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Shape Sensitivity Analysis for Fixed-Grid Analysis Based on Oblique Boundary Curve Approximation

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Fixed-grid analyses equipped with a fictitious domain method can avoid remeshing for shape optimization, but stresses on domain boundaries cannot be calculated accurately if the boundaries are improperly represented. For improved stress evaluation, we consider the direct boundary curve approximation by piecewise oblique lines which can cross boundary elements. In this approach, the intersection points between the fixed girds and the approximated boundary do not necessarily coincide with the analysis nodes unlike in existing fixed-grid analyses. The objective of this investigation is to derive the analytic shape sensitivity of stresses for the direct piecewise oblique boundary approximation. Since the force term in the sensitivity equation is associated only with the elements crossed by the design boundary curve, only the design velocities of the intersection points between the curve and the fixed mesh are needed for sensitivity analysis.

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