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APPENDIX A

A.1 Summary of results for tensile strain capacities

| Time (min) | Strain Capacity - Method 2 | | | | | | | Strain Capacity - Method 1 | | | |
|------------|----------------------------|--------|-----------|-----------|--------|--------|---------|----------------------------|-------|-------|--------|
| | OPC | Mortar | MSand 20% | MSand 50% | FA 20% | FA 40% | FA 100% | PLC | OPC | PLC | FA 20% |
| 10 | 0.068 | 0.09 | 0.065 | 0.072 | 0.072 | 0.082 | 0.09 | 0.065 | 0.099 | 0.098 | 0.107 |
| 30 | 0.044 | 0.087 | 0.047 | 0.051 | 0.052 | 0.06 | 0.071 | 0.044 | 0.086 | 0.09 | 0.1 |
| 60 | 0.03 | 0.081 | 0.031 | 0.044 | 0.038 | 0.049 | 0.055 | 0.031 | 0.081 | 0.08 | 0.09 |
| 120 | 0.025 | 0.029 | 0.026 | 0.032 | 0.03 | 0.035 | 0.042 | 0.024 | 0.06 | 0.055 | 0.07 |
| 180 | 0.019 | 0.022 | 0.02 | 0.026 | 0.022 | 0.026 | 0.03 | 0.017 | 0.051 | 0.05 | 0.062 |
| 240 | 0.017 | 0.016 | 0.019 | 0.021 | 0.019 | 0.021 | 0.023 | 0.015 | 0.042 | 0.035 | 0.051 |

A.2 Calculation of tensile strain capacities

| OPC (Method 2) | | | | | | | | | |
|-----------------------|----------------------|------------------|----------------------------------|---------------------|----------------------|------------------|----------------------------------|---------------------|---------------|
| | At start | | | | At failure | | | | Strain |
| | No. of pixels | Tape (cm) | Distance from center (cm) | Scale factor | No. of pixels | Tape (cm) | Distance from center (cm) | Scale factor | |
| 10 min | 280 | 104 | -35.6 | 1.0598 | 295 | 107.5 | -39.55 | 1.0665 | 0.068 |
| | | 114 | | | | 118 | | | |
| 30 min | 305 | 83.3 | -12.1 | 1.0203 | 317 | 84.8 | -13.95 | 1.0234 | 0.044 |
| | | 94.1 | | | | 96.1 | | | |
| 1 Hour | 261 | 86 | -14.15 | 1.0238 | 268 | 86.7 | -15.1 | 1.0254 | 0.030 |
| | | 95.3 | | | | 96.3 | | | |
| 2 hour | 267 | 103.5 | -34.35 | 1.0577 | 273 | 104.5 | -34.45 | 1.0579 | 0.025 |
| | | 113 | | | | 114.2 | | | |
| 3 Hour | 247 | 105 | -35 | 1.0588 | 251 | 105.3 | -35.3 | 1.0593 | 0.019 |
| | | 113.8 | | | | 114.3 | | | |
| 4 Hour | 261 | 103.3 | -33.45 | 1.0562 | 265 | 103.4 | -33.5 | 1.0563 | 0.017 |
| | | 112.6 | | | | 112.8 | | | |

| PLC (Method 2) | | | | | | | | | |
|-----------------------|-----|-------|--------|--------|-----|-------|-------|--------|-------|
| 10 min | 357 | 100.8 | -30.65 | 1.0515 | 376 | 103.3 | -33.9 | 1.057 | 0.065 |
| | | 113.7 | | | | 116.7 | | | |
| 30 min | 344 | 100.4 | -28.7 | 1.0482 | 356 | 102.8 | -31.6 | 1.0531 | 0.044 |
| | | 113 | | | | 116 | | | |
| 1 Hour | 347 | 87.6 | -19.3 | 1.0324 | 354 | 89.2 | -24.4 | 1.041 | 0.031 |
| | | 100 | | | | 102.2 | | | |
| 2 hour | 310 | 100.8 | -31.9 | 1.0536 | 315 | 101.2 | -35.5 | 1.0597 | 0.024 |
| | | 112 | | | | 112.4 | | | |
| 3 Hour | 291 | 102.7 | -30.95 | 1.052 | 295 | 103 | -32 | 1.0538 | 0.017 |
| | | 113.4 | | | | 115 | | | |
| 4 Hour | 301 | 114.9 | -43.6 | 1.0733 | 305 | 115 | -43.6 | 1.0733 | 0.015 |
| | | 126.5 | | | | 126.6 | | | |

| FA 20% (Method 2) | | | | | | | | | |
|--------------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 308 | 101.8 | -31.15 | 1.0524 | 326 | 105 | -35.15 | 1.0591 | 0.072 |
| | | 113.5 | | | | 117.1 | | | |
| 30 min | 299 | 102 | -32.05 | 1.0539 | 312 | 104.3 | -34.1 | 1.0573 | 0.052 |
| | | 113.1 | | | | 115.9 | | | |
| 1 Hour | 274 | 103.5 | -32.4 | 1.0545 | 282 | 105.4 | -35.2 | 1.0592 | 0.038 |
| | | 113.7 | | | | 118 | | | |
| 2 hour | 342 | 87.2 | -19.1 | 1.0321 | 349 | 89 | -23.45 | 1.0394 | 0.030 |
| | | 99 | | | | 101.9 | | | |
| | 380 | 76.4 | -5.8 | 1.0097 | 388 | 76.5 | -6 | 1.0101 | 0.022 |

| | | | | | | | | | |
|-------------------|-----|------|-------|--------|-----|-------|--------|--------|-------|
| 3 Hour | | 90 | | | | 90.5 | | | |
| 4 Hour | 360 | 86.2 | -16.2 | 1.0272 | 366 | 86.8 | -16.75 | 1.0282 | 0.019 |
| | | 100 | | | | 100.7 | | | |

FA 40% (Method 2)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 312 | 100.4 | -30.65 | 1.0515 | 333 | 103.6 | -34.8 | 1.0585 | 0.082 |
| | | 112.9 | | | | 117 | | | |
| 30 min | 308 | 99.5 | -29.15 | 1.049 | 323 | 102.4 | -32.35 | 1.0544 | 0.060 |
| | | 111 | | | | 114.3 | | | |
| 1 Hour | 337 | 80.2 | -10 | 1.0168 | 352 | 81.7 | -11.9 | 1.02 | 0.049 |
| | | 92.4 | | | | 94.5 | | | |
| 2 hour | 291 | 102.7 | -30.95 | 1.052 | 299 | 103.6 | -33.3 | 1.056 | 0.035 |
| | | 113.4 | | | | 116 | | | |
| 3 Hour | 311 | 101.5 | -29.75 | 1.05 | 318 | 102 | -30.25 | 1.0508 | 0.026 |
| | | 112.8 | | | | 113.5 | | | |
| 4 Hour | 270 | 105.4 | -35.35 | 1.0594 | 275 | 105.9 | -35.45 | 1.0596 | 0.021 |
| | | 114.5 | | | | 115 | | | |

FA 100% (Method 2)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 312 | 101 | -30.8 | 1.0518 | 334 | 105.2 | -37.1 | 1.0624 | 0.090 |
| | | 113.2 | | | | 119.4 | | | |
| 30 min | 342 | 98.2 | -28.15 | 1.0473 | 363 | 100.5 | -30.05 | 1.0505 | 0.071 |
| | | 109.1 | | | | 111.6 | | | |
| 1 Hour | 300 | 101.9 | -31.9 | 1.0536 | 314 | 104.2 | -33.45 | 1.0562 | 0.055 |
| | | 112.9 | | | | 115.7 | | | |
| 2 hour | 337 | 82.2 | -11.55 | 1.0194 | 350 | 83 | -12.5 | 1.021 | 0.042 |
| | | 93.5 | | | | 94.4 | | | |
| 3 Hour | 308 | 100.2 | -31.4 | 1.0528 | 314 | 101.2 | -35.8 | 1.0602 | 0.030 |
| | | 111.6 | | | | 112.6 | | | |
| 4 Hour | 284 | 98.7 | -27.05 | 1.0455 | 288 | 99.1 | -31.4 | 1.0528 | 0.023 |
| | | 105.4 | | | | 105.9 | | | |

Msand 20% (Method 2)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 296 | 90 | -21.75 | 1.0366 | 312 | 92.8 | -25.4 | 1.0427 | 0.065 |
| | | 100.5 | | | | 104 | | | |
| 30 min | 314 | 90.7 | -20.75 | 1.0349 | 327 | 92.4 | -22.4 | 1.0376 | 0.047 |
| | | 102.2 | | | | 104.4 | | | |
| 1 Hour | 317 | 80.2 | -8.05 | 1.0135 | 326 | 81.1 | -8.9 | 1.015 | 0.031 |
| | | 91.5 | | | | 92.7 | | | |
| 2 hour | 293 | 104 | -36.55 | 1.0614 | 299 | 104.4 | -37.95 | 1.0638 | 0.026 |
| | | 114.1 | | | | 114.5 | | | |
| 3 Hour | 307 | 102 | -31.05 | 1.0522 | 312 | 102.4 | -32.1 | 1.0539 | 0.020 |
| | | 113.3 | | | | 113.8 | | | |

| | | | | | | | | | |
|-------------------|-----|------|--------|--------|-----|-------|-------|--------|-------|
| 4 Hour | 346 | 99.3 | -29.65 | 1.0498 | 352 | 99.3 | -29.8 | 1.0501 | 0.019 |
| | | 112 | | | | 112.3 | | | |

Msand 40% (Method 2)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 323 | 90.2 | -18.45 | 1.031 | 343 | 92.1 | -21.75 | 1.0366 | 0.072 |
| | | 101.9 | | | | 104.6 | | | |
| 30 min | 343 | 100.8 | -31.95 | 1.0537 | 358 | 103.3 | -33.35 | 1.0561 | 0.051 |
| | | 113.5 | | | | 116.4 | | | |
| 1 Hour | 313 | 101.6 | -32.3 | 1.0543 | 326 | 103.5 | -31.35 | 1.0527 | 0.044 |
| | | 113 | | | | 115.2 | | | |
| 2 hour | 302 | 95.6 | -25.4 | 1.0427 | 309 | 98.5 | -27.9 | 1.0469 | 0.030 |
| | | 106.2 | | | | 109.3 | | | |
| 3 Hour | 359 | 100.1 | -31.15 | 1.0524 | 367 | 100.4 | -32.05 | 1.0539 | 0.026 |
| | | 113.2 | | | | 113.7 | | | |
| 4 Hour | 318 | 101.3 | -26.15 | 1.0439 | 324 | 101.4 | -26.6 | 1.0447 | 0.021 |
| | | 103 | | | | 103.2 | | | |

Mortar (Method 2)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 245 | 102.6 | -31.55 | 1.053 | 263 | 104.5 | -35.95 | 1.0604 | 0.090 |
| | | 110.9 | | | | 113.4 | | | |
| 30 min | 238 | 105 | -34.1 | 1.0573 | 254 | 109.7 | -40.35 | 1.0678 | 0.087 |
| | | 113.6 | | | | 119 | | | |
| 1 Hour | 256 | 88.1 | -19.75 | 1.0332 | 274 | 90.6 | -22.9 | 1.0385 | 0.081 |
| | | 97 | | | | 100.4 | | | |
| 2 hour | 204 | 98 | -28.35 | 1.0476 | 209 | 98.7 | -29.35 | 1.0493 | 0.029 |
| | | 105.5 | | | | 106.4 | | | |
| 3 Hour | 238 | 104.1 | -34.05 | 1.0572 | 242 | 104.3 | -35.8 | 1.0602 | 0.022 |
| | | 113 | | | | 113.3 | | | |
| 4 Hour | 228 | 107 | -32.8 | 1.0551 | 231 | 107.3 | -33.6 | 1.0565 | 0.016 |
| | | 105.4 | | | | 105.7 | | | |

OPC (Method 1)

| | | | | | | | | | |
|-------------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 187 | 90.2 | -25.65 | 1.0431 | 202 | 95.3 | -31.9 | 1.0536 | 0.099 |
| | | 112.3 | | | | 117.5 | | | |
| 30 min | 194 | 56.7 | 16.1 | 1.0271 | 210 | 57.4 | 15.4 | 1.0259 | 0.086 |
| | | 62.3 | | | | 63 | | | |
| 1 Hour | 187 | 100.8 | -28.5 | 1.0479 | 200 | 102.9 | -30.75 | 1.0517 | 0.081 |
| | | 106.2 | | | | 108.6 | | | |
| 2 hour | 196 | 101.3 | -29 | 1.0487 | 206 | 103.4 | -31.25 | 1.0525 | 0.060 |
| | | 106.7 | | | | 109.1 | | | |
| 3 Hour | 199 | 88.8 | -19.05 | 1.032 | 208 | 90.2 | -20.5 | 1.0345 | 0.051 |
| | | 94.3 | | | | 95.8 | | | |
| 4 Hour | 182 | 109.5 | -34.1 | 1.0573 | 188 | 111 | -36.8 | 1.0618 | 0.042 |
| | | 114.7 | | | | 116.6 | | | |

PLC (Method 1)

| | | | | | | | | | |
|---------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 279 | 102 | -31.1 | 1.0523 | 301 | 106.2 | -36.6 | 1.0615 | 0.098 |
| | | 109.6 | | | | 114.6 | | | |
| 30 min | 280 | 86.5 | -16.3 | 1.0274 | 302 | 89.2 | -20.1 | 1.0338 | 0.090 |
| | | 94.1 | | | | 97.2 | | | |
| 1 Hour | 331 | 106.5 | -35.25 | 1.0592 | 352 | 110.2 | -39.8 | 1.0669 | 0.080 |
| | | 115.4 | | | | 119.8 | | | |
| 2 hour | 269 | 52.4 | 23.65 | 1.0397 | 283 | 53.1 | 22.8 | 1.0383 | 0.055 |
| | | 59.5 | | | | 60.5 | | | |
| 3 Hour | 253 | 88.9 | -14.8 | 1.0249 | 264 | 90.5 | -16.95 | 1.0285 | 0.050 |
| | | 95.7 | | | | 97.6 | | | |
| 4 Hour | 262 | 101.6 | -27.95 | 1.047 | 270 | 103.2 | -29 | 1.0487 | 0.035 |
| | | 109.1 | | | | 110.8 | | | |

FA 20% (Method 1)

| | | | | | | | | | |
|---------------|-----|-------|--------|--------|-----|-------|--------|--------|-------|
| 10 min | 290 | 73.3 | -4.1 | 1.0069 | 319 | 75.9 | -6.85 | 1.0115 | 0.107 |
| | | 80.9 | | | | 83.8 | | | |
| 30 min | 320 | 106.2 | -38 | 1.0639 | 346 | 110.2 | -42.3 | 1.0711 | 0.100 |
| | | 115 | | | | 119.6 | | | |
| 1 Hour | 285 | 99.3 | -28.15 | 1.0473 | 306 | 103.3 | -32.95 | 1.0554 | 0.090 |
| | | 107 | | | | 111.8 | | | |
| 2 hour | 187 | 103 | -29.1 | 1.0489 | 198 | 105.5 | -31.75 | 1.0534 | 0.070 |
| | | 108.2 | | | | 111 | | | |
| 3 Hour | 212 | 101.1 | -29.8 | 1.0501 | 223 | 103.5 | -32.2 | 1.0541 | 0.062 |
| | | 107.1 | | | | 109.5 | | | |
| 4 Hour | 214 | 106.7 | -34.05 | 1.0572 | 223 | 108.8 | -36.2 | 1.0608 | 0.051 |
| | | 112.8 | | | | 115 | | | |

| | Time (min) | 300 | 360 | 420 | 480 | 540 | 600 | 660 | 720 |
|------------|------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Height (m) | 0 | 0.225 | 0.225 | 0.225 | 0.225 | 0.225 | 0.225 | 0.225 | 0.225 |
| | 0.01 | 0.219809 | 0.219483 | 0.219269 | 0.219128 | 0.219036 | 0.218975 | 0.218935 | 0.218908 |
| | 0.02 | 0.214503 | 0.213891 | 0.213489 | 0.213224 | 0.21305 | 0.212936 | 0.21286 | 0.212811 |
| | 0.03 | 0.208981 | 0.208157 | 0.207615 | 0.207258 | 0.207024 | 0.20687 | 0.206768 | 0.206702 |
| | 0.04 | 0.20317 | 0.202232 | 0.201616 | 0.20121 | 0.200944 | 0.200768 | 0.200653 | 0.200577 |
| | 0.05 | 0.197027 | 0.19609 | 0.195474 | 0.195068 | 0.194801 | 0.194626 | 0.194511 | 0.194435 |
| | | | | | | | | | |
| | | 0.012224 | 0.012222 | 0.012221 | 0.012221 | 0.01222 | 0.01222 | 0.01222 | 0.01222 |
| | | 0.012172 | 0.012167 | 0.012164 | 0.012162 | 0.01216 | 0.01216 | 0.012159 | 0.012159 |
| | | 0.012117 | 0.01211 | 0.012106 | 0.012102 | 0.0121 | 0.012099 | 0.012098 | 0.012098 |
| | | 0.012061 | 0.012052 | 0.012046 | 0.012042 | 0.01204 | 0.012038 | 0.012037 | 0.012036 |
| | | 0.012001 | 0.011992 | 0.011985 | 0.011981 | 0.011979 | 0.011977 | 0.011976 | 0.011975 |
| | | | | | | | | | |
| | $\Sigma(1 + e(z,t))\Delta z$ | 60.57477 | 60.54309 | 60.52225 | 60.50855 | 60.49954 | 60.49361 | 60.48972 | 60.48715 |
| | | | | | | | | | |
| s(t) (mm) | $h_0 - \Sigma(1 + e(z,t))\Delta z$ | 0.675234 | 0.706913 | 0.727747 | 0.741449 | 0.750459 | 0.756385 | 0.760282 | 0.762845 |

APPENDIX C – ANALYTICAL MODELS TO PREDICT VOLUMETRIC CONTRACTION FOR OPC AND OPC+20% FA

OPC (1m x 1m x 100mm) – Volumetric Contraction from 150min to 175min

| Layers across the depth (cm) | top | <i>e</i> at t= 150 min | % of water | porosity | volume of water (mm ³) | Volume loss (mm ³) ; up to 175min | Temp. difference (°C) | Thermal coefficient of expansion (α) |
|------------------------------|-----|------------------------|------------|----------|------------------------------------|---|-----------------------|---|
| | 1 | 0.255 | 11.5626 | 0.2032 | 2031872.510 | 48562.80 | 10.00 | 4.856E-04 |
| | 2 | 0.2471683 | 11.2075 | 0.1982 | 1981836.066 | 47071.31 | 10.00 | 4.707E-04 |
| | 3 | 0.2393366 | 10.8523 | 0.1931 | 1931166.890 | 45579.82 | 10.00 | 4.558E-04 |
| | 4 | 0.2315047 | 10.4972 | 0.1880 | 1879852.571 | 44088.31 | 10.00 | 4.409E-04 |
| | 5 | 0.2236727 | 10.1421 | 0.1828 | 1827880.400 | 42596.76 | 10.00 | 4.260E-04 |
| | 6 | 0.2158406 | 9.7869 | 0.1775 | 1775237.376 | 41105.18 | 10.00 | 4.111E-04 |
| | 7 | 0.2080082 | 9.4318 | 0.1722 | 1721910.213 | 39613.56 | 10.00 | 3.961E-04 |
| | 8 | 0.2001755 | 9.0766 | 0.1668 | 1667885.335 | 38121.90 | 10.00 | 3.812E-04 |
| | 9 | 0.1923426 | 8.7215 | 0.1613 | 1613148.882 | 36630.18 | 10.00 | 3.663E-04 |
| | 10 | 0.1923426 | 8.7215 | 0.1613 | 1613148.882 | 36630.18 | 10.00 | 3.663E-04 |
| bott om | | | | | $\Sigma = 420000$ | | | |

OPC (1m x 1m x 100mm) – Volumetric Contraction from 175min to 260min

| Layers across the depth (cm) | top | <i>e</i> at t= 175 min | % of water | porosity | volume of water (mm ³) | Volume loss (mm ³) ; up to 260min | Temp. difference (°C) | Thermal coefficient of expansion (α) |
|------------------------------|-----|------------------------|------------|----------|------------------------------------|---|-----------------------|---|
| | 1 | 0.247398 | 11.5449 | 0.1983 | 1983309.711 | 162782.99 | 33.52 | 4.856E-04 |
| | 2 | 0.239889 | 11.1945 | 0.1935 | 1934764.751 | 157842.78 | 33.53 | 4.707E-04 |
| | 3 | 0.232375 | 10.8439 | 0.1886 | 1885587.071 | 152898.45 | 33.55 | 4.558E-04 |
| | 4 | 0.224854 | 10.4929 | 0.1836 | 1835764.266 | 147950.00 | 33.56 | 4.409E-04 |
| | 5 | 0.217327 | 10.1417 | 0.1785 | 1785283.638 | 142997.44 | 33.57 | 4.260E-04 |
| | 6 | 0.209794 | 9.7901 | 0.1734 | 1734132.193 | 138040.76 | 33.58 | 4.111E-04 |
| | 7 | 0.202255 | 9.4383 | 0.1682 | 1682296.651 | 133079.99 | 33.59 | 3.96E-04 |
| | 8 | 0.194709 | 9.0862 | 0.1630 | 1629763.44 | 128115.13 | 33.61 | 3.81E-04 |
| | 9 | 0.187158 | 8.7338 | 0.1577 | 1576518.702 | 123146.23 | 33.62 | 3.66E-04 |
| | 10 | 0.187158 | 8.7338 | 0.1577 | 1576518.702 | 123146.23 | 33.62 | 3.66E-04 |
| bott om | | | | | $\Sigma = 1410000$ | | | |

OPC +FA 20% (1m x 1m x 100mm) – Volumetric Contraction from 100min to 170min

| Layers across the depth (cm) | top | e at $t=100$ min | % of water | porosity | volume of water (mm ³) | Volume loss (mm ³) ; up to 170min | Temp. difference (°C) | Thermal coefficient of expansion (α) |
|------------------------------|---------|--------------------|------------|----------|------------------------------------|---|-----------------------|---|
| | 1 | 0.255 | 11.0052 | 0.2032 | 2031872.510 | 124358.40 | 10.00 | 1.244E-03 |
| | 2 | 0.2497411 | 10.7782 | 0.1998 | 1998342.869 | 121793.76 | 10.00 | 1.218E-03 |
| | 3 | 0.2444765 | 10.5510 | 0.1964 | 1964492.809 | 119226.31 | 10.00 | 1.192E-03 |
| | 4 | 0.2392007 | 10.3233 | 0.1930 | 1930282.046 | 116653.39 | 10.00 | 1.167E-03 |
| | 5 | 0.2339086 | 10.0949 | 0.1896 | 1895672.209 | 114072.56 | 10.00 | 1.141E-03 |
| | 6 | 0.2285961 | 9.8656 | 0.1861 | 1860628.368 | 111481.74 | 10.00 | 1.115E-03 |
| | 7 | 0.2232596 | 9.6353 | 0.1825 | 1825120.446 | 108879.25 | 10.00 | 1.089E-03 |
| | 8 | 0.2178969 | 9.4039 | 0.1789 | 1789124.434 | 106263.97 | 10.00 | 1.063E-03 |
| | 9 | 0.2125068 | 9.1713 | 0.1753 | 1752623.359 | 103635.30 | 10.00 | 1.036E-03 |
| | 10 | 0.2125068 | 9.1713 | 0.1753 | 1752623.359 | 103635.30 | 10.00 | 1.036E-03 |
| | bott om | | | | | $\Sigma = 1130000$ | | |

OPC +FA 20% (1m x 1m x 100mm) – Volumetric Contraction from 170min to 260min

| Layers across the depth(cm) | top | e at $t=170$ min | % of water | porosity | volume of water (mm ³) | Volume loss (mm ³) ; up to 260min | Temp. difference (°C) | Thermal coefficient of expansion (α) |
|-----------------------------|---------|--------------------|------------|----------|------------------------------------|---|-----------------------|---|
| | 1 | 0.235714 | 10.9749 | 0.1908 | 1907514.105 | 164623.52 | 13.24 | 1.244E-03 |
| | 2 | 0.231004 | 10.7556 | 0.1877 | 1876549.112 | 161333.84 | 13.25 | 1.218E-03 |
| | 3 | 0.226282 | 10.5357 | 0.1845 | 1845266.497 | 158035.78 | 13.26 | 1.192E-03 |
| | 4 | 0.221542 | 10.3151 | 0.1814 | 1813628.653 | 154725.90 | 13.26 | 1.167E-03 |
| | 5 | 0.216782 | 10.0934 | 0.1782 | 1781599.644 | 151401.06 | 13.27 | 1.141E-03 |
| | 6 | 0.211996 | 9.8706 | 0.1749 | 1749146.632 | 148058.53 | 13.28 | 1.115E-03 |
| | 7 | 0.207181 | 9.6464 | 0.1716 | 1716241.194 | 144696.15 | 13.29 | 1.09E-03 |
| | 8 | 0.202336 | 9.4208 | 0.1683 | 1682860.463 | 141312.38 | 13.30 | 1.06E-03 |
| | 9 | 0.19746 | 9.1938 | 0.1649 | 1648988.055 | 137906.42 | 13.31 | 1.04E-03 |
| | 10 | 0.19746 | 9.1938 | 0.1649 | 1648988.055 | 137906.42 | 13.31 | 1.04E-03 |
| | bott om | | | | | $\Sigma = 1500000$ | | |

