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Analysis of vibration monitoring and safety prediction for opencast blasting

Zhan Cheng, Zhu Long, Zhang Wen Kang

College of Civil Engineering, Chongqing Jiaotong University, Chongqing, China

Abstract

For the study of earthwork blasting theory and engineering practice of leveling the field, basing on the third period blasting engineering of Hui-Cheng aluminum at industrial park in Qi-Jiang county. By timely monitoring the building (structure) near the blasting area, the results of the monitoring data show that the influence of the nearby structures is within the range of safety. By linear regression analysis of the monitored vibration data, in the range of safe value, the maximum charge quantity of the second calculation point and the third point is predicted to guide the actual construction.

Keywords: Rock Blasting, Blasting Vibration, Vibration Monitoring

1. Introduction

With the development of China's economy, especially for the development and construction of Chongqing area. Because of blasting is high efficiency and fast advantages, it cannot be replaced in the production process. Blasting is one of the indispensable and important links of flat base stone engineering in rock excavation. But due to the fast urban development and construction, the more constructions site near in the city center or Industrial Development Zone, population is numerous, surrounding building (structure) constructed dense materials, flying-rocks and vibration produced by construction may endanger the surrounding building (structure) creation and personnel safety. Therefore, timely detection of rock blasting, design and optimization, has important theoretical and guiding significance. The construction commonly used Sadaovsk formula, applying the empirical parameters of blasting vibration fou Analysis and calculation, but rock blasting engineering, complexity and levity of topography and geology, making measurement data has a significant difference. Resulting in inaccurate measurement and other consequences, a direct impact on the blasting safety and quality. So it should be used in the field measured data to calculate the parameters, so as to guide the construction of a reasonable adjustment.

1.1 Engineering condition

The project is located in Qijiang Industrial Park BeiDu Aluminum Industrial Park, area of 326 acres, West and north near Qingxi River, east of Huicheng the second phase project of the flat field plots; south of the flag to high-voltage tower (steel structure) and the reservoir (reinforced concrete structure); blasting from the area of the reservoir is about 110 m, from the high-voltage tower is about 95m. There is a 220KV high-voltage wire across the construction area. The height is 100m. According to the field reconnaissance and exploration data was informed that the land soil is mainly of Quaternary artificial embankment and residual soil, bedrock composed by sandstone and mudstone. Site in rock and soil order normal and no landslide, dangerous stone, debris flow and other geological field. The scene condition is shown in figure 1:

(a) The bedrock (sandstone and mudstone)

(b) Direction of rock strata

Fig 1: Scene geological conditions

2. Blasting vibration monitoring

2.1 Monitoring apparatus and method

Using in the Department of Surveying and mapping in TC-4850 intelligent blasting vibration meter. The instrument is placed on the hard and flat ground next to the monitoring target, and the adhesive is used to fix it to the ground. By blasting vibration recorder to record the vibration velocity of blasting, and the vibration velocity component of the 3 directions of the monitoring points is obtained. Through blasting vibration monitoring, the impact of blasting vibration on adjacent construction (structure) is analyzed, and evaluated to safety and stability of the adjacent building (structure). At the same time, it provides reference for the optimization of blasting parameters and safety construction in the construction scheme. Specific monitoring steps are as follows:

1) Before blasting, collect the blasting parameters, geological conditions, fill in the construction parameter form, and clear record the blasting time;
2) Confirm the monitoring instrument parameters are normal, and 30 min into the monitoring site before the initiation, laying a good monitoring network, and 10 min before blasting to monitor an environmental vibration to ensure the normal operation of the instrument;
3) Through professional analysis software to obtain the blasting peak vibration velocity and main vibration frequency of the different segments ;
4) The construction parameters, measuring point parameters, instrument parameters, data processing results are summarized into the monitoring report, and put forward the technical measures to reduce the vibration intensity. At the same time optimize the construction program.

2.2 Arrangement of monitoring points

The blasting environment of the project is relatively good, which has a 220KV high voltage line across the construction area. But only the high voltage tower, reservoir and plant on the south side of the blasting area is the key protection object. In order to accurately monitor the impact of blasting vibration on the surrounding facilities and building (structure). After monitoring the company and QiNeng aluminum company communication, site visits, on-site survey, selected 3 monitoring points. The position of the measuring point is shown in figure 2:

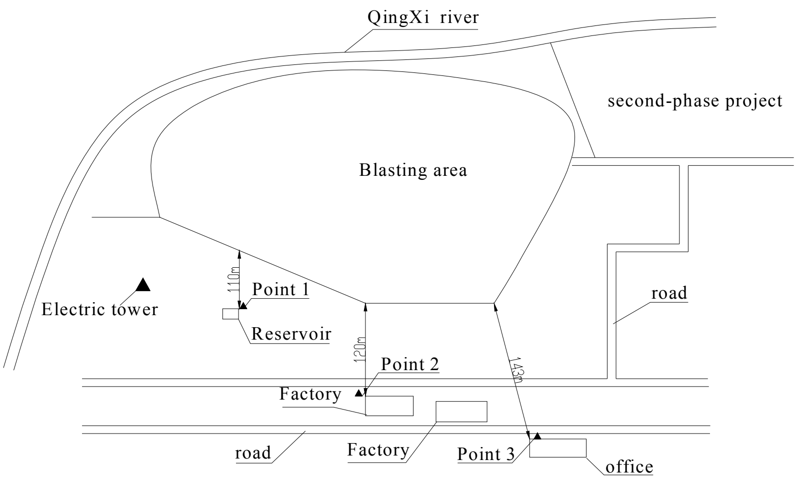
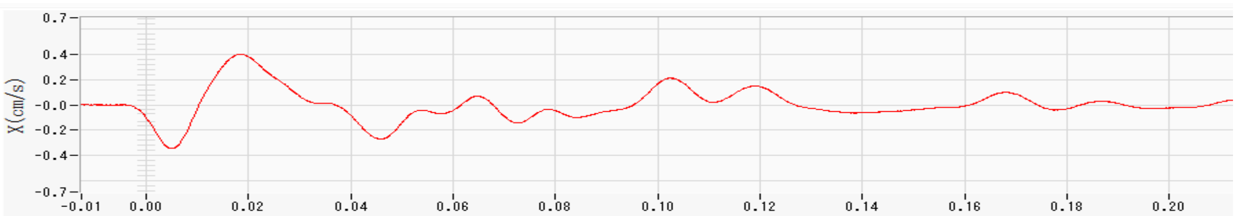


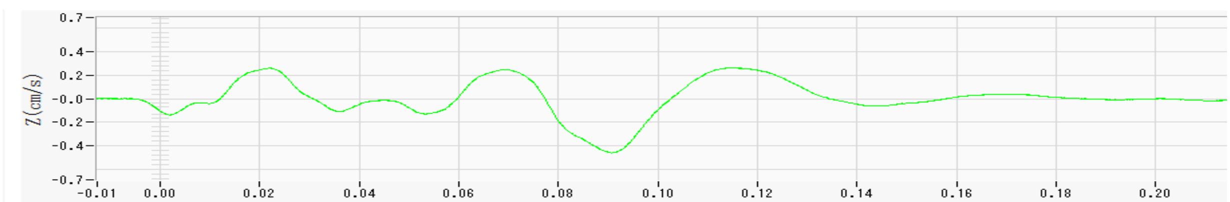
Fig 2: Schematic diagram of monitoring points (m)

2.3 Monitoring results

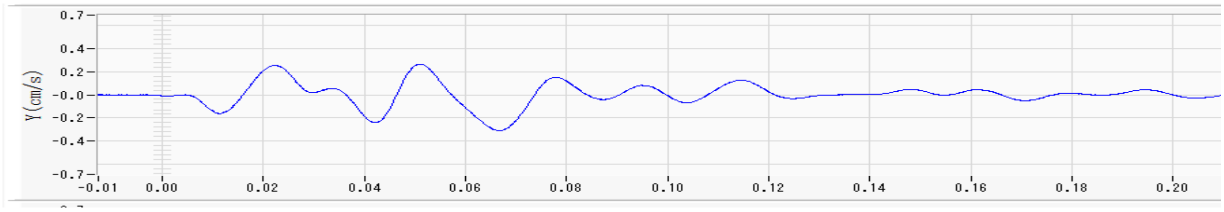
In order to ensure the accuracy and credibility of the monitoring results to carry out a test before monitoring. The figure 3 is the measured vibration time history curve of the test. From the curve can see the curve is not obvious fluctuations after 0.14s, and in which Z channel tends to be stable. Curves show that the electrical equipment around the large and high voltage line would not interfere with the vibration measurer. This fully guarantees the reliability and accuracy of the follow-up monitoring data.



(a) X direction Vibration velocity (cm/s)



(b)Y direction Vibration velocity (cm/s)



(c) Z direction Vibration velocity (cm/s)

Fig 3: Measured vibration velocity of blasting

Due to the change of the step size of each blasting, the distance between the vibration monitoring point and the blasting center are relatively change. Through timely monitoring each time after blasting obtain some data of the monitoring point 1. As shown in table 1:

Table 1: Blasting vibration monitoring data

Times	Charge quantity Q/kg	He maximum vibration velocity of reservoir *V* / (cm/s)	Distance R/m
1	115.7	0.48	130
2	200.4	0.43	150
3	120.8	0.34	142
4	93.5	0.41	120
5	180.0	0.35	162
6	137.7	0.27	170
7	120.4	0.25	168
8	104.9	0.27	155
9	152.5	0.31	162
10	97.4	0.42	120
11	133.6	0.30	157
12	138.7	0.38	141
13	220.6	0.32	180
14	234.4	0.34	179
15	86.6	0.46	110
16	70.8	0.36	117
17	43.3	0.22	127
18	54.9	0.20	146
19	72.8	0.23	149
20	94.0	0.25	156

3 Regression analysis and prediction

3.1 Regression results and analysis

According to the research results of "blasting safety regulation" in China and Some research results at home and abroad, the propagation and attenuation law of blasting vibration is generally adopted by Sadaovsk formula [3-4], As shown in the formula (1):

$$V = K\left(\frac{\sqrt[3]{Q}}{R}\right)^{\partial} \quad \dots (1)$$

Where,

V - Particle vibration velocity (cm/s);

Q - Maximum Charge quantity (kg);

R - The distance from the blasting center to the protected building;

K, α -The parameters related to the topography and geological conditions of the blasting area.

According to the measured data of the reservoir and maximum Charge quantity (table1). Using MATLAB to linear regression analysis of Sadaovsk formula. Through the Charge quantity, the maximum vibration velocity, the change of distance, fitting out the linear value of K and α. The values of K andα in this project are 210 and 1.91. And compared with the blasting scheme, in which the K is 150 and the alpha is 1.5.At the same time considering the nature of the sandstone and the actual engineering of the rock strata in the situation, some of the lots with a small amount of mudstone and other conditions analysis, then the linear regression of K and α are more suitable to the "Safety regulations for blasting" (GB6722-2014) [3] the specified value. It also shows that the regression value is more reasonable, and it has guiding significance to the improvement of the plan. The variation of the residuals in the regression analysis is shown in figure 4:

Fig 4: Residual variation of linear regression

3.2 Prediction and safety control

According to the linear regression analysis of the measured data of the reservoir, it is known that the intensity of blasting vibration decreases with the increase of distance. Therefore, we can improve the guide blasting construction by Factory (point 2) and (point 3) of maximum charge quantity at the shortest distance. The nearest distance from the blasting area to the factory is 120m, and the QiNeng office is 143m.Through the directly calculation of the factory maximum charge quantity to guide the safety of construction. The known K alpha, V, R values into the formula (1), got:

$$0.5 = 210 \times \left(\frac{\sqrt[3]{Q}}{120}\right)^{1.91}$$

The maximum charge quantity at the shortest distance is 131kg.

This has a significant difference compared with the maximum charge amount of 110kg in the program. Therefore, in the actual distance from the factory near the regional blasting, to ensure the effect of blasting, reduce the rate of a large stone, and ensure that the planned work is completed on schedule. We can appropriately increase the charge quantity, and will not affect the safety of production.

4. Epilogue

Through the real-time monitoring of blasting construction, the total charge and the maximum charge quantity strictly guided and controlled, so that the blasting vibration intensity was controlled within the allowable range. According to the statistical results which of the data of blasting seismic monitoring: on more than 300 times monitoring, particle vibration speeds all controlled within 0.48 cm/s, not beyond the control standard 0.5cm/s. The project has been successfully completed, one and half year, no occurrence of safety accidents, did not affect the normal production of power plant and aluminum plant, and nor were complaints from local residents and neighboring units. Qi-Jiang Industrial Park and the district government repeated check also not ordered to the construction side rectification work stoppage, this indicates that good control of blasting damage effect. This fully shows that through the scene monitoring, using the measured data regression analysis of blasting parameters, and then through the actual calculation parameters to predict and improvement program. So as to guide the engineering practice is feasible, and has the practical guiding significance.

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