La Jolla Commons Office Tower

Appendix Slides

- Architecture Breadth
- Dual Systems Check
- Shear Wall Modeling
- Lateral System Verification
- Model Verification
- Vibrations Analysis

Architecture Breadth

Appendix List

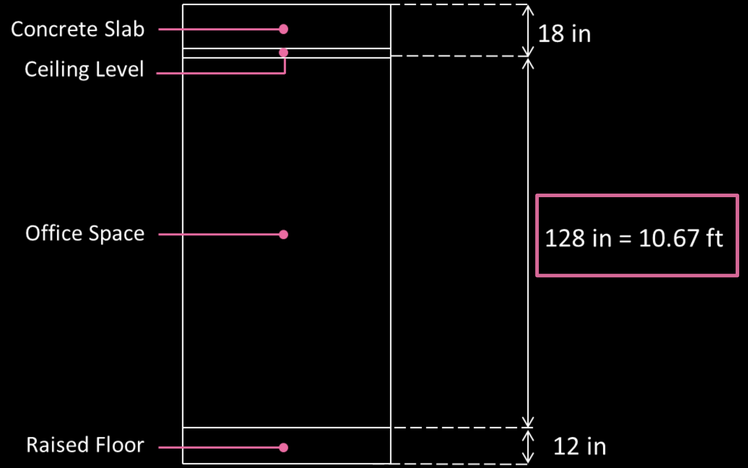
Floor-to-Ceiling Height

- Building height limited to 198’-8” by FAA
- Steel creates a deeper structural system than concrete
- Loss of floor-to-ceiling space

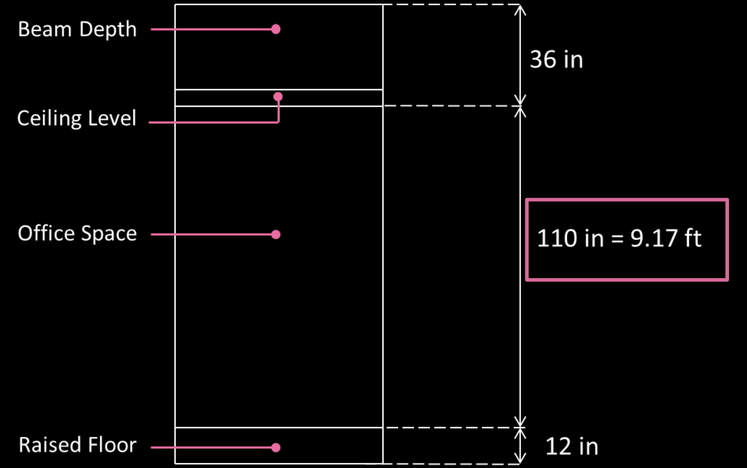
Appendix List

La Jolla Commons Office Tower

Floor-to-Ceiling Height



Concrete



Steel

1’-6” Decrease in floor-to-ceiling height

Appendix List

La Jolla Commons Office Tower

Fire Protection Breadth

Required Fire-Resistance Ratings		
Element	Construction Type	Required Rating (hours)
Primary Floor Framing Members	Type 1B	2
Secondary Floor Framing Members	Type 1B	2
Structural Columns	Type 1A	3

Appendix List

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A[d]	B	A[d]	B	HT	A[d]	B
Primary structural frame[g] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls									
Exterior[f, g]	3	2	1	0	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[e]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1^{1}/_{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

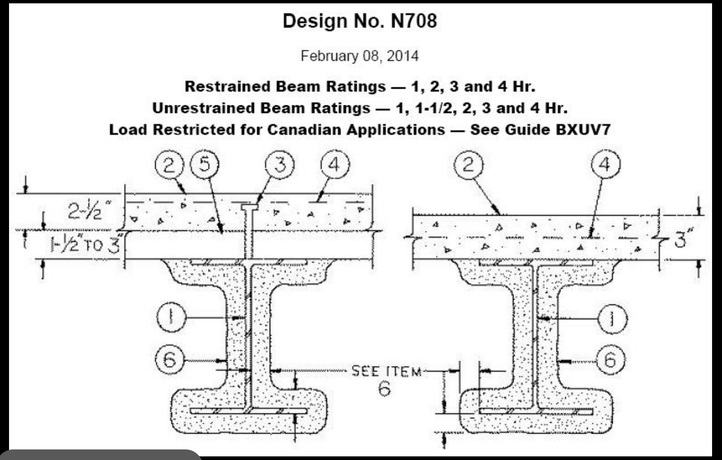
e. Not less than the fire-resistance rating required by other sections of this code.

f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

g. Not less than the fire-resistance rating as referenced in Section 704.10

La Jolla Commons Office Tower

Fire Protection Breadth



Appendix List

1.5” of SFRM

$$h_2 = h_1 \, [(W_1 / D_1) + 0.60] \, / \, [(W_2 / D_2) + 0.60]$$

(Equation 7-17)

where:

h = Thickness of sprayed fire-resistant material in inches.

W = Weight of the structural steel beam or girder in pounds per linear foot.

D = Heated perimeter of the structural steel beam in inches.

Subscript 1 refers to the beam and fire-resistant material thickness in the *approved* assembly.

Required Spray Fireproofing Thickness					
722.5.2.2.1 Requirements					
Min W/D for Substitute Beam:	0.37	OK			
Min Thickness of Protection:	0.375	in			
Unrestrained/restrained?	Unrestrained (to be conservative)				
Min Fire Rating:	1 hour				
Required Fire Rating:	2 hour				
Minimum Beam Size:	W12x14				
Heated Perimeter:	0.405				
Assembly Tested	Min Beam Size	h1	W1/D1	W2/D2	h2
N708	W8x28	1.00	0.819	0.405	1.412

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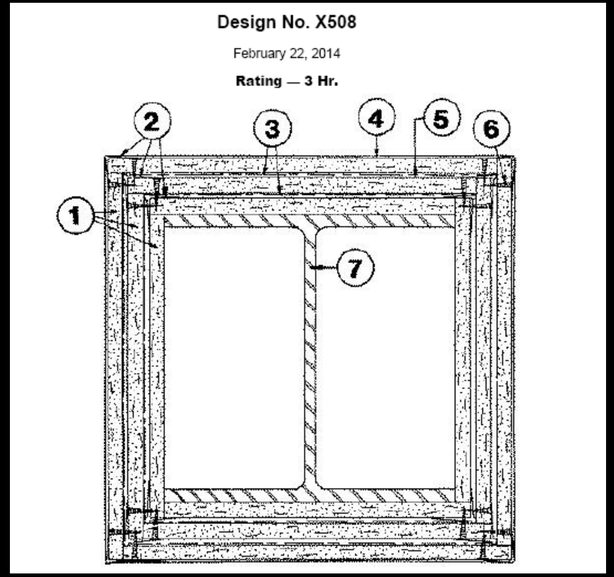
Fire Protection Breadth

1. The outer layer must be 5/8 inches thick. The inner layers will be 5/8 inch thick wall board as well. The wallboard is installed without any horizontal joints. 1 inch long self-drilling screws shall be spaced as required for the installation of the first layer of wall board.
2. 28 MSG galvanized metal corner bead
3. 18 SWG annealed wire, space 6 inches from each end and at 1’-9” intervals
4. May be finished with 3/32” thick gypsum veneer plaster. Joints reinforced.
5. Laminated with joint cement.
6. 1 inch long self-drilling screws spaced at 12” center to center
7. Minimum column size of W10X49. 9/16 flange thickness and 5/16 inch web thickness. 14.4 square inch area.

Appendix List



La Jolla Commons Office Tower

- 4.25 LW topping provided
- Adequate for 2 hour fire resistance between levels

Appendix List

Fire Protection Breadth

TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE BARRIER ASSEMBLIES OR HORIZONTAL ASSEMBLIES BETWEEN FIRE AREAS

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1

Restrained Assembly Rating	Type of Protection	Concrete Thickness & Type (1)
2 Hr. (continued)	Sprayed Fiber	2" NW&LW
		2 1/2" NW&LW
		2 1/2" LW
		2 1/2" NW
		3 1/4" LW
	Unprotected Deck	3 1/4" LW
		4 1/2" NW

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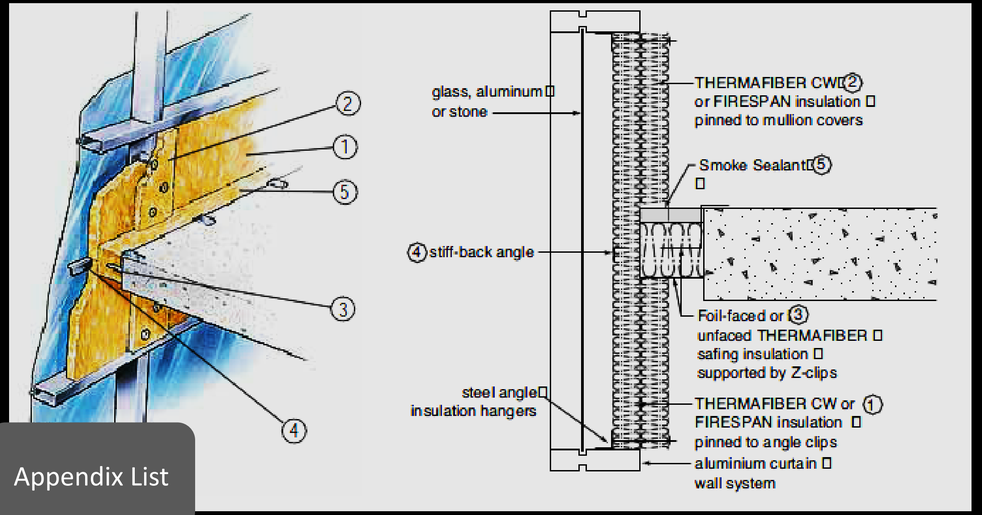
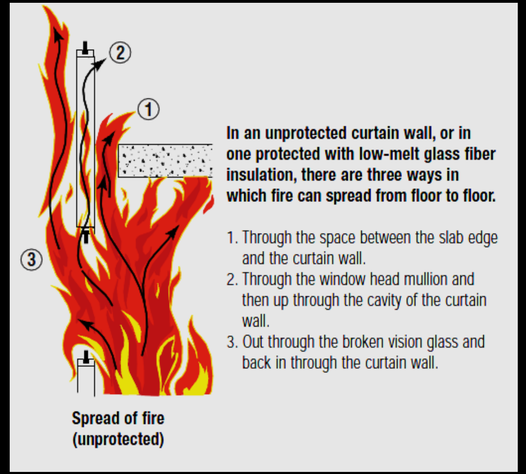
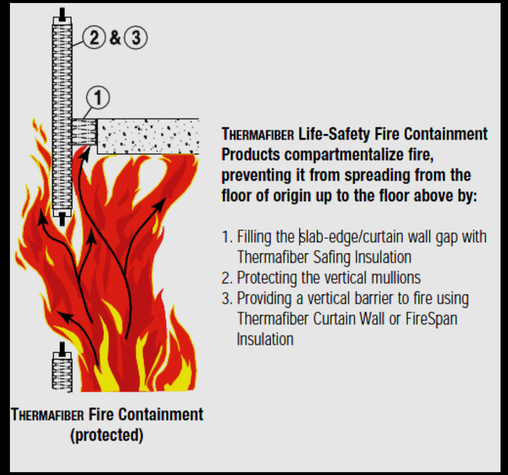
Fire Protection Breadth







Appendix List

Shear Wall Modeling

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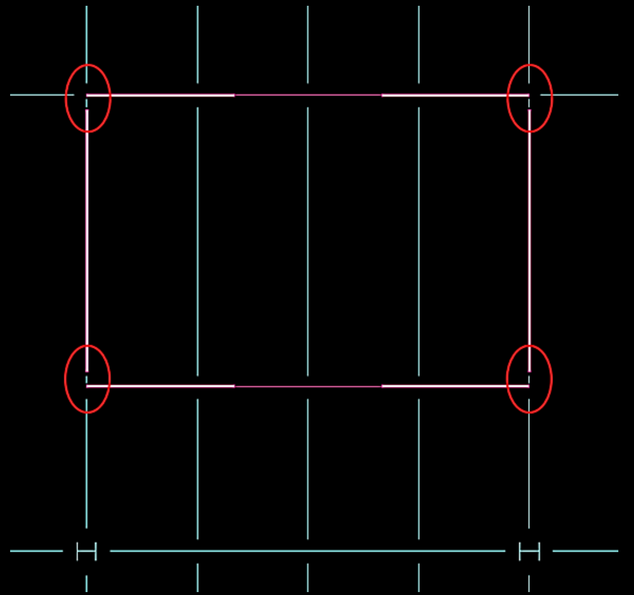
Shear Wall Modeling Method

- Shell elements connected at nodes caused an irregular distribution of torsional forces within the wall core
- Bentley suggested disconnecting the shear walls and adding gravity framing elements to eliminate a “framing tables” error
- Does not count on flanged walls to take out of plane loads or to help in flexure
- Eliminated odd torsionally anomaly



Appendix List

Model Verification

Appendix List

Model Verification

Model Verification Summary		
	% Error X-Direction	% Error Y-Direction
Center of Mass	0.284%	1.265%
Center of Rigidity	2.813%	1.681%
Floor Mass	11%	
Seismic Loads	15%	
Wind Loads	0.25%	3.31%
2D Analysis	10 - 20 %	

Appendix List

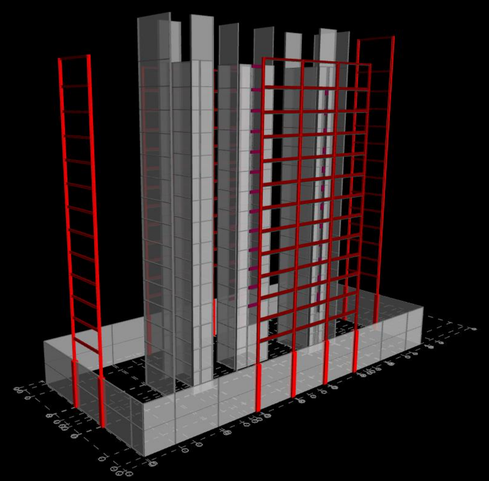
Dual System Check

Appendix List

La Jolla Commons Office Tower

Appendix List

Dual System Check



Dual System Check			
X-Direction Direct Shear			
Item	Shear (kip)	% of Total Shear	Dual System?
Frame 1	595.21	18.27%	No
Frame 2	643.37	19.74%	No
Shear Walls	2020.00	61.99%	-
Total Shear	3258.58 kip		
Y-Direction Direct Shear			
Item	Shear (kip)	% of Total Shear	Dual System?
Frame 3	35.61	1.18%	No
Frame 4	32.41	1.08%	No
Shear Walls	2941.00	97.74%	-
Total Shear	3009.02 kip		

Lateral System Verification

Appendix List

La Jolla Commons Office Tower

- Drifts for wind and seismic were verified to meet code and industry standard requirements (Cd=5, R=6)
- Torsional analysis was performed at each story under the different seismic load cases and found to no longer have an irregularity
- Stability coefficients were verified
- Overturning moment was checked under the controlling load case

Appendix List

Lateral System Verification

Wind Displacement Determination				
Load Case	X - Deflection (in)	Y - Deflection (in)	L/400 (in)	Pass/Fail?
Wind_ASCE710_1_X	1.91	0.00	5.940	Pass
Wind_ASCE710_1_Y	0.00	2.11	5.940	Pass
Wind_ASCE710_2_X+E	1.43	-0.01	5.940	Pass
Wind_ASCE710_2_X-E	1.43	0.01	5.940	Pass
Wind_ASCE710_2_Y+E	0.01	1.68	5.940	Pass
Wind_ASCE710_2_Y-E	-0.01	1.49	5.940	Pass
Wind_ASCE710_3_X+Y	1.43	1.58	5.940	Pass
Wind_ASCE710_3_X-Y	1.43	-1.58	5.940	Pass
Wind_ASCE710_4_X+Y_CW	1.07	1.11	5.940	Pass
Wind_ASCE710_4_X+Y_CCW	1.08	1.27	5.940	Pass
Wind_ASCE710_4_X-Y_CW	1.07	-1.26	5.940	Pass
Wind_ASCE710_4_X-Y_CCW	1.08	-1.10	5.940	Pass

La Jolla Commons Office Tower

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Seismic Story Drift Check

Level	Level Height (ft)	$C_d * \delta_x$		Allowable Drift (in)	Pass/Fail?	
		X-Direction	Y-Direction		X-Direction	Y-Direction
PH Roof	24.33	5.15	2.04	5.839	Pass	Pass
PH	14.5	3.08	1.22	3.480	Pass	Pass
13	14	2.83	1.02	3.360	Pass	Pass
12	14	2.87	1.01	3.360	Pass	Pass
11	14	2.89	1.00	3.360	Pass	Pass
10	14	2.89	0.97	3.360	Pass	Pass
9	14	2.85	0.93	3.360	Pass	Pass
8	14	2.76	0.88	3.360	Pass	Pass
7	14	2.62	0.82	3.360	Pass	Pass
6	14	2.41	0.74	3.360	Pass	Pass
5	14	2.13	0.64	3.360	Pass	Pass
4	14	1.76	0.53	3.360	Pass	Pass
3	14	1.29	0.40	3.360	Pass	Pass
2	15	0.78	0.27	3.600	Pass	Pass
Overall Displacement=		36.32	12.46			

La Jolla Commons Office Tower

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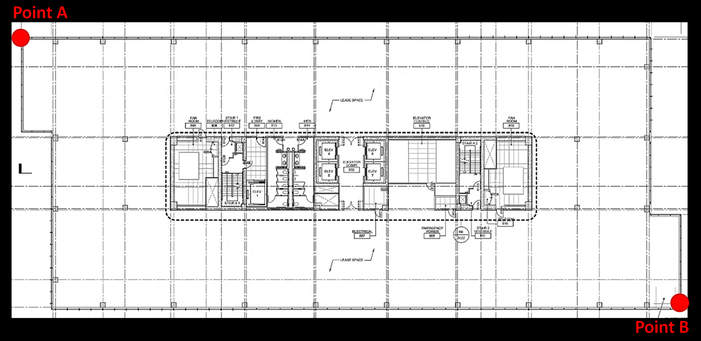
Lateral System Verification



Check for Torsional Irregularities X Direction					
Level	δ_A	δ_B	δ_{avg}	δmax	Does a torsional irregularity exist?
PH	0.6268	0.6269	0.63	0.6269	No
Level 13	0.5762	0.5764	0.58	0.5764	No
Level 12	0.5846	0.5847	0.58	0.5847	No
Level 11	0.5887	0.5888	0.59	0.5888	No
Level 10	0.5877	0.5878	0.59	0.5878	No
Level 9	0.5788	0.5789	0.58	0.5789	No
Level 8	0.5614	0.5615	0.56	0.5615	No
Level 7	0.5320	0.5321	0.53	0.5321	No
Level 6	0.4901	0.4902	0.49	0.4902	No
Level 5	0.4330	0.4331	0.43	0.4331	No
Level 4	0.3582	0.3582	0.36	0.3582	No
Level 3	0.2116	0.2637	0.24	0.2637	No

La Jolla Commons Office Tower

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Appendix List

Lateral System Verification

Building Resisting Moment		
Worst Case Resistance - Y Direction		
Total Building Weight =	82296	kip
Moment Arm =	57.5	ft
Factory of Safety=	0.67	
$M_{resisting}$ =	3170446	ft-k

Worst Case Moment for Building Overturning	
Seismic Y Direction - Load Case: Y + YET	
381110	ft-k

Check Overturning		
Worst Case Resistance - Y Direction		
Overturning Moment =	381,110	ft-kip
Resisting Moment =	3,170,446	ft-kip
Okay?	Pass	

Vibrations Analysis

Appendix List

La Jolla Commons Office Tower

- LL = 11 PSF
- Superimposed DL = 40 PSF

- Concrete weight = 50 pcf (Lightweight)
- Floor thickness = 5.75”
- 1.5VLR20 with 4.25” LW topping

- P_0 = 65lb
- β = 0.03
- a_0/g = 0.5%

Appendix List

Vibrations Analysis

- Beam Properties:
  - W_j = 153 kip
  - f_j = 4.39 Hz
  - W_g = 205.3 kip
  - f_g = 4.86 Hz

- Combined Mode Properties:
  - f_n = 3.36 Hz
  - W_{total} = 174.5 kip

- a_p/g = 0.38%
- $a_p/g < a_0/g$