# A global-local approach for phase field fracture modeling of shell structures: Application to static and fatigue loading conditions with efficient quasi-Newton solution

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**Abstract** To accurately predict the crack initiation and propagation in thin-walled structures, a reliable global-local approach for phase field modeling of solid shells considering the enhanced assumed strain (EAS) method and assumed natural strain (ANS) method for the alleviation of locking effects is proposed for the first time in this study. Aiming at tackling the poor convergence performance of standard Newton monolithic scheme, a quasi-Newton algorithm is adopted to solve the coupled phase field-displacement governing equations incorporating solid shell formulation in a monolithic manner. The excellent convergence performance of this quasi-Newton monolithic scheme for the solution of multi-field solid shell formulation is demonstrated through several paradigmatic boundary value examples, including single edge notched tension, fracture of cylindrical structure and fatigue induced crack propagation. Besides, compared with the popular alternating minimization (AM) or staggered solution scheme, it is also found that the quasi-Newton monolithic scheme to solve the highly nonlinear coupled equations in this framework is very computationally efficient, being at least 5 times faster than AM scheme to achieve the same accuracy in all the cases. In addition, a global-local approach for phase field fracture modeling in large-scale thin-walled structures is investigated in this work, and its effectiveness is verified by the modeling of a quarter of cylindrical plate subjected to both static and fatigue cyclic loading conditions, which can be appealing to industrial applications.