Volume 13, Number 3 Summer Issue 2004

Research and Technology REVIEW

Published by the Nevada Department of Transportation
RESEARCH DIVISION

Research Bulletin

Development of Seismic Design Method for Reinforced Concrete Two-Way Bridge Column Hinges

Two-way hinges are commonly used in reinforced concrete (RC) highway bridge column base to eliminate column moment transfer to foundation, thus reducing the cost of the bridge foundation. Although two-way hinges are common, there is very limited information regarding the seismic response and design of this type of connection. The soundness of the details used in practice has not been adequately investigated. Currently, the shear capacity of the two- way hinges is determined using the shear friction method. When subjected to lateral forces such as earthquake load, hinges are under a combination of axial load, shear, as well as a great deal of moment. Therefore, the shear transfer mechanism is different from the assumptions in the standard shear friction theory. The objective of the current study is to develop a reliable method and verify it through shake table simulation studies of large-scale bridge column models.

Specimen	Column Height (inch)	Column Diameter (inch)	Column Steel Ratio	Hinge Diameter (inch)	Hinge Steel Ratio	Area Ratio (Ah/Ac)	Axial Load (kips)	Axial Load Ratio ($P/A_{col}f'c$)	Key aspect
# THD-1	48"	16"	4.20%	10	1.0%	0.39	107	10.0%	High axial load, Low aspect ratio column.
# THD-2	64"	16"	3.88%	10	1.0%	0.39	60	6.0%	Low axial load, High aspect ratio column.
THD-3	48"	16"	1.40%	10	1.0%	0.39	107	10.0%	Low plastic shear demand, Column steel ratio = 1.4%.
THD-4	48"	16"	1.50%	10	1.0%	0.39	7	0.70%	Nearly Zero axial load.
THD-5	48"	16"	3.0%	8	1.31%	0.25	107	10.0%	Smaller hinge, $A_{hinge} = 0.25A_{column}$.

A preliminary step-by-step rational method has been proposed and is being evaluated based on test data. Five 1/3-scale highway RC bridge column specimens with two-way hinge details (THD-1 to THD-5) are being tested on a shake table. Several important parameters that affect the hinge and column performance are included in the tests. Typical specimen detail drawing and test setup are shown in Figure 1 and Figure 2 (see page 2). The main aspects of these five specimens are summarized and presented in the table above.

In This Issue

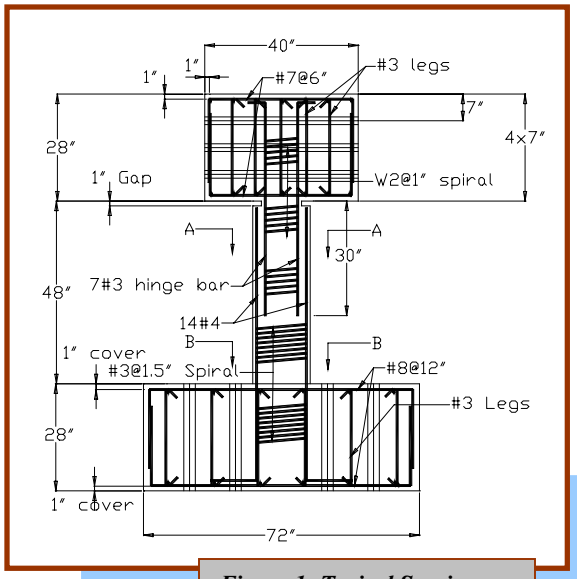

Figure 1: Typical Specimen

Figure 2 – Test setup

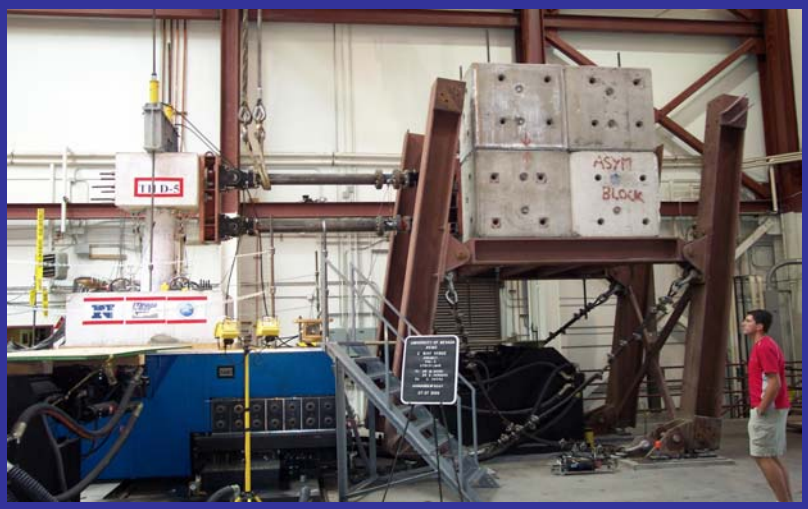

Figure 3 - Specimen under testing

Figure 3 shows one of the tests after the specimen failed at the hinge. A close up of the shear failure at the two-way hinge region is shown in Figure 4.

Four of the five specimens have been tested thus far and refinement of the design parameters has begun. The experimental results have shown that the proposed method provides a reasonable and conservative estimate of the shear capacity. A comprehensive evaluation of the data will be conducted once the last column is tested, and the design method will be finalized. The new method will allow engineers to design two-way hinges with confidence and will result in safer and more reliable bridges. Illustrative examples will be prepared to aid NDOT bridge engineers in design of future hinged bridge columns. For further information on the project, please contact Dr. M. Saiidi at (775) 784-4839 or via e-mail at saiidi@unr.edu

Figure 4 – Shear failure at hinge

Product Evaluation Committee (PEC) Meeting Recap

APPROVED

Specification Revision for Soil Stabilizers and Dust Palliatives

In the past, acceptance of soil stabilizers and dust palliatives was based on available information and vague criteria. Recently, the department placed a moratorium on acceptance of these products, so that Hydraulics Engineering can explore baseline characteristics of all dust palliatives and soil stabilizers listed in the QPL. The objective of the study was to determine whether the diversity in products listed in the QPL is beneficial to the department. This study demonstrated that currently employed minimum criteria are adequate for a broad range of products and that the diversity of the products is beneficial. Nevertheless, based on this study, criteria have been improved to include additional guidelines to assist in product evaluation. These additional aspects of acceptance criteria include but are not limited to assessment of the following: (1) product's composition; (2) the pH values of a product in both diluted and concentrated forms; (3) product's effect on existing and new vegetation; (4) product's performance when it is washed off equipment both before and after it is dried or cured; (5) modes of degradation (photo, bio, chemical or other); and (6) product's impact on water quality and aquatic life if product enters a surface water body.

Also, the new Storm Water Quality Handbooks include a matrix showing properties of common soil stabilizers and dust palliatives and also specific requirements by type of material and guidelines for their application limitations. This information will be very helpful to the contractors by enabling them to select the best product for each specific application. For example, for traffic areas, synthetic polymers and copolymers perform fairly well. The department also has used salts, magnesium chlorate and calcium chlorate. These products require about 30% humidity to be effective; however, such conditions would usually not exist in most of Nevada. For non-traffic areas, Clark County prefers gypsum products mixed with paper or wood mulch. These products may last up to 3 years if the treated area is not disturbed. The synthetic polymers and copolymers are also preferable products on non-traffic areas.

Additionally, since the department instituted a landscaping master plan, the Design Division has requested that the treated soils do not contain any sterilants that might prevent the growth or survival of newly installed vegetation.

Recognition of NDOT Employees on AASHTO/TRB Committees/Panels

NDOT would like to recognize the following individuals and show appreciation for their work as the department's representatives on AASHTO and TRB committees/panels:

Mr. Dennis Baughman
Ms. Sohila Bemanian
Ms. Jan Christopherson
Mr. Kent Cooper
Mr. Frank Csiga
Mr. William C. Crawford Jr.

(continued on page 4)

(continued from page 3)

Mr. Bob Dimmick
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Mr. Mark Elicegui
Mr. Jeff Fontaine
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Mr. Tie He
Mr. Brian Hutchins
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Mr. Scott L. Thorson
Mr. Dean C. Weitzel
Mr. Donald "Ed" Wilson
Ms. Masha Wilson
Ms. Marilyn Yezek
Mr. Richard J. Yeoman

Thank you for your continuing efforts and contributing work as AASHTO and TRB committee/panel members.

♦♦♦♦♦

The Research Division administers the Department's research, development and technology transfer program and serves as the "clearing-house" for product evaluations

Research and Technology Review
Is published quarterly by the NDOT Research Division. Its purpose is to provide the latest information on the NDOT research activities including product evaluation and other pertinent research topics.

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If you have comments or need additional information regarding any of the topics discussed in this issue please contact the Research Division at (775) 888-7223.

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