



Performance-Based Design Today

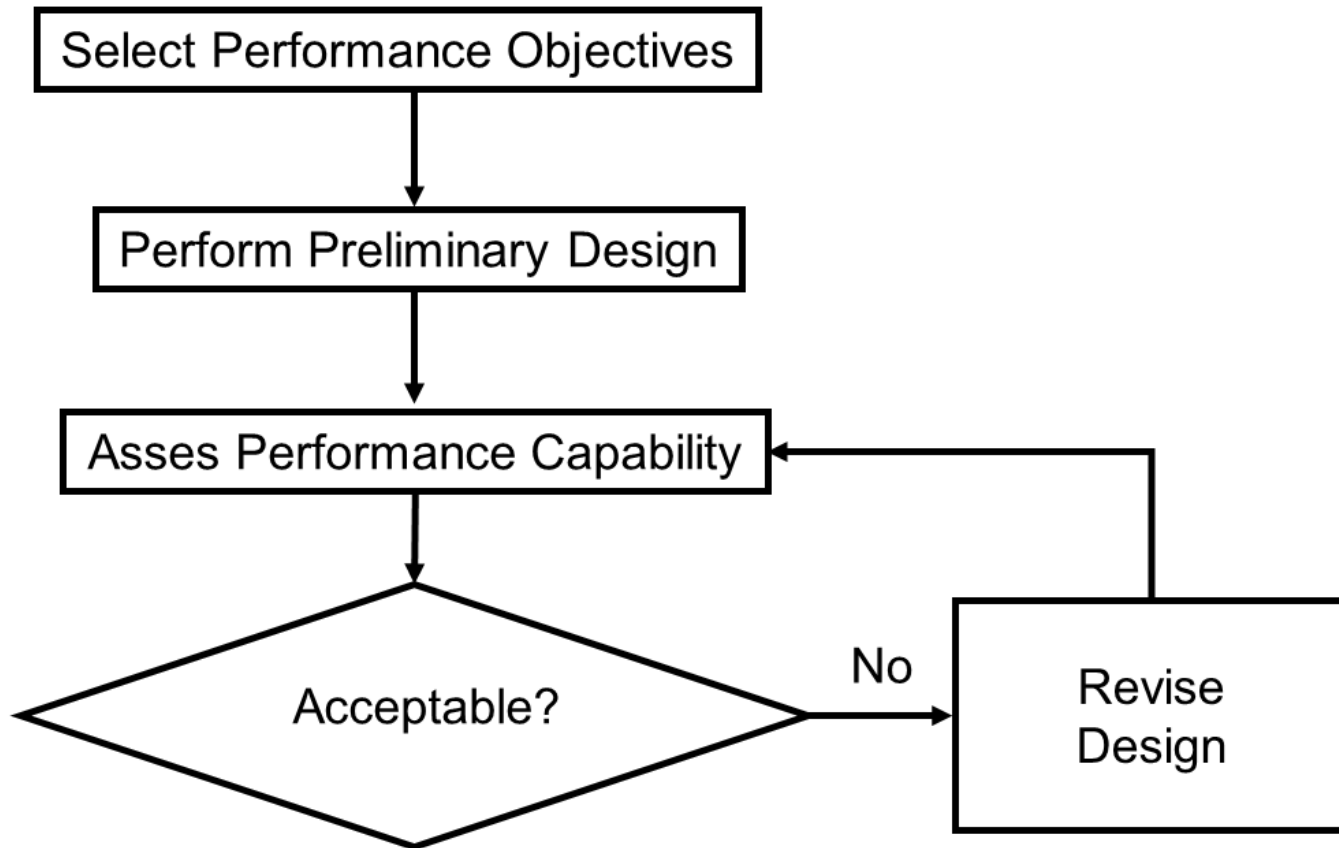
John Hooper, Magnusson Klemencic Associates

January 16-17, 2014 - University of California, Los Angeles

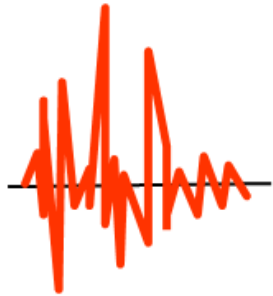
Projects Utilizing PBD

- Existing Building Retrofits
- New Buildings
 - Validating Code Performance
 - e.g., confirming an Essential Facility meets I.O. performance
 - Alternative Code Equivalent Designs
 - Building does not conform to one or more requirements
 - Height limit
 - Alternative to Capacity Design Requirements
 - Determination of Maximum Forces for Design
 - Columns, beams, foundations, diaphragms, etc.

The PBD Process



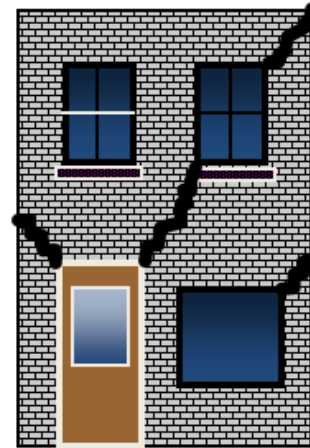
Performance Objectives



Ground
Motion

x% - 50 years

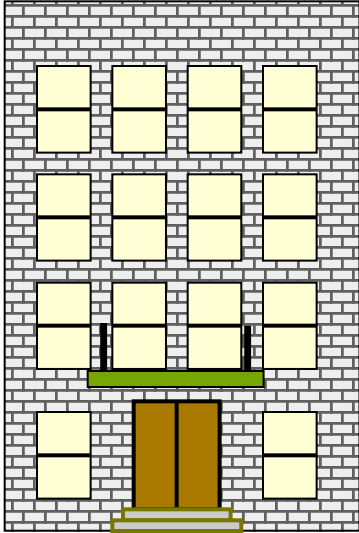
+



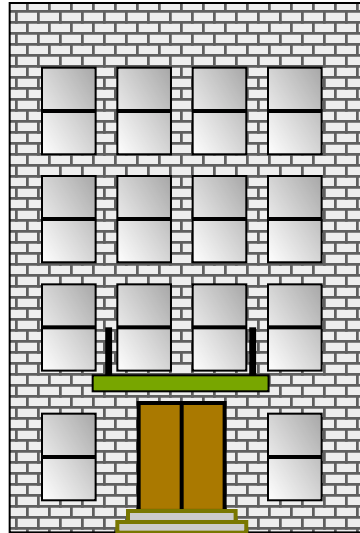
Performance
Level

- Earthquake Hazard
 - EQ ground shaking
- Acceptable Performance Level
 - Maximum acceptable damage given shaking occurs

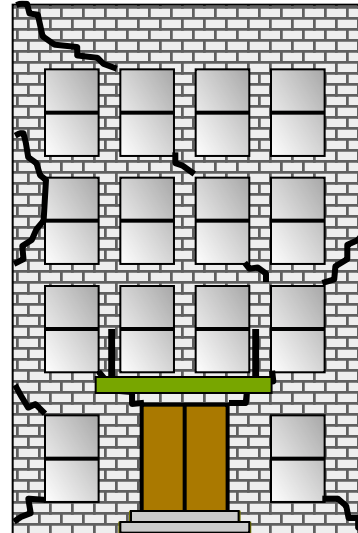
Standard Performance Levels



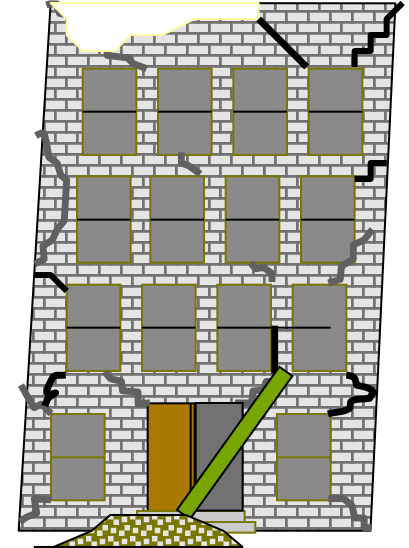
Operational



*Immediate
Occupancy*

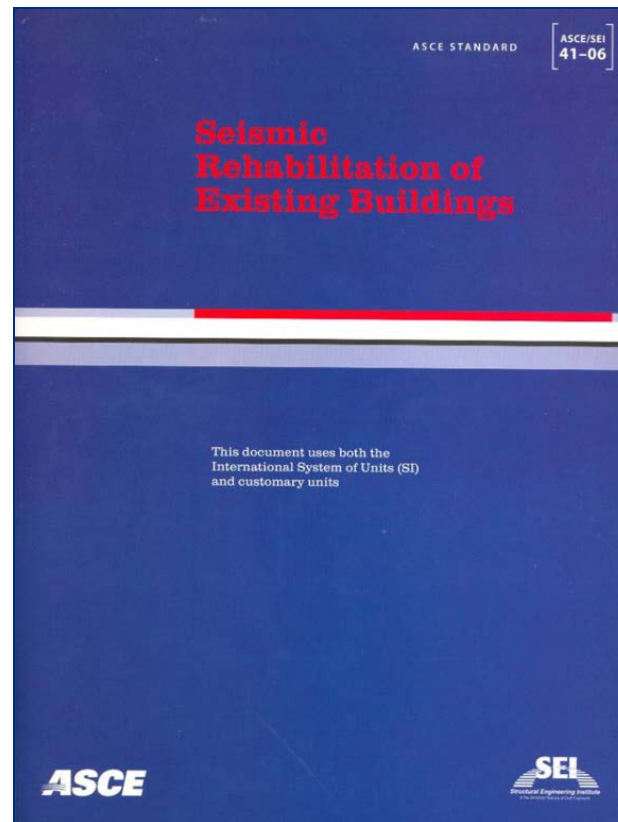


*Life
Safety*




*Collapse
Prevention*

Existing Building Retrofit Approach



New Building Approach—Code Equivalency



PACIFIC EARTHQUAKE ENGINEERING
RESEARCH CENTER

Structural Response and Cost Characterization of
Bridge Construction Using Seismic Performance
Enhancement Strategies

Ady Aviram
Božidar Stojadinović
University of California, Berkeley

Gustavo J. Parra-Montesinos
University of Michigan

Kevin R. Mackie
University of Central Florida


PEER 2010/01
MARCH 2010

Los Angeles Tall Buildings Structural Design Council

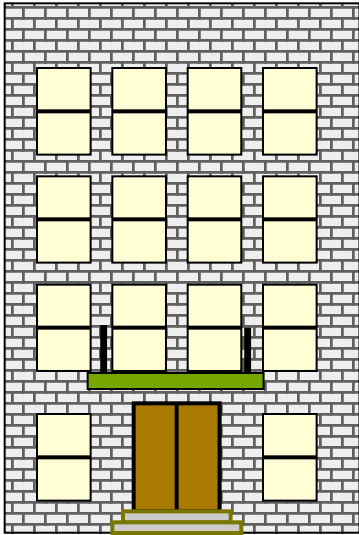
AN ALTERNATIVE PROCEDURE FOR
SEISMIC ANALYSIS AND DESIGN OF
TALL BUILDINGS LOCATED IN THE
LOS ANGELES REGION

A CONSENSUS DOCUMENT

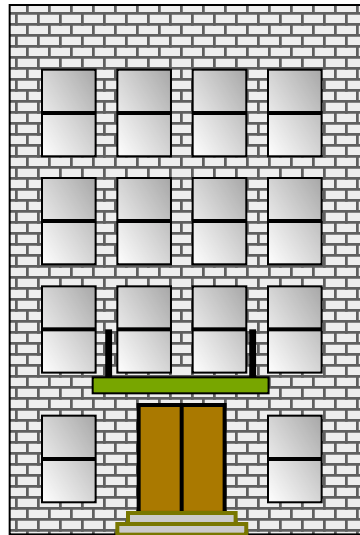
2008 EDITION with Supplement #1



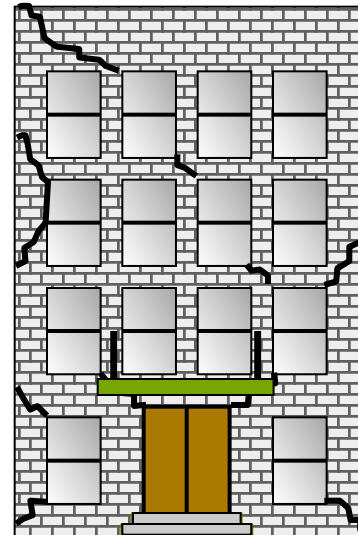
Performance Level for Tall Buildings:



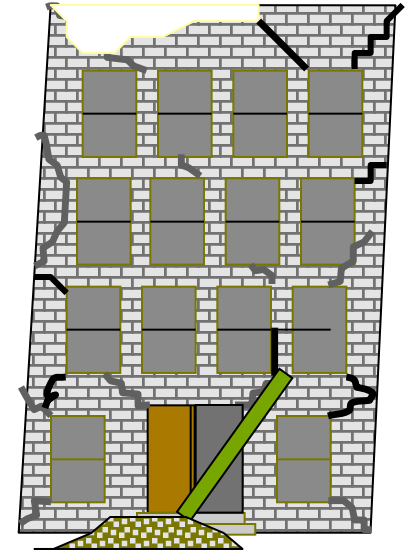
Operational



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*Life
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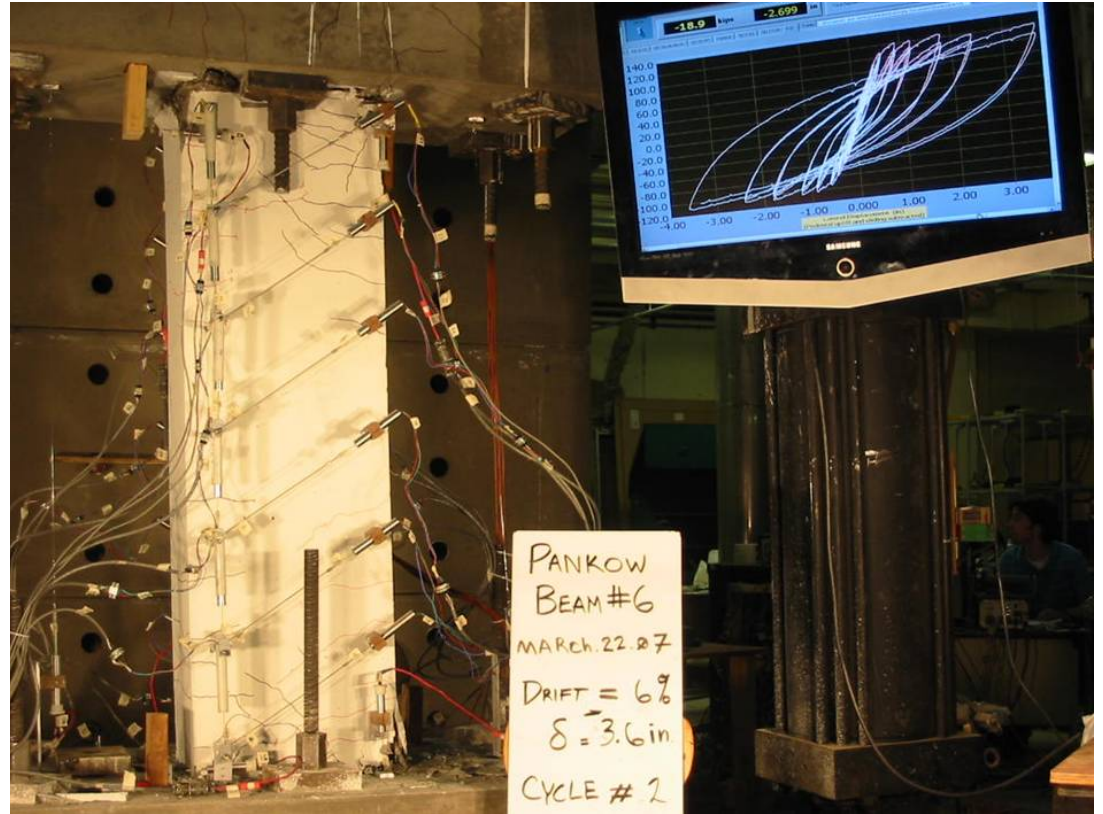
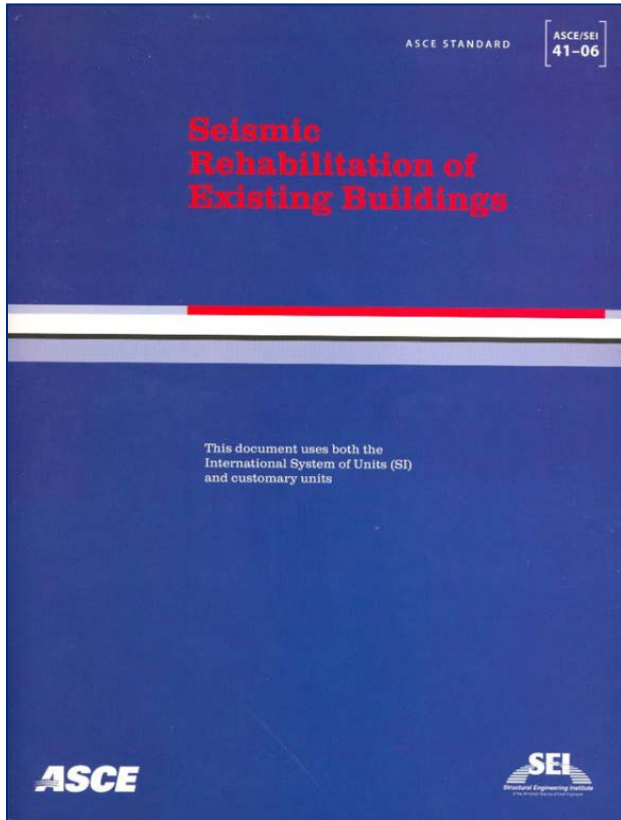
*Collapse
Prevention*



New Building Approach—Code Equivalency

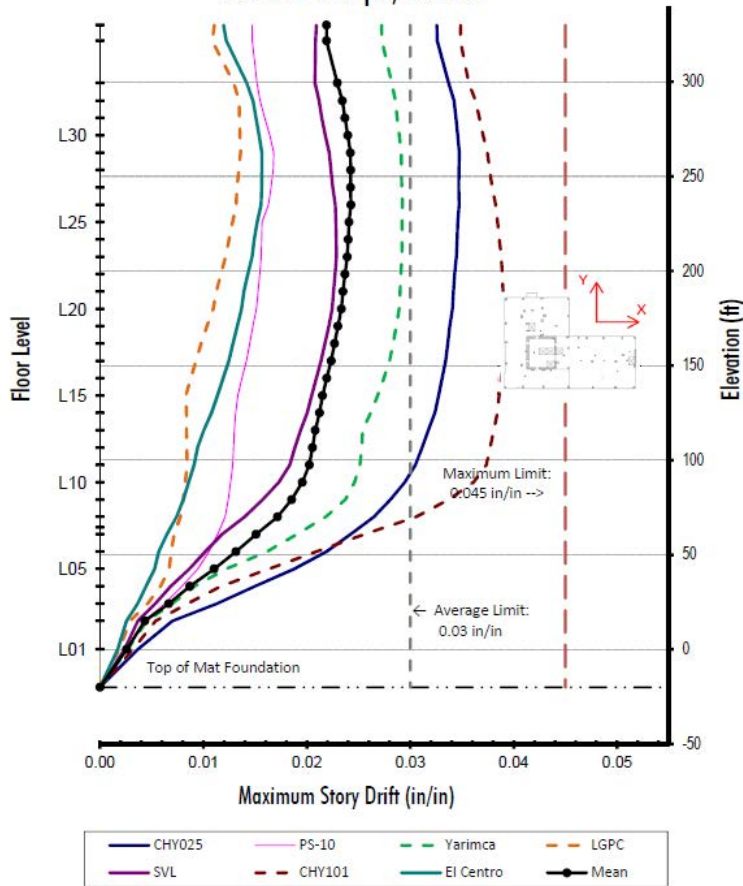
- Work with the Jurisdiction to determine the Peer Review Process
- Develop a Basis of Design
 - Specify code exceptions
 - Structural design approach
 - SLE, DE and MCE modeling and acceptance criteria
 - Site specific ground motions
 - Target spectra
 - Selecting and scaling of ground motions
- Work with the Peer Review Team until all comments have been resolved

New Building Approach—Code Equivalency

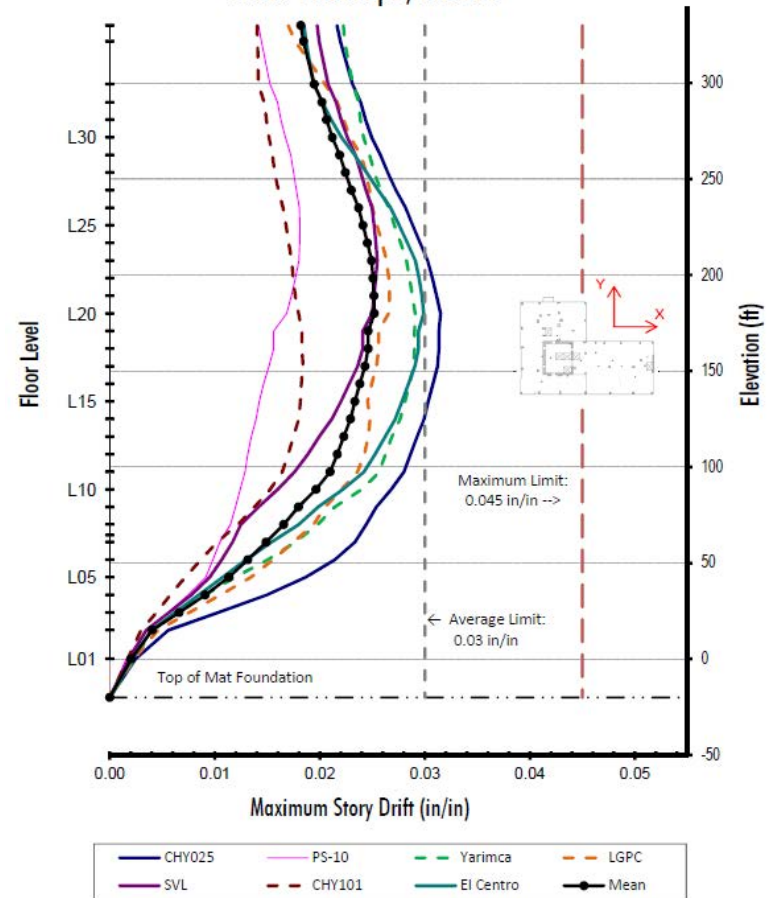


New Building Approach—Code Equivalency

Maximum Story Drift X-Dir
Case: Envelope, 3.5 sec

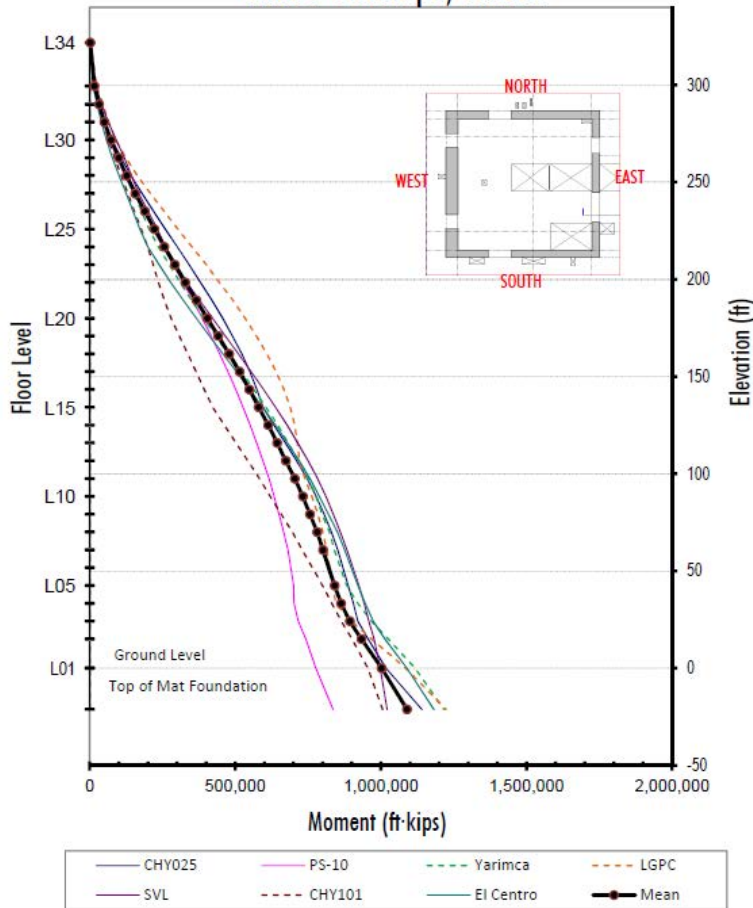


Maximum Story Drift Y-Dir
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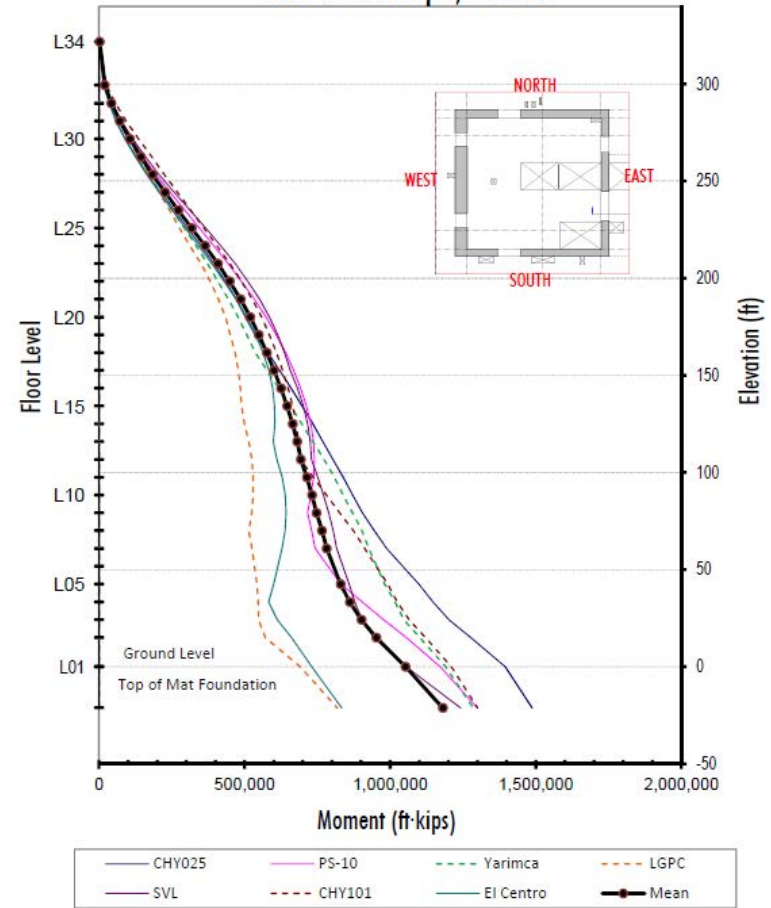


New Building Approach—Code Equivalency

Core Wall Overturning Moment, X-Dir
Case : Envelope, 3.5 sec

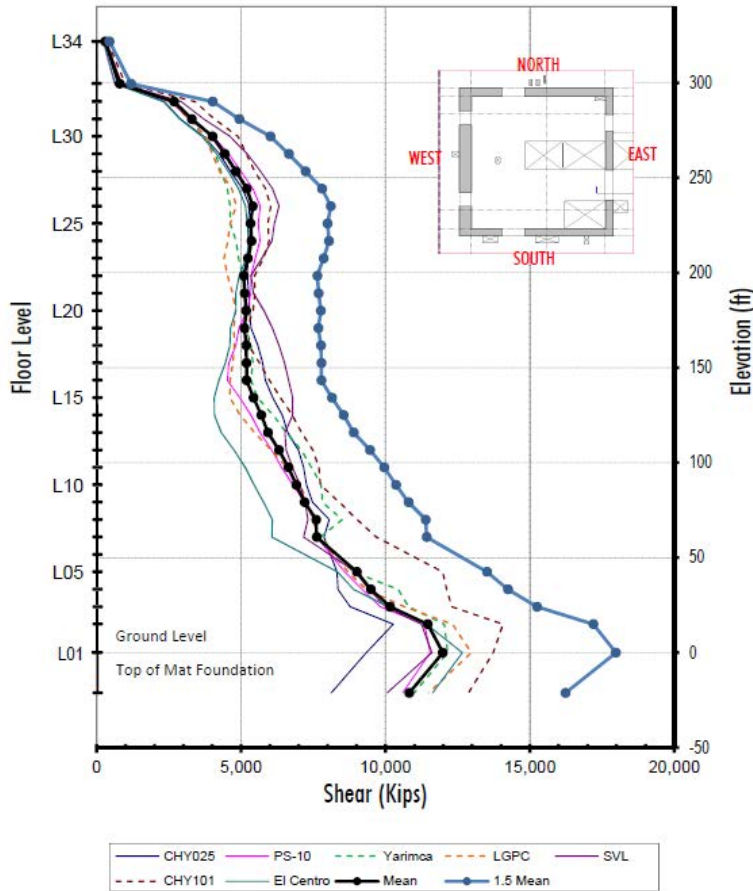


Core Wall Overturning Moment, Y-Dir
Case : Envelope, 3.5 sec

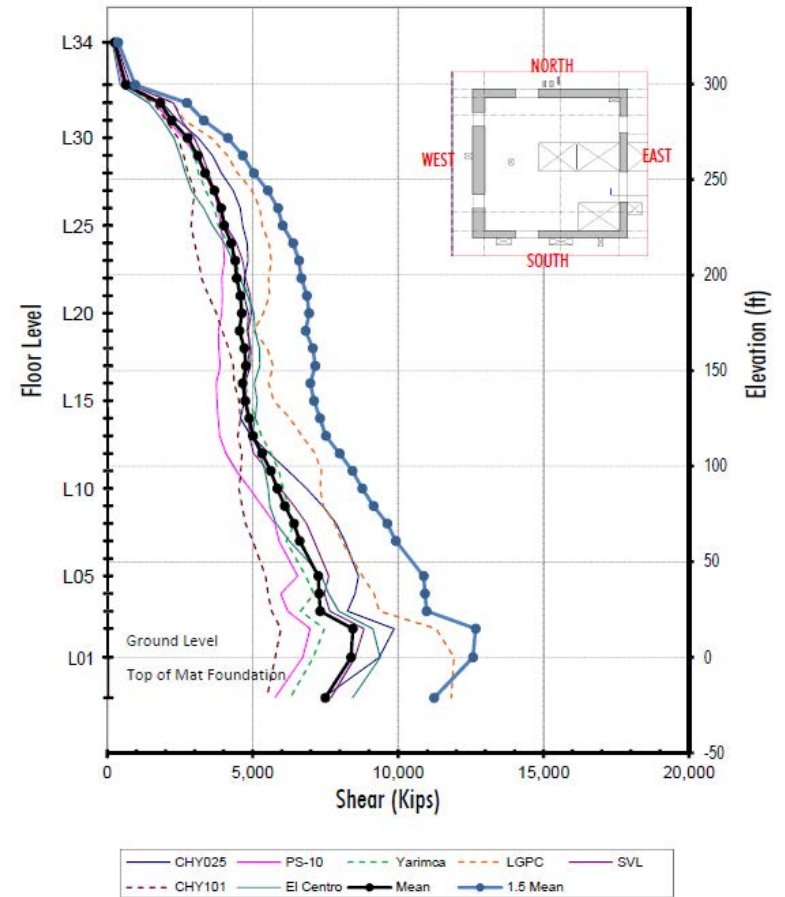


New Building Approach—Code Equivalency

Core Wall Shear Force, X-Dir
Case : Envelope, 3.5 sec

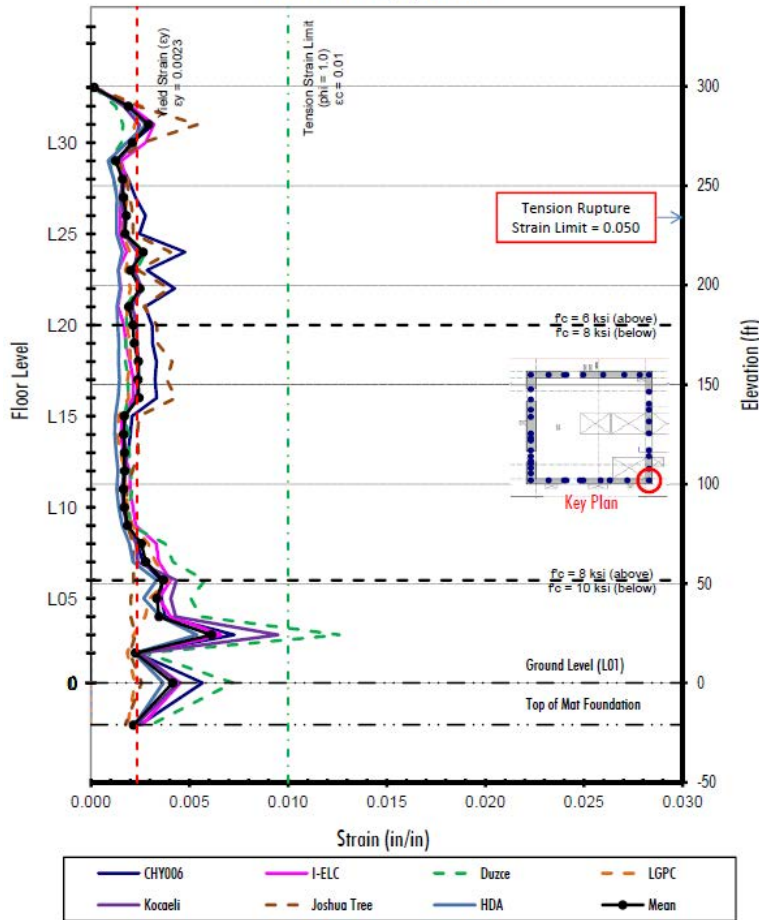


Core Wall Shear Force, Y-Dir
Case : Envelope, 3.5 sec

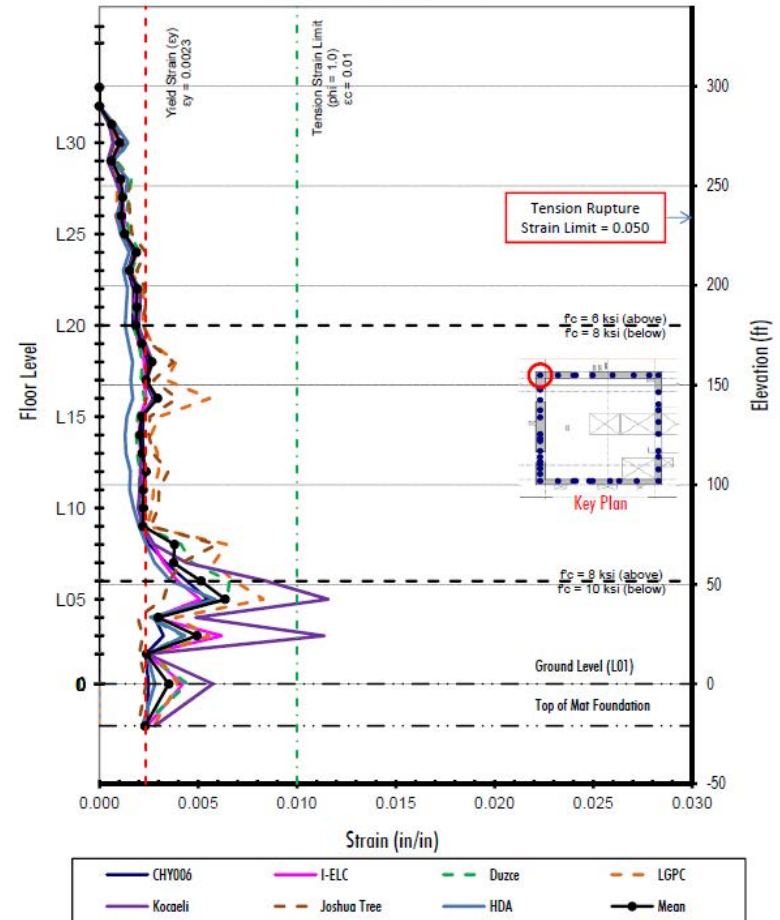


New Building Approach—Code Equivalency

Strain Gauge Tensile Strain
Case: Envelope, 0.8 sec

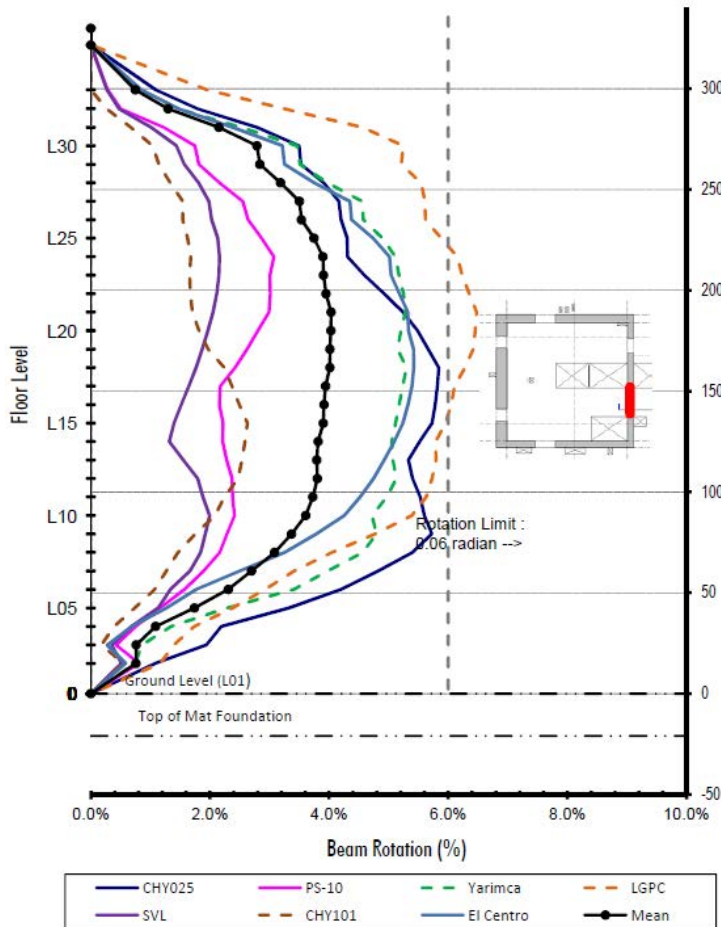


Strain Gauge Tensile Strain
Case: Envelope, 0.8 sec

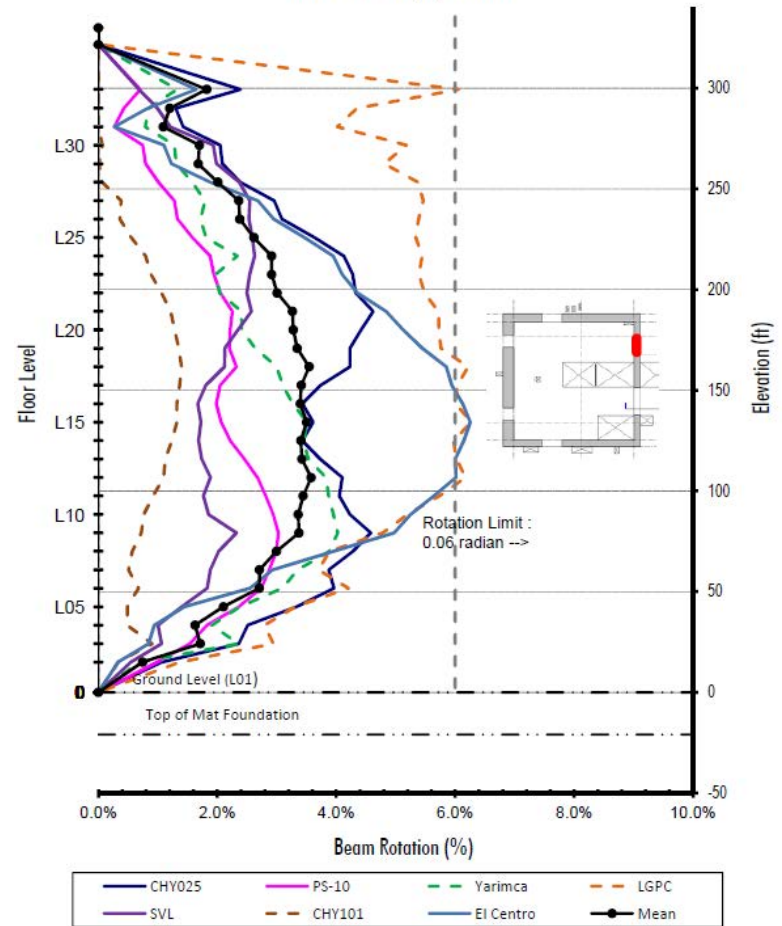


New Building Approach—Code Equivalency

Coupling Beam Chord Rotation
Case: Envelope, 3.5 sec



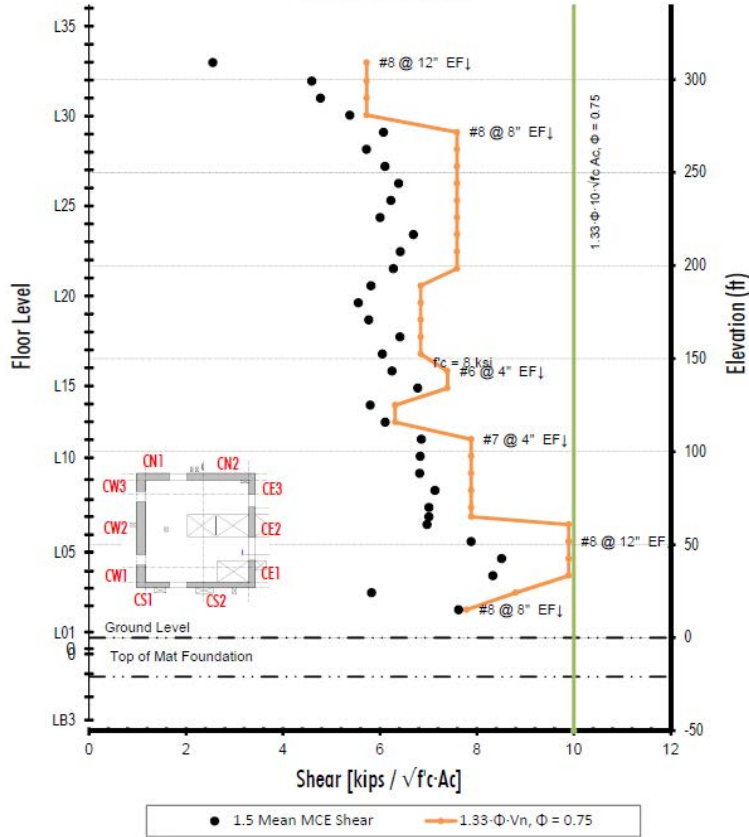
Coupling Beam Chord Rotation
Case: Envelope, 3.5 sec



New Building Approach—Code Equivalency

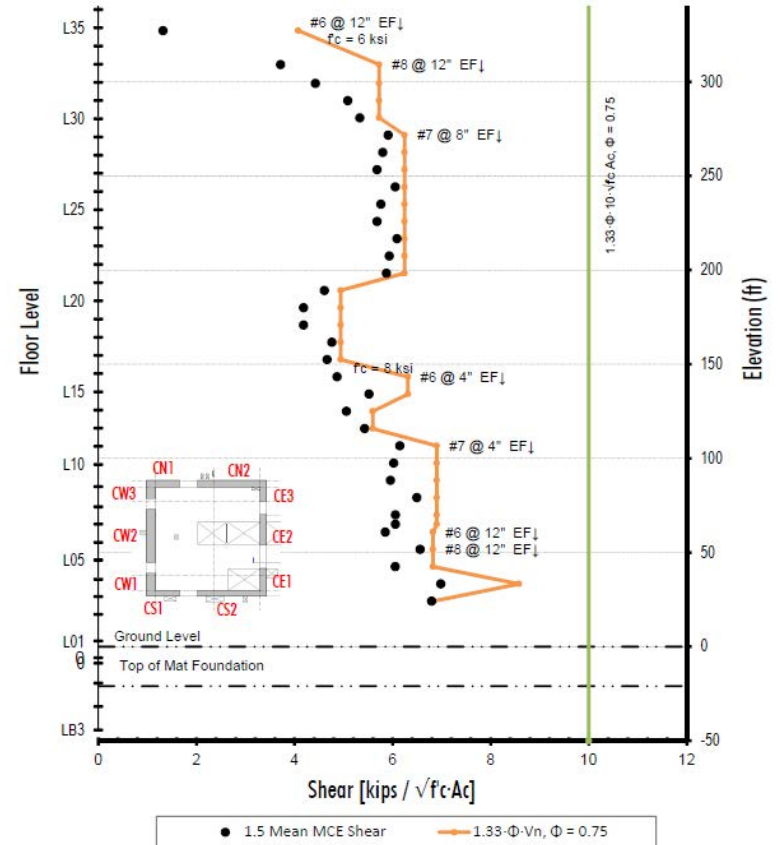
Shear Design Summary, North Core Wall, Pier 2

Case: Envelope

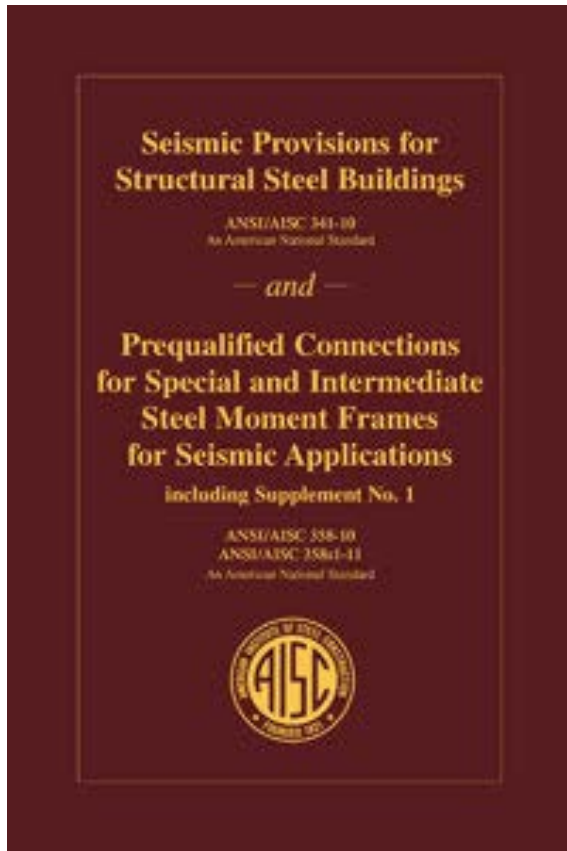


Shear Design Summary, West Core Wall, Pier 2

Case: Envelope



New Building Approach—Capacity Design



9.1-66

BUCKLING-RESTRAINED BRACED FRAMES (BRBF)

[Sect. F4.

- (2) The required strength of columns need not exceed the lesser of the following:
- (a) The forces corresponding to the resistance of the foundation to overturning uplift
 - (b) Forces as determined from nonlinear analysis as defined in Section C3

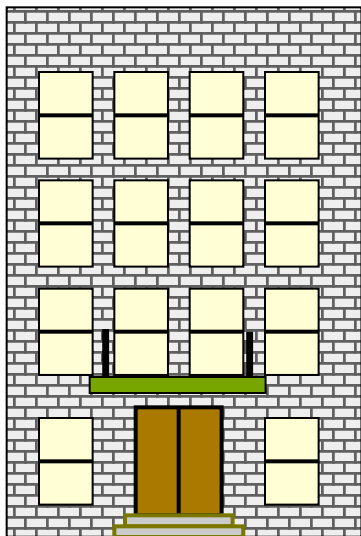
C3. NONLINEAR ANALYSIS

When nonlinear analysis is used to satisfy the requirements of these Provisions, it shall be performed in accordance with Chapter 16 of ASCE/SEI 7.

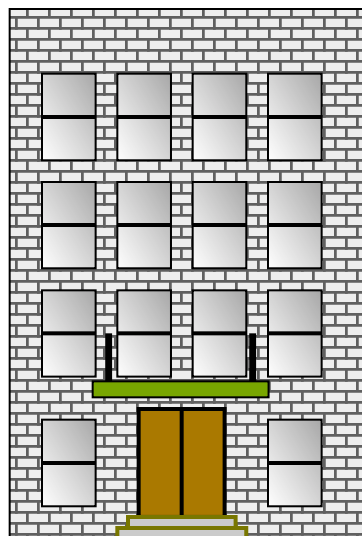
New Building Approach—Capacity Design



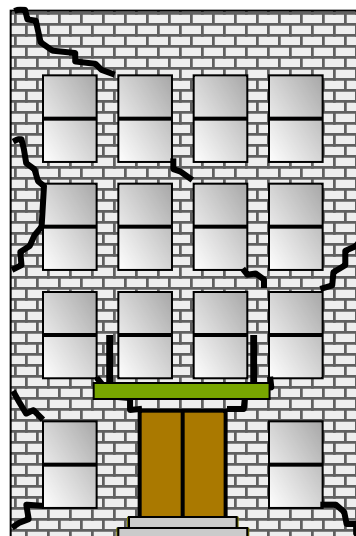
Performance Level of SF MOMA:



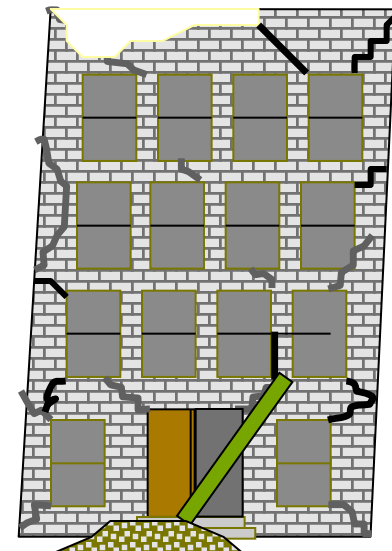
Operational



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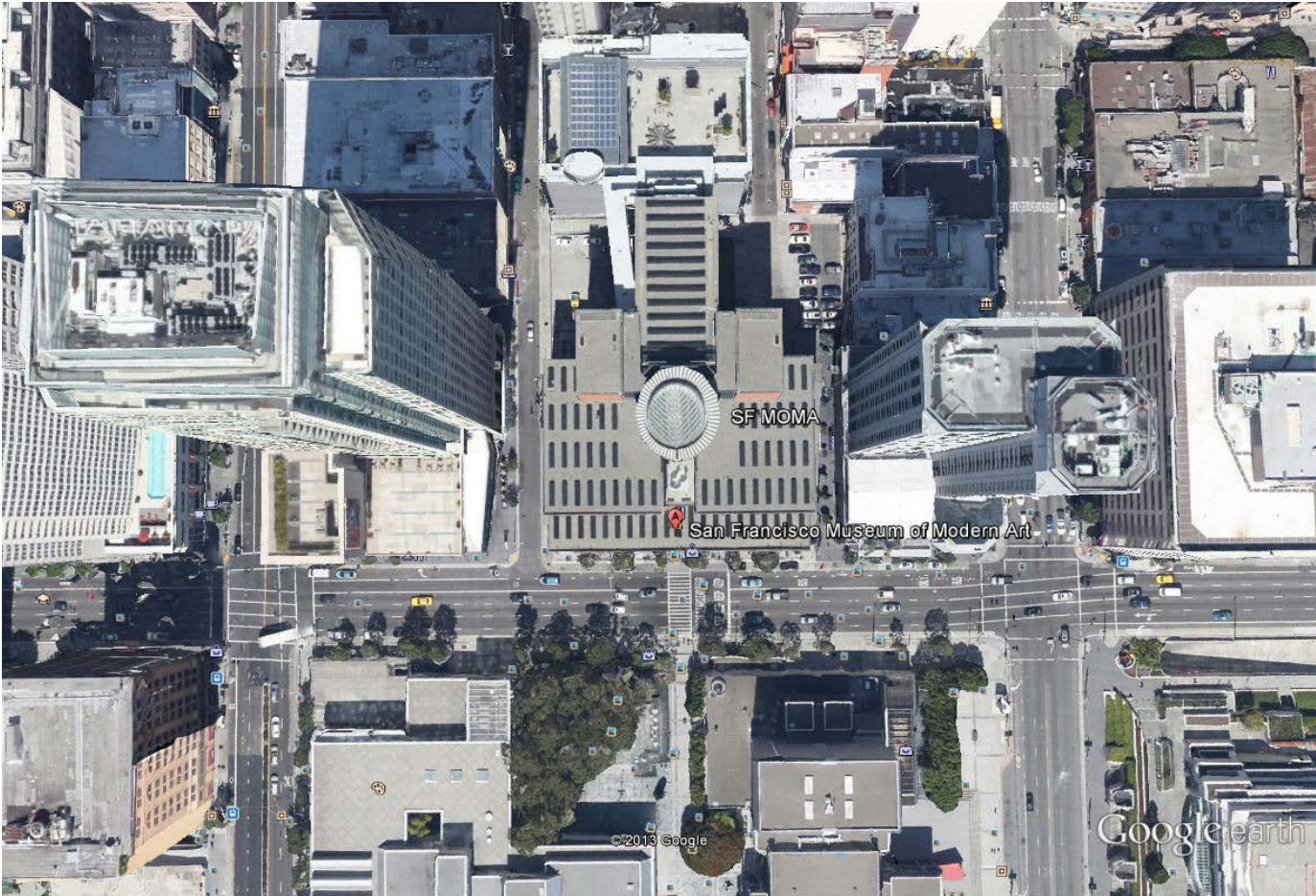
*Life
Safety*



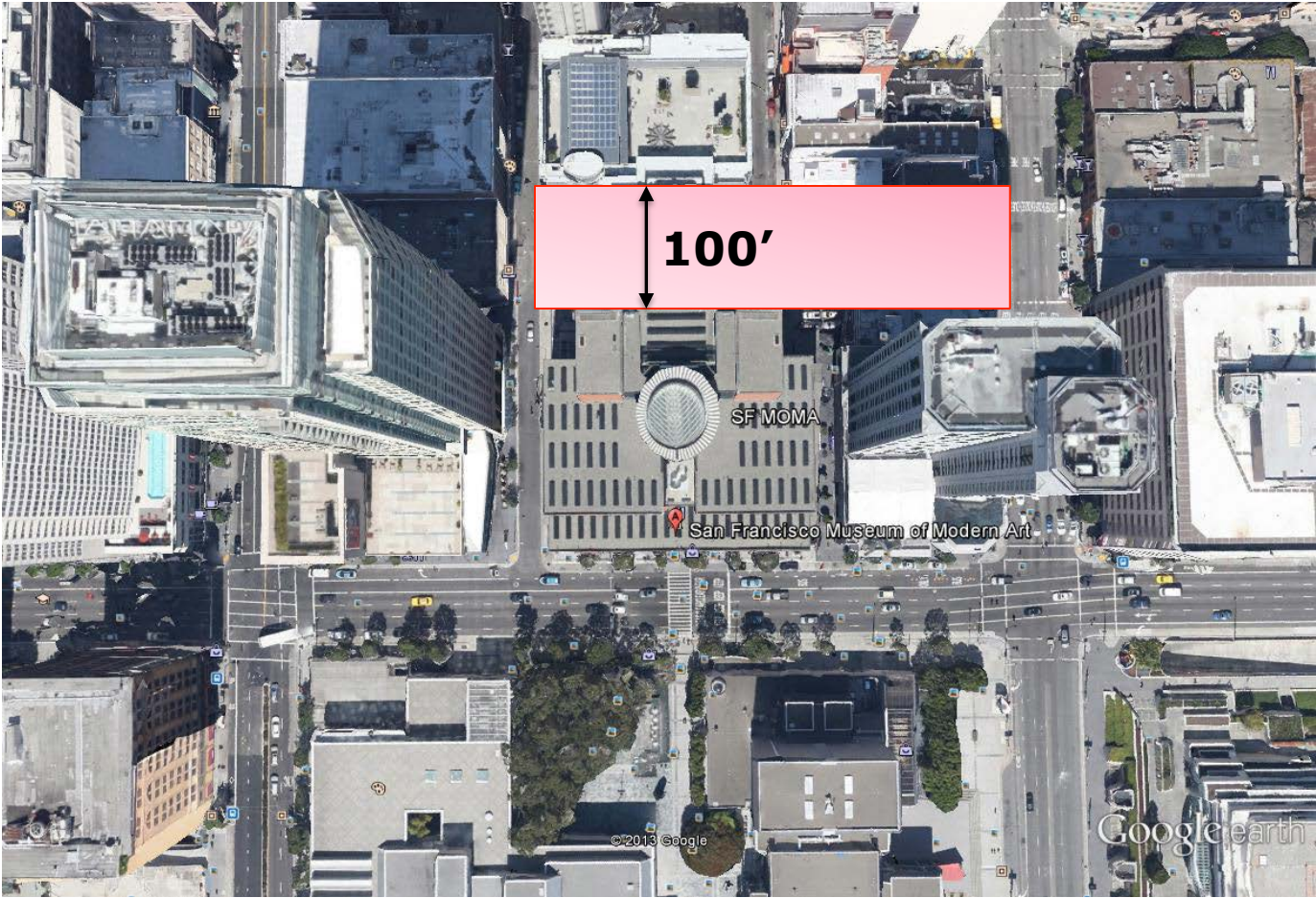
*Collapse
Prevention*



New Building Approach—Capacity Design



New Building Approach—Capacity Design



New Building Approach—Capacity Design

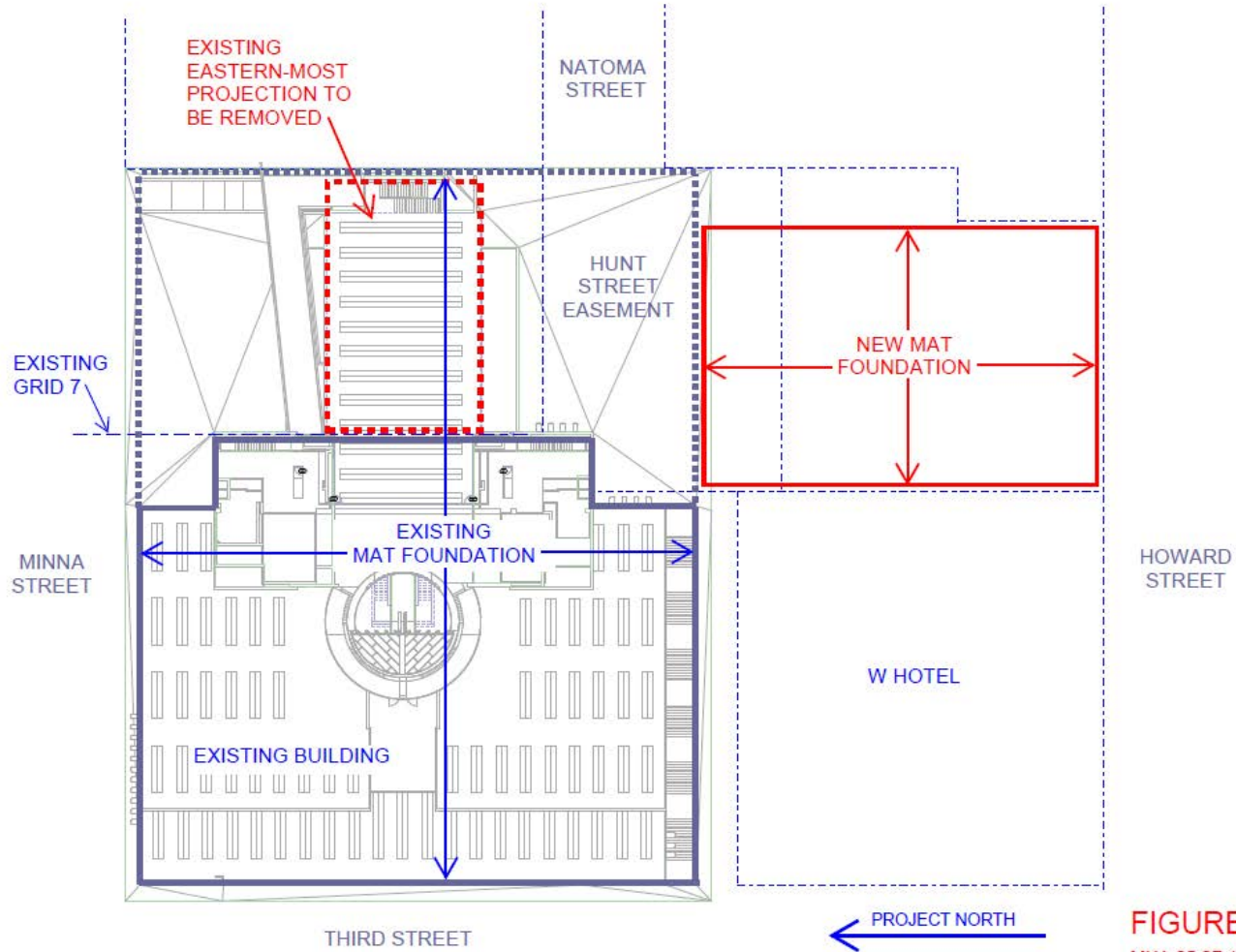
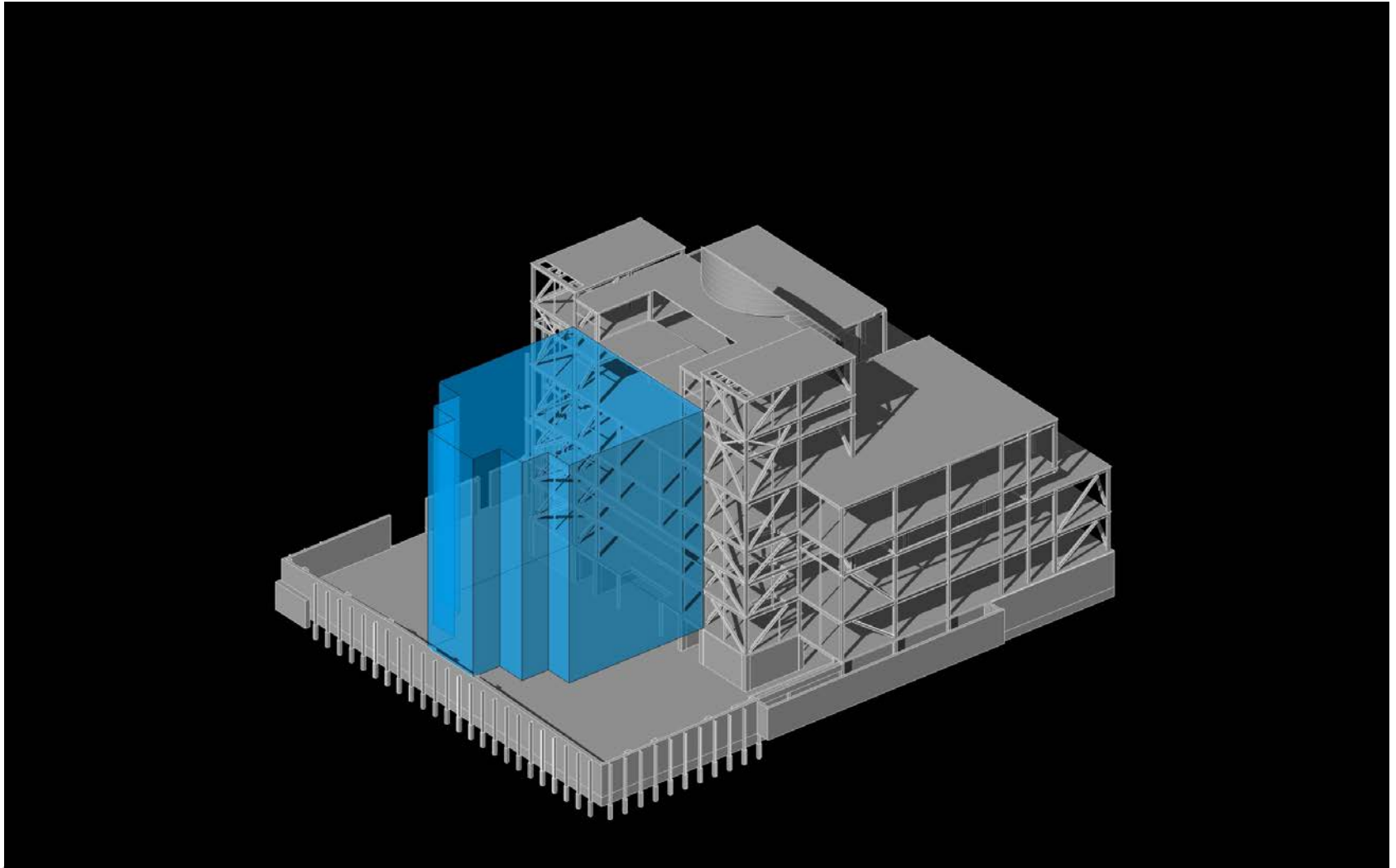
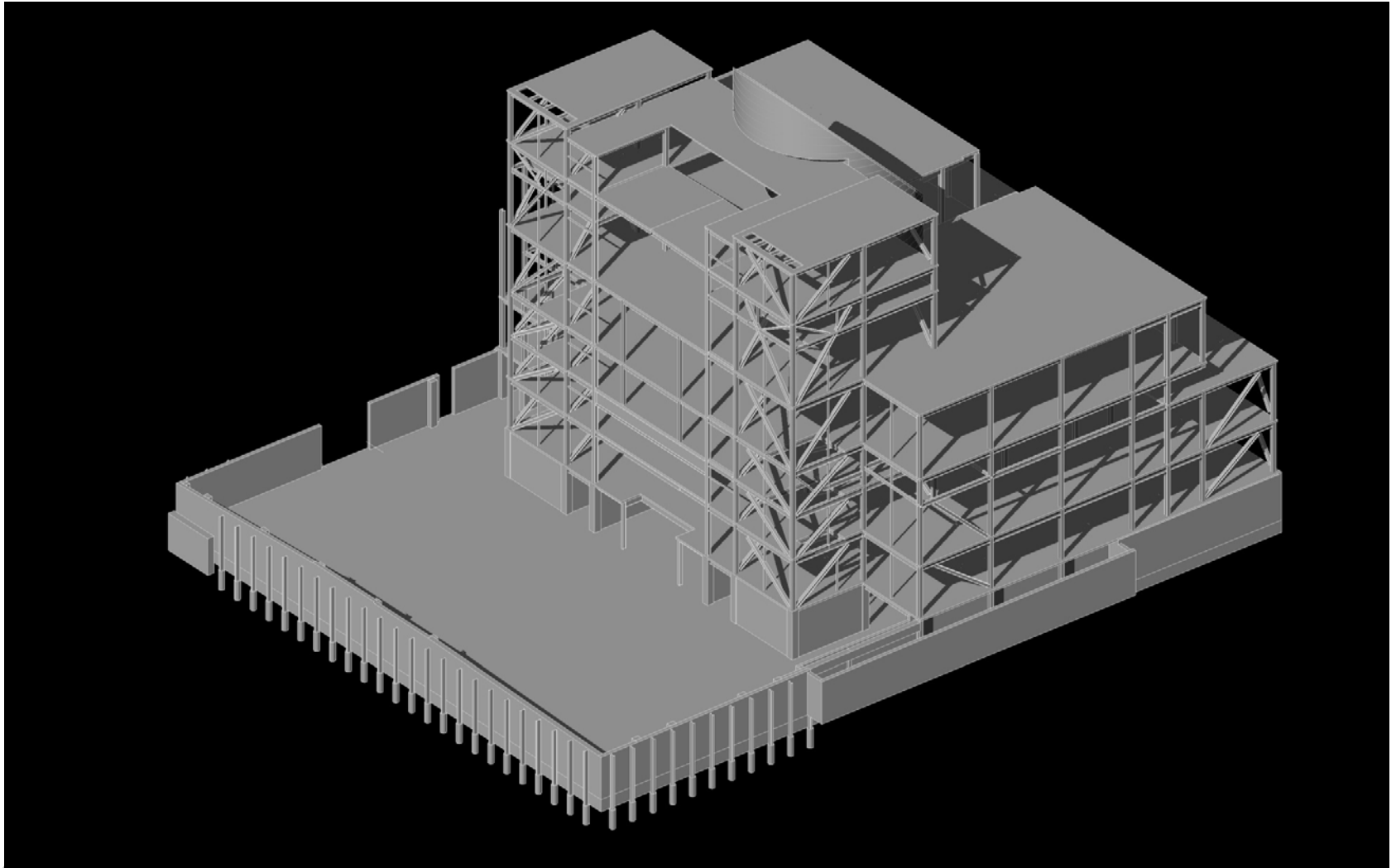


FIGURE 1
MKA 05.07.12

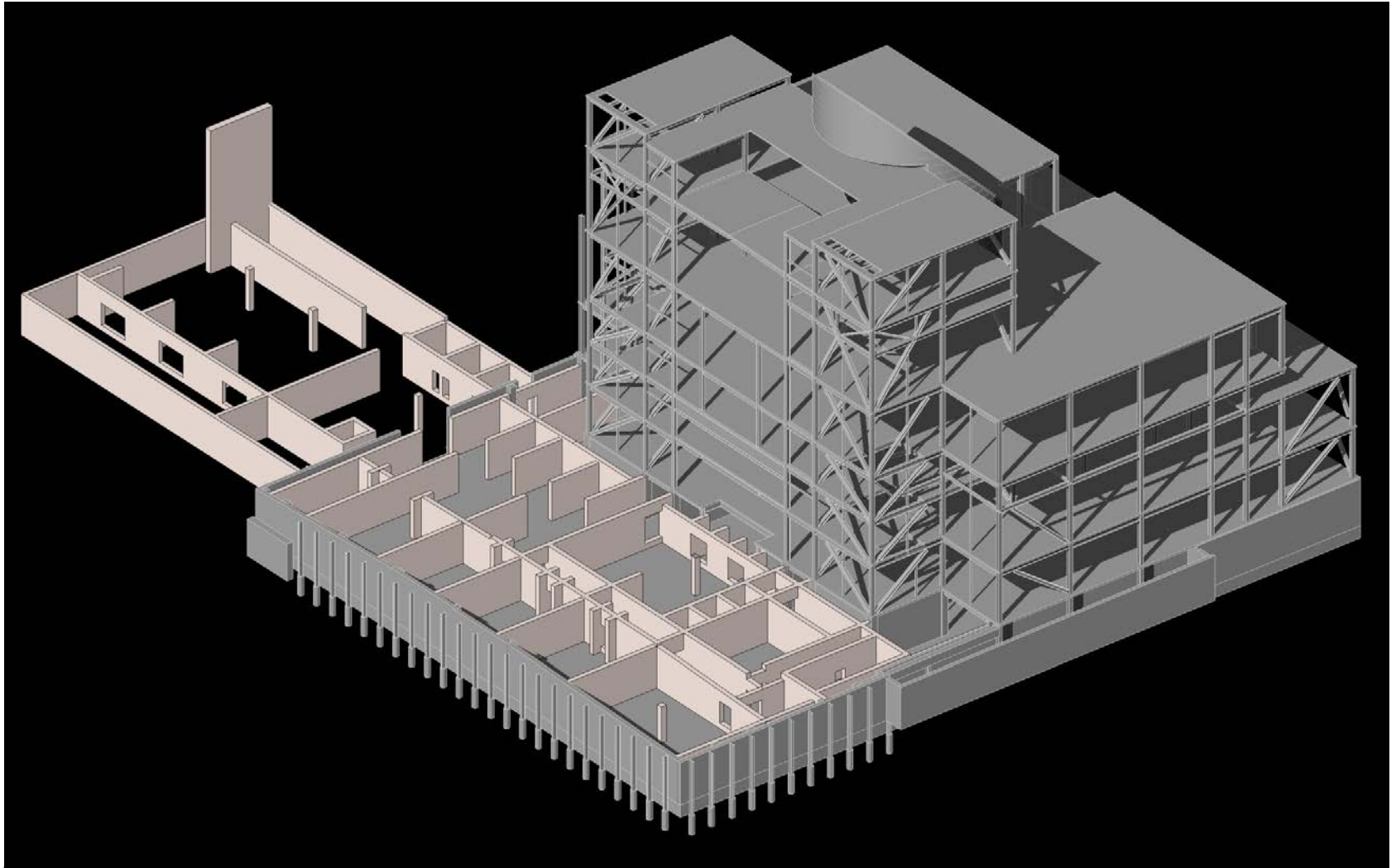
New Building Approach—Capacity Design



New Building Approach—Capacity Design



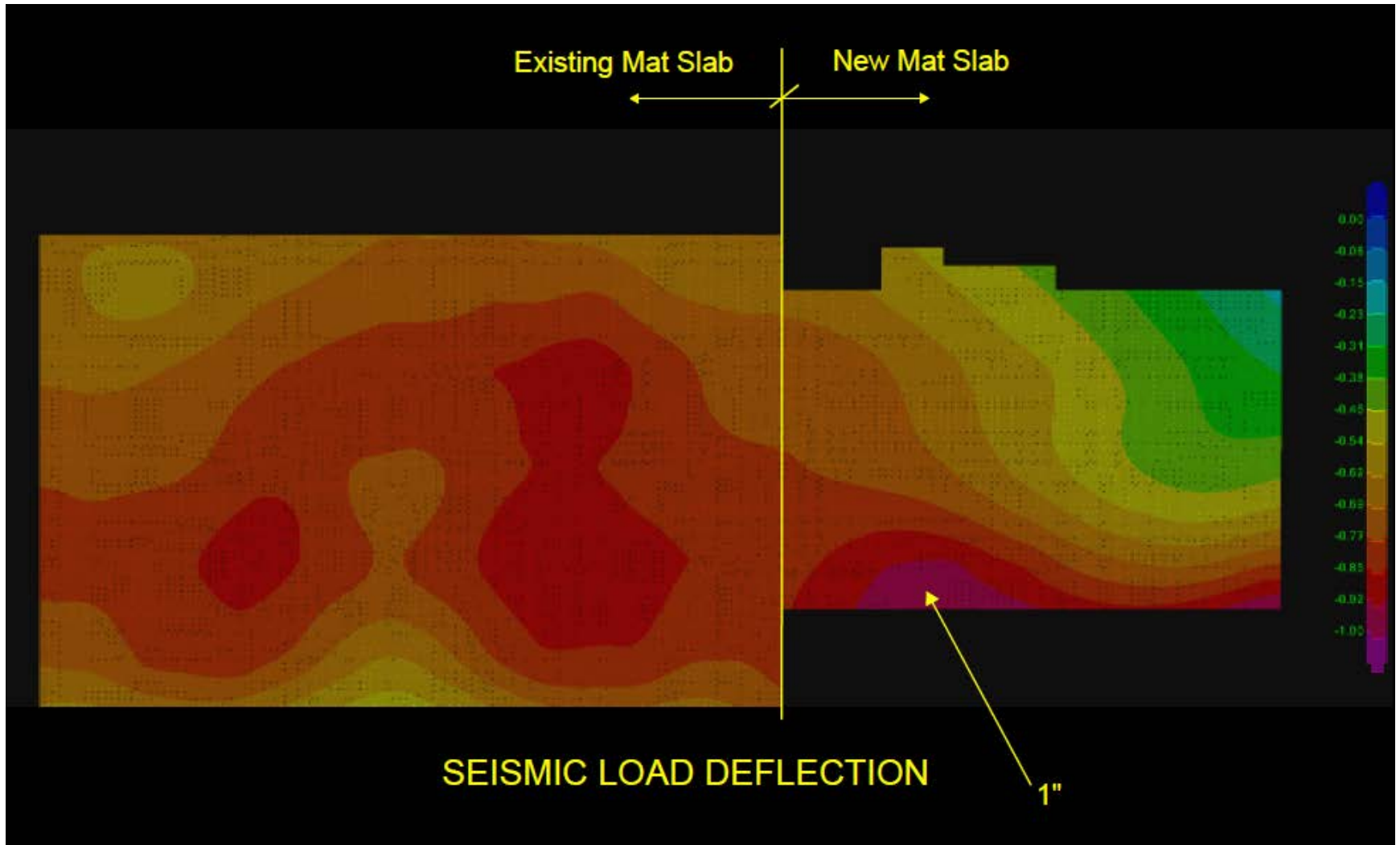
New Building Approach—Capacity Design



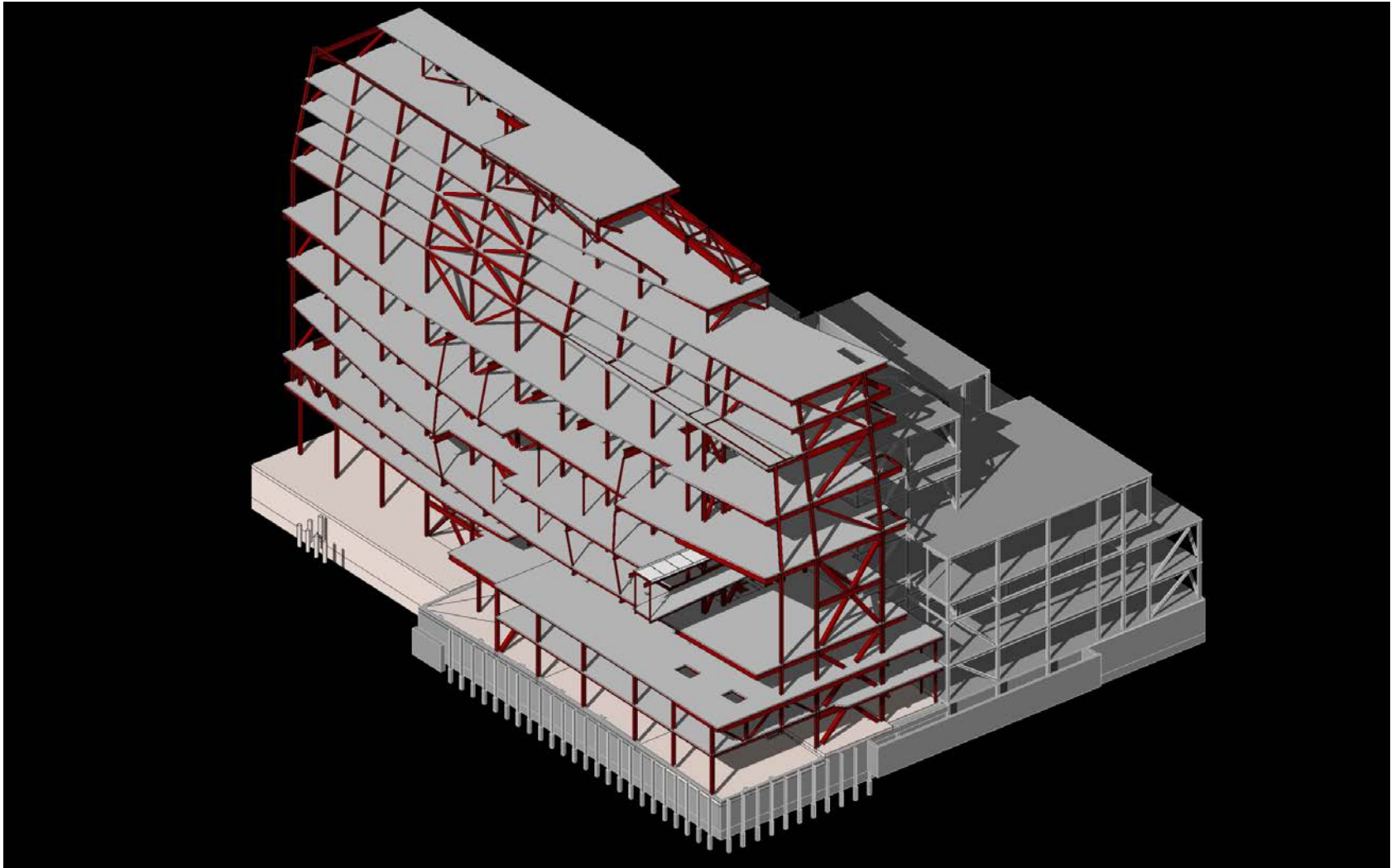
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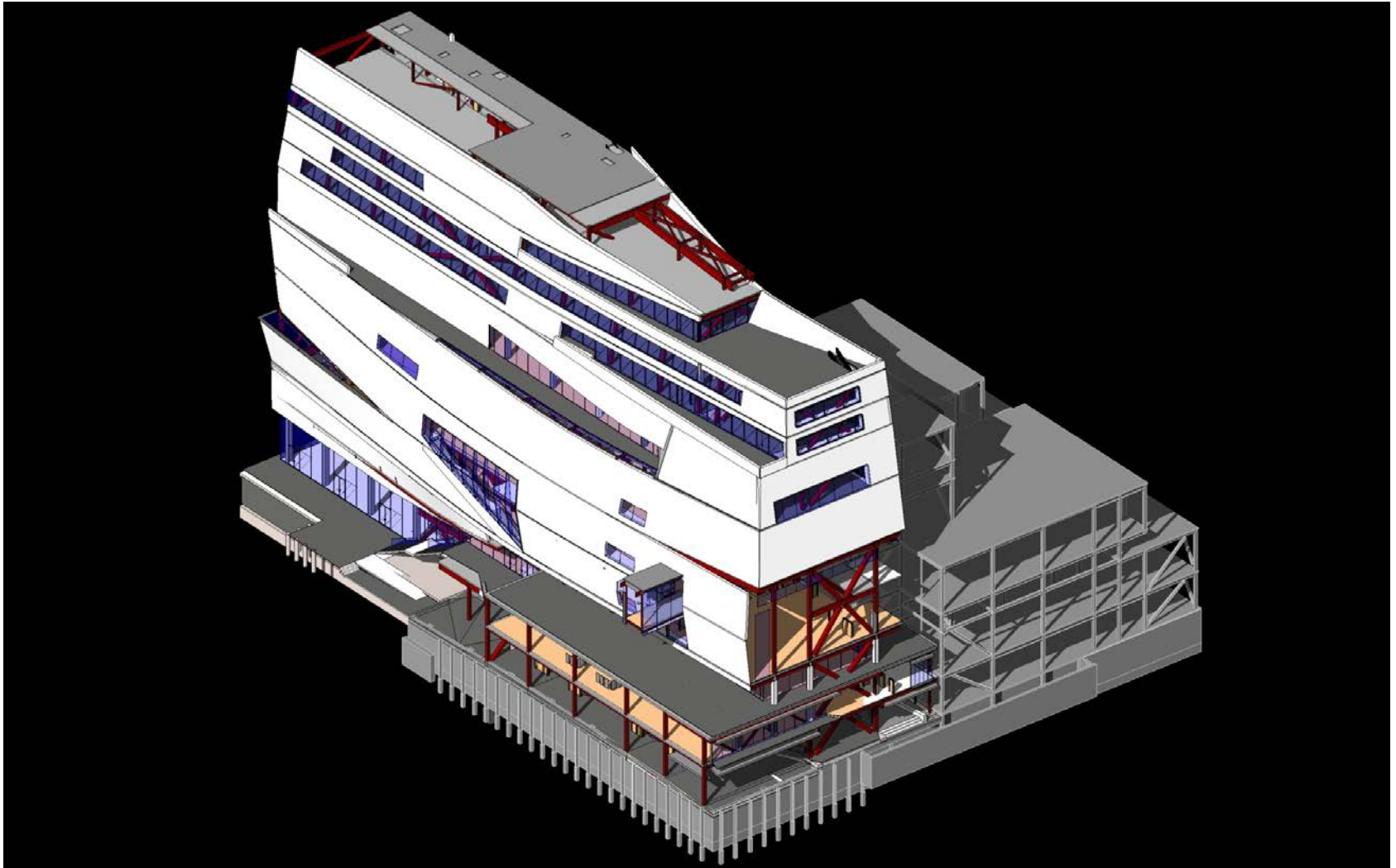
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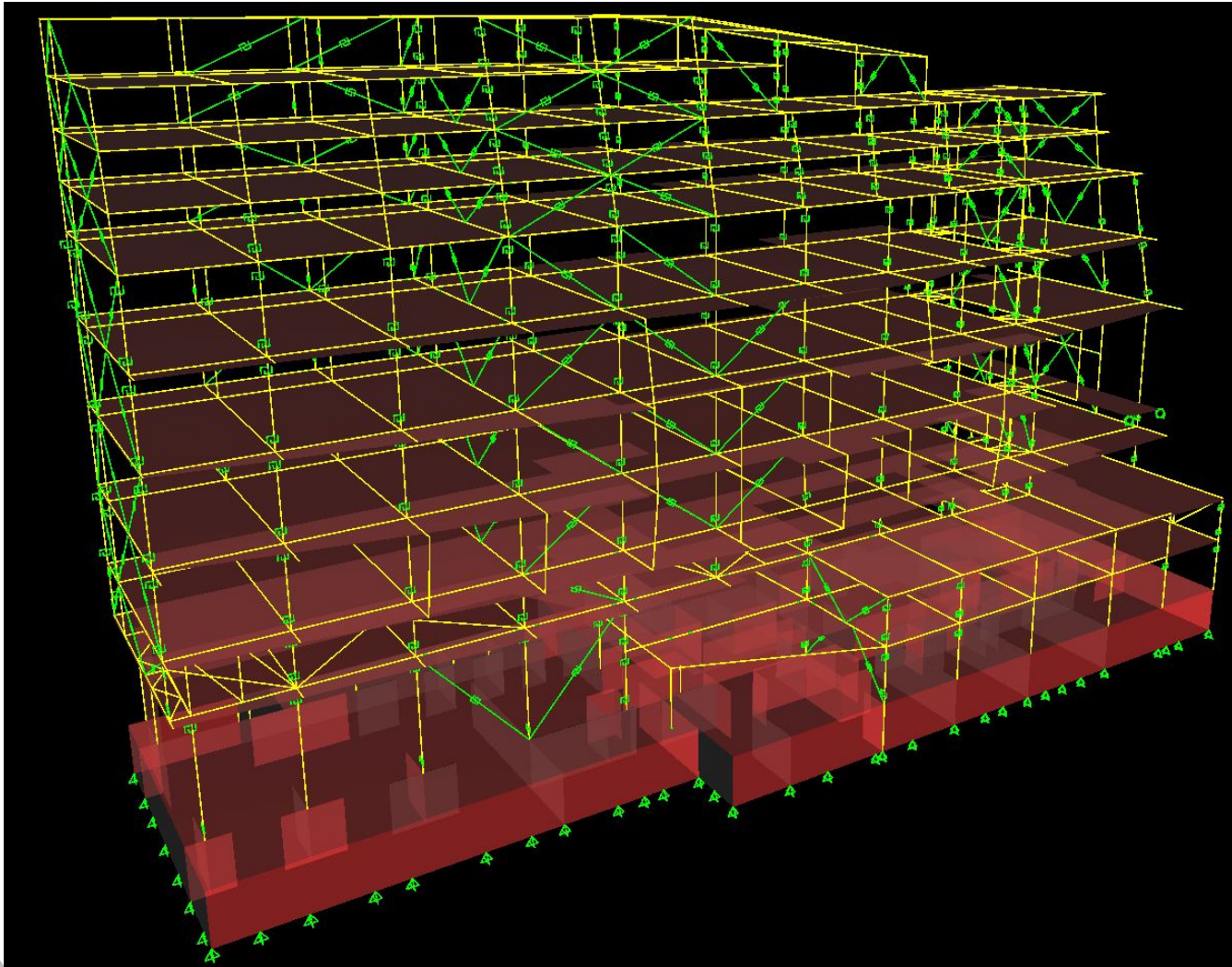
New Building Approach—Capacity Design



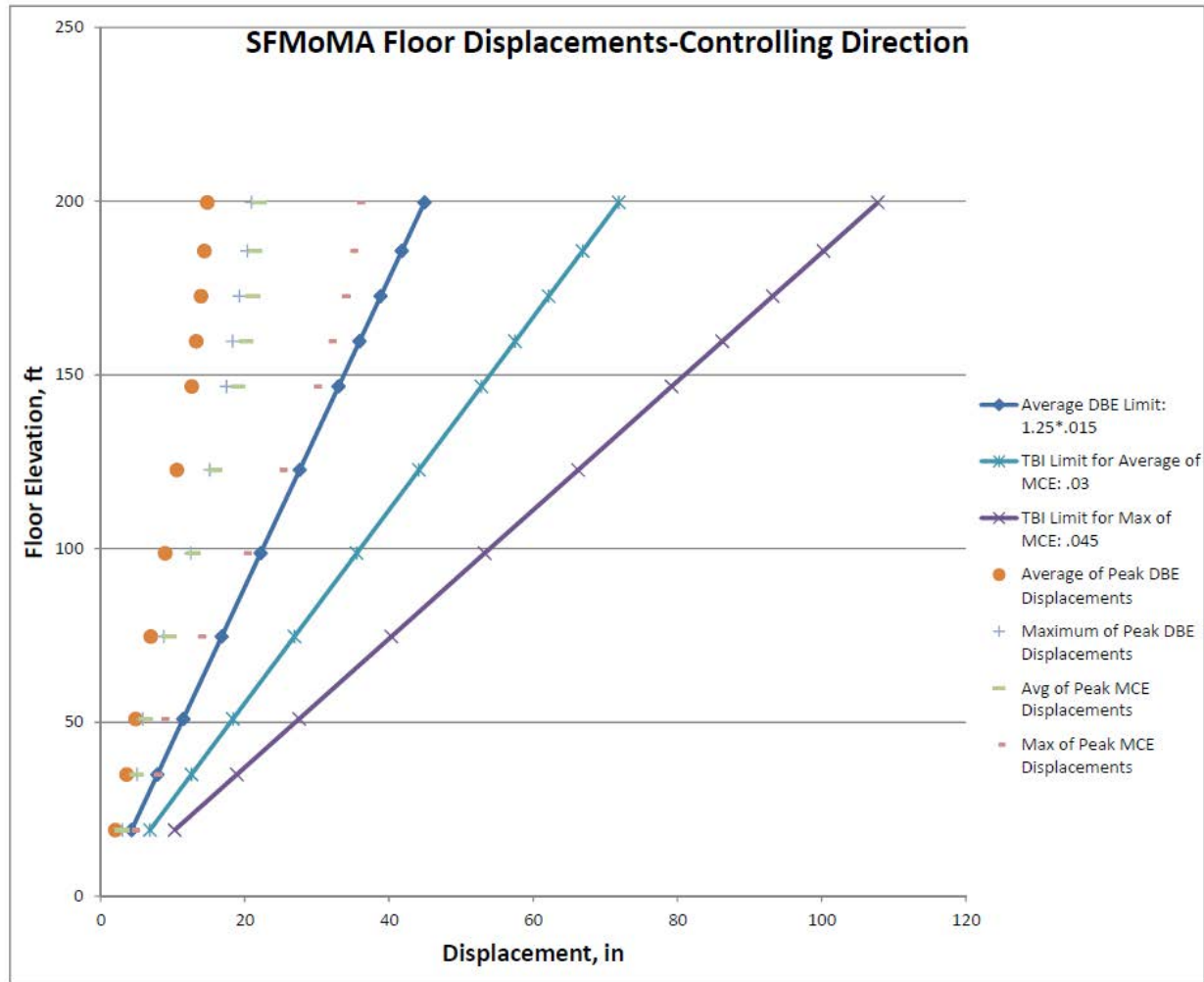
New Building Approach—Capacity Design



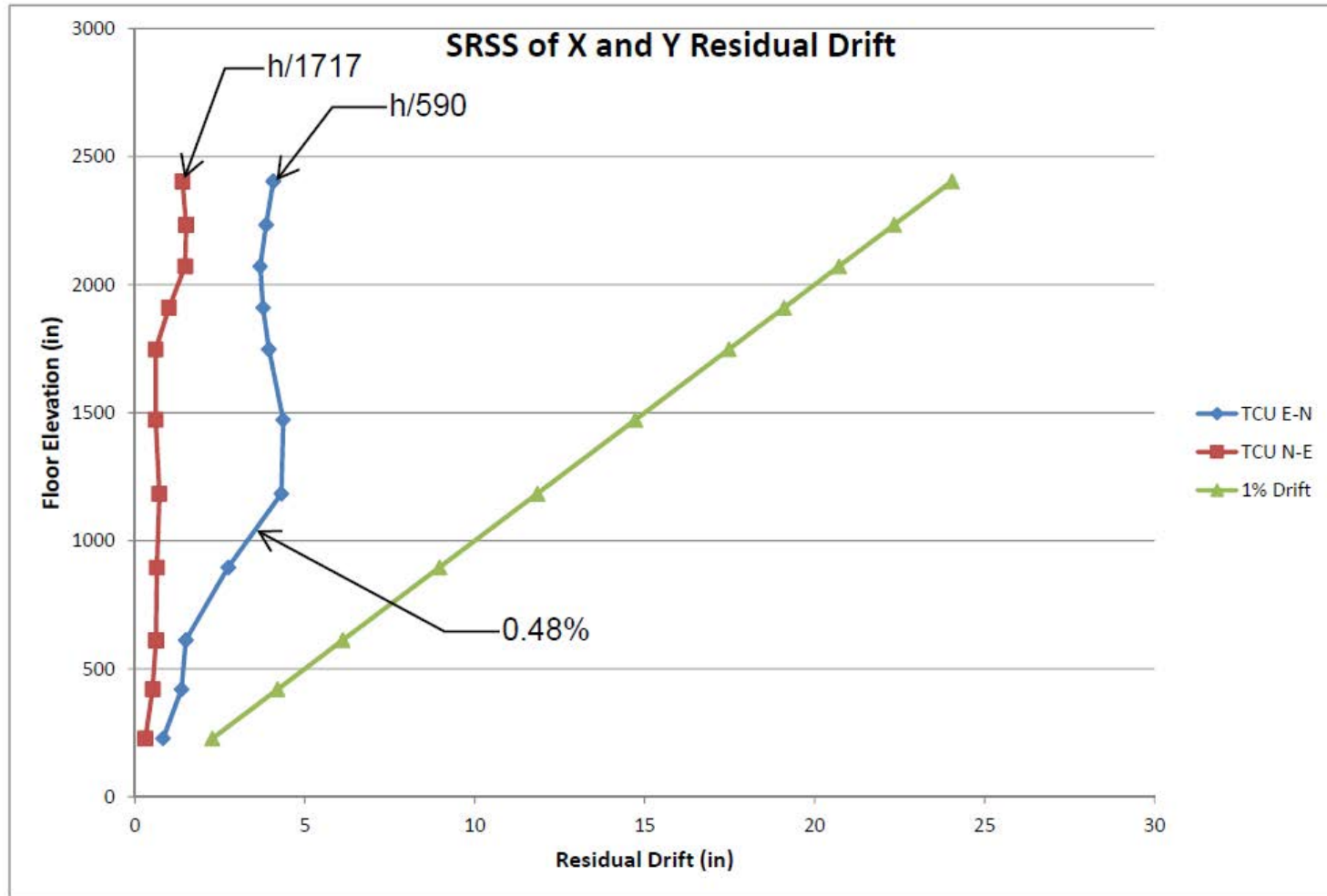
New Building Approach—Capacity Design



New Building Approach—Capacity Design



New Building Approach—Capacity Design



Thank You!



What does the Code Allow?

- IBC Section 104.11: The *provisions of this code are not intended to prevent the installation of any material* or to prohibit any *design* or method of construction *not specifically prescribed by this code*, provided that any such alternative has been approved.

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