Edited by Zhongxian Li Jiping Ru

PROCEEDINGS OF THE SEVENTH INTERNATIONAL SYMPOSIUM ON STRUCTURAL ENGINEERING FOR YOUNG EXPERTS

Volume 1

Science Press

PROCEEDINGS OF THE SEVENTH INTERNATIONAL SYMPOSIUM ON STRUCTURAL ENGINEERING FOR YOUNG EXPERTS

Volume 1

Edited by

Zhongxian Li

Jiping Ru

Science Press

2002

Responsible Editors: Jiafu Yang Baoli Liu Jianbo Liu

PROCEEDINGS OF THE SEVENTH INTERNATIONAL SYMPOSIUM ON STRUCTURAL ENGINEERING FOR YOUNG EXPERTS

Published by Science Press
16 Donghuangchenggen North Street
Beijing 100717, China

Printed in Beijing

ISBN 7-03-010663-6/TU · 215

The Seventh International Symposium on Structural Engineering for Young Experts

(ISSEYE-7)
August 28—31, 2002
Tianjin, P. R. China

Co-sponsored by

National Natural Science Foundation of China
Chinese Academy of Engineering

Organised by

Tianjin University, P. R. China

ACADEMIC COMMITTEE

PREFACE

The Seventh International Symposium on Structural Engineering for Young Experts (ISSEYE-7) will be held during the period from August 28 to 31, 2002 in Tianjin, China. The Symposium is co-sponsored by the National Natural Science Foundation of China and the Chinese Academy of Engineering, and organized by Tianjin University of China.

More than 200 abstracts were submitted to this Symposium, and 168 papers were contained in the Proceedings. All abstracts and papers submitted to the Symposium were reviewed by the members of the Academic Committee for the Symposium strictly. The papers in the Proceedings collect the newest achievements in the aspects of theoretical analysis, experimental research and engineering practice in structural engineering in the world.

The Symposium is to provide a good opportunity for young scholars to share their experience, exchange their ideas and discuss the challenges in structural engineering in the world. More than 100 young experts, who are under 45 years old and possess the doctoral degrees or senior technical titles, from 7 countries will attend the Symposium.

The technical sessions of the Symposium consist of 2 Keynote Lectures and 8 Sections as Analysis and design of structures, Experimental research of structures, Vibration control and health monitoring of structures, Disaster reduction and reliability of structures, Foundation and underground structures, Large-span bridge and spatial structures, Composite structures and Materials and others of structures.

The Proceedings are hoped to contribute to enhance the international research and development of structural engineering in the world and serve to solve the engineering problems through practical applications in the 21st century.

Sincere thanks are given to all the members of Academic Committee and the Secretariats of the Symposium for their hard work and kind support, and all those who have devoted their time and effort to the organization of the Symposium and the publication of the Proceedings.

Zhongxian Li in Tianjin, China
May 28, 2002

CONTENTS

PREFACE

Volume 1

KEYNOTE LECTURES

SECTION 1 ANALYSIS AND DESIGN OF STRUCTURES

SECTION 2 EXPERIMENTAL RESEARCH OF STRUCTURES

SECTION 3 VIBRATION CONTROL AND HEALTH MONITORING OF STRUCTURES

Volume 2

SECTION 4 DISASTER REDUCTION AND RELIABILITY OF STRUCTURES

SECTION 5 FOUNDATION AND UNDERGROUND STRUCTURES

SECTION 6 LARGE-SPAN BRIDGE AND SPATIAL STRUCTURES

SECTION 7 COMPOSITE STRUCTURES

SECTION 8 MATERIALS AND OTHERS OF STRUCTURES

KEYNOTE LECTURES

TECHNOLOGICAL FRONTIERS OF SMART DAMPING FOR PROTECTION OF CIVIL INFRASTRUCTURE

B. F. Spencer Jr.

Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
205 North Matthews Ave. , Urbana, Illinois 61801, USA

ABSTRACT: In recent years, considerable attention has been paid to research and development of structural control devices, with particular emphasis on alleviation of wind and seismic response of buildings and bridges. In both areas, serious efforts have been undertaken to develop the structural control concept into a workable technology. To date, full-scale active and hybrid control systems have been designed and installed in approximately 40 commercial buildings and 15 bridges (during construction). Yet the engineering community has been reluctant to fully embrace this technology. Demonstrated cost-effectiveness and reliability are key considerations for acceptance and successful implementation of structural control. Because of their mechanical simplicity, low power requirements, and large force capacity, smart dampers provide an attractive alternative to active and hybrid control systems for structural vibration reduction. The focus of this paper will be to review two smart damping approaches that have been proposed and implemented in full-scale structures.

KEYWORDS: Smart damping, Smart materials, Variable orifice damper, Magnetorheological fluid damper

1. INTRODUCTION

Passive supplemental damping strategies, including base isolation systems, viscoelastic dampers, and tuned mass dampers, are well understood and are accepted by the engineering community as a means for mitigating the effects of dynamic loadings such as strong earthquakes and high winds. However, these passive-device methods are unable to adapt to structural changes and to varying usage patterns and loading conditions.

For more than two decades, researchers have investigated the possibility of using active control methods to improve upon passive approaches to reduce structural responses (Soong, 1990; Spencer and Sam, 1997; Housner et al. , 1997; Soong and Spencer, 2002). The first full-scale application of active control to a building was accomplished by the Kajima Corporation in 1989 (Kobori, 1994). The Kyobashi Seiwa building is an 11-story (33. 1 m) building with a total floor area of 423 m^2. An active mass driver (AMD) system was installed, consisting of two AMDs—the primary AMD is used for transverse motion and has a mass of 4 tons, while the secondary AMD has a mass of 1 ton and is employed to reduce torsional motion. The role of the active system is to reduce building vibration under strong winds and moderate earthquake excitations and consequently to increase the comfort of occupants of the building. Since that time, active/hybrid structural control has been successfully applied in approximately 40 commercial buildings and 15 bridges (during construction).

Although extensive analytical and experimental structural control research has been conducted in both the US and Japan in the last decade, with the exception of one experimental system installed on a bridge in Oklahoma (discussed later in this paper), none of these full-scale active control installations are located the US Many possible reasons can be cited for this disparity. For example, the civil engineering profession and construction industry in the US are conservative and generally reluctant to apply new technologies. The absence of verified and consensus-approved analysis, design and testing procedures represent addition-