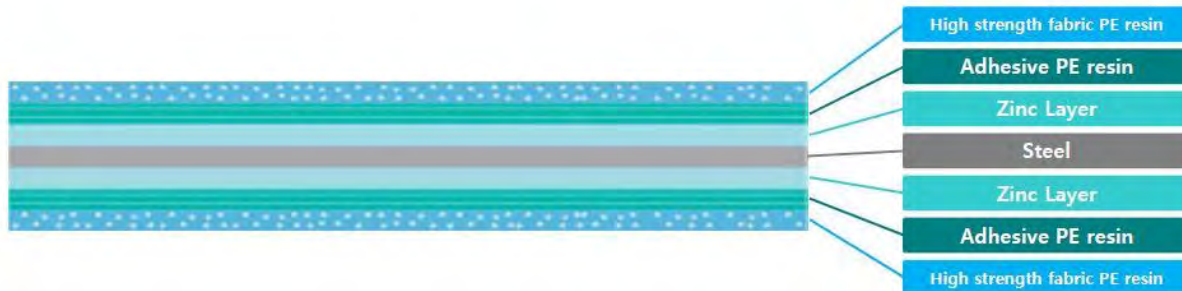


## Roundel HPL PE-coated steel culverts - overview.

HPL is a polyethylene-coated galvanised steel with the same steel strength and galvanizing weight (G250, Z600) as used in the manufacture of our standard culverts. The reinforced PE layer provides considerable additional protection to the underlying Z600 galvanizing resulting in substantially increased life-span of the culverts even in the most aggressive conditions.

Unlike other PE-coated steels, HPL has a reinforcement layer within the polymer that provides very high resistance to abrasion, harsh environmental conditions and localised surface damage. The coating is applied on both the internal and external surfaces of the culverts, as shown below:



The HPL materials are available in wall thicknesses of 1.6mm to 3.0mm in the 68 x 13mm and 125 x 25mm corrugation profiles specified in AS/NZS 2041.4. The culvert diameter range will remain the same – 300mm to 3,650mm on our standard mills, with the potential for >4,000mm on our mobile mills.

The Australian Standard for helically-formed corrugated steel culverts, AS/NZS 2041.4:2010, allows for the use of the polymer coated steel materials, as detailed in Section 2.2, and reproduced below.

## 2.2 MATERIALS

### 2.2.1 Base material

The base material consisting of the base metal and a protective coating shall be—

- (a) galvanized steel strip complying with the requirements of AS 1397 for steel base grade G250 and galvanized to Z600;
- (b) aluminium cladding aluminium substrate strip classification Alclad 3004-H34 (7072 cladding and 3004 core) in accordance with AS/NZS 1734 and ASTM B744;
- (c) steel strip of grade G230 minimum with an aluminized (Type II) coating in accordance with ASTM A929; or
- (d) galvanized steel strip of grade G230 minimum and galvanized to Z600 with a polymer coating in accordance with ASTM A742.

HPL has been tested independently to ASTM A742 and meets the requirements 2.2.1 (d) above in full. The tests include for the following:

- Adhesion
- Impact
- Thickness
- Holidays
- Abrasion Resistance
- Imperviousness
- Freeze-Thaw Resistance
- Weatherability
- Resistance to Microbial Attack

In reviewing the ASTM A742 standard, it is important to note the PE coating thickness specified in ASTM A 742 is 250 microns per side. This is due to the standard being based on the original Trenchcoat materials produced by Dow Chemicals, the only product available at the time. HPL materials are a minimum of 550 microns per side, including the reinforcement layer, which significantly increases its abrasion resistance and overall durability performance.

In addition to testing to the above ASTM standard, we have carried out extensive Taber abrasions tests comparing HPL materials to both standard Z600 galvanised steel and Trenchcoat PE-coated steel. By conducting directly comparable tests for the three materials, we were able to assess the benefits of against the known performance of Z600, together with comparisons to the Trenchcoat PE. The testing was carried out as follows:

**Abrasion test overview:**

- The Taber abrasion tests have been carried out in accordance with ASTM D4060 – 14.
- CS-17 abrading wheels have been used, as per the above standard.
- The abrading wheels are resurfaced every 500 cycles, as per the above standard.
- The abrading wheels are loaded with a 1,000-gram load.
- Three sample materials have been tested:
  - G250 Z600 galvanised steel.
  - Trenchcoat PE-coated steel; and,
  - HPL – PE-coated steel.
- In the case of the Z600 galvanised steel, testing continued until bare-metal was reached.
- In the case of the Trenchcoat PE-coated steel, the testing continued until the galvanised steel surface was reached. This was also originally the intention for the HPL, but testing was halted at 80,000 cycles without the galvanised substrate being reached. Given that both the Trenchcoat and the HPL coated materials are galvanised to Z600 prior to the application of the PE coating, we can assume the life-span of the underlying zinc coating will be the same across all samples.

The Z600 galvanised coating was removed after 8,000 cycles. The Trenchcoat PE-coated steel failed at 40,000 cycles. Testing on the HPL materials was stopped at 80,000 cycles without reaching the galvanized substrate. The samples were then water-cut and micro-measured to assess the degree of material loss, as detailed below:

Material	Original coating thickness - $\mu\text{m}$	Average coating thickness - $\mu\text{m}$	Total Cycles applied
HPL PE-coated Z600 steel	600, 630, 550, 610, 570	592	80,000
Z600 galvanised steel	30, 40, 30, 30, 30	32	8,000
Trenchcoat PE-coated Z600 steel	330, 350, 330, 340, 330	336	40,000

Material	Wear scar - $\mu\text{m}$	Average - $\mu\text{m}$
HPL PE-coated Z600 steel	300, 280, 280, 320, 300	296
Z600 galvanised steel	10, 0, 0, 10, 0	4
Trenchcoat PE-coated Z600 steel	30, 20, 30, 20, 20	24

We can see from the above results, the HPL materials wear at a rate approximately half that of the Trenchcoat materials. Given that the HPL coating thickness is also double that of Trenchcoat, the overall performance of HPL has the potential to be eight times superior.

### Culvert life-span:

In terms of the expected life-span of PE-coated steels, Section 3 of AS2041.1 details the estimated service life for PE-coated steel, against a range of pH and Resistivity values as shown in Table 3.7.2(E), copied below.

Estimated service life	Site environmental conditions	Maximum FHWA ID-85-15 (see Note 1) abrasion level
Minimum 100 y	$5.0 \leq \text{pH} \leq 9.0$ $r > 1500 \text{ ohm-cm}$	Moderate (see Notes 1 and 2 of Table 3.4)
Minimum 75 y	$4.0 \leq \text{pH} \leq 9.0$ $r \geq 750 \text{ ohm-cm}$	
Minimum 50 y	$3.0 \leq \text{pH} \leq 12.0$ $r \geq 250 \text{ ohm-cm}$	

NOTES:  
 1 See Bibliography.  
 2 Polymer precoated material in accordance with ASTM A742.

Ref. AS/NZS2041.1

As noted above, the estimated service life detailed in the above table assumes the thickness of the coating to be a minimum of 250  $\mu\text{m}$  as per ASTM A 742. Given the additional thickness of the HPL coating, together with the significant results of abrasion tests, it is reasonable to expect the HPL materials to last well in excess of the service life estimates detailed in Table 3.7.2 (E).

In conclusion, the HPL PE-coated steel materials represent a significant move forward in the production of helically-formed steel culverts, offering end-users and specifiers a significant choice where durability remains a concern. The material will provide substantial durability performance in aggressive environments and in areas where high abrasion rates are a concern, whilst offering the same cost-effective benefits of traditional steel culverts.

### Inclusions:

- Exceed Consulting ASTM A742 test report
- Exceed Consulting Taber Abrasion comparative test report
- Exceed Consulting HPL durability report



*HPL PE-coated steel - close up*

## Roundel HPL PE-coated steel specification:

PE-coated steel with the steel strip to be grade G230 minimum and galvanised to Z600. The specified steel wall thickness is uncoated.

Polymer coating on both sides to be tested in accordance with ASTM A742/A 742M with a minimum overall coating thickness of 500 µm (microns) per side. ASTM A742 testing to include:

Clause 9.1 – Adhesion.	Clause 9.5 – Abrasion Resistance.
Clause 9.2 – Impact.	Clause 9.6 – Imperviousness.
Clause 9.3 – Thickness of coating	Clause 9.7 – Freeze-Thaw Resistance.
Clause 9.4 – Holidays.	Clause 9.8 – Weatherability

Taber abrasion tests carried out to ASTM D4060 – 14 using CS-17 abrading wheels loaded with 1,000-gram loads. Abrading wheels to be resurfaced every 500 cycles. Abrasion tests to continue until the underlying zinc coating is reached with total cycles recorded and average coating loss measured. Minimum cycles to zinc coating to be 60,000 cycles.

Proof of compliance with these requirements shall be provided to the Engineer prior to purchase of culverts.





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## Setting new standards for corrugated steel culverts

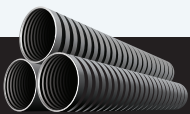
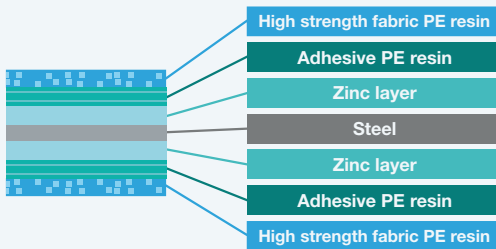
**Roundel's HPL PE-coated steel culverts offer significantly improved durability performance compared to traditional Z600 galvanised steel.**

HPL is fully compliant with AS / NZS 2041.4, ASTM A742, and has been extensively tested locally to demonstrate a **100-year life**, with exceptional abrasion performance. It is available for internal and / or external surfaces depending on your requirements.

The coating's superior performance has been recognised by the Department of Transport and Main Roads (TMR) and was approved for culvert relines on the Toowoomba Second Range Crossing.

Over 4,500 tonnes of HPL PE-coated culverts are also being manufactured on-site by Roundel for Rio Tinto's Koodaideri Rail project in the Pilbara, WA.

Roundel welcomes your inquiries for HPL-coated culverts, traditional Z600 galvanised culverts and our wide range of B200 and B381 bolted, corrugated steel structures.



**INQUIRIES:** WA 08 9404 5391 QLD 07 4789 6700 General 1800 194 746 [roundel.com.au](http://roundel.com.au)



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Toowoomba Second Range Crossing, QLD.

- Project:** Toowoomba Second Range Crossing.  
**Client:** Nexus Delivery (Acciona – Ferrovial Agroman J.V.)  
**Project outline:** A significant highway project bypassing the town of Toowoomba, QLD.



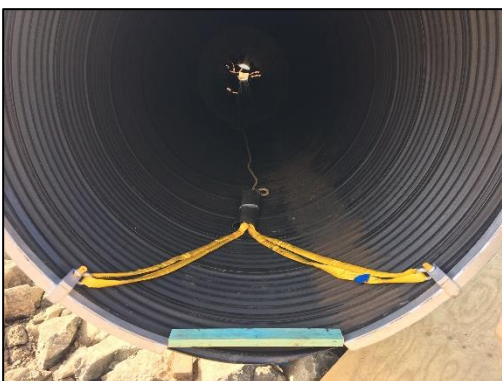
**Scope-of-works:** Our scope of works consisted of the on-site production of 300 tonnes of HPL PE-coated steel culverts to reline pre-cast concrete culverts, originally specified, that were failing. Roundel designed the lining system considering the live loads as per AS5100, together with high dead loads due to the heights-of-cover involved. Our design assumed no support from the existing concrete culverts. The steel culverts were internally coated in HPL PE materials to ensure the 100-year requirement was fully satisfied. The materials were approved for use by Transport & Main Roads (TMR), QLD.

The steel culverts were pulled into position, centred on wood battens, and the annulus between the new steel culverts and the original concrete was filled with injected / pumped grout.



Design life = 100 years, as per TMR requirements.  
Design & Manufacture to AS / NZS2041 standards.

HPL PE-coating considerably exceeds the requirements of AS / NZS2041.4:2010 Section 2.2.1 (d) and ASTM A742.



**Project:** Gudai-Darri Rail.

**Date:**

**Client:** Project owner: Rio Tinto. Civil Contractors: Acciona-Clough JV (Northern section), NRW Construction Pty. Ltd (Southern section).

**EPCM:** WorleyParsons Pty Ltd

**Project outline:** The Gudai-Darri (Koodaideri) Rail project consisted of 170 km of railway line connecting the Gudai-Darri mine to Rio Tinto's existing rail system. The mine is located in the Pilbara, WA.



**Scope-of-works:**

Our scope of works consisted of the on-site production of 4,300 tonnes of HPL PE-coated Stilcor CSP culverts, ranging diameter from 600 to 2,700mm. Two pipe mills were deployed on-site simultaneously to service both the Northern and Southern sections of the project. Both sections were completed on time and without incident.



RioTinto



The HPL PE-coated steel was specified for its considerable durability and high resistance to abrasion, with a tested life-expectancy in excess of 100 years.

The project was a first for Roundel in terms of the on-site manufacture of PE-coated steel. Extensive local durability testing was carried out to ensure material suitability.



To ensure the timely supply of culverts to the numerous installation crews, located throughout the chainage, we simultaneously ran two on-site mills across 7 locations, over a five-month period. The project was completed on time and without incident.



The manufacture of the HPL culverts was to AS / NZS2041.4 standards. The design & manufacture of the CSP culverts and the B381 bolted structures was to AS / NZS2041 standards. Roundel is the only Australian company offering the design & manufacture of corrugated metal pipes, and bolted, corrugated metal structures, operating nation-wide.

