RiskTopics

Guide to securing rooftop equipment to resist wind loads

Failure of rooftop equipment may occur during high-wind events. Such failures may expose building interiors to serious water damage.

To help minimize this potential source of water damage, consider securing rooftop equipment as recommended in this guide.

Introduction

Surviving high wind events with reduced property loss begins with maintaining the integrity of the building envelope. Any failure of the roof, glazing or cladding may allow storm water to enter the building. Experience shows that once water gets in, the potential for significant property damage and business interruption may begin.

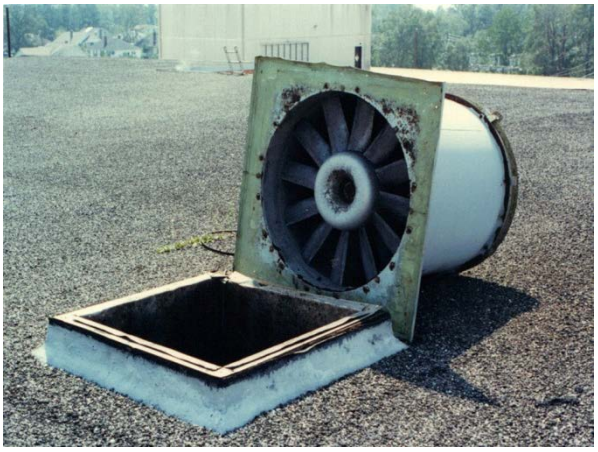
Time taken to evaluate and improve the securement of rooftop equipment can be time well spent. This applies to both the design of new buildings and the upgrade of existing buildings. Failure of rooftop equipment is a common outcome of high-wind events. Rooftop equipment failure may open points for water entry into the building and become sources of wind-borne debris that may cause further damage to the building envelope.

Discussion

Rooftop equipment often forms an integral part of the building envelope. Air intakes and exhaust fans cover large openings in the building envelope. If forced from their curbs, the unprotected opening that remains may allow significant quantities of water to enter.

Equipment dislodged by wind can also become wind-borne debris that may damage the roof cover, skylights, or other building envelope features.

Satellite dishes, lightning protection systems, electrical conduit, and piping may also become significant sources of damage to the roof cover and other building envelope features.



Wind damage to rooftop equipment *Roof cover damage from rooftop equipment*

Photo source: left – Tom Hall, The Zurich Services Corporation, right - FEMA

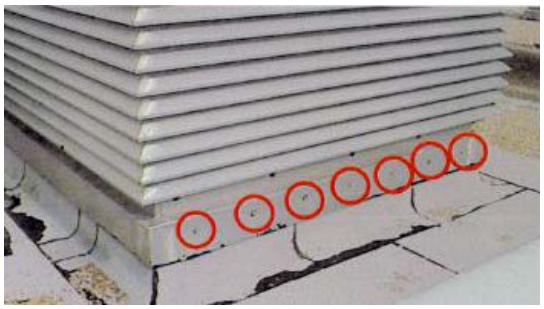
Guidance

Evaluate each piece of rooftop equipment to verify sufficient securement is provided against wind loads. For new buildings or new equipment on existing buildings, plans should be prepared that provide specific guidance for the appropriate securement of equipment. Where connections are engineered, consider following the guidelines of ASCE 7 (see References).

1. Small rooftop equipment – secure equipment to curbs: Secure small roof top equipment such as stacks, exhaust fans and air intakes to resist the wind loads in accordance with one of the following:

   a) ASCE 7

   b) FEMA guide "Attachment of Rooftop Equipment in High-Wind Regions" (see Reference 3)



Inappropriate securement *More appropriate securement*

Photo source: FEMA

2. Small rooftop equipment – securing exhaust fan cowlings: Secure fan cowlings with wire rope to the roof deck or the equipment curb.

Wind damage to fan cowling
Photo source: FEMA

Fan and cowling secured with wire rope

3. Goose necks: Secure goose-neck relief air hoods to resist the wind loads in accordance with one of the following:

   a) ASCE 7 (see Reference 1)

   b) FEMA guide "Attachment of Rooftop Equipment in High-Wind Regions" (see Reference 3)

4. Air conditioning condensers: Secure air conditioning condensers and similar equipment with straps fastened to the stand, curb, or roof deck.

Limited attachment to unsecured wood blocking

Limited attachment to stand

Better secured, two straps, 2 screws desirable per strap connection

Photo source: Rich Gallagher, The Zurich Services Corporation (left and center), FEMA (right)

5. Rooftop ductwork: Avoid exposed rooftop ductwork. Locate ductwork within the building, mechanical penthouse, or reinforced concrete or reinforced concrete masonry unit enclosure.

Exposed rooftop duct system

Duct system installed under roof cover

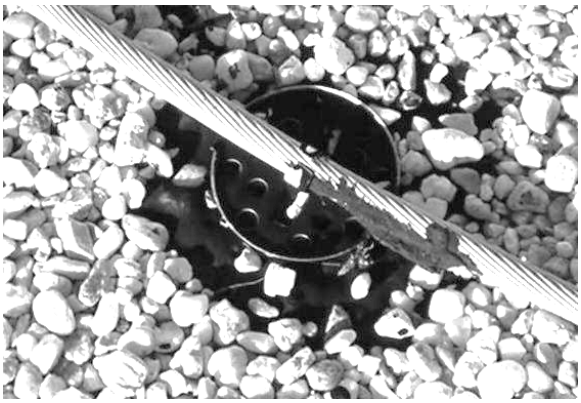
Photo source: Rich Gallagher, The Zurich Services Corporation

6. Lightning protection systems: Arrange lightning protection systems in accordance with the FEMA guide "Rooftop Attachment of Lightning Protection Systems in High-Wind Regions" (see Reference 4)

Air terminal penetrating roof cover

Air terminal screwed to wood nailer

Photo source: FEMA (left), Rich Gallagher, The Zurich Services Corporation (right)

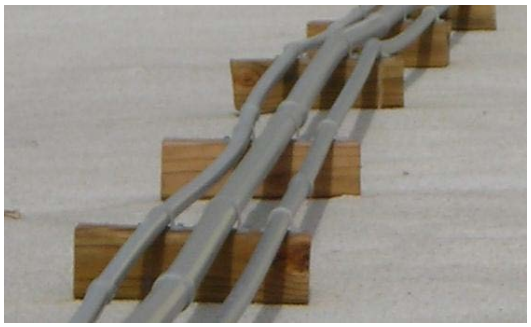


Conductor secured with clip adhered to roof cover

Conductor separated from clip after high wind

Photo source: Rich Gallagher, The Zurich Services Corporation (left), FEMA (right)

7. Pipe and conduit: Fasten piping and conduit to the building walls or to stands attached to the building roof deck or building frame in accordance with the to resist the wind loads of ASCE 7 (see Reference 1).



Conduit on unsecured wood blocking

Pipe support on stands anchored to concrete deck

Photo source: Rich Gallagher, The Zurich Services Corporation

8. Satellite dishes: Wind emergency action plans should be expanded to include relocating satellite dishes inside before any anticipated high-wind event. If the satellite dish frame is not secured to the building, it should be relocated inside with the dish.

Before high wind event

After high wind event

Photo source: FEMA

9. Large rooftop equipment: Engineer the connections for large equipment. Secure large rooftop equipment such as chillers, cooling towers, and HVAC units to resist the anticipated wind loads per ASCE 7 (see Reference 1).

Example of large equipment with non-engineered connection

Photo source: Rich Gallagher, The Zurich Services Corporation

Per the FEMA guide (see Reference 3) "Attachment of Rooftop Equipment in High-Wind Regions", this 18,000 lb. HVAC unit was secured to curb with 16 straps with only one screw per strap. An estimated wind speed between 85-90 mph dislodged this unit from the roof. Photo source: FEMA

10. Vibration isolators: Where rooftop equipment uses vibration isolators, verify that isolators include uplift securement.

Vibration isolator with threaded rod for upward travel limit
Photo source: Rich Gallagher, The Zurich Services Corporation

Conclusion

For either new buildings in the design phase or occupied buildings with existing or planned rooftop equipment, take the time to evaluate the anchorage of each and every rooftop feature.

When rooftop equipment stays in place during high-winds, a significant challenge to the integrity of the building envelope and source of water entry into the building may be reduced.

Remember, once water gets in, the potential for significant property damage and business interruption may begin.

References

1. ASCE 7. Minimum Design Loads for Buildings and Other Structures. American Society of Civil Engineers, 2016. Print.

2. Tom Smith, AIA, T L Smith Consulting Inc., "Wind Safety of the Building Envelope". Web. Web site accessed 20210322. http://wbdg.org/resources/env_wind.php

3. FEMA, "Attachment of Rooftop Equipment in High-Wind Regions. Web. Web site accessed 20210322. https://www.fema.gov/sites/default/files/2020-08/fema549_apndx_e_combined.pdf

4. FEMA, "Rooftop Attachment of Lightning Protection Systems in High-Wind Regions", Web. Web site accessed 20210322. https://www.fema.gov/sites/default/files/2020-08/fema549_apndx_e_combined.pdf

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