STRUCTURAL EVALUATION OF

MADERA ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
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By

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10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Madera Elementary School in El Cerrito, CA. The structural assessment includes a site walk through and a limited study of available architectural and structural drawings. The purpose of the structural assessment is to identify decay or weakening of existing structural materials (when visible), to identify seismic deficiencies based on our experience with school buildings, and to identify eminent structural life-safety hazards.

The school campus has had a walk-through site evaluation and a limited study of available architectural and structural drawings. The general structural condition of the buildings and any seismic deficiencies that are apparent during our site visit and review of existing drawings are documented in this report. This report includes a qualitative and quantitative evaluation of the buildings. A limited lateral (seismic) numerical analysis was performed to identify deficient lateral elements which could pose life safety hazards.

The site visits did not include any removal of finishes. Therefore, identification of structural conditions hidden by architectural finishes or existing grade was not performed.

10.2 Description of School

The school was built in 1955. The original building is a one-story wood and steel-framed structure with CMU wall infill on the exterior (see figure 2). There is one main building and four portable buildings all constructed in 1955 (see figure 1). The total square footage of the permanent structures is about 31,049 square feet. There is also a day care facility run by the City of El Cerrito on the campus that is outside the scope of this report.

10.3 Site Seismicity

The site is a soil classification S_C in accordance with the 1998 California Building Code (CBC) and as per the consultants, Jensen Van Lieden Associates, Inc.

The classroom wing of the main building has an educational occupancy (Group E, Division 1 and 2 building), and the multi-purpose wing of the main building has an assembly occupancy (Group A, Division 3). Both of these areas have an importance factor in the 1998 CBC of 1.15. The campus is located at a distance of less than 2 kilometers from the Hayward fault. The main building has a mixture of steel braced frames and plywood shear walls in both directions. Plywood shear walls and steel braced frames have response modification factors of R=5.5 and R=5.6 respectively. Therefore, a response modification factor of R=5.5 will be used. The 1998 CBC utilizes a code level earthquake, which approximates an earthquake with a 10% chance of exceedance in a 50-year period or an earthquake having a 475-year recurrence period.

The seismic design coefficient in the 1998 CBC is:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.40x1.5x1.15)W}{5.5} = 0.314W$$

The site seismicity is used to provide a benchmark basis for the visual identification of deficient elements in the lateral force resisting systems of campus buildings. The calculated base shear was used to perform a limited lateral analysis of the school buildings as described in section 10.7.

10.4 List of Documents

1. Madera Elementary School; John Carl Warnecke, Architect; sheets 1-14; Hall, Pregnoff, & Matheu, Structural Engineers, sheets S1-S8; August 15, 1955.
2. "Measure M" – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
3. "Geological Hazard Study – Recently constructed portable buildings – 24 school sites for Richmond Unified School District," by Jensen-Van Lienden Associates, Inc. dated March 7, 1990.
4. "Measure M" roofing report by "The Garland Company Inc.", Orinda, California.

10.5 Site Visit

DASSE visited the site on November 8th, 2001 and March 7th, 2002. The main purpose of the site visits was to evaluate the physical condition of the structure and in particular focus on the lateral force resisting elements of the building. Following items were evaluated during the site visit:

1. Type and Material of Construction
2. Type of Sheathing at Roof, Floor, and Walls
3. Type of Finishes
4. Type of Roof
5. Covered Walkways
6. Presence of Clerestory Windows
7. Presence of Window Walls or High Windows in exterior and interior walls
8. Visible cracks in superstructure, slab on grade and foundation

The main building is L-shaped, consisting of a long classroom wing (see figures 2-4) and a multi-purpose wing (see figures 8-12). The north and south faces of the classroom wing have multiple large window openings above CMU block infill. There are steel braced frames spaced along the length of the interior corridor, the tie rods of which are visible through the high windows along the corridor (see figure 5). There is a large opening in the roof diaphragm for skylights above the corridor and classrooms (see figures 4 and 6). Diagonal tie rods have been used to transfer diaphragm forces across this opening (see figure 7). The multi-purpose wing also has large high window openings along the east, west, and south faces. There is brick veneer and wood paneling on the north wall (see figure 8). The roof of the multi-purpose room is higher than that of the classroom wing. There is built-up roofing with gravel on the roof of the entire building.

10.6 Review of Existing Drawings

The classroom wing roof has a blocked plywood diaphragm over 2x12 joists. These joists span 16' between steel beams that span about 30' in the transverse direction between steel columns. The columns along the corridor are 5" wide-flange sections and the exterior columns are exposed 4" dia. pipe. There are 7/8" dia. tie rods in every other bay to brace the roof diaphragm where the skylight occurs (see figure 7). In the longitudinal direction (east-west), there are 6 braced frames at each side of the central corridor (see figure 5). These braced frames use 7/8" dia. tie rods with standard turnbuckles and #2½ clevises at connections. In the transverse direction, there are plywood-sheathed shear walls between classrooms. These shear walls do not align with the steel gravity framing in the roof above. The exterior longitudinal walls are 8" CMU cantilevered non-bearing walls with #4@16" o.c. vertical reinforcement and 2-#4@24" o.c. horizontal reinforcement. There are windows in the space between the top of the wall and the bottom of the roof structure.

The multi-purpose room roof has a blocked plywood diaphragm over 2x12 joists spanning between steel wide-flange beams. These beams span 50' over the main auditorium space and 18' over the bathroom and kitchen areas to steel wide-flange columns. There is a steel frame with two 8WF24 braces inside the interior wall between the main auditorium space and the bathrooms that supports the entire area laterally in the north-south direction. At the east and west walls, there is 8" CMU block infill between the columns with windows above. Therefore, the roof diaphragm cantilevers laterally off of the central frame. At the top edge of the CMU wall, there is a 10" channel that spans between columns to carry the wall out-of-plane load out to the columns. In the east-west direction, lateral loads are resisted by plywood shear walls with brick veneer and wood paneling.

The area of the building where the classroom and multi-purpose wings meet houses the administrative area. The roof framing and slope is similar to the classroom wing but in the perpendicular direction. In this area, there are multiple plywood shear walls providing lateral support. In the north-south direction, there are shear walls along the main interior corridor, whereas in the east-west direction the walls do not appear to line up with each other in an organized manner. At the location where the roof framing and slope changes orientation, there is California framing to join the roof together. There does not appear to be a positive drag connection between this area and the classroom wing.

The roof of the main building has built-up roofing and is about 14 years old. The entire building is supported on 12" deep x 14" wide typical strip footings under the walls and spread footings under steel columns. The spread footings are typically 12" deep and vary in size from 2'-6" to 4'-0" square.

10.7 Basis of Evaluation

The document FEMA 310, Federal Emergency Management Agency, *"Handbook for the Seismic Evaluation of Buildings – A Prestandard,"* 1998, is the basis of our qualitative seismic evaluation methods. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify the potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

The California Building Code (CBC 1998) is the basis of our quantitative seismic evaluation methods. Base shears identified in section 10.3 were used to perform a limited lateral seismic analysis of the school buildings. The scope of the analysis was not to validate every member and detail, but to focus on those elements of the structure determined to be critical and which could pose life safety hazards. Member *strength* values are based on the document FEMA 356, Federal Emergency Management Agency, *"Prestandard and Commentary for the Seismic Rehabilitation of Buildings"* 2000.

10.8 List of Deficiencies

Building deficiencies listed below have corresponding recommendations identified and listed in Section 10.9, which follow the same order as the itemized list of deficiencies identified below. The severity of the deficiency is identified by a "structural deficiency hazard priority" system based on a scale between 1.0 and 3.9, which is described in Section 10.11. These priority ratings are listed in section 10.9. Priority ratings between 1.0 to 1.9 could be the causes for building collapses, partial building collapses, or life-safety hazards, if the corresponding buildings are subjected to major earthquake ground motions, which are possible at these sites. It is strongly recommended that these life safety hazards are mitigated by implementing the recommendations listed below.

Item	Building Structural Deficiencies
1.	The tie rods in the classroom wing roof at the skylights only carry tension forces and are overstressed.
2.	The tie-rods at the classroom wing corridor frames only carry tension forces and are overstressed.
3.	The roof diaphragm chords at the multi-purpose room are overstressed because the diaphragm is cantilevered laterally off of the central frame.
4.	The connection of the roof diaphragm to the steel braced frame at the multi-purpose room is overstressed.
5.	The east-west shear walls at the administration area are not aligned with each other and no collector elements are present.
6.	There is a lack of building continuity between the classroom wing and administration area of the building. Because there are no collectors, these portions of the building may separate and cause a partial collapse.
7.	The overhang soffit appears to have some deterioration of wood.
8.	The exterior pipe columns appear to have some rust.

10.9 Recommendations

Items listed below follow the same order as the itemized list of deficiencies identified in section 10.8 above.

Item	Recommended Remediation	Priority	Figure Number
1.	Replace tie rods with new double-angle bracing.	1.2	7
2.	Provide double-sided full-height plywood shear walls, infilling the high windows at these locations. Strengthen collectors and add new holdowns as required.	1.2	5
3.	Infill windows at the east wall of the multi-purpose wing with new plywood-sheathed shear wall. Strengthen collectors and add new holdowns as required.	1.3	8
4.	By adding new shear wall in item number 3 above, this deficiency will also be remedied.	1.6	N/A
5.	Provide new blocking and straps at the roof.	1.8	N/A
6.	Provide new collector elements to tie these portions of the building together	1.0	10
7.	Replace the damaged wood and paint to protect it from weather.	3.0	14
8.	Repaint column to protect it from corrosion.	3.0	13

10.10 Portable Units

In past earthquakes, the predominant damage displayed by portable buildings has been associated with the buildings moving off of their foundations and suffering damage as a result. The portables observed during our site visits tend to have the floor levels close to the ground, thus the damage resulting from buildings coming off of their foundation is expected to be minimal. The life safety risk of occupants would be posed from the potential of falling 3 feet to the existing grade levels during strong earthquake ground shaking. Falling hazards from tall cabinets or bookshelves could pose a greater life safety hazard than building movement. The foundation piers supporting the portable buildings tend to be short; thus the damage due to the supports punching up through the floor if the portable were to come off of its foundation is not expected to be excessive.

Because of their light frame wood construction and the fact that they were constructed to be transported, the portable classrooms are not in general expected to be life safety collapse hazards. In some cases the portables rest directly on the ground and though not anchored to the ground or a foundation system could only slide a small amount. In these instances the building could slide horizontally, but we do not expect excessive damage or life safety hazards posed by structural collapse of roofs.

The regulatory status of portables is not always clear given that portables constructed prior to 1982 will likely have not been reviewed by DSA and thus will likely not comply with the state regulations for school buildings. Portables constructed after about 1982 should have been permitted by DSA. The permits are either issued as temporary structures to be used for not more than 24 months or as permanent structures.

10.11 Structural Deficiency Prioritization

This report hazard rating system is based on a scale of 1.0 to 3.9 with 1.0 being the most severe and 3.9 being the least severe. Based on FEMA 310 requirements, building elements have been prioritized with a low rating of 1.0 to 1.9 if the elements of the building's seismic force resisting systems are woefully inadequate. Priority 1.0 to 1.9 elements could be the causes for building collapses, partial building collapses, or life-safety falling hazards if the buildings were subjected to major earthquake ground motion.

If elements of the building's seismic force resisting system seem to be inadequate based on visual observations, FEMA 310 requirements and limited lateral (seismic) calculations, but DASSE believes that these element deficiencies will not cause life-safety hazards, these building elements have been prioritized between a rating low of 2.0 to 3.9. These elements could experience and / or cause severe building damage if the buildings were subjected to major earthquake ground motion. The degree of structural damage experienced by buildings could cause them not to be fit for occupancy following a major seismic event or even not repairable.

The following criteria was used for establishing campus-phasing priority:

First, the individual element deficiencies which were identified during site visit and review of existing drawings were prioritized with a rating between 1.0 to 3.9 and as described in this section.

The next step was to arrive at a structural deficiency rating between 1 and 10, with a rating of 1 representing a school campus in which the building's seismic force resisting systems are woefully inadequate.

Based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase I represents a school campus with severe seismic deficiencies, Phase II represents a school campus with significant seismic deficiencies and Phase III represents a school campus with fewer seismic deficiencies.

10.12 Conclusions

1. Given the vintage of the building(s), some elements of the construction will not meet the provisions of the current building code. However, in our opinion, based on the qualitative and limited quantitative evaluations, the building(s) will not pose serious life safety hazards if the seismic deficiencies identified in section 10.8 are corrected in accordance with the recommendations presented in section 10.9.

2. Any proposed expansion and renovation of the buildings should include the recommended seismic strengthening presented in section 10.9. Expansion and renovation schemes that include removal of any portion of the lateral force resisting system will require additional seismic strengthening at those locations. It is reasonable to assume that where new construction connects to the existing building(s), local seismic strengthening work in addition to that described above will be required. All new construction should be supported on new footings.

3. Overall, this school campus has a seismic priority of 1 and we recommend that seismic retrofit work be performed in Phase I.

10.13 Limitations and Disclaimer

This report includes a qualitative (visual) evaluation and a limited quantitative seismic evaluation of each school building. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report. Elements of the structure determined to be critical and which could pose life safety hazards are identified and documented during limited quantitative seismic evaluation of the buildings.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this limited evaluation. Our services have consisted of providing professional opinions, conclusions, and recommendations based on generally accepted structural engineering principles and practices.

DASSE's review of portable buildings has been limited to identifying clearly visible seismic deficiencies observed during our site visit and these have been documented in the report. Portable buildings pose several issues with regard to assessing their life safety hazards. First, drawings are often not available and when they are, it is not easy to associate specific drawings with specific portable buildings. Second, portable buildings are small one story wood or metal frame buildings and have demonstrated fairly safe performance in past earthquakes. Third, there is a likelihood that portable buildings (especially those constructed prior to 1982) are not in compliance with state regulations, either because they were not permitted or because the permit was for temporary occupancy and has expired.