

FIAS REGISTRY OF RESEARCH SPECIFICATIONS

Exchange Profile for Distributed Optical-Fibre Strain Traces on Concrete Specimens

REGISTRY IDENTIFIER

FOAR-CON2X-JGQZCD86F

VERSION

1.0

OBJECT TYPE

Data model or interchange format

SUBJECT AREA

Multidisciplinary

DOCUMENT MATURITY

Candidate for stable use

SUBMITTED

19 May 2022, 12:00 UTC

PUBLISHED

09 September 2022, 12:00 UTC

LICENCE

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AUTHORITATIVE VERSION

Registration records the outcome of the Registry review for this version: the submission was sufficiently identified, documented, and internally determinate for the stated procedure. Scope, adoption, and competing conventions are documented separately where relevant.

REGISTRY STATUS

Registered

09 September 2022, 12:00 UTC

Core description

SUBMISSION KIND

New registry concept

FULL TITLE

Exchange Profile for Distributed Optical-Fibre Strain Traces on Concrete Specimens

SHORT TITLE OR ACRONYM

DOFS-Concrete Exchange Profile

OBJECT TYPE

Data model or interchange format

STATUS CLAIMED BY THE SUBMITTER

Experimental specification

MATURITY OF THIS VERSION

Candidate for stable use

VERSION

1.0

PRINCIPAL SUBJECT AREA

Multidisciplinary

KEYWORDS

- structural health monitoring
- distributed optical fibre sensing
- concrete cracking
- strain time series
- calibration metadata

PROBLEM, SCOPE, AND EXCLUSIONS

Distributed optical-fibre measurements are sensitive to bonding, gauge length, sampling interval, temperature compensation and coordinate origin. This profile exchanges processed strain traces and the minimum specimen/sensor metadata needed to compare crack tests. It excludes live safety decisions, bridge certification, proprietary interrogator raw formats and universal conversion between incompatible sensing principles.

INTENDED USERS AND CONTEXTS

- Research laboratories comparing concrete crack-monitoring experiments
- Engineers publishing processed distributed-fibre strain traces
- Reviewers attempting independent reanalysis of sensor performance

RELATION TO EXISTING PRACTICE

Codifies an existing practice

SCIENTIFIC CONTEXT, SOURCES, AND SCHOLARLY DISCUSSION

This section describes the scientific background, underlying work, and sources of the specification, together with the research groups and scholarly settings in which the proposed solution or its formalisation was presented or discussed. It documents the context and nature of these scholarly exchanges.

Distributed optical-fibre strain measurements on concrete depend on how deformation is transferred from the specimen to the sensing cable. I. Alj et al. (2020) examine the influence of adhesive stiffness on crack-monitoring performance, and their subsequent study (2022) investigates the environmental durability of an optical-fibre cable. These results make bonding conditions, sensor characteristics and exposure history essential to the comparison of strain traces. Work by A. Pacitti et al. (2021) on cable-tension identification contributes to the wider discussion of how recorded mechanical responses support an inverse analysis.

The research setting is structural monitoring and experimental mechanics at Laboratoire Navier, involving expertise in concrete, sensing and mechanical interpretation. The publications associated with I. Alj, M. Quiertant, A. Khadour and K. Benzarti connect sensor behaviour to specimen preparation and environmental conditions. They provide the scientific basis for retaining those conditions with the data exchanged between laboratories.

The experimental work published by I. Alj and colleagues in December 2021 brought together the EMGCU and LISIS laboratories of Université Gustave Eiffel, Laboratoire Navier and IRSN to investigate the durability and strain response of optical-fibre cables used in concrete. The wider community also examined fibre-optic sensing and civil-infrastructure applications at the 13th International Workshop on Structural Health Monitoring, held on 7–9 December 2021. Together, these sources situate the exchange profile within collaborative experimental research and the broader discussion of structural-monitoring methods.

The profile pairs processed strain traces with a compact description of the specimen, fibre installation, bonding, gauge length, sampling interval, temperature compensation and coordinate origin. Structured metadata allow a receiving team to recover the spatial meaning of each trace and compare measurements obtained under documented conditions. Explicit units and calibration information support consistent processing of the exchanged files and interpretation of differences between tests.

References:

- Alj I. et al. Experimental and Numerical Investigation on the Strain Response of Distributed Optical Fiber Sensors Bonded to Concrete: Influence of the Adhesive Stiffness on Crack Monitoring Performance. *Sensors*. 2020;20:5144. DOI: <https://doi.org/10.3390/s20185144>
- Alj I. et al. Environmental Durability of an Optical Fiber Cable Intended for Distributed Strain Measurements in Concrete Structures. *Sensors*. 2022;22:141; published online 26 December 2021. DOI: <https://doi.org/10.3390/s22010141>
- Pacitti A., Peigney M., Bourquin F., Lacarbonara W. Cable tension identification via nonlinear static inverse problem. *Structural Health Monitoring*. 2021;20:546–566; published online 27 July 2020. DOI: <https://doi.org/10.1177/1475921720940645>
- *Sensors*. Special issue associated with the 13th International Workshop on Structural Health Monitoring (IWSHM 2021), 7–9 December 2021. Special issue: https://www.mdpi.com/journal/sensors/special_issues/IWSHM2021

EXTERNAL STANDARDISATION STATUS

None intended

LICENCE FOR THE SUBMITTED SPECIFICATION

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PUBLICATION DECLARATION

Yes

Data model or interchange format

ENTITIES, RECORDS, AND RELATIONSHIPS

Experiment contains Specimen, SensorInstallation, InterrogatorRun and Trace. Specimen records concrete age and geometry. SensorInstallation records fibre, coating, adhesive and spatial path. InterrogatorRun records acquisition settings and calibration. Trace links positions to strain values for one timestamp or load step.

SERIALIZATION AND MEDIA TYPE

UTF-8 CSV for numeric traces plus one UTF-8 JSON manifest. Media types text/csv and application/json. Decimal separator is period and line endings may be LF or CRLF.

REQUIRED FIELDS AND CARDINALITIES

Manifest requires profile_version; experiment_id; specimen geometry and test date; fibre model; coating; adhesive product or characterised modulus; bonding method; bonded length; coordinate origin; gauge length; spatial sampling interval; interrogator model; acquisition interval; strain unit; temperature-compensation method; CSV filename; SHA-256. CSV requires timestamp_or_step, position_m, strain_microepsilon and quality_flag.

DATATYPES, CONTROLLED VALUES, NULLS, AND UNKNOWN VALUES

SI quantities are JSON numbers with explicit units. Timestamps are RFC 3339. quality_flag is valid, saturated, missing, interpolated or detached. A missing numeric observation is an empty CSV cell with quality_flag=missing; zero is a measurement.

MACHINE VALIDATION MECHANISM

JSON Schema

VALIDATOR, SCHEMA, OR GRAMMAR DETAILS

JSON Schema validates the manifest. A companion deterministic checker verifies CSV headers, monotonic positions, permitted flags, digest and agreement between declared and observed spatial intervals within the stated tolerance.

FORWARD AND BACKWARD COMPATIBILITY

Version 1.x may add optional manifest fields and quality flags. Readers must preserve unknown columns on round trip. Changing the meaning or unit of a required column requires version 2.0. Raw vendor data are referenced but not transformed.

COMPLETE MINIMAL EXAMPLE

manifest.json:

```
{"profile_version":"1.0","experiment_id":"NAV-22-01",  
  "specimen":{"type":"RC beam","age_days":28},
```

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Registry review record

Submission received

19 May 2022, 12:00 UTC

Submission received.

Registered

09 September 2022, 12:00 UTC

Registered as a laboratory exchange profile. Operational safety monitoring and acceptable crack-width thresholds require separate qualification procedures.