LATEST TRENDS IN RAPID CONSTRUCTION TECHNOLOGY

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PREVIEW

LATEST TRENDS IN RAPID CONSTRUCTION TECHNOLOGY

3D PRINTING OF BUILDINGS

- CONCEPTS OF 3D PRINTING
- APPLICATIONS
- 3D PRINTING FOR CONSTRUCTION
- INFRASTRUCTURE
- MERITS
- ADAPTABILITY IN MES
- CONSTRAINTS
- CONCLUSION

TUNNEL FORM CONSTRUCTION

- CONSTRUCTION PROCESS
- SPECIAL FEATURES
- PARTS OF TUNNEL FORM
- BRIEF OF TUNNEL FORM
- USES & SCOPE
- IMPORTANT POINTS
- REMOVAL OF TUNNEL UNDER THE SLAB

MIVAN CONSTRUCTION

- ALUMINIUM FORMWORK
- HISTORY
- USES OF MIVAN FORMWORK
- ADVANTAGES
- LIMITATIONS
- CASE STUDY

3D PRINTING OF BUILDINGS

TECHNOLOGY AND ITS POSSIBLE APPLICATIONS BY MES

PREVIEW

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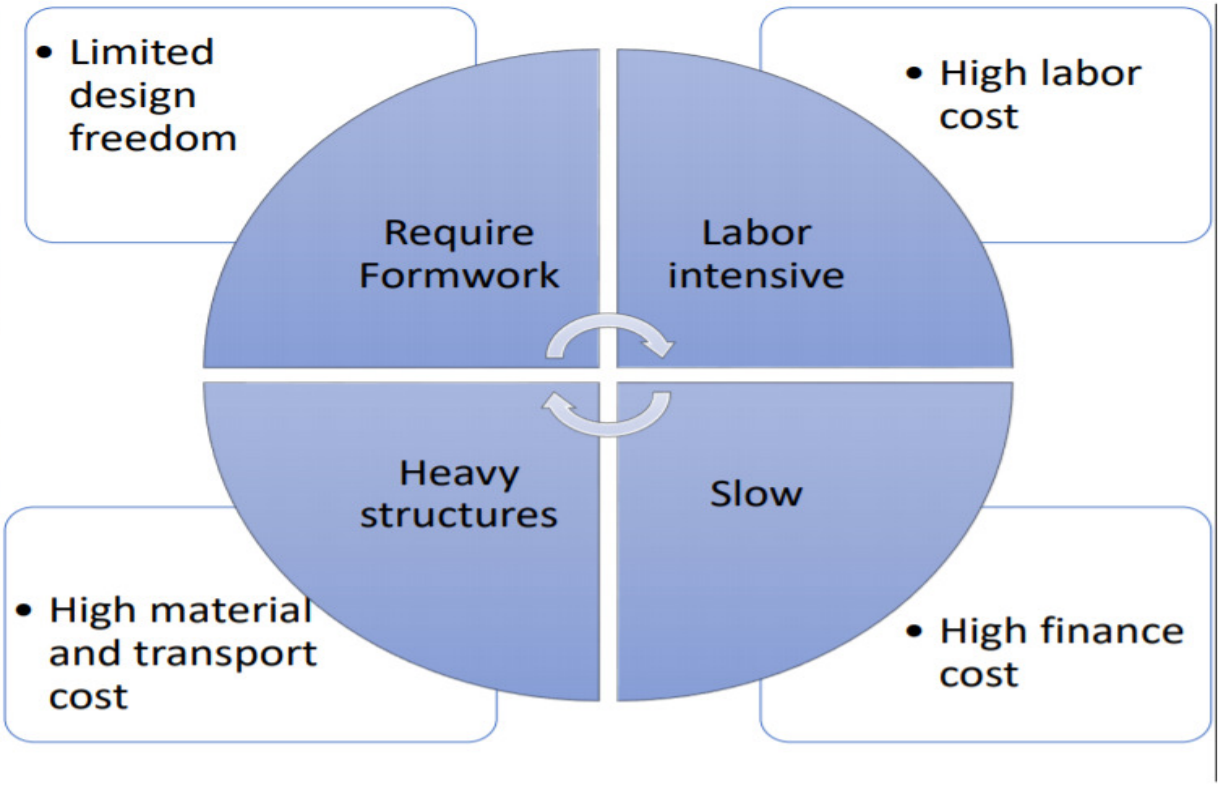
INTRODUCTION

On-site construction

Off-site/Pre-Fab/Precast construction



3D PRINTING - A WAY AHEAD

- Controlled deposition
- Formwork not reqd
- Design Freedom
- Hardware-Software integration
- Automated Constr
- Faster Constr
- Robust Quality control
- Ideal for COVID envt

CONCEPT OF 3D PRINTING

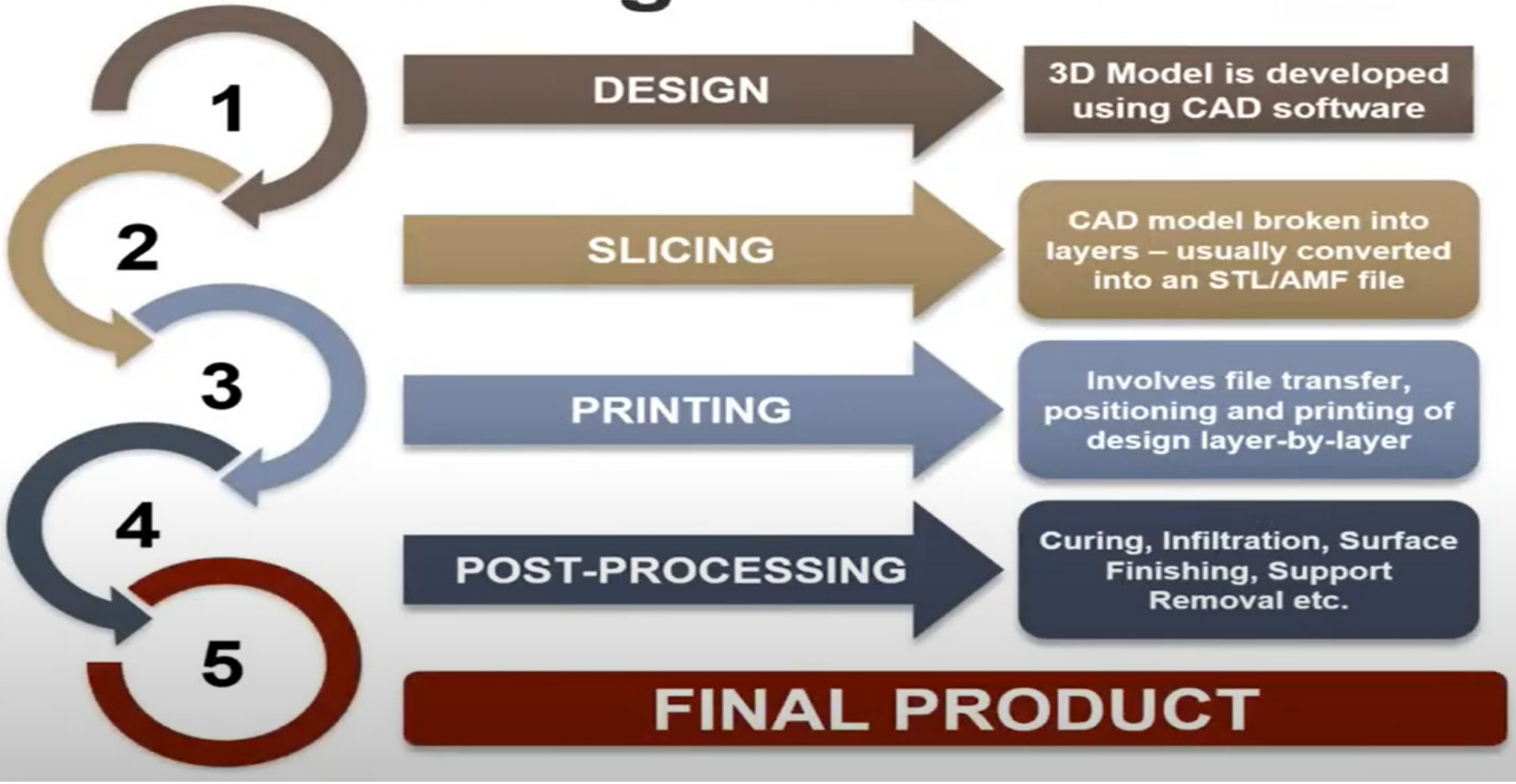
- Idea of 3D printing was born in 1983.
- Charles W. Hull led the invention of Stereolithography.
- Initially, complicated & expensive
- Usage spread to various fields – medicine, automotive, aerospace
- FDM – Fused Deposition Modelling invented in 1988
- First 3D printed house – Amsterdam – 2014
- Contour Crafting – most promising – in situ printing of bldgs

Charles W. Hull is the co-founder, executive VP and CTO of 3D Systems. He is one of the inventors of SLA 3D printer, the first commercial rapid prototyping technology

Stereolithography (SLA)

- A form of 3D printing technology
- Used for creating models, prototypes, patterns, and production parts
- In a layer by layer fashion
- Using Photopolymerisation

3D Printing – The Process



FIELDS OF APPLICATIONS

- Manufacturing applications
  - Additive manufacturing
  - Mass customization
  - Rapid manufacturing
  - Rapid prototyping
  - Research
  - Food
- Medical applications
  - Bio-printing
  - Medical devices
  - Pharmaceutical Formulations

- Industrial applications
  - Apparel, art and jewelry
  - Automotive industry
  - Construction
  - Firearms
  - Computers and robots
  - Space
- Sociocultural applications
  - Communication
  - Education and research
  - Environmental use
  - Cultural heritage

3D PRINTING FOR CONSTRUCTION

- A novel construction technique
- Fastest growing constr technology
- Deposited layer by layer
- Digitally designed printing route
- Without using any formwork

Akin to paper printers, 3D printers deposit layer upon layer of mtrl

3D PRINTED BUILDINGS
A WORLD VIEW

Canal House in Amsterdam - 2014

Printed as pre-fab elements in factory and assembled on site

House printed by Win Sun company in China - 2014

Five-storey building printed in 3D in China - 2015

3D PRINTED BUILDINGS – A WORLD VIEW

First 3D-Printed Office Building by WinSun Global in Dubai - 2016

Tvasta 3D-printed a 600 sqft house at IIT-Madras - 2021

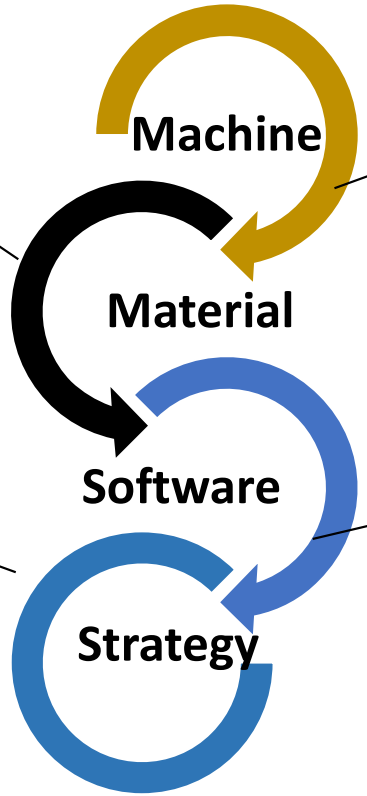
L&T printed a G+1 using Gantry at Kanceepuram - 2021

3D PRINTED BUILDINGS – GLOBAL PLAYERS

- CyBe – 3D Printing Company in Netherlands, partnering with Shapoorji Pallonji
- XtreeE – 3D Printing Company in France. Supported by LafargeHolcim (Swiss Building Material Company)
- COBOD – 3D Printing Company in Denmark. Supported by PERI (German Formwork Company)
- SIKA – Swiss Construction Chemical Company
- WINSUN – 3D Printing and Building Material Company in China
- ICON – 3D Printing Company in USA (In collaboration with Oakhouse Partners)

INFRASTRUCTURE

- 3D Printable special concrete mix
- Special Additives

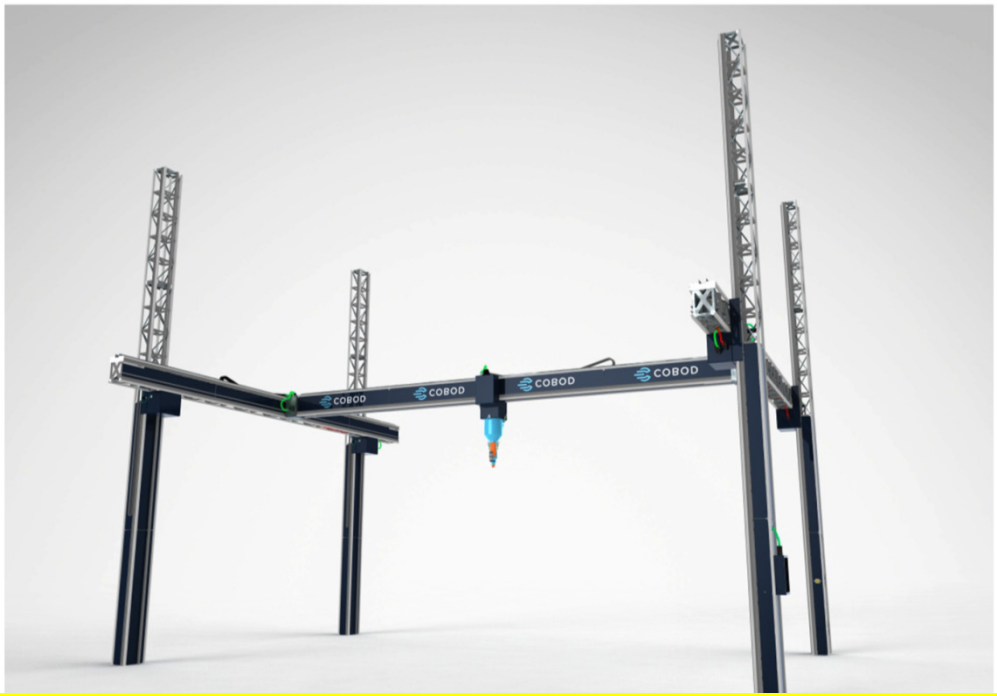


- Batching Plant
- Transit Mixer
- Concrete Pump
- 3D Printer

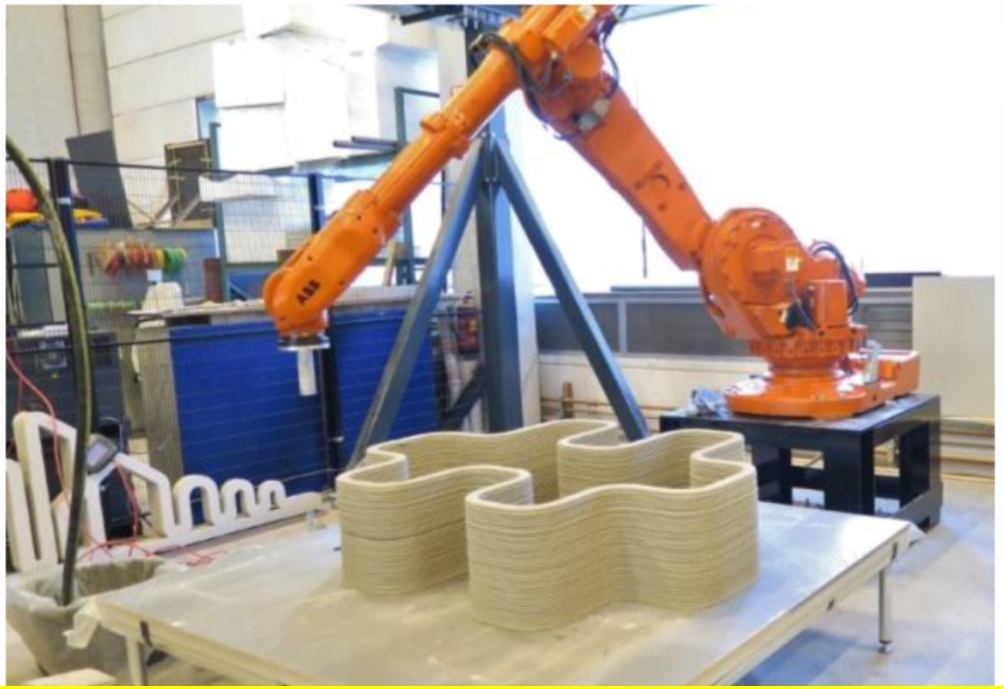
- Cast in-situ/ precast
- Rebar placement
- Constr process/ sequence

- CAD
- 3D Modelling

SYSTEMS FOR 3D PRINTING



Gantry system



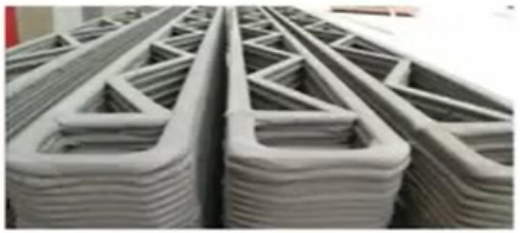
Articulated robot system

Printer to be Transported to site

Printer Assembled on-site

Printing on-site

Gantry system

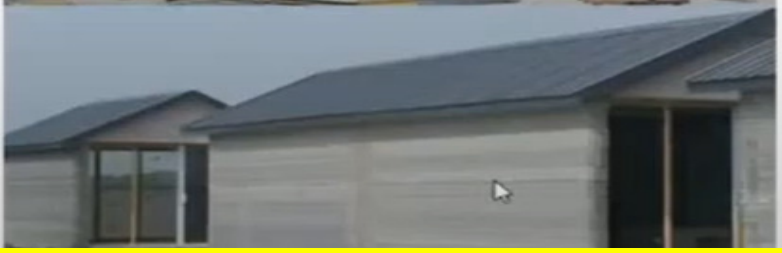


Fabrication in Centralised Factory

Transport to site

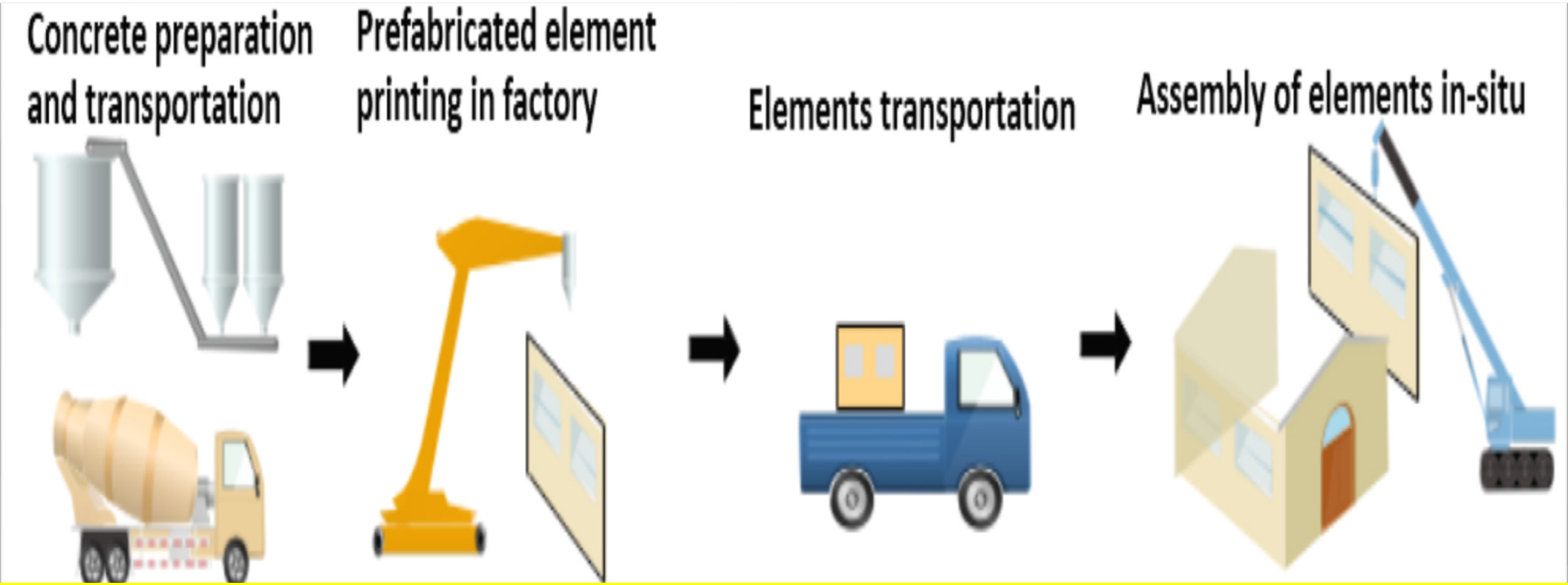
Assembly & Finishing on-site

Assembly & Finishing on-site



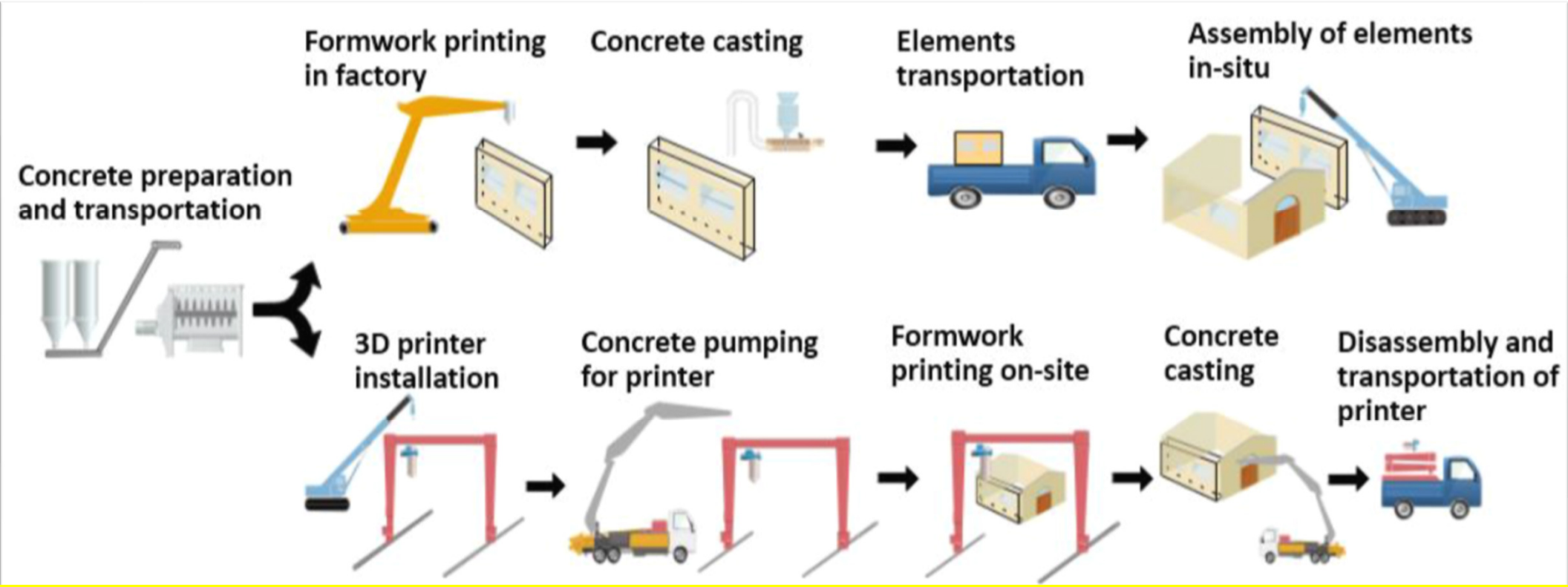
Articulated robot system in factory (off-site)

LARGE SCALE 3D PRINTING OF CONCRETE TYPE A



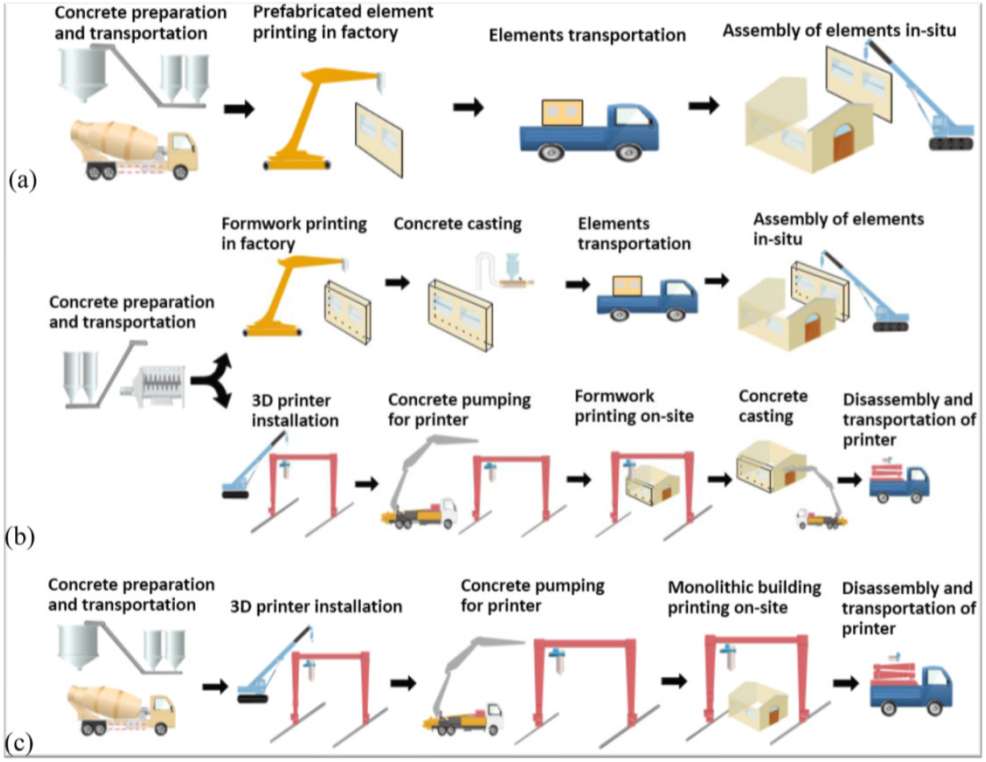
3D printing of modules in factory, tpt and assembly at site

LARGE SCALE 3D PRINTING OF CONCRETE – TYPE B



3D printing of formworks at factory/ site and casting in situ using 3D Printer

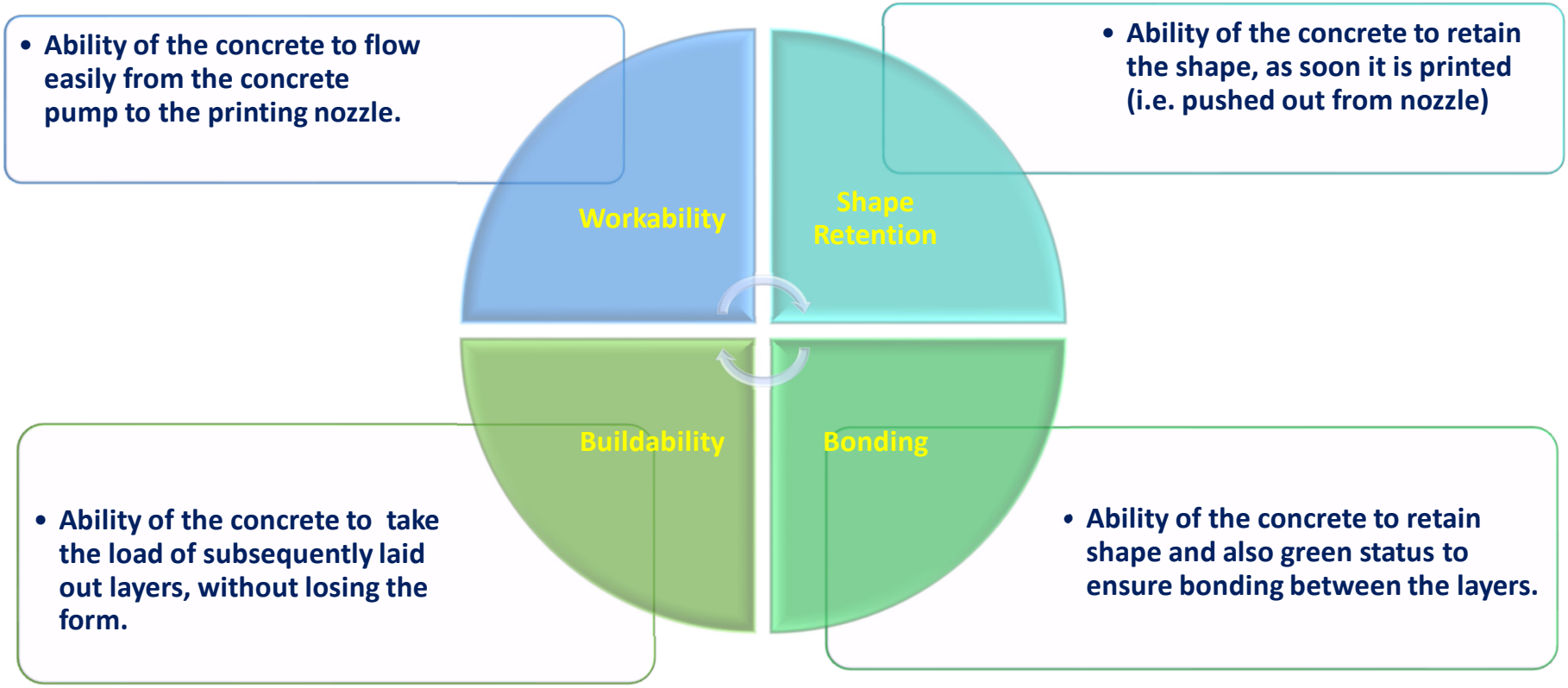
LARGE SCALE 3D PRINTING OF CONCRETE – TYPE C



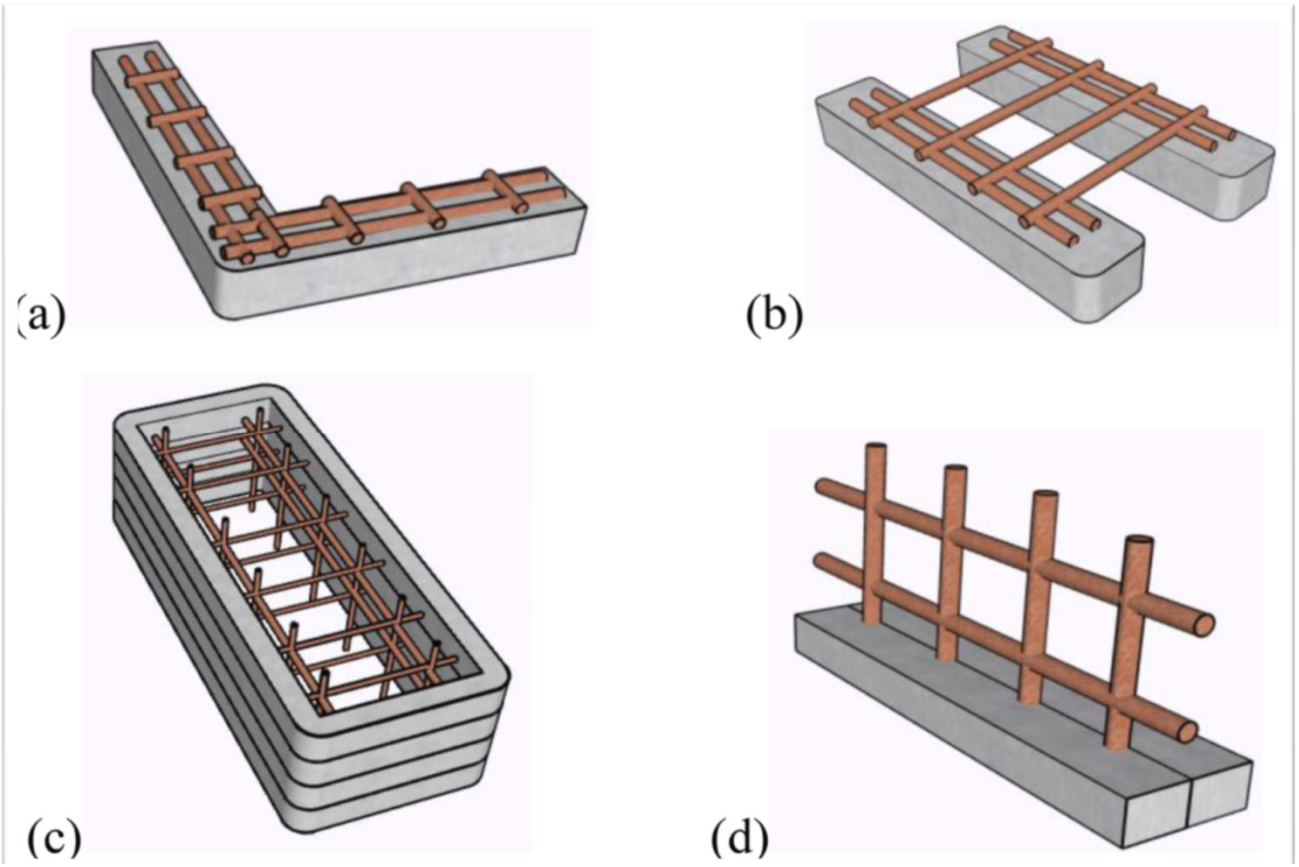
Monolithic 3D printing of concrete on-site

MIX DESIGN PRE-REQUISITES

3D concrete mix design - A paradoxical combination of concrete properties



PLACING OF NORMAL REINFORCEMENTS



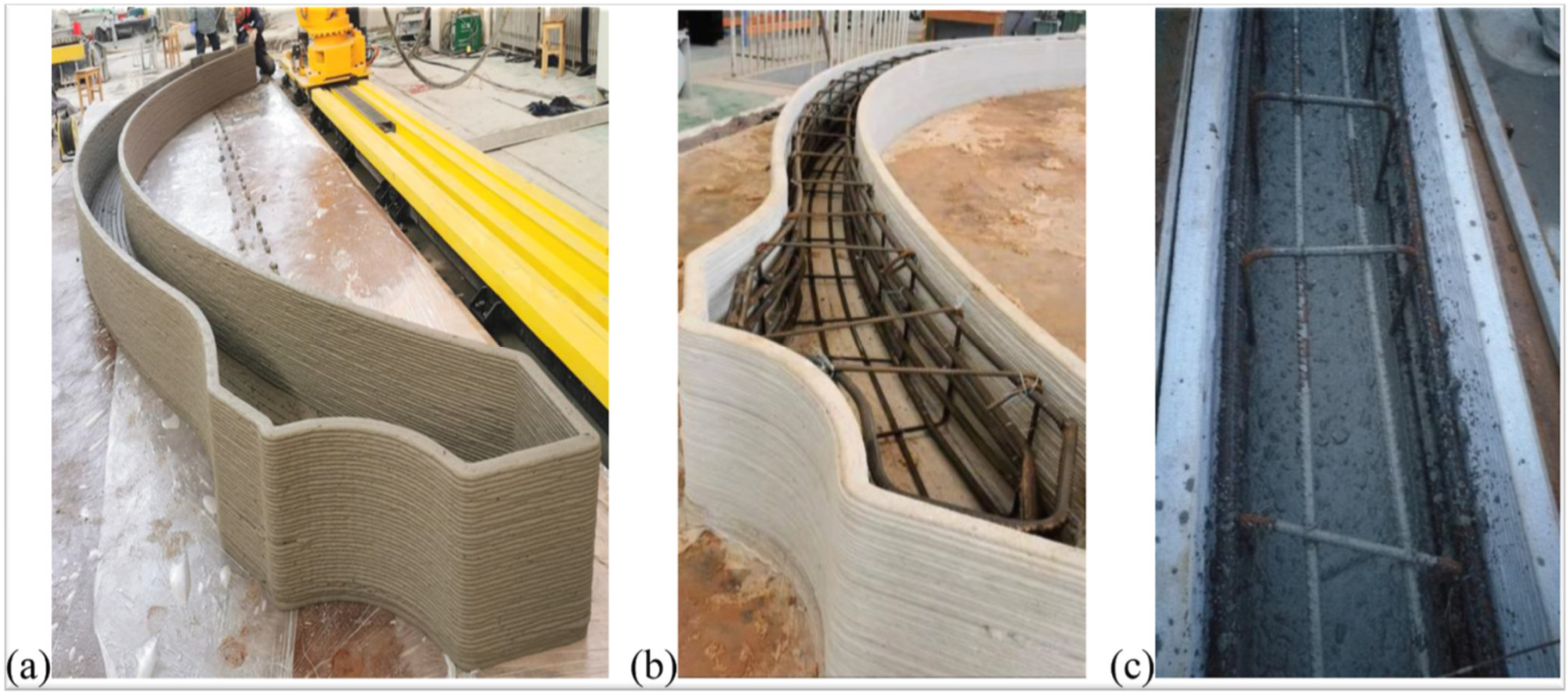
(a) Horizontal reinforcements placed on printed walls

(b) Horizontal reinforcements connecting printed walls

(c) Reinforcement placing in printed formworks

(d) Prepositioned reinforcement

CONSTRUCTION TECHNIQUE FOR PERMANENT FORMWORK STRUCTURES



MERITS

- Reduction of construction cost.
- Reduces the construction time.
- Labour cost upto 60% lower.
- Improves productivity.
- Greater geometric flexibility.
- Sustainability
  - Reduced waste production and Minimal formwork.
- Consistent quality
  - Minimal Human intervention/error
- Improved safety

CHALLENGES

Material

- Printability
- Buildability
- Time

Printer

- Scalability
- Directional dependency
- Cyber Security

Regulations

- Lack of Codes
- Liability

मानक: पथप्रदर्शक:
Bureau of Indian Standards

Design and Constr

- Exclusion of Services
- Structural integrity
- Suitability of site

MATERIAL CHALLENGES

Printability

- Extrudability
- Ability to pump
- Narrow parameters of quality

Buildability

- Material Quality; Strength and Bond

Time

- Limited Period for printability and buildability
- Delays may cause the concrete to harden
- Special material mixes

PRINTER CHALLENGES

- **Scalability**
  - Size of the project
- **Directional dependency**
  - Layer orientation influences the compressive strength of the material.
  - Vertically printed specimens versus horizontally printed specimens
- **Cybersecurity**

DESIGN & CONSTRUCTION CHALLENGES

Exclusion of building services

- Electrical and mechanical ducting is a challenge

Structural integrity is a key challenge

- Quality of the printed parts have been found to be brittle on occasion.
- Problems in printing load bearing components

Construction site setup is another challenge

- Infra setup reqd
- Digital Modelling involved
- Construction site may not be suitable for 3D printer that need a more controlled environment
- Site conditions may be irregular that hinder the movement and installation of the 3D printer

REGULATIONS CHALLENGE

- Lack of codes and regulations
- Liability issues

ADAPTABILITY IN MES

- Greenfield Projects
  - Site offices
  - Amenities
  - Space available
- Extreme weather regions – insulated walls
- Outdoor Furniture
- Para 35 & 36 wks

- Repair/Renovation
  - Partition walls
  - Sewage Appurtenances
    - Manholes,Chambers
    - Septic Tanks/pits
- Security Infra
  - Bdy Walls
  - Barricading
  - Guard posts

CONSTRAINTS

- **Progressing technology – till now only demonstrative**
- **Supply Chain issues – only very few firms - start-ups**
- **No Codal Provisions**
- **Design Philosophy for multistorey structures not available**
  - **For load bearing elements etc**
  - **Design process and validation**
- **Durability of structure/bldg – planned life of structure/elements**
- **Variation in cost vis-à-vis traditional framed construction needs justification**

CONCLUSION

- Technology is still young and presents lot of limitations
- A demanding technique
- Comprehensive material design schemes and rheology control methods needed
- No building-code system is currently available for regulating these processes
- Both technologies will need to co-exist in the industry

TUNNEL FORM CONSTRUCTION

HOW QUICKLY DO YOU BUILD?





PREVIEW

TUNNEL FORM CONSTRUCTION

- CONSTRUCTION PROCESS
- SPECIAL FEATURES
- PARTS OF TUNNEL FORM
- BRIEF OF TUNNEL FORM
- USES & SCOPE
- IMPORTANT POINTS
- REMOVAL OF TUNNEL UNDER THE SLAB

TUNNEL FORM CONSTRUCTION

Monolithic Concrete Construction System

- **In this system, Concreting of walls & Slabs to be done in one operation.**
- **Tunnel forms made of M S Plate, Angle Iron, C Channel, I section by welding and also using nuts and bolts.**
- **By using these accurate mould which is re-usable, room sized prepared/fabricated in factory and assemble at site location which called tunnel form.**
- **This tunnel form replace the conventional RCC beam-column structure which uses steel/plywood shuttering.**
- **Tunnel form system uses customised engineered steel form work consisting of two half shells which are placed together and then concreting is done to form a room size module.**

CONSTRUCTION PROCESS

- **Stripping of /taking out/fixing the tunnel from the yesterday/previous day and fixing in next units.**
- **Binding of reinforcement of wall with installation/fixing of electrical, plumbing and mechanical services.**
- **Putting the tunnel form for slab**
- **Making level of tunnel**
- **Binding reinforcement of slab with installation/fixing of electrical , plumbing and mechanical services.**
- **Concreting**

SPECIAL FEATURES

- **Facilitate to rapid construction of multiple /mass modular units.**
- **Making structure durable with low cost assets and less maintenance requirement.**
- **The Concrete designed to using industrial products such as GGBS, Micro silica etc to improved workability , durability and conserving natural resource.**
- **Being box type monolithic structure, it is safe against horizontal forces. i.e. Earthquake & Cyclone etc)**

COMPONENTS/PARTS OF TUNNEL FORM

- **MS Plate 3 to 6 mm thick according to span of mould**
- **Angle Iron, C Channel, I Section**
- **Round Pipes or tubular pipes**
- **Tie Rod**
- **Plastic Spacers for making hole for sanitary and water supply pipes**
- **Vertical jacks**
- **Horizontal jacks**

COMPONENTS/PARTS OF TUNNEL FORM

- **Moving Plates**
- **Kickers**
- **Inverted L Shaped half tunnel(One vertical and one horizontal panels)**
- **Roller plates**
- **Hooks**
- **Conical tie rod, nuts and bolts**
- **Plate forms with guard rails**

BRIEF OF TUNNEL FORM

- **This system is used above the plinth beam.**
- **Up to Plinth beam , all the process or activity carried out by same as conventional form work.**
- **Above Plinth beam, from Ground floor to any floor tunnel form can be used.**
- **At the time using tunnel form as a first time, Kicker (Starter) to be done on plinth beam or on shear wall, which is essential to put tunnel at same level and proper alignment. Kicker size appx 100mm in ht and same width as shear wall.**
- **Then according to size and shapes of rooms, all shells or half parts of tunnel puts in complete area with the help of crane.**
- **Tunnel fixed by tie rod, vertical and inclined jacks. Tie rod to be provided at every 1.0 sqm area.**

BRIEF OF TUNNEL FORM

- **For maintain constant width of walls, a plastic spacer or sleeves fixed with tie rod to use and put in between shear wall.**

- **Before placing or binding of reinforcement, release oil provided for coming out smooth surface of concrete.**

- **For next slab's kicker also been made at the time of concreting of slab so that no separate kicker to be made.**

- **By this technology, some shear wall to be constructed which given in structural design. Balance wall to be constructed by using AAC block masonry as a partition wall for making of such assets like toilets, kitchen, bed room and living room.**

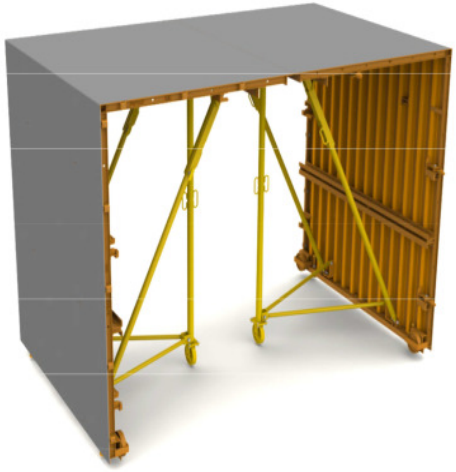
USES

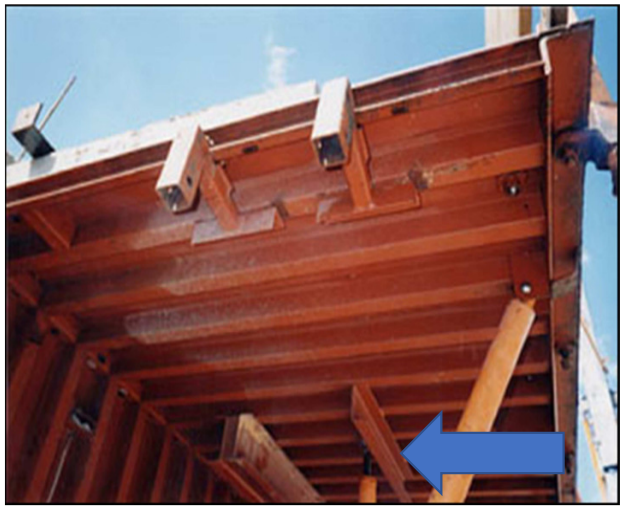
- Multiple Residential Dwelling units
- Housing Projects
- Garden Apartments
- Town Homes
- Hotels

SCOPE

- Load bearing walls
- Non load bearing walls
- Shear wall
- Slab

CONSTRUCTION IN PROGRESS





CONSTRUCTION IN PROGRESS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ELECTRICAL LEGEND
ELECTRICAL HEIGHTS SCHEDULE
FOR APPROVAL ONLY

POINTS TO BE KEPT IN MIND

- **Complete detailed layout plan to be finalised and approved before construction activity starts as addition/alteration is little difficult in middle of construction.**

- **Position of doors, windows , ventilators, open to sky and cut out with complete size, shape and dimensions to be finalised.**

- **Position of Electric conduit, Metal box, Ceiling rose box, Sewage and water supply lines, gully traps and nahni traps also to finalised.**

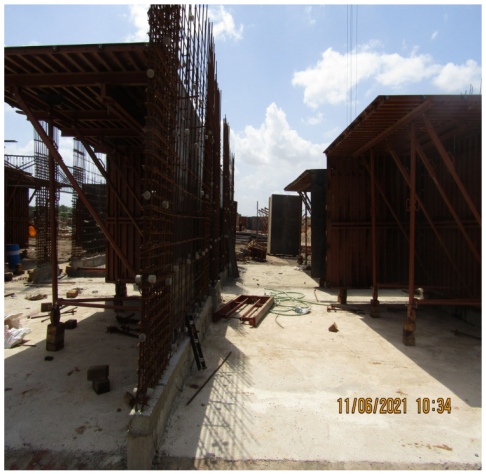
POINTS TO BE KEPT IN MIND

- **For Doors, windows, Ventilators and cut out portion , a steel frame to be fixed on tunnel form either on wall or on slabs according to position and places so that during concreting spaces coming out hollow at their correct position.**

- **For Plumbing and sanitary fittings, Plastic sleeves or spacers of various sizes as per pipes also be fixed in wall and slab as per its position along with reinforcement before concreting to avoid core cutting later on.**

- **For electric conduit and metal box in shear wall also fixed by welding to avoid misalignment during concreting when using vibrator.**

PHOTOGRAPHS OF WORK UNDER PROGRESS



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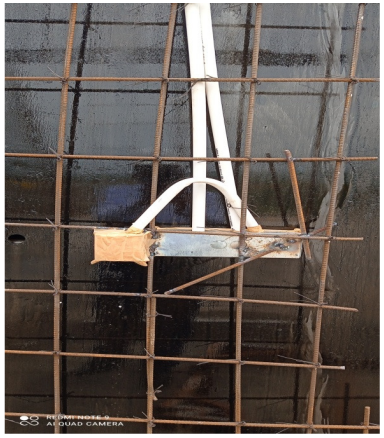

REMOVAL OF TUNNEL UNDER SLAB

- **Cube test after 12 hrs from finishing of concrete to be checked.**
- **Required strength is 8 to 10 MPa as per Design Mix M-40 for removing of tunnel form after 12 hrs.**
- **Tunnel to be removal after 12 hrs with the help of prop supports.**
- **Firstly outer side panels to be removed.**

REMOVAL OF TUNNEL UNDER SLAB

- **Then half shells of each mould to be loosed by vertical jacks and removed from slab by using roller plates.**
- **Immediately after prop support to be provide in half portion of slab of each mould.**
- **Then removing remaining tunnel by providing prop support under slab.**
- **One prop support to be provided at every 2.0 sqm area.**

MIVAN CONSTRUCTION

PREVIEW

MIVAN CONSTRUCTION

- INTRODUCTION
- HISTORY
- ALUMINIUM FORMWORK
- USES OF MIVAN FORMWORK
- ADVANTAGES
- LIMITATIONS
- CASE STUDY

INTRODUCTION

- It is the information about Advance Technologies In Building Construction.
- The construction industry is rapidly changing. With-changing times, new processes and the materials are being used.
- A lot of research and development is carried out in the construction industry throughout the globe
- Time, economy and utility of space have become the important aspects of the construction industry.

HISTORY

- Aluminum formwork developed in Europe in 1990s
- Mivan Company Ltd, a Malaysian Company started manufacturing these formwork
- Suitable for constructing houses in large nos in a short time frame
- Cast-in-situ concrete walls and floor slabs
- On removal of the formwork, high quality concrete finish is produced
- Lot of buildings being constr in Mumbai

MIVAN

- MIVAN is the brand name from Mivan Far East, Malaysia. It is Aluminum alloy Form work The Aluminum formwork system for concreting is probably the most versatile modern construction system. Unlike other systems it is equally suited to both high and low rise construction specifically designed to allow the rapid construction of multiple unit projects at optimum productivity.

ALUMINIUM FORMWORK

Formwork is the temporary moulds or shutters in which concrete is placed, so that it will have desired shape or outline when hardened. This temporary casing is known as *Formwork* or *Shuttering*.

USES OF MIVAN FORMWORK

- 3S – System of Construction – Speed, Strength, Safety.
- Column and beam construction are eliminated.
- Walls and slabs are cast in one operation.
- Specially designed, easy to handle light weight pre-engineered aluminum forms.
- Fitting and erecting the portion of shuttering.
- Carrying out concreting of the walls and slabs together.

ADVANTAGES OF MIVAN FORMWORK OVER CONVENTIONAL CONSTRUCTION

- More seismic resistance: - The box type construction provides more seismic resistance to the structure.
- Increased durability: - The durability of a complete concrete structure is more than conventional brick bat masonry.
- Lesser number of joints thereby reducing the leakages and enhancing the durability.
- Higher carpet area- Due to shear walls the walls are thin thus increasing area.
- Integral and smooth finishing of wall and slab- Smooth finish of aluminum can be seen vividly on walls.

ADVANTAGES OF MIVAN FORMWORK OVER CONVENTIONAL CONSTRUCTION

- Negligible maintenance – Strong built up of concrete needs no maintenance.
- Faster completion – Unsurpassed construction speed can be achieved due to light weight of forms.
- Lesser manual labour- Less labour is required for carrying formworks.
- Simplified foundation design due to consistent load distribution.

LIMITATIONS

- Concealed services become difficult due to small thickness of components.
- It requires uniform planning as well as uniform elevations to be cost effective.
- Modifications are not possible as all members are caste in RCC.
- The formwork requires number of spacer, wall ties etc. which are create problems such as seepage, leakages during monsoon.
- Due to box-type construction shrinkage cracks are likely to appear.
- Heat of Hydration is high due to shear walls.

ALUMINIUM FORMWORK

WALL PANEL: The Wall Panel forms the face of the wall from the top of the Rocker to the underside of the Top Panel.

ROCKER

KICKER: The kicker forms the wall Face at the top of the Top Panels. It is anchored to the concrete and acts as a ledge for the Wall panels on the next floor to sit on.

BEAM SOFFIT BULKHEAD

DECK COMPONENT: The deck panel rests between pairs of mid-beams and provides a horizontal surface for casting the slabs and provides a horizontal surface for casting the slabs.

INTERNAL SOFFIT CORNER: The Internal Soffit Corner forms the vertical corner between walls and / or beam faces and horizontal internal corners between wall / beam face and soffit of slabs.

INTERNAL CORNER:

The Internal Corner connects 2 pieces of vertical formwork together of their internal intersection.

PROP LENGTH:

The prop length is manufactured to a specific length for each project. It transmits load to the previous slab.

CASE STUDY

- **Project – Amanora Park Town**
- **Location – Hadapsar Pune**
- **Area – 78000 sq m**
- **Project Cost – 650 million**
- **Client – City Development Corp**
- **Consultant – P & T, J & W Consultant**
- **Cycle – 11 days per floor**
- **Storey – 22 Storeys**
- **System of Formwork – 6000 sq m**


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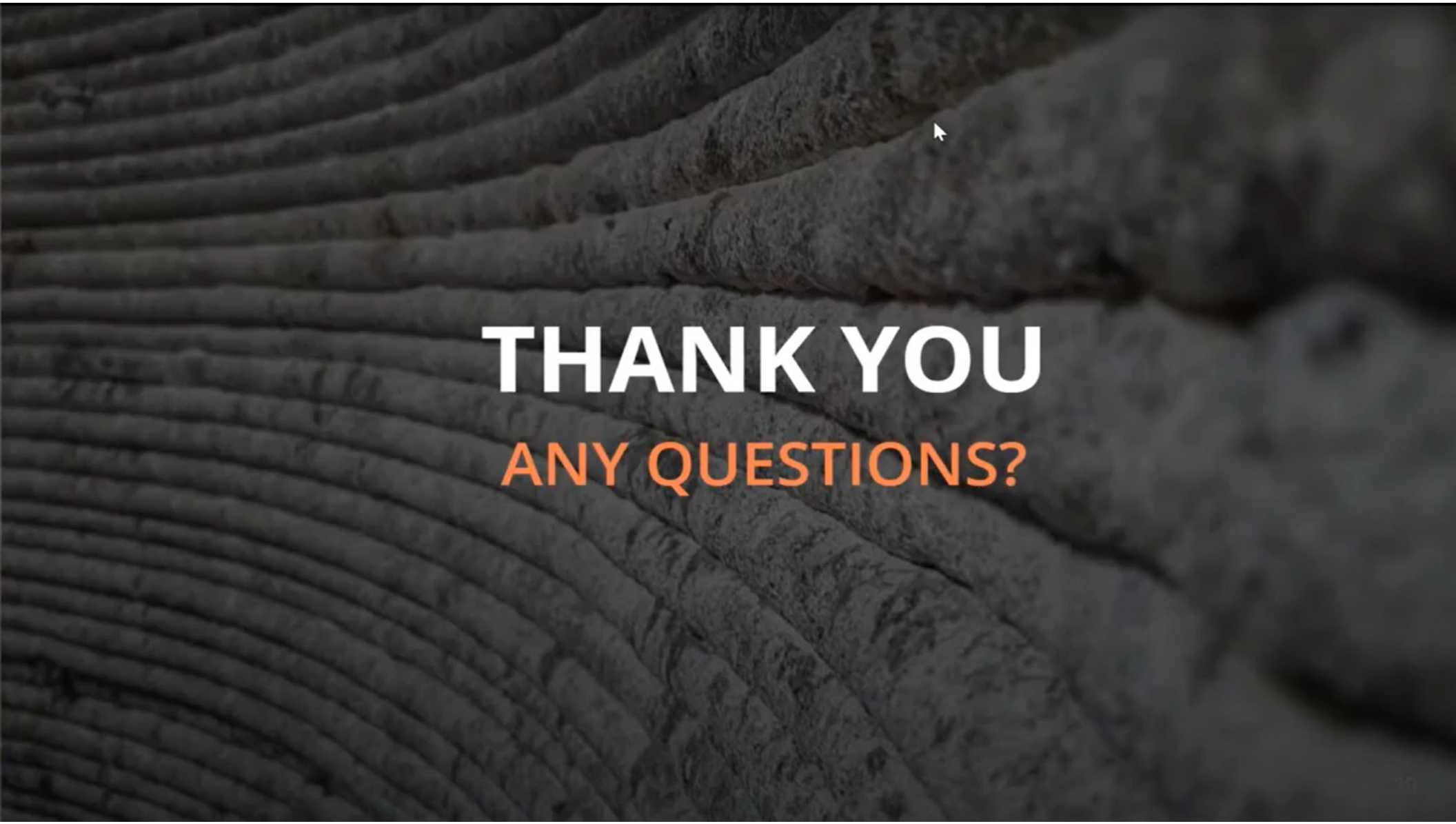
THANK YOU
ANY QUESTIONS?