



HORIZON 2020

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Training in Reducing Uncertainty
in Structural Safety

ESR8: Barbara Heitner



University College Dublin

Updating Bridge Safety Based on Damage Indicators



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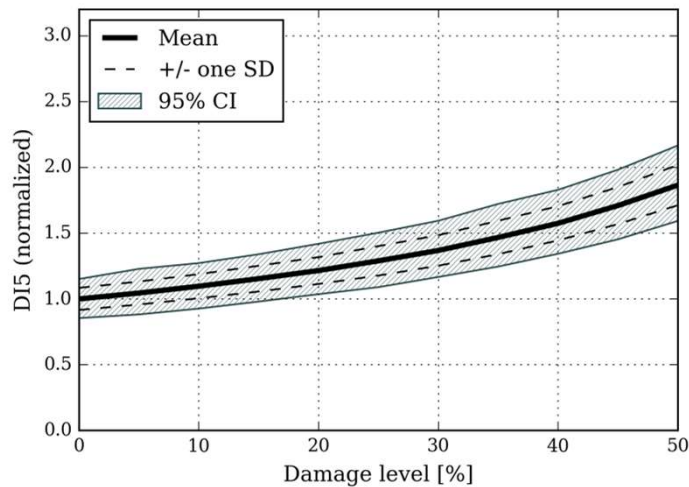
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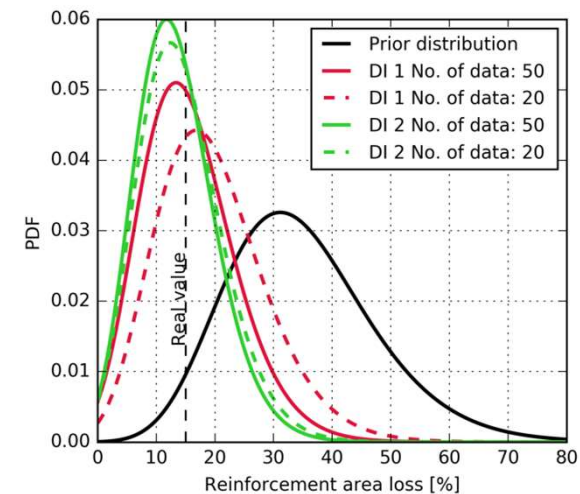
Research

Three research questions of this project:

1. How can measurement data be evaluated regarding its effectiveness in a bridge safety model and which measurements should be preferred?
 - Different damage indicators have been tested in ambient traffic conditions based on simulation
 - They have been evaluated in a Bayesian framework to estimate bridge damage due to corrosion



Rotation-based damage indicator versus reinforcement area loss



Examples of updating the reinforcement area loss distribution using different damage indicators



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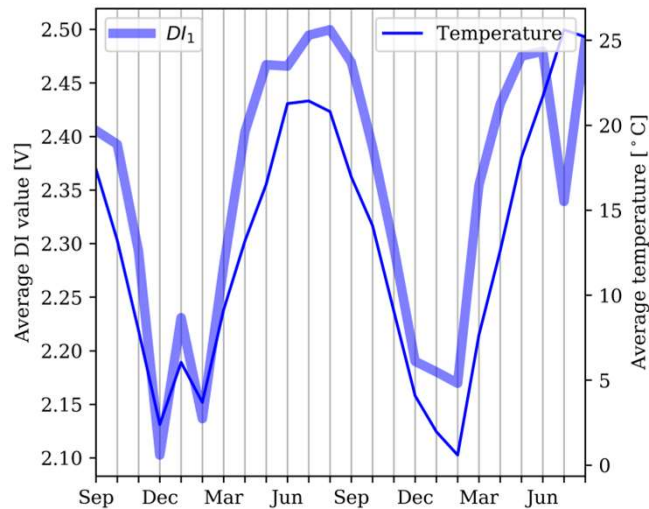
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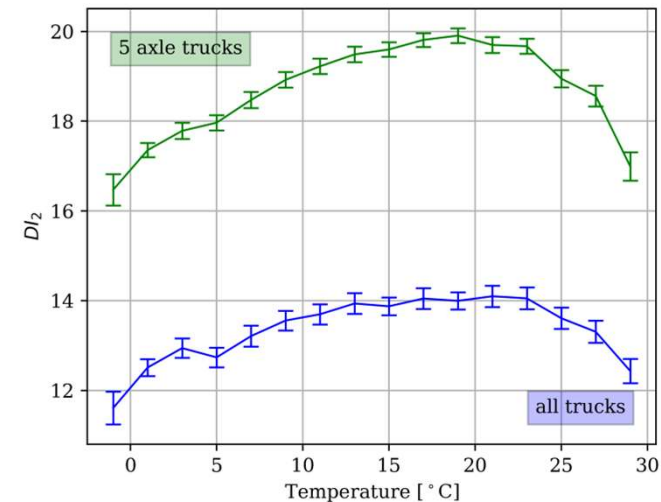
Research

2. How can damage indicators be tested and validated?

- Field data: 2 years of strain and temperature data of a bridge in Slovenia
- Young's modulus of concrete depends on temperature
→ Temperature change can be used potentially to evaluate damage indicators



Monthly average temperature of concrete and a chosen damage indicator plotted for the two years of data collection



Estimated mean and its 95% confidence interval for a chosen damage indicator plotted against temperature



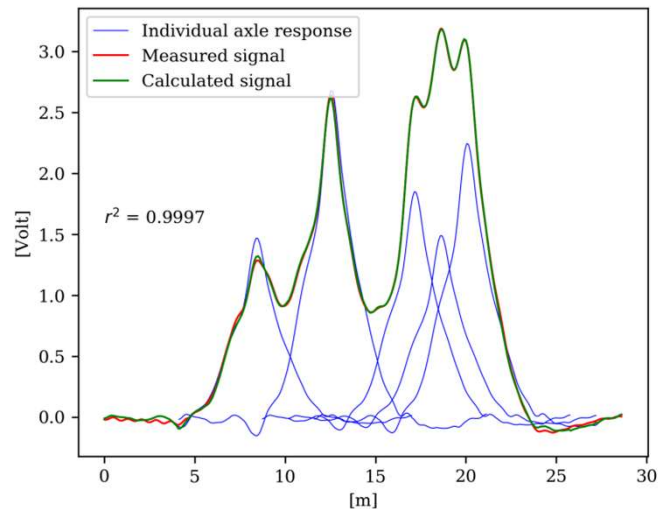
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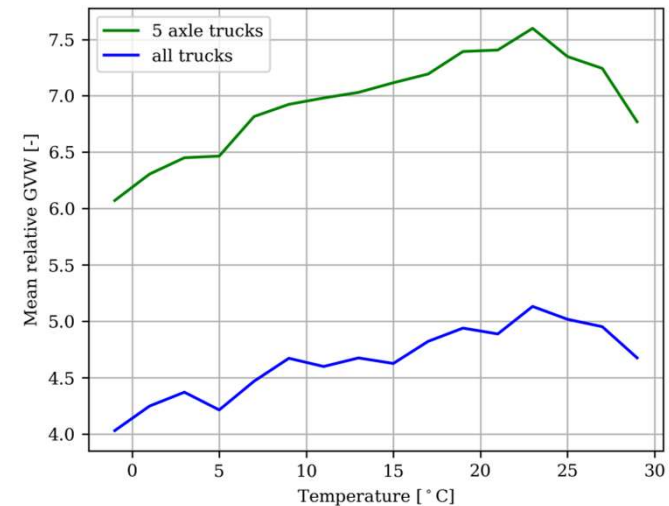
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Research

3. Can we use ambient traffic and measurement system without calibration to see the change in the health state of the bridge?
 - An iterative approach based on the combination of Moses and Quilligan's algorithm
 - Aim is to find in a relative context both the influence line for the bridge and the axle weights
 - Is it possible to use this method for indicating damage?
 - It is shown using the temperature measurement as before



Example of the use of the algorithm: the original measured signal and the calculated one using the obtained influence line



Calculated relative GVW and its dependence on temperature



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Training

Type of Activity	Start date	End date	Title of course/conference/activity and location	No. hours
Language Course	21/09/15	06/01/16	French course, Center FLEURA, Blaise Pascal University	50
Course (>1 day)	29/09/15	01/10/15	Euromem : From uncertainties to partial safety factors calibration : Application to tensile membrane structures - Discover the birth of Eurocode, A training school of COST Action TU1303, University of Nantes, France	12
Secondment (Short Stay < 3 months)	15/10/15	17/10/15	Consultation + visiting UCD	24
Workshop	10/12/15	10/12/15	Thesis defense of R. Decatoire and associated workshop, Phimeca, Fédération Nationale des Travaux Publics, Paris, France	5
Secondment (Short Stay < 3 months)	26/01/16	29/10/15	Consultation + obtaining student card from UCD	32
Other activity	29/03/16	29/03/16	Visiting the Polytech Clermont University, Clermont-Ferrand, France	2
Seminar (<=1 day)	28/04/16	28/04/16	Lecture on the 'Estimating rare event probabilities in finite random processes', Pôle commun ISIMA-Polytech Clermont, France	2
Secondment (Short Stay < 3 months)	04/05/16	05/05/16	Consultation and DSP meeting	16
Seminar (<=1 day)	19/05/16	19/05/16	Lecture on 'Reliability assessment with adaptive surrogates based on SVM regression', Amphi Poincaré at Sigma Clermont, France	2
Seminar (<=1 day)	07/06/16	07/06/16	Introduction to Latex, Phimeca, France	2
Conference	29/08/16	30/08/16	CERI 2016, Galway, Ireland	16
Seminar (<=1 day)	14/09/16	14/09/16	Introduction to random field modelling, Phimeca, France	2
Conference	29/09/16	01/10/16	BDB2016 Conference, Žilina, Slovakia	24
Conference/Seminar	20/10/16	21/10/16	51st ESReDA Seminar, Clermont-Ferrand, France	16
Secondment (Long Stay >= 3 months)	31/10/16	31/03/17	Long Stay Secondment, UCD, Dublin, Ireland	
Conference	18/06/17	22/06/17	ESREL 2017, Portoroz, Slovenia	40
Bridge visit	23/06/17	23/06/17	Visiting a bridge in Slovenia that has been subject of various measurements and continuous monitoring	2
Secondment (Short Stay < 3 months)	04/09/17	06/09/17	Consultation	24
Course (>1 day)	11/12/17	12/12/17	Formation à l'utilisation de PhimecaSoft / Training of PhimecaSoft - Uncertainty propagation software	16
Seminar (<=1 day)	06/03/18	06/03/18	Introduction to Kriging, Phimeca, France	3



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Dissemination

Type of activity	Start date	End date	Title of the Publication	Authors	Location, journal or conference (full reference)	Brief description of activity
Conference publication	29/08/16	30/08/16	Evaluation of bridge safety based on Weigh-in-Motion data	Heitner,B., OBrien, E.J., Schoefs, F., Yalamas, T., Décatore, R. and Leahy, C.	Civil Engineering Research Association of Ireland, CERI 2016, Galway, Ireland	Presentation of paper
Conference publication	30/09/16	01/10/16	Probabilistic Modelling of Bridge Safety Based on Damage Indicators	Heitner,B., OBrien, E.J., Schoefs, F., Yalamas, T., Décatore, R. and Leahy, C.	Science Direct, Procedia Engineering 156 (2016) 140 – 147	Published
Conference poster	30/09/16	01/10/16	Probabilistic Modelling of Bridge Safety Based on Damage Indicators	Heitner,B., OBrien, E.J., Schoefs, F., Yalamas, T., Décatore, R. and Leahy, C.	The International Conference on Bridges in Danube Basin, Žilina, Slovakia	Presentation of poster
Conference publication	20/10/16	21/10/16	Bayesian updating of bridge safety model	Heitner,B., Yalamas, T., Décatore, R., Schoefs, F. and OBrien, E.J.	51st ESReDA on Maintenance and Life Cycle Assessment of Structures and Industrial Systems, Clermont-Ferrand, France	Presentation of paper
Conference publication	18/06/17	22/06/17	Comparative study on Bayesian updating of bridge safety model	Heitner,B., Yalamas, T., Décatore, R., OBrien, E.J. and Schoefs, F.	27th European Safety and Reliability Conference (ESREL 2017), Portorož, Slovenia	Presentation of paper
Journal publication	25/09/17		Updating bridge reliability assessments using health monitoring data	Heitner,B., OBrien, E.J., Schoefs, F., Yalamas, T., Décatore, R. and Leahy, C.	Reliability engineering and system safety	Journal paper under review
Conference publication	08/04/18	11/04/18	Multi-step Bayesian updating of corrosion propagation in reinforced concrete structures	Heitner,B., OBrien, E.J., Schoefs, F., Yalamas, T., Causse G.	Joint ICVRAM-ISUMA-UNCERTAINTIES conferences, Florianopolis, SC, Brazil	Presentation of extended abstract



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Outreach

Type of Activity	Start date	End date	Title of course/conference/activity and location	No. hours
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Outreach (open day, talks)	15/11/16	15/11/16	Competition for a group of children aged 9-10 in building spaghetti structures, Willow School, Dublin, Ireland	2