

Nondestructive Testing of Existing Tension on Wind Tower Anchor Bolts

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BACKGROUND

Anchor bolts secure wind turbines to foundations. Insufficient tension in anchor bolts causes excessive fatigue stress and uneven pressure on the turbine foundation. Current maintenance practice is labor, time, and cost intensive, involving mechanical tools and hydraulic jacks.

OBJECTIVE

- Develop a nondestructive method that can identify tension in anchor bolts without applying the current tensioning process
- Reduce the cost of wind farm maintenance
- Increase the safety of the maintenance process

METHODS

Generating a Predictive Model for Anchor Bolts

Step 1: Tension/Frequency relationship

- Performed frequency response test sequences on several bolts at multiple load levels.

Step 2: Impact of rust

- Performed test sequences to understand the effect of corrosion bond on frequency response.

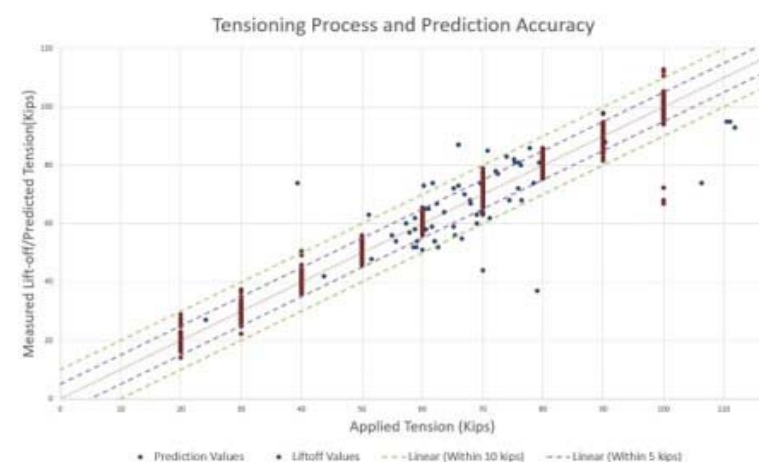
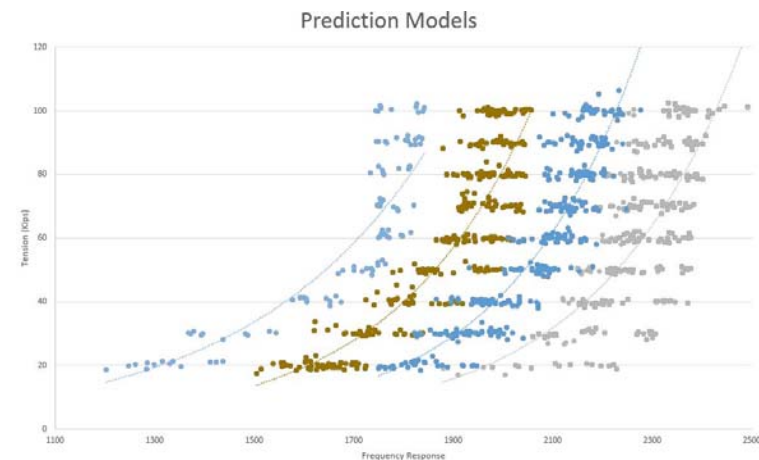
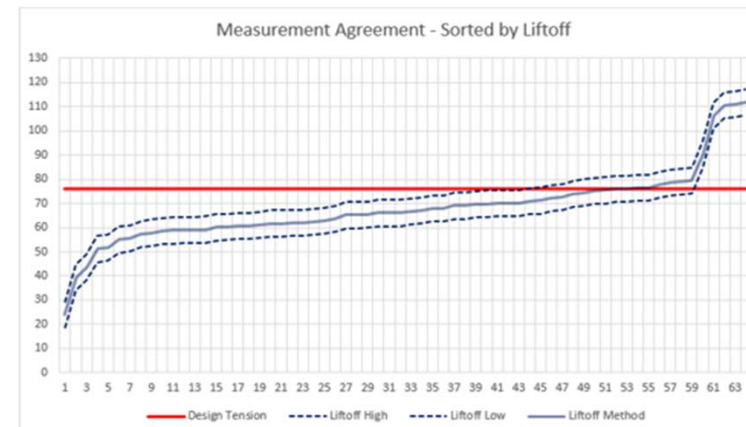
Step 3: Mathematical model

- Created a predictive model.

Step 4: Model validation

- Performed test on 64 bolts randomly selected from 8 different turbines on a single wind farm.

RESULTS



Top Left: Depicts the lift-off measurements variation of 64 verification bolts

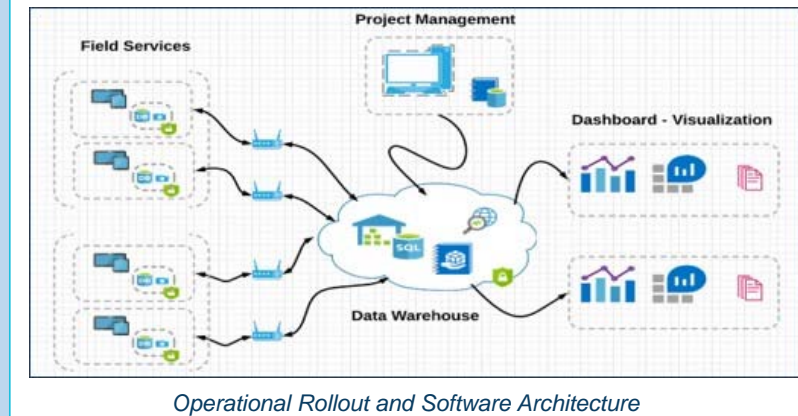
Top Right: Depicts current maintenance practice, lift-off measurements setup

Middle Left: Depicts NDT frequency response prediction models

Bottom Right: Depicts NDT maintenance setup

Bottom Left: Depicts the comparison between current maintenance practice vs NDT maintenance practice

* Patents pending for this method*



CONCLUSIONS

Lift-off Findings

- 64 bolts total from 8 turbines
- ± 5.4 kips: accuracy of lift-off testing
- **53 of 64:** below design tension
- **36 of 64:** less than 90% design tension

NDT Findings

64 bolts total from 8 turbines
49 of 64: within 10 kips of lift off

If passing test is 90% of design tension:

- False positives: 8 - NDT passing; lift off failing

Current development is focused on improving accuracy of the prediction models.

False positives can be lowered by changing the threshold requiring action. If passing test is at design tension:

- False positives: 2

CONTACT INFORMATION

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