BETEC Symposium addresses:

Security Glazing, Impact Resistant Window Systems & Thermal Performance

Destructive hurricanes and terrorist bombings have forced building designers, code organizations and the federal construction agencies to address the mitigation of property damage and injury from windborne debris and flying glass.

Thirteen of the nation's leading experts on security glazing, impact resistant windows and systems, and thermal performance described the state-of-the-art at a June 10 symposium hosted by NIBS' Building Environment and Thermal Envelope Council (BETEC) in Washington, D.C.

Paul E. Beers addresses BETEC Symposium

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BETEC Chairman Jack Warner explained that Hurricane Andrew (in Florida) brought recognition of the need to improve fenestration products to better withstand windborne missiles, and the bombings of the Alfred P. Murrah Federal Building in Oklahoma City in 1995 and the U.S. Air Force barracks in Saudi Arabia in 1996 brought recognition of the need to contain flying glass. Most of the casualties and injuries from both bombings were the result of flying glass shards.

Keynote speaker Richard Karney, director of building systems & materials division at the Department of Energy, presented a challenge to industry to develop effective systems that will address the issues of the symposium. He pledged DOE support for BETEC's continued efforts in the pursuit of these goals. He described the status of the FY 99 budget at DOE and predicted that DOE will be more "customer oriented" in the coming years. The primary areas of focus of DOE activities during the coming years will be lighting technology, windows, and whole and commercial buildings.

NIBS President David Harris described the current formation of NIBS' newest council - the Multihazard Mitigation Council. The purpose of this council, he explained, is to reduce the total losses associated with natural and other hazards by fostering and promoting consistent and improved multihazard risk mitigation strategies, guidelines, practices, and related efforts. He emphasized that the new council will have to reach out to organizations like BETEC for assistance.

David Harris

Jack Warner, Richard Karney and Herb Yudenfriend.

Symposium moderator Herb Yudenfriend of Sun-Trol Products described how innovations in the window industry have largely been the result of industry addressing newly arising needs. He provided a brief history of insulating glass by asking: "Anyone every hear of insulating glass units before 1940?" Without even one response, Yudenfriend noted the first patent for insulating glass was issued on August 1, 1865. However, little happened with insulating glass until after World War II, when architects in the U.S., with a desire to bring the out-of-doors inside began designing buildings with large window areas, Yudenfriend explained. Since single panes windows provided little in the way of insulation by the 1950s insulating glass systems started to become popular. But the Arab oil embargo of the early 1970s forced them to take a step back to designing buildings with smaller window areas. However industry, once again addressing a need, came out with low-e glass and other energy saving systems. "Everything was working fine, and then there was Oklahoma city and a new need: to combine energy performance with security glazing."

Paul E. Beers, president of Glazing Consultants, Inc., Palm Beach Gardens, Fla., provided a review of the current status of codes and standards activities addressing impact resistant windows.

Speaking primarily about hurricane plagued southern Florida, Beers noted that one of the impact resistant tests – "The two by four test was ridiculed at first, likened to a fraternity prank. But it's gained respect."

Codes and standards that are in place and those that are being considered in Florida are: the Southern Florida Building Code; the SBCCI test standard for determining impact resistance from windborne debris; ASCE 7 (requires that buildings in hurricane prone areas be designed so the openings are protected or the structure shall be designed as partially enclosed.); BOCA (similar to ASCE 7); ASTM's test method for

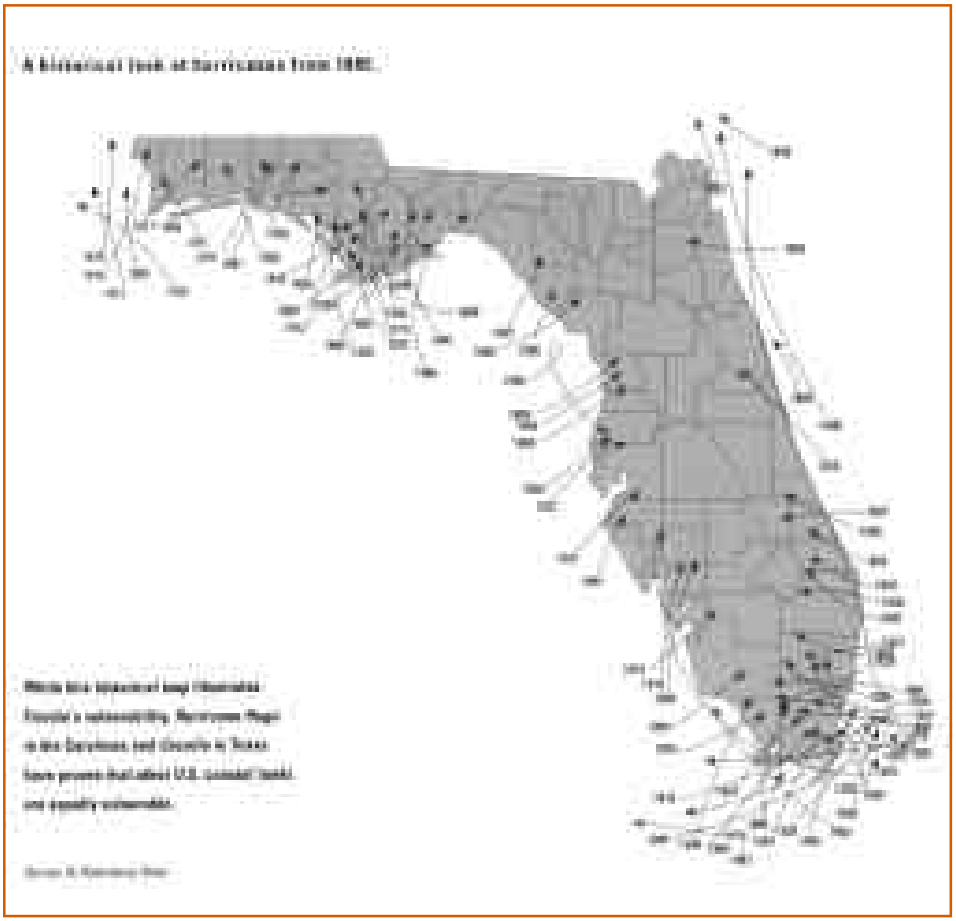
performance; Texas Department of Insurance (impact test similar to SBCCI); and Factory Mutual (an insurance evaluation service involving mainly commercial structures)

With the Southern Florida building code, the impact test procedure tells you exactly how to do the test, for example, the large missile test involves a 9 pound 2x4 fired level at 30 feet. SBCCI's involves testing missiles weighing four, eight and nine pounds, moving at the rate of 40 feet per second, 40 feet per second and 50 feet per second respectively. The International Building Code is currently developing a standard combining the SBCCI, BOCA and ICBO codes. This standard is expected to have missile impact requirements using ASCE7, and requiring impact protection within one mile of the Gulf and Atlantic coasts and in south Florida (with some exceptions). The ASTM standard that is expected to be completed within the year, is an attempt to harmonize ASTM and ASCE, Beers said.

Beers stressed that "every project that is being built in southern Florida is required to meet impact code requirements." The primary systems being used to meet the code are laminated glass, shutters, and adhesive applied films.

In conclusion, Beers said impact codes are well established in south Florida; impact codes will be a part of the International Building Code by the year 2000; the harmonization of ASCE and ASTM impact requirements should standardize the standards; and retrofit needs to be addressed and encouraged.

Bruce Hall and David Eakin



David B. Eakin and Bruce Hall, of the U.S. General Services Administration (GSA), described the status of GSA's security glazing criteria for federal buildings and integration into the thermal envelope.

Eakin outlined the Comprehensive Building Commissioning process at GSA and how it addresses building security. The bottom line, Eakin said, is "defining what you want, advocating what you want, verifying that you got it, and learning from the experience. He described a matrix approach to defining functional priorities when planning, designing, building and commissioning a building.

"The integration of all functional expectations is what we are after," Eakin said. "This requires a matrix management approach, to help prioritize the importance of the various functions. It also provides a visual checklist of how you can get what you are trying to achieve. It's a nice way to help you comprehensively look at determining whether you have achieved everything you set out to achieve," he concluded.

Bruce Hall, GSA's lead security engineer, has lead the effort to develop security criteria in response

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Ray Foss

to the 1995 Department of Justice report on the "Vulnerability of Federal Facilities." He showed films of various glass fragment mitigation technologies as they were subjected to large scale explosions, such as 500 pounds of TNT on 1/4 inch glass with and without security films. With a 7 millimeter security film, the glass was shattered but dropped within three feet of the window frame. "These tests showed that properly designed and installed security films are a viable protection scheme which can provide a significant reduction in glass fragment hazards in low blast pressure environments," Hall said.

Hall went on to explain how GSA has developed a system of performance based criteria to measure the security level desired: The levels are as follows:

Level A/B: Low threat - Low level of protection. No progressive collapse.

Level C: Moderate threat - Medium level of protection. Repairable damage.

Level D: High threat - High level of protection. Minor damage acceptable.

Level E: Very high threat - Very high level of protection. No damage acceptable.

For each of these security levels, GSA provides the following criteria for window glazing, for example:

Level A/B: Windows do not require design for specific blast loads. Use glazing materials that minimize hazards.

Level C: Windows designed and tested to perform for actual blast pressures up to 4 psi.

Level D: Windows designed and tested to perform for actual blast pressures up to 10 psi.

Ray V. Foss of the DuPont Co. described current glazing technologies with a focus on the benefits that can be provided by combining security and energy control. He described a number of laminated glass products that are tailored to the users needs and budget. Laminated glass is made by permanently bonding layers of ordinary or processed glass, using heat and pressure, with one or more interlayers or sheets of polyvinyl butyral resin (PVB).

James Aker

He described three categories of glazing systems for storm protection of buildings that are offered by DuPont.. Since weight is a major consideration an effective system is a single pane of glass laminated to polyester film having an abrasion-resistant coating. Other systems include laminated glass with abrasion resistent polyester on the inboard surface and other laminates incorporating glass with polycarbonates for extremely high risk applications.

Foss emphasized that security glazing can be tailored to provide a wide range of performances to combine security with energy efficiency in single glazing and insulating glass.

James H. Aker of Aker Scientific Industries provided a description of field applications of safety and solar films for security and energy savings. Window films were first applied in the 1950s as liquid coatings on glass. By the 1960s, a process was developed where a thin layer of aluminum was applied to polyester film. This was the true beginning of the industry, Aker said. The primary problem with the earlier water based application system was that when moisture reoccurred the film could often be pealed off.

The industry took off after film was pursued by both the U.S. and British government as a solution to window breakage at embassies and government offices in hostile communities. Using a film specially developed for the U.S. government, nearly two-thirds of the 217 U.S. embassies had their windows filmed.

Subsequent adoption in 1972 by ANSI of a glazing standard, sent the business into high gear, Aker said. Today's safety films are available in a wide range of thicknesses, levels of light transmission, and energy efficiencies. They can be applied to homes, offices, and commercial structures.

Ron Saunders of Sun Wave

Robert Smilowitz

Henry Chamberlain

International spoke about the challenges of manufacturing, installing, and the thermal performance of windows to meet security and impact resistance specifications. He described the security glazing component of the industry "probably the most fragmented of the window industry," where most are very small manufacturers.

Weight is one of the more critical issues that is not readily understood by those who specify specific types of security glass. "Most people have no idea of what they're getting themselves into. Glass is probably one of the most commonly used yet least understood building materials. 2.9 pounds per square foot is typical on the lower end, thicker glasses quickly go up to 6.5 pounds per square foot, Saunders said. Excessive glass weight will deform standard window hardware.

Robert Smilowitz of Weidlinger Associates said that although curtain wall systems were not their first choice, his company has been creating protective designs for curtain wall systems. The reason for the choice, Smilowitz said, is that "they evolved out of a need for the function, design, need, and appearance of the structure."

Smilowitz said his company's design philosophy with regards to curtain wall systems is that it is impractical to design an entire structure to resist localized effects resulting from a close in attack.

Weidlinger Associates has proposed the following glazing criteria:

1. Windows exposed to blast over pressure are to contain protective glazing in the form of laminated or anti-shatter filmed glass on the inner lite and/or blast curtains to reduce the hazard from airborne debris.
2. It must be shown through testing, analysis or existing data based that the performance of a majority of the windows by area will satisfy specified criteria when subjected to the postulated threat.
3. The windows are to exhibit a desired post-damage behavior consistent with a medium level of protection and a medium hazard level.
4. The frames and anchors for the windows shall be designed to retain the glass and withstand the equivalent static reaction loads consistent with the "750 break per 1000" capacity of the chosen glazing materials.

Victor Vella

Henry Chamberlain of Architectural Glass Engineering described issues involved in integrating security glazing in curtain walls. His presentation touched on guidelines and data for establishing standoff distances, as well as guidelines and tables for selecting blast, ballistic and forced entry glazing, and the costs involved.

Richard G. Walker of the American Architectural Manufacturers Association described AAMA's efforts to develop structural standards. He described AAMA's work on installer certification and global harmonization.

Victor Vella of Navy Facilities Engineering Command provided an overview of security glazing applications guidance developed by NAVFAC. He outlined the objectives of NAVFAC's recently published *Guidebook on Security Glazing Applications*. The objective of the limited distribution document is to define an easy to follow facility design process, provide sufficient criteria to support the analysis process, and provide examples for the use of the presented criteria. The guidebook deals primarily with the selection of glazing systems that will protect against the effects of explosives, ballistics, and forced entry. Vella pointed out that "although security glazing is not the most probable cause of death during an explosion (primary cause is building collapse), recent history shows the design of glazing systems can be a key factor in protecting personnel against injury."

Gerald Meyers of the U.S. Department of Energy provided a descriptions of options for blast resistant glazing, cost considerations and test results.

Robert Boyle of HDR, Engineers and Architects provided an assessment of the impact new glazing standards and criteria are having on architectural design considerations and contract specifications. He provided examples of design specifications for security glazings in high security buildings.

Robert Boyle