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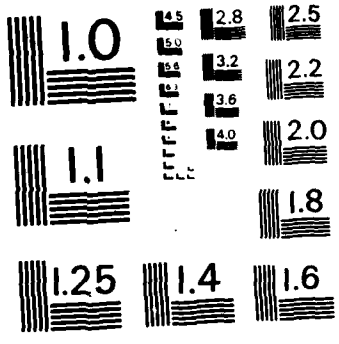

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# FOREIGN TECHNOLOGY DIVISION


INTRODUCTION TO SEVERAL METHODS OF FAST DIGGING

by

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# INTRODUCTION TO SEVERAL METHODS OF FAST DIGGING

Chen Huateng

In underground construction, the digging operation is the leading factor and a main work step in completing the entire project. The digging speed directly affects the project completion date. In order to speed up construction, the skillful handling of the digging operation is the most important. Then, how can we speed up the digging?

1. A closely coordinated operation organization is necessary. As underground construction works below the ground with a narrow operation surface, it is unable to simultaneously use more labor. To ensure rapid completion of construction, generally the operation should proceed day and night. According to different conditions of the construction situation, operation resources, machinery equipment, contents of construction accomplishment and technical operation level, generally shifts of the operation cycle used are 3-8 [hour] system, 4-6 [hour] system and 4-8 [hour] system. Usually, there are two ways of organizing the continuous digging operation: first is the parallel operation method of the main work steps. In this method, the major portion of the work (drilling and rubble removal) proceeds simultaneously. Thus, the time of the operation cycle is reduced and the digging speed is increased. This method is significantly superior for those with undesirable conditions of machinery equipment, while consuming longer time on primary work steps. The second method is cyclic continuous operation at multiple points for all work steps. In this method, the work steps of the digging operation

simultaneously proceed at various operation surfaces. Thus, for each operation, various work steps proceed cyclically. However, at all operation surfaces, there is parallel operation, frequently used in tunnels with multiple operation surfaces. This method can raise the use efficiency of machinery in a closely knit operation. The operators can be more professional and their technical level can be easily enhanced in speeding up the operation. Only with a strict and rational operation organization, can all workers produce their utmost effort and machines their optimal capacity in ensuring high speed in the digging operation.

2. There should be a scientific construction method. The selection of a rational construction method with scientific ways of operation is an important means to ensure fast digging. Most underground construction is small cross-section digging. When the digging area is smaller than 10 square meters, generally the construction method of one-time circumference completion of the entire cross section is used. For tunnels greater than 10 square meters in cross section, a pilot tunnel can be dug first and then enlarged. However, whatever the construction method, conventional cyclic operation should be conducted with the following measures:

a. Prepare scientific cyclic operation graphs and charts. According to the construction machinery equipment, operation organization and technical level, work cyclic graphs and charts are made to proceed as per instructions from graphs and charts; a prescribed work step should be completed within the prescribed time. According to the size of the construction cross section, boring efficiency, performance of rubble removing vehicles, and number of workers, every cyclic progress step is rationally prescribed. Generally, it is better to complete one or two digging cycles in a work shift. Thus, it is easy to calculate the progress, evaulation-comparison, repair-maintenance of machinery, and material consumption. It is forbidden to proceed without a definite schedule, such as detonation at random times.

b. Study rational shapes for the boring slot and select the optimal detonation plan. The desirable boring of detonation slots is the major factor in whether the whole cross-section detonation can attain the expected result. The quality of the detonation plan is the key affecting the construction progress. This is a technical problem. Generally several approaches to slot boring shapes

should be contemplated. Several plans of detonation should be pondered, and the appropriate plan be picked following discussion. Usually for deep hole detonation, straight line digging of slots should be used. During shallow hole detonation, wedge-shaped or cone-shaped slot boring should be used.

c. Operation with multiple compressed air drills for boring is used. For shortening the time of the boring operation and speeding up the digging, rational construction organization should be realized for operation using definite workers, definite machines, definite times, definite positions, definite quality and definite quantity to use the maximum number of compressed air drills in the limited cross-sectional space. According to the size of the cross section, rock hardness, types of drills, air pressure supply capacity, as well as different operation methods, modes and technical levels, for a single opening operation, when the coefficient of rock hardness f is less than 6, one drill is deployed for 2.5 to 3 square meters. For f greater than 10, each drill is deployed for 1.0 to 1.5 square meters. If a parallel continuous operation method (of boring and loading of rubble) is used, since rubble is piled on the working face in a relatively difficult operation, generally each drill can be deployed for 0.7 to 1.0 meter of the tunnel width.

d. One-time detonation of the entire cross section is practiced. By using this detonation method, the times of detonation and operation duration can be reduced in conducting the conventional cyclic operation.

e. The method of rubble-casting detonation is used. To ensure parallel operation of rubble loading and boring following detonation, the rubble-casting operation can be used. At present, there are the following ways of realizing the rubble-casting operation:

i. All boreholes or two groups of boreholes are deepened by 200 to 300 millimeters (or the number of boreholes is increased) and filled with more dynamite. Generally, 1.5 to 2.5 more dynamite-powder rolls are used for each borehole.

ii. A pit is dug at each of two corners at the tunnel floor; the dimensions of the pit are 100 to 150 mm deep, 80 to 120 mm wide, and 200 mm long. Then bundles of powder packs are buried in the pits; the weight of the powder pack is 0.5 to 1.5 kilograms.

iii. A comprehensive (using the two aforementioned methods) mixed rubble-casting method is used.

In comparing results of t he three rubble casting methods, in the first method the highest point of the rubble pile can be lowered and the piling position moved rearward to a distance of 1 to 1.5 meters from the operation surface. The second method is primarily to concentrate the rubble (following detonation) at the middle portion of the tunnel, thus facilitating loading of rubble. In the third method, rubble can be cast from the operation surface to be concentrated at the middle portion of the tunnel, thus achieving better results.

f. The method of strengthening ventilation and security is used. In order to shorten the smoke exhaust time following detonation, reducing the amount of dust due to loading and transporting rubble, speeding up the rate of rubble removal, and ensuring the health of operating workers, ventilation should be intensified and security enhanced.

g. The method is used for fast loading of rubble and fast dispatching of vehicles to remove rubble. After multiple drills are used for operation and the boring time is shortened, the loading and transporting speeds of rubble should be correspondingly raised. Hence, close coordination is required to rapidly load rubble and to rapidly dispatch vehicles for removing rubble. For loading of rubble, the operation may require wheel loaders, small and large slag dump trucks, battery-operated vehicles and/or others.

h. The work-category post-responsibility system should be strictly carried out. In order to realize rapid construction according to instructions of the conventional cyclic work graphs and charts, it is required that each operation personnel understands his post, job and responsibility to accomplish

the prescribed work on time. It is required to have clarified post, machine, tools, task and construction quality.

3. Advanced digging machines and tools should be used, since the advanced equipment can guarantee rapid digging; the organizing of mechanized digging teams is the effective means of fast digging. Some conditions are required in organizing a mechanized digging team on the available construction machinery equipment. At present, in the various work steps of digging construction, usually filling of dynamite powder and detonation, security and temporary support are done manually while machinery operation is done in other work steps. Thus, desirable objective conditions are present for fast digging with material availability. The exploitation of potentials of generators, ventilators, air compressors, rubble dozer shovels and transport vehicles can effectively speed up the digging and raise work efficiency. In addition, the number of in-tunnel workers can be reduced and their labor intensity lessened. At the same time, construction quality can be ensured in achieving the goal with faster, more, better and relatively economized results.

4. Professional construction teams should be present. In order to achieve fast digging, a professional digging construction team should be established. The team should have appropriate technique and skill to conduct the highly technical operation, and have faster digging speed, better construction quality, and lower cost. Thus, appropriate construction command units and technical training are easily realized.