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Statistical analysis of chemical admixtures usage for concrete: A survey of Eskisehir city, Turkey

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Abstract

Nowadays, the concrete admixtures are widely used in the construction projects. The main types of chemical admixtures can be summarized as plasticizers, accelerating/retarding agents, air entraining agents, waterproofing additives and others such as corrosion inhibitors and colouring agents etc. The benefits derived from the use of chemical admixtures include improved durability, strength, chemical resistance, colouring, reduction in water and cement requirement and enhanced working properties of concrete. Turkey is one of the major consumers in developing countries regarding chemical admixtures. Therefore, this study set out to determine general utilization and consciousness about admixtures through a survey in Eskisehir, Turkey. The survey was performed by 153 construction professionals. The questions about reasons for preference of admixtures, types of preferred admixtures and dosage, beneficial and adverse effects of admixtures, impacts on cost and judicious use of admixtures are included in the survey. A number of statistical analyses are carried out using SPSS on data obtained. According to results, chemical admixtures are used over 70% of the total annual concrete production. The initial expectation of the participants in the use of the admixtures is to improve the properties of the fresh concrete. Additionally, the most preferred admixtures are plasticizers. The ensuing types of admixtures are agents affecting the setting time of concrete. Although the participants' interest to using chemical admixtures is very remarkable, the awareness on this subject is very deficient. The similar studies can be suggested to apply more comprehensively. Professionals, at any level in the construction sector, need to be informed about the accurate consumption of these agents in order to avoid inappropriate results.

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1. Introduction

Concrete is the most widely used construction material in Turkey with annual consumption exceeding 90 million cubic meters. Moreover, concrete became a more effective construction material, except for its classical characteristics, as a result of new improvements in concrete production by application of new techniques and materials for improving the characteristics of fresh and hardened concrete [1]. Sometimes special qualities are expected from concrete that cannot be always achieved routinely by using conventional materials and standard mixing, placing and curing practices. In this case, concrete admixtures are utilized. Concrete admixtures are among the most important innovations in 20th century civil engineering [2].

In the past years, numerous studies were performed by many researchers about the effects of chemical admixtures. [3], [4], [5], [6], [7], [8], [9] can be referred as a few of examples of them.

Producers use admixtures primarily to modify the properties of fresh and hardened concrete, to ensure the quality of concrete during mixing, transporting, placing, and curing. The correct use of admixtures becomes possible with the use of appropriate methods of batching and concreting. Generally, the admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or worksite. The effectiveness of an admixture depends on several factors including: type and amount of cement, water content, mixing time, slump and temperature. Sometimes, some admixtures cannot affect similarly to the mixture, because the cement type, water ratio or any changes about aggregate gradation can alter the result.

The main types of chemical admixtures are classified as air-entraining, water-reducing, retarding, accelerating, and plasticizer. All other varieties of admixtures are the special chemicals that provide corrosion inhibition, shrinkage reduction, alkali-silica reactivity reduction, workability enhancement, bonding, damp proofing, and coloring.

The admixtures play an important role in the production of concrete which is suitable for the special purpose. They are used for various purposes depending upon their properties. Table 1 shows different types of chemical admixtures with their particle characteristics [10].

Table 1. Types of chemical admixtures

Chemical admixtures	Function
Plasticizer	To reduce the water requirement by 10% to 20% without affecting the workability leading to a high strength and dense concrete
Accelerator	To reduce the setting time of concrete thus helping early removal of forms and therefore used in cold weather concreting
Retarder	To increase the setting time by slowing down the hydration of cement and therefore are preferred in places of high temperature concreting
Water reducing admixture	To achieve certain workability (slump) at low water cement ratio for a specified strength thus saving on the cement
Air entraining admixture	To entrain small air bubbles in concrete which act as rollers thus improving the workability and therefore very effective in freeze-thaw cycles as they provide a cushioning effect on the expanding water in the concreting in cold climate

2. Method

In recent years, the chemical admixtures have been essential concrete components due to increase of the requested concrete properties. The producers are generally claimed that these admixtures have positive effects on concrete performance and economy. Therefore, the consumer's recognition and results obtained usage of admixtures are the basis of this study. In this study, a survey was conducted to determine the users experience and preference about concrete admixtures. For this purpose, the survey was applied on 153 professionals working in different workplaces of construction industry in Eskisehir (a city from Turkey). The distribution of participants by construction sectors and titles respectively Figure 1 and Figure 2. The questionnaire is consisted of 20 questions. The types of chemical admixtures used by companies, dosage, consciousness of the admixture usage, examinations

before using admixtures, disadvantages, effects on workability, strength, durability and cost were investigated with these questions.

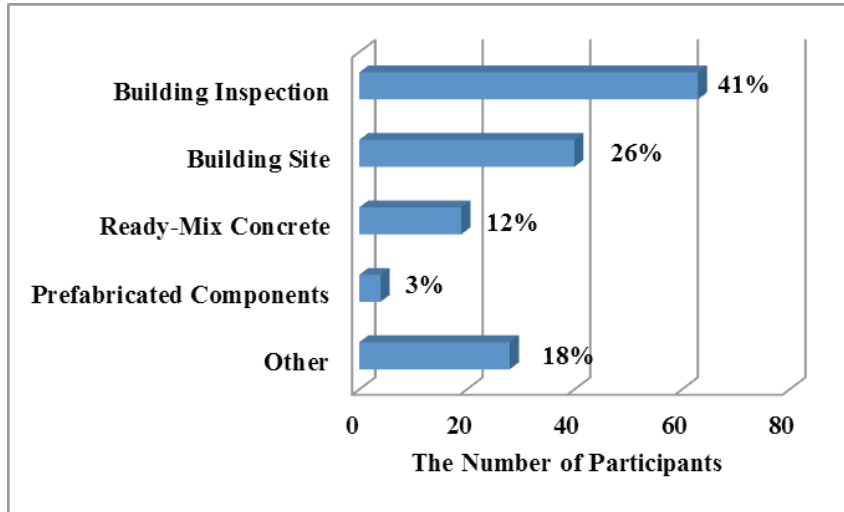


Fig 1. The distribution of participants by construction sectors

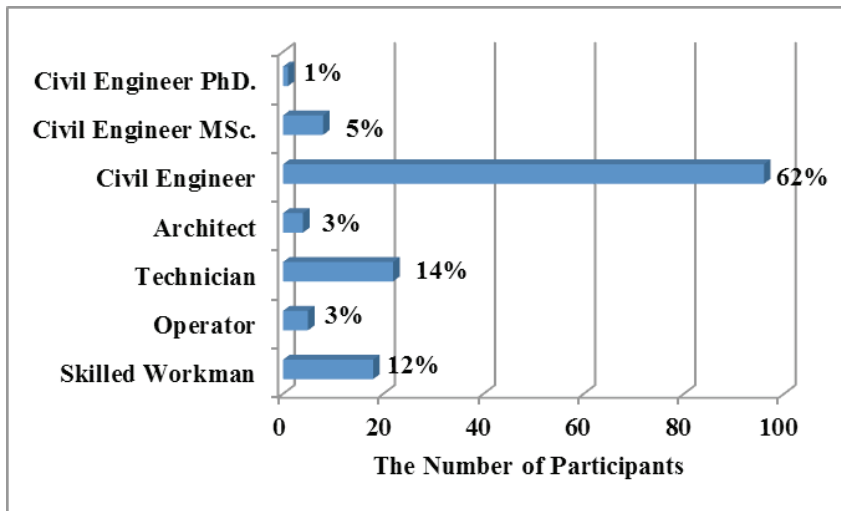


Fig 2. The distribution of participants by title

3. Results

The data was evaluated with IBM SPSS Statistics. Cronbach's Alpha was computed as 0.74 to found the reliability of data and that is considerably reasonable. Also the chi square method was applied in data analysis. The remarkable results are presented below.

According to results, the most preferred admixture type is plasticizer, and then the set controlling admixture follows with a high proportion. The total of air-entraining and other admixtures usage remains below 8%. This result can be shown in Figure 3.

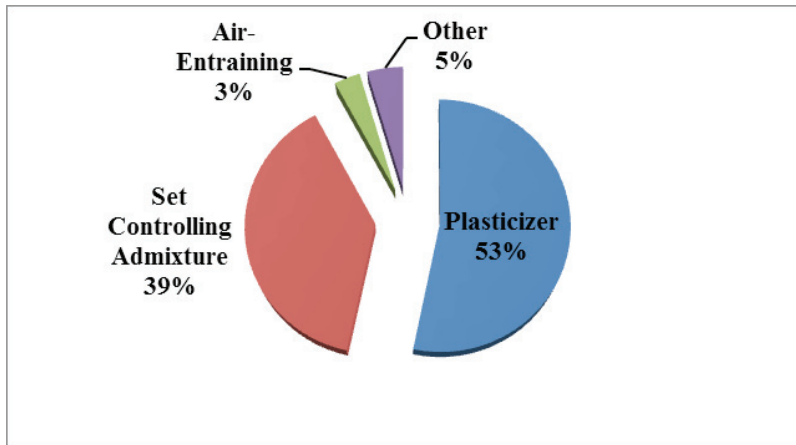


Fig. 3. The distribution of admixture preference of the participants

The participants are asked which percentage of the chemical admixtures is added for a cubic meter. When half of the participants express their admixture ratio 1% or less, there is nobody who uses the admixture more than 5% per cubic meter.

About 10% of the participants state that their usage of concrete with admixture has 70% share in the total annual concrete consumption. In contrast, the proportion of professionals who prefer less than 10% is appeared as 34%.

Figure 4 illustrates why the professionals use chemical admixtures. Accordingly, the vast majority of the participants use chemicals for improving the properties of the fresh concrete. For reducing cost is not considered as an important reason. The setting time, water demand, heat of hydration and workability can be listed as the properties of fresh concrete [11].

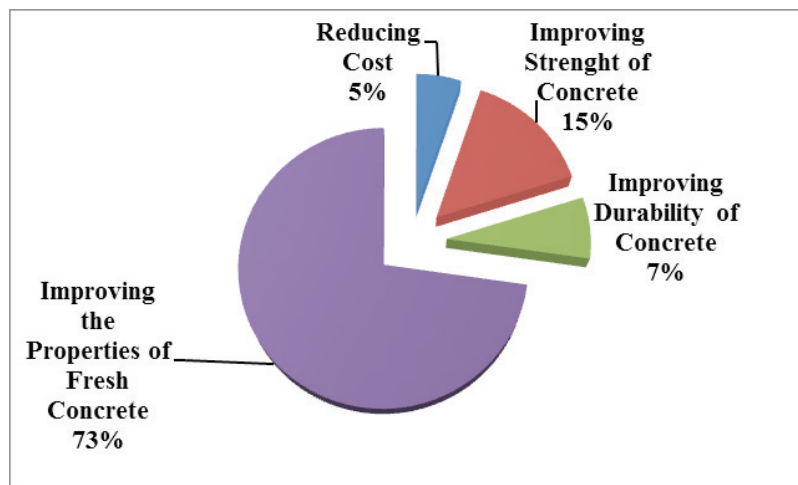


Fig. 4. The reasons for the use of chemical admixtures

Also the participants are asked water/cement ratio obtained by usage of plasticizer. 51% of the participants state that they achieve as minimum 0.40-0.50 water/cement ratio using plasticizer. 39% of the participants express that they can reduce water/cement ratio below 0.40.

73% of the respondents say that, in any time, they can reach admixtures which provide the requested properties, whereas 23% of the respondents say that they have a problem in this regard.

The use of admixture provides economic gains according to 70% of the participants. Also, the participants were asked to state how much the cost increase per cubic meter when use admixture. About 60% of the participants state that admixtures increase the cost among 3% to 10% per cubic meter. 36% of the participants state that the usage of the admixture increases the cost less than 3%. The percentage of the participants who believe that the cost increases 10% remain only 5%.

The participants were asked if they had encountered with adverse results due to the usage of chemical admixtures. Almost half of the survey participants say they do not detect any adverse effect. According to the same question, the most significant problem is related to the strength of concrete with 37%.

Any meaningful result cannot be obtained from the answers about the prevalence of the admixture usage in Turkey. When the use of the admixture is sufficient for one-third of the participants, another one-third part thinks it should be more spread.

The participants are asked whether they have attended any briefing to be informed about admixtures. Only 32% of the participants say that they attended in such meetings. However, the proportion of the participants who take into account the chemical compositions of the admixtures before using is 50%. On the contrary, 84% of the participants comply with the recommended ratio before using admixture.

If the type of cement used in production of concrete is changed, various laboratory studies should be done to determine the effects of admixture [12]. It is regrettable that according to the survey, 55% of construction professionals are not knowledgeable about this issue.

The compatibility test is required before using multiple chemical admixtures according to the producers. The participants were asked a question in this regard. 45% of the participants do not use multiple admixtures in combination. 43% of the participants use multiple chemical admixtures but they do not perform the test for compatibility. Only 12% of the participants apply the required tests.

Applying performance test before the use of chemical admixture is an important requirement. However, the percentage of the participants who perform this test is only 25.

4. Conclusions

In this study, a survey was conducted with 153 construction professionals in Eskisehir. Because of the variable weather conditions in Eskisehir, the use of chemical admixture becomes inevitable. Hardening of the concrete, workability, strength and durability are the most important problems. If our research results are generalizable, it can be said that the interest in the use of chemical admixture is quite high in our country. According to the obtained data, plasticizer is the most preferred type of the admixtures as expected. The use of chemical admixtures is known to require knowledge, experience and inspection. However, the users have been emerged inadequate in this regard. Arranging informative seminars from especially admixture firms are recommended to avoid adverse consequences.

References

- [1] U. S. Yılmaz, H. Turken, The effects of various curing materials on the compressive strength characteristic of the concretes produced with multiple chemical admixtures, *Scientia Iranica*, Volume 19, Issue 1, 2012, pp. 77-83.
- [2] B. Łaźniewska-Piekarczyk, The influence of chemical admixtures on cement hydration and mixture properties of very high performance self-compacting concrete, *Construction and Building Materials*, Volume 49, 2013, pp. 643-662.
- [3] F.M. Kılınçkale, G.G. Dogan, Performance of concretes produced with superplasticizer, *Journal of Applied Polymer Science*, 103, 2007, pp. 3214-3219.
- [4] A. Kapelko, The possibility of adjusting concrete mixtures' fluidity by means of superplasticizer SNF, *Archives of Civil and Mechanical Engineering*, 3, VI, 2006, pp. 37-53.
- [5] I. Papayianni, G. Tsohos, N. Oikonomou, P. Mavria, Influence of superplasticizer type and mix design parameters on the performance of them in concrete mixtures, *Cement and Concrete Composites*, 27, 2005, pp. 217-222.
- [6] M. Collepardi, Chemical admixtures today, *Proceedings of Second International Symposium on Concrete Technology for Sustainable Development with Emphasis on Infrastructure*, Hyderabad, India, 2005, pp. 527-541.

- [7] A. Papo, L. Piani, Effect of various superplasticizers on the rheological properties of Portland cement pastes, *Cement and Concrete Research*, 34, 2004, pp. 2097-2101.
- [8] B. Chatveera, P. Lertwattanaruk, Use of ready-mixed concrete plant sludge water in concrete containing an additive or admixture, *Journal of Environmental Management*, 90, 2009, pp. 1901-1908.
- [9] H. Turken, U. S. Yılmaz, An experimental study about the effects of various types of additives on the compressive strength of concrete, and the points that should be considered during the selection of concrete additive, *Cukurova University, Engineering-Architectural Faculty 30th Year Symposium*, Adana, Turkey, 16–17 October 2008, pp. 416–421.
- [10] V. Patel, N. Shah, A survey of high performance concrete developments in civil engineering field, *Open Journal of Civil Engineering*, 3, 2013, pp. 69-79.
- [11] S. U. Khan, M. F. Nuruddin, T. Ayub, N. Shafiq, Effects of different mineral admixtures on the properties of fresh concrete, *The Scientific World Journal*, Article ID 986567, 2014, 11 pages.
- [12] İ. B. Topçu, M. Canbaz, C. Karakurt, Utilization of chemical admixtures for concrete production, *Journal of Polytechnic*, Vol: 9 No: 1, 2006, pp. 59-63.