

# **3DCP? 3DPC? C3CP? AC? ACC? AM? Are They All the Same?**

*Chapter 2: Terminology, Emerging Technology Report*

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3DCP?

3DPC?

C3CP?

AC?

ACC?

AM?

# What's in a name?

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What's in a name? That which we  
call a rose by any other name  
would smell as sweet.

*William Shakespeare*

*www.thequotes.in*



That which we call 3DPC by any other name would still behave the same.

However, it isn't that simple!

# 3DCP

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- Web of Science Statistics
- Search resulted in 175 results

3D Concrete Printing

3D Capillary Porous

3D Concrete Printed



# 3DPC

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- Has been reported 160 times (Source: Web of Science)

3D **Printable** Concrete

3D Phase Contrast

3D **Printed** Concrete

3D Photonic Crystals

3D **Printed** Cement Mortar

3D Penetration Casting

3D **Printed** Cement-based Materials

3D Printed Direct Plated Copper

3D **Printing** Cementitious Materials

3D Porous Carbon

3D **Printing** of Concrete

3D Point Cloud Network

3D **Printing** with Concrete

3D **Printing** with UHPFRC

# ACI Concrete Terminology CT-23: Mortar or Concrete?

## Concrete

mixture of hydraulic cement, aggregates, and water, with or without admixtures, fibers, or other cementitious materials.

- Doesn't specifically mention what size of aggregates making it all inclusive?
- **Mortar** is a mixture of cement paste and fine aggregates
- In any case, there are papers now where coarse aggregates are being used for printing... so should we stick with concrete?

# Examples of using the term Concrete

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## Ultra High Performance Concrete (ETR-18)

UHPC is a concrete that has a minimum specified compressive strength of 22,000 psi (150 MPa) with specified durability, tensile ductility and toughness requirements, fibers are generally included in the mixture to achieve specified requirements.

The example table in ETR-18 provides two possible mixture designs and doesn't mention coarse aggregates.

# Going by that example...

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## 3D Printed Concrete (3DPC)

3D Printed Concrete is a concrete that can be pumped, extruded through a nozzle and can be placed layer-by-layer to achieve optimized desirable shapes.

I think I personally like 3DPC over 3DCP.



# 'C3DP' and 'Concrete'

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- A search for 'C3DP' and 'concrete' resulted in 6 results
- (Source: Web of Science)

Concrete 3D Printing

Construction 3D Printing



# DFC

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- A search for 'digital' and 'fabrication' and 'concrete' lead to 475 search results

Digital **Fabrication** with Concrete

Digital **Fabrication** for Construction

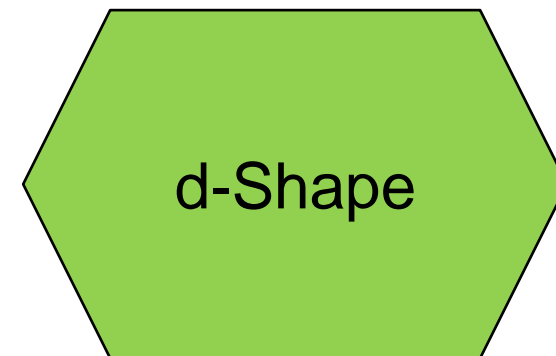
Digital **Fabrication** in Construction

Digitally **Fabricated** Concrete

Digital Concrete **Fabrication**

# Digital Fabrication with Concrete (DFC)

- RILEM Technical Committee 276,
  - ‘Digital fabrication with cement-based materials’
- Cement and Concrete Research (2020)
- DFC encompasses 3DCP and many other methods of production.



# ASTM: Committee F42 on Additive Manufacturing Technologies

- **Additive Manufacturing for Concrete (AMC)**

process to join materials to make structural and non-structural elements/components and systems from 3D model data usually by **depositing material layer upon layer** as opposed to subtractive and formative manufacturing methodologies

- **Additive Construction (AC)**

term to describe all relevant disciplines and knowledge for **the construction segment using Additive Manufacturing and 3D printing technologies**

# Definitions: Manufacturing

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**1** : something made from raw materials by hand or by machinery

| imports most *manufactures* used by consumers

– D. L. Cohn

**2 a** : the process of making wares by hand or by machinery especially when carried on systematically with division of labor

| the *manufacture* of automobiles

**b** : a productive industry using mechanical power and machinery

**3** : the act or process of producing something

| the *manufacture* of blood goes on constantly in the human body

– Morris Fishbein

# Definitions: Construction

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**1** : the act or result of construing, interpreting, or explaining

**2 a** : the process, art, or manner of **constructing** something

| *Construction* of the new bridge will begin in the spring.

*also* : a thing constructed

**b** : the construction industry

| working in *construction*

**3** : the arrangement and connection of words or groups of words in a sentence : syntactical arrangement

| That verb is often used in passive *constructions*.

**4** : a sculpture that is put together out of separate pieces of often disparate materials

# ASTM: Committee F42 on Additive Manufacturing Technologies

- Additive Manufacturing for Concrete (AMC)
- Additive Construction (AC)

Sector	Definition	North American Industry Classification System (NAICS)
11	Agriculture, Forestry, Fishing and Hunting	
21	Mining, Quarrying, and Oil and Gas Extraction	
22	Utilities	
23	Construction	
31-33	Manufacturing	
42	Wholesale Trade	
44-45	Retail Trade	
48-49	Transportation and Warehousing	
51	Information	

## **General Consensus from previous discussions?**

Let's not use Manufacturing!

### **Next Question:**

Should we use **Construction** or **Concrete** or **both**?

Additive Construction with Concrete (ACC)

Or

Additively Constructed Concrete (ACC)?



# NIST: Additive Construction by Extrusion Consortium

- Additive Construction (follows the convention of ASTM ...)
- There appears to be a trend here ... with the use of Additive (instead of 3D printing or digital fabrication) in the US.

# We want to hear from you!!

## Please scan the QR Code and Provide Feedback!



Please select your top choice!

- Additive Construction with Concrete (ACC)
- Additive Manufacturing with Concrete (AMC)
- Digital Fabrication with Concrete (DFC)
- 3D Printed Concrete (3DPC)
- I agree with Shakespeare, 'What's in a Name?'
- Other: \_\_\_\_\_

<https://tinyurl.com/ETR-concrete>

# Terms to be Defined: Systems/Platforms

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- 3DPC or ACC or whatever name is chosen
- 1K printer
- 2K printer
- Inclusive Term for (robotic and gantry printers)
  
- Pre-print (similar to pre-cast)
- Print-in-pace (similar to cast-in-place)

# Terms to be Defined

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- Filament / bead
- Toolpath
- Over Extrusion
- Under Extrusion
- Extrudability
- Printability

# Terms to be defined

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- Open Time
  - Should it be different for 1K and 2K printers?
- Interlayer time delay (Interlayer time gap)
- Green strength
- Structural build-up
- Buildability
- Plastic collapse

# Terms to be defined

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- Interlayer bond strength
- Interlayer adhesion
- Interlayer voids
- Intra-layer voids
- As-built

# **Thank you!**

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