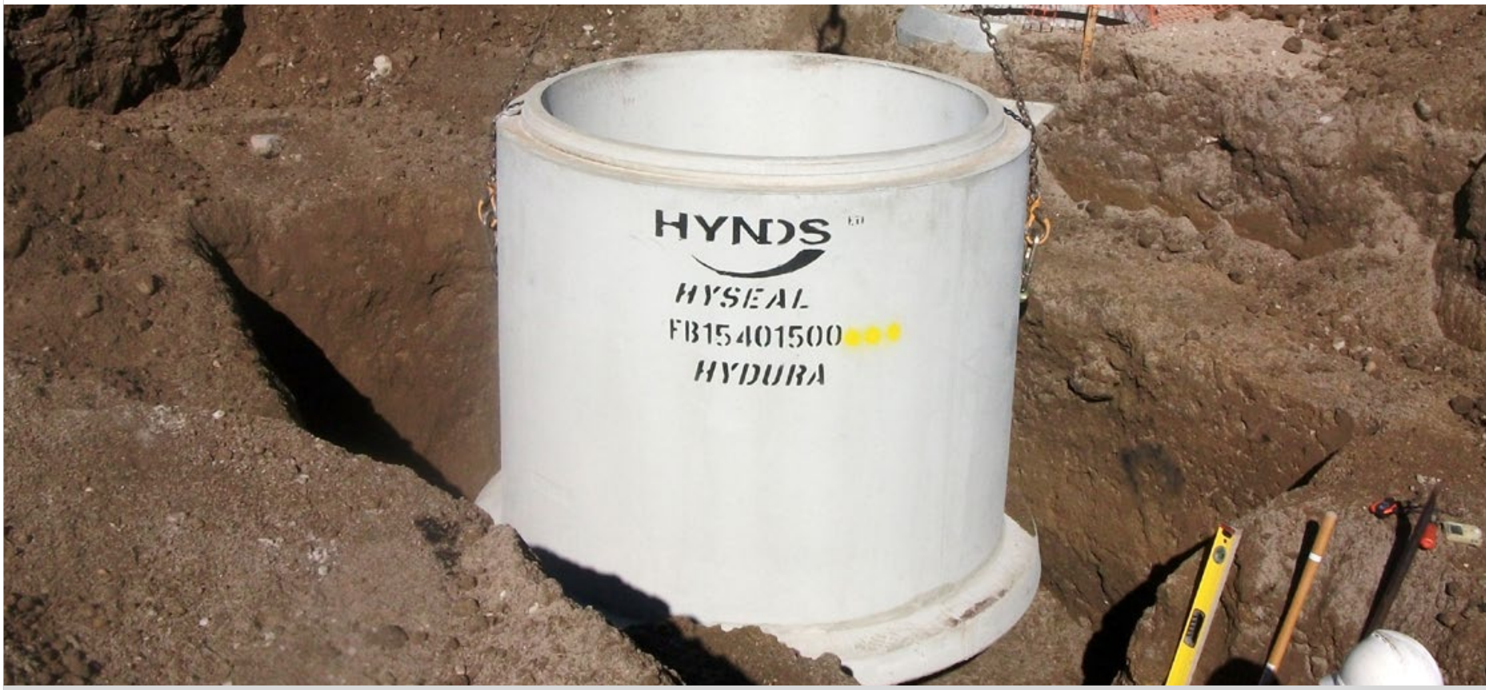
Hydura Concrete Pipe and Precast Structures

Technical Guide D1.11

Hynds Hydura concrete pipes and other precast components are made from a high quality concrete using a triple blend of cementitious materials.



Applications

- Pipelines carrying acidic trade wastes
- Pipelines in aggressive ground conditions
- Precast concrete structures subject to internal or external aggressive environments

Product Attributes

- Durable
- Strong
- Versatile

Approvals/Standards

- AS/NZS 4058:2007
- NZS 3101

Sustainability

- Available in Hynds LC® low carbon concrete
- Verifiable Carbon Footprint data available
- Climate-Resilient Infrastructure

Quality/Environment/Health & Safety

- ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018

HYNDS PIPE SYSTEMS

Hynds Hydura precast concrete pipes and other precast concrete components are made from a high quality concrete using a triple blend of cementitious materials.

Specifiers and Asset Managers are becoming more aware of the need to specify more durable concrete for use in aggressive conditions where concrete pipe may be subjected to acid attack in pipelines conveying sewage and trade waste, or groundwater containing acid, chlorides or sulphates.

Applications

- Acidic Environments **(except in sewers when H_2S is generated)**. Refer to page 3 of this brochure - Biogenic Sulphuric Acid Attack.
- Sulphate Environments
- Sewers conveying acidic trade wastes
- Environments with sugars in solution

Hydura concrete is used in the manufacture of precast concrete pipes, chambers, lids and a variety of other precast concrete components where additional durability is required.

Hydura concrete can be manufactured with a 25 mm internal sacrificial layer to provide additional durability.

For acidic soil conditions Hydura concrete pipe can be manufactured with increased internal and external cover to suit site conditions.

Concrete pipe manufactured using Hydura concrete will have a service life of 100 years, provided that certain service conditions are met. These are normal domestic sewage (without of H_2S gas generation), without highly aggressive industrial or commercial contaminants (pH≥4.5), and correct installation without overloading.

Common aggressive conditions that affect the durability of concrete

Acid Attack in Sewers

- Acid attack in sewer pipelines may arise from H_2S generation.

Note: *Hydura is not suitable for sewers where H_2S is generated. Refer to page 3 of this brochure - Biogenic Sulphuric Acid Attack.*

- Trade wastes discharges may introduce acids into the sewers, resulting in acidic conditions in the effluent.

Other Acid Attack

- Dairying, fruit processing, certain vegetables processing, wine manufacturing, fish and meat processing, wool scouring and other industries all produce various forms of acids and /or sugars in solution which will attack concrete.

Sulphate Attack

- Certain soils, geothermal sites and some sewage will also lead to concrete durability issues.

Chloride

- Marine and other tidal areas will require concrete to resist the ingress of chloride ions to the surface of the reinforcing.

Acid and Sulphate Attack

Acid attack on concrete is usually confined to the cement paste. Acids typically dissolve the calcium hydroxide and other products of hydration, leading to a loss of bond between the coarse aggregate particles. Spalling or removal of the aggregate from the concrete then exposes the reinforcement to corrosion leading to additional expansive stresses.

Sulphates react expansively with the hydration products tri-calcium aluminate and calcium hydroxide leading to stresses in the concrete and exposure of the reinforcement to corrosion.

In 1999 the CPAA (Concrete Pipe Association of Australasia) commissioned a study by Auckland UniServices (Department of Civil and Resource Engineering) into the durability of various concrete types used in sewer pipes.

The project investigated the behaviour of hydrogen sulphide induced corrosion through simulation using a chemical acid immersion test. The test procedure immersed various specimens in a 1% sulphuric acid solution for 500 days and measured the weight loss at various stages.

The results of the study confirmed improved durability of the Hydura concrete specimens compared to standard concrete mixes (using GP cement only), and mixes with 5 and 8% silica fume.

The report "Sulphide Corrosion of Concrete Sewer Pipes – Test Series Two – Final Report" dated July 2001 provides full details of the test results. www.cpaa.asn.au

Hydura concrete

Hydura concrete uses a ternary or triple blend of cementitious materials, comprising "Duracem®" (containing 75% ground granulated blast furnace slag (GGBS) and 25% GP cement), and Microsilica 600.

General Purpose Portland cement (Type GP), blended with ground granulated blast furnace slag (GGBS), a "natural" cement, provides superior protection and durability to concrete subject to moderate (pH≥4.5) acid attack. Use of slag cement is historically known to provide superior protection to deterioration due to acid attack e.g. Brussels. Belgium 1890's, sewerage and underground railway tunnels made extensive use of concrete containing high volumes of GGBS.

The durability of Hydura concrete arises from the low levels of calcium hydroxide $Ca(OH)_2$ in the slag concrete. Most of the remaining calcium hydroxide $Ca(OH)_2$ reacts with the Microsilica 600 to produce additional calcium silicate hydrate. The resultant refined pore structure of the concrete is more dense and less porous, and hence less vulnerable to leaching and attack by acids and sulphates etc.

Hydura concrete was developed by Hynds Pipe Systems Ltd engineers in 1997 and has been in use in New Zealand since then.

Biogenic Sulphuric Acid Attack (BSA)

In concrete sewer pipes carrying aged sewage the generation of hydrogen sulphide (H2S) leads to the interior surface of the pipe above the effluent level being attacked by sulphuric acid generated by bacterial action. Biogenic Sulphuric Acid attack is regarded as one of the most aggressive forms of attack on concrete sewer infrastructure.

Recent research has shown that Biogenic Sulphuric Acid corrosion is more severe than simulation using chemical acid immersion testing. The bacteria responsible are the Thiobacilli family, with various strains thriving at different pH levels. The attack mechanism comprises various stages with different strains of bacteria at each stage, eventually leading to a reduction of the concrete surface pH to 1-2. This pH level is considered highly aggressive to all cementitious materials, including all SCM's such as blast furnace slag, fly ash and microsilica.

It is generally accepted that the H_2S concentration is the most powerful indicator of potential BSA corrosion. However there is much conjecture in the literature surrounding the critical level of H_2S above which corrosion will occur. BSA corrosion has been reported at levels of H_2S gas phase concentrations well below 5 ppm.

BSA attack is likely to develop where low levels of H_2S generation is expected on an ongoing basis, or high levels expected on either an intermittent or ongoing basis.

The use of Hydura concrete (or concrete with any other SCM) will not provide additional durability.

Note: *Where Biogenic Sulphuric Acid (BSA) attack is expected to occur, we recommend the use of corrosion protection liner such as HyLiner HDPE. In small diameter pipes where liner installation is not practical we recommend the use of Bicrete concrete with either a 20 or 30 mm cover (refer to technical sheet D1.13 Bicrete).*

References:

- *Sulphide Corrosion of Concrete Sewer Pipes: Test Series Two Final Report, July 2001, Auckland UniServices Limited.*
- *Product Data – Duracem, August 2002, Holcim (New Zealand) Limited*
- *Biogenic Sulphuric Acid and the Role of Blended Cements – August 2013, Engineered Concrete Solutions Pty Ltd.*

Lifting and Handling

All Hydura Concrete Pipe and Precast Structures incorporate lifting anchors for safe lifting and must be used with the correct lifting clutch.

Hynds Pipe Systems has designed and manufactured Hynds Hydura Concrete Pipe and Precast Structures with a minimum dynamic factor of 1.2. This dynamic factor requires that all the following conditions are observed when lifting, moving or placing the pipes:

1. Lifting with mobile plant *(such as an excavator or similar)* where equipment is specifically exempt from the requirements of the PECPR Regulations 1999, subject to the conditions outlined in the New Zealand Gazette, No. 104, September 2015 and
2. Lifting, travelling and placing over rough or uneven ground where anchor failure is not anticipated to cause harm or injury, by adopting procedures such as:
   a. Transporting the element as close as practical to ground level (300mm recommended)
   b. Establishing and maintaining exclusion zones
   c. Transporting only precast concrete elements that are unlikely to topple if they were to hit the ground
   d. Inspecting lifting anchors both after transportation and before final lifting into place
3. Hynds uses both Reids and Ancon lifting anchors which are both designed to *(Haeussler)* specifications and as such are compatible with Reid, Deha or Ancon anchors, clutches, and recess formers of the same load range.

Refer to "Safe work with precast concrete - Handling, transportation and erection of precast concrete elements" published by Worksafe New Zealand (October 2018)

Shock loads resulting from travelling with suspended concrete pipe and precast structures over rough terrain and uneven ground may exceed design, dynamic and safety factors of the lifting systems. It is essential that care is taken during lifting and transporting as additional stresses could result in anchor failure.