IABSE Conference – *Structural Engineering: Providing Solutions to Global Challenges*
September 23-25 2015, Geneva, Switzerland

# Predicting structural disasters with Radar interferometry

**Karel Terwel, Ramon Hanssen**

*Delft University of Technology, Delft, the Netherlands*

**Henk van Waning**

*Koninklijke Volker Wessels Stevin N.V., the Netherlands*

**Contact:** k.c.terwel@tudelft.nl

## Abstract

Radar interferometry is a technique which can observe the earth's surface during day and night time. It makes uses of thousands of pulses per second that are transmitted by satellites and reflected by the surface of, for instance, structures. By analyzing the data it is possible to measure displacements of the surface within millimeter precision. For the building industry this might be a promising technique, for monitoring buildings or for forensic engineering. Variables that might be monitored are the displacements of roofs, of balconies or the settlements of buildings. In addition, the technique might be a tool which can be used for forensic investigations. This paper will discuss the possibilities and limitations of radar interferometry for both building monitoring and forensic engineering. The method is expected to be especially useful for measuring soil displacements and the resulting settlements of structures.

**Keywords:** radar interferometry, structural health monitoring, forensic engineering, new technologies

## 1 Radar interferometry and structural failures

Satellite radar interferometry (or InSAR: Interferometric synthetic aperture radar) is a technique to observe the geometry, and geometry changes, of the earth's surface from an orbiting satellite [1]. The satellite orbits are designed such that they repeat exactly after a given repeat interval, typically in the order of one or two weeks. The radar samples the earth's surface and all structures on it with a spatial resolution in the order of meters. In this way, time series are constructed with a typical length of a decade per satellite mission [2]. Using radar phase measurements, the precision of measuring geometry changes is in the order of millimeters, and the estimation of strain rates can achieve precisions of better than 1 mm per year [3]. This routine form of sensing holds great promise to assess and monitor the health of structures, anywhere on earth, and independent of weather conditions or solar illumination.

Although a limited number of the resolution cells in the images is useable, given that a typical radar image has ten thousand to a million resolution cells per square kilometer, this ensures that there remain many observation points, especially over structures. Furthermore, since radar images have been archived from many satellite missions since the early 1990's, there is a huge potential for retrospective analysis.

The investigation and determination of the causes of structural failures of buildings, bridges, and other constructed facilities is called forensic structural engineering [4]. A structural failure can be defined as the inability of a structure or a



https://doi.org/10.2749/222137815818357980
Distributed by structurae