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Corrosion Resistance of Ductile Cast Iron Tube under Effect of Harsh Environments

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***Abstract* - Some soil environments are corrosive. In this soil the life of the pipe goes down to years of tens. On the other hand, service life can be increased by using effective bonded coatings as well as polyethylene encasement and catholic protection. Experimental evaluations revealed from various water utilities showed that demonstrates sufficient service life and lower maintained costs against alternatives. Now apply modern pipe management systems. Before application several soil parameters such as resistivity/conductivity, moisture content, chloride and sulphide ions concentration, redox potential, presence of landfill, fly ash, coal, peat, mine waste, are searched. After that, if necessary required are taken before burying the pipes.**

Keywords: Corrosion Protection, Ductile Cast iron, Harsh Environments, polyethylene.

I. INTRODUCTION

Offers several advantages including its thick homogenous wall, availability, utility and contractor familiarity, allowing the flexible pipe design and low-cost maintaining. Having high tensile strength, high impact resistance, a high yield point and considerable elongation, it has consolidated the position of iron in the pipe market and gained for it the highly valued reputation of a rapidly developing new material. The explanation is quite simple: the carbon in grey iron is always present in the form of graphite flakes, which favor crack initiation and render the material brittle. This modern iron , which was discovered in 1948, has all the qualities of its antecedent “grey cast iron”, but none of its disadvantages. Ductile cast iron DCI piping has been used worldwide since 1960s for water transmission and distribution mains. DCI piping failures that are caused by corrosion have become more prevalent as the pipelines have aged The adaptation of external and internal coating on pipe since the 1960’s widened its usages. However, positive corrosion protection is warranted. Utility reports indicate that properly designed and installed iron pipe systems in moderately corrosive soils demonstrated a performance of more than100 years of service. Due to these and other developments, the water and wastewater industry has continued and increased its practice of installing. The strength of DIP permits a wide variety of design applications including shallow bury/heavy traffic loads, deep bury/high soil prism loads, and high operation /surge pressures.

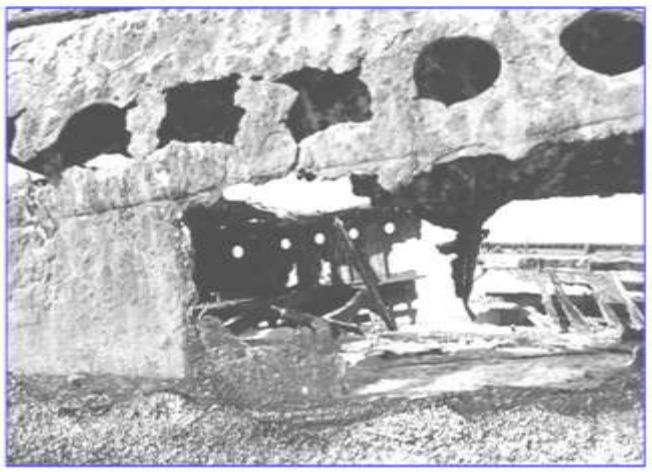

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Table-1: various features of selected high pressure. Length in (mm), Weight in (Kg)

Type	Nominal Diameter	External Diameter	Wall Thickness	Socket End Weight	Weight(kg/m)	Cement Lining Thickness	Total Weight of Standard length
DN 100	250	300	5	5	20	3	150
DN 300	450	500	10	20	50	6	350
DN 1000	850	950	15	150	250	9	2000

II. EXPERIMENTAL PRODUCER

Ductile Iron Pipe: DI is one of the most commonly used pipe materials in our modern society. Sandblasted, bare (with annealing oxide), asphaltic shoap coated pipes were used many years. The protection value of these surface conditions is often neglected. However, metallic (like Zinc), (polymeric like epoxy) and ceramic (like cement) coatings or linings have demonstrated very good corrosion protection for DIP (Figure1, and Table 1) [1-2].

Table-2: Cement linings

Water characteristics	Portland Cement	Sulphate resisting Cements (including blast furnace slag cements)	High alumina cement
Minimum value of pH Maximum content (mg/l) of:	10	5	5
Aggressive CO_2	5	15	No limit
Sulphates (SO_4^-)	500	2500	No limit
Magnesium (Mg^{++})	100	500	No limit
Ammonium (NH4-)	30	25	No limit

Table-3: General pipe protection

Internal and external condition	Internal protection	External Protection
Potable water - normal soil	Portland cement mortar	Metallic zinc + bituminous paint
Acidic water - corrosive soil	High alumina cement mortar	1-Metallic zinc + bituminous paint + PE sleeve or 2- 85Zn-15Al + epoxy paint
Industrial and abrasive liquid extremely corrosive soil	Epoxy or PE+silis (SiO2(	PE (DN≤500) or polyurethane≤(1200) coating

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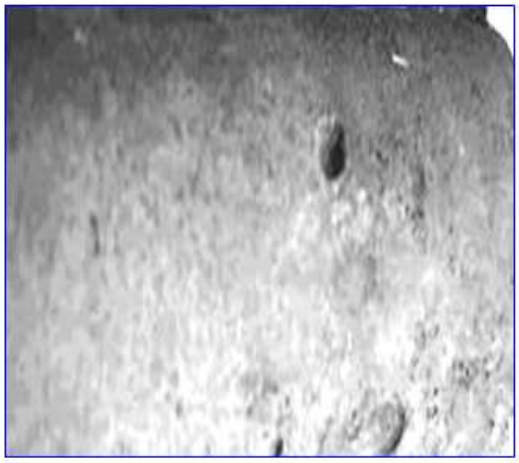

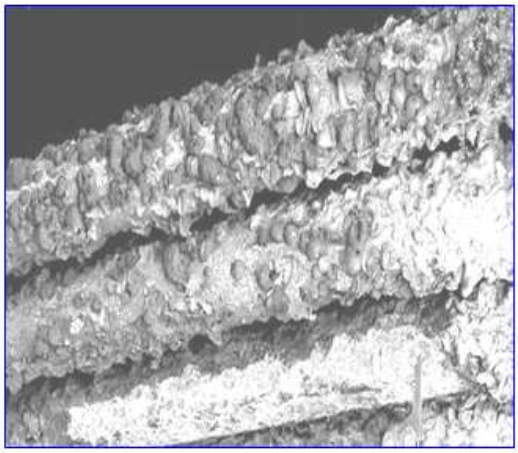

III. RESULTS AND DISCUSSION

High quality bonded coatings against harsh environment are neither necessary nor practical in many cases. These are either using advanced coating and lining (other than Zn coating and Portland cement lining) or applying of PE sleeve (with or without CP) on bare or standard coated pipes. For harsh environment users of the pipe have two options, These are either using advanced coating and lining or applying of PE sleeve on bare or standard coated pipes. High quality bonded coatings against harsh environment are neither necessary nor practical in many cases. Instead of promoting the use of advanced coatings, standard coating with conjunction of CP can be more appropriate for protection of DIP. These include the 12-point system as originally proposed by Ductile Iron Pipe Research Association (Table 4). This method assigns points for various soil backfill characteristics and defines a soil as corrosive if the some of the points is more than 12.

Table-4: Soil test evaluation for ductile iron pipe

Soil Characteristic	Points	Soil Characteristic	Points
Resistivity (ohm-cm)		Sulphides	
1250	8	Positive	4
1250-1500	6	Trace	2
1500-2000	4	Negative	0
2000-2500	2		
2500-3000	1	Moisture	
3000	0	Poor drainage, continuously Wet	2
		Fair drainage, generally moist	1
PH		Good drainage, generally dry	0
0-5	6		
5-10	3	Redox potential	
10-15	0	100mV	0

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15	**3**	**50 to +100 mV**	**2**
		0 to +50 mV	**5**
		Negative	**6**

Risk assessment zones		**Protection**
Case 1 > 10 point	**Severe**	**a)Tight bonded Zn coating + PE encasement or b)Zn-Al coating**
2 ≥ 10point	**appreciable**	**Asphaltic shop coating+ PE encasement**
3 < 10point	**Mild**	**a)Asphaltic shop coating or b)Bare**

Instead of promoting the use of advanced coatings, standard coating with conjunction of CP can be more appropriate for protection of DIP. This method assigns points for various soil backfill characteristics and defines a soil as corrosive if the some of the points is more than 10. Washington Suburban Sanitary Commission (WSSC), the seventh – largest water and wastewater utility in the U.S. uses this approach. For harsh environment users of the pipe have two options. These include the 10-point system as originally proposed by Ductile Iron Pipe Research Association (DIPRA) (Table 4). This modified risk assessment method is called the 25 point analysis. Lifetime costs for a water supply pipeline are measured not on the basis of the price of the individual pipes, but on the duration of problem-free operation without need for replacements of pipes. If the pipes do not live up the required demands, the investments in new components, the additional costs of the excavation, the working hours used on the replacement, and the re-establishment of the area afterwards increase the life cycle cost. . It should be noted that DI outlast steel and other pipes in many water transmission system. Buried steel pipe always needs CP in all soil corrosively zones, while DIP needs it only at very aggressive soils.

IV. CONCLUSIONS

1. Galvanic CP has been successfully applied to DI pipelines in corrosive environments and has proven to be cost-effective. Magnesium anodes are installed to provide protective current to areas of the pipe that have been identified as highest risk.
2. The major that DIP is the most appropriate material for water transmission. By referring the actual life cycle cost. Rather than the initial cost alone, DIP shows superiority against alternatives.
3. The industry experience of users, bonded coatings are cost effective and facilitate to use of DIP in large number of soils.
4. PE encasement as a corrosion-control method is both cost-effective and technically sound.

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