Experimental Study of Unconfined, Confined & Retrofitted Concrete Specimen

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Abstract

Traditional reinforcement methods in concrete have been accepted for many years as common practice. Recently confinement has become important for improving ductility & strength and for preventing shear failure. Now-a-days internal confinement & external confinement has been very popular for seismic up gradation of existing concrete specimens. The focus of this project is to compare the behavior of unconfined, confined and retrofitted concrete specimens using innovative materials.
Keyword- Unconfined, Confined & Retrofitted Concrete Specimen, CSM (Chopped Strand Mat)

I. INTRODUCTION

With the evolution of technology, construction industry has witnessed enormous advancement in the production of concrete and construction materials. Such materials have helped the community to produce structures that consume less energy, environmental friendly, have less carbon foot print and are more durable with longer life expectancy. However, old buildings that didn't follow the latest technology are no longer considered to have the previous qualities. In addition, they are no longer considered safe due to the deterioration of the concrete, steel or both. As a result, researchers continued to investigate different types of materials that can best strengthen and rehabilitate aging concrete structures and render them safe. The main focus of our study is to enhance the load carrying capacity and ductility of the concrete specimens by means of providing confinement and applying the various retrofitting techniques.

Lateral reinforcement used to provide shear strength, concrete confinement, and support to longitudinal steel reinforcement. The efficiency of the confinement generally depends on the shape and spacing of the confinement steel. Spirals are usually used in circular columns, while rectilinear stirrups, with or without cross ties, are generally used in rectangular columns. It has been recognized that rectilinear stirrups are less effective for concrete confinement because of the uneven distribution of the lateral confining stress.

A. Aim

An Experimental study of unconfined, confined & retrofitted concrete specimen.

B. Objective

To achieve the optimum strength at minimum cost by using the alternate arrangement of reinforcement
To strengthen the damaged specimen using innovative technique/material.
To study the behaviour of specimen after application of innovative technique/material.
To compare the different parameters by means of obtained charts and graphs.

II. EXPERIMENTAL PROGRAMME

A. Phase 1

- According to the feasibility of experimental set-up and laboratory conditions, we have adopted the size of the concrete specimen as 150 x 150 x 700 mm.
- First of all, casting of approximately 6 numbers of specimens was carried out and was kept for the curing period of 28 days.
- Concrete grade of M20 and water-cement ratio of 0.45-0.55 was adopted. Total 03 numbers of specimens were casted using normal design and remaining 03 numbers were constructed using links as reinforcement.
- Application of load has undertaken with the help of Universal Testing Machine (UTM) to damage the specimen.
- After identification of damaged zones in a specimen, detailed assessment of the in-situ quality of the material has done.
- Strength comparison has been done between both the sets of concrete having normal design reinforcement and links as a reinforcement.

Details of concrete specimen

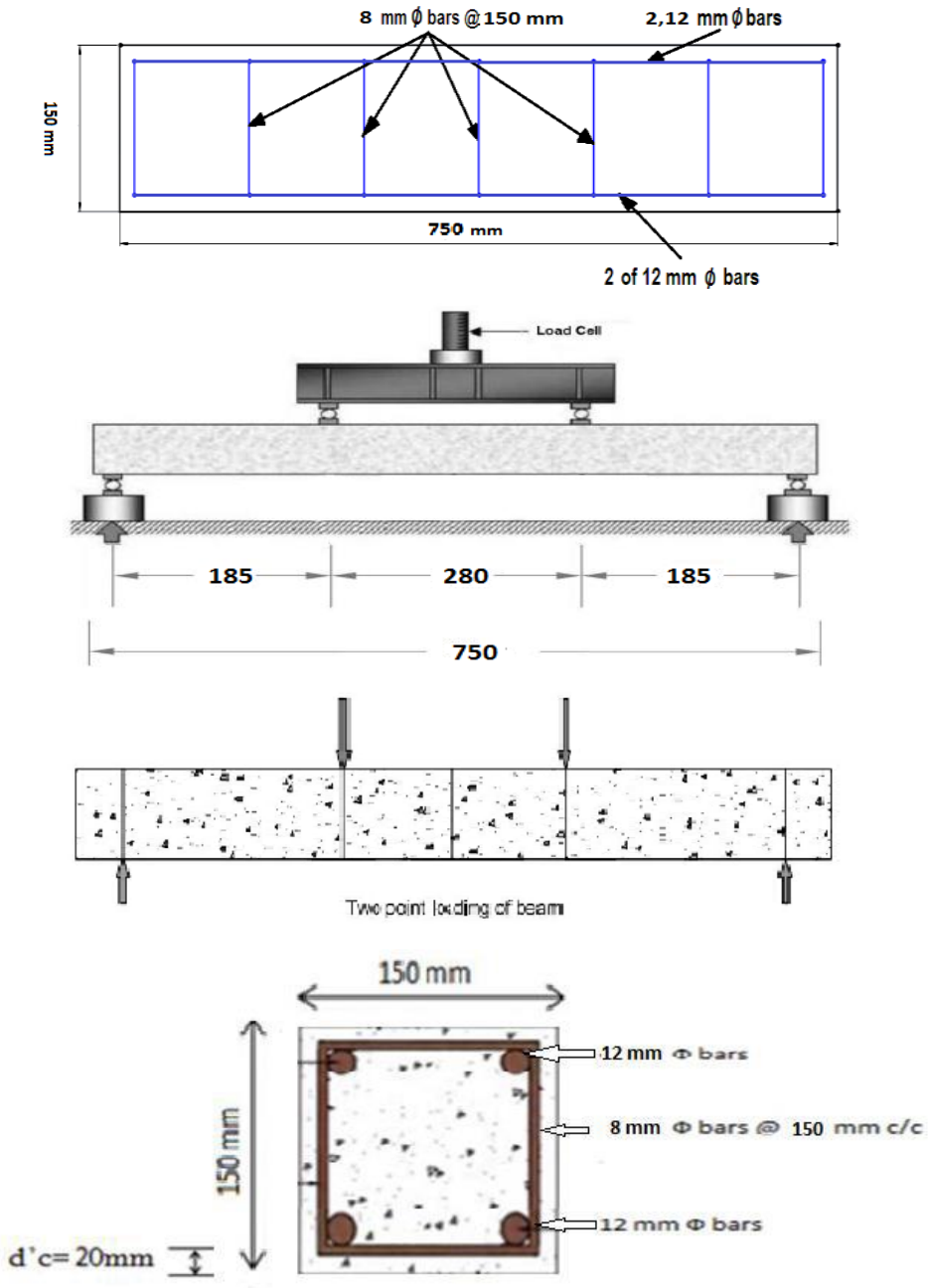

Fig. 1: Details of concrete specimen

B. Casting

- Casting consists of lying of concrete made from proper proportion of cement, sand and aggregate with required water cement ratio. Casting itself has its proper sequence which is to be followed.
- Casting can be done either by hand mixing or by concrete mixture machine. Mostly batching plant is used when mass concreting work is involved. In such cases, special type of RMC (Ready Mix Concrete) vehicle is needed.
- In our experimental work, casting was of two types.

1) Casting of Parent Specimen

1) Step-1: First of all, Oil was also applied on inner faces of moulds so set concrete can be easily removed without damaging the specimen
2) Step-2: Reinforcement cage was placed in mould by providing 25mm covering on bottom and side face. Two types of reinforcement cages were prepared
   1) Using conventional stirrups arrangement
   2) Using the alternate arrangement of links(wastage of reinforcement on the site) as shown in figure.

3) Step -3: Mixing of cement, sand and aggregate was done in the proportion of 1:1.5:3 with water cement ratio as 0.55 in concrete mixture machine.
4) Step-4: Concrete was poured in the mould in layers and properly compacted

2) Phase 2

- In this phase, concrete specimens have been casted using Innovative technique to compare the quality of concrete with reference to normal RCC specimens.
- In this phase helical reinforcement has been provided in central zone(L/3) of R.C.C beam to check its strength.
- Strength of all specimens and simultaneously test results have been compared.

3) Phase 3

In this Phase, appropriate retrofitting techniques have been applied to concrete specimens as described below.

1) Step 1: -First of all, cutting of CSM(Chopped Strand Mat) sheet has been done according to the dimensions of R.C.C specimen. And this sheet has been placed properly over the R.C.C specimen

2) Step 2: - Mixing of Cobalt accelerator and MEKP (Methyl Ethyl Ketone Peroxide) hardener has been carried out.
3) Step 3: - Application of above mixture has been done over the surface of R.C.C specimen over which the CSM mat has been already placed.

4) Step 4: - Air bubble has been removed from the retrofitted surface.
5) Step 5: - The retrofitted specimen were kept at room temperature for the period of 6 to 8 hours for drying purpose.

Sr no.	*Description*	*Double Wrap(CSM)*	*Total No*
1.	*6-Control Beam(Unconfined)* *3-Stirrups* *3-Alternate link*	-	*6*
2.	*3-Confined*	-	*3*
3.	*Two side wrap* *Bottom Side* *U-wrap*	*2* *2* *2*	*6*

Table 1: No. of Sets Specimen

III. RESULTS AND DISCUSSION

- Phase 1: -The flexural strength of concrete beam using alternate arrangement of links is very near to the flexural strength of a beam having stirrups.
- Phase 2: -By providing helical reinforcement in a central region of a beam length, the value of flexural strength is not achieved more compare to traditional arrangement of reinforcement.
- Phase 3: -The flexural strength of retrofitted concrete specimen has been observed as follows: -

1) With two side wrapping of CSM mat there is -9.94% increase/decrease in flexural strength compared to original strength of specimen.
2) With bottom side wrapping of CSM mat there is 14.74% increase in flexural strength compared to original strength of specimen.
3) With U-wrapping of CSM mat there is 20.48% increase in flexural strength compared to original strength of specimen.

Sr No	*Type of reinforcement*	*Specimen*	*Load in kN*	*Average load in kN*
1	*Alternate link*	*Rectangular(150X700 mm)*	*119*	*114.33*
2	*Alternate link*	*Rectangular (150X700 mm)*	*108*	
3	*Alternate link*	*Rectangular (150X700 mm)*	*116*	
4	*Stirrup*	*Rectangular 150X700 mm)*	*119*	*124.33*
5	*Stirrup*	*Rectangular (150X700 mm)*	*120*	
6	*Stirrup*	*Rectangular (150X700 mm)*	*134*	

Table 2: Result of Flexural Strength Test of Different Specimen

Description	*U-Wrap*	*Bottom Wrap*	*Two Side Wrap*
Strength before retrofitting	*114*	*125*	*124*
Strength after retrofitting	*137.36*	*143.43*	*111.67*
Increase in strength after retrofitting (%)	*20.48%*	*14.74%*	*-9.94%*

Table 3: Strength of Specimen Before and After Retrofitting

Description	*Percentage increase in Strength*	*Cost increase*
Bottom Wrap	*14.74%*	*733*
U-Wrap	*20.48%*	*2200*
Side Wrap	*-9.94*	*1466*

Table 4: Strength and Cost Comparison of Various Retrofitting Techniques

IV. CONCLUSION

1) As the value of flexural strength achieved with alternate link arrangement is good so the pieces of reinforcement bars which are considered as wastage on site can be used. So saving in material and cost can be achieved.
2) From the result it is observed that the flexural strength achieved with application of U-wrapping and bottom wrapping of CSM mat for retrofitting is more compare to original flexural strength of specimen

- Mostly the old structures all over the world are structurally poor due to older design codes. The replacement of deficient structural element required large amount of time and material compared to this strengthening of structural element by retrofitting will be more beneficial to improve their load carrying capacity and to increase their service lives at comparatively lower cost.

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