

# Flexural Strength of Reinforced Concrete Beam with Coupled Rebars

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## Abstract

For concrete construction, one problem that a constructor often encounters is that there is a large amount of fraction of reinforcing steel caused by cutting. This study shows a method of reducing waste from the cutting. The reinforcing steel used in concrete is virtually 100% recycled from other metal products. More than 7 million tons of scrap steel is recycled into reinforcing bars every year, virtually the entire feedstock. This recycling avoids massive energy expenditure - one ton of steel reinforcing bars would otherwise require about 2,500 pounds of ore, 1,400 pounds of coal, and 120 pounds of limestone. The steel industry believes that sustainable development must meet the needs of the present without compromising the ability of future generations to meet their own needs. Within this, a green economy delivers prosperity for all nations, wealthy and poor alike, while preserving and enhancing the planet's resources. The main objective of this study is to experimentally investigate the flexural behavior of RC beam containing coupler rebars and welded rebar and the experimental parameter is grade of concrete. Coupler and welding methods are used in this study to find which method will give more strength between both. Experimental results revealed that the coupler beam gives more strength than the welded beam but not more than the control beam specimen for 7 days and 14 days and 28 days. From the above observation it is suggested that we can use couplers in the rebar joining than the welding of rebar which gives better strength and also avoids congestion.

**Keywords:** Feed Stock, Flexural behavior, Coupler rebars

## I. INTRODUCTION

Steel has been a popularly used structural building material since the early twentieth century. Since then, it has changed the construction industry; bringing remarkable architectural designs to life. For over one hundred years steel has provided many benefits to the design and construction industry. Half of the world's steel is now produced in electric plants that generate zero CO<sub>2</sub> emissions. Steel is a highly recyclable material and is made of around 90% recycled content. The material can also be recycled over and over again and has a reclaimed rate of 98% (AISC, 2010) In order to use steel more sustainably, architects and engineers have looked to introduce steel to the prefabricated (prefab) building industry By doing so, it is possible to harness the benefits of both steel design and prefab construction, while the two cooperatively eliminate traditional inadequate aspects. Conventional prefabricated construction is cost effective, especially residentially, saving up to 15% compared to onsite construction. However sustainable the material may be, there are still some deficiencies with on-site steel construction Using a steel frame in prefab construction allows for a quick and easy installation just as traditional prefab does. The installation process is even further enhanced because there is an abundance of contractors familiar with steel work FCP Structures has patented their Connect Rite technique that establishes a moment resisting, bi-directional frame using only bolts (Connect Rite, 2009). This ensures that their product is reliable and can be assembled with ease onsite.

The role of steel is not limited to its structural components as prefabricated exterior wall and roof panels are being manufactured with steel. The steel not only offers a higher strength to weight ratio, but also contributes to the durability of the walls and roof.

### A. Coupler

Coupled rebar performs like continuous reinforcement. Splicing develops strength mechanically, independent of concrete. Therefore provides ductility in RCC structures independent of condition of concrete. Proven cyclic performance of coupled rebar offers strength during man-made, seismic or other natural events. The continuity of coupled rebar offers excellent provision for grounding electrical current. Coupler reduces rebar congestion and improves concrete flow & consolidation. It offers greater flexibility in design options. The simplicity in detailing of reinforcement, particularly in reinforcement congestion zones

minimizes the reinforcement fixing errors, detailing and fixing of seismic reinforcement becomes effortless. Workability with higher steel-to-concrete ratio allows optimum sizing of RCC structural members.

Table – 1

TECHNICAL SPECIFICATIONS								
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Coupler Dimensions								
Bar Diameter (mm)		16	20	25	28	32	40	50
External Diameter	<i>d</i>	25	32	40	45	48	60	80
Coupler Length	<i>L</i>	45	52	65	72	80	95	126
Thread Pitch		2.5	2.5	2.5	3.0	3.0	3.0	3.5
Weight (Kg)		0.09	0.20	0.31	0.51	1.02	1.21	2.94

## II. STUDY METHODOLOGY

**Aim of Investigation** The aim of the investigation is the concrete cube specimen were tested for 7 days, 14 days and 28 days and also the concrete beam specimen with control beam , coupled rebar beam and welded rebar beam are tested for 7 days, 14 days and 28 days. The effects of the coupled rebar and the welded rebar in concrete cubes and beams are evaluated through the following tests

They are Slump Cone test, Flexural strength test, Compressive strength test, Mix design using M30 Were conducted.

### A. Material Collection

The collecting Materials are Portland Cement, Aggregates and Coupler rebars. These may be broken brick or crushed air cooled blast furnace slag.

### B. Materials Investigation

The Bureau of Indian Standards (BIS) has classified OPC in three different grades The classification is mainly based on the compressive strength of cement-sand mortar cubes of face area 50 cm<sup>2</sup> composed of 1 part of cement to 3 parts of standard sand by weight with a water-cement ratio arrived at by a specified procedure. The grades are (i) 33 grade (ii) 43 grade (iii) 53 grade. The specific gravity of cement was tested according to IS 455:1980[10]

#### 1) Grading Of Fine Aggregate and Coarse Aggregate

Table - 2

Grading of fine aggregate and coarse aggregate

Fine Aggregate		Coarse Aggregate	
Sieve size	% of passing	Sieve size	% of passing
4.75mm	100	19mm	100
2.36mm	90	12.7mm	78
1.18mm	50	9.5mm	31
600 micron	25	4.75mm	0
300 micron	7		
150 micron	2		
pan	0		
Specific Gravity: 2.650		Specific Gravity: 2.610	

### C. Chemical Analysis

The chemical composition of steel is of great importance since it determines the potential mechanical properties of the finished steel product and controls the degree of corrosion resistance and weld- ability of the material For instance a specification which states that the percentage of silicon is to be within the range 0.15/0.30 tells the steel producer that killed steel is required, whereas if the percentage of silicon is specified to be 0.30 maximum, the steel producer is informed that the steel may be semi-killed or killed at his option.

#### 1) Mechanical Properties of Steel

Table - 3  
Mechanical Properties of Steel

Quality Structural Type	Tensile Strength		Yield		Elongation	
	Thickness (mm)	Minimum 2 (N/mm)	Range	Stress 2 (N/mm)	Minimum %	Range %
Fe 310-0	All Shapes	310	310-430	180	26	26-35
Fe 370-0	Upto 20	370	370-480	225	23	25-30
	Above 20	370		215	23	25-30
Fe 410-0	Upto 20	410	410-530	250	23	23-30
	20 to 40	410		240	23	23-28
	Above 40	410		230	23	23-28
Fe 540-HT Medium	Upto 16	540	540-620	350	20	20-25
	16 to 32	540	540-620	340	20	20-25
	32 to 63	510	510-600	330	20	20-25
	Above 63	490	490-580	280	20	20-25
Fe 570-HT	Upto 28	570	570-700	350	20	20-25
	28 to 45	570		340	20	
	45 to 63	570		320	20	
	Above 63	540		290	20	

O = Ordinary or Standard, HT = High Tensile

#### D. Casting of Specimens

Compressive strength and flexural strength of the concrete measured using 150mm x150mm x 150mm cubes and 150mm x150mm x 1000mm beams. All the cubes and beams were cast in three layers and each layer was fully compacted by using a needle vibrator for beam and a vibrating table for other specimen. Compressive strength of the cube was measured by compression testing machine (CTM) having a capacity of 2000KN at the age of 7 days, 14 days and 28 days.



Fig. 1: Testing of beam

#### E. Experimental Investigation

The Experimental Investigation done in Three methods They are Tensile Strength, Stress-Strain Curves, Slump cone test. The tensile tests were conducted on an electronic universal testing machine. A gauge with an effective range of 50 mm was attached to the most probable failure zone, i.e., where the severest corrosion was observed, on each corroded rebar.

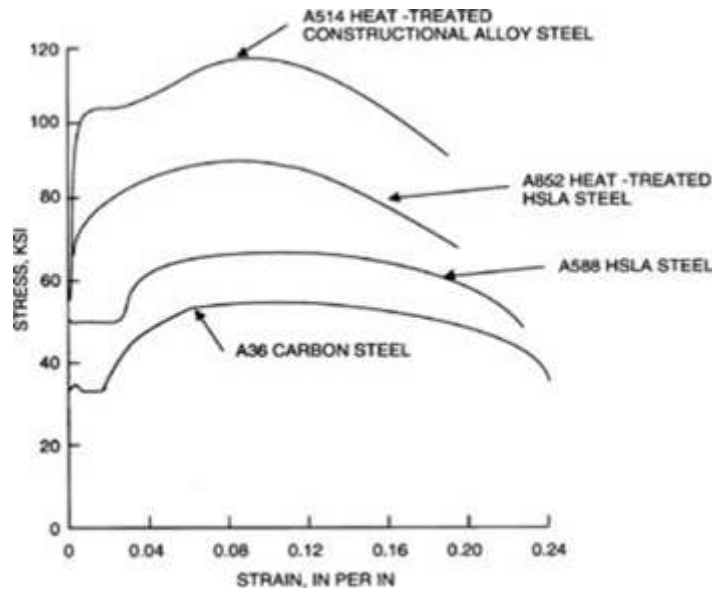


Fig. 2: Experimental Investigation

### III. EXPERIMENTAL RESULTS AND DISCUSSIONS

The objective of the study are as follows: (i) to evaluate the effective utilization of waste steel bar in the flexural behavior of concrete ,(ii) to evaluate the compressive strength of concrete with M30 mix design, (iii) to evaluate the flexural strength of concrete made with coupled rebar,(iv) to evaluate the flexural strength of concrete made with welded rebar.

#### A. Results of Flexural Strength Testing

Table - 4  
Results of Flexural Strength Testing

7	Control Beam	11.9	0.45	1.03
	Coupler Beam	11.2	1.35	
	Welded Beam	10.8	1.29	
14	Control Beam	15.3	0.58	1.31
	Coupler Beam	14.4	1.71	
	Welded Beam	13.9	1.66	
28	Control Beam	17.0	0.66	1.51
	Coupler Beam	16.0	1.99	

#### B. Results of Compressive Strength Testing

Table - 5  
Results of Compressive Strength Testing

Days	Ultimate Load (kN)	Ultimate Stress (N/mm <sup>2</sup> )	Average (N/mm <sup>2</sup> )
7	480	21.33	21.80
	492	21.86	
	500	22.22	
14	605	26.88	27.21
	610	27.11	
	622	27.64	
28	640	28.44	28.73
	645	28.66	
	655	29.11	

#### IV. CONCLUSION AND RESULTS

The observation and analysis made from the test conducted on concrete cubes and concrete beams with reinforcement rebar replaced with coupler rebar and welded rebar are given below

- 1) All the beams were prepared with reinforcement rebar in M 30 grade of concrete with 0.45 ratios with the rebar replaced with coupler and welding (or) splicing.
- 2) As per the experiment performed in the lab with coupler rebar beam, welded beam, and control specimen. The coupler beam gives more strength than the welded beam but not more than the control beam specimen for 7 days and 14 days and 28 days.
- 3) From the above result of beam we come to the conclusion that we can use couplers in the rebar joining than the welding of rebar which gives better strength and also avoids congestion.
- 4) Coupler offers quality, cost and time saving. Fixing couplers requires no special skills or equipments. Simple mechanical ways in adopting mechanical splicing compared to lapping, accelerates construction schedules for optimum cost and efficiency.
- 5) Coupled rebar performs like continuous reinforcement. Splicing develops strength mechanically, independent of concrete. The continuity of coupled rebar offers excellent provision for grounding electrical current.
- 6) Coupler reduces rebar congestion and improves concrete flow & consolidation. It offers greater flexibility in design options.

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