Progressive Agriculture 30 (3): 305-310, 2019 ISSN: 1017 - 8139

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Effects of selected chemical admixtures on physical and mechanical properties of cement mortar

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Abstract

This study was aimed to determination of appropriate dosage of selected chemical admixtures to reduce water cement ratio for mortar mix also to determine its effects on physical and mechanical properties of cement mortar. Amount of water used in concrete is very important for the physical and mechanical properties. Less amount of water increase the strength but reduce the workability. Water retarding admixture can reduce the water cement ratio with desired workability. In this experiment plasticizer (master pel 707) and super plasticizer (master polyheed 8632) was used. The used dosages of admixture were 0.5%, 1% and 1.5% according to cement weight. The test was done at 3 days, 7 days, 28 days and 91 days. 2.76″ cube mold was used for the work. The experiment was done to find the difference between with and without admixture used in mortar. Water used reduced with add of plasticizer and super plasticizer. In the experiment the workability of normal mortar and admixture used mortar remain same. The compressive strength is high for 1.5% super plasticizer used sample. So 1.5% super plasticizer is recommended for high strength.

Key words: Chemical admixture, plasticizer, physical properties, mechanical properties

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Introduction

Concrete is basically a mixture of two components which is called aggregates and binder. Concrete consists of cement, sand, aggregate and water. Mortar is one of the most important materials for construction. The properties (strength, durability, impermeability and workability) of concrete depend upon Grading of aggregates, quality and quantity of cement, moisture content of the aggregates, water-cement ratio, proportioning of the various ingredients of concrete, method of mixing, placing, Compaction and Curing of concrete. Water-cement ratio is very important for the physical and mechanical properties of concrete. Less amount of water increase the strength but reduce the workability. Chemical admixture can reduce the water cement ratio with desired workability.

Admixture called melamine formaldehyde sulfanilate (MFS) and cyclohexanone formaldehyde sulfonate (CFS). The results showed that the dosage of admixtures increases, the water of standard consistency decreases, this leads to a decrease in the total porosity of the cement pastes, and consequently the compressive strength value increases (Habib *et al.,* 2016). In the case of air-entrained, Very high performance self-compacting concrete (VHPSCC), both yield stress and viscosity increased with increasing air content (Łazniewska-Piekarczyk, 2013). Including super plasticizers (SPs). The workability of

the PCPC mixtures is greatly affected by the type and amount of chemical admixture added (Jimma and Rangaraju, 2015). The experiment results had good performance in almost all aspects of the mechanical behaviors in compression and the mechanical performances deteriorated with the increase in the amount of SRA up to 2% (Yoo *et al*., 2015).

The compressive strength of mortar varied logarithmically with the days of moist curing (Ransinchung and Kumar, 2010). Increase in workability loss was more severe with Portland Cement in comparison to Ligno Sulfonate (LS), Naphthalene Sulfonate Formaldehyde (Azarijafari *et al,.* 2014). Naphthalene sulfonate formaldehyde condensate powder (NSF) is used as water-reducing admixture (WRA) and recommended dosage of the WRA was 1.5–2.5 (% by mass of cement) (Zheng *et al*., 2016). Chemical admixtures like air entraining (AEA) and plasticizing(PA) to make Porous cement paste and identified Physical properties like dry density and compressive strength of hardened porous cement paste. It showed that the compressive strength of the porous hardened cement paste has been reduced from 100 to 2.5 MPa (Šeputyte-Jucike and Kligys, 2016). Silica fume led to a remarkable increase in flow resistance while it slightly reduced torque viscosity (Yun *et al*., 2015). As the added percentage of FBA increased, the workability of fresh concrete as well as the mechanical properties including the water-tightness of hardened concrete improved (Choi *et al*. 2015). Impermeability improvement effect and partially strength loss, well-predesigned strength offsetting and appropriate fly ash combining dosage was also suggested to generate remarkable workability in practical application (Yu *et al*., 2016).

This study was aimed to determine the appropriate dose of selected chemical admixtures for cement Mortar. Also to determine the effects of admixtures on the physical and mechanical properties of cement Mortar.

Materials and Methods

Mortar was prepared by the use of cement and sand (1:3) and admixture. The fineness modulus of used Sand was 1.53. The composition of used cement is Clinker - 95% to 100 % Gypsum - 0% to 5 % and Strength Class 52.5 N (Akij Portland Cement Product Information, Web page).

The used Admixtures were Masterpel 707 and Masterpolyheed 8632. Masterpel 707 is dark brown liquid which Relative Density1.17±0.02 at 25º C, $P^H \geq 6$ Chloride ion content <0.2, .Air entrainment 2 ± 1% and Surface absorption of water, BS 1881: Reduction of 60-80 %. It is plasticizer.

Masterpolyheed 8632 is Deep Brown in Color, $P^H > 6$, Relative Density 1.08+0.01 at 25^0C and Chloride ion content<0.2%. It is super-plasticizer.

The admixtures were taken at 0.5%, 1% and 1.5% of the weight of cement. Then cement and sand (1:3) was mixed properly. The measured admixture was mixed with water. Then water with admixture was given on the mixture of cement and sand gradually. The workability test was done by a cylinder of 80 cm diameter and 80 cm height. Cubic samples (2.78″) were prepared for the experiment. After proper mixing the mixture were cast in cube moulds. The cubes were taken out of the moulds after 3 days. After de-molding samples were immersed in water for curing. The temperature of that water was 20℃. Three cubes were cast for different ages called 7 days, 28 days and 91 days. Before crushing the weight of sample was taken for measuring density.

Results and Discussion

In this study physical and mechanical properties of chemical admixture used mortar cube was determined.

***Water Cement Ratio*:** Water cement ratio of 0%, 0.5%, 1%, 1.5% of plasticizer (Masterpel 707) and super plasticizer (Masterpolyhead 8632) was determined. One of the objectives of this experiment was to decrease the water cement ratio by using chemical

admixture. From the graphical representation (Figure 1) we can see the water cement ratio decreased with the increase of plasticizer use. Water cement ratio was minimum for the use of maximum chemical admixture. The use of water reduced 5.04% for 0.5%, 9.35% for 1% and 11.08% for 1.5% use of plasticizer in compare with 0% admixture used sample.

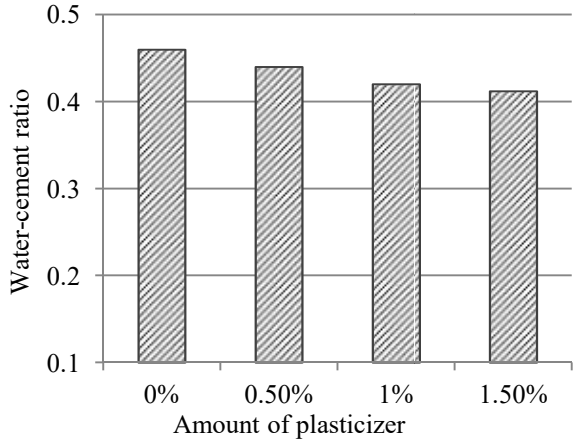

Figure 1. Water cement ratio for different dosage of plasticizer used in mortar.

The water cement ratio decreased with the increase of plasticizer use (Figure 2). The use of super plasticizer reduces water with 4.32% for 0.5%, 7.91% for 1% and 10.79% for 1.5% use.

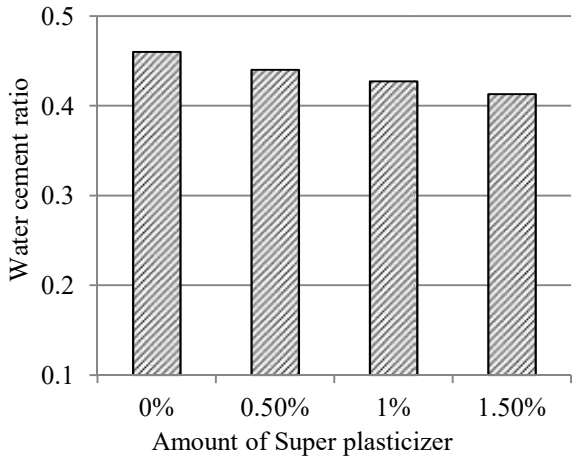

Figure 2. Water cement ratio for different dosage of super-plasticizer used in mortar.

Water cement ratio was almost same for 0.5% , 1% and 1.5% of plasticizer and super plasticizer used in mortar (Figure 3).

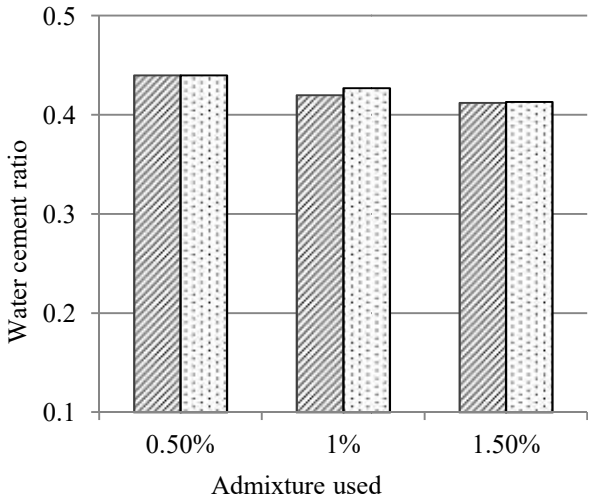

Figure 3. Comparison of water cement ratio for plasticizer and super plasticizer.

***Workability*:** The workability of the mortar prepared with plasticizer in various percentages was nearly the same. It varied 84 mm to 87 mm (Figure 4).

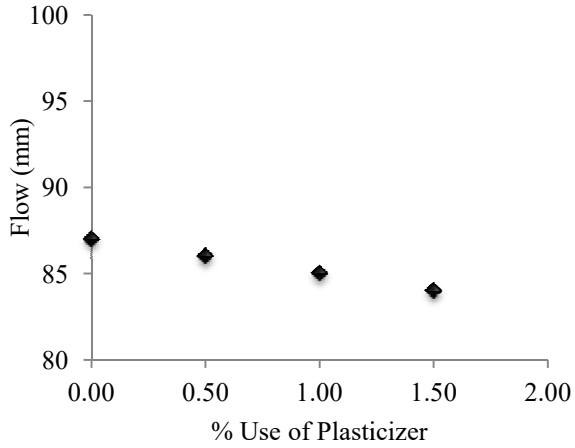

Figure 4. Relation between flow and amount of plasticizer used.

The flow of different dosage of super plasticizer was nearly same (Figure 5). The test result varies 85.5 mm to 87 mm. The 1.5% use of super plasticizer is same flow ability to 0%.

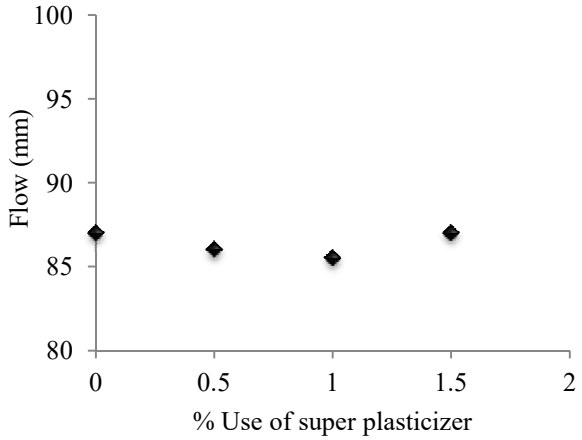

Figure 5. Relation between flow and super plasticizer used.

Compressive Strength: The compressive strength measured for the samples prepared with and without use of admixture (plasticizer& super plasticizer). The test was done in 3, 7, 28 and 91 days of curing. The compressive strength of plasticizer used samples increased with time and it was highest at 91 days of curing. Initially (at 3 days) highest amount (1.5%) of plasticizer showed the higher compressive strength. But at final age 0.5 and 1% plasticizer used samples showed better result (Figure 6).

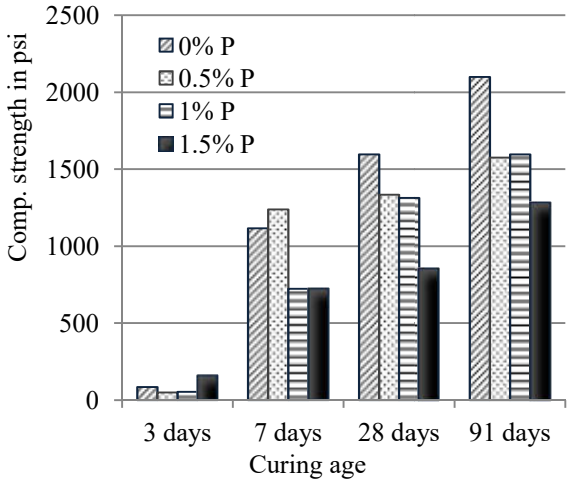

Figure 6. Compressive strength with different dosage of plasticizer (Masterpel 707).

The compressive strength of super plasticizer used samples increased with time and it was also highest at 91 days of curing. The values of strength shows that the 0.5% and 1.5% of super plasticizer used samples showed higher compressive strength than without admixture values (Figure 7). 1.5% super plasticizer used samples showed the highest compressive strength.

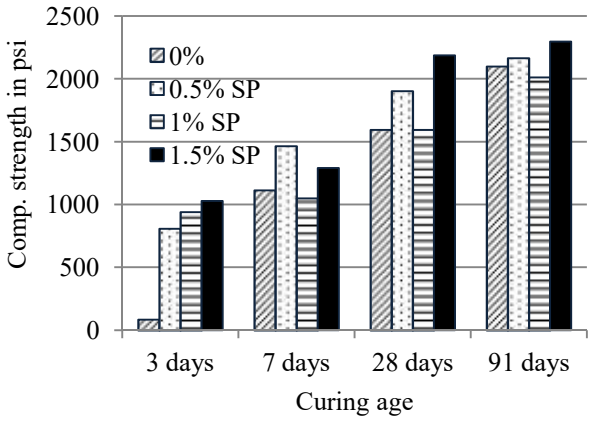

Figure 7. Compressive strength with different dosage of super-plasticizer (Masterpolyhead 8632).

Density: Density of plasticizer used mortar samples were increased with time (Figure 8). It was almost same at 28 and 91 days. So, curing up to 28 days is enough to reach its peak density.

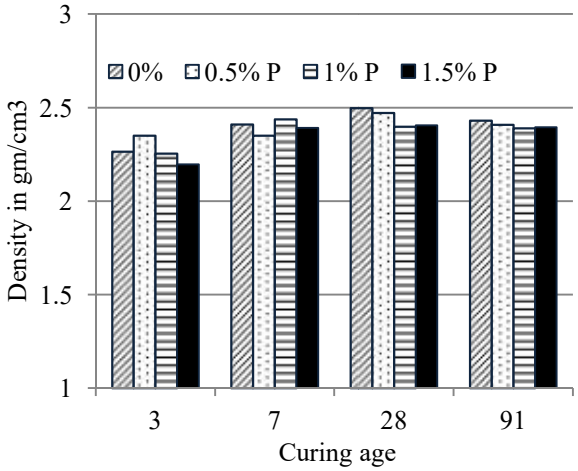

Figure 8. Density of plasticizer (Masterpel 707) used samples at different curing age.

Density of super plasticizer used mortar samples were increased with time (Figure 9). It was almost same at 7, 28 and 91 days. So, curing up to 7 days is enough to reach its peak density.

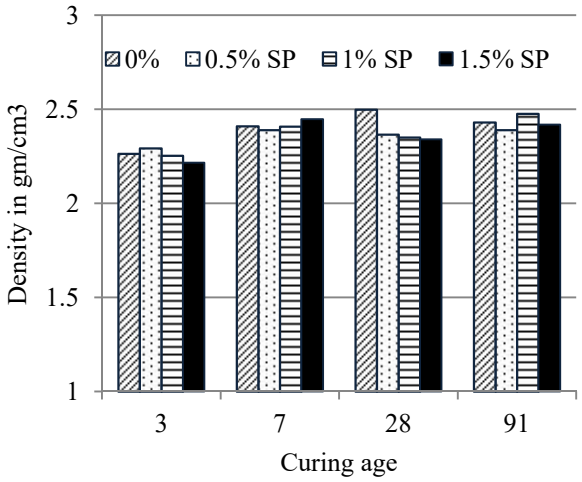

Figure 9. Density of super plasticizer used samples (Masterpolyhead 8632) at different curing age.

Conclusions

From the experiment, the following conclusions may be drawn:

- The water cement ratio of mortar (1:3) cubes decreases with increases of chemical admixture.
- Water used could be reduced with addition of plasticizer and super plasticizer.
- The workability result of normal mortar and admixture used mortar remain same.
- The 0.5 to 1 % of plasticizer is recommended for higher compressive strength.
- The 0.5% and 1.5 % of super plasticizer is recommended for higher compressive strength.
- Masterpel 707 is a water reducing admixture.
- Masterpolyhead 8632 is a water reducing as well as strength increasing chemical admixture.

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