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Strength of Sustainable Concrete

Kirubhalini.J
M.E., Assistant professor, Thangavelu Engineering College, Chennai, Tamilnadu, India

***Abstract*—** The experimental investigation was conducted to identify the suitability of recycled the demolished concrete waste as coarse aggregate in normal concrete. This research involved partial replacement of coarse aggregate by the demolished waste material in the M30 grade concrete. The percentage replacements of coarse aggregates by the recycled coarse particles respectively were 25%, 50%, 75%, 100%. The properties of coarse particles from demolished concrete waste were studied and compared to the normal aggregates used in normal concrete.In this project, to investigate the mechanical properties of concrete like workability, setting time of fresh concrete, compressive strength, Split tensile of hardened concrete, flexural strength of concrete. From the result, the compressive strength the compressive strength is 15% more than the conventional concrete. The maximum split tensile strength is attained at the same replacement level mentioned above. From the result, the split tensile strength the compressive strength is 7.5% more than the conventional concrete. The maximum flexural strength is attained at the same replacement level mentioned above. From the result, the flexural strength is 5% more than the conventional concrete. From these results, that the recycled concrete was more effective than the conventional concrete. Large scale recycling of demolished waste and concrete will offer not only the solution of growing waste disposal problem, but it will also help to natural resources for meeting increasing demand of aggregates for construction purposes. By using this debris concrete as the replacement material, we can imply the highly sustainable environment in construction industry worldwide.

NEED FOR THE PROJECT

- To compensate an alternate material for coarse aggregate should be identified.
- It is the most efficient way to utilize the concrete debris as coarse aggregates in normal concrete.
- To improve the strength of concrete.

SCOPE OF THE PROJECT

In India, The Indian construction industry consumes 400 million tonnes of concrete every year and it was expected that this may reach a billion tones in a less than a decade. All the materials required to produce such high quantities of concrete come from the earth crust, thus depleting its resources every year creating ecological strains.

- Higher strength should be attained than the normal concrete.
- It should be economical.
- To utilize the waste materials of concrete debris.

Recommendations based on the results obtained from the project.

OBJECTIVES

- To study the characteristics of concrete debris.
- To prepare the design mix for M30 grade concrete.
- To evaluate the viability of this process, an experimental campaign was implemented in order to monitor the mechanical behavior of such concrete.
- To achieve environmental aims of recycling of concrete with new economical aspects.
- To conserve natural resources for meeting increasing demand of aggregates for construction purposes
- To minimize the disposal of demolished concrete from the construction industry.

Materials Used

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Recycled coarse aggregate

No. of Specimens Prepared

Characteristics To Be Tested	Age of Testing in Days	No of Specimens
Compressive Strength	7, 14 & 28	45
Split Tensile Strength	7, 14 & 28	45
Flexural Strength	7, 14 & 28	45

Physical Properties of Cement

S.No	Properties	Obtained Values
1	Normal consistency	35%
2	Initial setting time (minutes)	40
3	Final setting time (minutes)	420
4	Specific gravity	3.25
5	Fineness of cement by sieve	2.50%

Physical Properties of River Sand

S.NO	Properties	Obtained Values
1	Specific Gravity	2.701
2	Water absorption	2.22%
3	Fineness modulus	2.7

Physical Properties of Coarse Aggregates

S.NO	PROPERTIES	OBTAINED VALUES
1	Specific gravity	2.65
2	Impact value	6.38%
3	Crushing value	2.90%

Physical Properties of Recycled Coarse Aggregate

S.NO	Properties	Obtained Values
1	Specific gravity	2. 5

2	Impact value	9.63%
3	Crushing value	4.34%

Slump Cone Value for Various Concrete

Water Cement Ratio	Cement	Fine Aggregate	Course Aggregate
0.45	413.33 kg/m^3	546.57 kg/m^3	1149.53 kg/m^3
	1	1.33	2.78

Compaction Factor Value

Normal Concrete	Recycled Concrete (mm)			
(mm)	25%	50%	75%	100%
0.75	0.8	0.82	0.82	0.85

Mix Design for M30 Grade Concrete

Step 1: Design Stipulations

Characteristics Compressive Strength required in the field at 28 days = 30 N/mm2
Maximum size of Aggregate = 20 mm
Degree of quality control =good
Type of Exposure = mild

Step 2: Test Data Materials:

Specific gravity of cement = 3.25
Specific gravity of sand (Fine aggregate) = 2.34
Specific gravity of Course Aggregate = 2.65
Specific gravity of recycled Course Aggregate =2.50

Step 3: Target Mean Strength

$ft = fck + (t \times s)$
$= 30 + (1.65 \times 5)$
$= 38.25 N/mm2$

Where,
Ft = target average compressive strength at 28 days
Fck = characteristic compressive strength at 28 days
S = standard deviation value for M30 grade = 4.0 from IS 456 – 2000
t = a statistic depending upon the accepted proportion of low results.

Step 4: Selection Of Water Cement Ratio:

Since OPC is used from the table, The estimated Water Cement(W/C) Ratio 0.45

Step 5: Selection Of Water And Sand Cement

ZONE II
Mix water content
= 186 kg/m3
Sand as percent of total absolute volume = 39%

Step 6: Determination Of Cement Content:

W/C ratio = 0.45
Water = 186 kg/m3
Cement = 186 = 413.33 kg/mm3 0.45

Step 7: Determination Of Course & Fine Aggregate Content

Normal Concrete	Recycled Concrete (mm)			
(mm)	25%	50%	75%	100%
35	32	32	30	28

AGGREGATE CONTENT:
Maximum size of aggregate = 20 mm
The amount of entrapped air is 3%
Absolute volume = 1 – 0.03
= 0.97

$0.97 = 186 + 413.33 + \frac{1}{3.25} \times fa \times \frac{1}{0.45} \times \frac{1}{2.34} \times \frac{1}{1000}$

$970 = 327.62 + 1.1 \times fa$

Type Of Concrete		Curing Days	Compressive Strength in N/Mm^2
Normal Concrete		7	26
		14	32.33
		28	39.45
Recycled Concrete	25%	7	29.33
		14	35.67
		28	45
	50%	7	28.33
		14	34.3
		28	41.67
	75%	7	23.67
		14	29.67
		28	35
	100%	7	20
		14	25.3
		28	29

fa = 549.979kg/m3

$Ca = \frac{1 - p}{P} \times fa \times \frac{Sfca}{Sfsa}$

$Ca = \frac{1 - 0.45}{0.45} \times 549.979 \times \frac{2.65}{2.34}$

= 1149.53 kg/m3

Mix Proportion for Normal Concrete.

Mix Proportion For M30 (Normal Concrete) = 1: 1.33 : 2.78

4.3.4 Mix Proportion for Recycled Coarse Aggregate

$Ca = \frac{1 - p}{P} \times fa \times \frac{Sfca}{Sfsa}$

$Ca = \frac{1 - 0.45}{0.45} \times 549.97 \times \frac{2.65}{2.5}$

= 1058.58kg/m3

Mix Proportion for Recycled Coarse Aggregate

W/C RATIO	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Course Aggregate (kg/m^3)
0.45	413.33	546.57	1058.58
	1	1.33	2.63

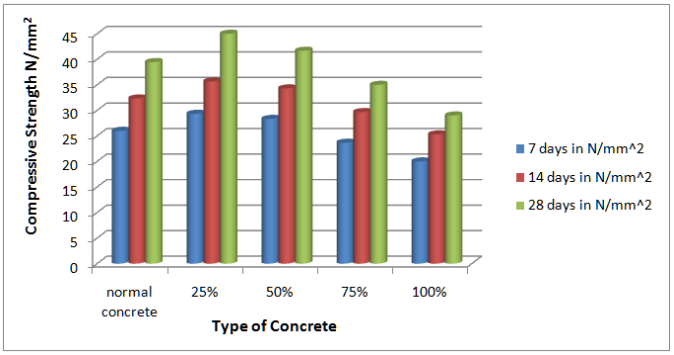
Mix Proportion for M30
(Recycled Coarse Aggregates) = 1: 1.33 : 2.63

Comparison of Compressive Strength of Concrete

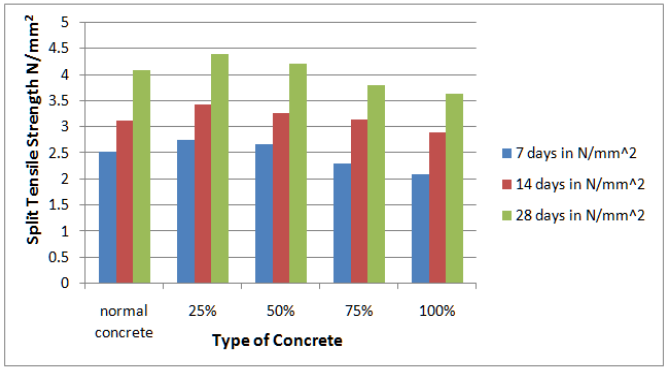
Type Of Concrete		Curing Days	Compressive Strength In N/Mm^2
Normal Concrete		7	26
		14	32.33
		28	39.45
Recycled Concrete		7	29.33
	25%	14	35.67
		28	45
		7	28.33
	50%	14	34.3
		28	41.67
		7	23.67
	75%	14	29.67
		28	35
		7	20
	100%	14	25.3
		28	29

Compressive strength of the concrete gets decreased when the replacement level increases. But the Compressive strength of recycled concrete was 15% @ 25% and 6% @ 50% more resistance than the conventional concrete.

Graphical Representation of Comparison of Compressive Strength of Various Concrete



Graphical Representation of Comparison of Split Tensile Strength of Various Concrete



CONCLUSION

The following conclusions can be drawn from the above test result.

- Compressive strength of recycled concrete was 15% @ 25% and 6% @ 50% more resistance than the conventional concrete.
- Split tensile strength test was7.5% @ 25% and 3% @ 50% more than the conventional concrete.
- Flexural strength test of recycled concrete was 5% @ 25% and 3% @ 50% than the conventional concrete.
- From the loss of compressive strength in test results also, it is clearly identified that the recycled concrete has more resistance than the conventional concrete.
- From the results, the replacement of aggregates at the level of 25% gives more strength compared to other replacements done here.
- The recycled concrete can be used in industrial and coastal regions

By using this debris concrete as the recycled materials, which imply the highly sustainable environment in construction industry.

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