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Investigation and modelling the effects of water proofing and water repellent admixtures dosage on the permeability and compressive strengths of concrete

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HIGHLIGHTS

- Max. compressive strength 36.1 N/mm^2, min. water absorption 4% with 2% chemical additive.
- Min. water absorption 4%, min. compressive strength 28.5 N/mm^2 with 0% chemical additives.
- Water absorption measured 5.9% on the same samples (0% chemical additive).
- Both statistical and ANFIS results have perfect match with experimental results.
- Compressive strength and water absorption can be predicted for known/unknown values.

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ABSTRACT

In this study, structural waterproofing products, structural water insulation applications and effects of waterproofing admixtures on the concrete were experimentally investigated. Different dosages in the concrete mixture (0%, 0.5%, 1.0%, 1.5% and 2.0%) were used to determine the effect of the chemical additive on the permeability of the concrete and the compressive strength the chemical additives. Maximum particle diameter of the aggregate used in the concrete mixture was selected 32 mm accordance to the Turkish Standard 802 "Design of concrete mixes" (TS 802) [1]. The selected aggregate granulometry of concrete mixture is located in B32 section of this granulometry curve and by using PC 42.5 cement, 320 kg/m^3 dosage concretes were produced in laboratory by adding four different kinds of aggregates. The compressive strength and permeability of the hardened concrete samples were measured after 14 days. The measured results showed that while maximum compressive strength were measured as 36.1 N/mm^2 on the concrete samples prepared with 2% chemical additive the minimum water absorption were measured as 4% on the same samples. However, while minimum compressive strength were measured as 28.5 N/mm^2 on the concrete samples prepared with 0% (Reference samples) chemical additives the maximum water absorption were measured as 5.9% on the same samples. Statistical analyses were conducted to determine the relationship between experimental parameters on the compressive strength and water absorption of the hardened concrete samples. By using Adaptive Neural Fuzzy Inference System (ANFIS) prediction models were developed based on the experimental inputs to predict the compressive strength and water absorption of the hardened concrete samples. The results showed that both statistical and ANFIS methods' results have perfect match with experimental results. The prediction models can be used to predict the compressive strength and water absorption of concrete samples for known and unknown experimental inputs values.

1. Introduction

Compressive strength of concrete is an important mechanical property. Concrete strength is influenced by lots of factors like concrete ingredients, age ratio of water to cementations materials, durability, etc. The ability of concrete to withstand the conditions for which it is designed without deterioration for a long period of years is known as durability. Durability is defined as the capability of concrete to resist weathering action, chemical attack and abrasion while maintaining its desired engineering properties. It normally refers to the duration or life span of trouble-free

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performance. Different concretes require different degrees of durability depending on the exposure environment and properties desired.

These effects wave, discharge of abrasive material, such as multiplication of the swab, acid salt effect crystallization chemicals, such as alkali-aggregate reaction can be physical such as freeze–thaw. The most important feature of the pore structure of concrete and the concrete is given in a solid ratio. This situation is directly linked to the permeability of concrete. Transmission in the concrete of water or other fluid will be moved this way and harmful substances into the concrete in this way. For example; in the sulphate damage and permeability caused by moving water into the concrete damaging sulphate causes some chemical reaction. In this respect, the mechanism of moisture movement in the concrete will need to understand better. Concrete fluid movement takes place in three ways. These are:

1- All of the cavities of the material are saturated water and saturated steam is caused by the existing water pressure influence.
2- The cavities of the concrete part which is filled with water, unsaturated flow due to the effect of surface tension or capillary force
3- Available vapour pressure difference between the two regions in the cavities of the concrete is thus formed from the water vapour flow.

With regard to the composition of the concrete water/cement ratio are important factors that affect the type and amount of cement concrete permeability.

Providing the impermeability of concrete additives; correcting the capillary water absorption water impermeability are providing mass waterproofing against pressurized water-repellent additives. Essential ingredient of these additives fatty acid soap (stearate, oleate and laureate and especially their zinc and aluminium soaps) and the fine powder. (Kieselguhr) Bentonite, fat lime, ground limestone, mineral powders, and acetate type plastic emulsions) to reduce the capillarity in addition to the most widely used group of stearate air entraining agent having water-repellent qualities which are also on the property. Occlusive mainly benefit the fines against pressurized water permeability task. On the other hand, the concrete with water reducing additives play an important role on the permeability increasing compactness air entraining and accelerator are used for waterproofing contributions.

2. Materials and methods

2.1. Materials

The chemical ingredients in different proportions (0%, 0.5%, 1.0%, 1.5%, 2.0%) concrete permeability and compressive resistance to the impact of the concrete using the investigation as this study experimental results obtained in impermeabilisation and models for the prediction of the compressive strength. Impregnation additive into the concrete is made by mixing different ratios of experiments. Aggregate mix, crushed sand, natural sand, crushed stone No. 1 and No. 2 was created from stone aggregates and aggregate grading curve close to the C32 reference is used (TS 802) (Fig. 1) [1]. Water absorption for the aggregate amount determined by experiments conducted and the test results are shown below (Table 1).

2.2. Methods

The produced concrete samples were measured air gap, water absorption of hardened concrete samples were determined. The compressive strength was determined at the 14th day. The obtained experimental results show that the relationships between the parameters studied has made meaningful statistical analysis, while there are differences as to whether the differences between the groups regarding which the group is different tests were performed. Adaptive to model, depending on the concrete compressive strength and water absorption of concrete inputs estimated by Neural Approach method developed models.

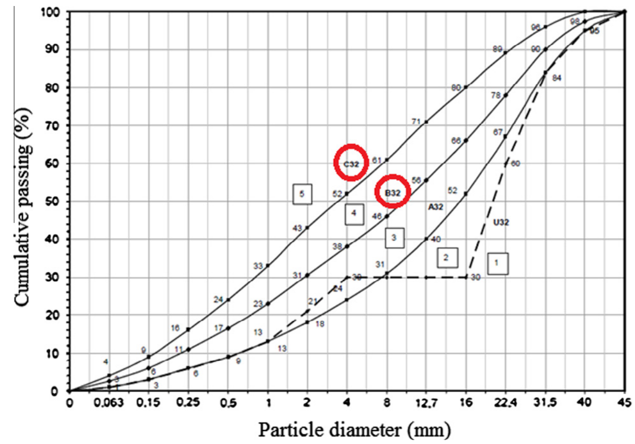

Fig. 1. Aggregate granulometry curve for max. 32 mm particle diameter (TS 802).

Table 1
Water absorption of aggregates used.

	Natural sand	Crushing sand	Gravel No. 1	Gravel No. 2
Humidity	0	0	0	0
Water absorption %	1.4	1.8	0.6	0.6
Total	−1.4	−1.8	−0.6	−0.6
Total Water (lt)	−6.7	−8.1	−3.0	−2.7

The artificial intelligence based techniques like artificial neural networks Hong-Guang et al. [2], Oztas et al. [3], Bilim et al. [4] and so called adaptive network-based fuzzy inference systems (ANFIS) Ramezanianpour et al. [5], Sarıdemir [6], Ozcan et al. [7], have been successfully applied these researches. Many studies can be found in the literature that focused on the prediction of the various properties of concrete [8–14].

It can be observed that a great number of studies in the field of artificial neural networks in structural engineering. For example, Yeh [15,16], Kasperkiewicz et al. [17], Lai and Sera [18], and Lee [19,20], applied the neural networks for predicting properties of conventional concrete and high performance concretes. Bai et al. [21] developed neural network models that provide effective predictive capability with respect to the workability of concrete incorporating metakaolin and fly ash. Guang and Zong [2] proposed a method to predict 28-day compressive strength of concrete by using multilayer feed forward neural networks. Dias and Pooliyadda [22] used back propagation neural networks to predict the strength and slump of ready mixed concrete and high strength concrete, in which chemical admixtures and mineral additives were used.

This model was modelled using experimental results as a whole and it is allowed to estimate the experimentally determined values. The resulting model with the results of validity of this model was tested by comparing the results in the actual experiment. Adaptive Neural Approach modelling results with statistical results and to compare their similarities and differences between them were put forward.

3. Mix concrete and test results

It is calculated based on the absolute volume of concrete mix made in accordance with the dosage of 320 kg/m^3 concrete was produced. Made in this experiment, pure (control) concrete and waterproofing additive providing a total of 5 blends was produced for use in different proportions. 15 ± 1 cm slump value of the concrete has set amount of water to keep it constant. Try for 15 × 15 × 15 cm cube compressive strength of the samples was used. Also 3 each 15 × 15 × 15 cm water absorption tests on the samples produced for each cube is made of a mixture. In the trials, 15 × 15 × 15 cm for compressive strength ’like cube moulds are used. The concrete samples were removed from the mould after mould was kept waiting for 24 h in 7 days in water in the curing room. Samples removed from the pool after 7 days cure for 4 days out (in a hot environment) was heated. After 4 days standing out-