**Title:**  A novel probabilistic model for structural reliability analysis.

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**Introduction**

The robustness of iterative formula as well as its computational efficiency is the essential characteristic of interest for effective reliability analysis of structures. Generally, the analytical approaches including the first order reliability method (FORM) can be used to estimate the failure probability. The FORM is a viable alternative for reliability analysis and is widely used for good balance between accuracy and efficiency in realistic structural engineering problem. The Hasofer and Lind - Rackwitz and Fiessler (HL-RF) iterative algorithm is noted to be an efficient and simple method for solving structural reliability problems. However, for highly nonlinear limit state equations, the iterative HL-RF scheme may lead to unstable solutions i.e. periodic and chaotic solutions. To circumvent such difficulty, various modified algorithms are attempted in the literature e.g stability transformation method (STM), directional STM, chaotic conjugate STM, finite-step length (FSL), relaxed HL-RF (RHL-RF). In this investigation, a robust and efficient iterative algorithm termed as finite-based Armijo line search (FAL) method is explored in the present study for FORM-based structural reliability analysis. The sufficient descent condition is implemented to adjust the finite-step size to achieve the stabilization of the FORM algorithm.

**Methods**

In the FORM, the computation of reliability involves searching the most probable point (MPP i.e.). The reliability index is the target solution of a constraint nonlinear optimization problem in FORM using MPP:

 (1)

Where,  are the standard normal random variables obtained by transforming the basic random variables from the original space (X-space) into the standard normal space (U-space) as  i.e. . The appropriate search direction can ensure stable convergence of an iterative reliability method. The degree of concavity of a performance function is important factor in the speed of convergence of the FORM formula.

**Results**

A simple iterative FORM algorithm based on steepest descent search direction and finite-step size using the Armijo rule and an adaptive factor based on the nonlinearity of performance function is proposed in the present study. The robustness and efficiency of the proposed finite-based Armijo search direction (FAL) method is compared with several existing reliability methods based on the steepest descent search direction including HL-RF, chaos control (CC), finite-step length (FSL), relaxed HL-RF (RHL-RF), improved HL-RF, (IHL-RF), and improved HL-RF-with Armijo rule (IHL-RF-A) through six numerical examples involving nonlinear structural LSFs. The results of six examples revealed that the IHL-RF and RHL-RF is more robust than the CC and HL-RF methods but yields unstable result for some performance functions and computational burden is also more inefficient. The FSL method is found to be more robust than the HL-RF, CC, IHL-RF and RHL-RF. However, the FSL inefficiently converged for some nonlinear problems in comparison with proposed FAL method. The convergence of the FAL method is noted to be more robust and efficient than other reliability methods. In general, the FAL is as robust as the FSL but is much more efficient for both moderately and highly nonlinear performance functions. Therefore, this approach-based adaptive finite-step size will be useful for reliability analysis of real engineering problems.