

UK Water Industry

EXTERNAL ZINC COATING OF DUCTILE IRON PIPE

1. INTRODUCTION

The objective of this note is to provide the Water Industry with background information and installation recommendations for zinc coated ductile iron pipe. Whilst the information in this note represents the best presently available to WRc, changes in coating specification and/or pipe installation practice may be warranted in the light of research currently in progress at WRc. The Industry will be kept informed of such changes through the WAA SWMC/WRc Information and Guidance Note system.

From April 1984, the UK ductile iron pipe manufacturers started supplying all new ductile iron pipes in the diameter range 80-800mm with a new factory-applied external corrosion protection system, zinc coating, i.e. sprayed zinc metal sealed with a finishing layer of a conventional bitumen paint.

The sprayed zinc metal coating has been introduced by the manufacturers for three main reasons:

- i) to augment the limited degree of external protection afforded by the traditional bituminous paint coating.
- ii) to minimise the risk of external corrosion which can result from installation errors during the site application of loose polyethylene (PE) sleeving, i.e. entrapment of soil clods between the sleeving film and pipe surface, and accidental sleeving damage.
- iii) to minimize the risk of external corrosion which can result from accidental damage to the present external protection systems (bitumen paint, loose PE sleeving) on a buried iron main by subsequent trenching/mainslaying activities.

The introduction of zinc coatings will enhance the external corrosion resistance of ductile iron pipe and, in conjunction with loose PE sleeving, will provide a durable, cost-effective solution for the external protection of buried ductile iron mains.

There will be no surcharge for the zinc coating of spun pipes in the size range 80-800mm diameter.

At present, there are no plans for the zinc coating of pipes greater than 800mm diameter, or of fittings.

2. ZINC COATING OF DUCTILE IRON PIPE

The process which has been adopted by the UK ductile iron pipe manufacturers essentially involves the spray application of a nominal 25-30 μ m (0.0010-0.0012 in) metallic zinc directly to the pipe surface immediately after the annealing heat treatment process. The minimum permissible coating mass per unit area is 130g zinc per square metre of pipe surface. Areas requiring repair after spraying, e.g. ground spigots, may be coated with zinc-rich paint containing a minimum of 85% zinc by weight in its dry film. The zinc layer is subsequently sealed with a coating of a conventional bituminous paint typically 70-100 μ m thick (figure 1).

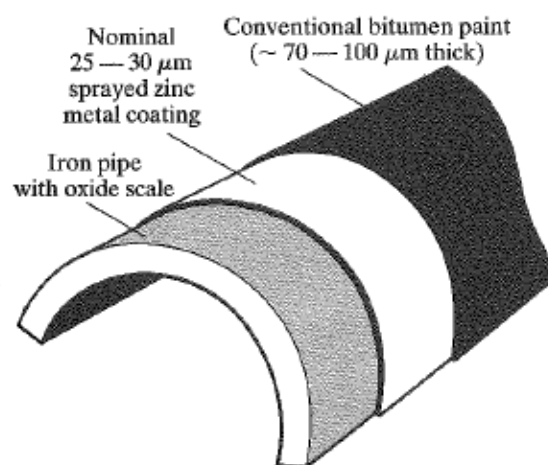


Figure 1 – Zinc coating details (not to scale)

Zinc-rich paint has been used in Japan as an alternative to sprayed zinc metal for the external protection of ductile iron pipe. When dry, such coatings should contain at least 85% of zinc uniformly dispersed throughout the film, and should be of a thickness to give a weight of zinc per unit area of coating equivalent to that in a sprayed zinc metal coating.

Metal spraying is the preferred method for the production zinc coating of spun ductile iron pipes in the range 80-800mm diameter, and will be specified as standard for these sizes in the forthcoming revision of BS 4772⁽¹⁾, Pipes greater than 800mm diameter and fittings will continue to be bitumen coated as standard in the UK. However, should additional protection of such castings be required for certain applications, zinc-rich paints may be specified as an optional extra by the customer where metallic zinc spray is not available. Should there be sufficient demand from the UK Water Industry for metallic zinc coating of the larger diameter ductile iron pipes the manufacturers will give serious consideration to investing in the necessary plant.

At present there is no British Standard covering the zinc coating of ductile iron pipes. As an interim measure, it is therefore proposed that the existing draft International] Standard ISO/DIS 8179⁽²⁾ will be used as a basis for the development of a UK specification, taking into account the views and comments of the UK user industries and pipe manufacturers. This specification will be incorporated without delay into the ductile iron pipe standard BS 4772⁽¹⁾, so that the zinc coating process can be subjected to a formalised quality audit procedure from its introduction. Further development of this specification will be pursued as necessary according to the results obtained from WRC's programme of research on zinc coatings (see section 5 below).

3. MECHANISM OF PROTECTION

Based on the available research, it has been suggested that the improved corrosion protection afforded to iron pipes by zinc coatings^(3,4) can be attributed to the following factors:

- i) The zinc coating slowly transforms in service due to reaction with soil electrolytes to form a tightly adherent, impermeable barrier layer of insoluble zinc corrosion products (carbonates, oxychlorides, etc) which prevents further attack and affords long-term corrosion protection to the iron pipe substrate. The slow transformation is said to be promoted by the presence of the bitumen paint seal coat⁽³⁾.
- ii) The zinc coating is ductile and deforms readily under blunt impact or slow loading conditions

to give a thinner layer at the point of damage, thereby continuing to provide a protective layer over the pipe surface (c.f. organic barrier coatings, e.g. paints, tapes, polymers, which can fail under similar loading conditions, exposing the iron pipe substrate to the corrosive effects of the external environment).

- iii) If the zinc coating is damaged (e.g. by sharp impact) and the iron pipe substrate is exposed to the soil environment, the exposed area of iron will continue to be protected galvanically due to the sacrificial corrosion of the zinc. Burial tests on pipes with zinc coatings which had been deliberately damaged have indicated that the damaged areas tend to heal over due to the precipitation of zinc corrosion products at the damage sites⁽³⁾. This suggests that the mechanism of protection afforded by a damaged zinc coating tends to revert from one of sacrificial cathodic protection to one of impervious barrier layer formation (as in (i) above).

The research has thus demonstrated that zinc coatings significantly reduce the sensitivity of ductile iron pipe to damage-induced corrosion.

4. SERVICE EXPERIENCE WITH ZINC COATED IRON PIPE

In introducing zinc coatings, the UK manufacturers have taken advantage of the extensive research and development which has been conducted by the French ductile iron pipe manufacturer, Pont-a-Mousson. This company pioneered the use of zinc coatings in the 1950s, and has applied this system as standard to cast iron pipes since 1961.

Considerable service experience with unsleeved zinc coated iron pipe has been accumulated to date in France. However, published details of its field performance have been limited to failures reported to the manufacturer only, which may not be a true reflection of its overall behaviour. Accepting this limitation, very few failures of unsleeved zinc coated pipe have been recorded, i.e. 4 in 20 years from an estimated 85,000 km production. All of these failures have been attributed to extremes of soil aggressivity and/or coating damage caused during handling and installation.

Zinc-rich paint has been used instead of sprayed zinc metal by one Japanese manufacturer, Kubota, for the external corrosion protection of ductile iron pipes up to 250mm diameter. No information is available on the service performance of this coating. However, burial trials conducted by the manufacturer have suggested that such paints can, if correctly applied,

provide a similar level of protection to that afforded by sprayed zinc metal coatings to iron pipes.

5. WRc RESEARCH

As an external corrosion protection system for ductile iron pipe, the coating of zinc metal plus bitumen paint has several important advantages over the conventional bitumen paint alone, i.e.

- It affords improved protection to iron pipes in all soils,
- It reduces the sensitivity of iron pipe to damage-induced corrosion through its ability to protect exposed areas of iron pipe substrate by sacrificial corrosion,
- It improves the corrosion resistance of PE sleeved ductile iron pipe. In particular, if the sleeving is accidentally damaged during installation or soil clods are trapped between the sleeving film and pipe surface during wrapping, the zinc will provide backup corrosion protection where direct soil-to-pipe contact occurs.

While the introduction of zinc will improve the corrosion resistance of PE sleeved ductile iron pipe, it is considered that further research on zinc coatings should be pursued to define more closely their service performance. In particular, it would be of value for the Water Industry to establish:

- Whether the zinc coating can **by itself** provide adequate corrosion protection to iron pipes in the whole range of soils encountered in the UK,
- If it cannot, whether it is possible to define those soil environments in which the additional use of loose PE sleeving is essential to ensure durable and cost-effective corrosion protection, and
- The level of damage which zinc coatings can tolerate without detriment to the corrosion protection afforded to the iron pipe substrate.

WRc has therefore initiated a programme of research which is aimed at,

- i) quantifying the effect of handling and installation damage on the corrosion protection afforded by zinc coatings,
- ii) optimising the zinc coating parameters (notably thickness),
- iii) establishing the service limitations of zinc coatings, and in particular identifying those situations in which the additional use of loose PE sleeving is necessary to ensure pipeline durability,

- iv) comparing the relative performances of sprayed zinc metal and zinc-rich paints for the external protection of ductile iron,
- v) monitoring the introduction of zinc coated ductile iron pipe by the UK Water Industry such that the operational performance of the protection system can be critically assessed.

The aim of this research programme is to provide an objective basis for the development of a UK Water Industry specification for zinc coatings, and a code of practice for the installation and operation of zinc coated ductile iron pipelines. It is anticipated that preliminary results of this research programme will be available by early 1985.

6. INSTALLATION RECOMMENDATIONS

1. It is recommended that the Industry accepts as standard the metallic zinc spray coating system for spun ductile iron pipes in the size range 80-800mm.
2. Until the limitations to the use of zinc coatings have been established, it is recommended that all new ductile iron pipes should continue to be wrapped with loose PE sleeving prior to burial, irrespective of soil type. This applies both to new installations and where zinc coated ductile iron is used to replace lengths of sleeved or unsleeved iron pipe in existing mains.
3. Although zinc coated ductile iron can tolerate some coating damage, it remains important to minimise damage to the external protection system during transportation, handling and laying in order to achieve optimum protection. Zinc coated pipes should be lifted using padded slings rather than chains, wire ropes etc.
4. Where it is necessary to grind back the barrel of precoated pipe lengths, any areas of exposed metal (other than the chamfered lead-in) should be coated with zinc-rich paint followed by a bitumen paint seal coat in accordance with the manufacturer's instructions, prior to installation. If zinc-rich paint is unavailable, areas of exposed metal should be coated with a conventional bitumen paint prior to laying, and the joint region overwrapped after assembly with a suitable waterproof tape, before sleeving and backfilling.
5. No special precautions need to be observed when making service connections to zinc coated ductile iron pipe apart from those noted above, provided that all sleeving damage at the point of connection is repaired with waterproof wrapping

tape in accordance with the recommended procedure (for further details see clause 4.4 of Information and Guidance Note 4-50-01 Issue 1⁽⁵⁾).

REFERENCES

1. **BS4772:1980:**
Ductile iron pipes and fittings.
2. **Draft International Standard ISO/DIS 8179-1983**
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Paper presented at the Fourth International Conference on the Internal and External Protection of Pipes, Noordwijkerhout, The Netherlands, 15-17 September 1981.
BHRA Fluid Engineering, Cranfield, Bedford, 1981. p 125-137.
5. **Information & Guidance Note No. 4-50-01.**
Operational guidelines for the loose polyethylene sleeving of underground iron mains.