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Application of CNC Waste with Recycled Aggregate in Concrete Mix

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ABSTRACT

In this Era of globalization when GDP of most of the countries are spending on an average 8% of the economy on infrastructure and when we see around us about the term infrastructure mostly we see the huge contribution of concrete in it; in addition to this three important terms are named as "Quality, Quantity and Economy".

There is a deadly race among the nations of various parts of the globe that each one is on the verge of attaining an economic aspect of having efficient quality that enhances our rapid and sustainable growth; but most importantly the construction should comprise of using waste product which are posing a greater threat to the environment.

When we look at the past many researchers during their research work have come across many benefits and barriers. In their research when the constituents of normal concrete were altered with the CNC waste (waste obtained by Computer Numeric Controlled Lathe Machine waste) and the Recycled aggregate as a substitute for the natural coarse aggregate then remarkable results were seen.

In this modern world when the unbelievable demand of steel is on its peak, this nature of blindly following the growth strategy not only leads toward urbanization but it heads towards a dumping ground of Industrial Waste as well. For harnessing this large quantity of steel the CNC Lathe Machines are used and due to their usage a large amount of waste is produced.

As the raw materials obtained from the demolition activity takes place such as, building roads, bridges and fly over, subway, remoulding cylinder and block etc. Dumping of raw material has become a problem for many countries. Construction industry in India generates around 10-20 million tonnes of waste annually. Recycled coarse aggregates are used to replace natural coarse aggregates as RCA are posing a greater threat for disposal. In addition to that when we think to make economical and eco-friendly concrete then use of RCA plays an important role.

The main aim for this project is to determine the strength characteristic of CNC waste with Recycled aggregates in concrete mix. The scope of this project is to determine and compare strength of concrete by using different percentage of CNC with recycled aggregates. several tests are performed on the different material like aggregate, sand, cement and recycled aggregate as per the IS specification.

The investigations were carried out using workability test, compressive strength test and bulk density, water absorption, impact value test, crushing value test, fineness modulus. There were total four batches of concrete mixes, consisting replacement of Natural coarse aggregates with 30%, 50% and 100% RCA in addition with 1% and 2% of CNC waste. Mix design is done with IS 10263-1999 (Revised) in which water cement ratio was taken as 0.5. For the strength of characteristics, the results showed that a gradual increase in the compressive strength up to 50% of recycled aggregate with 2% CNC waste.

Keywords - CNC, Lathe machine, Concrete mix, Recycled coarse aggregate, Natural aggregate, Compressive strength, Workability test, Impact value test, Crushing value test, Fineness modulus.

I. INTRODUCTION

1.1 Problem Description:

The Concrete Consist of Cement, Sand and Course and Fine Aggregate. Their proportion in the concrete is based on grade of concrete. Cement has two main functions, to fill voids between aggregate particles and water tightness and to give Strength to hardened concrete. The aggregate which comprises of 70 to 80 % of volume of concrete has three main functions are to provide a cheap filler, to provide a mass of particles for resisting the action of applied loads and to reduce the volume changes resulting from the settling and hardening process.

As the raw materials obtained from the demolition activity takes place such as, building roads, bridges and fly over, subway, remoulding cylinder and block etc. Dumping of raw material has become a problem for many countries. Construction industry in India generates around 10-20 million tonnes of waste annually. Recycled coarse aggregates are used to replace natural coarse aggregates as RCA are posing a greater threat for disposal. In addition to that when we think to make

economical and eco-friendly concrete then use of RCA plays an important role.

Recycling is the act of processing the used material for use in creating new product. The usage of natural aggregate is getting more intense with the advanced development in infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement material. Recycled aggregate comprised of crushed, graded inorganic particle processed from the materials that have been used in the construction and demolition wastes. These materials are from building, roads, bridges etc. [1]

To make concrete more economical and eco-friendly with a remarkable quality, application of Computer Numeric Controlled Lathe machine waste can have tremendous importance. By using this large amount of (according to ICI 1200 million tones annually) CNC waste can help to produce large quantity of eco-friendly concrete and reduces large amount of land pollution. As CNC waste is harmful in terms of environmental effects. It does not get decomposed and get corroded which is harmful for environment, so use of it to make concrete will be beneficial.

Use of RCA is good approach in concrete technology however it yields lower strength than NCA. In recent times various materials have been used in RCA concrete to improve its strength [3]. Here is another approach to improve the strength of RCA based concrete their by overcoming the drawbacks of RCA.

The main aim for this project is to determine the strength characteristic of CNC waste with Recycled aggregates in concrete mix. The scope of this project is to determine and compare strength of concrete by using different percentage of CNC with recycled aggregates. several tests are performed on the different material like aggregate ,sand, cement and recycled aggregate as per the IS specification. [2]

II. REVIEW ON PAST RESEARCH

By going through all the journals of Recycled Aggregate concrete the desired Strength could not be achieved by using only Recycled Aggregates so addition of CNC waste was introduced and remarkable results were obtained.

In various researches, various proportions of replacement of natural coarse aggregate with recycled coarse aggregate was carried out and it was seen that the results were enhanced when 30% and 50% replacement of natural coarse aggregate with recycled coarse aggregate was carried out and considerable desired results were obtained. [4] & [5].

III. MATERIAL SPECIFICATIONS

3.1 CNC lathe waste

To make concrete more economical and eco-friendly with a remarkable quality, application of Computer Numeric Controlled Lathe machine waste can have tremendous importance. By using this large amount of (according to ICI 1200 million tones annually) CNC waste can help to produce large quantity of eco-friendly concrete and reduces large amount of land pollution.

In this modern world when the unbelievable demand of steel is on its peak, this nature of blindly following the growth strategy not only leads toward urbanization but it heads towards a dumping ground of Industrial Waste as well. For harnessing this large quantity of steel the CNC Lathe Machines are used and due to their usage a large amount of waste is produced.

Fig No.: 1 Lathe Machine

Fig No.: 2 Lathe Waste

When we look at the past many researchers during their research work have come across many benefits and barriers. In their research when the constituents of normal concrete were altered with the CNC waste and the Recycled aggregate as a substitute for the natural coarse aggregate then remarkable results were seen.

3.2 RECYCLED CONCRETE AGGREGATE

The Recycled concrete aggregate (RCA) proved to be a good substitute for aggregate in the concrete production. In fact, the homogenous aggregate mixture is obtained from concrete construction, and it is not mixed with other materials .Therefore, RCA obtained from concrete wastes has proved even more effective than those prepared from debris materials. The RCA is grouped into two: fine and Coarse. the quality of the RCA, which has high capability to adhere (bond) with the cement paste, is closely related to the quality of the waste concrete.RCA specific gravity is lower and its water absorption rate value is higher than the natural aggregate . To use RCA in concrete, its water absorption needs to be known, and it has to be truly cleaned from other materials.

IV. MIX DESIGN

The mix proportion becomes
Cement- 383kg
Sand- 476.29kg/cum
Coarse aggregate- 1222.28kg/cum
Water- 191.60kg/cum

4.1 Mix Proportions-

Particulars	Water	Cement	Fine Aggregate	Coarse Aggregate
Ratio	0.50	1	1.24	3.19

4.2 MATERIAL REQUIREMENT PER M^3-

Particulars	Water	Cement	Fine Aggregate	Coarse Aggregate
Quantity	0.647 m^3	1.29 Kg	1.60Kg	4.125

4.3 Abbreviations-

MD: Mix Design with Natural Coarse Aggregate

MD30: Mix Design at 30% replacement of NCA with RCA

MD50: Mix Design at 50% of NCA with RCA

MD100: Mix of 100% replacement of NCA with RCA

CNC1: Concrete Mix with 1% CNC Lathe waste (by weight of concrete)

CNC2: Concrete Mix with 2% CNC Lathe waste (by weight of concrete)

W/C: Water cement ratio

CNC: Computer Numeric Controlled Lathe machine

RCA : Recycled concrete aggregate
RA : Recycled Aggregate
NA : Natural Aggregate
NCA : Natural Coarse Aggregate

V. TEST RESULTS

In these chapter results of compressive strength test is discussed and graphs are plotted according to the results. In this study MD represent concrete mix designation with natural aggregate where MD30, MD50 and MD100 represent 30%, 50% and 100% replacement of NCA by RCA.

VI. COMPRESSIVE STRENGTH TEST

To estimate the strength of concrete, compressive strength test on cubes of 15 cm is conducted. Concrete is made as per the mix proportion explained in the article 4.6. And mixing of the concrete, placing, compaction curing is being done as per the standard specification. For each result 3 cubes are casted. Then the tests on the cubes are performed after 7 days and 28 days. The test results for 7 days and 28 days compressive strength presented in table below. The dimensions are 150mmx150mmx150mm, and cross-sectional area is 22500mm². Calculation of average compressive strength with different percentage of CNC is shown.

Fig No: 3- Failure of Cube at Ultimate Load

Since MD50 gave the best results on lab-

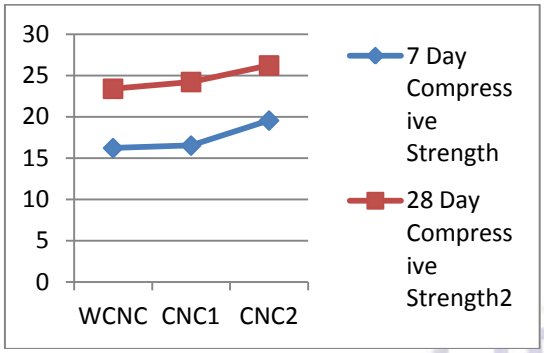
Test results of 7 day compressive strength test for MD50

Sr. No.	Percentage of CNC	Load in KN	Compressive Strength in N/mm^2	Average compressive Strength in N/mm^2
1	WCNC	290	12.89	13.33
2	WCNC	310	13.78	
3	WCNC	300	13.33	
4	CNC1	400	17.78	18.22
5	CNC1	410	18.22	
6	CNC1	420	18.67	
7	CNC2	440	19.56	18.82
8	CNC2	420	18.67	
9	CNC2	410	18.22	

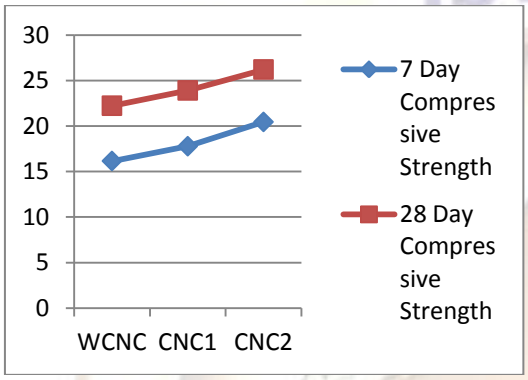
Test results of 28 day compressive strength test for MD50

Sr. No.	Percentage of CNC	Load in KN	Compressive Strength in N/mm^2	Average compressive Strength in N/mm^2
1	WCNC	710	31.55	31.10
2	WCNC	700	31.11	
3	WCNC	690	30.66	
4	CNC1	535	23.90	23.93
5	CNC1	540	24.00	
6	CNC1	535	23.90	
7	CNC2	585	26.20	26.20
8	CNC2	590	26.22	
9	CNC2	580	25.77	

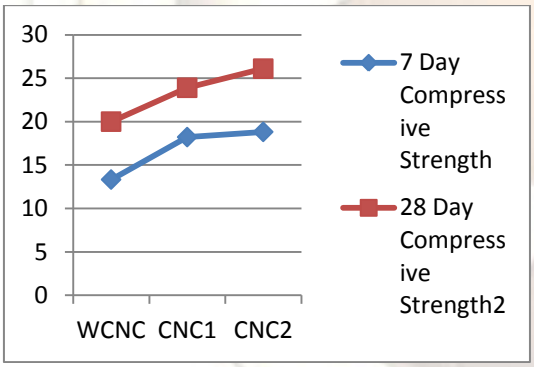
VI. RESULTS AND GRAPHS



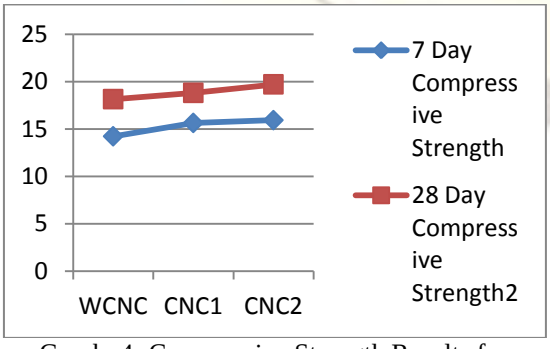
Graph: 1 Compressive Strength Results for MD



Graph: 2- Compressive Strength Results for MD30



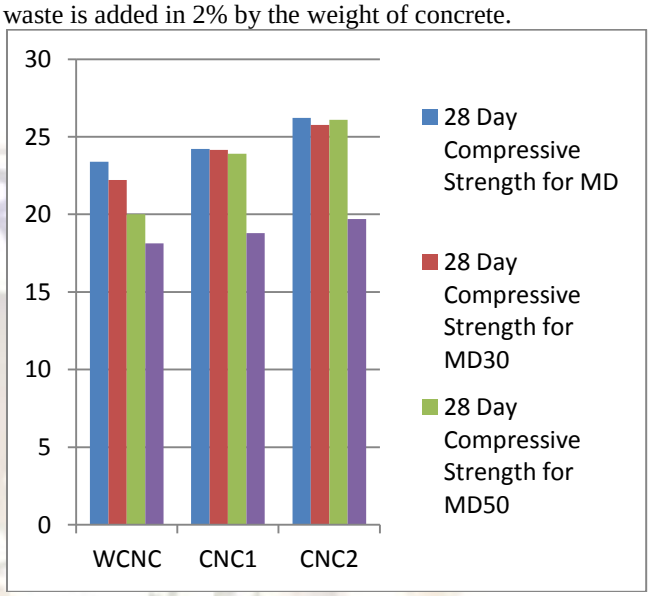
Graph: 3- Compressive Strength Results for MD50



Graph: 4- Compressive Strength Results for MD100

VII. DISCUSSION

The experiments study after casting 72 cubes with various pro done is Compressive strength shown in the above tables with water cement ratio 0.5. The results show that the concrete specimens have more compressive strength when 50% replacement is done with NCA by RCA. In addition to that highest results are shown when CNC waste is added in 2% by the weight of concrete.



Graph: 5- Comparative Study for Compressive Strength

VIII. CONCLUSION

The various experiments on the M20 concrete have been performed. From the experiments it was found that the addition of CNC2 and replacement of 50% NCA by RCA can be possible to get desired strength. It's a 'green' solution for anticipated world. From the various experiments and results the following conclusion were made.

1. It is found that up to 50% replacement of natural coarse aggregate by recycled coarse aggregate (in addition to 2% CNC lathe waste) increases the compressive strength. There was 11% increment in compressive strength.
2. Use of CNC lathe waste & Recycled Aggregates make concrete Economical and Eco-friendly as compare to Fly ash, Reinforced fibre, stone dust.
3. Natural resources are not unlimited. There is a global need to protect our environment and preserve our scarce natural resources for next generations.
4. These are economical to makes a large quantity of concrete with remarkable quality.
5. Use of the waste aggregate in the new concrete is beneficial as the recycled concrete aggregate reduces the environmental pollution as well as providing an economic value for the waste material.

IX. FUTURE SCOPE

1. It acts to be an Environmental savior. Due to lack of dumping sites in the present scenario, so there is need to save the land, this process leads as the savior of environment.
2. By various researches Percentage of CNC can be worked out with 100% replacement of NCA with RCA.
3. To produce and secure a system of sale based packed precast concrete batches, in which CNC waste and recycled coarse aggregate concrete will be present.

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