CABLE CLAMP SPLICE CONNECTIONS FOR REINFORCING STEEL IN GROUTED MASONRY CONSTRUCTION

Robert Alexander[1] and Robert Patterson[2]

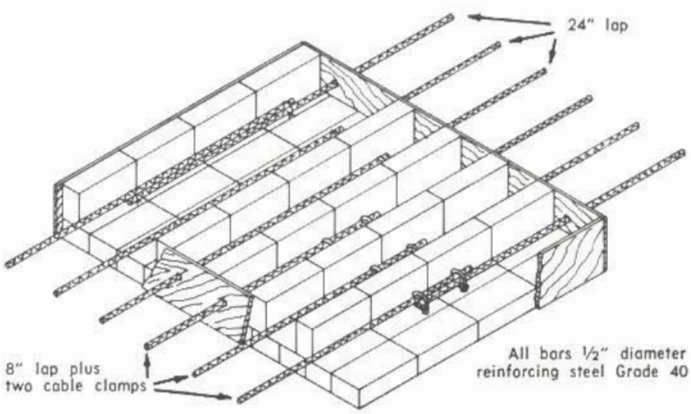
[1] Professor of Civil Engineering, California State University; Long Beach
[2] Civil Engineering Senior, California State University Long Beach

"How would the use of a cable clamp splice compare with the 48 bar-diameter lap splice, 24" for the ½" diameter bar, in reinforced masonry construction?" This was the question posed by Jim Amrhein, director of engineering of the Masonry Institute of America, to students in the Masonry Testing Laboratory at California State University, Long Beach. Obviously, the way to find out was to run tests on both types of splice connections. This is a report on the Cable Clamp Splice Project sponsored by the Masonry Institute of America and conducted in the laboratory at California State University Long Beach.

It was decided to make three lap joint specimens and three with cable clamps. No. 4 reinforcing bars were used for all six specimens, which is the standard size bar used in chimneys. The 24-inch lap specimens were wired together; the others were lapped for 8 inches, and each was secured with two half-inch cable clamps. The clamps were hand tightened with an ordinary 8-inch adjustable wrench using the average torque anticipated on the construction site.

The splice joints were assembled in the casting jig shown in the drawing. The jig consisted of common clay brick partitions fastened with epoxy glue to a flat brick base. The wood frame surrounding the jig served to close the end of each 4" by 4" by 33" mold and to support the steel as shown. Paper towel liners were used for absorption of excess water and to prevent bonding of the grout to the brick.

Each mold was filled with a sand grout of 8 to 9 inch *slump and puddled with a stick to make thorough contact* with the steel. The grout consisted of one part Type I-II portland cement, one-tenth part Flintkote Type S lime and three parts sand by volume. This grout would compare favorably with retempered, plastic to fluid mortar or grout used in normal chimney construction. The specimens were covered with burlap and kept wet continuously for seven days. They were then air-cured until being tested at 28 days. Two inch diameter by four inch high grout samples taken at the time of casting the specimens had a 28-day strength of 3,000 psi.



Casting jig of building brick which simulates construction conditions.

SPLICE SPECIMENS being removed from casting jig.

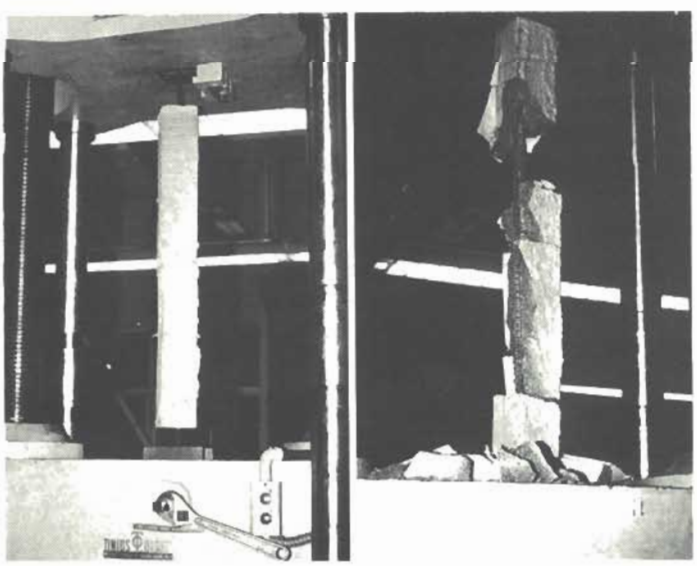
All six specimens were tested in tension after 28 days on a Tinius Olsen universal testing machine.

The table below shows the ultimate loads in pounds and stress in the steel resisted by all six specimens. The average ultimate load of the clamped splices was 9,700 lbs or 48,500 psi, which is greater than the specified and actual yield strength of the steel. The average ultimate load of the splices with the 24" lap was 12,900 lbs or 64,500 psi, which is 84.4% of the ultimate strength of the steel.

ULTIMATE LOAD CAPACITY OF SPLICES

Specimen	Two Clamps on 8 in. Lap	24 in. Lap
No. 1	9,900 (49,500 psi)	12,400 (62,000 psi)
No. 2	10,000 (50,000 psi)	13,000 (65,000 psi)
No. 3	9,200 (46,000 psi)	13,300 (66,500 psi)
Average	9,700 (48,500 psi)	12,900 (64,500 psi)

The bond stress developed in the lap splice at ultimate strength was:



TESTING SPECIMEN (left) in tension in Tinius Olsen Universal Testing Machine. (Right) Failure of 24" lap splice.

$$u = \frac{T}{\Sigma_o l} = \frac{12900}{1.571 \times 24} = 342 \text{ psi}$$

The allowable bond stress for inspected masonry is 143 psi in accordance with Table 24-H of the Uniform Buliding Code, 1973 and 1976 editions.

The factor of safety is:

$$\text{Factor of Safety} = \frac{342}{140} = 2.44$$

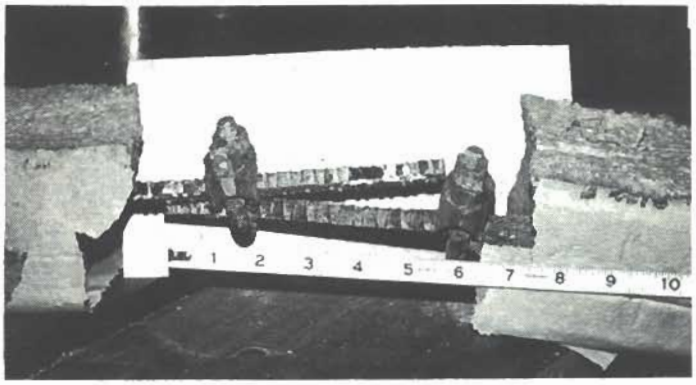
The allowable bond stress for uninspected masonry as per above UBC is 100 psi, and the factor of safety is:

$$\text{Factor of Safety} = \frac{342}{100} = 3.42$$

The relative strength between the cable clamp and splice and the lap splice is: $\frac{9700}{12900} \times 100 = 75\%$

The reinforcing steel used in the project was tested for yield and ultimate strengths, which were 47,300 psi and 76,400 psi respectively. The steel was intermediate grade meeting ASTM Specification A615-40, which requires a minimum yield strength of 40,000 psi and a minimum ultimate strength of 70,000 psi.

The cable clamp splice technique developed a stress of 102.5 per cent of the actual yield strength of the steel and 121.2 per cent of the specified yield strength.



FAILURE of cable clamp splice.

The results demonstrated that the clamps were effective beyond the field strength of the bars for the particular materials used in these tests.

The use of cable clamps as a splice device to extend reinforcing bars is quite satisfactory. This can be particularly useful where the stress in the bars is relatively low and not critical. Such applications may be the extension of bars near the top of a chimney, at the top of a retaining wall, extending bars into a parapet wall, etc.

This test program provided needed data on the comparative performance of cable clamp splice devices with a lapped splice.

Reprinted from the April 1977 issue of MASONRY INDUSTRY Magazine.