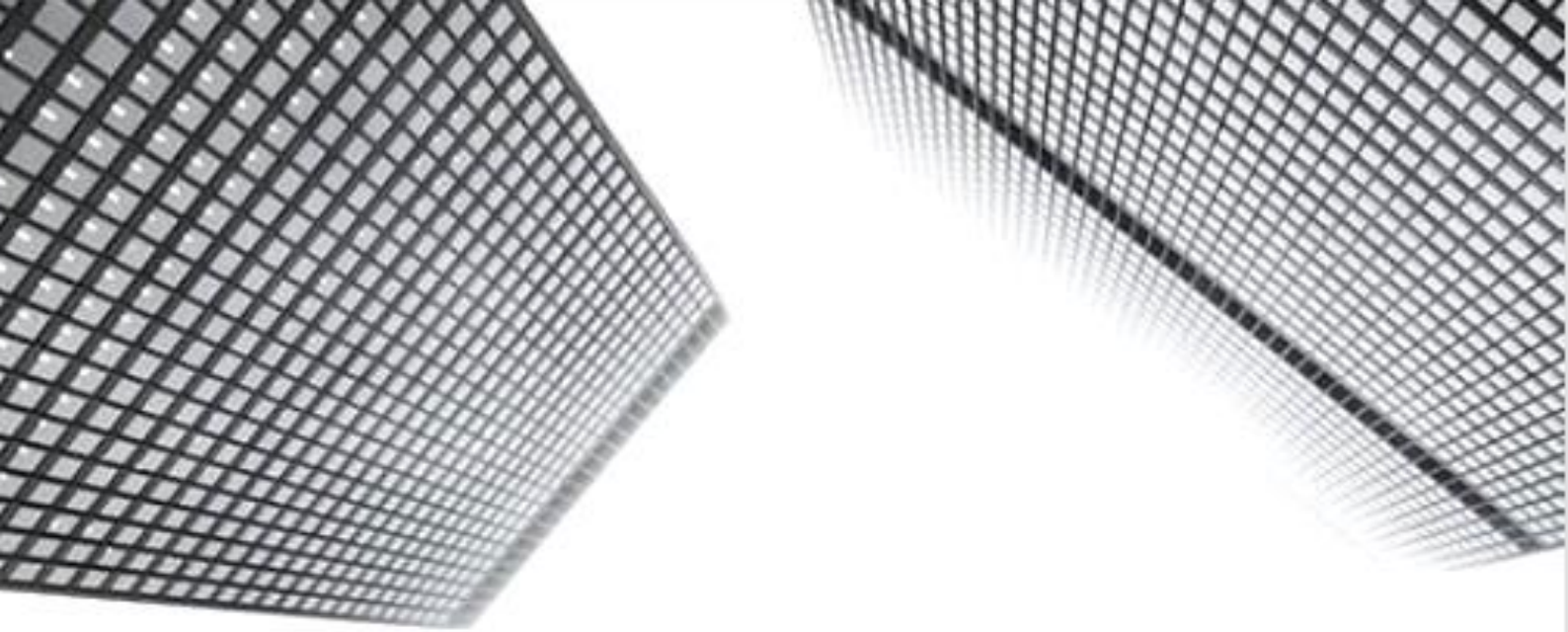

CIVIL ENGINEERING, SCIENCE AND TECHNOLOGY CHALLENGES: STRUCTURAL ENGINEERING AND CONSTRUCTION MATERIALS

EDITED BY

Wan Hashim Wan Ibrahim
Siti Noor Linda Taib
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The book is based on scientific and technological advances in various Structural Engineering and Construction Materials areas of Civil Engineering. It nurtures therefore the exchange of discoveries among research workforces worldwide including those focusing on the vast variety of facets of the fundamentals and applications within the Structural Engineering and Construction Materials arena. To offer novel and rapid developments, this book contains original contributions covering theoretical, physical experimental, and/or field works that incite and promote new understandings while elevating advancement in the Structural Engineering and Construction Materials fields. Works in closing the gap between the theories and applications, which are beneficial to both academicians and practicing engineers, are mainly of interest to this book that paves the intellectual route to navigate new areas and frontiers of scholarly studies in Structural Engineering and Construction Materials.

CIVIL ENGINEERING, SCIENCE AND TECHNOLOGY CHALLENGES: STRUCTURAL ENGINEERING AND CONSTRUCTION MATERIALS

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CHAPTER 7

LABORATORY STUDY OF WATER ABSORPTION OF MODIFIED MORTAR

Borhan,M.M. and Mohamed Sutan,N.*

ABSTRACT

This study investigates the effects of polymer additives namely polyvinyl acetate (PVAc) on water absorption and compressive strength of mortar. Twelve mortar mixtures were investigated for water absorption test and compressive strength test. Results showed that water absorption were inversely proportional to the percentage of PVAc addition. Final analysis showed that addition of PVAc had significant effects on water absorption. Samples with 1%, 3% and 5% addition of PVAc showed an increase of water absorption capacity in comparison to control mortar.

Keywords: Mortar, Water Absorption, Compressive Strength, Polymer Additive

INTRODUCTION

Concrete or mortar is always associated with construction. It is so common that its uses are found almost everywhere; from massive dams to elegant reinforced and prestressed buildings, to road construction, and even art sculptures. Apart from that, concrete is less expensive, possesses adequate strength and durability, and require less energy to produce; when compared to other materials [1]. Basically, concrete consists of cement, fine aggregates,which includes both fine and coarse aggregates; water and additional materials, known as admixtures added to modify its properties and without coarse aggregates it becomes mortar. It is important to have a good quality concrete or mortar. Thus, during the mix design, it is crucial to remember that apart from having a workable fresh concrete, homogenous and unlikely to segregate, the concrete or mortar must also achieve the required strength after it is harden. Mortar with addition of chemical admixtures or additives is known as modified mortar. Mortar is categorized as durable if it has the ability to relatively withstand the negative effects of the environment without excessive deterioration [1][2][3]. Water absorption can influence the durability of mortar. The higher water absorbed by mortar the less durable it becomes. Water absorption, usually measured by drying a specimen to a constant mass, immersing it in water, and measuring the increase in mass as a percentage of dry mass, is one of the important properties that determine the durability of mortars. Good mortar mixes have absorption well below 10 per cent by mass. Factors such as the type of material, additives, temperature and length of exposure can affect the amount of water absorbed. Water absorption can also influence the strength of mortar [4]. Polymer additives may have the possibility to improve the pore structures of mortar and by this may minimize the ingress of water by absorption. Mortar with polymer addition is called Polymer Modified Mortar (PMC).There are now a wide varieties of PMC in the market that are specifically designed for applications in decorative finishing, pavements, adhesives and repair materials. One of the polymers used to modify mortar is polyvinyl acetate (PVAc) emulsion. PVAc has adhesives and binding properties on wood, paper and cloth. There are extensive investigations on its adhesive and binding properties on before mention materials but yet on mortar [5]. Its adhesive and binding properties hypothetically can leads to improve pore structures of mortar hence less water absorption. Therefore a laboratory study was carried out to investigate the possible waterproofing effects of PVAc addition in mortar by water absorption test and compressive strength test.

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EXPERIMENTAL PROGRAM

MATERIALS AND MIX PROPORTIONS

Cement used in this experiment was Ordinary Portland Cement (OPC) produced by local manufacturer, Cahaya Mata Sarawak (CMS). It has a specific gravity of 3.16.The fine aggregate used in the experiment was natural sand (dry condition) with the specific gravity of 2.6. Ordinary pipe water was used throughout this experiment. PVAc used as an additive to mortar was Emultex 518 which was specifically designed to be used in mortar as plasters. It has a specific gravity of 1.07.

Table 1 shows three different mortar mixtures with 1%, 3% and 5% Polymer to cement ratio (P/C) respectively. These mixes were tested for their water absorption ability and compressive strength in comparison to the ordinary mortar as the control. Table 2, 3 and 4 showed the different mix proportions for different mixes. The mixes were casted in 100 mm^3 size steel moulds and were cured for 28 days.

Mortar Mixes		**PVAC (%)**
A (w/c 0.3)	AC	0
	A1	1
	A3	3
	A5	5
B (w/c 0.4)	BC	0
	B1	1
	B3	3
	B5	5
C (w/c 0.5)	CC	0
	C1	1
	C3	3
	C5	5

Table 1: Mortar mixes with respective PVAc %

	CEMENT (kg)	**WATER (kg)**	**FINE AGGREGATE (kg)**	**POLYMER (kg)**
CONTROL16	.60	4.98	12.42	-
1%	16.60	4.98	12.42	0.17
3%	16.60	4.98	12.42	0.50
5%	16.60	4.98	12.42	0.83

Table 2: Mix proportion for Sample A (W/C = 0.3)

	CEMENT (kg)	**WATER (kg)**	**FINE AGGREGATE (kg)**	**POLYMER (kg)**
CONTROL17	.50	7.00	11.05	-
1%	17.50	7.00	11.05	0.18
3%	17.50	7.00	11.05	0.53
5%	17.50	7.00	11.05	0.88

Table 3: Mix proportion for Sample B (W/C = 0.4)

	CEMENT (kg)	**WATER (kg)**	**FINE AGGREGATE (kg)**	**POLYMER (kg)**
CONTROL18	.00	9.00	9.87	-
1%	18.00	9.00	9.87	0.18
3%	18.00	9.00	9.87	0.54
5%	18.00	9.00	9.87	0.90

Table 4: Mix proportion for Sample C (W/C = 0.5)

WATER ABSORPTION TEST

Water absorption test is a measure of the capillary forces exerted by the pore structure causing fluids to be drawn into the body of the material [3]. The amount of water absorbed by mortar mixes depends on the water tightness or waterproofness of mixes All mixes were subjected to water absorption test at the end of wet curing period of 1, 7, 14, 21 and 28 day after demoulding. They were taken from the curing tank 2 days before the test and later oven dried at 100 ± 5°C for 7 days until a constant mass was achieved. Each sample was then weighed. The samples were covered with wax, except the bottom area before they were immersed in trays containing water. The reason of covering the cube with wax is to prevent air from entering the void during immersing process, since the cube is not fully soak in water, but only about 30-35mm of water level. The start time was immediately recorded. After 7 days, the samples were removed from the tank, shook to remove bulk of the water, and dried with a cloth as fast as possible to remove all free water on the surface. They were then weighed again. The measured water absorption of each samples were expressed as the increase in the mass as a percentage of the oven dry mass.

COMPRESSIVE STRENGTH TEST

All mixes were subjected to compressive strength test at the end of curing period of 1, 7, 14, 21 and 28 days after demoulding. This test was carried out to determine the maximum compressive load it can carry per unit area. Since strength of mortar was directly related to the structure of hydrated cement paste, thus this test was important not only to determine the strength development of the mortar specimen, but also the quality of the mortar sample. A good mortar sample should achieve the targeted mean strength at the end of 28 days [6].

RESULTS AND ANALYSIS

WATER ABSORPTION TEST

WATER ABSORPTION TEST RESULT FOR SAMPLE WITH 0.3 W/C

Figure 1 shows that water absorption rate of control mortar rises gradually until the end of 28 days, having the highest water absorption of 15.7% compared to other mixes .Water absorption rates of the 3 PVAc mortar mixes also increase as the mixes matures, with 5% PVAc having the highest water absorption of 14.0% compared to the other 2 PVAc mortar mixes.

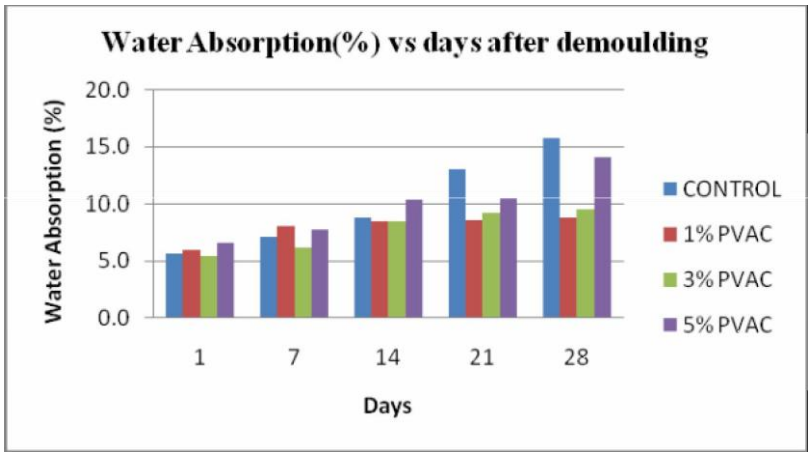

Figure 1: Water Absorption of PVAc modified mortar with 0.3 w/c

WATER ABSORPTION TEST RESULT FOR SAMPLE WITH 0.4 W/C

Figure 2 shows that 5% PVAc has the highest water absorption among the other PVAc mortar mixes and control mortar at the end of the 28 days. Starting from day 7, 1% PVAC mortar mix has nearly constant water absorption until the end of 28 days. Water absorption remains nearly constant from day 14 to day 28 for 3% PVAc mortar mix.

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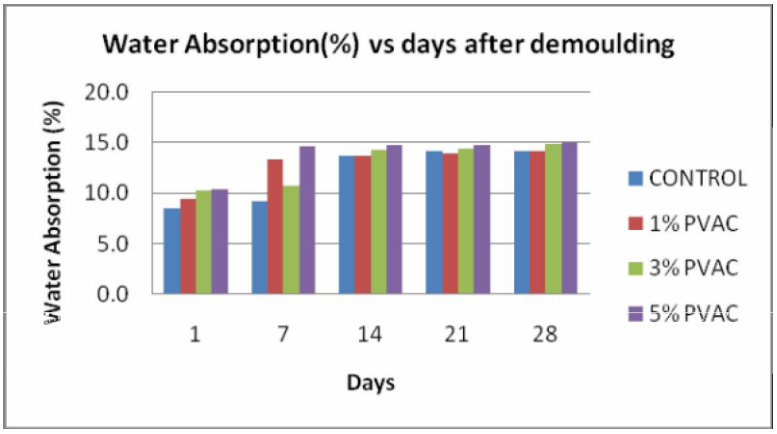

Figure 2: Water Absorption of PVAc modified mortar with 0.4 w/c

WATER ABSORPTION TEST RESULT FOR SAMPLE WITH 0.5W/C

Figure 3 shows that 5% PVAc mortar mix has the highest water absorption just like the previous sample. From day 14 onwards water absorption of control mortar and 1% PVAc mortar mix was almost the same with difference in margin of 0.1%.

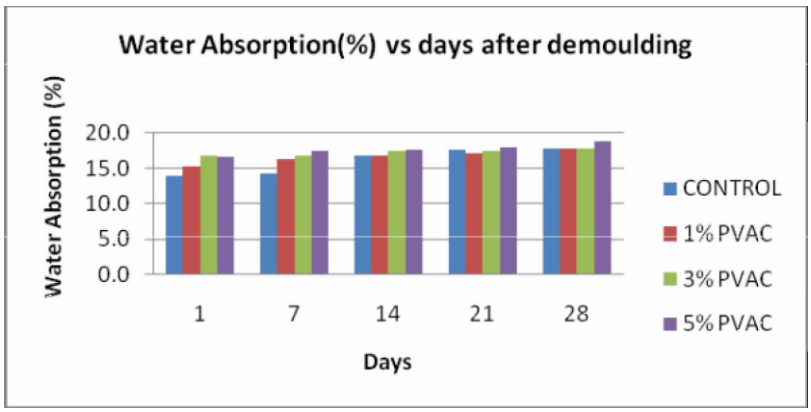

Figure 3: Water Absorption of PVAc modified mortar with 0.5w/c

COMPRESSIVE STRENGTH TEST

COMPRESSIVE STRENGTH TEST RESULT FOR 1% PVAC ADDITION WITH 0.3, 0.4 AND 0.5 W/C

Figure 4 shows that at 7, 14, 21 and 28 days after demoulding, compared to the other mixes,1% PVAc mortar mix with 0.3w/c ratio has the highest compressive strength which was 66.49 MPa.

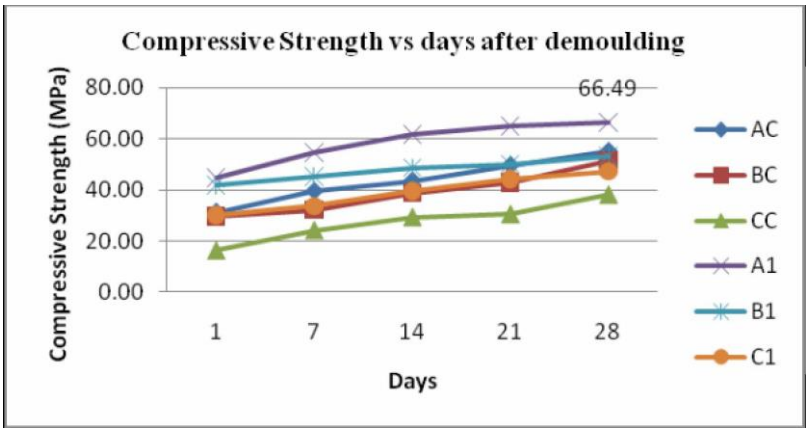

Figure 4: Compressive Strength for 1% PVAc addition

COMPRESSIVE STRENGTH TEST RESULT OF 3% PVAC ADDITION WITH 0.3, 0.4 AND 0.5 W/C

Figure 5 shows that at 7, 14, 21 and 28 days after demoulding , 3% PVAc mortar mix with 0.3w/c ratio has the highest compressive strength which was 57.41 MPa.

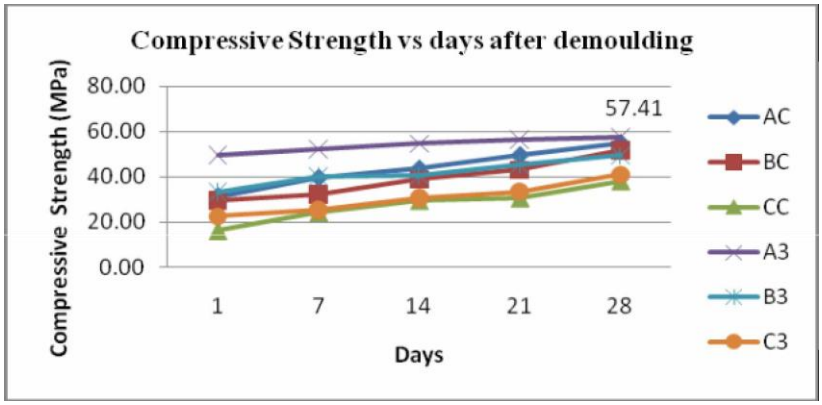

Figure 5: Compressive Strength of 3% PVAc addition

COMPRESSIVE STRENGTH TEST RESULT OF 5% PVAC ADDITION WITH 0.3, 0.4 AND 0.5 W/C

Figure 6 shows that from day 21 onwards after demoulding, control mortar mix with 0.3w/c ratio has the highest compressive strength which was 48.08MPa. Compressive strength for all PVAc mortar mixes increased as the mixes matured.

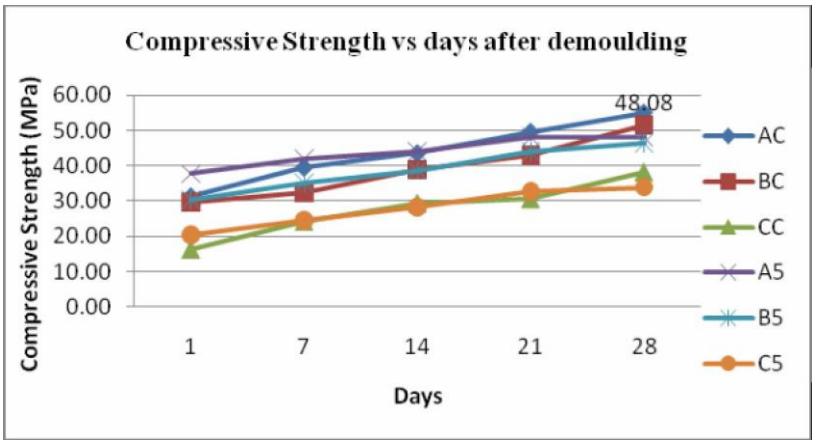

Figure 6: Compressive Strength of 5% PVAc addition

CONCLUSIONS

The following conclusions may be drawn from results of this study:

1. PVAc mortar mixes absorbed more water than control mix. They were potentially less durable than control mortar mix.
2. 1% PVAc excelled in the development of compressive strength. It had the highest strength at the end of the 28 days for all w/c ratios.
3. The adhesives and binding properties of PVAc only contributed to the increase of compressive strength of mortar but not to decrease the water absorption even though compressive strength should increases as the water absorption decreases.
4. Adhesive or binding properties of PVAc did decrease rate of water absorption of mortar hence no waterproofing effects.

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REFERENCES

[1] Mehta, P. K., & Monteiro, P. J. M. (2006). Concrete: Microstructure, Properties, and Materials (3rd ed.). New York: McGraw-Hill.
[2] Somayanji, S. (2001). Civil Engineering Materials (2nd ed.). Upper Sadle River, New Jersey: Prentice Hall.
[3] M. Neville (1996). Properties of Concrete. 4th and Final ed. Harlow, England: Longman
[4] M. S. J. Gani (1997). Cement and Concrete. 1st ed. 2-6 Boundary Row, London SE1 8HN, UK:Chapman & Hall
[5] Y.Ohama, (1994). Polymers in Concrete. 1st ed.CRC Press Inc. United States of America
[6] Michael S. Mamlouk and John P. Zaniewski. (2006). Materials for Civil and Construction Engineers. 2nd ed. New Jersey : Prentice Hall

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