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Research Article

Study on the Effect of Waste Water on the Physical Properties of Cement and Concrete at Fresh Stage

Sonali S. Patil[1], Omkar Bidkar[2], Nitin More[3], Shradha Gore[4], Priyanka Urade[5], Sharddha Ingale[6], Prajkta Limkar[7]

[1, 2,3,4,5,6,7]*Assistant Professor, SVERI's College of Engineering Pandharpur-413304, Maharashtra, India.*

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Abstract: *Concrete is one of the composite material consisting of Coarse Aggregate, Fine aggregate, cement and water to cement ratio. All the components of the concrete are very important and affect the properties of the concrete at both fresh stage and hardened stage. Fresh properties of the cement and concrete such as setting time, heat of hydration, consistency and soundness. Various fresh properties of the concrete are Segregation, Bleeding, Hydration and Setting Time. There is great effect of type of water on the both properties of fresh and hardened concrete. There is greater requirement of large quantity of the water for the preparation of the concrete along with its curing. It is always not economical and technically feasible to provide fresh water at the construction site.Hence, waste water is used at the construction site for the preparation of the fresh concrete. Effect of the waste water on the physical properties of the cement and concrete are studied. It is found that there is improvement in the physical properties of the cement and concrete such as setting time, heat of hydration, consistency and soundness.*

Keywords: - *Waste Water, Setting Time, Consistency, Cement and Concrete.*

I. INTRODUCTION

Concrete is one of the composite material consisting of Coarse Aggregate, Fine aggregate, cement and water to cement ratio. All the components of the concrete are very important and affects the properties of the concrete at both fresh stage and hardened stage. Fresh properties of the concrete plays important role for both strength as well as durability point of view. Various fresh properties of the concrete are cement and concrete such as settingtime, heat of hydration, consistency and soundness. There is great effect of type of water on the both properties of fresh and hardened concrete. There is greater requirement of large quantity of the water for the preparation ofthe concrete along with its curing. It is always not economical and technically feasible to provide fresh water at the construction site. Hence, waste water is used at the construction site for the preparation of the fresh concrete.Waste water is less costly than fresh water and also used to improve the properties of the concrete at fresh stage.Hence, it is very necessary to study the effect of waste water on physical properties of the concrete.

II. LITERATURE REVIEW

Chaabene et al. 2020 [1] studied Machine Learning prediction of the mechanical properties of the concrete. The current study investigates ML models, such as artificial neural networks, support vector machines, decision trees, and evolutionary algorithms, for predicting the mechanical properties of concrete. Each model's use and performance are examined critically, leading to the identification of useful suggestions, existing knowledge gaps, and areas in which additional research is necessary. Malik et al. 2021 [2] studied thermal and mechanical properties of the concrete. The purpose of this work is to provide a brief critical evaluation of the thermal and mechanical characteristics of several types of concrete and its constituents at high temperatures and to identify some potential future research directions. Bahij et al. 2020 [3] studied fresh and hardened properties of the concrete containing different forms of plastic waste.

This essay provides a summary of earlier works that have looked into the usage of various plastic wastes in concrete mixtures. The consequences of plastic waste on the initial, mechanical, thermal, and acoustical qualities of concrete are also discussed from a broad perspective. Pacheco et al. 2020 [4] studied experimental investigation of the variability of the main mechanical properties of concrete produced with coarse recycled aggregate. This study presents an experimental programme on the within-batch variability of numerous recycled and natural aggregate concrete mixes' compressive strength, Young's

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modulus, and splitting tensile strength. Analysed and discussed is the impact of recycled concrete aggregates on the mechanical characteristics and variability of concrete, and benchmarks and standard predictions for the variability of concrete with natural aggregate are created. Berredjem et al. 2020 [5] studied mechanical and durability properties of the concrete. This study will look at how differing granular compositions—recycled coarse and fine aggregate—affect the durability and mechanical properties of concrete. Five series of concrete mixes made with various granular (natural/recycled) combinations were researched. According to European standards, the formulation of the reference concrete was based on a consistent amount of 400 kg/m3 of cement and a constantworkability of fresh concrete that secured the S2 class of flowability and C25/30 concrete class. Chu et al. 2019 [6] studied the effect of paste volume on the fresh and hardened properties of the concrete. In this study, the effect of CPV on various performance attributes of concrete at fresh and hardened states was evaluated by varying the CPV from 26% to 32% at two different W/C ratios. Based on the tests results and inter-relationships among them, it was found that decreasing the CPV, i.e., reducing the cement content at constant W/C ratio, would decrease the uncompacted wet density while increase the compacted wet density, increase the strength at all curing ages, increase the Young's modulus, flexural strength and splitting tensile strength, and improve the quality of concrete, albeit the decrease of workability that could be compensated by increasing the superplasticizer dosage or adding fillers.

III. METHODOLOGY

Figure 1 shows the detailed methodology of the study. Introduction section involves the importance of the fresh and hardened properties of the concrete. Literature review is carried out in detail which involves literature related to the various properties of the concrete. Various properties of the cement such as setting time, heat of hydration,consistency and soundness are studied in detail. All the properties of the cement and concrete are studied for both normal water and waste water. Statistical analysis is used to check whether there is improvement in the propertiesof the concrete at fresh stage.

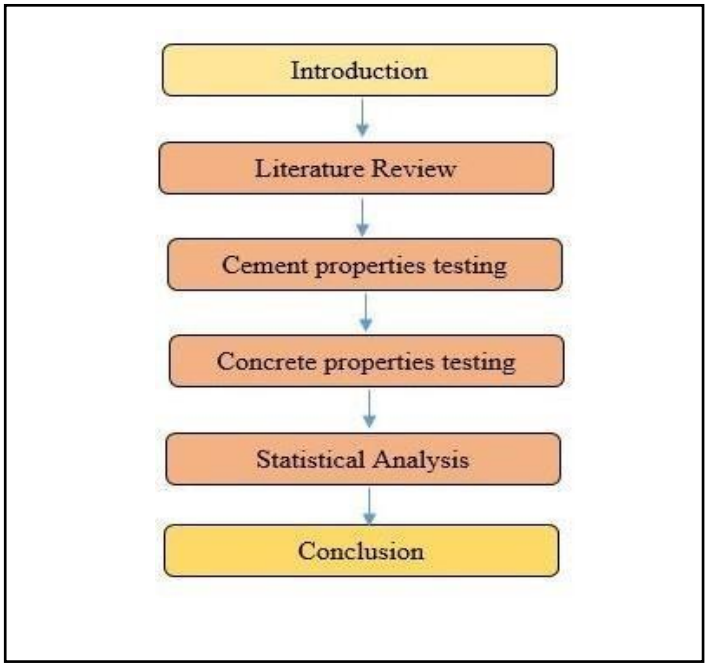

Figure 1: Detailed Methodology of the Study

IV. TESTING AND RESULTS

A. Types of Tests

Various types of the tests are studied which involves setting time, heat of hydration, consistency andsoundness.

a) Consistency of Cement

The ability of cement paste to flow is consistency. It is measured by Vicat Test. In Vicat Test Cement paste of normal consistency is taken in the Vicat Apparatus. The plunger of the apparatus is brought down to touch the top surface of the cement. The plunger will penetrate the cement up to a certain depth depending on the consistency. A cement is said to have a normal consistency when the plunger penetrates 10¡À1 mm.

b) Heat of Hydration

When water is added to cement, the reaction that takes place is called hydration. Hydration generates heat, which can affect the quality of the cement and also be beneficial in maintaining curing temperature during cold weather. On the other hand, when heat generation is high, especially in large structures, it may cause undesired stress.

c) Soundness

Soundness refers to the ability of cement to not shrink upon hardening. Good quality cement retains itsvolume after setting without delayed expansion, which is caused by excessive free lime and magnesia.

d) Setting Time

Cement sets and hardens when water is added. This setting time can vary depending on multiple factors, such as fineness of cement, cement-water ratio, chemical content, and admixtures. Cement used in construction should have an initial setting time that is not too low and a final setting time not too high. Hence, two setting times are measured:
Initial set: When the paste begins to stiffen noticeably (typically occurs within 30-45 minutes) Final set: When the cement hardens, being able to sustain some load (occurs below 10 hours)

B. Sources of Waste Water

Cement and concrete specimens are prepared with normal water, water with oils and fats, water with heavy metalsand waste with salt water and brines. Five samples of each type are prepared and tested for setting time, heat of hydration, consistency and soundness. One way ANNOVA test is used to see whether there is significant difference in the properties of the various cement and concrete.

C. Variation in Properties of Fresh Concrete

Table 1 shows Initial setting time for various types of samples. It is found from the Table 1 that there isincreasein setting time of cement with addition of industrial waste with respect to the normal water.

Table 1: Initial Setting Time of Cement for Various Types of Samples

Initial Setting Time of cement (minute)					
Samples	**Normal Water**	**ter with oilsand fats**	**Water with Heavy metals**	**Waste with salt water and brines**	**One way ANNOVA (95 % Confidence Interval)**
1	55	64	71	80	3.56 > 2.09
2	52	67	70	84	
3	53	68	76	86	
4	58	70	74	81	
5	57	72	73	78	

One way ANNOVA test also shows that there is significant difference between initial setting time ofvarioussamples at 95 % confidence interval.

Table 2 shows final setting time of cement in hours for various samples of the cement. It is found from the Table2 that final setting time of cement decreases with addition of waste water. One Way ANNOVA test alsoshow that there is significant variation in the final setting time of cement at 95 % confidence interval.

Table 2: Initial Setting Time of Cement for Various Types of Samples

Final Setting Time of cement (hours)					
Samples	**NormalWater**	**Water with oilsandfats**	**Water with Heavy metals**	**Waste with salt water and brines**	**One way ANNOVA (95 % Confidence Interval)**
1	6	4.9	4.1	4.3	
2	6.2	5.3	3.8	4.1	
3	5.8	5.4	3.6	3.9	

4	5.9	5.7	3.7	4.4	4.55> 2.09
5	6.1	5.8	4.2	4.6	

Table 3 shows consistency of cement in percentage for various samples of the cement. It is found from the Table 3 that consistency of cement decreases with addition of waste water. One Way ANNOVA test also show that there is significant variation in the consistency of cement at 95 % confidence interval.

Table 3: Consistancy of Cement for Various Types of Samples

Consistency of cement (Percentage)					
Samples	**NormalWater**	**Water with oilsandfats**	**Water with Heavy metals**	**Waste with salt water and brines**	**One way ANNOVA (95 % Confidence Interval)**
1	21	19.4	17.4	17.4	5.21> 2.09
2	22.5	18.2	18.2	17.2	
3	23	18.3	16.7	17.3	
4	24.1	19.4	17.5	16.9	
5	23.2	19.5	18.2	17.2	

V. CONCLUSION

i). There is improvement in the properties of cement at fresh stage with addition of waste water with respectto thenormal water in test sample.

ii). It is found from the results that there is increase in setting time of cement with addition of industrial waste with respect to the normal water. One Way ANNOVA test also show that there is significant variation in the finalsetting time of cement at 95 % confidence interval.

iii). It is found from the results that final setting time of cement decreases with addition of waste water. OneWayANNOVA test also show that there is significant variation in the final setting time of cement at 95% confidence interval.

iv). It is found from the results that consistency of cement decreases with addition of waste water. One Way ANNOVA test also show that there is significant variation in the consistency of cement at 95 % confidenceinterval.

v). Industrial water is the best option for the study for the preparation of cement mix where there is scarcityin the provision of normal water both in terms of economy and environment.

VI. REFERENCES

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