STRUCTURAL EVALUATION OF

SHANNON 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 Shannon 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 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

Located in the city of Pinole, the original school was constructed in 1965, with portable structures added at later dates. This original campus consists of two, very similar single story classroom structures that use a hybrid wood and steel framing system. These two classroom buildings are connected by an enclosed hallway. In addition to these permanent structures, the school utilizes three portable buildings. The two classroom portables were added in 1988 and 1998, while the larger lunchroom portable dates back to 1965. The total square footage of the permanent structures is about 22,718 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 classroom buildings have an educational occupancy (Group E, Division 1 and 2) and the lunchroom 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 3.9 kilometers from the Hayward fault. The classroom buildings described above utilize plywood shear walls to resist seismic loads, 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.40x1.31x1.15)W}{5.5} = 0.274W$$

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. Classroom Buildings: Jack Buchter – Architect – A.I.A. and Associates, Sheets 1 – 6, December 1, 1965; Eric O. Moorehead Structural Engineer, Sheets S-1 – S-8, December 1, 1965.
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 6^{th}, 2001 and March 8^{th}, 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 buildings are single story structures (see figures 2 - 8). The exterior longitudinal classroom walls have large lengths of window openings, below which are short concrete walls to the sill of the windows. These large windows leave little room for shear resistance in the shear walls at these lines. Elsewhere the exterior walls are finished with stucco of wood siding. The interior walls in the corridors and in the transverse direction between classrooms are continuous with minimal wall openings. A suspended T-bar ceiling with acoustical tiles is found in the classrooms and corridors. Additionally skylights occur periodically in the corridor. The enclosed hallway between the two classroom buildings (see figure 5) is supported by both buildings, which could result is significant damage and a life safety hazard should the two classroom buildings be subjected to differential displacements during a seismic event. Additionally, hard electrical conduits were observed to pass between buildings at this location without provision for these opposing movements. This also represents a life safety concern. At the portable lunchroom building, rust was observed on steel roof beams at the rear roof eave. This type of deterioration represents a life safety hazard. Furthermore, electrical conduits were observed passing between various portable buildings without the capacity to withstand differential movements.

10.6 Review of Existing Drawings

The classroom buildings are rectangular structures in plan and utilize multiple construction materials (see figures 2 – 8). The roof of these single story buildings are framed with 2x10 roof joists at 24” on center, spanning in the transverse direction. These roof joists are supported alternately by 2x6 wood stud bearing walls and W12 steel beams. The steel beams typically span 31’+/- between 3½” diameter steel pipe columns located with the transverse wood walls. Plywood sheathing (1/2”) covers the roof framing to provide a continuous roof diaphragm. Lateral forces are resisted primarily by plywood shear walls, which occur at both exterior and interior wall locations. The overall length of plywood shear wall provided in the transverse direction is substantial. In the longitudinal direction, the shear walls provided at the corridor appear to be of adequate length; however, at the exterior walls the large number of windows inhibits the shear strength at these lines rendering them inadequate to resist the prescribed seismic loads. At the hallway between the two classroom buildings, floor to roof concrete shear walls provide additional resistance to lateral loads. Collector loads in these buildings are typically transferred by double top plates or headers at the wood walls. The splices of these members are inadequate to transfer the prescribed seismic. Both classroom buildings are supported by a reinforced concrete foundation composed of typical 1’-2” wide strip footings at the walls and 3’-6” square spread footings at the steel pipe columns. A positive connection between this foundation and the wood shear walls for the purpose of resisting uplift forces has not been provided, and is critical at the narrow, exterior shear walls in the longitudinal direction. The inadequate strength of the longitudinal shear walls and the collector splices, along with the lack of uplift connection at the shear walls, constitute life safety hazards at the classroom buildings. The existing roofs at the classroom buildings are about 3 years old and appear to be in acceptable condition.
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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.	Classroom Buildings: Strength of plywood shear walls at the exterior longitudinal walls is inadequate to resist prescribed forces.
2.	Classroom Buildings: Strength of chord/collector splices is inadequate to resist prescribed forces at the interior and exterior longitudinal walls.
3.	Classroom Buildings: Positive connection of shear walls to foundation is lacking at critical locations in the exterior longitudinal walls.
4.	Enclosed Hallway: Structure is tied to two adjacent buildings with no provision to accommodate differential movement.
5.	Enclosed Hallway/Portable Buildings: Electrical conduits are connected to adjacent buildings with no provision to accommodate differential movement.
6.	Lunchroom Portable: Rust observed on steel roof beams.

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 holdowns at new shear wall locations.	1.1	3, 4
2.	Provide new strapping at inadequate locations.	1.5	N/A
3.	Provide new holdown anchors into existing foundation at lacking locations.	1.5	N/A
4.	Provide new beams and columns to support the hallway framing near each classroom building.	1.9	5

5.	Provide new flexible electrical conduits along enclosed hallway and between portable buildings.	1.9	N/A
6.	Remove portable building from site.	1.0	N/A

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

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

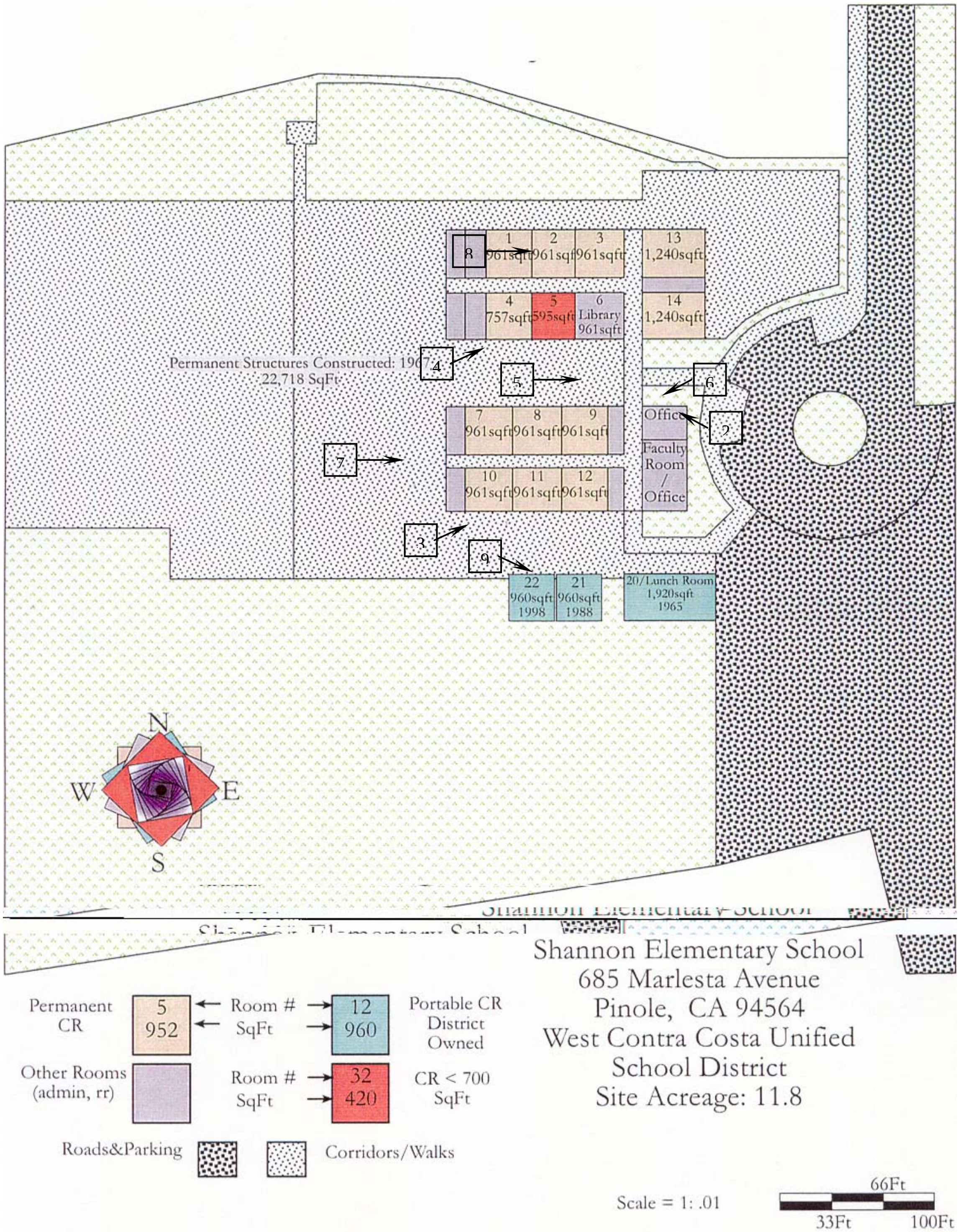

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: South Classroom Building, south face

Figure 4: North Classroom Building, south face

Figure 5: Enclosed Hallway, west face

Figure 6: South Classroom Building, north face at entrance

Figure 7: South Classroom Building, west face

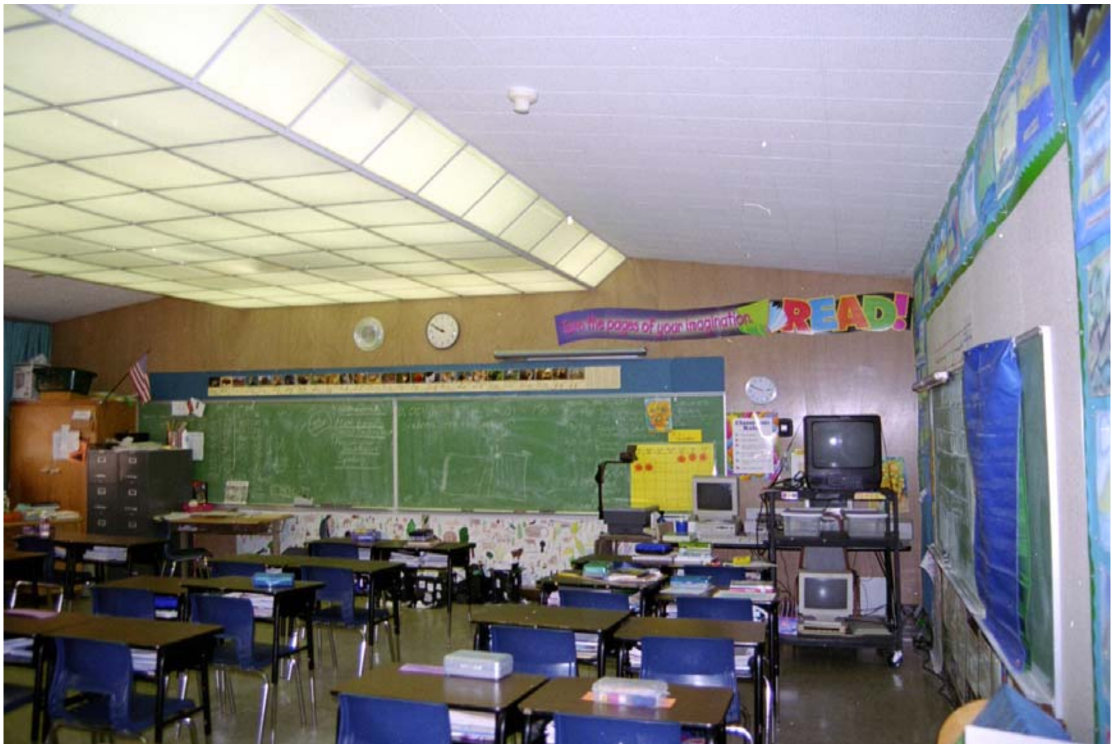

Figure 8: Classroom Building, interior classroom

Figure 9: Portable Buildings