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Zurich recommended practice for facilities in hurricane prone regions

Introduction

Surviving a hurricane with minimal property loss begins with providing a substantial building envelope that will resist wind loads, the impact of wind-borne debris, and the affects of floodwaters. Any failure of the roof, glazing or cladding can allow wind-driven rain to penetrate the building envelope. Any failure of walls or wall opening protective features that are within reach to flood waters can allow floodwaters to enter the building. Once water gets in, the potential for severe property damage and lengthy business interruption begins.

This recommended practice provides guidance for the design of new buildings and the upgrade of existing buildings to meet the Superior Wind requirement of Zurich.

A. General requirements

1. Scope

   This document establishes recommended minimum criteria for the location, design, construction, and protection of buildings and structures from damage due to the wind and water hazards associated with hurricanes.

2. Purpose

   The purpose of this standard is to guide the location, design, construction, and protection of buildings and structures to:

   a. Maintain building envelope integrity during a hurricane
   b. Avoid the entrance of water due to:

      - Wind driven rain
      - Rain water accumulations
      - Flood (including surface water runoff)
      - Storm surge

   c. Avoid foundation damage from the scouring effects of wave action and storm surge

3. Application

   This standard is applicable to buildings and structures located in hurricane-prone regions.

4. Features

   This standard address the following features of a facility:

   - Roof deck
   - Roof cover
   - Cladding (walls)
   - Wall opening (glazing, doors, louvers)
   - Floor elevations
   - Building foundations
   - Seawalls
   - Outdoor structures (utilities, landscape, hardscape)

B. Definitions

1. Basic wind speed (V). Three-second gust speed at 33 ft (10 m) above the ground in Exposure C (see American Society of Civil Engineers, ASCE/SEI 7, Section 6.5.6.3) as determined in accordance with ASCE/SEI 7, Section 6.5.4. The basic wind speeds for the U.S. are presented in a series of maps contained in ASCE/SEI 7.

2. Flood. An overflow or inundation that comes from a river or other body of water and causes or threatens damage.

3. Flood frequency. Refers to a flood level that has a specified percent chance of being equaled or exceeded in any given year. For example, a 100-year flood occurs on average once every 100 years and thus has a 1-percent chance of occurring in a given year.

4. Hurricane-prone region. Coastal regions vulnerable to hurricane activity where the basic wind speed exceeds 90 mph.

5. Important structures. Features exterior to a building that are needed to support the normal operation of the building. Examples of important structures include transformers, emergency generators, fuel tanks, water cooling towers, and satellite dishes.

6. Missile, large. Debris represented in wind-borne debris test standards by objects such as an 8 ft. long wood lumber (2" x 4").

7. Missile, small. Debris represented in wind-borne debris test standards by objects such as metal ball bearings.

8. SLOSH (Sea, Lake and Overland Surges from Hurricanes). A software program used by the National Hurricane Center to estimate storm surge heights based upon historical, hypothetical, or predicted hurricanes.

9. Storm surge. The elevation of water in addition to normal tides caused by water pushed towards land by the winds of a hurricane. Storm surge is a function of several factors including hurricane pressure, size, forward speed, and track. Storm surge elevation increases with hurricane intensity. Storm surge elevations are developed using a computerized model named SLOSH.

   a. SLOSH is used by the National Hurricane Center to estimate storm surge heights based upon either historical, hypothetical, or predicted hurricanes. SLOSH models cover the U.S. East coast, U.S. Gulf coast, parts of Hawaii, parts of Guam, parts of Puerto Rico, and parts of the Virgin Islands. Models have even been developed for some parts of the Peoples Republic of China and India.

b. The SLOSH program generates an animation. The animation shows the storm surge that develops as the modeled hurricane approaches. The US Army Corps of Engineers and FEMA use the SLOSH model results to work with state and local emergency management agencies to create storm surge atlases that depict storm surge for each hurricane category.

10. Storm tide. The total water elevation developed by a combination of normal tide and storm surge. In addition, wind-driven waves will extend above this elevation. The "storm surge" component of the storm tide is a function of several factors including hurricane pressure, size, forward speed, and track. Storm surge elevation increases with hurricane intensity. Storm surge elevations are developed using a computerized model named SLOSH (Sea, Lake and Overland Surges from Hurricanes).

11. Wave action. Damaging activities such as erosion, scouring, and loads caused by the forces associated with wind driven waves. The damaging activities include beach erosion, scouring of sand under and behind sea walls, scouring of sand under buildings and building foundations, and forces applied to buildings and building foundations. Typically, wave action would be expected within FEMA flood zone "V". FEMA defines the transition from the zone "V" (wave action zone with velocity) and zone "A" (100 year flood zone) as the point where wave crests are 3' or less above the storm tide stillwater elevation. These zones appear on FEMA Flood Insurance Rate Maps available at the FEMA web site: http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1

12. Wind-borne debris region. All areas exposed as follows:

    a. All areas within one mile of a coast where the "basic wind speed" is 110 mph or more.

    b. All areas where the "basic wind speed" exceed 120 mph.

    c. All of the U.S. state of Hawaii.

C. Code and references

ASCE/SEI 7-05, *Minimum Design Loads for Buildings and Other Structures*.
IBC 2003, *International Building Code*
FBC 2004, *Florida Building Code*

D. Documentation

When building new facility or retrofitting an existing facility to meet the hurricane protection criteria defined in this standard, maintain documentation to verify the successful implementation of this standard. Documentation may include data such as:

- Initial design requirements
- Wind load calculations
- Engineered securement of large rooftop equipment (chiller, cooling towers, etc.)
- Working drawings
- Material selections (roof deck, cladding)
- Product and system selections (roof cover, glazing, doors)
- Product and system approvals (wind load and missile impact)
- Test records (e.g. water leak testing for glazing systems)

E. Submittals

1. General

    a. For a project in a hurricane prone region, provide submittals to confirm that appropriate design features are provided to address wind and water exposures.

- Provide an initial submittal to confirm the design parameters to be addressed within the project scope.
- Provide architectural documents that specify the needed wind and water protection.
- Provide working plans for appropriate segments of the project to verify that specifications are being implemented in an appropriate manner.

b. Submittals as described below should be submitted to:

- The Zurich client
- Zurich Services Corporation

2. Design parameter confirmation

a. Documentation confirming the wind and water exposures to the property including:

- Site
  - Physical address
  - Sketch showing site boundaries and building footprint
  - Proposed building height
  - Propose building first floor elevation above mean sea level (MSL)
- Wind
  - Basic design wind speed
  - Exposure category
  - Importance factor
  - Topographic factor
  - Wind-borne debris region (yes/no)
- Water
  - Flood
    - Flood zone (per FEMA in U.S.)
    - Elevation of 100-year flood zone above Mean Sea Level (FEMA Zone A in U.S.)
  - Surge
    - Storm surge exposure (yes/no)
    - Storm surge elevation above Mean Sea Level
  - Wave action
    - Wave action exposure (yes/no)
    - Wave action protection
      - Seawall
      - Foundations on piles to bedrock

3. Architectural documents

a. Drawings

- Primary and secondary structural elements (footings, columns, secondary beams, etc.)
- Roof deck
- Roof cover
- Roof drains
- Rooftop equipment details
- Cladding
- Glazing
- Doors
- Louvers
- Balcony/terrace drains
- Wind load calculations
- Floor elevations
- Flood protection
- Surface water runoff protection (site grading, curbs, sump pumps)

- Storm surge protection
- Wave action protection (seawalls, foundations to bedrock)
- Emergency generator (fuel tanks, fuel pumps, location, loads)

b. Specifications
   - Roof deck (include quality control for metal deck installation)
   - Roof cover (include Miami-Dade NOA, quality control for installation)
   - Cladding (include Miami-Dade NOA for proprietary systems)
   - Glazing (include Miami-Dade NOA, quality control, and testing)
   - Doors (include Miami-Dade NOA)
   - Louvers (include Miami-Dade NOA)
   - Flood protection features
   - Seawalls

4. Working plans
   a. Roof deck (other than reinforced concrete or precast concrete)
   b. Roof cover (product literature, layer-by-layer description, design wind uplift resistance)
   c. Rooftop equipment (engineered connections for large equipment)
   d. Cladding (approval data for proprietary systems, product literature, installation drawings and details, design wind loads)
   e. Glazing (approval data, product literature, installation drawings and details, design wind loads, missile impact ratings)
   f. Doors (approval data, design wind loads)
   g. Flood barrier systems
   h. Seawall (foundation, height, toe protection, wing walls)

F. Wind - general

1. Basic design wind speed
   a. For U.S. locations or its possessions, the basic design wind speed shall be based upon the following:

      1. The basic wind speed maps contained in ASCE/SEI 7-05. These maps provide 50-year MRI (mean reoccurrence interval) based upon a 3-second gust over land.

      2. Adjustment of the basic wind speed to the 100-year MRI by applying an Importance Factor of 1.15 in the ASCE/SEI 7 wind load calculations.

   b. For non-U.S. locations, select an acceptable wind speed based upon a 100 year return period adjusted to a 3-second gust over land equivalent wind speed.

   Note 1: Wind speeds outside the U.S. may be measured using the "fastest mile", "1-minute average", or the "10-minute average". Appropriate conversion factors should be applied.

   Note 2: The International Building Code 2003 would not require designing "non-essential buildings" for wind loads based upon an Importance Factor of 1.15. For "non-essential buildings", it is recommended that the Importance Factor of 1.15 be applied to only the building envelope (e.g. roof, glazing, and cladding). It would not apply to the building structure.

2. Design hurricane category. The following steps should be used to determining the design hurricane category as applied in this standard.

   a. Start with the "3-second gust basic wind speed over land" from F.1 above.

   b. Convert this 100-year basic wind speed to the "1-minute average wind speed over water" using table C6-2 in ASCE/SEI 7-05.

c. Use the Saffir/Simpson Scale to select a hurricane category that includes the basic wind speed.

Saffir/Simpson Scale	
Wind speed	Category
74-95 mph	1
96-110 mph	2
111-130 mph	3
131-155 mph	4
155+ mph	5

G. Wind - roof

1. General. Design building roof decks, roof coverings, rooftop equipment, and roof drains in hurricane prone regions in accordance with the Florida Building Code to handle rain and wind loads associated with the basic wind speed selected in accordance with F.1. Outside of Florida, select Exposure Categories in accordance with ASCE/SEI 7-05.

2. Rooftop equipment

   a. Secure small roof top equipment such as stacks, exhaust fans and air intakes to resist the wind loads per ASCE/SEI 7-05 using the basic design wind speed selected in F.1. As a minimum, provide corrosion resistant fasteners (e.g. stainless steel or hot dipped galvanized #14 screws) not exceeding 6" on centers between the equipment, transition pieces, and the roof curb.

Inadequate securement (Photo source – FEMA)

Adequate securement (Photo source – FEMA)

See the FEMA guide "Attachment of Rooftop Equipment in High-Wind Regions" available at http://www.fema.gov/rebuild/mat/mat_katrina.shtm.

b. Secure exhaust fan cowlings with wire rope to the roof deck or equipment curb.

(Photo source – FEMA)

c. Locate ductwork within the building or enclosed in reinforced concrete or reinforced CMU.

d. Arrange lightning protection systems in accordance with the FEMA guide "Rooftop Attachment of Lightning Protection Systems in High-Wind Regions" available at http://www.fema.gov/rebuild/mat/mat_katrina.shtm.

e. Fasten piping and conduit to the building walls, or to stands attached to the building roof deck or building frame in accordance with the Florida Building Code.

f. Satellite dishes typically have a maximum design wind speed rating of 125 mph. In hurricane prone regions, hurricane emergency action plans should be expanded to include relocating satellite dishes inside before the hurricane. If the satellite dish frame is not secured to the building, it should be relocated inside with the dish.

(Photo source – FEMA)

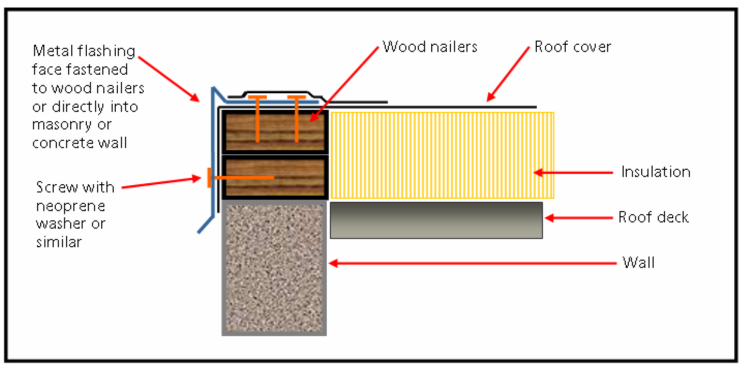
g. Secure large rooftop equipment such as chillers, cooling towers, and HVAC units to resist the wind loads per ASCE/SEI 7-05 using the basic design wind speed selected in F.1.

h. Where rooftop equipment use vibration isolators, verify that isolators include uplift securement.

Vibration isolator with threaded rod for upward travel limit.

3. Perimeter roof edge flashing

Avoid the use of hidden hook strips to secure perimeter roof edge flashing. Instead, use face fasteners with neoprene seals.



4. Parapets

Design parapets in accordance with ASCE/SEI 7-05.

5. Roof drains

a. Provide primary roof drains in accordance with the Florida Building Code.

b. Provide secondary roof drain in accordance with the Florida Building Code. Specifically, secondary drains will terminate to a visible above grade location.

6. Best practices

a. For roof edges with irregularities such as stair towers and dormers, the perimeter wind uplift loads can approach the loads typical to the roof corner. Consider using roof deck and roof cover securement similar to corners in these areas.

b. Locate rooftop air intakes and exhausts within rooftop penthouses designed for the anticipated wind loads in accordance with this standard. Use Miami-Dade County approved louvers that limit the entry of wind driven rain. The objective is to eliminate rooftop equipment exposed to wind loads.

c. Secure steel decks with screws rather than welds. The objective is to eliminate quality control concerns with welds that may not adequately form the appropriate connection diameter.

d. Areas with termite exposures, such as Hawaii and the Virgin Islands, should avoid the use of wood nailers (e.g. for curbs or roof edge flashing).

e. Insulation board adhered to concrete roof decks should be limited to 4' x 4' boards with a maximum thickness of 2". The objective is to select a board that can more readily conform to irregularities in the deck surface and achieve a better bond.

f. Avoid walking pads. The concern is that they commonly come loose in high winds.

g. Provided fully adhered roof cover systems where possible. The objective is to avoid progressive tear-off associated with mechanically fastened systems.

h. The use of sprayed-on poly foam roof cover systems must be accompanied by a program of weekly inspections. The objective is to promptly identify and repair any penetrations in the UV coating.

i. Avoid the use of standing seam roofs (structural or architectural). Where used, the system should possess and appropriate wind uplift test performed by the Army Corps of Engineers, or an agency using the ASTM 1592 test protocol. Where standing seam roofs are used, quality control over the location of clips and the number of screws per clips is essential. Lap seam roof decks are preferred as fastening can be visually verified.

j. Cooling towers should be protected with equipment screens engineered to withstand wind loads in accordance with this standard. The objective is to protect exposed fill and other internal components from damage from wind-borne debris.

k. Use corrosion resistant fasteners to secure rooftop equipment, and for ocean front properties, select stainless steel fasteners.

H. Wind – cladding

1. General

a. Design cladding systems in hurricane prone regions in accordance with the Florida Building Code to handle the wind loads associated with the basic wind speed selected in accordance with F.1. Outside of Florida, select Exposure Categories in accordance with ASCE/SEI 7-05.

b. In wind-borne debris regions, select cladding systems that are tested and approved in accordance with ASTM 1886 and ASTM 1996. Large missile impact resistant systems should be provided within 30 feet of grade. Small missile impact resistant systems should be installed within 30 to 60 feet above grade or within 30 feet above any aggregate covered roofs located with 1,500 feet.

c. CMU walls used in hurricane prone regions are to be reinforced.

d. Provide exterior door designed and reinforced to withstand the calculated wind loads.

e. Where louvers are needed, select Miami-Dade approved units designed to limit wind-driven rain carry-over.

2. Best practices

a. Carefully select EIFS cladding systems that possess the appropriate wind resistance based upon H.1.a above.

b. Where EIFS is used in wind-borne debris regions, use Miami-Dade approved missile impact resistant systems.

c. Use corrosion resistant fasteners, and for ocean front properties, select stainless steel fasteners or fasteners not prone to galvanic corrosion.

I. Wind – glazing

1. General

a. Design glazing systems in hurricane prone regions in accordance with the Florida Building Code to handle the wind loads associated with the basic wind speed selected in accordance with F.1. Outside of Florida, select Exposure Categories in accordance with ASCE/SEI 7-05.

b. In wind-borne debris regions, select glazing systems that are tested and approved in accordance with ASTM 1886 and ASTM 1996. Large missile impact resistant systems should be provided within 30 feet of grade. Small missile impact resistant systems should be installed within 30 to 60 feet above grade or within 30 feet above any aggregate covered roofs located with 1,500 feet.

2. Best practices

a. Use corrosion resistant fasteners, and for ocean front properties, select stainless steel fasteners.

J. Water – flood

1. Flood protection for buildings

a. Provide flood protection for building points of access located below the 100 year flood frequency elevation.

b. For the U.S. and its territories, the 100 year flood elevations are determined using FEMA (Federal Emergency Management Agency) flood maps available at http://msc.fema.gov/ . Building points of access may include door openings, windows, or utility penetrations through exterior walls. Protection may include:

1. Flood gates manually installed at openings. The top of a flood gate should be at or above the 100 year flood elevation.

2. Flood barrier systems manually installed to protect multiple openings.

3. Sump pumps to remove water that may leak past flood gates or flood barriers.

4. Use of construction materials that will not be readily damaged by the entrance of flood water.

5. Elevation of critical equipment above the 100 year flood elevation using housekeeping pads or mezzanines.

2. Water-borne debris protection for buildings

a. Provide water-borne debris protection for building walls that are not designed to withstand the impact of water-borne debris that is expected to expose the building. Water-borne debris could include:

- Boardwalk components torn free due to wave action
- Beach features such as storage sheds, storage lockers, rental equipment (surf boards, umbrellas)
- Vehicles parked adjacent to the building

- Trash dumpsters

b. Provide additional protection for building walls that cannot withstand the impact of debris. Additional protection may include features such as concrete barriers, pipe bollards, etc.

3. Flood protection for important structures

   a. Provide flood protection for important structures located within the boundaries of the 100 year flood frequency elevation.

   b. For the U.S. and its territories, the 100 year flood elevation can be determined using FEMA (Federal Emergency Management Agency) flood maps available at http://msc.fema.gov/ .

   c. The protection provided for important structures will depend upon the type structure. For example:

      1. An oil filled electrical transformer that will not be adversely affected by water immersion may be placed on a grade below the 100 year flood elevation as long as power is removed from the transformer before flood waters rise.

      2. A skid mounted emergency generator may be located such that the fuel tanks mounted within the skid is located below the 100 year flood elevation, but the enclosure housing the generator, engine, and controls is located above the 100 year floodplain.

      3. A water cooling tower is located such that electric motors for pumps and fans are located above the 100 year floodplain.

   d. Where tanks containing flammable or combustible liquids or gases are located below the 100 year flood frequency elevation, provide the following protection:

      1. Anchoring of the tank to resist the force associated with buoyancy.

      2. Extension of normal and emergency tank vents above the 100 year flood elevation.

4. Water-borne debris protection for important structures

   a. Provide water-borne debris protection for important structures that cannot withstand the impact of water-borne debris that could reasonably be expected to exposes the structure. Water-borne debris could include:

      - Boardwalk components torn free due to wave action
      - Beach features such as storage sheds, storage lockers, rental equipment (surf boards, umbrellas)
      - Vehicles parked adjacent to the building
      - Trash dumpsters

   b. Provide additional protection for structures that cannot withstand the impact of debris. Additional protection may include features such as concrete barriers, pipe bollards, etc.

K. Water – surface water runoff

1. Provide a site topography that directs rainwater away from buildings and high value or critical outdoor equipment.

2. Specific condition to evaluate:

   a. Large paved areas that support rapid rain water runoff.

b. Surrounding grade pitched towards building points of entry or important outdoor structures.

c. Ramps to below grade building access points such as truck docks or garage doors.

3. Where exposed features such as below grade truck docks cannot be avoided, provide protective features such as:

a. Passive protection

1. Berms or curbs that provide physical barriers to direct water away from the area.

2. Gravity dewatering systems that drain to suitable points of discharge. Size the systems based upon the 100 year rainfall rate and the size of the area that will deliver rain water to the location.

b. Active protection such as dewater pumps. Where electric motor driven pumps are used, provide back-up emergency power. In addition, provide redundant pumps. Size pumps and discharge piping based upon the 100 year rainfall rate and the size of the area that will deliver rain to the location.

c. Manual protection such as flood gates or flood barriers that are set in place when heavy rain is anticipated.

L. Water – surge

1. Enclosed building spaces

a. Locate enclosed building spaces above the surge water elevation associated with the design hurricane category as determined in accordance with F.2.

b. Where enclosed building spaces are located below the surge water elevation, the following conditions apply:

1. Enclose the space with construction that can withstand the static and dynamic loads associated with the storm surge.

2. Limit the use of the building spaces to operations, equipment, or systems that would interrupt the ability to use or occupy the remainder of the building. Examples of such operations, equipment, or systems include:

- Operations
  - Kitchens
  - Laundries
  - Operating rooms
- Equipment
  - Fire pumps
  - Fire alarm control panels
  - Boilers
  - Chillers
  - Transformers
  - Electrical switch gear
  - Medical diagnostic equipment
- Systems
  - Fire alarm systems
  - Door lock systems

- Computer systems
- Network systems

2. Important structures

   a. Locate important structures above the surge water elevation associated with the design hurricane category determined in accordance with F.2.

   b. Important structures include features that support the use and operation of the facility such as pools, hardscape, and similar features external to the buildings.

M. Water – wave action

1. General

   a. Protect beach front buildings and important structures from wave action that could undermine foundations and damage hardscape and landscape.

   b. Protection features include foundations extended to bedrock, or seawalls provided to protect foundations.

2. Seawalls

   a. Seawalls are to be designed by engineers experienced in this type of work.

   b. Seawall features shall include:

      1. Pilings. Piling supported the wall to avoid failure if scouring occurs under or behind the wall.

      2. Toe protection. A layer of protective stone at the seawall toe (sea-side) to preclude scouring of sand from under and behind the wall.

      3. Wall height. Wall height extended above the surge water elevation to preclude overtopping which will scour sand out from behind the seawall.

      4. Wing walls. Wing wall features to protect seawall ends from wave action.

      5. Drains. Drains to relieve water that will accumulate behind the seawall and the associated hydrostatic pressure.

References

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