Discussion of 017405JOR by L. Mohan *et al.*

Question: Yogesh Joshi: In your simulations, if a particle is subjected to a constant force, which is below that is necessary for that associated with yield stress, over a prolonged period of time, does the particle diffuse out of cage leading to creep (or delayed yielding)?

Author Response: Michel Cloitre: For an applied force below the critical value for steady-state motion of the particle, the forced particle remains in the cage for times as long as 3×10^7 time units (the time unit is $\tau_0 = E^*/\eta_s$). At this time, the particles are observed to no longer move and appear trapped in the cage (see Fig. 3(a) of the paper). For forces above the critical value, steady-state averaged motion is established at about 10^4 time units, that is three orders of magnitude faster. We thus consider that delayed yielding is not observed in our simulations.

Several mechanisms might contribute to the occurrence of delayed yielding, including Brownian motion, particle motion induced diffusivity, built-up of internal stress, and attractive interactions. In the simulations, Brownian motion is neglected because it is so weak compared to the elastic forces [Seth *et al.* (2011)]. With Brownian motion, it is possible that given enough time, well beyond the simulation times here, a particle forced below the critical value could move out of the cage when one or more caged particles move due to thermal motion, this then followed by another long period of no motion of the forced particle. The length of time between such possible hops due to thermal cage rearrangements probably increases dramatically the smaller the applied force, which is below the critical force. Effective diffusivity due to collective interactions between interlocked particles has been observed in the bulk motion of soft spheres [Mohan *et al.* (2013)]. It is unlikely that it plays a role here because the disturbance induced by the displacement of the probe particle is short-ranged as demonstrated in Fig. 10 of the manuscript. Finally, it is worth noting that delayed yielding is common in soft materials in the presence of attractive interactions. For instance, delayed yielding in colloidal gels has been attributed to the association/dissociation dynamics of interparticle bonds [Sprakel *et al.* (2011)]. This source of delayed yielding is absent from our simulation where the particles interact through purely repulsive forces.

References

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