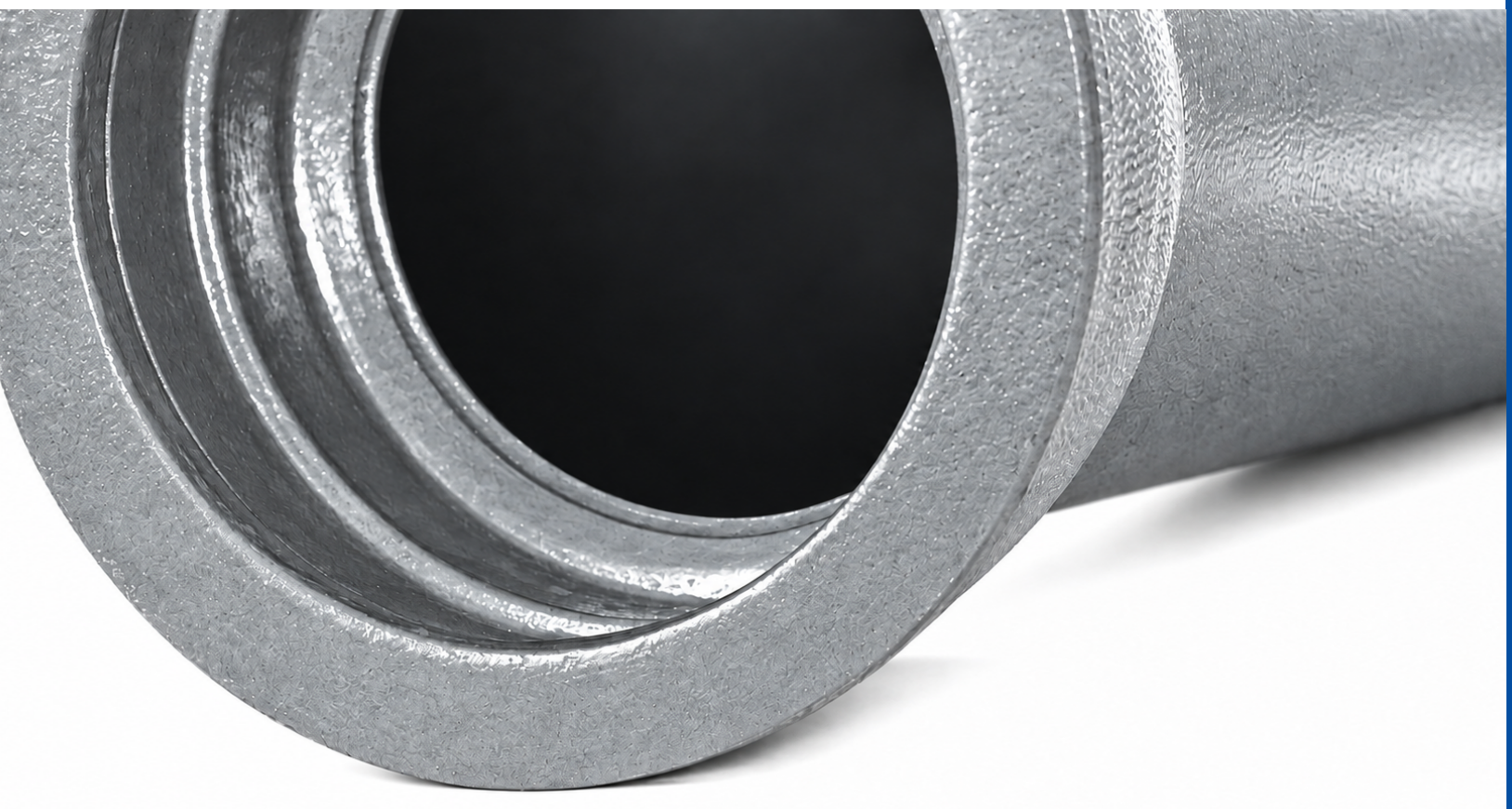
ELECTROSTEEL USA

External Zinc Coating for Ductile Iron Pipe

Laying pipe is tough enough. Protecting it shouldn't be.



26th Edition

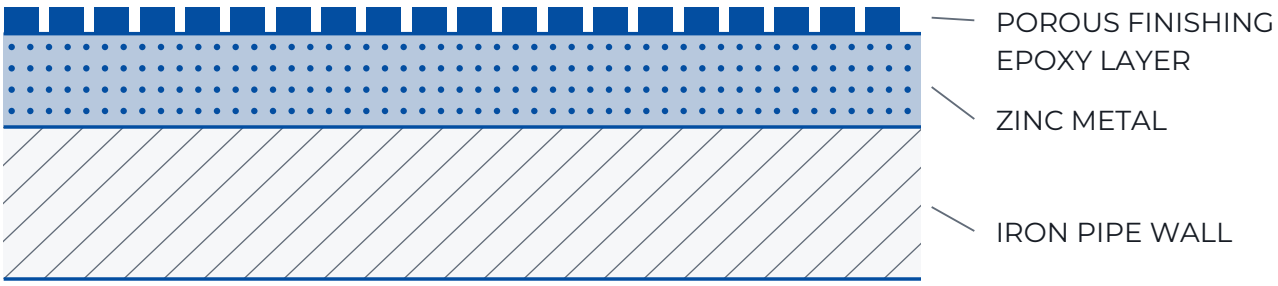
ZINC COATING FOR EXTERNAL PROTECTION OF DUCTILE IRON PIPES

Zinc coating was initially developed in the 1950s based on extensive field tests, and gradually emerged as an effective protection system for iron pipes. This coating is now extensively used across many continents, including Europe, Africa and Asia. In fact, zinc coatings have been adopted by most major pipe manufacturers throughout the world.

The process and composition of the protective coating

Step 1 Immediately after annealing heat treatment, a layer of metallic zinc — produced by melting zinc wire — is sprayed onto the outside diameter of the pipe resulting in fine droplets of molten zinc strung together.

Step 2 A finishing layer of blue, purple, etc., epoxy is applied over the zinc coating.



DIP WITH ZINC EPOXY COATING

The coating is applied per ISO: 8179, which specifies:

Minimum zinc metal : 200 gm/m^2

Minimum average thickness of 70 microns

TESTED PROVEN RESULTS

Several tests have been performed at Electrosteel's laboratory to demonstrate the main protective features of zinc-based coatings.

Test for polarization resistance

Samples were submitted to anodic polarization in a potentiostatic cell. The polarization resistance at the equilibrium potential Eo was about 3 times higher for samples with zinc salts layer and the anodic polarization current at Eo + 100 MV was 8 to 9 times less.

Salt spray test

After 67 days of exposure (1600 hours), no corrosion of ductile iron could be detected on samples with zinc salts layer whereas samples with out the protective layer suffered corrosion to depths up to 0.8 mm. Weight losses were respectively 11 mg/cm^2 and 133 mg/cm^2 (a factor of 12).

Test to investigate the self-healing mechanism of damages

Test samples were cut out of ductile iron pipes with and without zinc coating (bituminous paint only) using an abrasive disk. The samples were immersed for one year in a solution of sodium chloride and sodium sulphate, stimulating very corrosive soil. After inspection it was apparent no corrosion had occurred on the zinc-coated samples whereas samples without zinc were badly corroded.

Field tests

Decades of field tests in several countries have confirmed these laboratory test findings and demonstrated the durability of zinc coatings under various soil conditions.

ZINC COATING WITH EPOXY FINISHING vs USE OF POLYETHYLENE SLEEVING

The use of polyethylene sleeving is common in the US in aggressive soil conditions to render additional protection against pitting of ductile iron pipes. However, the use of site-applied polyethylene sleeving has its own potential problems.

- PE sleeving installation errors may result in loose sleeving and subsequent entrapment of soil clods between the sleeving film and the pipe surface
- Proper application is cumbersome and time consuming
- Inspectors must be very vigilant at site to ensure proper sleeving by the contractor
- Sealing of ends, overlaps and loose ends with adhesive tape requires utmost care
- Handling, installation or backfilling often results in damage or tearing
- Damage to the sleeving system on a buried main may happen by subsequent digging and trenching activities

COMPARISON OF ZINC AND NON-ZINC COATED DIP

S. NO	FEATURES	ASPHALT COATED DIP	DIP WITH ZINC
1	External Color	Black	Blue, Purple, etc.
2	Internal Lining	Cement mortar lining as per AWWA C151	Cement mortar lining as per AWWA C151
3	Internal Coating	Bituminous seal coat as per relevant standard	Bituminous seal coat as per relevant standard
3	External Coating	Finishing layer of 1 mil Bitumen paint	Metallic Zinc coating of 200 gm/m^2 followed by a finishing layer of Epoxy paint of 70 micron
4	CORROSION RESISTANCE PROPERTIES OF COATING		
4.1	Salt Spray Test as per IS 101 with NACE Solution : Exposure time 500 hrs.	94% surface area of pipe affected with red rust after 500 hrs.	No occurrence of rust even after 500 hrs.
4.2	Resistance against Acid (pH3) and Alkali (pH13) solution	Coating quality starts deteriorating within 2 days	No cracking, blistering or disbonding of coating when exposed to Acid and Alkali solution for 6 months
4.3	Bonding Strength when tested in accordance with ASTM D4541	4 Mpa	over 6 to 8 Mpa
4.4	Scratch Hardness when tested in accordance with IS 101, Part 5, Sec. 2	Cracks develop at 1 kg load	Exhibits no crack at 2 kg load
4.5	Impact Resistance, when tested in accordance with ASTM D2794	Coating cracks at 190 kg/cm load	Passes 200 kg/cm load in direct impact
4.6	Aesthetic	Normal Black	Attractive appearance. Blue is an internationally recognized color code for potable water
5	PERFORMANCE		
5.1	Effect on coating by contact soil or atmosphere	Suitable only for normal environments	Suitable even for very aggressive environments

THE UNIQUE PROTECTION MECHANISMS OF ZINC COATINGS

Zinc coatings act by two complementary methods to uniformly protect the pipe surface:

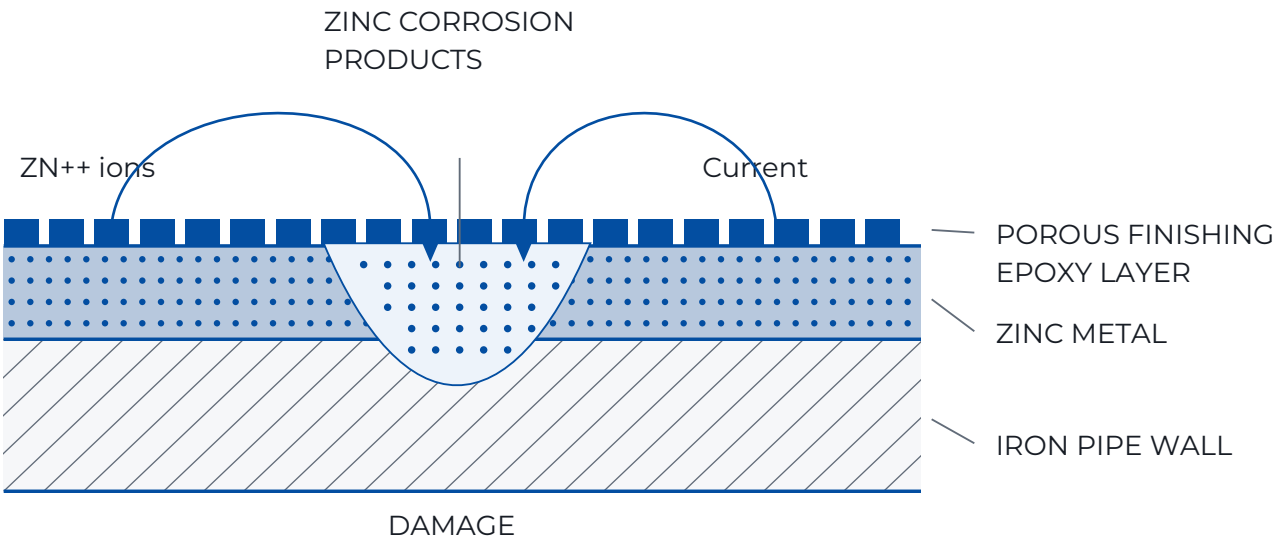
- Zinc coating provides a stable protection layer

In zinc-coated pipes, the metallic zinc in contact with corrosive soil slowly turns into a layer of zinc corrosion products such as zinc oxides, zinc carbonates, zinc oxychlorides, etc. This process results in a stable, dense, impervious adherent layer which occupies almost exactly the same volume as the initially porous zinc metal layer, uniformly covering the whole pipe surface.

- Self-healing of damages

Zinc is electronegative to iron and can protect it sacrificially. The pipe surface often gets damaged in the field, exposing bare metal. Under these circumstances the zinc coating works as a cathodic protection system. The porous layer of epoxy allows migration of zinc ions, normally resulting in a zinc transformation that fills the break in the coating, preventing or retarding further corrosion of the exposed iron.

When pipe is covered only with bitumen, the bare metal exposed becomes anodic and causes severe pitting. On zinc-coated pipes, the damaged zone becomes cathodic to the rest of the pipe and is progressively covered by zinc corrosion products.



SELF-HEALING PROCESS



Protection never looked so good

Oftentimes the simplest solutions are best. You could go through the extra step of painting your pipe. Or you could choose epoxy coatings from Electrosteel USA — the only pipe available in the USA with a colored exterior coating. Years later our pipe will still retain its durable epoxy coating color. Paint? Who knows how long that will last.

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