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DESIGN MEMORANDUM
November 4, 2008

RE: Structural Design Criteria for 61 India Street Rehabilitation, Portland, Maine
Four Story, Mixed-Use Building behind and above Existing Facade
Resurgence Engineering and Preservation Project Number 08-003

Discussion:

The proposed building would house the following functions:

LEVEL	FUNCTION AND CONSTRUCTION	DEAD LOAD (PSF)	LIVE LOAD (PSF)
First Floor	Commercial office or retail, (slab on grade or structural slab)	75 (6" slab)	100
Second Floor	Office (steel C7 joist system on steel girders cementitious deck and plywood subfloor)	34 (conservative)	80
Third Floor	Residential (steel C7 joist system on steel girders, single unit, third and fourth floors)	34 (conservative)	40
Fourth Floor	Residential (TJI joist system on steel, same unit as third floor)	20	40
Roof		20	42

Refer to TFH and Resurgence Plans, attached, for concept architectural and framing drawings for the building.

Determine wind, seismic, and snow design criteria for project:

Wind:

Wind design for this project considers the effect of wind loading per the 2003 International Building Code, which in turn references ASCE 7-02. Chapter 6 of ASCE 7-02 provides information about Wind Load design.

Wind Loading per Method 2 - Analytical Procedure (Section 6.5)

Main Windforce Resisting System

Building Classification	II -- office building
Exposure Coefficient	B
Wind Importance Factor I_w	1.00
Basic Wind Speed (3-sec gust)	100 mph

$q_z = 0.00256\, K_z * K_{zt} * K_d * V^2 * I$

Where K_z = velocity pressure exposure coefficient per 6.6.6.6, Table 6-3, pg 75.
$K_z = 0.76$ for $z = 41$ feet.

K_{zt} = topographic factor per 6.5.7.2 = 1.0 (no topographic effects)

K_d = directionality factor per 6.5.4.4 = 0.85 for components and cladding and MWFRS (see Table 6-4, page 76)

V^2 = square of wind velocity where velocity = 100 mph

I_w = importance factor for structure type, structure type II, (Table 1-1, Page 4); = 1.00

$q_z = 0.00256\, K_z * K_{zt} * K_d * V^2 * I$

$= 0.00256 * 0.76 * 1.00 * 0.85 * (100)^2 * 1.00$

= 16.54 psf Main Windforce Resisting System

Components and Cladding

The velocity pressure derived above is then applied into the design wind pressure Equation 6-22, pg 33.

$P = q_h\,[(GCp) - (GCpi)]$ Conservatively say $q_h = q_z$

(GCp) equals the following for Components and Cladding up to 10 sq. ft.:
Per Figure 6-11B, page 58, Gable Roofs slope less than 7 degrees
Per Figure 6-11A, page 57, Walls

-1.0, +0.3 Zone 1, Center of Roof
-1.8, +0.3 Zone 2, Middle Sides or Roof
-2.8, +0.3 Zone 3, Salient Corners of Roof
-1.1, +1.0 Zone 4, Center of Walls
-1.4, +1.0 Zone 5, Salient Corners of Walls

(GCpi) = +/-0.18

Conclusion for Wind Analysis:

MWRFS	**16.54 psf**
C/C Zone 1	**19.50 psf uplift at roof center**
C/C Zone 2	**32.75 psf center of sides of roof**
C/C Zone 3	**49.28 psf roof salient corners of roof (small area!)**
C/C Zone 4	**21.17 psf center of walls (will be lower at lower floors)**
C/C Zone 5	**26.13 psf corners of walls (lower at lower floors)**

Note that the component and cladding uplift loads for the roof will be resisted by roof sheathing screwed into the roof rafters. Because of the small building size, consider that the first four feet of plywood around the perimeter will be fastened at 6 inches on center along the roof rafters. This will accommodate any uplift encountered, and the uplift force will then be transferred to hurricane ties at the ends of the rafters.

Seismic:

Criteria	Variable Symbol	Variable Value
Building Classification (Occupancy Category) (ASCE-7, Table 1-1, page 4)	Category	II
Seismic Use Group (ASCE-7, Table 9.1.3, page 96) (based on Building Occupancy Category II)	Use Group	I
Occupancy Importance Factor (ASCE-7, Table 9.1.4, page 97) (based on Seismic Use Group I)	I_e	1.0
Short-Period (0.2 second) Structural Acceleration (ASCE-7, Figure 9.4.1.1(a), page 111) (percentage of gravity, g)	S_S	0.37
1.0-second Structural Acceleration (ASCE-7, Figure 9.4.1.1(b), page 113) (percentage of gravity, g)	S_1	0.10
Site Classification (ASCE-7, Table 9.4.1.2, page 108) (No soil report available) (For ledge within 50 feet of ground surface, consider Soil Type D)	Stiff Soil	D
Site Coefficients and Adjusted Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameters (used to calculate S_{MS}) (ASCE-7, Table 9.4.1.2.4a, page 129) $F_a = 1.50$ when interpolating between $S_s = 0.25$ and $S_s = 0.50$ for Site Class D	F_a	1.50
Site Coefficients and Adjusted Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameters (used to calculate S_{M1}) (ASCE-7, Table 9.4.1.2.4b, page 130) $F_a = 2.40$ for $S_1 \leq 0.10$ for Site Class D	F_v	2.40
Short-Period (0.2 second) MCE, 5% Damped Spectral Response Acceleration Adjusted for Site Class Effects (ASCE-7, Equation 9.4.1.2.4-1, page 129; $S_{MS} = F_aS_s \rightarrow\rightarrow 1.50 \times 0.37$)	S_{MS}	0.56g
1.0-second MCE, 5% Damped Spectral Response Acceleration Adjusted for Site Class Effects (ASCE-7, Equation 9.4.1.2.4-2, page 129; $S_{M1} = F_vS_1 \rightarrow\rightarrow 2.40 \times 0.10$)	S_{M1}	0.24g
Short-Period (0.2 second) Design Spectral Response Acceleration (ASCE-7, Equation 9.4.1.2.5-1, page 129; $S_{DS} = ⅔S_{MS} \rightarrow\rightarrow ⅔ \times 0.56$)	S_{DS}	0.37g
1.0-second Design Spectral Response Acceleration (ASCE-7, Equation 9.4.1.2.5-2, page 129; $S_{D1} = ⅔S_{M1} \rightarrow\rightarrow ⅔ \times 0.24$)	S_{D1}	0.16g
Seismic Design Category based on short period response accelerations (ASCE-7, Table 9.4.2.1a, page 131; $S_{DS} = 0.37$g, Seismic Use Group (SUG) = I)	SDC_S	C
Seismic Design Category based on 1-second period response accelerations (ASCE-7, Table 9.4.2.1a, page 132; $S_{D1} = 0.16$g, Seismic Use Group (SUG) = I)	SDC_1	C

CAN PROJECT BE DESIGNED USING SIMPLIFIED ANALYSIS PROCEDURE?

Design Procedure per ASCE 7-02 Section 9.5.4 (page 146) Simplified Analysis Procedure:

* *For SDC C, Simplified Analysis Procedure is allowed for SUG-1 buildings of light-framed construction not exceeding three stories in height. (this structure is four stories)*

* *For SDC C, Simplified Analysis Procedure is permitted for other SUG-1 buildings not exceeding two stories in height. (this structure is four stories)*

* *Simplified Analysis Procedure is not permitted for all other structures; Equivalent Lateral Force Analysis must be used. Use E L F Analysis.*

<u>Fails Simplified Analysis Criteria - Must use Equivalent Lateral Force Design Procedure</u>

Equivalent Lateral Force Design Procedure per ASCE 7-02 Section 9.5.5 (page 146):

Calculate Seismic Base Shear in Accordance with Equation 9.5.5.2-1, page 146.

$V = C_S W$ (Equation 9.5.5.2-1, page 146)

where
Cs = seismic response coefficient determined in accordance with Section 9.5.5.2.1
W = total dead load and applicable portions of other loads as indicated in Section 9.5.3

$C_S = \dfrac{S_{DS}}{R/I}$ (Eq. 9.5.5.2.1-1, page 146)

Where S_{DS} = design spectral response acceleration (0.2 sec) = 0.37g
R = response modification factor (Table 9.5.2.2, page 133-135)
R = 3 (ordinary steel not specifically detailed for seismic)
I = Occupancy Importance Factor (Section 9.1.4) = 1.00
$C_S = 0.37 / (3/1.00) \rightarrow\rightarrow C_S = 0.123$ (Calculated C_S)

But

$C_{Smax} = \dfrac{S_{D1}}{T(R/I)}$ (Eq. 9.5.5.2.1-2, page 146)

T = Fundamental period of Structure (Section 9.5.5.3)
Approx. Period, $T_a = C_t h_n^x$ (Eq. 9.5.5.3.2-1, page 147)
where: $C_t = 0.02$ (Table 9.5.5.3.2, page 147, for all other struct. syst.)
$h_n = 45$ feet
x = 0.75 (Table 9.5.5.3.2, page 147, for all other struct. syst.)

$T_a = 0.02 * 45 \text{ feet}^{.75} \rightarrow\rightarrow \mathbf{T_a = 0.35}$ **seconds**

Check Upper Limit on Period for Structure, T_{max} per Section 9.5.5.3. page 147

$T_{max} = C_u T_a$

$C_u = 1.6$ for $S_{D1} = 0.16g$, Table 9.5.5.3.1, page 147
$T_{max} = 1.6 * 0.35$ seconds
$\mathbf{T_{max} = 0.56}$ **seconds; can use $\mathbf{T_{approximate}}$ of 0.35 seconds**

So:

$C_{Smax} = S_{D1} / T*(R/I) = 0.16 / 0.35 (3.0/1.0)$ (Eqn. 9.5.5.2.1-2)
$C_{Smax} = 0.153$ (Does not govern)

And:

$C_{Smin} = 0.044 S_{DS} I = 0.044 (0.37) (1.0)$ (Eqn. 9.5.5.2.1-3)
$C_{Smin} = 0.02$ (Does not Govern)

$\rightarrow\rightarrow$ **Use Cs = 0.123**

$\mathbf{V = C_S W = 0.123W}$ (Equation 9.5.5.2-1, page 146)

Seismic Weights for Distribution per Section 9.5.3 are as follows:

Level and Occupancy	Area, Square Feet	Floor Dead Load	Perimeter Wall Loads*	Floor Live (snow) Load	Total Load
Roof 15 psf dead	1350	20	12.3	12	44.3
4 (Resid) 20psf d	1350	27	32.8	0	59.8
3 (Resid) 25psf d	1350	34	72.1	0	106.1
2 (Office) 25psf d	1350	34	72.1	0	106.1
1 (Retail/Office)	n/a	n/a	59		59.0
Totals:					375kips

Total Base Shear = 375 kips X 0.123 = 46 kips seismic load taken out through tops of perimeter walls.

Note that heaviest partition loads of existing brick masonry are taken out through the existing wall footings that have been reinforced with concrete. If the heavier loads from the second and first floor are removed from consideration, the "new" seismic force required to be taken out is

(375kips – (72.1 + 59) = 243 kips, and the "new" load base seismic shear is approximately 30 kips, which is much more manageable on the 160 foot exterior perimeter. Interior columns will also distribute significant base shears from gravity loads to the two large interior strip footings.

- Roof Wall Loads: 164 lineal feet x 5' x 15 psf avg = 8,200 lbs = 12.3 kips
- 4^{th} Wall Loads : 164 lineal feet x 10' x 20 psf avg = 32,800 lbs = 32.8 kips
- 3^{rd} Wall Loads: 164 lineal feet x 11 feet x 40 psf avg = 72,160 lbs = 72.1 kips
- 2^{nd} Wall Loads: 164 lineal feet x 11 feet x 40 psf avg = 72,160 lbs = 72.1 kips
- 1^{st} Wall Loads: 164 lineal feet x 6 feet x 60 psf avg = 59,040 lbs = 59.0 kips

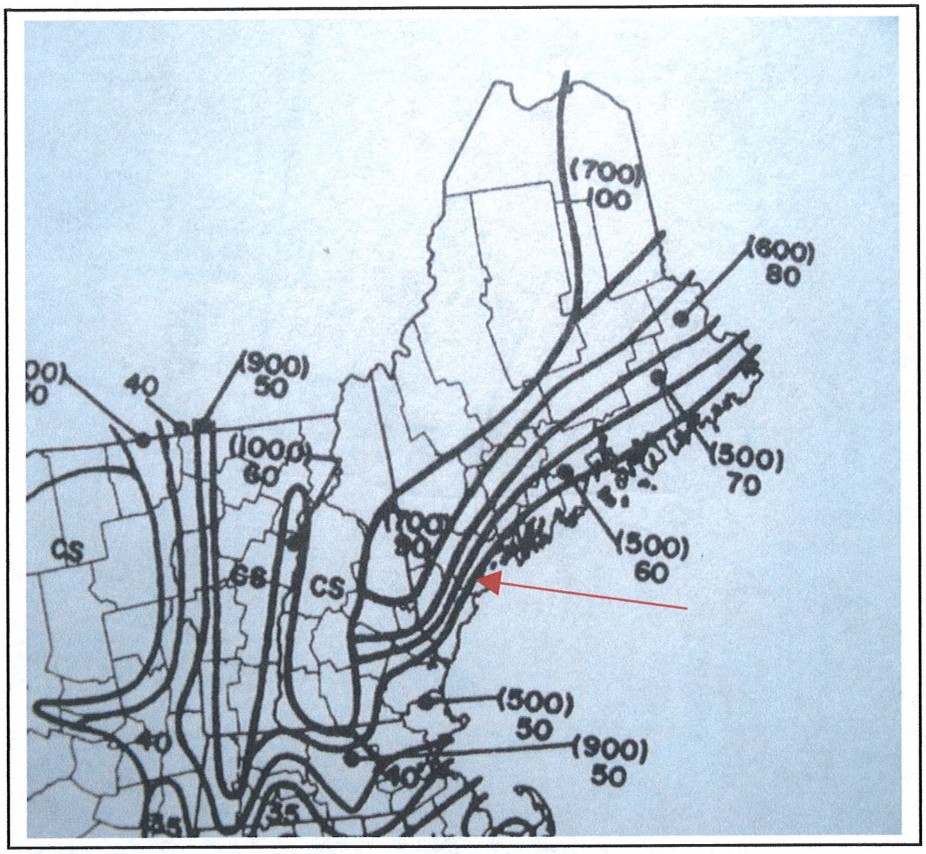
Snow Loading per Chapter 7 of ASCE 7-02

India Street sits close to sea level. No elevation concerns warranted.
Flat Roof Snow Load: $P_f = 0.7 * C_e * C_t * I * P_g$ (Equation 7-1, Page 81)

<table>
<tr><th>Variable</th><th>Discussion</th><th>Variable Value Selected</th></tr>
<tr><td></td><td></td><td>Assembly <300</td></tr>
<tr><td>Formula Coefficient =0.7</td><td>Given Coefficient preceding other factors:</td><td>0.7</td></tr>
<tr><td>C_e</td><td>Snow Load Exposure Factor per Table 7-2, Page 90</td><td>0.90</td></tr>
<tr><td>C_t</td><td>Thermal Factor for Roof per Table 7-3, pg 91 (summarized below):
<table>
<tr><th>Thermal Condition</th><th>Ct</th></tr>
<tr><td>All structures except as indicated below</td><td>1.00</td></tr>
<tr><td>Structures kept just above freezing and others with cold ventilated roofs with at least R25 insulation</td><td>1.10</td></tr>
<tr><td>Unheated structures and structures intentionally kept below freezing</td><td>1.20</td></tr>
<tr><td>Continuously heated greenhouses with a roof having a thermal resistance (R-value) <2</td><td>0.85</td></tr>
</table></td><td>1.10</td></tr>
<tr><td>I</td><td>Importance Factor for Snow Loads per Table 7-4, page 91
<table>
<tr><th>Category</th><th>I</th></tr>
<tr><td>I (Agricultural)</td><td>0.8</td></tr>
<tr><td>II (General Commercial, Assembly <300)</td><td>1.0</td></tr>
<tr><td>III (Assembly >300)</td><td>1.1</td></tr>
<tr><td>IV (Essential Facility)</td><td>1.2</td></tr>
</table></td><td>1.0</td></tr>
<tr><td>P_g</td><td>Ground Snow Load per Figure 7-1, pg. 83
See also discussion on sheet 3, this memo
(at ocean, on-peninsula)</td><td>60</td></tr>
<tr><td>P_f</td><td>Total Flat Roof Snow Load
Per Specified Occupancy→</td><td>41.58 psf
Commercial/Mixed Use
And Assembly <300</td></tr>
</table>

Sloped Roof Snow Load: $P_s = C_s * P_f$ (Equation 7-2, Page 81)
This does not apply for India Street Project.

Note also that the 60 psf ground snow load is conservative, as 50 psf could be considered on the Portland peninsula. See illustration next sheet.



ASCE 7-02 FIGURE 7-1 (ICC 2003 FIGURE 1608.2)
RED ARROW DENOTES APPROXIMATE LOCATION OF 61 INDIA STREET, NEAR THE BORDERLINE BETWEEN 50 PSF GROUND SNOW AND 60 PSF GROUND SNOW (LIKELY IN 50 PSF REGION)
USE 60 PSF AS CONSERVATIVE UNLESS NEEDED TO REDUCE FOR SEISMIC OR SNOW LOADS

INDIA STREET IS ESSENTIALLY AT SEA LEVEL AND CLOSE TO THE OCEAN, SO IT IS WELL BELOW THE 500-FOOT ELEVATION THAT REQUIRES SPECIAL CONSIDERATION OR EVALUATION FOR SNOW LOADS.