California Vocational Agriculture Curriculum Guidelines Instructional Unit

WOOD STRUCTURES

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WOOD STRUCTURES

Unit Goal:

The goal of this unit is to have students in Ornamental Horticulture become aware of the wood structures used in landscaping and how they are constructed and installed.

Unit Performance Objectives:

Upon completion of this unit students will be able to:

1. Identify the kinds of wood and materials used in the construction of wood structures in the landscape.

2. Identify the wood structures used in landscaping or landscape work.

3. Calculate the number of board feet in a given length of lumber.

4. Estimate a bill of materials from sketches and drawings provided in landscape plans or blueprints for wood structure.

5. Identify and use common carpentry tools used in the construction and installation of wood structures in the landscape.

6. Build wood structures commonly used in landscaping.

Teaching Outline

I. Introduction--Wood structures in the landscape are very important and necessary. Much of the cost and labor will be in the construction of wood structures in the landscape. Since this part of the landscape will last for time to come, it must be planned and executed with the utmost of consideration and forethought. All construction must blend in and compliment the rest of the landscape; therefore, design, size, texture, and color are very important and you must learn those techniques that will help you do an adequate job. These techniques involve horticultural sense, artistic talent, and engineering skill

II. Learning to construct wood structures

A. Materials used

1. Types of lumber (See TM 1 and TM 2)

a. Redwood--clear heart, select heart, construction heart, and merchantable
b. Red cedar--"C" and better finish, "C" finish, select merchantable construction, and standard
c. Douglas fir--"C" and better finish, "C" finish, construction and standard
d. Pine--"C" and better, land 2 clear supreme, "C" select choice, quality "D" select, 1-3 dimension, 1-5 common utility
e. Plywood--(exterior) A-A-X, A-B-X, A-C-X, A-D-X
f. Depending on appearance and use in the landscape, select lumber for durability

(1). Use redwood where lumber comes in contact with the ground
(2). Use douglas fir for structural strength
(3). Use plywood for exterior covering, roofs and siding
(4). Avoid pine as it is too soft and is best suited indoors

g. Finished lumber (S4S) is smaller than rough (RGH) lumber (i.e.--2 X 4 S4S is actually 1 1/2 X 3 1/2 dry)--See TM 2

2. Types of fasteners

a. Nails--TM 3

(1). Types--Common, box, casing, finishing wire brads, cut, and spike
(2). Coating--Galvanized, cement resin, etc.

b. Wood screws--TM 4

(1). Slotted (flat, oval, round)
(2). Phillips (flat, oval, round)
(3). Lag

Suggested Learning Activities	Suggested Resource Materials
1. Use TM 1 to discuss lumber grades. Show samples of grades.	1. TM 1. "Lumber Grading," British Columbia Lumber Association.
2. Have students bring in small samples of wood and key out its grade.	2. TM 1.
3. Have students measure various pieces of finished and rough lumber to determine actual dimensions.	3. TM 2, Rulers.
4. Bring in samples of fasteners for students to study.	4. Samples obtained from school shop, hardware or lumber stores, etc.
5. Have students develop display board featuring labeled samples of nails, screws, bolts or other fasteners.	5. 2' X 4' sheet of plywood, labeler, and fastener samples.
6. Pass out various types and sizes of nails and have students determine their size using a nail chart.	6. TM 2, also, "Hardware Identification Kit," The Interstate, Danville, Illinois 61832.
7. Have a display board made up of a "board foot" of lumber for each sample of wood use.	7. None
8. Visit a lumber yard to go over prices and see the different examples of wood in storage for sale.	8. Local lumber yard.
9. Write to the lumber companies for student packets on ideas and plans on wood structures in landscaping	9. Addresses obtained from the lumber yard. Also write: California Redwood Association 617 Montgomery Street San Francisco, CA. 94111 Simpson Timber Company 2000 Washington Building Seattle, WA. 98101

c. Bolts--Carriage, machine, stove, toggle, expansion--TM 5
d. Miscellaneous fasteners--staples, drive screws, roofing nails, corrugated fasteners, glazier points, and brackets--TM6

3. Estimating costs of materials (Bill of Materials)

a. Formula for computing board feet--thickness in inches X width in feet X length in feet--TM 7 and TM 8

(1). Some lumber is sold by the linear foot
(2). Some lumber is sold by the piece, i.e. plywood

b. Nail sizes are indicated by the "penny," abbreviated as "d" (for example 16d), and are sold by the pound (chart will give number of nails per pound)
c. Screws are classed by gauge (thickness) and length. Specify head shape, finish, gauge, and length when ordering
d. Bolts are classed by diameter and length and are sold by the piece or in boxes of 100
e. Other considerations

(1). Since prices have a tendency to fluctuate, contact local lumber dealers
(2). Materials cost more when sold in small lots or amounts
(3). To save time and money have adequate blueprints or drawings of actual construction items availale when purchasing
(4). You may need to check local and county building codes and have an inspector for the project

f. "Bill of Materials" includes all materials needed for completion of the job--TM 9

4. Labor costs, considerations

a. Does own labor actually save time or dollars?
b. Labor will be approximately 1/2 of the construction costs
c. Labor costs are proportionately higher for small-scale work
d. Schedule construction items in order of priority and finances if job is to be done in part
e. If a contractor is to be used, get estimates from several others before awarding work

B. Tools to be used--TM 10

1. Tools for layout and gauging

a. Measuring tools

(1). Flexible steel tapes
(2). Folding wooden rule

Suggested Learning Activities	Suggested Resource Materials
1. Have students calculate board feet of various sizes and quantities of lumber.	1. TM 7, TM 8.
2. Have students estimate Bill of Materials for sample construction project.	2. TM 9. Use plan for small wood working project at first, then use a more difficult project as skill develops. TM 12 (Fences) offers some simple plans.
3. Have a local contractor talk to the class about estimating costs of construction.	3. Local contractor.

b. Squares.

(1). Try square
(2). Combination square
(3). Framing square

c. Bevels

(1). Sliding "T" bevel
(2). Angle dividers

d. Levels and plumbs

(1). Carpenter's level
(2). Plumb bob

e. Marking tools

(1). Chalk line
(2). Marking gauge
(3). Wing dividers

2. Cutting tools

a. Saws

(1). Handsaws

(a). Cross-cut
(b). Rip

(2). Backsaw
(3). Compass saw
(4). Coping saw
(5). Portable electric saw
(6). Sabre saw

b. Chisels
c. Planes

(1). Block Plane
(2). Jack Plane

3. Fastening tools

a. Claw hammers
b. Staplers and nailers
c. Screwdrivers
d. Wrenches and pliers

4. Tools for drilling holes

Suggested Learning Activities	Suggested Resource Materials
1. Pass samples of common tools around class.	1. See tools listed in outline, also "Tools Identification Kit" (pictures) available from The Interstate, Danville, Ill. 61832.
2. Review tools list for the Ag. Mechanics Contest.	2. Curricular activities code or Vocational Education Productions, Tool and Materials I.D. Manual.

a. Brace and bit
b. Hand drills
c. Electric drills

5. Clamping tools

a. "C" clamps
b. Bar and pipe clamps

6. Finishing wood

a. Sand paper
b. Rasps
c. Electric sanders

III. Types of Landscape Wood Structures

A. Overhead structures

1. Patio covers
2. Arbors (Lattice or random patterns)
3. Gazebos
4. Awnings
5. Car Ports

B. Borders and Barriers

1. Header boards--TM 11
2. Grade change at end of property

C. Decks and platforms--TM 12

D. Fences--TM 13

1. Grapestakes
2. Board on board
3. Basket weave
4. Picket, 1 by 2's
5. Bamboo or reed
6. Louvered
7. Split rail
8. Cedar (2 X 2's or 1 X 2's)

E. Steps--TM 14

1. Railroad ties
2. Rough redwood
3. Redwood rounds
4. Four by four ends
5. Two by fours on end

Suggested Learning Activities	Suggested Resource Materials
1. Show samples of wooden landscape structures.	1. Sunset Garden Books a. Patio Book b. Garden and Patio Building Book c. How to Build Patio Roofs d. How to Build Fences and Gates
2. Field trip to areas where examples of wood landscape structures may be observed.	2. Local homes or parks.
3. Have students review publications on landscape structures.	3. Books available from Lane Books, Menlo Park, California: a. Basic Carpentry Illustrated b. Sunset Garden Plans c. Garden & Patio Building Book

F. Gates

1. Tongue and groove
2. Wagon wheels
3. Bamboo
4. Large dowels
5. Redwood siding
6. Split rail (redwood)
7. Picket

G. Benches

1. Smooth redwood
2. Two by fours on sides
3. Curved type
4. Fir, burned and varnished
5. Others

H. Bridges

1. Japanese curved type
2. Wood and gravel
3. Railroad ties
4. Natural logs

IV. Carpentry Techniques

A. Joining wood

1. Post anchors and caps
2. Joist hangers
3. Framing anchors
4. Plywood clip

B. Structural patterns

1. Cross bracing (car ports, etc.)
2. Triangular brace (gates)

C. Preserving wood

1. Staining
2. Painting
3. Creosote
4. Copper Napthenate
5. Zinc Napthenate
6. Penta chlorophenal
7. Varnishing

Suggested Learning Activities

1. Fabricate or build simple wood structures for use in landscaping (benches, arbors, screens, etc.)

2. Hold a sale or auction of construction projects to regain cost.

Suggested Resource Materials

1. Better Homes & Gardens Landscape Planning. Meredith Publishng Company. Also Sunset Books.

2. Combine this activity with local livestock show or other FFA activity.

Student Evaluation

1. Name five structures commonly made of wood in the landscape.

   a.

   b.

   c.

   d.

   e.

2. Describe the type of use for which each of these woods is best suited, i.e., structure base or covering

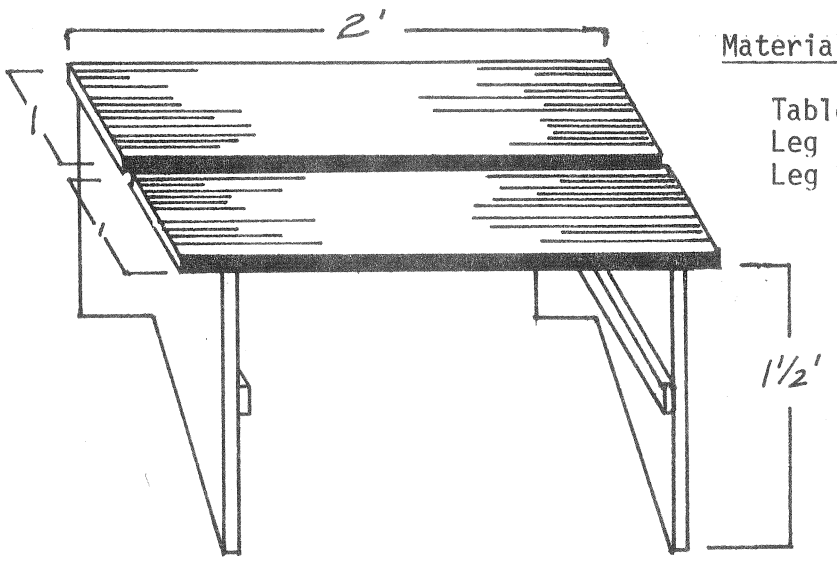
   a. Redwood--

   b. Douglas fir--

   c. Plywood--

3. If you need 24 feet of redwood 2x8's for a bench and it costs $.30/bd.ft., how much will you have to pay_

4. Calculate the amount of redwood needed for this bench.



Material Thickness

Table Top = 2"
Leg = 1"
Leg Brace = 1" x 4"

LUMBER GRADES

TM 1

USES	REDWOOD	RED CEDAR	DOUGLAS FIR	FINE	PLYWOOD EXTERIOR	PLYWOOD INTERIOR
Suitable for tabletops, benches, chair arms, shelves, cabinets, and other high finish surfaces. In the case of plywood, use where appearance of both sides is important.	Clear All Heart Clear	C and Better Finish	C and Better Finish	C and Better 1 and 2 Clear Supreme	A-A-X	A-A
May contain slight defects such as torn grain, but suitable for furniture framing, most types of shelves, exposed sheeting such as outdoor shelter walls. Often used where surface is to be planed and sanded.	Select Heart Select	C Finish	C Finish	C Select Choice	A-B-X	A-B
Suitable for general outdoor garden construction. Contains some knots and defects. Medium crook and cup. Use when appearance is not primary cosideration, or where surfaces will be painted. Economical. In the case of redwood, all-heartwood grade should be used if lumber comes in contact with the ground. In the case of plywood, use where appearance of only one side is important.	Construction Heart Construction	Select Merchantable	Construction	C Select Choice	A-C	A-D
Seldom used for finish work because of visible irregularities in surface or lack of resistance to decay. However, these grades are suitable for rough, bulky construction such as plating, studding or sub-flooring	Merchantable	Standard	Standard	1-3 dimension 1-5 common Utility	C-C C-D-X	C-D

STANDARD DIMENSIONS OF SURFACED LUMBER

FOR BOARD LUMBER

Size to Order	Surfaced (actual) Size	
	Unseasoned	Dry
1 X 3	25/32 X 2 9/16	3/4 X 2 1/2
1 X 4	25/32 X 3 1/2	3/4 X 3 1/2
1 X 6	25/32 X 5 1/2	3/4 X 5 1/2
1 X 8	25/32 X 7 1/4	3/4 X 7 1/4
1 X 10	25/32 X 8 1/4	3/4 X 9 1/4
1 X 12	25/32 X 11 1/4	3/4 X 11 1/4

FOR DIMENSIONED LUMBER

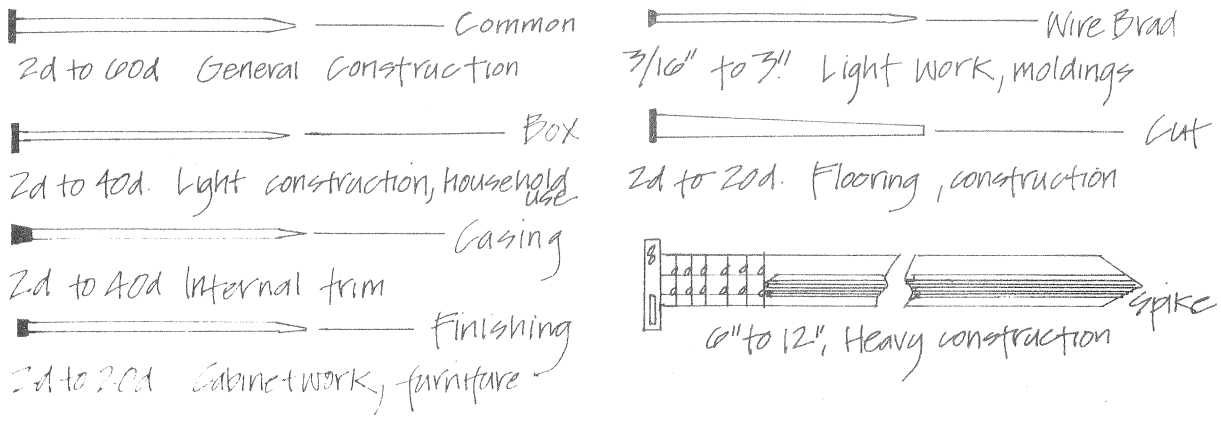
Size to Order	Surfaced (actual) Size	
	Unseasoned	Dry
2 X 3	1 9/16 X 2 9/16	1 1/2 X 2 1/2
2 X 4	1 9/16 X 3 9/16	1 1/2 X 3 1/2
2 X 6	1 9/16 X 5 5/8	1 1/2 X 5 1/2
2 X 8	1 9/16 X 7 1/2	1 1/2 X 7 1/4
2 X 10	1 9/16 X 9 1/2	1 1/2 X 9 1/4
2 X 12	1 9/16 X 11 1/2	1 1/2 X 11 1/4

Thicknesses of 3" and 4" lumber are same as respective widths above.

Dry lumber is preferred to unseasoned except in cases where large quantities are needed for rough work (such as fir used for house framing, redwood for fences). Price of dry lumber can run more than twice that of unseasoned.

NAILS, HOW TO USE, HOW TO BUY

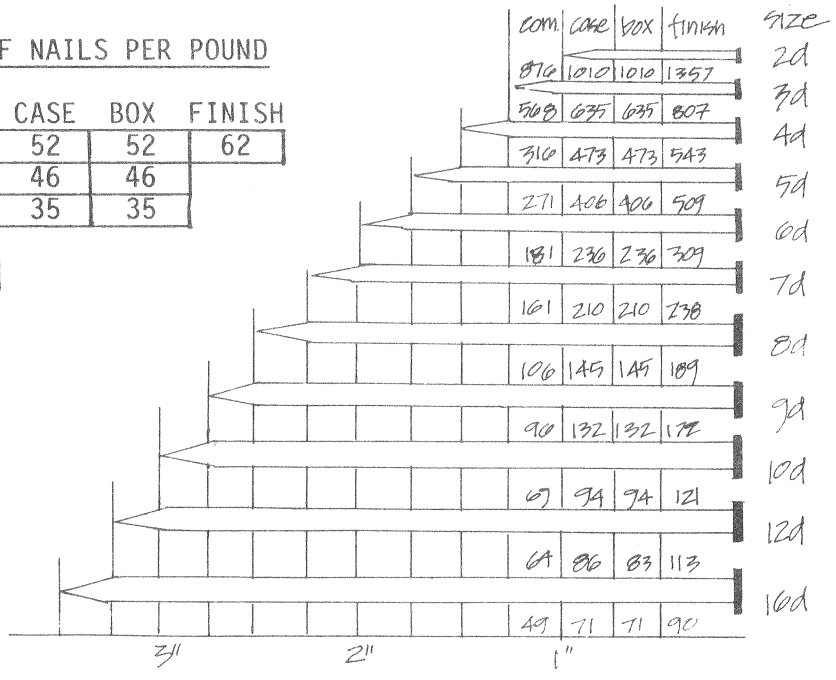
Use a nail that is three times as long as the thickness of the board you are nailing. Nails with sharp points hold better than blunt ones, but tend to split wood. Flatten the point with hammer before driving into easily split wood. Use thinner nails for hardwood than for soft. For weather resistance, use copper, aluminum or galvanized nails. Zinc or cement coatings increase resistance to withdrawl. Barbed nails hold best in green wood. Sizes are indicated by "penny," abbreviated as "d" (example, 20-penny nail is known as 20d nail). Always use weatherproof nails with exterior redwood.



number of nails per pound

LARGER SIZES

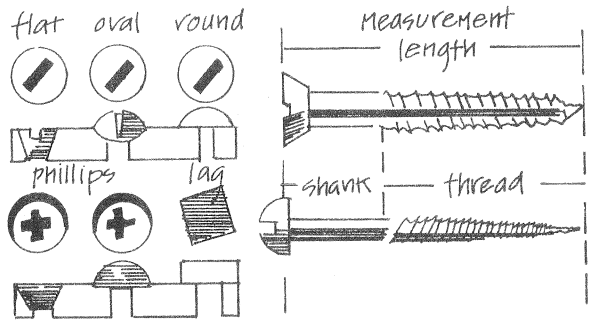
		NO. OF NAILS PER POUND			
SIZE	LENGTH	COM.	CASE	BOX	FINISH
20d	4"	31	52	52	62
30d	4 1/2"	24	46	46	
40d	5"	18	35	35	
50d	5 1/2"	14			
60d	6"	11			

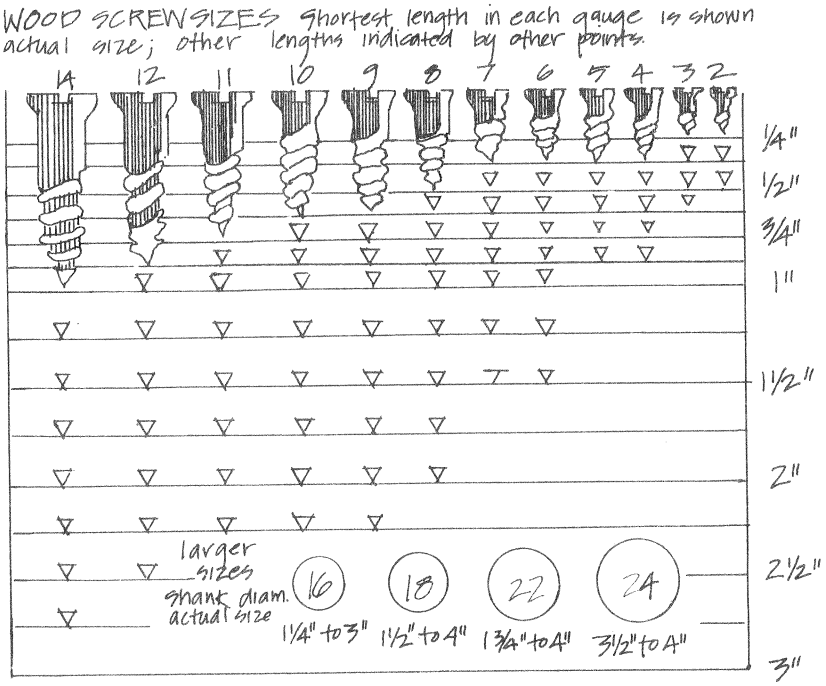


SCREWS, BOLTS--HOW TO USE, HOW TO BUY

WOOD SCREWS

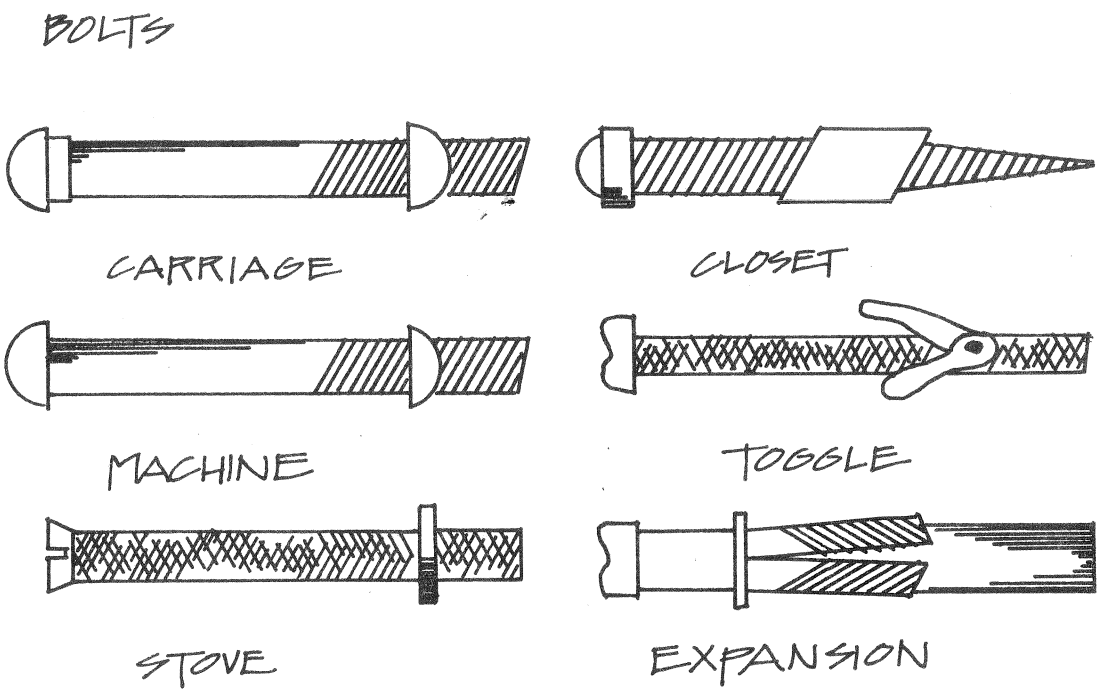
HOW TO CHOOSE--Use screw that is long enough so two-thirds (never less than one-half) of its length will enter base in which threads are imbedded. Length should be about 1/8 inch less than combined thickness of boards being joined. Use fine thread for hardwood, coarse for soft.
HOW TO USE--Always drill lead hole for screw. Hole in top board should be slightly larger than shank, in second board slightly smaller than threaded portion. In soft wood, bore to depth half the length of the thread; in hardwood, bore nearly as deep as length of screw. For lag screw: Drill two-thirds its length, drive in with hammer, tighten with wrench.
HOW TO BUY--Screws are classed by gauge (thickness) and length. Each gauge has a variety of different lengths, as shown on chart. When ordering, specify head shape (e.g., round head), finish (brass), gauge (number 5), and length (1 1/2 inches). Screws may obtained up to 5 inches in length. Square-headed lag screws come in diameters of 1/4 to 1 inch, lengths of 1 1/2 to 12 inches.





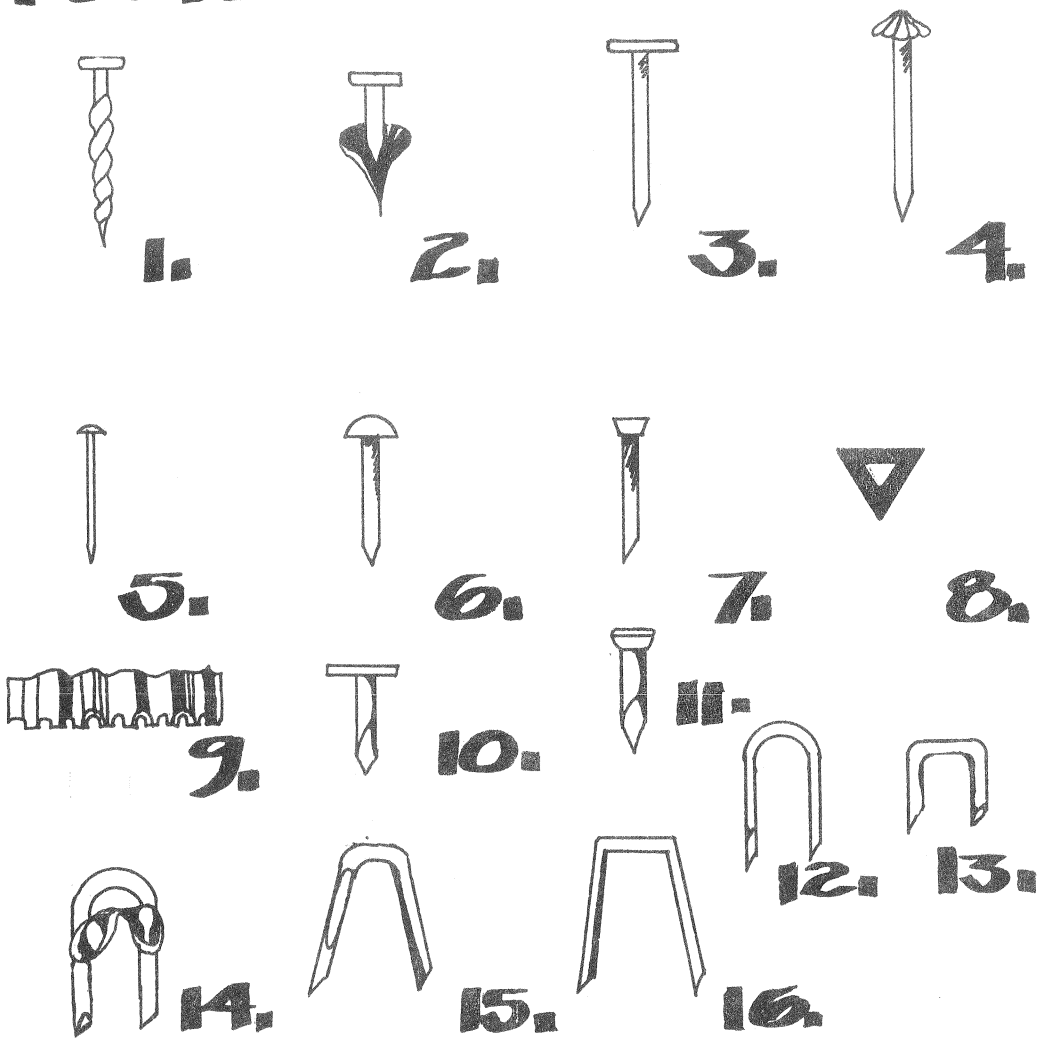
BOLTS--HOW TO USE, HOW TO BUY

HOW TO USE--Length of bolt should be sum of thickness of both pieces of lumber plus 1/2 inch. For lumber up to 2 inches use 1/4-inch-diameter bolts; for 3-inch lumber, 3/8-inch bolts; for 4-inch lumber, 1/2-inch bolts. Drill hole 1/16 inch larger than diameter of bolt unless snug fit essential. Use washers under head and nut of machine bolts, under nut of carriage bolts.
HOW TO BUY--Bolts are classed by diameter and length. Come in diameters from 1/4 to 1 1/4 inches, in lengths from 3/4 to 30 inches. Use toggle bolt for attaching fixture to plaster wall; expansion bolt for fastening to masonry. For outdoor exposure use brass or cadmium-plated finishes.



tm6

Miscellaneous Fasteners



1. Hardened drive screws for masonry and cement.
2. Expansion nail for masonry and cement.
3. Roofing nail.
4. Waterproof roofing nail.
5. Escutcheon pin for attaching fixtures where decorative head is required. Come in brass and nickel-plated finishes.
6. Upholstery nail, comes in variety of ornamental heads.
7. Brad for fine work. Obtainable in sizes ranging from 1/4" length to 3".
8. Glaziers points for holding glass in place.
9. Corrugated fastener for joining boards in rough work.
10. Cut tack for upholstery, screens.
11. Rounded head wire tack.
12. Common staple for attaching wire to a board, fence post.
13. Square tack for upholstery.
14. Insulated staple for electric wires.
15. Large staple for electric conduit.
16. Rose staple for attaching vines, roses to house or fence.

CONVERTING LUMBER DIMENSIONS--LINEAL TO BOARD FEET TM 7

LUMBER DIMENSIONS	LINEAL FEET	8	10	12	14	16	18	20	22	24
1 X 2	Sold by lineal foot									
1 X 3	Sold by lineal foot									
1 X 4		2 2/3	3 1/2	4	4 2/3	5 1/3	6	6 2/3	7 1/3	8
1 X 6		4	5	6	7	8	9	10	11	12
1 X 8		5 1/3	6 2/3	8	9 1/3	10 2/3	12	13 1/3	14 2/3	16
1 X 10		6 2/3	8 1/3	10	11 2/3	13 1/3	15	16 2/3	18 1/3	20
1 X 12		8	10	12	14	16	18	20	22	24
2 X 2	Sold by lineal foot									
2 X 3	Sold by lineal foot									
2 X 4		5 1/3	6 2/3	8	9 1/3	10 2/3	12	13 1/3	14 2/3	16
2 X 6		8	10	12	14	16	18	20	22	24
2 X 8		10 2/3	13 1/3	16	18 2/3	21 1/3	24	26 2/3	29 1/3	32
2 X 10		13 1/3	16 2/3	20	23 1/3	26 2/3	30	33 1/3	36 2/3	40
2 X 12		16	20	24	28	32	36	40	44	48
3 X 6		12	15	18	21	24	27	30	33	36
4 X 4		10 2/3	13 1/3	16	18 2/3	21 1/3	24	26 2/3	29 1/3	32

Formula for computing board feet: Thichness in inches X width in feet X length in feet.
Example: A 1x6 ten feet long would be computed--1" X 6/12' X 10'=1/10 X 5/10 X 10/10=50/10=5 board feet.

BOARD FOOT WORK SHEET

TM 8

Quantity	DESCRIPTION	Board Feet	Cost per 1,000 bd. ft.	Total Cost
8	1" X 4" X 10' #2 S4S Redwood	27	$280.00	$7.56
10	1" X 6" X 12' #2 S4S Redwood		$300.00	
8	2" X 4" X 14' Cons. Gd. Doug. Fir		$110.00	
27	2" X 6" X 12' #2 S4S Doug. Fir		$240.00	
30	1" X 4" X 10' #3 S4S Pine		$180.00	

*Sample

Length in ft. X width in inches X thickness in inches X number of pieces divided by 12.

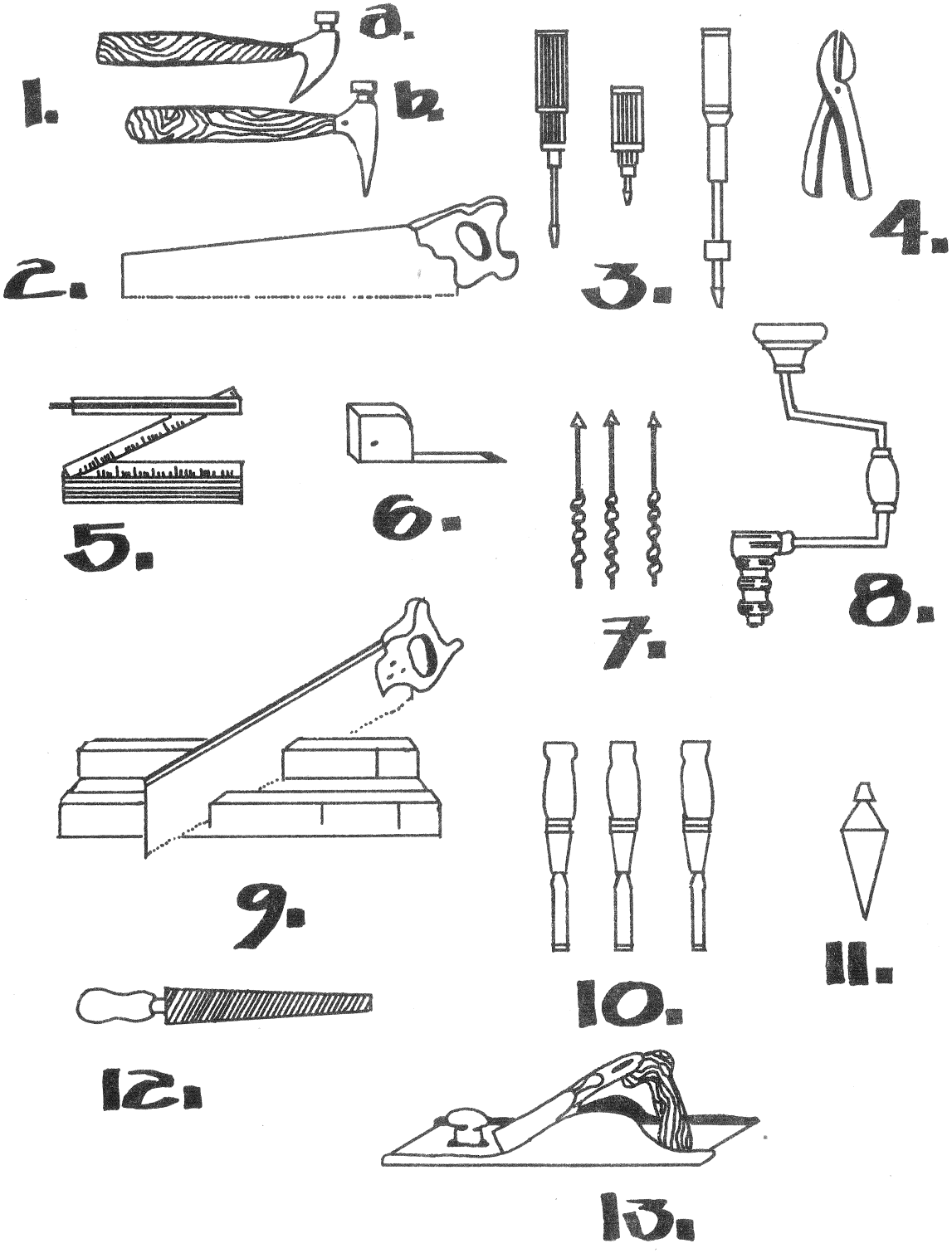
$$\frac{L' \times W'' \times T'' \times \text{No. of Pieces}}{12} = \text{Total Board Feet}$$

WORKSHEET OF A "BILL OF MATERIALS"

Quantity	Description	Unit Cost	Total Cost
		Total Cost	
		Tax @ 6%	
		Total	

tm 10.

Hand Woodworking Tools

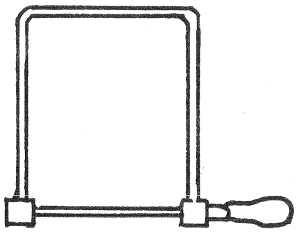


TM 10-2

Hand Woodworking Tools

14.

15.



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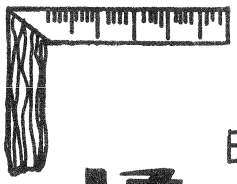

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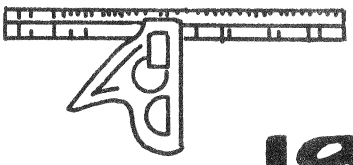

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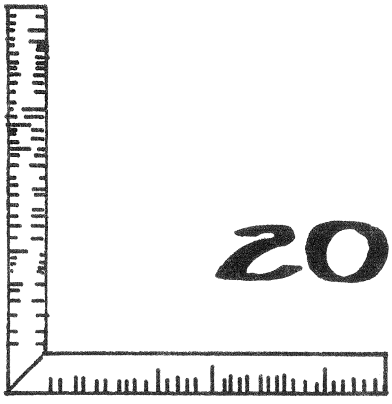

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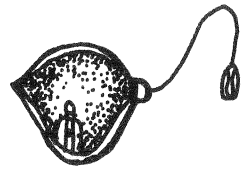


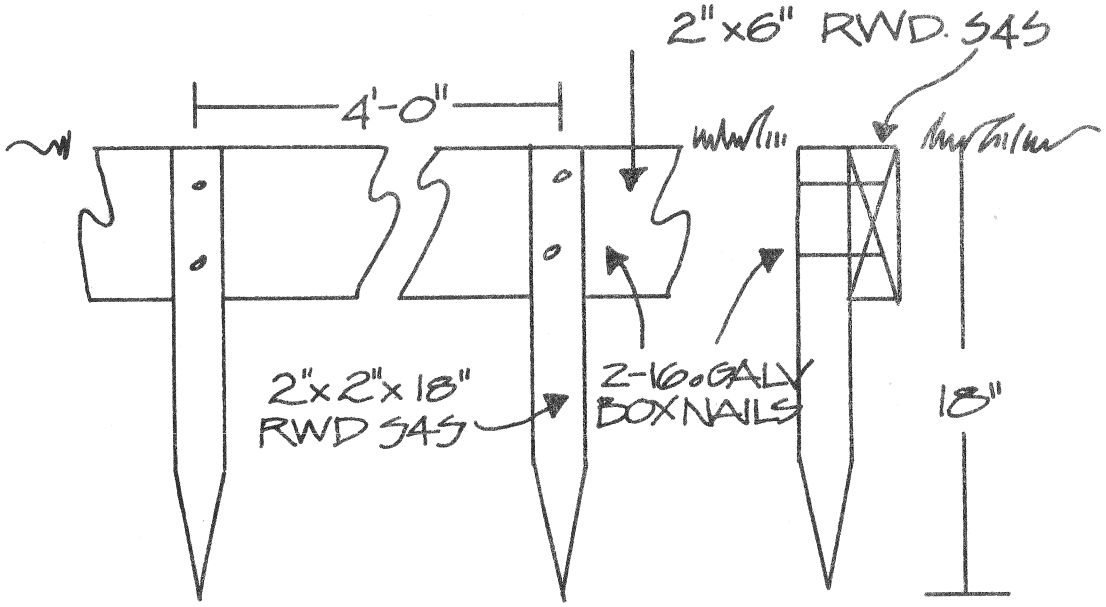
21.

22.

HANDWORKING TOOLS

1. HAMMER
   - A. CLAW HAMMER
   - B. STRAIGHT CLAW HAMMER
2. CROSS CUT SAW
3. SCREW DRIVERS
4. PLIERS
5. FOLDING RULE
6. ROLL UP STEEL TAPE
7. AUGER BITS
8. BRACE
9. MITER BOX AND BACK SAW
10. CHISEL
11. PLUM BOB
12. FILES
13. JACK PLANE
14. LEVEL
15. HAND DRILL
16. COPING SAW
17. TRY SQUARE
18. ADJUSTABLE TRY SQUARE
19. BLOCK PLANE
20. FRAMING SQUARE
21. CHALK LINE
22. KEYHOLE AND COMPASS SAW

TM 11



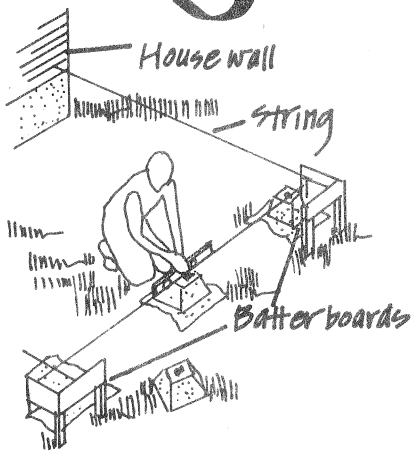
SIDE VIEW END VIEW

REDWOOD HEADER

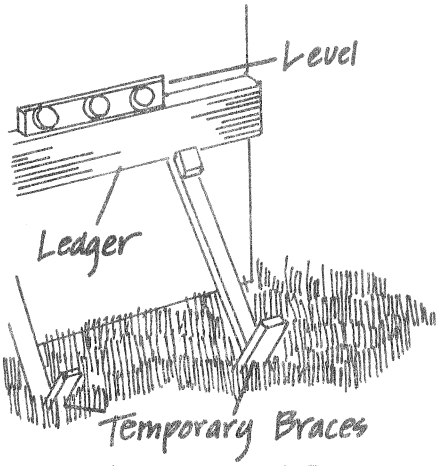
SCALE 1½"=1'-0"

Building Decks

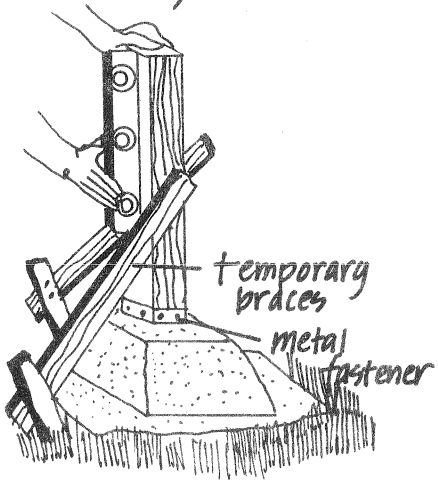
tm 12



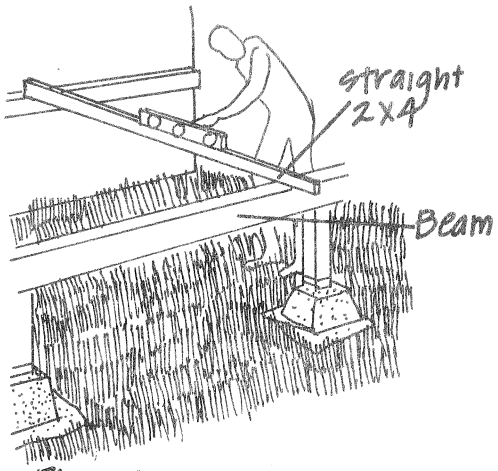
Level and position precast piers in footing



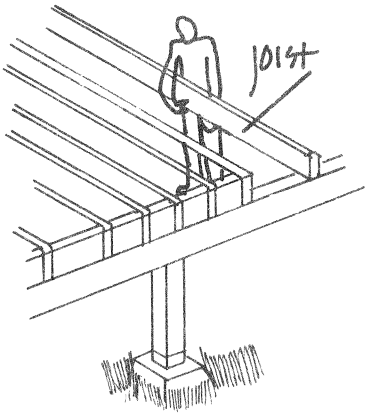
Set Ledger on Wall



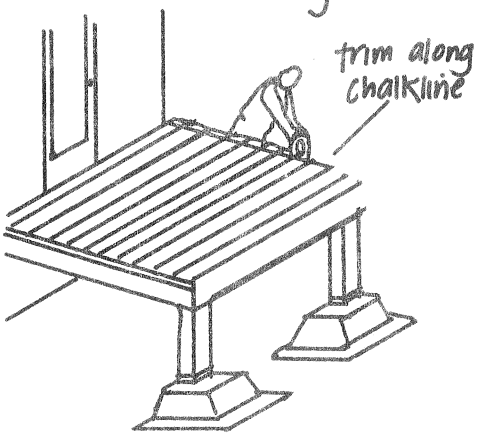
Temporarily brace posts in place



Place beam across post tops and level it with ledger.



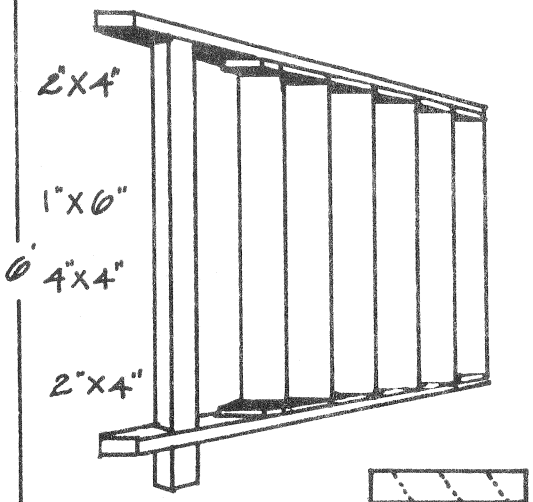
Fasten joists in place



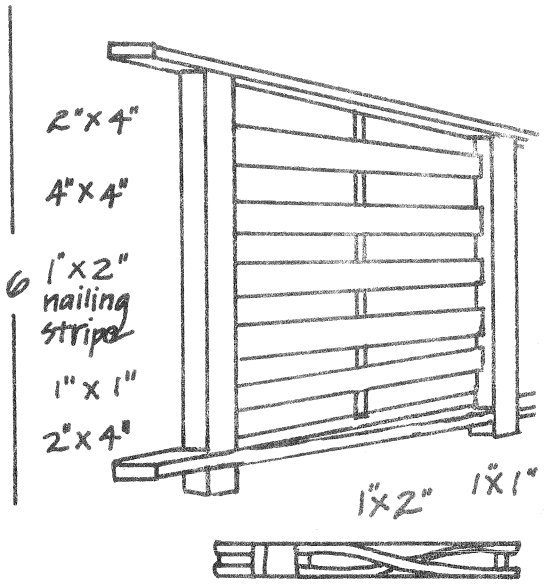
Space and nail decking to each joist

tm 13.

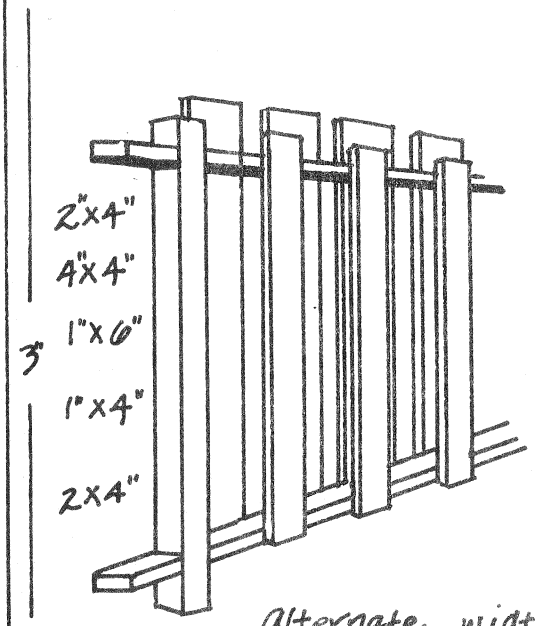
TYPES of FENCES



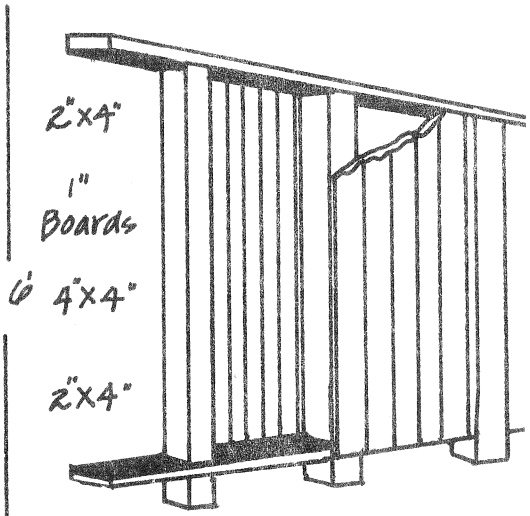
Louver



Basketweave



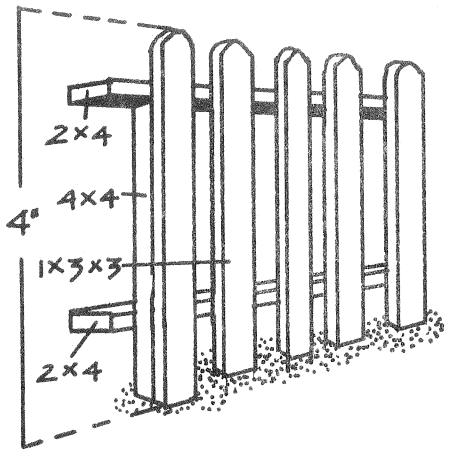
Alternate widths



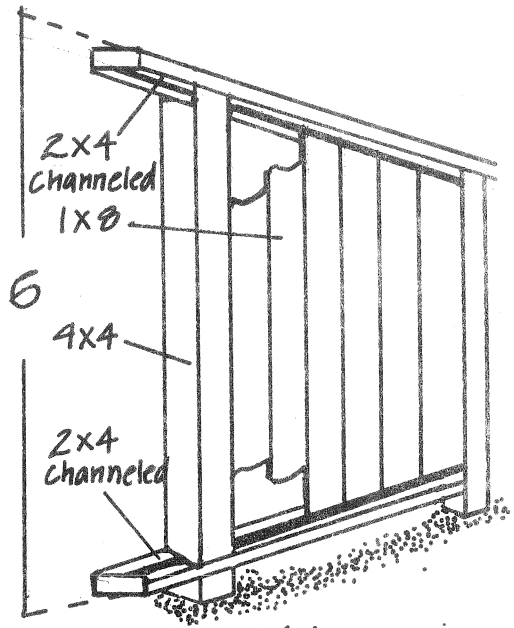
Alternate Panels

tmB2

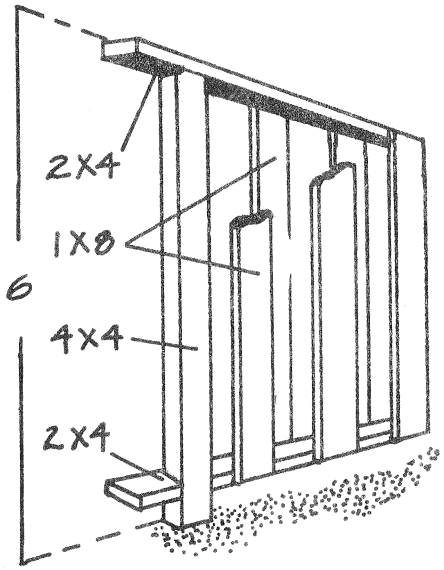
TYPES of FENCES



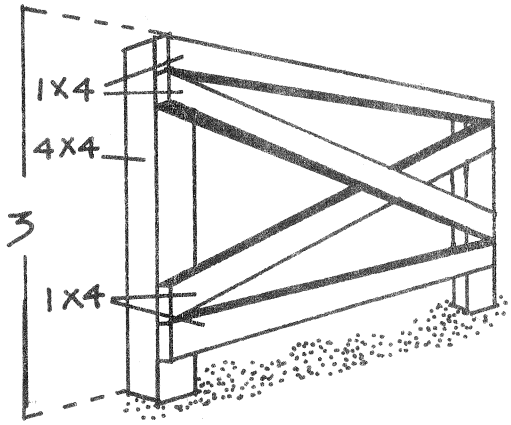
Gothic picket



Good Neighbor



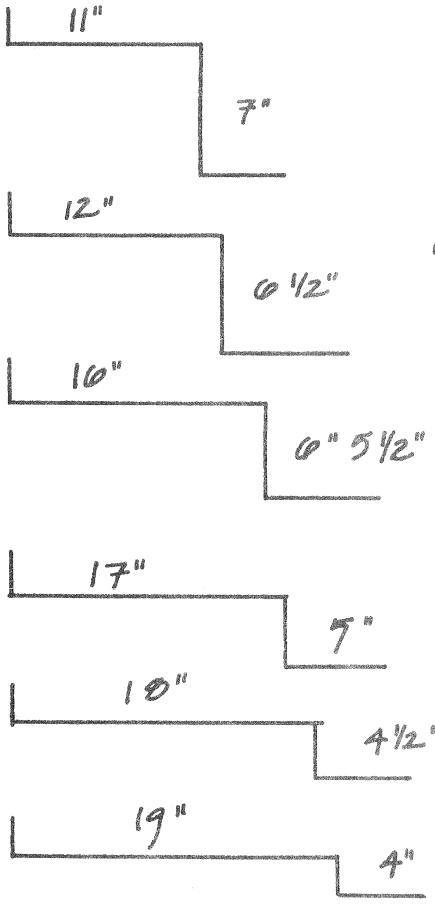
Board and Board

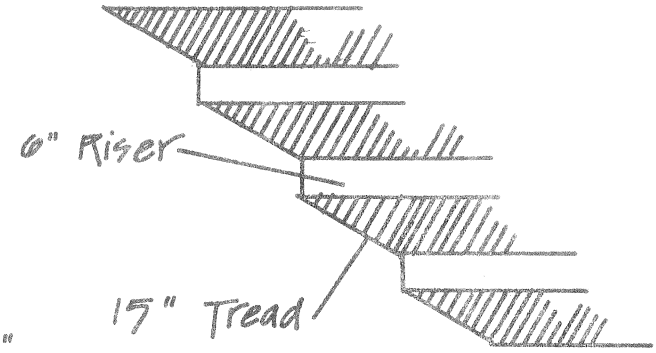


post and rail

Garden Steps

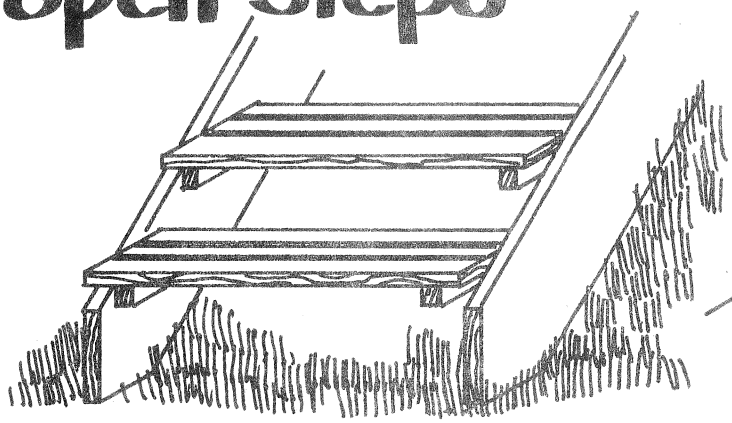
tread riser ratios

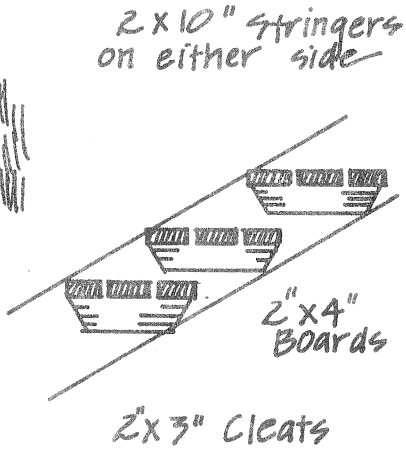




best average tread riser ratio

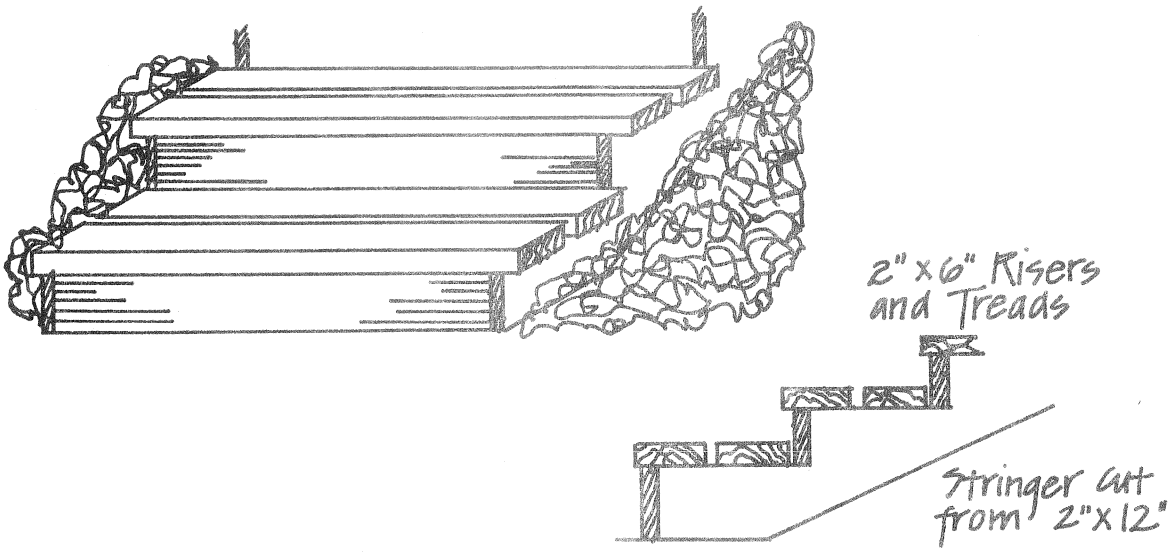
open steps



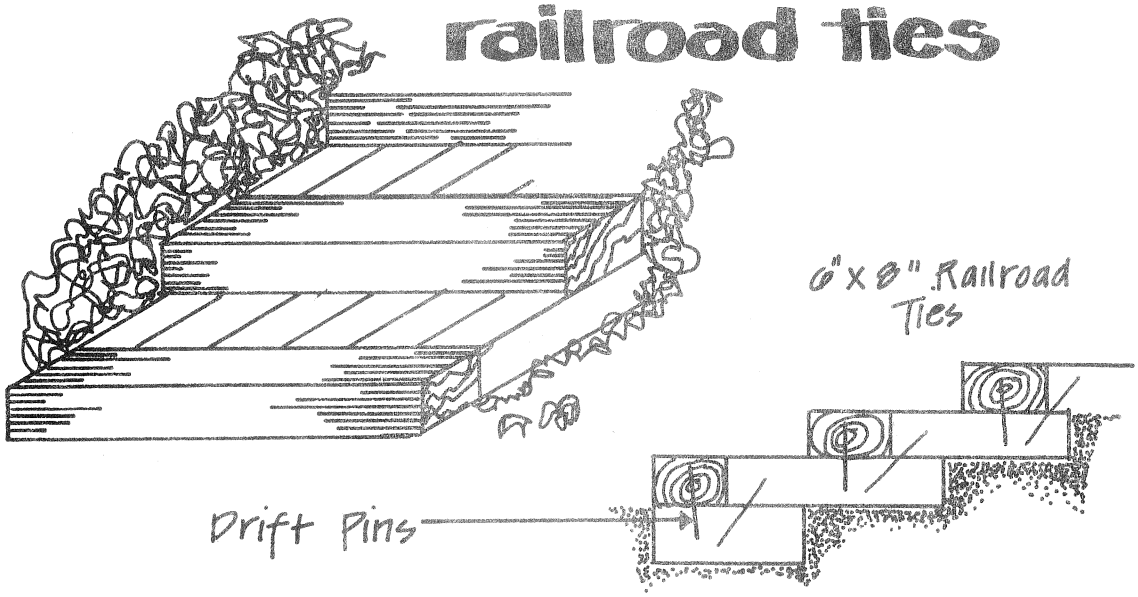


Garden Steps

closed stairs

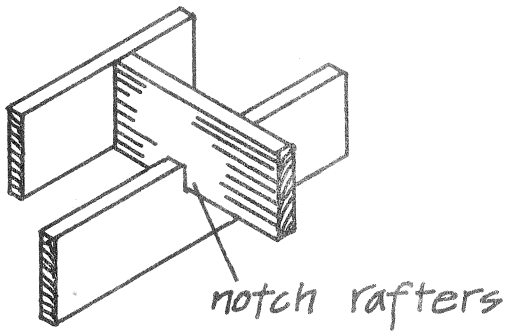


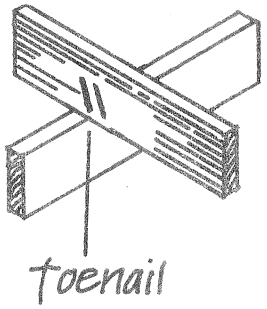
railroad ties

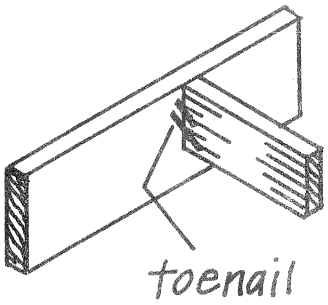


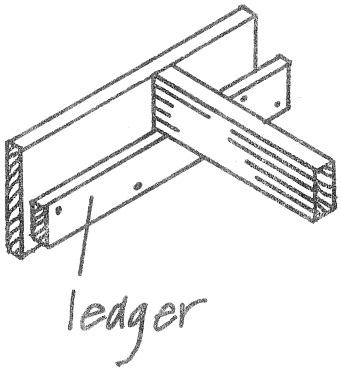
tm 5,

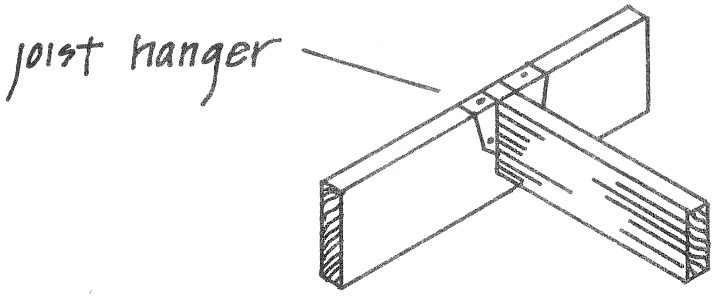
CONSTRUCTION TECHNIQUES RAFTERS





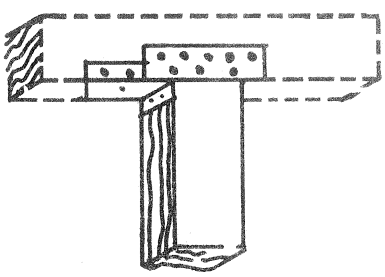




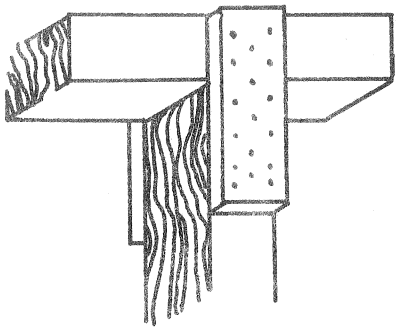


tm15 2

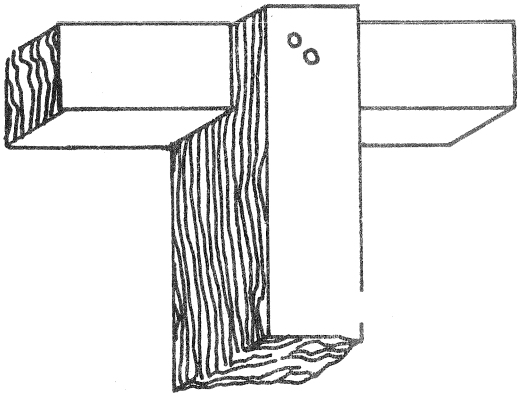
CONSTRUCTION TECHNIQUES POST AND BEAM



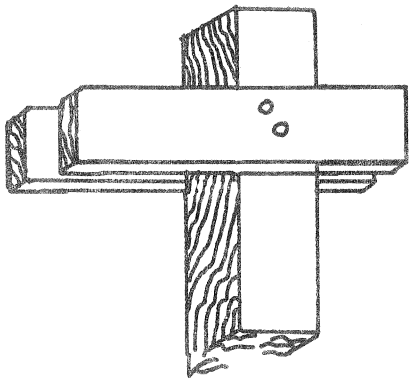
Post Cap



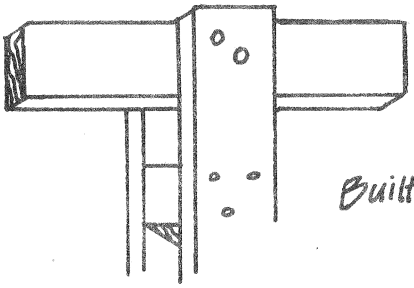
Wood Cleat



Single



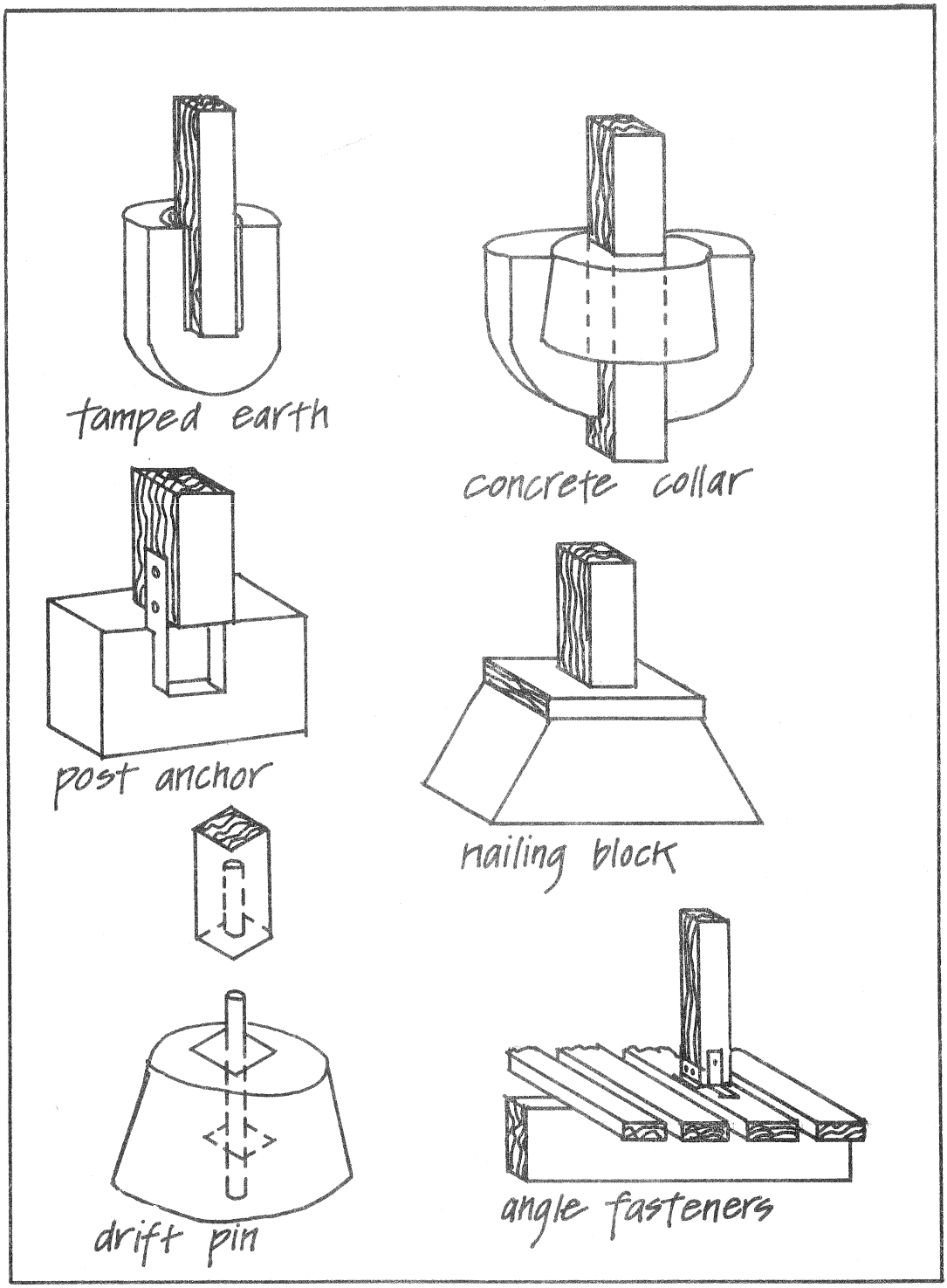
Double



Built up Column

Tm15 3

CONSTRUCTION TECHNIQUES FOOTINGS



General References

Reader's Digest Complete Do-it-Yourself Manual, Norton, 1973.

Decks, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.

Fences and Gates, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.

Garden and Patio Building Book, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.

Patio Book, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.

Patio Roofs, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.

Walks, Walls and Patio Floors, Sunset Books, Lane Publishing Company, Menlo Park, California 94025.