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Effect of acidic aggressive environment on strength of mortars in early stage

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Abstract : This paper presents the result of experimental investigation on strength of mortars in early stage in acidic aggressive environment. Cement mortar is a building compound made by blending sand and cement with a predefined measure of water. Superplasticizer is also added in cement mortars to study its effect on compressive strength. Mortar specimens were prepared in different proportions with and without superplasticizer and their effect on compressive strength is noted in acidic aggressive environment. Superplasticizer is a admixture which reduced the water-cement ratio or increase the workability at same water content..

Keywords: Superplasticizer, admixture, compressive strength, aggressive environment

1. INTRODUCTION

Sulphuric acid attack on mortar can occur in many ways i.e. can be subjected to attacks by mineral acids which includes sulphuric, nitric, phosphoric and hydrochloric acid. Sulphuric acid is also important component in acid rain which can affect the durability of the mortar. Sewage system is another source of severe sulphuric acid attack. Since sulfur compounds are formed as a result of the sulfuric acid-cement paste reaction, the increase in sulfur content of concrete specimens could be used as a measure of the chemical manifestation of deterioration [1]. The spectrum of aggressive acidic media is wide. Acidic attack usually originates from industrial processes, but it can even be due to urban activity. Even natural exposure conditions may cause acid attacks. Free acids in natural waters are rare. Exceptions are carbonic waters and sulfurous and sulfuric acids in peat waters. Soils may contain huminous acids [2]. Effect of aggressive environment on compressive strength have been investigated [3, 4, 5, 6]. However, Impact on durability due to acidic aggressive environment on mortars have been studied [7, 8, 9, 10].

However, Superplasticizer is also added to check its effect on compressive strength. Superplasticizers are frequently used in order to improve the workability of mortar and concrete mixes for demanding applications. The addition of superplasticizers aims at two objectives: first, the addition of superplasticizers allows controlling the flow properties, which are of major importance for the design of self-compacting concretes, and second, superplasticizers allow the reduction of the water to cement ratio while maintaining workability in order to reach high strength and durability. The cement–water system is highly sensitive to the addition of superplasticizers. Small amounts of superplasticizers enhance the workability properties efficiently, but are often associated with strong, undesired retardation phenomena of the setting of the cement paste[11].

Impact of superplasticizer on compressive strength have been investigated [12, 13, 14, 15].

Adsorption, fluidity and hydration property have been studied and it has been reported that use of superplasticizers improves these properties [16, 17, 18, 19, 20]. Durability, pore size distribution and rheological properties have been investigated and beneficial effect of superplasticizer have been reported [21, 22, 23, 24, 25].

This paper presents the results of an experimental investigation carried out to access the effect of acidic aggressive environment on strength of mortars in early stage. Moreover, SP is also added to investigate compressive strength of mortars in early stage in aggressive environment.

2. EXPERIMENTAL PROGRAMME

It was intended to observe the effect of acidic aggressive environment on cement mortars and performance of two cement mortar mixes with varying amount of superplasticizers. The experimental programme included the consideration of effect of sulphuric acid environments on cement mortars in early age. The ratio in cement and sand in mortar were 1:4 and 1:6 by weight.

In present investigations, different superplasticizer dosages (1%, 2% of weight of cement) are provided in mortar mix and mixes are prepared with different water cement ratio. Abbreviations of some typical mortar mix designations are explained below in Table 1.

Mortar cube samples of 70.6 mm size were prepared as per standard procedure and immersed in two tanks of sulphuric acid of 1 N and 2 N concentrations respectively. The compressive strength of samples were observed after 7 and 14 days of curing. Variations of compressive strength with and without superplasticizer were noted with 7 and 14 days of curing.

Table 1 – Explanation of Some Mortar Mix Designations

Typical mix designation	Explanation
CM4W	Cement Mortar 1:4 Water cured
CM4N1	Cement Mortar 1:4 Normal 1 acid environment cured
CM4N2	Cement Mortar 1:4 Normal 2 acid environment cured
CM4S0%	Cement Mortar 1:4 with SP Dosage 0%
CM6W	Cement Mortar 1:6 Water cured
CM6N1	Cement Mortar 1:6 Normal 1 acid environment cured
CM6N2	Cement Mortar 1:6 Normal 2 acid environment cured
CM6S0%	Cement Mortar 1:6 with SP Dosage 0%

RESULTS AND DISCUSSION

Compressive strength of mortar mix designations 1:4 for both 7 days and 14 days with and without superplasticizer in all curing medium is shown in Table 2 and Table 3 respectively. However compressive strength of mortar mix designations 1:6 for both 7 days and 14 days with and without superplasticizer in all curing medium is shown in Table 4 and Table 5 respectively.

Table 2 – Compressive strength for 7 days

Mortar Proportion [1:4]			
SP Dosage	CM4W (N/mm^2)	CM4N1 (N/mm^2)	CM4N2 (N/mm^2)
CM4S0%	3.41	2.90	2.42
CM4S1%	4.11	3.37	2.82
CM4S2%	3.59	2.80	2.40

Table 3 – Compressive strength for 14 days

Mortar Proportion [1:4]			
SP Dosage	CM6W (N/mm^2)	CM6N1 (N/mm^2)	CM6N2 (N/mm^2)
CM6S0%	4.19	3.57	2.98
CM6S1%	5.05	4.13	3.49
CM6S2%	4.41	3.45	2.94

Table 4 – Compressive strength for 7 days

Mortar Proportion [1:6]			
SP Dosage	CM4W (N/mm^2)	CM4N1 (N/mm^2)	CM4N2 (N/mm^2)
CM4S0%	2.25	1.92	1.56
CM4S1%	2.76	2.18	1.80
CM4S2%	2.38	1.78	1.44

Table 5 – Compressive strength for 14days

Mortar Proportion [1:6]			
SP Dosage	CM6W (N/mm^2)	CM6N1 (N/mm^2)	CM6N2 (N/mm^2)
CM6S0%	2.78	2.36	1.90
CM6S1%	3.41	2.68	2.22
CM6S2%	2.92	2.18	1.76

Generally, the effect of sulphuric acid to degrade the mortar specimens with time and the degradation depends on many factors such as concentration of sulphuric acid, time of exposure to aggressive environment etc. It has been investigated that the superplasticizer dosage will improve the compressive strength, there is still an ideal farthest point for the utilization of admixture. At the point when the doses go past this farthest point, increment in dose will just diminish the compressive quality. This marvel happen since over dose of superplasticizer will bring about draining and isolation, which will influence the cohessiveness and consistency of the solid. Accordingly, compressive quality will diminish if the utilized measurements is past the ideal measurement.

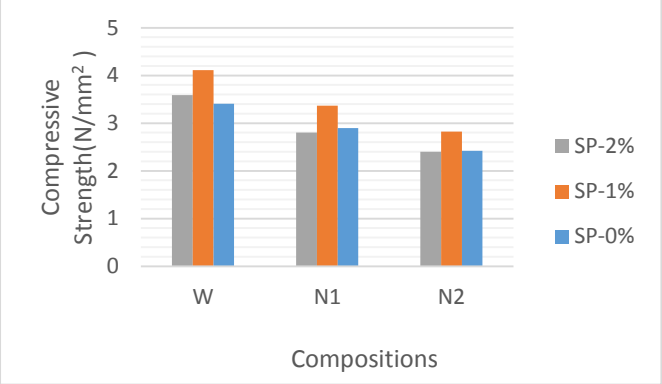

Figure 1 – Compressive strength for mortar 1:4 for 7 days

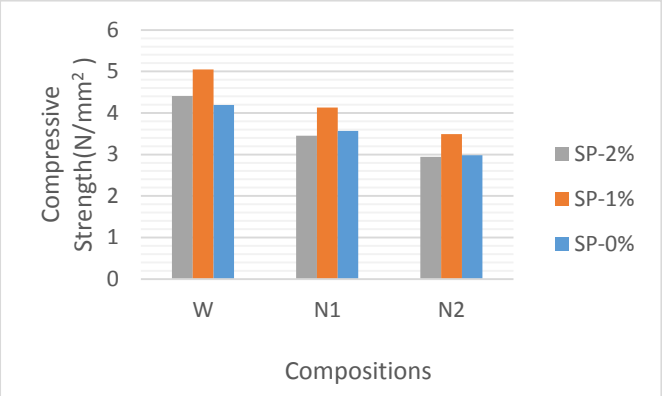

Figure 2 – Compressive strength for mortar 1:4 for 14days

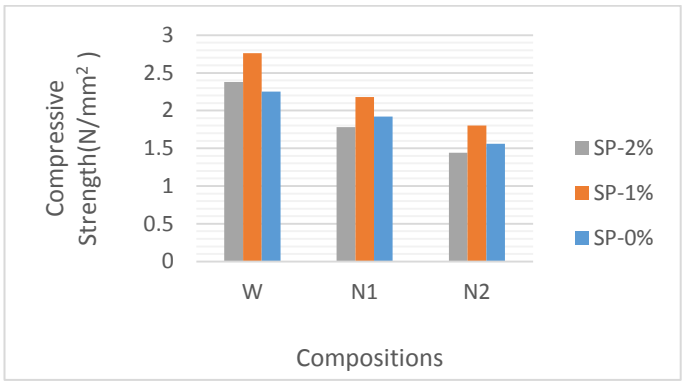

Figure 3 – Compressive strength for mortar 1:6 for 7days

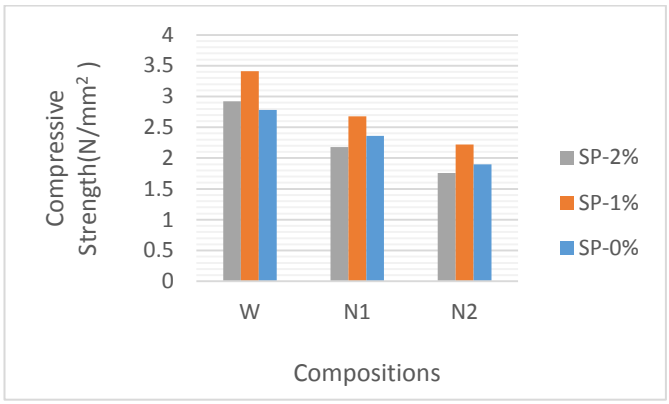

Figure 4 – Compressive strength for mortar 1:6 for 14days

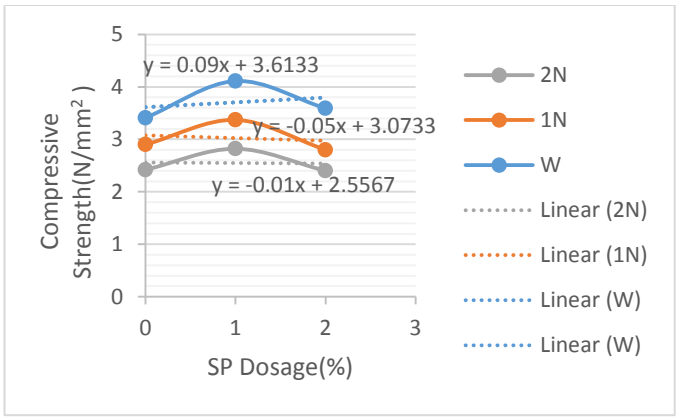

Figure 5 – Compressive strength for mortar 1:4 for 7 days

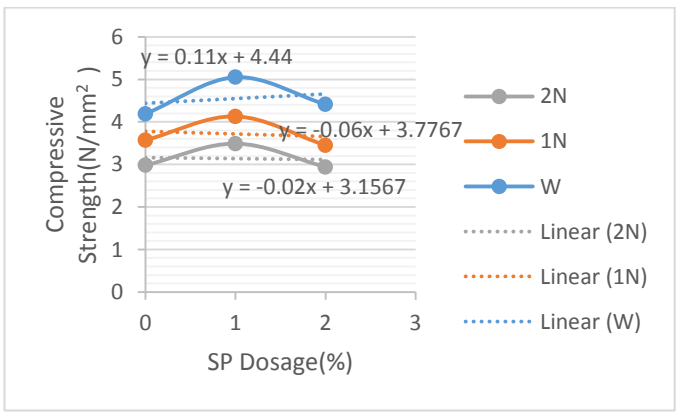

Figure 6– Compressive strength for mortar 1:4 for 14days

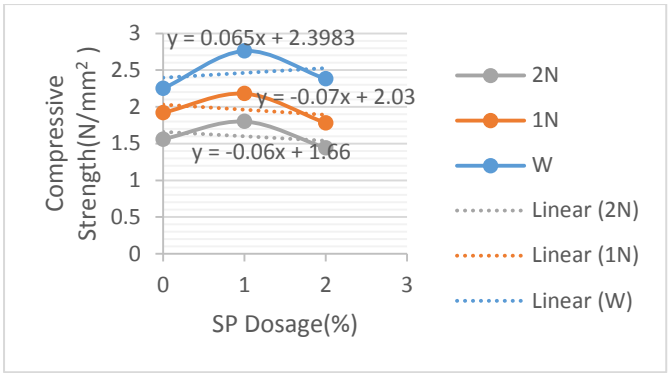

Figure 7 – Compressive strength for mortar 1:6 for 7days

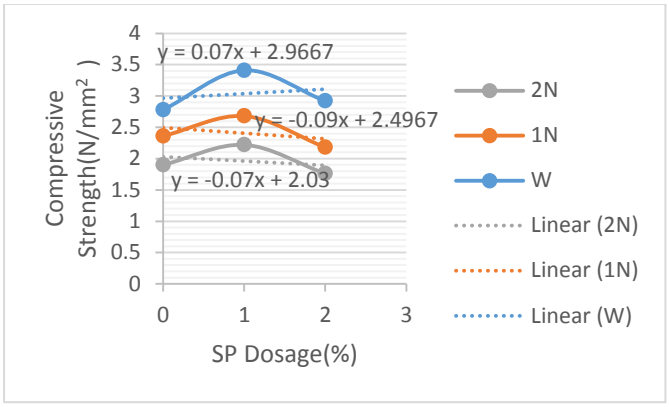

Figure 8– Compressive strength for mortar 1:6 for 14days

The figures are developed for all the above described results.

From the figure 1 to 4 it can be seen that there is approximately 17% decrease in compressive strength when curing medium changes from water to 1N and then finally to 2N concentrated sulphuric acid solution in both mortar mix designation 1:4 and 1:6 without superplasticizer. However, when 1% SP is provided, there is decrease of approximately 15% compressive strength. Moreover, there is decrease of approximately 18% when SP dosage exceeds to 2%.

From the figure 5 to 8 it can be seen that there is approximately 22% increase in compressive strength when curing days raised to 14 in both mortar mix designation 1:4 and 1:6. However, there is decrease of approximately 14% compressive strength when the curing medium changes from water to 1N and then finally to 2N concentrated sulphuric acid solution. It can also be concluded that there is increase of approximately 5% when dosage increases directly to 2% but when it compared with SP dosage 1%, it decreased. Moreover, in 2N concentrated solution compressive strength decreased at the rate of nearly 6% compared to 0% SP Dosage.

From the above figures it may be concluded that there is decrease of 15% compressive strength in increasing acidic aggressive environment. Moreover, due to increment of SP dosage there is decrease of 16% in compressive strength in both mortar mix designations 1:4 and 1:6.

CONCLUSIONS

An investigation has been performed to study the effects of acidic aggressive environment on strength of mortars in early stage in mortar proportion 1:4 and 1:6. The workability of mortar can be expanded by expansion of superplasticizer. Nonetheless, high doses of superplasticizer have a tendency to weaken the cohesiveness of concrete. Compressive strength decreases when curing medium changes. However, compressive strength increases when dosage exceed to 1% but there is decrease in compressive strength when dosage exceed to 2%. It indicates some optimum amount of SP which may be adopted for cement mortar mixes for best performances.

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