CONTENTS

■ PREFACE ................................................................. 1
■ REPAIR FLOWCHART .............................................. 2
■ CUTTING OF PIPE ..................................................... 3
■ CORRECTION OF DEFORMED SPIGOT ..................... 8
■ REPAIR OF INTERNAL LINING
  (CEMENT MORTAR LINING) .............................. 11
  □ Crack ........................................................... 13
  □ Chip ............................................................. 16
  □ Break ........................................................... 18
■ REPAIR OF INTERNAL LINING
  (FUSION BONDED EPOXY COATING) ............ 23
■ REPAIR OF EXTERNAL COATING ......................... 25
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.
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)
● 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 2)

(6) **Measure** the outside diameter in two or more different directions. (Picture 3)

*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 1)

*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 4)

(9) **Draw** white lines for jointing as per the dimensions specified in Table 2 of page 7. (Picture 5)

*Stenciled lines may be drawn also by spray painting.

(10) **Completion** of cutting work. (Picture 6)

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

<table>
<thead>
<tr>
<th>DN</th>
<th>Outside diameter</th>
<th>Allowable circumferential length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Tolerance</td>
</tr>
<tr>
<td>80</td>
<td>98</td>
<td>+1</td>
</tr>
<tr>
<td>100</td>
<td>118</td>
<td>+1</td>
</tr>
<tr>
<td>150</td>
<td>170</td>
<td>+1</td>
</tr>
<tr>
<td>200</td>
<td>222</td>
<td>+1</td>
</tr>
<tr>
<td>250</td>
<td>274</td>
<td>+1</td>
</tr>
<tr>
<td>300</td>
<td>326</td>
<td>+1</td>
</tr>
<tr>
<td>350</td>
<td>378</td>
<td>+1</td>
</tr>
<tr>
<td>400</td>
<td>429</td>
<td>+1</td>
</tr>
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<td>450</td>
<td>480</td>
<td>+1</td>
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<tr>
<td>500</td>
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<tr>
<td>600</td>
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<td>842</td>
<td>+1</td>
</tr>
<tr>
<td>900</td>
<td>945</td>
<td>+1</td>
</tr>
<tr>
<td>1000</td>
<td>1048</td>
<td>+1</td>
</tr>
<tr>
<td>1100</td>
<td>1152</td>
<td>+1</td>
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<tr>
<td>1200</td>
<td>1255</td>
<td>+1</td>
</tr>
<tr>
<td>1400</td>
<td>1462</td>
<td>+1</td>
</tr>
<tr>
<td>1500</td>
<td>1565</td>
<td>+1</td>
</tr>
<tr>
<td>1600</td>
<td>1668</td>
<td>+1</td>
</tr>
<tr>
<td>1800</td>
<td>1875</td>
<td>+1</td>
</tr>
<tr>
<td>2000</td>
<td>2082</td>
<td>+1</td>
</tr>
</tbody>
</table>

Note: Minus tolerance on outside diameter can be increased additionally 0.5 mm for DN500 and 1 mm for DN600 when the measured circumference of the pipe is within the allowable value.
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.

### Dimensions of Tapered Spigot for Push-on Joint

![Diagram of Tapered Spigot]

**Table 2**

<table>
<thead>
<tr>
<th>DN</th>
<th>Taper</th>
<th>White Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y</td>
<td>X</td>
</tr>
<tr>
<td>80</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>150</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>200</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>250</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>300</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>350</td>
<td>5</td>
<td>14</td>
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<tr>
<td>400</td>
<td>5</td>
<td>14</td>
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<tr>
<td>450</td>
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<tr>
<td>600</td>
<td>5</td>
<td>14</td>
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<td>700</td>
<td>6</td>
<td>15</td>
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<td>800</td>
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<td>900</td>
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<td>15</td>
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<td>1000</td>
<td>7.5</td>
<td>19</td>
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<tr>
<td>1100</td>
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<td>19</td>
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<tr>
<td>1200</td>
<td>7.5</td>
<td>19</td>
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<tr>
<td>1400</td>
<td>8.5</td>
<td>23</td>
</tr>
<tr>
<td>1500</td>
<td>8.5</td>
<td>23</td>
</tr>
<tr>
<td>1600</td>
<td>8.5</td>
<td>23</td>
</tr>
<tr>
<td>1800</td>
<td>9.5</td>
<td>26</td>
</tr>
<tr>
<td>2000</td>
<td>9.5</td>
<td>26</td>
</tr>
</tbody>
</table>
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)
Cement Mortar Liner

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

**Table 3  Selection of Repair Material**

<table>
<thead>
<tr>
<th>Condition of damage</th>
<th>Repair material</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack</td>
<td>Epoxy Resin (page 13-15)</td>
<td></td>
</tr>
<tr>
<td>Chip</td>
<td>Epoxy Resin (page 16-17)</td>
<td></td>
</tr>
<tr>
<td>Break</td>
<td>Epoxy Resin (page 18-19), Cement Mortar (page 20-22)</td>
<td></td>
</tr>
</tbody>
</table>

**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 5)
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.*
3. **Add** water in small amounts to the mixture and continue to mix them. (Picture 4)
4. **Keep** mixing until the mixture* becomes such that it can be formed into a lump when grasped firmly in one hand. (Picture 1)

*Use the mixture within one hour.*
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.

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.

**Abstract from BS EN 545 2010**

Tools and Equipment

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

**Table 4**

<table>
<thead>
<tr>
<th>DN (mm)</th>
<th>Maximum Crack Width and Radical Displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 300</td>
<td>0.4</td>
</tr>
<tr>
<td>350 to 600</td>
<td>0.5</td>
</tr>
<tr>
<td>700 to 1200</td>
<td>0.6</td>
</tr>
<tr>
<td>1400 to 2000</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**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 4)

2. Clean the surface of the cut-back portion with a brush etc. (Picture 3) Remove moisture from the surface.
**Repair Method**

### Crack

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

2. Inspect the finished surface. (Picture 5)

### Chip

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

   *Remove moisture from the surface.*

2. Tools and Equipment

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

3. 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 OF INTERNAL LINING
CEMENT MORTAR LINING

Repair Method

Chip

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

2. 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 3)

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**

**Tools and Equipment**

- Sandpaper (Picture ①)
- Portable disc grinder (Picture ②)
- File (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)
   *The area to be repaired shall be clean and free from sand, dust, moisture, etc.

2. **Clean** the surface of the damaged area with a brush, etc. (Picture ②)
   *Paint several times at intervals to obtain the specified dry film thickness.

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)

**Inspection**

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