

Informationsveranstaltung am 02.11.2023, 17.00 Uhr

Master-Arbeiten und Master-Projektarbeiten am IBI

Prof. Dr. B.T. Adey, Prof. Dr. Catherine De Wolf, Prof. Dr. G. Habert

IBI is structured along 3 main streams

- Infrastructure Management
 - Prof. Dr. Bryan T. Adey
- Circular Engineering for Architecture
 - Prof. Dr. Catherine De Wolf
- Sustainable Construction
 - Prof. Dr. Guillaume Habert



There are two possible prizes for great work with us

Fonds Bau und Infrastruktur-Förderungspreis

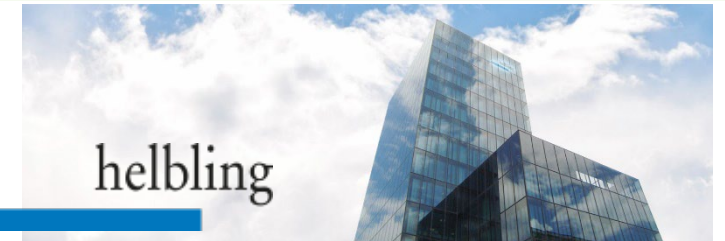
Ziel:

- Hervorragende Master- und/oder Doktor-Arbeiten aus dem Bereich „Bau- und Infrastrukturmanagement“ mit einem Preis auszuzeichnen
- Interesse für Probleme im Bereich des Bau- und Infrastrukturmanagements bei der heranwachsenden Ingenieurgeneration wecken und die Innovationsfreudigkeit für Weiterentwicklung von Bau- und Infrastruktursystemen gefördert werden.

Preisverleihung:

- In der Höhe von CHF 2'000 (Master-Arbeit)

Helbling-Preis



Ziel:

- Masterstudierende für die Themen des lebenszyklus-orientierten Planens, Bauens, Betreibens und Erhaltens von Infrastruktur mit einem besonderen Fokus auf Nachhaltigkeit zu begeistern Ambitionierte Masterstudierende, die exzellente Leistungen im Bereich Bau- und Infrastrukturmanagement erbracht haben, auszuzeichnen

Preisverleihung:

- Kann einmal pro Semester erfolgen in der Höhe von CHF 5'000



Switzerland



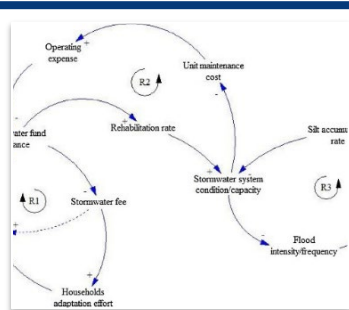
Singapore

Infrastructure Management Group

Topics “eher” for Spatial Development and Infrastructure Systems

Master project
and thesis

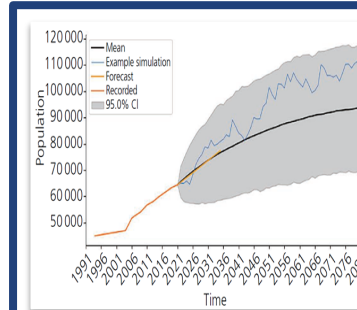
Master thesis



1. System dynamics model to determine funding allocation



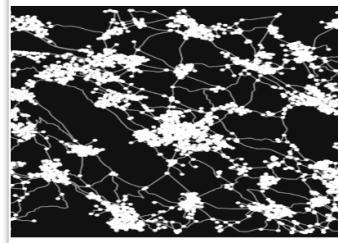
2. Land-Use transport interaction modelling for infrastructure planning



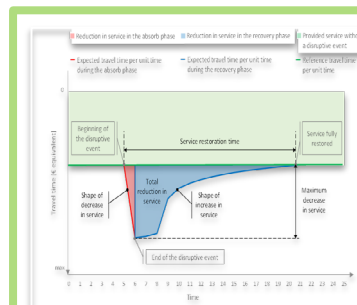
3. Infrastructure planning under future uncertainty



4. Health benefits in appraising cycling infrastructure



5. Impact on transport development on cantonal development



6. Stress tests for transport systems

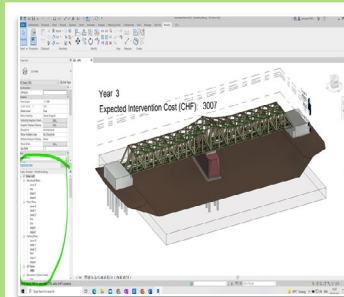
Topics “eher” for Civil Engineering

Master project
and thesis

Master thesis



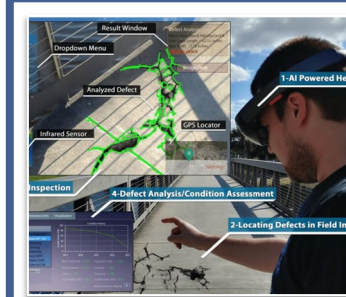
7. Failure trees to estimate probability of road asset failure



8. Connecting future predictions of asset condition and interventions to BIM

27.658	0.0004433	72.3035	-0.20335
27.772	0.11865	72.108	-0.10008
27.852	-0.12001	72.268	-0.012183
28.018	0.28527	71.696	0.079912
27.42	0.03074	72.549	0.53977
30.666	-0.074176	69.409	0.15922
27.618	-0.051278	72.433	-0.024804
27.352	0.25888	72.389	0.025501
30.053	0.092486	70.039	0.38322
27.195	0.01008	72.795	0.077588
30.691	-0.21527	69.524	-0.1001
26.567	0.31829	73.115	-0.24619
30.293	-0.20549	69.912	-0.018813
28.544	-0.11917	71.575	-0.25374
26.948	0.074281	72.977	-0.16524
29.397	-0.18033	70.784	-0.2165
26.15	0.10527	73.955	-0.3979
31.592	-0.1296	68.538	-0.4177
28.559	-0.14966	71.59	-0.2711
27.303	-0.271186	72.893	0.01

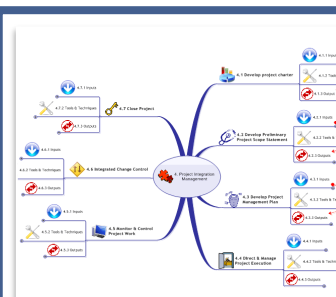
9. Information requirements to trigger intervention



10. Use of extended reality for bridge inspections



11. Connecting service and organisational performance indicators

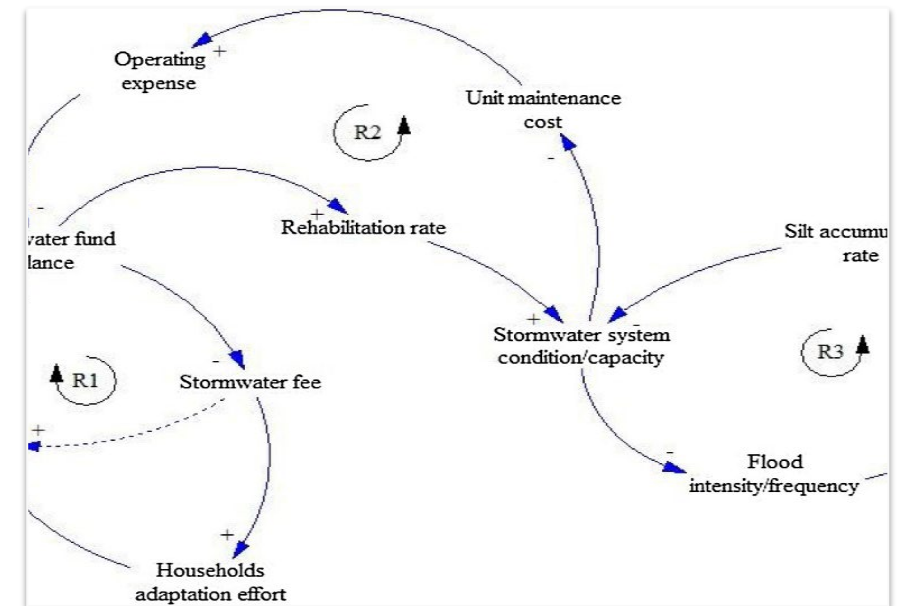


12. Mapping cost estimates

1 – System dynamics model to determine funding allocation

Limited to 2

- **Supervisors:** O. Roman (roman@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To replicate and further develop a model of how a nationwide infrastructure system works to enable the setting of high-level goals considering constraints.
- **Main Tasks:** 1) critically evaluate the key variables to be included in the model, 2) critically evaluate the relationships used in the model, 3) replicate the existing model in an environment in which you are comfortable, 4) test the model for plausibility using sensitivity analysis, 5) discuss the strengths and weaknesses of the model and propose potential improvements.
- **What you will learn:** how to model complex systems at a high-level, the strengths and weakness of such models.
- **What is a successful project?** Reproduction of the model, competent explanation of the model, clear explanation of the strengths and weakness, and clear proposals for improvement.
- **Prerequisites:** Discussion with Prof. Adey. Experience / interest in modelling infrastructure system. Experience / interest in computer programming or knowledge of system dynamics software (e.g., Vensim).



Connected to Scottish Water

2 – Land Use Transport Interactions (LUTI) modelling for infrastructure planning

Limited to 2 persons

- **Supervisors:** O. Roman (roman@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To model the interactions between land use and transportation for a specific case study and use it to inform strategic long-term planning.
- **Main Tasks:** 1) Document / explain the evolution of a region (e.g., Canton of Zurich) and its transportation infrastructure for the previous decades, 2) gather the required datasets needed for the LUTI model (some will be provided), 3) develop/apply the LUTI model to the studied region (code will be provided), 4) calibrate and validate the model, 5) use the model to evaluate potential future infrastructure projects in the region (e.g. changes in travel time, accessibility, urban sprawl, densification).
- **What you will learn:** how to synthesize data collected from different sources, calibration and validation of LUTI models, and how to use models for infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the model to evaluate infrastructure projects. Identification of the limitations of the work and suggestions on how to use these tools in planning practice.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Mr. Roman and/or Prof. Adey. Knowledge.



Supported by:

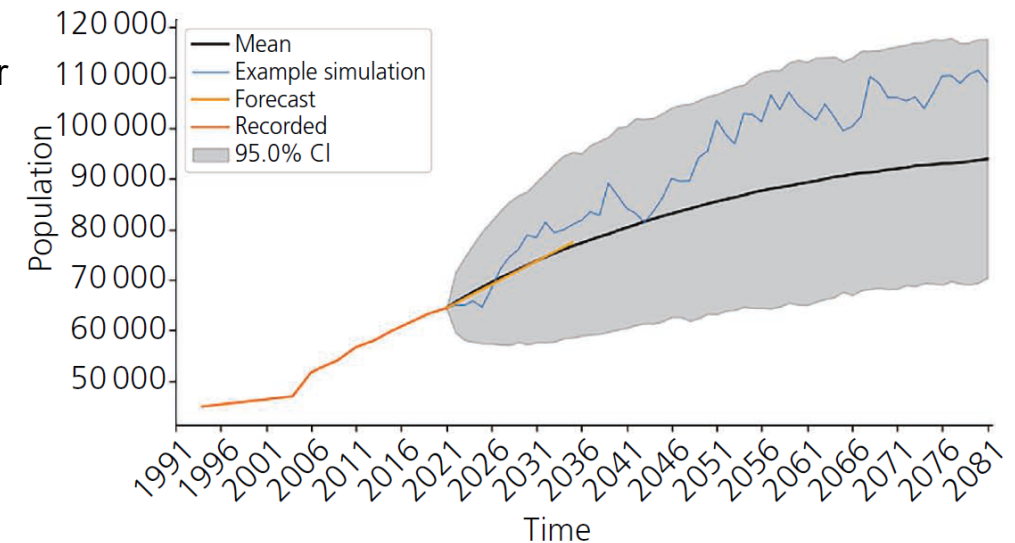
(FCL) FUTURE
CITIES
LABORATORY

3 – Infrastructure planning under future uncertainty

Limited to 2

- **Supervisors:** A. Elvarsson (elvarsson@ibi.baug.ethz.ch), Qiming Ye, Prof. Dr. B.T. Adey
- **Goal:** To use the real option approach to evaluate a real-world planning situation.
- **Main Tasks:** 1) Gather information for an infrastructure system (e.g., water or transport), 2) identify the planning objectives, 3) develop a model to relate key uncertainties to future outcomes of the system (e.g., how climate change will affect future water supply), 4) perform simulations of potential future states of the world, 5) evaluate the different alternatives and discuss the relevant implications on decision-making given future uncertainty
- **What you will learn:** how to quantitatively consider uncertainty for future infrastructure planning. How to provide planning support by exploring potential future scenarios.
- **What is a successful project?:** A clear description of the steps of the modelling process, and a clear analysis of potential future scenarios and their implications.
- **Prerequisites:** Infrastructure Planning, GIS and/or programming skills will be recommended. Discussion with Mr. Elvarsson and/or Prof. Adey. Comfort working with uncertain situations and interest for bringing clarity to them.

Example: Uncertainty in a population forecast for an infrastructure system



Connected to:

**(FCL) FUTURE
CITIES
LABORATORY**

4 – Health benefits in appraising cycling infrastructure

Limited to 2

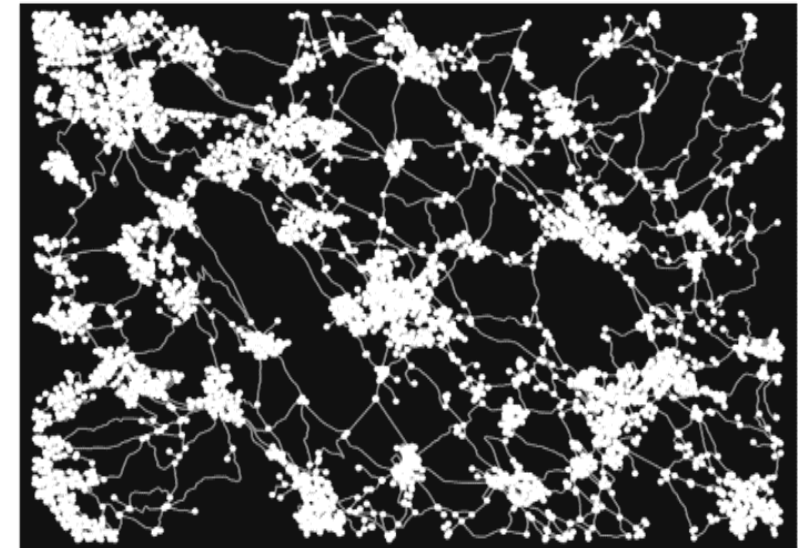
- **Supervisors:** D. Zani (zani@ibi.baug.ethz.ch), Qiming Ye (qiming.ye@sec.ethz.ch)
Prof. Dr. B.T. Adey
- **Goal:** To provide an overview of how health benefits of active mobility are considered in the appraisal of infrastructure projects and make suggestions as to how they should be considered
- **Main Tasks:** 1) become familiar with project investment appraisal processes, 2) become familiar with state-of-the-art cost benefit analyses of infrastructure projects, 3) summarize the efforts to quantify / value the effects of mobility and how they change over time, 4) re-evaluate an infrastructure development project aimed at improving active mobility, 5) make a proposal as to how health benefits should be considered in the appraisal of infrastructure projects
- **What you will learn:** about the costs and benefits of cycling infrastructure and the challenges with making solid business cases, how project investment appraisal works
- **What is a successful project?** A well argued proposal of how health benefits should be considered in the appraisal of cycling infrastructure projects.
- **Prerequisites:** Infrastructure Management 1, or Infrastructure Planning and discussion with one of the supervisors



5 – Impact of transport infrastructure development on other development in the Canton of Zürich

Masters Project –
Limited to 2 persons

- **Supervisors:** Arnór B. Elvarsson (elvarsson@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To explain the impact of infrastructure supply on infrastructure demand. You will set up a difference-in-difference (DiD) regression explaining regional development dependent on the presence/absence of infrastructure over time. This will help inform decision makers as to the benefits of an infrastructure development.
- **Main Tasks:** 1) Summarise literature on interdependence of infrastructure supply and demand and DiD analysis, 2) identify different regional corridors in the Canton of Zürich, mapping the historical changes in national roads on highways over time, 3) specify a DiD regression model explaining relevant indicators, e.g., population, using the presence/absence of infrastructure, 4) explain how these effects may change over time, and 5) discuss how this type of consideration would improve infrastructure benefit estimation.
- **What you will learn:** how to build solid arguments for decision-makers regarding infrastructure planning and being able to communicate these to management.
- **What is a successful project?** Clear results illustrating the impact of transport infrastructure development on other regional indicators.
- **Prerequisites:** Infrastructure Planning, programming skills and an affinity for quantitative model will be recommended. Discussion with Mr. Elvarsson and/or Prof. Adey.



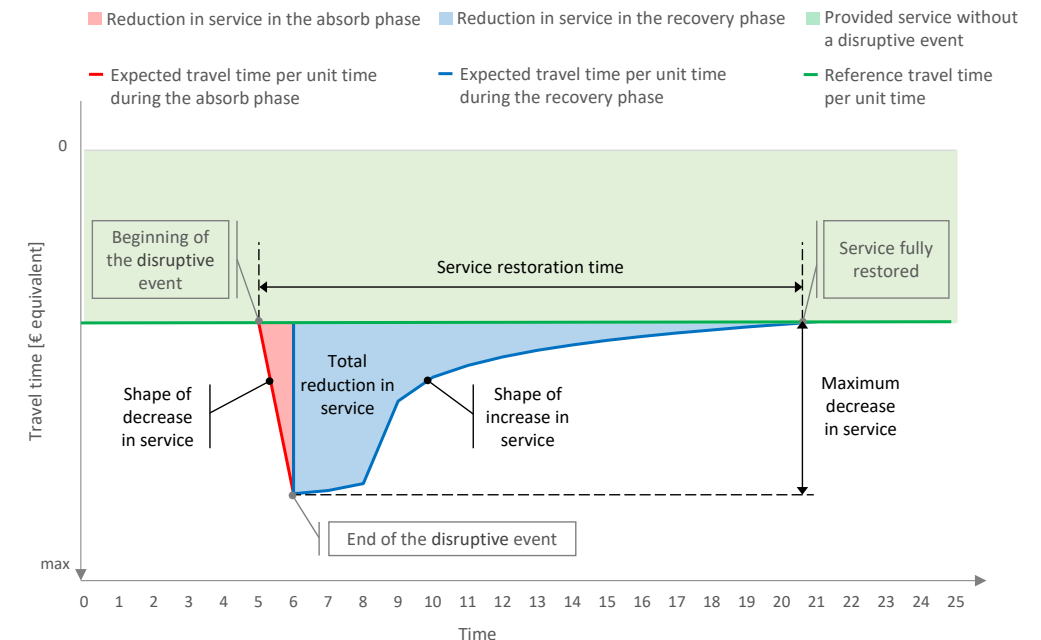
Supported by:

(FCL) FUTURE
CITIES
LABORATORY

6 – Stress tests for the transport systems

- **Supervisors:** H. Nasrazadani (nasrazadani@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To develop a set of stress tests for transport system of urban areas with 20'000 to 50'000 in habitants
- **Main Tasks:** 1) understand the transport system in Chur, Switzerland, 2) define a set of stress tests, i.e., what needs to be checked to say that there are acceptable levels of risks / resilience, 3) understand / modify system representation, 4) conduct the stress test using in house simulation software, 5) explore different ways of determining whether the stress test was passed, 6) discuss challenges of implementing real world stress tests.
- **What you will learn:** how to establish stress tests that balance the need for an overview of potential problems and an appropriate level of detail striking a balance between qualitative and quantitative measures
- **What is a successful project?** Convincing proposals of stress tests that can be used regularly to check to be able to say that there are acceptable levels of transport system risks
- **Prerequisites:** Infrastructure Management 1 or Infrastructure Planning, discussion with Hossein Nasrazadani and/or Prof. Bryan Adey.

Limited to 1



Connected to: United Nations

7 – Fault trees to estimate probability of road asset failure

- **Supervisors:** Josia Meier (meier@ibi.baug.ethz.ch) / H. Mehranfar (mehranfar@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** Estimate the probability of failure of a road or rail bridge subjected to both gradual deterioration, such as the corrosion of steel beams, and natural hazards such as scouring of abutments during floods.
- **Main Tasks:** 1) determine failure modes, 2) determine events that would lead to failure, 3) construct failure trees for each failure mode, 4) determine the basic events for which probabilities of occurrence are to be estimated, 5) determine the values of importance, i.e., structural, Birnbaum, Criticality, Fussel-Vesely of each structural element, 6) make intervention strategy recommendations
- **What you will learn:** How to use failure trees to estimate the probability of failure of a real-world bridge. How to use expert opinion and literature to obtain estimates of failure probabilities.
- **What is a successful project?** Failure trees providing complete and logical descriptions of how the bridge might fail, and defensible estimates of the probabilities of each failure type.
- **Prerequisites:** Infrastructure Management 1 and 2, a course in bridge design is beneficial, discussion with one of the supervisors

Limited to 2



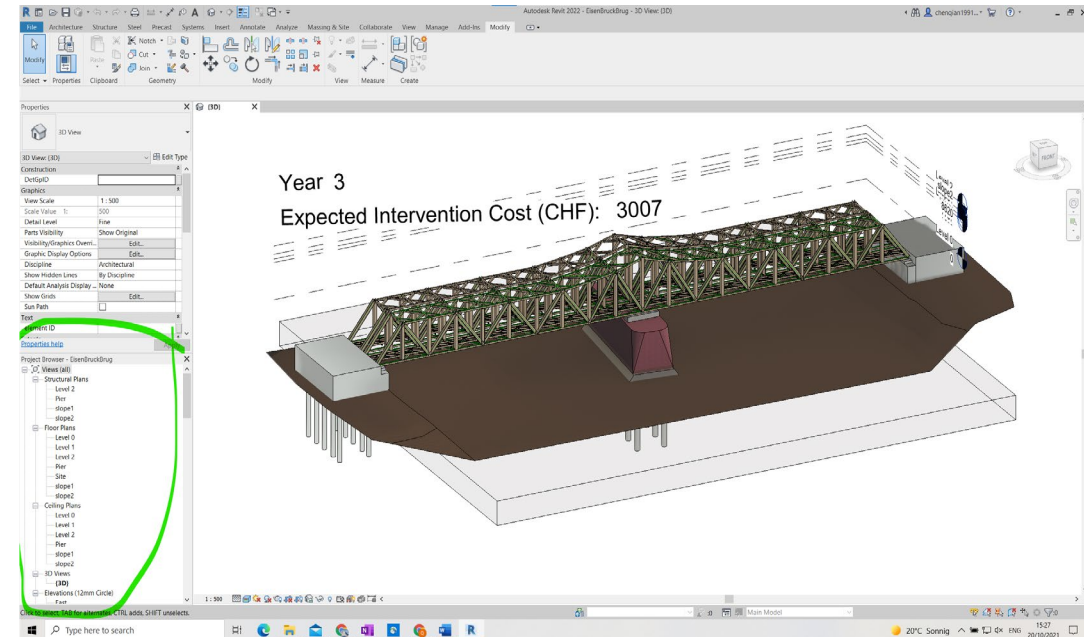
<https://structurae.net/de/bauwerke/felsenauviadukt>

Connected to: ASTRA / SBB

8 – Connecting future predictions to BIM

Limited to 1

- **Supervisors:** S. Hässig (haessig@ibi.baug.ethz.ch) / S. Chuo (chuo@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To connect simulation software to BIM.
- **Main Tasks:** 1) understand how future condition state predictions are made for bridge components, 2) understand how future interventions are predicted, 3) develop a data base which contains this information, 4) connect the database to BIM, 5) illustrate the possible visualisations of the expected deterioration and possible interventions, 6) determine how to best illustrate uncertainty, 7) develop guidelines for implementation.
- **What you will learn:** How to predict deterioration and failure of bridge components in infrastructure management, how to predict future interventions automatically, and how to connect models to BIM.
- **What is a successful project?** Connection of prediction models to BIM and demonstration of the possible visualization.
- **Prerequisites:** Infrastructure Management 1 or Infrastructure planning, discussion with Steve Chuo or Prof. Adey



Connected to: ASTRA

9 – Information requirements to trigger intervention

Limited to 2

- **Supervisors:** Marcelo Torres (gmarcelo@ethz.ch) / Simon Hässig (hässig@ibi.baug.ethz.ch) / David Zani (zani@ibi.baug.ethz.ch) / Prof. Dr. B.T. Adey
- **Goal:** To demonstrate the effect of having varying amounts of information on the decision to launch a detailed investigation.
- **Main Tasks:** 1) Understand the ways existing assets may require a sudden intervention, including engineering and management perspectives, 2) understand the intervention planning process, 3) identify the different levels of information that might be collected on the assets, 4) determine the triggers that engineers and managers might use to launch a detailed investigation, 5) develop representations of the uncertainty of the choices of inspectors and managers, 6) demonstrate the impact of increasing amounts of information on decision making, 7) estimate the costs of acquiring information, 8) estimate the value of the additional information.
- **What you will learn:** how inspectors and managers make decisions and use information.
- **What is a successful project?** A clear demonstration of the effects that having increasing amounts of information may have on engineering and manager decision making.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.

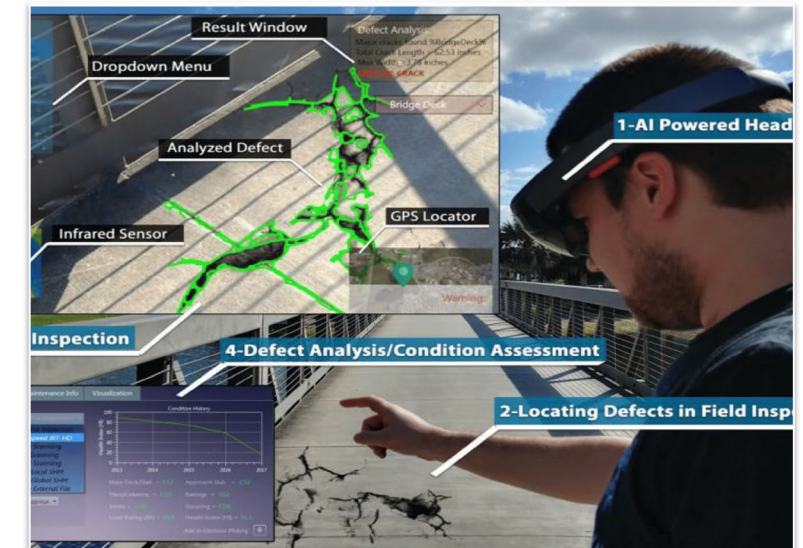
27.658	0.039411	72.303	0.29337
29.539	-0.094423	70.555	-0.20958
27.772	0.11865	72.109	-0.17023
27.852	-0.12001	72.268	-0.012183
28.018	0.28527	71.696	0.079912
27.42	0.03074	72.549	0.53977
30.666	-0.074176	69.409	0.15922
27.618	-0.051278	72.433	-0.024804
27.352	0.25888	72.389	0.025501
30.053	-0.092486	70.039	0.38322
27.195	0.01008	72.795	0.077589
30.691	-0.21527	69.524	-0.1001
26.567	0.31829	73.115	-0.24619
30.293	-0.20549	69.912	-0.018813
28.544	-0.11917	71.575	-0.25374
26.948	0.074281	72.977	-0.16529
29.397	-0.18033	70.784	-0.2165
26.15	-0.10527	73.955	-0.3979
31.592	-0.1296	68.538	-0.4177
28.559	-0.14906	71.59	-0.2715
27.309	-0.20186	72.897	0.63

Connected to: SBB / Scottish Water

10 – Use of extended reality of bridge inspections

Limited to 1

- **Supervisors:** Yushu An (an@ibi.baug.ethz.ch) / Simon Hässig (hässig@ibi.baug.ethz.ch) / Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how extended reality and the supporting framework could be used to improve bridge inspection processes.
- **Main Tasks:** 1) understand how extended reality works, 2) understand how information needs to be structured so that it can be used in extended reality, 3) understand how information needs to be structured so that it is helpful for inspectors and managers to make decisions, 4) understand the different possible ways to display information, 5) learn how to connect information from existing data bases to extended reality devices, 6) determine how current inspection procedures would have to change and could be improved if extended reality was used, 7) provide an assessment of the advantages and disadvantages of using such a technology.
- **What you will learn:** how extended reality may (or may not) improve bridge inspections.
- **What is a successful project?** A clear demonstration the potential of improvement of bridge inspection processes through the use of extended reality.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.



Connected to: SBB

11 – Connecting service and organisational performance indicators

Limited to 2

- **Supervisors:** Marcelo Torres (gmarcelo@ethz.ch) / Simon Hässig (hässig@ibi.baug.ethz.ch) / Prof. Dr. B.T. Adey
- **Goal:** To make an initial proposal of how service level indicators for roads could be connected with performance indicators for organisation units.
- **Main Tasks:** 1) Obtain an overview of the possible measures of services and service indicators for a highway, 2) Understand how these indicators can be used to determine strategies, programs, projects and portfolios, 3) Obtain an overview of how organisational units are evaluated, i.e., so that there is a comparison between what should have been done and what was done, 4) make an example that connects the service indicators, and the organisational performance indicators, using all four decision levels, 5) make a suggestion as to how this could be implemented for one of the regions of Switzerland using the highway from Lausanne to Vevey, 6) provide a critical discussion of your work and outline the next steps.
- **What you will learn:** the challenges of connecting service indicators to organisational performance indicators across different levels of decision making.
- **What is a successful project?** A clear example of the connection can be made between service indicators and organizational performance indicators.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.

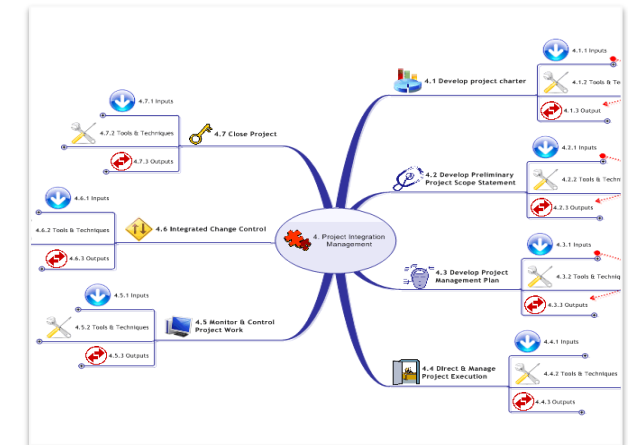


Connected to: ASTRA

12 – Mapping cost estimates

- **Supervisors:** David Zani (zani@ibi.baug.ethz.ch) / Marcelo Torres (gmarcelo@ethz.ch) / Prof. Dr. B.T. Adey
- **Goal:** To develop an automated solution capable of incorporating older project costs information into a new system including an intermediary step of verification of the data
- **Main Tasks:** 1) Conduct bibliographic research on costs management and organisations' challenges when facing transitions from older to newer systems, 2) Understand the specific problem of Drees & Sommer Switzerland, 3) Translation of historical data into standardized information (R tables), 4) Translate the verification dataset into standardized information (R tables), 5) Develop a way of verifying assigned codes in the historical data using the verification dataset, 6) Develop a costs matrix to be extracted that matches the structure of the new costs management system, 7) Convert the historical data into the new structure, 8) assess the probability of data loss
- **What you will learn:** how to work with real world data in a real world data management problem faced when digitizing infrastructure management activities.
- **What is a successful project?** Converted data to the new structure with a low level of information loss.
- **Prerequisites:** Infrastructure Management 1; discussion with one of the supervisors

Limited to 1



Connected to: Drees & Sommer



cea

Circular Engineering for Architecture

Prof. Catherine De Wolf

ETH zürich

Topics

Master project
and thesis

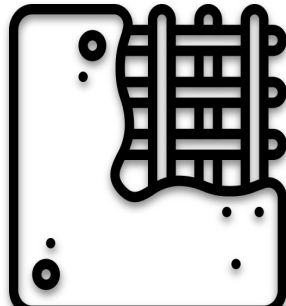
Master thesis



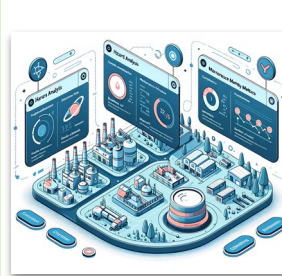
Environment as assets?
Towards regenerative
finance for the built
environment



Building Components as
NFT's, new mechanisms for
Building Component Reuse



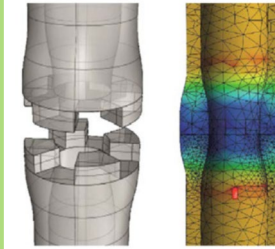
Optimal Integration
Techniques of Data
Storage via DNA in Setting
Construction Materials



Designing Decision Trees
and Circularity Metrics for
Post-Hazard and
Maintenance Interventions
in Infrastructure



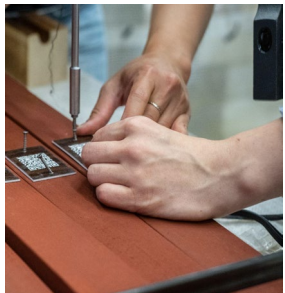
Digitalization and
Automated Inventorization
of Reclaimed Structural
Materials using Image
Segmentation Models



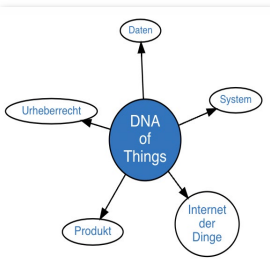
Development of a Digital
Pipeline for Structural
Modeling of Non Standard
Joints for Reclaimed
Concrete Elements



Digital Innovation and
Manual Traditions for
Circular Construction
Case Study: Huber
Pavilions



Internet of Things for
Component Tracking and
Product Passports



Stakeholder Interest in a
DNA-based Data Storage
Mechanism for tracking
Construction Materials



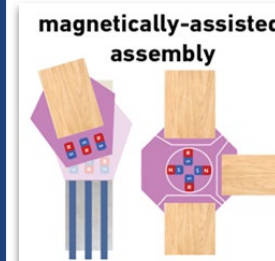
Development of Circularity
framework from Fragility /
Deterioration Models for
Infrastructure Hazard
Resilience



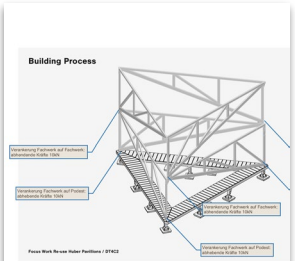
Early design stage
environmental impact
assessment for dfab:
a case study



Digitalization and
Automated Inventorization
of Reclaimed Structural
Materials using Image
Segmentation Models



Reversible Hybrid
Magnetic/Mechanical
Connectors for Reclaimed
Building Elements



Structural Material
Properties of Reuse
Elements
Case Study: Huber
Pavilions

Environment as assets?

Towards regenerative finance for the built environment

- ✦ **Supervisors:** Hongyang Wang, Jens Hunhevicz
- ✦ **Goal:** Financial systems are a critical component of the global economy, influencing sustainability, social equity, and environmental well-being. The concept of "Regenerative Finance" represents an innovative approach that seeks to transform the financial sector into a catalyst for regenerative, sustainable, and socially responsible practices. The goal of this master's thesis is to explore the principles, practices, and impact of Regenerative Finance in the built environment.
- ✦ **Main Tasks:** Conduct a comprehensive review of regenerative finance research, including concepts such as carbon credits, green bonds, and sovereign debt. Further, Identify key projects and implementation cases, especially the refi movement in the crypto field. Summarize the state of the art in regenerative finance and identify the bottleneck for Refi development in the built environment.
- ✦ **What you will learn:** 1. A deep understanding of the principles and practices of Regenerative Finance. 2. Proficiency in research methodologies, data analysis, and critical thinking. 3. Knowledge of sustainable finance, corporate social responsibility, and ethical investment.
- ✦ **What is a successful project?** The assessment criteria for the proposed thesis include the quality of the literature review and critical analysis, the depth and breadth of the analysis and comparison of regenerative finance cases. The clarity, coherence, and organization of the report, and the overall quality of the thesis.
- ✦ **Prerequisites:** Prospective students should have a strong interests in regenerative development in the built environment and economy. Strong research, analytical, and communication skills are essential.



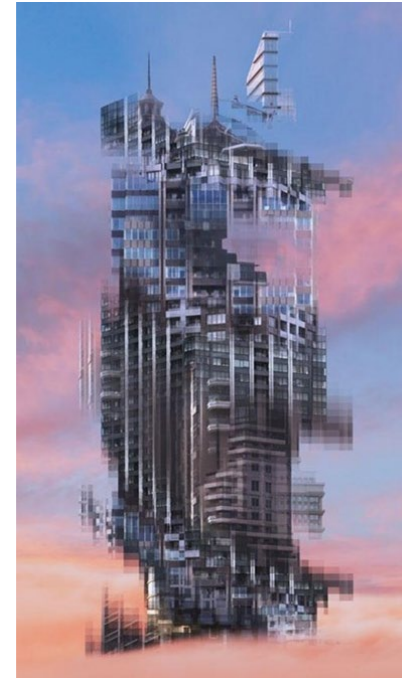
Internet of Things for Component Tracking and Product Passports

- ✦ **Supervisors:** Brandon Byers
- ✦ **Goal:** To compare different hardware Internet of Things devices to use for connecting physical components to a product passport
- ✦ **Main Tasks:**
 - ✦ Review of known use cases for IoT devices in construction
 - ✦ Qualitative analysis of IoT devices (e.g., requirements, industry perception, availability, security)
 - ✦ Experiment Design with participants
 - ✦ Quantitative Analysis (e.g., time of completion, costs, errors)
- ✦ **What you will learn:** You will learn about different hardware associated with Internet of Things and their potential relevance for AEC. You will also learn about quantitative and qualitative research methods
- ✦ **What is a successful project?** A final output that demonstrates comparative advantages of different IoT devices for tracking components
- ✦ **Prerequisites:** Ideally have previous experience in construction processes and interest in hardware technologies



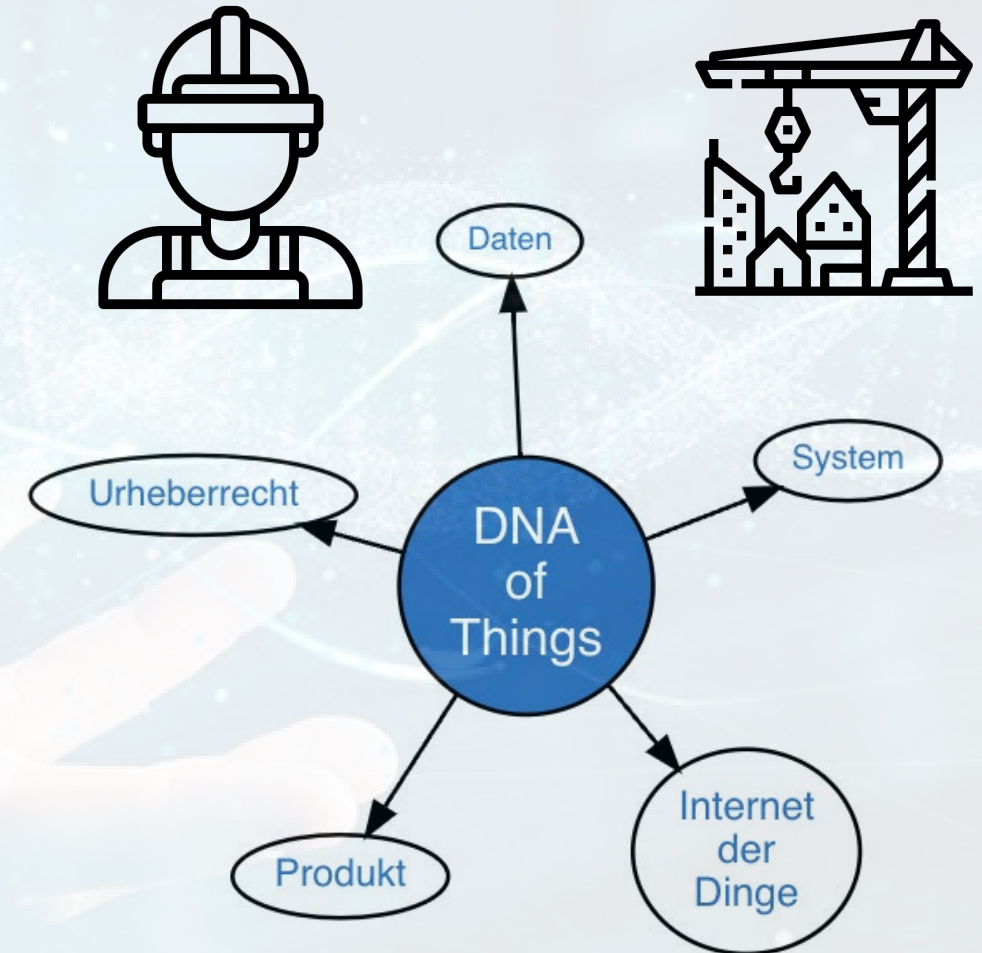
Building Components as NFT's, new mechanisms for Building Component Reuse

- ✦ **Supervisors:** Brandon Byers & Jens Hunhevicz
- ✦ **Goal:** Current popular methods for associating product information with components are QR Codes, barcodes, and RFID. What are the relative (dis)advantages of using an NFC chip coupled with a smart contract ([link](#))?
- ✦ **Main Tasks:** 1) create simple frontend to engage with component, 2) compare differences to other tracking mechanisms (we have potential case study), 3) cost analysis, 4) stakeholder perceived/actual benefits of application
- ✦ **What you will learn:** You will learn more about when/where we should use track and trace techniques in the built environment, case-specific blockchain programming, potential use-case for NFTs
- ✦ **What is a successful project?** A successful project will deliver a case-specific answer to the question if/when we should use NFTs for tracking building assets
- ✦ **Prerequisites:** Experience programming with solidity, preferred interest in blockchain technologies as well as electronics/hardware



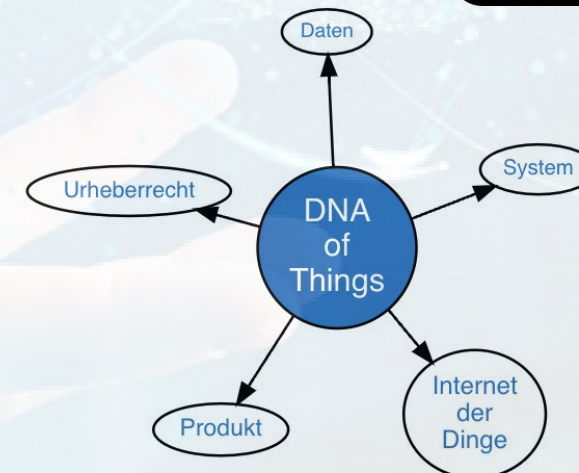
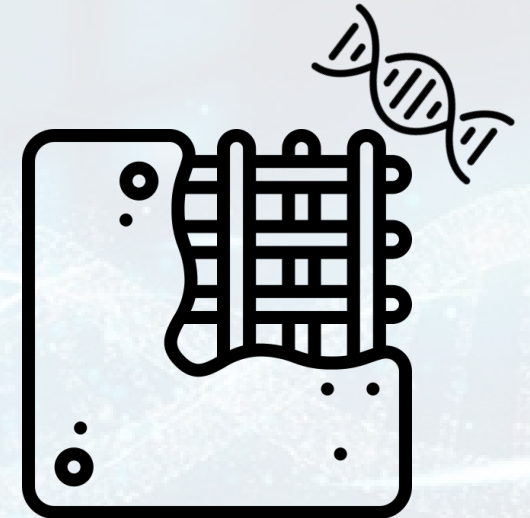
Stakeholder Interest in a DNA-based Data Storage Mechanism for tracking Construction Materials

- ✦ **Supervisors:** Brandon Byers & Prof. Dr. Robert Grass (D-CHAB)
- ✦ **Goal:** Explore and analyze the perceptions and readiness of key stakeholders in adopting DNA data storage within the AEC sector.
 - ✦ What are current stakeholders challenges in data storage in construction materials and what materials are of most interest?
 - ✦ What are perceived benefits and barriers among AEC companies regarding implementation of embedding DNA data storage?
- ✦ **Main Tasks:**
 - ✦ Survey/Interview: Engage with stakeholders (e.g., manufacturers, contractors, auditors) through surveys or interviews.
 - ✦ Analysis: Qualitatively analyze the data to unearth prevalent perceptions and potential barriers.
- ✦ **What you will learn:** Material track & trace for circular construction
- ✦ **What is a successful project?** Uncover preliminary insights into the industry's readiness and potential barriers to adopting DNA data storage in construction materials.
- ✦ **Prerequisites:** Interest in interacting with industry, ideally some exposure in data analytics, curiosity and interest in biology,



Optimal Integration Techniques of Data Storage via DNA in Setting Construction Materials

- ✦ **Supervisors:** Brandon Byers & Prof. Dr. Robert Grass (D-CHAB)
- ✦ **Goal:** Determine the best methods for embedding DNA into [paint or concrete] and establish the minimum concentration needed for reliable data retrieval.
 - ✦ Which techniques most effectively incorporate DNA into paint and concrete without compromising material or DNA quality?
 - ✦ What's the least DNA concentration required in materials to ensure data is consistently readable?
- ✦ **Main Tasks:**
 - ✦ Sample Preparation: Create paint and concrete batches with varying DNA concentrations.
 - ✦ Data Retrieval & Analysis: After material curing, extract/ decode DNA to gauge readability. Assess if DNA concentration affects retrieval success.
- ✦ **What you will learn:** Material track & trace for circular construction, state-of-the-art data storage techniques
- ✦ **What is a successful project?** A guideline on effective DNA integration in [paint and concrete], including the least DNA concentration required for reliable data retrieval
- ✦ **Prerequisites:** Curiosity and interest in biology, openness to collaboration with different departments and labs, experience w/ handling construction materials



Development of Circularity framework from Fragility / Deterioration Models for Infrastructure Hazard Resilience

- ✦ **Supervisors:** Brandon Byers & Dr. Dan Bompa (University of Surrey)
- ✦ **Goal:** To develop a circularity framework in infrastructure management that integrates fragility/deterioration models, utilizing digital and sensing data, for enhancing hazard resilience.
- ✦ **Main Tasks:**
 - ✦ Design an assessment framework that promotes circularity and hazard resilience, and apply it to selected case studies.
 - ✦ Develop fragility models to assess infrastructure vulnerability to various hazards.
 - ✦ Integrate digital and sensing data to refine these models.
- ✦ **What you will learn:** Advanced skills in circularity modelling of infrastructure, that adopts fragility and deterioration metrics, digital data and sensing technology.
- ✦ **What is a successful project?** A circularity framework that integrates hazard resilience principles in infrastructure management through real-world case studies.
- ✦ **Prerequisites:** Master's level understanding of civil engineering or related field. Basic knowledge of data analysis, infrastructure modeling, and sensing technology.



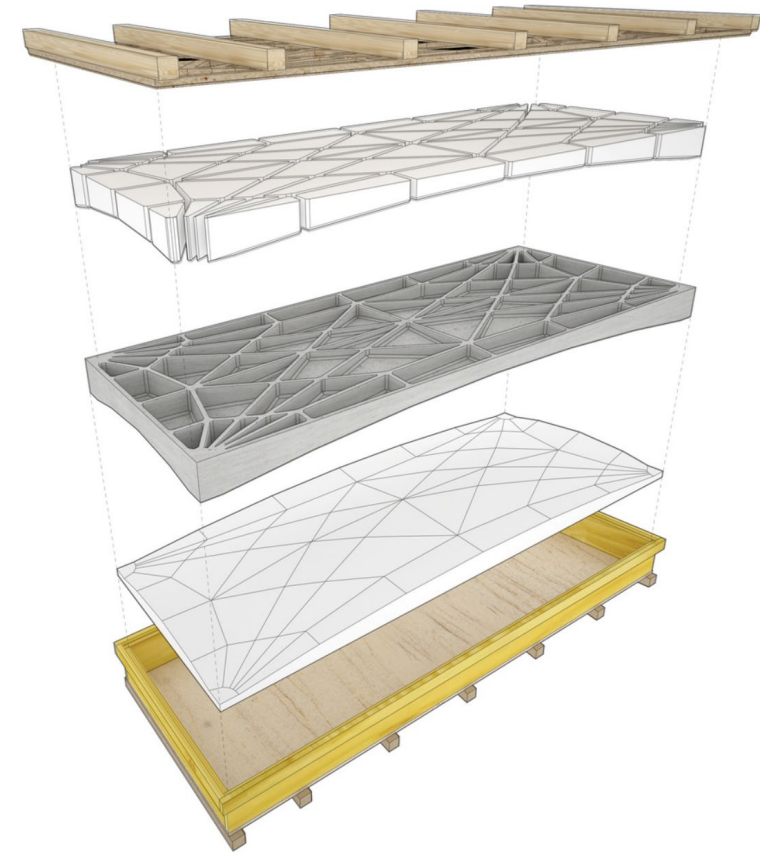
Designing Decision Trees and Circularity Metrics for Post-Hazard and Maintenance Interventions in Infrastructure

- ✦ **Supervisors:** Brandon Byers & Dr. Dan Bompa (University of Surrey)
- ✦ **Goal:** Develop decision trees and metrics that guide post-hazard and maintenance interventions towards sustainable and resilient infrastructure with digital and sensing data.
- ✦ **Main Tasks:**
 - ✦ Literature review on existing decision-making tools in post-hazard and maintenance interventions.
 - ✦ Develop decision trees and metrics tailored for sustainable and resilient interventions.
 - ✦ Design a decision-making framework incorporating the developed tools.
 - ✦ Apply the framework to selected case studies to verify its practical relevance and effectiveness.
- ✦ **What you will learn:** Development of decision-making tools for sustainable and resilient infrastructure interventions. Integration of digital data and sensing technology in decision-making.
- ✦ **What is a successful project?** A decision-making framework that effectively guides post-hazard and maintenance interventions towards sustainability and resilience, validated through real-world case studies.
- ✦ **Prerequisites:** Master's level understanding of civil engineering or related field. Basic knowledge of data analysis and decision-making processes.



Early design stage environmental impact assessment for dfab: a case study

- ✦ **Supervisors:** Heidi Silvennoinen
- ✦ **Context:** Digital fabrication (dfab) has significant potential for reducing the environmental impacts of construction, especially through the ability to optimise geometry. However, due to the complexity, material constraints and customised nature of dfab, environmental impacts need to be evaluated on a case-by-case basis.
- ✦ **Goal:** To map out the data available, design constraints, and environmental impact assessment opportunities for a specific dfab case study.
- ✦ **Main Tasks:** 1) Understanding the design process and decisions related to the case study dfab project. 2) Researching how to collect relevant environmental data: measurements and databases/literature/libraries. 3) Assessing how this data could be integrated into the design and decision-making process.
- ✦ **What you will learn:** Designing for environmental benefits; environmental impact assessment methods and data sources
- ✦ **What is a successful project?** A comprehensive overview of the design process, all the different data sources, and how the data could be used to inform design decisions.
- ✦ **Prerequisites:** Preferably basic understanding of LCA (life cycle assessment) and digital fabrication.
- ✦ **Extra:** Voluntary participation in NCCR sustainability workshop on Nov 8th, to see potential case studies. If interested, email heidi.silvennoinen@ibi.baug.ethz.ch.



Digitally fabricated slab and its formwork <https://block.arch.ethz.ch/brg/research/rib-stiffened-funicular-floor-system>

Digitalization and Automated Inventorization of Reclaimed Structural Materials using Image Segmentation Models

- ✦ **Supervisors:** Deepika Raghu, Beril Önalán, Veronica Contucci (Eberhard)
- ✦ **Goal:** To develop and implement a cost efficient digitization workflow that inventories and categorizes reused structural materials, specifically reclaimed steel beams, within a warehouse environment, using advanced image segmentation models.
- ✦ **Main Tasks:** 1) Data Collection: Gather and curate a data (images or point cloud data) of steel beams, ensuring a variety of lengths and profile types are represented. 2) Model Development: Develop and train a segmentation models to accurately detect and categorize steel beams. 3) System Integration: Integrate the segmentation models into a digital inventory.
- ✦ **What you will learn:** Gain proficiency in segmentation and machine learning model development. Enhance problem-solving skills, especially in the context of automation and digital transformation.
- ✦ **What is a successful project?** Validation of results through a segmentation model capable of detecting and categorizing steel beams and digital inventory system that integrates with the segmentation model.
- ✦ **Prerequisites:** Programming skills, preferably in Python and experience with deep learning frameworks like TensorFlow or PyTorch; familiarity with architecture, construction, and circular economy concepts.



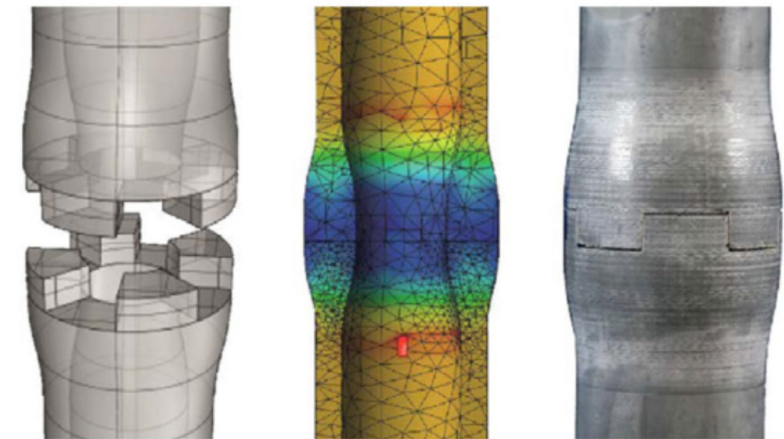
Digitalization and Automated Inventorization of Reclaimed Structural Materials using Image Segmentation Models

- ✦ **Supervisors:** Deepika Raghu, Beril Önalán
- ✦ **Goal:** To develop and implement a digitization and automated inventorization of concrete waste, using advanced image segmentation models to identify, categorize, and design with waste materials.
- ✦ **Main Tasks:** 1) Data Collection: Collect a diverse set of images capturing various types of concrete waste resulting from demolition processes. 2) Model Development: Develop and train image segmentation models to recognize and classify different categories of concrete waste. 3) System Integration: Integrate the segmentation models into a digital inventory to deployed in a Rhinoceros 3d/Grasshopper design workflow.
- ✦ **What you will learn:** Gain proficiency in image segmentation and machine learning model development. Acquire skills in developing a design from reuse workflow with computational design tools in Rhino/Grasshopper environment. Enhance problem-solving skills, especially in the context of automation and digital transformation.
- ✦ **What is a successful project?** Validation of results through an image segmentation model capable of detecting and categorizing concrete waste and digital inventory system that integrates with a computational design workflow.
- ✦ **Prerequisites:** Programming skills, preferably in Python and experience with deep learning frameworks like TensorFlow or PyTorch; familiarity with architecture, construction, and circular economy concepts.



Development of a Digital Pipeline for Structural Modeling of Non Standard Joints for Reclaimed Concrete Elements

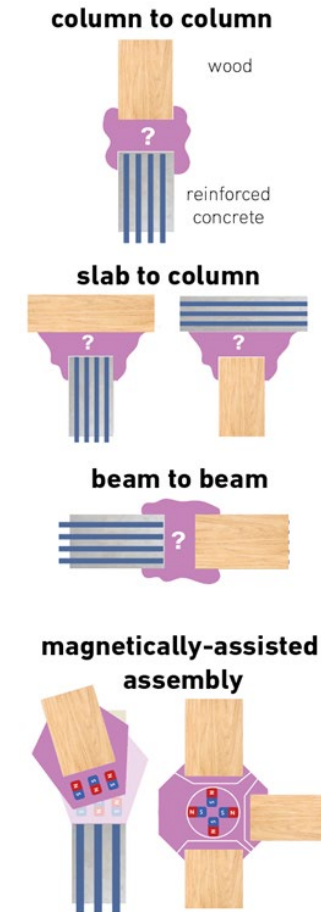
- ✦ **Supervisors:** Beril Önalán
- ✦ **Goal:** The objective of this research is to create a digital pipeline that aids in the structural modeling of novel joints specifically tailored for reclaimed concrete elements. Due to the non-standard nature and potential damage of interfaces in reclaimed concrete elements, there is a challenge in reusing them effectively.
- ✦ **Main Tasks:** 1) Create a 3D Finite Element Analysis (FEA) model to iteratively simulate and analyze the behavior of connections in reclaimed concrete elements, identifying any potential weaknesses or points of failure. This pipeline should be flexible enough to accommodate the variability of the stock of reclaimed elements and ensure that the final designs meet required structural behaviour.
- ✦ **What you will learn:** Enhance your knowledge of circular economy principles, with a particular focus on design for reuse strategies in the construction industry.
- ✦ **What is a successful project?** The creation of a robust structural analysis pipeline, culminating in a 3D modeled connection that is structurally optimized for use with reclaimed concrete elements.
- ✦ **Prerequisites:** Familiarity with Finite Element Analysis (FEA) tools and a willingness to learn and apply Python or Compas coding in the context of computational design.



Mainka et al. Non-Standard Fügeprinzipien für leichte Bauteile aus UHPFRC

Reversible Hybrid Magnetic/Mechanical Connectors for Reclaimed Building Elements

- ✦ **Supervisors:** Beril Önalán, Dr. Buse Aktas (Multi Scale Robotics Lab D-MAVT)
- ✦ **Goal:** The aim is to design hybrid magnetic and mechanical joints and connectors suitable for structural components at an architectural scale.
- ✦ **Main Tasks:** The project entails 1) developing various design concepts for connections, 2) comparing these concepts based on their performance criteria, and then proceeding 3) to model, prototype, and test the most promising among them.
- ✦ **What you will learn:** Throughout this project, you will gain insights into structural design with a focus on reversibility and modularity, understanding which structural components of a building can be reusable, and grasping the principles of circular economy, particularly design for disassembly.
- ✦ **What is a successful project?** A project will be deemed successful if a minimum of three joint design concepts are developed, with the main prototype undergoing thorough mechanical testing.
- ✦ **Prerequisites:** CAD, hands-on-prototyping (workshop, woodshop, 3D-printing, etc.), physics-based simulation software (e.g. COMSOL, Abaqus); familiarity with architecture, construction, and circular economy concepts.



Digital Innovation and Manual Traditions for Circular Construction

Case Study: Huber Pavilions

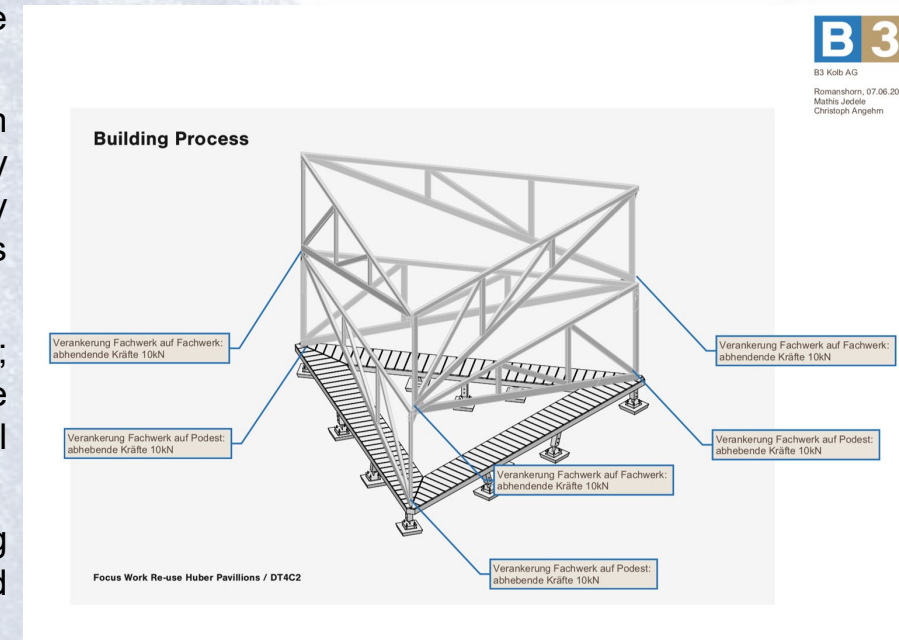
- **Supervisors:** Elias Knecht
- **Goal:** Investigating the potential of digital innovation integrated into traditional construction techniques in the case of the Huber Pavilions to achieve a more reuse-friendly circular economy.
- **Main Tasks:** (1) Conduct a comprehensive literature review of existing research on digital innovation, reuse-friendly modern architecture, and circular economy concepts. (2) Conduct fieldwork on the Circular Huber Pavilion (CircÜbi) and adjoining storage site (3) Evaluate the potential environmental and economic benefits of incorporating digitally innovative techniques into modern architecture design and construction.
- **What you will learn:** You will learn practical skills in fieldwork and data collection; circular economy concepts; digital innovation; the challenges and opportunities of circular construction
- **What is a successful project?** A successful project demonstrates the potential environmental and economic benefits of incorporating digital techniques into modern architecture design and construction.
- **Prerequisites:** Critical thinking and problem-solving skills; familiarity with digital tools, architecture, construction processes, and circular economy concepts.



Structural Material Properties of Reuse Elements

Case Study: Huber Pavilions

- **Supervisors:** Elias Knecht
- **Goal:** Investigating the structural material properties of reclaimed building elements of the Huber Pavilions within the reassembly project of CircÛbi.
- **Main Tasks:** (1) Conduct a comprehensive literature review of existing research on structural material properties for reuse of building elements, legal norms and exemplary projects. (2) Conduct fieldwork on the CircÛbi and adjoining storage site with real case study materials (3) Evaluate the structural challenges and benefits of incorporating reuse elements into modern architecture design and construction.
- **What you will learn:** You will learn practical skills in fieldwork and data collection; structural material properties of reuse components, circular economy concepts; the challenges and opportunities of reusing building elements within a normalized legal framework.
- **What is a successful project?** A successful project demonstrates the potential of reusing building elements in a new design context and illustrates the structural challenges and opportunities which the integration of reclaimed materials faces.
- **Prerequisites:** Critical thinking and problem-solving skills; familiarity with architecture, construction, circular economy concepts and structural analysis and attestation techniques.



Using imagery and extended reality to communicate Circular Pavilion

- **Supervisors:** Elias Knecht
- **Goal:** Learning to use imagery and extended reality tools to produce visual communication tools about circular construction with data of the Huber Pavilions and CircÛbi
- **Main Tasks:** (1) Data Collection of CircÛbi and adjoining storage site using scanning technology and photogrammetry with the aim of conveying the aspects of science and digitalization within circular economy principles (2) Visual representation of the sourced or existing data in an aesthetically captivating and beautiful manner.
- **What you will learn:** You will learn about different representation methods of point clouds and photogrammetry and portraying the core essence of the reuse case study.
- **What is a successful project?** A successful project illustrates the potential of reusing building elements in a new design context and demonstrates the technological aspects of the circular building projects.
- **Prerequisites:** Critical thinking and problem-solving skills; familiarity with architecture, construction, circular economy concepts, point clouds, 3D scanning and visual representation methods
- **Special:** The submission deadline is on January 31st. 2024 - Only suitable for Master Projects



The Chair for Sustainable Construction gathers a group of scientists, engineers and architects who aim to ground sustainability in all disciplines involved in the built environment.

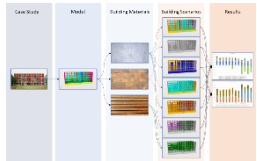


The objective is to identify the relevant parameters that influence the environmental impacts of buildings across spatial and temporal scales in order to implement sustainable practices throughout the development of innovative strategies adapted to each stakeholder.

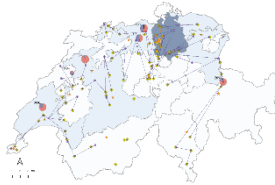
Topics

Master project
and/or thesis

Master thesis



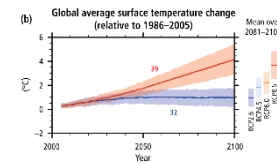
The responsibility of
structural engineers...



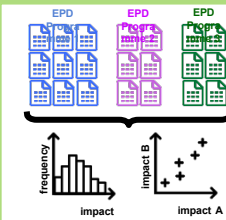
Urban-industrial
metabolism within the
context of recycling of
waste-to-energy residues
into construction materials



Future proof buildings –
what they are?



Integration of future climate
in LCA/energy models



Big data in LCA: assessing the
variability of environmental
impacts of ready-mixed concrete
production using EPDs



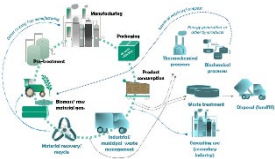
Comparative Lateral load test
and LCA of composite bamboo
shear walls influence of aspect
ratio



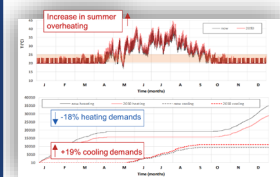
Alternative mix design of
poured earth



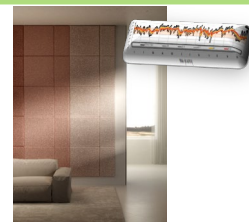
Enhancing Sustainability
through Dynamic Logistics
Optimization for Circular
Construction Materials



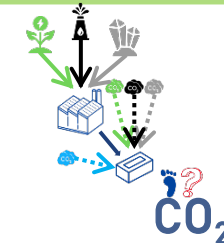
Mapping Bio-based
Material Potentials for
Sustainable Construction
in the Canton of Zurich



Integrating Future Comfort
Calculation into Energy
Analyses: The case study
FraumunsterPost.



Identification of appropriate
use of biobased/hygroscopic
materials in different contexts,
considering climate change.



Accounting for carbon capture
and storage in the Life Cycle
Assessment of mineral
construction products



Understanding how the earth
materials shrink upon water
drying, for poured and 3d
printed earth application

Policies

Supply chain , stakeholders

Comfort

Adaptation - modelling - Monitoring

LCA materials & technologies

Materials Development

1- The responsibility of structural engineers on GHG impact of a building

Supervisor: Yasmine Priore(priore@ibi.baug.ethz.ch)

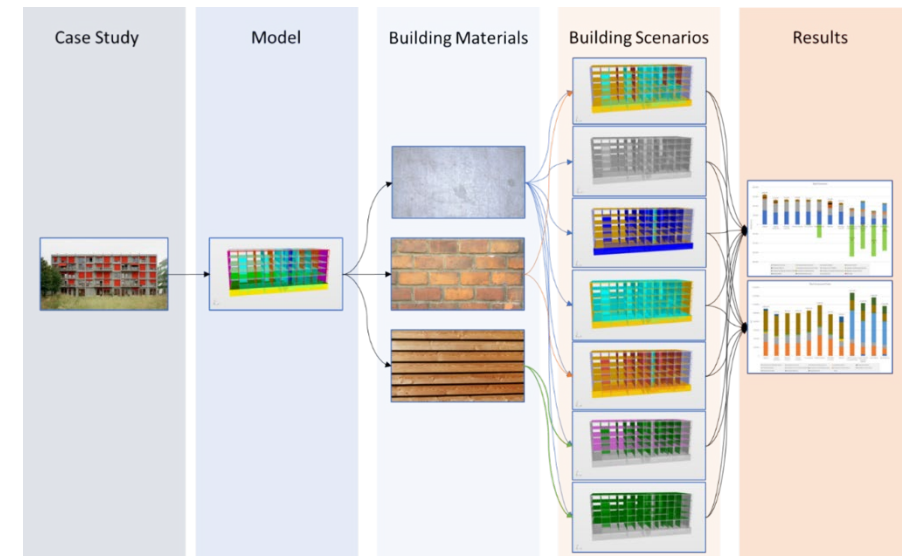
Goal: Structural elements often stand out for their high impact on overall Greenhouse Gas embodied emissions of a building. This usually is explained by the high volume and mass of materials put in place to respond to the structural function of the building. Although many strategies are available to reduce this impact (ex: optimize thicknesses of components, lower spans, shift to low-carbon and bio-based materials), it is unclear who bears the responsibility of these decisions. It may seem straightforward to think it's the structural engineer, but to what degree is she/he really responsible for it?

Main tasks:

Analysis of decision making, requirements, and constraints in the structural design process of a building. Environmental life cycle assessment (LCA) quantification of structural decisions at building scale.

Prerequisites: Knowledge of structural design process and requirements. Knowledge of LCA is a plus.

Students: 1



Life Cycle Assessment of a typical new Swiss construction. Farner 2023

2 - Enhancing Sustainability through Dynamic Logistics Optimization for Circular Construction Materials

Supervisor: Shuyan Xiong (xiong@ibi.baug.ethz.ch)

Anastasija Komkova (komkova@ibi.baug.ethz.ch)

Goal: The construction industry's impact on the environment necessitates a shift towards sustainable practices. The primary goal of the project is to establish a generalized and dynamic logistics optimization framework to streamline material flows and allow efficient utilization of wasted building materials, with an emphasis on circular construction practices and decentralized marketplaces. The results will be incorporated into the Circular Future Cities Project and promote circularity in broader context.

Main tasks:

- Research into the dynamics of waste building components/materials and strategies for optimizing material flow
- Develop a robust, adaptable logistics optimization model based on previous work from the chair
- Case study to validate the model with local database (Zurich)

Prerequisites: Basic knowledge in programming, experience working with logistics planning and GIS software is a plus.

Students: 1



Source: https://favpng.com/png_view/truck-fleet-management-software-routing-system-png/JP0auNGs

3 – Urban-industrial metabolism within the context of recycling of waste-to-energy residues into construction materials

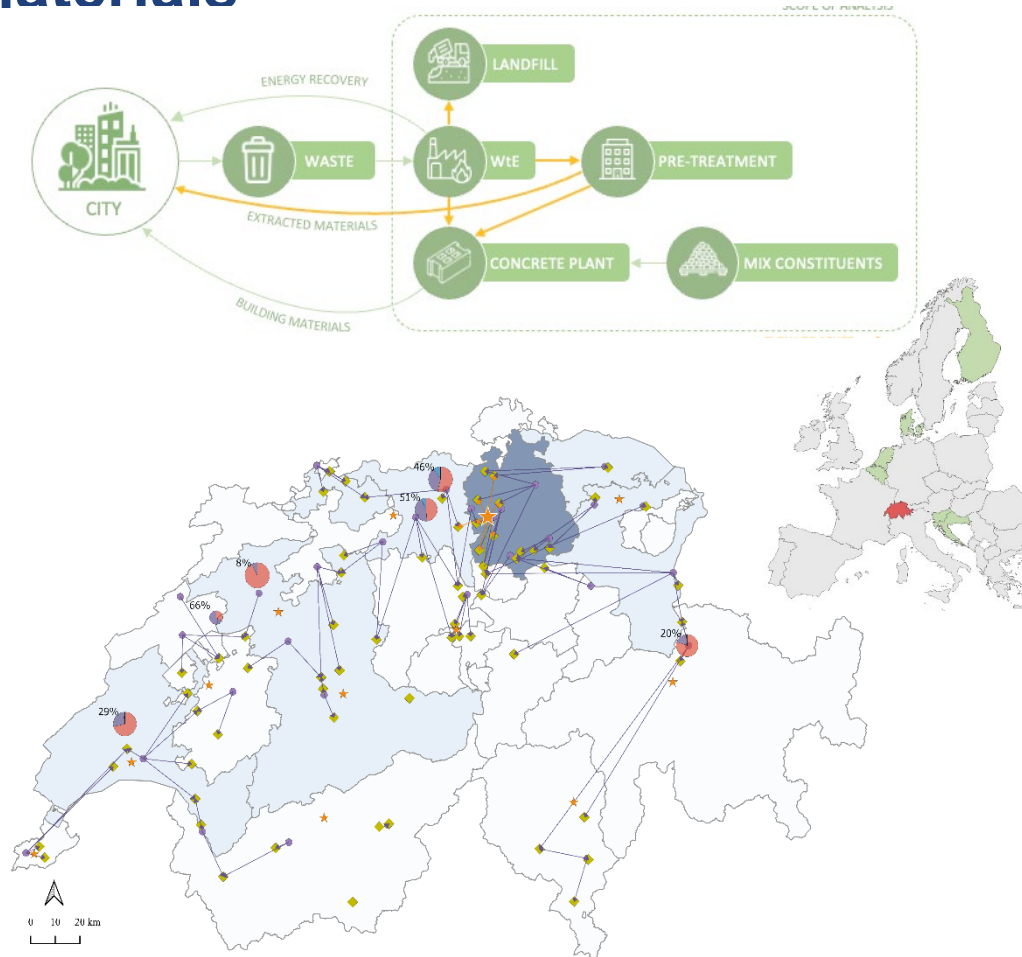
Supervisor: Anastasija Komkova (komkova@ibi.baug.ethz.ch)

Goal: In Europe, more than 35% of annually generated waste is disposed. But what if waste generated by urban environment can become a resource for construction sector? The goal of the project is to model urban-industrial metabolism within the context of recycling of waste-to-energy residues in construction materials. The case studies can focus on Northern, Central, or South-Eastern Europe.

Main tasks: Further adapt existing optimization model for supply chains within urban-industrial exchanges of waste, minimizing environmental impacts and costs. Match supply of waste and demand for construction materials. Where relevant, examine trans-boundary urban-industrial symbioses. Quantify contributions to national carbon reduction targets.

Prerequisites: Knowledge or interest in programming with python or GAMS. Knowledge of GIS could be useful, but not necessary.

Students: 3



4 - Mapping Bio-based Material Potentials for Sustainable Construction in the Canton of Zurich

Supervisor: Shuyan Xiong(xiong@ibi.baug.ethz.ch)

Huber Shoshana(shhuber@ethz.ch)

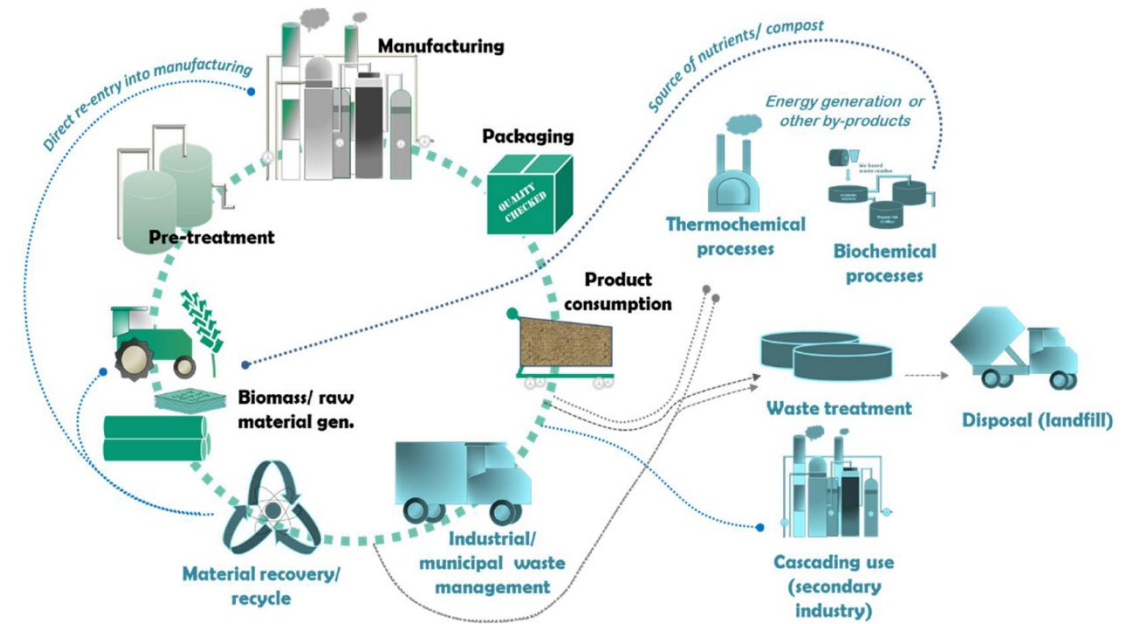
Goal: To compile information already available at the chair on a variety of bio-based products, with a particular emphasis on straw, reeds, hemp etc. in the Canton of Zurich. In order to provide a thorough overview of the existing state, difficulties, and future potentials of these bio-based resources for sustainable construction practices, the project will combine information from several master thesis, the BAFU database, and additional research. In addition to mapping physical resources, the study will also pinpoint important supply chain players, such as producers.

Main tasks:

- Compile and evaluate information from a variety of sources
- Map the manufacturing, supply chain, and application networks of bio-based products
- Identify important stakeholders, present uses, as well as potential development areas.

Prerequisites: Interest in bio-based materials and experience working with resource mapping and supply chain study is a plus

Students: 1



A generalised map of a bio-based value chain.

Source: Lokesh, K.; Ladu, L.; Summerton, L. Bridging the Gaps for a 'Circular' Bioeconomy: Selection Criteria, Bio-Based Value Chain and Stakeholder Mapping. Sustainability 2018, 10, 1695. <https://doi.org/10.3390/su10061695>

5- Future proof buildings: what are they?

Supervisor: Yasmine Priore(priore@ibi.baug.ethz.ch)

Goal: In the current climate crisis it becomes more and more evident that, although mitigating our impact is essential, **adapting** to the inevitable changes is required to further reduce losses and damages that in return also affect our capability at mitigating. How is this reflected in buildings? Climate is changing, extreme weather events are more recurrent, population structure is shifting, energy supply is not unlimited anymore, resources are depleting, etc.. The project aims at answering two fundamental questions: which future conditions/events do we need to proof our buildings for? And how can we quantify the level of proofing/resilience of our design strategies?

Main tasks:

Sustainability and multi-criteria approach of future proof influencing factors. Assessment of design strategies with future proof indicators.

Prerequisites: Knowledge of sustainability and multi-criteria approach is a plus.

Students: 1

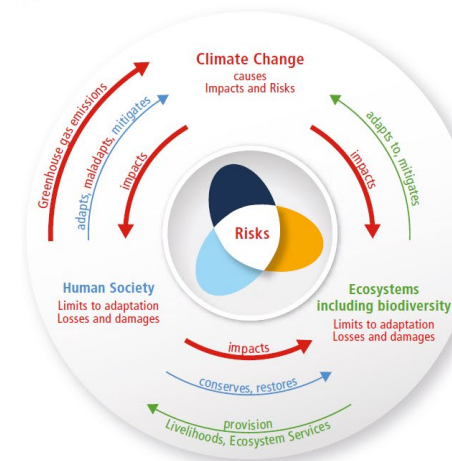


verb

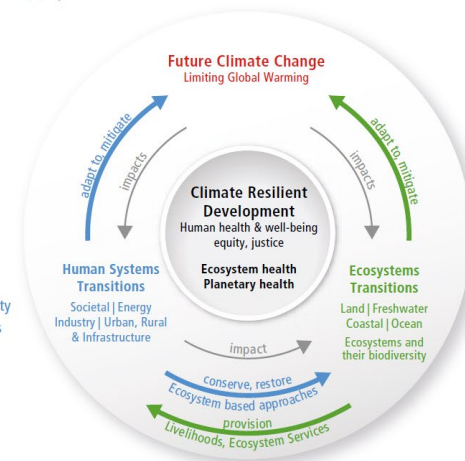
make (a product or system) unlikely to become obsolete or fail in the future.
"this approach allows you to future-proof your applications"

From climate risk to climate resilient development: climate, ecosystems (including biodiversity) and human society as coupled systems

(a) Main interactions and trends



(b) Options to reduce climate risks and establish resilience



From urgent to
timely action

Governance
Finance
Knowledge and capacity
Catalysing conditions
Technologies

The risk propeller shows that risk emerges from the overlap of:



IPCC AR6 – Summary for Policymakers (SPM.1)

Future Proofing Your Building

Future proofing is the process of optimising design and construction to account for unpredictable and ongoing change.

IT HELPS TO:



HOW TO FUTURE-PROOF:



FLEXIBILITY

RESOURCE USE

LOW CARBON FOOTPRINT

TECHNOLOGY

<https://middleeast.polypipe.com/blog/5-principles-futureproof-your-building>

6 – Integrating Future Comfort Calculation into Energy Analyses: The case study FraumunsterPost.

Supervisors: Dr. Magda Posani (posani@ibi.baug.ethz.ch)

Goal:

Climate is changing due to anthropogenic emissions. What will be the consequences for Swiss buildings? What do we have to get prepared for these new climate change-imposed challenges? This master thesis explores the possible future climatic expectations for the city of Zurich and evaluates possible low-carbon strategies to make constructions resilient.

Main tasks:

1. FUTURE CLIMATE ANALYSES

- Understand future climate extrapolation and the model behind it
- Analyse future climate data and understand the entity of change
- formulate expectations on climate-imposed challenges for Zurich buildings

2. CASE STUDY

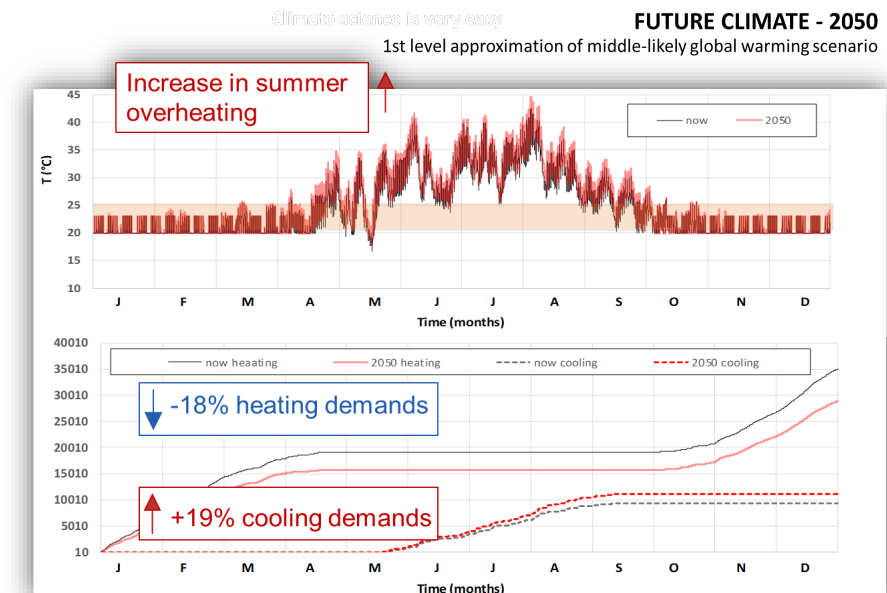
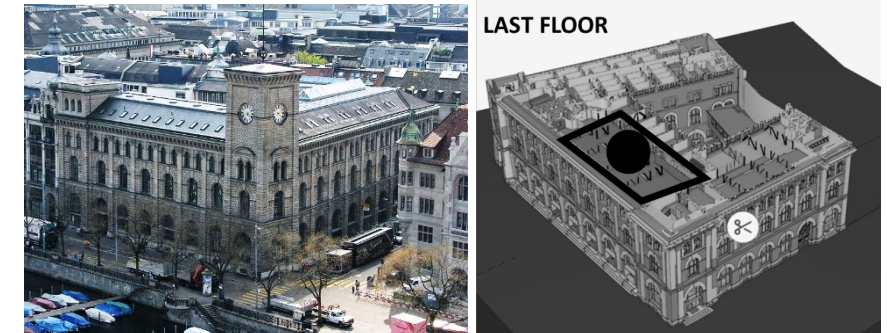
- Dynamic hygrothermal simulations for the case study
- Evaluate effect of climate change on comfort, energy demands, increased degradation risks

3. IMPLICATIONS AND POSSIBLE SOLUTIONS

- Based on literature and numerical simulations, propose possible solutions

Prerequisites: Interest in energy or hygrothermal simulations

Students: 1



7 – Identification of appropriate use of biobased/hygroscopic materials in different contexts, considering climate change.

Supervisors: Dr. Magda Posani (posani@ibi.baug.ethz.ch)

Goal:

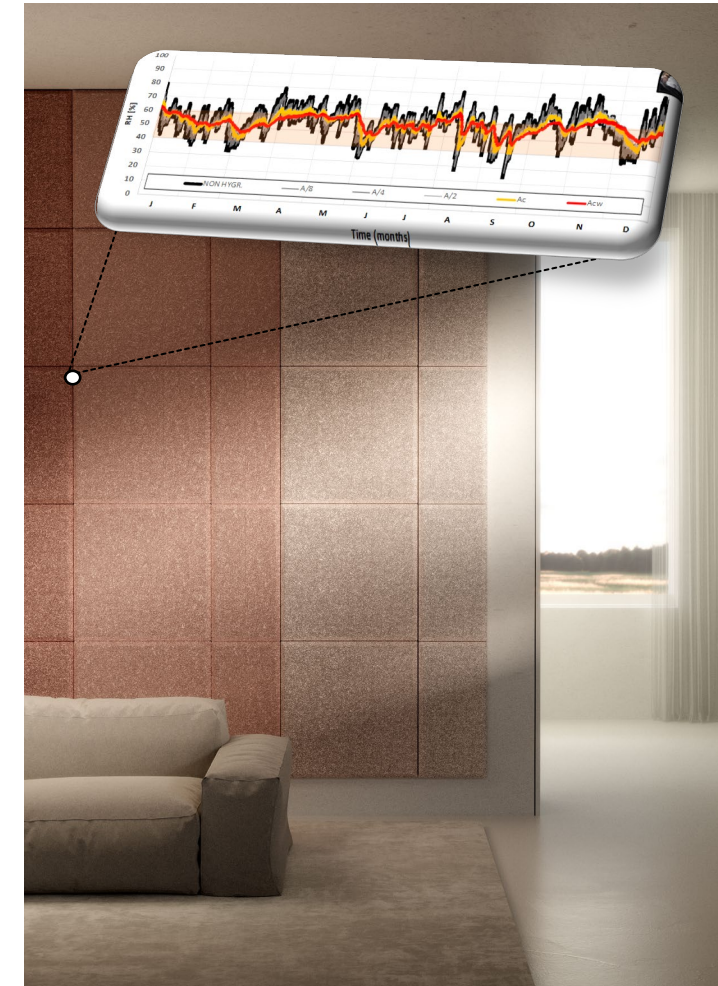
As we spend most of our lives indoors, internal environmental conditions have a significant impact on our health and well-being. Among various factors, indoor humidity plays a crucial role in determining our comfort, health, sleep quality, and productivity. Hygroscopic materials naturally regulate indoor humidity levels, with no energy consumption. The combination of low-carbon materials choices and hygroscopic properties holds the promise of reducing the environmental impact of our buildings, minimizing the need for mechanical systems, and enhancing indoor comfort for occupants. This thesis explores indoor environmental conditions in various buildings located across different European countries, integrating environmental analyses with hygrothermal simulations to identify the optimal use of low-carbon, hygroscopic materials in the European context.

Main tasks:

1. Indoor climate and comfort analyses in several case studies
2. Dynamic hygrothermal simulations: benefit of hygroscopic solutions in different contexts
3. (optional) Basic LCA
4. (optional) Crossed analyses with future indoor conditions (due to climate change)

Prerequisites: Interest in energy or hygrothermal simulations and LCA

Students: 1



8 - Integration of future climate in LCA/energy models.

Supervisors: Yasmine Priore /Dr. Magda Posani
(priore@ibi.baug.ethz.ch / posani@ibi.baug.ethz.ch)

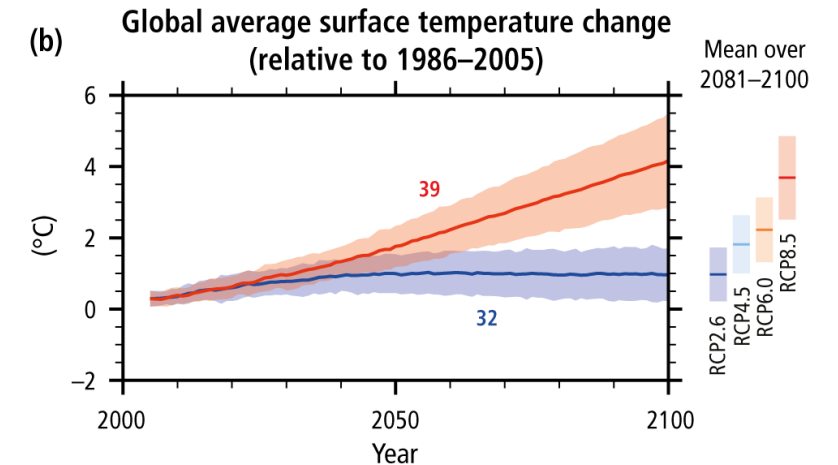
Goal: Although mitigating our impact (reducing emissions) is essential, adapting to the inevitable changes is required to further reduce losses and damages that in return also affect our capability at mitigating. Nature-based building materials are a strong solution to reduce impact of construction phase but can they also regulate indoor comfort? with summers getting hotter, can we avoid additional cooling energy demand by choosing the right materials? This thesis aims at addressing these questions.

Main tasks:

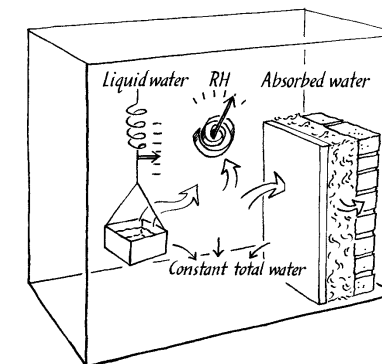
- A case study (residential) will be provided.
- The first task will be to set-up the energy model for the simulations.
- In a second step future climates will be analyzed and implemented into the model.
- Finally, the impact of materials on regulating internal comfort will be analyzed.

Prerequisites: Knowledge or interest in energy simulations in Rhino/Grasshopper with EnergyPlus.

Students: 1



IPCC AR5 – Future Climate Changes, Risks and Impacts. Time series of global annual change in mean surface temperature 2006-2100



Humidity buffering by absorbent materials in walls and objects

9 – Accounting for carbon capture and storage in the Life Cycle Assessment of mineral construction products

Supervisor: Dr. Fernanda Belizario Silva (silva@ibi.baug.ethz.ch)

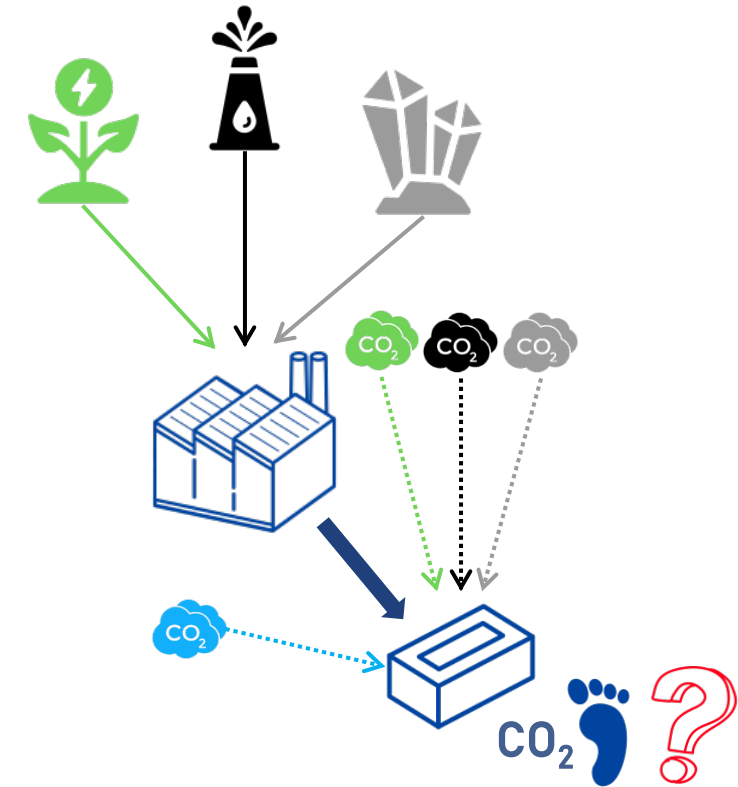
Goal: Mineral construction products can capture and store CO₂ through natural or artificial carbonation. Life Cycle Assessment (LCA) can be used to assess whether carbon capture leads to construction products with positive, neutral, or even negative CO₂ emissions over their life cycle. However, there is no consensus on how to account for carbon capture in the LCA of construction products. This project aims to conduct a literature review to identify and compare the existing approaches on how to account for carbon capture and storage in the LCA of mineral construction products.

Main tasks:

- Conduct a systematic literature review on accounting for carbonation and carbon capture in LCA, including scientific papers, technical reports, and standards
- Compare the existing approaches (system boundary, time frames, and calculation rules).
- Develop recommendations.

Prerequisites: Knowledge about Life Cycle Assessment (LCA).

Students: 1.



10 – Big data in LCA: assessing the variability of environmental impacts of ready-mixed concrete production using Environmental Product Declarations

Supervisor: Dr. Fernanda Belizario Silva (silva@ibi.baug.ethz.ch) in collaboration with the University of São Paulo and the Technological University of Panamá

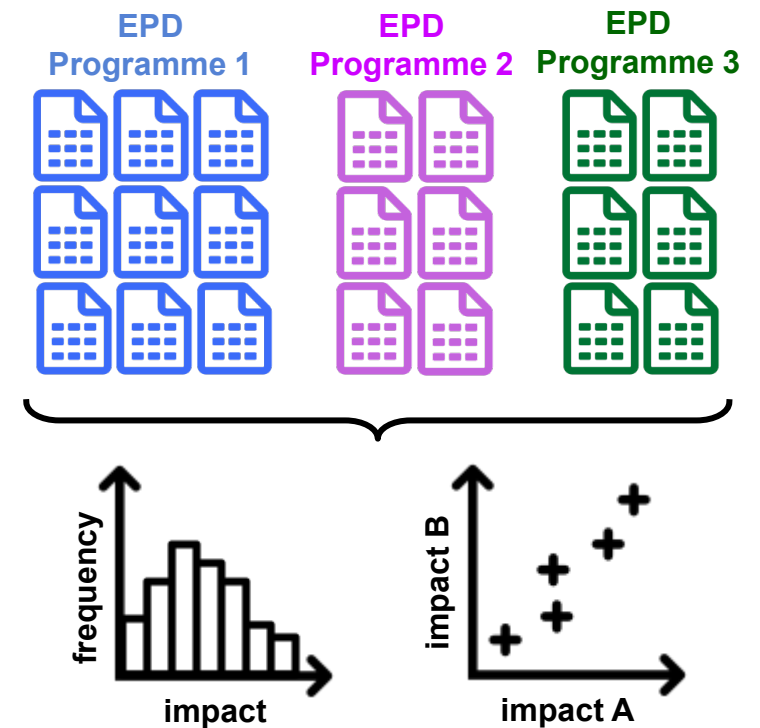
Goal: environmental impacts can vary a lot among ready-mixed concrete producers owing to differences in mix design and production processes. However, LCA usually ignores this variability despite the growing amount of data available in Environmental Product Declarations (EPDs). This project aims to investigate the variability of life cycle impacts and resource use for ready-mixed concrete production based on published EPDs to identify possible correlations between impact categories and eventual inconsistencies in environmental impact reporting.

Main tasks:

- Extract data from EPDs in PDF format (automatically)
- Organize and analyse the results
- Conduct correlation analysis

Prerequisites: Basic knowledge about Life Cycle Assessment (LCA). Computational skills to automatise data extraction. Statistical skills to analyse results

Students: up to 3 (working in group)



11 – Comparative Lateral load test and LCA of composite bamboo shear walls influence of aspect ratio

Supervisor: Dr. Edwin Zea Escamilla

Luis Felipe Lopez (BASE-Bahay)

Sebastian Kaminski (ARUP)

Goal: to determine the effect of the aspect ratio of composite bamboo shear walls on their ultimate lateral load. This thesis involves a field work of around 6 weeks in the Philippines. The student will be hosted by the BASE-Bahay foundation for the field work period (stay expenses covered by BASE). The results of this thesis will contribute to the update of the ISO standards for structural design with bamboo.

Main tasks:

- Define test program and samples
- Carry out experiments (@BASE Innovation center)
- Data analysis
- Life Cycle and cost assessment

Prerequisites: Knowledge on structural design and analysis. Knowledge on timber structures is an advantage

Students: 1



12 – Alternative mix design of poured earth

Taking Sustainable Future Challenge 2024, China as a case study.

Supervisors: Dr. Yi Du (du@ibi.baug.ethz.ch), Prof. Dr. Junjie Li (lijunjie@bjtu.edu.cn) in collaboration with *Beijing Jiaotong University*, China

Goal: Globally, decarbonizing the construction sector yet fulfilling the projected building boom in developing regions is challenging. With a lower carbon footprint and easy and fast processing characteristics, poured earth has the potential to serve as viable construction materials in rapidly developing regions. However, to ensure durability performance in severe areas, hydraulic binders such as cement and lime must be added, which undermines the initial decarbonization motivation of utilizing earth materials. Therefore, the objective of this project is to investigate the viability of utilizing low-carbon bio-stabilizers as a partially cement replacement in the preparation of poured earth that is appropriate for use in the region under investigation.

Main tasks: Screening of bio-stabilizers that are compatible with cement and exploring the mix designs for preparing poured earth based on selected stabilizers and locally excavated soil, as well as assessing the performances regarding mechanical, durability and environmental impact.

Prerequisites: interest in sustainable design and material development

Students: 1



13 – Understanding how the earth materials shrink upon water drying, for poured and 3d printed earth application

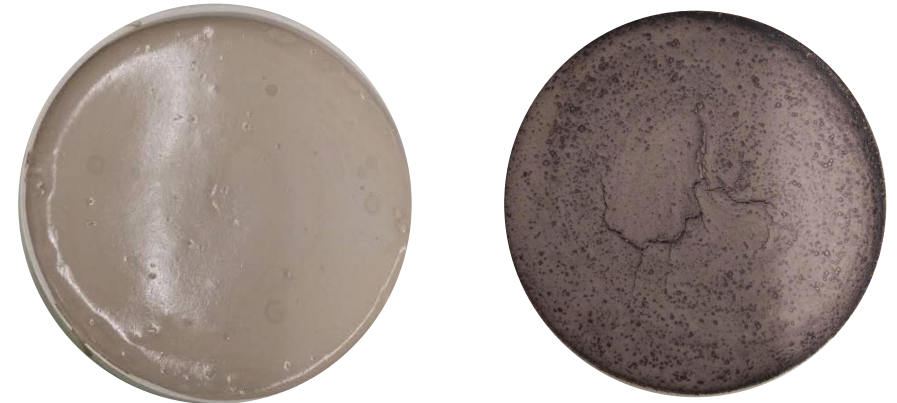
Supervisors: Dr. Yi Du (du@ibi.baug.ethz.ch), Julie Assunção (assuncao@ibi.baug.ethz.ch)

Goal: Earth materials are receiving growing interest nowadays due to their low carbon and infinite recyclability characteristics. However, much progress still has to be made for these materials to become widely accepted and utilized. Unpredictable shrinkage behaviors during the drying process are one of these obstacles, particularly for techniques involving higher water content. Water evaporation induces the clay paste to shrink perpendicularly to the surface of surrounding aggregates, and when the early strength of earth sample is insufficient against the tensile stress, cracks will generate. Therefore, it is imperative to comprehend the mechanisms underlying the shrinking of earth materials along with the water drying, to implement appropriate preventive measures.

Main tasks: Identifying the shrinkage types of earth materials along with the drying process and highlighting the key parameters controlling the shrinking and cracking behaviors.

Prerequisites: interest in Sustainable Materials and lab work

Students: 1



14 – Atlas of regenerative resources: How much, where, when and who?

Supervisor: Shoshana Huber shhuber@ethz.ch; Alia Bengana (EPFL)

Background: In order to build climate neutral buildings in Switzerland, we need to maximize the use of biobased resources. But knowledge about their quantities, their potential use in construction, the existing actors who can implement them and some exemplary buildings that can serve as lighthouse for the future of construction are not clearly registered.

Goal: For one resource (Wood, Straw, Hemp, Reeds, Stone, mycelium, earth..) and for one specific scale (canton, country, continent, World), conduct a systematic study leading in fine to being able to provide clear perspective on amount of resource available (growth potentials), current actors and buildings (and strategies for increasing numbers), performance and standards needed for the various constructive systems done with the materials.

Main Task: Literature review, interviews with actors, visits

Prerequisites: Willingness to help at the creation of an Atlas of regenerative materials

Students: 6

