

Investigation of Natural Lacquer Sap Based Glue

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Lacquer glue used in the repair of lacquerware and ceramics has shown uniformly good results. This is due to lacquer sap's characteristics of water resistance strength, and durability. In the present investigation, the breaking point of a mixed lacquer sap-rice paste glue, used on cypress wood, was found to be 76.3 kgf/cm², with an effective strength of 82.9 % based on standard. A lacquer sap-standard animal glue mixture had a breaking point of 84.3 kgf/cm² with an effective strength of 91.7 %. Finally, investigation of use of such a lacquer sap based glue on ceramics, using a 24 hour, 150 °C curing cycle, showed a breaking point of 49.6 kgf/cm². Considering the nature of use for ceramic products, such a lacquer sap based glue and curing schedule was found to be an acceptable application.

1. PREFACE

Lacquer sap (urushi) glue has increasingly been used with good results in the repair of lacquer and pottery or ceramic goods. This is due to lacquer's characteristics of water resistance, durability and strength. However, very little is known about the nature of such lacquer sap based glue or its properties. In this paper, results of strength tests on new lacquer glue in applications using Aomori Hiba and ceramic material are reported.

2. EXPERIMENTAL METHOD

2.1 Test Materials

Tests were conducted on two materials, Aomori Hiba wood and a ceramic material. The Aomori Hiba pieces (10% water, specific gravity 0.45) had dimensions of 350x20x10 mm. The ceramic pieces (INAX FC-1/43 R2 Hiuro Tile; 108x59x13 mm) were cut on the long axis into two pieces 54x59x13 mm each. Glued surfaces were sanded (100#paper;

standard belt sander), the glued space was 40x50 mm, and the glue amounts were 0.5 g (0.025g/cm²).

2.2 Test Glues

Four glues were tested, a standard glue, a glutinous rice base glue, a standard glue + lacquer sap mixture and a glutinous rice base glue + lacquer sap mixture. In the glutinous rice base + lacquer glue mixture, glutinous rice paste was mixed with lacquer sap at a 2 : 8 mixture ratio. The standard glue + lacquer sap glue mixture was made by mixing 15-80 µm powdered glue with raw lacquer in a 1 : 9 mixture ratio at temperature of less than 50 °C.

2.3 Drying Conditions

For the wood materials glued with standard glues, pieces were stored for 20 days at constant 60% humidity and 20 °C temperature with a press pressure of 6 kgf/cm². For lacquer glued pieces, after initial storage for 24 hours with 8 kgf/cm² pressure, pieces were left in an ordinary workroom for periods of from 2-8 weeks. The glued ceramic pieces were heated at

Table 1 Comparison of strength test results for different glues.

Shear Press Strength / Glue type	standard glue	standard glue + lacquer glue	glutinous rice base glue	glutinous base + lacquer glue	Hiba board (standard)
maximum strength (kgf/cm ²)	111.7	104.2	82.5	86.7	99.2
minimum strength (kgf/cm ²)	80.0	53.3	50.0	65.0	74.2
average strength (kgf/cm ²)	97.9	84.3	69.6	76.3	92.0
percent of standard (%)	106.4	91.7	75.7	82.9	100.0

approximately 150 °C for 24 hours.

2.4 Compression Shear Tests

Compression shear tests were conducted using a JIS K6852 Olsen All Purpose Test Machine, with a 150 kgf/cm² per minute load weight at normal temperature.

3. RESULTS AND DISCUSSION

3.1 Wood Materials

In the case of the wood materials, results are separated by glue types, specifically, the standard glue and the standard glue + lacquer sap mixture, followed by the glutinous rice base glue, and the glutinous rice base glue + lacquer sap mixture, as in Table 1 and Figure 1. Data for an unglued piece of Hiba as standard is provided for comparison.

The strength of the glutinous glue averaged 69.6 kgf/cm², and thus cannot be considered particularly strong. The standard glue had an average strength of 97.9 kgf/cm², stronger than that of the test piece standard. However, given that both glutinous and standard glues have low moisture resistance, these

glues are inappropriate for consideration in the repair and preservation of lacquerware and pottery.

The glutinous + lacquer sap glue mixture had a relatively high average strength of 76.3 kgf/cm²; furthermore, this glue has the water resistant capabilities characteristic of lacquer. Thus, in terms of being as strong as the original glue, as well as having long durability, such a glue fulfills the criteria.

The standard glue + lacquer sap mixture averaged strength results less than non-glutinous base glue alone. However, given the water resistance and long durability characteristics of such glue, together with the strength results as a percent of standard (91.7%), this glue is appropriate for use not only with Aomori Hiba and other wood products, but also for such recently developed porous materials as wood ceramics.

The results of shear pressure strength over time was measured for the standard glue + lacquer sap mixture, as shown in Table 2 and Figure 2. Following a curing period of two weeks, the shear pressure strength result ranged from 8.3-44.6 kgf/cm², for a four week curing period from 45.9 - 87.5 kgf/cm², for a six week period from 82.5 - 90.8 kgf/cm², and for an eight week curing period from 84.2 - 91.7 kgf/cm². With increasing

Table 2 Standard glue + lacquer sap mixture strength variation with curing time.

Shear Press Strength	No. of weeks				Hiba board (standard)
	two weeks	four weeks	six weeks	eight weeks	
maximum strength (kgf/cm ²)	44.6	87.5	90.8	91.7	99.2
minimum strength (kgf/cm ²)	8.3	45.9	82.5	84.2	74.2
average strength (kgf/cm ²)	24.3	60.5	86.1	89.0	92.0
percent of standard (%)	26.4	65.8	93.6	96.7	100.0

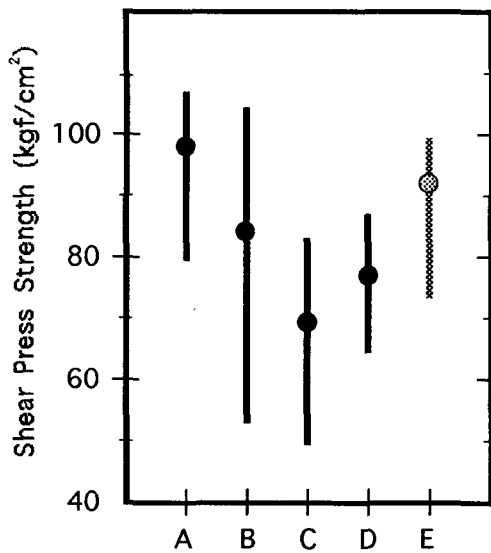


Figure 1 Strength results for various glues as compared to aomori hiba.

- A: standard glue,**
- B: standard glue + lacquer glue,**
- C: glutinous rice base glue,**
- D: glutinous base + lacquer glue,**
- E: Hiba board(standard).**

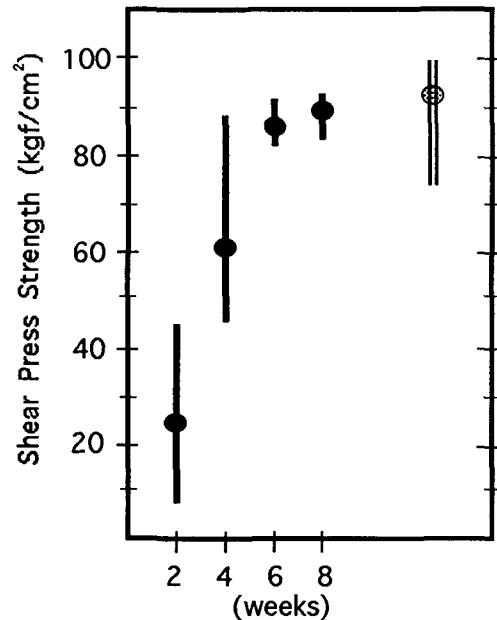


Figure 2 Strength results for standard glue + lacquer sap mixture with various cure time.

- curing weeks,
- == Hiba board(standard).

curing time the variability of the results decreased, reaching uniformity at six weeks. This is the point at which the lacquer enzyme has sufficiently reacted, thus stabilizing the lacquer oxidation reaction.

3.2 Ceramics

Perhaps the most important quality of lacquer glue is resistance to both water and heat. In the case of lacquer sap hardening, the combinative reaction of the lacquer enzyme is best facilitated at conditions of 80% humidity and a temperature of 20 °C. However, under these conditions, this hardening process takes considerable time, constituting a significant drawback to the use of lacquer glue.

Ceramics possess a heat resistant characteristic and are thus can be cured at temperatures of up to 150 °C. Although a 24 hour curing time does not allow the lacquer membrane to harden completely, with an average strength of 49.6 kgf/cm² (see Figure 3), such a glue, cured under these conditions is sufficient for use in pottery crafts.

4. CLOSING

Fluid lacquer sap glue has been shown to have strength characteristics suitable for applications in wood and pottery products. With increased curing times, the glue strength increases, which together with water resistance and durability characteristics, makes such glue superior to wood itself. In addition, considering materials with increased durability as compared to wood, in this paper, the test case of ceramics was included.

Lacquer sap has long been used in the repair of pottery objects. However, one drawback has been the time required for hardening of the glue. Given the

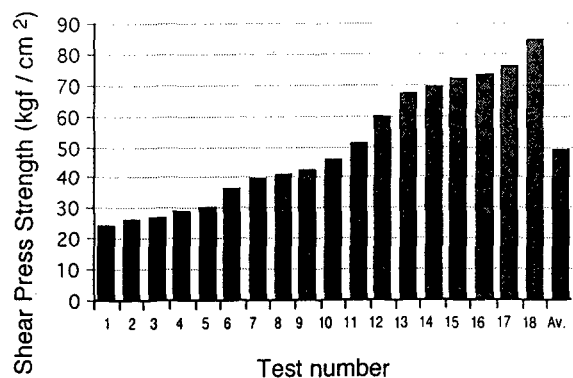


Figure 3 Strength results for standard glue + natural lacque sap glue mixture for ceramics.

appealing characteristics of water and heat resistance, using a heated hardening technique, the length of curing can be shortened, and this issue addressed. However, from the standpoint of glue strength, further study is necessary before application of this glue throughout various craftware industries is undertaken.

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