RAPID REPAIR DESIGN OF TEMPORARY SUPPORT SYSTEMS FOR BRIDGES DAMAGED BY EARTHQUAKES IN THE STATE OF WASHINGTON

APPENDIX A – DESIGN MANUAL

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FOR BRIDGES DAMAGED BY
EARTHQUAKES IN THE STATE OF WASHINGTON

Appendix A – Design Manual

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Purpose and Scope

This project provides a design manual that includes guidelines and procedures for constructing rapid temporary shoring systems for damaged bridges. This manual will be further integrated into the WSDOT Bridge Design Manual. The designs provided here will be used by the WSDOT bridge officials who will oversee all construction of the temporary shoring systems. This manual could also be implemented into the FEMA handouts for bridge inspection and could be provided to assist other local governments.

WSDOT responsibilities after an earthquake that damages the state transportation system are to insure the safety of the traveling public, protect transportation facilities from further damage, restore traffic on the highway system as quickly and safely as possible, and to maintain a timely and current assessment of the extent of damage and operation status of the transportation system.

The scope of this project deals primarily with the technical aspects of building a rapid pre-engineered shoring system for damaged bridges. Broad criteria were set forth by the WSDOT Bridge and Structures Office to accommodate 75% of all bridges within the state of Washington. The shoring system is to retain heights between 15 to 40-feet.
Flow Chart of Temporary Shoring
Construction Plans

START  →  Read Conditions of Use

Choose Shoring Column Type

Wood Columns  →  See Sheet 1

Choose Existing Bridge Type for General Layout

Pre-Stress Concrete Girder*  →  See Sheet 2
Concrete Box Girder*  →  See Sheet 3
Steel Plate Girder*  →  See Sheet 4

Wood Footing  →  See Sheet 5
Build Shoring System  →  See Sheet 10

Use Jacking Struts to abut columns to bridge**

Have Shoring System Inspected by WSDOT  →  Continually Monitoring of Temporary Shoring System

See Sheet 6 for miscellaneous Wood detail  See Sheet 11 for miscellaneous steel detail

End

*Transverse Cap Details are included  **Retighten connections after columns are firmly secured
Flow Chart of Temporary Shoring Construction Plans

START → Read Conditions of Use

Choose Shoring Column Type

Wood Columns
See Overview on page 1
Choose Existing Bridge Type for General Layout
Prestressed Concrete Girder*
See page 2
Concrete Box Girder*
See page 3
Steel Plate Girder*
See page 4

Wood Footing
See page 5
Build Shoring System
Use Jacking Struts to abut columns to bridge**

Have Shoring System Inspected by WSDOT

Steel Plate Footing
See page 8
Concrete Box Girder*
See page 9
Steel Plate Girder

Continually Monitoring of Temporary Shoring System

End

*Transverse Cap Details are included  **Retighten connections after columns are firmly secured

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Conditions of Use

This temporary shoring system is intended to be only a temporary solution. In no case shall the temporary shoring system act as a permanent solution or be in use for more than one year from the time of erection. Any changes to the manual must be documented and approved by a licensed Washington State Civil Engineer. The temporary shoring system is not intended to withstand after-shocks that follow the initial seismic event. This manual may be used only under the following conditions:

- Any chosen option in the flow chart must be followed through completely for each damaged column (or row of columns) such that there is no mixing and matching of flow chart options.

- Columns may not be subjected to any lateral earth pressures.

- Each damaged column must support its self-weight and the superstructure must maintain its integrity.

- All shoring foundations must be placed upon level ground.

- No vehicular traffic is allowed to traverse the damaged bridge without the prior consent from WSDOT. Temporary shoring must be in place and approved by the engineer of record before traffic may traverse the damaged bridge.

- Vehicular travel must be regulated in such a manner as to limit the effects from super-elevation, bridge curvature, acceleration and deceleration of vehicles. The suggested construction speed across the damaged bridge is to be 15 mph.

- Upon each after-shock, the damaged bridge and the temporary shoring system shall be thoroughly checked over to assess the integrity of the structure and the shoring system. Access to the road should be closed during this time until officials deem the bridge safe to open again to the public. WSDOT shall be notified of any signs of failure and the bridge shall be closed immediately.

- The depicted bridges in the manual represent 75% of all bridges within the State of Washington. The shoring system is only applicable if the damaged bridge’s geometry is the same or smaller than the bridge geometry shown in the manual.

- Jacking struts with hydraulic jacks will be used to pre-load the shoring system, such that bridge is shored properly. Steel or wood wedges shall be used to abut the temporary shoring system to the bridge. Shoring columns closest to the damaged columns or support will be preloaded more to distribute load equally with the outer most shoring columns.

- No welding is to take place on the existing damaged steel plate girder bridge.
Explanation of the Outline of Temporary Shoring Construction Plans

The flow chart is an aide for the rapid construction of temporary shoring systems for the Washington State Department of Transportation (WSDOT). This manual is designed to cover 75% of all bridges within the State of Washington in the event of a catastrophic earthquake. The following is an explanation of the flowchart.

The first step is to read the Conditions of Use, which provide limits and necessary information for which the shoring systems are valid. The second step is to determine the materials, either steel or wood, that the shoring columns will be comprised of. The initial overview drawings include design stresses, assumptions, criteria, and a general shoring layout. Identifying the type of bridge is the third step, either prestressed concrete girder bridge, concrete box girder bridge, or steel plate girder bridge. Please note, that the wood column shoring tower must be used for the prestressed girder bridges. Each bridge type has a drawing with construction details for the layout of the transverse cap, columns, cross bracing, connections, etc. The overview drawing is to be the main reference for assembling the temporary shoring tower for the particular bridge type. Finally, the footings for the shoring tower are the last general construction detail mentioned in the flowchart. Specific details are incorporated throughout the manual on the final drawing sheet.

Use of these shoring systems is contingent upon a safe working environment and a prior investigation of the damaged bridge. A suitable site for the footings and the shoring columns must also be determined, preferably within 10-feet of the damaged columns and 5-feet for simply supported bridge spans. The footings shall be placed upon level ground. Jacking struts with hydraulic jacks shall be used to pre-load the shoring system, such that bridge is shored properly. Steel or wood wedges shall be used to abut the temporary shoring system to the bridge. All bolted connections, after the jacking struts are removed, shall be re-tightened to complete the construction of the shoring systems.

The shoring system shall be checked and approved by a WSDOT official before traffic is allowed to travel across the bridge. The temporary shoring shall be monitored closely along with the bridge after the completion of the shoring system. WSDOT shall be notified of any signs of failure and the bridge shall be closed immediately.

Following these outlined steps will ensure consistency and safety for the construction crew and the public. The Department of Transportation Bridge and Structure’s Office shall address any questions about the construction of the temporary shoring systems.
The depicted columns are placed for strong axis bending.

Section A-A: Seal of Staging Tower along Bridge Length.