UNIVERSITY OF NORTH CAROLINA
SEA GRANT COLLEGE
NEWSLETTER

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The well-built beach house has:
—tiedowns connecting roof to walls to foundation;
—sufficient elevation to be above most storm waters;
—pilings of sufficient depth to withstand considerable beach erosion;
—well-braced pilings;
—and, no permanent walls enclosing pilings.

The well-built beach house

It's no secret that storms on North Carolina's coast take their toll on construction. As development increases, so does the loss of property. But it has been over 20 years since the last really severe hurricane struck the coast. "People have forgotten or are not aware of the destructive nature of hurricanes, and the quality of construction has continued to deteriorate," says Dr. Jerry L. Machemehl, of the North Carolina State University School of Engineering.

"Very few people would be prepared for a major hurricane," says Machemehl. "Most of our structures would not stand a very catastrophic storm based on how they're presently built. We do feel though that by properly anchoring the structures, by putting the piles into a sufficient depth, by choosing the right size

(See "Houses," page two)

Houses could stand 100 years

(Continued from page one)

members, by using the right type of wall section that we could harden these structures and decrease their vulnerability to the storms."

With Sea Grant funding, Machemehl is developing minimum foundation, roof and framework standards that will enable coastal builders to construct more storm resistant houses. Eventually Machemehl plans to compile his findings into a model building code which he will present to state officials.

Machemehl believes that a properly designed house, using the guidelines listed on page one, could stand for 100 years. Today most coastal structures do well to last 30 to 40 years, he says. Some even estimate average life at only 25 years. Machemehl and others believe that the keys to safety are getting the house above storm waters, presenting minimum resistance to those waters, and making the house one solid unit to resist destructive forces.

Coastal storms subject buildings to basically four types of damage. The most destructive force generated by a hurricane is usually the storm surge. The surge is a mound of water pushed up ahead of a hurricane advancing inland from the water. According to Machemehl, the surge causes the greatest property damage and loss of life. Nine out of 10 people who die during a hurricane are drowned by the storm surge.

Another major destructive force is flooding both from heightened ocean level and from the torrential rains that accompany hurricanes. Taken together, storm surge and flooding cause structural and foundation failures, says Machemehl.

Then come the winds. Minor damage such as broken windows can be expected with winds of about 50 miles per hour. Major structural damage begins to occur when winds exceed 100 miles per hour. If a roof goes, as is often the case in high winds, then walls are also subject to collapse and the entire structure is jeopardized.

Finally, erosion results from a combination of surge, winds and flooding. Beach structures are often undermined during severe beach erosion, weakening foundations and other structural supports, according to Machemehl.

The most severe damage to buildings in the coastal zone results from foundation failures, Machemehl reports. Next in severity is roof failures, normally caused by inadequate ties between the structure and the roof. The least severe damage, but largest in terms of monetary loss, involves failure of siding, broken windows, loss of porches and garages.

A major shortcoming of present construction, Machemehl contends, is that pilings are not placed deeply enough. The North Carolina Residential Building Code appendix on coastal construction specifies that pilings be placed at a depth of eight feet below the natural grade of the lot. But Machemehl says that often isn't deep enough. Erosion can undermine pilings, leaving the house vulnerable to wind and waves.

In addition, Machemehl believes more attention should be paid to the joints and connectors which make a beach house one unit. Though the state code Appendix D requires both in coastal construction, he says more precise specifications are needed. When lumber is connected properly with pieces of steel rather than with nails, the structure can withstand more force.

According to Machemehl, the most dangerous structures are prefabricated buildings and trailers, structures placed directly on the ground rather than on pilings (they float), and buildings which are not tied down with metal connectors.

The dangers

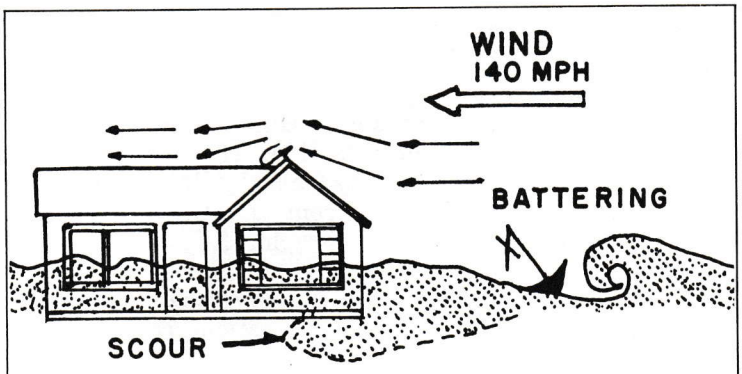
North Carolina's coast feels the brunt of both frequent Northeasters and hurricanes.

Considerable beach erosion, winds and waters damage property during Northeasters. The Ash Wednesday storm, the most severe in recent memory, caused more erosion on the coast from Hatteras northward than any previously known storm. It opened an inlet 200 feet wide on Hatteras Island and destroyed acres of protected dunes. Miles of highways were either washed out or buried in sand. Beach homes by the hundreds were destroyed or damaged.

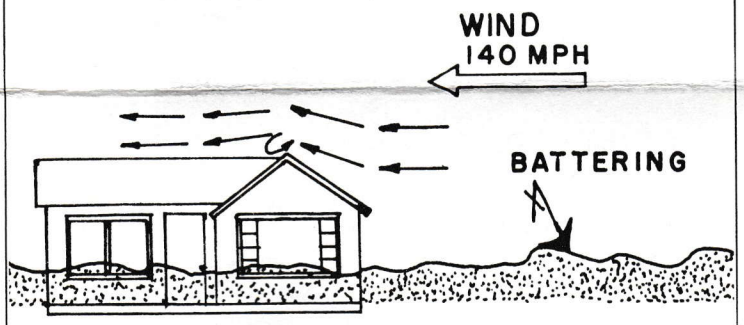
A hurricane the force of Hazel is likely to strike once every 100 years. An example of the destructiveness of coastal hurricanes is a National Weather Service report on Hazel, which made landfall in South Carolina on Oct. 15, 1954:

"Wind-driven tides devastated the immediate ocean front from the South Carolina line to Cape Lookout. All traces of civilization on that portion of the immediate waterfront between the state line and Cape Fear were practically annihilated. Grass-covered dune some 10 to 20 feet high along and behind which beach houses had been built in a continuous line five miles long simply disappeared, dunes, houses and all. The paved roadway along which the houses were built was partially washed away, partially buried beneath several feet of sand. . . .

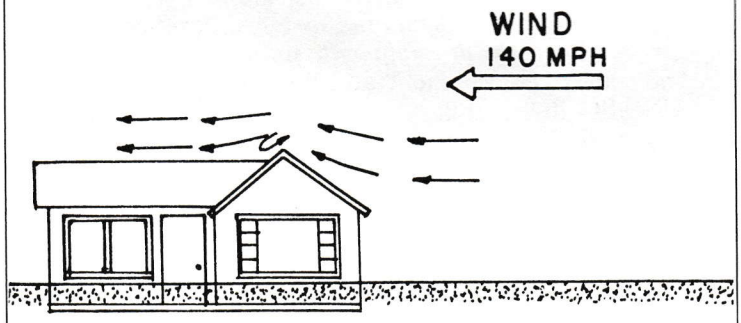
"Of the 357 buildings which existed on Long Beach, 352 were totally destroyed and the other five damaged. Similar conditions prevail on Holden Beach, Ocean Isle, Robinson Beach and Colonial Beach. In most cases it is impossible to tell where the buildings stood. Where grassy dunes stood, there is now only flat, white, sandy beach."



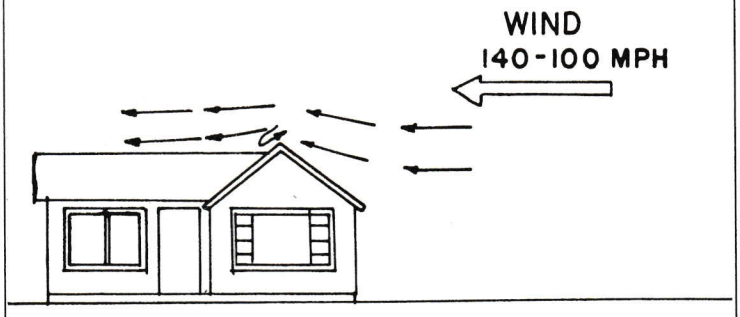
Hazard zone I



Hazard zone II



Hazard zone III



Hazard zone IV

If the surge doesn't get you, the winds will

Builders could make more informed decisions about construction standards if they knew what forces they were up against in a given area, says Dr. Jerry L. Machemehl of North Carolina State University.

With Sea Grant funding, Machemehl is mapping coastal hazard zones for five different classes of storms. When completed, the maps will show the geographical potential for flooding, beach erosion, winds, storm surge, rainfall, inlet migration and overwash. The storm classifications range from Northeasters (winds less than 74 miles per hour) to catastrophic hurricanes (winds over 150 miles per hour).

The maps will delineate four hazard zones in coastal North Carolina.

Hazard Zone I—which is the most seaward, including beach, berm and the first line of cottages—will be subject to the full impact of hurricane force winds, waves and flooding from storm surge. Buildings in this zone will be susceptible to battering by debris and may be floated off their foundations by storm surge. In addition, they may be undermined by severe beach erosion.

Hazard Zone II also will be subject to a hurricane's full impact; however, buildings will not be affected by beach erosion.

Hazard Zone III will be subject to hurricane force winds and flooding from rainfall, while structures in Hazard Zone IV will be subject to hurricane force winds only.

Machemehl's preliminary findings indicate that in North Carolina erosion of up to 30 feet, rainfall up to 20 inches or more, and winds of 130 to 140 miles per hour are not uncommon for a 100 year storm.

When his maps are completed, Machemehl hopes prospective builders will use them when deciding what storm forces to build for. Special precautions in coastal construction make building costs about 5 percent higher than in inland areas, Machemehl estimates.

The yatch club, Wrightsville Beach, after Hurricane Hazel

Definitions of 'safe' beach house vary

Shortly after Hurricane Hazel "tore up jack on the coast" in 1954, Kern Church sat down and wrote Appendix D of the North Carolina Residential Building Code. "We had to do something," says Church who is Deputy Commissioner of Insurance, Engineering and Building Codes Division for the state.

The building code and its appendix are one of three major controls on the quality and location of construction in North Carolina beach communities. The other two programs are the Coastal Area Management Act and federal flood insurance.

Appendix D deals specifically with coastal construction and is primarily concerned with wind storm resistance. Houses within 150 feet of the mean high water line are required to have pilings sunk eight feet below the natural grade of the lot (a figure Church says "I took off the top of my head"). Tiedowns must be used to secure roofs, walls and foundations. Though the Residential Building Code is used statewide, Appendix D must be adopted locally. And local building inspectors enforce the regulations.

The Coastal Area Management Act (CAMA) delineates ocean hazard areas including beaches, frontal dunes, excessive erosion areas and inlet lands. Development is kept behind the frontal dune. Setback guidelines, based on a 25-year storm surge, prohibit permanent structures in areas ranging from 61 to 156 feet landward from the toe of the frontal dune. Similarly, development within 75 feet of the mean high water line on the sound side requires a permit. In effect, CAMA first influences the location of construction, protecting natural features. Secondly, it calls for enforcement of state building codes, including Appendix D, in the areas of environmental concern. Local building inspectors are responsible for permit letting for sites smaller than 20 acres or 60,000 square feet.

Federal flood insurance is intended to provide a tool for regulation of development in flood prone areas and low cost flood insurance protection to individuals living in these areas. The coverage is written by private insurers and is federally backed through the Federal Insurance Administration (FIA).

Communities are required to assess flood potentials and adopt necessary guidelines to protect structures from 100-year flood levels. Elevations required in coastal North Carolina range up to 14 feet above mean sea level.

Individually or taken together, the three programs are not without problems. Administrators of the programs acknowledge that they do not mesh, and that they allow some construction to "fall through the cracks" with little control. Some programs are criticized for not being stringent enough. Each of the programs is administered in a given geographic area. "None of these areas really correspond. You may have one, two or three permits in a given area," says Mike Black, Chief of Technical Services for the Office of Coastal Management.

Rob Moul, coastal management consultant for the CAMA staff, cites another—and often raised—concern. On occasion, he says, it seems federal flood insurance actually encourages hazardous development.

(See "Rethinking," page five)

'Rethinking' codes, insurance, CAMA

(Continued from page four)

Moul cites an example of a builder who sought permits to build on land adjacent to an inlet; in addition, the site had little or no dune formation—land considered by the state to be highly unstable. Though the CAMA staff advised the builder of the danger, Moul says, he shrugged off their warnings saying that he had his federal flood insurance.

According to Moul the incident is not all that unusual. He has seen similar cases in which federal insurance has had the effect of taking the risk out of what the state considers hazardous development.

In response to the criticism, Bill Harris of the FIA, says "We don't know what the effect would be if we weren't there. I guess the question is would they (builders) be there anyway, regardless. You can always have specific cases in which someone may feel safer by virtue of having the insurance, but I doubt that has been the final, underlying, deciding factor.

"The flood insurance program," Harris continues, "makes (builders) aware of the consequences and requires a building that will at least preclude damage during certain types of storms.

"But greater storms will occur. We don't want people to get a false sense of security with this 100-year flood and they shouldn't get a false sense of security because they've built to a particular elevation."

The state's Residential Building Code and its Appendix D also draw criticism. Dr. Jerry L. Machemehl of North Carolina State University cites problems with inadequate piling depth, lack of detail on tiedowns, and inadequate consideration of the effects of wave action.

Church says "We're open to any suggestion. We just don't have the proper information." The code is scheduled to be rewritten in the next year, notes Church. He hopes the new code will have more information, in a simpler, illustrated format, on the hows and whys of coastal construction. He adds that some communities have already changed the piling depth to 12 feet.

Moul points out that fewer than three fourths of the towns in the coastal area have adopted Appendix D. Further, he says, the building code is not generally enforced in counties. But he adds, state guidelines call for all counties to enforce building codes by 1984.

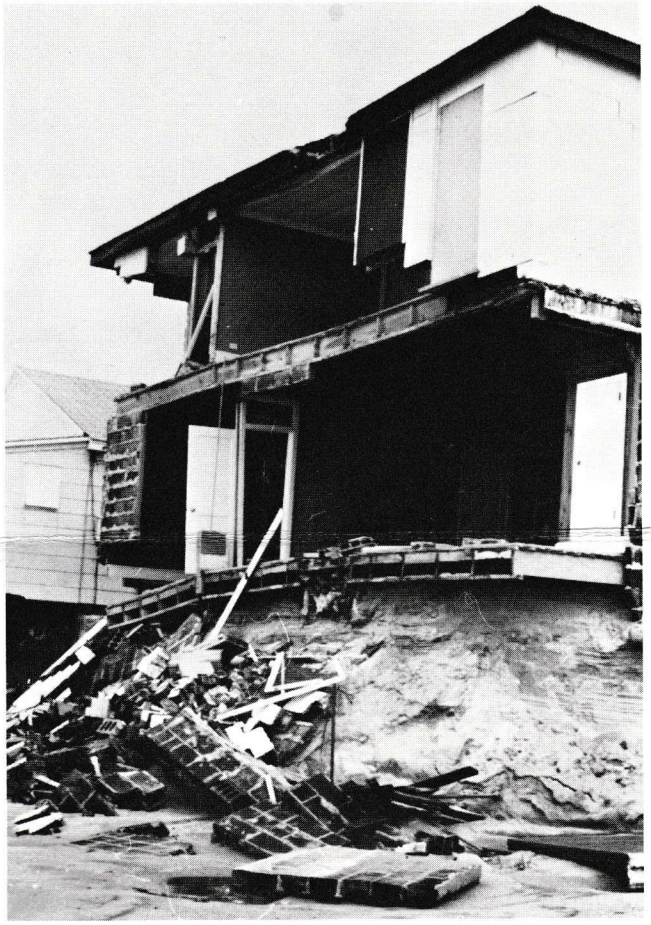
Another major sticking point on the code is enforcement. Critics and administrators alike agree that the code needs better enforcement. "That's a problem," says Church. "There never was anything on how qualified (the inspectors) had to be. It's a hit or miss proposition." And in some cases, he adds, "where a fellow was doing a good job, he got run off." Another factor which has sometimes kept more qualified people out of the job, says Church, is low pay.

Church explains the situation should change somewhat in the next year. On July 1, 1979, new regulations on qualifications for inspectors will go into effect.

"We may still have some who may not be as qualified as they ought to be," remarks Church. But he adds the problem should eventually be corrected with the new regulations.

The outlook for the federal flood insurance program and CAMA is changing too. Efforts are underway to better coordinate the programs and simplify the permit process, according to Mike Black.

The CAMA staff, says Black, is "rethinking" the ocean hazard areas category and better coordination with FIA is one of the goals. Harris also says his staff is working to mesh the various regulations and simplify programs, particularly the state sand dune ordinance and the building code.



Erosion can undermine ocean-front buildings

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Engineer offers builders help

During its useful life, a coastal house can be expected to experience severe weather conditions including continuing erosion, Northeasters and hurricanes. Houses could be made more storm resistant if buyers and builders knew more about the vagaries of coastal weather, says Spencer Rogers, Sea Grant's coastal engineering advisory specialist.

Rogers works out of the Fort Fisher Marine Resources Center advising coastal buyers and builders on sound engineering practices. He emphasizes, for example, the need for substantial pilings to elevate structures above the 100-year storm level as well as the use of secure tiedowns. Part of Rogers' job is to work with individuals who need help in designing homes that are as well engineered as possible.

Another of nature's nasty habits that takes people by surprise is estuarine erosion. Such erosion is a fact of life; but there are ways to slow its effects. Rogers' other major area of concern is advising people on how to deal with estuarine erosion using such devices as bulkheads, revetments and groin fields.

He is particularly concerned with the bulkhead problems he has seen recently. A well designed bulkhead should have a lifetime of 20 to 30 years. Instead, bulkheads are failing in a year to five years. Though the costs for a well designed bulkhead are high, in the long run, Rogers says, it is probably cheaper to do it right the first time rather than replace bulkheads every few years.

Rogers, a native of Virginia's Eastern Shore, came to North Carolina this year from Florida where he worked with the Bureau of Beaches and Shores in the Department of Natural Resources administering the coastal construction setback line. He holds a Bachelors degree in engineering from the University of Virginia and a Master's from the University of Florida Coastal and Oceanographic Engineering Laboratory.

For more information on bulkheads, erosion control and other coastal engineering questions, contact Rogers at (919) 458-5780.

Related publications

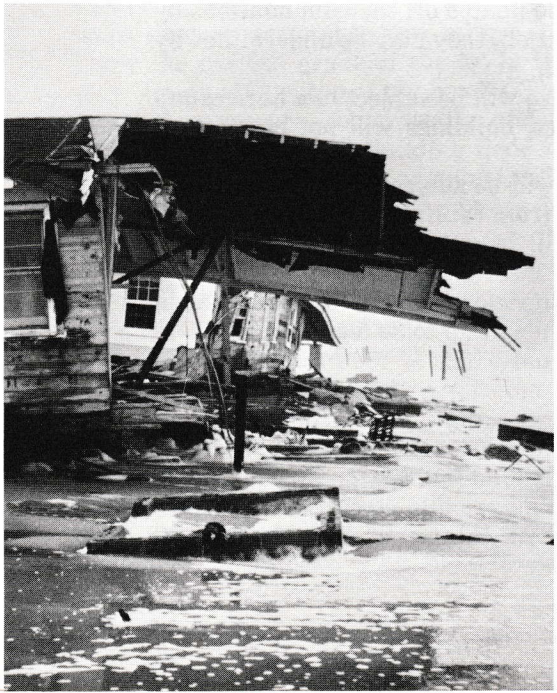
The following related publications are available from UNC Sea Grant, Box 5001, Raleigh, N.C. 27650. Please enclose a check made out to UNC Sea Grant where appropriate.

Information for buyers and owners of coastal property in North Carolina, details on permits and the coastal environment, no charge.

Relative estuarine shoreline erosion potential in North Carolina, a method for determining erosion intensity on specific shorelines, no charge.

The citizen's guide to North Carolina's shifting inlets, photos and illustrations of 22 migrating inlets, UNC-SG-77-08, $1.00.

Know your mud, sand and water, a practical guide to coastal development, information on the coastal environment and its management, UNC-SG-76-01, $1.25.



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