STATISTICAL ANALYSIS OF IMPROVING PERFORMANCE OF CONCRETE USING PORCELAIN AS REPLACEMENT OF FINE AGGREGATE

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Abstract – *construction and demolition wastes (C&D wastes) are highly produced in now a days due do various construction activities like alteration work, renovation work and demolition after building life time. Ceramic materials contribute the highest amount of non-recyclable waste in C&D waste. The current option of disposal of removal of those ceramic wastes is landfill only. In the present ceramic industry 10-20% of waste ceramic powder produced at various stages of manufacturing; those ceramic wastes generally not involve recycle process like ceramic waste obtained from C&D works. Those wastes are make pollution by settlement at the time of infiltration of rain water in landfill area, in addition to make health problem. Waste ceramics from C&D works and ceramic material manufacturing are used to the construction, glass and paper industries would help to product environmental pollution and health problems. Development of eco-friendly concrete from ceramic waste must help to product environment. Keeping all of this view, the aim of this project is to study the behavior of the concrete by replacing fine aggregate with ceramic waste (porcelain) in different proportions. Use waste powder according in the range of 15%, 25% & 35% by M-30 grade concrete. Compression and tensile tests were carried out to evaluate strength properties for 7, 14 and 28 days.*

Key Words: C&D wastes, eco-friendly concrete, ceramic waste, porcelain, compression test, tensile test.

1. INTRODUCTION

Concrete is building's binding material formed by cement, fine aggregate, coarse aggregate and water. The fine aggregate is sand; now a m-sand and various industries dust used as a replacement of sand due to demand of river sand. Various researches made to find alternate solution of sand replacement. Partially are fully replacement was carried by many researchers for finding the alternative solution of sand. Mostly the replacement considers many advantages like waste reduction as well as use waste to fine aggregate in concrete. This paper aims to use waste marble dust as a fine aggregate. To add fine aggregate various proportions to check the concrete behaviours. Because, large amount of ceramic manufacturing company present in India and nearly produce 500 million tons of wastes in last 5 years. The porcelain(ceramic waste) consist tough and durable in nature; generally the porcelain consist resistant property in biological, chemical, and physical degradation. Due to this property the porcelain not involve recycling process. Only land filling process carried out by municipality. Generally the ceramic wastes are created by ceramic industries and materials like tiles industries, refractory products, table and ornamental ware (house hold materials), sanitary material, vitrified clay pipes and etc., due to those non degradable property the ceramic waste create many major pollution to the environmental. The raw materials are directly collect from municipality waste.

2. OBJECTIVE

- Reduce the ceramic waste from environment to avoid land filling
- Find out concrete property by replacing fine aggregate with porcelain
- To match the property with normal concrete
- To find out effective percentage of porcelain used.
- To reduce the cost of the construction

3. LITERATURE REVIEW

The porcelain is rapid development waste in now a day. The following literature review deals with study of ceramic waste in concrete.

3.1 G V Vigneshpandianet , al (2017): ICCIEE 2017 IOP Publishing IOP Conf. Series: Earth and Environmental Science 80 (2017) 012007 do:10.1088/1755-1315/80/1/0120070

The tiles waste powder used as a replacement of fine aggregate in the range of (25%, 50%, 100%). It's improves compressive, flexural and tensile nature. The durability property of the concrete increased. The maximum strength was achieved at 50%.

3.2 L. SatishKumaret , al (2017): "AIJREAS, volume 2, issue 2 (2017, feb) (issn-2455-6300) partial replacement of fine aggregate with marble dust in concrete"

The test was carried out the use of replacing Marble dust by fine aggregates in different percentages i.e. 0%, 5%, 10%, 15%, 20%, 25%, 35%, 30% and 40%. Cubes are tested at the interval of 7,14,28 days. The compressive strength increases with the increase in percentage of Marble dust up to 30%. Marble dust can be replaced without affecting the target strength.

3.3 Vijay M et.al (2017): "Experimental study on mechanical behavior of concrete by using porcelain" (ICRTECITA-2017) - Special Issue - March 2017

In this paper authors replace the marble dust with cement in the percentage of 10,20,30%. The M-30 ratio was used. The nominal mix design ratio used. The optimum percentage of ceramic usage is 20%.

3.4 Abdullah Anwar et.al (2014): "Study of Compressive Strength of Concrete by Partial Replacement of Cement with Marble Dust Powder. Ird Indian ISSN (Print): 2321-5747, Volume-2, Issue-3"

In this paper the authors replace that Marble Dust Powder has replaced with cement of 0%, 5%, 10%, 15% 20%, & 25% by weight & M-20 grade concrete was used. The nominal mix ratio was used. The nominal result percentage is 10%.

4.METHODOLOGY

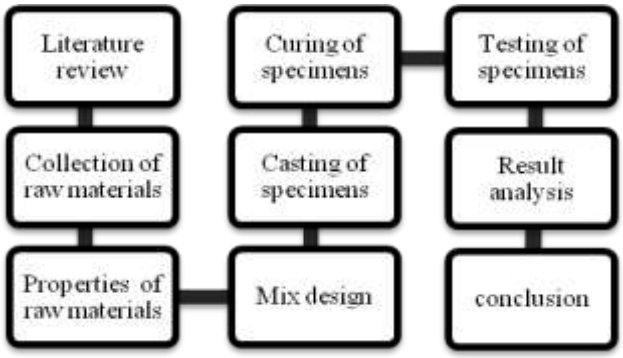

CHART-1:METHODOLOGY

5. PROPERTIES OF MATERIAL

5.1 Specific gravity of materials

Table1- Specific gravity of materials

S.no	Description	Specific gravity
1	Cement	2.85
2	Sand	2.46
3	Coarse Aggregate	2.98
4	Marble dust	2.25

5.2Properties of ceramic waste

(i) Silicon Dioxide (SIO2) =78.20%
(ii) Aluminium Oxide(AL203)=0.820%
(iii) Calcium Oxide (CaO) =1.510%
(iv) Magnesium Oxide(MgO) =3.580%
(v) Chloride (Cl) =0.302%
(vi) Sulphur as sulphur Trioxide(SO3) =0.064%
(vii) Loss of Ignition =3.590%

6.MIX DESIGN

Data

Concrete grade - M_{30}
Degree of quality control - Good
Type of exposure - Mild
Size of aggregate - 20mm angular
Specific gravity of cement - 3.02
Specific gravity of fine aggregate - 2.459
Specific gravity of coarse aggregate - 2.98
Compaction factor - 0.80
Grading zone for fine aggregate – type II
Bulking density-cement - 1440kg/m^3
Fine aggregate - 1498kg/m^3
Coarse aggregate - 1453kg/m^3

Step1:
Target mean strength fck-mean $=f_{ck}+ (t\times s)$
$= 30 + (1.65\times5)= 38.25N/mm^2$
Step2:
W/C ratio from graph for f_{ck} $= 38.25N/mm^2$
W/C ratio for mix in mild exposure Condition=0.40
Step3:
Calculate the amount of mixing water per cubic meter of concrete and the percentage of sand. For 20mm aggregate water content per cu. M of concrete =186kg.
Step4:
Cement quantity = corrected water quality / water cement ratio= 186/0.40= 465kg
Cement required =465kg
Step5:
Volume of fine aggregate =0.34 (zone III)
F.A= d× volume of fine aggregate ×S.G of F.A×1000
=0.66×0.34×2.459×1000=551.8kg
Step6:
Volume of coarse aggregate = 0.66
C.A= d× volume of coarse aggregate ×S.G of C.A×1000
= 0.66×0.66×2.746×1000= 1196kg
Quantity of material per m3 of concrete

BY WEIGHT:

Cement = 465kg
Fine aggregate = 551.8kg
Coarse aggregate= 1196kg
Water = 186kg
MIX PROPORTION =1:1.19:2.57

BY VOLUME:

Cement = 1440kg/M3
Fine aggregate = 1498 kg/M3
Coarse aggregate = 1453 kg/M3
Water = 1000 kg/M3
C = (465/1400) =0.322m^3
S = (551.8/1498) =0.368m^3
C.A = (1196/1453) =0.826m^3
W = (186/100) =0.186m^3
MIX PROPORTIONS =1:1.19:2.57

7. MIX PROPORTION AT DIFFERENT REPLACEMENT LEVEL

S.NO	REPLACEMENT LEVEL	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
1	0%	1	1.19	2.57
2	15%	1	1.0115	2.57
3	25%	1	0.8925	2.57
4	35%	1	0.7735	2.57

8.COMPRESSIVE STRENGTH

8.1 AT 7 DAYS

Table2-compressive strength at 7days

S.NO	REPLACEMENT	AVERAGE COMPRESSIVE STRENGTH
1	0%	19.94
2	15%	21.456
3	25%	21.77
4	35%	22.37

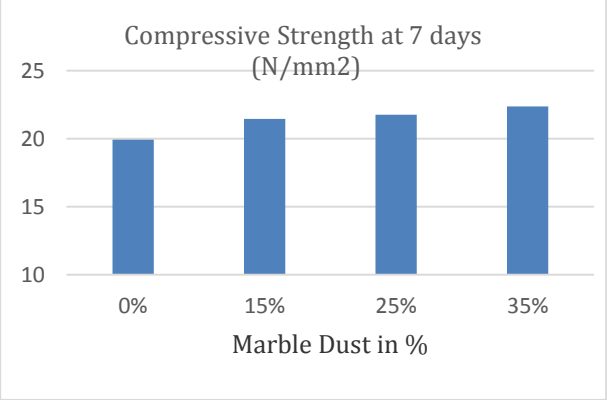

FIG-1: compressive strength at 7days

8.2 AT 14 DAYS

Table3-compressive strength at 14days

S.NO	REPLACEMENT	AVERAGE COMPRESSIVE STRENGTH
1	0%	28.45
2	15%	28.76
3	25%	29.59
4	35%	29.95

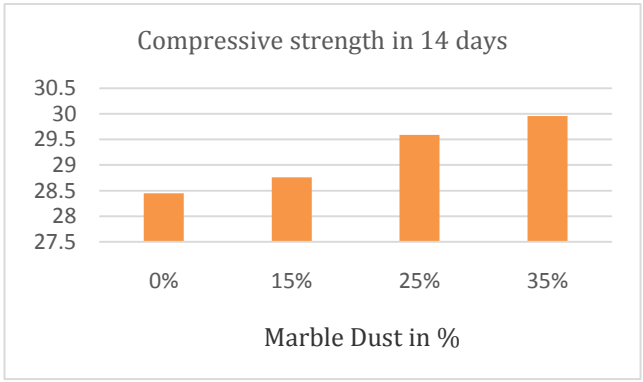

FIG-2: compressive strength at 14days

8.3 AT 28 DAYS

Table4-compressive strength at 28days

S.NO	REPLACEMENT	AVERAGE COMPRESSIVE STRENGTH
1	0%	30.74
2	15%	31.88
3	25%	33.81
4	35%	35.62

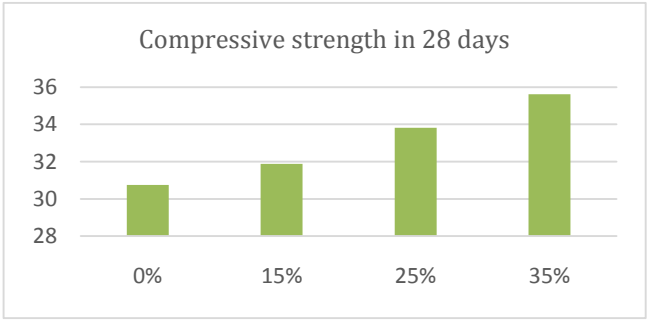

FIG-3: compressive strength at 28days

9.TENSILE STRENGTH

9.1 AT 7 DAYS

Table5-split tensile strength at 7days

S.NO	REPLACEMENT	SPLIT TENSILE STRENGTH
1	0%	1.65
2	15%	1.52
3	25%	1.38
4	35%	1.21

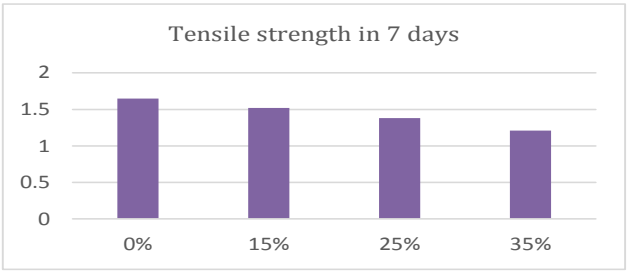

FIG-4: split tensile strength at 7days

9.2 AT 14 DAYS

Table6-split tensile strength at 14days

S.NO	REPLACEMENT	SPLIT TENSILE STRENGTH
1	0%	2.01
2	15%	1.913
3	25%	1.81
4	35%	1.62

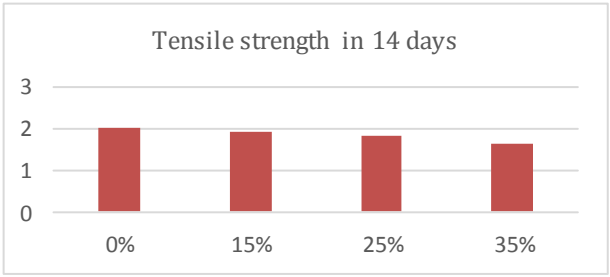

FIG-5: split tensile strength at 14days

9.3 AT 28 DAYS

Table7-split tensile strength at 28days

S.NO	REPLACEMENT	SPLIT TENSILE STRENGTH
1	0%	2.37
2	15%	2.22
3	25%	1.916
4	35%	1.733

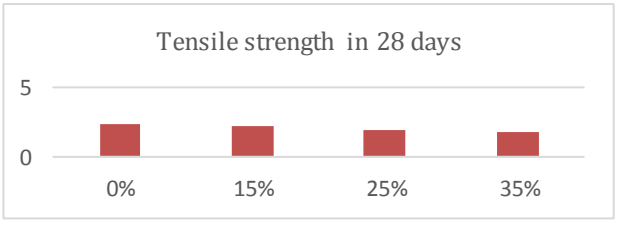

FIG-6: split tensile strength at 28days

10. CONCLUSION

Based on limited experimental investigation concerning the compressive strength and split tensile strength of concrete, the following observations are made :

RESULT ANALYSIS:

- Compressive strength of the concrete is nearly 10% increased when the 35% porcelain replaced in the fine aggregate.
- The split tensile strength is decreased when the increase the some percentage of the replacement in the fine aggregate.
- From this level, replacement of cement with this ceramic waste material provides maximum compressive strength 35% of replacement as fine aggregate.
- Cost of the material become low from this project
- Environmental pollution was reduced
- porcelain can effectively be used as alternative & supplementary materials in concrete

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