



Polymer Modified 3D Concrete Printing and Tesla Disc Pump Hybrid Manufacturing for Continuous Structural Block Production

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<https://electricship.com/continuous-production-3d-printed-ferro-cement-poly-hull-blocks.html>

A technical analysis of polymer use in 3D concrete printing, integration of Tesla disc pump systems for controlled extrusion, and the design of a continuous manufacturing line for polymer modified structural foam blocks with mesh reinforcement and HDPE overcoating.



This webpage QR code

PDF Version of the webpage (maximum 10 pages)

3D Concrete Printing Hulls

Modern 3D concrete printing is not simply cement and water extruded through a nozzle. It is a chemically tuned rheology system combining superplasticizers, viscosity modifiers, accelerators, and reinforcement strategies. When paired with a Tesla disc pump driven extrusion architecture and continuous manufacturing workflow, it becomes possible to fabricate structural foam core blocks with mesh reinforcement, accelerated curing shells, and protective HDPE outer coatings in a scalable industrial process.



Polymer Modified 3D Concrete Printing and Tesla Disc Pump Hybrid Manufacturing for Continuous Structural Block Production

Three dimensional cement printing requires precise control of rheology, early strength development, and interlayer adhesion. Traditional concrete is designed for placement and vibration. Printable cementitious systems are designed for extrusion, immediate shape retention, and rapid structural build up.

This article examines the polymers commonly used in 3D printing mixes, explains their role in extrusion stability and curing acceleration, integrates a Tesla disc pump based delivery architecture, and proposes a continuous manufacturing system for producing polymer modified structural foam core blocks wrapped in wire mesh, printed with a structural coating, and over sprayed with hot plasticized HDPE.

Polymer Chemistry in 3D Concrete Printing

Cement hydration fundamentally requires water. Polymers do not replace water but modify particle dispersion, viscosity, and microstructure formation.

Polycarboxylate Ether Superplasticizers

Polycarboxylate ether is the dominant superplasticizer in modern printable systems. Its electrosteric dispersion mechanism allows significant reduction of water cement ratio while maintaining pumpability.

Benefits include:

- Reduced water content
- Higher early strength
- Improved extrusion pressure control
- Enhanced particle dispersion

In 3D printing, a low water cement ratio between 0.28 and 0.35 is typical. Polycarboxylate ether allows this without clogging or excessive pumping energy.

Viscosity Modifying Polymers

Cellulose ethers such as hydroxypropyl methylcellulose and hydroxyethyl methylcellulose are critical for buildability.

These polymers provide:

- Increased yield stress
- Thixotropic rebuild after shear
- Slump resistance
- Reduced segregation

The material behaves as shear thinning fluid inside the pump and nozzle, but rapidly rebuilds viscosity after deposition. This property is essential for stacking layers without collapse.

Redispersible Polymer Powders and Latex

Styrene butadiene rubber and ethylene vinyl acetate improve tensile performance and interlayer adhesion. Because 3D printed layers are not vibrated, cold joints can reduce structural integrity. Polymer modification enhances cohesion between passes.

Accelerators

Sodium silicate and calcium aluminate based accelerators are used to increase early structural strength. In some systems, accelerator injection occurs at the nozzle to trigger rapid stiffening.

Polymers stabilize the mixture. Accelerators drive early strength gain. Both are required for reliable vertical build.

Integration of Tesla Disc Pump Architecture

A Tesla disc pump is a boundary layer driven pump that uses smooth rotating discs rather than impellers. It provides:

- Low shear bulk movement
- Reduced aggregate degradation
- Smooth flow without pulsation
- High efficiency at moderate pressures

For 3D cement extrusion, the Tesla disc pump offers specific advantages.

First, the disc pump maintains laminar dominant flow regimes that minimize fiber entanglement and preserve rheology modifiers.

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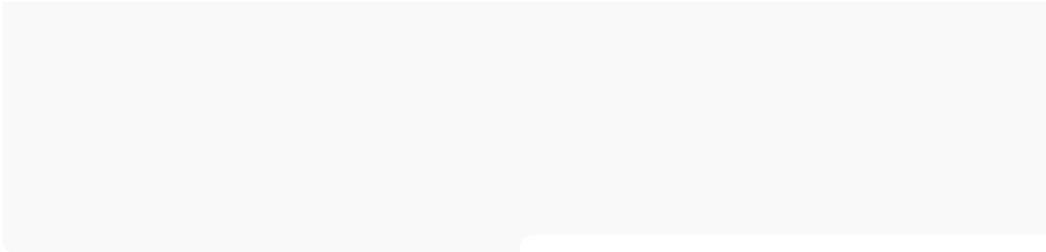
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Second, its shear characteristics promote temporary viscosity reduction inside the pump. When the mixture exits the nozzle and shear decreases, the cellulose ether based system rapidly rebuilds



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