BASE ISOLATION BEARINGS
(Dynamic Isolation Systems, Inc.)

Construction Report

OR-EF-91-02

by

Steve Starkey, P.E.
Senior Sturctural Design Engineer
Bridge Design Section
Oregon Department of Transportation

and

Bob Knorr
Research Unit
Oregon Department of Transportation

Prepared for

Oregon Department of Transportation
Research Unit
Salem, Oregon 97310

and

Federal Highway Administration
Washington, D.C. 20590

December1998

Technical Report Documentation Page

1. Report No. OR-EF-91-02	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Base Isolation Bearings (Dynamic Isolation Systems, Inc.) Construction Report		5. Report Date December 1997 6. Performing Organization Code
7. Author(s) Steve Starkey, P.E. Bob Knorr		8. Performing Organization Report No.
9. Performing Organization Name and Address Oregon Department of Transportation Research Unit 2950 State St., Salem, OR., 97310		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Department of Transportation Federal Highway Administration Washington, D.C. 20560 and Oregon Department of Transportation Research Unit 2950 State Street Salem OR 97310		13. Type of Report and Period Covered Construction Report (October 1993-November 1997) 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A 1,000-foot long, continuous, post-tensioned box girder bridge was constructed with proprietary seismic isolation bearings to address stringent design loading requirements while accommodating shrinkage deformations as well as elastic and creep deformations from post-tensioning. The bearing devices, supplied by Dynamic Isolation Systems, Inc., are rubber based with lead cores and introduce lateral flexibility and damping between the superstructure and the substructure. These properties modify and reduce the structure's response to seismic loads. After four years of service the bearings are performing well. Only three minor deficiencies have been observed: rust on the bearing plates, bulging of some bearings, and bearing inclined from verticle.

17. Key Words		18. Distribution Statement Available through the Oregon Department of Transportation Research Unit	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 23	22. Price

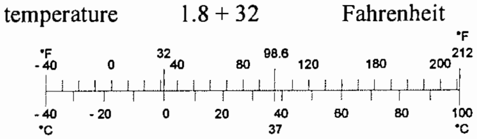
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

ACKNOWLEDGEMENTS

The authors would like to thank the following Oregon Department of Transportation (ODOT) personnel for their contributions and help gathering information for this report: Dennis Carlson, the Milwaukee Bridge Crew, and Jan Six. In addition, the authors thank Dynamic Isolation Systems, Inc.(D.I.S.) for their cooperation supplying technical data.

DISCLAIMER

This document is disseminated under the sponsorship of the Oregon Department of Transportation in the interest of information exchange. The State of Oregon assumes no liability for its contents or use thereof.

The contents of this report reflect the views of the author(s) who are solely responsible for the facts and accuracy of the material presented. The contents do not necessarily reflect the official views of the Oregon Department of Transportation.

The State of Oregon does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the object of this document.

This report does not constitute a standard, specification, or regulation.

BASE ISOLATION BEARINGS
Construction Report

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The project involves the base isolation of a connector ramp at the terminus of Highway 224 with highway 99E in Milwaukie, Oregon. Milwaukie is located in the Willamette Valley, six miles south of Portland in Clackamas County. Figure 1.1 shows the project location.

The connector ramp is the Clackamas Highway-Pacific East Connection bridge. It is a 1,000-foot long, continuous, post-tensioned concrete superstructure supported by isolation bearings (see Figure 1.2). The isolators bear on concrete columns and footings supported by steel pipe piling. One end of the bridge has a 280-foot long, wall-supported, cast-in-place slab approach. The other end has an embankment approach. See figure 1.3.

The isolation bearings, supplied by Dynamic Isolation Systems, Inc., are rubber based with lead cores. The bearings introduce additional lateral flexibility and damping between the superstructure and the substructure. These properties modify and reduce the structure's response to seismic loads. They also allow substructure elements to accommodate elastic and creep deformations from post-tensioning as well as deformations from shrinkage. (See Figure 1.4)

Dynamic Isolation systems, Inc. bearings were selected for this project as an experimental feature, allowing the Oregon Department of Transportation (ODOT) to benefit from the company's extensive experience while still monitoring the project-specific results.

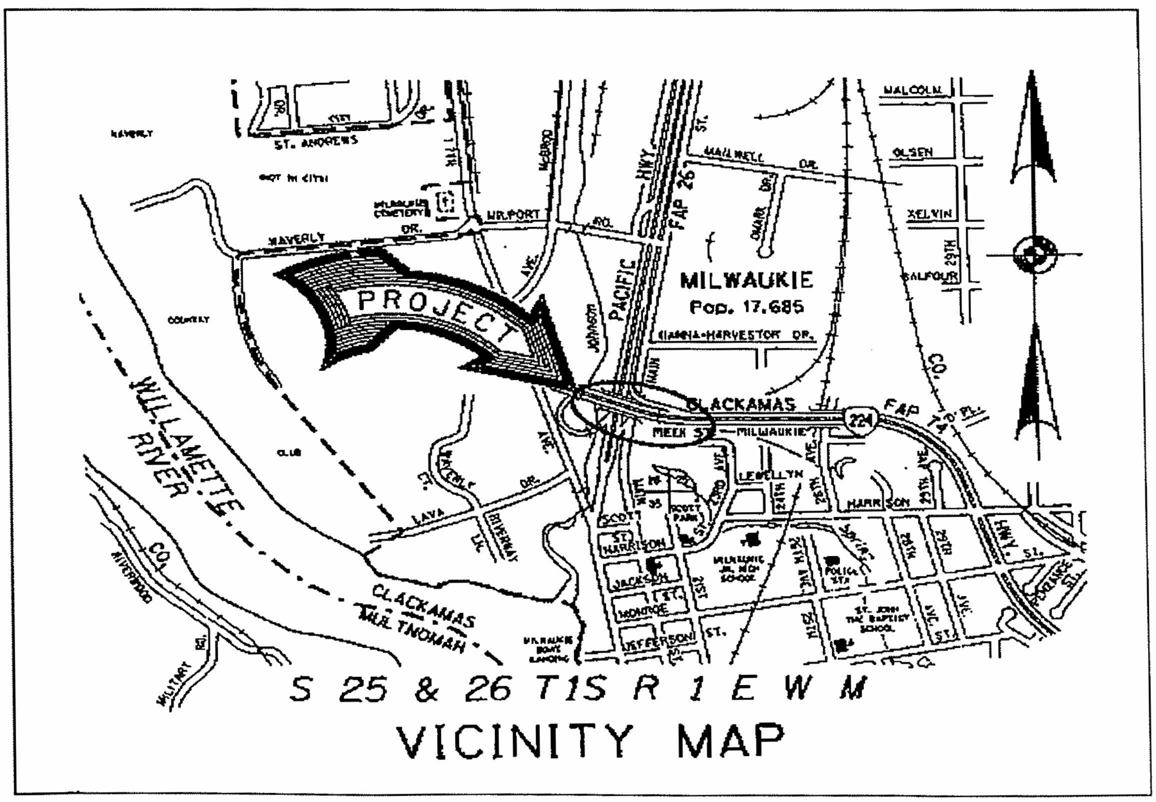


Figure 1.1 Project Location

Figure 1.2 Bridge # 9669A, south embankment as seen from Ore 224.

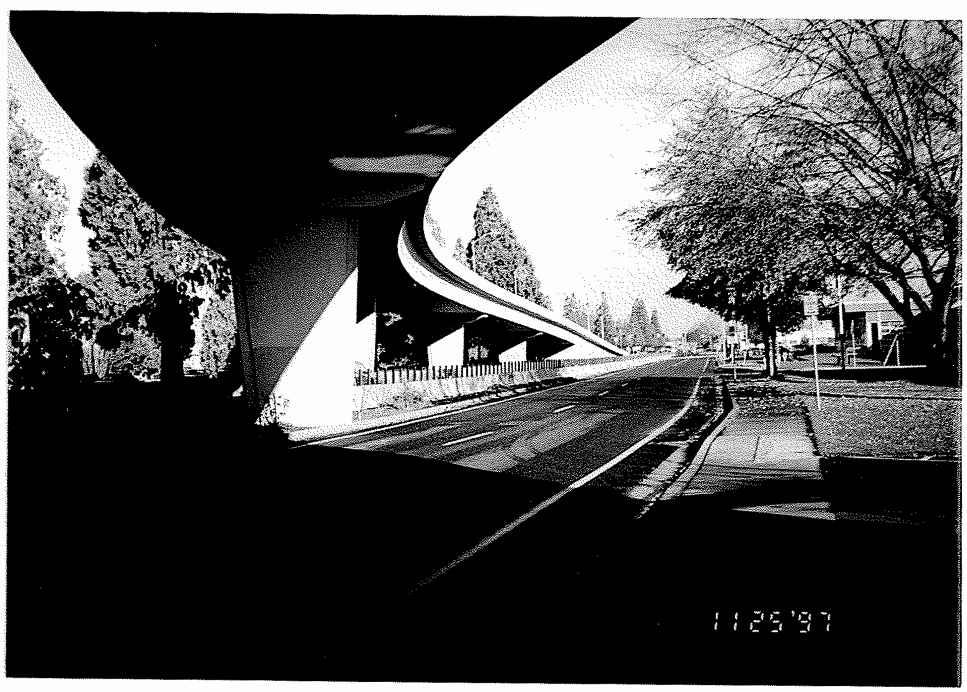


Figure 1.3 Bridge #9669A, wall-supported approach on the north end.

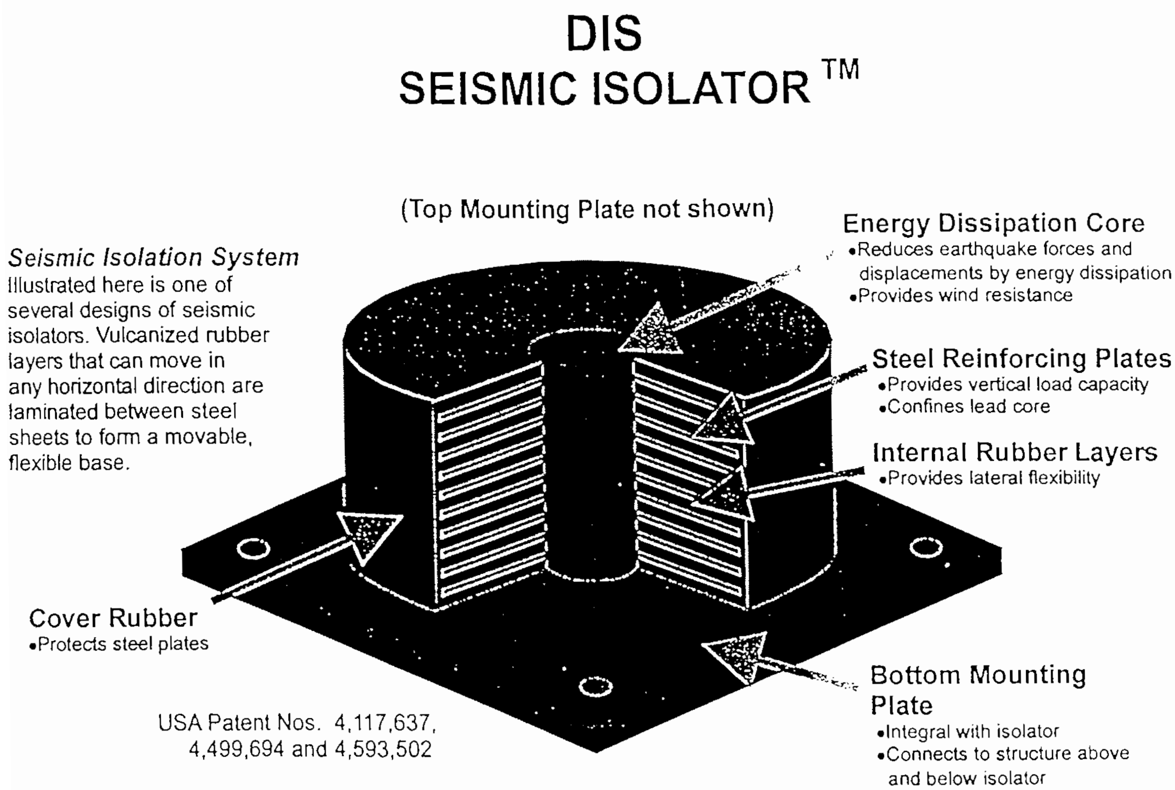


Figure 1.4 The dis bearings are made of bonded layers of rubber and steel. (http://www.dis-inc.com) dynamic isolations systems, inc., 1997

2.0 DESIGN

The structure design began in February 1989 and had progressed through type, size and location selection to final design when upgraded ODOT seismic loading requirements were implemented in January 1990.

The structure type selected had rigid connections to all interior supports, which gave a fully framed bridge. This structure form has been in common use in Oregon for many years. The redesign to the more stringent seismic loading resulted in unusually large substructure elements. At this time alternate structural forms were considered and base isolation was selected. See Figure 2.1.

The selected method of seismic loading mitigation - induced and controlled flexibility through base isolation - also has the added benefit of force reduction for deformation-induced loads. The technology has been in use for a number of years in other areas of the world but is relatively new to the United States. We chose to use the devices as an experimental system to allow better evaluation and subsequent testing for long-term considerations. See Figure 2.2.

The isolation bearing design was done using equivalent linear analysis for an idealized single degree of freedom system. Deformation induced deflections from post-tensioning elastic shortening, creep and shrinkage were large. Although these deformations were partially accommodated by specifying the construction staging sequence, the deformations were also considered when sizing the bearings. Bents 2 and 3 are the locations of greatest anticipated deflections. The anticipated deflections are 4" and 2.5" respectively.

To allow bearing evaluation under seismic loading, a strong motion instrumentation system was also designed for the bridge.

The project design was completed in August of 1991.

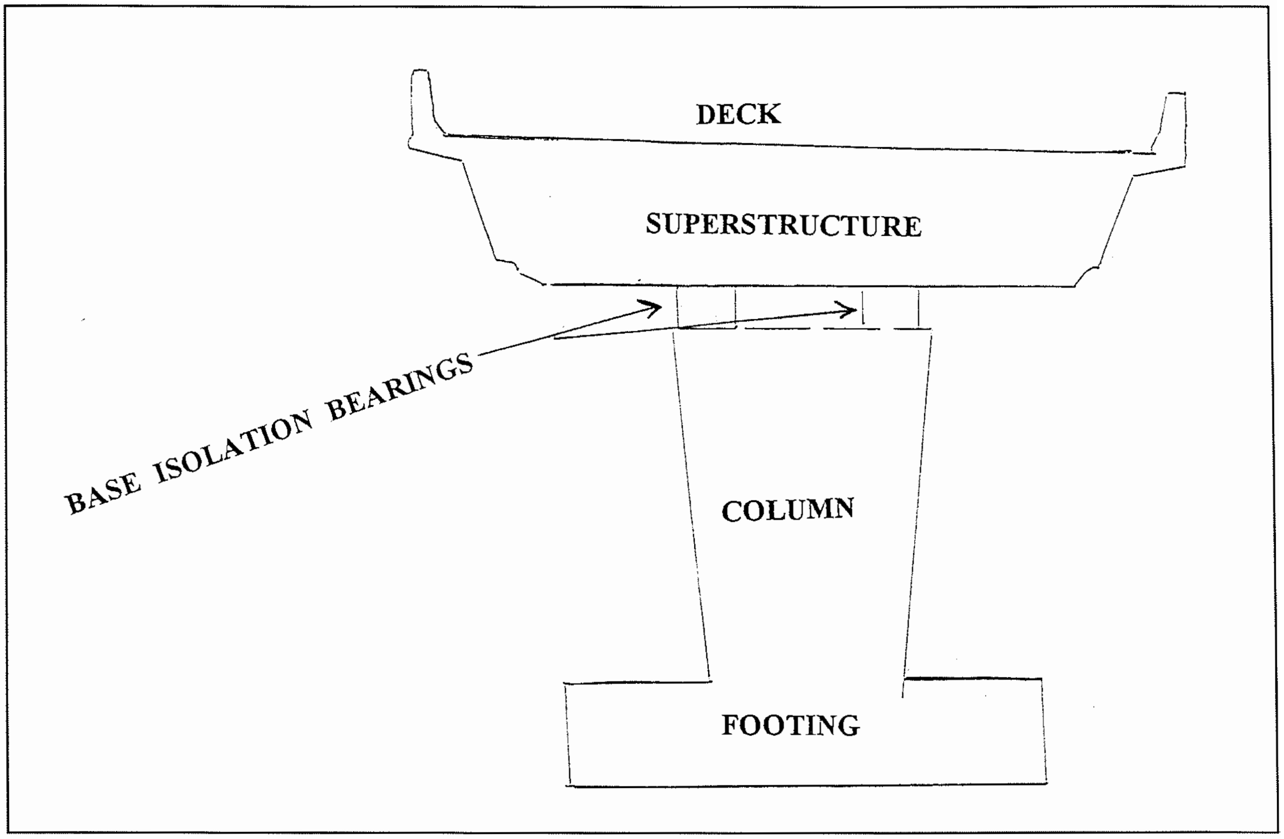


Figure 2.1 Base isolation bearings transmit the traffic loading and dead loads from the deck and superstructure to the columns.

Figure 2.2 An inspection access for the base isolation bearings at the top of a column on Bridge #9669A.

3.0 CONSTRUCTION

Project construction began in November 1991 and was completed in October 1993.

Construction was done with normal cast-in-place techniques. This involved falsework bents of driven timber pilings with steel beams spanning between falsework bents. Superstructure support was provided entirely through the falsework system until the completion of post-tensioning operations.

The bearings were lifted to the top of the columns by a crane. See figure 3.1. Then, they were attached to the top of the columns and the bottom of the superstructure. A steel plate with sheer pins is tied to the reinforcing steel of the superstructure and a second plate at the top of the column. As shown in Figure 3.2. These are cast-in-place then the bearing plates are attached to the poured-in-place plates with high strength-bolts.

The rubber sections of the bearings are attached to the upper and lower steel plates at the factory by vulcanizing process. These joint areas should be monitored for de-bonding. Two types of D.I.S. bearings were tested and used on this project: circular and rectangular. The square or S26-11-8.0 were 11 % below the design value. This type of bearing was used at bents 4,5 and 6. (See Appendix B.)

The supplied bearings met the project specifications except that the tested value of K_r (the slope of the inelastic limb of the hysteresis loop (see Figure 3.3) was one percent beyond the allowable range for two bearings. K_{eff}, the bearings' effective lateral stiffness at the design deflection, was within the specification limitations. The design was performed using K_{eff}, rather than K_r, and this slight deficiency in K_r is deemed insignificant. Appendix B contains the Force-deflection. Summary and sample curves.

The strong motion instrumentation was installed and operational as of October 1993. This system is monitored and maintained under a contract with the U.S.G.S. (See Figure 3.4). The system is checked twice a year for proper operation of the accelerometer graphing equipment. No earth quakes strong enough to trigger the recording equipment have occurred since the bridge's completion. The strong motion instrumentation begins recording at 0.1 G's.(3.2f/S^2) of accelerating force.

Figure 3.1. A worker prepares the isolation bearing to be lifted to the top of a column of BR# 9669A. Note the sheer pins at the top of the steel plates.

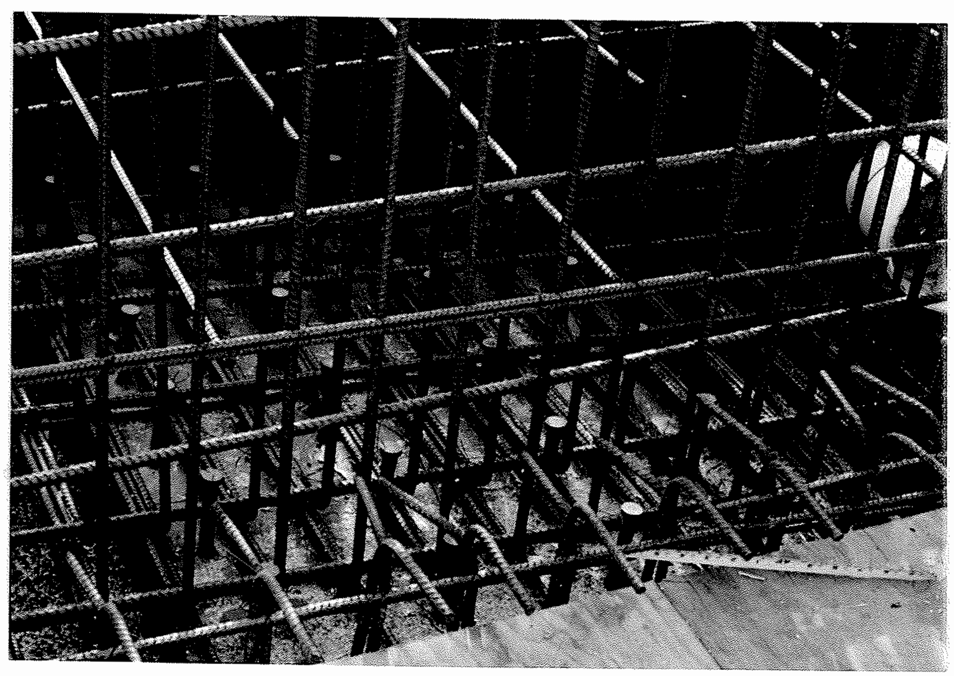


Figure. 3.2 The sheer pins are tied to the reinforcing steel of the superstructure on BR# 9669A.

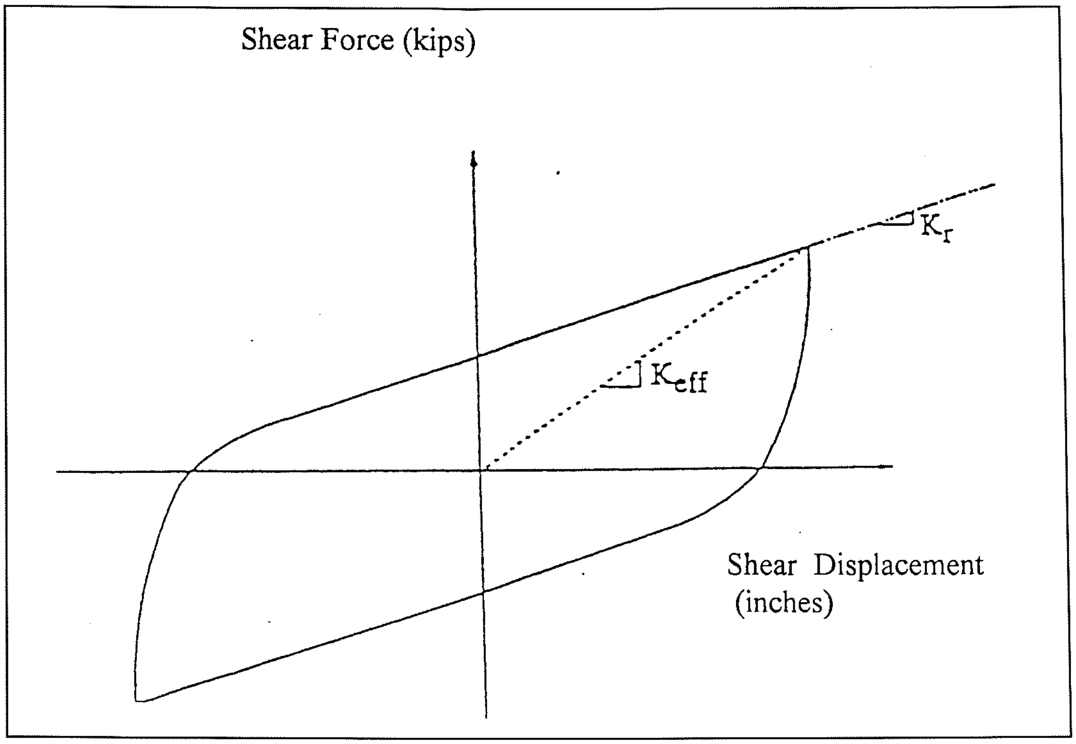


Figure 3.3 Typical Hysteresis Loop for bearing testing.

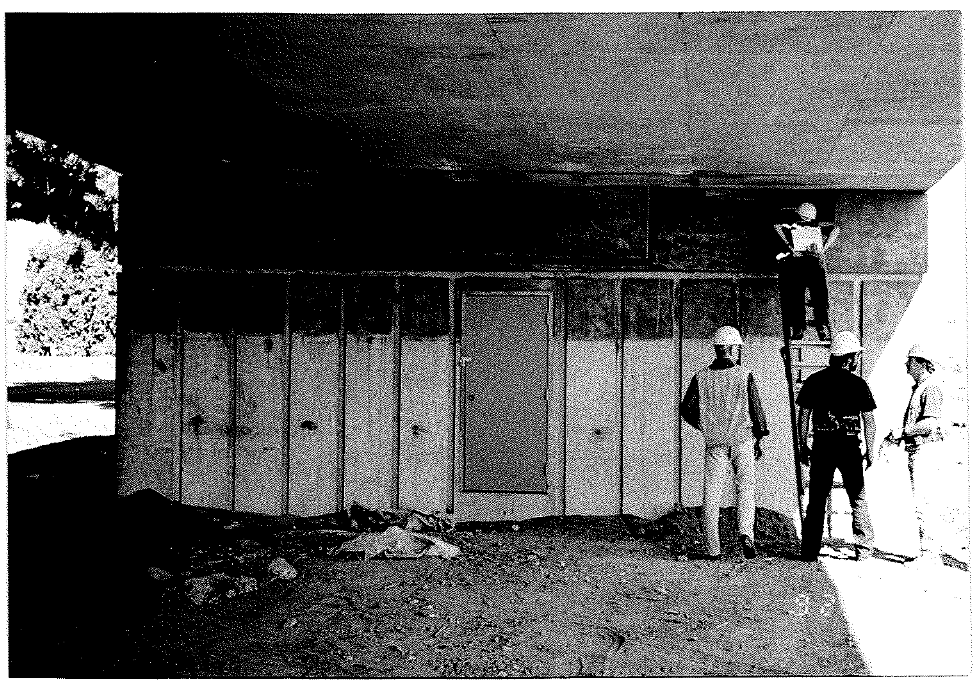


Figure 3.4 Access to strong motion instrumentation is located under the North end of BR# 9669A.

Figure 4.1 The bearing at bent 7 of BR.# 9669A is inclined to vertical and has rust on the steel plate.

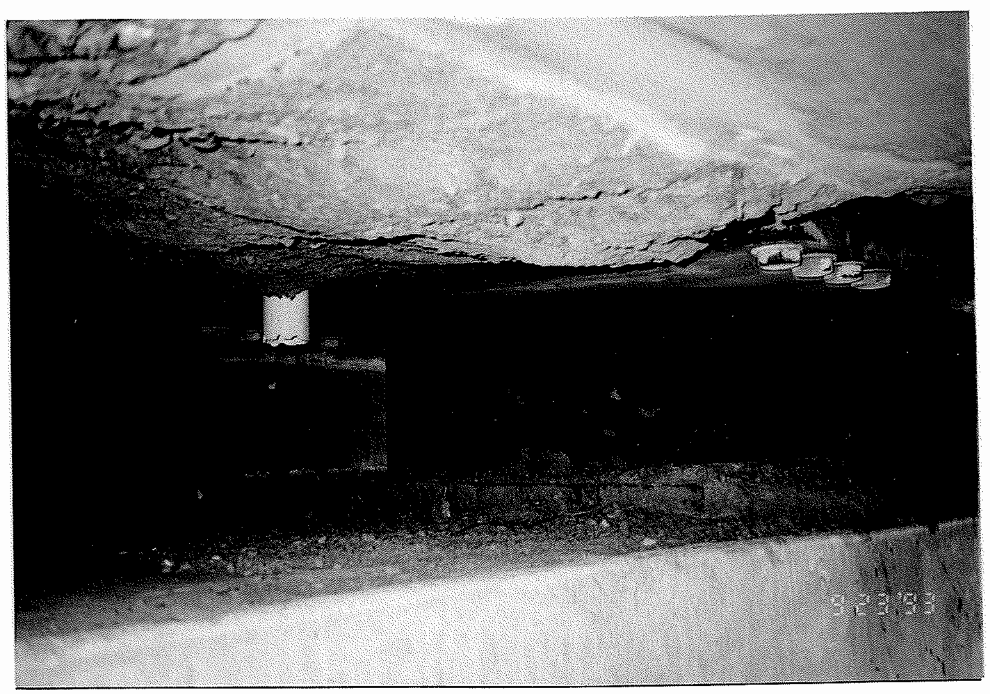


Figure 4.2 The circular bearing at bent 7 of BR.# 9669A is also inclined to vertical, and has a slight bulge.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The bearings appear to be in generally good condition and fit for the purpose intended.

All bearings should have continued serviceability monitoring. Special attention should be given to the right bearings of bents 2, 6 and 7 to verify the detected flaws are not serious.

Deformation-induced horizontal deflections should also be noted during serviceability monitoring. Special attention should be given to bents 2 and 3 as those bents are predicted to have the greatest deflections and presently have somewhat larger than expected deflections.

If a seismic event occurs the bearings should be inspected for any damage and to assess suitability for continued service load performance. The bridge's actual response should be compared to the predicted response to evaluate the bearings' effectiveness.

The original workplan specified removal and testing of one bearing after five years. Since other states have tested this type of bearing, the removal testing is no longer needed. Also, the original cost estimate of $10,000 has more than doubled.

APPENDIX A

BEARING SPECIFICATIONS

			Design Loads (K/Brg.)		Design Movements					
Location	No. of Brgs. Required	Type	Dead Load	DL+(LL+I)	Elastic Shortening (ES)	Creep + Shrinkage (CR+SH)	Seismic** (EQ)	+30° F (TR)	-45° F (TF)	Δ/10° F
Bent 1	2	Guided *	350	530	1⅞"	6⅜"	6"	1⅝"	2½"	⅜"
Bent 9	2	Guided *	350	530	1"	5"	6"	1½"	2¼"	⅜"

* - Provide 75k lateral capacity (each bearing).

DIS Bearings

Location	No. of Bearings	Model #	Type	Dia. or Width (in.)	Height (in.)	Lead Core Dia. (in.)	Vertical Translation Stiffness K_a(K/ft./Brg.)	Lateral Translation Stiffness K_{eff} (K/ft./Brg.
Bent 2	2	C-31-16-8.0	Circular	31.0	16	8.0	154660	208
Bent 3	2	C-31-11-7.5	Circular	31.0	11	7.5	255276	253
Bent 4	2	C-26-11-8.0	Square	26.0	11	8.0	154460	247
Bent 5	2	C-26-11-8.0	Square	26.0	11	8.0	154460	247
Bent 6	2	C-26-11-8.0	Square	26.0	11	8.0	154460	247
Bent 7	2	C-31-11-7.5	Circular	31.0	11	7.5	255276	253
Bent 8	2	C-31-16-8.0	Circular	31.0	16	8.0	154660	208

** - May be either ahead or back on line.
Provide for ES+CR+SH+TF+EQ (Case 1 - Toward adjacent Bent) and -EQ (Case 2 - opposite direction of Case 1)

APPROVED:
BRIDGE ENGINEER ________ PE PE NO. 8491
DESIGNED S.K. Starkey PE NO. 8856
DRAWN M.C. Young
CHECKED
REVIEWED
REVIEWED

OREGON DEPARTMENT OF TRANSPORTATION
BRIDGE DESIGN SECTION

CLACKAMAS HWY - PAC. HWY EAST CONN.

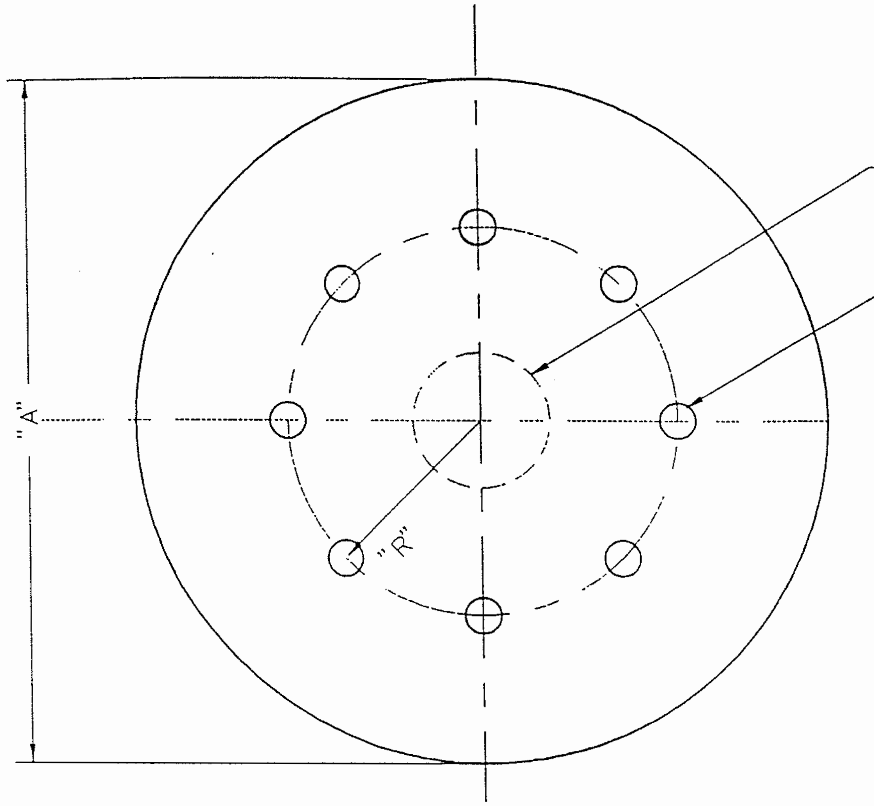
BEARING DESIGN DATA

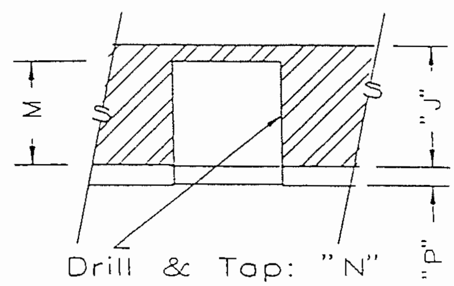
DATE Date 1991 CALC.BOOK ______ SHEET 17 OF 37
BRIDGE NO. 9669A DRAWING NO. 47858

U.S. PATENT NO. 4,117,637

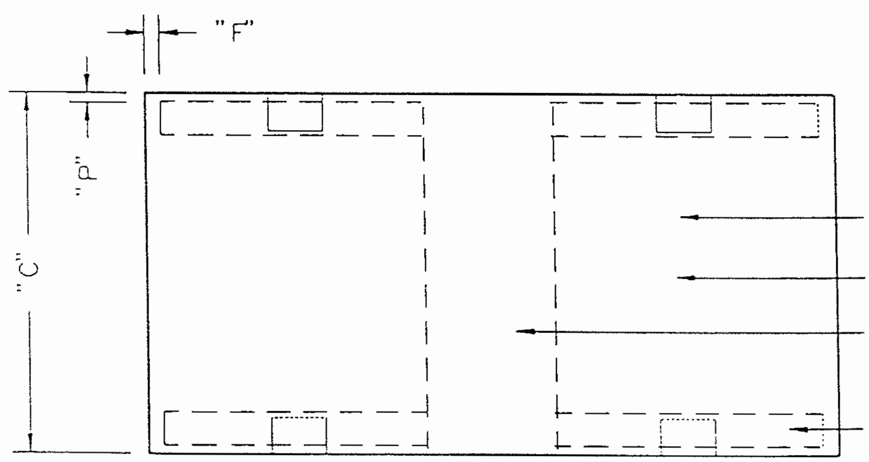
All Steel ASTM A36 or A570 Gr40
Elastomer Type NR Grade 3

PLAN





BOLT HOLE DETAIL



SECTION

DYNAMIC ISOLATION SYSTEMS INC	DWG NO. 5863-04	
Clackamas Highway East Connection	M.J.	1/20/92
DIS Seismic Isolators – Type 2 & 3		

Clackamas Highway East Connection
DIS Seismic Isolation Bearings
Drawing No.5863-04

Dimens.(1) \ **Type**	**2**	**3**
Quantity	*4*	*4*
A	31	31
C	10-7/8	15-7/8
D	7-1/2	8
F	1/2	1/2
H	1	1
J	1	1
M	7/8	7/8
N	1-8 UNC	1-8 UNC
P	1/4	1/4
Q	17	27
R	12.5	12.5
S	16	26

note: (1) all dimensions in inches unless otherwise noted

☑ APPROVED W... CHANGE
☐ APPROVED ...
☐ RETURNED ... CORRECTION

OREGON STATE HI... COMMISSION
Subject to Section ... the standard
Specification ... truction

BY SKS

APPENDIX B

FORCE-DEFLECTION CURVES

Tables 6, 7, and 8, below, contain the results of each isolator test. It can be seen that the results presented compare favorably with the theoretical values contained in the Specification. The measured value of K_r for isolator pair 101/103 was determined to be 11% below the predicted value; however, the effective stiffness, K_{eff}, for this same pair lies within the allowable range of ±10% of the Specification value. Since it is the effective stiffness which was used in the analysis, rather than an explicit modelling of the bilinear isolator properties, an analytical model using the measured values of effective stiffness should yield results which fall within the bounds defined by a range of ±10% on the predicted values of effective stiffness.

Each isolation bearing was inspected for faults during this test. No sign of lack of rubber to steel bond, laminate placement faults, or surface cracks wider or deeper than 0.08 inches were observed.

Table 6: Force-deflection Characteristics
Type 1 Isolators (S26-11-8.0)

Serial Number	K_{eff} (kip/in)	K_r (kip/in)	EDC (kip-in)
101	17.5	8.0	1267
102	18.0	8.2	1314
103	17.5	8.0	1267
104	17.9	8.4	1262
105	17.9	8.4	1262
106	18.0	8.2	1314
Mean Value	17.8	8.2	1281
Measured Range	17.5 to 18.0	8.0 to 8.4	1262 to 1314
Specification Value	19.0	9.0	1206
Allowable Range	17.1 to 20.9	8.1 minimum	1085 minimum

Table 7: Force-deflection Characteristics
Type 2 Isolators (C31-11-7.5)

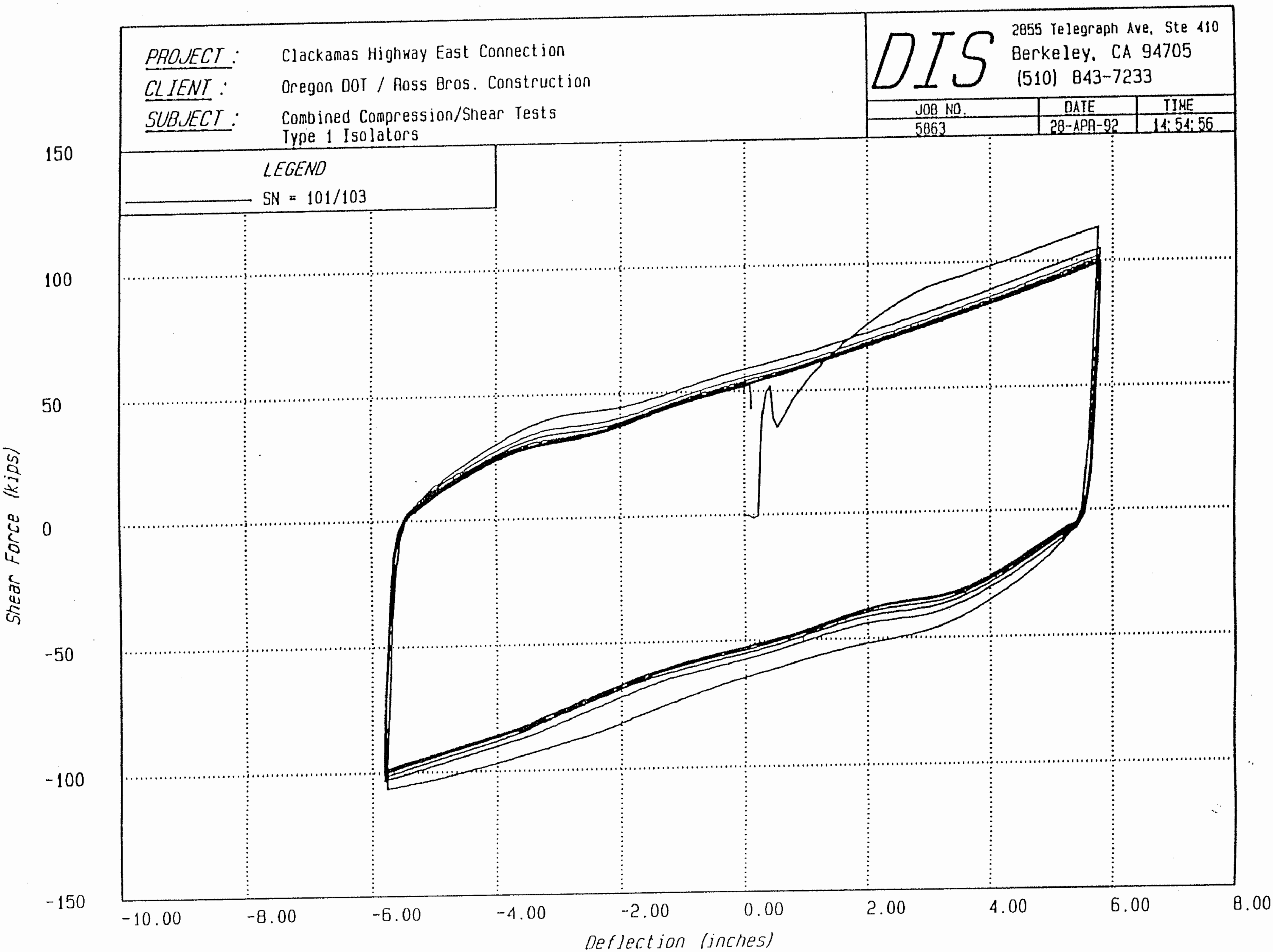
Serial Number	K_{eff} (kip/in)	K_r (kip/in)	EDC (kip-in)
201	18.6	10.2	1156
202	18.5	10.2	1144
203	18.6	10.2	1156
204	18.5	10.2	1144
Mean Value	18.6	10.2	1150
Measured Range	18.5 to 18.6	10.2 to 10.2	1144 to 1156
Specification Value	19.2	10.4	1075
Allowable Range	17.3 to 21.1	9.4 minimum	968 minimum

Table 8: Force-deflection Characteristics
Type 3 Isolators (C31-16-8.0)

Serial Number	K_{eff} (kip/in)	K_r (kip/in)	EDC (kip-in)
301	16.7	7.2	1247
302	16.3	6.8	1224
303	16.3	6.8	1224
304	16.7	7.2	1247
Mean Value	16.5	7.0	1235
Measured Range	16.3 to 16.7	6.8 to 7.2	1224 to 1247
Specification Value	16.5	6.5	1149
Allowable Range	14.9 to 18.2	5.9 minimum	1034 minimum

3 CONCLUSIONS

The D.I.S. seismic isolation bearings as supplied satisfy the requirements of the Specification (Section 511A, pages 227 through 233 of the Special Provisions), with one exception as discussed in Section 2.4 of this report.


PROJECT : Clackamas Highway East Connection
CLIENT : Oregon DOT / Ross Bros. Construction
SUBJECT : Combined Compression/Shear Tests
Type 1 Isolators
DIS
2855 Telegraph Ave, Ste 410
Berkeley, CA 94705
(510) 843-7233
JOB NO. 5063
DATE 28-APR-92
TIME 14:54:56
LEGEND
SN = 101/103
150
100
50
0
-50
-100
-150
Shear Force (kips)
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
Deflection (inches)


PROJECT : Clackamas Highway East Connection
CLIENT : Oregon DOT / Ross Bros. Construction
SUBJECT : Combined Compression/Shear Tests
Type 2 Isolators
DIS
2855 Telegraph Ave, Ste 410
Berkeley, CA 94705
(510) 843-7233
JOB NO. 5863
DATE 28-APR-92
TIME 14:39:52
LEGEND
SN = 202/204
150
100
50
0
-50
-100
-150
Shear Force (kips)
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
Deflection (inches)

APPENDIX C

BRIDGE INSPECTION REPORTS

OREGON DEPARTMENT OF TRANSPORTATION

Page No: 1 Bridge Inspection Report Br No 09669A

Br Name(6) CONN TO NB HWY 01E Insp Date(90) 08 17 95
(7) HWY 171 CONNECTION Rt(5b-e) 37002240 Insp Freq(91) 24 H(122) 171C
WearSurf(108) 101 Level of Imp A UW Cond Date(93B) NA MP(11) 0.33
AC Depth ConfinedSpace Inspector 1 No. S0023 Len(49) 1005
Temp.Struct(103) District(2) 2B Inspector 2 No. ST002 Width(52) 36.7
C-Group R1 Monitor RType(5a) 1 on

Signature ______________________________

CONDITION STATUS REPORT File: Region1

NAT BIS	ELE MNT	ELEMENT DESCRIPTION	ENV	TOTAL QUANT	UNIT	% IN EA PONTIS COND 1	2	3	4	5	NBI RAT
59p	140	ConcSlab-Prot w/AC Ovlay-New/No	3	95	CSFt	95	5	0	0		8
58s	102	Concrete-Bridge Railing	3	2630	LnFt	100	0	0			
58s	105	Strip Seal	3	72	LnFt	50	50	0			
59s	095	Elastomeric Bearing	3	18	Each	100	0	0			
59p	004b	P/S Poured In Place Box w/Deck	3	4020	LnFt	100	0	0	0		8
59s	159	Concrete-Diaphragm	3	500	LnFt	100	0	0	0		
60p	047	Conc-Posts,Col/Pile Extn(Dry)	3	7	Each	100	0	0	0		8
60p	051	Concrete-End Bent (Dry)	3	2	Each	100	0	0	0		8
				74	LnFt						
65s	100	Concrete-Approach Slab	3	2	Each	100	0	0	0		

OTHER NBI ITEMS

Traffic safety - ADEQUACY
bridge railings --------- Item 36A : 1
transitions ------------- Item 36B : 1
appr. guardrail --------- Item 36C : 1
appr. guardrail ends ---- Item 36D : 1
Channel & channel protect.- Item 61 : N
Operational Status--------- Item 41 : A
Bridge posting ------------ Item 70 : 5
Waterway adequacy --------- Item 71 : N
Approach alignment -------- Item 72 : 8

OTHER OBSERVED CONDITIONS

Deck Wearing Surface ------- : 7
Deck Drains ---------------- : 8
Approach Pavement & Embankmt : 8
Approach Shoulder & Embankmt : 8
Guardrail ------------------ : 8
Debris on Cap/Bearing Area - : 7
High Load Collisions ------- : 00

UNDER CONSTRUCTION

Contract Number :
Widening ------ :
Replacement --- :
New ----------- :

REMARKS

ELEM NO.	BENT/ SPAN	MEMBER ID	C #	DEFICIENCY DESCRIPTION	TEMP REPAIR
140	ALL	slab	1	SEE MEMO FOR EXPLANATION	
140	ALL	walls	1	SEE MEMO FOR EXPLANATION	

MAINTENANCE RECOMMENDATIONS

ELEM NO.	WORK ORDER	BENT/ SPAN	MEMBER ID	C #	WORK NEEDS LIST	EST COST	ACT COST	COMPLT DATE

MEMO:
There is a 280 foot long wall supported poured-in-place slab back on line from bent 1 (I have called this element No. 140). The typical section looks like a rigid frame. The walls have many vertical cracks with "effy" stains and some

OREGON DEPARTMENT OF TRANSPORTATION

Page No: 1 Bridge Inspection Report Br No 09669A

Br Name(6) CONN TO NB HWY 01E Insp Date(90) 08 14 97
(7) HWY 171 CONNECTION Rt(5b-e) 37002240 Insp Freq(91) 24 H(122) 171C
WearSurf(108) 101 Level of Imp A UW Cond Date(93B) NA MP(11) 0.33
AC Depth ConfinedSpace Inspector 1 No. S0023 Len(49) 1005
Temp.Struct(103) District(2) 2B Inspector 2 No. S0023 Width(52) 36.7
C-Group R1 Monitor RType(5a) 1 on
Signature [signatures]

CONDITION STATUS REPORT File: Region1

NAT BIS	ELE MNT	ELEMENT DESCRIPTION	ENV	TOTAL QUANT	UNIT	% IN EA PONTIS COND 1	2	3	4	5	NBI RAT
59p	140	ConcSlab-Prot w/AC Ovlay-New/No	3	95	CSFt	100	0	0	0		8
58s	102	Concrete-Bridge Railing	3	2630	LnFt	100	0	0			
58s	105	Strip Seal	3	72	LnFt	50	50	0			
59s	095	Elastomeric Bearing	3	14	Each	100	0	0			
59s	096	Move Bearing(Roller,Slider,Etc)	3	4	Each	100	0	0			
59p	004b	P/S Poured In Place Box w/Deck	3	4020	LnFt	100	0	0	0		8
59s	159	Concrete-Diaphragm	3	500	LnFt	100	0	0	0		
60p	047	Conc-Posts,Col/Pile Extn(Dry)	3	7	Each	100	0	0	0		8
60p	051	Concrete-End Bent (Dry)	3	2	Each	100	0	0	0		8
				74	LnFt						
65s	100	Concrete-Approach Slab	3	2	Each	100	0	0	0		

OTHER NBI ITEMS

Traffic safety - ADEQUACY
- bridge railings --------- Item 36A : 1
- transitions ------------- Item 36B : 1
- appr. guardrail --------- Item 36C : 1
- appr. guardrail ends ---- Item 36D : 1

Channel & channel protect.- Item 61 : N
Operational Status--------- Item 41 : A
Bridge posting ------------ Item 70 : 5
Waterway adequacy --------- Item 71 : N
Approach alignment -------- Item 72 : 8

OTHER OBSERVED CONDITIONS

Deck Wearing Surface ------- : 7
Deck Drains ---------------- : 8
Approach Pavement & Embankmt : 8
Approach Shoulder & Embankmt : 8
Guardrail ------------------ : 8
Debris on Cap/Bearing Area - : 7
High Load Collisions ------- : 00

UNDER CONSTRUCTION

Contract Number :
Widening ------ :
Replacement --- :
New ----------- :

REMARKS

ELEM NO.	BENT/ SPAN	MEMBER ID	C #	DEFICIENCY DESCRIPTION	TEMP REPAIR
140	ALL	slab	1	SEE MEMO FOR EXPLANATION	
140	ALL	walls	1	SEE MEMO FOR EXPLANATION	

MAINTENANCE RECOMMENDATIONS

ELEM NO.	WORK ORDER	BENT/ SPAN	MEMBER ID	C #	WORK NEEDS LIST	EST COST	ACT COST	COMPLT DATE

MEMO:
There is a 280 foot long wall supported poured-in-place slab back on line from bent 1 (I have called this element No. 140). The typical section looks like a

APPENDIX D

INSPECTION REPORT

To: File
From: Steve Starkey, P.E.
Structural Design Engineer
Subject: Base Isolation Bearing Inspection
Clackamas Highway Ramp
Tacoma St. Intch. – S.E. 17th Ave. Conn. (Unit 2)

Date: September 28, 1993

On September 23, 1993, Bob Knorr (Research), Mike Keyes (Project Manager's Inspector) and I viewed the Dynamic Isolation Systems, Inc. bearings in preparation for writing the Construction Report for a research project (Experimental Feature). The following people were also present for portions of the viewing:

Tony Stratis	(Region Bridge Inspector)
Stan Gamolo	(Asst. Region Bridge Inspector)
Clair Kuiper	(Tony's Supervisor)
Jim Adams	(Maintenance Worker – assisting Mike Keyes)
Kevin Hugulet	(Ross Brothers' current job superintendent)

This memo will address only the findings that pertain directly to the isolator bearings. A letter was written to Marjorie West, Project Manager, informing her of observed construction workmanship deficiencies.

Bent 2: Right bearing has a small surface void. It appears to be due to incomplete molding and does not seem significant. Some slight, localized bulging at reinforcing (bulges define reinforcing locations), each bearing. Top offset about 4" toward bent 3 relative to bottom (due to structure shortening). No other defects noted.

Bent 3: Same slight bulging as bent 2 (typical at all bearing of all bents). Offset about 3" (top toward bent 4). No other defects noted.

Bent 4: Offset about 2" (top toward bent 5). No defects noted.

Bent 5: Stripped bolt – laying on column top – bolt grip appears too short. Offset about ½" (top toward bent 6 at about 60 degrees left of normal to bent). No other defects noted.

Bent 6: Right bearing masonry and base plates are deformed – may be causing high edge stresses in the isolator. Offset about 1" (top toward bent 5 at about 30 degrees left from normal to bent centerline). No other defects noted.

Bent 7: Right bearing shows slightly more bulging in upper portion. Offset about 1" as described for bent 6. No other defects noted.

Bent 8: Offset about 2" (top toward bent 7). No defects noted.

Mike told us that he has experienced structure movement as the contractor's pickups move on the bridge while he is parked on it. Bob and I stood on the bridge while Mike drove his pickup on it - We detected very slight longitudinal shaking or movement at a low frequency. What we experienced was different than the more typical vertical vibrations at a higher frequency. This movement is not a concern at this time but should be further evaluated under normal traffic volumes.