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Neural Model of Projecting Compressive Strength of Cement Concrete Intended for Airfield Pavements

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1 Materials and Methods

The designed aggregate compositions each time complied with (PN-EN 206-1: 2003) and (NO 17A 204: 2015). Limit content of individual mix components have been presented in the table 1. On the 28th day since concreting, each sample, prepared and cured was subject to determined the compressive strength. The strength values obtained in this way were the input base to assess compressive strength of cement concrete intended for pavements using ANN.

Table 1. Limit component contents of the analyzed concrete mixes.

Elements content	Cement kg/m^3	Coarse aggregate kg/m^3	Fine aggregate kg/m^3	Water kg/m^3	Admixtures kg/m^3
Minimum	335	1149	358	120	0.0
maximum	380	1401	604	150	6.4

2 Data Preparation

Neuron used in the course of network designing process consists of output signal being the total of constant and relevant input signals multiplied by weight. The number of hidden layers was selected experimentally, assuming the accuracy of data representation from the experiment as the main objective. One output neuron forms output layer of the discussed network, the objective of which is providing the solution at network output. The number of iterations determining constants and weights, constant of learning α and momentum η are referred as control variables in case of the analyzed network structure. It was assumed that input signals will be subject to normalization and have numeric values from 0 to 1.

3 Results

In order to conduct cross-section analysis of the influence of variables parameters values (α and η) on the accuracy of representation of compressive strength, analyses including matrix of 90x90 elements. Values of learning constant and momentum was different (0.01÷0.9).

Analyzing the initial data for further analysis the tolerance of learning constant was assumed at 0.05 and the tolerance of momentum value was assigned at 0.3. In case of this tolerance, the least value of the generated mistake at the highest compliance of results was obtained. Influence of number of hidden layers (1÷2) and neurons number (5-10) in a hidden layer on the accuracy of representation of compressive strength was determined - table 2.

Table. 2. Influence of neurons number (5-10) in a hidden layer on the accuracy of representation of compressive strength at constant value of momentum 0.4, learning constant 0.03 and ε = 0.01

percentage of positive events	the number of neurons in the hidden layer					
	5	6	7	8	9	10
	100	100	100	98,6	100	59,4
$\Delta\, y_{sr}$	0.0028273	0.0022759	0.0031341	0.0022653	0.0027379	0.014378

According to the obtained analysis results ANN was assumed the best representing network for constant value of momentum 0.3, learning constant of 0.05, 6 neurons in a hidden layer and assumed ε = 0.01. The 5-6-1 structure was assumed as a result of accuracy tests of representing real compressive strength values by the network. Assessment criterion was assumed taking into consideration the lowest mistake level and 100% compliance. According to the obtained results of ANN analysis it was proved that the determined network can be recognized reliable for 38000 iterations. Out of the collection of 6500 diversified concrete mix compositions intended for airfield pavements, each 20 % was selected randomly and intended for testing and verification. Figure 1 and 2 presents graphic summary of data determined at testing stage and verification stage by the educated network.

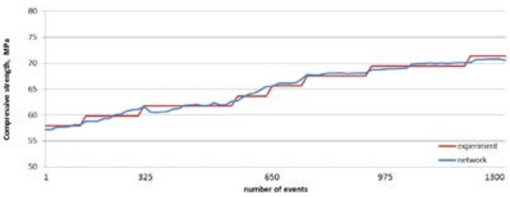

Figure 1. The course of testing process of the artificial neural networks of 5-6-1 structure.

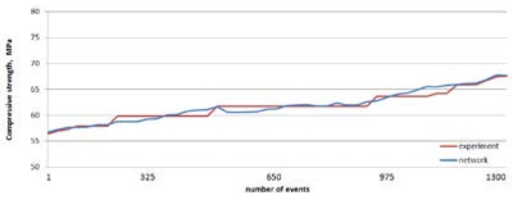

Figure 2. The course of testing process of the artificial neural networks of 5-6-1 structure.

4 Conclusions

The results obtained as a result of the conducted analyses prove the purpose of application of the presented method in case of modeling the composition of concrete mix and projecting the strength obtained by concrete after 28 days of curing in standard conditions. Based on the obtained results, the network structure has a large influence on the accuracy of mapping results from the experiment through the network. It was proved that 5-6-1 network, with learning constant of 0.05, momentum 0.3 and ε=0.01,is the most favorable structure for the assumed data. At testing stage, the coincidence was achieved at the level of 99.08%, and during model verification the average coincidence was 99.05%.

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