Advanced Materials Research Vol. 1041 (2014) pp 251-254
© (2014) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMR.1041.251
Submitted: 19.06.2014
Revised: 20.07.2014
Accepted: 06.08.2014

The use of Probability in Risk Assessment

Karel Kubečka[1,a*] and David Pustka[2,b]

[1]Institute of Technology and Business in České Budějovice, Department of Civil Engineering, Okružní 517/10, 370 01 České Budějovice, Czech Republic & VŠB-Technical University of Ostrava, Institute of Clean Technologies for Mining and Utilization of Raw Materials for Energy Use, 17.listopadu 15/2172, 708 33 Ostrava-Poruba, Czech Republic

[2]VŠB-Technical University of Ostrava, Department of Building Structure, Faculty of Civil Engineering, L. Podéště 1875, Ostrava 708 33, Czech Republic

[a] karel.kubecka@seznam.cz, [b] david.pustka@vsb.cz,

Keywords: Forensic Science, Forensic Engineering, Risk, Risk Analysis, Risk Management, Damage, Defect, Failure

Abstract. For a correct interpretation of the results of the risk analysis are necessary correct input data. Acquisition of data can be different. For logical and numerical methods the expert risk analysis can we ensure data through questionnaires. This can serve as questionnaires for experts. Acquisition of data can also be combined with methods for probabilistic analysis.

Introduction

Application of risk analysis is today common in banking and insuring industry. In the course of time the risk analysis started to use also in civil engineering. Approximately 30 years ago the UMRA (**U**niversal **M**atrix of **R**isk **A**nalysis) method [1] was used for project of a tunnel where assessment included whole cycle from the pre-project preparation of the construction up to its finished lifetime. The construction was here evaluated as a whole.

Afterwards, the idea to use method of risk analysis separately in individual phases of construction and as well in forensic sciences was realized (see e.g. [2, 3]). Application of risk analysis in separated stages of construction project was described in published papers [4, 5]. This idea was also successfully implemented into education in several subjects [6]. Simultaneously it was applied in practice in various fields [7] and even in forensic proving [8, 9]. Except the UMRA method the authors develop applications of SWOT analysis in civil engineering in the field of building foundations and decision process regarding of suitability of regions for realization of civil engineering buildings.

Acquisition of data for analysis

Universal **M**atrix of **R**isk **A**nalysis is logical-numerical expert method. The method is based on matrix [4, 5] which assesses the confluence of sources of danger and endangered segments. Matrix-forming is the verbal part of the analysis, filling in the matrix is the logical-numerical part. The method enables the identification of potential danger or the qualification of the relative seriousness of danger. It is important to form a team of experts (the recommendation is from 5 up to 20 people) led by a risk analyst whose role is not only to moderate the execution of the analysis but also to process the expert's statements.

$$M_{Sv} \equiv \left(c_{i,k}\right) = \begin{pmatrix} c_{1,1} & c_{1,2} & c_{1,3} & \cdots c_{1,n} \\ c_{2,1} & c_{2,2} & c_{2,3} & \cdots c_{2,n} \\ c_{3,1} & c_{3,2} & c_{3,3} & \cdots c_{3,n} \\ \vdots & & & \\ c_{m,1} & c_{m,2} & c_{m,3} & \cdots c_{m,n} \end{pmatrix} \tag{1}$$

Acquisition of data (1) do not have to be only using experts [5]. Assessment can be based e.g. on evaluation of a test or individual members of matrix (1) can be considered as a function or a histogram (see e.g. [10, 11, 12]). Evaluation of the matrix (1) is then alternative. For evaluation of numerical characteristics of the members of the matrix (1) we use analytical evaluation (2) [3]. In suitable cases we can use evaluation based on histograms [2].

$$Pc_k = \frac{\sum_{ij} Sv_{ijk}^E}{\left(Sv_{\max} + Sv_{\min}\right) \cdot n_{act,k}^E} \tag{2}$$

An example of risk analysis, where input data into formula (2) are represented by suitable histograms, is shown in Figs. 1-3. Input histograms representing properties of members of matrix (1) are shown in Fig. 1. Using formula (2) and Monte Carlo simulation (see e.g. [10, 11, 12]) is calculated resulting histogram shown in Fig. 2. Statistical evaluation of this histogram is shown on Table 1.

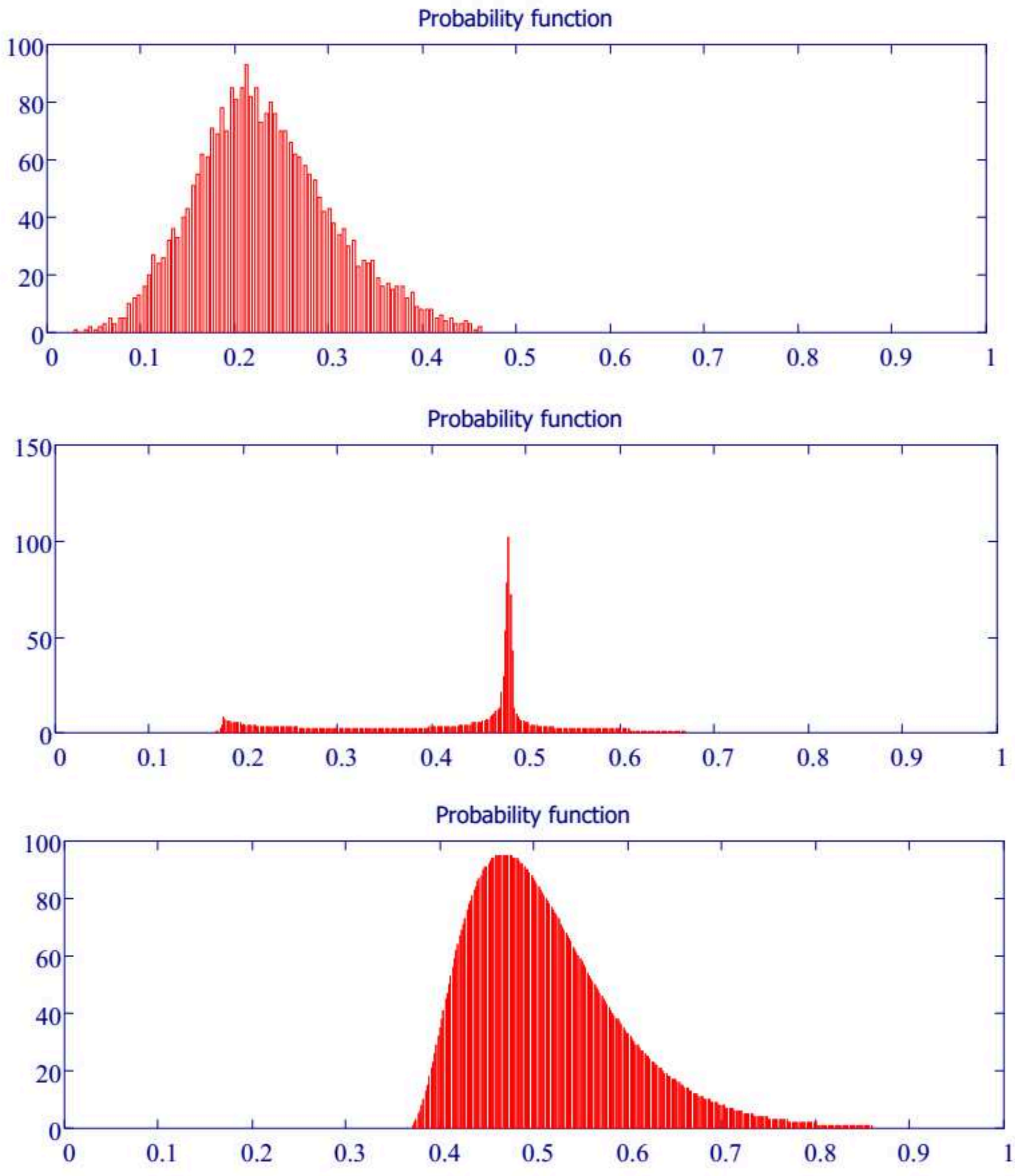

Figure. 1. Input histograms Sv_1, Sv_2, Sv_3.

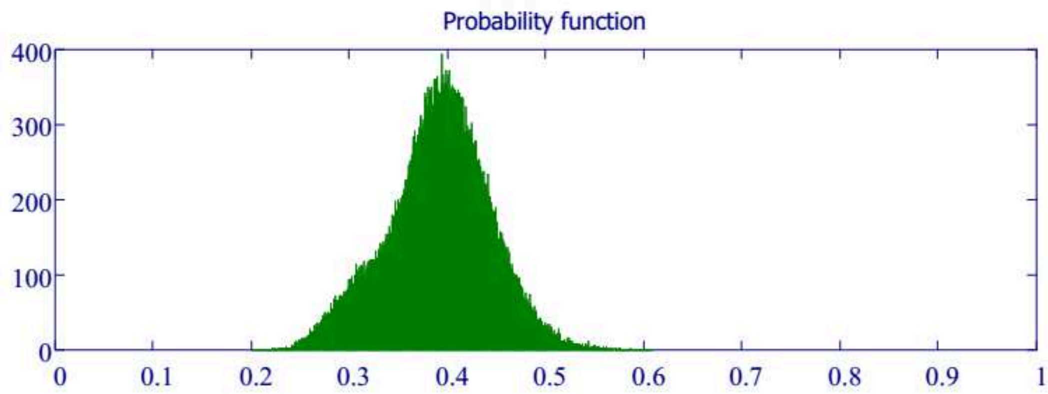

Figure. 2. Resulting histogram *Pc.*

Indicated procedure can be applied for various fields (practically for all fields requiring evaluation of a state).

Table 1. Calculated statistics of resulting histogram *Pc.*

"minimum"	0.201
"maximum"	0.609
"bins"	1000
"simulations"	100000
"mean"	0.391
"variance"	0.003
"standard deviation"	0.052
"median"	0.393
"variance coefficient"	0.133
"skewness"	-0.142
"concentration coefficient"	3.052
"kurtosis"	0.052
"probability(0)"	0
"quantile(0.05)"	0.298
"quantile(0.95)"	0.473

Summary

Using of risk analysis methods is useful as an alternative method for forensic engineering field. Practice has proved that the methods which are designed for management or designed for the others non-technical field can be used also in forensic field very effectively. The risk analysis methods provide additional decision-making forensic tool in the area where doesn´t exist any other relevant instrument.

Acknowledgements

Article has been done in connection with project Institute of clean technologies for mining and utilization of raw materials for energy use, reg. no. CZ.1.05/2.1.00/03.0082 (ICT: ED2.1.00/03.0082) supported by Research and Development for Innovations Operational Programme financed by Structural Founds of Europe Union and from the means of state budget of the Czech Republic.

References

[1] M. Tichý. Risk Control: Analysis and Management. 1st edition. Praha: C.H. Beck, 2006, XXVI, 396 s. Beck's edition economics. (In Czech) ISBN 80-717-9415-5.

[2] K. Kubečka, Methodology for evaluation of structures and buildings in the form of risk analysis: certified methodology, 1st ed., VŠB-TU Ostrava, 2010. RIV/61989100:27120/10:86082417. Project CIDEAS 1M0579. (In Czech)

[3] K. Kubečka, Methodology for determining the amount of damage to building structures and construction: certified methodology. 1st ed., VŠB-TU Ostrava, 2010. RIV/61989100: 27120/10:86082416. Project CIDEAS 1M0579. (In Czech)

[4] K. Kubečka, P. Vlček, D. Kubečková, D. Pieszka. Utilization of Risk Analysis Methods in Decision-Making Process on Fitness of Rehabilitation, Advanced Materials Research. 899 (2014), pp. 568-571.

[5] K. Kubečka, P. Vlček, D. Kubečková. Assessment and Damage for Building Structures Risk Analysis Methods. Advanced Materials Research. 899 (2014), pp. 535-538.

[6] K. Kubečka. Application of research results in teaching students. In: 2010 International Conference of Education, Research and Innovation: 15-17 Nov 2010, Madrid, IATED, 2010, pp. 84-87

[7] M. Marschalko, I. Yilmaz, M. Bednárik and K. Kubečka. Variations in the building site categories in the underground mining region of Doubrava (Czech Republic) for land use planning. Engineering Geology. 2011, vol. 122, 3-4, pp. 169-178. DOI: 10.1016/j.enggeo.2011.05.008. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0013795211001463

[8] K. Kubečka, P. Vlček, D. Kubečková and J. Česelský. Alternative procedure for determining the value of coefficient K6 comparative when using the method of valuation of buildings. In: 10th International Conference on Strategic Management and its Support by Information Systems: Valasske Mezirici, Czech republic. Proceedings Paper. VSB-Technical university of Ostrava, 17. Listopadu 15, Ostrava, 70833, Czech republic: Valasske Mezirici, Czech republic, 2013, pp. 88-96. ISBN 978-80-248-3096-4. WOS:000324842000008.

[9] K. Kubečka, S. Dobiášová, J. Fridrich, P. Vlček and M. Nič. Instruments for Risk Analysis as an Alternative Decision-Making Method in the Forensic Sciences, Advanced Materials Research 899 (2014), pp. 556-559

[10] P. Marek, J. Brozzetti, M. Guštar and P. Tikalsky (ed.). Probabilistic Assessment of Structures using Monte Carlo Simulation. Background, Exercises and Software. Second Edition. Institute of Theoretical and Applied Mechanics, Academy of Sciences of the Czech Republic, Prague, 2003.

[11] P. J. Tikalsky, D. Pustka, P. Marek. Statistical variations in chloride diffusion in concrete bridges. ACI STRUCTURAL JOURNAL. May-Jun 2005, vol. 102, issue 3, pp. 481-486.

[12] D. Pustka. Probabilistic Reliability Analysis of High-Performance Reinforced Concrete Beam using Matlab Software. International Journal of Mechanics 8 (2014), pp. 101-111.