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Steady and Unsteady Size-Dependent Couple Stress Creeping Flow GARY DARGUSH, ALI HADJESFANDIARI, AREZOO HAJESFANDIARI, HAOYU ZHANG, University at Buffalo, State University of New York — As an inevitable consequence of non-central forces acting at the atomic level, couple-stresses appear within the framework of continuum mechanics, and force-stress must be considered as a general non-symmetric tensor. Based upon recent theoretical work, the couple-stress tensor is shown to be skew-symmetric, as is its energy conjugate mean curvature rate tensor. Within this fully consistent couple stress continuum theory applied to fluid flow, there appears a material length scale l that becomes increasingly important as the characteristic geometric dimension of the problem reduces. In the present work, we study the effects of this theory for creeping incompressible flows by developing fundamental point force and point couple solutions, along with boundary integral representations for both the steady and unsteady cases. In addition, we develop the corresponding boundary element methods and solve several problems that highlight the size-dependent nature of these flows, which may be most relevant to a range of micro- and nano-scale technologies.

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