UC San Diego
JACOBS SCHOOL OF ENGINEERING

3D Printed Modular and Reusable Formwork for Precast Concrete: Proof-of-Concept

Rhowen Frakt, Georgios Tsampras, Kaixin Chen

GEAR Presentation | August 29, 2025

idea engineering student center

GEAR
Guided Engineering Apprenticeship in Research
IDEA Engineering Student Center

Concrete Construction: State-of-the-Practice

Concrete is the most used construction material

Concrete formwork accounts for more than half of the necessary materials on a construction site and up to 80% of costs[4]

Formwork is traditionally constructed with steel or wood

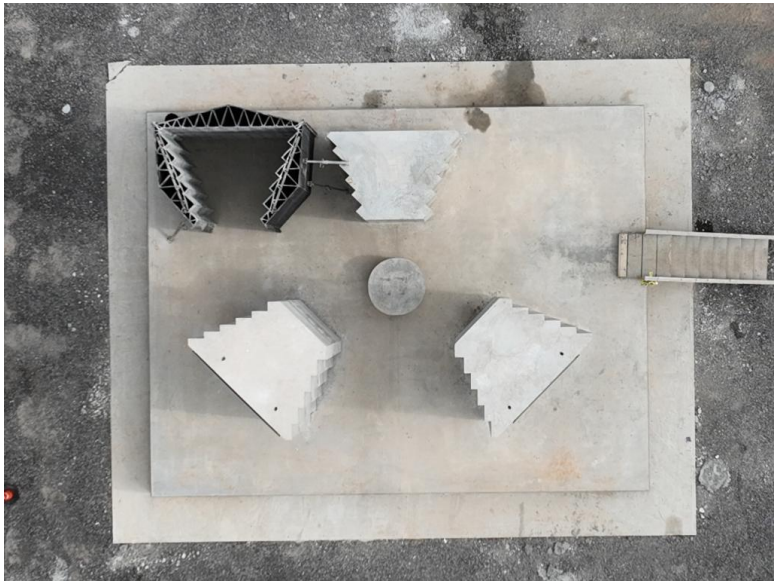




Additive Manufactured Formwork

Additive Manufactured formwork is:

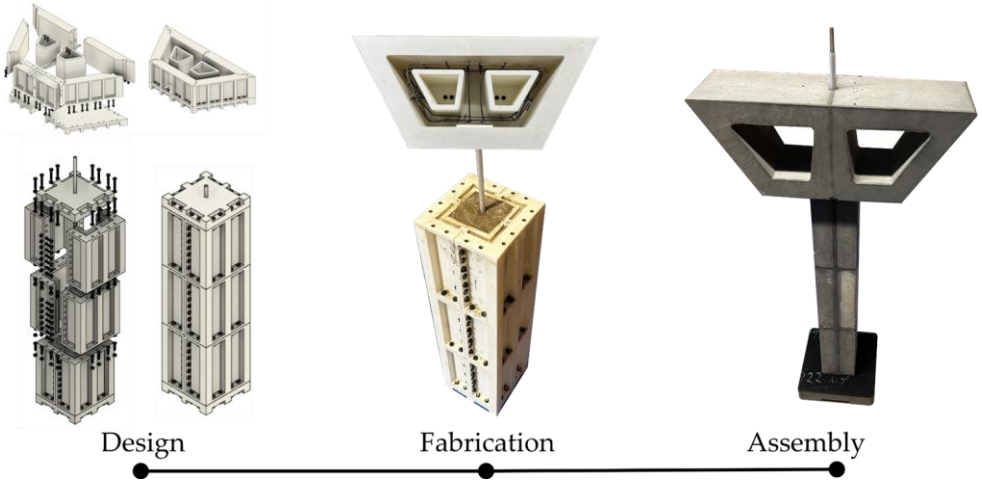
1. Cheaper
2. Reusable[3]
3. Lighter
4. Requires less labor
5. Has geometrical freedom



Dehoff, Ryan, and Ahmed Hassen. “3D Printing Reshapes Construction for Nuclear Energy.” *ORNL*, 23 July 2025

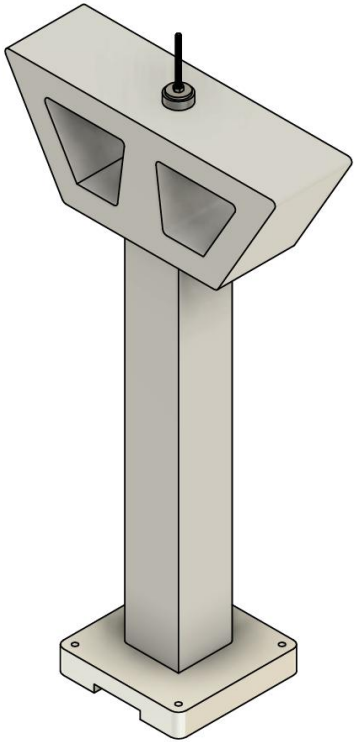
Objective

Experiment with the idea of additive formwork for the precast components of a small-scale bridge-pier assembly

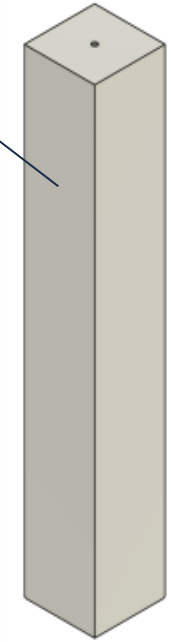


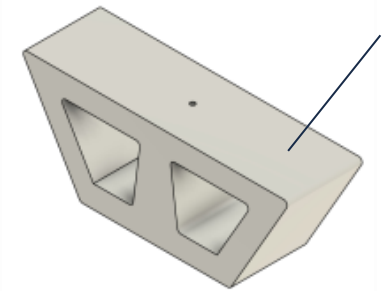


Design (pt. 1)

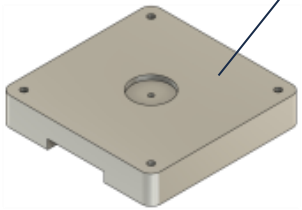


reinforced concrete column-pier



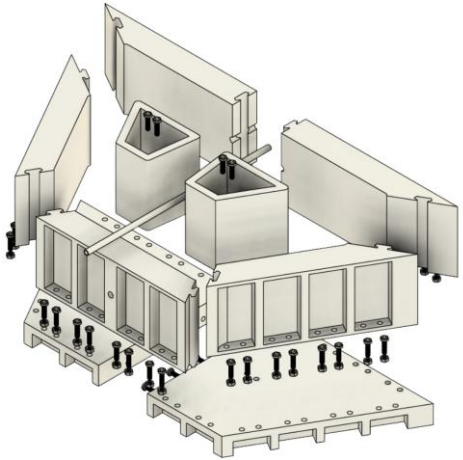


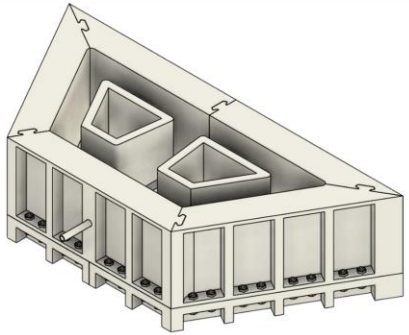
reinforced concrete box-girder



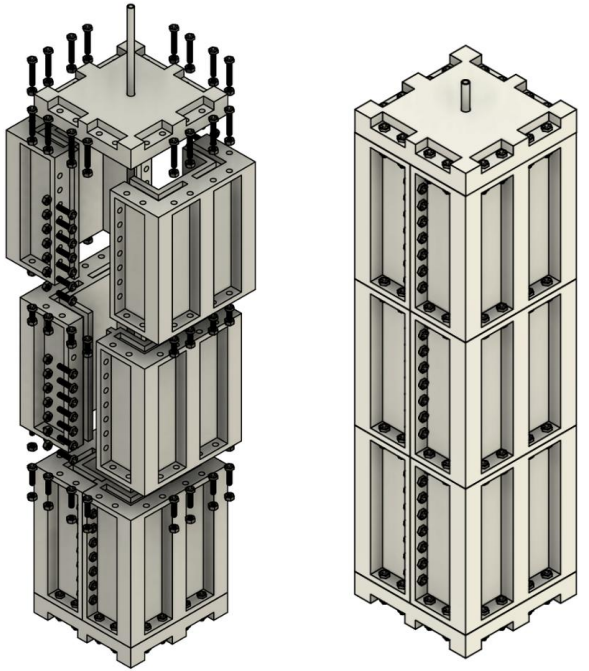
steel adapter plate

Design (pt. 2)





3D printed formwork
for box-girder

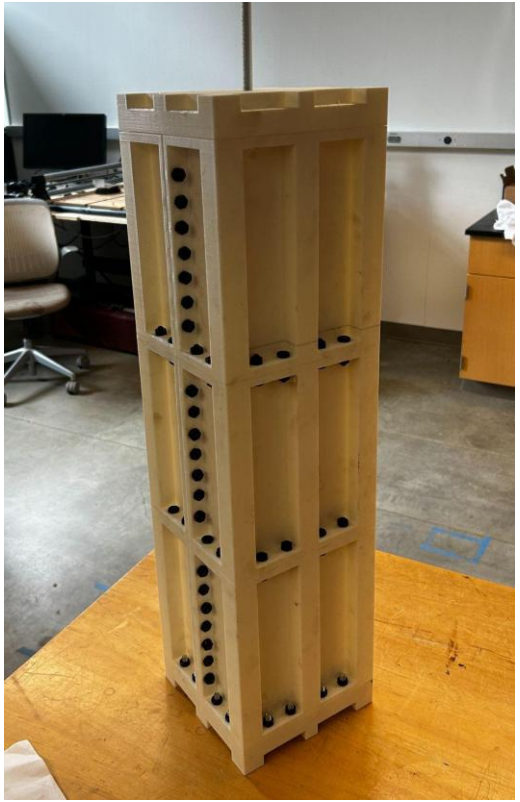


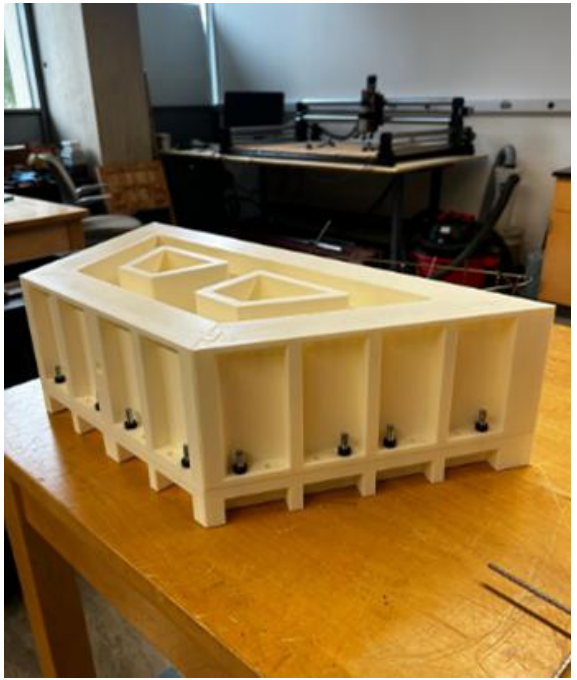
3D printed formwork
for column-pier

Fabrication

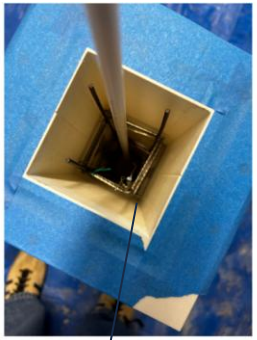
- PLA plastic
- 2 wall loops
- 15% grid infill perpendicular to walls
- random seam positions
- organic supports







Casting



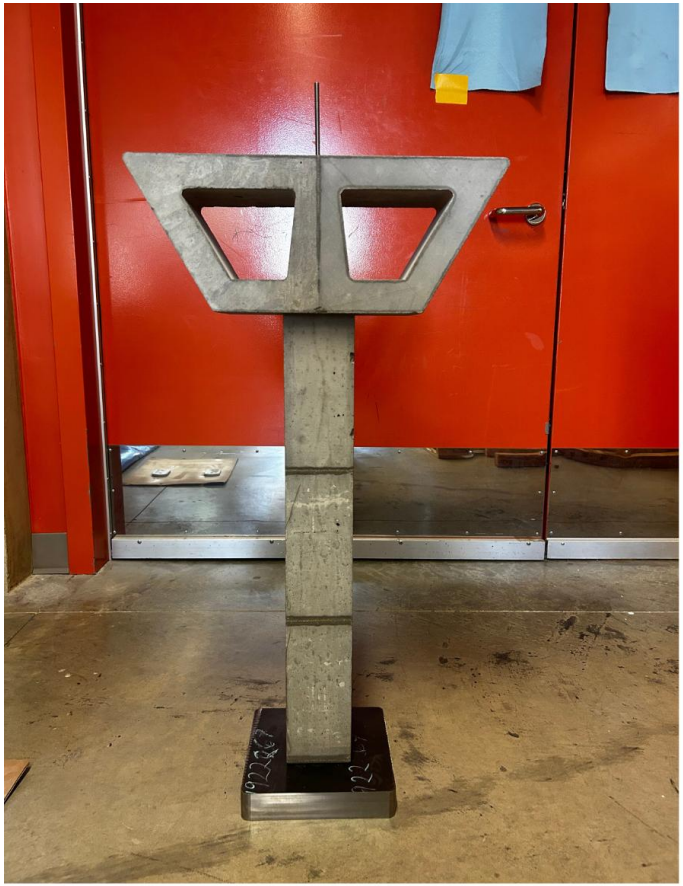



steel reinforcement

grout



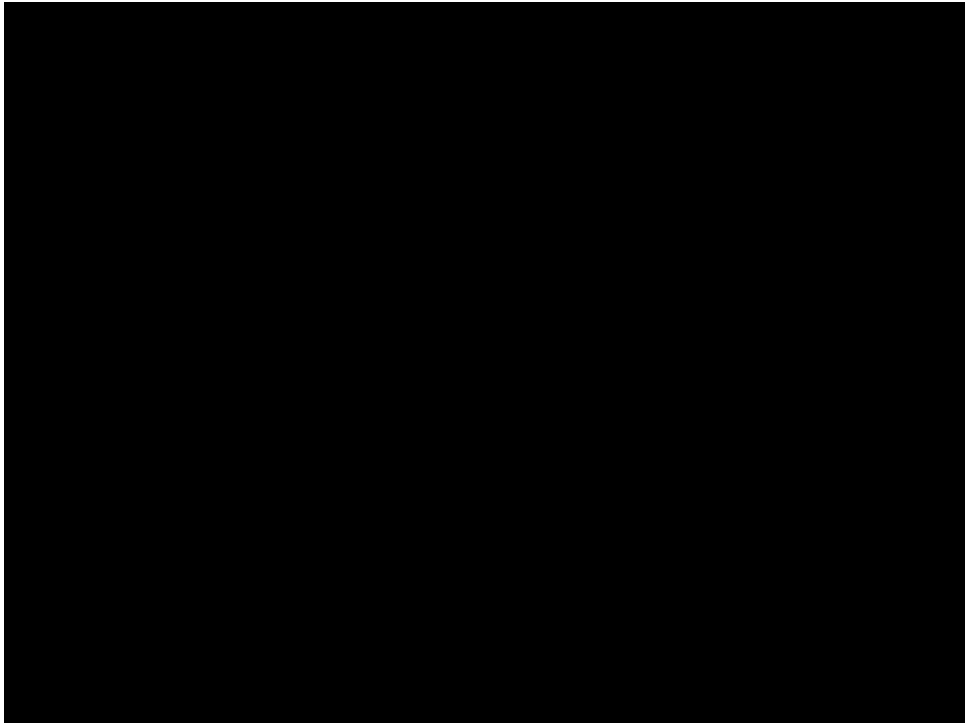






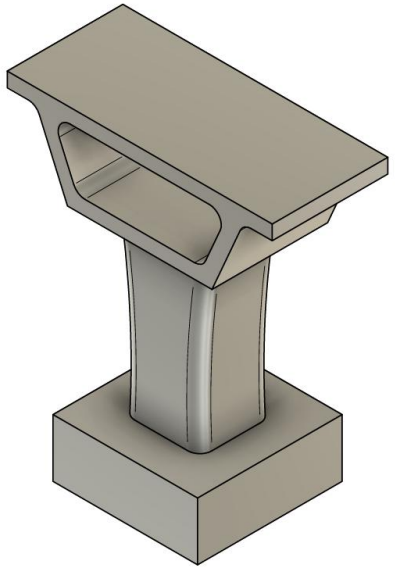


Future Work



4 meter tall bridge pier assembly

Material coupon testing for stress limits



GEAR
Guided Engineering Apprenticeship in Research
IDEA Engineering Student Center

idea engineering student center

UC San Diego
JACOBS SCHOOL OF ENGINEERING

Thank you!



GENERAL ATOMICS
AERONAUTICAL

References

[1] Diana E. Hun. Guide on 3-D Printed Molds for Precast Concrete. Chicago, Illinois] : [Oak Ridge, Tennessee: Precast/Prestressed Concrete Institute ; Oak Ridge National Laboratory, 2020.
[2] Joris Burger, Ena Lloret-Fritschi, Marc Akermann, Daniel Schwendemann, Fabio Gramazio, and Matthias Kohler. “Circular Formwork: Recycling of 3D Printed Thermoplastic Formwork for Concrete”. In: Technology—Architecture + Design 7.2 (July 3, 2023), pp. 204–215. issn:2475-1448. doi: 10.1080/24751448.2023.2245724. https://doi.org/10.1080/24751448.2023.2245724 (visited on 08/06/2025).
[3] Katie Schweizer, Sunil Bhandari, Roberto A. Lopez-Anido, Matthew Korey, and Halil Tekinalp. “Recycling Large-Format 3D Printed Polymer Composite Formworks Used for Casting Precast Concrete – Technical Feasibility and Challenges”. In: Journal of Composites for Construction 28.6 (Dec. 1, 2024), p. 04024061. doi: 10.1061/JCCOF2.CCENG-4758. https://ascelibrary.org/doi/10.1061/JCCOF2.CCENG-4758 (visited on 08/06/2025)
[4] Jipa, Andrei, and Benjamin Dillenburger. 3D Printed Formwork for Concrete: State-of-the-Art, Opportunities, Challenges, and Applications | 3D Printing and Additive Manufacturing, 11 Apr. 2022, www.liebertpub.com/doi/full/10.1089/3dp.2021.0024.
[5] Dehoff, Ryan, and Ahmed Hassen. “3D Printing Reshapes Construction for Nuclear Energy.” *ORNL*, 23 July 2025, www.ornl.gov/news/3d-printing-reshapes-construction-nuclear-energy.