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Study of blasting vibration safety security criterion method based on response spectrum

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Abstract

Based on lots of blasting vibration monitoring data, correlation analysis on blasting vibration velocity response spectrum S_R and blasting seismic waves with each signal characteristic, research that S_R has damage and associated influence on building structure vibration. Research found that S_R can reflect the values of the comprehensive effect of blasting vibration, and the dynamic characteristics of the influence of structural vibration. According to the research results, this paper puts forward with S_R as blasting vibration safety assessment criterion of new methods.

Keywords:blasting vibration; S_R; blasting vibration safety security criterion

1. Introduction

Currently blasting vibration intensity field measures are single parameter variation of independent threshold value theory, such as blasting vibration during the surface speed, acceleration and displacement etc, but in BLASTING SAFETY REGULATIONS (GB6722-2003), building structures of different safety standards is divided by the vibration velocity. Modern practice and research of engineering blasting show that the damage is associated with not only blasting vibration intensity but also the structure characteristics of building structures and duration. It is questioned by many researchers [1-10] that using only vibration intensity factor (vibration displacement, velocity and acceleration) as the safety standards of blasting vibration has great limitations.

Blasting vibration damage effect is a structure dynamic failure, so its structural damage is used as a process of dynamic response analysis. Response spectrum curves response the relations between different dynamic responses of the structure vibration period T and blasting vibration signal characteristics of dynamic time-history. Thus it can theoretically use response spectrum curve characteristic to describe and evaluate the blasting vibration of structures. Through the contrastive analysis of experimental data, they reflect the curve of the trend that blasting vibration response of integral value below setting the curve of the reaction. They reflect the vibration signal characteristics of

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vibration amplitude, frequency and vibration of structural vibration duration. The composer used reaction of offline as response spectrum curve of value, to analyze the characteristic value of blasting seismic waves of frequency and vibration of the strength of the comprehensive properties, and can estimate the damage effect of blasting seismic waves.

2. The correlation analysis of response spectrum area and blasting vibration under structures damage degree

Using self-designed response spectrum analysis system for 300 group of blasting seismic wave record and safety monitoring macro data are analyzed. Table 1 is blasting experiments monitoring macroscopic research statistics and blasting vibration velocity of blasting vibration velocity response spectrum area, macroscopic research object S_R for ordinary houses and frame structure of filling wall.

For 300 group of blasting seismic wave velocity response spectrum spectral data of S_R, results show that the range of S_R is 0.21~13.26. The macro investigation record statistical analysis shows that for ordinary houses and frame structure of filling wall "damage" above the effect of blasting vibration data contains more than 95% of value within the scope of S_R > 5.5. According to the statistical analysis, this paper put S_R is divided into three parts, in order to use of blasting vibration assessment of S_R structural damage effect: $S_R \leq 2$ blasting vibration of structural bodies are generally not adversely affect, $2 < S_R \leq 5.5$ is in the dangerous vibration limits, may create a slight injury, but usually not destructive impact. $S_R > 5.5$ is damage vibration limits, can cause damage, the S_R bigger, the serious of blasting vibration value to destruction of structures. According to the above analysis, the result will be collected test data of blasting seismic waves of 300 group velocity spectrum of S_R value is divided into three interval, the interval of data (see figure 1, table 1 and table 2).

Table 1 Blasting test investigation statistics and S_R monitoring macro

		Scope
No influence	190	**0.21~2.00**
Slight damage	60	**2.00~5.50**
Destruction	50	**5.50~13.26**
Destroy	**0**	**0**

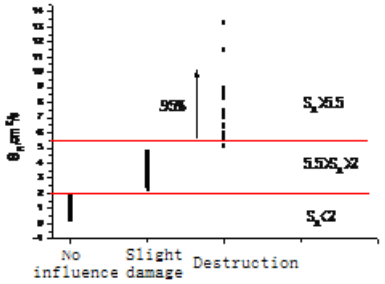

Figure 1The value distribution of S_R in different levels of blasting vibration damage.

Table 2 Speed response spectrum S_R and blasting vibration parameters statistics

S_R classification	Number of data	speed （cm/s）	main （Hz）
		scope	scope
$S_R \leq 3$	190	0.29~1.97	**16.6~56 .6**
$3 < S_R \leq 5.5$	60	0.33~2.58	**18~66**
$S_R > 5.5$	**50**	**0.98~5.10**	**14~63**

3. Blasting vibration safety unified of building structures criteria based on Spectrum area S_R

The division of S_R above, is based on the test data of intuitive, and put forward safety criterion based on S_R according to the results of the validation of the blasting vibration.

In (GB6722-2003) [17], the blasting vibration allowed safety regulations of the surface of the building structures are explained in detail, such as table 3 blasting vibration protection object can be divided into the following categories:

Table 3 Blasting vibration safe velocity regulation in BLASTING SAFETY REGULATIONS

Class Numbers	Protect object classes	Security allowed speed (cm/s)		
		<10Hz	10Hz~50Hz	50Hz~100Hz
1	TuYaoDong, adobe houses, rubble	0.5~1.0	0.5~1.2	**1.1~1.5**
2	General brick masonry buildings, large earthquake	2.0~2.5	2.3~2.8	**2.7~3.0**
3	Reinforced concrete structure housing	3.0~4.0	3.5~4.5	**4.2~5.0**
4	General buildings and monuments	0.1~0.3	0.2~0.4	**0.3~0.5**
5	Hydraulic tunnels		**7-15**	
6	Traffic tunnel		**10-20**	
7	**Mine roadway**		**15-30**	

From the blasting safety regulation of blasting vibration velocity of safety standards stipulated that the standard of safety vibration velocity is very different, this is due to the protection of building structures and earthquake caused by different levels, so will the second protection building structures of the blasting vibration safety criterion is extended to other six types of building structures:

$$S_{Ri} = K_Q \; S_{R2} / \; K_a \quad S_{Ri} = \frac{K_Q S_{R2}}{K_a} \tag{1}$$

Type in: S_{Ri}- Article i of the blasting vibration safety protection area criterion spectrum, i=1, 3, 4, 5, 6, 7;

S_{R2}- The second type of security protection of blasting vibration spectral area criterion;

K_a- Structure protection level coefficient;

K_Q- Structural seismic potential.

For the specific values, K_Q Ka, according to the statistical analysis of the literature, suggested index, see table 4.

Table 4 K_Q Ka about different objects of protection scope

Class Numbers	Protect object classes	K_a	K_Q
		1.0	**0.4~0.6**
1	TuYaoDong, adobe houses, rubble	1.0	**1.0**
2	General brick masonry buildings, large earthquake	1.2~1.5	**1.3~2.0**
3	Reinforced concrete structure housing	2~3.0	**0.2~0.3**
4	General buildings and monuments	1.1~1.2	**2.5~4.5**
5	Hydraulic tunnels	1.1~1.2	**3.0~5.0**
6	**Traffic tunnel**	**0.8~0.9**	**2.0~3.0**

Tab5 The seven categories of building structures of the blasting vibration security unification standard criterion is given based on the speed response spectrum S_R

Tab 5 The blasting vibration safety standard unified criteria of building structures

Class Numbers	Protect object classes	【S_R】
		≤2
1	TuYaoDong, adobe houses, rubble	**≤5.5**
2	General brick masonry buildings, large earthquake	**≤7.0**
3	Reinforced concrete structure housing	**≤0.5**
4	General buildings and monuments	**≤10.0**

5	Hydraulic tunnels	**≤14.0**
6	**Traffic tunnel**	**≤18.0**

4. Conclusion

In this paper analysis the relationship between blasting seismic wave velocity response spectrum curve and cycle shaft surrounded area and building structure vibration damage. Through analysis the relationship between the blasting vibration velocity response spectrum S_R and the characteristics of blasting seismic wave signal, analysis statistical analysis of the data of blasting vibration, put the blasting vibration with S_R as safety evaluation characteristic value of blasting seismic assessment of the effect of the new method, and preliminary establish can blasting vibration security unification criterion consider ed comprehensive effect of blasting vibration and structural vibration characteristics. The following conclusions:

(1) The destroy of vibration of structural bodies depends not only on the vibration amplitude but frequency and vibration and vibration with relevant. That using the independent threshold value theory or vibration frequency of blasting vibration damage safety standards as the standard cannot reflect the essence of blasting vibration damage.

(2) S_R can reflect the values of the three elements of blasting vibration, and the comprehensive effect of the dynamic characteristics of the structure vibration damage effect, thus S_R can be used as evaluation value of blasting vibration safety evaluation of comprehensive evaluation indexes.

(3) Through the statistical analysis of the data measured vibration, when $S_R > 5.5$, blasting seismic waves will destroy the general structure of resident probability increased significantly. According to the analysis of experimental data, Vibration velocity response spectrum area S_R of the second building structures of the blasting vibration damage safety-judging standard: 【S_R】 ≤5.5. Through introducing the building structures protection coefficient and structural seismic potential coefficient, the criterion of S_R extension extended to other six types of building structures.

(4) The criterion of blasting vibration security and unity establish requires a lot of blasting vibration data support industries. This research is finally complete and scientific blasting vibration unified safety criteria laid a theoretical foundation.

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