

Woodblocks of Vinh Nghiem pagoda and Bo Da pagoda-

Defects on the woodblock and solutions to repair.

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1. Introduction

Woodblocks are wood panels that are carved images or printed letters. In Vietnam, the woodblock appeared from the Ly dynasty (1010-1225), this was the period of Buddhism spread widely in Vietnam, according to which the printing techniques in woodblocks was also applied development. Bac Giang province is one of the centers of the famous Kinh Bac, especially in the Tran dynasty. The existence and development of Buddhism in Bac Giang have marked many valuable legacies in this area, most notably Vinh Nghiem Pagoda (Tri Yen commune, Yen Dung district) and Bo Da Pagoda (Tien Son commune, Viet Yen district) are two of the ancient pagodas that exist until now. At the two pagodas, there are still a number of Buddhist sutras woodblocks of great value in Buddhism and the culture of writing.

The woodblock storage of Vinh Nghiem pagoda still preserves 3,050 engravings dating from the second half of the nineteenth century to the beginning of the twentieth century (Vu Duc Nghieu, 2016) and have been recognized by UNESCO as World Documentary Heritage in Asia-Pacific Area in 2012. In addition, there are 1,935 carvings in the woodblock storage of Bo Da pagoda. The woodblocks are clearly carved in time, mostly in the nineteenth century. The earliest carving was in 1775 (Vu Duc Nghieu, 2016). At two pagodas, woodblocks were carved to print sutras, books, Buddhist scriptures used as teaching materials for Buddhist monks and nuns. In addition, there are woodblocks carving images for shrine and amulets serving for religious beliefs outside of Buddhism.

Wooden material used for carving woodblocks process in two pagodas has been identified as wood of *Diospyros decandra* Lour belongs to the Thi plant (*Diospyros*), the Thi plant family (*Ebenaceae*). (Do Van Ban, Nguyen Thi Bich Ngoc and partners, 2016).

Due to the influence of time, tropical climate, humidity and other elements from the last two centuries, the woodblocks at Vinh Nghiem Pagoda and Bo Da Pagoda have been decreasing in quality and quantity. In order to contribute to the preservation and promotion of the value of this precious woodblocks, the study of technical solutions to preserve the current status of each woodblock and the conditions at the pagoda are set very high. The Forest Science Institute of Vietnam has been assigned by the Ministry of Science and Technology to carry out a research project entitled "Application of scientific and technological advances to preserve the Woodblocks Heritage of Vinh Nghiem pagoda and Bo Da pagoda in Bac Giang province", implementing time from Dec. 2014 – Jun.2017. This topic is one of the State-level independent projects under the project "Conservation and promotion of the heritage value of Woodblocks in Vinh Nghiem Pagoda and Bo Da Pagoda, Bac Giang Province".

This presentation will introduce some main results of the project:

- Assess the current status of defects on the woodblocks of Vinh Nghiem pagoda and Bo Da pagoda;
- Propose technical solutions for preserving the woodblocks of the two pagodas.

2. Research methodology

2.1. Evaluation method of the defect status on the woodblocks of Vinh Nghiem Pagoda and Bo Da pagoda:

Randomly choose woodblock samples for inspection, the number is 15% of the total woodblocks at each pagoda. The defect status of woodblocks is shown by the following specifications:

+ The defects on the woodblocks: knot, split, wrap, loss of words, damage caused by fungi and insects; Composition of species of these fungus on the woodblocks.

+ The status of inscriptions on the woodblocks;

- Method of determining defects on the woodblocks (knot, split, wrap): According to TCVN 8932: 2013, Broad-leaved sawn timber - Defects - Method of measurement.

- Method of determining the status of the inscription: count the number of lost or missing letters on the texture of the woodblocks.

- Method of determining damage level of insects and fungus for the woodblocks: Survey, measure insect traces and harmful level of fungus (phenomena and degree of discoloration, staining) on the woodblocks to evaluate the damage level of these species to each woodblock.

- Method of determining the species of fungus harmful to the woodblocks: Collect fungi samples on the woodblocks. Culture, isolate fungus in the laboratory, identify the fungal species on the woodblocks according to the classification based on morphological characteristics of the fungus classified by DNA.

2.2. Propose technical solutions to preserve the woodblocks of the two pagodas

- Suggest physical measures to preserve woodblocks, including environmental conditions for methods of woodblock preservation, woodblock arrangement and preservation at the two pagodas: arrange test, evaluate stability and defects on wooden samples when placed in different environmental conditions (moisture, temperature).

- Propose solutions for preserving woodblocks by chemicals: Assay for preservation of *Diospyros decandra* Lour preservation capacity of some preservation drugs permitted for use in Vietnam. Choose the most appropriate medicine and treatment methods.

- Suggest location, architectural model and materials for construction of new woodblock preservation storehouses at Vinh Nghiem pagoda and Bo Da pagoda: Conduct according to field survey and expert method.

3. Research and discussion results

3.1. The status of defects on the woodblocks of Vinh Nghiem Pagoda and Bo Da Pagoda

At Vinh Nghiem Pagoda, the woodblocks are stored in 04 small bookshelves in the Upper Temple. The remaining bulk of the woodblocks are stored at the 5-storeys- warehouse at the end of Ta Vu Row. The woodblock storehouse has 2 large wooden shelves including 3 floors for woodblocks, each layer is stacked in two layers. At Bo Da pagoda, the woodblock storehouse consists of 3 floors with an area of over 30 m², in horizontal houses. The woodblocks of Bo Da pagoda are listed on the top 10 wooden shelves. Shelves include 3 floors and each floor is listed a layer of woodblocks. Both of the two woodblock storehouses of the two pagodas are temporary, the architectural space is narrow and do not guarantee the necessary environmental conditions for woodblock preservation. Random survey results show that 15% of the existing woodblocks in two pagodas have been found to have many defects such as warp, split, lost letters, fungi and insect pests.

a) The woodblocks are warped in the groove and on the texture.

Of the 973 woodblocks, only 29 ones were not warped, while 944 ones were warped at different rates (up to 97%). Up to 870 woodblocks are warped in the groove and on the texture, 20 woodblocks are only warped in the groove and 54 are only warped on the texture.

Most of the woodblocks warped in the groove have a deviation in the range of 1 mm to less than 3 mm. There are 127 woodblocks of warped groove with a deviation of 3 mm or more, some samples have a deviation of up to 10 mm. Most woodblocks (810/890) of warped texture have a deviation of less than 2mm. There are 15 warped woodblocks with a deviation of 3 mm or more, the largest deviation of 6 mm.

b) The woodblocks are split.

Table 1. Classification of splits in the woodblocks and the amount of woodblocks split in different forms

Types of split on the woodblocks	In Bo Da pagoda	In Vinh Nghiem pagoda	Total
Split head	303	463	766
Split texture	9	56	65
Split edge	0	22	22
No split	66	128	194
At least one type of split	308	471	779

Of a total of 973 woodblocks, 779 woodblocks are suffered from at least one damage due to split wood. The percentage of the split woodblocks in Bo Da pagoda is 82.3%, slightly higher than that of Vinh Nghiem (78.6%). The most common occurrence on woodblocks is the splitting form the head of the woodblocks, along with the wood grain (766/973 woodblocks in both pagodas).

On the woodblocks split at the top, most of them have only 1 to 4 splits. Of the total of 766 woodblocks split at the top, 385 samples get from 1 to 2 splits and 235 woodblocks get from 3 to 4 splits. Notably, there are 19 samples of more than 8 splits, of which half (9 woodblocks) is in Bo Da pagoda. Measurement of split length at the top of the woodblocks shows a large majority (97%) of splits ranging in length from 5 mm to less than 30 mm, of which up to 46.6% of splits are lengthened from 10 mm to less than 20 mm. Measurement of split depth at the top of the woodblocks shows that the split depth is from 10 mm to less than 100 mm.

c) The phenomenon of lost characters and words on the woodblocks

The investigation results show that the inscriptions on the woodblocks are also showing signs of damage. The main damage is loss of characters, or loss of words.

Table 2. Statistics of number of the woodblocks damaged in parts of inscriptions by reasons

Location	Caused by collision	Caused by splitting	Other reasons	Total
Vinh Nghiem pagoda	281	55	0	315
Bo Da pagoda	153	6	11	164
Total	434	61	11	479

According to the data in the table above, 49.2% of the woodblocks lose their words or lose their characters in a degree that may affect the accuracy of the printing. Among the causes of damage to inscriptions, the most common is the mechanical impact that occurs when there is direct contact with the wood texture during use and storage. Natural splits only cause damage to the texture of the woodblocks, while other causes (termites, clotted ink, carving because of repairing words) cause loss of character or loss of words on 11 textures.

d) The woodblocks get damages due to organisms

Table 3. Damage levels of mold, fungus, and insects to the woodblocks at Vinh Nghiem Pagoda and Bo Da Pagoda

	Number of woodblocks	Rate %

Damage levels of mold, fungus, and insects to the woodblocks		Vinh Nghiem pagoda	Bo Da pagoda	Vinh Nghiem pagoda	Bo Da pagoda
Woodblocks damage with mold	Mold at 1 texture	103	63	17,1	16,7
	Mold at 2 textures	418	302	69,6	80,3
	No mold	80	11	13,3	3
Woodblocks damage with fungus		2	2	0,3	0,5
Woodblocks damage with insects		5	42	0,8	11,2

A survey of 977 woodblocks in Vinh Nghiem pagoda and Bo Da pagoda shows that many woodblocks are affected by molds which change color, white, black or brown and affected to the beauty. The percentage of woodblocks affected by molds in both textures is quite high. Of that the woodblocks in Bo Da pagoda have a higher degree of mold than the woodblocks in Vinh Nghiem pagoda. The level of texture changed color by molds affecting takes account for 22% of the texture woodblock area in Vinh Nghiem Pagoda, and the woodblocks in Bo Da pagoda is 39%.

The ecological and architectural conditions of the area of Bo Da pagoda affect the extent of fungal damage. Bo Da pagoda is located in the campus with shady trees, the average temperature is about 23-24oC, humidity is quite high, 75-80%. The pagoda's architecture is unique with its successive buildings, shallow drainage system, and open-air drainage along the architectural system of the pagoda. This is the characteristic that makes the humidity in sub-climate at Bo Da pagoda higher. This feature is one of the causes leading to the phenomenon of wooden structures of the pagoda as well as the woodblocks affected more by fungus.

The woodblocks are not almost affected by fungal damage. Only 4/977 of woodblocks are affected by fungal damage, accounting for 0.4%. The number of woodblocks affected by termite damage is not much, accounting for 4.8%. However, at Bo Da pagoda, the woodblocks are damaged 12 times more than the woodblocks of Vinh Nghiem Pagoda.

Compared to the survey data on woodblock status at the Vietnam National Archives Center IV, the results are similar. According to Nguyen Thi Ha and partners (2009), the percentage of woodblocks damaged at the Vietnam National Archives Center IV, is as follows: caused by white mushrooms 2.5%; brown fungus 5.7%; termite 2.5%; wood-eater 0.1%; capricorn-beetle 0.07%. However, the authors did not provide data on the rate and extent of damage of molds to woodblocks.

e) Characteristics of harmful fungus on the woodblocks

Fungus harmful to the woods are very rich in species, so studying the characteristics of the fungus harmful to woodblocks is very important, as a scientific basis for the prevention of fungus to protect the woodblocks.

From the woodblocks of Vinh Nghiem Pagoda, 95 fungal species are classified. The classification result identifies 17 species of fungi, including 14 species of mold and 3 species of fungus. The most common species are *Aspergillus versicolor* and *Paracremonium contagium* with a rate of 12.6%; followed by *Aspergillus flavipes* and *Penicillium sp.* with a prevalence rate of 11.6%; followed by *Cladosporium tenuissimum* 10.5% and *Syncyphalastrum racemosum* 9.5%. The remaining species occur only with a prevalence rate of 1 to 5%.

Molds damaging woodblocks belong to 3 branches of fungi: *Zygomycota*, *Ascomycota* and *Deuteromycota*. The molds harmful to woodblocks in Vinh Nghiem pagoda are mainly in imperfect fungus (*Deuteromycota*), of which *Aspergillus* genus is most common with 4 pests.

It is identified 3 species of fungus that are harmful to woodblocks of Vinh Nghiem pagoda: *Schizophyllum commune*, *Phomopsis sp1* and *Phomopsis sp 2* belonging to 2 branches of *Zygomycota* and *Basidiomycota*.

From the woodblocks of Bo Da pagoda, 107 fungal species are classified. There are 24 species of fungi identified, including 18 species of molds and 6 species of fungi. The most common species are *Aspergillus versicolor* and *Aspergillus flavipes* with a catch rate of 14.95%; followed by *Leptosphaeria maculans* with a catch rate of 13.08%; *Paracremonium contagium* 6.54%; both *Ceriporia lacerata* and *Aspergillus sp.* are 5.61%. The molds harmful to woodblocks of Bo Da pagoda is mainly belonging to imperfect fungus, of which *Aspergillus* genus is most common with 6 pests.

Six species of fungus destroying woodblocks in Bo Da pagoda are identified as *Zygomycota* and *Basidiomycota*.

Comparison of fungus species in the pagodas of Vinh Nghiem and Bo Da shows that the composition of the fungus species at Bo Da pagoda is richer (17 compared to 24 species in Bo Da pagoda). This may be due to higher humidity conditions in Bo Da pagoda. This result is also consistent with the assessment of the level of fungal damage in Bo Da pagoda is higher than that in Vinh Nghiem pagoda.

3.2. Propose local preservation solution for woodblocks of Vinh Nghiem pagoda and Bo Da pagoda

In order to prolong the life expectancy of the woodblock legacy and maintain the quality and quantity of woodblocks at Vinh Nghiem and Bo Da pagodas, the preservation of the woodblocks is determined that synchronous organization of precaution solutions is mainly essential. Precaution is a set of measures used to avoid natural or abnormal damage to a woodblock, creating a good environment in a warehouse, woodblock preservation area. Whereas control of light radiation and ultraviolet radiation, control of humidity, temperature, wood-destroying

organisms, dust and polluted air, fire, floods help to prevent physical and biological elements harmful to the woodblocks. Precaution also includes techniques for storing, displaying, handling, transporting and using properly and timely for the woodblocks.

a / Create a good environment for woodblock preservation

- Propose model of new warehouse to store woodblocks:

- At present, two woodblocks warehouses at the two pagodas are using available structures with narrow area, not ensuring the stability of the environment (temperature, humidity) before the large fluctuations of the environment elements in the hot and humid tropical climate of the North. This is the main cause of defects occurring to the woodblocks (split, wrap, mold etc.). Therefore, the solution to build a new suitable warehouse for preserving woodblocks should be set first.

The new woodblock storehouse at the two pagodas should have an architectural model that is suitable for each pagoda's particular architecture. The function of the warehouse is to ensure the long-term quality and quantity of the woodblocks and to meet the requirements of the exhibition, introduction of woodblocks, the formation and development of woodblocks of each pagoda to promote the value of woodblocks. From the survey results, the project has proposed the location, architectural model, and construction materials for woodblocks storehouse in each pagoda. The proposed model has inherited from the traditional architectural models and building materials in the locality, combined with modern materials to create the stable environment sub-climate in the woodblock storage; fluctuations in temperature and humidity in warehouses are slow and at low level; good ventilation; minimizing the radiation of light and UV, meeting the requirements of preserving and promoting the value of the woodblocks.

- Propose environmental specifications suitable for preserving woodblocks made of *Diospyros decandra Lour*:

Temperature of warehouse is 20 - 25oC; relative humidity is 65 - 75%; the maximum illumination shall not exceed 50 lux at the woodblock storehouse; and minimize ultraviolet radiation into the woodblocks. In this condition, the woods are stable in size and the growth of mold is restricted.

- Propose shelves, arranging woodblocks:

+ Inherit the traditional experience of using woodblock shelves made of wood with good durability, mounted high legs and isolated from the floor.

+ Woodblock racks must be made of natural wood that is treated and preserved against pests or other materials with good mechanical strength and no impact on the wood blocks. The racks must be designed to ensure height for people with average height from 1.6 to 1.7 m can manipulate the woodblocks easily and conveniently; The carriers can hold 4-5 layers depending on the woodblock size; Each floor only lists 1 woodblock line.; the last woodblocks should be 0.45 - 0.5m from the ground to limit humidity absorption from the ground so as to facilitate the control of pests and easy air circulation in the storehouse.

+ At each floor of the rack, it is necessary to design fulcrums so that when each woodblock is arranged on the rack, it will lean on the fulcrum to always stand upright and stably. Two adjacent woodblocks is far 2 - 4cm apart. Woodblocks are not close to each other to limit mechanical collision, creating airiness on the texture of the woodblocks that contributes to restrict molds damaging to woodblocks.

+ Provide enough racks for the woodblocks warehouses of each pagoda.

+ Paths in the storages should be easy, large enough for convenient care and manipulation with woodblocks.

- Equipped with equipment to control and regulate the environmental conditions in the woodblock shed:

+ Equipment measuring temperature, humidity and lighting in the warehouse environment must be installed in appropriate locations to easily track the data. Environmental data is collected daily.

+ Air conditioning equipment, dehumidifiers: Do not use often. Only in extreme cases of temperature and humidity, use the equipment. When using the equipment, close monitor temperature, humidity parameters in the warehouse to regulate in order to maintain the lowest level of fluctuation and to avoid affecting the woodblocks.

- Control and prevent pests of wood in warehouses and woodblocks:

+ Assist knowledge for the monks and the helpers in the pagodas to recognize, distinguish and have basic knowledge about insects, fungi and wood pests in general and the risk of each group for architectural heritage, especially woodblocks.

+ Decentralize the protection needs for the blocks in the pagoda grounds based on the factors: the importance of the buildings; Levels of harm, the groups of pest; Difficulties in preventing pests.

+ Based on the results of the decentralization of protection needs, the program of pest management is developed as follows:

* Periodically assess and record the presence of harmful organisms. Identify important pests that need to be treated or monitored;

* Determine the level of acceptance there without need to prevent harmful organisms;

* Identify the objects to monitor closely for early detection and implementation of preventing and eradicating measures;

*Eradicate periodic pest for critical structures and construction with pests exceeding the level required for treatment or monitoring.

* Make active proactive precaution for the buildings of special importance that are woodblocks, storehouses and woodblock display cabinets.

+ Because main pests in two pagodas are molds. Once the woodblocks have been stored in the most suitable environmental conditions that can be create but still detect mold on the wood blocks, apply the treatment and preservation solution for woodblocks by chemical medicines. The preservative medicine that is studied and evaluated most suitable for preserving Diospyros decandra Lour is KAA-Antiblu CC 55SC, a concentration of 1.2%, treated by immersion in 60s. , then dry in the room temperature and then put into in the warehouse.

b) Compile dossiers on woodblock preservation

The woodblock warehouse in Vinh Nghi pagoda and Bo Da pagoda should be thoroughly inventoried and evaluated properly as the basis for a suitable preservation plan. Woodblock records include administrative record and scientific record.

- Administrative record: Documentation of information from the administrative inventory process: Tallying, sorting and arranging woodblocks according to the set of sutras books in order, in system and scientifically for management and conservation. and use.

- Scientific record: Documentation of information:

+ Information on the status of woodblocks: wood materials; processing time; size, types of defects arising on the woodblocks: wrap, split, broken, lost words, mold, insect; ink squeeze etc.

+ Information on the history of woodblock usage: the woodblock preservation environments have been experienced; woodblock treatment process, and how to preserve and repair.

+ Information on current woodblock preservation environment: Update measurement data of temperature, humidity, light intensity and records of abnormal climatic conditions in the locality where there are woodblock shed.

c) Use and clean woodblocks

- Handle and transport woodblocks: The woodblocks are at risk of damage leading to the major damage that occurs during transportation and use. It is important to take note:

+ Take and hold with the most care. Always use both hands when handling woodblocks. Do not try to carry a lot of woodblocks at the same time, in case of being unable to hold properly, it may drop the woodblocks.

+ Ensure that the road intended to transport the woodblocks must be convenient, and free from obstructions. Always use separators, soft foam pads or other pads between the woodblocks to reduce the strong collisions.

+ Avoid the woodblocks to be exposed to many extremes of environment, climate; and direct light. Have a plan to protect the woodblocks from the risk of loss during transport.

- Woodblocks in the process of storing can not stay away from dust and dirt on the texture, preventing humidity exchange with the environment, easy to be bent, split and moldy. Therefore, it is necessary to set a regular cleaning schedule with woodblocks at least once a year.

d) Security, safety and fire prevention

- The woodblock shed and display cabinets must be equipped with an automatic fire alarm system and appropriate fire fighting equipment; anti-theft surveillance camera system.

- In order to preserve the integrity of the original woodblocks, it is necessary to copy the material into a different format, such as paper, digitization or microfilm etc. for wide access on copies that helps reduce the pressure on the woodblocks.

- The pagodas have a plan to allocate responsibility for people taking care of the woodblocks shed in the long-term stability.

e) Enhance woodblock preservation capacity

- Strengthen professional training and retraining activities for preservation of the people who are assigned to preserve woodblocks at pagodas.

- Expand cooperation and exchanging experiences on woodblock preservation with domestic and foreign organizations and individuals; further research on woodblock preservation.

4. Conclusion

The woodblocks of Vinh Nghiem and Bo Da pagodas, Bac Giang province, with great values of Buddhism, culture and history have been researched to preserve and promote values. However, the technical solutions for woodblock preservation, limiting the negative impact on the quality of woodblocks are initially conducted research. The initial results show that the quality of the woodblocks is comparatively high. On the basis of inheriting the traditional preservation experience for wood materials and modern solutions, the model of woodblock preserving shed and woodblock preservation environment suitable for each pagoda are proposed. However, due to limited research time, there are no conditions to test the technical solutions for direct preservation of woodblocks. Therefore, it is necessary to continue to study, cooperate and exchange experiences on preservation of woodblock legacy of Vinh Nghiem and Bo Da pagodas in particular and the woodblock legacy of Vietnam in general.

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