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Contents

Article

Review

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Frontiers Research of Architecture and Engineering
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ARTICLE

Surveying of Tall Buildings over Theory Height within Obstacle Free Airspace

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ABSTRACT

According to the National Airport standards, this article has looked over the height of 180000 buildings in the airfield control height region of Cencun Airport (about 123.6 sq. km) for the first time. In the paper, based on the planning & approving data and ADS40 aerial survey data, GIS spatial analysis, ADS40 stereo-altimetry technology, field digital measurement and 2D/3D visualization are used synthetically to achieve the results above. Furthermore, the quantity and spatial distribution of over theoretical height buildings are clarified, which is significant to review the airfield height management and to guide the regulatory plan of Tianhe Intellectualized Business District.

1. Introduction

Tianhe District, as a national central city core zone under construction, continues to extend its urban area to the north-east suburb area, with the strategy of "eastward development" implementation acting on. There arises with a result that the Cencun airport located in a remote situation earlier also gradually starts the progress of urbanization, which makes the guarantee of airfield control height an important consideration when planning management. However, a phenomenon of partial over theoretical height buildings was caused by varieties of historical reasons, leading huge hidden danger to the flight safety.[1]

Under such background, based on the National Airport Standards and the Scheme of the Airfield Clearance and Control height Region of Cencun Airport brought out by the Guangzhou Military Region Air Force in 2001 , this paper has looked over the height of 180 000 buildings in the airfield clearance control region of Cencun Airport for the first time. With the full advantage of the planning and approving data, and ADS40 aerial survey data existed, using GIS spatial analysis, ADS40 stereo-altimetry technology as well, field digital measurement and 2D/3D visualization systematically and comprehensively, the results mentioned above are synthetically achieved under the combination of internal and external business. Furthermore, the quantities, space distribution, breaking rules and its historical reasons of over theoretical height buildings are all clarified. On one hand, the discuss results can enhance the dynamic monitoring system of over theoretical height buildings, and rethink profoundly on the

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planning management, in order to positively figure out the danger hidden in the flight safety;[2] On the other hand, the fundamental data is provided for Tianhe Intellectualized Business District as a regulatory plan.

2. Study Area and Data

In this paper, airfield clearance control region of Cencun in Tianhe District of Guangzhou (about 123.6 sq. km) is selected as the study area. The Scheme of the Airfield Control height of Cencun Airport was put forward in accordance with National Airport Standards by Guangzhou Military Region Air Forces, which control height region consists of the takeoff and landing strip, terminal clearance zone, side clearance zone, fillet surface, inside horizontal plane,[3] conical surface and so on, shown as the Figure 1 and Figure 2.

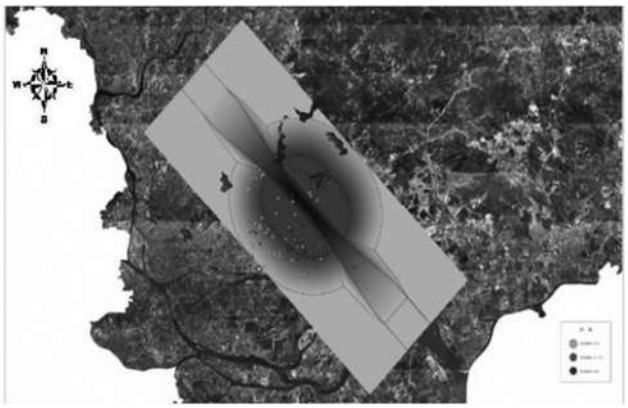

Figure 1. Location of the study area

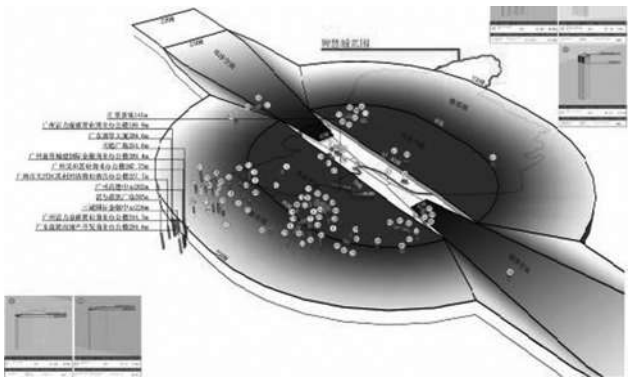

Figure2. 3D map of the study area

Judging by this scheme, the clearance control region of Cencun Airport, 30 kilometers long and 13 kilometers wide, has an area of 390 square kilometers. In terms of Tianhe District, over 90% region has been included into this control area, which covers 123.6 square kilometers approximately and involves about 180 000 buildings, other than a small area in the north, the Fenghuang Mountain.[4]

Here, buildings that exceed the "control tall" in this airfield can be defined as the following principles: it referrers to the ones apogee altitude (shift the ±00 sign of the building into Guangzhou elevation and plus the highest clear height which includes annexes like day surface, ladder house, pool, decorating frame, lightning rod and so on, drawn on the construction blue print) consented and approved by the Logistics Department of Guangzhou Military Region Air Forces, within the airfield clearance control management region of Cencun Airport, has exceeded the theory height stipulated by the Scheme of the Airfield Control height of Cencun Airport (according to the highest limited elevation in theory stipulated by the Scheme of the Airfield Clearance Control of Cencun Airport from Guangzhou Military Region Air Force, calculated based on related mathematical models).[5]

In addition, the fundamental data includes:1) Guangzhou city, a new generation of height precision dynamic three-dimensional urban space in surveying and mapping constructed in 2005 (including the continuous operation reference system detailed application in city surveying with comprehensive services and the Precision Quasi-geoids Determining Result of Guangzhou City); 2) "Three-Plan-Coordination" decision support platform in the Tianhe District and the planning and approved information database cut-off by the end of 2013; 3) the ADS40 aerial survey data of Guangzhou City in 2008, (covering the whole city about 7400 square kilometers with the resolving power of 0.2 meters), the DEM data with a precision of 5m*5m of the whole Guangzhou city in 2008 and an electronic topographic map scale 1:2000 in the best shape of reality of 2013.[6]

3. Integrated Technology Scheme for the Census of Airfield Clearance Control Region

Based on the planning and approving data, ADS40 aerial survey data as well, varieties of technical methods and software platform are used synthetically with the combination of internal and external business to achieve the census above. Five steps were studied:[7]

(1) Firstly, obtaining the clearance control region of study area according to the National Airport Standards and the Scheme of the Airfield Clearance and Control height Region of Cencun Airport brought out by the Guangzhou Military Region Air Force in 2001;[8]

(2) Using the similar "isohypse" model to start the process of interpolation encryption on the fillet surface, conical surface, terminal clearance zone and side clearance zone in the control height region, and then generate the "control loop" to construct a computing model for the control height of buildings in theory;[9]

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(3) Based on the "Three-Plan-Coordination" decision support platform in the Tianhe District with the GIS spatial analysis technology, this paper screens the suspected over theoretical height buildings from the planning and approving data existed, in order to quickly narrow the searching region of "over theoretical height" buildings, ;[10]

(4) Regard the suspected over theoretical height buildings screened out as a target organ, using the method of ADS40 stereo-altimetry technology and field digital measurement synthetically, and, ultimately clarify the quantities and space distribution of "over theoretical height" buildings;

(5) Analyze the research achievements and put forward reference suggestions to detailed control planning for Tianhe Intellectualized Business District.

4. Surveying of "Over Theoretical Height" Buildings Based on GIS Spatial Analysis Technology and ADS40 Stereo-Altimetry Method

4.1 Construct a Similar "Isohypse" Model for Theoretical Control Height Calculation of Buildings

With the thought of "isohypse", aiming at simplifying the calculation process of the theoretical control height of buildings, in the paper, the distance between the index contour is designed as 100 meters, which is regarded as a unit, starting the process of interpolation encryption respectively in accordance with 1/10, 1/20, 1/50, 1/75 on the fillet surface, conical surface, terminal clearance zone and side clearance zone, and then generate the "control loop" (see Figure 3). That is to say, the basic control height distances of these surfaces respectively are 10 meters, 5 meters, 2 meters, and 4/3 meters. Therefore, the calculation of the control height of buildings is more likely to the interpolation calculation of the elevation points' height based on the contour model.[11]

Specific steps are as following: ① Firstly, obtain the basal graphs of the buildings; ② Register the building bases to the model for control height calculation according to the spatial coordinates; ③ Obtained the angular point which is the closest to the inside horizontal plane from the building basal graphs; ④ Regard the control height gained from the model for control height calculation at the angular point through interpolation calculation, as the control elevation of the building. As Figure 4 shown, the building is on the 1/20 of the conical surface, which can prove that the theory height of this building is 102 meters.[12]

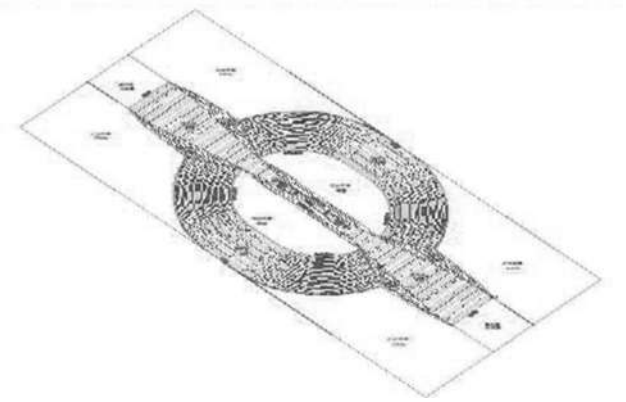

Figure 3. A theoretical calculation model for control height of buildings

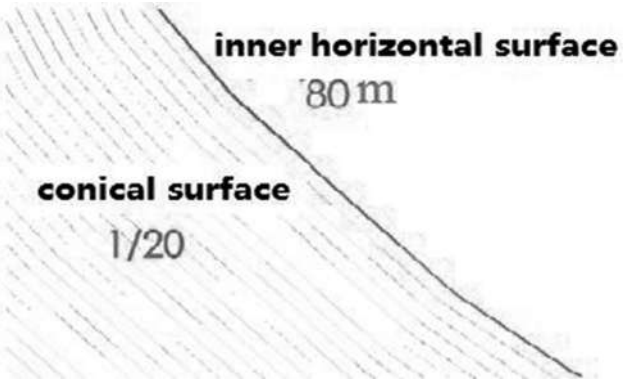

Figure 4. Example of the control height calculation of buildings

4.2 Obtain the Searching Region Based on GIS Planning Decision Support Platform

In order to narrow the searching region of "over theoretical height" buildings, this paper screens the suspected over theoretical height buildings from the planning and approving data existed of the Tianhe District. Specific steps are as following:[13]

(1) Lead "the control red line of the Cencun Airport region" into the platform mentioned above, which is overlay-analyzed with the "E-government map", "the administrative map of Tianhe District" in the platform database. Conduct the preliminary selection of related cases from the platform database, which own the "Construction Planning Permit", "acceptance certificate" and "letter" with approval information from adjusted planning permission, according to the query builders, such as the handling time, post types and whether located within the control height region.[14]

(2) The calculation of the height construction application: the planning elevation construction application of the building's highest point can be gained through referring to the construction graphs and pluses the biggest elevation

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of the building and the ±00 elevation shown in the general layout plan.

(3) Obtain the building basal graphs and check: find the general layout plan from the construction graphs downloaded, and by means of 1/1000, zoom out into a building basal graph with actual coordinates.

(4) Based on the model for theory height calculation, achieve the results of obtaining suspected evidences and buildings, through getting the theory height from the building basal graphs and comparing the building elevation planned and approved with the approvals from the air forces.[15]

4.3 Surveying of the "Over Theoretical Height" Buildings with ADS40 Stereo-Altimetry Technology

This paper applies two ways to obtain the elevation information of suspected over theoretical height buildings: to the cases approved by the end of 2008, one is the stereo-measurement, based on the ADS40 aerial survey achievements of 2008; to the ones approved after 2008, the other way is the field digital measurement (GPS+ total station).

4.3.1 Obtain the Height of Buildings through ADS40 Stereo-Altimetry Method

Based on the ADS40 stereo-altimetry technology, the general technological route to get the elevation information of buildings is:

(1) Firstly, the disposal of ADS40 data includes areophoto, photo field work control measurement, aerial triangulation, L1 level image generation and stereo-models construction. And obtain the elevation information of buildings through stereo-altimetry technology with automatic stereo-image;

(2) Then, the newest DEM data can be gained through semi-automatic DEM generation, correction of height anomaly, and the methods of updating DEM;

(3) At last, the elevation of each building can be gained by overlaying the DEM data and the elevation information of buildings.

Taking the resources of data and its accuracy requirements into consideration synthetically, the main steps to obtain the heights of buildings by means of stereology are as following:

(1) Using the PR0600 module in the Leica Photogrammetry Suite, add the 2D GIS house surface data which has already shifted into the utm84 coordinates into it and open corresponding air strips images before and after L1 level, conducted under stereo-environment.

(2) The top of the building and the basal height are needed to measure respectively in order to get the height of building. In the area of low visibility on the ground, the one-to-many pattern is advisable. Namely, first of all, a set of elevation points on the top of buildings are measured by the same building basal elevation point, and then, measure the building basal elevation point.

(3) Construct an automatic treatment process to eliminate the artificial errors. What follow is the specific methods: Firstly, the dense homonymy points are over theoretical through the algorithm of image matching and the parallax errors can be figured out, automatically building a database of homonymy points with parallax errors. In the single image, two points, one on the top of the building and the other one at the bottom, are chosen as centers by the computer. And then a N*N template (N depends on the circumstances to select) is used for searching selected points in the database that are the closest to and more similar to the pixel and obtain its parallax error; In the end, volume calculate the heights of buildings by means of formulas. As for the buildings sheltered from houses or trees, which cannot be measured, a field measurement as renewal surveying is needed.

4.3.2 DEM Generation and Updating

Under the premise of L1 level image, homonymy points can be over theoretical automatically before, after and under the visual image, with the image matching technology. Then, on the basis of elements of exterior orientation on each scanning line, geographic coordinate values of this point can be calculated. In the end, start the process of interpolation to over theoretical the DEM grid elevation. However, in the practical operating, with the surface features higher than the ground like houses, trees etc, the elevation of grid point is needed to be adjusted onto the ground, generating the DEM. The automatic over theoretical for DTM can be achieved by Inpho MATCH-T, and then, DEM can be generated after editing the DTM data based on the LPS software platform, which specific process refers to reference.[1] As for the region having changed recently, the newest large scale topographical map is required to update and distilled process the DEM data[1].

5. Experimental Analysis

In terms of Tianhe District, over 90% region has been included into this control area, which covers 123.6 square kilometers approximately and involves about 180 000 buildings, other than a small area in the north, the Fenghuang Mountain. 1109 planning cases yet to be investigated with control height requirements are screened out through the "Three-Plan-Coordination" decision support

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platform in the Tianhe District. 379 "over theoretical height" buildings are ultimately clarified and measured elevation practically. The accuracy of 337 buildings' elevation information, based on ADS40 stereo-altimetry technology, basically can reach 0.5 meters. 42 buildings' elevations were measured by GPS and total station, which accuracy gets to ±15 centimeters. 2D/3D visualization technology is used to analyze the quantities distribution, space distribution, breaking rules and causes of "over theoretical height" buildings.

5.1 Quantities Distribution of the "Over Theoretical Height" Buildings

With the analysis of quantities (As shown in Figure 5 and 6), the "over theoretical height" buildings' breakthrough proportion <10% covers the biggest part, almost 30%; breakthrough proportion <20% occupies about 50%; breakthrough proportion <60% takes up about 94%. As can be learned, almost half of the "over theoretical height" buildings' breakthrough proportion account for small part (<20%), and the overwhelming majority of them is <60%.

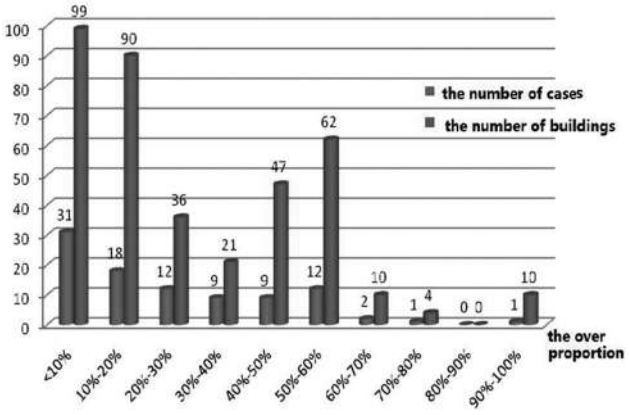

Figure 5. Statistics for proportion of the "over theoretical height" buildings

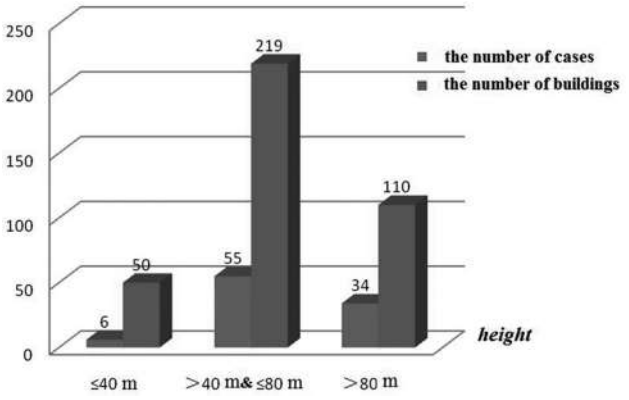

Figure 6. Statistics for Distribution of the "over theoretical height" buildings

Secondly, about 60% "over theoretical height" buildings located within the theory height of 40 meters to 80 meters (including 80 meters inside horizontal plane), and approximately 30% situated within the theory height of 80 meters to 230 meters, while only about 10% lied within the theory height of 40 meters.

In addition, as seen in the Figure 7, the building elevation construction of 13 cases (13.7%) and 36 buildings (9.5%) have exceeded the elevation document approval from the air forces, other than the historical causes. The rest building elevation construction of 82 cases (86.3%) and 343 buildings (90.5%) lie between the "airfield theory height" and "air forces approved height".

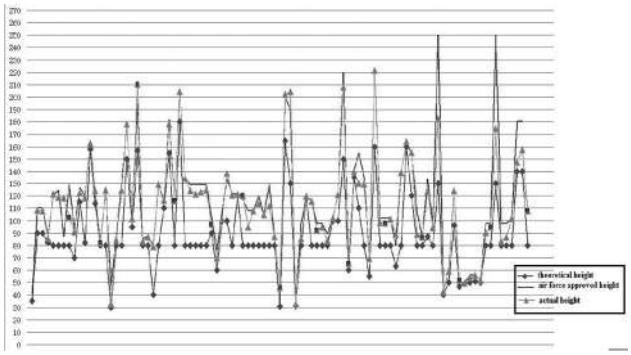

Figure. 7 Comparison for "theoretical height"," air force approved height" and "actual height" of the tall buildings

4.2 Spatial Distribution of the "Over Theoretical Height" Buildings

The colored points shown in the Figure 8 are the situation of over theoretical height buildings. The over theoretical height scope of buildings gradually increasing varies from pale red to russetish, while the blue ones are the extremely over theoretical height buildings. Seeing from the space, the "over theoretical height" buildings mainly distributed over the Zhujiang New Town, Huijing New Town, Tangxia Town Village, the Tianhe Sports Center, the Tianhe Park and the neighbor buildings of Cencun (for example, the security housing and the commercial residential buildings of the Guangdan District in Guangyuan Road, the both sides of Guangshen Railway, the Non-ferrous Metals Institute in the Changxing Road District, the Baocui Garden residence community and so on), focusing on the south, south-west and south-east of the Tianhe District. Some historical reasons cause the Zhujiang New Town and Huijing New Town (the distribution of blue point group) become part of the main accumulation of "over theoretical height" buildings with higher over theoretical height extent.

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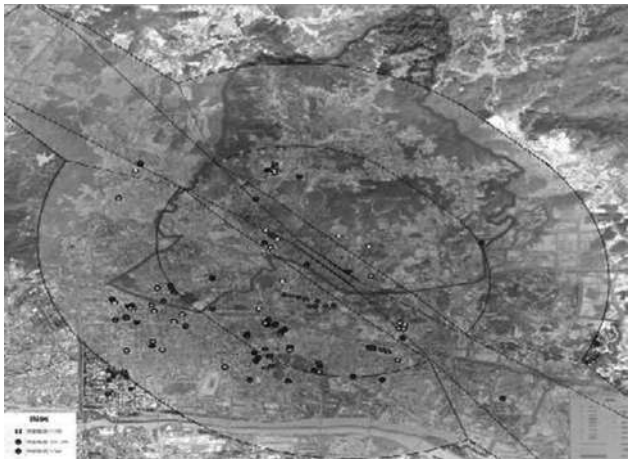

Figure 8. 2D spatial distribution map of the "over theoretical height" buildings

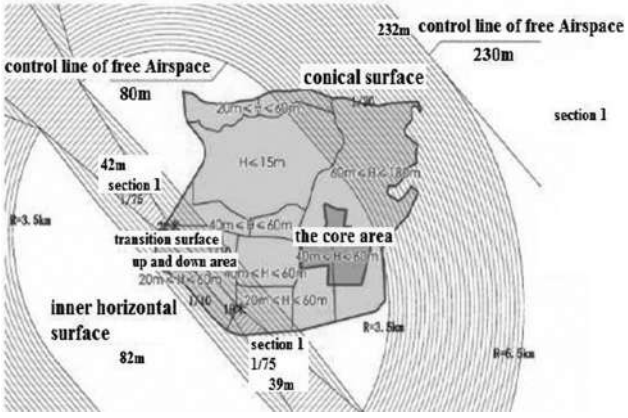

Figure 9. Comparison for "regulatory planning height" and "theoretical control height" of buildings in the core area of intellectualized city

4.3 Suggestions for the Regional Regulatory Planning

As Figure 9 suggested, the overwhelming majority region (over 70%) of the Tianhe Intellectualized Business District lied on the 80-meter inside horizontal plane within the theory height, namely airfield theory height of 40~80 meters, which caused universally the low development intensity of lots located in the core zone of Intellectualized Business District, leading to low land leasing revenue.

On the assumption that the average theory height of the whole region in the Intellectualized Business District is 80 meters, under the premise of good negotiation and understanding with Guangzhou Military Region Air Force, combining the research achievements mentioned above, (a number of buildings around the Cencun Airport have broken the requirements for restriction of the Cencun Airport, such as Huijing New Town, Shiji Lvzhou Garden, Huajing New Town etc, which breakthrough range lies between 30%-40%). Therefore, according to the 40% of allowed breakthrough theory height, the theory height is able to increase 80*40%=32 meters. As for the newest regulatory plan of Intellectualized Business District, the restriction of theory height has been taken into consideration. Calculating the weighted average measurement of the lots area, with the average control height of the buildings being about 60 meters of the Intellectualized Business District core region, assuming that the average height of buildings increase 32 meters on average with the theory height, (still satisfying the restriction of theory height), then the proportion of the construction scale is able to increase approximately 32/60=53.3% in accordance with the hypothetical theory, namely the overall floorage reaching 20 million six hundred and fifty-seven thousand square meters. The Tianhe District, being the motive force for the urban booming of Guangzhou City, advances itself further by land consolidation and economical use, greatly promoting the land output, economic and social effects synthetically.

5. Conclusion

This paper has surveyed the "over theoretical height" buildings within the theory control height of Cencun Airport in Tianhe District systematically and comprehensively for the first time, analyzing its quantities and space distribution, breaking rules and causes, and predicting quantitatively for easing the airfield control height standards or the influence on the construction planning of the Intellectualized Business District might being caused by the removal of the airports. It is not only significant to analyze the airfield height control, the management of engineering construction as well, and positively figure out the hidden danger of flight safety, but also provide exact fundamental data for a regulatory plan of the Tianhe Intellectualized Business District. What follows are the conclusions:

(1) In terms of the project implementation: this paper takes the full advantage of the planning and approving data, ADS40 aerial survey data as well, using multiple technology and software platforms, combining the office and field work, making a progressive, focused and practical technological route, and improving working efficiency.

(2) In terms of the creative technology: this paper builds up a easy yet efficient computing model for building theory height control; based on the "Three-Plan-Coordination" decision support platform in the Tianhe District, use the GIS spatial analysis technology, greatly zooming out the surveying building region; focus on and operate the key technology such as ADS40 data processing,

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height measurement, DEM generation and update; use the algorithm of image matching to automatically construct a database of identical points with parallax error, greatly reducing artificial interference, improving the automation; achieve the semi-automatic DEM generation and update based on the LPS software and ADS40 digital photogrammetry measurement data automation processing system. The conclusions mentioned above are significant to the process of the same type of projects.

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ARTICLE

The Research on Treating Collapsible Loess by Down Whole Deep Compaction and Cement Fly-ash Gravel

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ABSTRACT

The treatment of loess foundation is always difficult. The analysis of its advantages and mechanism of treating loess foundation by CFG, on the base of project geology, through construction example, we suggest the compound plan by both DDC and CFG. The tests illustrates that the down hole deep compaction and cement-fly ash-gravel are effective foundation treatment method to eliminate the collapsibility of loess, increase the bearing capacity and improve the behavior of composite foundations.

1. Introduction

DDC method, also called deep dynamic compaction method, which is an effective method of ground treatment. When uses DDC technology to strengthen the foundation, infilling in the deep parts of foundation treatment, and carrying on high pressure and high compaction of tamping operation to strengthen foundation and eliminate construction waste and dregs.[1]

Both CFG pile and natural foundation belong to foundation category. CFG pile is not connected with the foundation directly, instead, they connect with each other through gravel or rubble, and the primary bearing stratum of CFG pile is in reinforced material.[6] The reinforcement mechanism of collapsible loess has three main aspects:

·Compaction effect
·Replacement
·The role of the pile

As an effective method of ground treatment, DDC method has been applicated commonly, so does the CFG pile, and reports about the deep research of both methods can be found everywhere.[2] But using DDC method and CFG pile to compositely treat collapsible loess foundation is not common, and through the field test research ,we found that using DDC method and CFG pile to treat together collapsible loess foundation developing an effect what is eliminating the collapsibility of collapsible loess, increasing bearing capacity of foundation, improv-

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ing the behavior of load-bearing capacity, reinforcement mechanism and reinforcement effect, which is better than using DDC method or CFG pile only, and this composite foundation treatment method has a certain practical significance.[5]

2. Project Information

The project is a high-rise residential building in Xining of Qinghai Province, which with a total gross floor area of 31272.31m^2,building height is 94.25m, site ground elevation is 2228.81~2241.37m. The region low-lying South High North ,and showing the distribution ladder, tilts to the North, and the landform unit belongs to the front of the third terrace of the south bank of Huangshui river. The distributions of the main strata of the site are as follows:

·Miscellaneous fill in the soil, noise, ingredients to powder soil are given priority to, soil is uneven and structure is loose, 0.30~8.00m.

·Grain filling, tan, brown give priority to with powder soil ingredients, soil structure than to loose, 0.18~6.50m.

·The loess shape soil, tan, brown give priority to with powder soil ingredients, groundwater level is saturated with exuviate, empty, needle with micro level bedding, shake vibration reaction medium, without burnish, dry low intensity, and toughness is low, according to the collapsibility coefficient and saturation is divided into 3-1 layer collapsible loess shape soil, 0.8~16.90m, 3-2 layer the collapsible loess shape soil, 0~11.00m, 3-3 layers of loess soil (saturated), 1.00~12.60m.

·Barely, noise, ingredients to metamorphic primarily, parent rocks by granitic gneiss, sandy slate and quartzite composition, particle size general 20~70mm, maximum can reach 130mm, grinding roundness for him round, local have 0.30m around the cementing, describes the thick gravel layer surface elevation for maximum 12.58m.

·Strongly weathered mudstone, brown give priority to with plastic, caesious, in part, hard structure most damage, 3 body strong structure and soil shape structure, soaking easily become soft, rock mass basic quality grades for extremely soft rock, exposing the thickness weigh.40~9.4m.

This construction site is III level self-respect collapsible venues, collapsible degree intense, venue bearing capacity, which doesn't suit for the engineering requirement. [8]

3. The Design Requirements

In this project, construction of CFG pile composite foundation soil pile DDC meal before eliminating upper collapsibility CFG pile forms for positive triangle, horizontal spacing 1200mm, row spacing, 1039mm 500mm, pile diameter pile length 2~12m, the pile strength of concrete, cement adopted for C25 resistant Portland cement sulfate. Pile tip resistant layer whereas for pebble layer, and entering the pebble layer is not less than 500mm. DDC pile decorate spacing way with CFG pile, horizontal spacing, 1039mm 1200mm row spacing, pore forming 400mm DDC pile hole fill grain soil, using 1.5~2.0 t heavy hammer will hole ramming 550mm, expansion to pile length less than 6m. DDC pile and CFG pile are obligate 500mm pile construction, completing in virtual 1000mm thick pile top laid the gradation sand pad within 5%, 10% of cement mixed lime, and exactly amount water, compaction coefficient is not less than following. Design of composite foundation of bearing capacity is not less than 450kpa characteristic value; the base is about natural elevation below ground 7.0m.

4. Field Test and Analysis of the Results

In order to check after DDC method and the comprehensive handling CFG pile composite foundation bearing capacity, after eliminating the effect of collapsibility compliance with design requirements, followed by a single pile composite foundation static load experiment and DDC pile body filler and between the quality of pile soil test, and according to the relevant requirements are evaluated.[7]

4.1 CFG Pile Composite Foundation Static Load Test

The single pile composite foundation bearing capacity test use the slow maintain load method, loading counterforce device according to the condition on site selection pressure heavy platform counterforce device, use 500t hydraulic jack add lotus, orthogonal diameter symmetry position decorate 4 big span displacement measurement root plan for settlement, choose diameter read 1.26m, area of 1.25m2 circular rigid pressure plates. Excavation trial pit, dig the soil to design elevation, using 150mm thick layer make level several problems, make its elevation and pile top design elevation consistent, and timely placed pressure plates, rack good counterforce platform and began to experiment. Loading grading, using auto-merging equivalent load, For maximum loading grading load of 1/10, of which the first level desirable grading load of 2 times, maximum loading not less than 900kpa. Each additional level load, before and after each measurement, remember a reverse subsidence, there was no 0.5 hours measure remember once, when in consecutive 2 hours, every hour of subsidence 0.10mm, less than that already became stable both sides sinking, can add to the next level load. And every class load time interval of which shall not be less than 2 hours.[3]

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This trial of composite foundation for 3 place single pile composite foundation static load test, the test result see Figure 1, Figure 2 and Figure. 3. By the graph shows, 3 groups areas of the p-s curve saw no obvious proportion boundaries, and because of this site points with powder soil primarily, therefore take s/d = 0.010, according to the relative deformation values determine bearing capacity, and the characteristic values greater than maximum loading pressure value shouldn't half done.[4]

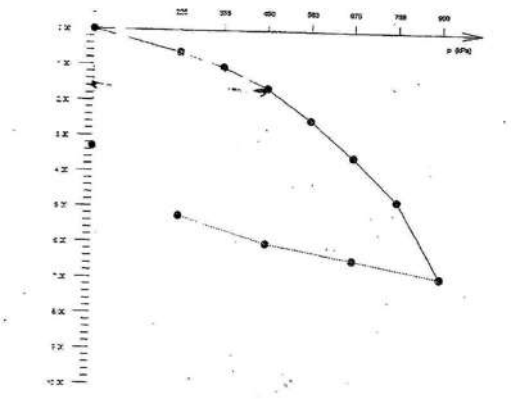

Figure 1. *p-s* curves of No.1 compound foundation

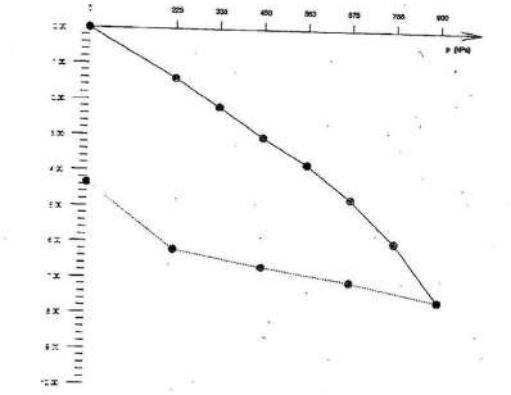

Figure 2. *p-s* curves of No.2 compound foundation

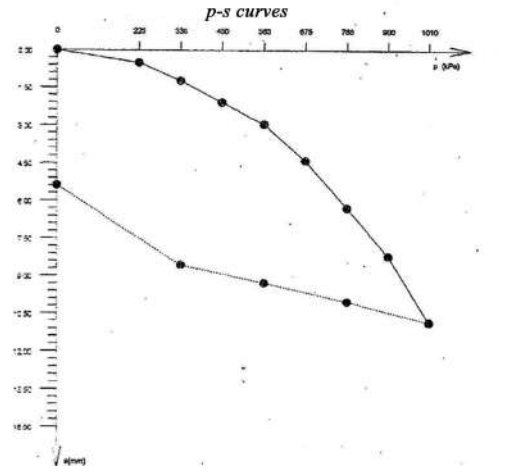

Figure 3. *p-s* curves of No.3 compound foundation

No.1 pile composite foundation sites (no 7-51, pile length 8.5m) the most damning jose 900kpa, maximum amount for the settlement is for 5.67mm, from p-s curve analysis, which is slow deformation, according to the building foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

No.2 pile composite foundation sites (# 11-45, the pile length 7.0m) the most damning jose 900kpa, maximum amount for the settlement is for 4.17mm. From p - the s curve analysis, which is slow deformation. According to the construction of foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

No.3 composite foundation sites (pile number 13-24, pile length 5.0m) the most damning jose 900kpa, maximum amount for the settlement is for 21.26mm. From p - the s curve analysis, which is slow deformation. According to the construction of foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

Above all, after DDC method after construction, CFG pile composite processing of composite foundation bearing capacity has been greatly improved, can satisfy the requirement of the project.

4.2 DDC Pile between Soil Collapsibility, Pile between Soil Confidential Coefficient and Pile Body Compaction Coefficient Test

Piles of soil dry density between pile top down since detection: 1.0m onwards, each 1m earth-gathering sample determination dry density, each 1m take 2 point, be in namely pile bore outside 100mm place 1 a.m. and pile bore the central distance between (1/2) place 1 point. Take and pile soil sample, do between mixture compaction tests, the result of soil pile between maximum dry density and optimum moisture content. The conversion between the averages obtained pile soil compaction coefficient and minimum confidential coefficient.

Pile body packing quality inspection: the pile top-down 1.0m onwards, each 1m earth-gathering sample determination dry density, each 1m take 2 point, be in namely pile hole pile hole edge 50 place from 1 point, pile hole center (namely 1/2) place 1 point. Take and pile body packing products, being the compaction test pile body filler, it is concluded that the maximum dry density and optimum moisture content. The conversion of pile body filler obtained average compaction coefficient. For the project in

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the open 2 DDC profile, test results are showed in Table 1.

Table 1

Exploratory Wells No.		T1	T3
Compaction coefficient	I	0.96	0.99
	II	0.88	0.92

***Notes*:** I representative pile body; II representative pile between soil

Pile between the collapsibility detection: the pile top-down 1.0m onwards, each 1m earth-gathering sample determination collapsible coefficient. For the project three place three piles DDC between soil profiles, the open experimental results as shown in Table 2.

Table 2. Comparison between related parameters of soil between piles before and after treating

situation	$\gamma_d / KN \cdot m^{-3}$	e	E_{s1-2} / MPa	δ_s
before	13.86	0.912	4.08	0.046
after	16.01	0.693	8.64	< 0.015

After the treatment of pile soil dry density between improve 16%, porosity ratio decreases 24%, compression modulus before 2.1 times for processing, explained through hole deep dynamic compaction pile after processing between soil compaction effect is good, greatly reduce the compressibility, bearing characters more uniformly and reliable.

5. Conclusion

Through the experimental study on the actual project, draws the following conclusion:

·Whole deep dynamic compaction method is an effective treatment method. After processing, the composite foundation bearing capacity can be easily achieve the design requirements, and much higher than the natural soil bearing capacity. It also can rise the compaction effect of soil between piles, so as to improve the bearing capacity of soil between piles, reduce soil compaction, greatly improve the bearing behavior of the foundation, and can effectively eliminate the collapsible loess foundation.

·After forced ramming, the characteristic value of bearing capacity of CFG pile composite foundation is bigger than estimated calculated value, it can not only meet the design requirement, but also can short the construction period and save economy.

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REVIEW

Mega-city Planning Challenges——Taking Beijing as an Example

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ABSTRACT

In the past 30 years, China has experienced development at full speed, and the cities have expanded rapidly. There have been dozens of megacities with millions of people. Due to the lack of preparation of various factors, these cities will inevitably also have some urban diseases similar to those in the mega-cities of the world. How to develop mega-cities, especially how to ensure the sustainable development of mega-cities, such as Beijing, Shanghai, Guangzhou, etc., is a question that must be answered. This paper mainly discusses the challenges faced with city planning, especially for mega-cities, taking Beijing as an example and analyzes from following aspects: institutional challenges, demographic challenges, and environmental challenges, and hopes to provide references for city planners.

1. City Background

Beijing, the capital and second largest city in China, has undertaken the culture center and the education center. And Beijing is the core city for the Beijing-Tianjin-Hebei Region, which is the pole of development in the region. Therefore, Beijing is of prime importance in Chinese cultural, politics and economic.[1] The whole city covers an area of 6336 m² and is combined by 16 urban districts and 2 counties. The urban form of Beijing is formed by circular expressways which makes the city as concentric structure. And in 2016, the Beijing government has started designing the 7th ring road. The 4th ring road is halving the line between the urban area and the peri-urban area of the municipality.[2]

Since Chinese economic reform, Chinese cities have begun rapid urbanization and economic development since the 1980s. Beijing, as one of the most important cities in China, is a very typical example of Chinese rapid urbanization of the past 30 years. The total municipal population increased from 9 million in 1980 to 21.7 million in 2015; this number includes the urban population, rural population and migrants. And Gross Domestic Product (GDP) increased from 13910 million Yuan to 2368570 million Yuan (see Table 1). Economic, population and spatial developments have been brought by the rapid urbanization rate and a great number of migrants, and many challenges have also been brought by the rapid urbanization for urban development. Moreover, many cities in the world have put forward the sustainable development of cities since the 1980s.[3] But the policy of Chinese economic reform and rapid urbanization doesn't come down to the importance of sustainable development because a question of questions in Beijing is poverty-solving issue.[4] The poverty problem has led to the urban planners making the city having the capacity of securing more economic benefits rather than sustainable develop-

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ment. Therefore, it is Inevitable to make some challenges during the rapid urbanization.

Table 1. Beijing population and GDP statistics during Chinese Economic Reform.

Years	Population (million)	Gross Domestic Product (million Chinese Yuan)
1980	9.04	13910
2015	21.73	2368570

***Source*:** Beijing statistical yearbook 2016.

In this paper, 3 main challenges will be focused on in Beijing urban development, which are institutional challenges, demographic challenges and environment challenges. These 3 challenges are indeed hinder the urban development of Beijing.

2. City Challenges

2.1 Institutional Challenges

The first challenge is supposed as the institutional challenge. In urban institute, economic benefit, which is evaluated by GDP, always occupies the most important aspect of urban development in the eyes of policy makers.[5] Focus on economic construction is the basic developing line of the Chinese central government, which is called "one central task and two basic points".[6] Therefore, the urban development of Beijing is also supposed to follow the central government, and economic development becomes the reason and the result for urban development.

From the Chinese economic reform, economic development relies a lot on urban development and infrastructure construction.[7] As we have talked, rapid urbanisation in China is not balanced. It destroys a lot of balance, for example, as Liu et al. claimed, "approximately 80% of urban growth has been at the expense of rural settlements (23.42%) and arable land (57.14%) in Beijing", which doesn't take into account the equality of social and spatial.[8][9] At same time, metropolitan area making by urbanisation also brings economic development and restructuring.[10] Although the urbanization makes the gap between urban and rural bigger and bigger, unbalanced urbanisation is still the indispensable cornerstone in order to sustaining economic prosperity of Beijing, even China's top leaders name it as "new form of urbanization". In other words, the urban development system in Beijing, considering economic development as its core, does not concern the life quality of urban residents as the most important part.

In next 5 to 10 years, if we still Beijing developing by choosing the most profitable institutional way, the urban economic may enhance development successfully, but social equality, environment and urban design processes will be broken. Actually, for Beijing urban design processes, because it is the capital of China and the core city of regional development in Beijing-Tianjin-Hebei Region, Beijing there are many "vanity projects" and high-end properties in Beijing although many basic needs of urban residents are not resolved.[11] That may make over-urbanization which may lead to housing price bubbles. If the majority of housing cannot suit the majority of people, a grievous social inequality will be inevitable in Beijing future urban development.

2.2 Demographic Challenges

As the capital of the most populous country, demographic problem cannot be neglected. The Beijing Statistic Bureau claims that the Beijing population is 15.3 million in 2005, 19.6 million in 2010 and 21.7 million in 2015, so it is very clear to know the rate of population growth is declining, which declined from 28% in 2010 to 11% in 2015.[12] But there is still 11% population growth in Beijing, so if the rate retain 11%, the population will reach 24.1 million in 2020. It is a population explosion because Beijing Overall Urban Planning (2004-2020) determines the total population size control in 18 million people and control the urban infrastructure and other related indicators for 20 million people.

As the central city of the Beijing-Tianjin-Hebei Region and the capital of the People's Republic of China, Beijing has a relatively high level of economic development and a large number chance of job, which has become the main driving force for the large number of rural migration which has led to the population explosion.[13] Apart from that, as the political center, cultural center and education center of the country, the diversified functions of the capital also have great attraction to rural migration, which also leads to a lot of talent to Beijing. Another reason is the inner demand in Beijing, which may have a link with population structure. Beijing has 2.46 million people aged 60 and above which accounts for 12.5 percent (China Data Online [CDO]). A city with more than 10% of the population aged 60 and above is named aged city. Therefore, the economic development of Beijing demands a large number of young people, which brings vitality to the sustainable development of Beijing.

In next 5 to 10 years, as a major resource-oriented city, Beijing has a shortage of natural resources, and 98% of its energy is imported.[14] 100,000 non-agricultural increasing population will increase the direct need of living energy consumption about 14.21 million tons and the indirect need of energy consumption about 23.46 million tons per year. As we have talked, in the future the population

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explosion brings more than 6 million people for Beijing which will demand the more resources for the city. Water, land, housing and other resources are demanded in a larger number, but it is difficult to supply full supporting resources which may bring a lot of risk and uncertainty to Beijing urban development.

2.3 Environmental Challenges

As it already mentioned the demographic challenge and rapid urbanization in Beijing, the excessive population growth and the development of urban area have a direct influence on the environmental challenges. In the case of green space, the scarcity of green space per capita in Beijing was 1072 square meter, which fell to 705.2 square meter in 2010. In terms of resource consumption, Beijing needs to import 13,000 tons' food from other areas and 777,000 tons' water (China Data Online [CDO]). Apart from that, there are 17,000 tons of household garbage, 3.8 million tons of polluted water and 310 tons of SO2 in 2010. As we have talked, rapid urbanization is happening in Beijing, which brings population aggregation and urban sprawl to cause ecological space occupied.[15] In a not very long time, the rapid urbanization will make Beijing become a cosmopolitan city, and that also means a large number of resources are demanded. In this process, the consumption of huge quantities of resources is beyond the capacity of local resources, and pollutant emission is also beyond Beijing environmental capacity at the same time.

In next 5 or 10 years, Beijing rapid urbanization is going on, and the population aggregation and urban sprawl will continue to increase. So, green spaces will be broken sequentially, and the pollutant emission will sustain to destroy sustainable development. We may pay the economic price to solve consequences which are made by environmental disruption. From the social perspective, hostile environment also has a bad effect on Urban Livability. Therefore, it is foreseeable that the environmental challenges will get an intricate location in Beijing urban development.

3. Conclusion

As we have talked about 3 main challenges, institutional challenges, demographic challenges and environmental challenges, in Beijing urban development, Chinese rapid urbanization is unbalanced development with many flaws. For our planners, we are supposed to solve these challenges by reasonable and scientific planning.

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REVIEW

Development and Application of Complete Equipment for High-speed Tunnel Boring and Bolting Machines

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ABSTRACT

With the improvement of coal mining speed and mechanization level in China, traditional tunnel boring methods can no longer meet the actual needs. In order to solve the problems of low efficiency, high labor intensity, slow tunnel boring speed, bad working environment and poor safety in traditional tunnel boring, on the basis of analyzing the development and application of coal roadway tunnel boring equipment at home and abroad, complete equipment for high-speed tunnel boring and bolting machines was developed by using the integrated technology of tunnel boring and bolting. The complete equipment for high-speed tunnel boring and bolting machines has the functions of tunnel boring and bolting synchronization, once-tunneling, negative pressure dust removal, digital guidance, independent cutting feed, digital cutting, safety monitoring and data interaction, which has the advantages of safety in use, reliability and efficiency.

1. Introduction

At present, China is the largest country in the use of coal machinery manufacturing and coal mine equipment. There are more than 130 imported tunnel boring and bolting machines in China. Most of the machines has reached the service life, and it is urgent to update and technically reform.[1] In the "Guiding Opinions on the 13th Five-Year Equipment Manufacturing Development of the Coal Industry" it has also been clearly proposed to vigorously promote the efficient tunnel boring technology for large-section roadways, high-speed tunnel boring technology and equipment for coal and coal-rock roadways, and integrated technology and assembly for tunnel boring to build an intensive, safe, efficient and green modern coal industry system. By 2020, the degree coal mining mechanization of will reach 85%, and the degree of tunnel boring mechanization will reach 65%.[2] Therefore, the development of domestic high-speed tunnel boring and bolting machines is of great significance.

2. Research Status of Bolter Miners at Home and Abroad

2.1 Overseas Research Status

The tunnel boring and bolting machine is an organic combination of continuous miner and jumbolter. In 1990, Austrian Voestalpine AG researched and developed the ABM20 Bolter Miner based on the experience and needs of Australian coal mining. The machine is equipped with

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4 roof jumbolters, 2 side jumbolters and temporary support devices. The main and auxiliary frames can slide relatively to each other with tunnel boring and bolting synchronization and the functions are complete. In 1992, it was modified to the ABM30 Bolter Miner, whose capacity of cutting and mechanism loading has been further increased. In the same year, British Anderson Co. Ltd. developed a prototype of the KBII Bolter Miner. The structural features are roughly equivalent to those of the ABM20 Bolter Miner; American Joy Mining Machinery Co. Ltd. developed the 12BM18 Bolter Miner, which uses a chain-cutting drum, a coal-loading mechanism for the shovel, a crawler-type walking mechanism, equipped with 2 roof jumbolters and 2 side jumbolters for tunnel boring in rectangular roadways; Sweden Sandvik Engineering Group developed the Sandvik MB670 Bolter Miner which integrates tunnel boring and bolting, and realizes the integrated operation of cutting, loading and timbering, once-tunneling. There are more than 120 Sandvik MB670 Bolter Miners which have been applied in the market. In summary, representative machines abroad include Voestalpine ABM20, Anderson KBII, JOY12CMl5-15DDVG, 12BM18 and SANDVIK MB670.[3-5]

2.2 Domestic Research Status

Because the foreign-developed bolter miners cannot be widely used in the complex coal seam geological conditions in China, and the equipment procurement, maintenance and repair costs are high, the domestic efforts have been made to develop the integrated tunnel boring and bolting equipment and technology suitable for most domestic roadways. Since the 1990s, China has carried out research and experiments in the field of high-speed roadway tunnel boring and bolting integration. For example, the Nanjing Research Institute of the China Coal Research Institute and the Baodian Coal Mine of the Yankuang Group Co. Ltd. jointly researched and developed the machine-mounted jumbolter, and installed it on the MRH-S100 Tunnel Boring Machine to form the integrated tunnel boring and bolting machine for testing. However, it is only a prototype of bolter miners, which is different from the actual bolter miners in foreign countries. In order to improve the mechanization level of jumbolter timbering of coal roadways, China has tried to carry out technical transformation of the existing comprehensive tunnel boring machines, and successively developed JMZ22 Machine-mounted Jumbolter matched with AM50 and S100 Tunnel Boring Machines (TBM), by installing the jumbolter on the tunnel boring machine, the bolting operation can be carried out without the need to return the machine during the tunnel boring process, which improves the efficiency of the tunnel boring and reduces the labor intensity of the workers. However, because the configuration problem of the jumbolters is not considered at the beginning of the traditional tunnel boring machine design, the mutual interference between the tunnel boring and bolting is serious, and the application effect is poor. In the true sense, the tunnel boring and bolting machines should consider the configuration of the jumbolters from the initial stage of the tunnel boring machine design. In 2005 and 2006, China's enterprises succeeded in developing a dual-arm geophysical prospecting bolter miner and EBZ160-JM Tunnel Boring and Bolting Machine. The dual-arm geophysical prospecting bolter miner can simultaneously carry out the bolting work on the roofs and the sides of roadways. On the basis of cantilever cutting, EBZ160-JM Tunnel Boring and Bolting Machine has increased the jumbolter and front roof timbering devices, which has changed the simplification operation drawbacks of the traditional tunnel boring machine that requires retreating, re-bolting and re-timbering. China's bolter miner products are still insufficient in the tunnel boring and bolting synchronization, the rock breaking efficiency of the cutting devices, the safety protection design of the tunnel boring and bolting and the reliability of the products, and have a large room for improvement.

Throughout the technical research and application development of the bolter miner products at home and abroad, the integrated technology of tunnel boring and bolting has become an inevitable trend of technological development in modern tunnel boring construction.[6-8]

3. The Characteristics and Functions of Complete Machine for High-speed Tunnel Boring and Bolting Machines

In order to solve the imbalance of tunnel boring and bolting in coal mines, carry out coal roadway construction operations safely and efficiently, focusing on mastering the key technologies and applications of coal mine roadway tunnel boring product—— bolter miner, the ZJM4200 Complete Equipment for High-speed Tunnel Boring and Bolting Machines developed by China Railway Construction Heavy Industry Co., Ltd. can realize the tunnel boring and bolting synchronization and parallel operation in the true sense, which has remarkable advancement and has been successfully applied to the 5824-meter roadway of Sunying Chayi Mine in Shenmu, Shaanxi, and completed industrial tests. The overall technical performance of the prototype has reached the international advanced level.

The equipment adopts full hydraulic drive, crawler type walking, retractable drum upper and lower cutting, cyl-

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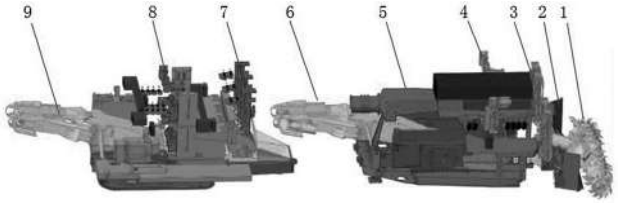
inder propulsion, stepping tunnel boring method, which has the characteristics of small rock stratum destructiveness and complete synchronization of tunnel boring and bolting. The complete machine is composed of the main machine and the post-matched lining trolleys. The main machine has the main functions of tunnel boring and bolting synchronization, once-tunneling, negative pressure dust removal, digital guidance, independent cutting feed, digital cutting, safety monitoring and data interaction. The overall structure is shown in Figure 1.



Notes: 1: Cutting devices; 2: Loading devices; 3,7: Roof jumbolters; 4,8: Side jumbolters; 5: Dust removal fans; 6,9: Scraper conveyers

Figure 1. The overall structure of complete machine for high-speed tunnel boring and bolting machines

3.1 Synchronous Operations of Tunnel Boring and Bolting

The complete machine for high-speed tunnel boring and bolting machines adopts the design concept of tunnel boring and bolting both synchronization and integration, and its implementation method is as follows: the cutting drum and the jumbolter timbering devices are arranged in a reasonable division and distributed on different trolleys, and the cutting drum and the front drilling machine trolleys are used as the main machine, and when tunnel boring at working surface of the roadway, the main machine is arranged with front timbering devices. When the cutting devices of the main machine are tunnel boring, the temporary timbering devices will support the wall surface of the coal roadway to temporarily stabilize the wall surface. At the same time, the front drilling timbering machine is supported to reduce the unsupported roof distance, which effectively protects the safety of the operators. 2 side jumbolter timbering devices are arranged on the main machine when the cutting drum is tunnel boring; the coal roadway side timbering is also carried out at the same time. The timbering trolley is specially used to make up the roof and side jumbolters to achieve the effect of tunnel boring and bolting synchronization.

At the same time, by analyzing the stress distribution after coal roadway tunnel boring, the jumbolter timbering devices are reasonably arranged, and the top bolting machine, the roof jumbolters, side jumbolters and jumbolter ropes are in a dislocation arrangement to ensure that the jumbolter timbering devices do not interfere with each other during operation. The jumbolter timbering work platform can move 1.3 meters on the chassis as a whole. The second row of side jumbolters, the third row of side jumbolters and the fifth row of side jumbolters have separate sliding functions, which can realize the jumbolter operations of any distance between rows in the range of 0.8-1 meters, which can ensure Comprehensive timbering of the entire coal roadway; the working mode of the temporary timbering of the main machine and the front synchronous timbering ensures the safety and reliability of the continuous operation of the bolter miners.[9]

The design concept of temporary timbering, jumbolter timbering devices and the working form of jumbolter timbering devices, as shown in Figure 2, have the following advantages:

(1) The tunnel boring and bolting are carried out simultaneously, and anchoring do not interfere with each other, and the roof and two sides of the coal roadway are timbered in time to realize high-speed and continuous tunnel boring of the coal roadway.

(2) The integration of the tunnel boring and bolting is carried out simultaneously, which reduces the auxiliary working time. By controlling the deformation of the surrounding rocks in time, the supporting operation can be completed without the need to retreat the machine, which greatly improves the tunnel boring speed of the coal roadway.

(3) It can provide large temporary timbering force in time, so that the integrated tunnel boring and bolting machine is under the protection of the safety of the timbering to ensure the safety of the construction personnel.

(4) It has low requirements on the bearing capacity of the footwall, and the crawler does not move in place when undermining and does not damage the footwall.

(a) The tunnel boring of main machine

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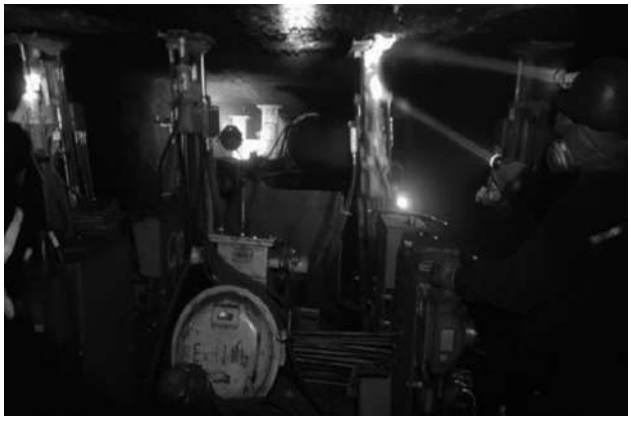


(b) The post-matched timbering

Figure 2. Synchronous operation of tunnel boring and bolting

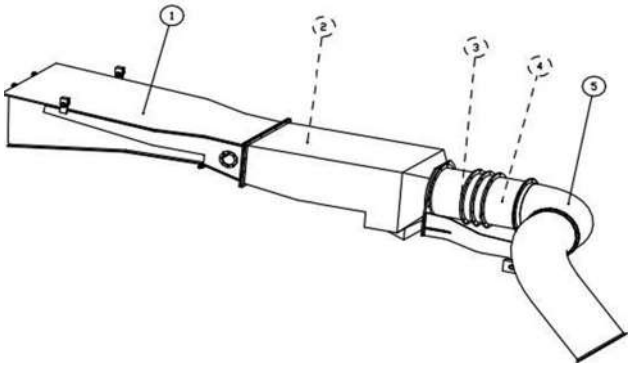
3.2 Once-tunneling

The tunnel boring system of complete machine adopts a retractable high-power, low-speed cutting drum structure, and the cross-section can be rectangular or arched (the drum-shaped cutting drum needs to be replaced when meeting the arched roadway). When tunnel boring, the chassis does not move; the cutting devices are advanced by the undermining oil cylinder to realize the cutting feed. The maximum one-time advance is 1 meter, and the cutting is completed into a once-tunneling roadway. The disturbance to the rock layer is small, and the quality of the roadway is high. In order to adapt to different specifications of coal roadways, the cutting drum stretchable width range covers 4.9m-6.2m, and can also be customized design; the roadway height covers 3.2m-5.5m. The structure is shown in Figure 3.

Figure 3. Once-tunneling

3.3 Negative Pressure Dust Removal

The dust removal system is designed to ensure the clean working environment in the coal roadway (as shown in Figure 4). The complete machine adopts semi-closed negative pressure dust removal and spray dust reduction system (as shown in Figure 5). The dust is effectively isolated from the operators, and the dust generated during the cutting process is sucked into the dust collector by negative pressure dust removal fans, and the dust removal capacity is up to 300 m3 /min. The coal water discharged after the dust removal by the dust removal fan directly enters the scraper conveyor and is transported to the transportation system along with the coal flow. The semi-closed negative pressure dust removal system improves the air quality in the working area and ensures the occupational health of the workers.



Notes: 1: Exhaust inlet; 2: Dust remover; 3: Fans; 4: Hydraulic motor; 5: Air pipes

Figure 4. The dust removal assembly units

Figure 5. Semi-closed negative pressure wet type dust removal system

For the negative pressure dust reduction technology, the main factors affecting the performance are the water supply pressure, the ventilation volume, the performance and position of the nozzle. The requirements for the fan during the construction operations of Bolter miner are very strict. The resistance of the ventilation system is an important parameter basis for determining the wind pressure of the fan. The air flow in the duct in the ventilation system produces two kinds of resistance: one is the resistance along the path, which is caused by the friction between the internal viscosity of the air and the wall of the ventilation duct, and the resulting energy loss along the path; the other is local resistance, which is generated by the eddy current generated when air flows through the elbow in the air duct and at the variable diameter, and the energy loss generated locally is concentrated. Fan wind pressure is used to over-

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come the above two resistances to ensure that the required design air volume is delivered to the working area.[10]

The complete equipment for high-speed tunnel boring and bolting machines adopts the above semi-sealed negative pressure dust removal combined with the principle of spray dust reduction, combined with theoretical analysis to design the ventilation dust removal device, effectively solve the dust removal problem and improve the working environment. The drum is equipped with an internal and external spray system, and the dust reduction effect can reach 80-90%, which is the first dust removal function. After dust removal, the dust concentration is still high, and a second dust reduction treatment is required. In the process of powder propagation and diffusion, it is captured and extinguished, namely, the vacuum flow of the roller end face is absorbed and purified by the negative pressure secondary dust reduction technology, thereby achieving the purpose of dust reduction. The dust removal structure separates the cutting section from the worker's operation area, and adopts imported wet dust-reducing equipment. The dust treatment capacity is 300m3 /min, and the dust removal field application works well with bolter miners.

3.4 Digital Guidance

Figure 6 shows top and side cross-sectional views of the roadway.

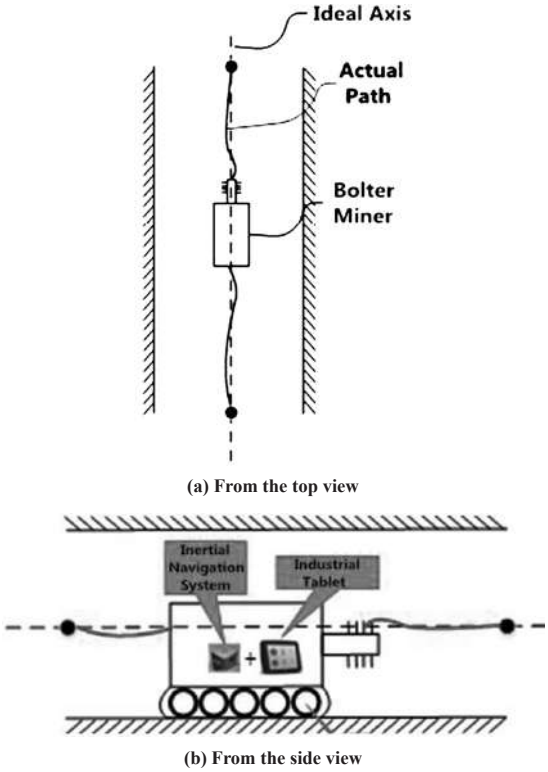

Figure 6. The top and side cross-sectional views of the roadway

As can be seen from Figure 6, when the bolter miner is advancing in the roadway, between the actual path of body axis and the ideal axis of the roadway, angular deviations in the three dimensions of pitching, roll and heading are inevitable. As the mileage of the bolter miner advances, the actual motion track will deviate from the ideal axis in the space coordinates of the roadway. The main purpose of the system (Figure 7) is to obtain the three-dimensional offset of the vehicle body and the absolute three-dimensional coordinate data (with the initial alignment of the total station) as the control input for the mileage advancement of the bolter miner to ensure that the actual propulsion trajectory of the bolter miner and the error of the ideal roadway axis are controlled within the threshold range allowed by the tunnel boring and bolting process.

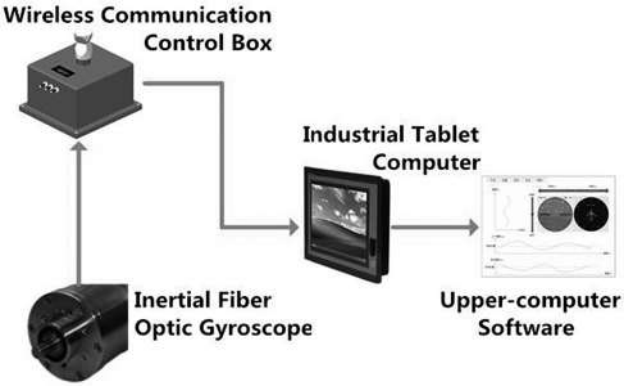

Figure 7. Automatic guidance system

The automatic guidance system of the device is mainly composed of: RMS-D automatic guidance system software, inertial fiber optic gyroscope, wireless communication control box, industrial tablet computer (pre-installed software), and dedicated power supply cable. The device adopts digital gyroscope inertial navigation technology to break the traditional discontinuous measurement method, constructs a three-dimensional coordinate model of the state of the anchoring machine, senses the state of the bolter miner, and combines the inertial guidance technology with the sensor measurement to realize the automatic positioning, rectification, remote control and automatic monitoring functions of the anchoring machine.

The system displays the offset in real time, which can accurately control the midline offset of the roadway, and the roadway tunneling deviation is ≤5cm. It has the following main characteristics and advantages (Figure 8):

(1) The measurement accuracy of the core inertial measurement unit and the stability of the long-term work index are improved, and the system index is improved in essence, and the continuous precision maintenance of 300m without manual correction is realized.

(2) The navigation information is abundant, which can

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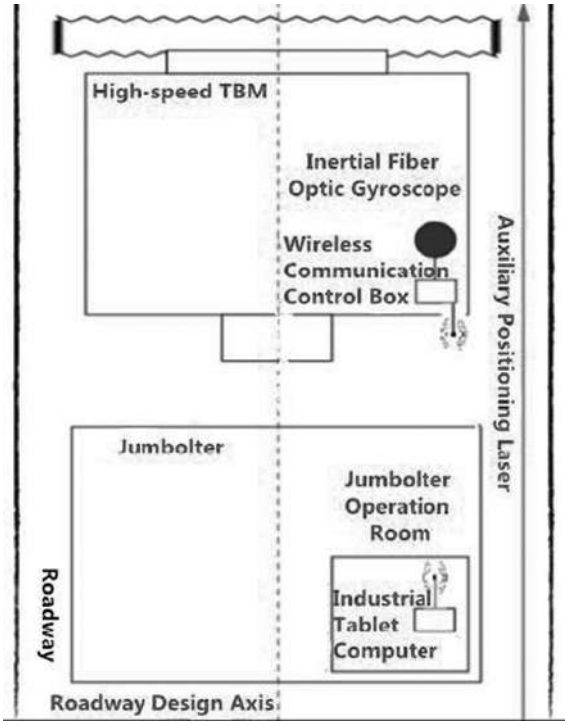
independently give all the high-precision information needed to realize automatic guidance, including: real-time attitude and heading, and three-dimensional translation data in the roadway coordinate system.

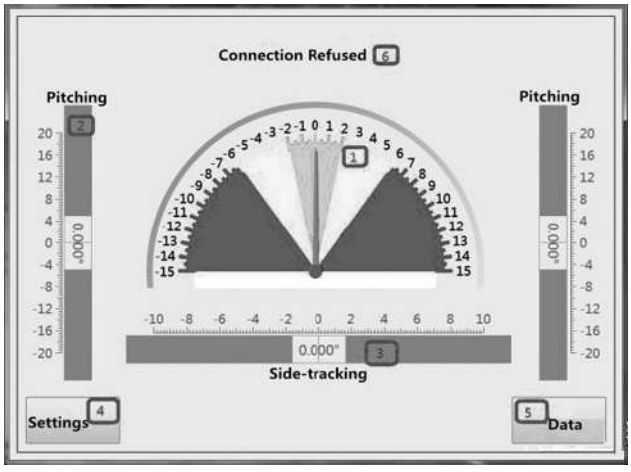
(3) It is tightly coupled with the data of system sensors such as encoders, and uses the inertial navigation information to automatically correct and compensate the disturbance errors such as track slip and idling, and the data of the system sensors participate in the inertial navigation solution.

(4) It has visual human-computer interaction with easy operation and low threshold.

(5) Optical measurement assisted calibration to further improve the overall guiding accuracy of the roadway.



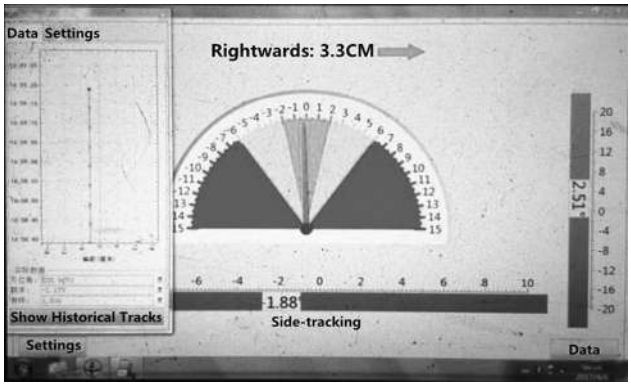
(a)



(b)

(c) Digital gyroscope —— precise guidance

(d)



(e)

Figure 8. Guidance control equipment and man-machine interfaces

3.5 Safety Monitoring

At present, the safety production status of China's coal is still not optimistic. In many coal mine safety accidents, there are many inducing factors. However, the incomplete

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monitoring equipment for harmful gases in the coal mine production process and the backward warning technology are one of the important factors causing accidents. Harmful gases are methane, carbon monoxide, carbon dioxide, dust, etc. When the gas concentration in the air reaches 5%-16%, it will explode when it encounters a certain ignition energy (usually caused by electrical sparks, accounting for 50% of the total fire). When there is coal dust in the mixed gas, the lower explosion limit is lowered. The proportion of various gases is different, and the accidents caused are equally deadly. Therefore, the monitoring and early warning system for harmful gases is an important management tool for controlling gas accidents, which can not only accurately detect the content of harmful gases, but also automatically issue an alarm when the measured harmful gas concentration exceeds a predetermined value, reminding the staff to stop working or leave immediately, so that the coal mine can take targeted preventive measures. In addition, it also immediately cuts off power in hazardous areas to avoid accidents. Therefore, real-time detection of methane, carbon monoxide, carbon dioxide, dust and other harmful gases in the underground air environment, as well as early warning is necessary.[11]

The complete equipment for high-speed tunnel boring and bolting machines has a set of digital, intelligent and automated monitoring and early warning system for harmful gases, which is equipped with a comprehensive methane detector, carbon monoxide sensor, infrared carbon dioxide sensor, dust concentration detector and other sensors to perform real-time, continuous and comprehensive monitoring of the main harmful gases (Figure 9). At the same time, through data acquisition, the main control system of the equipment performs data analysis, display, alarm, active braking, etc., and pre-processes and forecasts the upcoming danger (Table 1). In accordance with the requirements of the coal mine safety regulations, the "three special & two locks" (Special transformer, special cable, special switch; wind power lock, gas lock) were implemented to ensure the safety of the operators. At the same time, the sensor has good stability, strong anti-interference ability, small monitoring error, and few false alarms. The prediction and production do not affect each other, which provide a powerful guarantee for improving production efficiency under safe and reliable production conditions.[12]

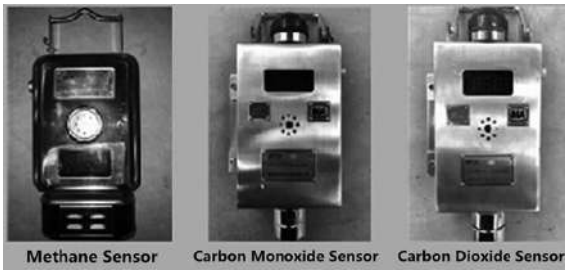

Figure 9. Gas sensors

The complete equipment for high-speed tunnel boring and bolting machines is also equipped with a combined amplified telephone with voice alarm function. The combined amplified telephone is intrinsically safe and is suitable for use in coal mines with coal dust and explosive gas. Up to 15 alarm sounds can be prepared according to site requirements. In addition, the combined speakerphone has two LED displays for light alarms. When the methane, dust and other harmful gases in the excavation site exceed the standard, the voice alarm function of the combined

Table 1. The Characteristics of gas sensors

Product Name	Explosion -proof Form	Testing Range	Measuring Errors	Response Time
Methane Sensor	Mining Intrinsically Safe	0 ~ 10.0%	00.00 ~ 1.00%≤±0.10% 1.00 ~ 3.00%≤±10% 3.00 ~ 4.00%≤±0.3% 4.00 ~ 10.00%≤±10%	20s
Mining Carbon Monoxide Sensor	Mining Intrinsically Safe	0 ~ 500 ppm	0.00 ~ 100.0ppm≤±4ppm 100 ~ 500 ppm≤±5%	35 s
Infrared Mining Carbon Dioxide Sensor	Mining Intrinsically Safe	0 ~ 5.00%	0.0~0.50%≤0.10 % 0.5~5.00%≤±0.05%+5% truth-value	30s
Mining Dust Sensor	Mining Intrinsically Safe	0.01 ~ 1000mg/m3	≤±2.5%	20s

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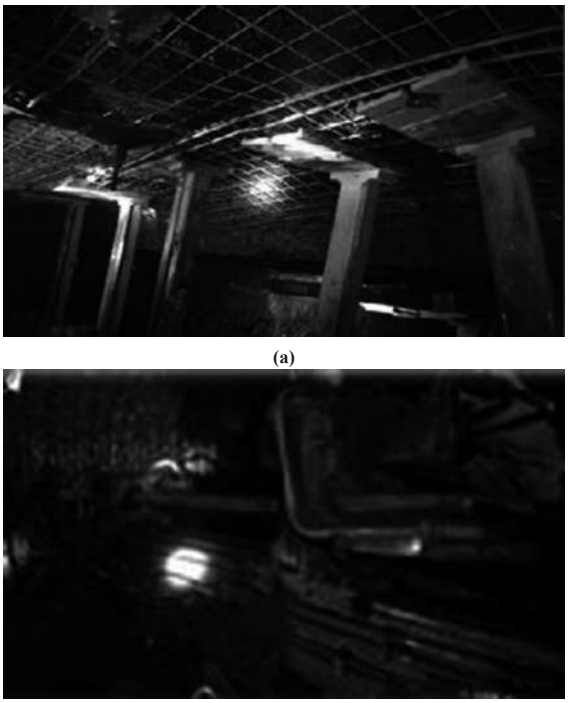
amplified telephone will emit methane exceeding the standard. Please pay attention to the dust, please pay attention to the voice prompts, and issue a light alarm.

4. The Application of Complete Equipment for High-speed Tunnel Boring and Bolting Machines

The equipment has achieved good results after being used in Sunying Chayi Mine in Shenmu, Shaanxi.

The main roadway of the mine adopts a rectangular section with a sectional area of 5.2*3.2m, a hardness of coal seam f4, a density of coal seam of 1.28-1.3t/m^3; the timbering method is arranged as 4 roof jumbolters and 3 side jumbolters on each side. This complete equipment for high-speed tunnel boring and bolting machines has completed the footage of 5824m, the highest daily footage is 92m, and the highest monthly footage is 2425m, the coal tunnel boring speed is high, and the labor intensity is low; it is also safe, reliable and efficient. The construction site is shown in Figure 10.



(a)

(b)

Figure 10

5. Conclusion

The successful development of this complete equipment for high-speed tunnel boring and bolting machines has filled the blank of the domestic integrated technology of tunnel boring and bolting, which has greatly promoted the market application of the domestic complete equipment for high-speed tunnel boring and bolting machines. Its successful development is of great significance to improve the mechanization level of coal mine construction and the safety, reliability and efficiency of construction.

(1) The synchronous operation of tunnel boring and bolting has been realized, which solves the key problem that the tunnel boring and bolting cannot be synchronized, greatly improves the efficiency of the roadway tunneling, breaks through the technical bottleneck of coal mine mining imbalance, and significantly improves the high-speed tunnel boring level of coal mine roadways under complex geological conditions.

(2) The use of negative pressure dust removal, digital cutting and other technologies has greatly improved the construction environment, improved the speed of coal roadway tunnel boring, ensured the safety of coal roadway tunnel boring, and reduced the labor intensity.

(3) The three-dimensional coordinate model of the state of the bolter miner is constructed. The sensor, automatic detection and positioning and rectification technology are used to realize the automatic positioning, remote control and automatic monitoring of the bolter miner, which improves the intelligent level of the bolter miner, provides a theoretical and practical basis for the development of intelligent bolter miners.

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REVIEW

Analysis of Urban Road Construction and Related Problems and Countermeasures

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ABSTRACT

With the rapid development of China's economy, China's urbanization process is also accelerating, the municipal road as an important supporting force to accelerate the construction of urbanization is becoming more and more important, corresponding, the city's requirements on the road is also gradually improving, the quality of the city road affects the daily travel of urban residents. If the road design is not reasonable or the construction quality is not up to standard, it will bring great changes to the urban residents. Therefore, urban road construction will face greater challenges in the future. This paper emphasizes the importance of road construction quality, analyzes some common problems in urban road construction, and puts forward some solutions to the problems in urban road construction.

1. Introduction

Road is the foundation of regional economic development, and it is of far-reaching significance to social and economic development. The quality of road construction in China has always been the focus of attention from all walks of life at all levels, especially in recent years; China to accelerate the pace of road infrastructure construction, road construction quality problems and control countermeasures to study has important practical significance. Road construction is a complex project affected by geological factors, hydrological factors and macro-environmental factors. Due to the strong safety and durability requirements of road construction, in the construction process, the construction subject should carefully consider the influence of the overall environmental factors such as geology, hydrology and climate, strictly control the quality, and practically carry out the construction work according to the actual environment and actual requirements of the road project. We need to improving the quality of road construction project, the most important thing is that the construction main body to set up the concept of "quality is the soul of engineering", through effective construction management in the process of concrete construction to ensure construction quality, to establish a scientific and effective construction plan, strictly control the construction quality supervision link, for the construction of damaged parts with specific quality control.

As one of the most basic urban facilities, roads bear the important responsibility of urban residents' travel. Just

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like the saying "if you want to be rich, build roads first", urban roads greatly promote the rapid development of China's economy and accelerate the process of urbanization, which is of great value. Urban roads are very important for a city. The quality and operation of urban roads are determined by the quality of urban road construction, which will have a corresponding impact on the development of the whole city. Therefore, urban road construction must be paid attention to.

2. Construction Characteristics of Urban Roads

2.1 The Space Is Relatively Small

The urban road construction site is relatively small, with large vehicle and pedestrian flow, which is easy to cause traffic jams. It is very inconvenient to control the traffic within the limited construction scope. And, all sorts of heat, underground electric power, communication, conduit and gas pipeline are in underground cross laid, bring bigger difficulty to the construction, cause construction spot to manage difficulty.

2.2 The Construction Time Is Tight

Urban road construction has the characteristics of quick start and short time, which makes the construction unit unable to screen the construction team seriously. Sometimes in order to shorten the construction period, some construction units unified different construction section teams to carry out construction, resulting in the lack of communication and cooperation between different construction teams, resulting in the decline of construction efficiency. At the same time, the technical management level and quality awareness of different teams are different, it is likely to appear project quality problems. Some even use the method of design while construction on one side, cause many mistakes, cannot ensure the qualified standard of construction working procedure and project quality.

2.3 Difficult Management

Urban road engineering involves many different units and departments, and the relationship between the units and departments is not close enough, which leads to the increase in the difficulty of construction management and cooperation, and affects the accuracy of design and the rationality of construction plan to a certain extent. At the same time, different construction conditions and construction environment will also have an impact on the construction process.

3. Existing Problems in Urban Road Construction

3.1 The Quality of Construction Personnel Is Not High

The construction of roads is inseparable from People's daily life. Good road construction can improve people's quality of life to a certain extent. Therefore, the construction of roads is of great significance. However, if we do not pay attention to road construction process management and neglect the quality of road construction, once the road construction is completed and put into use, there will be a traffic accident, which will bring great threat to people's property and life. From the subjective aspect, the causes of road construction quality problems, mainly some construction personnel overall quality is not high, in the process of construction without quality consciousness, lack of sense of responsibility to ensure the quality of the road, and some construction personnel technical level is not high also, cause the construction of roads and expected a certain gap.[1] There are many problems in the comprehensive quality of urban road construction technicians, such as their skills, abilities and quality consciousness. Especially today, with the rapid development of urban roads, the demand for technical talents is increasing, the talent reserve is insufficient, and the construction technology, quality management and cost control are lacking. In particular, a large number of migrant workers with low knowledge level joined in, although to a certain extent saved the cost of urban road construction investment, but the lack of construction safety control and management of comprehensive talent, resulting in the overall construction team level decline.

3.2 Problems in Groove Backfilling

The backfilling compactness of the groove is not up to the standard. Different pipelines are laid in the underground space of urban roads, so the compactness of groove backfilling has a great influence on the roadbed. The strength and stability of subgrade are the basic conditions to ensure the pavement strength and stability. In the process of road construction, the core to ensure the quality of subgrade construction is the embankment filling and the backfilling of pipeline groove. In the process of backfill compaction, the compactness of backfill will be affected by the super-thick backfill, rolling inclination or the type of filling soil that does not meet the construction requirements.[2] When the road trench is backfilled, the construction operation is not carried out in accordance with the relevant construction regulations and requirements seriously, or even the operation is violated. As a result, there will be

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relatively large subsidence at the part of the road trench once the new road is completed. This kind of phenomenon is quite common in the current road construction process. Therefore, great attention should be paid in the construction process. In practice, we will find that, in the process of road construction, construction personnel are not road grooves clean water exclusion in fill again, this will lead to road trench backfilling for sand will contain relatively high moisture content, this will make cars when building roads cause a settlement of the road groove parts, the traffic accident to happen.

3.3 Problems in the Management of Urban Road Construction

Construction site management is a key link in project construction and an important factor to determine the quality of road construction. Municipal road construction, field management work is particularly important, the scene of construction as the main venue of urban road construction, raw materials and equipment, and many other factors must be implemented in the field management, therefore, the standardization of the construction site management system construction work is very important, most engineering decision makers did not attach importance to the importance of the construction site management work, even the phenomenon of chaos. In the construction, there is often the phenomenon of lax site management, such as improper stacking of raw materials and low construction efficiency.[3]

4. The Solutions to Urban Road Construction Problems

4.1 Improve the Overall Quality of Road Construction Personnel

The main body of municipal road engineering construction is the construction personnel, construction personnel's comprehensive quality and professional technical level will directly affect the construction quality and safety of municipal road engineering, must attach great importance to the training of construction personnel, construction personnel to continuously improve the technical level, at the time of construction of the key link to must want to do a good job of compulsory education road construction personnel, continuously improve the accuracy of mechanical operation and security, can fundamentally guarantee the efficiency and safety of municipal road engineering construction.[4]

4.2 Strictly Control the Backfilling Quality

In the process of backfilling the trench, it is necessary to ensure that there is no water in the trench; and the water content of the backfilled soil should not be too high; finally, hierarchical backfilling management should be carried out, in which backfilling thickness should be less than 30 cm and compaction must be ensured. At present, in the construction, not only need to carry out manual compaction, but also need to properly use roller compaction operations.[5]

4.3 Strengthen the On-site Management of Urban Road Construction

Establish and improve the urban road construction site management rules and regulations, formulate a scientific operation process and strictly comply with the implementation, and do a good job in urban road construction site management. The specific measures are as follows:

(1) Strengthen the monitoring and assessment of construction quality on site. By the owners, supervision, quality inspection stations and other joint, the use of regular inspection and on-site random inspection and other methods, the overall operation of the construction quality and the quality of key parts of the supervision and control. The content of monitoring and assessment must be based on different project content and requirements.

(2) Strengthen the supervision and inspection of on-site construction. Develop operable on-site supervision and inspection measures, because the standard is too high or too low cannot solve practical problems. The current headquarters of the project manager, the project management department of the construction team have the site quality management objectives accountability, but only these big goals are not enough, also need to carry out specific details of the objectives, determine the quality management of the construction site small objectives, at the same time the site quality supervision and inspection and management measures must be strong.

(3) Strengthen on-site material inspection. The performance of materials used in urban road engineering largely determines the usage and service life of urban road engineering. In the construction process, the source channels of road engineering materials are usually complex and vary greatly; especially the sources of sand and stone change frequently, so it is necessary to strengthen the on-site material inspection. Concrete measures are: ① All materials prior to the acceptance of the project supervision engineers need to be inspection, sampling test and retest, the construction unit to procurement of engineering materials, "three certificates" and must be provided in accordance with relevant standard sampling inspection, implement the system of witness sampling, unqualified material is allowed to enter the construction site, the response to

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repel it. ② In the engineering material inspection and acceptance work, supervision engineer to strictly control the supply of materials, strengthen the sampling inspection of materials, to ensure that the quality of materials must be qualified.[6]

5. Conclusion

In recent years, the national economy is developing at a sustained high speed, and the urbanization process is also accelerating. Road engineering is a very important infrastructure for cities, and plays a particularly important role in promoting economic development. Therefore, it is necessary to master more advanced road construction technology, in the actual process of construction in strict accordance with national standards, only in this way can effectively improve the quality of the road, provide convenience for people's travel, and promote the national economic development.[7] in the process of road construction everywhere have security issues, and in the each link in the process of engineering construction are likely to exist hidden danger, cause serious threat to construction personnel life, so the road construction personnel should improve the quality of their own safety and the construction unit should implement the responsibility system for safety to each person, in order to supervise and urge and alert to every employee to the attention of the safety construction management. Moreover, safe construction management can be used for road construction site safety management to improve the safety index. According to different construction parts, different predictions and precautions can be made to meet the different needs of road construction site safety. The goal of safe construction management is to provide scientific basis for road construction safety management and reduce and avoid road safety accidents.[8]

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