Timber

Timber as a construction material in humanitarian operations

[DRAFT 3.0 for discussion]

April 2008

Foreword

This **third draft** of "Timber as a construction material in humanitarian operations" is for **discussion purposes**.

It follows on from the scoping study published by UN/OCHA in May 2007 and previous drafts discussed at peer reviews in Yogyakarta, Indonesia (November 2007), London, UK (January 2008.), and at a workshop in Bangladesh (February 2008) following cyclone Sidr. Additional peer reviews are anticipated for Nairobi, Kenya and Washington USA in 2008.

The guide has received inputs from over seventy people, representing more than twenty organisations. It aims to reflect best practice and consensus. A distribution list of over 300 individuals has been developed to help review and disseminate future drafts.

The final booklet will be available free of charge both digitally and in hard copy. If you would like to receive a copy or review future drafts, go to **www.humanitariantimber.org**, or email contact@humanitariantimber.org.

The project to develop this booklet has been lead by IFRC, UN/OCHA, and CARE international. The project has been coordinated by:

Isabelle de Muyser-Boucher, Florence Secula (UN/OCHA),

Graham Saunders (IFRC),

Elizabeth Babister (CARE International)

This is a draft and has room for improvement.

Please provide us with feedback on how to improve this document…

Acknowledgements

This booklet was compiled, written and illustrated by Joseph Ashmore and Jon Fowler.

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Organisations:

- Norwegian Refugee Council: allowed its 'Internal Guideline - Timber Procurement and Specifications' to be used as a starting point for the OCHA scoping study.

Contents

This booklet is divided into the following sections:

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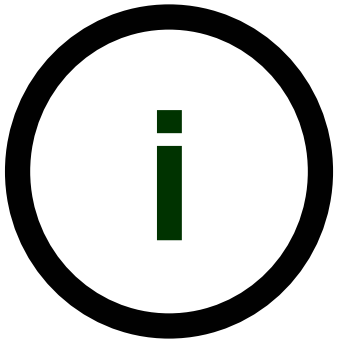


introduction

i.1 About this book

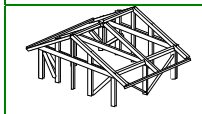
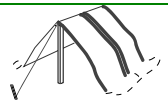
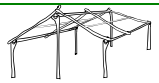
i.1.1 Aim and audience

This book provides information on selecting; specifying; procuring; using; and distributing timber as a material for the construction of small and medium-sized buildings as part of humanitarian operations.

This book is intended to complement international standards, such as Sphere[1], and agencies' own procurement policies. Readers should make allowances for the fact that not all the information can be applied to every local context.

The book is for program managers, logisticians, engineers and others working in humanitarian programs involving construction.

Some of the uses of timber in humanitarian operations

	*WATER & SANITATION: Timber used for a latrine frame*
	*WAREHOUSING: Timber used to build, for example, a food warehouse*
	*EDUCATION & HEALTH: Timber used to build school or clinic*
	*SHELTER: Timber used for temporary shelter with plastic sheeting roof*
	*SHELTER: Timber used for basic frame for family shelter*

i.1.2 Scope

This book deals with timber. In this book, 'timber' is used as a term for the following wood products:

- Sawn wood
- Timber poles
- Timber derivatives

'Timber' is also used to include the following:

- Palm wood (a tree, but grass-like in structure)
- Bamboo (a grass not a tree)

These are not dealt with in as much detail as wood products. See the Further Reading section for further information on bamboo and palm wood.

i.1.3 Warning!

Construction projects that are implemented without being part of a wider strategic plan can have negative implications. See section A for more advice on the planning stages of construction projects

Think before you build!

[1] www.sphereproject.org/

i.2 Timber principles

The following principles for the use and procurement of timber were developed following the first and second peer reviews.

Six principles for the use and purchasing of timber

1) Think before you build:

There should be a strategy, made in consultation with the beneficiaries, that takes into account issues including who owns the land, who will repair the building and who will take over the building in the future.

2) Choose appropriate materials:

Compare the environmental and economic impacts of using timber with other construction materials when deciding what to use. Check that the species available can be safely used for the correct purpose.

3) Reduce, reclaim and recycle timber wherever possible

Before ordering new timber, investigate options for reclaim and re-use of damaged of fallen timber. Such timber must be checked for its structural safety and any ownership issues clarified.

4) Buy timber from legal, and ideally, sustainable sources

Timber should, at the very least, be legal, even though there is no guarantee that a national program is correctly administered. When practical, source timber from verifiably sustainable sources.

5) Design appropriately:

Ensure that people who will use the building consider the material to be acceptable and understand how to build and repair with it, particularly when introducing an unfamiliar species through importing. Design using 'reduced timber construction' methods in order to maximise the efficient use of timber. Think long-term and design for potential re-use of timber at a later stage.

6) Use timber appropriately:

Timber is different to some man-made construction materials in that it is 'irregular' and requires special handling to ensure the highest durability. Choose the treatments according to the context and don't compromise the safety of those that are using the timber. Keeping timber dry is one of the best ways to protect it and ensure it is safe to use.

i.3 Introduction to timber and bamboo

Timber is the term normally used for all wood from trees (i.3.1), including that from coconut or date palms (i.3.4). Timber derivatives (i.3.2) are produced by processing timber in ways other than sawing (e.g. gluing to make boards). In this book, bamboo (i.3.3) is included in the term 'timber' although it is a grass.

i.3.1 Timber and trees

Timber is cut from the trunks of trees. The trunk of a tree supports the branches which form the crown. Leaves and fruits are usually supported by the branches. The trunk resists tension, compression and bending.

Heartwood, pith and sapwood

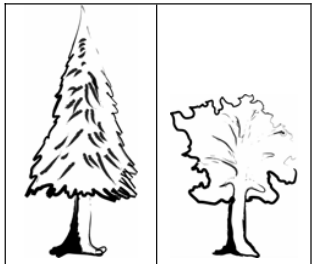
The heartwood of a tree provides the structural strength of the tree, the pith being the very centre, while the sapwood, which is normally lighter in colour, delivers liquids to the crown. The sapwood is more susceptible to attack by insects and fungi than the heartwood.

Softwoods and hardwoods

Trees are divided into two types: softwoods and hardwoods. This does not correspond to the hardness of the wood.

Hardwoods are from broad-leaved trees which produce seeds in a shell. Normally they are evergreen in the tropics and deciduous (lose their leaves once a year) in temperate zones.

Softwoods come from coniferous trees which produce cones and have leaves like needles. Hardwoods tend to be denser, stronger and grow slower than softwoods. However, balsa wood, one of the lightest woods, is actually a hardwood.



Softwood *Hardwood*

Naming trees

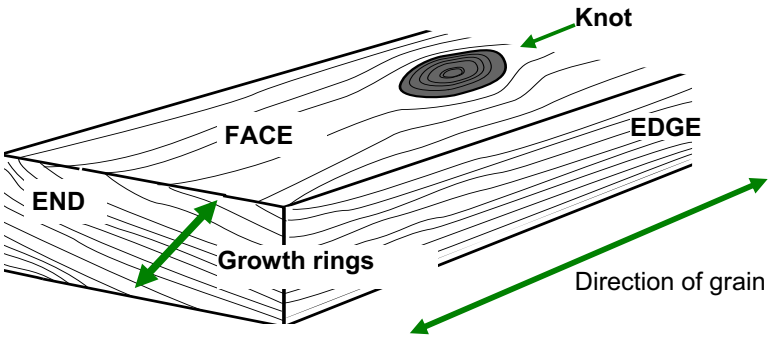
A tree has at least two names – a Latin (or 'botanical') name and a local common name. Because common names may vary locally and between countries, ensure that you know the Latin name of the species required, especially if purchasing large quantities of timber.

Primary and secondary timbers

The timber construction industry uses the terms primary and secondary to classify woods. Primary timbers are mostly slow-growing hardwoods which are naturally durable and normally expensive and in short supply. Secondary timbers are fast-growing species whose low natural durability can be improved with seasoning and preservatives.

i.3.2 Sawn wood

Sawn wood is wood that is cut, normally to certain standard sizes. Some basic sawn-wood terms are shown in the diagram below:

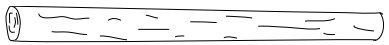


i.3.3 Timber poles

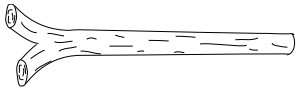
Timber poles can be stronger than equivalent sawn timber of the same cross section because the natural fibres of the timber are not interrupted by cutting through them. They can also be produced from younger trees than is required to make sawn timber, and do not require the costs of machining that sawn timber require.

Poles can be 'peeled' or 'rounded' (i.e. have their bark stripped to produce an even size). Rounding poles can lead to the loss 30% of their material and 40% of their strength but may ease import conditions.

In some cases local building practices prefer to use timber poles that have forks or other shapes. This guideline focuses on straight poles.



Usually straight poles should be specified



In some cases, local construction practices use specially shaped poles

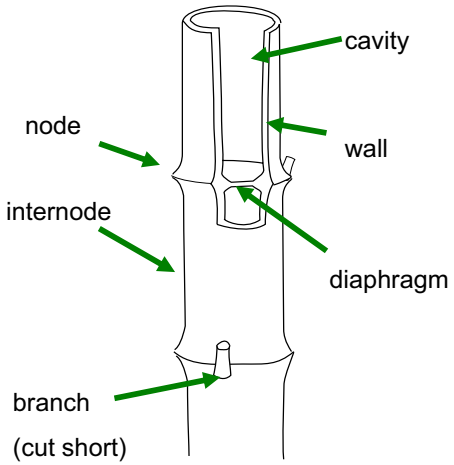
i.3.4 Boards (timber derivatives)

Boards, (plywood, chipboard etc. will be included in future drafts.

i.3.5 Bamboo

Bamboo is the stem of a woody grass. Bamboo is versatile and fast-growing, reproducing through its roots. It can be harvested in 3-5 years versus 10-50 years for most soft and hardwoods.

There are about 600 different botanical species of bamboo around the world so check advice on specific bamboo properties with local knowledge.



Culms, Growth and Harvesting

A bamboo **culm** is the equivalent of a tree's trunk. When harvesting, the roots should be protected and different methods are used depending on whether the species grows in patches (clump type) or are spread over a wide area (running type). Between 50 to 100 culms can grow in one clump.

Bamboo structure

A bamboo culm is between 2.5 and 6m long. It is usually hollow and tapered towards the top and consists of several cavities separated by nodes. The nodes are the strongest part of the culm, and if used correctly, help to prevent the bamboo from splitting at the ends and at joints. When jointing bamboo, cuts, pegs and bindings must take into account of the position of the node.

i.3.6 Palm / Coconut timber

Palm trees are closely related to grasses. They do not produce growth rings as other trees do, and the timber is softer in the centre. As well as the trunk being used for structural purposes, leaves can be used for thatching.

A factsheet on palm / coconut timber is being prepared for future drafts

For further information on bamboo, poles and timber properties, see section ii – annexes.

section

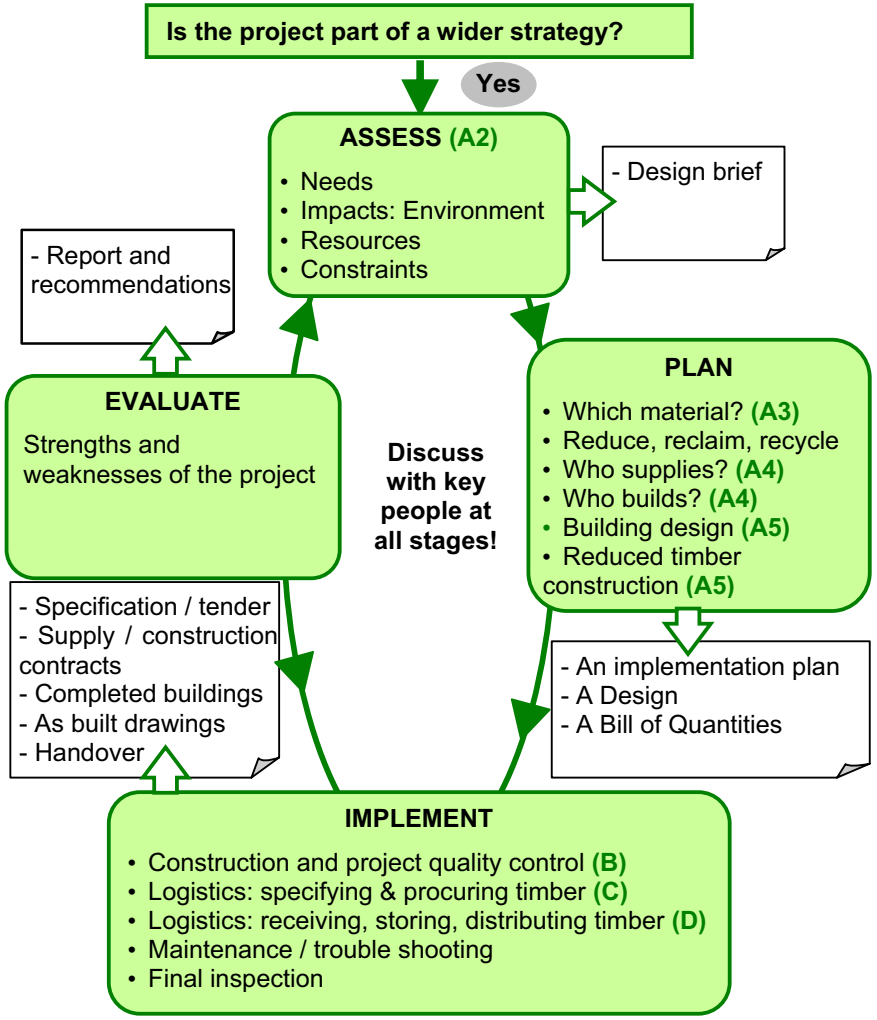
A

planning

A

A.1 Consult before you buy and build

Decisions involving the use and sourcing of timber are made at all stages of a construction project. These decisions must be based on an ongoing discussion between the affected community, humanitarian organisations, government, relevant authorities, suppliers and other key actors.



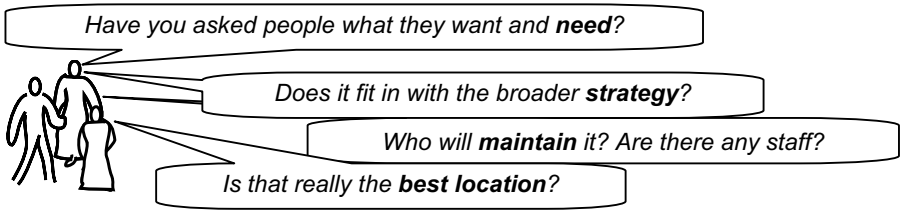
Within organisations, logistics, procurement, programme and engineering departments must develop programme strategy and response together.

A.2 Assess

A.2.1 Needs

The **need** for a building must be agreed and an appropriate **location** identified before starting a design and project planning can begin.

All buildings (including private houses) have **maintenance** costs, whilst public buildings have additional staffing costs. Decide who will be responsible for repairs (materials and labour) once supporting organisations have gone.



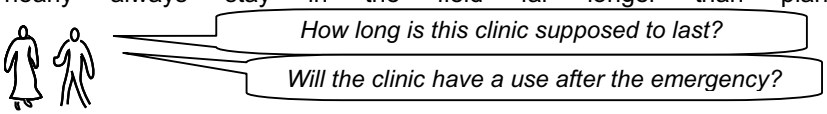
Consider rehabilitating existing buildings rather than building new buildings.

Needs assessments of damage and needs should be carried out jointly between organisations to avoid competition for resources.

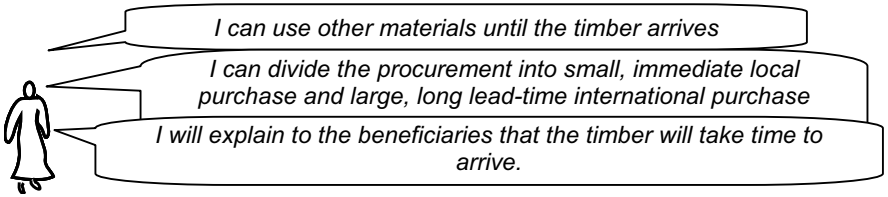
We should be working together!

Phasing and lifetime

In emergency phases of response, be aware that 'Temporary' structures nearly always stay in the field far longer than planned.



Lead times for importing timber can be considerable. Forward planning will help ensure timber arrives in time for the earliest phase of reconstruction.



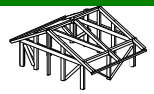
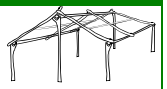
The lifetime of a timber building is dependent upon the type of timber and the treatments used as well as the design of the building.

Scale

The scale of the construction project and the volume of timber required will be one of the biggest determinants of whether procurement is made locally, nationally or internationally.

Calculations should take into account other uses of wood, such as wood used for fuel in cooking or brick-making.

Approximate timber volumes for simple structures

 Latrine (depends if 'slab' concrete or wood)	 8m x 6m timber framed shed	 All timber house / classroom	 Very basic emergency shelter	 Basic timber shelter frame
0.4 – 0.8m3	3m3	2 - 4m3	< 0.1m3	0.3m3

A.2.2 Impacts: Environment

The location of the house or settlement and the methods and materials used to build can have adverse environmental impacts including erosion, landslides, flooding, damage to watersheds and loss of biodiversity. These can adversely affect communities who projects aim to help. In many cases it may be necessary to conduct an environmental impact assessment and develop a multi-agency environmental strategy for timber procurement.

A major concern when using timber is deforestation. This may occur when timber is sourced from unmanaged forests or if people affected by a disaster or conflict cut down trees locally to meet their shelter and subsequent fuel needs. To avoid this:

- Do not distribute emergency shelter materials such as plastic sheeting without considering what will be used for frames.
- Have an agreed environmental strategy in place which involves the community.

I live near a fragile forest and have been given a plastic sheet. I need some poles to hold up my roof

Life Cycle Analysis (LCA) considers all environmental impacts of a material: production methods, transport, lifespan and energy efficiency. Fired bricks, for example, may consume a larger volume of wood in firewood than would be used by a timber-frame structure, but may present other advantages.

Making an accurate LCA is extremely difficult, even in advanced economies, but the principles should inform material choice.

A.2.3 Resources

Thought about recycling before buying new timber?

Reduce, re-use, reclaim, recycle

Before purchasing timber, aim to **reduce** the volume required (B.3), and assess what can be **re-used**, **reclaimed** or **recycled** (A.2.1). Bought timber should be from a verifiably legal and sustainable source (C.2).

Building traditions and skills

Construction methods should be understandable and acceptable to the community who will be maintaining their structures. Projects also provide opportunities to develop construction skills and employment opportunities through training (especially on projects to build safer structures).

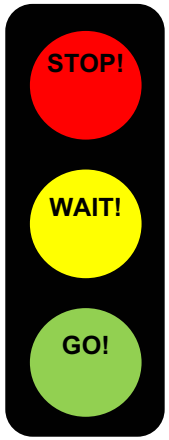
Supply: availability of appropriate materials

A co-ordinated, multi-agency market analysis to identify the availability of materials in local and national markets is necessary to reduce delays and inter-agency competition and minimise negative impacts on local economies.

A.2.4 Constraints

Legality and certification of timber is a primary consideration when deciding where to buy it. Verifiably sustainable wood is often expensive and in many countries even legal timber is difficult to find. In poorer countries, verifiably sustainable wood is often exported rather than consumed in-country.

At a minimum agencies must ensure that timber they purchase is legal. Ensuring timber is verified as sustainable may mean importing it and this will most likely take many months. See section C.2 for more on certification.



In a country with a reputation for corruption, especially in the timber trade? Are protected species grown here? Can't verify where the timber comes from?

Stop! – timber may be illegal!

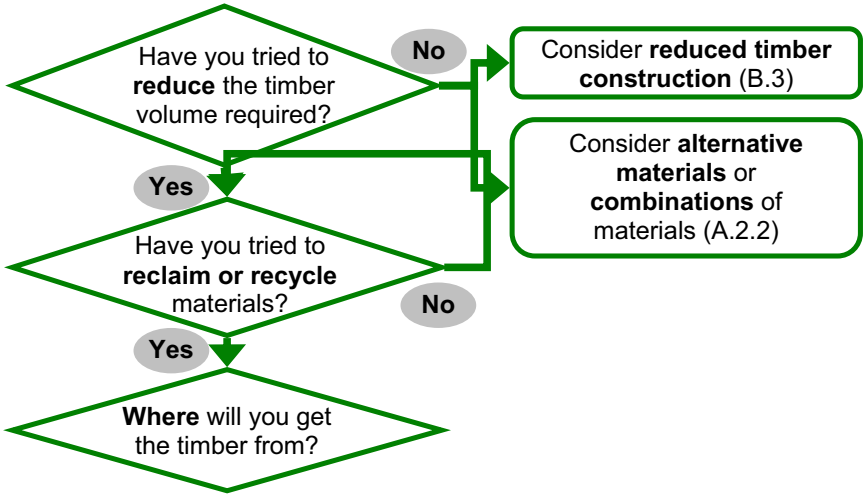
National certificate of legality, but not of sustainability? In a country without effective quality controls? Unsure of independence of certification?

Wait! Weigh up advantages of quicker supply times against potential environmental damage!

Timber verified as sustainable by a reliable, independent body? Local resource-management measures in place?

Go ahead!

A.3 Materials



A.3.1 Reclaimed timber

I cannot carry this tree home. I need support

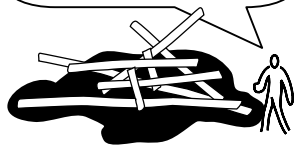
Significant amounts of timber construction material may be available from damaged or destroyed houses. Additionally trees (including palm trees) may have been felled by the disaster and may be salvageable.

Following earthquakes material will be on or near the site of buildings. Following flooding, material will be displaced.

Establishing ownership

- For timber that is on the site of an existing house this is usually simple.
- For timber that has been washed away, by water or landslides, local laws will have to be consulted or rules established.

This timber is covered with mud – we need to clean it



Collecting the timber

- For timber that has clear ownership this is usually done by the owners.
- For timber with disputed ownership, local authorities may need to be consulted.

- For timber that has been washed away, help might be required to retrieve it. This is especially the case for large volumes of wood or entire trees that might be usable but are too heavy to move.

Cleaning and drying the timber

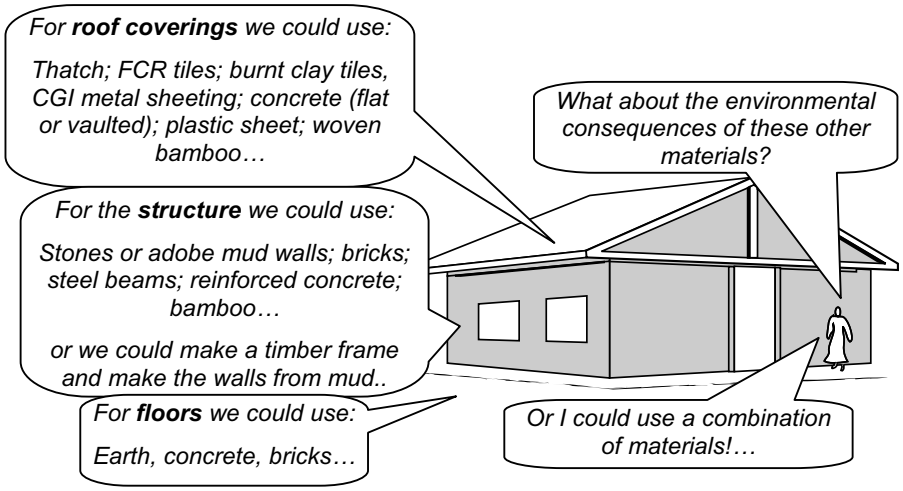
- Clean timber with water and tools, dry it (e.g. in the sun) and keep it dry.
- Take care if there is concern that it might be contaminated with bacteria or hazardous chemicals.
- Timber should be 'de-nailed' with all nails, screws and bolts removed.
- A cheap hand-held metal detector will help with removal of nails.

Using the timber

- Reclaimed timber may have been damaged and inappropriate for structural use. Cleaned timber should be carefully sorted and checked for splitting and fractures before being used.
- Timber should inspected for decay, rot, wood worm or insects before being used for structural purposes or introduced into existing buildings.
- Recently fallen trees will either need drying (which will take many months) or "green timber" construction techniques will be required (B.1.7)

A.3.2 Other materials

In many cases, alternative materials to timber can be used. The decision on which materials are to be used will be based on many factors including the design, the intended lifetime of the building, the available materials as well as the environmental impacts of the material to be used (A.1.3). In many cases, a combination of materials may be the best option.



A.4 Who will supply the timber and who will build?

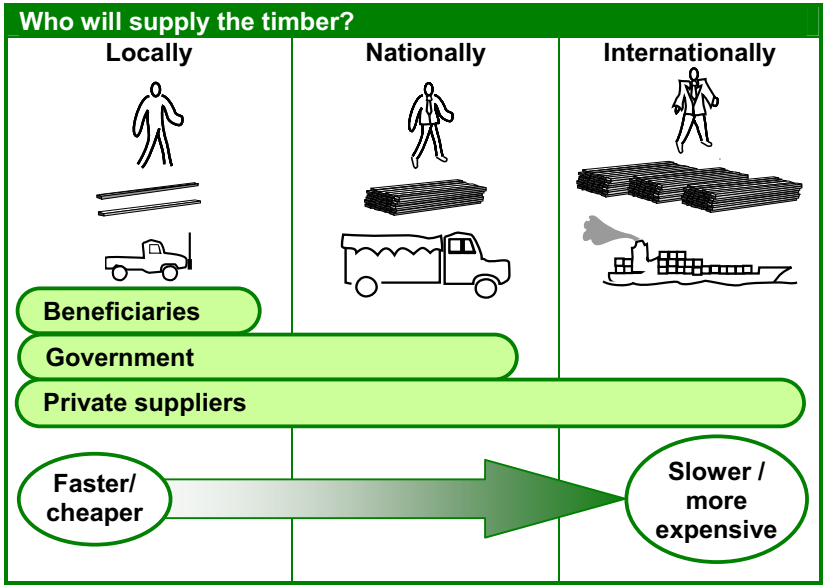
A.4.1 Supply

Local supply as default

Following a disaster where buildings are damaged or when people are displaced, there will always be a demand for timber. Local forests and markets will be the first place that people look to meet their needs. The ensuing demand for timber may be greater than local resources can sustainably support.

National or international supply

If local timber supplies are limited or unsustainable, the government or external organisations may need to provide additional timber from national sources. If national sources are insufficient then international sources may be required. Advice on procuring timber from local, national and international suppliers can be found in section C. In general, the further timber travels the longer it will take to supply, although there are many exceptions to this rule such as when timber needs to be dried.



Bamboo

Bamboo is frequently managed at a community level. When large volumes are required, procurement may have to be dispersed over many communities to prevent destroying the bamboo clumps.

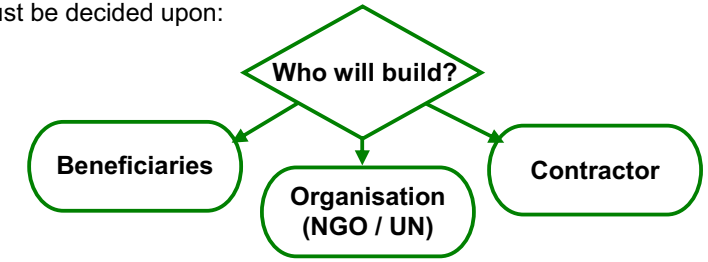
A.4.2 Who will build?

Ways of providing assistance

If timber is to be provided, there are several ways that it can be transferred to people these include:

- Directly distributed to people.
- Committees or individuals are given cash to purchase their own timber,
- Vouchers are given to exchange for materials from certain suppliers.
- A group of NGOs organise together to pool timber demands. They contract for a consistent supply, and deliver the timber to their contractors.

Whichever way individuals or communities obtain timber, a way to construct must be decided upon:



Beneficiaries construct for themselves

Most commonly people build their own shelters. Where timber is distributed, other materials (fixings such as nails etc.) must be provided with the timber so it can be used effectively.

The organisation constructs

With direct build, the organisation will directly hire labourers and supervisors to construct buildings. They will also be responsible for material procurement.

A contractor is hired

With indirect build, the organisation hires a contractor to manage the labour and daily construction activities. Construction may be partially carried out off-site (e.g. pre-construction of timber frames).

Monitoring

When responsibility is passed on to the contractor or the community, the **organisation's role is that of 'monitor'. Verification of** the legality / sustainability of the timber and health and safety practices in construction (D.5) must be carried out by the organisation.

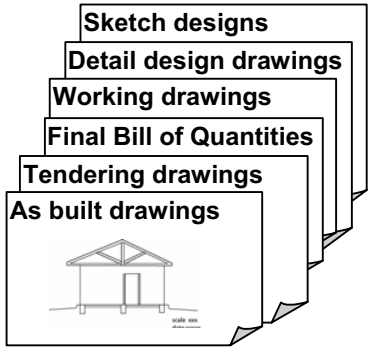
In emergencies, treatment and drying times may be squeezed as national suppliers try to meet rapid increases in demand. The quality of the wood and particularly the treatments, should be monitored.

A.5 Designing a structure

Plans required

However simple a structure may be, plans will have to be drawn before the structure is built. These may range from a sketch drawn in the sand for simple structures to a series of detailed architectural plans. From these plans, materials lists or bills of quantity will be developed.

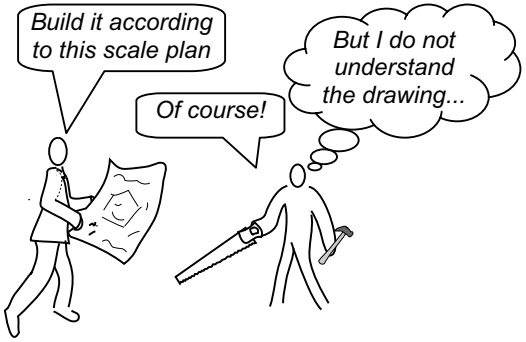
If a structure such as a housing unit is to be repeated on a large scale, building a prototype shelter is essential as it is the best way to test a structure technically, verify the Bill of Quantities and get feedback from those who will be using it.



Some of the drawings that may be required for larger construction projects

Acceptance

The design of a structure should be such that it is appropriate to needs and context (Sphere Shelter, Settlement and NFIs Standard 4, p.221).



The design of a building must take into account:

- Maintenance and upgrade at a later stage by the people who use it.
- Drainage and access to sanitation and infrastructure.
- Climate. Through appropriate design, buildings can be made that are cool in warm climates or conserve heat better in cold climates.

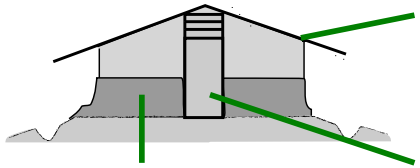
When family shelters are being built, it is common practice to provide a standard unit per family. However this may not take into account differing family sizes, so some flexibility in design may help meet differing needs better.

Do not build unless you are sure the structure is safe.

If in doubt get advice.

A.5.1 Reduced timber construction

Using reduced timber construction methods ensures efficient use of a limited supply of legal and sustainable timber.



Use of large roofing sheets rather than tiles reduces quantity of battening required

Door frame doubles as structural element

half wall made of masonry (not fully timbered wall)

Reducing waste

Construction programs can produce many off-cuts. With careful design, off-cuts need not be wasted and can be used for lintels, cross-braces and so on.

They can also be used as fuel, chipped for animal bedding or, in the case of bamboo, used for animal feed. Identifying possibilities for recycling off-cuts in advance reduces wastage. However be aware of the potentially hazardous chemicals that may have been used to treat the timber.

Combinations of materials

Consider using a combination of materials to use the available (and procurable resources to the best effect). By carefully selecting materials, environmental impacts and technical difficulties of procuring large volumes of timber can be reduced.

My house has coconut lumber corner posts, woven bamboo matting for walls, sawn timber door and window frames, and a bamboo structure for a roof.

If this beam breaks in the wind, my roof will still not fall down because the bracing will hold…

Structural redundancy

Buildings are strongest when designed so that that if one timber beam fails, the entire building will not collapse. Although this may use additional building materials it is a common building practice and should be encouraged for safety reasons.

Reducing timber in construction should not be at the expense the strength of the structure.

A.6 Checklists

A.6.1 Assessment checklist

Assessment: Start-up

- ☐ Is the project part of a wider strategy?
- ☐ Is the assessment being made with the key people involved?
- ☐ Has a working group been set-up to interpret the assessment?
- ☐ Are the construction sites suggested appropriate?

Assessment: Needs

- ☐ Is a construction project the right answer to meet people's needs?
- ☐ Has a lifespan been decided for the construction?
- ☐ Has a maintenance plan been agreed?
- ☐ Has the scale of the project been agreed?
- ☐ What structures do people normally use e.g. cooking space, etc?
- ☐ What construction materials and techniques are commonly used?

Assessment: Impacts

- ☐ Has an environmental impact assessment of different construction materials been made?
- ☐ What is the status of the country's timber trade? Are there particular environmental risks associated with illegal logging?
- ☐ Have economic impacts of using different materials been considered?

Assessment: Resources

- ☐ Labour and skills of beneficiaries and local population?
- ☐ Have re-usable materials been considered?
- ☐ Has a market analysis been conducted? How quickly can timber be imported?

Assessment: Constraints

- ☐ Has the cost of using different materials been considered?
- ☐ What are the rules and regulations regarding construction?
- ☐ What are the rules and regulations regarding legality of timber?

A.6.2 Building design checklist

Design: appropriateness

- ☐ Do the construction details fit the needs of those for whom it is intended? (Beneficiary / community needs)
- ☐ Can local builders make the structure that has been designed? (Available skills and materials)
- ☐ Are people familiar with design of the structure?(Cultural acceptance)
- ☐ Can the structure be upgraded, repaired or adapted at a later stage? (maintenance, adaptability)

Design: Stability

- ☐ Have you followed the checklist in B.1?
- ☐ Have precautions been made against local such as earthquakes and cyclones?

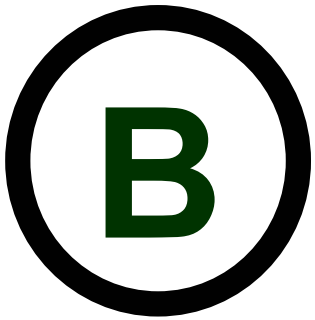
Design: reduced timber design

- ☐ Does the construction reduce the amount of timber required?
- ☐ Has the construction been designed for available sizes of timber? (reducing wastage) (B.3)
- ☐ Does the design use components in tension as well as components under compression? (reduces timber cross section)
- ☐ Does the structure include different materials including alternatives to timber where appropriate?
- ☐ Does the construction minimise wastage and off-cuts?
- ☐ Does the structure take account of the types and qualities of timber available?

For further reading on shelter and settlement programming and environmental assessment see section ii – annexes.

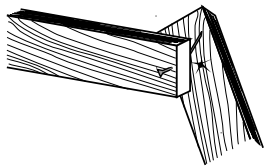
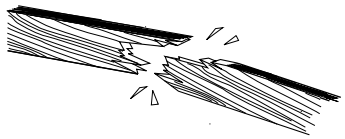
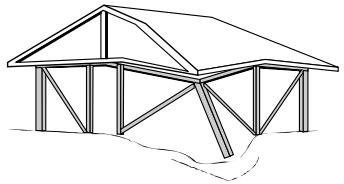
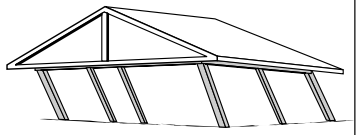
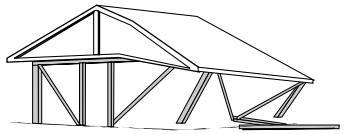
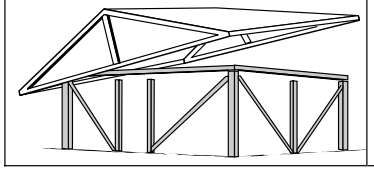
Timber as a construction material in humanitarian operations
SECTION [a] Planning :: DRAFT 3.0 :: 2008/04

section



construction

B.1 Construction checklist

Common causes of timber building collapse	
	**Joints or fixings fail** • Joints between timbers must be secure.
	**Timber fails** • The structure is poorly designed • The timber is of poor quality, rotten or attached by insects
	**Foundation collapse (B.1.6)** • Foundations must be on well prepared ground • Foundations must be sufficiently deep • Foundations must be protected from moisture and insect attack
	**Walls collapse – bracing (B.1.7)** • Walls should be braced diagonally or braced with boards • Timber joints must be strong.
	**Walls collapse – beam failure** • Tops of the walls should be tied together. • Walls get wet and rot due to small roof overhang.
	**Roof detaches (B.1.8)** • Roof must be properly connected to the walls to prevent it from lifting. • Timbers must be sized appropriately.

B.1.1 Monitoring construction

To help ensure that structures are safe, all construction projects should be monitored. When people are rebuilding their own houses, support, such as training, may help to improve the quality of the construction. If buildings are being built by an organisation or by a contractor, then a period for troubleshooting and repairs is usually needed before final sign off.

We just completed this building – then the roof blew off in a storm...

I wish we had monitored the construction more carefully!

Do not start to build or start to use a structure unless you are sure that it is safe.

If in doubt get advice.

B.1.2 Ground preparation

Before constructing, ensure the site is suitable. Ask:

- Is there clarification on who owns the land?
- Has the site been prepared with drainage?
- Has the site been levelled?
- Is the site safe from subsidence?
- Does the site have suitable access?

B.1.3 Foundations and treatment

The point where a building meets the ground is essential for its durability.

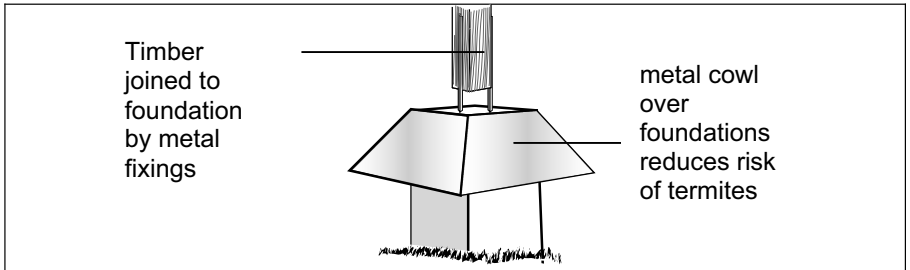
Post type foundation

The simplest type of foundation is to dig timber straight into the ground. Posts should be a minimum of 50cm deep, so allow extra timber for foundation poles. Unless a suitable type of wood, treatment or design precautions is chosen, a post is susceptible to rot due to getting wet. It is also at risk of attack by insects.

Treatments for foundation posts should always be completed before use.

Termites and rotting

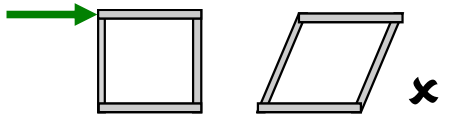
Prevent termite attack with metal plates just above the ground, or by treating the timber on site (dipping in sump oil) (C.3). Although some timber may be pre-treated (C.3), on-site dipping or painting treatments should take place once joinery work is complete as the termites will bore through freshly cut timber at the joints.



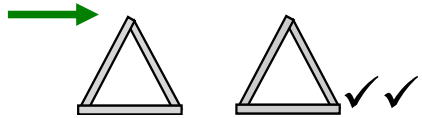
Example of connecting timber to a foundation to reduce termite attack

B.1.4 Walls

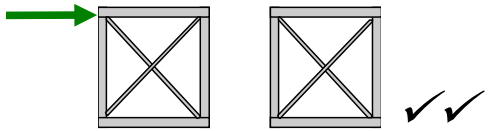
Walls bear vertical loads (roof) and horizontal loads (wind or earthquakes). Walls should always be braced, using diagonal timbers, boards or other infill.



A rectangular structure (such as a wall frame) can deform without bracing



A triangular structure is stronger than a rectangular structure

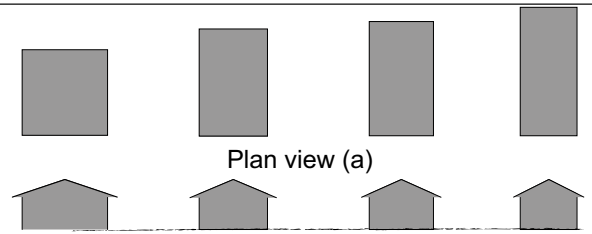


By bracing a wall diagonally, triangles are made, making the wall stronger. Boards or steel cable can also be used.

Walls must be built with fixing points so that the roof can be securely connected to them.

B.1.5 Roof

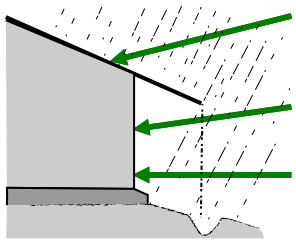
Timber in roofing is most commonly used as a frame, although wooden shingles can be also be used as a covering. Roof frames must be designed to bear the weight of the roofing material, wind load (or lift), the weight of those that repair them, and in some cases snow loads. Note that narrower span roofs are stronger than wider span roofs. There are many possible designs for the roof.

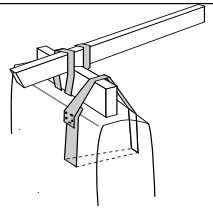


Section view (b)

Buildings with the same covered area are shown in the plan views (a). For the same covered area, square buildings have a wider roof span than rectangular buildings and so will need longer timbers.

Roofs should have significant overhangs to protect the walls. Roofs must be connected to the walls. Their pitch should be designed appropriate to the wind load expected as well as the materials available for the covering.



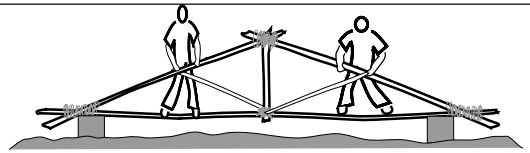


Connecting a roof to a wall

B.1.6 Strength testing

If all of the available timber is of an unknown strength, strength tests are better conducted on sample components rather than individual beams.

All timber expands and contracts in different weather and any design will have to account for this.



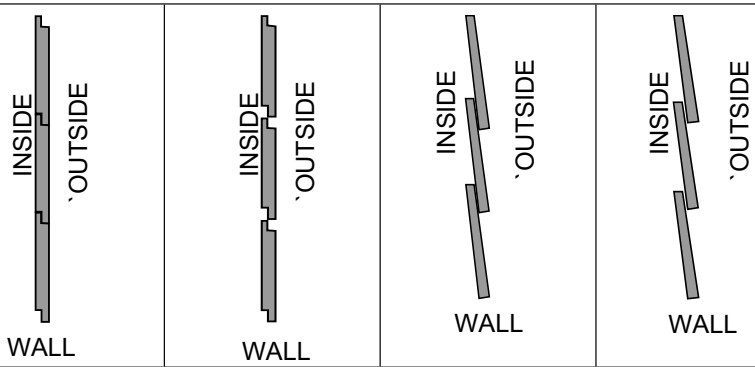
Sometimes the only way to know the strength properties of timber is to test a whole design element

B.1.7 Constructing with green timber

All timber shrinks and swells as it gains or loses moisture. For most applications, timber should be **seasoned** (C.3.1) and **kept dry** before use.

Unseasoned timber is known as **green timber**. Building with green timber requires skills and expertise, as it can expand, split and contract as it dries out. Unless design and construction take into account the expected contraction and warping of the wood, then buildings may leak or even fail. In some cases, training on construction with green timber may be required.

Green timber should only be used if there are the local skills in its use, and construction design takes into account the contraction of the timber.



Timber walling as anticipated (with green timber)	*Green timber shrinks causing wall to leak*	*Timber walling designed for shrinkage. (note that this may use more timber)*	*Timber shrinks and wall remains water-tight*

Example of how design might make allowance for green timber that will shrink

Note that the orientation of the trees growth rings is important – the center of the wood should be outwards to prevent gaps between planks as they swell during rain.

B.1.8 Constructing with poor quality timber

Sometimes a delivery of timber includes a number of pieces that are of poor quality. How can these be used to reduce waste?

Need tips on constructing with poor quality timber

B.2 Jointing timber

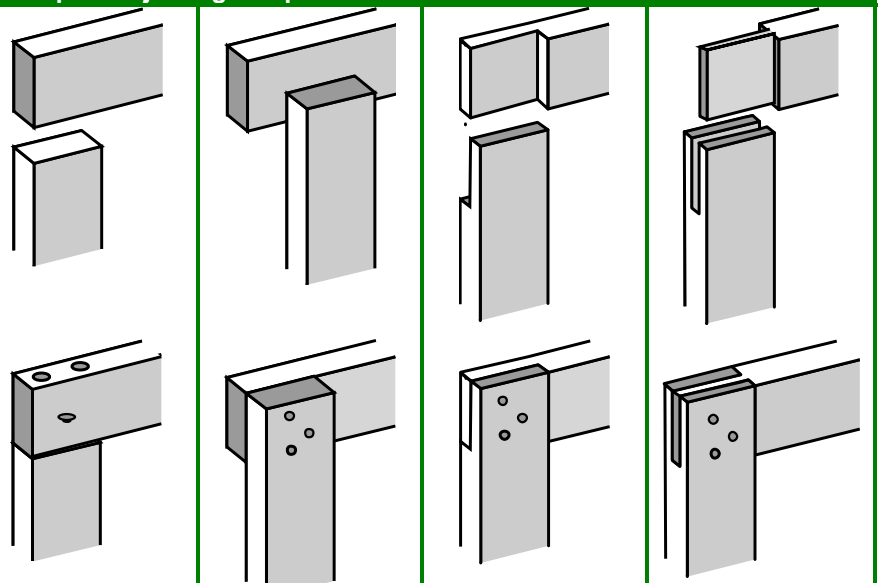
For simple constructions, timber is most commonly jointed by nails, pegs, screws or bolts. Joints can be strengthened with gang plates (metal plates nailed either side of a joint to provide strength) or metal strapping.

All joints should be made so that they strongest against the direction of the forces on the joint.

B.2.1 Making the joint

Cutting timber can improve the contact surface between pieces of timber and create a stronger joint. The type of joint made will depend upon the skills of the carpenters, the direction of the stresses on the joint and the fixings that will be used.

Examples of joining two pieces of timber.



Butt joint		Half lap joint / corner half joint	Bridle joint / slot mortice and tennon

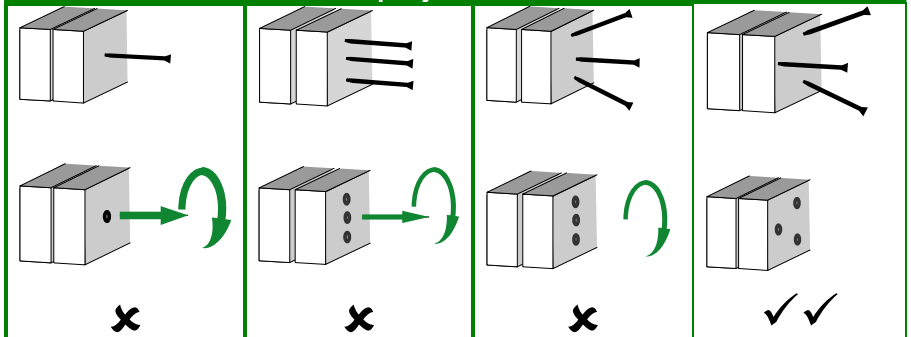
A few examples of how two pieces of timber can be cut at a joint. Generally increasing the contact areas improves the strength of the joint. However if too much timber is cut away, the timbers can become weakened.

B.2.2 Nails / Screws / Washers / Bolts

- Nailed joints are strongest when the forces act across the nail rather than in a direction that will pull it from the joint.
- Do not procure nails that are too large as they will split the timber.
- Properly sized screws or bolts are stronger than nails. They also allow the timber to be recycled at the end of the use of the anticipated lifetime of the building, but are slower and require drills and screwdrivers or spanners.
- Bolts need washers!

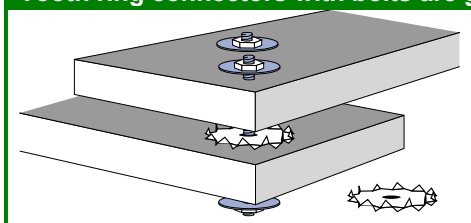
Wood treated with copper-based preservatives, such as ACQ (C.3.2), can corrode fasteners (nails, screws, bolts, brackets). To minimize corrosion, steel fasteners can be coated, or made from copper or stainless steel, although these may be expensive.

Use a minimum of three nails per joint!



✘ Single nail can easily pull out and joint can twist	✘ Parallel nails can pull out. Nails in a line can twist	✘ Angled nails stronger, but Nails in a line can twist	✓✓ Angled nails not in a straight line will not pull out or twist

Tooth ring connectors with bolts are good!



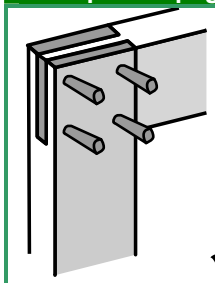
✓✓

To spread the load from a bolt use tooth ring connectors if they are available

Always use washers with bolts!

B.2.3 Pegs and dowelling

Examples of pegs, dowels and biscuits in a joint



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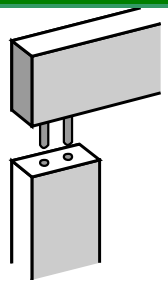
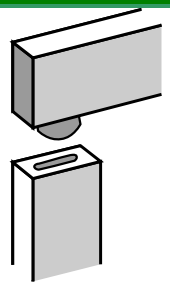
Pegs. The geometry of the joint takes most of the force



Dowels – not commonly used in construction – more common in furniture



Biscuit – not commonly used in construction– more common in furniture

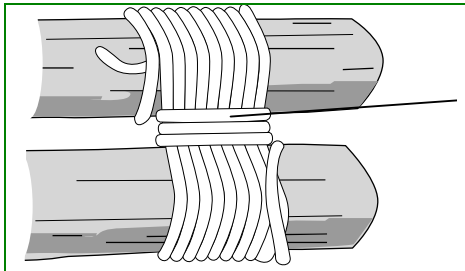
Pegs can be used to hold pieces of timber together. The geometry of the joint should hold the load, the pegs only keep the timbers in place. Pegs should only be used if the local carpenters have the skills to build with them.

Pegs should be made from timber that will not swell or shrink such as seasoned hardwood.

Dowels and Biscuits are smaller pieces of wood that are used internally to a joint – more often in furniture making than in construction.

B.2.4 String / wire or rope

- Binding timber with wire or rope (especially bush poles) is a very common way of building. If bound tightly, a strong joint can be formed.
- To make lashings as tight as possible, each turn should be tightened as it is made. “Frapping” turns should be wrapped around the binding to further tighten the lashing.

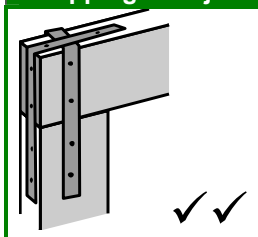


Frapping turns wound on after the main binding to tighten the joint

Illustration of a bound joint showing frapping.

B.2.5 Plates / Strapping

Strapping over joints and metal plates



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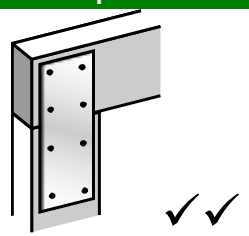
Strapped joint



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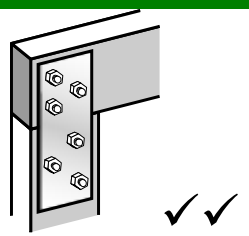
Nailed metal plate



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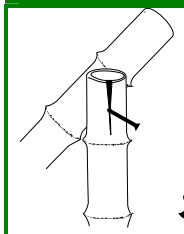
Bolted metal plate

- Metal straps and braces are simple ways to strengthen nailed joints. A distribution of metal straps in an earthquake zone would be a quick and simple way to protect timber buildings.
- Gang-nailed plates need a press so they may not be appropriate for emergency or on-site work.
- Specialised metal plates with bolts can be used as joints, although specifying them may lead to delays due difficulties in procurement.

B.2.6 Bamboo

Unlike timber, bamboo should not be nailed as the nails will cause it to split. Instead it should be pegged, bound or glued.

Bamboo should not be nailed!



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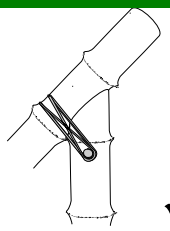
Bamboo should not be nailed as it will split.



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Peg, bind or glue bamboo paying attention to locations of nodes

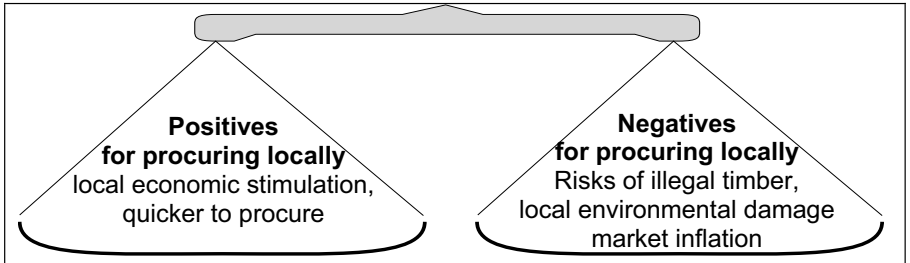
For more information on using timber, see section ii – annexes.

What other good reference books are worth mentioning here?

section C specification

C.1 Working with suppliers

A humanitarian agency's internal procurement guidelines should take precedence over the advice in this booklet. However, be aware that timber can be supplied locally, nationally or internationally and by communities, authorities or private suppliers. (see section A.4).



Weighing up the positives and negatives of procuring locally or from further afield.

Certification schemes can provide lists of approved suppliers of legal and/or sustainable timber (C.2.3).

Larger volume timber suppliers often have procedures that humanitarian organisations should be aware of. Timber procurement will be made easier if:

- Letters of credit are developed in advance
- Issues of non-performance can be agreed in advance
- Timber suppliers have time to identify mills, treating plants and shipping agents that will help speed up delivery
- Humanitarian agencies' orders are clear and are not subject to last-minute change
- Parties discuss pre-inspection of timber before it leaves port

Humanitarian agencies can join together prior to, or early in an emergency response, to information on suppliers policies and regulations as well as advocate for easing of transportation and customs regulations for the relief operation.

C.2 Source verification, certification and documentation

C.2.1 Timber and the law

Stop! *if you suspect timber is from a protected forest.*

Wait *and get more info.*

Go ahead *when the checks are in place.*

There is no single definition of 'legal' timber as different international agreements and national laws cover different parts of the timber industry. Humanitarian agencies must, at the very minimum, follow the law of the country they are working in and be aware of international timber agreements.

International trade in timber is controlled through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the International Tropical Timber Agreement (ITTA).These agreements are voluntary and implemented through the domestic laws of each participating country rather than by an external international legal body.

CITES is an agreement protecting certain plants and animals threatened by international trade. 172 states are signatories to CITES. See www.cites.org for a list of endangered tree species. Even If a country is not a signatory too CITES, international organisations should aim not too use species listed under CITES.

The **ITTA** (1976, updated 2006) relates to forest conservation and development, and controls for the trade in tropical timber. See www.itto.or.jp.

The Food and Agriculture Organisation (**FAO**) conducts work on forest law enforcement, supporting countries to strengthen their forestry policies and determine the extent of illegal operations. See www.fao.org/forestry.

When choosing an international timber supplier, ensure they are based in a country enforcing the above agreements.

See WWF's "Keep it Legal" guide for more information.[1]

Ownership

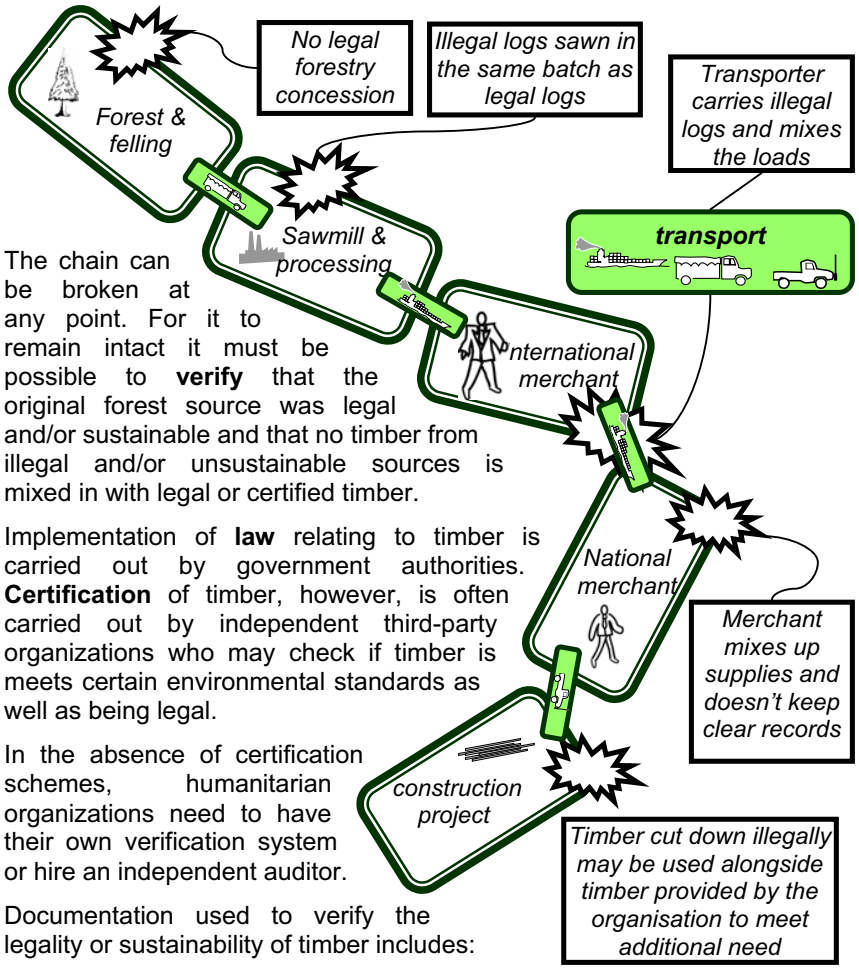
All resources belong to someone, a group or an institution. When purchasing timber harvested locally, check who really owns the timber. When using reclaimed timber after disaster, ownership must also be established.

Need more here on local forest ownership & management

[1] 'Keep It Legal' http://assets.panda.org/downloads/keep_it_legal_final_no_fsc.pdf

C.2.2 Chain of custody

Timber passes through different processes managed by different businesses - from the tree being cut down and sawn to a board being sold by a local merchant. This journey timber travels through is the "**Chain of custody**".



The chain can be broken at any point. For it to remain intact it must be possible to **verify** that the original forest source was legal and/or sustainable and that no timber from illegal and/or unsustainable sources is mixed in with legal or certified timber.

Implementation of **law** relating to timber is carried out by government authorities. **Certification** of timber, however, is often carried out by independent third-party organizations who may check if timber is meets certain environmental standards as well as being legal.

In the absence of certification schemes, humanitarian organizations need to have their own verification system or hire an independent auditor.

Documentation used to verify the legality or sustainability of timber includes:

- Third-party audit: certification schemes, national legal certificates
- Second-party verification: verification by another company, an organisation or a local community.
- First-party checks: a company's own documents

C.2.3 Third-party audits

Different audits of the chain of custody by third parties (i.e. not the supplier or buyer) verify different things. They might prove compliance with CITES; sustainability or environmentally sound processing. Humanitarian agencies must decide on what standards they expect to be met before deciding what documentation a supplier needs to provide.

Certification schemes

Certification schemes may be international, regional or national. **Each certification scheme has its own concept of 'sustainability' and not all are independent due to close links to the forestry industry**. Most certification bodies will provide lists of suppliers on request. The World Wildlife Fund has a tool[2] for finding certified companies (it recommends using FSC certified suppliers). Some of the major certification bodies are listed below:

Organisation		Description
Forest Stewardship Council (FSC) www.fsc.org	FSC	Certification conducted through accredited bodies. **Recommended by WWF**.
Programme for the Endorsement of Forest Certification (PEFC) www.pefc.org	PEFC	Global umbrella organization for the assessment of and mutual recognition of national forest certification schemes.
The Sustainable Forest Initiative (SFI) www.aboutsfi.org	SFI	SFI certifies different types of forest products.
Canadian Standards Association (CSA) www.csa.ca		CSA runs a Sustainable Forest Management (SFM) verification scheme.
Malaysian Timber Certification Council (MTCC) www.mtcc.com.my	mtcc	Operates voluntary national timber certification scheme for legal (rather than sustainable) certification.
Note: Inclusion in this list does not imply endorsement of the certification scheme.		

Ecolabelling

An Ecolabel is awarded through third party audit to products that meet certain environmental standards. There are many different Ecolabels (including some awarded by the certification bodies above) For example, ISO 14001 shows that a business has met standards for environmental management. Ecolabels are not the same as forest or timber certification but are complementary.

[2] http://gftn.panda.org/practical_info/certified_companies/index.cfm

Independent Forest Monitoring

IFM involves the monitoring of forestry processes by an international, independent third party with the agreement of state authorities.

IFM has so far been undertaken in Cambodia, Cameroon, Canada, Ecuador, Indonesia and the Philippines, by both NGO and corporate sector organisations. See http://www.illegal-logging.info/ for more information.

National certificates of legality

In order to follow the law in the country of operation, timber purchased nationally must be approved by the appropriate authorities.

Check with the national forestry and/or environment department to find out the details of national law relating to timber. Ask them for a list of approved suppliers; what certificates they issue and how to check if they are genuine.

Corruption

In addition to illegal harvesting (logging) of timber and illegal trading of timber, the World Wildlife Foundation (WWF) says timber is illegal when:

"Authorization to harvest or trade logs or timber products is secured through corrupt application of laws or administrative procedures." [3]

Corruption may be through falsified documents or through collusion with national authorities and is worth a lot of money to those involved.

If government collusion is suspected humanitarian agencies should seek advice from environmental groups and regional bodies for Forest Law Enforcement and Governance (**FLEG**).These bodies are supported by the World Bank, aiming to strengthen the implementation of forestry laws. See the World Bank's Forestry website for more information.[4]

Transparency International (http://www.transparency.org) produces a number of 'corruption indexes' that may be useful starting points.

C.2.4 Second-party verification

Second-party verification is initiated directly by the buyer.

We can work with other organisations to monitor legality and sustainability.

Private auditing

A private auditor can be hired by humanitarian agencies to verify the timber source (this may be more economically viable if agencies pool resources).

3 www.panda.org/gftn

[4] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/EXTFORESTS/0,,contentMDK:20636550~pagePK:210058~piPK:210062~theSitePK:985785,00.html

The following offer verification services. The list is not exhaustive nor does it imply recommendation:

- Certisource: www.certisource.net
- SGS: www.sgs.com
- Helveta: http://corporate.helveta.com
- Track record: www.trackrecordglobal.com

Community verification

A community group could be established to confirm that suppliers are not supplying timber from areas that are considered to be vulnerable by the local community.

This section needs more suggestions…

Direct verification by humanitarian agencies

For local purchases the agency could go and look at the area where the timber or bamboo is coming and make its own environmental assessment.

Forming a joint-procurement group will help agencies pool their resources in order to verify that the timber they are sourcing is legal and sustainable.

The UK's Central Point of Expertise for Timber Procurement (CPET[5]) has produced the following matrix for evaluating the legality of timber products:

Criteria	How does the source comply?	Mechanism for verification	Evidence
The forest owner/manager holds legal use rights to the forest			
Compliance with national laws e.g. • Forest management • Environment • Labour and welfare • Health & safety • Other groups' land rights			
Royalties and taxes are paid			
Compliance with CITES.			

This section needs more suggestions…

5 See http://www.proforest.net/cpet for useful guides on verification

C.2.5 First-party checks

First-party checks are declarations made by the supplier themselves to verify that the timber they are supplying is legal or meets certain environmental requirements. These checks may form part of a verification process initiated by humanitarian agencies as described above. CPET publishes Practical Guides to Supply Chain Information (www.proforest.net/cpet).

A supplier declaration is more than a letter. It should include the following:

1. A description of the timber supply chain up to the supplier in question
2. The controls that are in place to prevent mixing or substitution
3. Management of the implementation and adequacy of these mechanisms
4. Signed confirmation that information is up-to-date and correct

Humanitarian agencies will need knowledge of forest management to be able to decide whether such documents show that timber is from legal or sustainable sources and may well require the skills of an external consultant.

This table from CPET could be used in a tender process. Potential suppliers can fill in this table to help verify the chain of custody:

Supply chain	Supply chain description		Controls for preventing mixing or substitution	Mechanism for verification	Evidence available or provided
	Description	Location			
Forest					
Milling					
Trans-porting					

C.2.6 Community ownership

The ownership of a forest may be disputed or unclear, particularly when trees or bamboo is on communal land. Before allowing the use of timber collected or salvaged by beneficiaries or the local community establish who owns the resources and that collection is not causing environmental damage.

C.2.7 Phytosanitary certificates

Phytosanitary certificates are issued by quarantine authorities or agriculture ministries for raw timber products. Certificates issued by the country of export may not be considered valid by other countries, so check first.

Processed timber composites or chemically treated timber should not require phytosanitary certicates. Untreated wooden pallets used for packaging will.

Phytosanitary certificate checklist
• Details of packing • Botanical tree species names and whether softwood or hardwood • Country where tree came from • Serial numbers of phytosanitary certificates issued in the country of origin (import if timber is re-exported) • Dimensions / weight of packaging articles plus volume of wood in cubic metres • Name / number of boat or plane • Wood treatment type (e.g. Chemical Pressure Impregnation) • Name of chemical used • Duration of treatment applied for effective treatment • Dosage rate of chemical (number of grams per cubic meter) • Date of treatment

C.2.8 Documentation checklist

Below is a checklist for documentation a supplier might need to provide.

Document	Example
Proof of legality	Government certificate of legality Third-party certification Independent Forest Monitoring certificate
Proof of sustainability	Third-party certification Proof of forest management program
Customs clearance documentation (imports only)	Phytosanitary certificate from port of departure Customs authorities approval
Documents relating to other national law	Proof of tax/royalties paid Health and safety certificate
Description of harvesting/ logging process	Third-party certification Independent auditor / survey Company's own documentation
Description of seasoning and treatments used (operating procedures)	Third-party certification Independent auditor / survey Company's own documentation
Grade certification	Certificate of quality/grade by national grading authority
Other	Delivery note Invoice

C.3 Processes and treatments

Timber's durability is reduced by exposure to certain risks, or 'hazards'. These are mainly exposure to water and air and attack by insects or fungi.

Define and explain wet rot, dry rot etc.

'Hazard class' (HC) is a description of the hazards, or risks, timber is exposed to. Below is an example of a hazard class system which is useful for identifying the types of timbers and treatments required.

Hazard Class	Description
1	Timber not exposed to weather – frames / internal e.g. doors, roof trusses, floor boards
2	As above and protected from termites
3	Timber exposed to the weather but not in contact with the ground e.g. cladding, log-homes
4	In contact with the ground – fence posts etc.
5	Timber exposed to 'continual wetting'
6	Marine use – jetties etc.

Most construction timber is Hazard Class 2 or 3, and so should be kept out of the ground and out of exposure to "continual wetting". Timber used in certain parts of buildings will not need any chemical treatment at all, merely to be kept dry.

Timber's durability in these hazard classes can be improved by:

- Drying timber (seasoning) and keeping it dry (C.4.1)
- Treating timber with a preservative (C.4.2)

C.3.1 Seasoning

Seasoning is the drying of wood in a controlled way to avoid distortion. Seasoned wood is lighter, stronger and less likely to split, warp or rot. Wood is seasoned by: air-drying or kiln-drying (or 'forced-air' drying).

Moisture content (MC)

Seasoning reduces wood's moisture content. MC is calculated as a %:

$$MC = \frac{\text{Weight when cut minus oven-dry weight}}{\text{Oven-dry weight}} \times 100$$

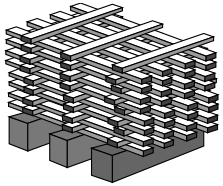
To measure this, a sample of timber several centimetres long can be cut (50cm away from the end of a board and free from knots and irregularities),

and weighed immediately. It should then be dried at a temperature of between 101-105 degrees Celsius and weighed successively until it has reached its lightest weight – its oven-dry weight (this may take between 12 and 48 hours).

The moisture present in wood can weigh more than the dry weight of the wood and therefore it is possible to have a MC of over 100% when timber is green. The MC required for construction grade timber is normally around 20% and can be measured with a moisture meter (an electronic meter with two metal pins that are inserted into the timber costing around $150).

Air-Drying

Air-drying reduces moisture content to between 15 and 20%. For a 2.5cm thickness of timber air drying takes around one year for hardwoods and six months for softwoods. Timber poles are often dried this way. The ends of the timber lose moisture fasted and are sometimes painted to protect them.



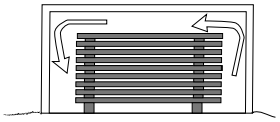
air drying by stacking timber so that air can circulate around it

Kiln-drying

This method reaches the desired moisture content within a period of a few days to a week. The maximum thickness of timber for kiln drying is around 45mm. Kilns can be electric, solar or fuel (e.g. oil) powered.

Bamboo

Bamboo shrinks more than wood when it loses water. On account of the varying starch and water content in bamboo the species type, the season and even the time of day should be taken into account when harvesting or treating bamboo.



kiln drying in controlled temperature and humidity

There are many treatments for bamboo – all aim to reduce water content and remove starch / sugars in order to reduce the likelihood of attack by insects:

- Air-dried - in stacked frames with good air circulation for (6 - 12 weeks.)
- Kiln-drying of some species of bamboo (2 – 3 weeks).
- Clump curing – cured in locations they are cut
- Smoking – cured by smoking (can lead to cracking)
- Soaking – soaked in mud/water for 4-12 weeks (removes starch and sugar) then dried in the shade.

Is there a useful free downloadable guide to solar drying?

C.3.2 Treatments

Treatments are used to improve the durability of wood by: preventing attack by fungi and insects; improving fire safety and protecting from weather and wear. Treatments may be toxic to people, animals or water supplies. Follow the Environmental Health and Safety Guidelines issued by the World Bank.[6]

The following table lists typical timber treatments. Note that some treatments are more readily available in some parts of the world than others.

Chemical name	Commercial names	Protects against	Application method	Toxicity	Availability
Oil based					
Often applied as a paint or under pressure.					
Creosote					
-	Waste engine oil & diesel				
	Linseed oil				
Pentachlorophenol					
Copper Naphthenate					
Water-bourne					
Fungicide/insecticide dissolved in water, sometimes with an added dye. Types: **Low-pressure** (quick-drying, used for Hazard Classes 1, 2 and 3) and **High pressure** (suitable for all hazard classes). High-pressure treatments can be fixed (do not wash out with water) or non-fixed (generally boron compounds).					
Chromated copper arsenate (CCA)				Highly toxic.	Often banned.
Alkaline copper quaternary (ACQ)					
Borate preservatives					
Bifenthrin	Talstar, Brigade, Capture,				
Light Organic Solvent Preservatives (LOSP)					
Similar to low-pressure water-borne treatments but use white spirit as the solvent. Normally for Hazard Classes 1, 2, often for joinery. Should not come into contact with drinking water supplies.					

[6] http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

Table needs completing…

Add column on whether treatment can be applied without technical supervision…

Search for chemical properties: http://extoxnet.orst.edu/pips/ghindex.html

Bamboo treatments

Treatment processes for bamboo include: the open tank method, butt treatment method or the Boucherie method.[7]

More needed on treatments for bamboo…

Choosing a treatment

This section needs writing…

Needs to include checking you are using the right treatment for the right hazard (different countries have different pests…)

More on field treatments…

Handling treated wood

Advice on dealing with burning cut offs. Also see section D…

[7] See Janssen (1995) Building with Bamboo: An Introduction, ITDG

C.4 Quality

C.4.1 Grading classification

Construction-grade timber can be graded visually or by machines (timber used for decorative purposes is graded visually, but is not considered here).

Different species of timber with similar properties are grouped together and given a grade. A buyer only needs to know what grade is needed, rather than the particular species. Grading systems differ from country to country. Some countries will have no system at all.

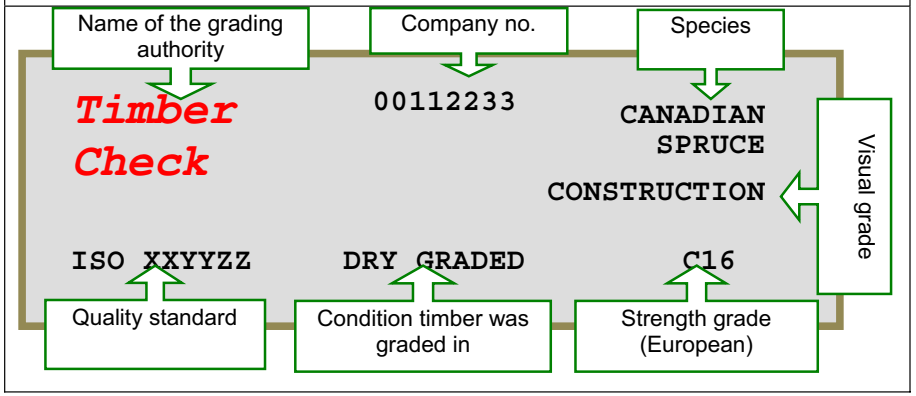
Always check what species is being supplied and whether people locally prefer to work with a hardwood or a treated softwood.

Grading classification may be known as **'strength'** or **'stress'** grades. Certificates are usually provided by independent grading bodies, authorised to verify whether specific quality standards (which also vary from country to country) are being met by a supplier.

Is there a simple table comparing different grading systems?

A summary of country-specific grades can be found in FAO's Tsunami information guides.[8]

Example of a stamp on graded timber



If there is supposed to be a stamp and no stamp is present do not use the timber for structural purposes.

[8] WWF and Greenomics Indonesia, *The Implementation Design: Timber for Aceh* (2005), http://assets.panda.org/downloads/wwftimberforaceh.pdf

Durability

Durability varies by species. However, the Australian classification[9] gives a good guide to what might be demanded. Their classification is based on trials of resistance to pests and decay of untreated heartwood in the ground.

Class	Description	No. of years durability in the ground	No. of years durability above the ground
1	Highest durability	25 years +	40 years +
2	High durability	15-25 years	15-40 years
3	Moderate durability	5-15 years	7-15 years
4	Low durability	0-5 years	0-7 years

C.4.2 ISO standards

Section on relevant ISO standards here…

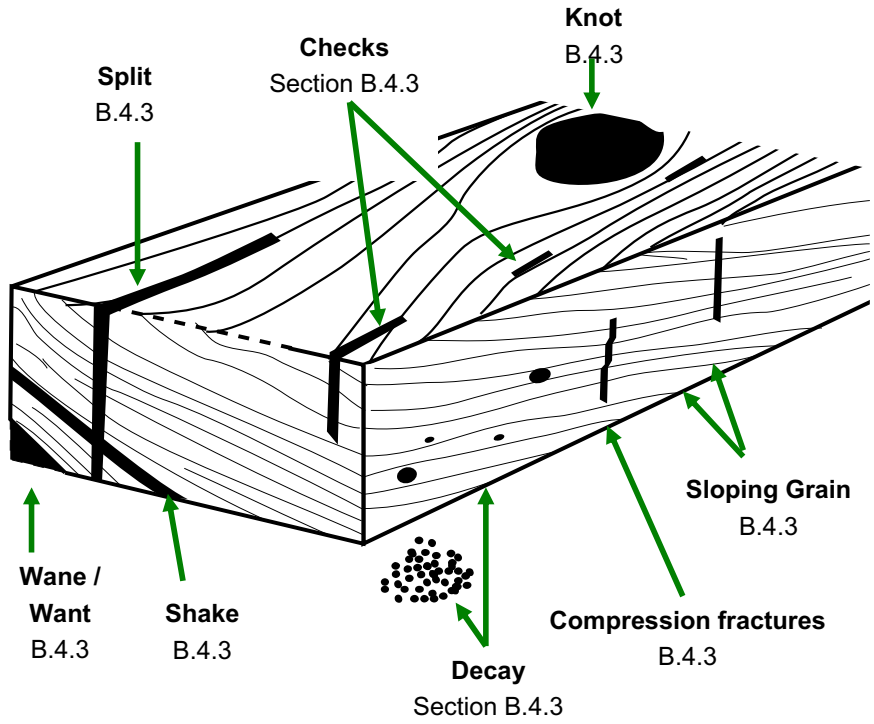
C.4.3 Visual grading: sawn wood

Visual grading, although part of classification systems, visual grading can be used to check timber quality in deliveries in countries where no grading system is in place.

Professionals undergo considerable training to become qualified in visual grading. However, in circumstances where small quantities of timber are being purchased and logisticians are involved in evaluating deliveries, some of the following basic guidelines will be of use.

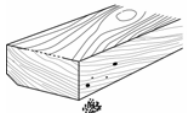
When visually grading timber, all surfaces should be checked and the timber is normally rolled along its length to reveal any obvious warping. Substandard pieces should be placed in a separate pile for double-checking. It is advisable to have a representative of the supplier (e.g. the delivery driver) to acknowledge and sign for defective timber.

9 http://oak.arch.utas.edu.au/glossary/view_glossarylist.asp?term=D



Decay

Damage caused by fungus, bacteria or pests.



Specify: Free of fungus, bacteria or pests

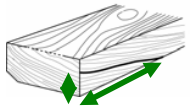
Look for: Signs of fungus or insects, such as fine sawdust or holes. Reject timber with any signs of decay.

Wet rot: wood is soft and breaks along the grain. The timber should be re-dried and any remaining rotten sections thrown away.

Dry rot: breaks into cubes and has a cotton-thread-like consistency. This timber is unusable and must be destroyed (burnt).

Sloping grain

The direction of the grain in relation to the length of the timber. This is measured by using a grainscribe.

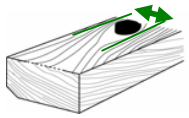


Specify: THIS NEEDS RE-WRITING

Measure: THIS NEEDS RE-WRITING

Knots

Knots are formed where branches grow out of the main tree trunk. A **sound knot** is one which is as strong as the surrounding wood and shows no sign of decay. An **unsound knot** is a weakness in the wood and is softer, chipped or shows other signs of decay. MORE DETAIL…

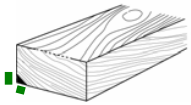


Specify: Limits on knot sizes for sound and unsound knots.

Measure: Measure the width of the knot and divide it by the width of the timber. Also measure the number of knots per metre along the timber.

Wane and want

Wane is the absence of wood from the face or edge of timber due to the board being cut near the edge of a log.



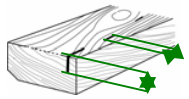
Want is the absence of wood due to some of the timber being split off in processing

Specify: maximum wane or want allowed

Measure: This is normally expressed as a percentage or fraction of the width or thickness of timber.

Checks

A separation of fibre bonds across the annual rings that **does not** carry all the way through an edge or face of a timber board.

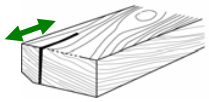


Specify: A limit on the absolute length of checks or as a maximum width of the board

Measure: the length of the checks and divide by the board thickness

Split

A separation of fibre bonds across the annual rings that **does continue** all the way through to an adjacent or opposite side of the timber.

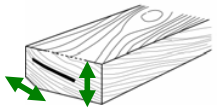


Specify: total length of the split, e.g. 15cm

Measure: the absolute length of the split from the end of the board

Shake

A separation or a weakness of fibre bond between the annual rings. Shake affects shear strength more than compression strength so specifications for the amount of allowable shake may vary depending on the timber's purpose. It can also allow water to enter the timber leading to rot

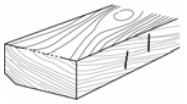


Specify: Maximum length of open shakes (cracks) as a fraction of timber end width. E.g. less than ½ of end width

Measure: Length of open shakes (cracks) divided by plank thickness

Compression failure

Cracks across the grain, and is due to excessive compression.

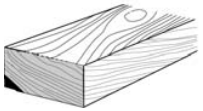


Specify: Timber should be free of all such fractures.

Measure: visual inspection

Sapwood

Sapwood (section i.5) is less strong than the heartwood. In softwoods it is treated to improve its durability.



Specify: If a hardwood is being ordered then should be considered as 'wane' (see B.4.6).

Warp

'Warping' is any variation from a true, flat surface. Bow, spring, Cup and Twist are all types of Warp

a) Bow Warp

Curve along the length of a board (along the grain)

Specify: Deviation per unit length.

e.g. Maximum 1cm per 3m length

b) Spring warp

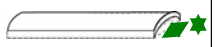
Curve along width of board (across the grain)

Specify: deviation per unit width.

e.g. 1mm/100mm width

c) Cup warp:

Curve along edge of a board but not affecting the face (along the grain)



Specify: deviation per unit length

e.g. Maximum 1cm per 3m length

d) Twist or curve warp:

twisted distortion along the length of the timber (along the grain and across the grain)

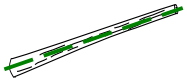
Specify: deviation per unit length

e.g. Maximum 1cm per 3m length

C.4.4 Visual grading: timber poles

Taper

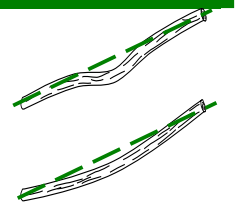
Taper is the natural thinning of a pole towards its tip.



Specify: The change in diameter should not be more than 5-10mm per meter of pole length.

Sweep and crook

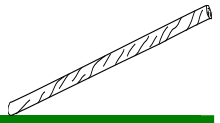
Sweep and crook measure straightness. 'Sweep', is where a pole bends like a banana, and 'crook' where a pole is crooked.



Specify: (draw an imaginary line from end to end of the pole and there should always be a part of the pole in the axis).Poles are usable if the sweep or crook deviation never falls beyond the central axis of the pole.

Spiral grain

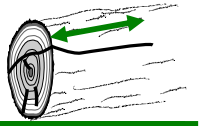
poles from trees that have grown in a twisted manner.



Specify: rejected poles with spiral grain

Splitting

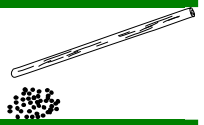
Poles might split at the ends



Specify: No splits larger than 100mm should be present at the ends of the poles.

Degradation

Specify: Poles showing insect or fungal attack should be rejected



Damage from felling

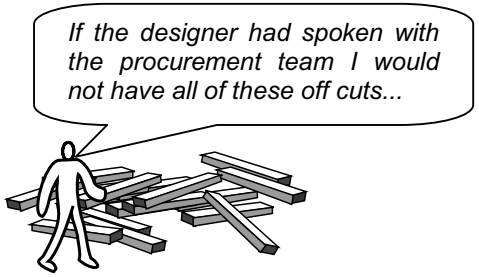
Specify: Poles that show severe damage from the logging process should be rejected.

C.4.5 Visual grading: bamboo

Section to be completed

C.5 Quantity

Depending on the scale of procurement, timber is procured by volume or by length. Within each order, individual planks or poles are specified by **length** and **cross section** or in the case of poles or bamboo, **diameter**. Sizes may be affected by finishing and shrinking.



Add 5% to order for wastage in transport.

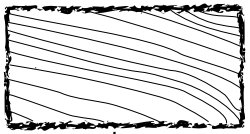
Standard lengths and cross sections vary from country to country, so it is important to check that any design is designing for the lengths and widths that can be supplied.

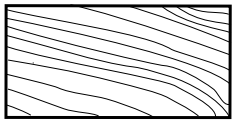
TABLE NEEDS IMPROVING…

Standard sawn timber sizes – metric & imperial and examples			
Inches	Metric equivalent	Swedish	Australian
2 × 4	50 x 100 mm	45 × 95 mm	45 x 90 mm
2 x 2	50 x 50 mm		
4 x 4	100 x 100 mm		
1 × 3	25 × 75 mm	22 × 70 mm	19 x 70 mm
3 × 3	75 × 75 mm	70 × 70 mm	70 x 70 mm
1 × 4	25 × 100 mm	22 × 95 mm	19 x 90 mm
1 × 5	25 × 125 mm	22 × 120 mm	19 x 120 mm
2 × 5	50 × 125 mm	45 × 120 mm	45 x 120 mm

C.5.1 Tolerances/deviation

"Tolerance" is the acceptable deviation, and may be expressed in millimetres for deviation of the cross-section of timber or as a maximum percentage deviation in length. Deviation may be caused by finishing and shrinkage.


rough sawn


finished

Different countries will have different quality standards for acceptable deviation in structural timber and this deviation may vary for sawn or machined timber. For example, British Standard BS EN 336 specifies:

Cross-section size (mm)	Sawn timber (mm)	Machined timber (mm)
≤ 100	+ 3 to -1	+ 1 to -1
> 100	+ 4 to -2	+ 1.5 to -1.5

Finishing and sawing

- Sizes are normally quoted as being 'rough sawn'. Planing the timber to make it 'finished' will mean a loss of width.
- Be aware that logs may lose 30-40% of their volume in wastage when being cut down to size.

Shrinkage

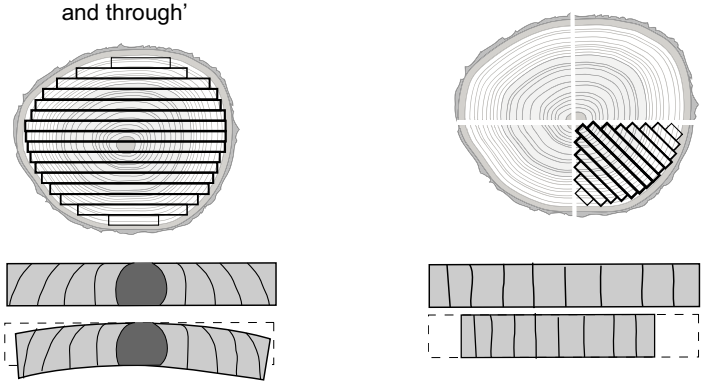
Timber shrinks as it dries. Shrinkage occurs more across the width of a timber board than along its length. Timber that is sawn before it is dried will shrink and distort more than timber that is dried first and then sawn.

Ask the supplier about any potential problems with distortion of timber due to moisture changes during transport or in storage.

The amount and direction of the shrinkage of wood will depend on its species, treatment and, for sawn wood, in what way it is cut from the tree. Quarter sawn wood bends less:

Back-sawn timber (also known as 'though and through'

Quarter-sawn timber



This diagram needs double-checking…

Bamboo shrinks more than wood, shrinking up to 17% in cross section and in wall thickness.

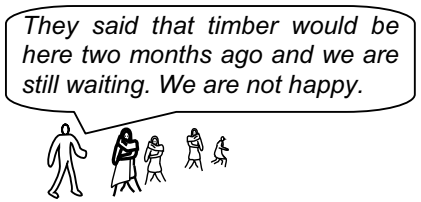
C.6 Delivery and payment

C.6.1 Delivery

Delivery conditions

Delivery conditions should establish:

- Delivery schedule – when the timber will be delivered
- Where and how the timber will be delivered
- Cost and organisation of loading / unloading
- Cost and organisation of any on-going transport
- What unloading equipment is required / available
- How timber will be packed ((do you need to be able to load and unload timber by hand?)

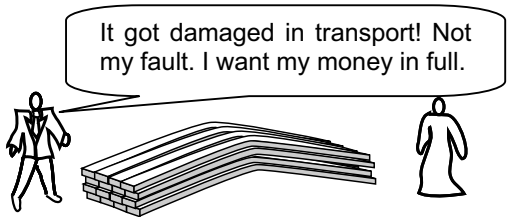


Lead-times should **realistically be agreed** and fixed in the contract. Beneficiaries need to know when they can expect construction to begin.

Contracting out procurement may be one option for speeding up the process, though in a situation where the timber market is under pressure, private companies may have just as many problems as humanitarian agencies in securing timber from limited sources.

As with all supplies, the delivery should be checked in terms of quality and quantity before being accepted.

C.6.2 Payment



International suppliers normally require a 'Letter of Credit' proving the agency's commitment and ability to pay before dispatching any timber.

Contracts should clarify who is responsible for:

- Cost of packing materials
- Costs of delays
- Import fees
- Payment process
- Insurance
- Damages (and compensation rate for damaged goods)

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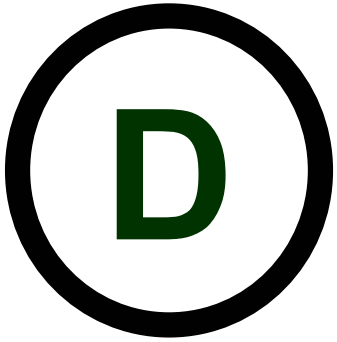
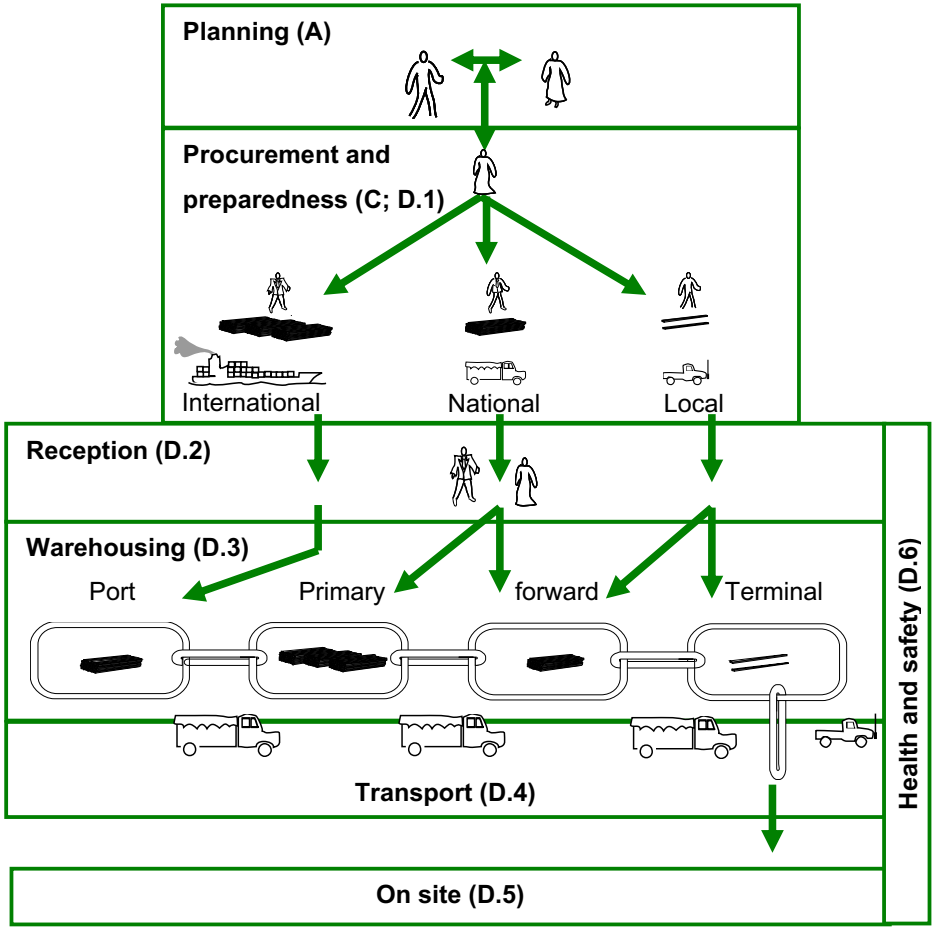
section



logistics

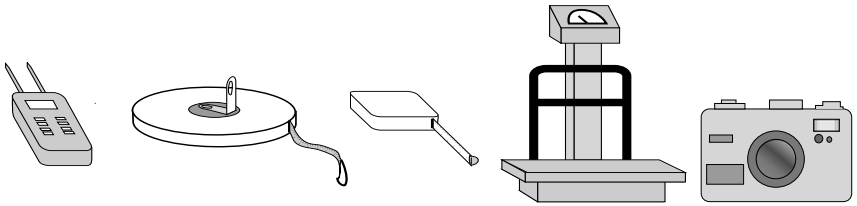
Timber needs to be checked for quality on delivery and needs to be stored with some care. For larger procurements, both the challenges of finding an appropriate timber supply and the potential transportation challenges can lead to significant delays in delivery. Programme staff and beneficiaries must be made aware of these expected delays.



D.1 Reception

D.1.1 Local deliveries

For large deliveries a professional or a trusted inspection company might be used. For smaller deliveries, the grading in B.4 might be used.



To receive timber and check specifications of timber, you will need: (left to right) moisture meter, measuring tapes, weighing scales. Also take pen, paper and a camera!

Some simple tests on the receiving of timber are:

- Measure moisture content
- Visually check for pests, damp and defects (see visual grading section)
- Roll timber on the ground to check if it is straight
- Check and photograph certification stamps on timber

Depending on warehouse layout, additional dry temporary storage space might be required.

Quality checks of local purchases could be carried out by beneficiary teams.

D.1.2 Imported deliveries

Where timber has been delivered internationally, it may be possible to check (either directly or through a third party validation) at the port of departure. This will help to avoid having to resolve disputes over quality once the timber has been imported.

Agree beforehand any penalties for timber that does not meet quality standards required.

Collective purchasing through a multi-agency consortium increases strengthens the buyers' position.

Prepare transport for loading and storage space beforehand.

Check any specific handling requirements in terms of loading and unloading machinery.

D.2 Storage

Keep timber dry

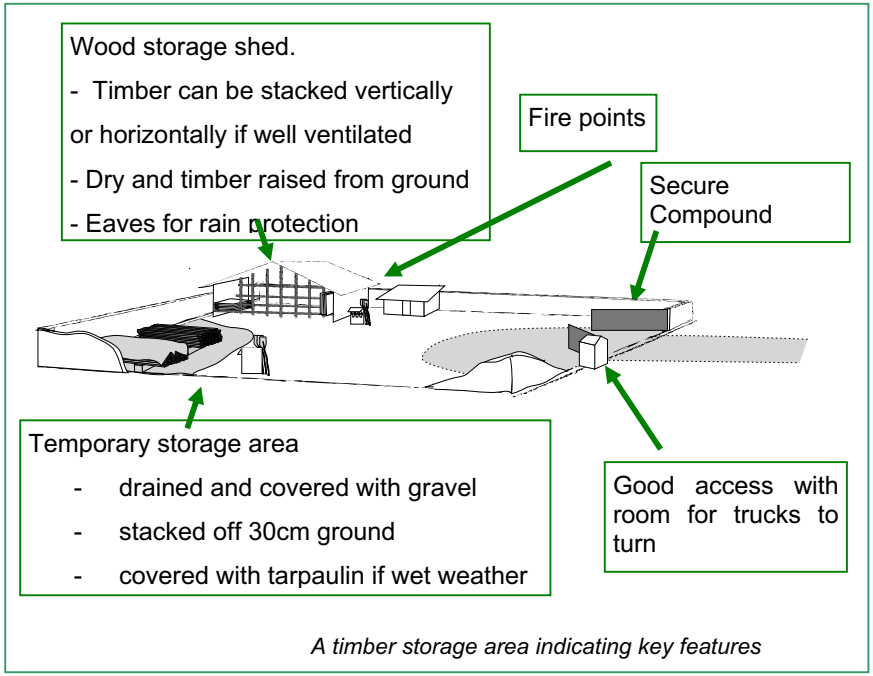
Timber should be kept dry – dampness is the main reason for it spoiling. Store it on 'bearers' to keep it around 30cm from the ground. Store in a clean, dry, well-ventilated building. If no building is available, place the bearers on sand or ashes and cover the timber with a ventilated tarpaulin to protect from rain and sun.

Moisture fluctuation

Timber moisture content can and will fluctuate in storage. However, once it is actually to be used in construction it must be within the correct limitations for moisture content. Maintaining the correct moisture content during storage is the best way of making sure that timber will be in the right condition when it is to be used.

Check regularly

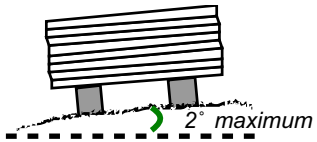
As timber and bamboo are perishable items, they should be regularly checked and moved. Checking should include at minimum visual checks and ideally checks with a moisture metre.



A timber storage area indicating key features

Site

The storage site should be solid with a slope of less than 2 degrees. The ground should be strong enough to withstand the load of timber and delivery trucks.



Banding

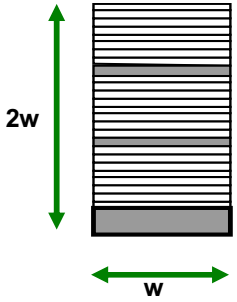
Sawn wood is often bound in packs by metal bands. Over-tight bands damage outer pieces and if shipped in small packs will result in high losses.

Regularly inspect for weakness - in high humidity swelling timber may cause bands to snap. Wear eye protection and gloves when removing bands.

Stacking

When stacking packs of sawn wood; poles or bamboo, ensure stacks are:

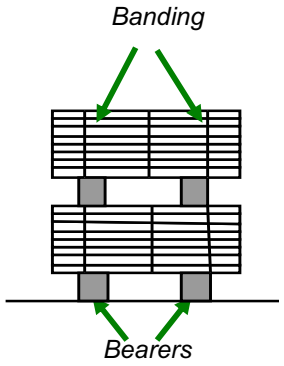
- Flat and off the ground on bearers.
- Organised with gaps for access/firebreaks.
- Ventilated, with air gaps within stacks.
- No higher than twice their width in public places or on slopes; three times their width if warehoused without lifting machinery; four times the width if warehoused with lifting machinery.
- Vertical only when storing small quantities.
- Checked after high winds.



In public places, timber a stack should be no higher than twice its width (w)

Bearers

Bearers prevent stacks from getting wet on the ground and facilitate the use of lifting equipment. Bearers should be straight and uniform in size, shorter than the width of the timber to prevent people from climbing the stack and positioned across the stack (not lengthways) to prevent stacks from toppling.



Container storage

If agreed in advance with the suppliers, the shipping containers can be used for storing wood. Like warehouses, containers should be sited in a secure location and away from flooding.

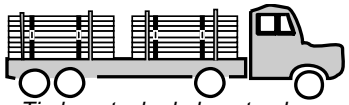
Storage of timber frames

Pre-built frames and trusses must also be protected in the same way as individual pieces of wood.

D.3 Transport

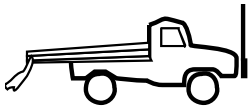
D.3.1 Transport by truck

Trucks should be loaded carefully. The diagrams below show how timber should be laid lengthways along a truck bed rather than across it. This is firstly so that it does not stick over the sides, but also to reduce risk of it tipping.



Timber stacked along truck

DO NOT stack timber across a truck – it is likely to fall



If large loads are to be carried, ensure that they are clearly marked at the end.

Loading / Unloading

Timber and bamboo is commonly split and damaged in handling. When unloading, staff should be under strict instructions to place rather than throw it from the truck. Staff should be issued with protective clothing (gloves / boots) to prevent splinters and injuries (D.5).

DO NOT THROW THE TIMBER FROM THE TRUCK!!!

Paperwork

The transportation of timber is frequently tightly controlled. Identify and ensure that the correct paperwork is in place before transporting timber by road.

Access

Due to timber's volume and weight, large trucks may be necessary. Check that these trucks will be able to the roads leading to delivery sites.

D.3.2 Transport by other means

Floating poles down river

This is a very particular form of transport and is not advised.

By boat

Transport by boat may be required when road transport is too expensive, impractical or dangerous. Shipping of timber should generally be the responsibility of the supplier or a freight company.

D.4 Distribution

Timber can be distribution direct to a construction site or to distribution point from where beneficiaries collect timber, though it may have to be treated first. Any site has the challenge of access, and arrangements should be made if trucks are to be used. (D.3.1)

Distribution to individuals

When timber or bamboo is being distributed, support will be needed by individuals with transport as timber is heavy and bulky.

As timber requires strength and skill to use, additional technical and possibly physical construction support will be needed by individuals to whom it is given.

Wood waste

When significant construction is underway at one site, have a wood-cut waste strategy in place

- **Store:** keep wood dry and off the ground;
- **Centralise:** have a centralised cutting area to make finding useable off-cuts easier;
- **Reuse:** reuse off cuts but be careful of the dust and the waste especially if treated.

D.4.1 Delivery to construction site

The delivery of timber should be timed with the delivery of other materials so as not to hold up construction or not to spoil or risk theft before it is used.

When delivered, timber should also be accompanied by fixing materials, tools and people who know how to use them.

D.4.2 Distribution of un-cut wood

Where projects involve the use of uncut logs (such as reclaim of fallen trees) or rough timber, cutting tools may need to be provided onsite. In many areas these tools might need to be controlled to ensure that they are not used for illegal logging activities.

D.5 Health and Safety

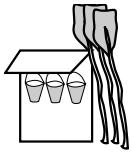
Timber itself is not a health risk (though rare poisonous woods exist) but there is a risk through skin contact with glues, treatments and splinters or inhalation of mould and sawdust.

Dust

Some national health and safety standards give a Maximum Exposure Limit (MEL) for exposure to dust.[1] MEL is measured as the weight of material per cubic metre of air, over a reference period of 8 hours. Note that hardwood dust is considered to be carcinogenic.

If prefabricated components are being built, or significant amounts of work are taking place indoors, an effective dust extraction system should be installed and protective equipment provided.

Fire safety



Ensure fire safety procedures in warehousing are enforced and particularly in work rooms since wood dust may present a risk of explosion. Fire-fighting equipment should be available and staff should be trained to use it. Ensure that sufficient firebreaks are present between stacks when storing large volumes of timber.

Transporting, loading and moving

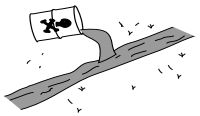
As for all heavy objects, workers must be trained in lifting of heavy weights.

Ensure timber stacks are stable and use signs to warn against dangers of climbing on stacks. Gloves should be worn to prevent splinters.

Chemicals

Always follow the advice of the chemical manufacturer. Be aware of the environmental impact of chemicals washed into surface or ground water. If in doubt seek technical advice and do not treat timber yourself.

- Do not distribute timber until chemical treatments are dry
- Do not handle wet, treated timber without gloves
- Excess treatments should be washed or brushed off before being handled.
- Ensure the legality and safety of chemicals purchased.
- Ventilate work space.
- Do not burn treated off-cuts as cooking fuel.
- Train people on the use of safety equipment (including gloves and goggles), and the importance of hand washing and hygiene.



Chemicals may enter water supply!

[1] The Control of Substances Hazardous to Health (COSHH), UK sets a 5 mg/m³ limit.

section

annexes

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ii ANNEXES

ii.1 Glossary

Term	Meaning
Board	A term used for a piece of timber which is wider than it is thick.
Cellulose	Complex sugar-based chemicals in a tree providing strength and elasticity to timber.
Chain of custody	Process through which wood passes from tree to finished wood product and can be traced back to its origin through inspection.
Check	Separation of fibers along the grain and across the growth rings. The crack formed does not run from face to face.
Compression failure	Fracture of wood fibers across the grain resulting from compression along the grain.
Crook	Deviation of a timber pole from a straight axis involving more than one bend.
Culm	Stem of a bamboo plant. Equivalent of the trunk of a tree
Degradation	Anything that lowers the value of wood e.g. rot/decay (from fungus or bacteria), damage by insects or damage in felling/transport.
Durability class	Classification determined by how many years timber will last above ground with and without treatment (seasoned or natural durability) at a constant moisture content.
Figure	The markings on the surface of sawn timber formed by the structural features of the wood.
Grain	Direction of the wood fibers relative to the main length axis of the timber.
Grain, sloping	Deviation of grain from being parallel to the longitudinal axis of a board.
Hazard class	The classification of timber by what 'hazard' it will be exposed to – e.g. whether it is to be used internally or externally or if it will be in contact with the ground or not.
Heartwood	The centre of a tree, darker in color, providing the structural strength.
Knot	Remains of a branch embedded in the tree trunk which appears as a dark round circular shape on timber board.
Knot, sound	A solid knot that is as hard as the surrounding wood, and shows no sign of decay.
Lignin	Bonding agent in the cellular structure of timber.
LCA / Life Cycle Analysis	A way to determining a product's impact on the environment through the entire life cycle of its manufacture, transport, and disposal. There is no rapid LCA tool available as yet. More information from: http://www.unep.fr/pc/pc/tools/lca.htm
Moisture Content	Weight of moisture in timber expressed as a percentage of its

	oven-dry weight (MC).
Name, Latin / common	Tree species have two names. The common name varies around the world while the Latin, or botanical, name is universally accepted.
Penetration class	The classification of treatments by how far it will penetrate timber. Note the penetration properties of timber vary between species.
Pole, peeled / rounded	Timber poles are un-swan logs. Rounded or peeled poles are poles with the bark removed, stripped to a regular size. Also known as ROUND TIMBER.
Primary wood	Timber from slow-growing forests, usually hardwood. Used mostly in joinery/furniture.
REA – Rapid environmental assessment	A process to collect, analyse and review information on environmental impacts, in order to reduce the potential negative environmental impacts of emergency assistance. More from: http://www.benfieldhrc.org/rea_index.htm
Rings, growth/annual	The rings marking the growth of the tree seen in a transverse tree section.
RIL / Reduced impact logging	A sustainable forestry management approach that includes selection of individual crop trees, and ensuring that other trees are not damaged by creating precise access to crop trees, and using appropriate felling techniques.
Sapwood	Wood surrounding the heartwood. It contains the living cells and is lighter in colour and more penetrative and vulnerable to insect attack and rot than heartwood.
Sawn, back / quarter	A division of timber by the angle of the rings to the wide face age. Quartersawn is where the rings are at an angle of not less than 45 degrees to the face.
Seasoning (also air/kiln drying)	Drying of wood, by stacking and allowing it to dry in the air (unforced) or drying in an oven (forced), to reduce moisture content and improve durability.
Secondary wood	Timber from fast-growing forests, usually softwoods, which will require seasoning and treatment. Used mostly in construction.
Shake	Fracture of the wood fibers between the growth rings caused by stresses caused by factors other than shrinkage.
Shrinkage	Linear shrinkage is caused by reduction of moisture content below fiber saturation point and expressed as a percentage of the original dimensions or volume of timber.
Strength/ stress grade	Classification of timber's ability to bear stress without breaking/weakening.
Sweep	Deviation of a timber pole from a straight axis with one bend. A banana has sweep.
Taper	When a pole this towards one end.
Wane	The absence of wood on any face or edge of a piece of timber.
Warp	Variation of a surface from a straight axis. It includes bow, spring, cup and twist and may be due to irregular seasoning.

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ii.2 Brief further references

Planning: standards and strategic planning

- Humanitarian Charter and Minimum Standards in Disaster Response (SPHERE) www.sphereproject.org
- Corsellis and Vitale, Transitional Settlement: Displaced Populations, Oxfam/shelterproject, www.sheltercentre.org/shelterlibrary/items/pdf/Transitional_Settlement_Displaced_Populations_2005.pdf
- UNHCR Handbook www.the-ecentre.net/resources/e_library/doc/han_Em.pdf

Environment

- UNHCR Environmental Guidelines (2005) www.unhcr.org/protect/PROTECTION/3b03b2a04.pdf
- UNHCR/CARE: Environmental Assessment www.benfieldhrc.org/disaster_studies/rea/frame/ea_hand_final.pdf
- Guidelines for Rapid Environmental Assessment in Emergencies (v4.4) www.benfieldhrc.org/disaster_studies/rea/rea_guidelines.v4.4.pdf
- FAO: Reduced Impact Logging in Tropical Forests www.fao.org/docrep/007/j4290e/j4290e00.htm

Use (design and engineering)

All hard-copy books (📖) from: www.developmentbookshop.com

- 📖 Mukerji and Stulz (1993) Appropriate Building Materials
- 📖 Lambert and Davies (2003) Engineering in Emergencies
- 📖 Janssen (1995) Building with Bamboo: An Introduction, ITDG
- 📖 Follett & Jayanetti (2000) Timber Pole Construction: An Introduction, ITDG
- 📖 SKAT: TK 24 Roof Structure Guide http://www.skat.ch/
- Heini Müller (2004) Basic Construction Training Manual for Trainers www.redcross.ch/data/activities/pdf/Basic_Construction_Training_Manual.pdf
- Inter-Agency Network for Education in Emergencies (INNE): Shelter and School Construction http://ineeserver.org/page.asp?pid=1322
- Practical Action's Technical Brief 'Non-Poisonous Timber Protection' http://practicalaction.org/practicalanswers/product_info.php?products_id=211

Timber properties

- Wood Handbook: Wood as an Engineering Material (1999) U.S. Department of Agriculture, Forest Service, Forest Products Laboratory www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/fplgtr113.pdf
- Timber Species summary reports: www.timber.net.au/documents/
- Bamboo: www.bamboocentral.org (includes treatment handbook)

RWTH Aachen University: "Bamboo As A Building Material" http://bambus.rwth-aachen.de/eng/PDF-Files/Bamboo%20as%20a%20building%20material.pdf

Procurement

FAO: Guidance notes for Indonesia www.fao.org/forestry/site/tsunami/en

WWF: Keep it Legal http://assets.panda.org/downloads/keep_it_legal_final_no_fsc.pdf

UNEP: CITES and the Wood Products Trade - What You Should Know www.fao.org/DOCREP/004/Y3609E/y3609e00.htm

CPET: www.proforest.net/cpet (instructions for checking legality without certification – includes checklist sheets etc.)

TTF Scoping Study: Sourcing Legal Timber from Indonesia www.illegal-logging.info/papers/Sourcing_Legal_Timber_from_Indonesia.pdf

FAO - Development and Implementation of a Wood Procurement Plan for Post-Tsunami Reconstruction in Indonesia www.fao.org/forestry/webview/media?mediaId=10473&langId=1

Logistics

FAO: Guidance notes for Indonesia www.fao.org/forestry/site/tsunami/en

Health and Safety Executive UK: Safe stacking of sawn timber and board materials http://213.212.77.20/pubns/wis2.pdf

The Roundwood Haulage Working Party: Road Haulage of Round Timber www.ukfpa.co.uk/pdfs/CODE_OF_PRACTICE_2003.pdf

Guidelines for the Use of North American Lumber and Plywood in Aceh, Indonesia http://www.wwfus.org/forests/pubs/guidelines.pdf

Health and Safety Executive (GB), Safe Stacking of Sawn Timber and Board Materials. (Great Britain Health and Safety Executive, 2000), http://213.212.77.20/pubns/wis2.pdf

Trussed Rafter Association, Guidelines for the Storage and Erection of Trussed Rafters on Site (part 1), Sheet No.3 May 2007 (Trussed Rafter Association, 2007), http://www.trada.co.uk/techinfo/asset/view/976/

Websites

TRADA Timber species database: www.trada.co.uk/techinfo/tsg/

FAO: www.fao.org/forestry/en & www.fao.org/forestry/site/tsunami/en

ITTO: www.itto.or.jp

WWF: www.panda.org/gftn/ & http://wwf.org.au/publications/WWFTimberForAceh/

Educational Resources – Materials: www.Timber.org.au

Practical Action: http://practicalaction.org

Timber as a construction material in humanitarian operations
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ii.3 Sample documents

Sample specification from FAO in Aceh[1]

Roofing Timber			
Product	Dimension	No. Pieces	Volume (m3)
Roofing beams	5cmx10cmx4m	16	0.320
Roofing cross beams	5cmx5cmx4m	18	0.180
Corner wall beams	10cmx10cmx2.5m	4	0.100
External wall supporting beams	5cmx10cmx2.5m	18	0.225
Allowable species: Ampupu, Bangkirai, Bayur, Berumbung, Bintangur, Bungo, Cemara Laut, Cengal, Kapur, Keruing, Meranti batu, Merawan, Nangka, Resak, Semantok, Sentang, Sungkai, Tanjung. Durability Class: Class I-III, under the roof, no ground contact and well ventilated.			

All Timber	
Legality status: Must be purchased from a timber merchant licensed by the Dinas Trade and Industries. **Treatment Required:** Pressure treated CCB with topical application on ends during construction for termite resistance. Must attain hazard class II. **Grading system / Grade:** Local grading system, Class II	
Minimum timber grading standards	
Sloping grain	1 in 8
Sound Knots	1/3 dimension of face, to max of 10cm dia. 1 per meter in length
Unsound knots or Knot holes	1/4 dimension of face, to max of 7cm dia. 1 per 3 meter in length
Decay (Rot)	None, except in an unsound Knot
Sound Sapwood, including Wane	1/3 sum of width and thickness
End Splits	Longest split, 15cm at each end
Stain free from decay	Unlimited
Twist	1 cm in 3m.
Compression failures	None
Brittle heart	1/4 of cross-section at ends
Open shakes, Surface checks, End checks	1/2 thickness
Seasoning / Drying	Timber should be dried to 15% or less

[1] George Kuru, *Development and Implementation of a Wood Procurement Plan for Post–Tsunami Reconstruction in Indonesia* (FAO, 2005), http://www.fao.org/forestry/webview/media?mediaId=10473&langId=1

Assessing possible impacts of forestry industries

[UNHCR/CARE "Environmental Assessment in Refugee-Related Operations"]

Sector Activity	Potential impacts	Causes	Mitigation Measures
Reforestation Tree-planting and forest product production Maintenance of young plantations and trees Forestry extension Wood supply and harvesting	**Will the activity lead to:** Lowering of the water table and/or interception of rainfall, which may be detrimental to other species or users of ground water? Conversion of agricultural land and reduction on food production? Exploitation or conversion of forested areas that support valuable ecosystems (e. g., protected areas, critical habitats, endangered species); or containing important historical/cultural sites? Conflict with existing uses for forested areas (e.g. fuelwood forest products, wildlife, wildlife habitats)? Altering livelihood support activities of local populations, leading to increased pressure on natural resources (e.g. soil, wildlife, potable water supplies)? Induced development through the construction of access or feeder roads and subsequent environmental impacts?	Forest dependent women and men not fully consulted in the planning process Special measures not targeted to vulnerable groups, for example the provision of secure tenure on demarcated reserved areas Harvesting of timber and non-wood products is not controlled by a management or working plan that is based on clear "ownership" of trees and non- timber forest productions Some forest, rich in biodiversity, is not set aside for complete protection from exploitation Inadequate institutional capacity to control and supervise the logging process at all stages	Resolve conflicts in local tenure systems Avoid new species or new technologies for which local knowledge is weak Match species to local needs and site conditions Control planting, cutting and spacing Limit the establishment of new roads Protect water resources and unstable slopes Adopt closure natural regeneration techniques when feasible Ensure that logging damage to the residual stand is minimized Ensure long-term viability by adopting only economically viable forestry operations Ensure that incentives are sufficient to allow for longer-term protection and maintenance Encourage sustainable forest management practices Establish long-term use/benefit-sharing contracts for community groups based in national or local land tenure systems Ensure traditional ownership rights and responsibilities are integrated into management and harvesting actions