STRUCTURAL EVALUATION OF

DOVER ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

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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 Dover Elementary School in San Pablo, 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 San Pablo and was built in 1958 and included several portable classroom buildings in addition to the five permanent structures. The Multi-purpose building was constructed in 1936. There are four 1965 portables, two 1987 portables, five 1989 portables, two 1997 portables, and one 1998 portable. The total square footage of the permanent structures is about 27,610 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 less than 2.0 kilometers from the Hayward fault. The classroom buildings are wood framed building with plywood shear walls, and have a response modification factor R = 5.5. The Multi-Purpose building is a wood framed building with diagonally sheathed shear walls, and has a response modification factor R = 4.5. 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.5x1.15)W}{4.5} = 0.422W \quad \text{for diagonally sheathed walls.}$$

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.5x1.15)W}{5.5} = 0.345W \quad \text{for plywood shear walls.}$$

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. Dover Elementary School, dated December 9, 1958, by Schachtman & Velikonia, Architect, Sheets A1-A15, and Milton G. Leong, Structural, Shets S1-S10.
2. Auditorium Bldg. San Pablo Grammar School, dated December 11, 1935, by P. L. Dragon & C. R. Schmidts, Architect, Sheets 1-6.
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 23rd, 2001and 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 1936 Multi-Purpose building is wood frame construction with stucco finishes. Several significant cracks were identified in the stucco (figures 7 & 8), which indicate that the crack is moving over time. These cracks did not extend through the foundation thus implying that the cause is not related to foundation problems. In addition there were signs of horizontal movement of the wood super structure with respect to the concrete foundation on the South-West side.

The Classroom and administration buildings are wood construction with vertical wood siding. The classroom buildings have a lot of windows on the sides (figure 3) but this is compensated for by the existence of cross walls and a continuous wall down the center.

Conduit and pipes were observed running between portable buildings (figure 6) and between permanent classrooms. This could potentially be a fire and life safety hazard, when the buildings move differentially in an earthquake and damage the conduits.

Water damage to the ceiling was observed in classroom #28. In addition the North interior wall of the Multi-Purpose Room showed signs of water damage near the exterior crack in the plaster.

10.6 Review of Existing Drawings

The drawings of the existing multi-purpose building provided, are not always readable.

The permanent classroom and administration buildings have a plywood roof which is supported by 2x joists, typically 2x14, which span to steel beams and wood walls which in turn rest on continuous footings 12” to 16” wide and 2’-6” deep with #6 top and bottom. The floor is a concrete slab on grade.

The lateral system of the classroom and administration buildings consists of plywood diaphragms, which distribute the load to the plywood sheathed shear walls. The typical classroom buildings have frequent transverse shear walls in addition to the central dividing shear wall. While the Kindergarten Classroom and Administration buildings have fewer walls in the longitudinal direction there are clearly defined shear walls and at least one of these short walls has tiedowns.

The original portable classroom buildings are similar to the permanent buildings except that they have a wood floor supported by steel beams. The steel beams are positively connected to the concrete foundation.

The covered walkways that run between the several wings are supported by 3” diameter steel pipe columns. They do not have their own independent lateral force resisting systems, and there is no seismic joint between them and the wings they connect (figure 9).

The vertical loads on the Multi-Purpose building are carried by straight sheathing supported by 2x roof rafters, which in turn are supported by deep wood trusses. The roof trusses rest on wood columns, which transfer the load to the perimeter footing which are typically 12” wide with 2’-6” spread footings located under the columns. The floor loads are supported by diagonal sheathing and 2x joists, which transfer the loads through 6x girders to un-reinforced spread footings 21”square.

The lateral loads on the Multi-Purpose Building are resisted at the roof by a system of 1” diameter rod bracing at the lower level of the roof trusses. In the transverse direction the roof trusses help to transfer the roof lateral loads to the plane of the rod bracing while in the longitudinal direction there are two lines of struts that stabilize the roof trusses and transfer the lateral forces to the rod bracing.

The lateral forces on the roof of the Multi-Purpose Building are transferred to the concrete foundation through diagonally sheathed perimeter shear walls.

The survey of the school district roofing reported that the roofs at Dover were about 4 years of age and no roof work was needed. The drawings indicate that a built-up roof was specified.

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.	Covered walkways are attached to the buildings at both ends with no provision to accommodate differential movement.
2.	There is a lack of capacity in the classroom buildings bracing systems that resist lateral forces parallel to the central wall.
3.	Electrical conduit spanning between roof of portable classrooms and between covered walkways.

4.	The longitudinal shear walls in the Kindergarten Classroom Building are overstressed.
5.	Cracks in stucco on Multi-Purpose Building that are continuing to move.
6.	For the Multi-Purpose Building the horizontal truss at the bottom of the roof trusses is overstressed.
7.	For the Multi-Purpose Building the transverse walls at each end of the Multi-Purpose room are overstressed.
8.	Water damage was observed in the ceilidng of Classroom #28 and on the inside of the Multi-Purpose Room.

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.	Provide new beams and columns close to the building so that damage will not lead to collapse of the walkway.	1.9	9
2.	Reinforce longitudinal walls.	1.9	3
3.	Relocate electric conduit or install flexible connection when conduit passes between adjacent portable classrooms and covered walkways. above ground level.	1.9	6
4.	Reinforce or add additional shear walls in the Kindergarten Classroom Buildin in the longitudinal direction. Provide formal drags to transfer loads to shear walls.	1.8	N/A
5.	Identify the cause of the cracking in the cracks in the Multi-Purpose building stucco and repair.	2.4	7,8
6.	Add plywood over the roof sheathing on the Multi-Purpose Building or retrofit horizontal roof truss to resist seismic loads.	1.9	N/A
7.	Add plywood on the transverse shear walls at each end of Multi-Purpose Building. Provide new collectors and holdowns.	1.9	N/A
8.	Verify water leaks have been patched and that decay has been repaired.	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 5 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

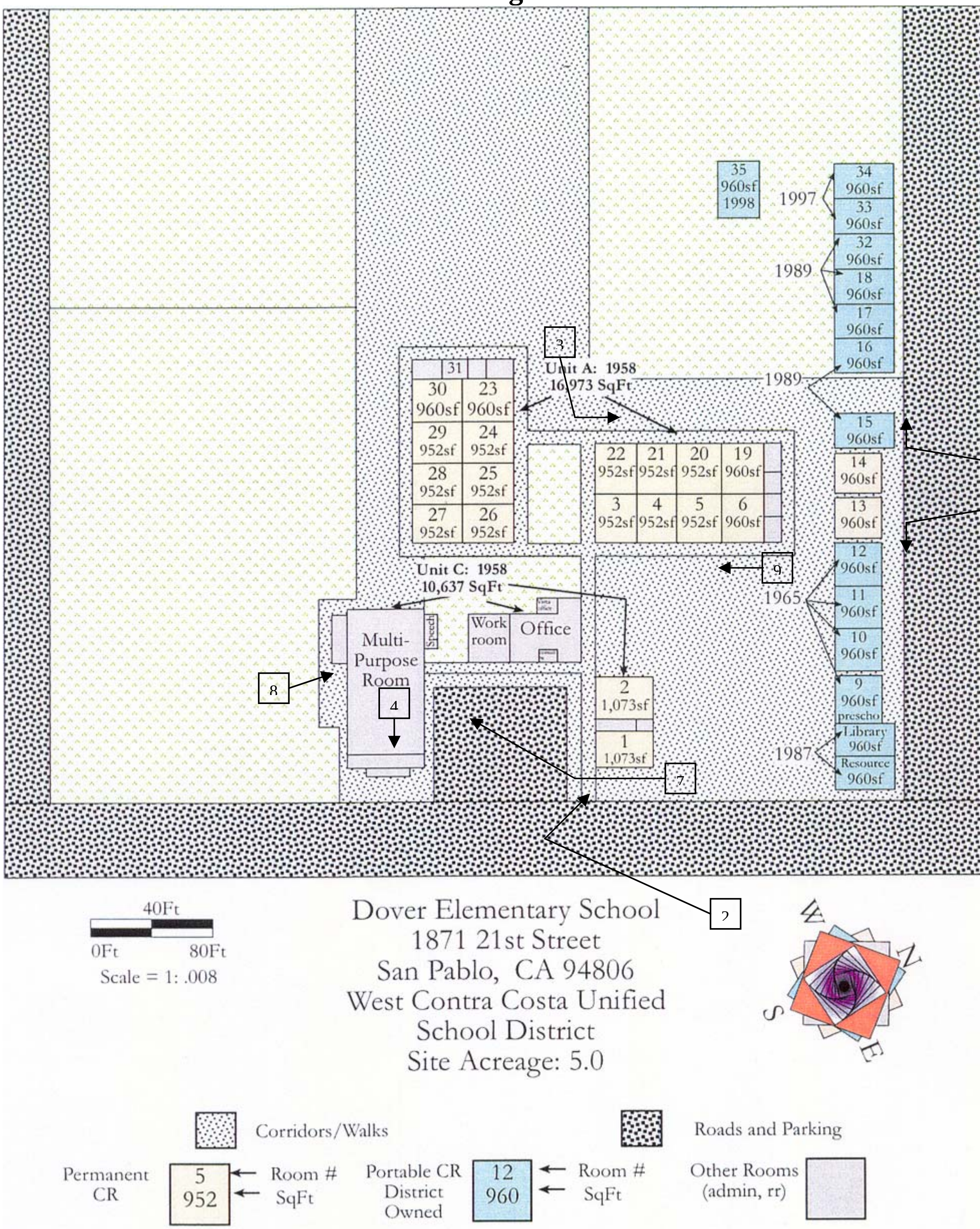

Figure 1: School Layout Plan

Figure 2: Front of School

Figure 3: Classroom Building

Figure 4: Interior of Multi-Purpose

Figure 5: Portable Classrooms

Figure 6: Conduit Between Classrooms.

Figure 7: Multi-Purpose Building – Cracks in Plaster

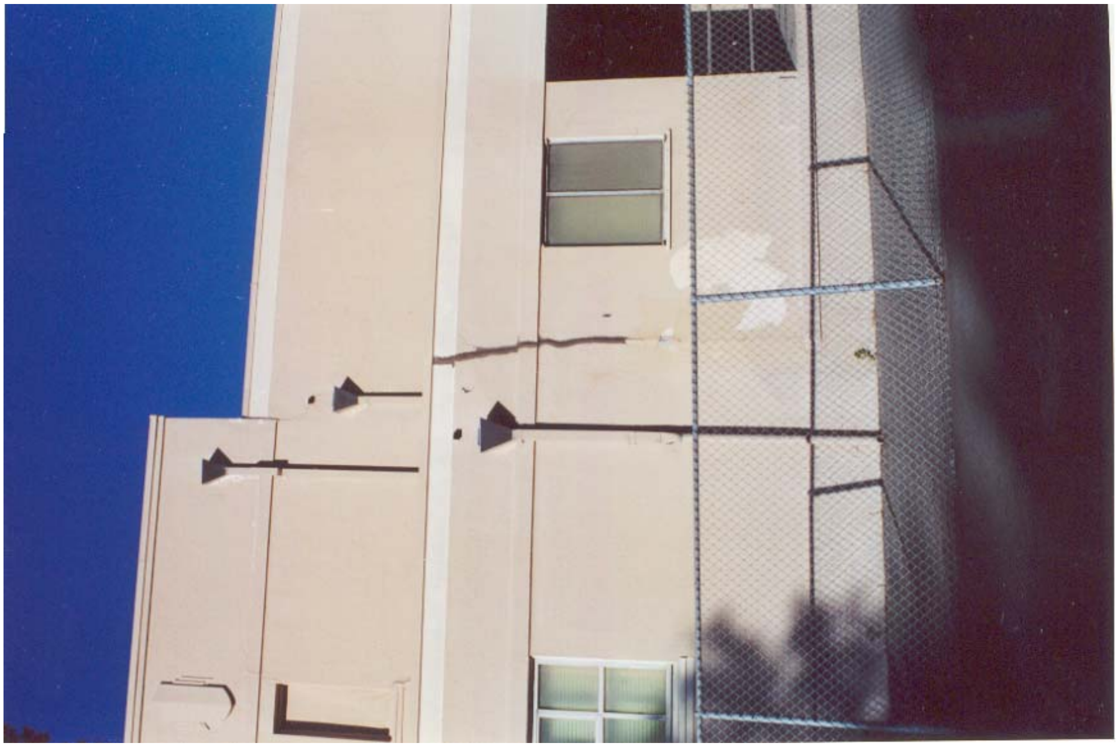

Figure 8: Multi-Purpose Building – Cracks in Plaster.

Figure 9: Covered Walkway Connecting Buildings.