

EARTHQUAKES AND SEISMIC DESIGN OF BRIDGES IN VIRGINIA

Junyi Meng, Ph.D., P.E., Assistant State Structure and Bridge Engineer

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To Dr. Phil Yen, My Friend, Brother and Mentor

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Confucius, Yen Zi, Zeng Zi, Mencius

Outline

- Introduction
- Earthquakes in Virginia
- Seismic Design of Bridges in Virginia
- Summary

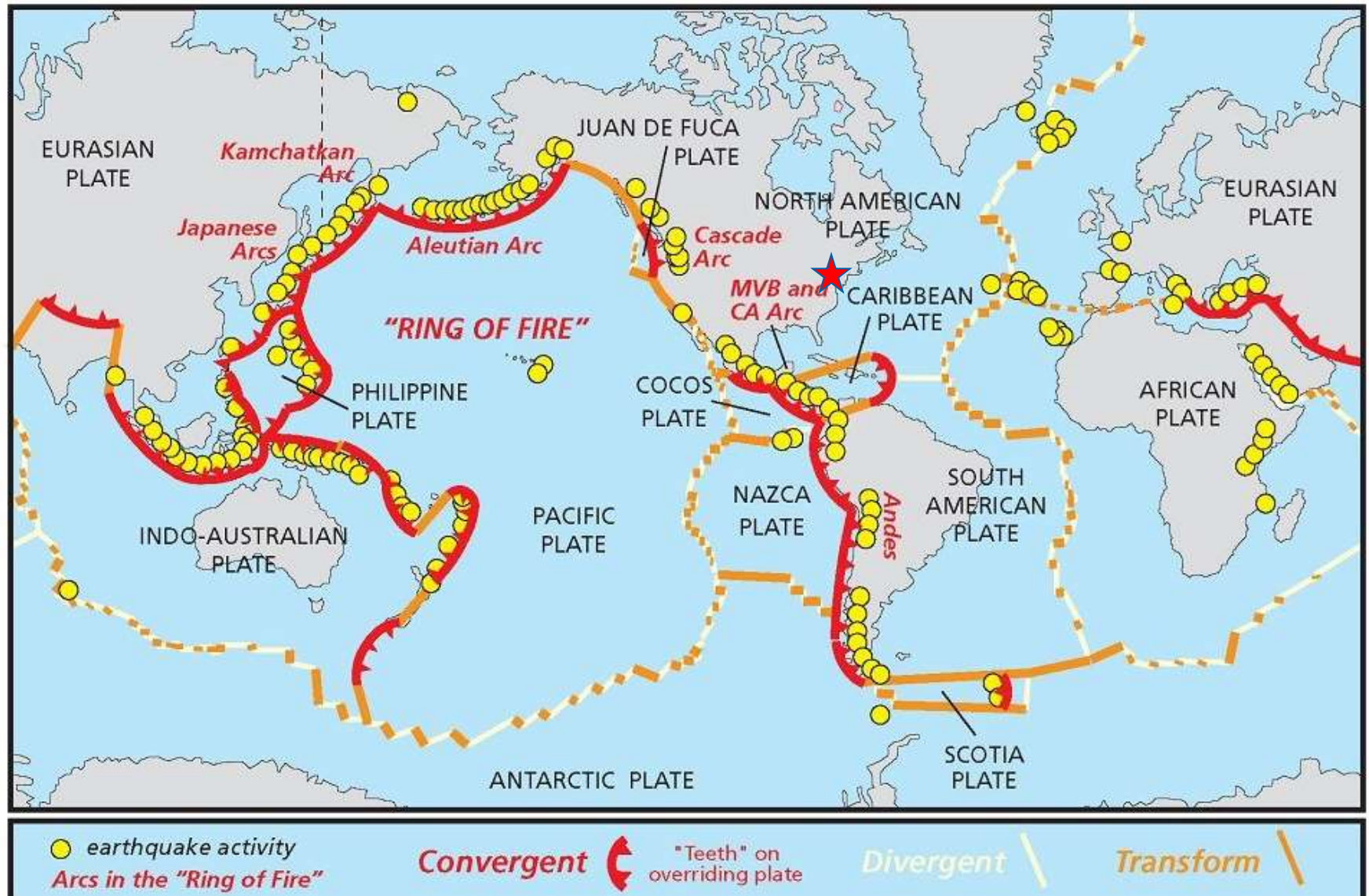


Introduction

- **Virginia is Located in a Lower Seismic Hazard Zone**
- **Earthquakes in Virginia are Not Well Understood**
- **Importance of Seismic Design may be Underestimated in East Coast**
- **Many Bridge Engineers in East Coast are not Familiar with Seismic Design**
- **VDOT Seismic Design of Bridges**

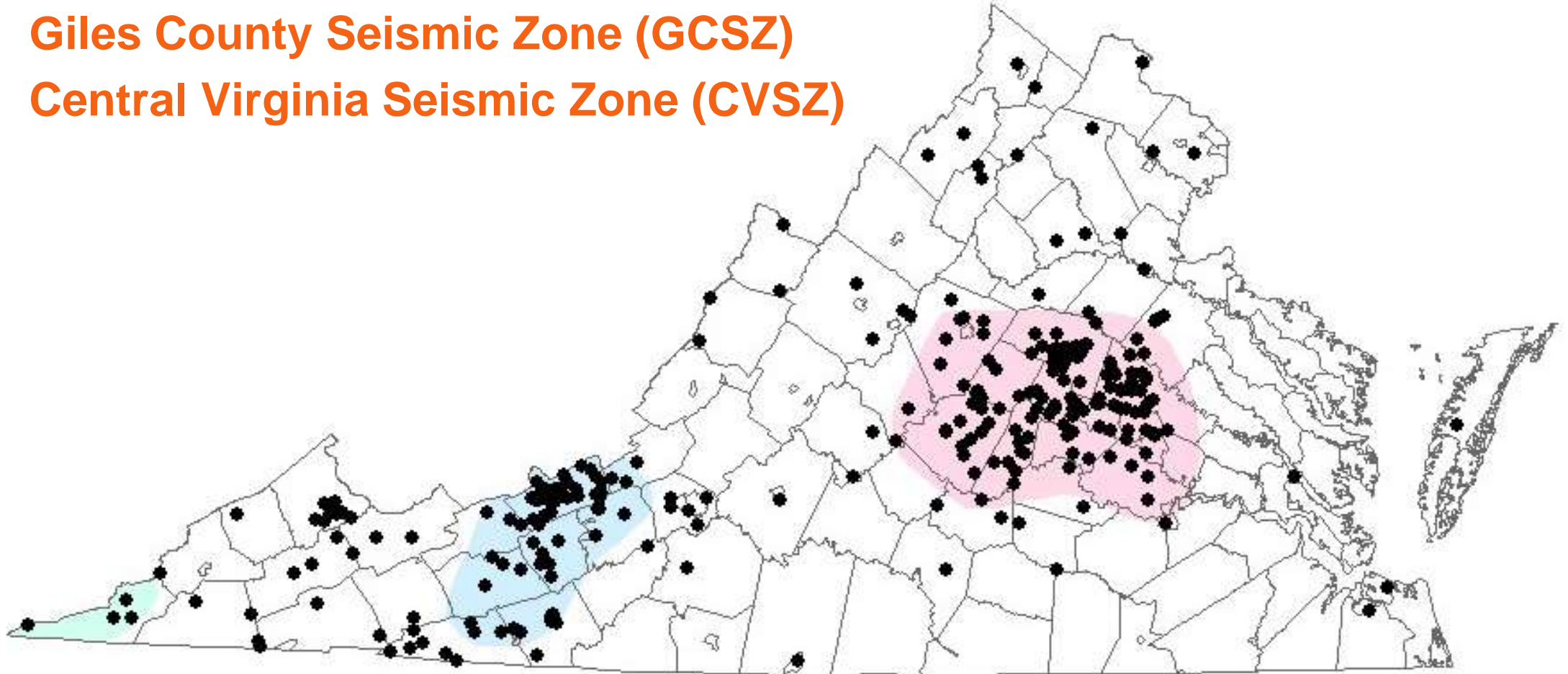
Earthquakes in Virginia

Theory of Plate Tectonics



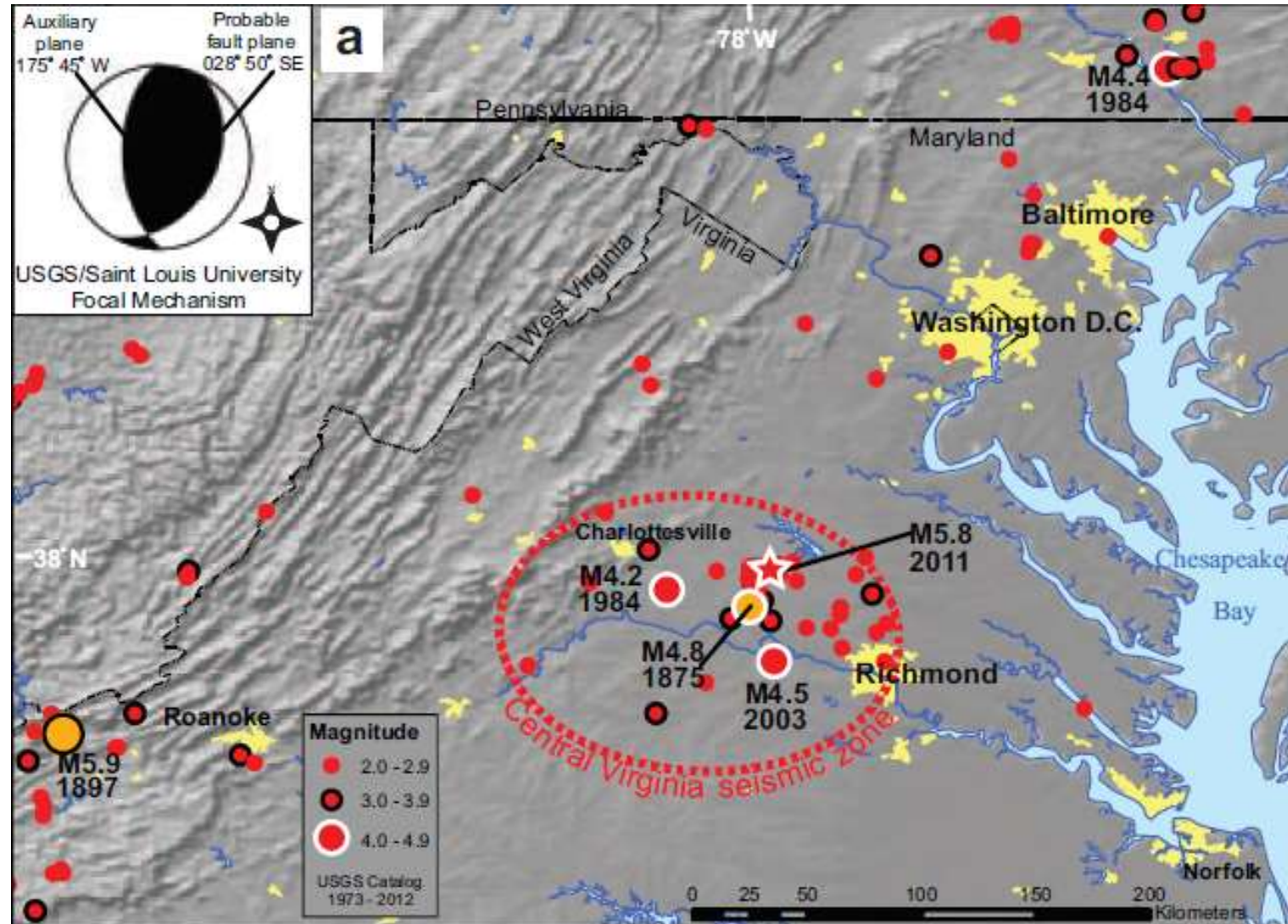
Earthquakes in Virginia

- **Eastern Tennessee Seismic Zone (ETSZ)**
- **Giles County Seismic Zone (GCSZ)**
- **Central Virginia Seismic Zone (CVSZ)**



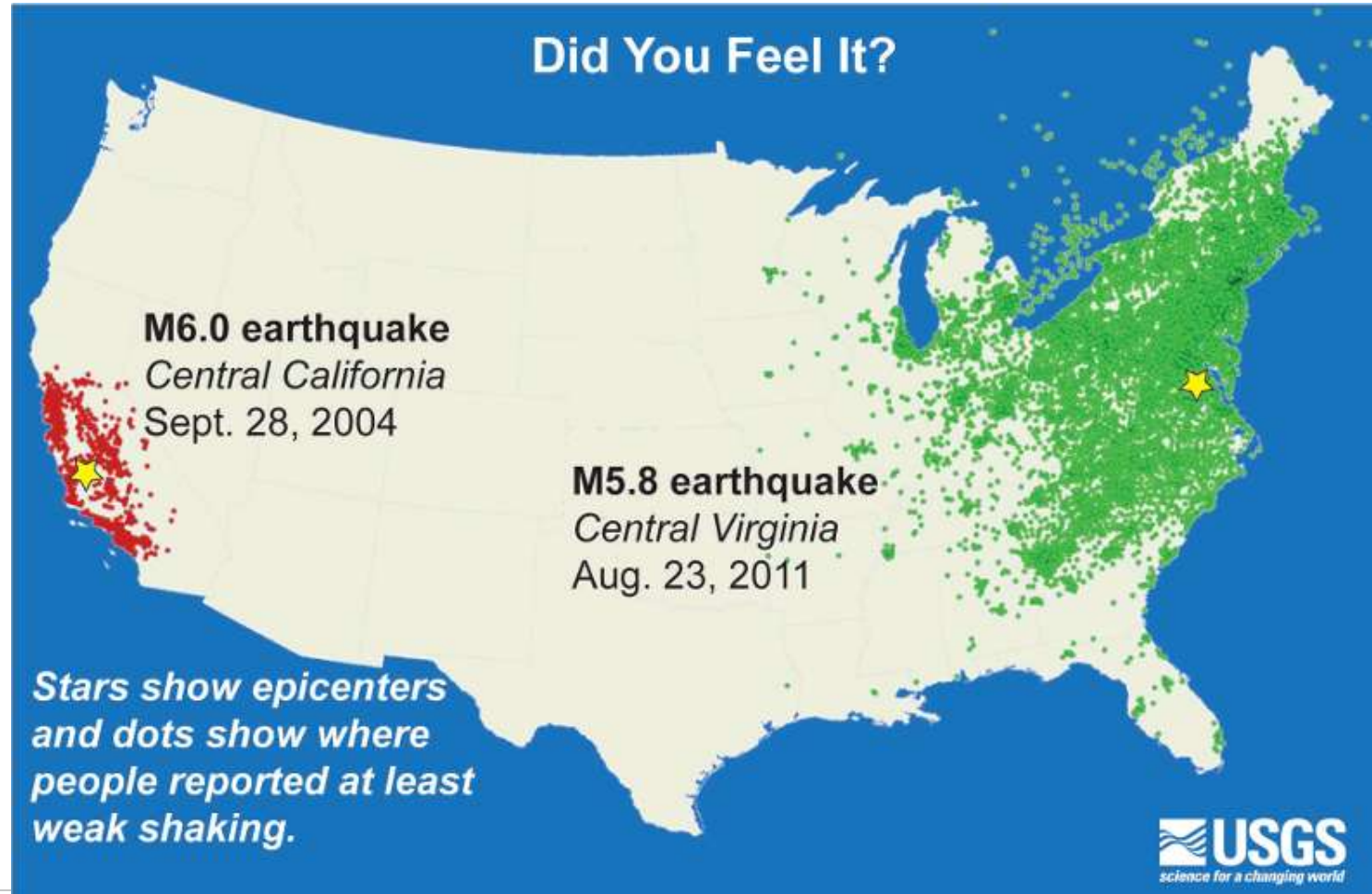
Earthquakes in Virginia

Big Earthquakes in Virginia



Earthquakes in Virginia

Uniqueness of Earthquakes in Virginia



Earthquakes in Virginia

2011 Virginia Earthquake, M5.8



Earthquakes in Virginia

2011 Virginia Earthquake, M5.8



Earthquakes in Virginia

2011 Virginia Earthquake, M5.8



Seismic Design of Bridges in Virginia

- **Use AASHTO LRFD Bridge Design Specifications**
- **Good Engineering Practice including Jointless Bridges**
- **Seismic Forces for Connections**
- **Seismic Analysis is not Required in Many Areas**
- **Seismic Detailing**

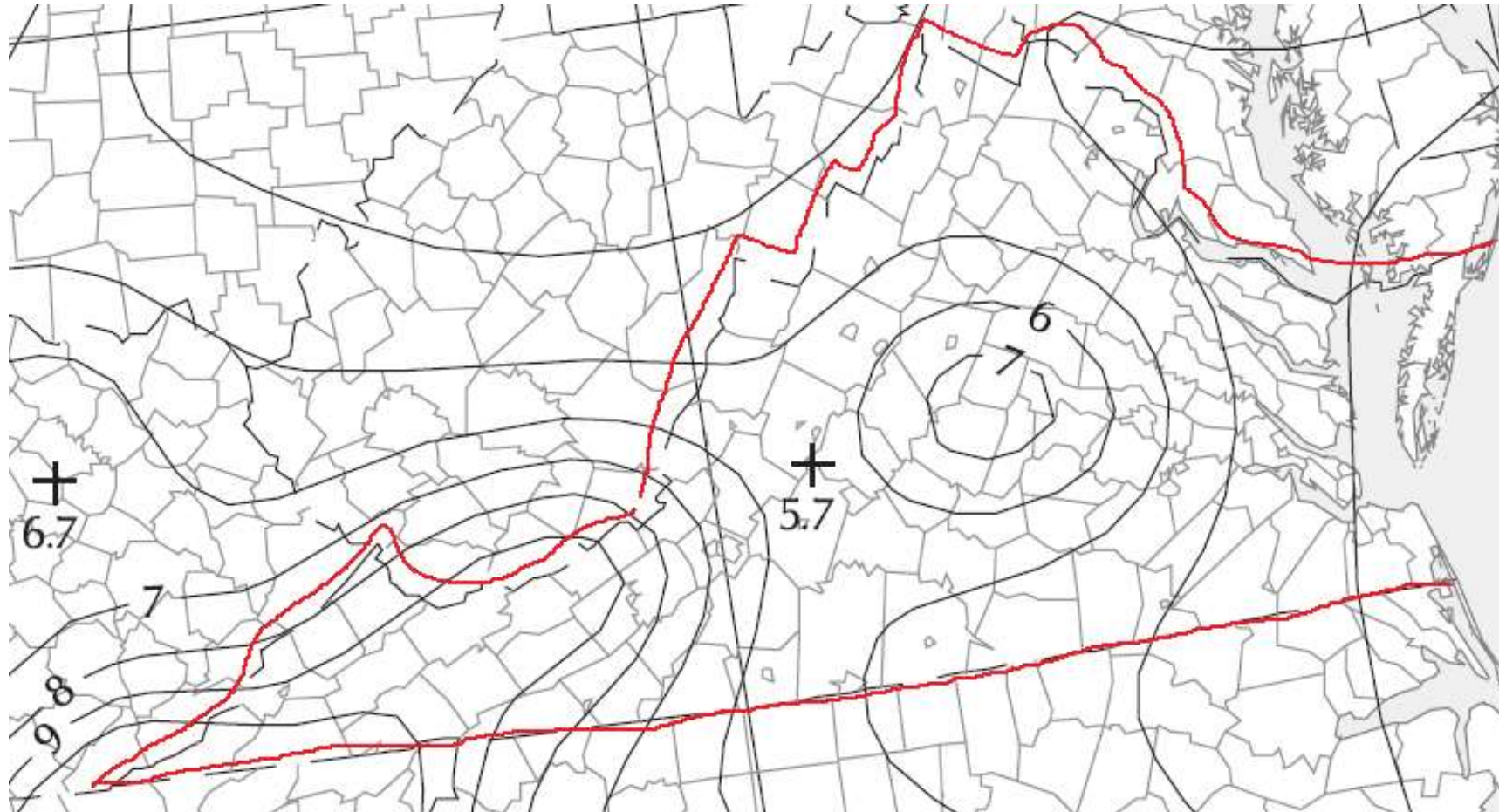
Seismic Design of Bridges in Virginia

Good Engineering Practice

- **Uniform Dead Load Distribution**
- **Continuity of Superstructure**
- **Symmetry in Structure Stiffness and Geometry**
- **No Skew**
- **Integral Abutments**
- **Firm Soil or Rock Foundation**
- **Overall Structure Redundancy**
- **Ductile Materials**
- **Lightweight Materials**
- **Flexible Connections Including Bearings**

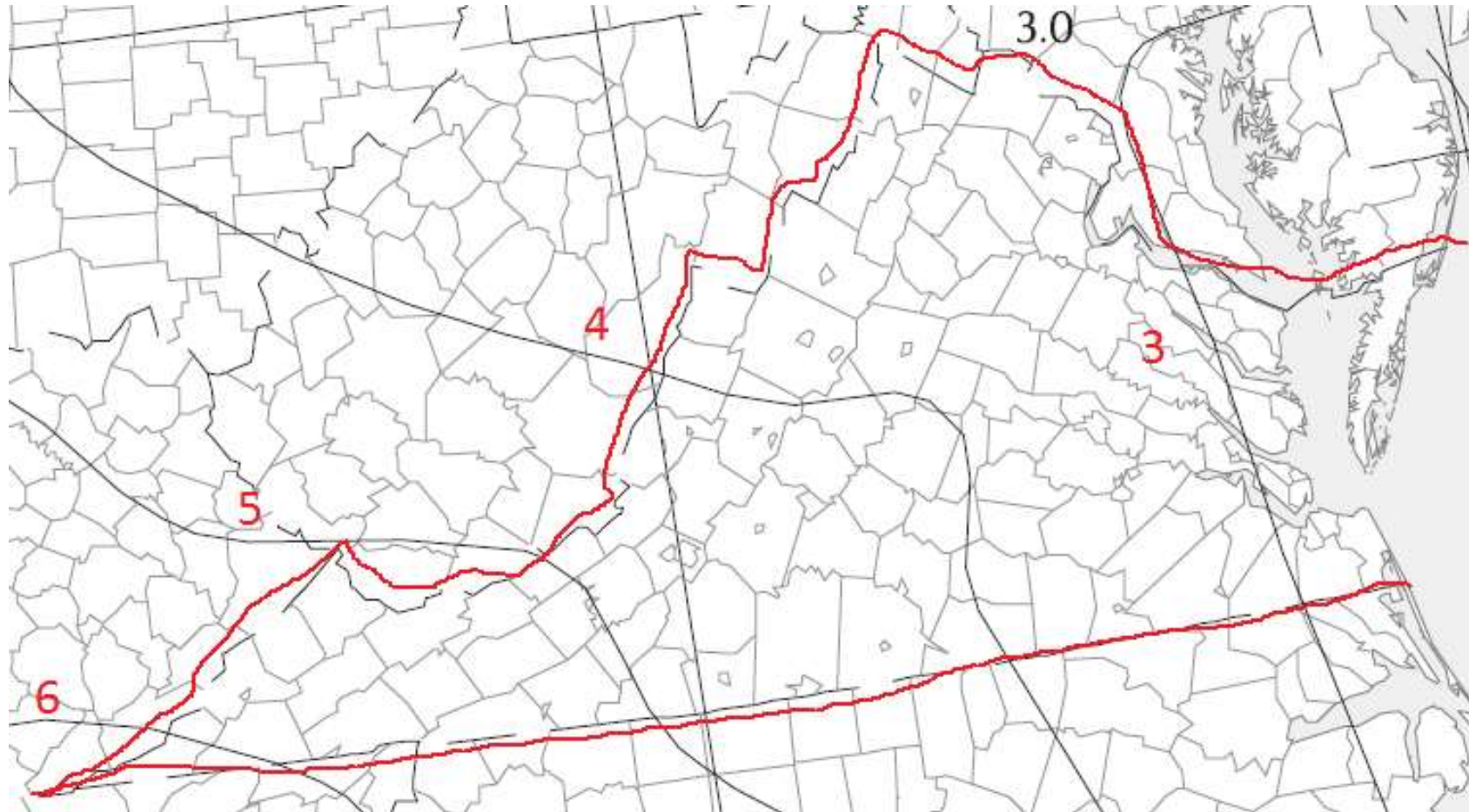
Seismic Design of Bridges in Virginia

Peak Ground Horizontal Acceleration



Seismic Design of Bridges in Virginia

Horizontal Response Spectral Acceleration of 1.0-sec Period



Seismic Design of Bridges in Virginia

Seismic Performance Zone

Response Acceleration Coefficient, $S_{D1} = F_v S_1$

Site Class	Site Factor*, F_v (for $S_1 < 0.10$)	S_1					
		0.02	0.03	0.04	0.05	0.06	0.0625
A	0.8	0.016	0.024	0.032	0.040	0.048	0.050
B	1.0	0.020	0.030	0.040	0.050	0.060	0.063
C	1.7	0.034	0.051	0.068	0.085	0.102	0.106
D	2.4	0.048	0.072	0.096	0.120	0.144	0.150
E	3.5	0.070	0.105	0.140	0.175	0.210	0.219
F	-	Site Specific Evaluation Required					

Seismic Design of Bridges in Virginia

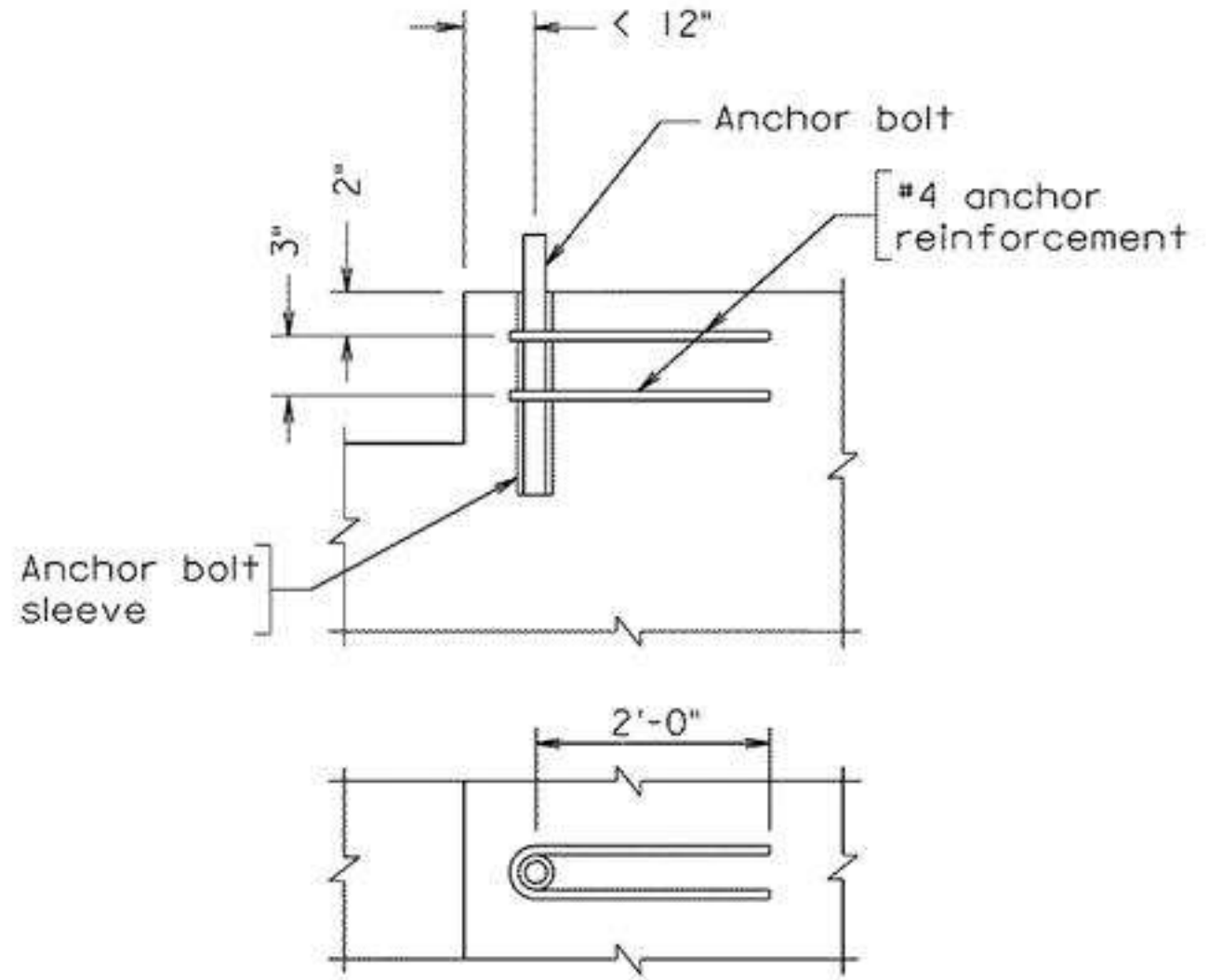
Seismic Detailing

Response Acceleration Coefficient, $S_{D1} = F_v S_1$

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Seismic Design of Bridges in Virginia

Anchor Reinforcement



Summary

- **Virginia is Located in Low to Moderate Seismic Hazard Zone though Big Earthquakes such as 2011 M5.8 Occur**
- **More Advocates are Needed to Educate the Public including Engineers about Seismic Design in East Coast**
- **More Research is Needed to Better Understand Earthquakes in Virginia and East Coast**
- **Jointless Bridges Have Good Seismic Performance**

Questions?

Contact Information:

Junyi Meng

Junyi.meng@vdot.virginia.gov

Phone: (804) 786-3817

www.virginiadot.org