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STRUCTURAL EVALUATION OF
CHARLES ADAMS MIDDLE SCHOOL
WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT
(WCCUSD)

For

WLC Architects
Kaiser Building
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By

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October 17, 2002 DASSE Design Project No. 01B300X2

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10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Adams Middle 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 school campus includes four permanent buildings and three portable classrooms. The Academic building was built in 1957 and it is a three-story steel frame structure with, wood floors and roof, and wood and concrete shear walls. The Gymnasium building was built in 1964 and it is a one-story wood roof with steel beams and girders supported on cast-in-place concrete walls. The General Arts building was built in 1964 and it is a two-story steel frame with wood floor and roof and wood shear walls. The Music building was built in 1964 and it is a one-story wood roof with steel beams and girders supported on cast-in-place concrete walls. There are three 1989 portables (see figure 1). The total square footage of the permanent structures is about 119,963 square feet.

10.3 Site Seismicity

The site is a soil classification SD in accordance with the 2001 California Building Code (CBC) and as per the consultants, Jensen Van Lieden Associates, Inc.

The campus is located at a distance of 1.5 kilometers from the Hayward fault. This fault, classified as source Type "A" by the 2001 CBC is active and capable of producing earthquakes of Richter magnitude higher than 7.0, and have a high rate of seismic activity. The 2001 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 Academic building has plywood shear walls and non-bearing concrete shear walls, which have a response modification factor $R=5.5$. The Gymnasium building has non-bearing concrete shear walls, which have a response modification factor $R = 5.5$. The General Arts building has plywood shear walls, which has a response modification factor $R=5.5$. The Music building has concrete bearing shear walls, which has a response modification factor $R = 4.5$.

Based on the occupancy per the 2001 CBC, the importance factor is equal 1.15. The seismic design coefficient in the 2001 CBC is:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44 \times 1.50 \times 1.15W)}{5.5} = 0.345W \text{ for all building except for the Music building}$$
$$\bar{F} = \frac{2.5CaIW}{R} = \frac{2.5(0.44 \times 1.50 \times 1.15W)}{4.5} = 0.422W \text{ for the Music building}$$

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. Charles Albert Adams Junior High School, Academic Building; John Carl Warnecke, AIA, Architect; sheets 1-23; Wildman and Morris, Structural Engineers; sheets S1-S17; August 2, 1957. DSA Application #16266.
2. Charles Albert Adams Junior High School, Gymnasium and Arts Buildings; John Carl Warnecke, AIA, Architect; sheets 1-17; Wildman and Morris, Structural Engineers; sheets SI-SI 3; December 29, 1964. DSA Application #17221.
3. "Measure D" - WCCUSD Middle and High Schools - 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.

10.5 Site Visit

DASSE visited the site on September 8th, 2001 and October 18th, 2002. The main purpose of the site visits 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 Academic building is constructed on a sloping site, where it is 2-story in front and 3-story in the rear. The east and west exterior walls have no lateral shear resisting elements (Figures 2, 3, 4, and 5). They are composed of glass, laminated panels, and windows. In the longitudinal (North-South) direction, the shear forces are resisted by a stud wall sheathed with plywood. There were several major cracks in the plaster observed at the wall lintels and this could be an indication of excessive drift the building experienced during previous earthquakes. Moreover, all the joints between this stud wall and the cross concrete walls show wide cracks in the plaster as a sign of lack of attachment between the stud walls and the concrete walls (Figures 16 and 17). Having only one shear wall in one direction would force the diaphragm to resist lateral forces in torsion. This results in overstressing it and leads to large drift.

The concrete walls on the south and north ends extends from ground to roof. However, the north and south concrete walls at the library do not extend to the ground creating a soft and weak first story phenomenon. Underneath these walls at the cafeteria, is a window wall system with stucco on one bay.

The covered walkway is attached to the structure. It is framed with steel columns and tapered steel beams. The column/beam connection is semi rigid. The shim plate weld to the beam and column seems to be unconventional.

The Academic building structure appears to be per 1957 drawings except for the addition of an elevator shaft laterally separated from the building.

The one story Gymnasium building is constructed on a level lot. It has steel girders spanning 86' supported on concrete pilasters and supporting steel joists (Figure 9). The exterior cast-in-place concrete walls on four sides appear to be in good condition (Figure 8). A small wall separation was observed between the interior stage stud wall and the exterior concrete wall where some roof leak damage was also observed. The steel joists were design-built type, therefore, not all details appeared in the drawings, such as the bridging.

The covered walkway is attached to the exterior concrete walls. It is framed with steel tube columns and channels beams supporting a metal deck. It is also connected to the Academic building covered walkway.

Other than what was indicated above, the Gymnasium building structure appears to be per 1964 drawings.

The two story Arts building is constructed on a level lot. The floor and the roof are framed with steel beams supporting steel joists and supported by steel columns. The exterior walls are stud walls with stucco finish and the walls interior finish is plaster.

Other than what was indicated above, the Arts building structure appears to be per 1964 drawings.

The one story Music building is constructed on a slightly sloping site. It has a steel girder supported on steel columns and concrete walls. The exterior cast-in-place concrete walls on four

sides appear to be in good condition. The steel joists were design-built type, therefore, not all details appeared in the drawings, such as the bridging.

Other than what was indicated above, the Music building structure appears to be per 1964 drawings.

10.6 Review of Existing Drawings

In general, all roofs and raised floors are constructed of open web steel joists spaced 3' to 5' on centers, supporting 2" T & G straight sheathing topped with plywood. The plywood used was 5/16" Douglas Fir C-C except for the Gymnasium's roof where 3/8" was used. The steel joists are supported on steel beams and/or concrete walls where they occur.

Steel columns and pilasters are supported on spread footings. Concrete walls, stud shear walls, and exterior walls are supported on continuous footing. The typical slab on grade is 5" unreinforced on engineered fill and the typical footing to the slab dowels are #3 at 18" on center with 12" to 30" development into the slab on grade.

The Academic building lateral system is composed of wood stud walls sheathed with 3/8" plywood and cast-in-place non-bearing concrete walls. The typical nailing of the wall plywood is 8d at 2", 3" and 4" on centers.

In the longitudinal (North-South) lateral direction, the library roof is supported by concrete wall on one side and the other side is a Clerestory (Figure 7), for which the diaphragm is subjected to torsion. The rest of the roof is supported by a stud wall sheathed with plywood on grid line 7. The central area (at the offices) is supported by two stud shear walls which discontinue at the 2nd floor. The 3rd floor is supported by the stud shear wall on grid line 7 except that the center area (at the offices) is supported also by stud shear wall on grid line 8.8 which discontinues at the 1st floor. The 2nd floor is supported by the foundation on one side and by the three concrete walls on grid lines 10 and 11. The 3rd floor diaphragm has to transfer the shear from the two discontinued stud shear walls at the library to the wall below due to plan offset. The 2nd floor diaphragm has to transfer the shear from the two discontinued stud shear wall at grid line 8.8 the wall below due to plan offset. This is a potential deficiency that could lead to a life safety hazard.

In the transverse direction, the library roof is supported by two concrete walls which discontinue at the 2ⁿ floor. The rest of the roof is supported by two end concrete walls and by 2 stud walls on grid lines F and R and by the two concrete walls on grid lines I and O through collectors. The 3rd floor is supported by two end concrete walls, by 2 stud walls on grid lines F and R, and by 4 stud shear wall on grid line 7 except that the center area (at the offices) is supported also by stud shear wall on grid line 8.8 which discontinues at the 1st floor. The 2nd floor is supported by the foundation on one side and by the three concrete walls on grid lines 10 and 11. The 3rd floor diaphragm has to transfer the shear from the two discontinued stud shear walls at the library to the wall below due to plan offset. The collectors at the 2nd floor diaphragm has to transfer the shear from six shear walls to the foundation due to discontinued shear walls at grid lines F, I, K, M, O, and R. This is a potential deficiency that could lead to a life safety hazard.

The north and south end concrete walls of the Academic anchorage at the roof and 3rd floor is shown as the steel truss joists spaced at 3'-4" are welded with $\frac{1}{2}$ "x2" fillet to a channel anchored with 1"x1/4" bar welded to it at 2'-0" on centers. At the 3rd floor, the walls on gridlines I and O are anchored with a 2 $\frac{1}{2}$ " piece of I section welded to the top of the edge beam, and at the roof it is welded to the bottom of W12. At the 3rd floor the concrete wall on grid line 3 appears to be anchored only at 2 beams with 2 bolts for each beam, and at the roof only the steel pipes are shown anchored to the beams. The walls on grid lines 10 and 11 at the 2nd floor are only anchored with the nailing of the 2" straight sheathing and the wall on grid line 11 is attached first to the bottom of the W12 beam. This is a potential deficiency that could lead to a life safety hazard.

The Gymnasium building lateral system is non-bearing concrete shear walls on four sides. The walls are 8" and 9" and are approximately 25' to 27' high with 3' to 4' parapet on the west wall. The 8" and the 9" walls are reinforced with #4 at 18" and at 16" on centers, respectively, each way and each face.

The north and south walls are anchored at 5' on centers to each truss joist through $\frac{1}{4}$ " plate welded with W'xS" fillet weld and anchored to the wall with 2-3/4"x12" bolts. The east wall is anchored at each beam with 2-1"x2'-0" anchor bolts and along the walls with 3x8 top plate anchored to the wall with $\frac{3}{4}$ "x14" anchor bolts at 4'-0" on centers. The west wall is anchored with 4"x $\frac{1}{2}$ " tie plate at 33" on centers and attached to the 2" sheathing with 2- $\frac{3}{4}$ " bolts (Figures 10 and 11). This is a potential deficiency that could lead to a life safety hazard. The cross bridging at 8' on centers observed are bolted to the wall with two bolts.

The General Arts building lateral system is wood shear wall with plywood sheathing. The roof is supported with shear walls on 4 sides, but a large portion of the north and south walls has openings. The 2nd floor is supported transversely with 3 walls and longitudinally with 2 walls. The west wall has many openings (Figures 12 and 13).

There is a 1 $\frac{1}{2}$ " separation between the Gymnasium and the General Arts buildings.

The Music building lateral system is bearing concrete shear walls. All concrete walls are 8" thick and approximately 17' high (Figures 14 and 15). The wood mezzanine is laterally supported in one direction with wood shear walls and in the other direction with the building concrete walls.

The north and south concrete walls are anchored with a continuous 4x $\frac{1}{4}$ " attached to the wall with $\frac{3}{4}$ " bolt and the joists spaced at 4'-0" on centers are welded to it. The east and west walls are anchored at the beam with 2-3/4"x1'-6" anchor bolts and along the walls with 2x6 top plate anchored to the wall with $\frac{3}{4}$ "x14" anchor bolts at 3'-6" on centers.

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 to identify the structural element deficiencies. The seismic performance levels included in FEMA 310 allow the engineer the choice to achieve the Life Safety

Performance or the Immediate Occupancy Performance. We have based our evaluation of school buildings on the Life Safety Performance level for which is defined as "the building performance that includes significant damage to both structural and nonstructural components during a design earthquake, though at least some margin against either partial or total collapse remains. Injuries may occur, but the level of risk for life-threatening injury and entrapment is low."

Because mitigation strategies for rehabilitating buildings found to be deficient are not included in FEMA 310 document, the California Building Code (CBC 2001) is used as the basis of our quantitative seismic evaluation methods and strategies for seismic strengthening of school buildings. The scope of our analyses were not to validate every member and detail, but to focus on those elements of the structures determined by FEMA 310 to be critical and which could pose life safety hazards. Element *strength* values not addressed in the California Building Code were based on the document FEMA 356, Federal Emergency Management Agency, "A 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 Academic building, the two discontinued concrete walls at the library create a soft and weak 2 ^{TK} floor story that could cause excessive drift and lateral forces.
2.	In the Academic building, the longitudinal (north-south) direction interior shear wall is overstressed in shear at the 3 rd and 2 nd levels. High drift is expected at the exterior east and west walls. The diaphragm is overstressed in shear due to the shear wall offsets.
3.	In the Academic building, the transverse (east-west) direction shear walls are overstressed in shear at the 3 rd and 2 nd levels.
4.	In the Academic building, at the Clerestory, excessive story drift is expected at the glass window.
5.	In the Academic building, concrete walls on grid lines 3, 1 and O at the roof do not have adequate anchorage. At the 3 rd floor wall on grid line 3 is only anchored at the beams. At the 2 nd floor the walls on grid lines 10 and 1 1 do not have adequate anchorage. The floor and roof are lacking cross ties.
6.	In the Gymnasium Building, the east and west concrete walls anchorage to the roof is inadequate and lacking cross ties.
7.	The west shear wall is overstressed in shear at the 1 ^{SI} level.

In the General Arts Building, the transverse (east-west) direction shear walls are overstressed in shear at the 1st and 2nd levels.

9. In the Music Building, the east and west concrete walls anchorage to the roof is inadequate and lacking cross ties.
10. The detached part of the covered walkway beam/column connection weld is inadequate to resist the induced moment.

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	Drawing 1 lumber
1.	Add a concrete wall in one bay at grid lines I and O at the 2 nd floor where the Cafeteria is in the Academic building.	.9	2
2.	Provide new Chevron bracing in 2 bays in the east wall and in 3 bays in the west wall for the 2 nd and 3 rd levels of the Academic building.	.1	1, 2, 3, & 4
3.	Provide plywood sheathing on both sides of the partition walls on grid lines D and S at the 2 nd and 3 rd floors and tie these partitions adequately to top and bottom sheathing.	1.5	1, 2, 3, & 4
4.	Provide a new Chevron bracing in the library window at the Clerestory.	1.9	5
5.	Provide adequate anchorage at the concrete walls on grid lines I and O at the roof, at the wall on grid line 3 at the roof and the 3 rd floor, and for the walls on grid lines 10 and 11 at the 2 nd floor. Provide cross ties for the diaphragms in those areas at the straight sheathing splice.	1.5	N/A
6.	Provide adequate anchorage at the east and west concrete walls at the roof. Provide cross ties for the roof diaphragm at the straight sheathing splice.	1.5	N/A
7.	Provide plywood sheathing on the inside of the west wall for the 1 st level.	1.5	6
8.	Provide plywood sheathing on the two partition walls near J and O and tie these partitions adequately to top and bottom sheathing. Eliminate one window in the south and in the north walls. Add a layer of plywood sheathing to the shear wall on grid line L.	1.5	6 & 7
9.	Provide adequate anchorage at the east and west concrete walls at the roof. Provide cross ties for the roof diaphragm at the straight sheathing splice.	1.5	N/A
10.	Provide side plates at the beam/column connection and weld to both at both sides.	2.0	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.

Next, based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase 1A represents a school campus with severe seismic deficiencies, Phase IB represents a school campus with significant seismic deficiencies and Phase 2 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, we recommend that seismic retrofit work be performed to this school campus in Phase IB.

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.