

# PCUBED ASSOCIATES

CONSULTING ENGINEERS

## UCLA PARKING STRUCTURE PS18 SEISMIC PERFORMANCE REVIEW

714 Tiverton Drive  
Los Angeles CA 90095  
Location: 34.064, -118.443



<b>Building ID</b>	
<b>Date</b>	June 4, 2020
<b>Project #</b>	19x044
<b>UC Rating</b>	VI

### GENERAL INFORMATION

<b>Year Built</b>	1975	<b>Orig. Design Code</b>	1973 UBC
<b>No. of Levels</b>	3 +1 U	<b>Foot print</b>	475' x 300'
<b>Vertical System</b>	1 Way CIP PT	<b>Lateral System</b>	Shear Wall EW & NS
<b>Occupancy Type</b>	Parking Structure	<b>No. of Spaces</b>	850 cars (approx.)



Arial View of Parking Structure



West Elevation of the Parking Structure

### EXECUTIVE SUMMARY

Based on our analysis, we classify parking structure PS18 to have an expected seismic performance level of VI per the UC Seismic Safety policy. Per the ASCE 41-17 Tier 1 and Tier 2 evaluation, under BSE-R and BSE-C level earthquake demands, the existing interior light well concrete shear walls were found to be highly overstressed. Based on the lack of special seismic detailing (e.g., boundary elements) the existing walls are not expected to perform in a ductile manner. The existing parking structure requires a more rigorous ASCE 41 Tier 2 type nonlinear evaluation or seismic retrofit. The expected retrofit costs would be in the low-cost range of around \$50 per square foot for the structure or lower.

## BUILDING BACKGROUND INFORMATION

The parking structure PS18 is located Northwest corner of the intersection of Tiverton Drive and Le Conte Avenue and nestled between the Doris Stein Eye Research Center building and the David Geffen School of Medicine building in the University of California Los Angeles (UCLA) Campus (Figure 1). The existing Parking Structure is a three/four-story exposed reinforced concrete shear wall building (Figure 2). Existing as-built drawings indicate that the building was designed and built circa 1975.

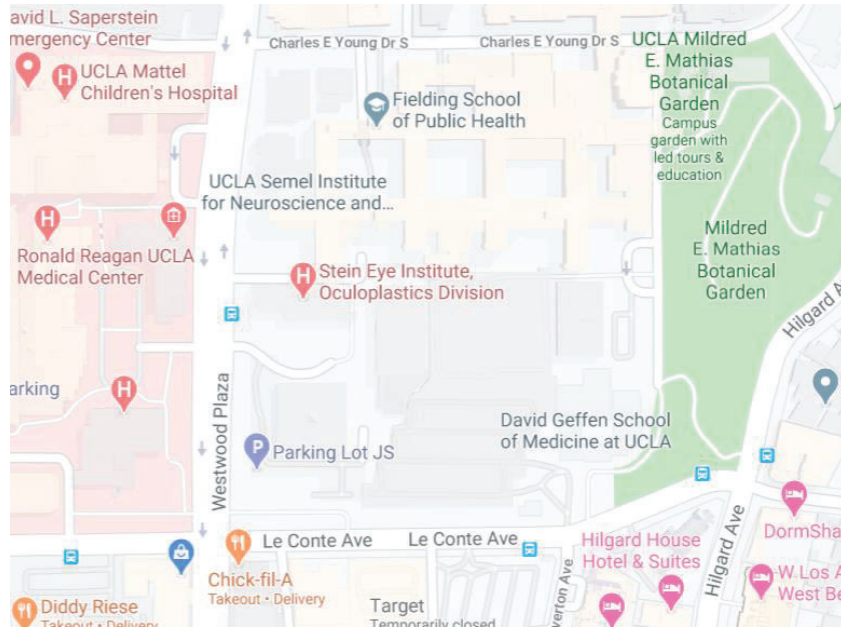


Figure 1 Location of Parking Structure PS18

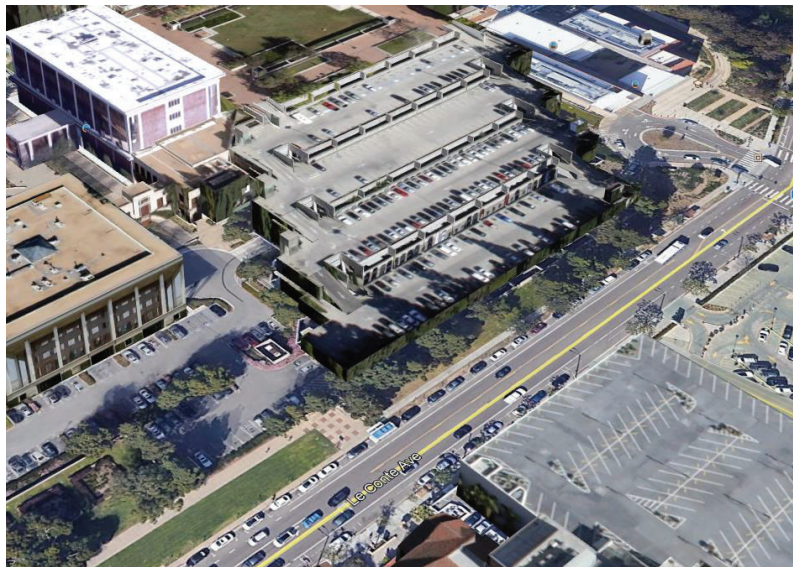


Figure 2 Aerial View of PS-18 Parking Structure

## PROJECT SCOPE OF WORK

The University of California Los Angeles (UCLA) engaged Pcubed Associates, Inc. to conduct a seismic performance review of the existing parking structure PS18 based on the earthquake damageability levels (VII-point scale) that have been adopted by the University of California (UC) system. The parking structure PS18 is located in a “High” seismicity area. It was designed and constructed circa 1975 under the 1973 Uniform Building Code (UBC).

## UC SEISMIC SAFETY POLICY

The University of California system developed the seismic policy to evaluate and identify existing academic buildings that are deficient. It uses the ASCE-41 procedure, customized for academic buildings that are considered to be in a higher importance category by the California Building Code. This process allows a quick building evaluation to confirm potential deficiencies. The process uses a VII-point scale to classify the potential damageability of a building. (See Table 1). Buildings that are higher than IV are typically considered to have poor performance and are candidates for retrofiting. This building was found to have an expected seismic performance of VI

Table 1 Determination of Expected Seismic Performance Level Based on CBC 2019

<b>Definitions based upon California Building Code (CBC) requirements for seismic evaluation of buildings using Risk Categories of CBC Table 1604A.5, depending on which applies, and performance criteria in CBC Table 317.5<sup>2</sup></b>	<b>Expected Seismic Performance Level <sup>1</sup></b>
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria with BSE-1N and BSE-2N hazard levels replacing BSE-R and BSE-C as given in Chapter 3.	I
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria.	II
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria with BSE- 1N and BSE-2N hazard levels replacing BSE-R and BSE-C respectively as given in Chapter 3; alternatively, a building meeting CBC requirements for a new building.	III
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria.	IV
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk 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
A building evaluated as not meeting the minimum requirements for Level V designation and not requiring a Level VII designation.	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

## Building Performance Objectives

Building performance can be described qualitatively in terms of the risk category and safety afforded to building occupants during and after the event; the cost and feasibility of restoring the building to its pre-earthquake condition; the length of time the building is removed from service to go through repairs; and economic, architectural, or historic effects on the larger community. These performance characteristics are directly related to the extent of damage that would be sustained by the building and its systems in a major seismic event.

An existing University of California building that is in Risk Category II needs to be evaluated for a Seismic force level of BSE-R with a safety criterion of S-3 (Life Safety) and Seismic force level of BSE-C with a Safety criterion of S-5 (Collapse Prevention).

Table 2 CBC Part 10 Seismic Performance Requirements for PS-18 Parking Structure

**TABLE 317.5**  
**SEISMIC PERFORMANCE REQUIREMENTS BY BUILDING REGULATORY AUTHORITY AND RISK CATEGORY.**

Building Regulatory Authority	Risk Category	PERFORMANCE CRITERIA	
		Level 1	Level 2
State-Owned [BSC]	I, II, III	BSE-R, S-3, N-C	BSE-C, S-5, N-D
State-Owned [BSC]	IV	BSE-R, S-2, N-B	BSE-C, S-4, N-D
Division of the State Architect - [DSA-SS]	I	BSE-1N, S-3, N-B	BSE-2N, S-5, N-D
Division of the State Architect - [DSA-SS]	II, III	BSE-1N, S-2, N-B	BSE-2N, S-4, N-D
Division of the State Architect - [DSA-SS]	IV	BSE-1N, S-2, N-A	BSE-2N, S-4, N-D
Division of the State Architect - [DSA-SS/CC]	I, II	BSE-1E, S-3, N-C	BSE-2N, S-5, N-D
Division of the State Architect - [DSA-SS/CC]	III	BSE-1E, S-3, N-B	BSE-2N, S-5, N-D
Division of the State Architect - [DSA-SS/CC]	IV	BSE-1E, S-2, N-B	BSE-2N, S-4, N-D

1. ASCE 41 provides acceptance criteria (e.g., m, rotation) for Immediate Occupancy (S1), Life Safety (S3), and Collapse Prevention (S5), and specifies in Sections 2.3.1.2.1 and 2.3.1.4.1 the method to interpolate values for S-2 and S-4, respectively. For nonstructural components, N-A corresponds to the Operational level, N-B to the Position Retention, N-C to the Life Safety level, N-D to the Hazards Reduced, and N-E to the Not Considered. When evaluating for the Hazards Reduced Nonstructural Performance Level, the requirements need not be greater than what would be required by ASCE 7 nonstructural provisions for new construction.

2. Buildings evaluated and retrofitted to meet the requirements for a new building, Chapter 16 of the California Building Code, in accordance with the exception in Section 319.1, are deemed to meet the seismic performance requirements of this section.

## EVALUATION METHODOLOGY

For this project, we performed basic calculations of the building lateral load resisting system in accordance with the guidelines of CBC 2019/ASCE 41-17 to evaluate the potential for damageability based on the seismic policy. Our review included the following:

1. Evaluation of the building characteristics per seismic guidelines.
2. Discussion of noted deficiencies and their impacts on the seismic performance
3. Recommendations for future remedial work, if any

The structural review assessed structural information provided on the UCLA's As-built structural drawings by Erkel/Greenfield & Associates dated February 7, 1975.

## PARKING STRUCTURE PS18 SEISMIC PERFORMANCE REVIEW

### Building Description

The parking structure PS18 is a three/four-story reinforced concrete shear wall structure with exposed reinforced concrete wall facade. The total area of the building, excluding the garage below the CHS plaza, is approximately 110,000 gross square feet.

The structural system of the building consists of post-tensioned one-way suspended slab supported on post-tensioned concrete beams. The lateral load resisting system of the structure consists of reinforced concrete shear walls. Layout of reinforced concrete shear walls is shown on as-built structural sheets S-2.5 (Figure 3).

The garage was designed by Erkel/Greenfield & Associates in 1975 based on the 1973 Uniform Building Code (UBC). It is located in a high seismic zone with close proximity to active fault lines as shown in Figure 4.

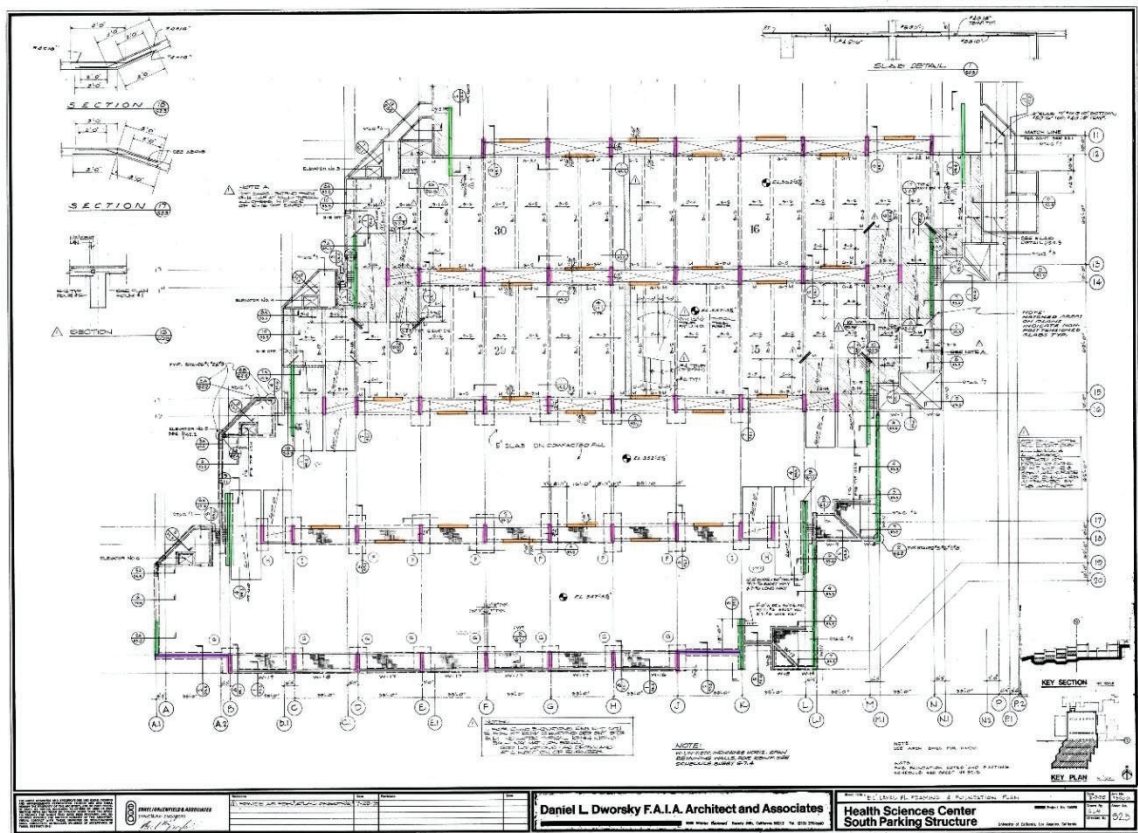


Figure 3 Ground Floor Plan Showing Concrete Shear Walls

### Risk Category

The Risk Category of a new or an existing building structure is defined by the governing regulations, building code, or policy, per ASCE 7. The parking structure PS18 is categorized as a Risk Category II building per California Building Code 2019 and ASCE 7-16.



Figure 4 Active Fault lines near UCLA campus

### Benchmark Buildings

Parking structure PS18 was designed using the 1973 Uniform Building Code. The lateral load-resisting system consists of reinforced concrete shear walls in two orthogonal directions. Based on ASCE-41 the benchmark year for this building type is 1994. Benchmark buildings are designed with more modern codes and are expected to satisfy the Building performance criteria of ASCE-41 and therefore, do not need additional evaluation.

Since PS18 is not considered to be a benchmark building, it could be seismically deficient per ASCE-41 and a more detailed evaluation was necessary to determine if it would satisfy the minimum CBC 2019/ASCE-41 requirements for building performance as required by the UC Seismic policy.

### Level of Seismicity and Seismic Hazard

The parking structure PS18 is located in the UCLA campus at 714 Tiverton Drive in Los Angeles, CA. The building coordinates are 34.064-degrees Latitude and -118.443-degrees Longitude. There is an active fault line, the Santa Monica fault, near this site, see Figure 4.

The design spectral acceleration parameters  $S_{Xs}$  and  $S_{X1}$  based on ASCE 41-17 for seismic hazard level BSE-R and BSE-C were determined using the ATC Hazards mapping tool. The values of the spectral acceleration parameters used in the analysis are listed below. The details of the calculations are included in Appendix.

SEISMIC HAZARD LEVEL	$S_{xs}$	$S_{x1}$	S Level
BSE-1N	1.358g	0.626g	S-3
BSE-1E/BSE-R	0.897g	0.516g	S-3
BSE-C/BSE-2E	1.549g	0.947g	S-5

The Level of seismicity for PS18 is determined as “High” for all Seismic Hazard Levels  
**Target Building Performance Level**

Evaluation for the building’s lateral load resisting elements were based on the two criteria per the CBC Part 10 Chapter 3.

*Level 1: Load Criteria BSE-R with Safety Criteria S-3 (Life Safety)*

The building’s reinforced concrete shear walls were evaluated with seismic force level BSE-R to determine if they have adequate capacity for Safety Criteria S-3 (Life Safety).

***All of the shear walls in the existing light wells do not pass this criterion.***

*Level 2: Load Criteria BSE-C with Safety Criteria S-5(Collapse Prevention)*

The building’s reinforced concrete shear walls were evaluated with seismic force level BSE-C to determine if they have adequate capacity for Safety Criteria S-5 (Collapse Prevention)..

***All of the shear walls in the existing light wells do not pass this criterion.***

*Falling Hazards*

In general the structure appeared to be compliant with falling hazards. All equipment that is mounted on the walls appeared to be secured to the structure and did not pose any imminent fall hazard. Some wayfinding signs were noted to be unbraced in two directions, however, they all appeared to be attached to the structure overhead with at least two supports. They would pose a very small risk of fall hazard during a seismic event.

**DISCUSSION**

The determination of the buildings Expected Seismic Performance Level categorized as Level I to Level VII are based on the California Code of Regulations Part 10 and current California Building Code which has been adopted by the University of California seismic policy.

The procedure requires that academic buildings in risk category II be checked for performance Levels 1 &2. Level 1 performance criteria requires building be checked for design force level of BSE-R under a service criterion of S-3 (Life Safety); Level 2 performance criterion requires building be checked for design force level of BSE-C under a service criterion of S-5 (Collapse Prevention). The PS-18 Parking Structure building was designed per the 1973 Uniform Building Code.

Based on the analysis conducted, the UCLA parking structure PS18 failed the performance criterion and could collapse during a major seismic event. Most of the issues noted were limited to the existing reinforced concrete shear walls in the existing light wells that were found to be highly overstressed in both flexure and shear.

Based on the analysis performed we believe that the building will not would satisfy the criteria for expected performance level V when the seismic forces are reduced by 2/3. As a result, we would classify the building under expected seismic performance level of VI per the seismic policy cited above and adopted by the University of California.

## RECOMMENDATIONS

Based on the analysis performed, it is our opinion that the UCLA parking structure PS18 P is in the expected seismic performance category VI based on the seismic policy adopted by the University of California. This would indicate that the building could sustain substantial structural damage, can experience partial collapse, and can cause substantial risk to life. Further evaluation/retrofit is recommended. Further detailed analysis and retrofit would be required per the UC policy.

Because of the localized nature of the issue at the light well walls and easy accessibility of structural elements, the expected retrofit costs for the parking structure are anticipated to be in the low range of less than \$50 per sq. ft.

## PCUBED ASSOCIATES INC.



Pawan R. Gupta Ph.D., P.E., S.E.  
Principal

## LIMITATIONS

This report has been prepared to provide recommendations with respect to a future course of action for the parking structure PS18. Pcubed Associates, Inc has no direct knowledge of, and offers no warranty regarding the condition of concealed construction or subsurface conditions beyond what was noted in our report. Any comments regarding concealed construction or subsurface conditions are our professional opinion, based on engineering experience and judgment, and derived in accordance with current standard of care and professional practice.