GHOST RANCH
SOLAR ADOBE SEMINAR
SUMMER 1990

PRESENTED BY MARK CHALOM
AND QUINTIN WILSON.

RESIDENTIAL PASSIVE SOLAR ENERGY SEMINAR
RECOMMENDED READINGS

ADOBE

Adobe, Build it Yourself
P.G. McHenry, Jr.
University of Arizona Press

The Earthbuilder's Encyclopedia
Joseph M. Tibbits
Southwest Solar Adobe School, Bosque, NM

Adobe Fireplaces
Adobe Remodeling
Myrtle Stedman
The Sunstone Press, Santa Fe

Build with Adobe
Marcia Southwick
Swallow Press, Chicago

Mud, Space and Spirit
Gray, Macrae, McCall
Capra Press, Chicago

SOLAR

The Passive Solar Energy Book
Edward Mazria
Rodale Press, Emmaus, PA

The Food and Heat Producing Solar Greenhouse
Yanda and Fisher
John Muir Publications, Santa Fe

Homegrown Sundwellings
Peter Van Dresser
The Lightning Tree Press, Santa Fe

Natural Solar Architecture
David Wright
Van Nostrand Rinehold, NYC

Sun Spaces
Clegg and Watkins
Gardenway Publishing, Charlotte Vt.

SOLAR (Continued)

Regional Guidelines for Building Passive Energy Conserving Homes
Superintendent of Documents
U.S. Government Printing Office
Washington, DC, 20402

Design Guidelines and Analysis Methods
PNM Passive Solar Design Guidelines and Standards
Public Service Company of New Mexico, Santa Fe

GENERAL

Design with Nature
Ian McHarg
Doubleday, Garden City, NJ

Architectural Graphic Standards
Ramsey and Sleeper
Wiley And Sons, NYC

Building Construction Illustrated
Francis D.K. Ching
Van Nostrand Rinehold, NYC

CONTACTS

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(505) 583-2356

SOLAR ENERGY RESEARCH INSTITUTE
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401

References

General

1. *A Sunbuilder's Primer*, Solar Energy Research Institute.

2. *Passive: It's a Natural*, Solar Energy Research Institute.

3. *The Passive Solar Construction Handbook*, Steven Winter Associates/Northeast Solar Energy Center/National Concrete Masonry Association/Portland Cement Association/Brick Institute of America. Available for $29.95 plus $3.00 handling, from Steven Winter Associates, Attn: Publications, 6100 Empire State Building, New York, N.Y. 10001

4. *Suntempering in the Northeast*, Steven Winter Associates. Available from them at the address above for $9.50.

5. *Passive Solar Design Handbook, Volume I, II, III.* Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Va, 22161, $32.00 each for I and II, $12.00 for III.

6. Balcomb, J.D., et al. *Passive Solar Heating Analysis.* This volume supercedes and expands Volume III of the Passive Solar Design Handbook (Ref. 5). Available from ASHRAE, Publications, 1791 Tullie Circle NE, Atlanta, Ga. 30329, $30.00 for ASHRAE members, $60.00 for non-members.

7. *Living With the Sun* (for consumers) and *Building With the Sun* (for builders), PPG Industries.

8. *The Passive Solar Information Guide*, PSIC.

9. *Passive Solar Trends.* Technical briefs from PSIC.

a. Infiltration in Passive Solar Construction
b. The State of the Art in Passive Solar Construction
c. Passive Solar in Factory-Built Housing
d. Radiant Barriers: Top Performers in Hot Climates
e. Glazings: The Design Considerations Aren't As Clear As Glass
f. Ideas for Passive Solar Remodeling
g. Passive Homes in the Marketplace (Class C Studies)
h. Daylighting in Commercial Buildings
i. Human Comfort and Passive Solar Design
j. Passive Design for Commercial Buildings
k. Passive Solar: Principles and Products
l. Increasing Design Flexibility
m. Utilities and Passive: Predicting the Pay-off

Insulation

10. *NAHB Insulation Manual*, National Association of Home Builders, National Research Center. Available from NAHB Bookstore, 15th and M Streets N.W., Washington, D.C. 20005. (202) 822-0200.

11. Lischkoff, James K. *The Airtight House: Using the Airtight Drywall Approach*, Iowa State University Research Foundation. Available for $14.95; Attn: Sarah Terrones, EES Building, Iowa State University, Ames, IA. 50011

12. Spears, John. *Radon Reduction in New Construction, Interim Guide*, National Association of Home Builders, Environmental Protection Agency OPA 87-009, , August 1987. Available from the EPA or the NAHB Bookstore, 15th and M Streets N.W., Washington, D.C. 20005. (202) 822-0200.

Appliances

13. *Saving Energy and Money with Home Appliances*, Environmental Science Department, Massachusetts Audobon Society/American Council for an Energy Efficient Economy. Available for $2.00 apiece from ACEE, 1001 Connecticut Ave. N.W., Suite 535, Washington D.C. 20036

14. *The Most Energy Efficient Appliances*, 1988 Edition, ACEEE, $2.00 apiece at address above.

Site Planning

15. *Builder's Guide to Passive Solar Home Design and Land Development*, National Fenestration Council. Available for $12.00 from NFC, 3310 Harrison, White Lakes Professional Building, Topeka, KS. 66611

16. *Site Planning for Solar Access*, U.S. Department of Housing and Urban Development/American Planning Association. Available for $6.50 from Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402

Sunspaces

17. Jones, Robert W. and Robert D. McFarland. *The Sunspace Primer: A Guide for Passive Solar Heating*, available for $32.50 from Van Nostrand Reinhold, 115 5th Avenue, New York, N.Y. 10003

18. *Greenhouses for Living*, from Steven Winter Associates, Attn: Publications, 6100 Empire State Building, New York, N.Y. 10001, $6.95.

19. *Concept IV*, from Andersen Corporation, Bayport, MN. 55003, $6.95.

20. *Passive Solar Greenhouse Design and Construction*, Ohio Department of Energy/John Spears, 8821 Silver Spring, Md., 20910.

More Information

Conservation and Renewable Energy Inquiries and Referral Service (CAREIRS) 1-800-523-2929, Renewable Energy Information, Box 8900, Silver Spring, Md. 20907

National Association of Home Builders
Attention: Technical Services
15th & M Streets N.W.
Washington, D.C. 20005

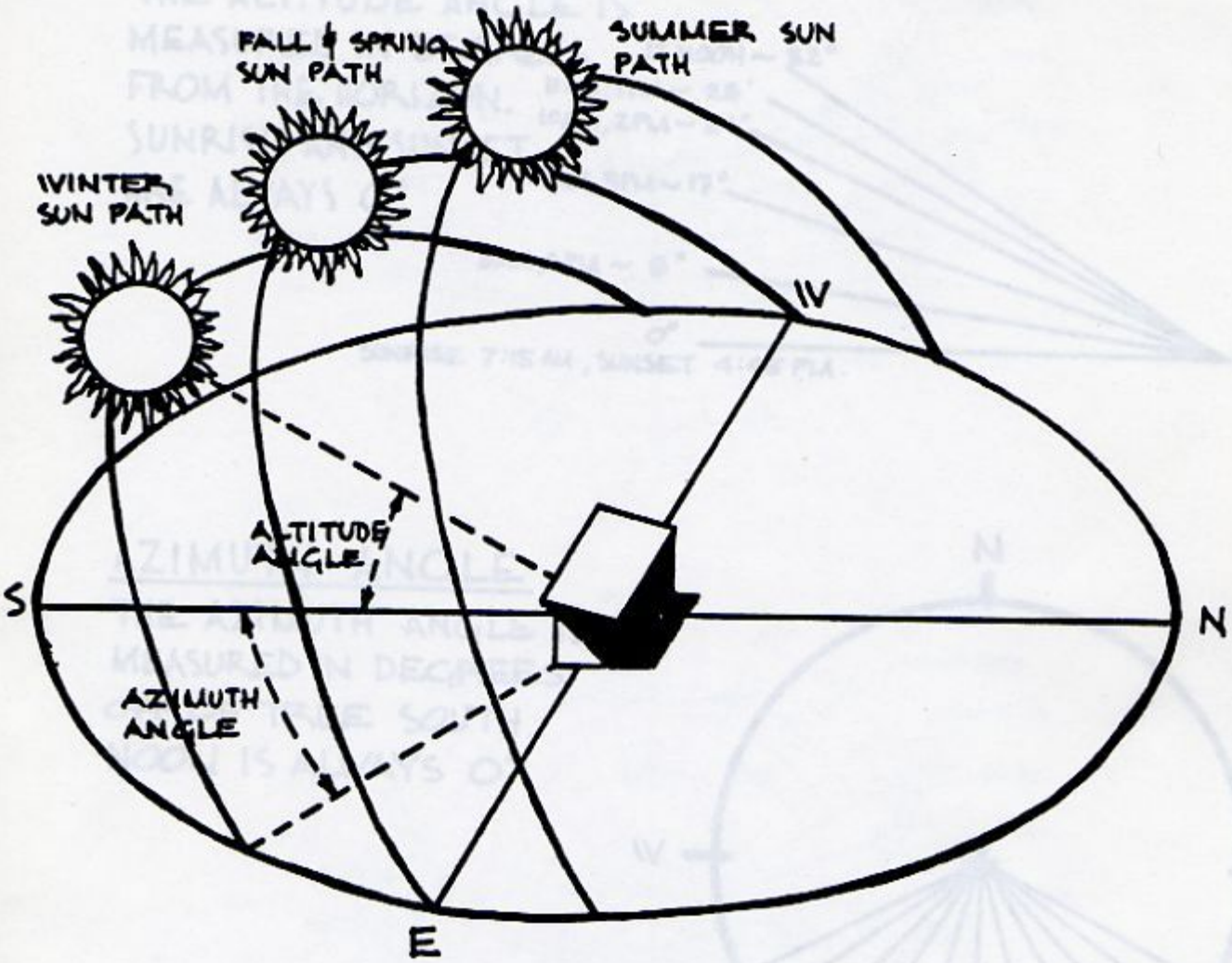
National Concrete Masonry Association
Attention: Energy Engineer
2302 Horse Pen Road
Herndon, Va. 22070

Brick Institute of America
Attention: Energy Engineer
11490 Commerce Park Drive
Suite 300
Reston, Va. 22091

Solar Energy Research Institute
Attention: Solar Buildings
1617 Cole Boulevard
Golden, Co. 80401

Passive Solar Industries Council
1090 Vermont Avenue, Suite 1200
Washington, DC 20005

SUN PATH

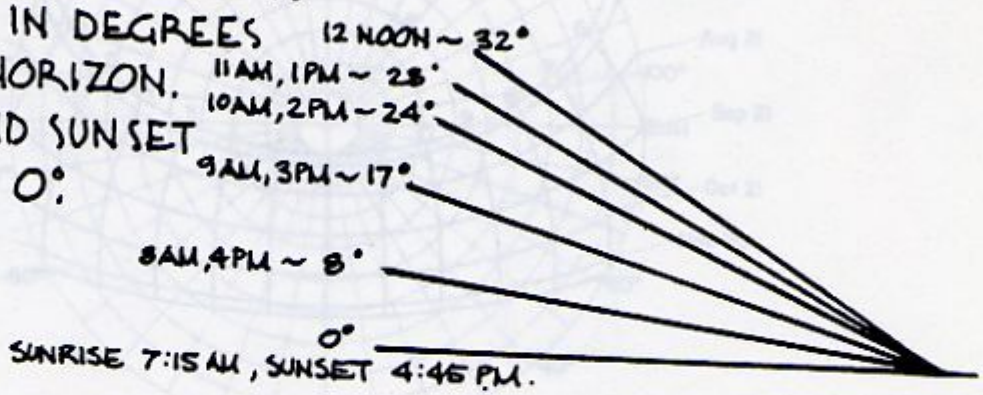

FALL & SPRING SUN PATH
SUMMER SUN PATH
WINTER SUN PATH
IV
ALTITUDE ANGLE
AZIMUTH ANGLE
S
N
E

SUN CHART 35° N. LAT.

DECEMBER 21

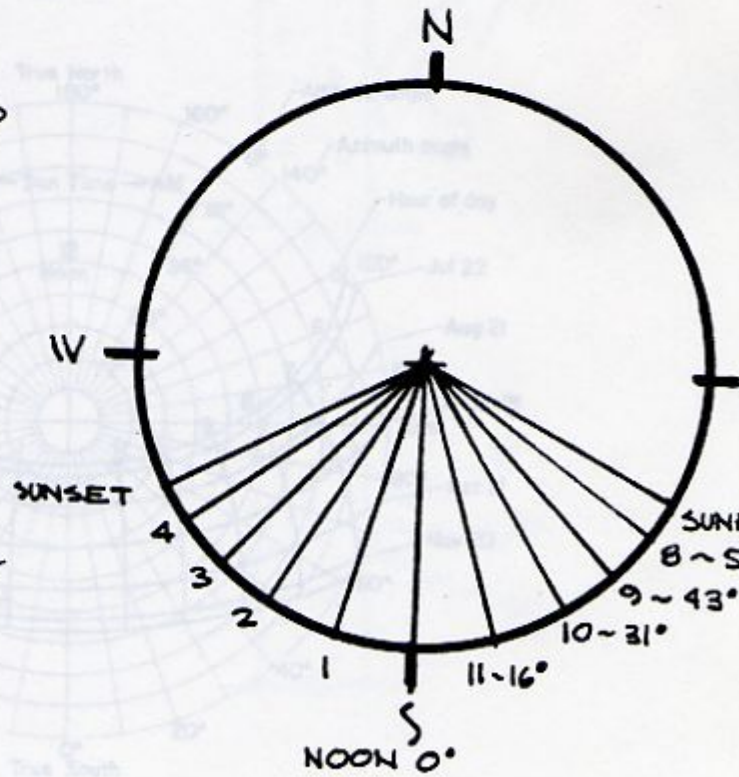
ALTITUDE ANGLE

THE ALTITUDE ANGLE IS MEASURED IN DEGREES FROM THE HORIZON. SUNRISE AND SUNSET ARE ALWAYS 0°.



AZIMUTH ANGLE

THE AZIMUTH ANGLE IS MEASURED IN DEGREES OFF OF TRUE SOUTH. NOON IS ALWAYS 0°



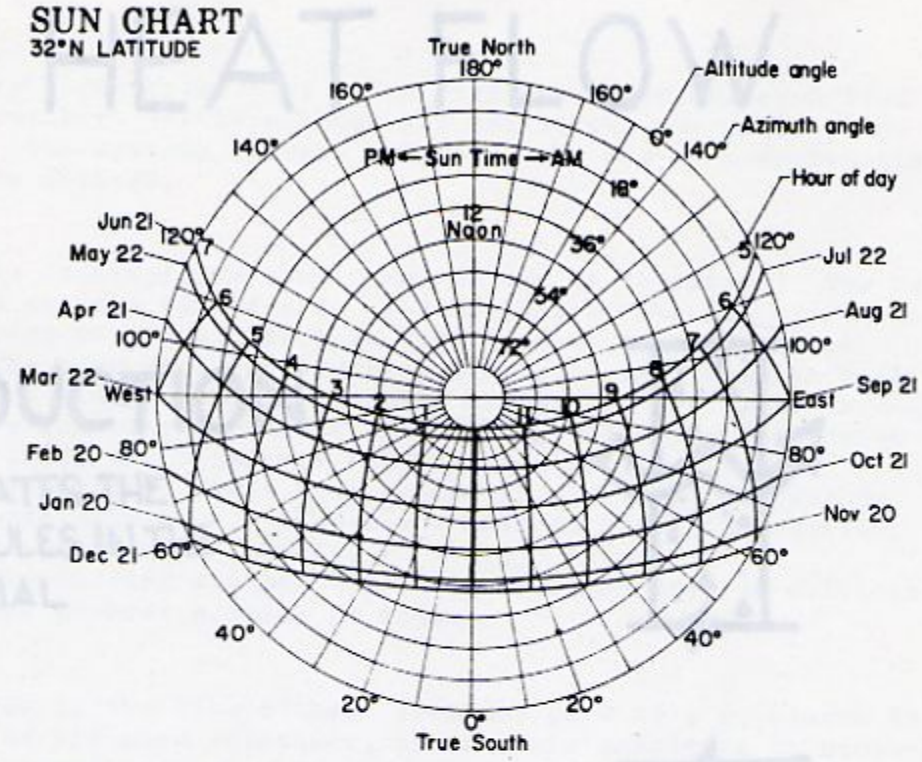


FIGURE 102

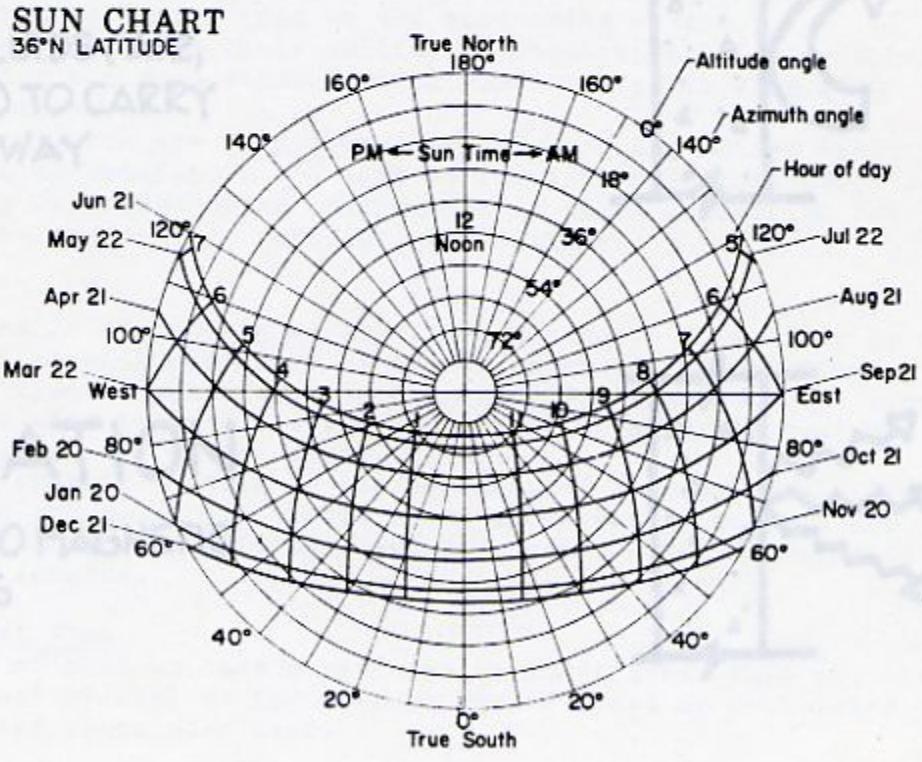


FIGURE 103

HEAT FLOW

CONDUCTION

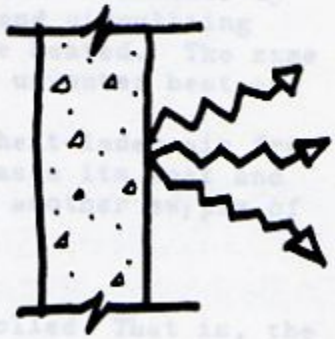
ACTIVATES THE MOLECULES IN THE MATERIAL

CONVECTION

USES FLUIDS (AIR, WATER) TO CARRY HEAT AWAY

RADIATION

ELECTRO MAGNETIC WAVES



Heat Transfer

There are three methods by which heat may be transferred from one body to another. These methods are radiation, conduction, and convection. Some systems of heat transfer make use of a combination of these three methods.

Radiation

The earth receives its heat from the sun by radiation. The heat rays from the sun are turned into heat as they strike an object which will absorb some or all of the heat rays (opaque or translucent material). The rays heat the air very little as they pass through it and they heat a glass windowpane a very minimum as they pass through it. Heat rays generate more heat on striking dark-colored objects than when striking light-colored and polished surfaces.

Any heated surface loses heat to cooler surrounding space or surfaces through radiation. Likewise a cold surface will absorb radiated heat which may strike it.

Some space heating systems depend on radiated heat in ceilings, walls or floors to heat a space or room.

Conduction

Conduction is the flow of heat from one part of a substance to another part of the same substance, or from one substance to another substance in direct contact with it. A piece of iron with one end placed in a fire will soon become warm from end to end. This is an example of the transfer of heat by conduction. The heat travels through the iron using the iron as the conducting medium.

Substances differ in their ability to conduct heat. In general, substances which are good conductors of electricity are also good conductors of heat.

Substances which are poor conductors of heat are called heat insulators. Such substances are used to insulate refrigerators, homes, and any structure whose temperature is to be controlled regardless of its surrounding (ambient) temperature.

Convection

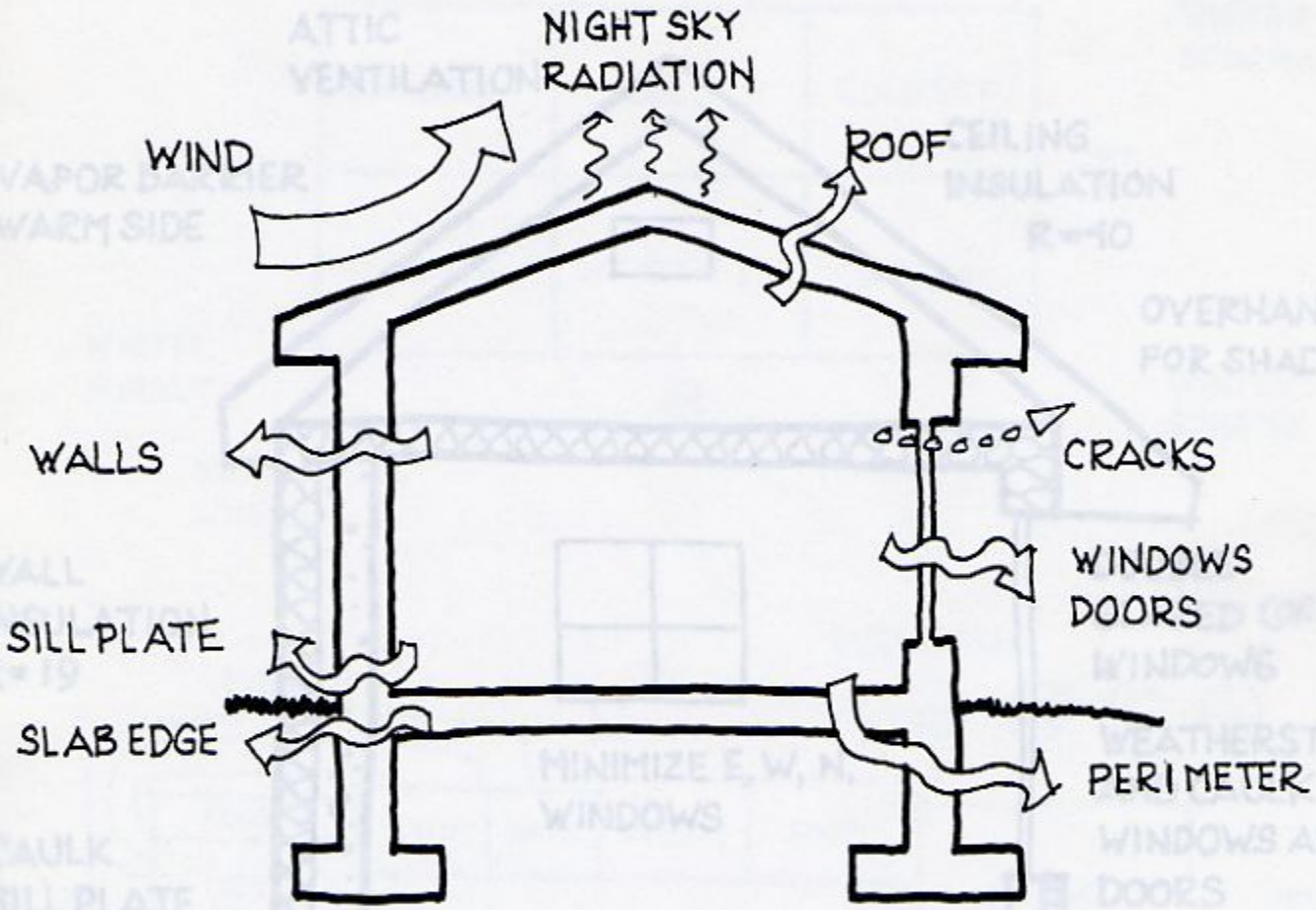
Convection is the moving of heat from one palce to another by heating a substance (fluid) such as air or water and circulating the substance from a heat source to the area to be heated. The same methods may be used to cool a space by picking up unwanted heat and discharging it outside of the space.

A common example of this is the movement of heat-laden air from a furance into the rooms of a house where it releases its heat and then returns through the cold air duct to receive another supply of heat from the furance.

Control of Heat Flow

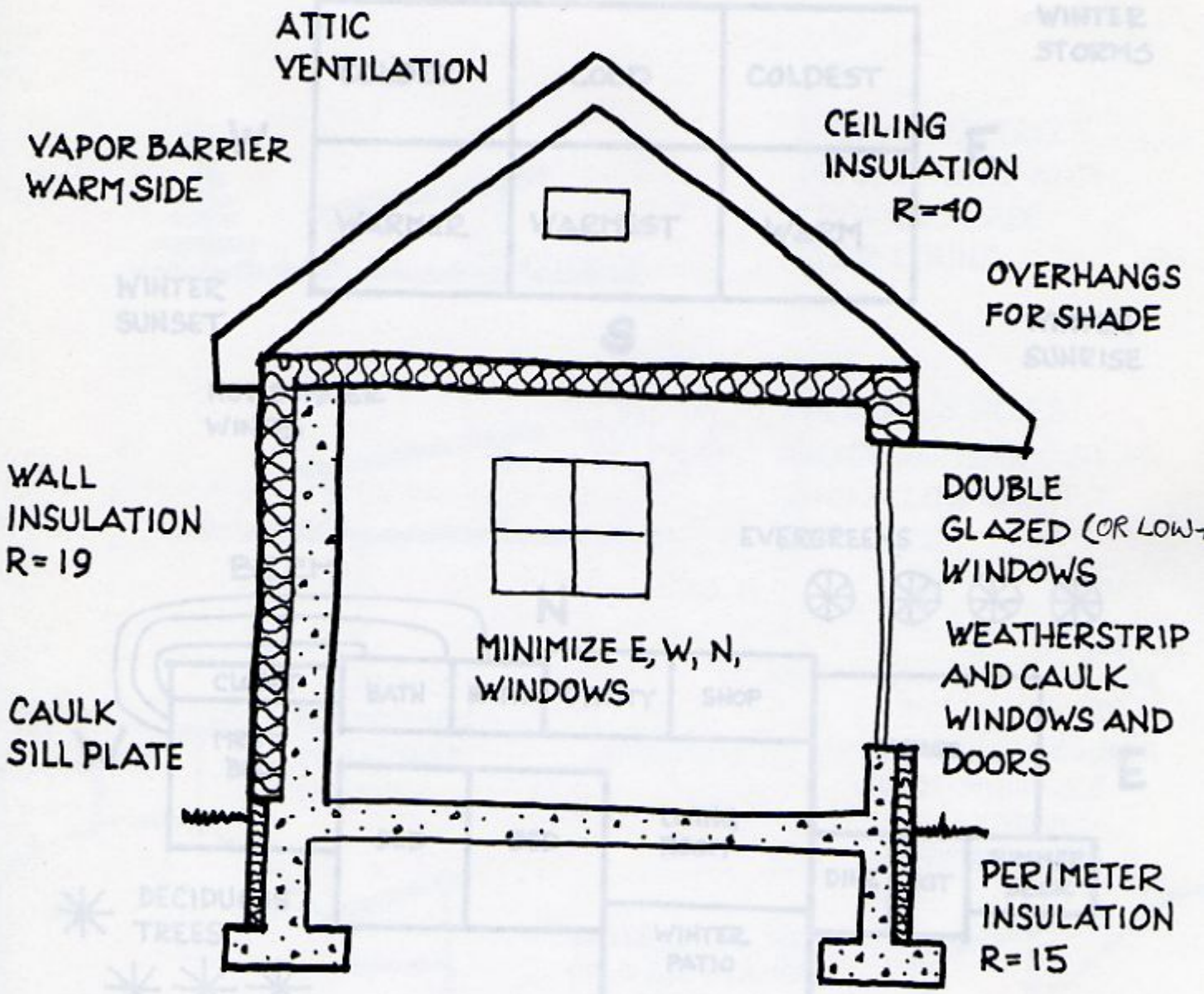
The flow of heat by each method can be controlled. That is, the transfer of heat by each of the methods can be aided or restricted according to the particular need.

HOUSE HEAT LOSS

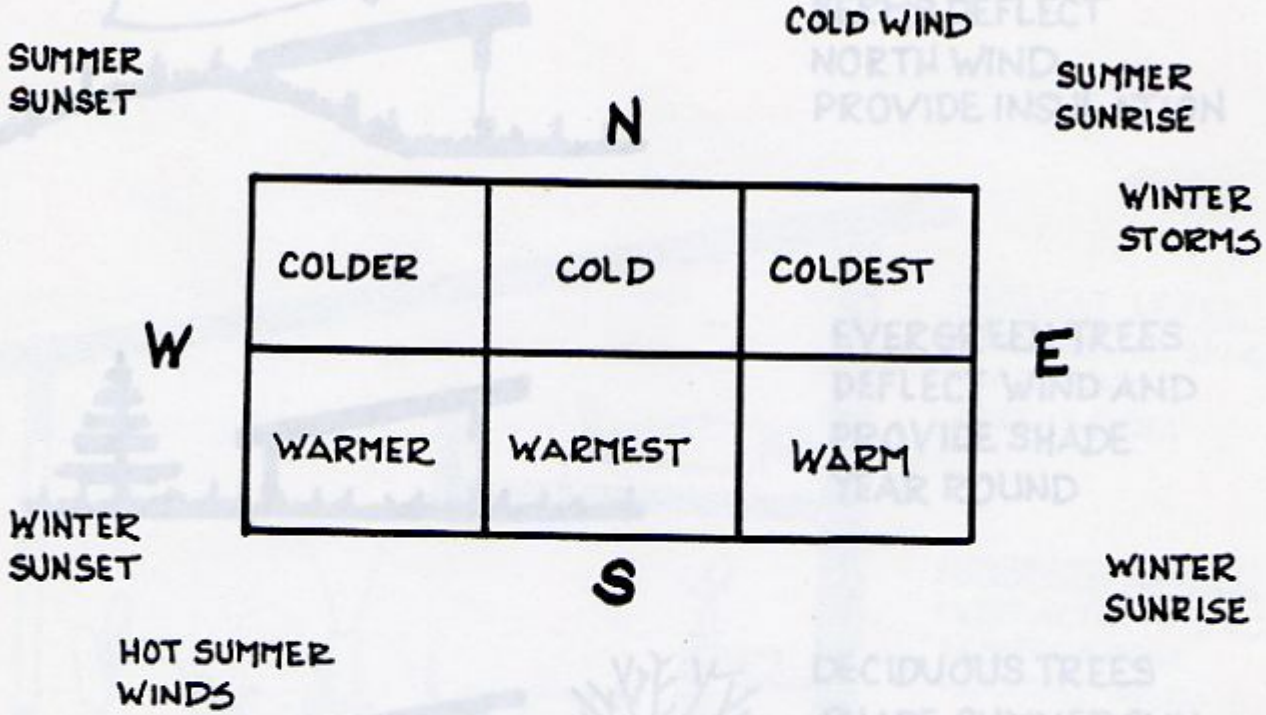


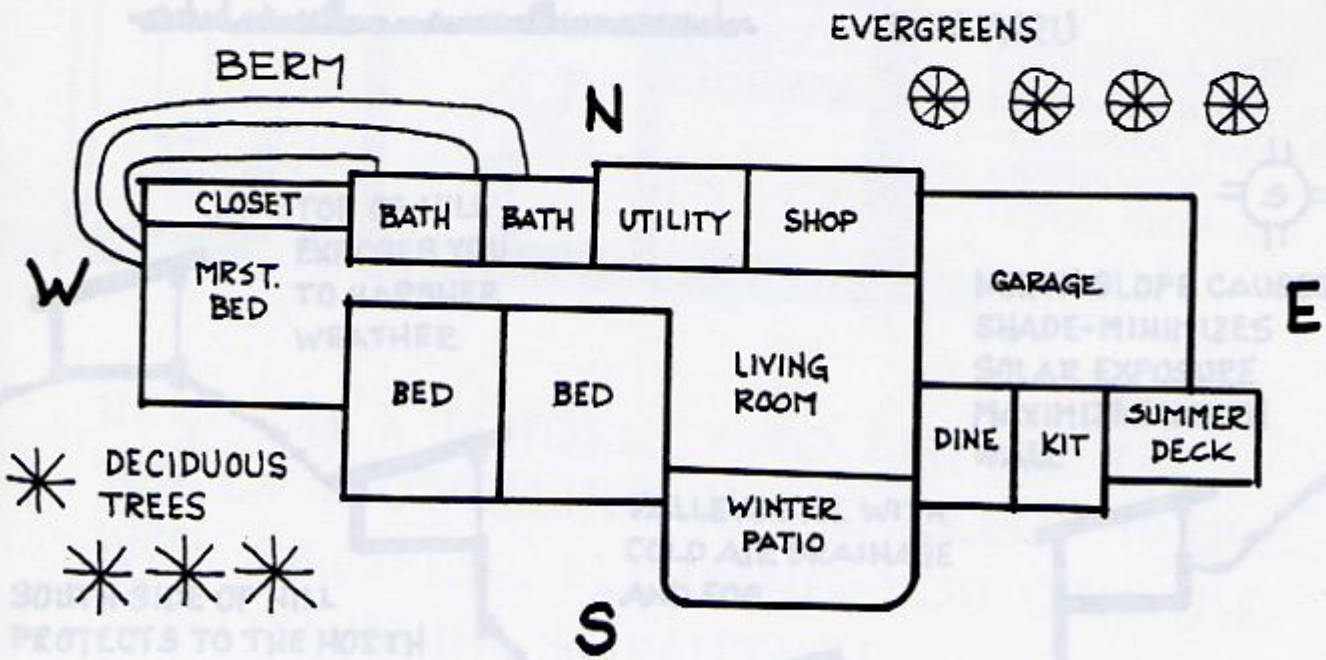
HEAT LOSS OCCURS THRU RADIATION, CONDUCTION, AND CONVECTION IN ALL DIRECTIONS. MINIMIZING HEAT LOSS IS THE FIRST AND CHEAPEST STEP TOWARDS SOLAR HEATING.

ENERGY CONSERVATION



HOUSE CLIMATE



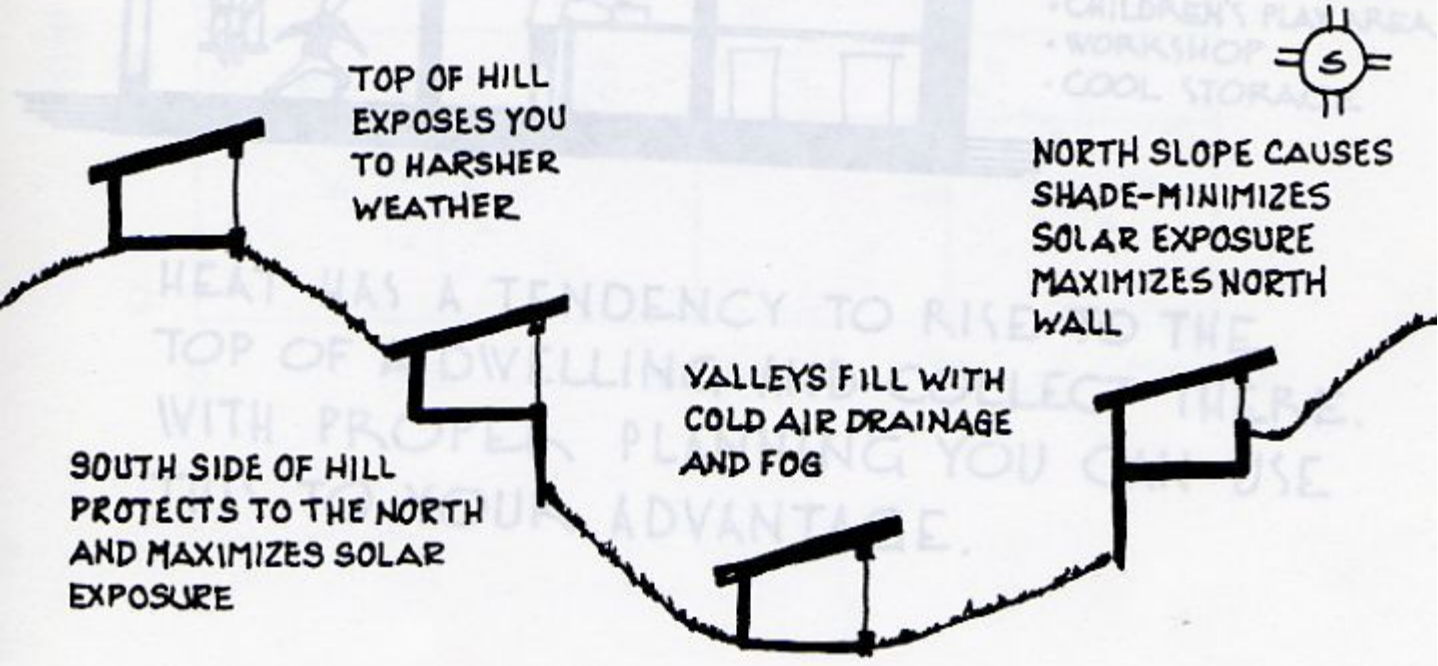


NATURAL SITING

BERMS DEFLECT
NORTH WIND
PROVIDE INSULATION

EVERGREEN TREES
DEFLECT WIND AND
PROVIDE SHADE
YEAR ROUND

DECIDUOUS TREES
SHADE SUMMER SUN
AND ALLOW WINTER
SUN THRU



HEAT STRATIFICATION

WARMEST LEVEL
MOST PASSIVE SPACES
- SLEEPING
- BATHROOM

MODERATE LEVEL
LIGHT ACTIVITY SPACES
- LIVINGROOM
- EATING AREA
- KITCHEN

COOLEST LEVEL
MOST ACTIVE SPACES
- CHILDREN'S PLAY AREA
- WORKSHOP
- COOL STORAGE

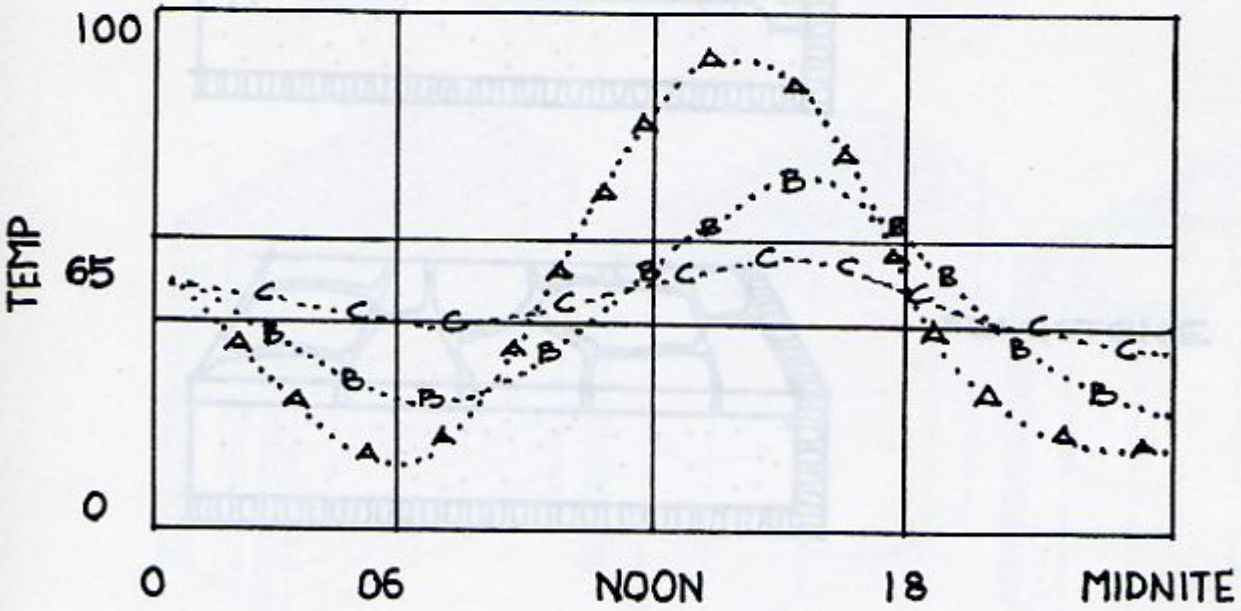
HEAT HAS A TENDENCY TO RISE TO THE TOP OF A DWELLING AND COLLECT THERE. WITH PROPER PLANNING YOU CAN USE THIS TO YOUR ADVANTAGE.

MASS EFFECT

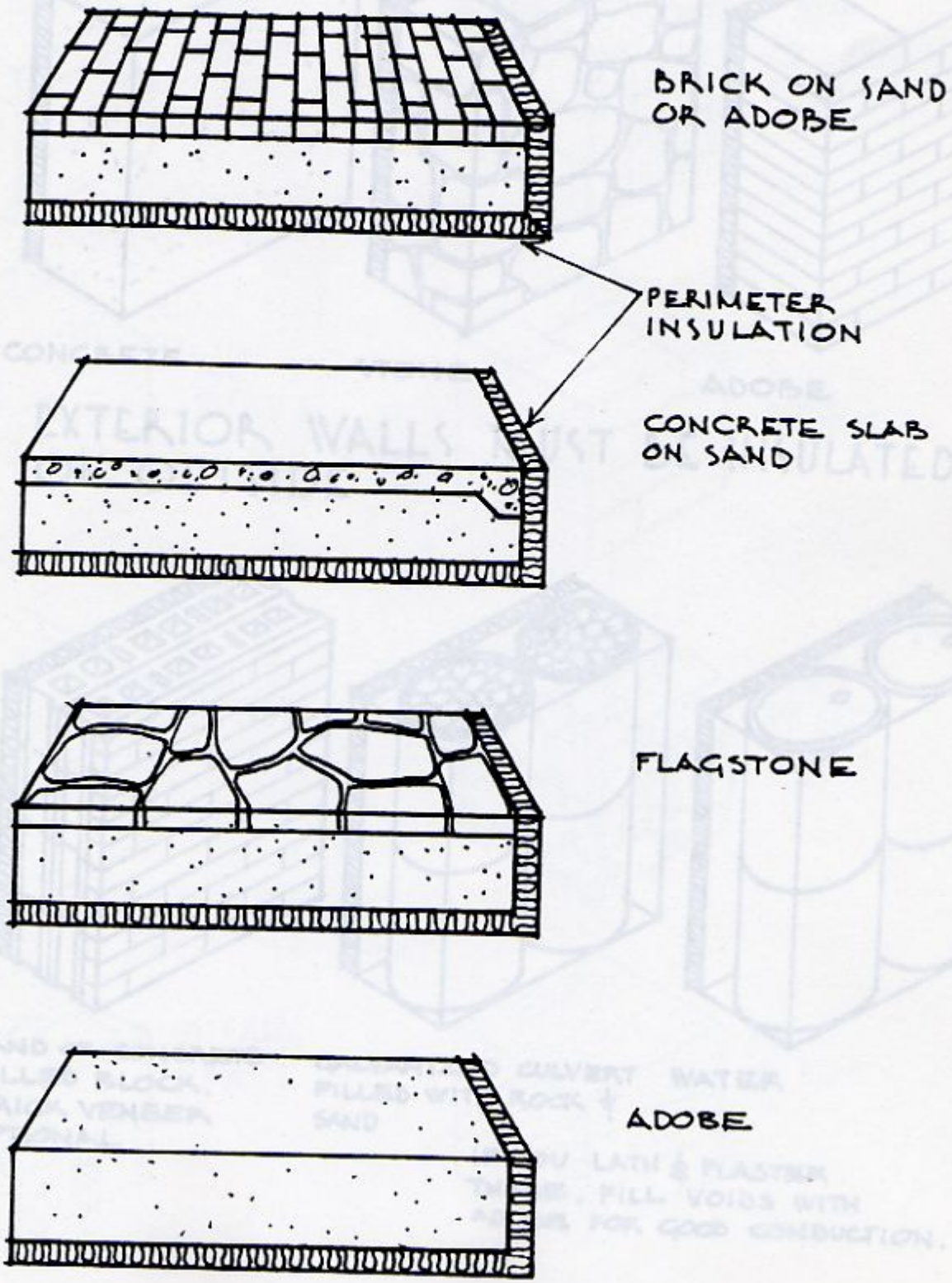
(A) ALL INSULATION

(B) ALL MASS

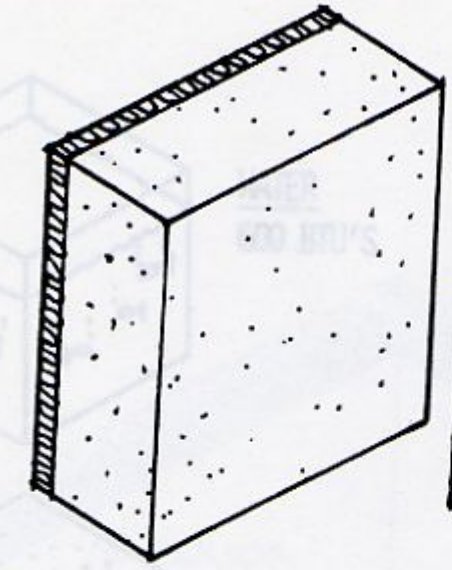
(C) INSULATED MASS



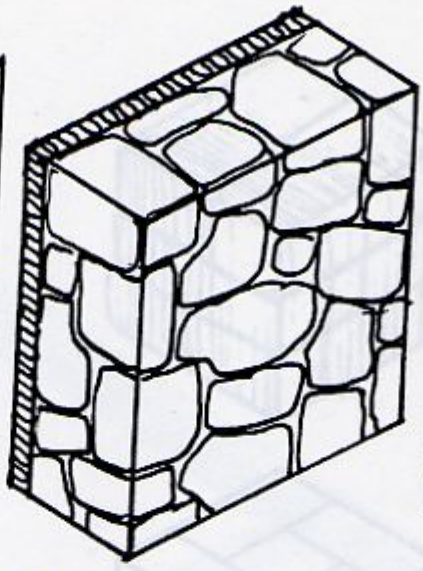
MASS STORAGE FLOORS



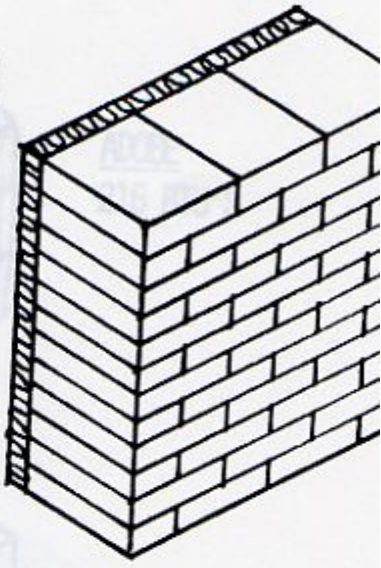
MASS STORAGE WALLS



CONCRETE

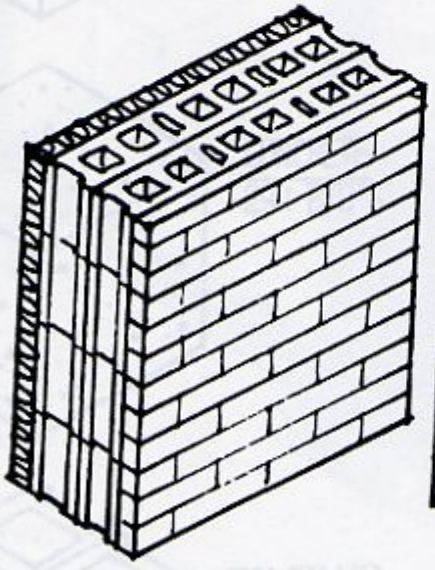


STONE

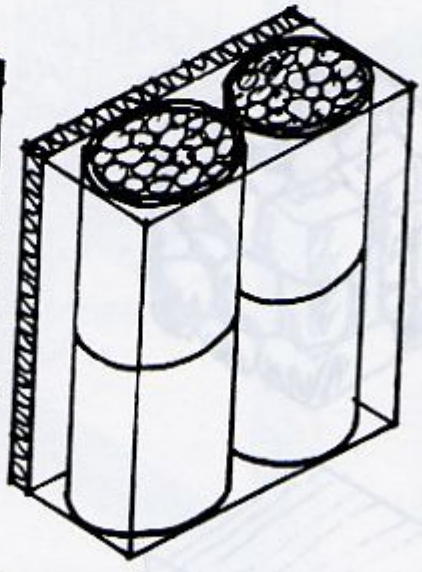


ADOBE

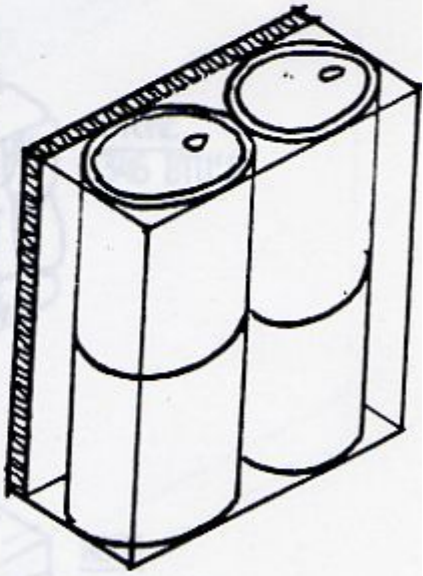
EXTERIOR WALLS MUST BE INSULATED ON OUTSIDE



SAND OR CONCRETE FILLED BLOCK. BRICK VENEER OPTIONAL



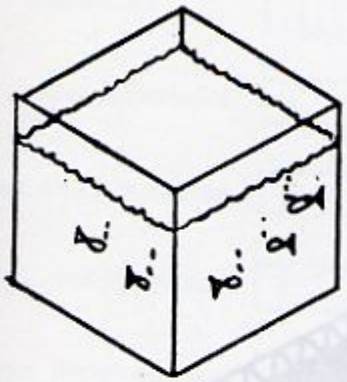
GALVANIZED CULVERT FILLED WITH ROCK & SAND



WATER

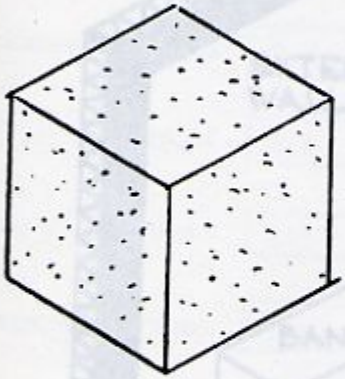
IF YOU LATH & PLASTER THESE, FILL VOIDS WITH ADOBE FOR GOOD CONDUCTION.

THERMAL STORAGE CAPACITY PER CUBIC FOOT OF MATERIAL WITH A 10°F RISE



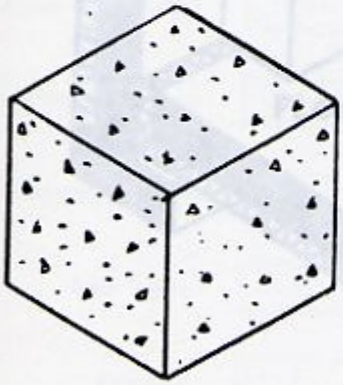
WATER
600 BTU'S

ADOBE
216 BTU'S



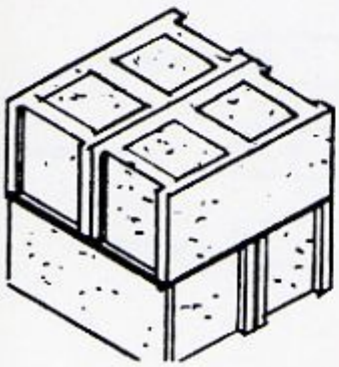
SAND
252 BTU'S

BRICK
273 BTU'S

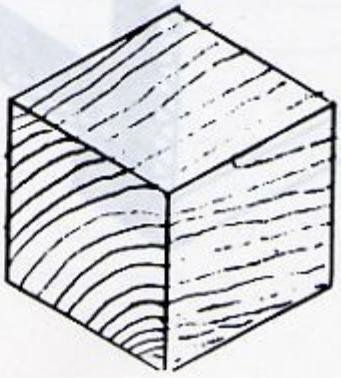


CONCRETE
294 BTU'S

STONE
346 BTU'S

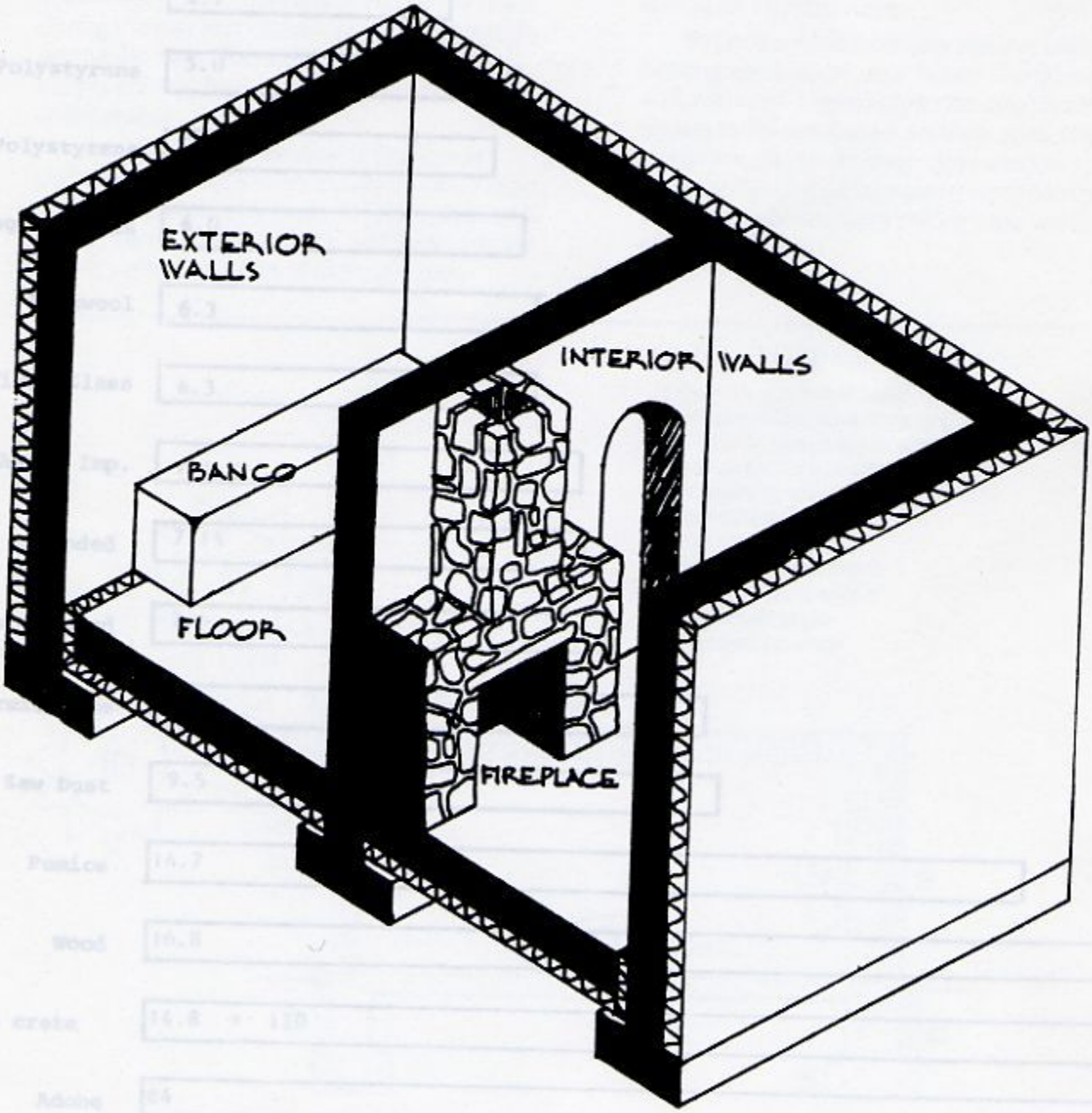


CMU FILLED
273 BTU'S

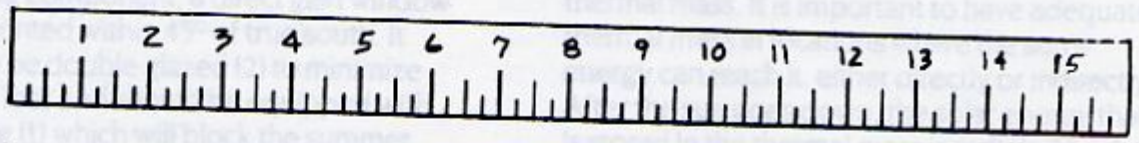


WOOD
147 BTU'S

THERMAL MASS STORAGE



EQUIVALENT THICKNESS OF INSULATION NEEDED TO EQUAL AN "R" OF 21



Material ↓

Material	
Polyurethene	3.57
llulose Fill w/Borax	4.7
Exp. Polystyrene	5.0
Molded Polystyrene	5.5
Fibreglas Batts	6.0
Rockwool	6.3
Rigid Fibre Glass	6.3
Celotex/Asph. Imp.	7.1
Perlite Expanded	7.14
Fesco Board	7.6
Vermiculite	9.25
Saw Dust	9.5
Pumice	14.7
Wood	16.8
Pumice crete	14.8 → 110
Adobe	84

The Direct Gain Window

What Does It Look Like?

Any window that receives direct sunlight is a direct gain window. To be an effective passive solar heating component, a direct gain window must be oriented within 45° of true south. It should also be double glazed (2) to minimize winter heat loss and should be equipped with an overhang (1) which will block the summer sun but still allow the winter sun to penetrate deep within the space. A direct gain window should be sized to serve the room adjacent to it. Too much direct gain will overheat the space during the day and cause it to lose heat rapidly during the night. Too little direct gain won't supply enough heat to keep the space comfortable.

If the direct gain window is to provide nighttime heating, it is necessary to incorporate thermal mass into the walls (5) and/or floors (7) of the room. Concrete, brick, adobe and water are very effective types of thermal mass.

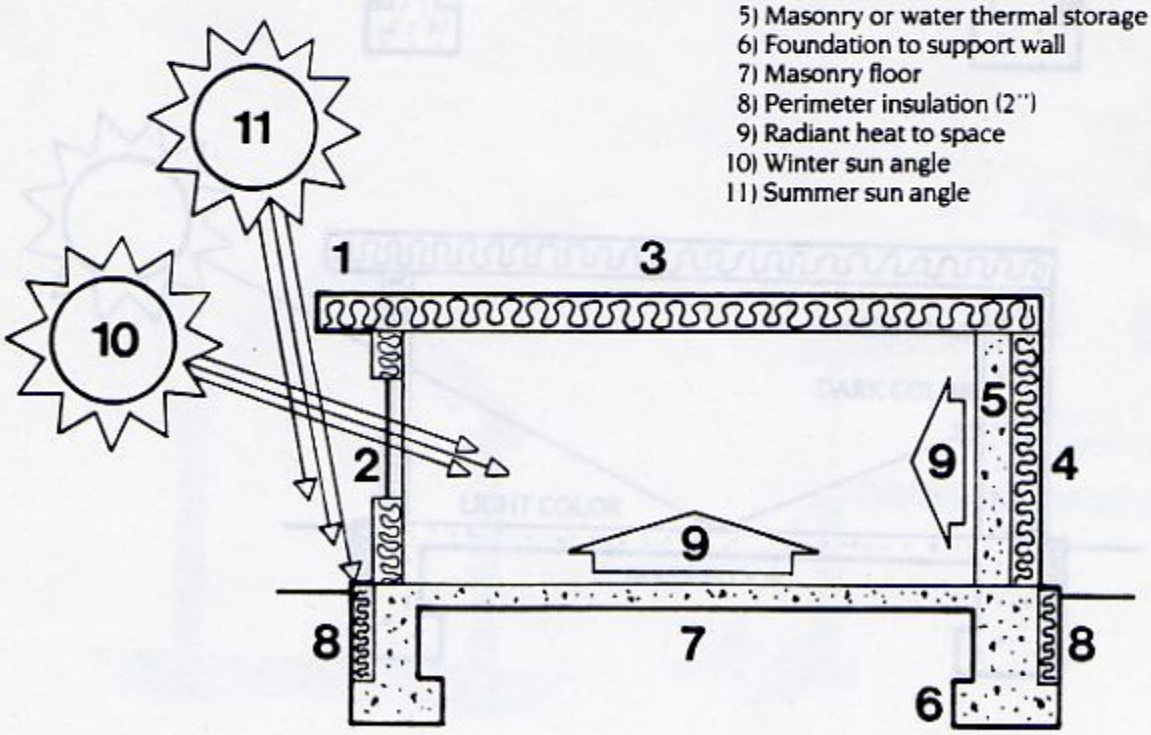
How Does It Work?

During the heating season, the sun shines through the window and is absorbed by the thermal mass. It is important to have adequate thermal mass in locations where the sun's energy can reach it, either directly or indirectly. After the sun goes down, the solar energy that is stored in the thermal mass is radiated back to the living space as heat. The more area (square footage of walls and floors) of thermal mass that is exposed to the sun, the more energy will be stored for nighttime use.

To get the most from any passive solar heating application, your house should be well insulated, preferably to the specifications shown in the numbered drawing. Also, night insulation placed on direct gain windows can improve heating performance significantly by reducing heat loss back through the windows on winter nights.

The Direct Gain Window

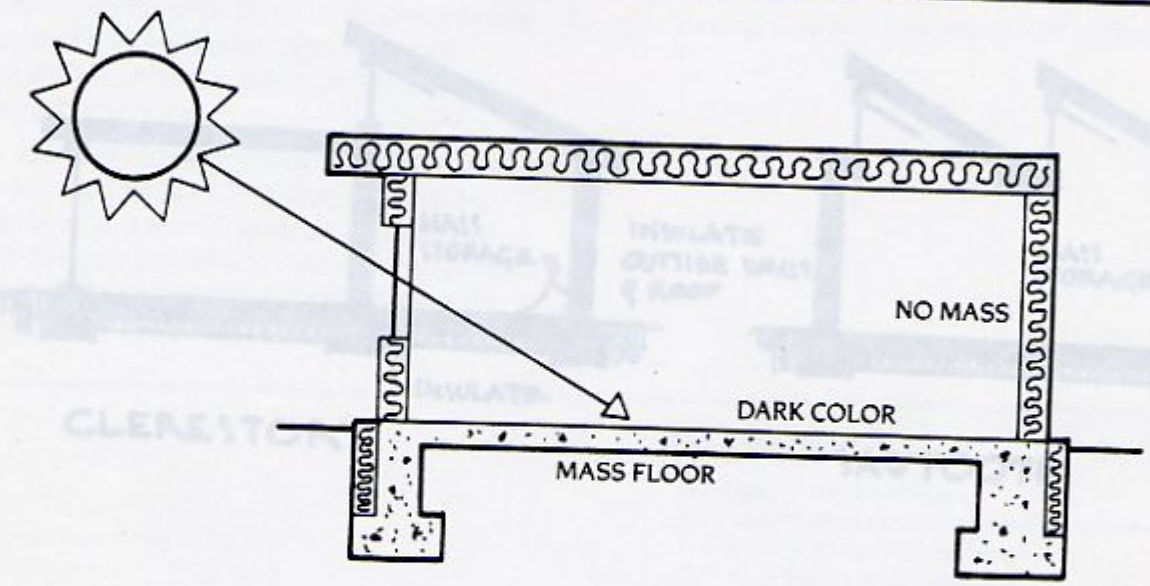
1) Properly sized overhang
2) Properly sized double pane glazing
3) R-30 to R-38 ceiling insulation
4) R-19 or better wall insulation
5) Masonry or water thermal storage
6) Foundation to support wall
7) Masonry floor
8) Perimeter insulation (2")
9) Radiant heat to space
10) Winter sun angle
11) Summer sun angle

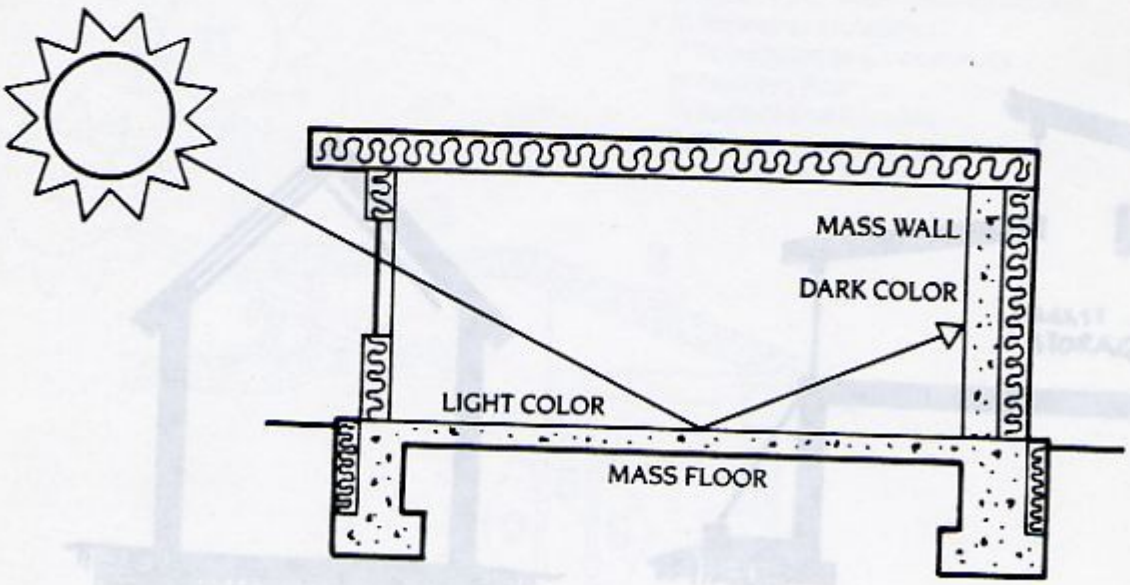


What About Interior Colors?

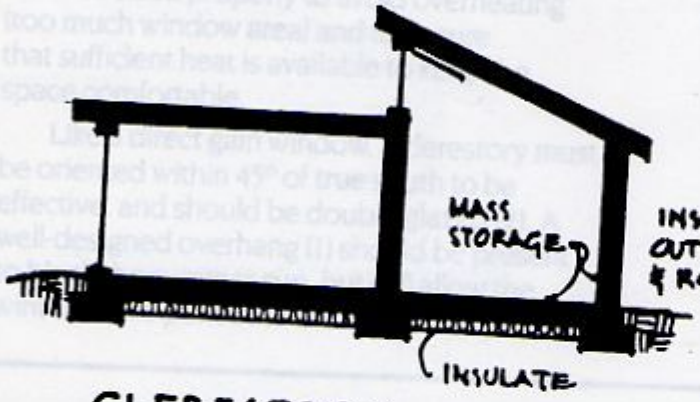
Interior colors can be used to increase the storage capabilities of thermal mass. If both the floor and the wall contain thermal mass (concrete, brick, adobe, etc.), the floor should be a light color to reflect the sun onto the back wall. The wall itself should be a dark color. This is especially important because the sun doesn't strike the wall directly.

The floor is generally the main storage component in a direct gain system. If the wall contains little or no mass and is not used for storage, the floor should be a dark color to absorb the maximum amount of energy. Carpets and furniture, which block the direct sun on the floor, can significantly reduce the storage capabilities of the thermal mass. If the room has little or no storage mass, only daytime heating will be possible. In that case, interior colors are not as important.

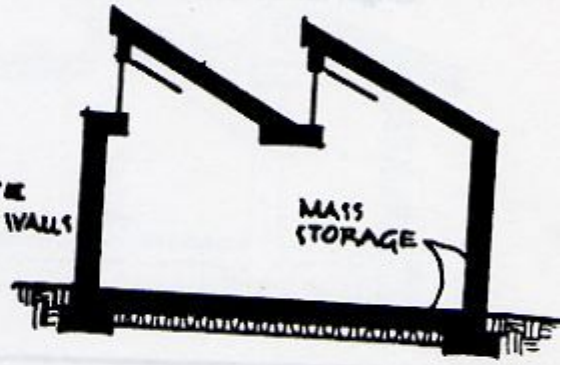




DIRECT GAIN VARIATIONS

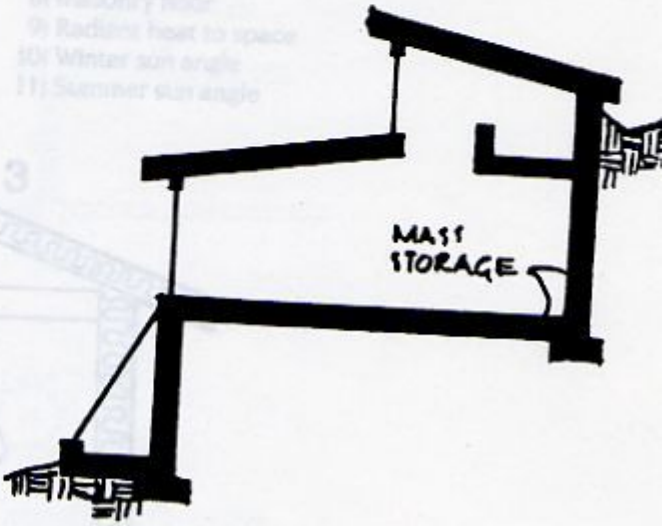


CLERESTORY



SAWTOOTH

PITCHED ROOF



STEPPED BACK

The Clerestory and Louvered Skylight

What Does It Look Like?

A clerestory is a direct gain window built into a wall which rises above an adjoining roof. As a passive solar device, it is used to bring the sun's energy to the north rooms of the house which do not normally receive direct sun.

The clerestory (2) is positioned so the winter sunlight strikes the rear wall of the rooms. If nighttime heating is desired, the wall should be constructed of a thermal mass material such as concrete, brick, adobe, or water. If thermal mass is not present in the rear wall, the clerestory will still provide natural lighting and daytime heating to the north rooms of a house. In either case, it must be sized properly to avoid overheating (too much window area) and to ensure that sufficient heat is available to keep the space comfortable.

Like a direct gain window, a clerestory must be oriented within 45° of true south to be effective, and should be double glazed (2). A well-designed overhang (1) should be present to block the summer sun, but still allow the winter sun to penetrate the space.

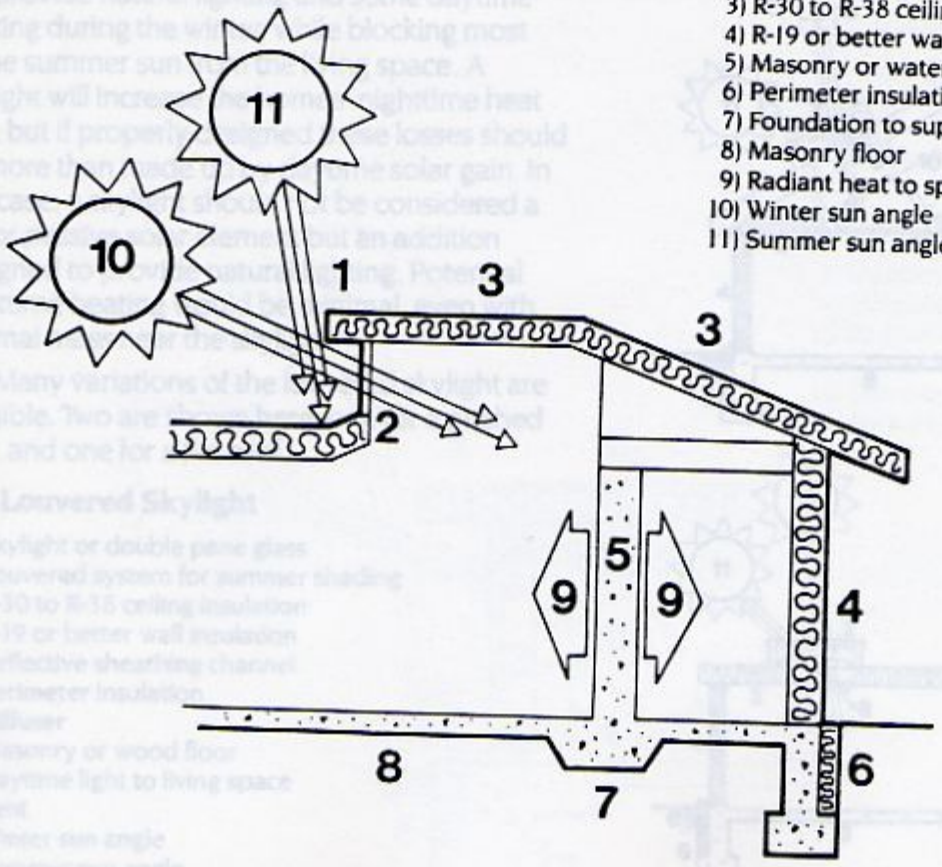
How Does It Work?

During the winter, the sun shines through the clerestory window and strikes the rear wall. If it is a thermal mass wall, part of the solar energy is absorbed for later use. After the sun goes down, the energy is radiated back to the living space as heat. The solar energy which does not strike the wall directly is either absorbed by other areas of thermal mass (the floors or other walls), or immediately turns to heat in the space.

Night insulation is recommended for use with clerestory windows. The heating performance of the system can be improved significantly by reducing the amount of heat which is lost back through the windows on winter nights.

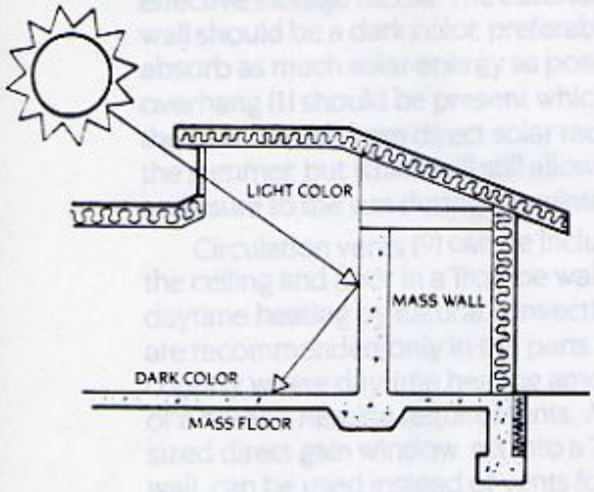
The Clerestory

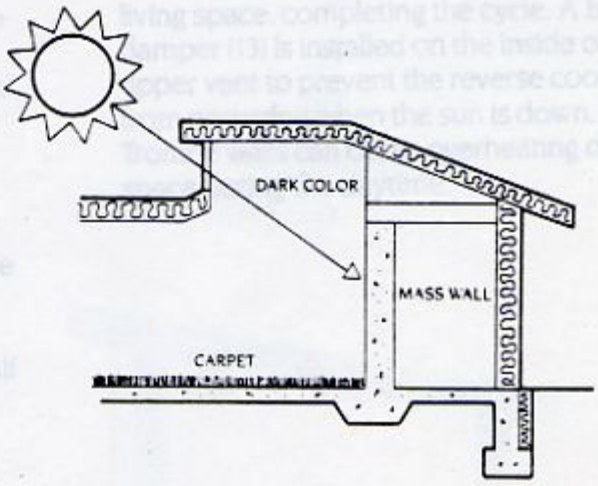
1) Properly sized overhang
2) Properly sized clerestory window (double pane)
3) R-30 to R-38 ceiling insulation
4) R-19 or better wall insulation
5) Masonry or water thermal storage
6) Perimeter insulation (2")
7) Foundation to support mass
8) Masonry floor
9) Radiant heat to space
10) Winter sun angle
11) Summer sun angle



What About Interior Colors?

A clerestory is different from a normal direct gain window because the primary storage area for a clerestory is the rear wall of a room, rather than a floor. With a clerestory, the rear wall should be a light color when both the wall and the floor are composed of mass. The light color will reflect part of the entering solar energy onto the dark-colored floor where it will be absorbed. When the rear wall is the only area of mass storage, it should be a dark color to absorb as much energy as possible. This also applies if the floor is fully carpeted, even though the floor itself may be concrete or brick. If little or no storage (mass) is present in the space, the clerestory will still provide some daytime heating and natural lighting. Interior colors, however, are less important.

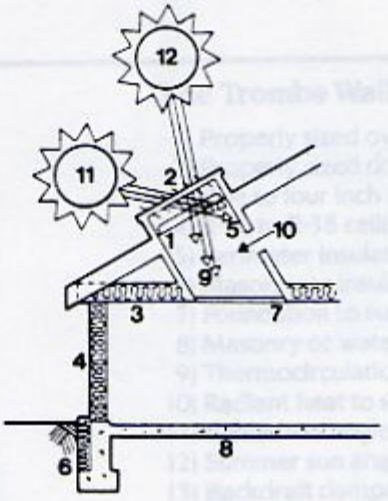


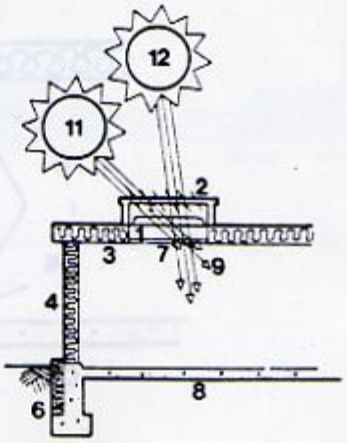


The Louvered Skylight

Unlike typical skylights, a louvered skylight will provide natural lighting and some daytime heating during the winter, while blocking most of the summer sun from the living space. A skylight will increase the homes' nighttime heat loss, but if properly designed these losses should be more than made up by daytime solar gain. In any case, a skylight should not be considered a major passive solar element but an addition designed to provide natural lighting. Potential nighttime heating would be minimal, even with thermal mass near the skylight.

Many variations of the louvered skylight are possible. Two are shown here: one for a pitched roof, and one for a flat roof.





The Louvered Skylight

1) Skylight or double pane glass
2) Louvered system for summer shading
3) R-30 to R-38 ceiling insulation
4) R-19 or better wall insulation
5) Reflective sheathing channel
6) Perimeter insulation
7) Diffuser
8) Masonry or wood floor
9) Daytime light to living space
10) Vent
11) Winter sun angle
12) Summer sun angle

The Trombe Wall and Water Wall

What Does It Look Like?

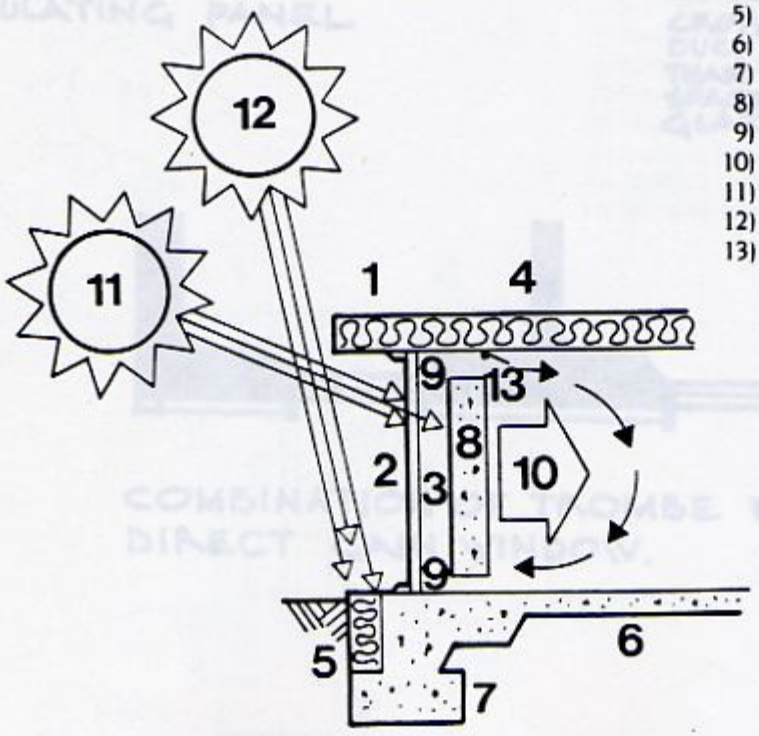
From the outside, a Trombe wall looks like a large window with a wall right behind it. Actually, it's not a window at all. A Trombe wall is a thermal mass wall (8) covered by some type of glazing (2). An air space (3), one to four inches deep, separates the glazing from the wall. The thermal mass wall can be constructed from concrete, brick, water or a number of other effective storage media. The exterior of the wall should be a dark color, preferably black, to absorb as much solar energy as possible. An overhang (1) should be present which will block the Trombe wall from direct solar radiation in the summer, but which will still allow full exposure to the sun during the winter.

Circulation vents (9) can be included near the ceiling and floor in a Trombe wall to provide daytime heating by natural convection. Vents are recommended only in the parts of the country where daytime heating amounts to half of a home's heating requirements. A properly sized direct gain window, set into a Trombe wall, can be used instead of vents for daytime heating in any climate. A Trombe wall without vents is referred to as a stagnating Trombe wall because air does not circulate.

How Does It Work?

Trombe Wall

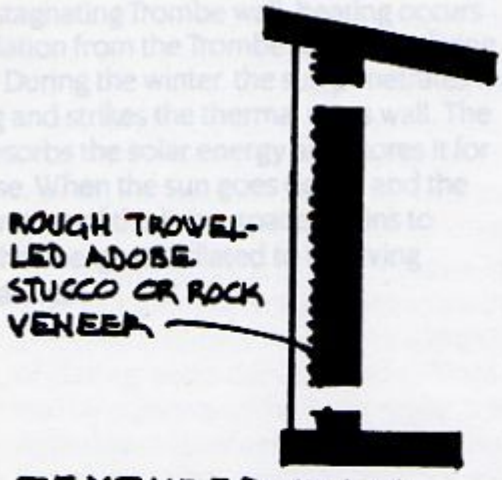
When vents are used, heating occurs both by convection (daytime) and radiation (nighttime). When the sun shines on a vented Trombe wall, the air next to the dark-colored wall heats up, becomes buoyant and rises up the wall, where it enters the living space throu the upper vent. Replacement air from the hou is drawn into the bottom vent, rises as it is warmed by the wall, and then re-enters the living space, completing the cycle. A backdra damper (13) is installed on the inside of the upper vent to prevent the reverse cooling cy from occurring when the sun is down. Vented Trombe walls can cause overheating of the space during the daytime.



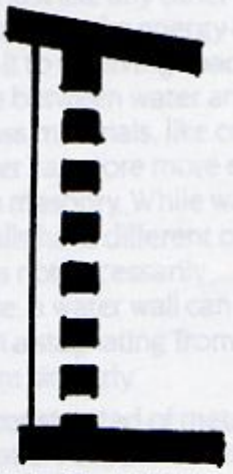
The Trombe Wall

1) Properly sized overhang
2) Properly sized double pane glazing
3) One to four inch air space
4) R-30 to R-38 ceiling insulation
5) Perimeter insulation (2")
6) Masonry or insulated frame floor
7) Foundation to support mass
8) Masonry or water thermal storage
9) Thermocirculation vents (optional)
10) Radiant heat to space
11) Winter sun angle
12) Summer sun angle
13) Backdraft damper

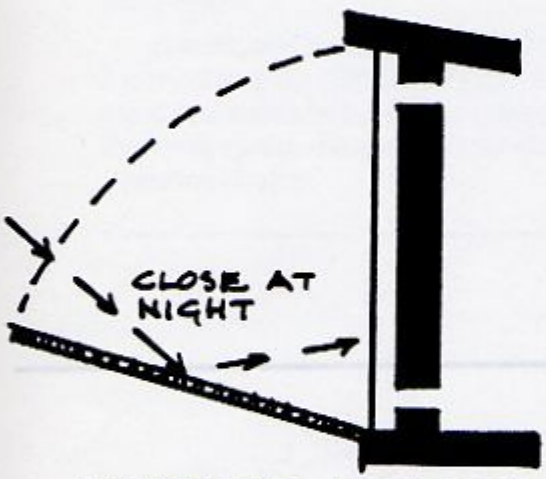
TROMBE VARIATIONS



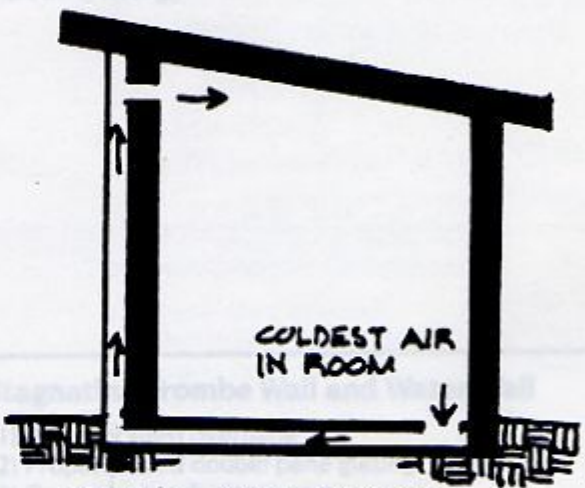
TEXTURED WALL



PERFORATED WALL



MOVEABLE REFLECTIVE
INSULATING PANEL



COLD AIR DUCTS

CROSS SECTIONAL AREA OF DUCT SHOULD BE MUCH LARGER THAN CROSS SECTIONAL AREA OF SPACE BETWEEN WALL AND GLAZING

COMBINATION OF TROMBE WALL AND
DIRECT GAIN WINDOW.

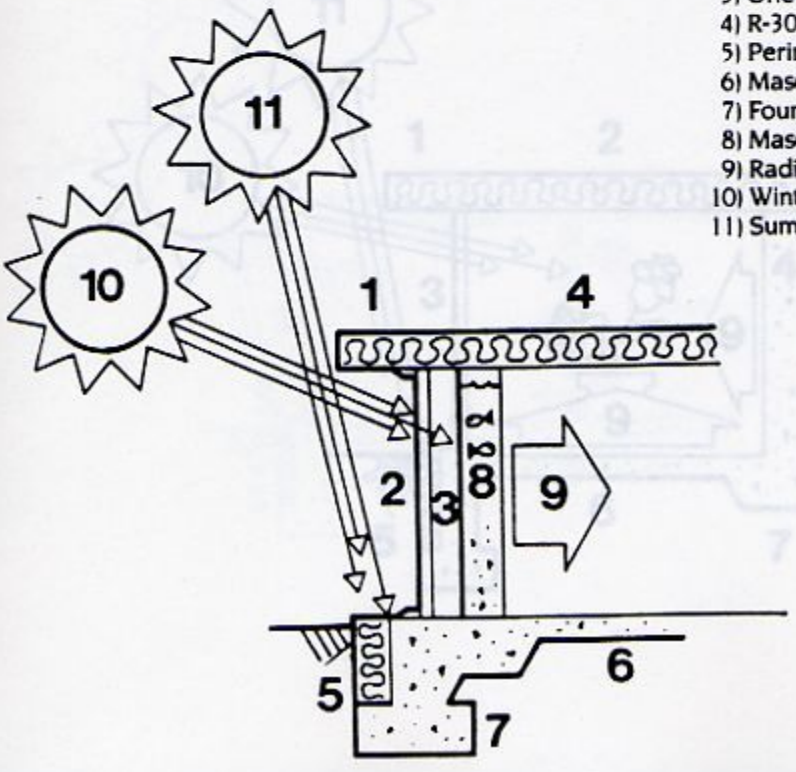
Stagnating Trombe Wall

In a stagnating Trombe wall, heating occurs by radiation from the Trombe wall to the living space. During the winter, the sun penetrates the glazing and strikes the thermal mass wall. The wall absorbs the solar energy and stores it for later use. When the sun goes down, and the temperature of the living space begins to drop, the energy is radiated to the living space as heat.

What About Water Walls?

A water wall acts just like any other type of thermal mass wall that absorbs energy during the day and radiates it to the living space at night. One difference between water and masonry thermal mass materials, like concrete or adobe, is that water can store more energy per unit volume than masonry. While water walls and Trombe walls have different operating characteristics, one is not necessarily preferable. Otherwise, a water wall can be used interchangeably with a stagnating Trombe wall because they perform similarly.

Water walls are constructed of metal or plastic containers that are separated into compartments. The outside surface of the wall should be painted black to help absorb the sun's energy.



Stagnating Trombe Wall and Water Wall

1) Properly sized overhang
2) Properly sized double pane glazing
3) One to four inch air space
4) R-30 to R-38 ceiling insulation
5) Perimeter insulation (2")
6) Masonry or insulated frame floor
7) Foundation to support mass
8) Masonry or water thermal storage
9) Radiant heat to space
10) Winter sun angle
11) Summer sun angle

Sunspace or Greenhouse

What Does It Look Like?

Most people are familiar with a greenhouse. The most common feature is a large expanse of south-facing glazing (3), either glass or plastic. The presence of other components in a sunspace or greenhouse will depend on how it is to be used. Will it be used mainly to supplement the heating needs of the home, will it be used to grow plants and food, or a combination of both?

When heating is its only function, this passive solar component is referred to as a sunspace. The ideal sunspace consists of a large expanse of glazing, and a dark-colored thermal mass wall (4) adjacent to the living space. It is also desirable to have a mass floor (6) to maximize the storage area, although the floor will act only to keep the sunspace warm, and will not contribute to the heating needs of the living space.

A sunspace becomes a greenhouse when it is used to grow plants and food. If a thermal mass wall exists between the greenhouse and the living space, the greenhouse doubles as a heating device.

In New Mexico, a greenhouse or sunspace should be designed with vertical glazing. Tilted glazing is not recommended. Greenhouses and sunspaces frequently contain tilted glass, either from the ground up, or just on the roof portion. Tilted glazing is used to increase the effective solar collection area of the space. This can cause extreme overheating when the sun is high overhead during the summertime, and significant heat loss at night during the winter. * Tilted glazing is only recommended for use in specially-designed hybrid passive solar greenhouses. Consult with PNM or another qualified expert before incorporating such a design into your home.

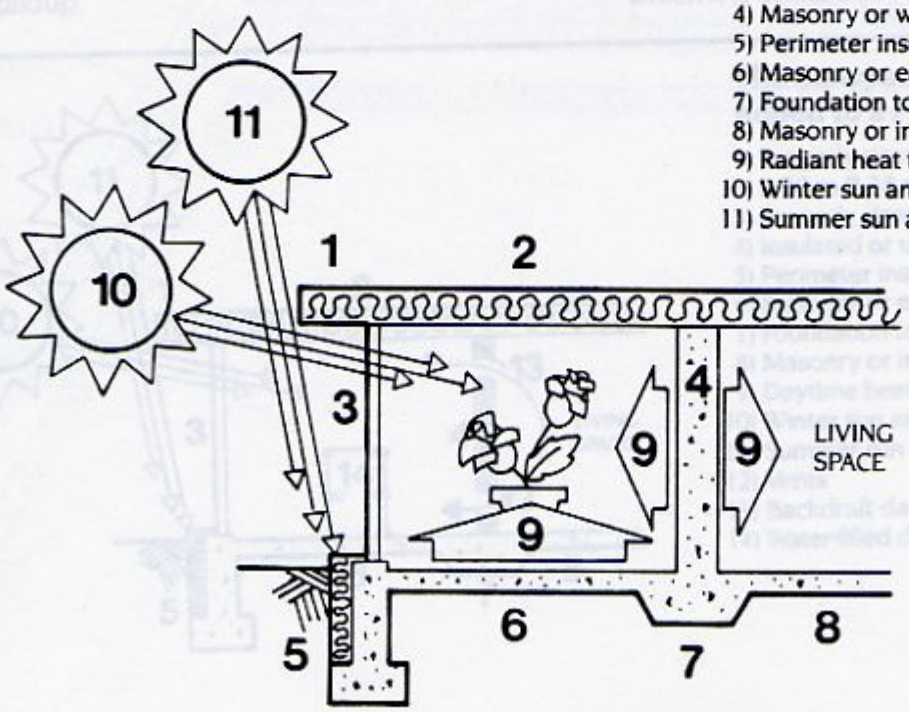
With the sizing procedures outlined in this brochure, however, you can easily design a greenhouse or sunspace with vertical glazing which will supply all the heat you need.

* Roof Glazing for:
1) Plants
2) Maximum Solar Collection
3) To see stars, moon, clouds, etc.

* Many shading options are available.

The Sunspace or Greenhouse

1) Properly sized overhang
2) R-30 to R-38 ceiling insulation
3) Properly sized vertical double pane glazing
4) Masonry or water thermal mass
5) Perimeter insulation (2")
6) Masonry or earth floor
7) Foundation to support mass
8) Masonry or insulated frame floor
9) Radiant heat to space
10) Winter sun angle
11) Summer sun angle



How Does It Work?

As a heating device in combination with a mass wall, the sunspace or greenhouse operates very much like a Trombe wall. During the winter, sun enters the space and is absorbed by the thermal mass in the wall. After the sun goes down and the living space begins to require heat, the thermal mass wall radiates energy to the living space, and also back into the greenhouse to help maintain a suitable temperature for growing plants. If the floor is also composed of mass, it will radiate its stored energy directly to the greenhouse at night to warm the plants. The floor does not supply any heating to the house itself; it is used only to temper the greenhouse environment.

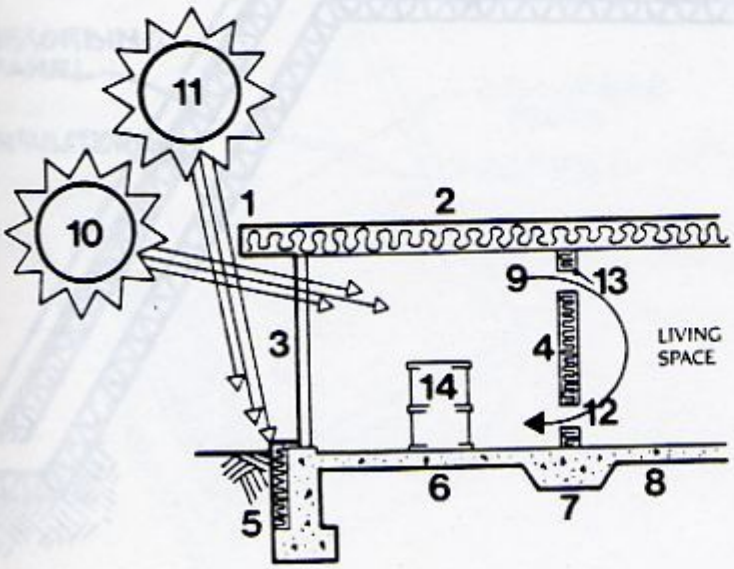
Because the large expanse of glazing present in a sunspace or greenhouse causes the space to have a wide swing in temperature (from very hot during the day to very cold at night), a sunspace/greenhouse is usually not considered a normal living space. Additional thermal mass, in the form of water barrels, can be placed in the greenhouse, if the space cannot maintain enough warmth for plants. East and west glazing is usually nonexistent, or kept to a minimum. For summertime operation, provide adequate natural ventilation of the greenhouse or sunspace to prevent excess heat buildup.

What About Adding a Greenhouse to a Frame Wall?

A greenhouse will work best for heating if the wall between the greenhouse and the living space is a thermal mass wall (concrete, water, adobe, etc.). If this wall is not a mass wall, very little solar energy will be absorbed and transmitted to the house.

Vents can be cut through the wall near the ceiling and floor to provide some daytime heating by natural convection. At night, however, the greenhouse will not supply heat to the house through these vents because the greenhouse air temperature drops below the inside house temperature. In fact, the house will lose heat rapidly to the greenhouse if the vents do not have backdraft dampers. Backdraft dampers are used to prevent the reverse (cooling) cycle from occurring. If there is a door between the greenhouse and the living spaces, it can be opened to provide daytime heat (and eliminate the need for vents).

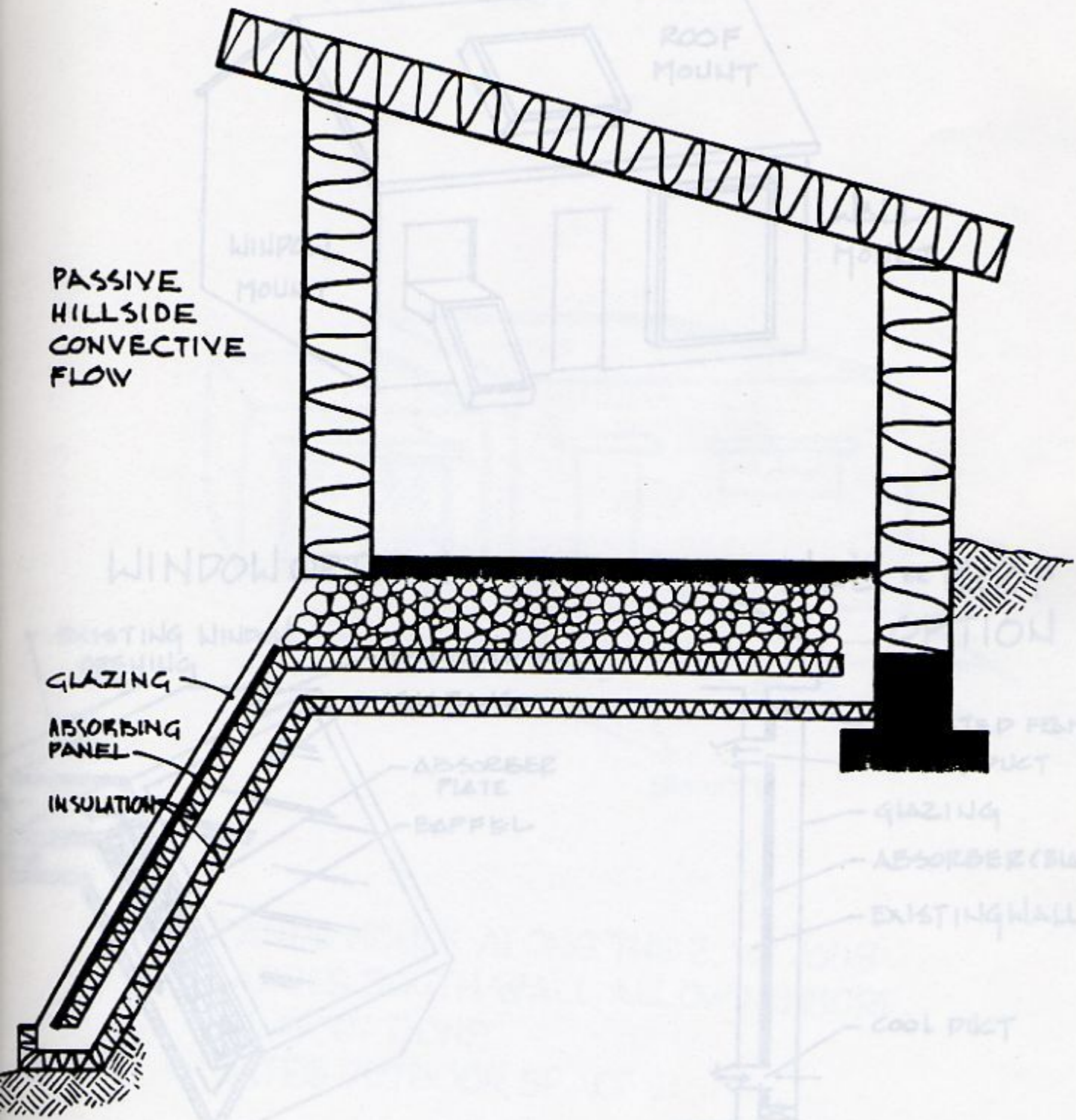
Whether or not heating is desired from the greenhouse, it can be used to grow plants throughout the year if enough mass is present in the floor, or if there is other mass present (water barrels) to keep the space warm enough to protect plants on a winter night. It will also help reduce the heat loss through the wall to which it is attached.



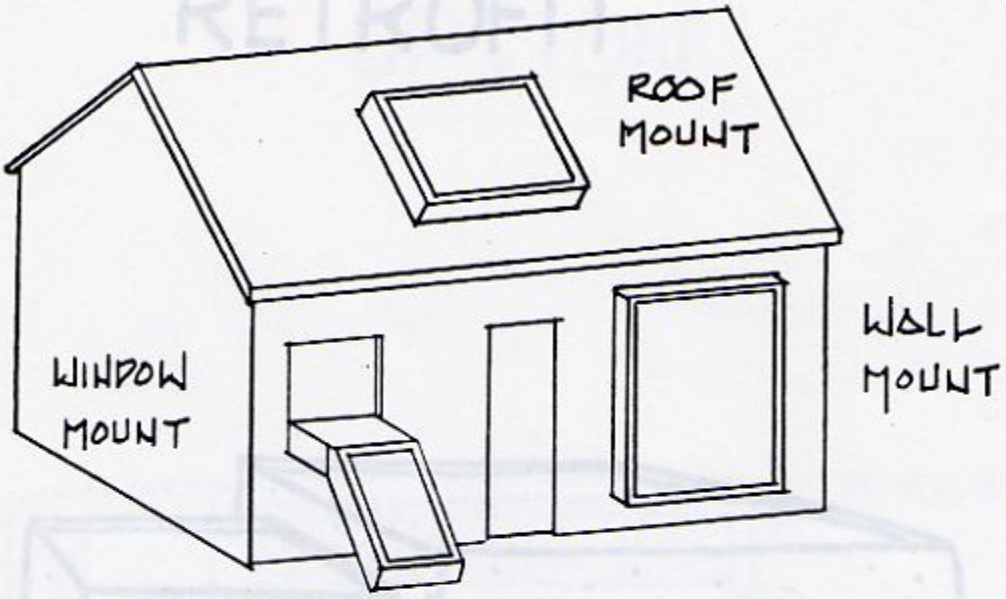
The Sunspace or Greenhouse Added to a Frame Wall

1) Properly sized overhang
2) R-30 to R-38 ceiling insulation
3) Properly sized vertical double pane glazing
4) Insulated or uninsulated wood frame wall
5) Perimeter insulation (2")
6) Masonry or earth floor
7) Foundation to support mass
8) Masonry or insulated frame floor
9) Daytime heat to space
10) Winter sun angle
11) Summer sun angle
12) Vents
13) Backdraft damper
14) Water-filled drums for added mass

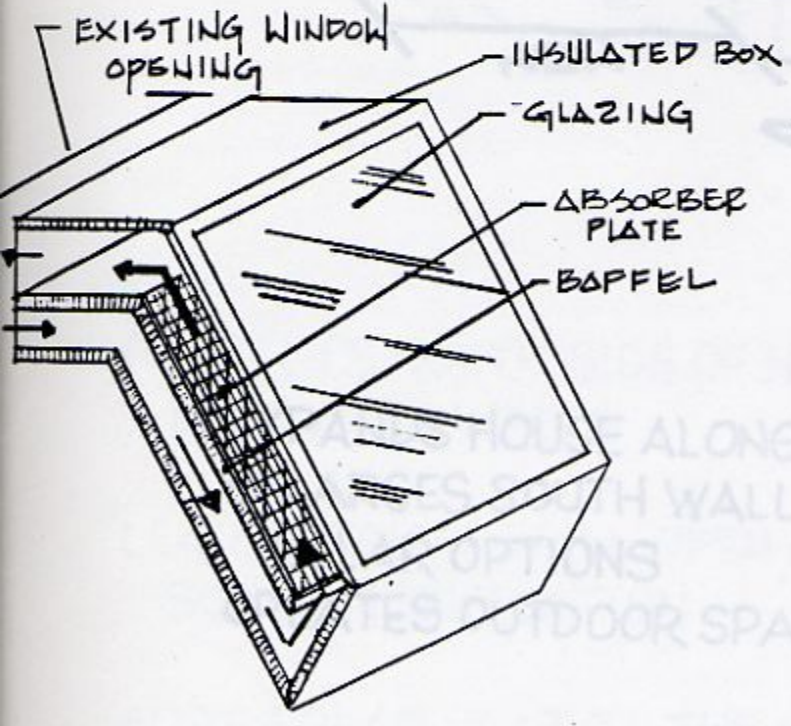
GLAZED COLLECTOR



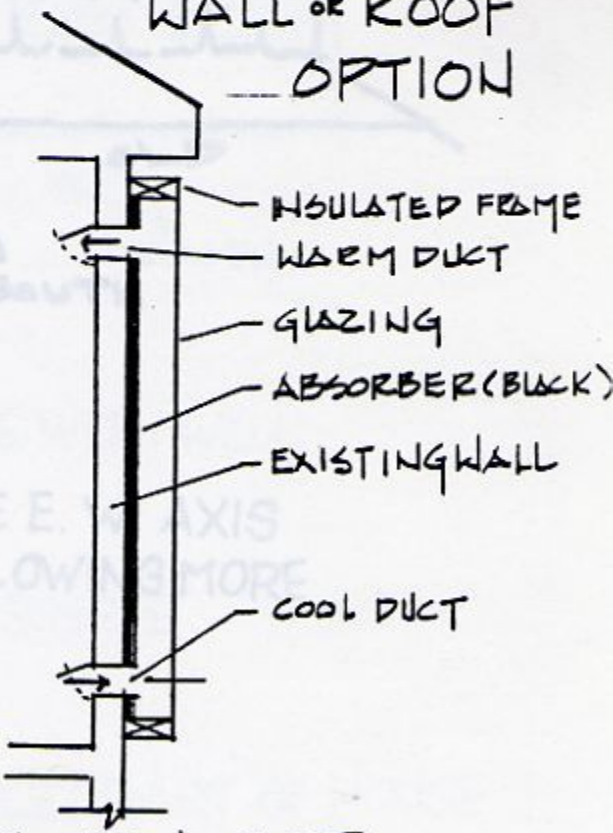
SIMPLE AIR COLLECTOR OPTIONS



WINDOW OPTION

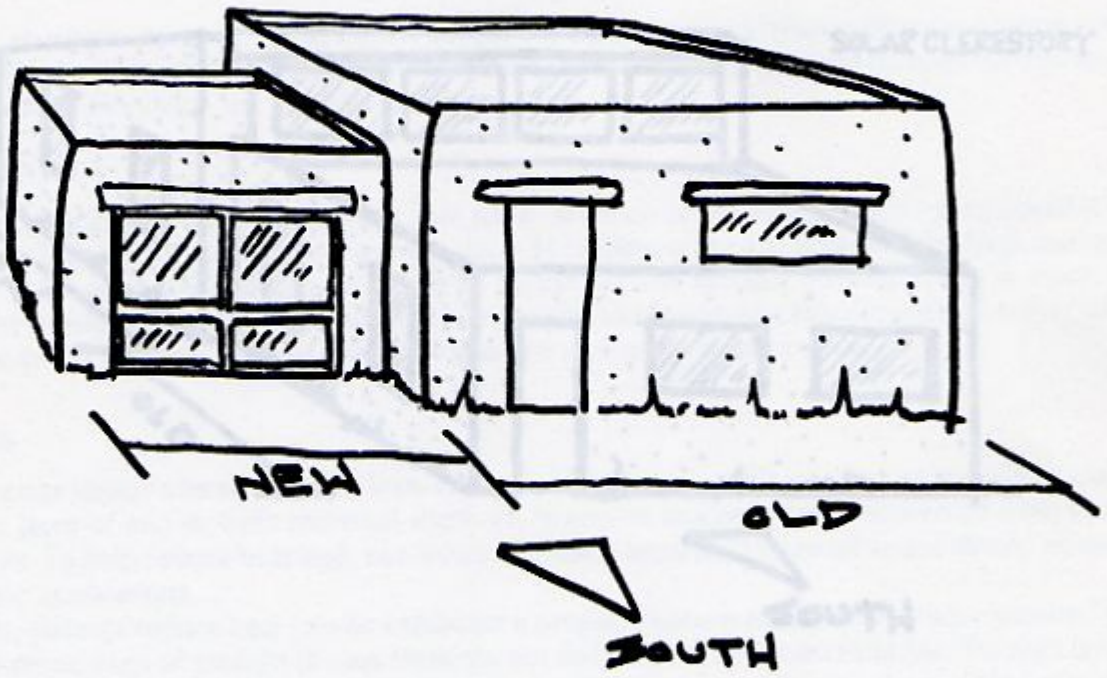


WALL OR ROOF OPTION



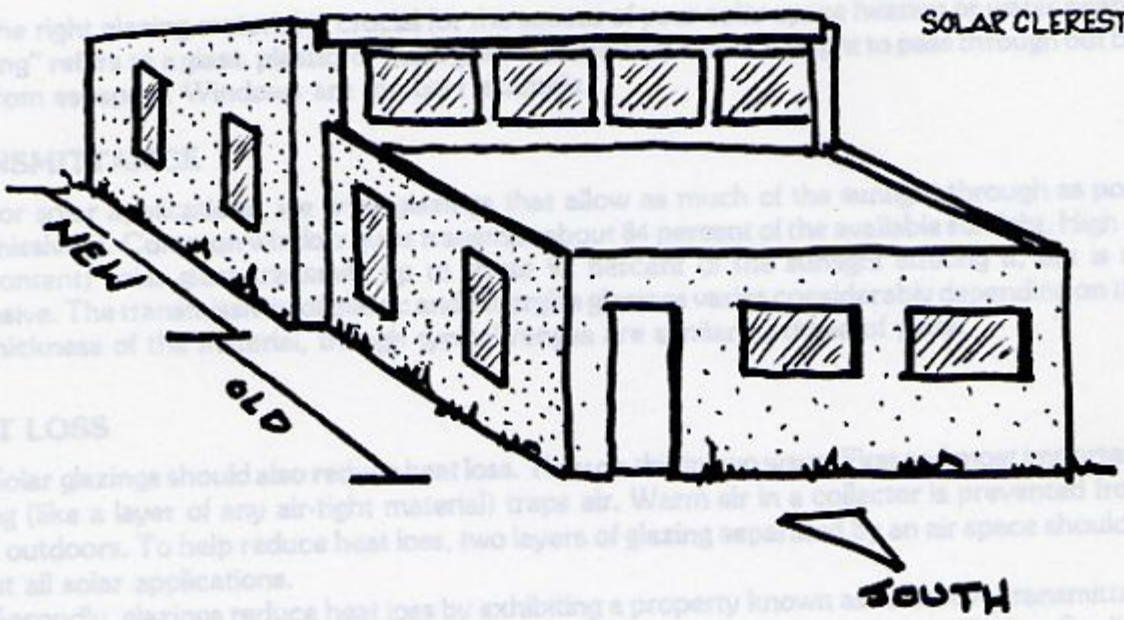
NATURAL CONVECTIVE LOOP

EAST OR WEST SIDE RETROFIT



EXPANDS HOUSE ALONG THE E. W. AXIS
ENLARGES SOUTH WALL ALLOWING MORE SOLAR OPTIONS
CREATES OUTDOOR SPACES

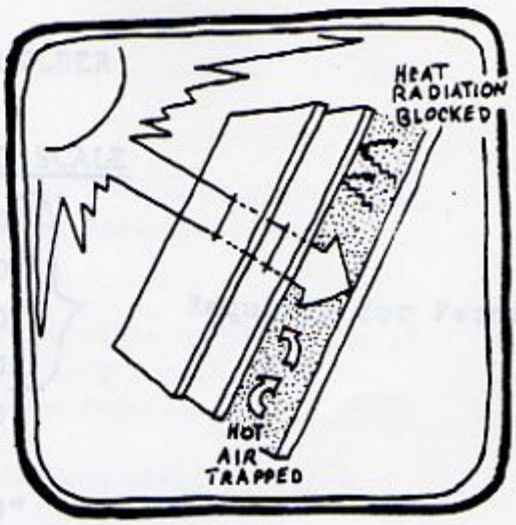
NORTHSIDE SOLAR RETROFIT OPTION



PROTECTS NORTH SIDE OF HOUSE WITH WELL INSULATED WALLS.

LEAVES SOUTH WALL OPEN FOR SIMPLE SOLAR MODIFICATION

ADDS SOLAR HEAT TO THE COLDEST PART OF HOUSE



Solar Glazing Materials

The right glazing material is crucial for the succes of your solar space heating or water heating system. "Glazing" refers to a glass, plastic, or Fiberglass material that allows sunlight to pass through but blocks most heat from escaping. Windows are the best example.

TRANSMITTANCE

For solar applications, we want glazings that allow as much of the sunlight through as possible (high transmissivity). Common window glass transmits about 84 percent of the available sunlight. High quality (low iron content) solar glass transmits up to about 92 percent of the sunlight striking it, but is much more expensive. The transmissivity of plastic and Fiberglas glazings varies considerably depending on the make-up and thickness of the material, though typical ranges are similar to those of glass.

HEAT LOSS

Solar glazings should also reduce heat loss. They do this in two ways. First and most important, a layer of glazing (like a layer of any air-tight material) traps air. Warm air in a collector is prevented from escaping freely outdoors. To help reduce heat loss, two layers of glazing separated by an air space should be used for almost all solar applications.

Secondly, glazings reduce heat loss by exhibiting a property known as "selective transmittance." Glass allows a large percentage of sunlight to pass through, but does not transmit heat radiation. Sunlight is mostly short wavelength light. When this light is absorbed by a surface in your collector, the surface heats up and begins to radiate heat. This heat being radiated is long wavelength or infrared (IR) light. Instead of transmitting this heat radiation, most glazings *absorb* it. In this way, much of the escaping heat is trapped—a principle known as the *greenhouse effect*. Most of the plastic films, like polyethylene, allow heat radiation to pass right through.

LONGEVITY

How long the glazing material on your solar greenhouse, Trombe wall, or solar water heater will last is important also. Glass is the most durable of solar glazings, —as long as it isn't broken. This is often a significant problem. Plastic glazings tend to yellow or break down when exposed to sunlight for a period of years. The high energy ultraviolet rays in sunlight are very harmful to all plastics. In recent years, however, many new plastic glazings have been developed by such companies as DuPont, Rohm & Haas, Monsanto, 3M, and CY/RO that hold up much better under continuous exposure to sunlight.

RECOMMENDED DRAWINGS FOR THE OWNER-BUILDER

DRAWING	RECOMMENDED SCALE	
Site Plan	1/8" = 1'0"	Required for Permit
Floor Plan	1/4" = 1'0"	
Elevations	1/4" = 1'0"	
Sections	3/8" = 1'0"	
Ceiling Plan	1/4" = 1'0"	
Schedules	No Scale	
Interior Elevations	3/8" = 1'0"	
Details	1½" = 1'0"	
Electrical Plan	1/4" = 1'0"	

Site Plan

Things to include:

1. Property lines — show property boundries and label lines with meets and bounds (legal description) show easements.
2. Building location - Locate proposed constructions with respect to property lines or existing structures. Use dimension lines to show location.
3. Setbacks - Show required setbacks and check building location.
4. Utility lines - Show existing and new lines which may be required. These may include: water, electric, sewer or septic, gas, telephone, cable TV.
5. Site Grading - Use contour lines to show new and existing grades. Show spot elevations at building corners and finish floor levels at buildings. Indicate direction of drainage.
6. Existing site features - Show existing structures, fences, walls, paving, and large trees.
7. Sitework and landscaping - Show proposed driveways, walks, patios, landcape walls, (patio or retaining), fences, trees, and vegetation.
8. Septic and Well - Identify whether new or existing. Check clearances.
9. Streets and Roads - Show street names.
10. Roof drainage - Indicate direction of pitch
11. Notes - Give lot identification and size
12. Titles - Project name, drawing name and number, scale, north arrow, date.

FLOOR PLAN

Things to be shown:

1. Walls - Distinguish between existing walls, new walls, walls to be removed, walls of differing construction (ie. frame/adobe). Draw wall thickness to scale

2. Doors - Indicate direction of swing. Door sizes may be noted on the plan or listed in a separate schedule.

3. Windows - Window sizes may be noted on the plan or listed in a separate schedule.

4. Dimensions - Use dimension lines to locate all walls, doors, and windows. Check all strings of dimensions against the total.

5. Section lines - Cross reference sections to floor plan.

6. Room names

7. Steps - Show all stairs, steps, and changes in floor plan.

8. Finish Floor Hights

9. Miscellaneous - Show fireplace, woodstoves, cabinets and built-ins, bathroom fixtures, kitchen and laundry appliances, mechanical equipment (water heater, boiler or furnace)

10. Note - Identify and cross reference items on the floor plan as needed. General notes may be listed in a column off to the side. Indicate square footage.

11. Title - Project name, drawing name and number, scale, north arrow, date.

ELEVATIONS

1. Materials - call out all exterior finishes.
2. Doors and windows - swings may be indicated.
3. Finish grade - Heavy line
4. Finish floor - Dashed line
5. Foundations below grade - dashed lines
6. Show canales and gutters
7. Title - Project name, drawing name, elevation identifications (north, south, east, west) scale, date.

SECTIONS

1. Cut items - Draw foundations, floors, walls, and roofs, cut through by the section. Show exterior finish grades.
2. Elevation items - Show items beyond the cut (lighter)
3. Dimensions - Show hights of finish floors, limtels, top of walls, top of parapets. Show depth of foundations.
4. Notes - Call out all materials. Note R-values of insulation. Call out size and spacing of structural members. Cross reference larger scale details.
5. Title - Project name, drawing name, and number, section numbers, scale, date.

CEILING PLAN

1. Walls and posts - Draw lightly

2. Beams and girders - call out sizes, check spans.

3. Viga ceilings - Show size, spacing, and location of all vigas. Indicate type of decking or latillas. Show overhangs.

4. Frame ceilings - Show size and spacing of joists and rafters. Call out ceiling materials. Show overhangs.

5. Headers and lintels - Indicate and call out sizes.

6. Roof penetrations - Show skylights, chimneys, stovepipes, flus.

7. Check all spans - Use a span table or consult an engineer or architect. Don't skimp here.

8. Notes - Cross reference any details.

9. Title - Project name, drawing name and number, scale, north arrow, date.

SCHEDULES

Door schedule - Give size (hight, width, thickness), type of door, (hollow core, solid core, panel, etc.), call out hardware, weatherstripping, and thresholds. Cross reference door details.

Window schedule - Type and size. Cross reference window details.

Finish schedule - Materials, finish and colors for walls, floors and ceilings at each room.

Appliance schedule - Call out appliances. Note power or plumbing requirements.

Plumbing schedule - Call out all plumbing fixtures.

Titles - Project name, drawing name and number, schedule names, dates.

INTERIOR ELEVATIONS

1. Cabinets - Show layout for all cabinets. Show door swings.

2. Other - Show other special features, (ie. fireplaces, wall tile, etc.) which require elevations for clarity. Don't forget that some elevations may be shown on the sections.

3. Cross reference - Key interior elevations by cross referencing the floor plan.

4. Titles - Project name, drawing name and number, elevation numbers, scale, date.

DETAILS

1. Door Details - Head, Jamb, and sill

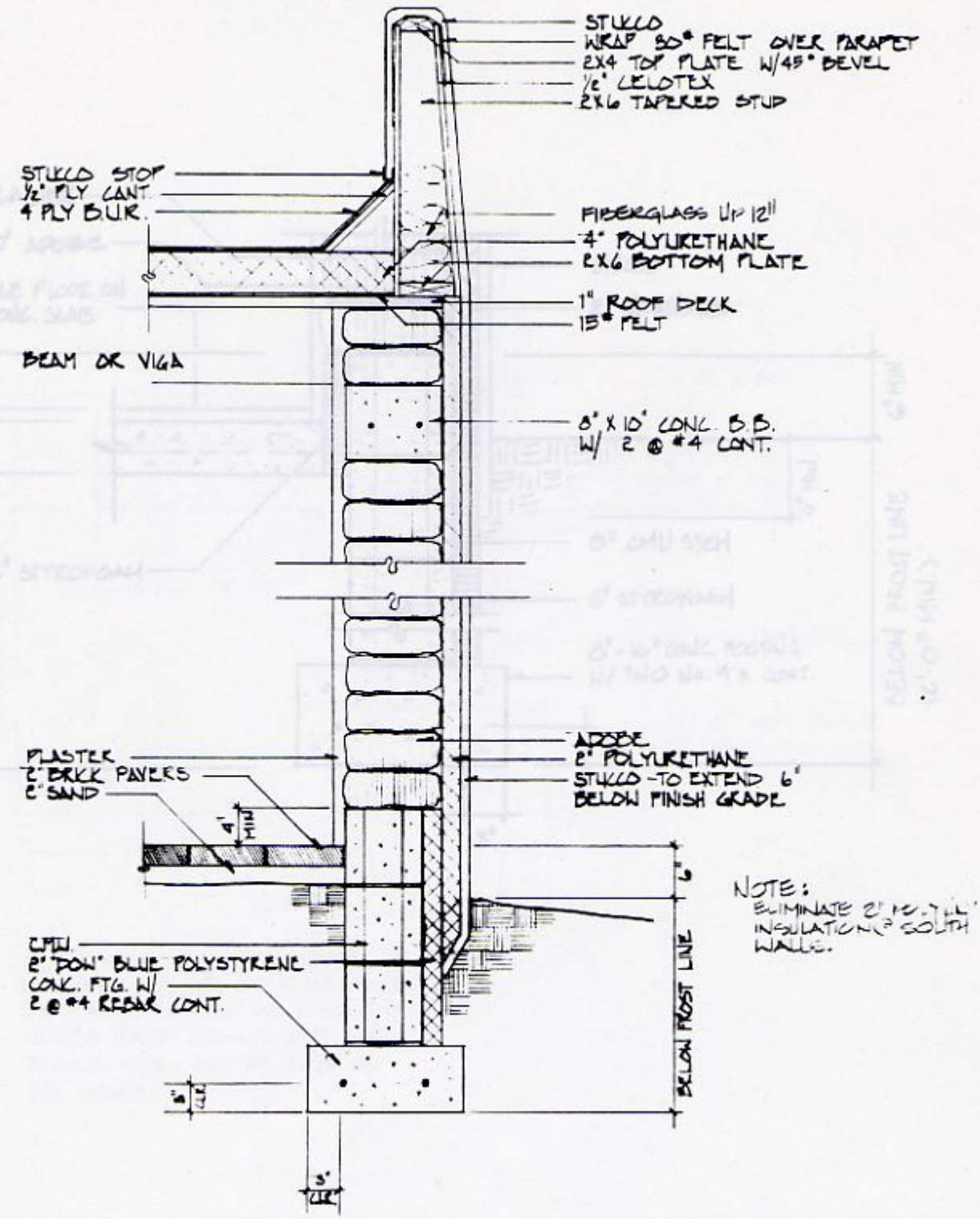
2. Window details - Head, jamb, and sill

3. Fireplace details - These may include: special framing connections, corbell layouts, cabinet sections, stair sections, and other special items. All details should be cross referenced to the floor plan, sections or interior elevations.

5. Titles - Project name, drawing name and number, detail number, scale, date.

ELECTRICAL

1. Floor Plan - Show walls, doors and swings, windows, drawn lightly.
2. Panel and meter - Show locations
3. Outlets - Show locations and type (standard duplex, 220v., waterproof outlets)
4. Lighting Fixtures - Show locations and type
5. Switches - Show location, type (standard, dimmer, 3-way), and connect to fixtures.
6. Appliances - Show hook-up locations and power requirements.
7. Equipment - Show hook-up locations and power requirements.
8. Telephone - Show locations of outlets.
9. Misc. - Show locations and types of fans, electric, heaters, smoke detectors, T-V Hook-ups, telephone, alarms, etc.
10. Symbols legend
11. Title - Project name, drawing name and number, scale, date.



4/4

TYP. ADOBE WALL SECTION

SC: 3/4" = 1'-0"

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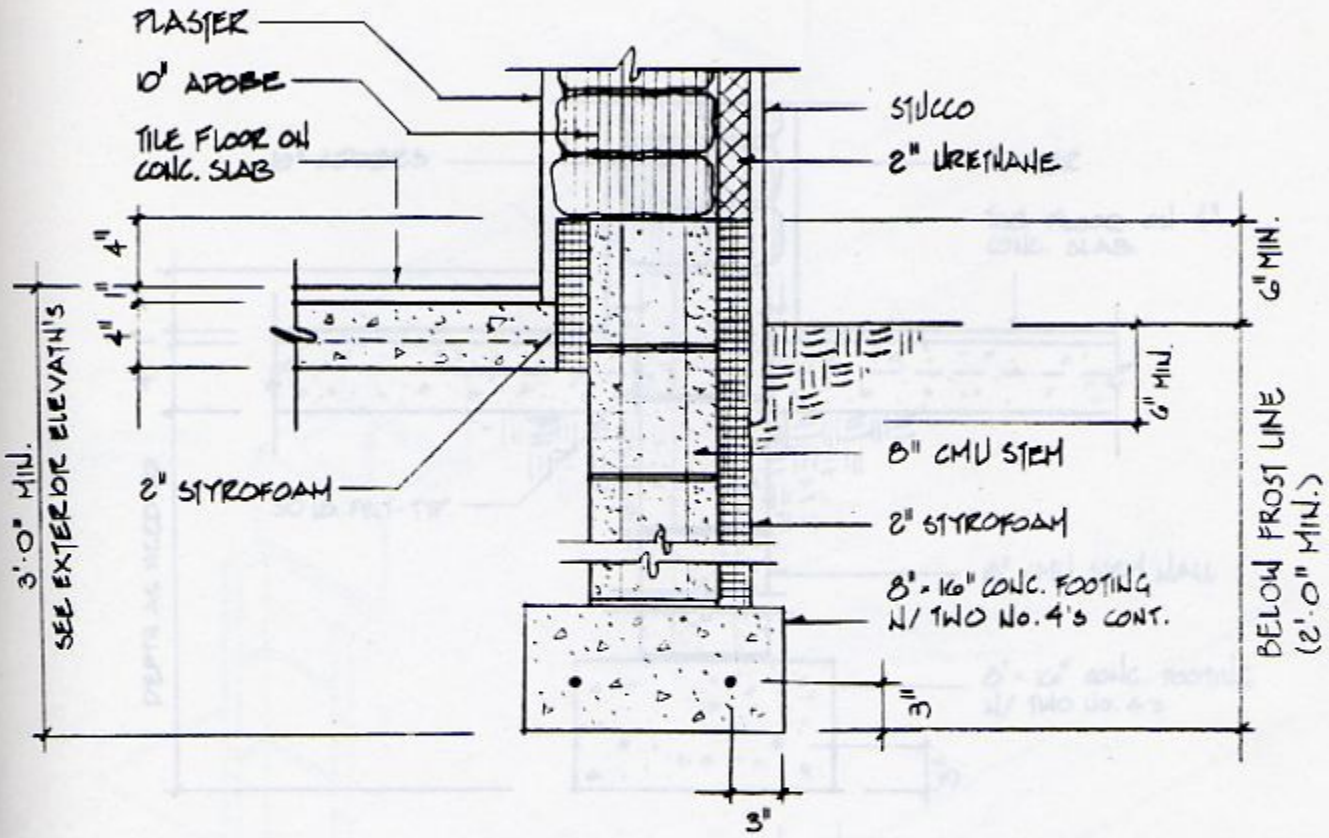

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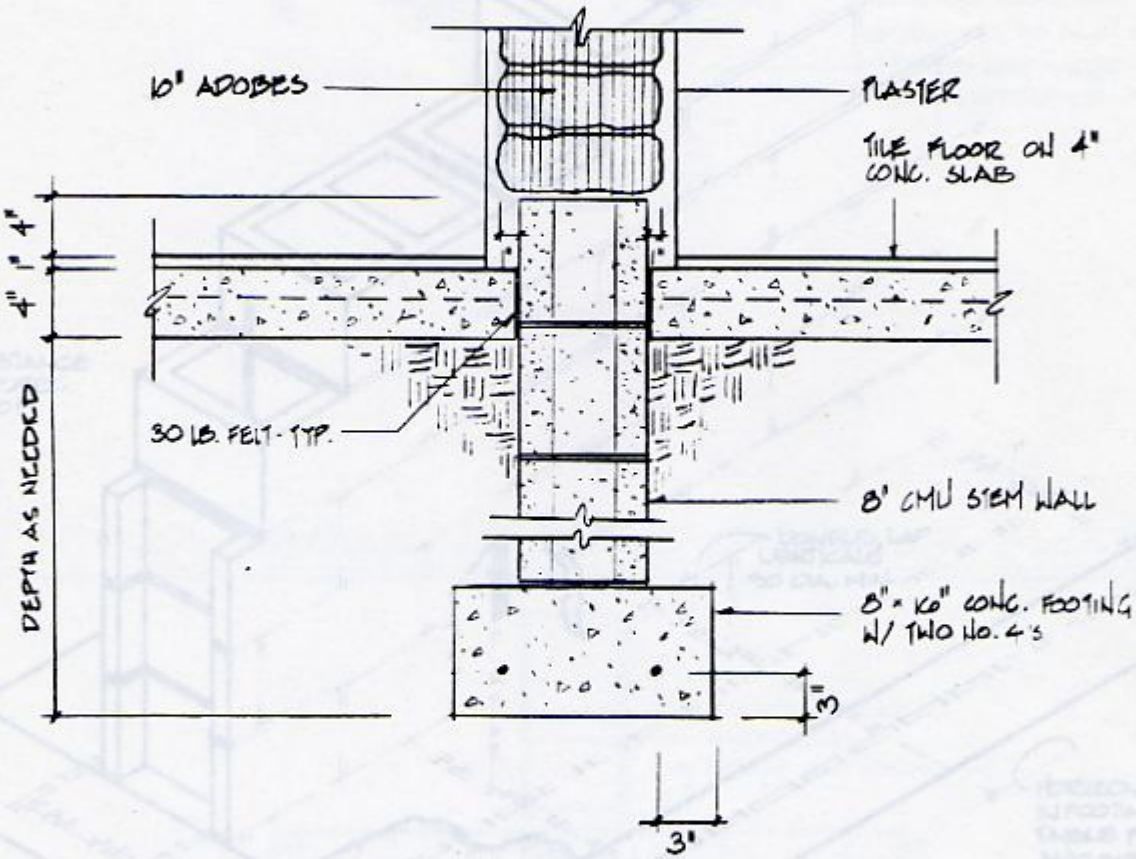
FOUNDATION @ EXTERIOR ADOBE WALL

SC: 1" = 1'-0"

1/4



NOTE: IN THE CASE OF AN EXTERIOR WALL CONTINUING INTO THE INTERIOR AND BECOMING AN INTERIOR WALL, THE ADOBE WOULD REMAIN CANTILEVERED TO ONE SIDE AND BE FLUSH ON THE OTHER.

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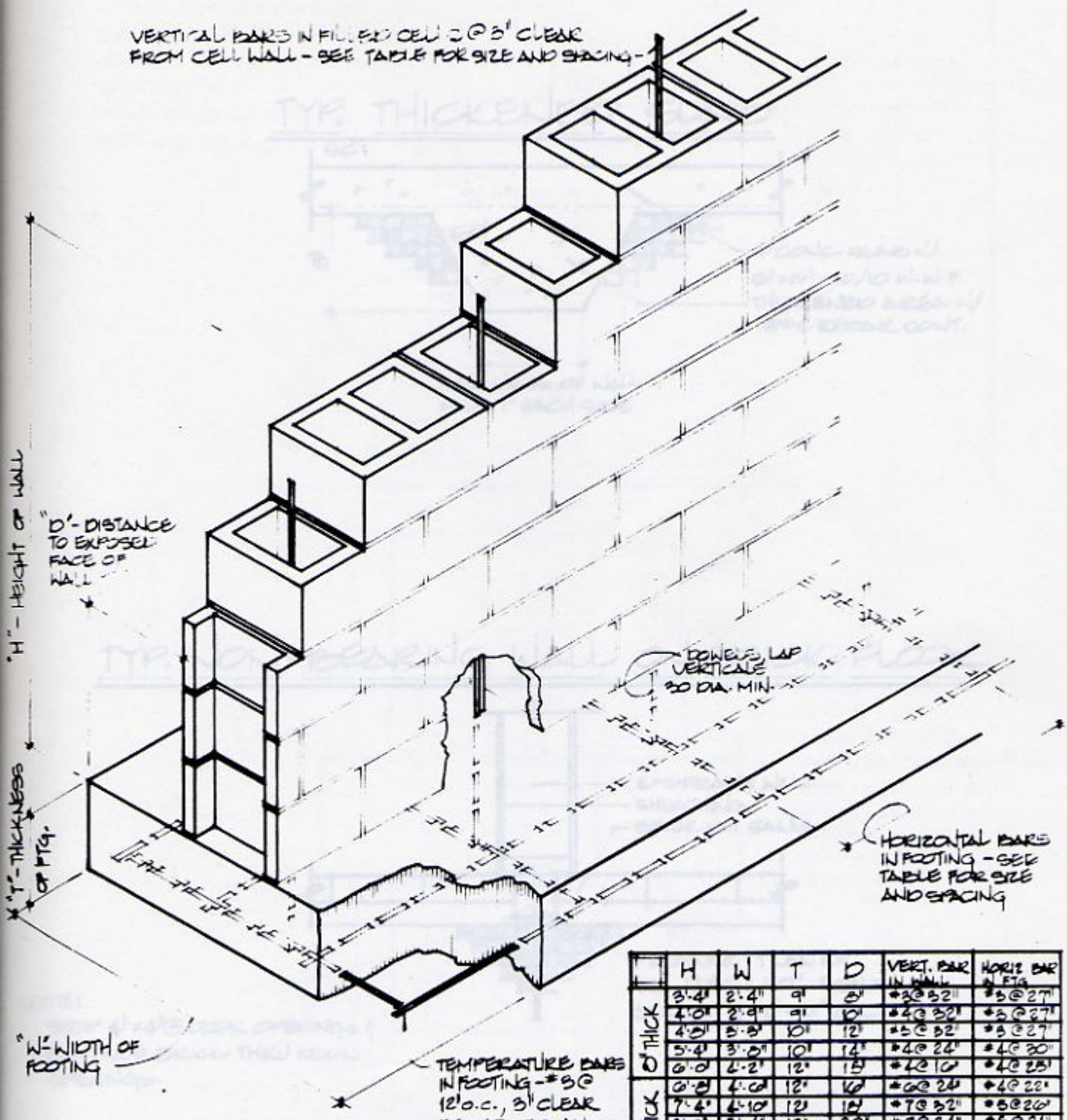
FOUNDATION @ INTERIOR ADOBE WALL

SC: 1" = 1'-0"

2/4



	H	W	T	D	VERT. BAR IN WALL	HORIZ BAR IN FTG
8" THICK	3'-4"	2'-4"	9"	8"	#3 @ 32"	#3 @ 27"
	4'-0"	2'-9"	9"	10"	#4 @ 32"	#3 @ 27"
	4'-8"	3'-3"	10"	12"	#5 @ 32"	#3 @ 27"
	5'-4"	3'-8"	10"	14"	#4 @ 24"	#4 @ 30"
	6'-0"	4'-2"	12"	15"	#4 @ 16"	#4 @ 25"
12" THICK	6'-8"	4'-8"	12"	16"	#6 @ 24"	#4 @ 22"
	7'-4"	4'-10"	12"	18"	#7 @ 32"	#5 @ 26"
	8'-0"	5'-4"	12"	20"	#7 @ 24"	#5 @ 21"
	8'-8"	5'-10"	14"	22"	#7 @ 16"	#6 @ 22"
	9'-4"	6'-4"	14"	24"	#8 @ 8"	#6 @ 21"

7/4

TYP. RETAINING WALL DET.

SC 3/4" = 1'-0"

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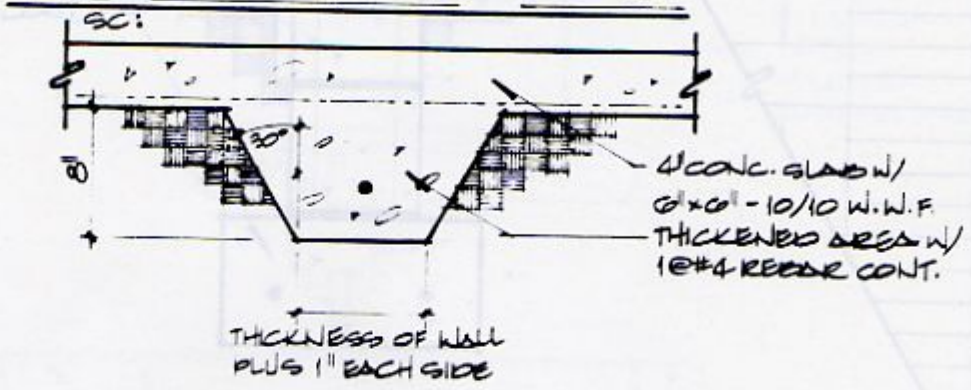
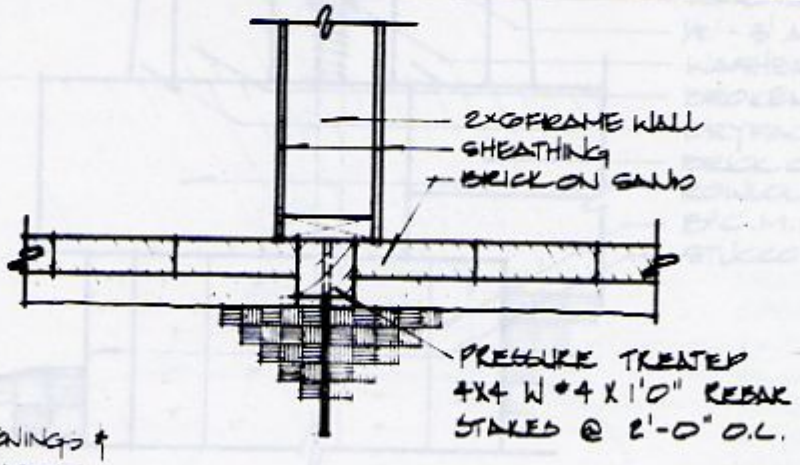
TYP. THICKENED SLAB



TYP. NON-BEARING WALL ON BRICK FLOOR



NOTE:
STOP 4"x4" DOOR OPENINGS & CONTINUE BRICK THRU DOOR OPENINGS.

4/3

TYP. SLAB & BRICK ON SAND DETAILS

SC: 1" = 1'-0"

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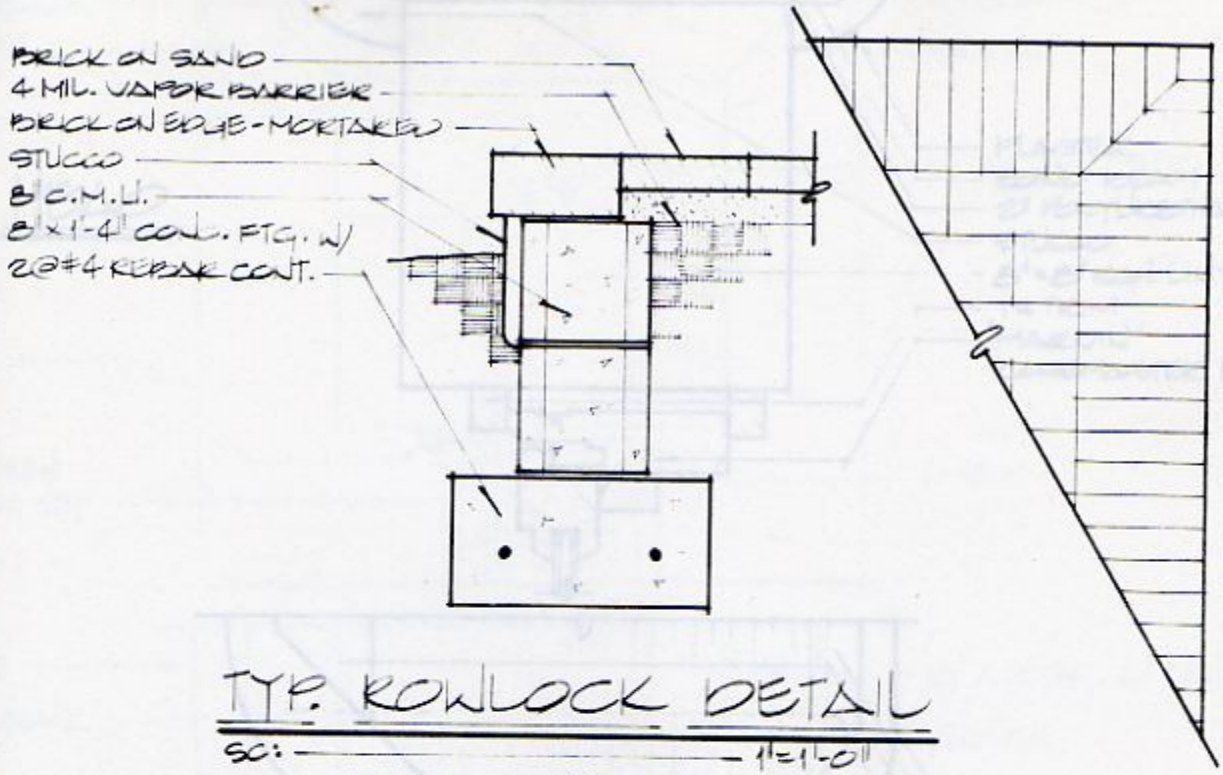
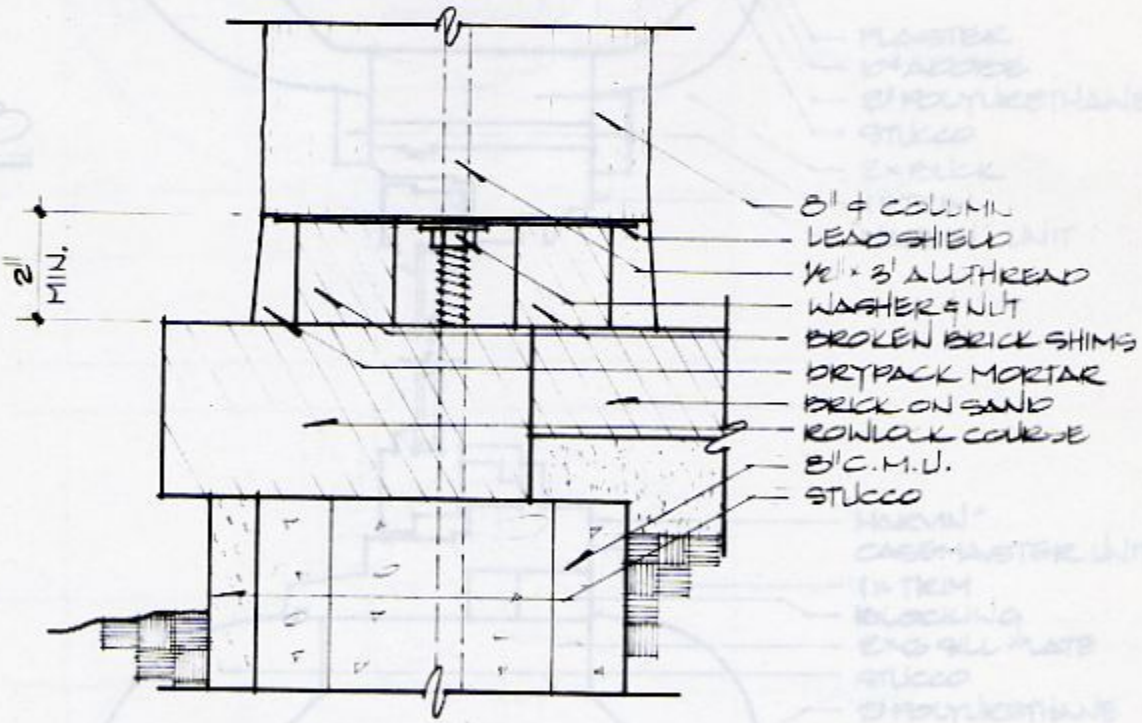


TYP. ROWLOCK DETAIL

SC: 1"=1'-0"



TYP. PORTAL POST BASE DETAIL

SC: 3"=1'-0"

4/4

TYP. ROWLOCK & TYP. PORTAL POST BASE DETAILS

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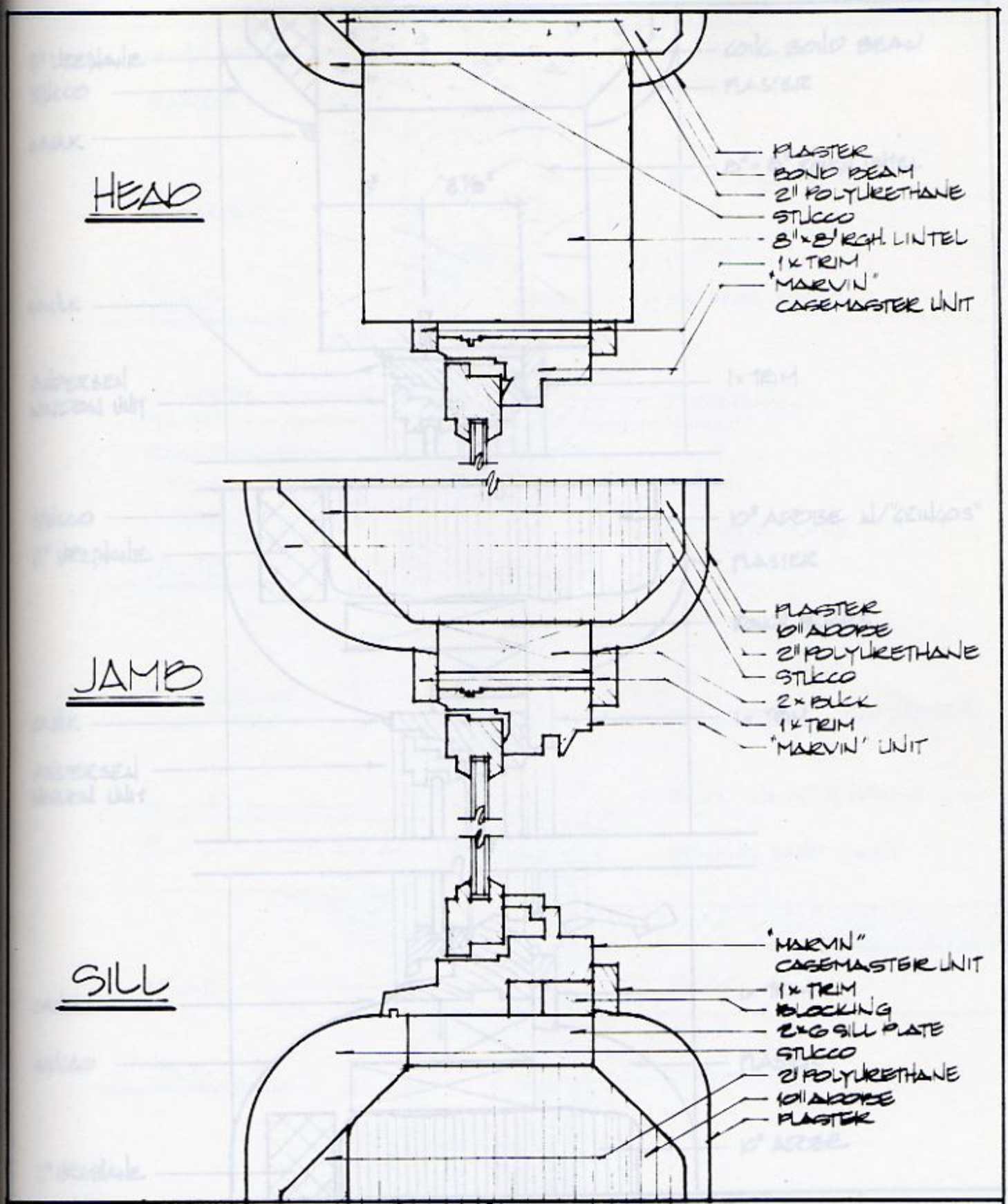

2.2
8

TYP. ADOBE/
CASEMENT DTL.

SC: 3" = 1'-0"

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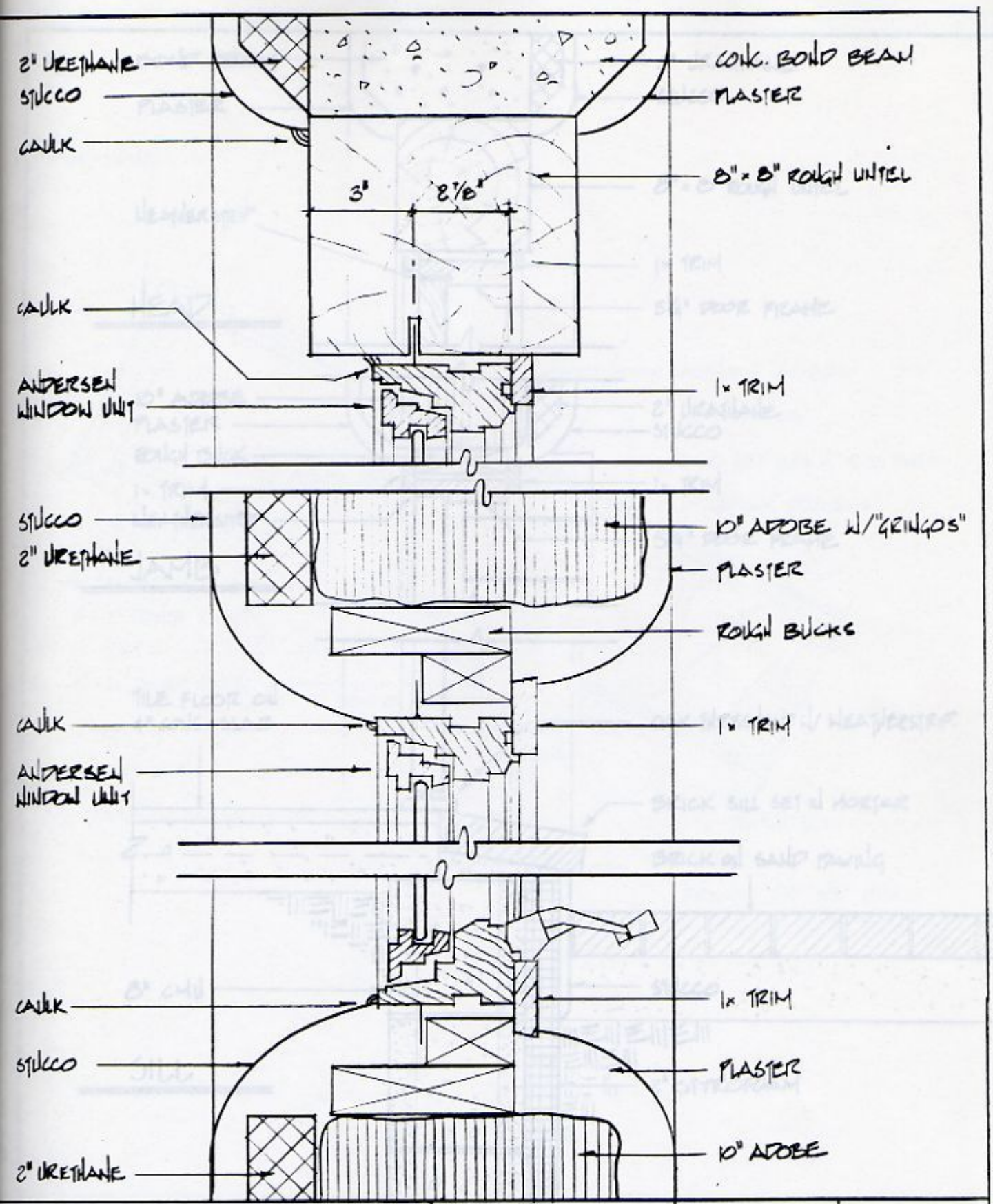

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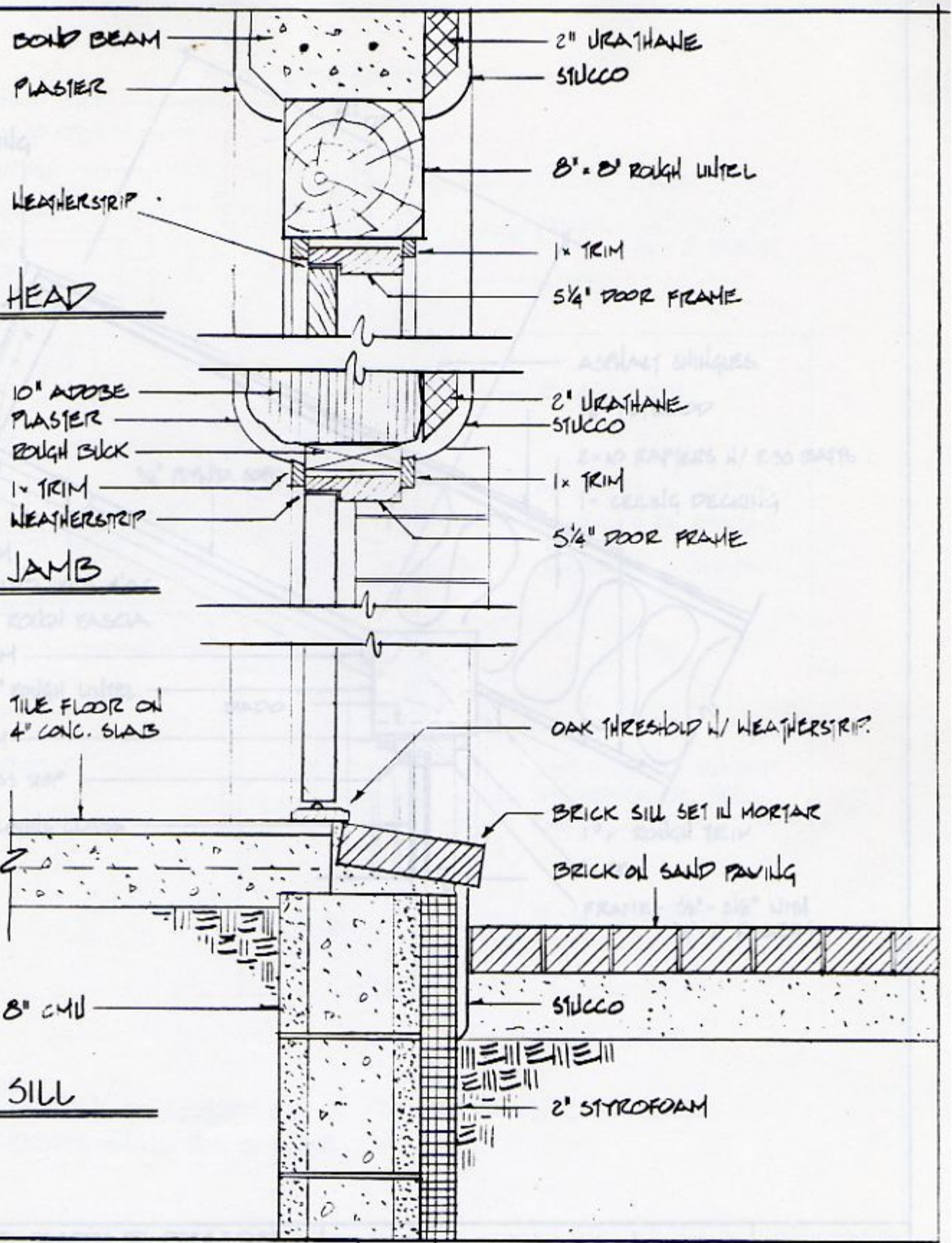
TYPICAL WINDOW AT INSULATED ADOBE WALL

SC: 3" = 1'-0"

9/8



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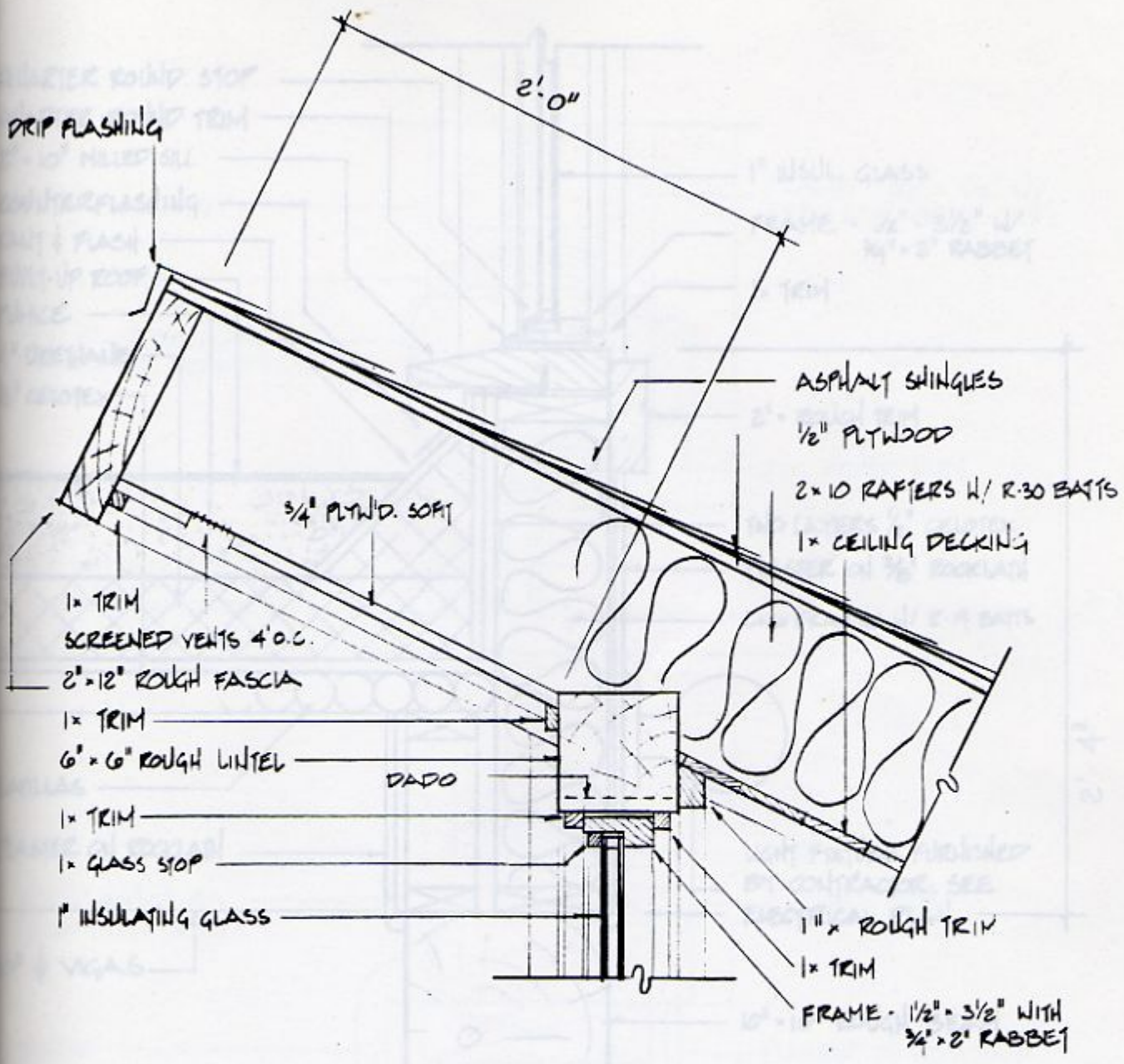
HEAD, JAMB, & SILL @ DOOR "A"

SC: 1½" = 1'-0"

1/8



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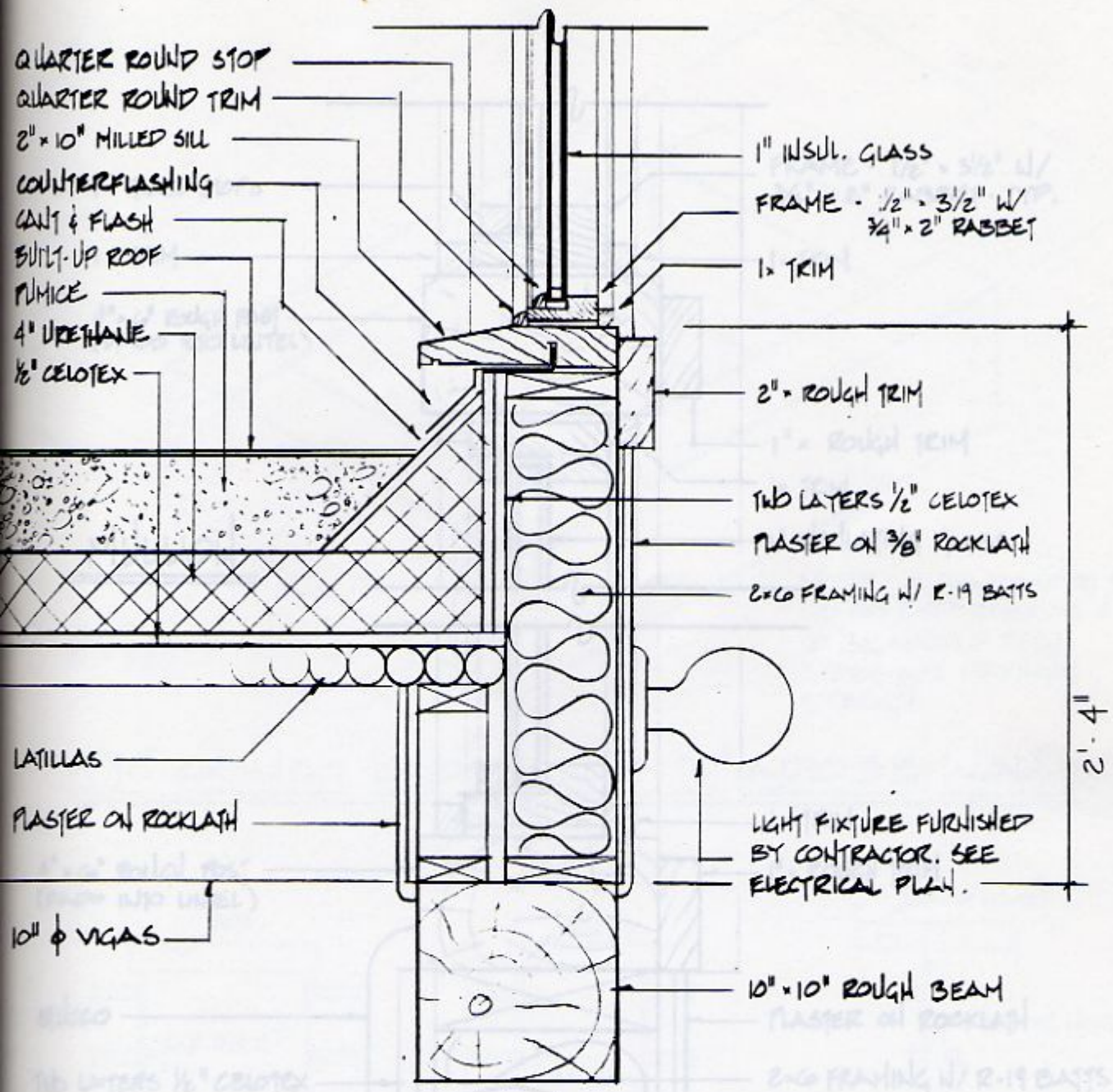
TYPICAL WINDOW HEAD AT CLERESTORIES.

SC: 1½" = 1'-0"

12/8



NOTE:
THIS DETAIL SHOWS CLERESTORY SILL AT KITCHEN. CLERESTORY SILLS AT OTHER ROOMS SHALL BE SIMILAR.

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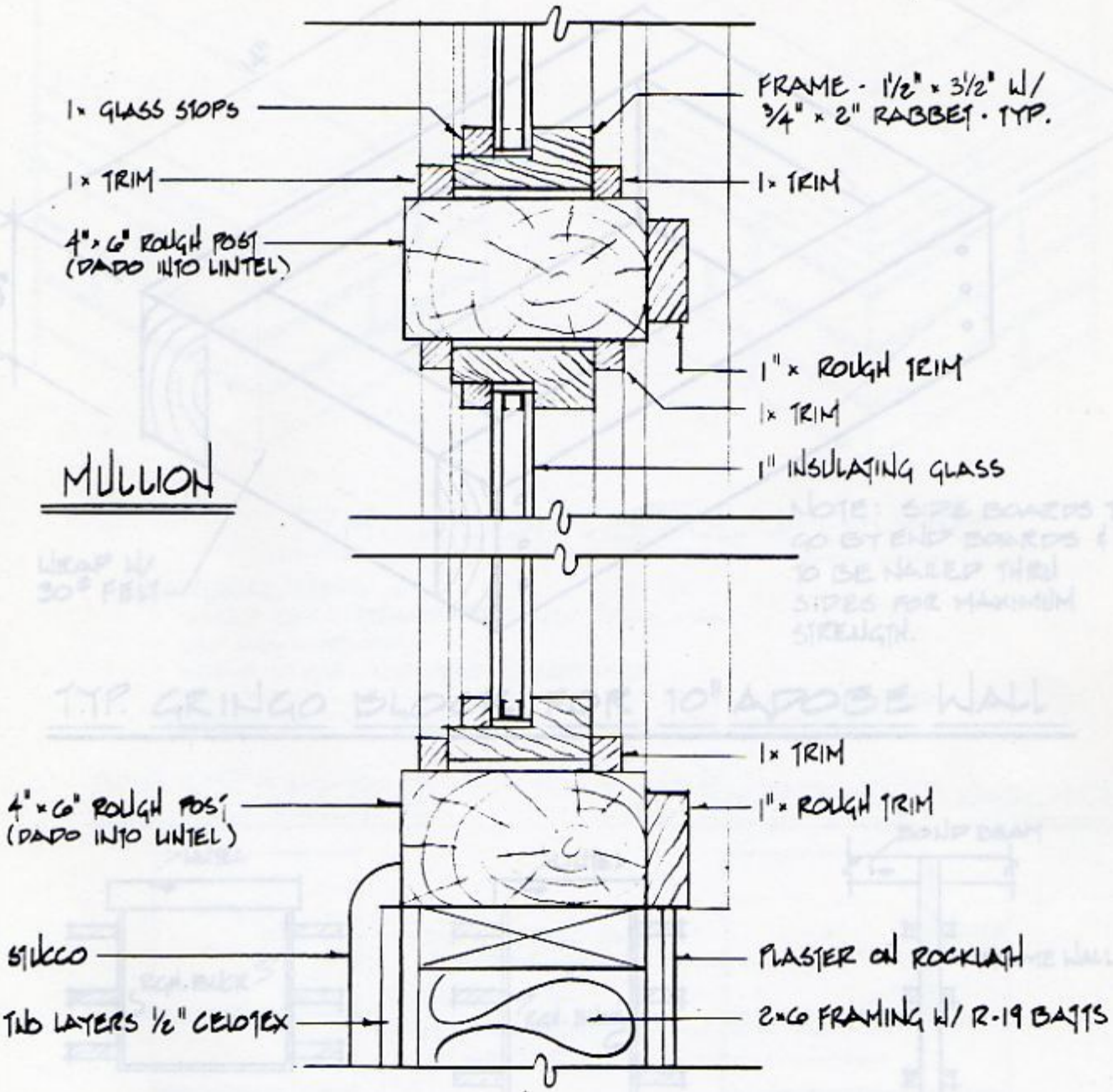
TYPICAL WINDOW SILL AT CLERESTORIES.

SC: 1½" = 1'-0"

14
8



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santa fe, new mexico 87501
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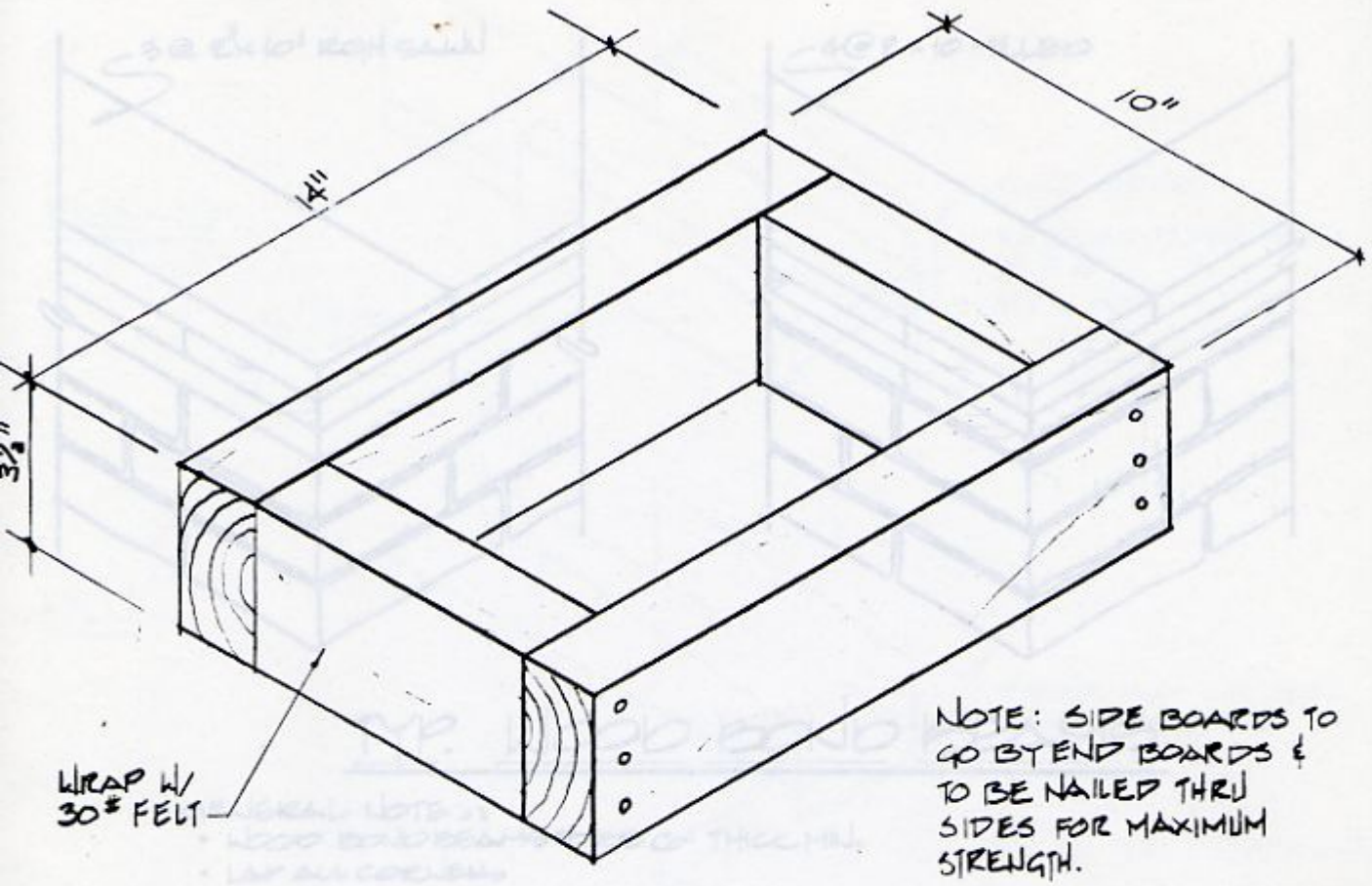
TYPICAL WINDOW JAMB AT CLERESTORIES

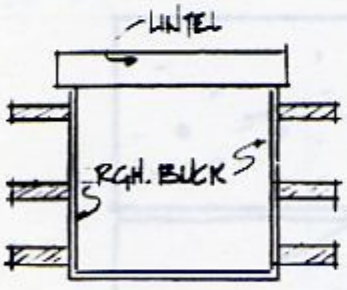
SC: 3" = 1'-0"

13/8

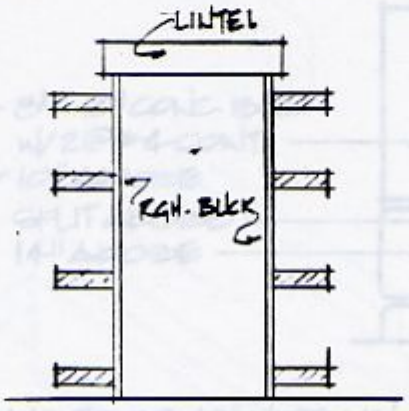


NOTE: SIDE BOARDS TO GO BY END BOARDS & TO BE NAILED THRU SIDES FOR MAXIMUM STRENGTH.

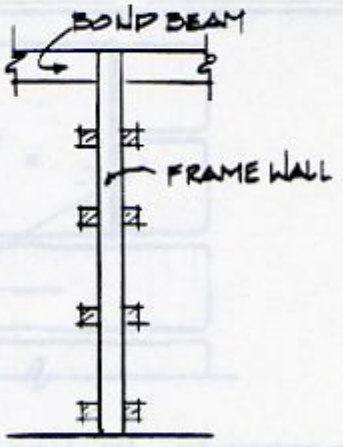
TYP. GRINGO BLOCK FOR 10" ADOBE WALL



3 BLOCKS PER WINDOW



4 BLOCKS PER DOOR



4 BLOCKS PER FRAME WALL INTERSECTION.

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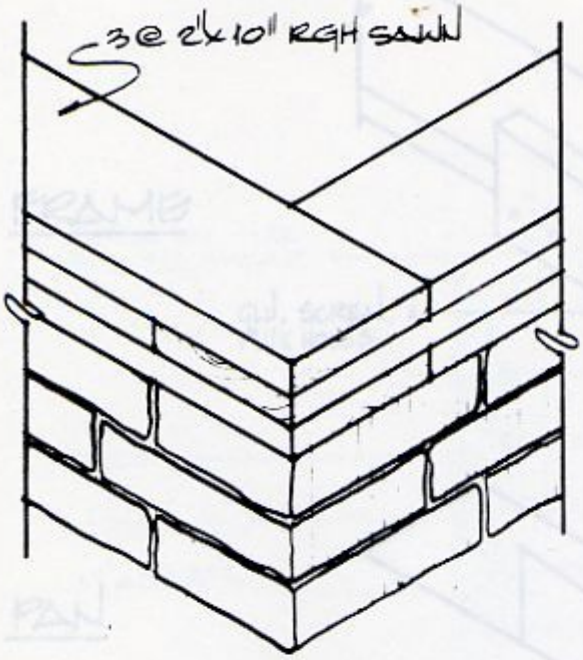
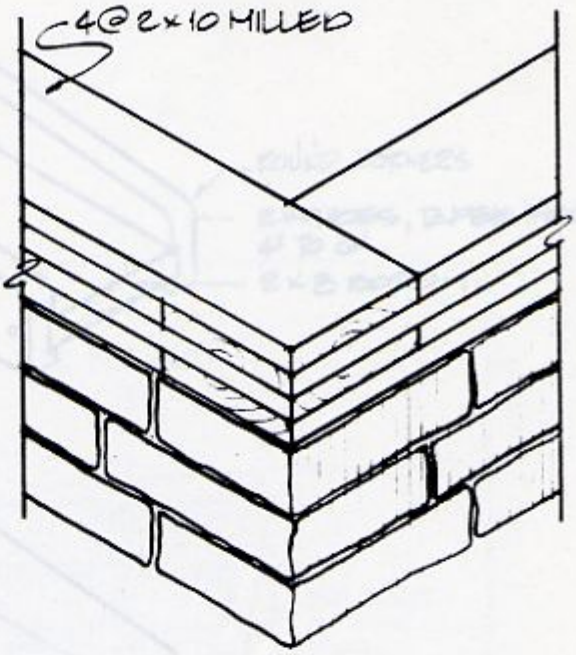
GRINGO BLOCK DET'S.

NO SCALE

0.1
4

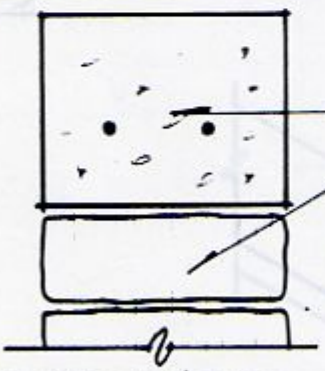




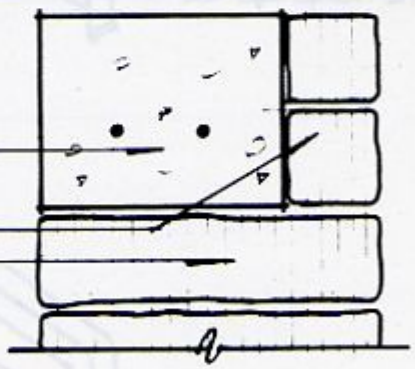
TYP. WOOD BOND BEAMS

GENERAL NOTES:
- WOOD BOND BEAMS TO BE 6" THICK MIN.
- LAP ALL CORNERS
- WOOD TO BE WRAPPED W/ 30# FELT
- SECURE TO WALL BY LAYING 6" EXP. METAL LATH 2 COURSES BELOW @ 2'-0" o.c. & WRAP UP & NAIL TO BOND BEAM.

TYP. 10" ADOBE



TYP. EXPOSED ADOBE



GENERAL NOTES:
- CONC. BOND BEAMS TO BE 10" WIDE MIN. & 6" HIGH MIN. - 8" PREFERRED

3/3

TYP. BOND BEAM DETAILS
NO SCALE

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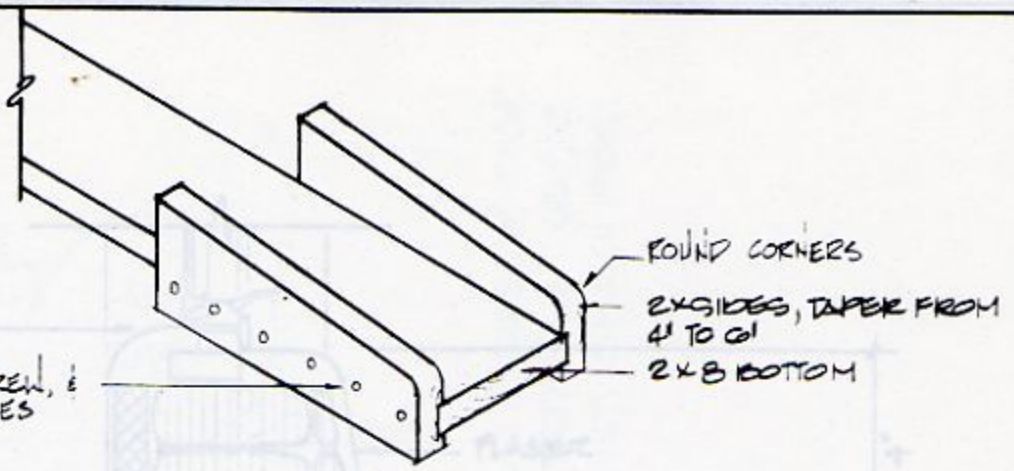
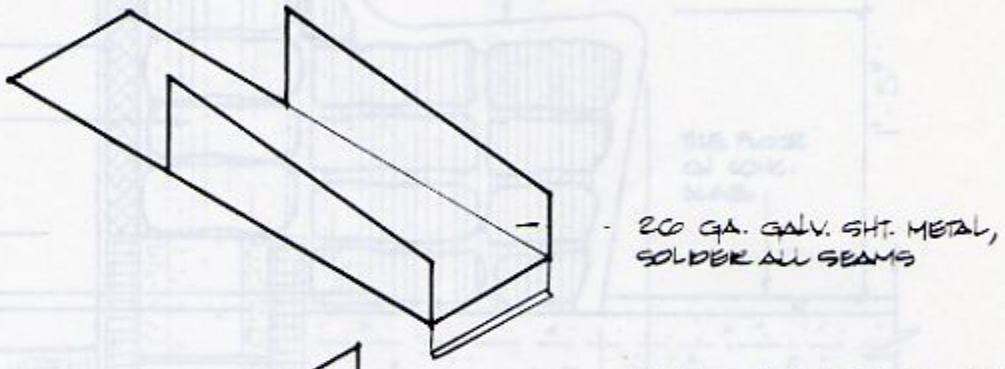
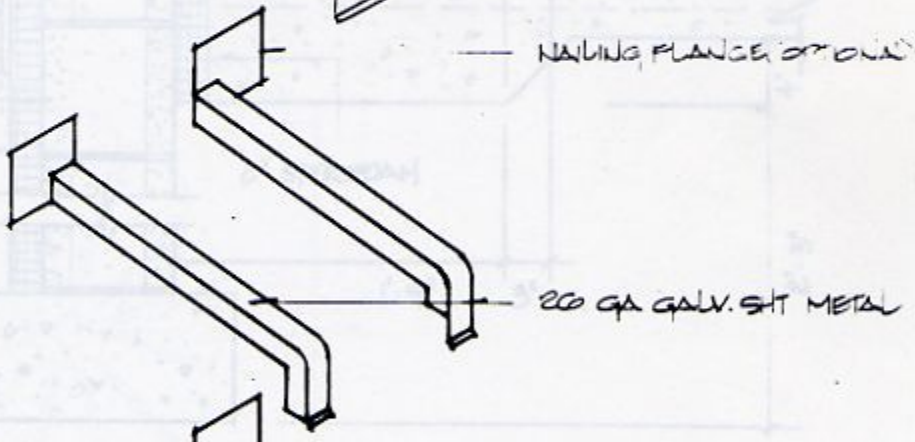
FRAME



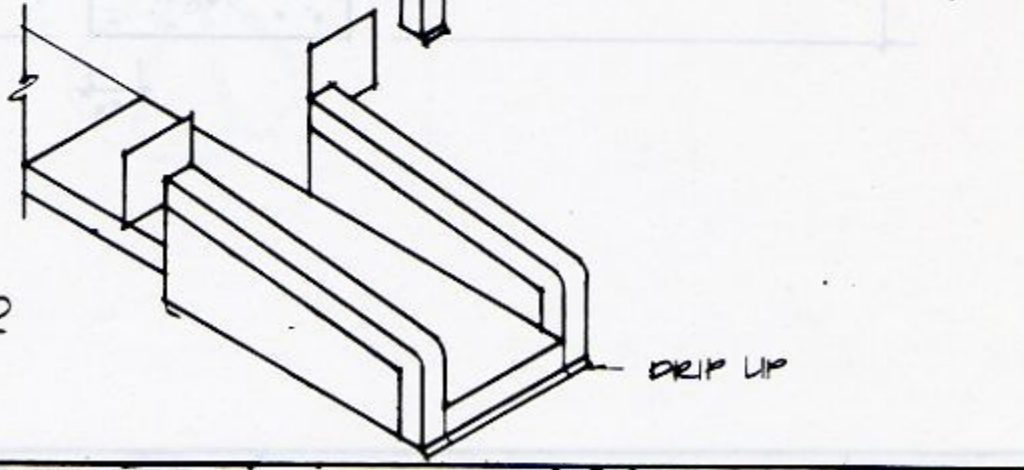
PAN



CAPS



ASSEMBLED CANALE



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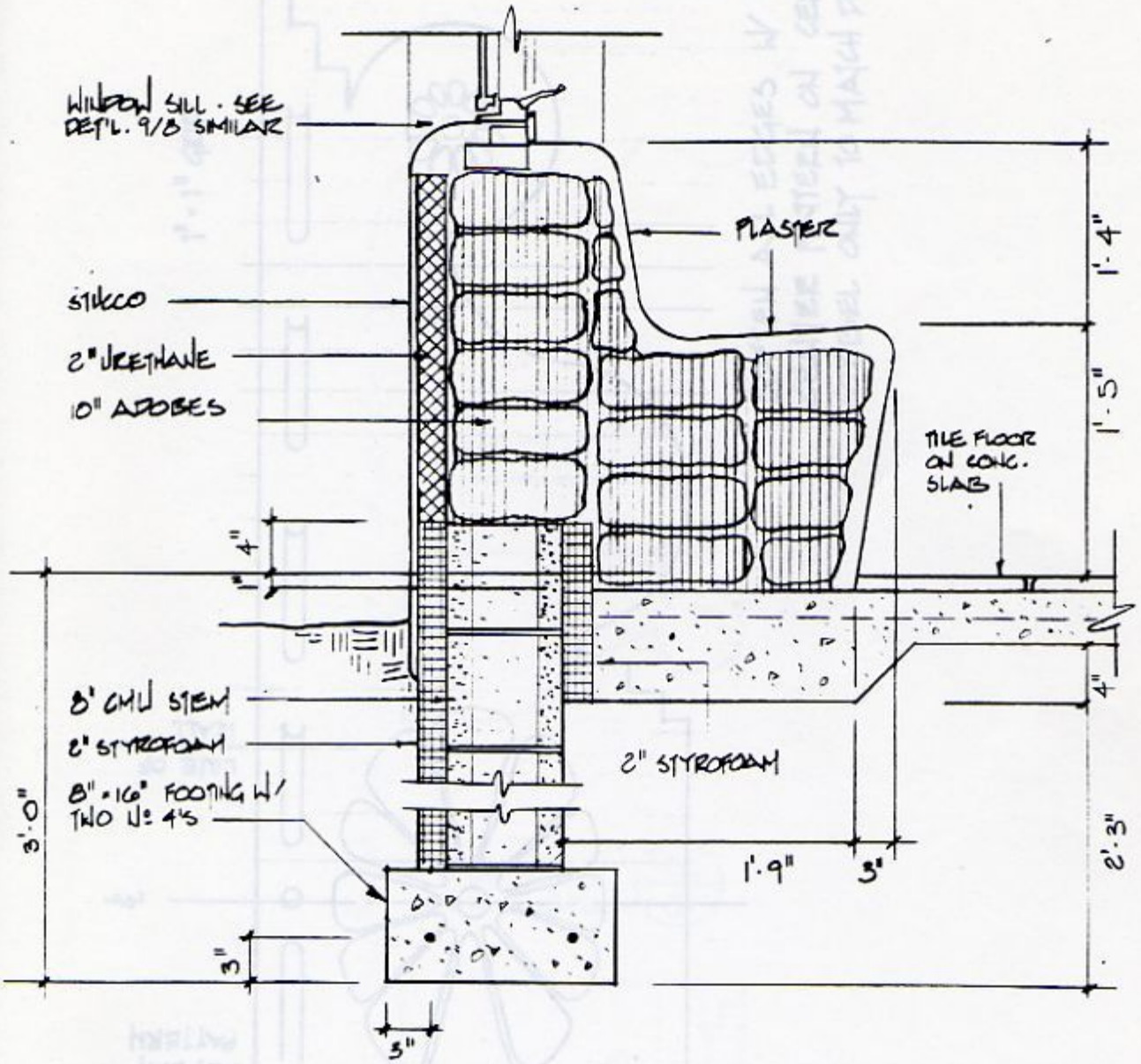
TYPICAL CANALE DETAILS

SC: _____ "1" = 1'-0"

7/7



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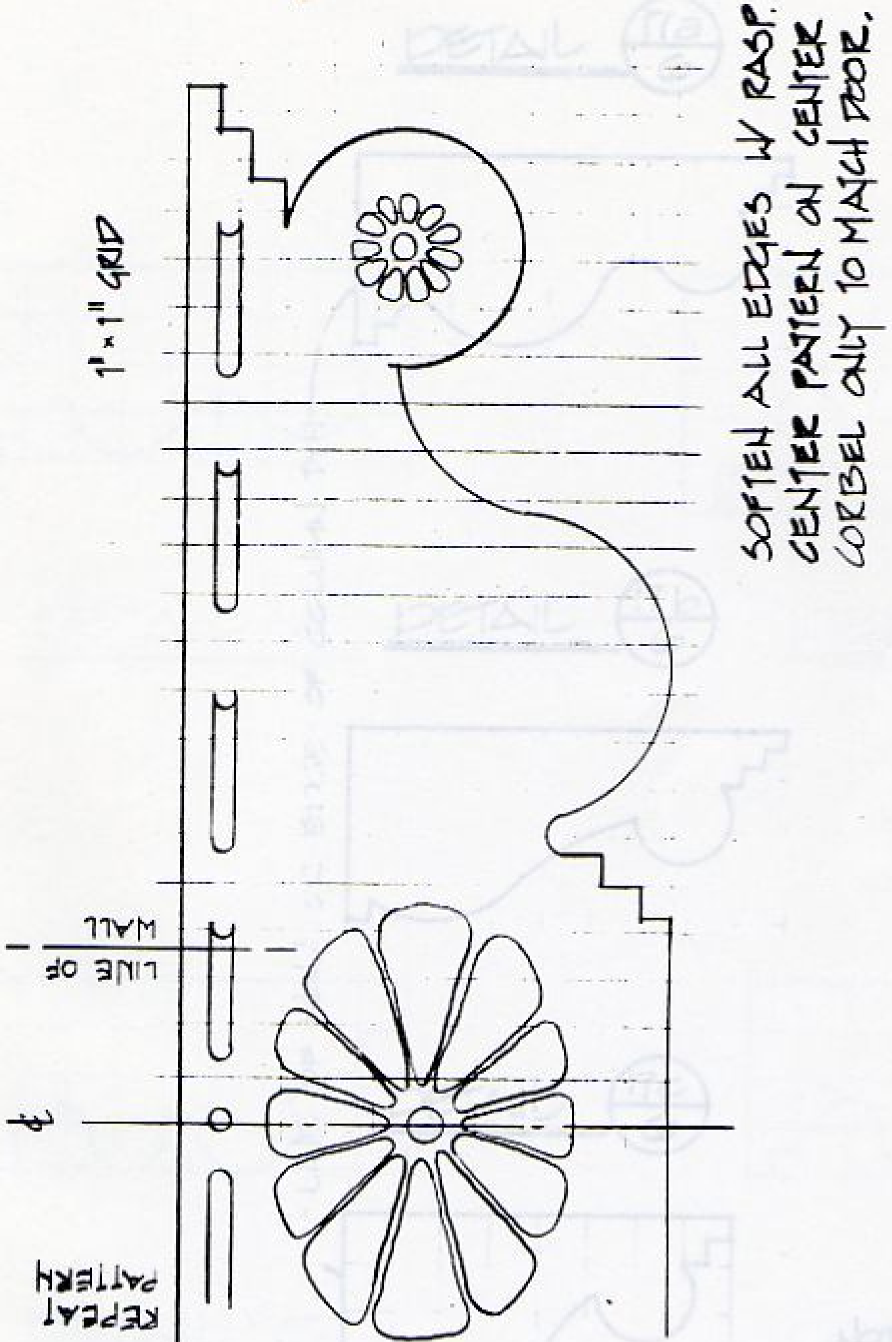
BANCO @ FAMILY ROOM

SC: 1" = 1'-0"

15
4



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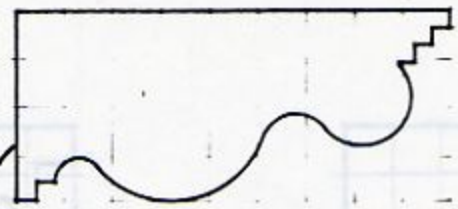
CORBELS @ PORTAL

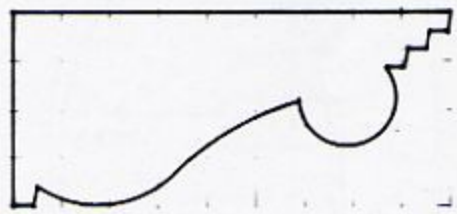
SC: 3" = 1'-0"

6 / 6

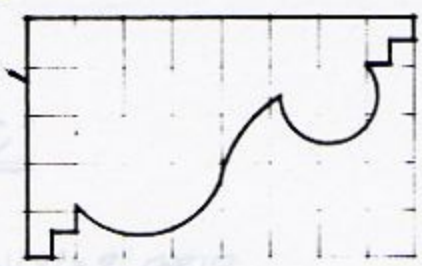
DETAIL 17a/6



DETAIL 17b/6



DETAIL 17c/6



LINE OF WALL SEE ELEVATIONS OF COLUMN TYP.

NOTE:
- DETAILS SHOWN W/ 2"=2" GRIDS.
- CORBELS TO BE LIGHTLY SANDED, BANDSAWN, EDGES TO BE ROUTED.
- CLIENT INTENDS TO DO SOME CARVING ON CORBELS. CONSULT HER PRIOR TO INSTALLATION.

17.1/6

TYP. CORBEL DETAILS

SC: 1½" = 1'-0"

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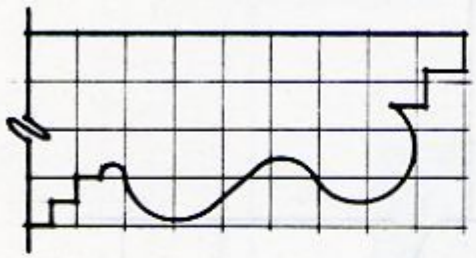
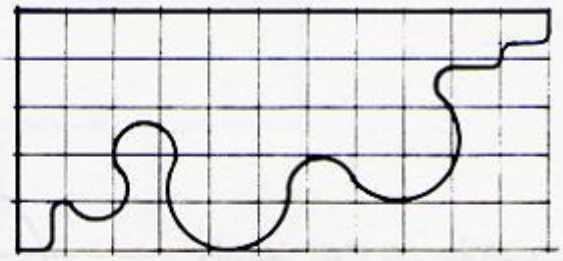
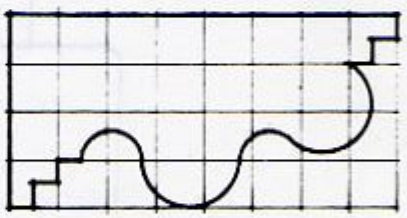


DETAIL "A"



DETAIL "B"

DETAIL "C"



DETAIL "D"

GENERAL NOTES:
- DETAILS SHOWN W/ 2" x 2" GRID
- CORBELS TO BE BANDSAWN & ALL EDGES TO BE ROUTED

8/6

TYP. CORBEL DETAILS

SC: 1½" = 1'-0"

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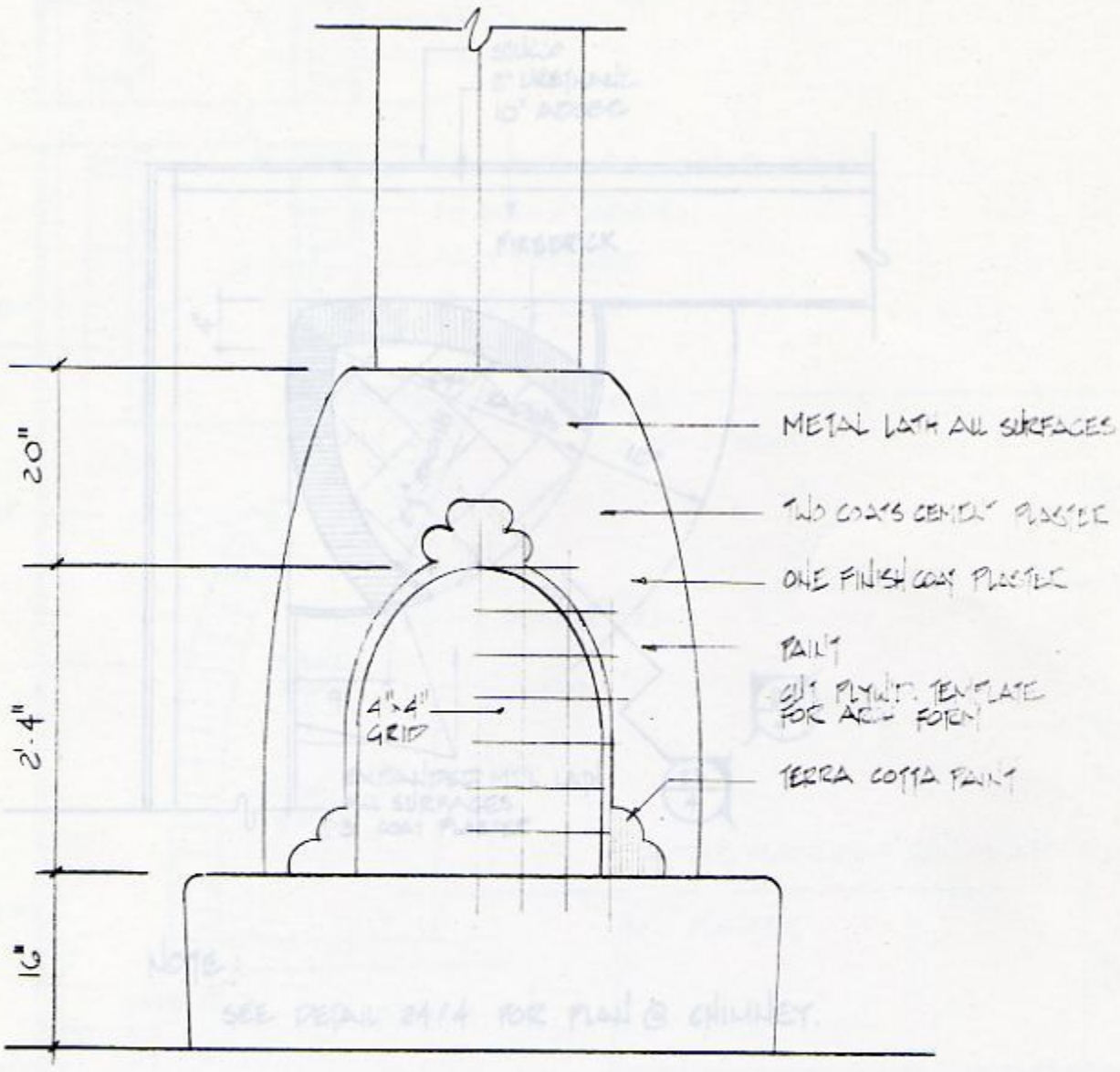

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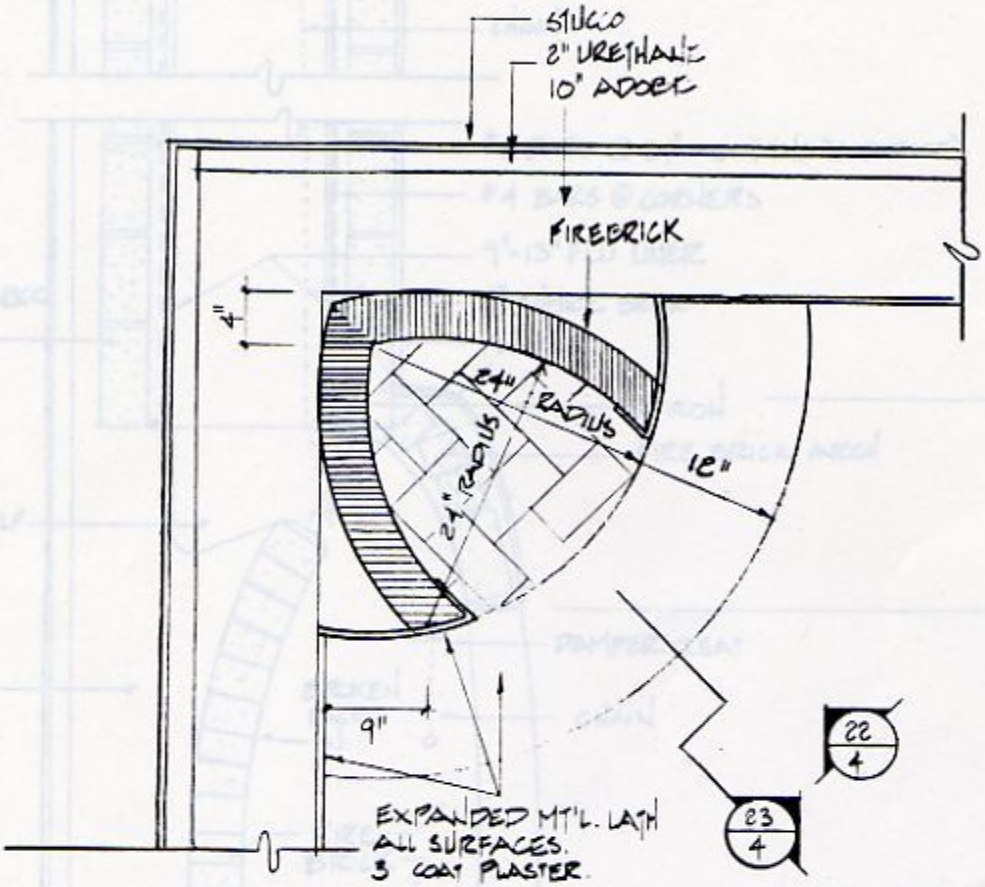
FIREPLACE ELEVATION

SC: 3/4"=1'-0"

24
4



NOTE:

SEE DETAIL 24/4 FOR PLAN @ CHIMNEY.

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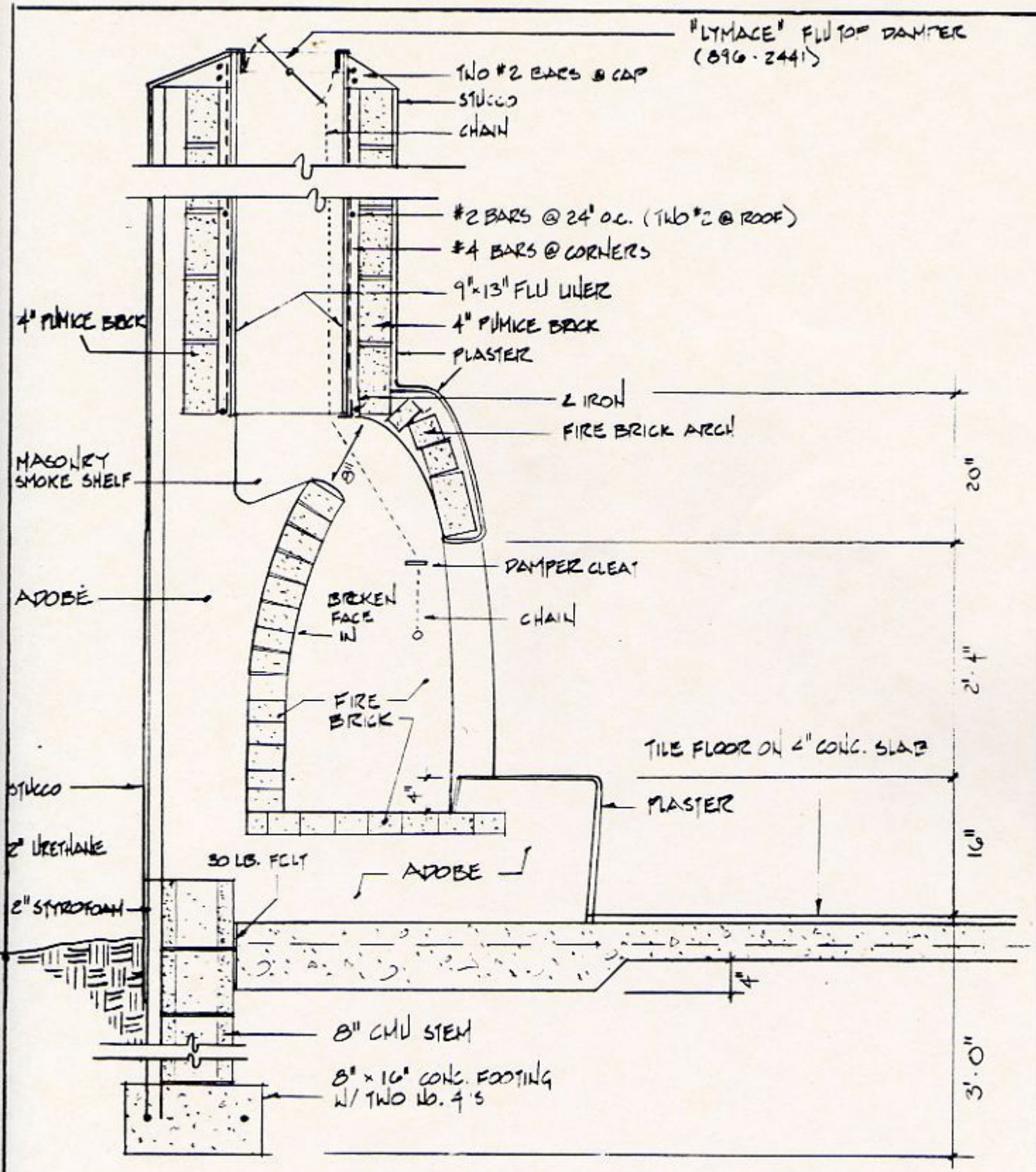
FIREPLACE PLAN @ LIVING ROOM

SC: ——— 3/4" = 1'-0"

21/4



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SECTION THRU FIREPLACE @ LIVING ROOM

SC: 3/4"=1'-0"

23/4