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ANALYSIS OF BLAST CONSEQUENCES BY USING ANFIS MODEL

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ABSTRACT

Explosion is one of the common causes of accidents that result in significant casualties in manufacturing facilities. It is also a phenomenon that occurs when objects release or transfer energy, and it is followed by strong mechanical effects and damages. The Kingery-Bulmash equation is one of the several blast load equations that can be used to calculate the parameters of a pressure-time background curve for both free-air and surface bursts. The explosives science is used in an Explosion Consequence Analysis (ECA) to assess possible hazards to buildings, individuals, or other targets. Accuracy of 98.5% has obtained through the implementation of support vector machines. In this paper, machine learning techniques such as supervised learning algorithm is proposed for ECA.

Keywords: Neuro-fuzzy, Explosion consequences analysis, Artificial Neural Network, Adaptive Neuro-fuzzy inference system.

I. INTRODUCTION

Explosives and blasting methods are one of the most effective and systematic ways to explore mines by drilling and civil engineering projects. On the other hand, the researchers had to use the data in a specific way. as a result of the existence of phenomena such as Massive vibrations, the collapse of valuable minerals, and so on environmental hazards, as well as damage to nearby structures residents [9]. The use of finite elements to analyze blast waves and any damaged structural components has gotten a lot of attention in the last few decades. Explosions have always piqued the military's interest, but with the global rise of terrorism, they've piqued the interest of researchers, as their effects could jeopardize the structural stability of engineering systems. Deliberate explosions, such as those caused by demolition operations, war acts, excavations, terrorist attacks, and so on, fall into the first group, while accidental explosions fall into the second.

A sudden release of energy occurs during an explosion due to a very quick chemical reaction. The gases emitted expand rapidly in the atmosphere, creating a pressure wave that moves away from the detonation centre. The study focuses on blast parameter calculations that are used to design structural elements that can withstand blast induced loads. It corrects problems with the commonly used relationships suggested in the Kingery-Bulmash technical manual. The explosives science is used in an Explosion Consequence Analysis (ECA) to assess possible hazards to buildings, individuals, or other targets scientific facts and procedures An ECA is a person who helps people with disabilities designing and implementing applicable physical safety norms compliance with these standards and maintaining the continuity of operations for any and all organizations that may fall within the scope of a potentially lethal threat. For medium and large scaled distances, the parameter values in it have proven to be correct. However, researchers have raised significant questions about their relevance for small-scaled applications close-in detonations, i.e. distances. ECA is approached using supervised machine learning. The support vector machine (SVM) algorithm was used to create a model that can perform well. The ECA. SVM algorithm has been applied successfully to a slew of classification issues Bulmash-Kingery. The basis of equations [16] for estimating blast parameters is model that has been suggested.

II. EFFECT OF EXPLOSIVE BLAST

A rapid exothermic chemical reaction occurs when an explosion is started. The explosive's explosive content is converted into a thick, high-pressure gas that expands rapidly to achieve equilibrium with the pressure in the atmosphere This attempt at achieving balance creates a sonic boom The shockwave propagates in a radial direction. supersonic velocities outwards from the source and triggers the highest amount of damage caused by an explosion dynamite. Following detonation, there is an instantaneous increase in pressure to this is referred to as the incident blast because of the peak over pressure a wave.

Charles Kingery and Gerald Bulmash created equations to estimate blast over-pressure at range. The US Conventional Weapons System is based on these equations, which are generally accepted as engineering

forecasts for calculating free-field pressures and loads on structures. CONWEP is a piece of software that allows you to create special effects. Their findings contains a set of data from a variety of sources Charge weights ranging from less than 1kg to over 400,000kg were used in explosive experiments. This makes use of curve-fitting techniques that use high-order polynomial equations to represent the data. For ease of use, it's included in the IATG's accompanying programme. Several equations have been proposed for estimating blast loads. Since blast loads are difficult to deal with using a computational solution, such as the Sadovsky equation or the Brode equation, these equations, which come in a variety of forms, are empirical equations based on experimental results [10].

$$Z = R/W^{1/3} \quad (1)$$

Where, Z is Scaled distance; R is Distance to the burst position; W is TNT weight.

The polynomial equation of Kingery and Bulmash for calculating all the blast parameters are given below:

$$Y = C0 + C1U + C2U + C3U \ldots..CnU \quad (2)$$

Where, Y = Common Logarithm of the Air Blast Parameter (metric) (Pressure or Impulse), C0,1 ,2 etc = Constant and U = K0 + K1T K0, 1 etc = Constant T = Common Logarithm of the Distance (m). To construct a predictive model by regression, blasting researchers typically create a blast dataset that includes calculated blast design parameters and particle per velocity values. analysis or other intelligent and logical approaches. This is a good example to forecast, this method uses primary calculated blast data vibrations in the ground (PPVs). In order to Khandelwal et al. predict the sum of PPV in India's magnesium mines Artificial neural networks are a form of artificial intelligence. They just took into account max charge per delay and distance are two parameters. as inputs, from the blasting face to the monitoring point, and compared the findings of their proposed approach to those of another techniques.

III. ADAPTIVE NEURO FUZZY INFERENCE SYSTEM

The combination of artificial neural networks (ANN) and fuzzy inference systems has resulted in the Adaptive-Neuro Fuzzy Inference Method (FIS). An artificial neural network is capable of learning. from data and has the benefit of pattern recognition. These ANN-created patterns, on the other hand, are extremely durable. However, it isn't practical. Fuzzy logic, on the other hand, is simple to understand. Due to its linguistic rules, it is simple to enforce and has the benefit of combining human intelligence in order to solve ambiguity uncertainty [9].A Neuro-fuzzy approach to user behavior classification and prediction is proposed. The dataset is made up of users' temporal logs that contain three types of information: local machine, network, and web use logs. Every user's 360-degree feedback is also used to supplement the study. Several guidelines have been put in place to address the company's strategy for deciding a user's particular conduct, which may be useful in managerial decisions. A Gaussian Radial Basis Function Neural Network (GRBF-NN) is trained for prediction using a Fuzzy Rule Based System (FRBS) example set and the user's 360-degree feedback. The findings are compared to other state-of-the-art schemes in the literature, and the scheme is found to be promising in terms of classification and prediction accuracy [2]. To begin, we will briefly explain the Neuro-fuzzy learning algorithm, which can tune fuzzy inference rules without changing the type of the fuzzy rule. We'll pretend that a fuzzy machine model has only two input variables, xl and x2, and one output variable, y, for the sake of simplicity. The case of multiple-input variables is not difficult to handle. ANFIS is also more efficient than the simple fuzzy logic algorithm and neural networks because it has a fuzzy modeling approach for learning information about the environment. In order to calculate the membership function, you'll need a data set parameters that make for the most accurate fuzzy inference a framework for tracking input/output data [5].

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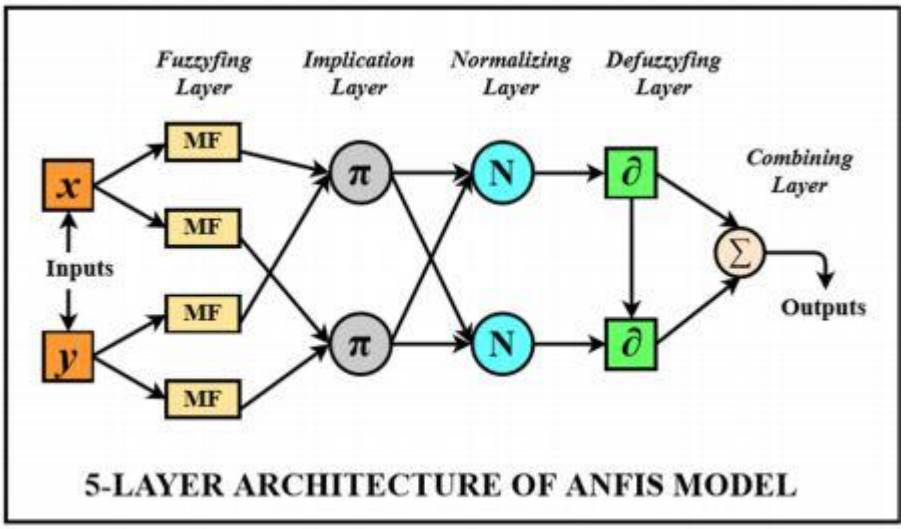

Figure 1: Adaptive Neuro-Fuzzy system

The architecture of the ANFIS Two inputs x, y, each with two labels (A, B) are considered for the ANFIS structure. The first layer performs a fuzzification process; the second layer performs the fuzzy AND (T-norm) of the antecedent part of the fuzzy rules; the third layer normalizes the membership functions (MFs); the fourth layer is in charge of the consequent part of the fuzzy rules; and finally, the last layer computes the output of the fuzzy system by summing the outputs of the fourth layer.

IV. PROPOSED METHOD

This paper proposes the ANFIS model for ECA. We can predict the effects of brick over a distance of 40 to 50 meters using this model. The flowcharts below depict the phases of the proposed work. We used the parameters mentioned above as input variables and the vibration rate (PPV) as an output variable when training the ANFIS model. Then, in order to compare the ANFIS' performance equally, we used the same training and testing samples that had been chosen previously. As a result, we made use of data samples for the ANFIS model's research samples. A five-layered model is developed during ANFIS network training, as previously mentioned. In the second layer, an initial FIS model for ANFIS training was created by first applying subtractive clustering to the data, and it was discovered that by raising the nodes up to six, the error converged (decreased). As a result, the number of nodes in the second layer is set. . One input, three secret, and one output layer make up the five layers. The network was built using the MATLAB programming language.

Table 1: Explosive Composition

Explosive	TNT Equivalent Mass		Pressure Range (MPa)
	Peak Pressure	Impulse	
Amatol	0.99	0.98	
Composition B	1.11	0.98	0.035 - 0.350
Composition C3	1.08	1.01	0.035 - 0.350
Composition C4	1.37	1.19	0.070 - 0.700
HMX	1.02	1.03	Estimate

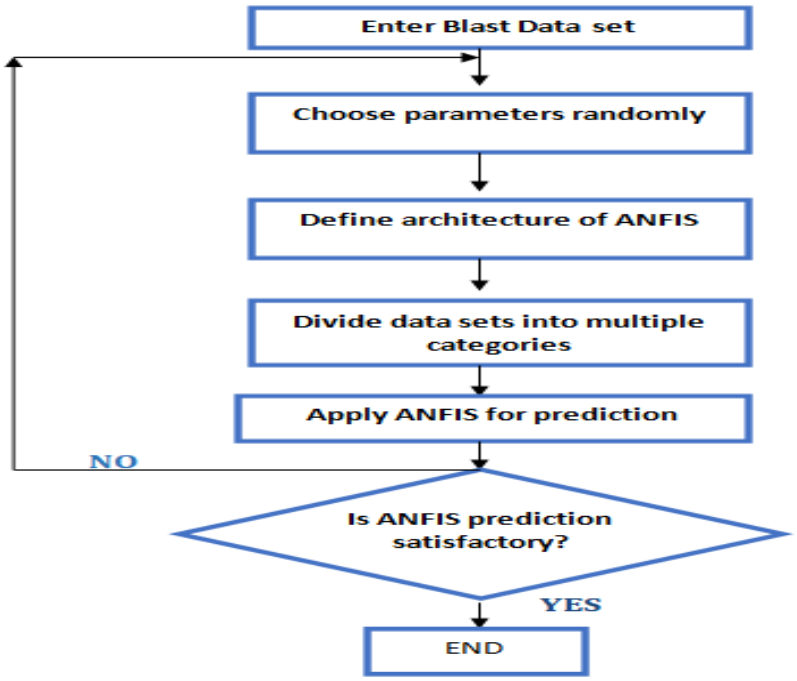

Figure 2: Flow chart of proposed method

V. CONCLUSION

This paper's key contribution is the effective application of ANFIS, a computational intelligence technique, in the development of a better ground vibration prediction model. The blast consequences over brick from 20 meters and above are predicted in this document. The model has been implemented by using MATLAB Simulink. We can predict the effects of a blast by using the Kingery equation. ANFIS model, ANN, and other relevant techniques are also discussed in this review article. Curve fitting the results of the numerical simulations resulted in a new set of equations as a function of scaled distance. These equations may be used on their own or in conjunction with Kingery- Bulmash's. As a result, the positive peak. It is possible to quantify the overpressure and positive impulse at a point caused by a free-air blast with increased precision and embedded into an explicit code for evaluating quantitatively the consequences of an explosion on a building However, the explosion must be remembered. At very small distances from the charge centre, the phenomenon is extremely complex, and depending on the charge form, the evolution of the chemical reactions will differ.

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