

**ce200-140G™**

ce200-140G™ is an Ultra-High Performance Concrete (UHPC) developed at ceEntek Pte Ltd, Singapore, containing HSR cement, finely graded sand, carbon nanofibers and other carefully selected components.

**MIX COMPONENTS**

1. ce200-140G™ premix
2. cePAA3-165SD (CNF paste)
3. Potable water

**MIX COMPONENTS QUANTITIES**

Table 1 outlines the weight of each mix component used in the mixing of ce200-140G™, for a typical batch sized in an IMER Mortaman 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 ce200-140G™, based on the mixing capacity of the high-shear mixer used and the desired plastic properties of ce200-140G™. 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 of ce200-140G™ at 2 °C**

| Mix Component              | kg/m <sup>3</sup> | lbs/yd <sup>3</sup> | kg     | lbs   |
|----------------------------|-------------------|---------------------|--------|-------|
| ce200-140G™ premix batch 1 | 2077.84           | 3502.31             | 271.02 | 597.5 |
| cePAA3-165SD batch 1       | 19.28             | 32.5                | 2.52   | 5.56  |
| Potable water              | 202.88            | 341.97              | 26.46  | 58.33 |

**Table 2: Material quantities per 300 kg of ce200-140G™ at 20 °C**

| Mix Component              | kg/m <sup>3</sup> | lbs/yd <sup>3</sup> | kg     | lbs    |
|----------------------------|-------------------|---------------------|--------|--------|
| ce200-140G™ premix batch 1 | 2170.62           | 3658.7              | 271.33 | 598.18 |
| cePAA3-165SD batch 1       | 20.14             | 33.95               | 2.52   | 5.56   |
| Potable water              | 209.25            | 352.7               | 26.16  | 57.67  |

Table 3: Material quantities per 300 kg of ce200-140G™ at 35 °C

| Mix Component                 | kg/m <sup>3</sup> | lbs/yd <sup>3</sup> | kg    | lbs    |
|-------------------------------|-------------------|---------------------|-------|--------|
| ce200-140G™<br>premix batch 1 | 2230.35           | 3759.38             | 273.1 | 602.08 |
| cePAA3-165SD<br>batch 1       | 20.7              | 34.89               | 2.53  | 5.58   |
| Potable water                 | 198.95            | 335.34              | 24.36 | 53.7   |

**ce200-140G™ Premix:** Premix bags must be protected from moisture, freezing, and kept dry at all times. Unopened bags of ce200-140G™ Premix have a shelf life of 6 months.

**cePAA3-165SD:** cePAA3-165SD paste must be stored in a dry place and be protected from sun and freezing. Unopened pail of cePAA3-165SD has a shelf life of 6 months.

## STORAGE AND SHELF LIFE

**ce200-140G™ Premix:** Premix bags must be protected from moisture, freezing, and kept dry at all times. Unopened bags of ce200-140G™ Premix have a shelf life of 6 months.

**cePAA3-165SD:** cePAA3-165SD paste must be stored in a dry place and be protected from sun and freezing. Unopened pail of cePAA3-165SD has a shelf life of 6 months.

## PROCEDURES

**Mixing:** Mixing ce200-140G™ 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 °C when using an IMER Mortaman 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 ce200-140G™ mixing.

Different models of high-shear mixer have successfully been used to batch ce200-140G™. Refer to ceEntek Technical Representative to use a different high-shear mixer.

Table 3: Mixing procedure for ce200-140G™

| Step | Component to Introduce         | Action   | Mixer Speed | Start (mm:ss) | End (mm:ss) |
|------|--------------------------------|--|-------------|---------------|-------------|
| 1    | ce200-140G™ premix             | Introduce ce200-140G™ premix the mixer                           |             |               |             |
| 2    | cePAA3-165SD and potable water | Dilute cePAA3-165SD with potable water to form CNF suspension    |             |               |             |
| 3    | CNF suspension                 | Slowly introduce the CNF suspension into the mixer during mixing | Medium      | 00:00         | 01:00       |
| 4    | -                              | Mix  | Medium      | 01:00         | 08:00       |

Table 4: Precautionary measures

| Cautions |  |
|----------|--|
| 1.       | All personnel involved in mixing operations are required to adhere to the PPE requirements as below.   |
|          | <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Hard Hat</p> </div> <div style="text-align: center;">  <p>Safety Glasses</p> </div> <div style="text-align: center;">  <p>Hand Protection</p> </div> <div style="text-align: center;">  <p>Foot Protection</p> </div> <div style="text-align: center;">  <p>Dust Mask</p> </div> </div> |
| 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 4 outlined in the mixing sequence of Table 3 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 ce200-140G™ 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 ce200-140G™ is demolded after 24 hours of casting and water-cured at approximately 23 °C (73 °F) in a humidity-controlled chamber.

**MECHANICAL, DURABILITY AND TIME DEPENDENT PROPERTIES OF ce200-140G™**

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

**Table 5: Fresh properties of ce200-140G™**

| Fresh properties          | Time             | Mean values |       |       |
|---------------------------|------------------|-------------|-------|-------|
|                           |                  | 2 °C        | 20 °C | 35 °C |
| Slump Flow <sup>1</sup>   | 2 min            | 350mm       | 335mm | 320mm |
|                           | 30 min           | 300mm       | 325mm | 310mm |
|                           | 60 min           | 280mm       | 320mm | 285mm |
|                           | 90 min           | 265mm       | 300mm | 265mm |
|                           | 120 min          | 250mm       | 290mm | 255mm |
| Air Content <sup>2</sup>  | After mixing     | 4.5%        | 2.2%  | 1.5%  |
| Setting Time <sup>3</sup> | Begin of setting | 12:30       | 8:45  | 8:35  |
|                           | End of setting   | 15:20       | 10:55 | 9:50  |

Table 6: Mechanical and durability properties of ce200-140G™

| Mechanical properties                     | Curing ages (day) | Parameter  | Mean values (Standard deviation) |                        |                        |
|---|-------------------|------------|----------------------------------|------------------------|------------------------|
|   |                   |            | 2 °C                             | 20 °C                  | 35 °C                  |
| Compressive strength <sup>4</sup>         | 1                 | $f_{c,1}$  | -                                | 56.1 MPa<br>(4.2 MPa)  | -                      |
|   | 3                 | $f_{c,3}$  | 62.4 MPa<br>(1.6 MPa)            | 112.2 MPa<br>(2.3 MPa) | 138.4 MPa<br>(2.8 MPa) |
|   | 7                 | $f_{c,7}$  | 96.6 MPa<br>(2.3 MPa)            | 126.2 MPa<br>(2.4 MPa) | 151.6 MPa<br>(2.0 MPa) |
|   | 28                | $f_{c,28}$ | 115.6 MPa<br>(2.8 MPa)           | 142.0 MPa<br>(4.9 MPa) | 171.0 MPa<br>(2.9 MPa) |
|   | 90                | $f_{c,90}$ | 133.3 MPa<br>(4.0 MPa)           | 160.1 MPa<br>(2.0 MPa) | 182.9 MPa<br>(4.8 MPa) |
| Flexural tensile strength <sup>5</sup>    | 28                | $f_{r,28}$ | 17.8 MPa<br>(0.8 MPa)            | 19.2 MPa<br>(1.4 MPa)  | 24.2 MPa<br>(1.3 MPa)  |
| Splitting tensile strength <sup>6</sup>   | 28                | $S_t$      | -                                | 9.5 MPa<br>(0.6 MPa)   | -                      |
| Static modulus of elasticity <sup>7</sup> | 28                | $E_c$      | -                                | 46.2 GPa<br>(0.9 GPa)  | -                      |
| Poisson ratio <sup>8</sup>                | 28                | $\mu$      | -                                | 0.2 (0.01)             | -                      |
| Chloride penetration <sup>9</sup>         | 28                | C          | -                                | 963 coulomb            | -                      |

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| Notes |   |
|-------|---|
| 1     | Slump-flow-tests in accordance to ASTM 1437-15                    |
| 2     | Air content in accordance to EN 12350-7:2009                      |
| 3     | Setting time in accordance to EN 196-3:2008                       |
| 4     | Compressive strength tests in accordance to EN 12390-3:2009-07    |
| 5     | Flexural tensile strength tests in accordance to EN 196-1:2005    |
| 6     | Splitting tensile strength tests in accordance to EN 12390-6:2009 |
| 7     | Static modulus of elasticity in accordance to ASTM C469-10        |
| 8     | Poisson ratio in accordance to ASTM C469-10                       |
| 9     | Chloride penetration in accordance to ASTM C1202-19               |