

PIPELINE STABILITY AND COATING DESIGN

CWC Thickness, Density and Submerged Weight Selection Guide

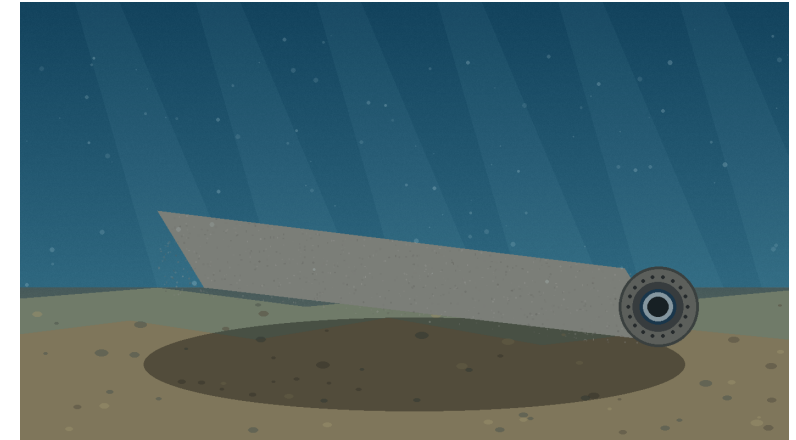
A data-led reference for pipeline engineers, procurement teams, QA/QC personnel and third-party inspectors.

Engineering scope and selection objectives

- Define the required submerged weight for the governing pipeline condition.
- Select thickness and density together because both affect mass, final coated OD and installation limits.
- Verify manufacturability through qualified concrete mix, reinforcement control, curing and pipe-by-pipe weighing.
- Release the design against measurable evidence, not a nominal coating value copied from a previous project.

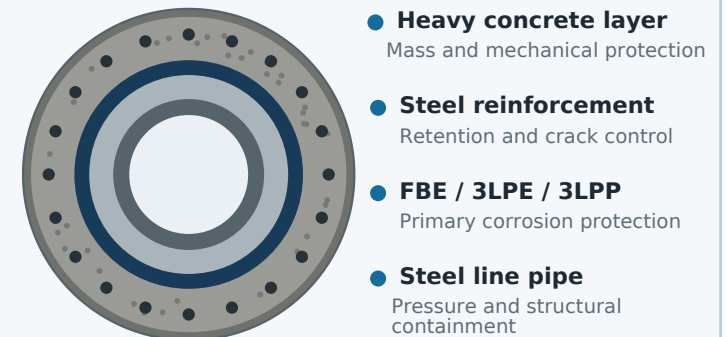
Core design principle

CWC thickness primarily controls concrete volume, finished geometry, reinforcement cover and mechanical protection. CWC density primarily controls mass within the selected coating volume. The final combination must also satisfy joint-weight and installation constraints.



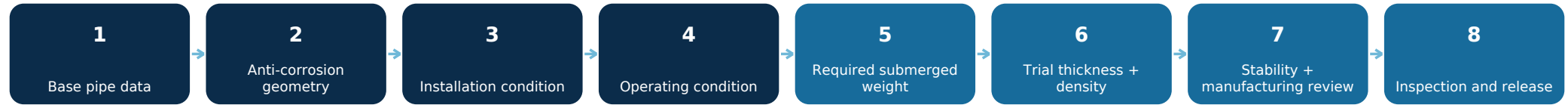
Technical render: CWC-coated pipe on seabed - illustrative, not to scale

Typical CWC system cross-section



Reference framework: ISO 21809-5:2017; DNV-RP-F109 Edition 2021-05, amended 2025-09; API Spec 5L, 47th Edition. Applicable project editions and acceptance criteria shall be stated in the purchase documents.

Decision sequence



Required selection inputs

Input category	Information to define	Engineering use
Base pipe	Standard/edition, grade, OD, WT, length, unit weight	Steel mass, displacement and traceability
Corrosion coating	System, nominal thickness, repair status, interface	Pre-CWC OD and application compatibility
Pipeline condition	Empty, flooded, hydrotest, product-filled, shutdown	Identify the lowest stability margin
Environment and soil	Water density, wave/current, soil resistance, embedment	Hydrodynamic load and lateral resistance
Installation system	Rollers, tensioner, clamps, stinger, lifting limits	Maximum coated OD and pipe-joint weight
CWC production	Qualified density range, thickness range, reinforcement, curing	Repeatable and inspectable manufacture

Design outputs to confirm

Required submerged weight

Defined for each relevant pipeline condition.

Finished coated OD

Used for hydrodynamic and installation checks.

Selected thickness and density

Meets mass, cover and plant capability.

Individual joint-weight limits

Compatible with lifting, vessel and transport limits.

Acceptance principle

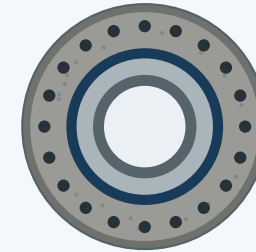
A nominal thickness or density is not a release criterion. Confirm measured OD, thickness, pipe-joint weight and traceable production records.

Project constraint matrix

Governing constraint	Preferred design adjustment	Required verification
Additional submerged weight with limited finished OD	Increase concrete density	Mix qualification, density uniformity and pipe-joint weighing
Greater impact or abrasion protection	Increase coating thickness	Reinforcement cover, handling performance and final coated OD
Restricted roller or clamp clearance	Increase density before thickness	Maximum OD and installation-equipment compatibility
Minimum reinforcement cover not achieved	Increase thickness	Mesh position and concrete-cover inspection
Excessive pipe-joint weight	Optimise thickness and density together	Lifting, vessel, stacking and transport limits
High hydrodynamic loading	Avoid unnecessary OD increase	Stability analysis using final coated OD
Limited heavyweight aggregate availability	Use practical density; revise thickness	Aggregate source, process trial and plant repeatability

What changes physically

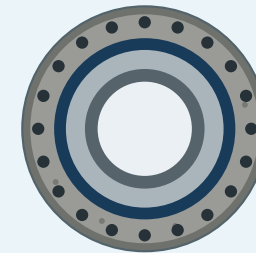
Increase thickness



Larger concrete annulus

- More concrete volume
- Larger finished OD
- Greater protective depth
- More displaced seawater

Increase density



Same geometry, denser mix

- More mass, same volume
- Finished OD unchanged
- Qualified aggregate required
- Density + joint-weight checks

Selection boundary

Higher density cannot replace the minimum thickness required for reinforcement cover and mechanical protection. Greater thickness cannot compensate for an unqualified mix, inconsistent batching or uncontrolled density.

Concrete-only calculation

1. Concrete volume per metre

$$V_c = \pi/4 \times (D_c^2 - D_0^2)$$

Geometry of the concrete annulus

2. Concrete mass per metre

$$m_c = \rho_c \times V_c$$

Mass before buoyancy correction

3. Simplified submerged contribution

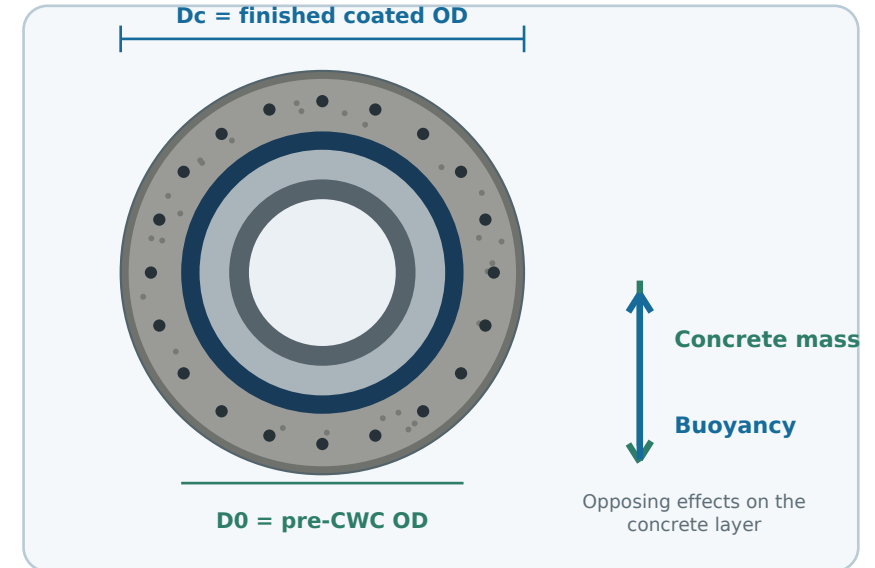
$$m_{c,sub} = (\rho_c - \rho_{sw}) \times V_c$$

Concrete mass minus displaced seawater

Variable definitions

Symbol	Definition	Unit
D0	Outside diameter before CWC	m
Dc	Finished outside diameter after CWC	m
Vc	Concrete volume per metre	m ³ /m
ρc	Concrete density	kg/m ³
ρsw	Seawater density	kg/m ³
mc	Concrete mass per metre	kg/m
mc,sub	Simplified submerged contribution of concrete	kg/m

Geometry and buoyancy schematic



Complete pipeline weight model

The final submerged line weight is not the concrete-only result. It should include the components and project allowances below.

- Steel pipe
- Anti-corrosion coating
- Reinforcement
- Anodes and attachments
- Internal water or product
- Marine-growth allowance, if specified
- Manufacturing tolerances

Concrete and cutbacks

Calculation -> pipe-by-pipe weighing -> release evidence

Field-joint system

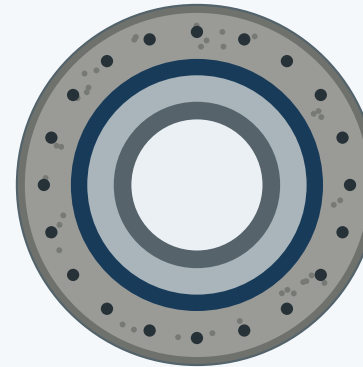
ILLUSTRATIVE CALCULATION ONLY

The results demonstrate the concrete contribution. They are not the final project submerged line weight and do not include the remaining components, allowances or tolerances.

Input data

Parameter	Value
Pre-CWC outside diameter, D0	0.768 m
CWC thickness, tc	75 mm
Finished coated diameter, Dc	0.918 m
Concrete density, ρc	3,200 kg/m ³
Seawater density, ρsw	1,025 kg/m ³

Example geometry



Dimensions

D0	_____	0.768 m
tc	_____	0.075 m
Dc	_____	0.918 m
ρc	_____	3,200 kg/m ³
ρsw	_____	1,025 kg/m ³

Cross-section is schematic and not to scale.

Calculation steps

STEP 1

Concrete volume

$$V_c = \pi/4 \times (0.918^2 - 0.768^2)$$

0.1986 m³/m

STEP 2

Concrete mass

$$m_c = 3,200 \times 0.198627$$

635.6 kg/m

STEP 3

Simplified submerged contribution

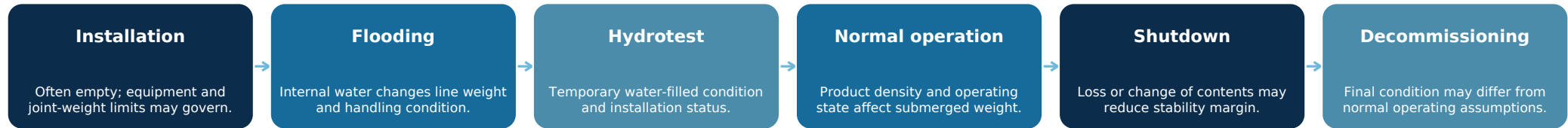
$$m_{c,sub} = (3,200 - 1,025) \times 0.198627$$

432.0 kg/m

Final project model must also include

steel pipe + anti-corrosion coating + reinforcement + field joints/cutbacks + anodes/attachments + internal contents + specified allowances + manufacturing tolerances

Pipeline condition chain



Governing-condition review

Condition / factor	Why it matters	CWC design implication
Empty or product-filled pipe	Internal contents change submerged mass	Check each condition; do not assume operation governs
Wave and current	Loads act on final coated diameter	Use final coated OD in stability analysis
Seabed soil / embedment	Controls lateral resistance	Confirm geotechnical input and pipe-soil model
Temporary exposure	Buried lines may be exposed before backfill	Installation or pre-backfill state may govern
Installation system	OD and joint weight may exceed equipment limits	Verify rollers, tensioner, clamps, stinger and lifting
Plant capability	Not every theoretical combination is repeatable	Approve mix, trial, process route and control records

Reference framework and acceptance gates

ISO 21809-5:2017

Qualification, application, testing and handling of external reinforced concrete coatings.

DNV-RP-F109

On-bottom stability guidance; Edition 2021-05, amended 2025-09.

API Spec 5L

Steel line pipe requirements; 47th Edition published in 2026.

Project purchase documents govern the applicable editions and acceptance criteria.

Final acceptance gates

- Stability verified for governing condition
- Final coated OD confirmed
- Minimum reinforcement cover achieved
- Pipe-joint weight within installation limits
- Qualified mix and production route
- Pipe-by-pipe weight and traceability available

Final design-release sequence

