DGES, Inc.

ODOT - Interstate 5 Bridges over Columbia River

Seismic Retrofit of Truss Span Bearings
Conceptual Design and Estimate

ODOT On-Call Design Contract 11814

Work Order No. 8

DGES Project No. 93-109.08

March 1, 1995

Description of Bearing Retrofit Concept

The phase 1 analysis of truss spans 2,3,4 indicates that the existing truss span bearings are overstressed by the design seismic event. Critical components are the anchor bolts and the outstanding pin plates.

Several options were considered in developing the bearing retrofit concept presented herein. These basic options are described as follows:

1. Bearing replacement. Bearing replacement could consist of standard contemporary bearing systems or seismic isolation type systems.

2. Rehabilitation of the existing bearing components.

3. Install a system of stops and/or restrainers to supplement the existing bearings. This system would be designed to prevent the total collapse of a span in the event the existing bearing fails during a significant seismic event. The system would provide temporary support for the span while repairs to the permanent system could be completed.

Option 2 is not recommended as full rehab of all components of the existing bearings while maintaining traffic on and under the bridge will be very expensive.

Option 1 using traditional bearing systems should be somewhat less expensive than option 2 as the need for extended traffic restrictions can be lessened. Option 1 using seismic isolation could result in reducing the seismic loads on other bridge components (foundations, trusses, piers). However, it is not possible to gauge the benefits of the seismic isolation option without additional analysis.

The design concept chosen for estimating purposes consists of providing external stop assemblies in both the transverse and the longitudinal directions which function to prevent the span from walking off of the pier cap during a seismic event. In addition, vertical bearing assemblies are provided to "catch" the truss in the event that bearing movements and/or anchor bolt failure(s) cause instability of the existing bearings. The temporary vertical bearing assemblies would permit the span to remain in at least limited service while repair or replacement of the permanent bearings is completed.

The available seat length at all bearings is compared to the minimum required seat lengths computed using AASHTO Division 1A, Section 4.9.3, Eqn. 4-4A (for SPC category C and D bridges). Existing seat length is adequate at all piers and is greater than 4 times the maximum computed displacement from the phase 1 analysis. Therefore, the ODOT Office Practice Manual (OPM), section 5.1.9.2 allows restrainers to be omitted. However, considering the inadequacy of the anchor bolts at the fixed bearings, longitudinal stops are provided to prevent the overall movement of the span relative to the piers. Span-to-span longitudinal restrainers would add load from a failed span to the adjacent span and could result in progressive failure. Therefore, external longitudinal stops for each span are judged to be the appropriate solution for this bridge.

Design seismic loads used for determining major member requirements are estimated from the results of the phase 1 analysis work. This analysis work dealt only with the lift span unit, spans 2,3,4. Results for other spans are estimated based upon the lift span unit results. Design loads utilized are tabulated on the concept drawing. The conceptual design of retrofit components is based upon ultimate strength design procedures.

We note that each of the transverse stops must be designed for the total transverse load which might occur at that end of the truss. That is, the stop must be capable of providing simultaneous transverse support for both bearings. At a given location, the transverse design load used is greater than the maximum SRSS load on either bearing, but is less than the sum of the maximum SRSS loads in both bearings. The combined transverse

load is estimated by reviewing the individual modal analysis results for span 4. Longitudinal stops are designed for a percentage of the span dead load as indicated by the sum of the SRSS longitudinal loads in spans 3 and 4.

The concept shown is one of several possible configurations. The detailed design of a retrofit scheme will depend strongly upon the performance criteria adopted. We recommend that establishment of design criteria be the first step of any final design program. Once the design criteria is established, a full range of design options and configurations may be evaluated to identify the most cost-effective solution.

Material quantities are estimated using the concept design as shown on drawing I5R-2. Unit costs are estimated with consideration of the relative difficulty of performing this work in close quarters and of the necessity to maintain the existing traffic on and under the bridge.

Limitations and Recommendations

The estimate submitted here considers only the truss span bearings; approach spans are not included. The estimate also does not directly include any costs associated with traffic control necessary for the project.

A conceptual design and estimate for retrofit of the truss span foundations was submitted previously. We note that the retrofit of the foundation units as described in the earlier submittal will change the stiffness magnitude and configuration of the bridge. This will in turn effect the dynamic response and may change the level of seismic demand on the bearings. Additional changes in response and demand could occur as the result of retrofit work on the trusses or on the pier columns. These changes can not be assessed without further analysis of the retrofitted system. Such analyses must be performed as a part of the final design work.

We also note that the phase 1 analysis which is used as the basis for this foundation retrofit estimate is based upon a limited set of geotechnical data and assumptions. Considering the overall costs of the anticipated work (foundations plus bearings), we recommend a full geotechnical investigation and analysis as a part of the final design package. In addition to geotechnical stiffnesses and capacities, the issues of soil liquefaction and riverbed scour should be investigated. The design concept and estimate presented here does not consider these issues.

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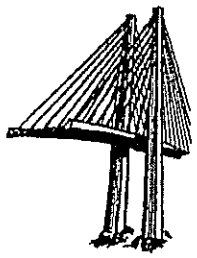


March 1, 1995

Mr. Phil Rabb
Oregon Department of Transportation
Rm. 329 Transportation Building
Salem, OR 97310

Re: Interstate 5 - Columbia River Crossing Seismic Survey
ODOT On-call Design Contract 11814, W.O. 8
DGES Project No. 93-109.08

Dear Mr. Rabb:

Enclosed for your review is our drawing I5R-2 illustrating one concept for reinforcing the truss span bearings against the design seismic event. Also enclosed is our estimate of design and construction costs associated with this concept. An overview of the conceptual design is provided in the enclosed summary. This submittal is a supplement to our draft submittal of February 13 which covered the conceptual design and estimate of foundation retrofits for this structure.

Please offer any comments on the scheme shown.

This submittal is being sent by fax and by U.S. Mail. A copy of the foundation retrofit submittal of February 13 will be included in the mailed package.

As of today, the extended budget for this work order (w.o. 8) has been exhausted. Please advise if you will be needing additional work on this task.

We are available for discussion at your convenience. Once again, we appreciate the opportunity to assist the Department with this interesting project.

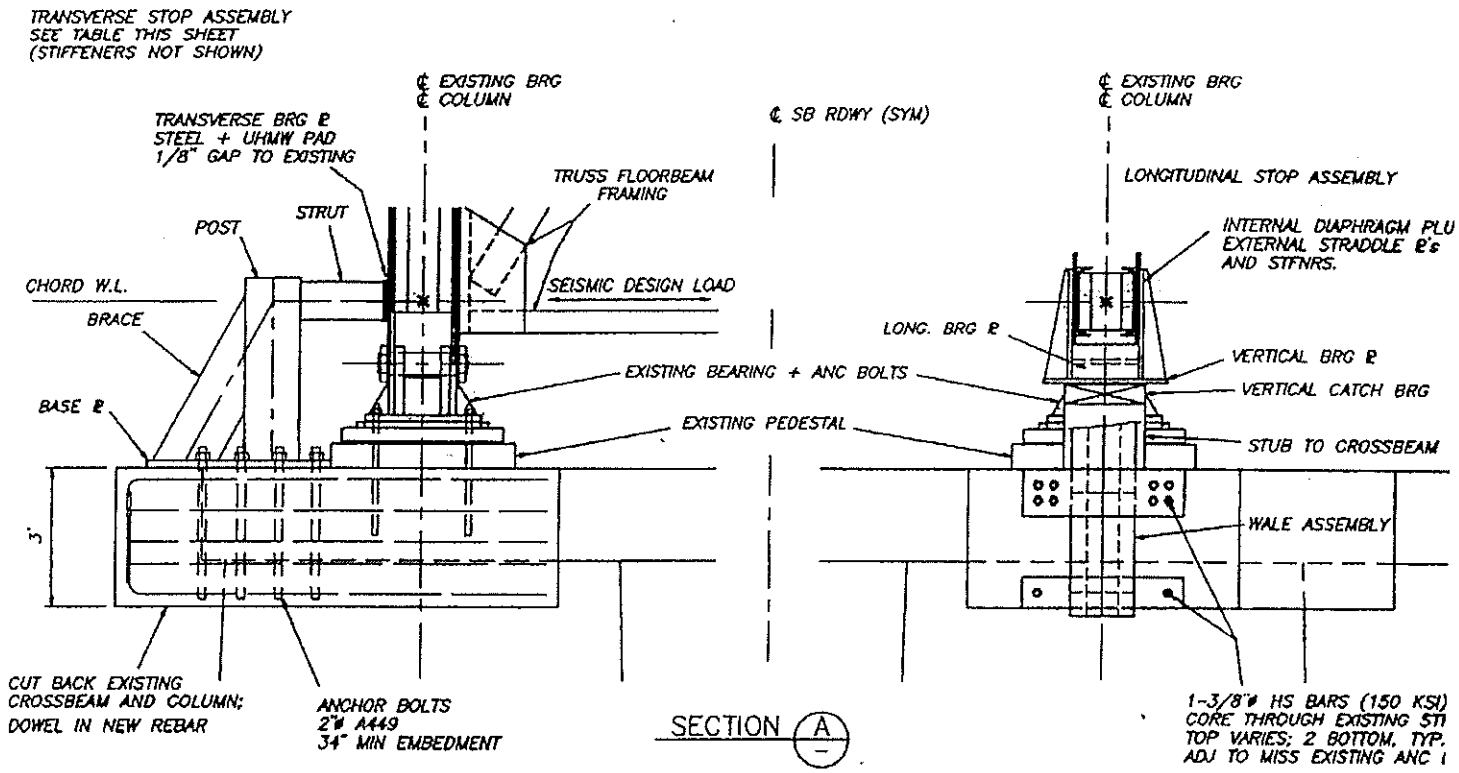
Very truly,
DGES, Inc.

Glen Scroggins, PE

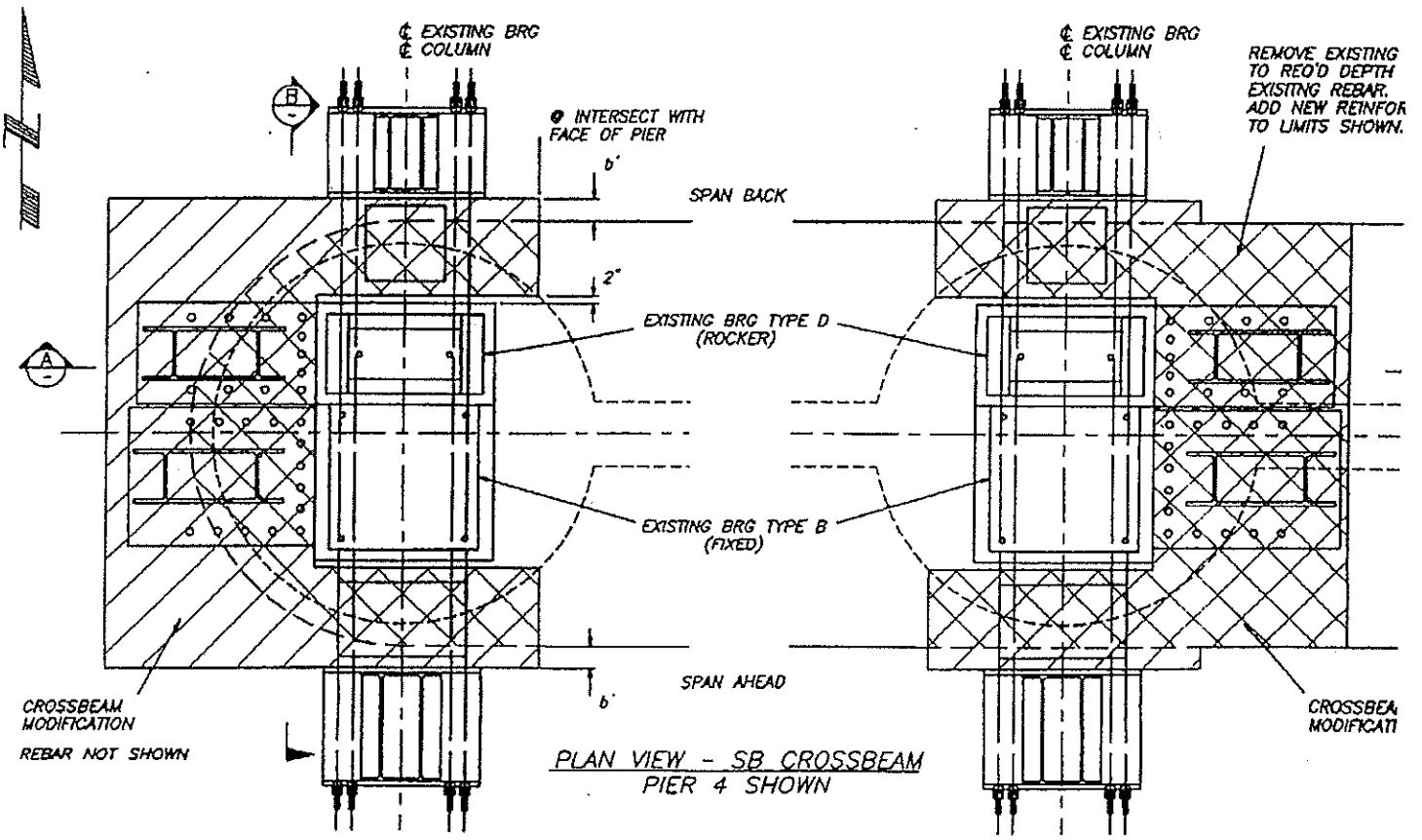
Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 7

To PHIL RABB	From GLEN SCROGGINS
Co. ODOT	Co. DGES
Dept. BRIDGE	Phone # 360-754-0544
Fax #	Fax # 360-754-1714

RECEIVED
MAR - 1 1995
BRIDGE DIVISION



END ELEVATION - STOPS
PIER 4 SOUTHBOUND BRG TYPE D SHOWN
OTHERS SIMILAR IN CONCEPT



PLAN VIEW - SB CROSSBEAM
PIER 4 SHOWN

TRANSVERSE STOP ASSEMBLY DATA					
BEARING TYPE	STOP DESIGN LOAD	ANCHOR BOLTS	BASE PLATE PLAN	POST/ BRACE	STRUT
A,B,C,G,H	1000	14	38x50	W14x132	W14x74
D,E,F	700	11	28x48	W14x99	W14x53

ALL STRUCTURAL STEEL Gr. 50
ASSEMBLY STIFFENERS NOT DETAILED

LONGITUDINAL STOP ASSEMBLY DATA						
BEARING TYPE	DESIGN LOADS LONG	DESIGN LOADS VERT	WALES 2 @ W	b' (IN)	PIER	TOP HS BARS
A,B	760	1500	30x108	7	1,2,3	6
C	560	2200	21x83	0	4,6	8
D	560	700	21x83	8	7-13	4
E,F,G,H	350	700	21x44	23 *		

* VARIES, 23" MAXIMUM

OP ASSEMBLY

AL DIAPHRAGM PLUS
NAL STRADDLE ℄'s
TFNRS.

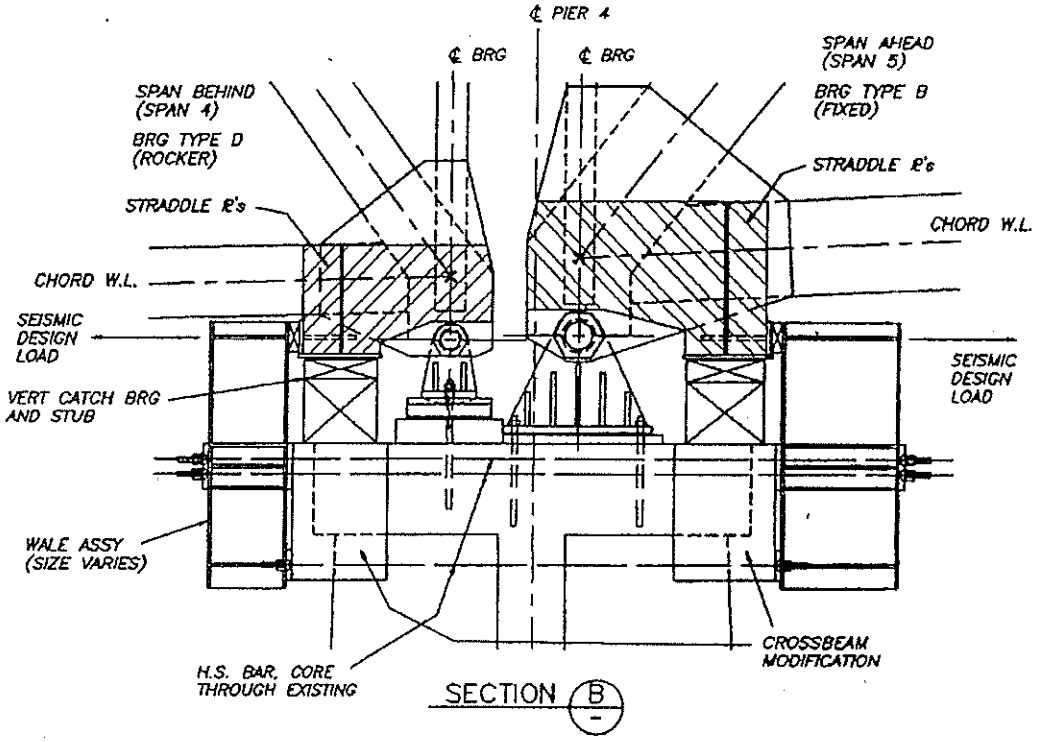
ICAL BRG ℄

TICAL CATCH BRG

)B TO CROSSBEAM

LE ASSEMBLY

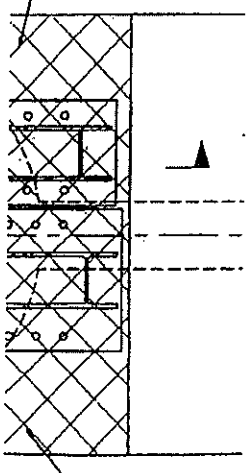
HS BARS (150 KSI)
ROUGH EXISTING STR.
ES; 2 BOTTOM, TYP.
ISS EXISTING ANC BOLTS, TYP.



SECTION B

SIDE ELEVATION - SOUTHBOUND
PIER 4 SHOWN

REMOVE EXISTING CONCRETE TO REQ'D DEPTH W/O DESTROYING EXISITNG REBAR. ADD NEW REINFORCING AND CAST TO LIMITS SHOWN.



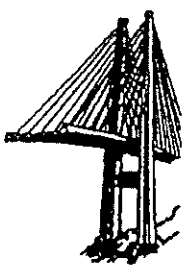
CROSSBEAM MODIFICATION

PRELIMINARY - NOT FOR CONSTRUCTION

DGES
CONSULTING ENGINEERS
OLYMPIA, WASHINGTON

TITLE

I-5 COLUMBIA RIVER BRIDGE
SEISMIC RETROFIT STUDY
BEARING RETROFIT CONCEPT



NO.	REVISION	DATE

DESIGNED		
DRAWN	C.S.	2/28/95
CHECKED		

DRAWING	REVISION
15R-2	0

DGES - FILENAME: BRGEST.XLS
LAST UPDATE: 3/1/95
ODOT - I5 COLUMBIA RIVER CROSSING
SEISMIC ASSESSMENT
ESTIMATE OF TRUSS BEARING RETROFIT COSTS
BASED ON CONCEPT LEVEL DESIGN

ITEM	QUAN	UNIT	PRICE	TOTALS	COMMENTS
CONCRETE REMOVAL	162	CY	$500	$81,000	
NEW CROSSBEAM CONCRETE	388	CY	$500	$194,000	
REINFORCING STEEL	78000	LB	$1.50	$117,000	
ANCHOR BOLTS (2" DIA A449)	40600	LBS	$6.00	$243,600	(1040 EACH)
POST-TENSIONING BARS	31200	LBS	$2.50 (1.75)	$78,000	(344 EACH)
CORING FOR PT	2200	LF	$125	$275,000	
STRUCTURAL STEEL (Gr. 50)	638000	LB	$5.00 (3.00)	$3,190,000	
CATCH BEARINGS	88	EA	$2,700	$237,600	FOR EMERGENCY TEMPORARY VERTICAL SUPPORT
MOBILIZATION/DEMOBILIZATION	1	LS	$433,800	$433,800	
SUBTOTAL CONSTRUCTION				$4,850,000	($3,100,000)
ENGINEERING			20%	$970,000	FINAL DESIGN INCLUDING ADMINISTRATION
CONTINGENCY			10%	$485,000	
ESTIMATED TRUSS BEARING RETROFIT COST				$6,305,000	($4,500,000)

NOTE: ESTIMATE DOES NOT INCLUDE TRAFFIC CONTROL PROVISIONS
ESTIMATE INCLUDES ASSESSMENT OF TRUSS SUPPORT AT PIERS 1-13 ONLY