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Building Structural Assessment
for
Unitarian Universalist Society of Sacramento

2425 Sierra Boulevard
Sacramento, CA

Prepared for:
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October 25 2010

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Unitarian Universalist Society of Sacramento
Structural Assessment

October 25, 2010

Re: **Main Building and Classroom**
Structural Assessment
2425 Sierra Boulevard
Sacramento, CA

This is a report on our observations and recommendations regarding the structural integrity of the main hall and classrooms at the above referenced site.

Document Review

A partial set of the original construction plans are available for review. The actual buildings have several major structural items that do not match the plans.

The roof framing plan is missing from the set. Sections and details refer to structural steel beam framing for the roof with metal pan decking. The actual construction uses glu-lam beams with wood decking above.

A brief structural assessment report was prepared by Heath Smalley recently. This report is well written and accurate. We agree with the observations.

Field Observations

This report is based on visual observations made on October 13, 2010. No destructive testing was performed.

The building was constructed in about 1960. Current Codes are much more restrictive than the Building Codes at that time. Our references to the "Code" references the 2007 California Building Code. This is Building Code that is in use today. A new Code will go into effect on January 1, 2011. The structural portion of the new Code will be similar to the current Code.

The precast concrete walls are shown on the plans as being 10'-2" above the slab. The plans call for a steel ring beam that attaches to the steel roof beams. The steel roof and ring beam were not installed. Instead, the walls were cast with an additional 3' of concrete at the top. The "ring beam" is now comprised of the top of the walls and cast in place concrete headers. The panels are probably tied together with reinforcing that laps in the columns and header beams.

The building appears to be in good condition. There are no visible signs of significant failures in the roof structure or in the perimeter walls.

Unknowns

The following items could not be determined during our visual inspection. Additional plans or destructive testing will be required to provide definitive answers regarding some of these items.

Roof Deck Construction and Diaphragm: It is not clear if there is a plywood roof diaphragm. The original plans call for metal pan decking. This was probably not used with the wood structural framing. It appears that solid or laminated decking was used for the ceiling/roof deck. Current Codes allow diaphragms using diagonal lumber sheathing, but not straight lumber sheathing.

Diaphragm to wall connection: The connection of the roof diaphragm (if it exists) to the top of the walls cannot be observed.

Lumber Grades: No lumber grade stamps are visible.

Radial Reinforcement of the Roof Beams: There could be lags in the top of the glu lam beams that add radial reinforcement . This would strengthen the beams.

Concrete Ring Beam Reinforcement: There are no plans available that detail the reinforcing at the top of the wall. The top 3' of the panels is not shown on the plans. The plans call for a steel beam at the top of the wall. This beam does not exist.

Steel Columns at Corners: The reinforcing for the cast in place concrete columns that tie the precast panels together is unknown. The plans call for steel columns in the columns at the corners, and no vertical reinforcing. The steel beams were eliminated from the project, so it is possible that the steel columns were also eliminated.

Connection of Beams at Roof Center: The connector can be viewed from the bottom, but there is no way of knowing if there are tension straps at the top center connection.

Concrete walls: The concrete walls are 3' taller than shown in the plans. The upper 3' does not have voids.

Soil Classification: We do not have a soils report.

Additional Items Required for a Complete Assessment

The following items are necessary to provide a detailed analysis of the existing structures:

Geotechnical Report: A structures response to an earthquake is highly dependent on the soil profile. Current Codes require geotechnical reports for all new structures and additions. The existing plans show a deep foundation (drilled piers) for the Main Building and shallow spread footings for the classrooms.

Destructive testing of the roof structure: This will determine thickness and grade of the decking, the presence and type of plywood roof diaphragm, the actual profile and grade of the glu-lam beams, and the presence of any radial reinforcing of the beams. The connection of the roof to the precast walls and to the center connection would be checked at this time.

Verification of the reinforcing of the columns, walls and ring beam: This could be accomplished with a combination of destructive testing (chip and patch the concrete), pacometer (metal detector) and x-ray.

A detailed analysis of the roof structure: Using the actual properties of the roof structure, an accurate analysis will be performed.

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A detailed lateral analysis: Our preliminary analysis is based on numerous assumptions. A more detailed check can be performed with additional information.

Assumptions

Because of the lack of several critical pieces of information we are making the following assumptions:

There is a plywood roof diaphragm. This was common at the time of construction.

The roof decking is at least 3" nominal. The design of this type of decking has not changed much since the design of the building.

The roof beams have reinforcing.

For this report we assume that the concrete columns have vertical steel, and horizontal ties. The classroom plans show column reinforcing, so the reinforcing probably exist in the Social Hall columns. This reinforcing is probably less than required by current Codes.

The concrete strength is adequate. Concrete gains strength over time. It is probably stronger than when the building was built. There are no signs of deterioration.

The foundations are adequate. The foundations are taking the vertical loads with no obvious signs of distress. The foundation will need to be augmented if additional shear walls, moment frames or posts are added.

Structural Items of Concern

Main Building

The roof framing consists of timber decking over glu-lam beams. We did not determine the thickness or grade of the decking. A check of tables using assumptions on the thickness and grade shows that the decking is probably adequate (see attached AITC tables). However it is not clear if there is plywood over the decking. Current codes do not allow straight decking as a diaphragm. The diaphragm collects wind and earthquake loads and distributes them to the lateral force resisting system (in this case, the concrete walls). The lack of connections of wood roof diaphragms to concrete walls was major factor in the failure of several buildings in the Northridge earthquake. The heavy concrete walls can pull away from the roof in an earthquake allowing the roof to fall.

The roof beams are tapered curved glu-lam beams instead of the built up steel beams as shown on the plans. There are no plans that show the size and grade of the existing beams. We used our estimates of the actual loads and converted it to a uniform load for comparison to the tables.

The steel beams as designed are much stronger than the wood beams as built.

The AITC tables specifies beams that are much stronger than the existing roof beams (6-3/4 x 36" with (16) 3/4" lag screws). Our calculations match the AITC tables.

There is a flat roof around the main building. This is supported over the entries with double cantilevered 4x6 beams. Steel brackets support the interior cantilever. The rest of the flat roof is supported by a back span. The back span is a ceiling over the offices and a ceiling/storage area over the stage. The roof feels very spongy when walking on it. Some of the 2x4 joists are broken. Our

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calculations show that the 2x4 are adequate, but the 4x6 cantilever beams are severely overstressed. The brackets is also overstressed.

Our lateral analysis is based on the potential damage from earthquakes. This will probably govern over the wind loads.

The foundation piers do not have the required minimum steel based on current Codes. The current foundation is supporting the vertical loads with no signs of distress. The foundation may be overloaded during an earthquake.

We assumed a soil classification of "D" and Occupancy Category III for our lateral analysis. This puts the building is Seismic Category "D". A different soils type might lower this Category. The Occupancy Category adds 25% to the earthquake load. The shape of the building also adds 30% to the force in the walls in one direction as described by Mr. Smalley.

The precast shear walls have a grid of voids. These void leave a net section of 28% vertically and 38% horizontally of a solid wall. The wall reinforcing does meet the code minimum for a solid 8" thick concrete wall. The steel at the perimeter of the wall needs to be checked. The perforations are a concern because they create a failure plane.

Using a building weight of 900,000 pounds and an lateral force of 14%, we get a seismic force of 125,000 in the east-west direction, and 162,000 lbs in the north south direction (with the 30% added force for non-orthogonal walls). This translates to a force of 900 plf N-S and 650 plf E-W. After pro-rating the wall for the perforations and using 1√f'c the allowable load on the walls is about 1,400 plf. This estimation is very rough due to the unusual shape of the building and the type of wall. A more detailed analysis will probably show that some walls will be overstressed in an earthquake.

Classrooms

The glu-lam beam and roof rafters for the classrooms generally meets the current Codes for vertical loads.

The class rooms also have wood diaphragms with concrete shear walls. The diaphragm connections that are currently required are not in place. These missing connections are critical. This includes the rafters to the concrete walls and the beams to the walls.

The classrooms have a plywood roof diaphragm.

The shear walls are similar to the Social Hall, but do not have the additional 3' of solid wall on top. The lateral capacity of these walls is questionable.

Findings and Recommendations

We have been asked to summarize our recommendations per the following :

Tier #1: Immediate fire/life/safety concerns that require immediate action or further investigation

Main Building

The lateral force resisting system is highly questionable.

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The ties from the roof to the walls and the beams to the walls are inadequate.

The capacity of the shear walls is questionable.

The lateral system could be reinforced by adding to the existing walls. The perforations cause problems with the insulation, so they need to be filled in anyway. The wall to roof connections could be reinforced at this time.

The uncertainty of the "ring beam" is a cause for concern. This beam works to support the roof. This could be upgraded as part of the wall repair.

The reinforcing of the columns may be inadequate. The design of concrete columns today uses more stirrups to contain the vertical steel during an earthquake.

The actual strength of the roof structure needs to be confirmed. Additional reinforcing could be added.

Classrooms

The lateral force resisting system is questionable. The ties from the roof to the walls and the beams to the walls is inadequate.

The capacity of the shear walls is questionable. There is much less demand on these walls so this is not as critical as the main building.

Tier #2: Recommended priorities for attention (repairs, replacements, further investigations, etc.) in the short-term period (within the next 5 year period) that will enhance existing facility use and/or longevity (being good stewards): This tier addresses the maintenance and remodel of the existing facility.

Main Building

The cantilever flat roof system should be replaced or reinforced. The beams are severely overstressed and the connection detail is inadequate. While this is not likely to fail and cause damage immediately, it is unsafe for workers on the roof. The roof could also be damaged by uplift from wind. One repair option is to add support beams for the 4x6 beams and to repair the damaged 2x4 rafters.

The roof diaphragm is questionable. Plywood should be added to the decking when the roof is removed for replacement.

Classrooms

Replace the roof posts that are exposed and dry rotted. Detail the new posts to avoid this condition by using flashing or steel posts.

Tier #3: Recommendations when considering the design of a substantive building addition.

A substantive addition should be kept structurally independent from the existing structure. This is true for both the Social Hall and for the classrooms.

Limitation

The conclusions and recommendations provided in this letter are based on the best information currently available, and on our experience in similar situations. If additional data is generated which indicates conditions different from those observed and described by this letter, our firm should be notified so that any necessary modifications may be made to our recommendations. This consultant does not imply or provide any or all material or product performance guarantee or warranty due to the typically encountered workmanship variance.

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