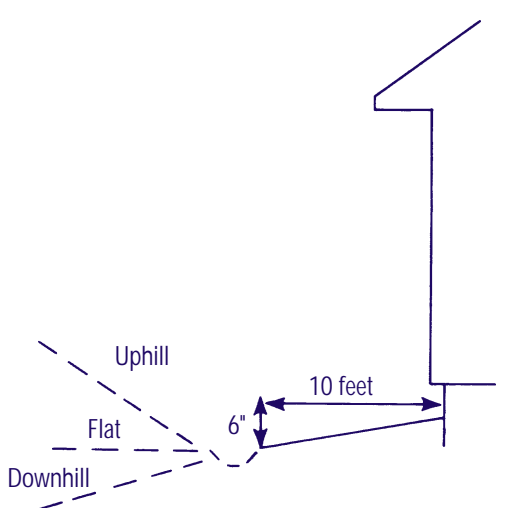


Residential Moisture Control - Basics

Big Ten Checklist

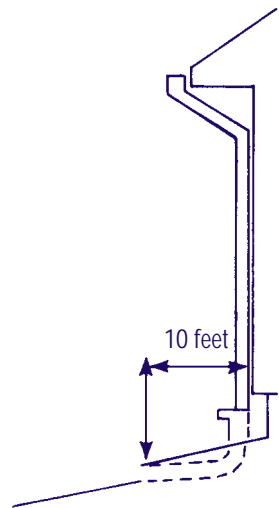
Requirements for the Prevention and Control of Moisture Damage in Residences



Uphill
Flat
Downhill

10 feet
6"

Check **1.** *Surface water drains away from the structure and is well managed on the site.*

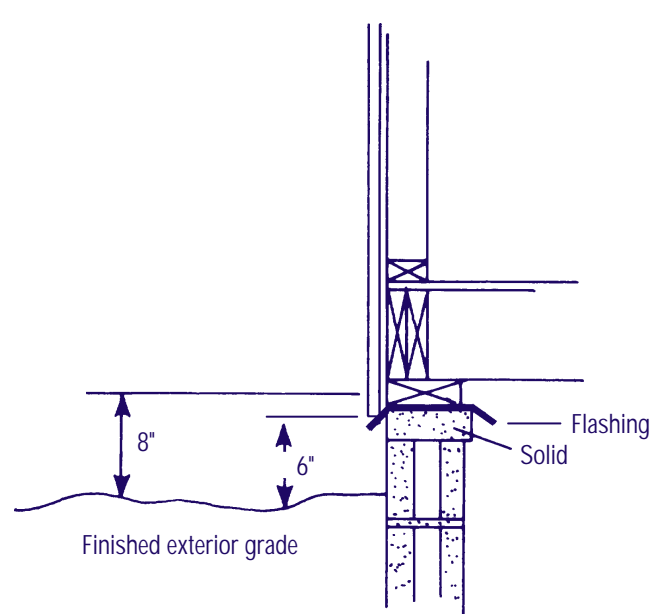


10 feet

Check **2.** *Drainage water from drain pipes, impervious surfaces and attachments to the structure are properly released and drain away from the structure.*

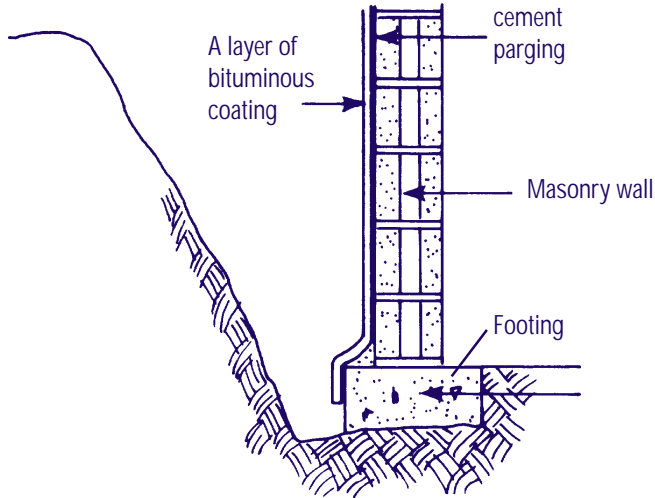
Check **3.** *Exterior ground surfaces occur no closer than six (6) inches below untreated wood or wood composition siding.*

Check **4.** *No untreated structural wood is used within eight (8) inches, horizontally or vertically, of any soil.*

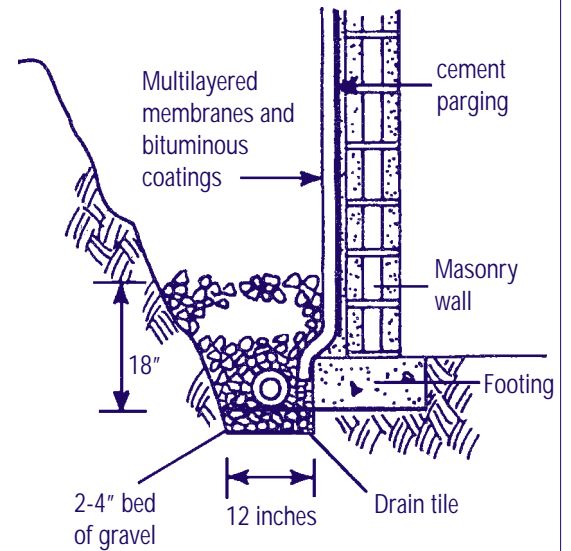


8"
6"
Finished exterior grade
Flashing
Solid

Damp Proofing

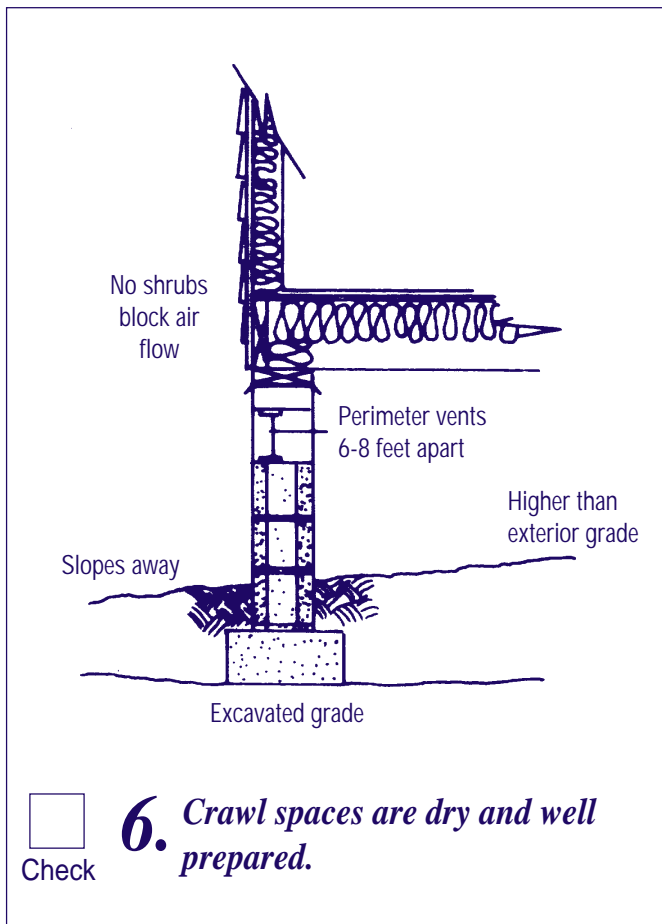


Waterproofing



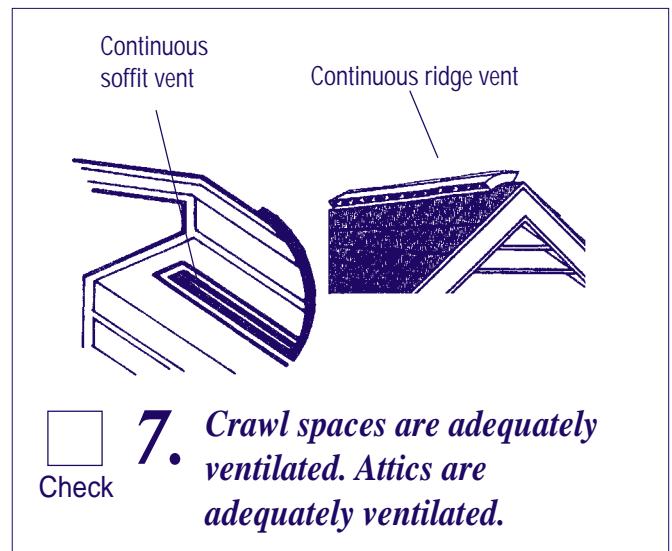
Check

5. *Damp proofing and/or waterproofing of slabs, basements and/or crawl spaces have been installed where required or needed.*



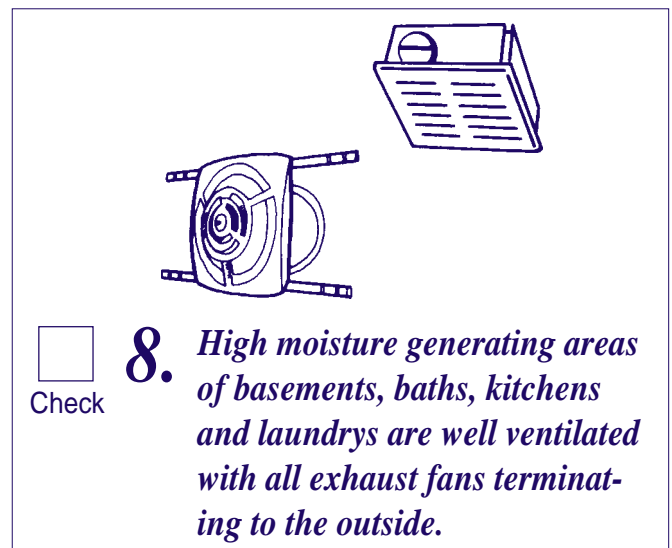
Check

6. *Crawl spaces are dry and well prepared.*



Check

7. *Crawl spaces are adequately ventilated. Attics are adequately ventilated.*



Check

8. *High moisture generating areas of basements, baths, kitchens and laundries are well ventilated with all exhaust fans terminating to the outside.*

9. *All roof and wall penetrations (such as windows, doors, chimneys, dormers, skylights, vent pipes, wires) are flashed, counter flashed and caulked properly.*

10. *Medium and tall shrubs are located at a proper distance away from the walls of the structure.*

CODE REQUIREMENTS AND AIDS FOR MAKING JUDGEMENTS AND DECISIONS ON THE BIG TEN CHECKLIST FOR PREVENTION AND CONTROL OF MOISTURE DAMAGE IN RESIDENCES

Following are some building code requirements and Clemson University recommendations that relate to the ten items on the BIG TEN checklist. Code quotations are from the CABO (Council of American Building Officials) Code, 1995. Political jurisdictions (counties, cities) adopt the Southern Standard Building Code for use which references, in Appendix N, the CABO Code as the applicable code for one and two family residential structures three stories or less in height. The CABO code is also the basis used by the South Carolina Residential Builders Commission for training and licensing homebuilders in South Carolina, along with the National Electrical Code.

Clemson University recommended practices come from various sources within the University and are based upon long term experience and considerable knowledge in dealing with housing problems in our warm moist climate. Departments and Colleges in the University who have been concerned and participated in the development of recommended procedures include Agricultural and Biological Engineering, Architecture, Entomology, Forestry, Family and Youth Development, and Horticulture. While the BIG TEN checklist is concerned with ten factors often found to cause problems across the state, the list certainly does not cover all factors from which problems emanate - just ten very common factors. Leaky plumbing, for example, is one major and commonly occurring cause of moisture problems not included here as it is obvious, easily understood and has a clear solution.

ITEMS 1. AND 2. DRAINAGE

The first defense against the development of moisture problems in structures comes with keeping large volumes of water from reaching the structure, and draining rain water rapidly away.

CABO CODE RELATED REQUIREMENTS INCLUDE: "SECTION 401.3 DRAINAGE: Lots shall be provided with adequate drainage and shall be graded so as to drain surface water away from foundation walls. The grade away from foundation walls shall fall a minimum of 6 inches within the first 10 feet, except as restricted by lot lines where the fall will be a minimum of 6 inches regardless of the horizontal distance available."

CLEMSON NOTE: It must be remembered that codes are **minimum** requirements. It is often possible to divert water farther than 10 feet away from the structure and releasing it 20 feet away would be a better situation. The requirement is applicable to all sides of the house. Each homeowner must control his own storm water on his own site releasing it to a storm drainage system on the street, into dry wells, etc. but never releasing it onto a neighbor's lot.

"CABO CODE SECTION 801.3 - ROOF DRAINAGE: In areas where expansive or collapsible soils are known to exist, all dwellings shall have a controlled method of water disposal from roofs that will collect and discharge all roof drainage to the ground surface at least 5 feet from foundation walls or to an approved drainage system."

CLEMSON NOTES: In addition to release of rain water from roof collection systems, water discharged from sump pumps and condensation drains should be similarly directed. Once again, a discharge point at a greater distance would be helpful. Clearly, **splash blocks 18-24 inches long do not meet this requirement** as they release water much too close to the structure. South Carolina's soils occur as both expansive (clays) and collapsible (sands).

Impervious surfaces such as driveways and walks, and attachments to structures such as porches, entry slabs, patios, staircases, etc. must be sloped so as to direct water away from the structure.

ITEM 3 & 4: CLEARANCES BETWEEN UNTREATED WOOD AND SOILS AND OTHER ORGANIC MATTER

"CABO CODE SECTION 404.1.3 BACKFILL: Foundation walls shall extend at least 6 inches above the finished grade adjacent to the foundation at all points.

CABO CODE PROTECTION AGAINST DECAY (Section 322) AND TERMITES (Section 323): LOCATION REQUIRED: In areas subject to termite or decay damage (Note: All of S.C. is classified as very heavy on termite and slight to severe on decay probability)...the following locations shall require the use of approved species and grade of lumber pressure preservatively treated...or decay-resistant...CABO code 322.1

2. All sills or plates which rest on concrete or masonry exterior walls and are less than 8 inches from exposed ground. CABO code 322.1(2)
3. Sills and sleepers on concrete or masonry slab which is in direct contact with the ground. CABO code 322.1(3)
4. Wood siding, sheathing and wall framing on the exterior of a building having a clearance of less than 6 inches from the ground." CABO code 322.1(5)

ITEM 5: DAMPPROOFING AND WATERPROOFING REQUIREMENTS

CLEMSON NOTE: Confusion often exists about the difference between dampproofing and waterproofing and many people think there is no difference. **There is a big difference** - in procedure, cost and performance, though to the untrained eye, appearance may be the same because some materials used are the same. Dampproofing serves to exclude or inhibit the migration of **moisture vapor** through a wall while waterproofing

excludes **water in liquid form** from passing through a wall. The main difference however, comes with the provision of a membrane layer strong enough to withstand the pressure of standing water in the case of water-proofing. Code requirements are as follows:

“CABO CODE SECTION 405.1 FOUNDATION DRAINAGE: CONCRETE OR MASONRY FOUNDATIONS: Drains shall be provided around all concrete masonry foundations enclosing habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials shall be installed at or below the area to be protected and shall discharge by gravity or mechanical means into an approved drainage system. Gravel or crushed stone drains shall extend at least 1 foot beyond the outside edge of the footing and 6 inches above the top of the footing and be covered with an approved filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper, and the drainage tiles or perforated pipe shall be placed on a minimum of 2 inches of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches of the same material.

CABO CODE SECTION FOUNDATION DAMPPROOFING: 406.1 DAMPPROOFING FOR CONCRETE AND MASONRY FOUNDATIONS: Exterior foundation walls of masonry construction enclosing basements shall be dampproofed by applying not less than 3/8 inch of portland cement parging to the wall from footing to finish grade. The parging shall be covered with a coat of approved bituminous material applied at the recommended rate. Exterior foundation walls of construction enclosing basements shall be dampproofed by applying a coat of bituminous material to the wall from the footing to the finish grade at the recommended rate. Foundation walls of habitable rooms located below grade shall be waterproofed with membranes extending from the edge of the footing to the finish grade line. The membrane shall consist of either 2-ply hot mopped felts, 6-mil polyvinyl chloride, 55-pound roll roofing or equivalent material. The laps in the waterproofing membrane shall be sealed and firmly affixed to the wall...”

CLEMSON NOTE: Additional appropriate procedures are contained in the CABO code for wood foundations and columns. Other methods of waterproofing may be approved on an individual basis by a code inspector.

ITEM 6: CRAWL SPACE CONDITIONS

A majority of South Carolina homes are built over partial or complete crawl spaces. Prevailing conditions in the crawl space largely determine the ability of the structure to withstand moisture and insect damage. Conditions should demonstrate :

- Removal of all organic material

- Dry, clean, smooth surfaces

- Sufficient height to provide an adequate volume of free flowing ventilating air to accomplish such conditions and maintain them over the life of the structure. A number of code requirements and additional recommendations are :

“CABO CODE SECTION 409 CRAWL SPACE; 409.3 REMOVAL OF DEBRIS: The under-floor grade shall be cleaned of all vegetation and organic material.” (Note: Organic material includes roots, stumps, topsoil, paper, sawdust, wood, etc.). All wood forms used for placing concrete shall be removed...All construction materials shall be removed...”

“CABO CODE 409.4 FINISHED GRADE: The finished grade of under-floor space may be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches of the finished grade at the building perimeter or where there is evidence that surface water does not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade, unless an approved drainage system is provided.”

CLEMSON NOTE: These conditions prevail over most of the state. Our high rates of rainfall produce very wet conditions often over long periods of time; thus crawl space finished grades should be at or above adjacent exterior finished grades.

“CABO CODE 322.1(1) LOCATION REQUIRED (FOR TREATED LUMBER USE):

1. Wood joists or the bottom of a wood structural floor where closer than 18 inches or wood girders when closer than 12 inches to exposed ground in crawl spaces or unexcavated areas located within the periphery of the building foundation.”

ITEM 7: CRAWL SPACE AND ATTIC VENTILATION

Ventilation is the major natural method used to remove air from crawl spaces with a high relative humidity level. Such ventilating procedures also remove other gases such as radon that may collect in crawl spaces. Thus the factors in adequate ventilation are related to: (1) volume of air, (2) the relative humidity of the outside air and the crawl space air, (3) unblocked air passages and adequate inlets and outlets. Similar conditions prevail in attics. Following are code requirements.

“CABO CODE 409.1 CRAWL SPACE VENTILATION: The space between the bottom of the floor joists and the earth under any building (except such space as is occupied by a basement or cellar) shall be provided with ventilation openings through foundation walls or exterior walls. Ventilation openings shall be provided with corrosion-resistant wire mesh, with the least dimension being $\frac{1}{8}$ inch. The minimum **net** area of ventilation openings shall not be less than 1 square foot for each 150 square feet of crawl space area. One such ventilating opening shall be within 3 feet of each corner of said building. Exceptions:

1. Ventilation openings may be vented into the interior of buildings where warranted by climatic condition.
2. The total area of ventilation openings may be reduced to 1/1500 of the under-floor area where the ground surface is treated with an approved vapor barrier material and one such ventilation opening is within 3 feet of each corner of said buildings. The vents may have operable louvers.”

CLEMSON NOTE: The above exception #2 has produced unsatisfactory conditions within crawl spaces and is **not recommended for use in S.C.** Dips allowing ponding on top of polyethylene vapor barriers, “sweating” ductwork dripping onto barriers, seepage of water into crawl spaces from differentials in crawl space finish grade in comparison to exterior finish grade all produce accumulation of large amounts of excess moisture that overwhelms minimum ventways reduced ten times or 1/10 of standard provision without vapor barriers. Instead, Clemson recommends installation of vents based on one square foot of clear vent area per 150 square feet of crawl space area placed along all sides of the perimeter foundation walls, **regardless of the addition of ground coverings or the existence of attached carports or porch slabs.**

“3. Ventilation openings may be omitted on one side.”

CLEMSON NOTE: See above note. This provision is to allow an adjacent car port slab to be poured abutting the foundation wall on one side without requiring ventways along the abutting walls. But ventilation should continue to be provided along the abutting foundation wall thus not cutting off free air flows but instead continuing to ventilate all crawl spaces. The same is true when porch slabs extend farther than 4 feet along a foundation wall. See Extension leaflet HL 244 “Two Special Cases of Crawl Space Ventilation.”

ADDITIONAL CLEMSON RECOMMENDATIONS:

1. The crawl space finished grade should be **equal to or higher than** the adjoining exterior finished grade.
2. A crawl space finished grade with a crowned center that is smooth and clean is preferable.
3. When ductwork is installed in crawl spaces for heating and cooling units, consideration must be given to prevent the blocking of cross ventilating air within the crawl space. Additional height is usually required in the crawl space to compensate for blocking free air flow passageways with ductwork.

“CABO CODE SECTION 806 ROOF VENTILATION: When determined necessary by the building official due to atmospheric or climatic conditions, (CLEMSON NOTE: Should apply to all of S.C.) enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilating openings shall be provided with corrosion-resistant wire mesh, with the least dimension being $\frac{1}{8}$ inch.

“CABO CODE SECTION 806.2 MINIMUM AREA. The total **net free** ventilating area shall not be less than 1 to 150 of the area of the space ventilated except that the total area is permitted to be reduced to 1 to 300, provided at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1 to 300 when a vapor barrier having a transmission rate not exceeding 1 perm is installed on the warm side (interior living space) of the ceiling.”

“806.3 VENT CLEARANCE. Where eave or cornice vents are installed, insulation shall not block the free flow of air. A minimum of 1 inch space shall be provided between the insulation and the roof sheathing at the location of the vent.”

ITEM 8: HIGH MOISTURE GENERATING AREAS IN THE LIVING SPACE

“CABO CODE SECTION 303 LIGHT AND VENTILATION 303.1 HABITABLE ROOMS: All habitable rooms shall be provided with aggregate glazing area of not less than 8 percent of the floor area of such rooms. One half of the required area of glazing shall be operable.

Exceptions:

1. The glazed areas need not be operable where the opening is not required by Section 310 [exits] and an approved mechanical ventilation system is provided capable of producing 0.35 air change per hour in the room or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cubic feet per minute (CFM) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom.
2. The glazed areas may be omitted in rooms where the opening is not required by Section 310 [exits] and an approved mechanical ventilation system is provided capable of producing 0.35 air change per hour in the room or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cfm per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom, and artificial light is provided capable of producing an average illumination of 6 foot candles over the area of the room at a height of 30 inches above the floor level.”

“CABO CODE SECTION 303.3 BATHROOMS: Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet, one-half of which must be operable.

EXCEPTION: The glazed areas shall not be required where artificial light and an approved mechanical ventilation system capable of producing a change of air every 12 minutes are provided. Bathroom exhausts shall be vented directly to the outside.”

“CABO CODE SECTION 1802.1 RANGE HOODS: Range hoods shall be vented to the outdoors by a single-wall duct constructed of galvanized steel, stainless steel or copper...have a smooth interior surface, be substantially air tight and shall be equipped with a backdraft damper. Vents serving range hoods shall not terminate in an attic or crawl space or areas inside the building...”

“CABO CODE SECTION 1801.1 CLOTHES DRYERS (MOISTURE EXHAUST) Dryer vent systems shall be independent of all other systems and shall convey the moisture to the outdoors...Approved flexible duct connectors may be used in connection with domestic dryer exhausts. Flexible duct connectors shall not be concealed within construction.” NOTE: See code for additional details on vent size, length limitation, and restrictions on bends.

ITEM 9: CAULKING AND FLASHING

“CABO CODE SECTION 703.8 FLASHING: Approved corrosion-resistive flashing shall be provided at top and sides of all exterior window and door openings in such a manner as to be leakproof, except that self-flashing windows having a continuous lap of less than 1 1/8 inch over the sheathing material around the perimeter of the opening, including corners, do not require additional flashing; jamb flashing may also be omitted when specifically approved by the building official. Similar flashings shall be installed at the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings; under and at the ends of masonry, wood or metal copings and sills; continuously above all projecting wood trim; where exterior porches, decks or stairs attach to a wall or floor assembly of wood-frame construction; at wall and roof intersections.”

CLEMSON NOTE: (1) All penetrations of roofs and walls need special consideration for excluding moisture by flashing, counter flashing and caulking. Chimneys should be flashed and counter-flashed. Windows and doors should be flashed at the top, bottom and sides. Pipes and wires penetrating walls and roofs must be sealed where they pass through the structure. (2) Flashing must be placed at any place where two unlike materials join, such as wood and concrete. (3) Where water running across surface congregates or changes direction, special measures are needed such as roof valleys and edges and joints in vertical siding. (4) Small penetrations through walls by such things as wires must be caulked.

ITEM 10: LANDSCAPING

CLEMSON NOTE: In general, codes do not specifically cover landscaping requirements though most developers and home builders provide some basic landscape plantings and owners add others. However, codes do give clues to moisture control considerations when landscaping by providing that watering of landscape materials should not occur closer than 5 feet to a structure in order to prevent oversoaked soils near the foundation. Thus a planting formula for medium (6-8 feet in mature height) and tall (greater than 8 feet in mature height) shrubs is: Locate a medium or tall shrub a minimum of 5 feet plus 1/2 the mature diameter of the shrub from any structural wall. By adding 1/2 mature diameter of the shrub, the second moisture control consideration is accomplished - a free air circulation area around the structure for clear ventways around foundations and soffit vents and a lessened likelihood of stagnant warm moist air around the house which promotes the development of mildew. The first 12 inches of ground surface adjacent to the house foundation may be covered with gravel or other low inorganic ground cover to minimize rain or roof water splashing up from the bare soil. Splashing contributes to wall decay and discolors the wall surface.

Caution: Organic mulch (such as wood bark, pine straw) may provide a physical bridge across the chemical termiticide barrier immediately next to the house foundation. Keep any organic mulch or ground cover **at least 12 inches away** from the foundation.

Revised by Linda L. Redmann, Ph.D., Extension Residential Housing Specialist, from original publication by Barbara J. Griffin, Former Extension Housing Specialist, Agricultural Engineering Department.

Appreciation is extended to Wayne Shirley, Special Investigator, Building Codes, SC Department of Labor, Licensing and Regulation for reviewing for compliance with current CABO One and Two Family Dwelling Code (1995 edition).



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