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## Use Of Recycled Coarse Aggregate In Concrete

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**Abstract:** The components that act as skeletons in concrete are called aggregates. Concrete waste using RCA causes environmental problems. That solves and reduces potential problems. Many researchers say that recycled concrete aggregate (RCA) are the only ones suitable for application of non-structural concrete. Use of recycled concrete aggregates (RCA) in concrete as partial and full . There is growing interest in construction industry. Recycled concrete aggregate (RCA) construction helps builders reduce waste and increase the life of builders, as well as save disposal fees. It also reduces transportation costs because often concrete can be reused in area near demolition or construction site. Also recyclable coarse aggregates have been used to replace virgin coarse aggregate. The largest application of recycled concrete aggregate is for the overall base coarse of road construction.

**Keywords :** Recycled concrete aggregate, Concrete, Compaction factor, Slump, Ultrasonic pulse velocity, Compressive strength, Rebound hammer.

### 1. INTRODUCTION

Concrete is the most common material used in construction around the world. About a million ton of concrete debris is used as construction waste every year. Plenty of crushed concrete is currently available. Which is the result of the destruction of old structures and waste concrete from new structure . The amount of recycled concrete aggregate (RCA) is likely to be greatly reduced [1]. The load-bearing capacity of that sub-grade can be improved by incorporating recycled aggregates and lime. The process changes the water sensitivity of the subgrade, there \_by increasing stability. Construction and disposal (C&D) waste is a central component of solid waste flow which accounts for about 25% of total solid waste nationally [2]. The largest portion of C-D material prior to recycling, according to the U.S. EPA is concrete. Which includes about 70% of the C-D material produced. According to the construction and demolition recycling. Association, 140 million tons of concrete are recycled annually [2]. RILEM Technical Committee proposed 121 – DRG (1994) only 20% of that natural material can be replaced coarse aggregate recycled to make new concrete [3]. All strength classes are limited when 100% recycled construction waste is used [4,5].



Fig1: Recycled course aggregate

### 2. TESTING OF RECYCLED AGGREGATE

#### A. Particle size distribution:

The fine and coarse aggregates that are used with the materials used are mixed concrete in construction activities. Aggregate is a composite material that helps to bind concrete, as it adds strength and maintenance to the concrete. Sieve sizes range from 40mm to 4.75mm for coarse aggregates and 2.36mm to 75µm for fine aggregates [4]. It is important to mix both fine and coarse aggregates (IS 2863) in concrete because the coarse plain surface cannot coalesce in a way that fine aggregate (IS 383) works [4,12]. It is important to remember that the coarse

aggregate contribution to the surface area contributes much less than the fine aggregate [6,12]

Table-1

PHYSICAL PROPERTY OF FINE &amp; COARSE AGG

Aggregate	Fineness Modulus	Density (kg/m <sup>3</sup> )	Specific Gravity
Fine Agg.	2.79	1758	2.54
Coarse Agg	7.094	1806.82	2.86
Recycle C.A.	7.386	1660.54	2.76

### B. Slump Test

The slump test is used to determine fresh efficacy. The slump test of concrete is done to check the consistency or homogeneity of the concrete. The test shows the workability of concrete. The amount of slump must be within the prescribed limits. For concrete slump test, iron tubes or cylinders with handles on both sides are used. Its height is 30cm and the diameter of the lower edge is 20cm and gradually the diameter of the upper edge will be 10cm [6,7]. The concrete test is simple and inexpensive. The best place to use it is in the laboratory and on the site.



Fig2: Slump Test

### C. Compacting Factor Test

The test used to find out the compacting factor for a low workability concrete is known as the compacting factor test. The compacting factor test was also used to determine. The reason for the efficiency of fresh concrete is that it gives more accuracy. Efficiency of fresh concrete than slump test. The test is used to look for the performance of low-performance concrete. To determine the workability of freshly mixed concrete by compacting factor test.[6].

$$\text{Compacting Factor} = \frac{W_2 - W_1}{W_3 - W_1}$$

$W_1$  = Weight of cylinder.

$W_2$  = Weight of partial compacted concrete with cylinder.

$W_3$  = Weight of fully compacted concrete with cylinder.

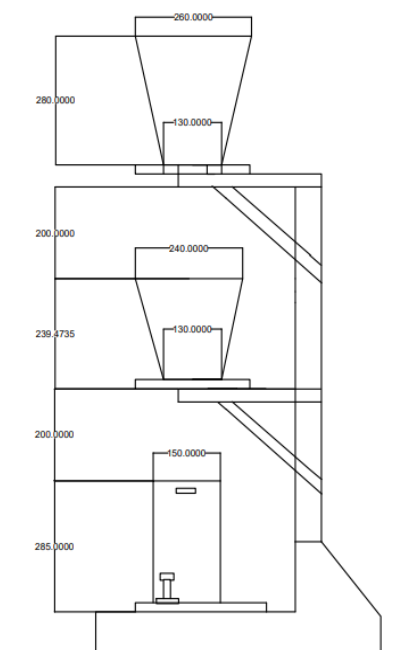


Fig3- Compacting factor test

There are three levels to a compacting factor test. Top hopper, lower hopper and cylinder. The concrete should be opened with a top hopper. As if all the concrete falls on the lower hopper. Then you have to open the trap door again so that the concrete falls into the cylinder. Measure the empty cylinder before starting the test [8,9].

Table-2

THE COMPACTING FACTOR RATIO FOR MIX CONCRETE (IS: 10262 -1982).

Percentage Of recycled aggregate (w/c=0.55)	0%	20%	40%	60%	80%	100%
CF	0.825	0.875	0.891	0.937	0.849	0.871

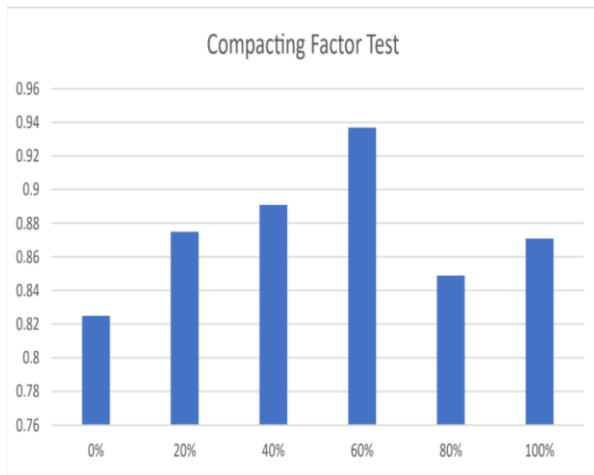


Fig4: Compaction factor results (0.55 w/c)

#### D. Non-destructive test:

##### (1) Schmidt's rebound hammer test:

Swiss engineer "Ernst Schmidt" developed the schmidt rebound hammer in 1948 [4]. It is usually a tool for determining surface hardness. This is a spring control hammer. The concrete rebound test is used to test strength of the general structure of the hammer and the strength of the various concrete members of the bridge (slabs, beams and columns). When testing the strength of concrete. A concrete test hammer uses a certain elastic force to transfer an impact hammer impact force to the concrete surface. A portion of this energy is synthesized by the concrete, another portion of the energy that is proportional to the surface hardness gives. Then the strength of the concrete is obtained from the proportional relationship between the height elasticity and the strength of the concrete [10].



Fig5: rebound hammer test

Table-3  
RESULTS OF REBOUND HAMMER TEST [11]  
(IS: 13311-1992)

Percentage of recycled aggregate	0%	20%	40%	60%	80%	100 %
Days	Compressive Strength (MPa)					
3	22.1	24.3	23.9	27.9	25.0	21.31
	4		6	2	7	
7	28.1	30.7	31.3	33.6	28.4	30.41
	1	8		3		

##### (2) Ultrasonic pulse test:

Due to the and slow conduction of ultrasonic pules waves, the fit ratio, the age of a certain amount of concrete and the test distance. This test is done to identify defects in the structure of the concrete. This test measures internal strength of concrete. Ultrasonic pulse uses frequencies between 1-15 MHz and sometimes 50MHz with very small ultrasonic pulse-waves, the material is excited [13]. Thus, problem can be identified on the floor or interior of the components. This technique is often used to determine the thickness of an objects.[13,10]



Fig6 - Ultrasonic pulse test

Table-4  
ULTRASONIC PULSE TEST RESULTS

Percentage of recycled aggregate	0%	20%	40%	60%	80%	100%
Days	Velocity(m/s)					
3	4140	4220	4160	3960	4120	4140
7	4160	3860	4190	4250	4230	4020
Days	Compressive Strength (MPa)					
3	20.8	19.3	18.0	14.5	16.6	17.3
7	21.7	15.1	19.1	22.6	19.3	19.8

#### (E) Compression Test:

The compressive strength of a concrete is defined as the ability of the concrete to with specific compressive force. Compressive strength of concrete depends on many factor such as, water cement ratio, cement strength and quality of concrete material. Typically the sample size of cube and cylinders is used to test the compressive strength of concrete. The size of cube 150mm × 150mm × 150mm. And while the cylinders specimen is 150mm diameter and 300mm length [14].

$$\text{Compressive strength of concrete} = \frac{\text{Load}}{\text{Area}}$$

Sensitive strength is one of the most important engineering properties of concrete. This is a standard art practice that is classified based on the grade of concrete. This grade is nothing but the sensitive energy of a concrete cylinder.

Table-5  
COMPRESSIVE STRENGTH (MPa)

Percentage of recycled aggregate	0%	20%	40%	60%	80%	100%
Days						
3	22.14	25.6	24.07	27.41	24.11	20.41
7	28.78	31.4	31.11	33.92	26.63	31.3

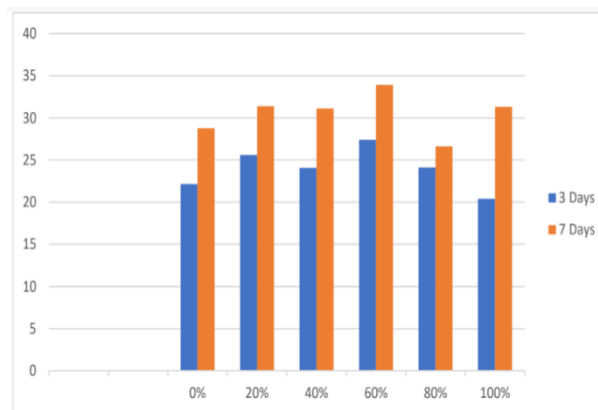


Fig7 : Compression strength test

### 3. RESULTS AND DISCUSSION

#### 1. Size distribution:

Recycled thick coarse aggregate are comparatively thick natural aggregate. So, Now in the field of 100% fineness modulus. The recycled coarse aggregate is 7.386, which is slightly higher than the natural coarse total of 7.094.

#### 2. Physical and Mechanical Properties:

It is observed from table 1, that the bulk density and specific gravity of recycled coarse aggregate are 1660.44 kg/m<sup>3</sup> and 2.74. The figure are less than that the natural coarse aggregate of 1805.62 kg/m<sup>3</sup> and 2.84 respectively. The recycled coarse aggregate contains original aggregate attached with mortar. The attached mortar is light and porous in nature.

#### 3. Workability:

Materials the performance of concrete plays a very important role. But when high performance concrete is required the strength of the concrete is close to the aggregate strength, there is no weakness in the structure so that fine aggregate is required. Efficiency has been achieved in 40% concrete mix here in place of RCA.

#### 4. Compressive strength:

The above graph shows the different with the age of RCA compressive strength. It can be seen that compressive strength is optimal with 60% replacement recycled coarse aggregate. The result of the rebound hammer tests and ultrasonic pulse velocity tests are also included in the concrete with the compressive strength of concretes made with replacement of different percentages of RCA.



#### 4. CONCLUSION

The latest can be said, Natural coarse aggregate and recycled coarse aggregate are the same. Because experimental results show that natural coarse aggregate and recycled coarse aggregate are approximately the same after application of compressive strength. So recycled coarse aggregate concrete with overall partial or complete can be used replacement of natural coarse aggregate.

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