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Rheological and Mechanical Properties of Standard Concrete by using locally available Calcareous and Siliceous Material

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Abstract: The investigates is basically on the Rheological and Mechanical properties of standard concrete by using Locally available Calcareous and Siliceous material and a comparative study is done for the rheological parameter for mixes with or without using superplasticizer. For rheological parameter, various mixes with water cement ratio of 0.45 and slump value of 120 mm were prepared for the experiment by replacing different percent as (0%,5%,10%,15%) of locally available material such as Metakaolin and tested with German based instrument ICAR Rheometer. Test on Rheometer is done to study flow property of concrete so that concrete mixes can be pumped to high rise building properly. As per the finding, as the metakaolin percentage were increased the static yield and dynamic yield stress decreases this indicate that it is easy to pump at higher blending. For mechanical properties, mixes were prepared and test Performed is compressive strength test. The findings of this experiment have important implication for construction industry basically in the high-rise structure.
Keywords: Metakaolin, Water – Binder Ratio, supplementary cementitious materials, Silica Fume

I. INTRODUCTION

Concrete is the most important component of any structure and is the most widely utilized material in the construction industry. A number of factors influence concrete selection, including environmental impact, energy usage, budget, and technical features. As a result, concrete technology has advanced in the production of alternative building materials that can match these specifications while remaining locally available, cutting construction costs. Standard concrete is a stronger concrete than common concrete. Its strength is achieved by using supplementary cementitious materials (SCMs) that is metakaolin, rice husk ash, fly ash, silica fume, granulated blast furnace slag etc. This material became popular in the construction industry because of its ability to enhance the mechanical and rheological properties of concrete.

A. *Rheology of Concrete*

Rheology is defined as the study of the behaviour of fluid flow and its deformation. In this case, material is taken as freshly prepared concrete. Study of rheology is important for understanding and managing concrete qualities like as workability, stability and ease of placement. Concrete's rheological properties affect everything from mixing, handling and transportation to the performance of structures. Our country is developing, so the consumption of concrete is increasing. Currently, high-rise structures or skyscrapers are preferred over low-rise buildings. To transport concrete from one place to another we need to modify properties of concrete as to make it pumpable and after pumping it can be workable.

1) *The Bingham Model:* The Bingham model is often used to represent concrete flow behaviour due to its simplicity and ability to represent the majority of concrete mixtures.

II. METHODOLOGY

A. *Materials Properties*

In the present experimental investigation, Portland slag cement (PSC) corresponding to Bureau of Indian Standard (BIS) IS:455:2015 [1]is used. The other cementitious materials included GGBS and AF was used in the densified form in this research. The GGBS and AF sample satisfied the requirements of IS 15388-2003 [2] and IS 12089–1987 [3]. W/b ratio is taken as 045 for all mixes. As fine aggregate, common riverbed sand with a Fineness modulus of 2.60 was used. Specific gravity and water absorption were found to be 1.0% and 2.63, respectively. As coarse aggregate 20 mm-sized crushed Pakur stone that was readily available locally was used.

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Specific gravity and Water absorption were found to be 0.78% and 2.74, respectively. Polycarboxylic ether-based water-reducing superplasticizer fosroc auramix 200 [4], [5]was used in preparing concrete mixes. Particle size distribution curve for coarse and fine aggregate is shown in Figure 1.

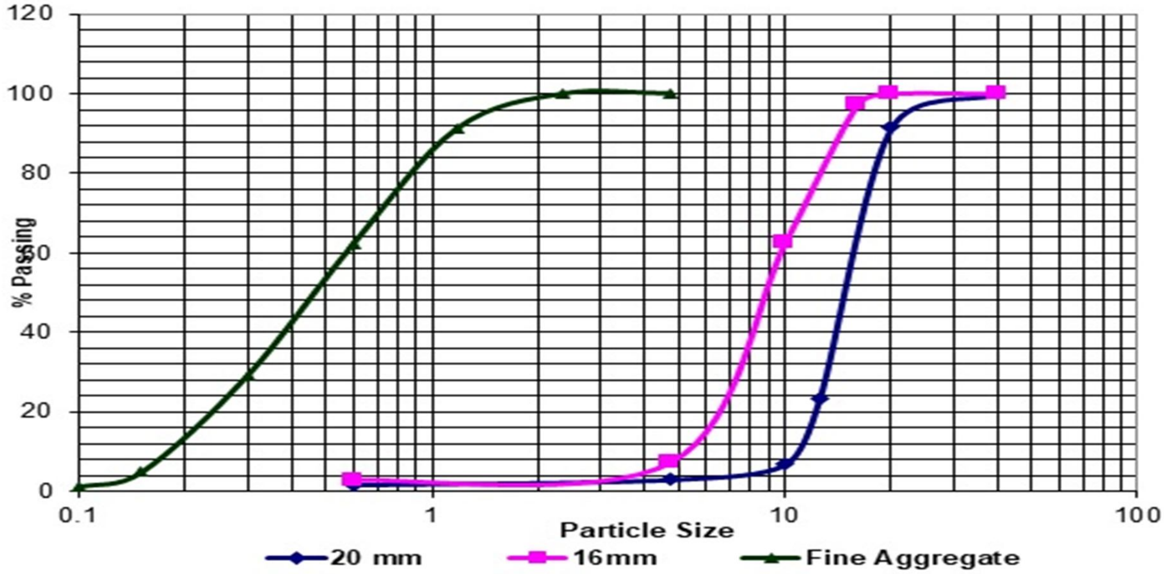

Figure1. Particle Size Distribution of Coarse and Fine Aggregate

B. *Mix Proportion*

Mix proportion of mixes without superplasticizer and with superplasticizer are shown below in Table 1 and Table 2 respectively.

Table 1. Mix Proportions without using HRWRA (Kg/m^3)

Metakaolin%	0 %	5 %	10%	15%	20%
Cement	440	418	396	374	352
Fine aggregate	727	729	726	724	723
Coarse aggregate	952	994	990	988	987
Water	200	200	200	200	200
metakaolin	0	22	44	66	88

Table 2. Mix Proportions using with HRWRA (Kg/m^3)

Metakaolin%	5%	10 %	15%	20%
Cement	323	306	289	272
Fine aggregate	810	815	813	813
Coarse aggregate	1103	1111	1110	1105
Metakaolin	17	34	51	68
water	154	154	154	154
admixture	2.55	2.55	2.55	2.55

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III. RESULTS

A. *Compressive Strength*

The uniaxial compressive strength of the concrete was determined by crushing three cube samples of size 150mm after 3, 7 and 28 days of curing, as per Bureau of Indian Standard (BIS) [6] equivalent to ASTM C39-18[7]. For each age, the average compressive strength of three specimens was calculated. Figure 2. Illustrate the compressive strength results obtain from experimental work.

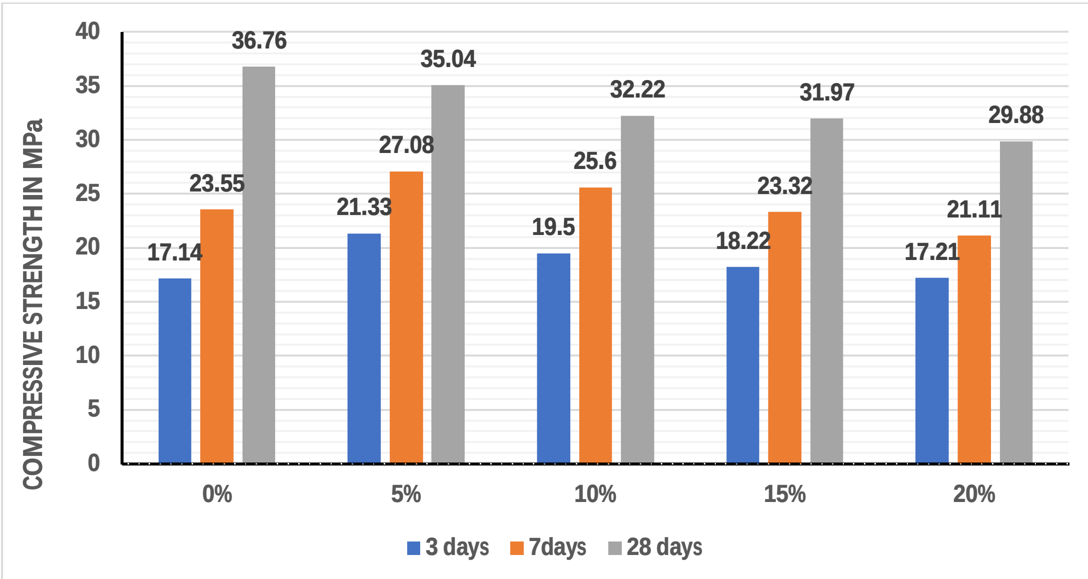

Figure 2. Compressive Strength Test Results

The optimum strength that has been obtained from the test result found to be at 0 % Metakaolin variation in the mix as seen in Figure 2. Approving the literature review revealing that blending percentage of metakaolin increases, early gain of strength increases i.e. strength at 3 days and 7 days. Further Strength decreases. In this concrete mix the water reducing agent was taken to be 1.2% and water content was kept around 0.45.

B. *ICAR Rheometer Test Result*

After conducting various test on ICAR rheometer different graph of stress growth test and flow curve test are obtained which are shown in Figure 3 to Figure 10.

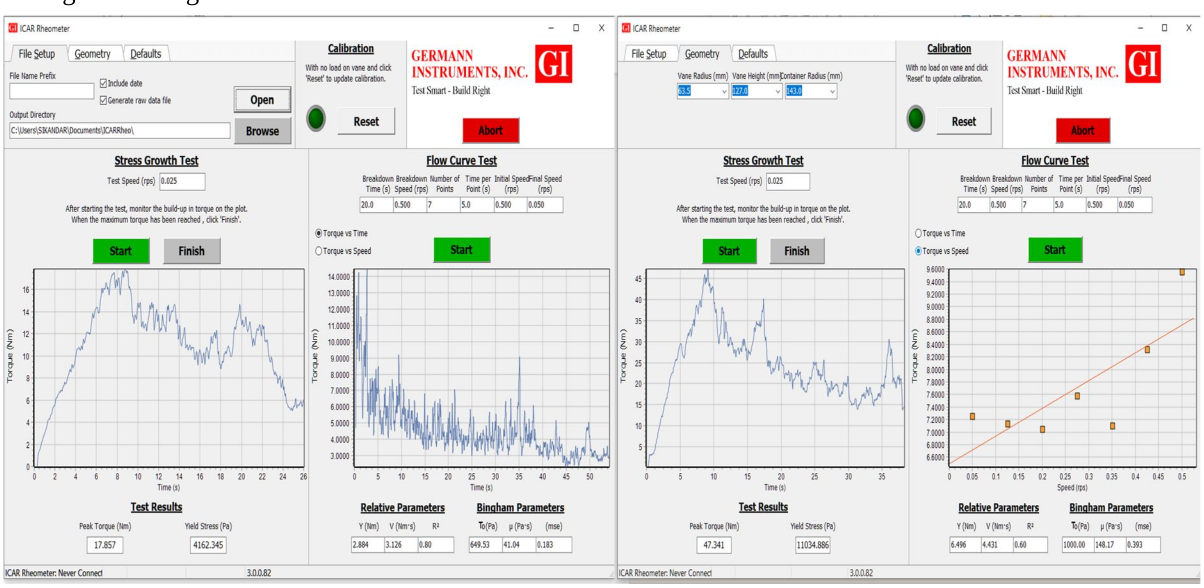

Figure 3. Trial result of test at w/b =0.45, metakaolin=0% without using superplasticizer

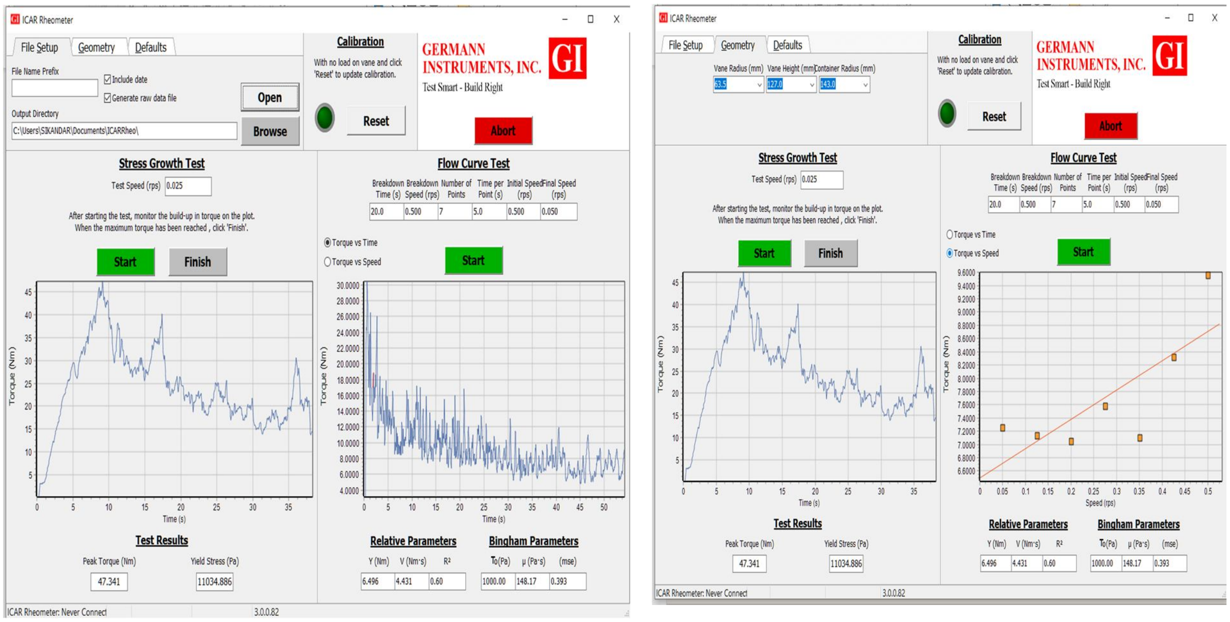

Figure 4. Trial result of test at w/b =0.45, metakaolin=5% without using superplasticizer

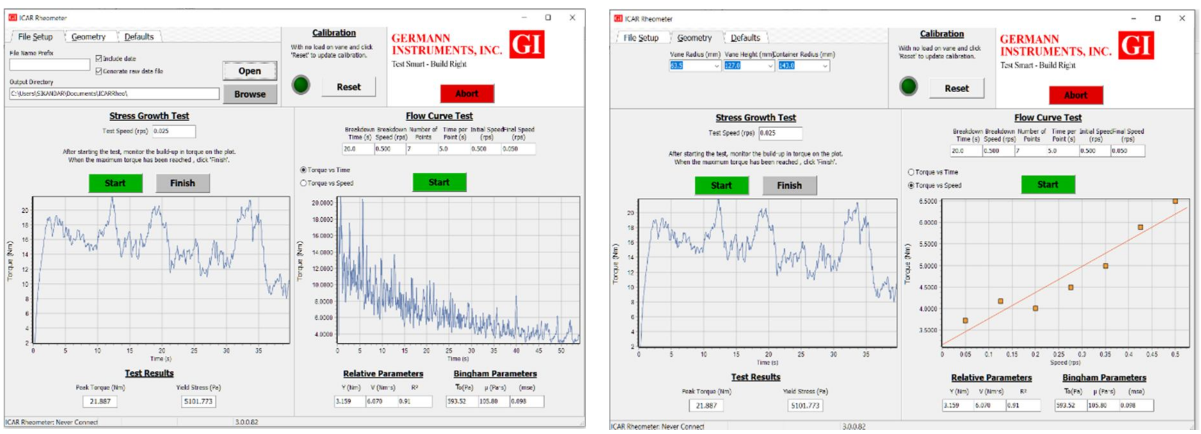

Figure 5. Trial result of test at w/b =0.45, metakaolin=10% without using superplasticizer

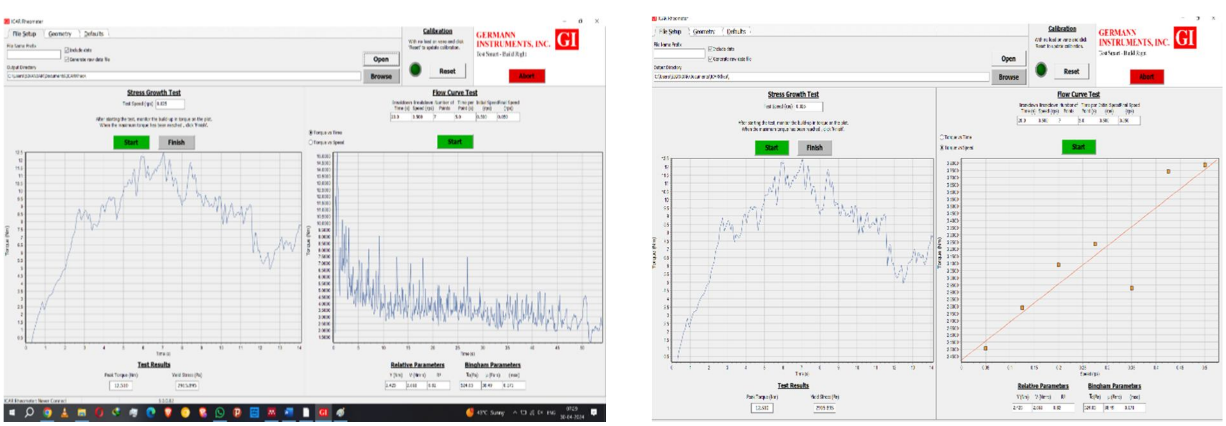

Figure 6. Trial result of test at w/b =0.45, metakaolin=15% without using superplasticizer

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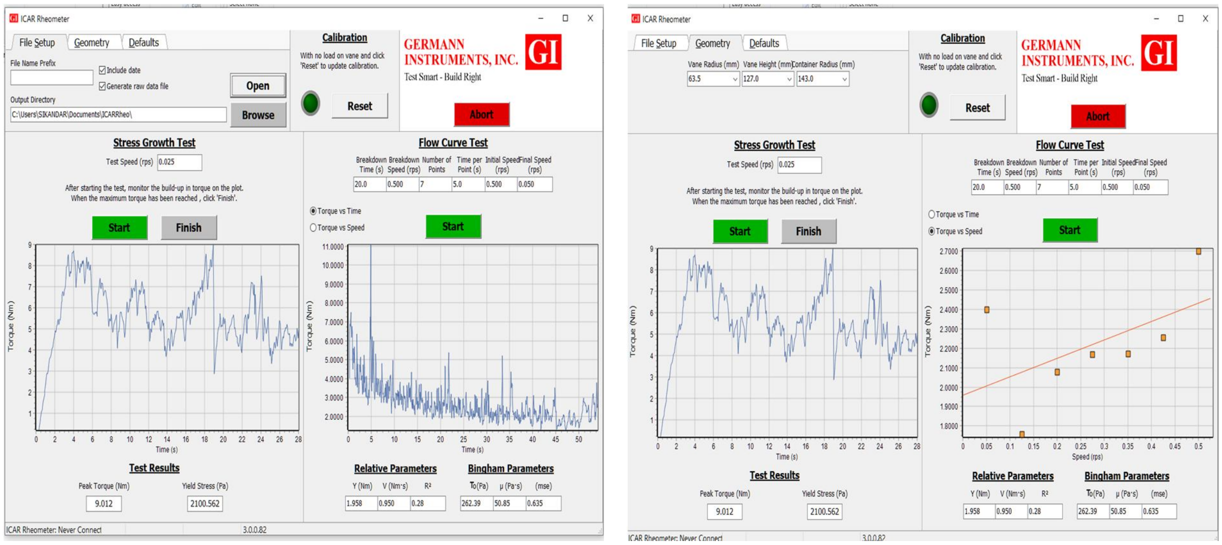

Figure 7. Trial result of test at w/b =0.45, metakalin=20% without using superplasticizer

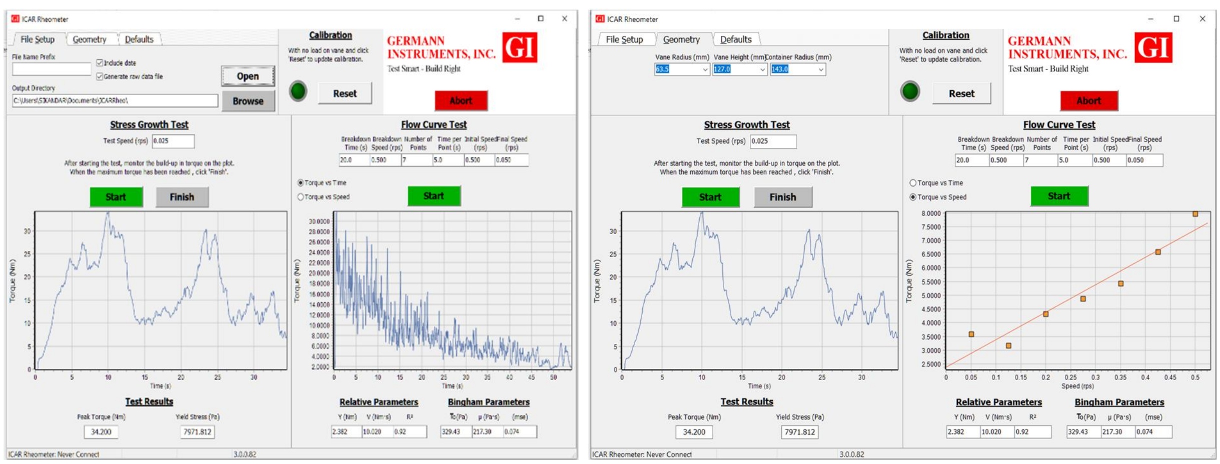

Figure 8. Trial result of test at w/b =0.45, metakaolin=5% with using superplasticizer

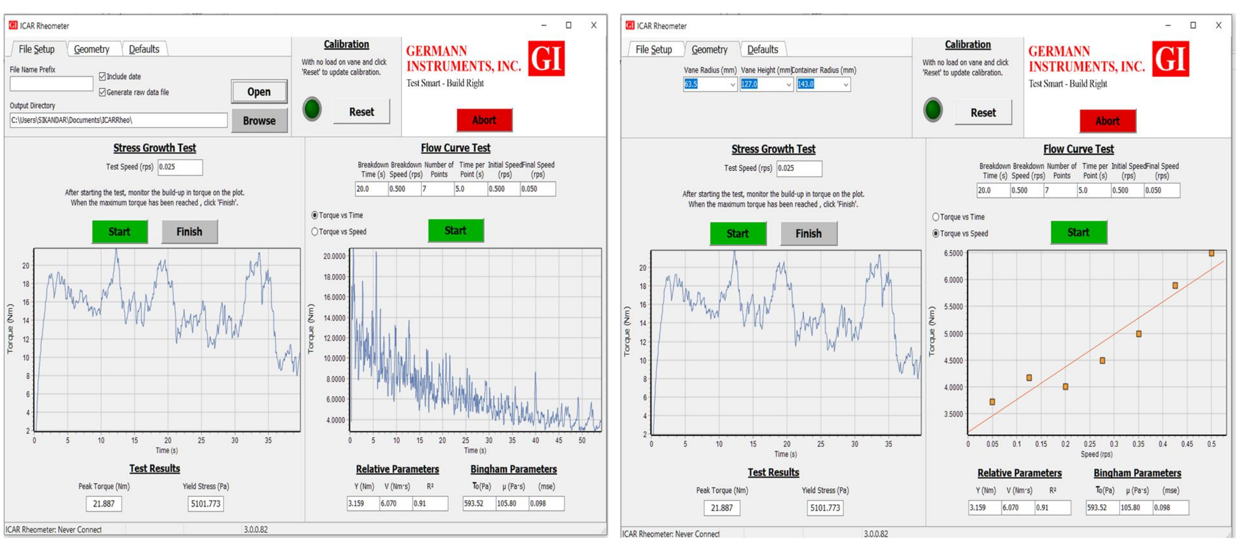

Figure 9. Trial result of test at w/b =0.45, metakaolin=10% with using superplasticizer

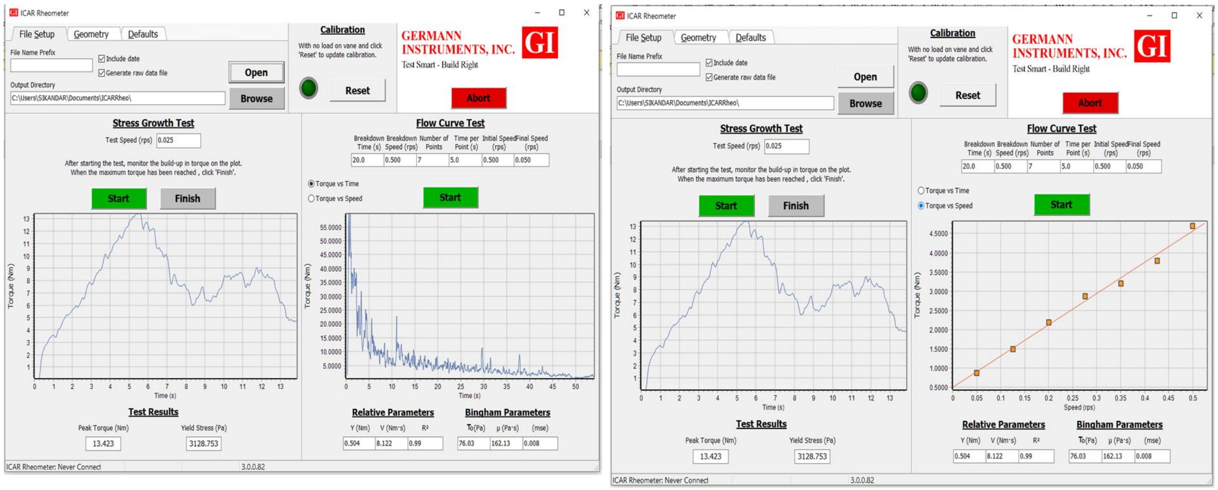

Figure 10. Trial result of test at w/b =0.45, metakaolin=15% without using superplasticizer

C. Comparison of Rheological Properties with or without using superplasticizer

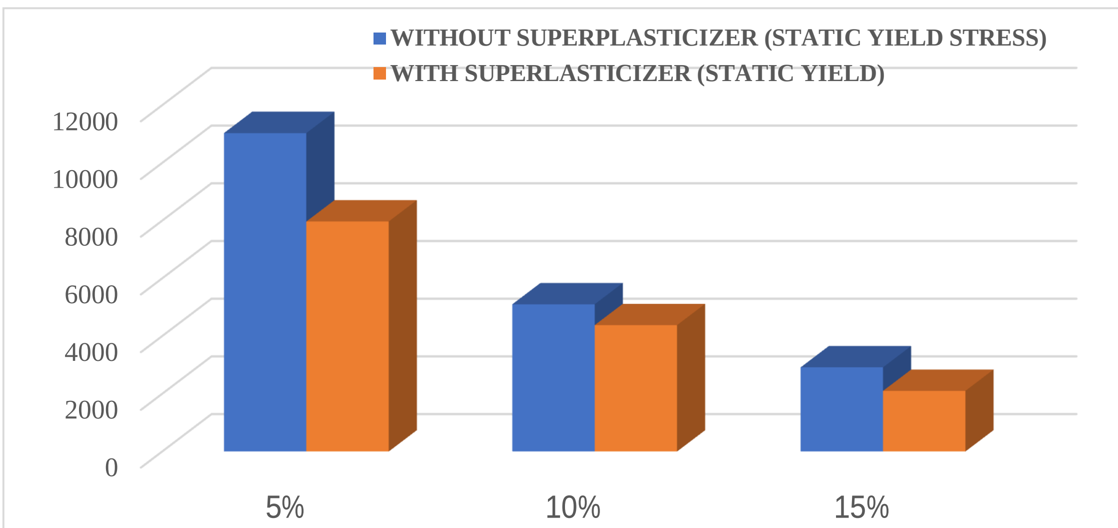

Figure 11. Comparison of static yield with and without HRWRA

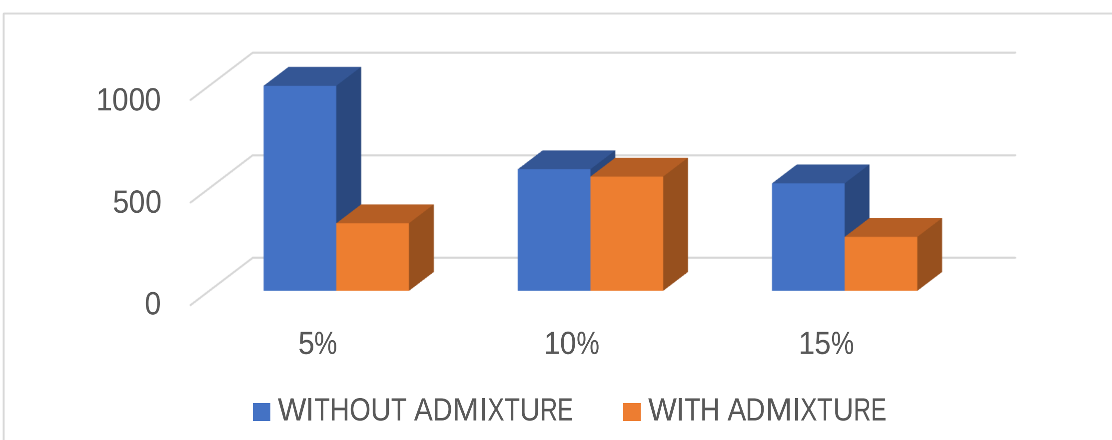

Figure 12. Comparison of dynamic yield with and without HRWRA

IV. CONCLUSION

1) After comparing rheology of mix prepared with HRWRA gives better result than mix which are not prepared with HRWRA.
2) It is seen that as blending percentage of metakaolin increases, early gain of strength increases i.e. strength at 3 days and 7 days.
3) It is seen that compressive strength at 28 days decreases as the percentage of metakaolin increases.
4) It is seen that if there is an increase of Metakaolin (%) from 0% to 15% then there is decrease in both the yield stress and plastic viscosity.
5) For the blending greater than 15%, compressive strength decreases below target strength. It is recommended to blend metakaolin up to 15%.
6) Compressive strength at 3 days is approximately 65% of 28 days strength.
7) As the percentage of metakaolin increases, pumping force decreases.
8) After detailed analysis of rheological and physical strength parameter, it is seen that mix with 15% of metakaolin is best choice

Conflict of Interest: The author declares that they have no conflict of interest

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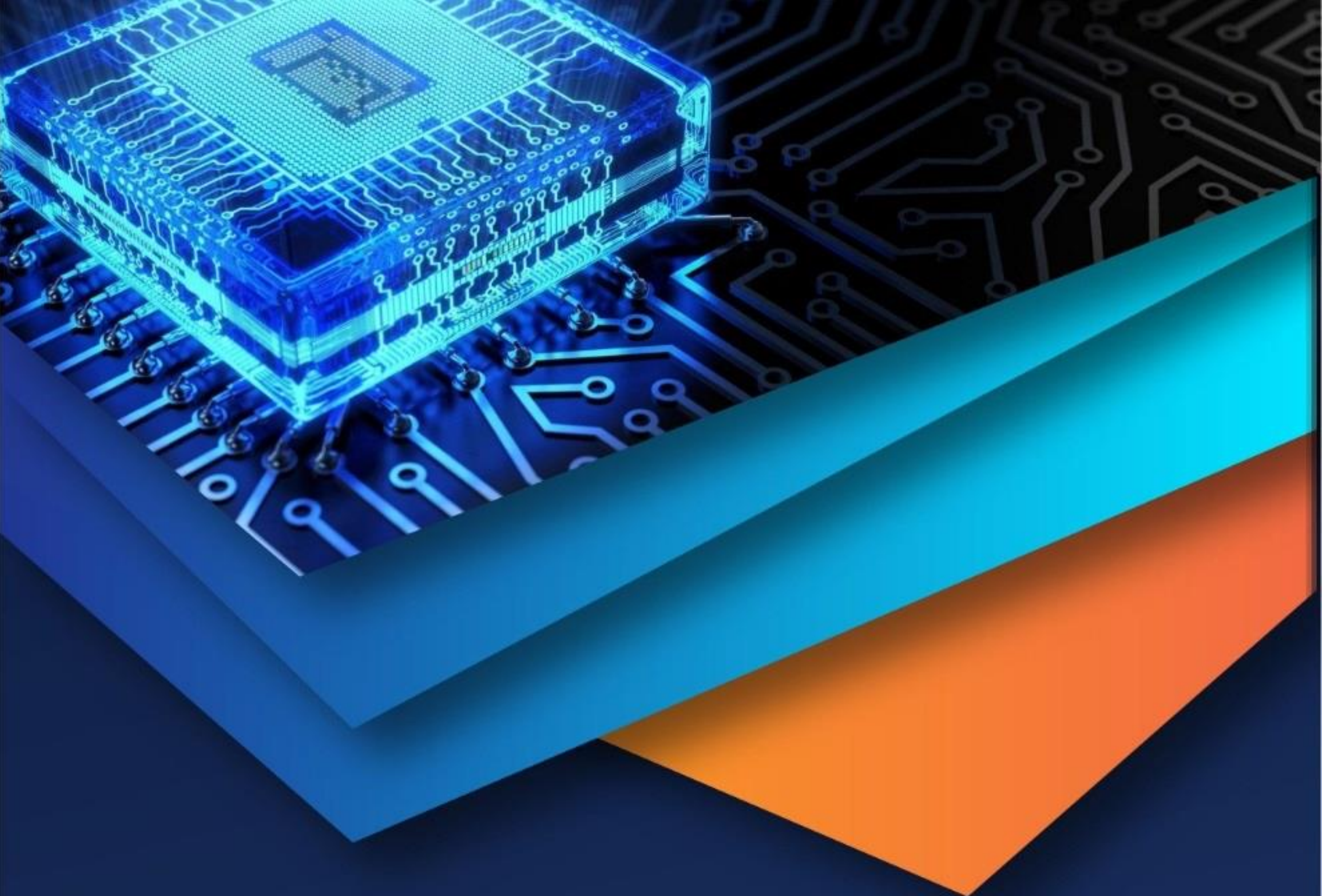

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