

# KENTUCKY TRANSPORTATION CENTER

# PRELIMINARY SEISMIC EVALUATION AND RANKING OF BRIDGES ALONG I-24 IN WESTERN KENTUCKY





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Research Report KTC-06-22/SPR206-00-3F

# PRELIMINARY SEISMIC EVALUATION AND RANKING OF BRIDGES ALONG I-24 IN WESTERN KENTUCKY

by

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> > in cooperation with

Transportation Cabinet Commonwealth of Kentucky

and

Federal Highway Administration U.S. Department of Transportation

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# **EXECUTIVE SUMMARY**

#### BACKGROUND

In May 1995, the Federal Highway Administration (FHWA) published a revised Seismic Retrofitting Manual for Highway Bridges (known hereafter as the Retrofitting Manual) to serve as a guide for seismic evaluation and retrofit design of current bridges in order to reduce serious damage due to an anticipated earthquake. The main draw of the retrofitting manual is that it provides a procedure for screening and/or ranking of bridges in seismically active regions. Such screening and/or ranking procedure allows bridge owners to identify and prioritize bridges according to their seismic vulnerability, and take a subsequent action.

#### **OBJECTIVE AND TASKS**

With the guidance provided in this manual, a screening and/or ranking process was carried out for bridges along I-24 in western Kentucky to identify the seismically vulnerable bridges. To achieve this objective, the following tasks were carried out:

- 1. Compile an inventory of bridges on and over I-24
- 2. Conduct field inspection of bridges on and over I-24
- 3. Develop a database of bridges on and over I-24
- 4. Carry out a preliminary seismic evaluation and ranking of bridges on and over I-24

Tasks 1 and 2 have been completed and the results are presented in a separate research report titled *Site Investigation of Bridges on/over I-24 in Western Kentucky* (KTC-05-xx/SPR206-00-2F) of this series.

#### SUMMARY AND CONCLUSIONS

A step-by-step procedure for the preliminary seismic evaluation and ranking of I-24 bridges is presented in this report. In general, the evaluation process takes into consideration the following aspects in deriving the bridge ranking: (a) structural vulnerability; (b) seismic and geotechnical hazards; and (c) bridge importance. The ranking process utilized the seismic input developed by Street et. al. (1996) specifically for the state of Kentucky, in lieu of the commonly used ASSHTO seismic maps.

One hundred and twenty seven (127) bridges, located in McCracken, Livingston, Marshall, Lyon, Caldwell, Trigg, and Christian Counties, on and over I-24 were rated using the aforementioned methodology for earthquake events of 50 years and 250 years (i.e. a seismic event that has 90% probability of not being exceeded in 50 and 250 years), respectively. Bridges that are excluded in this report are the Tennessee River Bridge and the Cumberland River Bridge (which are evaluated separately in the 5<sup>th</sup> and 6<sup>th</sup> report of this series) and culverts. Based on this preliminary investigation, bridges on and over I-24 have ranking from 0 to 38, based on a scale of 0 (lowest) to 100 (highest), for the 50-year seismic event, and 0 to 48 for 250-year seismic event. The bridges with the highest ranking are presented in Table E.1.

#### RECOMMENDATION

Bridges with relatively high ranking are located in counties closer to the New Madrid Seismic Zone (NMSZ). These counties are the McCracken, Livingston, and Marshall Counties. Based on this preliminary study, it is the recommendation of this study that some of the high ranking bridges be given the first priority for secondary and/or detailed evaluation. The detailed seismic evaluation of selected bridges is presented in the 4<sup>th</sup> report of this series.

County	BIN <sup>1,2</sup>	Year Built	Rank <sup>3</sup> (50-yr)	Rank <sup>3</sup> (250-yr)
McCracken	73-0024-B00107 & 73-0024-B00107P	1967	29	36
McCracken	73-0024-B00115 & 73-0024-B00115P	1971	29	36
McCracken	73-0024-B00114 & 73-0024-B00114P	1963	28	36
McCracken	73-0024-B00120 & 73-0024-B00120P	1975	14	18
McCracken	73-0024-B00113	1974	38	48
McCracken	73-0024-B00113	1974	38	48
McCracken	73-0024-B00112 & 73-0024-B00112P	1969	11	14
McCracken	73-0994-B00121	1971	19	24
Lyon	73-0024-B00041 & 73-0024-B00041P	1971	14	23

 Table E.1: Bridges with Relatively High Ranking

<sup>1</sup> As defined in the Kentucky Transportation Cabinet (KyTC) Bridge Inventory

<sup>2</sup> The letter 'P' stands for parallel bridges

<sup>3</sup> Based on a scale of 0 (lowest) to 100 (highest)

NOTE: This report is the third (3<sup>rd</sup>) in a series of seven reports for Project SRP 206: "Seismic Evaluation of I-24 Bridges". The seven reports are:

Report Number:	Report Title:
(1) KTC-06-20/SPR206-00-1F	Seismic Evaluation of I-24 Bridges and Embankments in Western Kentucky – Summary Report
(2) KTC-06-21/SPR206-00-2F	Site Investigation of Bridges along I-24 in Western Kentucky
(3) KTC-06-22/SPR206-00-3F*	Preliminary Seismic Evaluation and Ranking of Bridges along I-24 in Western Kentucky
(4) KTC-06-23/SPR206-00-4F	Detailed Seismic Evaluation of Bridges along I-24 in Western Kentucky
(5) KTC-06-24/SPR206-00-5F	Seismic Evaluation of the Tennessee River Bridges on I-24 in Western Kentucky
(6) KTC-06-25/SPR206-00-6F	Seismic Evaluation of the Cumberland River Bridges on I-24 in Western Kentucky
(7) KTC-06-26/SPR206-00-7F	Seismic Evaluation and Ranking of Bridge Embankments along I-24 in Western Kentucky

\* Denotes current report

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## **1. INTRODUCTION**

#### 1.1 Background

The New Madrid and Wabash Valley Seismic Zones (Fig. 1.1) can cause considerable vibrations in Western Kentucky if a sizable earthquake were to occur in that region. The New Madrid Seismic Zone (NMSZ) is potentially one of the most destructive fault zones in the United States. In 1811-1812, four of the most severe earthquakes in the American history occurred in the New Madrid Seismic Zone. The instrumental observations indicate that the New Madrid Seismic Zone is still the most hazardous zone in the east of the Rocky Mountains (Johnston 1985; and Johnston and Nava 1985).

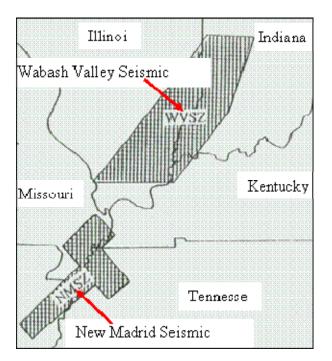


Fig. 1.1 – Seismic zones affecting Kentucky.

Interstate 24 (I-24) is located in close proximity to the NMSZ is depicted in Fig. 1.2. The Federal Highway Administration has designated I-24 as a high-priority route and an emergency route for the city of Memphis, Tennessee. Due to its close proximity to the NMSZ, Memphis is at a high risk of structural damage for its bridges and buildings, which were built before the use of seismic building codes. It is for these reasons that emergency personnel and equipment from surrounding states must utilize clear and safe routes in the event that a major earthquake strikes.



Fig. 1.2 – I-24 crossing McCracken, Marshall, Livingston, Lyon, Trigg, Caldwell, and Christian Counties in Western Kentucky (Courtesy of Kentucky Transportation Cabinet).

The Kentucky Transportation Cabinet (KyTC), as a result, has commissioned and is currently sponsoring numerous projects in an effort to investigate the structural integrity of bridges; especially those located in close proximity of these seismic zones (i.e. the New Madrid Seismic Zone to the west and the Wabash Valley Seismic Zone to the North-west of Kentucky). These efforts include field inspections, seismic evaluations, bridge prioritization, and retrofitting recommendations. One of the past projects in 1988 was to identify critical links along highways in the state of Kentucky. The study identified I-24 to be a critical link, and therefore was designated as a priority route. The significance of such identification is that bridges on this priority route are then labeled as "Essential" and must therefore remain open in the event of an earthquake. There are 127 bridges along I-24 in the seven counties in Western Kentucky. Fig. 1.3 shows the distribution of bridges in the seven counties. 70 of these bridges were designed using the pre-1971 design standards and were subsequently not built to withstand major seismic events.

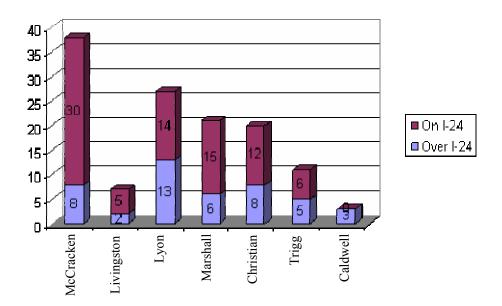


Fig. 1.3 – Distribution of bridges along I-24 among counties.

### 1.2 Objective and Tasks

The primary objective of the study is to provide ranking of these 127 bridges for the projected 50-year and 250-year seismic events. Such ranking is important because it assists in identifying and prioritizing seismically vulnerable bridges.

In this report, a step-by-step procedure for a preliminary seismic evaluation and ranking of these bridges is presented in Chapter 2, and the results are presented in subsequent chapters. The step-by-step procedure is based on the methodology provided in the retrofitting manual (Buckle and Friedland, 1995).

## 2. SEISMIC RATING SYSTEM

### 2.1 General

In this study, a preliminary screening process – known also as the "Seismic Rating System of Bridges" is used to: (1) identify the bridges that are seismically vulnerable; and (2) to subsequently prioritize bridges that are in greater need of further action (i.e. detailed seismic evaluation).

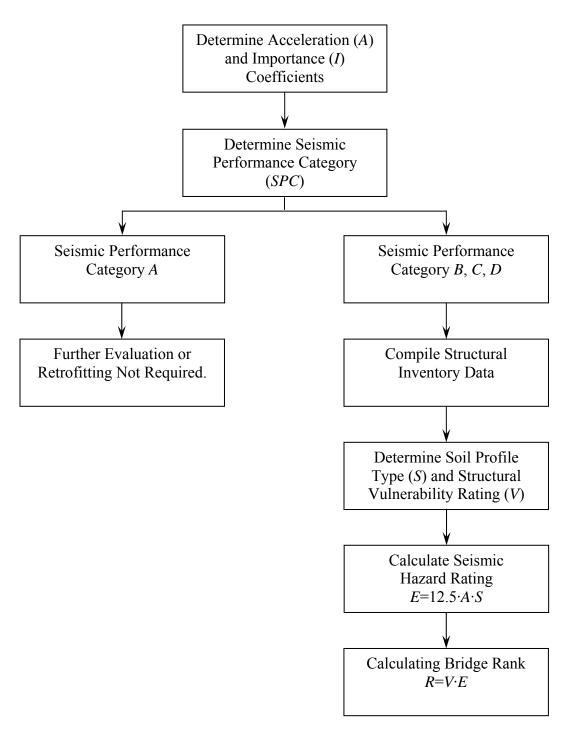
The information provided herein is obtained from the Seismic Retrofitting Manual for Highway Bridges (Buckle and Friedland, 1995) that is published by the Federal Highway Administration (Report No. FHWA-RD-94-052). The Seismic Rating System will be explained with the aid of Fig 2.1.

#### **2.2** Acceleration (A) and Importance coefficients (I)

A bridge attached to the earth during an earthquake, will move back and forth rather irregularly. Commonly, this movement can be described as time histories of displacements, velocity, and accelerations. Most building codes prescribe how much horizontal force has to be considered during to a design earthquake. Since this force is generally related to the ground acceleration, the ground acceleration has to be considered. The peak ground acceleration (*PGA*) is the maximum acceleration experienced by the building structure during the course of the earthquake motion.

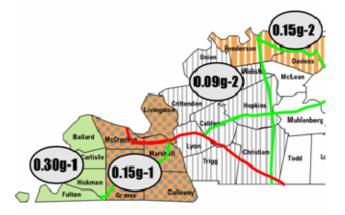
Peak ground acceleration contour maps (Fig. 2.2), defining the seismic zones and response spectra, are given on a county-basis for the seismic design of new bridges and the seismic evaluation of existing bridges in Kentucky. Peak ground accelerations (*PGA*) are listed in Table 2.1 for counties in Western Kentucky. The peak ground acceleration is a function of the acceleration coefficient (*A*) and the gravitational acceleration constant (g = 9.81m/sec<sup>2</sup> or 386 in/sec<sup>2</sup>).

The acceleration coefficient (*A*) adopted in this report is different from the American Association of State Highway and Transportation Officials (AASHTO) specifications because local peak-particle accelerations, time histories and response spectra for Kentucky have already been procured by the Kentucky Transportation Center (KTC). This information is obtained from a time history response spectra identification map for the 50-year event and the 250-year event derived by Street et. al. (1996).

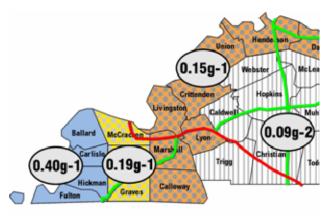


#### Fig. 2.1 – Seismic Ranking System.

(Seismic Retrofitting manual, Buckle and Friedland 1995, Figure 6)



(a) Seismic map for the 50-year seismic event



(b) Seismic map for the 250-year seismic event Fig. 2.2 – Seismic maps for bridges along I-24 (Street et al. 1996).

Table 2.1: Peak ground acceleration (PGA) and seismic performance category (SPC)

	Seismic Events					
County	50-Y	ears <sup>1</sup>	250-Years <sup>1</sup>			
	PGA	SPC	PGA	SPC		
Christian	0.09g	В	0.09g	В		
Trigg	0.09g	В	0.09g	В		
Caldwell	0.09g	В	0.09g	В		
Lyon	0.09g	В	0.15g	С		
Marshall	0.15g	С	0.15g	С		
McCracken	0.15g	С	0.15g	С		
Livingston	0.15g	С	0.15g	С		

<sup>1</sup> 90% probability of not being exceeded in the specified years

Two categories used to describe the Importance coefficient (*I*), as documented in the Seismic Retrofitting Manual (Buckle and Friedland, 1995). The two categories are known as *essential* and *standard*. Bridges classified as "*Essential*" are bridges that must remain functional and operational after an earthquake event. All other bridges are categorized as *standard*. The importance of all the bridges along I-24 in Western Kentucky can be classified as "*Essential*".

#### **2.3 Seismic Performance Category** (SPC)

Based upon the considerations for seismic hazard and importance, four Seismic Performance Categories (*SPC*) *A*, *B*, *C*, and *D* are defined by the Retrofitting Manual, as shown in Table 2.2. This classification system is different from the classification system used in the AASHTO Specifications for new design. Since all the bridges along I-24 are classified as "Essential" bridges, the *SPC* of these bridges can be exclusively determined by the seismic hazard (acceleration coefficient).

Acceleration	Importance (	Classification				
Coefficient	Essential	Standard				
$A \le 0.09$	В	Α				
$0.09 < A \le 0.19$	С	В				
$0.19 < A \le 0.29$	С	С				
0.29 < A	D	С				

 Table 2.2: Classification of Seismic Performance Category (SPC)

 (Seismic Retrofitting Manual, Table 1)

The Seismic Performance Category (*SPC*) of the bridges along I-24 are also listed in Table 2.1. The seismic evaluation procedures with regard to the *SPC* vary from one category to the other. For example, bridges in *SPC B* only need to be screened, evaluated, and strengthened based on the vulnerability of their bearings, expansion joints and support widths. In the seismic performance categories C and D, however, items including screening, evaluation and retrofitting shall include all major components subjected to failure during a strong earthquake. The effects of soil failure, such as liquefaction, are also considered for bridges in Seismic Performance Categories C and D.

#### 2.4 Structural Inventory Data

In order to obtain the critical information regarding each bridge, a comprehensive inventory of the bridges was compiled by review of the "as-built" plans, construction and maintenance records, and conducting on-site inspections. The on-site inspection form that is shown in Fig. 2.3 is used to collect the necessary data. In this inventory all the necessary data was organized and processed by a database entitled Seismic Inventory of Bridges, which was programmed using Microsoft Access 2000 (Appendix A). Data pertinent to one hundred and twenty-seven (127) bridges was collected and implemented as a seismic evaluation information system.

#### **2.5** Soil Profile Type and Soil Coefficient (*S*)

Table 2.3 shows how the different soil profile type and site coefficient (*S*) are determined. In locations where the soils properties are not known in sufficient detail to determine the soil profile type with confidence, or where the profile does not fit any of the above four types, the site coefficient shall be based on engineering judgment.

Soil Type	Soil Profile	Site Coefficient
Ι	Rock or stiff soils Soil depth less than 60 m (200 ft)	1.0
II	Stiff cohesive or deep cohesionless soil Soil depth exceeds 60 m (200 ft)	1.2
III	Soft to medium stiff clays and sands Soil depth exceeds 9 m (30 ft)	1.5
IV	Soft clays or silts Soil depth exceeds 12 m (40 ft)	2.0

 Table 2.3: Soil Profile Type and Site Coefficient (S)

 (Seismic Retrofitting Manual, Buckle and Friedland 1995, Table 3)

### 2.6 Structural Vulnerability Rating (V)

Although the performance of a bridge is based on the interaction of all of its components, it has been observed during past earthquakes that certain bridge components of four general types are more vulnerable to damage than others. These are (a) connections, bearings, and seats; (b) columns and foundations; (c) abutments; and (d) foundations. Of these components, the bearings are generally the least expensive to retrofit. For that reason, the Seismic Retrofitting Manual proposes a separate vulnerability-rating factor ( $V_1$ ) for the connections, bearings, and seat details.

	Crossing				Bridge	Number			
Γ	Year Built		County			Length (M	iles)		
SA	Latitude			Longitude		- 0- (		lease list them	
GENERAL	Have modif	ications be	en made since	the bridge was co	nstructed	1? No.	(Structure or	load).	
EZ	Does the bri	dge cross a	u body of wate	er?	Ye	s ÎNo			
5			ismically retro	ofitted?	Ye	s ÍNo			
	Is it a rigid l	oox culvert	?		Ye.	s ÎNo			
E	Is the supers	structure in	tegral with the	e abutments?	Ye.	s ÍNo Í	COMN	AENTS:	
LUR	Does the su	perstructure	e contain box	girders?		s ÎNo	_		
JC1			ent under traff	e	Ye.	s ÍNo			
SUPERSTRUCTURE	Is the bridge toppling fail			earthquake after	Ye.	s ÎNo	_		
ERS	Would gross	movement	of superstruct	ture cause instabilit	y? Ye	s No Í			
IUD	Is the bridge	e skewed?			Ye	s No Í			
S	Is there any	unusual ga	p or offset at	an expansion joint	? Ye	s ÍNo			
	Туре	Rocker <sup>®</sup> R	oller <sup>î</sup> Elastom	ٱsliding Pad Sliding	Multi-re	otation <sup>1</sup>	Condition		
	If there are pedestals, are the bearings likely to overturn in an earthquake?						Yes ÎNo		
BEARINGS	Does the bridge with less than 3 girders have exterior girder supported on the seat edge?						Yes No		
ARI	Are the bearing seats, under the abutment end-diaphragm, continuous?						Yes No 1		
BE	Are there an	y girders s	upported on in	ndividual pedestals	or colur	nns?		Yes No 1	
	What is the support?	longitudina	al support leng	gth measured in a d	lirection	perpendicu	lar to the	13 in	
RE	Is the abutm	ent a canti	lever earth-ret	aining abutment?				Yes ÎNo Î	
<b>U</b> L	Are the rein	forced con	crete columns	monolithic with th	ne supers	tructure?		Yes ÎNo	
IUC	Is there hori	zontal or v	ertical moven	nent or tilting of the	e abutme	ents, colum	ns or piers?	Yes ÍNo	
STR	Is there unu	sual or exte	ensive erosion	of soil at or near a	ny of the	e substructi	ure units?	Yes ĨNo	
SUBSTRUCTURE	Do you think abutment-slope failures are possible in an earthquake?							Yes <sup>Î</sup> No	
~									
OTHER									
TE									
0									

# Fig. 2.3 – Typical site investigation form for bridges along I-24 in Western Kentucky.

The other three components are combined under another rating factor ( $V_2$ ). The overall rating for the bridge (V) is then given by the larger of these two factors. A flow chart summarizing the process to calculate Vulnerability Rating (V) is shown in Fig. 2.4.

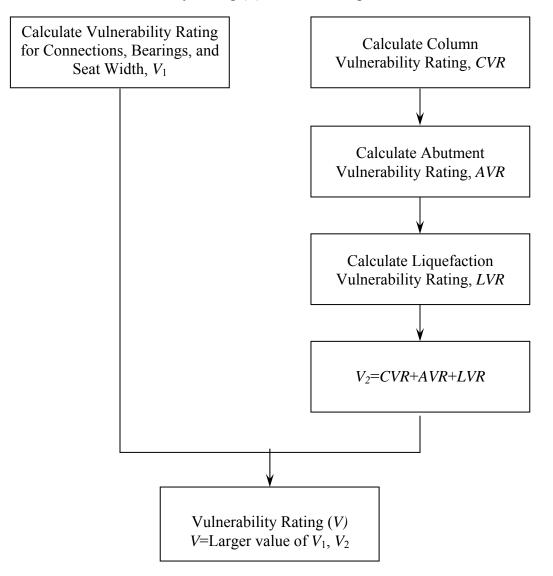
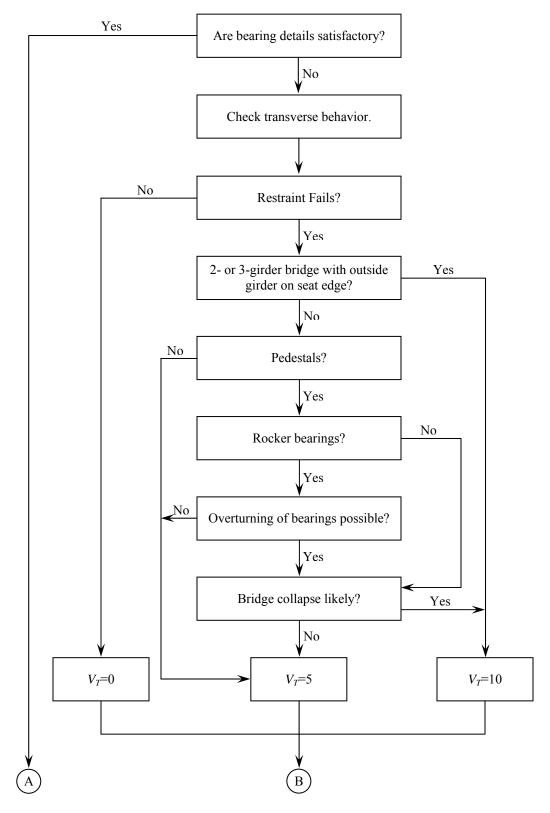
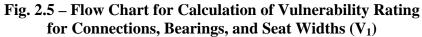


Fig. 2.4 – Flow Chart for Calculation of Bridge Vulnerability Rating (V)

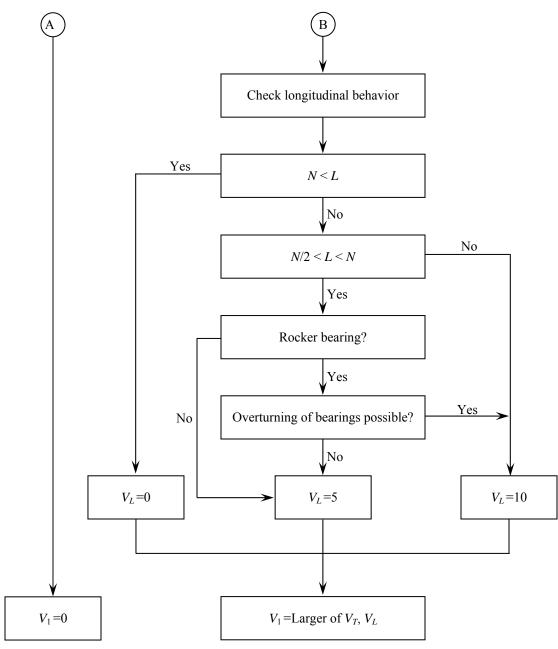
#### 2.6.1 Vulnerability Rating for Connections, Bearings, and Seat Widths (V<sub>1</sub>)

According to the Seismic Retrofitting Manual (Buckle and Friedland, 1995), a step-bystep method is suggested for determining the vulnerability rating for connections, bearings, and seat widths ( $V_1$ ). Fig. 2.5 shows a flow chart that details the process for determining ( $V_1$ ).





(Seismic Retrofitting Manual, Figure 9b)



**Fig. 2.5 (Cont') – Flow Chart for Calculation of Vulnerability Rating for Connections, Bearings, and Seat Widths (V1)** (Seismic Retrofitting Manual, Buckle and Friedland, Figure 9b)

#### 2.6.2 Vulnerability Rating for Columns, Abutments, and Liquefaction Potential (V<sub>2</sub>)

The vulnerability rating for the other components in the bridges that are susceptible to failure,  $V_2$ , is calculated from the individual component ratings as follows:

 $V_2 = CVR + AVR + LVR \le 10$ 

Where, CVR = column vulnerability rating

*AVR* = abutment vulnerability rating

*LVR* = liquefaction vulnerability rating

Suggested methods for calculating of each of these component ratings are given in Figs. 2.6 through 2.8.

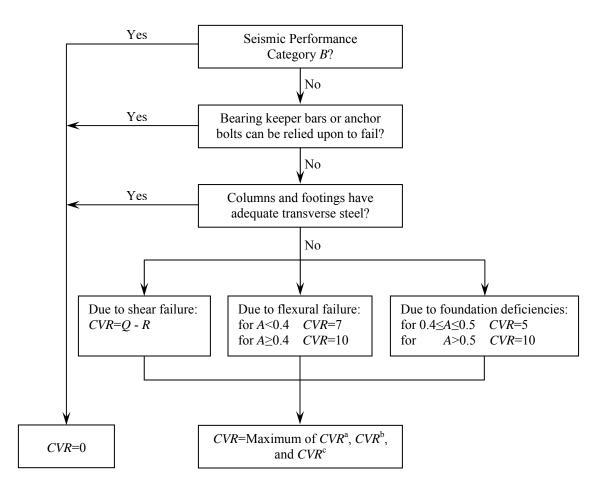


Fig. 2.6 – Flow Chart for Calculation of Column Vulnerability Rating (CVR)

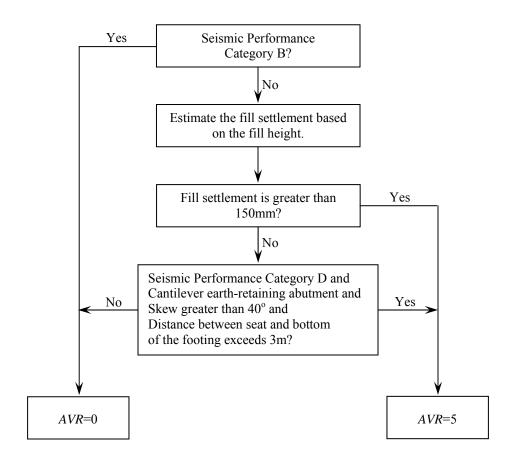


Fig. 2.7 – Flow Chart for Calculation of Abutment Vulnerability Rating (AVR)

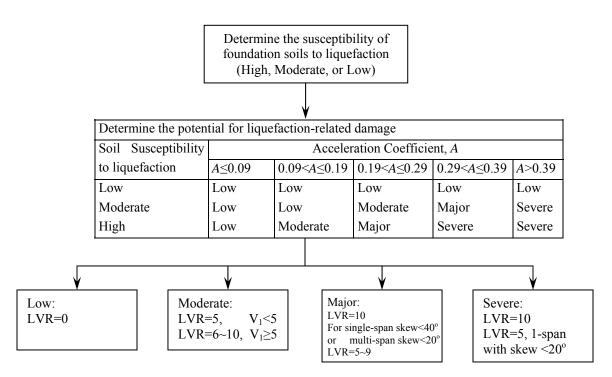


Fig. 2.8 - Flow Chart for Calculation of Liquefaction Vulnerability Rating (LVR)

### 2.7 Seismic Hazard Rating (E) and Bridge Rank (R)

As a measure of the seismic hazard, the peak ground acceleration (*PGA*) in rock or competent soil is used. The hazard is modified by the soil profile coefficient *S*, varying from 1.0 for rock to 2.0 for soft clays and sands, to allow for soil amplification effects. The seismic hazard rating (*E*) is calculated using the following equation:

 $E = 12.5 \cdot A \cdot S \le 10$  (Seismic Retrofitting Manual, Buckle and Friedland, 1995 Eq. 2-4)

The bridge rank (R) is calculated based on a structural vulnerability rating (V) and a seismic hazard rating (E). Each rating (V and/or E) falls in the range of 0 to 10 and the rank (R) is found by multiplying these two ratings.

 $R = V \cdot E$  (Seismic Retrofitting Manual, Eq. 2-2)

Since V and E, each, range from 0 to 10, the minimum and maximum values for R shall range from 0 and 100. In general, the higher the bridge rank (R), the greater the need for detailed seismic evaluation and potential for retrofitting needs.

# 3. INVENTORY OF BRIDGES ALONG I-24 IN WESTERN KENTUCKY

#### **3.1 Introduction**

As mentioned previously, the preliminary seismic bridge evaluation and ranking requires adequate knowledge of the bridge components, location, and site condition. In this study, a comprehensive inventory of I-24 bridges was compiled by reviewing the 'as-built' plans, construction and maintenance records, and site inspections, where applicable. The following briefly summarizes the general characteristics of the bridges along I-24 in Western Kentucky.

#### 3.2 Characteristics of Bridges along I-24 in Western Kentucky

The bridges along I-24 in Western Kentucky are characterized based on the associated construction type, length, number of spans, maximum span length, skew angle, bearing, etc. Over 50% of bridges are between 100 and 200 feet in length and 75% are between 100 and 300 feet in length. Thirty percent of the bridges are not skewed while 15% have a skew angle greater than 40 degrees.

Most bridges over I-24 in Western Kentucky were built in the same period, and are quite similar not only in their construction/material types but also in layouts. There are two main types of the bridges over I-24 in Western Kentucky. Forty of these bridges are designated as Type A that includes all 2-span continuous composite steel girder bridges. Three bridges are designated as Type B that includes all 2-span reinforced concrete box girder bridges. Other than these two types, there are two 1-span steel bridges and one 4-span continuous composite steel girder bridge. The maximum span lengths of the bridges range from 92 feet to 118 feet. Except for the bridge with the four main spans with a total length of 338 feet, all the 2-span bridges have a total length between 228 feet and 260 feet. Given such uniformity of the bridges over I-24 in Western Kentucky, makes analyzing a "typical" bridge, using qualitative analysis and quantitative analysis, a reasonable solution.

Despite the uniformity of the bridges over I-24 in Western Kentucky, bridges on I-24 vary in their structural characteristics. The bridges on I-24 include 38 pairs of parallel bridges (Westbound and Eastbound) and five reinforced concrete culverts.

Bearings are an important aspect in the evaluation process. They also include restraints provided at the locations of the shear keys and the restrainer bars. There are basically three types of bearings used in bridges along I-24 in Western Kentucky: (1) rocker bearings, used in 50% of

the bridges; (2) roller bearings, used in 40% of the bridges; and (3) elastomeric bearings, used in 10% of the bridges. A complete statistical data of the different aspects of bridges along I-24 in Western Kentucky is presented in the figures shown in Appendix B.

# 4. RANKING OF I-24 BRIDGES

This chapter presents the preliminary seismic evaluation and ranking of bridges along I-24 in Western Kentucky that is carried out using the methodology presented in Chapter 2 and the statistical data of the bridges, provided in Chapter 3. The preliminary seismic evaluation and ranking process that is based on structural vulnerability and seismic hazard as discussed, ranks the bridge on a scale from zero to 100, where zero stands for the lowest risk and 100 stands for the highest risk. All is all, 127 bridges along I-24 in Western Kentucky were evaluated for the 50-years and the 250-years. The rating of these bridges is presented in Table 4.1 for both the 50year and the 250-year seismic events.

				Seismic Events				
County	BIN <sup>1,2</sup>	Year Built		Year	250-Year			
			PGA <sup>3</sup>	Ranking <sup>4</sup>	PGA <sup>3</sup>	Ranking <sup>4</sup>		
	70-0024-B00061	1974	0.15g	0	0.15g	0		
Livingston	70-0024-B00062 & 70-0024-B00062 P	1977	0.15g	0	0.15g	0		
Livin	70-0024-B00063 & 70-0024-B00063 P	1977	0.15g	38	0.15g	38		
	70-0453-B00064 & 70-0453-B00064 P	1976	0.15g	14	0.15g	14		
	72-0024-B00035 & 72-0024-B00035 P	1697	0.09g	0	0.15g	0		
	72-0024-B00036 & 72-0024-B00036 P	1969	0.09g	7	0.15g	11		
	72-0024-B00037 & 72-0024-B00037 P	1976	0.09g	7	0.15g	11		
	72-0024-B00039 & 72-0024-B00039 P	1976	0.09g	0	0.15g	0		
Lyon	72-0024-B00041 & 72-0024-B00041 P	1971	0.09g	14	0.15g	23		
Ly	72-0024-B00044 & 72-0024-B00044 P	1967	0.09g	11	0.15g	19		
7 7 7 7	72-0024-B00048 & 72-0024-B00048 P	1967	0.09g	7	0.15g	11		
	72-5123-B00046 & 72-5123-B00046 P	1967	0.09g	0	0.15g	0		
	72-9001-B00049 & 72-9001-B00049 P	1976	0.09g	0	0.15g	0		
	72-0093-B00042	1976	0.09g	0	0.15g	0		

Table 4.1: Preliminary Seismic Ranking of Bridges along I-24 in Western Kentucky

<sup>1</sup> As defined in the Kentucky Transportation Cabinet (KyTC) Bridge Inventory

<sup>2</sup> The letter 'P' stands for parallel bridge

<sup>3</sup> The peak ground acceleration (PGA) is as defined in Street et. al. (1996)

<sup>&</sup>lt;sup>4</sup> The ranking methodology and procedure system is described in Chapter 2. A scale from zero (lowest risk) to 100 (highest risk) is employed.

~			Seismic Events				
County	BIN <sup>1,2</sup>	Year Built		Year	250-		
			PGA <sup>3</sup>	Ranking <sup>4</sup>	PGA <sup>3</sup>	Ranking <sup>4</sup>	
	72-0293-B00043	1976	0.09g	11	0.15g	19	
	72-0295-B00038	1976	0.09g	7	0.15g	11	
	72-0810-B00033	1976	0.09g	11	0.15g	19	
Lyon	72-0903-B00047	1967	0.09g	11	0.15g	19	
Ly	72-5039-B00040	1976	0.09g	8	0.15g	14	
	72-5118-B00045	1967	0.09g	0	0.15g	0	
	72-5225-B00032	1977	0.09g	8	0.15g	14	
	72-5229-B00034	1976	0.09g	11	0.15g	19	
Caldwell	17-0139-B00065	1970	0.09g	11	0.09g	11	
Cald	17-0276-B00066 & 17-0276-B00066 P	1971	0.09g	0	0.09g	0	
	79-0024-B00111	1967	0.15g	11	0.15g	11	
	79-0024-B00109	1970	0.15g	19	0.15g	19	
	79-0095-B00112	1967	0.15g	19	0.15g	19	
	79-1042-B00081 & 79-1042-B00081 P	1966	0.15g	19	0.15g	19	
shall	79-1610-B00092	1967	0.15g	19	0.15g	19	
Marshall	79-0024-B00116 & 79-0024-B00116 P	1970	0.15g	11	0.15g	11	
	79-0024-B00117 & 79-0024-B00117 P	1972	0.15g	19	0.15g	19	
	79-0024-B00118 & 79-0024-B00118 P	1969	0.15g	38	0.15g	38	
	79-0024-B00136	1973	0.15g	0	0.15g	0	
	79-0024-B00082 & 79-0024-B00082 P	1964	0.15g	0	0.15g	0	

Table 4.1 (Cont'): Preliminary Seismic Ranking of Bridges along I-24 in Western Kentucky

			Seismic Events					
County	BIN <sup>1,2</sup>	Year Built		Year	250-			
			PGA <sup>3</sup>	Ranking <sup>4</sup>	PGA <sup>3</sup>	Ranking <sup>4</sup>		
Marshall	79-0024-B00113 & 79-0024-B00113 P	1967	0.15g	11	0.15g	11		
	79-0024-B00114 & 79-0024-B00114 P	1974	0.15g	11	0.15g	11		
	79-0024-B00115 & 79-0024-B00115 P	1969	0.15g	0	0.15g	0		
	111-0024-B00027 & 111-0024-B00027 P	1969	0.09g	0	0.09g	0		
	111-0024-B00044 & 111-0024-B00044 P	1969	0.09g	0	0.09g	0		
	111-0024-B00048 & 111-0024-B00048 P	1970	0.09g	0	0.09g	0		
<b>5</b> 5	111-0024-B00043	1968	0.09g	11	0.09g	11		
Trigg	111-0024-B00045	1979	0.09g	11	0.09g	11		
	111-0024-B00050	1967	0.09g	0	0.09g	0		
	111-6049-B00047	1969	0.09g	11	0.09g	11		
	111-6051-B00049	1969	0.09g	0	0.09g	0		
	73-0024-B00115 & 73-0024-B00115 P	1971	0.15g	29	0.19g	36		
	73-0024-B00116 & 73-0024-B00116 P	1975	0.15g	14	0.19g	18		
	73-0024-B00118 & 73-0024-B00118 P	1975	0.15g	14	0.19g	18		
McCracken	73-0024-B00119 & 73-0024-B00119 P	1971	0.15g	14	0.19g	18		
	73-0024-B00120 & 73-0024-B00120 P	1975	0.15g	14	0.19g	18		
	73-0068-B00060 & 73-0068-B00060 P	1968	0.15g	14	0.19g	29		
	73-0024-B00117	1972	0.15g	0	0.19g	0		
	73-0062-B00121	1971	0.15g	14	0.19g	18		
	73-0024-B00113	1974	0.15g	14	0.19g	48		
	73-0131-B00009	1968	0.15g	14	0.19g	19		

Table 4.1 (Cont'): Preliminary Seismic Ranking of Bridges along I-24 in Western Kentucky

County	BIN <sup>1,2</sup>	Year Built	Seismic Events				
				Year	250-Year		
			PGA <sup>3</sup>	Ranking <sup>4</sup>	PGA <sup>3</sup>	Ranking <sup>4</sup>	
	73-0787-B00064	1966	0.15g	14	0.19g	18	
	73-0994-B00122	1971	0.15g	19	0.19g	24	
	73-3075-B00065	1966	0.15g	38	0.19g	48	
	73-0024-B00101 & 73-0024-B00101 P	1968	0.15g	14	0.19g	18	
	73-0024-B00102 & 73-0024-B00102 P	1969	0.15g	23	0.19g	29	
cken	73-0024-B00103 & 73-0024-B00103 P	1969	0.15g	11	0.19g	14	
McCracken	73-0024-B00104 & 73-0024-B00104 P	1968	0.15g	14	0.19g	18	
M	73-0024-B00105 & 73-0024-B00105 P	1969	0.15g	11	0.19g	14	
	73-0024-B00107 & 73-0024-B00107 P	1967	0.15g	29	0.19g	36	
	73-0024-B00111 & 73-0024-B00111 P	1971	0.15g	0	0.19g	0	
	73-0024-B00112 & 73-0024-B00112 P	1971	0.15g	11	0.19g	14	
	73-0024-B00114 & 73-0024-B00114 P	1963	0.15g	28	0.19g	36	
	24-0024-B00090 & 24-0024-B00090 P	1976	0.09g	8	0.09g	8	
	24-0024-B00122 & 24-0024-B00122 P	1968	0.09g	0	0.09g	0	
Christian	24-0024-B00125 & 24-0024-B00125 P	1972	0.09g	11	0.09g	11	
	24-0024-B00129 & 24-0024-B00129 P	1969	0.09g	8	0.09g	8	
	24-0695-B00124	1969	0.09g	0	0.09g	0	
	24-0024-B00130 & 24-0024-B00130 P	1968	0.09g	0	0.09g	0	
	24-0024-B00132 & 24-0024-B00132 P	1971	0.09g	8	0.09g	8	
	24-0024-B00128	1969	0.09g	8	0.09g	8	
	24-0024-B00133	1971	0.09g	8	0.09g	8	

Table 4.1 (Cont'): Preliminary Seismic Ranking of Bridges along I-24 in Western Kentucky

County	BIN <sup>1,2</sup>	Year Built	Seismic Events				
			50-1	Year	250-Year		
			PGA <sup>3</sup>	Ranking <sup>4</sup>	PGA <sup>3</sup>	Ranking <sup>4</sup>	
	24-0024-B00134	1971	0.09g	8	0.09g	8	
Christian	24-0107-B00127	1967	0.09g	8	0.09g	8	
	24-0115-B00131	1970	0.09g	8	0.09g	8	
	24-0164-B00123	1968	0.09g	11	0.09g	11	
	24-0272-B00121	1968	0.09g	11	0.09g	11	

Table 4.1 (Cont'): Preliminary Seismic Ranking of Bridges along I-24 in Western Kentucky

## **5. SUMMARY AND CONCLUSIONS**

The New Madrid Seismic Zone (NMSZ) is a seismically active zone. Interstate 24 (I-24) in Western Kentucky is close to the NMSZ, and is designated a high priority route that must remain open following a seismic event. As a part of the *Seismic Evaluation of I-24 Bridges* investigative series, the primary focus of this particular study is to perform a preliminary seismic evaluation and ranking of the bridges along I-24 in Western Kentucky. The ranking system shall assist in identifying and prioritizing bridges, based on their seismic vulnerability, for further detailed evaluations, retrofit measures, and/or other course of action. The ranking system in this study is based on a methodology developed by the Federal Highway Administration (Buckle and Friedland, 1995). The methodology takes into consideration the structural vulnerability, seismic and geotechnical hazards, and bridge importance, into consideration. Details of the methodology are presented in Chapter 2 of this report.

An inventory that includes information pertinent to the bridges along I-24 in Western Kentucky is compiled for the preliminary evaluation. The information listed in the inventory include: structural type, length, number of spans, maximum span length, skew angle, construction type, bearing, etc. The statistical data of the information is presented in Appendix B.

One hundred and twenty seven (127) bridges along I-24 in Western Kentucky were evaluated and ranked for the projected 50-year and 250-year seismic events. These seismic events have 90% probability of not being exceeded in the specified number of years. The Tennessee River Bridges and the Cumberland River Bridges along I-24 however are not included in the 127 bridges count and are evaluated separately in the 5<sup>th</sup> and 6<sup>th</sup> report of this series. Culverts are also not considered in this study. Bridges along I-24 in Western Kentucky have ranking of 0 to 38, based on a scale from zero (lowest risk) to 100 (highest risk), for the 50-year event, and 0 to 48 for the 250-year event. The bridges with the highest ranking are presented in Table 5.1. As expected, bridges that have high potential of seismic vulnerability are mainly located in counties that are in close proximity to the NMSZ.

Based on this preliminary investigation, it is the recommendation of this part of the study to consider that the bridges with relatively high ranking be given the first priority for detailed evaluations. The detailed seismic evaluations of selected bridges, in Table 5.1 are presented in the 4<sup>th</sup> report of this series.

Priority	County	BIN <sup>1,2</sup>	Year Built	Rank <sup>3</sup> (50-year)	Rank <sup>3</sup> (250-year)
	McCracken	73-0024-B00107 & 73-0024-B00107P	1967	29	36
	McCracken	73-0024-B00115 & 73-0024-B00115P	1971	29	36
First	McCracken	73-0024-B00114 & 73-0024-B00114P	1963	28	36
Fi	McCracken	73-0024-B00120 & 73-0024-B00120P	1975	14	18
	McCracken	73-0024-B00113	1974	38	48
	McCracken	73-0024-B00113	1974	38	48
_	McCracken	73-0024-B00112 & 73-0024-B00112P	1969	11	14
Second	McCracken	73-0994-B00121	1971	19	24
<b>5</b> 2	Lyon	73-0024-B00041 & 73-0024-B00041P	1971	14	23

Table 5.1: Bridges Requiring Detailed Evaluation

 As defined in the Kentucky Transportation Cabinet (KyTC) Bridge Inventory
 The letter 'P' stands for parallel bridge
 The ranking methodology and procedure system is described in Chapter 2. A scale from zero (lowest risk) to 100 (highest risk) is employed.

### REFERENCES

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# **APPENDIX A**

# **SEISMIC INVENTORY OF BRIDGES ALONG I-24**



Fig. A.1 – Seismic Inventory of Bridges along I-24 in Western Kentucky.

General Information Site and Superstructure Columns and Pier	s Abutments and Bearings	Bearings Continued	Seismic Rank	
General Information				
Bridge Name: KY 453 (Dover Ro.) NB	BIN Number	: 70-0453-B00064		
Location: 1.4 Miles N of US 62 NTRCH		,		
Average Daily Traffic: vehicles		Page Index:	1	
Year Built: 1970				
Alignment: Skewed  Additional Comments:				
Skew: 17.118 degrees				
Overall Length: 265 ft				
Overall Width: 43 ft				
Detour Length: miles		Note:		
Roadway carried by bridge: KY 453			bv bridae is the	roadway, river, valley, or
Feature crossed by bridge: I-24@MP.030.721		other landform the		
Does the bridge cross a body of water? $\square$				
Has the bridge been seismically retrofitted? $\square$				
Description/Date of Retrofit:				
Geometry: Regular 💽 Remarks:				

Fig. A.2 – Seismic Inventory of Bridges along I-24 in Western Kentucky.

General Information	Site and Superstru	ucture Columns a	and Piers Abutments	and Bearings   Beari	ings Continued Seis	smic Rank	
Site Info	rmation						
Acceleration C	oefficient	0.15	Peak Acceleration:	5.4096 ft/s^2	Importance Classif	ication: Essential 💽	I
Soil Type: So	oft clays or silts > 40	ft in depth		<b>•</b>			
Fill Height:		0 ft	Liquefaction	Susceptibility: Mod	erate 🔹		
Fill Settlement		0 ft	Potential for Liquefa	ction Damage: Low			
Cail Drofi	In. 11/						
Soli Proli	ie: iv						
Seismic	Seismic Performance Category: C						
	Seismic Performance Category: C						
Superst	Fill Settlement       0 ft       Potential for Liquefaction Damage: Low         Soil Profile:       IV         Seismic Performance Category:       C         Superstructure       C         Material and Type:       compsite welded plate girder units         Number of Spans:       2						
Material and T	Soil Type: Soft clays or silts > 40 ft in depth Fill Height: 0 ft Liquefaction Susceptibility: Moderate Fill Settlement: 0 ft Potential for Liquefaction Damage: Low Soil Profile: IV Seismic Performance Category: C Superstructure Material and Type: compsite welded plate girder units						
Number of Spa	ins:	2					
Number of Exp	ansion Joints:	2					
Length to Width	n Ratio of Deck:	6.0697674418604	17				
🗖 Would gros	s movements of the	e superstructure ca	ause instability?				
🔽 Is the super	structure continuou	s?					
🔽 Is the super	structure integral wi	th abutments?					
🗖 Does the su	iperstructure contai	n box girders?			Calculate	Export Excel Spreadsheet	

Fig. A.3 - Seismic Inventory of Bridges along I-24 in Western Kentucky.

General Information Site and Superstructure	Columns and Piers	Abutments and Bearings	Bearings Continued	Seismic Rank		
Columns and Piers						
Type Concretep pier with cross				Pier Configuratio	on: Multi-Column E	3er 🔸
Pier Material: Reinforced Concrete 💽	I			Top Fixit	y Free to Translate	e? 🗖
Smallest Transverse Column Dimension:	3 ft			Top Fixi	ty: Hinged	-
Smallest Longitudinal Column Dimension:	3 ft			Bottom Fixi	ty: Fixed	•
Range of column heights for this bridge:	23.25		nount of Reinforcing S Percent of Column Cro			2.9
Type ofTransverse Confinement Anchor b	polts		Effect	ive Column Leng	th:	16.275
Column Height: 23.25 ft	t			Framing Fact	or:	1
Reinforcement Grade: 40		· · · · · · · · · · · · · · · · · · ·	∕laximum Transverse (	Column Dimensic	on:	3 ft
			Number of points de	educted from Q (F	R):	6
Foundation Type: pile					Q: 1.775862068	396552
Does the bridge have single column be					A:	0.15
than 300ft, or does the superstructure has longitudinal reinforcement is spliced at						
		-	NOTE:			
Does the bridge have single column be reinforced for uplift or poorly confined for		that are not	This method is ba			
Are the columns monolithic with the superior	oretructuro?		columns and may Special measures			
			these columns.			
Do the columns conform to all design g	uidelines?					
Are there splices in longitudinal reinforce	ement in end zones?					
			Calcul	ate Export Ex	kcel Spreadsheet	

Fig. A.4 – Seismic Inventory of Bridges along I-24 in Western Kentucky

eneral Information	Site and Superstructure	Columns and Piers	Abutments and Bearings	Bearings Continued	Seismic Rank	
Abutme	nte					
Type:  Pile b	pent abutment					
Height:	10 ft Cutor	Fill to make abutme	nt? Fill 💽			
Foundation 7	Type: Pile					
Wingwalls:	Discontinuous 🔹	Wingwall Length	71 ft			
Does the bri	dge have approach slabs	? <b>—</b>				
Approach Sl	ab Length:	0 ft				
Is the abutm	ent a cantilever earth-retai	ning abutment? 🛛 🗖				
Bearing	js					
Bearing Typ	e: Sliding	•				
Condition [	Functioning	-				
Type of Res	traint (Transverse) : And	chor Bolts				
Type of Res	traint (Longitudinal) : And	chor Bolts				
Additional C	omments:					
				Calcula	ate Export Ex	cel Spreadsheet

Fig. A.5 – Seismic Inventory of Bridges along I-24 in Western Kentucky.

Please answer the following questions about the bearings of the bridge in consideration.         Please read the notes for instructions about the information needed.         Image: State bearing seat continuous and more than 3 girders wide?         L (see notes):       37 ft
All check-boxes represent a Yes/No answer with a check representing a Yes answer.
<ul> <li>Enter L and H in Feet</li> <li>Lis the transverse restraints likely to fail in an earthquake?</li> <li>Can bearing keeper bolts or anchor rods be relied upon to fail in an earthquake?</li> <li>Does the bridge have 2 to 3 girders with any outside girder supported on individual pedestals'</li> <li>If there are pedestals, are they likely to overtum in an earthquake?</li> <li>Is the bridge likely to collapse in an earthquake?</li> <li>Is the bridge a rigid box culvert?</li> <li>Is the collapse in an earthquake?</li> <li>In the collapse in an earthquake?</li> <li>Is the rigge a rigid box culvert?</li> <li>Is the bridge a rigid box culvert?</li> <li>Is the rigge a rigid box culvert?</li> <li>Is the rigge a rigid box culvert?</li> <li>Is the collapse at the foundation footing:</li> <li>In the collapse at the rigge at Width is the set to the bottom of the foundation footing:</li> <li>In the collapse at Width is the set to the bottom of the foundation footing:</li> <li>In the collapse at Width is the collapse at Width is the collapse at Width is the collapse at</li></ul>

Fig. A.6 – Seismic Inventory of Bridges along I-24 in Western Kentucky.

General Information	Site and S	uperstructure	Columns and Piers	Ab	outments and	Bearings [	Bearings Conti	nued	Seismic F	Rank		
Seismic	Rank											
Vulnerabil	ity Rating	s										
Connections,	, Bearings, a	and Seatwidth	۱s۱	√1:	0	unor		<u>атг</u>				
Other Compo	onents A	VR: <b>2.8</b> VR: <b>0</b> VR: <b>0</b>	Ň	√2:	2.8	This seism The rankin route or oth higher rank	g may need to k her social factor: king than an ove	sed sol be adju: s. For e irpass ti	- lely upon sted acco example, hat can b	ording t a critica e bypa	ysical features of to location of nea al river crossing r ussed easily by c	rest detour may need a n/offramps.
Overall Ratin	ıg			V:							ystem, using this is for the bridges	
Seismic Haz	ard Rating:	E: 2.9										
Seismic Ran	ik:	R: 8										
							Calculate	Save	e Exp	port Exc	cel Spreadsheet	

Fig. A.7 – Seismic Inventory of Bridges along I-24 in Western Kentucky.

### **APPENDIX B**

# INVENTORY OF BRIDGES ALONG I-24 IN WESTERN KENTCUKY

County	Bridge Bin				Leng	gth (ft)		aximum S otal Leng	
County	Number	50 -			200 -	300 -	350 -	400 -	450 -
Livingston	70 0024 B00062 70 0024 B00062P		+						
Lyon	72 0024 800035 72 0024 800035P 72 0024 800036P 72 0024 800036P 72 0024 800037P 72 0024 800037P 72 0024 800039 72 0024 800039 72 0024 800041P 72 0024 800044P 72 0024 800044P 72 0024 800048P		*	*	★	•		•	
McCracken	$\begin{array}{c} 73\ 0024\ 000101\\ 73\ 0024\ 000102\\ 73\ 0024\ 000102\\ 73\ 0024\ 000102\\ 73\ 0024\ 000103\\ 73\ 0024\ 000103\\ 73\ 0024\ 000103\\ 73\ 0024\ 000103\\ 73\ 0024\ 000105\\ 73\ 0024\ 000105\\ 73\ 0024\ 000105\\ 73\ 0024\ 000105\\ 73\ 0024\ 000105\\ 73\ 0024\ 000105\\ 73\ 0024\ 000115\\ 73\ 0024\ 000115\\ 73\ 0024\ 000112\\ 73\ 0024\ 000112\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000115\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000114\\ 73\ 0024\ 000115\\ 73\ 0024\ 000114\\ 73\ 0024\ 000115\\ 73\ 0024\ 000115\\ 73\ 0024\ 000116\\ 73\ 0024\ 000116\\ 73\ 0024\ 000116\\ 73\ 0024\ 000116\\ 73\ 0024\ 000116\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000110\\ 73\ 0024\ 000120\ 000\ 000\ 000\ 000\ 000\ 000\ $			*					*
Marshall	79 0024 B000082 79 0024 B00082P 79 0024 B00113 79 0024 B00113P 79 0024 B00114P 79 0024 B00114P 79 0024 B00115 79 0024 B00115P 79 0024 B00115P 79 0024 B00116P 79 0024 B00116P 79 0024 B00117 79 0024 B00117P 79 0024 B00117P 79 0024 B00136 111 0024 B00027		*	*	*				
Caldwell	111 0024 B00027P 111 0024 B00044 111 0024 B00044P 111 0024 B00048			*					
Christian	111 0024 B00048P 24 0024 B00090P 24 0024 B00090P 24 0024 B00122 24 0024 B00122 24 0024 B00125 24 0024 B00126 24 0024 B00129 24 0024 B00130 24 0024 B00130 24 0024 B00132 24 0024 B00132P			*	*		*		

Fig. B.1 – Total Length and Maximum Span Length of Bridges on I-24 in Western Kentucky

		Bearir	<u> </u>	
County	Bridge Bin Number	Sliding	Rocker	Elastometric
Livingston	70 0024 B00061			ić
LIVINGSTON	70 0024 B00062P 70 0024 B00062			
	1 72 0024 800035 1		•	
	72 0024 B00035P 72 0024 B00036			
	72 0024 800036P		•	
	72 0024 B00037 72 0024 B00037P			
Lyon	T 72 0024 B00039 I			•
	72 0024 B00039P 72 0024 B00041		• •	<b>†</b>
	72 0024 B00041P			
	72.0024 B00044	•		
	72 0024 B00044P			<b>_</b>
	72 0024 B00048 72 0024 B00048P			•
	73 0024 800101 73 0024 800101P	<u>1</u>		
	73 0024 B00102		•	
	73 0024 B00102P 73 0024 B00103		•	
	73 0024 B00103 73 0024 B00103P 73 0024 B00104			
	73 0024 800104	+		
	73 0024 B00104P 73 0024 B00105		→ ↓ ↓	
	73 0024 B00105P 73 0024 B00107		• • • •	
	73 0024 B00107			
	73 0024 B00107P 73 0024 B00111			+
McCracken	73 0024 B00111P 73 0024 B00112			+
	73 0024 B00112   73 0024 B00112P			
	73 0024 B00112P 73 0024 B00114		•	
	73 0024 B00114P 73 0024 B00115			
	73 0024 B00115P 73 0024 B00116			
	73 0024 B00116	<u>t</u>		
	73 0024 B00116P 73 0024 B00117 73 0024 B00118	<b>i</b>		
	73 0024 B00118 73 0024 B00118P			
	73 0024 800119			
	173 0024 B00119P I		•	
	73 0024 B00120 73 0024 B00120P			
	79 0024 800082			
	79 0024 B00082P 79 0024 B00113		•	
	79 0024 B00113P		• •	
	79 0024 B00114 79 0024 B00114P			
Marshall	79 0024 800115	•		
	79 0024 B00115P 79 0024 B00116	<b>†</b>		
	79 0024 B00116P		· · · · · · · · · · · · · · · · · · ·	
	79 0024 B00117 79 0024 B00117P			
	79 0024 B00136			
	111 0024 B00027		•	
Trian	11 0024 B00027P 111 0024 B00044			
Trigg	11 0024 B00044P		•	
	111 0024 B00048 11 0024 B00048P			
	24 0024 800090		•	
	24 0024 B00090P 24 0024 B00122			
	24 0024 B00122P			
	24 0024 B00125 24 0024 B00126			
Christian	24 0024 B00129			
	24 0024 B00129P		•	
	24 0024 B00130 24 0024 B00130P			
	24 0024 800132		•	
	24 0024 B00132P		•	

Fig. B.2 – Bearing Type of Bridges on I-24 in Western Kentucky.

County	Bridge Bin Number	Steel	Bridge Type	Precast Concrete	Culvert
Livingston				w	• •
Lyon	70 0024 B00062P 72 0024 B00035P 72 0024 B00036P 72 0024 B00036P 72 0024 B00036P 72 0024 B00037 72 0024 B00039P 72 0024 B00039P 72 0024 B00039P 72 0024 B00041P 72 0024 B00041P 72 0024 B00044P 72 0024 B00044P 72 0024 B00048P			*	Image: Constraint of the sector of
McCracker	73 0024 B00101 73 0024 B00102 73 0024 B00102 73 0024 B00103 73 0024 B00103 73 0024 B00103 73 0024 B00104 73 0024 B00104 73 0024 B00105P 73 0024 B00105P 73 0024 B00107 73 0024 B00107 73 0024 B00107 73 0024 B00107 73 0024 B00107 73 0024 B00107			* * * * *	
Marshal	79 0024 800082 79 0024 800082P 79 0024 800113 79 0024 800113P 79 0024 800114P 79 0024 800114P 79 0024 800116 79 0024 800116 79 0024 800116P 79 0024 800116P 79 0024 800117 79 0024 800117 79 0024 800117 79 0024 800117 79 0024 800116P 79 0024 800117 79 0024 800117 79 0024 800117			*	
Trigg	111 0024 B00027P 111 0024 B00044 111 0024 B00044P 111 0024 B00048 111 0024 B00048 111 0024 B00048P				
Christian	24 0024 800090 24 0024 800190 24 0024 800122 24 0024 800122 24 0024 800125 24 0024 800125 24 0024 800126 24 0024 800129 24 0024 800129 24 0024 800130 24 0024 800132 24 0024 800132 24 0024 800132			* *	

Fig. B.3 – Bridge Type of Bridges on I-24 in Western Kentucky.

County	Bridge Bin Number		S	kew Ang	le (Degree	s) t	<u> </u>	
	70 0024 B00061 70 0024 B00062 70 0024 B00062P		•					
Livingston	70 0024 800062 70 0024 8000628			+				
	72.0024 B0002F			•			•	
	72 0024 B00035 72 0024 B00035P						. Á	
	72 0024 800036					•		
	72 0024 B00036P 72 0024 B00037					•		
	72 0024 B00037P							
Lyon	72 0024 800039 72 0024 800039P		•					
	72 0024 B00039P	· ·	•					
	72 0024 B00041 72 0024 B00041P						<b>.</b>	
	72 0024 800044						L V	
	72 0024 B00044 72 0024 B00044P						٠	
	1 72 0024 B00048		•					
	72 0024 B00048P 73 0024 B00101	· ·	•	•				
	73 0024 B00101P							
	73 0024 B00102		•					
	73 0024 B00102P		+					
	73 0024 800103					*		
	73 0024 B00103 73 0024 B00103P 73 0024 B00104				-			
	73 0024 B00104P _73 0024 B00105							
	73 0024 B00105		•					
	73 0024 B00105P		•					
	73 0024 B00107 73 0024 B00107P							
	73 0024 B00111	L .	•	- <b>*</b>				
	73 0024 B00111P		•					
	I 73 0024 ⊟00112		•					
McCracken	73 0024 B00112P 73 0024 B00114 73 0024 B00114 73 0024 B00114P		•				•	
	73 0024 B00114P							
	1 73 0024 B00115		•				, i	
	73 0024 B00115P		•					
	73 0024 B00116		*					
	73 0024 800116P 73 0024 800117		• •					
	73 0024 B00118					•		
	73 0024 B00118P					+		
	73 0024 B00119				•			
	73 0024 B00119P 73 0024 B00120			•	•			
	73 0024 B00120P			÷.				
	73 0024 B00120P _79 0024 B00082		•					
	79 0024 B00082P		•					
	79 0024 B00113 79 0024 B00113P							
	79 0024 B00114		•			•		
	79 0024 B00114 79 0024 B00114P		•					
Marshall	1 79 HU24 HU1115				•			
	79 0024 B00115P 79 0024 B00116 79 0024 B00116 79 0024 B00116P				•			
	79 0024 B00116P				¥			
	79 0024 B00117 79 0024 B00117P			•				
				•				
	79 0024 B00136 111_0024_B00027	•	•					
	111 0024 B00027P			+				
<u>-</u> .	111 0024 B00044			<u>+</u>				
Trigg	111 0024 B00044 111 0024 B00044P			٠				
	1 111 0024 800048						•	
<u> </u>	111 0024 B00048P 24 0024 B00090				•		•	
	24 0024 B00090P				l 🕻			
	24 0024 B00090P 24 0024 B00122 24 0024 B00122				•			
	24 0024 B00122P				+			
	24 0024 800125							
Christian	24 0024 B00125 24 0024 B00126 24 0024 B00129				· · ·	•		
	24 0024 B00129P					- i		
	24 0024 B00129P 24 0024 B00130						•	
	24 0024 B00130P 24 0024 B00132 24 0024 B00132						•	
	24 0024 B00132		<b>I</b>					
	2,002,000,021		T					

Fig. B.4 – Skew Angle of Bridges on I-24 in Western Kentucky.

County	Bridge Number	Low	Moderate
Livingston	70 0024 B00062 70 0024 B00062		
Lyon	72 0024 B00035 72 0024 B00035 72 0024 B00036 72 0024 B00036 72 0024 B00037 72 0024 B00037 72 0024 B00039 72 0024 B00039 72 0024 B00039 72 0024 B00041 72 0024 B00041 72 0024 B00044 72 0024 B00044 72 0024 B00048 72 0024 B00048		
McCracken	72         0024         B00101           73         0024         B00102           73         0024         B00102           73         0024         B00102           73         0024         B00103           73         0024         B00103           73         0024         B00104           73         0024         B00104           73         0024         B00104           73         0024         B00104           73         0024         B00105           73         0024         B00105           73         0024         B00107           73         0024         B00117           73         0024         B00117           73         0024         B00117           73         0024         B00111           73         0024         B00112           73         0024         B00114           73         0024         B00115           73         0024         B00115           73         0024         B00116           73         0024         B00118           73         0024         B00118		
Marshall	79 0024 B00113 79 0024 B00113 79 0024 B00114 79 0024 B00114 79 0024 B00115 79 0024 B00115 79 0024 B00115 79 0024 B00116 79 0024 B00116 79 0024 B00117 79 0024 B00117 11 0024 B00027		
Trigg	11 0024 B00027 11 0024 B00044 11 0024 B00044 11 0024 B00048 11 0024 B00048		
Christian	24 0024 800090 24 0024 800090 24 0024 800122 24 0024 800122 24 0024 800125 24 0024 800125 24 0024 800129 24 0024 800129 24 0024 800130 24 0024 800130 24 0024 800132		

Fig. B.5 – Liquefaction Potential of Bridges on I-24 in Western Kentucky.

						at Wi	4+1			
County:	Bridge Bin							1		
County.	Number	,	л . с	÷ ;	5 10	ൃത്	25	8	2	ມ ກ
		Ĺ			1	1			· ·	
1 ::	70 0024 B00061 70 0024 B00062				• I • I		+			
Livingston	70 0024 B00062P	<u> </u>	-		· · ·	•	+			
	72 0024 800035					٠				
	72 0024 B00035P 72 0024 B00036	L			•		+			
	72 0024 B00036P	<u> </u>	-		▶ <b>♦</b>   ▶		•			
	72 0024 B00037				۱.		•			
Lyon	72 0024 B00037P				•					
l í	72 0024 B00039 72 0024 B00039P						•			
	72 0024 800041				l i		Ť			
	72 0024 B00041P				•			•		
	72 0024 800044		_		<b>•</b>	<u> </u>	+			
	72 0024 B00044P 72 0024 B00048	<b>├</b> ──			*	<u> </u>	+			
	72 0024 B00048P				► ◆ Ť					
	73 0024 800101				••					
	73 0024 B00101P 73 0024 B00102	<u> </u>		* *	*					
	73 0024 B00102	<u> </u>		<b>-</b>	•		+			
	73 0024 B00103				- ×					
	73 0024 B00103P				<b>•</b>					
	73 0024 B00104 73 0024 B00104P	<u> </u>	•			•	+			
	73 0024 800104	<u> </u>			-	÷.	+			
	73 0024 B00105P				۰ ۲					
	73 0024 B00107				•		-			
	73 0024 B00107P 73 0024 B00111	<u> </u>					+			
	73 0024 B00111P		<u> </u>			•	+			
McCracken	73 0024 B00112					•				
	73 0024 B00112P					•	+	*		
	73 0024 B00114 73 0024 B00114P	<u> </u>		-	•	<b>F</b>	+			
	73 0024 800115				•					
	73 0024 B00115P 73 0024 B00116					<u>t</u>	+			
	73 0024 B00116P	<u> </u>	-		•	<b>[</b> •	+			
	73 0024 B00117				•	٠				
	73 0024 B00118									
	73 0024 B00118P 73 0024 B00119					•	+		•	
	73 0024 B00119P	<b>├</b> ──					+			
	73 0024 B00120				•	٠				
	73 0024 B00120P				•	•	+			
	79 0024 B00082 79 0024 B00082P	<u> </u>				•	+			
	79 0024 B00113				•	Ť				
	79 0024 B00113P				•		$\rightarrow$			
	79 0024 B00114 79 0024 B00114P	<b>├</b> ──			•	<u> </u>	+			
Marshall	79 0024 B00115			•		٠				
	79 0024 B00115P			-		٠				
	79 0024 B00116 79 0024 B00116P	<u> </u>		• I • I		<u> </u>				
	79 0024 B00110P	<u> </u>	-	• <sup>•</sup> i	•	$\vdash$				
	79 0024 B00117P			• i	•					
<u> </u>	79 0024 B00136				• !			. 🛔 🚖		
	111 0024 B00027 111 0024 B00027P	<b>├</b> ──		•	• · ·	F	١Q	30	<b>—</b>	
Caldwell	111 0024 B00044			, ř	÷.		.(S)actual (in)	(S)required (in) (1/2S)required (in)		
Caluveit	111 0024 B00044P			٠	•		ua	reg Tui		
	111 0024 B00048 111 0024 B00048P			•		$\left  - \right $	9	빌 입	<u> </u>	
	24 0024 B00048P	<u> </u>			<u> </u>	$\vdash$	5	23	<u> </u>	
	24 0024 B00090P				*			Ĵ		
Christian	24 0024 B00122				•			$\overline{}$		
Christian	24 0024 B00122P 24 0024 B00125	<u> </u>		*		$\vdash$			<b>—</b>	
	24 0024 B00125			_	•					
	24 0024 B00129		_		<b>&gt;</b>		-			

Fig. B.6 – Seat Width of Bridges on I-24 in Western Kentucky.

County	Bridge Bir Number	c i	Si	te Coeffi Factor →		22
Livingston	70 0453 B00064 70 0453 B00064P					•
Lyon	72 0093 800064P 72 0093 800042 72 0293 800043 72 0295 800038 72 0810 800033 72 0903 800047 72 5039 800040 72 5118 800045 72 5123 800046P 72 5123 800046			•	•	•
	72 5225 B00032 72 5229 B00034 72 9001 B00049 72 9001 B00049P				•	•
	73 0024 B00113 73 0062 B00121				+	•
McCracken	73 0068 B00060 73 0068 B00060P 73 0131 B00009 73 0787 B00064					
	73 0994 B00122 73 3075 B00065				—	-
Marshall	79 0024 B00111 79 0024 B00112 79 0095 B00109 79 1042 B00081				•	• •
	79 1042 B00081P 79 1610 B00092					+
Trigg	111 0024 B00043 111 0024 B00045 111 0024 B00050 111 6049 B00047 111 6051 B00049					•
Caldwell	17 0139 B00065 17 0276 B00066 17 0276 B00066 17 0276 B00066P					
Christian	24 0024 B00128 24 0024 B00133 24 0024 B00133 24 0024 B00134 24 0107 B00127 24 0115 B00131 24 0164 B00123 24 0272 B00121				* * *	
	24 0695 B00124					+

Fig. B.7 – Site Coefficient of Bridge Sites on I-24 in Western Kentucky.

	Bridge Bin					L	ength (fi	)		
County	Number					150	2 !	ာ ရ	30	
	Number		č	50.0	53	5 3	200.	950.	5 7	350 .
Livingston	70 0453 B00064			•						
Livingston	70 0453 B00064			•						
	72 0093 B00042				+					
	72 0293 B00043				+					
	72 0295 B00038			+			•			
	72 0810 B00033				•					
	72 0903 B00047				+					
	72 5039 B00040			+			-			
Lyon	72 5118 B00045				+					
	72 5123 B00046				•					
	72 5123 B00046				<del>ب</del> ا	•				
	72 5225 B00032				•		•			
	72 5229 B00034			•						
	72 9001 B00049				•					
	72 9001 B00049				•					
	73 0024 B00113				٠					
	73 0062 B00121				•					
	73 0068 B00060			•			•			
	73 0068 B00060			•			•			
McCracken	73 0131 B00009				٠					
	73 0787 B00064			•			•			
	73 0994 B00122				•					
	73 3075 B00065			•			•			
	79 0024 B00111			•						
	79 0024 B00112	•		•						
Marshall	79 0095 B00109	∏ à		+			•			
Marshan	79 1042 B00081	0 g		+						
	79 1042 B00081	∏≝		+	•					
	79 1610 B00092	15		+						
	111 0024 B00043	<ul> <li>Mainspan Length</li> </ul>			•					
	111 0024 B00045				+					
Trigg	111 0024 B00050	[] ⊒		+						
	111 6049 800047	0 #			+					
	111 6051 B00049	Total Bridge		•						
	17 0139 B00065	] ĕ		•						
Caldwell	17 0276 B00066	Length			•					
	17 0276 B00066	∐ ₿			•					
	24 0024 B00128		J		•					
	24 0024 B00133				•	-				
	24 0024 B00134				+					
OL SHE	24 0107 B00127			•						
Christian	24 0115 B00131				•					
	24 0164 B00123			•						
	24 0272 B00121				•					
	24 0695 B00124			•						

Fig. B.8 – Total Length and Maximum Span Length of Bridges over the I-24 in Western Kentucky.

County	Bridge Number	Bearing Type	Sliding	Elastomeric-
Livingston	70 0453 B00064 - 70 0453 B00064P -			•
Lyon	72 0093 B00042 72 0293 B00043 72 0295 B00038 72 0810 B00033 72 0903 B00047 72 5039 B00040 72 5118 B00045 72 5123 B00046 72 5123 B00046 72 5123 B00046 72 5225 B00032		* * *	•           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •           •
	72 5229 B00034 72 9001 B00049 72 9001 B00049P		*	•
McCracken	73 0024 B00113 73 0062 B00121 73 0068 B00060 73 0068 B00060P 73 0131 B00009 73 0787 B00064 73 0994 B00122 73 3075 B00065		• • • •	• • •
Marshall	79 0024 B00111 79 0024 B00112 79 0095 B00109 79 1042 B00081 79 1042 B00081P 79 1610 B00092		• •	* * *
Trigg	111 0024 800043 111 0024 800045 111 0024 800050 111 6049 800047 111 6051 800047		• •	• • •
Caldwell	17 0139 B00065 - 17 0276 B00066 - 17 0276 B00066P -		•	•
Christian	24 0024 B00128 24 0024 B00133 24 0024 B00133 24 0024 B00134 24 0107 B00127 24 0107 B00127 24 0115 B00131 24 0164 B00123 24 0272 B00124 24 0695 B00124			•           •           •           •           •           •           •           •           •           •

Fig. B.9 – Bearing Type of Bridges over the I-24 in Western Kentucky.

County:	Bridge Bin	Seat Width (S) (in)							
ŕ	Number		י תי	<b>1</b>	15	20.	25.		
Livingston	70 0453 B00064			• •		•			
Livingston	70 0453 B00064P			• •		•			
	72 0093 B00042			•		۰ ا			
	72 0293 B00043			•	•	•			
	72 0295 B00038			• •		•			
	72 0810 B00033			• •		•			
	72 0903 B00047				•	•			
Lyon	72 5039 B00040			•	•	•			
2,011	72 5118 B00045			•		•			
	72 5123 B00046P		•		<b>♦</b> ►				
	72 5123 B00046		•		<b>♦</b> ►				
	72 5225 B00032			• •		•			
	72 5229 B00034			• •		•			
	72 9001 B00049			•		*			
	72 9001 B00049P			•		-			
	73 0024 B00113			M			•		
	73 0062 B00121			•	•	•			
	73 0068 B00060			• •		•			
McCracker	73 0068 B00060P			• •		•			
MICOTACKET	73 0131 B00009			•	•	•			
	73 0787 B00064			• •		•			
	73 0994 B00122			• •		•			
	73 3075 B00065			-		•			
	79 0024 B00111			• •		•			
	79 0024 B00112			• •		•			
Marshall	79 0095 B00109			• •		•			
	79 1042 B00081		•	•	•				
	79 1042 B00081P		•	•	•				
	79 1610 B00092			• •		•			
	111 0024 B00043		•	<b>►</b> 4	•				
	111 0024 B00045		•	•	•				
Trigg	111 0024 B00050		•	+					
	111 6049 B00047		•		•				
	111 6051 B00049			•					
	17 0139 B00065		•	• •					
Caldwell	17 0276 B00066		•	۰ ۲					
	17 0276 B00066P			۰ ۲					
	24 0024 B00128			•	•				
	24 0024 B00133		•	•	• ?	: <u>-</u> 2			
	24 0024 B00134			•		(0.5S)required			
Obsidian	24 0107 B00127		•	<b>&gt;</b>		t ÿra ⊑i			
Christian	24 0115 B00131			• •	· *	- qui red			
	24 0164 B00123		•	•	•	ed			
	24 0272 B00121		•	▶ ◀					
	24 0695 B00124			•					

Fig. B.10 – Seat Width of Bridges over the I-24 in Western Kentucky.

County	Bridge Bin			Sk	ew A	ngle (	Degre	ees)			
,	Number	╞	თ.	i ;	, ,	20 .	25 2	3	ვ.	40	45
T ::	70 0453 B00064 ·		1		٠	1					
Livingston	70 0453 B00064P				٠						
	72 0093 B00042 ·										•
	72 0293 B00043 🔅							٠			
	72 0295 B00038 🔅	-		٠							
	72 0810 B00033 🔅	-	•								
	72 0903 B00047 🔅	-					•				
Lyon	72 5039 B00040			•							
Lyon	72 5118 B00045	-					٠				
	72 5123 B00046P	-					٠				
	72 5123 800046	-				٠					
	72 5225 800032 🔅	•									
	72 5229 B00034	-		٠							
	72 9001 B00049	-					٠				
	72 9001 B00049P	-					٠		1		
	73 0024 B00113 ·	-						•			
	73 0062 B00121	-			٠						
	73 0068 800060 🔅	•									
McCracken	73 0068 B00060P	•									
MCCfacken	73 0131 B00009 🔅								•	•	
	73 0787 800064	•									
	73 0994 B00122					•			<u> </u>		<u> </u>
	73 3075 B00065	-		٠							
	79 0024 B00111 ·	•				1					$\square$
	79 0024 B00112			٠		1					$\square$
3.6	79 0095 B00109		•			<u> </u>			<u> </u>		
Marshall	79 1042 B00081 🔅	-	٠								
	79 1042 B00081P		•								
	79 1610 800092 🔅	•	<u> </u>			<u> </u>					$\vdash$
	111 0024 B00043 ·						٠				
	111 0024 B00045		<u> </u>			<u> </u>			+	•	$\vdash$
Trigg	111 0024 B00050			•							$\square$
	111 6049 800047		•			<u> </u>			+		$\vdash$
	111 6051 B00049					•					$\square$
	17 0139 B00065 ·		•								$\square$
Caldwell	17 0276 B00066				•						
	17 0276 B00066P	-			•				1		
	24 0024 B00128 ·	-						٠	1		
	24 0024 B00133	-							1		٠
	24 0024 B00134	-								•	
Chaintin	24 0107 B00127	•							1		$\square$
Christian	24 0115 B00131			٠					1		
	24 0164 B00123	-		•					1		$\square$
	24 0272 B00121	-				•	•		1		$\square$
	24 0695 B00124	<del> </del>		<b>I</b>	<b>—</b>	+	+	<u> </u>	+	+	+

Fig. B.11 – Skew Angle of Bridges over the I-24 in Western Kentucky.

County	Bridge Number	ω ·	3.1		C ik	ມ ບ	ມ 	3.4 -	35
Livingston	70 0453 B00064								•
Envirigation	70 0453 B00064	+					_		
	72 0093 B00042	+					_		
	72 0293 B00043								<b>†</b>
	72 0295 B00038	+					_		
	72 0810 B00033						_		<b>†</b>
	72 0903 B00047								_ <b>+</b>
Lyon	72 5039 B00040	<b>†</b>					_		
	72 5118 B00045	<b>†</b>					_		
	72 5123 B00046	<b>†</b>					_		
	72 5123 B00046	<b>†</b>					_		
	72 5225 B00032	<b>•</b>					_		
	72 5229 B00034						_		
	72 9001 B00049	<b>†</b>					_		
	72 9001 B00049	<b>†</b>					_		
	73 0024 B00113	<b>†</b>					_		
	73 0062 B00121						_		_ <b>!</b>
	73 0068 B00060						_		_ <b>!</b>
McCracken	73 0068 B00060						_		
	73 0131 B00009								
	73 0787 B00064	<b>•</b>					_		
	73 0994 B00122						_		_ <b>!</b>
	73 3075 B00065 79 0024 B00111								_ <b>t</b>
	79 0024 B00111 79 0024 B00112	<b>Ť</b>							<u> </u>
	79 0024 B00112 79 0095 B00109								<u> </u>
Marshall	79 1042 B00081			<ul> <li>Liquification Classification</li> </ul>			_		<u> </u>
	79 1042 B00081			[ 문 ]					<u> </u>
	79 1610 B00092			¦≣ ⊦					<u> </u>
	111 0024 B00043			똜			_		<u> </u>
	111 0024 B00045			١žŀ			_		<u> </u>
	111 0024 B00050			揻			_		<u> </u>
	111 6049 B00047			l≝ŀ					_ <b>_</b>
	111 6051 B00049			18					_ <b>_</b>
	17 0139 B00065			l₫ŀ			_		_ <b>_</b>
Caldwell	17 0276 B00066								_ <b>_</b>
Calowell	17 0276 B00066								+
	24 0024 B00128	+							
	24 0024 B00133	+							<u> </u>
	24 0024 B00134	+					-		
01-01-0	24 0107 B00127	+					<u> </u>		
Christian	24 0115 B00131	+					<u> </u>		
	24 0164 B00123	+							
	24 0272 B00121	+							
	24 0695 B00124	•							

Fig. B.12 – Liquefaction Potential of Bridges over the I-24 in Western Kentucky.

County	Bridge Bin	Site Soil Coefficient								
ocamy	Number	- i	<u>,</u>	1 .4	1.6		N			
	70 0453 B00064			+			1			
Livingston	70 0453 B00064 70 0453 B00064P		•				-			
	72 0093 B00042		•							
	72 0293 B00043						+			
	72 0295 B00038		•							
	72 0810 B00033						+			
	72 0903 B00047						+			
_	72 5039 B00040			•						
Lyon	72 5118 B00045			•						
	72 5123 B00046			•						
	72 5123 B00046P			•						
	72 5225 B00032			•						
	72 5229 B00034						+			
	72 9001 B00049			•						
	72 9001 B00049P			•						
	73 0024 B00113			•						
	73 0062 800121						+			
	73 0068 800060						+			
N	73 0068 B00060P						+			
McCracken	73 0131 B00009						+			
	73 0787 800064			•						
	73 0994 B00122						+			
	73 3075 B00065						+			
	79 0024 B00111			•						
	79 0024 B00112						<u>+</u>			
Marshall	79 0095 B00109						<u>+</u>			
	79 1042 B00081						<u>+</u>			
	79 1042 B00081P						<u>+</u>			
	79 1610 B00092			_			<u>+</u>			
	111 0024 B00043			_			<b>†</b>			
	111 0024 B00045			_			•			
Trigg	111 0024 B00050						<b>†</b>			
	111 6049 B00047			_		_	<b>†</b>			
	111 6051 B00049 17 0139 B00065			_			<u>I</u>			
Caldenal							<u>I</u>			
Caldwel	17 0276 B00066						<u>I</u>			
	17 0276 B00066P					_	<b>I</b>			
	24 0024 B00128 24 0024 B00133			•						
	24 0024 B00133 24 0024 B00134			•						
	24 0024 B00134 24 0107 B00127			•						
Christian	24 0107 800127			•			+			
	24 0115 B00131 24 0164 B00123									
	24 0272 B00121						I			
	24 0695 B00124						<u>I</u>			
	24 0035 000124						T			

Fig. B.13 – Site Coefficient of Bridges over the I-24 in Western Kentucky.

For more information or a complete publication list, contact us at:

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