STRUCTURAL EVALUATION OF

HIGHLAND 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 Highland Elementary School in Richmond, 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 is located in the city of Richmond, and the date of the original campus construction is 1958. The main classroom building is a single story wood-framed structure and is the largest building on campus. A second classroom building of the same construction is located adjacent to the main building. Dating back to 1959, the final permanent structure on the campus is the single story multipurpose building, which is also wood-framed. Besides these permanent structures, the campus includes 16 portable buildings (see figure 1). Of the portable structures there is six 1965 units, three 1990 units, two 1995 units, and five 1997 units. The total square footage of the permanent structures is about 29,647square feet.

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 buildings have an educational occupancy (Group E, Division 1 and 2) and the multi-purpose building has an assembly occupancy (Group A, Division 2 or 2.1), both of which 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. Where drawings are available, the wood-framed buildings described above utilize plywood shear walls to resist lateral loads. The response modification factor for this system is as follows: 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:

$$V = \frac{2.5C_a IW}{R} = \frac{2.5(0.40x1.50x1.15)W}{5.5} = 0.314W$$

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.

10.4 List of Documents

1. Multipurpose Building: Schachtman & Velikonia, Sheets A2 - A11, May 25, 1959; W.B. Clausen Structural Engineers, Sheets S1 - S5, May 25, 1959.
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 8th, 2002. The main purpose of the site visit was to evaluate the physical condition of the structure and in particular focus on the lateral force resisting elements of the building. The 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 classroom building (see figures 6, 7, and 8) and the adjacent classroom building (see figures 11) share many similarities in appearance and construction. Both of these buildings are single story with exterior stucco finishes. On the interior, the corridor ceilings are acoustical tile, while the classrooms have a suspended T-bar ceilings. A few skylights were also observed in the corridors of these classroom buildings. The main classroom building uses a hybrid steel/wood framing system that is evident by the transverse steel beams that are visible at the roof eaves. At the other classroom building these transverse beams are wood beams. The outside classroom walls are window walls whose length of solid wall appears to be inadequate to resist the seismic shear forces. This condition also occurs at the high windows found at the administration wing of the main classroom building. This inadequacy of shear strength represents a life safety concern. The multipurpose building is another single story, wood-framed building (see figures 3, 4, and 5). At the multipurpose building glue-laminated beams are used to span across the transverse width of the building. These glue-lam beams are spaced at 8'-0" on center and are supported by wood posts. The beam-to-post connections are minimal and, consequently, vulnerable to coming apart when subject to displacements induced by a seismic event. Due to the magnitude of load carried by these beams, the questionable integrity of these connections constitutes a life safety hazard. Covered walkways throughout the campus are constructed with very substantial steel frames that will resist lateral loading (see figures 9 and 10). However, these walkway structures are supported by multiple buildings giving them the potential to pull apart if the buildings experience opposing displacements during a seismic event. Additionally, electrical conduit mounted to some of the covered walkways passes into adjacent buildings, without compensation for the potential differential displacements. These two conditions also represent life safety hazards. At the portable buildings, hard conduits were observed to be passing from structure to structure, posing a life safety hazard similar to that observed at the covered walkway.

10.6 Review of Existing Drawings

Construction drawings for the main classroom building are not available for review at this time. The existing roof of the main classroom building, is about 14 years old and appears to need replacement.

The rectangular multipurpose building is wood framed, single story building with a large, open interior. The long span roof is framed with 7”x17-7/8” glue-laminated beams spanning 45’-0”. Between these beams, which are spaced at 8’-0” on center, 2” T&G decking overlaid with 3/8’ plywood completes the roof framing. The main roof beams are supported at the longitudinal walls by 7”x6-1/2” glue-laminated posts that are framed in the typical 2x6 stud walls. Lateral forces are resisted in the multipurpose building by 1/2” plywood shear walls of which there are significant lengths at each of the exterior walls. Like these walls, the chord/collector elements are also well detailed. The double 2x6 top plates and their bolted splices have substantial strength for resisting the prescribed forces. The building’s foundation is composed of typical 1’-0” strip footings at the walls and 3’-0” square spread footings at the post locations. The plywood shear walls are tied to this foundation with a significant positive tie-down connection. The existing roof of the multipurpose building is about 2 years old and appears to be in acceptable condition.

Construction drawings for the classroom building are not available for review at this time. The existing roof of the classroom building, is about 14 years old and appears to need replacement

Construction drawings for the original covered walkways are not available for review at this time. With the 1959 addition of the multipurpose building to the campus, additional covered walkways were constructed, which appear to be of a very similar construction as the originals. These walkway structures are composed of a series of steel moment frames constructed out of 6” wide flange beams and columns. The columns are supported on 6’-0” deep pier foundations. The existing roofs at the covered walkways are about 2 years old and appear to be in acceptable condition.

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.	Main Classroom Building: Wood shear walls at the classroom window walls are likely to be inadequate to resist prescribed forces. Wood shear walls at the high windows of the administration wing are likely to be inadequate to resist prescribed forces.
2.	Classroom Building: Wood shear walls at the classroom window walls are likely to be inadequate to resist prescribed forces.
3.	Multipurpose Building: Beam-to-post connection is likely to be vulnerable to failure when subjected to seismic displacements.
4.	Covered Walkway: Structure is tied to multiple adjacent buildings with no provision to accommodate differential displacements.
5.	Covered Walkway/Portable Buildings: Electrical conduit passing into adjacent buildings with no provision to accommodate differential displacements.

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.	Remove some windows and replace with new stud framing and plywood sheathing. Provide new holddown anchors and collectors as required.	1.1	6, 7, 8
2.	Remove some windows and replace with new stud framing and plywood sheathing. Provide new holddown anchors and	1.1	11

	collectors as required		
3.	Provide new beam-to-post connection.	1.3	5
4.	Provide new beams and columns in the covered walkway near its connection to adjacent buildings.	1.9	N/A
5.	Provide new flexible conduit with deformation capacity.	1.9	10

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 4 and we recommend that seismic retrofit work be performed in Phase II.

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

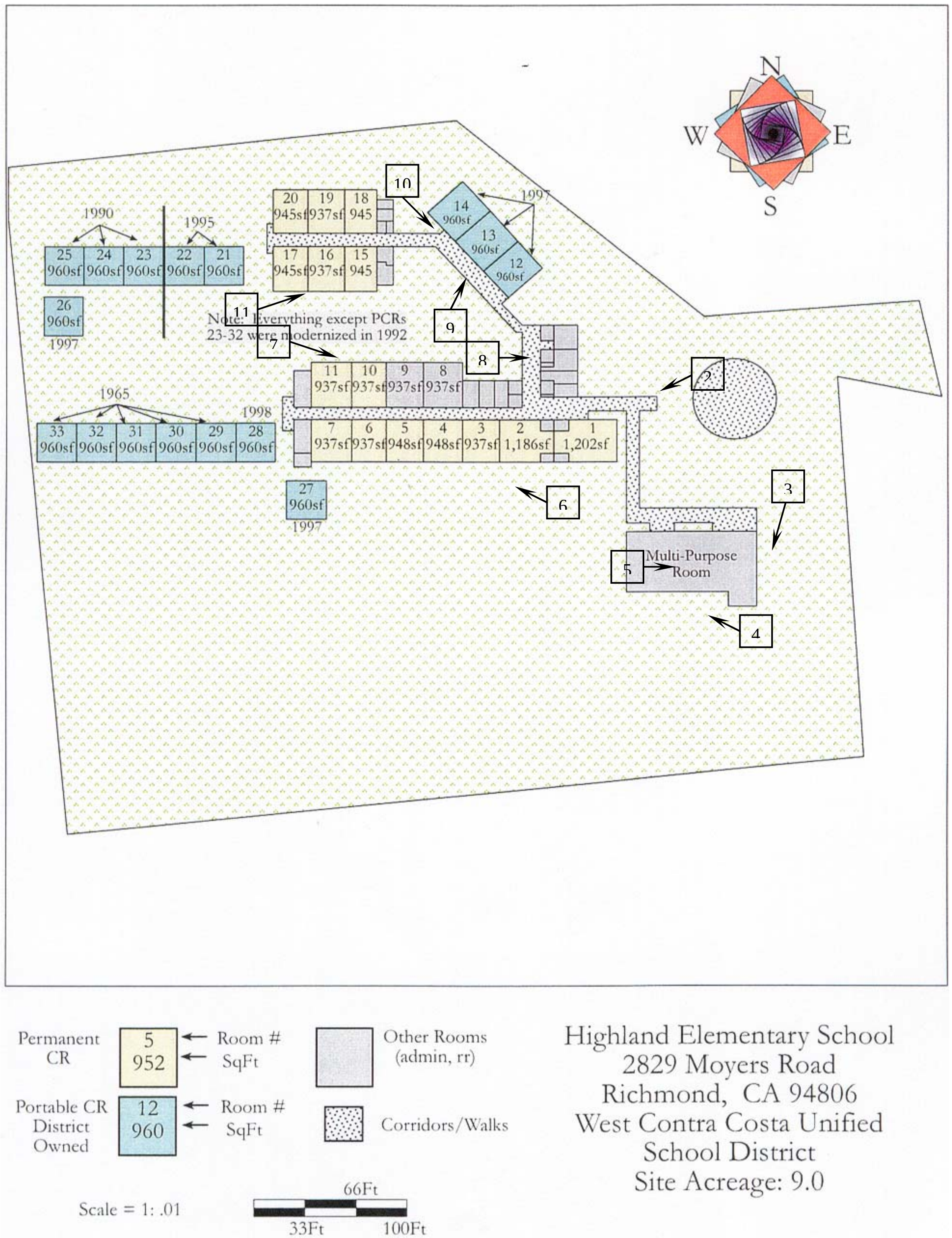

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: Multipurpose Building, east face

Figure 4: Multipurpose Building, south face

Figure 5: Multipurpose Building, interior

Figure 6: Main Classroom Building, south face

Figure 7: Main Classroom Building, north face

Figure 8: Main Classroom Building, north wing

Figure 9: Covered Walkway, outside

Figure 10: Covered Walkway, inside

Figure 11: Classroom Building, south face