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RELIABILITY AND MAINTAINABILITY OF ELECTRIC CABLE MACHINERY

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ABSTRACT: The paper aims to determine the reliability and maintainability of a machine for making electric cable. The results allow assessment of technical availability and determination of actions to increase working time. The study is conducted to a Komax machine, which were analyzed proper functioning times respectively stationary due to malfunction. Good time functioning and restore values were processed with Weibull ++9 software. Processing experimental data with Weibull ++9 software provides the most appropriate distribution laws for characterization of functional safety and maintainability. Once established distribution laws of reliability and maintainability parameters can be determined others (failure rate, the rate of restoration etc.) showing the current state of "health" machine and ways to increase the duration of operation. Implementation of measures to increase the length of the smooth functioning is through a proper collaboration between operating specialists and maintenance sector.
Keywords: reliability, maintainability, electric cable

1. INTRODUCTION

The correct operation of the cars is the result of correctness output of the execution and the fitting ensembles, building blocks and the marks components. Electrical components are connected by cables manufactured by special machinery. The paper studied a Komax machine.

The paper examines a specific case, but the procedure can be generalized to all electromechanical entities. It is important to know for each industrial entity the cycle of preventive interventions. This cycle is disrupted by random failures occurring during operation; so the real reliability is different from the expected one. Therefore, it is good to know how failures influence the reliability and maintainability entities. This can only be done by observing the behavior of operational entities, registration better functioning and recovery times and processing them with a mathematical apparatus provided by statistical and probability theory.

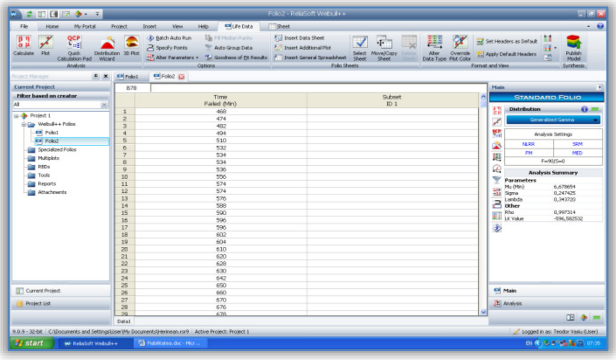

Figure 1. Good times running

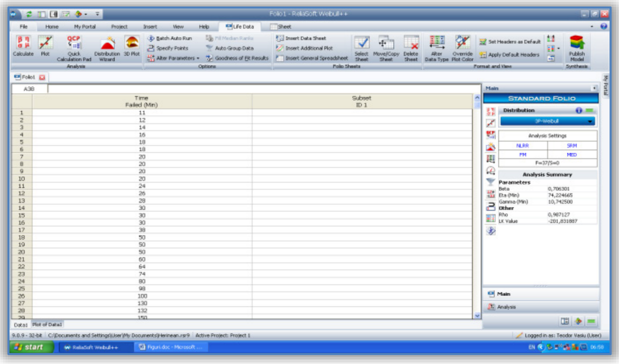

Figure 2. Maintenance times

2. REGISTRATION AND PROCESSING OF EXPERIMENTAL DATA

Proper use of Komax machinery implies their understanding and mastering of damage. This requires tracking operation such as machine during long and good operating records for the residence and due to defects. The prosecution case was done daily for three months. Good times running determines the reliability and stoppage times the maintainability. Experimental data processing was done with the software Weibul++9. Good times running placed in the program are given in Figure 1 and the maintenance in Figure 2.

The software is enabling a choice that provides optimal distribution law for each case, ie mathematical law with maximum correlation coefficient between experimental and theoretical data. For reliability, good times running abiding G-gamma (Figure 3) with a correlation coefficient Rho = 0.997314.

The reliability function for the generalized gamma distribution is given by:

$$R(t)=\begin{cases}1-\Gamma_I\left(\frac{e^{\lambda\left(\frac{\ln(t)-\mu}{\sigma}\right)}}{\lambda^2};\frac{1}{\lambda^2}\right) & \text{if } \lambda>0\\ 1-\Phi\left(\frac{\ln(t)-\mu}{\sigma}\right) & \text{if } \lambda=0\\ \Gamma_I\left(\frac{e^{\lambda\left(\frac{\ln(t)-\mu}{\sigma}\right)}}{\lambda^2};\frac{1}{\lambda^2}\right) & \text{if } \lambda<0\end{cases} \quad (1)$$

$$\Phi(z)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{z}e^{-\frac{x^2}{2}}dx$$

and $\Gamma_I(k;x)$ is the incomplete gamma function of k and x , which is given by:

$$\Gamma_I(k;x)=\frac{1}{\Gamma(k)}\int_0^x s^{k-1}e^{-s}ds \quad (2)$$

The parameters of this law are: μ = 6.678654; σ = 0.247425; λ = 0.34372.

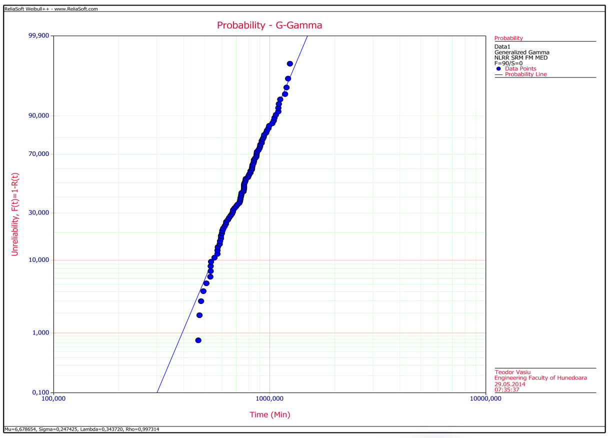

Figure 3. Probabilistic chart G – gamma

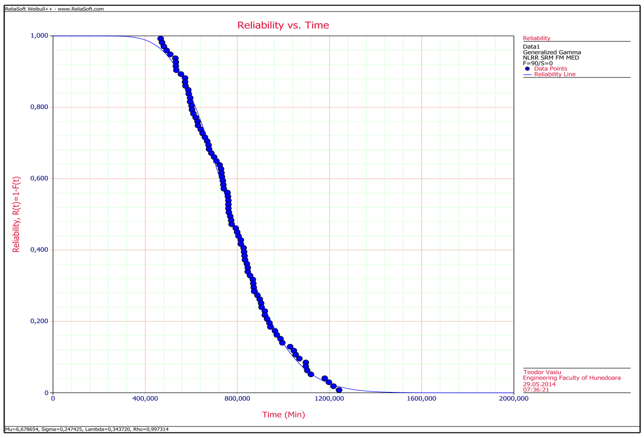

Figure 4. Reliability with respect to time

From Figure 4 it appears that reliability remains at high (close to 1 or 100 %) to about 400 minutes, ie this time the likelihood of falling machine is extremely low, which is seen from Figure 5 were failure rate is zero within this range of 400 minutes.

In terms of maintainability, literature considers that the law of distribution that best characterizes the times of restitution is the log- normal. In case the experimental data (Figure 2) shows that the law of distribution of maintenance time is Weibull three parameters (Figure 6), namely: β = 0.706301; η = 74.224665 and γ = 10.7425 with a correlation coefficient Rho = 0.987127.

The maintainability function M(τ) for the Weibull distribution is given by:

$$M(\tau)=1-e^{-\left(\frac{\tau-\gamma}{\eta}\right)^{\beta}} \quad (3)$$

The subunit value of β shows that intervenes to restore fallen machine is fast - there are known potential faults and logistic preparation to deal them - within 10 minutes (γ = 10.7425. So, maintainability kept zero within 10 minutes, then increases sharply (Figure 7), which confirms previous statement for rapid intervention.

Although maintainability is rapidly evolving, there is a possibility of postponing them for various reasons to be somewhat restoring mission failed because the rate of repair (Figure 8) is highest in the first ten minutes, then falling sharply.

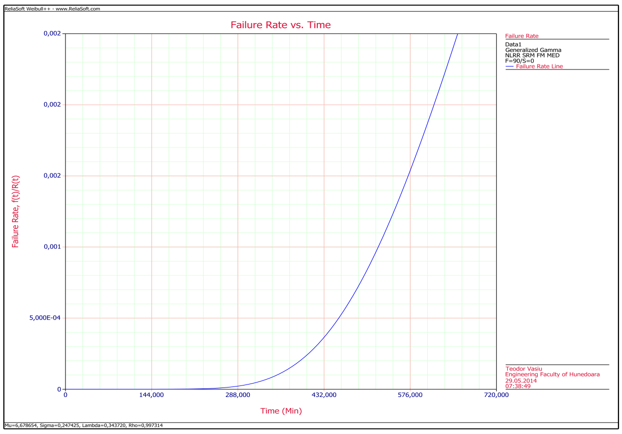

Figure 5. The failure rate against time

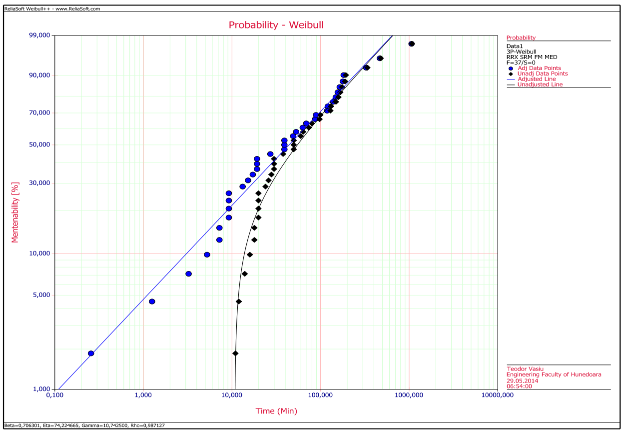

Figure 6. Alain Plait diagram for maintenance

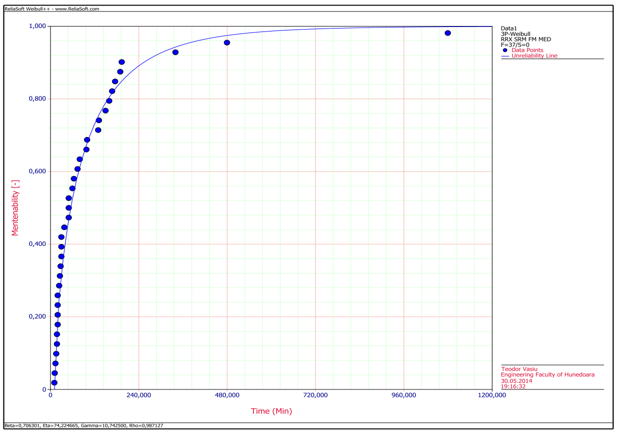

Figure 7. Maintainability versus time

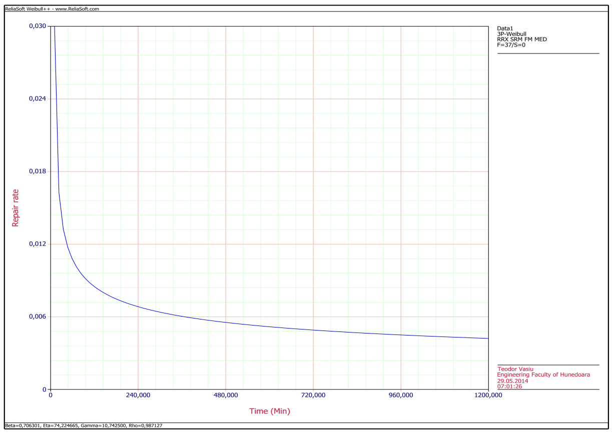

Figure 8. The rate of repair function of time

3. CONCLUSIONS

The technical availability of studied Komax machine can be achieved in three ways: ensuring high reliability, an increased maintainability or both conditions simultaneously. High reliability can be provided with fitted parts and spare parts whose quality is at a high level. It should not neglect the training of workers of machine. These solutions are necessary because the current reliability is maintained at maximum (figure 4) only about 400 minutes, i.e. more than one work shift. Otherwise there is a risk that the machine to be stopped three times a day for repairs. The rapid growth of maintainability (figure 7) shows that maintenance staff is well trained and there are necessary spare parts. Importantly is that spare parts must have material quality and manufacturing standards required accuracies.

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