Effective elastic properties of media containing coalescing holes

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Keywords: Cylindrical pores; irregular cross-section; bipolar coordinates;

A recent study about the temperature and heat flux distributions around two nonconductive (separate or intersecting) circular holes in a plane system recently appeared in Literature [1]. These results have been used to construct the second-rank resistivity contribution tensor which allows assessing the effective thermal properties of a composite including circular inhomogeneities.

Here, that study is extended to assess the overall elastic properties of an isotropic elastic matrix with two separate circular cavities or a cavity obtained by the union of two circles of generally different diameters (Figure 1).

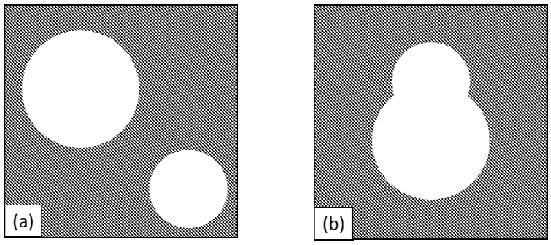

Figure 1. (a) two separate circular holes, (b) cross-section formed by two coalesced circular holes of generally different radii.

The problem is formulated in terms of stress functions expressed in Fourier series or Fourier transforms. Reference is made to bipolar cylindrical coordinates [2]. Once the displacement field $\boldsymbol{u}$ has been calculated, the extra strain $\Delta\varepsilon$ due to the inhomogeneity is assessed according to

$$\Delta\boldsymbol{\varepsilon} = \frac{1}{2V}\int_{\partial V}\left(\boldsymbol{un}+\boldsymbol{nu}\right)dS, \tag{1}$$

being $\boldsymbol{n}$ the normal vector and V the volume reference. Finally, the extra strain is used to assess the fourth-rank compliance contribution tensor varying the size of the circular arcs.

References

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