STRUCTURAL EVALUATION OF

SHELDON 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 Lincoln Elementary School in El Sobrante, 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 evaluation and, therefore, numerical seismic analysis of buildings is not included.

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 1951, 1955, and 1958. The buildings are one-story wood structures. There are eight main buildings (permanent structures) and twelve portable buildings of unknown age (see figure 1). The total square footage of the permanent structures is about 23,000 square feet.

10.3 Site Seismicity

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

The main classroom building has an educational occupancy (Group E, Division 1 and 2 buildings) and the multi-purpose building has an assembly occupancy (Group A, Division 3), both of which have an importance factor in the 1998 CBC of 1.15. The campus is located at a distance of about 2.6 kilometers from the Hayward fault. The buildings built in 1951 (classrooms #2 - #8, multi-purpose and administration) have diagonally sheathed shear walls, which have a response modification factor R=4.5. The other classroom buildings and the addition to the multi-purpose building (east end) have plywood shear walls, which have a response modification factor R=5.5. 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.44x1.15)W}{4.5} = 0.405W \text{ for diagonally sheathed shear walls}$$

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.44x1.15)W}{5.5} = 0.331W \text{ for plywood shear walls}$$

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.

10.4 List of Documents

Available drawings for review include:

1. Sheldon Elementary School #2; Jack Buchter, Architect; sheets 3-6 plus 3 sheets whose numbers are illegible (architectural only); December 6, 1951
2. Additions to the Sheldon Elementary School; John Hudapette (name partially illegible), Architect; sheets 1-12; George Jennings, Structural Engineer; sheets S1-S5; April 25, 1955
3. Second Additions to the Sheldon Elementary School; architect name illegible; sheets 4-6, B, and 2 additional sheets whose numbers are illegible (architectural only); undated (possibly 1958).
4. Sheldon Elementary School Reconstruction; Gerson/Overstreet Architects, sheets A1-A13 (A2 missing); December 30, 1993
5. “Measure M” – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
6. “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.
7. “Measure M” roofing report by “the Garland Company Inc.”, Orinda, California.

10.5 Site Visit

DASSE visited the site on November 7th, 2001 and March 8th, 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, 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

Although many of the classrooms are connected to each other, there are eight separate buildings on the campus (see figure 1). The division of buildings is as follows:

1. Kindergarten Classroom # 1

2. Classroom #2 and Administration (this is an L-shaped building)
3. Classrooms #3 through #5
4. Computer Lab and Classrooms #7 and #8
5. Library and Classrooms #10 and #11
6. Multi-Purpose Building
7. Classrooms #12 through #15
8. Classrooms #16 through #18

There are existing seismic joints in the between buildings 1 and 2, 5 and 6 (see figure 9), 7 and 8, and at the covered walkway separating buildings 7 and 8 from the rest of the buildings (see figure 13). There are covered walkways that connect building 2 to buildings 3, 4, and 5. These covered walkways do not have their own independent gravity systems and are supported by the aforementioned buildings connected buildings (see figures 7 and 8).

The classroom buildings are all of similar construction. There are high windows along most of the length of the back face of the buildings (see figures 10 and 12). On the front face of the buildings, there is a covered walkway with clerestory windows above (see figure 11). Consequently, the longitudinal walls lack adequate length of shear wall. The roof slopes down from the clerestory windows toward the back of the buildings. The classroom buildings have a stucco finish on their front and back walls, as well as on the side facing the administration building. At the west end of the buildings, there is wood panel siding. The covered walkways near classrooms #1 through #8 have exposed diagonal sheathing, whereas the covered walkways at the main entrance and other classrooms have a cement plaster soffit. Some of the classrooms have acoustical tile ceilings and others have suspended T-bar ceilings. There is some deterioration of the wood at the exterior of the building near classroom number 15 (see figure 14). The administration building has a low flat roof and multiple window openings facing the front of the school. The rear wall of the administration building, adjacent to the corridor, has long segments of shear wall. The multi-purpose building has a large open cafeteria space with and acoustic tile ceiling and high windows that run along about one half of the length of the building (see figures 2 and 4). Because the windows are all grouped together, there appears to be adequate shear wall but collector forces will be high. At the north side of the cafeteria space, there is a low area with some classrooms and service areas. This area has a large number of window and door openings at the exterior (see figure 3).

10.6 Review of Existing Drawings

The existing buildings were built in three phases. The original 1951 construction included buildings 2, 3, 4 (see descriptions above) and the main portion of the multi-purpose building (building 5). In 1955, buildings 6 and 8 were added. Finally, in 1958, buildings 1 and 8 were constructed and the northeastern low roof area of the multi-purpose building was added.

Only limited architectural drawings of the 1951 construction were available for review. The 1951 buildings are all wood framed buildings with diagonally sheathed roofs and walls. At the classrooms, the roof structure spans 30’ between the longitudinal stud walls that are supported on continuous strip footings. At the south side of the classroom buildings, there is a covered walkway below the clerestory windows that is connected to the other buildings. This walkway roof is at the same height as the roof of the Administration wing of building 2 and the restrooms at the west end of building 4. The cafeteria area of the multi-purpose building is framed with trusses spaced at 4' o.c. spanning the 40' wide high roof area. The kitchen and storage areas are in a low roof section of the building. All of the multi-purpose building bearing walls rest on continuous strip footings.

Buildings 1, 6, and 8 were built in 1955. There are seismic joints between these buildings and the others on the campus. The roofs at classrooms all are framed with blocked plywood sheathing over 2x3 stripping at 16" o.c. spanning 4' between open web steel joists. These joists span 32' between the exterior longitudinal stud walls. The walls are typically supported on 12" wide x 18" deep concrete strip footings. There originally was a strip of skylights near the north wall over each of the classrooms, but the diaphragm does not appear to be reinforced around these large openings nor is there any additional bracing provided to transfer shear across this opening. As these skylights do not appear on the architectural drawings for the 1988 reconstruction of the campus and were not noted during the site visit, it is to be assumed that they have been infilled as part of some previous undocumented work. The manner in which the roof infill is connected to the diaphragm, and the associate capacity to transfer seismic loads, is unknown. At the east end of buildings 6 and 8, there is a low roof area over the bathrooms and mechanical areas. This roof is at the same height at the covered walkway on the south side of the classrooms, and is conventionally framed with 2x joists at 16" o.c. spanning between stud walls.

A second addition, built in about 1958, includes building 7 and an enlargement of the multi-purpose building. Only limited architectural drawings of the 1955 construction were available for review. The construction of building 7 is similar to that of building 8, and is shown as a "future classroom" in the 1955 construction documents. Building 7 is seismically isolated from Building 8. The addition to the multi-purpose room entails an enlargement of the main cafeteria area, and the addition of low roof areas on the north side of the cafeteria. These additions appear to be framed similar to the previously constructed portions of the multi-purpose building and appear to be tied integrally into the older portion of the structure.

The existing roofing is about 22 years old and appears to need to be replaced.

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 seismic evaluation methods, although no numerical structural analyses were performed. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

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 classroom buildings have high windows or other large openings along the back longitudinal wall and clerestory windows along the front longitudinal wall. There is a lack of shear wall at these areas.
2.	The infill of the original classroom skylights is undocumented and may not be properly connected to the roof framing to provide adequate shear transfer
3.	The covered walkways are attached to multiple buildings. They may lose gravity support and collapse as the buildings move independently of each other.
4.	The covered walkway from the multi-purpose building to near classroom number 5 lacks adequate lateral bracing.
5.	There is an existing seismic joint at the covered walkway from the multi-purpose building to near classroom number 5. The electrical conduit crossing the existing seismic joint may be damaged and fall as the buildings move.
6.	At the intersection of the administration wing and classroom number 2, there is a change in roof height. There is a lack of continuity in the collectors at this location. This is further compounded by the presence of the re-entrant corner at this location.
7.	At the classroom buildings, there is a change in roof height where the bathrooms are located. There is a lack of continuity in the collectors at these locations.
8.	There are continuous high windows near the west end of the exterior longitudinal walls of the multi-purpose building. The shear wall and collectors may be overstressed at these locations.
9.	The shear walls at the north side of the multi-purpose building may be overstressed.
10.	There is a change in roof height between the kitchen and room number 43 of the multi-purpose building. There is a lack of continuity in the collectors at this location.
11.	The diagonally sheathed roof diaphragm at the multi-purpose building may be overstressed
12.	There is a lack of shear wall at some of the portable classroom units.
13.	There is some deterioration of the wood in the exterior wall near classroom number 15.

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.	Infill some existing windows with new plywood and framing. Strengthen existing collectors and add new holdowns as required.	1.2	5, 10, 11, 12
2.	Verify presence of adequate nailing at original skylight locations and re-nail diaphragm if required	1.2	N/A
3.	Provide new seismic joints. Add new beams, columns, footings, and lateral bracing at covered walkway. Provide flexible connections in conduit at seismic joints.	1.4	7, 8
4.	Provide lateral bracing of covered walkway	1.9	13
5.	Provide a flexible conduit connection at the seismic joint	2.5	13
6.	Provide new blocking and metal straps from the low roof to the wall.	1.9	5
7.	Provide new blocking and metal straps from the low roof to the wall.	1.9	9, 10, 12
8.	Infill some existing windows with new plywood and framing. Strengthen existing collectors and add new holdowns as required.	1.9	2, 3
9.	Infill some existing windows with new plywood and framing. Strengthen existing collectors and add new holdowns as required.	1.8	3
10.	Provide new blocking and metal straps from the low roof to the wall.	1.9	3
11.	Add new plywood sheathing above the existing diagonally sheathed diaphragm	1.7	N/A
12.	Provide additional length of shear wall. Strengthen existing collectors and add new holdowns as required.	1.9	N/A
13.	Remove and replace damaged wood. Repair stucco finish.	1.9	14

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 and based on FEMA 310 requirements, 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 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 building 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, 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 2 and we recommend that seismic retrofit work be performed in Phase I.

10.13 Limitations and Disclaimer

This report includes a qualitative (visual) level of evaluation of each school building. Numerical seismic analyses of buildings are not included in this scope of work. The identification of structural element code deficiencies based on gravity and seismic analysis demand to capacity evaluations are therefore not included. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this 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.

Figures

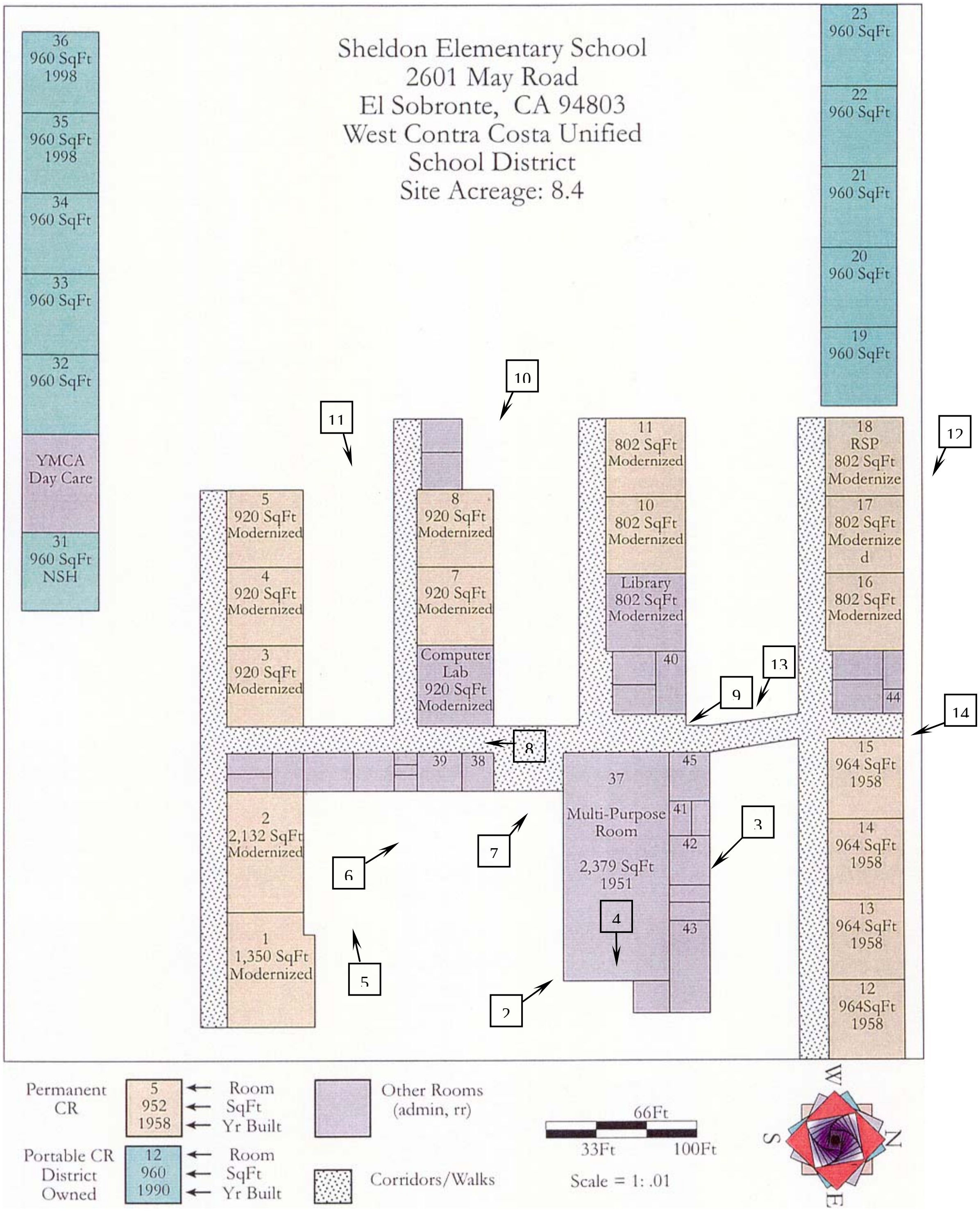

Figure 1: School Layout Plan

Figure 2: Multi-Purpose Building

Figure 3: North Face of Multi-Purpose Building

Figure 4: Interior of Multi-Purpose Building

Figure 5: Classrooms #1 and #2 and Administration

Figure 6: East Face of Administration Building

Figure 7: Main Entrance, between Administration and Multi-Purpose Buildings

Figure 8: Covered Corridor on West Side of Administration Building

Figure 9: Bathrooms East of Library; Seismic Joint between Classrooms and Corridor

Figure 10: North Face of Classrooms #7 and #8 (Typical Classrooms)

Figure 11: South Face of Classrooms #7 and #8 (Typical Classrooms)

Figure 12: North Face of Classrooms #12 through #18

Figure 13: Covered Walkway between Multi-Purpose Building and Classroom #15

Figure 14: Deterioration of Wood near Classroom Number 15