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Talking about Shirenzigou of Urumqi Highway Beltway, Tunnel Construction Plan under Conditions of V-class Surrounding Rock

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Abstract: Urumqi ring Expressway (East) second Contracting section tunnel located in Shuimogou district, Urumqi city Lucaogou town Shirenzi village, is the section of control engineering. Design for separate tunnels, around 35 m line spacing, which 393m the left line (ZK30+480~ZK30+873), and 447m the right line (K30+425~K30+872). Maximum depth of the tunnel 60M.

Keywords: NATM; Drilling-Blasting method; CD method; The double-side-drift; Method; Monitor; Excavation; Benching tunneling method

1. Introduction

1.1. Introduction to Engineering

Urumqi ring Expressway (East) second Contracting section tunnel located in Shuimogou district, Urumqi city Lucaogou town Shirenzi village, is the section of control engineering. Design for separate tunnels, around 35 m line spacing, which 393m the left line (ZK30+480~ZK30+873), and 447m the right line (K30+425~K30+872). Maximum depth of the tunnel 60M. The stone son of segment length of tunnel surrounding rock is shown as Table 1.

Table 1. Stone son of segment length of tunnel surrounding rock

Shihezi tunnel	Open cut tunnel (m)	Shallow v (m)	V deep (m)	Length overall (m)
Left line	32	171	19 0	393
Right line	31	181	235	447

Technical standards: double six-lane highways
Tunnel cross-section: 5.0m
Net width of tunnel: 0.75+0.5+3 × 3.75+1+1=14.5m

1.2. Natural Conditions

(1) Topography and geomorphology
Tunnel section of steep terrain, which imports slope 58 Degrees, The exit side is a steep slope and the slope is 68 °, Landform unit for low mountains and hills. The tunnel entrance is a steep terrain, a large boulder distribution on slope, mainly slope flow catchment area not focused; at the exit of the tunnel, there is wide 50~60M, length 250~300m of the flood ditch .Boulder and Pebble are visible in ditch and bottom. There is a Catchment area formed by the two small ridges on the south of the roof of the tunnel, and forming a small gully at the bottom, wide as 1.0M. Cutting depth is 0.3~0.5M, and there are vegetation growth and natural grasslands around the tunnel
(2) Geological conditions
It is not found that Regional large fault and Bad geological phenomenon in the tunnel site area, such as landslides, mud-rock flows. Integral stability of the site of Tunnel import and export and whole body is good. But due to many boulders and pebbles are distributed the bottom of the valley, which is located in the hole location of the tunnel, during the spring thaw period, loose accumulation body forming short-term debris flows under the action of torrent and sheet flow.
Crossing the surface of the tunnel site is pebbly low liquid limit powder soil layer thickness 1-2m , Soil quality is uneven; Lossiah salty soil layers thick 3-5M, homogeneous soil, and the pebble layer is 7-10m.Wall rock is Triassic Xiaoquangou area strong weathered mudstone and strong - weathered conglomerate.
Urumqi is located in the middle section of the Northern Tangshan seismic zone, different tectonic unit's convergence zone. Cenozoic strata fold, and crack is more developed, the earthquakes is frequent. The site seismic fortification intensity Ⅷ of the area, peak acceleration of ground motion for 0.15-0.20G, design Basic acceleration values for 0.20G, characteristic period 0.4S.
(3) Hydrological data
There is no surface water flow in the tunnel area, occasionally, there is atmospheric precipitation, and spring snow melt water, groundwater level is low. Surface water

and groundwater in Tunnel section are rudimentary, underground water had little effect on tunnel, but the surface water formed by spring snow may have an impact on the whole section of the tunnel.

(4) Meteorological conditions

Urumqi city belongs to the temperate continental climate, its characteristics is the dramatic changes in the summer and winter, dry and little rain, light rich, evaporation, and cold winters is very long, hot and not stuffy in summer, windy spring, cooling quickly in the autumn. Annual average temperature is about 6. 4 c, and July is the hottest month of the year, its average temperature of 24.5 degrees Celsius. The coldest January of average temperature of-14.9 c .Extreme maximum temperature is 42.1 degrees Celsius, and the extreme lowest temperature is -41.5 degrees centigrade.

Urumqi precipitation is less, the mean annual precipitation is 236mm, and the annual maximum precipitation is 401mm, minimum of precipitation is 131mm. Maximum depth of snow cover is 48cm, minimal is 11cm, average is about 27.5cm. It is snowfall period during mid-October to mid-April, and the average annual snow period is about 185 days.

Dominant wind direction in spring is a Southeast wind in Urumqi, and the highest frequency is 14.3%, the maximum wind speed is 28m/s, for the North and Northwest wind in the winter, its frequencies up to 8.75~9.5%, the maximum wind speed is 20m/s.

2. Construction Methods

According to the principle of the NATM to construct and using non rail transport modes. The main machines were equipped with the mechanical construction technology requirements of the large and long tunnel to organize excavation (drilling, blasting, loading), the anchor (mixing, transporting, anchor), lining (mixing, transport and perfusion, vibrating) production line and so on. Achieving the main process of mechanical operation, optimization of machinery, and striving for a tractor serving several purposes, giving full play the mechanical efficiency

Drilling and blasting method of excavation, using improvised trolleys and artificial air gun drilling. Early support nursing follow excavation surface timely construct to reduce exposed time of wall rock and inhibit wall rock deformation. Spray concrete used wet spray technology. Inverted arch, and bedding should be promptly carried out and construction before the two lining to prevent basement weakening. The Secondary lining masonry concrete used automatically measurement mixing station production, concrete transport car transport, the pump into the mold, integral steel formwork jumbo arch wall a times die built forming.

Strengthening geological advanced prediction and monitoring survey, and guiding construction in informationization mode.

3. General Construction Plan of V-Level Wall Rock

3.1. Construction Surveying

Firstly, the roadbed and bridges engineering which close to the tunnel entrance carry out measuring run-through to ensure the tunnel construction lines are correct. Outside control survey each hole set three fixed coordinates of control points, two elevation control points. Ensure the accuracy of the measurement is in accordance with the provisions of the measurement standard in laying off process. Tunnel central line measurement using precision traverse survey. Timely adjusting control network flat and midline inside the tunnel, continuing laying the baseline traverse. Tunnel height measurement using IV leveling. Passed by the elevation control point transfer outside the tunnel, inside every 100m establishing an elevation control point. The control point of the baseline is used as elevation control point to make round trips observation for observing tolerance and accuracy up to the required level of accuracy.

3.2. Excavation

Shirenzigou tunnel using the construction plan of unidirectional driving from the outlet end , excavation using simple drilling drilling rig, shallow hole loosening blasting, manual hand held pneumatic pick combining trimming. In the excavation process to strictly control the cyclic footage, and constantly revised blasting parameters to over break control. And using non-electric millisecond detonator. Mucking with side-dump loaders mounted ballast, and tipper transport.

According to the specification and design requirements, v level rock mass of shallow buried section used double side wall heading method construction. In order to facilitate the steps mucking, steps length control in 5~10m. Excavation on the steps of each cycle footage shall not is greater than 3 common arch spacing (1.5m), and side wall excavation each cycle shall not is greater than 4 common arch spacing (2m), the distance Between inverted arch of V level surrounding rock of shallow buried section and the heading working face is controlled in 80m, and the distance of the secondary lining control to the upper heading working face is controlled in 90m. Within tunnel being considered on a loop every day, daily advance 1.5m and consolidated monthly into the whole 45m.

Construction technology of V-grade wall rock of deep buried section use CD method and construction steps length is 3～5m. Excavation on the steps of each tapping cycle footage must not be greater than 3 common arch spacing(2.1m),and side wall excavation each cycle shall not is greater than 3 common arch spacing (2.1m).Tunnel boring daily footage 2.1m, consolidated monthly into the hole 63m.The distance Between in-

verted arch of V level surrounding rock of deep buried section and the heading working face is control in 60m,and the distance of the secondary lining control to the upper heading working face is controlled in 70m.

3.3. Surrounding Rock Support Measures

V level wall rock in shallow, fracture tunnel zone use ϕ 108 pipe-shed, ϕ 50 advanced small pipe and some auxiliary supporting measures' level surrounding rock of deep-buried section use ϕ 50 advanced small pipe as advanced support. System bolts are ϕ 25 hollow grouting anchor. Combined supporting with steel frame and steel mesh were produced by outside reinforcement plants, and installed inside the tunnel. Sprayed concrete use GSP-D wet spray processes.

3.4. Ventilation and Dust Prevention

The ventilation and dust control in this tunnel adopts ventilation management program of giving priority to ventilation and dust, net poison, and optimizing ventilation way of pipeline, paying close attention to the mechanical purification, reducing sources of pollution. implementing water scene dust, strengthening comprehensive management', and ventilation used ventilation of sent wind type .On the left and the right tunnel exit are respectively provided a FP-110KW Jet wind machine for wind, and wind tube use ϕ 150cm hoses which are hanged on the tunnel lining on the right wall by wire rope.

3.5. Monitoring Measurement

In strict accordance with the design and specification requirements, the introduction of professional monitoring unit, strengthen the advance geological prediction and monitoring of surrounding rock, to the informationization construction means to guide the construction.

3.6. Secondary Lining

The secondary lining uses 9.0m template for overall construction of lining trolley and 6m3 concrete truck transporting concrete, concrete use concrete pump into the mold. Invert arch and bedding advanced arch lining the wall construction.

3.7. Tunnel Waterproof and Drainage

Strictly checking structural waterproof and drainage, and strengthening water management of the construction, ensuring timely unobstructed drainage to prevent water soaking to soften the arch (wall) feet.

3.8. Spoil

Amount of slag is approximately 151000m3 of the Shirenzigou tunnel, but only a little of tunnel spoil can be used as lining material or surface material and tunnel spoil for roadbed in the original design. However, the entrance of the tunnel does not have whole conditions, water supply, electricity, and construction of sidewalks so that it is difficult to reach the construction site and it can only reach from the outlet hole. Due to the export-side connect Shirenzigou Bridge and could not use spoil, abandoned dreg site should be introduced. Abandoned dreg site set on the left of the tunnel exit mountain recesses, and it should be built the retaining wall before site.

4. Construction Control Points

4.1. Excavation

(1) Layout blast hole and explosive charge should be strictly in accordance with the drilling and blasting design.

Cut slot eye: the spacing error of rabbet and bottom is not more than 5cm. Auxiliary slot eye: the row spacing error and the line spacing error are not greater than 5cm; around slot eye: the spacing errors of a long tunnel design section profile line of is not greater than 5cm; fundus is not beyond excavation section profile line 10cm, and the maximum is not over 15cm.The deeper error should not be is greater than 100mm。

The angle of the peripheral slot eye control in 2~3° , and the outside tilt rate of blast hole of the post-mounted rock drill should not be more than 50mm/m.

When the convex and concave of the excavation is very large, adjusting blast hole depth and adjust the dynamite dosage accordingly according to the actual condition. Striving for all the eye of trough back in the same vertical plane in addition to cut slot eye.

All boreholes are jammed in soil, and length is not less than 20cm.

(2) Super owe dig control

Improving personnel 'quality awareness', strengthening management and responsibility to the people, implementation of reward and punishment system. Each class constructs before checking condition of drill and if finding fault, it should be timely treatment. Optimizing blasting parameters according to the conditions of surrounding rock and blasting design shall not be applied mechanically.

4.2. Slag-out and Transport

Transport vehicles is strictly forbidden to people, materials mixed and mucking slag are not allowed to be higher than the carriage. Between loaded ballast and ballast-carrying vehicle will not permit people to stay. To ensure ballast-carrying vehicles are in place and good safety in and out, assigning personnel to command. Tunnel entrance, level crossings and the narrow construction sites, set the "swift" flag. Overtaking is prohibited in the tunnel. Synthetic vehicle should keep 20 -meter distance, and when inside visibility is poor, increasing the vehicles

distance. Before starting the vehicle must be horns .Vehicles shall not take fault operation.

4.3. Initial Support

(1) steel arch
Arches in the machining field, are processed into semi-finished products, and prestressing assembled outside the tunnel. Technical personnel of the project department inspected and numbered before they are transported to inside to be used.
Arch use welding Groove when welding, when the two beams docking, repairing welding on both sides at webs '10mmx100mmx100mm' of steel reinforcement.
(2) Sprayed concrete
Using exposed anchor end as label, when netting and erected steel reinforcement area, the thickness of protective layer should take into account. Uneven concrete surface should be timely fill spray unit smooth so far.

4.4. Auxiliary Construction

Aid for the construction of advanced small pipe construction, angle control of a small catheter .Formerly an arch abdominal perforation with steel (As shown in Figure 1 perforation position), making a simple guiding hole to control the angle of the small catheter .

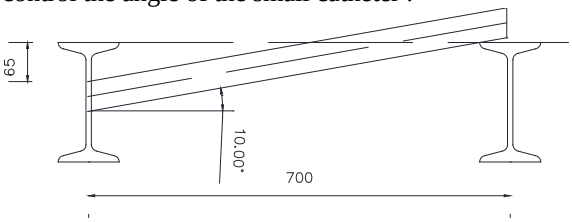

Figure 1. Advance catheter control

Lap length of catheters are 1.63m (That is, every 4 arch truss, making a set of advanced small pipe), and the ring spacing of small pipes is 40cm. Pipes layout as shown in Figure 2.

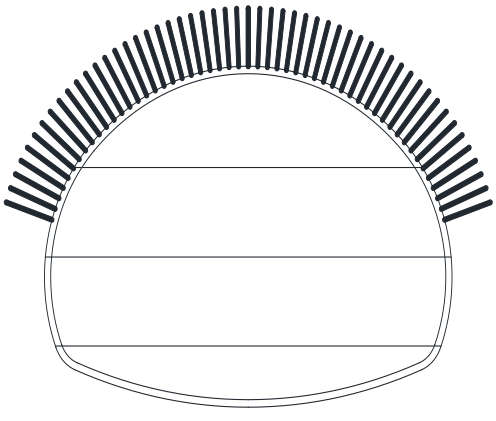

Figure 2. Ahead of tube layout

4.5. Invert

Every time excavation length of tunnel inverted arch is 2~3m, and it should timely construct early support to the inverted arch after the excavation is completed, making early support loop. The secondary lining and fill of inverted arch is separately constructed, and construction of inverted arch is control in 4~6m at a time, keep traffic through the steel trestle inside the tunnel. When binding Inverted arch steel, control bar spacing and pitch by using clamp. Setting aside the position of the center ditch and covering plate (2cm) when the construction

4.6. Lining Construction

Steel of lining, fastening by positioning frame, set aside sufficient lap length, weld requires full, joint welding slag requires cleaning up. The horizontal binding distance of the steel rings along, the row spacing and layer spacing steel shall meet the design requirements. The muddy, rusted steel is strictly prohibited to use, and lashing something stable. The steel of Cavities, reserve rose, galvanized steel pipe shall not be arbitrarily cut, and bending avoidance should be taken. In strictly accordance with the protective requirements lashing blocks (3 /㎡), steel mode is strictly prohibited.
To guarantee the quality of lining, the pouring of the concrete formwork use the whole section template pallet, its thickness is not more than 12mm. For subsidiary tunnel lining using stereotypes to make templates, structure is reliable, template surface is smooth, tight joints, no leakage. Panels of trolley and support systems should regularly repair and reinforcement by contacting the manufacturer, templates juncture, windows to focus on polishing , to ensure inner lining concrete quality and external quality, and beauty. When end template using wood pattern, block templates must be used, missing teeth hanging corners of the template must not be used in the construction. Identifier according to the left and right side number in construction, all gaps must be with geotextile windowsill. For large cross-section lining, assigning personal regularly checks the fixed plates which have or do not have virtual welding and sealing off. Must using special concrete release agent which has proved to have good results to ensure the surface quality of concrete structures.
Concrete pouring of the tunnel secondary lining to take over, layered, horizontal, symmetric perfusion, layer thickness are not greater than 50cm .Intermittent time shall not exceed the initial setting time of concrete. Assigning someone to monitor end of the template when casting process, finding run slurry leakage and burst-mode processing in a timely manner and ensure the infusion continues. In addition, speed of the casting is not fast, and taking low slump of concrete of sidewall, and high slump of inverted arches to increase their liquidity. Concrete is strictly prohibited to add water at the field, the operator must be standing next to the whole process.

Giving priority to with plug-in vibrator,and supplementing by using artificial wooden hammer mode knocking and vibration outside and small shovel inserted edge method, to ensure vibration compacting. Vibrators shall not touch the waterproofing layers, reinforcement and formwork. Meeting the design requirements before stripping, and maintain timely after stripping. Curing time of waterproof concrete of secondary lining is not less than 14d (using curing liquid).

5. Summary

This tunnel set up temporary facilities strictly according to the layout of the tunnel of determining. Layout of various materials and equipment is reasonable, and convenient for construction machinery in and out of. Do not leak and the drainage are unblocked, sight and ventilation is good and have heat thermal measures. Generators, air compressors, mixers and other equipment place reasonable, clean, safe, reliable, and easy to operate, and have reliable safety the card of operation and personnel in charge. Maintaining roads which path to the tunnel construction site keep in good condition, smooth do rain or shine. Roads in the tunnel are smooth, clean, having good drainages, and someone regular maintenance. Establishing system of listing on the site, and setting brand of engineering, the arrangement plan of construction site, safety signs, construction signs and banners, etc., in a prominent site of tunnel. The three tube two line of the tunnel is safe, reliable, rational layout, straight-lined, water-tight, no leakage, no air leakage, electricity safety, and always maintain good ventilation and lighting conditions. Spare parts, leftover material and cement bags, wrapping paper boxes collect and pickup timely, and keeping good hygiene conditions in the site to making field clean and beautiful. It is strictly prohibited in the tunnel to storage and product engineering materials. Tunnel has red paint marking number of miles which is easy to check.

Taking effective measures of pumping and drainage, and keeping drainage unblocked, inverted arch bed following up in time, ensuring the pavement without water in the tunnel. Strengthening the safety management in construction of the tunnel face, attaching great importance to monitoring measuring of tunnel. The surrounding rock should be check after excavation and blasting, and the loose rocks, cliff stone clear before anchoring. Supporting construction must follow the work face, closing into a ring as soon as possible to play a role in early. Spoil and tunnel muck do not randomly jumbled in strictly accordance with the planning requirements.

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