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High Altitude Mountain Wind Farm Fan Foundation Large Volume Concrete Analysis of the Construction Technology Characteristics

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Abstract

In today's world, the great changes unprecedented in a hundred years are accelerating, climate change and turbulence bring serious challenges to the survival and development of all mankind, the global energy industry chain supply chain has suffered serious impacts, the international energy price is high and oscillating, the energy supply and demand map has been adjusted in depth, and the new round of scientific and technological revolutions and industrial revolutions have developed in depth, so that the safety and efficiency of the energy and power systems, the transformation of green and low carbon, and the digitalization and intelligentization of technological innovation have become the global development trend. become the global development trend. By the end of 2022, the total installed capacity of all types of power supply in China will be 2.56 billion kilowatts, and the scale of west-to-east power transmission will reach about 300 million kilowatts. The ability to optimize the allocation of power resources is steadily improving, and the green and low-carbon transformation of power is accelerating; the installed capacity of non-fossil energy reaches 1.27 billion kilowatts, accounting for 49% of the total, exceeding that of coal power (1.12 billion kilowatts) In 2022, the power generation capacity of non-fossil energy reaches 3.1 trillion kilowatts per hour, accounting for 36% of the total power generation capacity. Among them, the installed scale of wind power and photovoltaic power generation is 760 million kilowatts, accounting for 30% of the total installed capacity; wind power and photovoltaic power generation is 1.2 trillion kilowatt-hours, accounting for 14% of the total power generation, which is 13 and 10 percentage points higher than that of 2010 and 2015, respectively. With the accelerated implementation of the construction of the Chengdu-Chongqing region of the Twin Cities Economic Circle, Sichuan economic and social development into a new round of high-speed development, Sichuan speed up the implementation of multi-energy complementary power projects and interconnection and mutual aid grid project. 2023, Sichuan energy builders "listen to the wind, explore the ground, see the water, chase the light," 18 wind power project to speed up the horse, and the wind power in Sichuan. The vast majority of the project is in the southwest region of Sichuan high-altitude mountains. Facing a series of problems such as high altitude, harsh climate, short construction period, high construction quality requirements, this paper optimizes the wind turbine foundation concrete pouring process, improves the secondary grouting mixing process, and strengthens the process control to improve the quality of the process, effectively shorten the construction period, and achieve the goal of high-quality project put into operation.

Keywords

Energy Supply and Demand; Green and Low-carbon; Green Transformation; High Altitude; Fan Foundation; Quality Control.

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1. Introduction

The 20th report of the Communist Party of China emphasizes: "we should actively and steadily promote carbon peak and carbon neutrality, further promote the energy revolution, and accelerate the planning and construction of a new energy system", which points out the direction and puts forward higher requirements for the high-quality development of China's energy and power in the new era. Practicing the "two-carbon" strategy, energy is the main battlefield, and electric power is the main force. The power supply structure takes fossil energy power generation as the main body to new energy to provide reliable power support. Coal power will still be an important support for the security of power supply in China for a long time in the future, promoting the gradual transformation of fossil energy power generation to basic guarantee and system regulatory power supply. In order to achieve the "double-carbon" goal, new energy should gradually become the main force of green power supply when the growth rate of traditional non-fossil energy sources such as hydropower is slowing down due to the constraints of site resources, and nuclear power construction is gradually shifting to the new generation of advanced nuclear power technology. The national Blue Book on the Development of New Power System clearly points out that China has entered a new development stage of building a modern socialist country in an all-round way, the economy and society have entered a high-quality development mode, and the industrial structure has been gradually optimized and upgraded. Based on China's energy and resource endowment, we should adhere to the first and then break, and implement the carbon peak action in a planned and step by step manner. The strategic goal of carbon peak is to promote the rapid development of non-fossil energy power generation, and promote new energy to become the main body of electricity generation, accounting for more than 40% of the installed capacity and more than 20% of the power generation. The development of new energy will be both centralized and distributed, and guide the transfer of industries from the east to the central and western regions.

In 2023, the national wind energy resource is a normal year. the annual average wind speed at 10m height is 0.03% smaller than that of the last 10 years (2013-2022), and 0.72% smaller than that of 2022. the annual average wind speed at 70m height is about 5.4m/s, and the annual average wind power density is about 193.5W/m2; the annual average wind speed at 100m height is about 5.7m/s, and the annual average wind power density is about 228.9W/m2 . The average annual wind speed at 70 meters height is about 5.4m/s, and the average annual wind power density is about 193.5W/m2; the average annual wind speed at 100 meters height is about 5.7m/s, and the average annual wind power density is about 228.9W/m2. 5 provinces (municipalities), such as Shanghai, Jiangsu, Hainan, Qinghai, Hebei, etc., have small average annual wind speeds of more than 5% at 70 meters height, and 3 provinces, such as Liaoning, Sichuan, Shanxi, etc., have large average annual wind speeds of more than 5% at 70 meters height, while the other areas are close to the average value of the last decade.

In 2023, the average national mean wind speed at a height of 70 m will be about 5.4 m/s. In terms of spatial distribution, the annual mean wind speed will be greater than 6.0m/s in most parts of Northeast China, northern China, most parts of Inner Mongolia, central and southern Ningxia, northern Shaanxi, western Gansu, parts of eastern and northern Xinjiang, most parts of the Qinghai-Tibetan Plateau, the mountainous areas of western Sichuan, the Yunnan-Guizhou Plateau, Guangxi, and along the southeastern coasts, with the Part of the western and northeastern Northeast, central and eastern Inner Mongolia, part of eastern and northern Xinjiang, western Gansu, most of the Tibetan Plateau and other places where the annual average wind speed of 7.0m/s, and some areas even reached 8.0m/s or more. Shandong west and most of the eastern coast of Shandong, most of Jiangsu, Anhui and other places in the annual average wind speed of 5.0m/s ~ 6.0m/s. The rest of China's annual average wind speed of less than 5.0m/s, mainly in the central and eastern plains and the basin area of Xinjiang.

Compared with the last 10 years, the annual average wind speed in northern Xinjiang, west-central Qinghai, southern Shaanxi, northeastern Tibet, southern Yunnan, most of Hebei, northern and eastern Shandong, most of Jiangsu, Shanghai, central and western Guangdong, most of Hainan, etc. is small, of which the annual average wind speed in north-central Qinghai, southern Jiangsu, Shanghai, and northern Hainan, etc. is obviously small. The annual average wind speed in southern Xinjiang, central and western Inner Mongolia, most of Sichuan, northeastern Yunnan, most of Liaoning, most of Shanxi, central Zhejiang, northern and western Hunan, northern Guangxi and other places is on the high side, of which the annual average wind speed in northeastern Liaoning, northeastern Yunnan, northwestern Guangxi and other places is obviously high, and the annual average wind speed in other areas is close to normal.

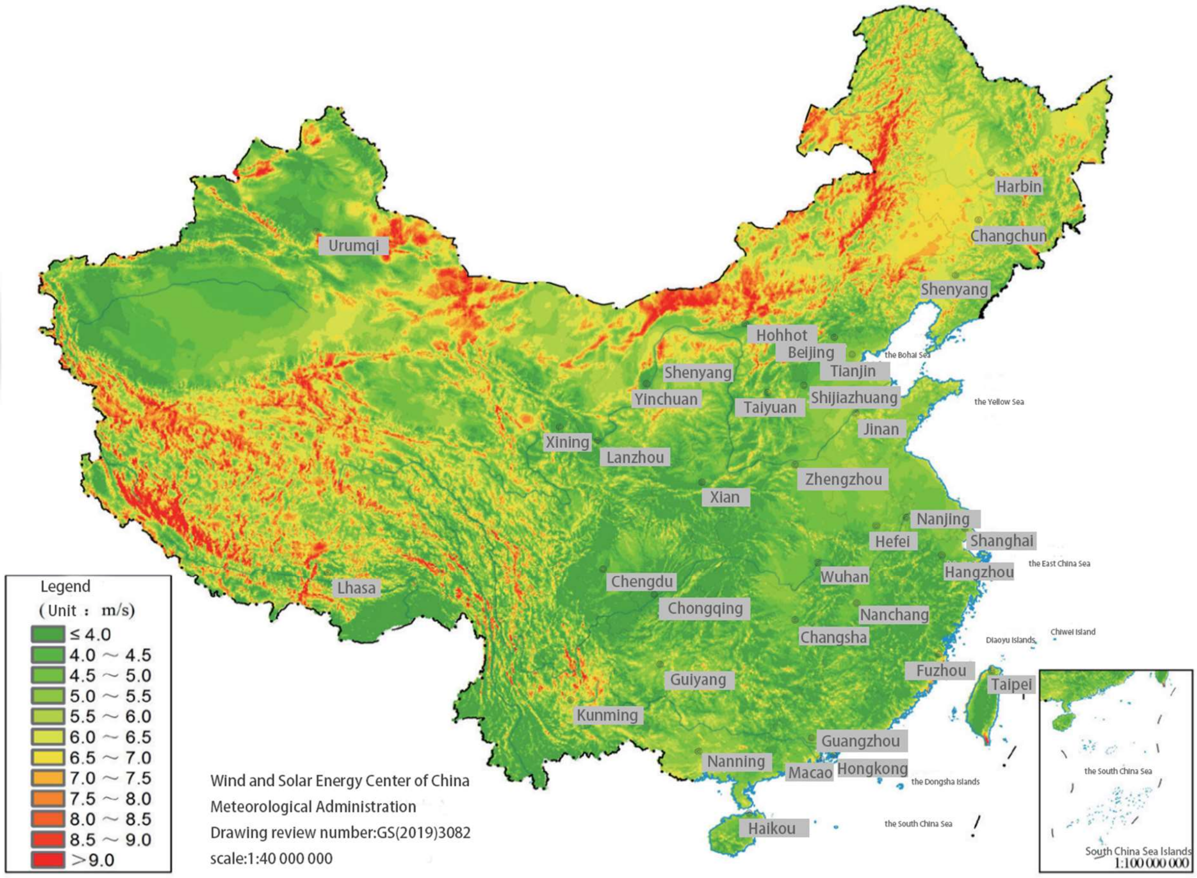

Fig.1 Distribution of annual mean wind speeds at 70-meter height over the national land mass in 2023(unit: m/s)

In 2023, the national annual average wind power density at 70 meters height is 193.5W/m2. In terms of spatial distribution, the annual average wind power density in most of Northeast China, North China, most of Qinghai-Tibetan Plateau, Yunnan-Guizhou Plateau, the mountainous areas in Southwest China and East China, and Southeast China coastal area exceeds 200W/m2, of which the annual average wind power density in the middle-east part of Inner Mongolia, east of Heilungjiang, north of Hebei, north of Shanxi, north and east of Xinjiang, and the ridge area of Qinghai-Tibetan Plateau and Yunnan-Guizhou Plateau exceeds 300W/m2. The average annual wind power density in other regions of China is lower than 200W/m2, of which the central and eastern plains and the basin area of Xinjiang are lower than 150W/m2. Compared with the past 10 years, the average annual wind power density in northern Xinjiang, west-central Qinghai, southern Shaanxi, northeastern Tibet, southern Yunnan, most of Hebei, northern and eastern Shandong, most of Jiangsu, northern Zhejiang, Guangdong, and other regions is lower than 200W/m2, Most of Jiangsu, northern Zhejiang, central and western Guangdong, Hainan and other places, the annual average wind power density is small, of which southern Jiangsu, northern Zhejiang and northern Hainan and other places, the annual average wind power density is significantly smaller. The annual average wind power density in southern Xinjiang, central and western Inner Mongolia, most of Sichuan, northeastern Yunnan, eastern Guizhou, most of Liaoning, most of Shanxi, central Zhejiang, northern and western Hunan, and northern Guangxi is large, of which northeastern Liaoning, northeastern Yunnan, and northwestern Guangxi are significantly large, while the annual average wind power density in other areas is close to normal.

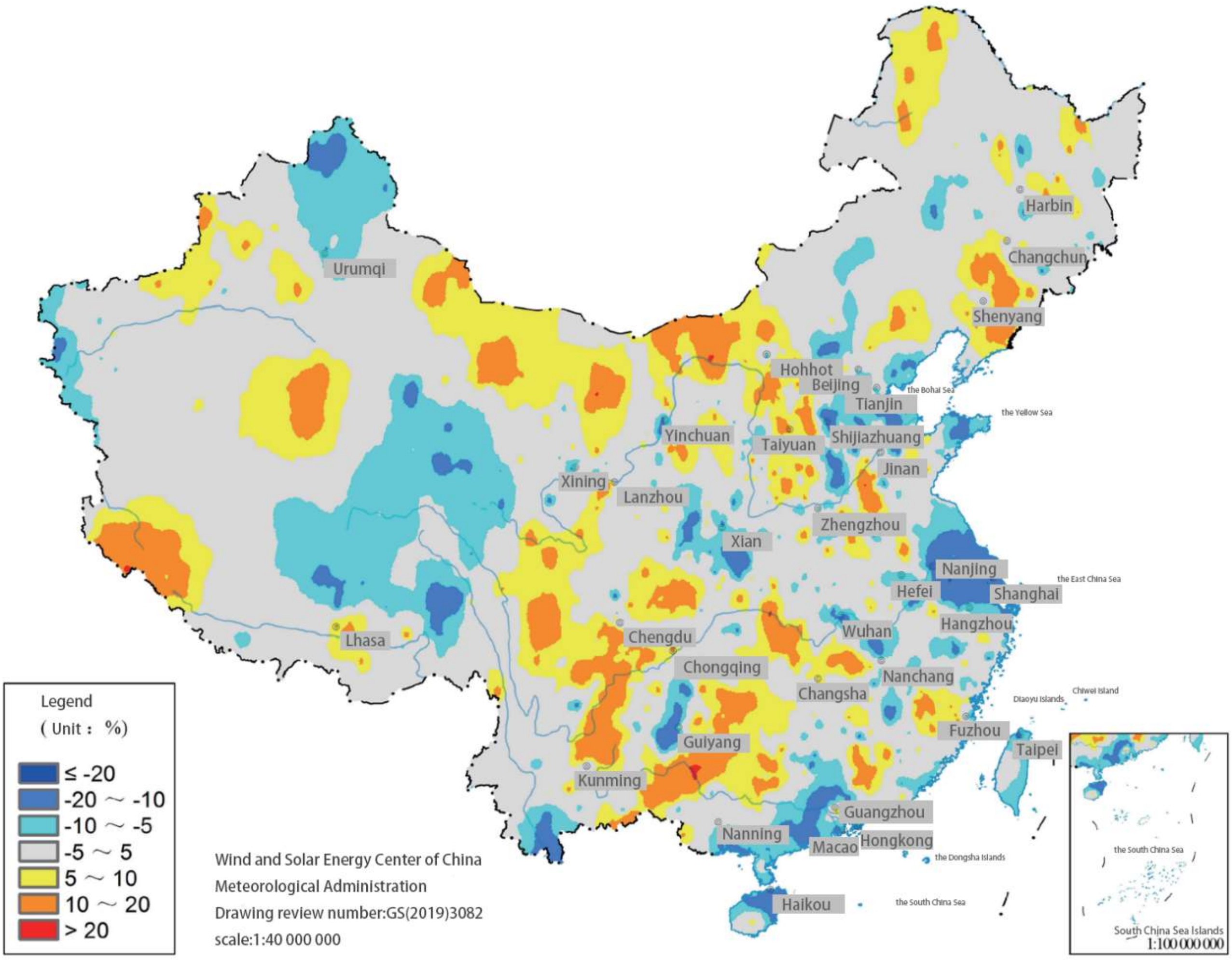

Fig.2 Distribution of the annual average wind power density anomaly at a height of 70 meters across China in 2023 (unit: %)

From the point of view of various provinces and cities, Sichuan Province, as an inland province in the central and western part of the country, has a clear advantage in wind resources, with the average wind speed and average wind power density higher than the national average in 2023. 100-meter height annual average wind speed, annual average wind power distance level percentage distribution graph is similar to that of 70-meter height, showing a linear growth trend. Sichuan's wind resources in the main position and concentrated in three states and one city (Liangshan Prefecture, Ganzi Prefecture, Aba Prefecture, Panzhihua City), along the Yaxi Expressway all the way south, into the size of the Liangshan Mountains, the core of the Hengduan Mountain Range hinterland, the "white windmills" can be seen everywhere along the ridges of the staggered arrangement, not only is the product of the optimization of the local power resource allocation, combined with three states and one city It is not only a product of optimizing the allocation of local power resources, but also a

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continuous boost for the economic development of local tourism industry by combining with the beautiful natural scenery of three states and one city.

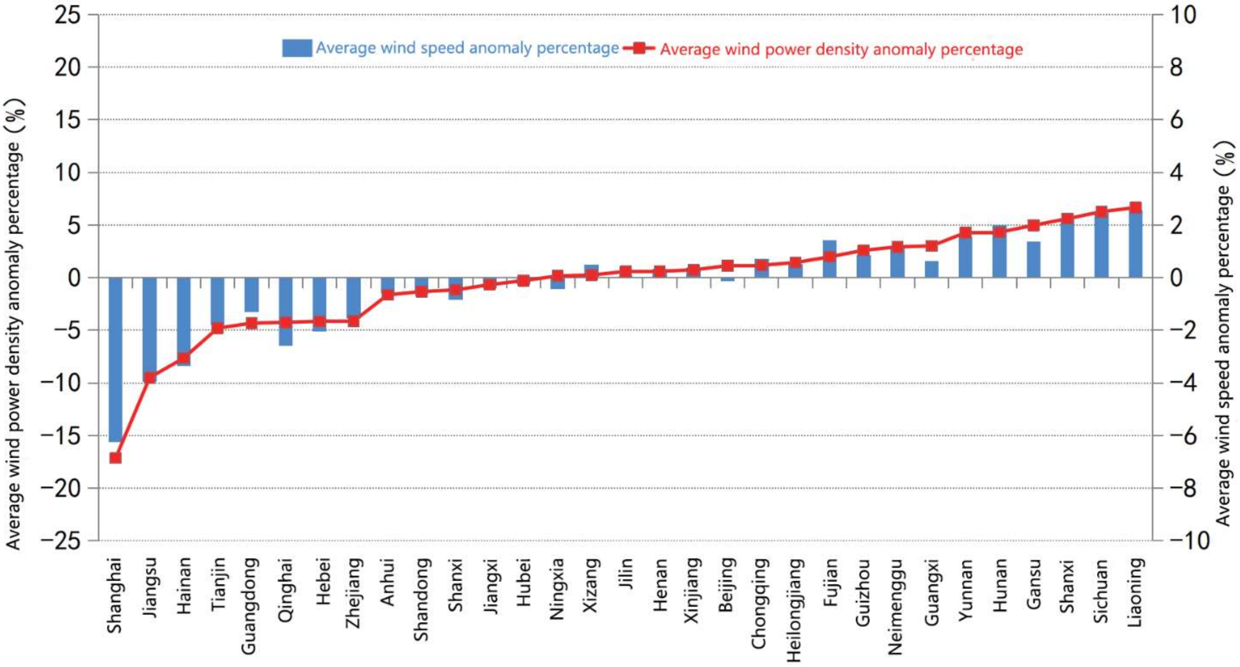

Fig.3 Average annual wind speed at 70 metres height and average annual wind power density distance level percentage (unit: %) by province (autonomous region and city) in 2023

2. Project Overview

Along the way in the construction of wind power projects without exception do not pass through the western and southwestern Sichuan series of mountains - the size of the Liangshan Mountain and the Hengduan Mountain Range, the Hengduan Mountain Range for the typical large undulation and great undulation of the mountainous terrain. Along the way, in addition to the south of the transition to the Yunnan-Guizhou Plateau for about 3,000 meters above sea level high school mountains, the vast majority of more than 4,000 meters above sea level, and the large river cuts strong, mostly deep canyons. The basic geomorphologic type in the area is obviously layered, the geomorphologic stress on the role of the obvious vertical differentiation. Climate by the high-altitude westerly circulation, the Indian Ocean and the Pacific Ocean monsoon circulation, winter dry summer rain, dry and wet season is very obvious, generally from mid-May to mid-October for the wet season, the precipitation accounts for more than 85% of the year, many areas more than 90%, and mainly concentrated in the three months of June, July, and August; from mid-October to mid-May of the following year for the dry season, rainfall less, the air is dry, and the climate with the increase in elevation has obvious vertical changes. Vertical changes.

The local high altitude, geographic environment, and complex climatic conditions put the construction, operation and maintenance of wind power projects to the test. The site selection and infrastructure construction of wind turbines account for a large part of the investment in wind farms. The longer the blade, the greater the wind shear, the higher the tower height, and the greater the incremental power generation. At the same time, the longer the blade edge, the larger the wind area of the blade, the higher the power generation efficiency. Therefore, large-scale blade has become the direction of future development, and supported by relevant policies. National Development and Reform Commission and the National Energy Board issued the "energy technology revolution innovation action plan (2016 ~ 2030)" also clearly pointed out that the future will focus on the research of 100 meters and above blade three-dimensional design methodology and design system, blade load and damage mechanism and optimization of calibration methods, as well as based on high-

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efficiency blade air bomb, lightweight structure, and new materials technology combined with the integration of design technology. But the blade length of the increasing, the current traditional glass fiber composite material, density, its own weight is also increasing. At the same time, the fan foundation also increases with the growth of the blade length.

Fig.4 Topography of the wind farm

Wind turbine foundation construction is an important part of wind power project construction, and its quality level is related to the quality and safe operation of the whole project. Fan foundation because it needs to carry more and more large upper load, the amount of work and foundation depth is getting deeper and deeper, more and more dense steel reinforcement, due to the large amount of cubic meters and need to be poured once, belongs to the large volume of concrete, perennial in the high cold and high humidity area, summer rainy high temperature, winter cold low temperature, day and night temperature difference is large, the foundation in addition to meet the intensity of the foundation, but also must have a good durability and anti-freeze performance. The harsh construction environment and climate conditions put forward higher requirements for construction quality and construction technology.

The project is located in the northeastern part of Meigu County, Liangshan Yi Autonomous Prefecture, Sichuan Province, which is about 18 km away from the Meigu County city center. It has a low-latitude plateau climate with obvious three-dimensional climate and four distinct seasons, with an average annual temperature of 11.4℃ and a minimum temperature of -15℃, and sufficient sunshine all year round, with 1790.7 hours of annual sunshine. Rainfall is abundant, with an average annual precipitation of 814.6 millimeters, but the precipitation is more in the north and less in the south, with uneven distribution. The winter season lasts 135 days, and the average annual frost period is 125 days, with a lot of windy and foggy weather. The installed capacity is 230MW with 6 sets of 5.0MW generator sets and 32 sets of 6.25MW generator sets. The wind farm construction area belongs to the deep-cutting middle-alpine landform type with high elevation, ranging from 3,100m to 3,900m.

The project site is located in an area where the peak acceleration of ground vibration is 0.15g, the characteristic period value of the ground vibration response spectrum is 0.45s, the seismic intensity is 7 degrees, the corresponding basic seismic intensity is VII, and the design seismic grouping is the third group. The preliminary proposed fan location is basically arranged on the top of the hill or on the ridge of the III level stripping surface, and there is no bad physical geological phenomenon in the location of each fan, and the stability of the mountain is generally better, only a few fan positions are located in the thinner parts of the ridge, and it is appropriate to appropriately expand the scope and depth of the excavation and do a good job of both sides of the mountain slope protection. Because the site is located in the ridge part, the bedrock is mainly Emeishan basalt, mostly strong weathering state, rock body is more broken, high bearing capacity, fan foundation holding layer all for basalt. Therefore, the gravity type extension foundation, its force is more uniform, isotropic good, the foundation overall stiffness, easy to meet the upper fan calculation model on the foundation stiffness

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requirements. At the same time, the construction is less difficult, the construction period is shorter, the technology is mature, and the reliability is high.

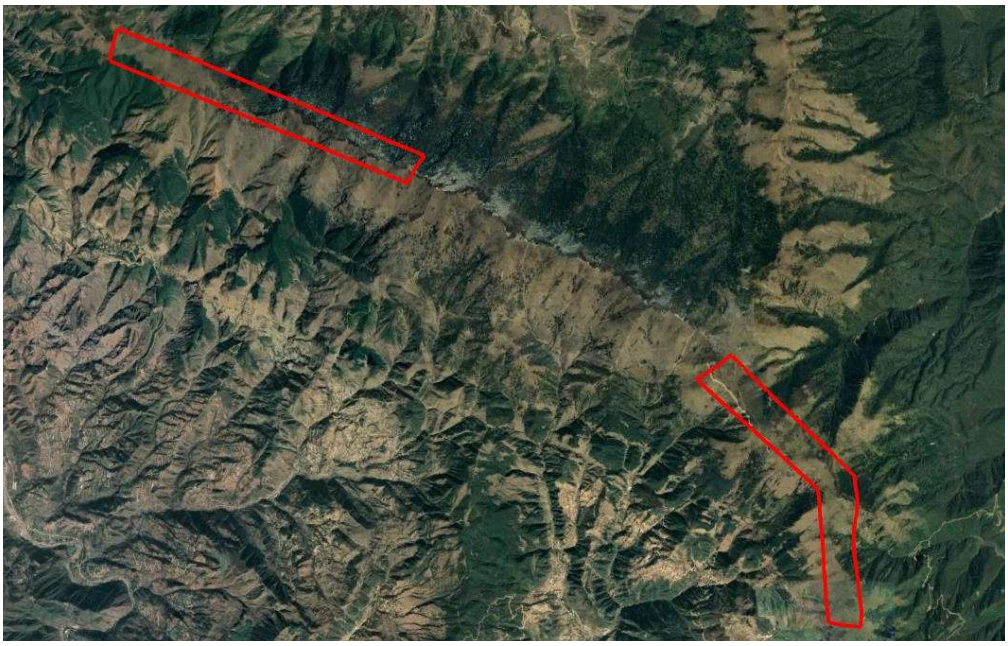

Fig.5 3D topographic maps of wind farms

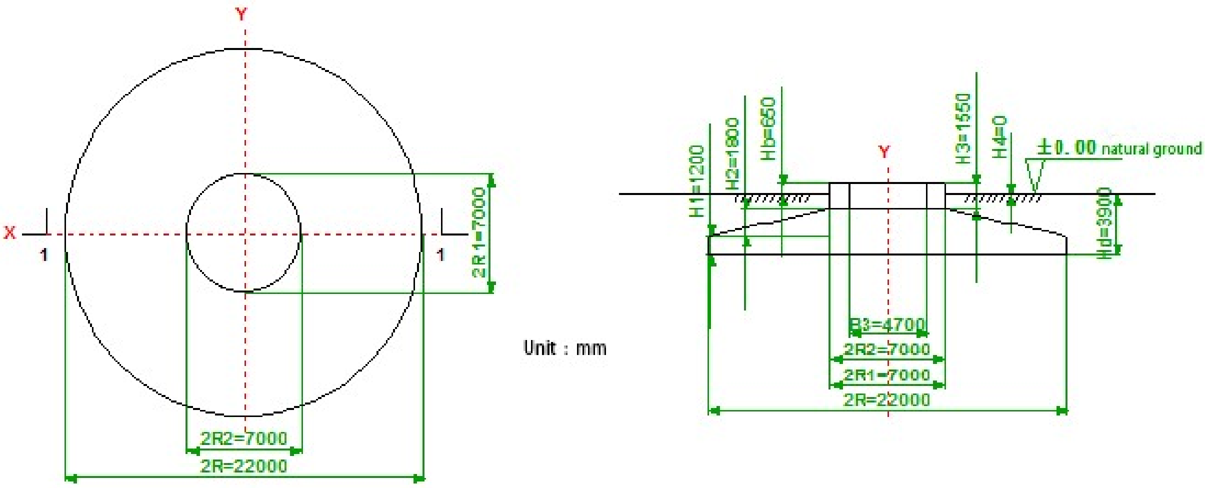

Fig.6 Fan foundation and dimensional drawings

The quantity of foundation concrete is 840m³ and 935m³ respectively, with 7 * 22 * 4.55 and 7 * 23 * 4.45, with C40 concrete strength. The foundation is buried in depth of Hd=3.8m, and the tower barrel and the foundation are connected by prestressed anchors. Four settlement observation points are uniformly arranged on the outer edge of the middle and pier of each fan foundation. Settlement observation and analysis at the midpoint of each adjacent observation point.

Observation requirements:

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(1) The reference point should be as close as possible to the location of the observation point, but should be outside the scope of influence of the foundation settlement, that is, from the edge of the base of the fan should be at least greater than 80m reference point is generally not less than three.

(2) The settlement observation of the foundation of the wind turbine adopts II level measurement, and II level measurement should adopt closed difference, and the closed difference should be less than ±5Nmm (N is the total number of measuring stations in the circuit).

(3) The amount of settlement at four observation points for each machine shall be recorded, and the observation after the installation of the unit shall also record the wind speed and direction data at the moment of observation. Each wind turbine settlement difference control tilt rate of 0.3%.

(4) When the settlement is stable, the observation can be terminated, whether the settlement is stable should be determined according to the settlement and time relationship curve, when a machine settlement rate is less than 0.02mm/d (refers to the average of a machine 4 measurement points), can be considered that the fan foundation settlement has been stabilized, can be terminated observation, but the total observation time should meet the requirements of not less than 12 months.

3. Construction of the Main Process Management and Difficult Points

The supply and transportation of large-volume concrete in high-altitude areas need to be efficiently coordinated to ensure that the concrete is supplied in a timely and adequate manner, and that the concrete is not damaged during transportation. The terrain of the region is relatively complex, the mountain road is narrow and curved, and there may be sections with large slopes, which will bring certain difficulties to the transportation of large volume concrete; due to the remoteness of most of the region, the supply of concrete raw materials and equipment may be affected, resulting in a delay in the construction progress; there is a large temperature difference in the low hilly areas, especially at night the temperature is low, which will have an impact on the solidification process of concrete; the regional water resources management is relatively complex, requiring rational planning and utilization of water resources, and the concrete mixing and curing process will be affected. Management is relatively complicated, requiring rational planning and utilization of water resources and requirements for concrete mixing and curing. In view of the above, the project proposes to set up a concrete production system with two HZS75 mixing plants to produce the concrete required for the whole project. There is no sand and gravel processing system in this project, and the required sand and gravel will be purchased in the nearby market, and only the sand and gravel yard will be arranged. The quality of local aggregates varies, and the aggregates are basically taken from the river; the river is cut off in winter, and the river sand is difficult to be washed, with high mud content, high gangue content in the river sand, low strength, and a great influence on the strength of the concrete; the powder content of the mechanism sand is as high as 3.2%, which needs to be increased to increase the dosage of the additives. Therefore, for aggregate, we should strictly require sand and gravel plants to reduce the mud content of river sand and ensure the quality of aggregate. Construction water includes two parts: production and fire-fighting water and domestic water. The total water supply for construction peak is estimated at 140m3/d, of which 120m3/d is estimated for production and fire-fighting water, and 20m3/d is estimated for domestic water. water supply from the neighboring booster station is considered for construction water in this project site. The water used for each wind turbine position in the wind farm is mainly for the concrete maintenance of wind turbine foundation and box transformer foundation, which is transported by tanker trucks to provide water for each construction site.

Due to the low temperature of the plateau mountain elevation area, the initial setting time of concrete is prolonged compared with the plains, high temperature and dry in summer, cold and wet in winter, the concrete is in the freezing and thawing environment. Foundation concrete selection of low heat of hydration, low alkali cement, under the premise of ensuring compliance with the design requirements can be mixed with the appropriate amount of fly ash and slow-setting type additives and reasonable control of cement dosage, at the same time, in order to prevent the heat of hydration of

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large volume of concrete temperature is too high, resulting in temperature cracks, the foundation of the concrete is mixed with a spiral polyvinyl alcohol crack-resistant fibers, the mixing amount of 0.9kg / m3 concrete. High altitude gravity expansion fan foundation in the pouring process through the past experience, so the pouring process optimization, can be divided into six directions according to the circumference of 360 ° fan foundation, each direction 60 ° isosceles arc-shaped area.

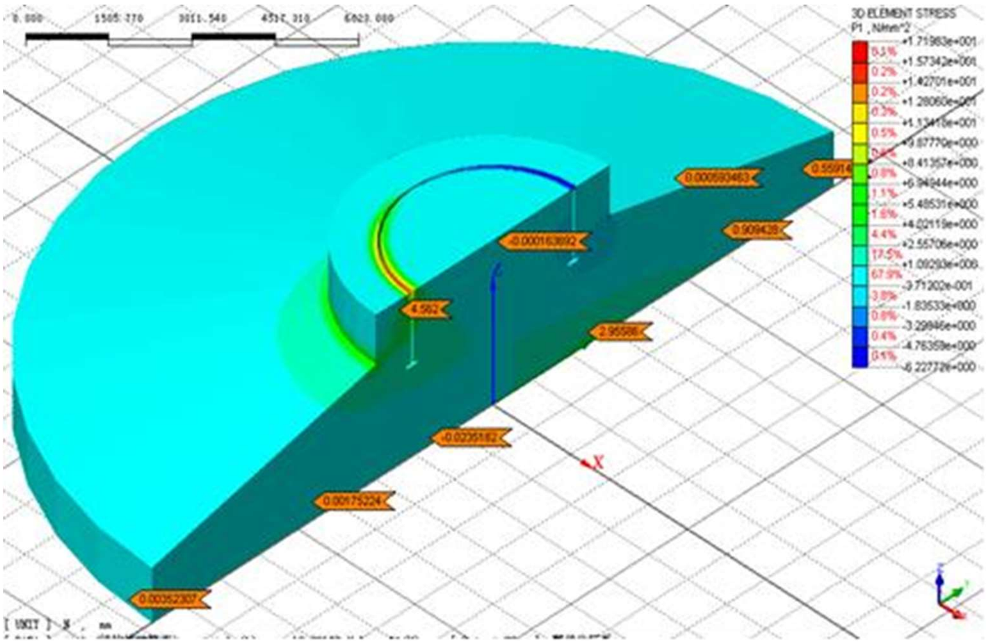

Fig.7 Half-arc section of wind turbine foundation

The foundation is divided into three sections: the upper section of the pedestal column is 1.55m high, the middle section is a round prismatic platform 1.8m high, and the lower section is 1.20m high; the sequence of concrete pouring is optimized, pedestal column - base plate prismatic platform - outer edge of floor - The concrete pouring sequence was optimized, table column - bottom slab prism - outer edge of floor - table column. First of all, the table column concrete pouring, will be the middle of the table column for the cycle of pouring vibration, and according to 30cm a layer of flat warehouse vibration, the table column under the vibration process, and the base plate combined with the part of the sloped concrete will not be able to maintain self-stabilizing, there will be a column concrete along the base plate spillage and scuttling, therefore, at the same time on the base plate spillage of the concrete vibration, the table column concrete casting to the height of the table column of about 1.20m. Foundation floor plus prismatic platform in accordance with the division of the 60 ° area for the layered level warehouse pouring, from the surface of the prismatic platform to 1.80m and then to the outer edge of the base plate at 3.00m, each layer of 30cm direction according to the clockwise or counterclockwise ring pouring, the area between the contact by the radial transition of the base plate naturally transition, one by one, up and down the two layers of concrete pouring time interval is not greater than the next layer of concrete before the initial setting of one hour (because of the implementation of the site based on the total amount of concrete settlement, so the construction unit). (Because of the implementation of the field based on the total amount of concrete settlement, so the construction unit to take two pumps pouring); to be the bottom plate prism plus the outer edge of the last layer of pouring, one of the pumps pouring columns the last 0.35m and close the storehouse, pouring concrete shall not be directly to the foundation ring body, concrete pouring should control the uniform rise of concrete fabric, to avoid inconsistent height of the rise of the concrete to the support bolts to produce lateral pressure. According to the characteristics of large flowability concrete, carry out appropriate vibration. Mark the parts where temperature measurement points and steel strain gauges are placed, and stipulate that no vibration is allowed within a radius of 0.5m around the test

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points to effectively avoid the impact of vibration on the temperature measurement points and strain gauges; the vibrator should not be in direct contact with the foundation ring, and at the same time, avoid collision of the vibrating rod with the foundation ring support members when vibrating. Layers of continuous pouring, the vibrating rod should be inserted into the lower layer of 50mm, plum blossom type vibration, in order to eliminate the joints between the two layers, each point of the vibration time is generally 10 ~ 30s appropriate, but also should be depending on the surface of the concrete is horizontal no longer significant sinking, no longer appear bubbles, the surface of the mortar flooding is appropriate. After optimization, it provides the waiting time for the ring beam between the upper and lower layers to wait for the initial condensation, reduces the waiting time for the upper and lower layers of concrete to pile up and form and the pouring time, and after optimizing the pouring sequence, it improves the efficiency of pouring, and the foundation concrete pouring is shortened from the original universal 14, 15 hours to 9, 10h, which achieves a better pouring effect, and greatly saves the time and reduces the duration of the work period.

Fig.8 Fan foundation reinforcement layout

Temperature monitoring and control of the concrete is required to control the temperature difference between the inside and outside of the concrete. Three temperature measurement points are embedded inside the concrete of each wind turbine foundation, which are arranged along the height of the foundation at the periphery, middle and center of the foundation. Each temperature measurement point is divided into 3 parts (upper, middle and lower), the upper part is 30cm away from the upper surface, the middle temperature measurement point is the center of the foundation depth, the lower part is 30cm away from the lower surface, and the temperature measurement points should be buried to avoid the foundation ring and the cable buried pipe. After the concrete is poured, the temperature measurement will be started, and if necessary, thermal insulation and curing measures will be taken. In the concrete temperature rise stage every 2 to 4h measurement, the temperature drop stage every 8h measurement, at the same time should measure the atmospheric temperature, in order to master the foundation of the internal temperature field, concrete temperature gradient should not be greater than 15℃ / m, control the temperature difference between inside and outside the concrete within 25℃, the center of the highest temperature shall not be > 70℃. When the temperature difference between inside and outside is more than 25℃, use cotton cloth to cover the concrete and increase the frequency of sprinkling curing to reduce the temperature and prevent the concrete from generating temperature difference stress and cracks. And avoid exposure to the sun. The temperature difference between

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morning and evening in winter at high altitude is large, and the temperature of aggregate is an important factor affecting the temperature of concrete. The main measures of aggregate heat preservation one is to lay thick canvas, felt, straw bags, etc. on the surface of aggregate for heat preservation; the second is to slightly delay the production time, the sun on the aggregate direct sunlight for a period of time, to improve the temperature of aggregate; the third is to set up a steam exhaust pipe in the aggregate yard, to ensure that the temperature of the aggregate is guaranteed through the steam heating. Under low air temperature conditions, water temperature is also a more important control factor. It is necessary to heat the pool at night to keep warm, and the pool also needs to be heated continuously during the day to ensure the temperature of the concrete out of the machine and the temperature of the mold. Local cement quality is unstable, and the strength of cementitious sand fluctuates greatly, which increases the difficulty of concrete strength control. Therefore, the concrete design should be designed with the lowest cement strength to minimize the impact of cement fluctuation on concrete quality. Air-entraining and antifreeze components need to be incorporated in the admixture. Due to the low solubility of antifreeze in the admixture, it is necessary to increase the admixture dosage. Under normal conditions, the admixture dosage of C40 concrete is 2.5%, and the dosage is elevated to 3.5% after adding antifreeze.

The following principles are to be followed when designing the mixing ratio:

(1) Local aggregates are poor, sand with high mud content is not conducive to the development of concrete strength, the water-cement ratio should be appropriately reduced to reduce water consumption and increase the amount of cement.

(2) Low air pressure at high altitude, poor stability of bubbles in concrete, slump preservation is difficult. In order to ensure the ease of concrete, additives can be mixed to the critical value.

(3) Mass concrete should control the temperature difference between inside and outside the concrete to prevent temperature cracks. Design of concrete should strictly control the use of admixtures, mineral admixtures will reduce the development of early concrete strength, is not conducive to construction at low temperatures. In summer, it may be appropriate to increase the use of admixture, the two balance, so as to control the temperature difference between the inside and outside of the mass concrete.

(4) Mass concrete slump should not be greater than 180mm, if you need to pumping construction, the collapse should be controlled at 160 ~ 180mm.

Water the formwork before pouring to prevent the contact surface from being too dry and causing the concrete to lose water too quickly, with poor joints and damage to the structure. Reasonably set up construction joints and back pouring zones during pouring to minimize the restraining stress and prevent cracking and mold expansion and other phenomena from occurring. Winter pouring as much as possible to choose the time of the sun, end as early as possible to the plastering surface to leave enough time, pouring process to increase the number of concrete plastering. Foundation concrete maintenance, the use of heat preservation method and moisturizing method combined implementation, reduce the heat diffusion of the concrete surface and temperature gradient, to prevent surface cracks, while prolonging the heat dissipation time, give full play to the potential of the concrete and the relaxation properties of the material, so that the average total temperature difference in the concrete generated by the tensile stress is less than the tensile strength of the concrete, to prevent the occurrence of penetrating cracks. Concrete surface at high altitude loses water quickly, the temperature changes drastically, the concrete is easy to freeze, if the maintenance is not timely, it is easy to have insufficient strength, cracks, surface chalking and other phenomena. After the completion of large volume concrete pouring, water should be sprinkled and covered with plastic film immediately to ensure that the concrete is moist. The duration of moisturizing curing after pouring should not be less than 14 d. Due to the low temperature at night in winter, surface insulation measures are also required after covering the film. Thermal insulation measures are:

(1) Cover the film after pouring to prevent moisture loss; (2) Cover the concrete with insulation materials such as felt and thick canvas to keep the concrete warm. Due to the low temperature and

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slow development of concrete strength, the concrete should not be demolded too early and the load should not be applied too early to ensure the strength and structural integrity of the concrete.

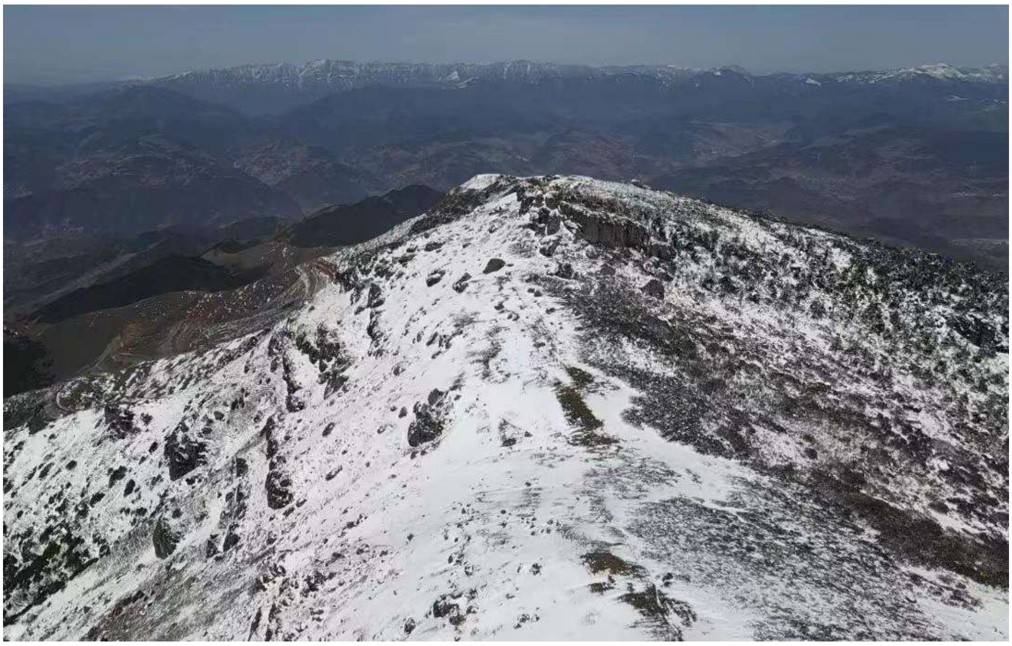

Fig.9 Winter field map

Secondary grouting for wind turbine foundations is the most important process after the foundation is poured with concrete, and the selection of secondary grout is the core element to ensure the solidity of the foundation. According to the unique climatic environment of the region, select the appropriate type of grout for wind turbine foundation. Due to the variability of geographic and climatic conditions, the strength requirements of wind power foundation grout will be different, usually fluctuating within the range of C80 to C130Mpa. Among them, C80 strength is one of the widely used strength standards in wind power foundation grout. Depending on the environment, foundation grout materials have high fluidity and micro-expansion properties, which are suitable for general wind power foundation construction. High-strength grouting materials have high toughness and abrasion resistance, and are suitable for parts with high strength requirements. Corrosion-resistant grouting materials are corrosion-resistant and suitable for use in corrosive environments such as coastal cities. For high-altitude mountain wind farms, grouting materials to take high-strength grout, grout dosage can be projected according to the empirical formula:

$$\text{Total grout volume (tons)} = \text{amount of concrete used } (m^3) \times \text{total grout as a percentage of concrete } (\%) \times \text{overfill factor}$$

In this formula, the amount of concrete used refers specifically to the total volume of concrete in the wind turbine foundation. The proportion of grout to concrete is determined based on actual experience and specific conditions during construction. The overfilling factor, as an important adjustment factor, takes into account the upward fluctuation of grout dosage caused by variables such as construction errors and concrete shrinkage, and its value is usually between 1.05 and 1.10. High-strength non-shrinkage wind power grout is a new type of high-strength grout for wind power anchor bolt foundation grouting, anchoring generator tower anchor bolt grouting and so on. The grout can start to solidify after two hours of pouring, and has excellent mobility, early strength, no shrinkage, high oil resistance, high durability, fire prevention and other characteristics. Its 1-day strength can be as high as 50Mpa or more, and can withstand low temperature and high temperature. Specific use in

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high-altitude areas, according to the weather temperature to increase or decrease the amount of water, in the mixing process is often wrong operation is directly poured into the water for mixing grout, due to a one-time amount is too large, the mixing rendering effect is not good, there is a large piece of dry material, a little attention is easy to block the mouth of the next material, resulting in grouting can not be carried out properly. The correct operation should be pre-added 65% to 75% of the water, and then slowly add the grout for uniform mixing, to be grout into the end of the grout, and then add the remaining amount of water for mixing, to be mixed uniformly and continue to mix for 3-4 minutes. Before the second grouting, we should pay attention to the foundation surface must be hair, and cleaned up before grouting and the foundation will be fully wet with water, experience acceptance before grouting, grouting process grout must be filled with the entire template and slightly higher than the bottom of the upper anchor plate, to ensure that there is no gap between the bottom of the upper anchor plate and grout, full of grout, in the process of grouting, for some parts of the parts, you need to use the deaerating rod to guide the grout in the grout constantly During the grouting process, for some parts, it is necessary to use the air removing stick to guide the air bubbles in the grout to be discharged, so as to make the grout dense and ensure the grouting quality.

Fig.10 Grouting construction

4. Conclusion

Project in the construction process, after the control of quality points and changes in the construction process, refinement of construction, scientific research and judgment, in the process of technology polishing, improve the efficiency of foundation construction, quantitative change to qualitative change, thus shortening the overall construction time of the project, the foundation of the quality of the indicators are in line with the requirements of the design and specifications, foundation construction in high-altitude mountainous areas in the process of the construction of valuable experience, the methods and measures mentioned herein are applicable to the entire process of foundation construction of high-altitude mountainous wind power projects, but also for the current period of time in the future similar projects provide the corresponding experience. The methods and measures mentioned in this paper are applicable to the whole process of foundation construction of wind power projects in high-altitude mountainous areas, and at the same time, they also provide corresponding experience for the construction of similar projects in the current and future periods. With the current construction technology digitalization, intelligence level is constantly improving, prefabricated assembly wind turbine foundation technology will be more and more mature, its application scene will be more and more extensive, which will solve many on-site construction problems for the future high-altitude mountain wind farms, General Secretary Xi Jinping pointed out that "we should grasp the transformation and upgrading of traditional industries with one hand, and grasp the development of strategic emerging industries with the other hand. ". Do a good job of industrial green transformation and upgrading, top-level design is the key, the development of wind power is an important way to achieve the goal of "3060 carbon neutral" in China. Further practice the concept of green development, continue to promote industrial transformation and upgrading, precise gathering of synergies, and effectively transform the various favorable policies into planning to promote the project ideas and initiatives, the actual results, is conducive to further enhance the core competitiveness of enterprises and brand influence.

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