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Building Solutions

Project

UNIVERSITY OF CALIFORNIA AT LOS ANGELES MORGAN ATHLETIC CENTER

SEISMIC EVALUATION

Prepared For

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APPENDICES

1.0 Background

The University of California at Los Angeles (UCLA) is planning to renovate its existing Morgan Athletic Center. Regardless of whether or not the extent of renovation will trigger a "mandatory" seismic evaluation (and potential retrofit), as required by the 2016 California Existing Building Code (CEBC), UCLA seeks to determine the building's expected seismic performance level and the recommended scope of retrofit (if any).

2.0 Scope

Thornton Tomasetti (TT) has been retained by Kevin Daly Architects on behalf of UCLA to perform a seismic evaluation of the existing Morgan Athletic Center. TT's scope of work for this assignment has been as follows:

- Review available "record" drawings.
- Perform a site visit to visually examine the general structural condition of the building, and to validate that existing construction is generally accurately reflected by the available record drawings.
- Perform a seismic evaluation of the lateral force resisting system, in general accordance with the requirements of Chapter 3 of the 2016 CEBC in conjunction with the University of California Seismic Safety Policy.
- Provide written evaluation report documenting the results of the seismic evaluation, and summarizing the recommendations for seismic retrofit and/or further study.

3.0 Seismic Evaluation Criteria

For the UCLA building renovations, Section 317.3 of the 2016 CEBC lists certain conditions that, when exceeded, trigger mandatory seismic evaluation in accordance with CEBC Section 317.4, and (if required by the evaluation) seismic retrofit in accordance with CEBC Section 317.6. The minimum seismic performance criteria for the evaluation and retrofit design are as stipulated in CEBC Section and Table 317.5, which require that two separate criteria be met. For Morgan Athletic Center, those criteria are as follows:

- Performance Criteria Level 1:
  - Earthquake Hazard Level BSE-R, which is an earthquake with a 20%/50-year probability of exceedance (225-year return period)
  - Structural Performance Level S-3, i.e. Life Safety
  - Non-structural Performance Level N-C, i.e. Life Safety (not included in the scope of this evaluation)
- Performance Criteria Level 2:
  - Earthquake Hazard Level BSE-C, which is an earthquake with a 5%/50-year probability of exceedance (975-year return period)
  - Structural Performance Level S-5, i.e. Collapse Prevention
  - Non-structural Performance Level N-D, i.e. Not Considered

The seismic design parameters associated with the Earthquake Hazard Levels BSE-R and BSE-C are determined from USGS seismic maps. For the UCLA campus, those parameters are as follows:

- For BSE-R:
  - S_S = 0.744g
  - S_1 = 0.245g
- For BSE-C:
  - S_S = 1.546g
  - S_1 = 0.536g

For the Morgan Athletic Center evaluation, Site Class D has been assumed; however, as noted in Part 7.0 of this report, TT recommends this be verified via new borings directed by a geotechnical engineer.

TT utilized the ASCE 41 Linear Static analysis procedure for this evaluation.

CEBC Section 319 prescribes that evaluation and retrofit design be implemented in accordance with Method A (per CEBC Section 320) or Method B (per CEBC Section 321). Since all University of California projects have a Seismic Advisory Board (SAB) campus peer reviewer assigned, the evaluation/retrofit design qualifies for Method B, which allows some freedom in selection of the specific procedure, subject to the agreement of the peer reviewer. TT has performed the seismic evaluation in accordance with the Tier 1 and Tier 2 procedures outlined in the standard "Seismic Evaluation and Retrofit of Existing Buildings" (ASCE 41-17), published by the American Society of Civil Engineers.

The Tier 1 "screening" procedure consists of completing checklists relating to the structural and nonstructural components of a building, in order to determine which components of the existing construction, if any, are non-compliant with established acceptability criteria. In completing these checklists, limited structural calculations are performed.

The Tier 2 "deficiency-based evaluation" procedure consists of performing detailed examinations, including structural calculations, to further assess the performance of structural components that have been identified during the Tier 1 phase as being potentially seismically deficient. Please note that assessing the performance of nonstructural components is not included in the scope of this evaluation.

The University of California Seismic Safety Policy defines various Expected Seismic Performance Levels. Level IV (designated as "fair" per the UC's historical ratings system) meets or exceeds the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria, and is the threshold at which existing UC campus buildings are deemed acceptable without the need for mitigation.

In addition to the hazards identified by the specific application of the ASCE 41 Tier 1 and Tier 2 methodology as described above, TT has evaluated and identified other seismic deficiencies that, in TT's professional judgment, may also pose life safety hazards in a moderate to severe earthquake.
The criteria & evaluation approach described in this Section and the retrofit measures recommended in Section 7.0 are subject to peer reviewer concurrence during the renovation project.

4.0 Basis of Evaluation

TT's seismic evaluation has been based primarily on the record documents of the building made available by UCLA. These documents include the following:

West Wing Building:

- partial architectural & structural drawings for the original building construction, dated 1963.
- partial architectural & structural renovation drawings, dated 1982.
- architectural, structural & MEP renovation and seismic retrofit drawings, dated 2000.
- geotechnical investigation report by Law/Crandall, dated 1980

East Wing Building:

- architectural, structural & MEP drawings for the original building construction, dated 2000.
- geotechnical investigation report by Geobase, Inc, dated 1997

TT performed a site walk and investigation on September 20, 2018. The intent of the site visit was to visually examine the general structural condition of the building, and to validate that existing construction is generally reflected by the available record drawings.

5.0 Existing Building Description

Morgan Athletic Center includes two structures, or "Wings", separated by a 6" seismic joint. Descriptions of the West and East Wings are provided below.

West Wing Description:

The West Wing is a 27,000 square-foot two-story building, rectangular in plan, with overall dimensions of 145 feet (in east-west direction) by 94 feet (north-south direction).

The building includes 6 inch thick concrete tilt up walls along the north and south building perimeter, and fully grouted reinforced concrete masonry (CMU) walls along the west and east perimeter which serve as the building's lateral force resisting system. The second floor construction consists of a 4 ½" thick reinforced concrete slab supported on structural steel beams and girders. At the building interior, the girders are typically supported by steel wide flange columns. At the perimeter, beams are supported by the CMU walls, and girders are supported by concrete pilasters integrated with the concrete walls.

The roof construction consists of light-gauge corrugated metal deck with non-structural vermiculite concrete topping supported by structural steel beams and open web steel trusses. Similar to the second floor described above, beams and trusses are supported by interior structural steel columns and perimeter CMU walls & concrete pilasters.

The building features an 8'-0" by 60'-0" long central atrium that penetrates the floor and roof diaphragms. The foundation consists of continuous grade beam footings and 24" diameter concrete piles. The First Floor construction is slab-on-grade.

West Wing Structural Modifications:

Summary of 1982 Renovations:

- The original building construction included only a partial second floor plate, with an area approximately 60% of the roof above and floor below. Second floor framing was added during the renovation to expand the floor plate to match the footprint of the roof above and floor below. Columns and foundations were added at level 1 to support the new framing above.
- New door openings were cut from the existing east side CMU shear walls. Only nominal steel jamb and header framing was added back.
- Two existing second floor window openings in the south perimeter concrete wall were infilled with reinforced concrete.
- New roof diaphragm horizontal bracing was added.
- An adjacent annex building was constructed to the east side, which was apparently subsequently demolished and replaced by the newer East Wing circa 2000.

Summary of 2000 Retrofit:

- At the second floor and roof levels, continuous steel drag members were added at the interior face of concrete walls along the entire north and south perimeter lengths.
- Supplemental diaphragm shear transfer connectors were added along the east and west perimeter CMU walls.
- At the second floor and roof levels, supplemental out-of-plane concrete wall to diaphragm anchorage framing was added.

East Wing Description:
The East Wing is a 35,000 square-foot three-story building, rectangular in plan, with overall dimensions of roughly 125 feet by 110 feet.

The building floor framing includes corrugated metal deck with concrete topping supported by wide flange steel floor beams, girders and columns. The roof framing is similar to the floor, but without concrete topping over the deck. The building's lateral force resisting system is reduced-beam section type (RBS) steel moment frames (SMF).

The foundation consists of continuous grade beams, pile caps and 24" diameter concrete piles. The First Floor construction is slab-on-grade.

6.0 Current State of Repair

Based on observation during TT's site visit, the existing building appears to be in generally good condition. There is no apparent deterioration of finishes, nor readily identifiable excessive cracking or signs of settlement that would indicate structural distress.

7.0 Seismic Evaluation Results

The West and East Wing building structures were originally designed and detailed with a generally complete seismic force resisting system. However, due to changes in design force levels and detailing requirements since the time of the original building design, there are elements of the West Wing seismic force resisting system of the that do not meet the required performance criteria, either as determined per the ASCE 41 Tier 1 & Tier 2 procedure, or as determined in TT's professional judgment. Those deficiencies, and recommendations for mitigation, are described below. In addition, refer to the plan mark-ups in Appendix A for specific locations.

The East Wing was determined to be in compliance with a Level IV Expected Seismic Performance Level; therefore, no retrofits are recommended.

West Wing:

CMU Shear Walls: A Tier 1 evaluation approach allows seismic forces to be distributed uniformly to all shear walls in a given direction in order to simplify the analysis; however, the relatively large door openings added as part of the 1982 renovation will in actuality result in an imbalance of wall stresses. Therefore, despite meeting the Tier 1 compliance requirements, in our professional judgement a more detailed Tier 2 evaluation was appropriate to assess the existing CMU walls more accurately.

Per the Tier 2 evaluation results, the east perimeter CMU shear walls have inadequate in-plane shear and flexural capacity to resist the seismic lateral forces. The openings added as part of the 1982 renovation contribute to this deficiency by reducing the effective shear wall length, and creating shorter wall pier lengths, which are subjected to higher flexural seismic force demands. Retrofit may consist of infilling the largest opening, approximately 18'-0" long, via reinforced shotcrete or CMU. This opening is currently infilled with non-structural framing which would need to be removed. See Appendix A for conceptual layout and additional information.

Foundations: As reflected in Section 4.0 above, a Geotechnical Report that served as the basis of foundation design for the 1963 construction was not available to TT for the purpose of this evaluation. If the subsequently published Geotechnical Reports (dated 1980 and 1997) are used as a basis for evaluating the building's original foundation system, the as-built concrete piles are shown to be globally deficient.
In lieu of adding a new foundation system throughout the West Wing, TT recommends that UCLA first retain a Geotechnical Engineer to provide evaluation design criteria to properly assess the original foundation system, and as required, take new boring samples at and around the existing building. The existing foundation system and conceptual retrofit recommendations (if required) can then be evaluated with a higher level of accuracy and confidence.

East Wing:

Tier 1 checklist requirements were satisfied for the Expected Seismic Performance Level. Additional seismic resisting elements checked via a Tier 2 procedure were also satisfactory.

After the 1994 Northridge Earthquake, structural steel moment frames designed to comply with the current codes of the time exhibited non-ductile cracking at the beam to column joint.

Subsequently, the FEMA-350 document was published which included improved moment frame connection design guidelines (these guidelines were ultimately incorporated into AISC 341, Steel Seismic Design Guide). The East Wing steel moment frame members and connections appear to incorporate all of the FEMA-350 requirements, for example 20 ft-lbs charpy weld material, and "strong column-weak beam" compliance. Furthermore, the RBS moment frame pre-qualified connection defined in FEMA-350 type was utilized, to force the inelastic hinge away from the column beam interface.

8.0 Considerations for Future Renovation Project

Based on the currently proposed Morgan Hall renovation scheme, the CEBC provisions for mandatory evaluation/retrofit will likely not be triggered by the proposed structural modifications alone, as the existing lateral system would not be significantly weakened by the proposed demolition of certain portions of existing walls. However, it is still possible that a mandatory evaluation/retrofit may be triggered by the construction cost of the proposed renovation (if greater than 25% of the building replacement cost). In either case, TT recommends the implementation of the seismic retrofit measures discussed in the previous section as a means to "modernize" the seismic force resisting system of the existing structure.