

City of Cranbrook 40 – 10<sup>th</sup> Avenue Cranbrook, BC V1C 2M8 Project No. 2023-130 Date: 2023-10-16

Attention: Steve Bell, Manager of Operations and Events

Re: Feasibility Review of Structural Repairs Cranbrook Memorial Arena 1432 2<sup>nd</sup> Street North, Cranbrook, BC

#### 1.0 Introduction

Bolen Engineering Inc. (Bolen Engineering) presents this report on the feasibility review of potential structural repairs to the deteriorated glulam arches of the Cranbrook Memorial Arena, located at the above noted address. It is the understanding of Bolen Engineering that this report was commissioned to review the feasibility of potential structural repairs to the arches, following the discovery of advanced wood deterioration and decay in the arches in September of 2023. This report is subsequent to an initial structural report for the building titled "Structural Condition Review Report of Glulam Arches" prepared by Bolen Engineering and dated 2023-09-26. It is the intention of this report to be read in conjunction with and with reference to the initial report. The review of demolition procedures, demolition safety, design of temporary shoring/bracing, and the detailed design of structural repairs (if required) is considered beyond the scope of this report.

## 2.0 Intent and Scope

It is the understanding of Bolen Engineering that the intent of this report is to explore and review the possibility of the structural repair of the deteriorated glulam arches of the Memorial Arena. This limited scope of work encompasses only the review of structural aspects of the building repair and does not include other aspects of the building, including but not limited to building functional use, building lifespan, building envelope conditions, occupant safety, fire safety, building egress, mechanical components, electrical components, geotechnical concerns, etc. Throughout this report, Bolen Engineering addresses the structural aspects of repair feasibility, however it is the recommendation of Bolen Engineering that all other aspects of the building be assessed and reviewed by a qualified consultant prior to moving forward with any proposed building repairs.

# 3.0 Site Description

The building can be described as an approximately 28,000 square foot ice arena. An entrance addition exists on the south end of the building and a changeroom addition exists on the north end. The main body of the building consists of (14) glulam arches spaced at 16'-0" o/c and spanning approximately 136'-0" across. Each of the (14) arches consist of (2) separate arch pieces joined at the roof peak with an unknown steel connection. The glulam arches exist with approximately 16'-0" exposed on the exterior portion of the building and the remaining span on the interior of the building. It is reported that original construction of the building is likely circa 1950 (73 years old) with new steel base bracket supports having been installed in 2008/2009 (14-15 years old).

The existing glulam arches of the building were reviewed by Bolen Engineering in September of 2023. At that time Bolen Engineering identified significant structural issues with the arches associated with wood deterioration and recommended that the building not be occupied. Following the issuance of that report, a "Do Not Occupy" notice was posted on the building on September 27, 2023, by City of Cranbrook staff.



Brandon Bolen, P. Eng, a structural engineer, and Ian Jones, AScT. employed at Bolen Engineering, attended the site on October 10th, 2023, along with an excavation contractor. At that time, Bolen Engineering uncovered and reviewed existing foundations of the glulam arches, recorded observations, collected measurements and took photographs.

# 4.0 Structural Repair Analysis and Discussion

It is the understanding of Bolen Engineering that this report was commissioned to review the feasibility of repairing the existing building structure due to the damage and deterioration of the existing glulam arches.

It should be noted that the BC Building Code loading requirements have been revised over the years and in particular the climatic (snow) loading requirements. It is worth noting, for example, that ground snow loading values for the Cranbrook area have increased from 2.1 kPa (1960) to 3.0 kPa (2018). Buildings may have been designed and constructed to loading requirements at the time of construction, however some structural components may not meet current BC Building Code (2018) requirements. The BC Building Code recognizes this changing requirement and accepts or "grandfathers" previously conforming buildings under the current code requirements, provided there is **not**:

- a change in occupancy/use,
- a major structural renovation,
- and the building is not exhibiting significant signs of structural distress/damage.

As the glulam arches of the building are showing advanced signs of structural distress, the "grandfathering" of these building components would not apply. As such, any structural repairs to the building arches would be required to meet **current** BC Building Code requirements and any supporting structural components would also be required to meet **current** BC Building Code requirements.

#### 4.1 Conceptual Structural Repair

A conceptual structural repair plan for the building was developed by Bolen Engineering with the intent of removing the existing deteriorated portions of the glulam arches, reinstating the structural integrity of the building structure, and incorporating a structural repair which could be installed minimal impact to the existing building layout. A preliminary 3D model of the conceptual structural repair developed by Bolen Engineering is shown below in Figure 1.

Design assumptions and loading requirements for the analysis of the building repair are as follows:

•	Ground Snow Load (Ss)	= 3.0 kPa
•	Rain Load (Sr)	= 0.2 kPa
•	Basic Roof Factor (Cb)	= 0.8
•	Importance Factor	= 1.0
•	Superimposed Dead Load (assumed)	= 0.8 kPa





Figure 1: Conceptual Structural Repair Option

4.2 Conceptual Structural Repair Overview

The conceptual structural repair consists of the following repair actions:

- 1. Excavation adjacent to building for new concrete foundation placement.
- 2. Placement of new reinforced concrete foundations.



Figure 2: Foundation Installation



3. Installation of new steel tension ties across each set of glulam arches.



Figure 3: Tension Tie Installation

- 4. Temporary shoring of glulam arches to support vertical loads.
- 5. Removal of exterior deteriorated portion of glulam arches and existing arch foundations.
- 6. Installation of new steel columns complete with steel beam saddles to connect to existing arches.







#### 7. Installation of new diagonal braces.



Figure 5: New Steel Brace Installation

8. Installation of diagonal bracing for lateral load resistance.



Figure 6: New Steel Cross Bracing Installation

The structural repair method outlined above addresses the structural deterioration observed within the existing glulam arches of the building and restores the structural stability of the existing building. Additionally, the structural repair can be accommodated within the existing building layout with minimal impact on existing building systems.

It should be noted that this list is conceptual and preliminary in nature. The list is intended to act as a presentation of the proposed structural repair and is not intended to be used for construction. Additionally, it is worth noting that other repair options and configurations may exist which have not been reviewed by Bolen Engineering. Any building repairs should only be completed under the direct supervision of a qualified structural consultant.

It should be noted that the scope of this report includes the feasibility of structural repair of the building and as such only the exposed structural components of the building were reviewed by Bolen Engineering. The condition of "Non-Structural" items, including but not limited to architectural, finishes, occupant safety, fire protection, civil, geotechnical, mechanical. electrical and building envelope, or any other non-structural items have not been reviewed by Bolen Engineering.

## 4.3 Structural Repair versus Replacement

It is worth noting that while the structural repair of the building appears structurally feasible, the replacement of the existing building arch roof structure can be considered a viable structural option as well.

The installation of a new building structure, potentially pre-engineered steel, was conceptually reviewed by Bolen Engineering as a potential repair option as well. While this option of repair would likely require additional demolition as well as additional construction timeframes, this option does provide the added benefit of providing a new building structure surrounding the existing rink space.

# 5.0 Opinions & Recommendations

Based upon the above noted observations, analysis and discussion, Bolen Engineering provides the following opinions and recommendations:

- 1. <u>Building Repair</u>: It is the opinion of Bolen Engineering that the structural repair of the building roof is a structurally viable option. It is the recommendation of Bolen Engineering that should structural repairs be undertaken on the building, a qualified structural consultant team should be engaged to provide detailed design of the structural repairs and to oversee construction.
- 2. <u>Building Replacement</u>: It is the opinion of Bolen Engineering that replacement of the existing arch roof system with a new building system is considered a structurally viable option as well. It is the recommendation of Bolen Engineering that both repair and replacement options be considered and evaluated when determining the planned rehabilitation of the building.
- 3. <u>Other Building Systems:</u> It is the recommendation of Bolen Engineering that the remaining building systems including but not limited to architectural, building envelope, mechanical, electrical, occupant safety, building functional use, and building lifespan be reviewed by a qualified building consultant prior to proceeding with structural



# repairs. Entry into the building is to be completed only as per the requirements of the City of Cranbrook Building Department.

## 6.0 Limitations:

This report has been compiled in a fashion consistent with the standard of care and skill which can ordinarily be expected of a member of the engineering profession under similar conditions. No warranty is made, whether implied or express. This document has been prepared for the sole use and benefit of this project and client only and represents the professional opinions and judgements of Bolen Engineering based upon the knowledge and information available at the time this report was prepared. Any and all recommendations provided by Bolen Engineering are based upon our site review as well as any information provided by the client. It is common for other issues to exist in a building which may not be detected during our review as they are not readily accessible or are hidden from view. As such, should additional issues be noted during construction or at a later date, Bolen Engineering should be notified immediately. Bolen Engineering cannot be held responsible in any way for unknown or hidden site conditions. Any persons relying on this report do so at their own risk. The observations, opinions, recommendations, and all other content contained within this report are specific and applicable to this project only and are not applicable to any other project. If reference is to be made to this report, it must be made to the report in its entirety.

We trust that this report satisfies your requirements for this project. If you have any additional questions or concerns, please contact the undersigned at (250) 464-9268.

Sincerely,

Brandon Bolen, P. Eng Structural Engineer