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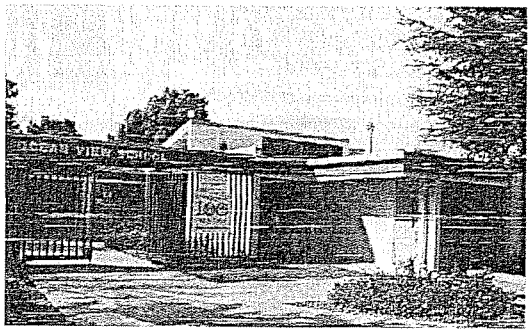
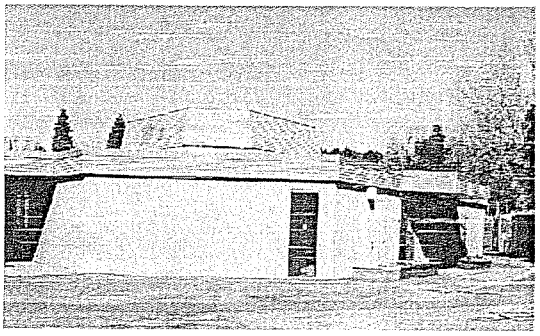
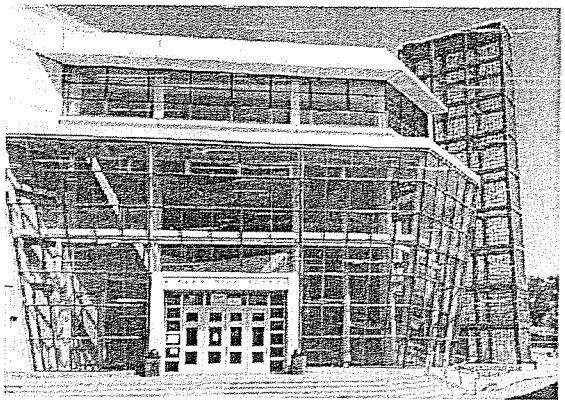
KIRKLAND • PASSAGLIA • WESTPHAL
STRUCTURAL ENGINEERS, INC

ALBANY UNIFIED SCHOOL DISTRICT
SEISMIC EVALUATION

Prepared for WLC Architects and Albany USD







KPW Project No. 13C133
April 24, 2013

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Introduction

The seismic evaluation reports prepared by R.P. Gallagher Associates, Inc. identified several building elements at Ocean View Elementary School and Marin Elementary School which did not meet the Life Safety Performance Level of ASCE 31. Our firm subsequently performed an additional analysis of these suspect buildings as well as a general seismic study of the remainder of the district school buildings.

The buildings in question at Ocean View Elementary School and Marin Elementary School were built in 1975 and 1973, respectively. The buildings at each campus consist of wood-framed roofs supported by masonry and wood bearing and shear walls. When built before the more stringent provisions of later building codes were implemented, buildings of this type are regularly found to have several deficiencies, the most common being inadequate wall to roof connection.

The buildings at the balance of the Albany USD campuses are generally of more recent construction, light-frame wood construction, or have been recently retrofitted.

The reports by R.P. Gallagher Associates, Inc titled "Seismic Evaluation of Ocean View Elementary School" dated October 2012 and "Seismic Evaluation of Marin Elementary School" dated November 2012 detail the complete results of their seismic assessments of these campuses. The report titled "Initial Seismic Study of Albany USD Schools and Facilities" provides an overview of each building in the District's portfolio, site geologic hazards, and a discussion of DSA AB300 issues. Refer to these reports for a complete discussion of their findings as well as building key plans and photographs.

KPW Evaluation Procedure

Our evaluation primarily focused on the buildings at Ocean View and Marin Elementary Schools which were previously found to have to have seismic deficiencies. In addition to studying the results presented in the previously prepared reports, we performed an independent seismic analysis of these structures using the provisions of ASCE 31 "Seismic Evaluation of Buildings" as well as the current code, the 2010 California Building Code. Our analysis included performing structural calculations, completing the ASCE 31 Tier 1 checklists and visiting the two campuses.

Our study of the remaining Albany USD campuses consisted only of tabulating the construction type, construction date, and retrofit date of each building for purposes of categorizing the potential seismic hazards to each building. Modular buildings were not reviewed.

This report summarizes the results of our in-depth analysis and general district survey.

Ocean View Elementary School

Built in 1975, the main buildings at Ocean View Elementary School consist of three single story structures connected by covered walkways. The roof is generally flat with a sloped, elevated clerestory roof in each classroom. The wood frame roof is supported by masonry and plywood walls on conventional shallow foundations. Lateral forces are resisted by the plywood roof diaphragm and the interior plywood and exterior masonry shear walls.

A review of the as-built structural drawings found that the lateral force resisting elements were relatively well engineered and better than average for the era. Design consideration was given to the primary seismic elements including the roof diaphragm, chords, collectors, shear walls and key connections.

Several modular classroom buildings installed at a later date occupy the rear portion of the campus; these were not part of our seismic evaluation.

The results of our seismic study of Ocean View Elementary School are as follows:

Roof Diaphragm

A building's horizontal diaphragm transfers lateral forces generated by wind or earthquake loads to the perpendicular shear walls through in plane shear. The roof diaphragm at Ocean View Elementary School consists of ½" plywood with edge blocking and relatively tight edge nailing. Our study found that the roof diaphragms have both adequate shear and chord strength to resist current code level forces.

Collectors

Collectors are intended to transfer the horizontal diaphragm forces to the in-plane shear walls. Recognizing the importance of these elements, current codes apply an amplification factor to the calculated seismic forces when designing these components. Collectors at Ocean View consist of wood beams connected to the masonry or plywood shear walls with bolted metal angles. These collector elements often extend across wall or roof openings to connect portions of the roof diaphragm to somewhat distant shear walls.

Our analysis found that in general the collector connections are significantly overstressed when compared to current code level forces. Refer to Figure 1 for a typical collector connection.

Shear walls

Shear walls transfer building lateral forces to the supporting foundations. At each of the three buildings the exterior masonry walls consist of fluted 8" concrete masonry. The masonry walls are fully grouted and well-reinforced in a similar manner to what would be required by current standards. Interior plywood shear walls are sheathed on one or both sides with plywood and are connected to the foundation with sill bolts and holdowns. In-plane shear forces are transferred to both wall types with blocking and shear clips.

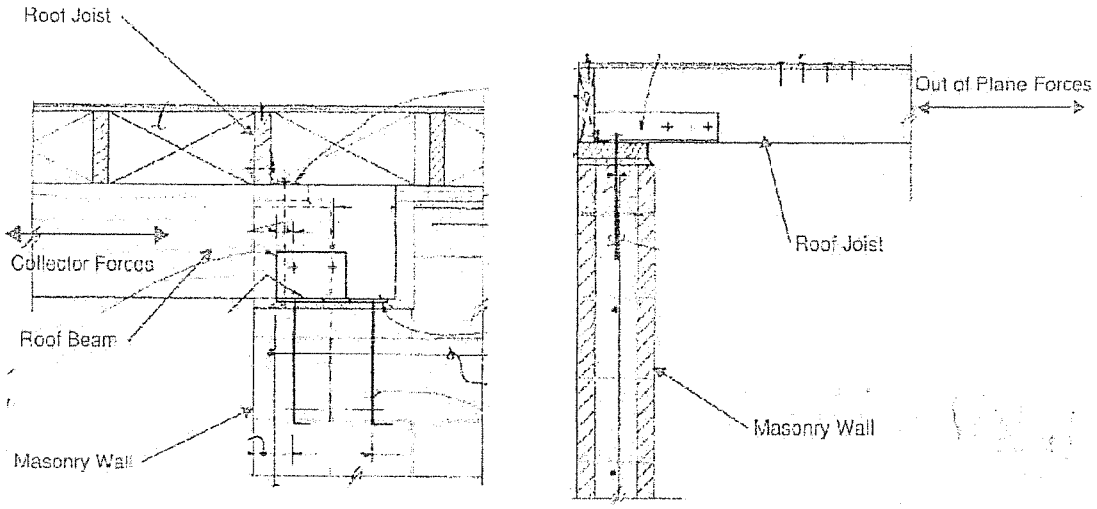
We found that both the masonry and plywood shear walls have adequate strength to resist the applied current code level forces.

Out-of-Plane Wall Anchorage

When subjected to earthquake shaking the connections between the heavy masonry walls and the light, flexible wood roof can be subjected to significant out-of-plane forces. Damage to these connections could result in separation of the walls from the roof and possible loss of support and collapse of the roof framing and walls. Building damage observed as a result of subsequent

earthquakes has led to the adoption of stricter anchorage standards in the building code since the time of Ocean View Elementary School's construction.

The out-of-plane wall connections at Ocean View generally consist of a steel angle bolted to the side of a roof joist and the top of the masonry wall as shown in figure 1. Our analysis of these connections found that they are significantly overstressed when subjected to the design forces of the current building code.



Typical Collector Connecion **Typical Out-of-Plane Wall Connection**

Figure 1: Typical Wall-Roof Connections

Marin Elementary School

The Marin Elementary School campus consists primarily of 6 hexagonally shaped classroom buildings (Buildings A, B, D, E, F, & G) and a multi-purpose building (Building C) built in 1973. The 1973 buildings consist of a wood frame roof supported by masonry and plywood walls on conventional shallow foundations. Lateral forces are resisted by the plywood roof diaphragm and the interior plywood and exterior masonry shear walls.

A rectangular, wood-framed classroom building (Building H) of unknown date and several modular buildings also occur on the campus. These buildings were not studied as part of our in-depth analysis.

A review of the 1973 as-built structural drawings found that the lateral force resisting elements of the wood/masonry buildings were relatively well engineered and perhaps better than average for the era. Consideration was given to the primary elements including the roof diaphragm, chords, collectors, shear walls and key connections.

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The results of our seismic study of Marin Elementary School are as follows. Also refer to our discussion of Ocean View Elementary School for a general definition of each lateral force resisting element.

Roof Diaphragm

The roof diaphragm at Marin Elementary School consists of ½" plywood with edge blocking and relatively tight edge nailing. Our study found that the roof diaphragms have both adequate shear and chord strength to resist current code level forces.

Collectors

As buildings are fairly regular in shape with limited wall openings roof diaphragm collectors are not a major component of the building's lateral force resisting system. However, in two locations the collector elements were found to be overstressed.

Shear walls

The exterior masonry walls generally consist of fluted 6" concrete masonry, with thicker block at the taller multi-purpose building wall. The masonry walls are fully grouted and well- reinforced in a similar manner to what would be required by current standards. Interior plywood shear walls are sheathed on one or both sides with plywood and are connected to the foundation with sill bolts and holdowns. In-plane shear forces are transferred to both wall types with blocking and shear clips.

We found that the masonry shear walls would have adequate strength to resist the applied current code level forces. The plywood shear walls were found to be overstressed.

Out-of-Plane Wall Anchorage

Similar to Ocean View Elementary School, the out-of-plane wall connections reflect practices common before the adoption of stricter anchorage criteria found in today's building code. The out-of-plane wall connections at Marin also consist of a steel angle bolted to the side of a roof joist and the top of the masonry wall. Our analysis of these connections found that they are significantly overstressed when subjected to the design forces of the current building code.

District Facilities Overview

Our survey of the remaining Albany Unified School District campuses consisted of determining the general characteristics of each building in order to identify potential seismic issues. We considered type of construction, building age, and whether past retrofits had been performed. Neither structural calculations nor a detailed as-built drawing review was performed for these buildings.

Cornell Elementary School

The main building at Cornell Elementary School consists of the seismically separated south, north, and admin wings and several modular buildings. The south wing and north wing, built in

1948 and 1950 respectively, are two story buildings with wood roofs and floors supported by reinforced concrete walls. The admin wing is a two story wood frame building built in 1974.

The north and south wing buildings were seismically retrofitted in 1997 and 2001, with the retrofit consisting of reinforcing the connection between the concrete walls and the wood floor and roof.

Given the type of construction and the past seismic retrofit these buildings these buildings would be considered to have a lower risk than older or more damage prone building types.

Albany Middle School

Built in 1997 with a steel braced frame lateral force resisting system, Albany Middle School could be expected to have a lower risk of damage when subjected to a large seismic event.

Albany High School

Albany High School was significantly rebuilt in 1999, with the addition of 4 new steel braced frame buildings. A reinforced concrete Fine Arts building with an unknown construction date remained on the site.

The 1999 steel frame buildings would be expected to have a lower risk of earthquake damage. The reinforced concrete Fine Arts building has was classified as Category 1 (expected to perform reasonably well in an earthquake) by the DSA AB300 list and the R.P. Gallagher Reports.

Albany Children's Center

The Children's Center consists of 5 wood frame buildings connected by a covered walkway and two modular buildings. The date of construction of the wood buildings is unknown though based upon our observations we estimated the buildings to be of 1950's or 1960's construction.

Macgregor High School

Macgregor High School Consists of 6 wood frame buildings and several modular buildings. The date of construction is unknown.

Conclusion and Recommendations

Our study found that certain elements at both Ocean View and Marin Elementary schools do not meet the life safety criteria of either ASCE 31 or the current building code. The primary elements found to be deficient were collector connections and out-of-plane wall anchors. Given the increased demand on these components prescribed by recent building codes, these deficiencies are commonly found in buildings of this type and vintage. The results of our evaluation are similar to those presented in the reports by R.P. Gallagher Associates Inc.

We would recommend that these deficient elements be strengthened as part of an overall seismic retrofit program. Retrofits of this nature are commonly performed and often can be implemented economically and with a minimal impact to the function or appearance of the buildings.