

Revolutionizing Road Infra with Modern Equipment, Technologies, Sustainable Materials and Policy Guidelines

February 29th - March 1st, 2024, Manekshaw Centre, New Delhi

Concrete 3D Printing for Fast and Sustainable Construction

Dr. A. V. Rahul

Assistant Professor

Indian Institute of Technology Tirupati



**International Road Federation
India Chapter**

www.indiairf.com |  india@irf.org.in

Outline

- ❖ Concrete 3D printing – infrastructure applications
- ❖ Research group - IIT Tirupati
- ❖ Summary



Outline

- ❖ Concrete 3D printing – infrastructure applications
- ❖ Research group - IIT Tirupati
- ❖ Summary

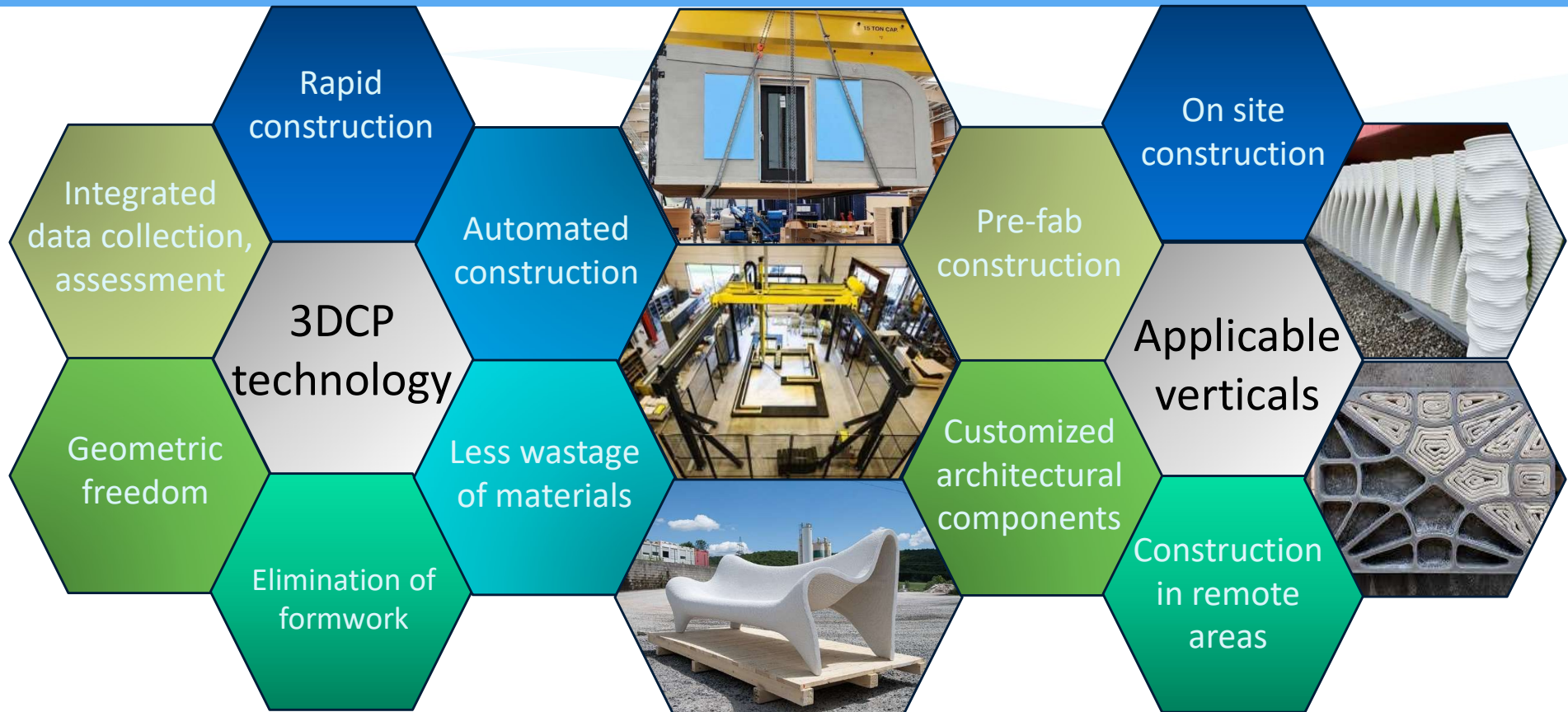


3D Concrete printing

- An emerging technology that can be used to rapidly fabricate elements or an entire structure in an automated manner
- The construction is through layer-by-layer addition of material



Advantages of 3D printing

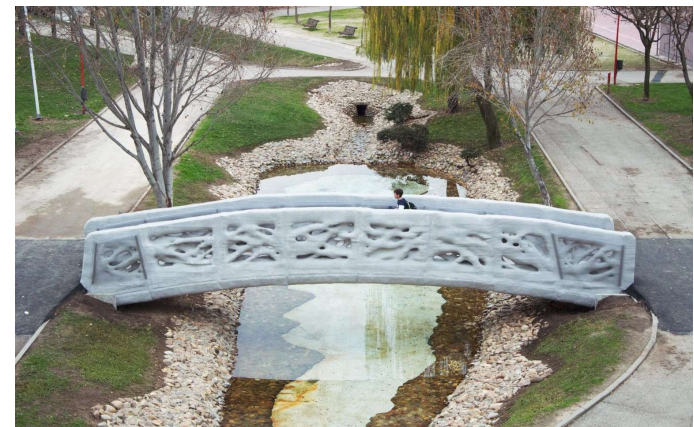


Application in Roadways and Infrastructure

- 3D printing can be used for construction of short-span bridges
- Provides advantages such as parametric design which allows to optimize the material usage



Nimegen Bridge, Netherlands



3D printed Footbridge Bridge, Spain

Source: <https://3dprintingindustry.com>; <https://iaac.net>

Application in Roadways and Infrastructure

- Since 3D printing allows to create customized shapes, it can be used for make custom-shaped culverts, revetment walls, sound barriers, bus stops, etc.



3D printed sound barriers, China



Culverts, UK



Revetment wall, China

Source: <https://www.newcivilengineer.com>; <http://www.winsun3d.com>

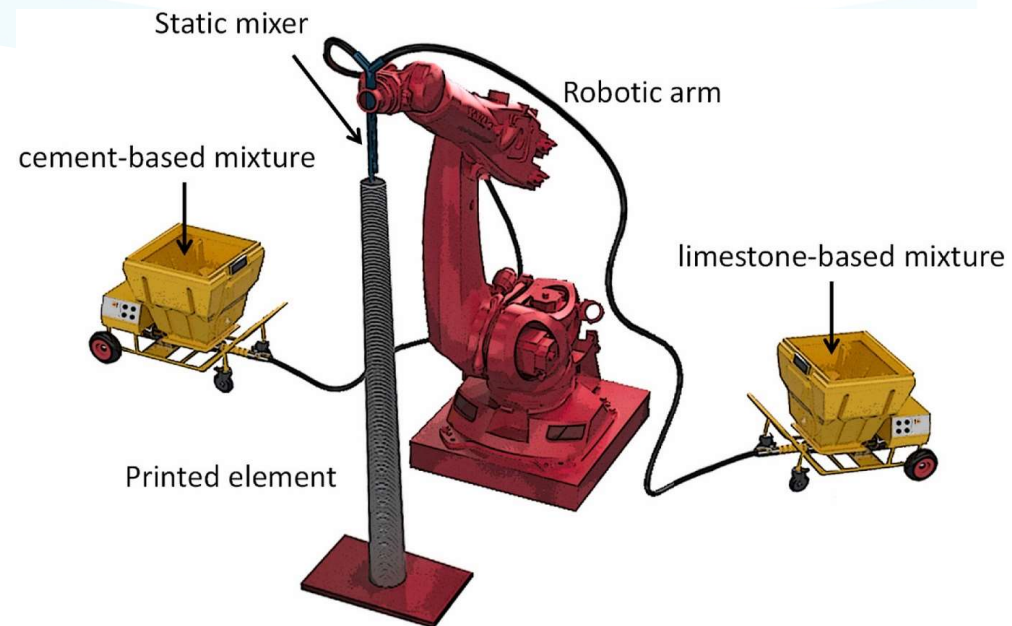
Outline

- ❖ Concrete 3D printing – infrastructure applications
- ❖ Research group - IIT Tirupati
- ❖ Summary



3D concrete printing using “set-on-demand”

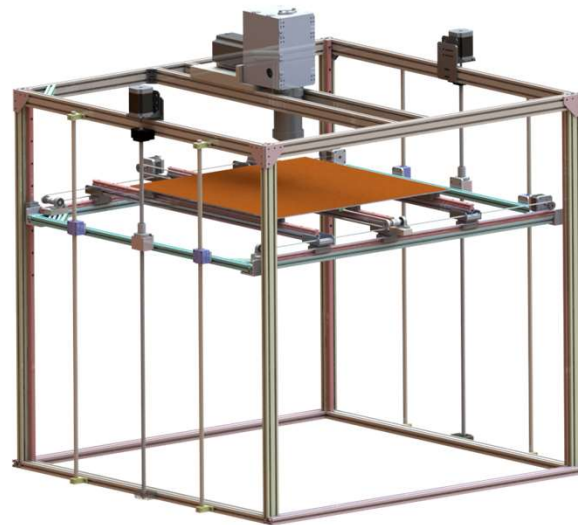
- In 3D printing , there is conflicting material requirements before and after extrusion
- A “set-on-demand” mixture can be used to overcome this problem



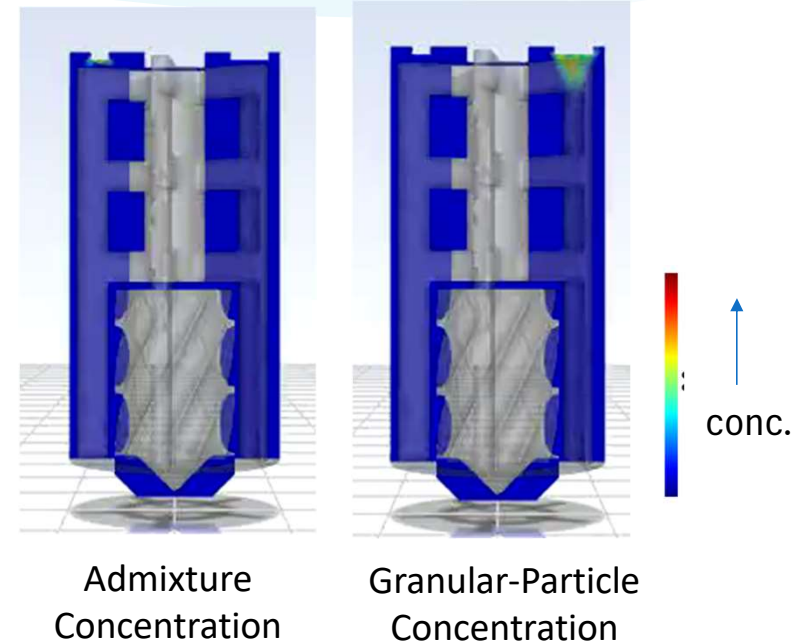
Source: Tao et al., 2021

Developing advanced 3D printer systems

- Printhead that allows to perform accelerator addition
- Printhead designed using computational fluid dynamics simulation studies



Parametric study of printhead geometry using CFD



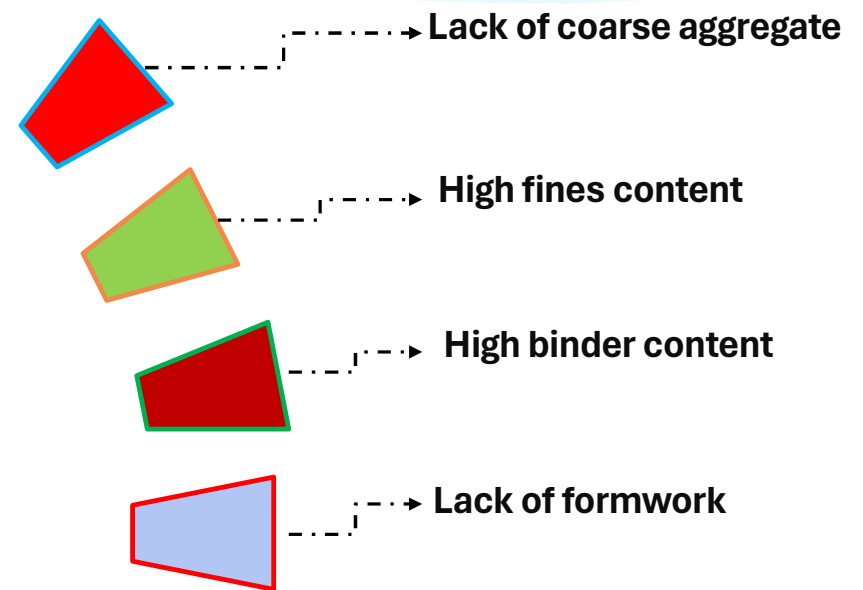
Courtesy : Viswanath R. (student, IIT Tirupati)

Durability of 3D printed elements

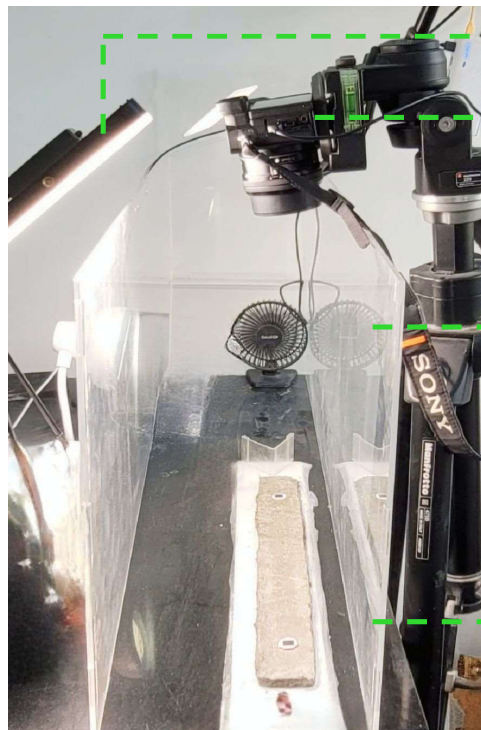
- Very limited studies on durability of 3D printed elements!
- A major concern can be early-age shrinkage



Shrinkage cracks in 3D printed elements (Moelich et al. 2020)



Test set-up for early-age shrinkage measurement



→ Constant light source

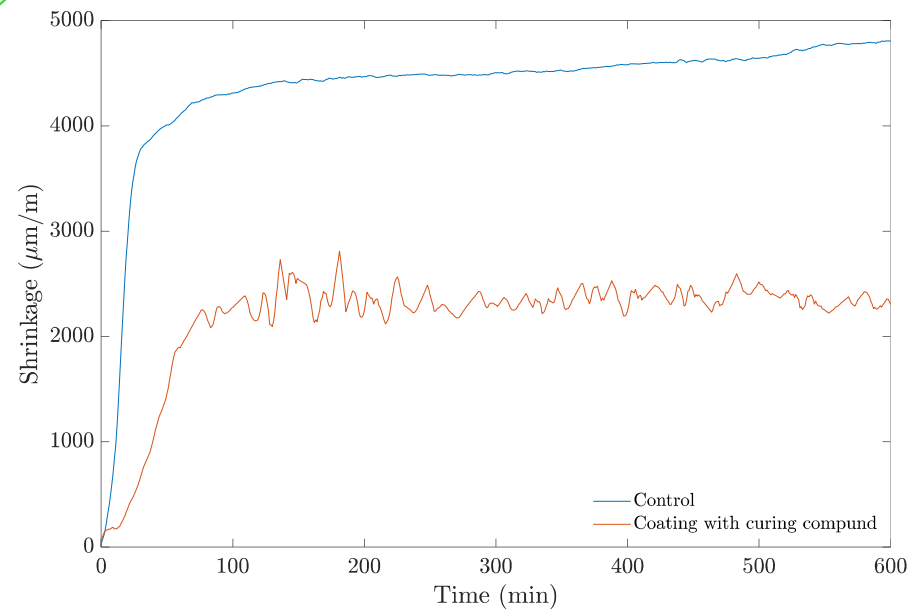
→ Digital camera

→ Fan with wind velocity of 3 m/s

→ Specimen (400 x 40 x 10 mm)



→ Marker pins kept at 300 mm c/c



Courtesy: Divya S. Kurup (student, IIT Tirupati)

Other infrastructure-related research

Products from waste-derived materials

AR-GF

Alkali-Resistant Glass fiber



Made from **chitosan graphene oxide**

Masonry

Bricks from industrial waste



Made from **glycerine pitch**



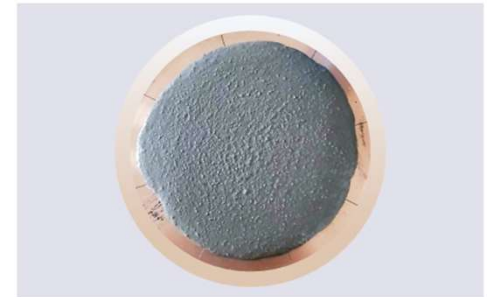
Low cost



Green

UHPC

Ultra High-Performance Concrete



Made from **industrial waste SCMs and wood pulp derived graphene oxide**

Courtesy: Revathy S., Rahul K., Naveen D. (students, IIT Tirupati)

Outline

- ❖ Concrete 3D printing – infrastructure applications
- ❖ Research group - IIT Tirupati
- ❖ Summary



Summary

- Concrete 3D printing is gaining more popularity in the construction industry
- Major advantages include rapid construction, elimination of formwork cost, and geometric freedom
- It be used for infrastructure applications like short-span bridges, and in elements requiring complex geometry and parametric design
- Research on developing set-on-demand type 3D printer systems and on understanding long-term performance of 3D printed concrete



Thank you for your attention!

Dr. A. V. Rahul

IIT Tirupati

Email: rahulav@iittp.ac.in

