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Use of Mechanical Splices (Couplers) for Reinforcing Steel

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***Abstract*: Construction practices in the building of concrete structures have focused on the use of steel reinforcement to transfer tension and shear forces. Lap splicing has become the traditional method of connecting the steel reinforcing bars. Splicing the reinforcement bars by laps or welding have various imperfections such as low-quality welds, inadequate length of laps, failure in joints, increase in labor cost etc. Present study was focused on the use and applicability of reinforcement couplers, especially threaded ones as an alternative to lap splices. A case study of an under-construction site was taken where couplers were used. An estimation of the cost of couplers was done. Alternatively, the cost of steel was also determined for providing lap splices in the columns. A comparison was done to show the difference of cost in lapping and use of couplers. It was found that the use of reinforcement couplers significantly reduces the consumption of both construction time and reinforcing steel. It also increases the overall reliability of reinforcement splices. This case study included calculations for 14 columns and showed that how couplers have effectively saved a huge amount of money in a single building. The reinforcement couplers not only provide strength to the joints but they are also an economic means of connections of two bars.**

***Keywords*: Lap splicing, reinforcement splices, couplers.**

1. Introduction

There are three basic ways to splice the bars: Lap splices, Mechanical connections and Welded splices. Lapped joints are not always an appropriate means of connecting reinforcing bars. The use of laps can be time consuming 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. Of the three, lap splicing is the most common and usually the least expensive. Couplers especially threaded one can simplify the design and construction of reinforced concrete and reduce the amount of reinforcement required. The coupler system is designed to connect two pieces of rebar together in the field quickly and easily. Taper threaded splices utilize the time-tested, field proven taper thread for assurance of strength, consistency and reliability while simplifying installation. Designed for use with worldwide grades of rebar, they develop the full tension splice strength requirement per numerous design standards.

A. Objectives of mechanical couplers

- Mechanical splices are fast and easy to install and require no specialized skilled labour.
- Mechanical splices 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.
- Bar terminators eliminate congestion and simplify bar placing.
- Repair splices eliminate the cost of breaking away massive amounts of concrete.
- It leads to the reduction of labor and therefore the overall cost of the structure.

B. Reason for using mechanical connections

- Eliminate protruding connections
- Eliminate the drilling of formwork
- Reduce crane time
- Reduce congestion

2. Methodology

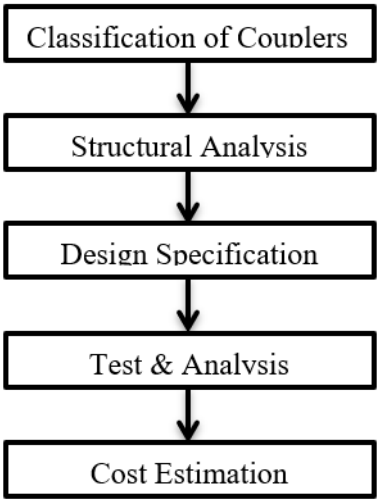

Fig. 1. Methodology

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Classification of coupler:

- Taper-Threaded
- Shear Bolte
- Steel Filled Coupling Sleeve

Fig. 2. Typical threaded splice system

Fig. 3. Mechanical threaded couplers

3. Design, Specification and Preparation

A. By Site Method

The site method that was adopted for lap splices was based on the grade of concrete. The lap splice was chosen as per the concrete used in the work as adopted on site.

M30 : 46d
M35 : 40d
M25 : 39d
Where d is the diameter of the bar.

B. By IS-456 Method

As a standard method IS 456 specifies a formula for determining the lap length in any structural member. As per IS code lap splice is given by the formula,

Ls = 48d

Where d is the diameter of the bar.

Quantity of material for 9 beams For M20 (1:1.5:3)

Total material required for 9 beams (lap splices) =
Cement = 2 Bags
Sand = $0.015m^3$
Aggregate = $0.03m^3$

Total material required for 9 beams (couplers) =
Cement = 2 Bags
Sand = $0.015m^3$
Aggregate = $0.03m^3$

Total material required for 18 beams (lap splices + couplers) =
Cement = 4 Bags
Sand = $0.03m^3$
Aggregate = $0.06m^3$

Fig. 4. Welded Lapping

Fig. 5. Splice (Coupler) lapping

4. Tests, Cost Estimation & Comparison

Fig. 6.

Fig. 7.

Table 1
Calculation of cost of lap splices (site method)

Bar dia. (mm)	Weight per meter $D^2/162$	Length of lap and beam (m)	Total steel for beam per meter (C2 x 4) (kg)	Total cost of bar (wt x 55)
10	0.61	2.4	2.4 x 0.61 = 1.46	80.3
16	1.58	3.84	3.84 x 1.58 = 6.06	333.3
20	2.46	4.8	4.80 x 2.46 = 11.80	649

Table 2
Calculation of cost lap splices (IS Code method)

Bar dia. (mm)	Weight per meter $D^2/162$	Length of lap and beam (m)	Total steel for beam per meter (C2 x 4) (kg)	Total cost of bar (wt x 55)
10	0.61	3.84	3.84 x 0.61 = 2.34	128.7
16	1.58	6.08	6.08 x 1.58 = 9.60	528
20	2.46	7.68	7.68 x 2.46 = 18.89	1038.95

Table 3
Calculation of cost of couplers

Bar dia. (mm)	Number of Couplers for each beam	Total cost of Coupler (No x Rate)
10	4	4 x 35 = 140
16	4	4 x 45 = 180
20	4	4 x 55 = 220

Table 4
Comparison of cost

Bar dia. (mm)	Cost by site method	Cost by IS Code method	Cost of coupler
10	80.3	128.7	140
16	333.3	528	180
20	649	1038.95	220

5. Conclusion

This shows that couplers are an effective and economic replacement of lap splices.

This case study shows how couplers have effectively saved large amount of money in a single beam.

The report concludes that the added structural and economic advantages of mechanical splices over laps make the benefit-to-cost ratio externally attractive because mechanical splices give the structure added toughness and load path continuity that laps cannot offer.

The reinforcement couplers not only provide strength to the joint but are they are also an economic means of connection of two bars.

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