Research Projects on High-Performance Utilization of Wood for Outdoor Uses

Laboratory of Innovative Humano-Habitability, RISH, Kyoto University

Yuji Imamura

Wood has a long history of use in familiar products, and even now wood is the staple material for buildings and furniture. Recently, new applications of wood have been decks, garden furniture, house fences, play equipment, boardwalks, and signboards. Wood products are also widely used in public construction works on river and roads such as bridges, sound-insulating fence, and guard-rail. The increase in the outdoor uses of wood products arises from their warmth and amenity properties, good design characteristics and natural harmony with the surrounding scenery. The environmental friendliness of wood is due to its renewability as a natural resource, to the low energy consumption in processing, and because it is easy to recycle or dispose.

As proven by Horyuji Temple in Japan, which is the oldest wooden structure in the world, wood is almost an everlasting material. However, exterior wood, wood for outdoor uses is always exposed to weathering such as light or rainfall, and to biological deterioration by decay fungi or termites. For high-performance utilization of exterior wood products, not only structural reliability, but also durability and weathering resistance are highly required.

We are conducting the research projects on the high-performance utilization of wood for outdoor uses, which are the characterization of the wood surfaces exposed to sunshine and rainfall, the non-destructive detection of decay and insect attacks in wood, the development of maintenance system to provide the long-life to wood, and so on. Among them, two research topics are outlined in this page (1).

Phenolic Resin Treatment of Wood for Improving Weathering Properties

Phenol-formaldehyde (PF) resin treatment was applied to wood to improve weathering resistance against sunshine and rainfall for out-door use. Treatment of wood with aqueous solutions of PF resin-forming compounds gives bulked products of insoluble polymers which will not leach out in water. The molecular weight of the resin was proven to affect the biological resistance as well as dimensional stabilization in relation to the bulking of the wood cell walls, and resin with a molecular weight below 500 was evaluated to provide sufficient stability and biological control. The low molecular weight PF- resin was assumed to yield a polymer within the wood cell walls giving the greater biological resistance.

For outdoor use of wood products, weathering properties such as change of color, occurrence of surface checks, and retention of good surface characteristics are considered to be as important as dimensional stability and biological resistance. Among the factors responsible for natural weathering in wood, solar radiation is thought the most damaging, with water acting to wash away degradation products causing the surfaces to erode. PF–resin treatment improved the surface resistance of wood such as color stability, physical performance in cracking and hangnail test, and biological resistance after weathering.

Improvement of Liquid Penetration of Wood by Precompression Treatment

Impregnating wood with liquid chemicals is a common technique for enhancing various physical and biological properties, such as dimensional stabilization and decay resistance. However, it is not always easy to impregnate the liquid evenly and deeply into refractory wood specimens. Although several pretreatment processes have been developed to increase the permeability of wood, none are particularly practical or economical, except the conventional methods such as incision.

A new system for enhancing the penetration of liquid into wood using a precompression treatment was designed, and the effects of compressive deformation and recovery on liquid uptake were evaluated. Precompression with large deformation under appropriate moisture and heat conditions, with optimum press schedules effectively increased the penetration of liquid into refractory wood samples of practical sizes without producing any strength reductions. Fracture of pit membranes during compression with little damage to unpitted cell-walls was believed to improve liquid penetration with negligible compression defects.

REFERENCES

[1] Imamura, Y. (2006) Mokuzai-Kogyo-Tanshin(Rapid Report of Wood Industry-Japanese) 24(1):1-11