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Magnetostatic XFEM analysis for internal discontinuity under uniform flux based on Joukowski transform

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ABSTRACT

In this presentation, we present a methodology of XFEM to analyze 2D Laplace problems which have a discontinuous line segment in the domain. The practical application which we aim at is the magnetostatic field analysis of ferromagnetic material structures which have inner defects. It is generally difficult to obtain the analytical solution of Laplace equation which has discontinuous line segments. For this reason, it is also difficult to find the appropriate enrichment function for line segments. Therefore we use what is called Joukowski transform to obtain the appropriate enrichment function. This transform is a kind of conformal mapping and it transforms circles on a complex plane to ellipses on the other complex plane. As the special case, ellipse reduces to a line segment. A 2D steady flow around a line segment (which has two corners) is, therefore, transformed to that around a cylinder as shown in Fig.1, and the latter has the theoretical complex potential. Thus, we use the real part of that complex potential to represent the inner defects using the partition of unity condition [1]. The result of the numerical example shown in Fig.2 is considered to be evaluated appropriately.

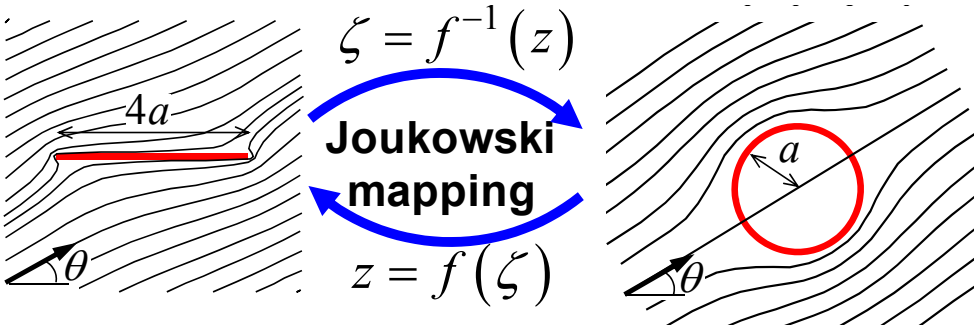

Figure 1: Transform of potential flow using Joukowski transform.

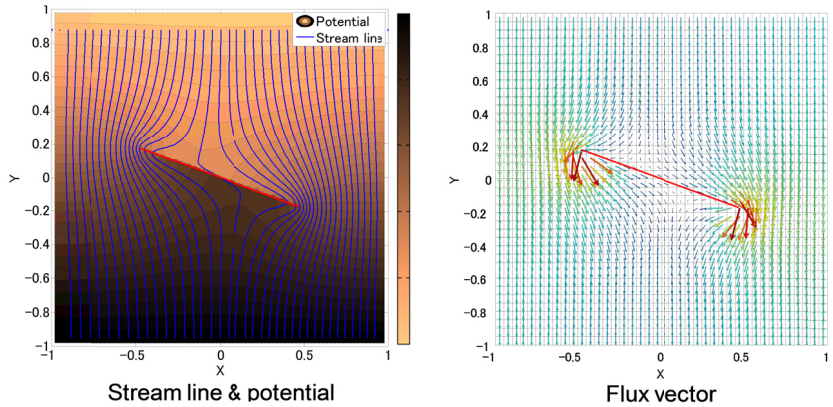

Figure 2: Distribution of stream line, potential, and flux vector around an inclined defect.

[1] J. Melenk and I. Babuska, The partition of unity finite element method: Basic theory and applications, Comput. Methods Appl. Mech. Engng. Vol. 139, pp.289-314, 1996.