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The Influence of Underground Structure Blasting Construction on the Geo-technical Structure of Nearby Surface Buildings under the Background of Fuzzy Neural Network

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Abstract: With the application of fuzzy neural network blasting technology in urban construction, the harm of fuzzy neural network blasting vibration to buildings is paid more and more attention. In order to avoid the blindness of fuzzy neural network blasting vibration reduction in project design, reduce the waste of manpower and material resources, to ensure the construction safety and construction quality and the safety of ground buildings, underground structures must be near the earth's surface building caused by fuzzy neural network blasting vibration monitoring, and to predict the strength of the fuzzy neural network blasting vibration, in order to guide the optimization of underground engineering fuzzy neural network blasting parameters adjustment and subsequent construction. Therefore, a series of related problems of fuzzy neural network blasting seismic wave and the study on the influence of engineering fuzzy neural network blasting on ground construction and structures are of great significance for the safe fuzzy neural network blasting construction in cities. This paper mainly studies the effect of fuzzy neural network blasting construction on the rock and soil structure of nearby buildings. In this paper, the fuzzy neural network blasting seismic waves of underground structures are monitored, and the fuzzy neural network blasting vibration of no. 2 and no. 1 buildings are monitored. According to the monitoring value of fuzzy neural network blasting vibration, the article element to be evaluated is established. In the experiment of this paper, it was finally concluded that the eigenvalues of grade variables at point 1 and point 2 were 2.22 and 2.28, and the evaluation results were all within the level of slight influence, and the fact also proved that only slight earthquake sensation was available, so special shock absorption measures could not be taken under the influence of the same fuzzy neural network blasting seismic wave.

1. Introduction

Fuzzy neural network blasting refers to a physical and chemical process in which a large amount of energy is released or transformed rapidly in a limited space and a very short time in a certain material system. Its essential concept is explosion [1]. fuzzy neural network blasting, commonly referred to by people, refers to fuzzy neural network blasting in soil and rock mass medium, also known as earth and rock burst [2]. Therefore, the essence of fuzzy neural network blasting refers to the interaction between explosive energy and earth-rock medium and work [3]. The fuzzy neural network blasting effect depends on the energy characteristics of explosives, the characteristics of earth-rock medium and the interaction between them [4]. When explosive explodes in rock, soil and other media, it is inevitable that part of energy is converted into seismic waves, and spreads rapidly from the source of explosion to the surrounding media, resulting in the ground and buildings (structures) shaking [5]. In the process of propagation, although the vibration intensity will decrease with the increase of distance, it is likely to cause different degrees of damage to nearby buildings (structures) within a certain range, which is called fuzzy neural network blasting seismic effect. With the extensive application of fuzzy neural network blasting technology, people pay more and more attention to the impact of fuzzy neural network blasting vibration on the surrounding environment and structures [6].

In order to study the impact of fuzzy neural network blasting vibration on adjacent tunnels, Zhao used field monitoring experiment and numerical method, namely finite element method, to study the fuzzy neural network blasting vibration velocity and vibration frequency of existing tunnels. Combined with fuzzy neural network blasting vibration velocity and vibration frequency, he studied the distribution of axial and radial fuzzy neural network blasting vibration velocity and the corresponding PSD distribution of the existing tunnel under the action of fuzzy neural network blasting vibration of the adjacent subway tunnel. His experimental results show that on-site monitoring experiment and numerical simulation can optimize fuzzy neural network blasting excavation scheme and provide reference for other similar engineering projects [7]. Jha was involved in a project in which a large structure should be built on a shaft adjacent to another existing large structure, built on a shaft embedded in bedrock. Several silos for the proposed structure are in place. However, due to changes in project requirements, the owner wanted to know if it was possible to eliminate the remaining silos and change the foundation type from a drilled silo to a mat foundation based on a layer of compacted gravel. This change will result in parts of the proposed structure remaining underground and having very high stiffness compared to other parts. In addition, this change can lead to different interactions with the adjacent structural foundations. He introduces more detailed information about the project, analyses the program use, the results showed that, which is useful practice for engineers to make informed decisions when different types of infrastructure are close to each other [8]. Dowding studied the measurement and interpretation of the strain generated by two, multi-storey and older urban structures by uhf impact excitation from adjacent excavations. He believed that these strains were relative displacements obtained by integrating time-dependent velocities and time histories at multiple locations on the structure and bedrock. During his eight explosions, observations were made at 10 instrumental locations of structures and underlying rocks, providing more than 70 time records for analysis. Through case studies and measurements, he came to the following conclusion: although the velocity of particles in the rock greatly exceeded the prescribed limit, the strain of the external wall was similar to or lower than the strain required for cracks in masonry structures and fragile wall materials. These strains are also below the capacity of the single-storey house structure when excited by the low frequency motion of the particles below the specified speed limit. The expected relative displacement of single-degree-of-freedom excitation motion calculated by using the quasi-velocity method is similar to the measured result [9].

Innovation points of this paper :(1) Double damage criterion is introduced to combine the damage threshold of accumulated damage with safety standard, which can more comprehensively evaluate the safety of structure in fuzzy neural network blasting vibration and ensure the safety of construction to a greater extent. (2) The instantaneous energy curve of each fuzzy neural network blasting vibration is obtained by using HHT transformation, which can more directly observe the initiation time of each detonator and the vibration intensity of each fuzzy neural network blasting. The research shows that with the increase of distance, the fuzzy neural network blasting vibration energy is concentrated in the lower section, that is to say, the fuzzy neural network blasting vibration energy in the higher section tends to attenuate. (3) The expansion model of risk prediction is established, and the prediction and evaluation are carried out according to the known fuzzy neural network blasting and geological conditions, so as to truly achieve prevention.

2. Proposed Method

Fuzzy neural network is the product of the combination of fuzzy theory and neural network. It brings together the advantages of neural network and fuzzy theory, and integrates learning, association, recognition, and information processing. Whether it is used as an approximator or a pattern memory, the fuzzy neural network needs to learn and optimize the weight coefficients. The learning algorithm is the key to optimize the weight coefficient of the fuzzy neural network. For logic fuzzy neural networks, an error-based learning algorithm can be used, that is, a monitoring learning algorithm. For arithmetic fuzzy neural networks, there are fuzzy BP algorithm, genetic algorithm and so on. For the hybrid fuzzy neural network, there is no reasonable algorithm; however, the hybrid fuzzy neural network is generally used for calculation rather than for learning, and it does not have to learn.

2.1. Influence Factors of Fuzzy Neural Network Blasting Seismic Wave on the Safety of Geo-technical Structure of Surface Buildings

(1) Influence of fuzzy neural network blasting seismic wave intensity on the safety of Geo-technical structure of surface buildings

The intensity of fuzzy neural network blasting vibration can be expressed by the maximum vibration velocity. The fuzzy neural network blasting vibration intensity has a good correlation with the particle vibration velocity, and the correlation between the vibration velocity and the rock and soil properties is weak and the law is stable. In addition, the velocity can be connected with the energy flux carried by the vibration and the ground stress generated, as well as the kinetic energy and internal stress generated in the structure. Therefore, the method of using peak vibration velocity as the index of fuzzy neural network blasting vibration intensity is widely popular in the world. The maximum amplitude of each waveform in the fuzzy neural network blasting vibration velocity diagram only represents the maximum amplitude of the measuring point moving in a certain direction, while the maximum amplitude of the actual measuring point moving should be the maximum value of the vector sum of three moving components of the point on the same side at the same time. If each coordinate axis of the orthogonal rectangular coordinate system is taken as a motion component of the measuring point, the motion amplitude of any instant of the three components can be expressed as:

$$V = \left(Vx^2 + Vy^2 + Vz^2\right)^{1/2} \tag{1}$$

However, since the maximum value of the three components of the measuring point usually does not occur at the same time, the actual maximum value of the motion of the measuring point is not the maximum vector sum of the motion components of the measuring point, but the maximum value of the sum of the transient vectors. Although the maximum value reflecting the space motion is obtained by this method, it is not suitable for engineering application due to the large computational workload. Therefore, the maximum value of the three components is often used in practical engineering. Generally, the maximum value in the area near fuzzy neural network blasting is vertical vibration. Therefore, vertical vibration is generally used in the area near fuzzy neural network blasting to express the intensity of seismic waves. As mentioned above, the peak of maximum particle velocity of three components is often used as the amplitude intensity of fuzzy neural network blasting vibration in engineering practice. Therefore, the role of peak velocity of fuzzy neural network blasting vibration in vibration hazard is only analyzed below. The damage of fuzzy neural network blasting vibration to the structure is mainly divided into two types. The other is that when the strain of the structure exceeds a certain value due to the cumulative effect, although the shear stress does not exceed the shear resistance, damage will occur. Therefore, the two destruction forms are analyzed respectively.

Firstly, the shear failure of buildings (structures) is analyzed. fuzzy neural network blasting seismic waves can be described by wave equation:

$$y = A\sin[w(t - x/c) + \varphi] \tag{2}$$

Where y is particle displacement, A is displacement peak, x is propagation distance, c is propagation velocity of fuzzy neural network blasting seismic wave, t is propagation time, φ is initial phase.

Thus, when the structure is disturbed and starts to vibrate, the shear strain is:

$$\varepsilon = dy/dt = -Aw\sin\left[w(t - x/u) + \right]/c \tag{3}$$

The fuzzy neural network blasting vibration velocity equation is:

$$V = dy/dt = Aw\sin\left[w(t - x/u) + \right] \tag{4}$$

So:

$$\varepsilon = -V/c \tag{5}$$

Where is the shear strain generated by the structure, v is the velocity of particle vibration, and c is the velocity of seismic wave propagation.

Therefore, the shear stress is:

$$\sigma = E\varepsilon = -Ev/c \tag{6}$$

According to equation (6), the relationship between stress and seismic velocity under the limit condition is:

$$\sigma_m = -Evm/c \tag{7}$$

Where,m is the maximum shear stress generated by fuzzy neural network blasting vibration in the structure; Vm is the peak particle velocity. Therefore, the shear stress generated by fuzzy neural network blasting seismic wave on the structure is proportional to the peak earthquake velocity. According to equation (6), the effect of fuzzy neural network blasting seismic wave on the structure is actually a dynamic process, and the stress generated in the structure is a kind of dynamic stress, which is jointly determined by particle velocity, medium property, propagation velocity of fuzzy neural network blasting seismic wave and other factors. It is because of the action of fuzzy neural network blasting vibration on the structure that a kind of dynamic stress is generated in the structure. When the stress value exceeds the dynamic shear resistance of the structure, the sudden shear failure will occur. The shear failure is mainly proportional to the velocity of particle vibration, that is, the greater the intensity of vibration, the greater the possibility of structural damage.

In addition, another form of damage caused by fuzzy neural network blasting seismic waves to buildings is mainly because the accumulated strain value exceeds the strain limit of the structure. This is a cumulative effect, and in response to this failure, some scientists have proposed a fracture criterion that states that materials do not break when the integral of local tensile stress over time, that is, when the overall local impulse is less than a certain value. That is:

$$\int_0^1 \sigma(t)dt \le Jc \tag{8}$$

This criterion can take into account the whole loading history, thus taking into full account the cumulative damage of loading energy to the structure during the whole loading process. In this case, the maximum stress cannot be considered alone, but the vibration of the whole fuzzy neural network blasting seismic wave should be taken into account. In this case, the shear stress is treated as a dynamic stress instead of the maximum value.

According to the above analysis, both the sudden shear failure and the cumulative strain failure of the building (structure) are closely related to the strength of seismic waves. When the structure and geological conditions are certain, the degree of damage of the structure is positively correlated with the strength of fuzzy neural network blasting seismic waves. Therefore reduce the strength of the fuzzy neural network blasting seismic wave, is the most effective way to reduce the fuzzy neural network blasting seismic wave, but the fuzzy neural network blasting seismic wave intensity decreases at the same time, the efficiency of fuzzy neural network blasting engineering will reduce, will cause the waste of time and material, so should be in both security and the project to achieve the highest efficiency can make the fuzzy neural network blasting down to choose the right means of fuzzy neural network blasting scale and fuzzy neural network blasting.

(2) The impact of fuzzy neural network blasting seismic wave frequency on the safety of Geo-technical structure of surface buildings

fuzzy neural network blasting seismic wave frequency has a great impact on the safety of ground structure of surface buildings. The impact of fuzzy neural network blasting seismic wave frequency on the safety of ground structure of surface buildings should be analyzed in combination with the natural vibration frequency of ground structure of surface buildings. Firstly, the response spectrum and structural response of fuzzy neural network blasting seismic wave are analyzed. Under the action of fuzzy neural network blasting seismic waves of the surface buildings Geo-technical structure dynamic effect, mainly adopts single degree of freedom system to simulate, the so-called single degree of freedom system is to structure feature sizes as than the structure of the fuzzy neural network blasting seismic wave wavelength smaller, then structure under the action of fuzzy neural network blasting seismic wave all particle displacement is equal, so that it can be as a single degree of freedom system for analysis of the structures. The structure can be regarded as a particle under the action of a damped spring. See figure 1.

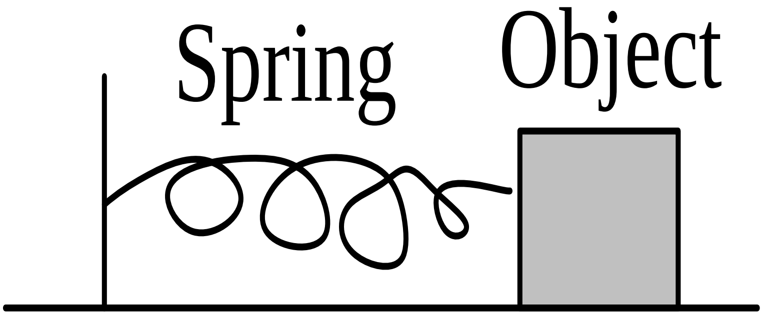

Figure 1. Structure hypothesis

Under the action of fuzzy neural network blasting seismic waves, the motion equation of the single-degree-of-freedom system can be written as:

$$ma + cv + ks = P(t) \tag{9}$$

Where m is the mass of the structure; A is the acceleration of the structure relative to the ground; C is the damping coefficient; V is the relative velocity of the structure and the ground; K is linear elastic constant; S is the displacement of the structure relative to the ground; P(t) is the ground force.

Where, P (t) =mA(t), and A(t) is the absolute ground acceleration, so the above equation becomes:

$$a + 2\varepsilon wv + w^2 s = A(t) \tag{10}$$

Where ε is the damping ratio; W is the frequency of the natural vibration circle.

According to the motion equation of the single-degree-of-freedom system, through duham integral, the relative displacement of fuzzy neural network blasting vibrating structure can be obtained as follows:

$$s(t) = -\int_0^1 A(\tau) e^{-w\varepsilon(t-\tau)} \sin\left[w\sqrt{1-\varepsilon^2}(t-\tau)\right] d\tau \Big/ w\sqrt{1-\varepsilon^2} \tag{11}$$

In the same way, the relative velocity of structures under the action of fuzzy neural network blasting seismic waves can be obtained.

When the natural frequency of the structure is equal to the frequency of fuzzy neural network blasting seismic wave, the amplification factor reaches the maximum, and its value is:

$$D = \left[\left(1-\beta^2\right)^2 + \left(2\varepsilon\beta\right)^2\right] \tag{12}$$

Type of $\beta = \sqrt{1-2\varepsilon^2}$, ε for structural damping ratio.

It can be seen from the above formula that different fuzzy neural network blasting seismic wave loads are applied to the same ground structure of a building, and the amplification coefficients are different, so the vibration velocity of the structure is also different. Therefore, under the action of seismic waves of the same intensity, the magnification factor changes due to different main frequencies, which determines the safety of the structure. When the seismic wave with small intensity ACTS on the structure, because the difference between the main frequency and the natural frequency of the structure is very small, the structure reacts strongly, which may cause danger. On the contrary, even if the seismic wave intensity is very large, the structure may not be damaged due to the small amplification factor. Therefore, when considering the impact of fuzzy neural network blasting seismic waves on the Geo-technical structure of surface buildings, the impact of frequency components of fuzzy neural network blasting seismic waves on the amplification factor cannot be ignored, that is, the impact on the safety of the Geo-technical structure of surface buildings.

(3) Influence of duration of fuzzy neural network blasting seismic wave on the safety of Geo-technical structure of surface buildings

The duration of fuzzy neural network blasting seismic wave is another factor to describe the fuzzy neural network blasting seismic wave besides the intensity and main frequency. Duration is affected in many ways, which has been introduced in detail in the previous section. This section mainly studies the role of duration of fuzzy neural network blasting vibration in the harm of fuzzy neural network blasting vibration. After many years of research and practical experience, many scientists have put forward the theory that the duration of fuzzy neural network blasting vibration affects the safety of structures. The main conclusions are summarized as follows: 1) For linear systems, the duration of vibration increases the probability of a higher response peak in the system's vibration response, but this effect is usually relatively small. 2) For nonlinear systems without degradation, the influence of vibration duration increases the probability of large permanent deformation of the structure. 3) For strongly degenerate nonlinear systems, the impact of vibration duration on maximum deformation may be very large. 4) The duration of vibration has a significant impact on the energy dissipation and accumulation of degenerate or non-degenerate linear systems. The duration of vibration sometimes plays a decisive role in the liquefaction of sand. In fact, the influence of vibration duration on the vibration response is mainly manifested in the nonlinear reaction stage. From the analysis of the mechanism of structural vibration failure, it is necessary to go through a process from local failure (nonlinear beginning) to complete collapse. The in recover ability of plastic deformation requires dissipated energy. Therefore, even if the maximum deformation reaction of the structure does not reach the maximum deformation under the static test condition, the structure may collapse due to the loss of stored energy reaching a certain limit value, which is called cumulative failure. In stochastic vibration theory, the probability of a larger value of the structural response increases as the duration increases, but this effect is less important than the cumulative effect of the damage. Therefore, the actual importance of vibration duration is mainly reflected in the cumulative failure of inelastic deformation after the structure exceeds the elastic stage and enters the nonlinear stage. It has been found in some foreign researches that when the duration increases from 1.0s to 50s, the damage capacity of ground motion to the structure increases by 40 times on average. Therefore, the significance of duration lies in the maximum reaction and energy loss accumulation of nonlinear system.

(4) The effect of cumulative fuzzy neural network blasting seismic wave on the safety of Geo-technical structure of surface buildings

fuzzy neural network blasting vibration cumulative effects, it refers to under the action of fuzzy neural network blasting seismic wave, the rock soil medium body with the structure or structure stress or strain state of the dynamic mechanical effects, namely the dynamic superposition state of material, or material damage state dynamically add, the relevant mechanical parameters of the dielectric material (such as stress, strain and the elastic constants) is a function of time, is closely related to the mechanical process of history, or the process of the results of a comprehensive history of mechanics. For example, the elastic constant E of the dielectric body, whose cumulative effect is reflected in two states: (a) The same fuzzy neural network blasting seismic wave is reflected in the effect of the effect at the previous moment on the state at the later moment; (b) The cumulative effect of multiple discontinuous fuzzy neural network blasting seismic waves is reflected by the significant effect of historical seismic wave effects on current seismic wave effects or the mechanical accumulation of all historical seismic wave effects on current seismic wave effects. State accumulation includes stress state accumulation, strain state accumulation and failure state accumulation. In the earthwork excavation of buildings and mining projects, fuzzy neural network blasting engineering is frequent. In addition to considering the influence of single gun on construction, the cumulative effect of multiple fuzzy neural network blasting on construction and construction structure should also be considered. Because in one construction, the site of the fuzzy neural network blasting is many times, short days, months or even years. However, it has been found that for most materials, the load must be a percentage of the critical strength of the material where damage occurs. If the vibration speed is much lower than the damage rate, no damage will occur no matter how long the accumulated vibration time is. In materials science, this means that the elastic limit will not be exceeded. The safe seismic velocity standard of fuzzy neural network blasting is higher than that of fatigue damage, so cracks do appear in the Geo-technical structure of many surface buildings that are closer or farther away from fuzzy neural network blasting, especially at the connection of the structure and the weak point of structural strength. Therefore, it is very important to study the cumulative effect of fuzzy neural network blasting on the structure. The cumulative effect will produce residual deformation and residual stress inside the structure. When it is stimulated by the fuzzy neural network blasting seismic wave again, the residual stress and strain will be superimposed under the new excitation, which will have an impact on the destruction of the rock-soil structure of the surface building. It is necessary to pay attention to the effect of cumulative effect when predicting the safety of the Geo-technical structure of the ground buildings around the mining area.

3. Experiments

3.1. Experimental Design and Experimental Tools

(1) Experimental tools

The experimental monitoring equipment in this paper is the intelligent monitor of fuzzy neural network blasting vibration, which is a small instrument for signal recording and analysis.

Its hardware test index is:

- Acquisition mode: multi-channel parallel acquisition;
- Analog input channel: 1~4 channels/set, multiple units can be expanded in parallel;
- Input mode: BNC single-ended / bipolar voltage input
- Input signal range: amplitude ⩽ ± 10V
- The highest sampling rate: 200KSps/channel (up to 50 KSps/channel in floating-point mode), 18-speed program control settings;
- A/D resolution: 16Bit;
- SRAM cache depth: 128K bytes / CH;
- Range: ±1V, ±2V, ±5V, ±10V program control; (no manual setup is required when floating point amplification is enabled)

- Input impedance: 1 megohm;
- Input capacitance: ≤25PF;
- Input signal bandwidth: 0Hz ~ 20KHz;
- DC accuracy error: ≤ ± 0.5%;
- phase difference between channels: flat response frequency band ≤ 0.3° ;
- Signal to noise ratio: ≥70dB;
- Isolation between channels: ≥100dB;
- Working temperature: 0-70 °C;
- Size: 171mm (length) ×148mm (width) ×64mm (height);
- Spectrum analysis: fast Fourier analysis method.

The trigger mode of data collector of fuzzy neural network blasting vibration intelligent monitor is manual trigger, internal trigger (including rising edge trigger, falling edge trigger, two-level trigger, two-level trigger) and external trigger. The multi-card extension has trigger logic or, logic and function. Manual trigger can also be called software trigger, that is, the acquisition process is triggered by software instructions. Internal trigger means the acquisition process is triggered by the input signal of the trigger channel selected by you. When the input signal level meets a certain condition, the device is triggered. As shown in figure 2, several cases of internal triggering are described.

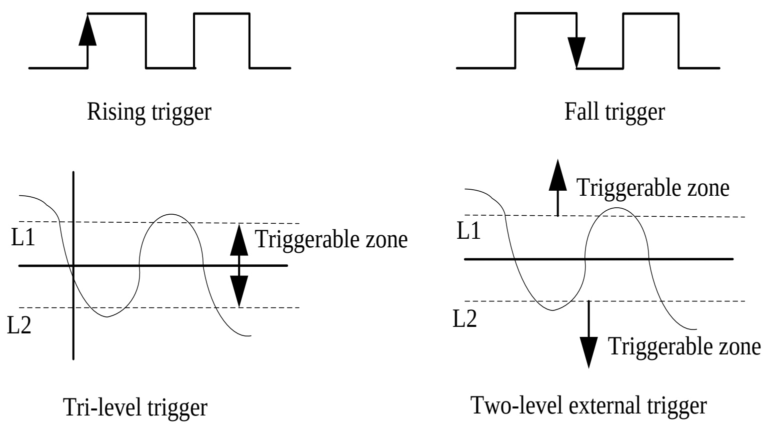

Figure 2. Diagram of trigger mode

External trigger means that the external signal is connected to the external trigger interface on the board and the acquisition process is triggered by the external signal. The external trigger signal is input through the internal embedded circuit on the board to protect the circuit on the board. TTL level (0~ 3.3v) is the best choice for external trigger level, and the positive pulse width should be greater than 10ns. The edge of the external trigger signal is effective, and the rising or falling edge can be programmed to be set as the trigger edge.

(2) Experimental design

In engineering monitoring, we know exactly the initiation time of fuzzy neural network blasting, so in order to record accurately, manual triggering is selected to trigger the collector for data collection before fuzzy neural network blasting, so as to analyze the waveform. Since the collector is equipped with FFT spectrum analysis function, it is convenient to obtain the spectrum diagram of fuzzy neural network blasting seismic wave during the data analysis, thus providing the main data basis for the following data analysis.

When the measuring points are placed on site, each measuring point tests several directional components. When the measuring points are arranged, if only the safety degree of the specified ground floor Geo-technical structure is known, only the measuring points are placed near the corresponding ground floor Geo-technical structure or in the building. To understand the response of different topography and geological conditions to fuzzy neural network blasting earthquake. The measuring points should be arranged near topographic changes. To understand the attenuation rule of vibration intensity with distance and to determine the safe distance, a line with multiple measuring points should be arranged. In short, different research methods have different measurement points layout, should be arranged as appropriate. When measuring because we want to analysis of the fuzzy neural network blasting seismic wave on the surface buildings the damage of rock and soil structure, and through the fuzzy neural network blasting has been behind the data to predict, so we need to analyze the safety of surface buildings Geo-technical structure, forecasting formula is obtained by several fuzzy neural network blasting data at the same time, and then carry on the forecast work.

Since fuzzy neural network blasting vibration is a three-dimensional motion, the velocity of vertical, horizontal and vertical motion is monitored simultaneously. When ground and building vibrate, their motion mode can always be decomposed into X, Y and Z directions. Therefore, fuzzy neural network blasting earthquake intensity can be described by three independent orthogonal components, which are the components of horizontal longitudinal L, horizontal transverse T and vertical direction V. From the perspective of structural response, the horizontal vibration tends to control the horizontal response of the structure's vertical wall and superstructure, while the vertical vibration tends to control the vertical response of the horizontal plate structure. The amplitude of the dynamic response of the structure should be the vector and the peak value of the three orthogonal directions, namely the actual maximum value, instead of the peak value of the amplitude of the three orthogonal directions (the three vectors may not reach the peak value at the same time). They have phase difference), so the latter is usually 40% larger than the former. Therefore, applying the nominal maximum value of fuzzy neural network blasting control is actually inconsistent with the theory, but not suitable for engineering application due to the complex calculation of the theoretical value. The above three parameters of fuzzy neural network blasting earthquake effect are all random and are time-dependent non-periodic dynamic processes. Therefore, the utility of fuzzy neural network blasting earthquake should be discussed with the four-dimensional problem, that is, time t,L, t, v. in the actual application process. Usually, in order to simplify the problem, the four-dimensional problem is transformed into a two-dimensional problem to study, that is, t, and (L, t, V) Max. Normally, only the directions of the maximum vibration velocity or acceleration in the three-dimensional space and time t are considered. However, ignoring the values of other two directions, the maximum value of space vector is simplified to the maximum value of one direction, which can greatly simplify the calculation and application, and has little impact on the results. And the peak value in the classical domain of the model is also the peak value of the vibration in the maximum direction.

3.2. Data Collection

The dynamic and static analog signals generated by the sensor (including velocity, acceleration, pressure, strain, temperature, etc.) are converted and stored digitally by the intelligent monitor of fuzzy neural network blasting vibration, and the trigger mechanism is used to ensure that only the signals of concerned features are recorded correctly. The power off protection function of this instrument makes the recorded data not lost for a long time. It can communicate and transmit data with the computer through the USB interface on the instrument, and has supporting software for further data analysis and processing, such as waveform display, FFT spectrum analysis, maximum, minimum, saving and printing data, etc.

4. Discussion

4.1. Analysis of the Influence of fuzzy neural network blasting Construction of Underground Structures on the Geo-technical Structure of Adjacent Buildings

(1) Analysis of single point breaking force of underground structure fuzzy neural network blasting

In data monitoring, we monitor the data and wave forms in three directions at the selected measuring points and record the peaks. Then we can obtain the main influence frequency of each vibration direction through spectrum analysis, and prepare for the establishment of the material to be evaluated. As shown in Figure 1, it is the vibration waveform of the collected No. 1 measuring point. The maximum vibration velocity of the first point is 1.128cm/s.

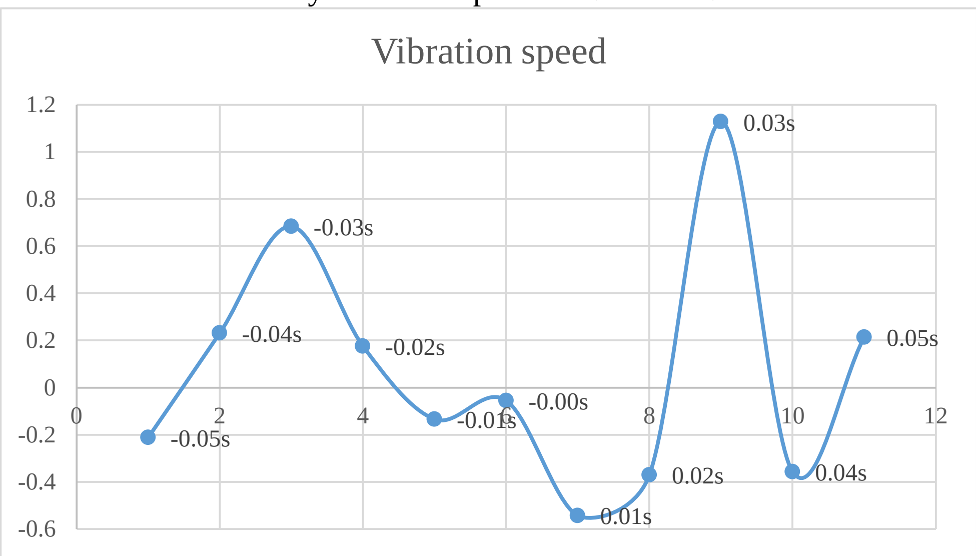

Figure 3. Vibration waveform of the first measuring point

Table 1. Basic data of the first measuring point

Testing time	blasting location	Test the venue	Horizontal distance from the midpoint of the blast to the measuring point (m)	Vibration speed		
				Maximum radial component	Maximum tangential component	Maximum vertical component
				Vr(cm/s)	Vz(cm/s)	Vτ(cm/s)
12:40	K17+570	Number one	40	0.980	8.899	1.131

The blasting vibration monitoring data table 1 of the first measuring point is obtained from Fig. 1. As shown in Table 1, the analysis shows that the hazard level of No. 1 under the action of the fuzzy neural network blasting seismic wave is 2, that is, at a very light level (almost unaffected, the impact is very light, the impact is moderate, the impact is heavier and has a serious impact. Therefore, No. 1 is safe under the action of this fuzzy neural network blasting seismic wave, and no special damping measures are needed. Therefore, this fuzzy neural network blasting parameter can be continuously applied in subsequent projects.

(2) Comparative analysis of fuzzy neural network blasting and breaking force of underground structures

Another monitoring point is No. 2, which analyzes a blast that is closer to the point of explosion. Because the peak value of the fuzzy neural network blasting vibration speed is the largest, the spectrum analysis of the monitoring waveform is also obtained, as shown in Figure 4. Vibration waveform of No.2 measuring point: It can be seen from the figure that the maximum vibration velocity of the second point is 1.315cm/s.

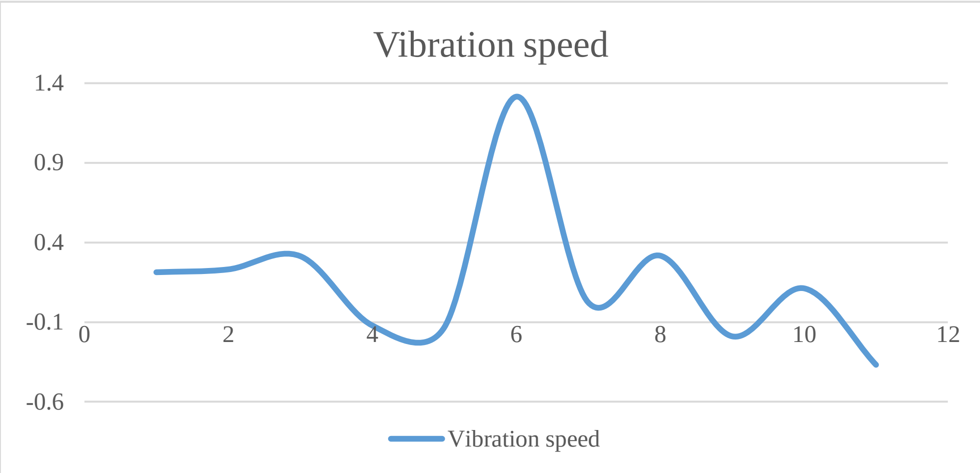

Figure 4. Vibration waveform of the second measuring point

Table 2 shows the basic fuzzy neural network blasting vibration monitoring data obtained by analyzing the waveform and the relative position of the explosion source and the measuring point.

Table 2. Basic data of the second measuring point

Testing time	blasting location	Test the venue	Horizontal distance from the midpoint of the blast to the measuring point (m)	Vibration speed		
				Maximum radial component Vr(cm/s)	Maximum tangential component Vz(cm/s)	Maximum vertical component Vτ(cm/s)
11:50	K18+393	Number two	35	1.322	0.873	1.214

From the comparative analysis of Fig. 4 and Fig. 3, although the latter is larger than the former, the safety of the final two Geo-technical structures is due to the combined effects of other factors, such as frequency ratio and robustness. The identification results are basically the same, so we can see the advantages of multi-factor safety criteria in engineering practice. He not only considers the various characteristics of seismic waves, but also takes into account the characteristics of the Geo-technical structures of surface buildings, so that he can analyze the problems more comprehensively when judging the impact of fuzzy neural network blasting seismic waves on the Geo-technical structure of surface buildings.

(3) Spectrum analysis of vibration data of adjacent buildings

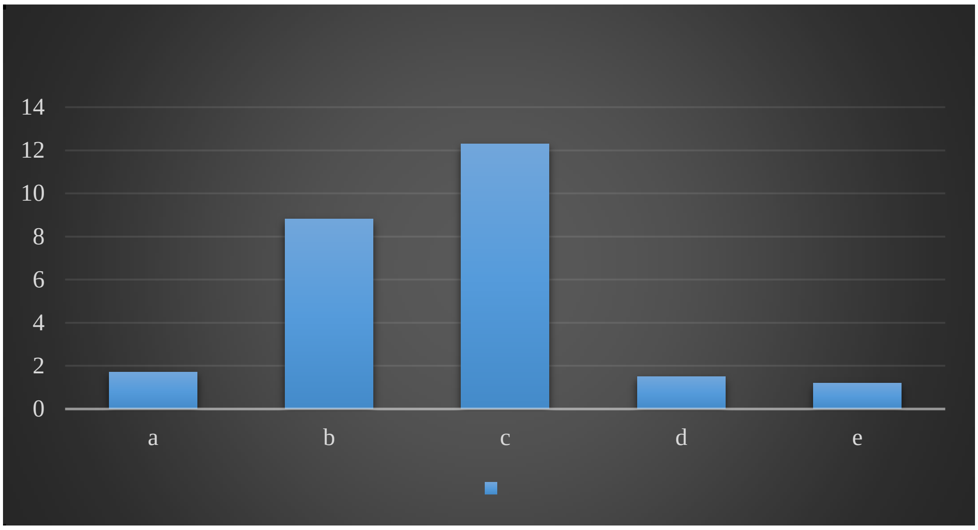

Figure 5. Main frequency distribution of fuzzy neural network blasting vertical seismic waves

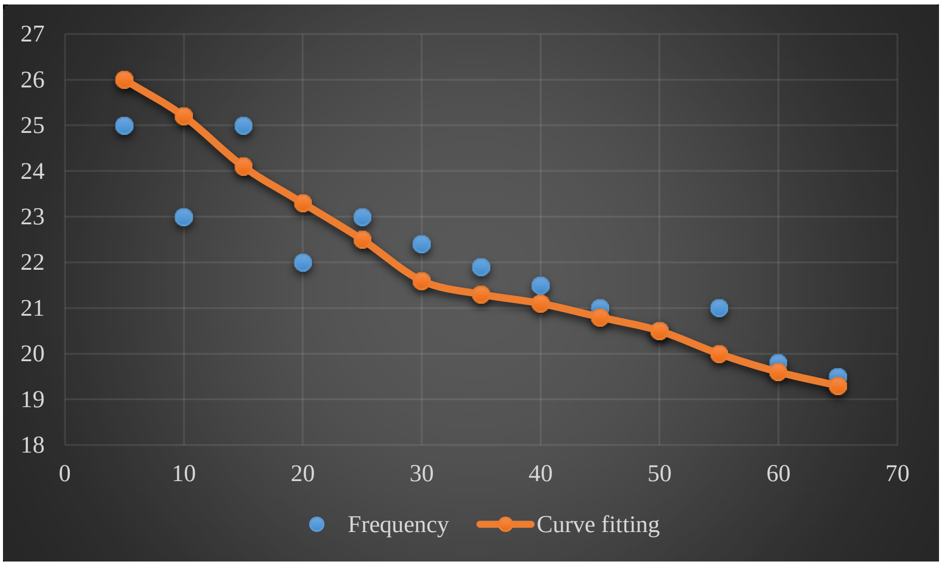

Figure 6. Vertical frequency of main vibration as a function of distance

As shown in Fig. 5, the main frequency distribution diagram of the fuzzy neural network blasting seismic wave is shown. Fig. 5 is the result of fitting the test data with the high-order curve, and the basic trend of the main vibration frequency of the fuzzy neural network blasting seismic wave can be roughly obtained. It can be seen from Fig. 5 and Fig. 6 that the main vibration frequency of the measured fuzzy neural network blasting vibration wave is between 0-50 Hz. The main vibration frequency is 89.3% at 10-35 Hz and 92.9% at 10-SOHz. It can be seen that the main vibration frequency is mainly concentrated in the 10-SOHz distribution. Check the relevant information to find that the main vibration frequency of the general building is at 1-lOHz. Therefore, the main vibration frequency outside the 50m explosion center is above lOHz, and the fuzzy neural network blasting distance adjacent to the foundation pit construction is within 50m, which basically avoids the situation that the main vibration frequency is close to the natural frequency of the building. There will be no resonance scenes. It is also found from Fig. 6 that the frequency of the fuzzy neural network blasting seismic wave has a certain randomness, but it can be seen from the fitting curve that the main vibration frequency tends to decrease with the increase of the fuzzy neural network blasting distance.

(4) Evaluation of the impact of dose control on the safety of adjacent surface buildings

According to the type of protection of the nearby building, select the corresponding safety allowable vibration speed to get the corresponding single-stage maximum detonation formula, as shown in Figure 7, it is a curve chart of the relationship between the maximum quantity of detonating charge in a single section and the distance between the centers of detonation for the safety allowable vibration speed of different buildings (structures). The distance from the explosion source to the protected object in each blast is substituted into the formula for calculation. The maximum single-shot dose in the fuzzy neural network blasting construction process is less than the control value, which can ensure the safety of the protected building.

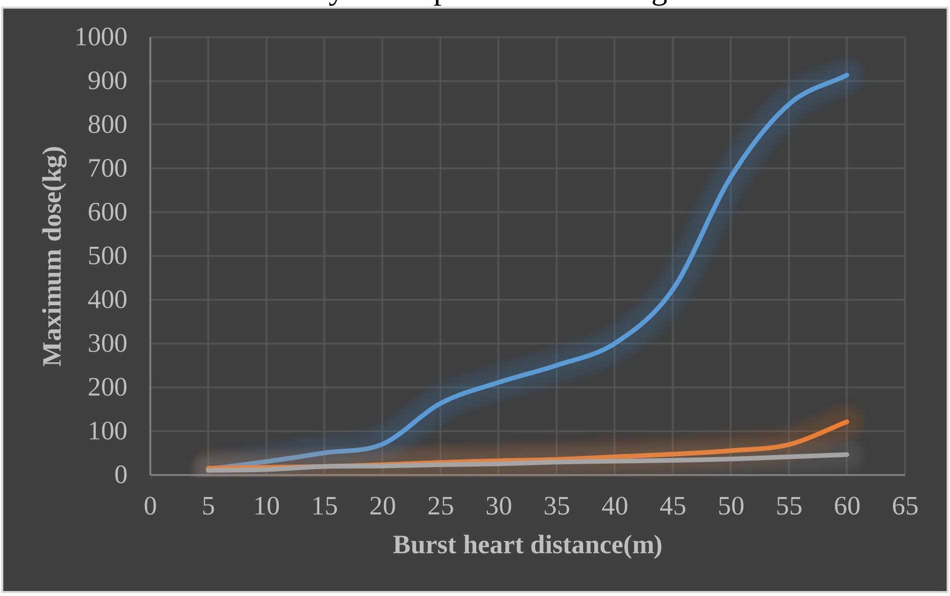

Figure 7. Relationship between the bursting heart distance and the maximum dose under the vibration speed allowed by the safety of adjacent buildings

5. Conclusion

In this paper, the multi-factor criterion of extension method is applied to the comprehensive analysis of the damage degree of the Geo-technical structure of adjacent buildings under the action of fuzzy neural network blasting seismic waves, which further points out that the criteria for evaluating the fuzzy neural network blasting vibration hazard in the past have become insufficiently accurate. Comprehensive, we need to fully consider the other parameters of the seismic wave and the parameters of the building (structure) itself, so as to make reference for the safe fuzzy neural network blasting construction design. At the same time, combined with the case of construction in progress, the applicability and accuracy of the extension method are verified.

The main conclusions of this paper are as follows:1 The fuzzy neural network blasting seismic waves with different parameters have different degrees of damage to the building (structure). The influence mechanism and influence trend of various parameters of seismic wave on the building (structure) are obtained through research and data summarization. And also studied the safety effects of some parameters of the building (structure) on the construction (structure) under the action of fuzzy neural network blasting seismic waves. 2 According to some basic characteristics of fuzzy neural network blasting seismic waves and some characteristics of the building, after careful research and discussion, finally, the safety criterion of extension method including many factors (earthquake velocity, duration, frequency ratio, robustness, cumulative effect, etc.) is established. And based on the previous empirical formula and practice, theoretical test, etc., the classical domain and the local domain of the extension method are established. 3 Applying the extension method to monitor and evaluate the buildings (structures) near the No. 1 subway line under construction. By establishing the object to be tested, the final conclusion is a slight impact, but in fact it is only slightly. There is a sense of shock, so the correctness and applicability of the criteria are tested by actual engineering.

There have been many preliminary discussions on the damaging effects of fuzzy neural network blasting vibration on the Geo-technical structures near the surface buildings, but the in-depth theoretical research literature is still relatively rare, so the space that needs to be expanded in this field is still very large, and it needs more people are investing in research work in this area, and the task for blasters and other researchers is still very difficult. There are two main points: (1) Engineering fuzzy neural network blasting should be recorded. Some engineering fuzzy neural network blasting records are too simple or have few records, so that when analyzing cumulative effects and performing regression analysis, data may be inaccurate or even no data available. A fuzzy neural network blasting record should be made. (2)The influencing factors of fuzzy neural network blasting seismic waves are various, not just in the prediction model. Therefore, the prediction model can not completely predict the parameters of fuzzy neural network blasting seismic wave. For other influencing factors, although the impact is not large, in the next development process, in order to make more accurate predictions, it is still necessary to consider as many influencing factors as possible to model.

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