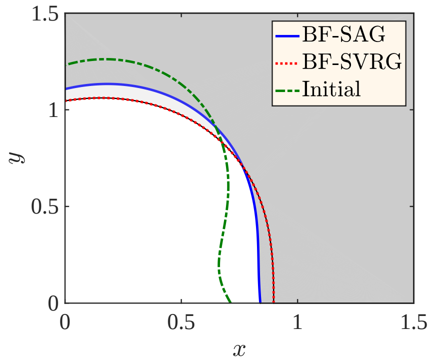

Figure 8: Optimized shape of the hole using the proposed bi-fidelity algorithms. Initial shape is shown using a dashed line. Note that, two-fold symmetry is assumed here.

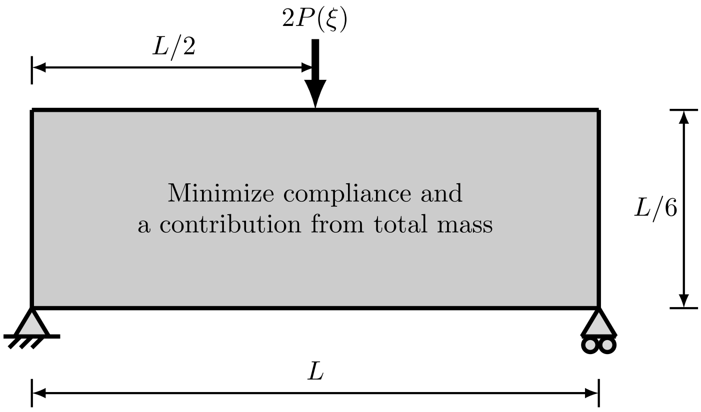

Figure 9: Schematic of the beam problem of Example III (a) (design domain is shown as the shaded region).

optimization problem, and use some parts of the widely-used 99 line topology optimization code in [92]. In SIMP, the material properties are interpolated by a power-law model in terms of the density ρ of a fictitious porous material, *e.g.*,

$$E(\rho_i) = \rho_i^{\beta_{\mathrm{P}}} E_0; \qquad 0 < \rho_i \leq 1; \qquad i = 1, 2, \ldots, N_e, \tag{35}$$

where β_{P} is a penalization parameter and E_0 is the bulk material's elastic modulus. For the formulation of the optimization problem considered here and $\beta_{\mathrm{P}} > 1$, intermediate densities are penalized as compared to densities closer to zero or one. We use $\beta_{\mathrm{P}} = 3$ in the present work. To avoid a checker-board design, we use filtered values of the design variables $\boldsymbol{\theta}$ to define the material density $\boldsymbol{\rho}$ [94–97]. This density filter is applied to the eth element as follows

$$\rho_e = \frac{1}{\sum_{i=1}^{N_e} H_i} \sum_{i=1}^{N_e} H_i \theta_i, \tag{36}$$