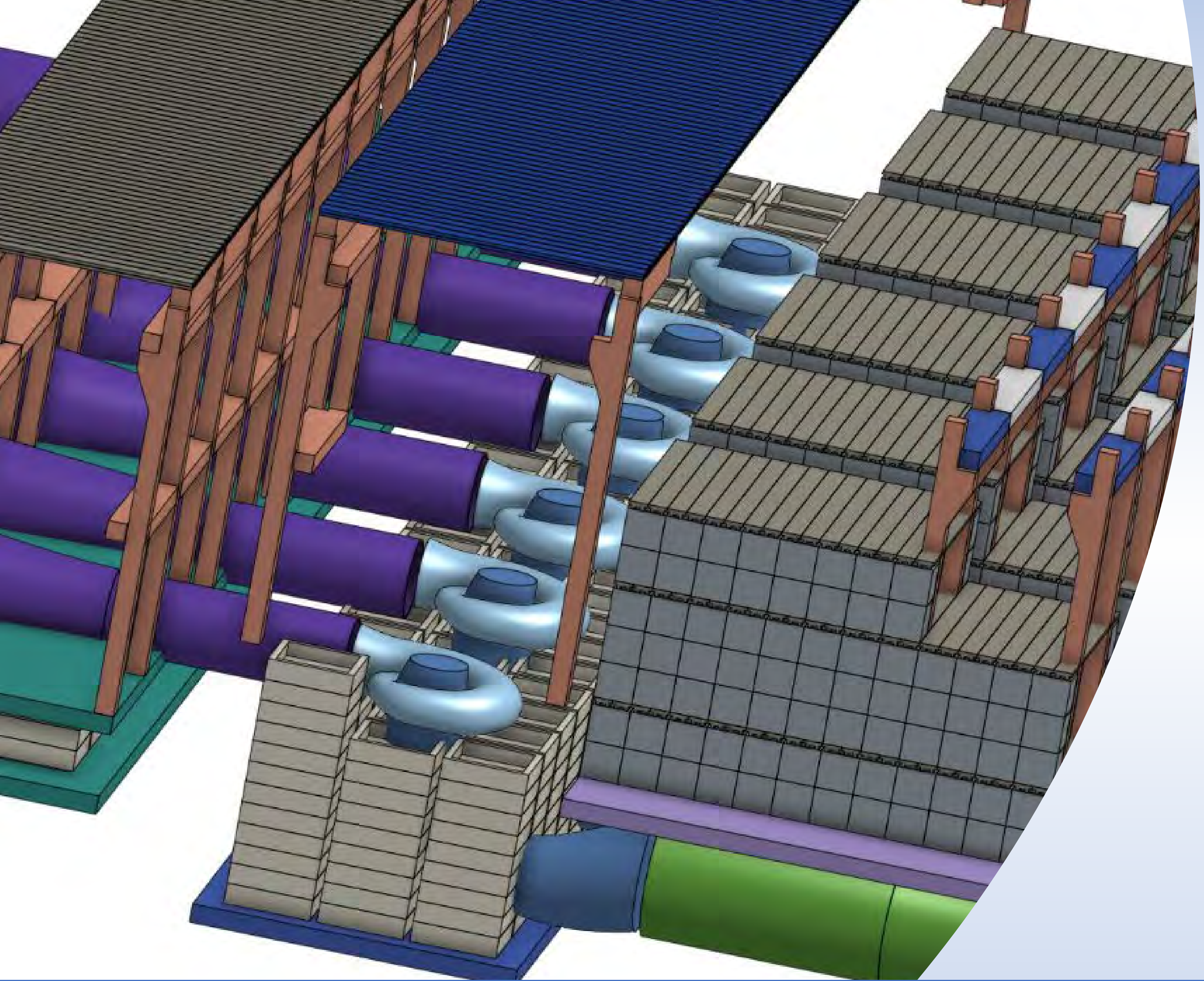

FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

FDE Hydro™ Modular Precast Pumped Storage Hydropower Solution

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"FDE Hydro Civil Solutions brings Predictability to an Unpredictable Environment"™

FDE Hydro™ Rapidly Deployable Design Models

Including Means and Methods

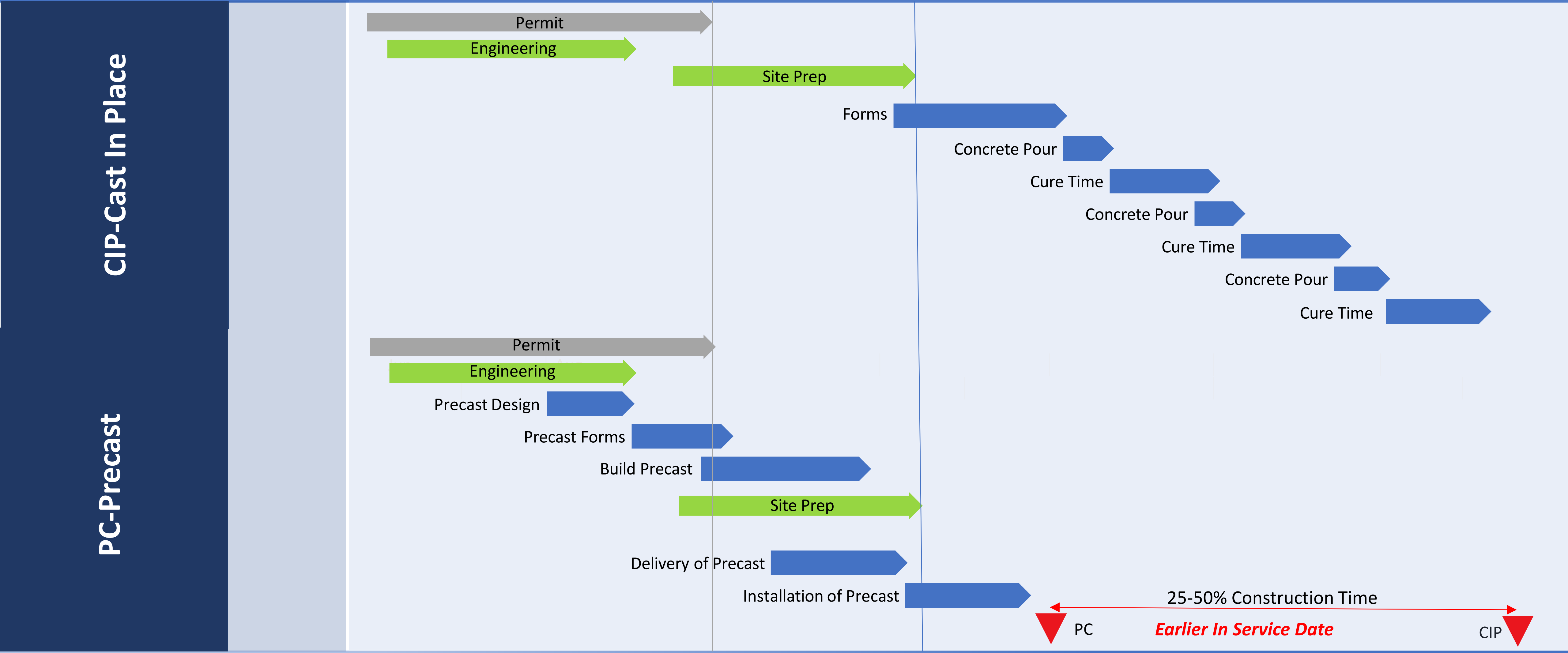
FDE FRENCH DEVELOPMENT ENTERPRISES MODULAR HYDRO SOLUTIONS

Renderings of modular precast designed for hydropower and mining industry tailing dam market – Further analysis to lock down exact number of linkages, dowels, sizes, thicknesses, reinforcements, etc.

- **FDE Hydro™ module catalog includes all shapes and sizes-based design loads and surrounding environment**
- **Designs engineered based on site specific reports (hydrologic, geotechnical, structural - <u>done by others</u>)**
- **Scalability of modules; linkages, keyways, injected UHPC grouting, and water stop, support with world class vendors and manufactures (turbine agnostic – design to fit any turbine)**
- **FDE Hydro™ modular solutions can encompass smart dam technology, water treatment, etc.**
- **Site study of conditions to provide efficient installation**
- **Shotcrete coating with rock anchors to stabilize vertical slope to accept modules**
- **<u>Modular precast methods and means project time reduces risk to all project stakeholders</u>**

"FDE Hydro™ Civil Solutions brings Predictability to an Unpredictable Environment"™

Schedule Comparison CIP to PC



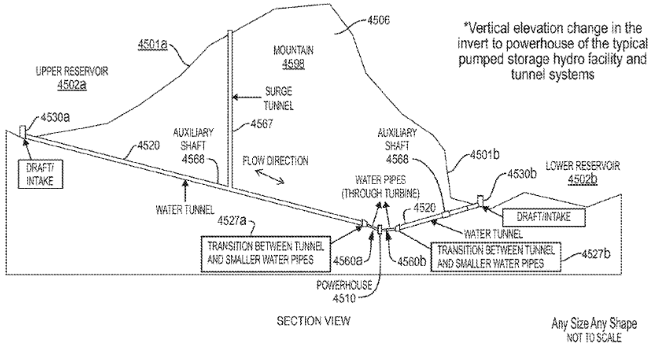
ANY SIZE ANY SHAPE
NOT TO SCALE

FDE Hydro™ Intellectual Property

Pumped Storage Hydropower Patented Images

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

Transition Between Larger Tunnel to Smaller Feeds
Precast Concrete Pumped Storage Hydro Facility



Tunnel Manifolds and Draft Tube
Typical Pumped Storage Hydro

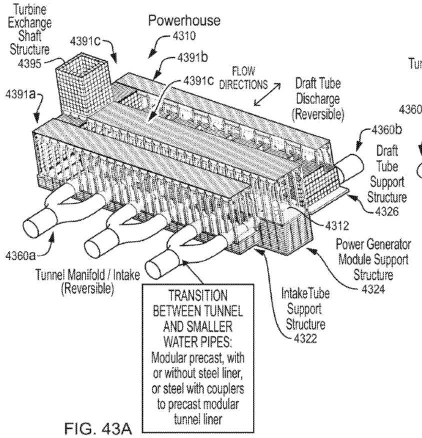


FIG. 43A

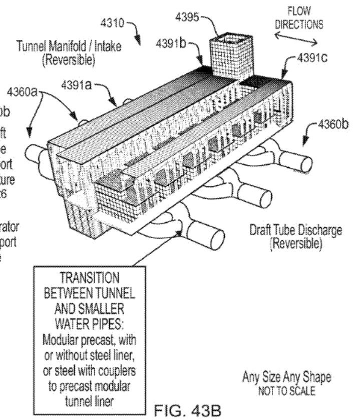


FIG. 43B

Tunnel Manifolds and Draft Tube
Typical Pumped Storage Hydro

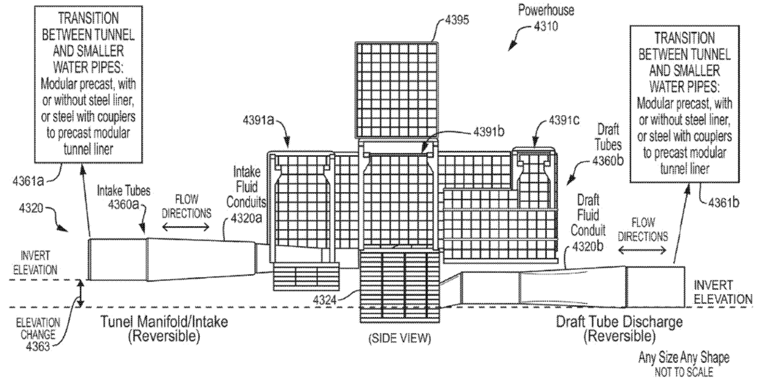


FIG. 43C

Tunnel Manifolds and Draft Tube
Typical Pumped Storage Hydro

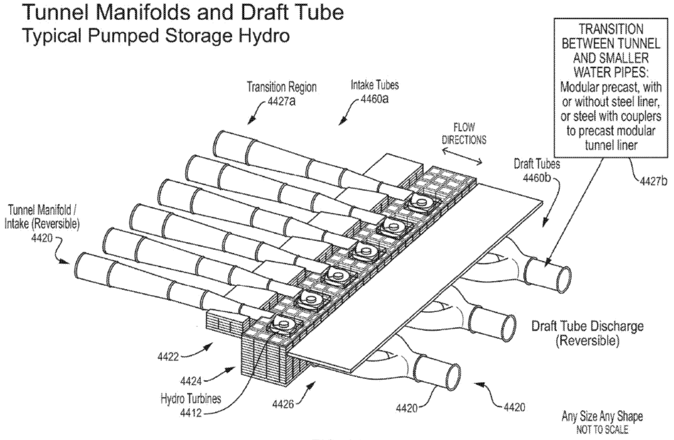


FIG. 44

PRECAST TBM OVER STEEL LINER

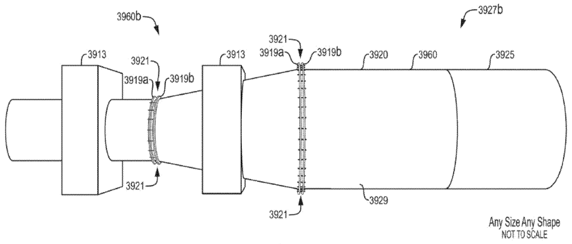


FIG. 39H

Top View of the Transition Section

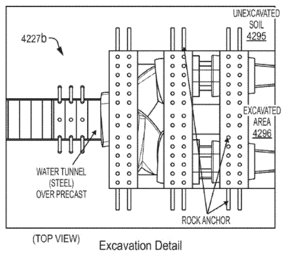


FIG. 42B

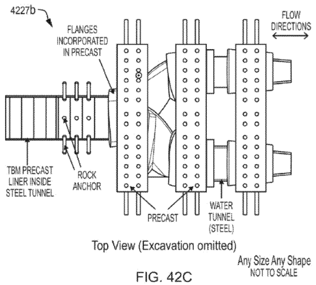


FIG. 42C

Draft-Intake Modular Precast Structures
Intake 2

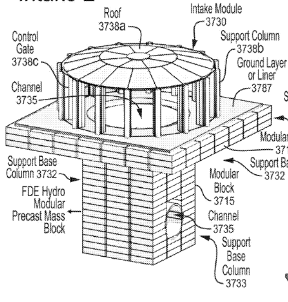


FIG. 37A

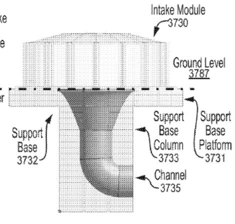


FIG. 37C

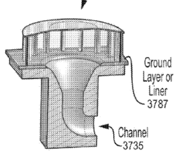
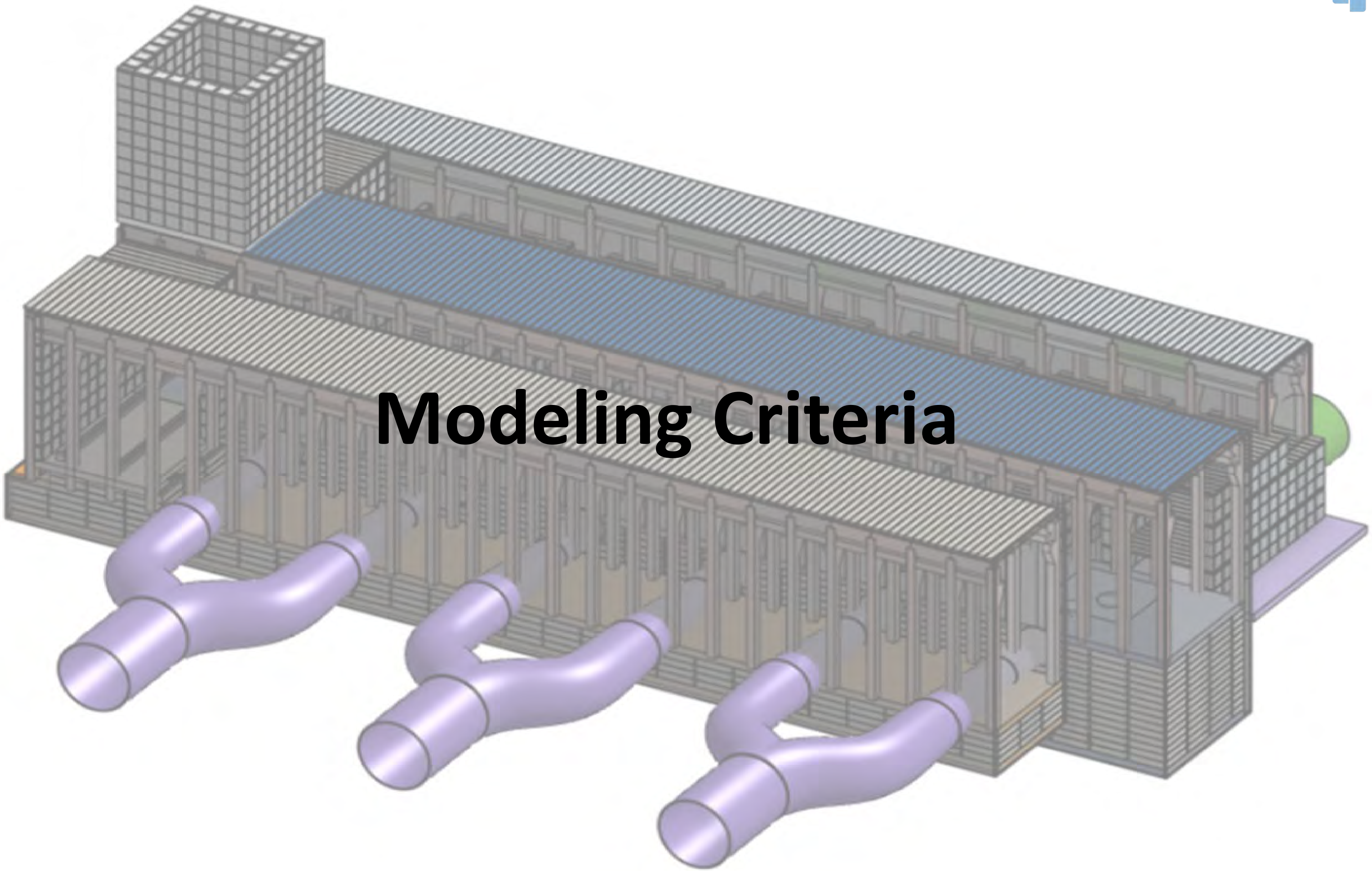


FIG. 37B

Any Size Any Shape
NOT TO SCALE

Modeling Criteria



Proprietary Picture: Powerhouse Model

Precast is Equal to or Stronger than CIP

Each section designed to bear the necessary combination of loads and transfer them safely to other members, as per engineer of record calculations. You can have any size, shape, wall thickness, and linkages adjustments to fit the needs of the project.

When comparing load capacity of precast concrete to cast-in-place concrete, precast concrete generally has higher load-bearing capacity due to its controlled manufacturing process, allowing for better quality control and higher compressive strength, making it capable of handling heavier loads compared to cast-in-place concrete poured on-site; however specific load capacity depends on the design and reinforcement of each individual element in both methods.

Given the same cross-sectional area, rebar configuration and load model, precast concrete can handle more load in shear, tension, compression, and torsion than conventional cast-in-place concrete (CIP).

The columns, beams, and ceiling in the powerhouse were conceptually designed using precast/prestress

Key points to consider:

Strength:

Precast concrete typically achieves higher compressive strength because it is produced in a controlled environment, allowing for optimal curing conditions and precise reinforcement placement.

Precast concrete has ultimate compressive strengths (averaging 6,000 psi to 7,000 psi) ranging between 25% to 75% higher than conventional CIP concrete (4,000 to 5,000 psi). Concrete cover requirements over reinforcing are also normally a little less than for CIP concrete. In some cases, the reinforcing in PC concrete can be reduced slightly and still yield the same strength as CIP concrete. PC concrete is more efficient than CIP.

Customization:

While precast concrete can be customized to a certain extent, cast-in-place concrete offers greater flexibility for adapting to complex site conditions and design requirements.

Operating Life:

PC concrete has a longer service life in comparison to CIP concrete, and therefore less maintenance. Therefore, PC concrete can handle loads for a longer period of time than CIP concrete. Therefore, PC concrete is not only stronger, but it also lasts longer under the same loads and has far less maintenance cost than CIP concrete. There are studies available that show this type of information.

Grout and Waterproof:

Areas in contact with water, or that require seal/unifying components benefit from the use of grout, chemical adhesives/water sealants that are capable to provide sufficient resistance to static and dynamic loads in general. Case-by-case analysis should be performed by engineer of record to choose most efficient material.

Seismic Loads:

Precast can be designed to accommodate lateral movement using specific linkages (also designed for same purpose) – as any other concrete material designed for seismic loads would too.

Cast-in-Place x Precast: Quality Control

FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

Cast-in-Place Concrete

Moisture reaches rebar and oxidation compromises structural integrity*
=

- **Weakened member,**
- **Material waste,**
- **Time consuming redo or repair, (Remove, reforming, and rebar laying again)**

*One of several cast-in-place challenges.
Others include curing weather, time window for pour, pumping, additives and water control/availability on site

Precast Concrete

Smooth finish, controlled curing temperature and batches
=

- **Higher strength**
- **Inspected before deployment**
- **Traceable quality insurance**
- **Lower Risk**
- **Predictable**
- **Rapidly assembled**
- **Environmentally friendlier**

Precast: Better Quality and Operational Life

The Manufacturing of Precast Modules provides numerous advantages. The reasons precast concrete is stronger than CIP concrete include the following.

Key points to consider:

Quality Control:

Precast concrete benefits from stricter quality control measures during manufacturing, which can lead to more consistent strength throughout the structure.

Manufacturing precast concrete (shop or field environment) is superior compared to conventional form, rebar, place, strip, and cure CIP concrete in the field. PC concrete has superior curing methods that include water misting and steam. Precast Concrete Institute (PCI) has strict guidelines for manufacturing plants to be certified in producing precast concrete. Concrete with strict quality control produces the same results repeatedly and predictably. Superior quality manufactured concrete yields stronger and longer service life than CIP concrete.

A precast concrete finish is also far superior to a CIP concrete formed finish. If the project specifications requires a rub finish on portions of CIP concrete, a major effort is required to do so. PC concrete is manufactured with an excellent finish in comparison to CIP concrete formed finishes. Form liners can also be used to develop desired architectural finishes/textures.

Construction Time:
Precast construction is often faster as the prefabricated elements are ready to install upon delivery, eliminating the need for on-site formwork and curing time. Potential factors affecting load capacity in both methods:

- **Concrete mix design:**
  The specific concrete mix used in both precast and cast-in-place construction will significantly impact the ultimate load capacity.

- **Reinforcement placement:**
  Proper placement and design of reinforcing steel in both methods is crucial for maximizing load-bearing capacity.

- **Curing conditions:**
  Ensuring adequate curing time and temperature control is essential for achieving optimal concrete strength in both precast and cast-in-place applications.

From Manufacturing to Placement

QUALITY CONTROL

CONCRETE MIX DESIGN

REINFORCEMENT PLACEMENT

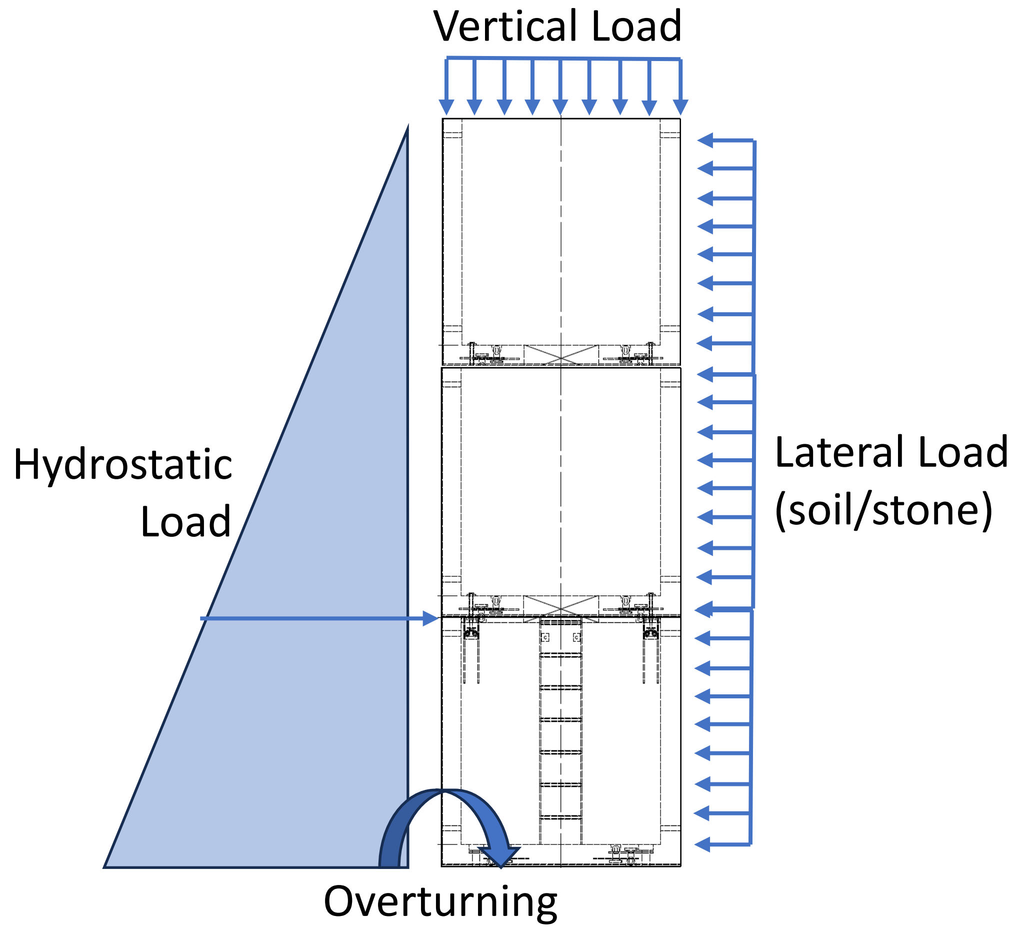
CONSTRUCTION TIME

CURING CONDITIONS

Advantages of Prefabrication Structural Concrete Modules

ANY SIZE ANY SHAPE
NOT TO SCALE

Modules for Project Load Criteria



Module Parameters

- Concrete strength (psi)
- Module wall thickness
- Overall module dimensions
- Steel reinforcement grade/diameter
- Double galvanized linkages
- Concrete keyways

Additional Features

- High quality control: materials and procedure
- Controlled curing conditions
- Accepted before installation

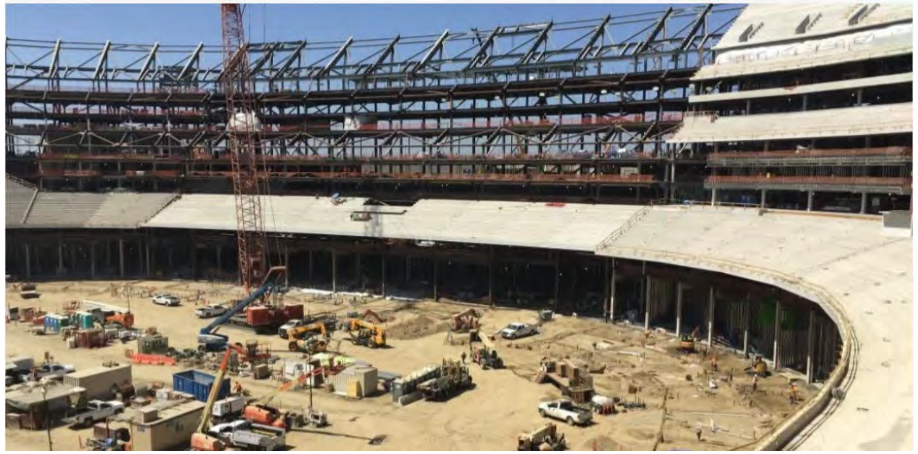
Load Criteria

- Tension
- Moment Coupling
- Compression
- Vibration/resonance
- Seismic
- More

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

Sample Precast Infrastructure Applications

Major Precast Concrete Innovations



SoFi Stadium, Inglewood, CA

Mario M. Cuomo Bridge, NY

Applepark Building, Cupertino CA

Precast built to withstand high loads including seismic

Using precast concrete elements on the Governor Mario Cuomo Bridge (Tappan Zee Bridge) construction significantly reduced construction time

The circular office building is thought to be the largest precast framed office building ever built.

Source: https://www.coreslab.com/projects/sofi-stadium/

References: Home | Governor Mario M. Cuomo Bridge

https://www.clarkpacific.com/project/apple-park-office-building/

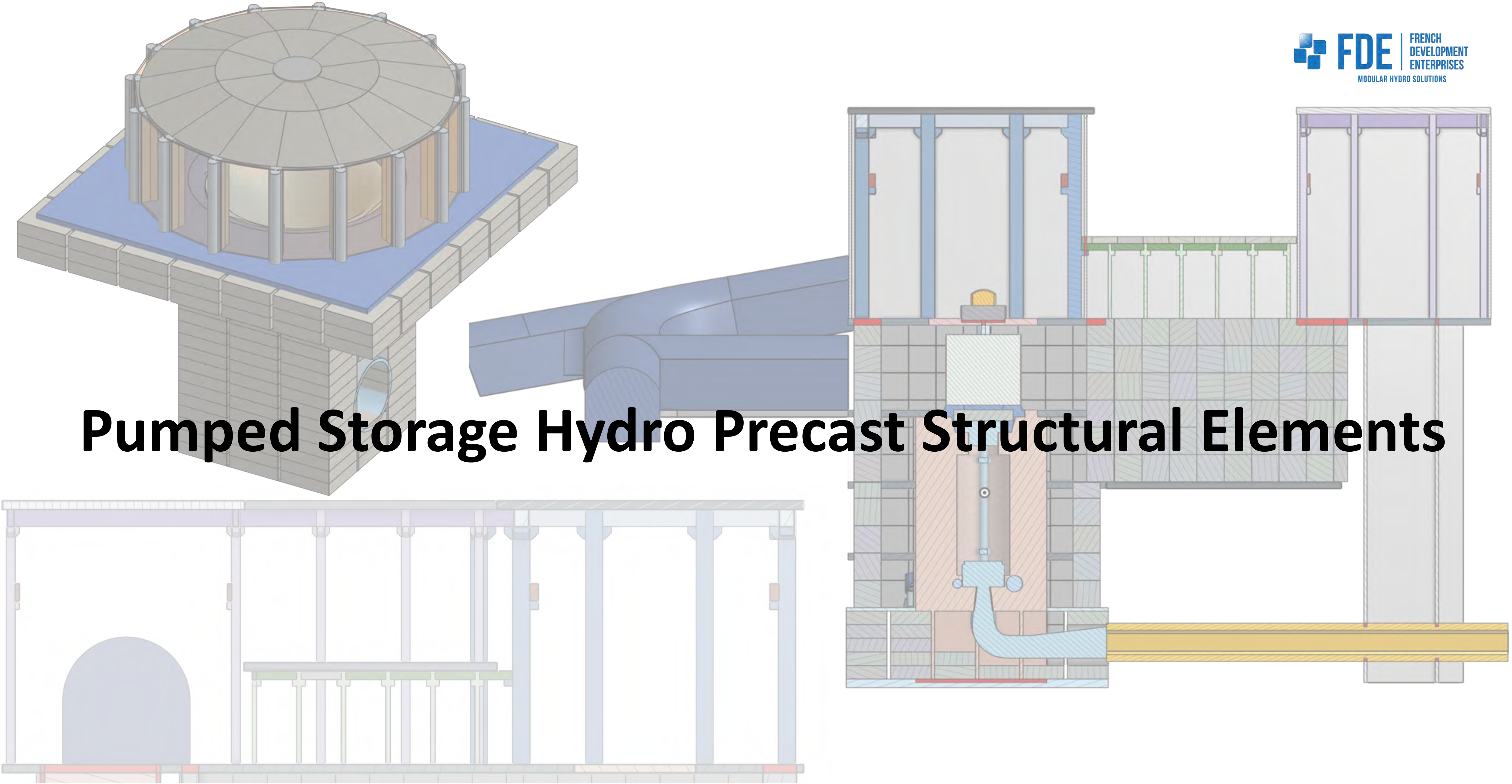
Precast TBM/Tunnel Liners

Source: https://www.youtube.com/watch?v=gaJfRzSDZSw

The Future is Now: Modernization and Innovation in Dam Engineering

The world of **hydroelectric dam design** is undergoing a remarkable change that's making projects faster, greener, and more efficient. At FDE Hydro™, we're proud to be part of this Reinvigorating Hydropower movement.

Pumped Storage Hydro Precast Structural Elements



Proprietary Picture: Powerhouse and Tap Model

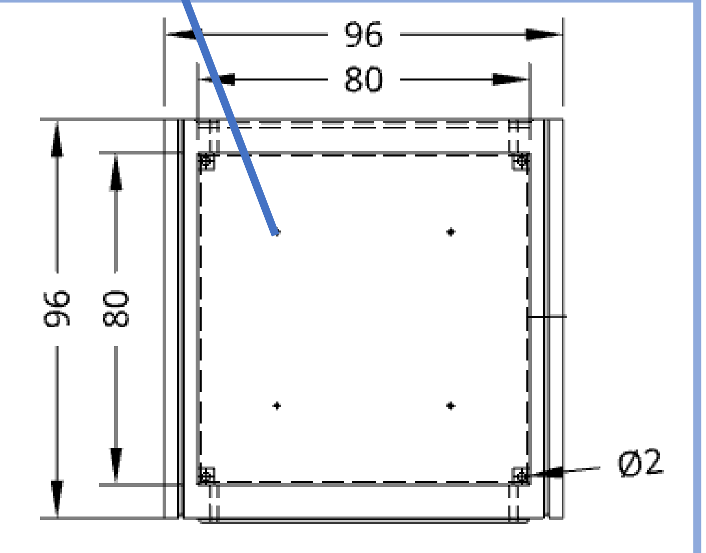
Block Dimensions and Details

Per Project Specification

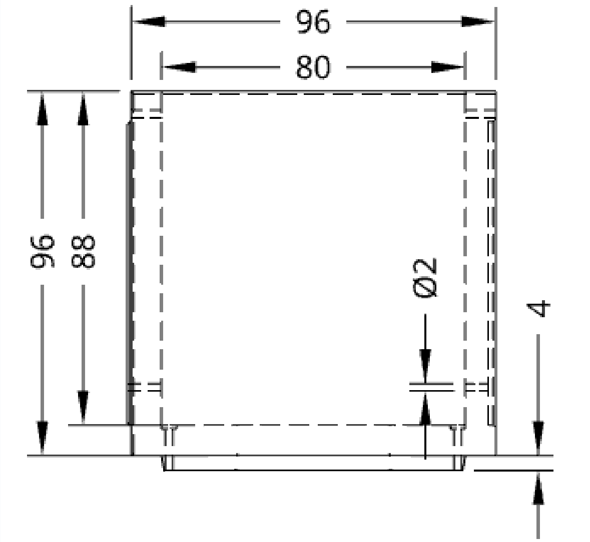
Lift point

Typical concrete weight of ea. block:
30,000 lbm (30 kip)

Keyways provide rapid alignment



Top View



Side View

Linkages, dimensions and other designed according to site requirements

Precast High Mass Lower Structure

Modernized Technology based on Historic Use

Photos in next slide are of the Hoover Dam foundation construction using box's forms and Cast-in-place (CIP) wood forms with a 28-day standard cure time.

FDE Hydro has taken the *slow and old* dam construction means & methods to develop **<u>RAPIDLY DEPLOYABLE MODULAR PRECAST</u>** concrete products bringing a disruptive technology to the water infrastructure industry!

Historic Cast-in-place Form Work

in Large Scale Hydro Projects

Form Work

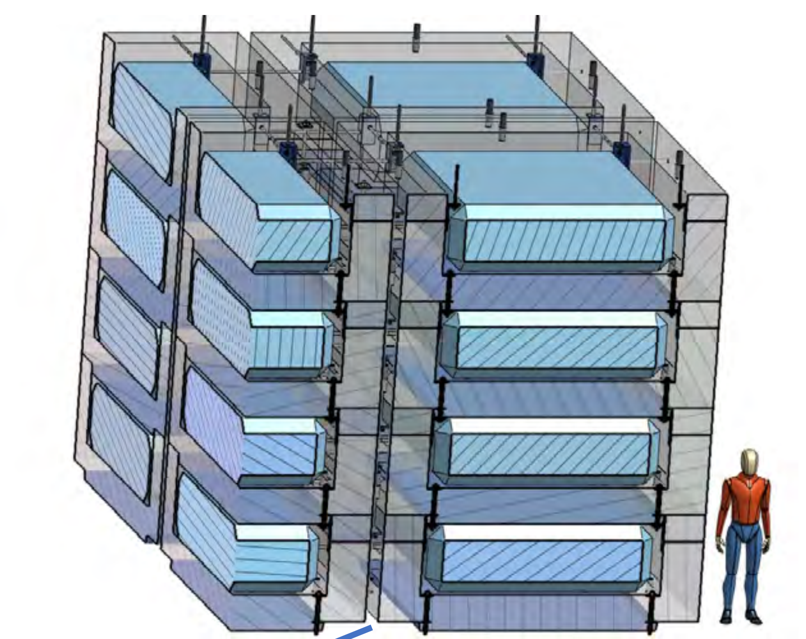
Filling the Forms

Final Product

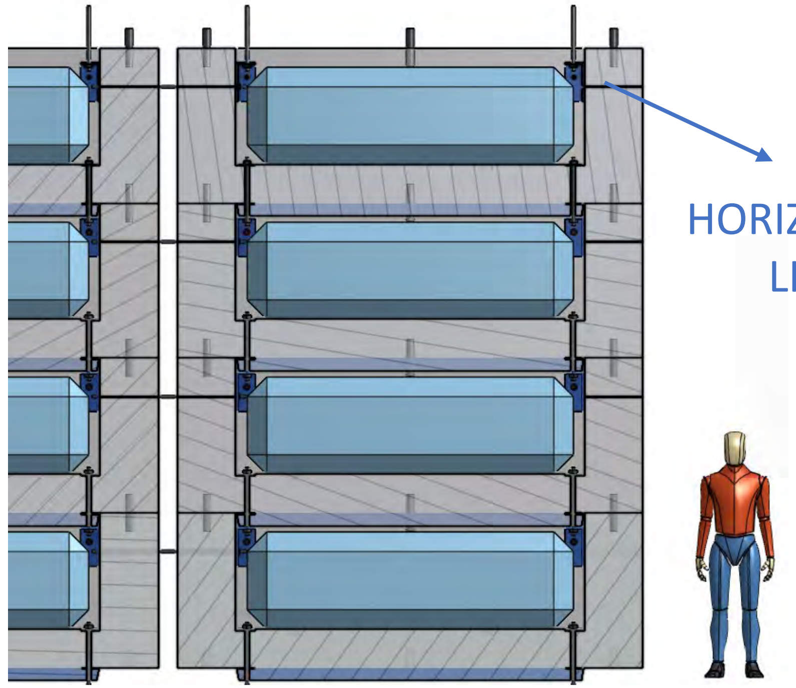
Reference: https://www.youtube.com/watch?v=khD_ryWxfMg

Key Advantages of Mass Block

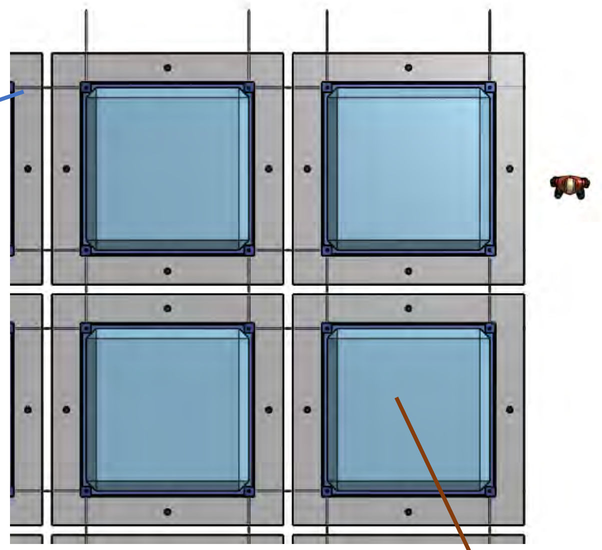
"Reduces Environmental Challenges of Extreme Heat/Cold Conditions"



Tolerance in between blocks*



HORIZONTAL LINKAGE



TOP VIEW

PRECAST INSERTS: DEAD WEIGHT

<u>Connected as one</u>

Double treated galvanized steel linkages (dipped and spun): bolts, rods, nuts, brackets, dowels and/or equivalent

<u>No water leaks</u>

Chemical and mechanical waterstop application (epoxies, reinforced grouts, and/or equivalent)

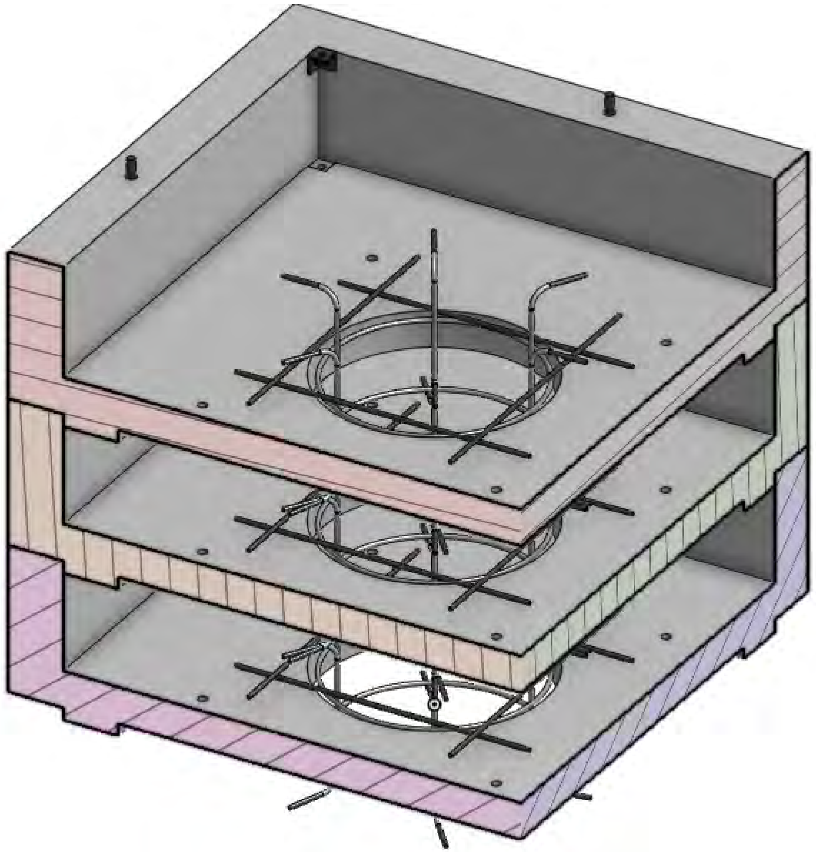
*Tolerance between blocks and linkage dimensions design according to project specs. Filling the gaps includes (but not limited to) grout and rebar, chemical waterstop compound, etc

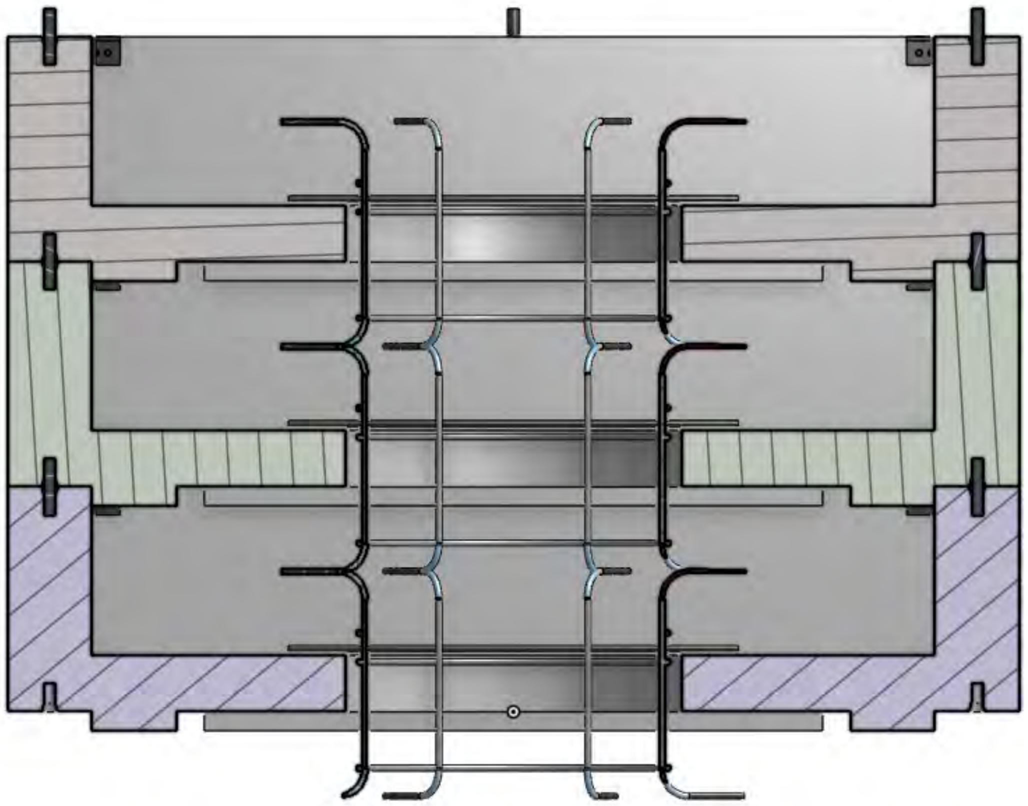
ANY SIZE ANY SHAPE
NOT TO SCALE

Pump Storage – Modular Blocks for Mass

Details – Option with Opening

FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS





Open-Source Picture

Linkages

Precast Modules are Linked

Forming One Monolithic Structure

- Concrete keyways, and double galvanized steel linkages or similar technology, much like any other precast components.

- FDE Hydro™ leverages existing linkages and waterstop with demonstrated history of deployment success.

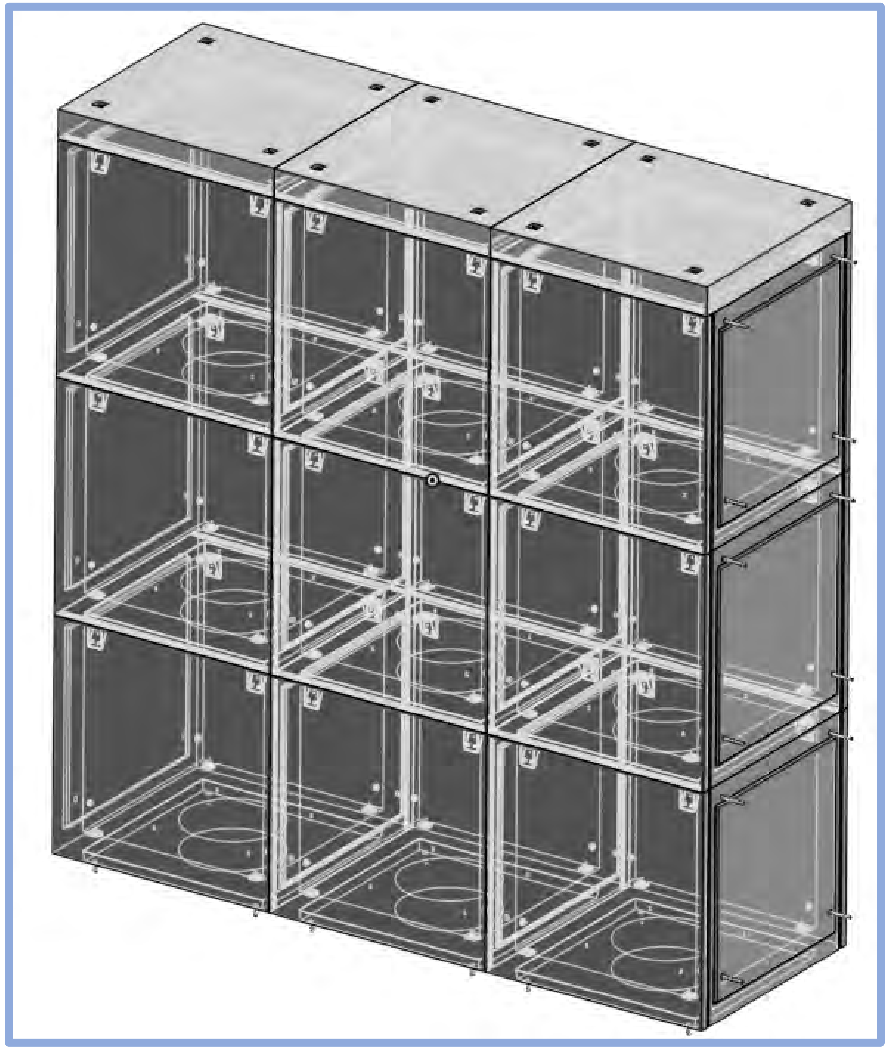
- Linkages and rock anchors or equal to will be sized based on engineering design loads for specific site requirements.

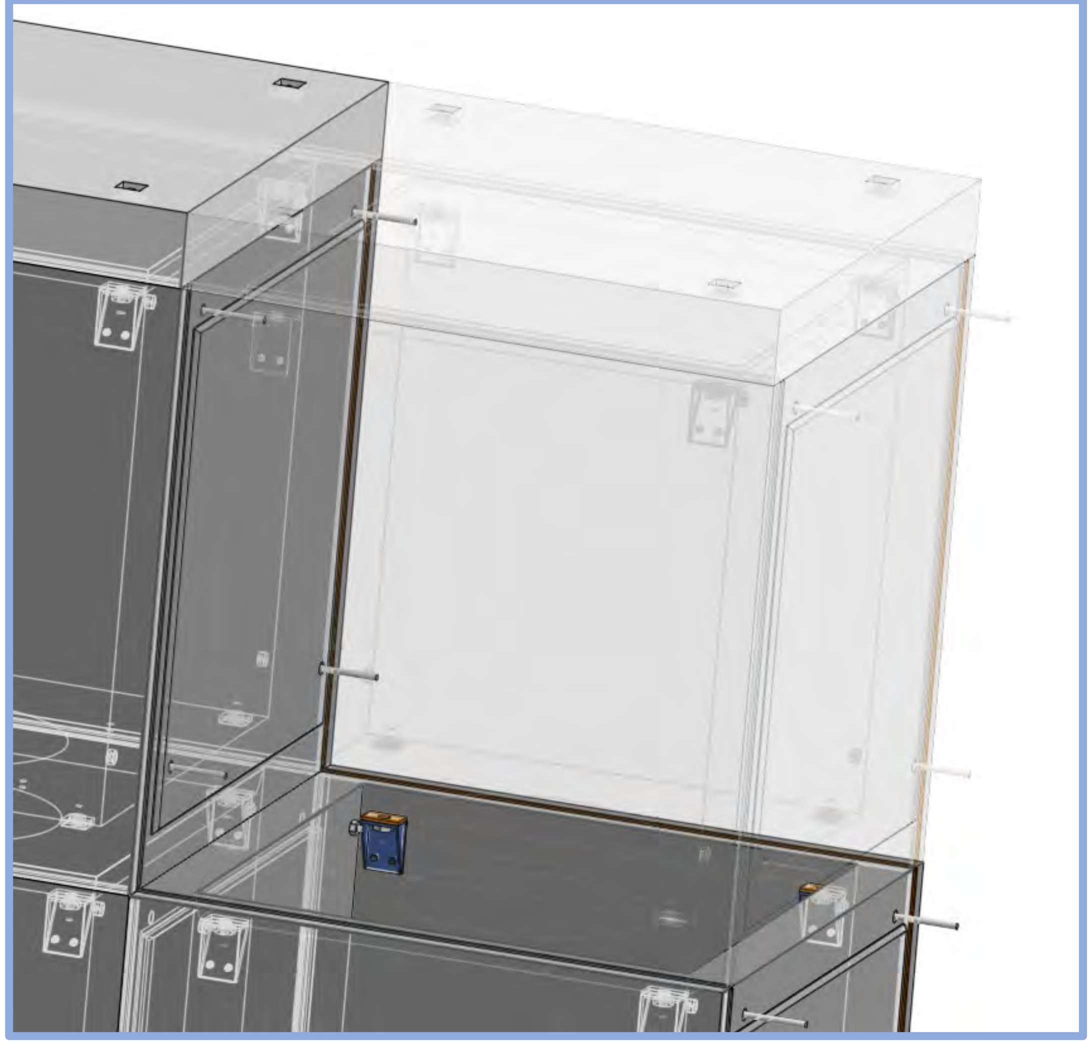
- Integrated concrete keyways in combination with linkages prevent slippage and overturn.

Sample - Water Stop and Linkage Bolts

Blocks 8x8x8 ft – Sample Wall

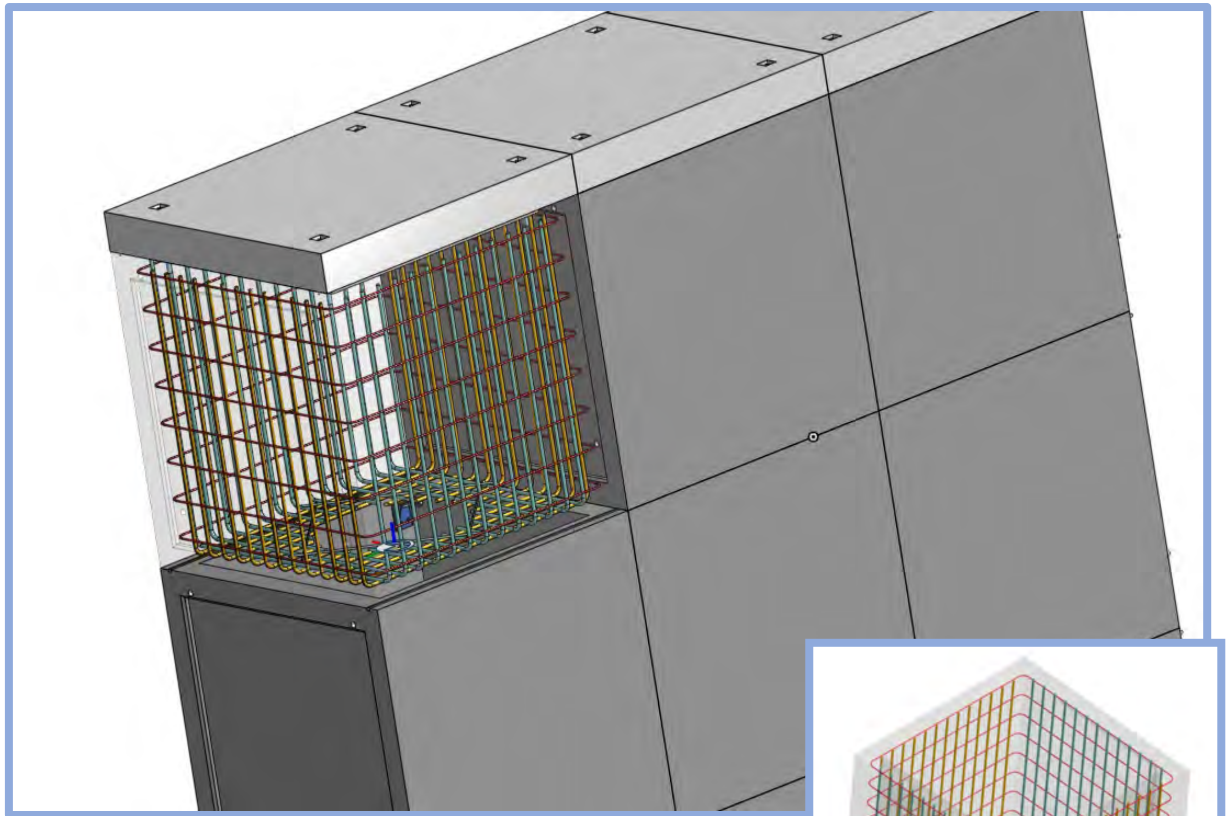
FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

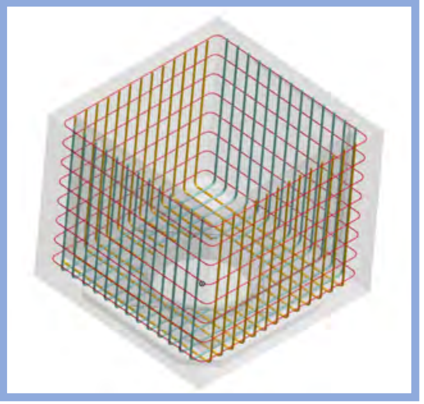


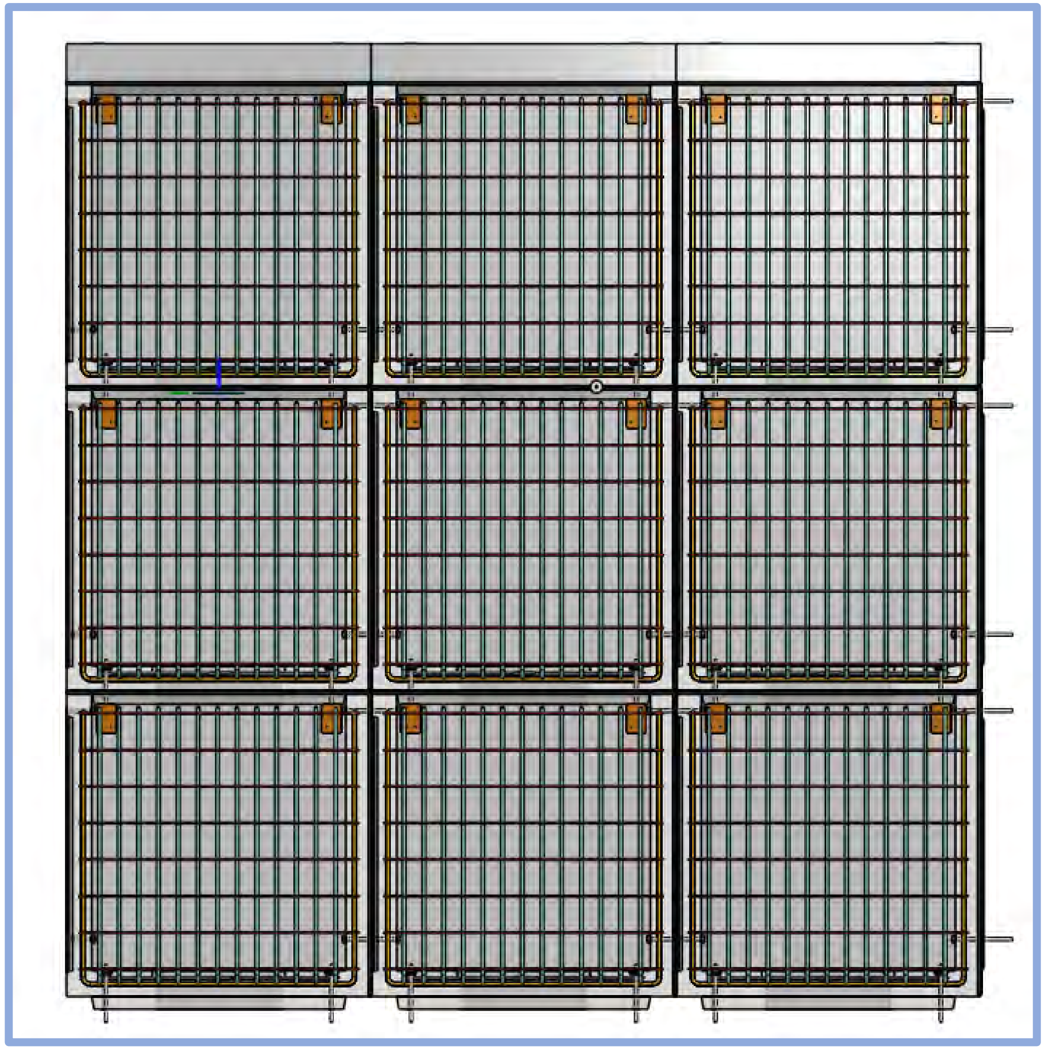


ANY SIZE ANY SHAPE
NOT TO SCALE

Precast Modules with Rebar per Specification

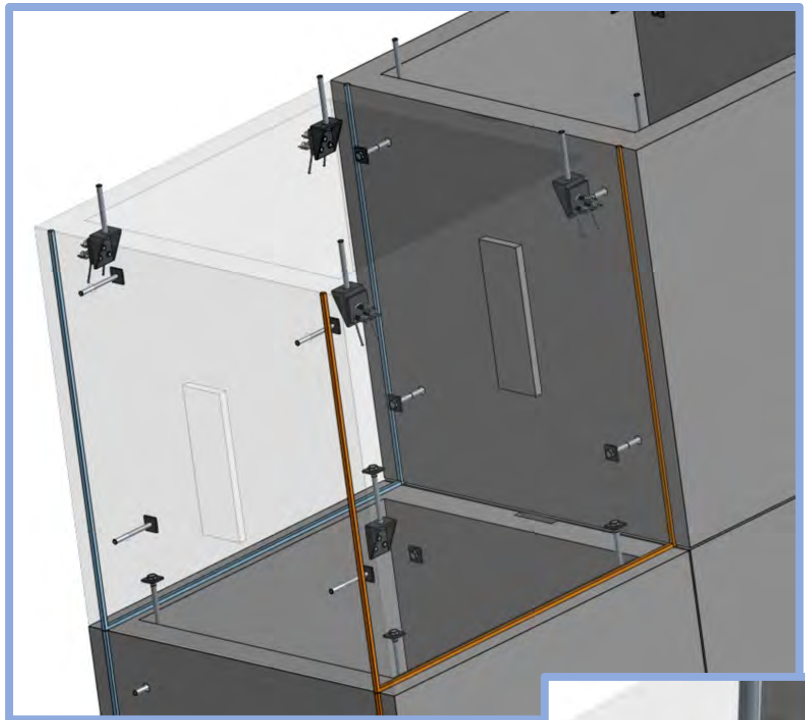


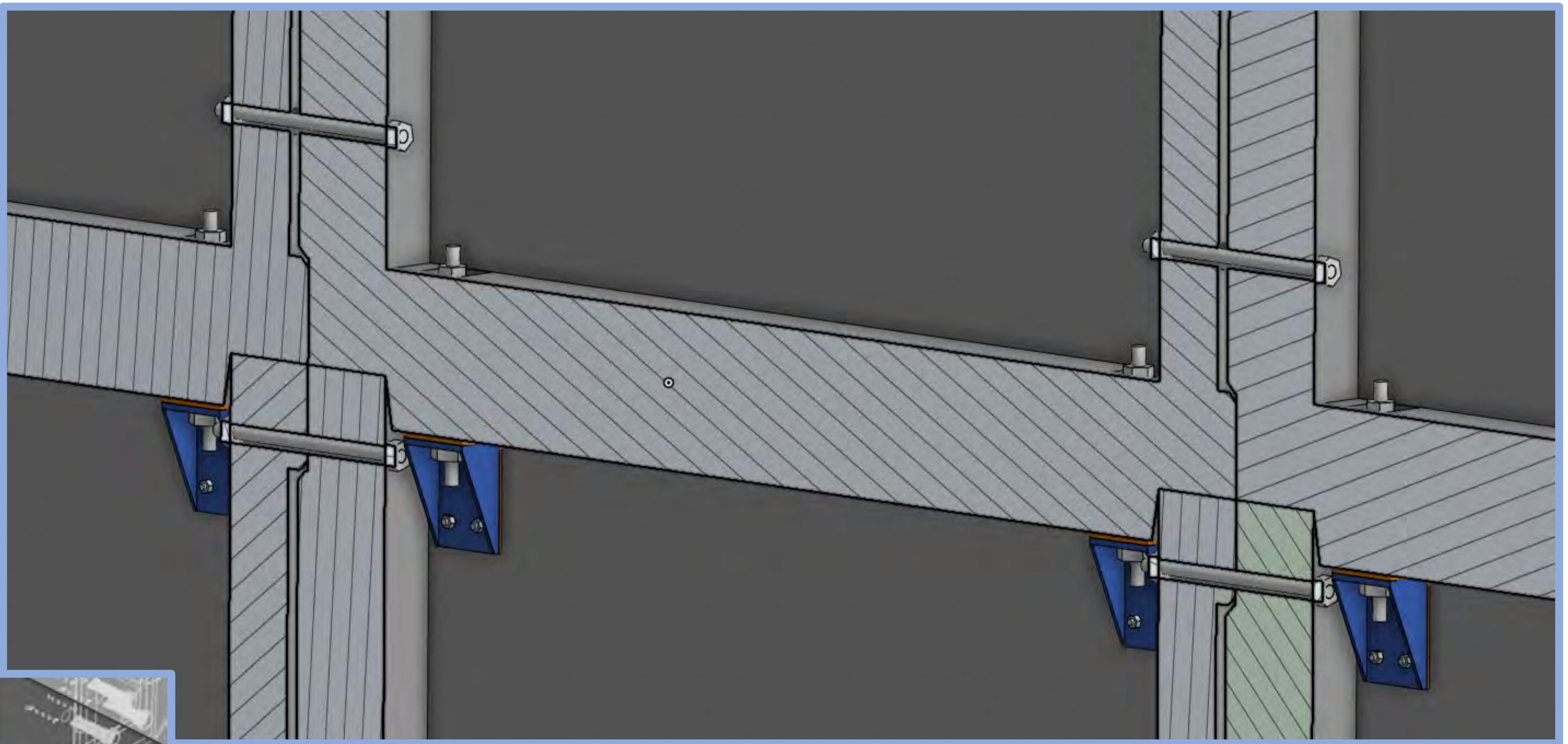


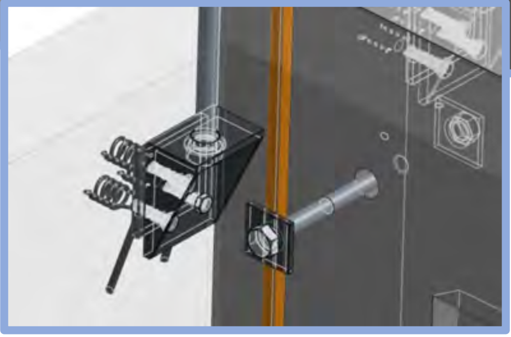


Structural design controls rebar dimensions and quantity

Blocks - Shear and Tension Resisting Linkage



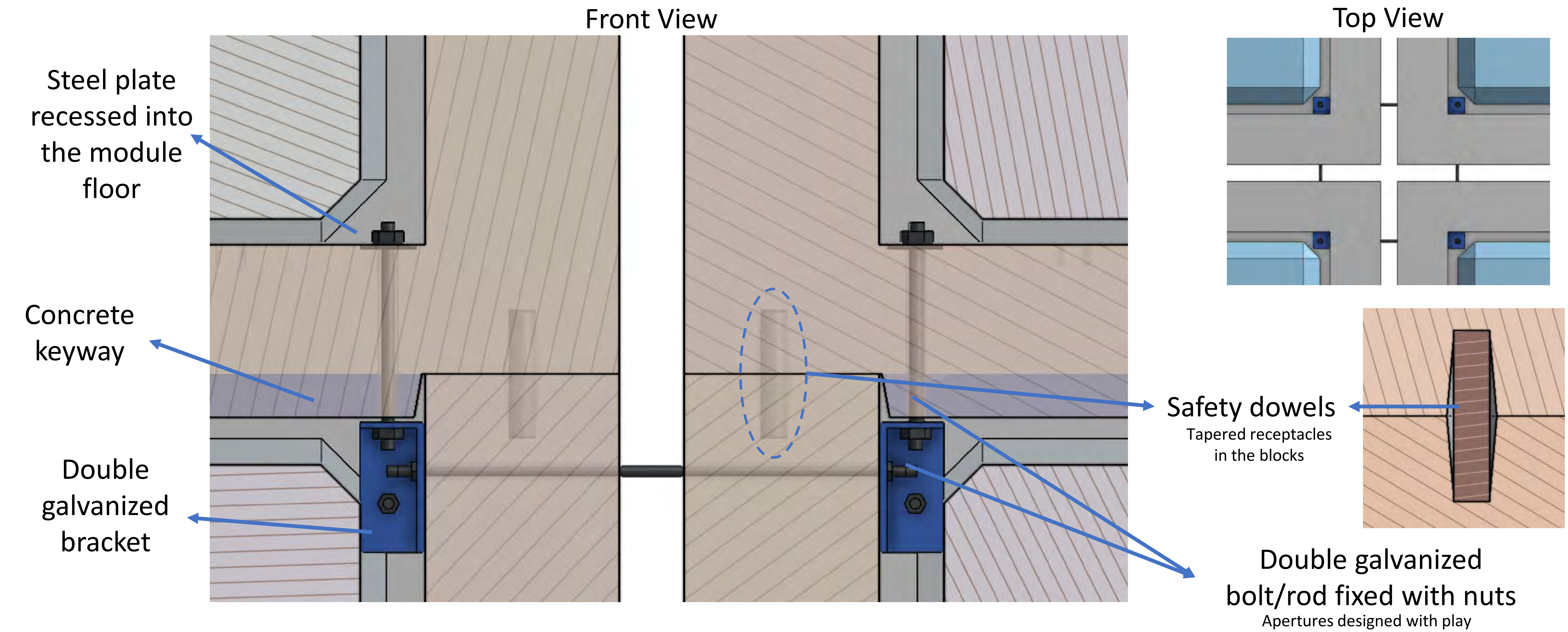




- 1 ¼'' bolts, double galvanized, grade 8 or equivalent,
- 6x6x0.5'' steel plate, double galvanized, grade 8 or equivalent
- Side bracket fixed to embedded anchor

* DETAILS OF 8x8x8 ft PRECAST BLOCK

Key Components – Mass Block:
Details



*Tolerance between blocks and linkage dimensions design according to project specs. Filling the gaps includes (but not limited to) grout and rebar, chemical waterstop compound, etc

Linkages: Block-to-Block & Working Platform to Block

- COPRA® Anchoring Coupler | Peikko Group 52P
- RockAnchorFoundation_brochure2015_web.pdf (peikko.com)
- FATBAR® Post-Tensioned Anchor | Peikko Group

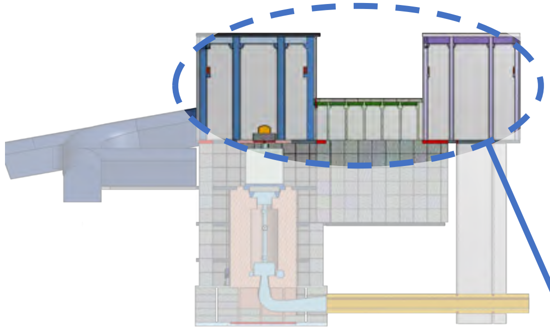
Saarenkyla Wind Park, V126-3.3 MW, IEC3A, HH 137m in Finland in 2015

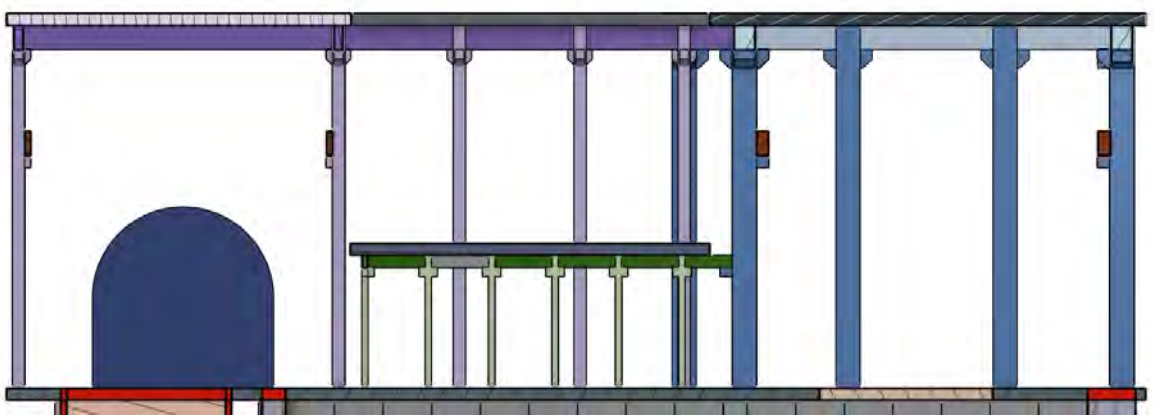
FATBAR

COPRA

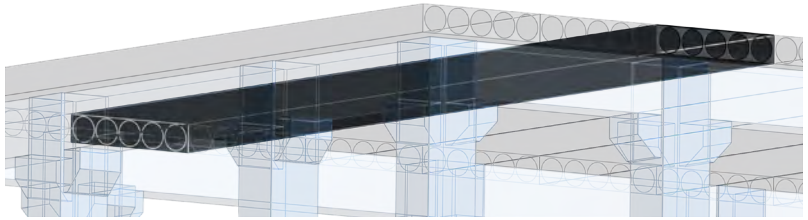
Powerhouse Upper Structural Components

Prestressed Elements

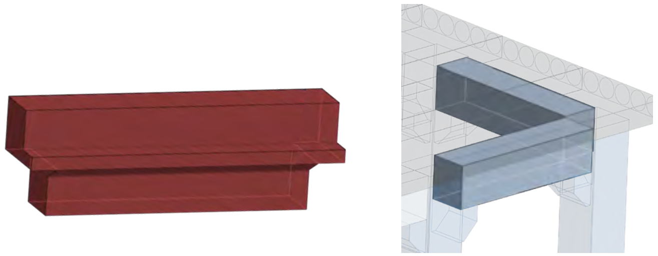




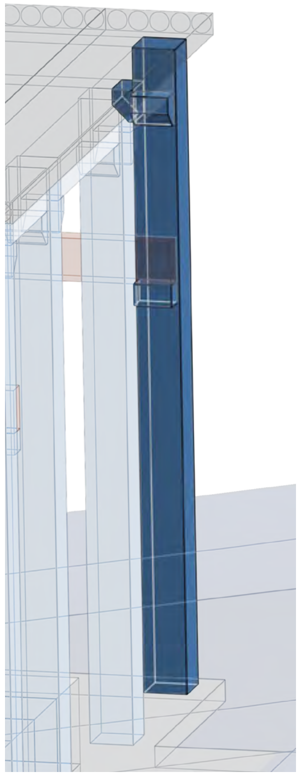
Turbine Hall Details



Precast ceiling hollow core slab

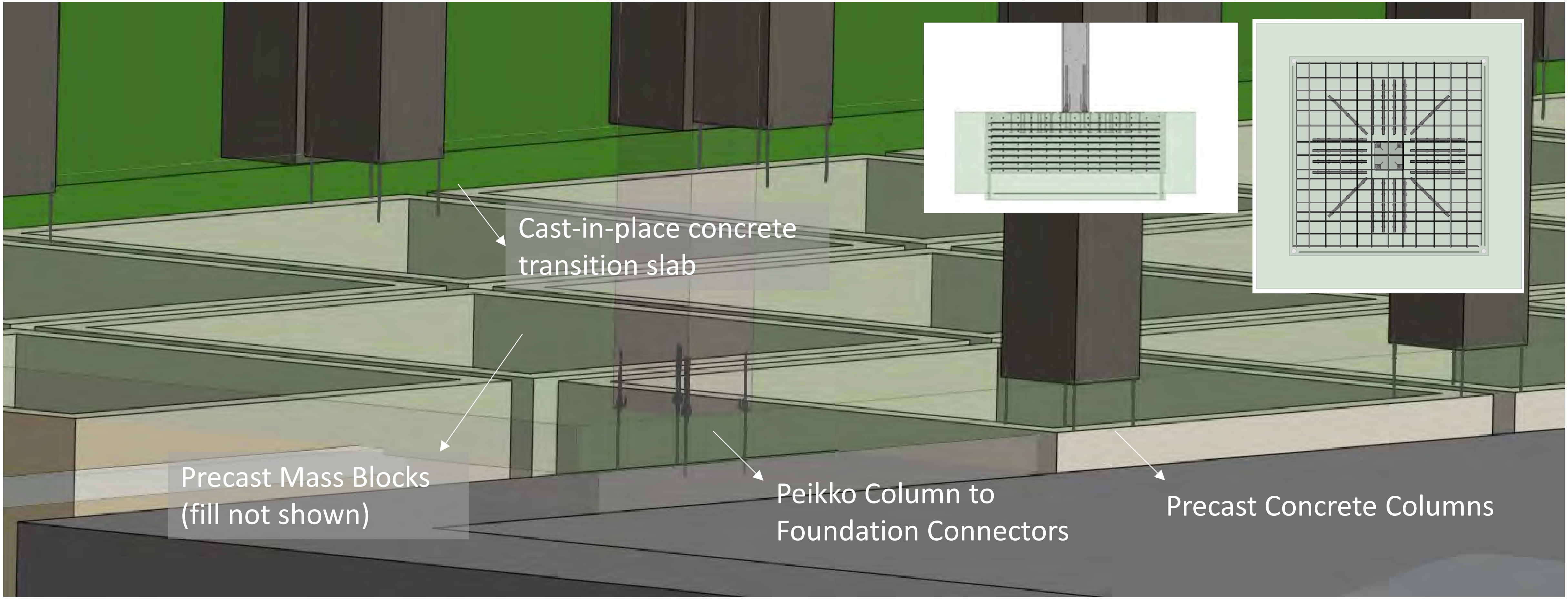


Precast rectangular beam and crane beam



Precast columns

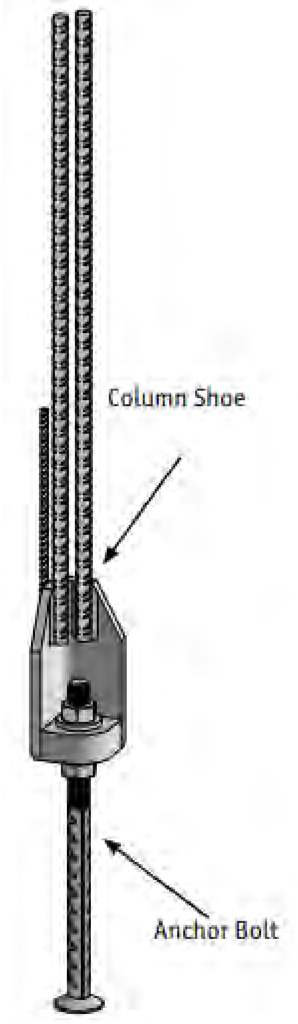
Transition Floor View



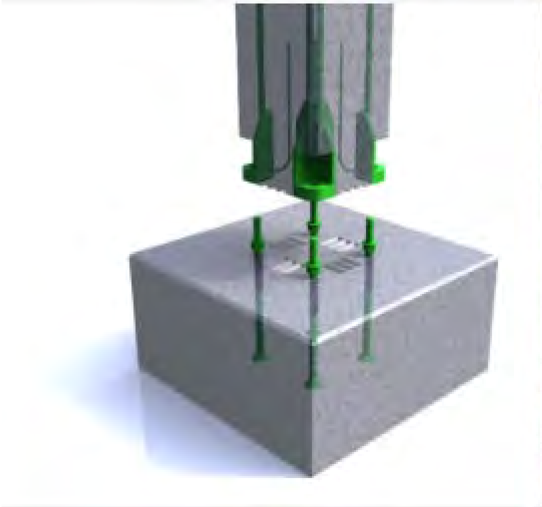
Columns shoes approval: [ICC-ES ESR-4723]
Anchor Bolts performance declaration: [DoP HPM-L]

Transition from Precast to Prestressed

At Powerhouse Floor Elevation



- Enables slender concrete member cross-sections (20%)
- Fast deployment with no need of temporary bracing
- Shallower anchorage depth compared to protruding bars
- Final product as stiff as cast-in-situ connection
- Tested, approved ETA-18/0037 and ETA-02/0006, widely utilized in civil market
- Peikko has bulk manufacturing ability (embedment, working platform' under slab linkages)



Peikko – energy dissipating bolted column connection ideal for seismic designs.

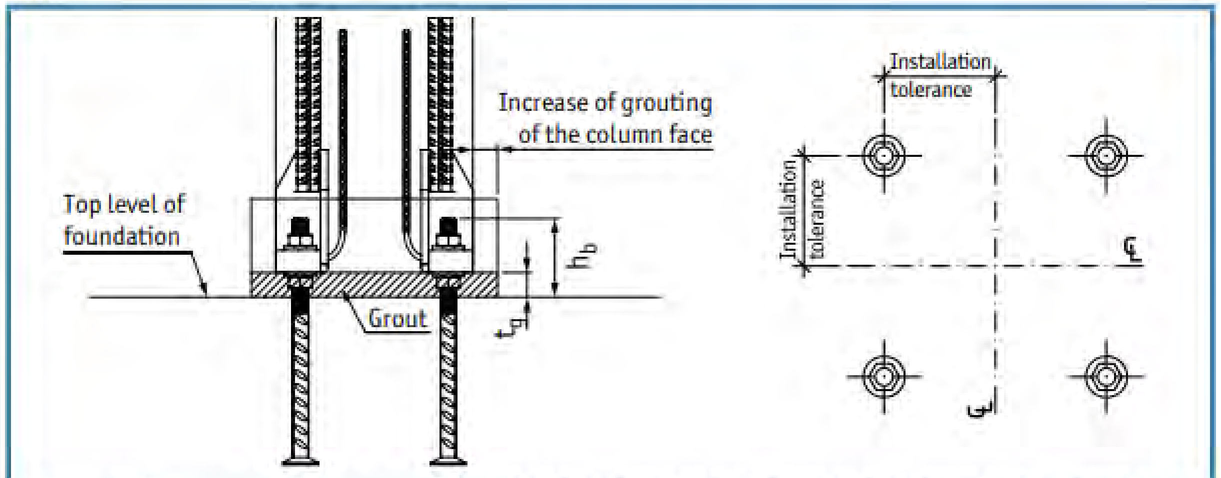
Columns shoes approval: ICC-ES ESR-4723
Anchor Bolts performance declaration: DoP HPM-L

Transition from Precast to Prestressed

At Powerhouse Floor Elevation

- [LINK TO VIDEO OF RAPID COLUMN ASSEMBLY]
- [Column to beams Peikko connections]

Installation tolerances and the anchor bolt's protrusion from the surface of concrete when HPKM® Column Shoes are used.

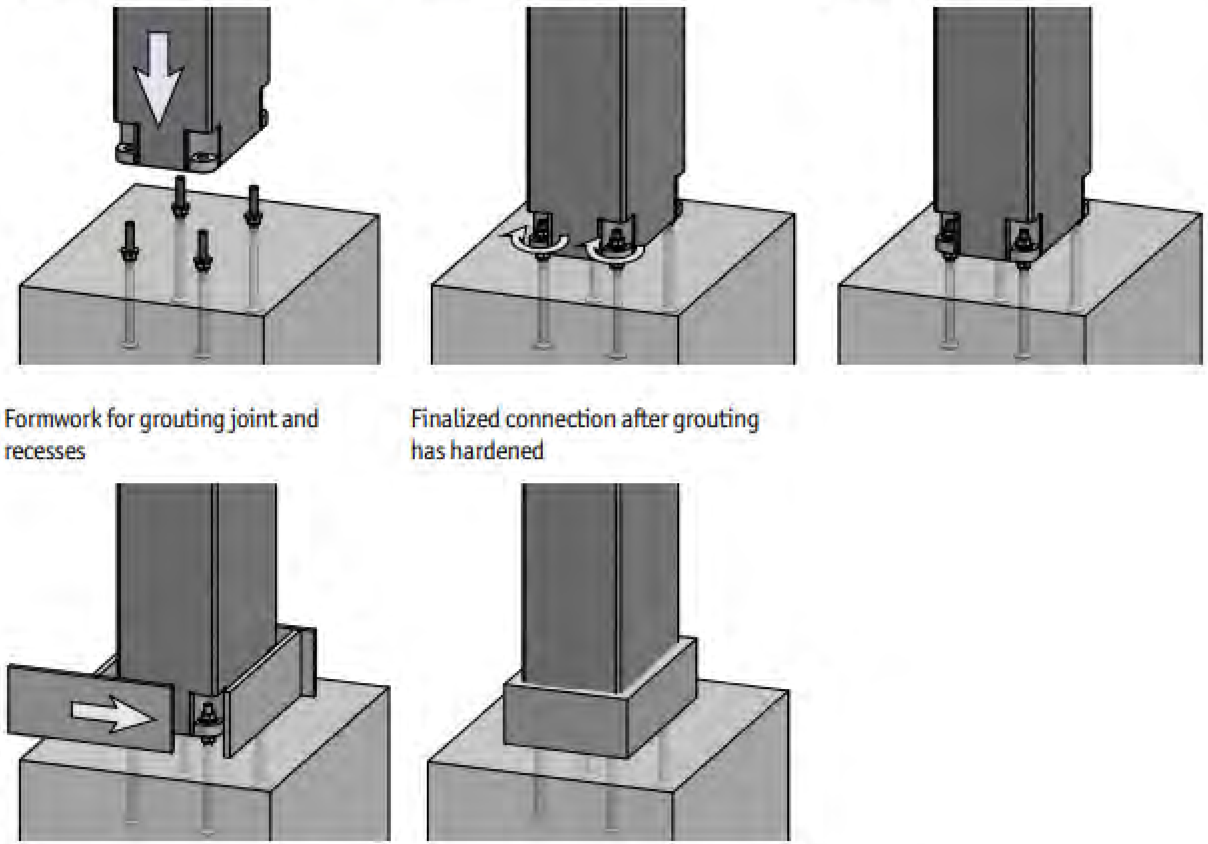


Column Shoe	HPKM 16 ACI	HPKM 20 ACI	HPKM 24 ACI	HPKM 30 ACI	HPKM 39 ACI
Rebar Anchor Bolt	HPM 16 ACI	HPM 20 ACI	HPM 24 ACI	HPM 30 ACI	HPM 39 ACI
Thickness of grouting t_g [mm]	50	50	50	50	60
Protrusion of the bolt h_b [mm]	105	115	130	150	180
Installation tolerance for the bolt [mm]	±3	±3	±3	±3	±3

Columns shoes approval: [ICC-ES ESR-4723]

Anchor Bolts performance declaration: [DoP HPM-L]

Erection of precast concrete column step by step.



In column-to-foundation connections, wider grouting can be provided to ensure higher concrete cover if it is required. It is recommended that the cover be increased in aggressive environments.

Working Platform Connections

Picture: Powerhouse Working Platform

Working Platform with Anchor Bolts or Equal To

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MODULAR HYDRO SOLUTIONS

- **Anchor bolts placed in grid formation based on hydrologist report data i.e. torques, soil pressures, and turnover**
- **Working platform tailored to specific site requirements, such as, receptive of modular precast segments, with embedded linkages and keyways/dowels.**

Precast Modules Connections

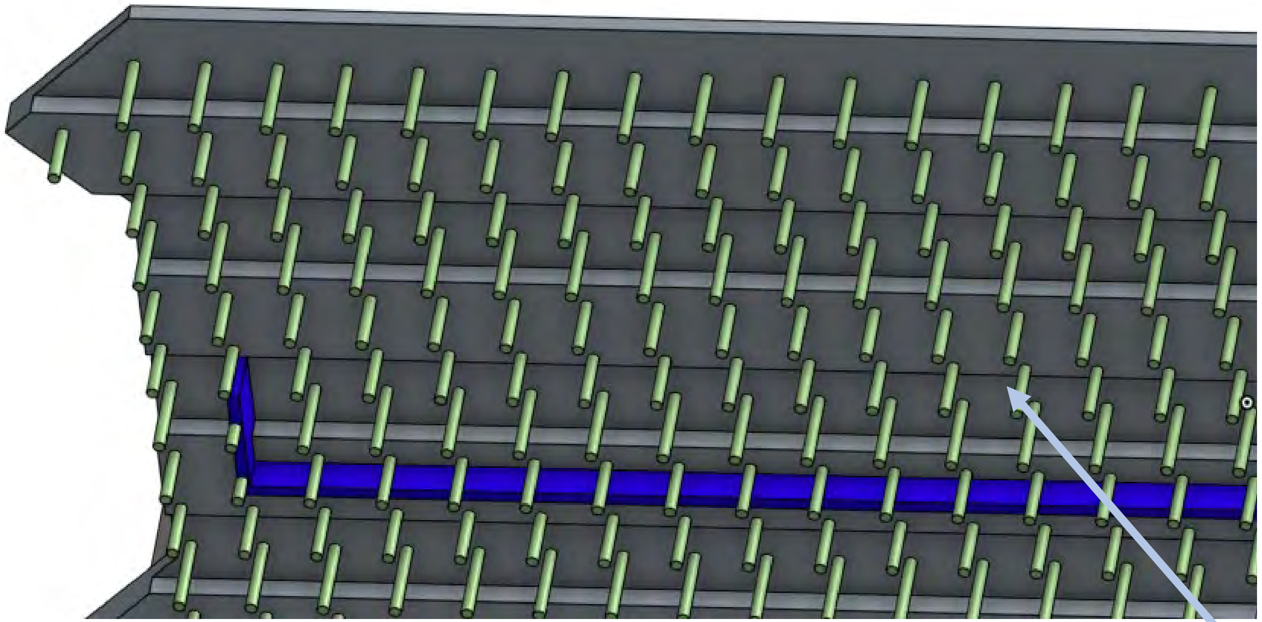
Surrounding Rock Formations

- System incorporates a cast-in-place working platform with embedded reinforcements, anchoring the first row of blocks and all subsequent layers of structure mounted above. The working platform is designed as part of the load path and serves as a foundation to the structure, safely transferring loads to surrounding rock.

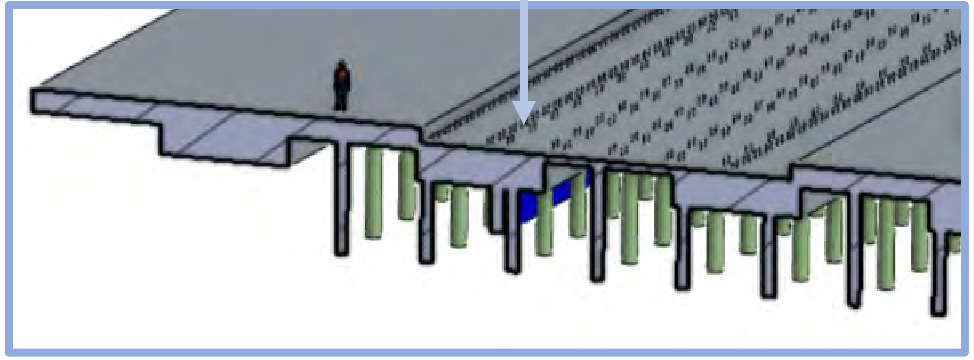
- Linkages installed/embedded in a CIP concrete base slab. The concrete base slab can be anchored to the cavern’s rock base with a series of designed rock anchors in conjunction with drilled and epoxied reinforcing L-bars. This will tie the concrete base slab to mass of the rock below the cavern.

Under the Working Platform

Links to the solid layer and accepts precast modular dam and powerhouse components



'Cleat' system, designed as auxiliary stress/strain transfer to soil



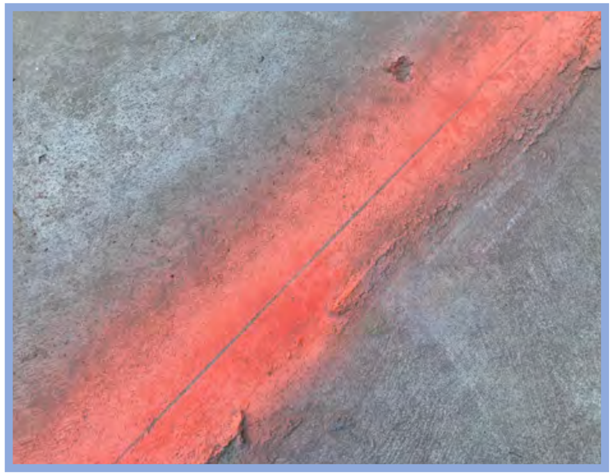
Rock anchors or equivalent system supporting working platform (dimensions and design subject to site analysis)

Working Platform Pictures
Means and Methods

- Cast In / Embedded linkage
- <u>Total Station</u> used to ensure precise layout of modular blocks







NOT TO SCALE

Embedments – Working Platform

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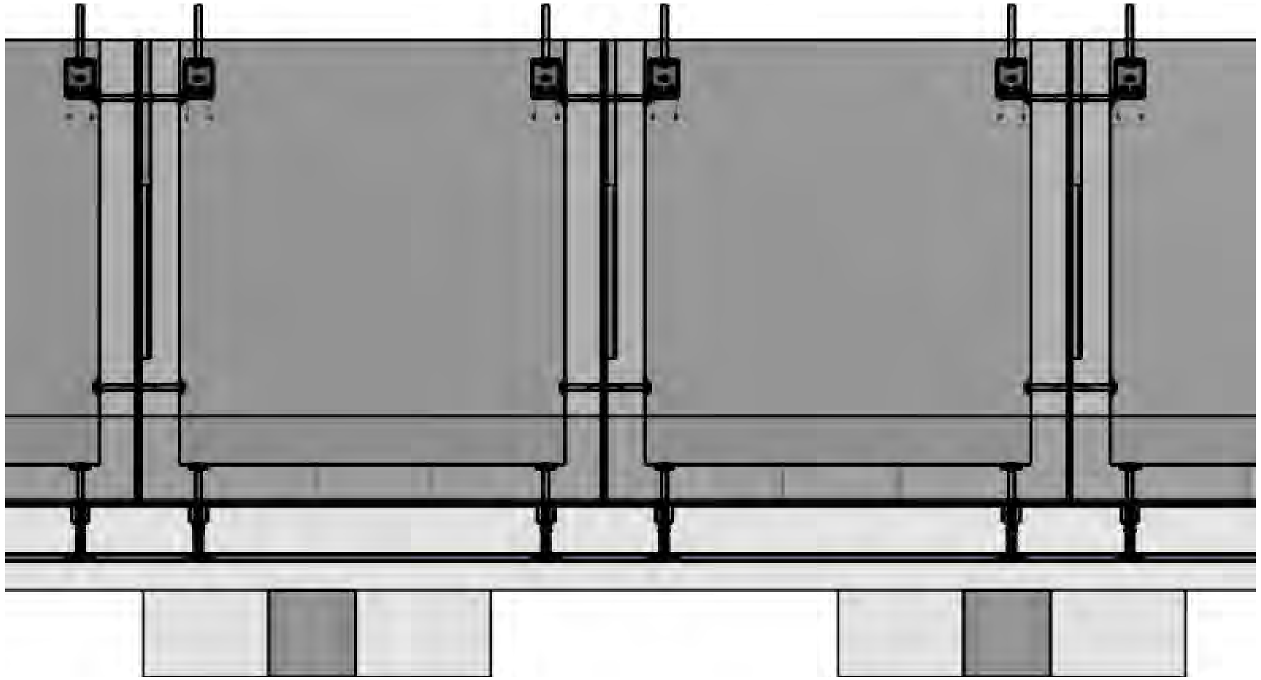
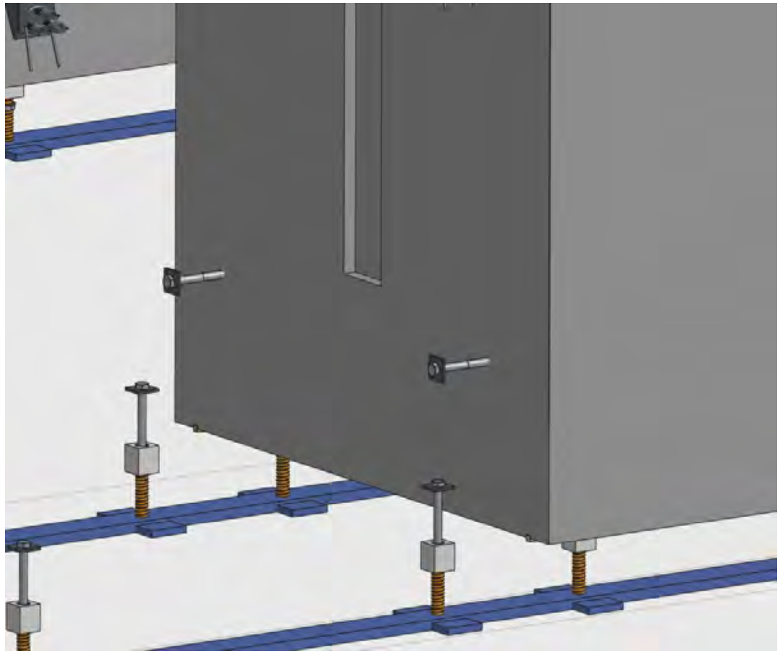
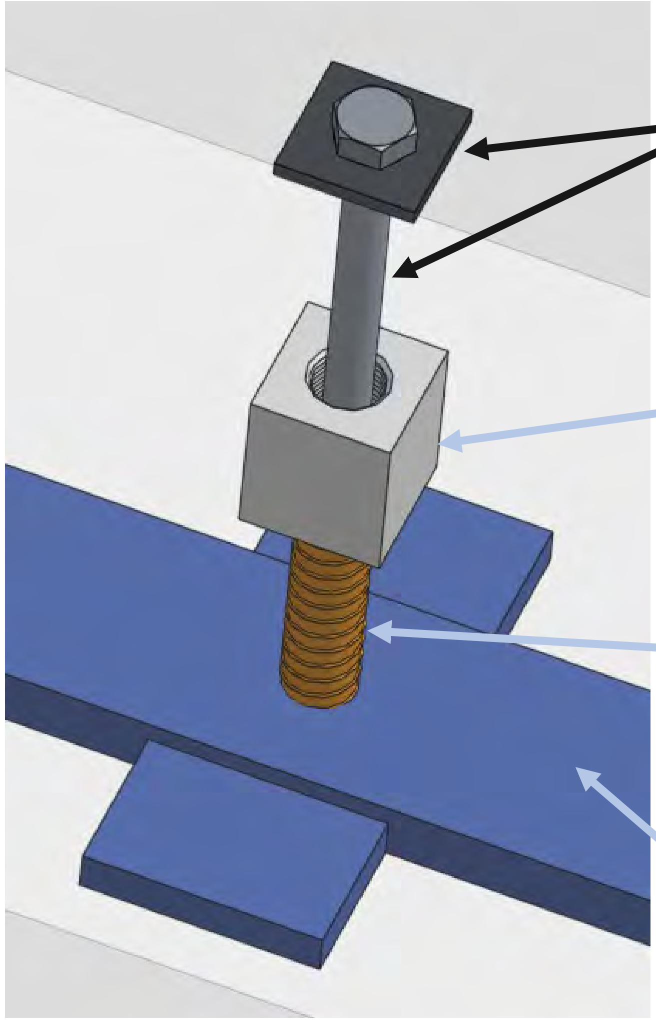
MODULAR HYDRO SOLUTIONS





Double galvanized (dipped and spun) steel reinforcement embedded in the CIP working platform.
Precise design (**1/16'' tolerance**) with unique dimensions to each project demands.

Embedment Components: Details

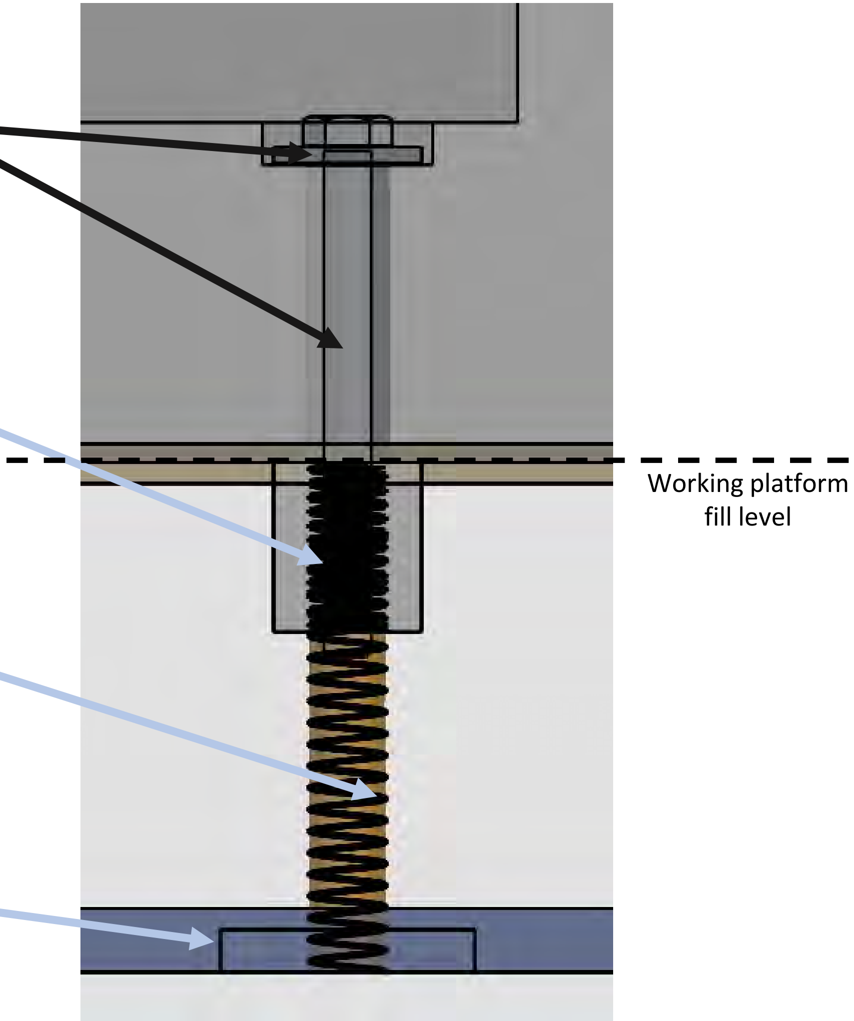


Double galvanized linkage from concrete precast module placed on top of working platform (physical and or chemical bond may be applied in the gaps)

Fixed to end of rod and receiving linkage from the block above. Physical and or chemical bond may be applied in the gaps

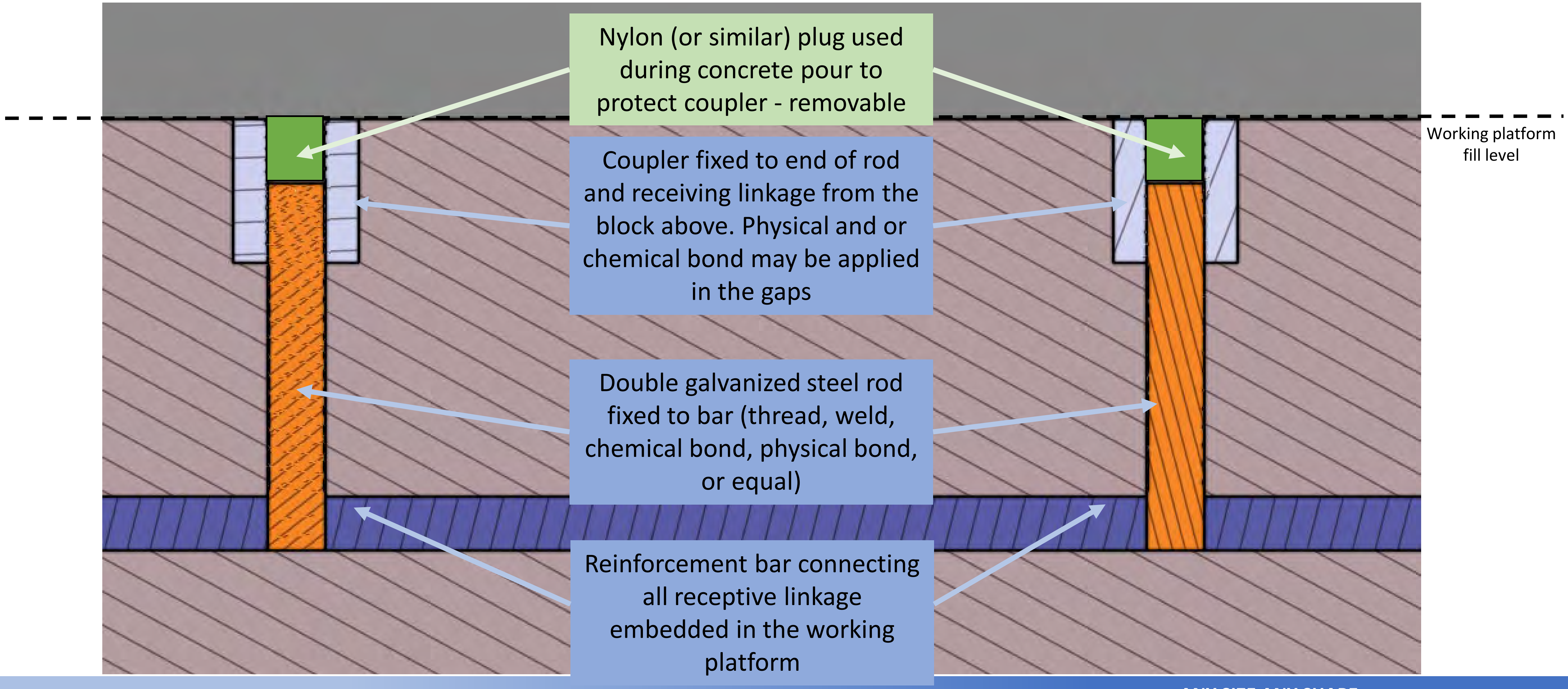
Double galvanized steel rod fixed to bar (thread, weld, chemical bond, physical bond, or equal)

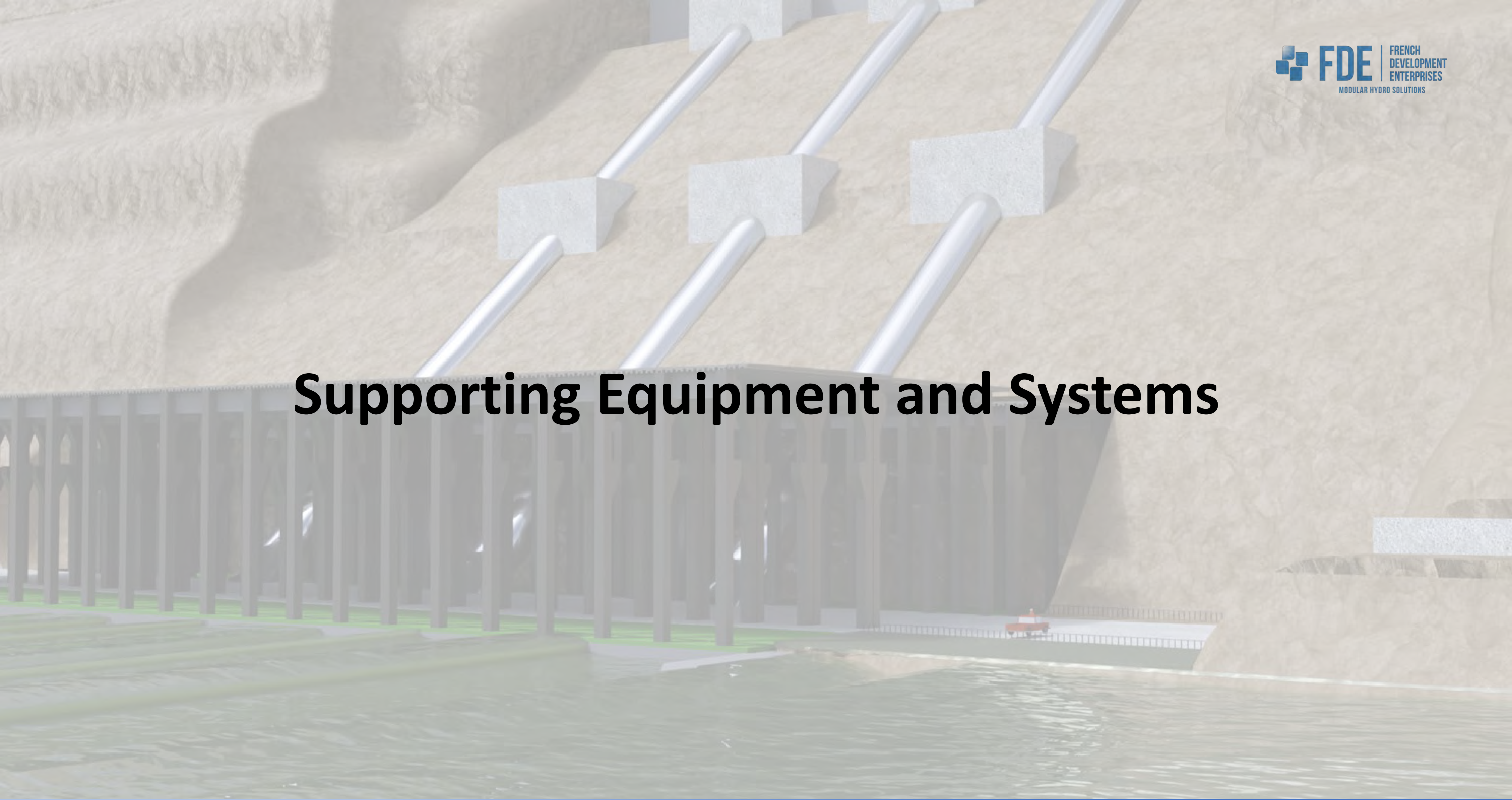
Reinforcement bar connecting all receptive linkage embedded in the working platform



Embedment Components:

Optional Plug for Cast-in-place Concrete Working Platform Pour

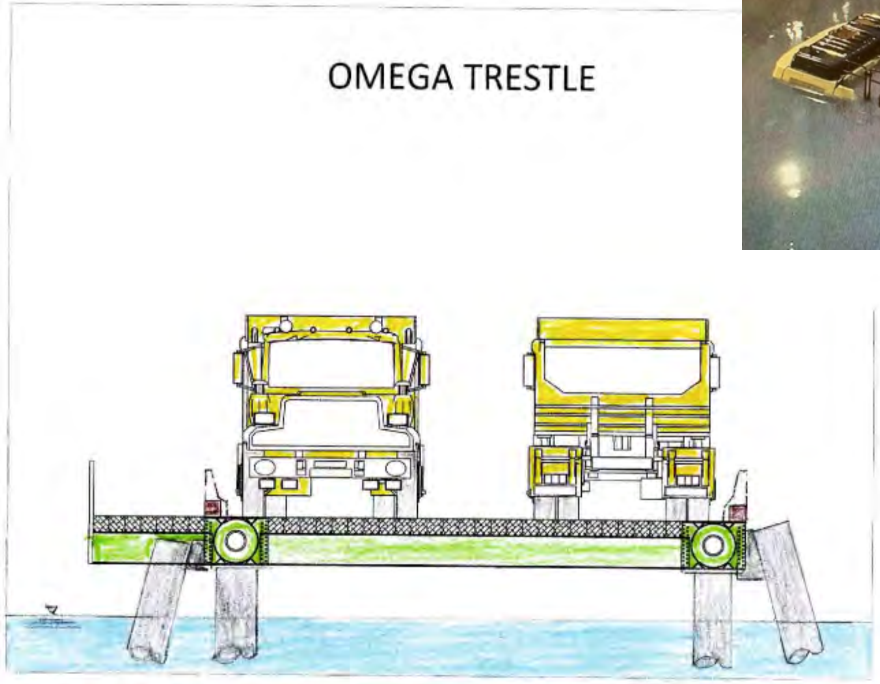




Supporting Equipment and Systems

Cofferdams

Upstream and/or Downstream of System

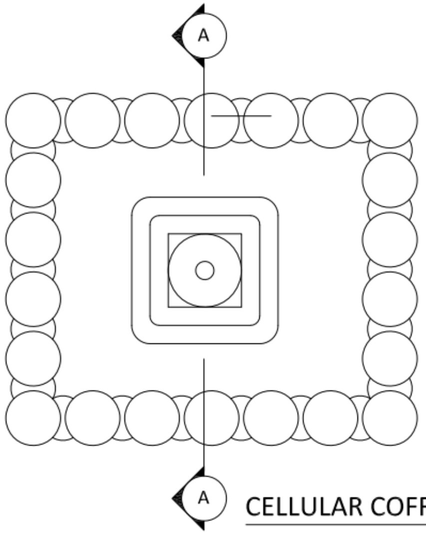


TEMPORARY BRIDGE TRESTLE

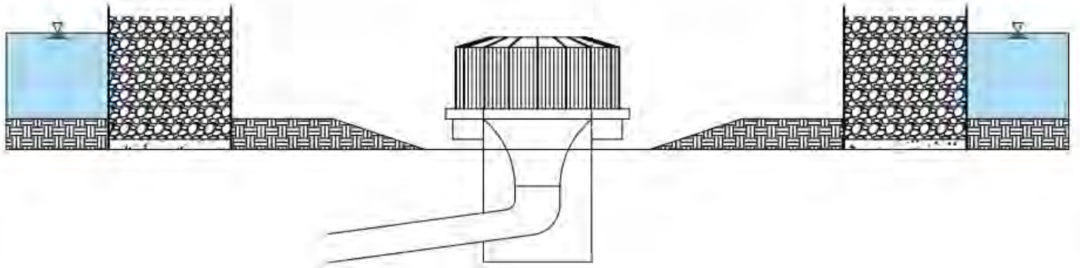
Reference: Open-source image

Cofferdam for TBM Entry Point

Cofferdams and Intake Construction



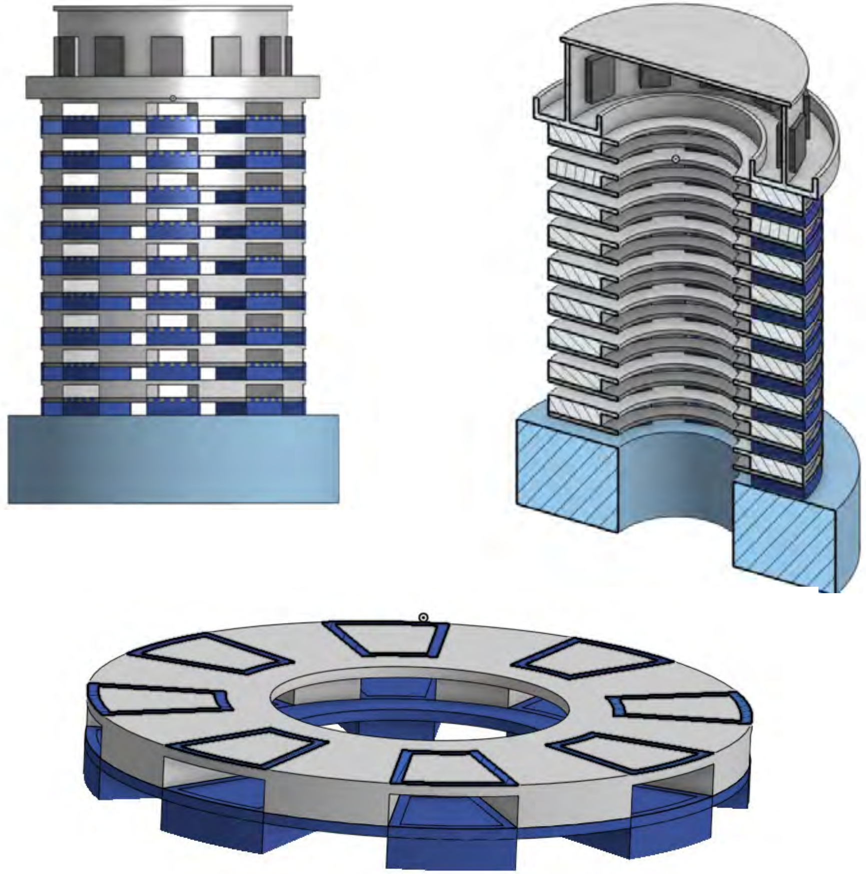
CELLULAR COFFERDAM
SCALE: N.T.S.



CELLULAR COFFERDAM - SECTION A
SCALE: N.T.S.

Reference: Delve Figure 7

Intake Tower Module



Precast Method

Cast-in-place Method

7 years until total completion
5 years of construction
$3000/day fine for delay (1935)

Intakes (4x):
395ft tall
82ft base
93,674 CY of concrete

30ft penstocks, 3ft lined concrete
4000 ft x 56 ft tunnels
1,5 M gal/s
(excavation: 13 months – 3 shifts 24/7)

21,000 workers (112 casualties)
Equipment and workforce transport by boat

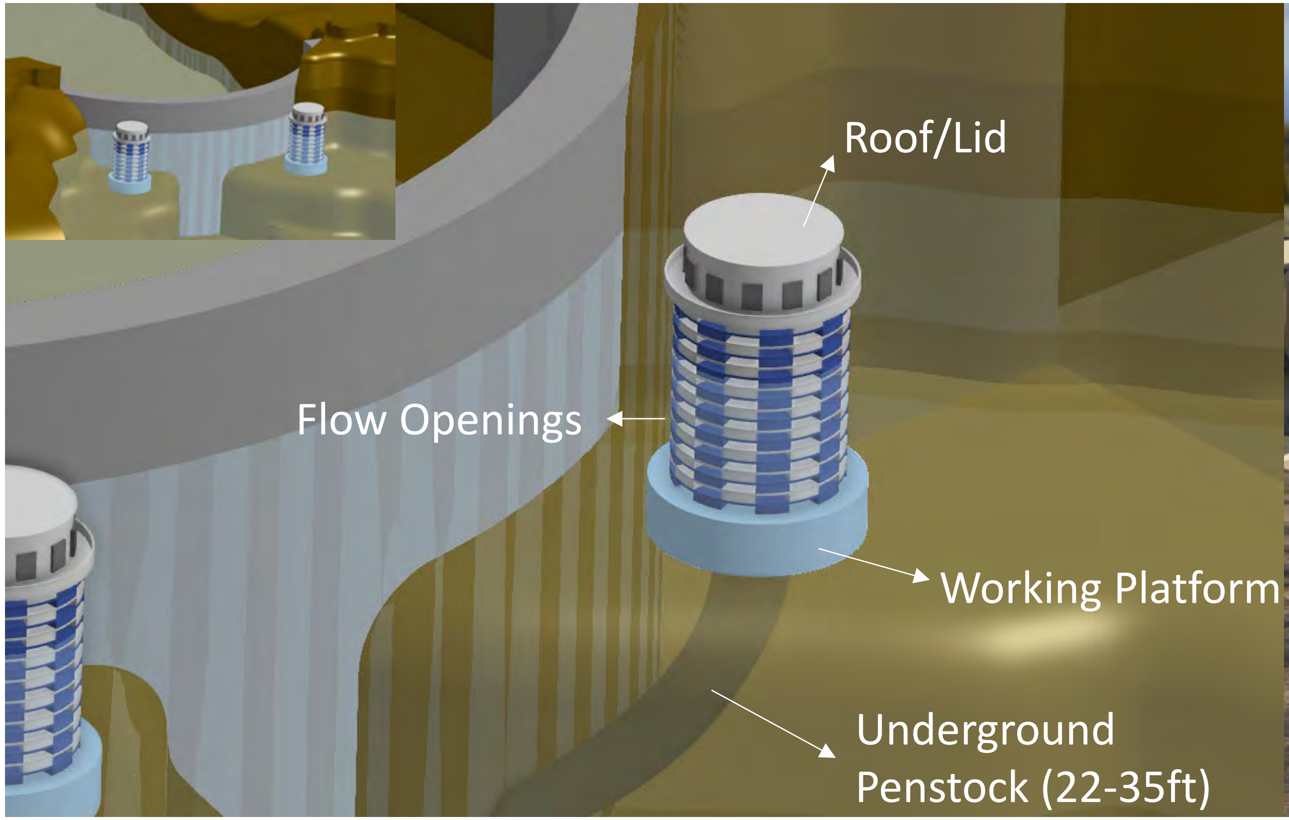
Sources: https://www.aboutcivil.org/hoover-dam-facts-statistics-structure-design-construction.html Hoover Dam | Bureau of Reclamation (usbr.gov)
https://tucson.com/news/retrotucson/photos-construction-of-hoover-dam-on-the-colorado-river-in-the-1930s/collection_12063a22-5f83-11e8-83ad-d73c65facc1d.html#6

ANY SIZE ANY SHAPE
NOT TO SCALE

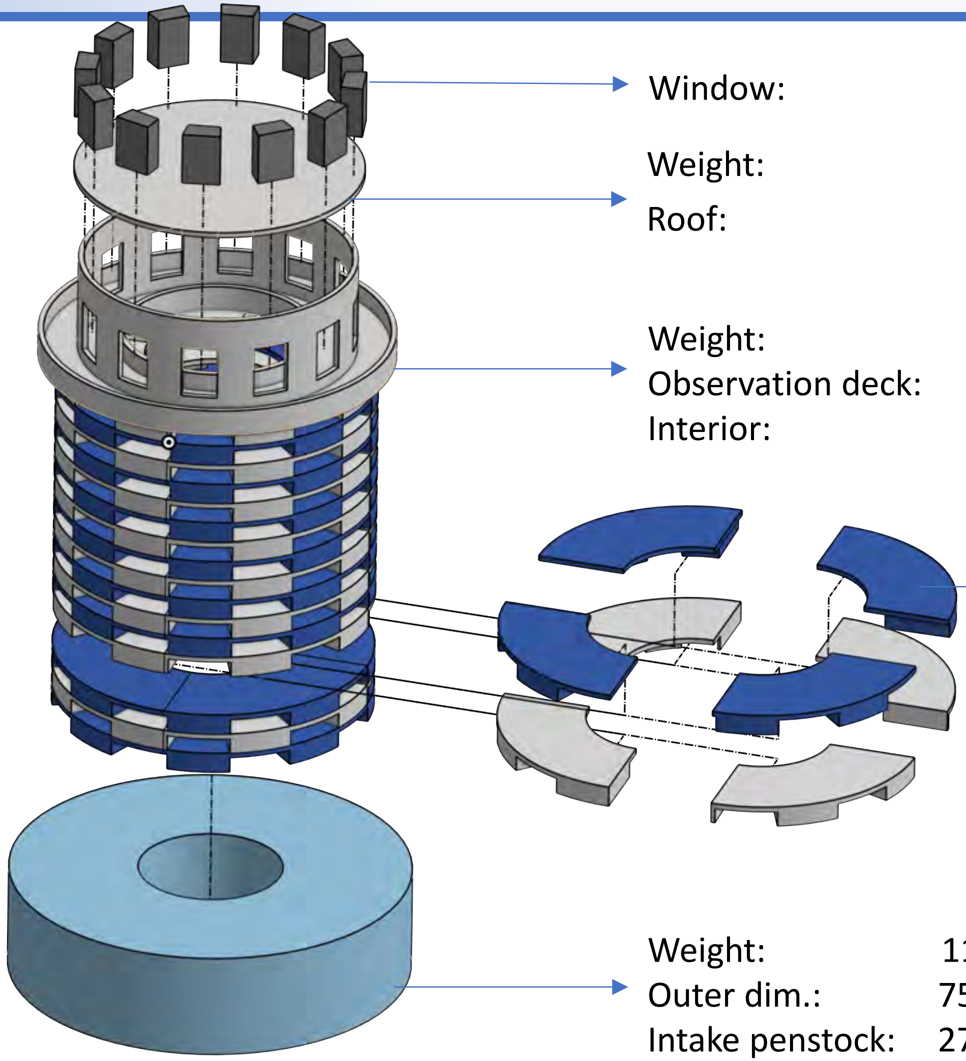
NOT TO SCALE

Intake Working Platform

Working platform anchors penstock and offers protection against floor sediment



Intake Tower Module



Window: 10 ft height x 7 ft length

Weight: 331,000 lb (volume=85 CY)
Roof: 55 ft diameter x 1 ft height

Weight: 1,015,000 lb (volume=262 CY)
Observation deck: 207 ft (33 ft r) x 7.5 ft wide
Interior: 163 ft (26 ft r) x 20 ft height

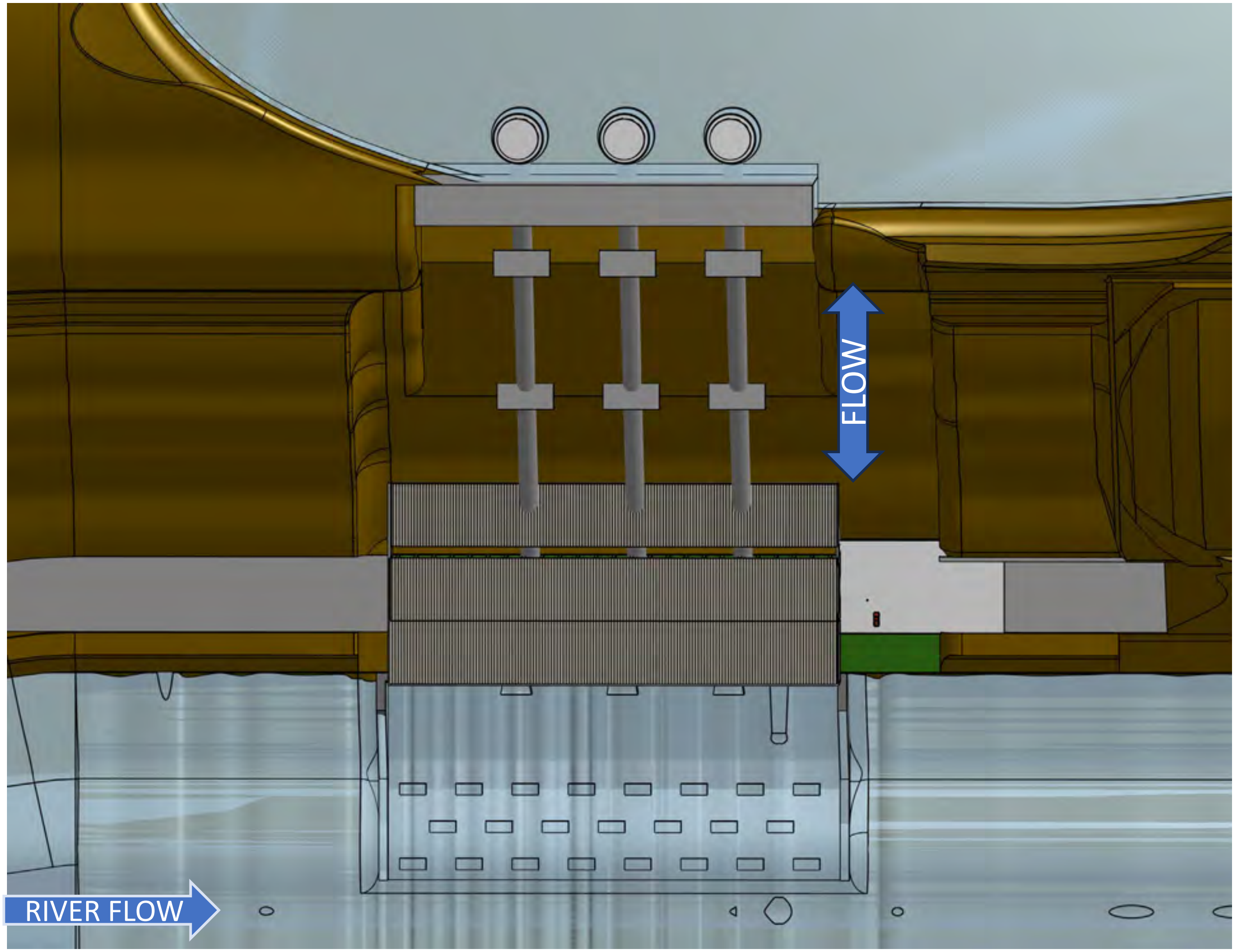
Weight: 265,000 lb each (volume=59 CY)
Disk (1/4): 47 ft (30 ft r) x 21 ft (13.5 ft r) x 4 ft height
Flow opening (2x): 11 ft x 3 ft

Weight: 11,000,000 lb (volume=2,848 CY)
Outer dim.: 75 ft diam. x 20 ft height
Intake penstock: 27 ft diam.

Valving and screening not shown in the drawing

Upper Impoundment Penstock

- **Tunnel Boring Machine (TBM) and Precast Lined Tunnel**
- **Steel Penstock and Thrust Blocks**
- **Surge Tanks / Towers**



Lower impoundment

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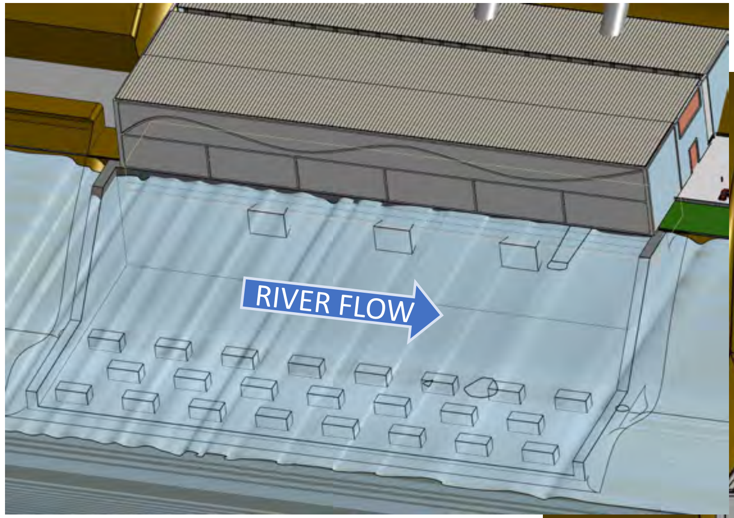

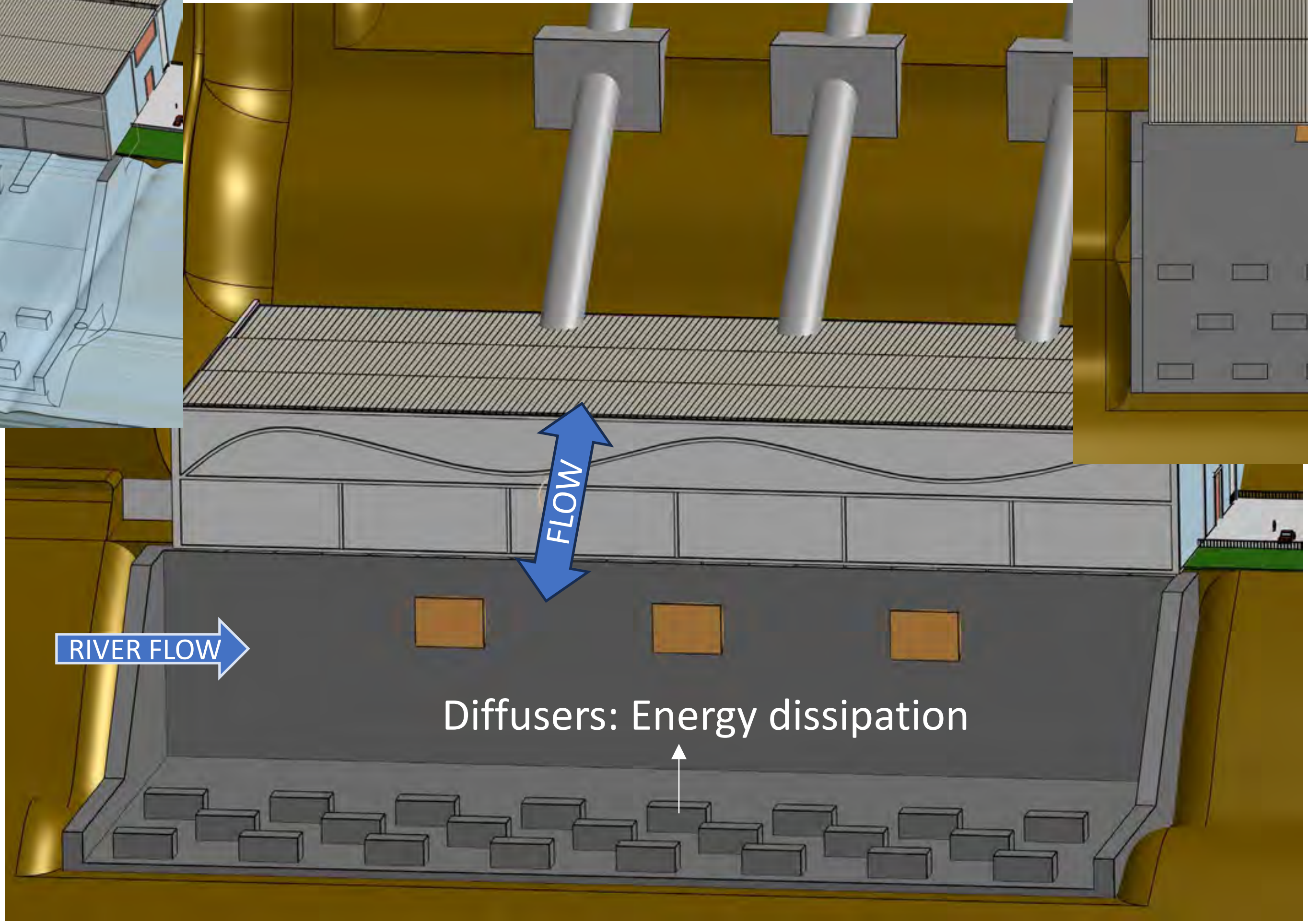

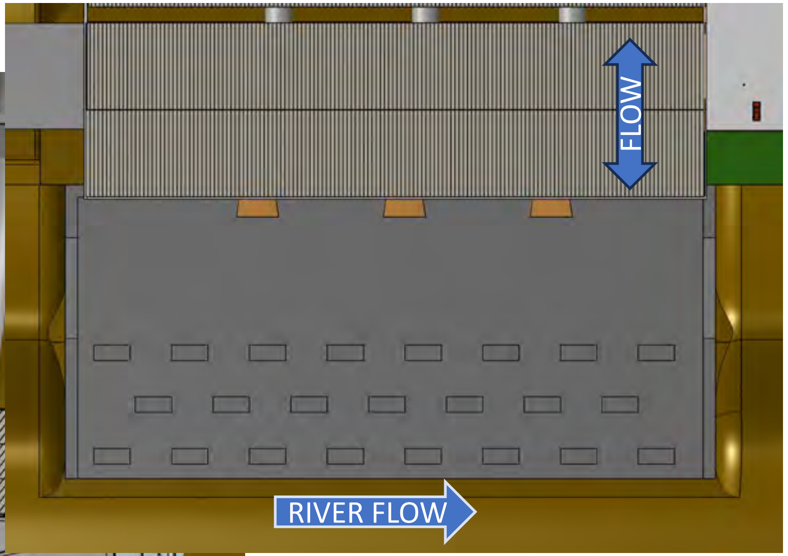

- **Open or closed loop systems reservoir**
- **Lower outflow and intake**
- **Diffusers**
- **Reduce silting on intake (pump-up)**

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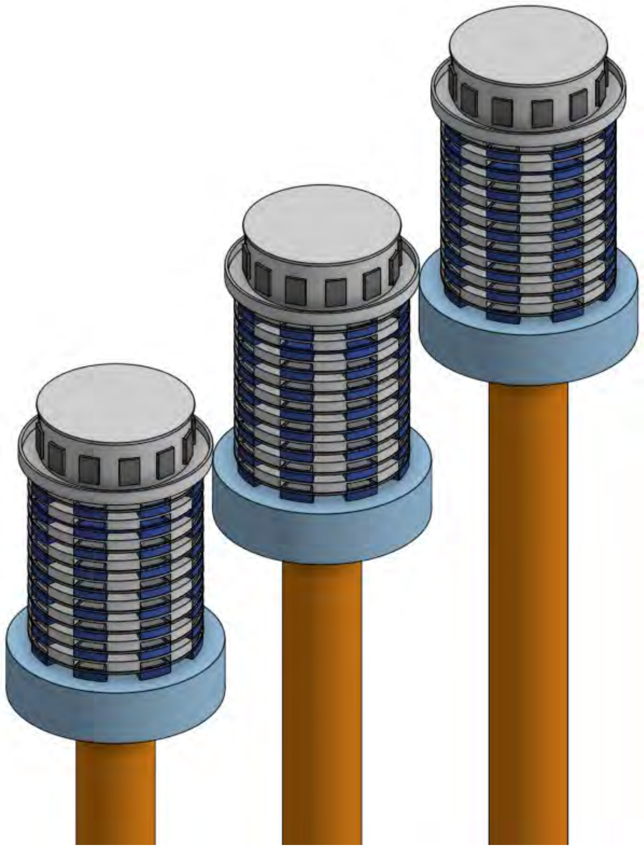
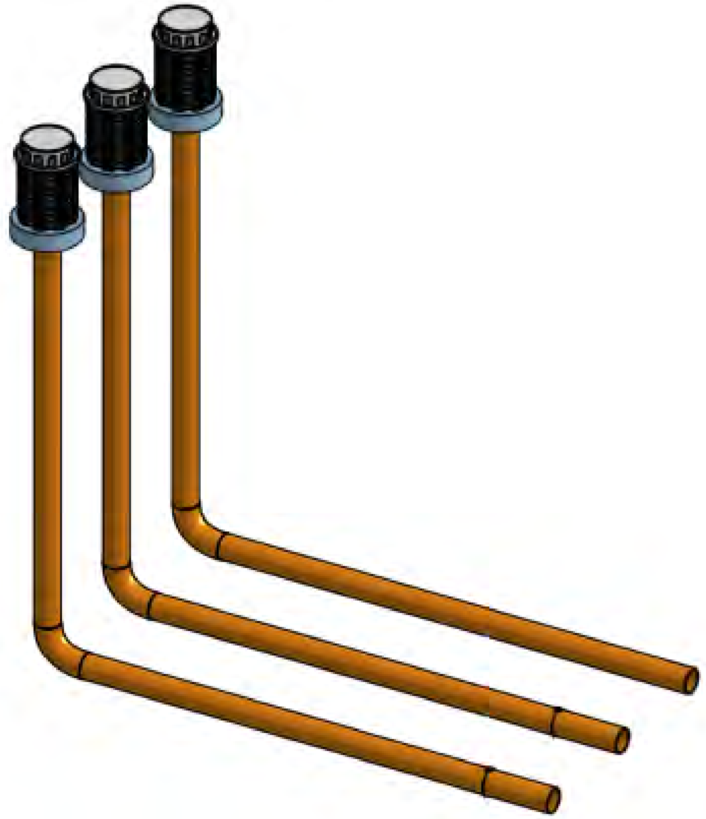
MODULAR HYDRO SOLUTIONS

Step-by-step Pumped Storage Hydro Build Out

Pump Storage: Step-by-Step

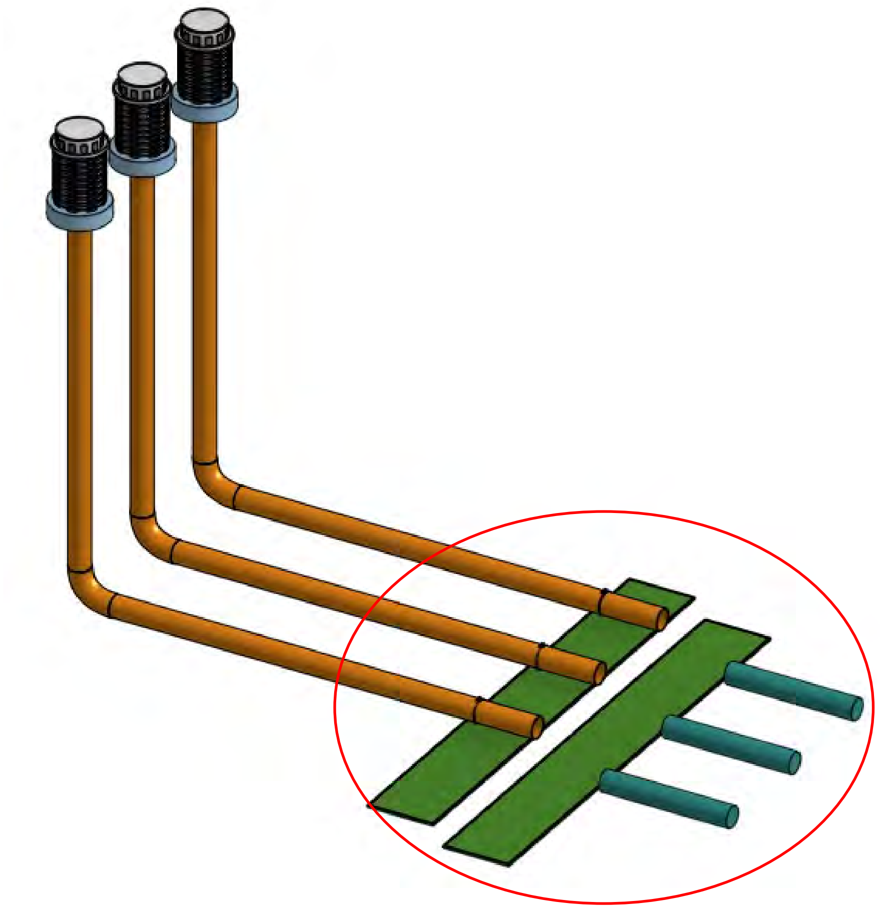


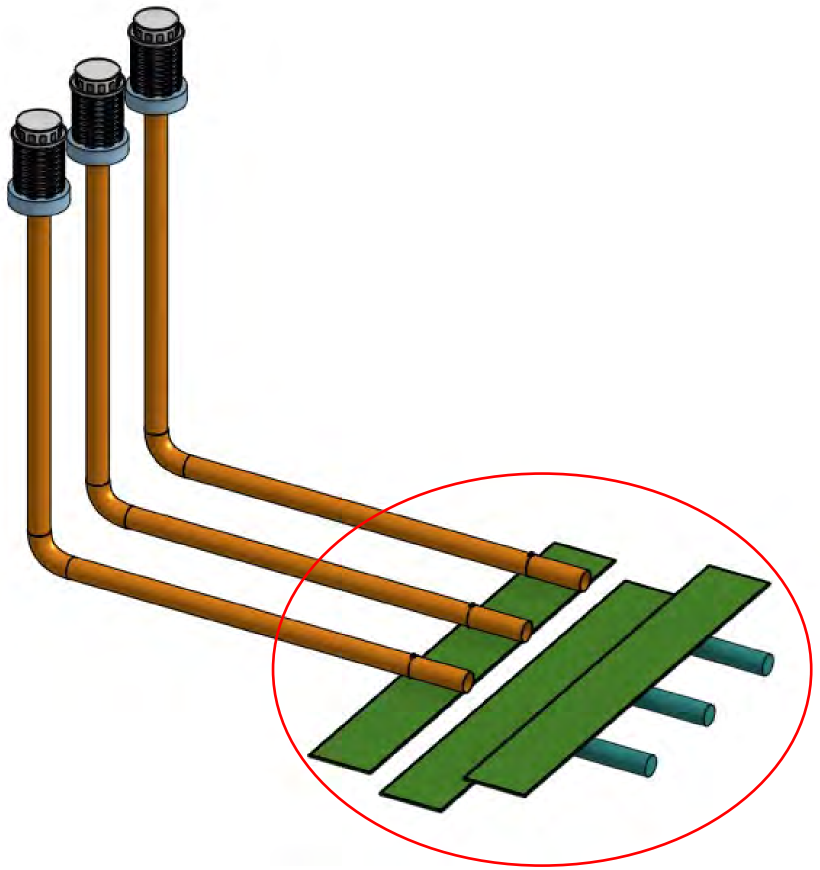


Intake Assembly and Excavation

Pump Storage: Step-by-Step

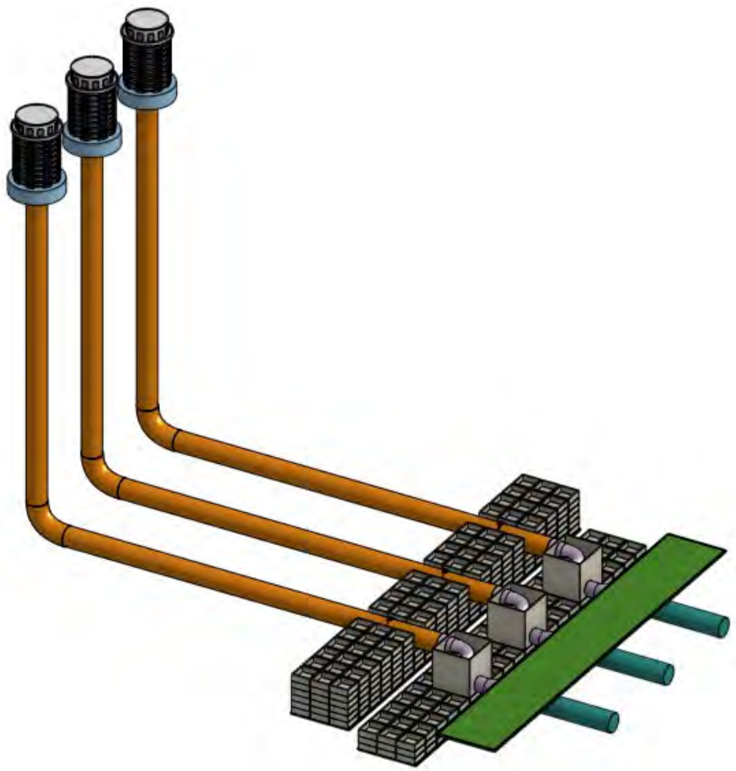
FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

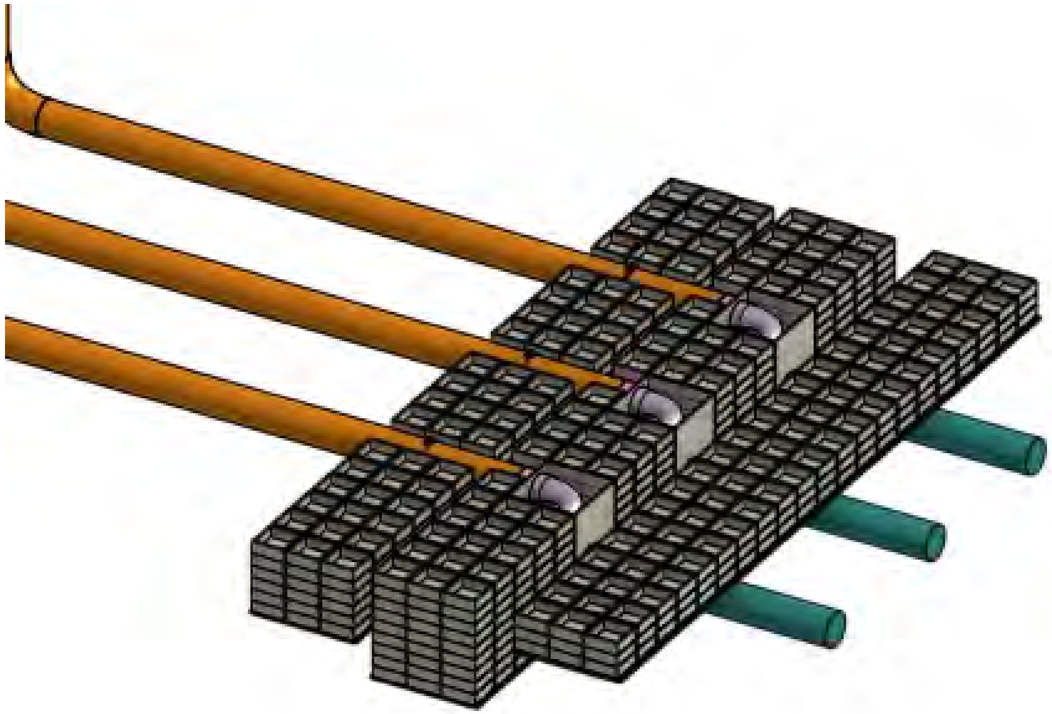




Working platforms and draft tubes

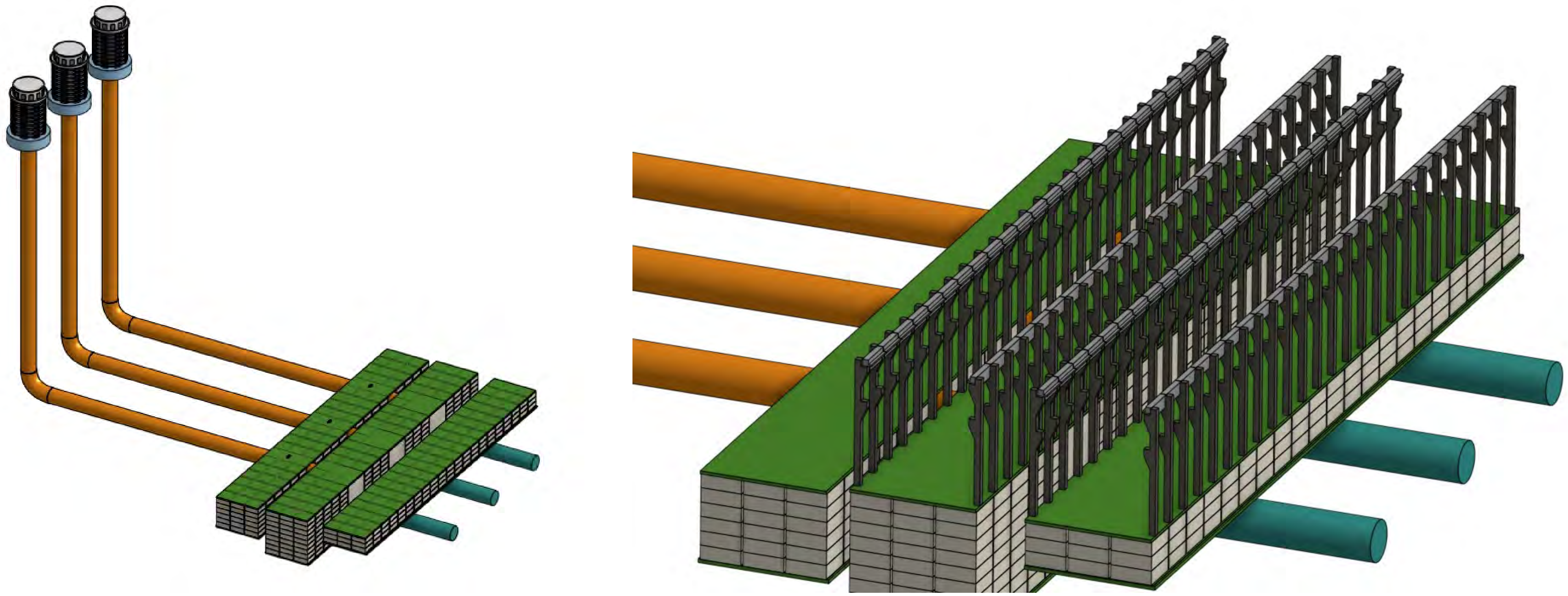
Pump Storage: Step-by-Step





Blocks Assembled (Lower Mass) and Equipment Secured in Place

Pump Storage: Step-by-Step



Upper Structure Foundation Secured and Leveling Slab Poured

Pump Storage: Step-by-Step

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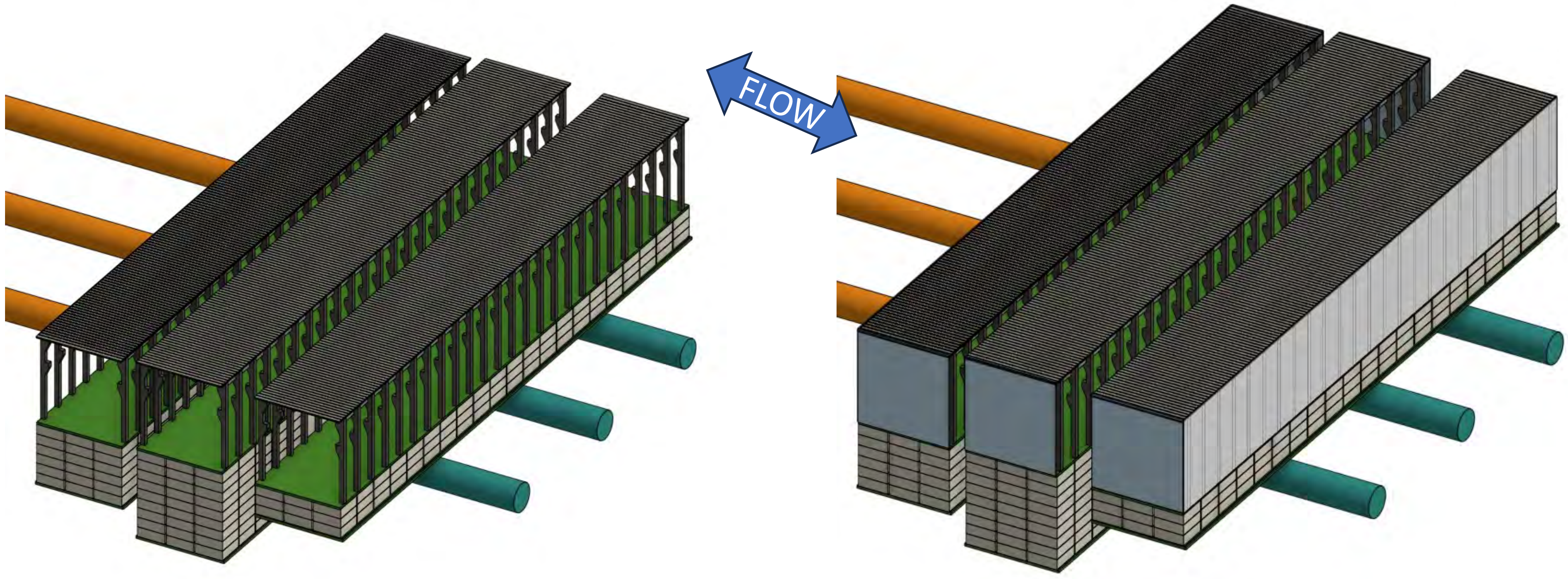
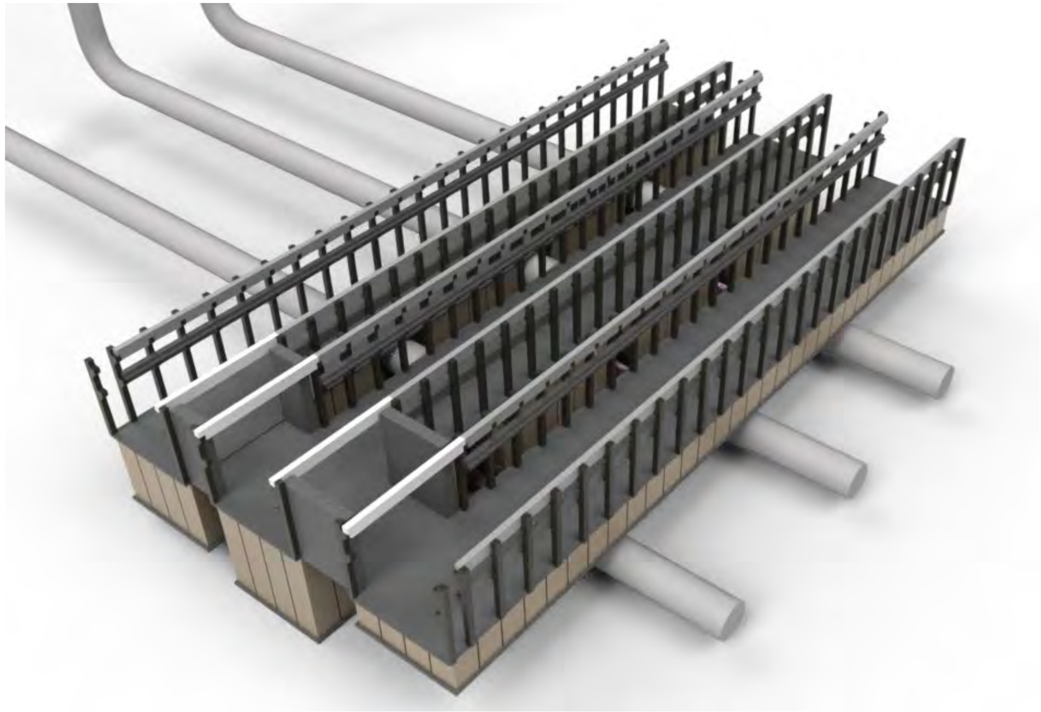
MODULAR HYDRO SOLUTIONS



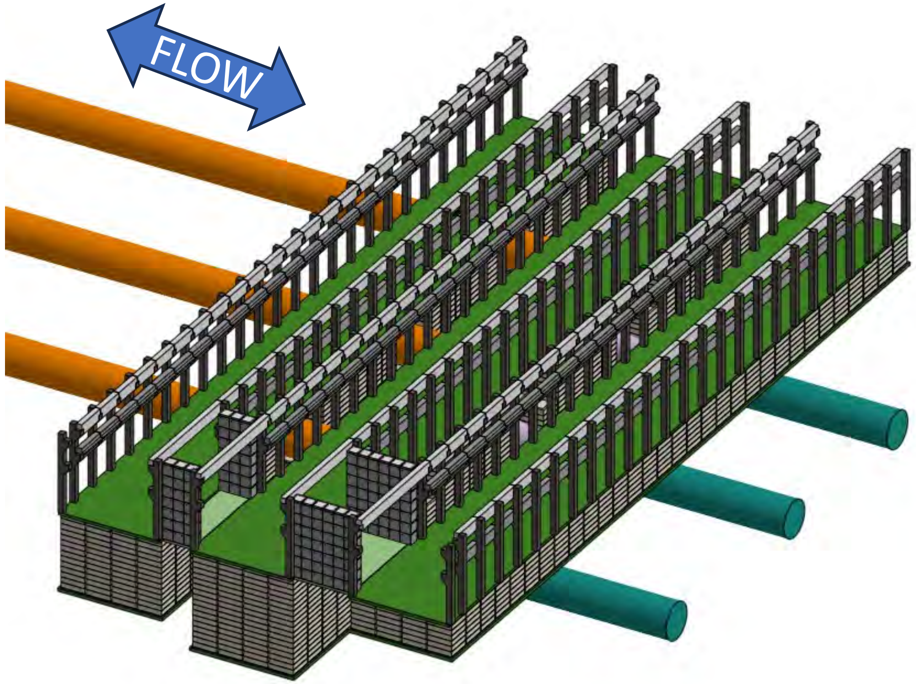
Upper Structure Finalized and Enclosed

Pump Storage – Details

Bridge Crane Structure and Access Between Galleries



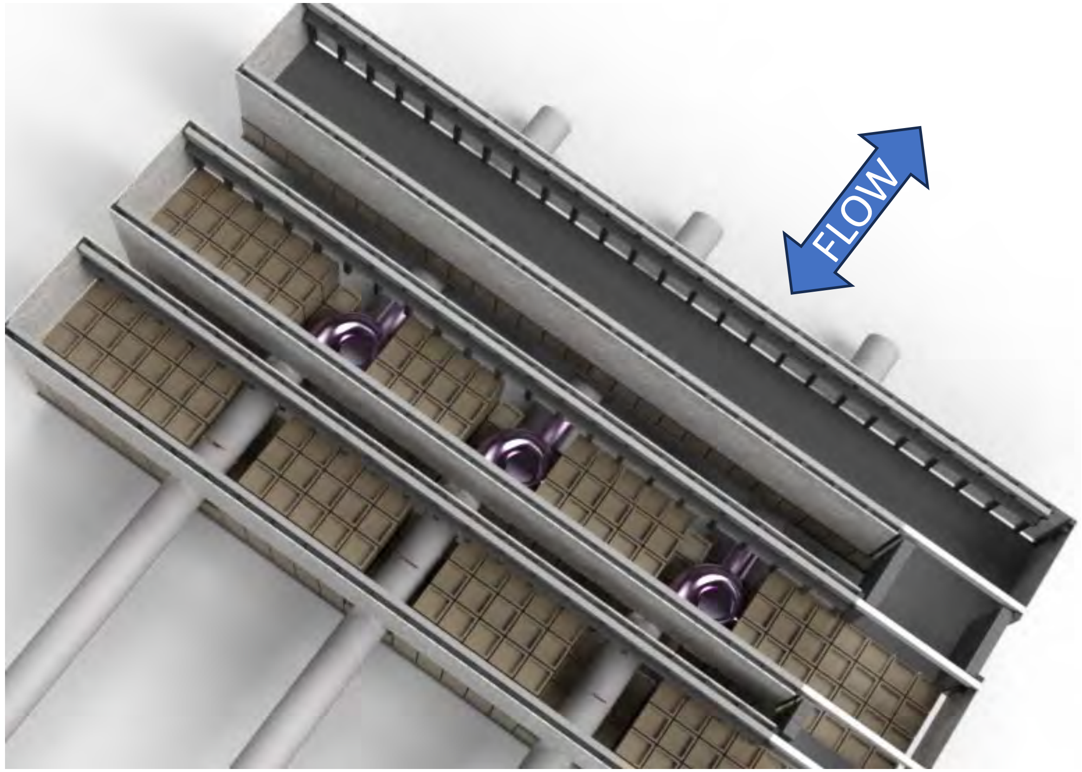
Rendered view

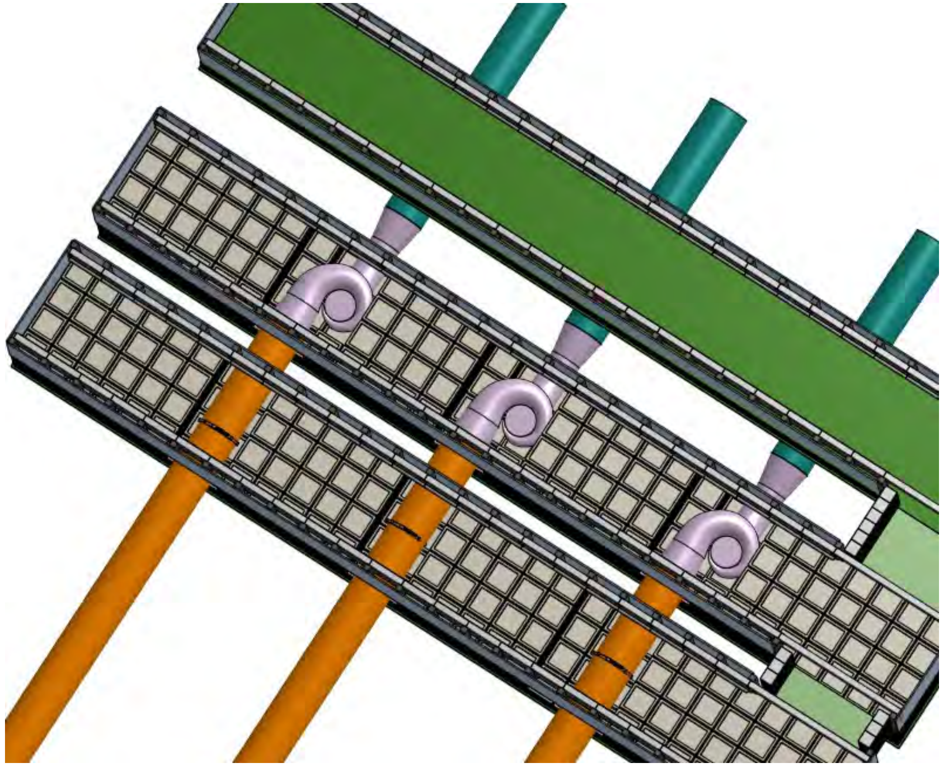


Components drawing

Pump Storage – Details

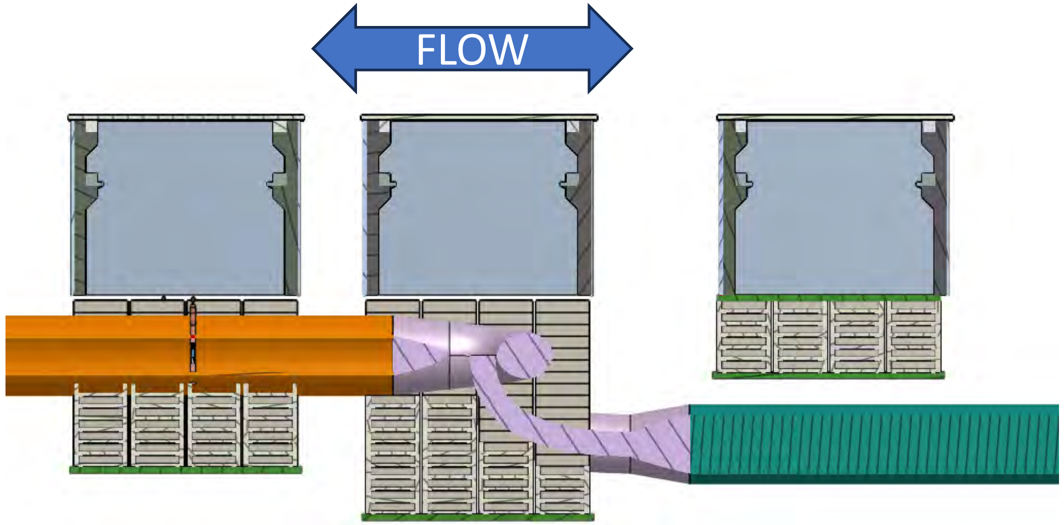
Turbines and Valves

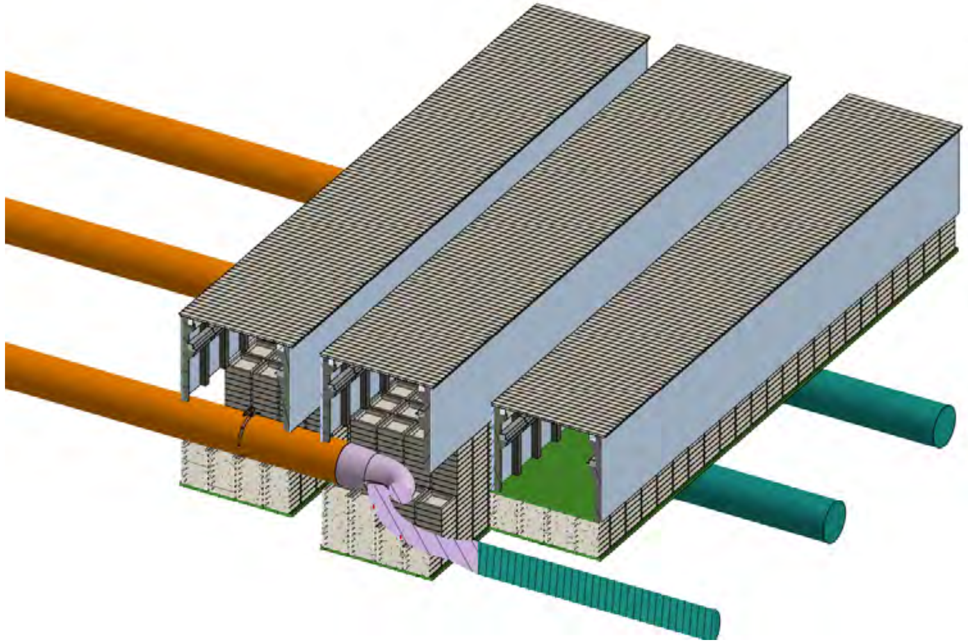




Pump Storage – Section View

Valve, Turbine and Electric Houses





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MODULAR HYDRO SOLUTIONS

PSH Powerhouse Interior Model

Pumped Storage Hydropower

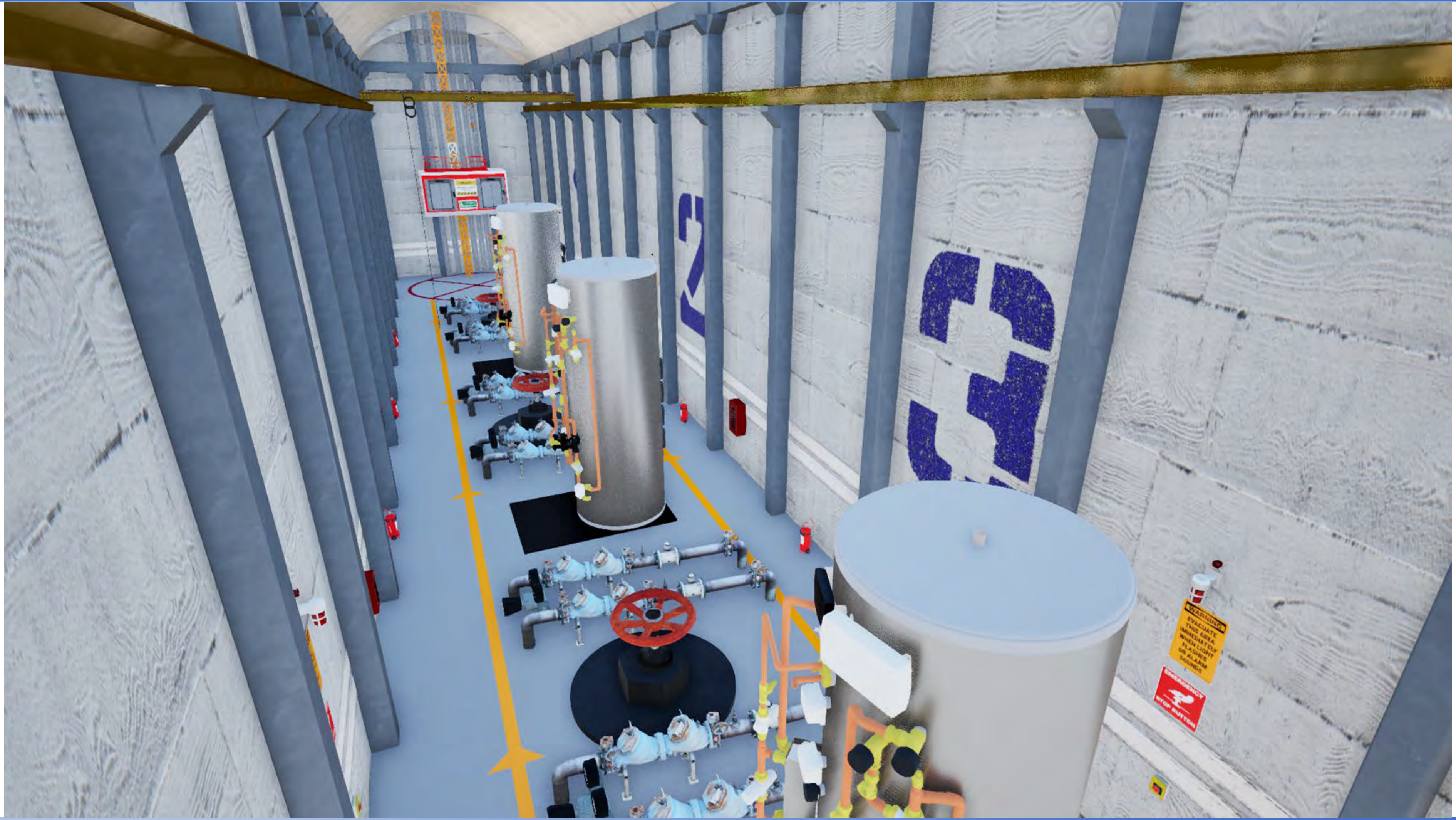
Pumped Storage Hydropower

ANY SIZE ANY SHAPE
NOT TO SCALE

Pumped Storage Hydropower

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

Pumped Storage Hydropower



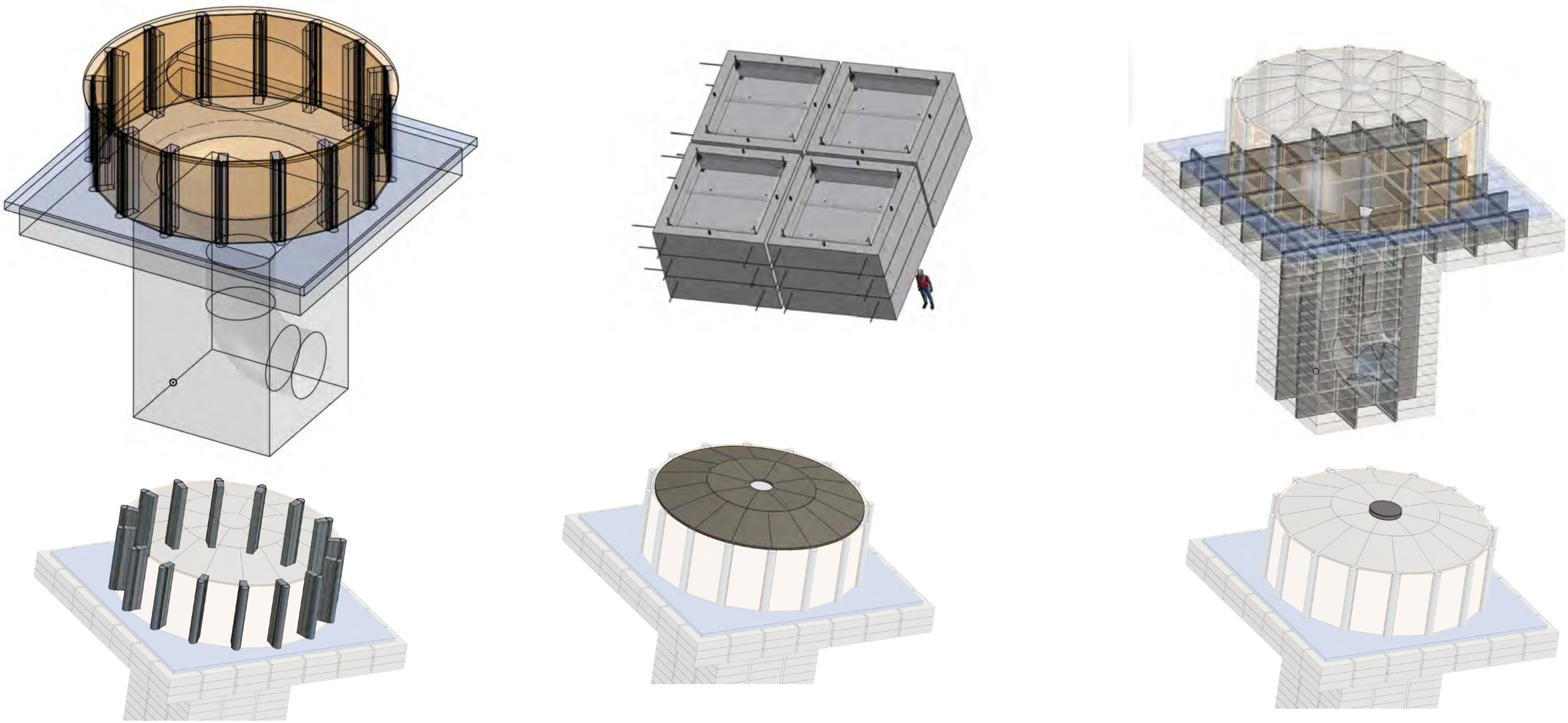
Pumped Storage Hydropower

Additional Information

Applications / Integration

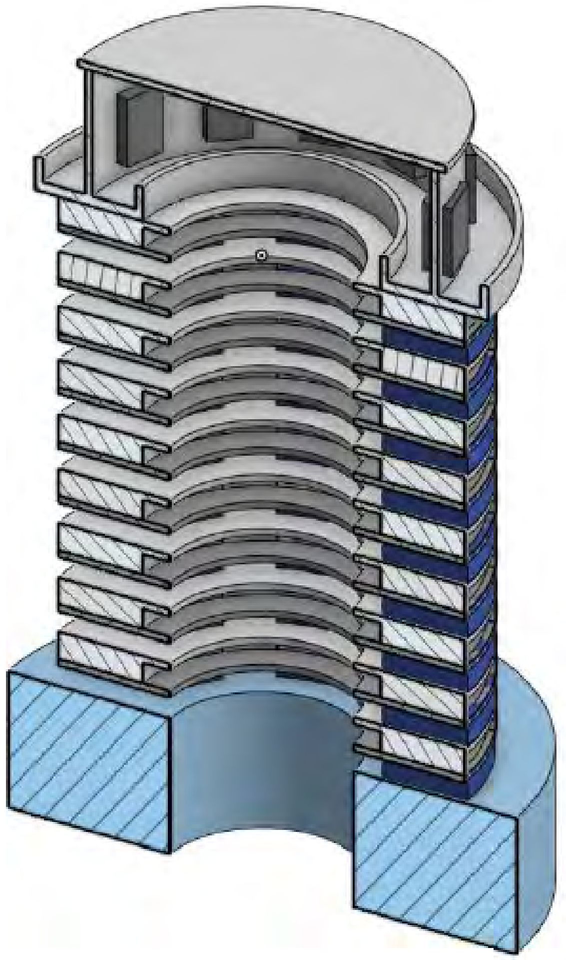
- Applications for Tunnel Boring Machines, Vertical Boring Machines
- Integration of valves, gates, control points, taps into precast modules
- Applicable integration with precast or steel penstocks and liners
- Not limited to these applications

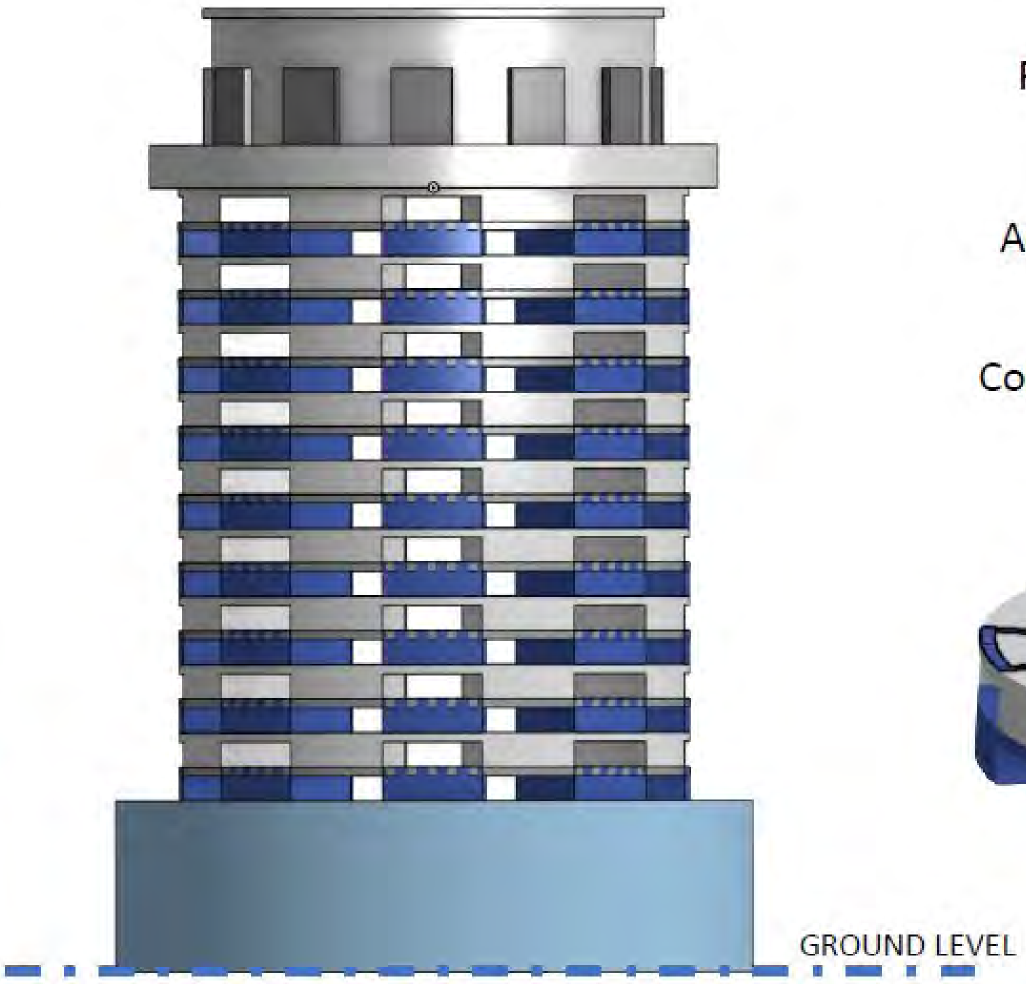
Intake Structure Models



Precast Components

Impoundment Draft & Intake Modular Precast Structures

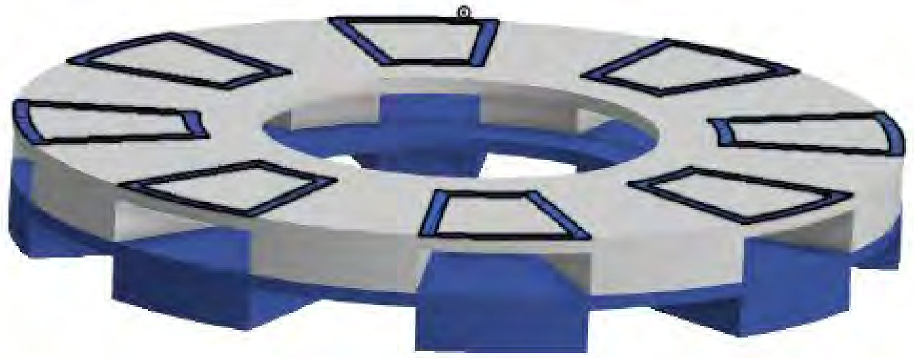




Precast Modular Intake and Draft Water Control Civil Structure

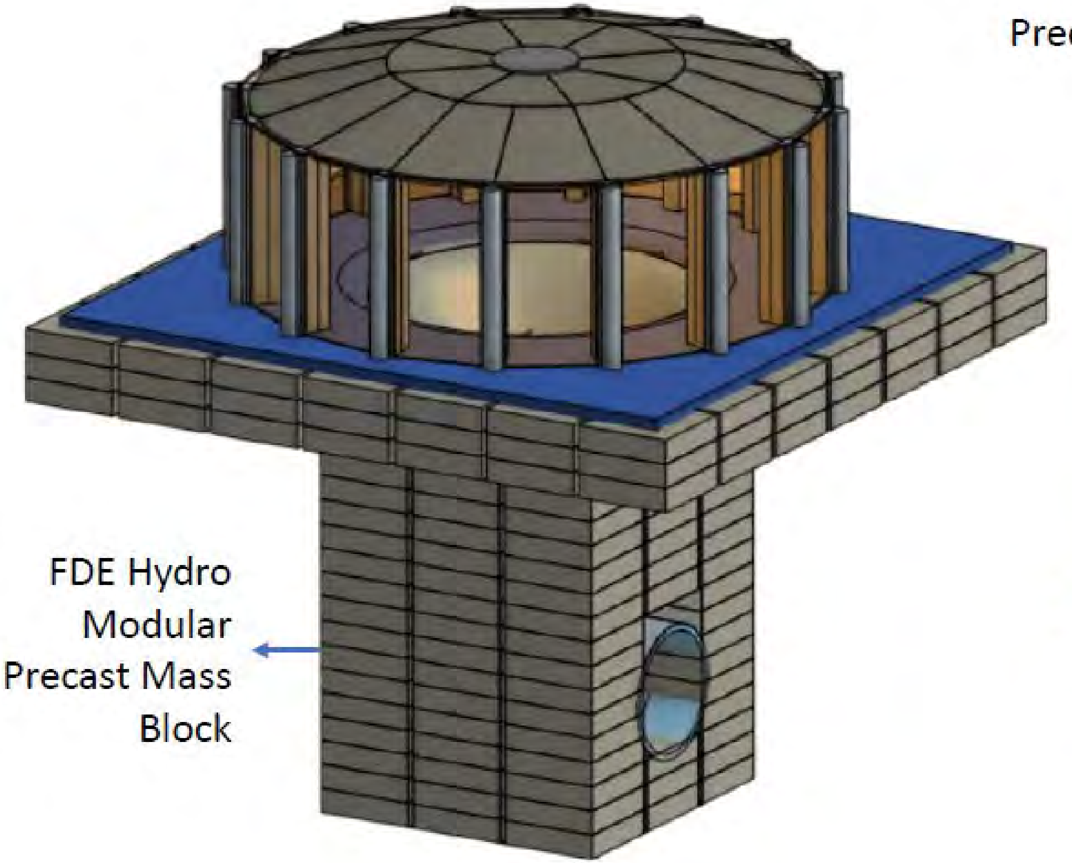
Automated gate systems and rack screens (not shown for clarity)

Control water intake to tunnels/powerhouse



Impoundment Draft & Intake Modular Precast Structures

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS



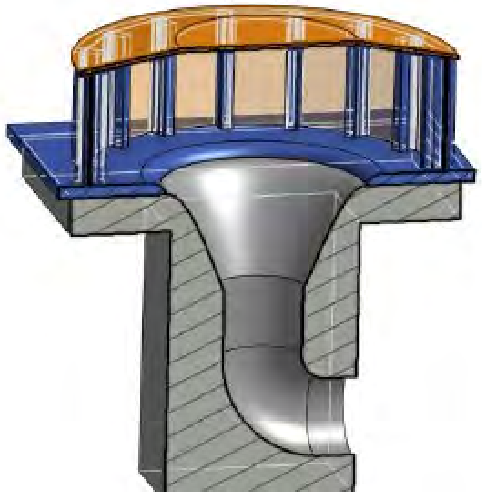
FDE Hydro Modular Precast Mass Block

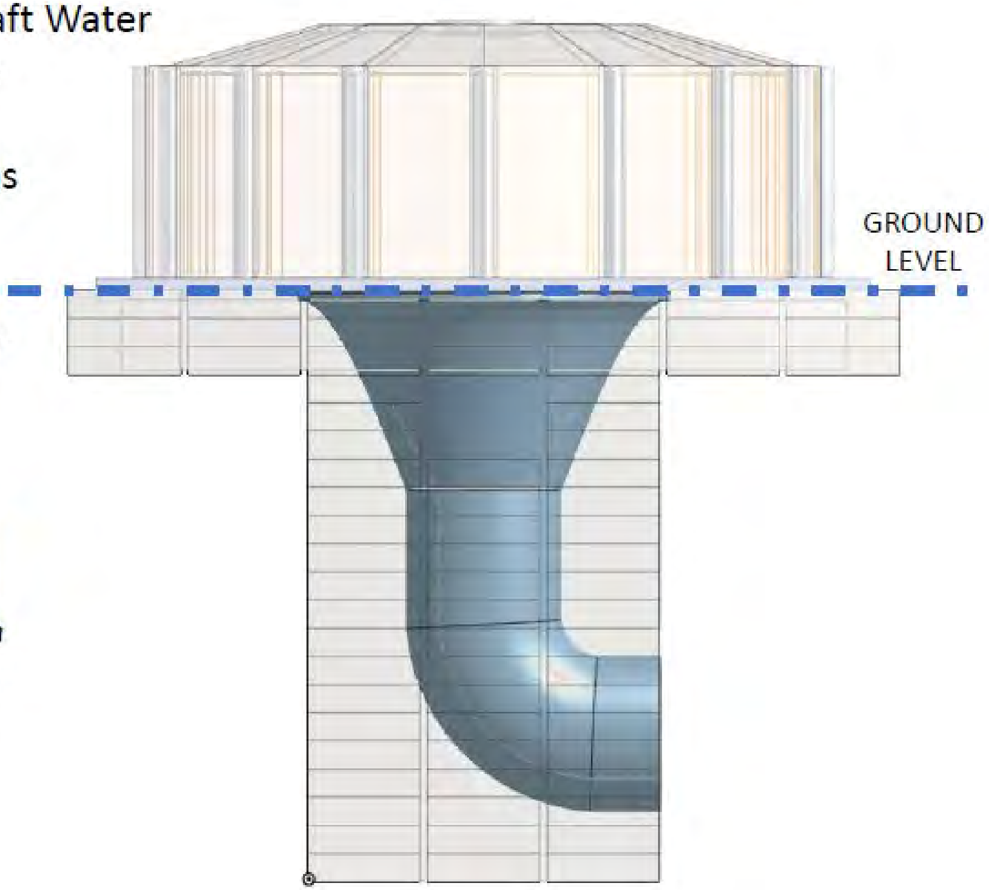
Control water intake to tunnels/powerhouse

Precast Modular Intake and Draft Water Control Civil Structure

Automated gate systems and rack screens

Above or below water level applications

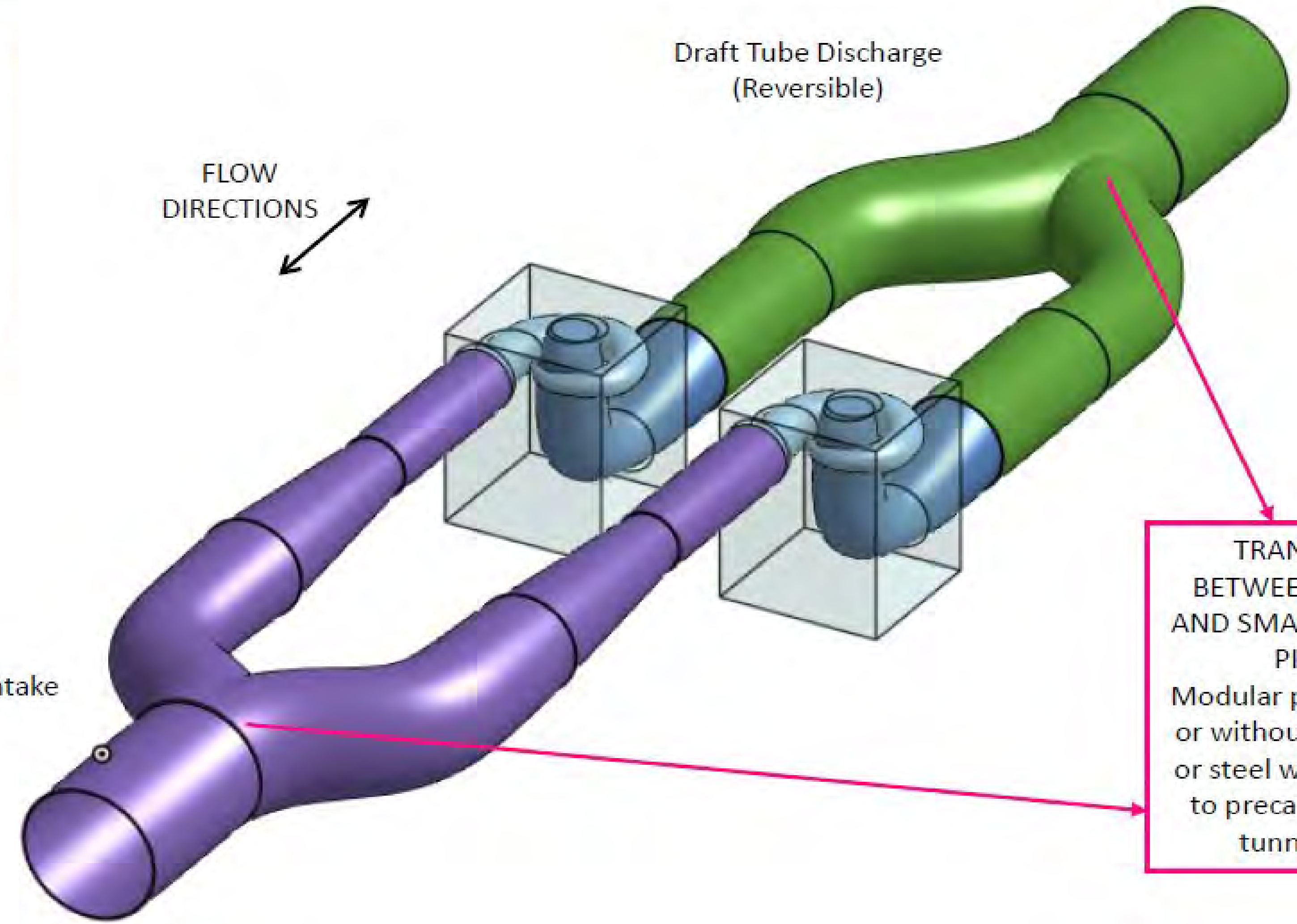




Transition Between Larger Tunnel to Smaller Feeds

FDE | FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS

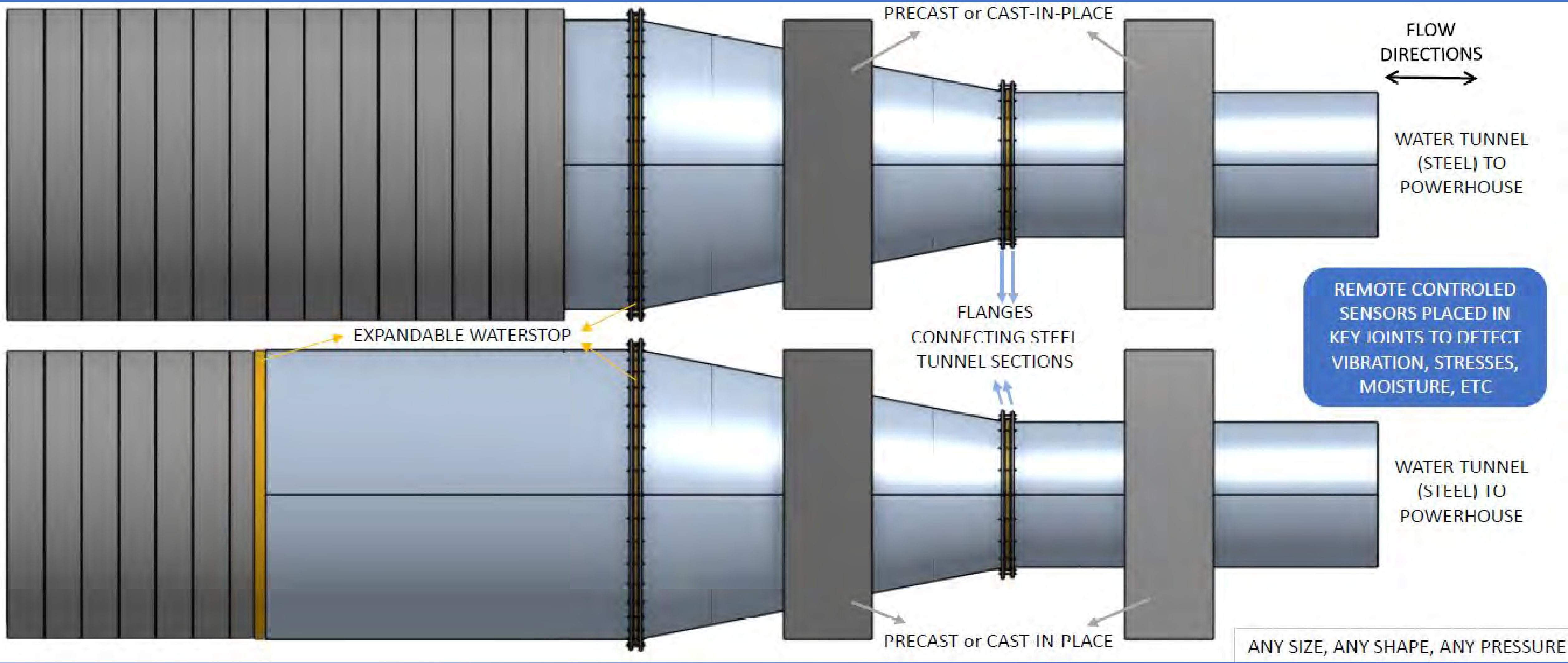
Turbine pipes diameter and transitions as per manufacturer specs



TRANSITION BETWEEN TUNNEL AND SMALLER WATER PIPES:
Modular precast, with or without steel liner, or steel with couplers to precast modular tunnel liner

Top View

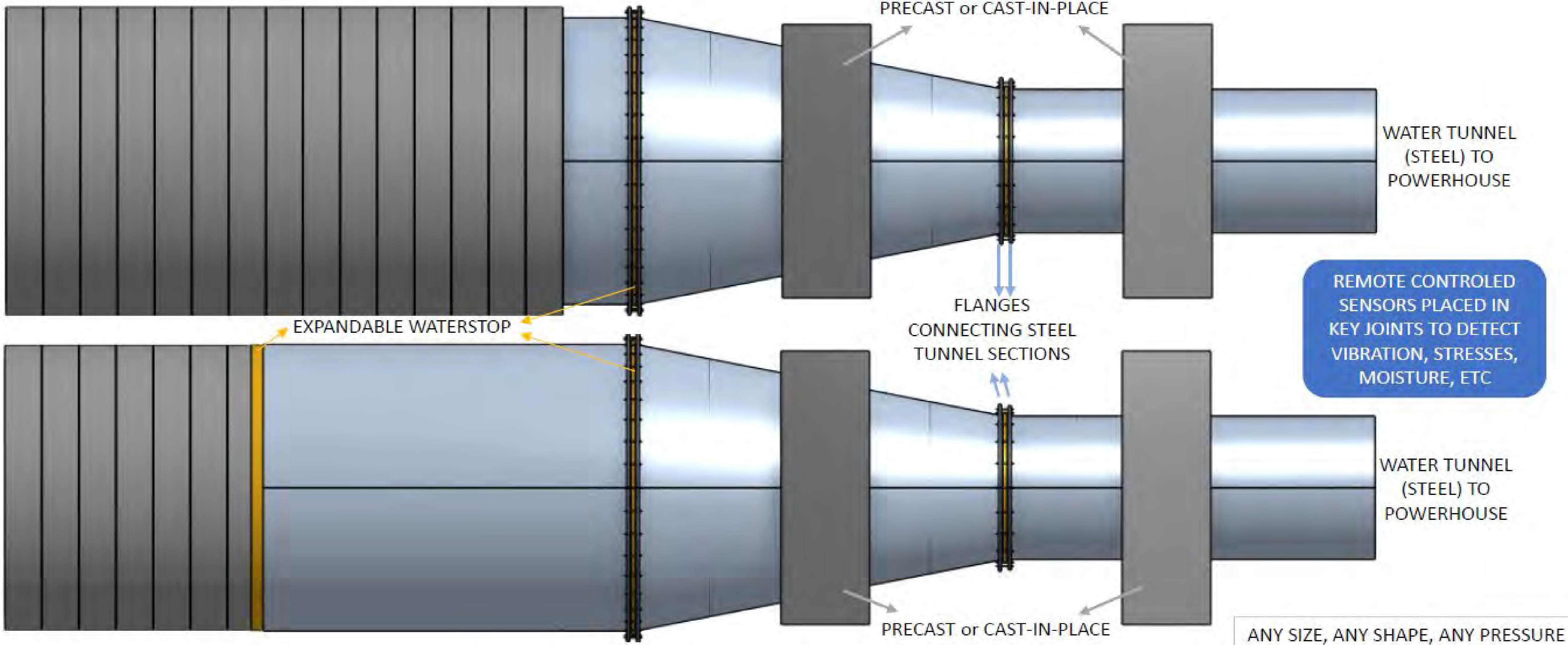
Two Options (Precast Over or Inside the Steel Liner



ANY SIZE ANY SHAPE
NOT TO SCALE

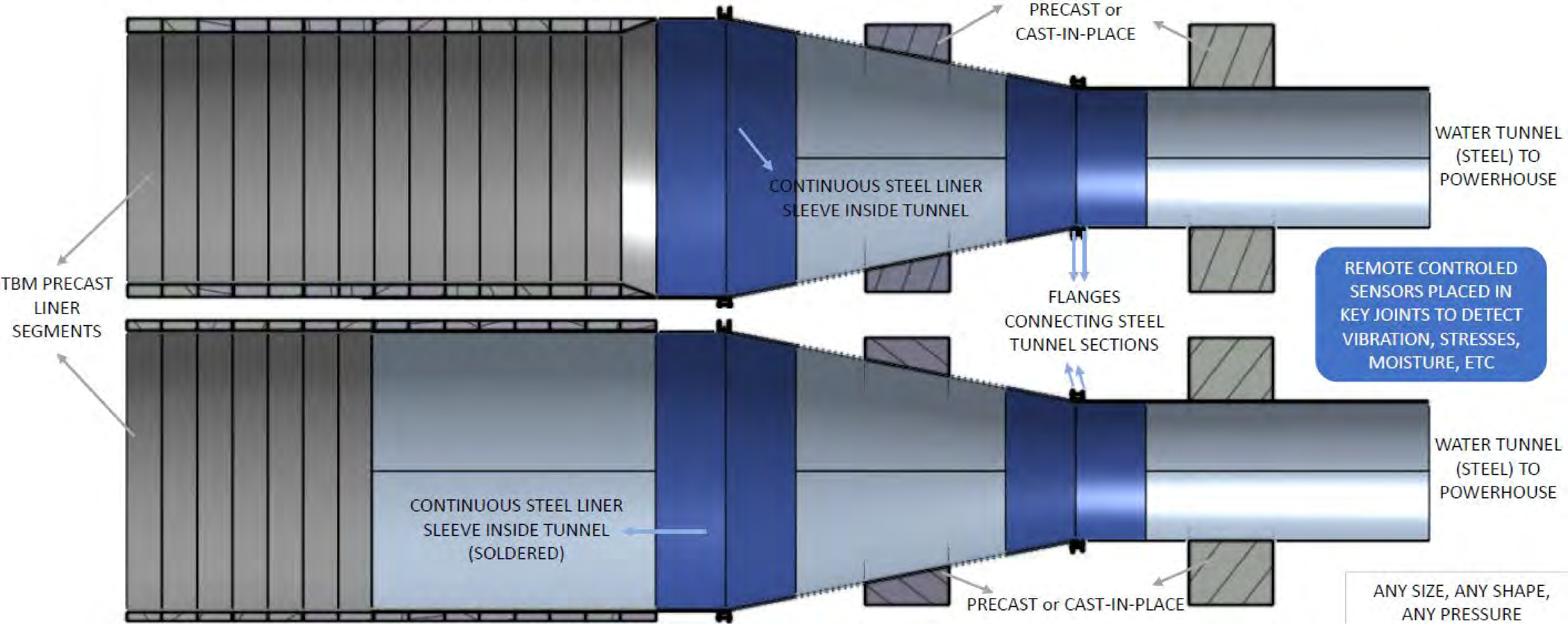
Side View

Two Options (Precast Over or Inside the Steel Liner



ANY SIZE, ANY SHAPE, ANY PRESSURE

Section Through

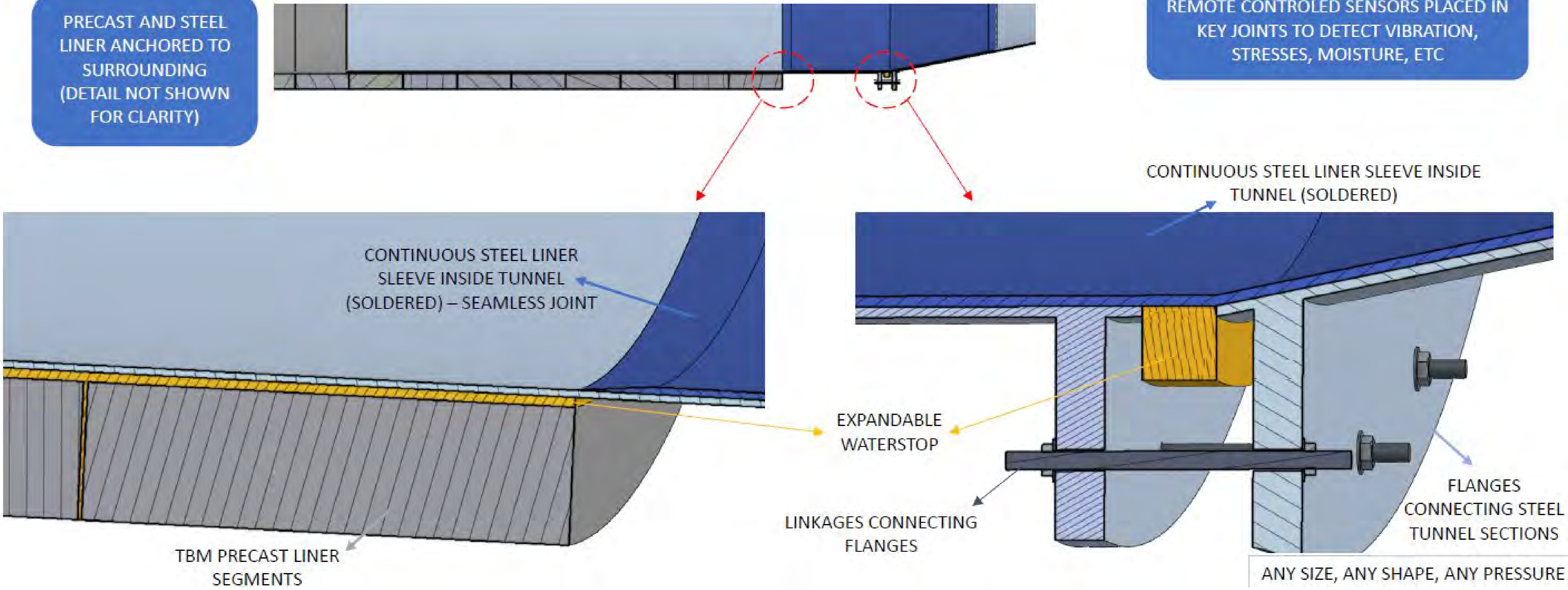


Linkage and Steel Liner Details

TBM Precast Over Steel Liner

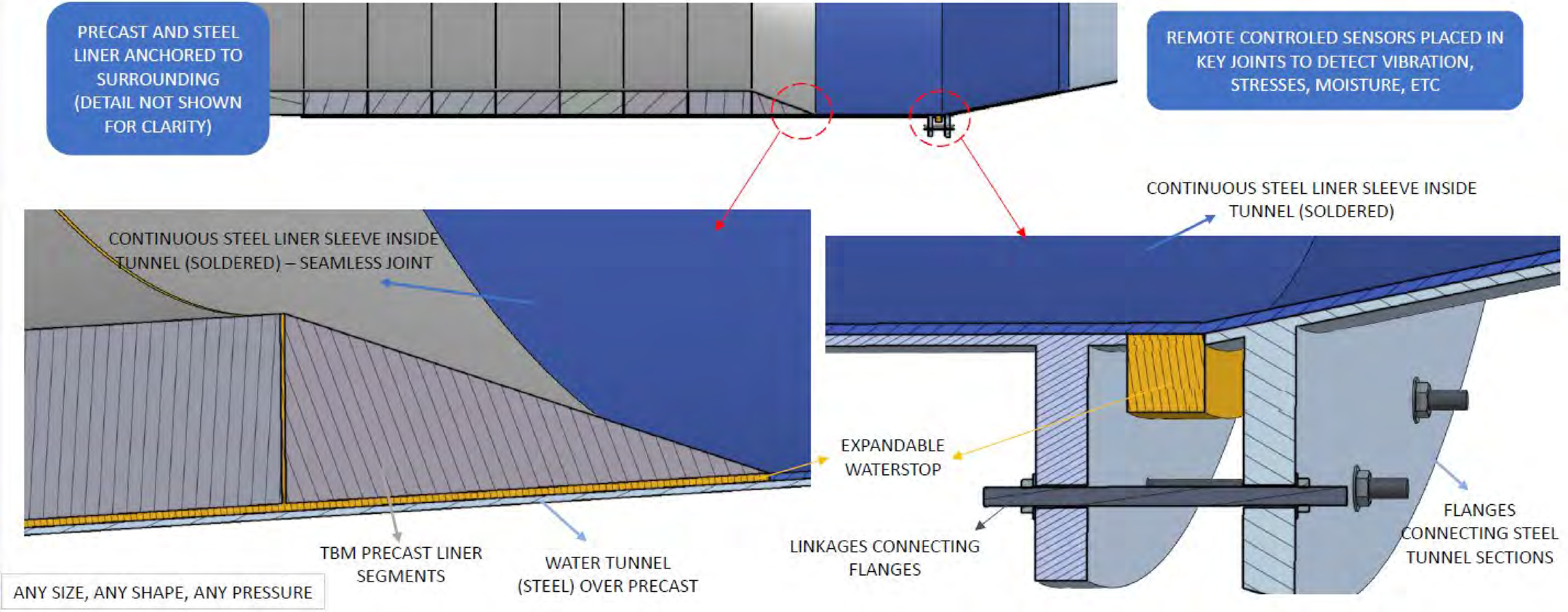
PRECAST AND STEEL LINER ANCHORED TO SURROUNDING (DETAIL NOT SHOWN FOR CLARITY)

REMOTE CONTROLED SENSORS PLACED IN KEY JOINTS TO DETECT VIBRATION, STRESSES, MOISTURE, ETC

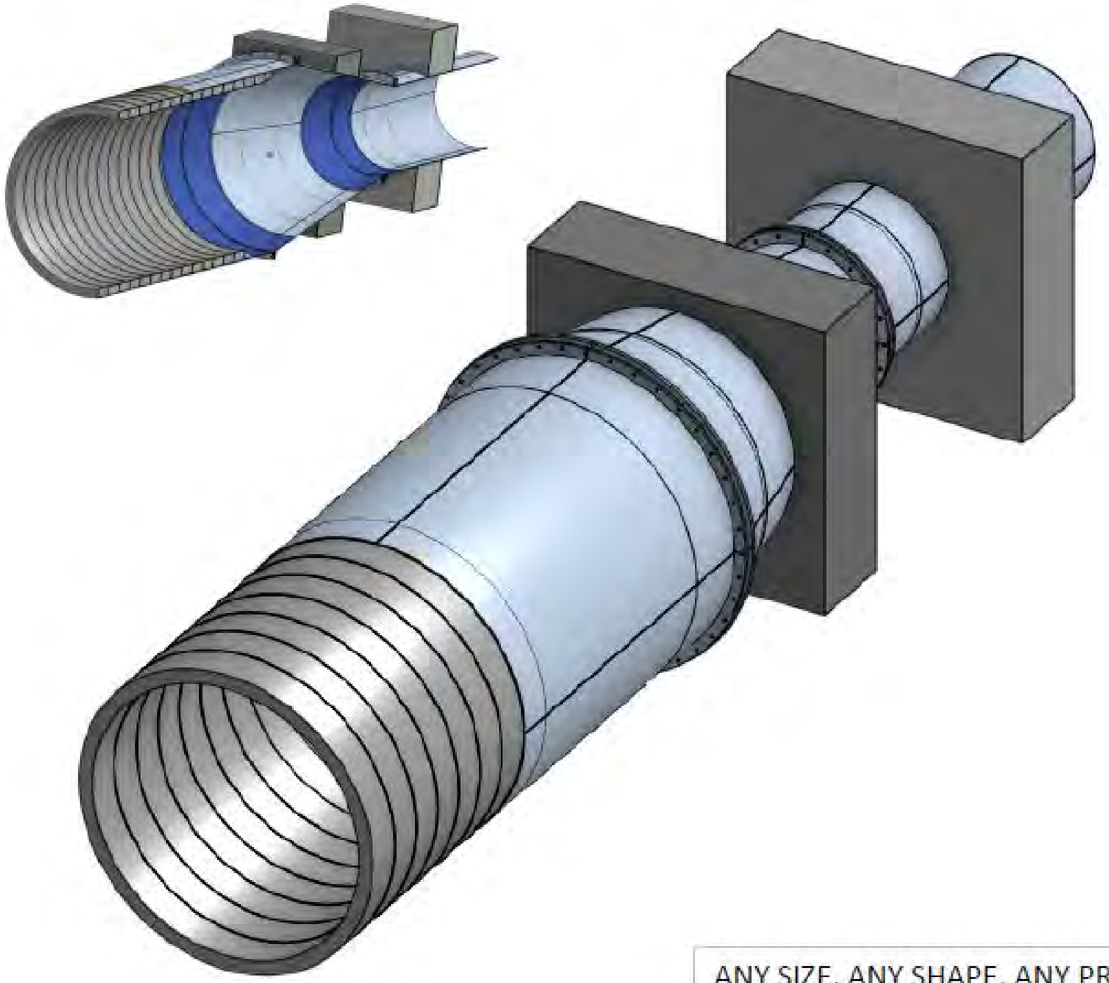


Linkage and Steel Liner Details

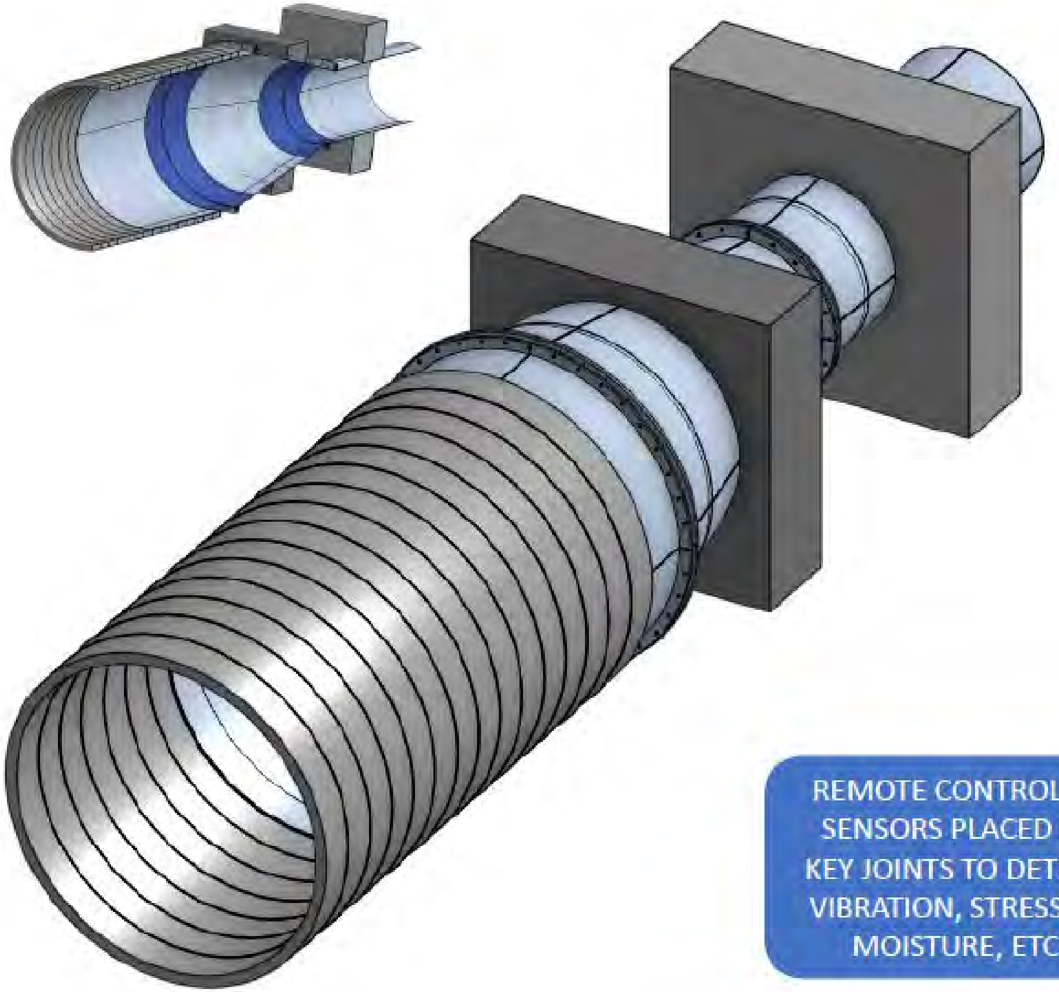
TBM Precast Inside Steel Liner



Isometric View

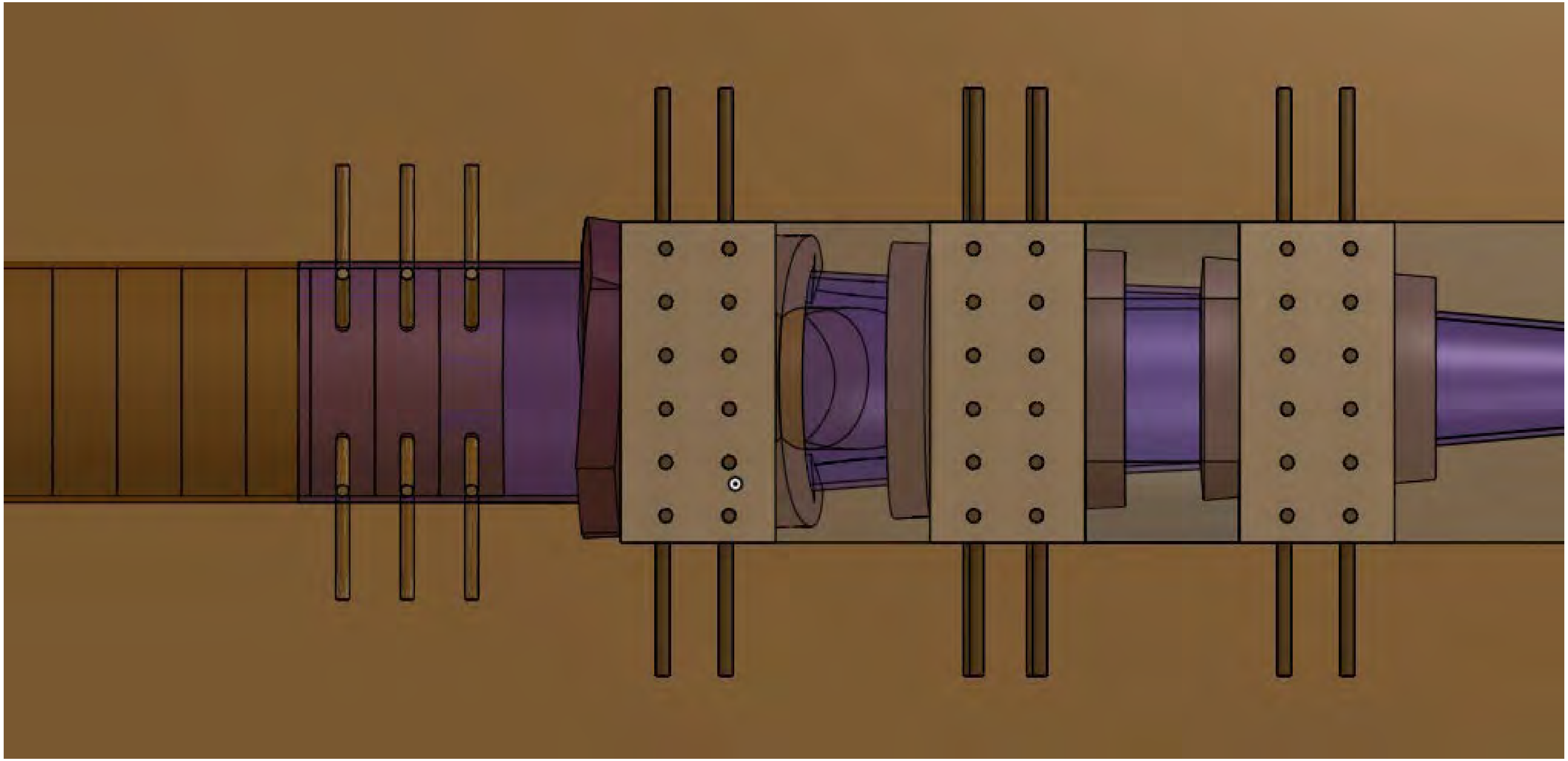


ANY SIZE, ANY SHAPE, ANY PRESSURE



REMOTE CONTROLED SENSORS PLACED IN KEY JOINTS TO DETECT VIBRATION, STRESSES, MOISTURE, ETC

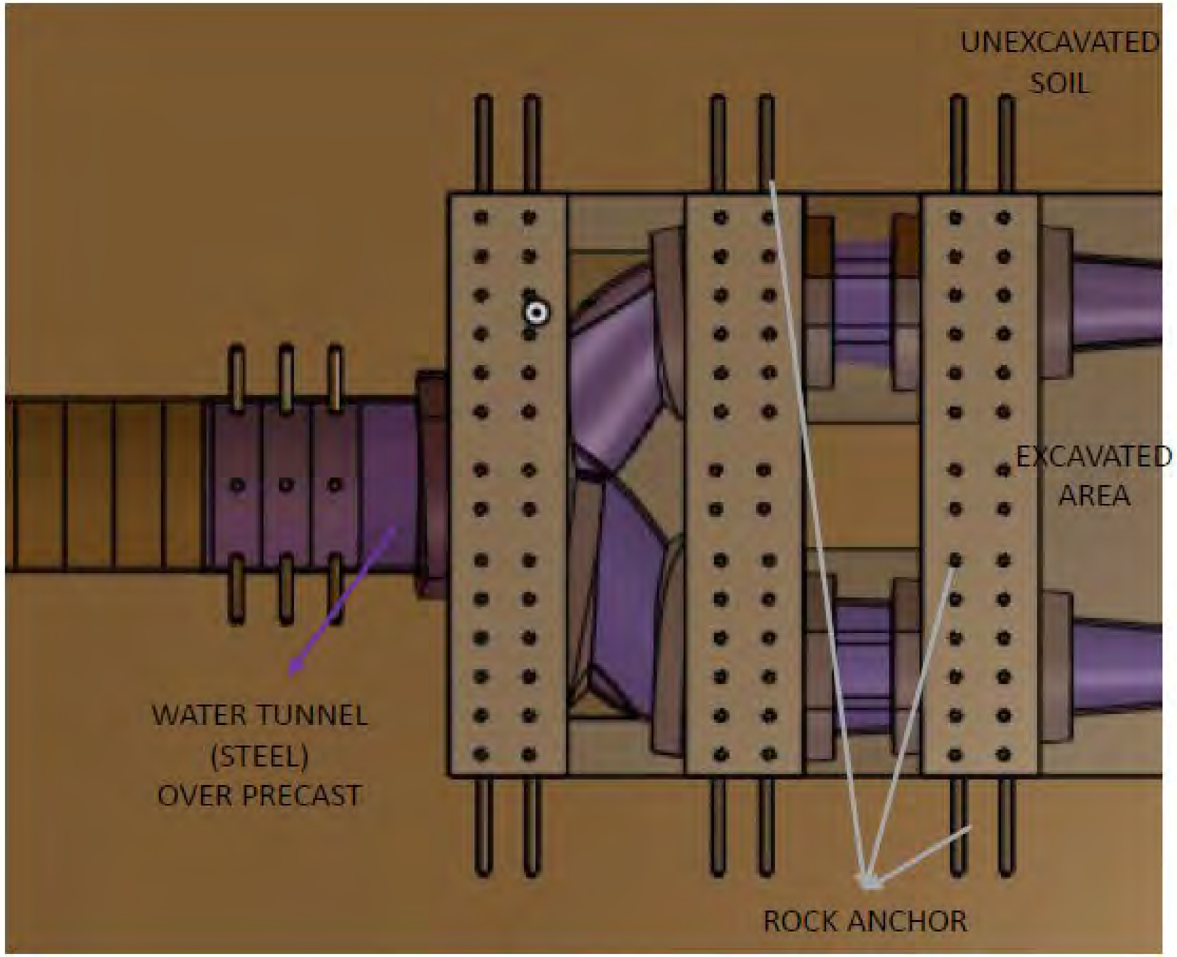
Side View of the Transition Section



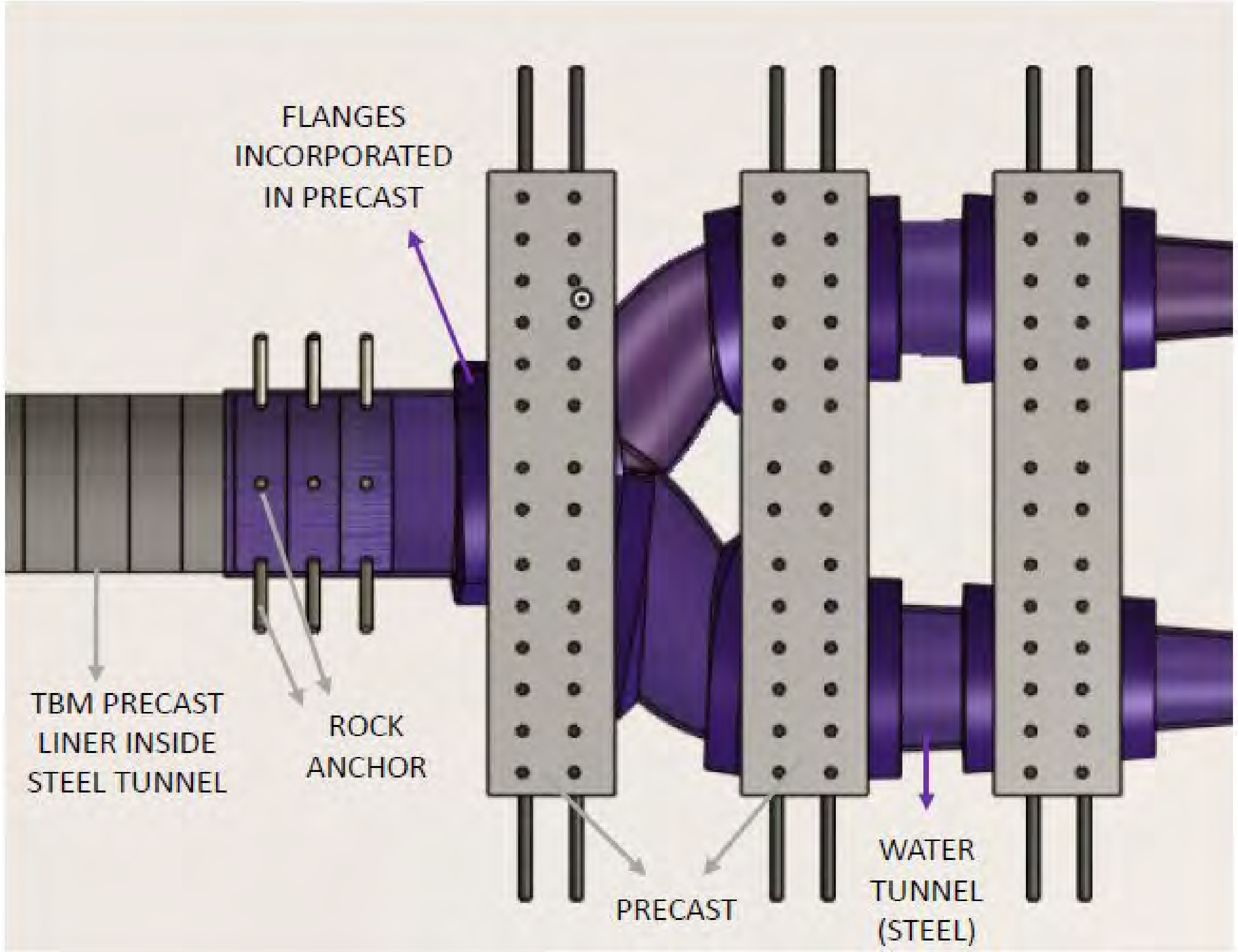
ANY SIZE ANY SHAPE
NOT TO SCALE

Top View of the Transition Section

FDE FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS



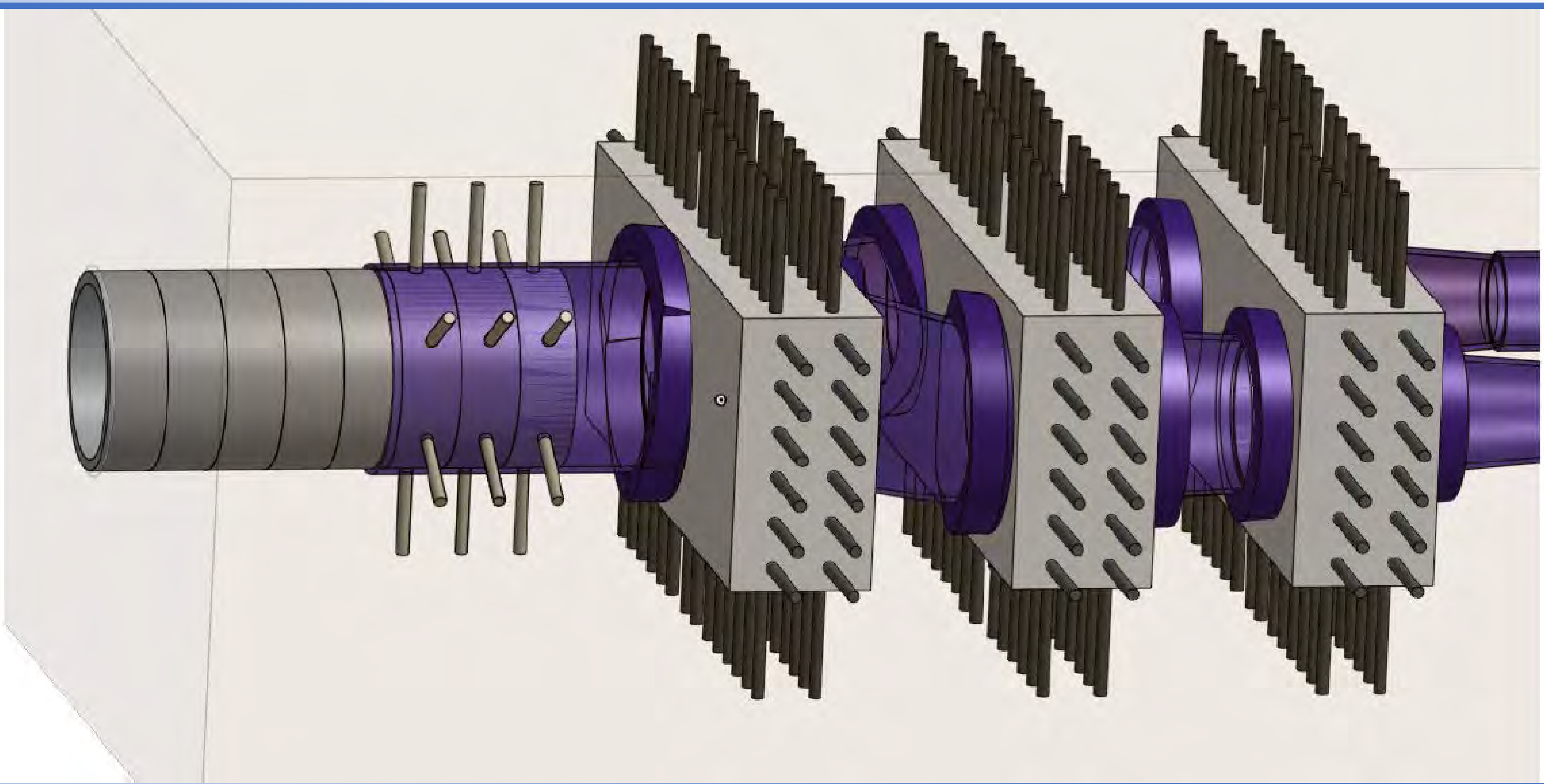
Excavation Detail



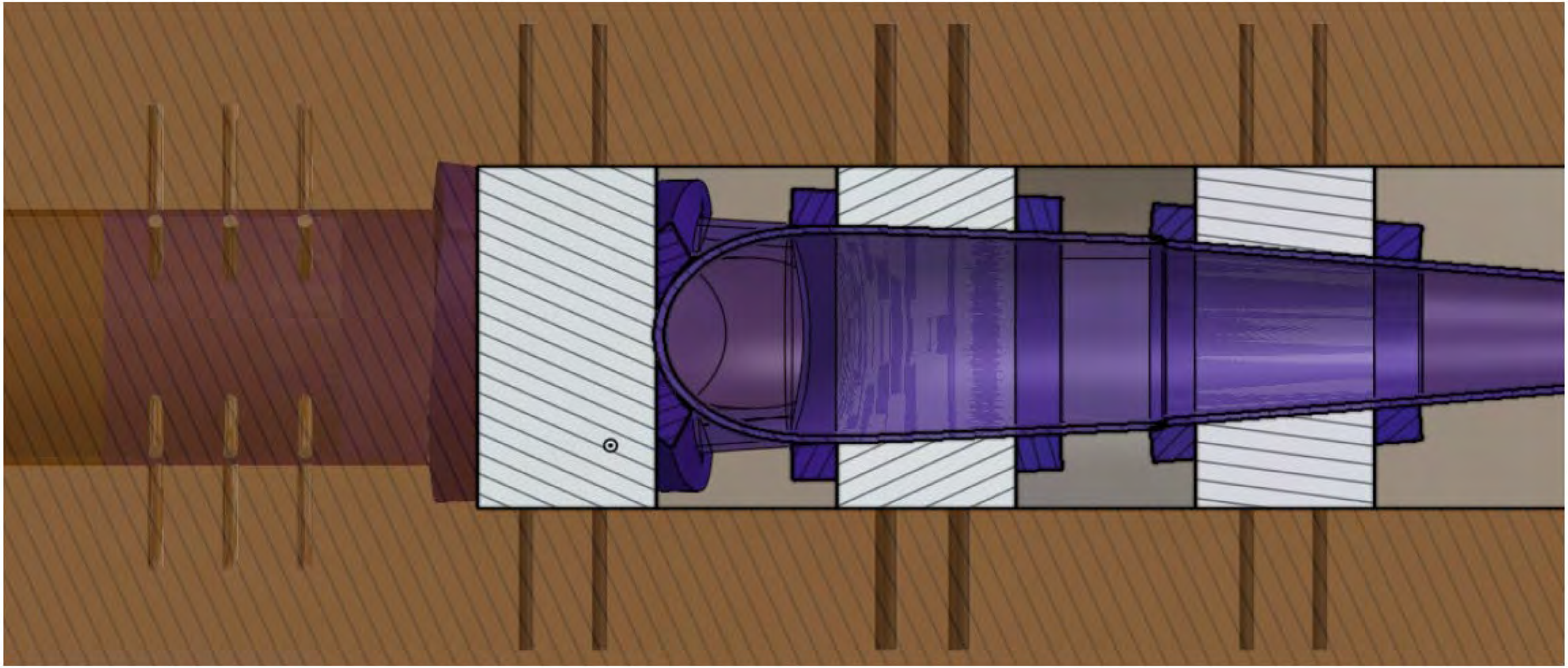
Top View (Excavation omitted)

Transition Manifold with Precast Thrust Blocks

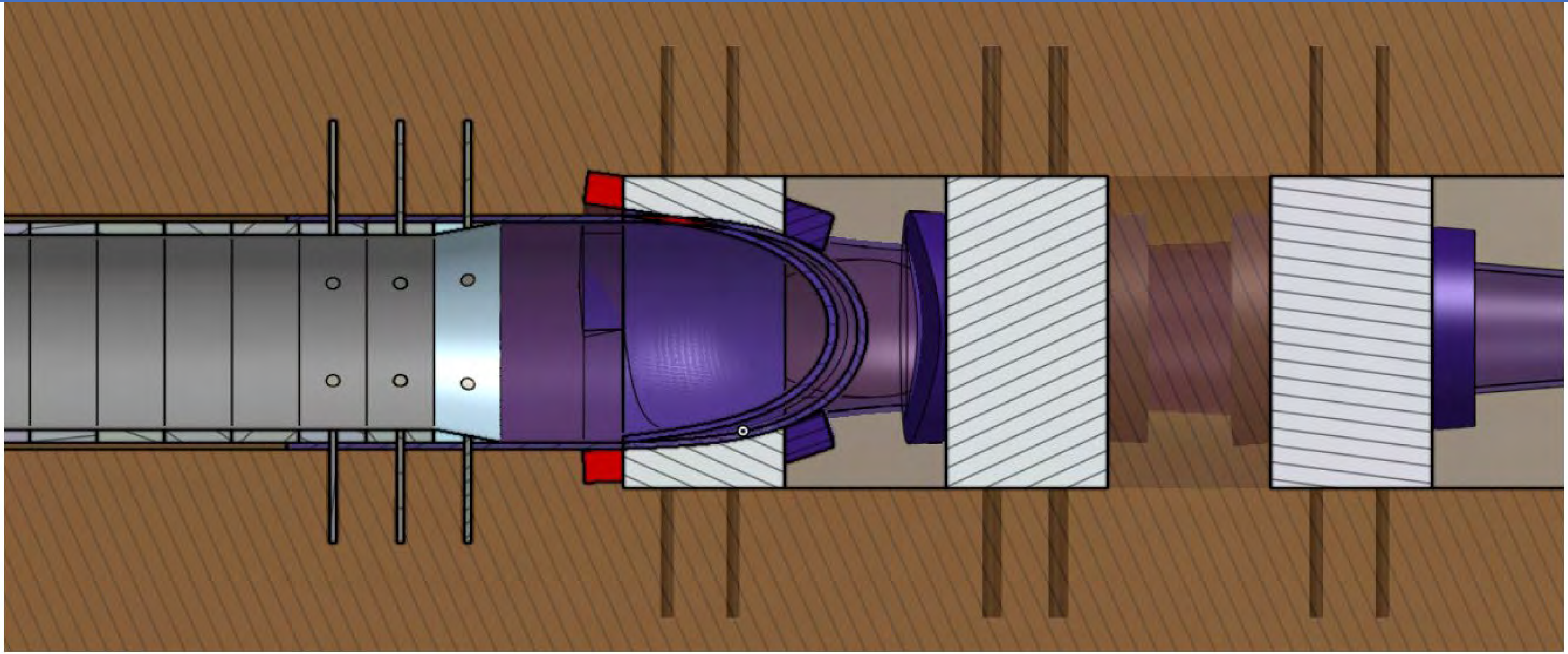
With Precast Tunnel Liners



Section Through Turbine Pipes

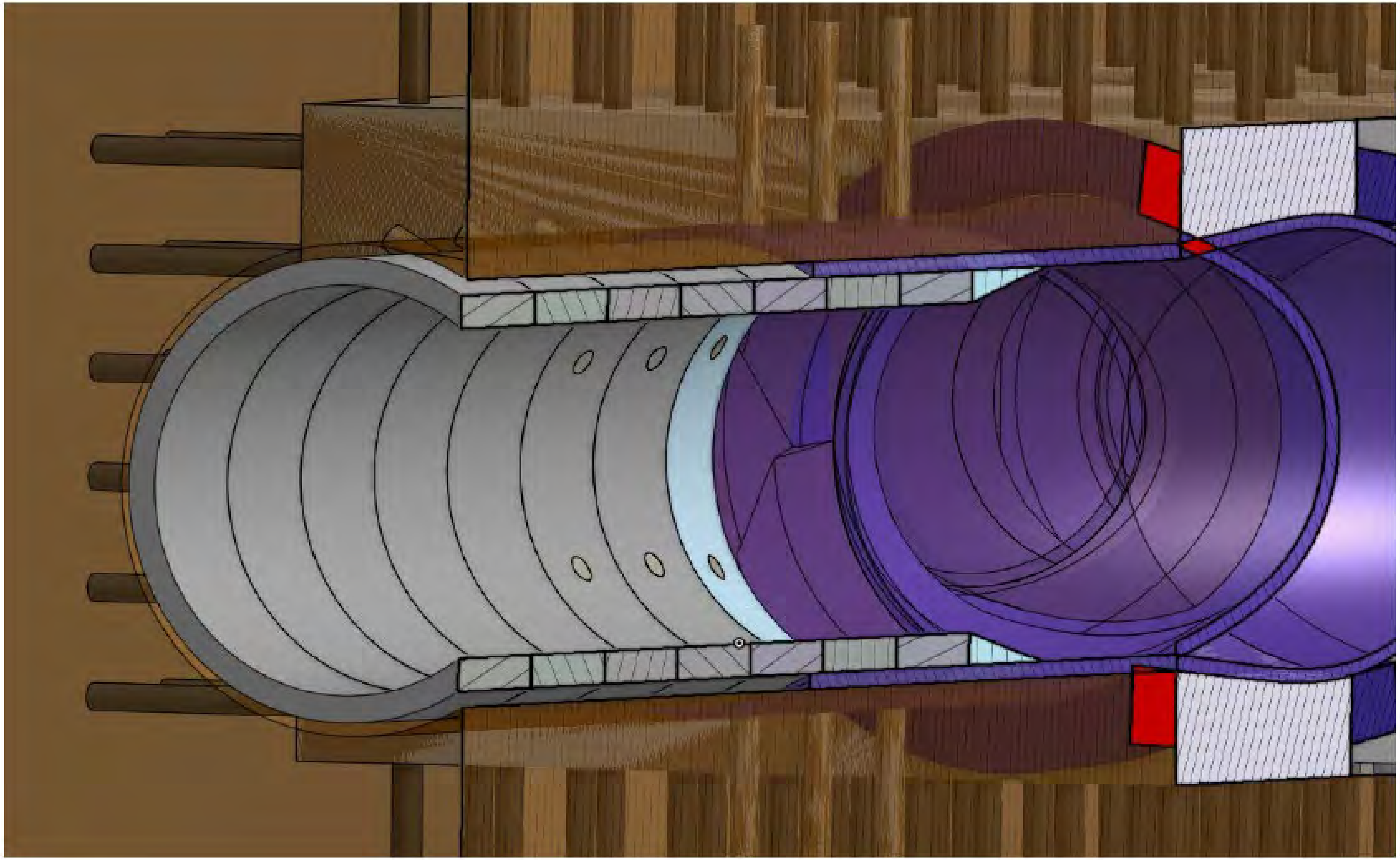


Section Through Tunnel Transition



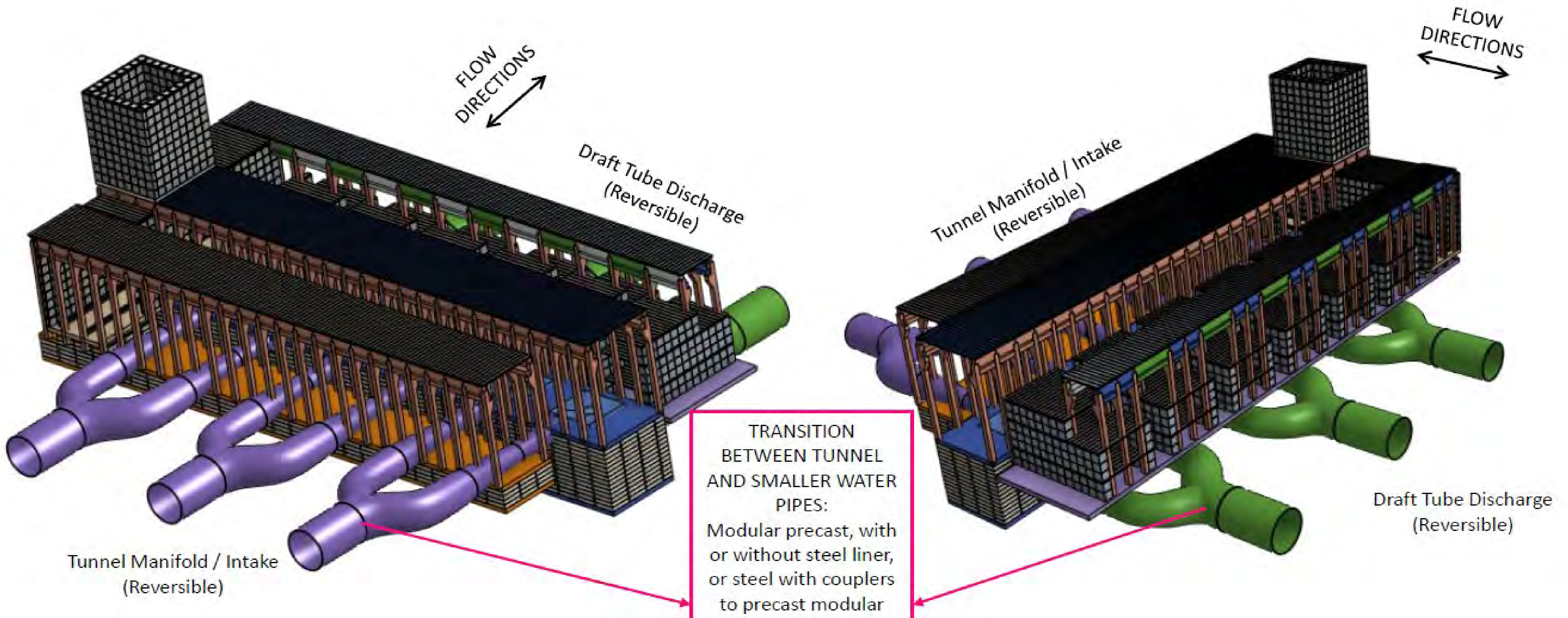
Section Through Tunnel Transition

FRENCH DEVELOPMENT ENTERPRISES
MODULAR HYDRO SOLUTIONS



Tunnel Manifolds and Draft Tube

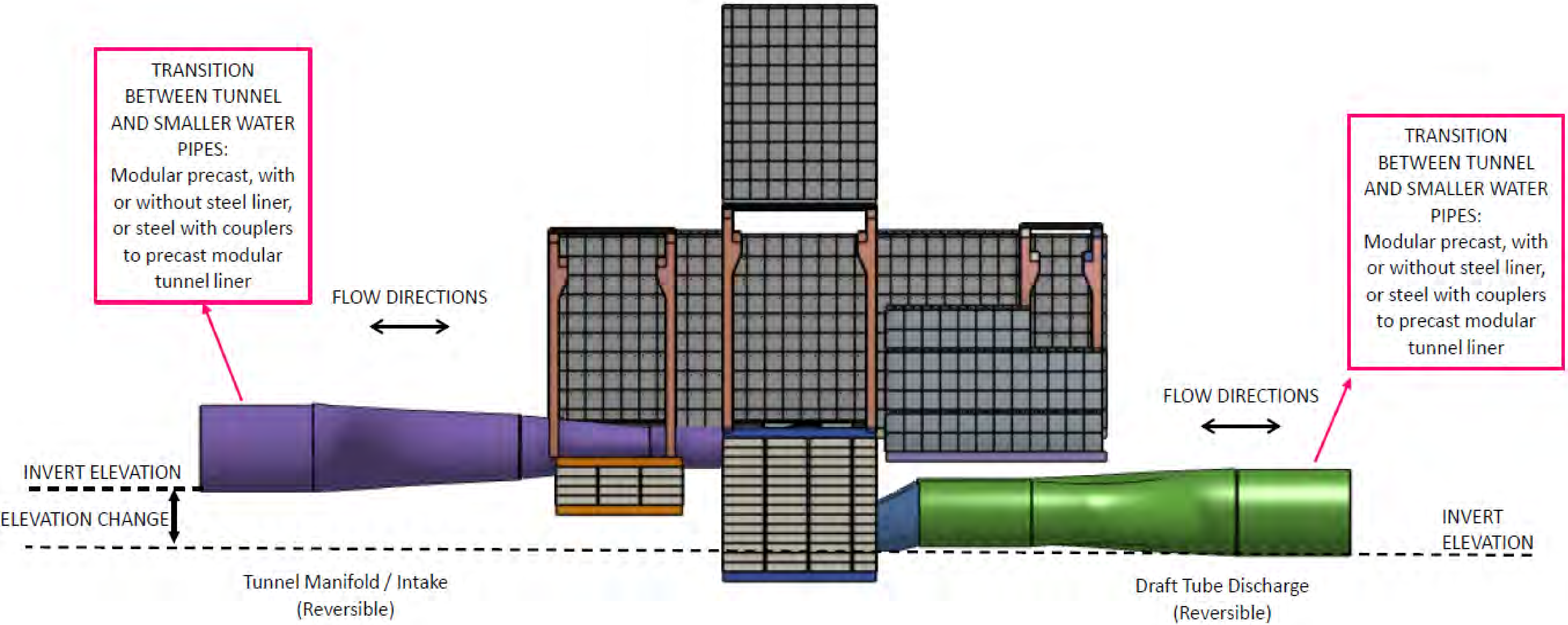
Typical Pumped Storage Hydropower



TRANSITION BETWEEN TUNNEL AND SMALLER WATER PIPES:
Modular precast, with or without steel liner, or steel with couplers to precast modular tunnel liner

Tunnel Manifolds and Draft Tube

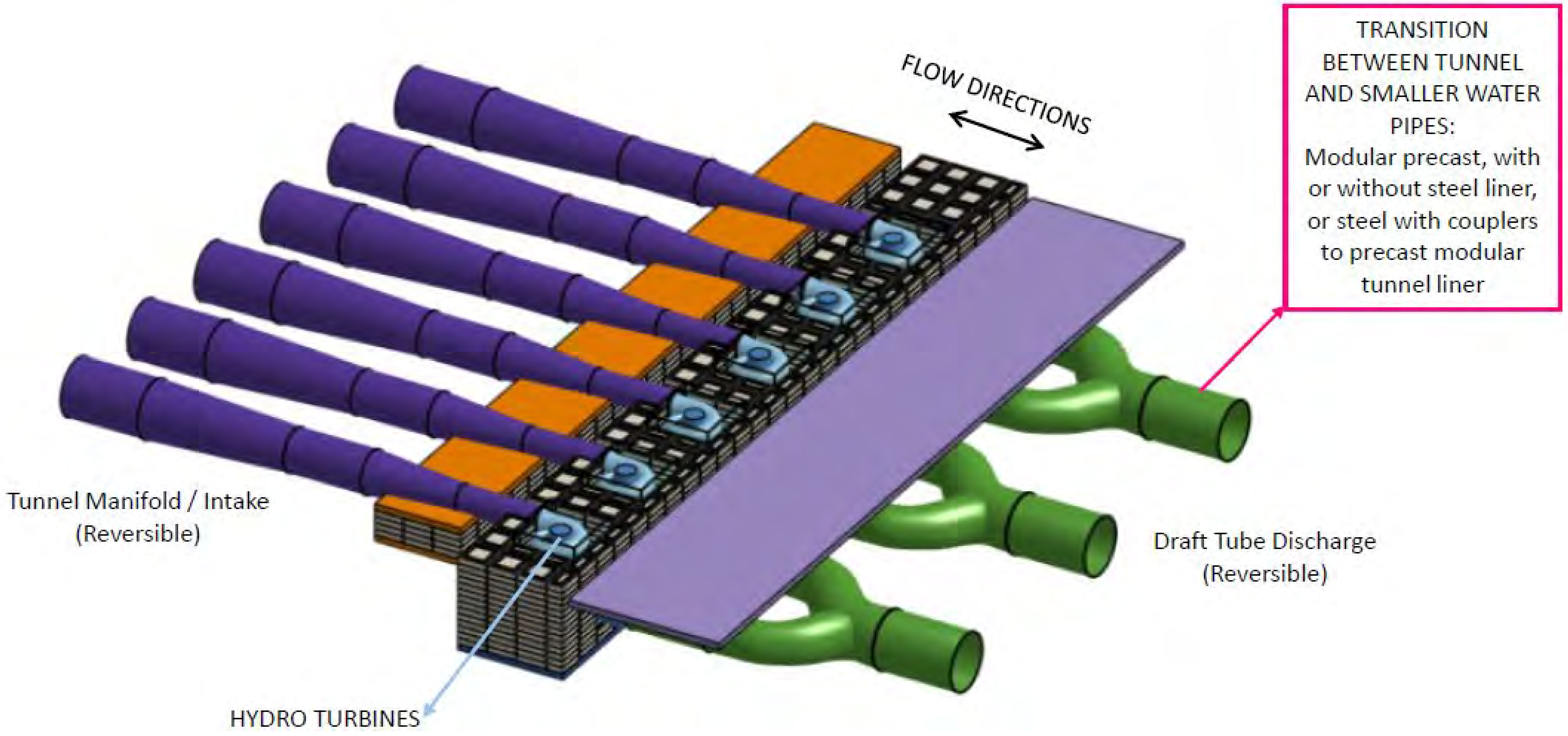
Typical Pumped Storage Hydropower



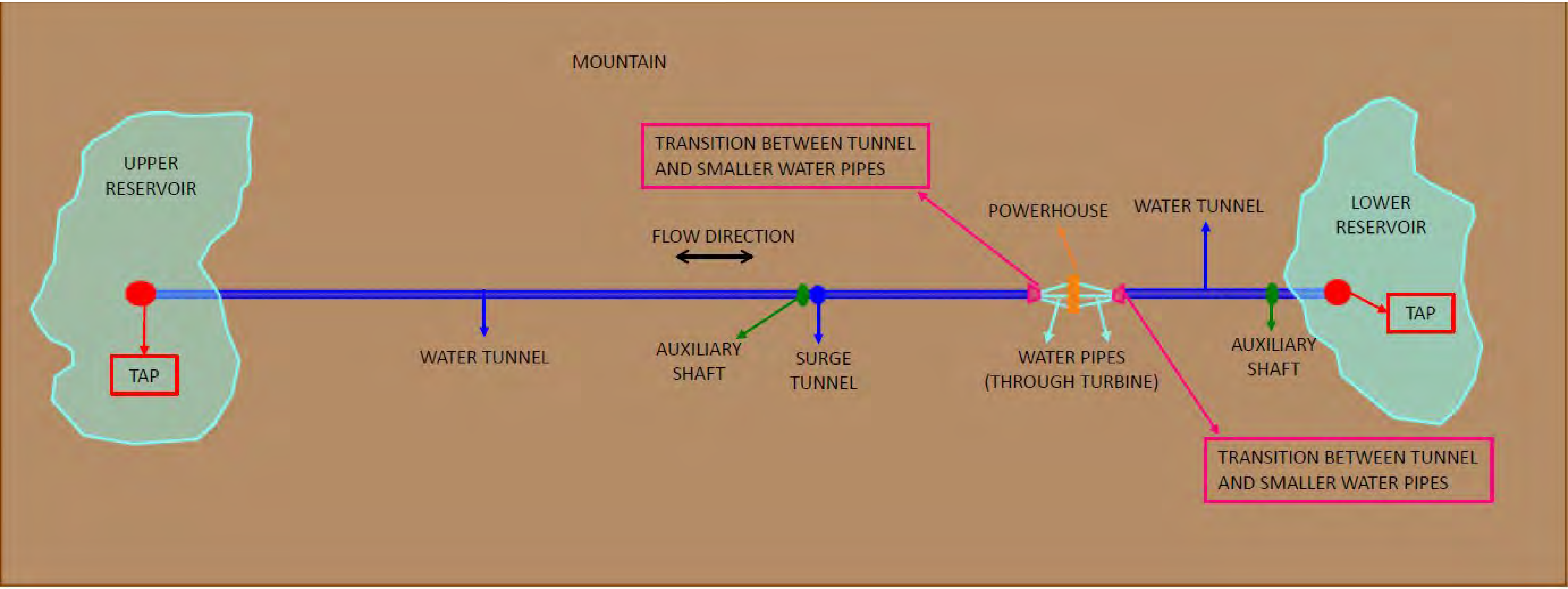
ANY SIZE ANY SHAPE
NOT TO SCALE

Tunnel Manifolds and Draft Tube

Typical Pumped Storage Hydropower



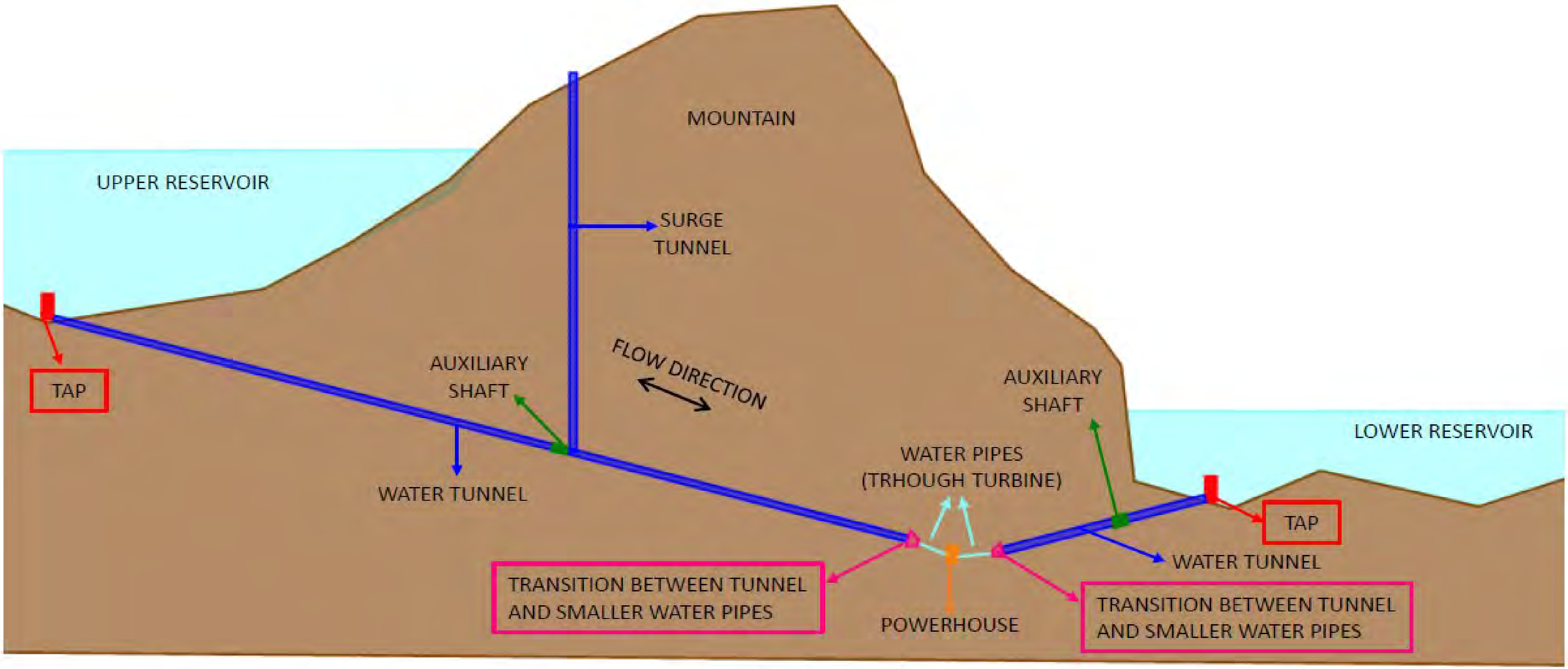
Transition Between Larger Tunnel to Smaller Feeds



TOP VIEW

Transition Between Larger Tunnel to Smaller Feeds

Precast Concrete Pumped Storage Hydropower Facility



SECTION VIEW

FDE | FRENCH DEVELOPMENT ENTERPRISES

MODULAR HYDRO SOLUTIONS

Modularity gives you predictable, redundant, rapidly deployable civil structures with 100+ years life span.
Building for America's future energy needs.

MADE IN THE U.S.A