An Overview on Admixtures in the production of concrete

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Abstract - *There are several admixtures available in the world in a form of plasticizer, superplasticizer and new generation plasticizer. The aim of the present paper is to understand the recent trend in the utilization of admixtures for user friendly concrete with respect to fresh property know as workability parameter. Several attempts have been done to look for alternative material for chemical admixtures and also successful in terms of usage as a catalyst to reduce water and enhancing the properties of concrete. This paper deals with review on different materials has been extensively used. There is a need to identify alternative chemical compounds with lesser price for economical concrete production*.

Key Words: **admixtures, different types, concrete, properties, curing, setting time**.

1.INTRODUCTION

Admixture is a material which is added to the concrete mix along with the other members like aggregates, water, cementitious materials. It is generally to modify fresh properties of concrete such as setting time, hardened properties which is added to the batch before or during mixing. To improve the properties of concrete, they can be divided into 2 types, namely mineral admixtures and chemical admixtures. Some of them are Water-reducing Admixture, which is used to reduce the amount of water addition to the concrete mix. The important property of concrete is workability which can be improved by the addition of water but more than the required addition of water may affect strength and durability of concrete, not only the workability but also the strength of concrete may improve. The bonding between the concrete and steel reduces segregation, ble eding, honeycombs and cracking in concrete. Some of the plasticizers commonly used are sodium, ammonium lignosulfonates and calcium. Few of the recent superplasticizers are acrylic polymer based, polycarboxylates based and multi carbonyl ethers.

Some of the admixtures are retarding admixture, accelerating admixtures, air entraining admixtures, water reducing admixtures, air detraining admixtures etc. In retarding admixtures, the rate of cement hydration will be reduced in initial stage and initial hardening time of concrete will be increased. These are normally used in the areas of high temperatures in which the concrete hardening takes place quickly. This may lead to the discontinuities in the bonds of structure, creates harmful surface voids in concrete etc. To decrease the initial hardening time of concrete the accelerating admixtures are used, the initial phase of hardening of concrete process speed is increased in this process.

Use of admixtures in concrete may increase or decrease in setting time, workability, increase in compressive strength, split tensile strength. Some of admixtures can be used in colour change of the cement and also to overcome the difficulties in transporting, placing and mixing of concrete. Many admixtures used till now in history like metakaolin (MK), fly ash (FA), silica fume (SF), ground granulated blast furnace slag (GGBS), and rice husk ash (RHA) but use of boric compounds like boric acid acts differently when it is added or used as a liquid solution in concrete. Some literatures say Boron compounds may be used as a replacement of cement up to certain quantity in which it shows good compressive strength, split tensile strength also delay in setting time. Whereas another says it can be used a curing solution says strength depends on the concentration of boric acid and time period for curing.

2. Literature survey

Liu et al reviewed on advanced chemical admixtures and influence of them on properties of concrete. The PCE effect on molecular structure compatibility and on flow property was studied in this paper. An expansive agent which is based on magnesia, super absorbent polymers, temperature rise inhibitor based on novel starch were used to mitigate risk of cracks and shrinkage of concrete. The mechanism of chemical admixtures were understood with the help of micro analytical methods which strongly encourage to use admixtures in high performance concrete[1].

Youyuan lu et al had used the ultrasonic method like piezoelectric composite sensors to monitor and evaluate the process of hydration of cement embedded with p wave measurement system, frequency domain, coefficient index detects ultrasonic waves during the hydration process were recorded. The admixtures like flyash, slag and silica fume which were replaced by cement weight in concrete mixture. The effect of acceleration from silica fume and retardation from flyash and the hydration of concrete at early stage from the slag was determined through the analysis and was compared with velocity curves. The frequency spectrum analysis determines the early stage of hydration process was determined at different ages of concrete[2].

Tugba Mutuk examined that usage of waste like boron waste and rice husk ash in concrete in which they added these two separately as well as together in different samples at different ratios and tested for compressive strength. 24 Factorial design was used for the optimization of properties of cement having both the wastes. At 10% rice husk ash as an additive showed the highest strength, he concluded that both the wastes can be used in the concrete for construction purpose[3].

Ping duan et al explains the use of different additives to the concrete like pozzolan, metakaolin, metakaolin and other mineral admixtures which are in trend because of they are environmental friendly. The interfacial transition zone and the structures with pore are the characteristics of microstructure with silica fume, slag and metakaolin were studied together. The results of the experiment showed that using of these admixtures leads to the satisfiable pore size distribution and denser interfacial transition zone. The different effect on microstructural concrete was shown by metakaolin. The compressive strength changes are dependent on the porosity and microhardness of interfacial transition zone. With the help of thermodynamic stability, the influence of these admixtures was analysed[4].

Salahaldein Alsadey did an experimental study on the changes in the properties of concrete by using superplasticizer admixture. Development of the new superplasticizer in the recent days determines the importance in the progress of discovering new ideas. Experiments were conducted to find the optimum dosage of admixture which can be used and the effect of it on the properties of concrete. The dosage of superplasticizer used were 600, 800, 1000, 1200 ml/100 kg of weight of cement and the control mixes were prepared along with others. The normal curing period of 28 days was carried out and workability, compressive strength were determined. The compressive strength of the concrete specimen with 1% of superplasticizer after 28 days of curing period showed 55N/mm^2 which was more than the control mix concrete. By increasing the dosage of superplasticizer more than 1% results in decreasing compressive strength was found and also effects the properties of concrete in a negative way[5].

Benjamin did research on pozzolanic admixtures which are taken from waste shells of snails, oyster and the shells are ashed at 800ºC chemical compositions were analysed. Pozzolanic nature of it was revealed from the results obtained and by using these shell ash as a admixtures the effect on compressive strength, setting time were determined for different percentages like 0%, 5%, 10%, 15%, 20%, 25% and 30% weight. By the addition of shell ashes the increase in water consistency, initial and final setting time of cement. The optimum percentage of compressive strength was obtained at 10% of periwinkle shell ash, 15% of oyster shell ash and 20% of snail shell ashes[6].

Mucteba Uysal et al did an experimental study on self-compacting concrete properties. The replacement material used were flyash. Granulated blast furnace slag, limestone powder, marble powder and limestone in different proportions. The effect of admixtures on workability, compressive strength, ultra pulse velocity was studied. Tests involved sulphate resistance immersion of 10% magnesium sulphate, 10% sodium sulphate for a period of 400 days was studied to understand the level of sulphate attack by visual examination and decrease in the compressive strength was also found. The experimental results showed that use of these mineral admixtures significantly increase in the workability and compressive strength of self-compacting concrete. The good resistance to sodium and magnesium sulphate attacks were obtained at 40% of Granulated blast furnace slag and 60% Portland cement[7].

Ase togero studied about the leaching of substances present in admixtures and additives that are generally used in concrete. For 3 types of concrete mixes containing ordinary Portland cement, flyash and slag, the concrete showed uniform leaching patterns which were clearly above the limit of detection. The difference between the concrete having byproducts and the one with Portland cement was not significant. In this study the proposal was made for alternative availability test to NEN 7341, to generate the data for the use of models of leaching during the service life of concrete as a single material. The tests for the two types were compared naturally carbonated and noncarbonated materials and also for different particle sizes. The admixtures having thiocyanate, resin acids were also studied as they were toxic in nature. The availability of fraction for leaching was 17% of the amount of oil added and 20-30% amount of nonylphenol ethoxylates added[8].

Collepardi has performed experiments to understand the role of superplasticizers and the effects of it on concrete. While the new superplasticizer is being used in concrete many aspects has to be considered like how it alters the durability, strength and other properties of concrete. The use of sulphonated polymer with polycarboxylate showed reduction in water and required workability with lesser slump loss. The recent trend in plasticizers perform many functions at the same time like keeping the slump without altering for one hour and also not affecting its early strength and are mainly used in the reduction of dry shrinkage[9].

Yakar Elbeyl used Borax waste containing more of boron oxide as an additive in cement , initially removal of boron oxide from boric waste and to use low boron borax waste treated with water to decrease its toxicity . The concrete containing Portland cement in which 5% of borax waste was added was tested for setting time and compressive strength in which the results observed was decrease in compressive strength with increase in soundness expansion of Portland cement. He concluded that borax waste can be used but with decrease in boron oxide and impurities[10].

R. J. Flatt studied the rheology of concrete and the influence of water, the amount of water, solid components size distribution and the addition of the superplasticizers to the mix. Hydration of cement over the time results in the evolution of rheological behaviour of concrete. In this paper the models have been prepared and examined degree of dispersion mainly and interparticle forces, model integration of yield stress. Based on the dosage of superplasticizers the efficiency of integration dispersion and structure of molecules were found in rheology of concrete[11].

G. De schutter et al explained about the effect of admixtures which are used as a corrosion inhibitor experimentally. They prepared 2 types of concretes one with Portland cement and other with blast furnace slag cement by considering 4 inhibiting admixtures namely organic inhibitor of ester and amino, inhibitor of calcium nitrite, inhibitor based on amino alcohol and migrating corrosion inhibitor. The hardened properties of concrete like compressive strength, split tensile strength, flexural strength were found along with the fresh properties of concrete. Corrosion inhibitor having calcium nitrite increases the workability of the concrete and gives early strength. Organic inhibitor amino and ester shows increased in air content and decrease in compressive strength by 10-20%. Amino alcohol inhibitor shows decrease in compressive strength and increase in workability [12].

Kavas investigated on setting and hardening property of borogypsum in Portland cement along with the flyash in which the usage of borogypsum in the place of natural gypsum was also studied with several tests. Setting time of cement was retarded by the molasses because of its usage in cement along with the borogypsum. Using of molasses by 0.1% decreases the early strength but increase in the strength was found after 7 days of curing. It is concluded that borogypsum usage and natural gypsum usage along with the molasses showed that strength will be increased after 7 days of curing period[13].

Borogypsum, the waste product formed during the production of boric acid due to the ore colemanite and sulphuric reactions. Borogypsum has been used in many process because it pollutes water. So to reduce this waste in the environment, it can be used in the production of cement [14].

M. Collepardi has enhanced properties of concrete placing by making use of admixtures like plasticizer and superplasticizer and not changing water cement ratio of the mix. The admixtures containing Formaldehyde superplasticizers were used as a superplasticizer. Acrylic polymers were also suggested to used as they have good resistance to the breakage than naphthalene formaldehyde and sulfonated melamine formaldehyde and also having low slump loss for lower water cement ratios. The amount of addition of acrylic polymer does not affect significantly whereas the other superplasticizers like sulfonated melamine formaldehyde and naphthalene formaldehyde effects the slump if the addition of it is delayed by mixing with water. Cement particles dispersion is responsible for the increase in flow due to the addition of superplasticizer[15].

3. Summary

Based on the literature reviews the different admixtures effect differently on the properties of concrete. Depends on the purpose using it like accelerating, retarding, air entraining, water reduction, air detraining, damp-proofing etc the admixtures can be chosen and used in a proper way to get the expected results. Some admixtures contain hazardous chemicals in their composition which is necessary to look after that it will not affect the working of concrete. If two or more admixtures using at the same time, one should be aware of the chemical reactions between them that will not have adverse effect on concrete and the quantity of admixtures added.

3.1 Scope for future work

The usage of many admixtures and their proportion to be added need to be know and further research is required like the use of boron compounds in concrete mix and the effect on the properties of concrete.

REFERENCES

[1] Liu, J. et al. (2019) 'Recent advance of chemical admixtures in concrete', Cement and Concrete Research, 124(July). doi: 10.1016/j.cemconres.2019.105834.

[2] Lu, Y., Ma, H. and Li, Z. (2015) 'Ultrasonic monitoring of the early-age hydration of mineral admixtures incorporated concrete using cement-based piezoelectric composite sensors', Journal of Intelligent Material Systems and Structures, 26(3), pp. 280–291. doi: 10.1177/1045389X14525488.

[3] Mutuk, T.; Mesci, B.(2014) Analysis of mechanical properties of cement containing boron waste and rice husk ash using full factorial design. Journal of Cleaner Production.; 69, 128-132.

[4] Duan, P. et al. (2013) 'Efficiency of mineral admixtures in concrete: Microstructure, compressive strength and stability of hydrate phases', Applied Clay Science, 83–84, pp. 115–121. doi: 10.1016/j.clay.2013.08.021.

[5] Alsadey, S. (2012) 'Influence of Superplasticizer on Strength of Concrete', International Journal of Research in Engineering and Technology, 1(3), pp. 164–166.

[6] Mahdi Majedi-Asl and Robabeh Jafari (2012) The Mathematical Modeling of Self-Purification of the Zarjoob River for Justification of Emission, Journal of Environmental Science and Engineering A 1.

[7] Uysal, M. and Sumer, M. (2011) 'Performance of self-compacting concrete containing different mineral admixtures', Construction and Building Materials, 25(11), pp. 4112–4120. doi: 10.1016/j.conbuildmat.2011.04.032.

[8] Togero, A. (2006) 'Leaching of hazardous substances from additives and admixtures in concrete', Environmental Engineering Science, 23(1), pp. 102–117. doi: 10.1089/ees.2006.23.102.

[9] Collepardi, M. (2005) 'Admixtures: Enhancing concrete performance', Proceedings of the International Conference on Admixtures - Enhancing Concrete Performance, pp. 217–230. doi: 10.1680/aecp.34075.Myrdal, R.

[10] Elbeyli, İ.Y. (2004)Utilization of industrial borax wastes (BW) for Portland cement production. Turkish J. Eng. Env. Sci.; 28, 281-287.

[11] Flatt, R. J. (2004) 'Towards a prediction of superplasticized concrete rheology', Materials and Structures, 37(5), pp. 289–300. doi: 10.1007/bf02481674.

[12] De Schutter, G. and Luo, L. (2004) 'Effect of corrosion inhibiting admixtures on concrete properties', Construction and Building Materials, 18(7), pp. 483–489. doi: 10.1016/j.conbuildmat.2004.04.001.

[13] Bothe, J.V. and P.W. Brown. "Kinetics of Tricalcium Aluminate Hydration in the Presence of Boric Acid and Calcium Hydroxide." Journal of the American Ceramic Society. Vol. 82. pp. 1,882–1,888. 1999.

[14] W. Ramm and M. Biscoping, Nuclear Engineering and Design 179, 191 (1998)

[15] Collepardi, M. (1998) 'Admixtures used to enhance placing characteristics of concrete', Cement and Concrete Composites, 20(2–3), pp. 103–112. doi: 10.1016/s0958-9465(98)00071-7.