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Design and Analyze the performance of Mechanical Rebar Coupler in the concrete structure Alternative to Lap Splices

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ABSTRACT

In construction practices, the buildings of concrete structure have focused on the use of steel reinforcement for transfer of tension and shear forces. In general construction purposes two types of steel are used including the mild and deformed steel bars. The mild steel bars which are used in reinforced cement concrete works are plain in surface and round in cross-section. Lap splicing is the conventional method of connecting steel reinforcement bars. Lapping is the method in that reinforcement bar is connected with each other. Purpose of lapping is to give continuity of reinforced structure like beam, column, slab etc. The splicing of bars by lapping may also have various imperfections such as that the low quality weld, inadequate length of lap and increase in the construction cost. But the lapping may also reduce the time and increase the structural reliability of the concrete structure. The practice of the use of coupler in the construction industry may overcome the problems of the construction time and simplify the design and construction of reinforced concrete and reduce the amount of reinforcement required. The present paper is to analyze the design and the performance of the coupler in the concrete structure. Couplers not only provide strength to joints but also prove as an economic mean for connections of two bars. The objective of this research study is that to investigate the new design of the coupler which reduces the consumption of reinforcement steel and construction time in concrete structure.

Keywords: Couplers, Splice, Lapping.

I. INTRODUCTION

In the versatile Civil Engineering industry reinforced concrete is widely used. The increasing use of cast in – situ reinforced concrete leads to development of new technologies. It helps to increase the quality of structure and reduces time consumption of construction works. In the reinforced concrete structures, some reinforcing bars must be spliced. Lapped joints are always an appropriate method of connecting reinforcement bars. There are three basic ways to splice the bars that are the Lap splices, mechanical connections and welded splices. Of the three lap splicing is the common and least expensive. We cannot avoid lapping as the bars come in standard lengths of 18m-12m. Steel reinforcing bars of larger diameter required about 15% more steel than that used in single steel. Continuing research, more demanding designs in the concrete structure development of hybrid concrete/steel designs have made the designers to consider an alternative to the lap splicing. The length of a bar required may be longer than the stock length of steel, or the bar maybe too long to be shipped conveniently. The use of mechanical couplers for connecting reinforcing bars is a 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. More and more engineers are specifying that mechanical reinforcement connections over the lap splicing. Their research has said that the mechanical connections afford reliability and consistency that can't be found with the lap splicing. In the reinforced concrete structure, some reinforcing bars must be spliced so that the force from one bar to the joining bar is transferred. So, in the field of construction various couplers are used. Couplers can simplify the design and construction of reinforced concrete and reduce the amount of reinforcement required. However lap splices cannot be used for bars having diameter greater than 36mm, so the bars having diameter greater than 36mm may be welded or coupled by using reinforcement couplers. Whereas welding requires skilled workmanship and continuous power supply. Therefore to overcome the above disadvantages and complexity of welded and spliced connection the rebar couplers are preferred for connection.

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 supply of couplers is becoming a global business and because of diversity in design codes, construction practices and specifications, standardization of specification and testing of coupler performance has been slow. The type of couplers available can be conveniently categorized on basis of joint made between the coupler and reinforcing steel. Couplers not only provide strength to joints but also proves to economic means of connections of two bars. In either case, rebar installers end up with two or more pieces of steel that must be spliced together. Designed for the use with worldwide grades of rebar, they develop the full tension splice strength requirement per numerous design standards.

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

II. STUDY AND METHODOLOGY

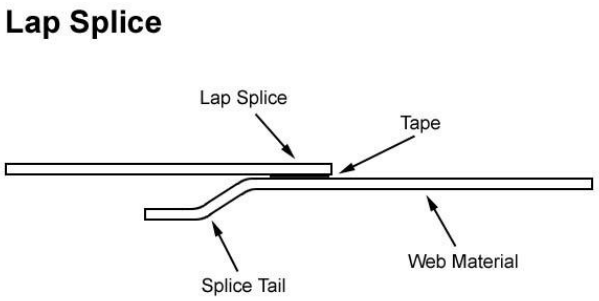
The study was divided into different parts as structural analysis, specifications and manufacturing, estimation and comparison made between mechanical and lap splices. Their performance was analyzed on the basis of ultimate tensile capacity and percentage elongation.

A. Structural analysis

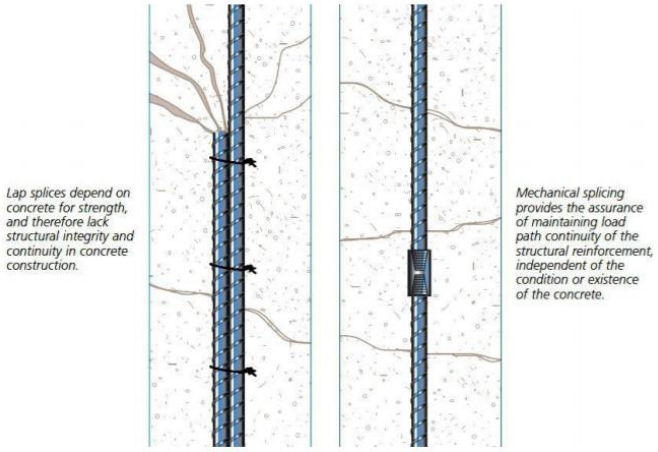
i. The development length and bond stress can be determined from IS 456: 2000.
ii. IS 4694:1968 States the information about basic dimensions for square threads.
iii. IS 7008:1988 States the information about isometric trapezoidal screw threads.
iv. Tensile Strength- The tensile strength of the mechanical splice should not be less than 690 N/mm^2.
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.



Congestion of Bars



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

C. Economic Survey

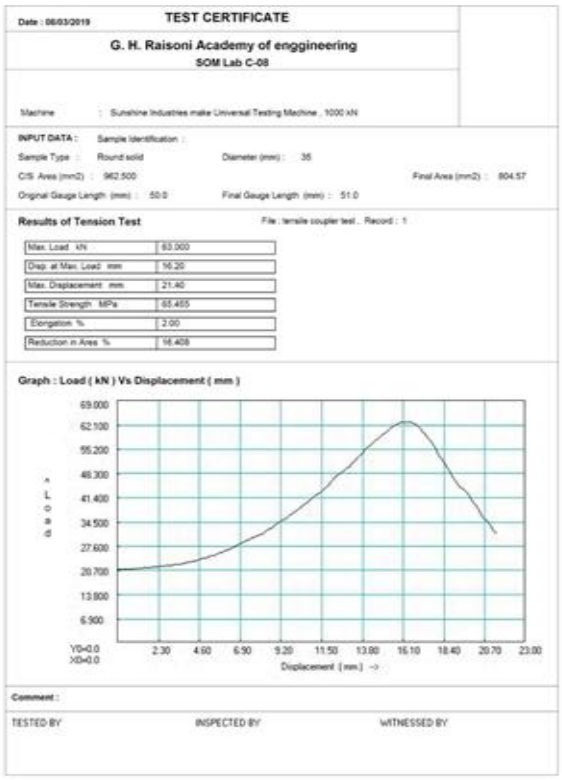
The conventional lap splicing methods require more time and steel. Hence there is wastage of money and also more wastage of reinforcement bars as scrap. We can avoid this by giving alternative to conventional lap splicing by mechanical splicing. For that purpose economic survey is much more needed.

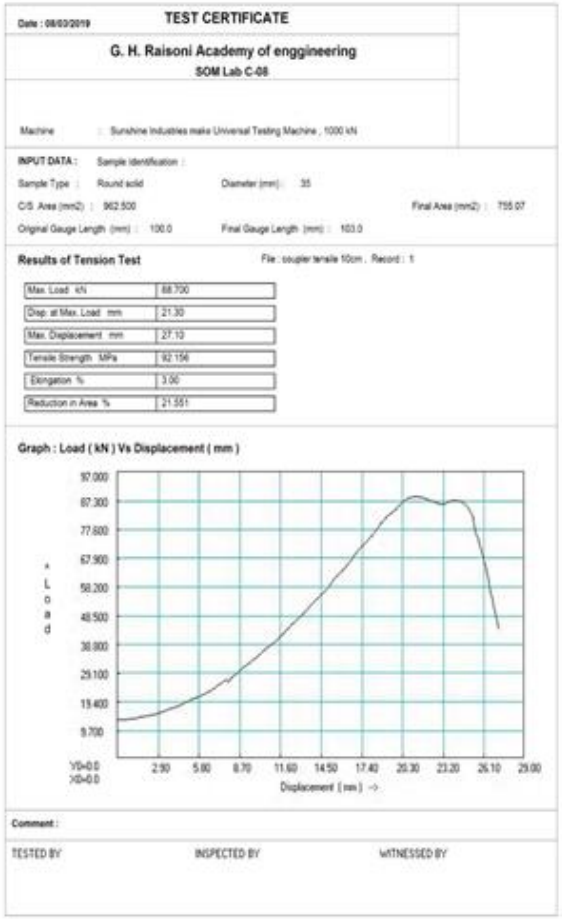
Table 1. Economy Survey for Various bars diameters.

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

III. TEST RESULTS

The Tensile test was carried on 5cm and 10cm diameter bar on the Universal Testing Machine where the strength of the coupler of 35mm diameter was checked respectively. The 5cm diameter bar strength is found out to be 65.455N/mm^2 and for 10cm diameter bar strength was found out to be 92.156 N/mm^2. Whereas, the tensile strength of the coupler is said to be more than 500N/mm^2 for the proper strength, therefore the test specimen failed as it has not given the expected result. It resulted in the failure of the test because of the use of the mild steel which is commonly used in the coupler. So therefore according to our research the better material such that EN8D, Fe500, Fe550D would result in giving the appropriate strength to the coupler.





IV. CONCLUSION

The use of mechanical splices as an alternative to lapping of reinforcement is a viable one in many situations. Couplers having high carbon contents have high strength and in addition with greater thickness are more sustainable and effective. The test was done to design and analyze the new coupler in the concrete structure. The use of better material such that EN8D, Fe500, Fe550D will result in the proper strength of the coupler, the use of mild steel resulted in the failure of test and couldn't attain the appropriate strength. The proper physical and chemical properties will result in the better material which will ultimately result in appropriate strength of the coupler. This will also result in the increase of the reliability and reduce both consumption of reinforcing steel and construction time. The mechanical coupler has significant improvement in loading capacity and ductility better than the conventional splicing methods independent of the concrete conditions. The conclusion from the various test and survey is as stated Tensile Test- Mechanical splice gives high performance than conventional lap splice; Mechanical splice strength is generally 125-150% more than conventional lapping strength.

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