IMPACTS ON STRUCTURES

Leatherman, Stephen P. 1990. Aftermath of Hurricane Hugo. Pp. 165–67 in National Research Council, *Managing Coastal Erosion*. Washington, D.C.: National Academy Press.

> A comparison of heavy damage and destruction in the Folly Beach area and the less extensive damage at Isle of Palms illustrates the importance of building structures in harmony with the natural dynamics of the beach system. The author emphasizes the need for better data on long-term shoreline change, public acceptance of the relevance of this information, and the institutionalization of conformance standards for setbacks.

Levinson, Nancy 1990. The costliest hurricane. *Architectural Record* 178(February):144,48

> The consensus of selected architects, engineers, and geologists who viewed damages in the Carolinas and the Caribbean was that Hurricane Hugo's damage to buildings was widespread, varied, and complex. Roofing suffered extensively from high winds. Numerous inferior construction practices—in noncompliance with applicable codes—were uncovered. Historic buildings, because they had hipped roofs, protective shutters over windows, raised first floors, and generally sturdier construction, performed well overall.

Manning, Billy R., and Gary G. Nichols 1991. Hugo—Lessons Learned. Pp. 186–94 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

> This paper is based on ground and aerial surveys of Hugo's damage to structures along most of the South Carolina coast, parts of the North Carolina coast, and in various inland areas. With special emphasis on wind damages, the authors describe the storm's impact on three categories of structures: those that were fully engineered (high rises, hospitals, and public buildings), those that were marginally engineered (low-rise motels, apartments, and offices), and those that were not engineered (most residences and small commercial buildings). Among the recommendations are that local sign codes be upgraded to include wind load requirements that comply with the building code, that a rating system be developed to assess the effectiveness of local code enforcement, and that closer inspections be made during the installation of roof coverings.

Rodriguez, Leandro, Carlos I. Pesquera, and Ricardo Lopez 1991. Hugo's structural damage in Puerto Rico. Pp. 93–102 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

> Wind damage to wood structures, industrial steel buildings, multistory reinforced concrete buildings, and poles in Puerto was assessed shortly after Hugo hit the island. The study corroborates that sound design and correct construction yielded good structural performance. The main structural elements of structures behaved very well, while facades did not fare well at all. The study concludes that the existing code does not need to be extensively revised, but it does need to be carefully enforced. Unfortunately, much of the repair and reconstruction was carried out in accord with pre-storm practices.

Wang, Hsiang 1990. Water and erosion damage to coastal structures—South Carolina coast, Hurricane Hugo, 1989. *Shore and Beach* 58(4):37–47.

> This article documents the unusually severe water and erosion damage inflicted by Hurricane Hugo on waterfront and near-waterfront properties along a 120-mile stretch from Seabrook Island to North Myrtle Beach. The amount of damage was attributed to the high level of the storm surge, the density of pre-code structures, and the high rate of chronic erosion along the barriers (about 6 feet/year). Assessments were made by visual inspection and interviews.

PERFORMANCE OF STRUCTURES

Baird, W. F., B. L. Edge, O. T. Magoon, and D. D. Treadwell 1990. Cyril E. King Airport runway extension and vicinity at St. Thomas, U.S. Virgin Islands, damage during Hurricane Hugo. *Shore and Beach* 56(4):64–71.

> Among the structures damaged by Hurricane Hugo were the shoreline protection systems on and in the runway extension at a St. Thomas airport. The 2,350-foot extension was completed in 1983 and was protected with an unreinforced concrete dolos armoring system composed primarily of 10-ton units. The adjacent shoreline was protected with 4–6-ton quarried stones. The article contains the observations of the American Society of Civil Engineers Committee on Rubble Mound Structures of the damages after Hugo, summarizes and discusses wind and wave data, and gives possible scenarios by which the damage may have occurred. The primary unexpected damage was localized mass slumping of the dolos layer and some associated breakage of individual units. The quarry stones used for armoring the adjacent shoreline were of a size expected to be displaced by waves generated by Hugo, and such displacement did occur.

Consulting Engineers Partnership, Ltd. 1989. Hurricane Hugo in Montserrat: Reconnaissance Report on the Structural Damage. Report to the United Nations Development Programme. Available from Consulting Engineer Partnership, Ltd., P.O. Box 625C, Bridgetown, Barbados, WI, Attn.: Rolf Stephanson at UNDP.

> This report of a reconnaissance team that visited Montserrat soon after Hurricane Hugo describes the damage sustained; assesses the extent to which building design, workmanship,

materials, and lack of maintenance contributed to the damage; offers advice on improving design and construction standards; and recommends procedures to be followed during the reconstruction period. Recommendations include 1) designing all buildings and structures in accord with the Caribbean Uniform Building Code, 2) designing all electricity and telephone poles to withstand hurricane force winds, with particular attention to topographic effects, 3) designing all communication masts to withstand wind forces appropriate to critical facilities, and 4) immediately instituting a formal education program for the construction sector.

Cook, Richard L., Jr. 1991. Lessons learned by a roof consultant. Pp. 144-52 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

It is estimated that over 80% of the losses caused by Hugo were related to roof failures and the associated water damage. This paper reviews the wind measurement techniques and wind design criteria that are applied to roofing systems, analyzes the performance during Hugo of several components of roof systems, describes the role of and problems faced by roofing specialists and contractors during the recovery period, and makes recommendations for learning some roofing lessons from Hugo.

Harris, Gill 1991. Lessons learned from Hugo about building design trends. Pp. 207-23 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

An investigation of 100 metal system buildings was made to evaluate their resistance to Hugo's winds. The performance of these buildings compared to that of older ones indicated that current standards, codes, and designs provide better resistance to wind loads. The author suggests using peak gust measurements instead of fastest-mile wind speeds.

Hogan, Mark, and Anthony K. Karwoski 1991. Masonry performance in the coastal zone. Pp. 195-206 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

This article summarizes the findings of a survey of coastal construction from Charleston to Myrtle Beach immediately after Hugo. The performance of selected masonry structures and masonry components is documented. In general, the findings substantiate the efficacy of existing design and construction recommendations. Principal areas of future concern are the performance of low-rise unreinforced masonry structures with light and heavy roof systems, the performance of high-rise masonry under suction loads, and the performance of roofs and foundations in relation to lateral support of masonry walls.

McDonald, James R., and Thomas L. Smith 1990. *Performance of Roofing Systems in Hurricane Hugo.* Lubbock, Tex.: Texas Tech University Institute for Disaster Research. 42 pp.

This report documents the findings of a study team dispatched into the area stricken by Hurricane Hugo to investigate the performance of various roofing systems subjected to the storm's high winds. They concluded that the wind speeds over most of the inhabited areas of South Carolina were below design value; that structural damage from wind was minimal; and that roofing systems performed poorly. Most property damage was due to loss of roofing materials and subsequent damage to the interior from wind and water. The report discusses damages to different types of buildings and styles of architecture, various roofing materials, and methods of connection.

Miehe, Ben K. 1991. Architectural lessons learned from Hurricane Hugo. Pp. 153-59 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

This paper is a series of observations about the performance during Hugo of buildings on the naval base and in the Charleston area, and about the process of rebuilding damaged structures. Some of the conclusions are that most homeowners are unaware of laws, codes, or standard building practices that ensure quality structures; that roof designs need to be checked to assure that all attachments and/or penetrations are specifically detailed; that the use of old-fashioned wooden shutters may be the most effective way to protect windows and structures; and that the use of multiple codes can prove confusing to designers and builders.

Murden, J. A. 1991. Hugo 1989—the performance of structures in the wind. Pp. 51-62 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

Wind speeds during Hugo in most areas of the Carolinas were below the design levels specified in the local building codes. Much of the damage was the result of failure to incorporate existing knowledge of wind loads in the building codes. Cladding and roofing system failures were the most widespread and expensive problems, even on professionally designed structures. The potential remains high for widespread wind damage from future storms below the design level.

National Conference of States on Building Codes and Standards (NCSBCS) 1989. Preliminary Report—Disaster Site Investigation of Manufactured Homes. Report prepared for the U.S. Department of Housing and Urban Development Office of Manufactured Housing and Regulatory Functions, Manufactured Housing and Construction Division by the National Conference of States on Building Codes and Standards. Washington, D.C.: Department of Housing and Urban Development. Available from HUD, 451 Seventh St., S.W., Washington, D.C. 20410, (202) 708-1920.

Several weaknesses in manufactured homes were identified as a result of investigations conducted after four disasters, including Hurricane Hugo. Problems were found with the improper installation and failure of tie-downs; loss of siding because negative wind pressure was not incorporated into the design; inadequate connections for metal roofs; and possible shortcomings in the design criteria for wind loading of structures in hurricane zones.

Rhodes, Perry E. 1990. Lessons from Hurricane Hugo on designing shore protection structures. Pp. 199-202 in Association of State Floodplain Managers, *Challenges Ahead: Flood Loss Reduction Strategies for the '90s, Proceedings of the Fourteenth Annual Conference.* SP#23. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. $10.00.

Most of the protective structures from Folly Beach to Myrtle Beach State Park were damaged or destroyed by Hurricane Hugo. This is not surprising because Hugo was at least a 100-year flood event and because most of the structures did not meet the Federal Emergency Management Agency's crediting criteria for base flood protection. Examination of the structures (or what was left of them) showed that their failure was usually due to inadequate toe protection, insufficient height and/or backfill protection, inadequate landward returns at the ends, and undersized structures. Recommendations are made for the improved design and use of such structures.

Rogers, Spencer M., Jr. 1990. *Foundations and Breakaway Walls of Small Coastal Buildings in Hurricane Hugo.* QR#37. 6 pp. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. $1.50.

This survey of small coastal buildings in North and South Carolina after the Hurricane Hugo disaster assessed the performance of elevated foundations, breakaway walls, and foundation cross bracing. Background information on the building techniques, observations from the survey, and summaries of the most reliable techniques are included. Adequately embedded piling foundations were found to be generally effective. Masonry and cast-in-place concrete foundations were revealed to have major construction flaws and experienced widespread failures. There was also widespread failure of elevated masonry foundations with shallow footings; these were found to be inappropriate for areas subject to coastal flooding. Modified construction practices are suggested.

Rogers, Spencer M., Jr., and Peter R. Sparks 1990. Damage to buildings. *Shore and Beach* 58(4):48-52.

Documents the performance of buildings under Hugo's wind speeds, wave impacts, and flooding. Hugo exceeded design conditions in very few places; most buildings experienced significantly less than design conditions. Therefore, much of the damage to new construction could have been prevented using available construction techniques and at a reasonable cost. Proper enforcement of adequate building codes is the key to avoiding extensive damage.

Rogers, Spencer M., Jr. 1991. Performance of building resistance to water, waves and erosion. Pp. 63-70 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

The water, wave, and erosion damage inflicted by Hugo on buildings throughout the low-lying coastal areas of the Carolinas was widespread and severe. Most of the damage to

buildings occurred not because Hugo substantially exceeded design conditions, but because the buildings were not constructed to tolerate any storm conditions at all. As expected, well-constructed buildings performed acceptably during Hugo as long as design conditions were not exceeded. The keys to preventing damage are 1) understanding the hazards likely for the location, 2) providing sufficient floor elevation to avoid the structure's getting wet or hit by a wave, 3) using piling foundations to resist waves (where appropriate), and 4) using adequately embedded pilings to avoid undermining by erosion.

Sparks, Peter R. 1990. The performance of structures in Hurricane Hugo 1989—the Carolinas. Paper presented at the 22nd Joint Meeting of the U.S.-Japan Cooperative Program on Wind and Seismic Effects, Washington, D.C. and Charleston, S.C., May 16-21, 1990. 22 pp. Reprints available from author, Department of Civil Engineering, Clemson University, Clemson, SC 29634-0911, (603) 656-0488.

The performance of structures subjected to high winds during Hurricane Hugo is assessed in this paper. In most locations wind speeds were less than the design levels specified by local building codes, but failure to incorporate modern wind loading principles and to enforce the codes resulted in extensive damage, especially in South Carolina. Most of the damage was in the form of roof and wall cladding failures, which led to rain damage to the interior of the structure. Wood-frame construction performed well in general, while unreinforced masonry buildings performed very poorly, even in sheltered locations. Recommendations are made for improving the wind resistance of future construction.

Sparks, Peter R. 1991. Wind conditions in Hurricane Hugo and their effect on buildings in coastal South Carolina. *Journal of Coastal Research* SI(8):13-24.

This article analyzes the wind conditions in the coastal zone of South Carolina during Hurricane Hugo. The effect of wind on buildings is discussed and the damage is surveyed. Wind damage was observed along the coast from 50 kilometers south of Charleston to 160 kilometers north. Damage ranged from loss of roof and wall coverings to complete structural collapse. Some buildings performed satisfactorily where the wind speed recurrence interval was nearly 100 years while others were damaged in locations where the recurrence interval was less than 20 years. Reasons for the poor performance of buildings included the use of an inappropriate building code, difficulties in enforcement, and an unusually long interval since the last major hurricane.

Taylor, Jon Guerry 1991. Hurricane Hugo's effect on marina structures. Pp. 79-92 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

The author visited about 25 marinas in South Carolina and Puerto Rico immediately after Hugo and during the rebuilding period to assess the impacts of the storm on those types of facilities. Floating docks, fixed piers, breakwaters, drystacks, retaining walls, and fishing piers of various ages were evaluated. Although the performance of marina structures in the hurricane was site-specific within the storm's path, patterns of performance can be related to the design, construction, and materials utilized. These data are useful in contributing to the improvement of future facilities.

URS Consultants, Inc. 1991. Flood Damage Assessment Report: Surfside Beach to Folly Island, South Carolina, Hurricane Hugo, September 21-22, 1989. Volume I, Damage Assessment of Flooded Buildings, and Volume II, Survey Forms. Reports prepared for the Federal Emergency Management Agency by URS Consultants, Inc., Paramus, N.J..

This report documents, with numerous photographs, a systematic inspection of structures damaged during Hurricane Hugo in order to assess the performance of building standards and practices under varying flood characteristics. Among several specific conclusions are that properly elevated structures on adequately embedded and structurally sound members are the key to reduced damages; that non-breakaway walls broke away from sound structural members with damage to the main structure; and that technical guidance is needed for storm-resistant residential roofing practices.

CONSTRUCTION PRACTICES AND CODE ENFORCEMENT

All-Industry Research Advisory Council 1989. *Surviving the Storm—Building Codes, Compliance, and the Mitigation of Hurricane Damage*. Oak Brook, Ill.: All-Industry Research Advisory Council. 70 pp. Single copies are free from the Council, 1200 Harger Road, Suite 310, Oak Brook, IL 60521, (708) 572-1177.

This study reports on the increase in people and property at risk from hurricanes along the U.S. coast and reviews the evidence on how the strength of local building codes and the level of compliance with them have made a difference in the amount of damage sustained in recent hurricanes, including Hugo. The report analyzes the wide variations in building codes in effect along the Gulf and Atlantic coasts, and highlights states and organizations that have paid special attention to wind resistance requirements in building codes. The cost implications of constructing new homes with stronger wind resistance are detailed. Comments made by coastal building officials and inspectors about the challenges of improving enforcement are summarized.

Brooks, Christopher 1991. Hurricane Hugo and the South Carolina Coastal Council. Pp. 259-62 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum*. New York: American Society of Civil Engineers.

The South Carolina Coastal Council's hurricane disaster plan, which had been prepared in advance of Hugo, enabled that agency to respond to the governor's directive to get the coastal economy rolling as soon as possible after the storm and still administer the provisions of the state Beachfront Management Act. The agency implemented a streamlined permitting system, allowing repairs to proceed quickly; had protected most of its computer equipment and files; and had video and hardcopy documentation of pre-storm coastal conditions.

Coastal Hazards Advisory and Mitigation Project 1989. Recommendations for Rebuilding after Hurricane Hugo. 8 pp. Available from the Coastal Hazards Advisory and Mitigation Project, 110 Lowry Hall, Department of Civil Engineering, Clemson University, Clemson, SC 29634–0911, (803) 656–0488.

Numerous relatively new buildings were demolished by Hugo's strong winds, indicating that community building codes are not adequate to withstand events of this magnitude. This short publication makes recommendations to legislators, building owners, architects, engineers, and building officials on ways to correct past mistakes and ensure that future structures are better able to withstand the high winds and storm surges of events like Hugo. It recommends that ANSI A58.1 be used as a guide to better structural design.

Curry, Bobby L. 1991. Structural engineering lessons learned from Hurricane Hugo. Pp. 139–43 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

The majority of the damage to the U.S. Navy's structures at the Charleston naval station were caused by wind and water after the buildings were torn open by high winds. Government structures, both old and new, suffered considerable damage even though they were designed, constructed, and inspected under strict guidelines. However, most of the failures occurred because the design criteria were not properly addressed or enforced. The vast majority of the navy's structures sustained little, if any, structural damage. Hugo showed that structures built to present Navy Design Criteria, which use ANSI A58.1 criteria for wind, will withstand hurricane wind forces. More attention should be paid, however, to the choice and installation of cladding and cladding fasteners, particularly along roof edges, corners, and eaves, and at the ends of walls.

Deegan, Daniel E., and Wayne D. Lasch 1990. Analysis of coastal flood hazards following Hurricane Hugo. Pp. 354–61 in Lawrence S. Tait, comp., *Beaches—Lessons of Hurricane Hugo, Proceedings of the 1990 National Conference on Beach Preservation Technology.* Tallahassee, Fla.: Florida Shore & Beach Preservation Association. Reprints available from authors, Greenhorne & O'Mara, Inc., 9001 Edmonston Rd., Greenbelt, MD 20770, (301) 982-2800.

A revised flood hazard analysis was performed for four localities in which Hurricane Hugo caused relatively large amounts of wave-associated damage to structures located in areas designated as zone A on FIRMs. The inclusion of wave set-up and more up-to-date beach profile data resulted in an average increase of 2–4 feet in BFEs along the open coast and an increase in the width of the V zone of from 100 to 1,000 feet. The study concludes that in general the methods now applied to evaluate coastal flood hazards are reasonable.

Mahoney, Michael 1990. The effects of coastal construction standards in reducing damages from Hurricane Hugo. Pp. 195–98 in Association of State Floodplain Managers, Inc., *Challenges Ahead, Flood Loss Reduction Strategies for the '90s, Proceedings of the Fourteenth Annual Conference.* SP#23. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. $10.00.

Although there was considerable destruction in the wake of Hurricane Hugo, some structures survived with little damage. This paper discusses the role played by building regulations in

determining which buildings did not survive intact, namely those inadequately elevated, those with inadequate foundation embedment, improper use of foundation materials, overloaded foundations, or inadequate structural connections. Among other ideas, the author recommends more restrictive building requirements in areas subject to wave damage, a statewide building code, and more rigorous enforcement of codes.

Manning, Billy R. 1989. Surviving the storm: building codes, compliance and the mitigation of hurricane damage. Pp. 18-20 in National Committee on Property Insurance, *America's Imperiled Coastlines: A New Concern for the Property Insurance Industry*. Boston: National Committee on Property Insurance. Available from the National Committee on Property Insurance, Ten Winthrop Square, Boston, MA 02110, (617) 423-4620.

Buildings that were professionally designed and engineered came through Hurricane Hugo better than those without such attention. In fact, buildings that were designed and constructed in total accordance with current code provisions withstood the wind forces with minimal damage. Signs created many of the problems in the Charleston area by acting as missiles, damaging buildings and power and utility lines. A system is needed to evaluate and rate the effectiveness of local code enforcement, and wind and flood insurance premiums should then be based on that rating.

Miller, H. Crane 1990. Hurricane Hugo: Learning from South Carolina. A Report to the Office of Ocean and Coastal Resources Management, National Ocean Service, National Oceanic and Atmospheric Administration. Washington, D.C.: U.S. Department of Commerce. 41 pp.

The author analyzed 3,700 Hugo damage claims on policies written by the South Carolina Windstorm and Hail Underwriting Association, which revealed a wide spectrum of building and management practices in South Carolina from excellent to extremely poor. This report discusses the success or failure of hurricane-resistant building design and construction practices, traces the development of building codes in the state, and examines how homeowner's, flood, and wind insurance acted as mitigating agents for disaster recovery. Appendices present damage data for much of the state's coastal zone and a synopsis of construction code legislation. The author observes that neither lending institutions nor property and casualty insurance companies exert their considerable leverage over the real estate market to ensure that migitative measures are implemented to reduce wind damage.

Mittler, Elliott 1991. *Building Code Enforcement Following Hurricane Hugo in South Carolina*. QR#44. Boulder, Colo.: University of Colorado, Natural Hazards Research and Applications Information Center. 11 pp. $1.75.

This project investigated how building codes were enforced in the city of Charleston and neighboring South Carolina cities and counties during the initial recovery period after Hurricane Hugo. Most local governments did not have adequate resources to deal with such widespread damage through the normal building review process and had to make choices about which buildings required inspection; no community attempted to enforce the building code on all structures damaged by the hurricane. In many cases, permit fees were waived or reduced to enable homeowners to more easily repair their structures. At the same time,

local officials were careful to enforce the guidelines of the Federal Insurance Administration—especially elevation standards—for repairing and rebuilding damaged structures.

Mittler, Elliott 1991. The plight of state legislation mandating building codes in South Carolina. Pp. 263–77 in Benjamin L. Sill and Peter R. Sparks, eds., *Hurricane Hugo One Year Later, Proceedings of a Symposium and Public Forum.* New York: American Society of Civil Engineers.

Since 1968, counties in South Carolina have exercised their individual options to adopt and enforce building codes, and at the time of Hugo, only 17 of the 46 counties in the state had chosen to adopt codes. Legislation to establish a statewide building code was introduced in the 1989 legislative session as a result of concern by building officials, civil engineers, and others that the health and safety of the state's citizens were being jeopardized by the lack of mandatory standards. The bill did not reach the floor of either the house or the senate in that session. This paper summarizes the bill's progress in the state legislature before and after Hurricane Hugo.

Saffir, Herbert S. 1991. Hurricane Hugo and implications for design professionals and code-writing authorities. *Journal of Coastal Research* SI(8):25–32.

Throughout the Caribbean and the Carolinas Hugo inflicted damage to structures that could have been avoided by adherence to existing design and construction guidelines. The author explains various modes of building damage and how they could have been avoided. Florida's coastal building provisions are used as an example of proper accounting for the inevitable force of hurricanes.

Sparks, Peter R. no date. Damages and Lessons Learned from Hurricane Hugo. Unpublished paper. 16 pp. Available from author, Department of Civil Engineering, Clemson University, Clemson, SC 29634-0911.

This paper reviews the wind and storm surge conditions during Hurricane Hugo and discusses their relationship to the extent and nature of damages. In general, building damage was related to local construction practices rather than to the relative severity of the storm. The disruption of the electrical supply is contrasted with the much better performance of the telephone system. The paper concludes that the extensive damage resulted in general not from unprecedented storm conditions but from the failure to use available knowledge in the selection of building and utility systems.

Sparks, Peter R. 1991. Development of the South Carolina coast 1959–1989: prelude to a disaster. Pp. 1–7 in Benjamin L. Sill and Peter R. Sparks, eds., *Hugo One Year Later, a Symposium and Public Forum.* New York: American Society of Civil Engineers.

Although reasonable design standards for wind and storm surge conditions could have been established before the intensive development, control of construction along the South Carolina coast over the last 30 years was left in the hands of local jurisdictions, resulting in considerable variation in the quality of control, including no control at all. The result of this

has been shortcomings in the building code, enforcement problems, and actions by the construction industry, lenders, insurers, and homeowners to produce buildings inadequately resistant to hurricanes, as demonstrated by Hugo.

Sparks, P. R. 1990. The Risk of Hurricane Wind Damage to Buildings in South Carolina: A White Paper. Charleston, S.C.: South Carolina Sea Grant Consortium. 19 pp. Available from South Carolina Sea Grant Consortium, 287 Meeting St., Charleston, SC 29401.

Written a year before Hurricane Hugo, this paper, issued after the hurricane with minor changes, provides a painful demonstration of the accuracy of many points made about the inadequacy of the state's hurricane mitigation measures. Comments are offered on the accuracy of design wind speeds, building codes and their enforcement, the evolution of building design standards in South Carolina, and ways to improve building design and construction standards in the state. The author contends that mandatory implementation of ANSI A58.1 would drastically improve the capability of buildings to withstand hurricane winds; that the construction industry influences building code policies too much; that enforcement is almost as important as the adoption of stringent standards; and that the state has an inventory of buildings along its coast that its decentralized laissez-faire system of building control deserves.

INSURANCE

Berry, Skip 1989. The CAT teams. *Insurance Review* 50(12):20–24.

In the wake of Hurricane Hugo and the San Francisco earthquake, platoons of experienced insurance adjusters were deployed from around the country to settle claims and advise disaster victims. This article describes briefly some of the preparations made for the teams in anticipation of Hurricane Hugo's landfall and the operational difficulties some of them overcame.

Coughlin, H. Joseph, Jr. 1990. Hurricane Hugo and federal flood insurance. *Common Ground* 1990 (March/April):9–10.

Insured losses to condominiums during Hugo were only a small part of the total number of losses, primarily because such multi-family structures are typically constructed to newer, stricter building regulations and are generally in compliance with them. This article, directed to associations of condominium owners, describes the National Flood Insurance Program, the construction standards that reduce flood damage in multi-family structures, and the value—both to the insureds and the general public—of full flood insurance coverage.

Flood Insurance Producers National Committee 1990. Notes on a hurricane. *Flood Insurance Producers National Committee Bulletin* IV(1):1-3.

A Florida insurance agent provided onsite assistance to another agency in the Charleston area soon after Hugo's impact. His observations include the disorganization evident everywhere, the widespread destruction and accompanying claims for losses, the apparent lack of planning for such a contingency on the part of the agency, the ignorance on the part of employees about basic crucial information such as whether or not a policy covered debris removal of trees, and the problems with using out-of-town adjusters. Recommendations are made for insurance agencies and companies to avoid repeating mistakes made during Hugo.

Friedman, D. G. 1989. Is Hugo a forerunner of future great hurricanes? Paper presented at the National Committee on Property Insurance Annual Forum, December 13, 1989. 81 pp. Available from National Committee on Property Insurance, Ten Winthrop Square, Boston, MA 02110, (617) 423-4620.

There is speculation among climate scientists that adverse impacts from anticipated global warming could encourage the formation of powerful "super hurricanes." It is also claimed that the appearance of these storms could begin during a transitional climate phase (1990–2010), as global warming starts to accelerate. This paper attempts to quantify these shorter-term effects, utilizing presently available information that is consistent with the current state of knowledge about regional storm characteristics (frequency, severity, location); their natural disaster production characteristics during the present climatic regime; and likely effects of a global atmospheric warming on these storms and their catastrophe-producing potentials. Results of the analysis suggest that the overall damage-producing potential of winter storms could decrease during the period of climatic transition. For severe local storms, it would increase slightly. For hurricanes, the increase in damage potential could be substantial. The estimated effect of various degrees of warming is expressed in three scenarios, and a new coding system, called the catastrophe index, is introduced to define the damage-producing potential for each.

Journal of American Insurance 1990. What Hugo taught us. *Journal of American Insurance* 66(Winter):1-13.

Hugo's impact rejuvenated the property/casualty insurance industry's catastrophe programs, reaffirming some successful approaches and redirecting others that did not work as well. This article describes the insurance industry's response to Hugo, from an analysis of the rationale for the "surplus" catastrophe funds to individual agents' heroic actions in the aftermath of the storm. Reminders of key aspects of pre-disaster planning for both agents and policyholders are given, clarifications of distinctions between federal flood insurance and coverage of homeowner insurance are provided, and checklists itemize safe construction techniques and disaster claim procedures.

Watermark 1990. Storm shatters NFIP records for number of claims, payouts. *Watermark* 1990(Fall):1-2.

In addition to the sheer volume of damage claims after Hugo, the National Flood Insurance Program faced other obstacles, including the inaccessibility to adjusters of many damaged properties and the uncertainty among the public, the media, and some officials about what kinds of damages were covered by what kinds of policies. The new "claims coordinating office," which assigned claims for both wind and flood damage to one adjuster, helped relieve the latter difficulty. The disaster also demonstrated an advantage of the NFIP's "write your own" program (under which flood insurance policies are written by private insurers): the private companies were able to draw on their own resources to provide the over 6,000 adjusters needed in the areas hit by the storm—a number that a purely governmental insurance program would not likely have been able to produce.