



KUBOTA Corporation

Pipe Systems Sales Section
International Water and Environmental Infrastructure Sales Dept.

1-3, Kyobashi 2-chome, Chuo-ku, Tokyo, 104-8307, JAPAN
Tel : +81-3-3245-3228
Fax : +81-3-3245-3830
Website : <https://www.kubota.com/products/ironpipe/>
E-mail : kbt_g.ironpipe@kubota.com

Kubota Water and Environment U.S.A. Corporation

HRDIP Dept. / North America

3528 Torrance Boulevard, Suite 112,
Torrance, CA 90503, U.S.A.
Tel : +1-424-358-5200
Website : <https://www.kubota-membrane.com/page/erdip>
E-mail : kbt_g.HRDIP-usa@kubota.com

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KUBOTA DUCTILE IRON PIPE

Repair Manual

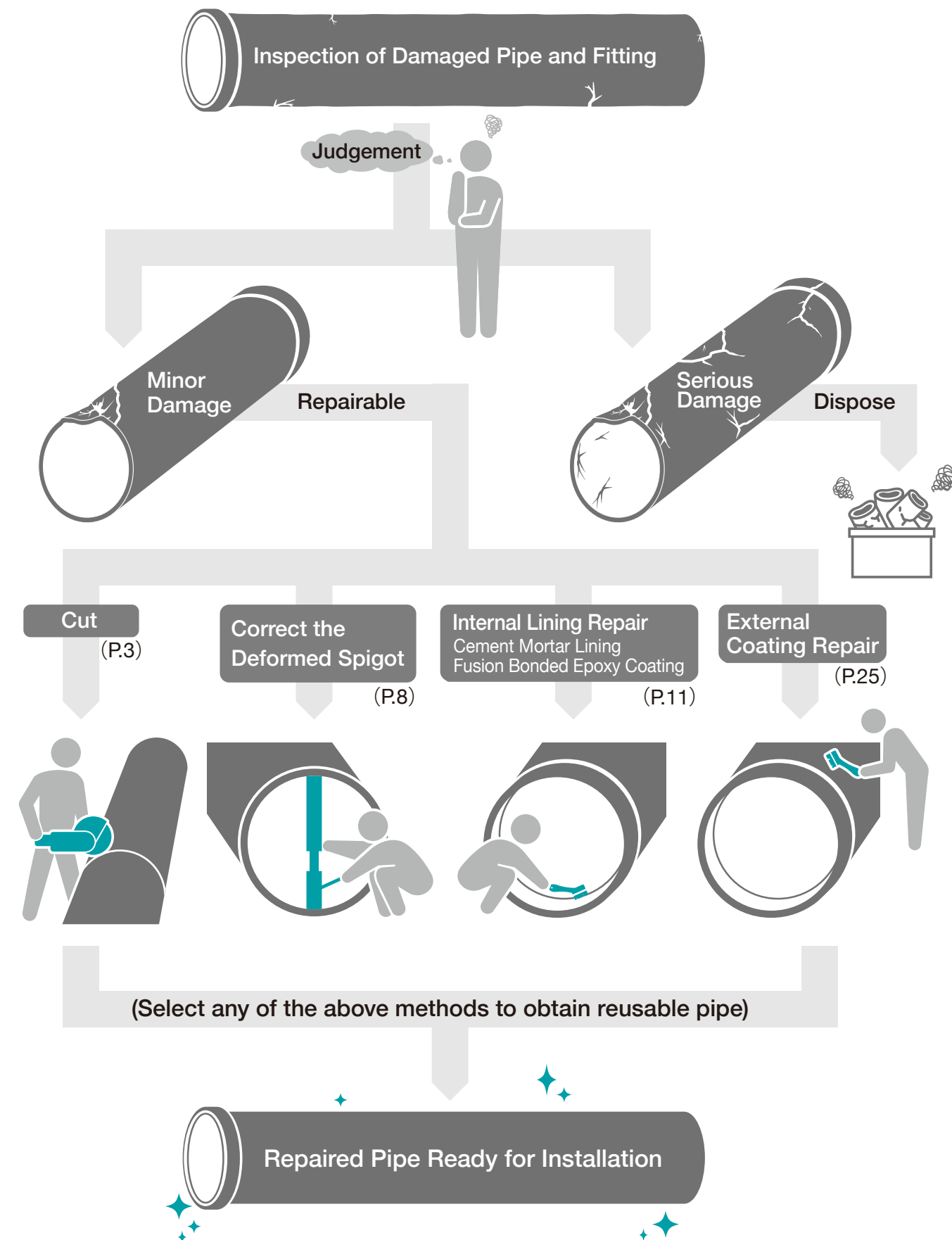
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Damage to ductile iron pipes, caused by improper handling during transportation, may be rectified by applying certain repair procedures.

This manual has been compiled to offer some quick and effective methods of repairing damaged pipes. Although these methods may change according to site conditions, Kubota would advise the site supervisor to follow the repairs outlined in this manual.

The ultimate purpose of this manual is to ensure that the pipes provide lasting service and stand up to the heavy usage regardless of the minor maintenance required.

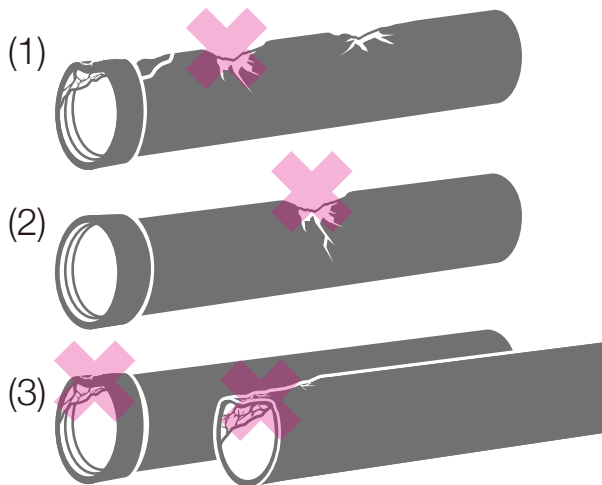


CUTTING OF PIPE

Inspection

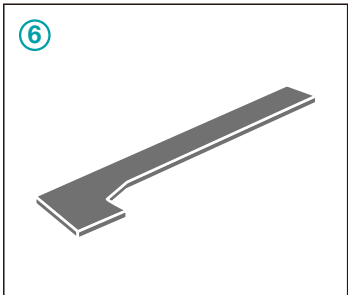
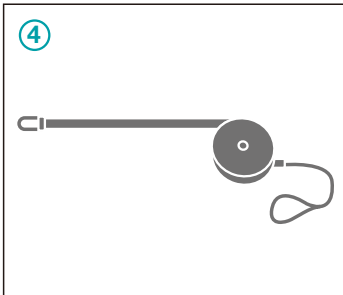
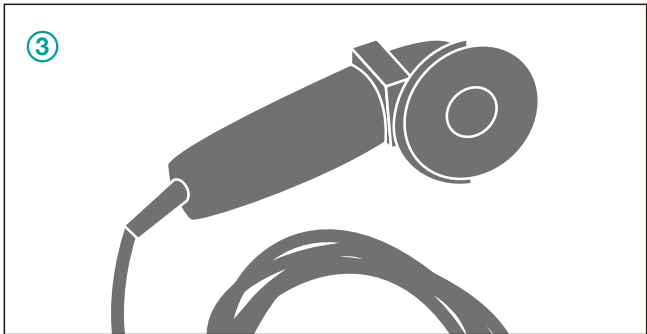
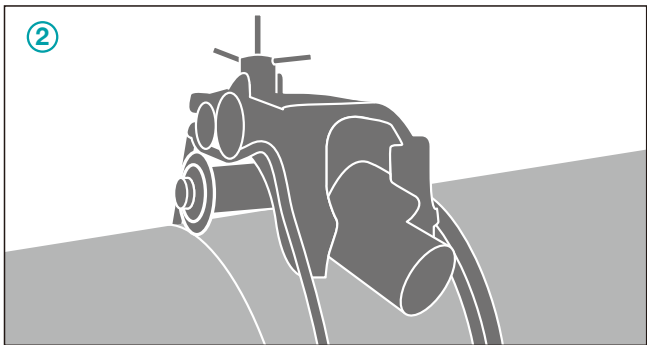
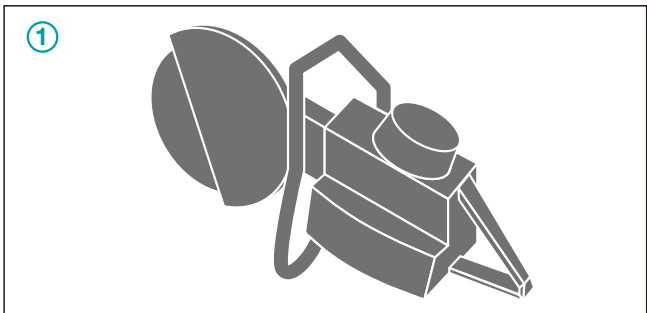
Before cutting, carefully inspect the pipe:

- (1) If the pipe is seriously damaged
→ reject the pipe.
- (2) If there is a hole or crack in the pipe body
→ reject or cut off the damaged portion.
- (3) If the socket is deformed or the spigot is seriously damaged
→ cut off the damaged portion.



Tools and Equipment

- Engine driven cutter (Picture ①)
or Power operated metal saw (Picture ②)
- Portable disc grinder (Picture ③)
- Measuring tape (Picture ④)
- Curvature gauge made of plywood, tin plate, plastic, etc.(Picture ⑤)
•This tool may be made on site using available materials.
- Taper gauge made of plywood, tin plate, plastic, etc.(Picture ⑥)
•This tool may be made on site using available materials.



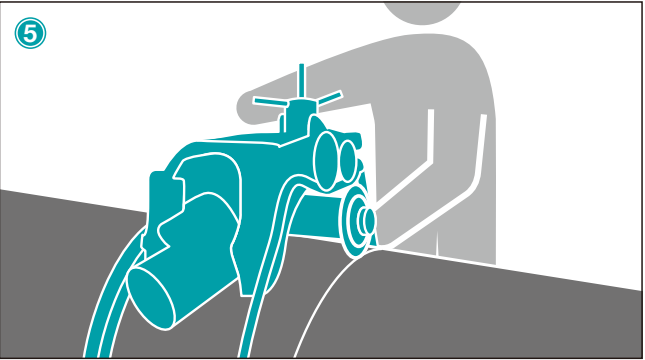
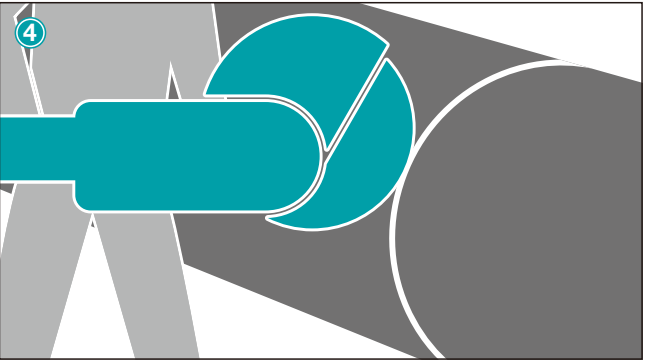
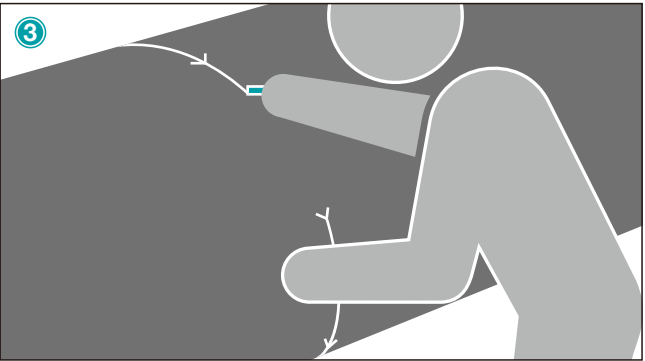
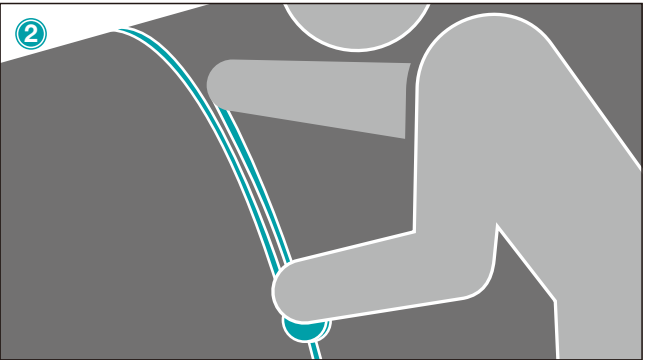
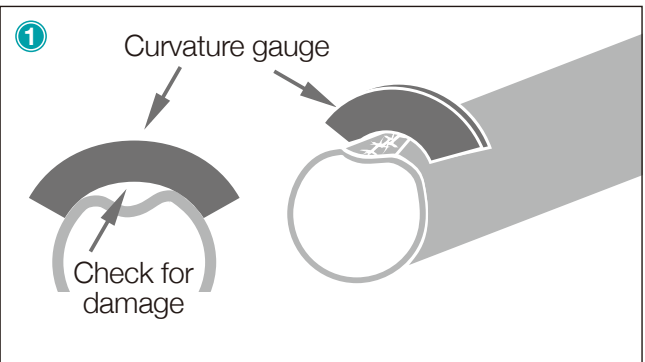
Procedure

- (1)**Check** the deformed portion and identify an undamaged portion with a curvature gauge.(Picture ①)

- (2)**Measure** the circumference with a measuring tape.(Picture ②)
•Dimension must be within the tolerance in Table 1 of page 6. If it is not, find a portion that satisfies the value.

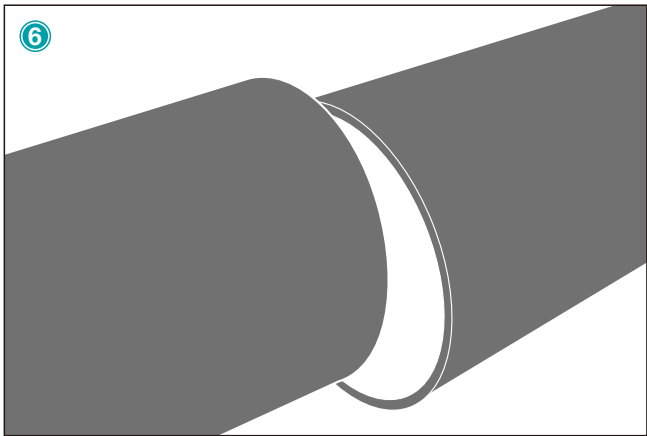
- (3)**Draw** a line to indicate where to cut. (Picture ③)

- (4)**Cut** the pipe along the line using an engine driven cutter (Picture ④) or a power operated metal saw. (Picture ⑤)

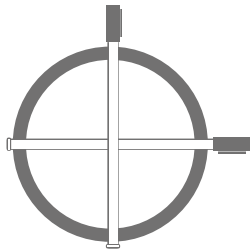


CUTTING OF PIPE

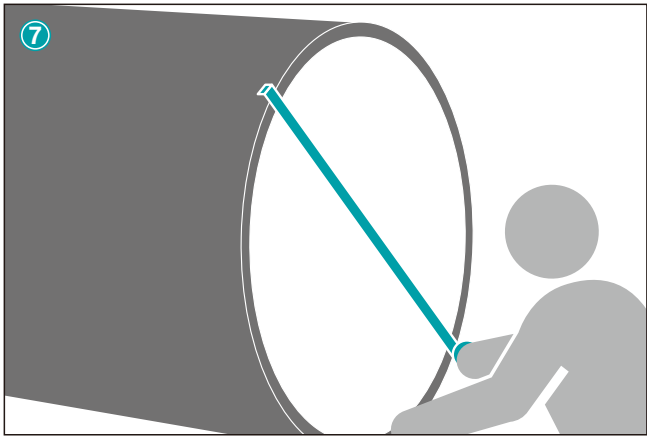
(5)**Completion** of cutting. (Picture ⑥)



(6)**Measure** the outside diameter in two or more different directions. (Picture ⑦)

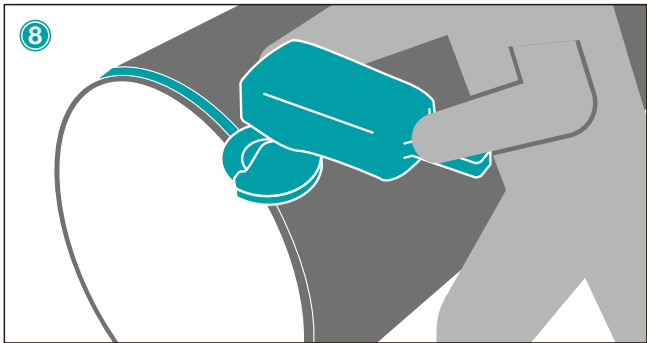
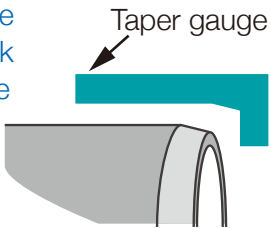


*The dimensions must be within the tolerance in Table 1 of page 6. If it is not,correct the pipe according to the procedure “Corrections of Deformed Spigot”. (See page 8-10)

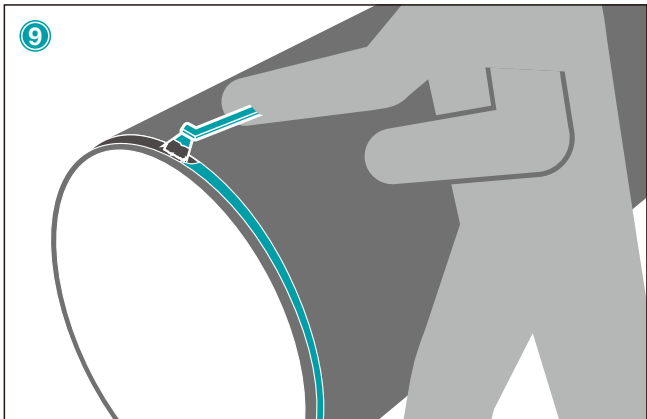


(7)**Taper** the edge of the spigot with a portable disc grinder as per the dimensions specified in Table 2 of page 7. (Picture ⑧)

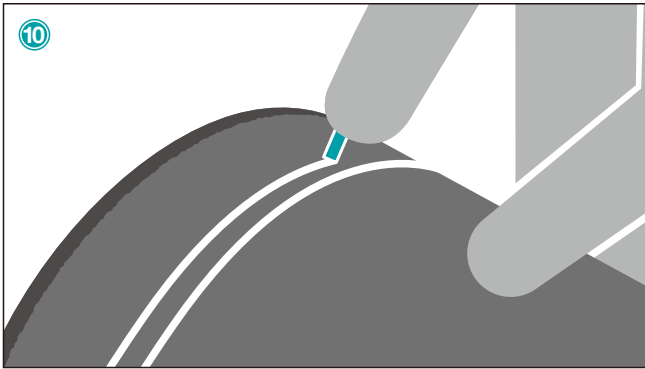
*Taper gauge can be used to easily check the angle of the tapered end.



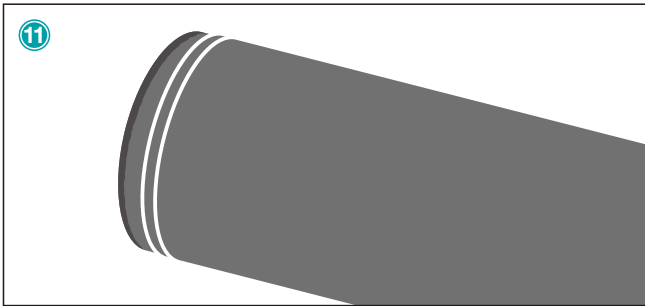
(8)**Apply** the zinc rich paint to the exposed iron surface. And then, apply the bituminous paint to the dried zinc rich coating. (Picture ⑨)



(9)**Draw** white lines for jointing as per the dimensions specified in Table 2 of page 7. (Picture ⑩)
*Stenciled lines may be drawn also by spray painting.



(10)**Completion** of cutting work.(Picture ⑪)



■Tolerances on Diameter and Circumference (ISO 2531/BS EN 545 & 598)

Table 1 (Dimensions in mm)

DN	Outside diameter			Allowable circumferential length
	Nominal	Tolerance		
80	98	+1	-2	301.6 ~ 311.0
100	118	+1	-2	364.4 ~ 373.8
150	170	+1	-2	527.8 ~ 537.2
200	222	+1	-2	691.2 ~ 700.6
250	274	+1	-2	854.5 ~ 863.9
300	326	+1	-2	1017.9 ~ 1027.3
350	378	+1	-2.3	1180.3 ~ 1190.7
400	429	+1	-2.3	1340.5 ~ 1350.9
450	480	+1	-2.3	1500.7 ~ 1511.1
500	532	+1	-2.3	1664.1 ~ 1674.5
600	635	+1	-2.3	1987.7 ~ 1998.1
700	738	+1	-3.5	2307.5 ~ 2321.6
800	842	+1	-3.5	2634.2 ~ 2648.4
900	945	+1	-3.5	2957.8 ~ 2971.9
1000	1048	+1	-3.5	3281.4 ~ 3295.5
1100	1152	+1	-3.5	3608.1 ~ 3622.3
1200	1255	+1	-3.5	3931.7 ~ 3945.8
1400	1462	+1	-3.5	4582.0 ~ 4596.2
1500	1565	+1	-3.5	4905.6 ~ 4919.7
1600	1668	+1	-3.5	5229.2 ~ 5243.3
1800	1875	+1	-5	5874.8 ~ 5893.6
2000	2082	+1	-5	6525.1 ~ 6543.9

Note : Minus tolerance on outside diameter can be increased additionally 0.5 mm for DN≤600 and 1 mm for DN>600 when the measured circumference of the pipe is within the allowable value.

■ Dimensions of Tapered Spigot for Push-on Joint

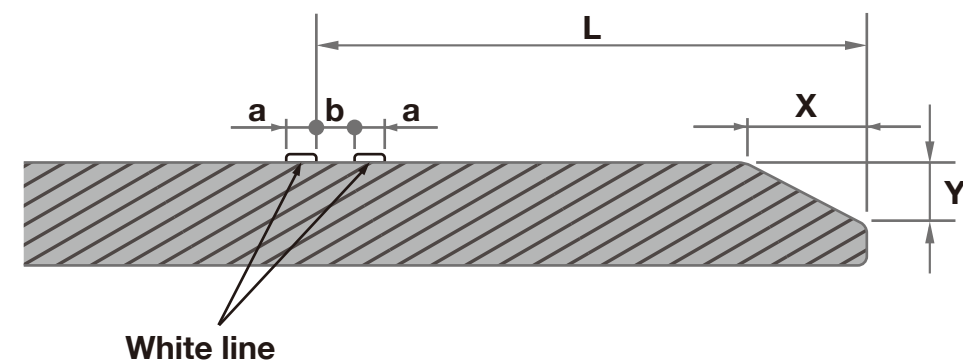


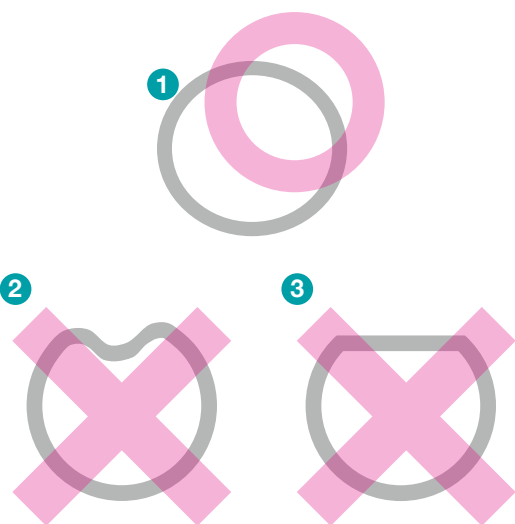
Table 2 (Dimensions in mm)

DN	Taper		White lines		
	Y	X	L	a	b
80	3	9	82	10	13
100	3	9	86	10	13
150	3	9	95	10	13
200	3	9	110	10	13
250	3	9	115	10	13
300	3	9	120	10	13
350	5	14	135	10	13
400	5	14	135	10	13
450	5	14	135	10	13
500	5	14	140	10	13
600	5	14	145	10	13
700	6	15	160	15	20
800	6	15	165	15	20
900	6	15	180	15	20
1000	7.5	19	190	15	20
1100	7.5	19	205	15	20
1200	7.5	19	220	15	20
1400	8.5	23	250	15	20
1500	8.5	23	265	15	20
1600	8.5	23	280	15	20
1800	9.5	26	310	15	20
2000	9.5	26	340	15	20

Inspection

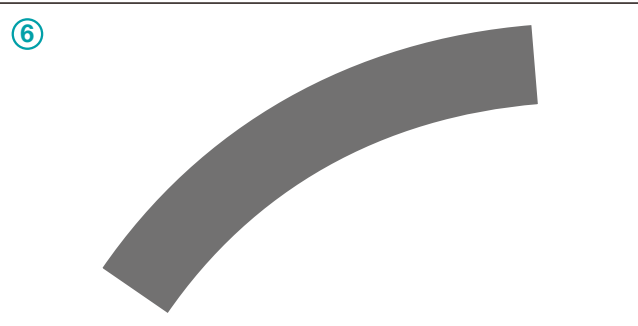
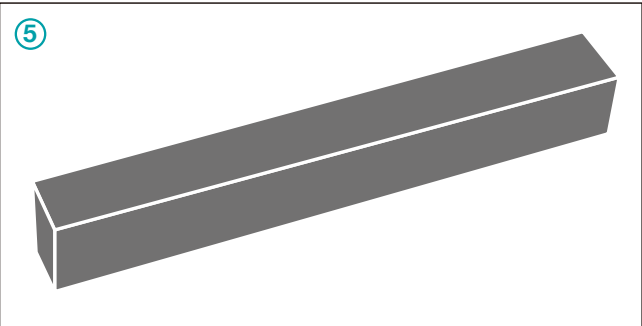
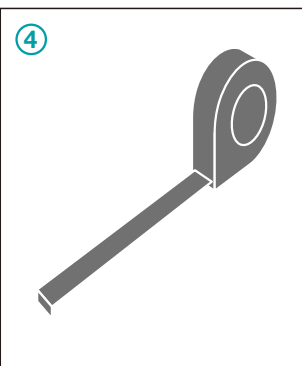
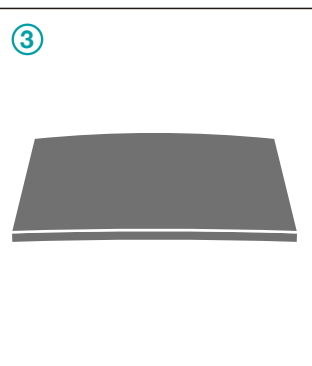
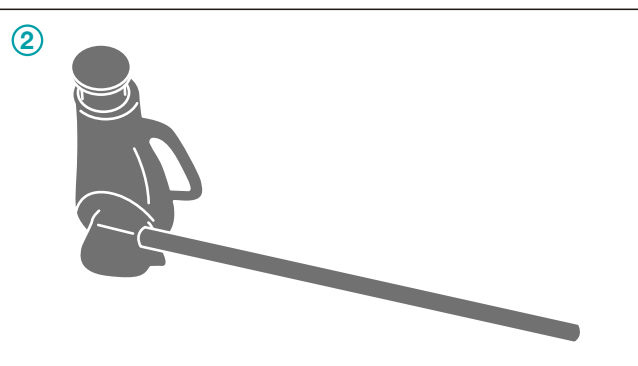
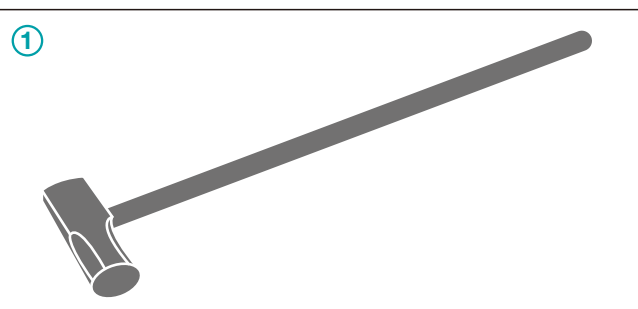
Although ductile iron pipes are tough and strong, they may be accidentally deformed by improper handling. However minor deformations can be repaired by the following method.

Generally only ellipse on the spigot end can be corrected. (Picture ①) However, if the spigot is severely deformed and concave (Picture ②) or extensively flat (Picture ③), generally it can not be corrected. In such a case, the deformed portion need to be cut.



Tools and Equipment

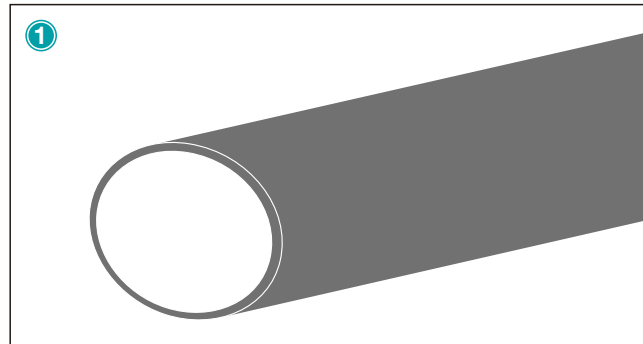
- Hammer (Large) (Picture ①)
- Hydraulic jack (Picture ②)
- Iron plate with curvature that conforms to the inner wall of the repairing pipe. (Picture ③)
**This can be made on site by cutting out pieces from rejected pipe or cut pipe, etc.*
- Measuring tape (Picture ④)
- Wood block (Picture ⑤)
- Curvature gauge (Picture ⑥) made of plywood, tin plate, plastic, etc.
**This can be made on site using available materials.*



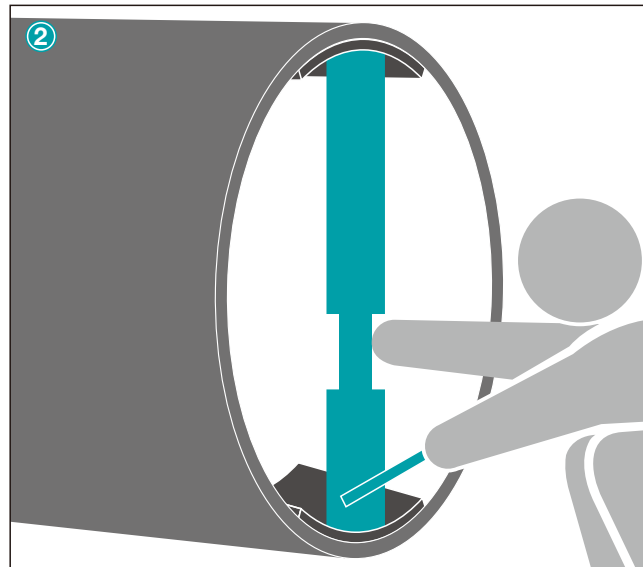
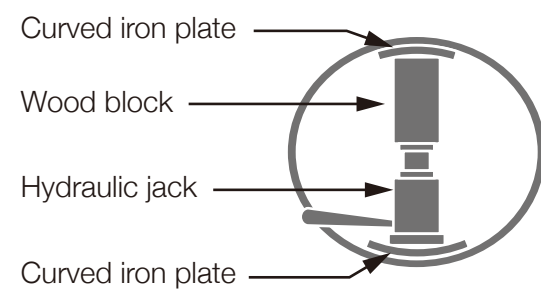
CORRECTION OF DEFORMED SPIGOT

Procedure

(1) **Position** the pipe so that the minimum diameter point is located vertically. (Picture ①)

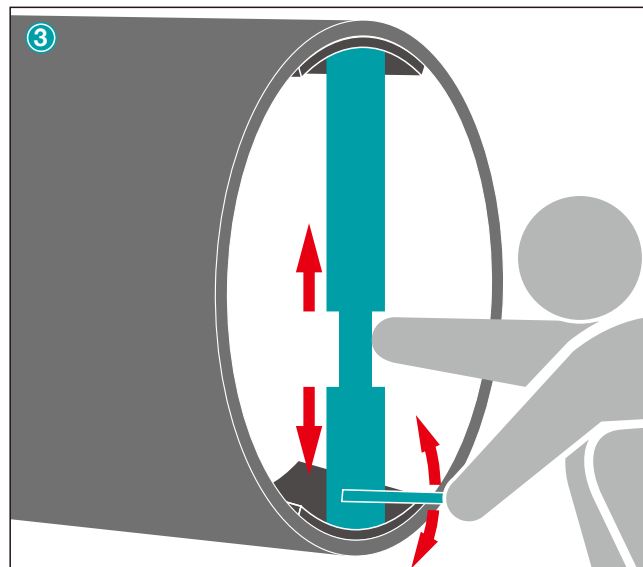


(2) **Set** the hydraulic jack, a wood block and iron plates in the pipe. (Picture ②)



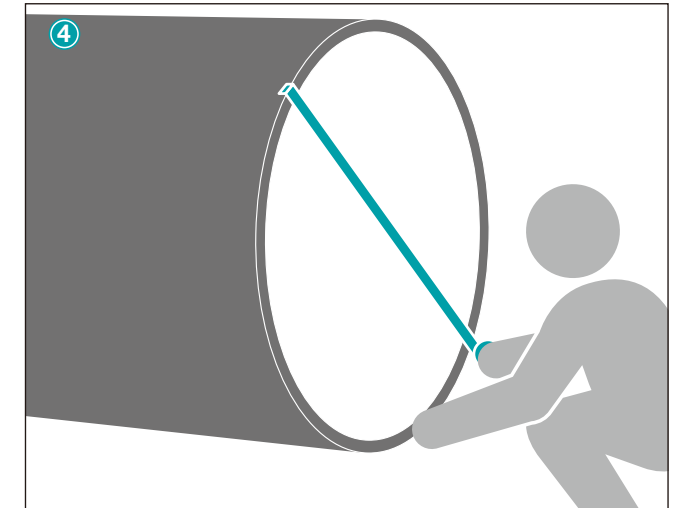
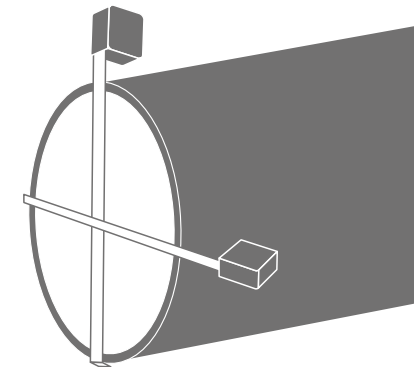
(3) **Gradually** expand the diameter until the diameter slightly exceeds the required dimensions. (Picture ③)

*Excessive expansion of the pipe diameter will cause the damage to the mortar lining.

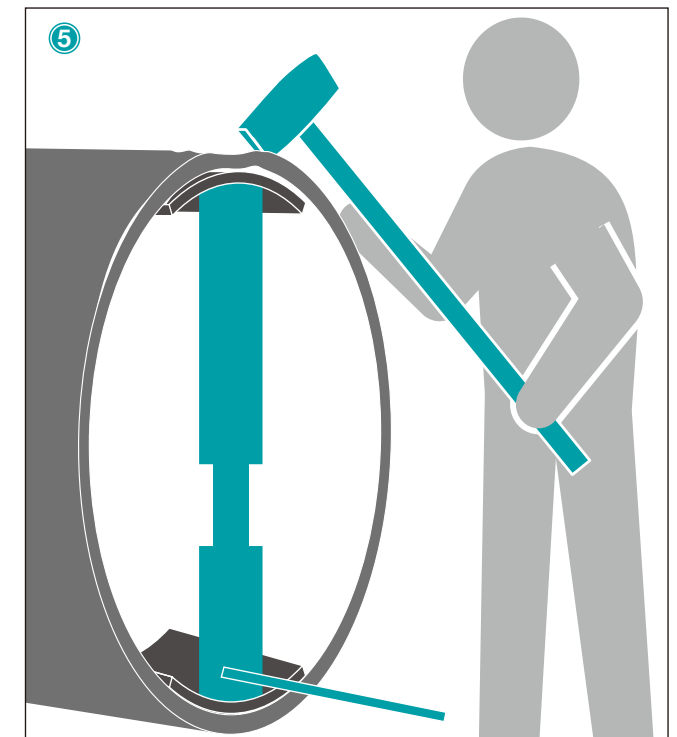


(4) **Release** pressure of the hydraulic jack and measure the diameters in two or more directions and see if they are within the tolerance specified in Table 1 of page 6. (Picture ④) If they are not, repeat (3) and (4).

*This procedure may be repeated several times until a correct circle is obtained.



In case there is a deformation on the pipe, correct the deformation with a hammer while expanding the diameter. (Picture ⑤)



Repair Material

Select Epoxy Resin or Cement Mortar depending on the degree of damage of cement mortar lining as per Table 3.

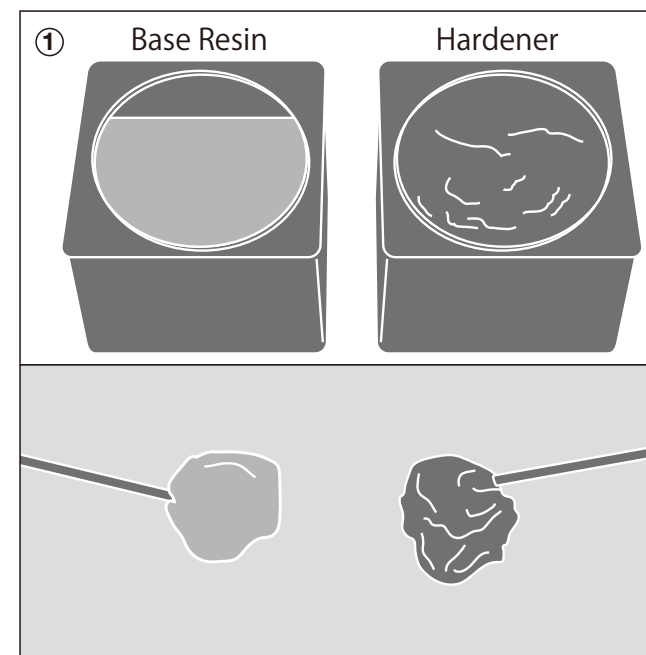
Table 3 Selection of Repair Material

Condition of damage	Repair material
Crack	Epoxy Resin (page 13-15)
Chip	Epoxy Resin (page 16-17)
Break	Epoxy Resin (page 18-19) Cement Mortar (page 20-22)

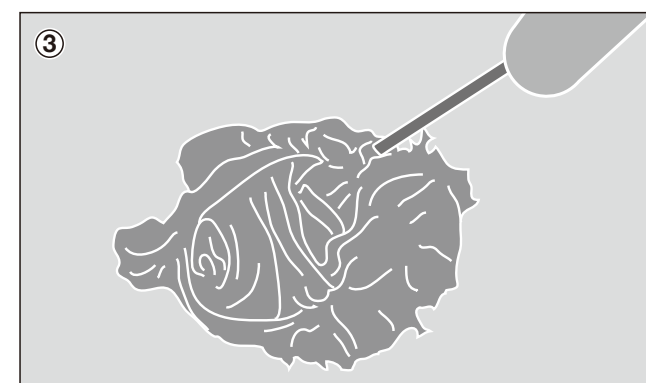
Epoxy Resin

The two different clay-like materials are mixed together and used as putty. The mixing procedure is as follows:

(1)**Prepare** Epoxy Resin compound. And take out appropriate ratio of "Base Resin" and "Hardener" with different spoons. (Picture ①)



(2)**Mix** them well until they become uniform in color (Picture ② and ③).

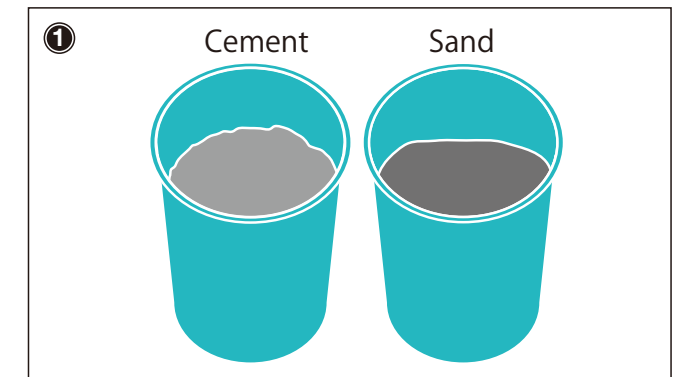


*The pot life and condition of the materials vary according to the materials and temperature.

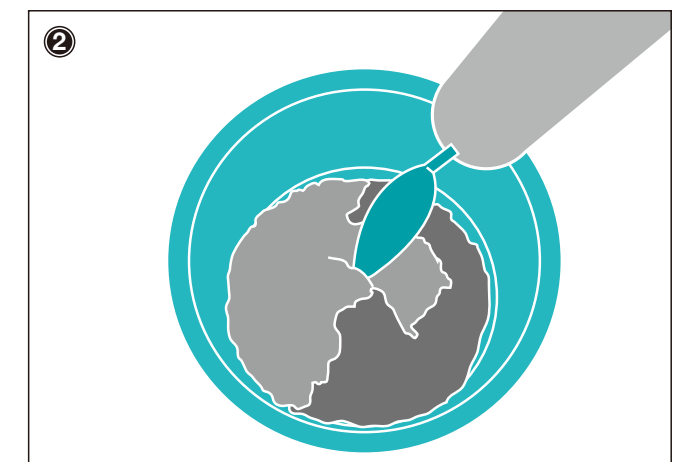
Cement Mortar

It is recommended to select cement of the same quality as that used for the cement mortar lining. (e.g. Portland cement, sulphate resisting cement, etc.)

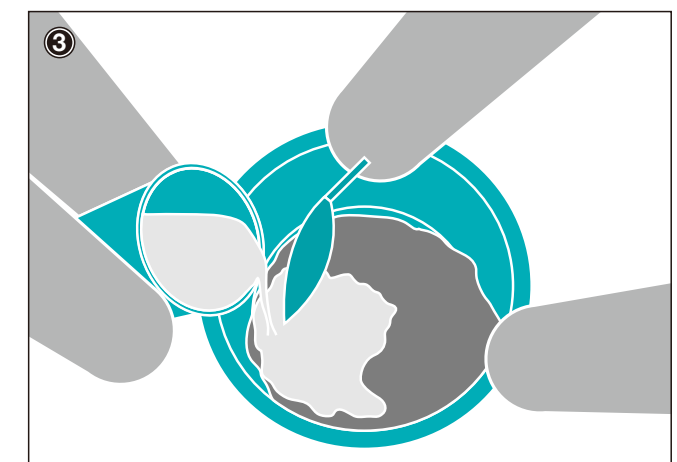
(1)**Prepare** cement and sand in the ratio of 1:1 by weight. (Picture ①)



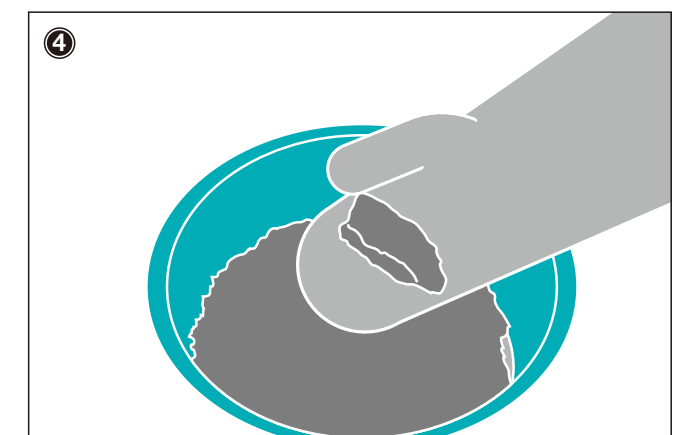
(2)**Mix** them well in a container. (Picture ②)



(3)**Add** water in small amounts to the mixture and continue to mix them. (Picture ③)



(4)**Keep** mixing until the mixture* becomes such that it can be formed into a lump when grasped firmly in one hand. (Picture ④)



*Use the mixture within one hour.

Repair Method

Crack

Inspection

1. Inspect the cement mortar lining. When the cement mortar lining has large cracks, deformation of pipe body is expected. In this case, correction of the pipe is necessary prior to the repair of the lining.
2. After the concern of deformation is cleared, check the crack width and radical displacement. If the pipe has cracks and radical displacement less than the width given in Table 4, it is not necessary to repair the surface crazing and the small cracks.
3. If the cement mortar lining has cracks and radical displacement exceeding the width given in Table 4, Kubota would recommend repairing them. However, there is an exception mentioned in BS EN 545 2010.

Abstract from BS EN 545 2010

Storage of pipes and fittings in a hot, dry environment can cause metal expansion and mortar shrinkage cracks exceeding the width given in Table 4. When the lining is reexposed to water, it will swell by absorption of moisture and the cracks will close to conform to Table 4 and will eventually heal by an autogenous process.

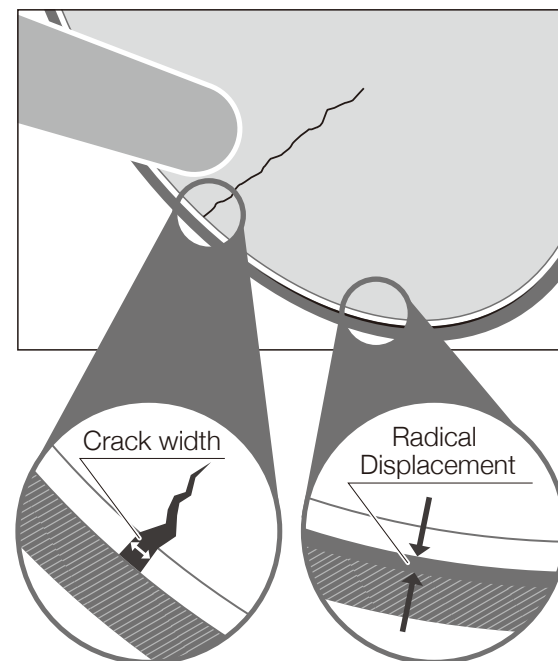
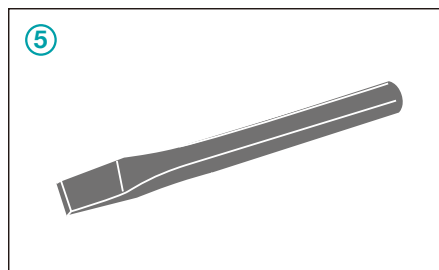
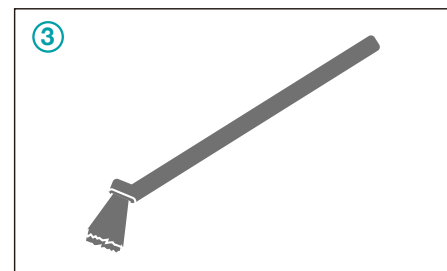
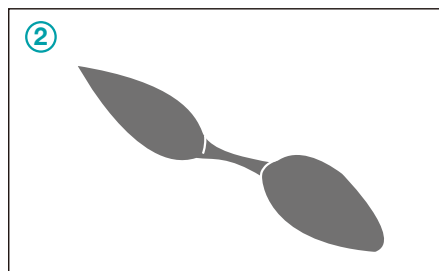
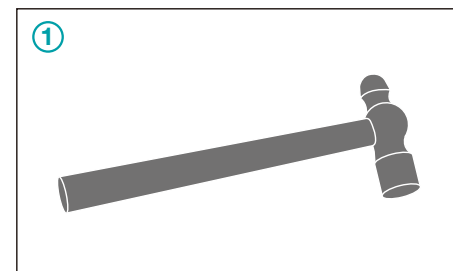


Table 4
Maximum crack width and radical displacement

DN	mm
40 to 300	0.4
350 to 600	0.5
700 to 1200	0.6
1400 to 2000	0.8

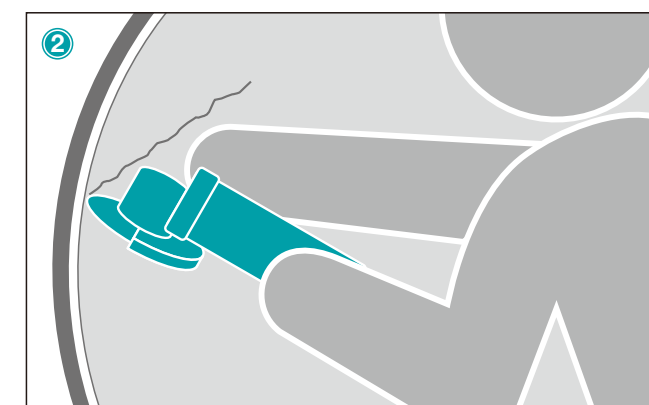
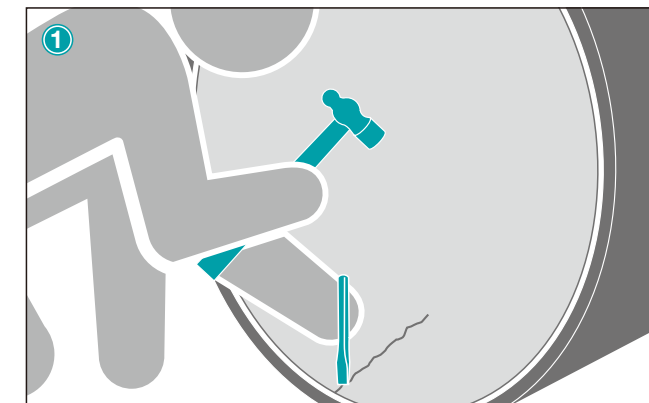
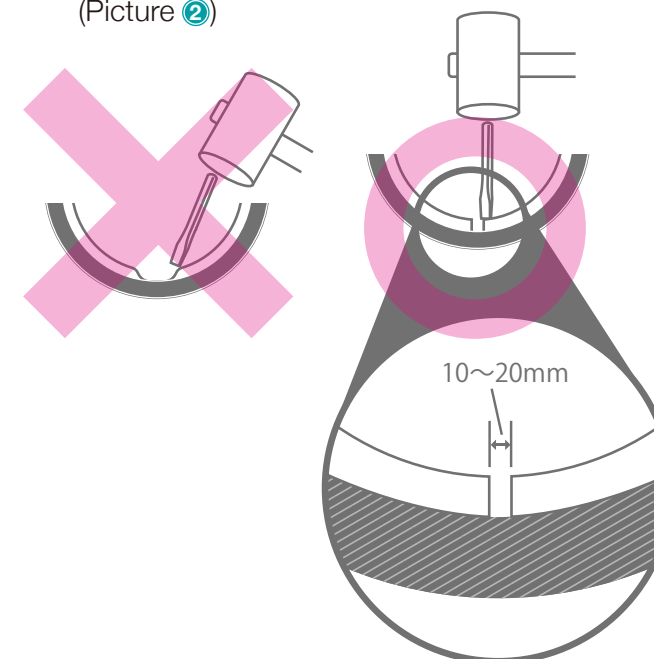
Tools and Equipment

- Hammer (Picture ①)
- Spatula (Picture ②)
- Brush (Picture ③)
- Portable disc grinder (Picture ④)
- Chisel (Picture ⑤)



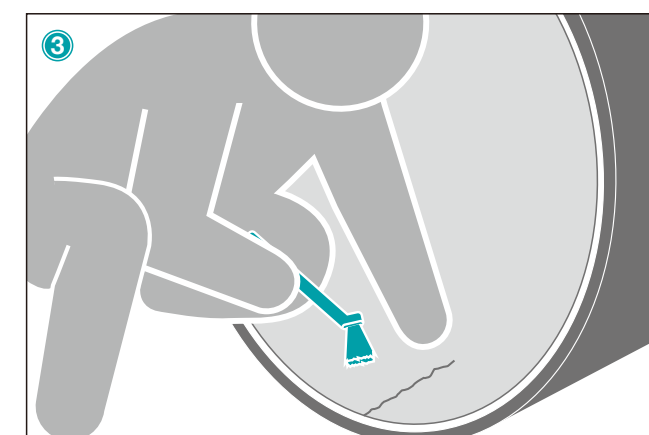
Procedure

- (1) **Cut** back the lining about 10-20 mm in width with a chisel and hammer. (Picture ①) A portable disc grinder may be used instead of a chisel and hammer. (Picture ②)



- (2) **Clean** the surface of the cut-back portion with a brush etc. (Picture ③)

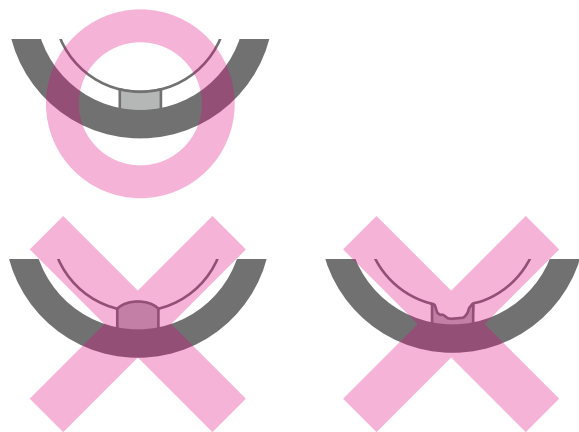
*Remove moisture from the surface.



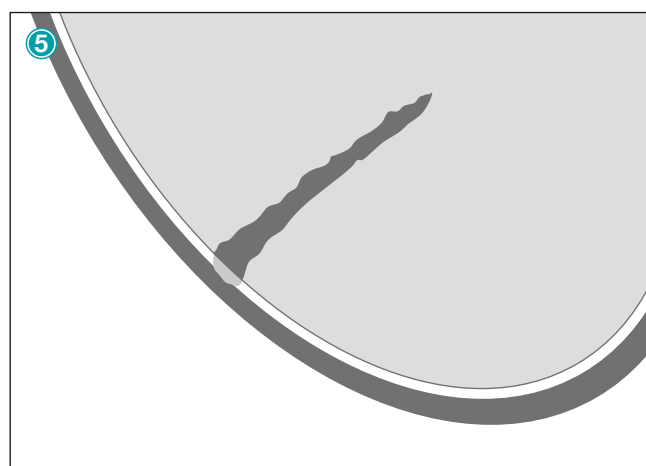
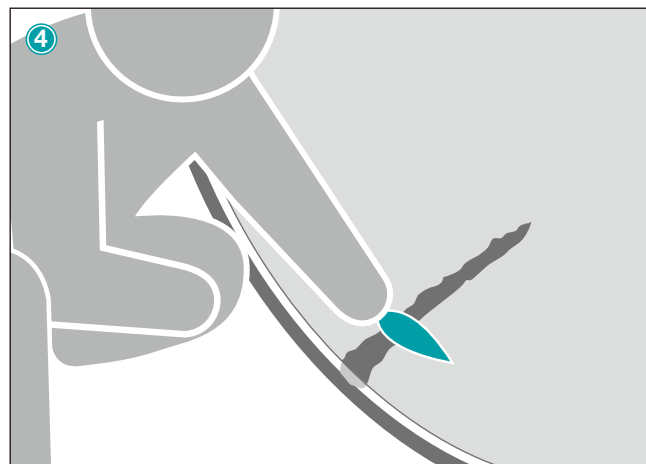
Repair Method

Crack

(3) **Fill** the cut-back portion with Epoxy Resin and smooth the surface with a spatula. (Picture ④)



(4) **Inspect** the finished surface (Picture ⑤)



Chip

Inspection

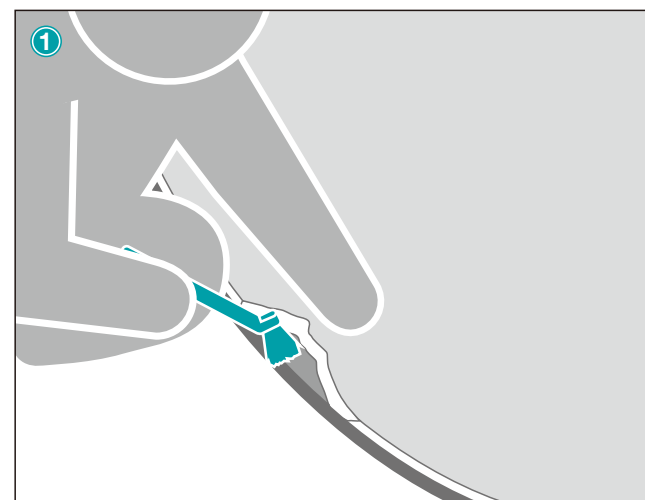
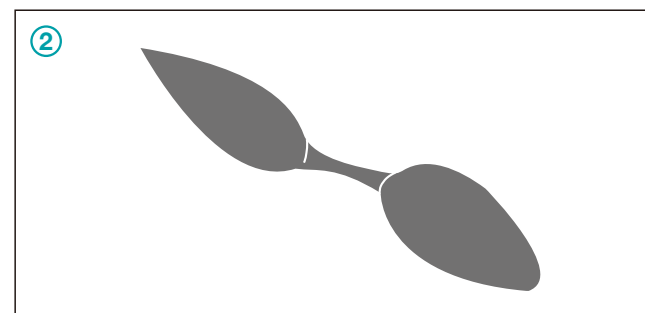
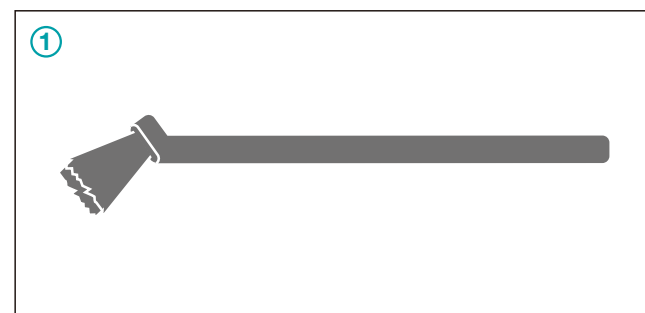
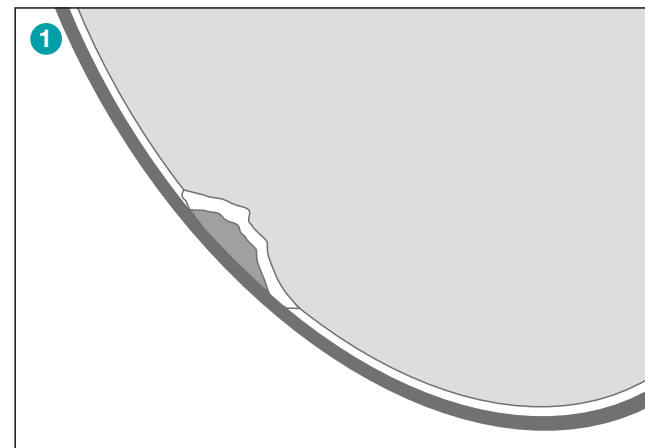
Inspect the damaged area carefully and confirm that there is no deformation or crack on the pipe body. (Picture ①)

Tools and Equipment

- Brush (Picture ①)
- Spatula (Picture ②)

Procedure

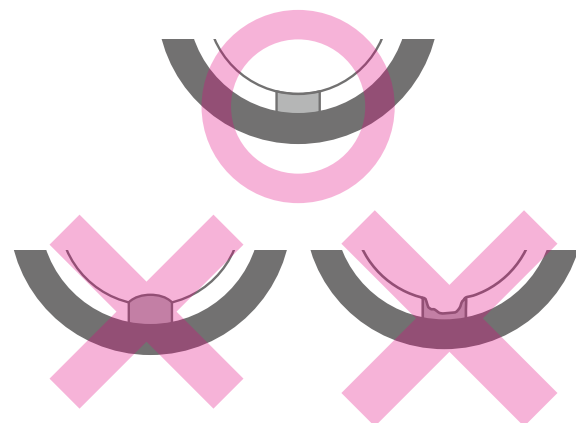
(1) **Clean** the surface of the damaged portion with a brush, etc. (Picture ①)
*Remove moisture from the surface.



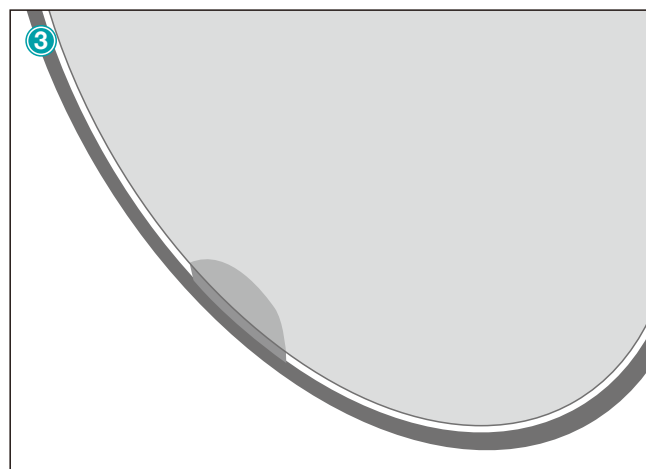
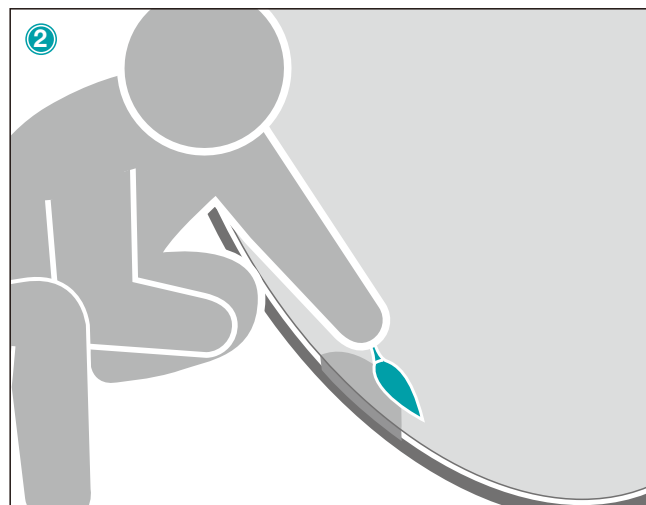
Repair Method

Chip

(2) **Fill** the chip with Epoxy Resin (See page 11) and smooth the surface with a spatula. (Picture ②)



(3) **Inspect** the finished surface. (Picture ③)



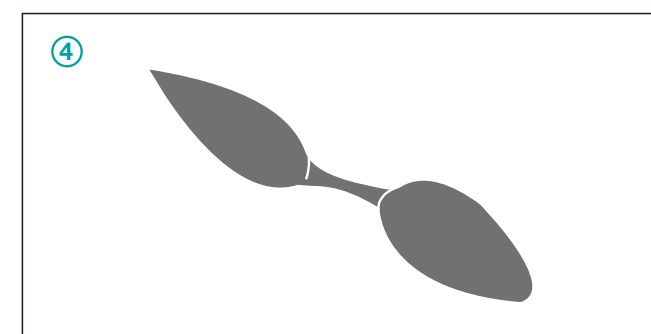
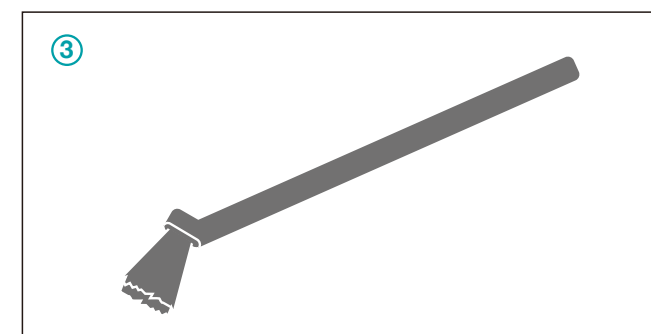
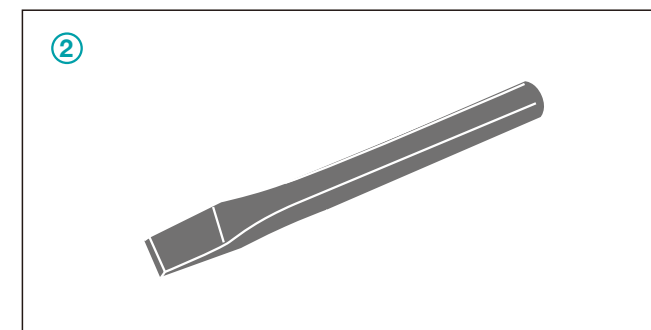
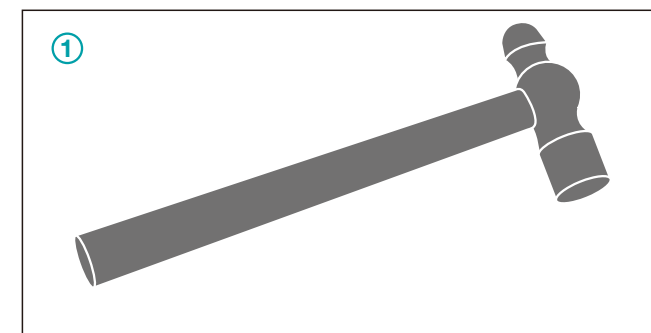
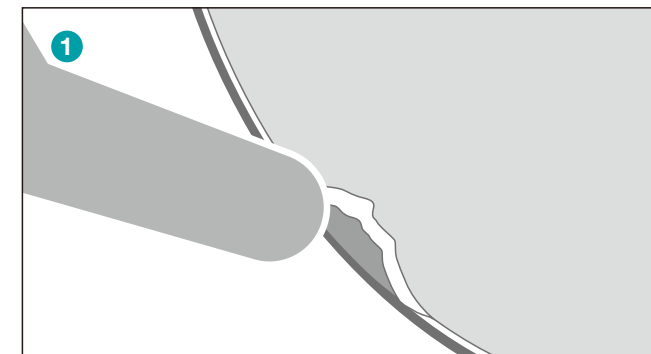
Break

Inspection

Inspect the damaged area well. If the cement mortar lining is broken off in a large area, cut the pipe to remove the damaged portion. (Picture ①)

Tools and Equipment

- Hammer (Picture ①)
- Chisel (Picture ②)
- Brush (Picture ③)
- Spatula (Picture ④)



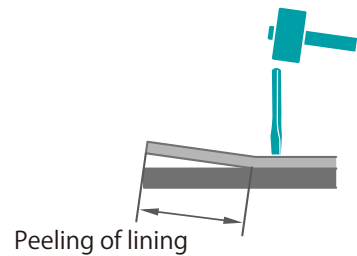
Repair Method

Break

Procedure

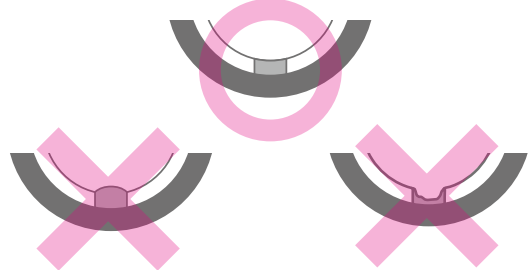
- (1) **Cut back** the damaged lining so that the edge of the lining is at right angles to the iron surface. (Picture ①)

*If the cement lining is peeled off from the iron surface, cut out the affected area.

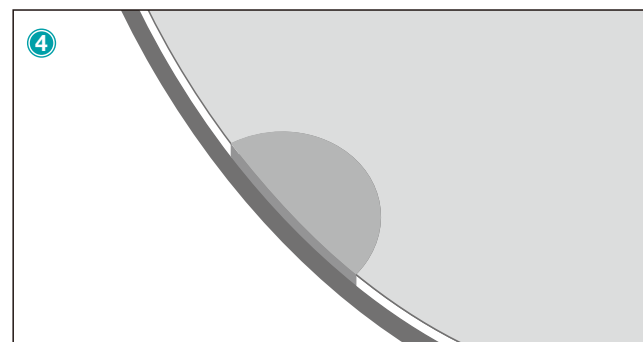
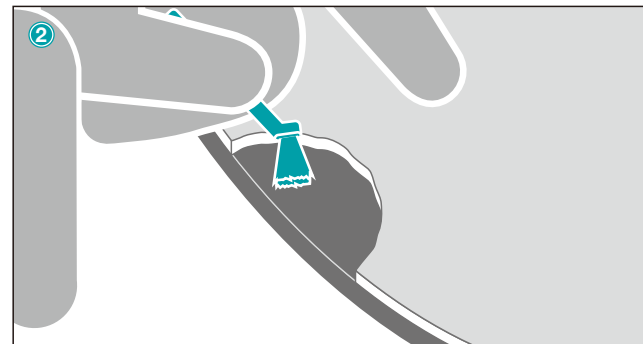
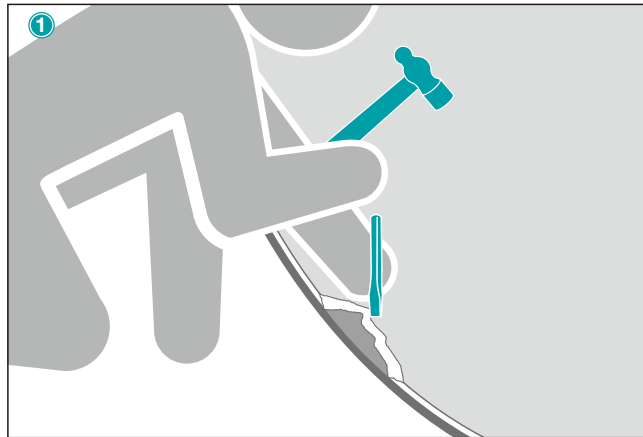


- (2) **Clean** the surface of the damaged portion with a brush. (Picture ②)

- (3) **Fill** the damaged portion with Epoxy Resin and smooth the surface with a spatula. (Picture ③)



- (4) **Inspect** the finished surface. (Picture ④)



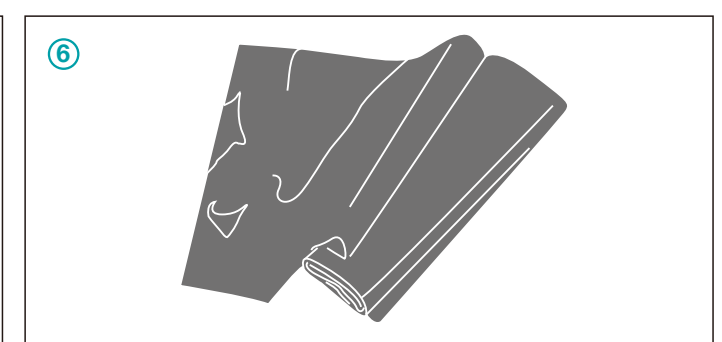
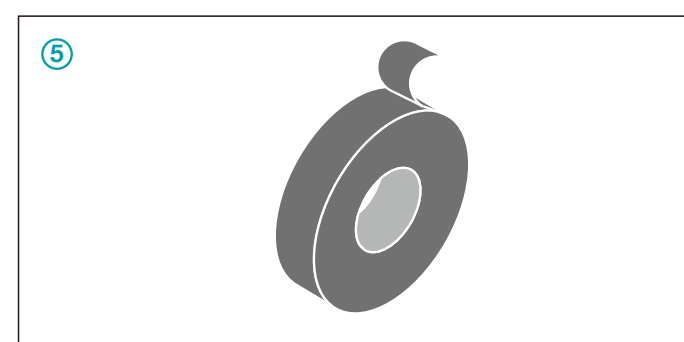
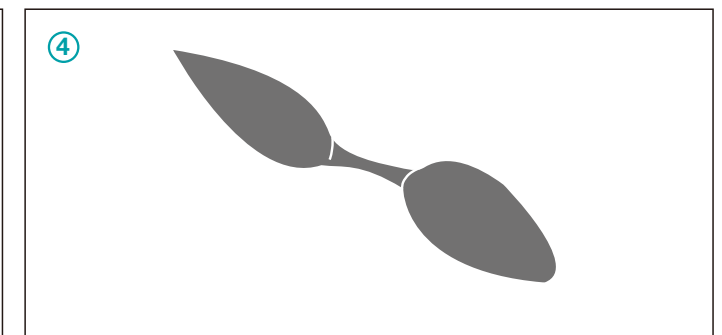
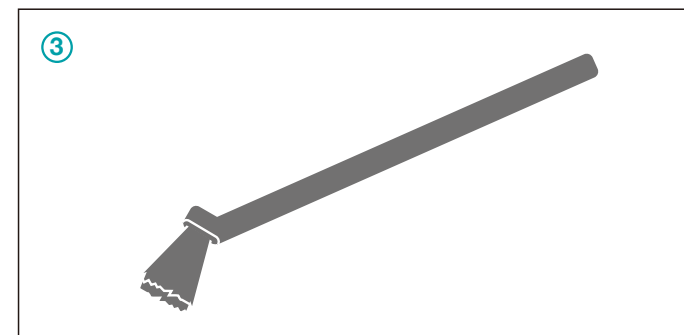
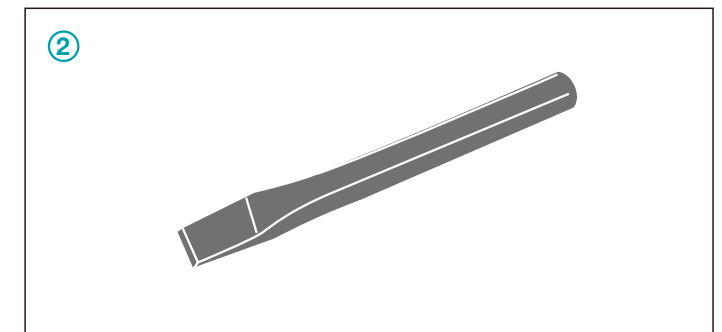
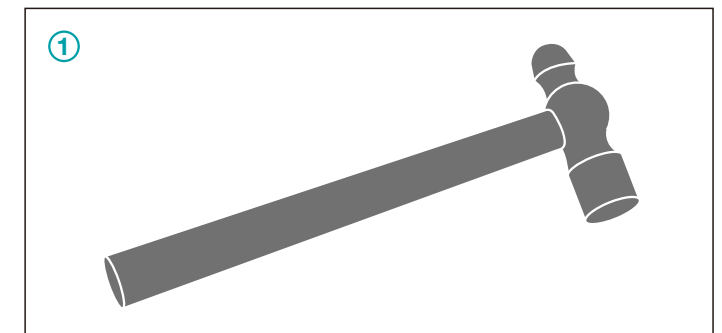
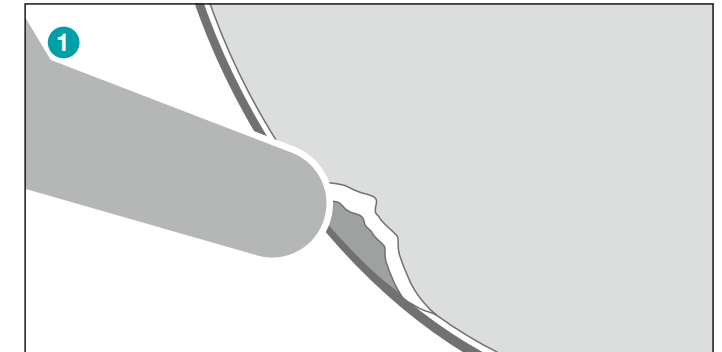
Break (Alternative Option - by means of Cement Mortar)

Inspection

Inspect the damaged area well. If the cement mortar lining is broken off in a large area, cut the pipe to remove the damaged portion. (Picture ①)

Tools and Equipment

- Hammer (Picture ①)
- Chisel (Picture ②)
- Brush (Picture ③)
- Spatula (Picture ④)
- Adhesive tape (Picture ⑤)
- Plastic sheet (Picture ⑥)



REPAIR OF INTERNAL LINING

CEMENT MORTAR LINING

Repair Method

Break (Alternative Option - by means of Cement Mortar)

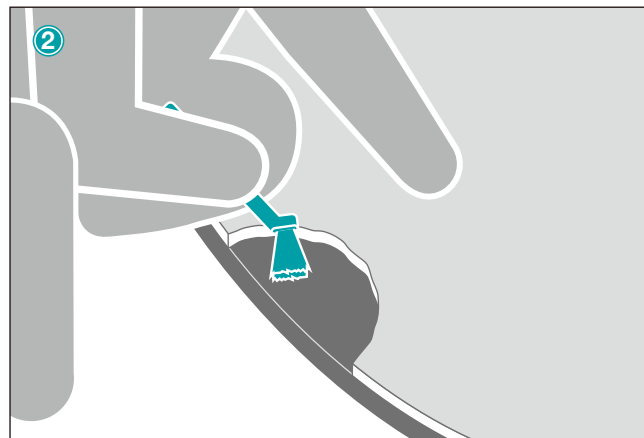
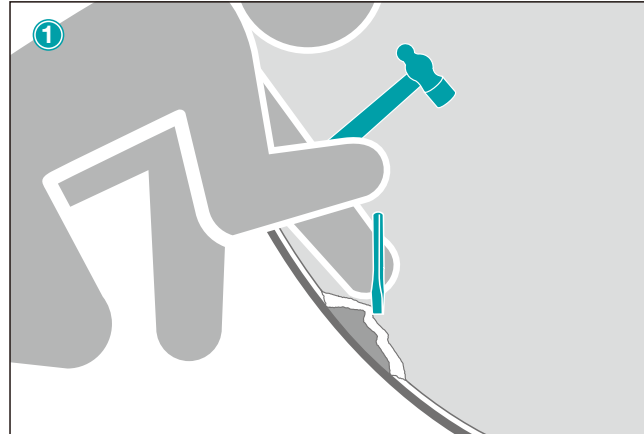
Procedure

- (1) **Cut back** the damaged lining so that the edge of the lining is at right angles to the iron surface. (Picture ①)

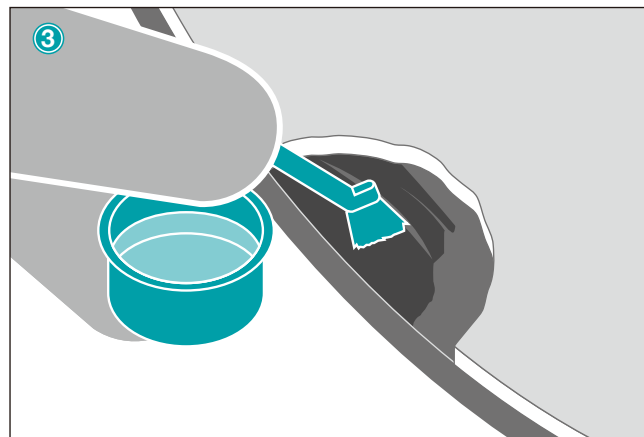
*If the cement lining is peeled off from the iron surface, cut out the affected area.



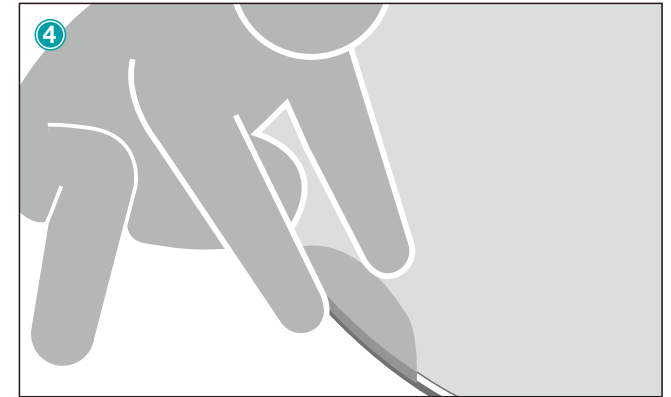
- (2) **Clean** the surface of the damaged portion with a brush. (Picture ②)



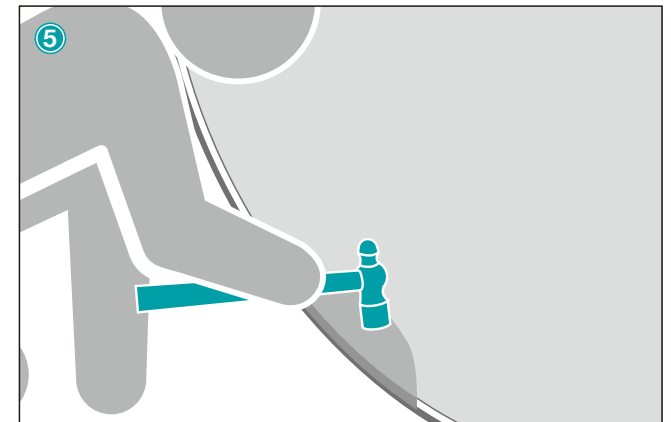
- (3) **Apply** some water to the damaged portion with a brush. (Picture ③)



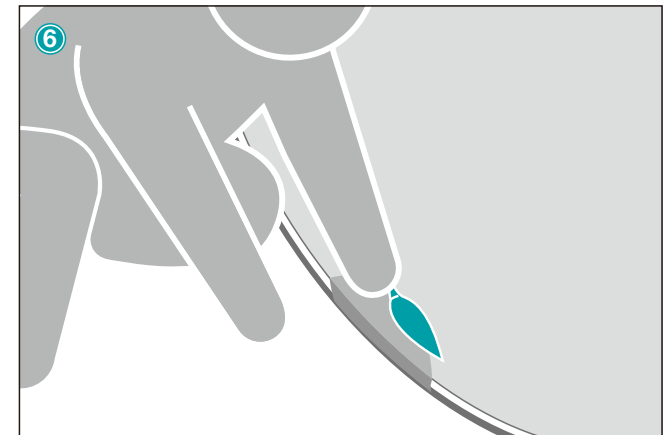
- (4) **Fill** the damaged portion with the cement mortar mixture. (Picture ④)



- (5) **Tap** the filled cement mortar mixture gently with a hammer until it is compacted. (Picture ⑤)

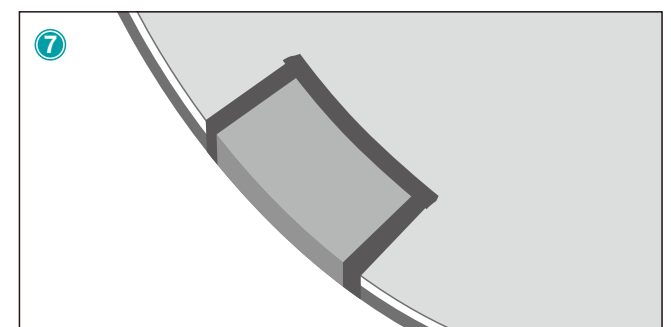


- (6) **Smooth** the surface with a spatula. (Picture ⑥)



- (7) **Curing:**
Cover the repaired portion with a wet towel or wet paper, then seal up with plastic film and adhesive tape. Keep it on for more than 24 hours. (Picture ⑦)

*Other curing methods may be applied according to the condition on site and the supervisor's decision.



REPAIR OF INTERNAL LINING FUSION BONDED EPOXY COATING

Repair Material

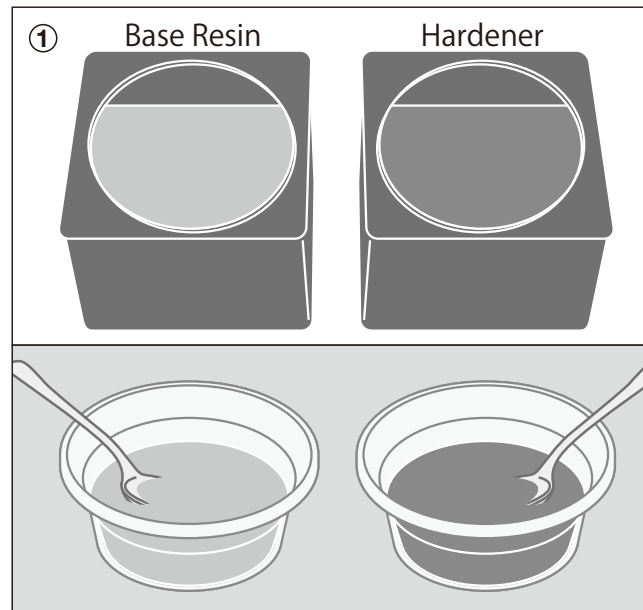
2-pack epoxy paint

The two different materials are mixed together and used as paint. The mixing procedure is as follows:

(1)**Prepare** 2-pack epoxy paint. And take out appropriate ratio of “Base Resin” and “Hardener” with different spoons. (Picture ①)

*Use our recommended repair material.

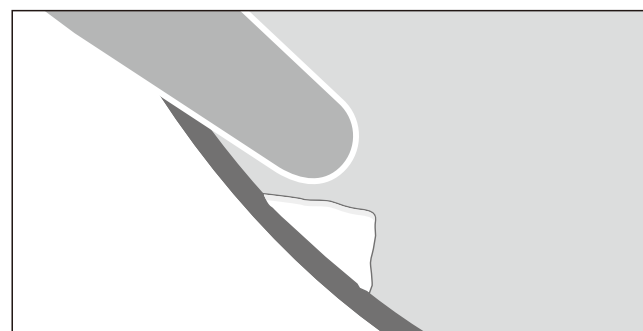
(2)**Mix** them well in a container until they become uniform in color. (Picture ② and ③)



Repair Method

Inspection

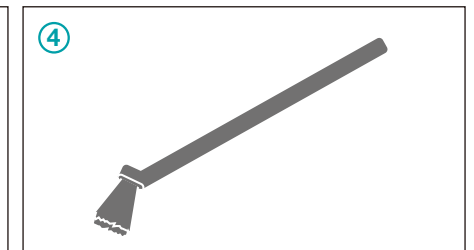
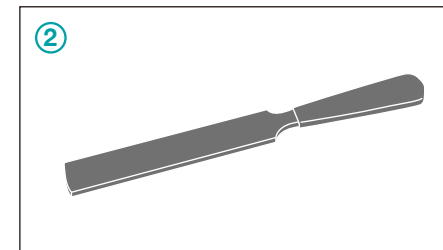
Inspect the fusion bonded epoxy coating. If the fusion bonded epoxy coating is damaged, repair of the fusion bonded epoxy coating is required.



Repair Method

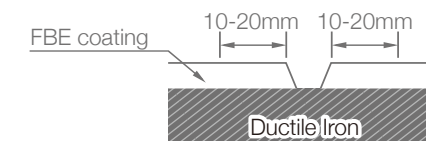
Tools and Equipment

- Sandpaper (Picture ①)
- File (Picture ②)
- Portable disc grinder (Picture ③)
- Brush (Picture ④)



Procedure

(1)**Roughen** the sound coating around the damaged area with a sandpaper, file or portable disc grinder to the extent of 10mm to 20mm. (Picture ①)



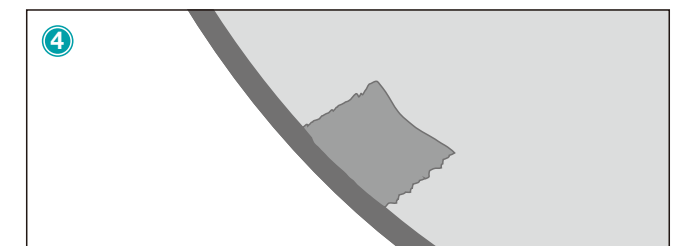
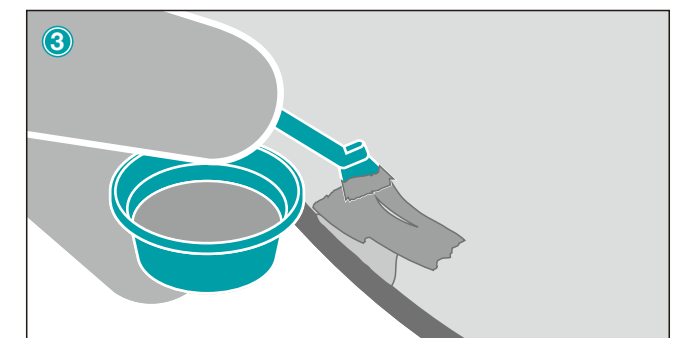
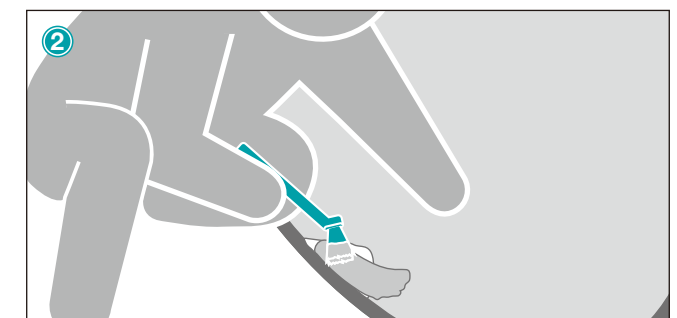
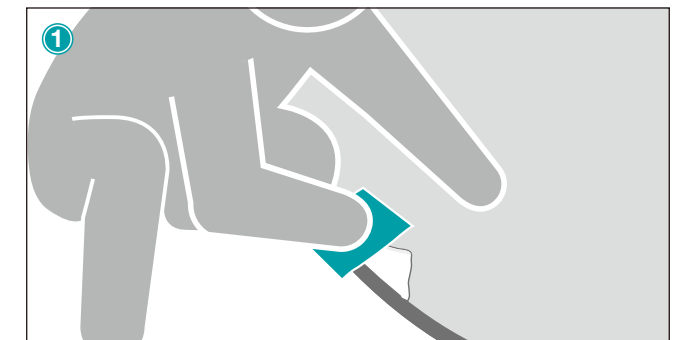
(2)**Clean** the surface of the damaged area with a brush, etc. (Picture ②)

*The area to be repaired shall be clean and free from sand, dust, moisture, etc.

(3)**Apply** the 2-pack epoxy paint to the damaged area and the roughened surrounding coating with a brush. (Picture ③)

*Paint several times at intervals to obtain the specified dry film thickness.

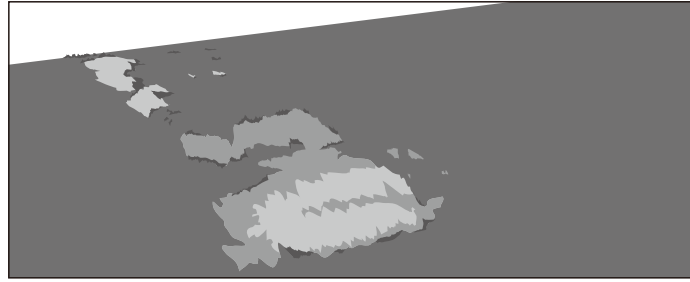
(4)**Inspect** the finished surface. (Picture ④)



REPAIR OF EXTERNAL COATING

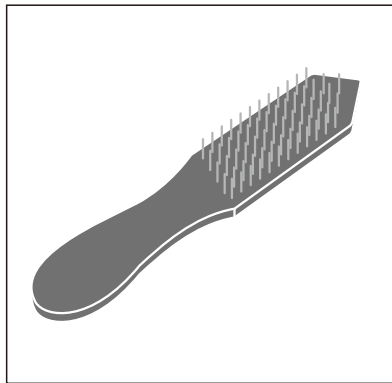
Inspection

Inspect the external coating. If the external coating is damaged, repair of the external coating is required.

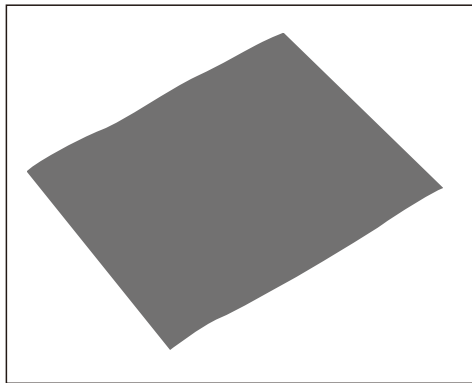


Tools and Equipment

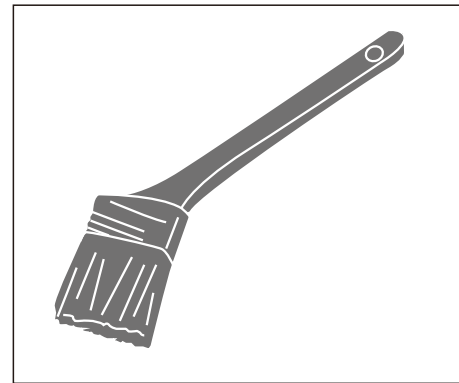
•Wire brush



•Sandpaper



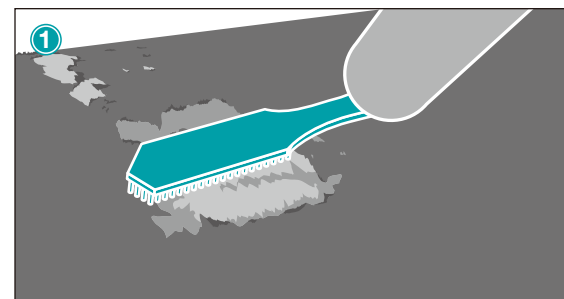
•Brush



Procedure

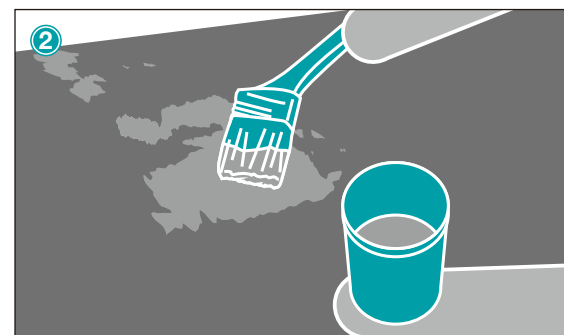
(1)**Remove** foreign materials and clean the surface. (Picture ①)

*If the surface is rusted, use wire brush or sandpaper to remove the rust, then wipe off with a cloth.



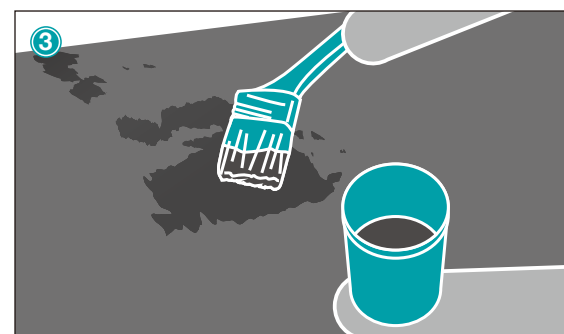
(2)**Apply** the zinc rich paint to the cleaned iron surface with a brush. (Picture ②)

*Zinc rich paint shall not be applied to the wet or moist iron surface or over the existing bitumen coating.



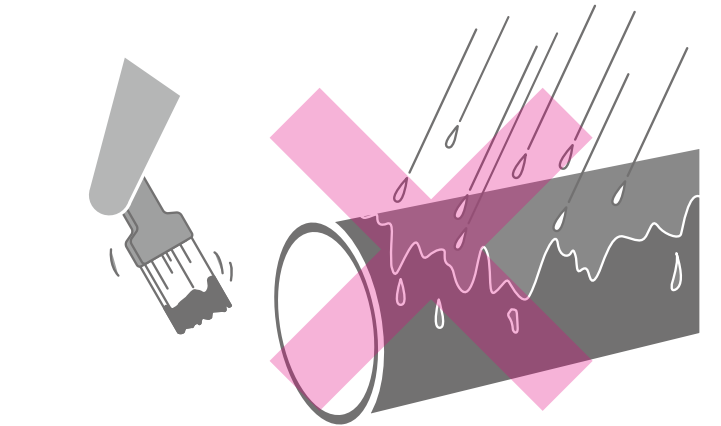
(3)**Apply** the bituminous paint to the dried zinc rich coating with a brush. (Picture ③)

*The bituminous paint can be thinned with the specific thinner when the viscosity of the bituminous paint is too high to apply with a brush.

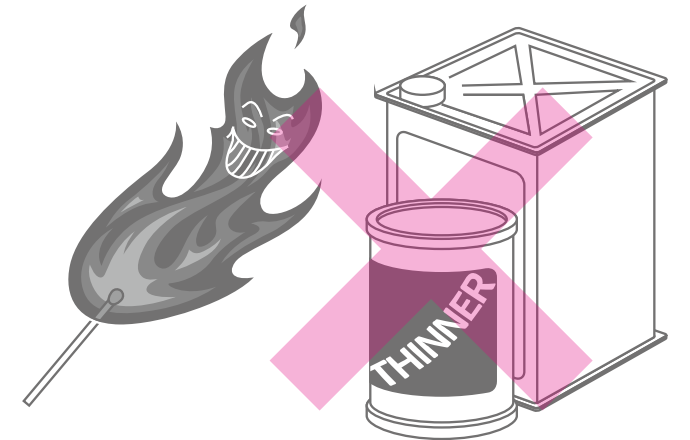


Precautions

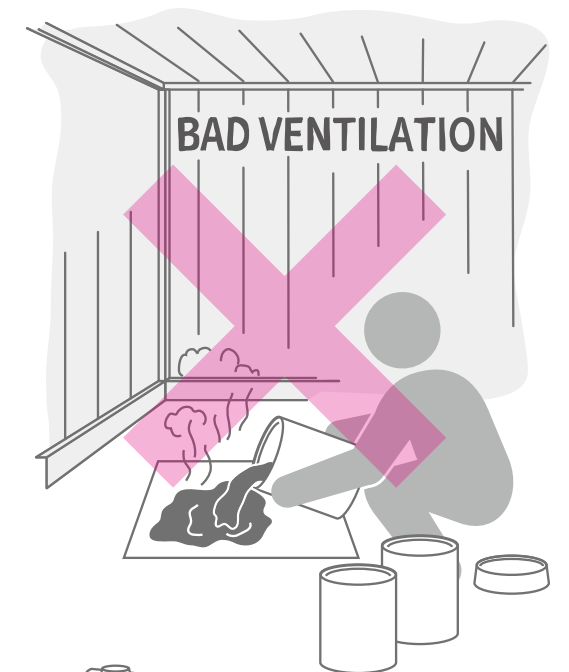
(1)**Do not apply** coating when the pipe surface is wet. The coated surface has to be completely dried before installation.



(2)**Keep away** from open flames because the coating material is inflammable.



(3)**Use** the coating material only in well ventilated areas.



(4)**Avoid** contact with the skin and eyes. If contact occurs, wash affected area immediately with soap and water.



This image shows a full page of primary-ruled paper. It features 20 horizontal rows, each consisting of three dashed lines. The top row serves as a header area, while the subsequent 19 rows are designed for student writing. The entire page is white with light gray dashed lines, and there are no margins or additional markings.