STRUCTURAL EVALUATION OF

MARTIN LUTHER KING JR. ELEMENTARY SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

WLC Architects
Kaiser Building
1300 Potrero Avenue
Richmond, CA 94804

By

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April 30, 2002

DASSE Design Project No. 01B300

TABLE OF CONTENTS

Page No.

List of Figures

10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Martin Luther King Jr. Elementary School in Richmond, 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 original school (Unit B) was built in 1944 and in the 1968 an additional and larger building was constructed. There is also a Community Room building on the site that is apparently being used as a multi-purpose building, and one 1998 portable building. The total square footage of the permanent structures is about 51,996 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 Lunch Room 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 2.3 kilometers from the Hayward fault. The original classroom building is of wood frame construction with diagonally sheathed shear walls which would have a response modification factor R=4.5. The 1968 building appears resist the lateral loads by means of masonry shear walls and thus would have a response modification factor R=4.5. The community building appears to act as a shear wall and we have tentatively assigned 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.47x1.15)W}{4.5} = 0.413W$$

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. Pullman School Unit #28, Dated Aug 9, 1943, by L.H. Nishkian Consulting Engineer; Sheets 1-6, S1, S3, S4.
2. Reconstruction & Refinishing of Pullman School Unit #28, Date unknown, by Dragon, Schmidts & Hardman Architects, Sheet A1.
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 22^{nd}, 2001 and March 5^{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. 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 1968 Main Building (figures 2 & 3) is a two story split level structure and is organized as a collection of pods around courtyards (figure 4) exterior walls are predominately constructed of 8x8 stacked bond split face masonry. Some of the masonry walls from the lower level are extended above the floor to act as guard rails for the upper level balconies (figure 5). There appears to be an adequate length of shear wall but given the vintage of the construction their are concernes about the adequacy of the anchorage of the wood floors and roofs to the masonry walls.

The 1944 Classroom Building is one story and of wood construction with a stucco exterior (figures 6, 7 & 8). The exterior classroom walls have window walls, which limit their ability to resist seismic loads.

At the 1944 classroom building the covered walkways do not appear to be well anchored to the building and thus there is a concern that they will pull away and become a life-safety falling hazard (figures 8 & 9).

The Community Room is a separate building of indeterminate age. The structure consists of 3 hinged arches at 4’-0” o.c. with a lot of windows on the longitudinal sides (figures 10 & 11). The 3 hinged arch is constructed of 3-1/2” glu-lam arches.

The handicap access ramp at the Community Room has a big hole in the plywood and in addition the plywood is sagging. This ramp is a immediate hazard.

10.6 Review of Existing Drawings

Structural drawings for the 1968 Main Building and the Community Room were not available. The drawings for the 1944 building were not always readable and sheet S2 was missing. As result of the missing drawings no review of existing drawings was performed for the 1968 Main Building
and the Community room.

For the 1944 classroom building the vertical roof loads are resisted by diagonal sheathing on 2x joists which are supported by stud walls. The walls are supported by continuous footings which are typically 12” wide. The floor loads are supported by the slab-on-grade which transfers the loads directly to the soil.

The lateral loads for the 1944 classroom building are resisted by diagonal roof sheathing, which transfers the loads to the diagonally sheathed shear walls which in turn transfer the loads to the foundation. While the exterior walls have considerable window openings the interior corridor walls have few openings and are diagonally sheathed.

The heater room that is a part of the 1944 classroom building was constructed with a cast in place concrete walls and roof. These concrete shear walls can be expected to contribute to the lateral resistance of the building thus resulting in better performance than for other comparable diagonally sheathed buildings.

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.	In the 1944 classroom building the large expanses of window walls, and the limited extent of diagonal sheathing on corridor walls results in a lack of adequate shear strength.
2.	There is a lack of bracing of the covered walkway adjacent to the 1944 building.
3.	In the 1968 building there is a concern about the anchorage of the masonry walls to the roof and floor diaphragms.
4.	The handicap ramp at the Community Room has holes and is deteriorated.
5.	Community room has a lot of window openings in the longitudinal walls resulting in inadequate length of shear wall.
6.	In the Community room building, 3 hinged arch ridge connection is possibly inadequate to transfer seismic axial forces.

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.	Reinforce longitudinal walls by adding plywood shear wall panels. Provide collectors and holdowns as required.	1.5	6 & 7
2.	Provide seismic bracing of the covered walkways.	1.9	8 & 9

3.	Investigate the adequacy of the anchorage of the masonry walls to the wood diaphragm and provide additional bracing if necessary.	1.5	5
4.	Repair handicap ramp at the Community Room.	1.0	N/A
5.	Replace some of the existing windows on the longitudinal walls with plywood shear wall panels. Provide collectors and holdowns as required.	1.5	N/A
6.	Analyze three hinged arch and reinforce connection as required.	1.5	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 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 the 1944 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

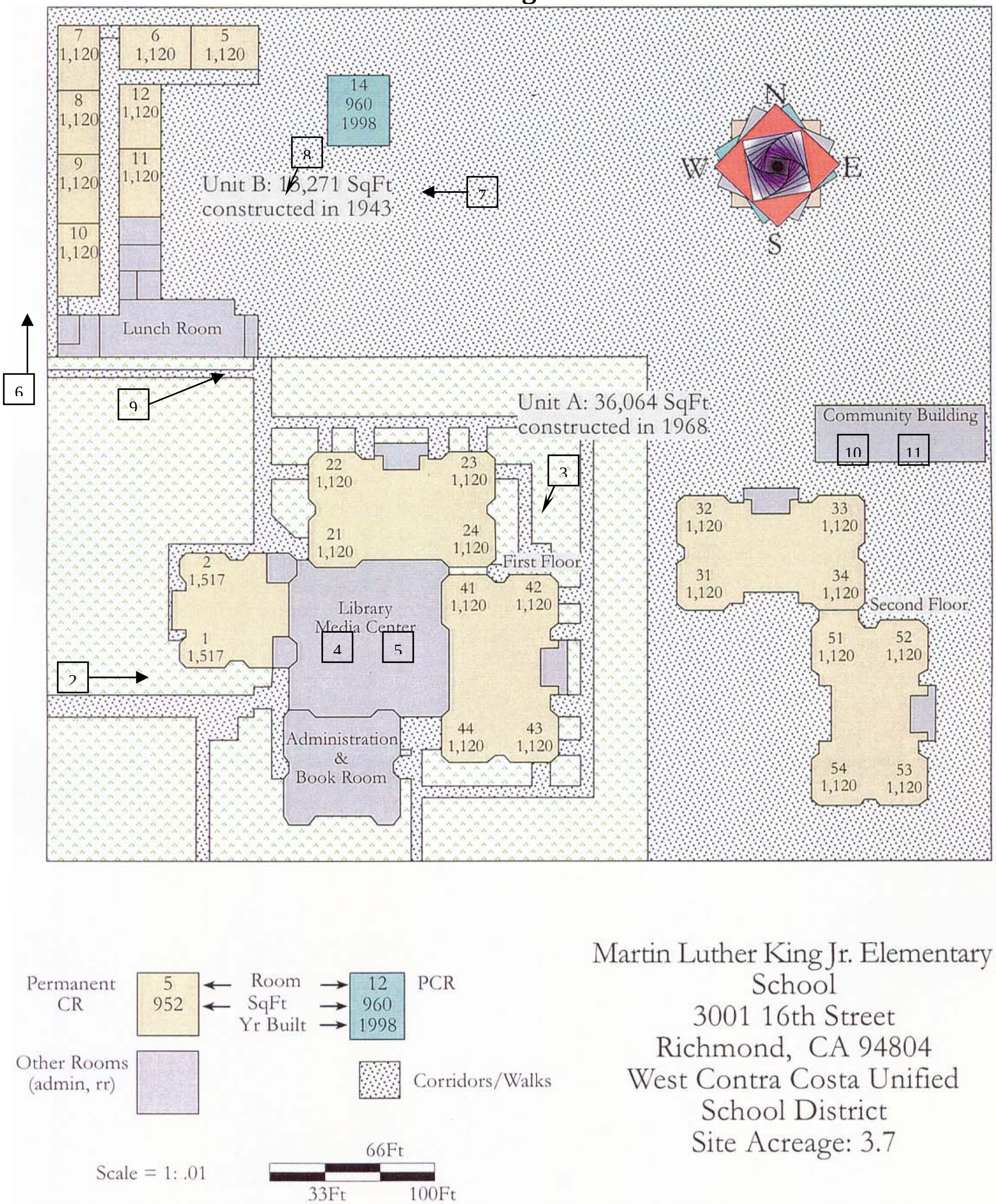

Figure 1: School Layout Plan

Figure 2: School Entrance

Figure 3: 1968 Building

Figure 4: Interior 1968 Building

Figure 5: Interior 1968 Building

Figure 6: 1944 Classroom Building

Figure 7: 1944 Classroom Building

Figure 8: 1944 Classroom and Covered Walkway

Figure 9: Covered Walkway

Figure 10: Interior Community Room

Figure 11: Interior Community Room