ceEntek

ce200SF-t™

ce200SF-t™ is an Ultra-High Performance Fiber Reinforced Concrete (UHPFRC) developed at ceEntek Pte Ltd, Singapore, containing HSR cement, finely graded sand, carbon nanofibers, steel fibers and other carefully selected components.

MIX COMPONENTS

1. ce200SF-t™ premix
2. Steel fibers
3. cePAA1-61D (CNF paste)
4. Potable water

MIX COMPONENTS QUANTITIES

Table 1 outlines the weight of each mix component used in the mixing of ce200SF-t™, for a typical batch sized in an IMER Mortarman 750 planetary mixer or equivalent planetary mixer.

The values below have been determined in order to simplify the weighing of components, as much as possible. In order to ensure the batch is mixed properly, a single batch requires a given weight of ce200SF-t™, based on the mixing capacity of the high-shear mixer used and the desired plastic properties of ce200SF-t™. When mixing a different volume than the volume in Table 1, each substituent weight is to be adjusted and verified by a ceEntek Technical Representative.

Table 1: Material quantities per 300 kg batch of ce200SF-t™

Mix Component	kg/m^3	lbs/yd^3	kg	Lbs
ce200SF-t™ premix	2101	3541.4	245.1	540.4
Steel fibers	234.6	395.4	27.4	60.4
cePAA1-61D	12.43	21.0	1.5	3.3
Potable water	223.1	376.0	26.0	57.3

STORAGE AND SHELF LIFE

ce200SF-t™ Premix: Premix bags must be protected from moisture, freezing, and kept dry at all times. Unopened bags of ce200SF-t™ Premix have a shelf life of 6 months.

Steel fibers: Steel fibers must be kept in dry conditions to prevent oxidation. Minor oxidation of the fibers is acceptable and can improve bond to the matrix. Any fibers showing signs of rust that cause clumping or balling of the fibers must not be used.

cePAA1-61D: cePAA1-61D must be stored in a dry place and be protected from sun and freezing. Unopened pail of cePAA1-61D has a shelf life of 6 months.

PROCEDURES

Mixing: Mixing ce200SF-t™ requires a high shear mixer and qualified personal on-site. The number of mixers should be adjusted to reduce the waiting time between batches, depending on the volume of material to be placed. Since a wheelbarrow or buggy will be used to transport the fresh material to the pouring location, the mixers must be raised high enough to ensure that it discharges properly. A platform can also be used next to the mixer to allow workers to batch properly and safely. The mixer should be kept as clean as possible between batches in order to guarantee the performance of subsequent batches.

Mixing Sequence: The following mixing procedure has been developed and tested thoroughly at an ambient temperature of 25 ± 1 ℃ when using an IMER Mortarman 750 planetary mixer or equivalent planetary mixer. The mixing procedure may be adjusted to better suit the temperature conditions, based on the recommendations of a ceEntek Technical Representative. Prior to the batching operation, the mixer must be inspected and cleaned so that no foreign material impacts the fresh ce200SF-t™ mixing.

Different models of high-shear mixer have successfully been used to batch ce200SF-t™. Refer to ceEntek Technical Representative to use a different high-shear mixer.

Table 2: Mixing procedure for ce200SF-t™

Step	Component to Introduce	Action	Mixer Speed	Start (mm:ss)	End (mm:ss)
1	ce200SF-t™ premix	Introduce ce200SF-t™ premix the mixer			
2	cePAA1-61D and potable water	Dilute cePAA1-61D with potable water to form CNF suspension			
3	CNF suspension	Slowly introduce the CNF suspension into the mixer during mixing	Medium	00:00	00:30
4	-	Mix	Medium	00:30	05:00
5	Steel fibers	Slowly introduce the steel fibers	Medium	05:00	10:00
6	-	Mix	Medium	10:00	13:00

Table 3: Precautionary measures

Cautions
1. All personnel involved in mixing operations are required to adhere to the PPE requirements as below.  Hard Hat · Safety Glasses · Hand Protection · Foot Protection · Dust Mask
2. Make sure that the inside of the mixer has been pre-dampened slightly (remove any excess water) prior to the preparation of every batch on each batching day.
3. The time to complete steps 1 to 6 outlined in the mixing sequence of Table 2 above may vary and must be validated by a ceEntek Technical Representative.
4. Cover the mixer with plastic during mixing to help control dust emissions or alternately, use a dust collector mounted over the mixer.
5. Clean and dry the mixer as best as possible between batches in order to help ensure consistency between batches. Remove any build up excess material on the mixer or mixing blades.

CURING

The curing of ce200SF-t™ is essential in obtaining the necessary mechanical and physical material properties. In order to properly cure the material, the contractor must cover the fresh material with formwork plywood, or plywood wrapped in a plastic film, immediately after pouring. Covering the material quickly after pouring prevents the top surface of the material from drying out. The ce200SF-t™ is demolded after 24 hours of casting and water-cured at approximately 23 °C (73 ℉) in a humidity-controlled chamber.

MECHANICAL, DURABILITY AND TIME DEPENDENT PROPERTIES OF ce200SF-t™

The following data is representative of typical values achievable under laboratory conditions. Results in the field may vary.

Table 4: Mechanical properties of ce200SF-t™

Mechanical properties	Curing ages (days)	Parameter	Mean values (Standard deviation)	
			SI Unit	US Unit
Compressive strength[1]	1	$f_{c,1}$	112 MPa (2.6 MPa)	16244 psi (377 psi)
	7	$f_{c,7}$	153.6 MPa (0.9 MPa)	22278 psi (131 psi)
	28	$f_{c,28}$	173.5 MPa (4.5 MPa)	25164 psi (653 psi)
Flexural tensile strength [2]	7	$f_{r,7}$	42 MPa (1.6 MPa)	6092 psi (232 psi)
	28	$f_{r,28}$	> 45 MPa	> 6527 psi
Elastic limit tensile stress[3]	28	f_{ute}	13.7 MPa (0.6 MPa)	1987 psi (87 psi)
Ultimate direct tensile strength [3]	28	f_{utu}	19.3 MPa (1.3 MPa)	2799 psi (188 psi)
Hardening Ratio[3]	28	f_{utu}/f_{ute}	1.41 (0.10)	
Strain at ultimate tensile stress (%)[3]	28	ε_{utu}	0.32 (0.065)	
Static modulus of elasticity[4]	28	E_c	43 GPa	6237 ksi

Table 5: Durability properties of ce200SF-t™

Durability properties	Mean values (S.D.)
Water absorption[5] (after immersion and boiling)	0.675% (0.035%)
Chloride ion penetration[6] (samples w/o steel fibers)	200 coulombs (13 coulombs)

Notes	
1	Compressive strength tests in accordance to ASTM C109
2	Flexural tensile strength tests in accordance to ASTM C348
3	Direct tension tests were conducted by a MTS hydraulic testing machine with 250 kN capacity. Two linear variable differential transducers (LVDTs) were attached to both sides of the dog-bone specimens to monitor the deformation of the sample with a gauge length of 120 mm. The specimen thickness is 15 mm and its width is 35 mm.
4	Static modulus of elasticity tests in accordance to ASTM C1856
5	Water absorption tests in accordance to ASTM C642
6	Chloride ion penetration tests in accordance to ASTM C1856