V-22 EFFECT OF LIMESTONE POWDER ON DOSAGE OF SUPER-PLASTICIZER PROVIDING MAXIMUM STRENGTH

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1. INTRODUCTION

Since the birth of self-compacting concrete which need high dosage of powder, limestone (LS) powder has been used to replace cement that is a more expensive material in order to produce the self-compactability at low price. On the other hand, in this paper, the effect of LS on the required dosage of super-plasticizer (SP) providing the maximum strength of mortar was investigated. For that purpose, two series of mortar mixes using low heat Portland cement were produced: one series were made without LS and the other series were made with LS then the strength was tested on 7^{th} and 28^{th} day. The strength of each series was studied with different dosages of SP. It was found that LS affected the SP dosage requirement when it was used and that without LS, the optimum SP dosage 1.0% was required to obtain the maximum strength and this dosage was increased to 1.18% when LS was used.

2. METHOD AND MATERIALS

In the experimental works, all mortar mixes were made with the same sand, the same Low Heat Portland Cement (LHPC), the same LS and the same SP. Sand volume was fixed constant when the SP dosages were the main variables in two series of mixes with and without LS. The first series without LS were composed of 7 mixes among which 6 mixes were cured in the sealed condition at the temperature 20°C and the relative humidity 60% and 1 mix was cured under water at the temperature 20°C (wet condition). The second series with the 20% replacement of LS were composed of 5 mixes which were all cured in the wet condition.

Table 1: Cement compositions LH (Low heat)

Mineral types	C3S	C2S	C3A	C4AF	Specific gravity in g/cm^3	Surface area in cm^2/g
Value	28	53	3	10	3.24	3280

Table 2: Mountain Sand properties

Property	Bulk SSD specific gravity	Apparent specific gravity	Absorption	Fineness modulus
Value	2.57 g/cm^3	2.64 g/cm^3	1.86 %	2.75

Table 3: Limestone

Property	Specific gravity (g/cm^3)	Fineness modulus (g/m^2)
Value	2.7	3530

All raw materials were stored in the same room of constant temperature before mixing. After mixing, mortars were loaded into a large container then were sampled into cylinders of 100x200 mm size for strength compressive test. 7 and 28 were the due ages for strength test which was conducted with Shimadzu Universal Testing Machine. The top and bottom surfaces of all specimens were ground before the compressive test. The test method was conformed to C39-96 [3].

3. RESULTS AND DISCUSSION

The results were presented on Fig.1 and 2. As can be shown by Fig.1, the strength started to increase when the SP dosage higher than 0.3%. This means that 0.3% of SP was the SP that was just absorbed by cement particles and it did not disperse cement particles. The strength increased until the maximum value at the SP dosage of 1.0% higher than which strength became constant or a little decreased, this explained that there was an optimum dosage of SP for obtaining the maximum strength. However when LS was used with 20% replacement ratio, the maximum strength was obtained at the SP dosage 1.18%. This means that LS replacement could absorb some SP and made SP lacked for cement dispersion, this is the reason why in order to get the maximum strength, SP dosage had to be increased.

When no LS was used, for SP=0%, the strength of mortar was low compared to the strength at SP=1%, this may be due to the efficiency of SP in dispersing the cement particles and then reducing the amount of un-hydrated particles. In low W/P, it was reported that the un-hydrated particles remained. The un-hydrated particles play the role as filler among the hydrated cement particles. Comparing the two charts on Fig.1 and 2, it was found that the maximum of LS mix was close to the strength of mix without LS at the 0% SP dosage for 7^{th} and 28^{th} day tests. This showed the interest of using powder replacement for low w/c.

Table 4: strength of mortars

w/p=0.3, No LS, seal		Strength in MPa		w/p=0.3, LS20%, wet		Strength in MPa	
SP/P	Flow	7^{th} day	28^{th} day	SP/P	Flow	7^{th} day	28^{th} day
0.00%	-	47.30	64.35	0.70%	218	43.85	74.66
0.30%	-	47.34	64.20	0.86%	250	44.47	75.62
0.60%	238	51.87	76.15	1.02%	301	46.49	80.40
0.80%	262	55.62	79.36	1.18%	349	51.35	84.35
1.0%	296	56.83	81.22	1.34%	405	49.35	82.09
1.2%l	343	56.03	81.45				
1.0%Wet	296	59.02	100.19				

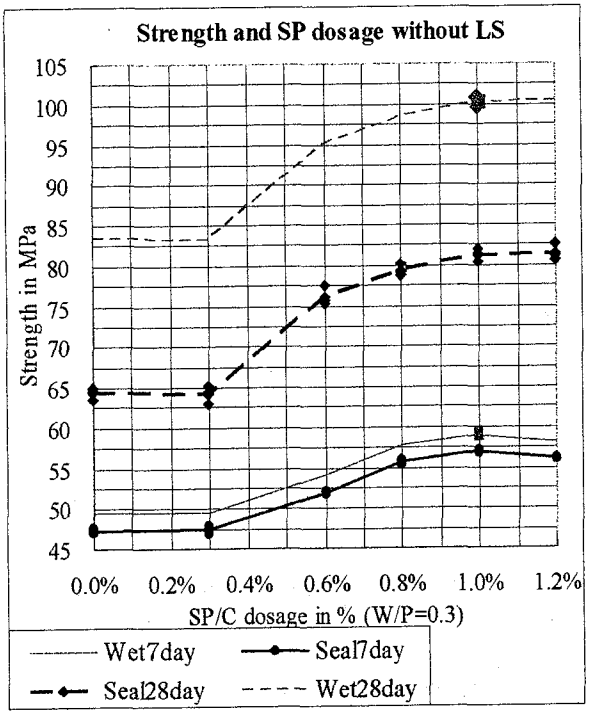

Fig.1: Strength behavior versus SP dosage without LS

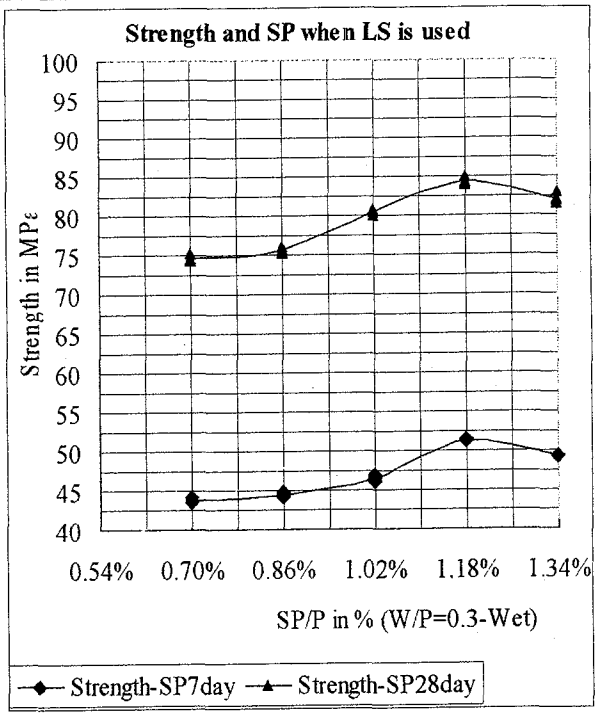

Fig.2: Strength behavior versus SP dosage with 20% of LS replacement

4. CONCLUSION

According to the above discussion, the following conclusions were obtained

① For the same W/P, the dosage SP requirement for obtaining the maximum strength was affected by LS replacement.

② Without LS, the SP requirement was 1.0% and this changed to 1.18% when LS was used in order to attain the maximum strength.

③ The requirement SP dosage in both cases for the maximum strength showed that LS absorbed super-plasticizer. This was confirmed by Sakai *et al* in their flowability study [4] and [5].

5. REFERENCE

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