

An Introduction to Civil Engineering Applications of Fuzzy Sets

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Foreword

It is indeed my pleasure to be invited to participate in the Festschrift honoring Wyllis Bandler. Wyllis Bandler is an outstanding teacher, a distinguished scholar, and an unselfish team-worker. I wish to dedicate this article to my friend Wyllis in wishing him continued success in all his endeavors and many happy returns.

1 Introduction

There exist many societal needs, which must be met with the collaboration of engineers and scientists. These societal needs include energy, food, housing, transportation, waste treatment, and water supply, all of which are within the domain of civil engineering. In meeting such needs, engineers and scientists must collect and process relevant information including incomplete knowledge and/or imprecise data for the design and construction of various systems and facilities.

With tragic accidents such as the failures of space shuttle Challenger and the Chernobyl reactor, we are now extremely sensitive to risks involved in our society. Frequently, catastrophic failures are caused by two or more major errors in design and/or construction. As an example, the failure of walkways in the Kansas City Hyatt Hotel was caused by two major errors. One error resulted in doubling the load, and another one resulted in reducing the strength of the critical member by half approximately. Thus, a factor of four resulted in the death of more than one hundred persons and injury of many others.

In the following, a brief history of civil engineering applications of fuzzy sets is presented. An NSF Workshop on this subject matter is then described. Active participation by interested persons in a technical committee on civil engineering application is strongly encouraged.

2 Development in the Seventies

Since Zadeh (1965) published his first paper on fuzzy sets, the theory has been applied in various disciplines (Zadeh, et al. 1975). Brown and Leonard (1971) introduced and discussed civil engineering applications of fuzzy sets during the ASCE Structural Engineering Meeting in Baltimore, Maryland. Later, Blockley (1975) published a paper on the likelihood of structural accidents, which was followed by a continuous flow of stimulating papers (Blockley, 1977, 1979) and a thought-provoking book (Blockley, 1980). Brown (1980a) then presented a fuzzy safety measure, with which more realistic failure rates were obtained by utilizing both subjective information and objective calculations. Later, Brown (1980b) also treated entropy constructed probabilities.

Dubois (1977) applied fuzzy sets in a comprehensive study of traffic conditions (Dubois and Prade, 1980). The general problem of uncertainty and fuzziness in engineering decision-making was discussed in a comprehensive manner by Munro (1979). In Japan, a series of summaries of papers were published including applications of fuzzy sets in solving civil engineering problems. A comprehensive review of literature was presented by Brown, Futura, Shiraishi, and Yao (1984).

Recently, the effects of human and gross errors have been studied by many investigators. In particular, several attempts are made to apply the theory of fuzzy sets in solving problems related to human errors.

3 NSF Workshop

The Workshop on Civil Engineering Applications of Fuzzy Sets, which was supported in part by the National Science Foundation, was held at Purdue University on 17-19 September 1985. There were 53 registered participants and observers. It was dedicated in the memory of the late distinguished Professor King-Sun Fu of Purdue University. The Workshop Proceedings were edited by Brown, Chameau, Palmer and Yao (1985). Due to many requests, the supply of this publication has been exhausted.

4 Concluding Remarks

As a result of these activities, a technical committee on civil engineering applications of fuzzy sets was established by the North American Fuzzy Information Processing Society (NAFIPS) under the Chairmanship of Colin B. Brown and Vice-Chairmanship of Jean- Lou Chameau. Felix Wong was responsible for the technical programs of this committee. They presented several sessions on civil engineering applications of fuzzy sets at NAFIPS '87 at Purdue University on 5-7 May 1987.

5 Postscript

This manuscript was prepared prior to my move to Texas A&M University in January 1988. Several thoughts on civil engineering applications of fuzzy sets are presented in several papers which are collected in an informal report (1992).

Interested persons may contact the writer to obtain a copy of this report. I wish to thank the editors of this special issue for the privilege of my participation to honor Wyllis Bandler.

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