Seismic Risk Assessment

REPORT NO. SRA-61-02

for

BLOCK #60-2 (GYMNASIUM)

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 #60-2 • Gymnasium
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 • 1 Storey • 5940 mm • 640 m^2
6	Type of Construction	• #32 (gym with URM running bond and wood roof)
7	Soil Type	• Site Class E
8	Previous Seismic Upgrade	• None
9	Liquefaction Potential	• Low risk
10	Post-earthquake Maximum Sa(1.0)	• 15 %g (subduction)
11	PPR Thresholds (subduction)	• 15 %g (green / yellow) • 20 %g (yellow / red)
12	Risk	• H1 (High Level 1)

(Professional Seal and Signature)
Date

Figure 2.1: South Elevation
Block #60-2
Gymnasium
Richmond Elementary School

INTRODUCTION

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

BLOCK DESCRIPTION

A typical elevation and cross-section of the gymnasium are given in Figure 3.1 and Figure 3.2. A description of the significant structural elements in the gymnasium is as follows:

Type of Construction: The gymnasium is comprised of a reinforced concrete frame with concrete masonry in-fill.

Year of Construction: The gymnasium was constructed in 1967.

Storey Height: The height of the gymnasium from the floor to the top of the roof is 5940 mm. The glulam beams are 4880 mm above the floor.

VLS: The VLS is comprised on reinforced concrete columns that are an integral part of the peripheral concrete frame. The glulam beams bear directly over the concrete columns.

Lateral System: The lateral deformation resisting system is comprised of masonry in-filled reinforced concrete frames.

Gymnasium URM Infill: The unreinforced concrete masonry comprising the gymnasium exterior walls is fully confined by the concrete frame. This masonry infill is a non-governing gymnasium element for both its in-plane behaviour and its out-of-plane behaviour.

Change Rooms URM Walls: The unreinforced concrete masonry end walls (non load-bearing) in the change rooms have been optimistically analyzed as out-of-plane walls supported at the top of the walls by the wood roof.

Glulam Beams: The glulam beams bearing on the concrete frame have limited lateral restraint for ground shaking in the longitudinal direction of the gymnasium. The glulam beams have been analyzed as rocking cantilevers.

Roof Diaphragm: The roof diaphragm is comprised of 20 mm board sheathing supported by roof wood joists spanning between the glulam beams. The roof diaphragm has a low capacity and is flexible. The roof diaphragm is considered a non-governing element in the analysis of the gymnasium.

GLULAM BEAMS – GOVERNING GYMNASIUM ELEMENT

The glulam beams, as illustrated in Figure 3.1, are the governing element in the seismic performance of the existing gymnasium.

For ground shaking in the longitudinal direction of the gymnasium, the glulam beams are relatively free to rock out-of-plane as laterally unsupported cantilevers. The wood frame infill between the ends of the glulam beams is assumed to be ineffective.

The analysis data for the assessment for the out-of-plane rocking of the glulam beams is given in Table 3.1.

The ground motion rating of the gymnasium, as given in Topic #10 and Topic #11 of Table 1.1, is based on the results of the analysis of the data given in Table 3.1.

URM WALLS – CHANGE ROOMS

The unreinforced concrete masonry end walls (non load-bearing walls) in the gymnasium change rooms comprise the second governing element for the seismic performance of the gymnasium. The end walls have no effective surcharge. The change room wood roof is assumed to provide lateral support for the top of these URM walls.

The analysis data for the assessment for the out-of-plane rocking of these URM walls is given in Table 3.2.

The ground motion rating results for these URM walls are very similar to the results given for the glulam beams in Table 1.1.

SOILS

The gymnasium 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 the gymnasium.

POST-EARTHQUAKE EVALUATION

The ground motion rating results for use in the post-earthquake evaluation of the gymnasium are given in Table 3.3. Some comments on the values in Table 3.3 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 3.3 are deaggregated spectral acceleration Sa(1.0) values (%g units) for the subduction hazard.

PPR Thresholds: The green/yellow PPR threshold value in Table 3.3 is the ground motion value for out-of-plane failure based on CPDE = 10%. The yellow/red PPR threshold value is the ground motion value for out-of-plane failure based on CPDE = 50%.

RISK SUMMARY

The risk ranking of the gymnasium is summarized as follows:

Risk: The gymnasium has been assigned a “H1 – High Level 1” Priority Retrofit Ranking.

Glulam Beams: This risk ranking is governed by the out-of-plane rocking of the glulam beams.

URM End Walls: The URM end walls for the gymnasium change rooms are highly vulnerable to out-of-plane failure.

Soils: The soft soils exacerbate the shortcomings of the deficient gymnasium elements.

Table 3.1: Analysis Data for Out-of-Plane Behaviour of Gymnasium Glulam Beams

No.	Data Description	Value
1	SRG3 prototype	OP-1
2	Glulam beam height	826 mm
3	Glulam beam width	178 mm
4	Surcharge	0 %

Table 3.2: Analysis Data for URM Change Room End Walls

No.	Data Description	Value
1	SRG3 prototype	OP-3
2	URM wall height	3460 mm
3	URM wall width	190 mm
4	Surcharge	0 %

Table 3.3: Post-earthquake Evaluation Data

Data Description	Maximum Sa(1.0) Value
Post-earthquake Engineering Assessment	15 %g
PPR Green / Yellow Threshold	15 %g
PPR Yellow / Red Threshold	20 %g

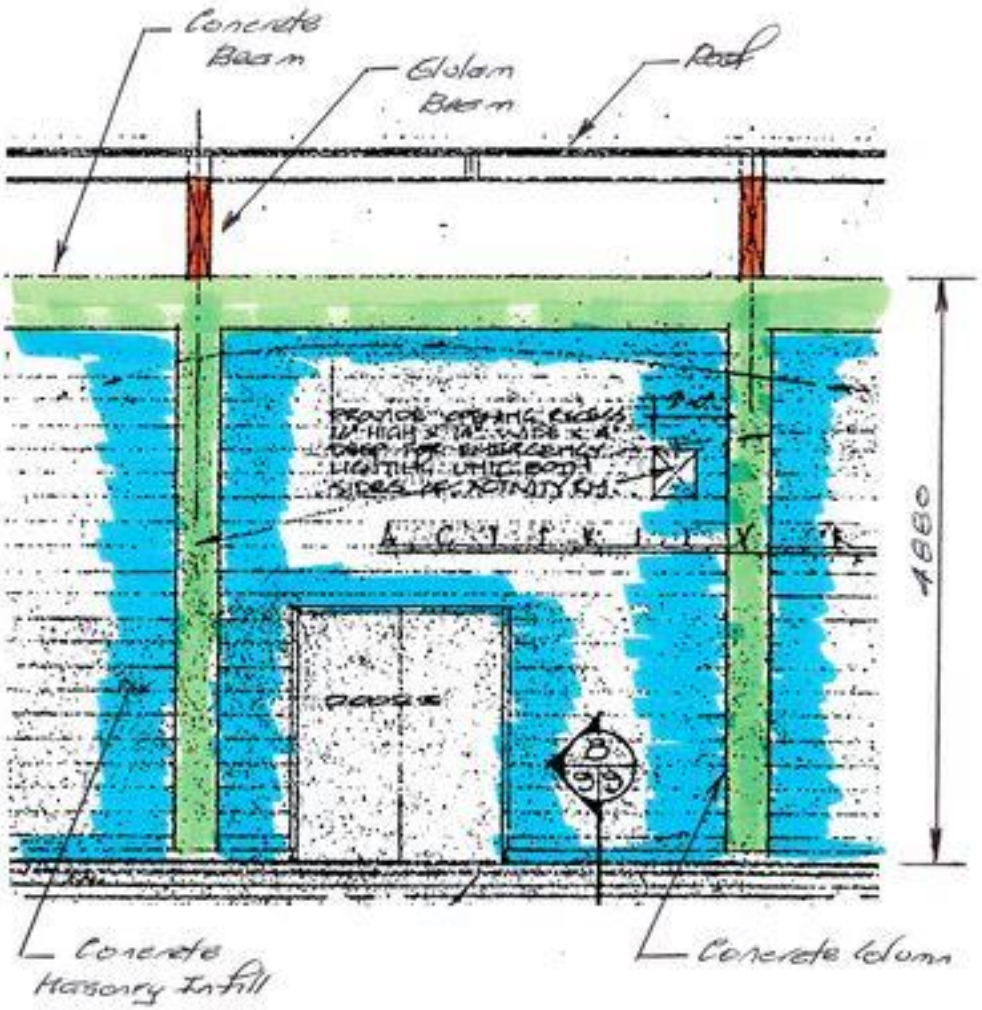

Figure 3.1: Typical Section
Block #60-2
Gymnasium
Richmond Elementary School

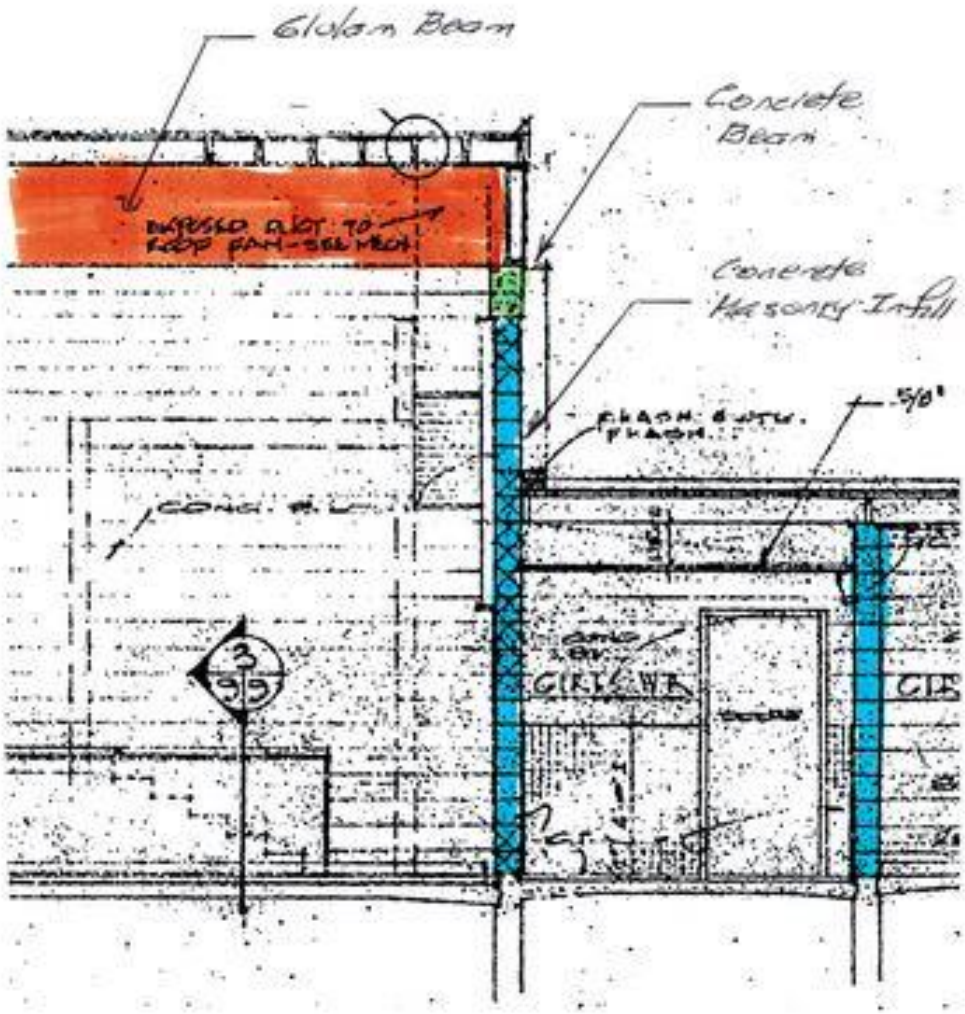

Figure 3.2 Typical Section
Block #60-2
Gymnasium
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