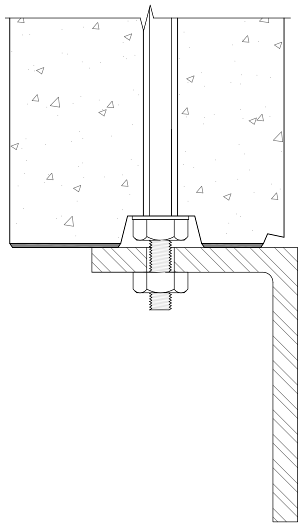
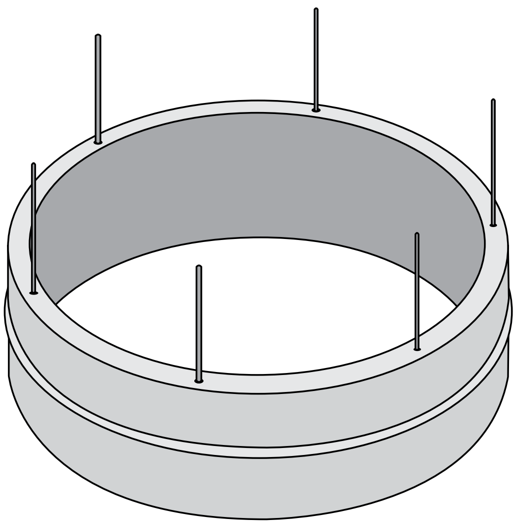


Figure 14 – Tie bars fitted to first ring



6. Lift and position the next ring using a leg chain and lifting clutches – fitted into the lifting anchors on the upper surface (refer to Figure 15). The lower surface of the ring should be cleaned. Ensure that the joint arrows provided on the inside surfaces line up.

7. Fit the steel washers and hexagonal couplers over the tie bars and tighten to a torque of 100 N-m.

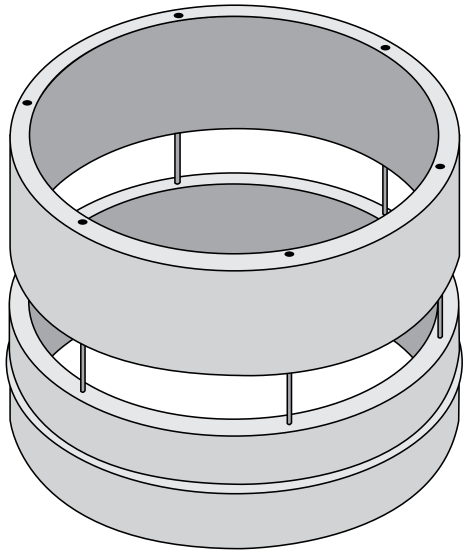
8. Sink the rings by excavating inside the shaft using a hydraulic grab mounted on a suitable excavator. The shaft will sink under its own weight in very soft ground but in harder ground pressure may need to be applied to the top section.

9. Check the shaft for accuracy of sinking, by using a spirit level or plumb line; adjustments can be made by applying pressure to the high point. Selective excavation of the ground will also help to control the sinking.

   Proceed with excavation and add rings until the required depth is reached.

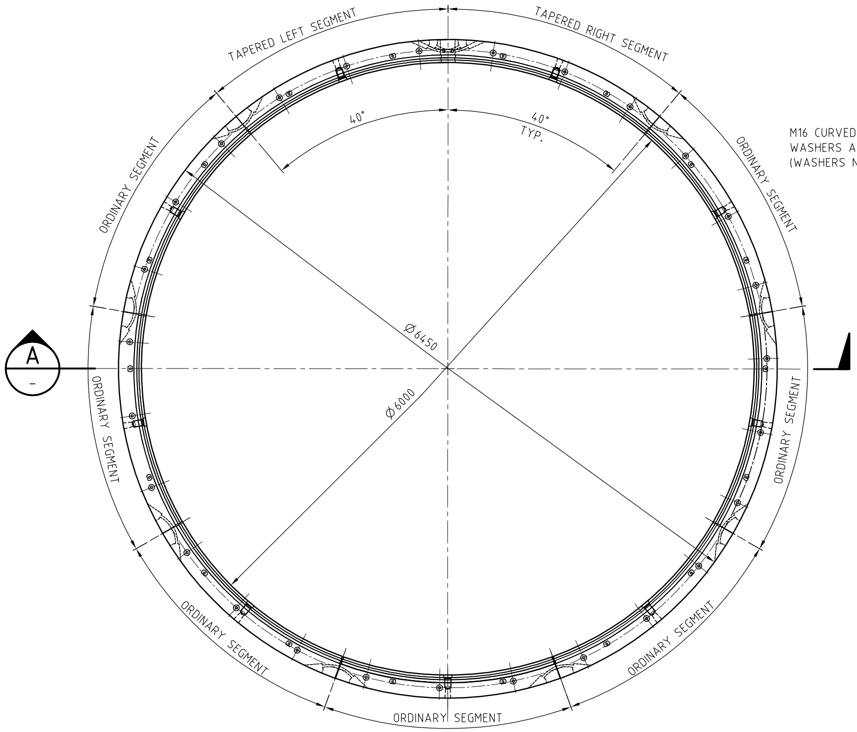
10. Fit a standard M16 nut instead of the hexagonal coupler on the last ring. This allows a cover slab to seat correctly on the shaft and provide a seal. At shallow depths it is not normally necessary to grout the annulus except when the shaft is to be used as jacking pit.

Figure 15 – Placement of the second ring



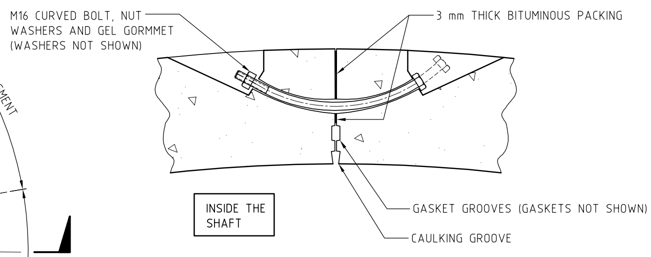
Complete one piece shaft installation

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	ISSUED FOR MANUFACTURE	DA	27-03-12	MZ
1	GENERAL REVISION, REISSUED FOR MANUFACTURE	DA	02-08-12	MZ



PLAN VIEW - ASSEMBLED RING

SCALE 1:25



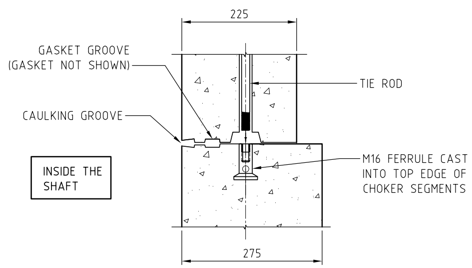
CROSS JOINT DETAIL

SCALE 1:5

	ITEM	No./RING	DESCRIPTION
PRECAST RINGS	ORDINARY SEGMENT (JS1)	7	SHAFT ORDINARY 6000x1000 CAISSON
	TAPERED LEFT SEGMENT (JS1)	1	SHAFT TAPERED LEFT 6000x1000 CAISSON
	TAPERED RIGHT SEGMENT (JS1)	1	SHAFT TAPERED RIGHT 6000x1000 CAISSON
SITE FIXING ITEMS	TIE ROD	27	SHAFT TIE ROD M16 x 985-COUPLER WASH AND GEL GROMMET
	CURVED BOLT	18	SHAFT CURVED BOLT M16 x 375
	GEL GROMMET	36	SHAFT GEL GROMMET 16mm
	EPDM GASKET (ORDINARY SEGMENT)	7	SHAFT GASKET 6000 ORDINARY CAISSON
	EPDM GASKET (TAPERED SEGMENT)	2	SHAFT GASKET 6000 TAPERED CAISSON
	PACKING	9	SHAFT 6000 BITUMEN PACKER CAISSON
CAST IN ITEMS	GROUT SOCKET ASSEMBLY	9	SHAFT GROUT SOCKET ASSEMBLY
	STACKING SPACER	36	SHAFT STACKING SPACER

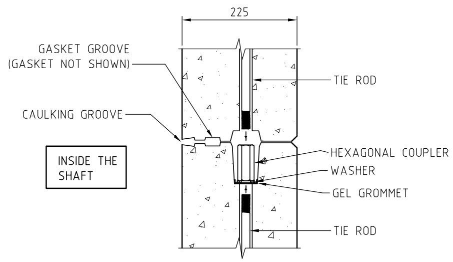
FIXING SCHEDULE PER RING (ALL ITEMS SUPPLIED BY HUMES)

ALL BOLTS, NUTS & WASHERS TO BE HOT DIP GALVANIZED UNLESS OTHERWISE SPECIFIED.



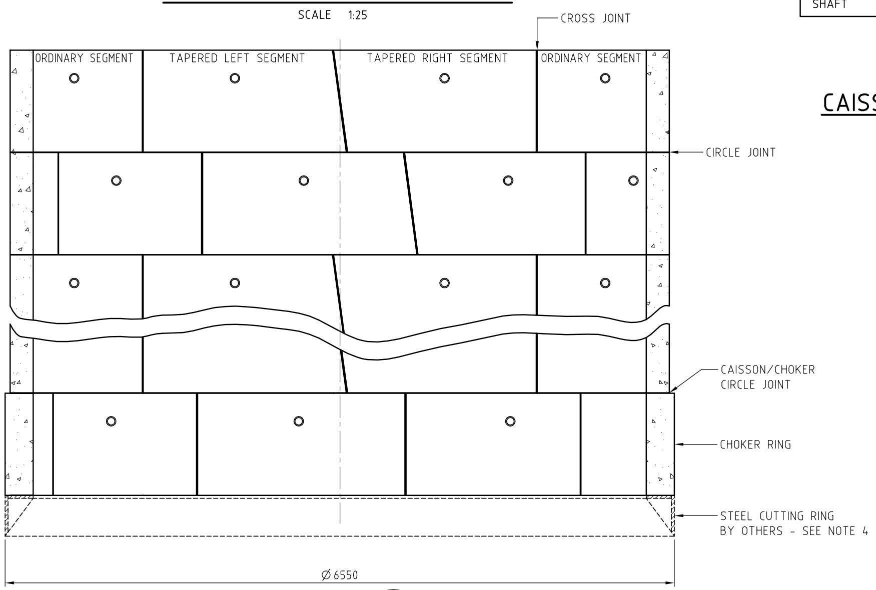
CAISSON/CHOKER CIRCLE JOINT DETAIL

SCALE 1:5



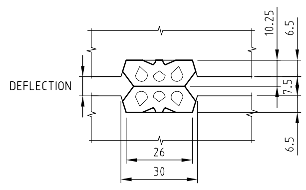
CIRCLE JOINT DETAIL

SCALE 1:5



SECTION A

SCALE 1:25



EPDM* GASKET JS1

DETAIL 1

SCALE 1:1

* ETHYLENE PROPYLENE DIENE MONOMER

NOTES:

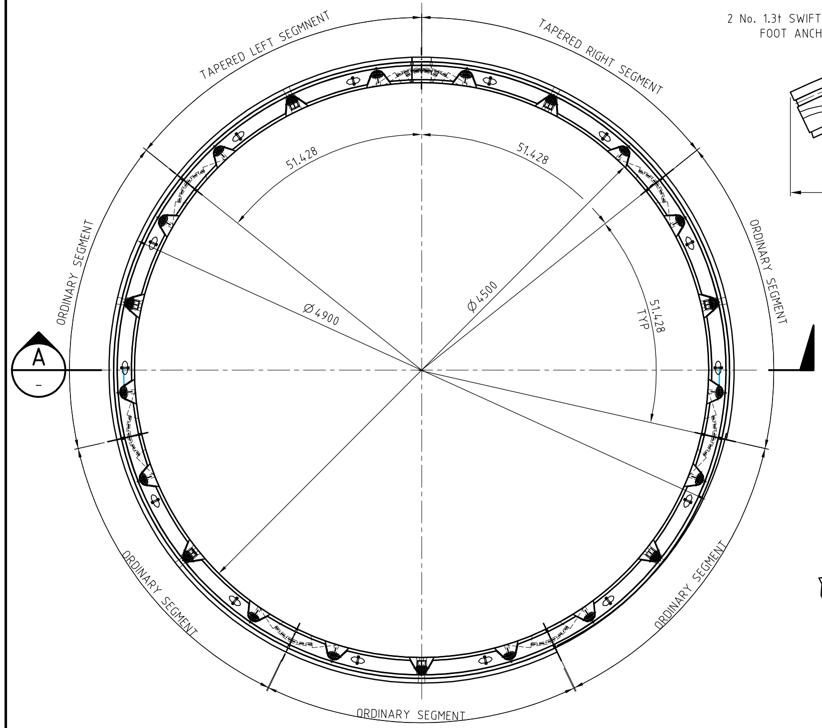
1. ALL DIMENSIONS IN mm UNLESS OTHERWISE NOTED.
2. EXPOSURE CLASSIFICATION B2 (AS 3735)
3. DESIGN IN ACCORDANCE WITH BRITISH TUNNELLING SOCIETY "SPECIFICATION FOR TUNNELLING" AND AS 3600.
4. FOR TYPICAL INSTALLATION DETAILS REFER DRAWING CAS-60-10.
5. SEGMENTS TO BE STORED VERTICALLY AND HANDLED ON SITE USING 2 No. 1.3 t SWIFTLIFT FOOT ANCHORS CAST INTO TOP FACE.
6. WEIGHTS:
   COMPLETE CAISSON RING WEIGHT: 11.2 TONNES
   MAXIMUM CAISSON SEGMENT WEIGHT: 1.25 TONNES
   COMPLETE CHOKER RING WEIGHT: 13.82 TONNES
   MAXIMUM CHOKER SEGMENT WEIGHT: 1.53 TONNES
7. EACH CAISSON RING CONSISTS OF:
   7 No. ORDINARY SEGMENTS
   1 No. TAPERED LEFT SEGMENT
   1 No. TAPERED RIGHT SEGMENT
8. EACH CHOKER RING CONSISTS OF 9 ORDINARY SEGMENTS.

Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND

DSN.	WST	16-02-12
DSN CKD.	CYZ	16-02-12
DWN.	DA	16-02-12
CKD.	MZ	27-03-12
APP.	WST	27-03-12
SUPERSEDES		

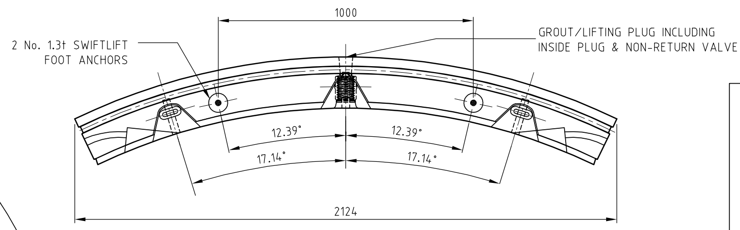
HUMES STANDARD DRAWING
PRECAST CONCRETE SEGMENTAL SHAFT
CAISSON SHAFT RING
6.0m ID
GENERAL ASSEMBLY

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:1	A1	CAS-60-01	1



PLAN VIEW ASSEMBLED RING

SCALE 1:20



PLAN - ORDINARY SEGMENT

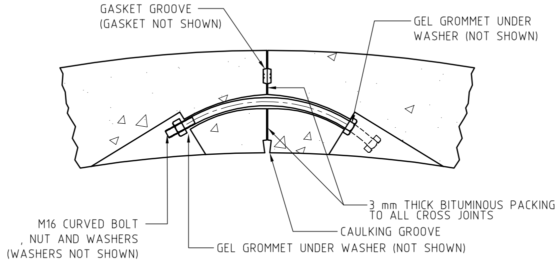
SCALE 1:10

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	ISSUED FOR MANUFACTURE	CH	07-02-12	CYZ
1	TABLE REVISED AND RE-ISSUED FOR MANUFACTURE	CH	07-02-12	CYZ

FIXING SCHEDULE PER RING (ALL ITEMS SUPPLIED BY HUMES)

	ITEM	No./RING	DESCRIPTION
PRECAST RINGS	ORDINARY SEGMENT (JS1)	5	4500x1000 UNDERPIN
	TAPERED LEFT SEGMENT (JS1)	1	4500x1000 UNDERPIN
	TAPERED RIGHT SEGMENT (JS1)	1	4500x1000 UNDERPIN
	EYEBOLT	21	SHAFT DOUBLE EYEBOLT 20X160 GALV
SITE FIXING ITEMS	DOWELS	42	SHAFT DOWEL 22 X 160 GALV
	CURVED BOLTS	14	SHAFT CURVED M16 X 375
	GEL GRUMMETS	1 28	SHAFT GEL GRUMMET 16mm
	EPDM GASKET (ORDINARY SEGMENT)	5	SHAFT GASKET 4500 ORDINARY UNDERPIN
	EPDM GASKET (TAPERED SEGMENT)	2	SHAFT GASKET 4500 TAPER UNDERPIN
	PACKING	7	SHAFT 4500 BITUMEN PACKER UNDERPIN
CAST IN ITEMS	GROUT SOCKET ASSEMBLY	1 7	SHAFT GROUT SOCKET ASSEMBLY
	ANCHOR PLATE (SET OF TWO)	42	SHAFT TWIN ANCHOR PLATES 138x49x10
	STACKING SPACER	28	SHAFT STACKING SPACER

* ALL BOLTS, NUTS & WASHERS TO BE ZINC PLATED UNLESS OTHERWISE SPECIFIED.

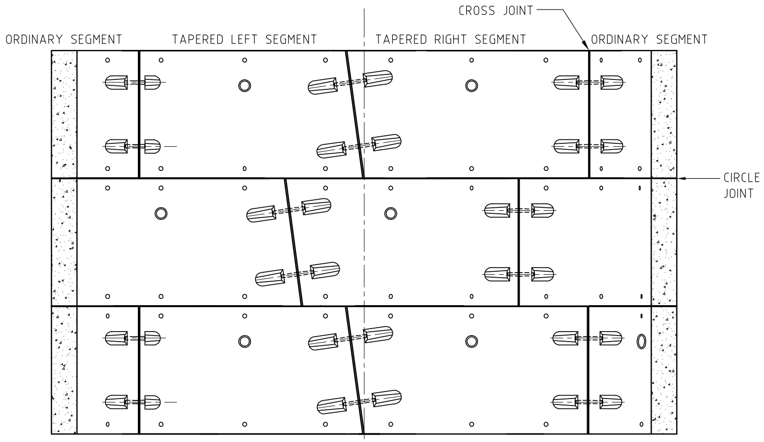


UNDERPIN CROSS JOINT DETAIL

SCALE 1:5

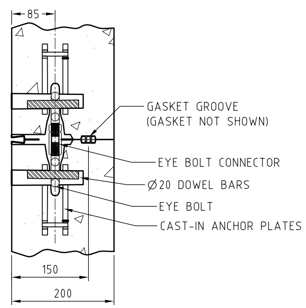
NOTES:

1. ALL DIMENSIONS IN mm UNLESS OTHERWISE NOTED.
2. EXPOSURE CLASSIFICATION B2 (AS 3735)
3. DESIGN TO AS3600
4. CONCRETE GRADE 50MPa.
5. FOR TYPICAL INSTALLATION DETAILS REFER DRAWING UPS-45-02.
6. SEGMENTS TO BE STORED VERTICALLY AND HANDLED ONSITE USING 2 No. 1.3 t SWIFTLIFT FOOT ANCHORS CAST INTO TOP FACE.
7. WEIGHTS:
   COMPLETE UNDERPIN RING WEIGHT: 7.36 TONNES
   MAXIMUM UNDERPIN SEGMENT WEIGHT: 1.05 TONNES
8. EACH UNDERPIN RING CONSISTS OF:
   5 No. ORDINARY SEGMENTS
   1 No. TAPERED LEFT SEGMENT
   1 No. TAPERED RIGHT SEGMENT



SECTION A

SCALE 1:20



CIRCLE JOINT DETAIL

SCALE 1:5

Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND

DSN.	WST	17-06-11
DSN CKD.	WST	19-12-11
DWN.	CH	17-06-11
CKD.	MZ	19-12-11
APP.	WST	19-12-11

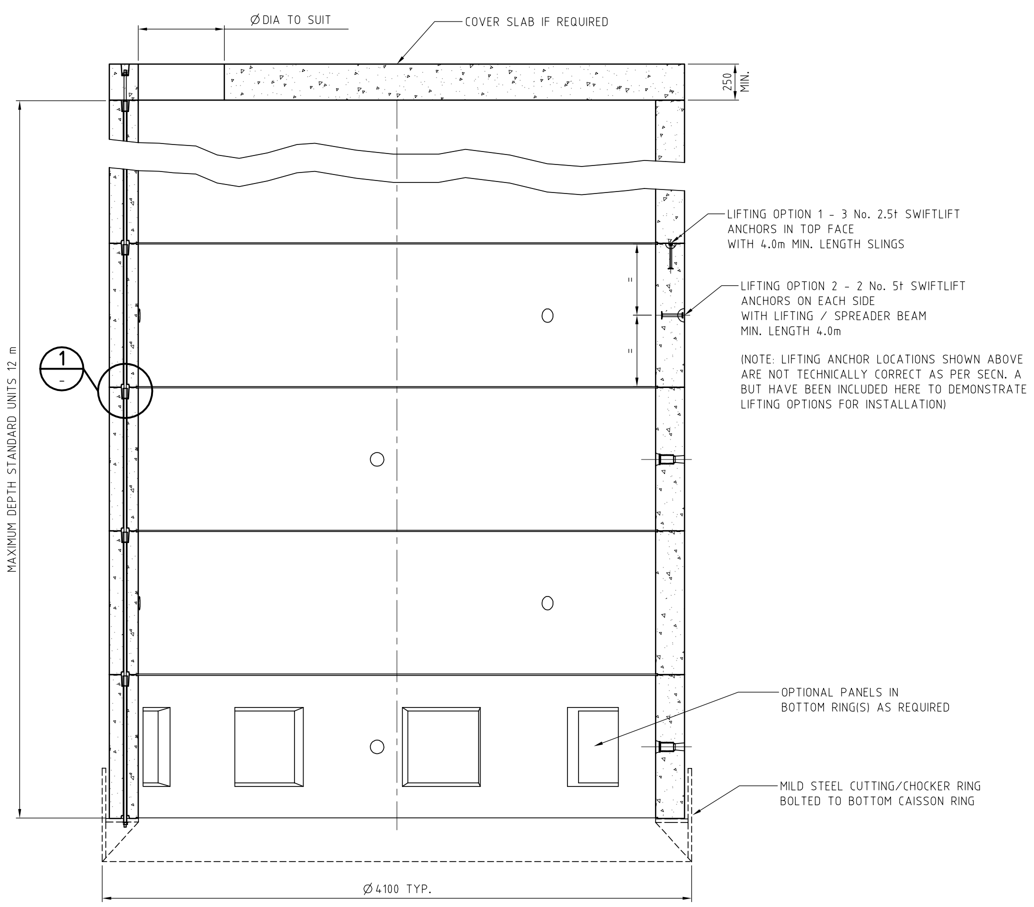
HUMES STANDARD DRAWING
PRECAST CONCRETE SHAFT SEGMENTS
UNDERPIN SHAFT RINGS
4.5m ID
GENERAL ASSEMBLY

SUPERSEDES | PLOT SCALE 1:1 | SIZE A1 | DRG. NO. UPS-45-01 | ISSUE 1

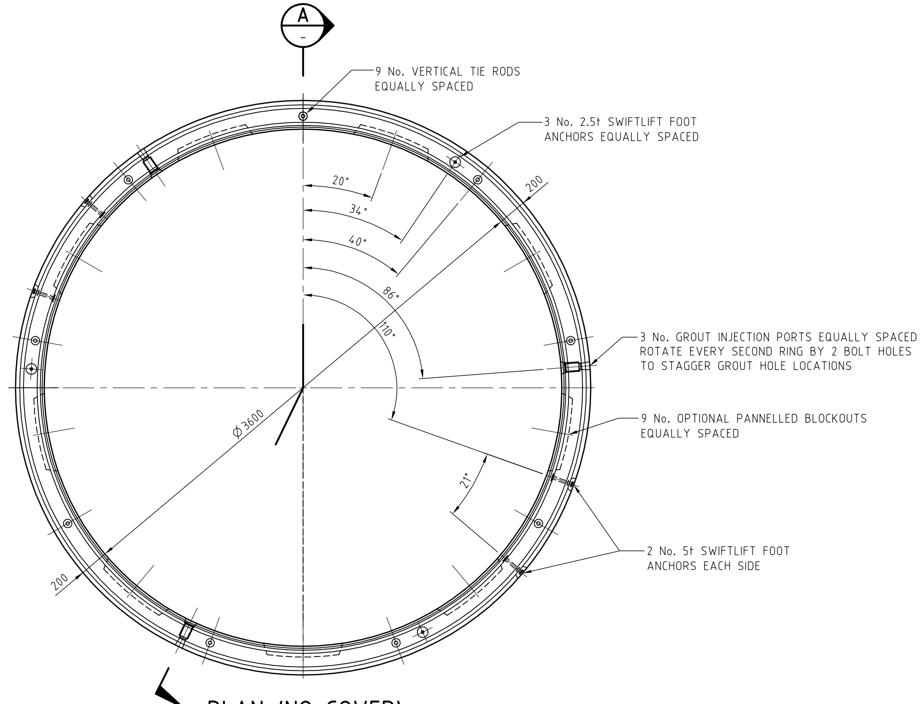
Holcim (Australia) Pty Ltd ABN 87 099 732 297

Indicative only

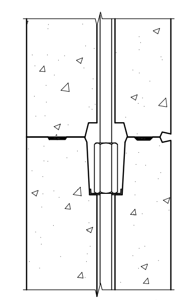
ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	ISSUED FOR MANUFACTURE	DA	07-03-12	WST



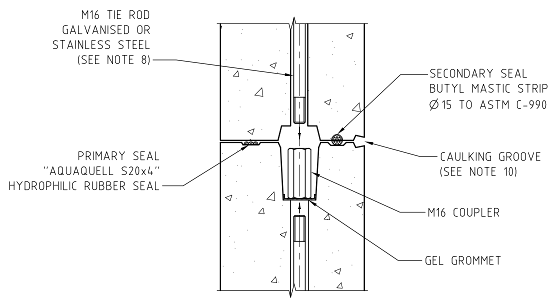
SECTION A
SCALE 1:25



PLAN (NO COVER)
SCALE 1:25



DETAIL 1
SCALE 1:5



DETAIL 1 EXPLODED VIEW
SCALE 1:5

NOTES:

1. ALL DIMENSIONS IN mm UNLESS SHOWN OTHERWISE.
2. INTERNAL SURFACE OF CAISSON UNITS TO BE 360° LINED WITH 2.5 mm THICK HDPE LINING. IF SPECIFIED (NOT PANELED RINGS) .
3. SURFACE FINISHES: TOP SURFACE AS CAST STEEL FLOAT FINISH OFF FORM SURFACES - CLASS 3 TO AS 3610.
4. MINIMUM SLING LENGTH (3 POINT LIFT) = 4.0 m
5. CONCRETE GRADE N50
6. EXPOSURE CLASSIFICATION B2 (AS 3735)
7. DESIGN IN ACCORDANCE WITH THE "*SPECIFICATION FOR TUNNELLING*" & "*TUNNEL LINING DESIGN GUIDE*" PUBLISHED BY THE BRITISH TUNNELLING SOCIETY.
8. 9 No. TIE RODS REQUIRED FOR INSTALLATION LOADS ONLY. FOR PERMANENT INSTALLATIONS USE 5 No. GRADE 316 STAINLESS STEEL & 4 No. GALVANISED
9. APPROXIMATE WEIGHT OF EACH UNIT = 6.0 TONNES
10. REFER TO HUMES FOR AVAILABILITY OF CAULKING GROOVE OPTION

Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND

DSN.	WST	17-02-12
DSN CKD.	CYZ	17-02-12
DWN.	DA	17-02-12
CKD.	MZ	07-03-12
APP.	WST	07-03-12
SUPERSEDES		

HUMES STANDARD DRAWING
PRECAST CONCRETE SHAFT SECTIONS
CAISSON SHAFT RINGS
DN3600 SINGLE PIECE RING
GENERAL ASSEMBLY

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:1	A2	CAS-36-01	0

Indicative only

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