

**TECHNICAL SUMMARY**

**LOAD CAPACITY OF HOLLOWED TIMBER PILES**

Summary of Report Number 325

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**Introduction**

Louisiana currently has over 4,000 timber bridges in its inventory of over 13,800 bridges. Many of these bridges are in excess of 40 years old and are showing signs of deterioration. One of the most common forms of deterioration is core decay of timber piling, resulting in a hollow pile with a solid outer shell. This outer shell may be solid or broken up by vertical splits along the longitudinal axis of the pile. Pile deterioration may extend from a few feet up to the entire length of the pile. Bridge maintenance personnel must make judgements on a regular basis as to the remaining capacity of these hollowed/decayed piles.

The goal of this study was to develop a reliable load-rating methodology for timber piles based on the level of documented damage. A concurrent research project undertaken to evaluate the parameters effecting the strength of the solid sections of deteriorated timber piles indicated that the only reliable indicator was the compressive strength of coupons from the damaged pile. Thus, a strength predictor must be based on a procedure that measures the basic strength of the material.

**Objectives**

The objectives of this research project were to:

1. Evaluate typical field inspection data generated by DOTD during timber pile inspections.
2. Develop methodologies and procedures for quantifying damage in pile test specimens.

3. Develop procedures for quantifying basic material properties of test pile material.
4. Formulate expected pile failure patterns and modes.
5. Develop mathematical models and evaluate key parameters and properties.
6. Develop a test protocol for measuring basic material properties of pile material.
7. Conduct a series of full-size tests.
8. Conduct comparison studies for each pile tested.
9. Modify analytical procedures for predicting the remaining strength in piles.
10. Develop a recommended DOTD guide describing the application of the load prediction procedure to determine the load rating (remaining capacity of decayed piles).

**Research Approach**

The Bridge Maintenance Division of DOTD supplied approximately 30 deteriorated timber piles up to 10 ft. (3 m) in length with a representative range of hollowness and splitting (checking). Small coupons were taken from each of the piles to determine the basic material properties. The degree of damage was quantified and each pile tested in axial compression. Mathematical models were developed to predict the axial load capacity and included all significant variables as typically reported by bridge inspectors. The theoretical and experimental results were compared to verify the model. Finally, recommended procedures were developed for load rating decayed timber piles.

## Conclusions and Recommendations

This study showed that the strength of the sound wood portion of decayed piles is significantly lower than that of new piles. Thus, aging reduces the strength of timber piles exposed to a wet environment, even when the decayed portions are excluded. The failure pattern of damaged piles depended upon the degree of hollowness. Piles having void areas less than approximately 20 percent of the gross area tended to fail by crushing. Piles with larger voids tended to fail primarily by buckling of the outer solid shell.

A series of approaches were developed for predicting the remaining strength of a damaged timber pile. In terms of ascending order of accuracy, the procedures include:

1. An allowable stress approach where the pile allowable stress is assumed to be 300 psi (2,067 kPa) applied to the net area that includes only the sound material in the cross section.
2. An allowable stress approach where the pile allowable stress is statistically computed over 200 clear wood specimens as 500 psi (3,450 kPa) applied to the net area of sound material.
3. A column buckling approach based on the gross area and the effective length of the hollowed section of the damaged pile.
4. A column buckling approach based on the clear wood strength, net area and effective length in which the clear wood strength is obtained by uniformly pushing an 8d nail or similar probe radially into the pile.

The last approach will provide results most consistent with actual pile strength. However, a pile penetrometer needs to be developed in order to measure clear wood strength without taking coupons for laboratory testing. The other approaches will provide conservative, but less accurate, results.

## Implementation Status

The product of this investigation is a methodology for determining the allowable stresses for damaged timber piles. Given that the degree of hollowness is known, the load capacity of the piles can be computed by the procedures described in this report.

Consequently, the bent capacity can be computed from the aggregate pile summation.

The procedures for computing the capacity of hollowed timber piles can be immediately implemented. However, the formulas using the nail/probe approach should be considered preliminary due to the relatively small number of tests conducted with the probe. Before general adaptation, the influence of the probe size should be evaluated so that this factor can be taken into account when determining the allowable stresses.

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