KILN DRYING STUDIES ON 5 CM PLANKS OF THIRTY TIMBER SPECIES

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The applicability of kiln drying schedules developed earlier were verified for 5 cm thick planks of thirty indigenous hardwood species. A series of charges were kiln dried covering the entire specific gravity range under four classes. It was found that the kiln schedules developed earlier for thinner stocks were equally effective in drying thicker ones. Five cm thick planks of different species having similar specific gravity range in different classes may, therefore, conveniently be kiln dried using the recommended schedules.

INTRODUCTION

Kiln drying schedules were developed at the Forest Research Institute, Chittagong for drying 3.2 cm planks of mixed hardwood species (Ali *et al* 1970, Ali *et al* 1980). These schedules were based on five specific gravity classes of timber employing linear dependancy of moisture loss on moisture content and kiln temperature. These facilitate the seasoning of a group of species having similar specific gravity range in a single charge. Experimental as well as commercial kiln drying was carried out using these schedules covering almost the entire range of the specific gravity of timbers. This schedule has provided a convenient method for efficient kiln drying of mixed hardwood species in a country like Bangladesh where the species having varied characters are numerous but their individual availability is limited in most cases. The applicability of these schedules were verified for lumber of lower thickness classes. Although the kiln drying schedules have been recommended for timber of higher thickness classes, the grouping of the species was made mainly on the basis of specific gravity without subjecting them to experiments (Sattar 1980). So the present investigation was undertaken to verify the applicability of these schedules for thicker planks with a view to recommending appropriate kiln drying schedules.

MATERIALS AND METHODS

Thirty indigenous timber species of different specific gravity ranges were used. Green timber of each species in the form of log was procured from the BFIDC timber depot at Kaptai. These logs were converted into 5 cm x 20 cm x 2.5m dimension planks.

Six full-length representative boards, three from flat-sawn and three from quarter-sawn planks were taken as test samples for each charge. Moisture sections were cut from each sample and the initial moisture contents were determined by the oven drying method. From another set, specific gravity of the species were determined based on green volume. The sample boards were end-coated with bituminous paint and their initial weights were also taken. Based on the initial moisture contents and weights, calculated oven-dry weights were found out for each sample board. During the subsequent process of drying, the daily moisture loss data were computed by simply weighing the samples.

A force-draft compartment type kiln was used for the drying. The selection of schedules was done, in the first instance, from the schedules developed for 3.2 cm thick lumber (Ali *et al* 1980) representing the specific gravity class determined by actual measurement. Then, schedules of higher specific gravity classes were tried. The schedules which offered the fastest drying rate with minimum drying degrades were considered to be the appropriate ones. The kiln schedules used are shown in Tables 1 to 5.

RESULTS

Drying times from green condition to 12 percent moisture content level were recorded for each species. The observed drying co-efficients were determined from the regressions of the rate of moisture loss on moisture content. The estimated drying co-efficients were found out with the help of the drying equation (Ali *et al* 1970). Drying degrade, on completion of drying, was assessed visually. These are presented in Table 6. Based on all these data, appropriate kiln drying schedules for 5 cm thick lumber are recommended (Table 7).

DISCUSSION AND CONCLUSION

The total periods of drying the planks from green condition to 12 percent moisture content seem to be reasonable (Table 6). These periods included the conditioning treatment of one to two days applied at the end of drying. This enabled the timber to attain a uniform distribution of moisture throughout the cross section of each piece in the charge.

In the employment of the schedules, one day was allowed for heating up the stock at the initial point of drying, and the adjustment was made thereafter as warranted by the drying rate. In the conventional schedules, temperature is normally held constant at the initial value till the fibre saturation point is reached (Torgesson 1951). But in the present approach, temperature is linearly adjusted with moisture content in order to ensure a constantly decreasing rate of drying.

It is found that 5 cm thick planks can satisfactorily be kiln dried using the schedules developed initially for planks of lower thicknesses. A comparison of observed and estimated drying co-efficients reveals that most of the species conformed

Table 1. Kiln schedule A

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	134–85	37.8	35.6	86	17.5
Drying	84–53	55.6	51.1	73	12.2
–Do–	52–34	67.2	58.3	64	9.5
–Do–	33–22	73.9	56.1	22	3.2
–Do–	21–14	78.3	50.6	24	3.2
–Do–	13–8	81.1	53.3	26	3.2
Conditioning	12	82.2	77.8	83	12.2

Table 2. Kiln schedule B

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Drybulb (°C)	Wetbulb (°C)		
Steaming	116–80	37.8	35.6	86	17.5
Drying	79–54	53.3	48.9	78	13.4
–Do–	53–37	64.4	55.6	64	9.2
–Do–	36–26	71.1	53.3	41	5.5
–Do–	25–18	76.1	48.3	24	3.3
–Do–	17–12	79.4	51.7	25	3.3
–Do–	11–9	81.7	53.9	26	3.3
Conditioning	12	82.2	77.8	82	12.2

Table 3. Kiln schedule C

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	98–73	37.8	35.6	86	17.5
Drying	72–54	51.1	46.7	77	13.3
–Do–	53–40	60.6	51.7	62	9.4
–Do–	39–30	67.8	50.0	39	5.6
–Do–	29–22	72.8	46.7	21	3.2
–Do–	21–17	76.7	48.9	24	3.2
–Do–	16–13	79.4	51.7	25	3.3
–Do–	12–9	81.1	53.3	26	3.3
Conditioning	12	82.2	77.8	83	12.2

Table 4. Kiln schedule D

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	80–65	37.8	35.6	86	17.5
Drying	64–52	47.8	43.3	77	13.3
–Do–	51–42	56.1	47.2	60	9.4
–Do–	41–34	62.8	45.0	63	9.4
–Do–	33–27	67.8	40.0	19	3.0
–Do–	26–22	72.2	44.4	21	3.2
–Do–	21–18	75.0	47.2	24	3.2
–Do–	17–14	77.8	50.0	25	3.2
–Do–	13–12	80.6	52.8	26	3.3
Conditioning	12	82.2	77.8	83	12.2

Table 5. Kiln schedule E

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	65–57	37.8	35.6	86	17.5
Drying	56–50	45.0	40.6	76	13.3
–Do–	49–43	50.6	41.7	58	9.4
–Do–	42–38	56.7	38.9	32	5.3
–Do–	37–33	60.6	32.8	14	2.6
–Do–	32–29	64.4	36.7	18	2.9
–Do–	28–25	67.8	40.0	19	3.0
–Do–	24–22	71.1	43.3	21	3.2
–Do–	21–19	73.3	45.6	22	3.2
–Do–	18–17	75.6	46.7	23	3.2
–Do–	16–15	77.2	49.4	24	3.2
–Do–	14–13	78.9	51.1	25	3.2
–Do–	12–11	80.6	52.8	26	3.3
Conditioning	12	82.2	77.8	82	12.2

to the predicted schedules. Gamar, Telsur and Jarul were found to dry slower but Teak and Nageshwar dried faster than was predicted (Table 6). Based on specific gravity, drying co-efficients and drying degrade, the thirty species under investigation have been grouped under different categories and kiln schedules have been recommended (Table 7).

It is apparent that kiln drying schedules based on specific gravity are equally effective in drying thicker planks. The seasoning plants of the BFIDC and some other wood based industries in the country have been using these schedules without encountering any difficulty.

Table 6. Drying times, drying co-efficients and drying defects of 30 indigenous species in 5 cm plank form

Species	Specific gravity (gr. vol.)	Initial moisture content (percent)	Drying times to 12 per-cent moisture content (days)	Drying co-efficients		Drying defects
				obser-ved.	estimated	
1	2	3	4	5	6	7
Chundul (*Tetrameles nudiflora*)	0.37	113	7	.443	.453	Minor twist
Kadam (*Anthocephalus cadamba*)	0.38	106	7	.430	.445	Minor twist
Simul (*Bombax ceiba*)	0.38	122	8	.412	.445	Nil
Pitali (*Trewia nudiflora*)	0.41	105	9	.402	.420	Nil
Narikeli (*Pterygota alata*)	0.44	104	9	.392	.396	Nil
Barta (*Artocarpus lakoocha*)	0.44	112	10	.387	.396	Nil
Gamar (*Gmelina arborea*)	0.44	127	24	.205	.396	Nil
Mahogany (*Swietenia mahogany*)	0.45	85	10	.313	.387	Minor bowing
Toon (*Toona ciliata*)	0.48	98	10	.297	.363	Tendency to distortion
Mango (*Mangifera indica*)	0.48	102	10	.292	.363	Nil
Chapalish (*Artocarpus chaplasha*)	0.48	118	9	.304	.363	Tendency to distortion
Keora (*Sonneratia apetala*)	0.50	102	11	.286	.347	Minor cupping
Uriam (*Mangifera sylvatica*)	0.51	108	12	.269	.338	Nil
Lali (*Amoora wallichii*)	0.51	112	12	.273	.338	Nil

—Contd.

1	2	3	4	5	6	7
Civit (*Swintonia floribunda*)	0.56	112	14	.213	.297	Tendency to distortion
Pitraj (*Aphanamixis polystachya*)	0.57	88	14	.221	.289	Tendency to splitting
Teak (*Tectona grandis*)	0.57	95	14	.335	.289	Nil
Telsur (*Hopea odorata*)	0.61	110	20	.169	.257	Tendency to splitting
Haldu (*Adina cordifolia*)	0.61	93	16	.238	.257	–Do–
Champa (*Michelia champaca*)	0.61	114	15	.209	.257	Tendency to distortion
Silkorai (*Albizia procera*)	0.63	85	17	.201	.240	–Do–
Bhadi (*Garuga pinnata*)	0.63	92	16	.198	.240	Tendency to distortion
Batna (*Quercus pachyphylla*)	0.63	84	18	.187	.240	–Do–
Chickrassi (*Chuckrassia velutina*)	0.64	80	18	.192	.232	Nil
Jarul (*Lagerstroemia speciosa*)	0.65	83	24	.123	.224	Nil
Jam (*Syzygium grande*)	0.65	72	21	.154	.224	Tendency to splitting
Garjan (*Dipterocarpus alatus*)	0.66	78	18	.166	.216	–Do–
Gutguttya (*Protium serratum*)	0.78	70	21	.109	.118	–Do–
Nageshwar (*Mesua ferrea*)	0.90	53	20	.182	.020	Tendency to distortion
Sundri (*Heritiera fomes*)	0.91	58	26	.035	.012	–Do–

Table 7. Recommended kiln schedules for seasoning 5 cm planks of different species

Sp. gr. range	Species	Recommended kiln schedule
0.35–0.44	Barta, Chundul, Gamar, Kadam, Narikeli, Pitali, Simul	B
0.45–0.54	Chapalish, Keora, Lali, Mango, Mahogany, Toon, Uriam	C
0.55–0.64	Batna, Bhadi, Champa, Chickrassi, Civit, Haldu, Pitraj, Silkorai, Teak, Telsur	D
0.65 and above	Garjan, Gutguttya, Jam, Jarul, Nageshwar, Sundri	E

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