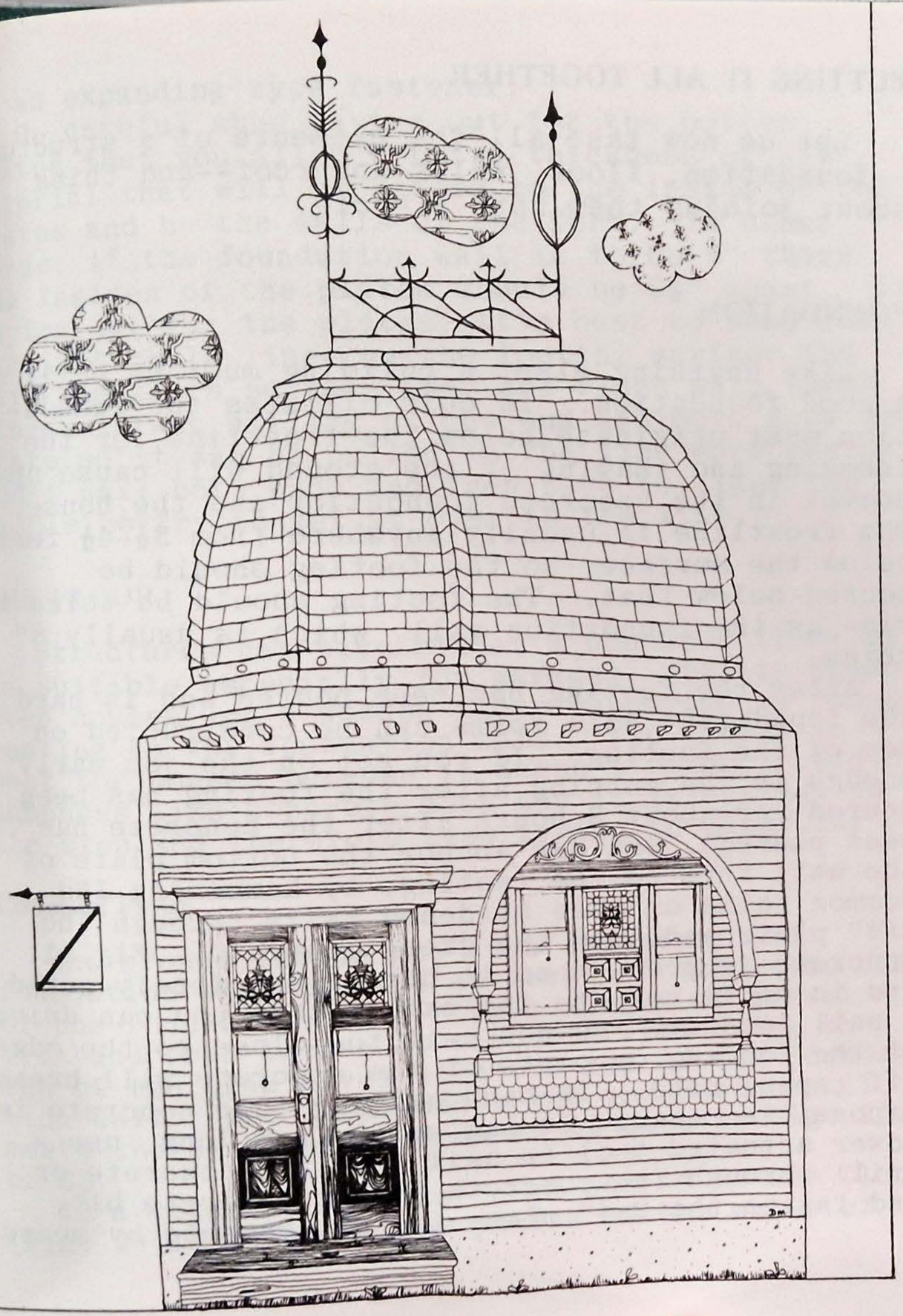

Chapter 11

Putting It All Together

Footing--See Concrete: Figs. 23-25

Frostline

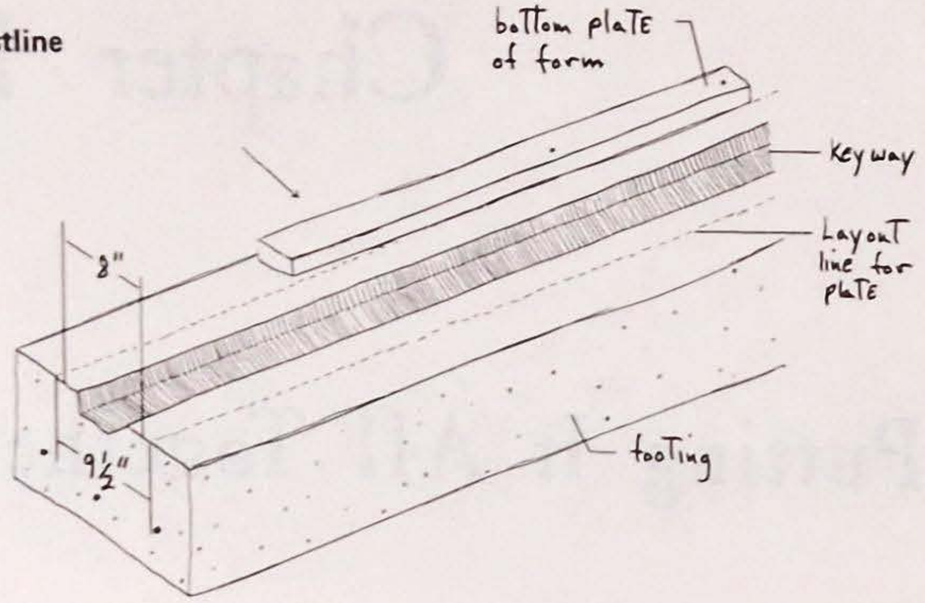

Fig. 1 - Laying Out for The Wall form

Case hardened nail--See Metal Fasteners And Glues: Fig. 3

Bottom plate of form--See Concrete: Fig. 29

Green concrete

PUTTING IT ALL TOGETHER

Let us now take all the elements of a structure --foundation, floor, walls and roof--and think about joining them into a whole.

FOUNDATION

Like anything else, a building must be built on a good foundation. In cold climates the foundation must originate below the frostline, or the freezing and thawing of the ground will cause upheavel in the concrete foundation and the house. The frostline is usually anywhere from $3\frac{1}{2}$-$4\frac{1}{2}$ feet below the surface, so the footing should be poured below that. The footing should be twice as wide as the foundation wall, which is usually 8" thick.

After the footing has been poured and is hard, the foundation wall forms can be constructed on top of the footing. If you get on the job early enough in the morning after the footing has been poured (or about 8 hours after the concrete has been poured), you can anchor the bottom plate of the wall form to the footing, by hammering 16d common nails or case hardened nails through the 2x4" plate and into the green concrete. Fig. 1. Concrete is green when it hasn't completely cured and is still soft to the extent that you can drive a nail into it. Do not nail too close to the edge of the footing or parts of the concrete will break off (spaul off). If hand nailing into concrete is impossible because it has set up too long, use a power actuated tool to nail into the concrete or drill through the concrete with a concrete bit, and fasten the 2x4" plate to the concrete by means

of an expanding type fastener.

Be careful when laying out for the bottom plates that you allow for two thickness of 3/4" material that will be nailed to the inside of the plates and be the walls of the form. In other words, if the foundation wall is to be 8" thick, the insides of the plates should be 9½" apart. In laying out for the plates, it's best to snap long straight chalk lines on the footing surface and nail the 2x4's so that they are flush with these lines. Start nailing at one end and move down the plate so it can be pulled to the line more easily. Don't nail both ends and then have to fight the middle to try to get it over to the line.

Fastening into concrete--See Metal Fasteners And Glues: Fig. 17

THE FLOOR

Structures can have either a concrete floor as is suitable especially for garages, utility sheds--even houses--or a wooden floor supported by joists resting on the foundation wall. The latter is best for houses because it doesn't conduct cold or dampness like concrete does and it is springy to the step and therefore less tiring to stand on.

Concrete Floor

The ground inside the area formed by the foundation wall must be at least 8" below the top of the foundation wall. Four inches of gravel fill and four inches of concrete will bring the top of the slab level with the top of the foundation wall. The joint where the foundation wall meets the slab should look as it does in Fig. 2A or 2B.

If a concrete slab is to be poured as the floor (Fig. 2), then the bottom plates of the walls of

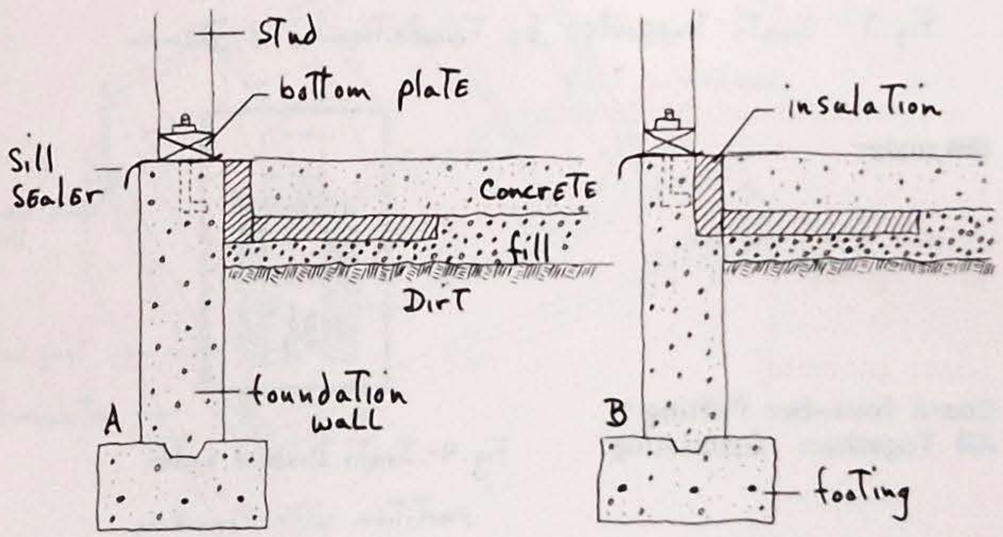

Fig. 2 - Two Types of foundations

Remember

Mudsill

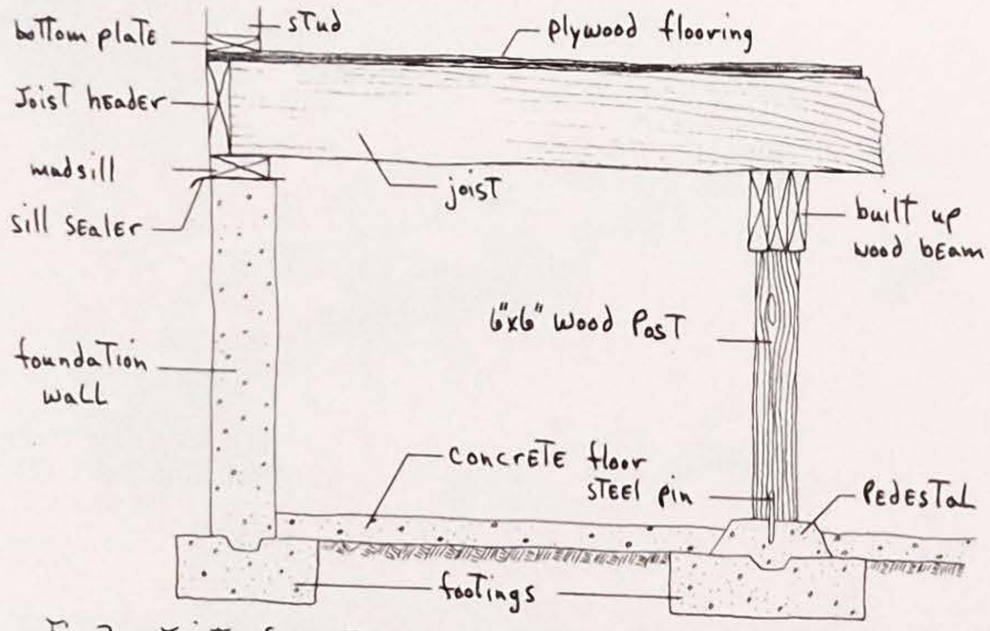

Fig. 3 - Joists Supported by Foundation and Beam

Sill sealer

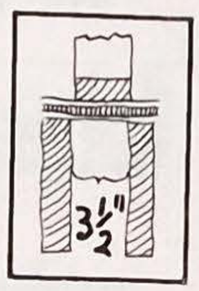

Fig. 4 - Joists Doubled under partition with Plumbing

Board foot--See Putting It All Together: Estimating

the building are going to rest on the top of the foundation wall. You must remember to imbed anchor bolts in the top of the foundation wall in these areas when it is poured. The anchor bolts will hold the walls to the foundation.

The mudsill is the horizontal member (usually a 2x6) upon which the joists rest. It should be made of redwood or treated wood and is attached to the foundation wall by means of anchor bolts. Fig. 3. In between the concrete slab and the plate or mudsill, there must be a layer of "sill sealer", which can be bought at the lumber yard. Sill sealer comes in a roll and consists of fiber glass insulation-like material with a treated paper backing. Between the slab and all bottom plates of interior partitions, there should be a layer of 15 lb. asphalt saturated roofing felt vapor barrier to prevent the wood from rotting. Treated wood can be used for the bottom plates, thus eliminating the need for the vapor barrier.

Wooden Floor

A wooden floor is supported by joists made from 2x-- material that span from one foundation wall to the other. Lumber yards normally carry 2x10" and 2x12" joist material up to lengths of 22' or 24'. These longer lengths cost more per board foot than the shorter and more common lengths of 12'-18'. If the span from mudsill to mudsill is 24', you may find that it is cheaper to obtain twice as many 12' joists and have them supported in the middle by a beam than it would be to buy 24' joists. Joists are laid with their width dimension vertical and their 2" dimension resting on a 2x6" mudsill, which rests on the top of the foundation wall and is secured by anchor bolts. Fig. 3.

Joists

The joists carry the weight from the middle areas of the floor (called live load: people, appliances, interior partitions, etc.) to the mud sills, which are supported directly by the foundation. The nominal size of the joists and their spacing depends on the live and dead loads they are to carry and the distance they span. It is best if they span the shortest distance across the building.

Joists should be doubled under partitions that run parallel to them, and around openings in the floor such as a stairwell opening. If plumbing pipes will run through the partition, such as in a bathroom or kitchen wall, the doubled joists beneath should be placed 5" O.C. to allow the pipes to come up from the floor below. Figs. 4 & 5. Partitions that contain pipes generally need to be constructed of 2x6's because of the diameter of the pipe.

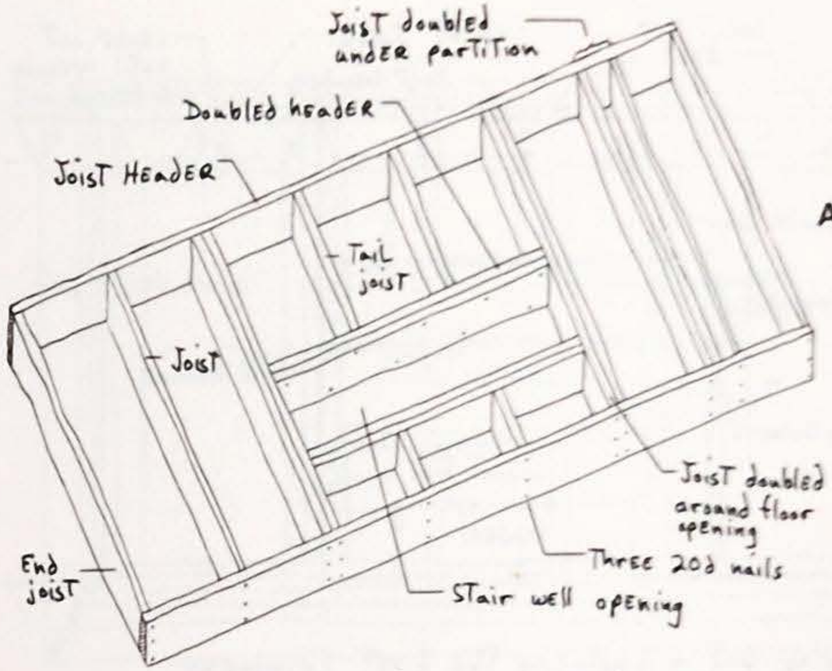

Fig. 5 - Joist Structure for a Small House

Joist

Loads–See Appendix III

Live load–See Walls: Building A Wall

Joist Layout

After all these things are considered, the layout of the joists is made on the joist header, which is then toenailed to the outside edge of the mudsill. The joist header is the joist that rests entirely on the foundation wall and into which all other joists butt. Before the joist header is nailed in place, the layout should be transferred to the joist headers for the other side of the building. The other joists are now placed on the mudsill and nailed to the joist header with three 20d nails per joist. Fig. 6.

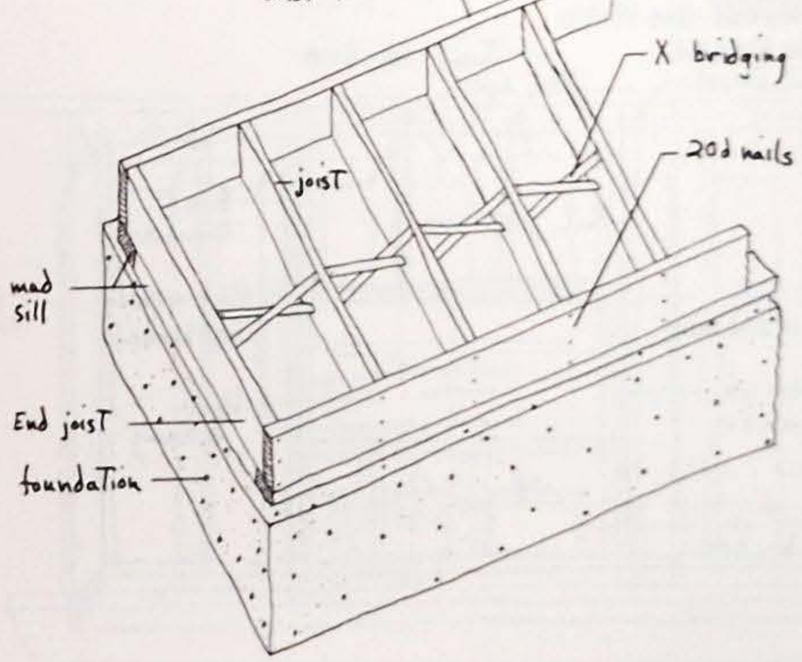

Fig. 6 - Joist Structure Bearing on foundation

Joist header

Trimmer

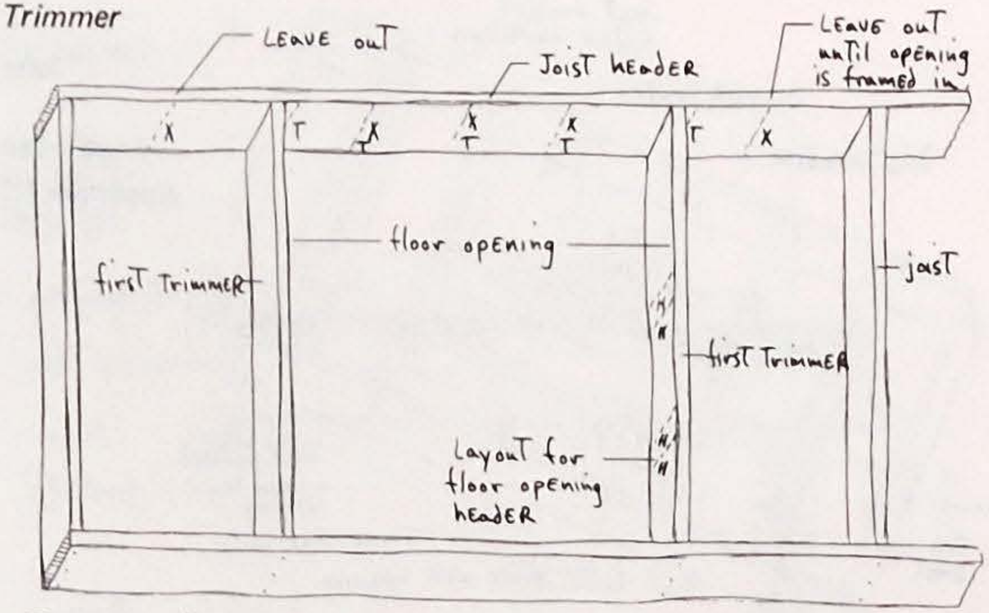

Fig. 7- Laying Out & Installing The first Trimmers

Tail joist

Inside dimension--
See Walls: Fig. 15

Transferring layout--See Walls:
Walls Between Rooms

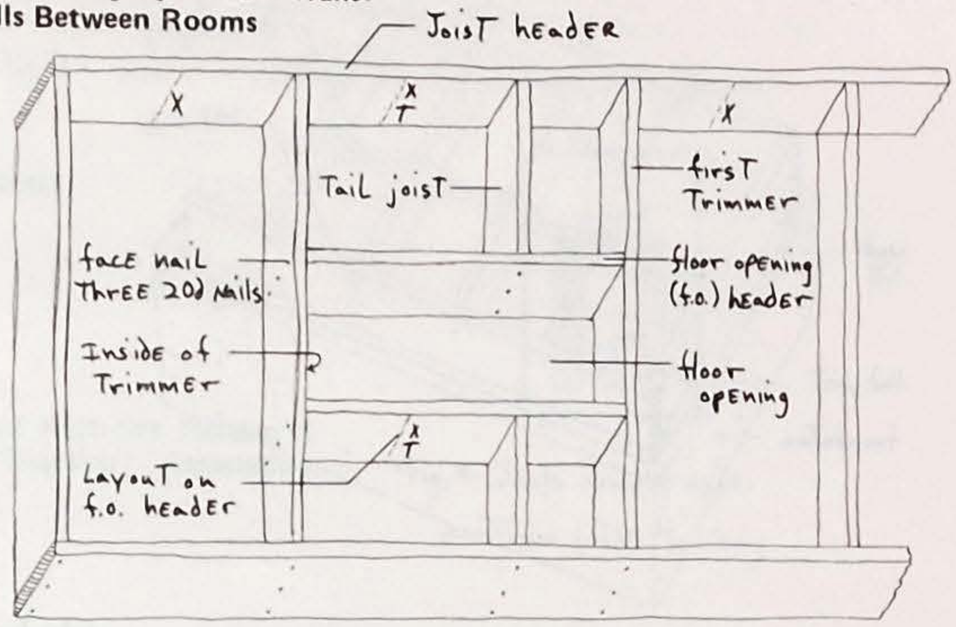

Fig. 8- Laying Out and Installing The floor Opening Headers

Framing A Floor Opening

If there is a floor opening for a stairwell to be framed in, place plywood over the joists around the area to be framed in, so you have a solid place upon which to work.

1. Install the first trimmers on either side of the opening, but leave out for now the adjacent joists so there will be nailing room when the header is nailed to the trimmer, and when the second trimmer is nailed to the first trimmer. Fig. 7.

2. From the layout on the joist header, figure out the length of the headers for the opening and cut the right amount of tail joists and headers. The length of the header will be the inside dimension between the two first trimmers. The inside dimension is the distance from the inside of one trimmer to the inside of the other. A tail joist is a joist that doesn't span the same distance as the regular joists. Its span is usually interrupted by the header of a floor opening. Lay out the position of the tail joists on the headers before you install them. The layout should be transferred from the joist header. Nail at least one tail joist to the header (with three 20d nails). This tail joist will act as a spacer block to keep the header in the proper place as you nail it to the trimmers. Fig. 8.

3. Install the remaining tail joists. Nail them with three 20d nails to both header joist and header. Nail the double header to the first header with 16d nails spaced 16" O.C. along each edge. Then face nail the double header to the first trimmer with three 20d nails. Fig. 9.

4. The final step is nailing the second trimmer to the first trimmer with 16d nails spaced 12"

O.C. along each edge. After the second trimmers are installed, the adjacent joists can be nailed in place. Fig. 10.

When Joists Must Be Cut

If you took a saw and began to saw from the top down on one of the floor joists that has just been installed, the weight of the joist would close the upper part of the kerf and bind the saw blade. If you sawed the joist in two by beginning from the bottom, the kerf would widen as you went and not bind the saw. The reason for both of these happenings is that, as a joist spans the distance from mudsill to mudsill, the top of the joist is in compression while the bottom part of the joist is in tension. Fig. 11.

The place on the width dimension of a horizontal structural member where compression changes to tension--that is, where the two forces neutralize each other--is called the neutral axis. It is usually halfway between the top and bottom edge of a joist. If holes for plumbing or conduit are drilled at the neutral axis, they will not reduce the strength of the joist (providing they are not over 1/4 of its width).

If the holes are drilled at the center of the span of the joist, they will weaken the joist more than if they were drilled nearer the plates. Try not to drill at the center of the span.

If a large pipe must be cut into the joist, it

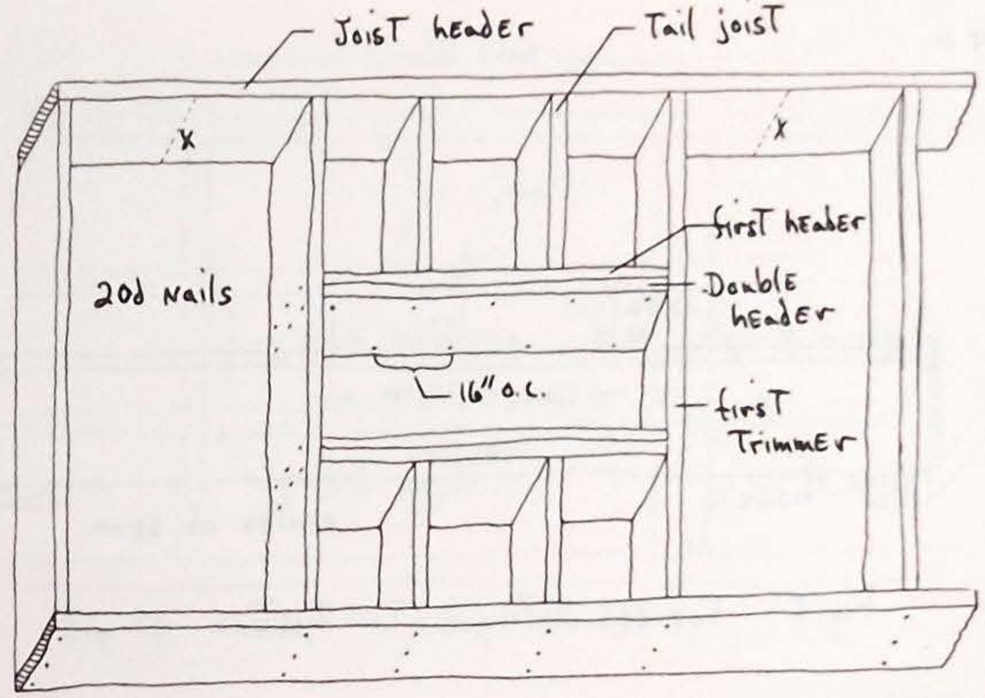

Fig. 9- Installing The Tail Joists

Face nail--See Metal Fasteners & Glues: Fig. 6

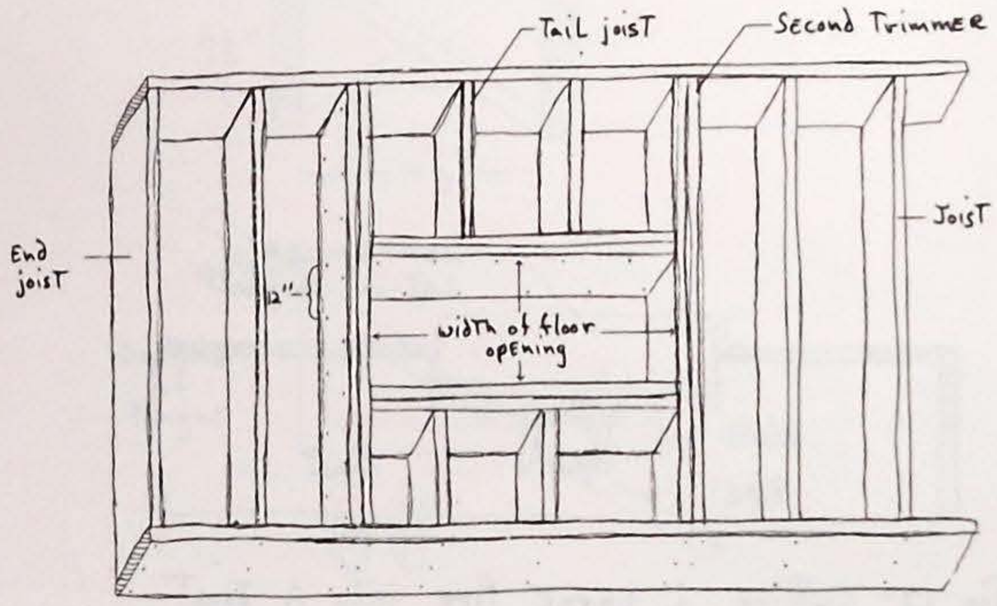

Fig. 10- Nailing in The Second Trimmers

Let in

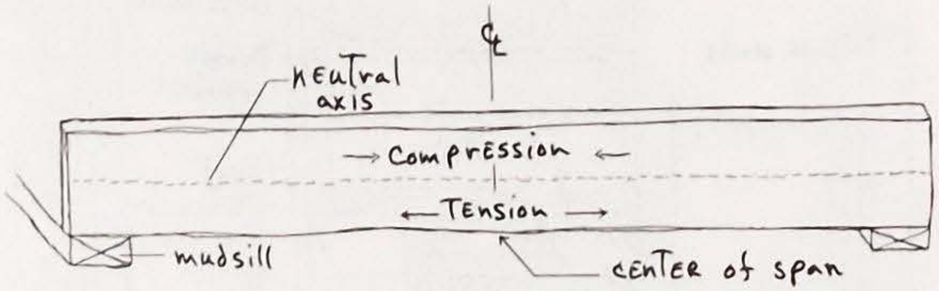

Fig. 11 - Forces Acting on a Joist

Bevel

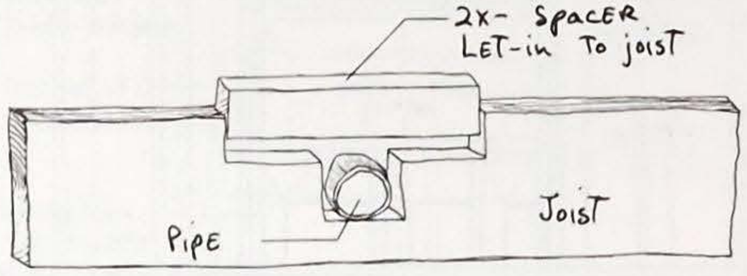

Fig. 12 - Cutting a Large Pipe into A Joist

should be cut from the top and a spacer block let in on top of it to carry the compression along the joist. Fig. 12.

BRIDGING

Bridging serves to hold the joists in a vertical position and help transfer loads from one joist to the next. A lot of building codes require bridging at intervals not exceeding 8'. There are two kinds of bridging: solid and cross or X bridging. Figs. 6 & 13.

Solid bridging is made from lumber the same nominal dimension as the joists. Each end of a piece of solid bridging is face nailed to the joists with two 16d nails if the joists are 2x8's and three 16d nails if they are 2x12's. X or cross bridging is made from 2x4's or 1x3's cut to a specific length with bevel cuts on each end. The ends of each piece of cross bridging are toenailed to the joists with two 8d nails.

To install either type of bridging, first chalk a line across the top of the joists (perpendicular to them) at 8' intervals. If solid bridging is being installed, stagger the pieces on either side of this line as in Fig. 13. For cross bridging, the top end of one piece of bridging goes on one side of the line and the top end of the other piece goes on the other side of the chalk line.

Since it is awkward to balance on the joists and nail the cross bridging at the same time, start two 8d nails in one end of each piece before beginning. The top ends are toenailed to the tops of the joists, but the bottom ends aren't nailed until after the subflooring or flooring is completed.

Laying Out The Angle Cut On Cross Bridging

The angle of the bevel cut on the end of a piece of cross bridging and the length of the bridging can be determined by using the framing square. Use the framing square to lay out one piece of bridging, make the bevel cuts and use this piece as a template. The other pieces of cross bridging can be laid out by tracing around the template.

Set a piece of bridging material on its edge (thickness dimension) across two saw horses. Lay the framing square on the top edge. The width measurement of the joist material ($9\frac{1}{2}$") is held on the tongue and lined up with any point on the edge of the bridging material furthest away from you. The inside dimension between two joists (14 3/8") is held on the blade and is lined up with the edge of the bridging material closest to you. When all these points are lined up, a line is drawn along the outside of the tongue, and a mark is made on the bridging material at the points on the blade where 14 3/8" is aligned with the closest edge of bridging. The square is moved down the material in order to make the layout for the other bevel. The tongue is placed over the 14 3/8" mark and the framing square is held with the same measurements as described above: $9\frac{1}{2}$" (tongue) over the furthest away edge and 14 3/8" (blade) over the closest edge. A line is drawn along the tongue through the first 14 3/8" mark to lay out the last bevel cut.

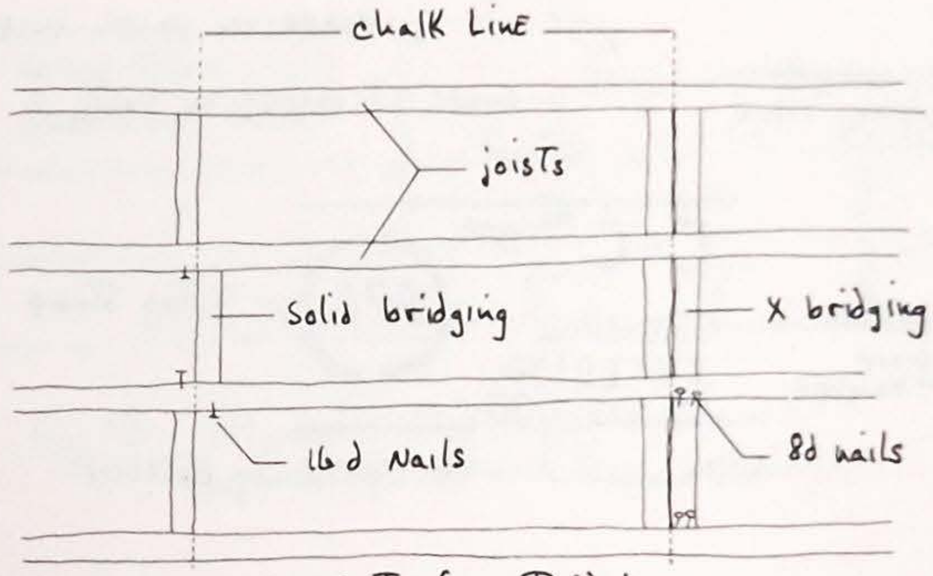

Fig. 13- Laying Out for Bridging

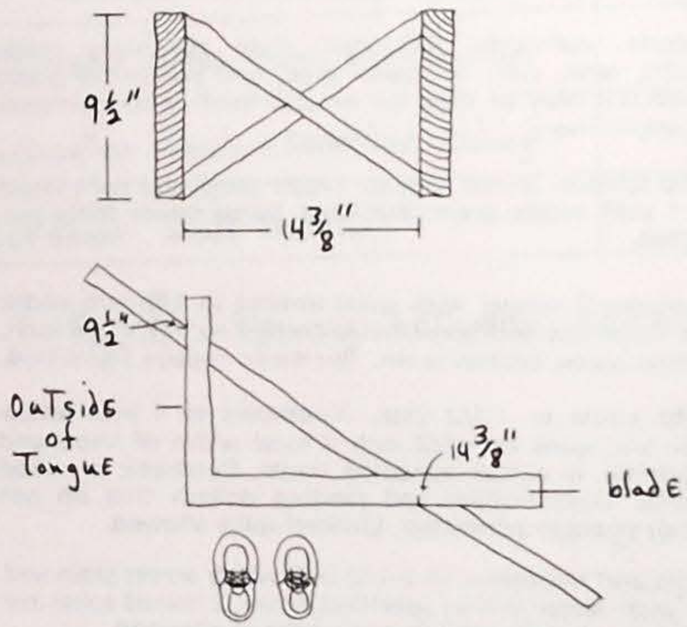

Fig. 14- Laying Out The Angle Cuts on X Bridging

PLYWOOD FLOORING

Older houses and more expensive modern houses

Template

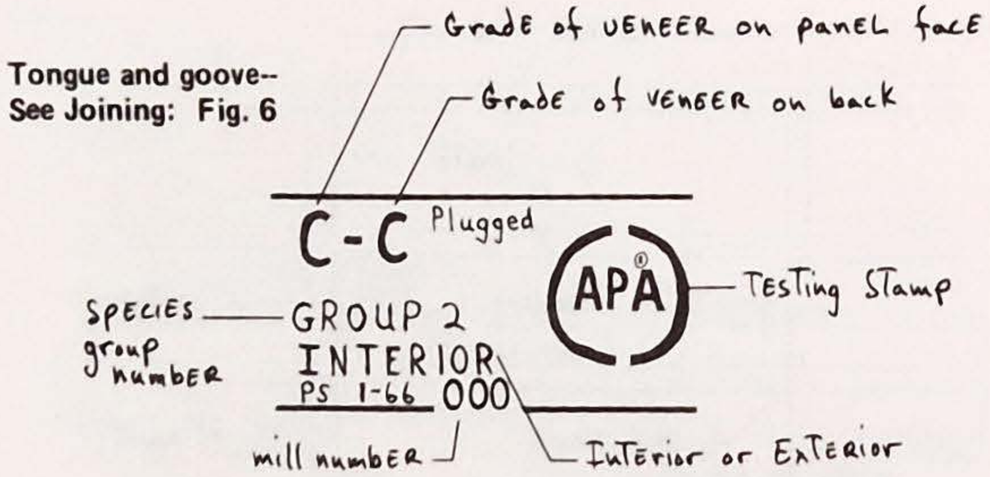

Fig. 15 - Grade Trademark for plywood

N	Smooth surface "natural finish" veneer. Select, all heartwood or all sapwood. Free of open defects. Allows not more than 6 repairs, wood only, per 4x8 panel, made parallel to grain and well matched for grain and color.
A	Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. May be used for natural finish in less demanding applications.
B	Solid surface. Shims, circular repair plugs and tight knots to 1 inch across grain permitted. Some minor splits permitted.
C Plugged	Improved C veneer with splits limited to 1/8 inch width and knotholes and borer holes limited to 1/4 x 1/2 inch. Admits some broken grain. Synthetic repairs permitted.
C	Tight knots to 1-1/2 inch. Knotholes to 1 inch across grain and some to 1-1/2 inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed.
D	Knots and knotholes to 2-1/2 inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted. Limited to Interior grades of plywood.

Fig. 16 - VENEER Grades of Plywood
(Courtesy American Plywood Asso.)

are constructed with a subfloor and a finish floor such as oak. The subfloor can either be plywood or common boards laid diagonally across the joists. Newer houses generally have only one layer of flooring and it is tongue and groove plywood.

There are many different types of subflooring and flooring and different methods of application. The easiest and cheapest way is to use plywood as a combined subfloor and finish floor. Rug, linoleum or floor boards can be laid over it later if desired.

When used as the only flooring, plywood should either be tongue and grooved along the edges or supported along all edges by solid bridging or joists. The grade of the plywood should be underlayment grade with exterior glue, C-C plugged.

Plywood By Any Other Name...

Plywood comes in different grades with different specifications and different surface veneers. It is important to be able to call plywood by the proper name when at a lumber yard, to avoid being taken advantage of.

Fig. 15 is an example of the stamp that is placed on every bundle of plywood to designate what kind it is. The big letters indicate the kind of veneer on each surface. This piece has C on one side and C plugged on the other. There are 30 kinds of softwood used in plywood and they are grouped into four groups based on their stiffness: Group 1 is stiffest, Group 2 is less stiff, and so on. The words Exterior or Interior at the bottom of the stamp indicate the type of plywood. In exterior plywood the plys are bonded with waterproof glue and can be used for concrete forms,

siding, and roofing. Interior plywood is bonded with non-waterproof glue and is suitable for cabinets and inside sheathing where the moisture content is less than 20%. Sheathing plywood usually has two numbers separated by a slash (for example 32/16) in place of a group number. The first number indicates the minimum spacing of rafters when the plywood is used for roof sheathing and the second number indicates the spacing of joists if the plywood is to be used for sub-flooring.

If plywood is to be used as combined subflooring and finish floor, it should be Underlayment grade with exterior glue, C-C plugged. Fig. 17.

Plywood sheets should not be laid tightly up against each other. The American Plywood Assoc. recommends spacing between sheets to accommodate expansion. Fig. 18.

Group from which Sheets are made	Joist Spacing 16" O.C.	20" O.C.	24" O.C.
1	$\frac{1}{2}$"	$\frac{5}{8}$"	$\frac{3}{4}$"
2	$\frac{5}{8}$"	$\frac{3}{4}$"	$\frac{7}{8}$"

Fig. 17- Minimum Thickness of Plywood Required by various Joist Spacings

Use & Location of Plywood	Spacing (inches) Edges	Ends
Roof & wall sheathing, subflooring	$\frac{1}{8}$	$\frac{1}{16}$
Combination finish & subfloor, siding	$\frac{1}{16}$	$\frac{1}{16}$
Interior wall Paneling	$\frac{1}{32}$	$\frac{1}{32}$

Fig. 18 – Spacing between Sheets

Laying Plywood Flooring

Sheets of plywood that are to be subflooring are laid with the grain of the surface plies perpendicular to the joists. Sheets of plywood that are laid over such a subfloor and are to be finish floor should be laid with the face grain parallel to the joists. If only one layer of plywood is to be used for flooring, the sheets should be laid with their face grain (8' length) perpendicular to the joists because a board is strongest when laid with its grain going across its support.

Layout

To lay out for the plywood sheets, measure from the corners of the joist header 4' out along each end joist and make a mark. Fig. 19. Snap a chalk line between the two marks across the tops of the joists. The 8' edges of the plywood are laid to

Solid bridging--See This Chapt.: Fig. 19

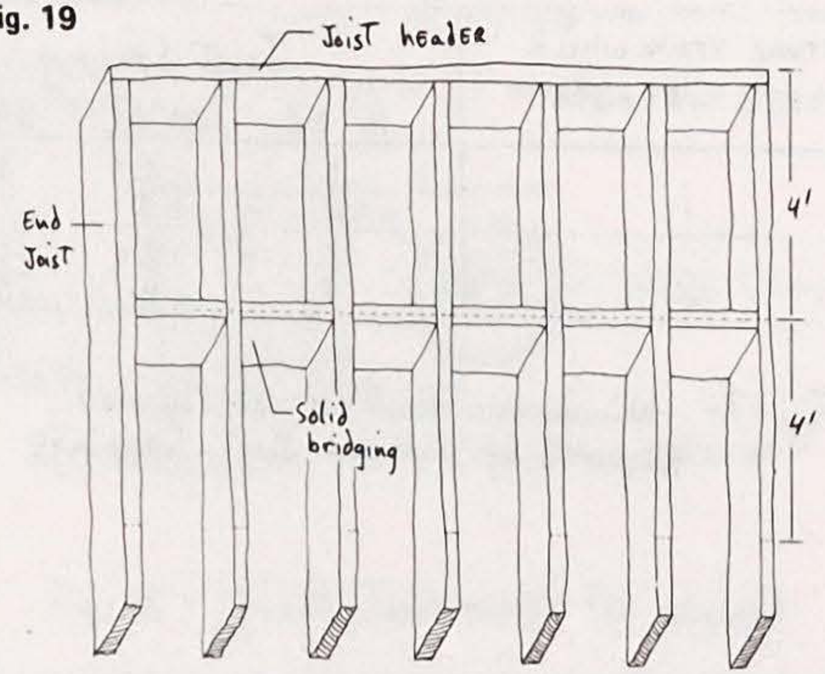

Fig. 19- Laying Out for Plywood Sheathing

Sledge hammer

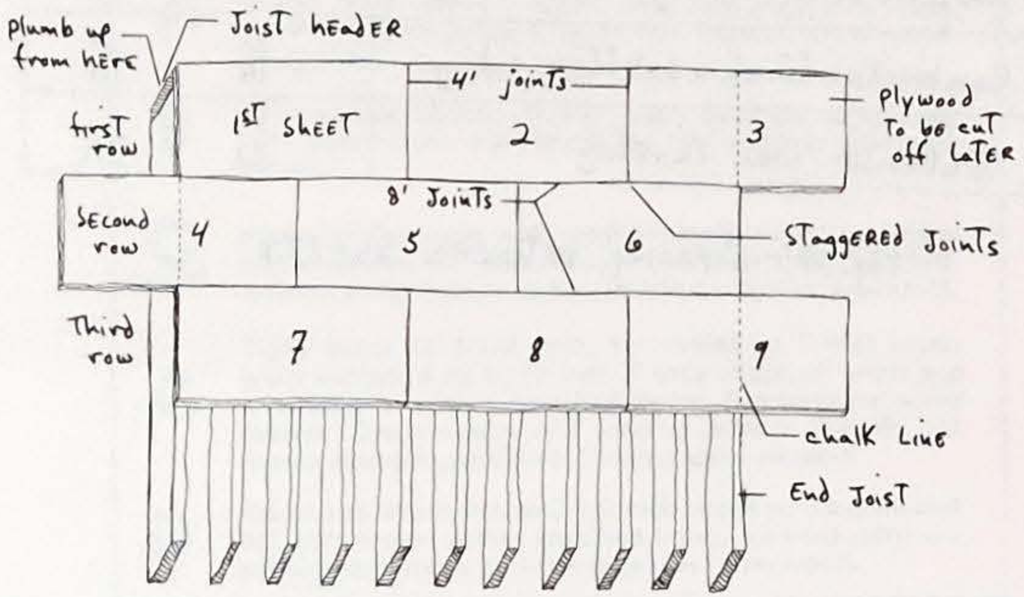

Fig. 20 - Staggering Sheets of Plywood

this line--not to the joist header. The reason for this is that the joist header may not be perfectly straight and therefore it wouldn't be good to start the layout from it. If the plywood is tongue and groove, no bridging is required under its joints. But if it is not T & G plywood, solid bridging should be installed every 4' under each intersection of the 8' dimension of the sheets.

The bridging in this case should be in-line bridging, not staggered bridging, as was explained before. In-line bridging is harder to nail because one side must be toenailed to the joist. Pieces of in-line solid bridging are toenailed to the joists with four 8d nails at each end for 2x8" joists. It is necessary that all four edges of each sheet of plywood break on either the center of a piece of bridging or the center of a joist, so that the sheets have a complete bearing and will not sag when people walk over the spaces between the joists.

Staggering Sheets Of Plywood Flooring

The sheets of plywood must be staggered so that the 4' edges do not always break on the same joint. Install the first sheet in the corner, but nail it only along the joists near the chalked line. Don't nail it to the joist header or end joist yet. After 2 or 3 sheets have been laid across the joists near the chalk line, line the joist header up with the 8' edge of the 3 sheets by hitting the header in or out with a large hammer. When the header and the edge of the plywood are in line, nail the sheets to the header joist with 8d galvanized, ring shank or rosin coated nails 4" O.C. Do the same with the next few sheets until all the sheets of plywood in the

first row are nailed to the joist header and regular joists--but not to the end joist. The last sheet in the row is not cut off in line with the end joist but is left to run wild for now.

Lay the second row of plywood against the first, but begin the layout by staggering the first piece and letting it hang over. Do not nail it to the end joist yet. After two or three rows have been installed in this fashion (Fig. 20.) the sheets that are running wild can be cut off even with and nailed to the end joist. Because the end joist is probably bowed in or out, it is not a good idea simply to cut the plywood to the out-of-line end joist. Instead a chalk line should be snapped across the tops of the sheets of plywood that are running wild. Hold the ends of the line even with the outside edge of the ends of one end joist.

If the width dimension of the end joist is not plumb, it is best to plumb up from the bottom outside corners of the end joist with two levels. Stretch a chalk line between the two levels, holding the string against the edge of the level that is against the end joist. Hold the string as close to the level of the plywood as you can and snap the line.

This usually takes two women and two levels unless of course you only have one level. In this case, nail a piece of 1x-- along the top of one joist header and let it hang slightly over the end joist. Fig. 21. Plumb up from the bottom outside edge of the end of the end joist and make the plumb mark on the 1x--. Take the level down to the other end of the end joist and plumb up from the bottom of the end joist. One woman holds one end of the chalk line on the plumb mark on the 1x-- while another woman holds the other end of

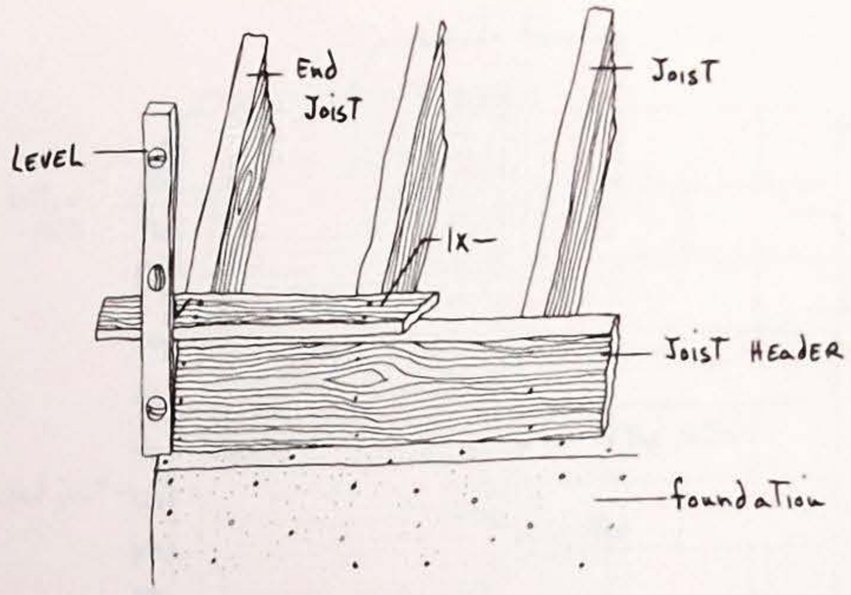

Fig. 21- Plumbing up from the End Joist

Plumbing–See
Walls: Fig. 9

the chalk line against the side of the level which is being held against the end joist. Snap the chalk line across the tops of the sheets of plywood when the level reads plumb.

This line is where the end joist would be if it were not crooked. Cut the sheets of plywood that are hanging over along this line and pound the end joist in or out until it is flush with the edge of the plywood and nail every 4" with 8d nails.

The pieces of plywood that have been cut off can be used as flooring if they span at least two joist spaces and can be cut to break on a joist.

The end joist should be pretty straight now, as it is held by three rows of plywood nailed to it. The rest of the plywood can be nailed to it without snapping a line along the end joist every three rows. If it isn't straight, then proceed as in the first three rows--not nailing the end joist until a line is snapped across the plywood.

When the floor is covered with plywood, be sure the nailing pattern is:

Along joist .....6" O.C.	8d galvanized ring shank or rosin coated nails
Along edges of sheets .... 4" O.C.	

In addition to this nailing pattern, a heavy construction adhesive such as "wall bond" or "PL-400" should be spread over the edges of the joists before the plywood is installed. It will help keep the flooring tight against the joists which will prevent squeaks in the floor. Galvanized, ring shank and rosin coated nails all have extra holding power in wood, which keeps them from working loose and causing squeaks.

Typical Wall Height

Most building codes specify that walls in apartments and houses should be at least 8' high. A usual building practice is to make the total height of the wall 97" (8'1") so that after the installation of sheetrock or plaster on the ceiling, the head room will still be at least 8'. If a finish floor such as oak flooring is to be applied over the rough plywood floor, the total height of the wall should be increased further.

RAISING THE WALLS

With the flooring completed there is now a nice, clean, level deck on which to work. The walls can be built on the deck near where they will be raised. Fig. 22.

When a side wall section is built as in Fig. 22, it can be raised right up into position by two or three women standing at the top plate, lifting the top end of the wall above their heads and then walking toward where the bottom plate will go. They must keep the wall balanced on their hands as they walk the wall into an upright position. Construct and raise the long walls first so that there is more room to work.

When the wall is upright, align the outside edge of the bottom plate with the end or header joist (depending on which wall it is). Nail the bottom plate into the header or end joist with 16d nails spaced 16" O.C. Along the inside of the plate, 16d nails are used to nail the plate through the floor and into the joists. Fig. 23.

It is a good idea to further secure the wall structure to the foundation by stretching pieces

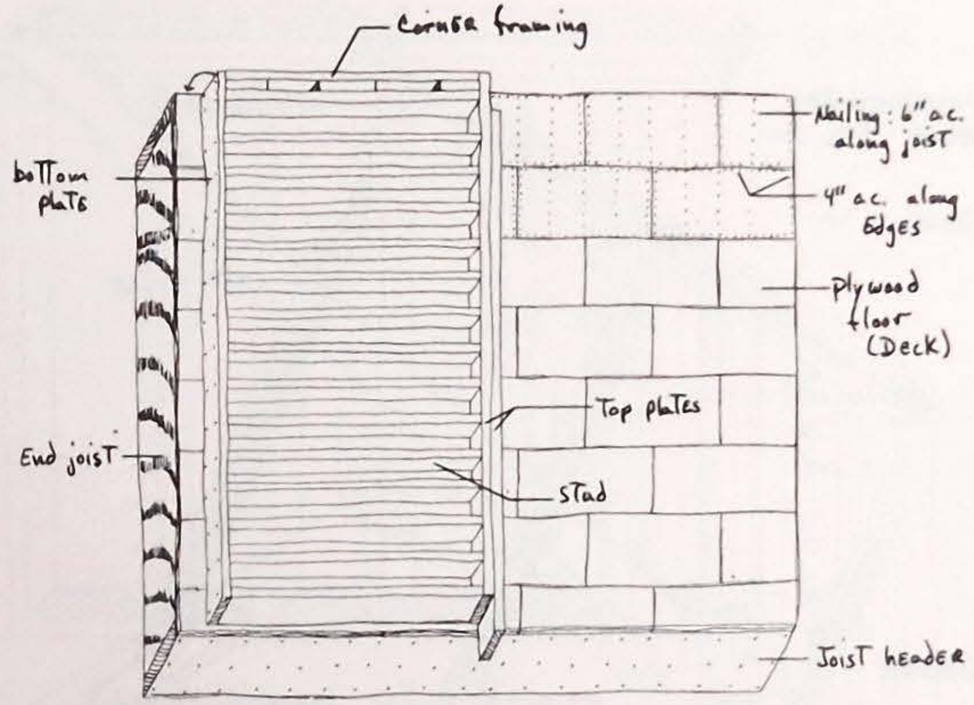

Fig. 22 - Building Side Walls on The Deck

Lifting walls--See Philosophy: Lifting

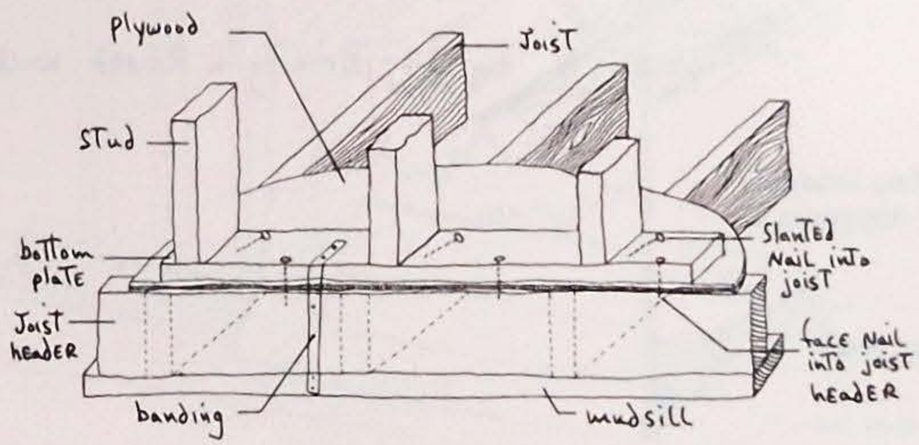

Fig. 23 - Nailing The Bottom Plate To The Deck

Plumbing--See
Walls: Fig. 9=

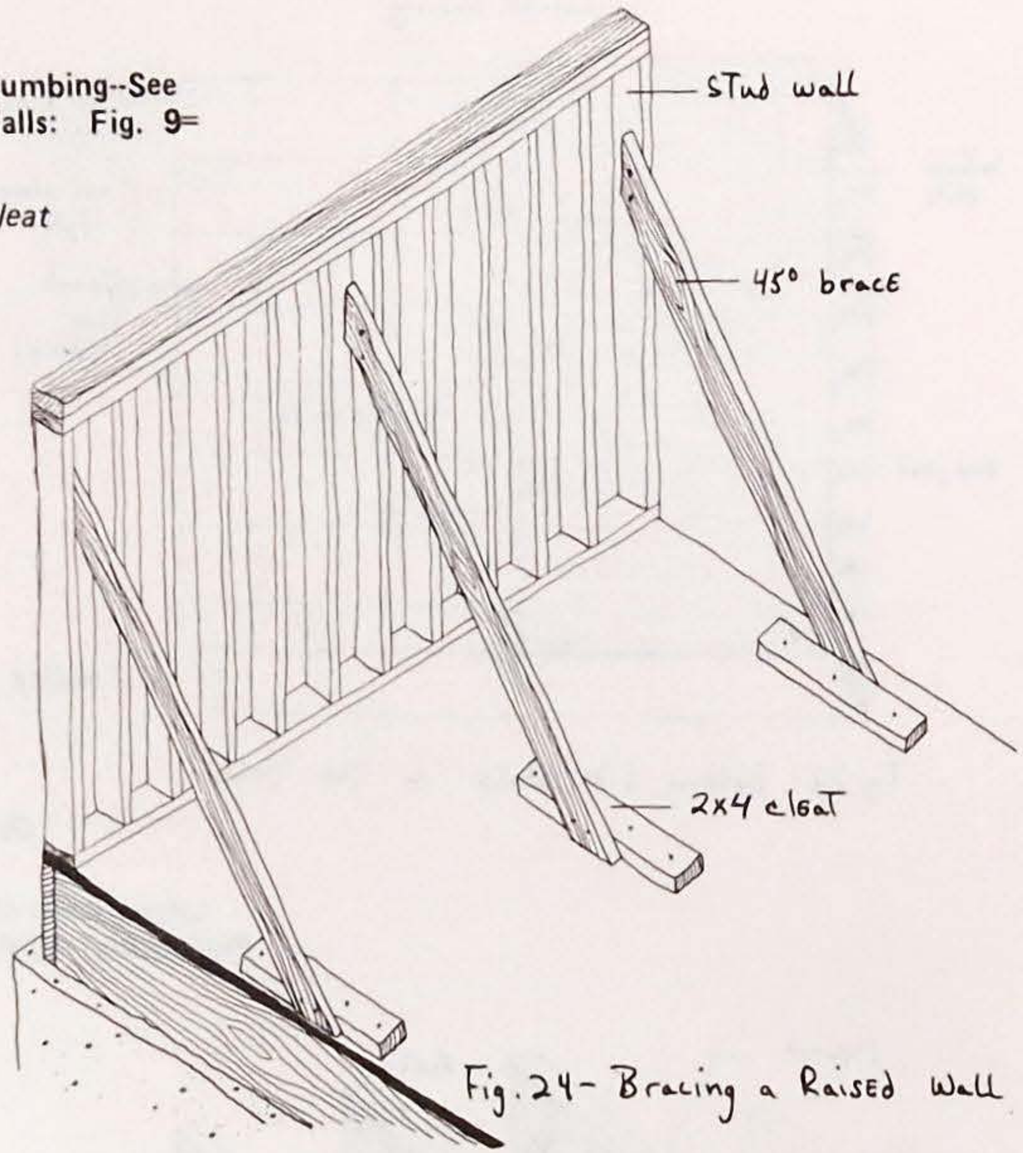

Fig. 24- Bracing a Raised Wall

Nailing Schedule
See Appendix II

Let-in brace

of banding (4' O.C.) from the bottom plate to the mudsill and nailing it securely. This should be done especially in areas where hurricanes and tornadoes are common. Fig. 23.

Banding is the metal strapping that holds bundles of 2x4's, plywood, etc. together while they are being shipped. It is useful to have around and can be used for many jobs that call for something stronger than wire but stiffer than rope. Lumber yards are always throwing it away. Banding is difficult to nail through (it will bend nails), so pre-punch nail holes in it with a case hardened nail or punch.

Plumbing And Bracing The Walls

Begin at one of the walls and work down the length of it plumbing each end and a couple of places in the middle (depending on how long the wall is). As each section is plumbed, brace it with a 45° brace running from a stud to a cleat nailed to the deck. Fig. 24.

Remember that the two end walls that are not supporting joists must have a 2x6" nailed to the top of the double top plate if there is to be a ceiling. The 2x6" serves as nailing for the ceiling material where it intersects the end walls.

Diagonal Bracing

Unless plywood is used as sheathing at the corners, diagonal bracing is needed to keep the walls rigid. Diagonal bracing is usually let in (that is, set into the studs) and made of 1x6". Tack the 1x6" temporarily in place, trace around it on each stud and plate, remove the 1x6" and cut between the two marks on each stud. If a power saw is used, it should be set to cut into the

studs only as deep as a 1x6" is thick. Use a chisel to remove the wood between each cut on each stud. Fit the 1x6" back into the recesses cut into (let-into) each stud and nail with two 8d nails per stud. Fig. 25. Patented metal bracing is also available. It is thin and does not have to be let-into the studs.

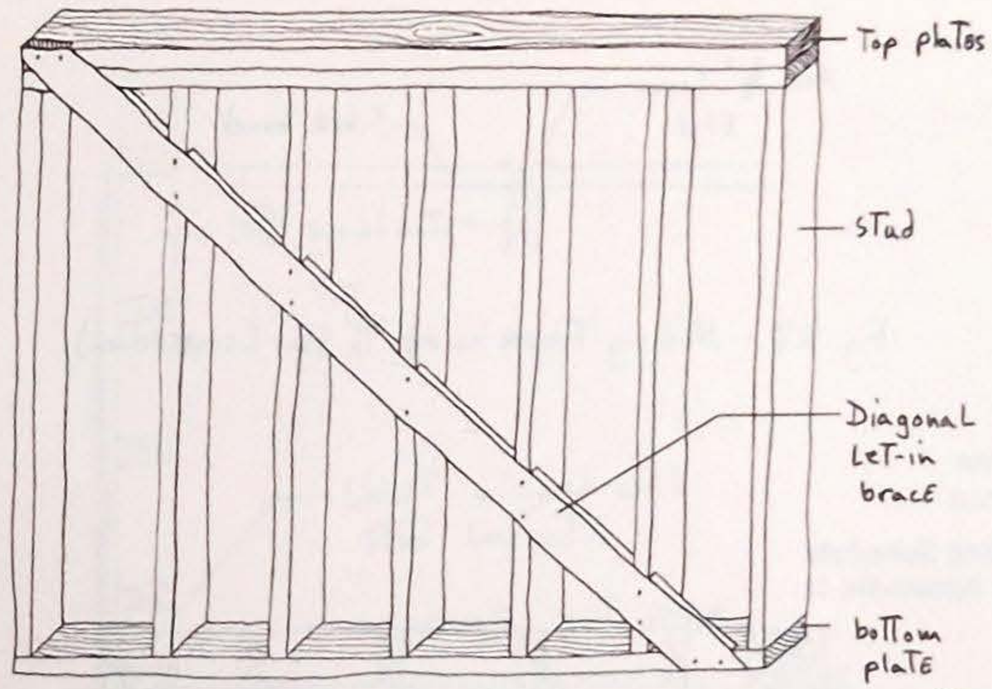

Fig. 25- Diagonal LET-in Bracing

SHEATHING

Sheathing

It is easier to work and nail sheathing to studs while the wall is lying horizontal on the deck. Some kinds of sheathing which come in 4x8' sheets such as plywood or fiberboard can be applied before the wall is raised. This makes the wall heavier to raise, but not too heavy. 1x6" common board or shiplap sheathing should be applied after the wall is raised and in place.

Plywood is the strongest sheet siding, and all sheet siding is strongest when applied vertically (8' dimension parallel with the studs). Usually for this reason, when structural fiberboard siding is being used on a house, sheets of plywood are laid vertically at the corners instead of fiberboard. This method of siding adds strength to the structure and eliminates the need for diagonal bracing to keep the stud wall square. Fiberboard comes in 1/2" and 25/32" thickness. Plywood sheathing should be a minimum thickness of 5/16" for studs spaced 16" O.C., 3/8" for studs spaced 24" O.C., 1/2" plywood is used when an exterior finish or siding is to be applied over the sheathing and nailed into the sheathing, not just into the studs.

Do not nail fiberboard less than 3/8" from its edge or it will split and spaul out and the nail won't hold. When two sheets break on a stud (as

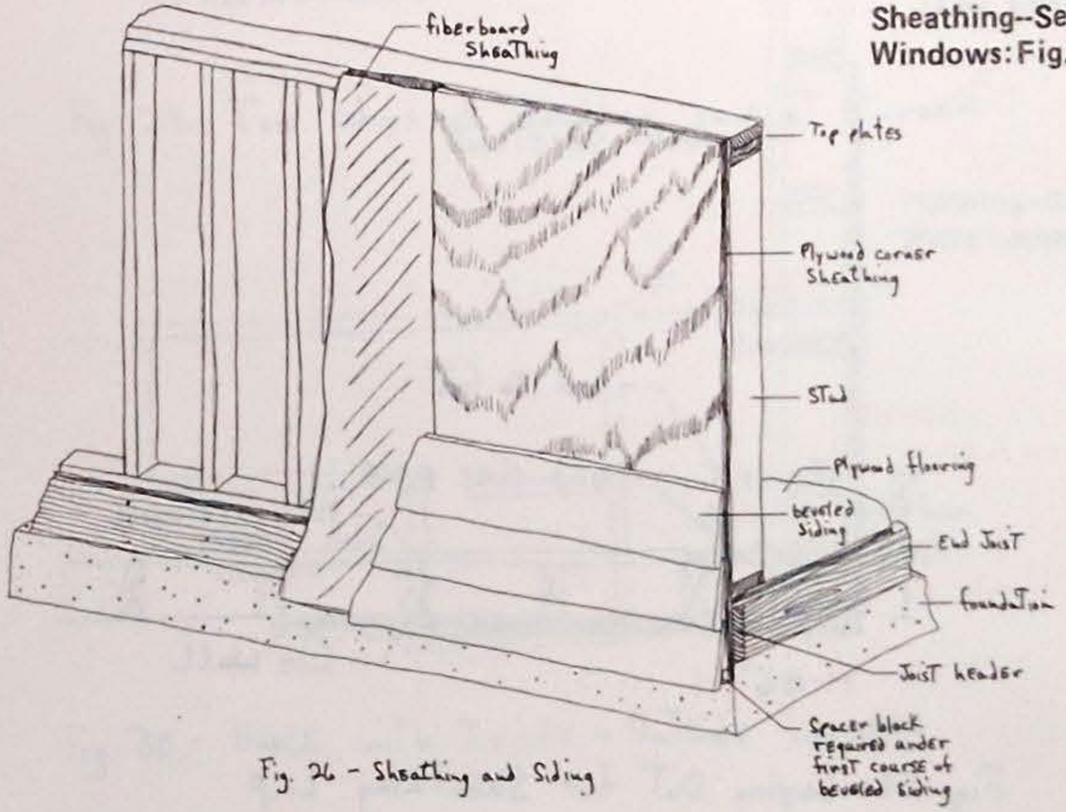

Fig. 26 - Sheathing and Siding

Sheathing--See Windows: Fig.3

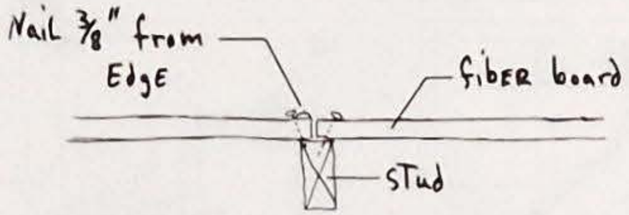

Fig. 27 - Nailing Fiber board To Stud (crossection)

Batten
Stucco

Nailing Schedule
See Appendix II

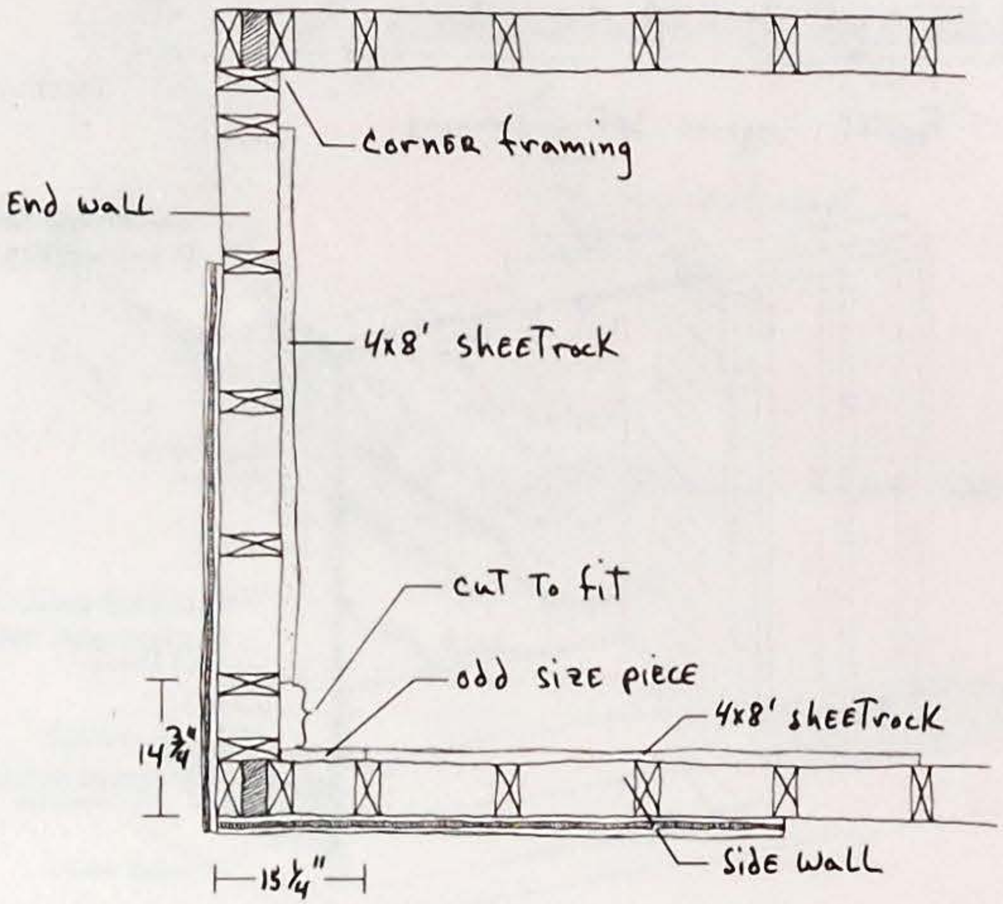

Fig. 28- Laying Out for Sheathing Lap

they must), and there isn't enough room to leave 3/8" at the edge and still hit the stud with the nail, slant the nail into the stud. Fig. 27. Fiberboard is nailed 3" O.C. around the edges and 6" O.C. on intermediate studs.

When applying 4' wide sheathing, leave 1/8" between all edges to allow for expansion.

In cold climates it is a good idea to have both sheathing and siding, but it's not necessary for strength. You could get away with putting 1/2" plywood (the 8' dimension vertical) on the exterior walls and cover the joints with battens. By installing 1x2" battens every 16" or 24", the wall could be very attractive. Warm climates often don't require sheathing. In California, where stucco construction is common, it is applied to chicken wire that is attached directly to the studs.

Sheathing Layout

There is a small problem that will arise concerning the stud layout and application of sheet siding, but it has many solutions and is not a terminal problem.

Unless the corner lap of the sheathing has been compensated for in the stud layout of the end wall, the first 4x8" sheet will not break on a stud when it laps the sheathing of the adjoining wall. Fig. 28.

The side wall studs can be laid out normally with 15¼" as the first spacing. However, the end wall must have 14 3/4" between the corner and the first stud, so that when the sheathing on the end wall extends 1/2" past the corner to lap the sheathing on the side wall, the other end of the sheet will still break on a stud.

The situation can also be solved in two different ways without changing the stud layout. First, the non-corner edge of the corner sheets can be placed along the center of a stud leaving the corner edge a little short. A corner board is applied over the sheathing to finish the corner. Fig. 29. Second, pieces of sheathing can be specially cut to fit in the odd-sized spaces between the corner and the first stud. Full sheets can be laid against this first piece and will continue to break regularly on a stud for the length of the wall. Fig. 29. Fig. 28 shows this method being used in applying the sheetrock to the interior of the wall, because a similar layout problem exists for the interior sheathing as for the exterior sheathing. If the stud layout is corrected for the exterior sheathing, then it is not going to accommodate regular layout of 4x8' sheetrock on the interior and a special cut corner piece will have to be used.

This is an illustration of how important it is to sit down and draw a plan--no matter what you're building. Pay particular attention to the corners and joints because this is where most problems arise. If you spend a day or two thinking and drawing what is to be built, you will eliminate 80% of the thoughtless, annoying, time consuming mistakes that <u>always</u> crop up.

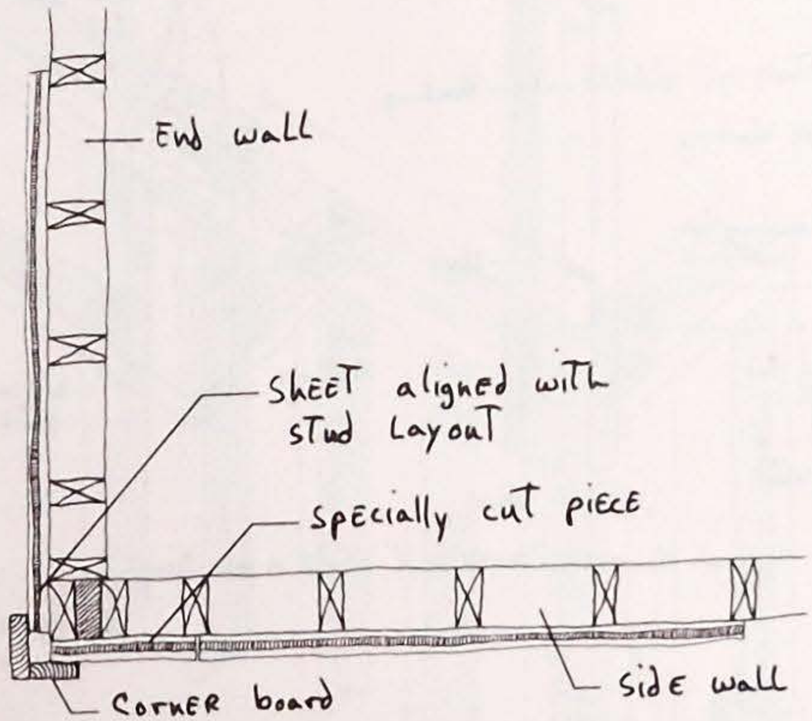

Fig. 29- Two Ways of Handling gap at Corner

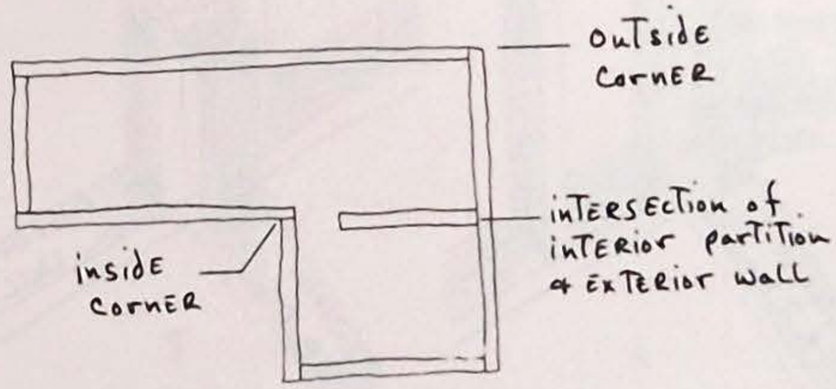

Fig. 30 - House with Inside & Outside Corners

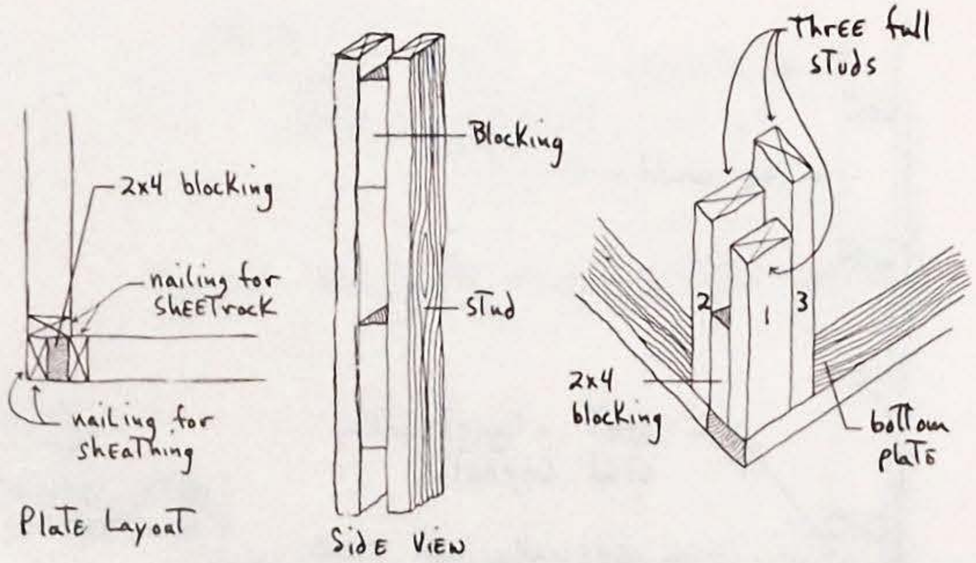

Fig. 31 - Typical Corner: Three full studs + blocking

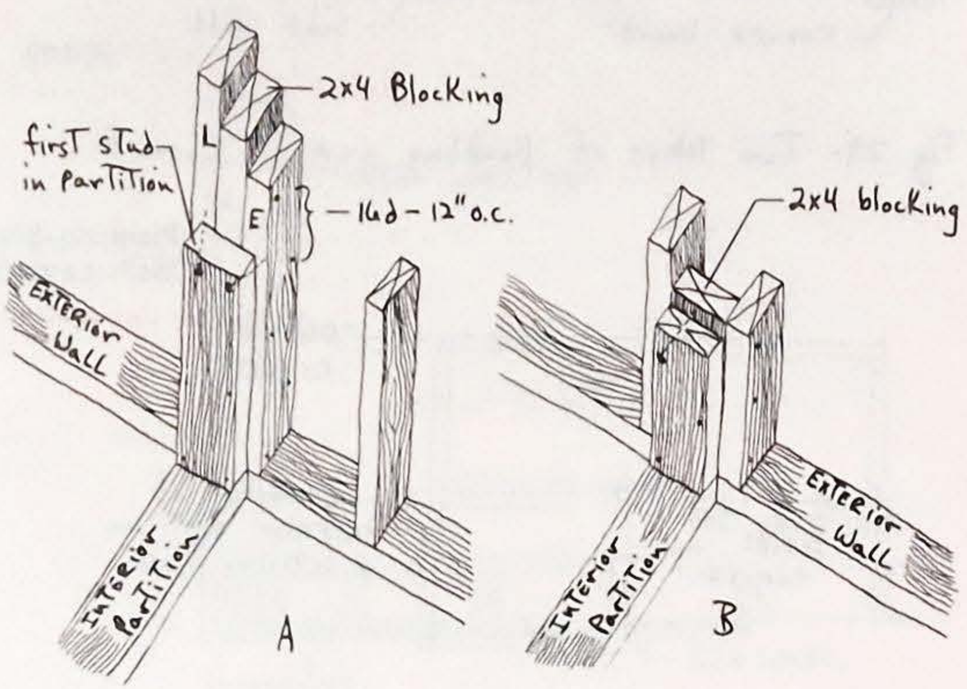

Fig.32-Interior Partition Intersection with Wall

CORNERS

Also in your plan should be details showing how to construct exterior and interior corners and interior partition intersections. Fig. 30.

The important thing to remember about corners is that they must provide a nailing base for sheetrock on the interior and sheathing on the exterior.

Fig. 31 shows different views of the standard corner framing for exterior walls whether they meet at an inside corner or an outside corner.

To construct an inside or outside corner, first nail three 2x4" blocks (approx. 16" long) about 2' apart to stud #1. Then nail stud #2 to the 2x4" blocks. All nailing is done with 16d nails. This assembly is now nailed to the bottom and top plates. Stud #3, although part of the corner assembly, is also part of the other wall and is nailed to the bottom and top plates of the intersecting wall. When the walls are raised into place, stud #3 is nailed to the corner assembly (studs #1 and #2 with blocking) with 16d nails 16" O.C.

Intersection Of Interior Partitions And Exterior Walls

There are two or three ways to frame the intersection of an interior partition and an exterior wall. Fig. 32 shows two of them.

In both methods the 2x4" blocking is nailed to the adjoining studs in the exterior wall with 16d

nails spaced 12" O.C. The first stud in the interior partition in Fig. 32B is nailed to the blocking with 10d nails spaced 16" O.C. The first stud of the interior partition in Fig. 32A is nailed into the two studs (in the illustration, studs L & E) it bears upon in the exterior wall.

Plate Layout

When drawing your plan, mark the center lines of interior partitions that intersect with exterior walls. (Remember that the thickness of the partition wall plus sheetrock will actually hang over the center line approximately 2¼" on either side.) Knowing, for example, that the center line of an intersecting partition is 15' from the end of the bottom plate makes it easier to lay out the plate. Fig. 33. Make the center line mark, ℄, on the plate 15' from the end with another color (red) to remind you that special layout occurs here. Lay out the stud positions for whatever corner framing is to be used from this center line mark.

Lapping The Double Top Plate

The double top plate should lap the top plates on all intersecting walls. This will tie all the walls together as one unit. Fig. 34.

Some carpenters like to nail the double top plate to the top plate while the wall is still lying on the deck. It is certainly easier and quicker to nail the double top plate while standing on the deck, than it is to nail from a ladder that must be constantly repositioned.

However, nailing the double top plate to the top plate and leaving 3½" hanging over at one end

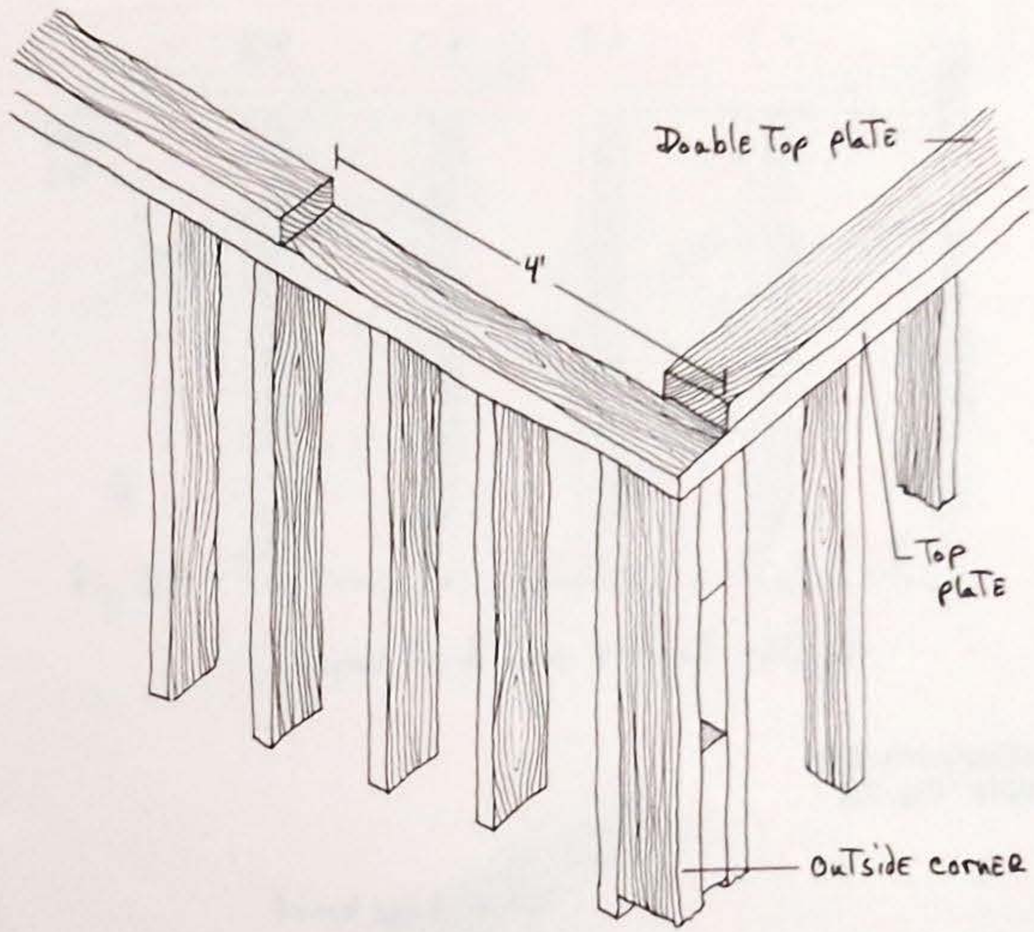

Fig. 35 - Lapping Sections Temporarily Withheld

Center line symbol

Double top plate–
See Walls: Fig. 4

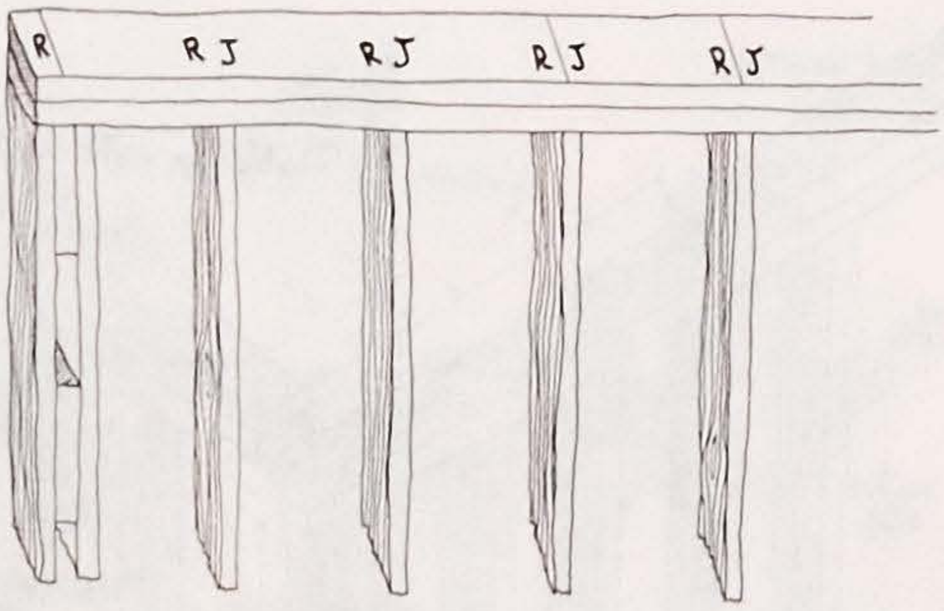

Fig. 36- RafTee and JoisT LayouT

Ceiling joists--See
Roofs: Fig. 23

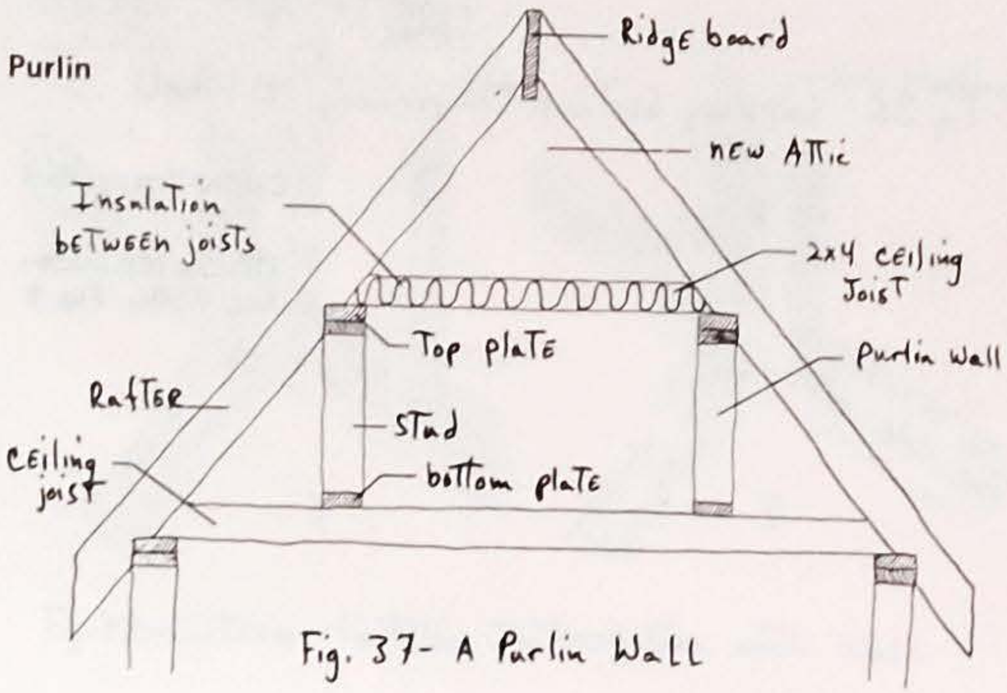

Fig. 37- A Purlin Wall

of a partition and a $3\frac{1}{2}$" space at the other can get you into trouble. When you are raising the walls into place, the parts of the double top plate that are hanging over may hit the walls already upright and thus prevent the new wall from being raised.

One way around this is to nail most of the double top plate to the top plate while the wall is lying on the deck--except for the end sections of the double top plate that will lap the top plates of the intersecting walls. These lapping sections can be nailed in place after the walls are raised and plumbed. The lapping section of double top plate should extend back into the wall it is a part of for at least 4'. Fig. 35.

Ceiling Joists And Rafters

Ceiling joists are laid out in the same way as floor joists. Make the layout marks on the double top plate for both the joists and the rafters--marking J for joist and R for rafter. Fig. 36. The rafter layout may be 24" centers depending on the load on the roof.

Nail the joists to the double top plate with two 10d nails, one toenailed on each side.

PURLIN WALLS IN ATTICS

A purlin wall is a short stud wall that helps support the rafters between the ridge of a roof and the double top plate. Fig. 37.

If the roof is going to carry excessive loads, a purlin can be constructed for strength. It can also be used when remodeling an attic to make more living space.

Attic space cannot be taken away in hot and cold climates without consequences. An attic is a container for dead air space which serves as insulation for a house. In summer the attic insulates the rooms on the floor below from the heat. If the attic is remodeled to accommodate a room, the insulating capabilities of the attic will be diminished and the new room will be very hot in summer. For this reason, if the house is an old one with a high pitched roof and there is room, it is best to construct a ceiling running from purlin to purlin to keep some dead air insulation above you.

If the slope of the roof is low, as in newer houses, and there is not room to construct a ceiling for the new attic room, then it is especially important to put adequate insulation between the rafter spaces from the ridge board to the double top plate.

The purlin wall can be attached to the rafters either by notching the double top plate into the rafters as if making a bird's mouth, or by nailing the top plate onto the rafters and then cutting the studs at a slant. Fig. 38B. The first method is strongest, but if the house is already built and you are remodeling, the second method is the easiest. Fig. 38.

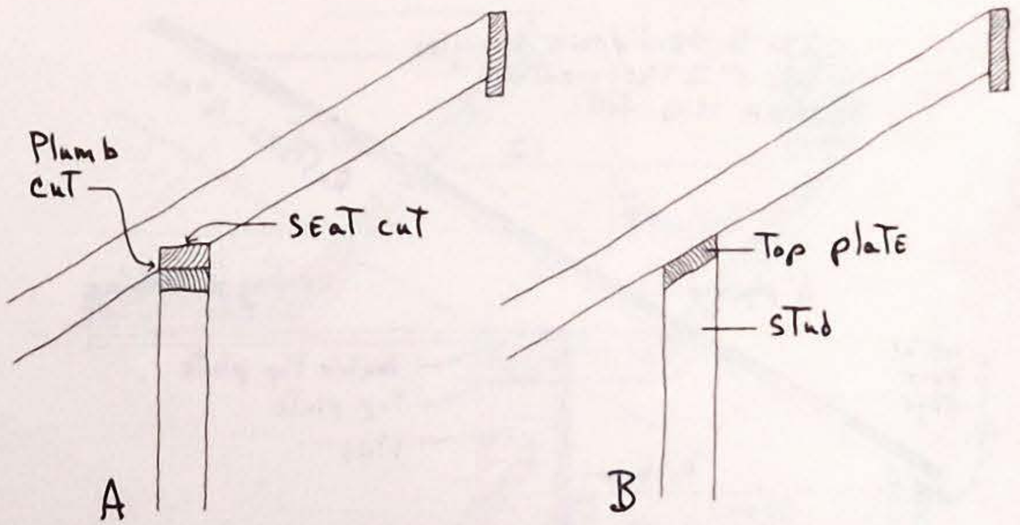

Fig. 38- Two Ways of Attaching a Purlin Wall

Calculating The Angle Cut On A Purlin Wall Stud

To get the angle of the cut at the top of the stud (second method), take a short piece of 2x4" and hold it next to a rafter with the width dimension of the 2x4" touching the width dimension of the rafter. Plumb the piece of 2x4" by holding a level on its thickness dimension. When the 2x4" is plumb, transfer the angle of the rafter to the

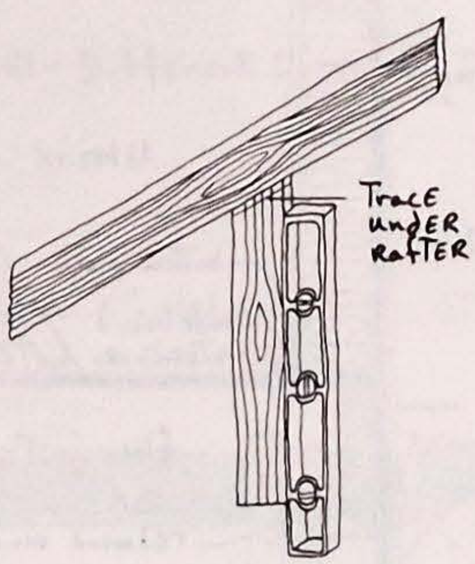

Fig. 39- Transfering Angle of the Rafter

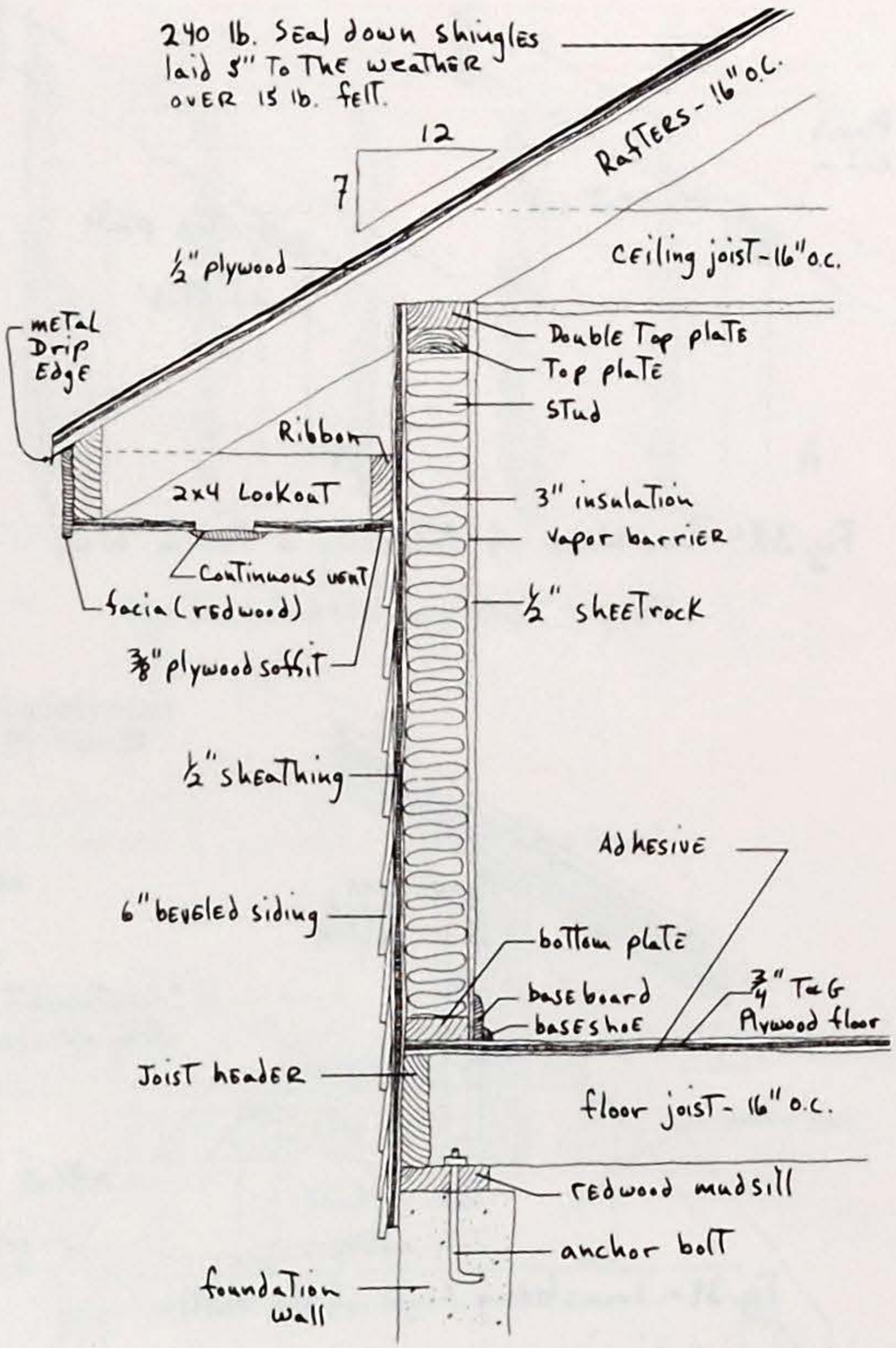

Fig. 40 - Cross section of foundation, Wall & Roof with Cornice

2x4: by tracing along the bottom edge of the rafter with a pencil. Fig. 39.

INSULATION

Insulation as we know it (the itchy pink stuff) was not used in houses until the 1930's and up until the 1960's only nominal amounts of it were used. Now that people in the United States are beginning to realize that we have been gobbling up the world's resources at an unforgivable rate, insulation is becoming very important.

Installing insulation is itchy, hot work. The fall is a good time to insulate attics because the air trapped in the attic isn't devastatingly hot. In houses being built, insulation is installed after the pipes, electrical wires or conduit and heating ducts have been laid. The interior wall covering is applied after the insulation has been installed.

There are several different types of insulation. Fig. 41.

Blanket And Batt

Blanket and batt insulation (Fig. 41) come in widths of 15" and 23" so they can fit between studs and joists spaced 16" O.C. and 24" O.C. respectively. A vapor barrier in the form of aluminum foil or heavy treated paper is usually bonded to one side of the fiberglass insulation. The vapor barrier extends beyond the edges of the fiberglass to form flanges that are stapled to the studs or joists when the insulation is being installed. Fig. 42.

A roll of 3½" thick, 15" wide blanket insula-

tion is 56' long. A roll of blanket insulation which is 6" thick and 23" wide is 32' long. Batts come in length of 24" and 48".

Loose Fill

Loose fill insulation comes in large bags approximately 4' x 2' x 1'. It is particularly suited to spreading in between joists in attics, filling in the hollows of concrete block walls or insulating the walls of houses already built and finished. (The insulation is blown down into the wall by drilling a little hole in the exterior siding at each stud space.)

Rigid

Rigid insulation has both insulating and structural properties and can be used as sheathing when siding is going to be added. It comes in 1/2"-1" thicknesses in sheets of various sizes.

Styrofoam insulation comes in different thicknesses and sizes and, although expensive, is one of the best insulating materials. One inch of styrofoam equals 6" of fiber glass insulation.

Vapor Barrier

If the insulating materials you have access to don't have a vapor barrier attached to them, it is necessary to install one. Asphalt coated paper, polyethylene film or aluminum foil make good vapor barriers.

The vapor barrier should <u>always</u> be installed on the <u>warm side</u> of the wall (toward the living space).

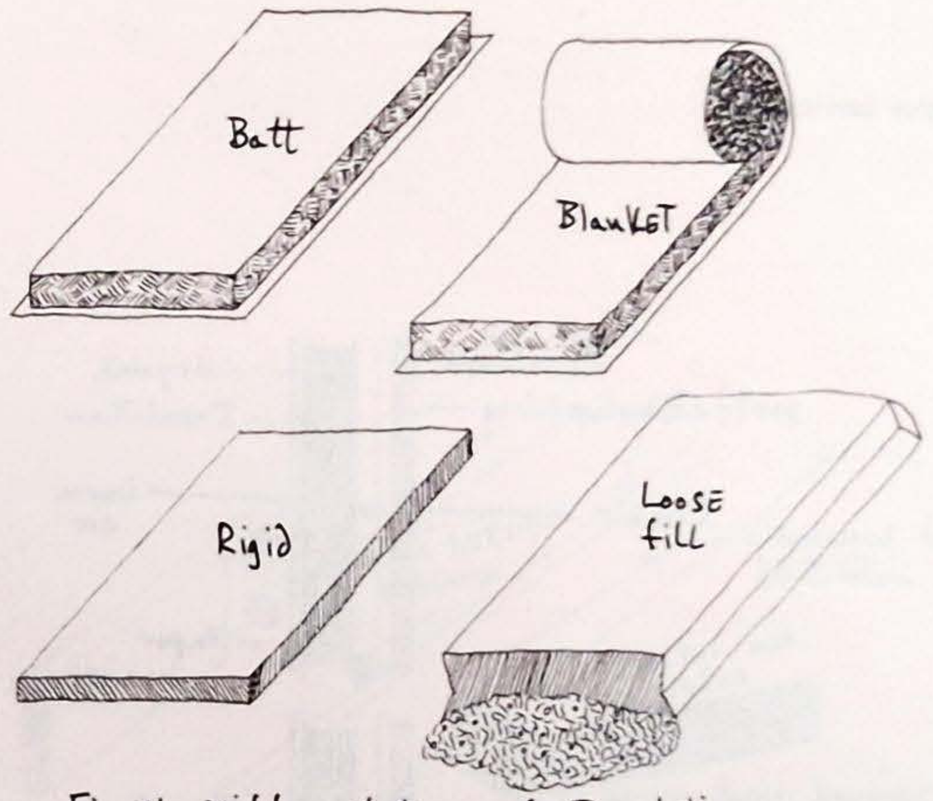

Fig. 41 - Different types of Insulation

Blanket and batt
Loose fill

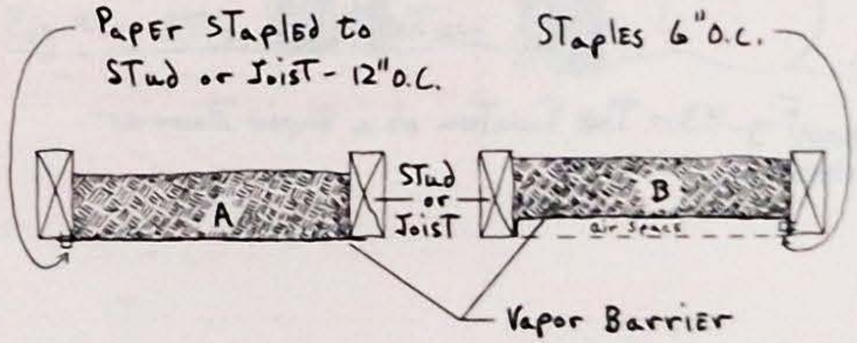

Fig. 42 - Installing Insulation (Cross section)

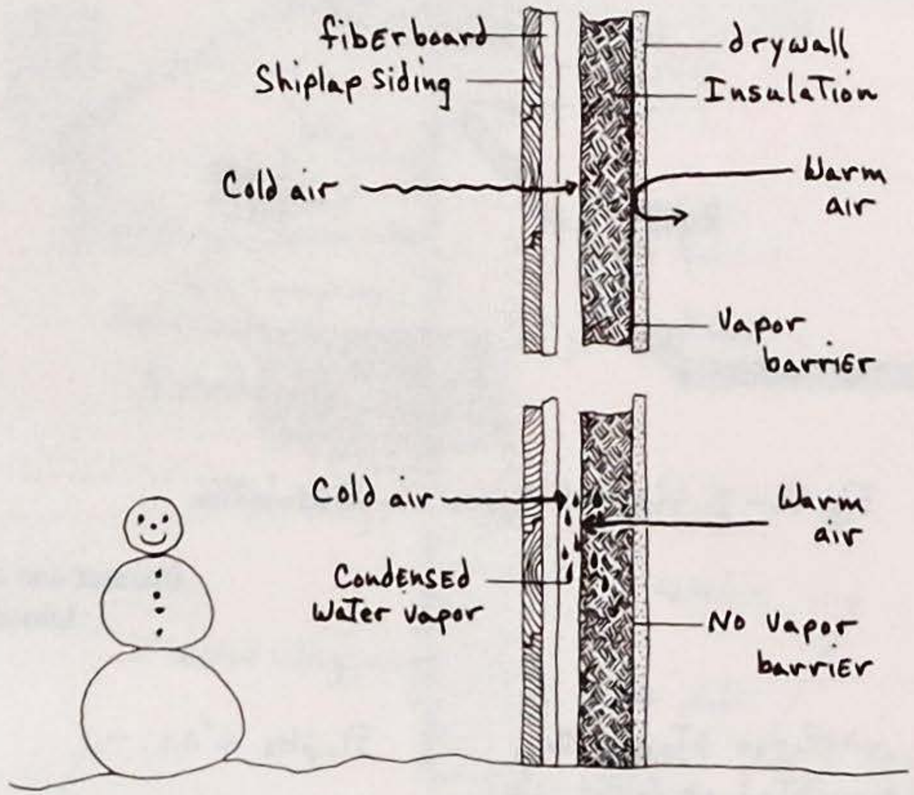

Fig. 43 - The Function of a Vapor Barrier

When warm and cold air meet, condensation of the water vapor carried in the moist warm air takes place. If this happens in the middle of the wall, the moisture will eventually destroy the effectiveness of the insulation by matting it. The wood will rot over time, and it will be impossible to keep a coat of paint on the exterior of the house because of the moisture content of the wood. By placing a vapor barrier toward the living space, the water vapor never gets into the middle of the wall. Fig. 43. Condensation will occur at the vapor barrier near the interior face of the wall, where it will be easily evaporated by the heat and circulation within the living space.

Insulation within a wall should always have a vapor barrier if possible. Attics are a different story. It is all right to use insulation with a vapor barrier in the attic floor of a house as it is being built because the vapor barrier can be installed toward the living space before the ceiling sheetrock is nailed in place. However, when insulating the attic of an existing house, it is important to use insulation that has no vapor barrier (called unfaced insulation). If you were to install faced blanket insulation in an attic in the usual way (stapling the flanges to the tops of the ceiling joists), the vapor barrier would end up on the non-living space side of the insulation. This would mean condensation would occur within the insulation. When loose fill or unfaced insulation is used in an attic, condensation occurs within the attic itself, but is rendered harmless due to good ventilation. Fig. 44.

Ventilation

It is very important to have ventilation throughout the interiors of walls and attics. For walls it is usually enough that the outside covering be weather tight but not airtight. Walls need to breathe. There are some paints nowadays that protect the wood they cover but are porous and let moisture escape. If the walls of an existing house are holding moisture to the extent that the exterior paint is peeling and blistering because of the water collecting under it, small holes can be bored through the siding and sheathing, and patented ventilators can be pushed into the holes to provide ventilation for the wall.

Unheated attics must have ventilation to carry off any moisture condensation or moisture that has seeped under the shingles by capillary action. In summer the ventilation prevents hot air from accumulating excessively and aids in the cooling of the house below.

Ventilation in attics comes in through vents in the cornice (Fig. 40) if there is one, or through spaces between the rafters if the rafter tails are exposed. Fig. 44. There should also be a louvered vent in each gable end of the roof. When insulation is laid in the attic floor between the ceiling joists, it should not be allowed to touch the roof sheathing above the plates. The insulation must not interfere with air flow from the eaves.

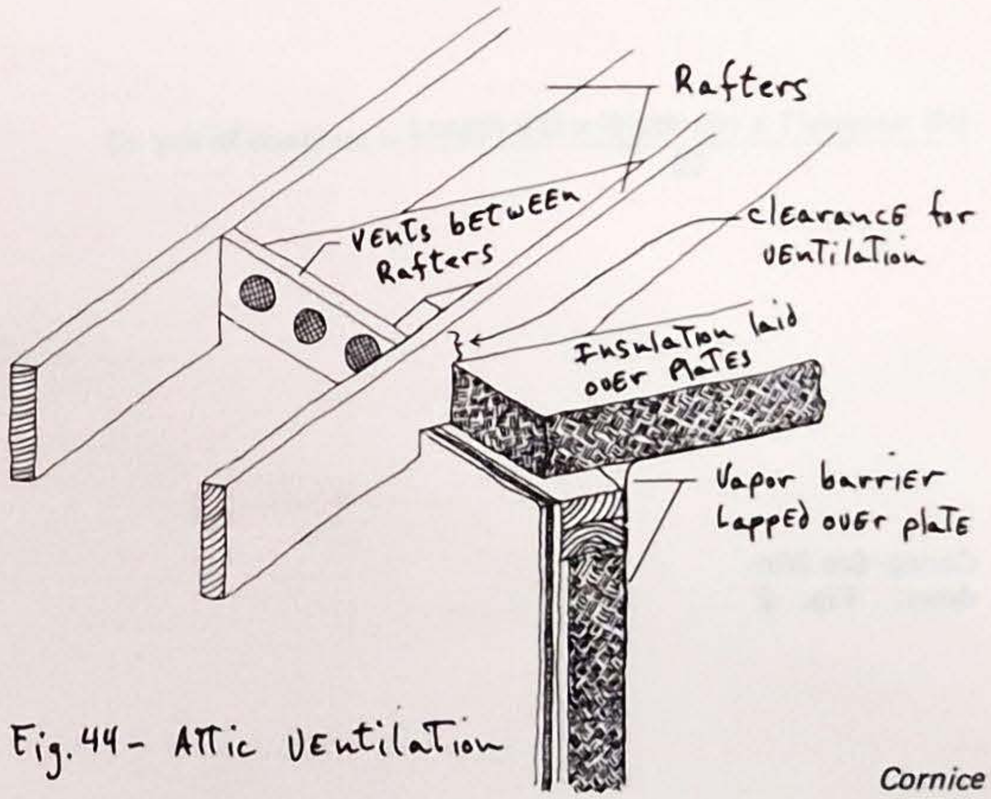

Fig. 44 - Attic Ventilation

Installation

When installing batt or blanket insulation, be careful to keep the vapor barrier intact. The vapor barrier should be lapped 1" at all edges and

Cornice

Venting--See Roofs: Fig. 38

at the ends of batts or rolls. Insulation can be cut with a utility knife, serrated kitchen knife (best) or a fine-tooth crosscut saw. When the insulation is to be attached to framing members and there is no flange, the insulation is removed from the part of the paper that is to be stapled to the stud or joist. The insulation should be carefully threaded behind pipes and conduit so as not to break the vapor barrier.

Insulation is usually stapled to joists or studs with staples no more than 12" apart. Fig. 42A. If the flanges are stapled to the insides of studs, joists or rafters, the staples should be 6" apart. Fig. 42B. Smooth out any buckles in the edge of the vapor barrier before stapling. Some applications of drywall require that the edges of the studs be bare as in Fig. 42B.

Don't forget to stuff insulation in the cracks around windows and doors between the jamb and the trimmers. Do this before you put on the casing. Cover the insulation with a vapor barrier and staple it to the rough opening framing and to the jamb. A primary source of heat loss in a house is the cracks around windows and doors.

Casing–See Windows: Fig. 2

When working with fiberglass insulation, wear long sleeves, gloves, a hat, goggles and a breathing mask. Little glass threads escape from the insulation and not only irritate the skin, but also the lungs and the eyes. They are <u>very</u> dangerous.

Concrete

To estimate the number of cubic yards of concrete to order for a particular pour, use the formula in the margin. The dimensions are the inside dimensions of the form.

If the area to be poured is 10' x 20' and 4" thick, the figuring would be thus:

$$\text{cu. yds.} = \frac{10' \times 20' \times 1/3'}{27}$$

$$\text{cu. yds.} = \frac{200 \text{ sq. ft.} \times 1/3'}{27}$$

$$\text{cu. yds.} = \frac{66.66 \text{ cu. ft.}}{27}$$

cu. yds. = 2.47 of concrete

$$\text{Cu yds of concrete} = \frac{\text{Length (ft)} \times \text{Width (ft)} \times \text{Thickness (ft)}}{27}$$

Joists

There are two ways joists can be laid out. First, the joists may span from one side of the foundation to the other without interruption. Or if the span is greater, one joist may extend from one side of the foundation, and another joist may extend from the other side. Each pair will meet and be supported in the middle by a continuous beam.

If the house you are estimating is of the first

Bearing

$$\text{No. of joists} = (\text{wall length}) \begin{pmatrix} 3/4 \\ 2/3 \\ 3/5 \\ 1/2 \end{pmatrix} + 1 \qquad \begin{matrix} \text{for 16" O.C.} \\ \text{for 18" O.C.} \\ \text{for 20"O.C.} \\ \text{for 24"O.C.} \end{matrix}$$

type, when estimating the number of joists, you need only take into consideration the length (in feet) of one of the foundation walls on which the joists bear. The length of the joists to be ordered is governed by what length joist will span from the outside of one mudsill to the outside of the other. The number of joists of this length is determined by the following formula. A more complete version is in the margin. The number of joists spaced 16" O.C. = (the length of one foundation wall) x (3/4) + 1. Extra joists should be added for doubling under parallel partitions, around floor openings, and for joist headers.

If the house is of the second type, where the joists extend from each foundation wall and meet in the middle, the lengths of both sides of the foundation walls on which the joists rest are taken into consideration. The length of the joists to be ordered will be governed by what length joist will span from one foundation wall to 2" past the other side of the middle beam. The number of joists of this length is determined with the above formulas, except that in this case the "length of the foundation wall" is the length in linear feet of both foundation walls on which the ends of the joists have bearing. Again, extra joists should be added for headers and doubled joists.

When you go to the lumber yard, list the joists needed in this fashion:

Floor joists
20 pcs -2 x 10 x 14'0"
10 pcs -2 x 10 x 12'0"

Joist headers
4 pcs -2 x 10 x 10'0"
2 pcs -2 x 10 x 12'0"

Plywood Flooring Or Subflooring

Calculate the total floor area by multiplying the length of the floor width and subtract the areas of the floor opening that will not be covered by plywood. There is almost no waste to be provided for in the installation of plywood as flooring. Follow this formula for determining the number of sheets of plywood needed. There are 32 sq. ft. per sheet of 4x8' plywood.

Total floor area = (length x width) – (area of openings)

$$\text{No. pcs of plywood (4x8)} = \frac{\text{Total floor area (sq ft)}}{\text{32 sq ft / sheet}}$$

Board Feet

Lumber is sold either by the linear foot or by the board foot. A board foot is a unit of measurement for lumber. One board foot is a piece of wood 1 inch thick and 12 inches square. To find out how many board feet there are in a given piece of lumber, multiply the nominal width in inches by the nominal thickness in inches by the length in feet and divide by 12.

$$\text{No. of board feet} = \frac{\text{W (inches)} \times \text{T (inches)} \times \text{L (feet)}}{12}$$

Studs

When studs are spaced 16" O.C., estimate one stud for each linear foot of walls and partitions. This will generally allow enough for sills, plates and doubled studs.

Wall Sheathing

Calculate the total perimeter of the structure (the lengths of all exterior walls added together) and multiply this figure by the height of the wall to be covered by sheathing (usually the distance from the top of the foundation to the top of the double top plate.) From this number (which is the total exterior wall area) subtract the sum of the

Total wall area = (length x height) – (area of windows)

$$\text{No. pcs of wall sheathing} = \frac{\text{(Total wall area)} - \text{(area of openings)}}{\text{No. of sq ft / sheet}}$$

$$\text{No. of rafters on one side of ridge} = \text{Length of the double top plate} \begin{pmatrix} 3/4 \\ 2/3 \\ 3/5 \\ 1/2 \end{pmatrix} + 1 \quad \begin{matrix} \text{for 16" O.C.} \\ \text{for 18" O.C.} \\ \text{for 20" O.C.} \\ \text{for 24" O.C.} \end{matrix}$$

Framing square--See Roofs : Fig. 7

areas of the openings such as windows, doors, etc.

If the sheathing is plywood or structural fiberboard, there will be almost no waste. Divide the total wall area (minus the area of the opening) by the number of square feet in one sheet of sheathing. This may vary from 4x8' to 4x9' to 4x10', etc.

Rafters

Rafters are calculated similarly to joists. Figure the linear length of the wall that one set of rafters rests on. Follow this formula: The number of rafters on one side of the ridge = (the length of the side wall the rafters bear on) x (3/4) + 1. This is for rafters spaced 16" O.C. Double this figure to determine the total number of rafters in the roof.

To estimate the lengths of rafters, use the framing square and the twelfths scale on the outside of both the tongue and blade on the non-trademark side of the square. The framing square will represent a scaled down version of the run and rise of the rafter (one foot = one inch). Hold the total run of the rafter on the blade and the total rise on the tongue and measure with a tape or ruler across the hypotenuse along the invisible rafter from one measurement to the other. This distance, which is in inches, will be the theoretical length of the rafter when scaled up to feet according to the formula of 1 ft. = 1 in. If there is an overhang, the additional length of rafter must be scaled separately and added to the length of the main rafter.

Roof Sheathing

The amount of roof sheathing required is esti-

mated the same way as wall sheathing is. Find the total roof area and divide by the number of square feet in one sheet of sheathing. The area of one side of a gable roof is found by multiplying the length of one rafter times the length of the ridge board.

$$\text{No. pcs of plywood} = \frac{(\text{length of ridge}) \times (\text{length of rafter})}{32 \text{ sq ft / sheet}}$$

Shingles

Shingles aren't ordered singly, they are ordered by the "square" (the amount of shingles needed to cover 100 sq. ft. of roof area--usually three bundles.) Add 10% of this amount for waste. Quantities of starter strips, drip edges, and ridge cap should be calculated from the length of the eaves and ridge.

$$\text{No. of squares} = \frac{\text{Total area of roof}}{100}$$

Insulation

Insulation is ordered by the square foot except for loose fill, which is ordered by the cubic foot.

For blanket and batt insulation, figure the wall area and subtract the area of the large wall openings. Including the area of small openings in the estimate will allow for cutting and fitting. Specify separately the thickness of the insulation needed.

$$\text{amt of blanket insulation} = (\text{wall area}) - (\text{area of openings})$$

To figure the amount of loose fill insulation for the floor of an attic 20' x 30' when the fill is to be 4" deep, calculate as follows:

$$\text{amt of loose fill insulation} = (\text{area}) \times (\text{thickness of insulation})$$

area of attic	=	20' x 30'
volume required	=	600 sq. ft. x 1/3'
volume	=	200 cu. ft.

less 10% for volume of joists	=	200 - 20
Amt. loose fill	=	180 cu. ft.