

## **A STUDY ON MOST ABUNDANTLY UTILIZED TIMBER FOR STRUCTURAL APPLICATION IN SRI LANKA**

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### **Abstract**

Day to day demand for timber is increasing as a natural construction material due to its performance, stability, aesthetic, durability and been environmentally friendly. Different timber species have distinct characteristics and those are selected for different applications based on their characteristics. Value of timber varies with physical and mechanical properties and their quality can be improved by thermal and chemical modifications. An industrial survey was conducted to identify most abundantly utilized timber for structural applications in Sri Lanka. Industrial survey was conducted as two distinct surveys such as clusters-based survey and the company-based survey. Under cluster-based survey, 23 clusters; saw mills and treatment plants which were located in Moratuwa, Moratumulla, Koralawella, Pannipitiya and Swarapola were selected. For company-based survey, 3 companies in Colombo district following international standards contributing on large scale were selected. Research discussion conveys demand for application of imported timber has been increased because the availability of locally sourced structural timber is rare and expensive. Treated local timber has been popular due to its high durability resistance to the pests and their dimensional stability. From the industrial survey data, brushing, spraying, kiln drying; dipping and impregnation were identified as utilizing preservative techniques which have been using in Sri Lanka. Different species have been popular for different structural components in structural application. Based on cluster-based survey for the results revealed different timber species for different timber applications; rafters- Palu timber, beams- Kempass timber, reapers- Alastonia timber and door/ window frames- Jak timber were mostly utilized. And results from company based survey mostly utilized timber are Jak timber for rafters, Jak timber for beams, Ginisapu timber for rafters and variety timbers such as Ketakela, Mahogany, Jak and Teak for door window frames.

**Keywords:** *Industrial survey, structural timber, thermal modification, chemical modification*

### **1. Introduction**

Lumber or timber is well known to be a structural wood that has been turned into planks to be used as building material and carpentry works. So does the day to day demand for timber is increasing as a natural construction material due to its performance, stability, aesthetic, durability and environmentally friendly. Timber has been categorized as hard wood; Jak, Mahogany, Teak, Alastonia, Rubber and soft wood. Examples for hardwoods are and for soft woods are Pine, Fir and Cypress. In Sri Lanka, timber species have become popular for various applications and functions based on its unique characteristics. Quality of timber varies according to physical and mechanical properties and their quality can be further improved by chemical and thermal modifications. Different chemical and thermal techniques are available all over the world. Either to be chemical or thermal treating is decided on based on effectiveness, timber specie and cost. Under chemical treatment three methods are available; under surface applying brushing and spraying, dip and impregnation (Townsend, 2016). The available thermal treatments are Thermo wood process, Rectification process, Les Bois Perdure, Plato process and OHT (Oil Heat Treatment) process (Sidorova, K., 2008).

#### **1.1. TIMBER**

Wood is fibrous material with heterogeneous and anisotropic properties which is the main substance of the trunk and branches of the tree (Nairn, 2008). Lumber or timber is a structural wood that has been turned into planks to use as a building material and ready for carpentry works (Osuji and Nwankwo, 2017). Sawing pattern depends on axial and radial density variation of wood.(Mendis, Halwatura, Somadevaa, Jayasinghe, & Gunawaardana, 2019 December) Sapwood is the living outermost portion of a wood trunk or a branch, while heartwood is the dead inner wood (Snyder, 2017).

Wood cell walls are composed of micro fibrils of cellulose, hemicellulose and lignin (Praveen, 2012).

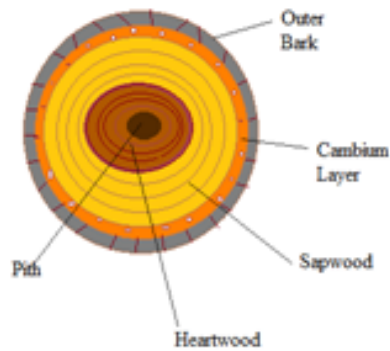


Figure 1, Macro structure of wood (source: Ramage, Burridge, & Busse-Wicher, n.d.)

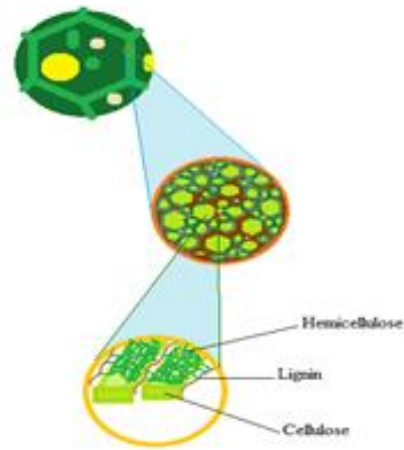


Figure 2, Micro structure (source: Praveen)

## 1.2. MECHANICAL AND PHYSICAL PROPERTIES

Physical properties of wood refer to macro structure of wood that includes colour, texture, odour, moisture, cracking, swelling and shrinkage. The mechanical properties refer to strength characteristic of wood. Mechanical properties are stiffness and elasticity, tensile strength, crushing or compressive strength, shearing strength, bending strength, toughness, hardness and resilience (Mendoza, 2014).

## 1.3. CHEMICAL MODIFICATION OF WOOD

Main function of chemical modification is the reaction between chemical agents and polymeric components of timber forming a strong bond between the chemical reagents and cell wall polymer. Except the monomers polymerization in the basic structure of lumen which will engage in cell wall penetrating but not the wall cross linking. Lumen filling is well known that would influence the improvement of the properties of timber specially the mechanical (Rowell, Roger M., 1983). Chemical modifications by externally applied chemical reagent react with hydroxyl and phenyl groups of the cell wall polymers and reduce hygroscopicity by blocking hydroxyl groups (Ramage et al., 2016).

## 1.4. THERMAL MODIFICATION OF WOOD

By thermal modifications, pyrolysis of wood is controlled at elevated temperature ( $>180^{\circ}\text{C}$ ) in different conditions such as nitrogen, steam and heat oil environments (Homan W.J., Jorissen A.J.M., 2004).

## 1.5. TIMBER INDUSTRY

Timber has higher structural efficiency as carried load per unit weight compared to reinforced concrete and steel structure (McGar, 2015). Many timber species has higher natural durability or can be enhanced durability by treating. And also it's an environment friendly natural construction material. Compressive strength is similar to general purpose concrete (Bolduc, 2017).

Figure 3 shows that wood designs are more sustainable other than steel and concrete designs because timber are less in fossil energy, resource use, global warming potential (GWP), acidification, eutrophication, ozone depletion and smog potential. Deforestation is huge problem in utilization of timber heavily. So, it can overcome by increasing forestry to supply more timber and as must be well planned and the forests well managed in order to maximize their broad and far reaching benefits (Ramage et al., 2016).

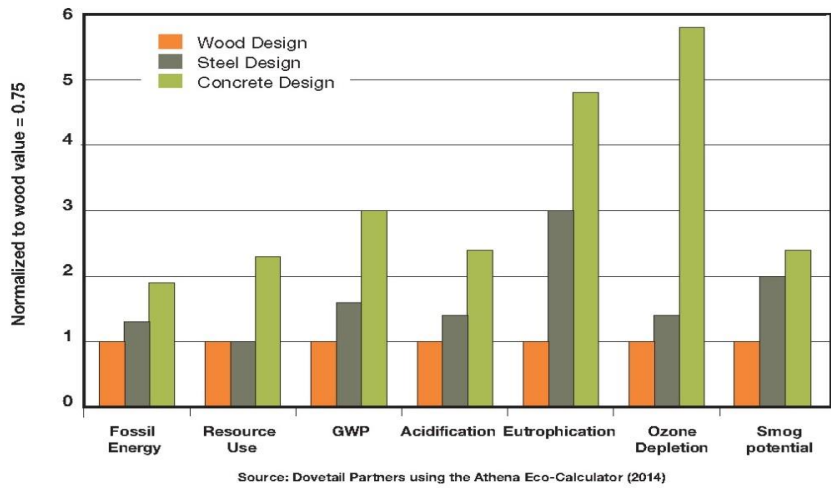


Figure 3, Comparison of timber, steel and concrete designs (Source: Dovetail Partners)

## 2. Methodology and material

Industrial survey was conducted to identify most abundantly utilized timber for structural applications in Sri Lanka. It was done in two distinct methods. One was based on clusters and other as the company based. For cluster based survey, 23 clusters; saw mills and treatment plants which are located in Moratuwa, Moratumulla, Korallawella, Pannipitiya and Swarapola are selected. For company based surveys, 3 companies in Colombo which were following the standards and doing in a large scale were selected. Questionnaire was based on most utilized timber for rafters, beams, reapers and window/ door frames and most utilized treatment.

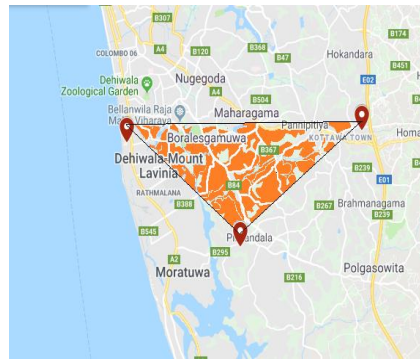
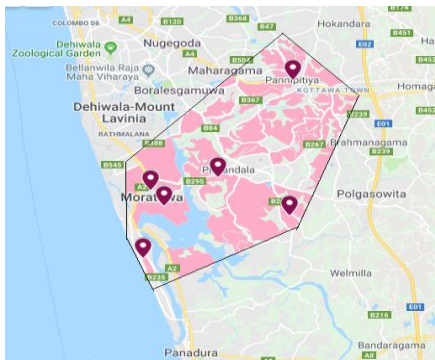


Figure 4, Clusters based survey locations

Figure 5, companies based survey locations

## 3. Results and discussion

### 3.1. CLUSTERS BASED INDUSTRIAL SURVEY

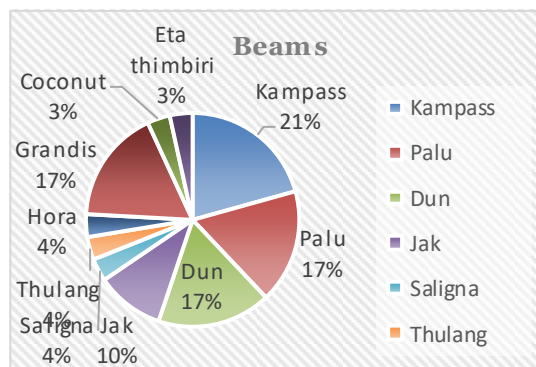


Figure 6, Utilization of timber for beams

For beams, the most demanded timber was Kempass timber about 21% and next Palu timber and Dun timber about 17% respectively. Kempass timber is an imported timber that has a slight high market in Sri Lankan timber industry. Palu timber and Dun timber belong to high rated rare timber species and mostly found in forests (Amarasekara, 2000). Palu timber belongs to special class upper and Dun timber belongs to class 2 according timber classification by state timber cooperation.

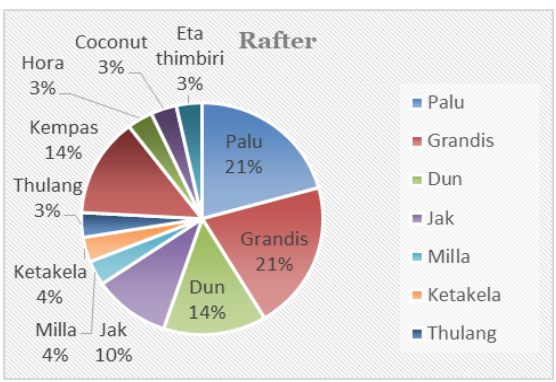


Figure 7, Utilization of timber for rafters

For rafters, the most demanded timber species are Palu timber and Grandis timber about 21%. But Availability of Palu timber was rare in the timber market. So timber industry has to rely on alternative timber species which are highly available and cultivated timber species. Grandis specie is common home garden specie (Ruwanpathirana, 2008). Grandis timber belongs to class 2 according to timber classification by state timber cooperation.

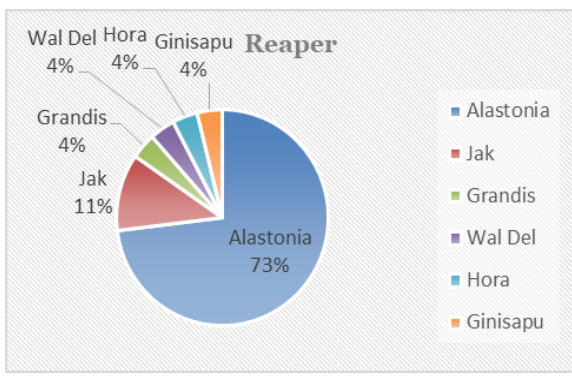


Figure 8, Utilization timber for reapers

For reapers, the most demanded timber was Alastonia timber about 73%. Alastonia is fast growing specie and has a very high adaptability to different soil types in wet zone (Subasinghe, 2010). It belongs to class 2 according to timber classification by state timber cooperation.

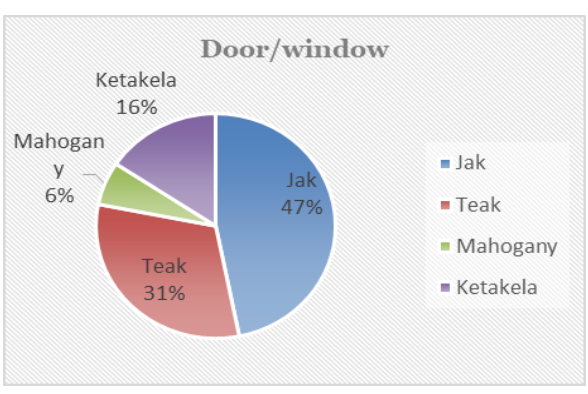


Figure 9, Utilization of timber for door/ window frame

Here we observed about 47% demand is for Jak timber while it contributes heavily on the total timber produced in home gardens (Ruwanpathirana, 2008). Jak belongs to luxury class according to timber classification by state timber cooperation

### 3.2. COMPANIES BASED INDUSTRIAL SURVEY

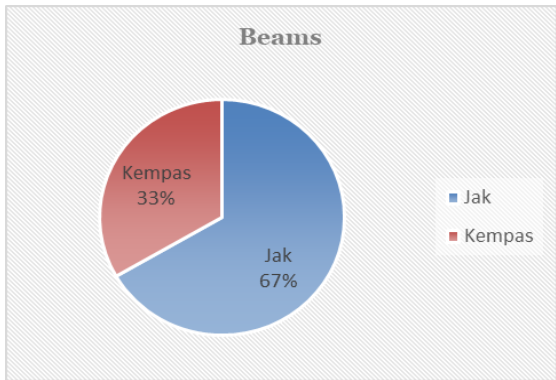


Figure 10, Utilization of timber for beams

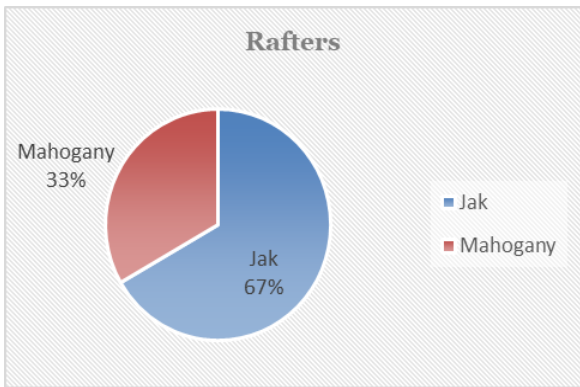


Figure 11, Utilization of timber for rafters

Jak is the most popular for rafters and beams.

For the reapers, Ginisapu timber was the most demanded among other species according to the field survey. And also Ginisapu timber is classified under class 2 according to state timber cooperation.

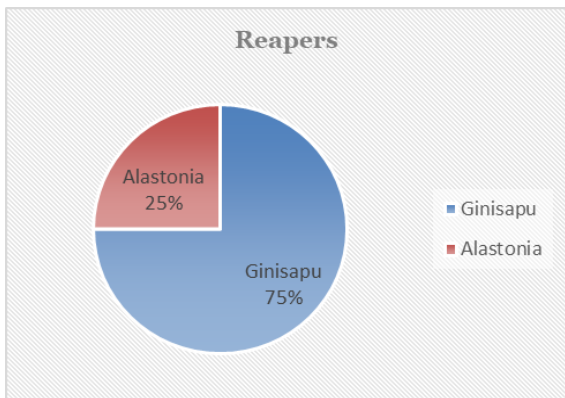


Figure 12, Utilization of timber for reapers

Variety timbers such as Ketakela, Mahogany, Jak and Teak are mostly utilized for door window frames. Teak timber belongs to super luxury class, Mahogany and Jak timber belong to luxury class and Ketakela timber belongs to class 1 according to state timber cooperation.

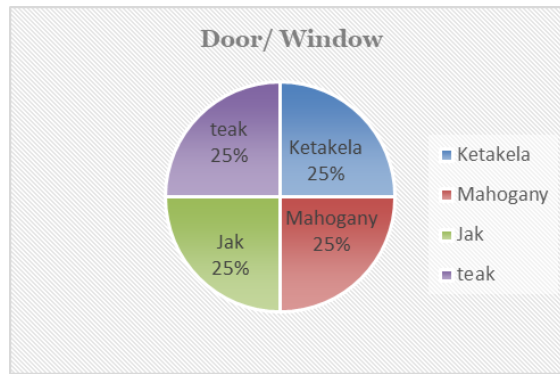


Figure 13, Utilization of timber for door/ window frames

Obtained results from the companies are quite deviated from the results from the clusters. According to company based survey Jak timber has a significant demand for different structural applications than other timber species. And also Jak timber has been utilizing for different structural applications in clusters as well. Timber species utilized for door / window frames are same for companies and clusters but only change of the demand for the each timber specie.

### 3.3. PRESERVATIVE TECHNIQUES

With the massive development of the construction sector in Sri Lanka, the demand for timber as a construction material is projected to increase over the next half century.(Dissanayake et al., 2019) Main objective of preservation of timber is to increase the life time of timber, ensure long life and enhance quality (Gérardin, 2017). Durability and dimension stability of the timber are increased by preservation methods such as thermal modification and chemical modification (Rowell et al., 2009).

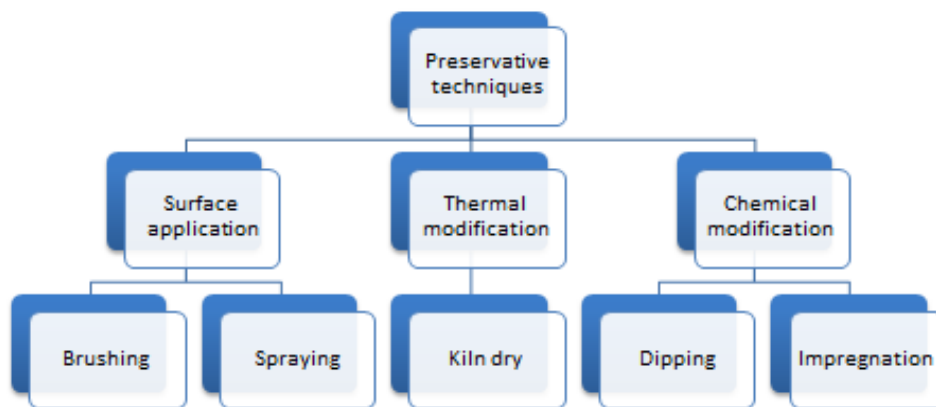


Figure 14, Identified preservative techniques in Sri Lanka

From the industrial surveys, above mentioned preservative techniques were identified. Those techniques are practiced currently in Sri Lanka for selected timber species under different conditions such as treated duration. Example for *Alastonia* timber kiln dry and for Rubber timber chemical modification (dip or impregnation) are utilized generally as the preservative techniques. In clusters, all methods are commonly used and kiln dry and impregnation are done in small scale. For brushing and spraying, water base, kapuru & diesel and wood preservatives are used. And also boron treatments are done by dipping or impregnation process. In the industry kiln dry process is conducted around temperature 45°C- 60°C. In companies, kiln dry and impregnation methods are mostly utilized and more consideration has been given for quality assurance when processes are continued. Example during kiln dry, gradually increase temperature or pressure inside the kiln for minimize impacts on wood.



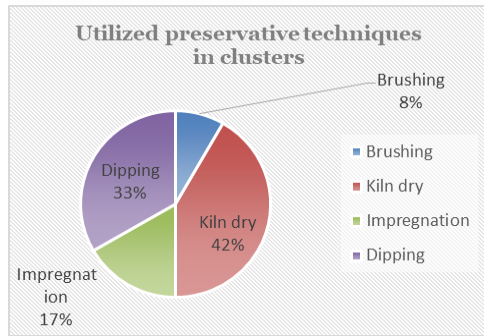


Figure 15, Utilized preservative technique in clusters

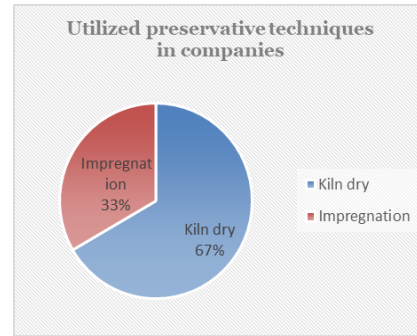


Figure 16, Utilized preservative technique in companies

In both clusters and companies kiln dry is the mostly utilized preservative technique.

#### 4. Summary

Table 1 : Summary of demanded timber

Most demanded timber specie	From clusters based survey	From companies based survey
For beams	Kempass	Jak
For rafters	Palu/ Grandis	Jak
For reapers	Alastonia	Ginisapu
For doors and windows	Jak	Jak/ Teak/ Ketakela/ Mahogany

Table 2 : Summary of most demanded preservative techniques

Most demanded preservative technique	From clusters based survey	From companies based survey
	Kiln dry	Kiln dry

#### 5. Conclusion

The research concluded the following as Palu timber for rafters, Kempass timber for beams, Alastonia timber for reapers and Jak timber for door/ window frames were mostly utilized in clusters. While from the company-based survey, mostly utilized timber species were Jak timber for rafters and beams, Ginisapu timber for rafters and variety timbers such as Ketakela, Mahogany, Jak and Teak for door window frames. Kiln dry was identified as the most utilized preservative technique performed as a thermal modification in both cluster and company based survey.

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