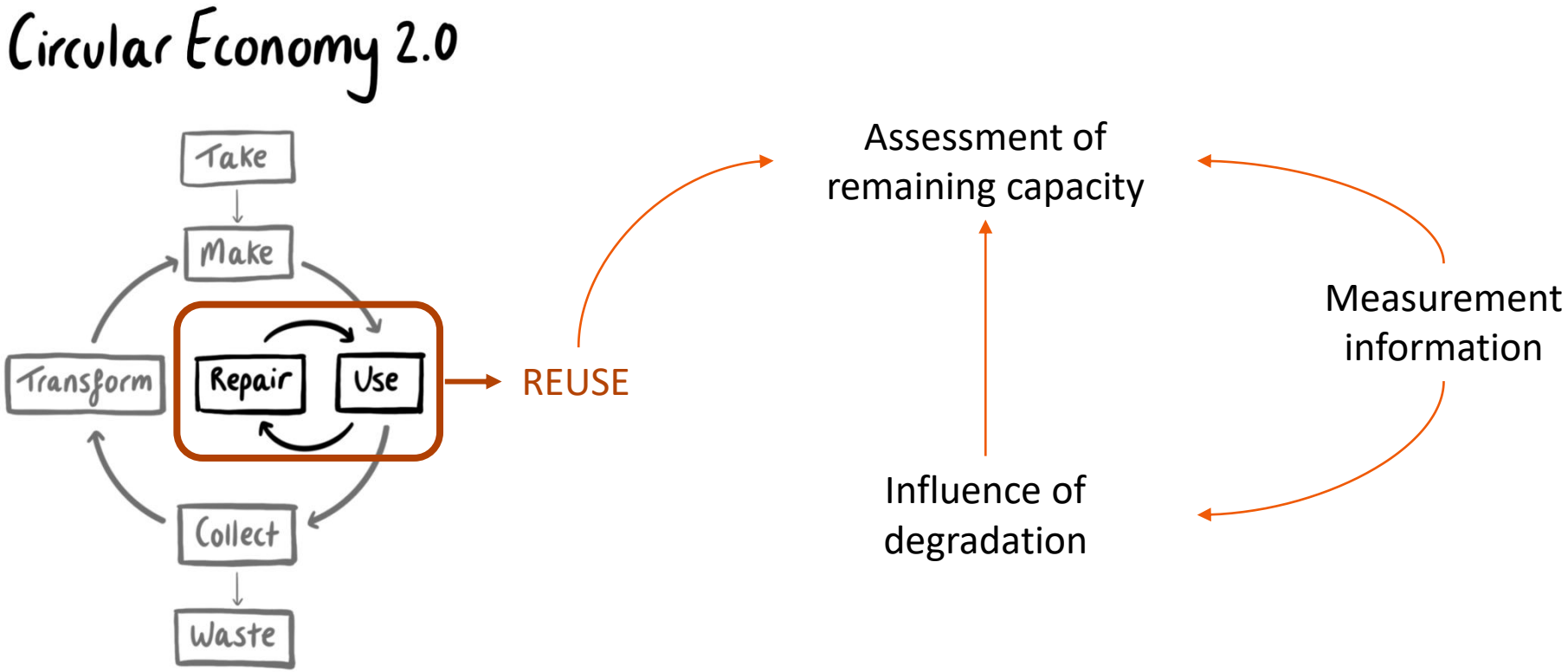
Investigations on the effect of corrosion on testing data of reinforced concrete beams

Eline Vereecken
Hasselt University,
Hasselt, Belgium

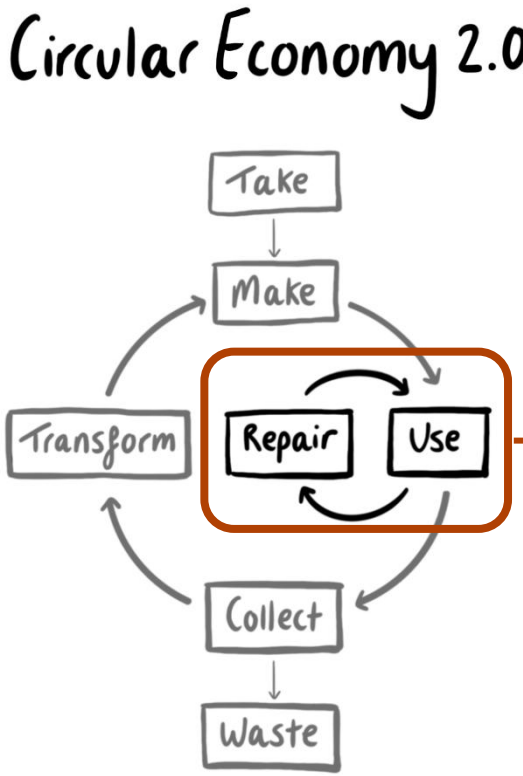
Wouter Botte, Robby Caspeele
Ghent University,
Ghent, Belgium

Geert Lombaert
KU Leuven,
Leuven, Belgium

Introduction



Introduction



REUSE

Assessment of remaining capacity

Measurement information

Influence of degradation

Investigate with real-case data

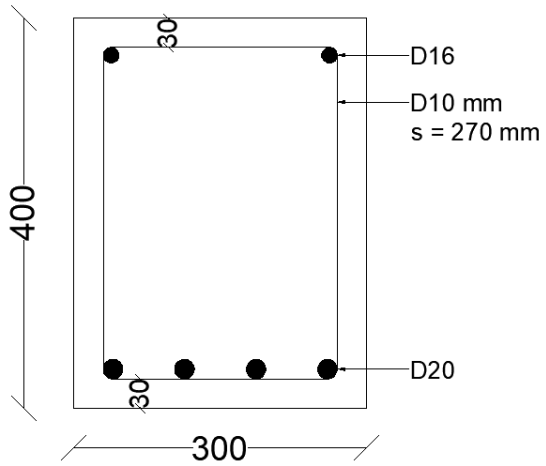
Experiments at Magnel-Vandepitte laboratory (Ghent University)

Experimental campaign

Experimental campaign

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → Destructive tests → Actual corrosion degree

Beam layout



Length 5 m

Accelerated corrosion

Current: 100 µA/cm²

Salt solution: 5% NaCl

Applied at age of 28 days

Top reinforcement isolated from current

Corrosion duration

Beam 1.1: 330 days → 6,2%

Beam 1.2: 63 days → 2,7%

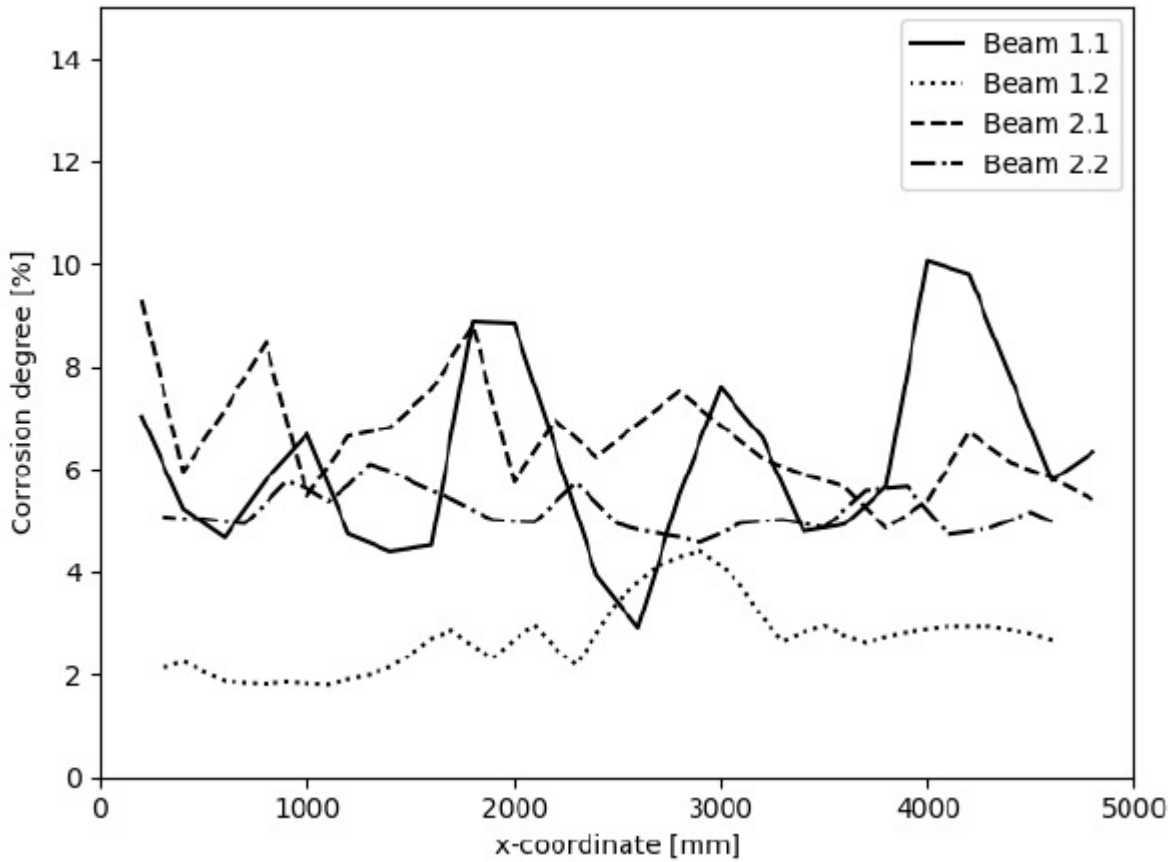
Beam 2.1: 285 days → 6,6%

Beam 2.2: 182 days → 5,2%

Beam 4.1: 0 days → Reference

Actual corrosion degree

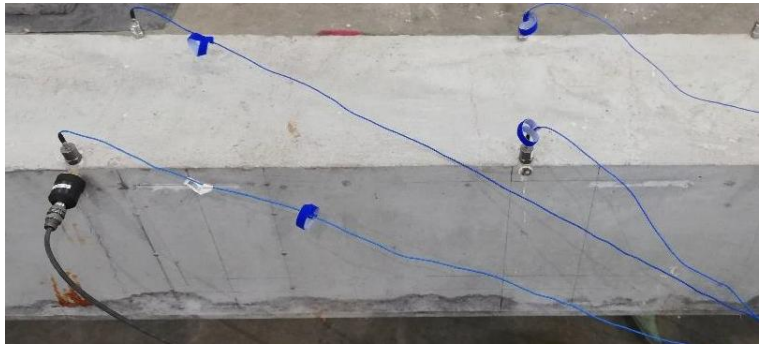
Beams subjected to accelerated corrosion → Dynamic tests → Static tests → Destructive tests → Actual corrosion degree



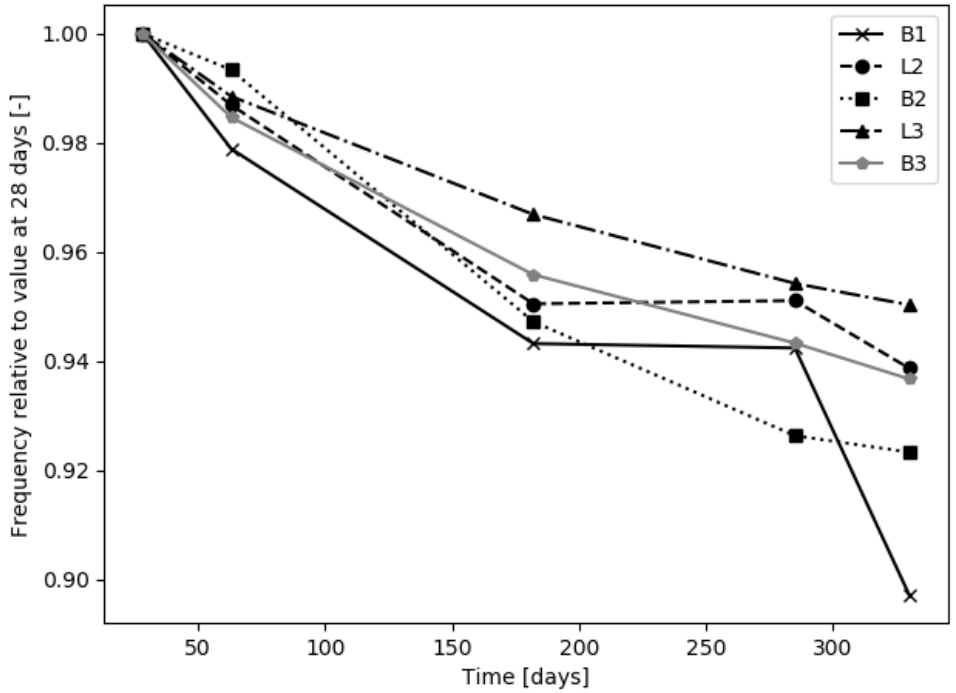
Parts of 20 cm reinforcement bar
Cleaned and weighed

Dynamic tests

Beams subjected to accelerated corrosion → **Dynamic tests** → Static tests → Destructive tests → Actual corrosion degree



Reference beam



Dynamic tests

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → Destructive tests → Actual corrosion degree

Beam 1.2 – 2,7% corrosion

Mode	28 days	63 days	Rel. Diff. [%]	Rel. Diff. Ref. 63 days [%]
L2	120.97			-1.31
B2	164.70	167.03	1.41	-0.67
T1	204.51	201.27	-1.58	
L3	228.26			-1.15
B3	303.97	304.43	0.15	-1.54
L4	362.75	358.56	-1.16	
…	…	…	…	…

General reduction in frequency BUT not larger than for reference beam.

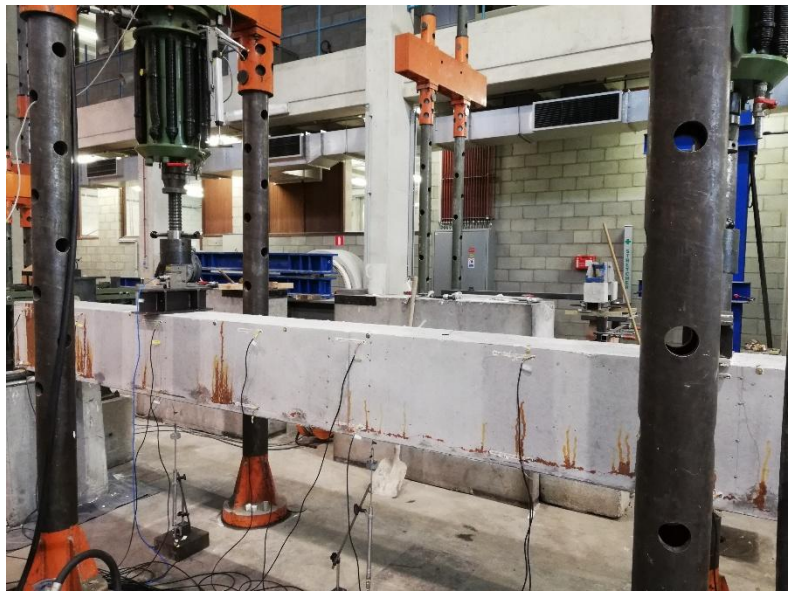
Beam 1.1 – 6,2% corrosion

Mode	28 days	330 days	Rel. Diff. [%]		Rel. Diff. Ref. 330 days [%]
L2		103.60			-6.13
B2	169.16	146.33	-13.5	<	-7.67
T1	202.01	186.57	-7.64	<	-2.82
L3		202.41			-4.97
B3	306.48	274.17	-10.54	<	-6.33
L4	363.36	322.05	-11.37	<	-5.46
…	…	…	…		…

General reduction in frequency AND larger than for reference beam.

Static tests

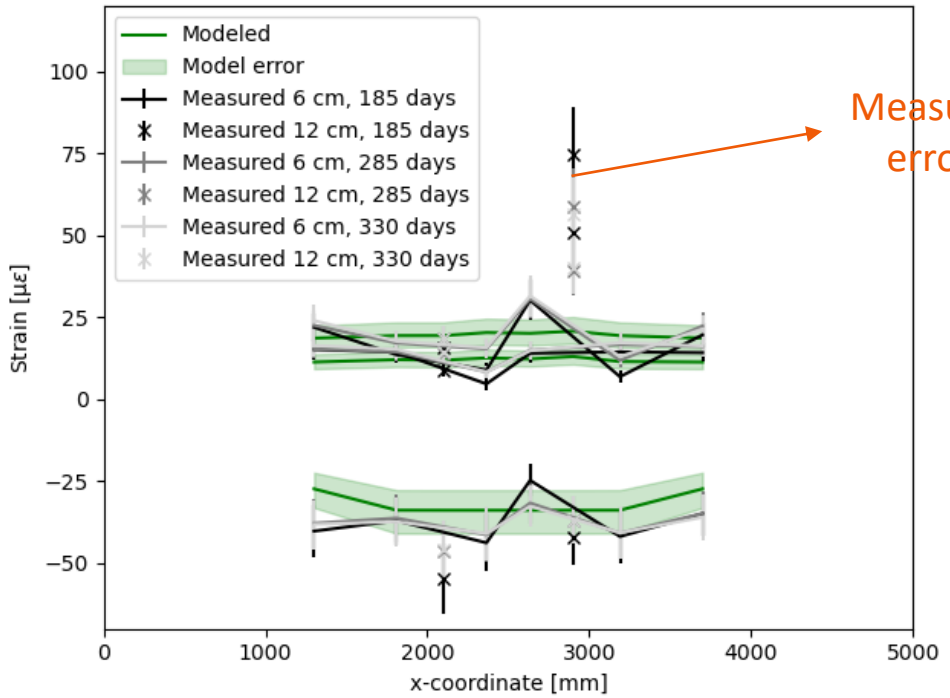
Beams subjected to accelerated corrosion → Dynamic tests → **Static tests** → Destructive tests → Actual corrosion degree



4-point bending
Strains between 5 and 15 kN (load in one loading point)

Modelled values = FEM model with input of actual corrosion degree

Reference beam

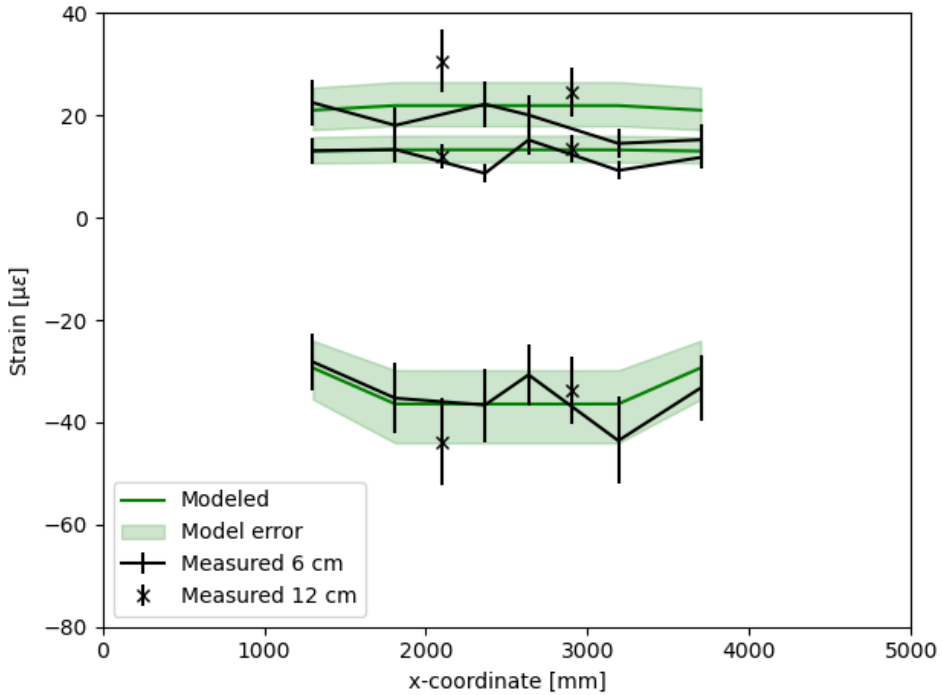


No reduction in stiffness over time

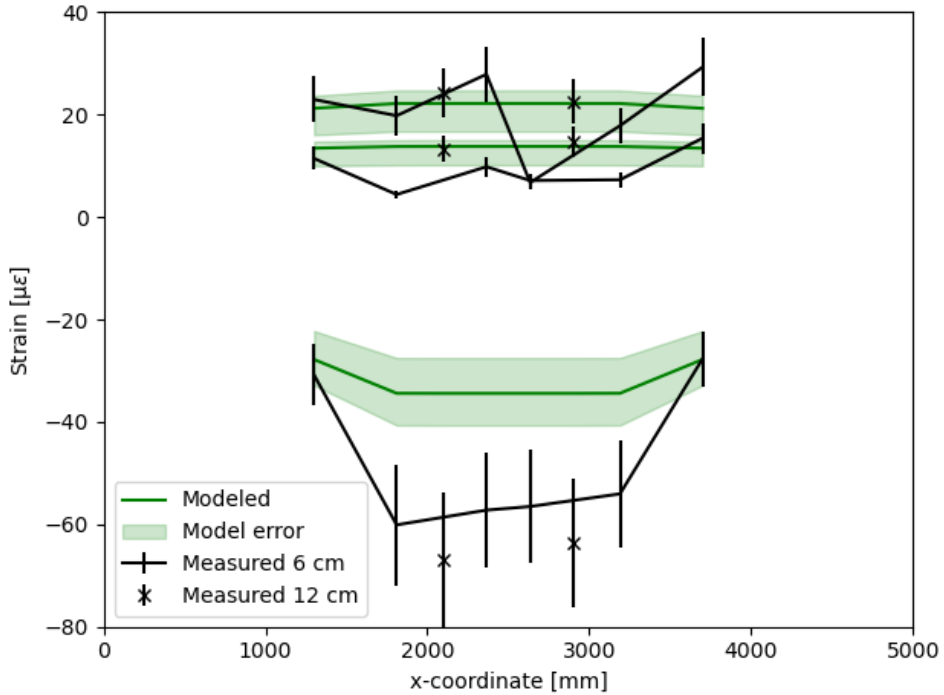
Static tests

Beams subjected to accelerated corrosion → Dynamic tests → **Static tests** → Destructive tests → Actual corrosion degree

Beam 2.2 – 5,2% corrosion



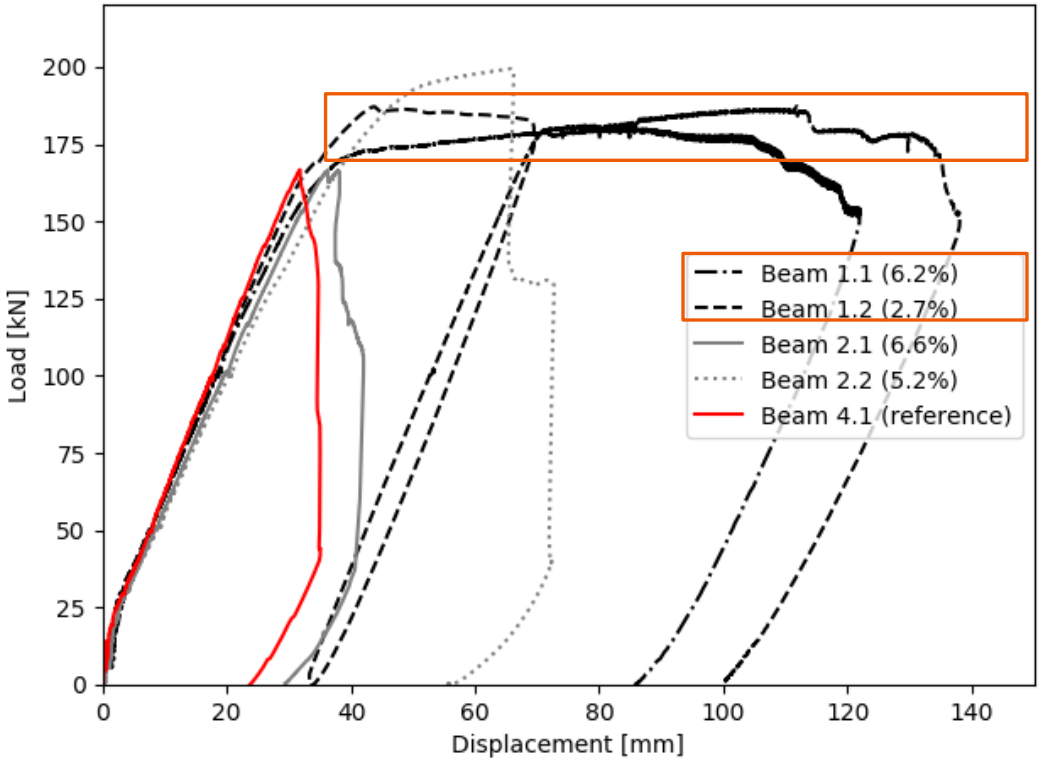
Beam 1.1 – 6,2% corrosion



On average higher strains than for reference BUT difference not exceeding measurement error

Destructive tests

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → **Destructive tests** → Actual corrosion degree



(at midspan)

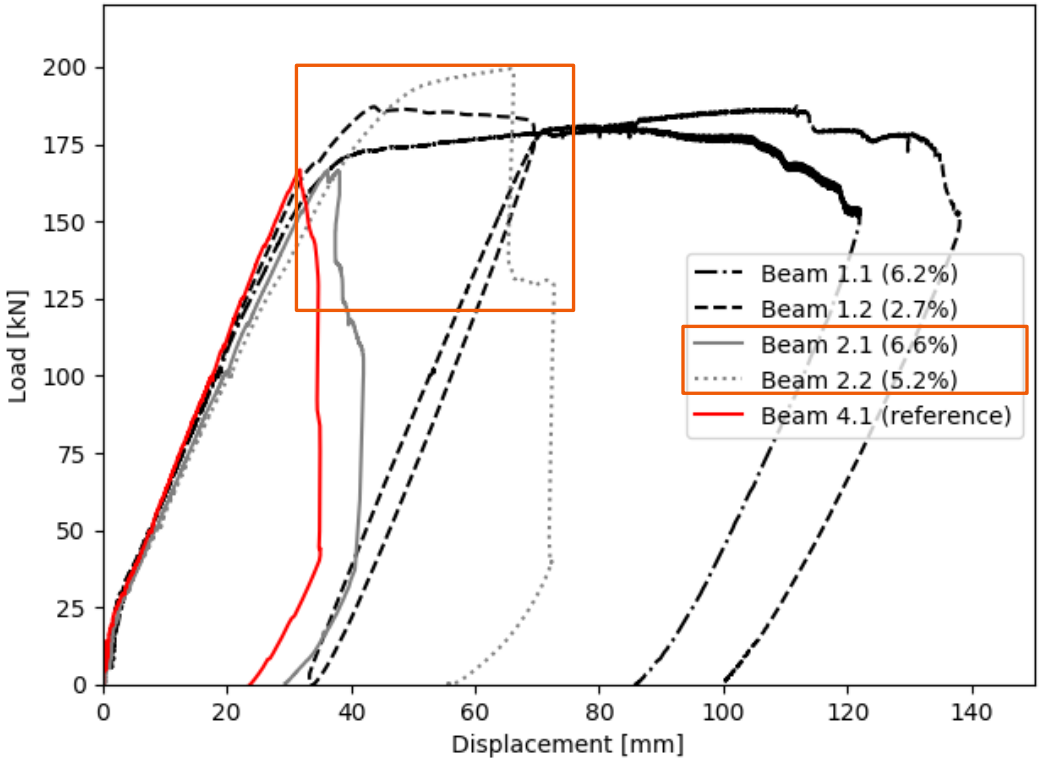
Crushing of concrete in compression zone

Higher corrosion degree (beam 1.1) =

- Lower ultimate load
- Lower initial stiffness

Destructive tests

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → **Destructive tests** → Actual corrosion degree



(at midspan)

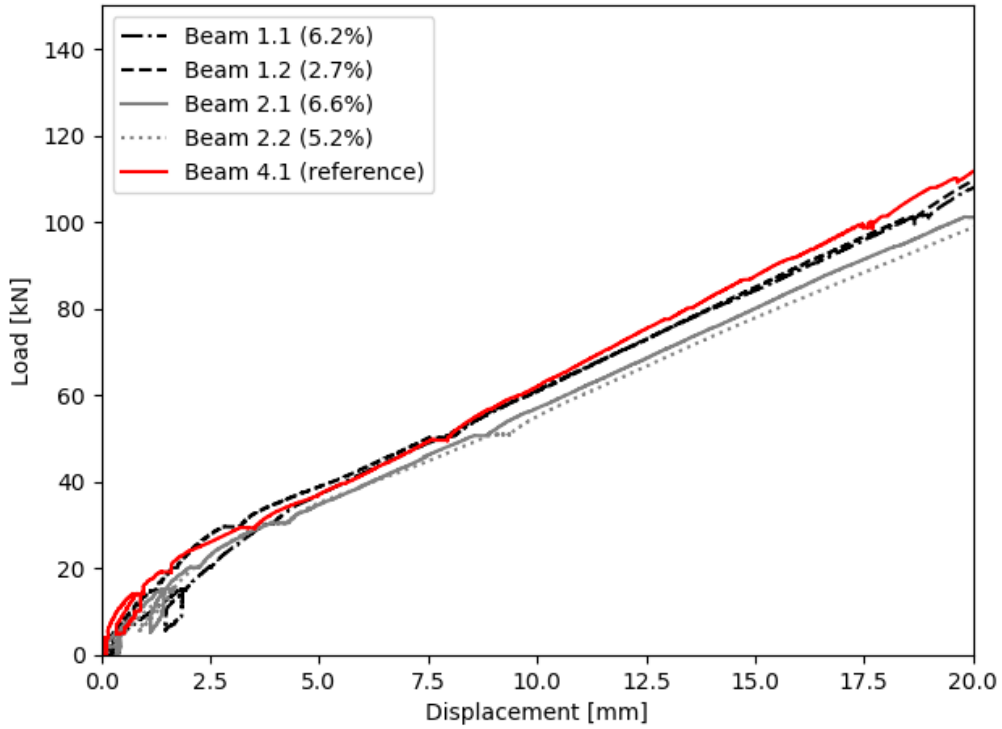
Shear failure

Higher corrosion degree (beam 2.1) =

- Lower ultimate load

Destructive tests

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → **Destructive tests** → Actual corrosion degree

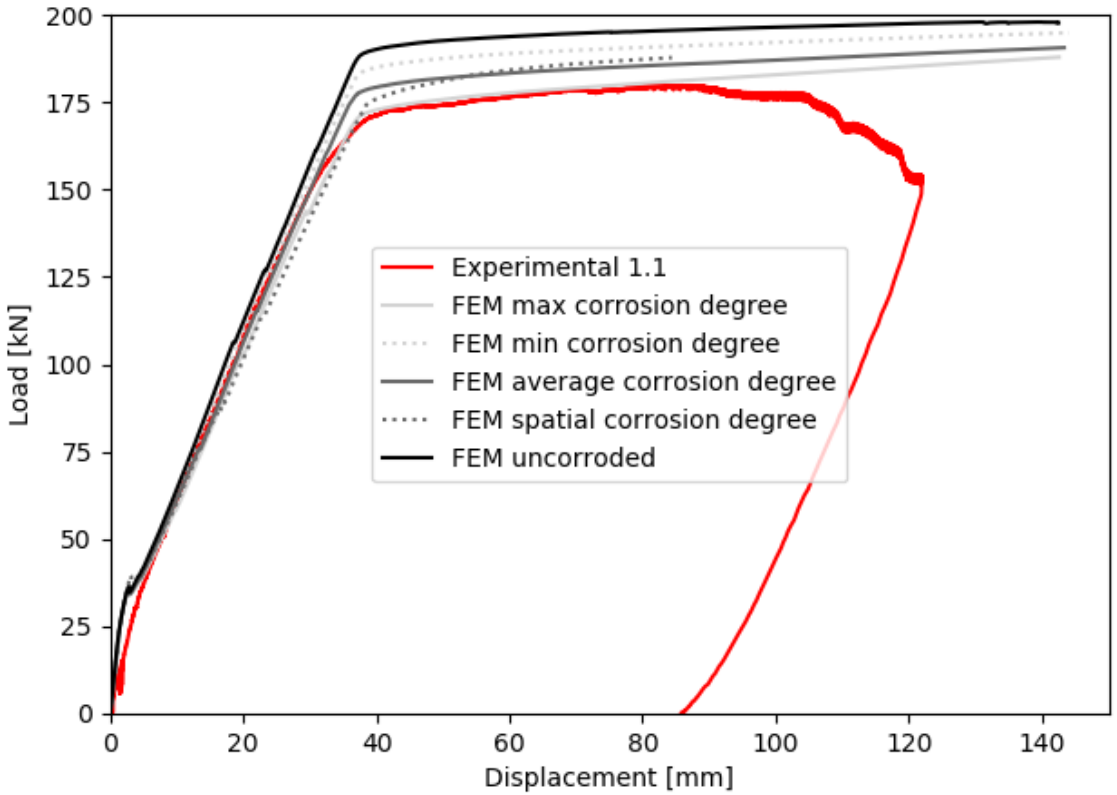


(at midspan)

Reference beam: highest initial stiffness

Destructive tests

Beams subjected to accelerated corrosion → Dynamic tests → Static tests → **Destructive tests** → Actual corrosion degree



FEM results (beam 1.1)

- **Uncorroded** = max. capacity
- **Max. corrosion degree** = best approximation of experiments
- **Average corrosion degree** ≈ ultimate load of spatial corrosion degree

Conclusions

Dynamic tests

- **Reference beam**: Reduction in natural frequency over time.
- **5,2% and 6,2% corrosion**: Decrease in natural frequencies compared to reference beam at same age.
- **2,7% corrosion**: No influence on natural frequencies compared to reference beam.

Static tests

- Overlap modelled and experimental values (+ uncertainty bounds).
- No clear increase in strain with corrosion degree.

Destructive tests

- Influence of corrosion on stiffness and ultimate failure load.

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