Résumé

New Application of Synthetic Resins for the Conservation and Restoration of Wooden Parts in Structures

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1. The historic monuments of Japan are, for the most part, wooden structures. When the expected life span of such buildings approaches its end, all structures are dismantled into single parts and a close examination is conducted piece by piece. As the first step, these parts are restored individually, according to what extent they are rotten or broken: some parts are replaced entirely by new ones, while others are partly cut off and made whole again either by binding to them some new pieces or by filling up in the missing parts with new materials. They are then reassembled to their original state. This process of replacing, albeit partially, the old materials with new ones is comparable, so to speak, with the phenomenon of metabolism observable in the animate creation. What is most essential, therefore, in the conservation and restoration of wooden monuments is to leave unreplaced as great a portion as possible of their old materials, and the challenge before us is how far we are capable of proceeding to meet this demand with our modern science and technology.

Numerous are the factors that affect the durability of wood: apart from external disasters such as fires, earthquakes, storms, floods, etc. involving a structure in its entirety, the principal causes lie in damages from weathering, as well as biodeterioration traceable to bacteria, moulds, fungi, and insects, both of which are progressive. The primary objective of conservation work has been to prevent beforehand such damages and deteriorations. At the same time it has also been our mission to carry on repair work wherever there have been perceived serious damages either in the strength of the material itself or in the exterior forms of certain parts, due to decay or undermining by microbes, insects, etc. In cases of partial damages, methods so far employed have been those of partial restoration based on wooden technics, such as joining, binding, inlaying, and so on. These methods, however, have presupposed cutting off or shaving off of the rotten or decayed parts.

In search of a headway in the application of synthetic resins to the conservation and restoration of wooden reliefs the Department of Conservation Science of our Research Institute has repeatedly conducted a series of experiments on modest scales, with some success. Recently, however, on the occasion of the conservation and restoration of the Rakan-do Hall of the Fuki-ji Temple, we have gone so far as to carry out more developed test, involving all of the precious parts making up the

entire structure. The excellent results so obtained have encouraged us to apply similar methods, with a high degree of precision and success, to the dismantling and reassembling the tea-pavilion "Jo-an", designated as a national treasure, in spite of the fact that this had been regarded as a most difficult project.

2. The component parts of the dismantled ancient Rakan-do Hall of the Fuki-ji Temple, had been kept by the late Mr. Moritatsu HOSOKAWA, in the warehouse of his residence in Tokyo. As the parts in question were seemed to be of extreme importance because of their ancient traits reminiscent of the Heian Period, which fact dated them to the XIIth Century or earlier, it was decided that all the investigations and studies, as well as scientific treatments required for a thoroughgoing conservation and restoration of the materials in question, be conducted in the ateliers of the Department of Conservation Science of our Research Institute itself.

Having been left unattended more than thirty years in the said storehouse, however, the parts in question had been reduced almost to a state of scrap wood, and in this sense they had already surpassed the limits of the traditional technics for restoration.

So far as the application of synthetic resins for the scientific treatments of rotten or broken parts of wood is concerned, experiments, though on minor scales, had been conducted on and off ever since 1964. Urgently needed now on the basis of these experiences were the selection of the most appropriate synthetic resins and the development and study of synthetic compounds, in order to attain the following objectives: 1. Reinforcement of the fragile and rotten parts; 2. filling-in of the hollowed parts; and 3. supplementary mouldings of missing parts. The standards set in this connection were that in the case of reinforcement, the ultimate strength should be found halfway between the strength of ancient wood and that of new wood, and that the specific gravity of the wood employed for filling-in and supplementary mouldings should not exceed that of new wood. It was also considered as a necessary condition for the reinforcement processes that the colour changes on the surface be confined to the minimum and that the colours and the colour tones of the supplementary wood intended for use on the surface be made to resemble as closely as possible those of ancient wood. Furthermore, with reference to wood which had already passed the half-rotten stage, the policy followed was either to remove the rotten parts and to replace them with new conglomerate of pieces of ancient wood and synthetic resin, or to rely on fiber reinforced plastics (FRP) which were so employed as to be unvisible. Namely:

1) Reinforcement of the membrane of wooden cells was accomplished either by means of application of isocyanate with a brush or of its infiltration, with particular precautions being taken against over-hardening. In order to prevent the wet colour left exposed on the surface, precautionary measures were also required such as covering the surface beforehand with some appropriate materials

or matting the surface with a view to giving it an appearance of ancient wood.

2) As a rule, as for filling up a hollowed part or moulding a missing part Araldite SV426 was to be applied.

3) Araldite SV426 is dark redish colour, so usually it is not suitable for finishing the surface of the parts comparing the original colour. So for the surface layer a compound was made of epoxy resin modified with thiokol, micro-baloon, titanium white and yellow ocher or some similar substance. After a colour adjustment, to suit the wood in question, this compound was applied in an appropriate softness and speed of hardening, and was then duly moulded. In carrying out this process, a provisional formation of a suitable armature might be helpful; or again, the compound might first be worked into a sheet and then be fastened on the part in question.

4) For a larger hollow, ancient wood, cut into pieces of appropriate sizes and forms, were combined to fill it up, along with Araldite ASV426; in so doing, minute attention had to be paid not to leave any vacant space.

5) The last stage consisted in the general adjustment, such as giving the different component parts standardised sizes and forms by means of tools, working on the surfaces to leave there impression resembling grains of wood, and so on. It was to be considered as the most desirable state that the parts, viewed at a certain distance, possessed harmony in brightness, tint, and quality, while to a closer observer the supplementary parts were more or less discernible from the original material.

6) On completion of the general conservation treatments, these component parts were provisitionally reassembled and whatever revisions needed were made.

The work in question planned for the period of 1 November, 1970 - 31 March, 1971, was completed exactly on schedule. The ancient pieces of wood formally making up the Fuki-ji Temple have been restored in the form of a one-storeyed pagoda, and has been given the name of the Rakan-do Hall of the old Fuki-ji Temple. On 21 October, 1971, was held a ceremony marking the completion of the Rakan-do Hall of the old Fuki-ji Temple, at the Horyu-ji Temple, as well as a memorial service in honour of its dedicator, the late Mr. Moritatsu HOSOKAWA.

On 28 December, 1971, the said Hall was designated as an Important Cultural Property by the law.

The tea-pavilion "Jo-an" (designated as a National Treasure) was built in 1618, in Kyoto. In 1909, it was taken over by the Mitsui Family who had it moved to Tokyo and looked after its conservation. As it was transported from Tokyo in two parts, without being dismantled, and restored at its latest site in Oiso-machi, Kanagawa Prefecture, in 1937, it was spared the havoc of air raids during the Second World War.

On the occasion of the transfer of its ownership to the Nagoya Railway Co.,

Ltd., in February, 1970, it was agreed to have the "Jo-an" moved to Inuyama City, Aichi Prefecture; the actual work of its moving was started on 10 November, 1970, as an undertaking under the direct management of the Meitetsu Real Estate Co., Ltd. In particular, our Department of Conservation Science had been entrusted with scientific investigation and research, as well as with technical guidance, in connection with its conservation and restoration.

Prior to its actual dismantlement and transportation, X-ray radiographic investigations were conducted with reference to its structure, component parts, the degree of damage by insects or decay, and the state of conservation of walls. Consequently, it was established beyond doubt that with the exception of a single wall under eaves, with a round opening, the all walls of pavilion in question had been built anew on the occasion of its transfer to Tokyo in 1909. It was, therefore, decided to leave the above-named round-windowed wall kept together as a single whole, to pull down almost all other walls, and to dismantle the wooden structure for its transportation to the new site. This decision was accordingly put into practice.

In handling the parts needing treatments, the methods adopted in treating the ancient pieces of wood for the old Fuki-ji Temple of the Horyu-ji Temple were to be followed, with some further improvements. Particular emphases were to be laid on the following parts, with higher degrees of decay: a beam of natural pine-tree log with bark, bamboo rafters and bamboo window grilles, and the single-splitted sloped cieling of Japanese cedar.

Unlike the case of the ancient pieces of wood for the Fuki-ji Temple, whose treatments were conducted in the ateliers of our Department of Conservation Science, with the entire responsibility entrusted to us, the scientific treatments of the wooden pieces from the "Jo-an" constitute a case of success of work on the spot, under the joint guidance and a cooperative setup of restorers on the spot and conservators of our institute.

The restoration work of the "Jo-an" required a higher level of precision. It was indeed an epoch-making accomplishment that all of the slender wooden parts of the tea-pavilion, once dismantled, were rendered reserviceable, and not only the bamboo rafters, bamboo window grilles, and the bamboo post of the round opening, but also the shingles broken in pieces just at the place of rafters, which seemed to pose a most difficult problem, were all restored successfully.

The treatments, based on conservation science, applied to the ancient pieces of wood for the Fuki-ji Temple and the dismantled pieces of the "Jo-an" may not be limited to the cases of dismantlement and restoration of structures: they are suggestive of new methods also in the conservation and restoration of sculptures and industrial art objects. It seems worthwhile to add that in the future a longer period will be needed for observation of the changes from year to year of the parts restored by such new methods.