ETH zürich

Informationsveranstaltung am 18.04.2024, 17:00 Uhr

Master-Arbeiten und Master-Projektarbeiten am IBI

Prof. Dr. G. Habert

Institut für Bau- und Infrastruktur-management

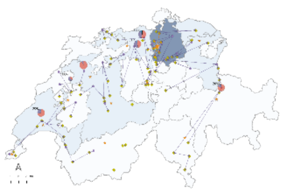
D BAUG

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.

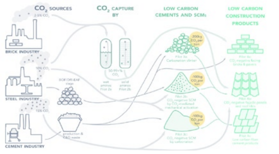
The objective is to identify the relevant parameters that influence the environmental impacts of buildings across spatial and temporal scales in order to implement sustainable practices throughout the development of innovative strategies adapted to each stakeholder.

Topics

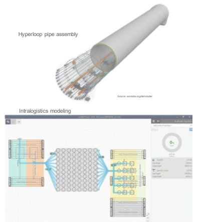
Master project and/or thesis | Master thesis



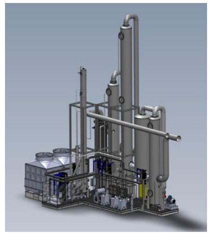
Urban-industrial metabolism within the context of recycling of waste-to-energy residues into construction materials



Estimation of waste streams availability for CO2 mineralization in construction products in Europe

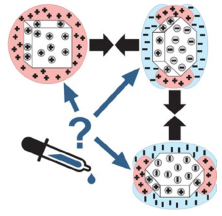


Assess carbon emissions from prefabrication processes thanks to digital twins of factory

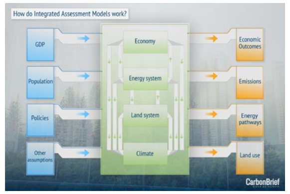


Embodied Carbon of CCUS

Do high-carbon binders reduce the hygrothermal performance of earthen construction?

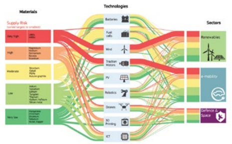


Identifying the dominating sorption sites in Mg-binder stabilized clay based construction materials



Building WLC emissions in IAMs for climate change mitigation

How to model a Global building stock?

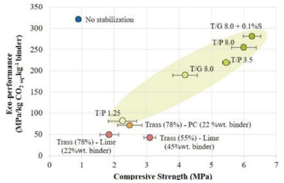


Implications of EU climate policy for urban waste incineration & recycling

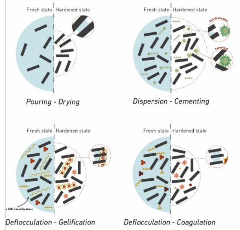
LCA of construction method and material for building project in Zurich

Assessment according to ESGs framework of water pipe maintenance technology

Design for carbonation



Low-tech binder for poured earth stabilization



Poured earth techniques: a systematic performance comparison

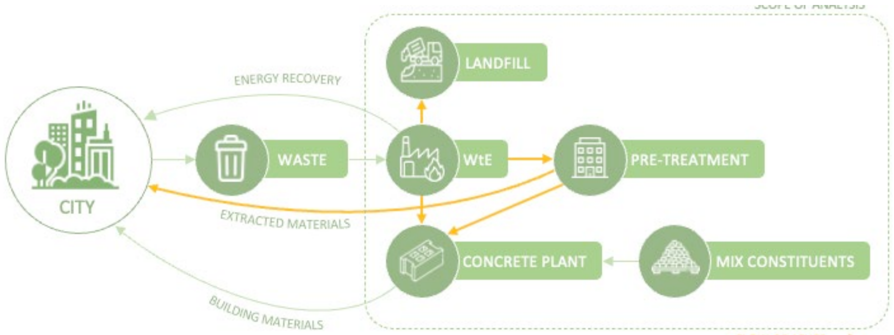
MFA

Supply chain, stakeholders, policies

LCA materials & technologies

Materials Development

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



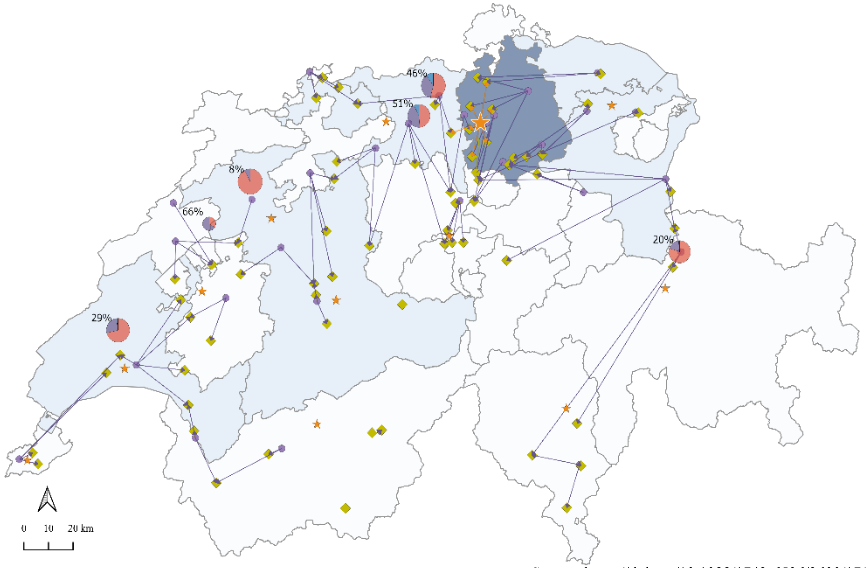
Supervisor: Dr. Anastasija Komkova (komkova@ibi.baug.ethz.ch)

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: Basic skills in one of the programming laguages/softwares: e.g. python, Matlab, R or GAMS. Knowledge of GIS could be useful, but not necessary.

Students: 1



Source: https://doi.org/10.1088/1742-6596/2600/17/172002.

2- Building whole-life carbon emissions in Integrated Assessment Models (IAMs) for climate change mitigation

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

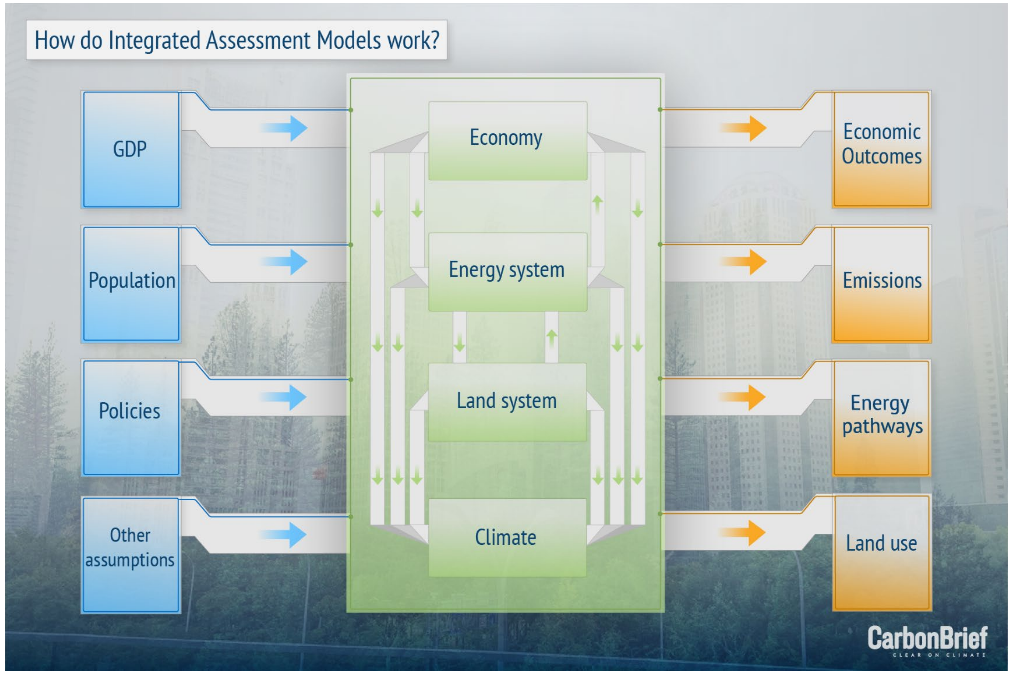
Goal: To understand how Integrated Assessment Models (IAMs), which are used by the Intergovernmental Panel on Climate Change (IPCC) to analyse scenarios for carbon emission and mitigation options at the global scale, model the whole-life carbon emissions of buildings, including the identification of the parameters used to model the evolution of the building stock and corresponding emissions for the different Shared Socioeconomic Pathways (SSPs)

Main tasks:

- Review the documentation of the main IAMs used by the IPCC to identify the parameters used to model the carbon emissions of building-related sectors (buildings and construction materials industry)
- Compile the identified parameters in a systematic way
- Analyse and compare the modelling approach, the underlying premises, and the outcomes of the different IAMs for building-related carbon emissions

Prerequisites: Good analytical skills / Interest in climate change mitigation

Students: 1



Source: CarbonBrief

3- How to model a global building stock?

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

Goal: To understand the existing approaches and methods to model the current global building stock and its evolution, in order to support the estimation of the resource demand and whole-life carbon emissions of buildings.

Main tasks:

- Review technical and scientific works that model the global (and eventually regional) building stock
- Understand what types of buildings are differentiated
- Understand which methods they use (statistical data, GIS, etc.)
- Identify the required data / data sources
- Analyse the methods and draw recommendations for robust and effective global building stock models

Source: Tuca Vieira

Prerequisites: Good analytical skills

Students: 1

4-Estimation of waste streams availability for CO_2 mineralization in construction products in Europe

Supervisors: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)
Nikhil Kunati (kunati@ibi.baug.ethz.ch)

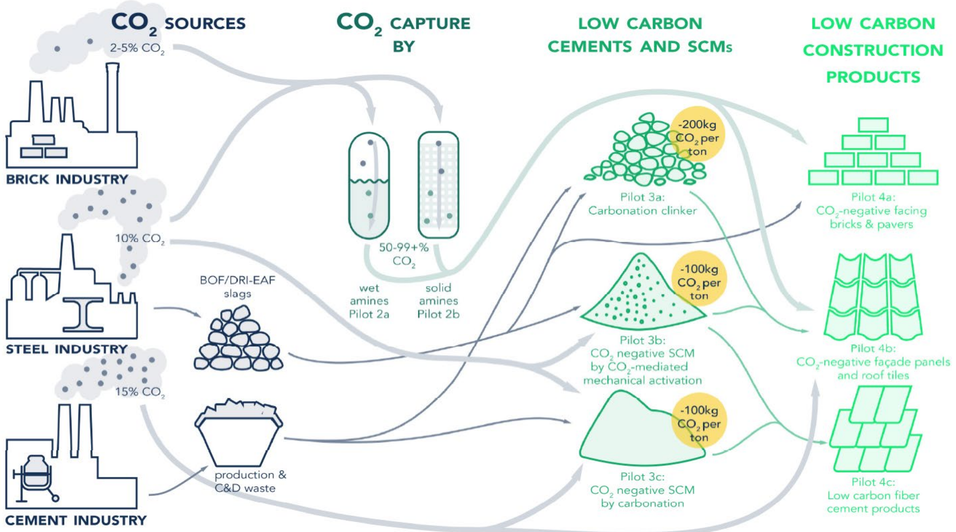
Goal: To estimate the availability and location of various waste streams such as steel slag, CDW fines, fibre cement waste and other relevant sources for CO2 mineralisation through carbonation into construction products

Main tasks:

- Identify waste stream sources in Europe
- Understand the current flow patterns of these waste streams (use/disposal)
- Quantify waste stream availability for carbonation
- Synthetize results in the form of a map

Prerequisites: Basic knowledge about Material Flow Analysis (MFA) / GIS

Students: 1



Source: Carbon4Minerals

5-Implications of European climate policy for urban waste incineration & recycling

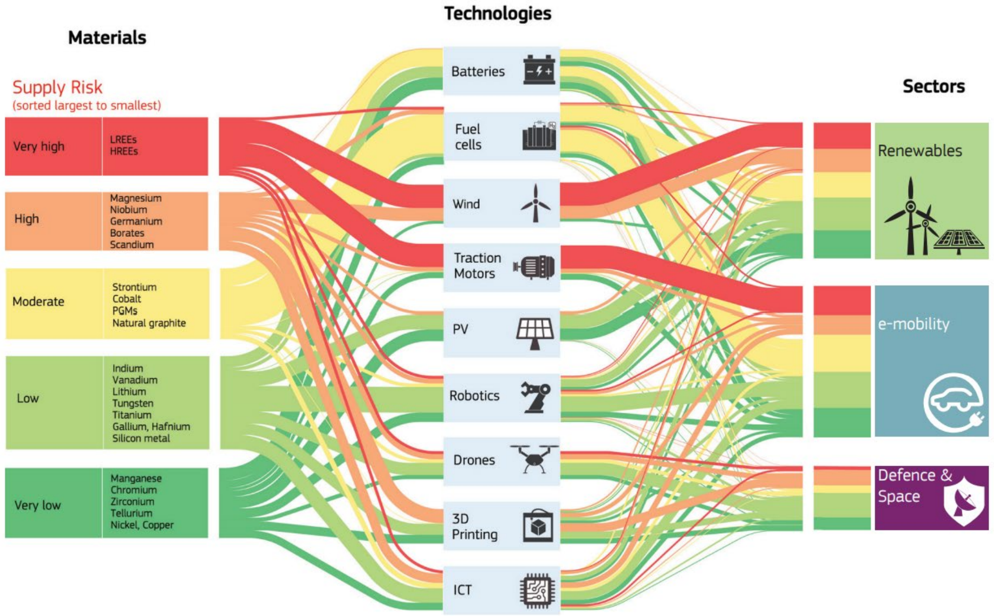
Supervisor: Dr. Anastasija Komkova (komkova@ibi.baug.ethz.ch)

Goal: Identify how European & Swiss 2050 climate targets will affect the municipal solid waste and sewage sludge treatment and incineration practicies. What would be the implications for industrial symbiosis between waste-to-energy (WtE) plants and construction sector that recylces ashes in alternative cement and clay-based construction materials? How extraction of critical raw materials (e.g. P) from ashes can influence such industrial symbioses.

Main tasks: Literature review of policies and legislations. Analysis of material flows between waste producers, WtE, construction sector and agriculture sectors using Eurostat database and national statistics. MFA of current and future scenarios in Europe, considering policy targets.

Prerequisites: Knowledge or interest in material flow analysis.

Students: 1



Source: EC (2020) Critical Raw Materials for Strategic Technologies and Sectors in the EU

Source: https://doi.org/10.1088/1742-6596/2600/17/172002.

6- Assess carbon emissions from prefabrication processes thanks to digital twins of factory

Supervisors:
Jianxiang Ma (ma@ibi.baug.ethz.ch)
Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)

Industrial Partner: EuroTube Foundation

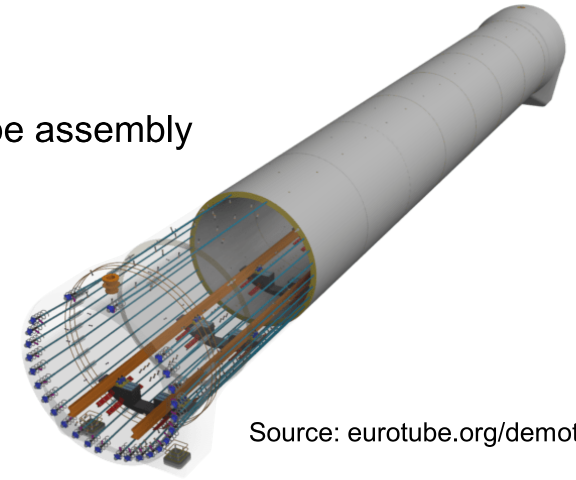
Goal: Evaluate the CO_2 emissions generated during the prefabrication of hyperloop pipes, including an analysis of both **intralogistics** and **manufacturing operations**.

Main tasks:
- Literature review
- LCA modeling of manufacturing operations
- LCA modeling of the intralogistics
- Data analysis for prefabrication processes
- Result interpretation and recommendation for carbon reduction

Prerequisites: Basic knowledge about Life Cycle Assessment

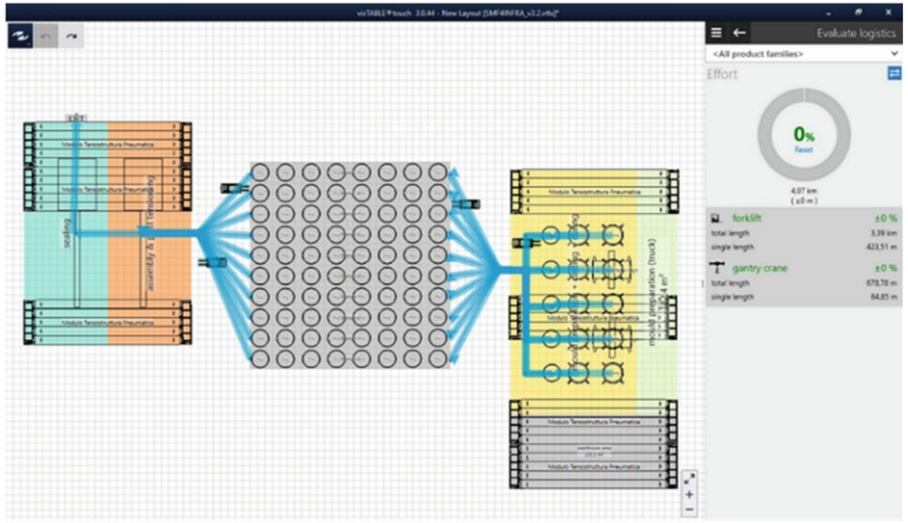
Students: 1

Hyperloop pipe assembly



Source: eurotube.org/demotube/

Intralogistics modeling



Source: www.smf4infra.net/

7- Embodied carbon of carbon capture, storage and use (CCUS) plants

Supervisors: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)
Nikhil Kunati (kunati@ibi.baug.ethz.ch)

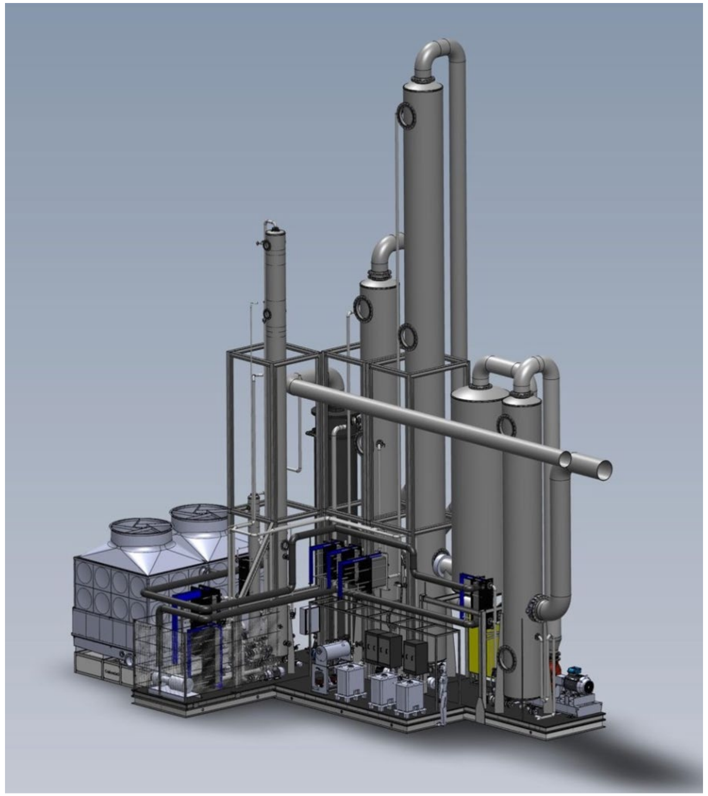
Goal: To estimate the embodied carbon of industrial carbon capture storage and use plants (CCUS) including the equipment and the civil infrastructure, and calculate the time of operation required for the CCUS plant to offset its own CO2 emissions.

Main tasks:

- Compile information about CCUS plants for liquid amines and/or solid zeolite-based carbon capture of large point sources
- Develop LCA model for CCUS plant
- Perform LCA to estimate the embodied carbon of CCUS plant
- Analyse the results and estimate the time of operation for the CCUS plant to offset its own emissions

Prerequisites: Basic knowledge about Life Cycle Assessment / Interest in Carbon Capture and Storage technologies

Students: 1



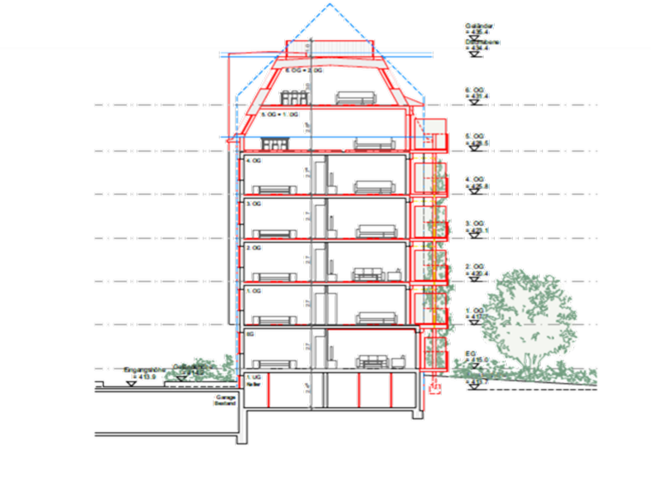
Source: CarbonOro

8-Life Cycle Analysis of Construction Methods and Materials for a building project in Zurich

Supervisors: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)
Dr. Verena Göswein (goeswein@ibi.baug.ethz.ch)

Industrial Partner: FREO
Project: Design stage starting September 2024, this project focuses on two Zurich properties within a Swiss bank's portfolio.

Goal: This Master project involves guiding the design phase of two residential building projects in Zurich: one involving deep refurbishment and floor additions, the other entailing demolition and reconstruction. The project aims to quantify embodied and operational emissions across various scenarios, including technical building systems (e.g., mechanical vs. natural ventilation), material selection (e.g., bio-based vs. conventional), and circularity measures (e.g., reuse/recycling of deconstructed elements). The findings will directly inform the construction definitions, offering students practical insights into environmental impact assessment within real construction projects.



Main tasks: Compile and organize data, develop an LCA model, conduct LCA, interpret results, and provide recommendations aligned with the targets outlined in the new SIA 390/1 "Klimapfad - Treibhausgas- und Energiebilanz von Gebäuden.".

Prerequisites: Basic LCA knowledge and willingness to learn LCA software.
Students: This is a groupwork for 2 students.

9-Assessment according to ESGs framework of water pipe maintenance technology (Dipan)

Supervisors: Prof. Guillaume Habert (habert@ibi.baug.ethz.ch)

Industrial Partner: Dipan

Project: Dipan is a company specializing in anti-corrosive treatments and maintenance of sanitary water, heating, sprinkler and cooling networks in the real estate sector. Many buildings in Switzerland are experiencing problems of deterioration of water distribution pipes, linked to the development of corrosion (crevice corrosion for galvanized steel pipes, pitting corrosion for copper pipes). To prevent these pipes from deteriorating, Dipan offers three-step treatments (chemical cleaning of pipes; creation of a protective sodium silicate film inside the pipes; maintaining this film by injecting a low concentration of this product (which is consumable) into the domestic water supply).

Goal: Dipan's clientele consists mainly of institutional clients representing real estate funds, some of which are listed on the stock exchange. As investors are becoming increasingly aware of sustainability issues, indicators have been introduced, such as ESG and energy indicators for real estate funds. For the purposes of this study, we would like to compare three options available to our clients for ESG scores and the environmental indicator,

- Do nothing and let the deterioration of sanitary water systems continue
- Benefit from Dipan treatments and maintenance
- Carry out a renovation

Main tasks: Understand ESG calculation, adapt it for water treatment questions. Compile and organize data from DIPAN. Calculate ESG + LCA results

Prerequisites: Basic LCA knowledge and willingness to learn ESGs

Students: This is a individual work.

10-Design for carbonation

Supervisors: Prof. Guillaume Habert (habert@ibi.baug.ethz.ch)
Dr.Tim Wangler (wangler@ifb.baug.ethz.ch)

Project: 3d Printing is often pushed forward as the new solution. However, it usually brings more cement per cubic meter of concrete leading to actually higher emission. In this project we want to explore how 3DP technology can be used to effectively reduce the emission, concentrating on the unique possibility of fast carbonation due to high exposed surface.

Goal: Model accurately the contribution to climate change a concrete structure is creating when looking at the cement carbonation speed. This can allow to define proper design that would release as less CO2 during production and recapture as fast as possible during life time, minimizing the footprint the carbon structure have on the environment.

Main tasks: Perform LCA once discussing with material expert responsible of the construction and carbonation measure from Tor Alva. Conduct advanced dynamic LCA

Prerequisites: Basic LCA knowledge and willingness to dive into advanced LCA methods. Knowledge of carbonation and concrete technology.

Students: 1

11- Do high-carbon binders reduce the hygrothermal performance of earthen construction?

Supervisors: Dr. Magda Posani (mposani@ethz.ch) / Dr. Rathod Ramawat (sramawat@ethz.ch) and Dr. Yi Du (du@ibi.baug.ethz.ch), Dr. Coralie Brumaud (brumaudc@ethz.ch)

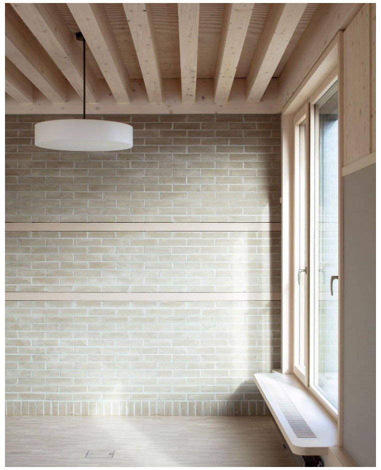
Industrial Partner: TERRABLOC

Goal: Compressed Earth Blocks (CEBs) are becoming increasingly popular due to their significant advantages: they have a low environmental impact and can passively enhance indoor comfort for occupants. However, upon closer examination, the CEBs currently available in the market may not be as environmentally sustainable or effective at ensuring users' comfort as believed. Indeed, to meet the construction industry's requirements for mechanical performance and durability, manufacturers often incorporate carbon-intensive binders into the mix, typically cement. This addition can substantially increase the material's carbon footprint and it is believed to diminish its ability to regulate indoor comfort. There is an urgent need for experimental studies to determine whether the latter concern is valid and to assess its significance relative to the type of binder used. Furthermore, the effect of bio-aggregates addition can be considered for the purpose of maximizing the hygrothermal performance of the material.

Main tasks: Hygrothermal characterization of compressed earth blocks with no stabiliser, cement stabiliser, and an alternative stabiliser. Bio-based aggregate addition can be also considered. Additional tests to clarify the reasoning behind the effect of different binders/bio-aggregates on the hygrothermal behaviour of the earthen product.

Prerequisites: Interest in building materials, sustainable construction, and laboratory work

Students: 2



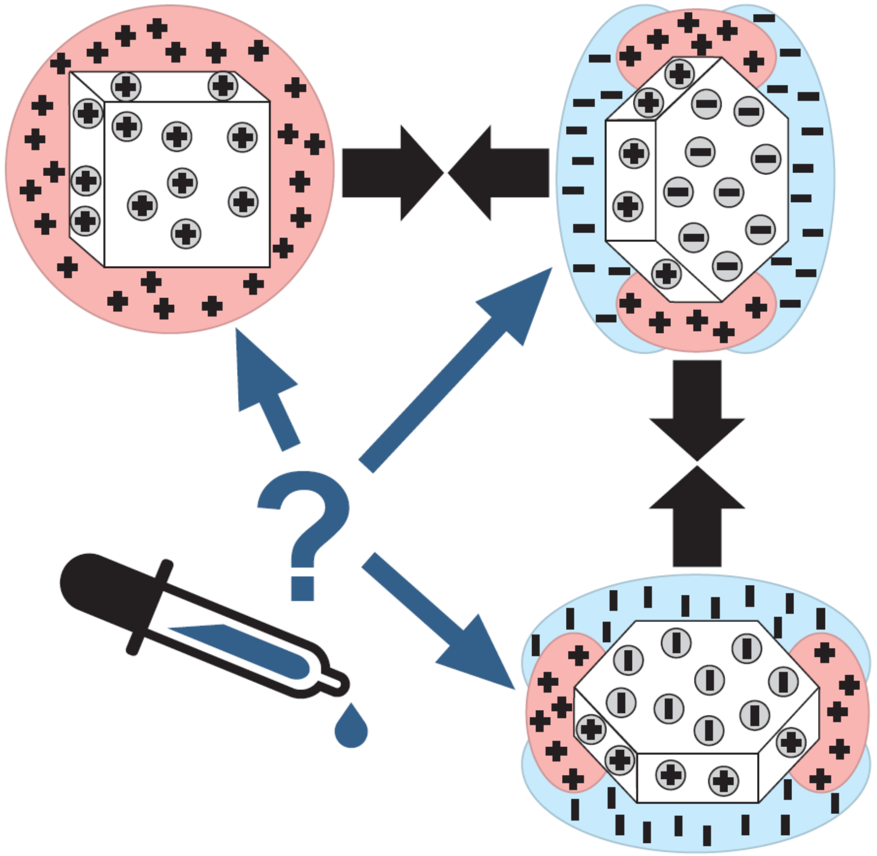
12- Identifying the dominating sorption sites in Mg-binder stabilized clay based construction materials

Supervisors: Raphael Kuhn (raphael.kuhn@empa.ch), Dr. Yi Du (du@ibi.baug.ethz.ch)
Lab work at ETH and Empa (Swiss Federal Laboratories for Materials Science and Technology, Dübendorf)

Goal: Growing attention is being directed towards earthen materials due to their sustainable characteristics. To broaden the scope of earthen construction materials, research is exploring sustainable stabilization methods using Mg-based binders to strengthen its resilience. A critical aspect is enhancing the limiting rheology, achieved through various superplasticizers. However, it remains unclear how and where these superplasticizers operate in suspensions of clay minerals with Mg-binders, and what other factors counteract coagulation. Understanding the mechanisms of these agents is crucial for designing effective building material. The goal is to leverage insights gained from this research to further the application and dissemination of earthen materials.

Main tasks: Identification of how superplasticizers disperse and affect the properties of clay minerals stabilized with Mg-cement and which factors are influenced. Lab work with BET, ICP-OES, pH electrode, zeta probe and rheometer.

Prerequisites: Interest in material development and lab work
Students: 1



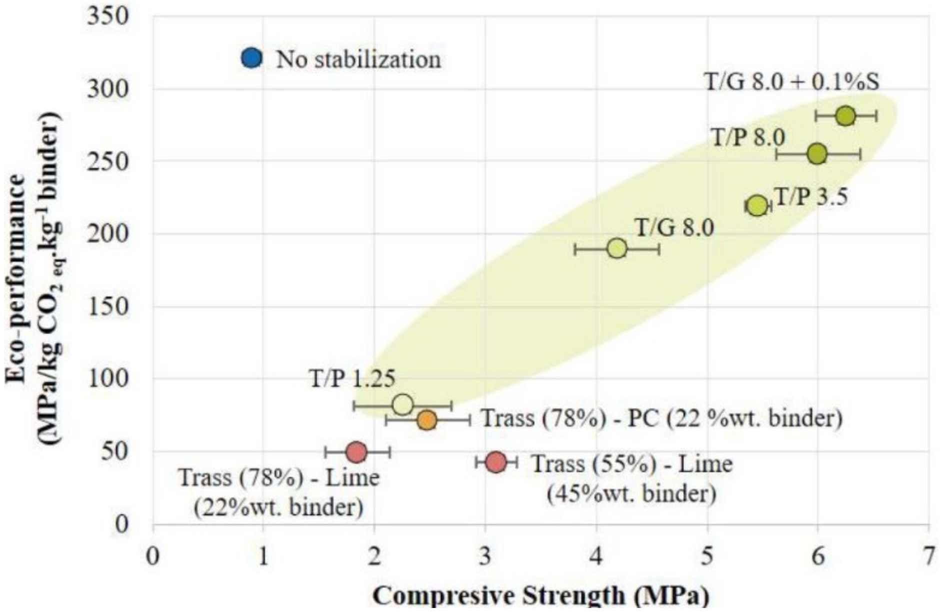
13- Low-tech binder for poured earth stabilization

Supervisors: Julie Assuncao (assuncao@ibi.baug.ethz.ch),
Dr. Coralie Brumaud (brumaud@ibi.baug.ethz.ch)

Goal: Earth is a building resource with many advantages. It is available everywhere, it has the best recycling potential, and its transformation into building material releases low CO2 emission. Despite numerous advantages, this building material presents many weaknesses that limit its use in some conditions. To overcome these difficulties, a mineral (hydraulic) stabilizer such as lime or cement is commonly added to enhance the performances of earth-based materials. However, this method is under debate regarding its environmental impact and recycling potential. Eco-friendly alternative solutions need to be addressed. The aim of this work will be to investigate the use of vernacular CSA binder as stabilizer in the specific case of poured earth application, a recent technique allowing casting earth as concrete via the use of additives.

Main tasks: Poured earth with previously developed alternative binder and dispersant will be prepared and tested. Fresh state properties (rheology) and hardened state properties (strength, setting time, etc) of the different samples will be studied to highlight the influence of additives on stabilized poured earth performances.

Prerequisites: Interest in material development, sustainable materials and lab work
Students: 1



N. Pires Martins et al., Beyond efficiency: Engineering a sustainable low-tech cementitious binder for earth- based construction, CCR, 2022

14- Poured earth techniques: a systematic performance comparison

Supervisors: Daria Ardant (ardant@ibi.baug.ethz.ch),
Dr. Coralie Brumaud (brumaud@ibi.baug.ethz.ch), Dr. Yi Du (du@ibi.baug.ethz.ch)

Goal: Poured earth is a promising technique to develop earth constructions in an urban context. Several techniques were developed over the last decades to get a better control on the rheological behavior of the material, and make possible its hardening in hermetical formwork. However, even if data exist on each poured earth technique, the use of different clay or earth as primal material make impossible the comparison of the techniques. Moreover, some properties that could be relevant for poured earth application are still missing, reducing its possible advantage in use when compared to conventional materials.

Main tasks: Different poured earth techniques will be prepared with the same earth to reduce external variables. The properties of the different samples at fresh state (flowability) and hardened state (hygrothermal properties, strength, shrinkage) will be studied and compared.

Prerequisites: Interest in material development, sustainable materials and lab work
Students: 2