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ARTIFICIAL INTELLIGENCE USED TO DESIGN CONCRETE MIX

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ABSTRACT

These methods allow you to examine the integrity of a dataset, allowing you to examine the properties of a dataset and arrive at a single numbered result. In this study, twelve materials and fresh concrete parameters were used for statistical analysis describing the strength of hardened concrete for fourteen different mixes. These parameters are taken from the original concrete. The works were carried out in two stages: the first stage involved the treatment of concrete with treated water and the second stage involved the use of groundwater. Both steps were performed simultaneously. This adds two datasets to a 14-by-12 matrix, adding to the matrix. Since the 28-day compressive strength of concrete is the usual indicator of the characteristic strength of concrete, the same strength index is used here for statistical evaluation. You can find all these studies in this section. It has been suggested that this is a method that can be used to analyze the strength differences of concrete that occurs when groundwater is used for mixing. This study analyzes results from various studies conducted. Within the scope of this research, statistical studies were also used to investigate the effect of water quality on the strength and durability of concrete. During this research, an artificial neural network was used to try to generate density estimates

Keywords: *Artificial Intelligence, Concrete Mix*

INTRODUCTION

Concrete is essentially a mixture of putty and particles. Uniaxial compressive strength of concrete is considered to be the most valuable property of concrete in terms of concrete mix design and concrete quality control. This property is influenced by a number of different factors. The formulation of the cement mixture is subject to the principles of workability of fresh concrete, the desired strength and durability of hardened concrete, followed by the law of the water-cement ratio. The properties of the mortar, coarse aggregate, and interfaces contribute to the overall composition of concrete, which in turn determine its strength. By using mortars of the same quality, it is possible to produce concrete of different strengths from different types of coarse aggregates, each of which has its own shape, texture, mineralogy and strength. There are several categories of mixes, the most common being nominal mix, standard mix and design mix. Mixtures with a certain cement/aggregate ratio are called nominal mixes. This ratio ensures that the mixture has sufficient strength. However, due to the wide variety of elements that go into the mix, the strength class of concrete can vary greatly depending on how easily it can be worked. There are significant differences in strength of nominal mixes with a constant cement/aggregate ratio (by volume), which can lead to mixtures that are too rich or not rich enough. In this logic, the minimum compressive strength is integrated into numerous standards. These mixtures are called typical mixtures. In designed mixes, the performance of the concrete is determined by the designer, but the mixing ratios are determined by the concrete manufacturer. The only exception to this rule is when a minimum concrete quality may be required. Cement, fine aggregate, and coarse aggregate, taken together in their proportions in the context of a concrete mix, are usually expressed in parts or proportions. For example, a concrete mix with a 1:2:4 ratio indicates a 1:2:4 ratio of cement to fine aggregate and coarse aggregate, or the mix is one part cement, two parts fine aggregate, and four parts. parts. Coarse aggregate pieces. Proportions can be expressed as volume or mass and offer two different design approaches. Concrete mix design can be done using the American unit system or the IS standard code. After the concrete has hardened, compressive strength tests are usually done after about seven, fourteen, or twenty-eight days. The 28-day exam is systematic and therefore compulsory, exams can be given at a later age if necessary. ANN has had several successful applications in civil engineering, particularly in more complex problems.

The growth of smart buildings in the construction industry will greatly assist construction companies in their efforts to improve both their efficiency and the quality of their work. The term "intelligent construction" refers to a management system that monitors the entire construction process in real time. This is achieved through the use of mobile, wearable and Internet of Things (IoT) technologies. Due to the challenges of IoT implementation, there is a need to create an efficient and cost-effective mix design through data management in the field of high strength concrete mix design.

Concrete has been the most widely used material in construction in recent years, as it has been shown to have stable, high strength properties. In addition to cement, coarse aggregate and fine aggregate, which are the four basic components traditionally found in concrete, various cement composition materials such as fly ash, blast furnace slag and chemical mixtures have been used as superplasticizers. , and water. Conventional concrete consists of these four components. Since Portland cement is the most expensive component of concrete mixes, the use of additional components to the cement composition also provides economic benefits. On the other hand, the addition of additives to concrete is becoming more and more common as these additives can increase the workability, durability and strength of concrete. Modeling the compressive strength of concrete must now take into account the new dimensions brought about by these new additions to the concrete mix, leading to increased complexity. On the other hand, traditional modeling approaches, often used in the concrete behavior prediction process, are less capable of providing reliable predictive results.

In most cases, the strength test is done 7 to 28 days after the concrete is poured. The 28-day waiting period required to perform such tests may cause a slight delay in the progress of construction. On the other hand, ignoring testing will reduce QA coverage at a very large and complex build scale. Even in the early stages of design, the ability to quickly and accurately predict the compressive strength of concrete is critical to quality control. If concrete strength is out of specification, save time and money by changing the mix ratio immediately. This provides a faster and less costly construction process. Estimating the time required to open concrete formwork, meeting project deadlines, and maintaining quality depends heavily on concrete strength estimation.

Because of the non-linear nature of the relationship between concrete components and properties, it can be quite difficult to model the material using a mathematical technique. The empirical equation for calculating compressive strength published in the current standard is based on testing concrete without additional cement composition materials. This is because the empirical equation was developed using the latest standard code. When it comes to maximizing a concrete mix, it is important to understand the relationship between the components of concrete and its strength. Experiments, which often require a lot of time and resources, have been used to conduct a substantial amount of research. This requires a new modeling system that is not evidence-based but can accurately predict the compressive strength of concrete. Ideally, this system should combine both features.

In the last hundred years, the world population has increased from 1.5 billion to 7.7 billion (Leridon, 2020) and more than half of the current world population lives in urban areas (Chen et al., 2019). With the increase in world population, the rate of global urbanization, which continues to accelerate, will also increase. By 2050, two out of three people are expected to live in cities (Buhaug et al., 2013). Urban sprawl of this magnitude requires the acquisition of large quantities of raw materials to enable the creation of residential, commercial buildings, sewer systems and other infrastructure. The construction and infrastructure industry relies almost entirely on concrete as the main building material (Mehta and Monteiro, 2014). Even after decades of research and study, many scientific and technical questions regarding concrete materials, including those related to mix design optimization and service life prediction, still remain unanswered without satisfactory answers (DeRousseau et al., 2018; Dolado and Van Breugel).) . , 2011). While much of the initial concrete research relies on expert knowledge and intuition, trial and error experiments, or physical modeling, recent advances in data-driven techniques such as artificial intelligence (AI) can offer new perspectives on how to approach the problem. research questions that have already been asked (Asteris et al., 2021; Cai et al., 2020; Young et al., 2019).

Artificial Neural Network (ANN)

Dense parallel connections distinguish neural networks from other types of networks. These networks consist of many simple processes called units, nodes or neurons. Synapses are the names of the connections established between neurons. Each neuron in the network receives information in the form of weighted inputs from other neurons and uses an activation function to send its outputs to other neurons. As a result, knowledge is represented by heavily weighted links. Neural networks can have one or more layers. Single-layer neural networks have processing units that receive information from outside the network and transmit their output outside the network; otherwise, neural networks are considered multi-layered. In single-layer neural networks, the input comes from outside the networks and the output goes out. The three phases of training, testing, and implementing the network are the key stages of the neural network approach. During the learning phase of the neural network, the connection weights change and the resulting learning effect is called learning. Training the neural network typically involves making adjustments to connect the weights according to a predetermined learning rule. The training process can be done by changing the weights according to certain conditions or by providing calculated weights and offsets based on a set of training data. In other words, neural networks can learn from past experience and show the ability to generalize beyond the data used for training. Then more test data is used to test the generalization. In most cases, randomness is used to determine the initial weights and biases applied to the connecting nodes of an input layer, hidden layers, and an output layer. Adjustments are made to the weights and offsets of the network output to meet the required data values. In most cases, sigmoidal activation functions are used in the process of transmitting input data through hidden layers. Data is randomly selected throughout the training process to ensure consistency. A particular run can be considered complete when all records have been processed. In most cases, more than one pass is required to achieve the desired forecast accuracy. Long-term memory, also known as synapses, are recent weights and biases associated with certain experiences. Therefore, learning can be compared to the process of calculating the weights and biases associated with connections in networks. Back propagation networks were used for the purpose of this study. The backpropagation network learning mechanism is a generalized version of the delta rule. This gradient rule reduces the error field to minimize the total error that exists between the calculated actual and desired values of an output level when the link weights are changed. In other words, the least mean squares method is used in conjunction with a gradient descent method to determine the values of the link weights that cause the error function to shrink to its smallest possible value.

Multilevel data driven systems that can be trained with artificial neural networks (ANNs). It has been used effectively to provide accurate estimates for a wide variety of concrete grades. On the other hand, predictive ability is highly dependent on the completeness and accuracy of the experimental database used in the training process. Multi-Layer Perceptron Networks (MLPs) are the most widely used Artificial Neural Networks (ANNs) in engineering applications, thanks to their ability to apply nonlinear transformations for functional approximation problems and map one or more given inputs to a desired output. [citation needed](s). When developing a model based on ANN, the main goal is to train a particular network architecture to find an optimal set of weights (link strength between processing units) using a comprehensive database. This allows the trained ANN to accurately predict the output values for a given set of inputs within the training data range. A neural network model does not require functional relationships between variables, as do most traditional regression analysis techniques. A neural network-based modeling algorithm requires configuring various learning parameters (such as learning rate and momentum), the optimum number of nodes in the hidden layer, and the number of hidden layers to have a network. . It is less complex and has relatively better generalizability.

The ANN application offers the following advantageous features and capabilities to the user :

- non-linearity
- Mapping inputs and outputs
- adaptability
- context information
- Consistency in analysis and design.

The term "artificial n eural network" (ANN) refers to a mathematical and computational model that mimics a biological neural network. A biological neural network consists of a series of interconnected artificial neurons that serve as the basic processing unit for computations. The purpose of artificial neural networks is to answer difficult questions that arise in life and in various fields.

CONCRETE

Concrete is one of the oldest and most widely used building materials in the world. This is mainly because it is inexpensive, readily available, has a long service life, and can withstand the effects of various weather conditions. Measured in tons, the world's concrete production is ten times that of steel. On the other hand, alternative building materials such as steel and polymers are not only more expensive but also much rarer than concrete materials. Concrete is a brittle material with high compressive strength but low tensile strength. This duality gives concrete its high compressive strength. Therefore, concrete should be strengthened to absorb tensile stresses. Steel is commonly used to provide reinforcement in this type of work.

Concrete is a composite material consisting of fine and coarse aggregates held together by a liquid cement (cement paste) and then cured (hardened) over its lifetime. Concrete is the most used material and the most used building material after water in the world. Its global consumption in tonnes is twice the combined consumption of metal, wood and plastic. The ready mixed concrete industry, which represents the largest part of the concrete market, is expected to realize sales of over 600 billion dollars worldwide by 2025. Large-scale application has many adverse effects on the surrounding ecosystem. In particular, the cement production process involves the release of significant greenhouse gas emissions, equivalent to 8% of total global emissions. Other environmental concerns include illegal sand mining, impacts on the surrounding ecosystem such as increased runoff or urban heat island effect, and potential public health effects of the presence of harmful substances. Significant R&D work is underway to reduce emissions or make it a true source of carbon sequestration, as well as increasing the amount of secondary and recycled raw materials included in the mix to achieve the goal of a circular economy. Concrete is expected to play an important role in the development of structures that are resistant to the effects of climate change. It can also provide a solution to reduce pollution produced by other industries by trapping waste such as concrete, coal fly ash or bauxite deposits and deposits.

When the aggregate is combined with dry Portland cement and water, the resulting product becomes a slurry that can be poured relatively easily and molded into almost any desired shape. In a process known as the hydration of concrete, cement interacts with water to form a matrix that hardens within a few hours, forming a rigid structure that binds materials together into a stone-like solid that has a variety of uses. At this time, not only concrete is poured into the mold, but also various compaction techniques can be performed with concrete. Since the hydration process is exothermic, the temperature of the surrounding environment is a very important factor in the setting time of concrete. It is common to include additives such as pozzolans or plasticizers in the mix to improve the physical properties of the wet mix, delay or accelerate the setting time, or otherwise modify the resulting material. In most concrete projects, reinforcing components (eg rebar) are included during the pouring process, resulting in reinforced concrete production

concrete elements

The components that make up the concrete mixture, which is a heterogeneous substance, are as follows:

Approximately 75% of the concrete volume consists of aggregates. Sand, crushed stone, recycled concrete rubble and even other materials can be used as aggregates in construction.

Cement: It makes up about 7 to 14% of concrete. Cement is used to impart cohesive properties to concrete. The American Society for Testing and Materials (ASTM) divides Portland cement into five different classes based on its individual properties.

1. Form I concrete is the most popular type of concrete and is a standard Portland cement that can be used for a variety of purposes. It is used when the risk of exposure to sulfates is low.
2. Type II cements, B. Used in the production of concrete that can be exposed to low-sulphate environments such as low-sulphate soils.
3. Type III Applications requiring initial strength are best done with cements used in these cases.
4. Type IV cements are used in dams and in areas requiring large amounts of concrete, in applications that require fast setting time such as B. This type of cement is generally used where large quantities of concrete are required.
5. Type V cements: Portland cements with high resistance to sulfates and used where concrete is exposed to high levels of sulfates, eg. B. waste water.

OBJECTVE OF THE STUDY

1. To study on components that make up the concrete mixture
2. To study on concrete is essentially a mixture of putty and particles.

CONCLUSION

The sample prepared from treated water reached a strength exceeding the target strength of 28.25 MPa after only 3 days of aging, unlike the samples prepared from groundwater, which reached the target strength only after 14 days of storage.With filtered water, you can replace up to forty percent of the material with another material and reach the appropriate strength level in 28 days. This can be done when cement is mixed with other material. When groundwater is used for mixing, proper concrete strength can be achieved in just 28 days by replacing up to 20% of the cement with groundwater. This can be done by varying the amount of groundwater used in the mixing process.The explanation of the strength increase rates that can be expected from the use of treated water in asphalt production is given below. After a period of three days, the concentration of the control mixture reached the target level. After a period of 14 days a marked increase in the overall efficacy of the other mixtures is observed. After 28 days, the cement equivalent made with over forty percent fly ash did not reach the expected strength level; however, it reached the desired effect level after 56 days.The strength increase rate of the mixtures formed using groundwater is shown in the table below: Up to thirty percent of the cement was replaced with fly ash in each of the other four mixtures, and all showed an immediate improvement in the compressive strength of the mixture. The control blend and four other blends showed this improvement. The rate of strength increase follows a gradient that is essentially the same for nearly all blends, and this gradient is nearly the same for 3:56 days. The 56 to 90 day period shows a slower rate of resistance development than any other period in which all mixtures are studied.Over a 28-day period, there was not much difference in the tensile strength of the control mixture and the 10FA samples created using purified water. Both mixtures were subjected to the same amount of water treatment.After adding fly ash to the mixture, the tensile strength of the samples decreased significantly.

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