# Case Study - Buildings

## Structural Health Monitoring of Critical Public Buildings in Municipality of Hellinikon

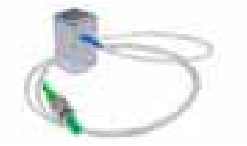
Hellinikon,  Athens, Greece

2008

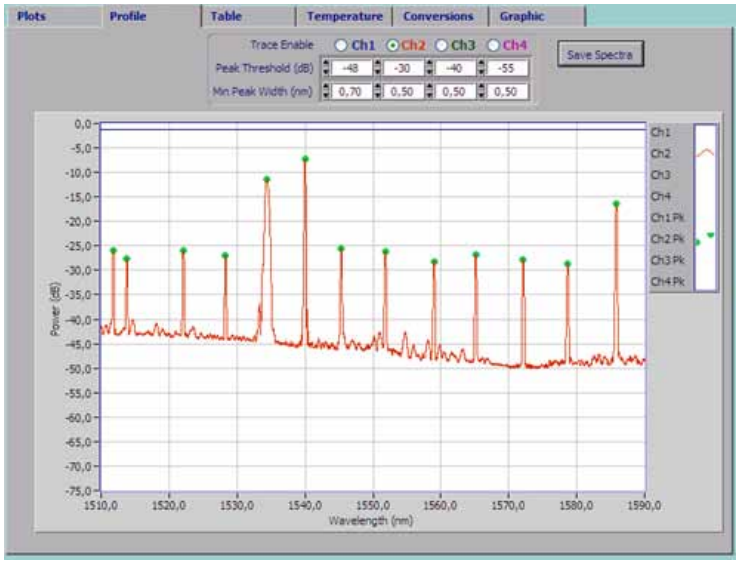
| | |
|---|---|
| Aim | This project aims to monitor the structural status of 5 Critical Buildings of Public Interest in Hellinikon, real-time by using modern sensors based on fiber optic technology. Optical sensors are polled on predefined intervals and collected data are sent directly to the Technical Department of the Municipality. |
| Location | Hellinikon, Athens, Greece |
| System Integrator | H + S Technology Solutions S.A and SmartSensing |
| End Customer | Municipality of Hellinikon |
| Date | 2008 |
| Instrumentation | (4) Micron Optics sm125 @ 1Hz, Optical Sensing Interrogator<br>(1) Micron Optics sm130 @1kHz, Optical Sensing Interrogator and 1 sm041 expansion module<br>(1) HP server in Municipality of Hellinikon Technical Department<br>(5) HP laptops<br>(5) Cisco 800 Series Routers (877 and 876 models) and 1 Cisco 1841 Router in Control Center, located in the Technical Department. |
| Sensors | (250) Optical strain sensors pre-strained ±3500<br>(50) Optical temperature sensors<br>(15) Optical accelerometers |
| Software | SmartSensing Central Suite |
| FBG Technology Benefit | Easy installation, only one cable needed to monitor all sensors installed on a building. |

- The key parameters measured were:
  - Strain
  - Temperature
  - 3-axis acceleration

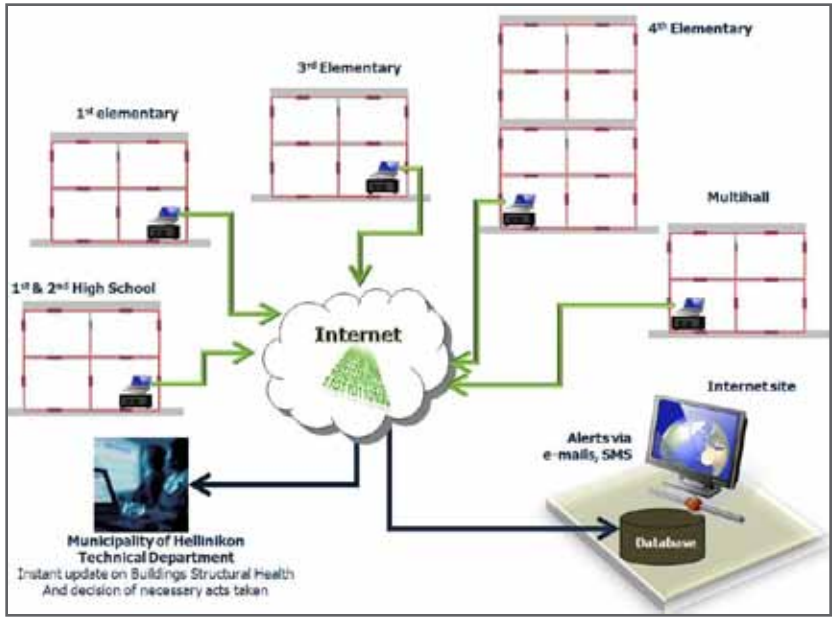
- The sensors used for this project were:
  - 250 long gage, 100mm, optical strain sensors pre-strained, ±3500με
  - 50 optical temperature sensors
  - 15 optical accelerometers

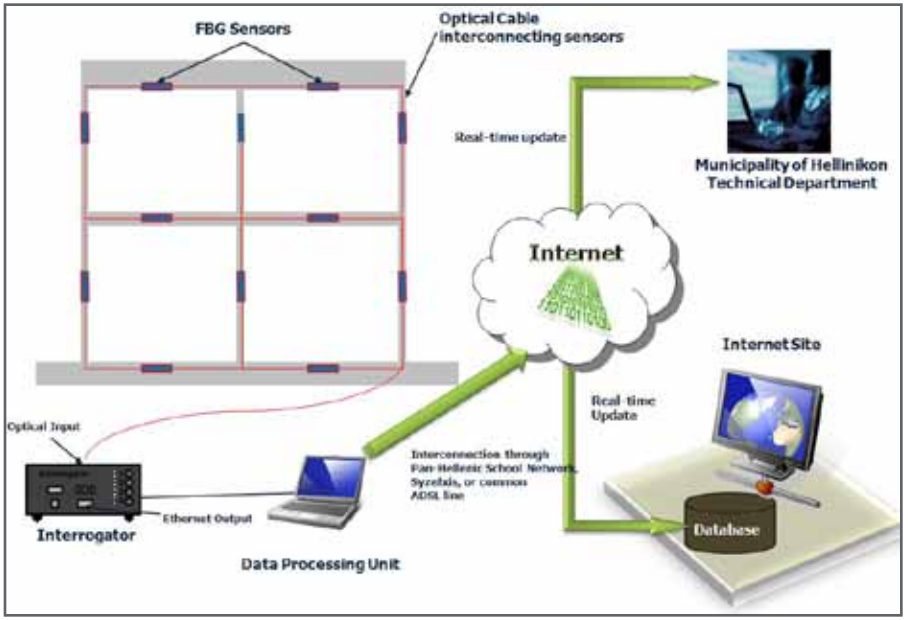


- SmartSensing Central Suite is installed in the Control Center, which is located in Municipality Technical Department. SmartSensing Central Suite:
  - § Collects and stores data from each building centrally
  - § Processes data and, in case of an emergency, issues alerts by dispatching SMS and e-mails to predetermined users.
  - § Remotely manages the interrogator units.
  - § Provides access to historical and real time structural health data.
  - § Provides data to the project web site (http://www.smartsensing.gr).
  - § Manages the rights of the system users.



- Data is collected from the fiber optic sensors and dispatched real time to the Municipality Technical Department. In case of an emergency alerts (e-mails and SMS) are sent to key pre-determined destinations. Parents and citizens have access via project's web site, to information regarding the state of the buildings.



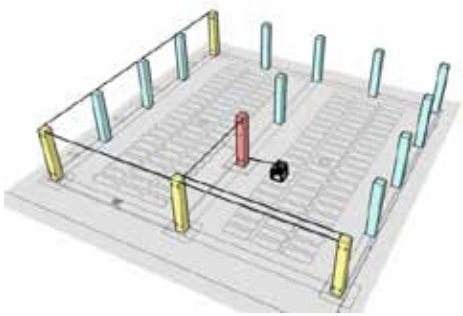
Instrument Hub


W4 (sm125) FBG Interrogator inside

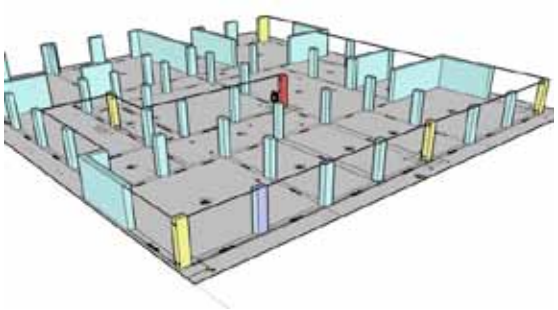
- Iron-plates cover the pillars where the sensors are placed. Stickers on each iron-plate have useful information for the children (i.e. what is an earthquake, preventive actions at the homes, what to do during an earthquake).



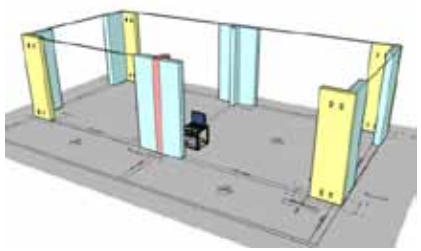
- In 4 buildings 5 “critical pillars were measured with 8 strain sensors and 2 temperature sensors in each pillar. There were also 3 accelerometers ( 1 x-axis, 1 z- axis, 1 y-axis used in the main pillar).
- In the 5th building, 6 “critical” pillars were measured with 8 strain sensors and 2 temperature sensors in each pillar. There were also 3 accelerometers ( 1 x-axis, 1 z- axis, 1 y-axis used in the main pillar).



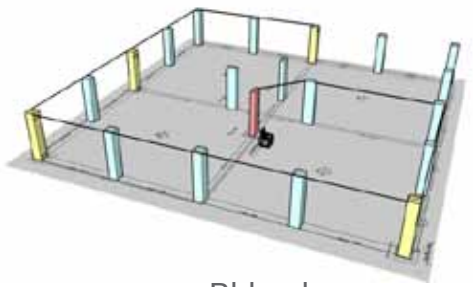
Bldg. a



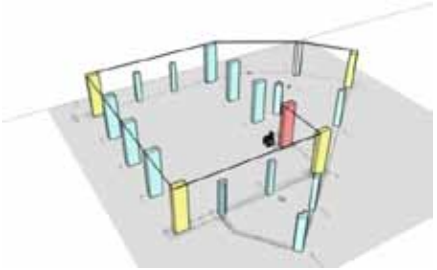
Bldg. b



Bldg. c



Bldg. d



Bldg. e

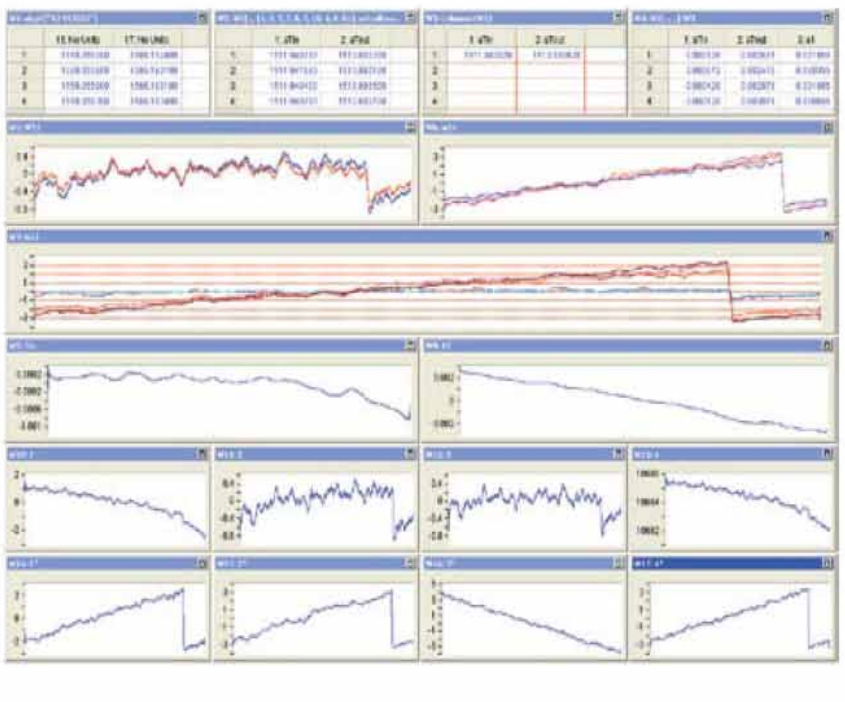
- Easy installation, no need for extra security measures, although it would be better to install sensors in non operating buildings.

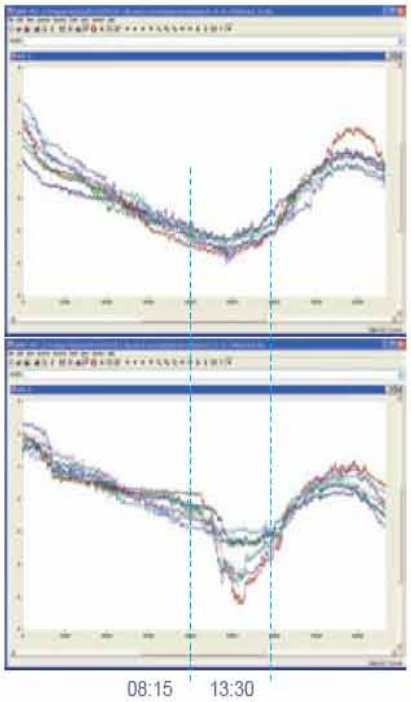
- Installation continued..

- Installation continued..

- This is a pillar's behavior during a 4.5 Richter earthquake, 80Km away from the school. As you can see, soon after the earthquake the strain at the pillar reverted to its normal level without leaving any permanent deformation.

## Field Results






A pillar's behavior during a day without kids (Saturday).

A pillar's behavior during a working day (Monday). The change of the curvature takes place from 08.15 to 13.30, the working hours, and indicates the children's extra load.

- An FBG Optical Sensing System was used because of:
  - Easy installation, only one cable needed to monitor all sensors installed on a building.
  - Electrically safe (the buildings being monitored are mainly schools, so there isn't a risk of an electric shock, in case a child cuts a wire).
  - New Technology used (the program was funded by the 3rd European Union Community Support Framework.
- Electrical power was provided through a main electricity network.

- Results
  - The significance of such a project is obvious, especially in this region which characterized by intense seismic activity and aging building structures. In the future, based on the results and conclusions from this pilot project, the buildings of public interest could use similar systems and be interconnected with the institutions which are responsible for the maintenance and repair of the facilities using different networks.
  - The customer and the end users kids and parents are happy, since now the can use the buildings without the fear and the stress of the unknown structural status of the buildings after an earthquake.

- Acknowledgements
  - H + S Technology Solutions, Mr. Stavros Habakis
    - Tel: +30 210 96 00 988, e-mail: habakis@hstech.eu, web: http://www.hstech.gr or www.smartsensing.gr
  - Smart Fibres, Ltd
    - Tel: +44 (0)1344 484111, email: info@smartfibres.com, web: www.smartfibres.com
  - Micron Optics, Inc.
    - Tel: 404-325-0005, email: info@micronoptics.com, web: www.micronoptics.com