STRUCTURAL EVALUATION OF

OHLONE 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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10.1 Introduction

The purpose of this report is to perform a seismic assessment of the Ohlone Elementary School in Hercules, 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 evaluation and, therefore, numerical seismic analysis of buildings is not included.

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

This school is located in the city of Hercules and was built in various stages. All the buildings in this campus are portable buildings except for multi purpose building (see figure 1). The classroom numbers K1, K2, 3 through 10, 23 through 25 and Library buildings were originally constructed in the years 1965 and 1966. Computer and RSP (called out as Multi Use building in existing drawings was built in 1970. Classroom numbers 11 through 13 were built in 1984, classroom numbers 15 through 18 were built in the year 1985. Classroom number 14 and 19 based on existing drawings were added in April 1987. Further classroom additions (room numbers 20 through 22) were made in the year 1988. Multi Purpose building, which is same as that in Hercules elementary school, was added in the year 1987. The last classroom additions were made in the year 1996 (room numbers 27 to 30). The total square footage of the permanent structures is about 4800 square feet. The City Day Care center built in the year 1986 was beyond the scope of this evaluation and was not reviewed.

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 about 7.2 kilometers from the Hayward fault. The classroom building and the administration building has plywood shear walls, which have a response modification factor R=5.5. The multi-purpose building is a wood framed building with plywood shear walls, and has 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:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.44x1.11x1.15)W}{5.5} = 0.255W$$

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.

10.4 List of Documents

1. School Site Grading Plan, City of Hercules, 1965/1966 Classroom Building, Barbachand & Associates, Architects, Sheet 3 dated April 1979, and Structural Drawings by Modulux, Inc., Sheets S1 to S4 dated 1965.
2. Hercules Elementary School #2, 1616 Pheasant Drive, Hercules, Computer/RSP (Multi-Use) Building, Barbachand & Associates, Architectural Drawings Sheet 1 to 10 dated May 1979, Addendum #1 by Barbachand & Associates, Architectural/Structural Drawing Sheets X1, 2B to 7B dated 1979.
3. Ohlone Elementary School, 1987 Classroom Additions, Architectural/Structural Drawings by Deltec and Shapiro, Okino, Hom and Associates, Sheets 1, A-1, A-2, F-1 (Foundation Plan), S-1, S-2, S-3 dated December 1986.
4. Ohlone Modular and Classroom Additions, Stow Group Architects, Sheets 1 & 2, Deltec and Shapiro, Okino, Hom and Associates, Sheet A1, A2, S1, S2, S3 and Truss Layout Sheets dated June 1984.
5. Ohlone Modular and Classroom Additions Classroom Additions, Paul Y. Wong Architect, Sheets 1, A1 & A2, Deltec and Shapiro, Okino, Hom and Associates, Structural Drawings F-1 (Foundation Plan), S-1, S-2, S-3 dated April 1985.
6. Multi Purpose Building, Ohlone Elementary School, Architectural Drawings by Barbachand & Associates Inc., Sheets A-0 to A-9 dated January 1988 and Structural Drawings by Shapiro, Okino, Hom and Associates, Sheets S1 to S6 dated March 1988.
7. "Measure M" – WCCUSD Elementary School – UBC revised parameters by Jan-Van Lienden Associates, Inc., Berkeley, California.
8. "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.
9. "Measure M" roofing report by "the Garland Company Inc.", Orinda, California.

10.5 Site Visit

DASSE visited the site on October 24th, 2001. 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

All the buildings on this campus are portable buildings except the Multi-Purpose building. The original classroom buildings (built in 1965& 1966) have numerous openings (long and narrow slit window) on the rear longitudinal wall (see figure 3). This results in a lack of mechanism to transfer seismic forces from the roof diaphragm to the longitudinal shear wall. Some leakage of roof was reported during the site visit. There is a 5 feet roof overhang on front and back side of the portable units. There are two window openings and a big door opening at the front of each of these portable units (see figure 9) resulting in inadequate length of shear wall to resist seismic forces.
Each classroom building is assembled by attaching three individual modular units. Each module is 10' wide by 32' long making it a 32' long by 30' wide classroom building. This portable building has plywood exterior. The interior of the building has a suspended T-bar ceiling. Buildings labeled K1 and K2 have numerous openings on the south longitudinal wall.

The 1984 and 1985 classroom addition is a one story wood and steel framed portable building made from 11'-10" wide by 40 feet long modular units. The roof has plywood sheathing and the exterior wall has plywood. The front and rear walls of these classroom building have few openings (see figure 3, 4, & 5). The interior of the building has a suspended T-bar ceiling.

Electrical conduits were running between the portables (see figure 7), can get damaged during an earthquake due to differential movements and is a life safety hazard.

The multi-purpose building is a roughly square wood-framed building with stucco finish. The roof has sheet metal roofing. In the central part of the building, the roof slopes in the east-west direction to a central ridge. At the north and south sides, the roof slopes up in the perpendicular direction from the exterior to a short pony wall. The exterior walls have windows only above the door openings, leaving reasonable lengths of shear wall at all four sides of the building. The interior of the building has a suspended T-bar ceiling.
Roofing report indicates that existing roofing needs to be re-roofed for the older classroom buildings.

10.6 Review of Existing Drawings

Drawings for the City Day Care center building were not reviewed as it was beyond the scope of this evaluation. Drawings for the Computer/RSP (Multi-Use building) were not reviewed as all structural drawings except for foundation sheet were missing from the set provided for review. Drawings for 1996 classroom additions were missing from the set provided and hence were not at this time.

Classroom buildings built in the years 1984 and 1985 and the 1987 addition are assembled from individual portable units. There is a seismic separation at the center of the 96' long classroom building. The floor framing consists of 2-1/2" x 9" x 10 guage perimeter rim joist and 8"x3"x14 guage floor joists at 4' on center which frames into 9"x2-1/2"x 10 guage girder. The walls are made of 2x4 studs at 16" with plywood siding on the exterior with a double top and bottom plate.. Interior has 3/8" plywood. Sub floor consists of 1-1/8" plywood. The foundation at the perimeter consists of continuos 1' wide x 1' deep strip footings. The foundation at the interior consists of 1' thick by 3' square. The perimeter rim joists rests directly on the top of footing and is attached to the footing at the exterior by a side plate with 2-3/8" diameter expansion anchors (4"embed length) and to the exterior plywood and rim joists by number 12 "TEK" screws (8 total). The above connection is inadequate to resist seismic uplift forces. At the interior, the floor joist is attached to the footing by angle 3x3x3/16" with 4-5/8" diameter expansion anchors. The roof framing consists of 2x6 joists at 16" on center that frames into an exterior light guage metal truss (approximately 40' span by 18" deep). The roof has ½" plywood with 8d at 6" on center nailing. The exterior plywood also has 8d at 6" on center nailing. The roofing is a built-up roofing.

The original (1965 & 1966) classroom buildings are made of modular unit 10' wide x 32' long and each classroom is typically 32' long by 30' wide. This building is similar to the original portable classroom building in Hercules elementary school. The drawings provide for review for the original classroom portable buildings were of poor quality. They were illegible and difficult to read on various sheets. These portable units have floor framing made of steel channels at perimeter with intermediate joist at 2' on center. Roof appears to have plywood with built-up roofing and the exterior walls have plywood sheathing.

The multi-purpose building (similar to the one at Hercules elementary school-see figure 8) has a plywood sheathed roof supported by 2x10 joists at 16on center that span about 15' between 6x12 beams and the exterior stud walls. The 6x12 beams span about 16'-6" between 6x6 posts. These posts rest on 10¾"x27" Glu-Lam beams at the ceiling level, which span 60' between posts at the exterior of the building. The 2x10 ceiling framing, spaced at 48" on center, are also supported by the Glu-Lam beams. Both the roof and ceiling plywood sheathing is fully blocked, and the pony wall at the vertical discontinuity in the roof has structural plywood sheathing. Blocking and strapping have been provided at the ceiling level to create sub-diaphragms to resist out-of-plane wall loads. The Glu-Lam beams are supported on built-up columns made of seven 2x6 members bolted together. These rest on 2'-6" square spread footings. The interior and exterior walls are supported on 12 wide strip footings. It appears that the connections are generally well detailed and adequate collectors have been provided. The existing sheet metal roofing at the multi-purpose building is about 10 years old and appears to be in good condition.

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 seismic evaluation methods, although no numerical structural analyses were performed. The seismic performance levels that the FEMA 310 document seeks to achieve are lower than the current Building Code. However, it attempts to identify potential for building collapse, partial collapses, or building element life safety falling hazards when buildings are subjected to major earthquake ground motion.

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.	Rear longitudinal walls of the original (1966/1967) classroom portables have numerous long and narrow slit window opening. Due to these openings, the diaphragm forces cannot be transferred to the shear wall below at these locations resulting in inadequate length of shear wall.
2.	In original (1966/1967) classroom portables, connection of portable units to foundation appears to be inadequate to resist seismic uplift forces.
3.	Numerous openings at the front wall of original (1966/1967) classroom portables. Due to these openings, the diaphragm forces cannot be transferred to the shear wall below at these locations resulting in inadequate length of shear wall.
4.	Electrical conduit runs between portable buildings and is at risk of being damaged during an earthquake due to differential movements of the portable units.

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.	Fill in some windows with new plywood and framing. Provide new collectors.	1.3	N/A
2.	Provide new holdowns to resist seismic uplift forces.	1.2	N/A
3.	Fill in some windows with new plywood and framing. Provide new collectors.	1.3	9
4.	Relocate electrical conduit or install flexible connection when conduit passes between adjacent buildings.	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 and based on FEMA 310 requirements, 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 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 building 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, 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 8 and we recommend that seismic retrofit work be performed in Phase III.

10.13 Limitations and Disclaimer

This report includes a qualitative (visual) level of evaluation of each school building. Numerical seismic analyses of buildings are not included in this scope of work. The identification of structural element code deficiencies based on gravity and seismic analysis demand to capacity evaluations are therefore not included. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this 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

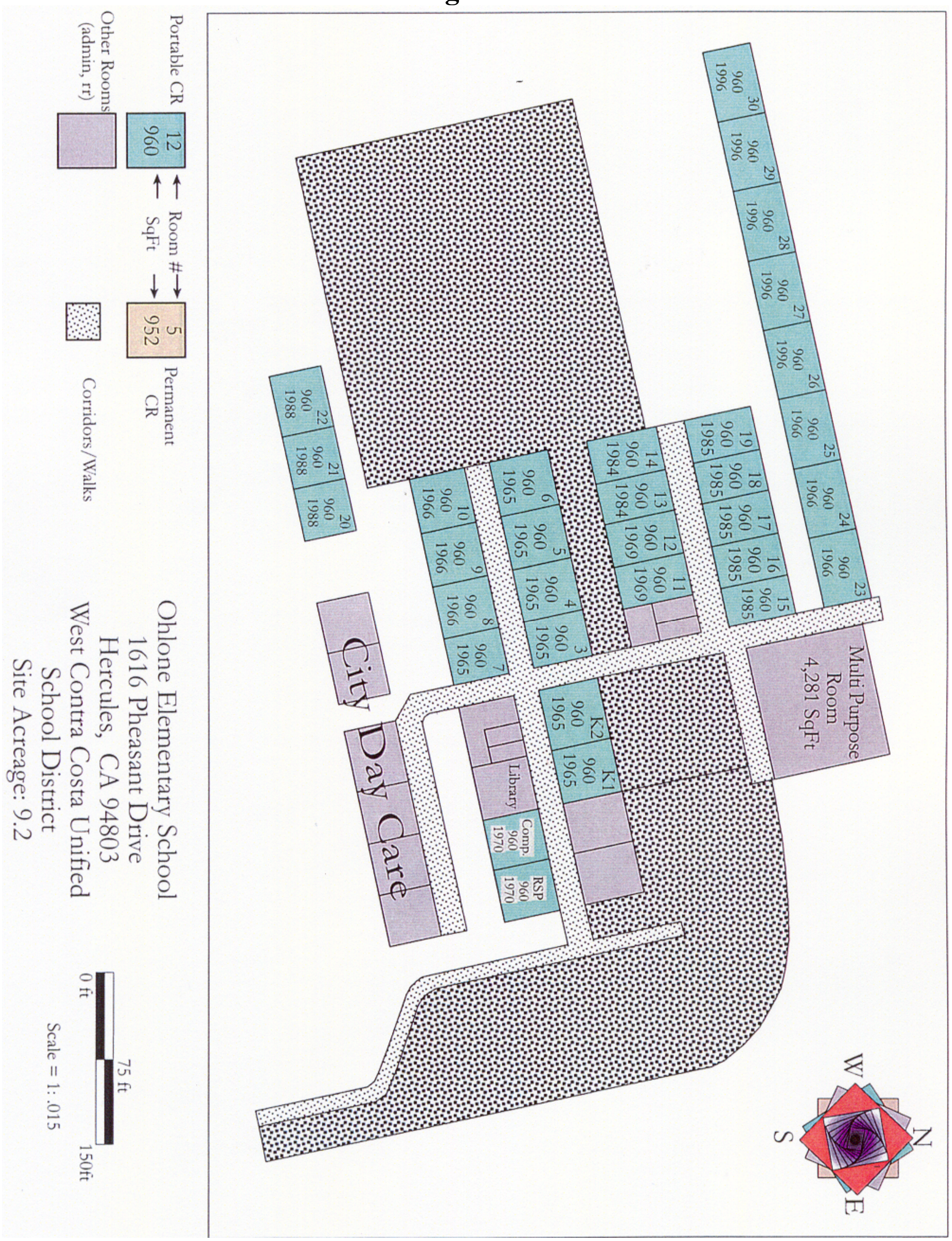

Figure 1: School Layout Plan

Figure 2: Main Entrance

Figure 3: Front Entrance of Classroom numbers 11 to 14

Figure 4: Front Entrance of Classroom numbers 15 to 19

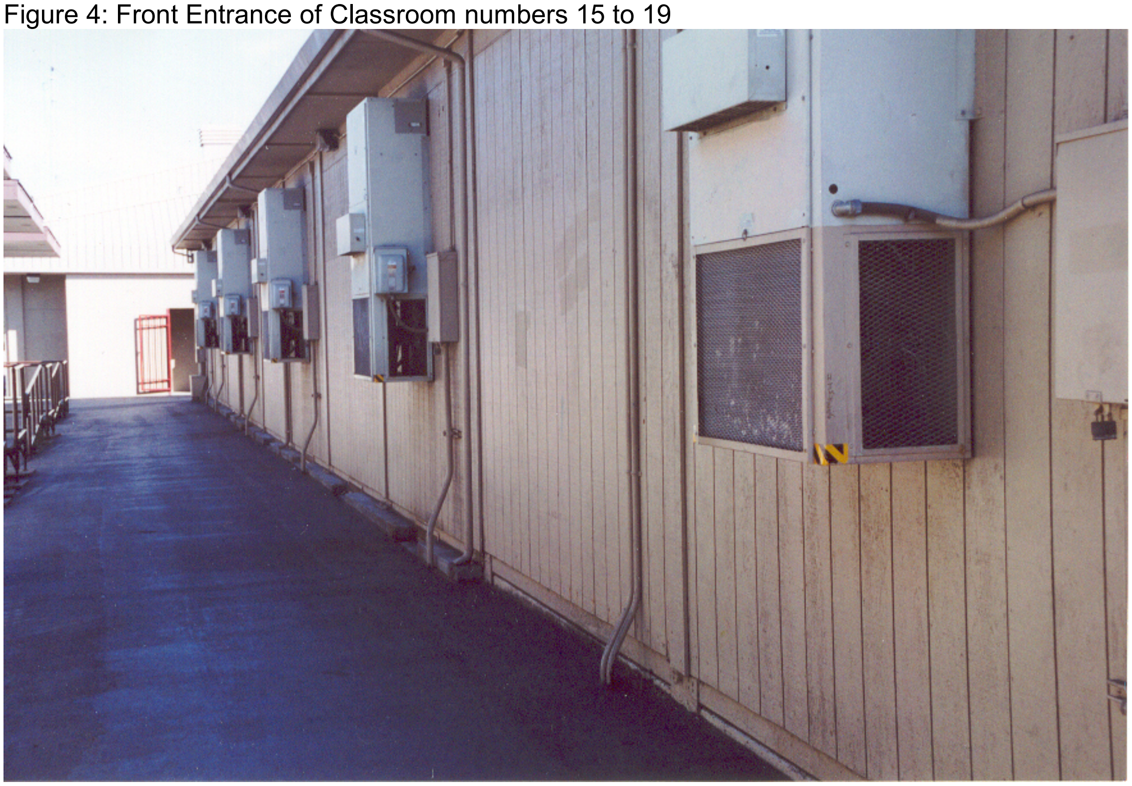

Figure 5: Rear Wall of Classroom numbers 15 to 19

Figure 6: Front Entrance of Classroom numbers 23 to 25

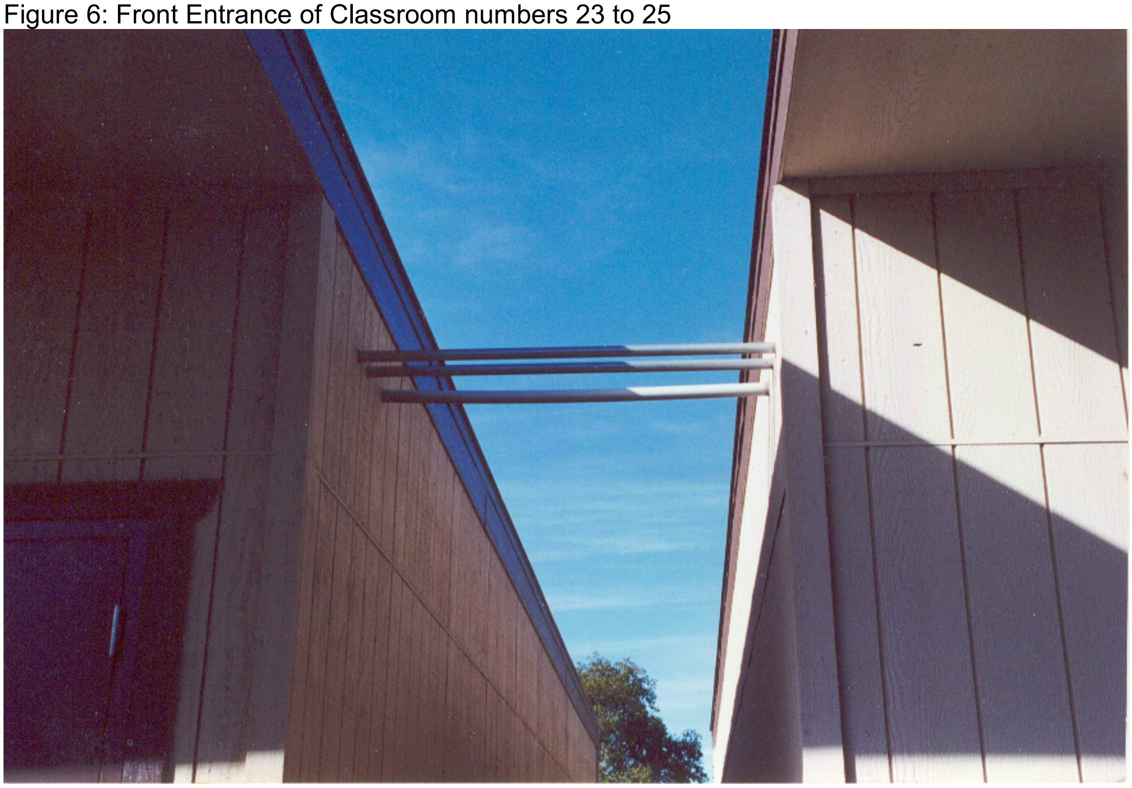

Figure 7: Electrical Conduits running between Portables

Figure 8: Multi-Purpose Building

Figure 9: Front Entrance of Classroom numbers 7 to 10 & 11 to 14