Large Corrective Action Of A Wind Turbine Blade

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PAPER

In this wind mill technology is a unique and versatile one designed for various complicated site conditions. The wind turbine sector is growing rapidly than other continuous process industries of cost oriented. The wind energy generation is technology oriented, user friendly mechanism and much different from the other manufacturing technologies which are in force. Unlike other continuous process manufacturing industries, the wind mills have also more vital continuous operating mechanics which requires instantaneous maintenance in order to maintain a trouble free mechanism to keep the assets. Keeping the above mission, to give optimum benefits to the developers of the wind farm the author designed a special tool for erection and de erection of heavy base wind components not with standing the conventional crane technology

Keywords: *Renewable energy, save energy, carbon capture, Pollution free environment.*

INTRODUCTION

Innovation is the key driver of the organic growth necessary to generate sustained, above average returns. Windcare had earlier conducted a field study on dismantling and re-erection works for wind energy installations and found that a big chunk of the maintenance cost came from the use of heavy-duty lattice boom cranes for dismantling and re-erection of the various parts of the wind turbine. To cut out or reduce this cost significantly, we devised a value driven approach by using highly trained manpower resources to de-erect, repair and re-erect the wind turbines and its components without the use of heavy-duty cranes. This research-based innovation has helped us reinvent the way wind energy systems are maintained and operated. The principle behind our innovation lies on simple yet effective use of technology and talent in a safe manner to handle virtually any critical issues on versatile landforms and in adverse conditions. On comparison, the customer is benefited by almost 90% on adopting Windcare's methods of crane-less technology.

Our survey reveals about the innovation in the service providing as the wind energy sector that top ranked as the most innovative and leading service provider in the field.

NECESSITY OF THE INVENTION

The wind farm is a highly invested project. The design and the project cost are met by the developers at the time of installation. But after about two and a half years from the commissioning of the parent equipment, the Operation and Maintenance expenses almost double and so, much of the revenue obtained from the fixed assets have to be spent for maintenance due to various reasons i.e. frequent failure of heavy base components like Blade, Gear Box, Generator, Transformer, Main shaft and Rotor of the Wind Mill. So with a huge capital investment cost, the operation & maintenance cost is also relatively huge.

In spite of the technology evolution, no cost cutting solution could be found to reduce the high cost impact on the maintenance of heavy base components. So the operation & maintenance became an expensive & time consuming process because whenever the heavy base components failed, the rectification operation became highly expensive to the developer as they have to depend on expensive heavy duty crane technology which itself could not meet the entire demand of the trade whenever needed.

The drastic challenges in the Crane Technology includes high difficulty for heavy duty cranes to reach the place, interruption due to curvy routes, hills, path corners, public restrictions, travel time restrictions, more support frames and accessories, need of an additional support vehicle to pull the trailer if it is locked in muddy roads, crane pad to be prepared and constructed as per each location, local permission issues, huge fuel consumption and more time for assembly of booms. Also it involved a huge amount which included cost of crane movement, overheads of operators and supporters to operate, fixing ROW issues, etc.

In order to avoid these setbacks and to reduce the cost of operation and maintenance, reduce pollution, and reduce the delay in rectification, the Windcare team put their heads together on the hard task of designing a fully indigenous tool to substitute the crane technology and to enable a low cost service.

PRINICPLE OF THE DESIGN

A method for removing a rotor blade from a rotor of a wind turbine with three blades installed on the top of wind turbine tower is explained below in steps:

Step 1: Positioning the rotor blade being removed in a 6 O' clock position.

Step 2: Attaching a Blade basket over a substantial length of the blade being removed.

Step 3: Attaching a first two sheave pulley to a first attachment point at a first adjacent rotor blade to a rotor blade being removed and attaching a second two sheave pulley to a second attachment point at a second adjacent rotor blade to the rotor blade being removed.

Step 4: Attaching a first lifting line from a first ground winch over the first two sheave pulley through the tower bottom one sheave pulley mounted at tower bottom and one sheave pulley at a first attaching point to the blade harness as three falls and attaching a second lifting line from a second ground winch over the second pulley to the blade harness.

Step 5: Attaching a tail end support line between the blade harness and a tail pick crane lowering the rotor blade being removed by coordinated winch operation;

EQUATION AND FORCE DIAGRAM

Here we accommodate the attribute of all input point is consider like as wind load, contact area, dead weight etc., are taken as input to derive the calculation for designing the blade lifting tool. The following details are

Load Assumption:

Blade mass (Bm)	- 800 kg
Bearing Mass	- 1170 kg
Tolerance (Tm)	- 3% of Actual mass
Stud Mass (Sm)	- 100 kg
Total mass (F)	- 2130 kg

- 2150 kg (1)

Force Diagram:

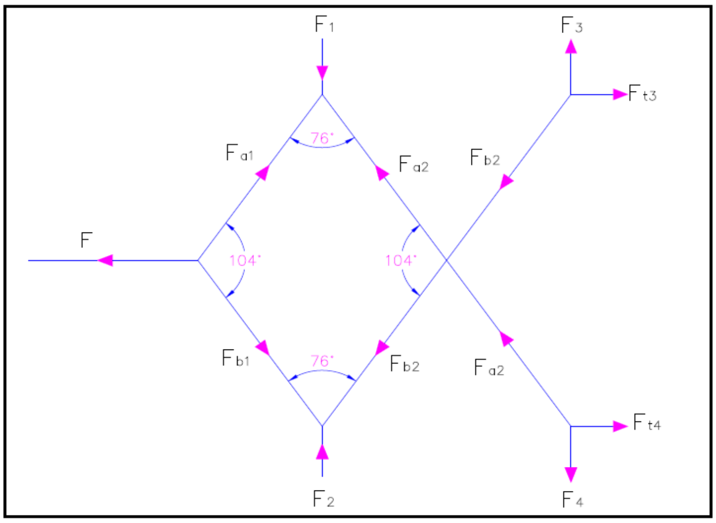

Figure 1 – Force Diagram

Total mass blade and bearing	- 2150 kg
Wind and tagline force	- 1108 kg
Accessories weight	- 182 kg
Acceleration load	- 11.6 kg
Impact load	- 215 kg
Total load	- 3666.6 kg
	- 3670 kg

Based on the weight only, the blade lifting tool is designed which is considered by the factor of safety.

OVERVIEW DESIGN LAYOUT

As mention below figure-2 is modeled in solid works and it is analyzed in the grouping of webbing belt which is derived and used as a component of blade to be replaced in wind turbine.

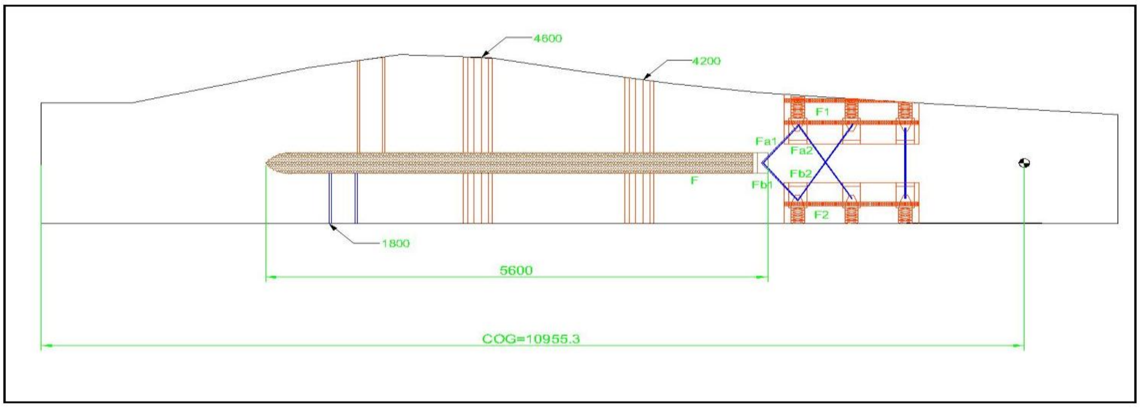

Figure 2 –Blade lifting tool

PROJECT TIME REDUCTION

With our new technology of blade replacement in wind turbine, which can complete the whole operation within 5 days (144 hours) of its commencement. With the old technology, mobilization of the crane to the site, De-erection, Repair and Re-erection of the blade will take a minimum of 20 days (480 hours).

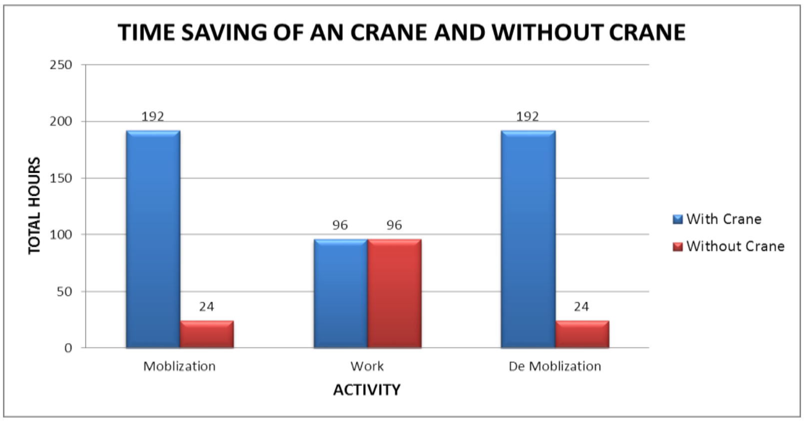

Figure 4 – Project time Reduction

FUEL UTILIZATION

97% Reduction of transportation Fuel Consumption and Pollution:: Transporting the Lattice Boom Truck crane from one place to another place requires at-least 17 trailers which consume 850lts of fuel/100km. Our new technology requires only one 20ft container trailer which consumes 25lts/100kms. This also reduces the pollution by 97%.

Table 1 Comparison of fuel usage

ACTIVITY	WITHOUT CRANE	WITH CRANE
Mobilization	550 Liters	18700 Liters
DG	80 Liters	0 Liter
Crane	0 Liter	100 Liters
Fuel Utilization Calculation	Total KM (Up & Down) = 2200 Mileage = 4 KM / LIT Fuel Utilization = Total KM/Mileage = 2200/4 = 550 Lit Total Fuel = No of Vehicle x Fuel Utilization = 1 x 550 = 550 lit Fuel for 100KM = (TotalFuel/TotalKM)x100 = (550/2200)x100 = 25 Lit	Total KM (Up & Down) = 2200 Mileage = 2 KM / LIT Fuel Utilization = Total KM/Mileage = 2200/2 = 1100 Lit Total Fuel = No of Vehicle x Fuel Utilization = 17 x 1100 = 18700 lit Fuel for 100 KM = (Total Fuel/Total KM)x100 = (18700/2200)x100 = 850 Lit
Fuel for 100 km	25 Lit	850 Lit
Percentage of Fuel Utilization Calculation	% of Fuel Utilization (WITHOUT CRANE) = $\frac{WITHOUT\ CRANE\ Fuel\ for\ 100\ KM}{WITH\ CRANE\ Fuel\ for\ 100\ KM}$ x 100 $= \frac{25}{850}$ x 100 = 2.94 %	% of Fuel Utilization (WITH CRANE) = 100 - % of Fuel Utilization (WITHOUT CRANE) =100-2.94 = 97.06 %
Environmental Pollution in %	2.94 %	97.06 %

COST CUTTING SOLUTION

89.3% Project Cost Reduction: Windcare's Crane-less solution is 89.3% less when compared to the older technology which uses Lattice Boom Truck crane.

Table 2 Project cost in INR & US Dollar

S No.	Description	Technology using crane		Using our Invented Technology	
01	Mobilization charges	50,00,000 INR	76828.55 $	1536.57 INR	1536.57 $
02	Working days (including Mobilization working & reserve day)	20 days		6 days	
03	Hiring charges per operation	25,00,000 INR	38414.28 $	8,00,000 INR	12292.57 $

THE PRESENT STATE OF OUR INNOVATION

Our innovation is rapidly growing and revolutionizing the wind industry. From the year 2007 the Blade Replacement activity is successfully implemented in even megawatt class wind turbines and is growing up day by day and reaching many regions. The table below gives a clear picture of this growth and development.

Table 3 Technology Improvement Application

Year	Strategy of Technology Used	Description of Application
Oct 2007	First single blade replaced by basket with ratchet belt in both lattice and closed type tower	Achieved the capacity 1.25MW, length of span is 32mtr, weight of the blade is 3500kg, tower height is 65mtr.
Jun 2008	Single blade replaced by basket with ratchet belt in both lattice and closed type tower	Achieved the capacity 1.5MW, length of span is 39mtr, weight of the blade is 4500kg, tower height is 72mtr
Nov 2010	Single blade replaced by the method of three point socks with lace in closed type tower	Achieved the capacity 1.65MW, length of span is 40.1mtr, weight of the blade is 6900kg, tower height is 78mtr
May 2012	Single blade replaced by the method of three point socks with lace in closed type tower	Achieved the capacity 2MW, length of span is 45mtr, weight of the blade is 8000kg, tower height is 100mtr
Aug 2015	Single blade replaced by the method of simplified two point socks with lace in closed type tower and hybrid tower	Achieved the capacity 2.1MW, length of span is 47mtr, weight of the blade is 8100kg, tower height is 120mtr
Mar 2016	Single blade replaced by the method of simplified two point socks with lace in closed type tower	Achieved the capacity 2MW, length of span is 55mtr, weight of the blade is 10000kg, tower height is 100mtr

ENGINEERING SOLUTION OF OEM'S

In uttermost end of the exaggerated engineering solution providing in operational maintenance of all manufacturer wind turbine available in India, which is mostly rectified in onshore and sea shore. As well as the same operation in launched and executed in some of the international countries like Sri Lanka, Thailand, Philippines, etc. The range of defined to achieve the maximum

Windcare have provided services without cranes from minimum to maximum specified size of WTG

- WTG Capacity 225 KW to 2.5MW
- WTG Component Weight 2 to 60 Tons
- WTG Hub Height 30 to 114 Meters

Windcare have provided service in all type of WTG towers

- Lattice tower
- Closed type tower
- Hybrid Tower

With Windcare’s solution, the rewards of renewable wind energy are much more

- Cost effective
- Less time-consuming
- More technology-driven
- Free from Pollution

Fig 4. Straight Blade Erection

Figure 5. Damage Blade Erection

Figure 6. Pre-Bend Blade Erection

CONCLUSION

The above invention is a technological innovation in Wind Farm of Non Conventional Energy sector very much vital usage for wind farm developers by reducing the cost factor & pollution, time savings and energy savings since attending of the defect immediately without waiting for crane technology of sophisticated only. By simple, versatile, user friendly mechanism this invention helps the developers of the Wind Farm in the core sector of non conventional energy.

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BIOGRAPHIES

Mr. S. Anthony Raj Prem Kumar –, a youth with a diploma in ME, a native of Sayarpuram, a small village in Tuticorin started out with big dreams about his career. He made a start in the cement industry but eventually traversed into the Wind Sector which was to have a powerful impact on his life. He toiled as a site in-charge for NEPC India Ltd and learned the art and science behind the Wind Turbine Technology.

In 2001 Mr. Antony began to dream of an innovation - inventing special tools to be used for erection and de-erection of wind turbines without the use of heavy duty cranes which is an expensive affair. By his extensive research and innovation, he brought about a revolution in the maintenance industry by pushing down the cost of maintenance of turbines by about 50%, a boon for wind farm owners.

A man of deep spiritual experience, Mr. Antony began to execute his dreams with a small 5 member team and faith in God who makes impossible things possible. Today, he heads a 1000 member strong team which works with the same passion to bring quality in the field and catering to nearly 40 % of the industrial needs.

Mr.N.Kalimuthu – with a mechanical in BE completed in 2008, a native of Aranthangi in Pudukottai district. He started in apprenticeship training in BHEL, Trichy. In 2010 he join in M/s. Windcare India Pvt. Ltd, is posted as junior Engineer in tools development in Technical.

He traveled the wind industry experience for more than 7 year under various capacities with reputed Indian manufacturers in the industry holding complete responsibility of designing the craneless technology, modelling, analysis, researches the technology and solution providing of operational maintenance of wind turbine. The activitiy of replacing the failure components of wind turbine in simplified technology. By the experience and efficient solving capacity, he placed and leading as Research and Development team head from 2014 onwards.