KILN DRYING OF GAMAR *(GMELINA ARBOREA)* USING VARYING STICKER THICKNESSES AND DRYING SCHEDULES

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ABSTRACT

Kiln drying characteristics of 2.5 cm gamar planks were studied using three types of stickers and schedules. Nine charges of gamar were run in a steamheated dry kiln. It was found that the difficulty of kiln seasoning of gamar could be eliminated substantially if an accelerated drying schedule with comparatively higher temperatures was employed in conjunction with the standard sticker thickness of 2.5 cm.

সারসংক্ষেপ

২·৫ সেঃ মিঃ পুরু গামার তক্তার কিল্‌নে শুকানোর বৈশিষ্ট্য নিরীক্ষা করা হয়েছে। প্রচলিত বাষ্পচালিত সিজনিং কিল্‌নে নয়টি গামার কাঠের চার্জ শুকানো হয়। দেখা যায় যে, অপেক্ষাকৃত উচ্চতাপ মাত্রার কিল্‌ন সিডিউল এবং সাধারণ ২·৫ সেঃ মিঃ পুরু ষ্টিকার ব্যবহার করে গামার কাঠ কিল্‌ন সিজন করার সমস্যা বহুলাংশে দুর করা সম্ভব।

INTRODUCTION

Gamar *(Gmelina arborea)* is an excellant timber suitable for the manufacture of good quality furniture, joinery and construction materials. It is ideally suitable for novelty articles, toys and other specialty products (Qasem *et al* 1987; Sattar 1986). Like all other timbers, gamar needs to be dried prior to use for getting better performance. Drying is critically essential for products requiring proper glue bond.

The kiln drying schedules developed earlier are based on density classes (Sattar 1980a). A number of species having similar density can conveniently be dried in a single charge with these schedules. Gamar does not conform to the drying schedule of its density class (Ali *et al* . 1980). It thus cannot be seasoned in a mixed commercial charge. Because of its slow drying propensity, conventional drying of gamar becomes commercially uneconomic. This is why, gamar planks are seldom dried to a lower appropriate moisture content level in this country.

The sticker thickness is related to the air flow through the timber stack which may affect the kiln drying appreciably. The use of thicker stickers was found to decrease the drying time, but output per

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unit time also decreased as less timber could be stacked in the kiln (Bassett 1974; Robert and Resh 1976; Stevens and Pratt 1938).

The effects of air circulation, temperature and humidity are fundamental on the rate of drying of particular species. The kiln drying schedules suggest variations of temperature and humidity at different stages of drying. The drying rate may be accelerated by using the kiln schedules which provide higher temperature and lower humidity. But, with the same charges of timber, the severe drying conditions may lead to undesirable degrade.

The present study was aimed at establishing a method for economic drying of gamar by employing varying sticker thicknesses and drying schedule.

MATERIALS AND METHOD

Gamar *(Gmelina arborea)* logs were procured in green condition from the BFIDC timber depot at Kaptai. Logs were converted to 2.5 cm X 20. 0 cm X 2. 5 m dimensions prior to drying of each charge. The stickers of three thicknesses, viz., 2.5 cm, 3.8 cm and 5.0 cm were prepared from the dried garjan *(Dipterocarpus spp)* planks. Three kiln charges were run with these stickers employing the conventional drying schedule (Sattar 1980a). Six other kiln charges were dried using the two accelerated kiln schedules established earlier (Sattar 1980b).These kiln schedules are shown in Table 1. The stickers of 2.5 cm, 3.8 cm and 5.0 cm were used for each of these charges. All drying experiments were conducted in a force draft compartment type steam heated kiln of 1.0 m^3 capacity.

Ten full length boards, seven from flat sawn and three from quarter sawn, were taken as the samples. The initial moisture content of each board was determined by preparing two moisture sections from 15 cm apart of both ends. Moisture loss data were taken every day during the course of drying. At the conclusion of drying, qualitative assessment was made for the drying degrade.

RESULT

Drying time from the green condition to the 12% moisture content level was determined from the sample boards of each charge. Table 2 contains the average drying times and drying defects of gamar. Analysis of variance was performed to ascertain the overall effects of sticker thickness and drying schedule on drying time. The result of the test is presented in Table 3. Least significant difference test was also done to know whether there were any significant differences between the mean drying times. The result is shown in Table. 4. The total drying cost was calculated for each of drying charge assuming the total expenditure per day as Tk 1750 (Sattar 1989). This basic economics is given in Table 5.

Table 1. Schedules for kiln drying of gamar

Type of schedule	Temperature (°C)		Relative humidity (%)	Equilibrium moisture content (%)	Stage of drying
	Dry bulb	Wet bulb			
Conventional – 1	37.8	35.6	86	17.5	Steaming for 24 hours
	53.3	48.9	78	13.4	Drying
	64.4	55.6	64	9.2	-do-
	71.1	53.3	41	5.5	-do-
	76.1	48.3	24	3.3	-do-
	79.4	52.7	25	3.3	-do-
	81.7	53.9	26	3.3	-do-
	82.2	77.8	82	12.2	Conditioning for 24 hours
Accelerated-II	60	55	79	13	Warm-up for 6 hours
	70	43	21	3	Drying
	75	70	80	12	Conditioning for 6 hours
Accelerated - III	71	65	75	11	Warm - up for 6 hours
	77	49	24	3	Drying
	82	78	83	12	Conditioning for 6 hours

Table 2. Kiln drying times and drying defects of gamar planks for different sticker thicknesses and kiln schedules

Type of kiln schedule	Type of sticker thickness (cm)	Initial moisture content (%)	Average drying time from green to 12% mc (days)	Drying defect (qualitative assessment)
Conventional-I	2.5	166.0	15.7	Minor twist
	3.8	188.9	13.4	Minor twist
	5.0	170.5	12.2	Severe twist and cup
Accelerated-II	2.5	161.2	14.3	Minor twist
	3.8	158.9	12.8	Minor twist and cup
	5.0	162.3	11.8	Severe cup, bow and twist
Accelerated -III	2.5	165.2	13.6	Minor twist
	3.8	163.8	11.4	MInor twist
	5.0	152.6	11.1	Severe cup and twist

Table 3. Result of analysis of variance on drying time

Source	DF	SS	MS	F	Singnificance
Replication	9	1454.01	161.56	98.5	*
Sticker thickness(A)	2	125.24	62.62	38.2	*
Drying schedule (B)	2	45.16	22.58	13.8	*
A X B	4	5.76	1.44	0.9	ns
Residual	72	118.29	1.64		
Total	89	1748.16			

* Significant at 0.1% level, ns = not significant.

Table 4. Result of least significant difference test on drying time

Variation		Mean drying time (days)	Significance
Sticker thickness (cm)	2.54	14.32*	
	3.80	12.55*	
	5.04	13.77*	
Kiln schedule	I	13.77*	
	II	12.97*	
	III	12.03*	

* Significantly different at 5% level.

Table 5. Economics for kiln drying of 2.5 cm gamar plank (assuming a total expenditure for kiln drying a charge of 14 m^3 timber using 2.5 cm thick sticker is Tk 1750 per day)

Type of kiln schedule and sticker thickness	Drying time (days)	Volume of timber dried (m^3)	Total drying cost (Tk)	Per m^3 drying cost (Tk)
Conventional kiln schedule-I				
2.5 cm	15.7	14.0	17,475	1,963
3.8 cm	13.4	10.5	23,450	2,233
5.0 cm	12.2	7.0	21,350	3,050
Accelerated kiln schedule-II				
2.5 cm	14.3	14.0	25.025	1,785
3.8 cm	12.8	10.5	22,400	2,074
5.0 cm	11.8	7.0	20,650	2,950
Accelerated kiln schedule-III				
2.5 cm	13.6	14.0	23,800	1,700
3.8 cm	11.4	10.5	19,950	1,900
5.0 cm	11.1	7.0	19,425	2,775

DISCUSSION AND CONCLUSION

It is apparent from Table 3 that gamar planks could be kiln dried from green condition to a 12% moisture content level. Drying times ranged from 15.7 to 12.2 days when the conventional schedule was used, from 14.9 to 11.8 days in case of the accelerated schedule II and from 13.6 to 11.1 days for the accelerated schedule III. These drying times were significantly different within and among the drying schedules (Tables 2, 3 & 4). All these drying times are, however, quite high compared to drying timber of similar density class, i.e., 0.40 to 0.45. It was found earlier that chapalish timber was dried from green condition to 12% moisture content in 6 to 7 days (Ali *et al* 1980). Chapalish timber, which has a specific gravity of 0.52, is denser than gamar wood having specific gravity of 0.42. The abnormal high drying time of gamar was also noticed by the Indian workers (Rehman 1956). This abnormality may be due to occurrance of moisture pockets in gamar from which it is difficult to evaporate moisture. The other reason may lie in the anatomical structure of gamar wood which is characterised with the presence of heavy tylosis. Tylosis obstracts the moisture movement and thus gamar cannot be dried easily.

Table 5 shows that conventional drying with standard sticker of 2.5 cm thickness becomes uneconomic. The expenditure for drying per m^3 of gamar was Tk 1963 for this type of drying. Two other types of stickers of thicker dimension were used and thus effected higher drying rates resulting less drying times. But these entailed higher expenditure due to less accommodation of timber in the kiln (Table 5.). The application of accelerated schedule II which provides a comparatively higher temperature and a lower relative humidity needed lower drying times. As such, the drying cost per unit volume of gamar becomes also lower than those of the conventional schedule. The accelerated kiln schedule III which provides further higher temperature increased drying rates and thus significantly more rapid drying times were noted (Tables 3 & 4). Among all the drying combinations, the standard sticker of 2.5 cm thickness was the most efficient in drying gamar with the accelerated schedule III. It took 13.6 days. It is not the lowest drying time among the nine charges, but it reduced 2.1 days from the conventional charge and this reduction along with higher accommodation of timber resulted in the lowest drying cost (Table 5).

As regards drying degrade, distortion like cup and twist was apparent in gamar planks in all categories of drying. Minor defect was observed in the charge where thinner sticker, i. e., 2.5 cm thickness was used while severe distortion was found in the timber stacked with thicker stickers, i. e., 3.8 cm and 5.0 cm thicknesses. It was found that the defects in the refractory timber may be substantially reduced if some form of mechanical restraint is applied (Beset *et al* 1980). Even the simple restraint like heavy weight on the top of the stack can minimise the distortion (Sattar 1991).

It is recommended that gamar planks which exhibits drying problem may be kiln dried using the standard sticker of 2.5 cm and accelerated schedule with higher temperature. This drying method was found comparatively economical and the quality of timber related to defect was acceptable.

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