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## Structural health monitoring of bridges based on heterogenous data enriched with physical simulation

*A Data Management Plan created using DMPonline.be*

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**Template:** FWO DMP (Flemish Standard DMP)

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### **Project abstract:**

Recent advances in Vibration-Based Monitoring (VBM) of bridges include the monitoring of modal strains. During my PhD and junior postdoctoral research, I have demonstrated that these satisfy some long-standing VBM demands: they have low sensitivity to temperature, high sensitivity to small-scale local damage and they can be obtained in a dense grid with high accuracy and precision. However, there are still significant fundamental challenges that need to be solved before modal strain VBM can break through. First, an in-depth investigation of the influence of different types of damage on a multitude of monitored quantities including modal strains is needed, so that the appropriate features for damage identification and condition monitoring can be defined. Second, the combined processing of modal strains with other damage-sensitive features remains largely unexplored. Data fusion, based on Machine Learning (ML) can lead to new features that are highly sensitive to damage. Third, optimal sensor placement (OSP) for modal strain monitoring and combined features monitoring of bridges is an open problem. Finally, combination of experimental data and numerical models for damage assessment is gaining attention in the past years but is currently facing limits due to scarcity of experimental data and modelling issues. This project proposal aims to address these challenges and develop a robust VBM methodology for bridges.

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### Application DMP

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#### Questionnaire

**Describe the datatypes (surveys, sequences, manuscripts, objects ... ) the research will collect and/or generate and /or (re)use. (use up to 700 characters)**

- Several experimental campaigns will be conducted within the framework of the project on laboratory, small-scale test structures (concrete and steel beams) as well as on full-size civil structures, such as bridges. Existing data of similar structures will be used as well.
- No personal data will be used in this project.
- A large amount of data is expected to be generated in the form of recorded time series such as strains and accelerations. Expected data formats are: Matlab Data files (.mat) and CSV (comma-separated values) files.
- The expected volume of data is in the range of a few TB (up to 10) and will be stored in external drives and online on clouds.

**Specify in which way the following provisions are in place in order to preserve the data during and at least 5 years after the end of the research? Motivate your answer. (use up to 700 characters)**

1. Prof. dr. ir. Edwin Reynders of KU Leuven will be the responsible person for data preservation.
2. The expected volume of data is in the range of a few TBs (up to 10) and will be stored in external drives and online on clouds during and after the end of the project.

**What's the reason why you wish to deviate from the principle of preservation of data and of the minimum preservation term of 5 years? (max. 700 characters)**

N/A

**Are there issues concerning research data indicated in the ethics questionnaire of this application form? Which specific security measures do those data require? (use up to 700 characters)**

N/A

**Which other issues related to the data management are relevant to mention? (use up to 700 characters)**

N/A

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## FWO DMP (Flemish Standard DMP)

### 1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
M2.17 railway bridge	Strain time series from 1/10/2022 to 31/10/2023	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> <li>Reuse existing data</li> </ul>	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> <li>Digital</li> </ul>	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> <li>Experimental</li> </ul>	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> <li>.mat, .csv,.pdf, .txt</li> </ul>	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> <li>&lt;1TB</li> </ul>	
M2.17 railway bridge	Strain time series from 1/11/2023 on	<ul style="list-style-type: none"> <li>generate new data</li> </ul>	<ul style="list-style-type: none"> <li>Digital</li> </ul>	<ul style="list-style-type: none"> <li>Experimental</li> </ul>	<ul style="list-style-type: none"> <li>.mat, .csv,.pdf, .txt</li> </ul>	<ul style="list-style-type: none"> <li>&lt;1TB</li> </ul>	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

Existing data from experimental campaigns that were initiated during previous projects where I have been involved will be used: i) FWO project G099014N “Robust vibration-based damage identification with a novel high-accuracy strain measurement system”, ii) Vlaio COOCK HBC.2019.2505 project “Monitoring of structures and systems with fiber optic sensors”. The data have been generated by me and are stored in external hard disk drives (HDD) and on KU Leuven OneDrive and I: drive.

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

## 2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

Data are stored in chronological order in identical Matlab Data files (.mat) on KU Leuven OneDrive, Teams-site and on external HDDs for backup purposes, while a clear explanation of the contents of these files is provided in accompanying Readme.txt files that are included in the same folders.

The Matlab scripts (.m) that are used for data treatment are also stored in the corresponding folders. Relevant commenting is included in the scripts so that they can be used by third parties.

At the end of each experimental campaign, a detailed report will be generated that will contain all the necessary information (data acquisition, treatment, sensor setup, units, etc.) so that the data can be used by third parties. Reports are stored on KU Leuven shared J: drive.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- No

N/A

## 3. Data storage & back-up during the research project

**Where will the data be stored?**

Data will be stored on Teams-site, KU Leuven OneDrive and external HDD drives.

**How will the data be backed up?**

Standard backup provided by KU Leuven ICTS will be used. In addition, external HDD drives will be used.

**Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.**

**If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.**

- Yes

Access to KU Leuven OneDrive, Teams-site, I: and J: shared drives is guaranteed during the project. Several HDDs are also available. The amount of data that will be generated (expected to be less than <5TB) means that there is an abundance of available storage.

**How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?**

External HDD drives will be stored on secure places (closets, drawers) that can be locked. For online data, KU Leuven authentication is in place for KU Leuven OneDrive, Teams-site and backup I: as well as shared J: drives.

**What are the expected costs for data storage and backup during the research project? How will these costs be covered?**

Costs are related to external HDD drives as the available free space provided from KU Leuven on OneDrive and Teams-site is sufficient. HDD cost is about 100 euros per disk and no more than 2 disks will be required. Cost will be covered by my FWO bench fee.

#### 4. Data preservation after the end of the research project

**Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).**

All data can be preserved after the end of the project and for period of at least 10 years both online (e.g., KU Leuven One Drive) as well as on HDDs. Prof. Edwin Reynders of KU Leuven will have access to all generated data.

**Where will these data be archived (stored and curated for the long-term)?**

Data will be archived on KU Leuven One Drive and Teams-site as well as on external HDDs as backup.

**What are the expected costs for data preservation during the expected retention period? How will these costs be covered?**

Datasets will be of a limited size that can be stored with no cost (<5 TB).

#### 5. Data sharing and reuse

**Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.**

- Yes, in a restricted access repository (after approval, institutional access only, ...)

Some of the data generated from experimental campaigns might be used for research collaboration purposes with other researchers during the project. The same applies for the period after the project ends.

If access is restricted, please specify who will be able to access the data and under what conditions.

Data will not be restricted.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- No

Where will the data be made available? If already known, please provide a repository per dataset or data type.

N/A

When will the data be made available?

After publication and upon request and agreement with research collaborators.

Which data usage licenses are you going to provide? If none, please explain why.

This is not clear yet. Will be decided if necessary during the project.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- No

What are the expected costs for data sharing? How will these costs be covered?

No cost is expected.

## 6. Responsibilities

Who will manage data documentation and metadata during the research project?

Dimitrios Anastasopoulos

Who will manage data storage and backup during the research project?

Dimitrios Anastasopoulos

Who will manage data preservation and sharing?

Dimitrios Anastasopoulos

**Who will update and implement this DMP?**

Dimitrios Anastasopoulos