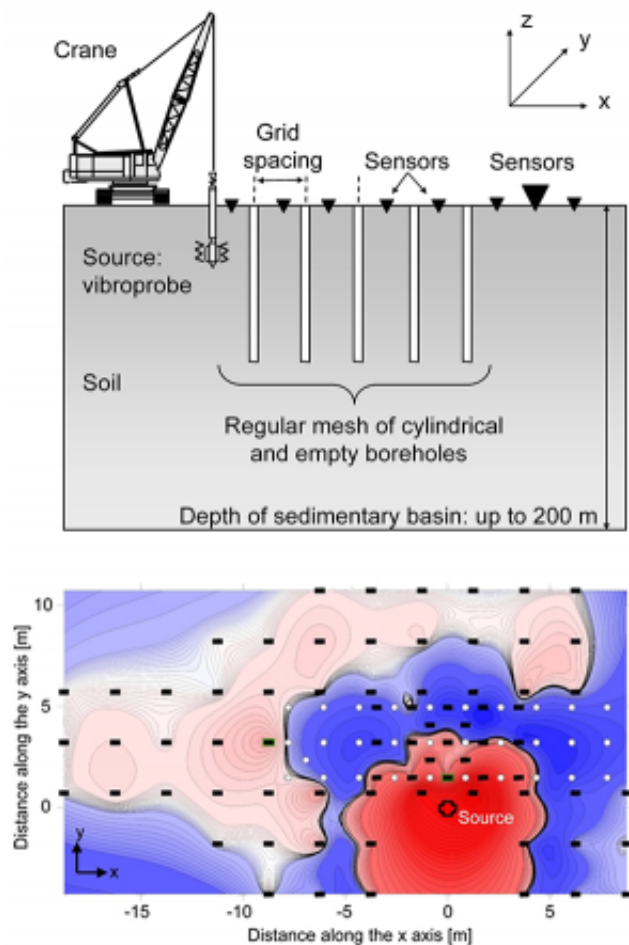


Field study shows possibility of deflecting seismic waves around desired geologic surface areas

April 9 2014, by Bob Yirka



(a) Scheme of the testing device for seismic metamaterials. An oscillating probe generates acoustic waves at 50 Hz in front of a mesh of cylindrical boreholes. An array of sensors monitors the intensity of the waves at various positions. (b) Experimental results. The map (black rectangles: sensors; white circles: boreholes; red cross: source) plots the difference of energy after and before

drilling the boreholes. The dark blue region behind the holes indicates that the presence of the borehole mesh results in a decrease of elastic energy transmitted to that area. The red region indicates the area close to the source in which the wave intensity increases because of reflection. Credit: S. Brûlé et al., *Phys. Rev. Lett.* (2014)

(Phys.org) —A team of researchers in France has successfully demonstrated small-scale reflection of seismic waves around a desired geological area. In their paper published in the journal *Physical Review Letters*, the researchers describe an experiment they conducted at an outdoor site to test whether lessons learned in creating cloaking devices using metamaterials (and other techniques) might be applied to seismic waves generated by earthquakes.

The construction of tiny [cloaking devices](#) has made headlines around the world in recent years, though they are still very much in their infancy. In this new field study, the team in France sought to learn whether a similar cloaking device could be built on a much larger scale. More specifically, they wanted to know if it might be possible to cloak parts of the surface of the Earth, from destructive seismic waves, i.e. earthquakes.

To find out, they noted the frequencies at which seismic waves tend to move through the ground and then devised a grid system that in theory could cause the waves to change course due to diffraction among the elements that made up the grid. To test their theory they dug an array of boreholes five meters deep (.32 meters diameter) in a section of ground to serve as the cloaking device. They then buried several sensors around and near the grid to test how well the cloak worked. Finally, a crane was used to lower a vibrating pole into a hole a meter and a half away from the grid to cause the creation of seismic waves.

In analyzing data from the sensors, the researchers found that the bore-hole grid did indeed reflect a significant portion of the seismic waves, leaving the ground around them nearly unshaken. They also noted that areas next to the bore-hole grid had nearly double the amount of seismic energy—they were exposed to the initial waves from the source and also from the waves that were reflected off the grid.

The experiment opens the door to the possibility of protecting populated areas from the devastation of earthquakes. Many questions must still be addressed however. First, if a massive grid were constructed to protect a city, where would the waves be sent instead. Also, there is the question of how well the idea would scale—much more work needs to be done to find the answers to such questions, though it will be a near certainty that the results by this team will cause others to join in as well.

More information: Experiments on Seismic Metamaterials: Molding Surface Waves, *Phys. Rev. Lett.* 112, 133901 – Published 31 March 2014, [dx.doi.org/10.1103/PhysRevLett.112.133901](https://doi.org/10.1103/PhysRevLett.112.133901)

ABSTRACT

Materials engineered at the micro- and nanometer scales have had a tremendous and lasting impact in photonics and phononics. At much larger scales, natural soils civil engineered at decimeter to meter scales may interact with seismic waves when the global properties of the medium are modified, or alternatively thanks to a seismic metamaterial constituted of a mesh of vertical empty inclusions bored in the initial soil. Here, we show the experimental results of a seismic test carried out using seismic waves generated by a monochromatic vibrocompaction probe. Measurements of the particles' velocities show a modification of the seismic energy distribution in the presence of the metamaterial in agreement with numerical simulations using an approximate plate model. For complex natural materials such as soils, this large-scale experiment was needed to show the practical feasibility of seismic metamaterials

and to stress their importance for applications in civil engineering. We anticipate this experiment to be a starting point for smart devices for anthropic and natural vibrations.

© 2014 Phys.org

Citation: Field study shows possibility of deflecting seismic waves around desired geologic surface areas (2014, April 9) retrieved 25 April 2024 from <https://phys.org/news/2014-04-field-possibility-deflecting-seismic-desired.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.