Estimate of the Number of Highway Tunnel Works in Mountainous Area during the Feasibility Study Stage

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Abstract: Reasonable estimation of tunnel engineering quantity in the feasibility study stage of highway construction project is one of the bases for compiling investment estimation. Combined with many years of practical work, this paper introduces the content and compilation method of tunnel engineering quantity in the engineering feasibility study stage of Expressway in mountainous and hilly areas.

Keywords: Tunnel engineering; tunnel body; tunnel portal; surrounding rock category; electromechanical facilities

1. Introduction

The feasibility study of highway construction project is a comprehensive study and demonstration of the necessity, technical feasibility, economic rationality and implementation possibility of project construction. It is the main basis for construction project decision-making, and investment estimation is an important part of the project feasibility study report. It is one of the bases for the demonstration of technical feasibility, economic rationality and implementation possibility, and an important basis for construction project decision-making. Reasonable determination and control of project investment in the feasibility study stage is an important work of construction project feasibility study [1,2].

The preparation of investment estimation is based on the design documents of the project, comprehensively understand the construction conditions of the project location, master various basic data, and correctly quote indicators, charging standards, labor unit price, material and equipment prices, The work shall be carried out in accordance with the preparation methods for investment estimation of highway capital construction projects and highway engineering estimation indicators implemented at the present stage, as well as the provisions in line with the current relevant national and industrial standards [3,4].

The reasonable estimation of engineering quantity in the feasibility study stage of highway construction project is the key work of feasibility study and an important basic data for the preparation of investment estimation. The engineering quantity of feasibility study of highway construction project includes: estimation of temporary works, subgrade works, pavement works, bridge and culvert works, tunnel works, intersection works, facilities along the line, greening and environmental protection works, other works, land scale and demolition [5].

The proportion of tunnel engineering in mountain expressway is increasing, and the investment of tunnel accounts for a large proportion of the construction and installation cost of the project at the present stage. As follows, the tunnel engineering in the feasibility study stage of mountain expressway construction project.

Reasonable estimation of tunnel engineering quantity is one of the key works to determine and control engineering investment estimation [6].

The estimation of tunnel engineering quantity in the feasibility study stage of highway construction project is reflected through the preparation of tunnel engineering quantity estimation table. According to the relevant provisions of highway engineering implemented at the present stage, it is advocated to promote the standardization of engineering quantity estimation table in the feasibility study stage of highway construction project, which is beneficial to improve the preparation efficiency of cost documents. The standardization and standardization of cost document preparation is conducive to the whole process control of cost documents.

In the feasibility study stage of highway construction project, the standardization of the bill of quantities of highway tunnel projects in mountainous areas needs to be systematically studied in combination with the project characteristics, the rules for the preparation of project cost, the requirements of highway engineering estimation index, the number of similar projects of built projects, etc. Combined with many years of work experience, this paper studies the standardized compilation of tunnel quantity table of Mountainous Expressway Engineering in the feasibility study stage of highway construction project from the following aspects.

2. Contents of Tunnel Engineering in Highway Engineering Estimation Index

The preparation of tunnel quantity table in the feasibility study stage of highway construction project is mainly based on the contents and measurement rules contained in the tunnel process of highway engineering estimation index. First, you need to be familiar with the

tunnel engineering contents and measurement rules of highway engineering estimation index.

Estimation index of highway engineering tunnel engineering is a comprehensive index prepared on the basis of budget and budgetary estimate. The index includes tunnel body, open tunnel, tunnel portal, inclined shaft, shaft, pipe shed and other items.

According to the estimation index of highway engineering, tunnel engineering refers to the engineering in the tunnel, that is, the engineering between the end wall and the wall at the entrance and exit of the tunnel. The works outside the portal wall shall be calculated separately according to relevant indexes.

The indexes of tunnel body, open cut tunnel and portal in highway engineering estimation indexes are applied according to the layout form of tunnel. The indexes are divided by expressway, class I Highway (two lane, three lane and four lane) and different tunnel lengths, double arch (two lane and three lane) and small clear distance (two lane). Index pricing of class II and below highways.

2.1. Layout of Tunnel

The tunnel body, open cut tunnel and portal in the estimation index are applied according to the layout form of the tunnel. Therefore, the layout type of the tunnel should also be counted separately in the tunnel estimation table.

The indexes of tunnel body, open cut tunnel and portal in highway engineering estimation indexes are applied according to the layout form of tunnel. The indexes are divided by expressway, class I Highway (two lane, three lane and four lane) and different tunnel lengths, double arch (two lane and three lane) and small clear distance (two lane). Index pricing of class II and below highways.

Separate or multi arch tunnels shall be set. The tunnels of Expressway and class I highway shall be designed as independent double tunnels with up and down separation. The minimum clear distance of separated independent double tunnels shall be determined according to the principle that the structural batch of the two tunnels does not produce harmful factors, combined with the plane alignment of the tunnel, geological conditions of surrounding rock, section form and size, construction scheme and other factors. Generally, it can be taken in a standardized way. For a separated double tunnel, the minimum clear distance between the two tunnels can be determined according to the representative level of its surrounding rock.

When the clear distance of the tunnel in special sections such as bridge tunnel connection, tunnel connection and topographic conditions can’t meet the requirements of the specification, the form of small clear distance or multi arch tunnel can be adopted, but sufficient technical demonstration and comparative research shall be made, and reliable technical guarantee measures shall be formulated to ensure the project quality.

In terms of estimated cost, the unit price of multiple arch in the same tunnel is about 38% higher than that of separated arch. The unit price of small clear distance is about 32% higher than that of separated type.

2.2. Tunnel Portal

The portal index unit is the portal at each end. The quantities of a tunnel for Expressway and class I highway are calculated according to the portal at both ends. The quantities of a tunnel for class II and below highways are calculated according to the portal at one end. One end portal contains two openings.

The portal works in the estimation index of highway engineering include all procedures to complete the portal works, such as portal pouring, masonry of tunnel top drainage ditch, pouring of cable trough of portal drainage ditch, installation of portal nameplate, portal excavation and protection.

The estimated quantity of engineering feasibility study of Dongmen highway construction project, regardless of the type of Dongmen (end strength type, bamboo cutting type, etc.). Only divided lanes (two lanes - double arch and separated. Three lane - split. Four lane - split.)

The portal index unit is the portal at each end. The quantities of a tunnel for Expressway and class I highway are calculated according to the portal at both ends. The quantities of one tunnel of class II and below highway tunnels are calculated according to the portal at one end.

3. Tunnel Body

3.1. Index and Engineering Content of Tunnel Body

The tunnel index has included all works of tunnel excavation, steel support, shotcrete anchor support, waterproof and drainage, lining, decoration, pavement concrete leveling layer and so on.

The tunnel body index includes the tunnel pavement leveling layer, but does not include the tunnel pavement. The quantity of tunnel pavement needs to be calculated separately and priced according to the estimation index and relevant norms of budget.

3.2. Hole Body Area

The quantities of tunnel body are calculated based on the sum of the area of tunnel main tunnel, pedestrian cross tunnel, vehicle cross tunnel and emergency parking zone. The main tunnel area is the tunnel length multiplied by the tunnel width. The tunnel length does not include the length of open cut tunnel and portal. The tunnel width refers to the width of carriageway plus lateral width plus the width of sidewalk or access road.

The quantities of separated and small clear distance tunnels are calculated according to the length of single tunnel body, and the quantities of multi arch tunnels are calculated according to the length of double tunnel body.

The tunnel width in the tunnel estimation table is calculated according to the width of the tunnel construction gauge.

The area in the index is only provided for the preparation and estimation, and many work contents are integrated in the index. It is not equal to the actual tunnel section area. When calculating the quantity of excavated earthwork, the area of the index cannot be used.

3.3. Emergency Parking Zone

Long and extra long tunnels with one-way traffic shall be arranged on the right side of the traffic direction. Two way road tunnels and emergency parking zones shall be staggered. The width of the emergency parking zone, including the right side width, is 3.5m, the length is 40m, and the effective length in the middle shall not be less than 30m. The setting spacing shall not be greater than 750m.

When calculating the area, the overlapping part of the main hole and the emergency parking belt shall be deducted, and the area of the gradually changing part of the triangle shall be deducted.

For tunnels without inspection and repair roads and crosswalks, emergency parking zones may not be set, but almond refuge holes shall be staggered at an interval of 500m.

In the estimated quantity table of engineering feasibility study of highway construction project, no emergency parking zone is set in the and short tunnels. The spacing of emergency parking zones for long tunnels ($3000m \geq L > 1000m$) and extra long tunnels ($L > 3000m$) shall be set at about 500m.

3.4. Transverse Passage

For up and down separated independent tunnels, transverse channels shall be set between double tunnel highway tunnels. The transverse channels are generally divided into pedestrian channels and vehicle channels.

The setting spacing of pedestrian cross passage can be 250m, not more than 500m.

The crosswalk shall be set at an interval of about 500m, and the crosswalk shall be staggered with the crosswalk.

The length of transverse passage calculated in the feasibility study stage of highway construction project can be calculated as 50m, the width of pedestrian crossing tunnel is calculated as 2.0m, and the width of vehicle crossing tunnel is calculated as 4.5m.

3.5. Open Cut Tunnel

Open cut tunnel refers to a tunnel built by open cut method. It is often used in sections with poor geology or tunnels with shallow buried depth. The structural type of open cut tunnel is determined according to the terrain, geology and backfill conditions. In the feasibility study of highway construction project, the setting principle of "entering the tunnel early and leaving the tunnel late" is considered, and a section of open tunnel is set at both ends of the inlet and outlet to increase settlement joints. Try to reduce the height of the front slope of the portal excavation and restore the original topographic landscape.

In the index of open cut tunnel, all works of open cut tunnel excavation, tunnel body pouring, inverted arch backfilling, waterproof and drainage, tunnel body decoration and spraying, pavement concrete leveling layer and so on have been integrated.

The estimated number of open cut tunnels in the feasibility study stage of highway construction project can be considered to set 10m long (single tunnel) at both ends. The work quantity is calculated by multiplying the length of open cut tunnel by the width of tunnel.

4. Pipe Shed and Electromechanical Equipment

4.1. Pipe Shed

The pipe shed is used when the geological conditions of the entrance and exit are very poor (such as sandy soil, seriously broken rock, loess, etc.). The general length is about 20-30m. The pipe shed is a steel pipe with a wall thickness of 3.5mm and a diameter of 108mm. Of course, when the geological conditions in the tunnel are very poor, the pipe shed in the tunnel can also be used (for example, when the length along the tunnel axis is large and the volume is large due to roof fall in the tunnel).

The estimated index pipe shed has integrated the engineering contents such as sleeve arch concrete, steel arch frame, sleeve arch hole nozzle, pipe shed and grouting, steel pipe filling mortar and reinforcement.

The quantities of pipe shed shall be calculated according to the design length of single row pipe shed. In the feasibility study stage of highway construction project, it can be calculated according to 30m of single tunnel. The project content of grouting has been integrated in the pipe shed index, and the grouting quantity does not need to be calculated separately.

4.2. Tunnel Engineering Electromechanical Facilities

In the feasibility study stage of the highway construction project, the electromechanical facilities of the tunnel project include the monitoring system, ventilation system, fire control system, power supply and distribution and lighting, reservation and embedding and other projects of the tunnel. The investment estimation of the feasibility study of the highway construction project is calculated according to the expenses of electromechanical installation engineering and electromechanical facilities.

The engineering contents of electromechanical facilities in the estimation index include all works such as tunnel monitoring system, fire protection system, power supply and distribution and lighting, reservation and embedding, etc.

The estimated quantity of electromechanical facilities installation works of the estimated index is calculated and listed according to the tunnel length (the project content of the index is prepared according to the double tunnel of the tunnel). The cost of computer electric facilities is calculated for the whole tunnel length in the feasibility study stage of highway construction project.

Ventilation system: tunnel ventilation is mainly divided into natural ventilation and mechanical ventilation. Natural ventilation can be adopted for tunnels with a length of less than 800m, full longitudinal jet ventilation can be considered for tunnels with a length of 800m-6000m in combination with the traffic volume, and sectional ventilation scheme can be considered for tunnels with a length of more than 6000m, which shall be determined according to the ventilation calculation results. The ventilation scheme of extra long tunnel shall be

comprehensively considered with the tunnel rescue scheme.

Power supply and lighting system: power supply and lighting facilities are only considered for tunnels over 100m.

5. Conclusions

The number of pavements in the project feasibility study stage mainly adopts the empirical estimation method at this stage, which is applied to the highway construction project feasibility study of most expressways and other grade highways in mountainous and hilly areas of Yunnan Province, such as e Shi Hong expressway, Kun Chu expressway, Yu Chu Expressway and so on. With the improvement of scientific and technological means, the promotion of application programs, the improvement and improvement of the accuracy of basic data collection, and the continuous improvement of the estimation method of the number of tunnel works in the feasibility study stage of highway construction projects, it can greatly improve the efficiency and quality of the preparation of the feasibility study of highway construction projects.

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