

Research Article

Experimental Study of Mechanical Characteristics of Tunnel Support System in Hard Cataclastic Rock with High Geostress

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Received 22 September 2020; Revised 9 November 2020; Accepted 17 November 2020; Published 4 December 2020

Academic Editor: Xianjie Hao

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In hard cataclastic surrounding rock with high geostress, the rock monomer strength is high and the rock is broken, and tunnel excavation in it is apt to cause large deformation, collapsing, and breaking, causing initial support crack and even intruding of the initial support deformation. The characteristics of the support system under different support parameters and shapes are analyzed, and the reasonable support section shape and support parameters are determined. The results showed that (1) under the condition of high geostress and hard cataclastic surrounding rock, the initial support deformation is large, the horizontal convergence is much larger than the settlement of arch, and the deformation duration is relatively short; (2) the distribution of pressure and stress in initial support are very uneven on the cross-section and greatly affected by the construction process; (3) in the case of large horizontal tectonic stress, the use of large curvature side wall support is beneficial to improve the quality of support and control the deformation of the structure, especially to improve the stress of concrete; (4) the closure time of the supporting system greatly influences the stress state and deformation, so it is necessary to shorten the length of the lower bench and the distance of the invert as possible so as to close the support as early as possible; (5) different location of the tunnel surrounding rock stress distribution is very uneven, the measured value is much larger than calculated value in level III based on the specification of surrounding rock; (6) under high strength and ground stress, the initial supporting stress of steel frame increases rapidly, and the measured stress is larger. This indicates that the steel frame structure bears heavy early load. Therefore, the stiffness of the steel frame should be as large as possible to meet the loading requirements.

1. Introduction

Because of the complex terrain in the western region of China, many special geological problems will be encountered in the construction of tunnels in these areas, including the problem of high geostress. Therefore, it is particularly urgent and important to study the mechanical properties and engineering properties of high geostress surrounding rock.

Under the condition of high geostress, hard rock is apt to cause rock burst, and soft rock is apt to cause large deformation. Scholars at home and abroad have done a lot of research on these two situations and put forward some

relevant solutions. The best rock burst support system should have two major functions of active support and energy release, and the research and development of anchoring components is the most critical. The large deformation support types of soft rock are mainly strong support, layered support, and yielding support [1]. In view of the large deformation of the initial support and the cracking of the secondary lining during the construction of the high geostress section of Muzhailing Ridge on Lan Yu Railway, the deformation mechanical characteristics and control measures of the lining-surrounding rock structural system are analyzed by means of actual measurement and numerical simulation [2]. In view of the scientific and technical

problems in the construction process of deep buried soft and weak surrounding rock tunnel, the spatial deformation law and mechanism of the tunnel during the construction process, the identification technology of surrounding rock stability and load-bearing capacity limit state of supporting structure, the concept of tunnel deformation control, and key control technology are studied [3]. Through field test and numerical calculation, the selection of initial support steel frame for large deformation tunnel in extruded soft rock is studied. It is concluded that it is advisable to adopt multilayer and multiple supports, and the first layer of support should use a stronger steel frame. [4]. Through field test and analysis, it is determined that compared with the traditional initial mode, the new structural type of “single-layer initial support + double-layer secondary lining” and “double-layer support first yielding and then resisting” and circumferential grouting reinforcement of surrounding rock have a good guarantee for the long-term stability and safe operation of high geostress soft rock tunnel [5]. Based on the elastic-plastic solution of deep buried tunnel considering strain softening characteristics and using the bolt neutral point theory, we systematically analyzed the failure mechanism of short bolt support in high geostress soft rock tunnel and demonstrated the effectiveness of long and short bolt-combined support on deformation control of high geostress soft rock tunnel [6]. It is proposed that traditional anchor-plate retaining is a typical compression-bending component, which cannot meet the deformation control requirements of soft rock tunnels. The circular yielding support with rigid-flexible-rigid mechanical characteristics is an effective means to control deformation [7]. Through numerical simulation and field test, the feasibility and effectiveness of “bolt-cable-mesh-shotcrete + grouting” is proposed and verified [8].

Based on the rock strength stress ratio method, combined with the results of magnetotelluric sounding EH4, the prediction method of rock burst occurrence section and grade is proposed, which comprehensively considers surrounding rock lithology and groundwater conditions [9]. By zoning of rock strength stress ratio of surrounding rock of underground cavern groups, combining with surrounding rock failure phenomenon and occurrence location, the relationship between deformation and failure of surrounding rock of large-scale cavern group with high geostress hard rock and rock strength stress ratio is established, and the crustal stress classification standard based on strength stress ratio correction is proposed, and the variation law of stress-induced failure of surrounding rock with rock strength stress ratio is revealed [10]. FLAC3D software is used to simulate the disturbance of stress, strain, and displacement of surrounding rock with high geostress under different excavation conditions. It is proposed that the excavation face passes through the monitoring section as a process of loading before unloading, and the support construction timing has little influence on the stability of surrounding rock [11]. Combined with the rock burst engineering in the Cuihuashan Tunnel, the conditions and mechanism of rock burst in tunnel are analyzed in detail. It is considered that lithology and stress field are the main factors of rock burst. Measures

such as advanced geological prediction, borehole stress release, excavation face watering, strengthening initial support, and other measures can be taken to effectively control the occurrence of rock burst [12]. The maximum tangential stress of surrounding rock is obtained by finite element calculation, and the point load strength is obtained by using it. The relationship between them is drawn to predict rock burst and determine the grade of rock burst [13]. Based on the observation results of surrounding rock failure of mining roadway in South Africa, the discriminant of rock burst classification is proposed [14]. It is found that rapid unloading of horizontal stress can lead to rock burst in triaxial loading state [15].

The above scholars have not studied the possible large deformation of hard cataclastic surrounding rock under high geostress. In fact, when the hard rock mass is relatively cataclastic, loose and buried deep, the surrounding rock will become compacted under the action of surrounding rock pressure. Due to the stress release and redistribution after the tunnel excavation, the structural plane originally compacted and closed will open and slip, and the surrounding rock mass will be further broken and cracked. The surrounding rock will be loose immediately, and the deformation and failure of surrounding rock will be characterized by progressive expansion of loose circle. However, with the difference of principal stress direction and coefficient of lateral pressure, the plastic zone can appear in different parts around the tunnel, which will cause the destruction of surrounding rock and supporting structure in these parts, which will lead to the occurrence of large deformation [16]. In addition to rock burst in hard surrounding rock, large deformations may also occur in some sections of Guanshan Tunnel. Based on the Guanshan Tunnel with large buried depth and hard brittle diorite affected by high geostress, the variable pressure uniaxial compression test and borehole television test show that the structure of hard brittle diorite is deteriorated and the possibility of deformation and failure under the condition of stress change [17].

However, there is no systematic reference material to solve the problem of large deformation of rock with high geostress. In order to obtain the mechanical characteristics, reasonable support parameters, and construction methods of tunnel support system in hard cataclastic surrounding rock with high geostress, the main tunnel of 2# inclined shaft working area of Guanshan Tunnel was selected as the test section, and the displacement, surrounding rock pressure, steel arch stress, and initial support concrete stress of tunnel support system were monitored. Based on the monitoring work, the deformation and mechanical characteristics of the support system are analyzed, which provides a reference for the support design of tunnels with high geostress and hard cataclastic surrounding rock.

2. Engineering Background

Guanshan Tunnel is one of the most important projects of Tianping Railway, with a total length of 15634 m. It is the second longest tunnel in the whole line and a single-track

tunnel. The maximum buried depth is 831 m, and the excavation section is about 7 m wide and 9 m high.

The 2# inclined shaft working area is responsible for the construction section in the Tianshui direction of the main tunnel. According to the original design, the surrounding rock is grade III, and the actual construction reveals that the surrounding rock is diorite, bluish gray, and the mineral composition is mainly feldspar, hornblende, and biotite. The hardness of single rock is relatively large, but the joints are developed. Under the action of external force, the rock along the joint is broken into blocks, and the rock on the joint surface is seriously weathered. The surrounding rock of the excavation face is shown in Figure 1. In the design, this kind of rock is classified as grade III to grade IV, and the highest support form is IV reinforcement of single-track tunnel. This section has obvious horizontal tectonic stress. Rock compression test results of drilling rock sampling based on crustal stress, the saturated compressive strength RC of rock is 74.1–107.8 MPa. The measured maximum horizontal principal stress value SH is 23 ~ 24 MPa. RC/SH is 3.01–4.69, which indicates that the section is in high or extremely high geostress state.

During the construction of the 2# inclined shaft, the surrounding rocks of the arch, side wall, and excavation face fell off and collapsed after excavation. Large deformation occurred after the initial support. The local initial support concrete block, steel arch frame distortion and fracture, and even collapse occurred. The collapse mass is block stone, the maximum diameter is less than 40 cm, and the collapse mass has not been stable for several days, as shown in Figure 2. During the main tunnel construction, according to the characteristics of the hard surrounding rock in this section, the original designed grade III surrounding rock section was constructed in the form of grade V reinforced support of single-track tunnel. The rigid support was carried out with 16 I-shaped steel arch frames, the benching tunnelling method was used for excavation, and the inverted arch and the secondary lining were followed up in time. However, the problems in the construction are basically the same as the inclined shaft. After excavation, the blocks fall frequently, the support deformation is very large, and some parts are seriously violated, and the construction progress is extremely slow.

In view of the fact that the free face formed by tunnel excavation is easy to be destroyed in the form of block sliding, extrusion and shear along the structural plane containing filling materials and the adjacent rock blocks slide down. This is a special geological problem of high geostress broken surrounding rock deformation and is a typical large deformation problem of hard cataclastic surrounding rock with high geostress.

3. Monitoring Situation

According to the previous similar engineering construction experience, combined with the specific situation of Guanshan Tunnel, the support form and parameters of high geostress or extremely high geostress and cataclastic diorite section in 2# inclined shaft of Guanshan Tunnel are

proposed. In Tianshui direction, three test sections (about 52 m in total) are set up according to different support parameters (according to the principle of “strong first and then weak”), and field tests of surrounding rock pressure, support stress, and displacement are carried out, respectively. Then, the mechanical characteristics of tunnel support system in high geostress and cataclastic surrounding rock are analyzed. Finally, the support parameters are optimized and adjusted according to the test results. The location of the test section is shown in Figure 3, and the support form and parameters are shown in Table 1.

Monitoring content is the arch crown settlement, horizontal convergence, surrounding rock pressure, initial support shotcrete stress, and steel frame stress. The surrounding rock pressure adopts JXY-4 vibrating string double membrane pressure box. JXG type steel bar stress sensor is used for the initial steel frame stress. The stress of the supporting concrete adopts JXH-2 embedded strain sensor. The displacement measurement and initial support measurement points were embedded within 2 hours after blast and deslag. Each test section is excavated by benching tunnelling method, and the bench length is not more than 5 m. The footage of the first and third cycles of the test section is 0.8 m, and the second test section is 0.6 m. The excavation width of the first and second sections of the test is 7000 mm and the height is 9000 mm. The excavation width of the third section of the test is 7600 mm and the height is 9630 mm. The layout of measuring points is shown in Figure 4. Field measurement of shotcrete and steel frame stress is shown in Figure 5.

According to the geological conditions revealed in the construction process, the geological conditions of the three test sections are relatively close, and the surrounding rock is mainly diorite with hard rock; joints and microcracks are developed and sealed, and joint dense zones are developed; the surrounding rock is relatively cataclastic, and the surrounding rock presents the mosaic structure of broken (block) stone or crushed rock structure; there is no water seepage in the excavation section. Generally speaking, after excavation, the block falls frequently at the excavation face, the stability of the tunnel is poor, the surrounding rock on the left side of the line is relatively poor, and the surrounding rock on the right side of the line is relatively hard and stable. This is consistent with the test results of loose circle of surrounding rock. The thickness change of the loose circle is basically between 3.5 ~ 4.4 m, and the local position is more than 5 m. The scope of loose circle on the left is larger than that on the right.

4. Measurement Results and Analysis

When the excavation face was excavated to the test section 2 (DIK77 + 570 ~ 566), the cracking and peeling of the initial support concrete of the upper bench is serious, and some arch frames are seriously deformed. The cracking of initial support and the deformation of steel frame in the test section 2 are shown in Figure 6. According to the site determination of the owner, the designer, and the construction unit, it is considered that the second test section cannot meet the load-



FIGURE 1: Hard cataclastic surrounding rock in excavation face.



(a)



(b)

FIGURE 2: Collapse in excavation face.

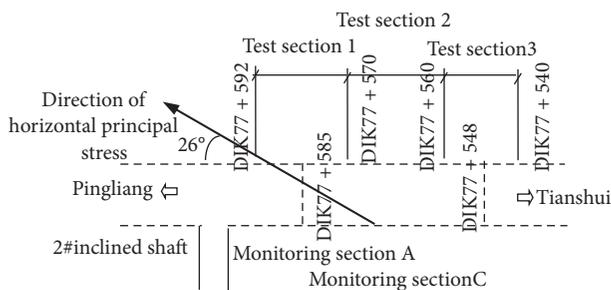


FIGURE 3: Positions of three test sections.

bearing requirements after reducing the support stiffness. In view of the high ground stress and hard fractured surrounding rock, the supporting stiffness should be strengthened. Therefore, the scheme is cancelled, and the deformation of the initial support of this section shall be treated, and the reinforcement support is applied during the construction of the lower bench.

4.1. Displacement Measurement. It can be seen from Table 2 of displacement measurement results of test section that horizontal convergence is far greater than arch crown settlement; horizontal convergence one is much greater than

horizontal convergence two (deformation of upper bench is dominant), and horizontal displacement of left measuring point is greater than that of right side. The typical displacement time curves of the first and third test sections are shown in Figures 7 and 8. The shape of the displacement time curve is obviously affected by the excavation and support of the lower bench. The displacement rate of the support increases significantly due to the excavation of the lower bench. After the inverted arch is closed, the displacement rate gradually decreases and tends to be stable. This feature is especially obvious in the first test section, while the third one is not obvious. It shows that the stability of the supporting structure is relatively good after increasing the curvature of the side wall, and it is not easy to be disturbed by excavation and other processes. The common feature of the two methods is that the horizontal displacement tends to be stable about seven days after the inverted arch is closed. This is different from the deformation duration of soft and weak surrounding rock with obvious creep characteristics, which is more than half a year.

The displacement measurement results of test section 1 are generally larger than those of test section 3. On the one hand, the curvature of the side wall is increased in the test section 3. Although the support stiffness is reduced, the

TABLE 1: Support parameters of three test sections.

Test sections	C25 shotcrete		Initial support		Steel support		Secondary lining	Deformation allowance (cm)
	Thickness (cm)	Position	Bolt Length (m)	Spacing (m)	Steel support	Spacing (m)	Arch wall thickness	
1	27	Arch/wall	4.0	0.8 × 0.8	I20b	0.8	40 cm (reinforced concrete)	40
2	25	Arch/wall	4.0	0.8 × 0.8	I18	0.6	40 cm (reinforced concrete)	40
3	25	Arch/wall	3.5	1.0 × 0.8	I18	0.8	40 cm (reinforced concrete)	30

Notes: (1) according to the data of deformation and stress measurement, support parameters and deformation allowance are adjusted dynamically in time. (2) The advanced support is made of $\phi 42$ grouting small pipe, the length is 4.0 m, and the circumferential and longitudinal spacing are 0.4 m and 2.4 m, respectively. Steel mesh: the arch wall adopts $\phi 8$ steel bar with mesh size of 20×20 . 3. The original design is adopted for the section of supporting structure in test sections 1 and 2; only the parameters are changed (the section of Figure 4(b)). The support form of side wall with large curvature is adopted for test section 3 (the section of Figure 4(c)).

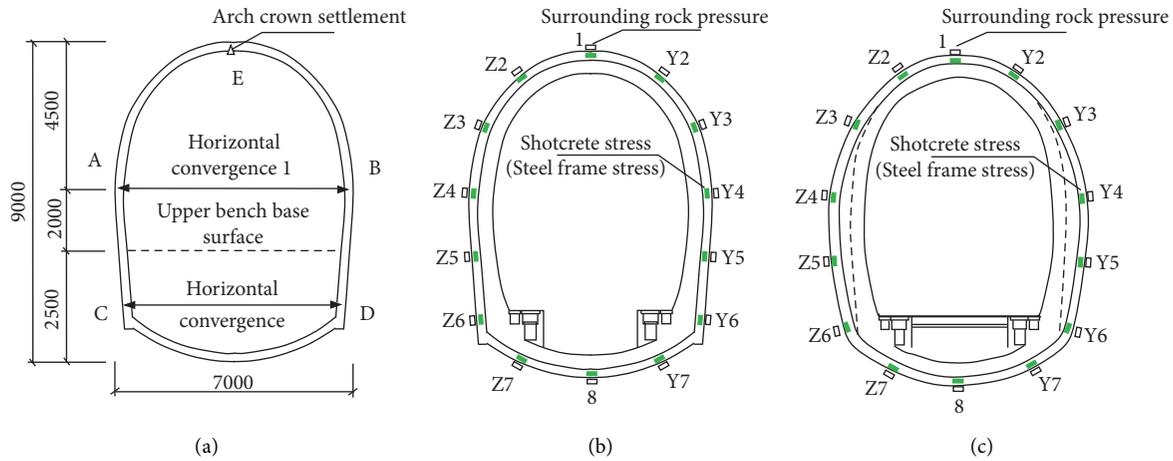


FIGURE 4: Location for measuring points in support system. (a) Displacement measuring points. (b) Section A. (c) Section C.

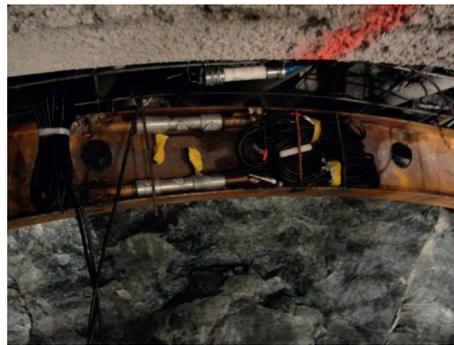


FIGURE 5: Field measurement of initial support stress.

support displacement is reduced. The results show that in the aspect of controlling support displacement, changing the curvature of side wall of excavation section is more effective than simply strengthening support. Therefore, under the action of a higher horizontal force, the most effective way to control the deformation is to increase the curvature of the excavation section to make it as close to the circle as possible. On the other hand, the lower bench, inverted arch excavation and support of test section 3 are

more timely than those of test section 1, and the structure is closed as soon as possible so that the deformation can be controlled.

4.2. *Surrounding Rock Pressure of Initial Support.* It can be seen from Figures 9 and 10 that the surrounding rock pressure distribution of the two sections is extremely uneven, and there is a great difference in different parts. The



FIGURE 6: The cracking of initial support and the deformation of steel frame in the test section 2. (a) The cracking of initial support. (b) The deformation of steel arch.

TABLE 2: Measured results of displacement (mm).

Test sections	Mileage	Arch crown settlement	Horizontal convergence one	Horizontal displacement		Horizontal convergence two	Horizontal displacement	
				Point A	Point B		Point C	Point D
1	DIK77 + 590	Destruction	295.1	176.2	-118.9	98.8	87	-11.8
	DIK77 + 585	31.3	333.0	178.3	-154.7	67.6	56.2	-11.4
	DIK77 + 574	43.3	324.4	200.7	-97.5	62.8	52.2	-10.6
	Average value	40.45	333.8	234.1	-123.7	76.4	65.1	-11.3
3	DIK77 + 557	23.5	295.4	169.4	-126			
	DIK77 + 552	23.6	238.8	140.4	-98.4			
	DIK77 + 548	17.5	222.8	142.0	-80.8			
	Average value	21.5	252.3	150.6	101.7			

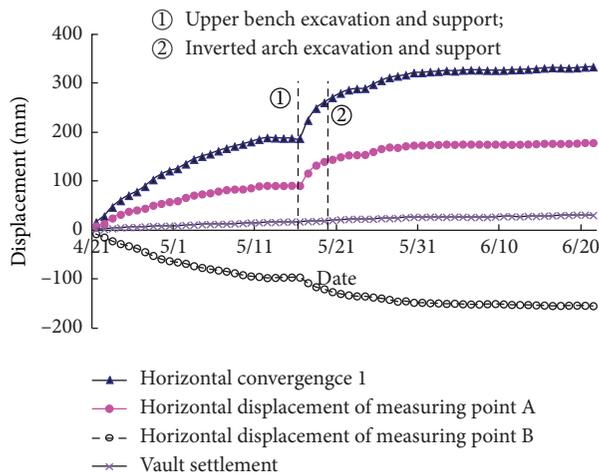


FIGURE 7: Time-history curves of tunnel deformation in the first test section (DIK77 + 585).

vertical pressure is dominant, and the arch is greater than the side wall. The vertical surrounding rock pressure at 5 days after the excavation of section A, the excavation of lower bench and inverted arch, and before the construction of secondary lining is far greater than the calculated value of

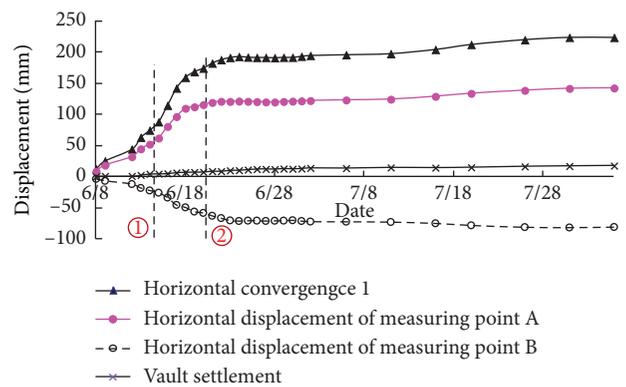


FIGURE 8: Time-history curves of tunnel deformation in the third test section (DIK77 + 548).

grade IV surrounding rock pressure (0.099 MPa) recommended in the standard for design of railway tunnel, especially the measured value of surrounding rock pressure at 5 days after excavation is far more than that of grade V (0.174 MPa). Finally, the vertical component of the measured maximum pressure value reaches 132% of the standard of grade V surrounding rock pressure value. The measured value of surrounding rock pressure of section C is

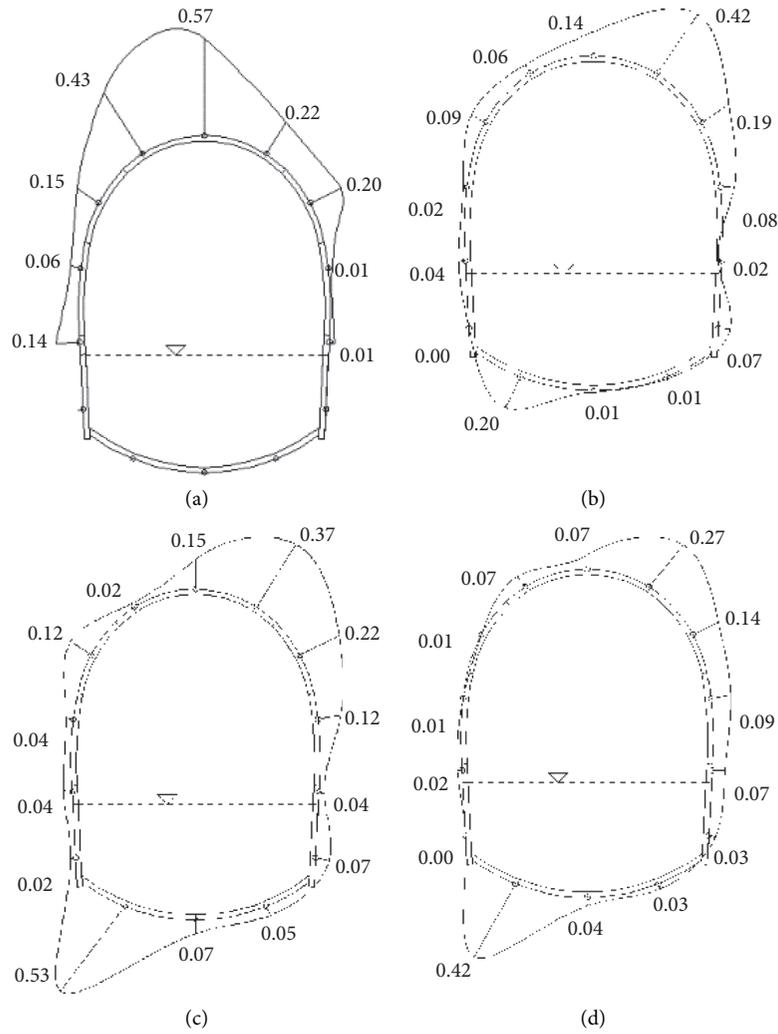


FIGURE 9: Distribution of surrounding rock pressure on the cross-section A (unit: MPa) (a) 5 days after excavation, (b) after excavation of lower bench and inverted arch, (c) before construction of secondary lining, and (d) after deformation stabilization.

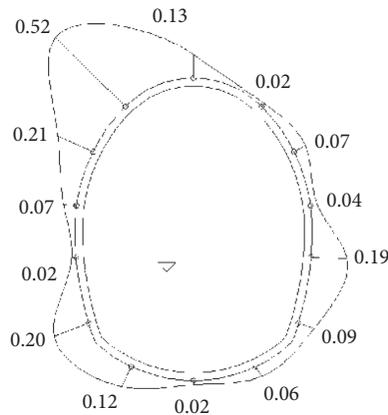


FIGURE 10: Distribution of surrounding rock pressure on the cross-section C (unit: MPa).

greater than that of section A, and the maximum vertical component reaches 253% of the value of grade V surrounding rock pressure.

It can be seen from Figure 11 that the surrounding rock pressure of section A is greatly affected by time and construction factors. The surrounding rock pressure reaches the

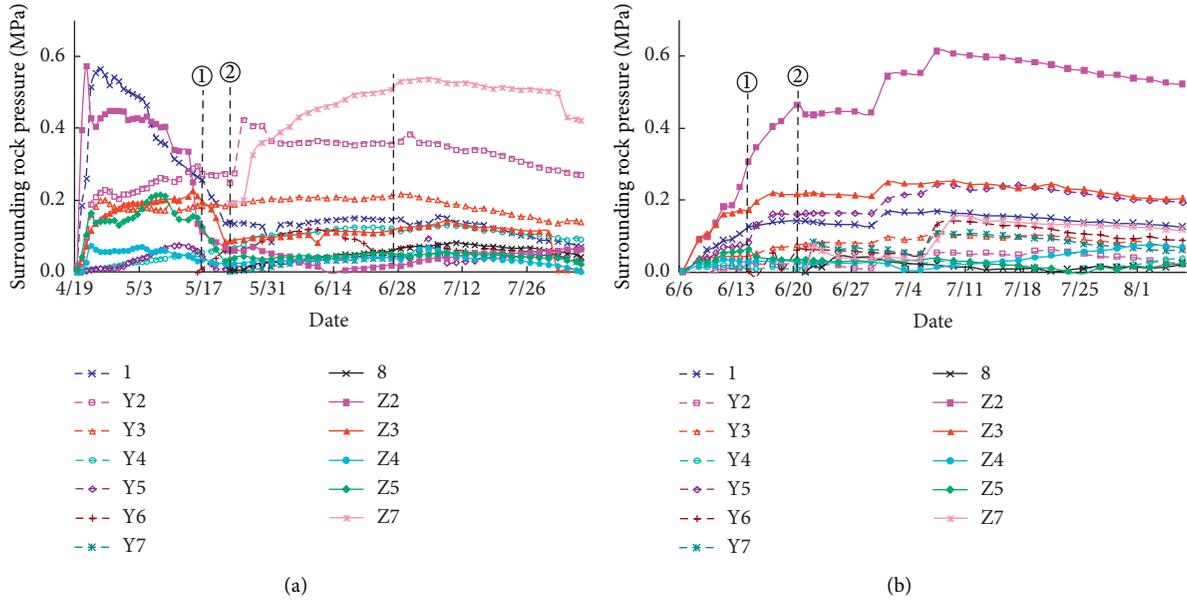


FIGURE 11: Time-history curves of surrounding rock pressure. (a) Section A. (b) Section C.

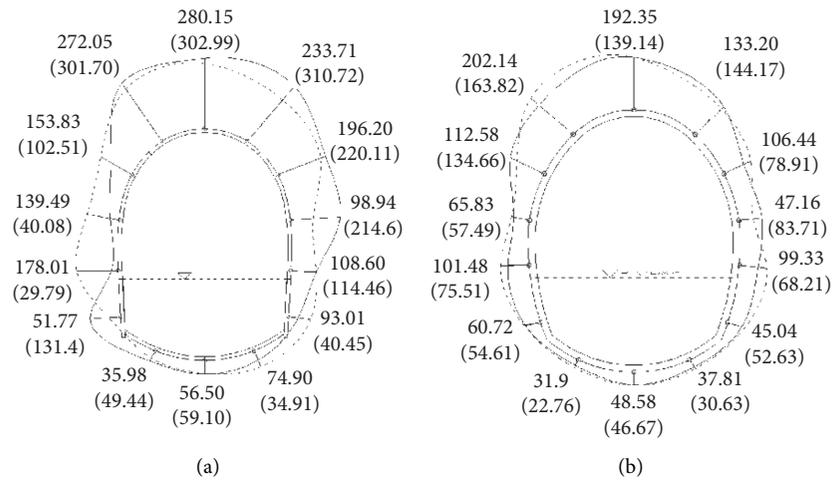


FIGURE 12: Distribution of steel frame's stress of initial support on the cross-section A (unit: MPa). (a) Section A. (b) Section C.

initial peak value 5 days after the support construction. It shows that under this kind of surrounding rock conditions, the stress redistribution caused by excavation is basically completed in a short time. Afterwards, due to the coordinated deformation of the support and the surrounding rock, the gradual release of the load causes the surrounding rock pressure to decrease. During the excavation of lower bench and inverted arch, as the right end sinks first, the distribution of surrounding rock pressure changes greatly. After the construction of the second lining, part of the load is shared, and the value of the surrounding rock pressure decreases. Section C has an earlier support closing time due to its favorable support shape. The final value of the surrounding rock pressure of section C is slightly larger than that of

section A, but the change over time is more stable than that of section A. The construction process does not have a significant impact on the distribution pattern.

In a word, the distribution of surrounding rock pressure is very uneven in the cross-section under such geological conditions, and the vertical pressure is dominant, and the maximum surrounding rock pressure is located at the arch waist. The straight wall structure of section A is not conducive to structural stability. The pressure distribution of surrounding rock is easy to change once disturbance occurs during construction. The large curvature side wall section of section C is conducive to structural stability, and early closure of support is also conducive to structural stability.

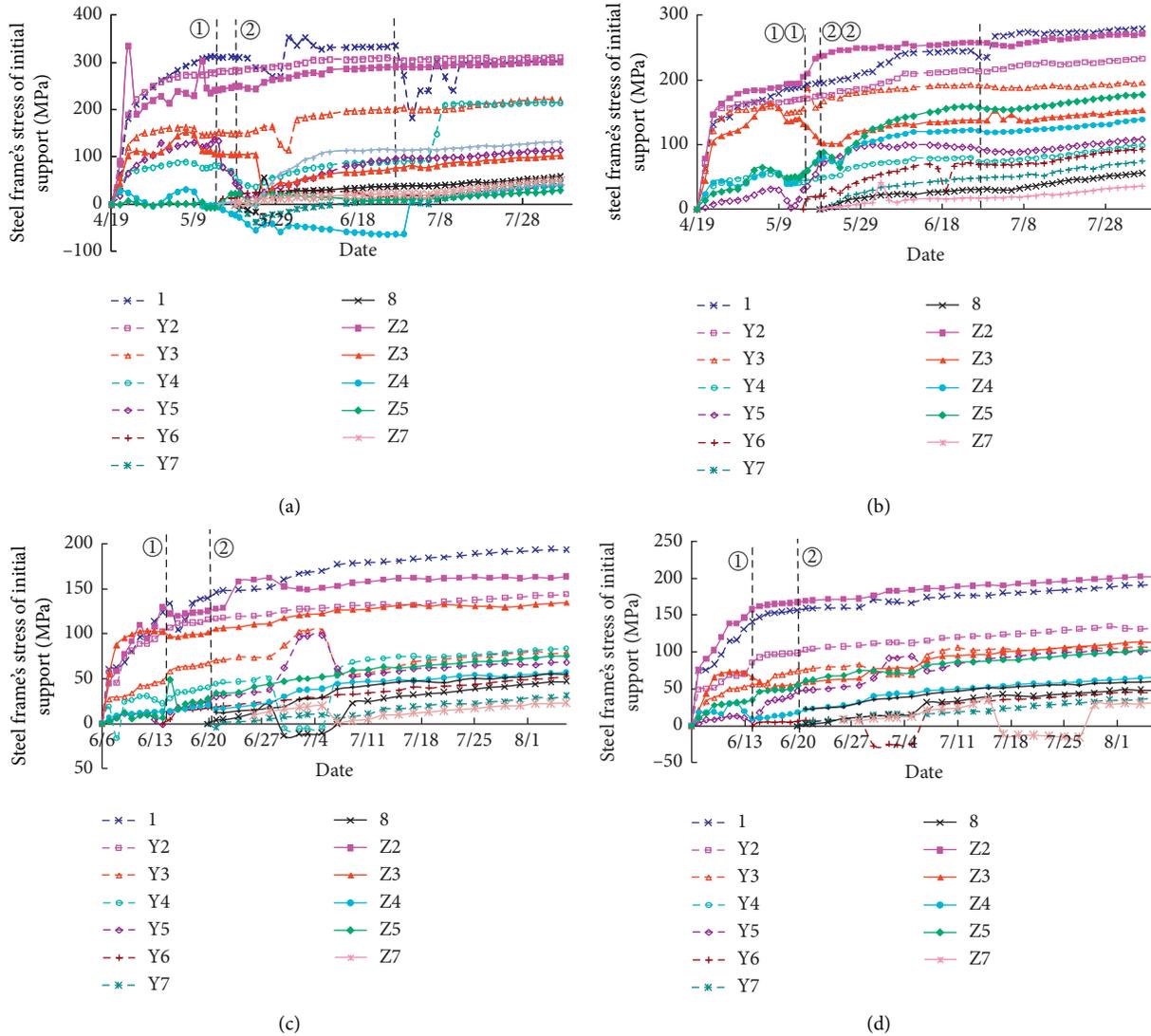


FIGURE 13: Variation curves of steel frame's stress of initial support. (a) Outer flange of section A. (b) Inner flange of section A. (c) Outer flange of section C. (d) Inner flange of section C.

4.3. *Initial Support Steel Frame Stress.* Distribution of steel frame's stress of initial support on the cross-section A is shown in Figure 12.

After excavation and support, the steel frame stress increases rapidly, and the measured steel frame stress is very large, which indicates that the steel frame plays a very important load-bearing role in the initial stage of excavation. The maximum value of section A is 310.72 MPa and that of section B is 202.14 MPa. The stress of the steel frame of section A is greater than that of section C, and the measuring point at the arch of section A has exceeded the yield strength of Q235 steel products. The stress of the steel frame at the arch of two sections is far greater than that of the side walls on both sides (the solid line in the figure and the value in brackets indicate the outer flange of the arch frame). Similar to the distribution of surrounding rock pressure, the maximum stress of steel frame does not appear in the vault, but in the arch waist. It can be seen from Figure 13 that

section A changes greatly with time and process, while section C is relatively stable. The outer flange of the two sections changes obviously due to external construction disturbance.

4.4. *Shotcrete Stress of Initial Support.* It can be seen from Figures 14 to 16 that the distribution of shotcrete stress on the cross-section is not even, and the stress concentration occurs at some measuring points, but generally speaking, the arch is far greater than the side wall. The concrete stress of section A is large, and the maximum value is located at the right arch waist (about 30 MPa), which has exceeded the design strength of shotcrete. The excavation of the lower bench has a great influence on the stress data, which leads to a significant decrease in the initial concrete stress. After the inverted arch is closed, the concrete stress increases gradually and tends to be stable before the construction of the

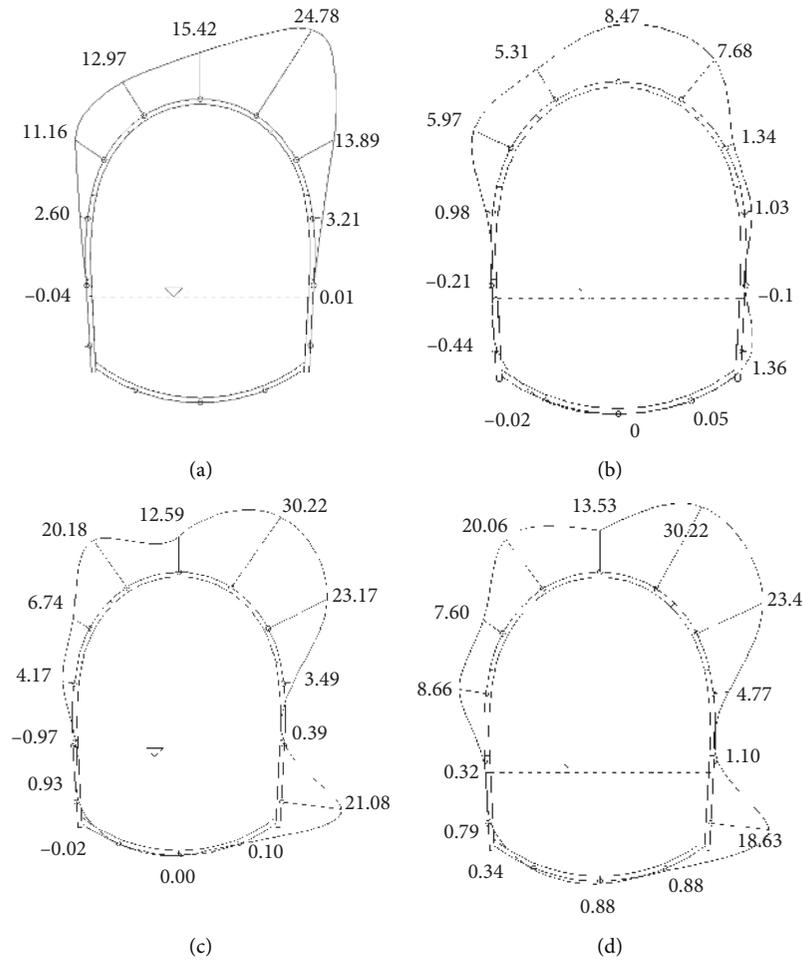


FIGURE 14: Distribution of shotcrete stress of initial support on the cross-section A (unit: MPa) (a) 7 days after excavation, (b) excavation of lower bench and inverted arch, (c) before construction of secondary lining, and (d) after deformation stabilization.

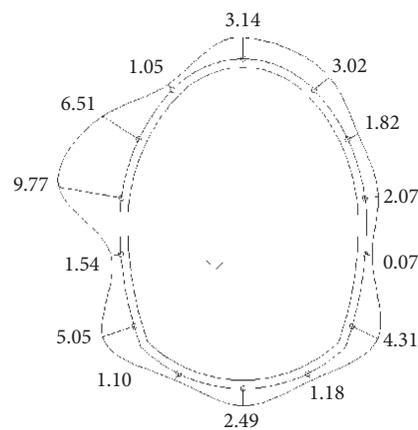


FIGURE 15: Distribution of shotcrete stress of initial support on the cross-section C (unit: MPa).

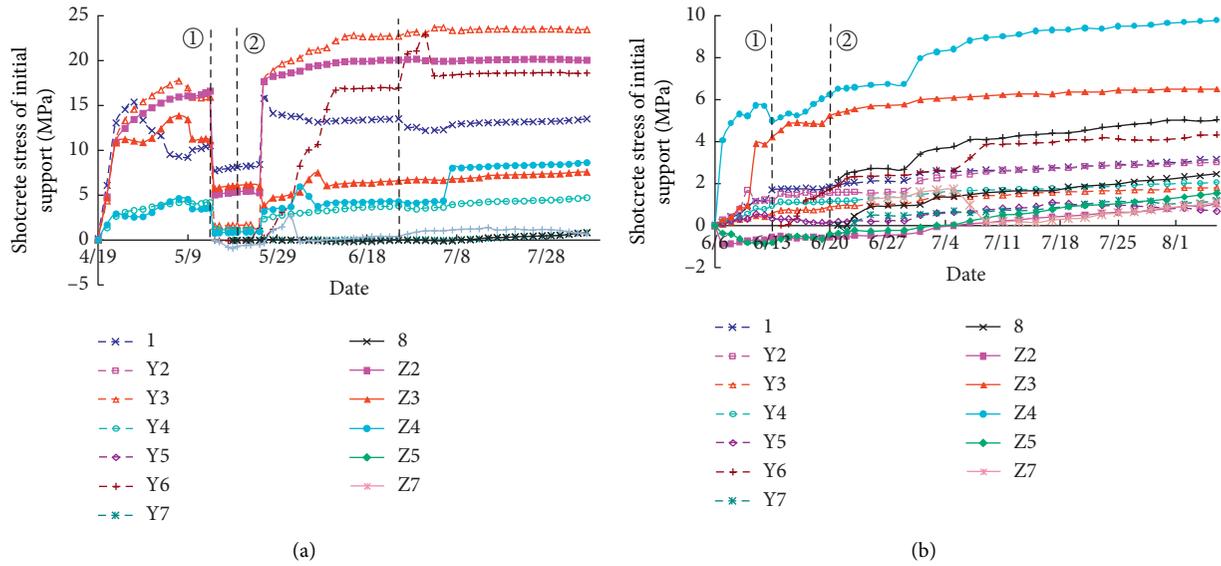


FIGURE 16: Time-history curves of shotcrete stress of initial support. (a) Section A. (b) Section C.

secondary lining, and the stress value of the measuring point of the load-bearing part is slightly reduced after the construction of the secondary lining. The results show that the initial support concrete stress measured by section C is smaller, the cross-section distribution is relatively even, and the stress-time curve changes gently with time. It shows that increasing the curvature of side wall is very beneficial to improve the stress state of shotcrete structure.

5. Conclusion

Based on the monitoring of Guanshan-Tianping Railway Tunnel, the deformation law of tunnel with high geostress and hard cataclastic surrounding rock are analyzed and studied, and the distribution characteristics of surrounding rock pressure, concrete stress, and steel frame stress as well as their variation with time are obtained. Finally, the following conclusions are drawn:

- (1) The initial support displacement is large, the horizontal convergence is far greater than the settlement of the arch, and the relative horizontal convergence approaches or exceeds the relative limit displacement of the initial support. Compared with the deformation of soft and weak surrounding rock with obvious creep characteristics, the deformation duration of tunnel support system with high geostress and hard cataclastic surrounding rock is relatively short, and it is basically stable within 7 days after the support is closed.
- (2) Under the action of horizontal tectonic crustal stress, the deformation control ability of straight side wall support is weak, but the effect of increasing the curvature of side wall (initial support) is better. At the same time, large curvature side wall can improve the mechanical state of the structure. The measured results show that the displacement, concrete stress,

and initial support steel frame stress of large curvature side wall support system are relatively reduced. Increasing the curvature of supporting side wall is the most significant to improve the mechanical state of shotcrete. At the same time, the stability of the vertical wall section is poor, which is easily affected by the construction process. Therefore, the curvature of the excavation section can be adjusted to make it as close to the circle as possible to control the deformation and improve the mechanical state of the structure.

- (3) Excavation will produce great disturbance to the tunnel. Each excavation will bring about the sudden change of surrounding rock deformation, support pressure, and stress. With the final closure of the support, the deformation, support pressure, and stress will tend to be stable. Therefore, the length of lower bench and inverted arch distance should be shortened as far as possible to make the support structure close as soon as possible.
- (4) From the perspective of mechanics of support structure, the surrounding rock pressure of arch, initial support stress of steel frame, and initial support stress of concrete are much larger than those of both sides. By strengthening the arch support and presupport strength, the mechanics and deformation of the support system can be controlled.
- (5) The distribution of surrounding rock pressure on the cross-section is very uneven, but it is still dominated by vertical pressure. The construction sequence will affect the final distribution of surrounding rock pressure. In numerical value, the surrounding rock pressure exceeds the standard value of grade IV and V surrounding rock.
- (6) Under the condition of high geostress and hard cataclastic surrounding rock, the stress of steel frame

increases rapidly at the beginning of excavation, and the measured stress of steel frame is very large. It shows that the steel frame bears a large load, and the supporting stiffness should be large rather than small in order to meet the load-bearing requirements.

- (7) Based on the above analysis, the support form and parameters of test section 3 are more reasonable.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by National Natural Science Foundation of China (NSFC) under Grant no. 51778380, the Key Research and Development Program of Hebei Province under Grant no. 17275408D, and the Science and Technology Research Project of Hebei Province under Grant no. ZD2019034.

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