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Confinement of Recycled Aggregate Concrete (M-20) Using U-PVC Pipe

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Abstract*: *There is a issue of rusting and brittle failure in building structures so there is a need of more durable structure for better performance. The durability of the structure is affected by the choice of the construction material only .But here our main focus is not only to increase the durability but we are also aiming towards increasing the strength of the structure which can be achieved by the confinement of the column. Studies shows that by confining the column, its strength can be increased significantly. From durability point of view, we have carried out the complete replacement of the natural coarse aggregate with the recycled aggregate in order to know its properties and suitability as a replacement material and to promote the idea of sustainable development. In the present paper, an experimental study is presented regarding the load carrying capacity of the unplasticized poly vinyl chloride (U-PVC) confined columns subjected to axial compressive load. The cylinders that are used for this study are M20 grade concrete cylinders which are made using the recycled coarse aggregates. The cylinders are confined using the U-PVC pipes of 2.5mm & 3.5mm thickness and epoxy resin was used to increase the bond strength between the concrete cylinders & the U-PVC pipes. The cylinders that are used in this study are of length 300mm & diameter 150mm. The concrete used in study are designed as per the latest versions of Indian Standard Code of Practice and are prepared after running various trial mixes. A total of 9 specimens were casted for this study out of which 6 specimens were confined using U-PVC pipes while the other 3 specimens were unconfined. The specimens were subjected to gradual compressive load in universal testing machine (UTM) upto the failure and the results were recorded. The results indicated significant increase in the load carrying capacity of the confined columns as compared to the unconfined columns.

***Keywords* : U-PVC, Confinement, Compressive Strength, Recycled Aggregate, M20.**

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I. INTRODUCTION

Column is one of the important member of a structure, whose failure at any critical location can cause progressive collapse of the structure. (1)It is generally observed that the concrete structures that are exposed to the marine environment & saline environment are prone to the problem of surface deterioration as well as the corrosion of steel reinforcement. Several studies have been performed regarding this problem & it is found that confinement is one of the option to solve this problem. For the confinement of the column, different types of materials have been studied by the scholars like the (2)steel tubes, (3)ferrocement laminates, fiber reinforced polymer(FPR), shape memory alloy, etc. out of which steel tubes are widely used for the confinement of column in recent years. (4)Although the steel tubes that are used for the confinement have shown various types of good results, it has a severe problem regarding the low resistance to corrosion. (5)Hence to cope with this problem, an alternate confining material called as U-PVC have been used in our study for the confinement of the concrete column. It has various advantages like it is having high resistance to corrosion , it is cheap as compared to steel, it is light in weight as compared to steel & it is easily available in the market. (6)Apart from all these advantages it can act as the formwork jacket, it helps the column to resist the shear and local buckling and (7)to enhance their load capacity, ductility as well as energy absorbing capacity. It also helps in preventing the deterioration of the concrete surface due to external environment. (8)Apart from this, an attempt has been made to use recycled coarse aggregates as a replacement to natural coarse aggregates. As we know that concrete is the basic requirement of all the civil engineering structures and with all the countries aiming towards the rapid development, the use of the concrete will increase rapidly. The production of this concrete is not possible without the use of coarse aggregates and as we know that all the natural resources that are present on the earth are limited and so are the coarse aggregates. Therefore, we should try to use the recycled coarse aggregates instead of the natural coarse aggregates. This will not only reduce the usage of natural coarse aggregates but will also help in reducing the cost of concreting. The use of these recycled coarse aggregates will help in saving the cost of men, machine and power required from the process of extraction to the process of finishing of these natural coarse aggregates. The use of these recycled coarse aggregates will also promote the idea of sustainable development which is popular nowadays.

A. Benefits and Scope

- Improvement in resistance to corrosion and other environmental degradation.
- Improvement in strength
- Improvement in ductility
- Improvement in toughness
- Improvement in impact resistance
- Improvement in abrasion resistance
- Improvement in fatigue resistance
- Improvement in shear strength
- Availability of low cost structures to the poor people
- Less maintenance cost
- Long life of the structure

II. OBJECTIVES

To compare the load carrying capacity of the unconfined and the confined concrete cylinders made using the recycled coarse aggregates and by varying the thickness of pipe used for the confinement of the concrete cylinder.

III. EXPERIMENTAL METHODOLOGY

A. Flow Chart

Flow chart depicting the methodology

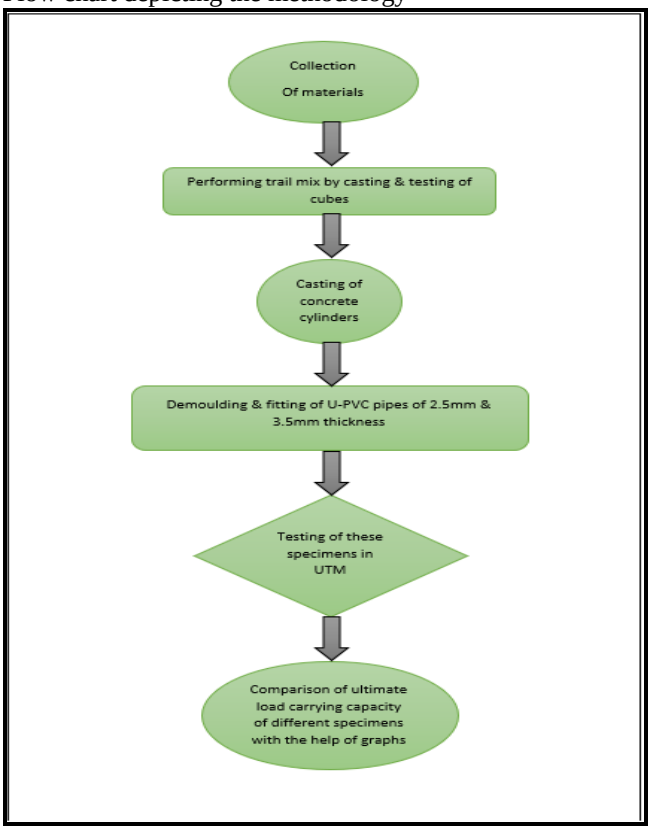

Fig. 1: Flow chart explaining methodology

B. Materials specification

1) Coarse Aggregate

For the preparation of the specimen the recycled coarse aggregates were taken from demolished building site located at Money Center, Footi Kothi Road, Gumasta Nagar, Scheme 71, Indore, Madhya Pradesh, India. The aggregates were having the water absorption of approximately 4% and size of aggregate that were taken or the study are the ones that passed through the 25mm IS sieve and were retained on 20mm IS sieve.

2) Fine Aggregate

Locally available Narmada river sand of size passing through 4.75mm IS sieve was used in the preparation of specimen.

3) Cement

Pozzolana Portland Cement (PPC) of grade 53 of Ultratech Brand was used.

4) U-PVC

U-PVC pipes of 2.5 and 3.5 mm thickness are used for this experiment. They are easily available and can help to withstand different environmental conditions.

Fig. 2: U-PVC Pipe of 2.5 and 3.5 mm thickness

5) Water

Normal tap water was used for making concrete mix.

6) Epoxy Rasin

Araldite Standard Epoxy Adhesive AW106 and Hardener HV 953 IN were used in this work.

C. Properties of Concrete

At first, three cubes were prepared as trial mix according to the nominal mix design ratio of 1:1:2 with complete replacement of coarse aggregate with recycled aggregate and they were tested after 28 days of curing. The result indicated that the strength attained by this mix is almost equal to the strength of M20 grade of concrete. On the basis of these results, the cylindrical concrete specimens were prepared with the ratio of 1:1:2

Fig. 3: Casting of Cube

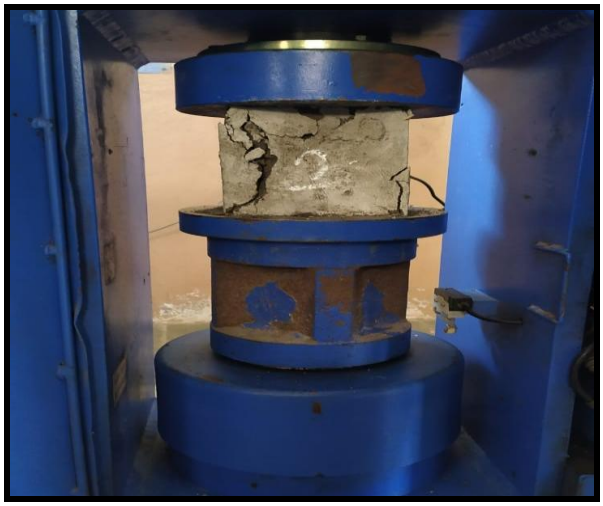

Fig. 4: Testing of Cube

D. Preparation of Column Specimens

A total of 9 cylindrical specimens were casted for this experiment. Cylindrical moulds of length 300mm and diameter 150mm were used for the casting of specimens. U-PVC pipe of thickness 2.5mm and 3.5mm were cut into length of 300mm. When the specimens were demoulded, 6 of them were confined with U-PVC pipe along with application of Epoxy Resin and cement slurry. The columns were covered with jute bags for curing. The specimens were cured every day after 24 hours.

Fig. 5: Casting of Cylinder

Fig. 6: Confinement of column using U-PVC Pipe

Fig. 7: Application of Cement Slurry

E. Nomenclature

For the identification of the specimens, a nomenclature system is adopted in order to differentiate the specimens. For this purpose, the confined cylindrical columns of grade M20 were named as **20/C/1**

Where number '20' represents the strength of the concrete column as 20 N/mm^2 and alphabet 'C' represents the confinement and numbers i.e., 1,2 and 3 represents the sample number.

Similarly, the terminology adopted for the unconfined sample was such as **20/U/1**

Where number '20' represents the strength of the concrete column as 20 N/mm^2 and alphabet 'U' represents the unconfinement and numbers i.e., 1,2 and 3 represents the sample number.

F. Test Study and Procedure

Surface grinding was performed with the help of the hand grinder at the top and bottom surface of the specimen in order to remove the surface imperfections and to maintain uniformity of loading on the surface. UTM with a capacity of 1000KN was used for the testing of the specimens. The specimens were subjected to axial compressive load. The columns were placed carefully at the center of the UTM in order to avoid eccentricity. The deflections were measured with the help of magnetic dial gauge. The readings of the load were taken at regular intervals. The load was applied until the failure of column.

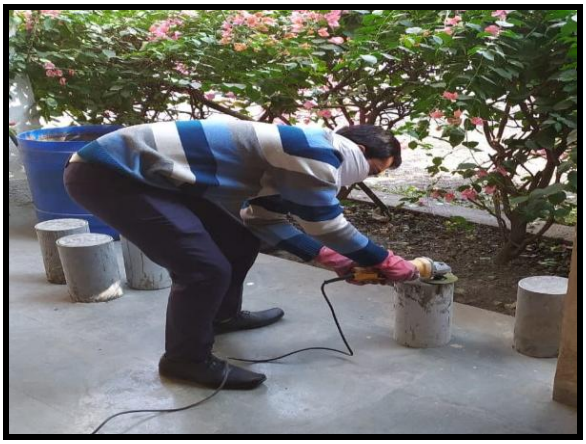

Fig. 8: Surface Grinding of Specimen

Fig. 9: Testing of Cylindrical Specimen

IV. RESULT

The confinement of concrete column using U-PVC pipe enhances the compressive strength of a column and shows a better performance in resisting load as compared to that of unconfined column as follows:

Table- I: Compressive Strength of Specimens

S.No.	U-PVC thickness(mm)	Samples	Ultimate Compressive Strength(KN)
1.	-	20/U/1	296
2.		20/U/2	342
3.		20/U/3	368
4.	2.5	20/C/1	388
5.		20/C/2	448
6.		20/C/3	482
7.	3.5	20/C/1	480
8.		20/C/2	554
9.		20/C/3	596

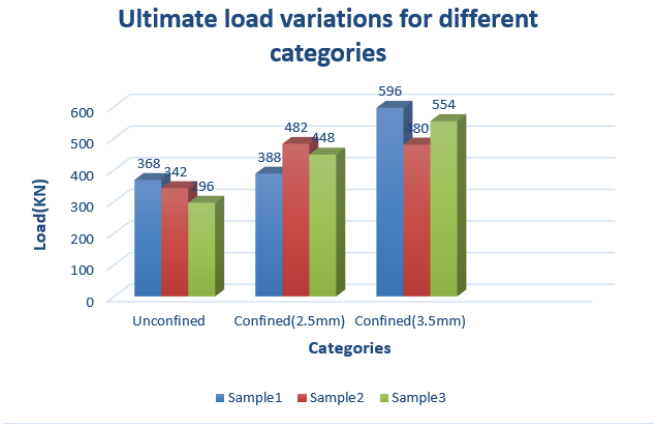

Fig. 10: Graph comparing ultimate load carrying capacity

V. FAILURE PATTERN

In this study some types of failure were recorded i.e., shear failure & drum failure. The shear failure was observed for the conventional concrete and the concrete columns confined with U-PVC pipe of thickness 2.5mm. In shear failure of U-PVC confined pipes the cracking of the pipe occurs with sudden explosive sound without any warning. The drum type failure was observed in U-PVC pipe of thickness 3.5mm. In drum type failure, the outward bulging of the specimen was recorded which happened mostly in the top and bottom part of the specimen because of crushing of concrete.

Fig. 11: Shear failure in Unconfined Specimen

Fig. 12: Shear failure in Confined Specimen of 2.5 mm Thickness

Fig. 13: Drum Type failure in Confined Specimen of 3.5 mm Thickness

VI. CONCLUSION

- Use of U-PVC pipe for confinement, results increase in compressive strength of the column.
- As the thickness of confinement increases, load carrying capacity of the column also increases.
- All the confined specimens that were tested, failed without any warning, so we can conclude that sudden failure occurred in all the confined specimens.
- After confinement with 2.5mm thick pipe, compressive strength increased by 31% as compared to unconfined specimens.
- After confinement with 3.5mm thick pipe, compressive strength increased by 62% as compared to unconfined specimens.
- Strength of the column is increased by 23% when the thickness of pipe used in confinement is increased from 2.5mm to 3.5mm.

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