“In and Out Air Strategies. From Climate Change to Microclimate. Library, Archives and Museum Preservation Issues”

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http://www.ifla.org/VI/4/pac.htm
WIND RESISTANCE STRATEGIES FOR CULTURAL HERITAGE BUILDINGS IN THE AFTERMATH OF HURRICANE KATRINA

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Fig. 1.28. Flow pattern around a circular cylinder indicating vortex shedding downstream in the wake.
Figure 4-20. Length of leeward eddy area for flat-roof building.
Figure 9a  AIR FLOW AT CIRCULAR OBSTRUCTION

Figure 9b  AIR FLOW AT RECTANGULAR OBSTRUCTION
Figure 11a  AIR FLOW AT SIMPLE STRUCTURE

Figure 11b  PRESSURE DISTRIBUTION AT SIMPLE STRUCTURE
Figure 20 ZONE OF INCREASED PRESSURE COEFFICIENT AT CORNER CONDITION

Typically taken as $0.1 \times$ least plan dimension of building or $0.4 \text{ h}$ but not less than $3 \text{ ft}$.
**Figure 21** ZONES OF INCREASED PRESSURE COEFFICIENT AT ROOF CONDITION

Typically taken as 0.1 x least width or 0.4 h but not less than 3 ft

**Figure 22** UPLIFT PRESSURE AT ROOF OVERHANG

Negative pressures at windward eave and at leading edge of leeward roof (leeward of ridge)

Section

h = Average roof height

Section

Uplift pressure at overhang
HURRICANE KATRINA

Wind damage to shop structure near Long Beach MS
HURRICANE KATRINA

Wind-damaged apartments near West Jefferson Hospital – classic gable end failure
HURRICANE KATRINA

Gable end failure causes loss of roof due to increased internal pressure
HURRICANE KATRINA
DEBRIS TYPES

- compact object
- sheet
- rod
COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE

Compact object falls until it impacts the ground or a building
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WIND-BORNE DEBRIS: ROD-TYPE OBJECT

2 by 4s and rod-type objects have complicated rolling and tumbling motions
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WIND-BORNE DEBRIS DAMAGE

Wind-borne debris causes damage to windows, followed by failure of roof
Penetration of wall by flying debris
Figures 23a, 23b, 23c STEPPED PRESSURE PROFILES—WINDWARD WALL

Pressure based on $V_{33}=90$ mph, exposure category $C_1$, $C_p$ for windward side. No other effects included.
Aerial view showing proximities of debris source buildings and damaged buildings
Flyover view of Hyatt with 1250 Poydras in foreground
HURRICANE KATRINA

North façade of Hyatt from 1250 Poydras
HURRICANE KATRINA

Damage to rooms on north face of 27th floor
HURRICANE KATRINA

Scoured gravel on Amoco roof, a source of debris causing damage to Hyatt
Ballasted single-ply roof - Source of debris causing damage to Amoco and Dominion Bank
Debris damage to 1250 Poydras, viewed through broken window. Building had 900 broken panes, 200 of which were complete penetrations (both layers of glass were broken)
HURRICANE KATRINA

Typical window damage to 1250 Poydras due to wind-borne gravel
HURRICANE KATRINA

Documenting gravel debris
HURRICANE KATRINA

Gravel in the gap between broken outer pane and intact inner pane
HURRICANE KATRINA

Gravel on sidewalk at base of Amoco
HURRICANE KATRINA

Texaco Building, single-ply ballasted roof, debris source
HURRICANE KATRINA

2x4 penetrating cooling tower screen
Protection from wind-borne debris

Metal screens
Protection from wind-borne debris
Rolldown perforated metal screen
Tree Damage
Hurricane Katrina

Aug 29, 2005
Peak Gust Wind Speeds
LiDAR Mosaic

DeWitt Braud and Rob Cunningham
MULTIPLE FAILURES

From poor design, to construction not matching plans, to levees not high enough to withstand the storms they were designed for, man-made weaknesses in the hurricane protection system failed metro New Orleans on August 29.
10 M SPOT Satellite Image: 2 Sept 2005
10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays
Aerial photograph of New Orleans after Hurricane Katrina
THANK YOU

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www.buoyantfoundation.org