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RELIABILITY-BASED DESIGN OPTIMISATION METHODS IN LARGE-SCALE SYSTEMS

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Structural optimisation is an important field of applied mathematics, which has proved useful in engineering projects. Reliability-based design optimisation (RBDO) can be considered a branch of structural optimisation. Different RBDO approaches have been applied in real-world problems (for example, vehicle side impact models, short-column design and so on).

Double-loop, single-loop and decoupled approaches are three categories in RBDO. This research focuses on double-loop approaches, which consider reliability analysis problems in their inner loops and design optimisation calculations in their outer loops. Double-loop approaches have been studied and modified in order to improve their stability and efficiency, but many shortcomings still remain, particularly regarding reliability analysis methods.

This thesis will concentrate on development of new reliability analysis methods that can be applied to solve RBDO problems. As a local optimisation algorithm, the conjugate gradient method will be adopted (see [4]). Furthermore, a new method will be introduced to solve a reliability analysis problem in the polar space (see [3]). The reliability analysis problem must be transformed into an unconstrained optimisation problem before solving in the polar space. Two methods will be introduced here and their stability and efficiency will be compared with the existing methods via numerical experiments. Further developments are presented in [5, 6].

Next, we consider applications of RBDO models to electricity networks (see [1, 2]). Most of the current optimisation models of these networks are categorised as deterministic design optimisation models. A probabilistic constraint is introduced in this thesis for electricity networks. For this purpose, a performance function must be defined for a network in order to define safety and failure conditions.

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Then, new nondeterministic design optimisation models will be formulated for electricity networks by using the mentioned probabilistic constraint. These models are designed to keep failure probability of the network below a predetermined and accepted safety level.

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