EFFECTS OF VERTICAL AND HORIZONTAL EXCITATION ON REINFORCED CONCRETE BRIDGE COLUMNS

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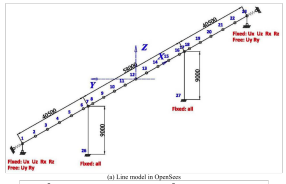
INTRODUCTION

The effects of vertical ground excitation due to earthquakes on bridges are not given enough consideration when designing. Caltrans Seismic Design criteria for peak ground acceleration (pga) less than 0.6g has no added provision for design and for pga greater than 0.6g uses a static equivalent lateral load procedure. The most common accepted value for the ratio between vertical and horizontal components (*V/H*) of pga is 2/3. For most cases this is a conservative estimation but it does not always hold true, especially for structures near faults. There have been several instances where this value has been exceeded. For example the *V/H* ratio of the Northridge 1994 earthquake at the Jensen Filer Plant was .825/.764=1.08.

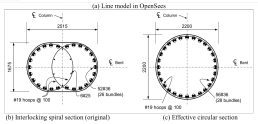
SPECIMEN DESIGN AND CONSTRUCTION

In order to investigate the effects of vertical and horizontal excitation on reinforced concrete bridge columns testing will occur at the Richmond Field Station. The specimens are a 1/4 scaled version of the Plumas Arboga Overhead Bridge Prototype.

Plumas Arboga Overhead Bridge



(a) Line model in OpenSees



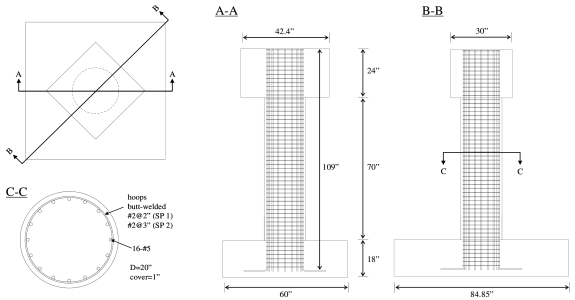
(b) Interlocking spiral section (original) (c) Effective circular section

Fig. 5.8 OpenSees line model and column sections of the Plumas-Arboga Overhead Bridge (units: mm)

Section Properties

Parameter	unit	A.PAOB	B. SP1	C. SP2	A/B	A/C
Diameter, D	[in] ([m])	78.7 (2.0)	20 (0.508)	20 (0.508)	3.94	
Area, A	[in^2] ([m^2])	4859.5 (3.14)	314.2 (0.203)	314.2 (0.203)	15.47	
Height, h	[in] ([m])	275.6 (7.0)	70 (1.778)	70 (1.778)	3.94	
Longitudinal re-bars		42#11	16#5	16#5		
Diameter, d_l	[in] ([mm])	1.41 (35.8)	0.625 (15.875)	0.625 (15.875)	2.26	
Area, A_l	[in^2] ([mm^2])	1.56 (1007)	0.307 (197.9)	0.307 (197.9)	5.09	
Net Area, A_c	[in^2] ([mm^2])	65.52 (42310)	4.909 (3166.9)	4.909 (3166.9)	13.36	
Reinf. Ratio	[%]	1.348	1.563	1.563		
Transverse re-bars		#6@4.5	#2@2	#2@3		
Diameter, d_h	[in] ([mm])	0.75 (19)	0.25 (6.35)	0.25 (6.35)	3.0	
Area, A_h	[in^2] ([mm^2])	0.44 (283.5)	0.0491	0.0491	9.0	
Spacing, s	[in] ([mm])	4.5 (114.3)	2 (50.8)	3 (76.2)	2.25	1.5
Reinf. Ratio	[%]	0.543	0.545	0.363		
$A_c D/s$	[in^2] ([mm^2])	15.46 (9974.6)	0.982 (623.4)	0.655 (415.6)	16.0	23.6

Specimen:1/4 scale



Construction

Footing and column construction

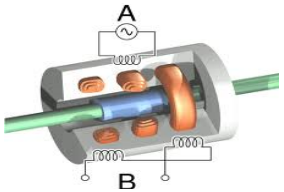
Column and top block forms

Top Block reinforcement

Slump Test

Instrumentation

Strain Gauge [2]



LDVT (Linear variable differential transformer) [1]

Ground Motion Selection

Northridge EQ, Pacoima Dam, MCE level

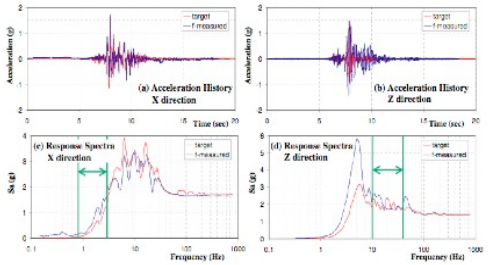


Figure 2: Fidelity Test

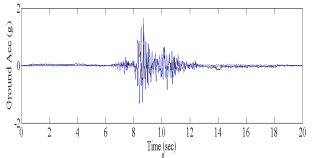
ANALYTIC RESULTS

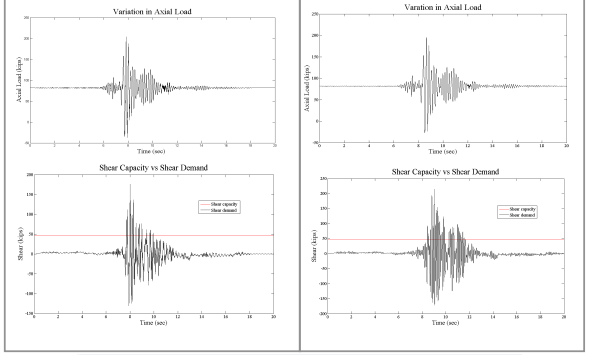
SAP Modeling

Preliminary analysis of a linear elastic model was completed. A comparison between a conventional SAP model to an academically rigorous OpenSEES model was done.

SAP model	OpensSEES Model

Northridge EQ (filtered)





CONCLUSION

Construction will end in August and the specimens will be transported to the shaking table August 9th. The physical testing of the specimens will not occur until September.

This is pre-assessment of a linear model of the specimen. The actual testing will be nonlinear and dynamic. Analytical linear elastic model shows an significant increase in the axial force of the bridge column with vertical excitation for both the OpenSEES and SAP model.

ACKNOWLEDGEMENTS

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