Appendix C
Structural Evaluation

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STRUCTURAL EVALUATION REPORT

LA Trade Tech College Theater
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Project Description

John A. Martin & Associates, Inc., has performed a structural evaluation to assess the seismic upgrade requirements of the Magnolia Hall Auditorium at LA Trade Tech College. Construction documents for an extensive seismic upgrade to this building, based on the requirements of the 2001 California Building Code, were approved by DSA in 2008 but the work was not completed. The purpose of this assessment is to determine the magnitude of changes to the previously approved drawings that will now be required for the building to comply with the current 2019 California Building Code (CBC).

Structural Evaluation

Documents Reviewed

The following documents were available for our review:

- Reconstruction Work drawings for the Auditorium and Classroom Annex by Albert C. Martin dated October 1, 1934.
- Structural drawings for the Auditorium Rehabilitation by Franklin D. Howell / William N. Howell Architects and WM D. Coffey Associates, Inc. Consulting Engineers dated October 11, 1977.
- DSA approved Structural drawings for the Auditorium portion of the Building 'A' Restoration and Modernization project for LA Trade Tech College by John A. Martin and Associates dated March 14, 2008.
- DSA approved Structural drawings for the Classroom portion of the Building 'A' Restoration and Modernization project for LA Trade Tech College by Englekirk and Sabol, Consulting Structural Engineers dated March 14, 2008.
- DSA approved Architectural drawings for the Building 'A' Restoration and Modernization project for LA Trade Tech College by Tetra Design dated March 14, 2008.
- ASI #51 structural drawings for the Building 'A' Restoration and Modernization project for LA Trade Tech College by John A. Martin and Associates dated July 8, 2010.
- Structural drawings for the Grand Theater Demolition by V C A Engineers, Inc dated December 3, 2019.
- Supplemental Recommendations to the Geotechnical Investigation Report, A-Building Restoration and Modernization, LA Trade Tech College by Converse Consultants dated July 30, 2007.
- Updated Geotechnical Recommendations, Grand Theater Demolition and Remodel Project, LA Trade Tech College, by Converse Consultants date December 20, 2019.

Structural Description

The building is located at 400 West Washington Blvd. in the City of Los Angeles, California. The building was originally constructed in the late 1920s and consisted of an auditorium with a classroom annex attached to the south wall of the auditorium. The above grade auditorium has a partial second floor balcony area, a partial one level basement for mechanical equipment, an above grade stage area with one level of basement and two small one and two story side areas. The roof and second floor balcony framing for the auditorium consists of wood sheathing and joists that are supported by steel beams. The steel beams span to steel trusses that are supported by steel columns. The perimeter walls of the

auditorium consist of non-bearing unreinforced masonry. The roof over the stage area consists of a concrete slab that spans to concrete beams and concrete bearing walls. The roof and floor framing at the two side areas consist of wood sheathing and joists that span to unreinforced masonry walls. Concrete retaining walls are provided below grade and the steel and concrete columns are supported by spread footings.

The lateral force resisting system for the building was upgraded in the 1930s. This upgrade included adding steel vertical trusses along the URM walls at both the auditorium and side areas. A steel horizontal truss diaphragm system was also added along the north, south and west walls above the auditorium. The URM walls were strengthened with minor concrete columns. At the stage area, the existing concrete walls provide lateral support for the high stage concrete roof diaphragm.

The design of a major restoration and modernization project for the building began in 2007. Extensive structural upgrades were required for all parts of the building. It was determined that the seismic performance of the building would be improved if the classroom wings were separated from the auditorium structure. The floors and roofs of the classroom building are supported by the south wall of the auditorium; therefore, new gravity columns and shear walls at the classroom building were required to separate the buildings. The new gravity columns near gridline A8 are supported by the auditorium foundations. John A. Martin and Associates is the Structural Engineer of Record, (SEOR), for the auditorium building and Englekirk and Sabol, Consulting Structural Engineers are the SEOR for the classroom building. Construction documents for the Building 'A' Restoration and Modernization project were approved by DSA in March 2008 and construction for the auditorium and classroom building began later that year.

The 2008 seismic upgrade of the existing auditorium building were based on the requirements of the 2001 CBC. The following is a summary of the required structural upgrades as indicated on the 2008 DSA approved drawings by John A. Martin and Associates:

1. Out-of-plane strengthening of the existing URM walls consist of adding reinforced shotcrete to the interior or exterior face of the walls. The shotcrete walls are designed to support the URM walls and span horizontally to the adjacent pilasters or shear walls. Per sheet SA201, the horizontal reinforcing in the 6" and 8" thick shotcrete walls consist of #6@10" and #7@12" respectively.
2. In-plane strengthening of the existing URM and concrete walls consist of adding reinforced shotcrete to the interior or exterior face of the walls. These strengthened shear walls serve as primary lateral force resisting system of the building. Per sheet SA201, the horizontal reinforcing in the 6", 8"and 12" thick shotcrete walls consist of #6@10", #7@12" and #6@12" each face respectively.
3. Strengthening of the existing concrete walls at the sides of the proscenium opening could not be achieved without adversely impacting the theatrical operations; therefore , the existing URM wall on gridline AB and north of line A2 was to be removed and replaced with a new 30" thick concrete shear wall. Per elevation A/SA302, this wall is heavily reinforced with #8@12" each face and 20-#11 tied boundary elements at each end of the wall. The new footing for this wall is 20'-0"wide and 4'-0" thick with #10@6" and #6@8" bottom and top reinforcing respectively.
4. Strengthening of the existing foundations consist of adding continuous reinforced concrete to both sides of the existing wall footings and column piers. The foundation strengthening is designed to support seismic and gravity loads based on the Geotechnical Investigation Report by Converse Consultants dated June 29, 2007. The report specifies a maximum allowable bearing

capacity of 4,200psf with a 1/3 increase for seismic loading. Per sheet SA201 and applicable details on sheet SA401, the strengthened footings are typically 12'-0" wide and 3'-6" thick with #8@12" top and bottom reinforcing each way.

5. Strengthening of the existing first floor seating area of the auditorium consists of adding steel channel diagonal braces in two directions at every vertical support. Per sheets SA201, SA202 and SA402, the new MC6x15.3 diagonal braces are connected to the bottom of the existing wood floor framing and the existing concrete footings.
6. Strengthening of the existing balcony consists of replacing the wood framing at the lower balcony and anchoring the existing steel trusses to the new concrete pilasters at the north, south and west walls.
7. Strengthening of the existing pilasters that encase the existing steel columns supporting the roof trusses at the north and south sides of the auditorium consist of removing the existing URM and replacing it with reinforced concrete. The new pilasters support the out-of-plane wall loads and transfer these loads to the roof level horizontal truss. Per detail 1/SA505, these pilasters are 36"x38" with 6-#10 bars at the north and south faces. Per detail 2/SA501, four welded steel plates with embedded studs anchor the pilasters to the horizontal truss.
8. Strengthening of the existing pilasters that encase the steel columns supporting the balcony trusses at the east side of the auditorium consist of removing the existing URM and replacing it with reinforced concrete. The new concrete pilasters support the out-of-plane wall loads and lateral loads from the balcony and transfer these loads to the roof level horizontal truss. Per detail 2/SA508, these pilasters are 30"x36" with 6-#10 bars at the east and west faces.
9. Strengthening of the exiting horizontal truss consists of adding new double angle truss members where they do not exist on the east side between gridlines lines A2-A7 and AB-AC and adding steel channels to the existing double angle truss members. The upgraded horizontal truss delivers the lateral loads from the auditorium walls, floors and roof to the new concrete shear walls on lines A1, A8, AB and AK. Per sheet SA205A, the new truss members consist of 8x6x1/2 and 6x4x3/8 double angles and the strengthening for the existing diagonal members on the north, south and west sides of the truss consist of added MC10x33.6 and MC9x23.9 channels welded to the existing double angles. Typically, the existing gusset plates must be extended to accommodate the welded connections for the new channels.
10. Strengthening of the existing wood roof over the auditorium consists of adding plywood sheathing over the existing straight sheathing. Per detail 6/SA107, the boundary, edge and field nailing for the new sheathing is 10d@ 2 ½" 4" and 12" respectively.
11. The roof above the stage extends above the main auditorium roof to accommodate the gridiron for the theatrical rigging. Per sheet SA206, the existing concrete diaphragm at this high roof area over the stage is strengthened by adding continuous 5"x3/8" steel plate chord members at the east and west sides. Similar steel plate strengthening is also required at the large smoke vent openings near the center of this roof. The north and south concrete walls of the stage extend over the auditorium roof to a concrete wall located above the roof truss at line AC. The walls and roof over this area creates a ventilation plenum between gridlines A2-A7 and AB-AC. The existing wood roof over the plenum was to be demolished and replaced with a new wood roof with adequate wall anchors and ledgers. Drag connections per detail 10/SA506 anchor the plenum walls to the strengthened concrete shear walls at the sides of the stage. The existing steel truss at line AC provides vertical and lateral support for the plenum walls and roof. Per the details on sheet SA301, extensive strengthening of the existing steel truss is required to support

the gravity and lateral forces imposed by the heavy concrete walls. This truss is designed as a discontinuous system per CBC section 1630A.8.2 using special load combination 1612A.4. Per truss elevation 1/SA301, the top chord, diagonal and vertical members of the truss are strengthened with two continuous 1"x11" plates, 10½"x6"x5/8" bent plate channels and MC9x23.9 channels respectively. The existing concrete wall is anchored to the truss with 3-1" diameter through bolts and welded double L6x4x1/2 angles at 8 locations. The horizontal truss transfers the reaction from the vertical truss into the new concrete shear walls.

12. The side areas adjacent to the stage required upgrades to the foundations, URM walls and the wood floors and roofs. The existing URM wall are reinforced with shotcrete and the foundations are strengthening similar to the main auditorium. The wood floors and roofs will be strengthening with added plywood sheathing, new drag structs and wall anchors per the details on sheet SA502.

Construction for the seismic upgrades listed above was started in 2008 but only the foundations, walls, pilasters and roof work adjacent to the classroom building along gridlines A8 and part of AK was completed. This limited scope of this work was documented in ASI #51 dated July 8, 2010. It is our understanding that in order to complete the work, the structural design must be updated to comply with the 2019 CBC. There have been many significant changes to the seismic design requirements from the 2001 CBC to the 2019 CBC. Most notably, the seismic base shear (V) for this building has increased by 96% from V=0.246W to V=0.480W and the seismic design category (SDC) has changed from SDC=D to SDC=E.

The following is a summary of the changes to 2008 upgrades that will be necessary to comply with the requirements of the 2019 CBC:

1. The out-of-plane strengthening of the existing URM walls per the 2008 drawings appears to be adequate.
2. In general, most of the strengthening of the existing shear walls is not adequate and the walls are overstressed by 16% to 46%. The shear wall on line A8, adjacent to the classroom annex, appears to be adequate.
3. The 30" concrete shear wall on gridline AB and north of line A2 is not adequate for the required seismic demands. Added wall reinforcing, increased boundary elements and larger foundations are required.
4. In general, the 2008 foundation strengthening is not adequate for the required seismic demands. Wider footings with increased reinforcing steel is required at most locations. Also, the Geotechnical Investigation Report by Converse Consultants dated December 20, 2019 reduces the maximum allowable bearing capacity from 4,200psf to 4,000psf.
5. The 2008 strengthening of the existing first floor seating area is not adequate for the required seismic demands. All of the steel channel brace sizes and their connections must be increased.
6. The 2008 strengthening of the existing balcony is not adequate for the required seismic demands. Also, using the concrete pilasters to laterally support the balcony may not be allowed since the design of the building's lateral force resisting systems must now comply with the requirements of seismic design category E. A complete lateral force resisting system consisting of an upgraded diaphragm and added shear walls or braced frames with new foundations at the west side of the balcony will likely be required.

7. The 2008 strengthening of the existing pilasters at the north and south walls are not adequate for the required seismic demands. In general, these concrete pilasters must increase from 36”x38” with 6-#10 bars at the north and south faces to 42”x48” with 10-#14 at the north and south faces. The 2008 welded steel plates with embedded studs anchor to the horizontal truss must also be upsized accordingly. The pilasters at the south wall, adjacent to the classroom annex, were constructed in accordance with the 2008 drawings. In lieu of removing and replacing these concrete pilasters, it may be possible to strengthen them with externally applied carbon fiber reinforced polymer (CFRP). Please note that CFRP can enhance the strength of the pilaster but it will not increase its stiffness. The calculated mid-span deflection for the 2008 pilasters increases from 1.9” to 3.3” based on the 2001 CBC and 2019 CBC seismic demands respectively. The seismic separation between the auditorium and classroom annex was constructed on 2008 based on the requirements of the 2001 CBC; therefore, modifications to the existing seismic separations at the floor and roof levels of the classroom building may be required.
8. The 2008 strengthening of the existing pilasters at the east side of the auditorium are not adequate for the required seismic demands. In general, these pilasters must increase from 30”x36” with 6-#10 bars at the east and west faces to 36”x36” with 8-#11 at the east and west faces. The 2008 welded steel plates with embedded studs anchor to the horizontal truss must also be upsized accordingly. Per item #6 above, using these pilasters to laterally support the balcony may not be allowed by the 2019 CBC.
9. The 2008 strengthening of the exiting horizontal truss consists is not adequate for the required seismic demands. The new 6x4x3/8 double angle truss members must increase to 7x4x1/2 double angles and the strengthening for the existing diagonal members on the north, south and west sides of the truss must increase form MC10x33.6 and MC9x23.9 channels to C15x50 and C10x40.1 channels respectively. The existing 8x6x7/16 double angle chord members at the north and south and west sides that did not require strengthening in 2008 must be strengthened by welding approximately 670’ of MC10x41.1 channels to the existing double angles. Gusset plate extensions and welded connections must be upsized accordingly.
10. The 2008 strengthening of the existing wood roof over the auditorium appears to be adequate.
11. The 2008 strengthening of the existing concrete diaphragm at the high roof area over the stage is not adequate for the required seismic demands. The 2008 5”x3/8” steel plates must increase to 6”x1/2” and the connections must be upsized accordingly. The 2008 wood roof over the plenum appears to be adequate. The 2008 drag connections per detail 10/SA506 must be upsized. The 2008 strengthening of the existing steel truss at line AC is not adequate. The continuous 1”x11” plates, 10 ½”x6”x5/8” bent plate channels and MC9x23.9 channels from the 2008 drawing must be increased to two continuous 2”x11” plates, C10x30 channels and MC12x50 channels respectively. The bottom chord that did not require strengthening in 2008 must now be strengthened with a continuous C10x25 channel. The 2008 concrete wall to truss connections must also be upsized accordingly.
12. The 2008 strengthening of the side areas is not adequate for the for the required seismic demands. Increased foundation strengthening and upgrades to the 2008 wood floor and roof strengthening is required.

Conclusions

There have been significant changes to the seismic design requirements from the 2001 CBC to the 2019 CBC. Extensive structural upgrades to all parts of the building, as indicted in the DSA approved 2008 construction documents, were necessary to comply with the requirements of the 2001 CBC and substantial increases to these upgrades will be necessary for the building to comply with the requirements of the 2019 CBC.