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Conservation and Restoration Guidelines for the *Omo Sebua* in Bawömataluo Village, South Nias, Indonesia

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Abstract

In recent years, wooden structures have been being gradually replaced by reinforced concrete and brick buildings. Although a conservation system has been established in Indonesia, specific conservation and repair guidelines for traditional wooden buildings have not been well-regulated. This paper takes the *omo sebua* as a research subject, aims to clarify the deterioration, deformation and their causes, and to propose guidelines for its conservation.

The results of the deterioration and deformation investigation are as following: the maximum inclination of the short pillars is 5/100, and the most common inclination is 2/100. The significant sinkage of the foundation stones reaches 56 cm and the average sinkage is 20~30 cm. The maximum inclination of side pillars is 4/100, and the most common inclination is 2/100. Besides, the corruptions of the roof frame concentrate on the gable wall and termite damages can be seen in the whole building.

Basing on the investigation result, our proposals are as following: 1) conduct a dismantling restoration; 2) recycle the used materials as much as possible to maintain the authenticity of the building; 3) use new materials that are the same as the original ones; 4) rethatch the roofing by sago palm leaf; 5) conduct a structural diagnose, reinforce the structure against an earthquake; 6) include electrical equipment and disaster management in a restoration.

Keywords: conservation, repair, guideline, wooden building, *omo sebua*

1. Introduction

Indonesia is a country blessed with forest resources. Wooden buildings in Indonesia, rooted in the nature and multiple ethnic cultures, show diversified features. Even nowadays, there are abundant historical wooden buildings with unique structures and plans, which a have high cultural value and should be well protected. However, due to the durability and high expenses of timber, in recent years, wooden structures have been being replaced by reinforced concrete and brick buildings, and the number of wooden buildings, including historic ones, is constantly decreasing. On the other hand, the preservation activities conducted in Indonesia are focused on the stone structures owned by the government such as Borobudur and Prambanan. In 2010, the Law of the Republic of Indonesia Number 11 of 2010 Concerning Cultural Properties was amended, and the cultural properties owned by private sectors, including building groups and traditional villages, were included in the conservation guidelines. Although the conservation system has been established, there are not enough responsible persons nor enough experts, so that specific conservation methods for the traditional villages in the country still have not been well regulated. Traditional houses are usually being sustained by the villagers' lives.

The Bawömataluo village, taken as a special study subject in our research, is located in South Nias prefecture (Figure 1). It was registered on the World Heritage tentative list in 2009, which indicates that this village has outstanding historical and cultural values. There are 252 houses in the village, 124 of which are built by the traditional construction method. The house of the chief, which is called *omo sebua*, is built in the center of Bawömataluo village. It is the largest and most impressive extant wooden structure in south Nias (Feldman, 1977; Inoue, 1983). The o*mo sebua* stands on about 23 meters high, and rests upon massive interwoven pillars.

Some parts of this building remain the same since it was built, which makes it an especially valuable cultural heritage. However, no major restoration works have been conducted since it was completed, structural and material damages and decays can be seen in many parts, caused by earthquakes and the high-temperature and high-humidity tropical climate.

Figure 1. The location of Bawömataluo

This research clarified the structure and the damage degree of the *omo sebua*, through the filed survey investigation. We classified and sorted out the damages, and recorded them on our drawings. The purpose of our research is to discuss basic restoration methods for huge heritagewooden structures, since there are still very few restoration experiences accumulated in Indonesia.

2. Overview of Bawömataluo village and the *omo sebua*

The Bawömataluo village stands on the flat peak of a hill which is about 4 km off the coast. It is considered that the Bawömataluo village was built by the people who moved from the Orahili village, which was burnt down by the Dutch in their punitive expedition of 1863 (Feldman, 1977). The form of the village reflects the traditional social structure, centering on the chief's dwelling, and composed by villagers' houses, a men's council house, several churches and other structures (Ando, Inui, Yamashita and Inoue, 1982; Gruber and Herbig, 2006, Figure 2). There are two main streets in the village, and all the houses face the main streets. The middle part of the main streets, paved by narrow stones, is a common part, while the rectangular part, connecting the middle part and the villagers' houses, belongs to each house holder, and it is used for drying laundries and crops (Uekita et al, 2013, Figure 3). The villagers' houses are called *omo hada*, they are grouped in pairs and facing each other. Between each group of two *omo hada*, there is a common stairway which leads to a platform connecting on either side to the doors of the *omo hada*. It is possible to walk the whole length of the village by going through the side doors of each house and the platform between each group of two houses (Feldman, 1977).

The *omo sebua* consists of a substructure, main structure (living space) and roof frame (Figure 4). The substructure is made up of an interwoven pattern of longitudinal and transverse pillars, which has a proven earthquake resistance (Gruber and Herbig, 2005). Above the substructure is the living space, and side wall panels, connected by beams, stands on both sides. The roof frame is composed by heavy crossbeams and struts, which raises the roof very high. In addition, the roof is now covered by zinc, while it used to be covered by sago palm leaf.

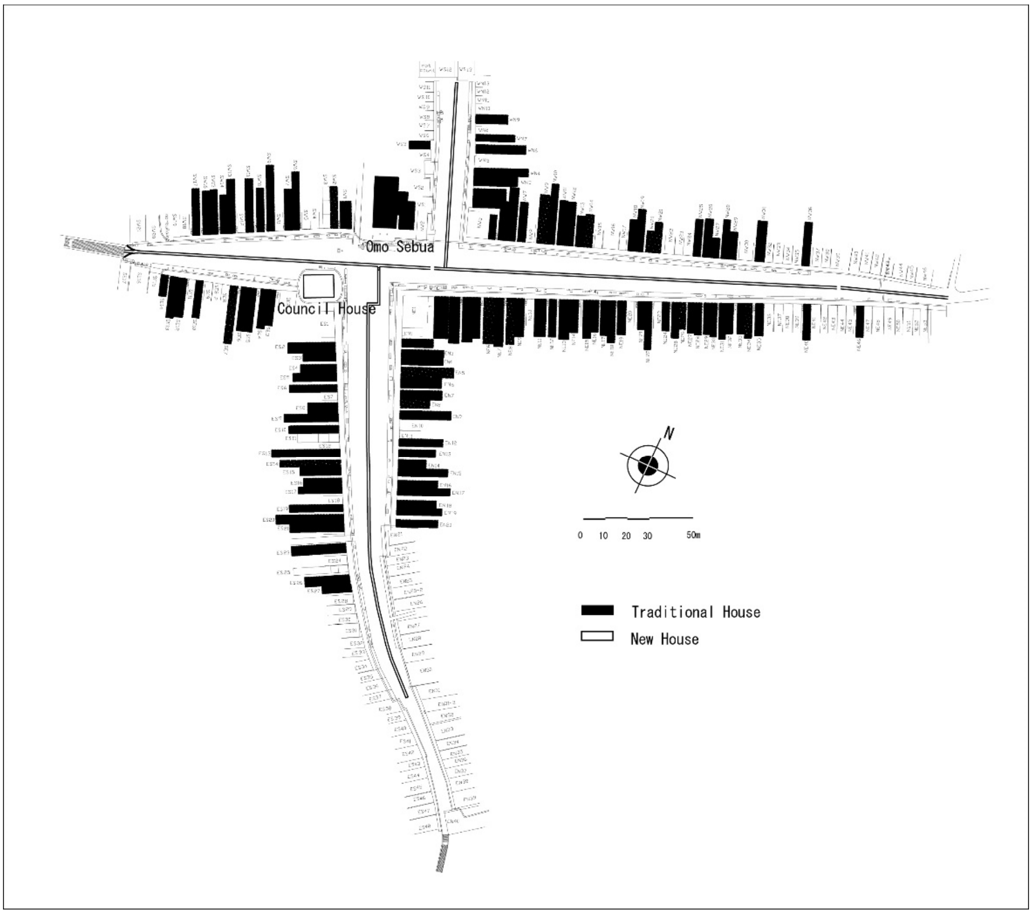

Figure 2. The plan of Bawömataluo

Figure 3. One of the main streets

Figure 4. *Omo Sebua*

On March 28, 2005, a massive earthquake occurred 90 km to the south of Sinabang at a magnitude of 8.7. Although no buildings collapsed at the Bawömataluo village, some pillars of the *omo sebua* slanted, and subsidence can be seen in several parts of the floor (S. Hanazato, T. Hanazato, Uekita, Ono, Nitto, & Oodaira, 2014).

3. Research Method

Our research team is made up of several Japanese heritage conservation experts. The field investigation is conducted based on the conservation and restoration experiences accumulated in Japan. The restoration work of wooden structures in Japan starts with an investigation of decay and damage, and it values the methods of restoring a wooden structure to its original and sound condition. As for restoring a cultural heritage, the original materials should be kept and reused as much as possible, and only the totally damaged parts should be replaced. In this way, the authenticity of a cultural heritage can be well preserved. Although the culture of wooden structures in Indonesia is somewhat different from that of Japan, it is considered that the technical skill of retaining original wooden materials and restoring a historic wooden structure to a sound condition are appropriate to the restoration of the wooden structures in Indonesia as well.

We conducted field investigation twice, in August 2011 and July 2012 respectively, and recorded the deteriorations and deformations on our drawings. Deterioration and deformation investigation mainly included decay, termite, axis inclination and uneven settlement investigations. Decay was mainly confirmed by visual inspection; the termite distribution was examined by percussion with wooden hammers; the axis inclination and uneven settlement were measured by laser beam and plummet, and the height of the short pillars and other components were measured by laser distance measurer. The corruption survey of the roof frame was conducted at the same time as an earthquake recorder was set up, and, in addition, visual inspection was carried out twice.

In order to find an appropriate method for the restoration of *omo sebua*, we extracted the architectural characteristics and understood its original construction techniques by measuring each part of the building. Besides, we also interviewed with the local residents and carpenters on the living style of this village, construction and repair method, building materials and roof coverings. Part of the interview results was reported in the annual conference of 2014 held by the Architectural Institute of Japan (Nitto, Uekita, T. Hanazato, Ono, S. Hanazato, & Oodaira, 2014).

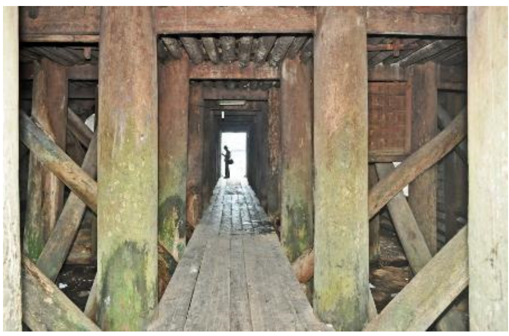

Figure 5. Substructure

Figure 6. Termite damage

4. Results: the Characteristics and Corruptions of *omo sebua*

4.1 Substructure

The substructure consists of 66 short pillars and 43 cross pillars. The short pillars are 38-68 cm in diameter and about 3.8 meter in length, and they are lined in 6 columns in the trabecular direction and 11 rows in the spanwise direction. The cross pillars arranged in a crisscross pattern are 35-67 cm in diameter and about 6.5 meter in length (Nitto, Uekita, T. Hanazato, Ono and S. Hanazato, 2012, Figure 5). Deteriorations caused by humidity can be often seen both in the short pillars and cross pillars, the number of which that need to be replaced is 20 and 13, respectively.

Termite damage in the pillars is significantly serious. Some parts have become hollow, and the surfaces of some pillars have become rutted and uneven due to the termite feeding (Figure 6). In some parts of the short pillars, the termite damage tracks extend until the floor of the main structure, which indicates that the damage has already spread to the living space. In addition, since fresh feces can still be seen around, like grains of sand, we can know that there must be termites still inhabiting inside. Among these pillars, new materials and second-hand components are included, which makes it very difficult to tell which are the original ones from the appearance.

As for the inclination and uneven settlement, the investigation results showed a quite big difference between each pillar. The maximum inclination is 5/100, and the most common inclination is about 2/100, which has already reached the dismantling restoration level (Figure 7). Especially the short pillars supporting the floor of the main structure incline seriously towards the inner side. It is said that the earthquake caused this inclination, but we believe that the wooden walls resting on the pillars are the main reason for the inclination. According to our investigation in 2011, the number of short pillars that needed to be replaced was 29 (44%), and that of cross pillars was 13 (22%, Figure 8).

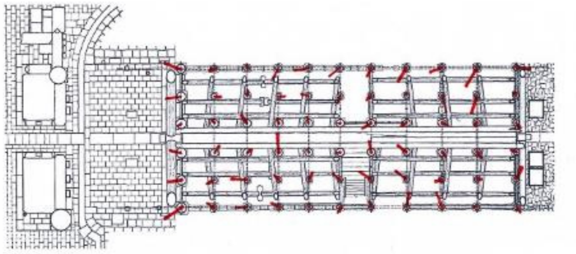

Figure 7. The inclination of the pillars (Base map from Inoue' mater thesis, 1982)

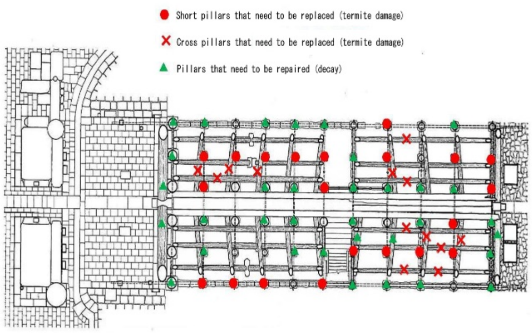

Figure 8. The situation of the substructure in 2011(Base map from Inoue' mater thesis, 1982)

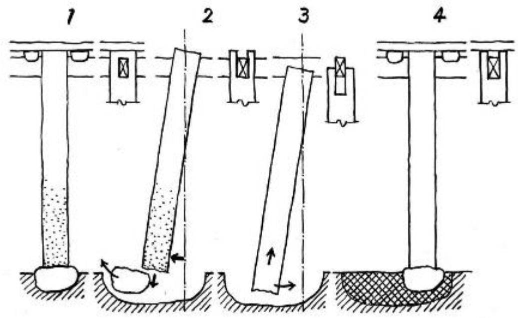

Figure 9. The traditional replacing technology

The uneven settlement of the foundation stone is also significant, the most notable sinkage depth reaches 56 cm, and the average sinkage depth is 20~30 cm. The reason for the uneven settlement, according to the interview with the local carpenters, is that the components of the substructure are pretty frequently replaced due to the termite damage. The traditional technology for replacement is to dig out a foundation stone, pull out the corrupted pillar, replace it with a totally new one, and put the foundation stone back (Figure 9). The problem with this method is that it is difficult to set up a pillar vertically, and to put back the foundation stone exactly to the same height. This is probably the reason why the measurement result showed such variability.

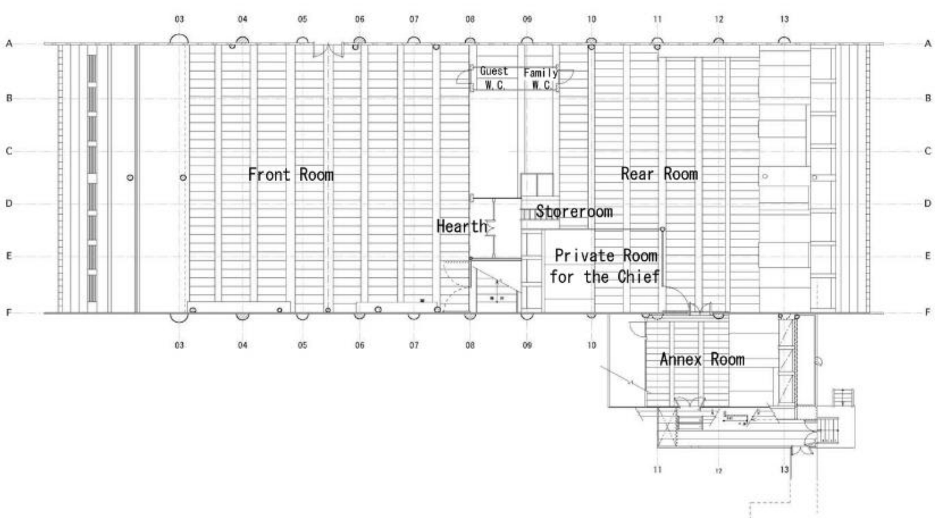

Figure 10. The plan of the second floor (1:200)

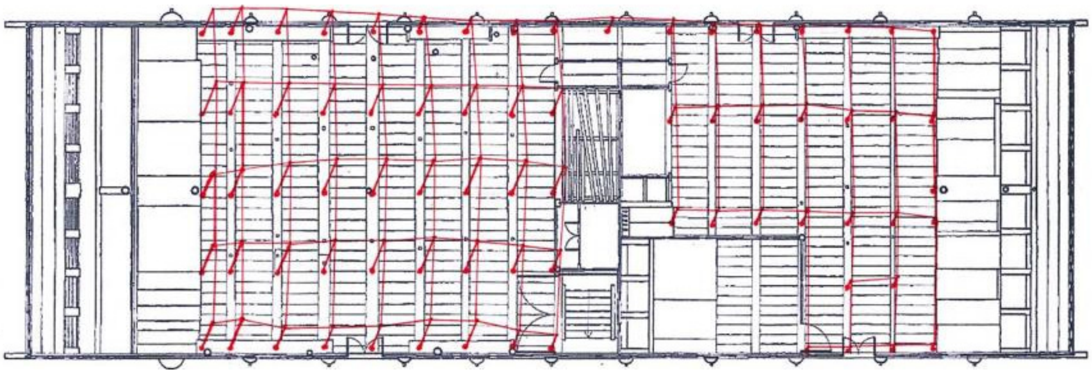

Figure 11. The uneven settlement of the second floor (Base map from Inoue' master thesis, 1982)

4.2 Main Structure

The second floor is used for daily life. The plan of the second floor is mainly composed by a front room (public) and a rear room (private, Figure 10). The front room is very spacious with no pillars. The area reaches 133 m^2. It is an open space, used for guests and visitors, and the villagers can also enter it freely. At the front, there is a large trellis window, and through the window people can see the street. The rear room is for the chief family's private life. There is a hearth and a 5 m×3 m scale private room for the chief, arranged with a staircase. In addition, there is a private room for the chief's wife, which is located on the third floor over the storeroom with a protruded window overlooking the spacious room. To the east of the rear room, there is an annex room that is 6.5 meter in the spanwise direction and 3.5 meter in the trabecular direction. The annex room connects another independent room via a vestibule. This room was built several years later than the *omo sebua*, serving as a living space of the *omo sebua.* Its structure, is composed by many thin side pillars, which are about 20 cm in diameter, standing on both sides of the second floor, supporting the walls and the roof frame. The central side pillar on each side is made of two joint woods and directly supports the ridge.

The major damages of the main structure are the inclination of the side pillars and the uneven settlement of the floor. All the side pillars inclined to the center of the spacious room. The maximum inclination is 4/100 and the minimum inclination is 2/100, whilst even the minimum one should be considered serious. The uneven settlement resulted in a bent shape of the floor with the central part of the floor is higher than the marginal part, and the marginal part seems to be falling (Figure 11). The maximum sinkage is near the eastern staircase, which has already reached 17 cm. The same situation can also be seen in the family bedroom, the sinkage of which is 10 cm. The reason for the uneven settlement of the floor is considered to be connected with the damages of the substructure, and there seems a connection between the inclination of the pillars and the uneven settlement of the floor. This causal link cannot be well understood just by visual inspection.

Termite damage has spread to the walls and all construction elements and it is extremely significant at the back of the family bedroom. Besides, termites are obviously still inhabiting the building because the damages can be seen in the recently replaced components.

4.3 Roof Frame

The roof frame is supported by the wooden walls as well as the side pillars. Twenty-four crossbeams are bridged across the tie beam with an interval of 1 meter. There are the struts standing above them. The huge roof frame consists of 9 piled up collar beam- and-strut groups, which eventually raises the ridge beam 23 meters from the ground (Figure 12). The tie beam is 7 cm in width and 53 cm in length, and it is shaped in a unique form by the dilated middle part. The collar beam is 40 cm in diameter. There are two types of struts. One type is 20 cm in width and 3 cm in thickness and the other type is 8 cm in width and 3 cm in thickness. The two types are set up alternately with an interval of 30 cm. Besides, there are round poles, 6-10 cm in diameter, used as struts and installed cross multiply in the transverse direction.

The corruptions of the roof frame concentrate on the gable wall, and they are caused by the rain penetration through the wide gable (Figure 13). Although the gable is covered by sago palm panels, the flashing is not thorough, and, easily damaged. In addition, a part of the sheet-metal roofing has been pried loose by wind, which caused the leakage and brought the corruptions. The other parts of the roof frame are relatively sound, but there is a high possibility that termite damages are occurring in the roof frame above the spacious room, because 3~4 beams have been replaced by new materials.

The roof used to be covered by sago palm leaves, thatched into panel over the rafters and laths, but now it is covered by a metal roofing panel. It is said that the roofing was changed in 1920 because the sago palm roofing is technically difficult to rethatch.

The great earthquake occurred in Sumatra caused significant damages to the roof frame and its elements. It loosened the roof frame and caused the cracks, which intensified the leakage and corruptions. Therefore, the *omo sebua* demands an urgent restoration.

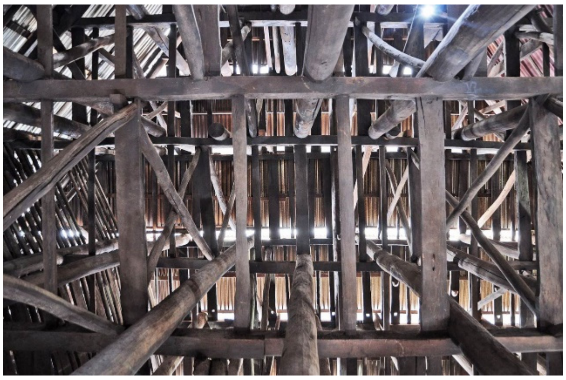

Figure 12. The roof frame

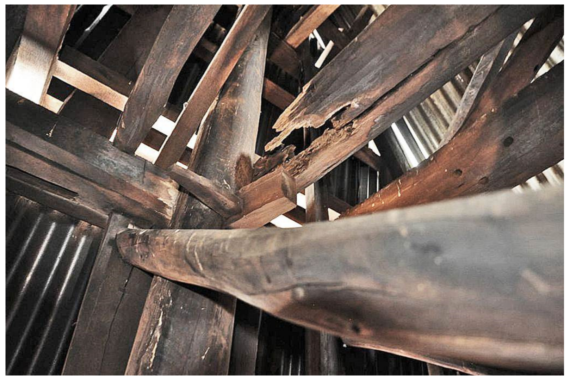

Figure 13. The corruption of the roof frame

5. Restoration guidelines for the *omo sebua*

5.1 Draw up a Restoration Guideline

As mentioned above, the *omo sebua* has shown significant age-related deteriorations and earthquake-related damages. In order to conserve the building in a good physical condition in the future, it is considered that a dismantle restoration is needed.

5.2 Points of Restoring the Omo Sebua

The unique forms and technologies of traditional buildings are still maintained in South Nias. To pass on the traditional buildings including the traditional skills to the future generation, the basic principles below must be strictly observed.

· On the occasion of dismantling the *omo sebua*, overhaul of all components, techniques and tracks should be recorded.

· If a component or roofing needs to be replaced or restored, in principle, new materials should be the same as the original. Another principle is that materials should be produced locally. If the materials are not available, they should be procured from the neighboring region.

For example, we suggest that the roofing of the *omo sebua* should be rethatched by sago palm leaf. In addition to the authenticity of the building, there is another significant reason for restoring the sago palm leaf roofing. It is that the temperature and humidity change in the roof frame doubles when it is covered by a metal panel instead of sago palm leaf. The dramatic change of temperature and humidity led to the acceleration of the decay of the roof frame (Sadaka, Uekita, T. Hanazato, Nitto, S. Hanazato, Ono and S. Hanazato, 2013; T. Hanazato, Uekita, Ono, Nitto and Oodaira, 2014), so restoring the roofing will help to restrain the decay. However, sago palm tree is not being produced anymore in South Nias because of the changes in the eating and drinking habits of the local people. Therefore, in order to get the roofing materials for the *omo sebua,* sago palm trees need to be planted.

· Recycle used materials as much as possible. Partially damaged materials can be reused by grafting or splicing.

· Restoration calls for sufficient grounded data based on a thorough investigation, which can only be conducted after getting the owner's permission.

· Conduct a structural diagnose, reinforce the structure against an earthquake if it is necessary.

· Include electrical equipment and disaster management in a restoration, such as lighting, fire alarm, hydrant, lightening protection, security, and so on.

· The effective use after it is restored should be well considered when making a restoration plan.

6. How to Recycle Used Materials

To restore a historic building, one principle is to recycle the used materials including the damaged ones as much as possible. This matches the article of respecting the authenticity that is stated in the Venice Charter. For a wooden structure, recycling old materials is the most significant principle.

Wood is a vegetal material and relatively soft. This is why wood buildings usually suffer diversified age-related damages. The damages can be generally divided into two types: natural damage and artificial damage. Insect and fungal damage, decay, breakage, crack, bend, shrink, distortion, component absence can be listed as natural damage, and defacement, burnout, reform can be listed as artificial damage. Carrying out a damage investigation and figure out the types, scope and extent of these damages are essential to understand their causes. As a practical matter, the damages are often a compound of natural damage and artificial damage.

Among these damages, the most destructive ones are termite damage and decay. Although termite damages differentiate from each other depending on the different species of the termites, the most serious damage is made by hollowing a wood structure. In this occasion, most materials have to be totally replaced by new materials. If there is an important component needed to be preserved or a bent beam that cannot be replaced, an appropriate solution is to cut the component in lengthways and bury a new material into it. After that, scientific technologies should be used to join the surfaces of the old materials again. This mending is technically difficult, so it requires a preservation specialist and an epoxy resin specialist to accomplish it together.

Decay usually occurs partially, so it is possible to take mending measures like grafting, splicing and embedding. There are cases that the decay is so serious that the elements have to be replaced by new materials, but usually old materials should be mended and reused as fully as possible.

The breakage caused by an earthquake usually occurs in the stress concentration part, therefore, it is difficult to mend. In most of the cases it is treated by replacement. There are also some attempts to reuse the damaged parts by making scientific treatment. Scientific treatment often refers to using carbon fiber or aramid fiber to restore the structure of the damaged part. Both of them require the cooperation of an architectural structure expert, a preservation expert, and a construction expert, therefore the expenses are very high.

Treatment methods for other damages are different depending on the causes, damage extent and symptoms, but many cases can be treated with grafting, splicing and embedding. A restoration technician is just like a surgeon who needs to diagnose a symptom and choose the most appropriate treatment.

Structural safety has to be well considered whether there are many old materials reused in a traditional building or not, and the building should be taken as a whole. In a seismic area, it is especially necessary to conduct a seismic diagnosis and take some major earthquake resistance measures. In this occasion, many cases can be settled with metal fittings in a place out of sight, but some cases require a steel frame which can become a large-scale reinforcement. In any case, reinforcement should make full use of the characteristics of a wooden building basing on an extensive discussion between the structure experts and restoration technicians.

7. Conclusion

Wooden buildings are a significant component of the Indonesian culture; especially those rooted in the ethnic belief show unique structures and have a high cultural value. In 2010, along with the amendment of the law of cultural properties in Indonesia, private houses and traditional villages were included in the conservation system. However, due to the insufficiency of experts, conservation and restoration methods for traditional wooden buildings have not been well discussed and regulated. Traditional houses are still being sustained by the local people's lives and repaired by the local traditional technical skills. As a matter of fact, the traditional technical skills are not appropriate for preserving the authenticity of a wooden building. In Japan, in order to preserve the authenticity of a wooden building, old materials are recycled as much as possible. By contrast, there is no tradition to mend an old material in South Nias. The damaged components are frequently replaced by totally new materials even if they are only partially damaged. Therefore, the guideline for conserving the *omo sebua* may provide a reference for other wooden buildings.

On the other hand, the shape of the traditional buildings in South Nias is very special, and the traditional techniques are quite unique. Conservation and restoration experiences accumulated in Japan are probably not totally suitable to those traditional buildings in South Nias. They must be well examined and discussed basing on a sound filed investigation. On the occasion of preserving a traditional village such as Bawömataluo, reaching a consensus among the villagers is the most significant matter.

Acknowledgments

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