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New Classes of Analytically Derived Optimal Topologies and Their Numerical Confirmation

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Numerical FE-based derivation of optimal topologies can give grossly incorrect solutions for several reasons, particularly in the case of new classes of problems. Examples are checkerboard patterns, diagonal element chains and hinges in perforated plates with in-plane stresses and non-global optima due to singular topologies. For the above reasons, analytically derived optimal topologies for new classes of problems are of paramount importance for the conclusive verification of numerical methods in topology optimization. They are also useful in understanding the basic nature of optimal topologies. Unfortunately, the number of researchers understanding the theory of exact optimal topologies is becoming very small. The paper will discuss several new classes of optimal topologies, for problems with (a) new types of support conditions, (b) different permissible stresses in tension and compression, (c) variable external forces of nonzero cost, (d) several active displacement constraints, and (e) combination of external forces and selfweight. These exact, analytical solutions for optimal topologies will be verified by numerical, FE-based solutions using the SIMP method with checkerboard control.

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