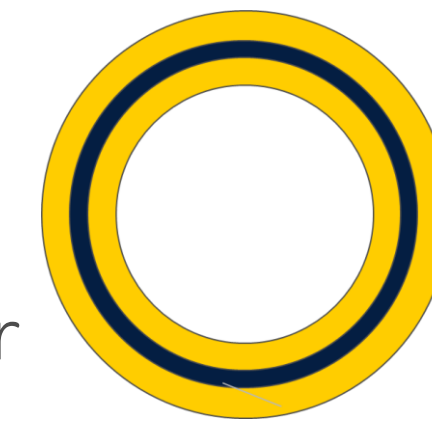


WHAT IS RTP?

The term refers to a multilayer pipe construction where at least one layer is acting as reinforcement.

- Liner:** Inner layer transporting the fluid.
- Structural Layer:** Fiber reinforcement layer provides the high burst resistance of the pipe construction
- Jacket:** External layer protects the inner structure from the external environment.



APPLICATION OVERVIEW & REQUIREMENTS - ONSHORE

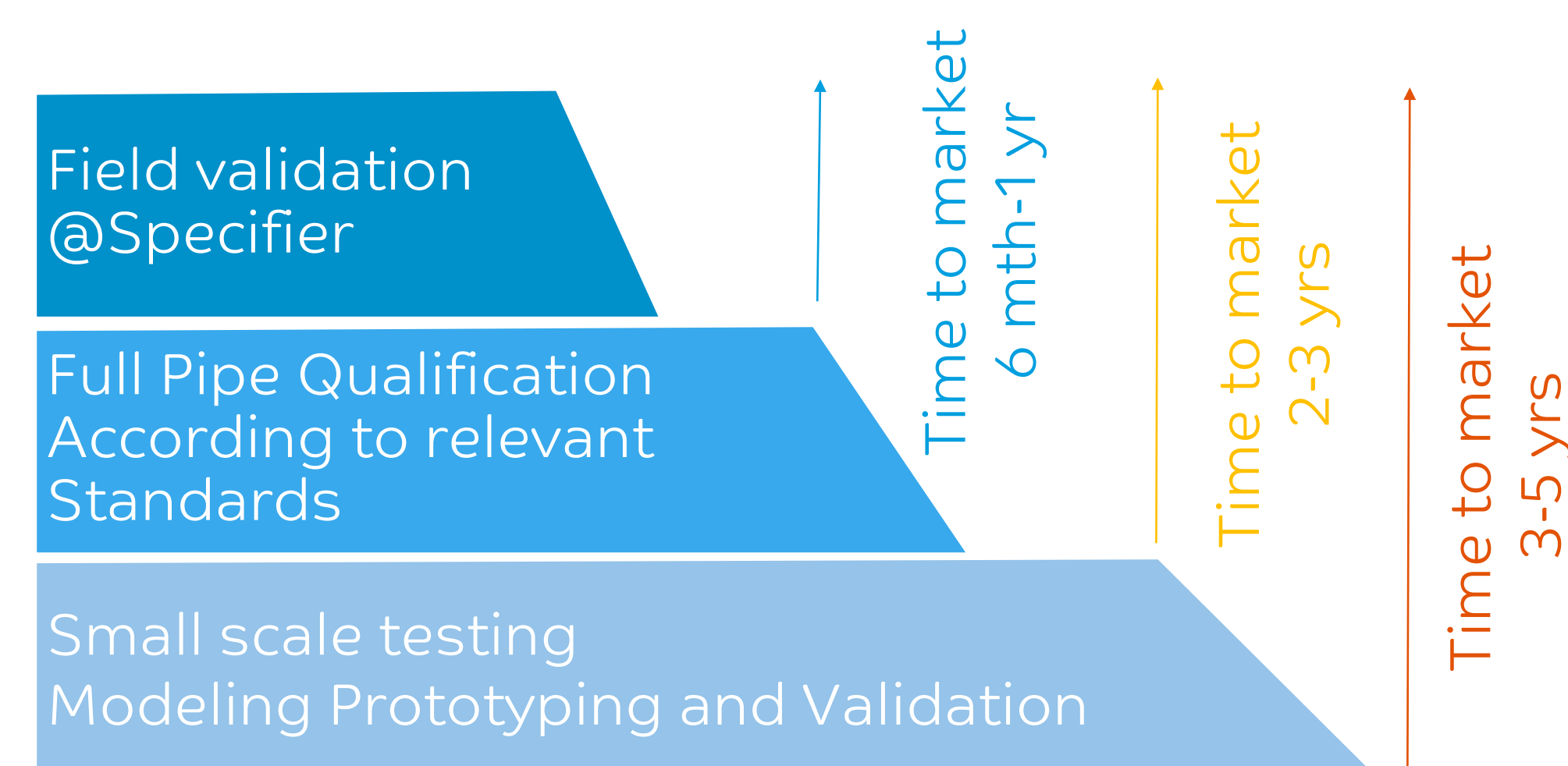
Onshore RTP

- Hydrocarbons & Water
- Up to 2200 psi
- Up to 105 C

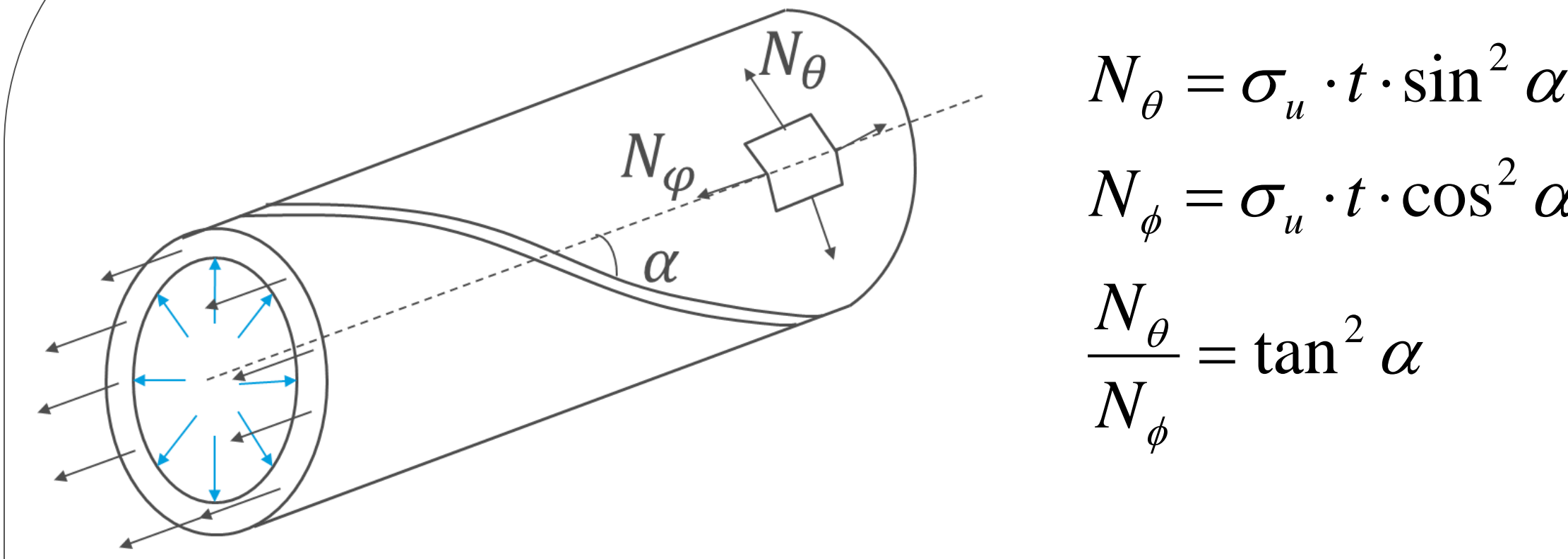
Offshore TCP

- Hydrocarbon & Water
- up to 5000 psi
- up to 130 C

TESTING & VALIDATION – HOW CAN WE SHORTEN TIME TO MARKET?



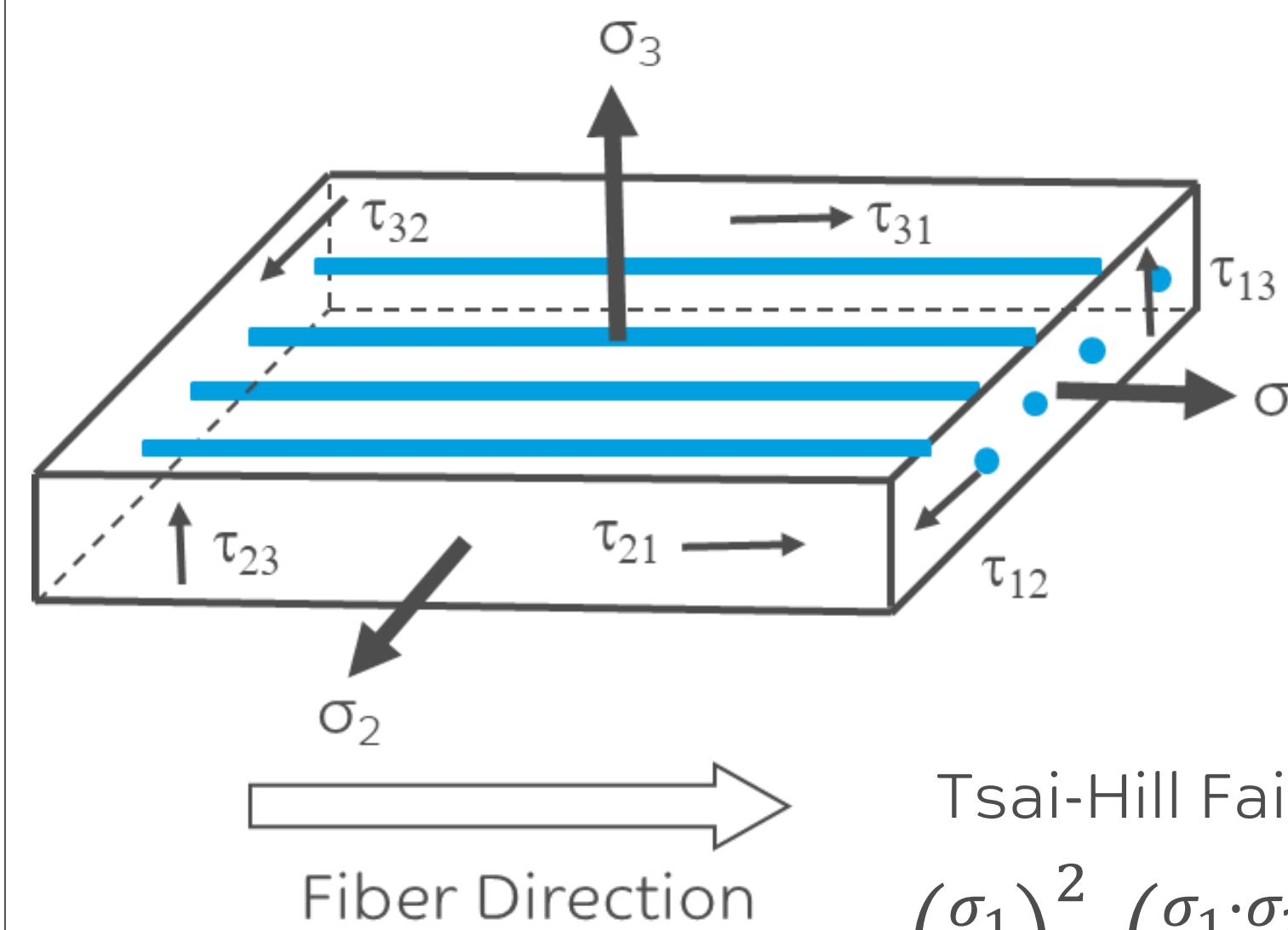
COMPOSITE LAY-UP OPTIMIZATION



Cases	Description	Optimum angle (Netting Analysis)
1	No axial load	90
2	Axial load = 0.25*Hoop Stress	63.4
3	Axial load = 0.5*Hoop Stress	54.7
4	Axial load = Hoop Stress	45

By assuming a hoop-to-axial ratio of 2:1, the optimum angle of the lay-up is estimated to be 54.7°

COMPOSITE FAILURE CRITERIA



Tsai-Hill Failure Criterion (TH)

$$\left(\frac{\sigma_1}{X_t}\right)^2 - \left(\frac{\sigma_1 \cdot \sigma_2}{X_t}\right) + \left(\frac{\sigma_2}{Y_t}\right)^2 + \left(\frac{\tau_{12}}{S_{12}}\right)^2 \geq 1$$

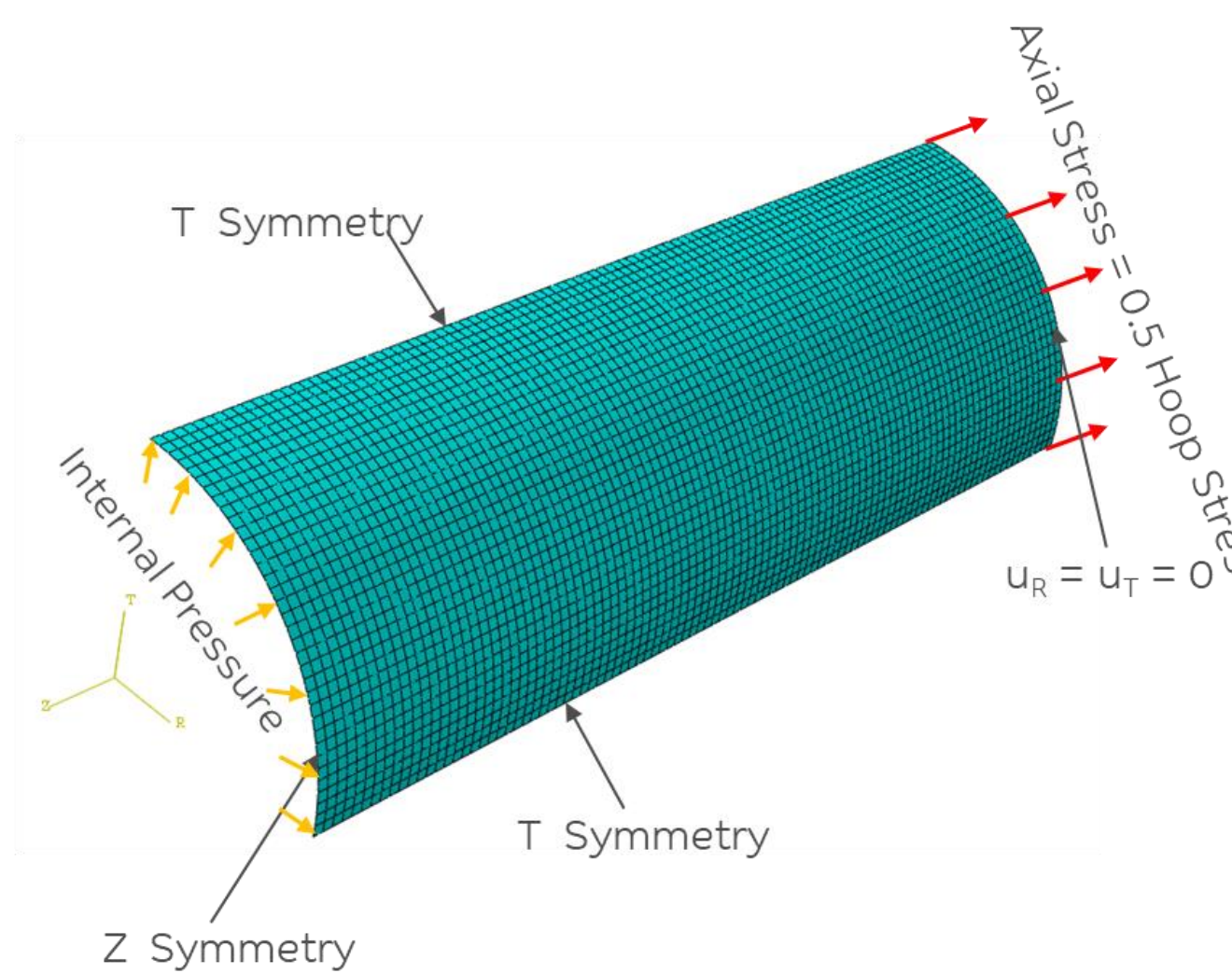
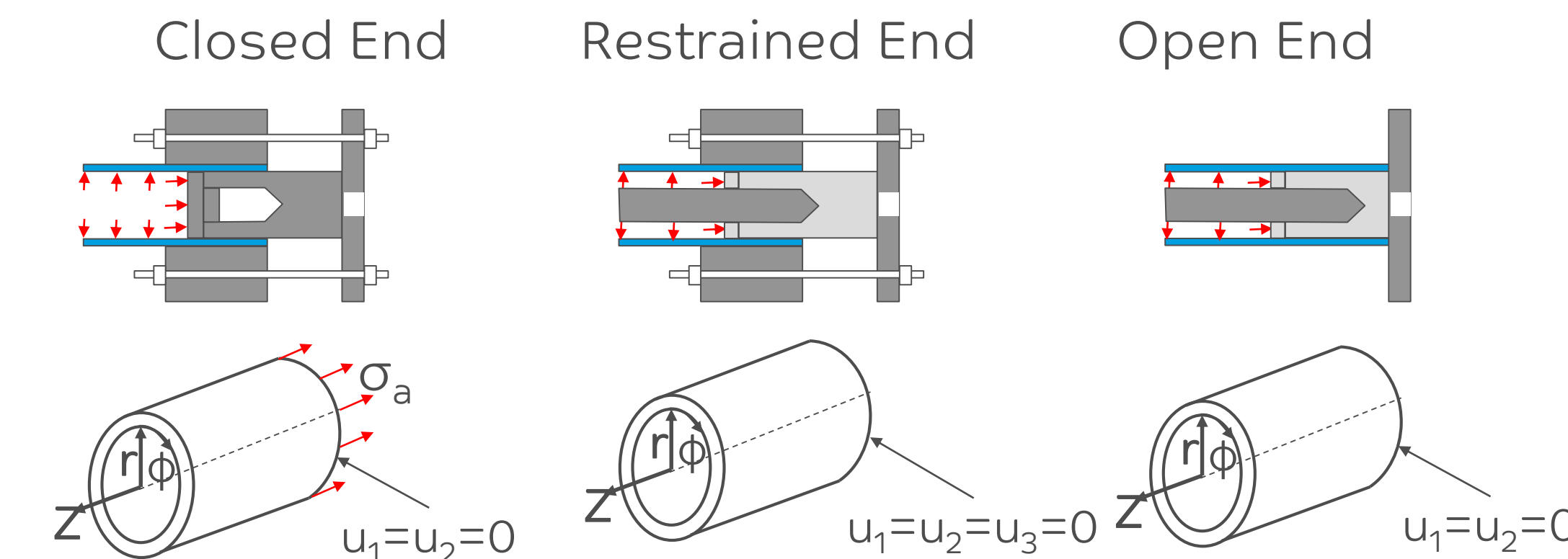
Hashin's failure criteria (HF)

$$\left(\frac{\sigma_1}{X_t}\right)^2 + \left(\frac{\tau_{12}}{S_{12}}\right)^2 \geq 1$$

Fiber failure criteria (FF)

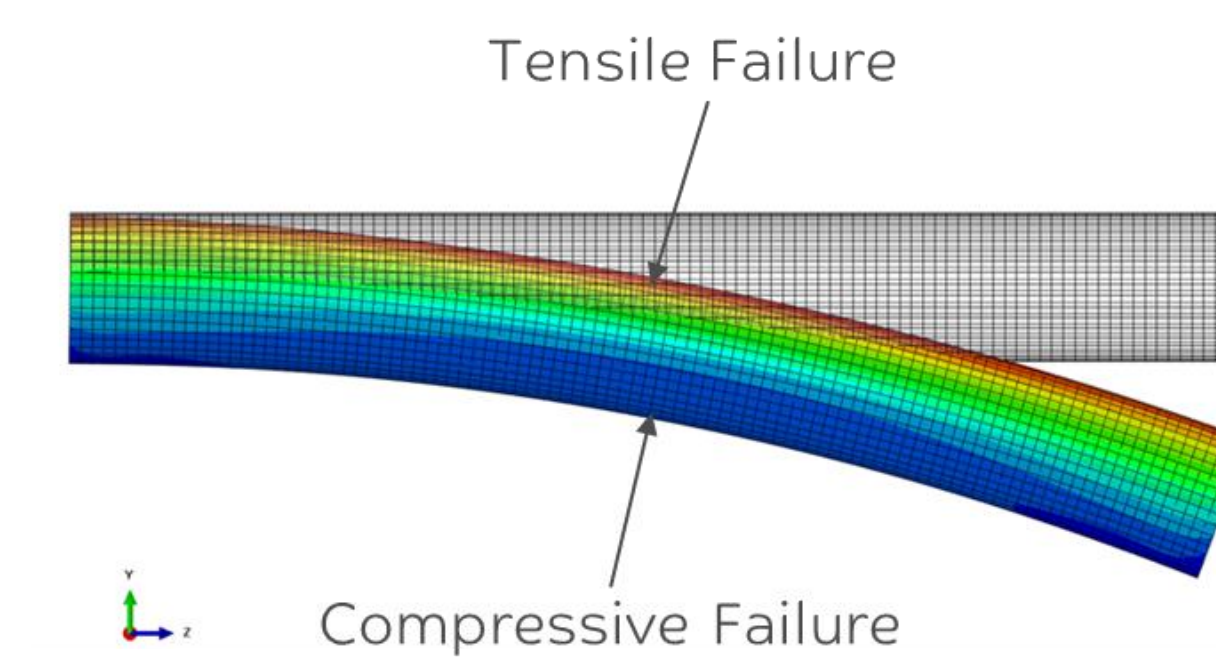
$$\sigma_1 \geq X_t \text{ or } \sigma_1 \leq X_c$$

ANALYSIS OF BURST PRESSURE



Closed-End Condition

ANALYSIS OF MINIMUM BENDING RADIUS



- Two type of failure:
- Strain/stress reaches the failure strain/Stress
 - Buckling of the pipe

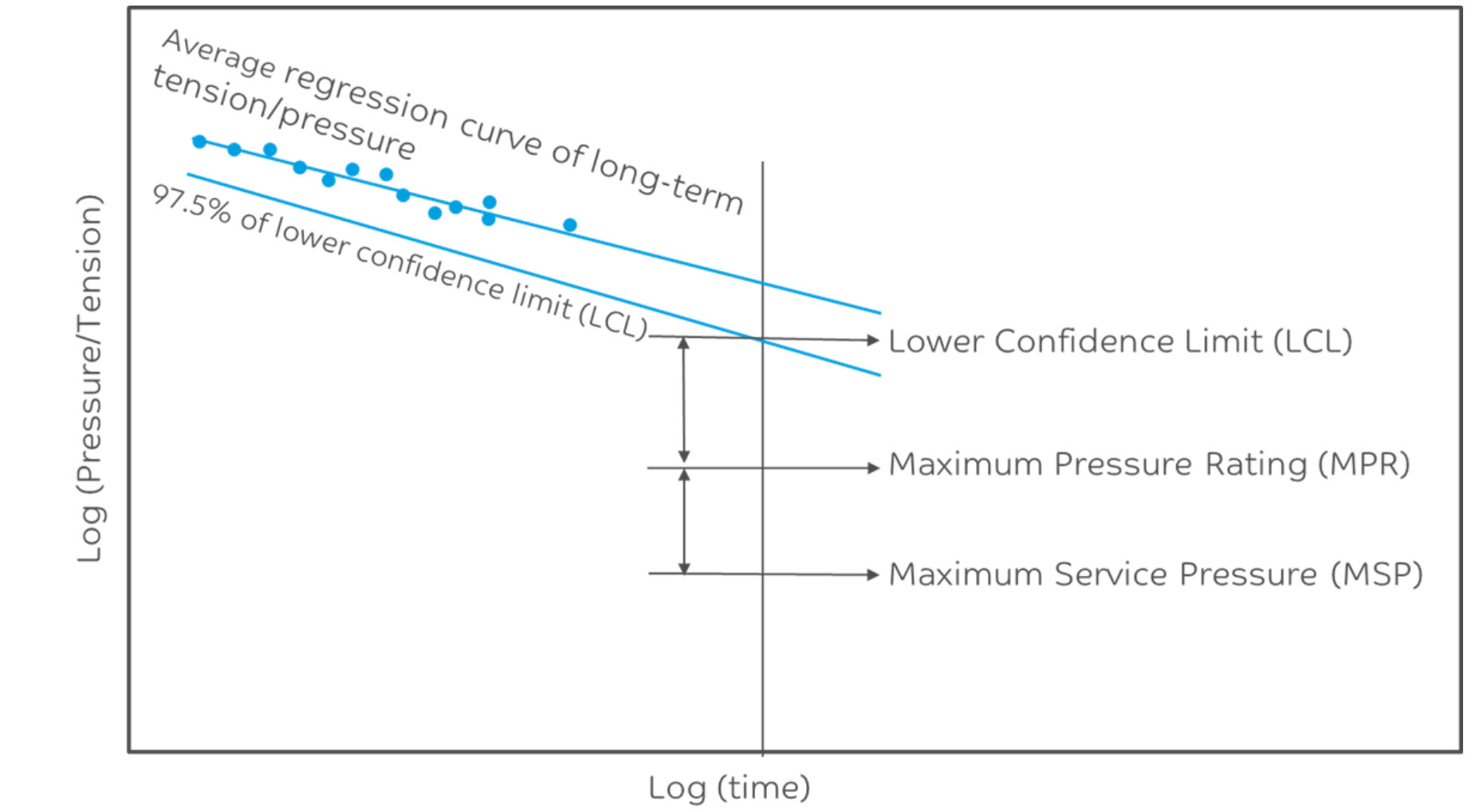
Standard Dimension Ratio: $SDR = \frac{D_0}{t}$

Minimum Bending Radius:

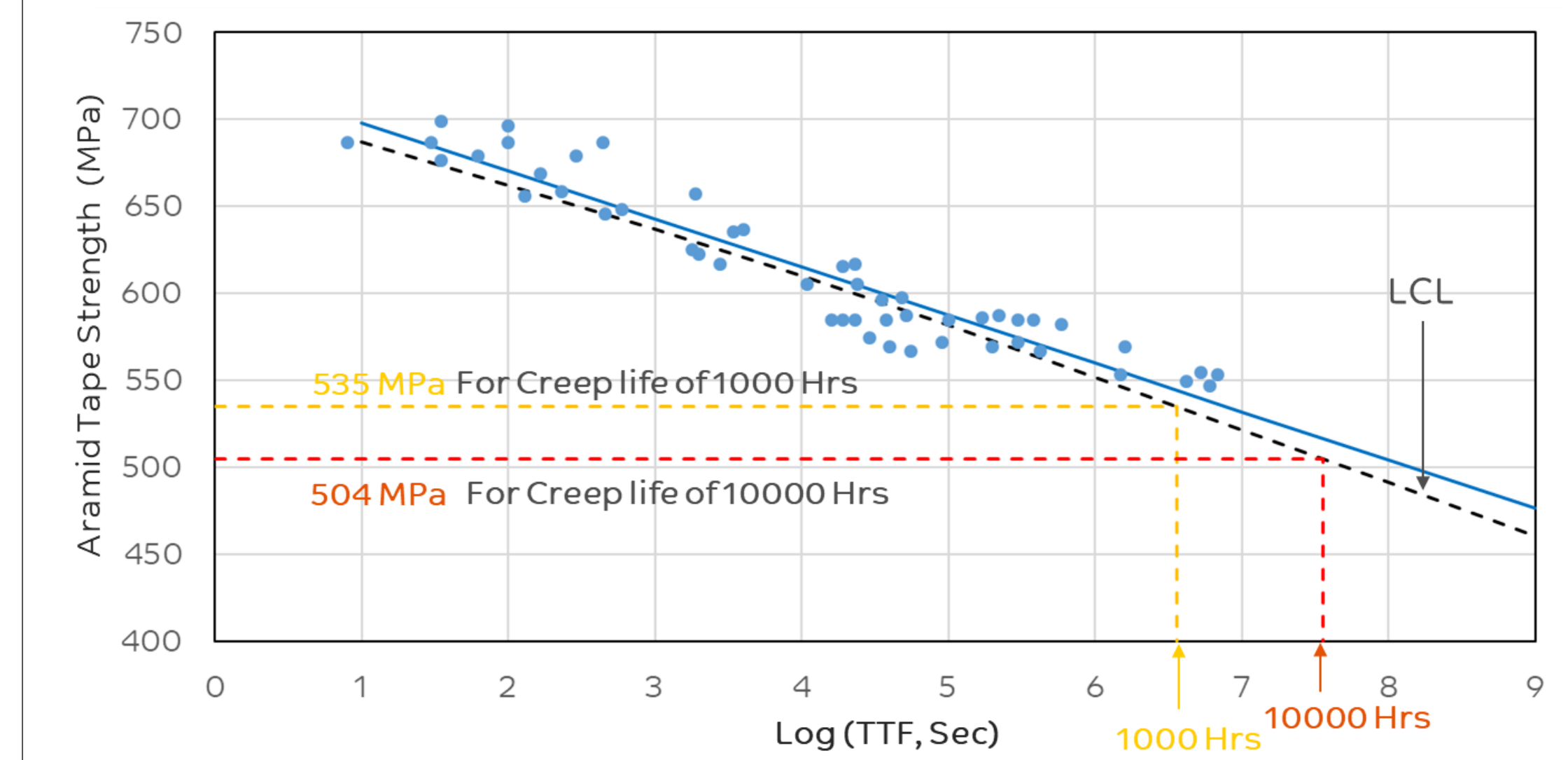
$$MBR = \frac{E \cdot D_0}{2 \cdot \sigma_{cr}}$$

$$MBR = \frac{E \cdot t \cdot SDR}{2 \cdot \sigma_{cr}}$$

ANALYSIS OF LONG-TERM DESIGN LIFE



Life of the RTP pipe whose structural layers are made of Aramid fiber composite tape is same as life of the tape



RESULTS

Tape	Burst Pressure (Bar)		MBR (m)	MPR (Bar)	
	Exp.	Model		1000 Hrs	10,000 Hrs
Aramid Pipe (4.8 mm thick)	300	330	2.21	290	275
Aramid Pipe (7.2 mm thick)	440	495	2.25	435	410

