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Management of Design and Construction for Civil Works under EPC contract in one Oversea Wind Farm Project

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Abstract: This paper presents problems encountered at the beginning of the project, summarizing the works done by EPC Contractor for Wind Farm Project in terms of design optimization, construction managements and quality control, introducing the role which EPC contractor plays in the civil works.

Keywords: Wind farm; EPC contract; Design and construction; Construction management

1. Project overview

Phu lac Wind Farm is the first of its kind project invested by Electricity of Vietnam (EVN) with 12 Turbines and design capacity of 24MW under construction period of 14 months. The Power China Chengdu Engineering Corporation LTD is the EPC Contractor. It will be very important both for the Employer and for the Contractor whether the project can be completed in time.

The paper briefed the problems encountered at the beginning of the project; the works of design, construction management and quality control have been done by the EPC contractor in civil works.

2. Selection of subcontractors for Design and construction and problems faced

2.1 Selection of Design and Construction subcontractor

The civil works design is assigned to the local subcontractor who is good at Turbine foundation design.

The subcontractor of civil work is undertaking construction of temporary office, access roads, substation, overhead transmission line, wind turbine foundations, laydown area and crane platform.

2.2 Main problem encountered

Due to many elements, the approved design was three months later than planned. Half time has been used for design and construction preparation so the time pressure is very big for the project, how EPC contractor can completes the project is one of the key tasks in run over the project.

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3. Some of the Tasks done by the EPC Contractor

3.1 Establish System Management Documents

EPC contractor finished the following systemic management documents during the design period:

1) Emergence plan for Health, Safety and Environmental;
2) HSE Site Specific Plan;
3) Updated Environmental & Social Management Plan;
4) Work safety plan;
5) Test plan for Civil Works;
6) QC/QA Management plan and Concrete Monitoring plan for Wind turbine foundations;

3.2 Design Optimization

During stage of the design and construction, EPC contractor carried out the following design optimization:

3.2.1 Pavement Structure Design

The preliminary design submitted by the designer proposed the pavement structure are all made by Asphalt concrete, but only two access roads shall be designed as Asphalt concrete road. After made correction as per the advice from EPC contractor, the construction time was shortened and the cost was saved.

3.2.2 Pavement Thickness Design

The thickness of the earthwork fill was firstly proposed 1.2m by the designer. It was advised by EPC Contractor to carry out the pavement thickness design by using 1000 axial equivalent traffic load and to use natural gravel material with CBR over 45 for subbase and CBR over 7 for the road bed according to the material available.

The final Pavement thickness is 45cm including two layers of natural gravel as subbase coarse and one layer of crushed and graded stone as Base course.

3.2.3 Design optimization during construction stage

Some design optimizations have been done again during the construction stage, it reduced unnecessary excavation of sandy soil in unnecessary section in cut, it reduced unnecessary disposal material and the disposal area, and it avoided unnecessary environment protection cost and maintenance cost. The optimization design corrected the mistakes made by the designer due to big changes to the elevation of the turbine foundations and the final design was revised as per the opinion of the EPC contractor.

3.2.4 Adjusting two turbines locations

Considering the stability of the two turbines, slightly shifting locations of turbine #3 and #10 is made by EPC Contractor. After making the adjustment, the AEP has increased 9.1MWh which bring attractive benefit for the Employer.

3.2.5 Mass concrete mix proportion design

Mass concrete mix proportion design is made as per the requirement of local specification, 28 days concrete mix proportion design is propose based on 7 day's test results and it saved 21 days for the project.

3.2.6 Adjusting levels for platform #5 on site

The Wind Turbine #5 including the platform is near the mountain side, rocks are encountered during the construction.

EPC contractor is determined raise the level 1m higher than the design level. it reduces rock cut and saved some time for the project.

3.2.7 Adjusting level for TB#3

The Wind turbine #3 is also near the mountain side, the preliminary design made by designer is to excavate 6m lower than existing ground. EPC contractor instructed civil subcontractor to work according to the proper way instead of lowering 6m but shifting the turbine location 5m inside the mountain side.

The final design and construction was made according to the ideal of the EPC contractor.

3.2.8 Foundation improvement

The improvement plan to the 8 turbine foundation was made by the EPC contractor based on revised bearing capacity calculation and the construction capacity for the subcontractor, addressing all the issues raised by the consultant and finally completed soil improvement for 8 turbine foundations.

4. Construction quality control

4.1 Quality control for turbine foundations

4.1.1 Plate bearing capacity test for foundations

Total 8 turbine foundations are weak in subgrade, soil improvement is made to these foundations, and the plate bearing capacity is used for the quality control. For those tests unpassed, recompaction and retest are done until the tests meet design requirement.

4.1.2 Materials quality control for concrete

All materials such as water, sand and aggregate are tested and approved before using.

4.1.3 Materials quality control for reinforcements

The yielding strength over 500MPa is used for the design and construction of turbine foundation, the tests have been done to each of the reinforcements before using.

4.1.4 Concrete mix proportion test

EPC contractor had assisted local subcontractor to complete mass concrete mix proportion design, the slump is controlled under 14±2cm, the setting time is controlled over 9 hours.

4.1.5 Concrete mixing plant calibration

The concrete batching plant with capacity of 60m^3/h is setup and the calibration is done by the local Authority.

4.1.6 Checking before cast concrete

Before casting concrete foundation, 13 items are checked for source of the materials, 8 items are checked for HSE, 12 items are checked for manpower, 9 items are checked for mechanic, 16 items are checked for others items.

4.1.7 Concrete cast quality control

Concrete slump and concrete mixing temperature is monitored for each truck of concrete. Sample for concrete strength test is taken for each 30m^3. Concrete strength is tested after 7 days and 28 days.

4.1.8 Concrete temperature control

Ices are added inside mixing water in order to reduce concrete temperature. Concrete for turbine foundations is poured during the night in order to minimize high temperature and high radiation.

4.1.9 Concrete temperature monitoring

Concrete temperature monitoring is made to each turbine foundation. The proper time to remove the formwork and curing material can be determined accordingly.

4.1.10 Quality control for instillation of Anchor cage

The quality control for installation of Anchor cage is mainly to control the flatness which is within ±2mm and ±4mm respectively for bottom flange and top flange. The moment for tightening space anchor bolts is 200N.m and 50N.m for other anchor bolts.

4.1.11 Grouting material test

Compressive strength test is carried out for the grouting materials after 1 day, 7days and 28 days. In order to install tower as early as possible, the test under 14-19 hours is also carried out.

4.2 Road construction Quality control

4.2.1 Material tests for Base and Subbase

Material tests for base and subbase are carried out at local independent Laboratory, the CBR value for subbase is over 80% and CBR value for base is over 100%.

4.2.2 Compaction test

Compaction test is carried out by local independent Laboratory, the designed compaction for subbase is 95% but average is over 98%, the standard deviation for the test is 3.9 and deviation coefficient is 0.038, the design assurance is 98%.

4.2.3 The construction quality control for the crane platform

The slope for crane platform is controlled in 3%, the plate bearing capacity is carried out for the crane platform. The required bearing capacity is 250kPa under settlement limit of 30mm (Max).

4.3 Construction quality control for substation

The main structures for substation are control building, foundations of equipment, capacitor, Auxiliary transformer, steel tower and cable trench, also including lighting protection tower, internal road, water tank for fire protection, water supply, manhole, pump house, septic tank, Fence *etc*.

The quality control for substation mainly applies to the levels and position control, concrete quality control, backfilling test. Material certificates are submitted before the specific construction work started.

Strength is applied to all the substation concrete, the concrete design assurance reaches 100%.

5. Some main functions for EPC contractor in Civil works

Some of the main functions for EPC Contractor in civil works are:

1) prepared necessary management documents such as HSE, ESMP, WSP, QA/QC management plan, Civil work specific test plan, concrete temperature monitoring plan, quality checking and approval sheets *etc*.

2) Carry out the necessary checking and approving for designs submitted;
3) To make necessary design revision during the construction stage in order to speed up the progress of the works;
4) Try to sort out any kind issues raised during the design and construction;
5) Coordinating with the subcontractors, urge them to work as per the plan and as per the required quality.
6) Carry out levels and position controls for the structures;
7) Provided necessary assistant to the subcontractor for their construction management, and signing the quality control sheets;

6. Conclusion

EPC Contractor keep the principle of the best service for the Employer, creates necessary smooth conditions for subcontractors in their construction works, help them in their daily construction, quality control, planning and management. The civil work has been completed in time as per the target time.

The project is successful completed with zero accident, acceptable quality and on the scheduled time.