REPAIRING WALLS & FLOORS

Hurricane damage can result from wind-borne debris, flooding, fallen trees, sustained winds and strong gusts, driving rains, and other water intrusion. This Technical Brief will guide homeowners and contractors when repairing damaged exterior walls and floors.

STEP 1: Assess the Extent of Damage

Do you need to patch a hole, or replace all the sheathing? Replace carpet, or tear out and replace a soaked floor? Do a quick structural evaluation before expending time, effort, and money on a building that is not structurally sound. If damage compromises the structural integrity of the home, consult a professional engineer. When in doubt, call a professional.

FIVE SIGNS OF STRUCTURAL DAMAGE:

- The structure shifted on the foundation
- There are broken pilings, shifted stairs, or slanted walls
- The foundation shifted or floors are not level
- Crawlspace or foundation walls have cracked or caved in
- Erosion cut into the soil to the bottom of the foundation or has undermined the foundation

HOW WET IS TOO WET?

Some moisture is unavoidable, but too much causes mold, decay, and other problems. An electric moisture meter, which you can buy or rent at many building supply stores, can easily determine the moisture content of various building materials. Wood should have a moisture content below 20% before you cover it. Drywall and plaster should have a moisture content below 2%.

STEP 2: Remove Damaged Materials and Allow Structure to Dry

Some storm-damaged materials can be recovered, but many cannot. Always choose the safest option. Reusing unsound materials will come back to haunt you through structural problems, mold issues, and unpleasant appearances (buckling). If material will not have time to dry before being covered again in the repair process, do not reuse.

Move the materials that you want to reuse to a secure, dry place. Move unrecoverable materials away from the home, but save until an adjuster confirms your losses.

GUIDANCE ON WHAT TO KEEP AND WHAT TO DISCARD:

- Tear out and discard **wallboard** – drywall (sheetrock) and paneling – that has been soaked by floodwater.
- Keep **plaster** if it appears undamaged, but note that it will take a long time to dry. If plaster separates from its wood laths, that entire interior portion should be removed and replaced.
- Remove and discard **fiberglass batt insulation** and **cellulose insulation** that has been soaked. **Rigid insulation** can be washed off and kept.
- **Vinyl wall covering** will blister, peel, and debond after flooding. This may damage the surface of the gypsum board and inhibit drying of the substrate or wall system.

U.S. Department of Energy
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HOW TO'S *for the* HANDY HOMEOWNER SERIES

- Your House is a System
- Selecting the Right Product
- Repairing Walls & Floors
- Repairing Roofs & Ceilings
- Repairing Windows & Doors

This Technical Brief is one of a series targeted to skilled do-it-yourself homeowners in the Gulf States region. It provides general guidelines for repairing storm-damaged homes.

***NOTE:** Contact a professional engineer if there is any evidence of structural damage to the home. If filing an insurance claim related to the damaged area, consult an agent before conducting any repair work. The local building agency can provide further guidance on applicable codes.*

CAUTION

TURN OFF UTILITIES: Turn off electricity, gas, propane, and other utilities before assessing damage and starting repairs to avoid accident or injury.

BE AWARE OF LEAD-BASED PAINT HAZARDS: Many residences built before 1978 have paint that contains lead, which can pose a serious health hazard if paint, chips, and dust are not handled properly. See the U.S. Environmental Protection Agency's (EPA's) brief before disturbing painted surfaces in homes of this vintage: www.epa.gov/lead/pubs/leadinfo.htm#remodeling

BE AWARE OF ASBESTOS HAZARDS: Homes older than 1977 may have building products that contain asbestos, such as insulation, high-temperature gaskets, roofing and siding shingles, and vinyl sheet flooring. See EPA's brief before disturbing such materials: www.epa.gov/iaq/asbestos.html

10 STEPS FOR WALL & FLOOR REPAIR

STEP 1:
Assess the extent of damage

STEP 2:
Remove damaged materials and allow structure to dry

STEP 3:
Replace sheathing

STEP 4:
Install weather-resistant barrier

STEP 5:
Replace subflooring as necessary

STEP 6:
Attach roof to wall

STEP 7:
Secure exterior attached structures

STEP 8:
Install siding

STEP 9:
Weatherize the home

STEP 10:
Repair drywall and plaster

- Keep wet **studs** and **floor joists**, which will retain their shape if allowed to dry naturally, unless they are obviously damaged or warped. They may swell when soaked, but usually dry back to their original shape. **Sheathing** (plywood and oriented strand board [OSB]—OSB looks similar to fiberboard and particle board, but OSB has structural capability) might be kept if it is not soaked for too long. Plywood and OSB will peel or fall apart if they stay wet.
- **Finish flooring materials** hold or trap water above the slab or subfloor and slow the overall drying process. If cost effective, **wood flooring** should be removed, washed, and stacked during the drying process. Both glued-in-place and floating **vinyl flooring** can trap water, so they should be removed during the drying process. Vinyl flooring can be reused if it is removed without damage.
- **Floor framing and subflooring** retain moisture. **Drying of the subfloor** occurs predominantly through its bottom side, so wet floor insulation should be removed and the floor framing and subfloor should be allowed to dry thoroughly before new floor insulation is installed. With no floor insulation, the subflooring generally dries well, although OSB subflooring may swell.

STEP 3: Replace Sheathing

Non-structural exterior wall sheathing is part of the barrier system that keeps out the destructive effects of moisture, provides varying degrees of insulation, and serves as the nail base for exterior siding. Structural sheathing also provides rigidity and shear resistance to the main framing elements.

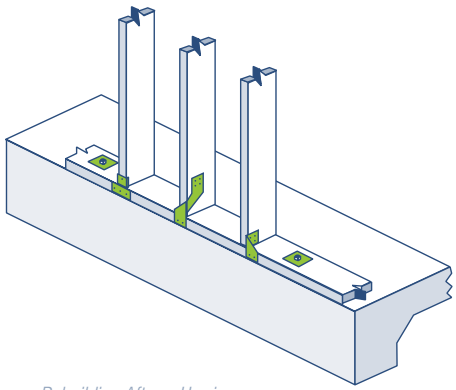
- If non-structural sheathing (tar board) is intact, you can **strengthen exterior walls** by using plywood or OSB sheathing to the greatest extent practical. At a minimum, strengthen the exterior corners. Use sheathing with minimum $^{15}/_{32}$"-thick 32/16-rated sheathing (plywood or OSB), or match the thickness of the existing sheathing. A stamp on the plywood or OSB indicates the 32/16 rating and means that the panel is rated for roof decking where the rafters or trusses are spaced 32" on center, and rated for subflooring where the floor joists are spaced 16" on center.
- If structural sheathing is intact, it can be cost-effective to **increase the number of fasteners or connectors** from the sheathing to the studs or to **add resistance** with foamed-in-place adhesives. This can be accomplished when replacing the siding.

Remove water-damaged wood siding and sheathing. Inspect wood-sided walls to ensure there are at least 8" between any wood and the earth.

When wall coverings are removed, **check the wall anchorage** to determine if it can be improved to provide enhanced protection in a future storm. If you find that anchors are missing or spaced further than 4 feet apart, use the following recommendations:

- All walls should be adequately anchored to the foundations or piers. Anchor bolts should be at a minimum of $^{5}/_{8}$" in diameter, with 3"x3"x$^{3}/_{16}$" washers. Bolts should be embedded and epoxied into the foundation as recommended by the hardware manufacturer. *(See Figure 1.)* Stainless steel hardware should be used for any connections that will be exposed to weathering in service. Metal fasteners used with such hardware should also be stainless steel.

Figure 1. Adding foundation anchors

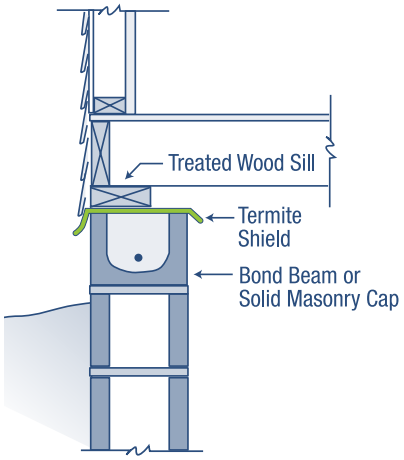


Source: Rebuilding After a Hurricane, Institute for Business & Home Safety

- Sill plates should have anchor bolts every 4 feet and within 6" to 12" of the end of each plate.
- For unreinforced masonry block wall construction, insert #5 vertical reinforcing steel (rebar) down into open cells and then grout at each corner, on either side of each window and door opening, and at a minimum of every 4 feet thereafter.

Guard against termites. Whenever possible, place a shield made of termite-resistant material, such as metal, between a cement or masonry foundation and wood framing, as shown in *Figure 2*.

Figure 2. Install a termite shield



Source: Durability by Design, U.S. Department of Housing and Urban Development

Fully sheath all exterior wood framed walls with minimum $^{15}/_{32}$"-thick 32/16-rated sheathing (plywood or OSB). Sheathing should overlap both top and bottom sill plates and be continuous from the plate for at least 2 feet up or down the wall. For two-story homes, sheathing should also overlap wall framing in both stories by no less than 2 feet to provide inter-story connections, as shown in *Figure 3a*.

Follow recommended nail schedules:

- 10d (10 penny) nails at 6" spacing along 8-foot edges
- 10d nails at 6" staggered double row along 4-foot edges where there is a double plate
- 10d nails at 12" spacing in the field of each structural panel

Follow recommended blocking for wood-frame walls:

- One-story walls – 48" on center in first two framing spaces from all corners and at either end of garage door openings.
- Two-story walls – Add where needed in all framing spaces to allow nailing around the perimeters of wall sheathing.

For maximum strength, **construct all exterior walls as "shear walls" for at least 50% of their length**. Fully sheathed wall segments wider than 48" without any openings larger than 144 square inches are considered shear walls, provided that they have hold-downs:

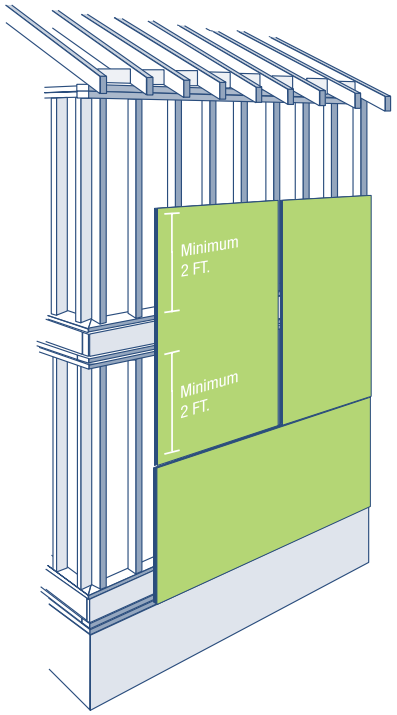
- At the bottom ends of each shear wall segment on a **one-story house**
- At the bottom ends of each shear wall segment and at the top and bottom corners of lower stories on **houses two stories and higher**

Secure the wall from roof to foundation, as shown in *Figures 3(a) and 3(b)*, by creating a continuous "load path" or "hold-down path" with sheathing or metal connectors so the walls, floors, and roof act together as a structural unit. Plywood or OSB sheathing provides a hold-down path and resists shear or racking forces. Sheathing can be used to tie components together, as shown in *Figure 3(a)*. Reinforce the connections between the wall and foundation, wall and floor, and wall and roof. Line up bracing and tie-downs at critical load points to maintain the integrity of the load path.

Use light-gauge steel straps to anchor the first story to the foundation. (During Hurricane Andrew, hurricane ties had a 92% success rate.) A number of different anchor bolts, straps, or threaded-rod connections can be used to reinforce the connection of the frame to the foundation. Typical floor-to-floor connectors include bolted hold-downs with threaded rods or straps designed specifically for that use. Follow manufacturer's guidelines when selecting and installing anchors.

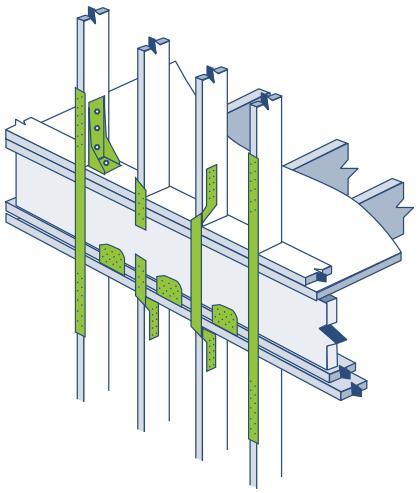
As an alternative to using sheathing alone to tie components together, inter-story (second story to first story) details, as shown in *Figure 3(b)*,

Figure 3(a). Alternate method of tying first- and second-story walls together with sheathing



Source: Builder's Guide, Institute for Business & Home Safety

3(b). First- and second-story walls tied together with metal connectors



Source: Builder's Guide, Institute for Business & Home Safety

can include metal strapping every 48" (every third stud) along exterior walls, with an allowable load capacity of at least 1,500 pounds, and can be sheathed with continuous wood structural panels of at least $^{15}/_{32}$".

STEP 4: Install Weather-Resistant Barrier

Building paper or housewrap installed over the wall sheathing keeps water from entering the wall assembly and also may act as an air barrier to reduce air infiltration (see *Figure 4.*). The recommended weather-resistant barrier for hot and humid climates is 15# tarred felt or housewrap with moderate permeability.

- Housewrap is often viewed solely as an air barrier, but it also blocks liquid water that gets past the siding. In addition to acting as an air barrier and drainage plane, housewrap is designed to allow water vapor to pass through so the wall assembly can dry out should it get wet.
- 15# tarred felt has a permeability of about 18 perms. This means it resists the transmission of water vapor, which is important in hot, humid climates where vapor movement is from outside to inside.

During home repair, housewrap or 15# tarred felt will generally be placed over sheathing. They are installed in a similar manner, though felt is sealed with caulk while housewrap is taped. Housewraps come in rolls of varying widths, but 9 feet is standard. Housewrap sheets are installed shingle-style, from the bottom up. Horizontal laps should be a minimum of 2"; vertical laps of 6" are acceptable. To be fully effective in their primary role as air infiltration barriers, **all seams and edges must be taped or caulked**.

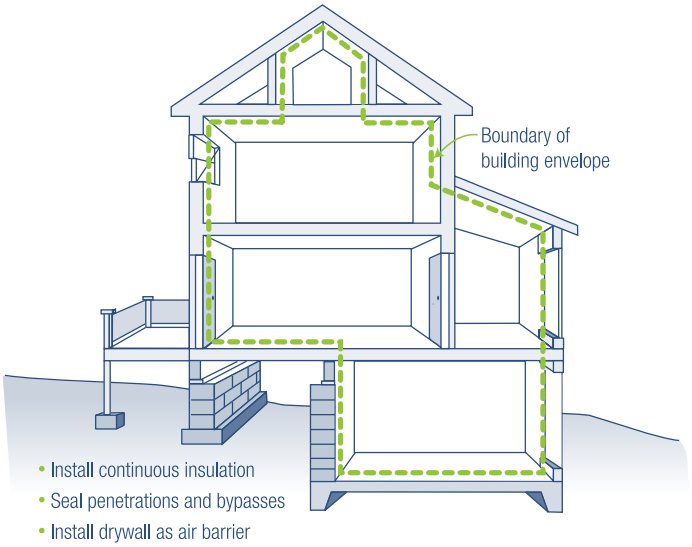
Beginning at an outside corner, hold the roll of housewrap vertically and unroll the material across the face of the sheathing for a short distance. Make sure the roll remains plumb and that the bottom edge of the housewrap extends over the foundation by 2". The application should start at an outside corner extending around the starting point corner by 6". The first course of weather-resistant barrier should be tucked up under the sill and under the loose ends of jamb flashing.

Manufacturers specify acceptable fasteners, typically large head nails, nails with plastic washers, or large crown staples. Fastener edge and field spacing patterns are also specified. Nails with plastic washers (e.g., cap nails) tend to seal against water and air leaks better than nails alone or staples. *(See Figure 5.)*

Ensure proper flashing at windows and roof connection

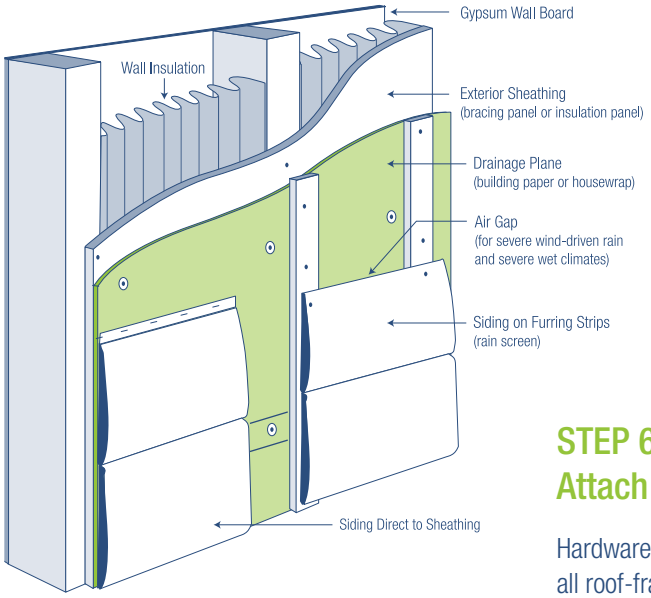
Most leakage problems are related to improper flashing. Good flashing installation takes time and it is time well spent toward eliminating future leaks. *(See other Technical Briefs)*

Figure 4. Creating a continuous air barrier



Source: Alabama Builder's Field Guide, Alabama Department of Economic and Community Affairs, Southface Energy Institute, Inc.

Figure 5. Weather Barrier Construction



Source: Durability by Design, U.S. Department of Housing and Urban Development

STEP 5: Replace Subflooring as Necessary

In platform framing, the walls rest on the subfloor, so replacing damaged subfloors without removing the bottom plate of the wall presents a challenge. Most contractors **adjust a circular saw to cut the exact depth of the subfloor** and cut out the damaged sections starting 1" to 2" inside the wall. If sections of wall are damaged severely enough to require replacement, any damaged subfloors will be replaced before the new walls are constructed.

All wood-framed floors should have full depth 2x blocking (the blocking should span the full length and be the same dimension—2x6, 2x8, etc.—as the joists) in the first two spaces between the floor joists at each end of the floor diaphragm. Blocking should be spaced no more than 4 feet on center, and should correspond with the joints between subflooring panels for edge nailing purposes.

Subflooring to floor framing nailing pattern: 10d common nails at 6"/12" spacing (fasten every 6" on the edges and every 12" on intermediate supports) on the first floor and 4"/12" spacing on the second floor for shear resistance. Where subflooring overlaps the first two framing spaces at each end of the diaphragm, proper edge nailing must be used to connect the subflooring to the blocking below.

STEP 6: Attach Roof to Wall

Hardware connectors must be provided from all roof-framing members to wall frames (see other Technical Briefs). Ideally, all connectors should wrap over the top of the roof truss or rafter on both ends and be installed according to the manufacturer's recommendations. Alternate side-mount connectors can be used if the roof decking is intact. The minimum allowable load for roof-to-wall straps is 1,345 pounds for roof framing spaced at 24", and 900 pounds for roof framing spaced at 16".

STEP 7: Secure Exterior Attached Structures

Securely anchor connections for exterior attached structures, such as carports and porches, which attach to the house. Stainless steel hardware should be used for any connections that will be exposed to weathering. Metal fasteners used with such hardware should also be stainless steel.

A licensed professional should develop reinforcement strategies for masonry buildings on a case-by-case basis. Masonry buildings generally perform well in high wind as long as they are reinforced in accordance with codes, and as long as the connections to the roof structure are adequate to prevent uplift failure.

The integrity of the weather barrier should not be compromised when securing exterior attached structures. Any disruption of the weather barrier should be repaired by flashing shingling in additional housewrap or 15# tarred felt, and all seams should be taped or caulked as appropriate. Any slits made in the weather-barrier for porch roof flashing should be taped or caulked using the same approach described in the *Windows & Doors* Technical Brief.

STEP 8: Install Siding

Siding nails and screws should be galvanized to prevent corrosion. Fiber cement and vinyl sidings withstand flood conditions better than hardboard lap siding and plywood siding. Plywood sheathing with flood-damage-resistant lap siding is a good combination. Plywood sheathing covered with plywood siding does not dry well and is not recommended for flood-prone areas.

Vinyl siding sections that are buckled, dented, cracked, stained, or otherwise damaged can be easily replaced by means of a "Zip" tool that slips behind the bottom of the siding panel above the damaged panel, allowing access to the damaged panel for replacement. The Vinyl Siding Institute and individual manufacturers provide instructions.

Fiber cement siding that is dented, cracked, or otherwise damaged can be repaired with the use of a latex-modified cementitious patching compound available from fiber-cement manufacturers or from specialty product manufacturers. Damaged sections can be cut out with hand or power saws and new sections installed as necessary. Joints between new and old materials should be primed and caulked.

Metal siding panels can be replaced relatively simply. Cut the damaged panel along its center with a utility knife or metal shears. Remove and discard the bottom section. Cut and remove the top lock or a new panel. Apply a heavy bead of gutter sealant along the full length of the defective panel. Install the new panel over the sealant. Apply pressure with the palm of the hand. Do not nail the panel.

Wood shingles that are badly curled, cracked, or missing can be removed and replaced relatively easily. Cut nails holding damaged shingles with a hack saw blade. Split shingles with a chisel and remove pieces. Cut a new shingle to fit with a ⅛" to ½" clearance on each side.

Replace trim and corner boards with plastic or wood/plastic composite. This is likely more cost effective than restoring sawn wood trim, which requires thorough drying, renailing, crack filling, and repainting.

STEP 9: Weatherize the Home

Air seal and insulate the home to maximize comfort, minimize energy bills, and avoid moisture problems. Reducing air leakage is an inseparable part of insulating: you should not do one without doing the other.

Provide a continuous air barrier. A continuous air barrier system is a combination of materials linked together to create a tight building envelope. The air barrier should seal all leaks through the building envelope—the boundary between the conditioned portion of your home and the unconditioned area—and be in contact with the insulation. An air barrier also minimizes air currents inside the cavities of the building envelope, which helps to maintain insulation R-values and avoid condensation. (See *Figure 4*.)

So, what does this mean for the homeowner or contractor rebuilding a damaged home? Interior drywall is the primary air barrier, but a good weather-resistant barrier (described previously) is also needed to reduce air infiltration and improve the thermal resistance of the insulation. Taping, caulking, or tar-sealing the housewrap or 15# tarred felt to provide a continuous weather-resistant barrier prevents air leaks that can bypass the wall insulation entirely or reduce its effectiveness.

Seal air leaks. Before installing wall insulation, all holes in the open stud-wall cavities should be sealed with caulk or foam sealant, including holes in the top/bottom plates and sheathing around electrical wires, plumbing pipes, and heating and cooling ducts, as shown in *Figures 6(a) and 6(b)*.

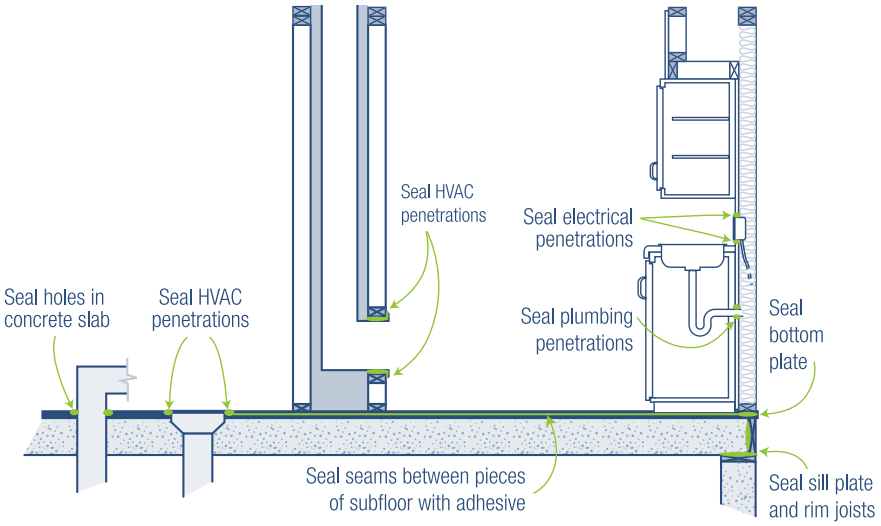
Fully insulate walls. The prescriptive requirements for wall insulation in the International Energy Conservation Code indicate a thermal resistance of at least R-13, except in coastal Texas (south of Galveston) and Florida (south of the panhandle), where the requirement is R-11. A do-it-yourself homeowner is likely to insulate walls with rolls of fiberglass insulation (also called fiberglass batts) because of its availability and ease of installation. Unfaced rolls without the paper backing should be used since an interior vapor barrier is not recommended for hot, humid climates.

Rolls of R-13 fiberglass insulation are 3½" thick and will fit in a 2"x4" wall cavity. A wall constructed with 2"x6" studs and plates can hold R-19 fiberglass batts, which will reduce energy bills better than R-13.

Electrical wires, boxes for receptacle or light switches, plumbing pipes, or ducts should not compress fiberglass batts. Instead, slice the fiberglass so the insulation can be formed around wires and pipes uncompressed. Cut the insulation so it fits neatly around electrical boxes. Stuff spare fiberglass between the back of electrical boxes in the wall sheathing.

If a contractor is repairing the damaged walls rather than the homeowner, cellulose wall insulation blown into open stud cavities may be an option. Using the "wall spray" or "wet spray" method, bags of cellulose with powdered glue added are fed into a truck-mounted blower where the cellulose is chopped up and blown through a ribbed hose. As the cellulose exits the hose, water is sprayed to activate the glue and make the cellulose stick to the wall cavity. A long, rotating brush (reminiscent of a street sweeper) is used to scrape off the excess cellulose, leaving a smooth, flat surface ready for drywall. Some buildings use spray foam insulation, which seals and insulates.

Figure 6(a). Seal all air leaks

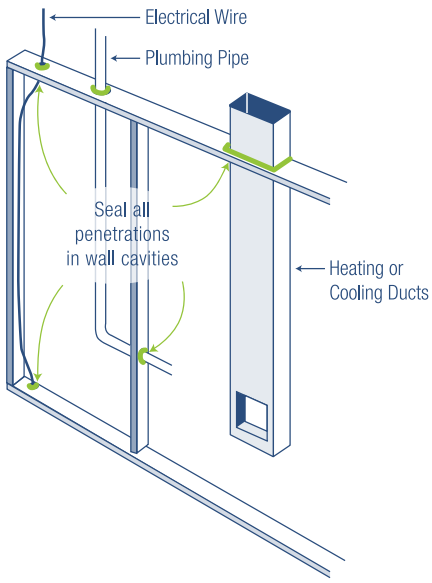


Source: Adapted from Alabama Builder's Field Guide, Alabama Department of Economic and Community Affairs, Southface Energy Institute, Inc.

WIRING IN OLDER HOMES

Older homes may have "knob-and-tube" wiring, where two separate wires run through ceramic tubes inserted into holes drilled in the wall framing. Since this type of wiring was designed to dissipate heat to the air in the empty wall cavity, insulating walls containing knob-and-tube wiring can cause dangerous overheating. Consider having an electrician modernize your wiring so that the walls can be insulated.

Figure 6(b). Seal all air leaks in wall cavities



STEP 10:
Repair Drywall and Plaster

Repair large holes or water-damaged areas of **drywall** with a US Gypsum repair kit or equal. To replace large sections of drywall, nail or screw drywall to existing or newly replaced studs. Scrape excess glue, if any, from the existing studs so that the new drywall is flat and plumb. Mold-resistant drywall is now available, though it is more expensive than standard drywall.

If studs do not adequately back the drywall throughout the entire area, frame the opening with blocking to support new drywall. Cut new drywall panel section to fit damaged area, leaving approximately 1/8" gap all around. Use **quick-setting joint compound and fiberglass tape**, which perform much better under flood conditions than standard drywall compound and paper joint tape.

The least expensive and most desirable way to repair old plaster walls after they dry is to carefully patch and then paint or wallpaper them, but not with vinyl wallpaper. Covering cracked or deteriorated walls with an additional layer of gypsum board or paneling is the next cost-effective option.

The most expensive option is to tear out old plaster in its entirety and replace it with new drywall and trim. Generally, because studs in old walls are typically uneven and will require extensive shimming or furring before new drywall can be applied, it is less expensive to repair up to 50% of walls and ceilings that have otherwise sound plaster, than it is to remove all the existing plaster and replace it with drywall.

WHERE SHOULD THE VAPOR BARRIER BE INSTALLED IN HOT, HUMID CLIMATES?

The primary purpose for installing a vapor retarder in residential rehabilitation is to minimize vapor migration into a wall or roof assembly where it has the potential to condense when the dew point is reached. *(See Figures 6(a) and 6(b).)* The resulting water in liquid form may cause decay in structural wood framing, wood-based sheathing materials, and interior gypsum board or plaster wall coverings. The prolonged presence of moisture also will encourage and facilitate mold and mildew growth, raising potential serious health concerns for the occupants of the home.

In hot, humid climates, moisture moves from outside to inside. Therefore, the vapor barrier should be on the outside of the wall sheathing. While neither 15# tarred felt nor housewrap are vapor barriers, they will act as a vapor retarder if the seams are properly sealed.

In hot, humid climates, wall assemblies should be built to allow drying toward the interior by using permeable interior wall finishes, installing cavity insulation without vapor retarders (i.e., unfaced fiberglass batts), and avoiding interior wall coverings such as vinyl wallpaper *(see Figure 5)*. Only in cold climates well north of the Gulf Coast states is an impermeable vapor barrier such as 3 mil polyethylene plastic sheeting required. In fact, a polyethylene vapor barrier in the Gulf Coast states could trap moisture inside the wall cavities, potentially causing rot, decay, and mold growth.

The material in this Tech Brief was adapted from the following sources:

Alabama Builder's Field Guide: *Energy Efficient Building Envelope* prepared for the Alabama Department of Economic and Community Affairs by Southface Energy Institute, Inc., September 2004

Durability by Design: *A Guide for Residential Builders and Designers* Partnership for Advancing Technology in Housing, U.S. Department of Housing and Urban Development, May 2002

Field Testing of Energy-Efficient Flood-Damage-Resistant Residential Envelope Systems, Summary Report Oak Ridge National Laboratory, 2004

Fortified…for safer living®, Builder's Guide Institute for Business & Home Safety, January 2005

Rebuilding After a Hurricane Institute for Business & Home Safety (undated)

Repairing Your Flooded Home American Red Cross, 1992

The Rehab Guide Volume 2: Exterior Walls prepared for the U.S. Department of Housing and Urban Development, August 1999

The Rehab Guide Volume 5: Partitions, Ceilings, Floors, and Stairs prepared for the U.S. Department of Housing and Urban Development, August 1999

Common Questions and Answers About Mold and Wood-Based Products Forest Products Laboratory Advanced Housing Research Center, Residential Moisture Management Network

FOR MORE INFORMATION SEE:

Building America Best Practices Series: Volume 1: *Builders and Buyers Handbook for Improving New Home Efficiency, Comfort, and Durability in the Hot and Humid Climate* www.buildingamerica.gov

Energy Efficient Rehab Advisor www.rehabadvisor.com

Practices for Improving Hurricane Resistance www.pathnet.org/hurricane

ENERGY STAR www.energystar.gov

JANUARY 2006