Supplementary Material: Choice of Micromechanical Parameters

*Calibration of Young’s Modulus (E)*: The bulk Young’s Modulus increases with the Young’s Modulus of Particles (*Ep*), which is controlled using input elastic parameters of particles, *Gp* and *νp*, through Eq. 5. We derive a Young’s Modulus of 4.28x109 Pa for Berea Sandstone [Fig. SF1] is attained by using values of 2.90x1010 Pa and 0.33 for *Gp* and *νp* respectively [Table 1]. Similarly, we derive a Young’s Modulus of 42.07x109 Pa [Fig. SF1] for Lac du Bonnet Granite is attained by using values of 2.00x1012 Pa and 0.26 for *Gp* and *νp* respectively [Table 1].

*Calibration of Unconfined Compressive Strength (UCS)*: *Tb* and *Cb* describe the energy required to break assigned bonds in tensile and shear mechanisms respectively. Scholtès and Donzé, 2013 prescribe that assigned values of *Tb* and *Cb* must have a ratio equal to bulk *UCS*/*TS*, where *TS* is the tensile strength of the rock, to ensure that micromechanical processes are reflective of the bulk geomechanical behavior of the rock. In this study, we maintain a *Tb*/*Cb* ratios of 10 for Berea Sandstone [Bobich, 2005], and 20 for Lac du Bonnet Granite [Martin and Chandler, 1994]. *UCS* shows a direct correlation with *Tb* and *Cb* which are adjusted to match experimental values, while obeying the guidelines of Scholtès and Donzé, 2013. We attain a UCS of 85.05x106 Pa for Berea Sandstone [Fig. SF1] by employing values of 9.00x106 Pa and 9.00x107 Pa for *Tb* and *Cb* respectively [Table 1]. Similarly, we attain a UCS of Pa for Lac du Bonnet Granite [Fig. SF1] by employing values of 6x108 Pa and 1.2x1010 Pa for *Tb* and *Cb­­* respectively [Table 1].

*Calibration of Mohr-Coulomb Cohesion (C) and slope (µ)*: After attaining the desired values of bulk Young’s Modulus and UCS through unconfined tests, confined compression tests are conducted to attain the desired Mohr-Coulomb behavior (*C* and *µ*) by varying interparticle friction (*µp*). Interparticle friction shows a direct correlation with slope of the Mohr-Coulomb envelope and is adjusted to attain the bulk compressive behavior of Berea Sandstone and Lac du Bonnet Granite. We employ values of 0.3 and 0.7 for Berea Sandstone and Lac du Bonnet Granite respectively [Table 1] to attain desired Mohr-Coulomb behavior, described by the following equations [Fig. SF2]:

(Eq. 16)

(Eq. 17)

where *τ* is the shear stress (MPa) and *σn* is the normal stress (MPa) on the sample. Thus, through retroactive adjustment of micromechanical parameters we calibrate the bulk properties of simulated samples of Berea Sandstone and Lac du Bonnet Granite to match experimentally derived geomechanical properties [Table 2].