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A Review of Possibility of making Geopolymer Concrete using Foundry Sand and Recycled Aggregate

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Abstract: ***Geopolymer Concrete is a new class of concrete based on an inorganic alumina silicate binder system compared to the hydrated calcium silicate binder system of concrete. It possesses the advantages of rapid strength gain, elimination of water curing, good mechanical and durability properties and is eco-friendly and sustainable alternative to Ordinary Portland cement based concrete. In the construction industry mainly the production of Portland cement causes the emission of air pollutants which results in environmental pollution. In this paper a review has been attempt to study the geopolymer concrete using foundry sand and recycled aggregate. It was found from literature that foundry sand and recycled aggregate are used separately in different study but there is no use of these material in combination with geopolymer so this is good option to check the various properties of concrete by replacing foundry sand and recycled aggregate with geopolymer in various parentage.***
Keywords: Geopolymer Cement, Recycled Aggregate, Foundry Sand

I. INTRODUCTION

The geopolymer concrete has been recognized as a more durable "green" material with less CO_2 emission and less energy consuming as compared with the widely used Portland cement (PC) concrete. It is predicted that the geopolymer will replace the traditional cement and will lead to a revolution in civil engineering. Every great breakthrough in the civil engineering history is due to the research and application of new materials in civil engineering, such as the occurrence of concrete and steel, etc.

Many by products and solid recyclable materials can be used in concrete mixtures as aggregates or cement replacement, depending on their chemical and physical characterization. The capacity of concrete for incorporating these secondary raw materials is very wide and the main limit is their availability, which has to be comparable with the cement stream, since it is not worthwhile to develop new cementations materials if their availability on the market cannot be guaranteed. Focus is being shifted on developments in concrete technology that are already underway and are revolutionary in the sense that the goal is not a special concrete type meeting a particular engineering need. There are different types of industrial waste or by product is used in concrete as a replacement material like fly ash, pond ash, foundry sand , red sand, copper slag, various types of plastic etc. In this review paper we are try to find replacement of cement is done with geopolymer cement, fine sand with foundry sand in different percentage and also fresh aggregate with recycled aggregate.

II. LITERATURE REVIEW

Several researchers have used different materials like copper slag, foundry sand, sawdust ash, rice husk ash, fly ash, cow dung ash as partial replacement of cement and foundry sand in concrete to find various physical properties. It was observed that the strength of concrete different by product is different from that of concrete using natural aggregates. In present study we focus on replacing of cement with marble powder and fine sand with foundry sand as partial replacement. There are some literature review explain below

1) *LIoyd et al. (2010)* conducted experiments on geopolymer concrete with fly ash. The study conclude that geopolymer concrete has useful properties and is well suited to manufacture precast concrete products that are needed in rehabilitation and retrofitting of structures after a disaster.
2) *Abdul et al. (2012)* conducted a review surveying on geopolymer concrete. It was presented that due to the high early strength geopolymer concrete shall be effectively used in the precast industries, so that huge production is possible in short duration and the difficulties during transportation can be minimized in a broad way.
3) *Naidu (2012)* presented out a study on strength properties of geopolymer concrete with addition of GGBS. In this paper an attempt was made to study the strength properties of Geopolymer concrete using low calcium fly ash replacing

with slag in 5 different percentages. They obtained compressive strength of geopolymer concrete increases with increase in percentage of replacement of fly ash with GGBS was up to 28.57% of replacement of fly ash by GGBS, the setting was normal and fast setting was observed.

4) *Madheswaran et al. (2013)* conclude that compressive strength of the geopolymer concrete is increased with the increasing concentration of NaOH. The geopolymer concretes produced with different combination of FA and GGBS are able to produce structural concretes of high grades (much more than M40MPa) by self curing mechanisms only.

5) *Patel1 et al. (2013)* studied the application of used foundry sand as a replacement with cement is feasible for strength in interlocking paver blocks. Use of foundry sand in concrete can save the ferrous and non-ferrous metal industry's disposal, cost and produce a 'greener' concrete for construction.

6) *Prajapati et al. (2013)* studied say that India ranks fourth in terms of total foundry production (7.8 million tonnes) according to the 42nd Census of World Casting Production of 2007. Foundry sand which is very high in silica is regularly discarded by the metal industry. Currently, there is no mechanism for its disposal, but international studies say that up to 50 per cent foundry sand can be utilized for economical and sustainable development of concrete. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.48:3.21 with partial replacement of fine aggregate with used foundry sand as 10%, 30% and 50%. The result show good variation in compressive and flexural value after replacement of sand with foundry sand. The result for the compressive and flexural strength are given below –

Compressive Strength of Cubes at 7, 14, 28 Days

Types of Concrete	Average Compressive Strength (N/mm^2)		
	7 days	14 days	28 days
A0	13.93	20.59	24.00
A1	18.81	24.30	28.15
A2	25.48	28.15	32.30
A3	27.26	37.19	40.89

Flexural Strength of Cubes at 28 Days

Types of Concrete	Average Flexural Strength (N/mm^2)
	28 days
A0	24.00
A1	28.15
A2	32.30
A3	40.89

7) *Singla et al. (2016),* found in his study that the compressive strength of Concrete increased with the increase in sand replacement with different replacement levels of foundry sand. However, at each replacement level of fine aggregate with foundry sand, an increase in strength was observed with the increase in age. The compressive strength increased by 4.2%, 5.2%, & 9.8% when compared to ordinary mix without foundry sand at28-days. The result for the compressive and tensile strength by replacing sand with foundry sand is mention below-

Compressive strength of concrete with various level of replacement of foundry sand

Designation	Compressive Strength, MPa	Compressive Strength (N/mm^2)	
28 Days	56 Days		
0	M-1	27.5	33.80
10	M-2	28.7	34.13
20	M-3	30.0	33.50
30	M-4	31.30	36.50

Split tensile strength of concrete with various levels of replacement of foundry sand

Designation	Split Tensile Strength, MPa	Compressive Strength (N/mm^2)	
28 Days	56 Days		
0	M-1	2.6	3.1
10	M-2	2.9	3.3
20	M-3	2.89	3.4
30	M-4	3.1	3.7

8) *Akiyoshi et al. (2011)* study on compressive strength of concrete using low quality recycled coarse aggregate. As the absorption of coarse aggregate increased, the compressive strength decreased accordingly, and the corresponding reduction in the 28-day strength for the concrete with RCA content of 100%. Similarly, as RCA content increased from 0% to 100%, the compressive strength decreased on the whole.
9) *Shinde et al. (2013)* From the experimental work it is investigated that water absorption of recycled aggregate is about 3 to 5% higher than natural aggregate. It is therefore important that water absorption of recycled aggregate is determined carefully prior to their use in concrete as the strength of concrete decreases with increase in water absorption. Significant decrease in compressive strength observed in concrete with recycled aggregate as compared to concrete with natural aggregate.
10) *Ali, Zia et al. (2014)* Based on the extensive laboratory investigation, it can be easily concluded that recycled aggregate is less workable as compared to virgin aggregate concrete at low water cement ratio. Study also showed that the workability of recycled aggregate concrete increases with increase in the water cement ratio.
11) *Chavhan, Ingole et al. (2016)* According to test results if the percentage of recycled aggregate increases by replacing the natural aggregate, the corresponding strength goes on decreasing, but up to 30% it achieve target mean strength. Hence, for structural concrete recycled aggregate can replace the natural aggregate up to 30%. The workability of concrete considerably reduces as the amount of recycled aggregate increases. The compression test by using UTM indicates that an increasing trend of compressive strength in the early age of the concrete specimens. However, it shows that the strength of recycled aggregate specimens is lower than natural aggregate specimens also the slump test indicates a decreasing trend of workability when the percentage of recycled aggregate increased.

Compressive strength with age

%of RA	0%	30%	50%
7 DAYS	14	12.8	12.5
14 DAYS	18.5	17.3	16.8
28DAYS	27.8	26.4	25.6

Slump test result for mix concrete

Percentage of Recycled Aggregate (%)	Slump (mm)
0% recycled aggregate	80
30% recycled aggregate	70
50% recycled aggregate	65

III. GAP IN STUDY

As discussed in literature review mention below we find the use of geopolymer cement and foundry sand separately by different researchers in different study in building and roads in different way but there is no use of geopolymer cement and foundry sand together with recycled aggregate. So it is proposed to use of both material together to find their effect in concrete by replacing the geopolymer cement with cement and foundry sand with sand in concrete at different percentages & replacement and also replacement of fresh aggregate with recycled aggregate at various percentage.

IV. CONCLUSION

A. From the above literature it conclude that there is separate use of foundry sand recycled aggregate in different study so it is a good option to use both material with geopolymer cement for this particular study.

B. Foundry sand is a good option to replace with sand as it found from above literature.

C. Study based on mix design of any grade also taken in consideration by replacing foundry sand and recycled aggregate with geopolymer cement.

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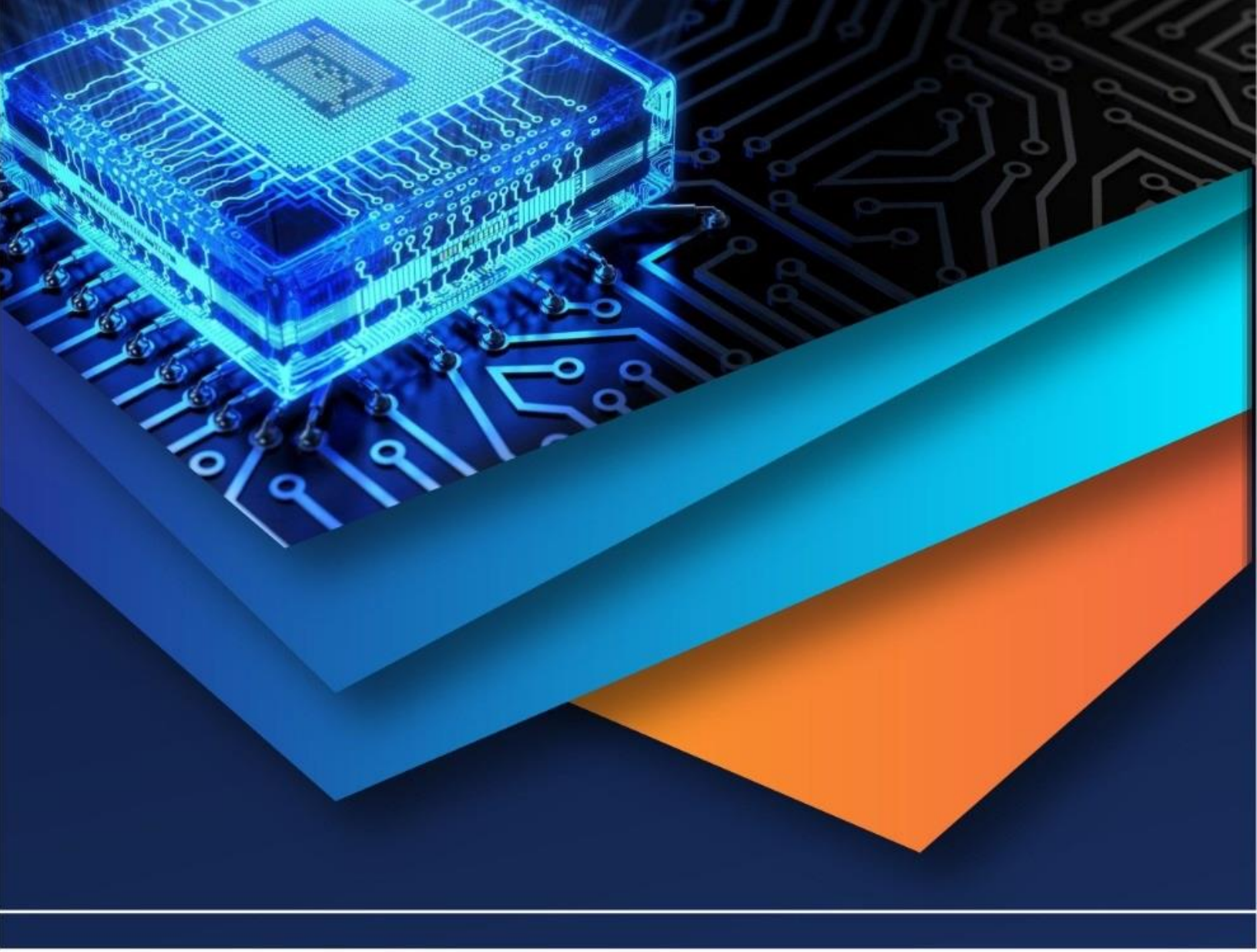

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