

Additive manufacturing methods

Zaid Marmash, COBOD

Manufacturing methods

Status: Deliverable submitted

Objective: Develop and refine additive manufacturing strategy for 3D-printed (3DP) caissons

Actions realized in this tasks:

- Review manufacturing strategies of reference design
- Manufacturing methods feasibility for potential 3D caisson design with integration of sensors
- Manufacturing method refinement on selected design, validate with 3D printing trials

Involvement of partners and their major contributions:

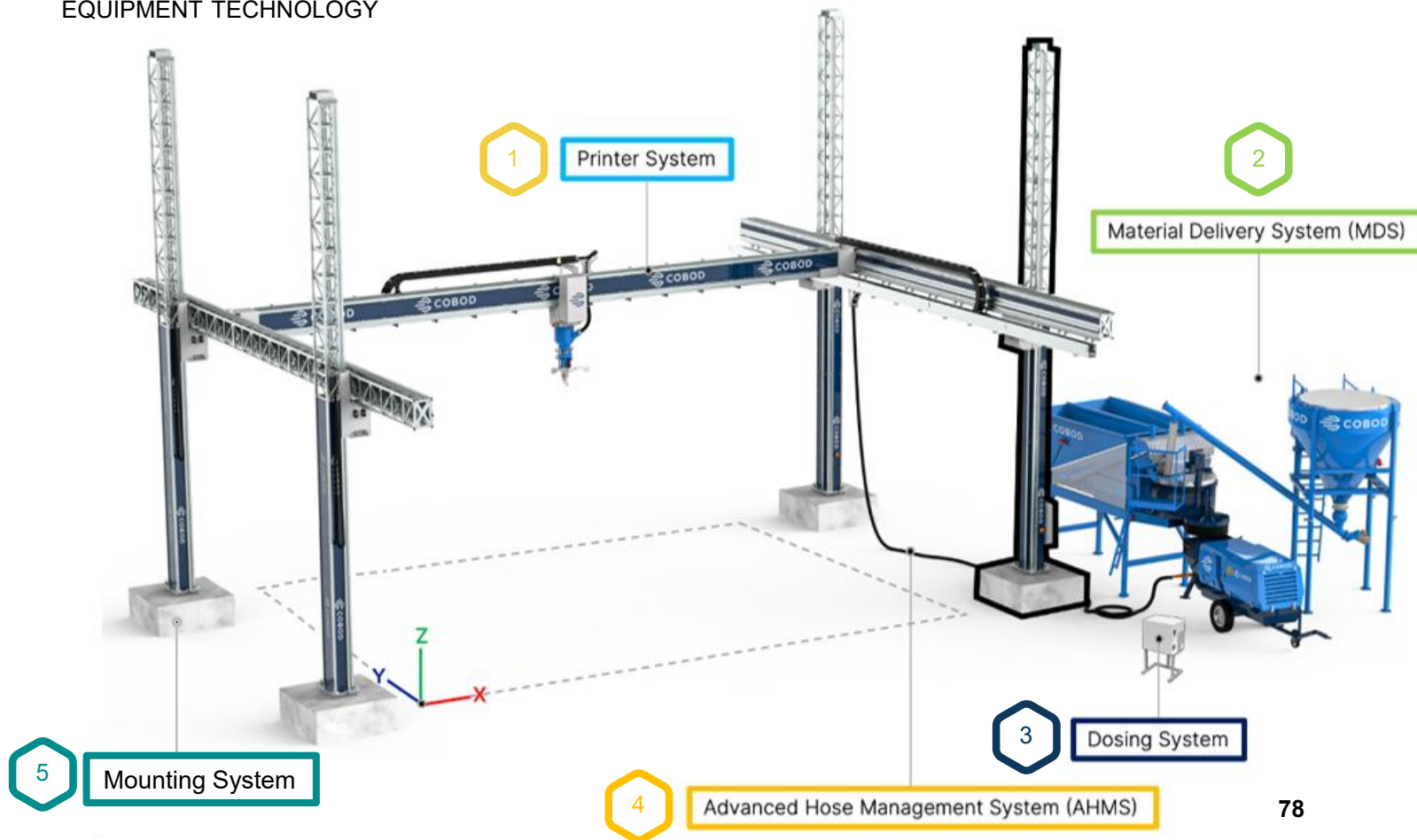


Organization and resources:

- 1 workshop and following work sessions organized to establish caisson construction procedure
- 2 work shops organized to progress on the manufacturing methods

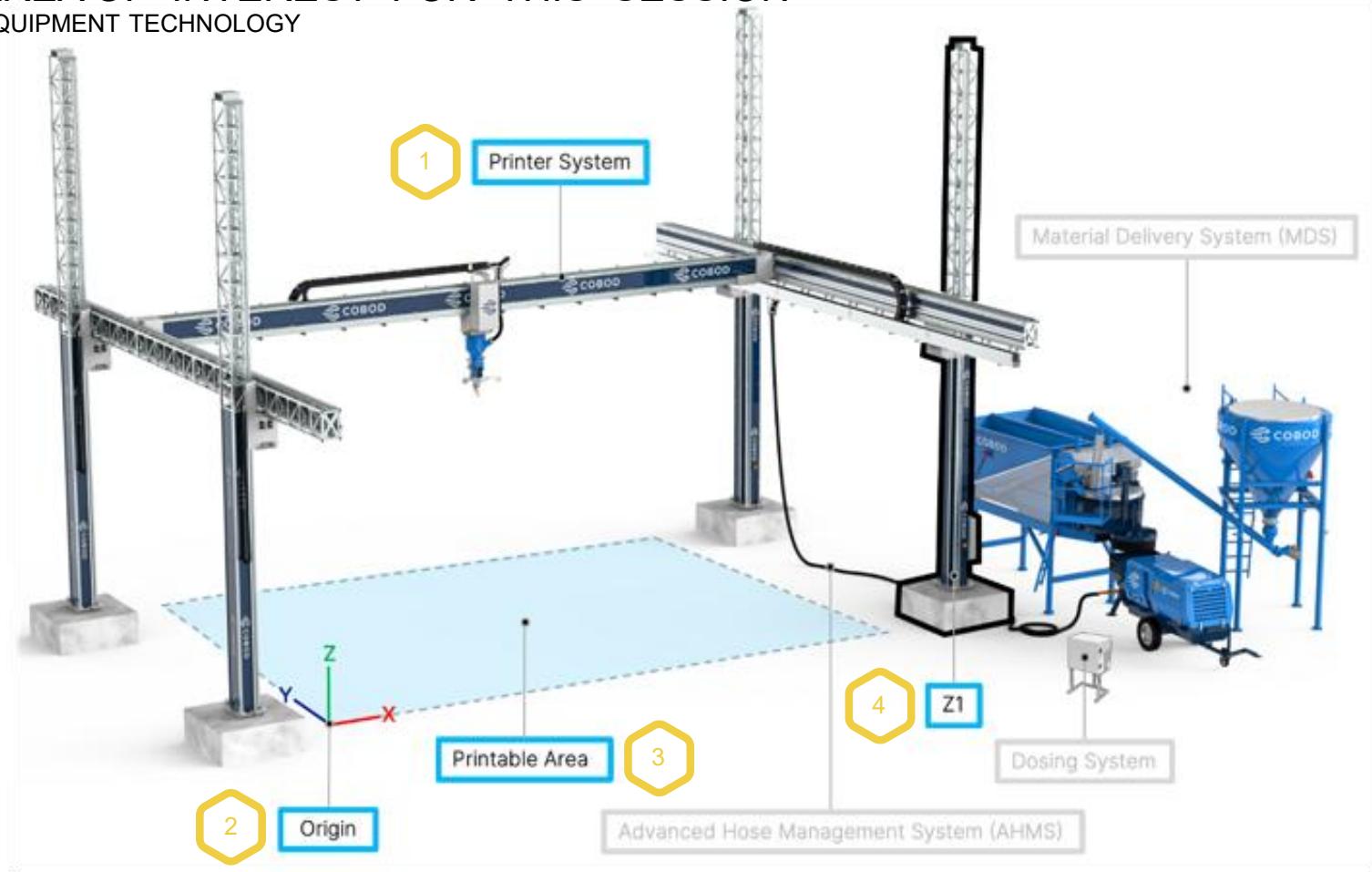
BOD2 3DCP SYSTEM OVERVIEW

EQUIPMENT TECHNOLOGY



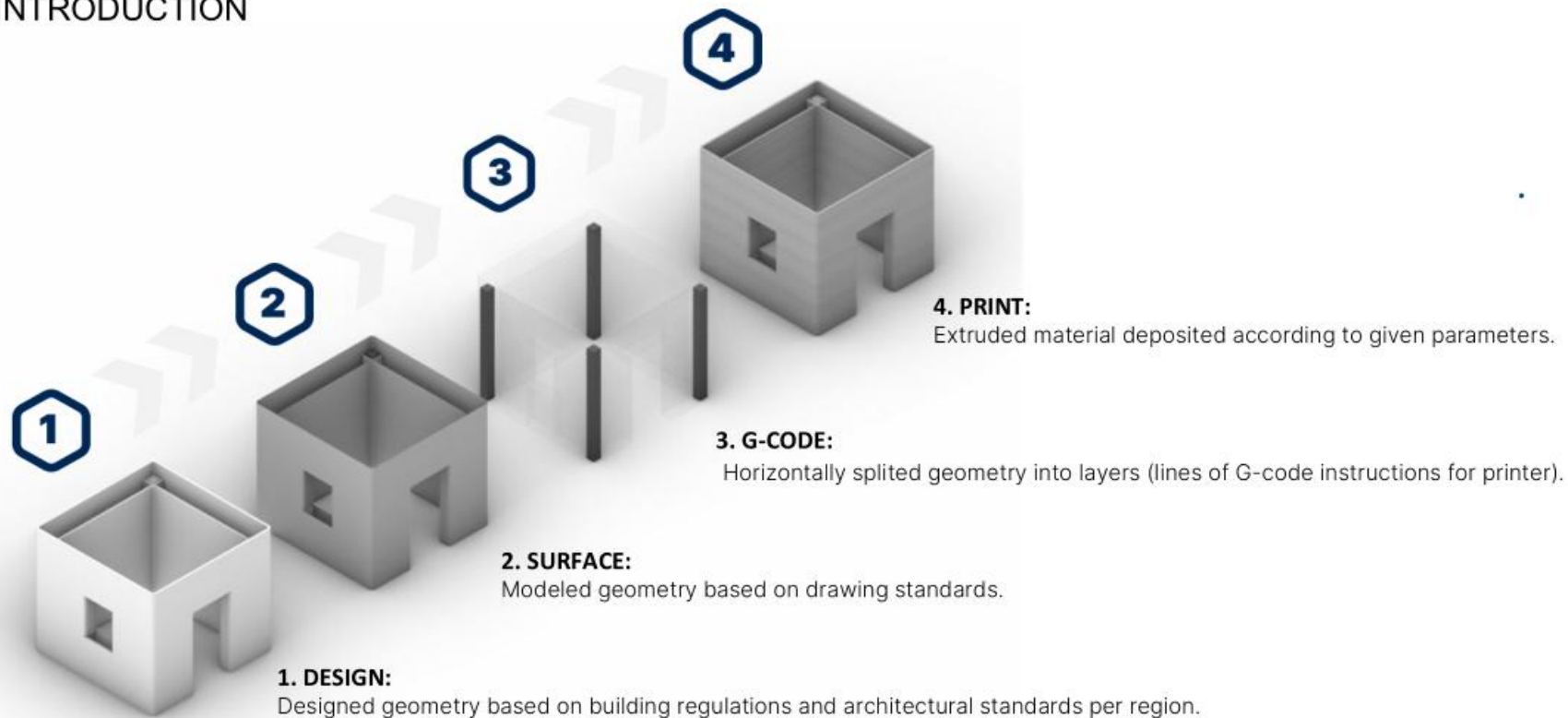
AREA OF INTEREST FOR THIS SESSION

EQUIPMENT TECHNOLOGY



3DCP PROCESS WORKFLOW

INTRODUCTION



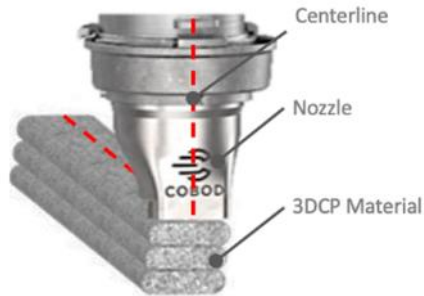
CENTERLINES

LAYER SPECIFICATIONS

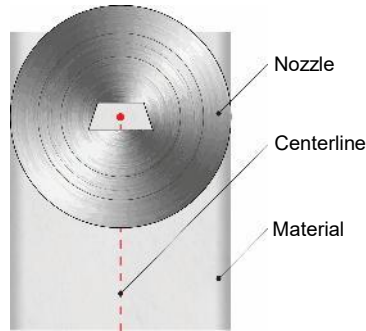
A centerline is a theoretical surface or plane representing the center of each 3D printed element. This surface is then imported into COBOD Slicer as a step file where it will be divided into individual horizontal layers, each layer act as a toolpath for the 3D printer to deposit material layer by layer.

A centerline runs exactly through the middle of the nozzle as seen in the pictures.

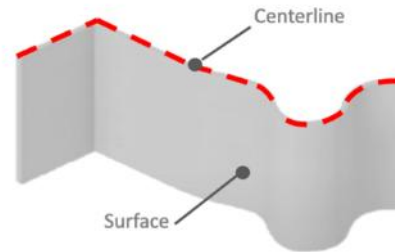
Front view



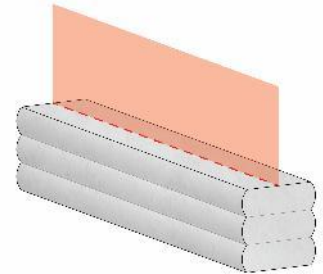
Top view



Centerline in COBOD Slice

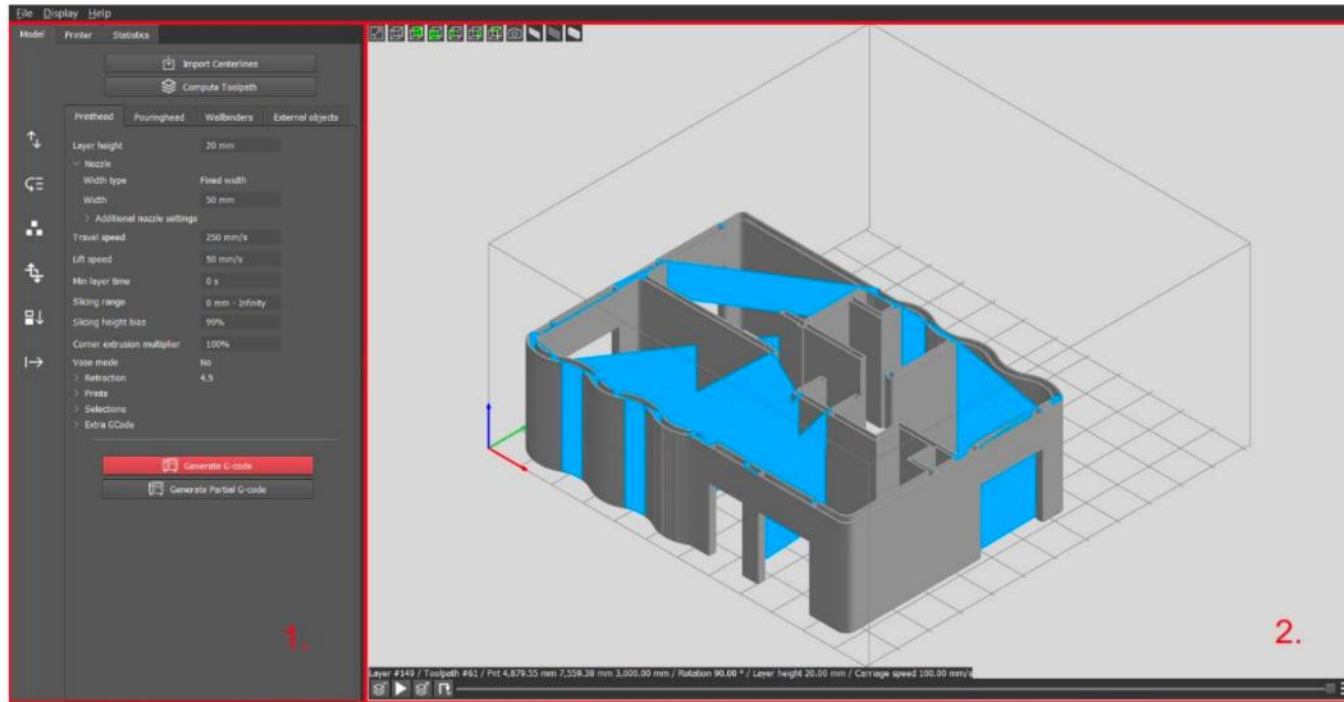


Centerline in reference to edges



PROGRAM NAVIGATION AND INTERFACE

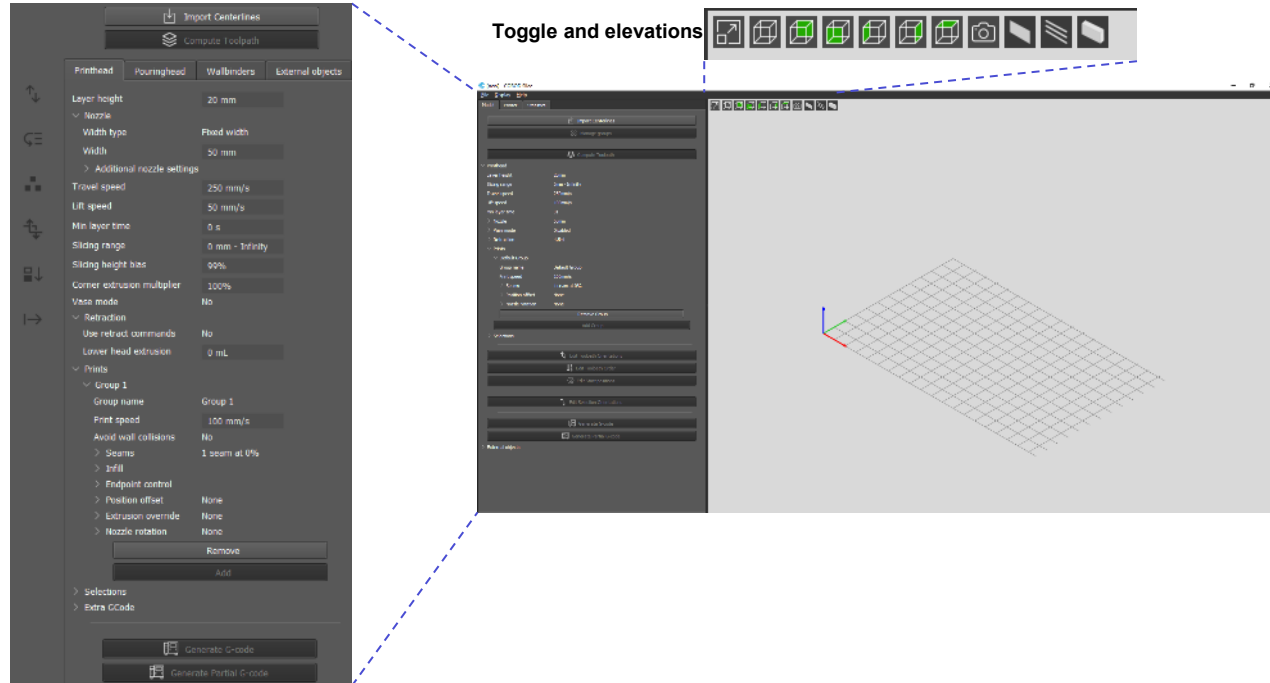
MAIN INTERFACE



PROGRAM NAVIGATION AND INTERFACE

INTERFACE TABS

Import , print parameters and Gcode export



Statistics/output

Total length	0m
Print length	0m
Rapid length	0m
Estimated duration	
Estimated concrete volume	0L
Layer count	0
First layer Z	0m
Last layer Z	0m
Average layer time	
Min layer time	
Max layer time	

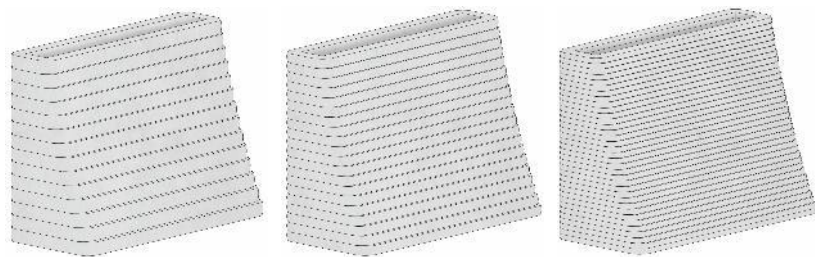
Layer	Print length	Rapid length	Duration	Print speed	Vo
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PARTS OF A LAYER

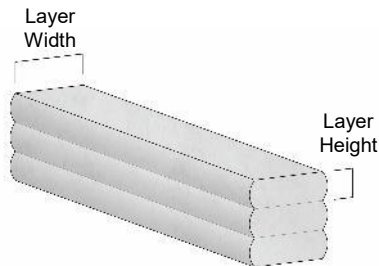
LAYER SPECIFICATIONS

Layer specifications such as centerlines, height and width (that create high or low resolution, high or low production) can vary depending on the design criteria, however, it is important to decide such parameters when you start designing a 3DCP building as they will significantly impact look, operation and quality control of your product.

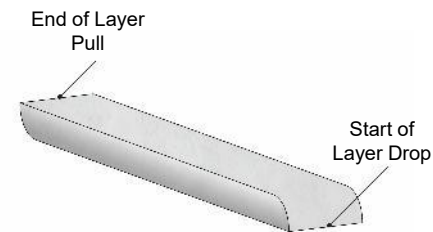
Surface Finish Resolution



Basic Dimensions



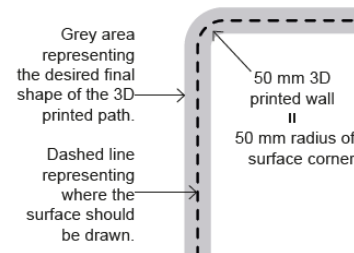
Start and stop locations, also known as “SEAMS”



CORNERS

The COBOD printers cannot make 90 degrees sharp corners today, which is why when you are modeling, the corners must have a fillet.

The radius of the fillet must be greater or equal to your layer width. For example, if you have a wall which is 50mm, then the radius of your corner fillet must be equal or greater than 50mm, or as a reference, the radius of the corners is equal to the width of your nozzle



MATERIALS PER COMPONENT

SILO



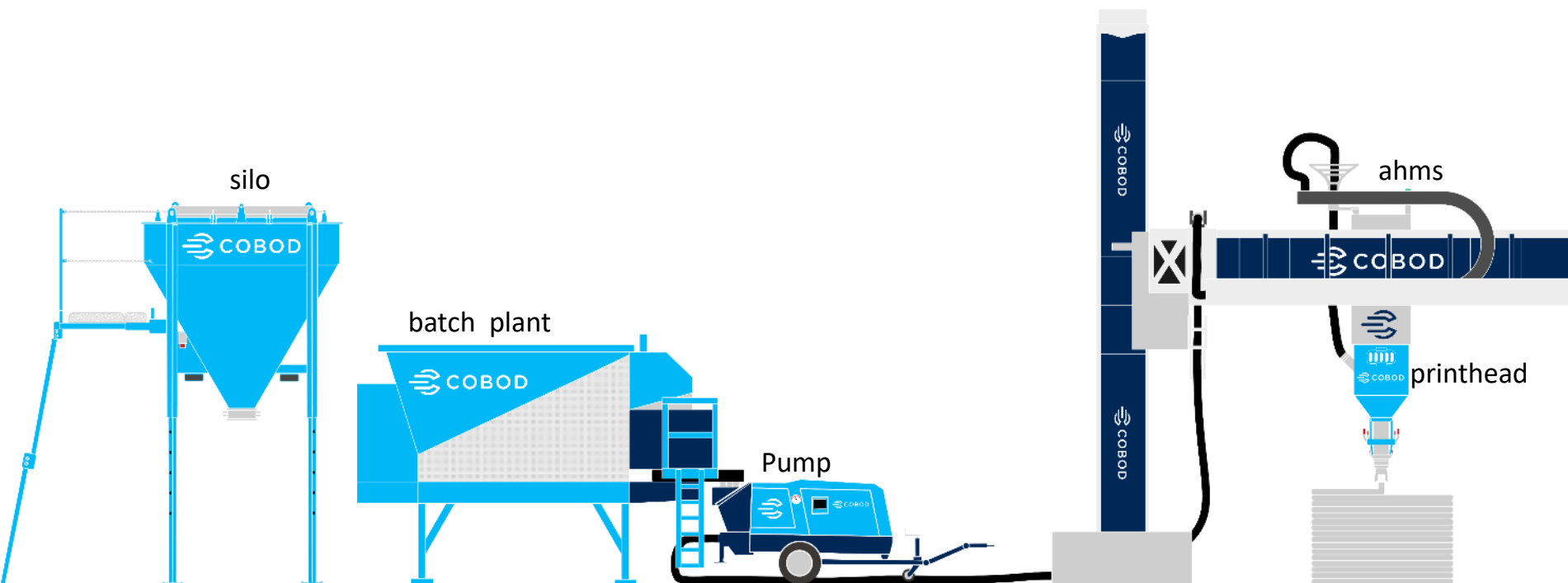
BATCH PLANT



PUMP



SYSTEM OVERVIEW (MDS + PRINTER)



ADDITIVE MANUFACTURING STRATEGY

- The print parameters are evaluated to determine the potential construction requirements
- Key considerations:
 - Printer selection,
 - Infrastructure requirements,
 - Material delivery systems
- Operational workflow
- Sensor integration (Moisture & environmental sensors for material performance monitoring)
- Other considerations: Safety, environment, risk, cost etc.

ADDITIVE MANUFACTURING STRATEGY

- Printer selection
 - COBOD BOD XL 4-10-5
 - 20 x 50 x 25 m
 - Production speed 36 m³/h
 - Using RMC truck MDS -
 - Note: for small scale demonstrators, a mini batchplant is used to test and calibrate materials, for the actual sale caisson, moving to RMC trucks will be necessary for scaling up.

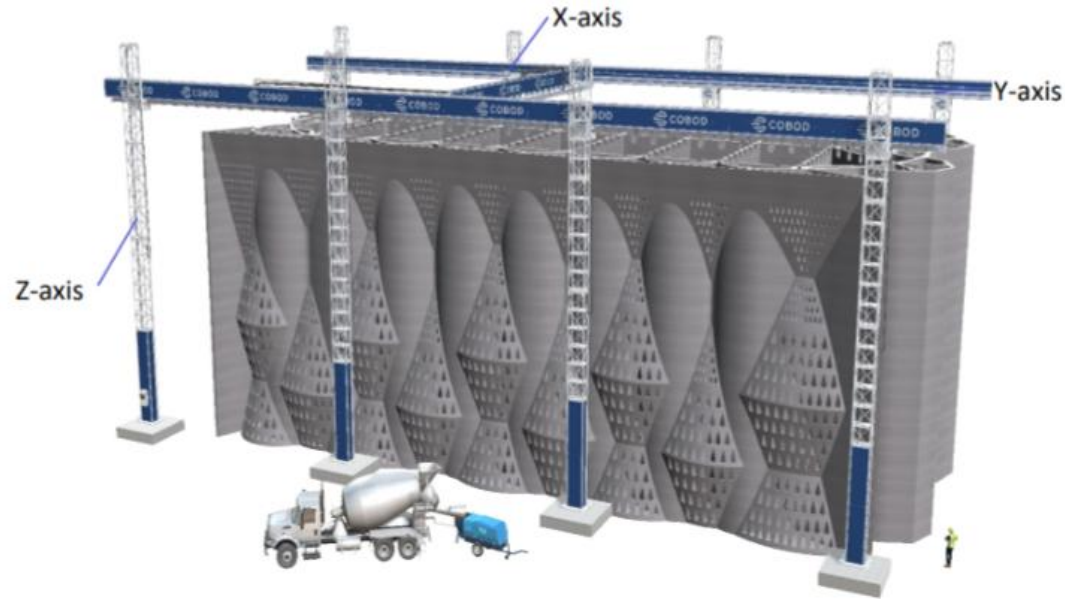
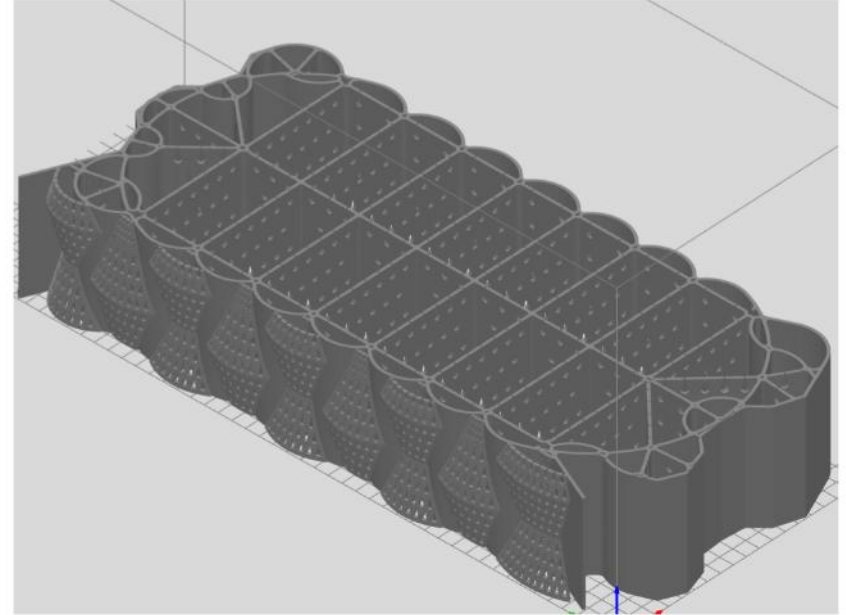


Figure 4.2 – COBOD BODXL 4-10-5 constructing the 3DCP caisson

PRINT PARAMETER EVALUATION

- Input:
 - Layer height (60 mm) –
 - We aim to increase printed layer height to 150mm, thereby increasing execution speed with respectively 150%
 - Layer width (200 mm) -
 - Print speed: 250 mm/s on average, up to 500 mm/s
- Output:
 - Extrusion rate (m3/hour)
 - Time between layers (layer time) (minutes)
 - Print duration (total hours of printing)



Print stage, Layer #132 (COBOD Slicer)

PRINT PARAMETER EVALUATION

(Changes expected due to vertical reinforcement and technology developments)

Print speed	250	mm/sec
Layer height	60	mm
Printing efficiency (Downtime, cleaning, maintenance etc.)	66%	%
Output pr hour in m3	7.11	m3
Layer count	325	
Layer time	46	Minutes
Print time caisson	251	hours