RESEARCH in Progress

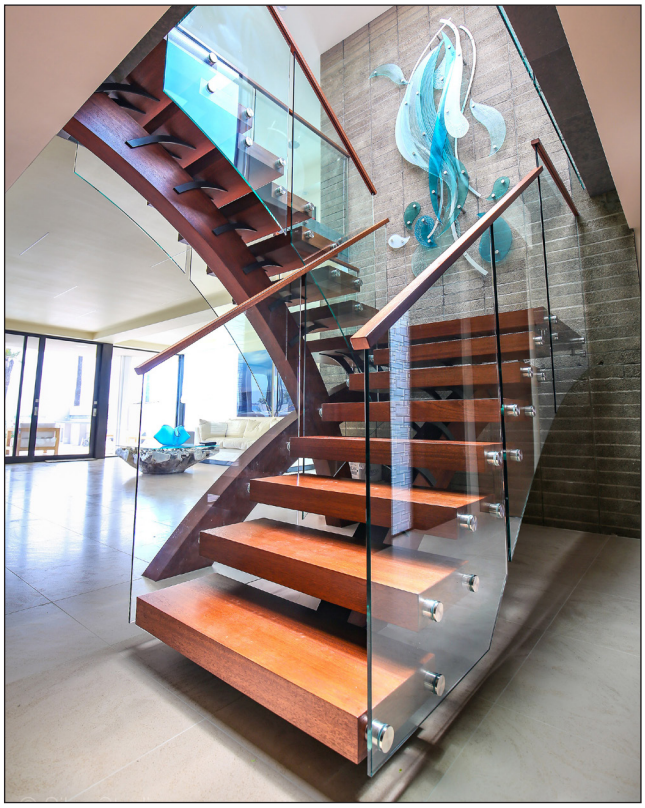
Coalition for Advanced Wood Structures
a university, industry, government partnership

Design Values for Domestic Wood Species Used in Stairway Construction

This work seeks to develop engineering design values for domestic species that are at present limited to appearance, nonstructural grading. To date, with input from project cooperator Stairbuilders and Manufacturers Association, red oak, white oak, hard maple, yellow poplar, and Southern Pine have been identified as the major species of interest. These species groups have the greatest volumetric and economic impact in stair and guard construction. These appearance-grade domestic hardwoods and Southern Pine do not have engineering design values associated with them. Similarly, lumber less than 2 in. thick also in general lacks structural design values. The opportunity to retain and increase domestic and worldwide demand for high-value U.S. lumber for structural and architectural millwork is current and pressing. U.S. building regulations are striving to enforce structural code requirements with more than an approving jump on the stairs or bump of the rail, as has often been the case for years in residential construction. Inspection officials in municipal building departments are asking for engineering calculations or testing that proves compliance with accepted standards. On large commercial projects, these analyses are routine and expected, but in typical home construction, it is a barrier to the use of many U.S. species of wood. When engineering design properties for U.S. wood species are not available, other nonwood materials, such as steel, concrete, drywall, and glass, are often substituted for hardwood stair and balustrade systems.

Background

The domestic grades and species used in stair and guard construction are largely graded for appearance.



Hybrid hardwood, glass, and steel staircase in a commercial building.

The grades and sizes of these U.S. species are not at present, in general, graded for structural design. Building codes and code officials require demonstrated or calculated minimum performance criteria for anticipated uniform and concentrated load stress and deflection. Absent the basic engineering data on the U.S. species, grades, and sizes used in stair and guard construction, these species are disadvantaged in the market, despite decades of demonstrated performance.

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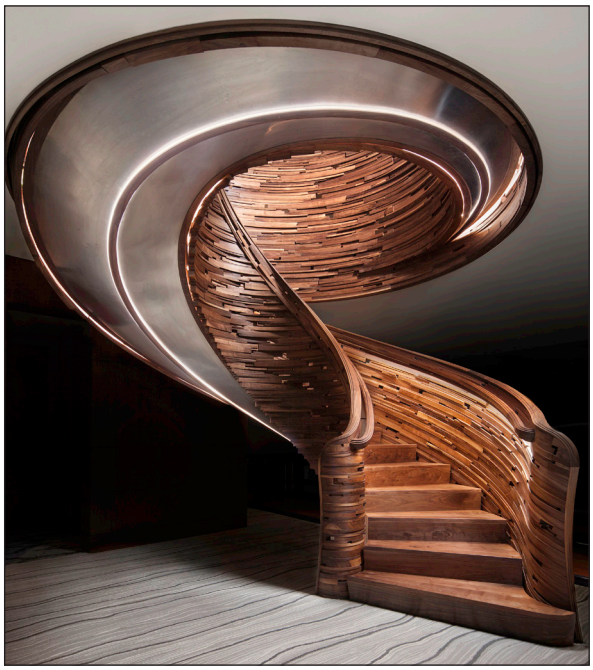

Laminated hardwood curved staircase that incorporates a large variety of species for architectural effect.

Objective

The overall objective of this research is to develop strength and stiffness design values for the most widely used domestic species in the grades and sizes that are used in stair, guard, and other structural applications. It also seeks to include graduate student education and professional training as a major developmental objective.

Approach

To meet the objectives, existing mean strength and stiffness values for small clear specimens will be input into grade, size, and statistical models to develop defensible design values. These values will then be verified with confirmatory sampling and testing. Samples will be taken from throughout the eastern United States, the primary wood basket from which these species groups draw. It is anticipated that this evaluation will include testing a sample of over 1,500 specimens from the Northeast, Upper Midwest, Southeast Mid-South, Appalachian, and Southeastern regions of the United States. The design values derived will then be made publicly available in general and to the nationwide membership of the Stairbuilders and Manufacturers Association.

Expected Outcomes

It is expected that the information derived from this study will be implemented by homebuilders and light frame contractors throughout the United States. It will allow these building professionals to maintain and increase their use of these species in domestic wood construction. It will also increase international markets, specifically structural applications, for these U.S. hardwood groups and Southern Pine. The stabilization and increase of domestic and foreign markets for these species will enhance forest health and stewardship throughout the United States on both private and public lands. It will also help promote job growth throughout the forestry and wood products supply chain, from forest landowners and manager through processing, design and engineering, and ultimately into the construction of buildings and building systems.

Timeline

The project started in April 2017. The first year will include identification of species groups, analysis of small clear strength and stiffness data, development of sample size, specimen characteristics, cutting plans for testing, testing regime, and sample collection. The second year will include confirmatory testing for mechanical properties per applicable ASTM standards. The third year will see completion of testing, analysis of data, comparison of test data to mechanical property models, and dissemination of results and analysis.

Cooperators

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