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**IMPACT OF VILLAGE TREE SPECIES ON PHYSICAL AND MECHANICAL PROPERTIES OF HARDBOARD IN KHULNA HARDBOARD MILLS LTD., BANGLADESH**

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**Abstract:** The conventional raw materials of Khulna Hardboard Mills Ltd. (KHML) has been only *sundri* (*Heritiera fomes*). Due to recent shortfall in raw material supply from the Sundarbans, KHML is now using several village tree species in mixture with *sundri*. The study was undertaken to assess the changes in physical and mechanical properties of hardboard produced from the mill owing to introduction of some village tree species. The samples were collected and tested for modulus of rupture (MOR) and changes in thickness and weight after immersion in water. Weight and thickness changes of the samples were found significantly higher than that for *sundri* and US Standard class-1 Hardboard Specifications. A significant correlation was found between weight and thickness changes. The MOR values were found significantly lower than that of *sundri* and but significantly higher than that of US standard class-1 Hardboard Specifications (minimum) value which indicates that the strength properties of the boards produced from mixed species is satisfactory with respect to US standard but unsatisfactory with respect to *sundri*.

**Keywords:** Village tree; Wood-physics; Wood-mechanics; Hardboard, Wood Technology

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## Introduction

Initially, the Khulna Hardboard Mills Ltd. (KHML), Khulna, Bangladesh, an enterprise of Bangladesh Chemical Industries Corporation, was designed to utilize *H. fomes* particularly the dead, dying, diseased, malformed trees, lops and tops and thinning products of *sundri* collected from the Sundarbans Mangrove Forest. Currently owing to shortage of *H. fomes*, it is using a composition of raw materials such as 30-40% *H. fomes*, 5% bagasse and 60- 65% village wood including *Bombax ceiba*, *Albizia saman*, *Ficus hispida*, *Anthocephalus chinensis*, *Mangifera indica*, *F. benghalensis* etc., (KHML record, 1998). Here thermo-mechanical process is followed for pulping and hot press method for board preparation (KHML record, 1998).

The physical and mechanical properties of hardboard vary greatly depending on the raw materials, chemical pre-treatments, tempering agents, process of manufacturing, temperature and pressure used and time taken for manufacturing and curing (Ota and Kawabe, 1976; Hawake, *et al.*, 1992 and 1993; Youngquist *et al.*, 1994; Khan and Shafi, 1988). Shafi and Khan (1995) studied the suitability of nine village tree species for hardboard manufacturing where the quality of hardboard produced from individual species was tested and compared with class-1 hardboard of the US

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Hardboard Specification. Schwartz (1961) studied the suitability of *H. fomes* for hardboard and tested for various physical and mechanical properties of hardboard produced from it.

This investigation is intended to find out the physical and mechanical properties of the hardboard produced from the mill and to compare the test results with that for pure *H. fomes* and also US Standard Hardboard Specifications.

### Materials and Methods

Laboratory tests were done in the Khulna Hardboard Mills Limited. For water absorption test, at first 10 specimens (12.7 cm X 5.10 cm X 0.32 cm) were taken from 10 boards through sequential sampling (i.e. one specimen was drawn from each board with an interval of 24 hours). Here it is to be mentioned that sequential sampling was followed as it permits the study of a smaller sample size and also sample size need not to be predetermined. Each specimen was accompanied by three replications. Thickness of the specimens was measured by slide calipers and weight of the specimen was measured by balance. The specimens were submerged horizontally in deionized water at room temperature (23±3)°C. After 24 hours immersion, the specimens were taken out and the adherent surface water was wiped off with blotters. The specimens were then immediately weighed and measured for thickness change with slide calipers. The following formula was used to calculate the thickness and weight change in hardboard specimens (Razzaque, 1963):

$$\frac{100(W - W')}{W'} = \% \text{ of water absorption}$$

$$\frac{100(T - t)}{t} = \% \text{ of thickness change}$$

Where, W= weight after immersion; W'= conditioned weight; T= thickness after immersion and t= conditioned thickness.

For MOR test, 10 boards were selected through sequential sampling with an interval of 24 hours from the production unit of the mill. From each board two specimens were taken: one along the machine direction and another one across the machine direction. Each specimen (12.7 cm X 5.10 cm X 0.32 cm) was accompanied by three replications (samples from different locations of board). Razzaque (1963) suggested that 12.7 cm X 5.10 cm size of specimen assure better accuracy of results. McNatt (1974) stated that, test environment affects the test results of physical and mechanical properties of hardboard. During this test the room temperature was recorded as (23 ± 3)°C and the relative humidity was (50 ± 4)%. The size of the specimens was 12.7 cm X 5.10 cm X 0.32 cm. The following equation was followed to determine the MOR values (Anon., 1954):

$$\text{MOR} = \frac{3PL}{2bd^2} \quad (\text{Kg/cm}^2)$$

Where, P= pressure in Kg; L= length of specimen in cm; b= width of span in cm and d= thickness of span in cm.

### Results and Discussion

The results of this study show a significant difference in quality between the boards produced from mixed species (*sundri* and village tree species) and that from *sundri* and US standard. There was a good correlation (r = 0.79) between weight and thickness changes. After 24 hours immersion in

water, the samples showed 31.70% to 48.60% (mean 36.47%) weight change (Fig. 1), which are significantly higher ( $t = 9.67$  and  $11.23$  respectively at  $p = 0.05$ ) than that of pure *sundri* board average 21.45%, and US standard Class 1 Hardboard Specification max 20%. (Schwartz, 1961). Thickness changes were 14.33% to 35.87% (mean 21.67%) (Fig. 2), which are significantly higher ( $t = 2.85$  and  $4.3$  respectively at  $p = 0.05$ ) than that of pure *sundri* board average 15.73% and US standard Class 1 Hardboard Specification max. 16% (Schwartz, 1961). The higher the percentage of weight and thickness change, the lower the water repellency of boards and the lower will be the board quality.

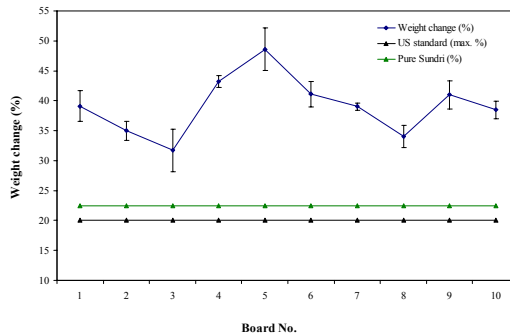


Fig. 1. Weight change after 24 hours water immersion. Bars show standard error at 95% confidence.

MOR values for the samples (Fig. 3) were found 377.66 to 542.44 Kg/cm<sup>2</sup> (mean 487.02) along the machine direction and (346.25 to 498.47) Kg/cm<sup>2</sup> (mean 438.46) across the machine direction which are significantly higher ( $t = 9.53$  and  $6.57$  respectively at  $p = 0.05$ ) than that of US Standard (minimum 453.6 Kg/cm<sup>2</sup> irrespective of machine direction) but significantly lower ( $t = 4.34$  and  $8.32$  respectively at  $p = 0.05$ ) than the values for pure *sundri* boards (548.42 Kg/cm<sup>2</sup>) (Schwartz, 1961). MOR values along the machine direction were found significantly higher ( $t = 2.5$  at  $p = 0.05$ ) than that across the machine direction.

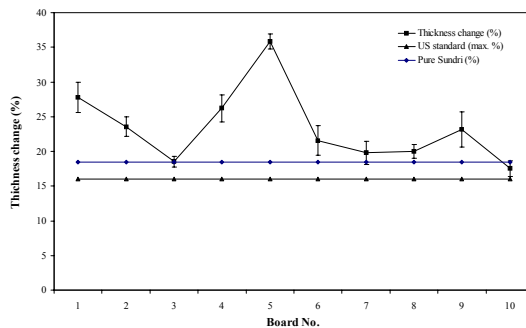


Fig. 2. Thickness change after 24 hours immersion in water. Bars show standard error at 95% confidence.

The mill is using *H. fomes* a high density wood (0.96 gm/cm<sup>3</sup>, Sattar, 1981) mixed with some village tree species of low to medium density wood (0.32 to 0.60 gm/cm<sup>3</sup>, Sattar, 1981; Sattar and Talukdar, 1985 and Ali *et al.*, 1980). A wide range of variations is found in the samples in terms of water absorption, thickness change and MOR (Fig. 1, 2 and 3), which might be due to uneven distribution of fibers (i.e. low uniformity in pulp and mat consistency) from different species of varying specific gravity in the manufacturing process.

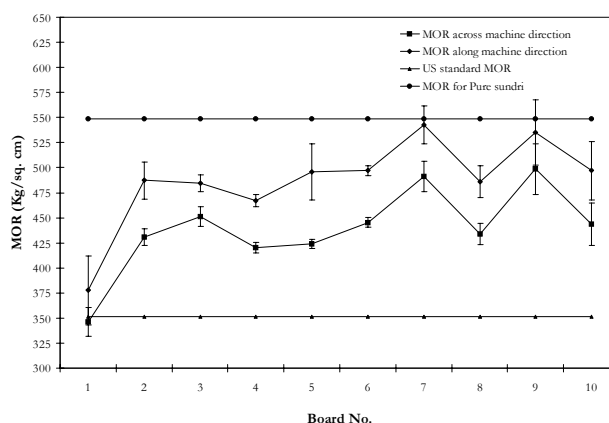


Fig. 3. MOR across and along machine direction and comparison with US standard and pure *sundri*. Bars show standard error at 95% confidence.

## Conclusion

It is evident that incorporation of village tree species in hardboard manufacturing process of the mill has resulted in significant changes in physical and mechanical properties of boards. Water repellency characteristics of the boards have been declined with respect to pure *sundri* and US Standard Class 1 Hardboard Specification. This property can be improved through using water repellent chemicals such as paraffin wax and ensuring uniform mixture of fibers from different species. On the other hand, declined mechanical properties of boards with respect to *sundri* can be desirable when compared with US Standard Class 1 Hardboard Specification. Incorporation of village tree species in the manufacturing process has little alternatives due to short supply of *sundri* raw material. So further research should be carried out to increase the uniformity of fibers in hardboard pulp and mat thus as well as to improve the physical and mechanical properties of boards.

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## References

- Ali, M.O., Sattar, M.A. and Talukdar, Y.A., 1980. Kiln drying schedules of 1.25" planks of Bangladeshi timber species. Wood Seasoning Series, Bangladesh Forest Research Institute Bulletin No. 6, pp. 1-10.
- Anonymous, 1954. Evaluating properties of building boards. D-1037-52 T, ASTM.
- Hawke, R.E., Sun, B.C.H. and Gale, M.R., 1993. Effect of fibre mat moisture content on physical properties of polyisocyanate-bonded hardboard. *Forest Products Journal*, 43(1): 15-20.
- Hawke, R.E., Sun, B.C.H. and Gale, M.R., 1992. Effect of fibre mat moisture content on strength properties of polyisocyanate-bonded hardboard. *Forest Products Journal*, 42(11-12): 61-68.
- Khan M.S. and Shafi, M., 1988. Effect of chemical pretreatment of *Sundri* wood chips in making hardboards. *Bangladesh Journal of Forest Science*, 17(1-2): 1-7.

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KHML Record, 1998. Unpublished report of Khulna Hardboard Mills Ltd. (KHML), Khulna, Bangladesh.

McNatt, J.D., 1974. Effects of equilibrium moisture content changes on hardboard properties. *Forest Products Journal*, 24(2): 29-35.

Ota, M. and Kawabe, J., 1976. Studies on the strength properties of SIS hardboard. Part 4: Manufacture of fibreboard core plywood. Reports of the Kyushu University- Forests, Japan, No. 26: 141-147.

Razzaque, M.A., 1963. Classification, definition and tests of hardboard. *Pulp and Paper Series*, Pakistan Forest Research Laboratory Bulletin No. 4, pp. 2-5.

Sattar, M.A., 1981. Some Physical Properties of 116 Bangladeshi timbers. *Wood Seasoning Series*, Bangladesh Forest Research Institute Bulletin No. 7, pp. 1-15.

Sattar, M.A. and Talukdar, Y.A., 1985. Kiln drying studies on 5 cm planks of thirty timber species. *Bano Biggyan Patrika*, 14(1&2): 18-25

Schwartz, S.L., 1961. The suitability of Sundriwood (*Hirtiera fomes*) for hardboard. Forest Product Laboratory, Forest Service, U.S. Department of Agriculture Project No. 7-394/1536, Madison 5, Wisconsin.

Shafi, M. and Khan M.S., 1995. Suitability of village tree species of Bangladesh for hardboard manufacture. *Bangladesh Journal of Forest Science*, 24(1): 36-40.

Youngquist, J.A., Scharmer, R.C., Chow, P. and Bao, Z.Z., 1994. Density, modulus of elasticity and durability of hardboard. *Bibliographies and Literature of Agriculture*, No. 126, 41 pp.