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SEISMOGRAPH: PROBABILITY &RELIABILITY W.R.T EARTHQUAKE

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ABSTRACT

Reliability of a system, machine or instrument is very essential to operate. A machine or an instrument is said to be reliable if it gives consistent result every time it is tested against the same values. The result it gives is valid or not is not a matter of question here. If an instrument gives consistently same result, the n we can say that it is reliable. Reliability of an instrument can be measure through many ways depending on the factors we are considering. These methods of measuring reliability are termed as Software Reliability Growth Model (SRGM). There are many SRGMs based on different techniques and criteria. In this paper a generous study is done on different terms used synonymously, their meanings, applications of seismograph, its basic model and try to find the reliability of its model to a certain extent.

KEYWORDS

Reliability, SRGM, Seismograph, Seismogram, Seismometer

INTRODUCTION

Seismograph is an instrument that detects, amplifies and records earthquakes as well asthe motion of the ground. It works on the simple principle of inertia of stationary objects Seismograph and its working can better be understood after getting through some of the important terms on which it works. These are

⇒ **Richterscale:-** It is a standard scale used to compare earthquakes. It is a **logarithmic scale**, meaning that the numbers on the scale measure factors of 10.
⇒ **Magnitude**: the size of the earthquake.
⇒ **Depth**: how deep the earthquake was.
⇒ **Location**: where the earthquake occurred.

Some of the terms in this area have been used synonymously with each other , but if we look through these in details , they differ in some way or the other. These are ***Seismometers***, ***Seismographs*** and ***Seismograms.***

Seismograph, as we have discussed is an instrument which is used to determine and record the ground motion when an earthquake occurs. Whereas, a ***seismometer*** is an integral part of a seismograph, be it be a pendulum or the mass mounted on the spring. On the other hand, a ***seismogram*** is the graph or we can say the output record of the motion of the ground

APPLICATIONS

Seismographs are not only used to determine the earthquakes but for any others too. Some of the major applications are depicted as under:

⇒ Sensitive Seismographs are used to predict Volcanic activities as the eruption of a volcano is usually accompanied by few small earthquakes.
⇒ These also pay important roles in predicting very small tremors as well as disastrous earthquakes.
⇒ Microseisms, the small and long-continuing oscillations of the earth, which causes storms near/at the sea can also be detected with the help of seismographs.
⇒ Moreover, Remote underground Nuclear weapon tests can also be detected with the help of seismographs.
⇒ The earth's inner structure i.e., the depth of underground layers, their inclination angle and the speed of seismic waves in each layer can also be observed by a seismograph.
⇒ Vibrations on the lunar surface can be observed as an important activity of a seismograph.
⇒ Seismographs also play important roles in detecting ground motions like dynamite blasts in mines and many more such activities.

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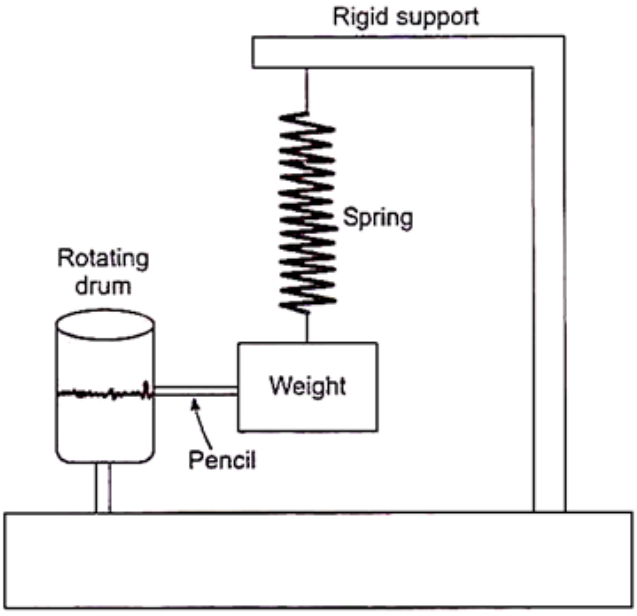
MODEL OF SEISMOGRAPH

Basically, a Seismograph consists of a mass and a fixed base. As soon as there is an earthquake, the fixed base moves while the mass does not. As a result, the pen attached to the mass moves and records some marks on the paper next to the pen. These marks are the signals which are then converted to the magnetic signals to determine the intensity of the earthquake. A simple seismograph looks like



Now, the reliability of a seismograph can be stated in terms of the following parameters:

- Earthquake Strength
- Its epicentres of how far away it is?
- And, how long it lasts.

Many seismograph centres have been installed in order to determine the above three parameters whenever there is an earthquake.

The given graph shows the number of earthquakes per annum with a magnitude of 5.0 and higher recorded since 1964. Now taking this data, we will calculate the probability that an earthquake occurs in more than 5 years using exponential distribution.

It is concerned with the extent of time until a distinct event occurs.

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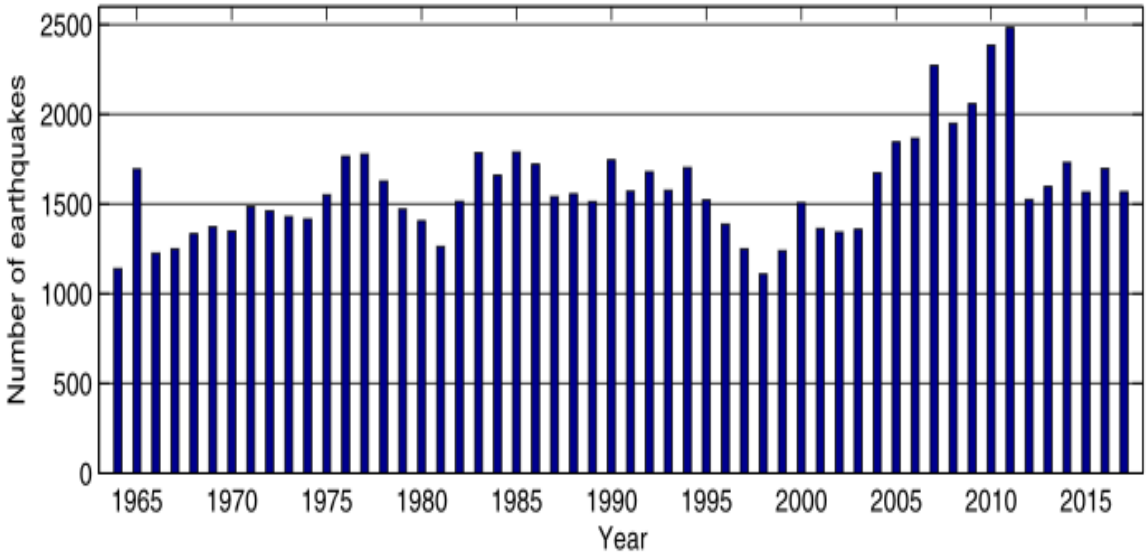

Source: BGR

In this case,

$\mu = 6$, since a certain earthquake occurs every six years.

Let x be the amount of time (in years) an earthquake occurs.

Then,

decay parameter, $m = 1/\mu$

$=1/6 = 0.1$

Now, find $P(x > 5)$

$P(x > 5) = 1 - P(x < 5)$

Since $(P(X < x) = 1 - e^{-mx}$ then $P(X > x) = 1 - (1 - e^{-mx}) = e^{-mx}$

$P(x > 5) = e^{(-0.1)(5)} = 0.6065$.

Therefore, The probability that an earthquake occurs in more than five years is 0.6065

CONCLUSION

Here, we have come to a conclusion that the probability that an earthquake occurs in more than five years is 0.6065. Since reliability of 0 or1 signifies that either the system is altogether unreliable or entirely reliable, respectively. Complement Reliability can also be said as Probability of Failure on Demand (PFD) Like reliability, this is also a probability value ranging from 0 to 1, where , zero (0) means there is no probability of failure and one (1) means it is completely unreliable.

Thus:

$R + PFD = 1$

$PFD = 1 - R$

$R = 1 - PFD$

Obviously, a system designed for high reliability should exhibit a large R value (very nearly 1) and a small PFD value (very nearly 0).

For the above given case, if we consider the earthquake occurs for 5 seconds in 5 years then ,

PFD = 5/ seconds in 5 years

= 5 / 157680000

= 0.000000017616551

= 3.17098E-08

Therefore , R = 1- 3.17098E-08
= 0.999999997
≈1

REFERENCES:

[1] Porfido Sabina ,"New Perspectives in the Definition/Evaluation of Seismic Hazard through Analysis of the Environmental Effects Induced by Earthquakes".
[2] MingweiZhang,JunLi, Scott Brooks, "Seismograph: Observing, Measuring, and Analysing Internet Earthquakes", IEEE ACM Transactions on Networking, Volume 25, Issue 6, Dec 2017, pp. 3411 – 3426.
[3] Hugo Benioff, "Earthquake Seismographs and Associated Instruments", Elsevier Advances in Geophysics, Volume 2, 1955, Pages 219-275
[4] Nievas Cecilia l. , Bommer Julian J. , Crowley Helen, Elk Jan van, NtinalexisMichail, SangirardiMarialuigia, "A database of damaging small to medium magnitude Earthquakes ", Journal odf seismology, Jan 9, 2020.
[5] Fagin, S. W., 1991, Seismic Modeling of Geologic Structure: Tulsa, OK, Society of Exploration Geophysicists, Geophysical Development Series, v. 2
[6] Hubral, P., 1977, Migration: Some ray theoretical aspects: Geophysical Prospecting, v. 25, p. 739-745.
[7] Hilterman, F. J., 1970, Three-dimensional seismic modeling: Geophysics, v. 35, p. 1020–1037., 10., 1190/1., 1440140
[8] Dhyani Divya, Sharma Viresh, "Modelling reliability of the probability of an earthquake**",** Jour of Adv Research in Dynamical & Control Systems, Vol. 11, 06-Special Issue, 2019
[9] Kelley, K. R., R. W. Ward, S. Treitel, and R. M. Alford, 1976, Synthetic seismograms—a finite difference approach: Geophysics, v. 41, p. 2–27., 10., 1190/1., 1440605.
[10] Ramasamy Subburaj, Lakshmanan Indhurani**, "**Machine Learning Approach for Software Reliability Growth Modeling with Infinite Testing Effort Function", Mathematical Problems in Engineering Mathematical Problems in Engineering.
[11] Da-Gang Lu, Peng-Yan Song, Xiao-Hui YuandGuang-Yuan Wang, "Global seismic reliability analysis of building structures based on system-level limit states", The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.
[12] KNOPOFF, L., "Earthquake prediction: The scientific challenge", Proc. Natl. Acad. Sci. USA, Vol. 93, pp. 3719-3720, April 1996 Colloquium Paper.
[13] Ishibashi Katsuhiko, "Two categories of earthquake precursors, physical and tectonic, and their roles in intermediate-term earthquake prediction", Springer, , Volume 126, Issue 2–4, pp 687–700,1988.
[14] Wang Qian,"Vp/Vs Anisotropy and Implications for Crustal Composition Identification and Earthquake
[15] Prediction", Journal of elogical Society of China, vol 83 No. 4 pp. 801-815, 2009.

[16] SAHU, KANTI, and ROSHAN KUMAR BHARDWAJ. "RELIABILITY ESTIMATION OF A TWO UNIT PARALLEL SYSTEM." International Journal of Applied Mathematics & Statistical Sciences (IJAMSS) 5.2 (2016):1-6.
[17] PATOWARY, AN, GL SRIWASTAV, and J. HAZARIKA. "EVALUATING APPROXIMATE MEAN AND VARIANCE OF ESTIMATED RELIABILITY IN INTERFERENCE MODELS USING MONTE-CARLO SIMULATION (MCS)." International Journal of Applied Mathematics & Statistical Sciences (IJAMSS) 6.2 (2017):1-10.
[18] Salimin, Norkhalid, et al. "Validity and Reliability Of Comprehensive Assessment Instruments For Professional Skills In Field And Court Sport Among Major Students Coaching Based On Model K." BEST: International Journal of Humanities, Arts, Medicine and Sciences (BEST: IJHAMS) 2.4 (2014): 37-44.
[19] RANI, T. CHITRAKALA, and R. NEELAMBARI. "A STUDY ON FUZZY RELIABILITY FOR WEB SERVER USING STATISTICAL APPROACH." International Journal of Computer Networking, Wireless and Mobile Communications (IJCNWMC) 5.1 (2015):35-40.

ISSN- 2394-5125 VOL 7, ISSUE 13, 2020

[20] Singh, Ajay, and Shakti Kumar. "Reliability Optimization Using Hardware Redundancy: A Parallel BB-BC Based Approach." *International Journal of Electronics and Communication Engineering (IJECE)* 4.5 (2015): 37-44.

[21] Chibu, Oti Robinson. "INTEGRATION OF RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND SUPPORTABILITY (RAMS) IN MAINTENANCE DECISION POLICIES IN AFAM ELECTRIC POWER STATION IN RIVERS STATE NIGERIA." International Journal of Electrical and Electronics Engineering (IJEEE) 7.6 (2018):1-16.

[22] OMBIRDAHIYA, MONIKA SAINI, and ASHISH KUMAR. "THE MATHEMATICAL MODELLING AND PERFORMANCE EVALUATION OF PAINT MANUFACTURING SYSTEM USING FUZZY RELIABILITY APPROACH." International Journal of Mechanical and) Production Engineering Research and Development (IJMPERD) 9.4 (2019): 869-886