SPIRAL RIB ALUMINUM PIPE

MANUFACTURING METHOD

Spiral Rib Aluminum Pipe is produced in diameters from 15" thru 84" in accordance with ASTM B 745 or AASHTO M 196, Type IR Ribbed Pipe. Standard lengths are 20'. The pipe is manufactured from a continuous strip of clad aluminum alloy sheet approximately 27-3/8" wide in wall thickness, normally from 16 gage (.060") to 10 gage (.135"). The coil is passed through the roller dies forming three equally spaced rectangular ribs projecting outward from the wall. The formed section is then helically wound into a pipe configuration and the edges are joined by lock seaming. The rectangular ribs measure approximately 3/4" wide and 3/4" deep with a spacing approximately 7-1/2", center-to-center. The ends of pipe are either recorrugated to receive coupling bands with annular corrugations or are flanged to fit narrow channel bands. Bituminous coatings are avail- able to help resist abrasion and corrosion. In addition to the use of heavier gage aluminum, bituminous paving in the invert has been used to resist abrasion. Exterior protection against corrosion is usually in the form of bituminous coatings.

QUALITY CONTROL

A constant diameter is difficult to achieve due to the path the material follows in forming the product. This diameter variation may create considerable offset at the field joints. In accordance with ASTM B 745 or AASHTO M 196, the average inside diameter shall not vary more than 1% or 1/2", whichever is greater, from the nominal diameter when measured on the inside flat sections, excluding rectangular ribs. For example, on a 72" pipe, one end could be 71-1/4" and the adjoining end could be 72-3/4", resulting in a 1-1/2" offset.

STRUCTURAL ASPECTS

Structural design is based on theories, which are highly sensitive to the quality of the bedding and backfill. It is assumed the pipe is installed in perfectly homogeneous soil and the pipe will maintain a circular shape. However, field experience has demonstrated excessive deflection, flat spots, buckling (reverse curvature), and damaged joints do occur and should be considered in evaluating structural performance. The thin wall is subject to structural damage during installation as evidenced by punctures, indents, and damaged ends. Pipe stiffness decreases with diameter increase, further aggravating structural problems.

FIELD DEPENDENT FACTORS

Due to the low stiffness, the product is very dependent on proper (high) compaction of the backfill materials. Pipe performance often depends on the backfill to provide 95 percent or more of the strength of the installation, while the pipe provides the remaining five percent. This places most of the burden of performance in the field on the contractor's installation methods, type of backfill material and adequacy of field inspection. Poor site conditions, such as weak native soils and groundwater, further aggravate the problem. Native soils should be checked for pH and resistivity to determine whether aluminum can be used.

HYDRAULIC FACTORS

For a pipe flowing full, laboratory tests indicate a clear water "n" value of 0.012. For field applications, a value of 0.014, or greater, should be used to account for variations in shape, flat spots, indents, joint offsets, bends, recorrugated ends, manholes, junction structures, bed load, debris and corrosion. For partial flow conditions, the "n" value may increase.

DURABILITY, ABRASION AND CORROSION

Aluminum pipe is more corrosion resistant than galvanized steel pipe. However, no dissimilar metals or metal systems should be bonded to the aluminum pipe.

Other characteristics of aluminum are: 1) suffers localized pitting, as opposed to steel that is attacked more uniformly; 2) is less ductile than steel, elongation of steel being five times that of aluminum; 3) is easily damaged due to handling and installation; 4) has very low resistance to abrasion; and 5) is very flexible. The modulus of elasticity of aluminum is one-third that of steel.

Aluminum pipe is also subject to corrosion due to soil potential changes along the line, stray currents and pH of the soil. Run-off water and de-icing salts can also seriously corrode the pipe exterior. Cathodic protection by sacrificial anode or impressed current may be required.

Bituminous coatings have been relatively ineffective, providing very limited additional protection.

FIRE RESISTANCE

While fires may only occur infrequently, serious problems will result. Bituminous coatings support combustion and are very difficult to extinguish.

JOINTS

Joints are very susceptible to differential movement and shape change during the backfilling operation and tend to be one of the weakest parts of the pipe; therefore, extreme care is needed during installation. While there are several methods of coupling the pipes together, all are time consuming. A narrow one-piece band is used for sizes up to 48" diameter. Two-piece bands are used for larger diameters. Double O-ring gaskets or a pliable mastic material may be used to seal the joints.

As evidenced in the field, joint performance can be a major problem due to the pipe diameter varying from one end to the other. Deflection and shape of the pipe on each side of the joint can also vary, resulting in joint leaks. Such leaks may pull fines from the backfill, creating voids, loss of pipe support and eventual failure.

CONCERNS

Field installation is a major concern. Spiral Rib Pipe virtually has no inherent strength to resist external loads and handling stresses. Its supporting strength depends on more stringent and difficult requirements for foundation preparation, bedding preparation, pipe handling and placements, backfill material and compaction requirements. Potential problems increase with increase in pipe diameter.

SPECIFICATION SUGGESTIONS

- Limit deflection to 3%, using the Iowa Formula with pipe/soil stiffness correction factors.
- Require deflection check after installation.
- Specify a minimum pipe stiffness such that the pipe inherent strength be at least 10% of the soil contributing strength.
- Require a "n" factor equal to 0.014 or greater.
- Do not use when flow velocity exceeds 5 fps under abrasive conditions.
- Require select pipe embedment materials to at least 12" over the top of pipe, and 1 pipe diameter on each side in good soils and 2 pipe diameters each side for poor or wet soils.
- Test soils and water for pH and resistivity, sulfates and chlorides.
- Flexibility factor should be equal to Corrugated Steel Pipe, i.e. 4.3×10^{-2}.
- Limit use to soils with 1500 ohm-cm or greater and pH between 5.5 and 8.5.
- Do not use in salt or brackish water.