Application of advanced design concepts in the design of wind farms

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Abstract

With the increase of wind farm construction scale and renewable energy development requirements need to change the design concept,this paper presents the design of advanced work ethic,these ideas have been repeatedly used in wind farm design,in order to save a lot of construction investment,improve the power generation efficiency.

Keywords

Design rationale,wind farms,design applications,micro-siting.

1. Introduction

2014,China's wind power industry to continue to maintain strong growth momentum, annual new wind power installed capacity of 19.81 million kilowatts, a record new capacity,and net cumulative installed capacity reached 96.37 million kilowatts, accounting for 7% of total electricity generation capacity, accounting for 27% of global wind power installed capacity. 2014 wind power 153.4 billion kwh of electricity, accounting for 2.78 percent of all electricity generation. According to the latest national "Thirteen Five" development planning requirements, "Thirteen Five" plan will dilute the installed capacity of wind power target, focusing adjustment policies, and focus on resolving the subsidies, abandoned wind power rationing problem. "Thirteen Five" is the key to the transition, into the new normal economy, energy will be transferred to the new norm. At the national energy authorities opinion, the next five years in renewable energy development to achieve two major changes: the high subsidies dependent mode to the low subsidy improved competitiveness paradigm shift, and change the scale expansion to quality and efficiency of development.

This requires the wind farm design, the need to fine direction, as far as possible to improve the design quality of wind farms, save investment and improve power generation.

Wind farm project mainly to meet the transport wind turbines,installation and running for 20 years as the main design principles. The main design includes several large section contains the booster station, wind farm site road,lifting platform, fans and me change basis,35kV collector lines and cable and other communications. In a specific design, in strict compliance with national laws and planning, strict compliance with national and the power industry design rules, norms and standards,and in strict accordance with contract requirements to optimize the design, satisfy the requirements of the project.

2. advanced design concepts

2.1 wind turbine foundation design

In the wind turbine foundation design, since the IECS class fans, load larger loads through the use of advanced analytical methods and finite element analysis software of detail, targeted to enhance the structural strength of the weak node design, optimized overall basis.

According to "The wind turbine foundation design requirements," wind turbine foundation design calculations and checking the following:

(1) The calculation of foundation bearing capacity; (2) checking the soft underlying layer; (3) the basis of stability against sliding, overturn stability of computing; (4) the basis of settlement and tilt deformation calculation; (5) Basic width of crack ; (6) Basic (pile) internal forces, reinforcement and material strength checking;

After analysis, wind power base belonging to withstand large bending moments,high torque structure, infrastructure against overturning, anti-slip base disengagement situation demanding;

In connection with the wind turbine foundation design basis of the ring, it has been designed based on focus and key points, for detailed analysis carried out by using the more popular abroad finite element software, targeted to enhance the structural strength of the weak node design, optimized overall basis. Preliminary analysis of the results of the finite element software, there is a large base ring surrounding the pulling stress, and stress the rest is relatively small, and thus the foundation reinforcement ring surrounding the situation, is the key point where the entire infrastructure.

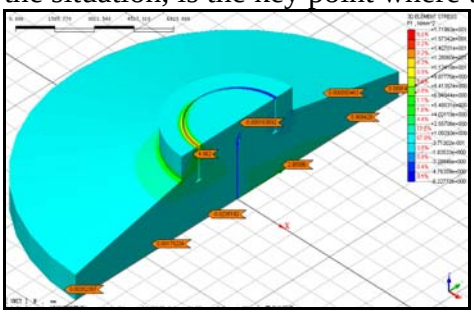

Fig. 1 Basis optimizing structure diagram

2.2 collector circuit design

Collector lines flexibility to use a single, double loop erected manner, effectively saving the line channels, thereby enhancing the economy. Communication line using ADSS and OPGW combinations.

For the wind farm collector lines with respect to the internal particularity general transmission line, the project must follow the following design principles:

1) If a T junction more, resulting in full-line gear more isolated in the design process to pay attention to the problem in isolation stalls relax;

2) outlet direction of the box changes should choose the opposite side of the main platform, lifting to avoid interference with the fan;

3) During the measurement, pay attention to the direction of the outlet box changes elevation and platform drilling platform, with the fill side;

4) fan blades longer because, in the design process to control the main circuit at 20 meters distance from the platform outside;

5) wind farm road transport more towers need to avoid road position, when crossing the road, the line should be greater than the distance from the ground five meters , to meet the transport requirements of the wind farm;

6) According to the conductor economic current transmission capacity,6 wind turbines of the following branch selection LGJ-95/20 wire, I, II back to the main selection LGJ-240/30 wire;

7) communication line by line packet transmission is divided into two back;

8) due to fan communication for a double closed loop communications network, in a wind farm,ADSS optical cable communication lines using two loops of 16 and 17 respectively in series wind turbines to the booster station communications room.

2.3 road and platform design

In the design of the road, take the design principles consistent with the engineering characteristics meet the engineering needs of the curve widened for special design, road construction disturbance of soil and water as little as possible and destroy vegetation, thus saving investment.

1) Since the special nature of the passage of the vehicle (eg: blade length 40.3m,main transformer weighs about 120t),routes in this paragraph refer to "Road Engineering Technical Standards" (JTGB01-2003) and "factories, mines and road design specifications" (GBJ22-87) combined with the size of the fan and blower equipment transportation equipment vehicles on the basis of relevant standards designed special circumstances, generally by 10% longitudinal control, regional and special sections control in less than 12.5%,partial sections particularly difficult to control within 14%. The minimum turning radius of 35m,20m radius using local difficult road, turn widened widened transition mode is linear, when the inside of the flat curve radius greater than 50m embankment widened.

2) If the main highway located in the mountains, along the geological structure in sandstone,mudstone, cut side slope of 1: 0.5 to 1: 0.75 slope, depending on the excavation site to determine the geological conditions, should also be common on the slope and geological staff Stability was evaluated to determine whether it needs additional processing mode, for processing the scene to make a decision based on the actual situation. Excavation ditch rectangular section mortar rubble drains, section size 0.5mX0.5m.

3) fill slope set 1: 1.5 and 1: 1.75 levels, the height difference every time 8m set up a chipping station. Set mainly in the subgrade retaining wall of gravity shoulder the main principles taken the slope is greater than the set when filling height 5m,when the original ground wire directly to fill more gentle consideration. Also, to ensure the stability of the excavation at Embankment, local surface slope is greater than 25% of geological stairs, step by 1m width settings.

4) In the design of the fan platform, adopted a platform compact arrangement, according to local conditions shape the platform design, all lifting platforms are designed to be based on the actual terrain of irregular shape, to meet the lifting requirements of the premise, to minimize the lifting platform area. According to the irregular shape of the terrain settings, in particular to reduce the large number of fill.

2.4 micro-site design

The micro-site, depending on the degree of concentration of the dominant wind direction, and breaking ranks conventional spacing, full use of wind energy resources.

Our institute in the design methods and design solutions made some exploration and innovation, crew selection and design of micro-siting, particularly in. Unit selection ideas, from the original overall review, to our institute proposed a separate review for each wind turbine, in security to meet the conditions, as far as possible with a long blade models, gradually extended and become the mainstream in 2013 ~ 2014.

Micro-siting of the method is no longer a fixed 3D pitch to fan arrangement, but consider the effect of wake turbulence, and gradually formed the advanced experience in complex terrain altitude wind farm site, at present, about fan arrangement specification being updated, also verified the 2012 proposed design ideas.

3. Project Application Examples

The above design philosophy applied to the design of our institute multiple wind farms, especially in Dali a project, the project installed capacity of 148.5MW,put into operation since 2012,each phase of the project equivalent number of full load hours are more than 3500h 2014 Engineering-hour average equivalent number of years to reach 4000h.

At the time of project construction, well implemented site design intent,posted a site-work, timely solutions to design problems in the construction process and participate in project acceptance, to ensure that the on-site implementation of practical philosophy.

After three years of running the verification, excellent indicators of wind farms, with a demonstration effect of high altitude mountain wind farms. Full 2-year project put into operation, the unit works well,its power generation capacity in 2013 translated into full load utilization hours reaches

3820h,2014 its generation capacity are translated into full load utilization hours reaches 4050h,the number of hours the Internet in the country and the world large-scale wind farm in the top.

In a subsequent plurality of wind farms in the institute these design concepts applied to wind farm design, and achieved good results.

4. Conclusion

Wind farm design, the design requires not only reasonable and feasible, but also to design excellence, to save investment and improve efficiency purposes, thereby changing the mode of development of renewable energy.

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References

[1] Z. Chen,J. M. Guerrero and F. Blaabjerg "A review of the state of the art of power electronics for windturbines", IEEE Trans. Power Electron., vol. 24, pp.1859 -1875 2009
[2] ZHANG Shuang-yi;WANG Yi-qun;LV Zhou-an;ZHANG Ji-li;China Three Gorges New Energy Co.,Ltd.;Correcting error of representative year for wind measurement data using MERRA data[J];Renewable Energy Resources;2014-01
[3] GAO Yan-qing et al(Chaoyang Weather Bureau of Liaoning Province,Chaoyang,Liaoning 122000);Evaluation on Wind Power Resources of the Wind Power Plant in Yanshan Lake Area of Chaoyang County[J];Journal of Anhui Agricultural Sciences;2007-36
[4] A. D. Hansen,F. Iov,F. Blaabjerg and L. H. Hansen "Review of contemporary wind turbineconcepts and their market penetration", J. Wind Eng., vol. 28, no. 3, pp.247 -263 2004 M.P. Kazmierkowski,R. Krishnan and F. Blaabjerg Control in Power Electronics-Selected Problems, 2002 :Academic
[5] F. Blaabjerg,M. Liserre and K. Ma "Power electronics converters for wind turbine systems", IEEE Trans. Ind. Appl., vol. 48, no. 2, pp.708 -719 2012
[6] Wind Turbines Overview, 2011 :Vestas Wind Power [online] Available:
[7] www.vestas.com/
[8] Design Limits and Solutions for Very Large Wind Turbines, 2011 [online] Available:
[9] S. Muller,M. Deicke and R. W. De Doncker "Doublyfed induction generator systems for wind turbines", IEEE Ind. Appl. Mag., vol. 8, no. 3, pp.26 -33 2002
[10] D. Xiang,L. Ran,P. J. Tavner and S. Yang "Control of a doubly fed inductiongenerator in a wind turbine during grid fault ride-through", IEEE Trans. EnergyConvers., vol. 21, no. 3, pp.652 -662 2006
[11] R. Pena,J. C. Clare and G. M. Asher "Doubly fed induction generator using back-to-back PWM converters and its applicationto variable speed wind-energy generation", Electr. Power Appl., vol. 143, no. 3, pp.231 -241 1996
[12] M. Liserre,R. Cardenas,M. Molinas and J. Rodriguez "Overview of multi-MW wind turbinesand wind parks", IEEE Trans. Ind. Electron., vol. 58, no. 4, pp.1081 -1095 2011
[13] F. K. A. Lima,A. Luna,P. Rodriguez,E. H. Watanabe and F. Blaabjerg "Rotor voltage dynamics in the doubly fed induction generator during gridfaults", IEEE Trans. Power Electron., vol. 25, pp.118 -130 2010
[14] F. Blaabjerg,Z. Chen and S. B. Kjaer "Power electronics as efficient interface in dispersed power generationsystems", IEEE Trans. Power Electron., vol. 19, pp.1184 -1194 2004