

# Majdi Flah

**P.Eng., M.E.Sc. | PhD Candidate, Civil Engineering**

McMaster University | Hamilton, Ontario, Canada

flahm@mcmaster.ca | ORCID 0000-0002-2838-278X

## Research statement

### Durability evidence for lower-carbon infrastructure decisions

My research connects experimental durability evidence, probabilistic machine learning, service-life modelling, and life-cycle assessment. My current PhD focus is natural carbonation and climate-aware selection of lower-carbon concrete. I study how durability uncertainty changes the conditions under which material and maintenance alternatives can be compared.

#### 1. Research foundation

My master's research at Western University investigated structural condition assessment from concrete images and acceleration signals. Image-based work combined crack classification with geometric measurement. Vibration-based work developed learned damage signatures for classification and localization. This background connects observable infrastructure condition with the deterioration assumptions used in decision models.

#### 2. Current doctoral programme

At McMaster University, under Professor Moncef L. Nehdi, my doctoral work connects traceable literature data with transport calibration and engineering decisions. The programme includes durability-informed LCA, reconstruction of literature datasets, uncertainty in chloride diffusion, risk-sensitive mixture optimization, and the influence of aging and surface-chloride assumptions on corrosion initiation. Published studies, submitted manuscripts, and prospective directions are identified separately.

#### 3. Demonstrated contribution

The published chloride-uncertainty study carries calibration residual dispersion into Fickian initiation, maintenance rules, and life-cycle scenarios. It uses 141 experimental records, dispersion estimated from 36 real test observations, and 15,000 Monte Carlo simulations per case. The article reports approximately 20-40% higher expected maintenance demand than deterministic estimates in its reference scenarios. My published roles include methodology, software, formal analysis, investigation, data curation, visualization, and original drafting. The numerical consequences remain conditional on the specified material domain, exposure, planning horizon, and intervention policy.

# Research direction & collaboration

## 4. Current focus: climate-aware natural carbonation

My current research investigates the selection of lower-carbon concrete under present and evolving climatic conditions. Published natural-carbonation observations are examined with their mixture, curing, exposure, and source identities. The developing framework compares candidate mixtures over a 50-year planning horizon with cover, strength, and exposure requirements explicit. The intended outputs connect carbonation limit-state screening with GWP and cost. Independent evaluation and provenance checks are used to examine whether recommendations are supported across studies and locations. Carbonation reaching reinforcement is treated as a screening endpoint; corrosion-rate prediction requires its own evidence.

## 5. Next research direction: uncertainty and comparable decisions

A second direction is to test whether a material or maintenance recommendation remains stable when calibration, exposure, and deterioration assumptions change. Comparisons should hold the engineering function, exposure, planning horizon, and intervention rules explicit. Candidate outputs include initiation distributions, intervention probabilities, maintenance demand, and environmental and economic consequences. An environmental advantage should be interpreted within the functional unit and boundary conditions that generated it.

## 6. Collaboration and translation

I welcome research collaborations and postdoctoral enquiries involving concrete durability, service-life uncertainty, structural monitoring, and durability-informed environmental assessment. I can contribute literature-data reconstruction, computational analysis, probabilistic modelling, and engineering interpretation. Collaboration with experimental and infrastructure-monitoring teams would connect these methods with independent material and field evidence. My engineering practice and teaching experience provide additional routes for communicating methods to designers, professionals, and students.

## Selected evidence

Durability-informed LCA framework | doi:10.1016/j.rser.2026.116730

Chloride uncertainty and maintenance decisions | doi:10.1016/j.cemconcomp.2026.106552

BuildingNet structural monitoring | doi:10.1016/j.autcon.2022.104271

Document basis: the research programme and published records identified in the portfolio. Manuscript submission statuses retain their September 2026 snapshot.