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Optimal maintenance policy for a system subject to damage in a discrete time process

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Abstract

Consider a system operating over n discrete time periods (n=1, 2, …). Each operation period causes a random amount of damage to the system which accumulates over time periods. The system fails when the cumulative damage exceeds a failure level ζ and a corrective maintenance (CM) action is immediately taken. To prevent such a failure, a preventive maintenance (PM) may be performed. In an operation period without a CM or PM, a regular maintenance (RM) is conducted at the end of that period to maintain the operation of the system. We propose a maintenance policy which prescribes a PM when the accumulated damage exceeds a pre-specified level δ ($<\zeta$), or when the number of operation periods reaches N, whichever comes first. With the long-term average cost rate as an optimality criterion, we optimize the maintenance policy parameters δ and N and discuss some useful properties about them. It has been shown that a δ-based PM outperforms a N-based PM in terms of cost minimization. Numerical examples are presented to demonstrate the optimization of this class of maintenance policies.

Keywords

Maintenance; Cumulative damage; Expected cost rate; Operation period; Renewal reward theory

Figures and tables from this article:

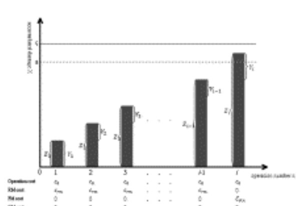

Fig. 1. PM due to damage level δ at i th (i=1, 2, …, N) operation.

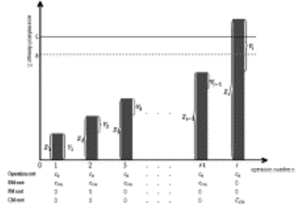

Fig. 2. CM due to damage level ζ at i th (i=1, 2,…, N) operation.

Figure options

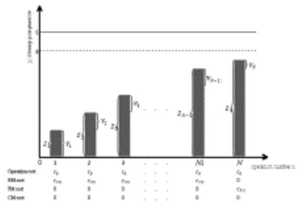

Fig. 3. PM due to the completion of N th operation without exceeding damage level δ.

Figure options

Table 1-1. N and $CR(\delta,N)$ for a given δ=20 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 1-2. N and $CR(\delta,N)$ for a given δ=18 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 1-3. N and $CR(\delta,N)$ for a given δ=16 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 1-4. N and $CR(\delta,N)$ for a given δ=14 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 2-1. δ and $CR(\delta,N)$ for a given $N=\infty$ and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-2. δ and $CR(\delta,N)$ for a given N=15 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 2-3. δ and $CR(\delta,N)$ for a given N=10 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

View Within Article

Table 2-4. δ and $CR(\delta,N)$ for a given N=8 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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Table 2-5. δ and $CR(\delta, N)$ for a given N=5 and under ζ=20, C_{PM}=10, and c_{rm}=c_0=1.

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