Architectural Technology V

WOOD

Preamble: *Why does Wood go First?*

Anybody who wants to work in this country in the construction industry needs to understand:

The use of WOOD is folded deep into the cultural DNA of American professional practice.

Even when one is working with concrete, and *especially* when one is working with steel, the patterns of thought which accompany **wood** manufacture and assembly affect the way in which we are guided in that work.

Preamble: *Why does Wood go First?*

In one sense, this is an outrageous statement, since it is hard to imagine that a concrete beam has anything in common with a couple of 2x12's.

But the historical relationship is clear.

Furthermore, the interaction among all the building systems is, in the United States, defined by the requirements and traditions of stick-built construction, which itself first emerged here in the mid 1800's...

Architectural Technology V

But before we begin to chop down the cherry tree...

- Housekeeping: Hand in Homework, Chapter 2;
- Review: Waterproofing, Soil Types, and Foundations
- **Allen:** *Chapters 3, 4, 5 Wood!*
- *Media Portion: Foundations, Codes, Steel, and Politics*
- Assignment: Assignment #4, and Field Sketch #1

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Waterproofing and Drainage 2.1**

... 1. For each condition below, indicate whether dampproofing or waterproofing is most appropriate:

a. Below-grade space for housing library stacks — Waterproofing

b. Crawlspace in well-drained soil — Damproofing

c. Below-grade utility room, normally-drained soil — Waterproofing

d. Finished basement, normall-drained soil, expressed owner concerns about moisture... — Waterproofing

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Waterproofing and Drainage 2.2**

... 2. For each of the following, propose a waterproofing system and comment briefly on the reason for your choice:

a. Concrete basement, poured in the winter.
Bentonite clay, spray-on or sheeting.

b. Concrete foundation carrying a prestressed concrete deck.
Unadhered sheet membrane.

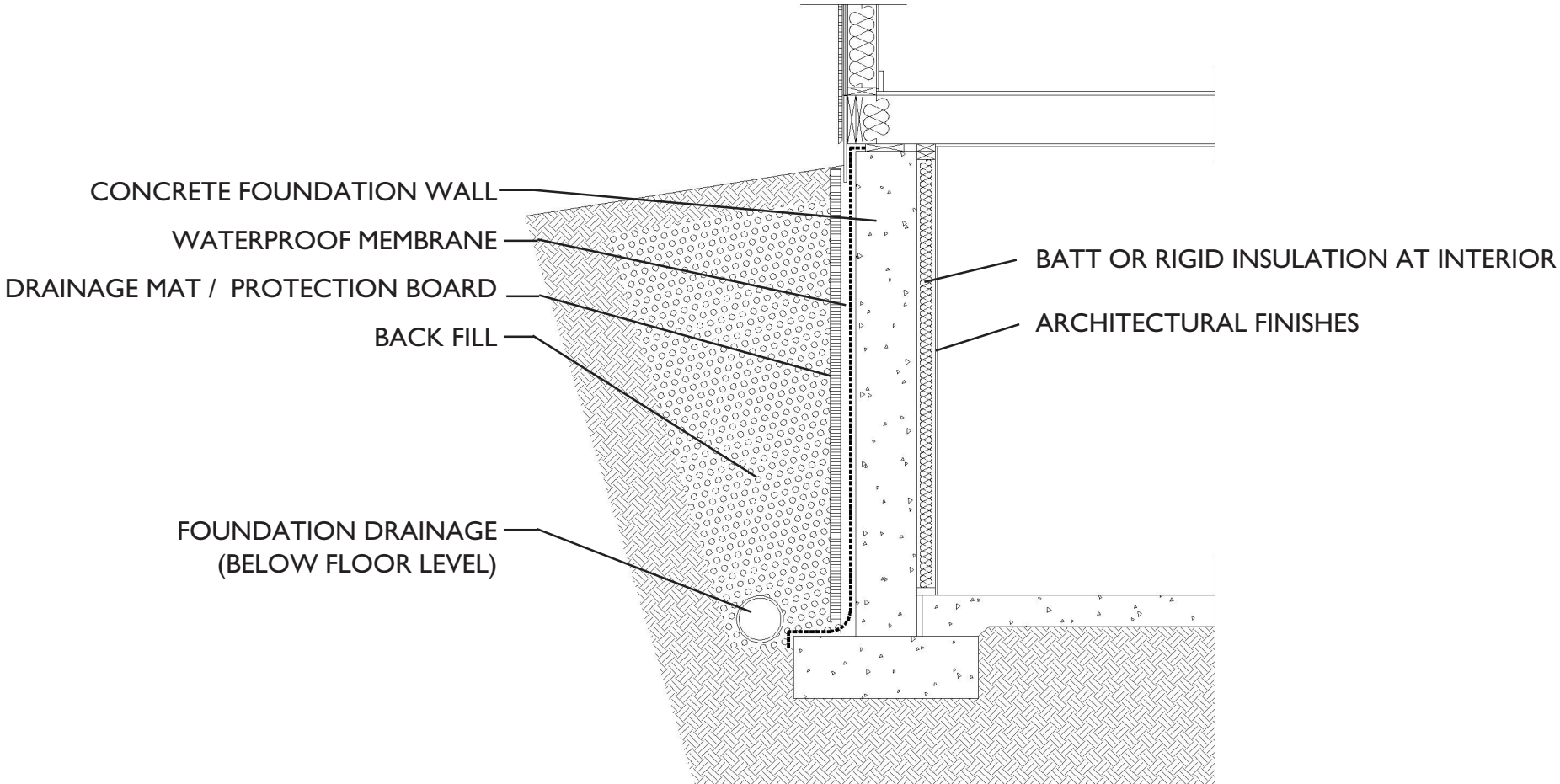
c. Concrete elevator pit.
Cementitous damproofing applied to visible surface, "parging";
Alternative: Blind-side sheet waterproofing.

d. Underground Mechanical Room, with many wall penetrations.
Spray-on or Fluid applied waterproofing.

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review Waterproofing and Drainage 2.3

... 3. Detail drawing for waterproof membrane, insulation, drainage system, backfill, and finish grade:



Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Soil Types and Bearing Capacity 2.2**

... 1. Give one or two possible identifications for each of the following. Provide Group Symbol and a descriptive name for each:

a. All of the soil particles are visible; some are large enough to pick up individually, but *most are not:* GM/GC

b. When dry, the soil seems to be a dusty sand; when wetted it is still gritty like sand, but the soil sticks together : SC, ML

c. No individual particles are discernable, but the soil came out of the ground in hard chunks; easily moldable : CH, OH

d. The smallest particles in the soil can be individually lifted between two fingers, the largest with the whole hand : GW/GP

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Soil Types and Bearing Capacity 2.2**

... 1. (continued) Give one or two possible identifications for each of the following. Provide Group Symbol and a descriptive name for each:

e. No soil particles are discernible by eye, yet the soil, even when wet, falls apart when an attempt is made to mold it into a shape*:*
MH

f. The soil smells musty and is very dark in color. It seems to spring back slightly after being compressed:
Pt

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Soil Types and Bearing Capacity 2.2**

... 2. Which of the above soils is likely to have the highest loadbearing capacity under a wall footing or strip footing?

GW/GP

3. Which of the above soils would you expect to drain freely?

GW/GP

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Soil Types and Bearing Capacity 2.2**

... 4. How large does a square column footing need to be to support a load of 85,000 pounds on a compact, sandy gravel soil?

Bearing Capacity of Compact, sandy gravel (GW/GP) = 3,000 psf

85,000# / 3,000#/ft^2 = 28.333 ft^2
Required Square Footprint for 28.333 ft^2 = ~ 5.32 ft x 5.32 ft

5'-4" x 5'-4"

Worksheet #3: *Waterproofing, Soil Types, and Foundations*

Review **Soil Types and Bearing Capacity 2.2**

... 5. How wide must a wall footing be if the load is 3,200 lb per foot of wall length, and the footing rests on a sandy clay soil?

Bearing Capacity of Sandy Clay (CL) = 1,500 psf

3,200#/ft / 1,500#/ft^2 = 2.1333 ft

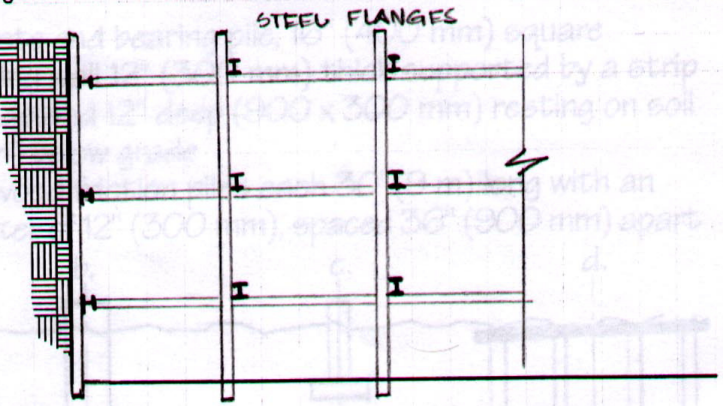
Required Footing Width = ~ 2'-1 $^1/_2$"

Worksheet #3:
Waterproofing, Soil Types, and Foundations

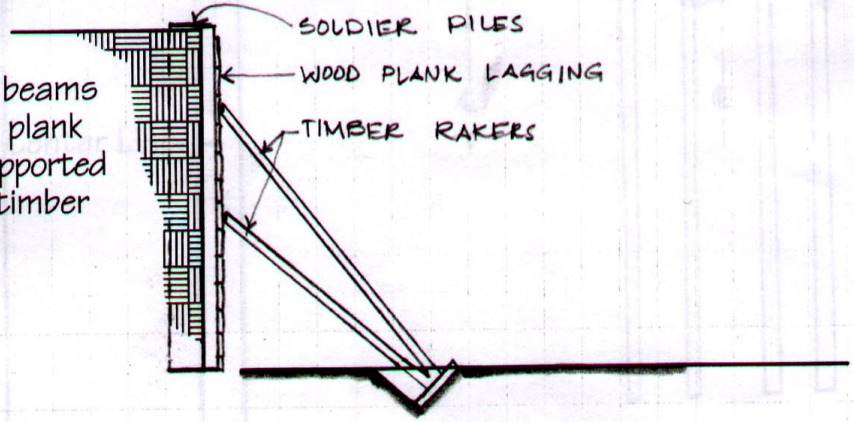
Foundation and Slope Support Systems 2.3

1. Three excavations are shown below in cross section. Draw a slope support system for each as indicated.

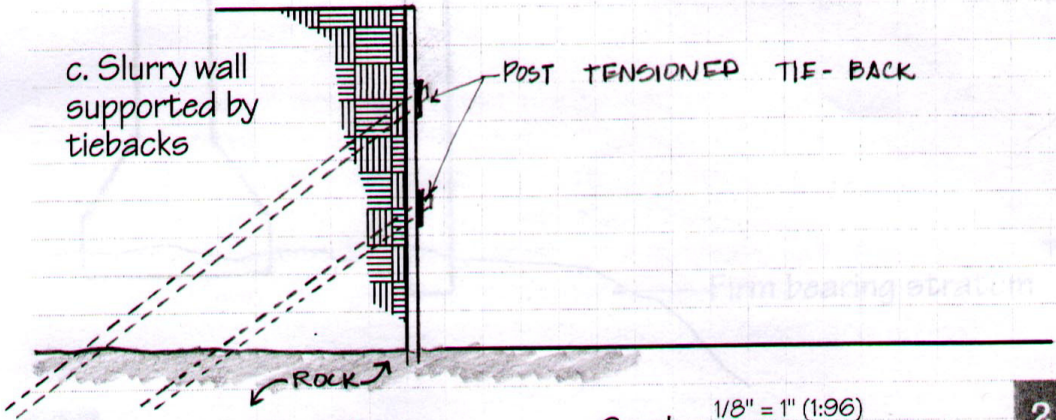
a. Steel sheet piling supported by cross-lot bracing made of steel wide-flange shapes (see Figure 11.10 of the text for illustration of wide flange shapes)



b. Soldier beams and wood plank lagging supported by heavy timber rakers



c. Slurry wall supported by tiebacks



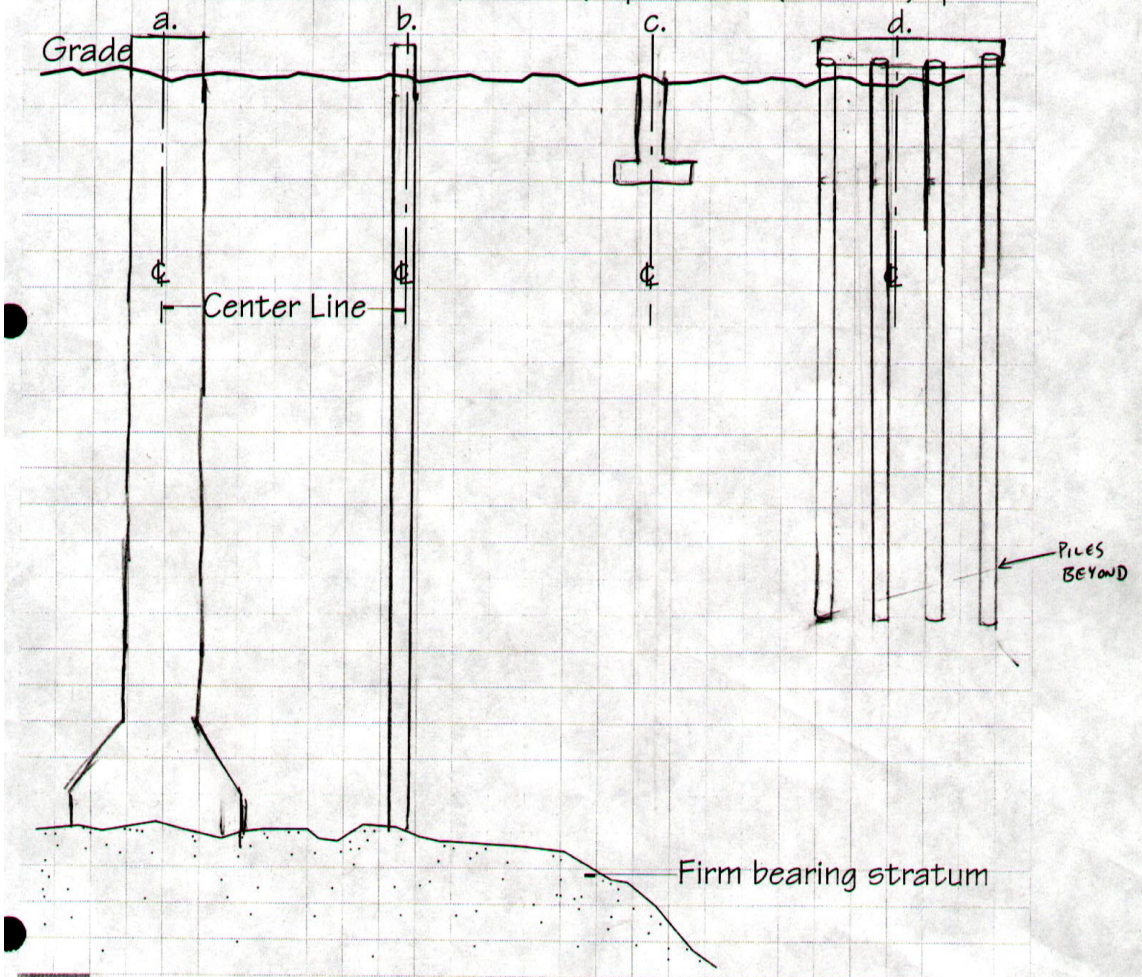
Name: GOURI MIRJE Scale: 1/8" = 1" (1:96) 1 square = 2' (600 mm)

Worksheet #3:
Waterproofing, Soil Types, and Foundations

Foundation and Slope Support Systems 2.3

2. On the section below, draw foundation elements as indicated.

a. Caisson 4' (1200 mm) in diameter with a bell 2.5 times this diameter
b. Precast concrete end bearing pile, 16" (400 mm) square
c. Concrete bearing wall 12" (300 mm) thick supported by a strip footing 36" wide and 12" deep (900 x 300 mm) resting on soil 48" (1200 mm) below grade
d. Cluster of 16 wood friction piles each 30' (9 m) long with an average diameter of 12" (300 mm), spaced 36" (900 mm) apart



22 Scale: 1/8" = 1' (1:96) 1 square = 2' (600 mm)

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

BACK TO WOOD...

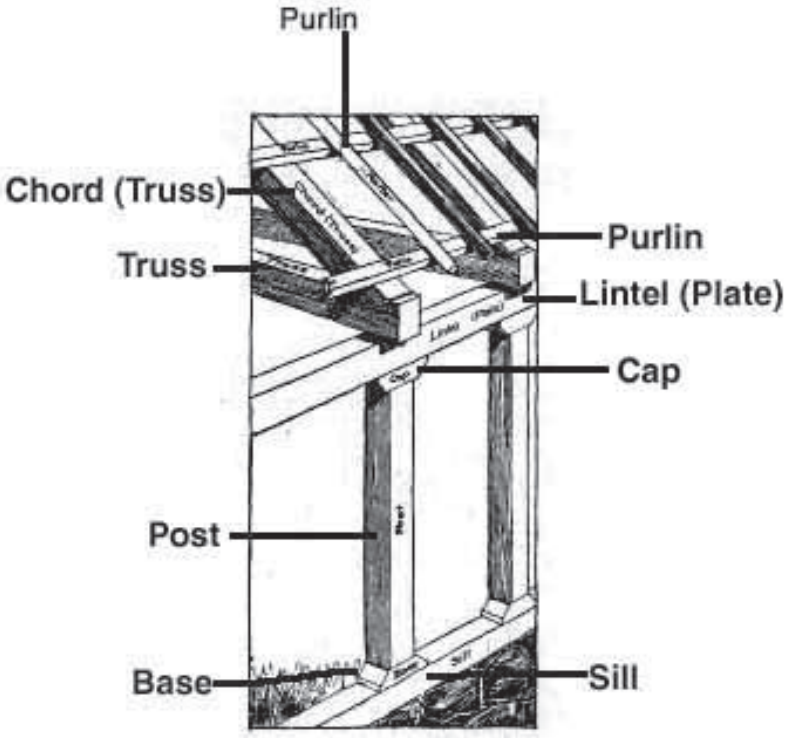
Why? Our building tradition in the US derives mostly from Northern Europe, by way of England and Scandanavia.

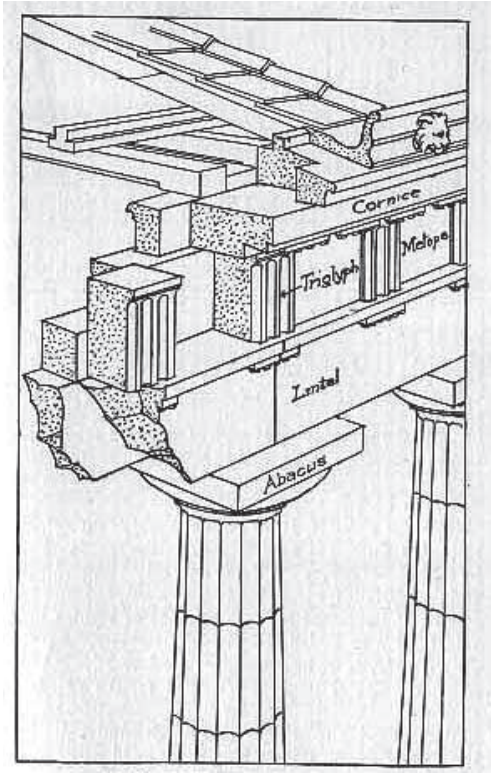


The forests of Europe were a plentiful and inexpensive source of both building material and fuel until, in each society in almost every phase of history, that source had been exploited to extinction.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

PRECEDENTS: Greece, Rome, France, England





Although all these societies have parallel traditions in masonry, depending on their wealth at any one time, each of them began as wood-based building cultures and only later adapted themselves to building in other materials.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

ANTECEDENTS: North America

In the United States, of course, it is the English tradition that dominates. What crossed the Atlantic in the 17th and 18th century as a post-and-beam technology continued as such into the 19th century. But what transformed wood construction in the US was the advent of... what? ***Power.***

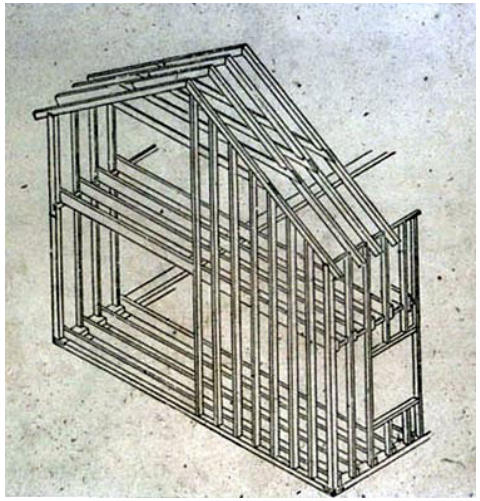
This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

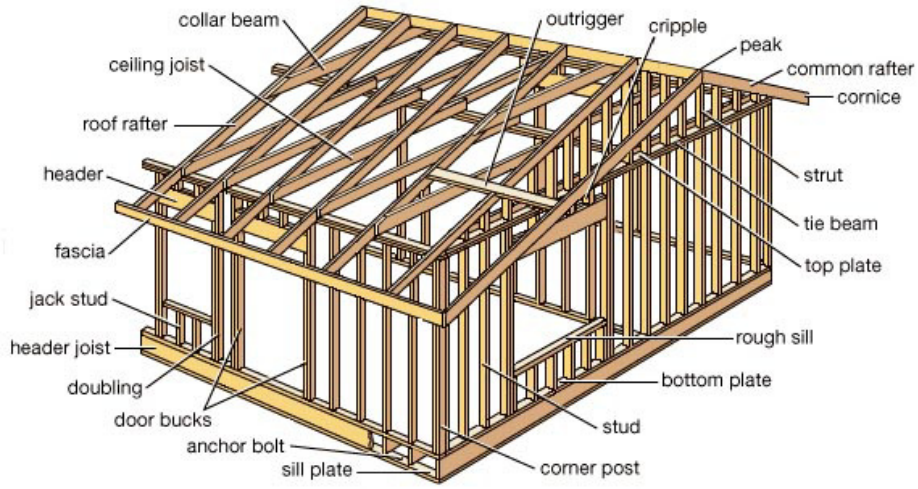
POWER: Water, Wind, and Coal in the 19th Century

As the power of wind and water and coal was harnessed for the propelling of ships and land vehicles, that same "mechanization took command," to allude to Sigried Gideon's book of the same title, of the processing of lumber thoughout the US and Europe. But it was only the US (and in some parts of Scandanavia) which had retained a large store of unforested land.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

REVOLUTION: The Rationalization of Lumber Fabrication





The rationalization of lumber fabrication affected society in a profound way; and it was primarily in the US, where an economic rationale is usually the only acceptable one, in which these changes effected a real revolution in building technology:

Balloon Framing | Platform Framing.

These innovations were due to the application of power to wood.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

Although cheaper and easier to handle than masonry, traditional wood construction was coarse, hard to finish, and required experienced labor.

With "stick" framing, on the other hand, a single person can handle individual pieces without aid, and a small team of relatively uneducated laborers can build an entire structure in much less time than the traditional carpenters can.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

IT'S EVERYWHERE: The US Domestic Housing Market

Who can deny the incredible advantages of platform framing, which remains the primary form of construction for low-rise construction in the US to this day?

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Species and Categories

Most folks know in general terms about Hardwoods and Softwoods.

In fact, *most construction is done with softwoods:* differnt kinds of **fir, pine,** and **hemlock**.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Species and Categories

Furniture and decorative items are often built from the hardwoods, such as Ash, Beech, Oak, etc.

Floors, too, are mostly built from hardwoods, *if you can afford it.*

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Sustainability

Your reading also alludes to some important characteristics of wood which affect Sustainability.

Can anyone tell me what they are?

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Sustainability

Your reading also alludes to some important characteristics of wood which affect Sustainability.

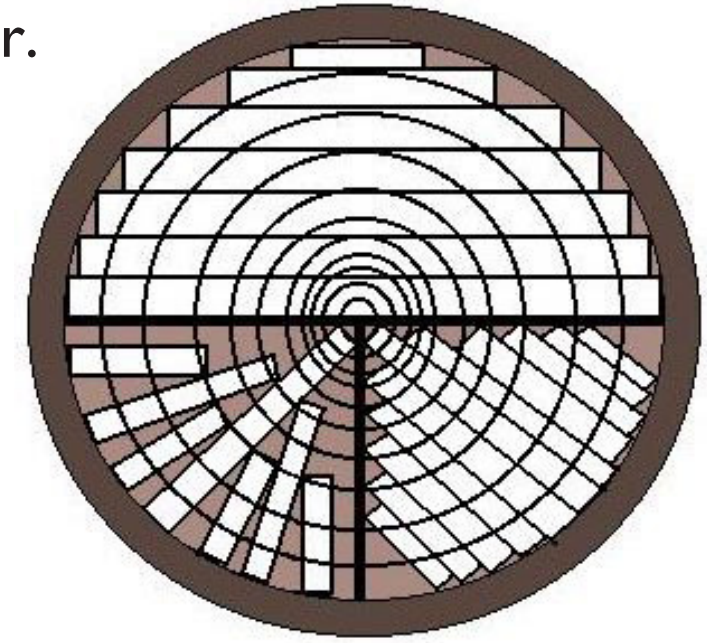
Can anyone tell me what they are?

> **Renewable Resource** (Forestry, Conservation)
> **Usable by-products** (Mill practices)
> **Distance to installation**...
> **Low Embodied Energy**
> **On-site practices** (wastage and collection)
> **Low Impact upon Indoor Air Quality**
> **Combustibility & Life Cycle Characteristics.**

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Processing and Material Characteristics

As for wood itself, your reading describes that the way boards and wood pieces are extracted from the original lumber can determine their strength and structural behavior.



Plain Sawing

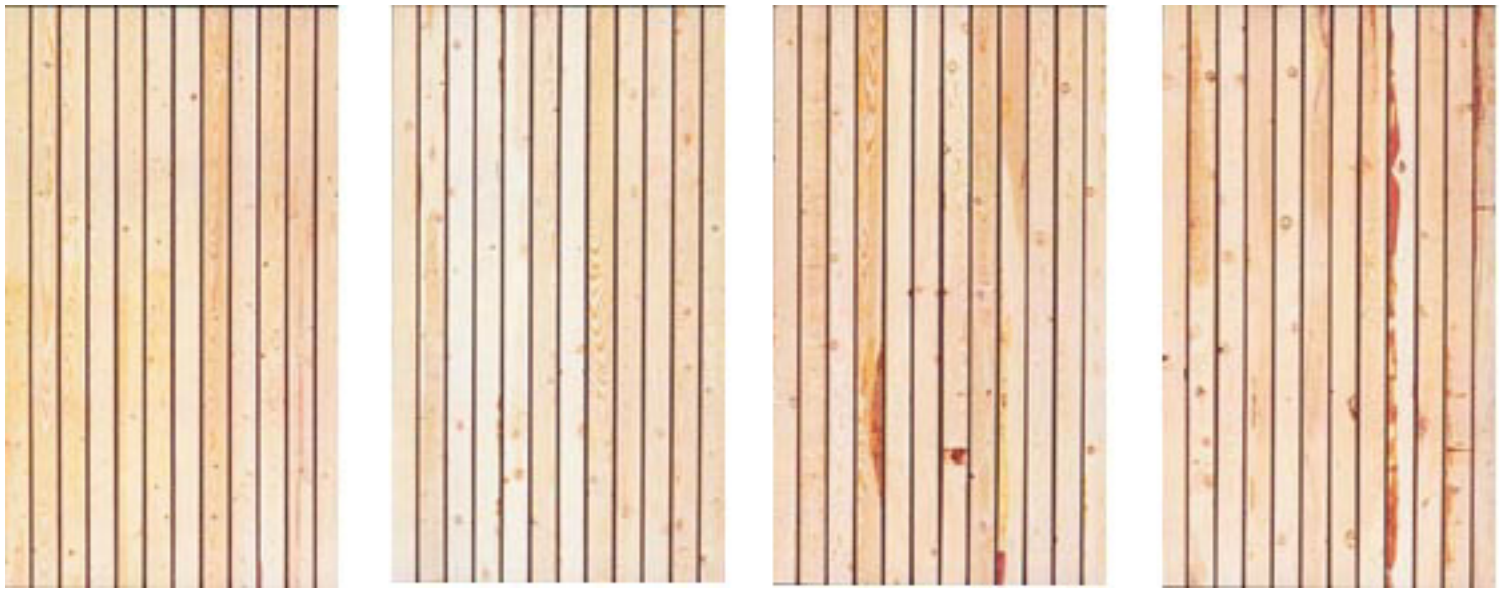
Quarter Sawing

A significant aspect of processing is cutting: *plain sawing* or *quartersawing*. *Seasoning* is also important. Wood is dryed either by air or in a kiln to encourage uniform shrinkage before its delivery to a job site.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Processing and Material Characteristics

Naturally, all these different methods combine with the characteristic of the individual species to determine their performance, which may be expressed by standard grades. The most common are "visual grades":

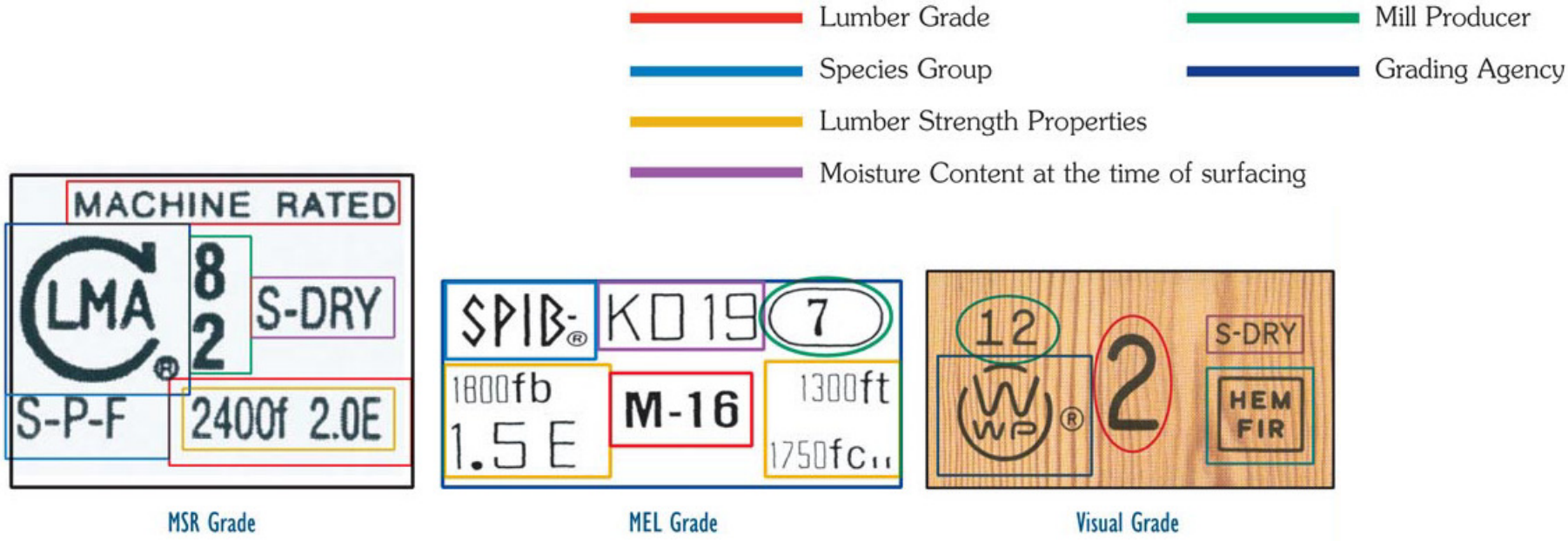


Select Structural **No. 1** **No. 2** **No. 3**

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: How to Read a Grade Stamp

Mechanical testing uses testing equipment to measure an actual property like stiffness or density for each piece of lumber. Then a machine stress rated (MSR) or a mechanical evaluated lumber (MEL) grade is assigned to each piece. MSR and MEL grades are not widely used outside the truss and glulam manufacturing industries.



This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Building with... #$%@$% !

This week's reading includes description of miscellaneous wood products developed to both enhance the structural behavior of wood *and* to make use of wood byproducts which would otherwise be wasted.

Plywood
Glue-lam Beams
OSB
Wafer-board
Particle board
MDF
Bamboo Flooring

It's all somebody else's junk all glued together!

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Building with... #$%@$% !

This is almost a dialectical proposition: In the United States, we *live* in *garbage*.

Literally.

Most of our building materials are composites formed downstream in the consumption flow, making use of industrial by-products and advanced organic chemicals.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Laminated Wood

Includes glue-lams, mirco-lams, parallel strand lumber...

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Laminated Wood

Laminated Wood significanlty enhance the capacities of wood-based products, but they share the ease-of-use that character-izes stick-built wood construction.

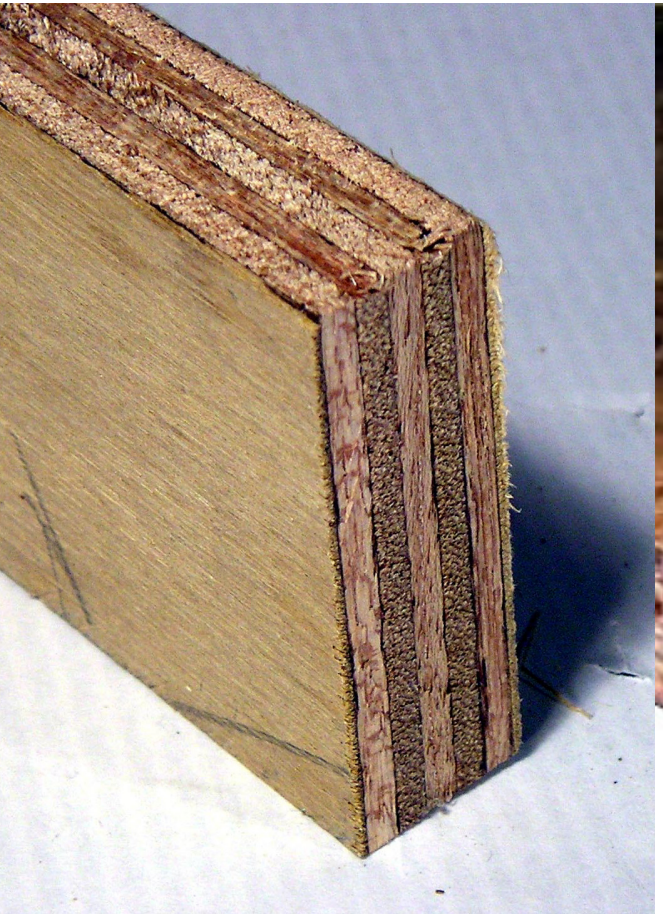
The same guy who frame your house will hang the glue-lam.

(If you had used a steel beam, a different trade would have to have been called in.)

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Wood Panel Products

Includes plywood, OSB, waferboard, particle board...
Products may include additional finishes or layers (melamine, SIP).



This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Wood Panel Products

Panel products, such as plywood and OSB, are most often used as sheathing either vertically in walls or horizontally, for use as sub-floor decks. But where the boards have notable *tensile* properties, as with plywood, the possibility of shell-like behavior is also possible.

There's very little not to like about plywood.

(Unless you smoke in bed.)

Particle board (and its related product, MDF) are often seen in furniture applications, at interiors.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Wood Panel Products

Some chemical technology is available to address wood's undesireable characteristics, such as suceptibility to combustion and to water damage.

Treatments for fire-resistance and for moisture resistance add some level of dependability, but this improved perforance is notiable mostly during one's code anaylsis, where the introduction of treated wood might allow a larger floor-area per floor.

In general, ***wood is wood*** *-- and you better protect it or assume that it's going to burn.*

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Fasteners

But what would we do without the bits and pieces that hold it all together?

Pringle Richards Sharratt: Sheffield Winter Garden

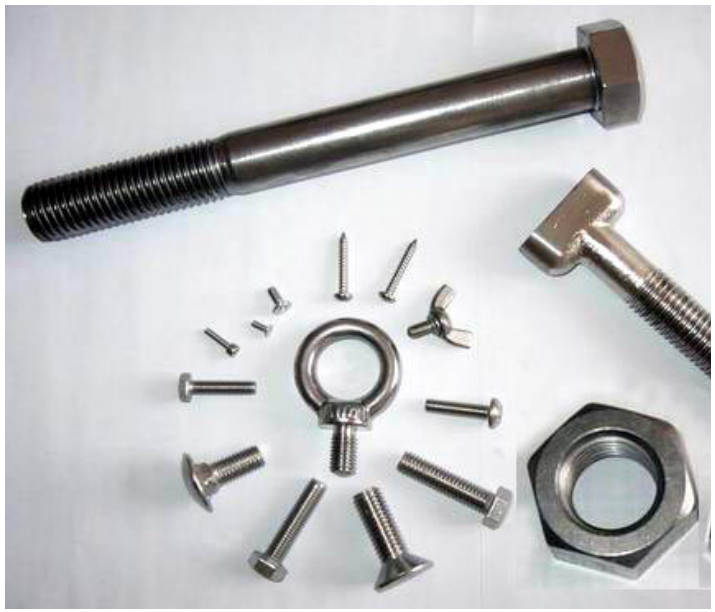
Fasteners, such as nails, bolts, gang-nails, and glues, comprise a technology unto itself. From the architectural perspective, the possibility of putting the fasteners to use for decorative purposes is enticing, and the history of architecture is filled with wonderful examples of ornamental joinery.

The contrast between fine metal objects and coarser, more elemental wood members is usually quite appealing.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Fasteners

From a technological perspective, however, the reality is more prosaic: We have **nails**, which might be galvanized, zinc-coated or stainless steel; we have **bolts**, which are usually stainless, and we the metal equivalent of a throw-everything-but-the-kitchen-sink approch, the **toothed-plate connector**.



This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Fasteners

Although we may feel that often the specification of connectors in wood is out of our hands as Architects, the more awareness you have of *what / where / when* will allow you to choose the locations for which a decent bolted detail will highlight your design intention.

We saw a good example of this at the Douglass-Myers museum.

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Manufactured Systems

In our reading, Chapter 3 ends with a review of wood-based manufactured systems, such as pre-fab trusses, Wood joists, & Composite Panels.

This is the future, and we've been living it for 50 years!

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: The Present of the Future's Past

Most laypersons don't notice the radical innovation to which our building industry has been subject, *because all the best efforts of US technology is brought in to create essentially antique-looking architecture.*

Jeremy's Rant About Building Technology in America

All the high-tech resins, all the cool new vapor-permeable weather barriers, and all the laminated wood members are there to recreate in Owings Mills houses which would have looked **ugly** *two hundred years ago in Colonial Williamsburg!!!*

But I digress...

This Week: ***Wood*** (Allen, Chapters 3, 4, 5)

WOOD: Continuing Systemization

The continuing systemization to which wood construction has been pushed is one of the more interesting and potentially useful trends for us architects.

I challenge each of you to think of new uses for these manufactured components, so that you can explore in truth the nature of a material which has little nature about it anymore...

Tjibaou Cultural Center
Renzo Piano

Architectural Technology V

Structural Insulated Panels

This Week: ***Assignment #4***

Exercises in Building Construction, # 3.1, 3.2, 5.1, 5.2 (1 & 2 only)

> Working With Wood

> Laying Out Floor Framing

> Laying Out Wall Framing

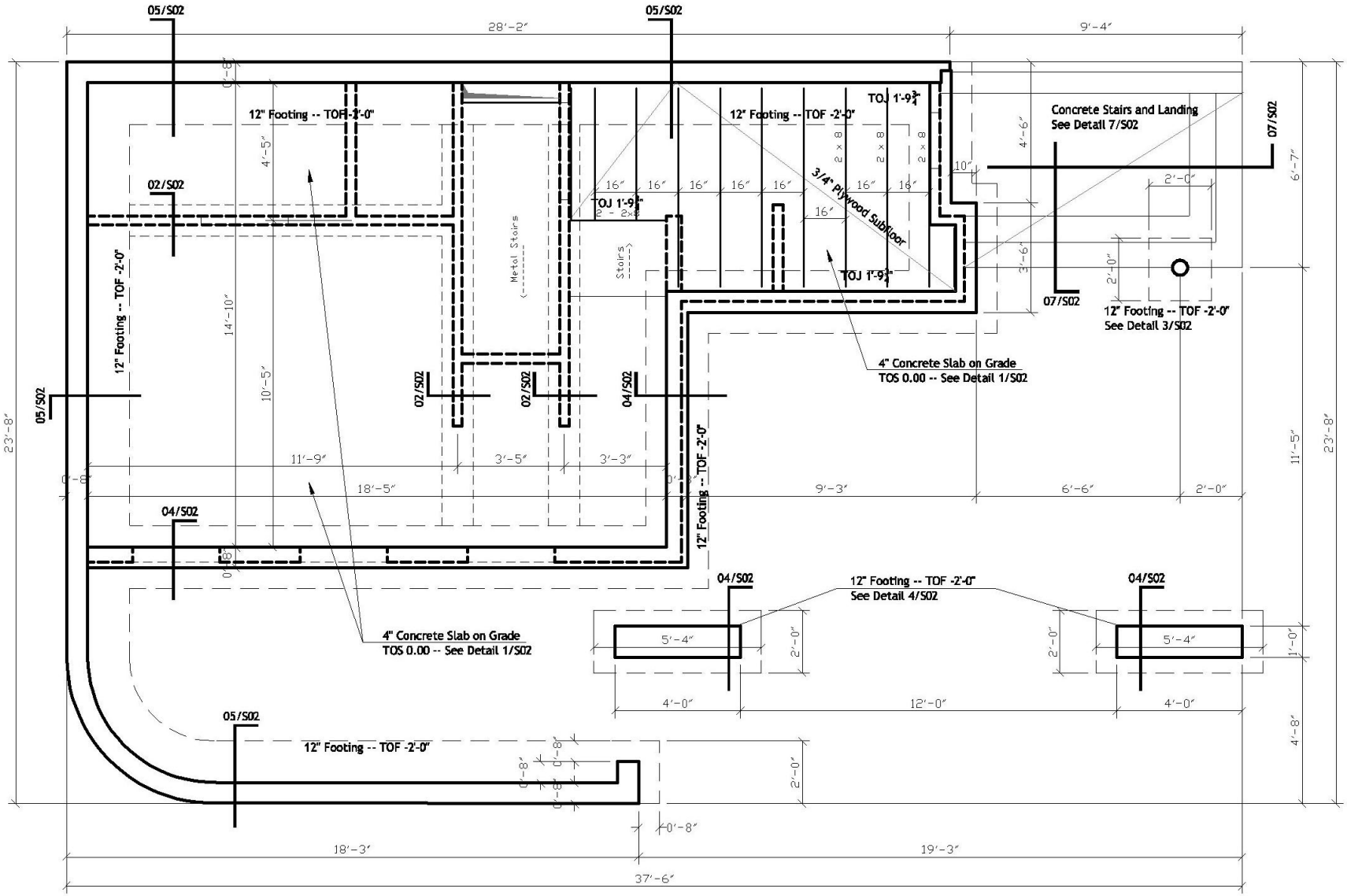
I will e-mail a link to this material after this class session.

Field Sketch #1

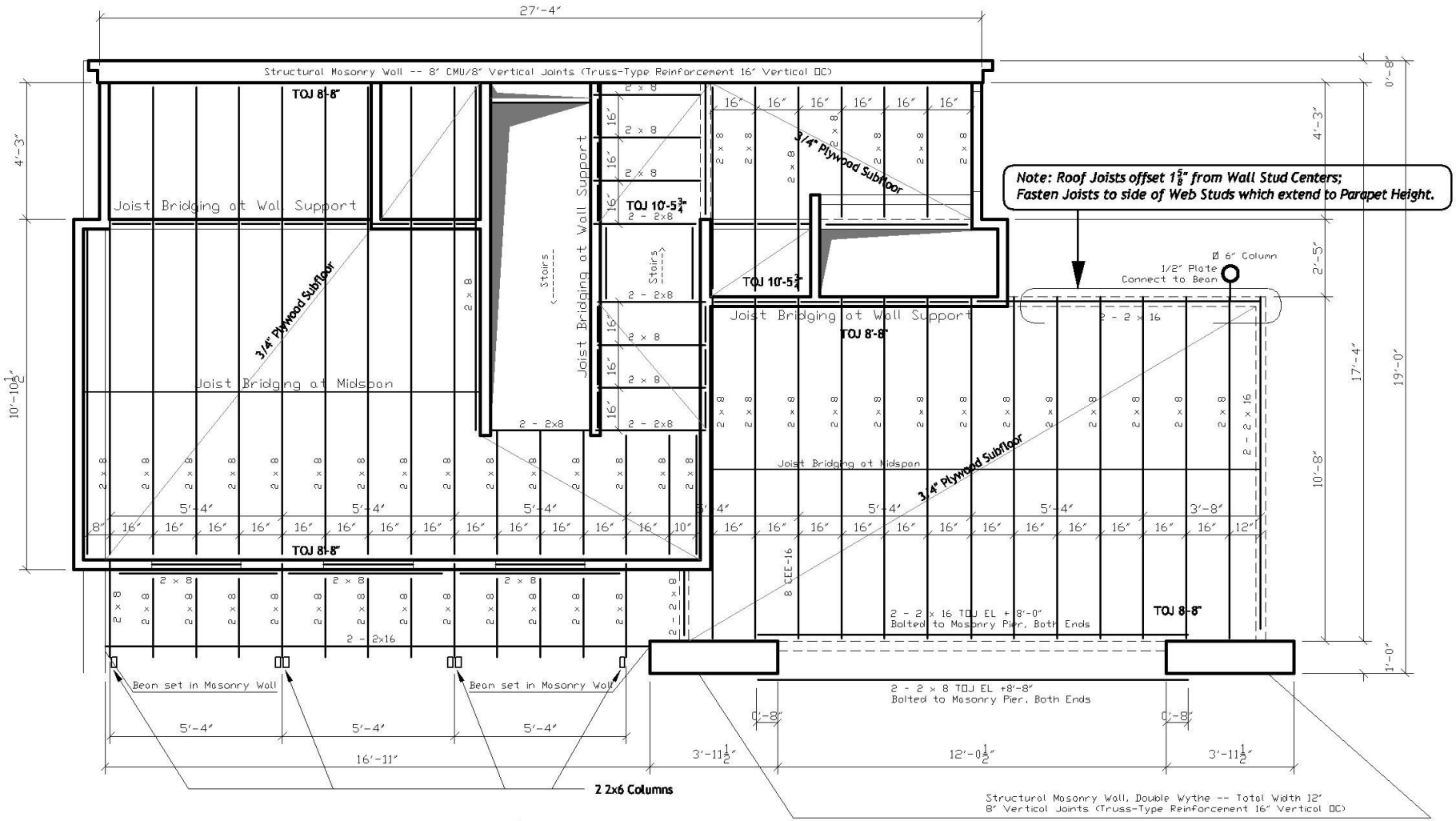
This work will be due at the *beginning* of our next session.

~~ Let's take a 10 minute break! ~~

WOOD: Light-Frame Construction



WOOD: Light-Frame Construction

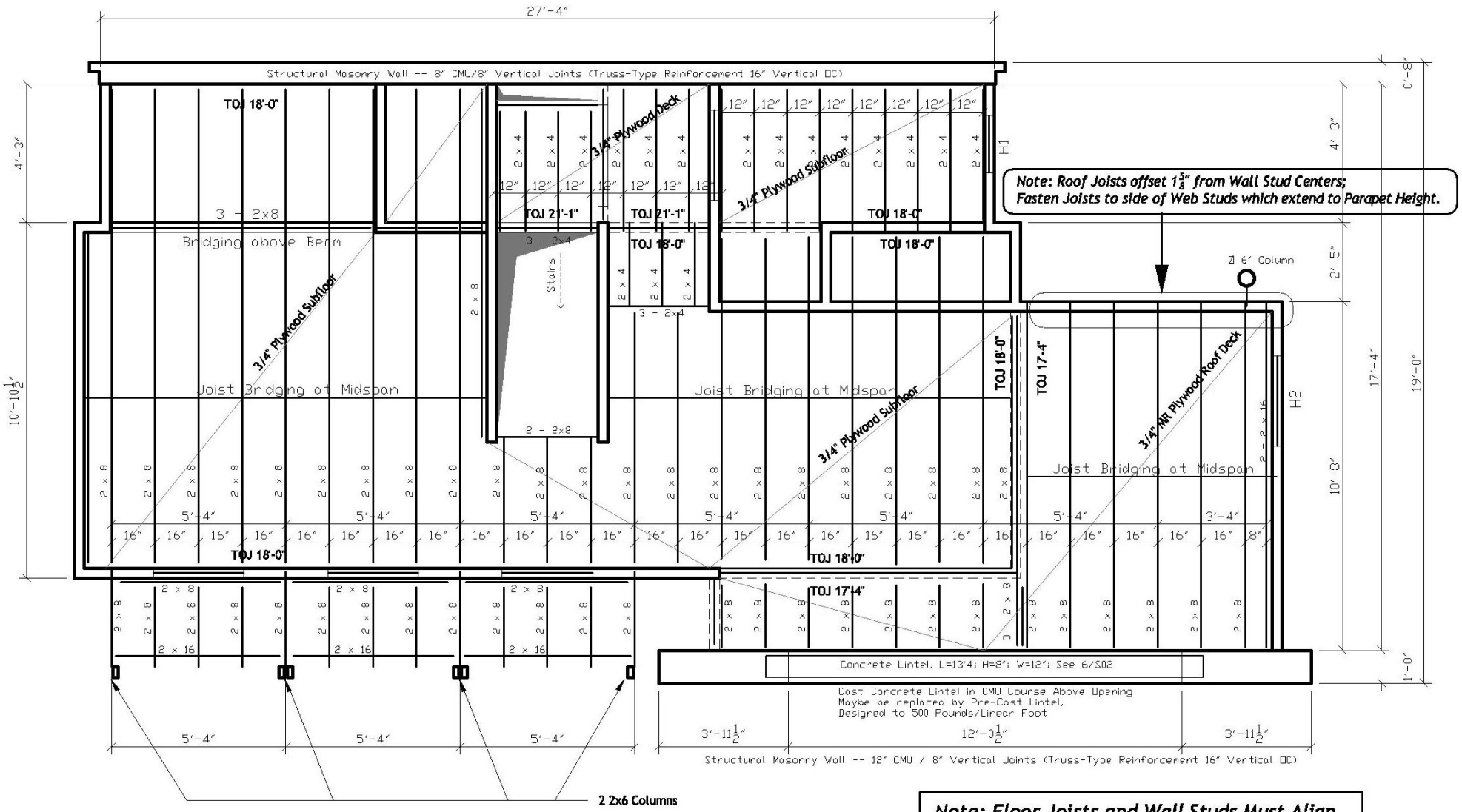


Note: Floor Joists and Wall Studs Must Align Except Where Noted at Parapet Walls;

Double-Studs at all Bearing Points in Walls

See Note S00 Concerning Headers at Door and Window Openings

WOOD: Light-Frame Construction

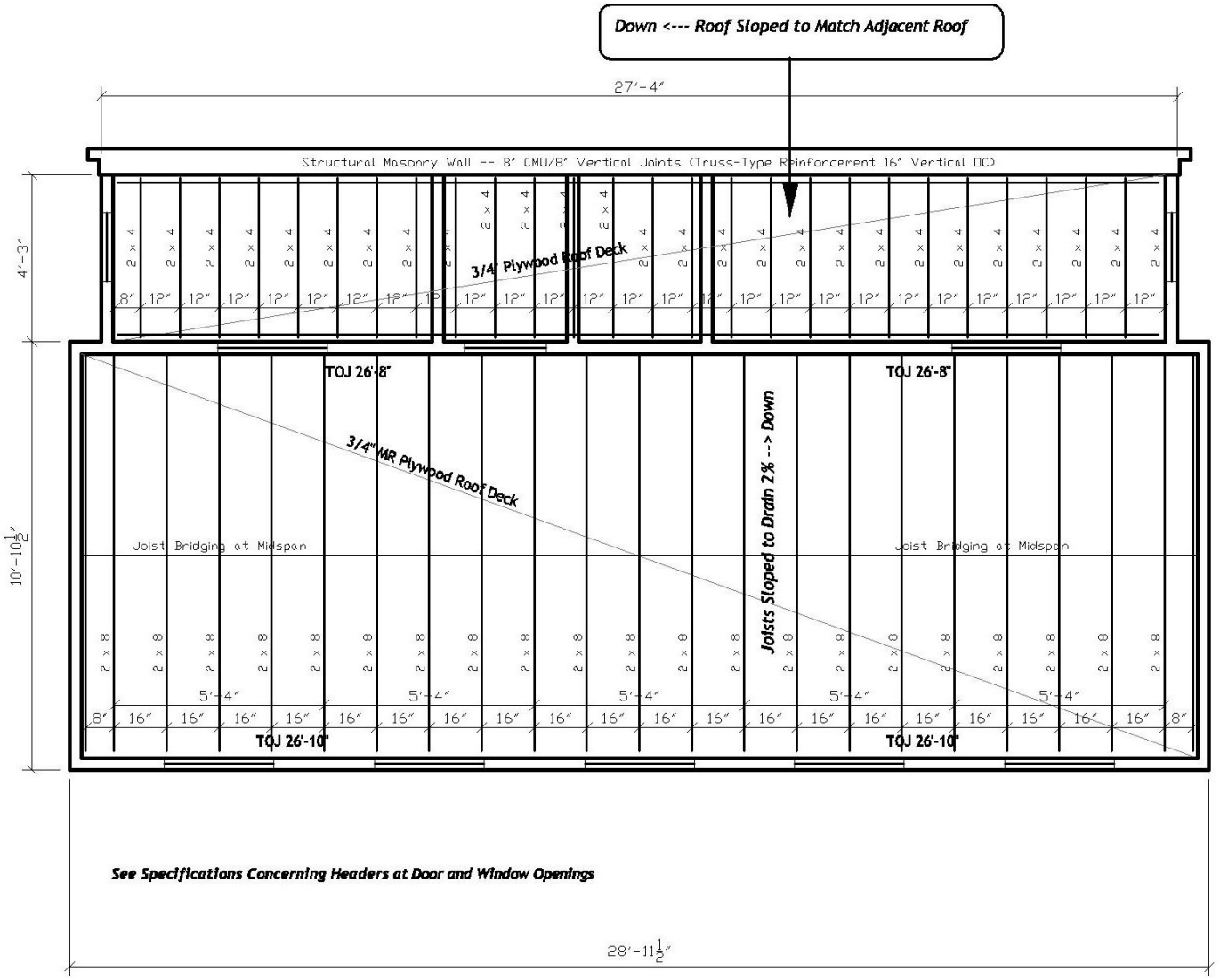


See Specifications Concerning Headers at Door and Window Openings

Note: Floor Joists and Wall Studs Must Align Except Where Noted at Parapet Walls;

Double-Studs at all Bearing Points in Walls

WOOD: Light-Frame Construction



Note: Roof Joists offset $1\frac{5}{8}$" from Wall Stud Centers;
Fasten Joists to side of Web Studs which extend to Parapet Height.