Probabilistic Service Life Analysis Using Reactive Transport Degradation Modeling

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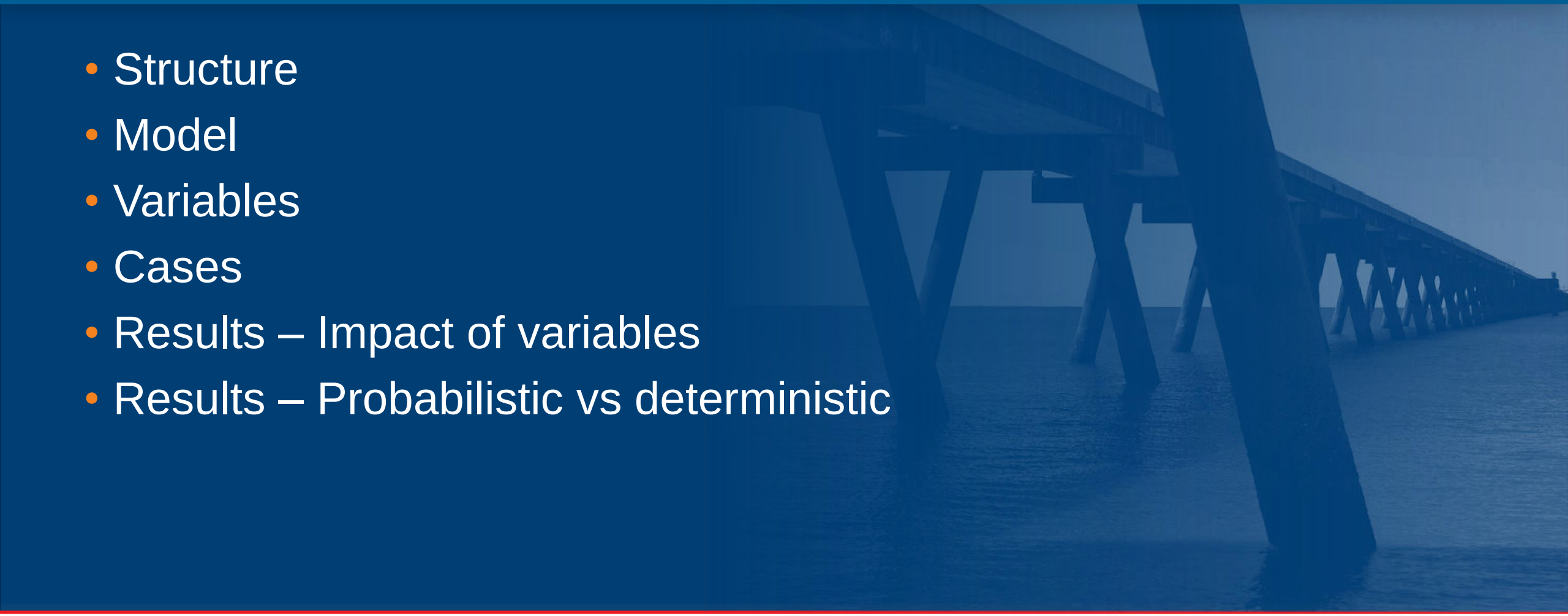
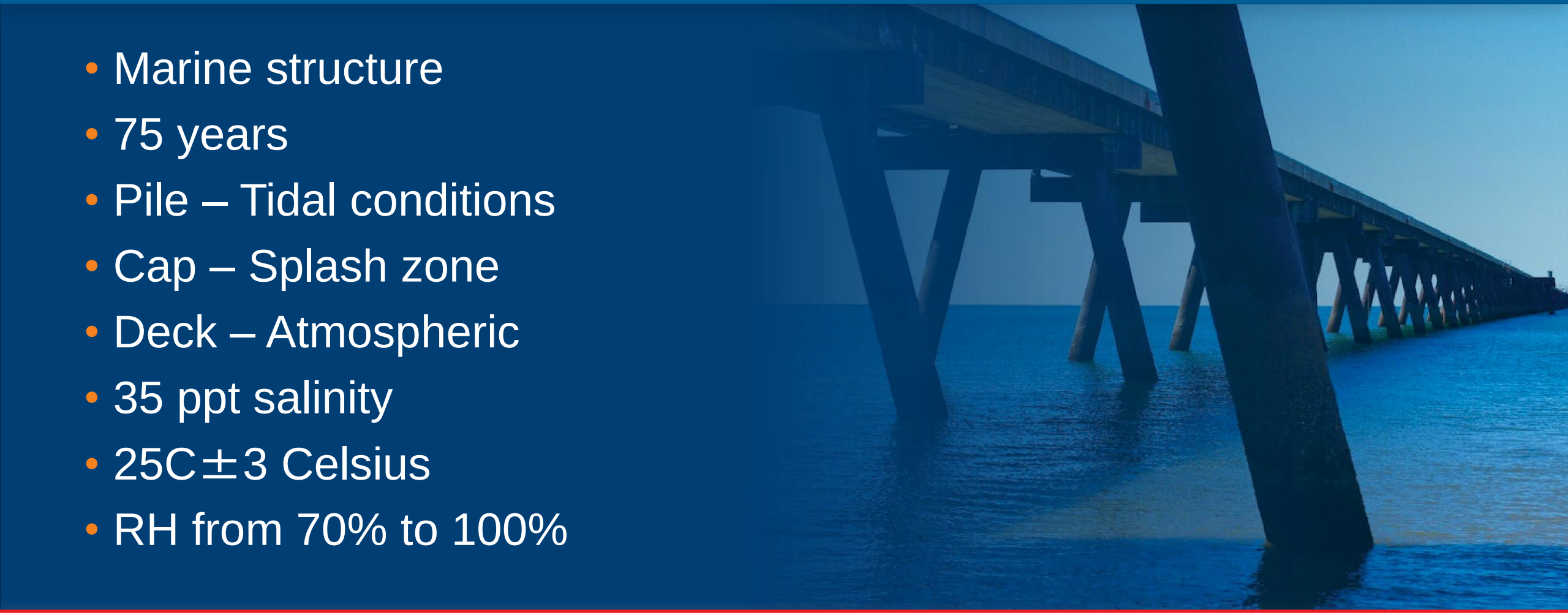
Presentation Summary



- Structure
- Model
- Variables
- Cases
- Results – Impact of variables
- Results – Probabilistic vs deterministic

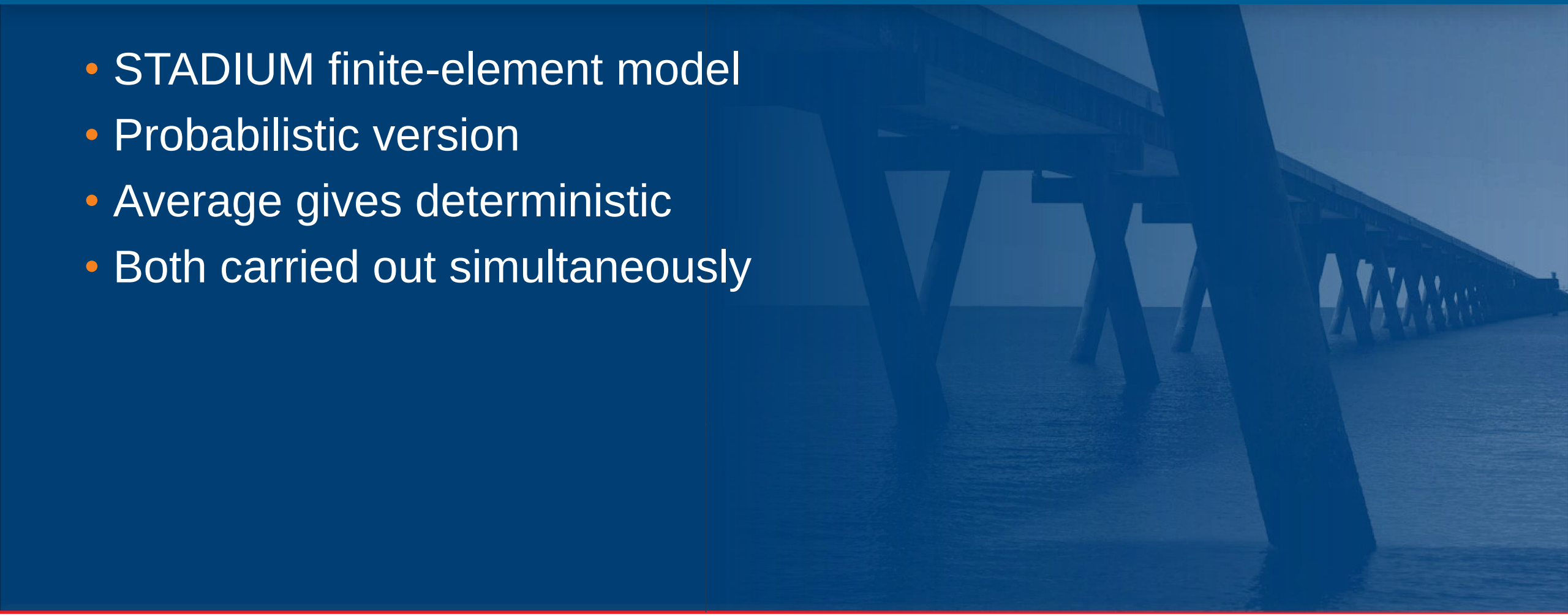
Structure and Conditions

- Marine structure
- 75 years
- Pile – Tidal conditions
- Cap – Splash zone
- Deck – Atmospheric
- 35 ppt salinity
- 25C±3 Celsius
- RH from 70% to 100%



Model

- STADIUM finite-element model
- Probabilistic version
- Average gives deterministic
- Both carried out simultaneously



Probabilistic Variables

- Transport properties
- Diffusion coefficient
- Volume of permeable voids
- Permeability
- Salinity
- Cover
- Corrosion initiation threshold

Cases

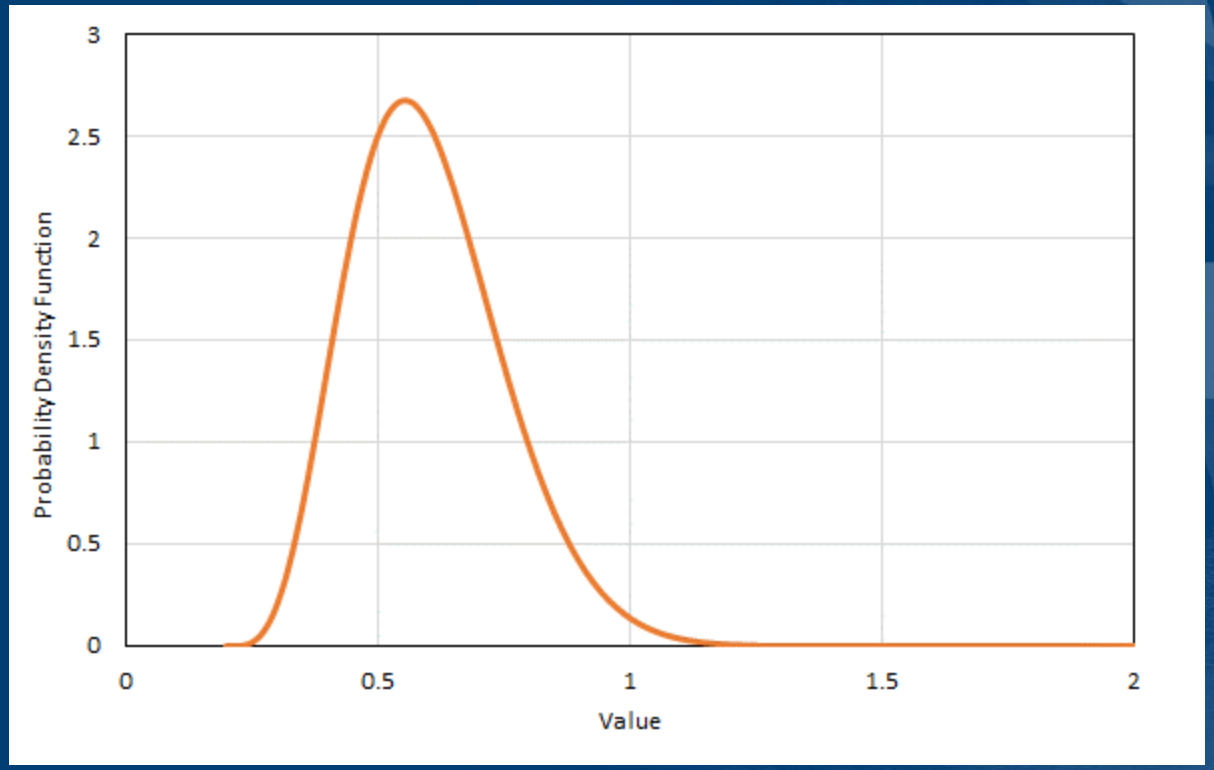
- Standard concrete with 0.40 W/B, 25% FA-F
- Variability of transport properties:

  VPV: 5%

  Diff. coefficient: 8%, 15%

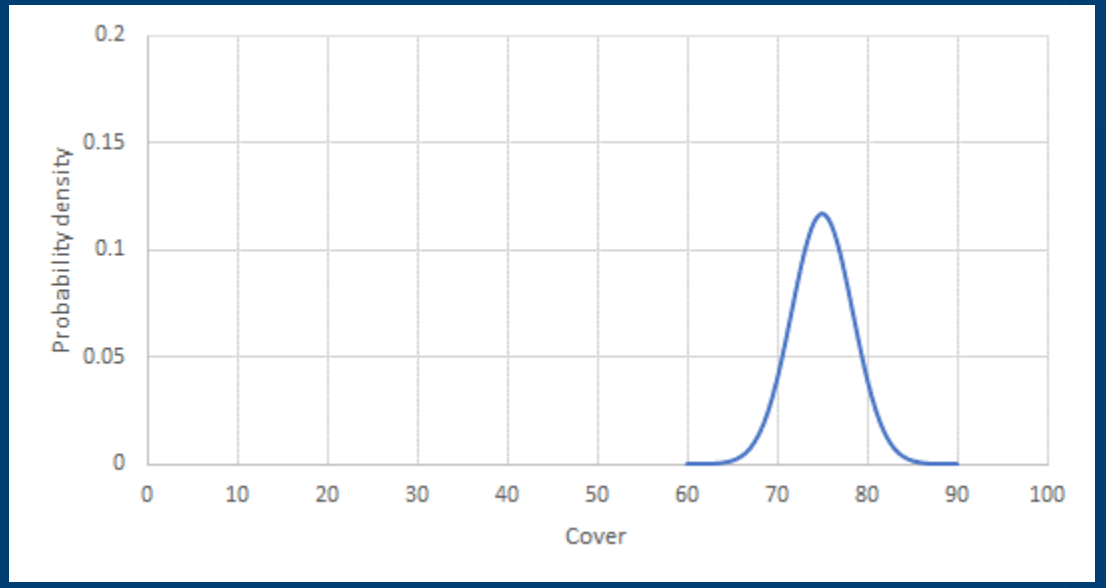
  Permeability: 10%, 20%
- Variability of salinity: 10%, 20%
- Cover: normal with 75 mm (pile and cap) and 50 mm (cap and deck)
- Threshold: *fib Bulletin 34* – Beta 0.6%, 0.2%, 2.0%

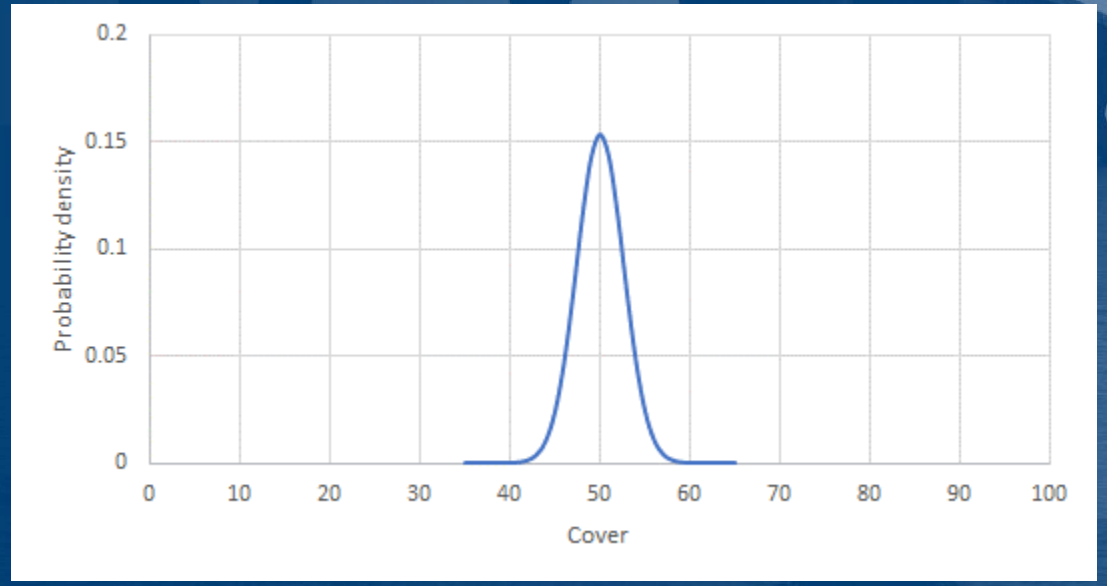
Threshold - Probabilistic



Cover Distribution

- Tolerance of 13 mm for piles and cap
- Tolerance of 10 mm for deck
- Distribution within tolerance (criterion: 10^{-5} probability at tolerance)

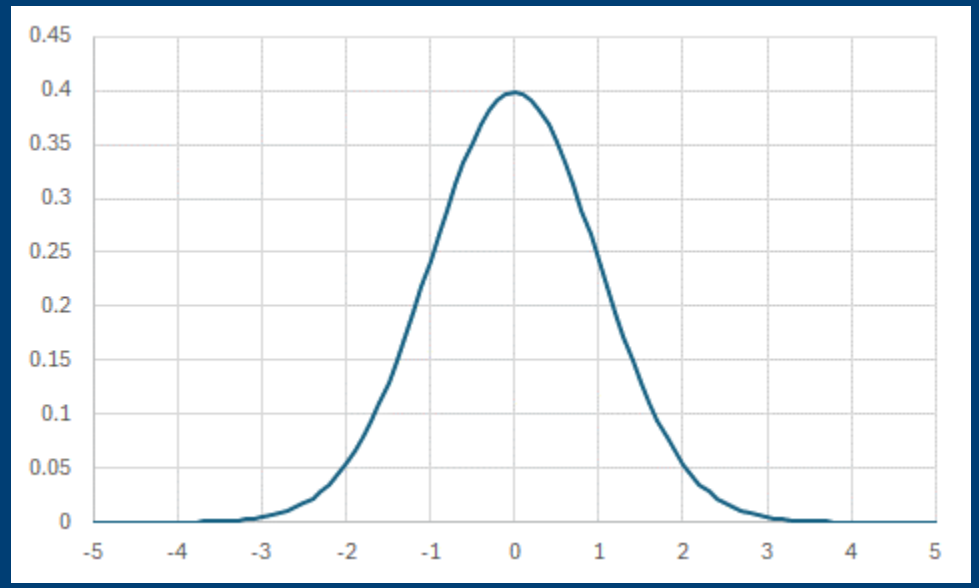




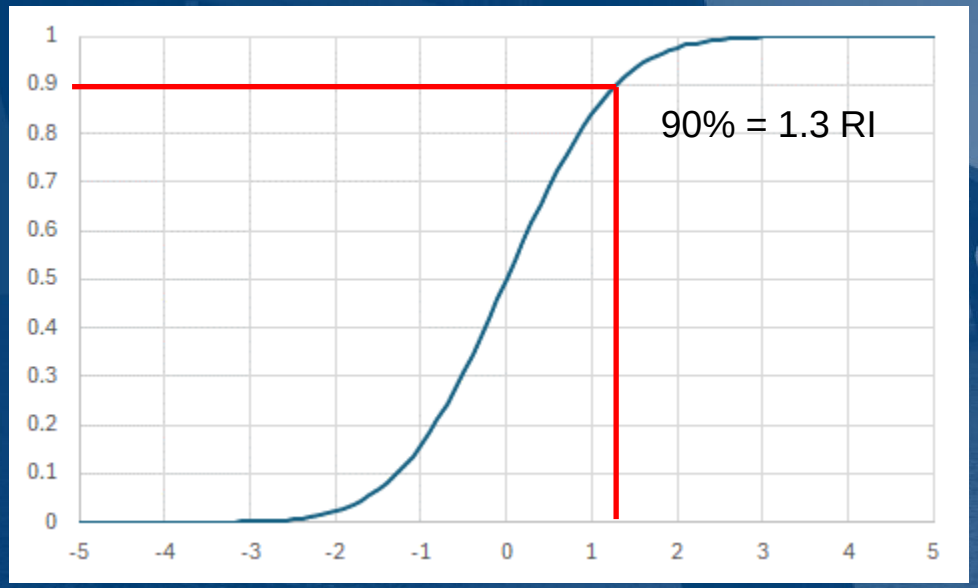
Cases – Summary

Case	Element	Exposure	Concrete	VPV	DOH	Perm	Salinity	Cover	Threshold
1	Pile	Tidal	0.40-25 FA	5	8	10	10	75	0.6
2	Pile	Tidal	0.40-25 FA	5	15	10	10	75	0.6
3	Pile	Tidal	0.40-25 FA	5	8	20	10	75	0.6
4	Pile	Tidal	0.40-25 FA	5	15	20	10	75	0.6
5	Pile	Tidal	0.40-25 FA	5	8	10	20	75	0.6
6	Pile	Tidal	0.40-25 FA	5	15	10	20	75	0.6
7	Pile	Tidal	0.40-25 FA	5	8	20	20	75	0.6
8	Pile	Tidal	0.40-25 FA	5	15	20	20	75	0.6
9	Cap	Splash	0.40-25 FA	5	8	10	10	75	0.6
10	Cap	Splash	0.40-25 FA	5	15	10	10	75	0.6
11	Cap	Splash	0.40-25 FA	5	8	20	10	75	0.6
12	Cap	Splash	0.40-25 FA	5	15	20	10	75	0.6
13	Cap	Splash	0.40-25 FA	5	8	10	20	75	0.6
14	Cap	Splash	0.40-25 FA	5	15	10	20	75	0.6
15	Cap	Splash	0.40-25 FA	5	8	20	20	75	0.6
16	Cap	Splash	0.40-25 FA	5	15	20	20	75	0.6
17	Deck	Atmospheric	0.40-25 FA	5	8	10	10	50	0.6
18	Deck	Atmospheric	0.40-25 FA	5	15	10	10	50	0.6
19	Deck	Atmospheric	0.40-25 FA	5	8	20	10	50	0.6
20	Deck	Atmospheric	0.40-25 FA	5	15	20	10	50	0.6
21	Deck	Atmospheric	0.40-25 FA	5	8	10	20	50	0.6
22	Deck	Atmospheric	0.40-25 FA	5	15	10	20	50	0.6
23	Deck	Atmospheric	0.40-25 FA	5	8	20	20	50	0.6
24	Deck	Atmospheric	0.40-25 FA	5	15	20	20	50	0.6

Results – Probability vs RI



Centered standard normal

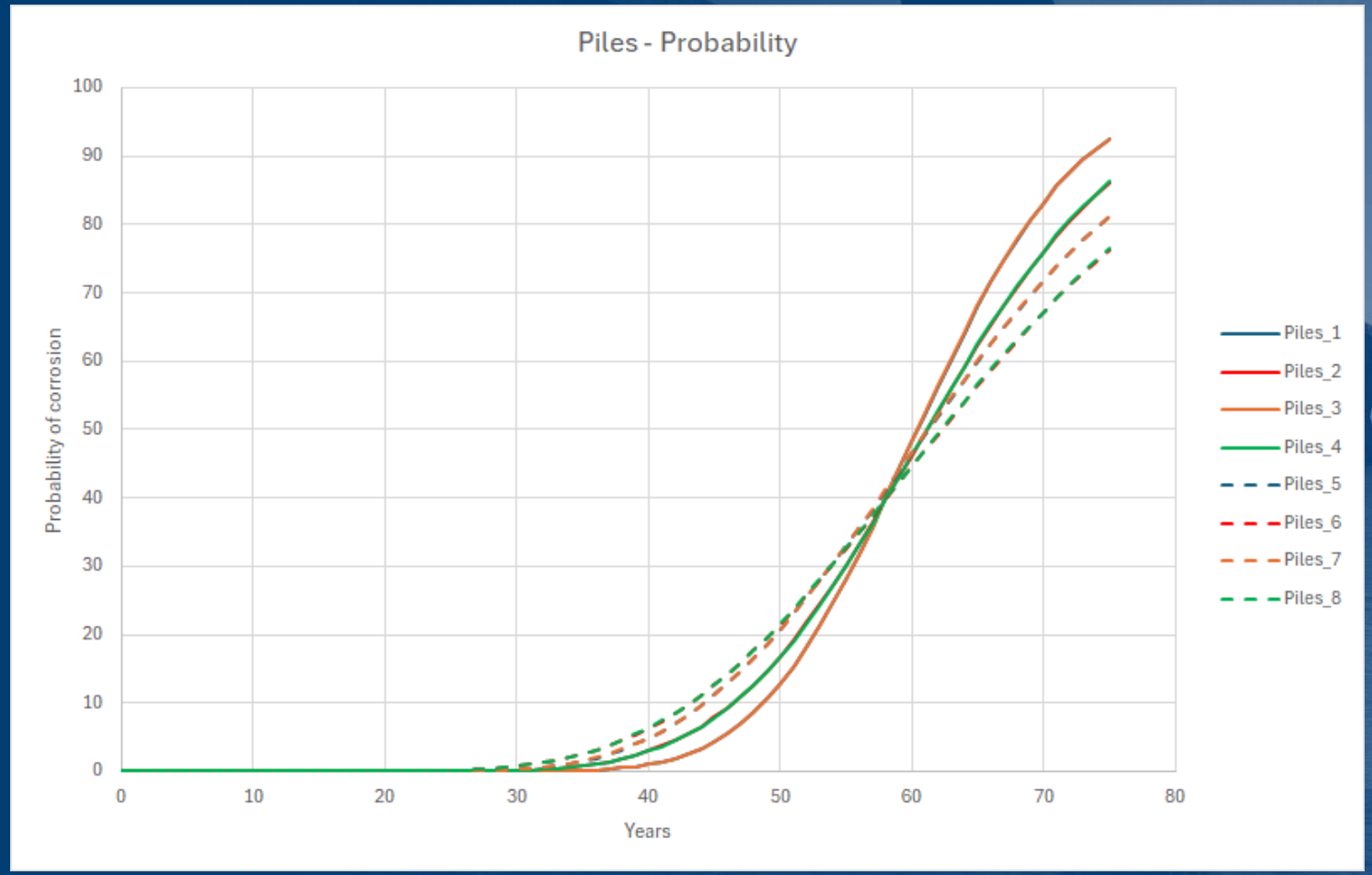


Cumulative probability

Results - Pile

Case	VPV	DOH	Perm	Salinity
1	5	8	10	10
2	5	15	10	10
3	5	8	20	10
4	5	15	20	10
5	5	8	10	20
6	5	15	10	20
7	5	8	20	20
8	5	15	20	20

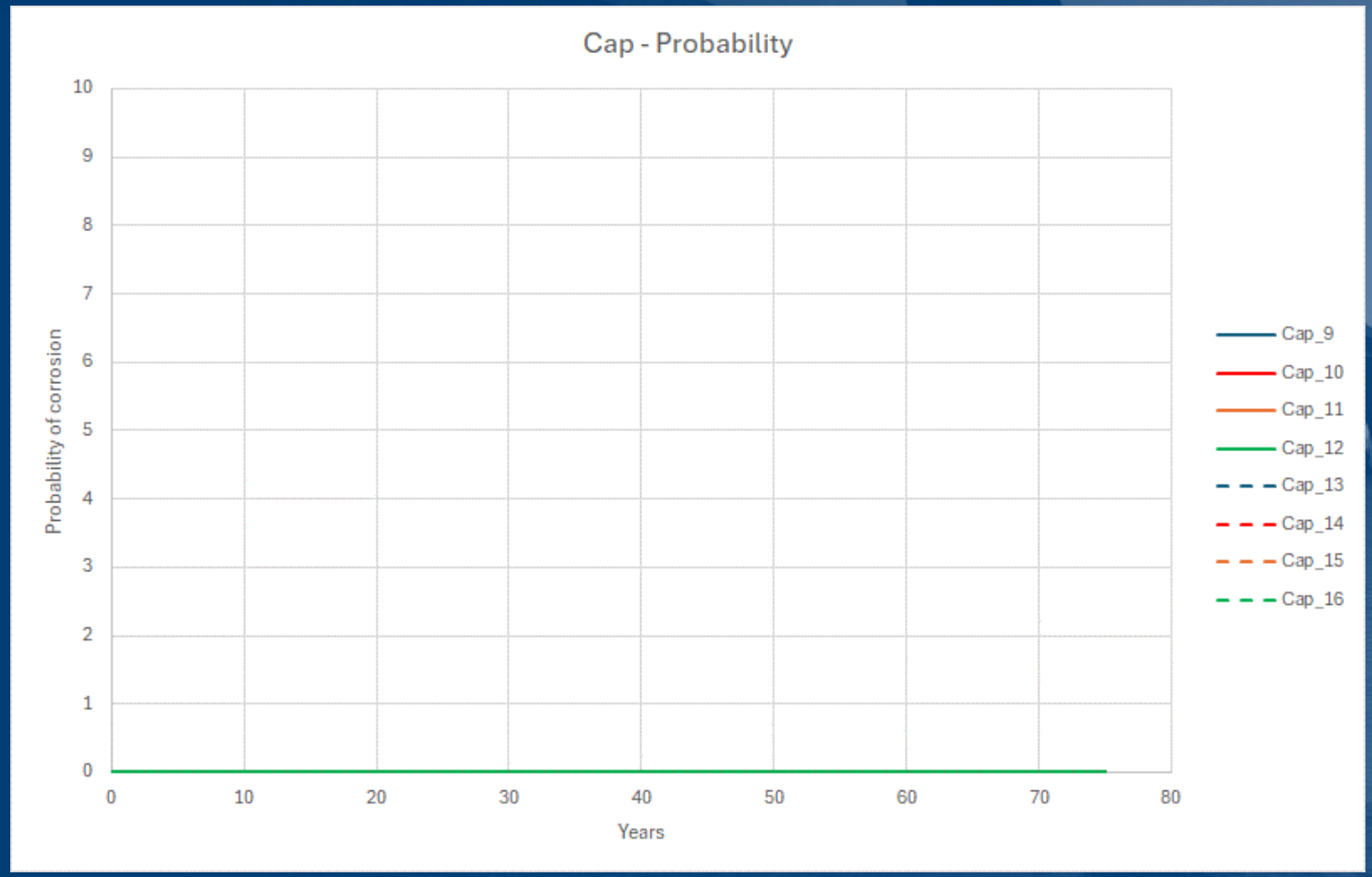
- 1 & 3 overlap
- 2 & 4 overlap
- 5 & 7 overlap
- 6 & 8 overlap



Results – Cap 75 mm

Case	VPV	DOH	Perm	Salinity
9	5	8	10	10
10	5	15	10	10
11	5	8	20	10
12	5	15	20	10
13	5	8	10	20
14	5	15	10	20
15	5	8	20	20
16	5	15	20	20

- 0%
- 75 mm of cover is high enough
- Could be reduced



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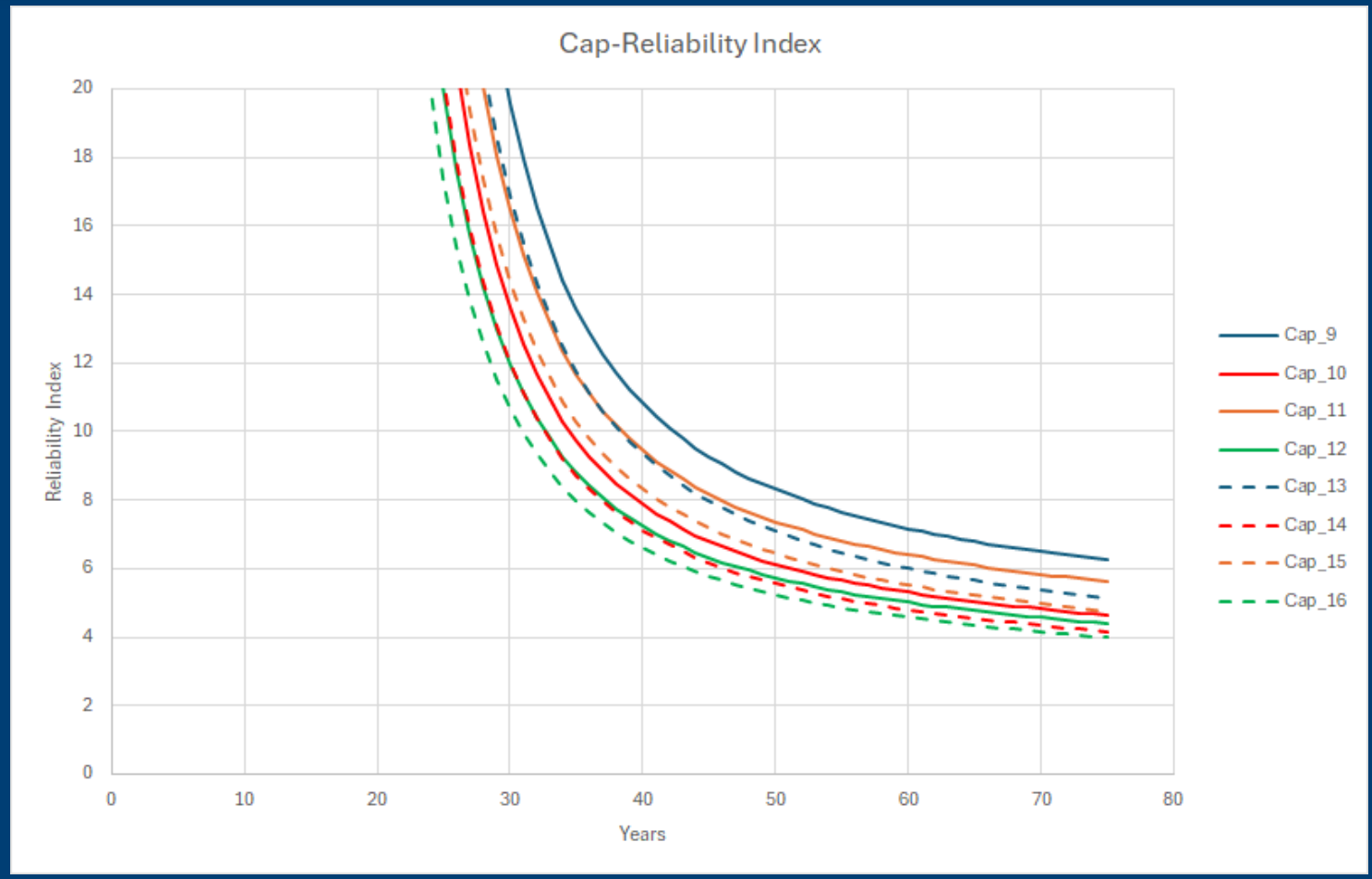
10	5	15	10	10
11	5	8	20	10
12	5	15	20	10
13	5	8	10	20
14	5	15	10	20
15	5	8	20	20
16	5	15	20	20

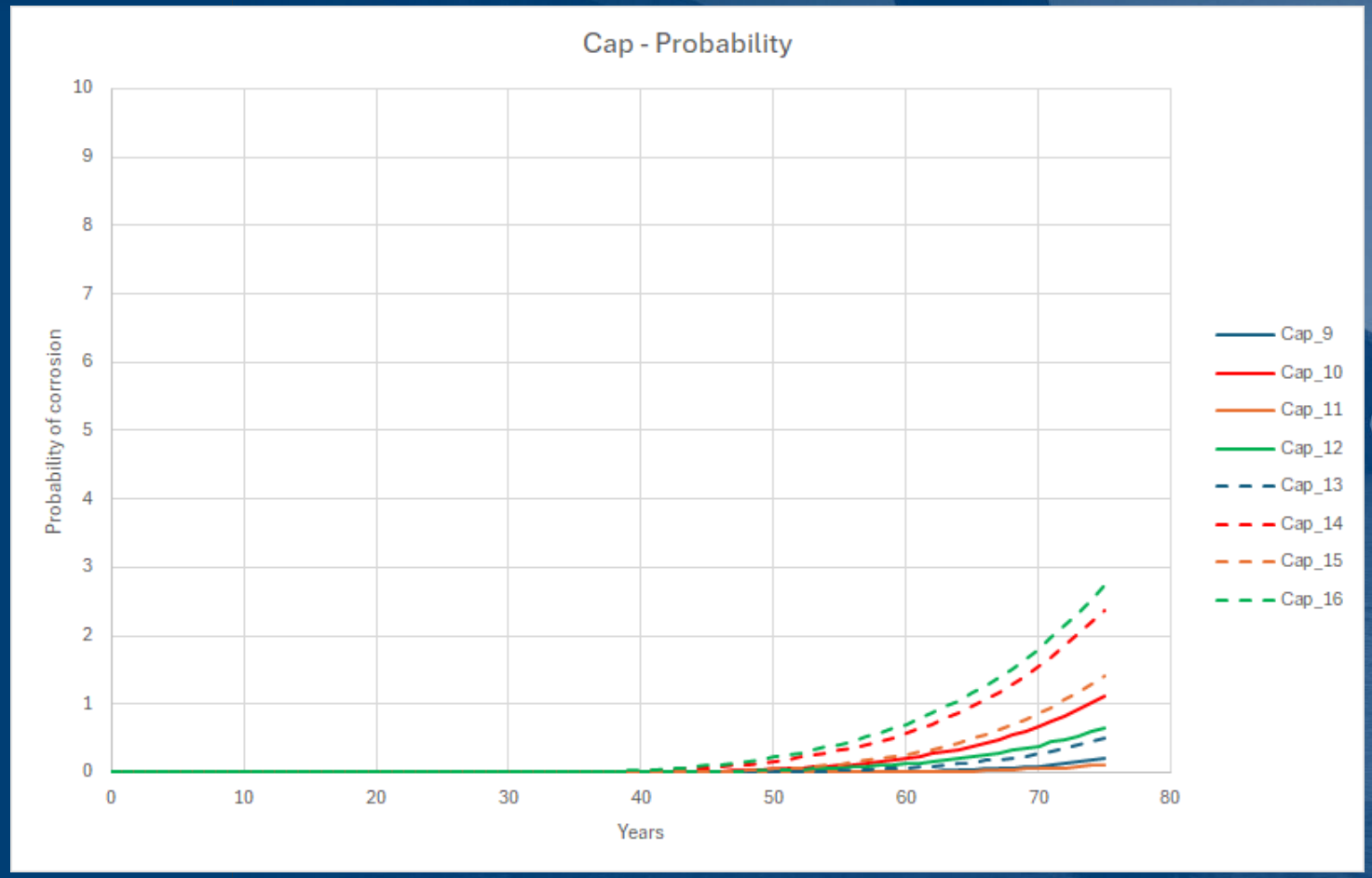
- RI curves do show some differences although probability is near 0%



Results – Cap 50 mm

Case	VPV	DOH	Perm	Salinity
9	5	8	10	10
10	5	15	10	10
11	5	8	20	10
12	5	15	20	10
13	5	8	10	20
14	5	15	10	20
15	5	8	20	20
16	5	15	20	20

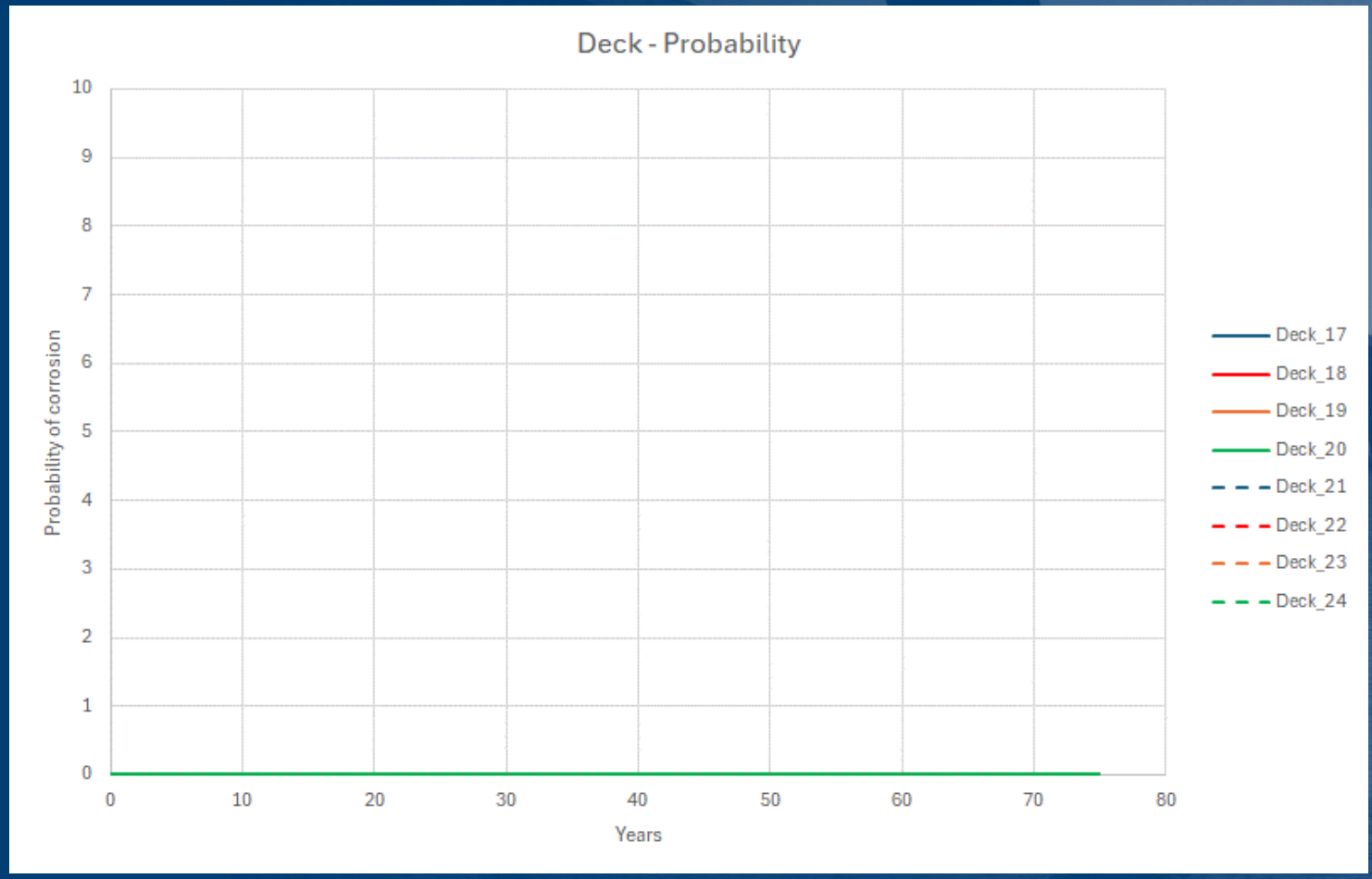
- 50 mm of cover is also enough
- Corrosion probability< 10%
- Higher for 14 - 16



Results - Deck

Case	VPV	DOH	Perm	Salinity
17	5	8	10	10
18	5	15	10	10
19	5	8	20	10
20	5	15	20	10
21	5	8	10	20
22	5	15	10	20
23	5	8	20	20
24	5	15	20	20

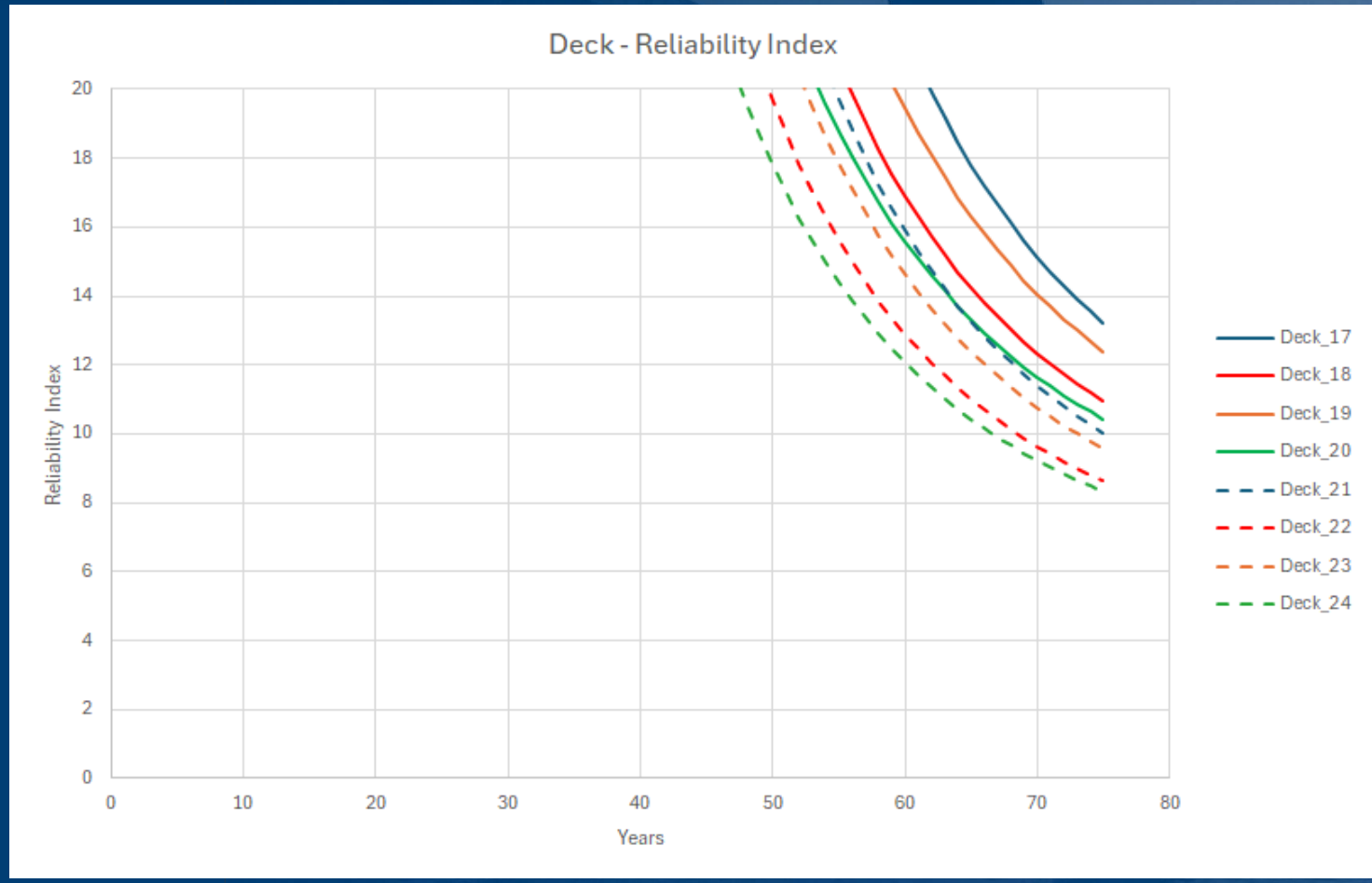
- 0% probability
- 50 mm of cover is enough
- Could be reduced



Results - Deck

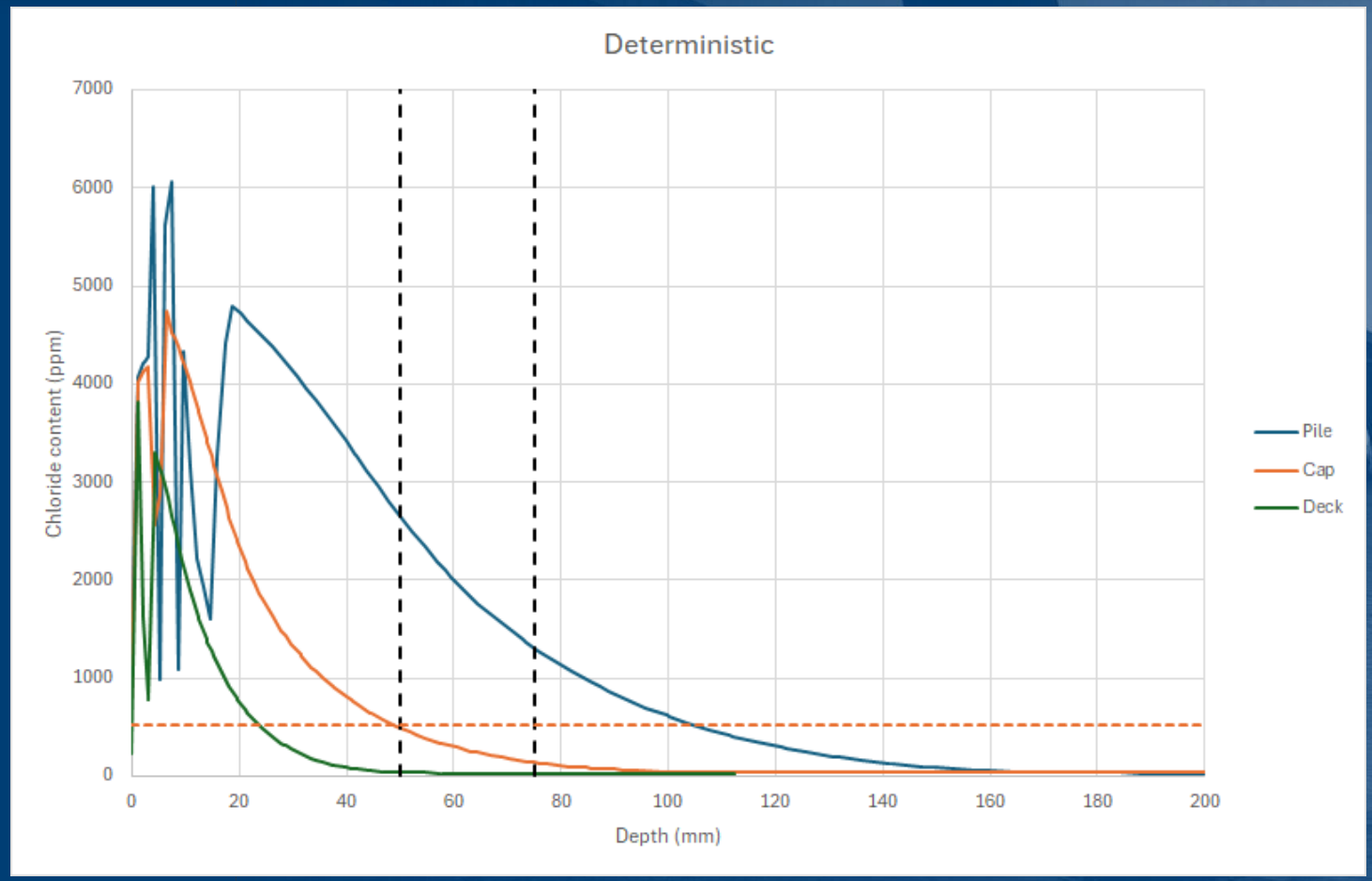
Case	VPV	DOH	Perm	Salinity
17	5	8	10	10
18	5	15	10	10
19	5	8	20	10
20	5	15	20	10
21	5	8	10	20
22	5	15	10	20
23	5	8	20	20
24	5	15	20	20

- RI curves do show some differences although probability is near 0%



Results - Deterministic

- Average values
- Lower threshold
- Threshold = 0.3%



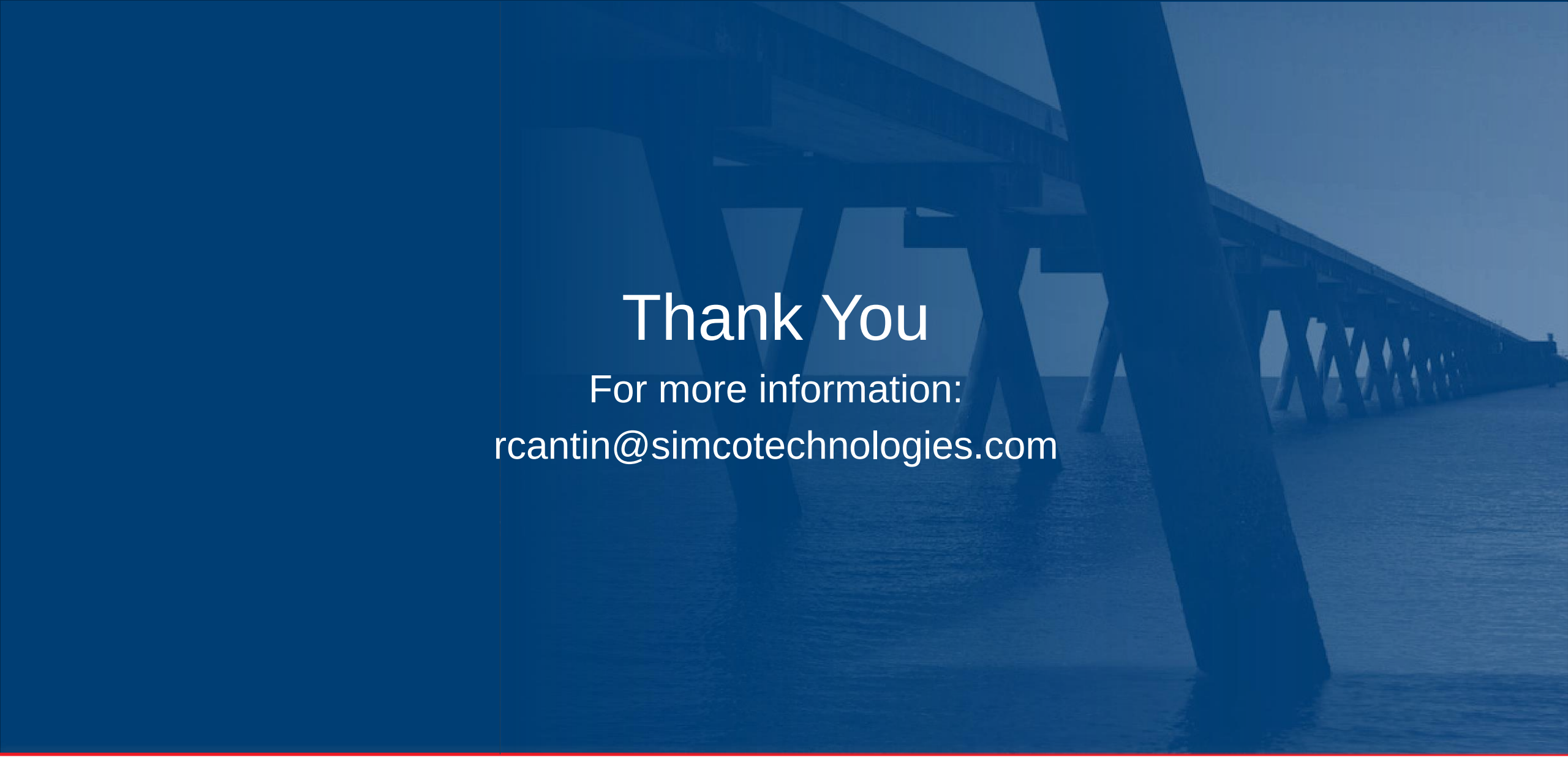
Results

- Comparable service life for the different calculations
- 50 mm is sufficient for the cap and deck
- For the piles, cover should be increased

	Probabilistic	Deterministic
Piles	44-49	41
Cap	>75	>75
Deck	>75	>75

Conclusions

- The calculations allow to determine the required cover in each case
- Accounting for uncertainty of the probabilistic parameters does not affect significantly the calculation results
- Probabilistic and deterministic calculations can yield similar results depending on corrosion initiation threshold
- Selection of calculation parameters values has a greater influence than their variability
- Key point = importance of determining the right parameters



Thank You

For more information:

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