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Revealing the hidden structures of an historical bridge by high resolution geophysical methods : A case study of Pont de Coq, France

R. Antoine and C. Fauchard

Centre d'Études Techniques de l'Équipement, Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux, France (raphael.antoine@developpement-durable.gouv.fr)

In the last decades, public institutions have shown an increased interest in heritage conservation and monuments protection. Geophysical methods have been used for 20 years as powerful tools to assist in the curation of buildings. Ancient masonry bridges usually exhibit a complex structure/geometry. This complexity makes the use of combined geophysical methods highly necessary to obtain a meaningful model of the internal structure of such constructions and their environment.
A high resolution geophysical survey was carried out at a stone arch bridge called Pont de Coq and located near Menerval, Normandy (France) in 2011. This decameter-sized bridge was built 400 years ago and crosses the Epte river, which is a tributary of the Seine river. The main objective of this work was to evaluate the structural state of the bridge and its vicinities. Two complementary methods were used : Electrical Resistivity tomography (ERT) and Ground Penetrating radar (GPR). Several profiles were realized along the road crossing the bridge and transversally to the construction, as well as on the two banks of the Epte river. High resolution electrical resistivity data were obtained both in the horizontal and vertical direction up to 8 meter-depth by two ERT methods (Wenner/Schlumberger and dipole-dipole). The GPR was used with shielded antennas at three different frequencies (200 MHz, 400 MHz and 1.5 GHz). This approach lead to the investigation of the subsurface up to approximately 6 meters-depth, with a resolution in the range of 0.04 m-0.40m. An excellent correlation is obtained between the ERT and the GPR methods, allowing us to propose a precise structural model of the Pont de Coq and to characterize the soil under the building. Several anomalies are observed within the roadway of the bridge at 50 cm-depth, as well as within the vaulting, corresponding to the presence of voids and a root network which lead to the slow destruction of the structure.