Re: FX-70® Structural Repair and Protection System for Wood Piles – Design Recommendations

To Whom It May Concern:

This letter provides information and prescriptive design recommendations for wood pile repairs using the Simpson Strong-Tie FX-70® Structural Repair and Protection System.

Successfully used for more than 40 years, the FX-70 Structural Repair and Protection System is a high-strength, water-insensitive system designed to repair and protect timber piles. The system encompasses the damaged area, providing improved performance, corrosion resistance, and protection against further deterioration. The FX-70 system is composed of a high-strength fiberglass jacket filled with epoxy and/or cementitious grout. The system has two prescribed repair solutions dependent on the extent of pile cross-sectional area loss (see page 5).

The repair system has undergone extensive cyclic testing at the Simpson Strong-Tie® Tyrell Gilb Research Laboratory in Stockton, California. Figure 1 shows the typical test set-up. Timber pile systems typically include x-bracing or batter piles. The connections of these bracing systems are usually unable to sustain large displacements. Removing them from the analysis will result in structural support primarily through cantilever column action. For this reason piles were tested as fully fixed cantilevered columns.

The prescriptive repair recommendations in this letter are based on full-scale cyclic flexural testing and apply to round piles up to 16" in diameter and square piles up to 14" in width. The test program evaluated the two repair solutions on creosote-treated Douglas fir timber piles. To simulate marine conditions, piles were damaged, then conditioned, repaired and cured in a saltwater environment. Unrepaired control specimens were also tested, both undamaged and damaged. Adhesion testing of FX-70-6 MP epoxy grout applied to treated and untreated piles, which were saltwater conditioned, indicated no loss of adhesion due to the pile treatment. Contact us or visit strongtie.com for more information on the FX-70 pile repair system.
It is common for piles in marine environments to experience damage at the waterline. When prescribing an FX-70® repair, the location of the repair on the pile is important. The repairs often occur at a location of much lower moment demand; therefore the moment capacity of the repair need not exceed the bending capacity of the pile. Figure 2 illustrates a typical lateral loading and moment response of a timber pile in a marine environment. The maximum moment (point of fixity) is located well below the ground line. Depending on soil conditions this can occur 8 to 12 feet below the ground line.

![Typical Pile Moment Diagram](image)

**Figure 2: Typical Pile Moment Diagram**

Damaged piles with cross-sectional area loss exceeding 60% were not investigated in this program and thus require a detailed investigation by the design professional. The following chart, Figure 3, is a prescriptive design tool, based on the results of the test program, intended to aid designers in properly prescribing the FX-70 Structural Repair and Protection System.
Figure 3: FX-70 Structural Repair and Protection System Prescribe Chart
**Example**

How to prescribe an FX-70® Structural Repair and Protection System for wood pile repair.

**Given:**
- Pile diameter at ground level = 14" max.
- Pile length to point of fixity = 27'
- Distance from top of pile to damage = 8'
- Estimated CROSS-SECTIONAL AREA LOSS = 20%

**Step 1)** Determine the percentage of the maximum MOMENT AT THE DAMAGE location. For cantilever columns, the relationship is linear and is based on the location of the repair compared to the maximum moment location.

\[
\frac{8'}{27'} = 30\%
\]

- **Draw a horizontal line at 30%**

It is conservative to assume the maximum moment occurs at the ground surface, if fixity location below grade is unknown.

**Step 2)** Estimate the CROSS-SECTIONAL AREA LOSS at the damage location. This example assumes a 20% CROSS-SECTIONAL AREA LOSS.

- **Draw a vertical line at 20%**

**Step 3)** The lines intersect within the shaded area on the chart and on the left side of the 25% CROSS-SECTIONAL AREA LOSS line. The recommended repair is as follows:

- FX-70 Jacket with minimum 18" extension beyond damage
- \(\frac{1}{2}\)" annulus filled with FX-70-6MP Multi-Purpose Marine Epoxy Grout

If the intersection falls below the shaded area, an alternate repair solution may be required. Contact Simpson Strong-Tie for assistance.
Figure 4: Repair Detail

Refer to the FX-70 Flier (F-R-FX7019) for complete system information.

The information in this letter is valid until 12/31/22, when it will be re-evaluated by Simpson Strong-Tie. Please visit strongtie.com for additional information. If you have questions or need further assistance regarding these design recommendations, please contact the Simpson Strong-Tie engineering department at 800.999.5099.

Sincerely,

SIMPSON STRONG-TIE COMPANY INC.