

HI-RISE BUILDINGS DYNAMIC MONITORING

Introduction

Today, the measurement of displacements and vibrations of high buildings still represents a challenge for structural engineers mainly due to logistics matters. **IBIS-S** introduces a totally new solution in the domain of structural monitoring of hi-rise buildings, with many advantages over traditional instruments for this field of application:

- remote sensing at a distance of up to 1 km
- displacement accuracy up to 1/100 mm
- real-time one-dimensional simultaneous mapping of all displacement detected on the structure
- fast installation and operation
- the same instrument can be used for static and dynamic monitoring
- structure vibration sampling up to 100 Hz
- operates day-night, in all weather conditions

Hereinafter the results from an investigation performed on a hi-rise building are given as an example of hi-rise buildings monitoring with **IBIS-S**. The experimental results consist of:

- visualisation of the displacement of the top of the building
- identification of the resonance frequencies of the structure



Fig. 1: IBIS-S.

Measure description

IBIS-S can retrieve several reliable measurement points in the scenario illuminated by the antenna beam measuring simultaneously the displacement of all of them. It doesn't require specific reflectors to be installed on the structure but just the presence of discontinuities such as bolts, beams or windows representing "natural" reflectors.

In order to exploit this key feature for buildings monitoring, IBIS-S has to be installed at the base of the building and tilted in elevation as much as you need to illuminate the building with the antenna beam.

In the described test IBIS-S was installed in front of an hi-rise building at a distance of about 390 m.

From this position IBIS-S illuminated the 207 m high building from the bottom to the top.

The system was configured with the following operational parameters:

- maximum range distance: 500 m
- spatial resolution (in range): 0,5 m
- sampling frequency: 13.5 Hz

The whole measurement consisted of 4 sessions of 10 minutes each and it was performed in only 1,5 hours (instrument installation/dismantlement included).



Fig. 2: IBIS-S in front of the hi-rise building.

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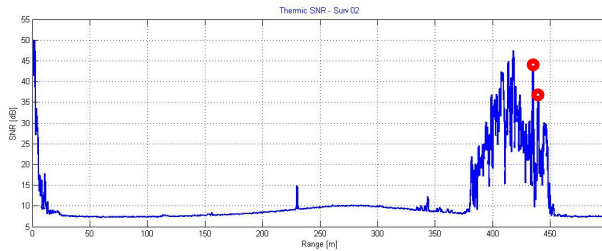


Fig. 3: Distance profile (radar image).

Fig. 3 shows the image of the building acquired by IBIS-S. Peaks in the distance profile correspond to good reflecting points. In the graph there are peaks ranging from 400 to 450 m, corresponding to the discontinuities of the front of the building.

The displacement of the two points highlighted with a red dot (the first corresponding to the top of the building and the second corresponding to a section 14 m below) are showed below as an example of IBIS-S potentiality.

Results

IBIS-S raw data consist of the displacement of the targets belonging to the illuminated scenario. The following figures show the displacement measurement and the frequency analysis of two points belonging to the building located at different heights for a measurement session of 10 minutes (600 seconds). As an accurate analysis should require at least one hour of data, this is just an example of IBIS-S potentialities.

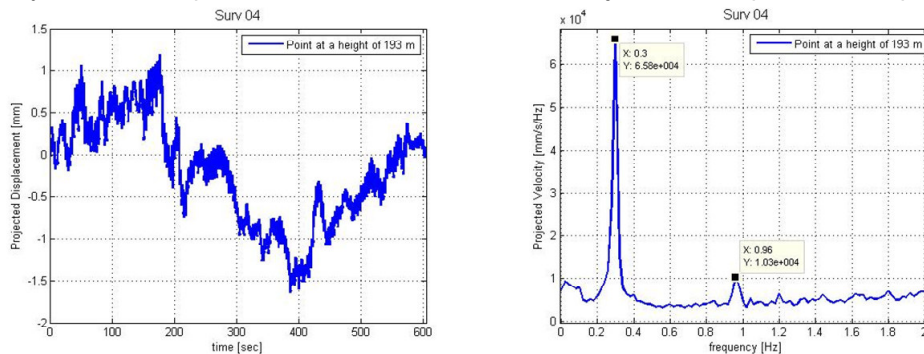


Fig. 4: displacements (left) and spectrum (right) of a building point located at 193 m height.

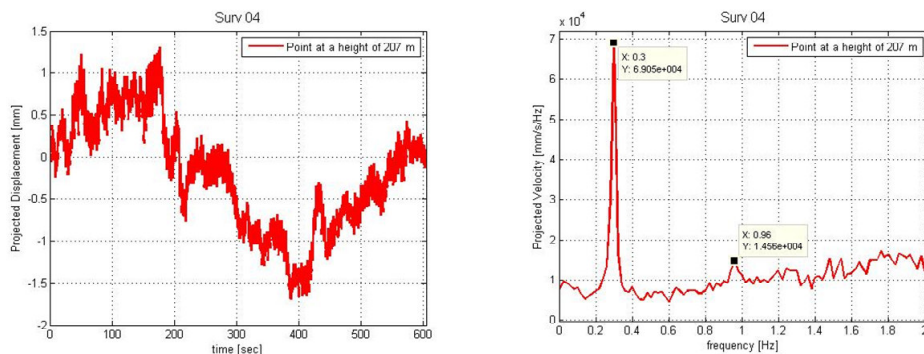


Fig. 5: displacements (left) and spectrum (right) of a point located at the building top (207 m).

By the observation of the previous displacements and of their spectrum it is possible to assert that IBIS-S can be a useful and innovative instrument even for hi-rise buildings monitoring.

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