Laqnican Joint
Mechanical Joints for Steel Pipe Piles and Steel Pipe Sheet Piles

KUBOTA Corporation
The Concept of Laqnican Joint

In the construction of steel pipe piles and steel pipe sheet piles, the common practice for joining these piles has been the on-site weld-joining of the piles carried onto the construction site.

In weld-joining operations, however, careful construction managements are required such as the confirmation of the skill of welding operators, securement of appropriate operating conditions and weld quality confirmation inspections by means of Radiographic Test (RT) and Ultrasonic Test (UT).

Further, because the application of steel pipe piles with larger outside diameters and heavier wall thickness tends to increase, and as a result the ratio of welding operations to total pile construction time also tends to increase, there has been a need for the development of a highly reliable, simple, low-cost pile joining system that replaces conventional weld-joining.

Laqnican joint are mechanical joints developed as a pile joining system that replaces the on-site weld-joining of steel pipe piles and steel pipe sheet piles. The trade name Laqnican comes from the Japanese word “laqni” (easily) and “can” (fitting together). The application of Laqnican joint in the on-site joining of piles offers many advantages such as securing stable quality, reducing pile construction times and mitigating joining load, which will contribute to cutting down construction costs.

Laqnican joint demonstrate a rich record of applications in the field of highways, railways, ports and harbors, rivers and electric utilities.

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Features of Laqnican Joint

1. **Higher strength than steel pipes**
   Joining with higher strength is available regardless of weather conditions and operator skills.
   (Steel pipes with Laqnican joint possess strength and deformation capacity equal or superior to those of steel pipes with no joints.)

2. **Faster Joining of Steel Pipes even with Larger Outside Diameters and Heavy Wall Thickness**
   Faster joining is achieved regardless of steel pipe sizes.
   Steel pipes with different wall thicknesses can be joined at the construction site.

3. **Simple Joining Procedures**
   Joining is achieved by just inserting joints and fastening bolt for pushing and fixing key.
   No special skills or qualifications are required.

4. **Simple Pile construction management**
   Construction management is achieved by only confirming fastening depth of bolt for pushing and fixing key using a depth gauge.
   No particular inspection devices are required for joining confirmation and construction management.

Contribution toward higher quality of on-site joints

Contribution toward the reduction of construction term

Anyone can easily join pipes

Inspection of every joint section

Load-transfer Mechanism of Laqnican Joint

**During working of compression force**
Compression force is transferred by the use of contact surface (metal touch section) perpendicular to the axial direction of box joint and pin joint.

**During working of tension force**
Tension force is transferred from the joint key channel to the other joint via the load-transfer key.

(Reference) A List of Steel Pipe Sizes Employing Laqnican Joint in Past Construction Projects

<table>
<thead>
<tr>
<th>Wall thickness of steel pipe t (mm)</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1000</th>
<th>1100</th>
<th>1200</th>
<th>1300</th>
<th>1400</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>23—30</td>
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<td>20—22</td>
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<td></td>
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<tr>
<td>17—19</td>
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<td>12—16</td>
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<td></td>
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<tr>
<td>9—11</td>
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<td></td>
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</tbody>
</table>

Symbol Application field:
- : Highway
- : Railway
- : Port and harbor
- : River
- : Energy
- : Others
Laqnican Joint are composed of a box joint, pin joint, load-transfer key, bolt for pushing and fixing key and rotation-suppression key.

The box joint has a structure in which multiple arc-shaped plates (divided in the circumferential direction) called the load-transfer key are housed in circumferential channels inside the joint, and the load-transfer key can be pushed out to the pipe center direction by rotating the bolt for pushing and fixing keys. The pin joint has a structure in which peripheral circumferential channels are cut in a position relative to the box joint channel.

Joining steel pipes with Laqnican joint is completed in the following sequence: Insert a box joint which is shop-welded with the upper steel pipe pile is inserted into a pin joint which is shop-welded with the lower steel pipe pile; Then rotate the bolt for pushing and fixing key to push out the load-transfer key housed in the box joint in order to make the load-transfer key enter into the channel of the pin joint; Finally integrate the joining members to join the pipes. Every piece of completed junctions employing Laqnican joint can easily be inspected by confirming the fastening depth of bolt for pushing and fixing key.

Further, rotation torque occurring during the pile construction can be transferred by arranging the rotation-suppression key outside the surface of the Laqnican joining members. Meanwhile, in the case of adopting Laqnican joint in Pile driving Method and Vibro-hammer Method, measures (stop ring, etc.) are provided that prevent from loosening of bolt for pushing and fixing key.

Conceptual Drawing of Laqnican Joint Structure

Step type

Flat type

Basic Flow of Joining Processes Employing Laqnican Joint

1. Positioning
2. Insertion of Laqnican Joint
3. Removal of bolt for temporary fixing key
4. Attachment of bolt for pushing and fixing key
5. Fastening of bolt for pushing and fixing key
6. Confirmation of joining (completion of inspection)
Product Specifications of Laqnican Joint

1. Material Quality of Base Steel Pipe
   The material quality of base steel pipe shall apply or conform to JIS A 5525 (steel pipe pile) and JIS A 5530 (steel pipe sheet pile).

2. Material Quality of Laqnican Joint
   The material quality of box joint and pin joint conforms to SFCM880R (chromium-molybdenum steel forged product) or POSTEN80 (high-strength steel plate). The material quality of load-transfer key conforms to SFCM980S (chromium-molybdenum steel forged product).

### Chemical Composition(%) SFCM880R, SFCM980S

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>≤0.48</td>
<td>0.15</td>
<td>0.30</td>
<td>≤0.030</td>
<td>≤0.030</td>
<td>0.90</td>
<td>1.50</td>
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<tr>
<td></td>
<td>&gt;0.48</td>
<td>~0.35</td>
<td>~0.85</td>
<td>0.15</td>
<td>~0.30</td>
<td>~1.50</td>
<td>~0.30</td>
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</tbody>
</table>

### Chemical Composition(%) POSTEN80

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤0.16</td>
<td>0.10</td>
<td>1.50</td>
<td>≤0.030</td>
<td>≤0.030</td>
<td>0.40</td>
<td>~0.80</td>
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<tr>
<td></td>
<td>&gt;0.16</td>
<td>~0.40</td>
<td>~1.00</td>
<td>0.40</td>
<td>~0.80</td>
<td>~1.00</td>
<td>~0.80</td>
</tr>
</tbody>
</table>

### Mechanical Properties

<table>
<thead>
<tr>
<th>Member</th>
<th>Kind</th>
<th>Wall thickness</th>
<th>Yield point (N/mm²)</th>
<th>Tensile strength (N/mm²)</th>
<th>Elongation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box joint</td>
<td>SFCM880R</td>
<td>Less than 50 mm</td>
<td>705</td>
<td>880~1030</td>
<td>≥13</td>
</tr>
<tr>
<td>Pin joint</td>
<td>SFCM880R</td>
<td>50 mm or more</td>
<td>675</td>
<td>880~1030</td>
<td>≥13</td>
</tr>
<tr>
<td>POSTEN80</td>
<td>Wall thickness: Less than 80 mm</td>
<td>705</td>
<td>800~1030</td>
<td>≥16</td>
<td></td>
</tr>
<tr>
<td>Load-transfer key</td>
<td>SFCM980S</td>
<td></td>
<td>≥755</td>
<td>980~1130</td>
<td>≥11</td>
</tr>
</tbody>
</table>

Available Size of Laqnican Joint

Laqnican Joint can be applied as the joints for steel pipes with sizes shown in the table below.

<table>
<thead>
<tr>
<th>Steel pipe wall thickness applied (mm)</th>
<th>SKK400 SKY400</th>
<th>SKK490 SKY490</th>
</tr>
</thead>
<tbody>
<tr>
<td><del>12</del>16<del>19</del>22<del>25</del>29~30</td>
<td><del>10</del>12<del>14</del>16<del>19</del>22~30</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steel pipe outside diameter applied (mm)</th>
<th>SKK400 SKY400</th>
<th>SKK490 SKY490</th>
</tr>
</thead>
<tbody>
<tr>
<td>~400</td>
<td>~500</td>
<td>~600</td>
</tr>
<tr>
<td>~700</td>
<td>~800</td>
<td>~900</td>
</tr>
<tr>
<td>~1000</td>
<td>~1100</td>
<td>~1200</td>
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<tr>
<td>~1300</td>
<td>~1400</td>
<td>~1500</td>
</tr>
<tr>
<td>~1600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Corresponding types of Laqnican Joint

- :Step type
- :Corresponding only to flat type
Joining Procedures for Laqnican Joint

1. Suspending upper pile
2. Positioning
3. Joining of Laqnican Joint
4. Removal of Bolt for temporary fixing key
5. Attachment and fastening of bolt for pushing and fixing key
6. Completion of attachment of all joining members
7. Inspection employing depth gauge
8. Completion of inspection of joining employing Laqnican Joint
Effects of Laqnican Joint on Joining Time Reduction

In the recent design of foundation pile structures, the application of steel pipe piles with large outside diameters and heavy wall thicknesses tends to increase. Due to the application of these piles, the ratio of welding time to total pile construction time is increasing. Because the time required for the on-site joining of steel pipe piles with Laqnican Joint is about 5 minutes per junction regardless of the outside diameter and wall thickness of the steel pipe, steel pile joining times can be reduced using Laqnican Joint, and as a result Laqnican Joint can contribute to construction cost reduction due to reduced construction term.

The table below shows examples of comparison between the Laqnican Joint method and the weld-joining method conventionally applied. In the table, the joining time using Laqnican Joint is set as the time required from attaching bolt for pushing and fixing keys to their fastening. The joining time using weld joining is as shown in the Estimation Standard for Construction Contracts of Port/Harbor Civil Works (2015).

<table>
<thead>
<tr>
<th>Comparison between Laqnican Joint and Weld Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Influence of weather condition</td>
</tr>
<tr>
<td>Main tools applied</td>
</tr>
<tr>
<td>Joining time</td>
</tr>
<tr>
<td>Site A</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Site B</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Level of difficulty in joining operation</td>
</tr>
<tr>
<td>Quality control method</td>
</tr>
<tr>
<td>Time required for quality control</td>
</tr>
</tbody>
</table>

Load-carrying Capacity and Corrosion Resistance of Laqnican Joint

- **Load-carrying Capacity of Steel Pipes with Laqnican Joint**

  The tensile, compression, bending and shear strengths and deformation capacity of steel pipes with Laqnican Joint are equal or superior to those of steel pipes with no joints.

  ![Graph showing load-carrying capacity comparison](image)

- **Corrosion Resistance of Steel Pipes with Laqnican Joint**

  - **Different metals contact specimen**
    - Average value of single pipe corrosion test
    - No peculiar corrosion due to the contact of different metals observed in the contact section.
    - Laqnican Joint possess the corrosion resistance equal to that of steel pipe.

  ![Graph showing corrosion resistance comparison](image)
Examples of Piling Methods Employing Laqnican Joint

- Pile driving Method
- Vibro-hammer Method
- Composit pile Method of Steel pipe pile and soil cement
- Rotation pressing-in pile Method
- Screwed pile Method
- Press-in Method
- Center Bored pile Method
- Hydraulic rotation Center Bored pile Method
Application Examples of Laqnican Joint

Application to port construction

Application to railway construction

Application to highway construction

Application to steel pipe sheet pile foundation

*Example using a pile driving barge

*Example of night time construction during railway tracks closing

*Example of application to platform columns

*Example of construction under the condition in which an overhead clearance is restricted.

*Cutoff performance of Laqnican Joints can be improved by the use of cutoff materials.
Various Optional Functions of Laqnican Joint

Construction instruments (example: protection of pin joints)

Rotation-Suppression key for preventing from loosening

*Example of application in Gantetsu piling method (soil cement method)

*Applied to prevent from loosening of rotation-suppression key

Nut for preventing from loosening

*Applied to prevent from loosening of bolt for pushing and fixing keys

Stop ring

*Applied to prevent from loosening of bolt for pushing and fixing keys

Removal Procedures for Laqnican Joint

1. Condition before removal
2. Removal of bolt for pushing and fixing key
3. Attachment of hexagonal socket head cap bolt to load-transfer key
4. Pulling load-transfer key to box side
5. Completion of removal

*(Note) Confirm that the load-transfer key is housed at the box side
*(Note) There is a case in which Laqnican Joint cannot be removed depending on construction conditions.
Evaluation Reports (Coastal Development Institute of Technology)

Certification organization: Coastal Development Institute of Technology
Certification date: April 28, 2004 (Renewal: April 28, 2014)
Certification No.: 08002
Name of technology: Laqnican Joint Mechanical Joints for Steel Pipe Piles and Steel Pipe Sheet Piles
Dimensional range: Pipe outside diameter= ø 400~ø 1600 mm; Pipe wall thickness= t9~t30 mm
Applicable pile Method: Vibro-Hammer Method, Pile driving Method, Bored precast pile Method (Center Bored pile Method, Composit pile Method of Steel pipe pile and soil cement, etc), Screwed pile Method, Press-in Method

Evaluation organization: Coastal Development Institute of Technology
Evaluation No.: 17003
Name of technology: Laqnican Joint (Step Type) Mechanical Joints for Steel Pipe Piles and Steel Pipe Sheet Piles
Dimensional range: Pipe outside diameter= ø 400~ø 1200 mm; Pipe wall thickness= t9~t52 mm (SKK490), t9~t29 mm (SKK400)
Applicable pile Method: Vibro-Hammer Method, Pile driving Method, Bored precast pile Method (Center Bored pile Method, Composit pile Method of Steel pipe pile and soil cement, etc), Screwed pile Method, Press-in Method