2020

The use of sea sand and sea water in concretes for floating wind farm foundations

Farnell, H.

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http://hdl.handle.net/10026.1/16510

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Appendices

Appendix A – General Risk Assessment Form

Date:	5/02/2019	**Assessed by:**	H. Farnell	**Activity/Location**	Concrete casting with use of dry admixes in BRL014	**School of Engineering**	

Hazard	**No. at Risk**	Uncontrolled Risk			**How is the hazard controlled**; (E.g. CoPs – Guidance Notes – mechanical measures – supervision – training etc.)	**Residual Risk**			**Responsible Person**
		L	**S**	**L x S**		**L**	**S**	**L x S**	
Manual handling	Everyone	2	3	**6**	Minimize handling loads. Two people to lift cement bag.	1	3	**3**	
Burns from cement	Those working with cement/concrete	3	3	**9**	PPE gloves to be worn	2	2	**4**	
Slips, trips, falls	Everyone	3	4	**12**	Walkways kept clear, spillages cleaned up, wet floor signs used, rubbish disposed of in bins.	1	4	**4**	
Inhalation of admix or cement Admix powders non-toxic and safe for general use. Contains sodium alkyl and aryl sulphonates.	Everyone working with cement/admix	3	3	**9**	Wear a dust mask while mixing and dealing with the material	1	3	**3**	
Skin irritation from admix	Everyone working with the admix	3	3	**9**	Wear gloves and suitable protective clothing while mixing and applying the material.	1	3	**3**	
Eye contact	Everyone	3	4	**12**	Wear goggles while mixing and preparation.	1	4	**4**	
Heavy concrete moulds, samples and equipment	Everyone	3	3	**12**	Wear PPE boots to prevent injury if dropped on foot	1	3	**3**	

Approval							
Approved Signature		Print Name		Date		Review date	

Risk Rating

Low		Medium		High	

Severity		Likelihood	
5	Extreme – Multiple Fatalities	5	Probable
4	High – Single Fatalities or Multiple Serious injuries	4	Very likely
3	Medium – RIDDOR Reportable Injury	3	Likely
2	Low – Minor Injury	2	Possible
1	Very Low – No injury / Near Miss	1	Not Likely

			Severity				
			Very Low	Low	Medium	High	Extreme
			1	2	3	4	5
Likelihood	Probable	5	5	10	15	20	25
	Very Likely	4	4	8	12	16	20
	Likely	3	3	6	9	12	15
	Possible	2	2	4	6	8	10
	Not Likely	1	1	2	3	4	5

Appendix B – Lab Procedure

Concrete cubes, cylinders & textile reinforced beam casting – Henry Farnell

Start time: Mix 1 (Sea water) 26th Feb 2019 & Mix 2 (Fresh water) 5th March 2019

1. **Mix recipe and required content for the casting:**

Table 1 Mix design of the fine aggregated concrete (mortar)

w/b	Mortar mix ratio (Kg/m3)			
	Cement	Sea sand	Sea/fresh water	Water reducer
0.3	700	1400	210	7

Mortar volume required:

(1) cube: 100*100*100 mm; quantity: 12 = 0.012m^3

(2) cylinder: 100d*200h; quantity: 12 = 0.019m^3

(3) beam: 80*100*500 mm; quantity: 4 = 0.016m^3

Total: 0.047 m^3

Note: sand oven dried so 0% moisture content

Usage of raw material: (assume the mortar is 2400 kg/m3)

Assume extra 10% needed for losses

(1) cement: 0.047*700*1.1= **36.19 kg**

(2) sea sand: 0.047*1400*1.1= **72.40kg**

(3) sea/fresh water: 0.047*210*1.1= **10.86 kg**

(4) water reducer: 0.047*7*1.1= **0.362 kg**

2. **Textile preparation**

   Textile is cut to size, approximately 480mmx100mm.

3. **Mould preparation**

   The rubber plug is to be inserted from the bottom of the beam mould and electrical tape stuck over the top of the hole to prevent leakage. The bottom inserts are to be put in place, then the CFRP mesh, followed by the top inserts. All cube, cylinder and beam moulds are to be coated with releasing agent.

4. **Mixing**

   Weigh all components.

   Mix the water reducer admix with water.

   Add half sand to mixer.

   Add all cement to mixer.

Add remainder of sand on top of cement.

Gradually add water to dry materials and slightly mix with trowel.

Start mixer for two minutes before using trowel to displace any unmixed cement/sand stuck in edges of drum etc.

Mix for further minute.

5. **Casting**

   Add concrete to moulds and compact cubes and cylinders using tamping rod and shaker table. Beams to be hand shaken to compact concrete and work through the mesh. Surface of moulds to be levelled then moulds covered with plastic sheet to reduce water loss.

6. **Curing**

   After casting, all samples will be demoulded after 24 hours. Then samples will be cured in the water tank for 7, 14 and 28 days (until 5th, 12th, 19th, 26th of March and 2nd April).

7. **Testing**

   Before testing, samples will be taken out from the water tank and weighed dry and wet. The cubes and cylinders will be tested in Brunel W15 at 7, 14 and 28 days. The beams will be tested at 28 days only in the Smeaton Building, using the 100 kN Instron machine.

Appendix C – Admixture Specification & Safety Data

Rockbond Admix 201 is a powdered admixture for concretes and grouts intended to reduce the water content of mixes.

The following details were accessed on 15/01/2020:

Website product page:

https://rockbond.co.uk/products/rockbond-admix-201-rb-a201/

Product information sheet:

https://rockbond.co.uk/wp-content/uploads/2018/06/PL06_Rockbond_Admix_0201_1_Flowing_Water_Reducing_Admixture_Jan_18.pdf

Product safety data sheet:

https://rockbond.co.uk/rockbond-products-safety-data-sheets/

Appendix D – CFRP Specification

V.FRAAS SIT grid 017 is a Carbon 48k textile grid.

The following details were accessed on 15/01/2020:

Datasheet available from: www.solutions-in-textile.com

Appendix E – Individual Sample Results

Density of samples

Mix 1 (SW)	
Cube	Density (kg/m^3)
1	2223
2	2209
3	2210
4	2218
5	2207
6	2215
7	2220
8	2214
9	2221
10	2216
11	2234
12	2224
Average	2218

Cylinder	Density (kg/m^3)
1	2186
2	2199
3	2194
4	2206
5	2279
6	2299
7	2287
8	2283
9	2200
10	2209
11	2200
12	2220
Average	2230

Mix 2 (FW)	
Cube	Density (kg/m^3)
1	2163
2	2182
3	2168
4	2160
5	2222
6	2241
7	2182
8	2168
9	2219
10	2177
11	2182
12	2223
Average	2191

Cylinder	Density (kg/m^3)
1	2172
2	2159
3	2182
4	2174
5	2187
6	2188
7	2174
8	2161
9	2192
10	2178
11	2195
12	2175
Average	2178

Cube results

Mix 1 (SW)		7 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
1	1.232	2.236	592
2	1.215	2.216	588
3	1.225	2.234	582
4	1.242	2.258	593

Mix 2 (FW)		7 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
1	1.186	2.202	512
2	1.180	2.175	535
3	1.188	2.201	517
4	1.175	2.184	508

Mix 1 (SW)		14 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
5	1.230	2.245	607
6	1.238	2.253	582
7	1.242	2.256	623
8	1.227	2.234	603

Mix 2 (FW)		14 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
5	1.220	2.215	613
6	1.237	2.230	604
7	1.182	2.178	562
8	1.184	2.194	550

Mix 1 (SW)		28 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
9	1.236	2.245	683
10	1.233	2.243	642
11	1.256	2.270	682
12	1.242	2.253	681

Mix 2 (FW)		28 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
9	1.210	2.199	641
10	1.192	2.201	617
11	1.176	2.167	598
12	1.224	2.221	648

Cylinder results

Mix 1 (SW)		7 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
1	1.866	3.433	147.7
2	1.885	3.452	147.4
3	1.879	3.447	141.7
4	1.888	3.448	127.9

Mix 2 (FW)		7 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
1	1.851	3.425	135.6
2	1.827	3.398	144.2
3	1.850	3.409	125.7
4	1.841	3.404	134.5

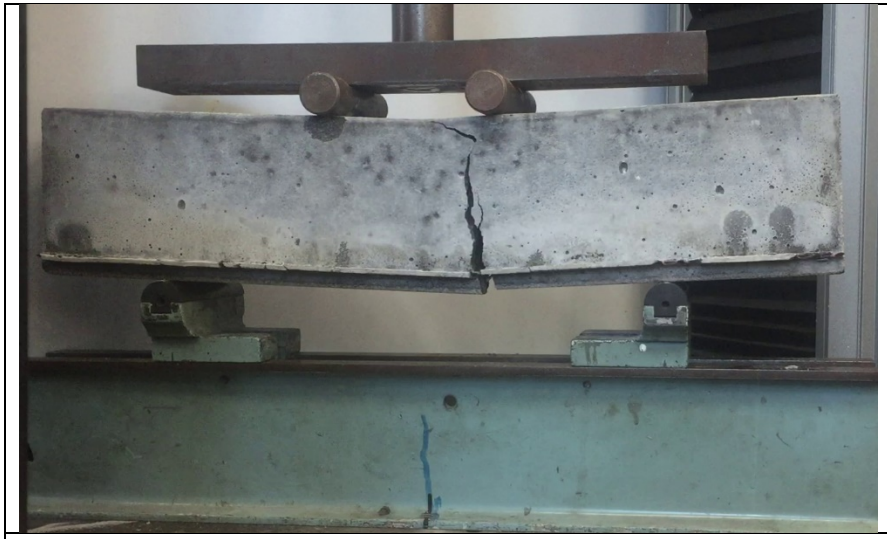
Mix 1 (SW)		14 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
5	1.951	3.471	145.6
6	1.968	3.478	144.8
7	1.950	3.460	133.6
8	1.955	3.473	148.9

Mix 2 (FW)		14 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
5	1.865	3.430	129.9
6	1.867	3.433	138.1
7	1.840	3.402	141.5
8	1.808	3.360	145.3

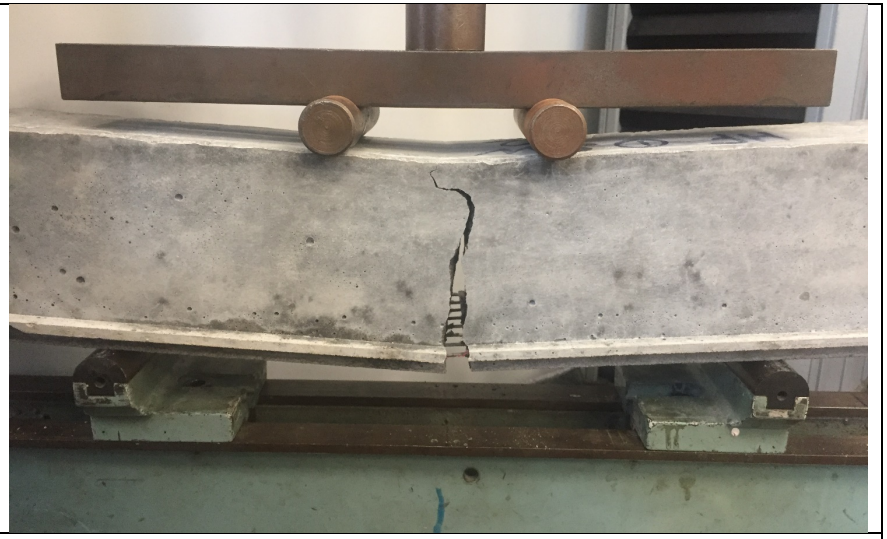
Mix 1 (SW)		28 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
9	1.906	3.489	180.1
10	1.887	3.442	147.3
11	1.875	3.432	151.2
12	1.912	3.474	147.5

Mix 2 (FW)		28 days	
Cube	Wet weight (kg)	Dry weight (kg)	Maximum load (kN)
9	1.842	3.381	148.1
10	1.841	3.398	146.1
11	1.874	3.437	142.5
12	1.821	3.365	150.8

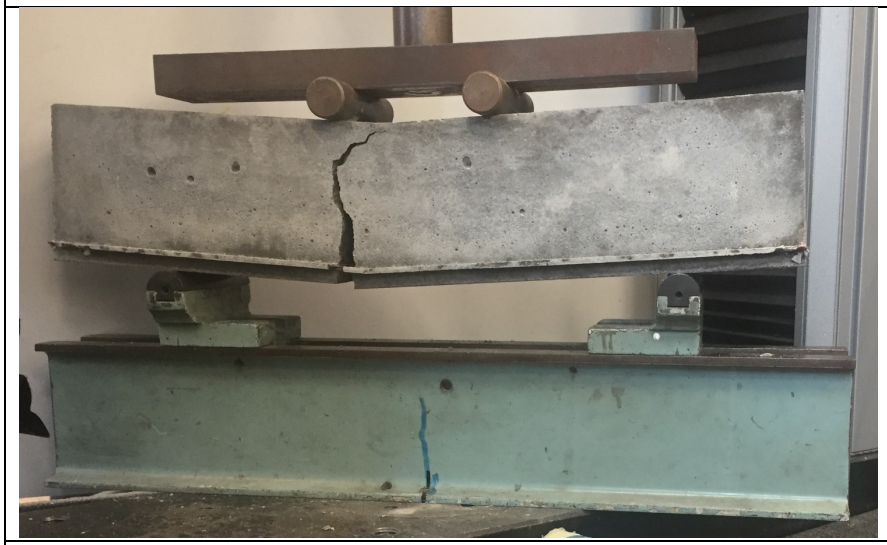
Appendix F – Flexural Test Beam Photos



SW1

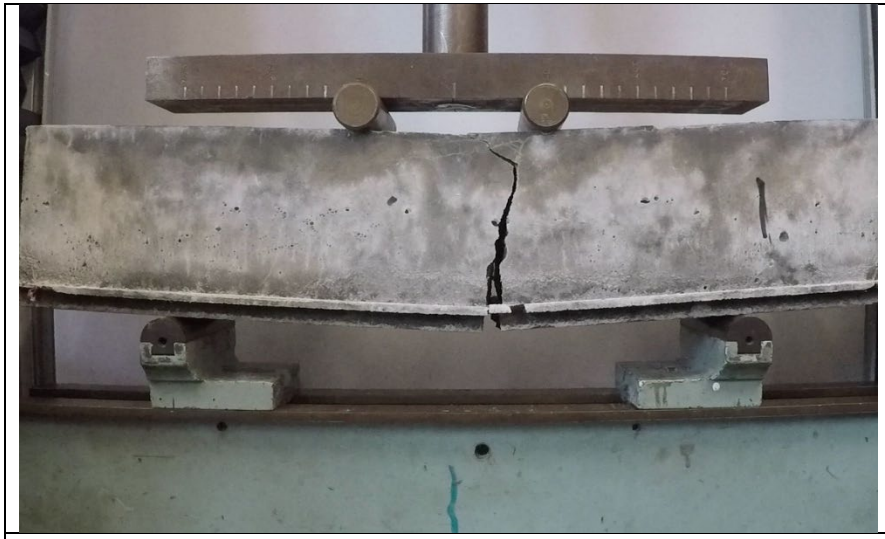


SW2



SW3

SW4



FW1

FW2

FW3

FW4

Appendix G – Statistical Calculations

Standard deviation

$$\sigma = \sqrt{\frac{\Sigma(x_i - \mu)^2}{n}}$$

σ = standard deviation
x_i = data value
μ = mean
n = number of samples

Coefficient of variation

$$CV = \frac{\sigma}{\mu} * 100$$

CV = Coefficient of variation
σ = standard deviation
μ = mean