



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

# Characterization of Pervious Concrete Using Recycled Aggregates and Fly Ash

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**ABSTRACT:** The construction industry is responsible for large volumes of raw material extraction for cement manufacturing, and also disposes of construction and demolition wastes (CDW) in landfills. The pervious concrete is considered a sustainable alternative for pavement, since its main characteristic is to permeate the water, allowing its reuse. In this sense, for an adequate use it is necessary to optimize its properties in its dimensioning and maintenance to avoid the clogging of its voids. In this way, the main purpose of this research was to analyze the use of recycled aggregates (RA) from construction and demolition waste and fly ash in pervious concrete. This investigational study aims to examine the influence of using recycled coarse aggregate (RCA) instead of natural coarse aggregate (NCA) on the fresh properties (workability) and mechanical properties of pervious concrete (PC). The mechanical properties include compressive strength, splitting tensile strength and flexural strength and the impact resistance of PC was also assessed using drop weight test. Thus 30% of cement replacement by flyash were investigated, all with 100% RCA replaced the NCA in the preparation of PC mixes without using any fine aggregate and fixing the water-cement ratio (w/c) to 0.4. The outcomes of the study reveal that the content of the RCA has significant adverse effects on the workability and mechanical performance of the investigated mixtures.

**KEYWORDS:** Recycled Aggregates, Flyash, No-Fines, Compressive strength, Flexural Strength, Tensile Strength.

## I.INTRODUCTION

Pervious concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources that allows water from precipitation and other sources to pass through it, thereby reducing the runoff from a site and recharging ground water levels. The high porosity is attained by a highly interconnected void content. Typically pervious concrete has little to no fine aggregate and has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. Pervious Portland cement Concrete, or pervious concrete, was developed by the Florida Concrete Association and has seen the most widespread application in Florida and southern areas. Like pervious asphalt, pervious concrete is produced by substantially reducing the number of fines in the mix in order to establish voids for drainage. In northern and mid-Atlantic climates such as Pennsylvania, pervious concrete should always be underlain by a stone sub base designed for storm water management and should never be placed directly onto a soil sub base. Pervious concrete is an innovative building material with many environmental, economic, and structural advantages. The proper utilization of pervious concrete is a recognized Best Management Practice by the U.S. Environmental Protection Agency (EPA) for providing first-flush pollution control and storm water management. Property owners and developers can also reduce fees and enhance the bottom line by using pervious concrete, which commonly provides 20-40 years of service with little or no maintenance.

## II.MATERIALS

### 2.1 RECYCLED AGGREGATES

Construction materials are increasingly judged by their ecological characteristics. Concrete recycling gains importance because it protects natural resources and eliminates the need for disposal by using the readily available concrete as an aggregate source for new concrete or other applications. According to a 2004 FHWA study, 38 states recycle concrete as an aggregate base; 11 recycle it into new portland cement concrete. The states that do use recycled concrete aggregate (RCA) in new concrete report that concrete with RCA performs equal to concrete with natural aggregates. Most agencies specify using the material directly in the project that is being reconstructed.

Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a

material with a specified size and quality. See ACI 555 (2001) for more information on processing old concrete into recycled concrete aggregates. The quality of concrete with RCA is very dependent on the quality of the recycled material used. Reinforcing steel and other embedded items, if any, must be removed, and care must be taken to prevent contamination by other materials that can be troublesome, such as asphalt, soil and clay balls, chlorides, glass, gypsum board, sealants, paper, plaster, wood, and roofing material.

## 2.2 Cementitious materials

Cementitious materials are one of the principal ingredients that make up the concrete mixture.

There are two types of cementitious materials:

- Hydraulic cement and
- Supplementary cementitious materials (SCMs).

Hydraulic cements set and harden by reacting chemically with water. During the reaction, which is called hydration, heat is given off as the water-cement paste hardens and binds the aggregate particles together. Portland cement is the most common hydraulic cement.

SCMs are used in conjunction with portland cement in concrete mixtures to improve the workability of fresh concrete and reduce thermal cracking in massive structures by reducing heat of hydration.

- **Fly ash** is the waste byproduct of burning coal in electrical power plants; it used to be landfilled, but now a significant amount is used in cement. This material can be used to replace 5-65% of the Portland cement.

## III.MIX DESIGN

### ➤ Mix design

- Cement concrete mix 1:8
- Water-cement ratio 0.4 to 0.45
- Max. size of aggregates 20mm(Table 1)
- Type of Cement- OPC 53 grade
- Type of aggregates- Recycled concrete aggregates

## IV.CASTING OF SPECIMEN

### 4.1 Cube for Compressive Strength

The cubes of size 150mmx150mmx150mm were cast to find out the compressive strength of recycled pervious concrete. The fresh concrete mix was filled in mould in three equal layers and each layer is compacted using tamper rod. curing was done upto 14 and 28 days and testing is done in compressive testing machine of 100ton.

### 4.2 Cylinder for splitted sile strength test

The cylinders of 100mmx200mm are cast to find out the tensile strength of pervious concrete and also cylinders of size 150mmx300mm were also cast to see stress-strain relationship. The fresh concrete mix was filled in mould compacted using tamper rod. curing was done upto 14 and 28 days and testing is done in compressive testing machine of 100ton.



**V. TESTING PROCEDURE**

**Compressive Strength**

The Compressive Strength is the primary test to identify the strength of cube specimen. The test is done after 14 and 28 days.

**Split Tensile Strength**

The split tensile strength is an indirect test to measure tensile strength of concrete. The test is done after 14 and 28 days of curing.

**Flexural strength**

The test is done after 14 and 28 days of curing.

**VI. RESULTS AND DISCUSSION**

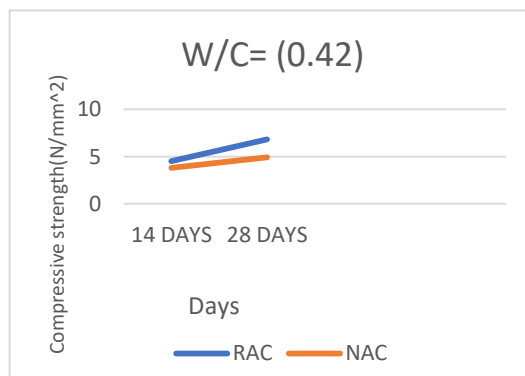
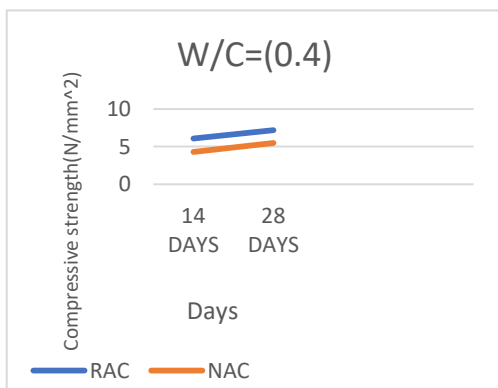
**6.1 Compressive strength:**

Demonstrating the 14<sup>th</sup> and 28<sup>th</sup> day Compressive strength values of different w/c ratio.

**6.1.1 Observation:**

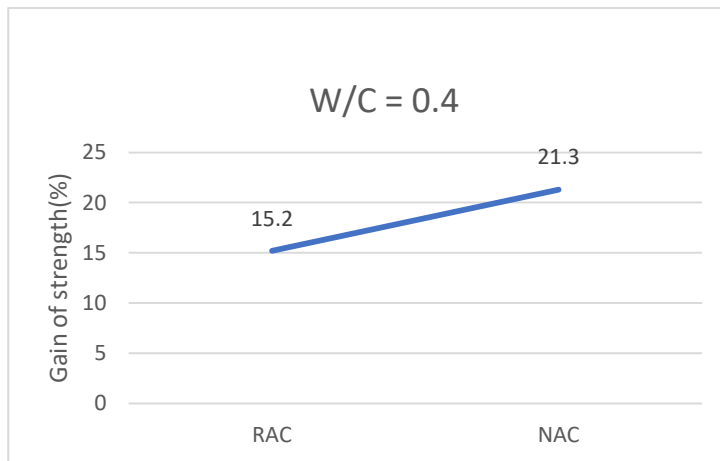
Specimen Type	Dimension(mm)	W/C	Compressive strength N/mm <sup>2</sup>	
			14 <sup>th</sup> day	28 <sup>th</sup> day
Natural aggregate concrete cube	150x150x150	0.4	4.3	5.5
		0.42	3.8	4.9
Treated Recycled aggregate concrete cube	150x150x150	0.4	6.1	7.2
		0.42	4.5	6.8

**6.1.2 Graphical representation:**





**6.1.3 Rate of gain of strength 14<sup>th</sup> day to 28<sup>th</sup> day**



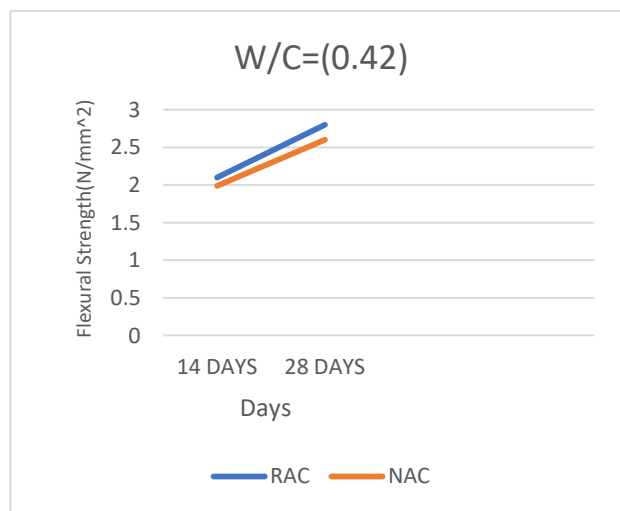
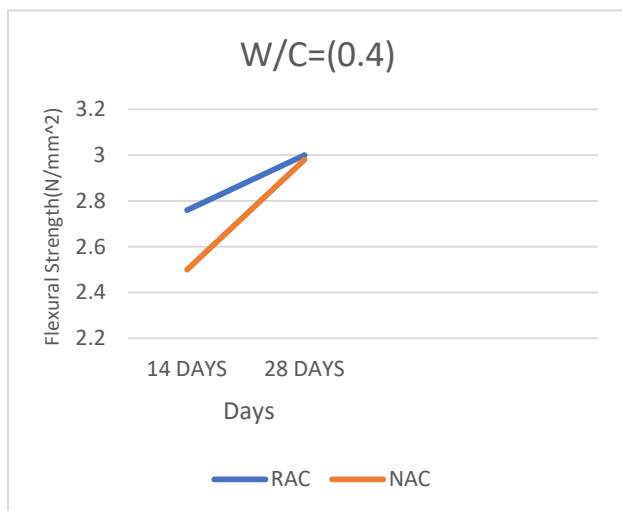
**6.2 Split tensile strength:**

Demonstrating the 14<sup>th</sup> and 28<sup>th</sup> day Split tensile strength values of different w/c ratio.

**6.2.1 Observation:**

Specimen Type	Dimension(mm)	W/C	Split tensile strength N/mm <sup>2</sup> 14 <sup>th</sup> day	Split tensile strength N/mm <sup>2</sup> 28 <sup>th</sup> day
Natural concrete aggregate cylinder	150(dia) & 300(ht)	0.4	1.35	1.7
		0.42	0.98	1.6
Recycled concrete aggregate cylinder	150(dia) & 300(ht)	0.4	1.4	1.8
		0.42	1.1	1.63

**6.2.2 Graphical representation:**







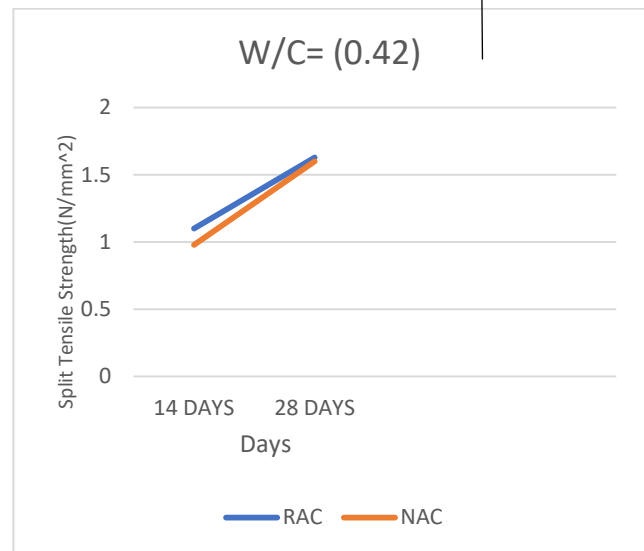
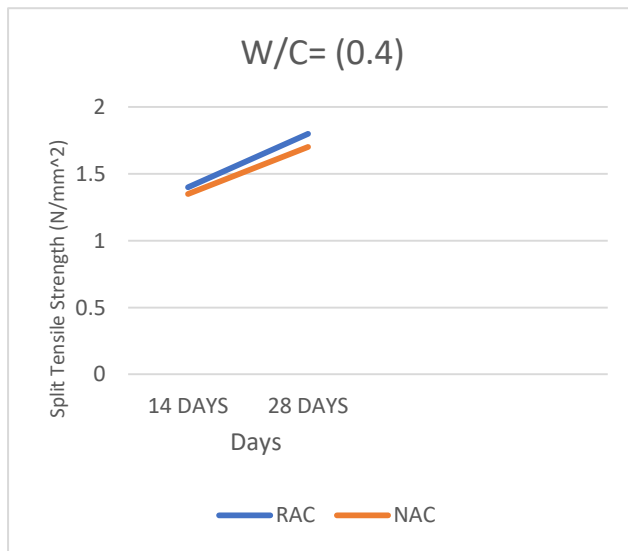
### 6.3 Flexural strength:

Demonstrating the 14<sup>th</sup> and 28<sup>th</sup> day flexural strength values of different w/c ratio.

#### 6.3.1 Observation:

Specimen Type	Dimension(mm)	W/C	Flexural strength N/mm <sup>2</sup>	
			28 <sup>th</sup> day	14 <sup>th</sup> day
Natural aggregate concrete Prism	100x100x700	0.4	2.5	2.98
		0.42	1.99	2.6
Treated Recycled concrete aggregate Prism	100x100x700	0.4	2.76	3.0
		0.42	2.1	2.8

#### 6.3.2 Graphical representation:



## VII. CONCLUSION

- The effect of w/c ratio has greater impact over the strength of no fine concrete. So with 0.4 w/c ratio we have obtained higher load carrying capacity by the concrete with Treated recycled aggregates.
- It is observed that influence of treated RA is not much on flexural and split tensile strength
- The rate of gain of strength in RAC is Found to be marginally higher. This helps in early removal of formworks and subjecting structure for desired usage.

## VIII. SCOPE OF FUTURE STUDY

- The replacement of cement by flyash can be varied at an interval of 5% from 30% to 50%.
- Cement could be totally replaced by flyash, as a result geopolymers porous concrete can be attempted.

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