DES120: Designing for Permanence
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In this eCourse, you will learn construction techniques that prevent moisture from entering a wood-framed structure including: a discussion of code-required clearances, site drainage, correct placement of moisture barriers, remedies for improper design, preservatively treated wood, grading issues, and tips on preventing moisture-related insect and fungal attack.

### DES120: Learning Outcomes

- **By the end of this eCourse, you will be:**
  1. Functional with construction techniques that prevent moisture from entering a wood-framed structure, including:
     - Code-required clearances
     - Site drainage
     - Correct placement of moisture barriers
  2. Functional with remedies for improper design
  3. Knowledgeable about:
     - Pressure treated wood
     - Grading issues
     - Tips on preventing moisture-related insect and fungal attack
When trees are growing they need moisture and air.
Wood, like any other good building material can be subject to deterioration under the right conditions. This is extremely advanced decay and not usually present on dimension lumber, but lumber can nonetheless can still be destroyed by fungus.
These four conditions will foster decay in wood. Take away any one of them and
wood will not decay. 1) Adequate Moisture, 2) Oxygen, 3) Temperature range (50F-
90F), 4) Food Source (Wood).
Fully functional wood stave church in Urnes, Norway built in 1100 A.D. clearly demonstrating a wood frame structure can have a very long service life. The builders of this church used good design practices such as the steeply sloped roof to allow for good drainage off the structure. This allows for natural drying and avoids moisture collection points.
Proper design: 1) creates a physical barrier between wood and termites, 2) take measures to control the moisture content of wood, 3) use naturally durable or pressure treated wood.
Positive drainage; adequate separation; ventilation & condensation control; naturally durable and pressure treated wood.
An objective with wood is to keep its moisture content (M.C.) at or below 20%. If this is done there will be NO DECAY! Moisture content between 20-25% is a marginal range where probably will not have harmful decay, but may get mold or mildew. If moisture content exceeds 25% then there's serious trouble. This creates an optimum condition for decay. This can be a localized problem, like at a joint or catch point, but that local problem can effectively destroy the strength properties of that member. Its OK to get wood wet...but continually wet wood holds water and leads to decay.
This chart from the USDA Wood Handbook maps the relationship of air humidity, air temperature, and wood equilibrium moisture content. The red triangle maps the region over which the wood EMC rises to over 20% - a dangerous place for wood to maintain its resistance to fungal growth and rot. Clearly, when wood is placed in service into this kind of environmental condition, measures to preserve the wood must be taken; otherwise the environment will need to be controlled such that these conditions do not occur.
How to prevent moisture content from exceeding 20%? Good drainage design from roof to foundation. Accomplish by taking the following steps to control M.C. in wood: 1) Adequate site drainage; 2) Adequate building drainage - Always drain away from the structure, whether structure is on a slab or is elevated; 3) Separate wood elements from moisture sources; 4) Thorough condensation control.
Here is a wood framed structure that has not been closed in yet. While it is not always possible to close in a structure as it is being built it is important to get it closed in as quickly as possible. It is also important to clean because scraps can attract both termites and fungi.
This shows what condensation can do to sheathing in an attic without proper ventilation.
How not to store lumber & engineered wood products. EWP's will typically have MC<15%, so this type of storage quickly raises MC. can cause problems with metal connector plates. wet service factor adjustments may be required per NDS.
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EWP's will typically have MC<15%, so this type of storage quickly raises MC. That's why manufacturer's wrap these products for shipment.
Note untreated Glulam fully exposed to the elements. Looks like they capped the member being carried, which is still inadequate, but made no attempt to protect the carrying member.
Again, untreated Glulam exposed. Looks as if it were painted at one point, but has not been maintained, exposing wood members to moisture.
Close-up of previous slide. Solution: continuous maintenance (paint) or taper back under roof system if design allows.
Attempted to provide some protection. capping top surface is inadequate. ends and sides still exposed. solution: continuous maintenance (paint) or taper back under roof system if design allows.
Ends are capped, but sides and top still unprotected. solution: continuous maintenance (paint) or taper back under roof system if design allows.
Variation of previous slide.
Variation of previous slide.
Tropical Climate

High temperature/moisture conditions.
Exposed Glulam Roof Arches

No moisture barrier provided, obvious decay.
Here is a bad detail of wood members which do not provide adequate moisture barrier. The connection of these two Glulams serves as a natural moisture collection point. The deterioration at this connection is due to a constantly wet condition. Note that only one of the Glulams is covered. Also notice the rust stains from the fasteners which clearly indicates the wrong type fasteners were used. This is not only unsightly, but the fastener capacity at this connection has been weakened and will continue to do so. The correct fasteners to use here are HDG.
Bracing Members - up close and personal
Ground Clearance - crawl space girder
Building codes typically require specific clearances for the separation of wood framing members and potential high moisture sources like the ground to prevent decay and termite attack and provide for periodic inspection. Floor joists less than 18" above the ground, or girders less than 12" above the ground must use treated wood. Since typical clearance for decay/termite is 8", these tolerances are most likely to allow for inspection. Codes may also require a non-penetrable moisture barrier (i.e., polyethylene) if wood is in contact with the concrete, and the concrete is in contact with the ground.
When in basements, cellars or exposed to weather, wood members should be protected from moisture with barriers and vapor retarder. This applies above a slab.
When in basements, cellars or exposed to weather, wood members should be protected from moisture with barriers and maintain 6” clearance above exposed earth.
Brick veneer on above grade foundation requires clearances, flashing material, and weep holes to allow moisture to escape from behind the brick veneer. Trapped water will wet the wood and keep it wet.
Codes typically require overlap of minimum 1” past the wood frame and the masonry cap. The wood framing elements themselves are required to be a minimum of 8” above exposed earth. Placing these members less than any of these dimensions require the use of treated wood.
Codes typically require minimum 2" clearance from slab, concrete steps, or planters.
Codes typically require minimum 2" clearance and flashing for roof framing into siding to prevent moisture from entering joints between building elements.
Codes typically require flashing across heads of all openings in exterior walls to prevent moisture from entering joints between building elements.
There are over a half-dozen types of termites in the United States, but the three generally mentioned are the drywood, subterranean, and the formosan. Termites are by far the most destructive agent where wood is concerned.
Most common termite in the country is the subterranean termite. Subterranean termites are much easier to control than the drywood species and certainly the ferocious Formosan termites. This is because they are easier to recognize (mud burrows a.k.a. water tubes, usually infest easy to reach places). The other two types don't do this and are normally found infesting in hard to reach places.
Pressure treated wood; shields; chemical treatment in ground - good only for subterranean termites at this time. Formosan termites burrow over or through the treated soil to get to the wood. They then live off the condensation; concrete foundations - as long as cracks do not exceed 1/64"; concrete caps; inspection;
Pressure treated wood has been around for decades, and with proper retention and chemical dose is highly effective against insects and decay forming fungi.
Effectiveness: chemical type; penetration; retention; uniform distribution.

Pressure Treated Wood

Effectiveness
- chemical type
- penetration
- retention
- uniform distribution
Bunks of lumber rolled into a pressure cylinder.
Chemicals like CCA are forced into the wood members under pressure.
Pressure drives chemicals to certain depth. AWPA standards specify the depth and retention level.
Not all woods treat the same way...some are refractory (hard to treat) and have to be incised to get proper treatment. examples: DF, HF, SPF.
Incising

There is a reduction in design values due to incising, but NOT for the treating itself. The reason for this is effective decrease in section properties (area, section modulus) of the member.
AWPA is the standard rules writing agency for preservatively treated wood in the US. They set retention levels among other criteria.
Types of Preservatives

- Creosote
- pentachlorophenol
- waterborne preservatives (of which CCA is the most widely used)

Creosote; pentachlorophenol; waterborne (like CCA).
Industrial applications like marine applications - minimal human contact.
Industrial application (this may be foundation system for New Orleans Superdome). another common application is railroad ties.
Bulkhead application.
Industrial applications like timber bridges (probably logging bridge) - minimal human contact.
Pentachlorophenol is a biocide, so this slide is actually probably no longer appropriate since this product should not be used where there is much human or animal contact.
Timber bridges may use any of the three types of treatment.
Probably the most common application for penta.
Another application for penta.
Another application for penta.
Water-borne Preservatives

Water borne preservatives are used in residential construction where there is human contact with framing members. most common is CCA.
Permanent wood foundations use wood typically treated to 0.6pcf retention. As a point of comparison, ground contact retention is typically 0.4pcf.
60 million decks in US. source: SFPA.
Deck Seats

60 million decks in US. source: SFPA.
60 million decks in US. source: SFPA.
As noted earlier, ground contact is typically 0.4pcf retention. Some codes allow 0.25 for decks, fascia, soffits...sometimes bottom sill plates.
Decay resistant: redwood, cedar, black locust. Termite resistant: redwood, eastern cedar.
14 acres roof structure using Alaskan Yellow Cedar Glulam and trusses to avoid any use of chemicals near drinking water supply. See LRFD Manual Ch. 2 for more details.
There are non-pressure additives that can be added to wood. Example: additives for door and window applications that usually involve an immersion process which coats framing members with a stain and/or a paraffin wax coating that is resistant to moisture. There is also a framing system for exterior door jambs that uses finger jointed lumber coated to resist moisture at the bottom of a door framing assembly where most moisture damage occurs.
Available from EPA regarding chemicals used in the treating process.
AF&PA's DCA#6, Design of Wood Structures for Permanence outlines much of the information presented here.
Questions?

- **www.awc.org**
  - Online eCourses
  - FAQ’s

- **HelpDesk**
  - AWCinfo@afandpa.org
  - (202) 463-4713 or (800) 292-2372

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This concludes this approved continuing education program.