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COMPARISON OF FIELD CHLORIDE PENETRATION DATA WITH ESTIMATES FROM SERVICE LIFE PREDICTION MODELS

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The results obtained by three commonly used service life prediction models are compared with chloride profiles from concrete specimens exposed to a marine splash zone for 2, 6 and 19 years.

Concrete Society TR 61 Enhancing reinforced concrete durability (2004) includes a spreadsheet model **(CSM)**. Service life predictions can be made using either details of the concrete mix (i.e. w/cm ratio, binder type and content) or measurements from tests or exposure trials on structures (i.e. apparent diffusion coefficient at a defined age).

The transport of chloride ions is modelled using Fick's second law of diffusion.

Life 365 requires the following general user inputs for each project; Geographic location, Depth of concrete cover to the reinforcing steel and materials details such as w/cm ratio, type and quantity of fly ash, GGBS, silica fume, or corrosion inhibitors, type of steel, uncoated or coated; and presence of membranes or sealers.

The transport of chloride ions is also modelled using Fick's second law of diffusion. Life 365 is freely available online.

STADIUM® uses time-step finite element analysis to simulate the progress of harmful ions (including chloride and sulphate) into and through concrete, by considering the chemical and physical properties of the concrete being analysed.

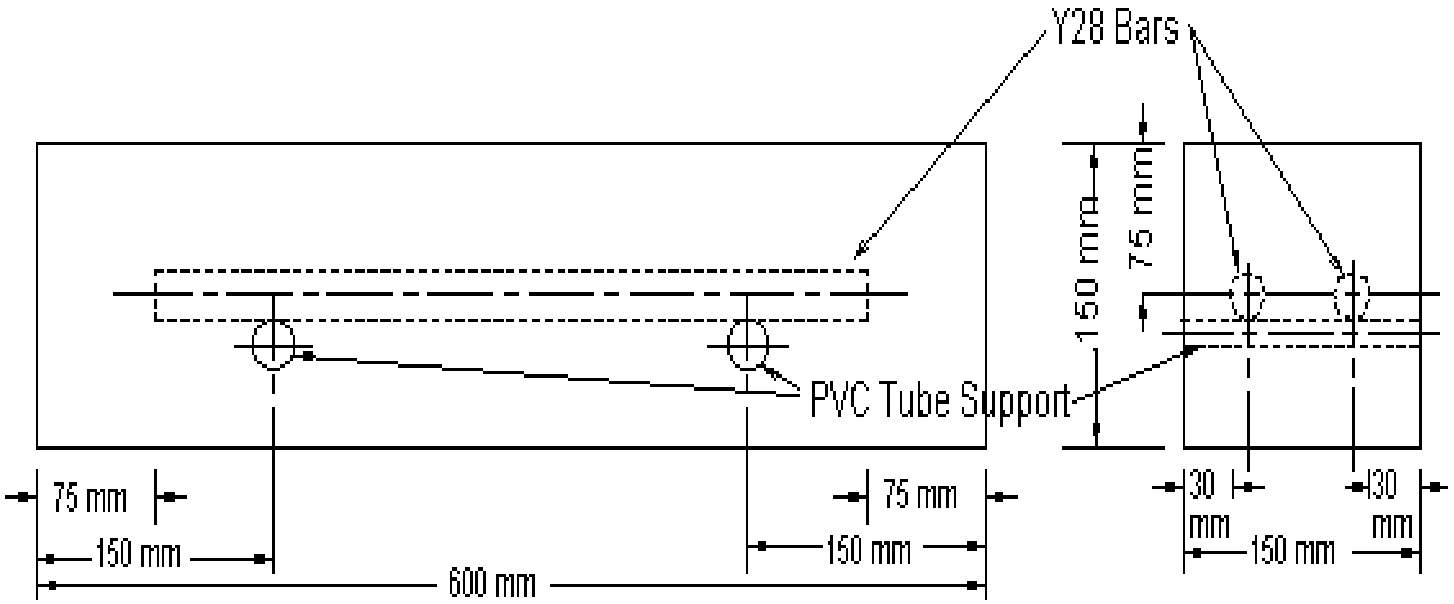
Transport is modelled with a volume-averaged version of the extended Nernst-Planck equation, which accounts for the electrical coupling between the ions as well as for the chemical activity of the species in solution.

Mix design for Berth 8 specimens (kg/m^3)

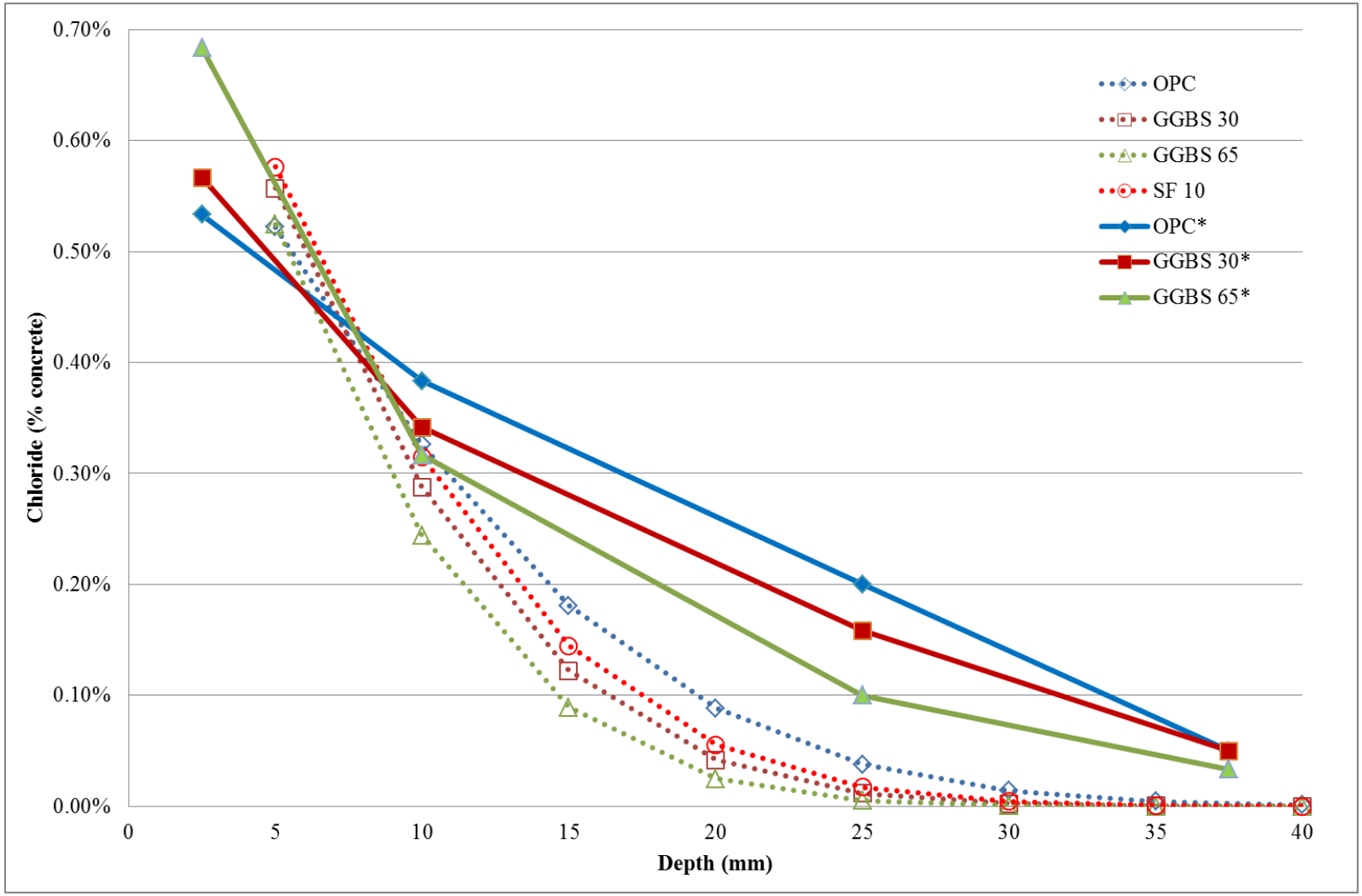
Designation	OPC	SF 10	GGBS 30	GGBS 65
OPC[1]	400	360	280	140
GGBS[2]	-	-	120	260
Silica fume[3]	-	40	-	-
20 mm granite	860	860	860	860
10 mm granite	310	310	310	310
7 mm granite	200	200	200	200
Dune sand	520	520	520	520

Berth 8 – Fremantle Port

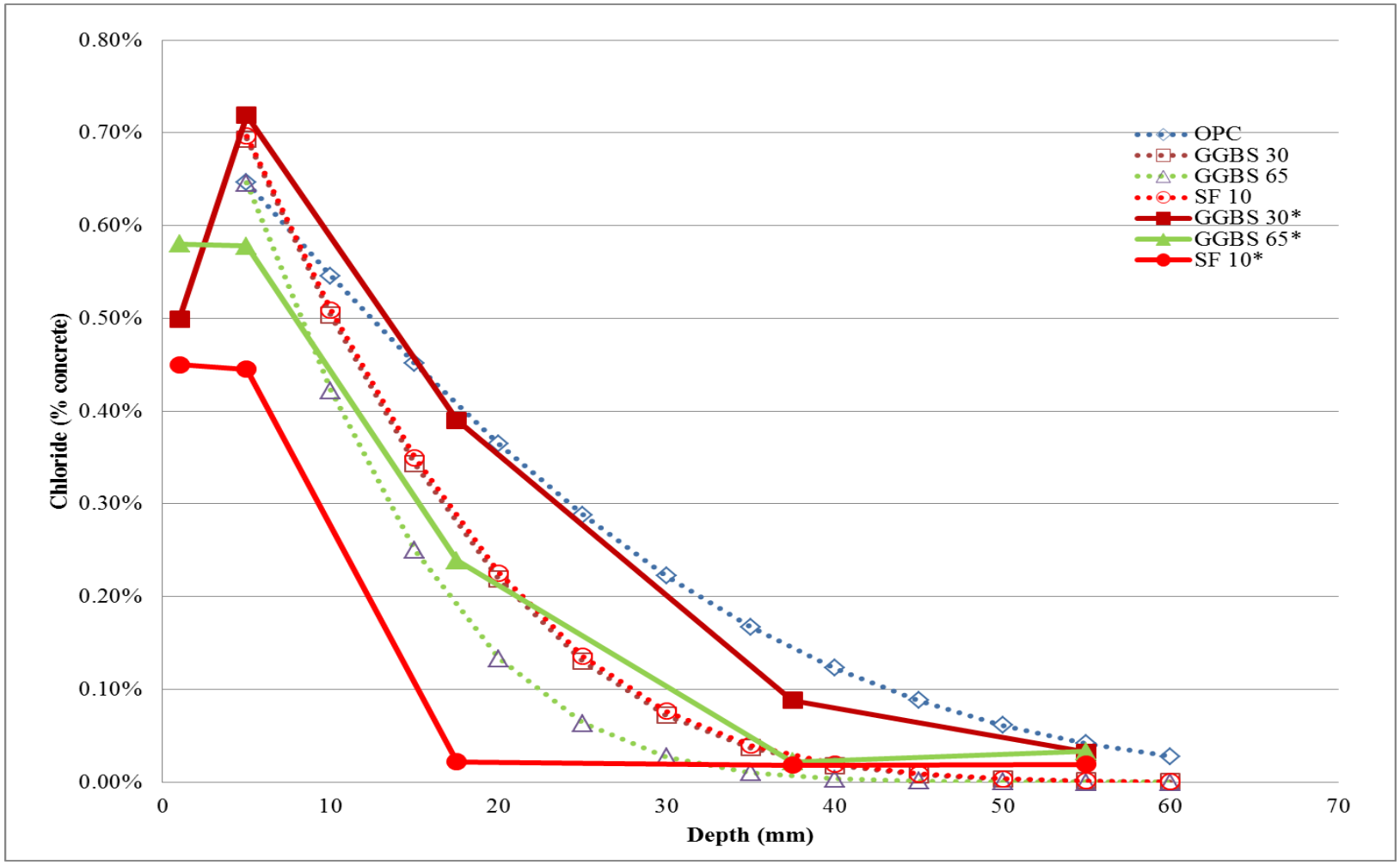
Nominal Dimensions of Berth 8 Beams



Predicted and measured chloride penetration after 2 years using CSM.



Predicted and measured chloride penetration after 19 years using CSM.



Predicted and measured depth of chloride threshold level after 2, 6 and 19 years

	OPC	GGBS 30%	GGBS 65%	SF 10%
2 year				
Concrete Society	23	19	17	20
Life 365	<30	<30	<30	<<30
Stadium	31	20	19	15
Core	37	37	34	nt
6 year				
Concrete Society	35	25	22	26
Life 365	45	35	<30	<30
Stadium	53	31	31	26
Core	75	nt	35	15
19 year				
Concrete Society	54	34	27	34
Life 365	>>75	67	40	45
Stadium	89	51	52	43
Core	>>75	50	35	13

Effective chloride diffusion data from Berth 8 specimens

	Dce (based on Cl profile)			Dc (Nordtest 443)	Ratio Dc/Dce
Age (yrs)	2	6	19	20	
OPC	5.10E-12	1.09E-11	n/a	n/a	n/a
GGBS 30	2.28E-12	4.30E-13	4.05E-13	3.72E-12	9.19
GGBS 65	1.10E-12	1.34E-12	2.30E-13	2.04E-12	8.87
SF 10	n/a	1.45E-13	5.30E-14	2.54E-12	47.92

CONCLUSIONS

Chloride penetration data obtained from field exposure was compared with the predictions from CSM, Life 365 and STADIUM® using their default values.

This study has shown a significant underestimation of early chloride penetration by all three models.

The predictions at later ages were more varied; sometimes similar to the field data but sometimes underestimating or overestimating penetration.

This study highlights the complexity of service life prediction modelling and the potential for non-conservative or overly conservative predictions when using default values in certain microclimates.