

AI and Concrete: an Idea Whose Time Has Come

ACI Fall Summit 2023

Presented by:

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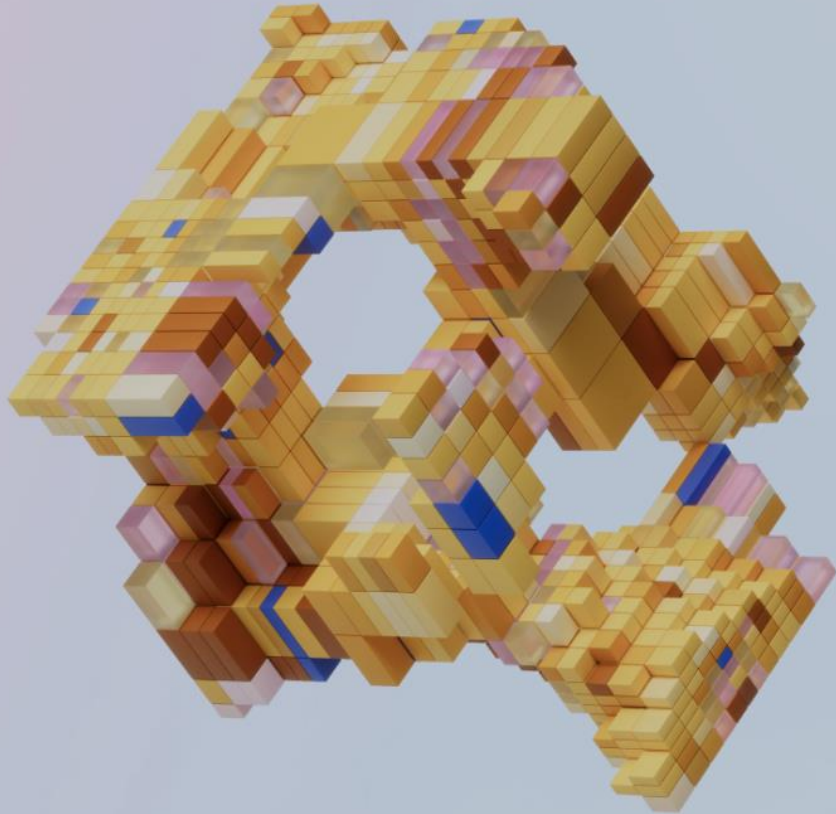
Meta Platforms, Inc



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



AI for Sustainable (Data Center) Concrete



Novel concrete formulas are needed to meet new challenges – **Sustainability, Speed, Reliability, novel materials** – AI can accelerate the discovery process



In our data centers

#1 source of CO2 emissions in data center construction

Concrete is about 30% of a data center's embodied carbon footprint (cradle to grave)

(* based on estimates from 2022)

AI for Sustainable (Data Center) Concrete

STRENGTH



In the world

8% of global human-caused carbon emission

If the concrete industry were a country:
#3 in the world behind China and USA

COST



In our data centers

#1 source of CO2 emissions in data center construction

Concrete is about 30% of a data center's embodied carbon footprint (cradle to grave)

(* based on estimates from 2022)

SPEED



Potential AI Impact

Predict, Accelerate, Discover & Optimize

Concrete performance under regional and operational constraints

KPIs: Sustainability, Speed, Cost, Strength

SUSTAINABILITY



Novel concrete formulas are needed to meet new challenges – **Sustainability, Speed, Reliability, novel materials** – AI can accelerate the discovery process and simultaneously optimize for all key metrics

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Work that has been done so far

AI

Leverage work at Meta and UIUC to develop AI for concrete: strength curve prediction, active learning, Pareto front computation

Pilot @DKL

Tested chosen formulas in non-critical applications at DKL in spring 2021, achieved 40% lower CO₂ than regional baseline

At-scale @DKL

Poured 70k cubic yards, avoided 15k tons CO₂, achieved 20% lower CO₂ than regional baseline

2023+

AI-in-the-loop
AI for cold temps & new materials
Open source

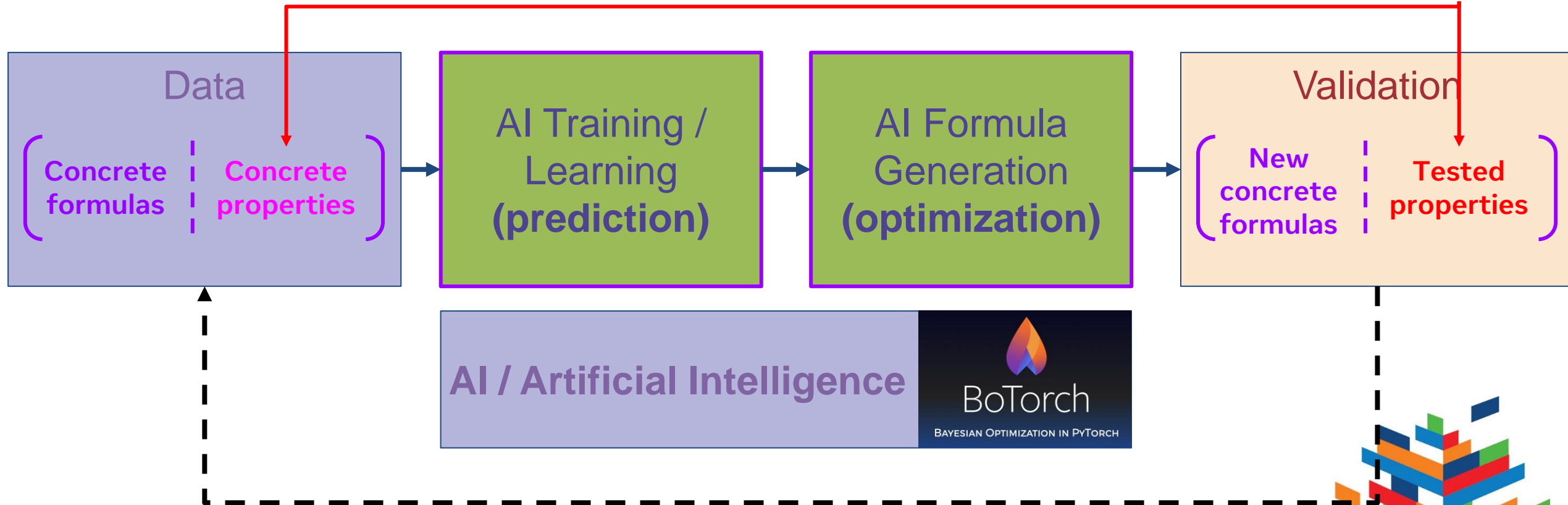


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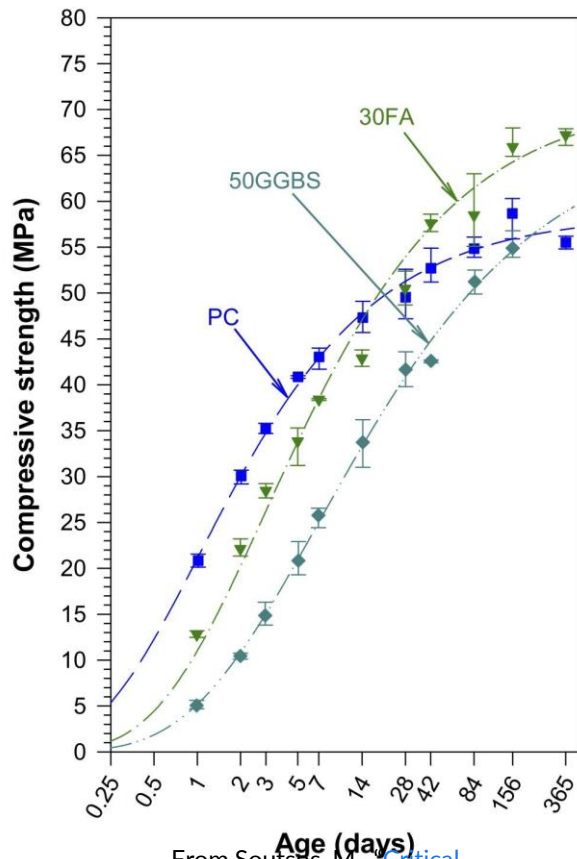
AI-in-the-loop concept accelerates AI training, development and discovery of high-performing sustainable concrete formulas using Active Learning

*(Lab)
testing and
validation
methods*



New data is added into the database after validation

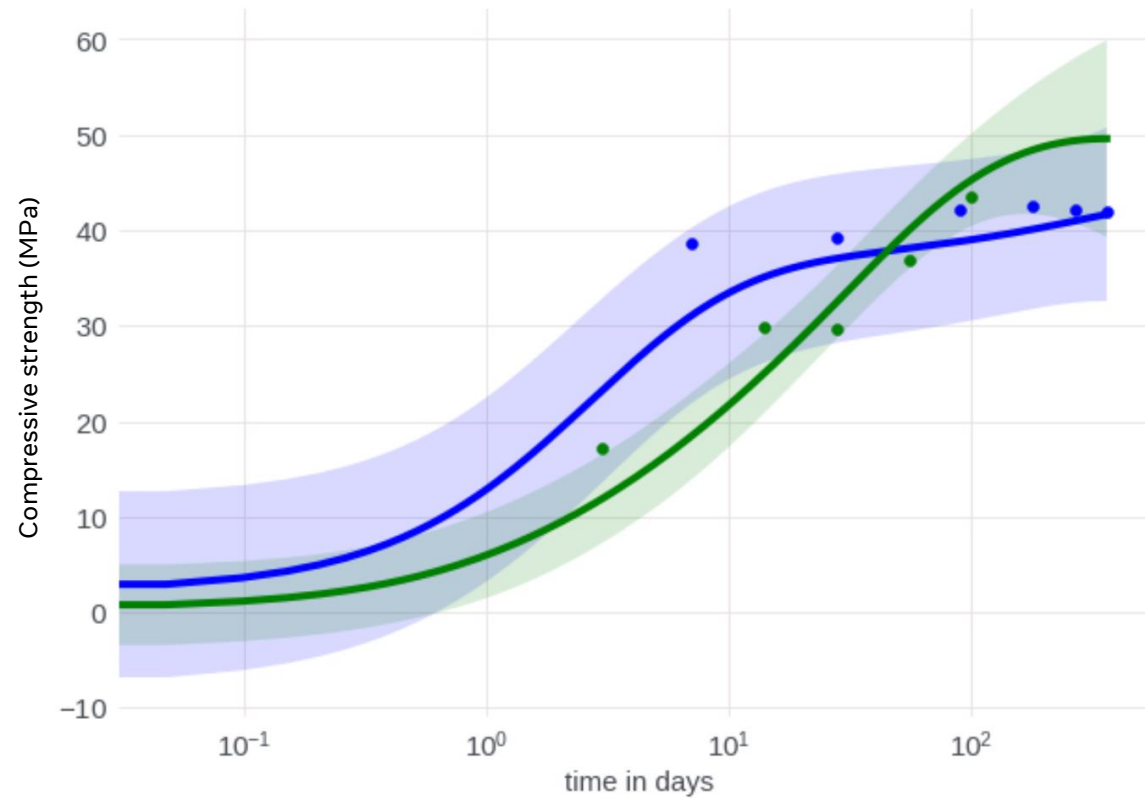
AI for concrete formulas



From Soutsos, M., [Critical analysis of strength estimates from maturity functions](#), Case Stud. Constr. Mater. (2018)

Meta AI prediction output:

- Blue: “conventional” concrete
- Green: “low-carbon” concrete with 20% SCM replacement
- None of the points were seen by the model during its training
- A single output of the model is an entire strength curve (composition -> curve)

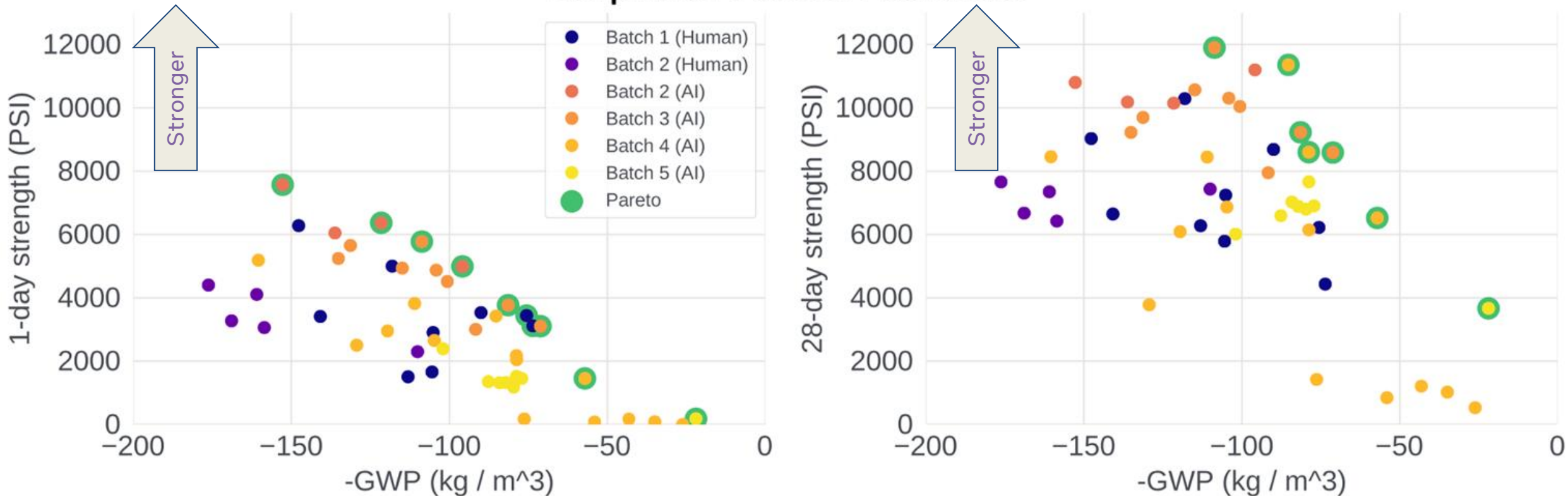


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aci CONCRETE CONVENTION

AI for concrete formulas

Empirical Pareto Frontiers



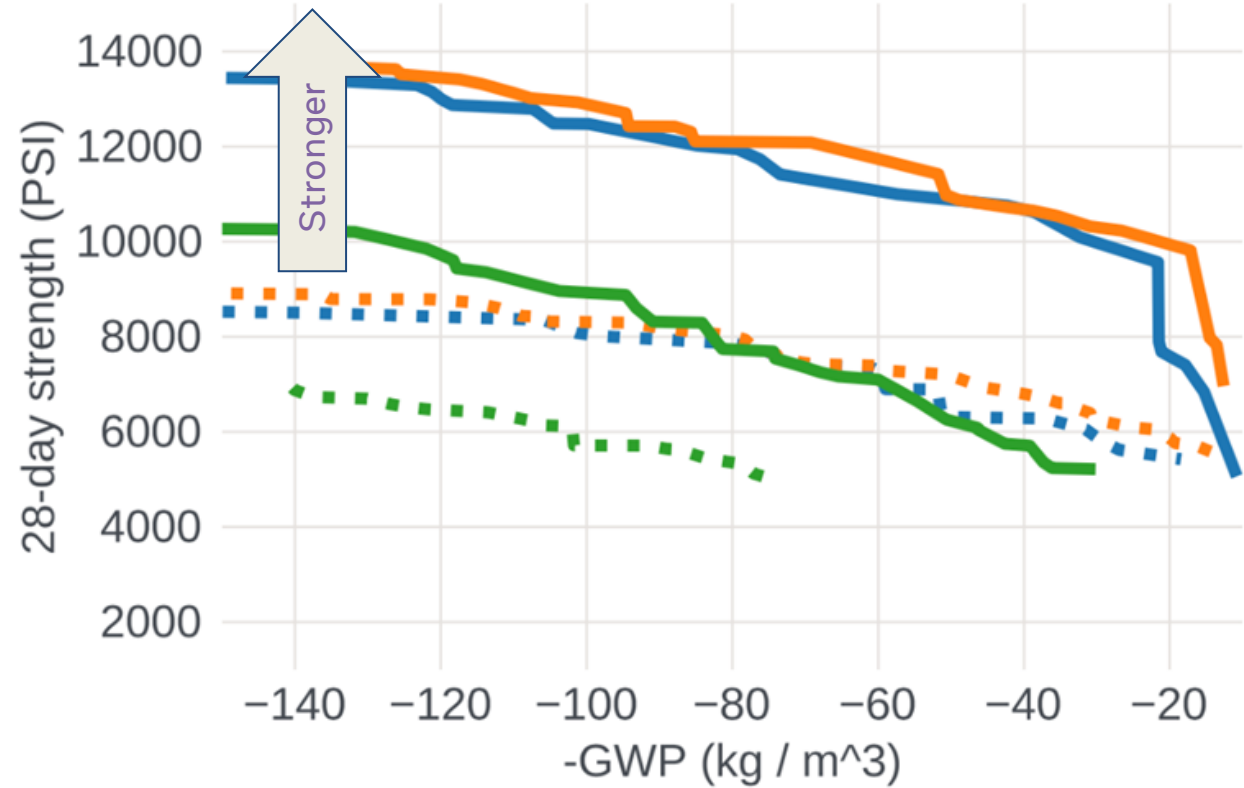
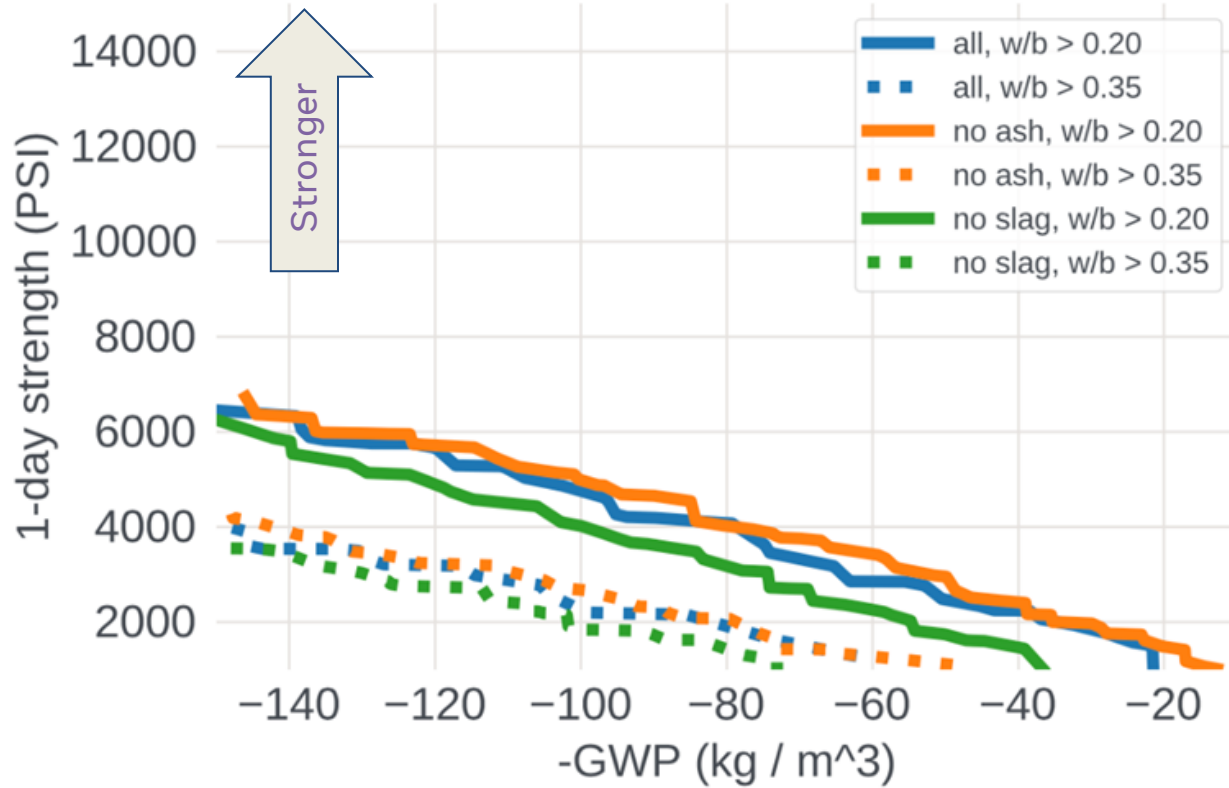
AI helps accelerate the discovery of better formulas – Meta’s **Active Learning** is developed to find the optimal trade-off between Learning and Optimization

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AI for concrete formulas

Predicted Pareto Frontiers



More sustainable

AI can learn regional, operational, supply-chain constraints and derive the achievable design space

More sustainable

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How to scale the impact?

WHAT IF

AI is made accessible

- Basic source code
- Basic reference formulas w/ strength curves
- Regionalized examples

AI is integrated into design & construction workflow

- Accelerate discovery & testing of novel materials & formulas
- Optimize for sustainability, speed, cost, strength
- Understand the opportunity space in design
- Margins against environmental & operational conditions

AI & Data go hand-in-hand

Access to data is an important consideration

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AI, Sustainability & Data Centers = Avenue for Impactful Innovation

- Better algorithms
- Better data

More sustainable Data Centers

<https://tech.fb.com/engineering/2022/04/sustainable-concrete/>

<https://github.com/facebookresearch/SustainableConcrete/>

<https://arxiv.org/pdf/2310.18288.pdf>



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