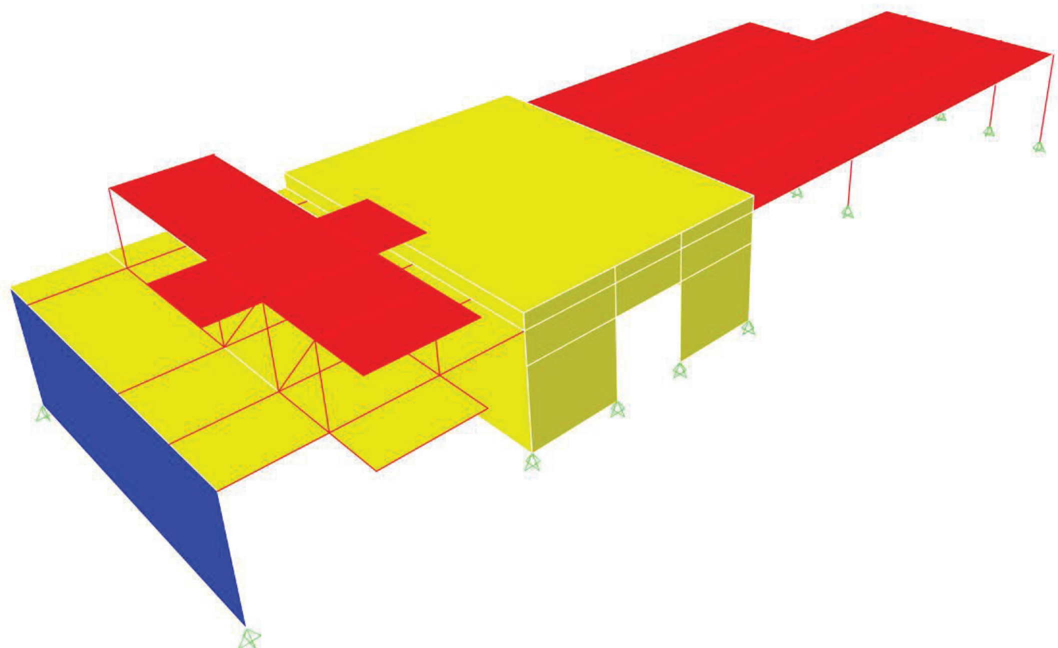
UCLA CENTER FOR HEALTH SCIENCES
CYCLOTRON BUILDING

CONCEPTUAL RETROFIT RECOMMENDATION
APRIL 5th, 2012



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1.0 EXECUTIVE SUMMARY

The subject of this report is the Cyclotron Building located within the Center for Health Sciences Campus at the University of California, Los Angeles.

The cyclotron building is a single story rectangular structure approximately 126'x40' in plan. The original building was designed in 1969 with approximate plan dimensions of 97'x40'. An adjacent addition was added in 1989, consisting of a single story structure roughly 29'x40' in plan with a mechanical penthouse on the roof. The structural system is structural steel framing and a combination of reinforced concrete, masonry and light gauge steel walls. Earthquake resistance is provided primarily by the reinforced concrete shear walls around the vault and western perimeter, with steel braced frames provided for the mechanical penthouse.

The objective of this report is to summarize our findings and recommendations regarding structure's ability to resist future earthquake hazards. Based upon these evaluations, the structure has been determined to meet the UC Seismic Safety Criteria "GOOD" (Rating Level III), per the UC Seismic Safety Policy.

2.0 INTRODUCTION

The subject of this report is the Cyclotron Building located within the Center for Health Sciences Campus at the University of California, Los Angeles.

The objective of this report is to summarize our findings and recommendations regarding the structure's ability to resist future earthquake hazards. Based upon these evaluations, the structure has been determined to meet the UC Seismic Safety Criteria "GOOD" (Rating Level III), per the UC Seismic Safety Policy.

The structural engineering scope of work includes the following services to assist in interim seismic planning for the Center for Health Sciences at UCLA:

- Based upon limited visual survey, prior engineering reports, and existing documents, evaluate the building using a 3D computer model
- Identify seismic forces resisting elements, connections, and weak points or discontinuities in the buildings seismic load path and develop professional opinion of the adequacy of the structure to resist seismic forces
- Develop conceptual rehabilitation schemes
- Summarize the analysis methods and conclusions in a written report.

The following documents were available for this review:

- Complete set of original architectural and structural drawings prepared by Neptune and Thomas Associates dated December 15, 1969.
- Complete set of addition architectural drawings prepared by Lee Burkhart Liu dated October 5, 1989.
- Complete set of addition structural drawings prepared by KPFF dated October 5, 1989.
- Original geotechnical reports were not available for review.

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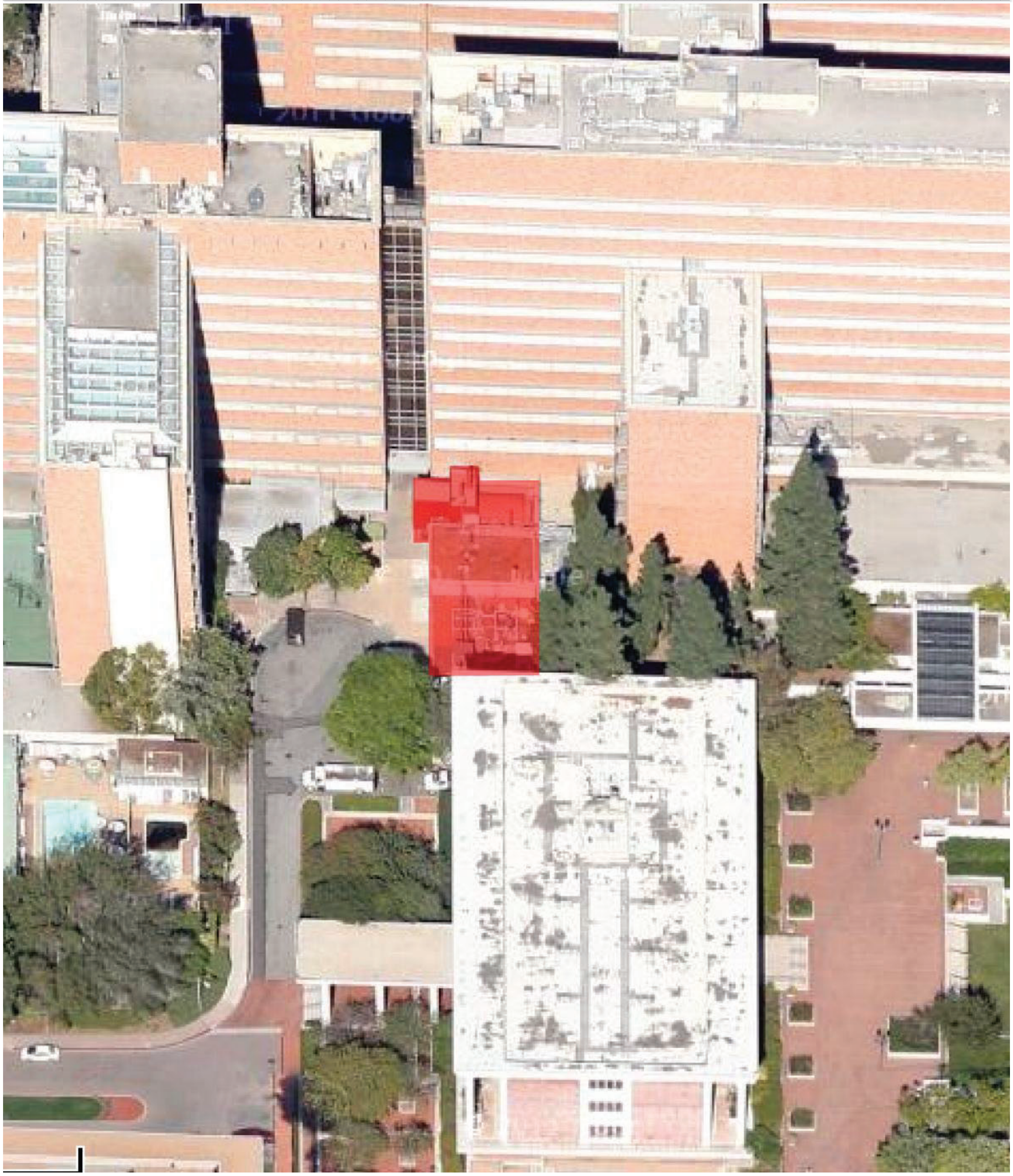


Satellite image of Cyclotron highlighted (view from south), adjacent to other CHS structures

3.0 BUILDING DESCRIPTION

3.1 General

The Cyclotron Building is located at the Center for Health Sciences (CHS) at the University of California, Los Angeles (UCLA). The original facility was designed in 1969 by architects and engineers Neptune and Thomas Associates. This original construction consisted of a single story rectangular building roughly 97'x40' in plan. An addition was designed in 1989 by architect Lee Burkhart Liu with structural engineer KPFF. This addition included an adjacent single story structure approximately 29'x40' in plan with a mechanical penthouse at the roof level. The overall floorplan is rectangular and lies immediately to the south of the School of Medicine South building.

3.2 Structural Materials

The structural system is composed primarily of cast-in-place reinforced concrete construction with structural steel roof framing and a combination of reinforced concrete, masonry and light gauge steel walls. The materials specified on the original construction drawings are:

- Structural Steel: ASTM A-36 for original construction and ASTM A-36 or ASTM A-572 for the addition. The addition also specifies ASTM A-53 for pipe sections and ASTM A-500 for steel tubes.
- Concrete: Compressive strength f'c = 3,000 psi.
- Masonry: Medium weight concrete masonry units with f'm = 1,500 psi.
- Reinforcing: Steel reinforcing with Fy = 60,000 psi for #6 bars and larger and Fy = 40,000 psi for #5 bars and smaller.

The exposed structural framing appears to be in good condition. In-situ testing has not been performed to verify the assumed material properties from the original drawings.

3.3 Gravity Framing System

The gravity framing system typically consists of the following:

- 4 ½" thick cast-in-place reinforced concrete structural slab.

- Metal roof deck spanning between 7' and 8'. Steel wide flange beams support the roof deck with spans up to 36'. Steel posts support the steel beams.

- Perimeter walls are either reinforced concrete or light gauge steel for the original construction. For the addition, 8" CMU walls were constructed adjacent to existing reinforced concrete retaining walls.

- The building is supported on isolated spread footings.

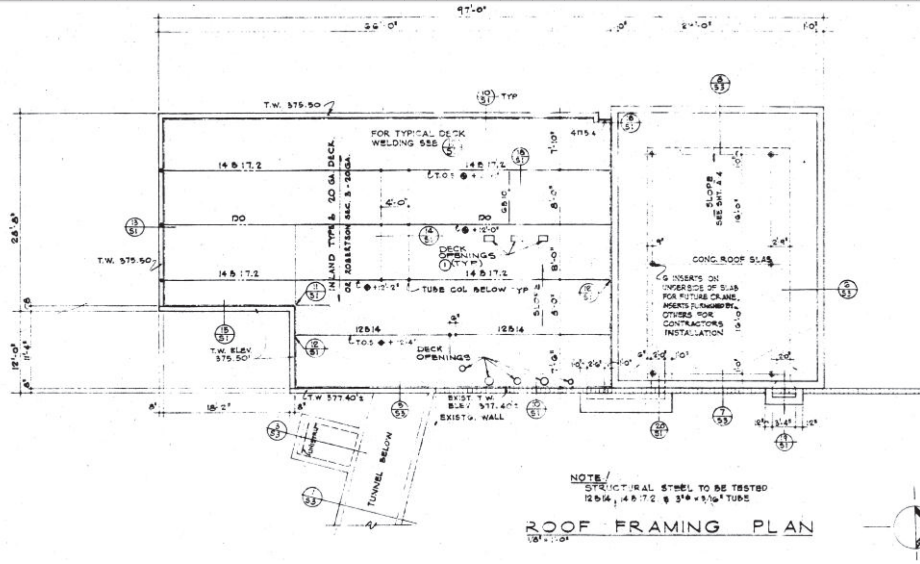
3.4 Seismic Framing System

The seismic lateral force resisting system consists of:

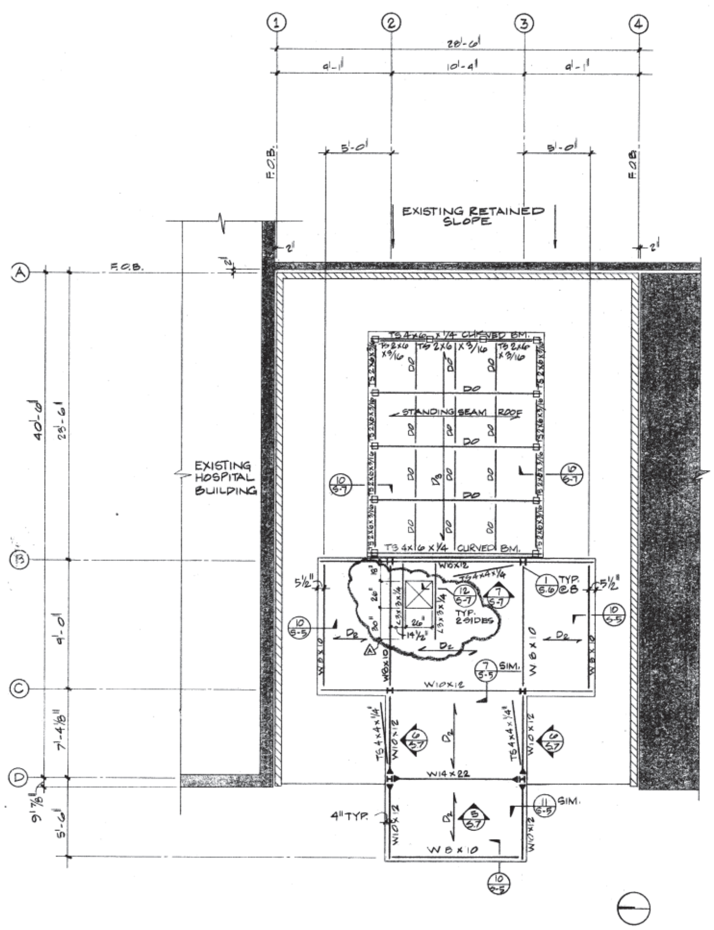
- The reinforced concrete shear walls around the cyclotron vault are typically 5’ to 6’ thick with 2 layers of #4 reinforcing bars.

- Additional lateral resistance is provided by the existing reinforced concrete retaining walls as well as the concrete block walls added with the addition.

- The mechanical penthouse for the addition structure also contains a series of braced frames and moment frames for lateral resistance.



Roof Framing for 1969 Structure



Penthouse Framing for 1989 Addition

4.0 SEISMIC EVALUATION CRITERIA

4.1 UC Seismic Policy

The structural evaluation criteria for the proposed building rehabilitation is the University of California Seismic Safety Policy dated August 25, 2011. The purpose of the policy is *"…to the maximum extent feasible by present earthquake engineering practice to provide an acceptable level of earthquake safety for students, employees, and the public who occupy University buildings and other facilities, at all locations University operations and activities"*.

Per Section III.D of the UC Seismic Safety Policy, "The seismic rehabilitation shall reconstruct buildings and other structures to a Performance Level ranking of I, or III (formerly expressed as "Good"), depending on occupancy, and based on current practice of earthquake engineering". Given the occupancy of this structure, the rehabilitation goal is that of rating level III (otherwise known as "Good").

The implied risk to life and seismic damageability of this ranking is represented in the UC Seismic Safety Policy Table A.2 (highlighting added to note Rating Level III):

Table A.2. Indications of Implied Risk to Life and Implied Seismic Damageability

Rating Level [1,5]	Historic Risk Ratings of [6,7]		Implied Risk to Life [3]	Implied Seismic Damageability [4]
	DSA/SSC[7]	UC[6]		
I	*I*		Negligible	0% to 10%
II	*II*		Insignificant	0% to 15%
III	*III*	Good	Slight	5% to 20%
IV	*IV*	Fair	Small	10% to 30%
V	*V*	Poor	Serious	20% to 50%
VI	*VI*	Very Poor	Severe	40% to 100%
VII	*VII*	Very Poor	Dangerous	100%

The definition and correlation of rating level III to requirements in the CBC 2010 document are presented in the UC Seismic Safety Policy Appendix A:

Table A.1. Determination of Expected Seismic Performance Based on Structural Compliance with the 2010 Edition, California Code of Regulations, Part 2, California Building Code (CBC)

Definitions based upon California Building Code (CBC) requirements for seismic evaluation of buildings using Occupancy Categories of CBC Table 1604A.5, depending on which applies, and performance criteria in CBC Table 3417.5 [2]	Rating Level [1]	
	No Peer Review [5]	Peer Review [5]
A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category IV performance criteria with BSE-1 and BSE-2 hazard levels replacing BSE-R and BSE-C as given in Chapter 34.	**I**	**I**
A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category IV performance criteria.	**II**	**II**
A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category I-III performance criteria with BSE-1 and BSE-2 hazard levels replacing BSE-R and BSE-C respectively as given in Chapter 34; alternatively, a building meeting CBC requirements for a new building.	**III**	**II**[5]
A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category I-III performance criteria.	**IV**	**III**[5]
A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category I-III performance criteria only if the BSE-R and BSE-C values are reduced to 2/3 of those specified for the site.	**V**	**IV**[5]
A building evaluated as not meeting the minimum requirements for Level V designation and not requiring a Level VII designation.	**VI**	**VI**
A building evaluated as posing an immediate life-safety hazard to its occupants under gravity loads. The building should be evacuated and posted as dangerous until remedial actions are taken to assure the building can support CBC prescribed dead and live loads.	**VII**	**VII**

For Notes, see page 14

As shown in the Table A.1, given that a peer review is to take place per the UC Seismic Safety Policy standards, a rating level of "III" correlates to *"A building evaluated as meeting or exceeding the requirements of CBC Chapter 34 for Occupancy Category I-III performance criteria"*.

4.2 2010 CBC Criteria

The UC Seismic Safety Policy correlates to certain performance criteria defined by the 2010 CBC Chapter 34. For a UC rating level "III", the CBC Chapter 34 correlation is a building meeting or exceeding Occupancy Category I-III evaluation. The criteria for this evaluation is presented in the 2010 CBC Table 3417.5:

TABLE 3417.5
SEISMIC PERFORMANCE REQUIREMENTS BY BUILDING REGULATORY AUTHORITY AND OCCUPANCY CATEGORY. ALL BUILDINGS NOT REGULATED BY DSA ARE ASSIGNED AS "STATE-OWNED."

Building Regulatory Authority	Occupancy Category	PERFORMANCE CRITERIA Level 1	PERFORMANCE CRITERIA Level 2
State-Owned	*I, II, III*	*BSE-R, S-3, N-D*	*BSE-C, S-5, N-E*
State-Owned	*IV*	*BSE-R, S-2, N-B*	*BSE-C, S-4, N-C*
Division of the State Architect - Public schools	I	*BSE-1, S-3, N-C*	*BSE-2, S-5, N-E*
Division of the State Architect - Public schools	II, III	*BSE-1, S-2, N-C*	*BSE-2, S-4, N-D*
Division of the State Architect - Public schools	IV	*BSE-1, S-2, N-C*	*BSE-2, S-4, N-C*
Division of the State Architect - Community college	*I, II, III*	*BSE-R, S-3, N-D*	*BSE-2, S-5, N-E*
Division of the State Architect - Community college	*IV*	*BSE-R, S-2, N-B*	*BSE-2, S-4, N-C*

1. ASCE 41 provides acceptance criteria (e.g. m, rotation) for Immediate Occupancy (S1), Life Safety (S3), and Collapse Prevention (S5), and specifies that values for S-2 and S-4 are to be determined by interpolation between the adjacent performance level values.
The required method of interpolation is as follows:
For level S-2, the acceptance value is 1/3 of the sum of the tabulated value for Immediate Occupancy (IO level) and twice the tabulated value for the Life Safety (LS level).
For level S-4, the acceptance value is one-half the sum of the value for the LS level and the value for the Collapse Prevention (CP) level.
For nonstructural components, N-A corresponds to the IO level, N-C to the LS level, and N-D to the Hazards Reduced (HR level).
For evaluation procedures, N-B shall be the same as for N-A. Where numerical values are used, the values for N-B are one half the sum of the appropriate IO and LS values. Where IO or CP values are not given by ASCE 41, then the LS values are permitted to be substituted.
2. Buildings evaluated and retrofitted to meet the requirements for a new building, Chapter 16, Part 2, Title 24, in accordance with the exception in Section 3419.1, are deemed to meet the seismic performance requirements of this section.

4.3 Hazard Criteria

The summary of the criteria defined in the 2010 CBC Chapter 34 results in a two-tier performance evaluation utilizing ASCE 41.

Level	EARTHQUAKE HAZARD	ACCEPTANCE CRITERIA
1	BSE-R (225yr return)	S-3 (Life Safety)
2	BSE-C (975yr return)	S-5 (Collapse Prevention)

Based upon the site conditions, the following earthquake seismic design criteria was used:

Soil Site Class=D
Occupancy Category=I

<u>Site Spectral Response</u>
Acceleration Parameters….S_s = 1.804g, S_1 = 0.617g

Site Coefficients…………F_a = 1.0, F_v = 1.5

Adjusted MCE Spectral Response Acceleration Parameters <u>BSE-1</u>

S_{XS} = 1.203g, S_{X1} = 0.617g

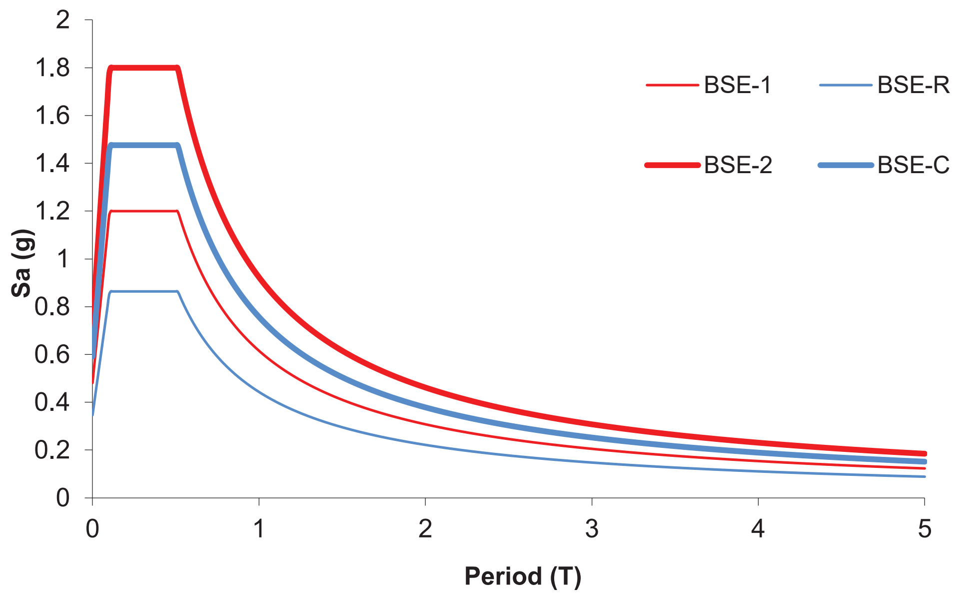
Adjusted MCE Spectral Response Acceleration Parameters <u>BSE-R</u>

S_{XS} = 0.866g, S_{X1} = 0.444g

Adjusted MCE Spectral Response Acceleration
Parameters <u>BSE-C</u>

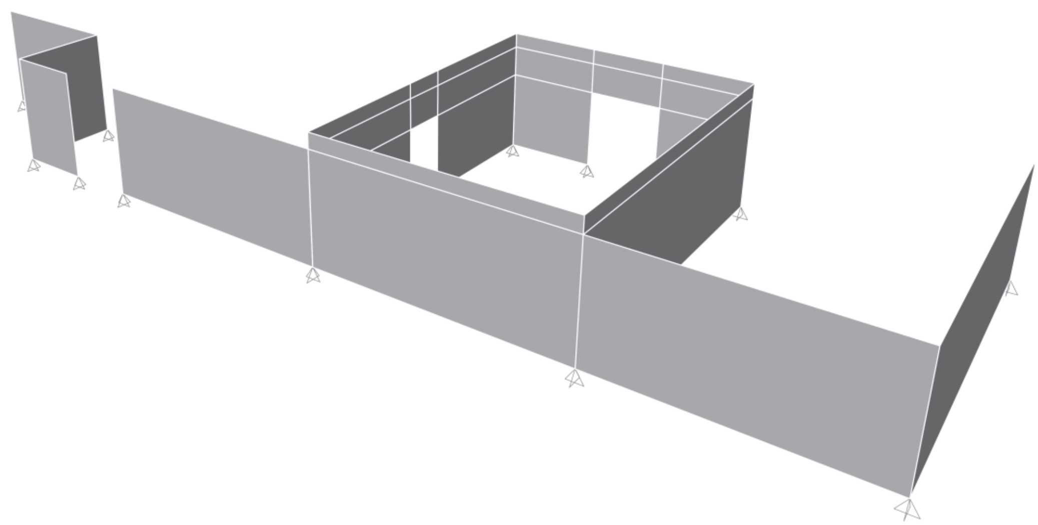
S_{XS} = 1.650g, S_{X1} = 0.85g

UCLA CHS ASCE 41 Response Spectrums



4.4 Modeling/Acceptance Criteria

ASCE 41 was used as the guidelines for the modeling/acceptance criteria. A 3D linear analysis model was created in the CSI program ETABS, and a linear dynamic procedure (including load combinations, inclusion of torsion, etc..) as defined in ASCE 41 Chapter 3 was performed to analyze the structures response. The relevant BSE-R and BSE-C response spectrums as shown above were used for the dynamic analysis. The model includes the mass of the structural components and superimposed dead loads. Gravity load effects were also represented with superimposed dead and live loads in addition to the structures self-weight. The analysis in ETABS considered P-Delta effects. The existing building was irregular in plan, and therefore multidirectional effects were considered per ASCE Section 3.2.7.



3D view of model showing lateral system only (penthouse framing not shown for clarity)

The existing concrete shear walls and masonry walls were considered the primary lateral force resisting element. Concrete shear wall modeling and acceptance criteria was based upon ASCE 41 Chapter 6.7. Concrete shear wall model stiffness modification was based upon ASCE 41 Table 6-5, which reduces the gross flexural rigidity of the wall by 50% to represent cracking in the wall under a seismic event. Masonry wall modeling and acceptance criteria was based upon ASCE 41 Chapter 7. Walls were determined to either be flexure or shear controlled, and their corresponding “m” values utilized to check acceptance were determined from ASCE 41 Tables 6-20 and 6-21 for concrete walls and Table 7-6 for masonry walls as required. Both shear wall flexure and shear was considered a deformation-based action, and therefore shear wall acceptance was based upon ASCE 41 Section 3.4.2.2.1, using expected strengths and “m” values.

5.0 RECOMMENDED REHABILITATION

The analysis results indicated that the existing lateral system is sufficient to meet the UC Seismic Safety Criteria “GOOD” (Rating Level III), per the UC Seismic Safety Policy. Consequently, no rehabilitation of the existing structure is required.