SAFETY AND SERVICEABILITY

Enhanced Stability of Bridge Column Reinforcing Bar Cages

by Ahmad M. Itani, University of Nevada, Reno

Close-up of a collapsed cage on a jobsite. All photos and drawings: University of Nevada in Reno.

View of test Specimen II having a 34 ft height and 3 ft 8 in. diameter.

The collapse of reinforcing bar cages during construction causes schedule delays, cost overruns, and sometimes injuries and deaths. A series of experimental and analytical studies on the stability of bridge column cages was conducted at the University of Nevada, Reno (UNR) through a research project funded by the California Department of Transportation (Caltrans). The purpose of the study was to develop guidelines to enhance the stability of bridge reinforcing bar cages, and minimize their instability during placement or potential for full collapse.

The project included designing and testing two full-scale reinforcing bar cages under lateral loads in addition to testing hundreds of tie wire connections under various types of loading conditions. The height of both test specimens was 34 ft, with an outside diameter of 3 ft 8 in. Specimen I had the longitudinal and transverse reinforcement ratios equal to 1% while Specimen II had the longitudinal and transverse reinforcement ratios equal to 2%. Internal X-type braces were used in Specimen I and square-type braces were used in Specimen II. The X-type was made of four No. 8 bars, while the square-type was made of eight No. 8 bars. The height of the braces was equal to

Test Specimen II following collapse.

9 ft 4 in. and 9 ft 8 in. for the X-type and square-type, respectively. Clear spacing for both types was 10 ft 6 in. along the height of the cage.

A series of nonlinear finite element analyses were carried out on various reinforcing bar cage configurations (height, diameter, reinforcement ratios, and braces) to determine the stability of cages under accidental dynamic loading. It was concluded that internal braces in cages play an important role in stability and lateral stiffness. Without these braces, reinforcing bar cages have low lateral stiffness and are vulnerable to significant instability or even collapse.

The following photos show recommendations that are proposed to improve the stability of bridge column cages during construction:

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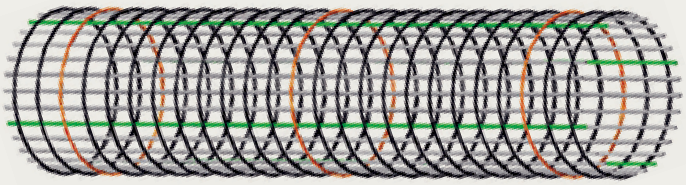
EDITOR'S NOTE

This article is a condensed summary of the report "Stability of Bridge Rebar Cages," (CCEER Report No. 10-07) by J.C. Builes-Mejia, A. Itani, and H. Sedarat, published in 2010 by the University of Nevada, Reno, and is available at http://go.hw.net/cc-rebar-cages.

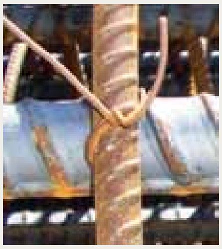
A PDF file of a detailed PowerPoint presentation on this work by Dr. Ahmad M. Itani may be downloaded from the *ASPIRE*™ website, www.aspirebridge.org, click on "Resources" and select "Referenced Papers."

All tie wire connections should use 15-gauge, soft annealed black steel with a minimum tensile strength of 40 ksi.

Four longitudinal bars around the perimeter of a circular cage form the corners of a square shape and are typically identified as the "pick-up" bars. These four vertical bars should be tied at every intersection with double-wire ties. They are indicated with green markings.



Template hoops or rings, which maintain the circular shape of the cage, should be provided at a maximum of 10 ft increments and tied at every intersection with double-wire ties. The hoops are shown marked with paint to position the longitudinal bars. Above, hoop bars are indicated in orange.



Between the template hoop bars, at least 20% of the remaining reinforcement intersections should be tied with at least single-wire ties. Ties should be staggered from adjacent ties.

Internal braces with box configurations should be provided at a maximum of 10 ft increments using eight bars (minimum No. 8) tied to the "pick-up" bar and to the interlocking hoops at their ends.