Inclusion of damage detection methods for the sustainable life cycle design of bridges in aggressive environments

DOCTORAL PROGRAM IN CONSTRUCTION ENGINEERING

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OBJECTIVES OF THE INVESTIGATION

General objectives

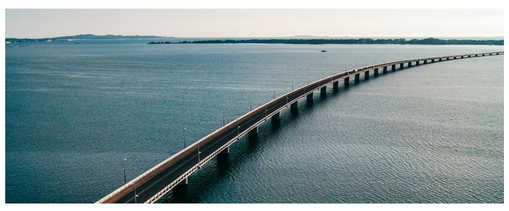
Nowadays, due to the high costs of building large structures such as bridges, it is very important to pay attention to the repair and maintenance of the structures, to increase the lifespan of these structures, and to use the appropriate methods to reduce the costs related to the maintenance and repair of the structures. In this regard, it is very important to use appropriate and non-destructive methods in diagnosing and predicting damage to such structures. In addition, life cycle assessment and the sustainability of using different damage detection methods are important.

Specific objectives

- Examining the accuracy of different dynamic and non-destructive damage detection methods in identifying the extent, location, and time of damage to the structure during the lifetime of the building.
- Evaluate the accuracy and possible changes in the accuracy of each of the damage detection methods in different environments, especially coastal environments and aggressive environments.
- Performance evaluation and comparison of different non-destructive damage detection methods for design sustainability and life cycle assessment cases, including economic, environmental and social impact assessments.

MAIN STAGES OF RESEARCH DEVELOPMENT

1 Model Description



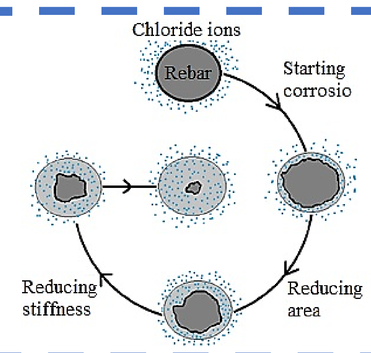
Coastal RC Arosa bridge (1985)

2 Damages causes

Natural marine damage causes

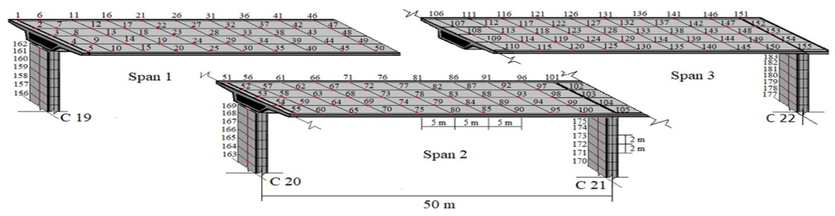
- Carbonation
- Chloride ions attack
- Sulfates

The process of chloride corrosion in rebar

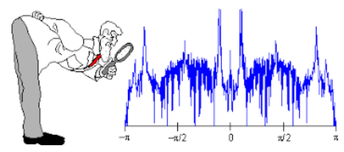


3 Damages detection

Prediction of location and amount of damaged elements through a Non-destructive damage detection methods based on signals



Yearly Monitored structure



Signal frequency response assessment from sensor points

Analyzing and processing according to comparing data from the measurement in undamaged and damaged structure frequency

Identify the location and percentage of damages

4 Life cycle Assessment

Life cycle assessment (LCA)

- *Economic analysis*
- *Environmental analysis*
- *Social analysis*

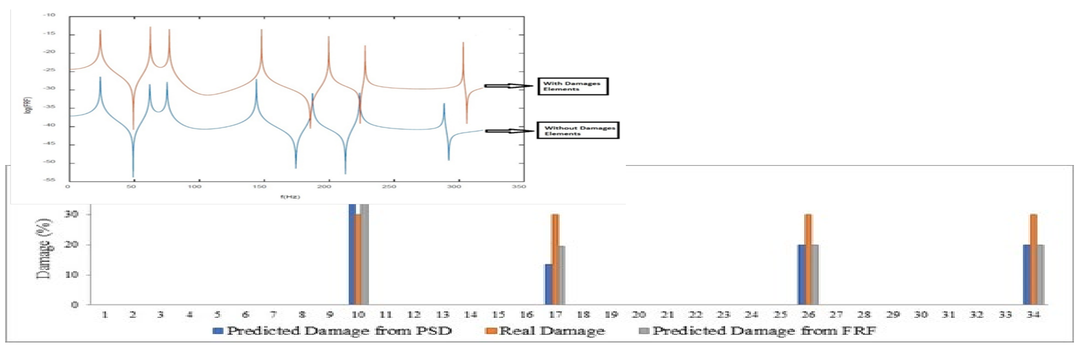
Life cycle cost assessment levels

- Design and construction
- *Maintenance and repair*
- *Destruction at the end of structure life*

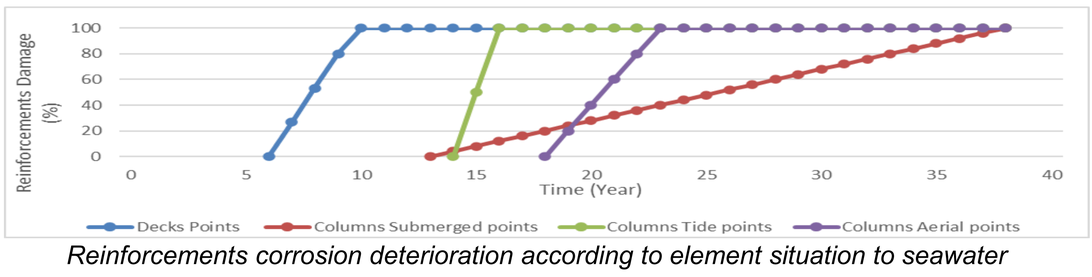
EXPECTED RESULTS AND POTENTIAL PROFITS

Damage detection method results

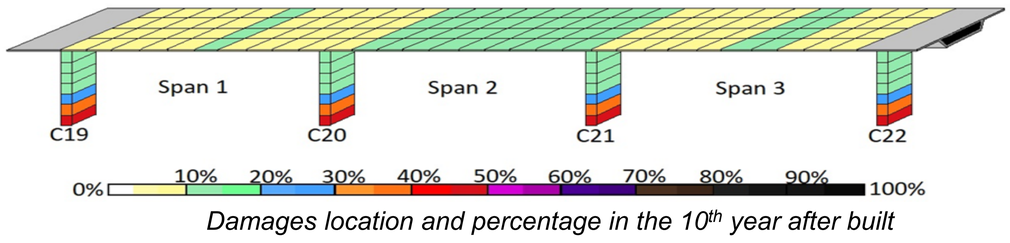
Compared the performance of two damage detection methods based on frequency response function (FRF) and power spectral density (PSD).



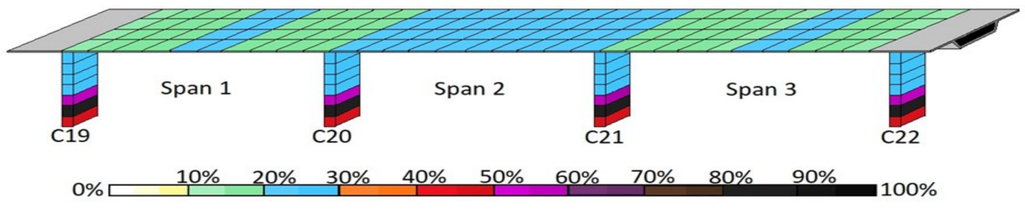
To identify and predict corrosion damages at the coastal bridge use the PSD method to assess the performance of the method to predict the location and amounts of damages during the bridge life (100 Years).



Reinforcements corrosion deterioration according to element situation to seawater



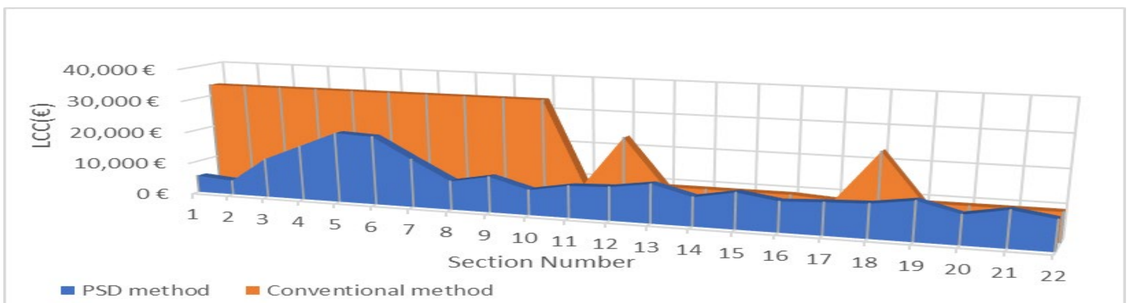
Damages location and percentage in the 10th year after built



Damage location and percentage in the 33rd year of the bridge life

Life cycle cost assessment through damage detection method

The results of the PSD approach to damage detection and the performance of this method in reducing the repair and maintenance costs compared to the conventional method to decrease the total cost of maintenance and repair.



Compare the life cycle cost assessment for a span of the bridge until the end life of the bridge with PSD and Conventional damage detection methods

CONCLUSIONS

In conclusion, this research is not finished completely but in the middle of the assessment, results showed that these kinds of non-destructive damage detection methods based can be applicable to specialists and engineers in the field in reducing the costs of repair and maintenance of structures. However, this investigation to get the main results is continuing.

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