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Range of studies to define best asset management for aged foundations

By 2030, an increasing number of overhead lines (OHL), built after the Second World War, will reach the age of 85. To counteract this network aging, OHL will have to be rehabilitated, involving the replacement of a large number of old non-galvanised pylons.

Administrative procedures in France are easier when pylon replacements are kept on the same location, thus RTE has to evaluate the risks of reusing old foundations and decide whether to demolish, refurbish or reinforce the existing asset.

In order to adopt the best approach of this matter, RTE is launching a series of studies regrouped under the label "plan fondation" [foundation plan]. Its aim is to deal with the following questions:

- How to best diagnose the properties of old concrete?
- For a better asset management predictions, can RTE identify groups of foundations which are more likely to deteriorate faster
- How to choose when is the right time for a refurbishment/reinforcement and therefore prevent incidents?
- Which rehabilitation methods are best suited to the different levels of deterioration?

The "plan fondation" is composed of 4 parts:

1. Failure defining – At which level does aging deterioration impact the stability of the foundation?
2. Define the environmental conditions that will cause an early failure of the foundations
3. Rehabilitation and reinforcement methods – How to improve those methods and reduce costs
4. Foundation design with longer life span and easier maintenance

For now, a focus on parts 1 & 3 is made due the oncoming and challenging rehabilitations. The details of each parts are described below.

1. Part 1 : Failure defining

1.1 Study 1: Historical analysis of pylon failures due to foundations

The aim of this study is to gather every ruins or failures occurred on the French network and to select those caused by a faulty foundation. Then, RTE will be able to answer the following questions:

- Are foundations the cause of a large number of ruins?
- Is aged concrete to blame for the failures caused by foundation?

1.2 Study 2: finite element analysis of foundations structural strength with deteriorated parameters

The aim of this study is to evaluate, using Plaxis 2D, how diminished strength parameters affect the overall capacity of the foundation.

This study will help distinguish 2 configurations:

- Aging deteriorations impact mainly life span while strength capacity is maintained above needed capacity. In this case, a rehabilitation of the foundation is sufficient.

- Aging deteriorations impact strength capacity earlier than the total life span. In this case, a reinforcement of the foundation is needed.

This analysis (Figure 1), will measure the impact of 3 factors:

- Concrete strength
- Concrete fractures, their size and position,
- Behavior model used for rocks tested on old fractured concrete.

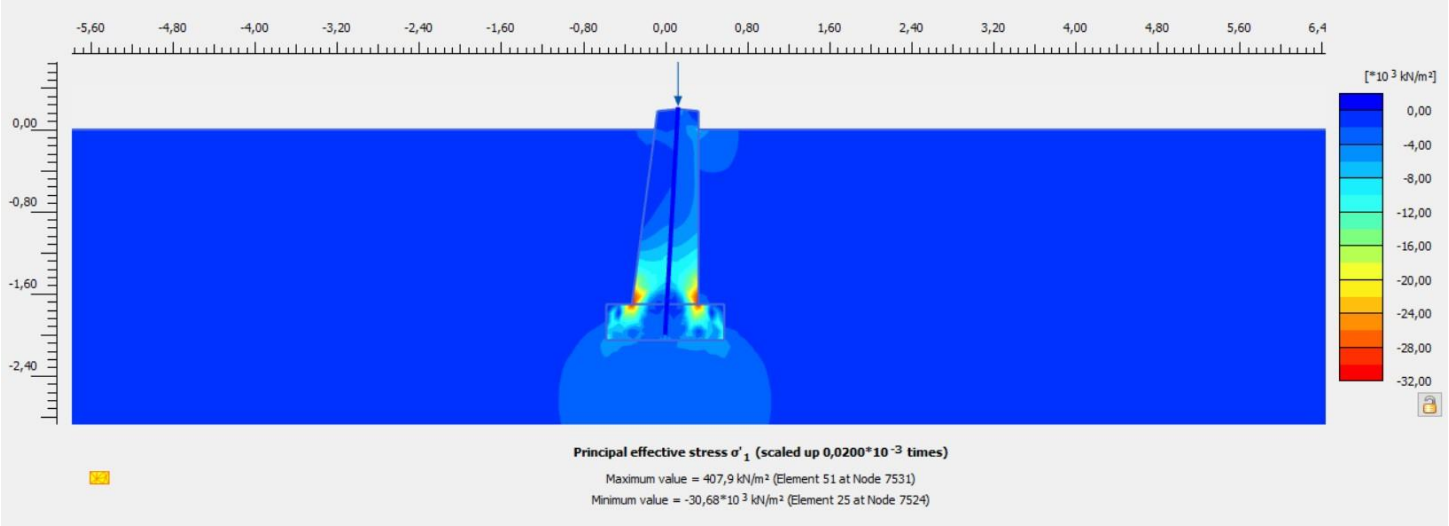

Figure 1 : 2D finite element analysis of a footing

2. Part 2 : failure prediction and aging signs

2.1 Study 1: Benchmark with other TSO

The aim of this benchmark is to list and share practices from different TSOs.

2.2 Study 2: National diagnostic of the foundations

The goal of this study is to diagnose, on a large number of foundations spread evenly across the country, the properties of the concrete. The sampling is made by core drilling (figure 2) in

different position of the foundation. An analysis of soil and water aggressiveness is also performed.

Figure 2 : concrete sampling performed by core drilling on an existing asset

Acquired data will be studied statistically in order to find trends or correlation between parameters such as age or location.

2.3 Study 3: aggressive soils cartography

Using existing data gathered during previous studies, RTE plans to map zones where the soils are more likely to be aggressive and lead to concrete deterioration. The chosen threshold values are based on the NF EN 206 CN, a European standard with national specifications.

A first map was established with a limited number of measures (Figure 3).

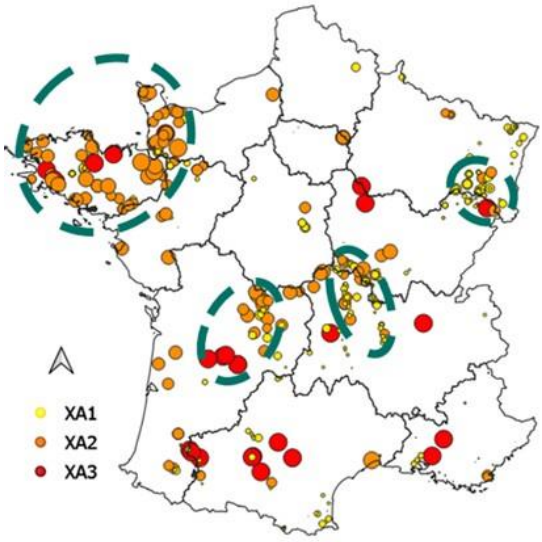

Figure 3 : aggressive soil and water to concrete map

3. Part 3 : Rehabilitation and reinforcement

This part contains some studies that aim at developing new rehabilitation and reinforcement techniques at reduced costs. Today, micro piles are often installed to reinforce foundations, this technique is proven to work well but has a significant cost. New solutions criteria are:

- Quick to install,
- At reduced cost compared to micro piles,
- Minimum life span expectancy after rehabilitation or reinforcement,
- Provisory stability of the pylon during all work phases.

Some tests are being performed.

4. Part 4 : Foundation design improvement

Studies in this part are not launched yet, prioritizing part 1 & 3. Completely new foundations construction are scarce, the main challenges concerning the existing assets.