



INTERNATIONAL SOCIETY FOR STRUCTURAL HEALTH MONITORING OF INTELLIGENT INFRASTRUCTURE

ISHMII Membership Notes February 2013

Vol. 3 Issue 2

President's Letter

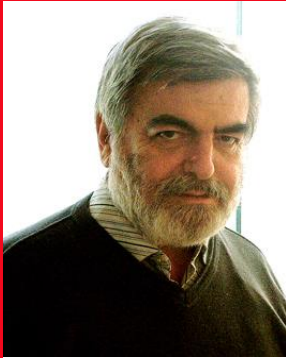
Dear Society Members and Colleagues,

The creative, innovative use of our knowledge of CSHM and the opportunity to develop new and necessary applications is something that we all hope to have. At the latest ISHMII Conference (SHMII-5) and Workshop (CSHM-4) we explored this as our colleagues presented in-depth results of their research. In the January issue of *Membership Notes*, I referred to the work of our colleagues in Italy where earthquakes are a challenge to all types of structures both old and new. The preservation challenge is compounded with heritage structures, some of which have been already destroyed by earthquakes. If the trend is not reversed, more historic structures will be lost. I know of the innovative work of a couple of our ISHMII members in Italy who have been involved in the development of technologies for the proactive preservation of the heritage structures, especially against the threat of seismic events. Paolo Clemente of ENEA and Alessandro De Stefano of the Politecnico di Torino, Italy are leaders in this field. They were kind to accept my invitation to write a technical note in this issue; *Experimental Analysis and Seismic Isolation of Historical Buildings* adds to this discussion. I am sure that you will all enjoy their article as much as I did. My thanks to them.



Paolo Clemente, Ph.D., a civil engineer with his doctorate in structural engineering, joined ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development, in 1985. He is head of the "Natural Risk Prevention" department. His main fields of interests include experimental dynamic analysis of structures and system identification, new anti-seismic technologies, structural preservation of the cultural heritage, long-span bridges, shake table tests, masonry structures, and seismic input.





Alessandro de Stefano, Ph.D., a member of the ISHMII Council, is a professor in the Department of Structural, Geotechnical and Building Engineering at Politecnico di Torino. With research interests in earthquake engineering (historical building protection, passive control), experimental dynamics, SHM, and system resilience, he is a consultant to the regional administration for earthquake engineering and a co-inventor of a new patented technology for seismic isolation of historical heritage sites. Prof. de Stefano is a member of a National Technical Norm committee for masonry arch bridges safety.

Experimental Analysis and Seismic Isolation of Historical Buildings
Paolo Clemente and Alessandro De Stefano

Historical structures have been built without accounting for the seismic actions and are vulnerable even to moderate events, but due to their historical importance and to the daily presence of tourists, their seismic rehabilitation is quite delicate, aiming at the protection of both human life and cultural heritage. Seismic preservation should be based on a good knowledge of the dynamic characteristics of the structure and a suitable choice of the intervention, if necessary.

The first step is very important in order to assess, by means of a suitable numerical model, the possible dynamic behaviour of the structure during strong events. But, it is not easy for several reasons: the structural size of the various elements, such as walls, floors, etc., cannot be evaluated with the needed accuracy; the material characteristics, such as the tension-strain relationship, the strength, etc., are not known; structure and materials often exhibit inelastic behaviour; horizontal structures are not effective in joining the vertical ones; the depth of the foundations is often variable as well as their geometry and material properties, including the soil characteristics; buildings are often connected to other constructions, so that their behaviour is very complicated. For such kind of structures, the experimental analysis is often the only way to improve our understanding about their dynamic behaviour.

Speaking of interventions, it is worth noting that traditional techniques are not suitable for the seismic rehabilitation of cultural heritage buildings. In fact, these are based on the increasing in strength and ductility, and so are often not reversible, making use of materials different and incompatible with the original ones, and can determine changes in the original structural conception. Furthermore, under high-intensity earthquakes, traditional techniques can only guarantee against the collapse, but cannot avoid heavy damage both to structural and non-structural elements. Therefore, base isolation could be a suitable solution for the seismic rehabilitation of historical structures. It aims to reduce seismic actions, thus avoiding significant damage to the structure and its contents even under strong earthquakes, and presents very low interference with the structure itself.



Figure 1. Palazzo Margherita: main façade and courtyard

A detailed study was carried out on Palazzo Margherita in L'Aquila, whose construction started in 1294 and was completed in 1541. The building suffered heavy damage during L'Aquila earthquake of April 6th, 2009. Several cracks were apparent and local collapse mechanisms were activated. In more detail, the seismic events caused the disconnection between the orthogonal walls, the out-of-plane collapse of some masonry walls, the formation of large cracks, the collapse of some floors, and important damage to the stairs.

First of all, an experimental campaign was carried out in order to find out the dynamic characteristics of the structure. Velocimeter sensors were used in two different configurations. In the first one, the sensors were deployed in the building, in order to point out the global and local resonance frequencies (Figure 2). In the second configuration, they were put at different levels of the tower. Ambient noise only was used as source of vibrations.

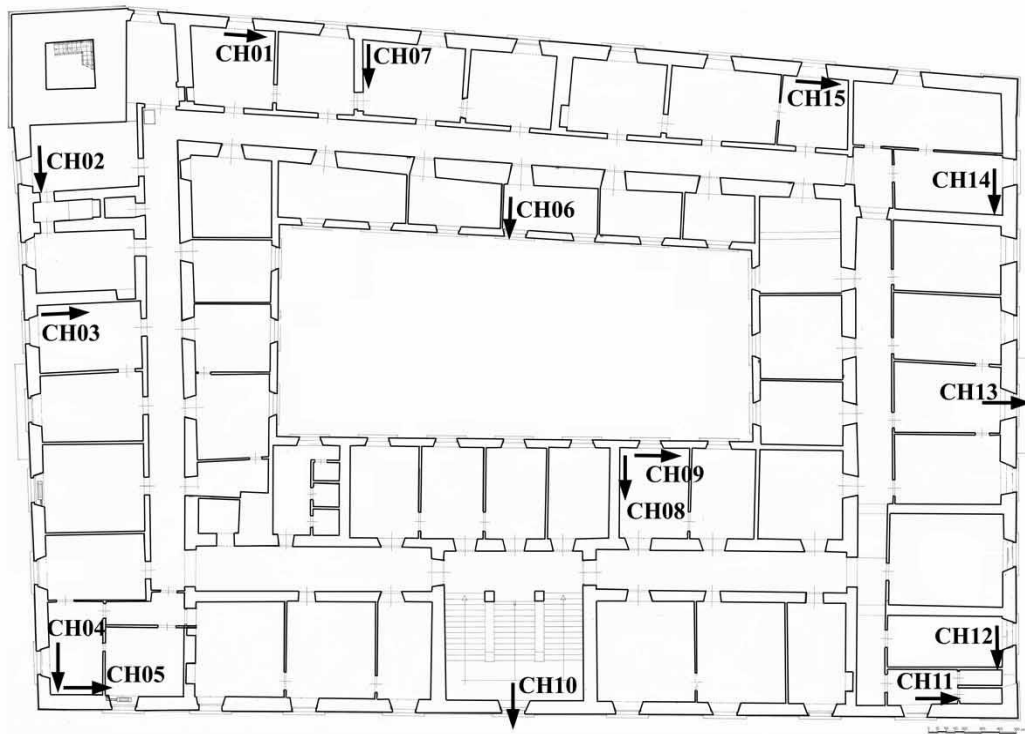


Figure 2. Second floor: sensor deployment in the building

Spectral analysis showed the resonance frequencies of the building and of the tower, which are listed in Table 1.

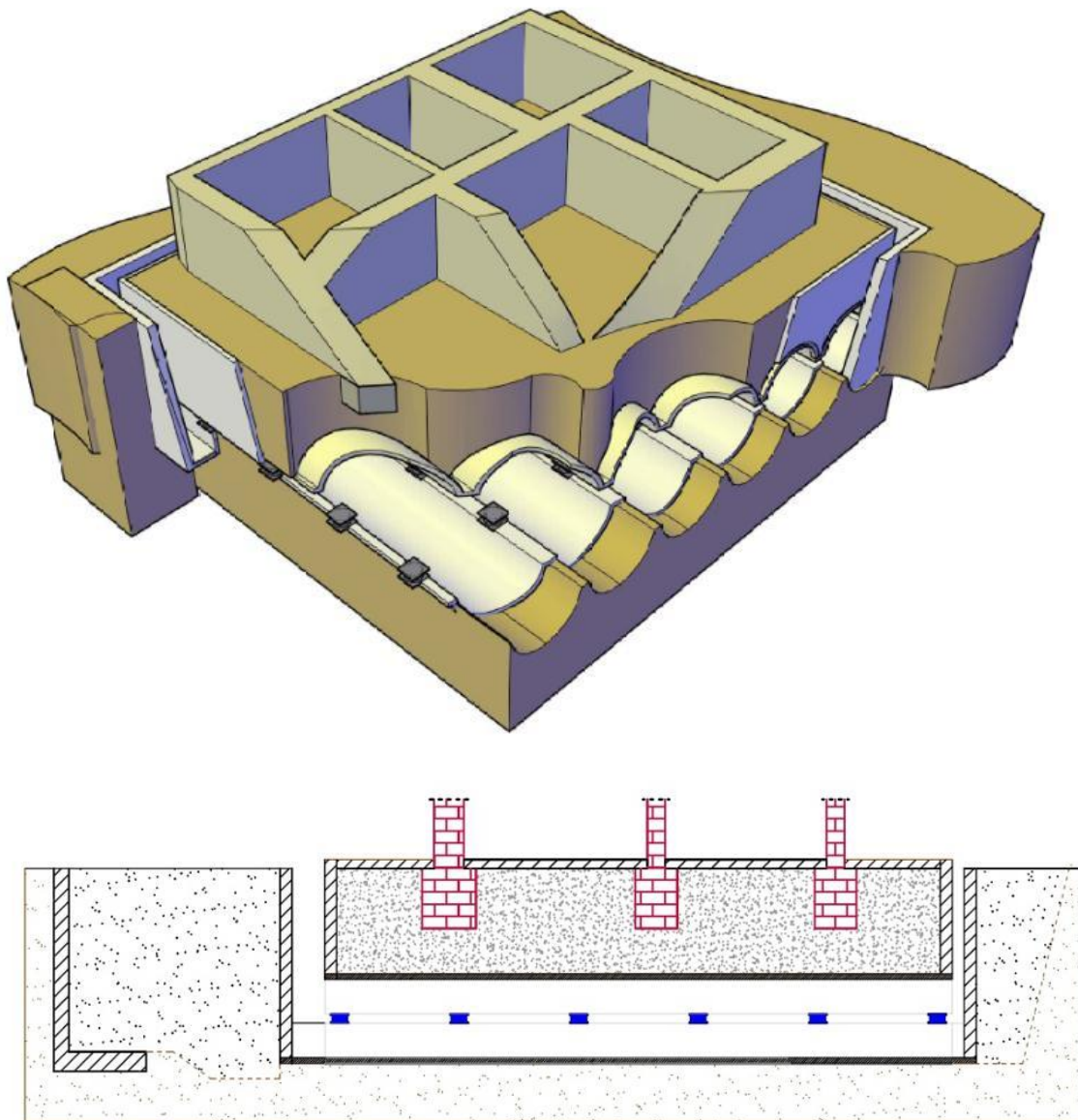
Table 1. First resonance frequencies of the building and of the tower

| <u>Building</u> | | <u>Tower</u> | |
|-----------------|---------------------|--------------|--------------|
| Freq. (Hz) | Description | Freq. (Hz) | Description |
| 2.24 | Transversal | 1.46 | Transversal |
| 2.74 | Transversal + Tors. | 1.46 | Longitudinal |
| 3.32 | Longitudinal | 2.83 | Transversal |
| 3.71 | Torsional | 3.22 | Longitudinal |

Due to the historical value and the strategic relevance of the building, base isolation was chosen as the most appropriate type of intervention. Taking into account the dynamic characteristics of the structure and the results of the seismic microzoning, carried out by the Italian National Civil Protection Department, which pointed out the presence of seismic amplifications in the range $0.4 \div 0.6$ Hz in the area, a period of the isolated building equal to 3.0 sec was fixed, which guarantees a spectral acceleration values lower than 0.10g.

An innovative solution has been proposed, which consists in the realization of an isolated platform under the foundations of the building, without touching the building itself (Figure 3). A discontinuity between the foundations and the soil is created by inserting horizontal pipes, by means of auger boring or micro-tunneling technique, the positioning of isolation devices at their horizontal diametric plane and the realization of a double system of vertical walls around the building. The pipe diameter should be ≥ 2 m, in order to allow the inspection and the substitution of the devices. The pieces of pipe have a particular shape.

composed of a lower and an upper sector, connected by means of removable elements. The removable elements, placed in correspondence of the isolator locations are first removed, and the isolation devices are positioned also joining each pipe with the two adjacent ones by means of reinforced concrete elements. Then, also the other connection elements along the pipe are removed; other reinforced concrete elements are cast to connect adjacent pipes, so the lower sectors are definitely separated from the upper ones. Finally, vertical walls are built along the four sides of the building.



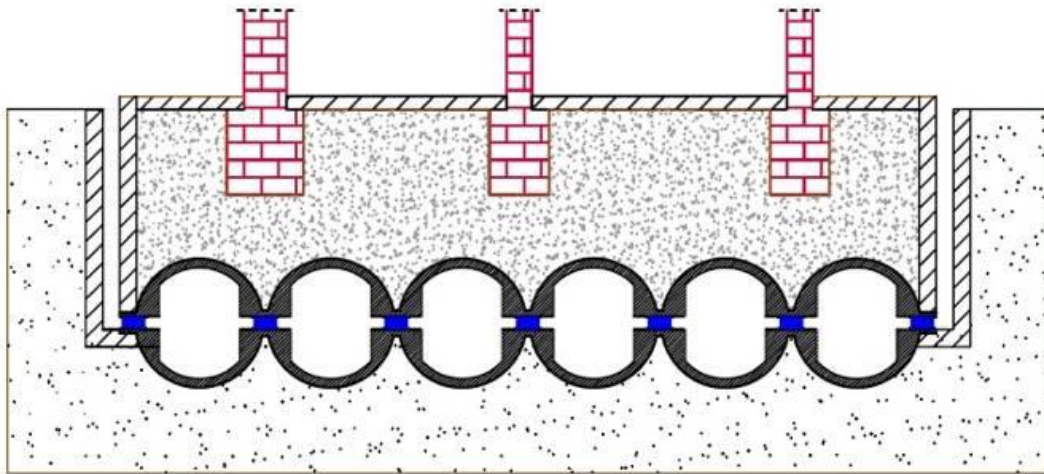


Figure 3. The new isolation system: (a) view (top), (b) longitudinal (middle) and (c) transversal sections (bottom)

Soil settlement and vibration induced at the surface level, which can arise during the micro-tunneling have been accounted for. In more detail, a first evaluation of the soil settlement gave values lower than 10 mm. The structure is seismically isolated, but not affected by any interventions that could modify its architectural characteristics, which is very important for historical buildings. Even underground level are not modified, but can be part of the seismically protected building. The system also allows the realization of a tunnel for pedestrians or vehicles.

We are now approaching [SHMII-6 \(2013\)](#), in Hong Kong in December 2013 and are accepting abstracts for review. There are only a few weeks remaining in which to submit your abstract. March 15, 2013 is the deadline. Please refer to the Conference Web site for full instructions on the procedure and then submit your abstract to shmii6.2013@polyu.edu.hk. I hope to see you in Hong Kong.

A final word to members and non-members. The *Journal of Civil Structural Health Monitoring* welcomes your research submissions. *JCSHM* Volume 3, Issue 1 was published this week. Members may log in through the ISHMII.org Web site to read the *Journal*. Non-members are invited to peruse the [JCSHM Index](#) and read abstracts. I hope it entices you to become an active member of ISHMII.

With warm wishes,

Farhad Ansari, President

FAnsari@uic.edu

An animation of this innovative seismic activity research solution may be downloaded through the ENEA Web site, which is available in Italian.

Visit: [ENEA](http://www.enea.it)

Then, click on:

- Tecnologie antisismiche innovative
- Adeguamento edifici esistenti
- Palazzo Margherita a L'Aquila
- Filmato



The citation for this article is: Clemente, P., and De Stefano, A. (2013), "*Analysis and Seismic Isolation of Historical Buildings*," ISHMII Membership Notes, V. 3, N.2, PP. 1-3.

Join Us at SHMII-6
December 9-11, 2013
Hong Kong

Abstracts
of Papers
Being
Accepted

Call for Papers - SHMII-6
Deadline: March 15, 2013

The 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-6) will be held in Hong Kong on

December 9-11, 2013.

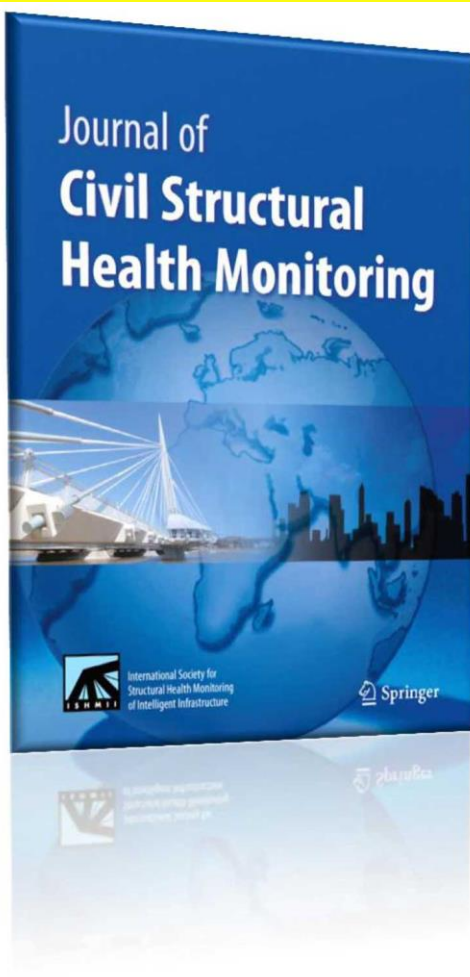
You are invited to submit your 300-word abstract by email to shmii6.2013@polyu.edu.hk by March 15, 2013.

Authors will be notified regarding the acceptance of their abstracts.
Full papers are due June 15, 2013.

The sample templates of an abstract and full paper, manuscript instructions and copyright transfer form are available for download on the Conference website <http://www.cce.polyu.edu.hk/shmii-6/>.

Click here to download the latest [Announcement](#) through ISHMII.org.

Thank you for your support and contribution to the Conference.



Curious about the *Journal of Civil Structural Health Monitoring?*

Investigate the
[Index to Articles and Read
Abstracts](#), here.

You may submit research
articles through the [JCSHM
Editorial Manager](#)

*Volume 3, Issue 1, February 2013
is available to ISHMII members who
have logged in to their account at
[ISHMII.org](#).*



Join ISHMII Today

WWW.ISHMII.ORG

2013 Membership Renewals Now Being
Accepted

WORKSHOPS AND CONFERENCES

2013



**MoDeRn International Conference
and Workshop, Luxembourg
March 19-21, 2013**

[International Conference and Workshop -
Monitoring in Geological Disposal of
Radioactive Waste.](#)



**7NSC 2013
Oakland, California
May 20-22, 2013**

[7th National Seismic Conference on Bridges
& Highways](#)

Additional information is also available from Jerome
O'Connor, P.E., Conference Coordinator at
conf7NSC@buffalo.edu.

CONTACT ISHMII

www.ISHMII.org

ISHMII President

Farhad Ansari, Ph.D.
University of Illinois at Chicago
Civil & Materials Engineering
(MC 246)
842 W. Taylor Street
Chicago, Illinois 60607-7023
USA
FAnsari@uic.edu

ISHMII Administrative Centre

University of Manitoba
Agricultural & Civil Engineering Bldg.
A250 - 96 Dafoe Road
Winnipeg, Manitoba R3T 2N2
Canada



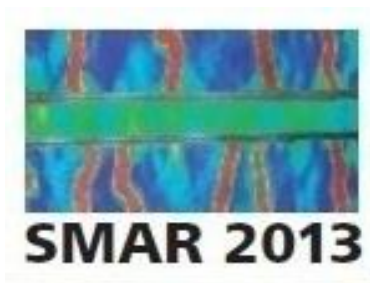
*ISHMII is Proud to be an
Outreach Partner of 7NSC.*



ICSBOC - 2013
**8th International Cable Supported
Bridge Operators Conference**

June 3-5, 2013
Edinburgh, Scotland, UK

The only event hosted by and for owners and
operators of the world's major bridges.



SMAR 2013
Istanbul, Turkey
September 9-11, 2013

**2nd Conference on Smart Monitoring,
Assessment and Rehabilitation of Civil
Structures.**

**Join ISHMII Today or
Renew Your Membership
for 2013**



**Build ISHMII by Sharing
*Membership Notes***

Membership Notes and *The Monitor* are
delivered to members and
colleagues. Your colleagues can receive
both for free.

Refer them to or forward contact
information to NancyC@ishmii.org.
Your comments on *Membership Notes*
are welcome.