Research on Construction Application of Earth and Stone Blasting Technology in Subgrade Excavation Engineering

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Abstract. It is more difficult to construct stone subgrade than earthwork subgrade, so quality control should be strengthened in every link during construction. In the actual construction process, because the rock or geological structure is complex, blasting technology should be applied to achieve the purpose of earth and stone excavation. However, the application of blasting technology will bring many potential safety hazards, and even cause a large number of casualties in severe cases. Construction units should strengthen construction management, strictly regulate the application of technology, and avoid the occurrence of safety accidents. In order to ensure the high efficiency and safety of construction, the relevant engineering construction departments should fully display their guarantee function and reasonably apply the blasting technology. On the basis of introducing the engineering characteristics, this paper analyzes the construction requirements of earthwork and stone excavation of subgrade, and discusses how to correctly apply earthwork blasting technology in highway subgrade excavation engineering.

1. Introduction
With the rapid development of China’s economy, people pay more and more attention to the construction of highway engineering projects. In practice, as the key construction part of highway engineering, subgrade Earthwork is more and more concerned by the majority of engineering and technical personnel [1]. In highway engineering, subgrade engineering is an important basic engineering, which occupies a very important position in the whole highway engineering [2]. The construction of stone subgrade is more difficult than that of earthwork subgrade. In the process of construction, the quality control of all links should be strengthened. In recent years, with the wide application of earthwork construction technology, the construction process is also faster and faster, but the risk of safety accidents is also gradually increasing, especially in the process of blasting construction, it has a lot of security risks [3]. In the actual construction process, due to the complex rock or geological structure, it is necessary to apply blasting technology to achieve the purpose of earth rock excavation [4]. However, the application of blasting technology will bring many potential safety hazards, even cause a large number of casualties. Therefore, the construction unit should strengthen the construction management, strictly standardize the application of technology, and avoid the occurrence of safety accidents [5]. Although the current earthwork excavation has a high degree of mechanization, and the construction efficiency has been
greatly improved, the construction quality and safety objectives need to be achieved through effective control, which has an important role and significance for Subgrade excavation construction [6].

With the continuous development of China's economy and the continuous progress of society, the demand for highway engineering is increasing, and more roads and higher quality roads are needed to match the economic and social development [7]. Now the highway has become a bridge connecting different regions and a main channel for communication between different regions. Before the formal start of construction, the construction unit should carry out the survey and setting out work [8]. Because some sections need to be filled contain a variety of bad materials such as topsoil and organic matter, the construction personnel should take effective measures to clean them up in time [9]. Different engineering scale or engineering conditions require different blasting technologies, and the selection of blasting technology should consider many aspects, such as blasting range, demolition objects, blasting seismic effect, etc. [10]. The construction of Highway Stone subgrade is more difficult than that of earthwork subgrade, and in the whole construction process, the quality requirements of each link are particularly high [11]. Based on the introduction of the characteristics of the project, this paper makes an in-depth analysis of the construction requirements of the Subgrade Earthwork and stonework excavation, and mainly analyzes how to correctly apply the earthwork blasting technology in the highway subgrade excavation project. In order to ensure the efficiency and safety of the construction, the relevant engineering construction departments should fully display its safeguard role, and reasonably apply the blasting technology, so as to effectively improve the shortcomings and deficiencies of the project.

2. Application of blasting technology in earthwork engineering of subgrade excavation

The improvement and perfection of Subgrade Earthwork Construction Technology of highway engineering can greatly improve the quality of highway engineering and promote the development of highway engineering construction in China. Due to the influence of geological structure, rock and other factors, it is necessary to apply blasting technology in earthwork engineering. In order to apply the blasting technology reasonably, it is necessary to do a good job in the blocking and loading of explosives. Highway engineering Subgrade Earthwork construction is a systematic project, the requirements of construction technology is also very high, the construction process is very difficult, which is determined by the diversity of subgrade construction geological conditions. In the process of charging, the corresponding cleaning work should be done before charging. The residual stone powder, mud and other debris in the borehole should be removed to ensure that there is no debris in the borehole, so as to promote the smooth implementation of blasting work. The quality of highway is the key point in the whole construction process, so the quality and ability of construction personnel have a certain impact on the quality of the whole subgrade, so it is necessary to select the construction team with better comprehensive quality [12]. After the installation of explosives, it is necessary to plug them in time, and use fine stone powder or loose soil to fill the gaps caused by the completion of explosive filling. In the process of plugging, it is necessary to pay attention to the reasonable control of its length, preferably not lower than the minimum resistance line. The blasting holes should also be cleaned up to avoid the occurrence of problems such as damp explosives. These problems will not only affect the blasting effect, but also lead to a variety of safety accidents. Therefore, if necessary, oil paper can also be laid under the borehole. If bulk explosives are used, they should be loaded by stages and compacted after loading.

In the process of charging, it is necessary to reasonably control the frequency and number of personnel entering and leaving the site. For non relevant personnel, it is necessary to prohibit them from entering and leaving. At the same time, it is necessary to divide the dangerous area and safety area, set eye-catching signs and warning lines, so as to ensure the safety of filling. Highway engineering Subgrade Earthwork construction technology is now a very important construction technology in the process of highway engineering construction, which occupies a very important position in China's highway engineering, and is now valued by highway engineering designers and construction personnel. In highway engineering, subgrade not only needs to bear the weight of its own soil and stone, but also needs to bear the weight of pavement. After driving, the subgrade also needs to carry the driving weight.
From this aspect, we can see the important position of Subgrade Engineering in highway engineering. In the process of the application of blasting technology in earthwork engineering, in order to ensure the construction safety, it is necessary to establish a clear safety standard and take effective safety guarantee method. In the process of bench blasting, do not carry out other operations on other bench. The experimental results show that the length of packing has a direct impact on the quality of blasting to a certain extent. If its length is long, after the blasting work, all kinds of problems will occur in its orifice, and a lot of stones will appear around it. After the completion of blasting construction, the remaining blasting materials shall be sorted out in detail, and the materials shall be handed over to the special management personnel within the required time. In the earth rock engineering blasting, in the application of its blasting technology, in order to fully guarantee the safety of the project, it is very important to create the corresponding safety specifications, which requires the implementation of the safety guarantee law. It has great advantages to use GIS powerful spatial information processing ability to analyze the construction process of highway subgrade excavation engineering. The structure design of the system is shown in Figure 1.

![Figure 1. System structure design](image)

After the blasting project is finished, the remaining blasting materials should be effectively treated and transferred to the corresponding management department in time. The use of explosive mixing truck can not only reduce the labor cost, but also improve the charging speed, thereby reducing the construction cost of the whole earthwork project and improving the project benefit. In the process of blasting, if severe weather such as thunderstorm is encountered, the blasting should be stopped in time, and the construction team should be organized to evacuate to a safe area in time, and the construction work should be carried out after the weather conditions have improved significantly. Finally, the road should be blocked ten minutes before the start of blasting [13]. After confirming that there is nothing wrong with the blasting signal, the constructors can enter the safety shed, and detonate the signal after re-confirming the surrounding safety. In the process of construction, the complicated and difficult highway earthwork project is simplified to a certain extent through specific construction technology, which can effectively reduce the construction pressure, improve the construction level and improve the overall construction quality of the project.

3. Management measures for blasting construction of earthwork engineering

3.1. Improve the management mechanism

With the gradual complexity of highway engineering construction conditions and the gradual expansion of highway construction scale, every link of highway engineering from design to construction needs a
perfect construction technology as support. In the process of earthwork blasting construction, its risk is relatively high. In order to fully ensure the construction safety, it is very important to create a scientific and perfect management mechanism. Before construction, it is necessary to test the construction process and the feasibility of the corresponding scheme, then test the utilization rate of machinery to ensure the maximum use of machinery, and establish a safety awareness again, putting safety first in the whole construction process. As far as managers are concerned, they need to fully understand the contents and requirements of construction and engineering, and then create the corresponding management structure. As for the management organization, it not only needs to implement the corresponding safety management work, but also needs to train the management personnel with strong professionalism, so as to further improve their own literacy and professional technical ability, create an efficient management team, and further strengthen the rigor of work.

Management personnel should actively communicate with construction personnel, understand each blasting case and each risk factor in blasting engineering, and take effective measures to solve each risk factor. In earthwork construction, relevant construction personnel need to strengthen the management and analysis of details, and pay attention to subtle operations to reduce the risk of safety accidents. The data relationship model of subgrade construction project management based on task-resource is shown in Figure 2.

![Figure 2. Project management data relationship model based on task-resource](image)

Construction environment is a factor that affects the engineering quality, and it is also a factor that affects the quality of subgrade earthwork engineering. Therefore, before starting the construction of subgrade engineering, we should have a corresponding understanding of the subgrade construction environment. Under normal circumstances, before the commencement of blasting construction, various inspections should be carried out according to the relevant requirements and contents of the construction, and the specific conditions of the blasting construction site should be understood and mastered, mainly including environment, weather and geological conditions. Before the formal construction, it is necessary to make a comprehensive and detailed survey of the construction site, such as verifying the surrounding natural environment, climatic conditions and geological conditions, and determining the specific direction of the route [14]. The underground water level and geological conditions of subgrade should be investigated, and the special subgrade sections should be marked by reasonable methods. For earthwork blasting engineering, its risk is relatively high. Therefore, in the actual construction process, it is necessary to guarantee the professional ability of operators, and strictly regulate the personnel entering and leaving the blasting site, and prohibit the irrelevant personnel from entering and leaving at will.
3.2. **Strictly standardize the blasting process**

Earth and stone blasting construction is highly dangerous. In order to ensure safe construction, it is essential to establish a sound management mechanism. From the perspective of managers, they need to fully understand the project content and construction requirements, and establish a special management organization. The management organization must not only engage in various safety management tasks, but also train management personnel to improve their professional quality and technical capabilities, and then establish an efficient management team and strengthen the rigor of work. During the construction process, it will be affected by factors such as cutting corners and technical operations, which will affect the quality of blasting to a certain extent, thereby making the scope of blasting unable to fully meet relevant requirements, resulting in collapse, and serious damage to life and property. And personal safety poses a serious threat. To ensure the quality and safety of blasting construction, it is essential to develop a scientific blasting construction process. In earth and stone works, construction personnel must strengthen the management and summary of details, pay attention to every small operation, and avoid the occurrence of safety accidents. In the roadbed earth and stone works, the first step of construction is to conduct perfect measurement and survey on the construction site. After accurate measurement and survey, the construction site needs to be cleaned and excavated. During the construction process, the ground needs to be cleaned and cleaned carefully to ensure that the roadbed is clean enough and not careless.

In the construction of earth and stone works, in order to ensure construction safety and project quality, it is very important to implement the corresponding daily management work. Relevant management departments can analyze the problems and deficiencies in the project management in the form of regular meetings, and at the same time analyze and explore the solutions to the problems according to the causes of the problems. The relationship between changes in city status and influencing factors can be expressed as:

\[ Y = F(A, X) \]  

(1)

Among them, \( Y \) is the degree of change of the city state, \( X \) is the influencing factor, \( A \) is the degree of effect of the influencing factor, and \( F \) is the influencing function. Suppose there are \( n \) city states \( S \) to be evaluated, the corresponding city state change is \( y \), and there are \( m \) influencing factors \( X \). Among them, each influencing factor is \( x \), the urban planning factor is \( x_p \), the degree of influence of each influencing factor is \( a \), and the degree of influence of urban planning factors is \( a_p \), then the above formula can be expressed as:

\[ y = f(a_1, a_2, \ldots, a_p, \ldots, a_m, x_1, x_2, \ldots, x_p, \ldots, x_m) \]  

(2)

If the spatial dimension and the temporal dimension are considered, this relationship can be expressed as:

\[ Y_k' = F(A_k', X_k') \]  

(3)

Where \( k \) is the area ID and \( t \) is the time period. The city state \( s_k' \) of the area \( k \) at the beginning of the time period \( t \), and the state \( s_k'' \) at the end time, the city state of the area \( k \) at the time period \( t \) changes \( y_k' = s_k'' - s_k' \).

The risk index of earthwork blasting construction is very high, so in the actual construction process, we must ensure the professional ability of operators, strictly regulate the personnel entering and leaving the blasting site, and prohibit the entry of irrelevant personnel. Regular education and training of
technical personnel, blasting visual function personnel should not only master sufficient knowledge of blasting technology, but also master effective self-rescue measures and safety prevention measures to ensure that reasonable countermeasures can be taken in case of accidents. In the process of earthwork excavation of highway engineering subgrade, we should adopt the method of cement concrete filling to properly handle the unfavorable geological phenomena, so as to ensure that the highway subgrade has enough strength and stability [15]. There are many treatment methods applied in the specific construction process, which should be determined according to the specific construction environment. In the whole process of blasting construction, professional quality inspectors should closely audit and inspect the related operation, preparation and later stage of blasting construction to minimize safety risks. In carrying out quality inspection, if it is found that it cannot fully meet the relevant requirements, it should be reported in time and effective countermeasures should be taken to deal with it. In the whole process of earthwork construction, it is necessary to do a good job of daily management to ensure the engineering quality and construction safety. The management department can hold regular meetings, during which it points out various deficiencies in construction management, discusses solutions to various problems, clarifies potential safety hazards in blasting construction, and takes effective preventive measures against the causes of potential safety hazards.

4. Conclusions
In the construction of highway engineering, the quantities of subgrade earthwork construction account for a large proportion, and the effective control of subgrade earthwork construction determines the regulation and control of the overall construction of subgrade engineering. As the basic work of highway engineering, the quality of subgrade earthwork construction has a great influence on the overall quality of the project. In the actual engineering construction, we must do a good job of construction quality control, so as to lay the foundation for the overall engineering quality and ensure the normal operation of the project in the future. Whether the engineering quality control of blasting and filling of stone roadbed is ideal or not has an important influence on its function and service life. With the increasing scale and quantity of earthwork, its construction technology has also been greatly developed. In the process of construction, due to the interference of geology and rock hardness, it is necessary to apply blasting technology. In the actual situation, the construction should be carried out in strict accordance with the plan approved by the supervision engineer, and effective measures should be taken to ensure the safety of earthwork excavation, especially stone blasting, so as to meet the quality requirements of subgrade construction and lay a solid foundation for subsequent construction.

References
[1] Fan Liang. Construction technology of controlled blasting for roadbed stonework [J]. Jiangxi Building Materials, 2016, 183(06):224-224.
[2] Ge Ling. Discussion on construction technology of excavation of roadbed earth and stone [J]. Architectural Engineering Technology and Design, 2016, 000(005): 1020-1020+1128.
[3] Zhong Haidong. Blasting construction technology in the excavation of highway subgrade soil and stone[J]. Heilongjiang Transportation Science and Technology, 2020, 043(004): 61-62.
[4] He Song, Lin Daneng, Yu Zhi, et al. Deep hole combined with shallow hole bench millisecond blasting for excavation of roadbed [J]. Mining Technology, 2017, 017(001): 52-54.
[5] Peng Rui. The application of soil and stone construction technology in highway engineering [J]. Heilongjiang Transportation Science and Technology, 2018, 041(005): 52-53.
[6] Zhou Zilin. Earth and stone construction technology for reconstruction and expansion of roadbed [J]. Sichuan Building Materials, 2019, 45(03):94-95.
[7] Wu Zhonghua. Construction technology of soil-rock mixed roadbed in highway construction [J]. Urban Construction Theory Research (Electronic Edition), 2015, 000(023): 7070-7071.
[8] Xiao Lianyong. Design control strategy in the blasting construction of the soil and stone excavation of the Nanliang Expressway [J]. World of Transportation, 2018, 000(007): 46-47.
[9] He Wei. Construction technology of blasting in excavation of highway subgrade soil and stone[J].


World of Transportation, 2019, 512(26):89-90.

[10] Xiao Bing. Research on the construction technology of roadbed earthwork in highway engineering[J]. Smart City, 2018, 4(11):118-119.

[11] Chen Feng, Hu Fan. Application of carbon dioxide blasting technology in roadbed stone excavation[J]. Engineering Construction and Design, 2019, 408(10):110-112.

[12] Wang Xin. Discussion on construction technology of earth and stone works for filling roadbed [J]. Heilongjiang Transportation Science and Technology, 2019, 042(003):45-46.

[13] Huang Baoan. On the construction technology of earth and stone filling in highway subgrade engineering[J]. Green Building Materials, 2020, 159(05):127-128.

[14] Lan Shengbin. Blasting technology and methods for excavation of roadbed stone slopes[J]. West China Transportation Science & Technology, 2020, 151(02):48-49+87.

[15] Wu Jianghua, Chen Zilin, Bu Junrui, et al. Research on the Control of Harmful Effects of Subgrade Blasting in Urban Complex Environment[J]. Blasting, 2018, 150(04): 128-132.