New technologies for wind turbines foundation repair

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Abstract

In the past years many faults in the foundations of wind turbines around the world have been detected. Even when it is a matter subject to a strong degree of confidentiality, it is known that thousands of foundations, all over the world have been cracked, allowing movements inadmissible by the turbines. **This communication presents for the first time, the fully satisfactory result of repair work of more than 300 foundations in various countries of Europe in the last decade.**

Objectives

In 2007, a wind farms owner reported us a serious problem affecting dozens of foundations of wind turbines: there were movements, increasing with time, forcing its decommissioning. The challenge was to find a technology able to meet the following requirements:

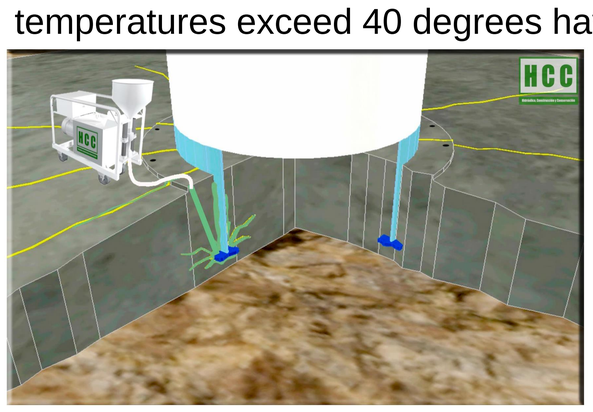
- Long-lasting solution.
- Minimize the turbine downtimes.

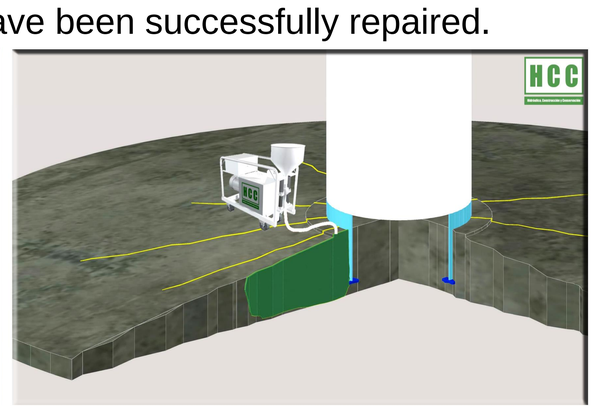
A system, inspired by the repair of dams, has been developed, using high viscosity synthetic resins, injected at very high pressure, has been shown, after nine years of the first experiences, to fulfill the above requirements.

HCC Technology

The technology is based on the use of very high viscosity resins, specially formulated, injected at very high pressure. Viscosities up to 1.000.000 cP and pressures up to 600 atm are used.

The aim was to return the monolithic concrete fractured under the flange and encapsulate the ferrule on its pedestal, with a strong and elastic material, minimizing the movements and ensuring the durability of the repair.
Resins have been especially formulated for this application, as well as machinery and working procedures, suitable for any environment. Foundations in areas close to the Arctic or southern Spain where temperatures exceed 40 degrees have been successfully repaired.



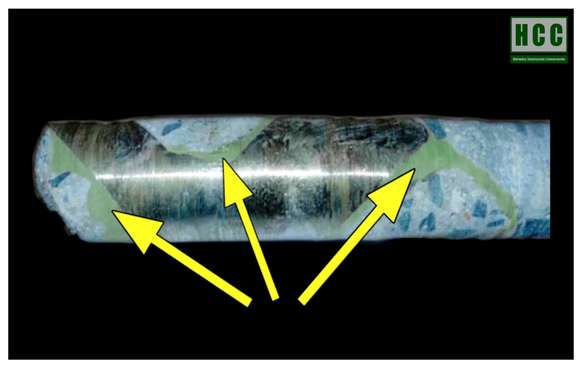


Results

A first qualitative assessment of the effect of the injection is obtained by inspecting the samples extracted from the flange area first, prior to pumping the epoxy resin and secondly, after executing the work.

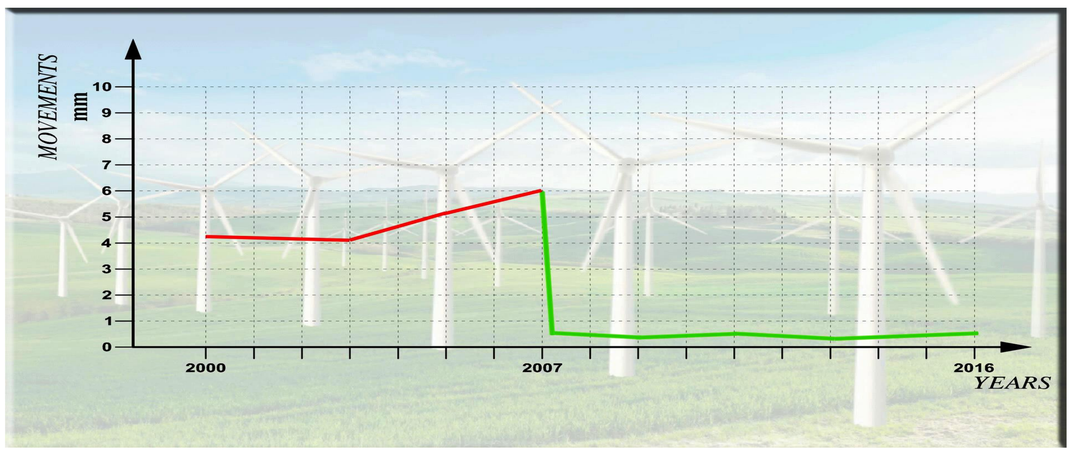
In the first case, concrete and steel appear to be completely separated.

In the second case, we notice how the resin adheres to the concrete as well as to the steel, constituting a monolithic structure. The injection of highly viscous putty at high pressure allows completely filling in all areas and strengthening the pulverized concrete. It is noticed that the injected areas are several millimetres thick.



Also, it is noticed that the resin rises through the annular space between the ring and the pedestal, through the inner as well as outer area.

In terms of effectiveness, given the perspective of nine years of experience and **more than 300 foundations repaired** in extreme latitudes of the northern hemisphere, is concluded that the repair technology ensures a stable performance of the foundation. The graph below shows the typical changes in the movements of the turbines before and after the injection of the foundation.



Downtime

In terms of loss of profits, the total downtime for repairing each wind turbine has been reduced to only three days, leading to significant cost savings in respects to other technologies.

Conclusions

New materials and technology developed especially for repairing wind turbines foundations, after nine years of experience and **more than 300 units repaired** in different latitudes of Europe, Spain, France and Sweden, allow to conclude that a mature methodology is ready to be launched with full guarantees of success.
Its main strengths are:

•Reduces movements to permissible values, not suffering significant increases in time.

•Executable in any environment or temperature.

•**Minimizes the turbine downtime to only three days.**