

EVALUATION SUBJECT:

TESTING OF REGNUM REINFORCING BAR MECHANICAL SPLICE COUPLERS

1.0 EVALUATION SCOPE

Compliance with following codes:

- 2006 *International Building Code* (IBC)
- 2009 *ISO-15835, Category S2*
- 2000 *TS500 Turkish Code*
- Other Codes (see section 4 - Bibliography)

2.0 USES

Barcoup without Lock-Nut is used for tension and compression mechanical splices of steel reinforcement bars where rotating the continuation bar is difficult or impossible. The mechanical couplers comply with Section 12.14.3.2 of ACI 318 (ACI 318 is referenced in IBC Section 1901.2) and 9.2.3 of TS500.

2.0 DESCRIPTION

2.1 General:

The Barcoup® L system is one of the smallest couplers produced by Regnum. Barcoup® system utilizes internally-threaded couplers with a single right hand thread, and it's suitable for applications where the continuation bar can be rotated. The ends of the bars are enlarged and a parallel thread is cut onto the ends to suit the threaded coupler. The coupler is assembled using a pipe or chain wrench. Calibrated wrenches are not necessary.

REGNUM BARCOUP COUPLER				
Coupler Code	Rebar Size	Metric Thread	Rebar Short Thread* (mm)	Rebar Long Thread* (mm)
BARCOUP.XX.16.12	16	M20	22	43
BARCOUP.XX.20.12	20	M24	25	50
BARCOUP.XX.22.12	22	M27	27	53
BARCOUP.XX.26.12	26	M30	30	60
BARCOUP.XX.28.12	28	M33	33	66
BARCOUP.XX.30.12	30	M36	34	68
BARCOUP.XX.32.12	32	M36	36	72
BARCOUP.XX.40.12	40	M45	45	89
* Thread lengths are approximate.				

2.2 Material:

2.2.1 Couplers: The couplers are produced from steel complying with ASTM A576-06.

2.2.1.1 Identification: A sticker or stamp shall exist on coupler to identify its length, radius and test number.

2.2.2 Steel Reinforcing Bars: The steel rebar must comply ASTM A615, Grade 60 or TS708, S420a - B420C specifications. The performance of mechanical splices may be dependent on the rib geometry of the steel reinforcing bar. The specified rib geometry of the test bar shall be provided by the supplier and recorded with the test results.

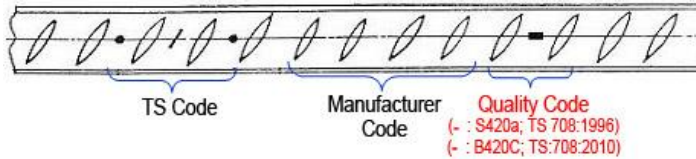


Figure 1 - Rebar ID

“-“ sign between two ribs indicates S420a or B420C type.

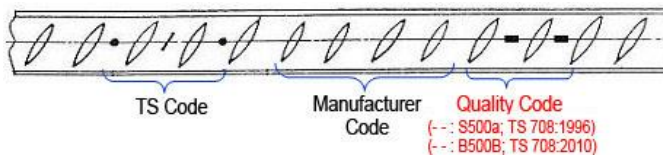


Figure2 - Rebar ID

“- -“ sign between three ribs indicates S500a type.

3.0 TENSILE STRENGTH TEST

3.1 Objective:

The objective of the experiment is to investigate the behavior of Regnum Barcoup® mechanical coupler under a Tensile Test. A reference bar from the same heat shall be tested to determine its actual mechanical properties. According to the calculations the mechanical coupler is checked whether it complies with the related standards or not. Experiment method complies with ISO 15835-2 standard.

3.2 Preparation:

Reinforcing bar specimens are picked up from the jobsite under the supervision of the customer's assigned engineer or controller. The couplers shall be positioned in the middle of the test piece. The test piece for the tensile test shall be sufficiently long to ensure a free length between the grips of the testing machine to allow determination of percentage total elongation at maximum tensile force (A_{gt}) in case needed. The minimum sufficient free length, in millimeters, of the test piece for the tensile test is $400+L$, where L is the length of mechanical splice (ISO 15835-1). There shall be at least three coupled samples and one control sample from same diameter. Regnum prepares specimens at 1000mm length for reliable result. General testing system figure can be seen on Figure 4.

3.3 Testing Equipment:

As stated in ISO 15630-1; the testing machine shall be verified and calibrated in accordance with ISO 7500-1 and shall be at least of class 1. If an extensometer is used, it shall be of class 1 in accordance with ISO 9513 for the determination of $R_{p0,2}$; for the determination of A_{gt} , a class 2 extensometer (see ISO 9513) can be used. Any extensometer used for the determination of the percentage total elongation at maximum force (A_{gt}) shall have a gauge length of at least 100 mm. The gauge length shall be indicated in the test report. Testing equipment can be seen in Figure 4.

3.4 Special Inspection:

Special inspection shall be provided at the test site. The inspector's duties include verifying grade and size of reinforcement bar, coupler identification, thread quality of bar, position of coupler and placement of rebar splices. The specified rib geometry of the test bar shall be controlled as defined in section 2.2.2.

3.5 Test Procedure:

The test shall be carried out according to ISO 15630-1. A research assistant must attend to test to record the tensile stress at yielding point and ultimate point for each specimen. For the calculation of stresses, the nominal cross-sectional area of the reinforcing bar shall be used.

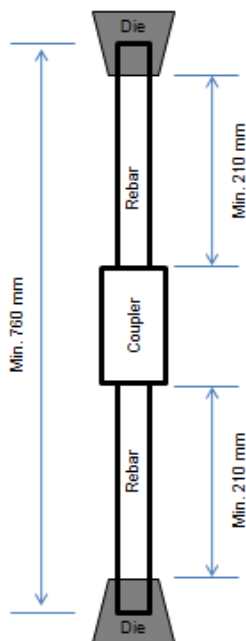


Figure 3 - Testing System View

3.6. Calculations:

Force determinations are recorded in kilogram unit. After all required forces are determined; yielding strength and ultimate strength shall be calculated through following steps:

$$\sigma = \frac{F \times g}{S_n}$$

$$S_n = \pi \times r^2$$

Where;

σ : Tensile stress [MPa] F : Recorded force [kg]

g : Gravity [9,81 m/s²] r : Radius of rebar [mm]

S_n : Nominal cross-sectional area of the bar [mm²]

Units shall be converted in English Unit System for detailing. Conversion is shown in Table 2.

UNIT CONVERSION TABLE	
1 kg = 2,2046 lb	1 kg/m = 0,6719 lb./ft.
1 mm = 0,03937 in.	1 Mpa = 1 Newton/mm ²
1 m = 3,281 ft.	= 145,03 psi
1 m ² = 0,00155 in ²	

Table 1 - Unit Conversion

3.7. Results:

If the control sample yields less than the specific yielding point (i.e under 420 MPa for S420a steel) and at the point of 30% more than the specific yielding point (i.e 420x1,3=546 MPa for S420a steel); then the test must be cancelled according to TS 708 and ACI 318.

Strength of the mechanical splice shall be verified by testing to satisfy the requirements of 3.7.1 with the following exception.

If all samples of the mechanical splice tensile strength tests fail outside the length of the mechanical splice and the test results satisfy the product standard of the bar, no further verification of tensile strength or ductility of the mechanical splice is required. (ISO-15835-1 section 5.2.1)

Regnum warrants its products not to fail before reinforcing bar, which is called "100% Bar Break".

Allowable test failure that will be tolerated by engineer's safety factor is 2,5%.

3.8. Strength:

The tensile strength of the mechanical splice shall be at least $R_{eH, spec} \times (R_m/R_{eH})_{spec}$.

If $R_{m, spec}$ is the only value specified in the reinforcing bar standard, the tensile strength of the mechanical splice shall be at least $R_{m, spec}$.

If calculating the strength of coupler as stated in ISO 15835-1 is not useful for comparison; the statement “Developing of mechanical splice in tension or compression, as required, at least $1.25f_y$ of the bar” in ACI318-8, ICBO1997 and TS500 codes are authoritative.

1.1 Reporting:

The test report shall contain at least the following information:

- a) A reference to part of this report
- b) Name, address, and telephone number of the laboratory
- c) Name of the organization ordering the test (including the date)
- d) Unique identification number of the test report.
- e) Name of the individual who prepared the test piece
- f) Standard for, and grade of, reinforcement with which the test piece was prepared
- g) Nominal size of the bar
- h) Rib geometry of the bar
- i) Name of the supplier of the coupler and markings on the coupler (size, type)
- j) Details of assembly of the test piece(s) (e.g. torque value used, temperature)
- k) Diameter and length of the coupler;
- l) Tensile strength achieved
- m) Location of failure (i.e. in the bar, in the interface bar/coupler or in the coupler)
- n) Evaluation writing of Regnum authorized controller
- o) Name of the laboratory operator;
- p) Name and signature of the person responsible for preparation of the test report.

r) Photographs from the test. Sample photographs before, during and after test is shown in Figure 5



Figure 4 - Photograph Before Tensile Test

4.0 BIBLIOGRAPHY:

- [1] UBC 1997, *Uniform Building Code*
- [2] TS500, *Requirements for design and construction of reinforced concrete structures*
- [3] TS 708, *Steel for the reinforcement of concrete - Reinforcing steel*
- [4] DBYBHY2007, *Specification for Structures to be Built in Disaster Areas*
- [5] ACI 318-8, *Building Code Requirements for Structural Concrete*
- [6] ISO 15835-1, *Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars — Requirements*
- [7] ISO 15835-2, *Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars — Test Methods*
- [8] ISO 15630-1, *Steel for the reinforcement and prestressing of concrete — Test methods — Reinforcing bars, wire rod and wire*
- [9] ASTM A 615/A 615M – 04a, *Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement*
- [10] ICC AC85, *Acceptance Criteria For Test Reports*