

Annex B. Approximation Equations for Cement Pastes Modified by Multi-Walled Carbon Nanotubes Suspension with and without Plasticizing Admixture according to Herschel-Bulkley Rheological Model

Table B.1. Approximation equations for nanomodified cement pastes

MWCNT suspension	5min	60min	120min
REF	$\tau = 3.6 + 4.00\dot{\gamma}^{0.935}$	$\tau = 3.8 + 4.21\dot{\gamma}^{0.955}$	$\tau = 3.9 + 4.25\dot{\gamma}^{0.965}$
0.00375	$\tau = 3.5 + 4.05\dot{\gamma}^{0.940}$	$\tau = 3.6 + 4.19\dot{\gamma}^{0.943}$	$\tau = 3.8 + 4.20\dot{\gamma}^{0.935}$
0.0075	$\tau = 3.7 + 4.15\dot{\gamma}^{0.970}$	$\tau = 4.0 + 4.22\dot{\gamma}^{0.972}$	$\tau = 4.2 + 4.24\dot{\gamma}^{0.963}$
0.015	$\tau = 3.6 + 4.18\dot{\gamma}^{0.965}$	$\tau = 3.9 + 4.20\dot{\gamma}^{0.970}$	$\tau = 4.0 + 4.25\dot{\gamma}^{0.968}$
0.030	$\tau = 3.8 + 4.11\dot{\gamma}^{0.935}$	$\tau = 3.9 + 4.15\dot{\gamma}^{0.900}$	$\tau = 4.3 + 4.00\dot{\gamma}^{0.840}$
0.060	$\tau = 3.9 + 4.23\dot{\gamma}^{0.980}$	$\tau = 4.2 + 4.24\dot{\gamma}^{0.955}$	$\tau = 4.4 + 4.42\dot{\gamma}^{0.980}$
0.120	$\tau = 3.6 + 4.13\dot{\gamma}^{0.975}$	$\tau = 4.1 + 4.21\dot{\gamma}^{0.910}$	$\tau = 4.4 + 4.50\dot{\gamma}^{0.975}$
0.240	$\tau = 4.1 + 4.17\dot{\gamma}^{0.981}$	$\tau = 4.3 + 4.30\dot{\gamma}^{0.997}$	$\tau = 4.5 + 4.55\dot{\gamma}^{0.985}$
CMC 0.29% bwoc	$\tau = 3.2 + 2.65\dot{\gamma}^{0.985}$	$\tau = 4.0 + 4.10\dot{\gamma}^{0.947}$	$\tau = 4.2 + 4.12\dot{\gamma}^{0.940}$

Table B.2. Approximation equations for nanomodified cement pastes with LS

MWCNT suspension + LS	5min	60min	120min
LS	$\tau = 11.3 + 13.50\dot{\gamma}^{0.700}$	$\tau = 11.3 + 15.10\dot{\gamma}^{0.705}$	$\tau = 11.5 + 16.30\dot{\gamma}^{0.720}$
LS+0.00375	$\tau = 11.0 + 13.20\dot{\gamma}^{0.635}$	$\tau = 11.4 + 15.05\dot{\gamma}^{0.695}$	$\tau = 11.5 + 16.25\dot{\gamma}^{0.700}$
LS+0.0075	$\tau = 11.1 + 13.15\dot{\gamma}^{0.630}$	$\tau = 11.3 + 15.08\dot{\gamma}^{0.695}$	$\tau = 11.6 + 16.38\dot{\gamma}^{0.740}$
LS+0.015	$\tau = 11.0 + 13.17\dot{\gamma}^{0.635}$	$\tau = 11.3 + 15.20\dot{\gamma}^{0.700}$	$\tau = 11.5 + 16.30\dot{\gamma}^{0.715}$
LS+0.030	$\tau = 11.2 + 13.60\dot{\gamma}^{0.660}$	$\tau = 12.4 + 16.35\dot{\gamma}^{0.757}$	$\tau = 12.7 + 16.45\dot{\gamma}^{0.745}$
LS+0.060	$\tau = 11.0 + 13.25\dot{\gamma}^{0.641}$	$\tau = 11.2 + 15.07\dot{\gamma}^{0.698}$	$\tau = 11.2 + 16.20\dot{\gamma}^{0.650}$
LS+0.120	$\tau = 11.1 + 13.10\dot{\gamma}^{0.670}$	$\tau = 11.4 + 15.17\dot{\gamma}^{0.730}$	$\tau = 11.7 + 16.40\dot{\gamma}^{0.720}$
LS+0.240	$\tau = 12.5 + 14.65\dot{\gamma}^{0.780}$	$\tau = 12.6 + 16.10\dot{\gamma}^{0.760}$	$\tau = 13.0 + 16.90\dot{\gamma}^{0.780}$

Table B.3. Approximation equations for nanomodified cement pastes with NF

MWCNT suspension + NF	5min	60min	120min
NF	$\tau = 5.2 + 6.00\dot{\gamma}^{0.825}$	$\tau = 5.4 + 6.40\dot{\gamma}^{0.890}$	$\tau = 5.6 + 6.50\dot{\gamma}^{0.830}$
NF+0.00375	$\tau = 4.4 + 5.50\dot{\gamma}^{0.700}$	$\tau = 5.0 + 5.60\dot{\gamma}^{0.790}$	$\tau = 5.0 + 5.90\dot{\gamma}^{0.790}$
NF+0.0075	$\tau = 4.7 + 5.70\dot{\gamma}^{0.720}$	$\tau = 5.6 + 5.80\dot{\gamma}^{0.820}$	$\tau = 5.7 + 6.10\dot{\gamma}^{0.820}$
NF+0.015	$\tau = 4.6 + 5.60\dot{\gamma}^{0.715}$	$\tau = 5.2 + 5.50\dot{\gamma}^{0.780}$	$\tau = 5.6 + 5.90\dot{\gamma}^{0.780}$
NF+0.030	$\tau = 5.1 + 6.10\dot{\gamma}^{0.765}$	$\tau = 5.4 + 5.45\dot{\gamma}^{0.795}$	$\tau = 5.8 + 5.70\dot{\gamma}^{0.860}$
NF+0.060	$\tau = 4.7 + 5.20\dot{\gamma}^{0.725}$	$\tau = 5.4 + 5.50\dot{\gamma}^{0.780}$	$\tau = 5.8 + 6.40\dot{\gamma}^{0.797}$
NF+0.120	$\tau = 4.7 + 5.30\dot{\gamma}^{0.760}$	$\tau = 5.0 + 5.30\dot{\gamma}^{0.770}$	$\tau = 5.1 + 5.90\dot{\gamma}^{0.785}$
NF+0.240	$\tau = 5.1 + 6.10\dot{\gamma}^{0.810}$	$\tau = 5.8 + 6.45\dot{\gamma}^{0.835}$	$\tau = 6.1 + 6.65\dot{\gamma}^{0.835}$

Table B.4. Approximation equations for nanomodified cement pastes with PCE

MWCNT suspension + PCE	5min	60min	120min
PCE	$\tau = 0.4 + 0.6\dot{\gamma}^{1.197}$	$\tau = 0.4 + 0.61\dot{\gamma}^{1.230}$	$\tau = 0.4 + 0.58\dot{\gamma}^{1.190}$
PCE+0.00375	$\tau = 0.4 + 0.66\dot{\gamma}^{1.200}$	$\tau = 0.4 + 0.60\dot{\gamma}^{1.210}$	$\tau = 0.4 + 0.58\dot{\gamma}^{1.190}$
PCE+0.0075	$\tau = 0.4 + 0.68\dot{\gamma}^{1.220}$	$\tau = 0.4 + 0.63\dot{\gamma}^{1.250}$	$\tau = 0.4 + 0.66\dot{\gamma}^{1.200}$
PCE+0.015	$\tau = 0.4 + 0.65\dot{\gamma}^{1.210}$	$\tau = 0.4 + 0.61\dot{\gamma}^{1.240}$	$\tau = 0.4 + 0.60\dot{\gamma}^{1.190}$
PCE+0.030	$\tau = 0.4 + 0.90\dot{\gamma}^{1.200}$	$\tau = 0.4 + 0.93\dot{\gamma}^{1.215}$	$\tau = 0.4 + 0.88\dot{\gamma}^{1.180}$
PCE+0.060	$\tau = 0.5 + 1.23\dot{\gamma}^{1.175}$	$\tau = 0.5 + 1.24\dot{\gamma}^{1.175}$	$\tau = 0.5 + 1.13\dot{\gamma}^{1.175}$
PCE+0.120	$\tau = 1.4 + 1.26\dot{\gamma}^{1.175}$	$\tau = 1.4 + 1.26\dot{\gamma}^{1.170}$	$\tau = 1.2 + 1.16\dot{\gamma}^{1.170}$
PCE+0.240	n/d	n/d	n/d