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COMPARATIVE STUDY ON RECYCLED CONCRETE AND NATURAL CONCRETE

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ABSTRACT*: However, using recycled concrete aggregate (RCA) in concrete involves various obstacles and controversial issues in controlling the quality of recycled concrete aggregate (RCA). Recycled concrete aggregates is the base of mechanical and testing of concrete under various conditions. In this time natural aggregates is more consumption and reduce it. Then Recycled concrete aggregates where natural aggregates are replaced with RCA is a technology for conserving natural resources and also the reducing the environmental impact of concrete. In cement test include consistency test, initial setting time test, and final setting time test. Aggregate test is also included impact valve test, abrasion test and sieve test and water abrasion test. Tests were undertaken to establish the compressive strength, workability and water absorption of each batch. The results indicate that the compressive strength is not the only decisive factor on mechanical and durability-relatedproperties of RACs.*

KEYWORD: *Recycled coarse aggregate and Natural aggregates Test and durability, water absorption compressive strength*

INTRODUCTION

In India is very high urbanization growth by the industry. And also, rapid growth in infrastructure to requires a large quantity of materials land requirements. If we construct any building then properly used materials and check their property as strength, durability. And we construct any building to longer life, low maintenance & good performance. In India demolished materials are dumped on landfill and foundation filling of building or house & do not reuse. This demolished waste is affecting the environment and also the affect the fertility of land. The concrete waste is produced by the production of concrete and return the fresh concrete is more than wastes comes in demolition wastes.

More than 900 million tons per year concrete waste produced in Europe. And India generates 23.75 million tones concrete waste annually. As per report of Central Pollution Central Board (CPCB) Delhi in India. about 0.1 million tons of municipal solid waste is generated in India every day. India produced solid waste 48 million tones out of 14.5 million tones waste is produced from construction waste sector. And waste 3% is used from embankment.

In total construction demolished waste is collected are 47% concrete, 25% ceramic's, 3% plastic, 10% wood, 5% metal & 10% other materials. If production of concrete is required is 69-74% of aggregate out of 60-65%of coarse aggregate & 32-40% is fine aggregate. In future global demand on aggregate also exceed in 34 billion tones by 2022. And this demand from India, Europe, China & USA. As the environment point of view the more carbon exist production of NA less than the RAC. As we know that NA is limited resources about 50 to 60 years then it is utilizing properly and also the RAC can be reused properly. We use recycle aggregates generally increase water absorption, decrease compressive strength of concrete to compare the natural aggregate and porosity to water. The aggregate is generally replaced 5 to 25%. Waste of concrete can be problem to through its disposal and recycling activity and emission the Carbon dioxide is more. In this activity produce more amount of carbon dioxide emission and contribute the global warming and acidification of land.

MATERIALS USED

Natural aggregate:

Natural aggregate is obtained from nature. The aggregate is generally acquired by blasting in stone

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quarries or breaking them by hand or crusher machines. The aggregate manufactured by machine-crushed consist of stones of various sizes whereas hand –broken aggregates consist of only single stones.

Recycled concrete aggregate

Recycling is the process the old materials used to creating a new product. Recycled concrete aggregate is found the construction and demolition debris. And also, they recycling the waste materials with the source of construction and demolition waste. After separation the plastic, wood, iron and also seined the recycle aggregates and crushed its. And we replace the natural coarse aggregates in concrete, sub base or layer in pavements. RCA is clean and freeform chemical impurities and waste materials can be crushed to comprising primary jaw and secondary cone crushers. The coarse aggregate can be produced two sizes 20-10 and 10-5mm. RCA is the 2 times the higher water absorption than NA. And RCA is lower relative density 7 to 8%. All the mechanical properties of RCA are less than the NA. And we check the compressive strength of RCA and NA then we add super plasticizing admixture to maintain workability and air –entraining admixture used.

EXPERIMENTAL METHODOLOGY

3.1 Materials Test on Recycled Aggregates and Natural Aggregates:

Demolished materials of reinforced concrete can be used in recycling in foundation. The demolish materials life is 25 to 30 years. Demolish materials can be crushing, sieving and separation process can be done by manual and it separates the iron and plastic. The test can be conducted on recycled aggregates and natural aggregates and comparedtheir results are IS code 2386.

Specific Gravity:

The specific gravity of aggregates normally used in construction ranges from about **2.5 to 3.0** with an average value of **about 2.68**. Specific gravity of aggregates is considered as an indication of strength. Material having higher Specific Gravity is generally considered as having higher strength. Water absorption of aggregate is a measure of porosity. This value is considered as a measure of resistance to frost action, and as a measure of sustaining weathering action by the IS code 2386(part 3).

The specific gravity of recycled concrete aggregate of dry condition was found from **2.35 to 2.58**. If specific gravity is less than 2.4, The yield of concrete may get reduced and also cause segregation, honeycombing in concrete.

Water Absorption:

Water absorption of recycled aggregates is higher absorption to natural aggregate. Because cement mortar is integral part of recycled aggregates and has more porous of recycled aggregates than comparison to natural aggregates. Water absorption is defined as the amount of water absorbed by a material and is calculated as the ratio of the weight of water absorbed to the weight of the dry material. Water absorption gives an idea on the internal structure of aggregate. Aggregates having more absorption are more porous in nature and are generally considered unsuitable. Normally, recycled aggregate is more absorptive than natural aggregate. Water absorption lies around 3–10 percent for recycled aggregate and from less than 1 up to 5 percent for natural aggregates.

Table :1

Sr.no.	Particulars	Values	
		Natural Aggregate	**Recycled Coarse Aggregate**
1	Specific Gravity	2.5-3.0	2.35-2.58
2	Water Absorption	<1%-5%	3%-10%
3	Bulk Density	1200-1750kg/m^3	1300Kg/m^3
4	Crushing Values:	18.5%	36.2%
5	Impact Values:	14.9%	18.3%

Bulk Density:
Bulk density of recycled aggregate is lower than the natural aggregate. The less bulk density of RA is affected to mix proportion and it is not similar to the NA. Recycled aggregates is a higher porosity due to cement mortar layer and lower bulk density of natural aggregates. If the cement mortar layer is high on a recycled aggregates than lower bulk density. And some practical experience says that 7 to 10% lower bulk density to natural aggregates.

Crushing and Impact Values:
The recycled aggregates are weaker than the natural aggregates and their mechanical properties. as per IS code 2386-part 4 crushing value and impact value of concrete is do not exceed 30%. Recycled aggregates crushing value and impact value is satisfy the BIS specifications. Crushing value and impact value of Recycled aggregates is higher than the Natural aggregates.

1. Test of cement

Consistency test of cement (IS:4031 part4): Presented in Table 2.
Apparatus: Vicat mould glass plate, weight balance, stop watch, tray, trowel.
Calculation: pan weight =736 gm. cement =300 gm. (PPC)

Fig: (1) Consistency test of cement

Table :2

Sr.no.	Weight of cement	% Of water by weight of cement	Penetration of plunger, mm
1	300gm	30% =90 ml	25mm
2	300gm	33% = 99 ml	31mm
3	300gm	35% =105 ml	33mm

(Penetration of plunger value – Top to bottom)

Initial Setting time of Cement Test:

The time to which the cement can be molded in any designed shape without losing its strength . Fig 2

Table :3

SR.NO.	Penetration Time	Starting Penetration (mm)	Initial Setting (min)
1	12:25	0 mm	0 min
2	12:35	3 mm	10 min
3	12:55	7 mm	30 min

Result: Initial setting time is = 30 minute

(a) Final Setting time of Cement test:

The time taken to reach the stage when the cement paste becomes a hard mass and can taken some minor load.

Fig: 2 Initial and Final setting time of cement

Table :4

SR.NO.	Penetration time	Starting penetration (mm)	Final setting time (minutes)
1	12:25	0	0 min
2	12:55	7mm	30 min
3	1:30	20mm	65 min
4	2:00	35mm	100 min
5	2:45	40mm	140 min

Result: Final setting time = 140 minute

IMPACT VALUE TEST: The aggregate impact value gives a relative measure of the resistance of anaggregate to sudden shock or impact, which in some aggregates differs from its resistance to a slow compressive load. IS 2386 (part 4)

IMPACT VALUE OF NATURAL AGGREGATE

Aggregates can be used 12.5 mm Sieve Retained

W1= empty weight if cylinder =800 gm

W2 =weight of oven dried sample =318 gm

W3 =weight of aggregate passing throughout 2.36 mm sieve =47.5gm

Aggregate impact value:

=(w3/w2) *100

= (47.5/318) *100 =14 %

Fig :3 Impact Testing machine

IMPACT VALUE OF RECYCLED AGGREGATE:

Aggregates can be used 12.5 mm Sieve Retained

W1= empty weight if cylinder =800 gm

W2 =weight of oven dried sample =318 gm

W3 =weight of aggregate passing throughout 2.36 mm sieve =47.5gm

Impact value: = (60.73/325) *100 = 18 %

WATER ABSORPTION:

Demolished waste of concrete aggregates is absorption and its ranges from 1.5% to 8%, which is higher than the natural aggregates. IS 2386 (Part 3) Aggregates can be used 12.5 mm Sieve Retained.

Fig (4) Natural Aggregate

Weight of Natural aggregate = 2 kg

After 24 hours:

Weight of Natural aggregate with absorb water = 2.00+0.036

= 2.036 kg

Water absorption % = ((wet weight – dry weight)/dry weight) *100

= (2.036-2.000/2.000) *100

= **1.8% water absorption**

Fig (5) Recycled Aggregate

Weight of Recycled aggregate =2.083 kg
Aggregates can be used 12.5 mm Sieve
Retained**After 24 hours:**
Weight of recycled aggregate with absorb water = 2.083+0.185
= 20268 kg

Water absorption % = ((2.268-2.083)/2.083) *100
= 8.8% water absorption

TESTING METHODOLOGY

All the experiments can be conducted by the department of civil engineering labs at Bansal Institute of Engineering and technology. The test can be conducted is compression test.

COMPRESSION TEST ON CUBE (IS 516:1959)

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. The specimen ofcubes of 15cm x15cm x 15cm are commonly used. This concrete is poured in the mold and appropriately tempered so as not to have any voids. After 24 hours, molds are removed, and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by placing cement paste and spreading smoothly on the whole area of the specimen. These specimens are tested by compression testing machine after seven days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete. These tests can be measured in accordance with IS Code IS 516 (1959): Method of Tests for Strength of Concrete.

Specimen: 9 cubes of 15 cm size Mix. M20 Grades both RCA and NAC.

Fig 6: Recycled concrete aggregates cube

Fig 7: Natural aggregates concrete cube

Fig 8 Compressive Strength of RCA

Fig 9 Compressive Strength of NAC

Calculations of Compressive Strength of RCA and NAC

Size of the cube =15cmx15cmx15cm

Area of the specimen (calculated from the mean size of the specimen) =22500 mm^2

calculating compressive strength =F/A
F=force or load at point of failure A=initial
cross-sectional surface area

Table 5

Sr.no	Age	Strength
1	7 days	65%
2	14 days	90%
3	28 days	99%

Results of Concrete Cube Test RCA and NAC:

Compressive Strength of M20 Grades of Concrete at 7, 14 and 28 Days of NAC and RCA.

Table 6

Sr.no.	Grade of concrete	Minimum compressivestrength n/mm^2 at 7days	Minimum compressive strength n/mm^2 at 14 days	Specified characteristic compressive strength (n/mm^2) at 28 days
1	M20 NAC	14.07	18.95	23.56
2	M20 RCA	9.47	14.95	19.33

CONCLUSIONS

- Recycled aggregates can be conducted various test and also compared with natural aggregates as per IS2386.
- RCA has low compressive strength; more water absorption and bulk density is lower than the naturalaggregates.
- The use of recycled concrete aggregates is more economic and friendlier to the environment. RCA is used in construction energy & transportation cost and excavation of natural aggregates is saved. And do not moreaffect to the environment.
- The result of Recycled aggregates is less than the NA. Then it is using admixtures and improves the result of Recycled Aggregates. RCA can be used in structure 25 to 30% but its strength, durability and performance is more than the Natural aggregates.
- The Recycled aggregates strength is decreasing with increasing water –cement ratio. if more waterabsorption of recycled aggregates, then inhibitory effect of strength.

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