

# Application Analysis of Blasting Construction in Tunnel Excavation

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**Abstract:** This article combines the engineering background and relies on geological conditions and blasting construction methods to briefly analyze the necessity of applying tunnel blasting construction technology and the influencing factors of the rear support structure of the palm face. The aim is to provide reference significance for efficient and safe construction in complex geological conditions and its later use.

**Keywords:** Tunnel engineering; Blasting construction; Safe construction; Initial support.

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## 1. Introduction

With the rapid development of China's economy and the gradual improvement of transportation infrastructure, tunnels, as an important component of modern transportation infrastructure, play an important role in connecting transportation hubs, shortening travel routes, and improving regional transportation convenience. The construction of tunnels is greatly constrained by geological conditions, which is also one of the important factors restricting the development of tunnels [1]. Tunnel blasting construction technology, as an efficient and fast construction method, is increasingly becoming an important means to overcome these difficulties.

The drilling and blasting method in blasting construction has the advantages of simple process, low cost, and strong adaptability to engineering environment, and is widely used in the construction of mountain tunnels [2]. The initial support of the tunnel is the main load-bearing structural layer during the tunnel construction stage. However, the vibration generated by blasting construction has adverse impact loads on the support structure behind the face and surrounding rock, which has a certain disturbance effect on the support layer. The stability of the support structure is of great significance to ensure the rapid and safe construction of the tunnel. Therefore, studying the disturbance of blasting loads on the initial support structure of tunnels is also of great significance.

## 2. Advantages of Blasting Construction

Blasting construction is widely used in engineering such as highways, railways, and rock mining, with characteristics such as high power and high construction efficiency [3]. Compared with traditional mechanical excavation methods, blasting construction can quickly destroy geological conditions such as hard rock and hardness, thereby saving construction time and accelerating the rapid completion of projects; At the same time, blasting construction can save a lot of equipment consumption caused by mechanical excavation, saving construction costs. This is a convenient and efficient construction method for the rapid completion of long-distance and large-scale model projects.

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## 3. Blasting Construction Technology

### 3.1. Safety assurance measures for blasting construction

During tunnel blasting construction, it is necessary to pay attention to strengthening the safety management of blasting operations. Due to the energy conversion of some explosives into seismic waves during the blasting process, certain flying rocks, shock waves, blasting gas, and noise are generated, which poses a certain threat to personnel safety and also causes financial losses to surrounding buildings, construction machinery and equipment. Therefore, it is necessary to ensure blasting safety during the blasting construction process.

(1) Requirements for safety distance in blasting construction: Personnel should maintain a safety distance of at least 200m. The safety distance of mechanical equipment should be maintained at a distance of over 100 meters, and protective measures should be taken to counteract damage such as shock waves and flying rocks.

(2) Requirements for safety measures in blasting construction: The equipment used in blasting must meet the prescribed requirements. Before blasting construction, safety positions must be determined, safety responsible persons must be assigned, and safety precautions must be taken.

(3) Requirements for blasting construction personnel: Blasting operations in tunnel tunnels must be carried out by certified blasting operators who have received professional training. When carrying out hole layout, charging, covering, and blasting procedures, they must be carried out under the supervision and guidance of blasting engineers. After blasting, it is necessary to check for dangerous rocks, damage to support structures, and blind shots.

### 3.2. Technical requirements for blasting

The blasting design scheme requires safety, reliability, ease of operation, and ease of learning, mastery, and safe construction for operators. Tunnel excavation construction requires maintaining the integrity of the surrounding rock mass as much as possible, reducing over excavation and under excavation, and using micro vibration controlled smooth blasting technology to ensure that there are no obvious blasting cracks or loose rocks around the blasting holes.

### 3.3. Blasting safety verification

In tunnel excavation blasting, there may be individual rock blocks scattered far away, which can easily cause harm to personnel, equipment, or building (structure) products, and must be taken seriously and controlled. The scattering distance of individual flying stones is related to factors such as blasting parameters and the quality of hole blockage. During tunnel excavation blasting, the excavation hole is most likely to produce harmful flying rocks; Pay special attention to the quality of its filling and perform distance verification for flying stones.

The maximum distance of individual flying stones generated by blasting is determined by the following equation:

$$R_{max} = K_f q d$$

In the formula,  $R_{max}$  To provide the maximum distance for individual flying stones, Unit: (m);  $K_f$  is the coefficient related to blasting method, filling situation, geological terrain, etc., with a value of 1.0~1.5;  $q$  is the unit consumption of explosives, with a value of 0.7~0.9kg/m<sup>3</sup>;  $d$  is the diameter size of the borehole.

The safety distance for personnel involved in shallow hole blasting of individual flying stones shall not be less than 200mm, and for equipment, the safety distance shall not be less than 100m.

In the early stage of tunnel excavation, mechanical excavation should be used. If blasting is required, a safety assessment should be conducted. When the blasting point is less than 100m from the opening, certain protective measures must be taken for the surrounding buildings (structures), such as hanging wave barriers. There should be no personnel or equipment in the opposite direction of the exit. Before blasting inside the tunnel, personnel should evacuate the tunnel, and mechanical equipment should be evacuated to a place with a certain safety distance for refuge.

### 3.4. Measures for controlling the generation of flying objects during blasting

Reasonable blast hole design, qualified measurement and acceptance of blast hole position are prerequisites for controlling flying object accidents. On this basis, loose stones on the blasting working face should be cleaned up before blasting, and the minimum resistance line of the charge should be verified to completely avoid situations where the charge exceeds the limit. For areas with weak zones, well-developed joints and fissures, and sparse geological structures, technical measures such as changing pore network parameters, interval plugging, and adjusting drug dosage should be taken. The length of the blockage must be greater than the minimum resistance line, and the blockage must be dense; Ensure the quality of blockage and avoid the inclusion of crushed stones during blockage.

### 3.5. Verification of blasting vibration speed control

The relationship between vibration speed, maximum single hole charge, and distance from the blasting core to the building (structure) is as follows[4]:

$$R = \left(\frac{K}{V}\right)^{\frac{1}{\alpha}} Q^{\frac{1}{3}} \text{ 或 } V = k \left(\frac{Q^{1/3}}{R}\right)^{\alpha}$$

In the formula,  $Q$  is the maximum single hole charge for one blasting, unit:(kg);  $R$  is the closest distance from the center of the medicine package to the building (structure), unit:(m);  $V$  is the vibration velocity of the medium particle, unit:(cm/s);  $\alpha$ The coefficients and attenuation indices related to the terrain and geological conditions between the blasting point and the calculated protected object.

According to the above equation, the range of impact on different buildings can be calculated. Based on this data, protect the buildings within this range to avoid or reduce property damage.

## 4. The Influencing Factors and Dynamic Response of The Initial Support Structure

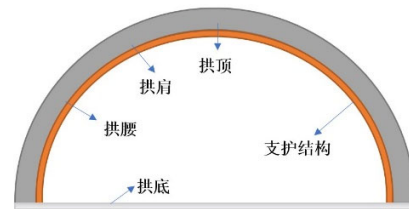


Figure 1. Tunnel excavation contour map

The supporting structures inside the tunnel mainly include steel arches, anchor rods, grouting, reinforced concrete lining, sprayed concrete lining structures, etc. The supporting structures are divided into initial support and secondary lining. The supporting structures play an important role in bearing the stress of the tunnel body, increasing the stability, durability, and overall aesthetics of the tunnel body.

The support structure plays an important role in strengthening the surrounding rock, improving its strength, and improving its stress state; The stability of the support structure affects the stability of the surrounding rock and its tunnel body.

The impact load during blasting construction has a certain disturbance on the surrounding rock and initial support structure. Therefore, maintaining the stability of the support structure is of great significance for safe and orderly construction and subsequent use.

The drilling and blasting method is widely used in tunnel blasting construction. The level of surrounding rock, charge amount, and support thickness have the most significant impact on the dynamic response of the initial support structure. Wang et al[5]. analyzed and studied the dynamic response mechanism of the initial support structure of the tunnel through tunnel simulation and drew the following conclusions:

(1) The surrounding rock conditions of the tunnel are gradually deteriorating, the mechanical properties are getting worse, and the support response is becoming more intense. When constructing under harsh surrounding rock conditions, increasing the support thickness can be adopted to

ensure the stability of the tunnel surrounding rock.

(2) The charge amount during tunnel construction is linearly positively correlated with the vibration speed and displacement response of the initial support of the tunnel. The larger the charge, the more obvious the dynamic response of the initial support of the tunnel.

(3) The thickness of the support is negatively correlated with the dynamic response of the initial support of the tunnel. The thicker the initial support, the higher the stability, and the smaller the maximum values of vibration velocity and displacement.

In the process of tunnel construction, when the geological conditions and surrounding rock conditions are poor, increasing the thickness of tunnel support, shortening the footage, reducing the amount of explosives, multiple blasting, and adding anchor rods can be used to ensure the safety of tunnel construction while ensuring cost and progress.

## 5. Conclusion

The blasting technology has obvious advantages in the excavation of hard rock geological tunnels. The advancement of blasting construction technology will reduce the occurrence of geological disasters, while also reducing the difficulty and risk of construction. Based on the use of blasting technology and the rapid development of tunnel construction, scientific research and innovation should be further strengthened. It is expected that blasting technology can be applied in more complex geological environments, accelerate the completion speed of projects, and save construction costs.

In summary, blasting construction has certain advantages, and there is a certain correlation between blasting construction and the dynamic effects of support structures. In subsequent research, further exploration should be carried out in this direction to reveal the internal connection mechanism and provide a theoretical basis for accelerating tunnel construction and safe operation.

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