Degenkolb

San Francisco
Los Angeles
Portland
Oakland
San Diego
Seattle

July 26, 2011

Mr. Karl Burrelsman
Design & Construction Services
Building 439
University of California, Santa Barbara
Santa Barbara, California 93106

Reference: **Seismic Evaluation**
Davidson Library 1965 Addition (Eight Story)
UCSB
[Degenkolb Job Number B1138010.00]

Dear Karl:

Upon the request of the University of California at Santa Barbara, Degenkolb Engineers has conducted a seismic analysis of the Davidson Library 1965 Addition (Eight Story). A memorandum dated October 24, 2003, from John A. Martin and Associates indicated that the building "appears to have some seismic performance issues such that a more detailed review is recommended." From our initial review of the drawings, we agreed with the opinion of JAMA. It was noted that the gravity frames are not detailed for ductile performance and there is concern that they may fail if the building experiences significant drift. Given these conditions of the structure, an investigation was warranted and conducted.

Referencing structural drawings provided by Wheeler & Gray Structural Engineers, the Davidson Library is an eight story reinforced concrete structure built in 1965. The building is approximately 202 feet by 69 feet in plan. The structure is comprised of lightweight concrete, with a compressive strength of 3,750 psi up to and including the third floor framing, and 3,000 psi above the third floor. Reinforcing is typically intermediate grade deformed bars with a yield stress of 40,000 psi, but for columns where reinforcing is stated to be 60,000 psi. The only occurrence of normal weight concrete in the structure is at the precast wall panels at the exterior perimeter of the structure.

The gravity system is constructed of two-way reinforced concrete slabs that are supported by reinforced concrete gravity columns and reinforced concrete bearing walls. Interior columns are square in cross section with spiral-pattern reinforcement ties. Exterior columns are rectangular in cross section with rectangular stirrup patterns. All columns are located at panels at supported slabs, and are laid out on a relatively square grid-pattern. Concrete bearing walls are located at the two stairway locations, at the elevator locations, and at the east and west ends of the building.

www.degenkolb.com

Degenkolb Engineers
235 Montgomery Street
San Francisco, California 94104
415 392.6952 *phone*
981.3157 *fax*
500 SUITE

The lateral system is comprised of reinforced concrete moment frames and reinforced concrete shear walls. The concrete moment frames are located at the perimeter of the building and were a common design approach in the 1960s but they are not detailed for ductility or large deformations and could fail in strong shaking. The concrete shear walls occur at the two stairway locations, at the elevator locations, and run north-south at the east and west ends of the building and are the primary lateral force resisting system.

To determine the demands and capacities of the structure and its components, an analysis was conducted per ASCE 41-06 and ASCE 7-05 for Life Safety. A site visit was not conducted; therefore some assumptions had to be made to conduct the analysis. The layout of the book stacks was assumed to occur over 60% of the floors, and was included in the seismic mass per ASCE 7-05, which may be a bit conservative. A two dimensional computer model was developed using the ETABS computer code for each horizontal direction. The models included the two concrete cores, the east and west ends of wall, column and beam elements and the north and south facades of beams and columns.

The analysis results indicated that the building is seismically sound in the north-south, or transverse, direction where the stiff axis of the core walls plus the end wall system provides a good seismic resisting system. The core walls have numerous large vertical reinforcing bars which make them rather strong. In the east-west, or longitudinal, direction the structure is much more flexible with the weak axis of the core walls. The exterior beam-column frames on the north and south façade are subjected to moderate forces. Unfortunately the 18 inch wide by 31 inch deep beams overlap only 15 inches with the 49 inch dimension of the 49 inch by 15 inch columns which extend outside the edge of the building. These columns have nominal #3 ties at 16 inch centers with non-seismic 90° tie hooks plus a few extra ties top and bottom. Due to the large eccentricity between the beams and columns, both the columns and the beam-column joints (area common to both beams and columns) are considerably overstressed in shear. This suggests that the columns could experience considerable cracking, spalling and possible column failure in a severe earthquake. Unfortunately, shear is a brittle failure mode which we try to avoid in a seismic resisting system.

The precast concrete exterior panels are typically 11 feet high by 3 ½ feet wide and have connections detailed on the 1965 Wheeler & Gray drawings. The connections are steel angles welded to reinforcing steel in the panels and bolted to embedded steel plates in the concrete beams. While these appear to be reasonable details, the specified 3/8 inch joint between panels may not be sufficient to prevent panels from interacting during the potentially large longitudinal drift of the building.

Based on the results of this study, we must assign a seismic performance rating of POOR to Davidson Library 1965 Addition (Eight Story) in accordance with University Policy Seismic Safety. The building can be strengthened to achieve a seismic performance rating of FAIR or GOOD by strengthening the exterior columns on the north and south facades or adding new reinforced concrete shear walls or steel braced frames on the north and south facades. Adding the new walls or braced frames is probably the most feasible and their goal would be to reduce seismic deformation to a level which would protect the existing columns from potential failure.

Please contact us if you have any questions or desire additional information. We can provide additional studies to develop a conceptual seismic strengthening solution should you desire. It has been our pleasure to be of continuing service to UCSB.

Very truly yours,

DEGENKOLB ENGINEERS

Loring A. Wyllie, Jr.
Senior Principal, SE 1648