



Productivity increases when pre-assembled column reinforcing cages, top right, are quickly swung into position and attached with a minimum of labor and crane time.

By George Hoff

**T**he XFL is gone, and the X-Generation has grown up, and now we have the Xtender, a new mechanical tension and compression rebar splicing system that is finding widespread acceptance in the western United States. The Xtender splicing system has both structural and field installation advantages. Using upset or “button” heads formed on one or both ends of the reinforcing bar being coupled, threaded male and female sleeves

provide the actual coupling. The coupler is positional, meaning that there is no need to turn the bars during installation—only the coupler is rotated. No heavy tools or equipment are required to assemble the splice after bar end preparation, although a torque wrench is recommended to ensure the coupler is locked into position. Bar end preparation is quick, simple, and economical and can be done either in the shop or in the field. Compared to lap splices, the Xtender reduces crane time and can result in fewer cranes being needed

on the job. The relatively short couplers do not interfere with other reinforcing, particularly hoops.

#### Equipment Needed

The Xtender Mechanical Splicing System requires three pieces of equipment: the Xtender upsetting machine, a hydraulic pump, and gas heating equipment. The splice manufacturer furnishes the upsetting machine and trains the contractor’s staff in its use. Three sizes of upsetting machines are available, depending on the diameter

# Getting Connected

New mechanical rebar connector  
uses button heads and splice sleeves



Attaching new rebar to existing bars as part of a retrofit is an ideal application. The minimum length protruding from the existing concrete varies from 5 inches for #4 bars to 10 inches for #14 bars. This eliminates long lap splices and is done very quickly using site labor.



First, the worker positions one-half of the coupler on the bar, then heats the bar end to the proper temperature. He then places the upsetting machine onto the heated bar, and pressure is applied to create the button.

of the bars to be spliced. The hydraulic pump (which the user provides) must be rated for 10,000 psi. For heating, a gas mixture of propane and oxygen is recommended, although other mixtures, such as acetylene and oxygen, may be used.

### Installation Procedures

Although installation of the Xtender is fairly simple, workers must complete several steps to get a successful splice:

- First, check that the ends of the bars to be spliced are reasonably straight.

- Place the male and female portions of the threaded coupler on the two bars that are to be joined.

- Use a gas torch to heat the ends of the bar to the appropriate temperature.

- Position and clamp the upsetting machine onto the hot end of the bar.

- Using the upsetting machine, apply hydraulic pressure to the hot end of the bar to deform it into an upset or button head.

- After cooling, bring the upset heads of the two bars to be spliced together and hand-tighten the coupler.

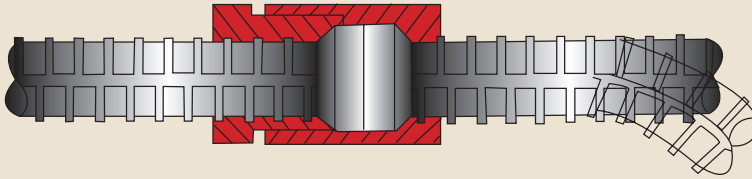
- Complete the splice using a torque wrench to achieve the appropriate tightness.

The ends of the bars can be either cropped, saw-cut, or flame-cut. If the reinforcement bar is bent over its last few inches, the bent portion should be removed before starting the splicing operation, since the best heads are formed on straight sections.

To form the button, the installer heats the end of the bar evenly over a length of about two bar diameters. The ideal temperature is determined to be between a bright cherry red (1650° F) and an orange yellow (2300° F). The splicing manufacturer provides guidelines for the heating process for bars from #4 to #14, including heated length and duration, and required gas pressures. The nominal heating duration varies from 30 seconds for #4 and #5 bars to 120 seconds for #14 bars.

The installer then places the lightweight, portable upsetting machine over the heated end of the bar and pushes it on as far as possible. A crank on the end of the machine is used to

## Xtender Splicing System



**A flexible mechanical coupler can be used as a standard coupler to splice new reinforcement to existing bars or as a position/transition coupler to splice multiple bars in pre-tied reinforcing cages.**

tighten the internal jaws of the machine onto the bar. The worker then activates the hydraulic pump, applying pressure to the end of the bar; the pressure is released as soon as 10,000 psi is reached. The worker then turns the crank, releasing the clamping jaws, and removes the upsetting machine.

The couplers should be kept away from the hot heads as they cool for a minimum of 30 minutes. Once cool, the heads are inspected for a uniform head profile. The minimum acceptable head thickness is  $\frac{2}{3}$  of the bar diameter and the minimum acceptable head diameter is 1.3 times the bar diameter. When the coupler needs to meet a slip requirement (total elongation), workers use a hand or powered wire brush to remove all excess mill scale; if ridges are present on the head's conical underside, they are ground off flush.

To connect the bars, workers bring together the cooled upset heads and tighten the male and female components of the coupler. The coupler is then tightened with a torque wrench to the torque values recommended by the manufacturer. The Xtender Splicing System will develop the bar's full strength at the minimum recommended torque, which varies from 50 pound-feet for #4 bars to 250 pound-feet for #14 bars. To comply with the more strenuous slip requirements [total elongation requirements specified by the California Department of Transportation (CalTrans)], the required torque increases to 150 pound-feet for #4 bars to 400 pound-feet for #14 bars.

Unlike welding and many other mechanical coupling systems, the quality of a completed Xtender splice can

be determined by a simple visual inspection. If the upset heads were not properly formed, either threads will still be visible or else the two parts of the coupler will screw all the way together. Ideally, about  $\frac{1}{8}$  inch will remain between the two flanges of the coupler when the assembly is complete.

### **Mechanical and Structural Properties**

The capacity of the Xtender Splicing System far exceeds that of A706 reinforcing steel for stress and strain in tension, compression, and cyclic loading. It is designed to consistently develop 175% of the tensile yield strength of Grade 60 rebar, regardless of variations in the heat used to form the heads. Compared with Grade 75 steel, the coupler develops 160% of the yield strength. The short length of the completed splice causes it to behave as a nonspliced bar, since the bar has increased stiffness only over the combined length of the upset heads (about 1.5 times the diameter of the bar).

A variation on the standard Xtender coupler allows bars of different diameters to be coupled together. Couplers also are available for stainless steel reinforcing bars and for square bars for retrofit applications. The splicing system exceeds all specifications, including the CalTrans Ultimate Splice criteria and the 1997 UBC Type 2 splice for seismic areas 2, 3, and 4. It also has ICBO and City of Los Angeles approval.

### **Applications**

Some recent applications of the Xtender Splicing System include the expansion of the San Francisco air-

port; all recent CalTrans retrofits of bridges, footings, and columns; columns at the new PacBell Stadium; a light rail project in Portland, Ore.; splicing to create continuous hoops for freeway approaches in California; and joining of precast girders for the San Mateo-Hayward Bridge. ■

For more information on this splice system, contact the Headed Reinforcement Corporation at 800-472-6775, [www.hrc-usa.com](http://www.hrc-usa.com), or circle 4 on the reader service card.

*George Hoff is a consultant in Clinton, Miss., and was formerly the chief engineer for construction of Mobil's concrete offshore oil platforms. He is a past president of the American Concrete Institute.*

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**The Xtender is being used in California to create continuous hoop steel for retrofit of the columns on elevated freeways. For hoops, the couplers can be used on rebars up to #8.**