

# *Ecco-friendly support materials for reinforced concrete 3D printing*

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*Advances in sustainable and bio-inspired cementitious materials for 3D printing applications*

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ORNL is managed by UT-Battelle LLC for the US Department of Energy

# Construction automation : An overarching goal!

## *Matching heights and spans*



## *Form freedom*

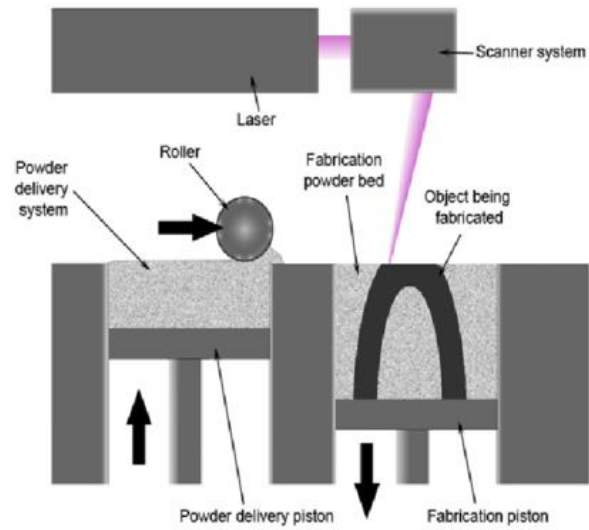


## *At least*



# Concrete 3D printing by adaptation of other 3D printing methods

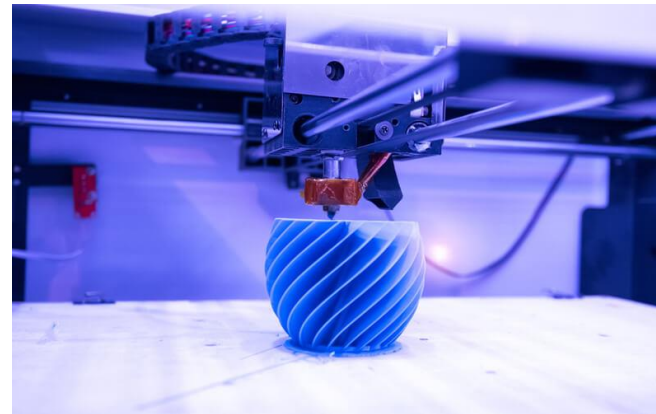
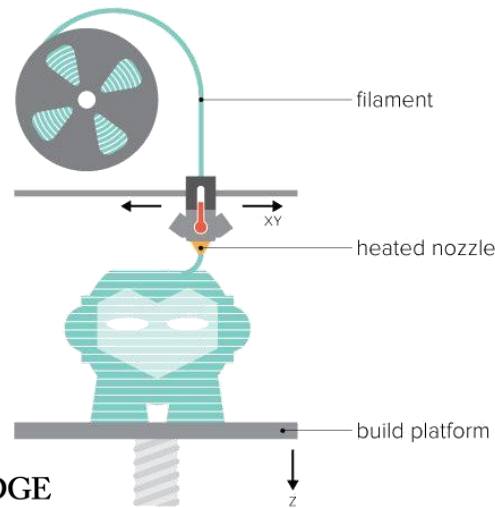
## Selective Laser Sintering (SLS)



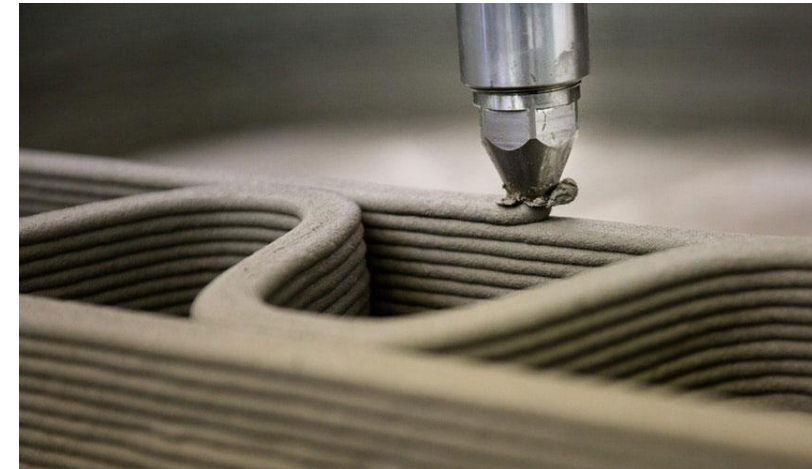
## Selective Binder jetting



## Fused Deposition Modeling (FDM)



## Extruded Deposition Modeling



# Concrete 3D printing as a form of 3D casting

*Fabric-cast concrete*

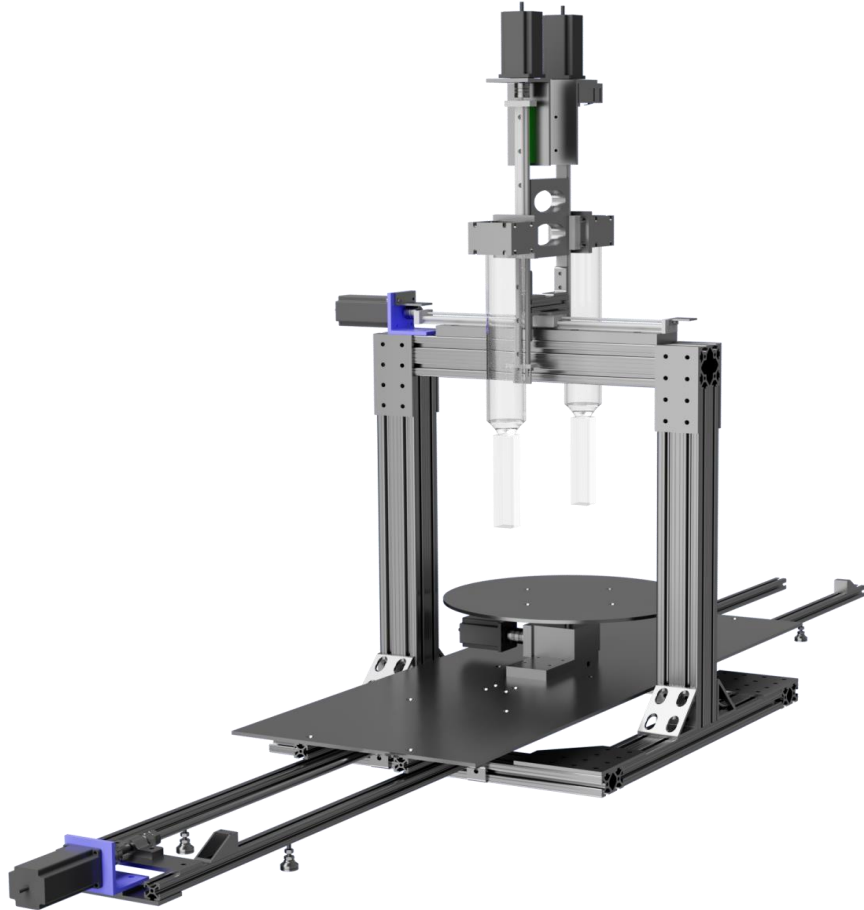


*Molding + 3D printing*

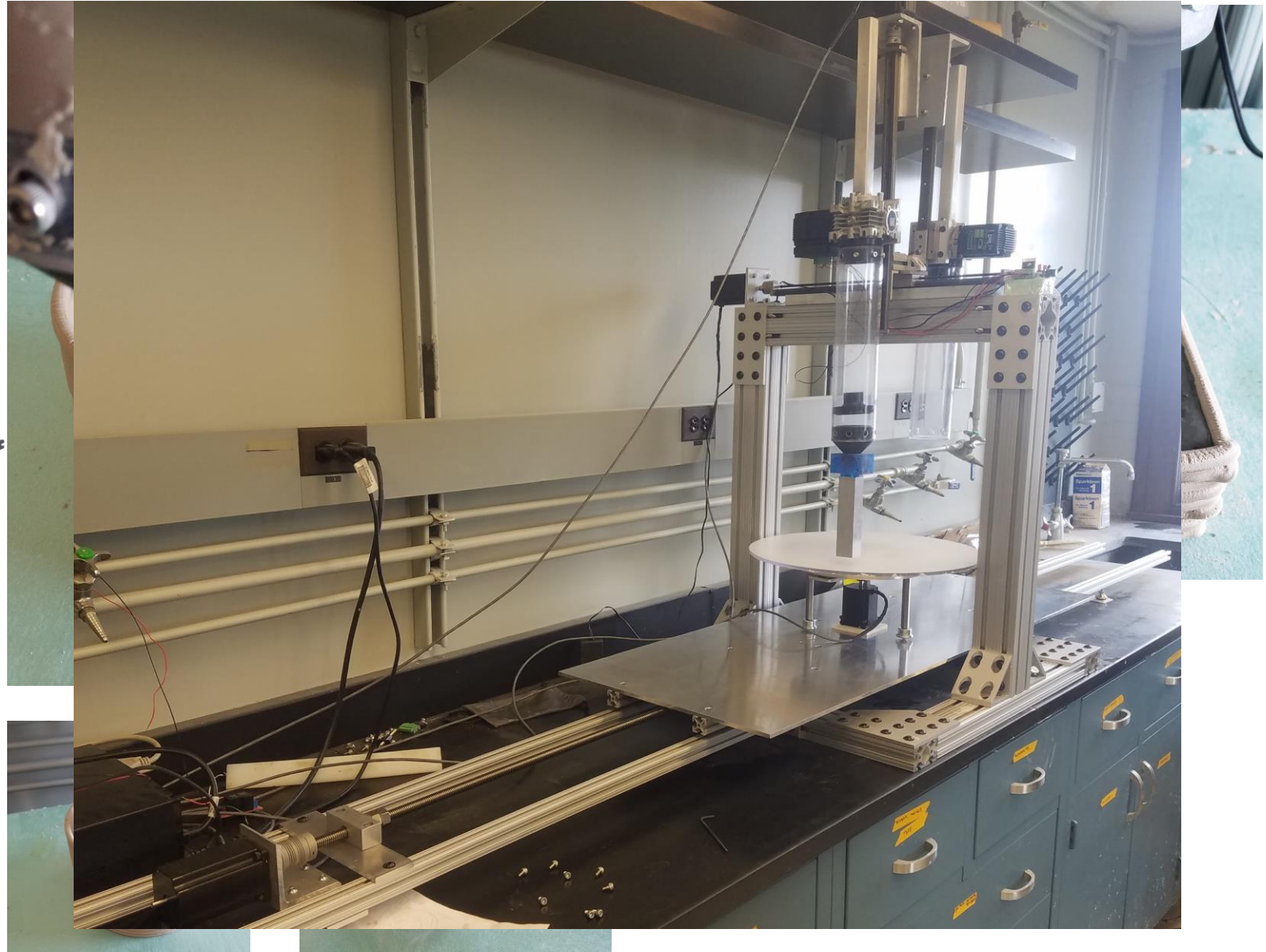


# Printing with removable support: Dual extrusion

Bench-top 3D printer with dual extruders



Printing support then casting concrete



Printing support on concrete

# Printing with removable support: Support removal and recycling

Clay shrinks naturally!



After support removal



Just add water again!



# Printing with removable support: Printing openings and overhangs

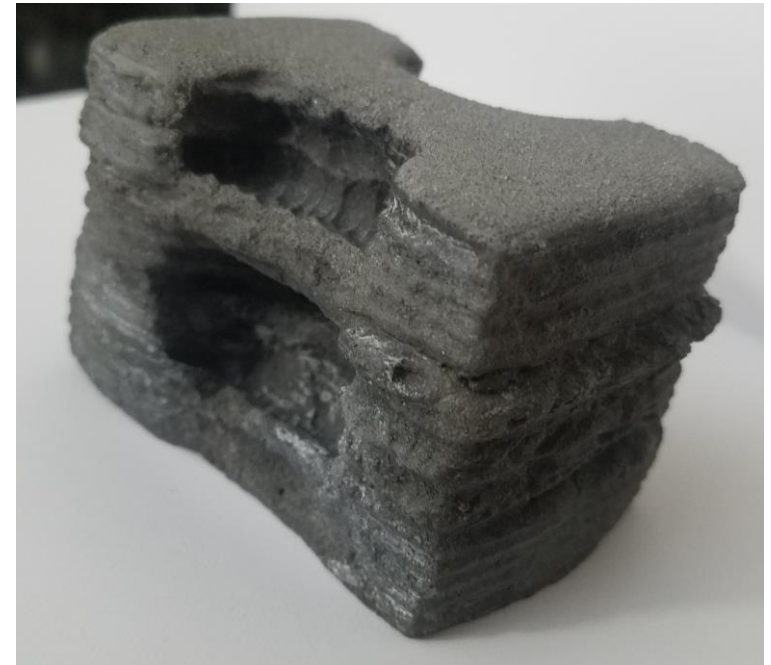
UHPC with X-shaped opening



Openings at multiple layers



Partial openings (overhangs)



# Printing with removable support: Printing a scaled reinforced portal frame

Adding stirrups



Adding reinforcement





# Printing with removable support: Printing a scaled reinforced portal frame

All reinforcement placed



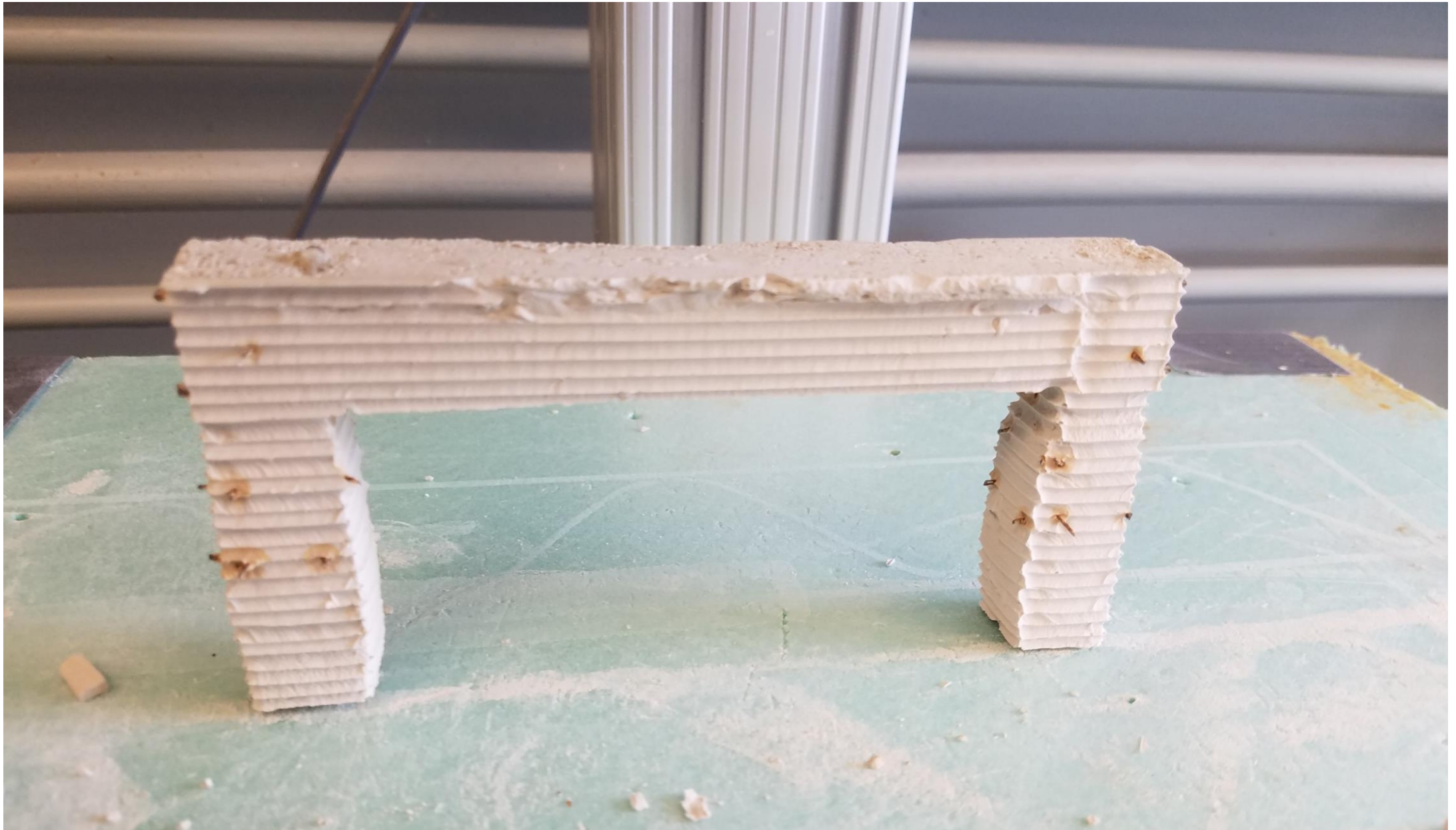
Casting Underlayment



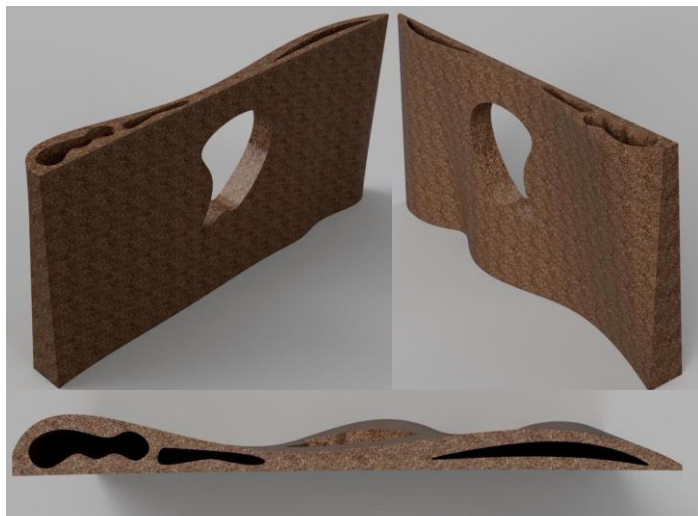
After casting



# Printing with removable support: Printing a scaled reinforced portal frame



# Possible scalability and on-site process



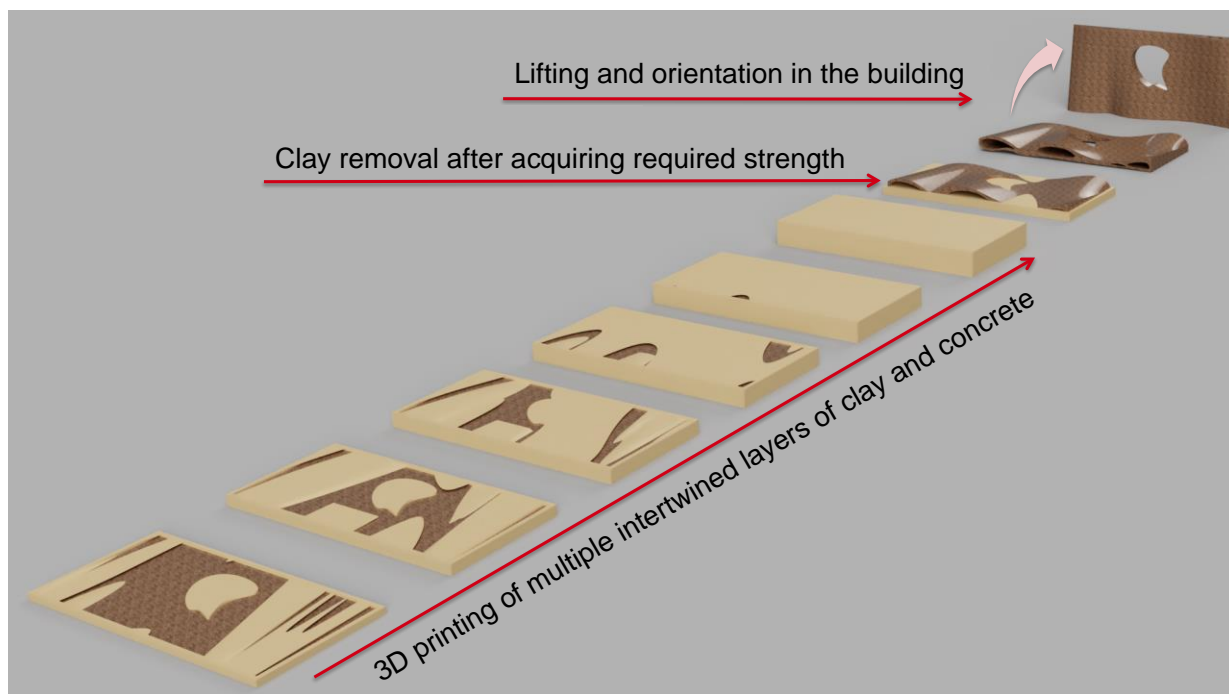
3D wall with optimized geometry



Dual extrusion robotic arm



Robotic arm in action !

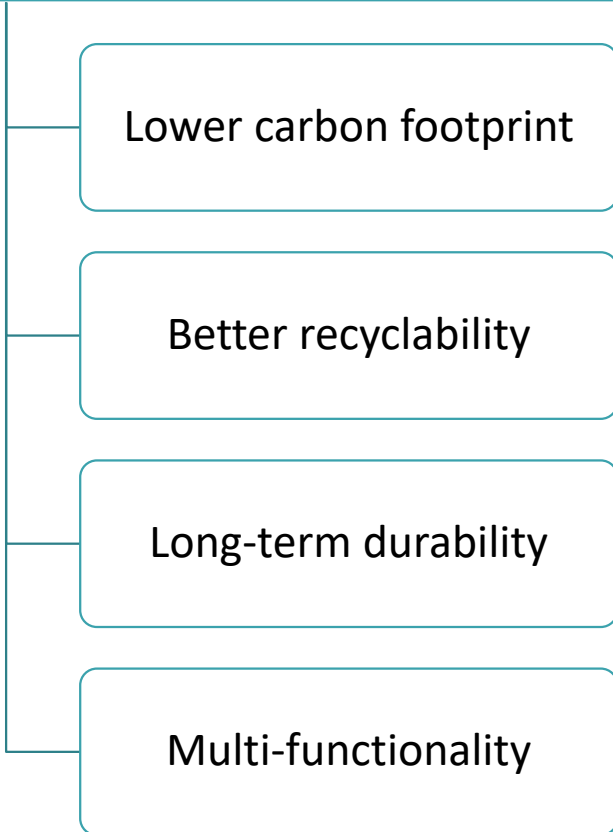


On-site printing sequence

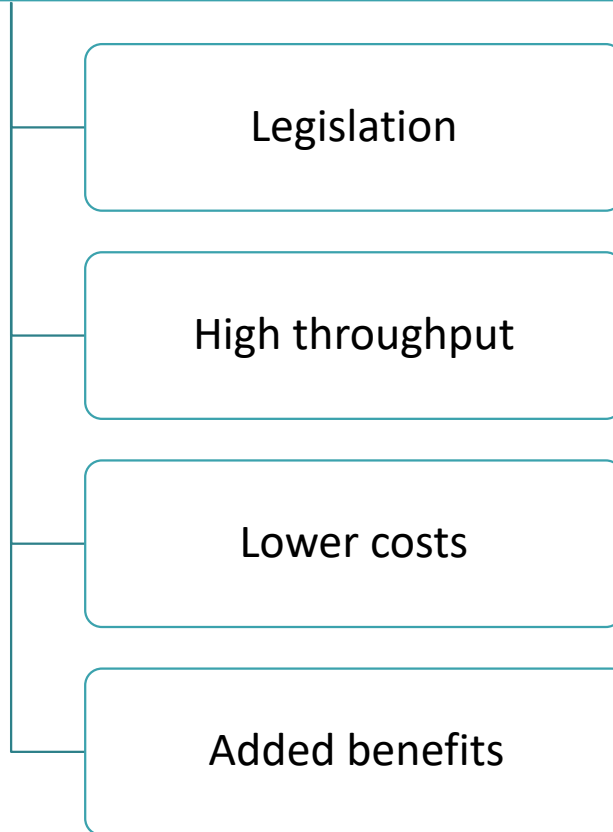
# Closing remarks:

Challenges facing 3D printing of concrete structures

## Sustainability



## Scale up



## Form freedom

