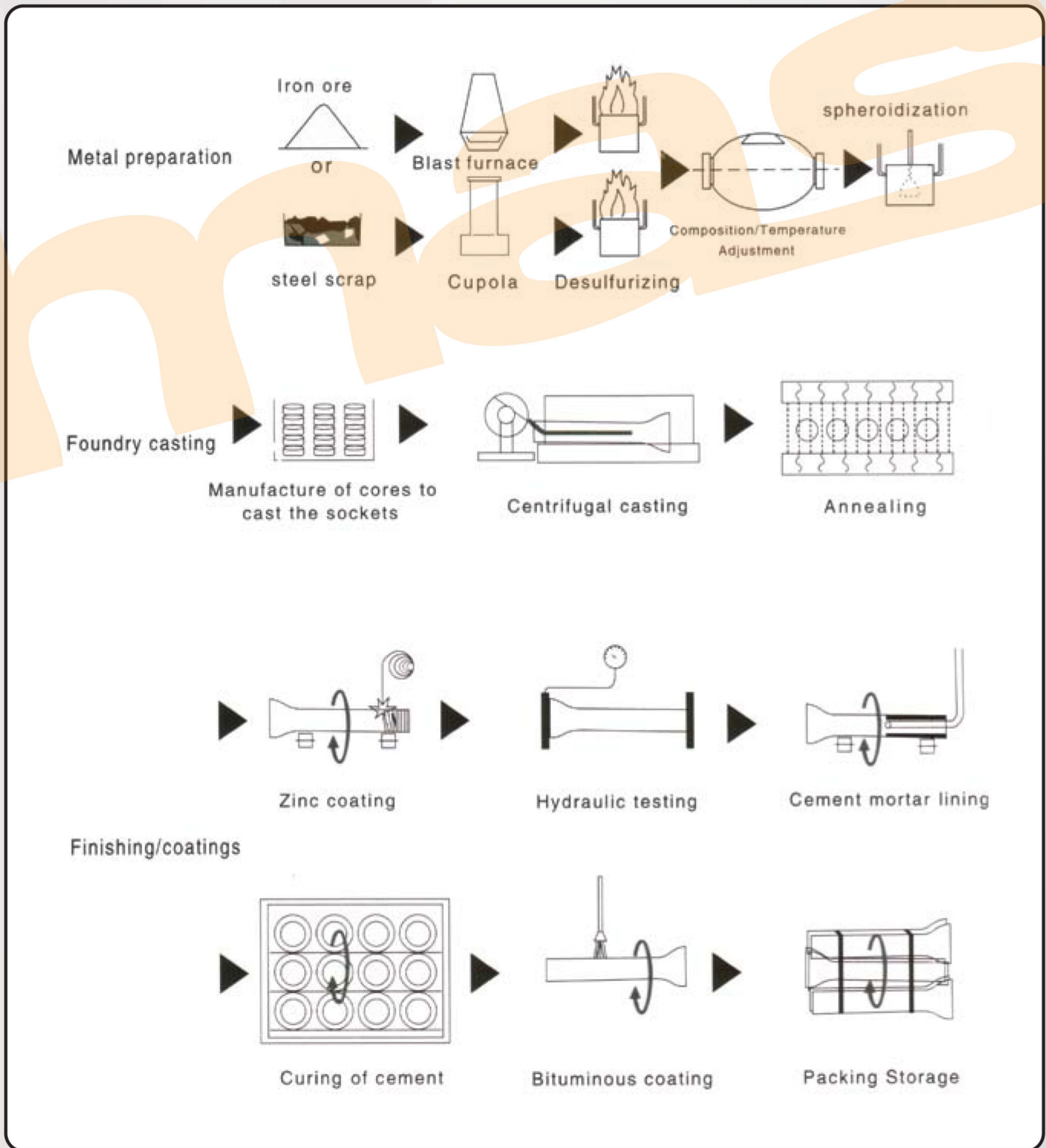


Pipes Production Process

Three stages are involved in the manufacture of ductile iron pipes:
Metal preparation : blast furnace, cupola & metal treatment.
Pipe spinning / foundry casting.
Finishing/coatings.

Production Flow Chart



Metal preparation

Molten metal can be obtained directly by deduction of iron or in a blast furnace or by melting pig iron and scrap in a cupola (or electric furnace). In all cases the materials have to be selected and checked carefully, in order to produce a very high purity base metal suitable for the treatments described below.

After desulfurization, the iron temperature is adjusted in an electric furnace to provide the optimum casting temperature.

At this stage corrections can be made to the chemical composition by additions of scrap metal, or specific Ferro-alloys. Magnesium is introduced into the molten metal to render it ductile.

Wall thickness. The nominal iron wall thickness of pipes and fittings shall be calculated as a function of the nominal size, DN, by the following formula, with a minimum of 6 mm for centrifugally cast pipes and 7 mm for pipes not centrifugally cast and fittings:

$$e = K (0.05 + 0.001 \text{ DN})$$

Where : e = is the nominal wall thickness, in millimeters;

DN = is the nominal size;

K = is a coefficient used for thickness class designation. It is selected from a series of whole number: 7, 8, 9, 10, 11, 12...

Tolerance on lengths. The tolerance on lengths shall be given in the under table.



Foundry casting ISO 2531

The pipe spinning process consists of deposition of a layer of molten iron inside a rapidly rotating cylindrical mold, and solidification of the metal by continuous mold cooling.

The principle methods used are the "DE LAVAUD" process and the "WET SPRY" process.

In the "DE LAVAUD" process molten metal is poured into an uncoated steel mould and is subjected to rapid cooling. A graphitizing, then ferritizing heat treatment is necessary to obtain pipes with the required structure and mechanical properties.

In the "WET SPRY" process, before the iron is poured, the internal service of the mould is coated with a fine layer of powdered refractory silica, which reduces the thermal conductivity of the molten metal/mold interface.

The pipe therefore cools at a slower rate than in the "DE LAVAUD" process and consequently only a ferritizing heat treatment is required.

Type of Casting	Tolerance
Socket and spigot pipes (full length or shortened)	+ - 30
Fittings for socket joints	+ - 20
Pipes and fittings for flanged joints	+ - 101)

1) By agreement between manufacturer and purchaser, smaller tolerances are possible, but not less than + - 3mm for DN ≤ 600 and + - 4mm for DN > 600.

Straightness of pipes. Pipes shall be straight, with a maximum deviation of 0.125% of their length.

The verification of this requirement is normally carried out by visual inspection, but in case of doubt or in dispute the pipes shall be rolled on two supports or rotated along its axis on rollers, which in each case are separated by at least two thirds of the standard pipe length. The point of maximum deviation from the true axis shall be determined, and the deviation measured at that point shall not exceed the limit.



Pipe Extracting

Zinc coating.

DIN 30674, BS-EN 545, ISO8179.

On leaving the heat treatment furnace, the pipes receive an external coat of pure metallic zinc applied by electric arc melting of zinc wire and spraying with compressed air.

The coating materials are metallic zinc with a content of at least 99 % or zinc-rich paint, which contains more than 85% zinc in dry film. The zinc shall normally be applied on oxide-surfaced pipe. It may be applied on a blast-cleaned pipe. The pipe surface shall be dry, and free from rust or non-adhering particles or foreign matter such as oil or grease.

The coating shall be applied at the work projecting small droplets of zinc heated to the molten state by means of spray guns. The coating shall be applied at the works by spraying or brushing zinc-rich paint unto the pipe surface.

The zinc coating shall cover the external surface of pipe apart from the socket face. It shall be free from such defects as bare patches or lack of adhesion. A spiraled appearance is permissible provided the zinc coating masses comply with the requirements of zinc coating mass.

Pipes with damaged areas of coating caused by handling are acceptable, provided the area of damage is less than 5 cm² per square meter coated.

The manufacturer is permitted to carry out repairs by any procedure of his choice, for example zinc-rich painting, provided the requirements of zinc coating mass and the inspection are met.

The mass of sprayed metal as measured under the conditions defined in procedure shall be not less than 130 gram per meter squared.

Zinc - rich paint coating. The mass of zinc coating as measured under the conditions defined in the inspection shall not be less than 150 g/m².

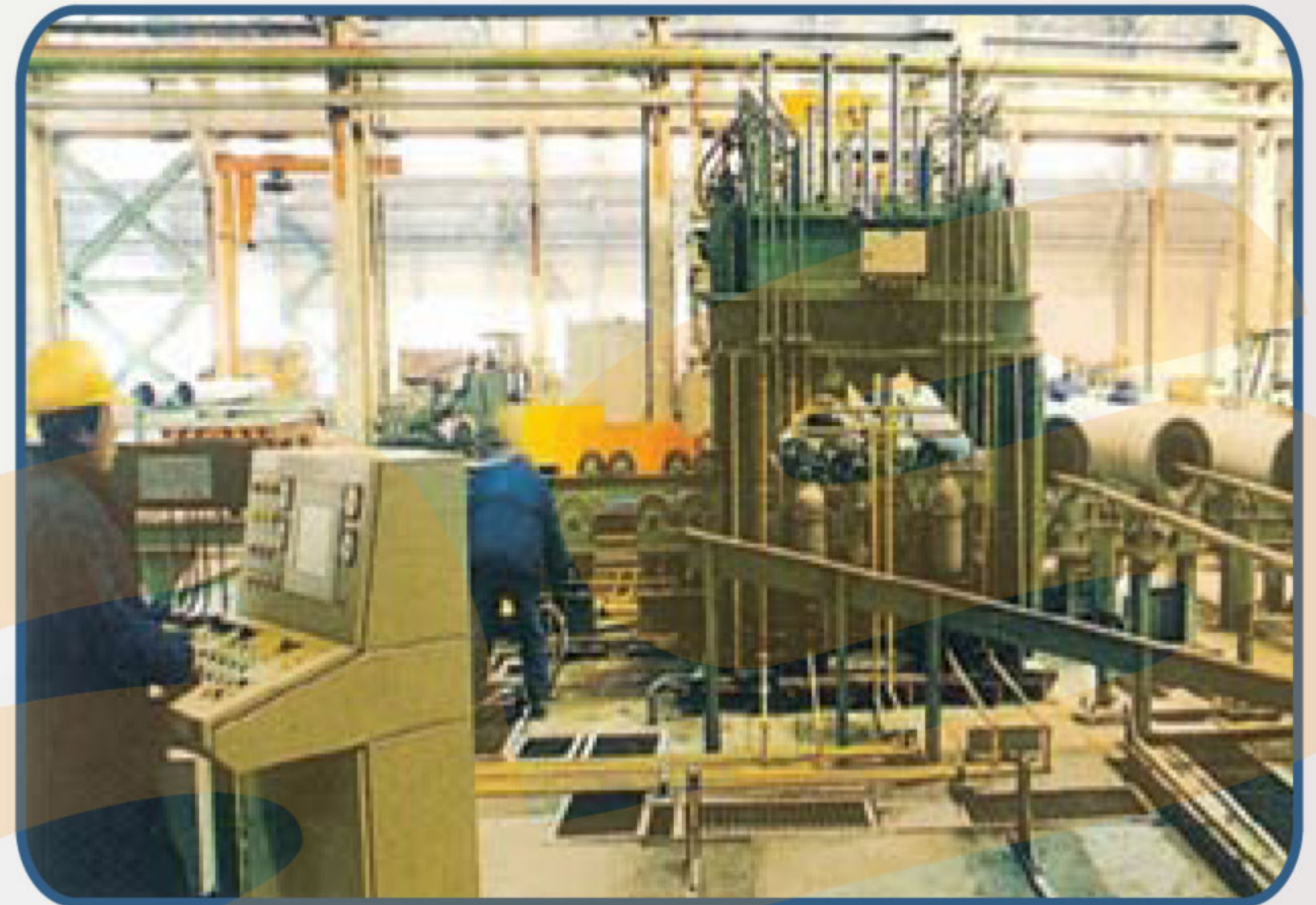


Cement lining.

DIN 2614, BS-EN 545, ISO4179.

The cement mortar is then cured under controlled temperature and humidity conditions.

The cement used for the lining shall conform to the standards on cement producing country. The type of cement to be used is left to the discretion of the pipe manufacturer who shall, however, inform the customer.



The sand used shall have a controlled granulometric distribution from fine to coarser elements and shall be composed of inert, hard, strong and stable granular particles.

The water used for preparation of the mortar shall not contain substances deleterious to the mortar nor to the water it is eventually intended to transport pipe.

The mortar of the lining shall be composed of cement, sand and water. The mortar shall be thoroughly mixed and shall have a consistency, which results in a dense and homogeneous lining. The mortar shall be free of any cavities or visible air bubbles, and care shall be taken to insure maximum density at all points.

Thickness and Surface Condition

From BS-EN 545 1994 Ed. (Clause 4.4.3.3)

The nominal thickness of the cement mortar lining and its tolerance shall be given in the table as shown below. When measured with accordance with the standard specification, the lining thickness shall be within the specified tolerance.

The surface of the cement mortar lining shall be uniform and smooth; trowel marks and protrusion of sand grains are acceptable, but there shall be no recesses or local defects which reduce the thickness below the minimum value given in table.

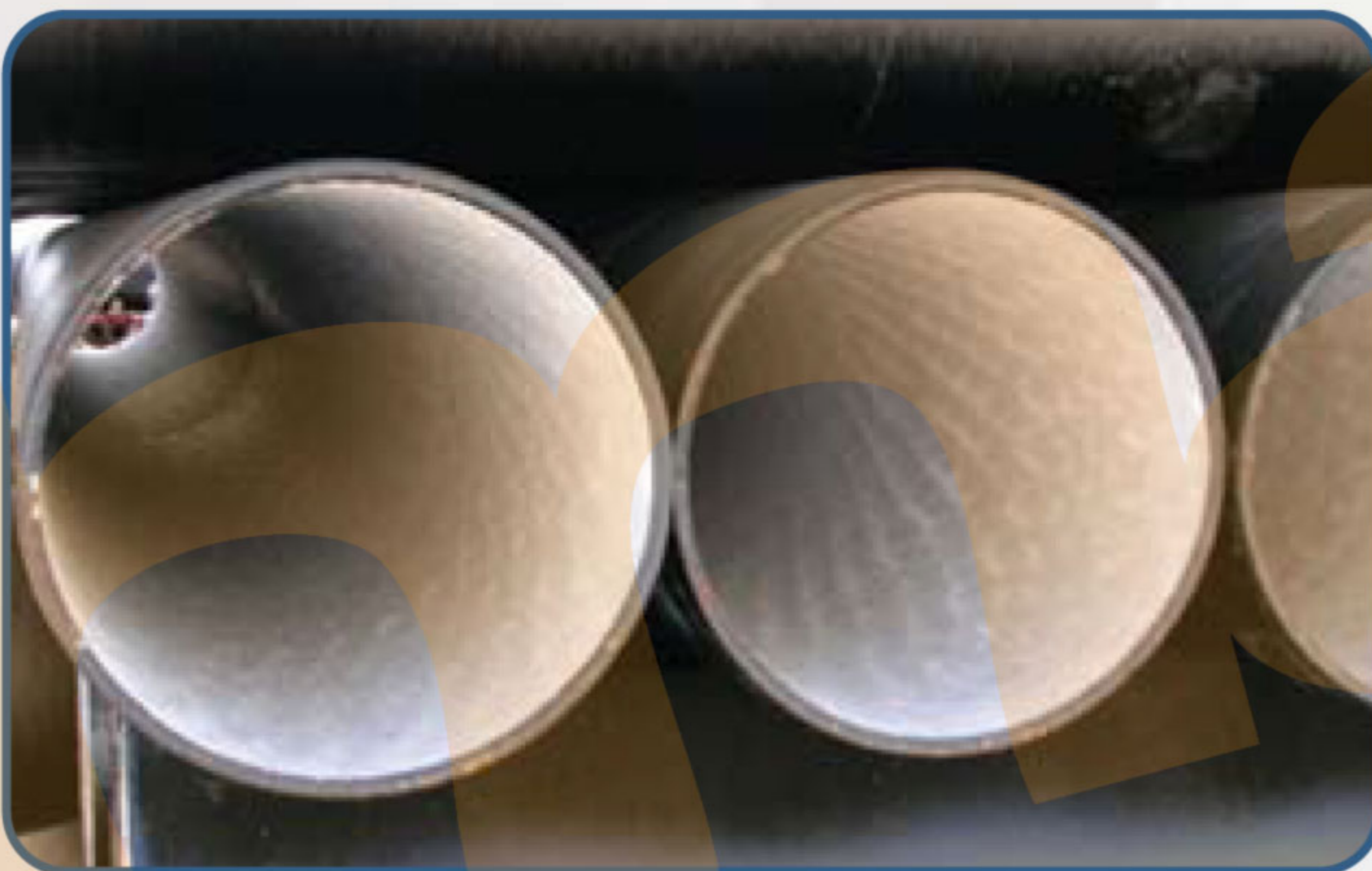
If fine crazing and hairline cracks associated with cement rich surfaces appear in dry linings, there shall be no evidence of disbondment. When Shrinkage cracks inherent to cement-bound materials have developed in the dry linings, the displacement shall not exceed the values given in table below.

Nominal Size DN	Thickness		Maximum Crack width and radial displacement
	Nominal Value	Tolerance	
40 to 300	3.5	-1.5	0.8
350 to 600	5	-2	1.0
700 to 1200	6	-2.5	1.2
1400 to 2000	9	-3	1.5

Dimensions in millimeters

Note: Storage of pipes and fittings in a hot, dry environment can cause metal expansion and mortar shrinkage which may result in the dry lining developing areas of disbondment and shrinkage cracks.

When the lining is re-exposed to water, it will swell by absorption of moisture and the cracks will eventually heal by an autogenous process.(a negative tolerance only is given.)



Repairing damaged cement. Within the transportation process, loading and unloading, cement lining cracks which is acceptable as per ISO could be happened and is not affecting the pipes efficiency, that kind of cement damages can be repaired in the jobsite.

Materials required for repair. For the cement repair the following materials are requested:

- Standard cement
- Arenaceous sand (max. coarse grain, size 1.6 mm).
- Adhesion improver e.g. Icoment additive by Lechler.
- Mixing water.

Preparing the damaged area. The damaged area must be removed without affecting the surrounding area.

Repairing materials composition. The formula for the mixed materials should be as follows.

- 3 parts sand.
- 2 parts cement.
- 1 part icoment additive.
- 2 parts water.

To ensure that the damaged area is properly repaired, it should be covered with plastic sheet until to be fully dried.

TABLE - Thickness of the cement mortar Lining

Nominal Size, mm DN	Barrel Thickness	Outside Diameter OD	Layer Thickness for Cement e		Approximate Mass/unit length Kg/m
			Normal Mm	Min. Mean Value	
80	6.0	98	3	2.5	1.7
100	6.1	118	3	2.5	2.1
125	6.2	144	3	2.5	2.7
150	6.3	170	3	2.5	3.2
200	6.4	222	3	2.5	4.2
250	6.8	274	3	2.5	5.2
300	7.2	326	3	2.5	6.3
350	7.7	378	5	4.5	12.3
400	8.1	429	5	4.5	14
500	9.0	532	5	4.5	17.5
600	9.9	635	5	4.5	20.9
700	10.8	738	6	5.5	29.3
800	11.7	842	6	5.5	33.4
900	12.6	945	6	5.5	37.6
1000	13.5	1048	6	5.5	41.7
1200	15.3	1255	6	5.5	50
1400	17.1	1462	9	8	87.6
1600	18.9	1668	9	8	100.1
1800	20.7	1875	9	8	112.5
2000	22.5	2082	9	8	135
2200	24.3	2288	12	10	183.5
2400	26.1	2495	12	10	200
2600	27.9	2702	12	10	216.6

* This specification is taken from the International Standard ISO 4179-1985 Ed.



1



2



3



4

Bitumen coating. BS 3416

The standard specifies the requirements and test on outer bitumen coating with a minimum coating thickness of .07 mm applied in the manufacturer's works to ductile cast iron pipes complying with DIN 28600 or DIN 19690.



Requirements to be Met.

The surfaces of the pipes shall be free of rust, loose constituent materials, dirt, oil, grease and moisture. Coating materials, which come into contact with drinking water, shall comply with the relevant regulations.

Property	Requirements for Bitumen coatings	Testing in accd.
Softening point (ring and ball) Of the evaporation residue	min. 100° C	A
Needle penetration for Evaporation residue at 25° C Expressed in 0.1 mm	max. 10° C	B
Flash Point	min. 21° C	C
Drying period	max. 2 hours	D
Solid matter content	min. 65% by mass	E
Ash and filler content	min. 40% by mass max. 50% by mass	F

Testing methods

- The softening point of the evaporation residue according to DIN 52010.
- The needle penetration according to DIN 52010
- The flash point according to DIN 53213.
- The period of time until dryness according to DIN 53150.
- Solid matter content according to DIN 53215.
- Ash and filler content according to DIN 52005.
- Non-destructive thickness measuring according to DIN 50982.

