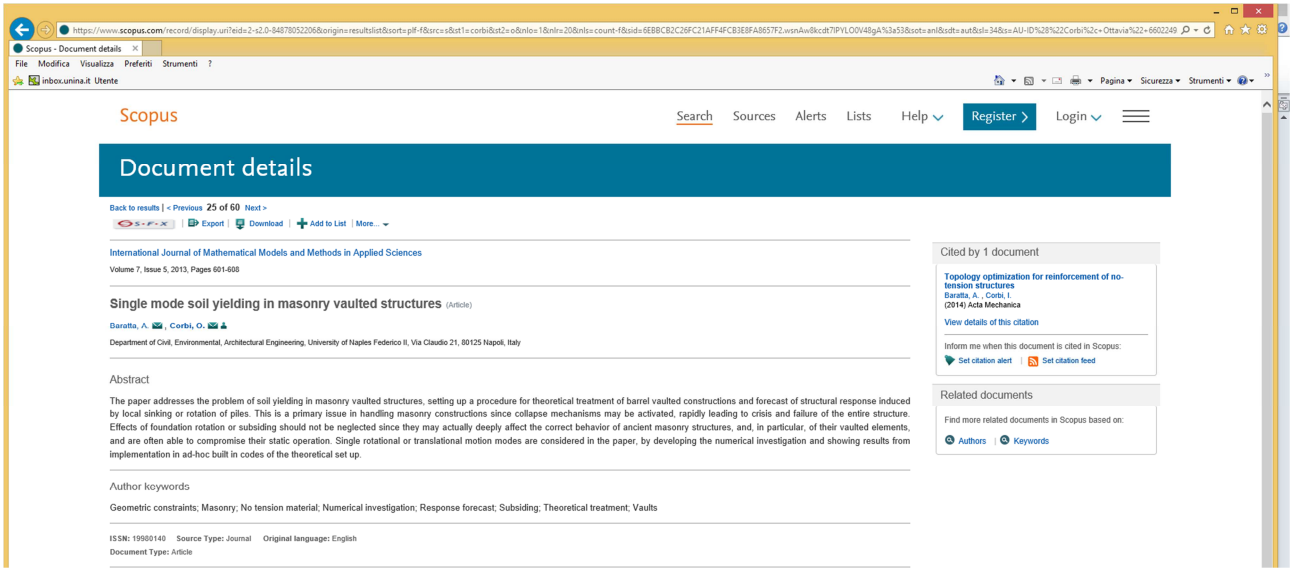

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Single mode soil yielding in masonry vaulted structures (Article)

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Abstract

The paper addresses the problem of soil yielding in masonry vaulted structures, setting up a procedure for theoretical treatment of barrel vaulted constructions and forecast of structural response induced by local sinking or rotation of piles. This is a primary issue in handling masonry constructions since collapse mechanisms may be activated, rapidly leading to crisis and failure of the entire structure. Effects of foundation rotation or subsiding should not be neglected since they may actually deeply affect the correct behavior of ancient masonry structures, and, in particular, of their vaulted elements, and are often able to compromise their static operation. Single rotational or translational motion modes are considered in the paper, by developing the numerical investigation and showing results from implementation in ad-hoc built in codes of the theoretical set up.

Author keywords

Geometric constraints; Masonry; No tension material; Numerical investigation; Response forecast; Subsiding; Theoretical treatment; Vaults

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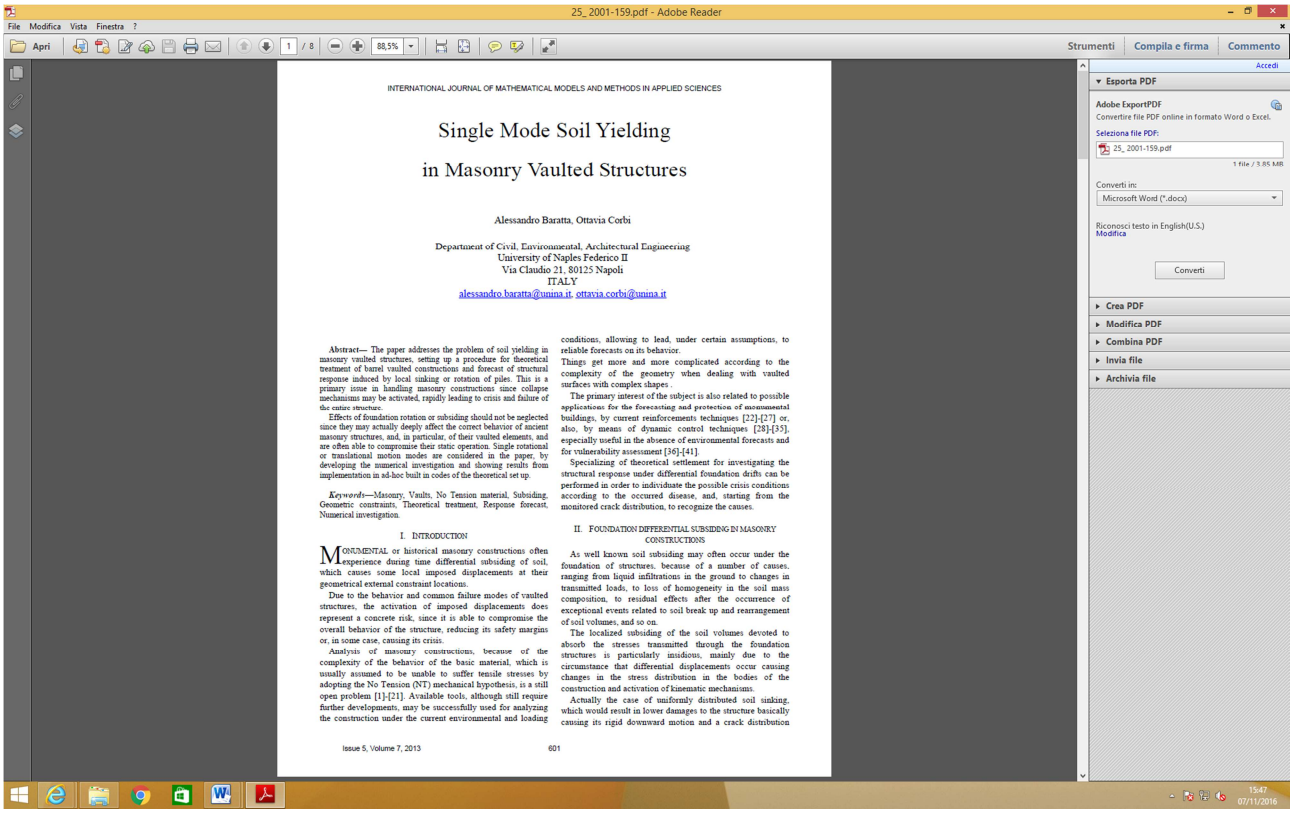

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INTERNATIONAL JOURNAL OF MATHEMATICAL MODELS AND METHODS IN APPLIED SCIENCES

Single Mode Soil Yielding in Masonry Vaulted Structures

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Effects of foundation rotation or subsiding should not be neglected since they may actually deeply affect the correct behavior of ancient masonry structures, and, in particular, of their vaulted elements, and are often able to compromise their static operation. Single rotational or translational motion modes are considered in the paper, by developing the numerical investigation and showing results from implementation in ad-hoc built in codes of the theoretical set up.

Keywords—Masonry, Vaults, No Tension material, Subsiding, Geometric constraints, Theoretical treatment, Response forecast, Numerical investigation.

I. Introduction

Monumental or historical masonry constructions often experience during time differential subsiding of soil, which causes some local imposed displacements at their geometrical external constraint locations.

Due to the behavior and common failure modes of vaulted structures, the activation of imposed displacements does represent a concrete risk, since it is able to compromise the overall behavior of the structure, reducing its safety margins or, in some case, causing its crisis.

Analysis of masonry constructions, because of the complexity of the behavior of the basic material, which is usually assumed to be unable to suffer tensile stresses by adopting the No Tension (NT) mechanical hypothesis, is a still open problem [1]-[21]. Available tools, although still require further developments, may be successfully used for analyzing the construction under the current environmental and loading conditions, allowing to lead, under certain assumptions, to reliable forecasts on its behavior.

Things get more and more complicated according to the complexity of the geometry when dealing with vaulted surfaces with complex shapes .

The primary interest of the subject is also related to possible applications for the forecasting and protection of monumental buildings, by current reinforcements techniques [22]-[27] or, also, by means of dynamic control techniques [28]-[35], especially useful in the absence of environmental forecasts and for vulnerability assessment [36]-[41].

Specializing of theoretical settlement for investigating the structural response under differential foundation drifts can be performed in order to individuate the possible crisis conditions according to the occurred disease, and, starting from the monitored crack distribution, to recognize the causes.

II. Foundation Differential Subsiding in Masonry Constructions

As well known soil subsiding may often occur under the foundation of structures, because of a number of causes, ranging from liquid infiltrations in the ground to changes in transmitted loads, to loss of homogeneity in the soil mass composition, to residual effects after the occurrence of exceptional events related to soil break up and rearrangement of soil volumes, and so on.

The localized subsiding of the soil volumes devoted to absorb the stresses transmitted through the foundation structures is particularly insidious, mainly due to the circumstance that differential displacements occur causing changes in the stress distribution in the bodies of the construction and activation of kinematic mechanisms.

Actually the case of uniformly distributed soil sinking, which would result in lower damages to the structure basically causing its rigid downward motion and a crack distribution

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