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Mechanical Rebar Coupler: Alternative to Lap Splices

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***Abstract:*— Lap splicing is the conventional method for connecting the steel reinforcing bars since many years. Splicing the steel reinforcing bars by lapping or welding have various imperfections such as inadequate length of laps, low quality welds, increase in labour cost, failure in joints, etc. To overcome the problems stated above new techniques for splicing steel reinforcing bars has come into practice. Present study is focused on investigation of new techniques for splicing steel reinforcing bars. The use and applicability of reinforcement couplers as an alternative to lap splices would overcome reinforcement congestion problem and increase strength of structure. It was found that the use of reinforcement couplers significantly reduces the consumption of both reinforcing steel and construction time. It also increases the overall reliability of reinforcement splices. Couplers not only provide strength to joints but also prove to economic means of connections of two bars. The objective of our study is to investigate for new techniques in mechanical rebar coupler over the present couplers as an alternative to lap splices. The paper presents performance of mechanical splices as an alternative to lap splices along with experimental test results and the types of failure observed.**

I. INTRODUCTION

The reinforced concrete is widely used in civil engineering industry globally. The increasing use of cast-in situ reinforced concrete leads to the development of the new technologies and gaining the experience from the other countries. Overall it helps to increase the quality of structures and reduces time consumption of construction works. In the reinforced-concrete structures, some reinforcing bars must be spliced. The length of a bar required may be longer than the stock length of steel, or the bar may be too long to be shipped conveniently. In either case, rebar installers end up with two or more pieces of steel that must be spliced together. Lap splicing, which requires the overlapping of two parallel bars, has long been accepted as an effective, economical splicing method.

Splicing with lapped joints is not an appropriate means of connecting reinforcing bars always. The use of lapping requires more steel in terms of design and installation and can lead to greater congestion within the concrete because of the increased amount of rebar used. It also increases the overall reliability of reinforcement splices. Steel reinforcing bars of large diameter used in concrete members in concrete structures requires about 15% more steel than that when used as a single bar. We cannot avoid lapping as the bars come in standard lengths of 18-12 m. The practice of lapping large diameter bars has been discontinued, considering the congestion of reinforcing bars and economy, by providing "Mechanical Couplers". The Indian construction industry has felt the immediate need, and is encouraging the builders to use mechanical couplers for use in many major infrastructure and multistoried construction projects.

The use of mechanical couplers for connecting reinforcing bars is an promising technology, is continuing to develop in terms of the types of couplers available and their performance. The supply of couplers is becoming a global business and because of the diversity in the design codes, construction practices and specifications, standardization of the specification and testing of coupler performance has been slow. The types of couplers available can be conveniently categorized on the basis of joint is made between the coupler and the reinforcing steel.

With all coupler systems, the joint (or splice) is made either in the fabricator's works or on the construction site. Therefore there is a requirement for control of both the coupler manufacturing operation, and also the production of the splice itself, which will normally require some end preparation of the bar.

II. STUDY AND METHODOLOGY

The study was divided into different parts as structural analysis, specifications and manufacturing, estimation and comparison made between mechanical and lap splices. Their performance was analyzed on the basis of ultimate tensile capacity and percentage elongation.

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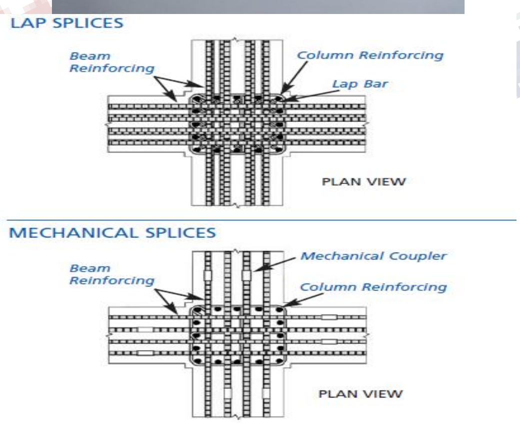
A. Structural analysis

i. The development length and bond stress can be determined from IS 456: 2000.
ii. IS 4694:1968 States the information about basic dimensions for square threads
iii. IS 7008:1988 States the information about isometric trapezoidal screw threads
iv. Tensile Strength- The tensile strength of the mechanical splice should not be less than 690 N/mm2.
v. Percentage Elongation - The minimum percentage elongation at maximum force should be minimum 3% before the failure of test piece.

B. Specifications and manufacturing

According to the specifications required various materials and their alloys can be used for preparing the couplers. Generally the couplers are manufactured from mild steel. The manufacturing of couplers includes various steps such as cutting, boring, threading, tapping and finishing. Couplers are manufactured on Metal Lathe machine.[3][4].



C. Economic Survey

The conventional lap splicing methods require more time and steel. Hence there is wastage of money and also more wastage of reinforcement bars as scrap. We can avoid this by giving alternative to conventional lap splicing by mechanical splicing. For that purpose economic survey is much more needed.

Table1. Economy Survey for Various bars Diameters.

Description	Units	Quantities			
Rebar diameter	MM	16	20	25	32
Length of rebar	M	12	12	12	12
Weight of rebar per meter.	Kg/M	1.571	2.469	3.858	6.321
Cost of steel	Rs	50	50	50	50
Rebar length as per floor	M	4	4	4	4
Lap considered	D	50	50	50	50
Lap length	M	0.8	1	1.25	1.6
Weight of overlapping lap	Kg	1.26	2.47	4.82	10.11
Total bar consumed per floor	M	4.8	5	5.25	5.6
No. of lap in 12 m rebar	No.	2	2	2	2
Actual consumption of bar	M	9.6	10	10.5	11.2
Wastage scrap in length	M	2.4	2	1.5	0.8
Wastage in Kg	Kg	3.769	4.938	5.787	5.057
Wastage as scrap in 12 meters in Rs.	Rs.	188.47	246.91	289.35	252.84

3) *Result and Discussion*

i. For Mild Steel Coupler

Sr. No.	Diameter of Bar (mm)	Ultimate Load(KN)	Ultimate Stress(N/mm^2)
1	20	61.20	194.8
2		65.00	206.9

ii. For EN8D couplers

Sr. No.	Diameter of Bar (mm)	Ultimate Load(KN)	Ultimate Stress(N/mm^2)
1	20	130.08	646.97
2		141.12	701.88

Discussion

Tensile test carried on mild steel couplers which comes out in between 190 to 210 N/mm2 which is not satisfactory as per recommended in IS code 1786-2008.Therefore EN8D material is used for making couplers having high carbon content and high strength. Test results of these specimens are satisfactory.

V. CONCLUSION

In our study, mild steel couplers fail in tension test, because the thickness and strength of coupler is less as compared to the EN8D couplers having high strength and thickness. Couplers having high carbon contents have high strength and in addition with greater thickness are more sustainable and effective.

REFERENCES

[1]IS:1786-2008, “High strength deformed steel bars and wires for concrete reinforcement - Specification(Fourth Revision)”.

[2]IRC:21-2000 (clause no. 304.6.6.7) for a mechanical joint including its connecting elements shall developed strength in tension or compression at least 125 percent of the characteristics strength fy.

[3]IS 456-2000 (Plain and reinforced concrete - code of practice).

[4]V. B. Bhandari, “Introduction to machine design”.

[5]IS 4694-1968: Basic dimensions for square thread.

[6]IS 7008-1988: ISO metric trapezoidal screw threads.