

# **EARTHQUAKE DISASTER PREVENTION AND MITIGATION RESEARCH CENTER, HARBIN INSTITUTE OF TECHNOLOGY, P. R. CHINA**

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## *INTRODUCTION AND MAIN RESEARCH AREAS*

Earthquake Disaster Prevention and Mitigation Research Center (EDPMRC), Harbin Institute of Technology (HIT), was founded in 50's of last century. In the early stage, structural seismic experiments, analysis and design methodologies have been the focus research subjects in the center. During the 80-90s of last century, the center has been developed quickly, great achievements on structural control have been made, and consequently, the research center plays a critical role in promoting the development of structure control in China and becomes one of the most important research centers of structure control in China. Now as the same of over the world, the center is facing new challenges and chances on earthquake engineering research, the center is contributing to the advanced sensors, smart materials and structures, intelligent health monitoring, advanced disaster prevention and mitigation techniques, performance-based design of seismic structures and engineering.

Main research areas in the center are included as follows:

- Engineering seismology and earthquake ground motion
- Seismic analyses and design methodologies of structures and engineering systems
- Interaction seismic analysis of soil-structure
- Soil liquefaction and foundation stability in earthquake
- Seismic damage, reliability and performance-based design of civil infrastructures
- Passive energy dissipation systems and base isolation
- Active, semi-active and smart vibration control
- Intelligent health monitoring of civil infrastructures
- Smart material and structures
- Seismic experiments of structures

## *FACULTIES*

There are 21 faculties, including 12 full professors, 7 associate professors and 2 assistant professors, working in this research center, in which there are 3 academicians of Chinese Academy of Engineering (CAE). In addition, about 110 research assistants, including 10 post-doctors, 40 PhD students and 60 graduate students, are also simultaneously working in this center. The faculties of center are listed as follows:

NO.	Name	Title	Research Area
1	OU Jinping Tel:86-451-86419150, 86282209 Fax: 86-451-86282094 Email:oujinping@hit.edu.cn	Director Dr. and Professor (Vice-President of HIT) Academician of CAE	1. Seismic damage, reliability and performance-based design 2. Structural vibration control 3. Intelligent health monitoring of civil infrastructures 4. Smart material and structures
2	LI Hui Tel:86-451-86282013, 86282068 Fax: 86-451-86282013 Email: lihui@hit.edu.cn	General-secretary Dr. and Professor	1. High performance concrete and seismic structures 2. Active and smart vibration control 3. Smart concrete and self-sensing structures 4. Intelligent health monitoring of civil infrastructures
3	TIAN Shizhu Tel:86-451-86282085 Fax:86-451-86282704 Email:tianshizhu@hit.edu.cn	Chief of testing center Dr. and Professor	1. Structural vibration control 2. Seismic experiment of structures
4	WANG Guangyuan	Professor Academician of CAE	1. Seismic optimum and life-cycle design of engineering system 2. Structural analysis and dynamics
5	XIE Lili	Professor Academician of CAE	1. Seismic performance-based design of civil infrastructures 2. Digital system and advance management of earthquake disaster and mitigation
6	WANG Huanding	Professor	1. Seismic analysis of structures 2. Base Isolation systems
7	LU Qingnian	Professor	1. Engineering seismology and earthquake ground motion 2. Seismic reliability analysis of structures
8	ZHANG Kexu	Professor	1. Interaction seismic analysis of soil-structure 2. Soil liquefaction and foundation stability in earthquake
9	TAO Xiaxin Tel: 86-451-86282095 Email:taoxx@public.hr.hl.cn	Dr. and Professor	1. Engineering seismology and earthquake ground motion 2. Soil dynamics and earthquake engineering
10	DUAN Zhongdong Tel:86-451-86282096 Fax: 86-451-86282096 Email: <a href="mailto:duanzhongdong@hit.edu.cn">duanzhongdong@hit.edu.cn</a>	Dr. and Professor	1. Seismic reliability analysis of structures 2. Intelligent health monitoring of civil infrastructures
11	WANG Wei	Dr. and Professor	1. Seismic analysis of structures 2. Structural vibration control

12	WU Bin Tel:86-451-6282091 Fax: 86-451-6282209 Email: Bin.wu@hit.edu.cn	Dr. and Professor	1. Passive energy dissipation systems 2. Seismic performance-based design 3. Real-time sub-structure Pseudo-dynamic tests
13	TANG Aiping	Dr. and Associate Professor	Seismic analysis and design of life lines
14	LU Dagang	Dr. and Associate Professor	Seismic optimum and life-cycle design of engineering system
15	HE Zheng	Dr. and Associate Professor	Structural seismic damage and performance-based design of structures
16	GUAN Xinchun	Dr. and Associate Professor	Smart material and structures
17	XIAO Yiqing	Dr. and Associate Professor	Intelligent health monitoring and safety evaluation of civil infrastructures
18	GUO Anxin	Dr. and Associate Professor	Passive energy dissipation systems and structural smart control
19	WANG Zhenyu	Dr. and Associate Professor	High performance concrete and seismic structures
20	ZHOU Zhi	Dr. and Assistant Professor	Smart sensors and health monitoring systems of civil infrastructures
21	HE Ling	Dr. and Assistant Professor	Seismic damage identification and model updating of structures

### MAIN RESEARCH PROJECTS

The main research projects finished or carrying out by the research center in recent five years

NO.	Project	Original	Time	Funds ¥10, 000	Investigator
1	Real-time monitoring technique and inspection imaging for ocean offshore platform	National "863" Program	2001-2004	1000	DUAN Zhong-Dong
2	Structural control for ocean offshore platform	National "863" program	2001-2004	250	WU Bin
3	An innovative active mass damper for vibration control of ocean offshore platform	National "863" program	2003-2005	60	OU Jin-ping
4	Smart concrete and intelligent structure systems	National "863" Program	2003-2005	80	OU Jin-ping
5	Net-based optical fibre sensors and practical application	National "863" Program	2002-2004	60	OU Jin-ping

6	Smart isolated layer with smart limitation device for vibration of ocean offshore platform	National “863” Program for youth	2002-2004	20	LONG Xu
7	Approaches of damage detection and model updating for ocean offshore platform	National “863” Program for youth	2002-2004	20	HE Lin
8	Standards and criteria of capacity evaluation of disaster prevention and mitigation	National “973” Program	1998-2003	32	XIE Li-li
9	Intelligent health monitoring of key infrastructures	NSFC	2004-2006	98	OU Jin-ping
10	Smart concrete and structures	NSFC	2003-2005	50	LI Hui
11	Internet-based pseudo-dynamic test methods and technology	NSFC	2003-2006	50	WU Bin
12	Three-dimensional velocity detection based on measured pulse motion of site	NSFC	2004-2006	24	TAO Xia-xin
13	Optical fibre sensors for structural strain monitoring	NSFC	2004-2006	24	ZHOU Zhi
14	Wireless sensor networks and health diagnostic method in real time based-on global variables	NSFC	2004-2006	24	XIAO Yi-qing
15	FRP reinforced concrete structures	NSFC	2003-2005	24	HE Zheng
16	Health monitoring and damage control of infrastructures by using SMA systems	NSFC	2001-2003	35	LI Hui
17	Key issues of science problems and design theories for	NSFC	1998-2002	910	WANG Guang-Yuan
18	Smart control for infrastructure vibration	NSFC	2000-2003	40	OU Jin-ping
19	The mechanics of ice induced vibration and control for offshore platform structure	NSFC	1998-2002	40	OU Jin-Ping
20	Seismic criteria of Performance based design method	NSFC	1998-2002	40	XIE Li-li
21	Random loads in ocean environment and their combination	NSFC	1999-2002	40	DUAN Zhong-Dong

22	Design theory for structural vibration control	NSFC	1998 -2002	40	WU Bo, LI Hui
23	Safety evaluation, damage detection and maintaining policies	NSFC	1997 -2001	80	OU Jin-ping
24	Evaluation on the seismic performance of urban infrastructures	Ministry of Science and Technology	1998 -2003	35	XIE Li-li
25	Seismic design boilerplate code	China Seismological Bureau	1996 -2001	85	XIE Li-li
26	The whole life quality control and management for engineering	National high tech development department	1999 -2001	80	OU Jin-Ping
27	New Energy dissipation device and design theory	NSFC	2000 -2002	15	WU Bin
28	Infrastructure vibration control by MR dampers	NSFC	2002 -2004	32	GUAN Xin-chun
29	Advanced pseudo-dynamics experimental techniques	NSFC	1998 -2000	12	TIAN Shi-zhu
30	Seismic behaviors of high performance concrete composite structures	NSFC	1998 -2000	14	LI Hui
31	Damage diagnostic technologies of stay cables	Ministry of Transportation	2003 -2005	298	OU Jin-ping
32	Safety evaluation methods of highway bridges in series	Ministry of Transportation	2003 -2005	120	OU Jin-ping
33	Study of intelligent RC structures embedded with SMA	Ministry of Education	2003 -2005	30	LI Hui
34	Vibration monitoring and control of long-span bridge by using SMA	Heilongjiang outstanding youth funds	2001 -2003	23	LI Hui
35	Implementation of health monitoring systems for long-span bridges: (I) Shandong Binzhou Yellow River Bridge (II) Shandong Dongying Yellow River Bridges (III) Hunan Maocaojie Arch Bridge	Shandong Department of Transportation	2002 -2006	850	OU Jin-ping

## AWARDED PRIZES

Some achievements won prizes in recent five years

NO.	Project	Achieved by	time	Rank
1	Base isolation and vibration control techniques and applications for masonry structure earthquake hazard mitigation	LIU Ji	1998	The National scientific and technology progress prize of China (ranking 2 <sup>nd</sup> )
2	Seismic hazard analysis and information system based on AI and GIS	XIE LiLi	1999	Scientific and technology progress prize of National Earthquake Bureau. (ranking 2 <sup>nd</sup> )
3	Seismic damage theory and applications of RC structures	OU Jinping	1999	Scientific and technology progress prize of the Ministry of Construction. (ranking 1st)
4	High strength concrete composite structures	LI Hui	1998	Science and technology progress prize of the Ministry of Construction (ranking 2 <sup>nd</sup> )
5	IMR, safety evaluation and monitoring systems of offshore structures	OU Jinping	2001	Science and technology progress prize of the Ministry of Education (ranking 1st)
6	System reliability analysis and safety evaluation of offshore structures	OU Jinping	2001	Heilongjiang Science and technology progress prize (ranking 2nd)
7	Stiffness variable control systems	OU Jinping	2002	Guangdong Science and technology progress prize (ranking 2nd)
8	Seismic design method of high performance concrete composite structures	LI Hui	2002	Heilongjiang Science and technology progress prize (ranking 2nd)
9	IMR, safety evaluation and monitoring systems of offshore structures	OU Jinping	2003	The National Science and technology progress prize of China (ranking 2nd)

## TESTING FACILITIES

There are two laboratories in this research center, one is *Structural and Earthquake Prevention and Mitigation Laboratory (SEPM)* founded in 1986, which is one of key LABs of Ministry of Construction, and another is *Intelligent Health Monitoring and Control Laboratory (IHMC)*.

**The Structural and Earthquake Prevention Mitigation Laboratory (SEPM)** provides extensive facilities for experiments in structural, earthquake and control engineering for research and educational purposes. The below is a brief description of these facilities.

**(1) Shaking Table**

The SEPM houses a uniaxial shaking table sized 4m×3m that was produced by Siemens Corporation and built in 1986. The shaking table consists of a hydraulic actuator/servo valve assembly and a hydraulic power supply that drive a slip table. The capabilities of the shaking table are: maximum displacement ±12.5 cm and maximum acceleration ±1 g's with a 15,000kg test load. The nominal operational frequency range of the simulator is 0.1-45 Hz. This facility has a variety of high quality sensors / actuators and a complete computer control / data acquisition system. The intent of having such a facility is to experimentally verify response reduction strategies developed at Harbin Institute of Technology.

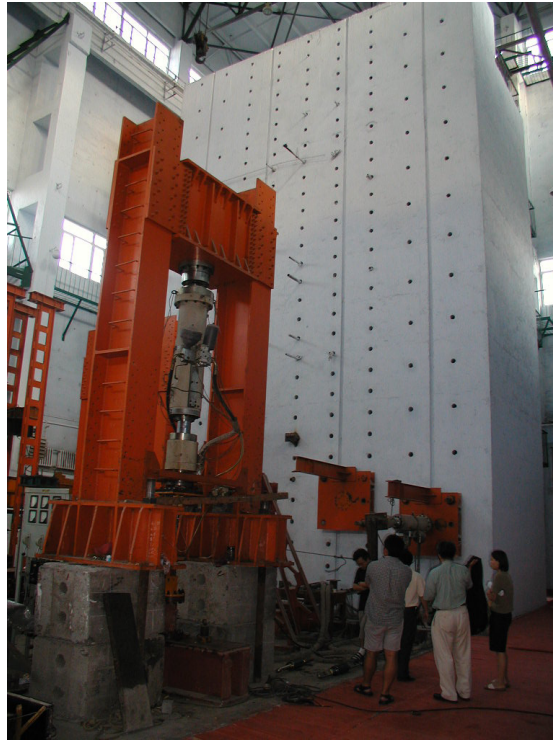


**Shaking Table and part of tested structural models**

**(2) Pesuo-dynamic Testing Facilities for Large-Scale Structures**

The SEPM has the capabilities of testing five-story full-scale seismic building by using the pesuo-dynamic testing facilities. Actuators with capacities of 630 kN and 230kN are available for pesuo-dynamically loading the building. The stroke of the actuator is ±25cm. The hydraulic system is control by a multi-channel servo-controller. A

hydraulic accessory manifold (HAM) is connected in the hydraulic pressure and return lines to allow for increased control and safety of the system. In addition, a match reaction wall with 15.6m in height and permission of 6,000 kN maximum base shear force provides the capabilities to conduct tests in various aspects of seismicity of buildings.



### **Pesuo-dynamic Testing Systems**

### (3) MTS 2500 kN Construction Materials Test System

MTS 2500 kN Construction Materials Test System is used for static test, dynamic test and fatigue test. Nominal dynamic load rating that the Construction Materials Test System can provide is +/- 2500 kN with 150% static overload capacity. The test space is width 762 mm (30 in.), depth 508 mm (20 in.), height 400 mm to 3000 mm. Overall frame height is Approximately 4500 mm. The Load frame stiffness is  $40E8$  N/m. The travel of Integral 2500 kN Fatigue Rated Actuator is 300 mm (12 in) total. MTS's TestStar II is a direct digital test control system for material and component testing. TestStar II Base Controller can provide digital servo control, function generation, data acquisition, and hydraulic control. TestStar II System Software provides a software interface for configuring the controller and the user interface to the test station. The user can enter and save user preferences (units, valve adjustments, loop tuning) for recall at any time.



**One of Testing Halls**

The variety of pressure testing machines, universal testing machines, measure instruments and data acquisition systems, and data processing software are also included in this laboratory besides above equipments.

**The *Intelligent Health Monitoring & Control Laboratory (IHMC)*** provides extensive and advanced facilities for experiments in health monitoring and control engineering for research and educational purposes. The facilities could be employed to conduct the research on following topics: (1) Study on Smart materials (or structures) and sensors including optical fiber sensor, piezoelectric sensor, fatigue life gauge, shape memory alloy (SMA) sensor, FRP with FBGs sensors, local damage detection systems based on these smart sensors and its application in civil structural health monitoring. (2) Study on Wireless sensor network and communication system. (3) Study on 3S (GPS, GIS and RS) techniques with GPS and GIS systems. (4) Study on ultrasonic inspection and imaging technique, and acoustic emission damage detection technique. (5) Study on structure earthquake response reduction strategies vibration reduction for small-scale models on an uniaxial shaking table, structure identification, structural model updating and

safety evaluation, real-time system of structural health monitoring and in civil structural health monitoring application.

### *RECENT PUBLICATIONS*

More than 500 academic papers have been published by the researchers in the center in recent 5 years. The main books published in recent 5 years are listed as follows:

1. OU Jinping. Structural Vibration Control \_\_\_\_\_ active, semi-active and smart control systems. Press of Science, China, 2003
2. OU Jinping *et al.* Structural Vibration Control \_\_\_\_\_ Passive Energy Dissipation Systems, Science Press of China (to be published)
3. OU Jinping and WANG Guangyuan. Random Vibration of Structures. Higher Education Press, 1998.
4. WANG Guangyuan. Seismic Reliability of Buildings. Press of Science, China, 1999.
5. WANG Guangyuan. Simplified Seismic Optimal Design Methods of Engineering Structural and System. Building Industry Press of China, 1999
6. WANG Guangyuan. Design Methodology Based Construction, Design and Maintain for Engineering Structural System. Defense Industry Press of China, 1996
7. LI Hui. High Performance Concrete and Composite Structures. Press of Science, China, 2004
8. WU Bo and LI Hui. Theory and Applications of Passive Vibration Control. Press of Harbin Institute of Technology, 1997.
9. WANG Huanding. The Structural Analysis. Higher Education Press, 2002