

The image shows the Seattle Public Library building, a modern architectural structure with a complex, angular design. The building's facade is composed of large, dark, rectangular panels arranged in a grid-like pattern, creating a textured, crystalline appearance. The building is set against a clear blue sky. To the left, a tall, white, classical-style building with a pointed roof is visible. To the right, a shorter, grey building with vertical lines is partially seen. In the foreground, there are green trees and a street with a traffic light.

# SEATTLE PUBLIC LIBRARY

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# BACKGROUND

2004

OMA/LMN - Rem Koolhaas &

Joshua Prince-Ramus

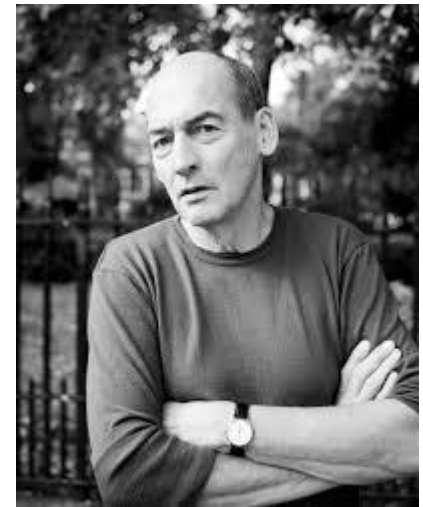
Magnusson Klemencic

362,987 sf.

\$169.2 mil

Redefine Library

Form by Program





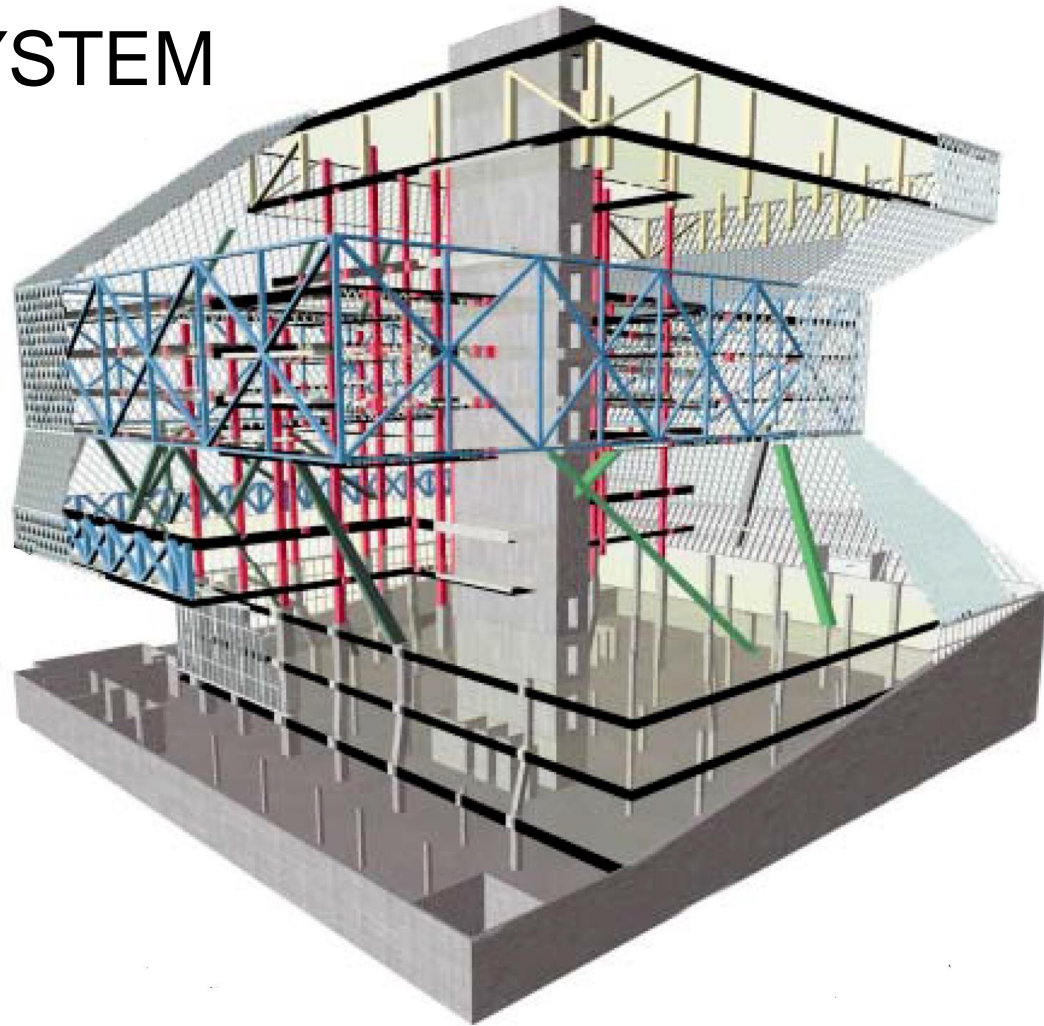
# THE STRUCTURAL SYSTEM

Concrete base and shear walls

Beam-columns

Platforms and mega-trusses

Some traditional framing



# CONNECTIONS

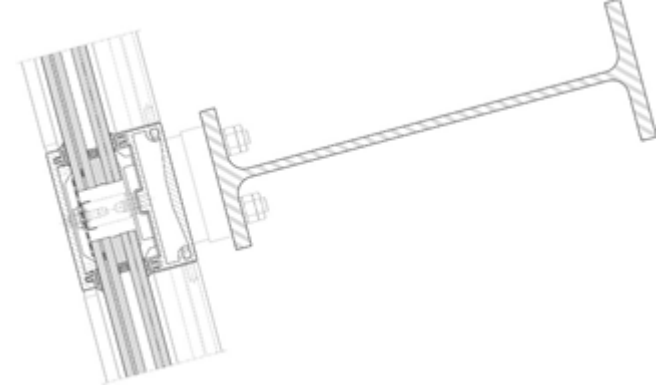
## Diagrid

### Non-vertical Faces

2 support connections per diamond

Setting blocks

Mullion system - screw-within-a-screw connect



### Vertical Faces

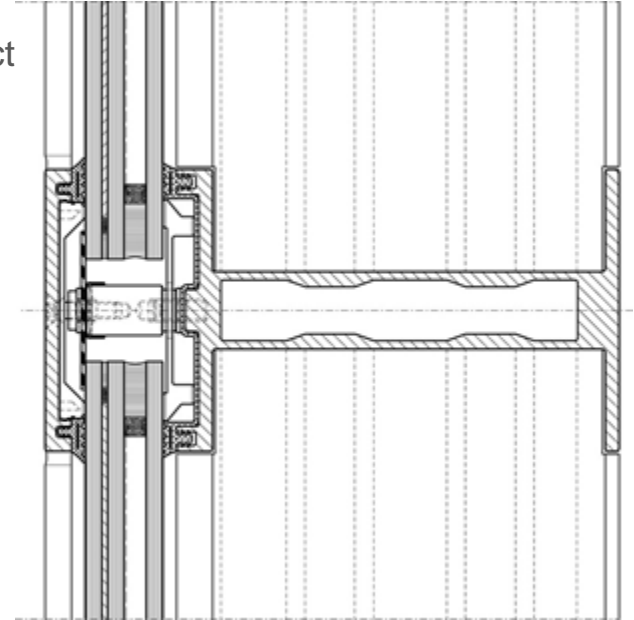
Structural

No seismic steel

Deeper aluminum

Armatures

Threaded rod attachments



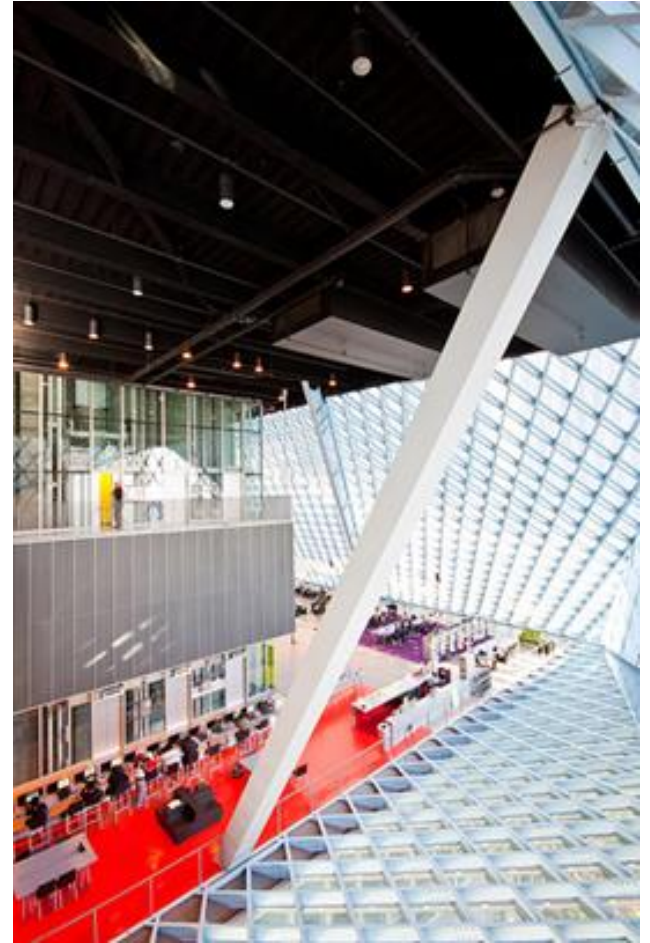
# CONNECTIONS

## Slanted Columns

Pinned connection at bottom

Welded connection to diagrid structure

Afterthought - cut and welded on site



# LATERAL COMPONENTS

Diagrid

Beam columns

Non-symmetrical - offset floors result in twisting

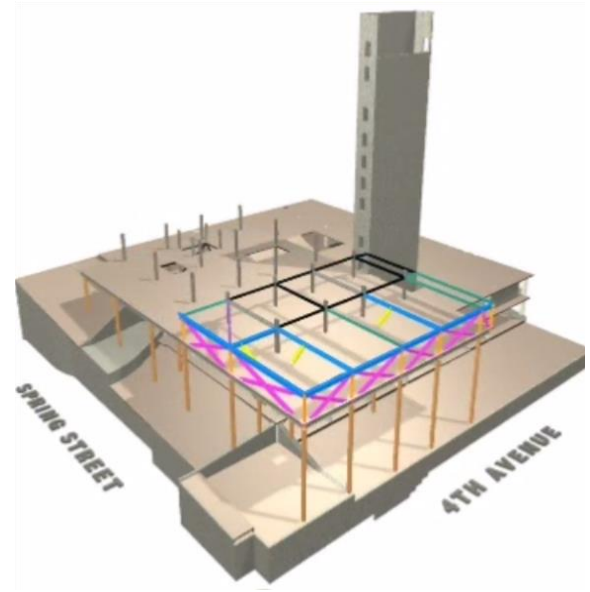
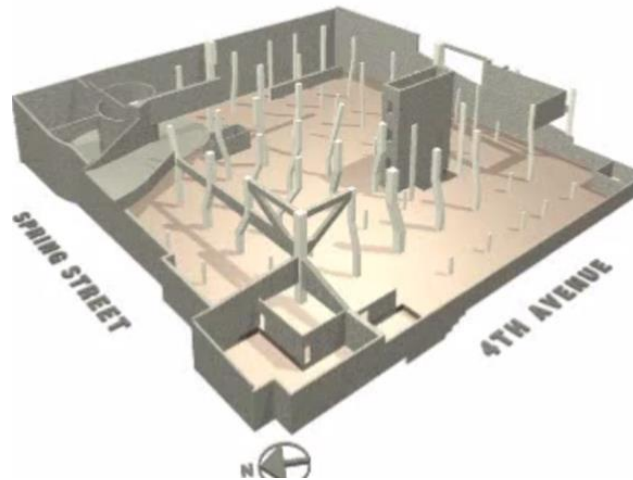


# LOAD TRANSFER

Shear walls and lower column grid

on the northwest corner

transfer loads down to foundation





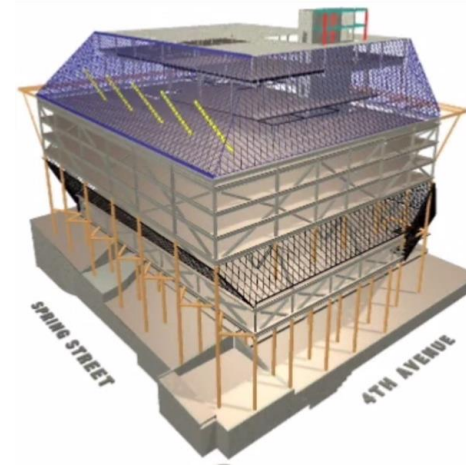
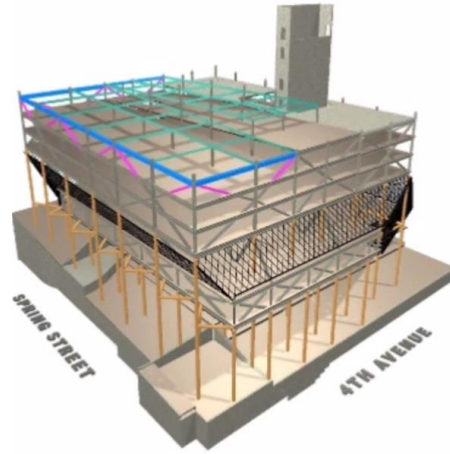
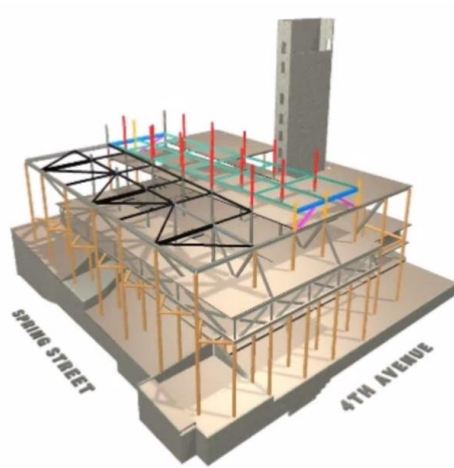
# LOAD TRANSFER

## Central loads

down elevator core and vertical columns

## Other loads and thrust from beam columns

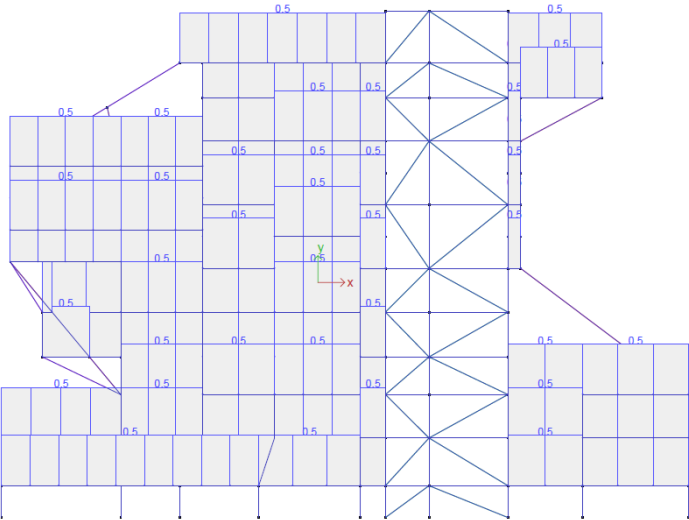
carried to platform edges, down mega trusses, out to diagrid



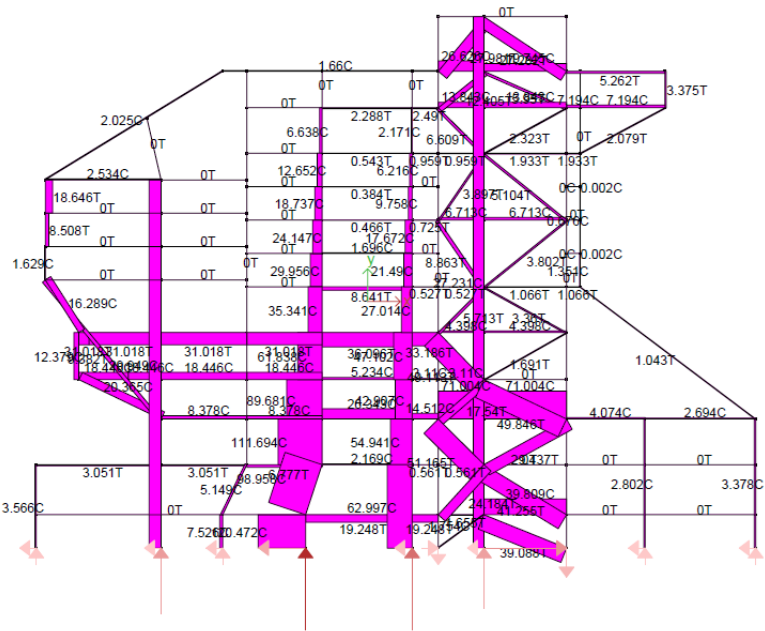


# MULTIFRAME ANALYSIS

Gravity Loads

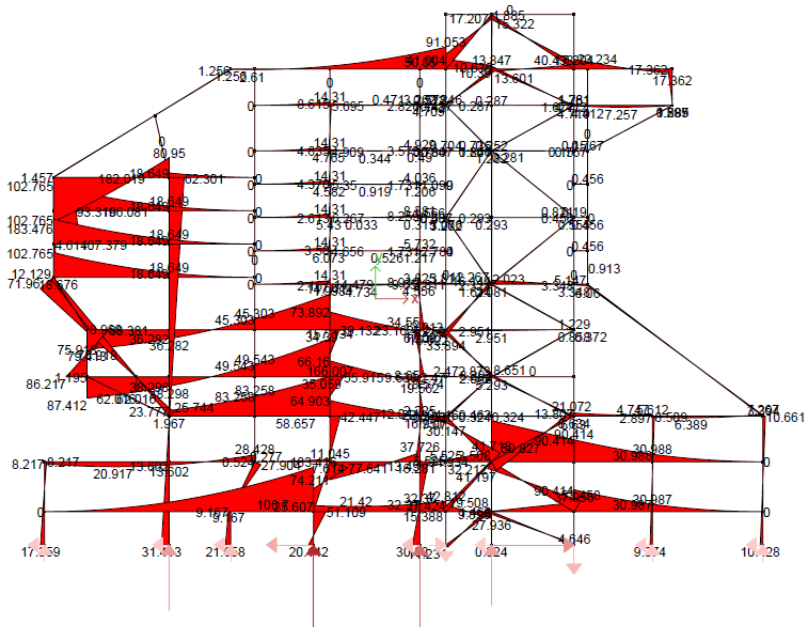


Loads Distribute

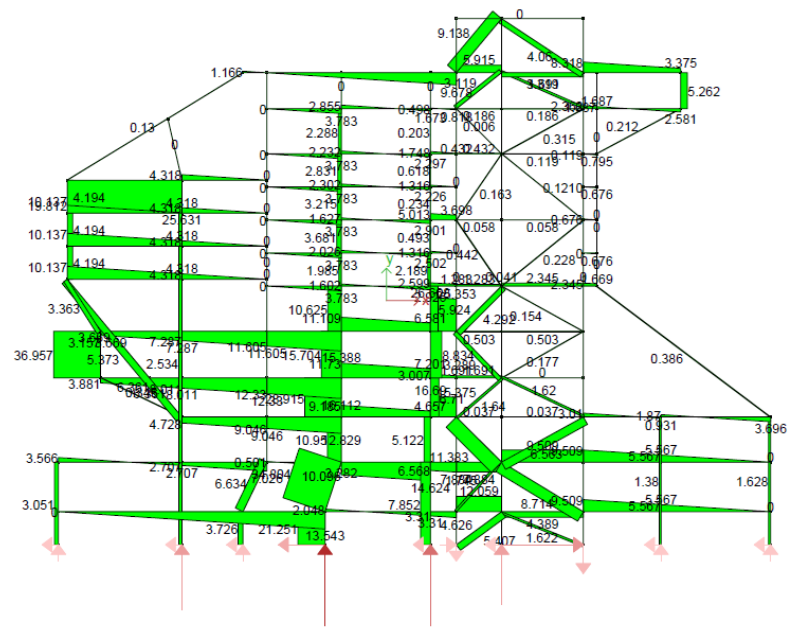


Axial Loads Diagram

# MULTIFRAME ANALYSIS



## Bending Moment Diagram



## Shear Diagram

# MULTIFRAME ANALYSIS

## Wind Loads

Find the wind speed according to the ASCE -7-05 Chapter 6

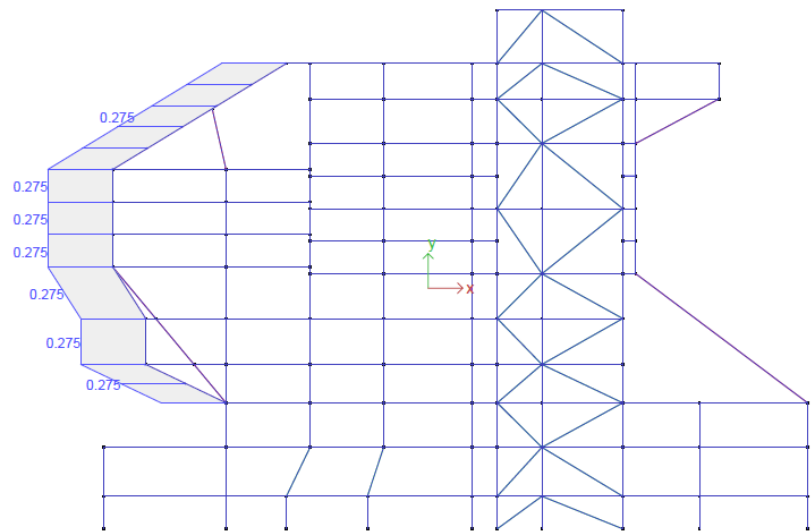
Total lateral load from one side =  $7.6 \text{ lb/ft}^2 * 24145 \text{ ft}^2/4 = 47775.5 \text{ lb}$

Distributed load along the edge =  $47775.5 \text{ lb} / 174 \text{ ft} = 275 \text{ lb/ft}$

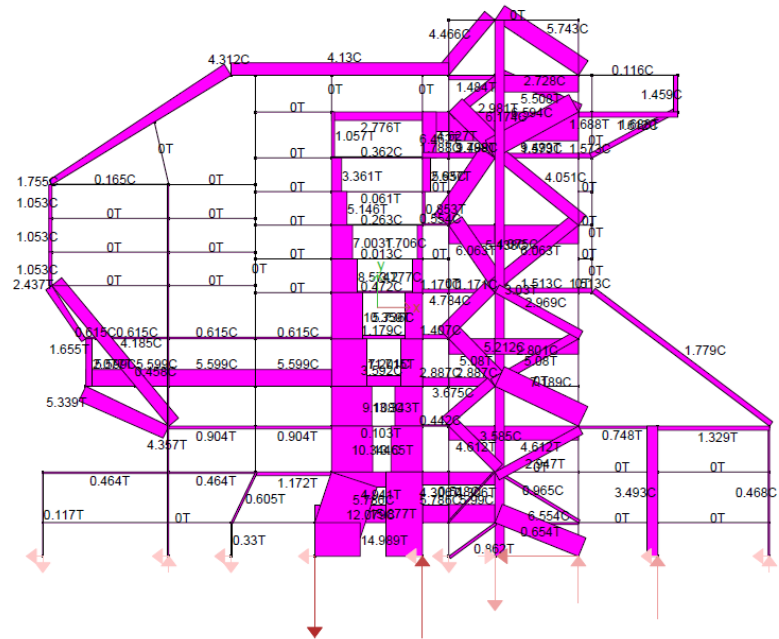
Main Wind Force Resisting System – Method 1						h ≤ 60 ft.						
Figure 6-2 (cont'd)		Design Wind Pressures				Walls & Roofs						
Enclosed Buildings												
Simplified Design Wind Pressure, p <sub>s30</sub> (psf) (Exposure B at h = 30 ft., K <sub>z</sub> = 1.0, with I = 1.0)												
Basic Wind Speed (mph)	Roof Angle (degrees)	Load Case	Zones									
			Horizontal Pressures				Vertical Pressures				Overhangs	
			A	B	C	D	E	F	G	H	E <sub>OH</sub>	G <sub>OH</sub>
85	0 to 5°	1	11.5	-5.9	7.6	-3.5	-13.8	-7.8	-9.6	-6.1	-19.3	-15.1
	10°	1	12.9	-5.4	8.6	-3.1	-13.8	-8.4	-9.6	-6.5	-19.3	-15.1
	15°	1	14.4	-4.8	9.6	-2.7	-13.8	-9.0	-9.6	-6.9	-19.3	-15.1
	20°	1	15.9	-4.2	10.6	-2.3	-13.8	-9.6	-9.6	-7.3	-19.3	-15.1
	25°	1	14.4	2.3	10.4	2.4	-6.4	-8.7	-4.6	-7.0	-11.9	-10.1
		2	-----	-----	-----	-----	-2.4	-4.7	-0.7	-3.0	-----	-----
	30 to 45	1	12.9	8.8	10.2	7.0	1.0	-7.8	0.3	-6.7	-4.5	-5.2
	2	12.9	8.8	10.2	7.0	5.0	-3.9	4.3	-2.8	-4.5	-5.2	

# MULTIFRAME ANALYSIS

Wind Loads



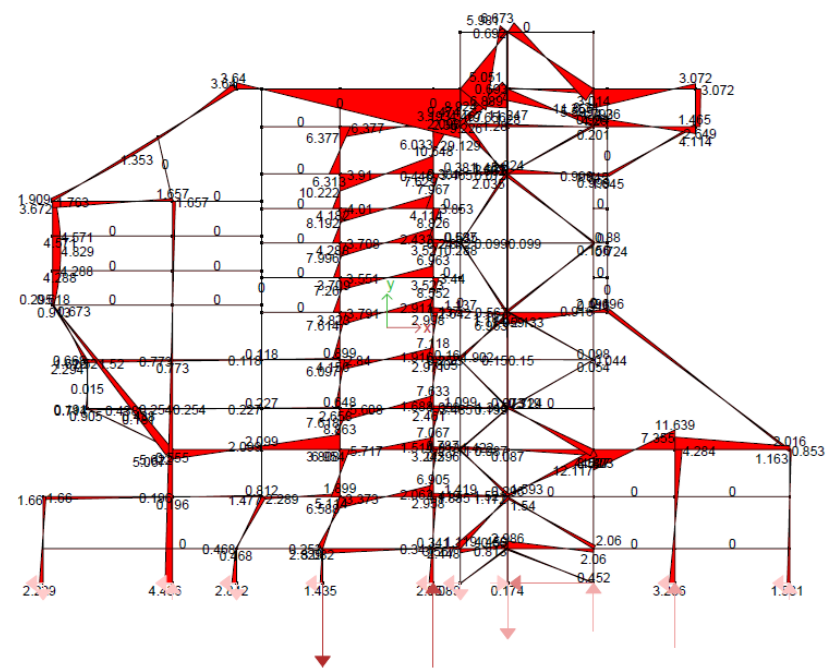
Loads Distribute



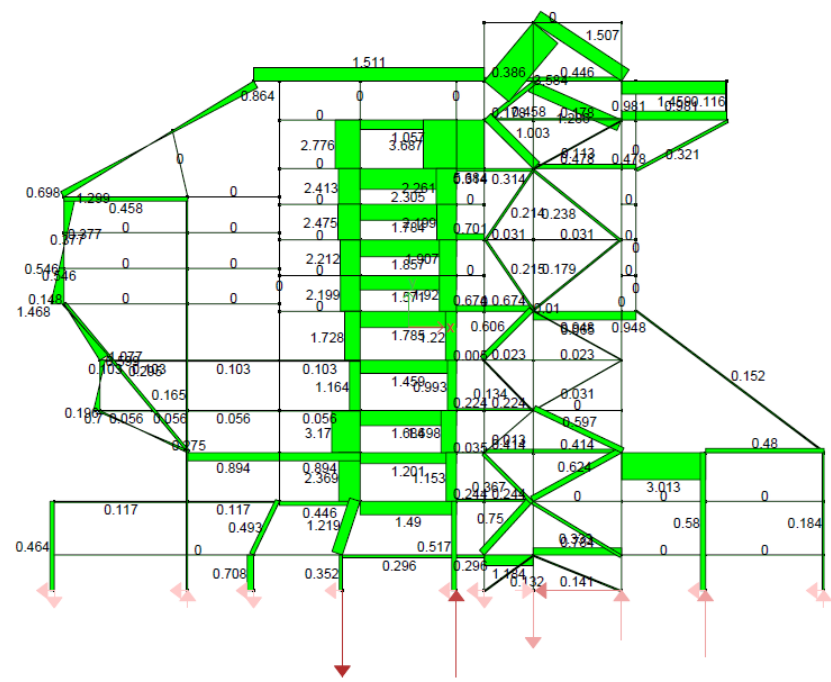
Axial Loads Diagram



# MULTIFRAME ANALYSIS



Bending Moment Diagram



Shear Diagram

# FOUNDATION SYSTEM

Soil Type - Seismic Site Class C

Shallow Foundation System

Mat-slab Foundations

Spread Footing Foundations

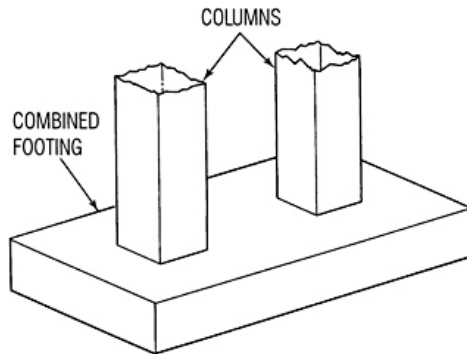


# Mat-slab Foundations

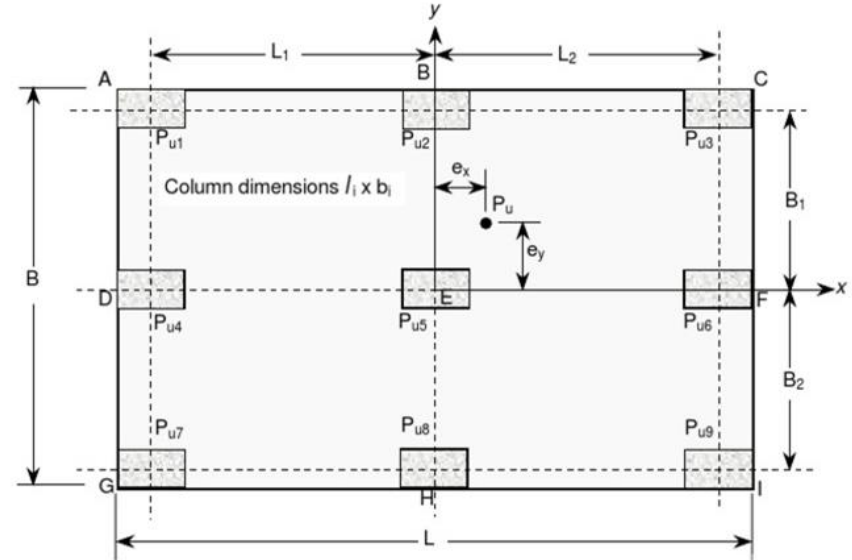
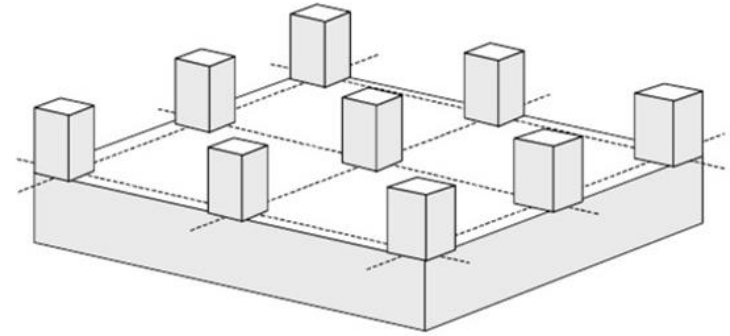
Dimension: 44 ft \* 65 ft

Location: Under stairway cores

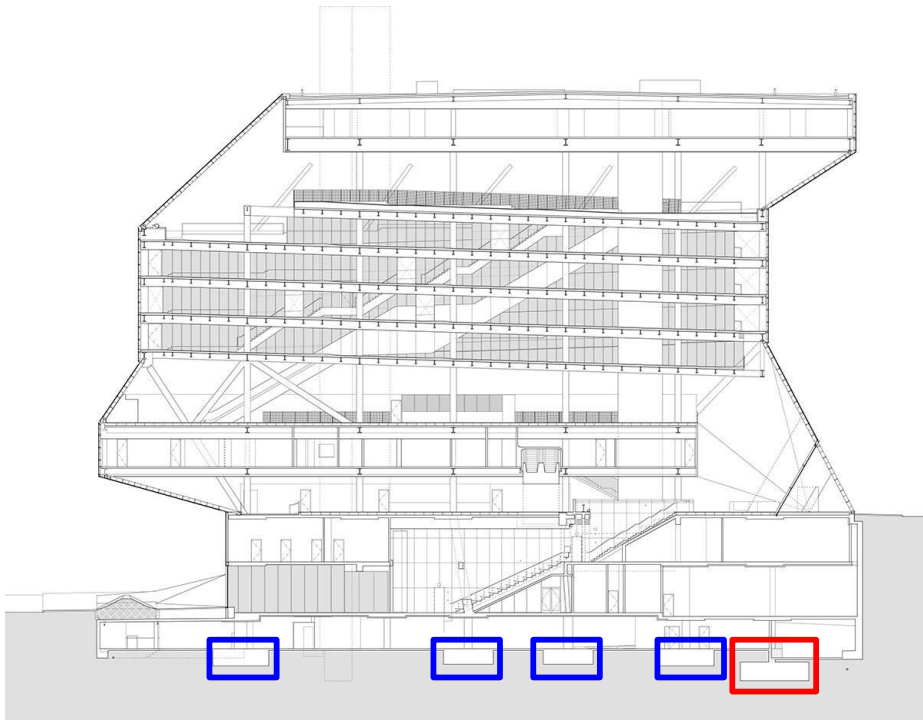
Northwest corner: Combined Footings



3D View of Mat (Raft) Foundation



Top View of Mat (Raft) Foundation



Spread Footings



Elevation Change Follow the slope of site



# FOUNDATION SYSTEM

## Soil Bearing Pressure

$$q = \frac{P}{A}$$

Where  $q$  = Soil bearing pressure

$P$  = Load applied

$A$  = Area of the footing



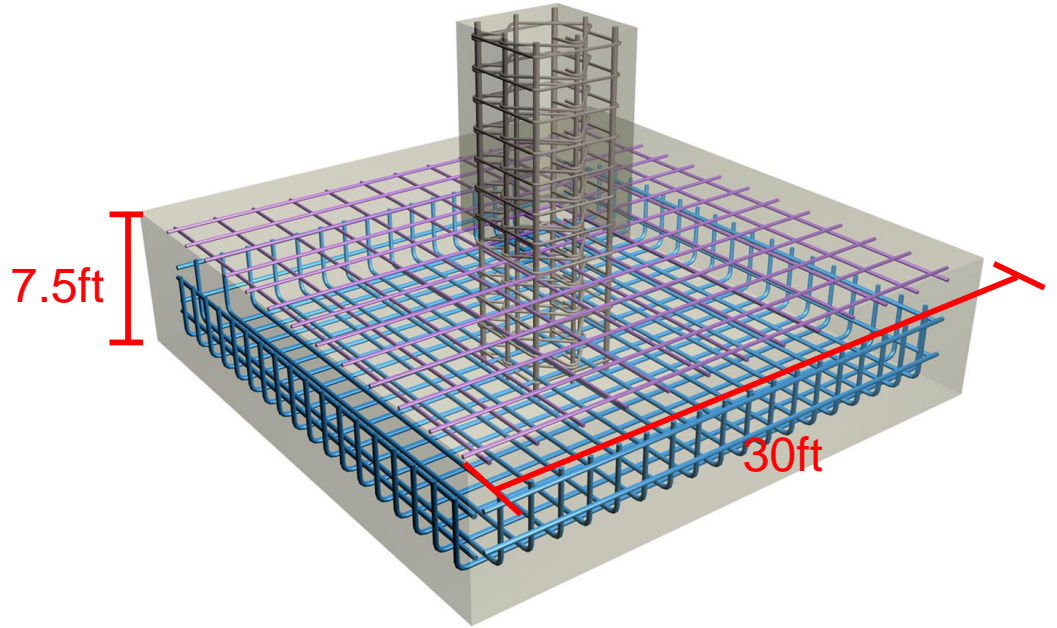
# Spread Footings

Significant Factors:

Structure Load

Penetration

Frost heave & Shrink-swell



Allowable Bearing Pressure: **10000 psf**

# FOUNDATION SYSTEM

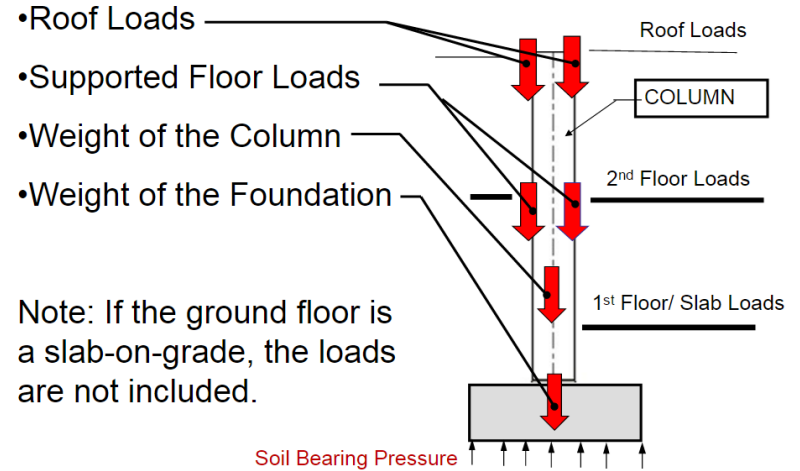
The 30x30 footing has an area of 900 ft<sup>2</sup>.

The soil capacity for Class C is 1,500 lb/ft<sup>2</sup>.

Using the equation  $q=p/a$  we find  $p$  to be 1.3 Million lbs. This 1.3 Million lbs represents the maximum column load per footing.

The allowable bearing pressure per footing over most of the site is 10,000 lb/ft<sup>2</sup>

## Column Loads







QUESTIONS? COMMENTS? CONCERNS? REGRETS?

Thank You!



# SOURCES

<http://www.matveyconstruction.com/foundation-repair/foundation-services/replace-repair-foundation.html>

[https://en.wikiarquitectura.com/index.php/Seattle\\_Public\\_Library](https://en.wikiarquitectura.com/index.php/Seattle_Public_Library)

<https://lmnarchitects.com/case-study/seattle-central-library-curtain-wall-design>

[https://lmnarchitects.com/wp-content/uploads/2015/03/SPL\\_CivilEngineering\\_Mar2003\\_Web.pdf](https://lmnarchitects.com/wp-content/uploads/2015/03/SPL_CivilEngineering_Mar2003_Web.pdf)

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[https://lmnarchitects.com/wp-content/uploads/2015/03/library\\_challenge.pdf](https://lmnarchitects.com/wp-content/uploads/2015/03/library_challenge.pdf)

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