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Experimental Study on Reinforcement bar Coupler as a Cost Effective Component

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ABSTRACT: Among the methods available for splicing of reinforcement bars in reinforced concrete construction, lap splicing has long been accepted as an effective economical splicing method. However major disadvantages of this method are the congestion of the reinforcement bars at lap zone and also the material wastage occurs due to the lapping of two bars which could be considerable for bars with large diameters. Rebar couplers or in other words mechanical joints can be introduced as a remedy for these two disadvantages. Although this technique seems effective, it is found that mechanical joint is not a popular method of splicing in Sri Lanka yet. Therefore this study focuses on evaluating the reasons behind this and also to analyse the feasibility of using couplers in place of lap splices. To achieve these objectives, a questionnaire survey, cost analysis as well as tensile testing were conducted. Results of the study reveal that the use of rebar couplers in place of lapping is considerably cost effective for larger diameter bars such as 32 or 40 mm bars. Other than the cost, the other obvious advantage of couplers is avoiding congestion of rebars which may occur at a lap zone. However, couplers have a high risk of disconnecting at the joint if not properly fixed. However, this point of failure for all the specimens tested was found to be beyond the yield point and closer to the ultimate load point. This denotes that the risk of disconnecting at the joint may not considerably affect the structural performance. Therefore, couplers can be recommended as a more effective method of splicing compared to lapping for larger diameter bars such as 32 or 40 mm and especially where congestion of bars become critical.

KEYWORDS: Rebar Coupler, Tensile Testing, Cost Effective

I. INTRODUCTION

Rebar couplers are used for joining rebars with full tension capacity. The ends of bars to be joined are provided with threads, and the bars are joined using a coupler sleeve that transfers the force on the rebar across the connection

1) Crimping rebar coupler is known as the first coupler in reinforcement in the construction and after that threaded rebar coupler was introduced. In crimping rebar coupler there is no thread. The rebar coupler without thread is fitted in the two ends of the TMT bar and then the coupler is crimped by a crimping machine. 1.2 Classification of Buildings

Rebar Coupler eliminate tedious lap calculations. Rebar Coupler are fast and easy to install and requires no specialised skilled labour. Rebar couplers are cost effective by reducing labour costs and accelerating job schedules. Dowel bar substitutes reduce labour on site, formwork costs and increase job site safety.



Crimping rebar coupler Threaded rebar Coupler

II. LITERATURE REVIEW

Singh R, Himanshu S. K and Bhalla N (2013) conducted a case study to check the cost effectiveness of using reinforcement bar couplers in comparison with lap splices. They carried out case study at Jaypee Greens new undergoing project 'Wish Town Klassic' extended over 40 acres in sector- 129 of Noida, India. The couplers were installed in the columns and the corresponding cost was worked out.

Gary Connah (2013) conducted a study on requirements for the prequalification of mechanical splices for reinforcing bars in Seismic Conditions. The method for calculation of cracking moment when tensile reinforcement is spliced by couplers was presented. He concluded that the test specifications for mechanical splices vary, depending upon the specifying authority and country and application.

Vidmantas Jokubaitis and Linas Juknevičius (2010) conducted a study to analyze the influence of reinforcement couplers on the appearance of normal cracks in reinforced concrete beams. The method for calculation of cracking moment when tensile reinforcement is spliced by couplers was presented. The analysis of experimental and numerical results obtained by calculation method mentioned above has shown that the first normal cracks usually appear at the end of the coupler (Yoshikazu Kanoh, Hiroshi Imai, Yashiro Matsuzaki 1988). Performance of evaluation of mechanical joints of reinforcing bars.

Ling Jen Hua, Ahmed Bahuraddin Abd. Rahman Izni (2013) Feasibility grouted splice connector under tensile load. The tensile load under the feasibility of grouted splice.

Singh R, Himanshu S. K, Bhalla N. (2013) Reinforcement couplers as an alternative to lap splice. Use of Couplers as compared to lap joints. Comprehensively, the extent of the work is to play out the static examination and flexible plan of the individuals from Pre-engineered Industrial structure and to limit the heaviness of a standard Pre-engineered gateway outline with an accessible PC investigation and plan programming STAADPRO-2006. The work additionally includes investigation and plan of the Secondary part for example Purlins, Eave Strut and Girts where investigation is finished by utilizing programming STAADPRO-2006 and plan of the individuals is done physically utilizing Cold-framed determinations. The Parametric investigation is additionally being fused here to reach to the practical answer for the structure overall, The Design after effects of Pre-Engineered Industrial structure are contrasted and the Conventional Industrial structure and an examination is made between the weight and Costing of these structures.

III. METHODOLOGY

To make the coupler more economical we are trying to fabricate the coupler with minimum dimensions hence following methods are adopted for the complete procedure-

1. Manufacture
2. Fabrication
3. Testing
4. Result

Manufacture

Following steps are adopted for production process-

Step 1 The brass rod is delivered from companies across Europe

Step 2 The rod is cut into billets on automatic saws to the size required for the production of a particular fitting

Step 3 The Billet is coated with a graphite powder prior to heating in a gas furnace. The temperature of the furnace is held between 700 and 750 degrees centigrade. By applying the graphite coating the optimum flow of the metal during stamping can be assured

Step 4 The heated Billet is stamped in one of the automated stamping presses where the metal is forged into its required shape. These presses have a platen force of between 100 tonne and 380 tonne

Step 5 The Stamped product before machining

Step 6 The fittings are then machined in one of our many rotary transfer machines

Step 7 Some Machine processes take place using our CNC Lathes.

Step 8 The machined fittings now go to the Burnishing machine where they will be degreased and cleaned prior to assembly

Step 9 The burnished components are now ready for assembly and packing.

Step 10 The finished components are assembled, packed and boxed ready for transfer to finished goods stores where the products are packed and despatched to each customer's specific order.

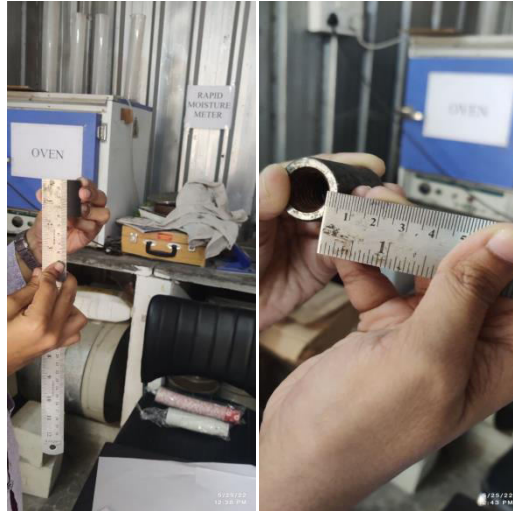
Fabrication

The coupler fabricated by us had following dimensions

Length of the coupler :- 80mm

Inner diameter of coupler :- 16mm

Outer diameter of Coupler : 24mm



Following steps are adopted for Fabrication process-

Step 1 Cutting: - The end of the reinforcing bar is sawn square.

Step 2 Cold forging: - The sawn end of the reinforcing bar is then enlarged by a patented cold forging process. The core diameter of the bar is increased to a pre-determined diameter.

Step 3 Threading: - Finally, the thread is mechanically cut onto the enlarged end of bar.

Testing-

Following tests are performed-

1. Yield strength
2. Ultimate tensile strength
3. Elongation

Ultimate tensile strength

TEST PROCEDURE

Tensile Strength The tensile strength shall be determined by means of test carried out in accordance with IS 1608. A tensile test on an un-spliced specimen from the same bar used for the preparation of spliced specimen shall be performed to establish actual tensile strength of the reinforcing bar. For the calculation of stresses, the effective cross sectional area of the reinforcing bar shall be used.

Percentage Elongation at Maximum Force

The gauge length for determining percentage elongation at maximum force for both spliced and un spliced specimens shall be the same. In both spliced and un-spliced specimen, it shall be located outside the length of the mechanical splice in both the bars. The percentage elongation at maximum force shall be tested and measured according to IS 1608 outside the length of the mechanical splice on both sides of the connection. Both values shall be recorded and the largest shall be used to assess conformity.

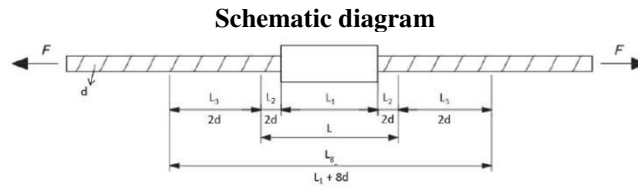
TEST REPORT

Each individual test report on both the spliced and un spliced specimens shall include at least the following information:

- a) Tensile strength,
- b) Total percentage elongation at maximum force,
- c) Load-extension curve to the smaller of 2 percent strain or the strain at specified tensile strength of the reinforcing bar, and
- d) Location of failure, that is within the mechanical splice length or outside the mechanical splice length

The location of failure shall be deemed to be in the bar, if it is outside the length of the mechanical splice as defined in.

Where requirement of bar break is specified by the purchaser/user, a failure located inside the length of the mechanical splice shall be recorded as a splice failure.



Where F = applied Force

L = length of the Mechanical Splice

L_1 = coupler Length

$L_2 = 2d$, Where d is the Nominal Diameter of the

L_3 = in the Range, $2d$ to $3d$ Reinforcing Bar

L_g = overall Gauge Length in the Range from $L_1 + 8d$ to $L_1 + 10d$

IV. RESULT AND DISCUSSION

Test report No:-gs-0077/STL-001/05/2022

Grade of coupler:- EN8D

Grade of steel :- 500D

Material/sample details- TMT bar joint with coupler

Material/sample condition:-Dry

Temperature :- 26.80o C

Method of Test:- As per IS 186:2008 RA-2018 IS-1608 RA-2018.

Sr.No	Brand Name	Nominal Dia	Yield Stress	Ultimate Tensile Stress	Elongation
1	SANGAM FE500D	16MM	639.90	772.31	16.25





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 Geotechnical Investigations
 Soil, Steel, Concrete & Material Testing Laboratory

TEST REPORT

Test Report No.:	GS-0077/STL-00105/2022	Date:	04 Jun 2022
Customer Name:	Babyojoo Tembume	Sampled By:	By Client
Customer Address:	Nagpur, Maharashtra		
Authority:	Not Mentioned		
Work Order & Date:	11 May 2022	Location:	Not Mentioned
Project/Site:	Experimental study on RIF Bar Coupler as a Cost effective component.		
Identification Mark:	GRADE OF COUPLER/END GRADE OF STEEL-500D/AS REEPORTED BY CLIENT	Proposed Structure:	Not Mentioned
Material Sample Details:	TMT Bar Joint with Coupler (As Reported by Client)	Sample Rec.Date:	26 May 2022
Material Sample Condition:	Dry	Date Of test:	01/06/2022 To 03/06/2021
Temperature (°C):	26.80	Humidity (%):	64.00
Method of Test:	As Per IS 1786:2008 RA-2018 IS-1608 RA-2018	Amendment No.:	---

PHYSICAL TEST ON STEEL

TENSILE STRENGTH					
Sr. No.	Brand Name	Nominal Diameter	Yield Stress	Ultimate Tensile Strength	Elongation
		mm	N/mm ²	N/mm ²	%
1	Sangam Fe 500D	16	639.90	772.31	16.25

SPECIFICATIONS (As per IS: 1786-2008 RA-2018):

Fe 500 D

Tensile Strength for high strength Deformed Bars should be as below.

Yield Stress: Not less than 500N/mm²

Ultimate Tensile Strength: Minimum 10% more than actual 0.2% Stress or Yield but less than 565 N/mm²

Elongation: Not less than 16%

For GEOsystems Research & Consultants (I) Pvt.Ltd.

Verified By: (Dy. Technical Manager)

Authorised Signatory: Adwait Wankhede (Technical Manager)

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End Of Report

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V. CONCLUSION

As per the criteria given in IS 16172-2014 the results must be –
 Tensile Strength for high strength Deformed Bars should be as below.

1. Yield Stress Not less than 500N/mm²
2. Ultimate Tensile Strength Minimum 10% more than actual 0.2% Stress or Yeild but less than 565 N/mm²
3. Elongation |Not less than 16%

Hence the results are pass and the coupler is safe to use.

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