

論文審査の要旨

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論 文 題 目 A Study on Opportunity-Based Age Replacement Models and Their Applications (機会ベースの年齢取替モデルとその応用に関する研究)			
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〔論文審査の要旨〕 This doctoral dissertation presents several opportunity-based age replacement models with applications. In reliability theory, replacement opportunities often refer to delivering of spare parts with lower cost, special service durations, or specific replacement time points. Hence, preventive maintenance can be performed flexibly and conveniently when the replacement opportunities arise. Chapter 1 briefly overviews the existing work on the preventive maintenance modeling. In Chapter 2, the applicant considers two classical age-based replacement models within a discrete-time framework: a standard age replacement (AR) model and an opportunistic age replacement (DD) model. More specifically, he introduces the concept of replacement priority in situations where both failure replacement and preventive replacement occur at a given age/opportunity arrival, and explores two priority cases in each replacement model. The optimal preventive replacement policies are obtained by minimizing the associated expected cost rates through the familiar renewal reward argument, and the results are extended by taking account of net present value (NPV) method. The applicant develops the expected total discounted costs over an infinite time horizon and obtains the optimal preventive replacement policies by minimizing them. Also, unified stochastic models are introduced by incorporating the probabilistic priority of replacement options. To provide practical insights, numerical illustrations are given using real failure data for pole air switches, comparing the performance of			

these optimal preventive policies.

Chapter 3 focuses on discrete time opportunity-based age replacement models with replacement first (RF) and replacement last (RL) disciplines, where the expected cost model under each discipline can be further classified into six cases by taking account of the priority of multiple replacement options. Several optimal opportunity-based age replacement policies are characterized by minimizing the relevant expected costs. The NPV method is also applied to formulate the expected total costs under RF and RL disciplines. Similar to Chapter 2, the unified six discrete time opportunity-based age replacement models are also derived with deterministic priority for each model. In numerical illustrations, all the optimal scheduled preventive replacement times with RF and RL disciplines are compared and quantified.

Chapter 4 concerns two different opportunity-based age replacement problems in continuous/discrete time. First, the opportunity-based age replacement models are formulated with RF and RL disciplines in continuous time, where a restricted duration is introduced for the opportunity arrivals which obey a homogeneous Poisson process. Next, these associated opportunity-based age replacement models in discrete time are considered, where the inter-arrival times of replacement opportunities obey an independent and identical geometric distribution. The optimal two-phase opportunity based age replacement policies are characterized by minimizing the long-run average costs. The results indicate that RL policies could be better than RF policies in a few limited cases where the impact of failure replacement is relatively small.

Chapter 5 generalizes the opportunity-based age replacement policies with the NPV of expected total costs, where two basic opportunity-based age replacement models with RF and RL disciplines are reformulated, under the assumption that the failure time and the arrival time of a replacement opportunity are statistically independent. Next, the applicant takes place the NPV analysis for the failure correlated opportunity-based age replacement models with RF and RL disciplines, obtains the expected total discounted costs over an infinite time horizon, and derives the optimal preventive replacement policies by minimizing them in both cases. Numerical examples with the Farlie-Gumbel-Morgenstern bivariate copula are presented to investigate the dependence of correlation between the failure time and the opportunistic replacement time on the age opportunity-based replacement policies.

Finally, Chapter 6 concludes the dissertation and give some remarks on the future studies.

以上、審査の結果、本論文の著者は博士（情報科学）の学位を授与される十分な資格があるものと認められる。

備考：要旨は、400字程度とし、試験の方法も記載すること。