Master's Thesis Engineering Technology

2024-2025

Crack Monitoring in Dapped-End Beams: A Study of Sensor Technologies under Corrosive Conditions and Numerical Modelling of Crack Formation

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Problem & method

Aging bridges face increasing safety concerns due to corrosion-induced cracking in **dapped-end beams** (Figure 1). Traditional monitoring sensors often fail in corrosive environments. There is a need to identify durable, long-term sensors capable of **monitoring crack** and **corrosion** development in these conditions. This master's thesis includes a literature review of sensing technologies suitable for corrosive environments, followed by the development of multiple **DIANA finite element models** (Figure 2) to predict crack formation in dapped-end beams. The models provide a **baseline** for evaluating both DIANA's predictive accuracy and the future use of corrosion-resistant sensors.

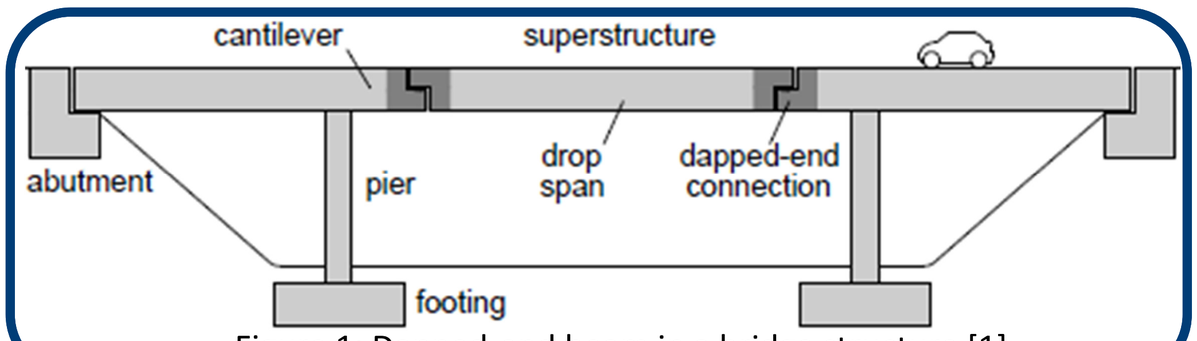

Figure 1: Dapped-end beam in a bridge structure [1]

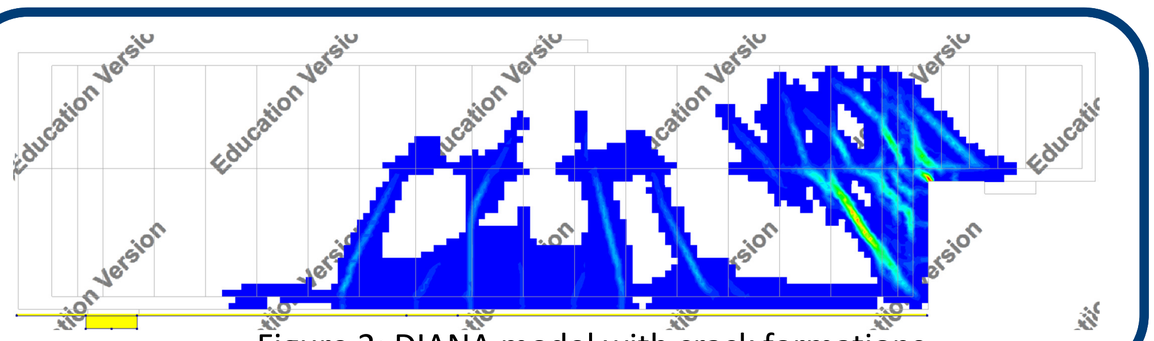

Figure 2: DIANA model with crack formations

Sensor

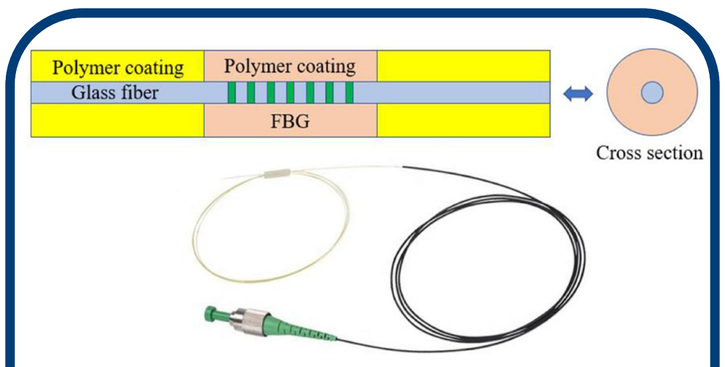

Figure 3: FBG Sensor [2]

The **Fiber Bragg Grating (FBG) sensor** (Figure 3 and Figure 4) was chosen for this research due to its combination of **high precision**, long-term stability and **resistance** to **corrosive environments**. Other sensors lacked resistance to corrosive environments, or no testing had been conducted to determine whether the sensors could withstand such conditions.

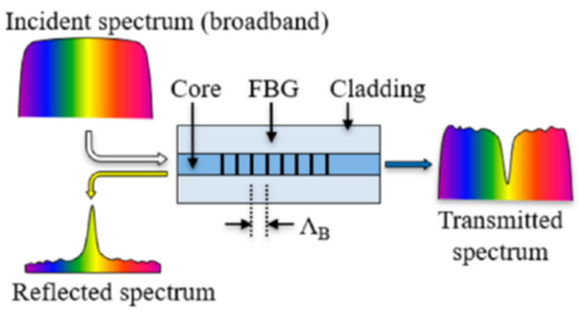

Figure 4: Working principle of an FBG Sensor [2]

Results & conclusion

The analysis (Figure 5) shows that while crack patterns (Figure 6) are generally **consistent** between the **nominal** and **actual** models, the nominal model fails earlier and exhibits more minor cracks due to a lower concrete strength.

This **data** is **essential** due to the **limited understanding** of dapped end beams, particularly in structural calculations and crack behavior, which are **critical** for enhancing **structural safety**.

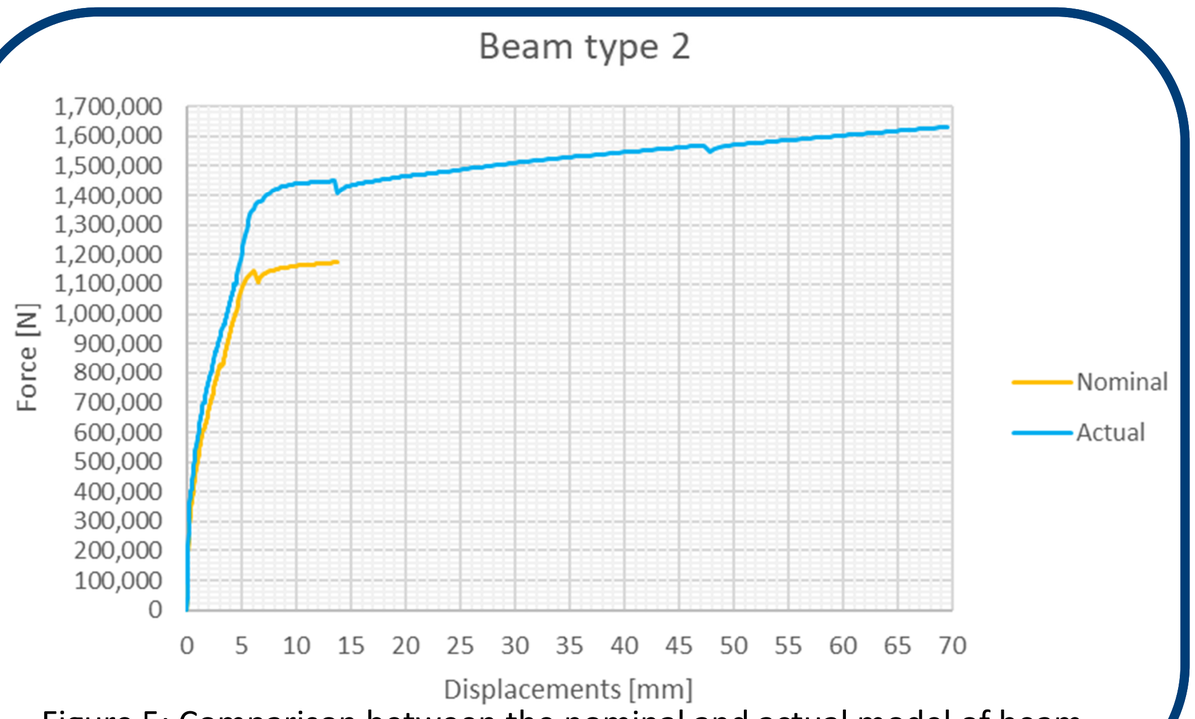

Figure 5: Comparison between the nominal and actual model of beam type 2

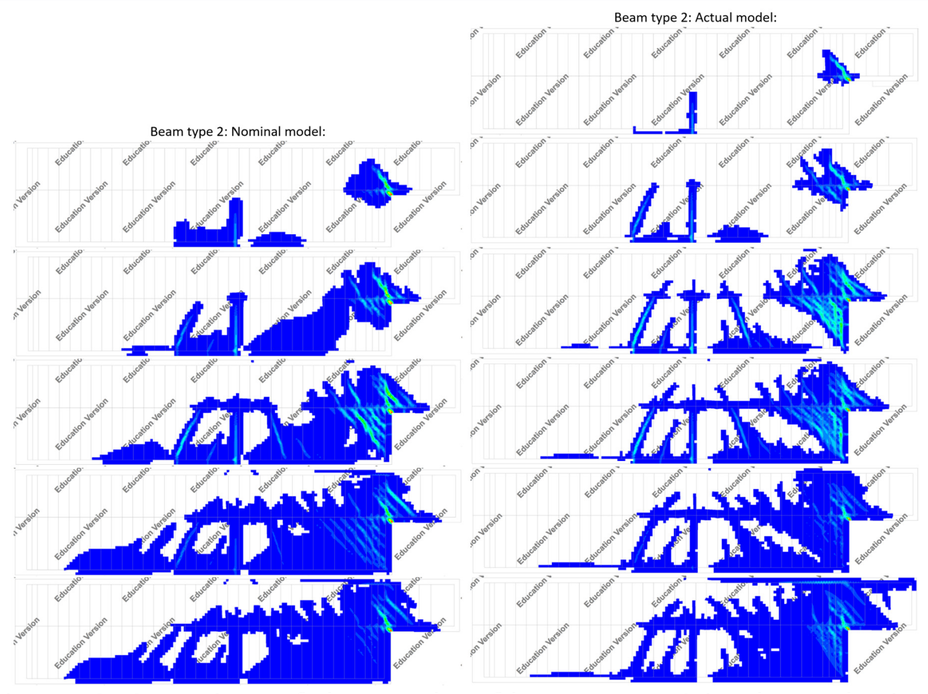

Figure 6: Overview of the cracks of beam type 2 in chronological order

Supervisors / Co-supervisors / Advisors: Prof. dr. ir. Hervé Degée
Ing. Luke van Ratingen

[1] C. Rajapakse, "Behaviour and Modelling of Reinforced Concrete Dapped-End Connections," Engineering Scienced and technology, Engineering Technology, Liège, Hasselt, 2023.

[2] Y. Yoa, Y. Meng and Y. Boa, "Measurement of cable forces for automated monitoring of engineering structures using fiber optic sensors: A review," *Automation in construction,* pp. 1-14, 23 March 2021.