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Decreasing Absorption in Concrete Lined Canals by Modifying the Mechanical Properties of Concrete Using Integral Waterproofing Admixtures

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Abstract: The need to have a concrete with low absorption is very important in irrigation canals to keep water inside it without losses due to permeability, since, concrete is a porous material, therefore, this study include the effect of integral waterproofing admixture type ADM-10-1110 which is a liquid chemical polymer with organic compounds and using it individually with concrete and also using it with polymer modified concrete that contains styrene butadiene rubber polymers. This admixture make concrete with very low absorption and having a high mechanical properties. The ordinary mixes with 475 kg cement for each 1 m^3 concrete show high increment in compressive and flexural strength by using Integral Waterproofing Admixture (IWA) and less absorption, absorption decreased from 7.8-1.3%, compressive strength increased from 36.9-47.4 MPa and flexural strength increased from 2.7-7.24 MPa for polymer modified concrete, water absorption for it was very less, it decreased from 4.8% for reference mix of PMC to only 0.18% when adding 2.5% IWA by weight of cement.

Key words: Lined canals, integral waterproofing mixture, absorption, permeability, polymer, concrete

INTRODUCTION

Concrete is a brittle pervious material, it has high permeability, low tensile and flexural strength, thus, its durability is low, especially, when we use concrete in foundations, lining the irrigation canals bed, dams, infrastructures, piers of bridges where in those cases, the concrete subjected to salty or chloride water attacks or leads to permeate water (in canal cases) and lead to losses in quantity of water that kept in irrigation canals. Thus, the using of admixtures is very important to avoid those problems. One of the most significant materials is the waterproofing admixture which works as water reducer and also gives higher values of mechanical properties and also another liquid material called Styrene Butadiene Rubber (SBR) which gives concrete low porosity, higher mechanical properties and higher impact strength and toughness and also high durability concrete (Qasim, 2018; Anonymous, 2008). In this research, the effect of integral water proofing admixtures was studied on both ordinary and polymer modified concretes.

MATERIALS AND METHODS

Experimental work: Ordinary type V cement used in all mixes, coarse aggregate used in this study with maximum size of 14 mm as shown in Table 1 and confirms IQS-standards, fine aggregate grading shown in Table 2 and it was confirming zone 3. SBR latex was used in polymer modified concrete with 5% from weight of cement. Integral Waterproofing Liquid Admixture (IWPA) was used as a percentages of cement weight, the percentages were 0.5, 1, 1.5, 2 and 2.5%. Some properties of this IWPA shown in Table 3. Figure 1 shows IWPA

Table 1: Grading of coarse aggregate used in the study

Sieve size (mm)	Passing by weight (%)	IQS specification for 5-14 mm coarse aggregate (%)
20	100	100
14	97.3	90-100
10	63.6	50-85
5	3.4	0.0-10

Table 2: Grading of fine aggregate used in the study

Sieve size	Passing by weight (%)	IQS specification for zone 3 fine aggregate
10 mm	100	100
5 mm	94.3	90-100
2.36 mm	93.2	85-100
1.18 mm	85.7	75-100
600 mic	78.3	60-79
300 mic	28.1	12-40
15 mic	4.8	0.0-10

Table 3: Some properties of integral waterproofing admixture used in the research

Ingredient	Composition	Color	Specific gravity
Integral waterproofing admixture ADM-10	Poly carboxylate liquid polymers with organic polymers compounds (Copolymers)	Brown	1.04

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Fig. 1: Integral water proofing admixture and SBR latex used in the study

Table 4: Quantities of ingredients of concrete used in the research

Ingredient	Cement	Sand	Gravel	Water
Weight for each 1 m^3 concrete	475 kg	680 kg	1020 kg	209 kg

and SBR admixtures used in study. Table 4 shows the mix proportions of cement, sand, gravel and water for each 1 m^3 concrete that used in study.

Testing procedure: The testing of specimens includes, absorption of concrete by using cylindrical specimens and testing it after 28 days curing, the cylindrical specimens for each mix were dried in oven for 24 h, then put in water after taking its average dry weight, the submerged in water for 24 h then taking their saturated weight, the absorption was found from Eq. 1:

$$\text{Absorption (\%)} = \frac{W_2 - W_1}{W_1} * 100 \tag{1}$$

Where:
W_1 = The dry weight of concrete
W_2 = The saturated weight of concrete

The compressive strength test was done by casting 3 specimens of dimensions of 10*10*10 cm and subjected after 28 days curing to axial compressive force until failure, then taking the average of three specimens. The compressive strength was found by simple Eq. 2, Fig. 2 show IWPA concrete under testing for compressive strength:

$$\sigma = P/A \tag{2}$$

Where:
σ = The maximum compressive strength of concrete
P = The maximum force (at failure) applied by compression machine.
A = The Area subjected to compressive force

Fig. 2: Cubic concrete specimen under compressive strength test

Fig. 3: Cylindrical IWPA concrete specimen under tensile test

Tensile strength test was done by using cylinders with 10 cm diameter and 20 cm high and testing by using splitting method and the tensile strength was found by Eq. 3. Figure 3 shows cylindrical concrete specimen under testing for splitting tensile strength:

$$\sigma_t = 2P/\prod.D.L \tag{3}$$

Where:
σ_t = Maximum tensile strength
P = Maximum force applied (at failure)
D = Diameter of cylinder
L = Height of cylinder

The flexural strength test was done by using the British standard which done by third point loading test for beams with dimensions of 10*10*40 cm. The flexural strength was found by Eq. 4. Figure 4 shows IWPA concrete beam specimen under testing for flexural strength (third point loading):

Fig. 4: Beam concrete specimen under third point flexural test

$$F_b = PL/bd^2 \quad (4)$$

Where:

- F_b = The max. flexural strength of concrete beam
- P = Maximum load applied until flexural failure
- b and d = The width and thickness of beam respectively
- L = Length of beam

RESULTS AND DISCUSSION

Table 5 shows ordinary mixes without SBR latex, reference mixes (without IWPA), gives average compressive strength of 36.9 MPa and high absorption (7.8%) with using IWPA with 0.5% by weight of cement, compressive strength increased to 38.5 MPa and absorption lowered to 6.3% with more percentages of IWPA added the mechanical properties are more improved, compressive strength increased to 47.41 MPa, flexural strength increased from 2.7-7.24 MPa and absorption was very less, the absorption decrease to 1.29% and that mean low voids and porosity concrete and that attributed to the action of IWPA which contains Polycarboxylate and organic polymers chains which action is reducing the water cement ratio and that lead to decrease voids inside concrete and increase strength and decreasing permeability (Alsadey, 2015; Puertas *et al*., 2005). Also, the polycarboxylate chains are coupled with calcium ions liberated from hydration of cement (Sakai *et al*., 2003) and since, the calcium ions are not good product due to hydration of cement because of its property of leaching and gave porosity to concrete (Cheng *et al*., 2013), thus, calcium ions in this case bonds with chemicals chain of integral waterproofing admixtures (polymers and polycarboxylate chains) and prevent the porosity of concrete (Fig. 5-7).

Table 6 shows the effect of IWPA admixture on polymer modified concrete mixes, the reference polymer concrete (without IWPA) show lower values of absorption compare with original reference mixes which have no any admixtures. The reference mixes of polymer

Table 5: Mechanical properties and absorption of ordinary concrete mixes modified with IWPA

Mix type	W/C	Dosage of IWPA	Compressive strength (MPa)	Tensile strength (MPa)	Flexural strength (MPa)	Absorption (%)
Ref. Mix	0.44	0.0	36.93	2.39	2.73	7.81
Mod.Ref. Mix	10.38	0.5	38.53	2.88	3.71	6.32
Mod.Ref. Mix 2	0.35	1.0	40.21	3.10	4.67	4.43
Mod.Ref. Mix 3	0.32	1.5	44.05	3.96	6.05	2.55
Mod.Ref. Mix 4	0.30	2.0	46.30	4.24	7.02	1.31
Mod.Ref. Mix 5	0.28	2.5	47.41	4.91	7.24	1.29

Table 6: Mechanical properties and absorption of polymer modified concrete mixes improved with IWPA

Mix type	W/C	Dosage of IWPA	Compressive strength (MPa)	Tensile strength (MPa)	Flexural strength (MPa)	Absorption (%)
Polymer concrete 5% SBR	0.40	0.0	38.54	2.70	3.21	4.82
Mod. Ref. Mix 1	0.35	0.5	41.22	3.45	4.20	3.54
Mod. Ref. Mix 2	0.32	1.0	43.76	3.93	5.82	2.35
Mod. Ref. Mix 3	0.30	1.5	45.81	4.62	6.85	0.93
Mod. Ref. Mix 4	0.25	2.0	49.36	4.90	7.53	0.32
Mod. Ref. Mix 5	0.23	2.5	51.90	5.11	7.90	0.18

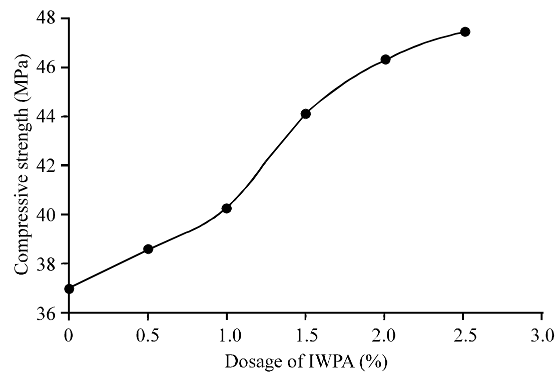

Fig. 5: Relationship between dosage of IWPA and compressive strength for ordinary concrete

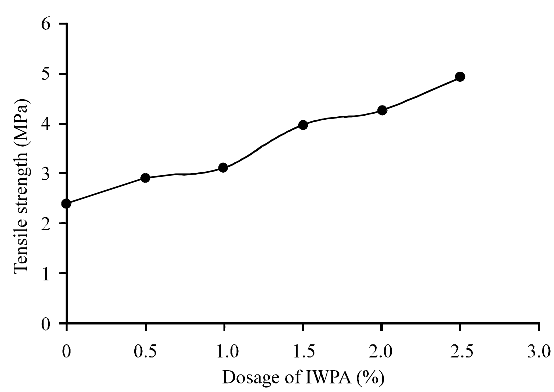

Fig. 6: Relationship between dosage of IWPA and tensile strength for ordinary concrete

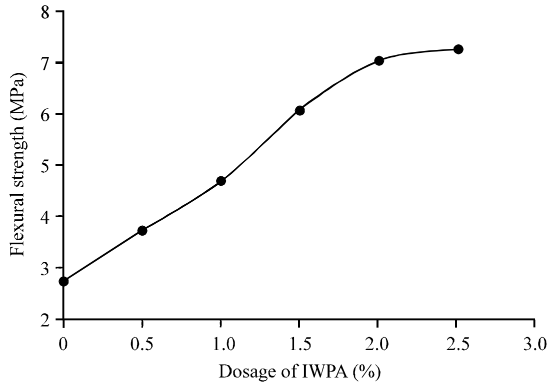

Fig. 7: Relationship between dosage of IWPA and flexural strength for ordinary concrete

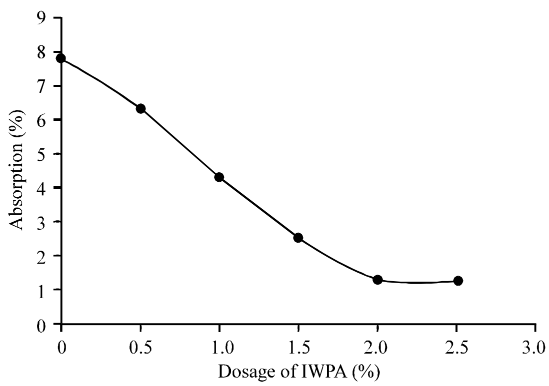

Fig. 8: Relationship between dosage of IWPA and percent of absorption forordinary concrete

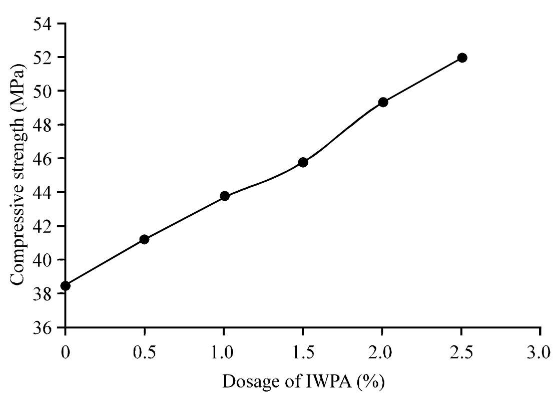

Fig. 9: Relationship between dosage of IWPA and compressive strength for polymer modified concrete

modified concrete have 4.82% absorption which is less than ordinary concrete reference mixes. This attributed by the action of SBR polymer resin which filled some voids inside concrete and also the SBR polymer films bond

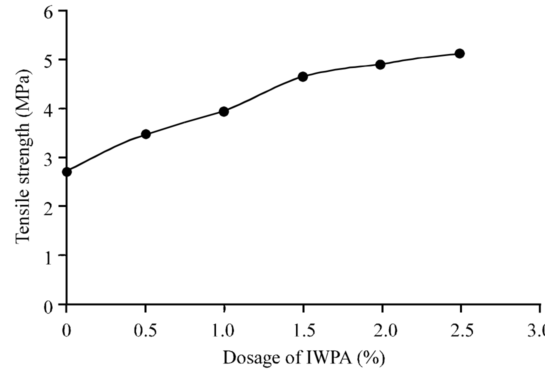

Fig. 10: Relationship between dosage of IWPA and tensile strength for polymer modified concrete

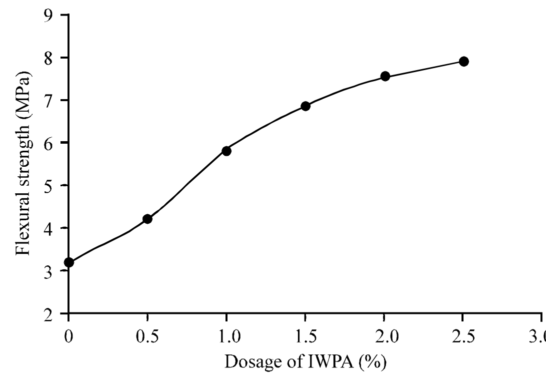

Fig. 11: Relationship between dosage of IWPA and flexural strength for polymer modified concrete

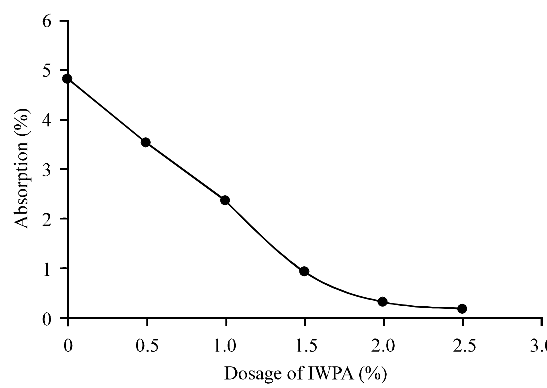

Fig. 12: Relationship between dosage of IWPA and percent of absorption for polymer modified concrete

with the gel of cement and bond also with external silica of aggregates and give additional strength to concrete (Al Numan *et al*., 2018; Yang *et al*., 2009). Polymer modified concrete with IWPA shows higher mechanical properties, compressive strength increased from 38.5-51.9 MPa, tensile increased to 5.1 MPa and flexural strength increased from 3.2-7.9 MPa and absorption is highly decreased, it lowered to 0.18% only and that is very excellent and make concrete very durable.

CONCLUSION

Mechanical properties of ordinary concrete and polymer modified concrete improved by using Integral Waterproofing Admixture (IWPA) and also the absorption is highly decreased with using IWPA and that means high performance and durability for new concrete. In ordinary concrete mixes, compressive strength increment was 28.4%, tensile strength increment was about 114%, flexural strength increment was about 165% and the absorption decreased from 7.8-1.3% by using IWPA in ordinary mixes concrete. For Polymer Modified Concrete (PMC), the reduction is very high in absorption and the absorption decreased from 4.8-0.18% and that is significant effect. Compressive strength increment by using IWPA in polymer modified concrete was about 34.7%, tensile strength increment was 89% and flexural strength increment was 64%.

REFERENCES

Al Numan, B.S., F.R. Ahmed and K.K. Hamad, 2018. Effect of styrene butadiene rubber latex on mechanical properties of eco concrete: Limestone powder concrete. ARO. Sci. J. Koya Uni., 6: 1-6.

Alsadey, S., 2015. Effect of superplasticizer on fresh and hardened properties of concrete. J. Agric. Sci. Eng., 1: 70-74.

Anonymous, 2018. SBR bonding agent: Technical sheet. Construction Chemicals, London, United Kingdom. http://www.constructionchemicals.co.uk/

Cheng, A., S.J. Chao and W.T. Lin, 2013. Effects of leaching behavior of calcium ions on compression and durability of cement-based materials with mineral admixtures. Mater., 6: 1851-1872.

Puertas, F., H. Santos, M. Palacios and S. Martinez-Ramirez, 2005. Polycarboxylate superplasticiser admixtures: Effect on hydration, microstructure and rheological behaviour in cement pastes. Adv. Cem. Res., 17: 77-89.

Qasim, O.A., 2018. Experimental investigation on effect of SBR and steel fiber on properties of different concrete types. Intl. J. Civil Eng. Technol., 9: 361-378.

Sakai, E., K. Yamada and A. Ohta, 2003. Molecular structure and dispersion-adsorption mechanisms of comb-type superplasticizers used in Japan. J. Adv. Concr. Technol., 1: 16-25.

Yang, Z., X. Shi, A.T. Creighton and M.M. Peterson, 2009. Effect of styrene-butadiene rubber latex on the chloride permeability and microstructure of Portland cement mortar. Constr. Build. Mater., 23: 2283-2290.