Preparation of Artificially Degraded Wood Samples Similar to Archaeological Waterlogged Wood.

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Some effective conservation methods for archaeological waterlogged wooden objects have been developed. However, the choice of the procedure or the extent of the treatment still is made by experience because it is difficult to obtain the detailed characteristics of waterlogged woods without destruction. If we can obtain large amounts of uniformly degraded samples, we could expect to establish a systematic procedure for waterlogged wood conservation. Because it is difficult to obtain such samples from "real" waterlogged woods, it is important to prepare an artificially degraded specimen, which is similar to the actual waterlogged wood in physical, chemical and microstructural aspects.

In order to investigate degradation process of buried archaeological wooden objects, core samples of soil, underground water and wood samples obtained from several points of Aoya-Kamijichi archaeological site were analyzed. From the results of underground water analyses, oxidation-reduction potential (ORP), dissolved oxygen (DO) and concentration of ions varied periodically through a year. ORP of soils even from the neighboring boring points were different. The soil layers that included wooden archaeological objects were subacidity and oxidative. However, as the ORP of underground water varied periodically through a year, that of the soil layers also may vary in the same manner. The woods in upper and sand layer were decayed severely. In the silt layer of high water content which oxygen is not supplied sufficiently, it is considered that woods were decayed anaerobicaly.

To understand the degradation degree of waterlogged woods, we related the physical and mechanical properties, and the chemical compositions with one another. Generally, it is known that in the initial stage of degradation, hemicelluloses prefecturally is attacked, and in this study it was proved that cellulose and lignin also are degraded considerably in further stages of degradation. An approximate linear relationship, obtained by the maximum moisture method, was observed between the reciprocals of basic specific gravities and the maximum moisture contents, although the changes in the densities of wood substances should be considered. The shrinkage resulted from collapse is increased over 300% of maximum moisture content(Figure 1). The irreversible shrinkages in the tangential directions increased with decreases of the basic specific gravities. The compressive strength parallel to grains was closely with the specific gravities.

To prepare artificially models of waterlogged wood, we degraded woods by acid, Fenton's reagent, brown-rot fungi, and soft-rot fungi, and their physical properties were compared with those of waterlogged woods reported in the previous paper. Some of the physical properties of the degraded woods: decreases in basic specific gravities, compressive strength, and hardness, and increases in shrinkages and maximum

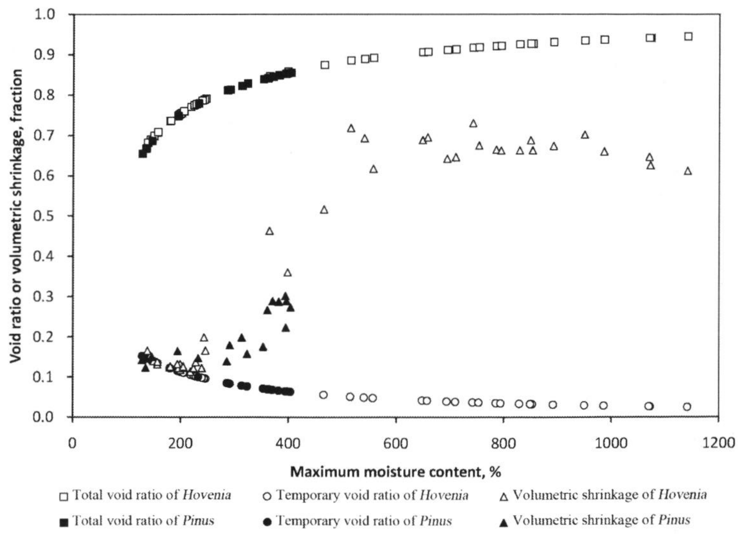

Figure 1. Changes of void ratio and volumetric shrinkage of archaeological waterlogged wood.

moisture contents, were similar to those for waterlogged woods. The basic specific gravity, shrinkage in the tangential direction, and maximum moisture content of the wood degraded by brown-rot fungi resulted in 0.132 g/cm^3, 25.6%, and 700%, respectively, the values being similar to those of the most deteriorated waterlogged wood. A linear relationship between the maximum moisture content and the reciprocal number of the basic specific gravity was observed in all artificially degraded samples, and the relationship also was applied to the waterlogged wood(Figure 2). However, it was impossible to attain the desired degradation level by the fungi treatment because the decay progressed unevenly within the specimen. Considerably polysaccharides were lost during both acid and fungi treatments similarly to waterlogged wood, but lignin probably was subjected to considerable chemical change by the former treatment.

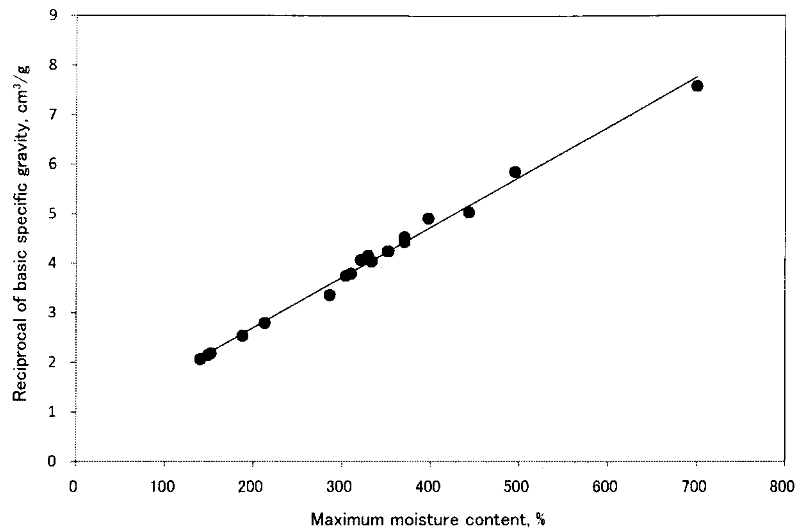

Figure 2. Relationship between maximum moisture content and reciprocal of basic specific gravity.

In the wood samples artificially degraded with Fenton's reagent, the basic specific gravity decreased to 0.171 g/cm^3, while the maximum moisture content and the shrinkage in the tangential direction increased to 495% and 16.2 %, respectively. These values were comparable to those of moderately degraded waterlogged softwood. Similar to the waterlogged wood, the density of wood substance degraded with Fenton's reagent decreased with the progress of degradation. A good relationship was found between the treated/control ratio of shrinkage and the reciprocal number of the basic specific gravity. Within the experiment, considerable lignin, as well as polysaccharides, was lost by the Fenton's reagent treatment. This tendency was similar to that of the waterlogged wood, although the degree of degradation was different. From the analysis of the neutral sugar composition of the wood treated with Fenton's reagent, it was found that cellulose was degraded to the same degree as hemicelluloses, as is the case of real waterlogged wood.

PEG impregnation method, vacuum freeze drying and alcohol xylene resin method were applied to artificially degraded woods which had similar physical properties to archaeological waterlogged wood. When wood samples degraded by acid hydrolysis and wood rot fungi were treated by vacuum freeze drying and alcohol xylene method respectively, the contents of PEG and dammar resin were different depending on the degradation treatment even in the same degradation degree.

It is cleared that absorbance of solute to wood substance should be considered from polarity and interaction of solvent with temporary void in evaluation of efficiency of conservation method.

It is difficult to apply the artificially degraded wood to consideration of conservation treatment of extremely degraded archaeological wood. It is possible to apply the artificially degraded wood to consideration of diffusion, penetration and absorbance of agent.