STRUCTURAL EVALUATION OF

ELLERHORST ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
Richmond, CA 94804

By

DASSE Design, Inc.
33 New Montgomery Street #850
San Francisco, CA 94105
(415) 243-8400

April 30, 2002

DASSE Design Project No. 01B300

TABLE OF CONTENTS

List of Figures

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Ellerhorst 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

The school is located in the city of Pinole and was built in the year 1959. Additions to the teacher's room and the administrative building were added in 1970 and 1972 respectively. Two portable buildings were added in 1997. The total square footage of the permanent structures is about 35,985 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 5.3 kilometers from the Hayward fault. The classroom and multi-purpose buildings are wood framed building with plywood shear walls, and 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.19x1.15)W}{5.5} = 0.274W$$

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. Pinole Valley School, dated August 15, 1956, by Jack Buchter Architect AIA and Associates, Sheets 1-5, S1-S4.
2. First Addition to Pinole Valley School, dated August 17, 1959, by Jack Buchter Architect AIA and Associates, Sheets 1-7, S1-S4.
3. Administration Wing Remodel, dated March 22, 1972, various un-numbered sheets.
4. Addition to Teachers Room, dated March 11, 1970, Sheets 1-4.
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 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 Administrative and classroom buildings are one story wood buildings with wood siding. The exterior walls of the classrooms have numerous windows and as a result need additional shear walls. Similarly the high windows on either side of the interior corridor create a situation where the interior walls are not effective in resisting earthquake loads. The ceilings in the corridors and classrooms are of acoustical tile.

The floors of all of the permanent buildings on the campus are slab-on-grade. In the Administrative building, at the interface between the original building and the more recent addition, there is a crack in the floor slab that is large enough to stick a pencil through. Because of the large number of cracks in the ground it is likely that the crack in the Administrative Building is a result of expansive soil at the site.

In classroom 17 there is an on going problem of tile delamination apparently due to moisture from under the slab. The adjacent grades seem to be fairly flat and a lack of good drainage may have contributed to the problem.

On the South-west exterior wall near classroom 7 it appears that there is some decay in the exterior siding near the ground.

The Multi-purpose Building (figures 2 & 3) is wood framed building with exposed glued-laminated wood roof beams spaced approximately20' on center. Checks and splits (figure 8) were noticed in both the sides and the bottoms of these beams. The exterior walls of the Multi-purpose Building is covered with cement plaster.

10.6 Review of Existing Drawings

Construction drawings for the teachers room and administration wing additions were missing and therefore not available to review.

The Administration Building (figures 4 & 5) and the classroom buildings (figures 4 & 7) are constructed of light frame wood construction with wood joists spanning to beams and posts, or walls which are then supported by spread footings. In the original classroom building the roof joists span between the exterior walls and the interior corridor. In the new classroom building the roof joists span parallel to the interior corridors and are supported by either transverse walls or transverse steel beams. The floors of all of the classroom buildings consist of concrete slabs on grade.

The lateral forces from the classroom buildings are distributed to the shear walls by means of the plywood roof diaphragms. The lateral forces are transferred from the roof diaphragm to the foundation by means of plywood shear walls. The exterior and the transverse walls have 3/8" plywood sheathed shear walls. The photos (figure 6) show plywood on the interior corridors but the structural drawings do not reflect this plywood thus raising a question as to size of the plywood and the adequacy of the nailing. The lack of adequate shear walls on the interior corridors and the lack of blocking in the roof plywood diaphragm raises concerns regarding the adequacy of the roof diaphragm.

There are fewer holdowns installed at the ends of the shear walls than would be adequate.

The Multi-purpose Building is light wood construction with glued-laminated beams spanning the width of the building. The roof dead and live loads are transferred through the walls and columns to the spread footing foundation. The floor of the Multi-purpose building is a concrete slab on grade.

The lateral system of the Multi-purpose building consists of an unblocked plywood diaphragm that transfers the lateral forces to the perimeter walls, which act as shear walls. The perimeter shear walls have both plywood sheathing and cement plaster to help resist the forces. No holdowns were installed at the ends of the shear walls which limits their capacity.

The covered walkways that pass between the classroom buildings are rigidly connected and thus could be damaged in an earthquake and loose vertical support. In addition the existence of electrical conduit at underside of walkway roof creates a potential for severed electrical lines posing a life-safety hazard. Similarly the covered walkway that passes between the multi-purpose building and the Administrative Building are rigidly connected and could also be damaged in an earthquake and loose vertical support.

The site plan indicates that two portable classrooms were added in 1997. No drawings of the portable buildings were provided and as a result a review was not undertaken.

The age of the roof is reported to be 7 years and therefore roof work is not believed to be necessary.

The lack of construction drawings for the teachers room and the administration wing remodel signed off by the Division of the State Architect raises the question that this construction was accomplished without the necessary permits and construction inspections. If this is the situation the school district should review the legal issues and take steps to mitigate this problem.

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 classrooms have numerous window openings resulting in an inadequate shear wall capacity.
2.	The interior longitudinal corridor walls do not have a mechanism to transfer roof diaphragm forces to the shear walls due to continuous slit windows in the wall.
3.	The multi-purpose building roof glulam beams have longitudinal cracks at the side and bottom of the beams.
4.	The front wall of the Multi-Purpose Building is overstressed due to lateral forces.
5.	The slab on grade in the Administrative Building has big cracks at the intersection between the new and old slab.
6.	Covered walkways are connected to more than one building and will suffer damage in an earthquake.
7.	Electrical conduit runs in the covered walkways and thus could break in an earthquake as the buildings more.

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 the longitudinal shear walls. Provide new collectors and holdowns	1.2	7
2.	Increase the length of the longitudinal shear walls by filling in some of the slit windows. Provide new collectors and holdowns	1.2	6
3.	While it is likely that these cracks are due to shrinkage of the wood, further field investigation is needed as to the cause and impact of the cracks on the roof glu-lam beams in the multi-purpose building.	1.2	8
4.	Reinforce front wall of multi-purpose room below the top of the doors.	1.6	N/A
5.	Refer to the Geotechnical Engineer for recommendations.	3.0	N/A
6.	Provide supplemental support adjacent to building so that damage will not lead to collapse of the covered walkway.	1.9	N/A
7.	Either reroute electrical conduit at the covered walkways or provide a flexible connection to prevent earthquake damage.	1.9	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 2 and we recommend that seismic retrofit work be performed in Phase I.

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

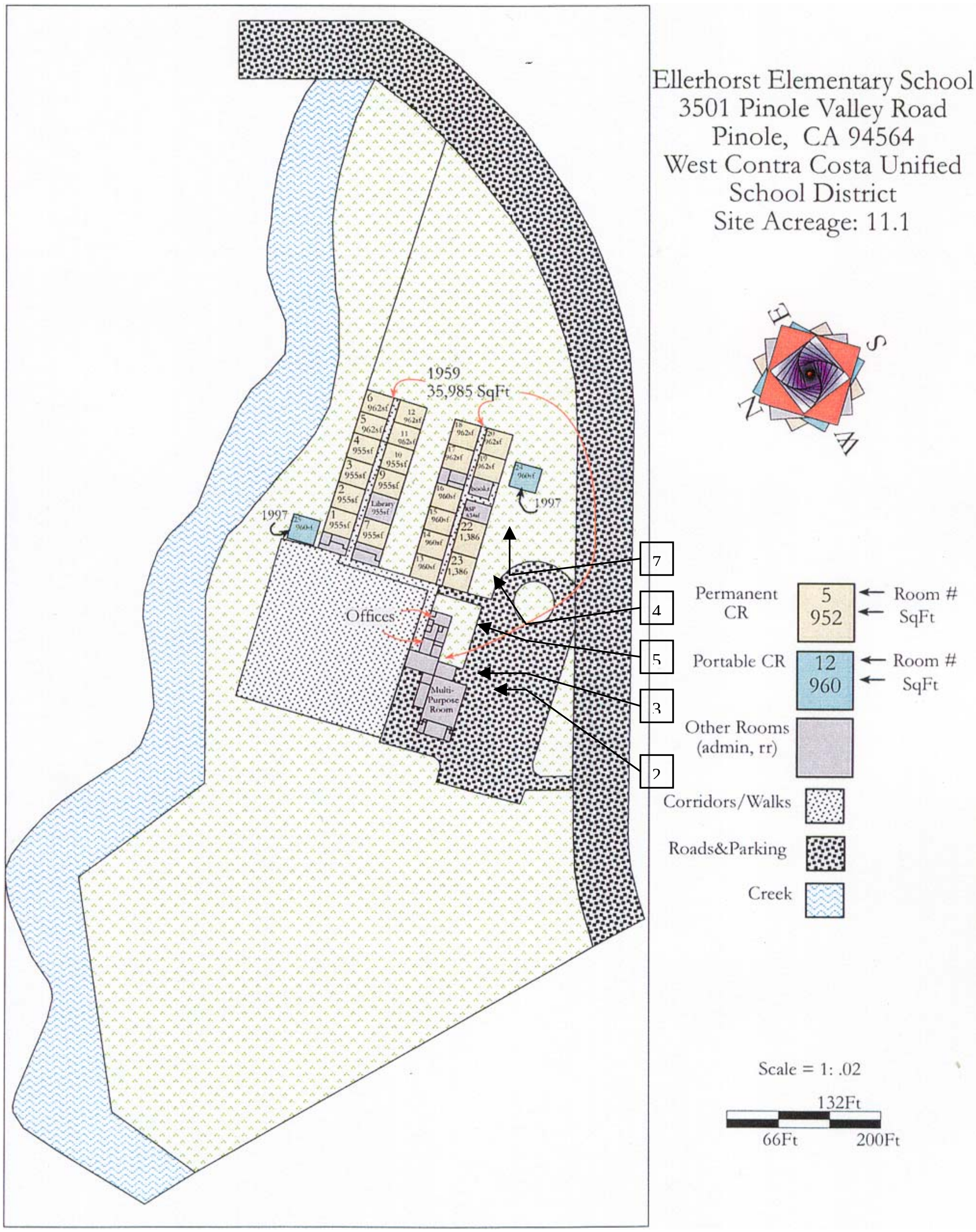

Figure 1: School Layout Plan

Figure 2: Multi-purpose Building

Figure 3: Multi-purpose and Administrative Buildings

Figure 4: Administrative and Classroom Buildings

Figure 5: Administrative Building.

Figure 6: Classroom Building – Interior Corridor

Figure 7: Classroom Building - Exterior

Figure 8: GluLam Beam with Crack