Mike Dupuis

Vibration Analyst and Engineer, MASc, PE (California), PEng (British Columbia),

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I am a data scientist, engineer, and signal processing specialist who develops software, data processing pipelines, novel algorithms, and neural networks with real-world applications. I have 14 years of industry and research experience in python programming, signal analysis, and engineering, applying academic insights to industry needs through software development. I'm currently based in Davis, California, working full time as an analyst and engineer.

Areas of Expertise

`operational modal analysis` `computer-aided engineering` `Python` `vibration signal processing` `data collection pipelines` `data visualization` `finite-element analysis` `machine learning` `mixed-effects regression` `structural engineering`

Finite-Element Analysis: ETABS, HyperMesh, LS-DYNA, LS-PrePost, SAFE, SAP2000
Machine Learning: Keras, PyTorch, Tensorflow
Programming: Python, R, VBA, Git
Python: Nuitka, Numpy, Matplotlib, ObsPy, Pandas, PyInstaller, scikit-learn, Scipy, WxPython
Vibration Signal Processing: ARTeMIS Modal, Exploratory Record Toolbox (Personal IP), Time History Selection

Software Developed

Exploratory Record Toolbox (Demo Video and User Sign-Up Here)

- Personal IP, developed in Python, which implements a data collection pipeline for signal processing analysis
- The program features an intuitive GUI and comprehensive API which enables users to construct customized data collection pipeline(s).
- Implemented fully customizable data visualization and figure generation

Structural Design Package (Demo Video Here)

- I have conceived and developed a structural analysis software program for Geosyntec which can be used as either a GUI or API and is used for structural design checks of new and existing structures.
- The program allows the user engineer to complete design checks of various structural components to various international standards and facilitates compilation of pdf design packages.
- The software is provided to external organizations for educational use with the hope that it will inspire companies and organizations within the hydropower industry to develop similar technologies.

Machine Learning and Earthquake Time-Series Analysis Publications

Jesse A. Hutchinson, Chuanbin Zhu, Brendon A. Bradley, Robin L. Lee, Liam M. Wotherspoon, **Michael Dupuis**, Claudio Schill, Jason Motha, Elena F. Manea, Anna E. Kaiser; The 2023 New Zealand Ground-Motion Database. Bulletin of the Seismological Society of America 2024; doi: https://doi.org/10.1785/0120230184

Dupuis, M.R., Schill, C., Fairhurst, M., Lee, R.L., and Bradley, B. Subduction megathrust earthquake record selection assisted with a deep-learning-based model. 2024 United States Society on Dams Annual Conference & Exhibition, Seattle, WA, April 22-26, 2024; https://www.geosyntec.com/ussd

Dupuis, M., Schill, C., Lee, R., & Bradley, B. (2023). A deep-learning-based model for quality assessment of earthquake-induced ground-motion records. Earthquake Spectra; doi: https://doi.org/10.1177/87552930231195113

Dupuis, M.R., Paterson, J., Lee, R.L., and Bradley, B. Progress towards hybrid broadband ground-motion simulation of megathrust earthquakes on the Hikurangi Subduction Zone. CCEE and PCEE Conference on Earthquake Engineering, Vancouver, Canada, June 25-30, 2023; https://www.caee.ca/wp-content/uploads/13th-CCEE-PCEE/CCEE-PCEE-2023-Proceedings.pdf

Hutchinson, J., Bradley, B., Lee, R., Wotherspoon, L., **Dupuis, M.**, Schill, C., Motha, J., Kaiser, A.E. and Manea, E. (2022). 2021 New Zealand Ground-Motion Database; https://ir.canterbury.ac.nz/items/b6bcbc65-2e82-42a0-afd3-67e202f28cf6

Hutchinson, J., Bradley, B., Lee, R., Schill, C., **Dupuis, M.**, Motha, J., van Houtte, C., Kaiser, A., Manea, E. and Wotherspoon, L. (2022). Insights from the 2021 New Zealand strong ground motion database; https://ir.canterbury.ac.nz/server/api/core/bitstreams/cd70a465-cafb-4d05-b255-6429b6c4afdd/content

Dupuis, M.R., Schill, C., Lee, R.L., and Bradley, B. A neural network for ground motion quality classification from New Zealand earthquakes of variable magnitudes and tectonic types. 2020 QuakeCoRE Annual General Meeting, Nelson, New Zealand, Nov 7-10, 2020; https://ir.canterbury.ac.nz/server/api/core/bitstreams/8dec65af-7d12-4fb1-8760-da124c9faf98/content

Structural Engineering Publications

Dupuis, M., de Melo, L., Rix, G. Estimated Rates of Failure for Dams in the United States. Association of State Dam Safety Officials, Dam Safety 2023, Palm Springs, CA, USA, Sept 17-21, 2023; https://www.geosyntec.com/news/item/8193-geosyntec-to-present-on-dam-safety-at-asdso-2023

Dupuis, M. R., Best, T. D., Elwood, K. J., & Anderson, D. L. (2014). Seismic performance of shear wall buildings with gravity-induced lateral demands. Canadian Journal of Civil Engineering, 41(4), 323-332; doi: https://doi.org/10.1139/cjce-2012-0482

Baradaran Shoraka, M., **Dupuis, M. R.**, Macauley, J., Elwood, K. J., Anderson, D. L., and Simpson R. Seismic performance of shear wall buildings with gravity-induced lateral demands. Tenth U.S. National Conference on Earthquake Engineering, Anchorage, AK, USA, July 21-25, 2014.

Dupuis, M.R.L. (2012). Seismic performance of buildings with permanent lateral demands (master's dissertation, University of British Columbia); https://open.library.ubc.ca/soa/cIRcle/collections/ubctheses/24/items/1.0073465

Education

MASc in Structural Engineering, University of British Columbia (2012)

- Thesis: Seismic performance of buildings with permanent lateral demands
- Basis of the Gravity-Induced Lateral Demand Seismic Irregularity in the National Building Code of Canada

BASc in Civil Engineering, Queen's University (2010)

- Ranked 1/118

Professional Experience

Senior Engineer, Geosyntec Consultants Inc.

Nov 2022–present, Davis, California, USA

- Technical lead for seismic hazard studies in hard rock geology via mixed-effects regression and neural network model, developed with TensorFlow, to predict site-to-site residuals
- Technical lead for ambient vibration testing and operational modal analysis, completed in Python, for dams and levees using state-of-the-art vibration monitoring equipment
- Technical analyst for quantitative risk analyses of earthquake prone concrete gravity dams
- Technical lead in the Dam and Levees Group for research and development of internal analysis tools

ARTeMIS Modal, Exploratory Record Toolbox, LaTeX, Python, R, RMC-TotalRisk, Structural Design Package, VBA,

Engineering Consultant and Analyst, BC Hydro

July 2017–Nov 2022, Vancouver, British Columbia, Canada

- Engineer and analysis for LS-DYNA modelling and analysis of large concrete gravity dams in LS-DYNA
- Engineering seismologist for earthquake ground-motion time series selection and optimization using Python and MATLAB
- Engineering seismologist leading structural analysis and post-processing of earthquake response time series using Python

Python, HyperMesh, LS-DYNA, LS-PrePost, LSPROC-GUI, Time History Selection

Structural Design Engineer, Read Jones Christoffersen Ltd.

Jan 2013–July 2017, Vancouver, British Columbia, Canada

- Design engineer for concrete, steel, and mass timber elements for libraries, community centres, transit hubs, and towers
- Data analyst for seismic time-series analysis and response spectrum analysis using finite-element models

SAP2000, SAFE, ETABS, Python

Selected Projects

Operational Modal Analysis of Foster Dam

`microseismic sensing` `Python` `time-series analysis`

I managed, executed, and was the technical lead for all aspects of this ambient vibration testing program at a large seismically prone concrete gravity dam in Oregon. I recorded and analyzed ambient vibrations at various locations across the concrete and earthfill portions of the dam to identify the dynamic characteristics of the dam including modal frequencies, damping, and mode shapes, through operational modal analysis.

Southern California Edison Hard-Rock Ground Motion Study

`machine learning` `mixed-effects regression` `programming`

Completed a partially crossed linear mixed-effects regression study using Python to investigate the site-to-site residuals of hard-rock time-series across California relative to empirical ground-motion predictions from Chiou and Youngs (2014). Examined geospatial residual trends, and trends with various predictor variables. Developed novel site adjustment factors to reduce misfit of the empirical predictions relative to observed strong-motion data. Trained a neural network using Tensorflow and Keras to estimate ground-motion prediction misfit for hard-rock dam sites across California.

Sacramento Levee Vibration Testing and Analysis

`microseismic sensing` `prototype velocimeters` `Python` `time-series analysis`

Recorded and analyzed construction-induced peak ground velocities across a large project area along the American River in Sacramento to identify the attenuation of vibrations across the site, correlated recorded velocity spikes with specific construction activities, and to develop best practices to reduce vibrations for upcoming construction sequences.

Blue Ridge Dam Quantitative Risk Analysis

`Python` `quantitative risk analysis` `RMC-TotalRisk`

Conducted a quantitative risk analysis of a large hydroelectric facility in Tennessee using state-of-the-art risk analysis software RMC-TotalRisk. Used python to automate conversion of elicited logic tree probabilities to continuous probability distributions. Conducted risk analyses to determine annualized life loss and economic cost for 10 alternative upgrade options and compared with baseline future without action life loss and economic cost.

John Hart Dam Analysis

`data visualization` `finite-element analysis` `Python` `time-series analysis`

Completed seismic analysis and design of the spillway and gate hoist structure upgrades using LS-DYNA. Developed suites of crustal and subduction ground-motion time series for response history analysis using Python for this large seismic upgrade of an aging dam on Vancouver Island. Managed a large-scale concrete testing program to develop nonlinear material model for displacement-based strength degradation.

Ladore Dam Analysis

`data visualization` `finite-element analysis` `Python` `time-series analysis`

A large seismic upgrade project for a dam upstream of John Hart Dam. Reviewed ground-motion time series and processing methodology using Python, checked structural models of gates, gate hoist tower, hoist deck, and overall spillway structure in LS-DYNA. Prepared report summarizing the results of my independent seismic assessment of an existing concrete power conduit structure which was presented to Dam Safety. Reviewed in-house scripts for computing and assigning reservoir loads to the upstream faces of solid mesh elements in the overall spillway model.

Cheakamus Dam Seismic Structural Capacity Assessment

`data visualization` `finite-element analysis`

Prepared report collating years of independent (and often contradictory) seismic assessments of seismically deficient spillway piers which are suffering from alkali-aggregate reaction. This included producing results from a new and independent seismic assessment and analysis using SAP2000 which were passed on to Dam Safety.

Ruskin Dam Ambient Vibration Signal Processing and Analysis

`finite-element analysis` `Python` `time-series analysis`

A large seismic upgrade project for a concrete gravity dam in a narrow gorge. Completed signal processing of ambient vibration data from broadband accelerometers on the dam using Python to confirm structural accuracy of LS-DYNA models, considering modal frequencies, damping, and mode shapes. Developed and reviewed LS-DYNA models for dynamic analysis of various steel components of the dam including gates and gate hoists.

MNP Tower Nonlinear Dynamic Response History Analysis

`data visualization` `finite-element analysis` `Python`

Nonlinear dynamic response history analysis of a slender 35-storey office building in Vancouver, British Columbia. Seismic performance-based design of unique outrigger truss/buckling restrained brace system at the roof level of a central concrete core wall. Data post-processing and visualization in Python to produce graphical summaries of the structural performance of components throughout earthquake ground-motion vibration time series.

Affiliations

Licenses

- Board for Professional Engineers, State of California
- Engineers and Geoscientists of British Columbia

Memberships

- Association of State Dam Safety Officials
- Canadian Dam Association
- Earthquake Engineering Research Institute
- Structural Engineers Association of British Columbia
- United States Society on Dams