

Development and State of Research on Conservation Treatment of Underwater Cultural Heritage in Korea

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ABSTRACT

Conservation treatment of large waterlogged wooden historic ships improved gradually as historic ships were excavated one after another. After 40 years, exhibition halls and conservation treatment centers have been established and in operation in Mokpo and Taean. Taean is equipped with Asia's largest vacuum freezer and Mokpo conservation treatment place with a long history is being transformed into a new conservation treatment center. In addition, the National Research Institute of Maritime Cultural Heritage, which has Korea's only underwater cultural heritage conservation and treatment facility, has been publishing treatment reports and guidelines for many years. However, as the acidic aging was discovered on the Sinan shipwreck like the Vasa and Mary Rose, it has become an issue and various studies were conducted to identify the cause and treatment method accordingly. It is unreasonable to apply the results of test pieces in the laboratory directly to the entire Sinan shipwreck, which was restored and displayed at the exhibition hall. Therefore, it is planned to conduct a partial test gradually to find a method that can handle exhibition and treatment at the same time.

Keywords: underwater cultural heritage, conservation treatment, research status, challenges

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INTRODUCTION

This study deals with overall matters related to the conservation treatment of underwater cultural heritage (UCH) in Korea which started in 1976.

The research was partially addressed in *Conservation Treatment of Historic Ships Collected from the Sea* published by the National Research Institute of Maritime Cultural Heritage (NRIMCH) in 2021. This study intends to deal with the current state of research on conservation science of UCH in Korea in detail from more various perspectives. In addition, this study intends to highlight the current research projects and future tasks.

We will examine the process of development before touching upon the current state of conservation science of UCH in Korea.

DEVELOPMENT OF CONSERVATION TREATMENT OF UNDERWATER CULTURAL HERITAGE IN KOREA

Conservation treatment of UCH in Korea began with the excavation of the Sinan shipwreck in 1976. However, excavation of the Sinan shipwreck which started in the sea, a special environment, presented many challenges from the beginning. There was no infrastructure to speak of such as professionals, budget and treatment facility and there was a big problem of how to treat super-large wooden historic ships. At that time conservation treatment technology of Japan was more advanced than that of Korea but the conservation treatment technology for wooden historic ships in East Asia was not comparable to that of Europe. Accordingly, Korea started direct exchanges with museums in many parts of Europe including Switzerland, Germany, Denmark, Sweden and the UK in order to learn Europe's historic ship conservation treatment method and restoration technology in 1983. Korea dispatched domestic experts to international courses for wooden cultural heritage conservation sponsored by UNESCO and ICCROM and started forming academic exchanges. Thanks to this, the current state of wooden

historic ships in Europe and various treatment methods became widely known in Korea. In the 1990s, the waterlogged wooden conservation treatment area took its root firmly in Korea's cultural heritage conservation science.

In addition, PEG-2 step treatment method was applied to the Sinan shipwreck through joint basic experiment and research conducted together with the German Maritime Museum. PEG-2 step is a method of impregnating a low-molecular PEG400 solution at a low concentration, and then heating the high-molecular solid PEG4000 at 40-45 °C and impregnating it to a high concentration (Kim Ik-joo 2004, 68-69). This method still works for submerged shipwrecks.

Table 1. State of conservation treatment of historic ships recovered from underwater (as of May 2023)

No.	Name	Size (length x width (m)) / No. of pieces	Treatment method	Date of treatment period	Treatment status	Location
1	Sinan shipwreck	34 x 11 / 1, 729 pieces	PEG 2-Step method (400/4000)	1981-2004	Exhibition	Mokpo Museum
2	Wando shipwreck	9 x 3.5 / 1, 81 pieces		1984-1998	Exhibition	Mokpo Museum
3	Dalido shipwreck	10.5 x 2.7 / 1, 33 pieces		Jul. 1995- Dec. 2009	Exhibition	Mokpo Museum
4	Sipyidongpado shipwreck	7 x 2.5 / 1, 14 pieces		2004-2016	Exhibition	Mokpo Museum
5	Jindo shipwreck	16.8 x 2.3 / 1, 2 pieces		Jun. 1992-present	Dried	Mokpo Conservation Center
6	Anjwado shipwreck	14.7 x 4.5 / 1, 39 pieces		Aug. 2005-present	Dried	Mokpo Conservation Center
7	Daebudo shipwreck	6.6 x 1.4 / 1, 7 pieces		Dec. 2006-present	Dried	Mokpo Conservation Center
8	Taeon shipwreck	8.2 x 1.5 / 1, 7 pieces		May 2008-present	Reinforced (70%)	Taeon Conservation Center
9	Mado shipwreck no. 1	10.8 x 3.7 / 1, 40 pieces		Oct. 2009-present	Reinforced (70%)	Taeon Conservation Center
10	Mado shipwreck no. 2	12.8 x 5 / 1, 41 pieces	-	Oct. 2010-present	Desalinated	Taeon Conservation Center
11	Mado shipwreck no. 3	12 x 8 / 1, 21 pieces	-	-	Conserved on site	-
12	Yeongheungdo shipwreck	6 x 1.5 / 1, 3 pieces	-	Jul. 2013-present	Desalinated	Mokpo Conservation Center
13	Mado shipwreck no. 4	12 x 5 / 1, 22 pieces	-	-	Conserved on site	-
14	Daebudo shipwreck no. 2	9.2 x 2.9 / 1, 50 pieces	-	Jul. 2015-present	Desalinated	Mokpo Conservation Center
15	Jebudo shipwreck no. 1	9.2 x 2.9	-	-	Conserved on site	-
16	Jebudo shipwreck no. 2	9.2 x 2.9	-	-	Conserved on site	-

The Sinan shipwreck was unveiled in 2004 after 18 years of conservation treatment and 10 years of hull restoration.

After excavation of Sinan shipwreck, historic ships were discovered one after another in the West Sea of Korea, including Wando shipwreck (1984), Jindo Pyokpari Tongnamu Pae (1992), Dalido shipwreck (1995), Sipyidongpado shipwreck (2004), Anjwado shipwreck (2005), Daebudo shipwreck (2006), Taeon shipwreck (2008), Mado shipwreck no. 1 (2009), Mado shipwreck no. 2 (2010), Mado shipwreck no. 3 (2011), Yeongheungdo shipwreck (2013), Mado shipwreck no. 4 (2014), Daebudo shipwreck no. 2 (2015), Jebudo shipwreck no. 1 (2016) and Jebudo shipwreck no. 2 (2016). Table 1 summarizes where these ships have been treated for conservation or in the process of conservation treatment, while some are conserved on site.

As historic ships have been excavated continuously, Korea's underwater archeology and conservation treatment technology of historic ships have grown remarkably. The conservation treatment infrastructure, organization and budget have become one of the top in Asia.

The NRMCH, which started in Mokpo Conservation Center in 1982, is now operating museums in Mokpo (Jeollanam-do) and Taeon (Chungcheongnam-do) respectively and has its own conservation treatment facility. Mokpo conservation center, which started with two employees about 42 years ago, has now ten employees in Mokpo and five in Taeon. Taeon conservation center has installed and run test operation of Asia's largest vacuum freezer.

CURRENT STATE OF CONSERVATION SCIENCE FOR UCH IN KOREA

Cultural heritage excavated from water is very diverse in materials such as metal, ceramics, wood, and stone. Various kinds of artifacts are excavated from ships as ships are a carrier of transport goods, which contains living space on the ship. Therefore, conservation methods should be applied differently depending on materials.

Korea has already prepared guidelines on conservation treatment by material with dividing artifacts into those excavated from land and those from underwater and has treated them by referring to these guidelines.

Recovered Artifacts so far are mainly made of wood (hull components, etc.) and ceramics (transport goods), so the proportion of conservation treatment for historic ships and ceramics is high.

Out of 50,762 artifacts excavated, 47,036 pieces are ceramics, accounting for more than 93 per cent. In addition, all five pieces which are nationally designated cultural property and in possession are ceramics.

Natural scientific analysis of ceramics excavated from the sea began in earnest in the early 2000s. Depending on the excavation site and function, various analyzes have been conducted, such as the base soil, firing temperature, minor components, and estimation of the production site. Starting from this year, research is being conducted to scientifically reveal the relationship between the production and the consumption areas, and the correlation between the times and materials based on the existing research results.

Table 2. List of publications on conservation of UCH

No.	Title	Date	Major content	Cover
1	Guideline on Conservation Treatment of Artifacts Excavated from Underwater	2013	A guideline on conservation treatment of artifacts excavated from underwater including treatment cases.	
2	Conservation Manual of Maritime Archaeological Objects in Korea	2014	English version of the guideline on conservation treatment of artifacts excavated from underwater, introducing how to treat wooden artifacts, ceramics and metal artifacts.	
3	Conservation Treatment of Ceramics Excavated from Underwater	2020	Classifying pottery which was excavated the largest in volume into pottery, celadon and white porcelain and reporting treatment methods and cases.	
4	Conservation Treatment of historic Ships Excavated from Underwater	2021	Containing the process of conservation treatment for Sinan shipwreck, Wando shipwreck, Jindo shipwreck, Dalido shipwreck and Sipyidongpado shipwreck and natural scientific analysis details.	
5	Comprehensive Report on Sinan Ship Conservation Project	2022	Summarizing the research on analysis on aging of Sinan shipwreck and conservation treatment method comprehensively.	

ISSUES REGARDING CONSERVATION SCIENCE OF UCH IN KOREA

Korea's historic ship conservation treatment can be divided into two fields. First, conservation treatment of waterlogged wood using PEG and infrastructure. Second, neutralization treatment of acidic aging that occurs in historic ships treated with PEG.

First, the conservation of waterlogged wood with PEG is to treat the wood using PEG-2 step method as mentioned earlier. Reinforcement treatment is done with PEG 400-PEG 4000 and not vacuum lyophilization but control drying is done for conservation. Taean conservation treatment room is equipped with the latest vacuum lyophilizer that can treat 10 m. The Mokpo Conservation Center needs facility replacement as it was established in 1981.

Conservation treatment of waterlogged wood using PEG and infrastructure

The hull varies in length from about 2 m to 10 m for each member and a specially designed tank is required for reinforcement treatment. The tank should be made of stainless steel with strong corrosion resistance, and a heat source (boiler hot water and electric coil) and temperature sensor should be attached to maintain a constant temperature. In addition, in order to mix the high molecular weight

PEG well, a solution circulation pump facility that can exchange the upper and lower solutions is required. Moreover, boiler, expansion tank, and hot water pipe facilities should be in place in the boiler room upon heating treatment using boiler hot water.

Assuming that the hull members are 5-6 m long, 0.1 m thick, and 0.5 m wide, the weight usually reaches 300 kg. Hoists, cranes, and lifts that can lift and move these members safely and easily are essential. Therefore, in order to conserve and treat large-sized timbers such as hulls, a large-scale processing facility should be established.

The NRMCH started seismic construction of PEG reinforcement treatment in 2022, and planned PEG reinforcement treatment internal construction (water drainage, piping, electricity, etc.) and tank (10 m x 1 m x 1 m * 1 unit, 6 m x 1 m x 1 m * 6 units), desalination treatment room improvement in 2025 and drying treatment room improvement in 2026.

Acidic aging of historic ships treated with PEG

Acidic aging is caused by the presence of iron compounds in wood and prolonged exposure, and the same phenomenon has already appeared in foreign ships such as Vasa, Mary Rose, and Batavia, and efforts have been made to solve this problem.

The Sinan shipwreck experienced acidic aging since 2010 and various methods were tried inside and outside the laboratory to solve the problem. Constant temperature and humidity monitoring has been conducted to secure raw data and the aging condition of the hull has been recorded with 3D scanning using 3D digital methods. After that, surface contaminants were removed through dry cleaning, and a deterioration map was also prepared to compare changes in surface conditions. Integrated Pest Management is being implemented to prevent harmful organisms in exhibition halls and storage areas and to establish a stable conservation environment. Various acidic aging treatment experiments were conducted in the laboratory and the *Comprehensive Report on Sinan Ship Conservation Project* that contains the results of experiments was recently released. This experiment is the result of the experiment on a test piece carried out in the laboratory, but it is difficult to practically apply chemical treatment to the 924 m² exhibition room. Therefore, the Heritage Science Team of the NRMCH plans to expand the treatment area in the future, starting with a direct spot test on the Sinan shipwreck, which was exhibited from this year. Our future task will be how to open the exhibition site to the audience safely as the conservation treatment is underway in the exhibition hall.

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