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Fabrication of One-Touch Rebar Coupler for Mechanical Connections

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Abstract: Due to the growing technical challenges faced in the construction industry today, traditional methods for connecting rebar, such as lapping or welding is no longer the best method to connect rebar because lack in the treatment of construction waste requires concrete pour forms at joints and their structural discontinuity leads to low redundancy in the load paths. Also lap splices and welded joint are not considered reliable under cyclic loading, which are not effective for larger spans and can become weaker with time due to corrosion. This study aims to provide novel solutions to these problems by developing interlocking mechanical joints with fully restrained moments for the connections of both steel-concrete composite precast and reinforced concrete precast columns by designing and manufacturing one punch rebar's coupler, which will solve all those problems and can save a lot of time during the time of construction. It has various other benefits such as reduces congestion and are more reliable as well since they do not depend on concrete for load transfer. Superior cyclic performance and greater structural integrity during man-made, seismic or other natural events are other advantages of one punch rebar coupler. This coupler does not require the tedious calculations, which is necessary to determine proper lap lengths and their potential errors. Since it does not overlap, less rebar is used to reduce materials costs.

Key Words : Lap Splice, Welding, Rebar Coupler, One Punch Coupler

1. Introduction

Lap splicing has become the traditional method of connecting two steel reinforcing bars in civil engineering industries globally. Lap splice and welded splices have various imperfections such as poor quality of welds, increased labour cost, failure at joints, requires of skilled labour and inadequate length of laps, etc. There are also other ways to splice the bars which is welded splices and mechanical splices (one punch rebars coupler).

Lapped joints are not that effective mean of splicing since it has various disadvantages such as greater congestion, time-consuming and also lap splices are not considered reliable under cyclic loading and they are not effective for larger spans and have many hidden costs and it does not provide load path continuity, independent condition of the concrete.

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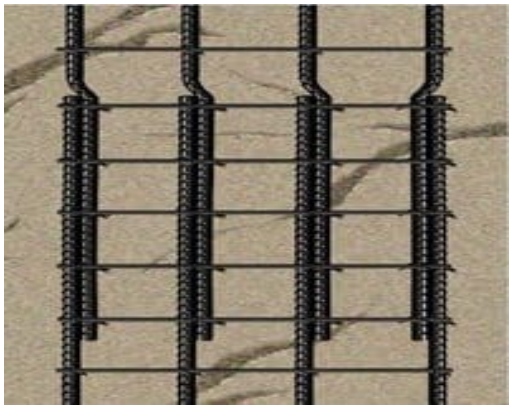

Fig. 1 Rebar's connection of lap splices

Fig. 2 Rebar's connection of welded splices

Mechanical splices i.e. the coupler system is used to connect two bars in the field quickly and easily. Hence mechanical splices such as one punch coupler can be very effective since they ease the design parameters, easy in installation and also reduce the amount of reinforcement required. Hence more and more engineers are specifying mechanical reinforcement connections overlap splices since they have found that mechanical connections afford reliability and consistency that cannot be found with lap splicing. Mechanical splices deliver higher performance than a typical lap splice. Generally, this is 125 - 150% of the reinforcement bar and this is also an economic means of connecting two bars. The purpose of this study is to compare the strength and behaviour of normal and coupled bars under tensile loading and also to study the economic cost comparison of the same.

Fig. 3 Rebar's connection of one-touch coupler

2. Structure of One-Touch Coupler

The material of the coupler is steel which consist of Top and bottom side assembly of parts, by hold two rebars of the same or different diameters. It consists of female, male parts, springs, and threaded holders and round disk with a small magnet. The female part is in the cylindrical shape with threads inside; the total length of this part is 87 mm with the diameter of 48 mm. The threaded side is connected to the male part and rebar is inserted from the other side, the coupler consists of total two female parts attached to both sides of the male part. The male part has a diameter of 43 mm with total length of 30 mm and the numbers of threads are 14 as shown in Figure below.

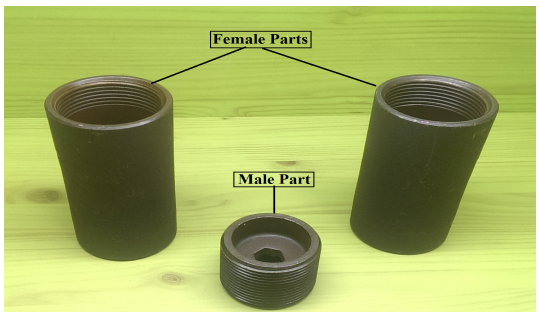

Fig. 4 Male and female parts of one-touch rebar coupler

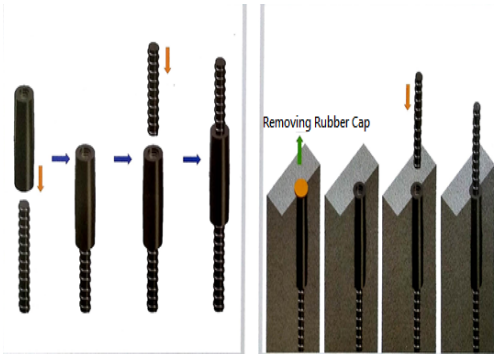

Fig. 5 Reinforce method of generally joint and concrete joint

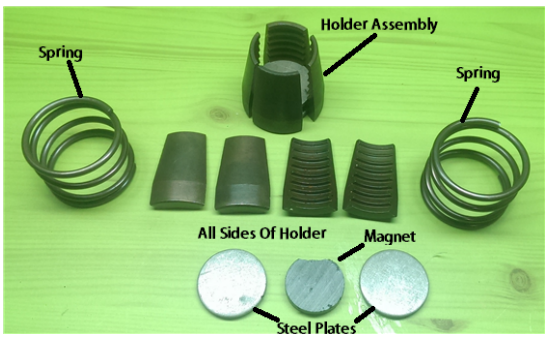

Fig. 6 Internal parts of one punch rebar coupler

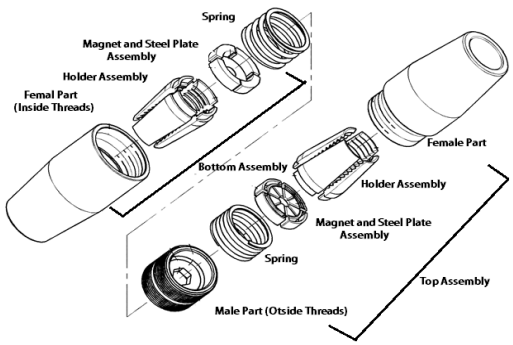

Fig. 7 Schematics representations of one-touch rebar coupler

The inner parts of the coupler consist of two threaded holders which provide the grip force for connecting and holding the rebar. The locker is a conical shape which increases the friction force of locking. Spring also play an important role in moving the holding components to their final position of locking. The engagement of the fastening pieces is separated from each other so that the bunched as considered to move by the elastic force of the spring piece body is strongly pressed to the outer surface of the reinforcement it is possible to firmly fix the reinforcement. The inner parts of one-touch rebar coupler are shown in Figure.

3. Working Mechanism

A coupler body having a hollow portion formed in the longitudinal direction, the coupler body is formed in a helical shape so as to provide the inner peripheral surface of the hollow portion with a rebar fastening force in the circumferential direction, and the coupler body comprising a first guide helix coupling portion, which has first guide sloping portions that slope from the centre portion of the hollow portion towards the outside of one side thereof, and a second guide helix coupling portion, which has second guide sloping portions that slope from the centre portion of the hollow portion towards the outside of the other side.

A first fastening unit screw-coupled to the first guide helix coupling portion of the coupler body and inserted into one side of the hollow portion, the first fastening unit comprising a plurality of first fastening members, which are coupled to the first guide sloping portions so as to be able to slide, respectively, each of the first fastening members having a first fastening helix coupling portion, which has a first fastening sloping portion, provided on the outer peripheral surface thereof and having a first grasping portion, which grasps the outer peripheral surface of a rebar for connection, provided on the inner peripheral surface thereof such that, when tensile forces act on coupled rebar's, the first fastening members move in the opposite

direction of the radial direction and thereby provide the rebar's with fastening forces; and a second fastening unit screw-coupled to the second guide helix coupling portion of the coupler body and inserted into one side of the hollow portion, the second fastening unit comprising a plurality of second fastening members, which are coupled to the second guide sloping portions so as to be able to slide, respectively, each of the second fastening members having a second fastening helix coupling portion, which has a second fastening sloping portion, provided on the outer peripheral surface thereof and having a second grasping portion, which grasps the outer peripheral surface of a rebar for connection, provided on the inner peripheral surface thereof such that, when tensile forces act on coupled rebar's, the second fastening members move in the radial direction and thereby provide the rebar's with fastening forces.

4. Cost Analysis

A cost has been computed based on saving of steel in lapping which indicates couplers are an effective and an economic replacement of lap splice.

Table 1 Cost analysis of one-touch rebar coupler

Bar diameter(mm)	32	25	16
Weight of steel per meter(kg/m)	6.3	3.8	1.5
Development length(mm)	1925	1416	910
Quantity of steel saved (Kg)	12.2	5.5	1.4
Steel saving (USD)	8.6	4.0	1.0
Cost of coupler (USD)	4.3	3.0	0.9
Total saving (USD)	4.3	1.0	0.1

Table 1 shows how couplers have effectively saved a huge amount of money in a single joint. The total cost saved per joint for 25 mm rebar is 1 USD/- and for 32 mm rebar is 4.3 USD/-. On the same line for 16 mm rebar the saving is comparatively less. Mechanical splices add structural and economic advantages over laps make the benefit-to-cost ratio extremely attractive because mechanical splices give the structures added toughness and load path continuity that laps cannot offer. The reinforcement couplers not only provide strength to the joints but they are also an economic means of connections of two bars.

5. Comparison of the mechanical joints

There There are three basic ways to splice the bars i.e. Lap Splice, Weld Splice, and Mechanical Splice. For comparison purpose, incremental tensile load tests were carried out on welded splices. The results were analyzed as shown in Table 2 and the feasibility of the specimens was determined based on several evaluation criteria.

Table 2 Average comparative results of 32 mm diameter rebar for splicing

Sample	Normal Bars	Welded Bars	Coupled Bars
Nominal diameter (mm)	32	32	32
Yield stress obtained (N/mm2)	579.283	526.275	540.960
Ultimate stress obtained (N/mm2)	675.767	621.295	655.173
Percentage elongation	16.19%	18.38%	15.88%

6. Conclusions

This study shows that couplers are effective and economical replacement of lap splice and can save a huge amount of money in a single joint. The couplers were considerably more cost effective and time-saving than welding the bars together. No special high strength, enlarged thread section or increased rebar size is necessary, thus allowing the supply of reinforced bar from multiple sources for maximum cost savings. The other rebar couplers need more labours, time, space, wrenching, add chemicals and also including technical knowledge about connecting rebars. On another hand one-touch rebar coupler offers many advantages to the designer and constructor to help improve the design and reduce construction time and cost while providing versatility and can help to solve many construction problems today. It increases the overall reliability of reinforcement splices. Couplers not only provide strength to joints but also proves to economic means of connections of two bars. It is broadly applied to tunnels, towers, bridges, subways, airports, nuclear power stations, high rise building and many more. It can connect rebar's of same or different diameters laterally and vertically. During construction time there is no effect on the environment because of no flames and no noise, air pollution compared to welding splices method. The application time is very small compared to other method and can be prefabricated.

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