Seismic Risk Assessment

REPORT NO. SRA-61-01

for

BLOCK #60-1 (CENTRAL CLASSROOMS)

RICHMOND ELEMENTARY SCHOOL

2780 Richmond Road
Victoria, BC
V8R 4T4

Facility No: 6161060

School District No. 61
Greater Victoria School District

Structural Engineering Guidelines for the Performance-based Seismic Assessment and Retrofit of Low-rise British Columbia School

This Seismic Risk Assessment (SRA) report is the report that documents the seismic risk posed by a potentially high risk school block.

The Ministry of Education requires that a School District submit a SRA for any school block as the first due diligence step in support of the District's request that the given block be added to the list of high risk school blocks in the province.

The Engineers and Geoscientists British Columbia (EGBC) was requested by the Ministry of Education to develop the format and technical requirements for the SRA.

From a structural engineering perspective, the SRA for a high risk block is the first step toward starting a Seismic Project Identification Report (SPIR) that will document seismic retrofit options for the seismically deficient school block.

On-going feedback from engineering practitioners is encouraged to advance future enhancements of the SRA document.

Table 1.1: Seismic Risk Assessment Summary		
No.	**Technical Topic**	**Summary**
1	School Name and School District	• Richmond Elementary • Greater Victoria School District (SD #61)
2	Block No. / Name	• Block #60-1 • Central Classrooms
3	Engineer-of-Record Structural Firm	• Graham Taylor • TBG Seismic Consultants
4	Technical Reference	• Seismic Retrofit Guidelines 3rd Edition (June, 2017)
5	Year Built, Number of Storeys, Clear Storey Height, Floor Area	• 1967 • 2 Storeys • 3200 mm • 2,700 m^2
6	Type of Construction	• #13A (non-ductile concrete frame with URM partitions)
7	Soil Type	• Site Class E
8	Previous Seismic Upgrade	• None
9	Liquefaction Potential	• Low risk
10	Post-earthquake Maximum Sa(1.0)	• 13 %g (subduction)
11	PPR Thresholds (subduction)	• 15 %g (green / yellow) • 30 %g (yellow / red)
12	Risk	• H1 (High Level 1)

(Professional Seal and Signature)
Date

Figure 2.1: East Elevation
Block #60-1
Central Classrooms
Richmond Elementary School

INTRODUCTION

This chapter details the engineering analysis that generated the seismic risk classification (H1) given on the summary page (page 1-1).

BLOCK DESCRIPTION

A typical cross-section of the block is given in Figure 3.1. A description of the significant structural elements in this block is as follows:

Type of Construction: This block is comprised of a concrete frame with concrete masonry in-fill and a wood roof (glulam beams supporting a wood roof).

Year of Construction: This block was constructed in 1967. In this 1960s design, the tie spacing in the concrete columns is large by contemporary standards. A majority of the concrete columns have #3 ties (15M) at 200 o.c.

Storey Height: The majority of the block is two storeys in height.

VLS: The VLS for both storeys is comprised of non-ductile concrete columns that are an integral part of the concrete frame structural system.

Lateral System: The lateral deformation resisting system is comprised of the reinforced concrete frame. The concrete frame has been classified as a non-ductile concrete frame (SRG3 prototype #C-3) because of the large tie spacing in the concrete columns.

URM In-fill: The URM in-fill, for both the exterior walls and the interior partition walls, is constructed on unreinforced masonry. These concrete masonry walls were detailed on the architectural drawings, not the structural drawings. These walls have no vertical reinforcement and are therefore prone to out-of-plane failure.

Roof Diaphragm: The roof diaphragm is unblocked plywood with an unspecified nailing pattern. The roof diaphragm is considered a non-governing element in this seismic risk assessment.

GOVERNING PORTION OF BLOCK

The location of the governing portion of the block is illustrated in Figure 3.2. This portion of the block is typical of the two storey section of the block. The two storey section governs the overall block performance. The location of the governing portion of the block is illustrated in Figure 3.2. Figure 3.2 shows the location of the section detailed in Figure 3.1.

The governing storey for this block is the first storey.

SOILS

This block is founded on Site Class E soils (soft soils). The soil type is a crucial consideration in the overall assessment of the life safety risk posed by this block.

UNREINFORCED MASONRY WALLS

The exterior unreinforced concrete masonry walls are confined by the concrete frame and have been analyzed as SRG3 prototype #OP-3 walls. These exterior walls have a "H3 – High Level 3" Priority Retrofit Ranking.

The interior URM walls are not effectively supported at the top of the walls. These interior walls have a "H1 – High Level 1" Priority Retrofit Ranking.

CONCRETE FRAME

Analysis of the concrete frame in the first storey (SRG3 prototype #C-3) has determined that this non-ductile concrete frame has a "H1 – High Level 1" Priority Retrofit Ranking. This risk ranking has the greatest life safety consequences of all block elements with a deficient seismic rating. The data used in this analysis is given in Table 3.1.

The risk ranking of this block is governed by the risk ranking of the non-ductile concrete frame.

POST-EARTHQUAKE EVALUATION

The ground motion rating results for use in the post-earthquake evaluation of this block are given in Table 3.2. Some comments on the values in Table 3.2 are as follows:

Governing Hazard Type: The subduction hazard is the governing earthquake hazard type for this block. The maximum ground motion for this block is lowest for the subduction hazard. The subduction hazard has the largest numerical value for the deaggregated ground motion that has a 2% probability of exceedance in 50 years.

Sa(1.0): All numerical values given in Table 3.2 are deaggregated spectral acceleration Sa(1.0) values (%g units) for the subduction hazard.

PPR Thresholds: The green / yellow PPR threshold value in Table 3.2 is the ground motion value at the transition from the green damage state to the yellow damage state (drift limit ≤ 1%). The yellow / red PPR threshold value is the ground motion value at the transition from the yellow damage state to the red damage state (drift limit ≥ 2%).

RISK SUMMARY

The risk ranking of the block is summarized as follows:

Risk: This block has been assigned a "H1 – High Level 1" Priority Retrofit Ranking.

Concrete Frame: This risk ranking is governed by the performance of the non-ductile concrete frame in the first storey.

Soils: The soft soils exacerbate the shortcomings of the deficiency block elements. The combination of a poor structural system, heavy concrete construction and soft soils is a potentially dangerous combination.

Table 3.1: Analysis Data for Central Classrooms Non-ductile Concrete Frame

No.	Data Description	Value
1	SRG3 prototype	C-3
2	R_m	2 %W_s
3	Clear storey height	6000 mm
4	Drift limit	1 %

Table 3.2: Post-earthquake Evaluation Data

Data Description	Maximum Sa(1.0) Value
Post-earthquake Engineering Assessment	24 %g
PPR Green / Yellow Threshold	20 %g
PPR Yellow / Red Threshold	25 %g

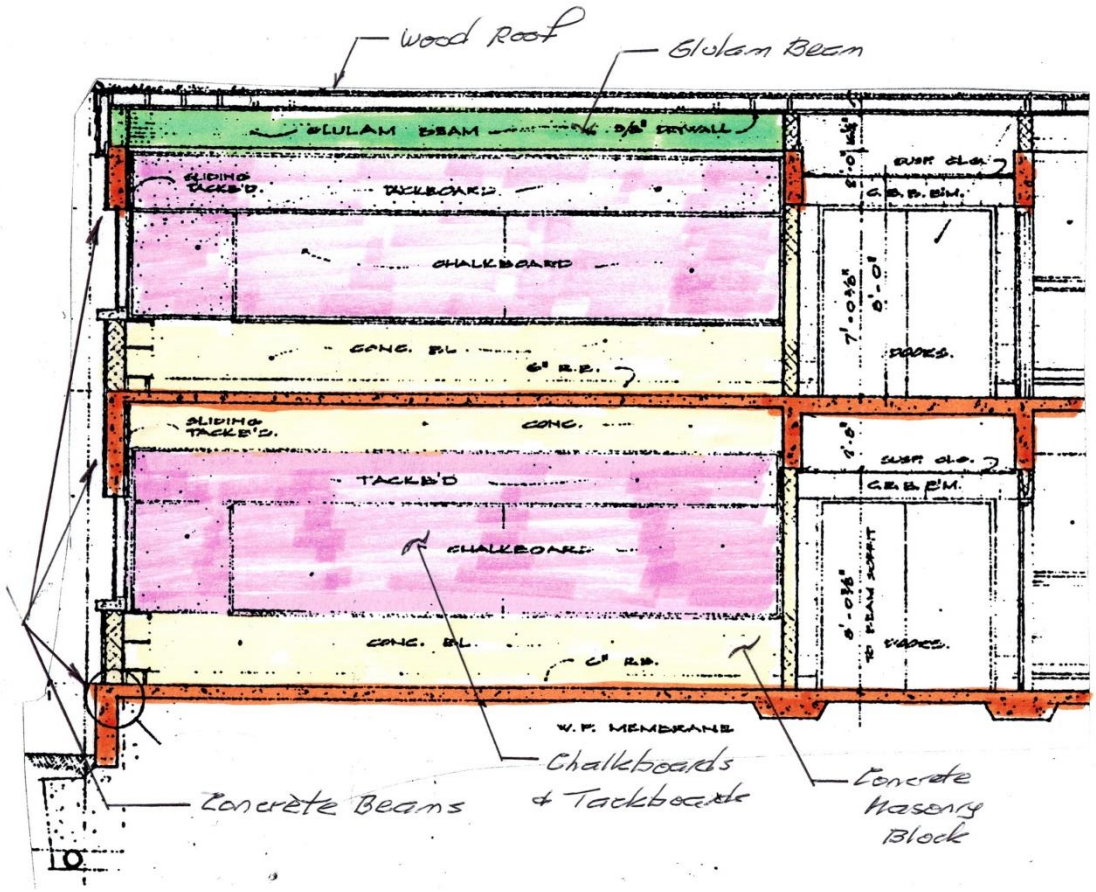

Figure 3.1: Typical Section
Block #60-1
Central Classrooms
Richmond Elementary School

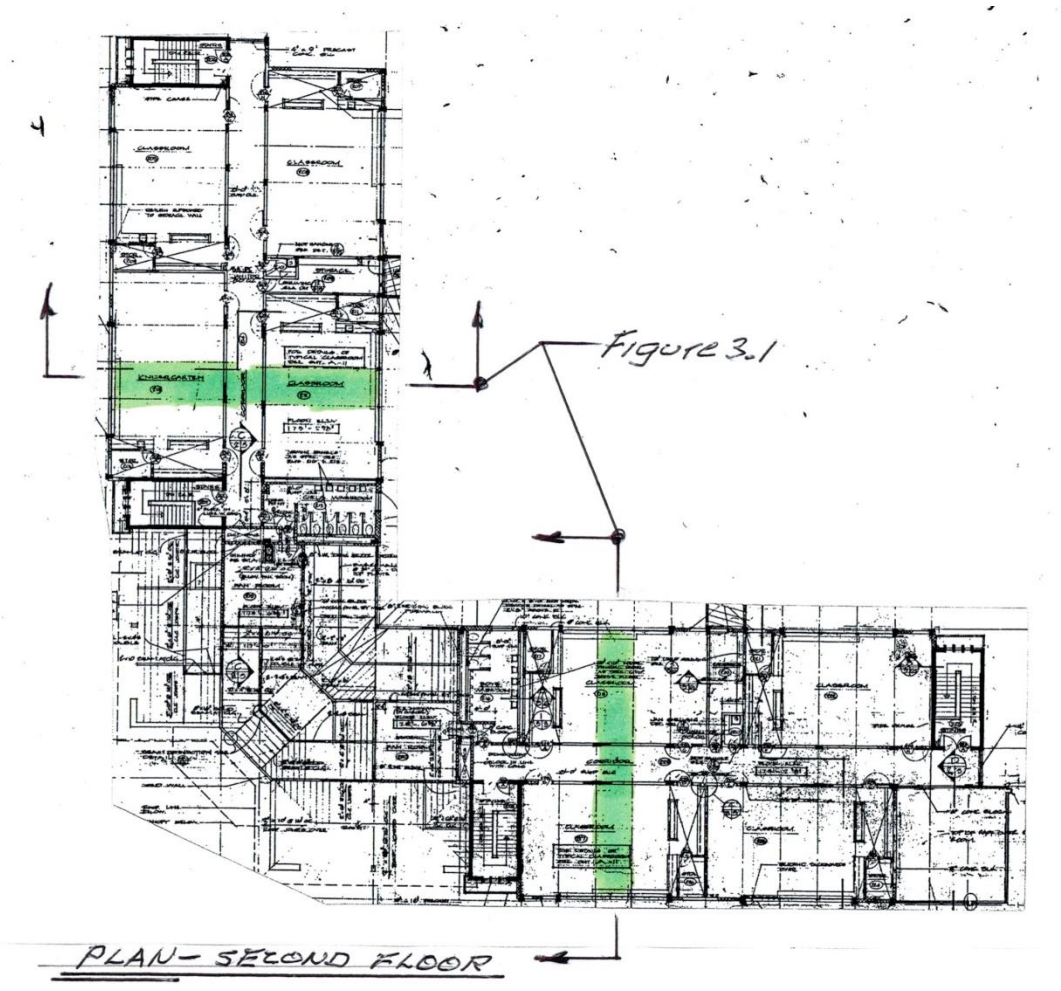

Figure 3.2: Governing Portion of Block
Block #60-1
Central Classrooms
Richmond Elementary School