STRUCTURAL EVALUATION OF

COLLINS 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 Collins 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

School is located in the city of Pinole and was built in 1949 and consisted of Administration wing and classrooms 1 to 6 and K1. Subsequently, additions were made in the years 1954, 1960, and 1965. This is a one-story wood framed structure and has stucco finish on the exterior (see figure 2). There are six main buildings (permanent structures) and seven portable classroom buildings (see figure 1). There are two 1988 portables, three 1989 portables, one1996 portable, and one 1997 portable. In addition there are three portable buildings of indeterminate age used for day care. The total square footage of the permanent structures is about 43,327 square feet.

10.3 Site Seismicity

The site has 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 5.6 kilometers from the Hayward fault. The buildings are wood framed buildings with plywood and diagonally sheathed shear walls. The buildings with diagonally sheathed shear walls have a response modification factor, $R = 4.5$. The 1998 CBC code 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.18x1.15)W}{4.5} = 0.332W \text{ where diagonal sheathing is used.}$$
$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.18x1.15)W}{5.5} = 0.271W \text{ where plywood sheathing is used.}$$

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. Pinole Hercules Elementary School #2, dated Aug 25, 1949, by Jack Buchter Architect and Associates, Sheets 1-9, and Robert D. Dewell Civil and Structural Engineer; Sheets S1-S7
2. Pinole Hercules Elementary School #2 Additions, dated Aug 20, 1954, by Jack Buchter & Lillis Architects, Sheet 8.
3. Addn to Pinole Hercules Elem School #2, dated Dec 29, 1959, by Jack Buchter Architect and Associates, Sheets 1-3, and Smith and Morehead Structural Engineers; Sheets S1, S2.
4. Addn to Pinole Hercules Elem School #2, dated Jan 29, 1965, by Jack Buchter Architect and Associates, Sheets 1-2, and Eric O. Morehead Structural Engineer; Sheets S1-S2.
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 October 24th, 2001 and March 7th,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. 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 buildings are one-story wood buildings. The roof diaphragm appears to be made of straight sheathing. The wall sheathing appears to be made of diagonal sheathing. Classrooms and corridors have suspended ceilings. Covered walkways in the school campus are supported typically on 4 inch diameter pipe columns and have plaster ceiling (see figure 7). Exterior longitudinal walls of the classrooms and Kindergarten rooms have numerous wall window openings (see figures 3 & 4). The exterior longitudinal (back) wall of classrooms have clerestory windows (see figures 5 & 6). Classrooms have wood beams spaced at about 8ft. on center spanning across to the exterior wood stud walls. Transverse walls of the classrooms have solid wood framed walls without any openings. Exterior longitudinal walls of the multi-purpose room have continuos high windows across the length of the wall.

There are no seismic joints between the original building built in 1949 and subsequent additions in the years 1954, 1960, and 1965. It is expected that the covered walkways connecting the various wings will suffer some distress in a major earthquake and as a result they should be modified to prevent collapse as a result of the expected damage.

Large cracks in the slab on grade were observed and this might be due to the presence of expansive soil (see figure 8).

The ceiling of Kindergarten classroom K1 showed signs of water damage indicating the existence of a roof leak. On the south wall between classrooms K1 and K2 is a vertical crack which is likely the result of the fact that these classrooms were constructed at different times.

Overall the school campus appears to be in good condition.

In addition to the other buildings on the campus there is a metal building located on the West end of the campus. This building has not been recently painted and has plywood over the windows leaving the impression that it is used for storage or other similar uses.

10.6 Review of Existing Drawings

The 1954 Structural drawings (Classrooms numbers 17 to 22 and K1, as well as Multi-purpose building and additional support facilities) were not provided.

The 1949 administration buildings and classrooms (rooms #1-#6 and K2) have diagonal roof sheathing supported on 2x6 joists at 12" oc which in turn are supported by either the center steel beam or the perimeter walls. The floor is provided by a concrete slab on grade. The foundation is supported on spread footings and strip footings under walls.

The 1960 classroom addition has plywood roof sheathing supported on 2x6 joist at 24" oc which in turn are supported by either the end walls or glu-laminated beams at 8 feet on center. The glu-laminated beams are supported by 6x6 wood posts which transfer the vertical loads to the foundation. There is a concrete slab on grade acting as the classroom floor. The foundation consist of drilled piers, some will bells at the bottom. The library addition is similar with the exception that the roof joists are 2x14's and no glu-lam beams are used.

The lateral system for the 1960 addition consists of plywood roof diaphragm being braced by plywood shear walls with tiedowns at the ends of the walls. The 1965 classroom and administration additions are similar to the 1960 additions.

The existing roof is about 18 years old and it has been recommended that it be re-roofed.

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.	Exterior longitudinal walls of classroom numbers 1 through 6, 17 through 22, K1, K2, 25, and 26 have large portions of wall window openings (see figures 3, 4, 5, & 6), resulting in inadequate length of shear wall to resist seismic forces.
2.	Transverse shear walls of classroom numbers 1 through 6, and 17 through 22 are overstressed.
3.	Multi-Purpose room has continuous high windows on exterior longitudinal walls. Hence there is no mechanism to transfer the roof diaphragm (seismic) forces to shear wall below.

4.	Large cracks in slabs on grade indicate presence of expansive soil.
5.	Existence of 1x sheathing on roof limits roof diaphragm capacity.
6.	The covered walkways that connect the buildings do not have any provision to accommodate the movement of the adjacent buildings and thus will likely experience damage in a major seismic event.

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.	Increase the length of shear walls by filling-in existing window openings with new plywood and framing. Provide new collectors to transfer the seismic forces to the new shear walls. Provide holdowns as required.	1.2	3, 5
2.	Reinforce transverse shear walls.	1.2	N/A
3.	Fill-in some of the existing high window openings at each end of the wall with new plywood and framing. Provide new collectors and holdowns as required.	1.2	N/A
4.	Use epoxy grout to fill in existing cracks in slabs on grade and follow Geotechnical Consultant's recommendations regarding treatment of expansive soil.	3.0	8
5.	At pre 1960 buildings install new plywood sheathing over existing 1x sheathing when new roofing is installed.	2.5	N/A
6.	Provide supplemental support adjacent to building so that damage will not lead to collapse of the walkway.	1.9	7

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 3 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

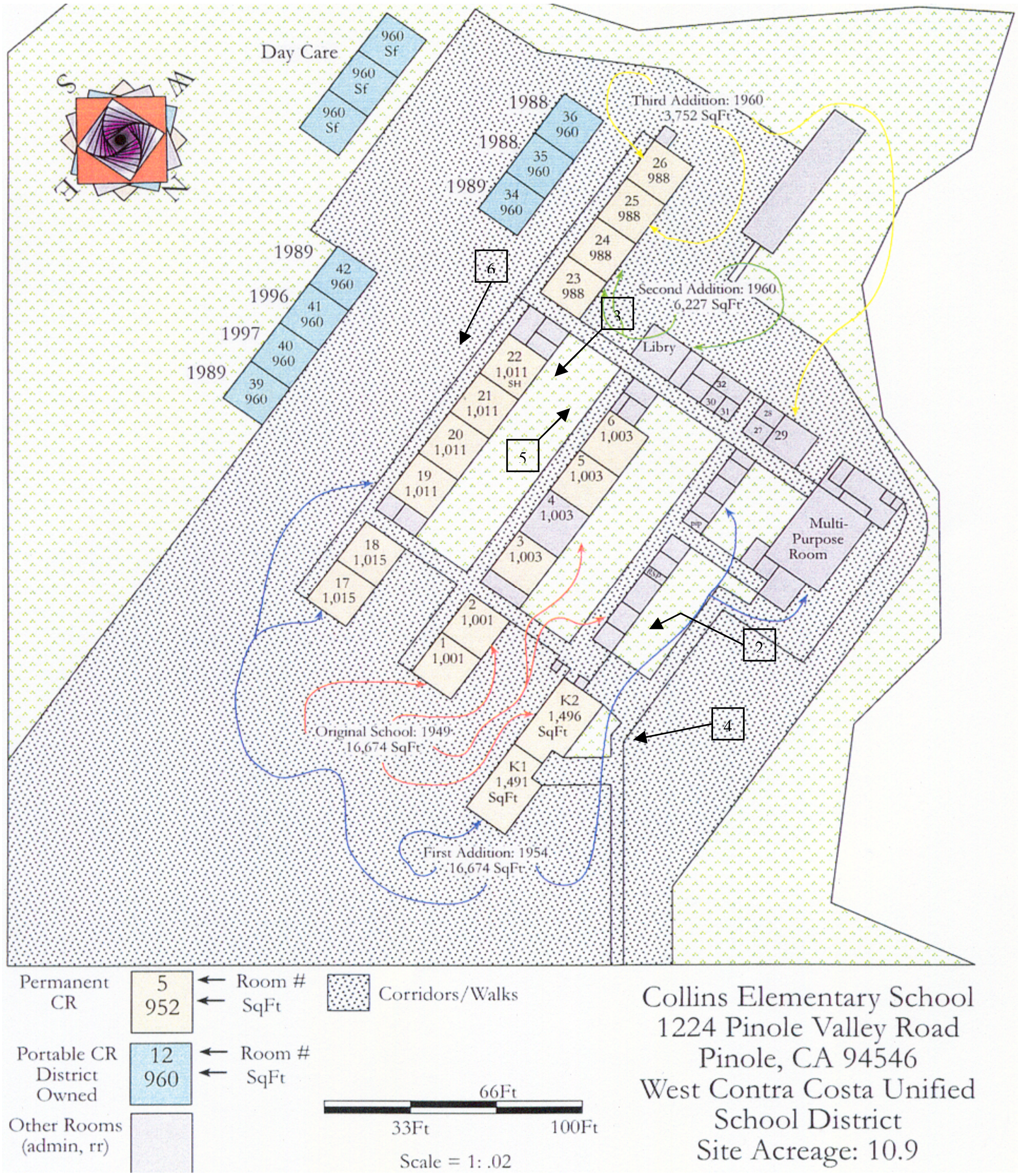

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: Exterior (front) wall of Classrooms 19 through 22

Figure 4: Exterior (front) wall of Kindergarten classroom

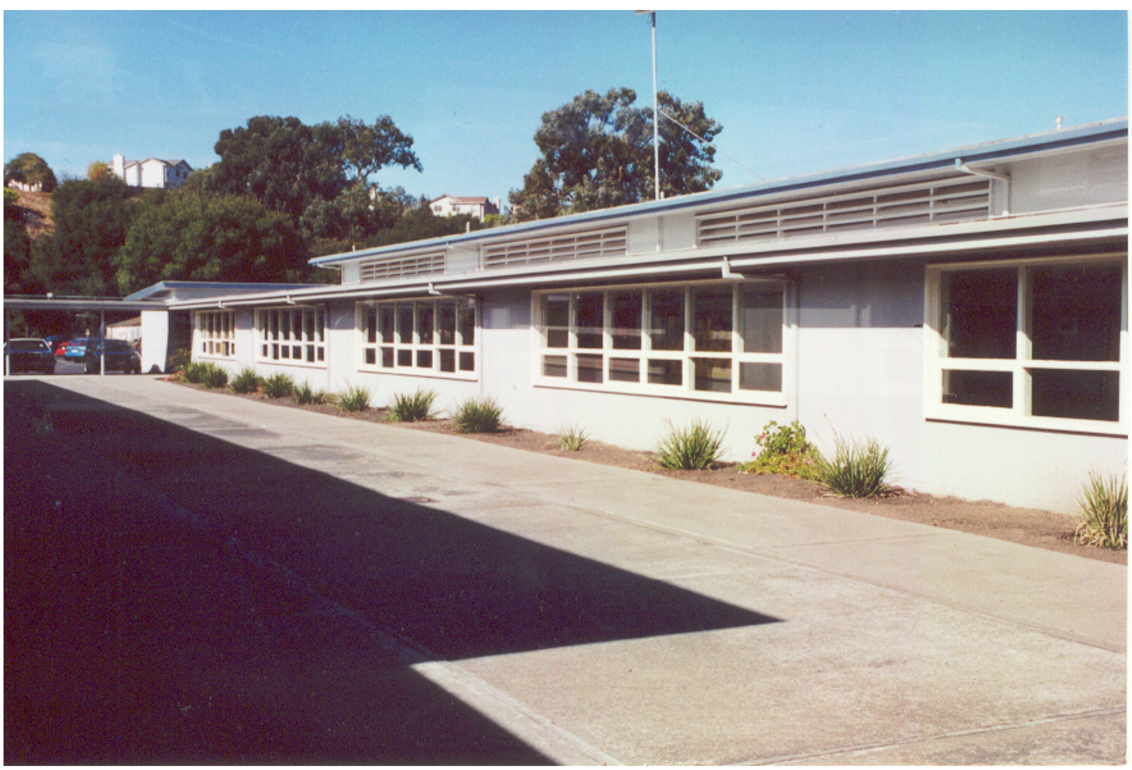

Figure 5: Exterior longitudinal (back) wall of class rooms with clerestory windows

Figure 6: Exterior longitudinal (rear) wall of classrooms (No.'s 19 to 22) with clerestory windows.

Figure 7: Covered walkway supported on pipe columns

Figure 8: Cracks in existing slab-on-grade