STRUCTURAL EVALUATION OF

STEWART ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
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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 Stewart Elementary School in Pinole, 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 constructed from 1963-1966. The original Classroom Buildings are one-story wood framed buildings comprising of two Main Classroom Buildings, and an Administration Building. An addition made shortly after the original construction includes a Kindergarten Building and a Multi-purpose Building with a kitchen (see Figures 1-6). Additionally, two sets of portable buildings are on site, one set of three portables used as an after school “Y-care” facility (to the east) and another set of seven portables (behind the school to the south) used as additional classrooms and a computer lab. The total square footage of the permanent structures are approximately 32,767 square 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 main classroom buildings have 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 4.8 kilometers from the Hayward fault. The classroom buildings and the multi-purpose building are wood framed buildings with plywood walls, and have response modification factors, 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.40x1.22x1.15)W}{5.5} = 0.255W$$

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. Elizabeth Stewart Elementary School, dated October 12, 1960, by Jack Buchter and Associates, Architect, Sheets 1-6, and Smith and Moorehead, Structural Engineers, Sheets S1-S6.
2. First Addition, Elizabeth Stewart Elementary School, dated January 29, 1965, by Jack Buchter and Associates, Architect, Sheets 1-4, and Eric O. Moorehead, Structural Engineer, Sheets S1-S7.
3. “Measure M” – WCCUSD Elementary School – UBC revised parameters by Jensen-Van Lienden Associates, Inc., Berkeley, California.
4. “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.
5. “Measure M” roofing report by “The Garland Company Inc.”, Orinda, California.

10.5 Site Visit

DASSE visited the site on October 22nd, 2001. 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. 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 buildings are one-story wood framed buildings with very slightly sloping roofs (see figures 2 and 4). The buildings are built as long classroom buildings with a central corridor and with window walls to the exterior. During the site visit, access into a ceiling space above a corridor revealed that the corridor walls and roof employed plywood sheathing and the corridor walls framed directly up to the roof framing.

These buildings had very pungent smells and discussions of mold infestation were being investigated. Discussions suggested that roof leaks may have been the cause of problems. Thus, roof leaks and the absence of the ability for wood framing to dry out may lead to possible decay of existing wood construction in the roofs and in the walls.

Information from the Garland Report indicates that the roofing at classrooms are 6-9 years old and that re-roofing is not yet required. At the Multi-purpose Building, Kindergarten and Covered Walkway, the roofs are 22 years old and required re-roofing.

10.6 Review of Existing Drawings

The Main Classroom Buildings have plywood sheathing on the exterior walls, as well as on classroom cross-walls and corridor walls, which frame completely from floor to roof. Roofs have a slight slope (1 ½ : 12) and have plywood sheathed diaphragms. The roofs have six foot exterior overhangs allowing passage under cover of roof outside the perimeters of the buildings. The Main Classroom Buildings have central corridors and classroom cross-walls. The exteriors of the buildings have window walls allowing light into classrooms. A closed in covered walkway passes between two Classroom Buildings and the Administration wing.

The foundations of these buildings are spread footings with a slab-on-grade ground floor. Aline of steel beams is located at mid-classroom and spans down the middle of the classrooms in the longitudinal directions. These steel beams are supported on pipe columns located in classroom partition walls and thus lessen the span of 2x10 roof joists at 24 inch spacings. Plywood sheathing of ½ inch thickness is utilized as the roofing deck and as the roof diaphragm. Exterior walls and corridor walls have 3/8 inch plywood sheathing on studs for shear resistance. Perimeter walls have 6 inch concrete cantilever walls extending up 2’-6” to the bottom of windows with wood studs spanning from the top of the cantilever concrete walls to the roof at solid portions of the window walls.

The Multi-purpose Building and a Kindergarten were an addition in 1965. The Multi-purpose Building is a tall wood framed building with large glued laminated pitched/curved girders in the roof supporting 2x10 roof joists at 24 inch spacings. The roof is sloped at 1 ½ / 12. Walls are wood stud walls and a portion over the kitchen has a lower sloped roof. The Kindergarten includes two classrooms and is framed similarly to the Main Classroom Buildings. Both of these buildings employ ½ inch plywood sheathing at the roof and 3/8 inch plywood sheathing on walls used for shear walls.

The foundations of the Multi-purpose Building and Kindergarten spread footings with a slab-on-grade ground floor. Wood stud walls support the roof construction at the Kindergaren and large portions of the Multi-purpose Building. Additionally, wood glued laminated posts support glued laminated girders at the Multi-purpose Building. Plywood sheathing of ½ inch thickness is utilized as the roofing deck and as the roof diaphragms. Exterior walls and corridor walls have 3/8 inch plywood sheathing on studs for shear resistance. All walls are bolted to the foundations.

Covered walkways are framed from the multi purpose room to the main classroom buildings, however, do not contact the Kindergarten Building. The Covered Walkways utilize 3 inch pipe columns supported on square footings with slab-on-grade to tie individual footings together. The roof framing employs longitudinal 6x8 beams with transverse spanning 2x8 roof joists on 24 inch centers. The Covered Walkway roof sheathing is ½ inch plywood. The pipe column attachment to the longitudinal girders is a flat plate with two lag bolts, and to the footings is a base plate with 4 anchor bolts. The absence of a cantilevered column lateral force resisting system or a roof level moment frame system indicates that this covered walkway is vulnerable to seismic load resistance and is a falling hazard if it were subjected to strong earthquake ground shaking.

The detailing and design of these buildings appears to be quite good with complete seismic detailing and continuity representative of current day requirements. The overall base shear design employed in the early 1960's is lower than current standards, however, all other requirements for current code seismic design were considered in the structural design of this school. The only element not given this same consideration seems to be the covered walkway.

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 covered walkways employ pipe columns without cantilever moment connections at the foundation level or moment connections at the roof level. The lateral stability of the covered walkway between the Multi-purpose Building and the Main Classroom Building is not adequate and poses a falling hazard if it were subjected to large seismic ground motions.

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.	Recommend adding steel frames to provide increased lateral stability for covered walkway.	1.9	6

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 buildings, some elements of the construction will not meet the provisions of the current building code. The main buildings have employed an adequate design in the construction drawings using very similar construction techniques required of buildings in current building codes. Based on the qualitative evaluations, the buildings do not pose serious life safety hazards, however, the covered walkways between the main classroom buildings and the multi purpose room do pose a lie safety falling hazard. We recommend that the covered walkway seismic deficiencies identified in section 10.8 are corrected in accordance with the recommendations presented in section 10.9 to assure that the covered walkways do not continue to pose life safety falling hazards.

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 8 and we recommend that seismic retrofit work be performed in Phase III.

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.

Figures

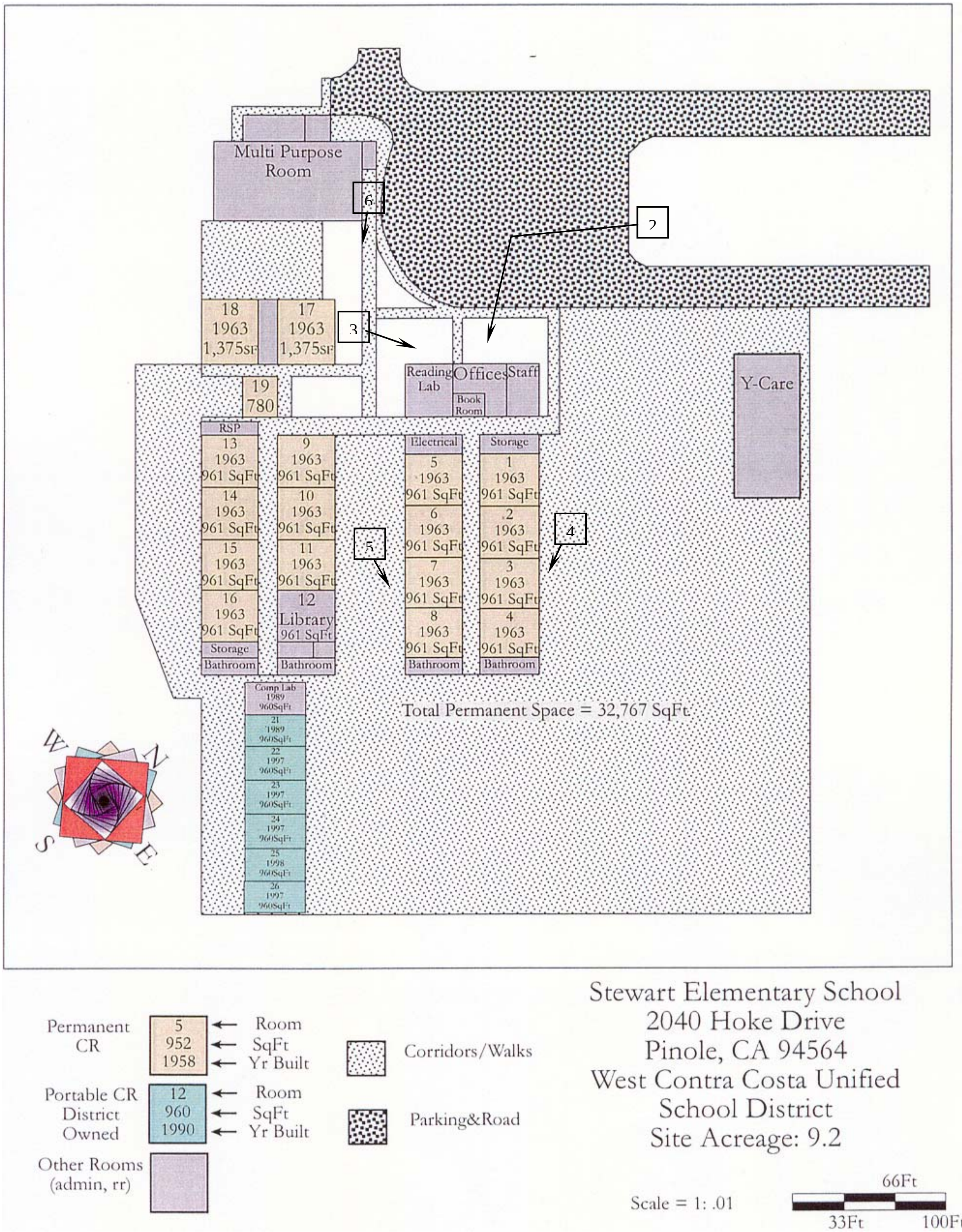

Figure 1: School Layout Plan

Figure 2: North-west Elevation Looking at School Offices

Figure 3: North-west Elevation

Figure 4: East Elevation of Main Classroom Building (portables behind)

Figure 5: Elevation of Main Classroom Building inside Courtyard (looking east)

Figure 6: Covered Walkway between Multi-purpose Room and Main Classroom Buildings