

## The Challenges of Replacing Existing Pot Bearings

Alex Stuart  
Senior Structural Engineer  
Egis  
Kingston, Ontario  
alex.stuart@egis-group.com

Joel Covert  
Structural Engineer  
Egis  
Kingston, Ontario  
joel.covert@egis-group.com

Derek Simms  
Structural Engineer  
Egis  
Ottawa, Ontario  
derek.simms@egis-group.com

Paper prepared for the session Transportation Structures  
2025 Transportation Association of Canada (TAC) Conference & Exhibition  
Quebec City, Quebec

## Abstract

Pot bearings are commonly used in post-tensioned superstructures due to their ability to support heavy loads, control articulation with guides, and offer a longer service life compared to conventional elastomeric bearings. However, longer post-tensioned structures often face issues with insufficient sliding surface length. Original designs have not always accommodated the time-dependent effects of creep and shrinkage, as well as the updated sliding requirements under seismic conditions. Additionally, pot bearings can deteriorate from sustained exposure to chlorides and continuous loads. The work associated with bearing replacement is costly, challenging, and time-consuming.

Particularly for pier columns, the design and construction of temporary support systems to facilitate pot bearing replacement present numerous challenges. Finite element analysis (FEA) is suited to assess load redistribution during jacking and temporary conditions while maintaining structural stability. Temporary supports require robust structural capacity to provide sufficient load transfer during jacking and supporting of the structure during the replacement work; however, the robustness of the temporary supports in proximity to the pier columns can limit access to the bearings and impact the constructability of the work.

This paper will explore these challenges and the unique aspects of replacing pot bearings on post-tensioned bridges. It aims to provide valuable insights and practical recommendations for engineers and practitioners involved in the maintenance and rehabilitation of post-tensioned bridges, ultimately contributing to the longevity and reliability of critical infrastructure assets.

## 1.0 Introduction

### 1.1 What Are Pot Bearings

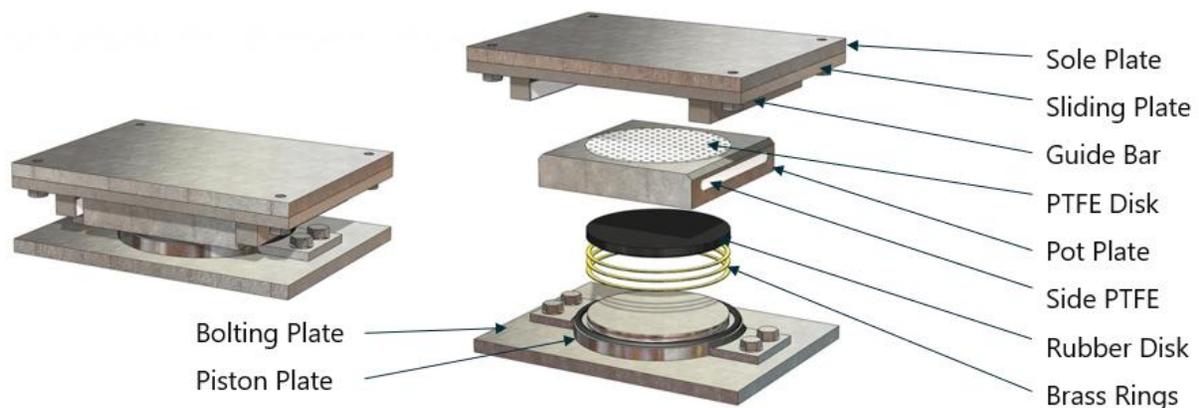
Bridge pot bearings are a type of structural bearing used in bridge construction to accommodate movements and rotations between the bridge superstructure and its supporting piers or abutments. They are designed to support large vertical loads while accommodating or guiding horizontal movements and rotations due to thermal expansion, seismic activity, or other factors. Key components of pot bearing assemblies include:

1. Pot: A shallow steel cylinder that contains an elastomeric disc.
2. Elastomeric Disc: Polymer material that allows for rotational movement by deforming under load.
3. Piston: A steel plate that sits on top of the elastomeric disc and transfers the load from the superstructure to the pot.
4. Guide and Restraint Mechanisms: These may be included to control the direction and magnitude of movements.

Figure 1. Pot Bearing Assembly Installed



Figure 2. Pot Bearing Exploded Assembly Schematic



Source: Canam-Bridges<sup>1</sup>

Pot bearings offer a longer service life compared to conventional elastomeric bearings and are favoured for their ability to handle high loads and accommodate large movements, making them suitable for solid and voided slab post-tensioned bridges, which are commonly found in Ontario, Canada.

While pot bearings are generally designed with extended service lives, certain situations and conditions warrant pot bearing replacement. Such conditions include bearings that become seized and no longer allow the superstructure to move relative to the underlying substructure components, or bearings with insufficient sliding surface necessary to accommodate the full thermal expansion and contraction cycles that the structure will undergo on an annual basis.

## **1.2 Common Problems with Existing Bearings**

Pot bearings are generally designed to provide sufficient sliding surface length for a structure's anticipated thermal expansion and contraction cycles. Bearings are typically detailed with the maximum required thermal expansion or contraction length calculated at each bearing location, and this maximum thermal cycling length is provided on either side of the bearing. Given that the bearing arrangement is temperature-dependent, 15°C is typically used as the neutral temperature for general bearing installation. When bearing installation is completed at temperatures varying from 15°C, installation instruction is typically provided to shift the bearing's arrangement on the sliding surface to accommodate the non-neutral temperature at installation. When these provisions are followed, pot bearings typically perform well for the service life of the structure.

However, particularly for post-tensioned concrete voided deck structures, time-dependent material effects (i.e., creep and shrinkage) of the bridge structure can result in notable changes to the overall structure length and must be accounted for in the initial bearing design. The time-dependent effects of creep and shrinkage both result in an overall reduction of the structure's length. Where these time-dependent material effects are not considered, the available sliding surface provided on one side of the bearing may decrease over time to such an extent (depending on the magnitude of these effects) that the necessary sliding surface for thermal contraction cycles is insufficient.

Figure 3. Bearing Insufficient Sliding Surface Due to Time-Dependent Material Effects



As a result, the bearing may become irregularly loaded, resulting in potential bearing failure or the bearing becoming pinched and no longer providing thermal movement capacity. Along with potential displacements across the structure should a bearing fail, this condition could also result in disastrous effects for the substructure. When bearings fail or become seized, the structure's intended load distribution and articulation could significantly change, transferring unintended forces into substructure elements.

Along with time-dependent material effects, pot bearings may warrant replacement due to seismic requirements or permanent displacements that resulted from previous seismic loading. Additionally, bearings may degrade due to environmental exposure, resulting in much higher friction forces transferred between the superstructure and substructure throughout thermal cycles.

The following sections will explore the challenges and the unique aspects of replacing pot bearings on post-tensioned bridges.

## **2.0 Pot Bearing Replacement Design Considerations**

Pot bearing replacement design must ensure that the original cause of the previous bearing's poor performance (time-dependent effects, seismic activity, environmental exposure) is well understood (and mitigated where possible) to ensure that similar poor performance is not repeated. Whatever the proposed bearing replacement arrangement, the designer must use caution, ensuring not to alter the overall structure's articulation without considering the effects on each structural element.

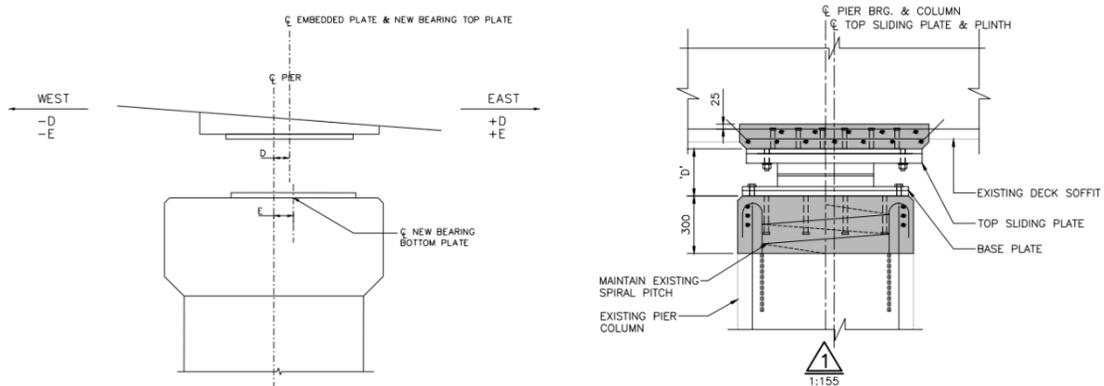
### **2.1 Replacement Bearing Layout**

For conditions where bearings are being replaced due to a lack of available sliding surface resulting from time-dependent material effects (i.e., bearing top plate on superstructure permanently shifted relative to bearing assembly on substructure), various alternatives can be considered for the replacement bearing arrangement.

One approach to bearing replacement involves reinstalling a new bearing with similar geometry to the original, but with the replacement bearing permanently shifted on the substructure. For example, this would involve installing the new pier column bearings at an offset to the centroid of the pier column. While this arrangement may be suitable for the performance of the new bearing by eliminating the time-dependent effects and resetting the bearing's neutral position for thermal movements, caution must be used with this approach. By shifting the bearing location and creating a load eccentricity at the top of the pier columns, additional flexural loading will be induced in the pier columns (which may not possess sufficient flexural capacity). While the additional flexural loads may not result in catastrophic failure of the columns, the additional loading may exceed the serviceability limits of the columns, resulting in flexural cracking near the base of the columns, thereby affecting the column's durability and anticipated service life. For these reasons, this approach is not typically preferred.

Alternatively, rather than shifting the replacement bearings relative to the substructure, a preferred replacement bearing arrangement involves maintaining the original bearing location on the substructure and simply designing the bearing top plate (affixed to the underside of the superstructure) with a longer sliding surface. While this approach does not truly restore the replacement bearing to a "neutral" position (i.e., not centred on the top plate sliding surface), the intended function of the bearing's movement capacity is restored without inducing additional eccentric loads into the substructure.

Figure 4. Replacement Bearing Arrangement (Substructure Offset vs Extended Top Sliding Plate)



## 2.2 Construction Considerations in Design

When detailing pot bearing replacement, the removal and reconstruction of the existing superstructure (i.e., deck soffit) and substructure (i.e., pier column or abutment) require sufficient removals to allow for sufficient embedment of the new bearing top and bottom plate studs.

For bearing replacement on a pier column, the reconstruction of the top of the column is relatively straightforward, as the column's concrete and reinforcement are partially replaced. Typically, column reinforcement is primarily concentrated towards the outer edge of the pier column, which provides a relatively uncongested area within the column core to locate the bearing bottom plate anchors with minimal conflicts. However, when trying to perform removals and reconstruction of the bearing top plate area on the deck soffit (particularly over the abutments), conflicts with the existing structure reinforcement are generally present. Due to the tight reinforcement spacing and size of reinforcement over pier areas, the available space for the top plate anchors is limited, requiring custom fitting for each bearing location, and can only be confirmed once the soffit concrete removals are complete. In light of these challenges with installing the top plate, it is advised that the top plate anchor layout be identified as a field fit to suit the existing reinforcement. Ultimately, the final anchor arrangement must be reviewed by the bearing manufacturer.

Figure 5. Congested Soffit Reinforcement and Top Plate Custom Anchor Layout to Suit

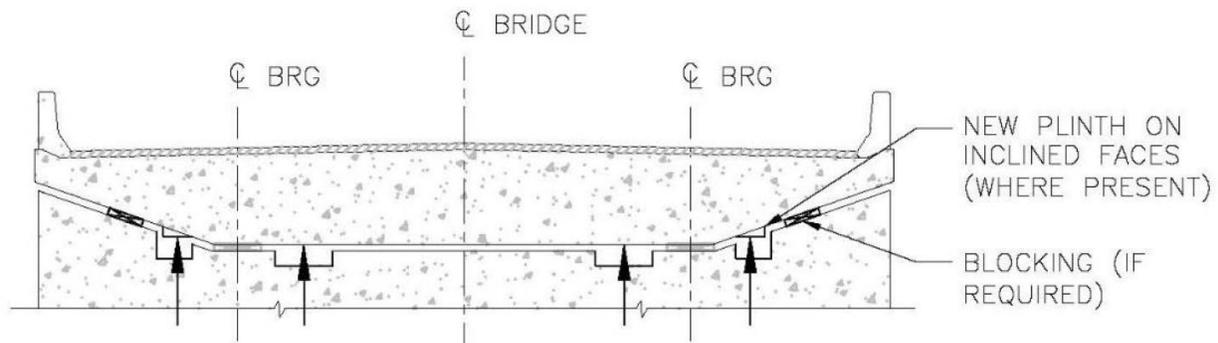


### 3.0 Temporary Support Systems

To facilitate the bearing replacement, the superstructure must be jacked and temporarily supported. Since pot bearings are generally required to support heavier superstructures (solid or voided concrete slab bridges), jacking is more difficult for these types of structures than conventional slab-on-girder bridges.

At abutments, the existing bearing seat is commonly used with the addition of jacking pockets to create additional vertical space for the jacks below the existing superstructure. An example of this configuration is provided in Figure 6.

Figure 6. Example of Jacking Pockets at Abutments

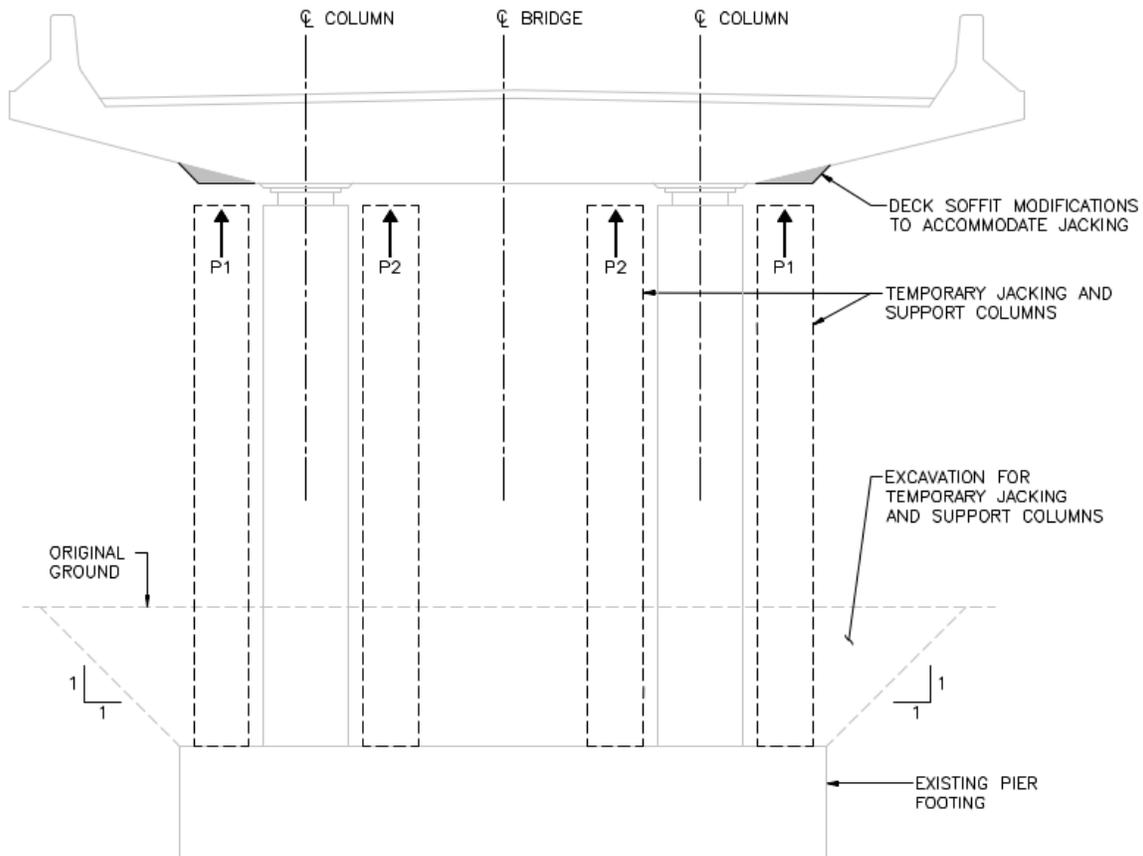


Source: MTO Bearing Replacement and Jacking Guidelines<sup>2</sup>

The temporary support system, at piers, is more complex for solid and voided slab bridges, as these types of structures were commonly built in Ontario with a single pier column supported on a spread footing or pile cap with piles. Because of this, jacking from the existing pier bearing seat is not possible, requiring the construction of a temporary support column adjacent to the pier column as shown in Figure 7.

Depending on the load demand and Contractor preference, temporary steel or concrete columns are erected on the existing pier footing.

Figure 7. Typical Pier Jacking Configuration



The temporary jacking and support columns can be constructed of steel or concrete, depending on the load demand and the Contractor's preference. Ideally, these columns can be supported on the existing pier footings (where present). The designer will need to assess the stability and capacity of the existing footing to accommodate the additional loads and eccentricities associated with jacking.

Alternatively, if there isn't an existing pier footing or if the existing pier footing can't accommodate the temporary support columns, an independent foundation (spread footing, piles, or caisson) must be constructed to support the columns. The construction of this foundation is often challenging as the existing superstructure will restrict the height of the foundation installation equipment and may also require additional temporary roadway support if being constructed adjacent to an existing roadway.

Figure 8. Steel Temporary Support Columns



Figure 9. Concrete Temporary Support Columns



The superstructure needs to be analyzed with the proposed jack locations to determine the expected jacking loads and load changes to the superstructure. The temporary jacking columns must also be designed to accommodate any longitudinal and transverse loads applied to the support columns during jacking. This would include superstructure translation from thermal changes, construction loads, wind loads, earthquake loads, and potential impact loads.

The number of jack locations at each pier bearing is dependent on the number of jacks required, the existing space, and the construction access requirements. Jacks should be placed as close to the existing bearings as practically possible while also providing sufficient space for concrete and bearing removal and reconstruction.

It's important to highlight that each jack location will have different load demands, requiring a Finite Element Analysis of the superstructure to assess these configurations.

Under temporary support conditions, the structure's existing stability (lateral and rotational) and articulation must be considered and maintained throughout all stages of construction. Examples of structures that require diligent review include bearing replacements on curved structures, structures with inclined bearings, and bearing replacements for piers consisting of single columns. Staging provisions may also be warranted.

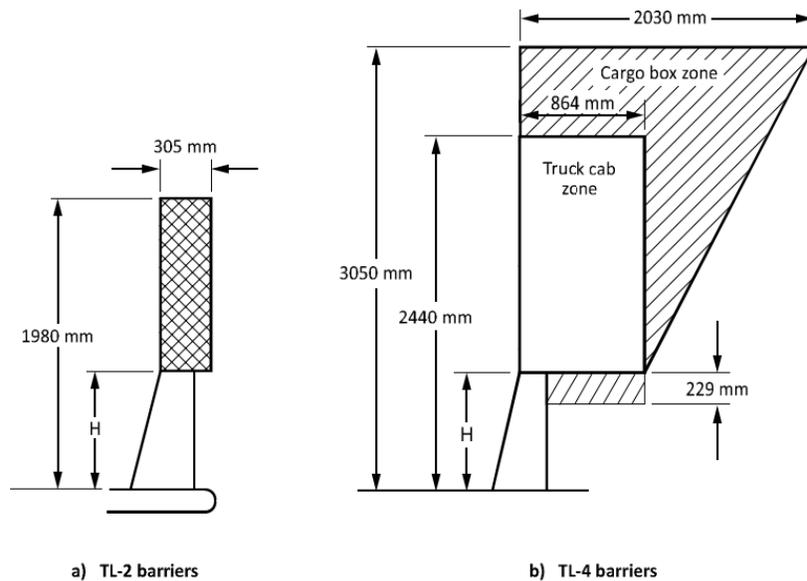
#### **4.0 Constructability Considerations**

The Designer must consider the constructability of the bearing replacements. The following is a summary of major design considerations that can impact the success of replacing the bearings.

**Access and Space Constraints:** Bridge piers are often located in areas with limited access, such as over water or in urban settings, making it difficult to bring in heavy equipment and materials. The Designer must anticipate the expected limits of the working area and determine if any additional measures need to be taken, such as in-water work permits, short-term or long-term lane closures, or potential reconstruction of the roadway safety features.

In addition, the designer should consider the limits of the access platform and whether the truck's zone of intrusion may overlap with the access platform and work area.

Figure 10. Zone of Intrusion for TL-2 and TL-4 Barriers from CSA S6-19



Source: Page 830 of CSA S6-19<sup>3</sup>

**Safety Concerns:** Working at heights and near traffic can pose significant safety risks. The Contractor must provide suitable access platforms to permit safe removal, inspection, and replacement of the bearing.

**Jacking Elevations:** The existing top of bearing elevations must be restored to ensure strain compatibility of the superstructure is restored upon completion of the bearing replacement. This will require the Contractor to set the new bearing elevation to match the existing.

**Shear Studs:** Shear studs in the upper and lower bearing plates of the pot bearing assembly need to be adjusted/measured in the field to ensure the shear studs can fit up between the existing structure reinforcement. In Ontario, the design for the length and number of shear studs required for the pot-bearing assembly is the responsibility of the bearing supplier. This requirement should be highlighted to the Contractor in the Contract package. An example of the irregular layout of shear studs is included in Figure 5.

**Bearing Alignment:** The new pot bearings must be aligned in accordance with the requirements of the Canadian Highway Bridge Design Code (S6-19).

**Construction Duration:** Based on recent construction projects, pier bearing replacements for bridges with a single pier column took 1.5 to 2 months per pier column. The designer must consider this when developing the anticipated construction schedule for tendering.

## 5.0 Summary

Bridge pot bearings are structural components used in bridge construction to accommodate movements and rotations between the superstructure and supporting piers or abutments. They are designed to support large loads while allowing for horizontal movements and rotations due to factors like thermal expansion and seismic activity. They offer a longer service life compared to conventional bearings and are suitable for post-tensioned bridges, such as those in Ontario, Canada.

Common issues with pot bearings include insufficient sliding surfaces due to time-dependent material effects like creep and shrinkage, which can lead to poor performance. Environmental exposure and seismic activity can also necessitate bearing replacement.

Replacement design must address the causes of poor performance and ensure the structure's articulation is not adversely affected. Bearing replacement at piers often requires the robust construction and design of temporary columns founded on the existing pier spread footings. The Designer needs to consider the space required for the temporary support to ensure all necessary provisions are included in the tender document to support the replacement.

Pot bearing replacement is a time-consuming activity that typically requires 1.5-2 months per pier bearing. The Designer must consider this when developing the anticipated construction schedule for tendering.

Figure 11. Bearing PTFE Dislodged



Figure 12. Finite Element Modelling

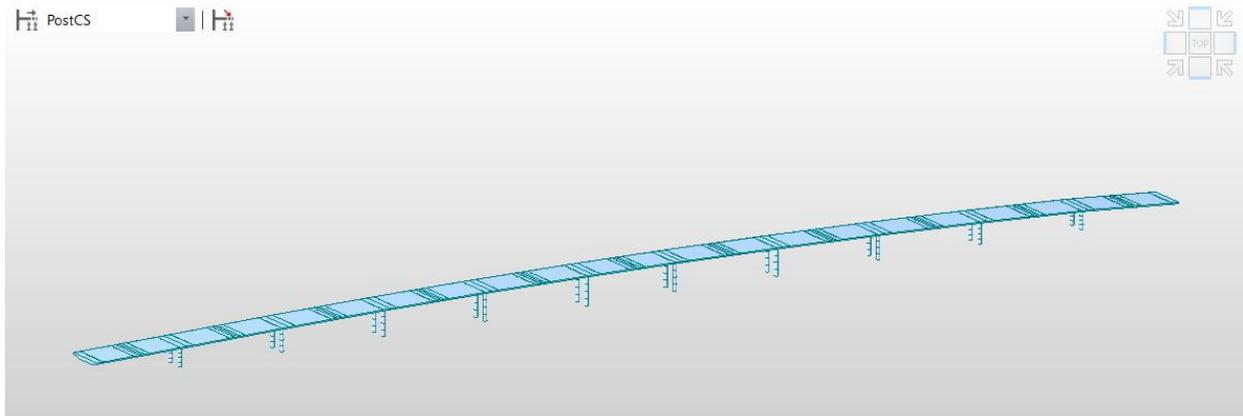


Figure 13. Removal of Top of Pier

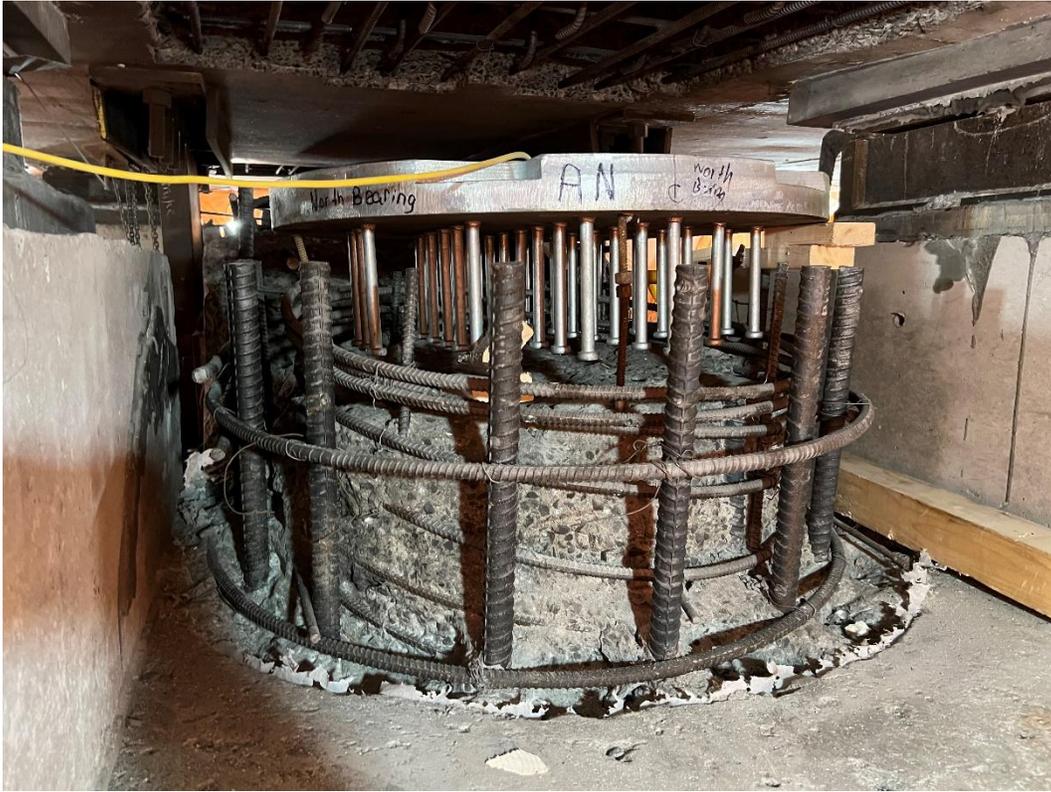


Figure 14. Access Platforms



Figure 15. Newly Installed Pot Bearing

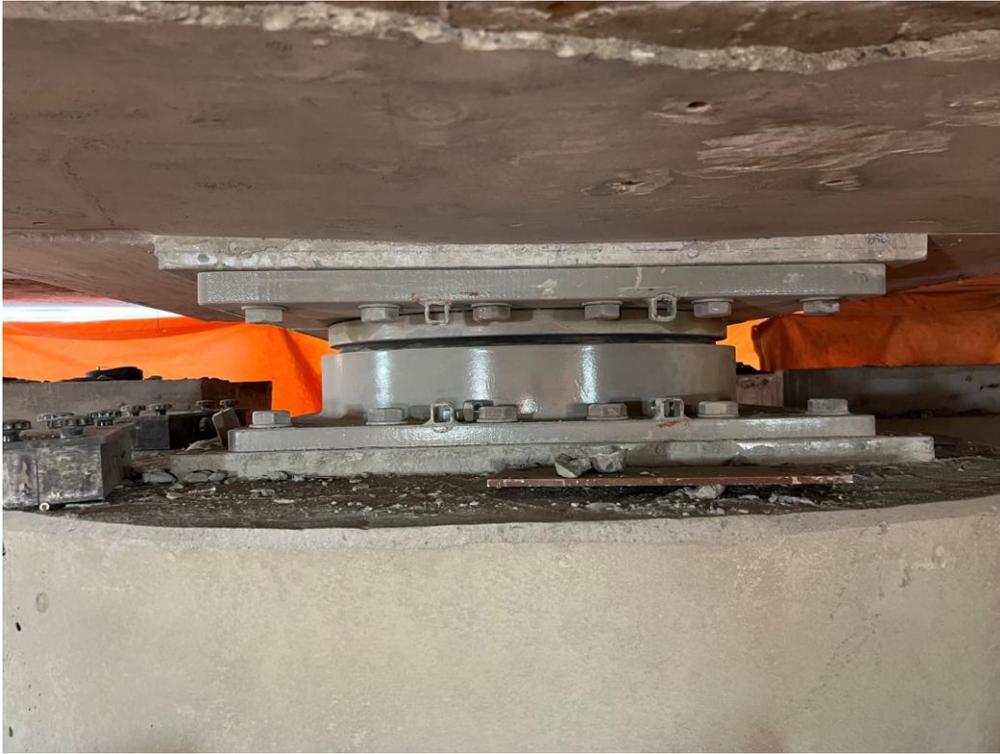


Figure 16. Temporary Support and Jack Housing Assembly



---

## References

- <sup>1</sup> Canam-Bridges, <https://www.canambridges.com/products/goodco-z-tech/structural-bearings/pot-bearings/pmg-series-unidirectional-edge-guided-bearings/> (accessed September 26, 2025)
- <sup>2</sup> Ontario Ministry of Transportation. *BRO-062: Bearing Replacement and Jacking Guidelines*. St-Catharines, Ontario (July 2018)
- <sup>3</sup> Canadian Standards Association. *CSA S6:19: Canadian Highway Bridge Design Code*. Mississauga, Ontario (2019)