

# TEAM 97

## PORTABLE BLOCK MANUFACTURING CONCRETE MACHINE

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### ELEVATOR PITCH

We are revolutionizing the construction industry by enabling on-site concrete production with CO<sub>2</sub> injection. Our machine reduces transportation inefficiencies, minimizes carbon emissions, and ensures cost-effective solutions for small to medium-sized projects. Join us in transforming construction practices into a sustainable future

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### CONSTRAINTS

1. The CO<sub>2</sub> storage system must withstand 50 bar pressure (CHE).
2. 90% components must be locally machinable with  $\geq \pm 0.5$  mm tolerance, using conventional processes and off-the-shelf steel, aluminum, or polymer (ISE).
3. Operating temperature range: -10°C to 50°C (ME).
4. Coarse aggregate sizes are 4.75 mm and 12.5 mm (CE).

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### PROTOTYPE DESIGN

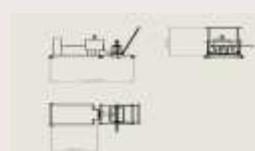
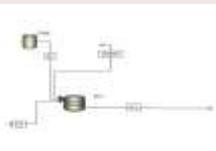
The system aims to produce concrete blocks on-site using a portable machine, enhancing construction efficiency and reducing transportation emissions. It incorporates CO<sub>2</sub> injection into the mix, improving strength and sustainability by sequestering carbon. A built-in mixer, controlled by optimization algorithms, ensures consistent quality. If environmental conditions are ideal, the system operates at full capacity with a targeted slump range. If outside limits, adjustments are made to water or CO<sub>2</sub> input to maintain performance. The lightweight design enables quick setup and high mobility, making it suitable for remote and urban projects alike.

CAD Design



ASPEN PLUS Design

2D Drawing



### PROJECT IMPACT

#### Economic:

The project reduces material costs by optimizing resource utilization and minimizing waste while increasing productivity through an automated block production cycle. It also qualifies for potential carbon credits and government incentives, lowers transportation and labor costs, and provides an affordable, eco-friendly alternative for small and mid-sized construction businesses.

#### Societal:

By promoting sustainable construction practices, the project encourages the adoption of low carbon building materials, improving air quality and public health. Its ease of use and portability make it accessible to small contractors and community-led construction projects, supporting economic growth and environmental awareness in both urban and rural areas.

#### Environmental:

The project prevents CO<sub>2</sub> emissions by sequestering carbon into concrete, ensuring zero leakage into the atmosphere. It also reduces cement consumption, which helps lower overall greenhouse gas emissions, and minimizes its environmental footprint through efficient material use and portable design.

### PROBLEM STATEMENT

Traditional production methods for concrete blocks depend on centralized production on a large scale, demanding heavy machinery, energy consumption, and extensive transportation networks. Therefore, costs incurred, carbon emissions, and logistical issues become great problems for small projects or construction projects that are far away. Conventional curing processes are time-intensive and unsustainable.

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### TARGET SPECIFICATIONS

1. Mold dimensional tolerance  $\pm 1.5$  mm (ME).
2. Structural frame support: Must handle  $\geq 200$  kg dynamic load (ME).
3. Reduce shrinkage and creep strains by at least 5% (ISE).
4. Nozzle performance: steel nozzle must deliver 0.3 kg/s flow with  $< 0.05$  bar pressure drop (CHE).
5. The slump is between 75 mm to 100 mm (CE).

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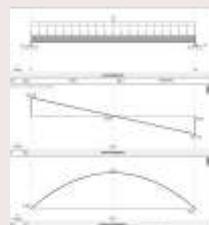
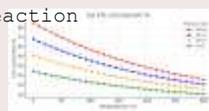
### VALIDATION & TESTING

#### Gas vs. Liquid CO<sub>2</sub> Injection Summary:

Injecting 0.30 g of CO<sub>2</sub> in gas form at 25 °C achieved higher conversion (0.19 g, 63.3%) with good dispersion, while liquid CO<sub>2</sub> at 5 °C resulted in lower conversion (0.11 g, 36.7%) due to limited reaction and some losses.

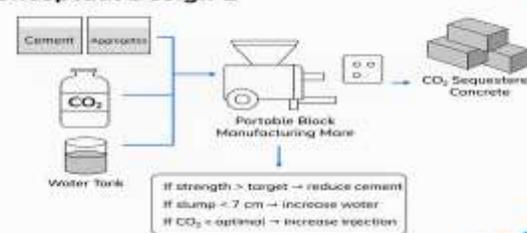
validation:  
 $d = \left( \frac{M}{\pi S_y} (M^2 + T^2) \right)^{\frac{1}{2}}$

$$\frac{dX}{dt} = -k_c \frac{X}{1-X}$$



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#### Conceptual Design 1



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### CONCLUSION

The portable concrete block machine enables on-site production, reducing transport, waste, and environmental impact. CO<sub>2</sub> is injected into the mix to enhance strength and sustainability. The prototype showed a 28% increase in CO<sub>2</sub> sequestration, 11.8% better cement use, and reduced shrinkage and creep strains, improving durability. Medium-density mixes (2200–2400 kg/m<sup>3</sup>) are tailored to project construction needs, ensuring structural strength. The system supports lean, eco-friendly construction.

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Factor of safety (FOS),  $n=1.8$