

# Behaviour of Mechanical Coupler in Reinforcement

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**ABSTRACT:** Lap splicing requires the overlapping of two parallel bars. During impact load condition, the lap splicing gets failed easily. To resist the tensile stresses, steel reinforcement is provided in concrete. In order to increase its structural performance, to achieve continuity of load path and to reduce the amount of steel reinforcement, “MECHANICAL COUPLER” is used instead of providing development length in the bars. The length of the coupler is decided as 3, 5 & 8 times the diameter of the bars. The normal, developed and coupled bars are tested by using UTM. After testing of developed and coupled bars, the length of coupler ( $L=3D$ ) gave good result when compared to welded splices and development length (i.e.  $L_d=45D$ ) as per IS 456:2000.

**KEYWORDS:** Mechanical coupler, tensile strength, development bar

## I. INTRODUCTION

Steel reinforcement bar is also known as rebar and reinforcement steel. It is versatile constructional material which is widely used in the construction industry for making of reinforced concrete. Reinforcement concrete(RC) is a composite material made up of concrete and some form of reinforcement, most commonly steel rods, wires or mesh of steel rods and steel wires. The steel reinforcement bars normally consist of such shape and size that they may easily bent and placed in concrete so as to form a monolithic structure. In the reinforced concrete structures, some reinforcing bars must be spliced. The length of bars required may be longer than the stock length of steel. 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, instead of providing lapping, the “MECHANICAL COUPLER” may be used in order to achieve the continuity of load path and reduce the amount of steel reinforcement.

The previous papers are, Use of mechanical splices for reinforcing steel (swami PS et.al,2016). Investigation of new techniques in mechanical rebar coupler as an alternative to lap splices (Harinkhede SN et.al,2016). Reinforcement coupler as an alternative to lap splices (Singh R et.al, 2013).

## II. MECHANICAL COUPLER

Couplers are manufactured on a metal lathe machine. It rotates the work piece on its axis to perform various operations such as cutting, sanding, knurling, drilling(or) deformation with tools that are applied to the work piece to create an object which has symmetric about its axis of rotation.

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**Fig 1- Material preparation**

Fig. 1 shows the preparation of mechanical threaded couplers by using metal lathe machine after the process of cutting and sanding.

Table 1 gives the specifications of mechanical couplers. The length of the coupler is decided as 3, 5 and 8 times the diameter of the steel rod. The table shows the provisions for dimensions of the mechanical couplers. The tests were conducted on 12mm and 16mm steel rods.

**TABLE 3.1: SPECIFICATION OF COUPLER**

Specimen ID	Diameter of bars (mm)	Length of Coupler (mm)	External Diameter (mm)	Internal diameter (mm)	Depth of thread (mm)	Pitch (mm)
MC-04	12	36	16	10	2	1.2
MC-05	12	60	16	10	2	1.2
MC-06	12	96	16	10	2	1.2
MC-01	16	48	20	12	2	1.2
MC-02	16	80	20	12	2	1.2
MC-03	16	128	20	12	2	1.2

Table. 2 show the chemical composition for mechanical couplers. In the present study, the tests were conducted on Fe 500 steel rods. So, the couplers were made by matching steel rods. Table 2 shows the constituents of the material is within the permissible limit.

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**TABLE 3.2: CHEMICAL COMPOSITION**

Constituents	Maximum percentage	Obtained percentage
Carbon	0.300	0.287
Sulphur	0.055	0.05
Phosphorous	0.055	0.049
Sulphur & phosphorous	0.105	0.992



**Fig 2- Threaded coupler**

Fig. 2 shows the mechanical coupler and reinforcement with outer thread (Fe 500) manufactured on metal lathe machine after drilling and deformation. The tensile tests were conducted on 3, 5 and 8 times the diameter of the steel rod.

### III. EXPERIMENTAL PROCEDURE

The cross section area of the specimen is measured by using vernier calliper and markings are made on the specimen. The gauge length is punched on the specimen on either side of the centre of the rod. Chalk piece marking is made on the specimen at the punched points. The specimen is fixed between the jaws of the UTM. Initially the release valve is kept opened and the control valve is kept closed fully, close the left release valve. Switch on the hydraulic push button. Slightly open the right control valve. Press TARE and RESET push button when constant readings are shown by electronic digital screen. Open the right control valve gradually. Note down the reading shown by the electronic recorder. Load in kN and extension in mm is recorded at regular interval till the specimen breaks. When specimen is broken, close the control valve fully and switch off the hydraulic mechanism. Open the left release valve completely.

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**Fig 3: Testing of welded and development bars**

Fig. 3 shows that the failure occur in development and welded bars when subjected to tension test by using Universal Tensile testing machine. ( $\pm 1000$  kN)

## IV. RESULTS AND DISCUSSION

**TABLE 5.1: OBSERVATION AND CALCULATION (MECHANICAL THREADED COUPLER)**

Specimen id	Diameter of bar(mm)	Diameter of coupler(mm)	Ultimate load(kN)	Ultimate stress(N/mm <sup>2</sup> )
MC-04	12	16	110.4	976.15
MC-05	12	16	90.18	797.4
MC-06	12	16	80.02	707.5
MC-01	16	20	211.95	1054.2
MC-02	16	20	193.1	960.4
MC-03	16	20	180.3	896.74

Table 5.1 shows the results of steel rods with mechanical threaded coupler subjected to a tensile test. The tensile were conducted on 12mm and 16mm diameter of the steel rods with mechanical couplers. The tests were conducted on 3, 5 and 8 times the diameter of the rods.

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**TABLE 5.2: OBSERVATION AND CALCULATION (WELDED SPLICES)**

Specimen id	Diameter of bar (mm)	Ultimate load (kN)	Ultimate stress (N/mm <sup>2</sup> )
WB-06	16	180	895.25

Table 5.2 shows the value of ultimate stress for steel rod with welded splices was subjected to a tensile test. The welded splices were made by IS codal provisions. (IS 456: 2000)

**TABLE 5.3: OBSERVATION AND CALCULATION (DEVELOPMENT BAR)**

Specimen id	Diameter of bar (mm)	Ultimate load (kN)	Ultimate stress (N/mm <sup>2</sup> )
DB-07	16	30	265.26

Table 5.3 shows the value of ultimate stress for steel developed bars subjected to tensile test. The development length of the steel bar is 45 times the diameter of the bar as specified in IS 456: 2000.

**TABLE 5.4: COMPARISON OF COUPLED , WELDED AND DEVELOPMENT BARS**

Types	Diameter of bar (mm)	Ultimate load (kN)	Ultimate stress (N/mm <sup>2</sup> )
Coupler	16	211.95	1054.2
Development	16	30	265.26
Welded	16	180	895.25

**FAILED SPECIMEN:**



**Fig 4: Coupled bars (12mm and 16mm)**

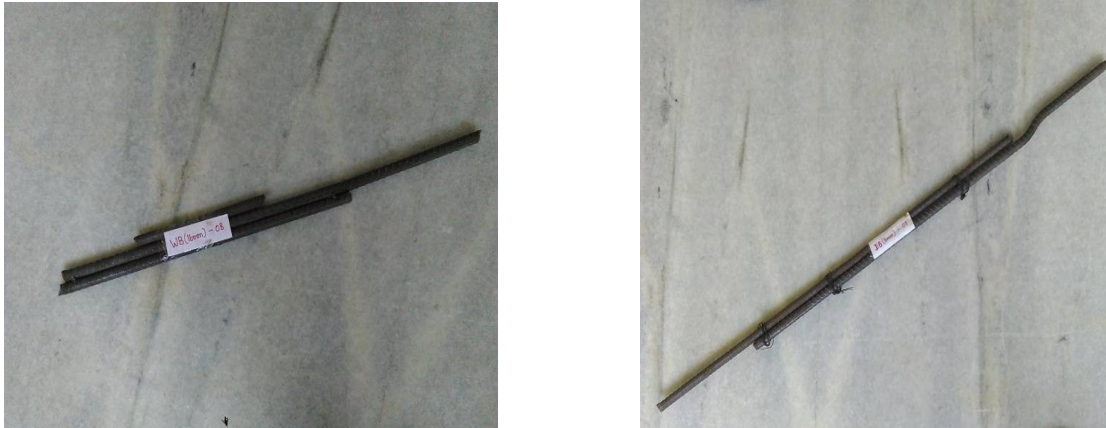


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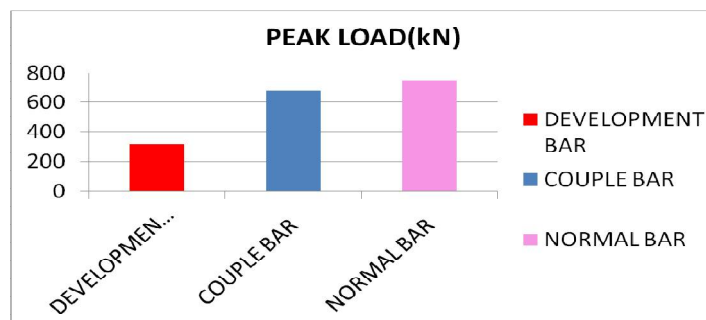


**Fig 5: Welded splices and development bar**

The above figures shows the failed specimen of mechanical coupler, welded splices and development bars after subjected to tension test by using UTM

## DISCUSSION:

The coupled bar, development bar and welded bars are subjected to pure tension by using UTM. The performance of coupled bar is good when compared to development bar and welded bar. From the different length of couplers (3D, 5D & 8D), where small length of coupler (3D) performed well due to less reduction in main bars. The strength of different couplers are shown below,



**Fig 6 - Load comparison graph**

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## V. ECONOMICAL SURVEYING

Method of lap splicing requires more steel. Therefore, the wastage of cost and more wastage of reinforcement bars may occur. In order to avoid this problem, mechanical couplers are used. Solving this problem economic surveying is needed.

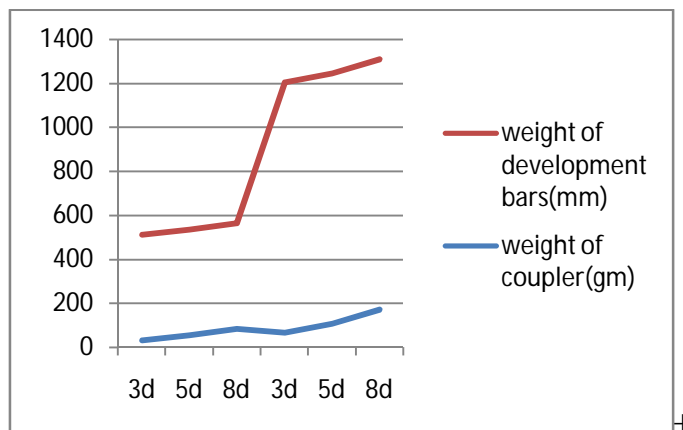
**Development bars:** 45D (for less than 20mm dia bar) and 50D (for more than 20mm dia bars) as per provisions  
**& Coupler length:** 3D, 5D & 8D (Decided value)

**Table 6.1: ECONOMIC SURVEY REPORT**

Specimen id	Dia of bar (mm)	Length of coupler(mm)	Weight of coupler(gm)	Weight of development bar(gm)	Quantity of steel saved(gm)
MC-04	12	36	33	480	447
MC-05	12	60	56	480	424
MC-06	12	96	84	480	396
MC-01	16	48	66	1140	1074
MC-02	16	80	107	1140	1033
MC-03	16	128	170	1140	970

Table 6.1 shows the economical survey report for both developed bars and mechanical couplers. This study proves the use of mechanical couplers in reinforcement to reduce the large amount of steel and increases the structural performance like continuity of load path and high load carrying capacity when compared to the developed bars.

The graphical representation of economic survey is shown below,



**Fig 7 – Weight comparison of mechanical coupler and development bars**

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## VI. CONCLUSION

The three different couplers are subjected to tension test. The 3d coupler gave good result when compared to 5d and 8d coupler. Therefore mechanical couplers are used instead of providing development length in the reinforcing bar may achieve continuity of load path, to save amount of steel reinforcement and also save the cost of construction.

## REFERENCES

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