Application of Controlled Blasting in Urban Complex Environment Foundation Excavation

Cheng-Li ZENG1,2,a, Guo-Jun LIU 1,2,b*, Hai-Long ZHANG 1,2,c

1Gansu LanJin Civil Explosion High Technology Limited Liability Company, Lanzhou, Gansu, China
2China Gansu Chemical Industry Research Institute, Lanzhou, Gansu, China
aemail:zengcl2018@163.com, bemail:gsxysm@163.com, cemail:zhanghl@163.com

Abstract. In the city buildings, dense area blasting to excavate mass rock belongs to the controlled blasting of stonework in complicated situations. In order to reduce the impact of blasting vibration on the surrounding environment, it is necessary to take a variety of blasting technology combined with the construction scheme. Lanzhou Ming Cheng Plaza foundation excavation uses millisecond short-hole blasting technology, by taking measures of choosing the reasonable digging groove position and control maximum charge weight per delay interval, achieved the purpose of control flying rock and reduce the blasting vibration.

1. Introduction
In deep foundation pit rock blasting excavation, to make the blasting pit surrounding rock section and contour is remained a safe and stable condition, while avoiding the blasting vibration cause adverse effects on the surrounding buildings and environment, it is crucial that take reasonable blasting scheme and technology, also important to improve the quality of engineering blasting, speed up construction progress and ensure construction safety. This paper introduces a method of control blasting construction in deep foundation pit in the city, provides a reference for the similar complex environment pit blasting engineering.

2. Engineering situation
The project is located in the downtown area, construction process needs comprehensive consideration of the surrounding environment, duration, rock fragment size, and rock mass stability, etc. According to the construction conditions, geological conditions, and technical requirements of the blasting area, blasting construction must be held no flying rock and low vibration. At the same time to speed up the construction progress, determine the thickness in each tunneling layer is about 2m, in the near slope area use static blasting technology, other field region stonework use dynamic blasting technology. Due to the release process of the potency of explosive in static crushing has no vibration, the negative impact of slope displacement can be effectively reduced to the minimum, and the static crushing can effectively reduce the environmental disturbance such as dust, noise, and so on, has little influence on the surrounding residents and structures and is conducive to civilized construction.

Surrounding the excavation area excavate damping ditch, drill damping hole and take the smooth blasting finally, to reduce the influence of blasting vibration on the surrounding buildings. The main part excavation from the middle to around expanding, in the side of the high building excavate damping ditch (wide 3m, deep 2m). In the blasting process, adhere to the principle of "more drilling,
less charge ", strict control the maximum charge quantity in each detonating period and total charge of each blasting. Take effective measures such as strengthen the stemming quality of the blasting hole and reinforce perimeter protection to maximize reduce the blasting vibration. After each layer is blasted, timely removal of sediment, and then blasting the next layer, to control the flying stone.

The surrounding environment of the foundation pit is complex, to complete the construction safely and smoothly, in the scheme design and construct process, the following key issues are considered:

1. The project is located at the intersection of the urban main road, road traffic in the area is heavy and pedestrians are dense; the construction needs to strengthen the communication and coordination with surrounding units and residents.

2. The main blasting zone and blasting hole of damping ditch can easily produce flying stone, need to strengthen the surrounding environment protection;

3. Must ensure the integrity of the foundation pit supporting structure when blasting, the blasting vibration needs to strictly follow the “blasting safety regulations” and design requirements.

3. Hole pattern and charge structure

3.1. Intermediate cutting position
Cutting holes are more intensive than normal conditions, hole pattern parameters a×b=0.5×0.5 m, vertical drilling in the middle, borehole diameter d=40mm, blast hole depth L=3m. Side hole toward outer flank oblique 15 degrees, two-layer charge and filling densely.

3.2. Surrounding rock mass position
Take quincunx of hole layout pattern, hole pattern parameters a×b=0.5×0.5 m, vertical drilling. Stratify according to field situation or concentrate charge at the bottom. Filling densely, the upper filling length is 1.1m.

3.3. Smooth blasting layer position
To reduce the influence of blasting vibration, a row of damping holes is arranged around the foundation pit. When excavating the foundation pit slope in the late stage, take the damping hole space as a smooth blasting hole. Smooth blasting hole spacing is 0.5m, the concentration factor is 0.9. Take decoupling charge mode, decouple coefficient not less than 3.5. Filling takes sublevel filling mode, orifice filling needs to ensure sufficient length and filling densely. The upper stem length value takes 1/3-1/4 of the depth of the blast hole, the middle section should be evenly sublevel filling.

4. Safety effect control of blasting
The blasting damage effect including blasting earthquake, air shock wave, flying stone, toxic gas, and noise, etc. The project construction blasting produced the harmful noise, toxic gas and air shock wave have less effect, the harmful effect is negligible, the main effect is caused by blasting flying stone and blasting vibration. For this reason, need to strengthen the warning before initiation, evacuate all site personnel and vehicles, to ensure construction safety.

When foundation pit excavation blasting, the main safety hidden danger is the edge of foundation pit damage by blasting vibration and the landslide of foundation pit caused by a rainy day. For this to take the following measures:

1. Through take two measures of damping hole and smooth blasting to reduce the spread out the speed of blasting vibration, to reduce the damage of retaining edge of foundation pit caused by blasting vibration of excavation area of foundation pit.

2. Strictly by the requirements of the "construction project fugitive dust pollution prevention and control standards".

3. The work of blasting dustproof, transport dustproof, and blasting soot pollution prevention should be done well, take measures of watering and clean in time to control the fugitive dust.
The project belongs to urban controlled blasting engineering. The task is heavy, the construction time is tight and the construction site is limited. The surrounding environment is complex for sediment transport; through trial, blasting determined blasting 6 times a day finally, the number of explosives used in each blasting must be less than 250kg. According to the particularity of this project, the blasting area of scribing is divided into 4 areas, established a set of the orderly construction workflow of drilling, blasting, and excavation. In the construction site management, to take the full closed construction, reduce mutual interference with the outside world.

5. Safety effect control of blasting
The whole blasting construction lasted 120 days, the number of blasting reached 184 times, there is no accident in the whole process of blasting construction, and surrounding buildings are all in good condition. Through take effective safety measures and vibration reduction measures before initiating, a more ideal effect was obtained. Table 1 and Figure 1 to 4 shows the results of the four measuring points recorded by the blasting vibration meter, all parameters meet the design standards, which amply demonstrate the effectiveness of various vibration reduction measures taken in the project.

| Measuring point | Channel number | Channel name | Maximum value | Maximum value time | Half-wave frequency | Unit | Range | Sensitivity |
|----------------|----------------|--------------|---------------|-------------------|--------------------|------|-------|-------------|
| 1              | 1              | CH1          | 0.40cm/s      | 0.6930s           | 14.60Hz            | m/s  | 42.83cm/s | 23.35V/m/s  |
| 1              | 2              | CH2          | 0.25cm/s      | 0.9872s           | 17.86Hz            | m/s  | 41.27cm/s | 24.23V/m/s  |
| 1              | 3              | CH3          | 0.50cm/s      | 0.9289s           | 30.77Hz            | m/s  | 36.76cm/s | 27.20V/m/s  |
| 2              | 1              | CH1          | 0.09cm/s      | -0.0040s          | 16.13Hz            | m/s  | 42.83cm/s | 23.35V/m/s  |
| 2              | 2              | CH2          | 0.12cm/s      | 0.0043s           | 16.00Hz            | m/s  | 41.27cm/s | 24.23V/m/s  |
| 2              | 3              | CH3          | 0.11cm/s      | 0.0114s           | 15.63Hz            | m/s  | 36.76cm/s | 27.20V/m/s  |
| 3              | 1              | CH1          | 1.21cm/s      | 0.3262s           | 21.51Hz            | m/s  | 42.83cm/s | 23.35V/m/s  |
| 3              | 2              | CH2          | 0.95cm/s      | 0.3881s           | 23.53Hz            | m/s  | 41.27cm/s | 24.23V/m/s  |
| 3              | 3              | CH3          | 0.86cm/s      | 0.4078s           | 23.26Hz            | m/s  | 36.76cm/s | 27.20V/m/s  |
| 4              | 1              | CH1          | 0.23cm/s      | 0.0101s           | 14.08Hz            | m/s  | 42.83cm/s | 23.35V/m/s  |
| 4              | 2              | CH2          | 0.20cm/s      | 0.0156s           | 14.55Hz            | m/s  | 41.27cm/s | 24.23V/m/s  |
| 4              | 3              | CH3          | 0.13cm/s      | 0.0547s           | 18.96Hz            | m/s  | 36.76cm/s | 27.20V/m/s  |

Figure 1 measuring point 1

Figure 2 measuring point 2
6. Conclusion

In the foundation pit blasting construction of densely populated urban areas, blasting results are influenced by lots of factors, including geological structure, physical and mechanical properties of rock, surrounding environment, selection of blasting scheme, selection of blasting parameters, charge structure, blasting network arrange and construction factors, etc. Therefore, the influence of these factors should be comprehensively considered in blasting construction design, so the choice of the parameters is more reasonable. The blasting actual results should be carefully observed and analyzed and make the quality assessment and effect analysis in time, to obtain the blasting parameters which suitable for the practical engineering finally.

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