Comparative Analysis of Concrete Using Recycled Aggregate

Ali Mohd, Mohd. Asif, Vikas Kumar, Karunesh Bali, Faizan Hafeez Khan, Dr. Arvind Dewangan

Abstract— **The purpose of this paper is to expose to real work of environment experience and at the same time to gain knowledge through hands on observation and job execution. From the major project the students will also develop skills in work ethics, communication, management, others. Moreover this major project program allows students to relate theoretical knowledge with its application in the field.**
The objectives of this paper are:
To provide the opportunity to test their interest in a particular career before permanent commitments are made.
To develop skills in the application of theory of practical work situations

***Index Terms*— Recycled aggregates, Workability, Compressive Strength, RCA**
Sub Area : Construction Material Engineering
Broad Area : Civil Engineering

I. INTRODUCTION

The entire students from engineering colleges have to undergo the major project as a compulsory program before they graduate. These are the following scopes:

1. Gain knowledge and precious experience in the entire networking and programming failed which related to information technology course.
2. Learn to know the proper way and procedure to work as a team.
3. Understand the whole main operation of a specify firm from different angle and situation.

The main reason engineering students need to do major project is so they are well prepared for graduate job in their chosen field. It is a chance for you to put what you have learned at college to work in the kind of real life situation you will come up against when you start your career. Major project gives you great experience during your Bachelor of Engineering Degree. If you can demonstrate the ability to take responsibility, make sound decisions and apply technical skills you will stand out as someone that might be great for their organization.

This paper aims to evaluate the data collected from survey, 70% of the respondents have given the reasons for not adopting recycling of waste from Construction. Recycled aggregate is produced as a result of crushing, graded inorganic particles processed from the materials that have been used in the constructions. These materials resulted from destruction of buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes. The raw materials used in the production of recycled aggregates come from demolition of pavements and buildings. This material is broken into large pieces and transported to the processing plant. It must be clean, free of contaminants like steel reinforcing bars, wood and soil. Then it passes through three main phases crushing, sizing and blending.

The processes of recycling of construction and demolition wastes are similar to those producing natural aggregate both have the same equipments, crushers, screens, removal impurities and transportation facilities.

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II. LITERATURE REVIEW

According to the "International Journal of Engineering Trends and Technology" (IJETT) – Volume 13 Number 3 – Jul 2014, "Study of Recycled Concrete Aggregates"by Jitender Sharma and Sandeep Singla

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The journal describes the application of recycled aggregates in construction areas are wide. The applications are different from country to country and are as follows:

1. Aggregate Base Course: The untreated aggregates used as foundation for roadway pavement, it is the underlying layer which forms a structural foundation for paving.
2. Ready Mix Concrete: It is used for residential slab and foundation; walk and curb residential street; commercial slab and foundation and concrete paving per aggregate approval.

3. Pipe Bedding: Recycled concrete can serve as a stable bed or firm foundation in which to lay underground utilities.
4. Paving Blocks: Recycled aggregate have been used as paving blocks in some countries.
5. Building Blocks: Recycled aggregate has been used as building blocks.
6. Value engineering benefits: Produce specification sized recycled aggregates at own location. Avoid haul-off costs and landfill disposal fees. Eliminate the expense of aggregate material imports and exports. Increase project efficiency and improve job cost - recycled concrete aggregates yield more volume by weight (up to 15%).
7. Landscape Materials: Recycled concrete can be used in various landscape settings. Sized concrete rubble can serve as landscape feature. To date, recycled concrete aggregate has been used as boulder/stacked rock walls, underpass abutment structures, erosion structures, water features, retaining walls, etc.

III. METHODOLOGY

The properties of RCA determined by the study conducted are as follows:

1. Shape and Texture: RCA aggregates, both coarse and fine, tend to be very angular and rough due to the crushing of the virgin aggregate particles and the presence of cement paste that continues to cling to the surfaces of the aggregate.
2. Absorption Capacity: The amount of water that an aggregate can absorb is called absorption capacity. The porous nature of the cement paste portion of the recycled aggregates increases its absorption capacity. Limiting the use of recycled fine aggregate will also reduce the absorption capacity of the aggregate.
3. Specific Gravity: It is a measure of the density of an aggregate. The lower specific gravity of RCA is due to the crushed mortar present in and on the aggregate particles which makes it less dense than NA because of its porosity and entrained air structure.
4. L.A. Abrasion Mass Loss: The loss for RCA is usually higher than NA. In general, the greater the loss the softer the aggregate and the less suitable it is for concrete.
5. Chloride Content: There is concern that RCA with high chloride contents may affect the durability of the new concrete and the corrosion of steel in new concrete.

Comparison between NA & RCA Properties

Property	RCA	NA
Shape and Texture	Well rounded ,smooth to angular and rough	Angular with rough surface
Absorption Capacity	0.8-3.7 %	3.7-8.7 %
Specific Gravity	2.4-2.9	2.1-2.4
L. A. Abrasion Test Mass Loss	15-30%	20-45%
Chloride Content	0-1.2kg/m^3	0.6-7.1kg/m^3

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The conclusions made by the study are as follows:

1. When the water cement ratio used in recycled aggregate mix is reduced, tensile strength and modulus of elasticity are improved.
2. The RCA replaced mixes have greater water absorption and porosity than normal mix but within the permissible limits. These properties can be modified by reducing the w/c ratio.
3. The specific gravity, water absorption and Los Angelesabrasion clearly indicate that RCAs are of lower quality than NCAs as they contain mortar.
4. From past studies it is cleared that 10% extra water and 5% extra cement should be preferred to produce a rich mix by using RCAs.
5. Recycled aggregate materials produce harsh mixes with lower workability than NA.
6. New standards should be introduced for recycled aggregates so that these materials can be used successfully in future.
7. The 100% replacement of NA by RCA in concrete mixture may effect on chloride ions resistance, if proper design is not adopted.

According to "International Journal of Emerging Research in Management &Technology ISSN: 2278-9359 (Volume-6, Issue-5) on "Concrete Blocks using Recycled Aggregates" by Chandrashekar Kudupaje1, Dhananjay Kurunji, Akshatha Balakrishna, Madhu Kurunji, Arun Kumar Haniadka and Ravi Kumar BS.
This paper aims to evaluate the physical properties of concrete using RCA with 0%, 25%, 50%, 75% and 100% by weight of NCA in cement blocks.
Following are the conclusions drawn from the study:

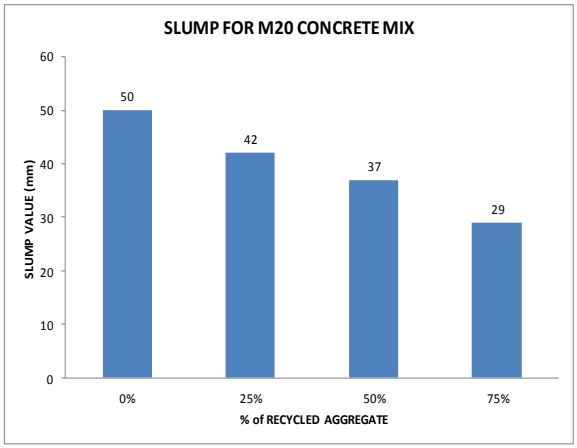
AIM:

- The aim of this investigation is to compare the basic properties of concrete (concrete made with natural aggregate) and the properties of concrete made with different proportions of recycled aggregate.
- To determine the sustainability, strength and other important properties of concrete made with recycled aggregate, so that recycled aggregate can be used as a substitute for natural aggregate.
- The main purpose of carrying out this investigation is to check the suitability of demolition wastes of concrete to be recycled and reused for construction purposes which may lead to the better economic growth.

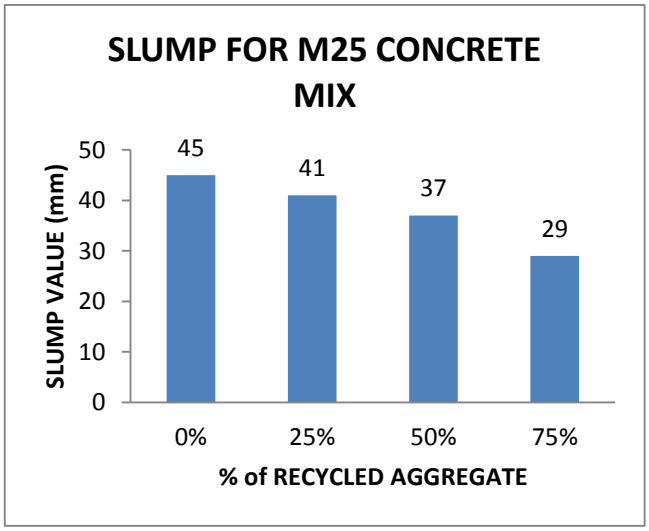
EFFECT ON WORKABILITY:

- It has been found that the increase in the ratio of the recycled aggregates in the concrete mix leads to a decrease in the workability of the concrete mix. The slump value has remained in acceptable range even when the percentage of recycled aggregate was increased up to 75% both in case of M20 and M25 concrete mix.
- The decrease in the workability with increase in recycled aggregates was observed, this phenomenon isdue to the porous surface of recycled aggregate which leads to increased absorption of water by aggregates leading to decrease in workability of concrete mix.

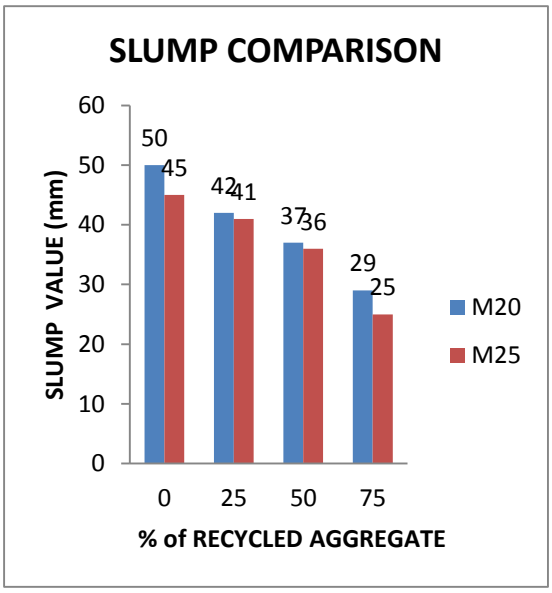
Note:- The workability of a concrete mix can be increased by supplementing the mix withsuitable admixture preferably a plasticizer or by simply adding more water to it.



Graph -1



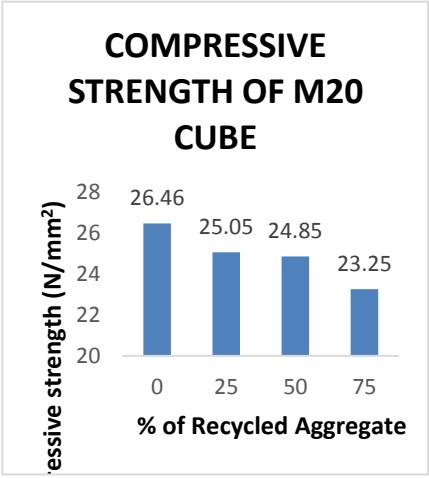
Graph 2



Graph 3

EFFECT ON COMPRESSIVE STRENGTH:

- The compressive strength of concrete mix was decreased as the percentage of recycled aggregate was increased. But the decrease in the compressive strength was not significant upto the replacement of 25% and the rate of change of strength is almost negligible for replacements of aggregates between 25% and 50%. Therefore a suitable value for replacement can be adopted between 25% and 50% after considering safety and economical factors.
- The recycled aggregates are subjected to fatigue stress during their life span and hence suffer a decline in their overall strength. However, due to high porosity of recycled aggregates, water-cement ratio will increase and will lead to decrease in compressive strength and which in turn will make it more prone to the ingression of certain agents that limits its application for RCC and acid resistant concrete works. Since, these are cost effective and promote resource conservation therefore, should certainly be promoted for construction practices.



Graph 4

COST EFFECTIVENESS OF CONCRETE USINGRECYCLED AGGREGATE

Cost analysis is a primary component of any constructional project. The one of the basic pillar of every civil engineering is project is its economy.

The project should be economical viable. The material used in project should be economically viable.

The relative cost analysis of recycled aggregate with natural aggregate for $1m^3$ is done below:

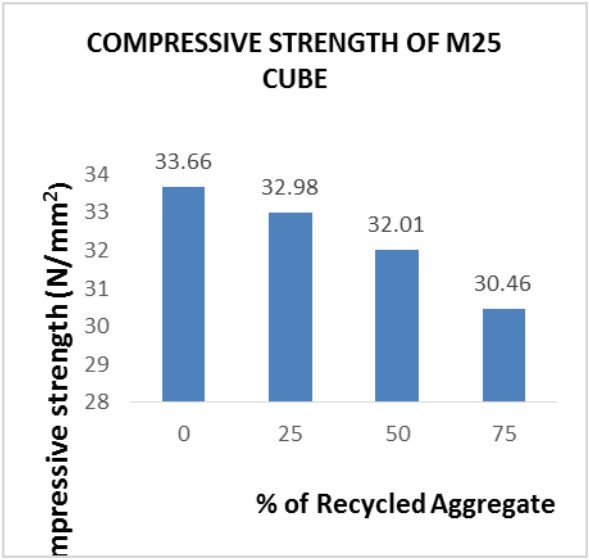
Cost of $1m^3$ Quantity of Natural Aggregate = Rs.740

Cost of $1m^3$ Quantity Recycled Aggregate = Rs.560

Difference in cost of Natural aggregate and Recycled aggregate for $1m^3$ = Rs.180

Therefore the percentage decrease in the cost is 22.32% which is approximately equal to 23 to 25% according to the topography and market value of location.

Note: The cost analysis has been done according to the current price of aggregate in the month of March 2018 in Jammu, J&K (INDIA). The cost may vary from place to place.



Graph 5

APPLICATION FOR CONSTRUCTION PURPOSES

Recycled aggregates can replace virgin aggregates for almost every constructional purpose. In our test programme, nominal strength for M20 and M25 grades was achieved for up to 75% replacement of virgin aggregates by recycled aggregates. Considering some hypothetical factor of safety for constructional purposes replacement of aggregates up to 50% can be adopted for beams, columns, foundations and slabs while, on the other hand, for mass concreting works replacement of NA by RA up to 75% can be adopted without compromising with its strength.

CONCLUSION

The scope of this investigation included an examination of the main factors of RA that influence the compressive strength of concrete. The main conclusions that can be drawn from this study are given below:

- As the quantity of recycled aggregates increases, there is a decrease in compressive strength, the extent of which mainly depends on the RCA's type, size and origin.

- The recycled aggregate are found to be very resilient and useful in various situation. Their properties are almost similar to virgin aggregate.
- If the aggregates are properly selected, separated and graded from a good source will have more superior qualities. In near future, RCA will become backbone of construction industry and may come up as reliable and cheap construction material.
- The basic test results of both NCA and RCA satisfies the IS specifications. The specific gravity of RCA is lower and water absorption is greater than natural aggregate.
- The recycled aggregate is relatively weaker than the natural aggregate against mechanical actions but satisfies the IS requirements.
- The slump value of the mix was decreased with the increase in the percentage of RCA.
- For cement solid block, up to 50% RCA replacement to NCA there is no much effect on compressive strength i.e., the design strength was achieved.
- Density of cement block decreases with increasing in RCA percentage.
- From this investigation it can be concluded that 25%RCA block having more strength than conventional, but 50% RCA block strength also acceptable.

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