ALABAMA COOPERATIVE EXTENSION SERVICE/AUBURN UNIVERSITY/AUBURN, ALABAMA

Sea Grant Considery

GUIDELINES

F O R

HURRICANE RESISTANT CONSTRUCTION



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Oct. 25, 1979

MEMORANDUM

To:

Coastal Leaders & Residents

From:

Mac V. Rawson, Jr., Specialist

Subject: Furth

Further Information on Storm Resistant Structures

A few weeks ago I forwarded you information regarding building storm resistant structures. Enclosed is another Community Resource Development Timely Information publication with further information in this area.

There has been some confusion regarding the nature of this information. $\underline{YOU\ DO\ NOT\ HAVE\ TO\ FOLLOW\ THESE\ GUIDELINES}$. These publications are only for your information as we are not a regulatory agency but an educational organization.

MVR/bd Enclosure Any type of construction (i.e. wood, brick, or masonry) can be designed-to withstand hurricane force winds if designed properly. This publication is aimed at providing some general guidelines. Much of the information within this section can be obtained in two excellent publications: "Houses Can Resist Hurricanes" FPL 33 by the Forest Products Laboratory, and "How to Build Storm Resistant Structures" by the Southern Forest Products Association.

Wood Frame Construction

Wood is an excellent building material for use in the hazar-dous coastal zone provided it is properly treated. Using good anchorage and fasteners can make the difference in a normal house and a hurricane-resistant house.

To be structurally sound, a building should be rigidly fastened. Proper fastening throughout the entire building is the key to good construction. This process begins at the foundation where the wood sill is anchored to the concrete or concrete block foundation wall (Figure 1). From there fastening should continue from the sill to the wall studs (Figure 2). Commercial framing anchors and fastenings are available for this type construction which consists of punched metal straps. These types and other similar connectors are used in the Southern Standard Building Code and are available at building suppliers.

At the top of the walls, other type metal connectors can be used (Figures 3, 4) to provide a rigid connection between the wall studs, plate, and the roof trusses.

Poor nailing practices are also a cause of numerous building failures due to high winds.

Due to the severe racking forces encountered in high winds, it is recommended that wood frame homes use either plywood sheathing or wood sheathing on all walls of the house. Additionally, plywood sub-flooring and attic flooring should be used to increase wind resistance.

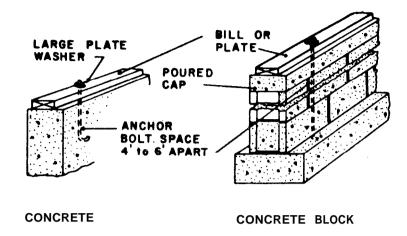


Figure 1 Anchoring wood sill or plate to foundation.

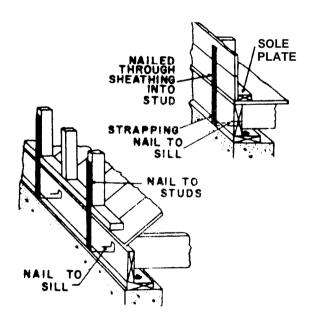


Figure 2 Foundation-to-wall connections: \underline{A} , straps nailed directly to studs; \underline{B} , straps nailed through sheathing into studs.

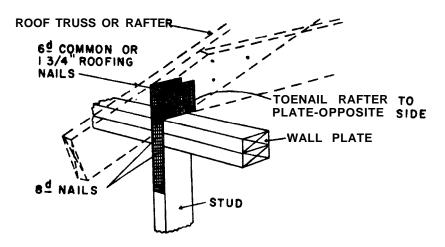


Figure 3 Single member plate connectors.

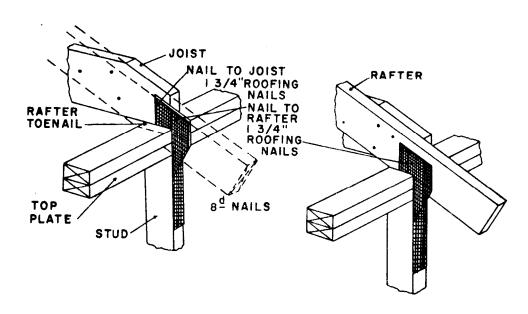


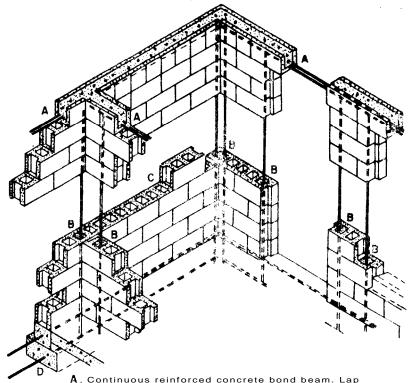
Figure 4 Rafter-to-stud plate connector for:
A, ceiling joist over stud, and B,
rafter over stud.

Masonry and Brick Construction

Unsupported masonry walls of typical home construction with a height of 8-9 feet per floor, are enough to withstand typical hurricane-wind forces if they are constructed in accordance with the Southern Standard Building Code. This would include reinforcement bars internally through the blocks from foundation to ceiling in inside and outside corners of the house and at all framed doors or large windows in the case of masonry block walls (Figure 5). A continuous reinforced concrete bond beam completes the top layer and should be tied into the roofing system by metal fastenings (hurricane clips) or some method of bolting.

The exterior surface of concrete block walls should be stucced or waterproofed. The interior of concrete block walls should have furring strips and then interior cladding to reduce any throughthe-wall moisture penetration. Water may condense in uninsulated masonry block but can be controlled by installing a vapor barrier on the warm side of the wall. A water emulsion asphalt paint applied to the wall surface as it is constructed is one method used to provide a moisture barrier. Moisture penetration through masonry foundation walls below grade is controlled by pargeting the outer face with portland cement plaster or mortar.

Cavity type brick walls with inner cavities not greater than 2 feet have withstood the strongest winds of 150 mph. This type of wall (Figure 6) should have metal ties not less than one per two square feet of wall bonded into the mortar between walls, Cavity walls are very good for severe exposure because the cavity acts as a barrier to moisture. Rain penetration to the inside wall is practically impossible if proper flashing and weep (drain) holes are installed. To be effective certain precautions must be observed during construction,



- A. Continuous reinforced concrete bond beam. Lap bars at corners
- B Reinforced concrete studs tied to footing
- C Reinforcement in horizontal mortar joints
- D Reinforced concrete footing

Figure 5 Typical methods of reinforcing concrete masonry walls.



Figure 6 Cavity type walls.

The cavity must be kept free of mortar droppings and weep holes must be provided in conjunction with flashing to properly drain the cavity of any water which enters the outer wall and collects on the flashing. A vapor barrier is not required in a cavity wall where the cavity is insulated with fill materials such as water repellent vermiculite or silicon treated perlite which will not retain excessive moisture, or with rigid board materials such as glass tubes, framed glass, or foamed plastics that are at least 1" less in thickness than the cavity and are installed next to the inner wall.

Solid brick walls bonded with masonry headers are considerably less resistant to rain penetration than the metal tied cavity type walls and should not be used in this severe exposure area.

If veneer brick walls are to be used (Figure 7), wood or plywood sheathing should be used behind it to provide protection against water penetration and also to provide additional racking resistance. Corrosion resistant metal ties should be used to tie in the brick work to the sheathing and studs. One metal tie should be provided for each 2 feet of wall area.

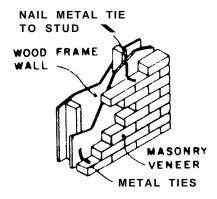


Figure 7 Veneer Brick Wall

Pole Houses

Due to the enactment of the National Flood Insurance Program and the requirement that the first habitable floor level of the building be above the 100 year storm tide, many of the

future residential structures built in the coastal zone will be required to be on poles (i.e. pole houses or "stilt" houses). Pole houses are a special type of wood house using pressure treated timber poles to provide elevation and structural strength. In areas where erosion due to wave forces or deflation due to wind forces can cause a loss of foundation material, it is also wise to use pole type construction.

Two basic types of pole house construction exist. One type has its poles cut off at the first floor level and is tied into the first floor. A better type of construction from a structural standpoint is to have the pole system running throughout the structure and tying into the house frame at the first floor level and the rafters.

Depth of pole embedded for a given house depends on both the house shape, exposed surfaces to the wind, wind speed and height of structure above ground. If the structure is built too close to water or is built in an area of loose sand (i.e. no vegetative cover to prevent deflation), then consideration should be given to possible loss of pole embedment cover due to erosion by wind or water. Determining pole embedment in the design of a pole house is the job of a professional engineer or architect and should not be attempted by unqualified persons. Lateral and diagonal bracing between poles to provide for wind or water forces is also a job for professional engineers or architects.

Where diagonal structural bracing is to be used between poles, (in areas where design flood level is above grade), it is suggested that cable-type cross bracing be used to minimize water or wave forces on the structural framing. Another good building practice is to use plywood sheathing on the underside of the house.

Where through-house type pole construction is not used, it becomes necessary to properly anchor the house to the poles. Again, a professional engineer or architect should either design or certify the design of such structures to withstand the required structural loadings of the house.

It is common practice in pole-house construction to have a contractor who specializes in pole-type construction build the pole and beam framing for the house, while a second contractor (home builder) builds the house to design specifications on this framing system.

Special Considerations

Roofs

By far, the greatest damage to homes in hurricane zones is roof losses and consequent water damage. Although any roof can be properly designed to withstand hurricane forces, some roof types are considerably better than others. Shapewise, it appears, hip roofs are better than gable roofs while at the same

time more steeply pitched roofs fair better than low-pitch roofs. Low-pitch roofs act as airfoils and have higher uplift pressures exerted on their windward sides. Resisting uplift pressures becomes of more importance in design of low--pitched roofs.

It appears from research on wind pressure on roofs that roofs having a pitch angle of over 40° should prevent suction pressures from developing on the windward side of roofs.

The majority of roofs today are framed with prefabricated roof trusses which have tension-compression web members in them. These provide a very good framing system. Although the designer should require that the trusses be sufficiently strong to withstand design wind loads.

It appears that the longitudinal bracing provided for in hip roofs may contribute to the success of hip roofs over the more common gable-type roof systems.

Roof coverings should be used which high winds do not cause a loss of water shedding ability. Both wood shingles and wood shakes have resisted storm damage better than most roofing materials. Asphalt shingles have performed poorly in most instances, although much of this is believed due to a lack of good fastening techniques used. Metal roof cladding has proved to be least acceptable and has failed in numerous instances. Again, though, the probable cause was the lack of proper fastening procedures of the metal roofing to the roof system.

Large overhangs (eaves) are a major cause of roof Failures. Eaves should extend out from the building a minimum distance necessary to provide drainage. Proper shading from the sun can be provided by shutters or awnings designed to be bolted down during storms.

Doors, Garage Doors

Any doors to be used in hurricane-prone zones should he checked for design loading by a professional engineer or architect, or be certified by the seller as to strength under a given design wind load. This is especially true of garage doors. There have been many failures of typical metal and wood overhead sliding doors. A typical failure in overhead garage doors occurs when the wind causes the door to 'buckle which allows the garage door rollers to come out of their tracks causing a total failure. Projected missles are also of considerable danger in a hurricane. Both doors and garage doors should be strong enough to prevent damage due to flying objects such as a 2" X 4" or tree limbs.

Failures of both garage and normal doors occur due to poor attachment to the framing. Usually a door is connected by two hinges and a lock. Additional fixtures such as dead bolts can be fastened onto the framing for use during hurricanes to provide more rigid connection to the house framing.

Garage doors can have similar connections made depending on the type of door. Again, due to the importance of doors in providing both protection to the interior and preventing wind-blown water damage, it is desirable to have these features checked for their strength by a professional engineer or architect where building codes are lacking.

Windows, Glass, Glazing, and Hurricane Shutters

No window is safe from projected missiles such as tree limbs or similar storm debris. For this reason, it is suggested that storm shutters of adequate strength to prevent missle damage be used with all window systems. Storm shutters can help minimize glass breakage. For swellings, the combination awning pull-down type offers ease of operation with reasonable possibilities of protection.

Additional damage due to wind blown water during hurricanes can be prevented by insuring that good caulking practices are around the window system.

Landscaping and Siting

Proper landscaping and siting of a home can be of great value to a home owner as a protective measure.

The more exposed the house, the higher the winds it will experience. Siting a house behind a sand dune on a pole type frame is better than building on the dune, even if the final floor elevation is at the same height. This is because the dune will deflect the winds upward and also reduce wind speeds somewhat.

The home closest to the coast or bay may provide the best scenic view, but, from a protection standpoint, has the worst exposure to severe weather. Usually the greatest damage from winds is found in the first row (most exposed) of homes. Of course, this is true for water and wave damage also. As wind speeds are significantly reduced when wind passes over land, as opposed to water, it pays to construct as far away from the water as is reasonable.

Vegetation prevents sand from blowing and therefore causing either wind-blown sand abrasion damage, loss of foundation material (scour), or a buildup of sand against a wall causing additional structural loading that the house was not designed for. Providing good vegetation to hold sand in place during high winds should be in a coastal homeowner's checklist.

As mentioned earlier, exposure to higher winds increases with height. Keep as low a profile as possible and yet be above storm tide design level.

SUMMARY

The following items provide a checklist for home builder or home buyer considerations when building in the high hazard coastal area:

- 1. Check to see if your area is covered by adequate building codes. Find out what important provisions have been put into the code to protect you from wind or water damage due to poor construction practices.
- 2. Find out what design flood levels are for your area. You must again decide whether you wish to be more conservative than the local regulations provide for.
- 3. Find out what design wind loads are for your area. You must again decide whether you wish to be more conservative than the local regulations provide for.
- 4. Consider the details: The large majority of homes experience minor hurricane damage due to some small overlooked portion of design. Either change the plans if you are building a home, or modify the existing structure in case you are buying an existing home.
- 5. Have a design professional check out your home plans and certify them as adequate to withstand your specified hazard designs or his recommended designs. If you are buying a home, have him check out the home for possible modifications to make it structurally sound against wind or water.

Adapted from:

Walton, Jr., T. L. 1976. Hurricane-resistant construction for homes. Florida Cooperative Extension Service, Marine Advisory Program. SUSF-SG-76-005, 31 p.

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