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**Two basic problems in reliability-based structural optimization.** (English) Zbl 0896.90106  
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Summary: Optimization of structures with respect to performance, weight or cost is a well-known application of mathematical optimization theory. However optimization of structures with respect to weight or cost under probabilistic reliability constraints or optimization with respect to reliability under cost/weight constraints has been subject of only very few studies. The difficulty in using probabilistic constraints or reliability targets lies in the fact that modern reliability methods themselves are formulated as a problem of optimization. In this paper, two special formulations based on the so-called first-order reliability method (FORM) are presented. It is demonstrated that both problems can be solved by a one-level optimization problem, at least for problems in which structural failure is characterized by a single failure criterion. Three examples demonstrate the algorithm indicating that the proposed formulations are comparable in numerical effort with an approach based on semi-infinite programming but are definitely superior to a two-level formulation.

**MSC:**

[90B25](#) Reliability, availability, maintenance, inspection in operations research Cited in 9 Documents  
[74P99](#) Optimization problems in solid mechanics  
[90C90](#) Applications of mathematical programming

**Keywords:**

[reliability-oriented optimization](#); [probabilistic reliability constraints](#); [one-level optimization](#); [structural failure](#); [semi-infinite programming](#)

**Software:**

[NLPQL](#)

**Full Text:** [DOI](#)

**References:**

- [1] Abdo T (1990) Zur Zuverlässigkeitsberechnung von statisch beanspruchten Tragwerken mit unsicheren Systemeigenschaften. Berichte zur Zuverlässigkeitstheorie der Bauwerke, Technische Universität München, H. 86
- [2] Abdo T, Rackwitz R (1991) A new  $\beta$ -Point algorithm for large time-invariant and time-variant reliability problems. In: Der Kiureghian A, Thoft-Christensen P (eds.) Reliability and optimization of structural systems, Proceedings of the 3rd IFIP WG 7.5 Conference Berkeley '90, Springer, Berlin/Heidelberg/New York, pp. 1-12 · [Zbl 0783.90040](#)
- [3] Breitung K (1984) Asymptotic approximations for multinormal integrals. *Journal of the Engineering Mechanics Div.* 110(3):357-366 · [Zbl 0571.73100](#) · [doi:10.1061/\(ASCE\)0733-9399\(1984\)110:3\(357\)](#)
- [4] Der Kiureghian A, Kirjner-Neto C, Polak E (1995) Algorithms for reliability-based optimal design. In: Rackwitz R, Augusti G, Borri A (eds.) Reliability and optimization of structural systems, Proceedings of the 6th IFIP WG 7.5 Conference Assisi '94, Chapman & Hall London, Glasgow, Weinheim, New York, Tokyo, Melbourne, Madras, pp. 144-152
- [5] Der Kiureghian A, Liu P-L (1986) Structural reliability under incomplete probability information. *Journal of Engineering Mechanics*, ASCE 112(1):85-104 · [doi:10.1061/\(ASCE\)0733-9399\(1986\)112:1\(85\)](#)
- [6] Enevoldsen I, Sørensen JD (1993) Reliabilitybased optimization in structural engineering. *Structural Reliability Theory Series*, Report No. 118 (August), University of Aalborg (Denmark)
- [7] Enevoldsen I, Sørensen JD (1994) Decomposition techniques and effective algorithms in reliability-based optimization. *Structural Reliability Theory Series*, Report No. 130 (April), University of Aalborg (Denmark)
- [8] Hasofer AM, Lind NC (1974) An exact and invariant first order reliability format. *Journal of the Engineering Mechanics Div.*, ASCE Vol. 100, No. EM1, pp. 111-121
- [9] Hohenbichler M (1984) Mathematische Grundlagen der Zuverlässigkeitsmethode erster Ordnung, und einige Erweiterungen. Dissertation, Technische Universität München
- [10] Hohenbichler M, Gollwitzer S, Kruse W, Rackwitz R (1987) New light on first- and second-order reliability methods. *Structural Safety* 4:267-284 · [doi:10.1016/0167-4730\(87\)90002-6](#)

- [11] Hohenbichler M, Rackwitz R (1981) Non-normal dependent vectors in structural safety. *Journal of the Engineering Mechanics Div., ASCE* 107(6):1227-1249
- [12] Madsen HO, Friis Hansen F (1992) A comparison of some algorithms for reliability-based structural optimization and sensitivity analysis. In: Rackwitz R, Thoft-Christensen P (eds.) *Proceedings of the 4th IFIP WG 7.5 Conference Munich*, Springer Verlag Berlin/Heidelberg/New York, pp. 443-451
- [13] Rackwitz R, Fiessler B (1978) Structural reliability under combined random load sequences. *Comp. & Struct.* 9:484-494 · [Zbl 0402.73071](#)
- [14] Winterstein SR, Bjerager P (1987) The use of higher moments in reliability estimation. *Proceedings of the 5th ICASP, International Conference on Applications of Statistics and Prob. in Soil and Struct., Vol. 2, Vancouver*, pp. 1027-1036
- [15] Pedersen C, Thoft-Christensen P (1994) Interactive structural optimization with quasi-Newton-Algorithms. *Structural Reliability Theory Series, Report No. 129 (November)*, University of Aalborg (Denmark)
- [16] Pedersen C, Thoft-Christensen P (1996) Guidelines for interactive reliability-based structural optimization using quasi-Newton-algorithms. *Structural Reliability Theory Series, Report No. 156 (April)*, University of Aalborg (Denmark)
- [17] Schittkowski K (1985) User's guide for nonlinear programming code. *Handbook to optimization program package NLPQL*, University of Stuttgart (Germany) ? Institute for informatics
- [18] SYSREL (1994) Software for system reliability analysis. RCP GmbH, München, Germany

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