CLIFFS

ALUMINIZED STEEL TYPE 2

CORRUGATED STEEL PIPE

Technical Bulletin

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ALUMINIZED STEEL TYPE 2 CORRUGATED STEEL PIPE

STRENGTH OF STEEL, CORROSION RESISTANCE OF ALUMINUM

Corrugated Steel Pipe (CSP) manufactured from Aluminized Steel Type 2 offers the corrosion resistance and surface characteristics of aluminum with the strength and value of steel.

The product is fabricated from steel coils that have been hot dip coated in a bath of commercially pure aluminum. The coating has uniform thickness on both sides of the sheet, with a strong metallurgical bond between the metals. The Aluminized Steel Type 2 material meets AASHTO specifications M274 and ASTM A929.

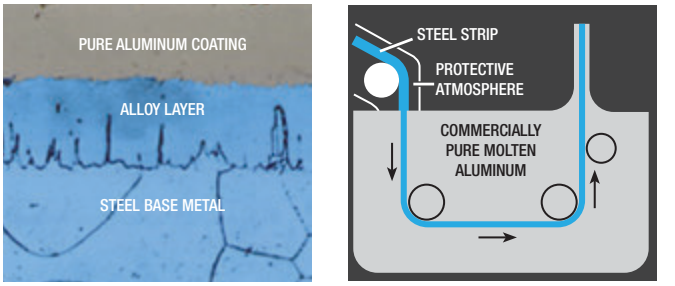
The coils are then fabricated into helically corrugated pipe meeting the requirements of AASHTO specifications M36 and ASTM A760. Helically corrugated steel pipe has been a standard of the construction industry for decades. Pipe is fabricated with lock seams or welded seams depending on the job requirements, and each pipe end can be reformed to provide at least two annular re-corrugations.

EXCELLENT BARRIER PROTECTION

Aluminum forms a passive oxide layer that adds to the service life by providing good barrier protection. This passive oxide forms rapidly and maintains better protection over a wider environmental range than zinc reaction products. The aluminum oxide is stable in both hard and soft water.

The passive oxide will endure as long as the free aluminum coating layer is present. When this layer is eventually penetrated, there is an underlying hard, thick aluminum-iron alloy layer that provides further corrosion protection plus abrasion protection.

Based on field studies of 42 – 50 year installations, Aluminized Steel Type 2 service life is estimated to be 75 years minimum at 16 gauge in the 5 – 9 pH and ≥ 1,500 ohm•cm resistivity ranges, and 100 years in the same pH range and resistivity ranges > 5,000 ohm•cm. For a narrower pH range of 6 – 8, culvert data supports 100 year estimated service life for resistivities ≥ 1,500 ohm•cm. If pH is between 4.5 – 5.0 and the resistivity ≥ 5,000 ohm•cm, the estimated service life for 16 gauge Type 2 should be 75 years.



The photomicrograph on the left shows how the thick alloy layer metallurgically bonds the aluminum coating to the steel base metal, as well as how the coating provides continuous protection to the base metal. The same coating protection is provided to both sides of the steel base metal.

In general, however, environments outside the recommended pH/resistivity ranges should be subjected to additional testing to see if conditions conducive to accelerated corrosion actually exist. For example, low resistivity waters and soils may contain excessive concentrations of corrosive chloride and sulfates salts. In addition, any dark or light gray, blue, or olive colored clay constituents observed in a heterogeneous soil should be isolated for pH measurement since these sometimes contain watersoluble heavy metal salts. These constituents induce strong acidification necessitating the use of ample imported compliant backfill to envelop the pipe and ensure normal soilside corrosion behavior.

Environments that are outside the recommended pH/resistivity ranges should be avoided, including acid minewater, seawater, estuary brackish water, and sanitary/industrial sewage.

STANDARD SPECIFICATIONS

1. AASHTO M274 (Aluminized Steel Type 2 material) and ASTM A929
2. AASHTO M36 and ASTM A760 (conduit, pipe)
3. AASHTO Standard Bridge Design Specifications, Section 12
   (structural design) and ASTM A796
4. ASTM A798 (installation)

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IDEAL FOR STORM SEWERS

Aluminized Steel Type 2 corrugated steel pipe is an ideal material for municipal storm sewers or any normal drainage project. Aluminized Steel Type 2 pipe offers a durable and economical alternative to reinforced concrete pipe. Features include light weight, long lengths, and joints that have positive pull-apart resistance and the ability to adjust to yielding foundations.

LONG-TERM FIELD TESTING

Based on extensive data from actual field installations dating back 50 years, Aluminized Steel Type 2 is a superior product for storm sewer and drainage projects. It has better corrosion resistance than galvanized structures and displays better abrasion resistance.

Prior to 1953, Aluminized Steel Type 2 and galvanized steel culverts were exposed in sites across the U.S. These sites represented a variety of service conditions including farm field drainage, fresh water swamps, alkali soils, and erosive applications. Test installations were sampled after 8 years and again after 24 years. Weight loss data analyzed at all sites indicate Aluminized Steel Type 2 provided significant additional corrosion resistance.

In addition to the careful sampling and evaluation accomplished during this 24 year program, simple visual inspection revealed that:

- The appearance of Aluminized Steel Type 2 was clearly superior to that of conventional metallic coating.
- The condition of Aluminized Steel Type 2 pipe inverts, a critical point in durability design, was excellent.

In 1952 – 53, an additional 135 composite culverts of Aluminized Steel Type 2 and galvanized steel were installed in 20 states. Based on the current conditions of the pipes available, the data indicates a minimum 100 year service life for 16 gauge Aluminized Steel Type 2 pipe when installed in the recommended environment, pH 5 – 9 with resistivities ≥ 5,000 ohm•cm or pH 6 – 8 with resistivities ≥ 1,500 ohm•cm.

INDEPENDENT STUDIES

Independent studies have been performed that confirm Cleveland-Cliffs Steel Corporation long-term field test.

Coatings for Corrugated Steel Pipe; R. M. Pyskadlo and J. P. Ewing (NYDOT); FWHA-NY-SR-87-90

Durability Analysis of Aluminized Type 2 CMP; J. P. Ault and J. A. Ellor (OCR); FWHA-RD-97-140

This close-up view shows the Aluminized Steel Type 2 pipe installed in Garland, Maine, with the dark staining wiped away to reveal the like-new underlying aluminum

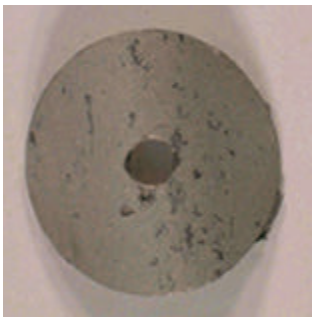
This Aluminized Steel Type 2 corrugated steel pipe was installed in 1953 in El Dorado, California. It was inspected in 1982,1995 and in 2005. Coupons were removed for evaluation by the Cleveland-Cliffs Research Center and CALTRANS.

Cleveland-Cliffs Research Center's corrosion engineers and Missouri DOT material engineers inspect a 43 year old Aluminized Steel Type 2 pipe installation. This is one of two culvert installations in Carter County, Missouri, installed in a series containing half Aluminized Steel Type 2 pipe and half galvanized steel pipe.

ALUMINIZED STEEL TYPE 2 CORRUGATED STEEL PIPE

50 YEAR OLD ALUMINIZED STEEL TYPE 2 COUPONS TAKEN FROM PIPE INVERTS AROUND THE UNITED STATES

Marshall County, IA
Installed 1952 – Inspected 2003

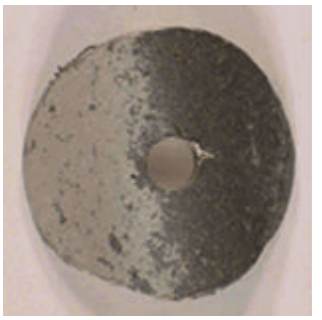


Lafayette County, MO
Installed 1952 – Inspected 2003

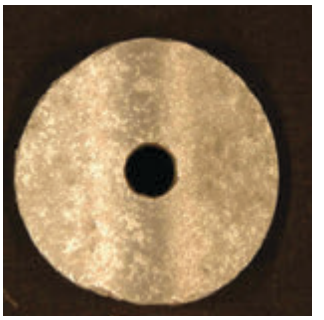
Greene County, IL
Installed 1953 – Inspected 2003

Morgan County, IL
Installed 1952 – Inspected 2003

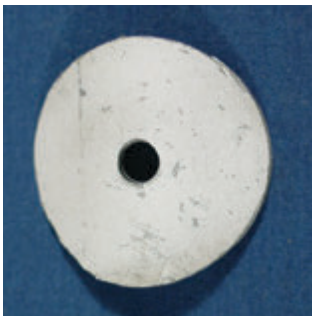
Bernalillo County, NM
Installed 1952 – Inspected 2005



Carter County, MO
Installed 1953 – Inspected 2003

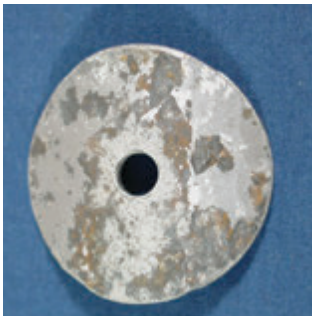


San Benito County, CA
Installed 1952 – Inspected 2005

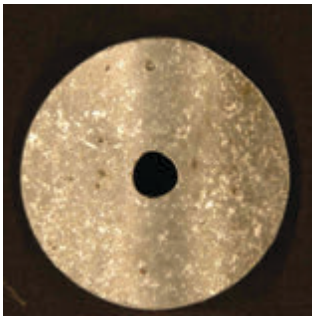


Decatur County, KS
Installed 1953 – Inspected 2003

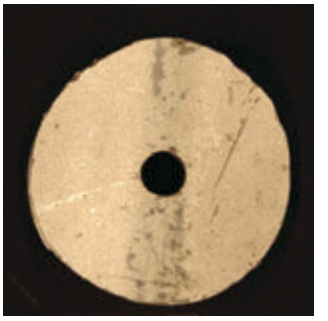
Pratt County, KS
Installed 1953 –Inspected 2003



Dickenson County, KS
Installed 1953 – Inspected 2003



San Juan County, WA
Installed 1953 – Inspected 2005



Eldorado County, CA
Installed in 1952 –Inspected 2005

Cleveland-Cliffs has inspected many more pipe sites around the United States, and these field research studies indicate a minimum 75 year service life for Aluminized Steel Type 2 Corrugated Steel Pipe installed in the recommended environment.

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About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

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