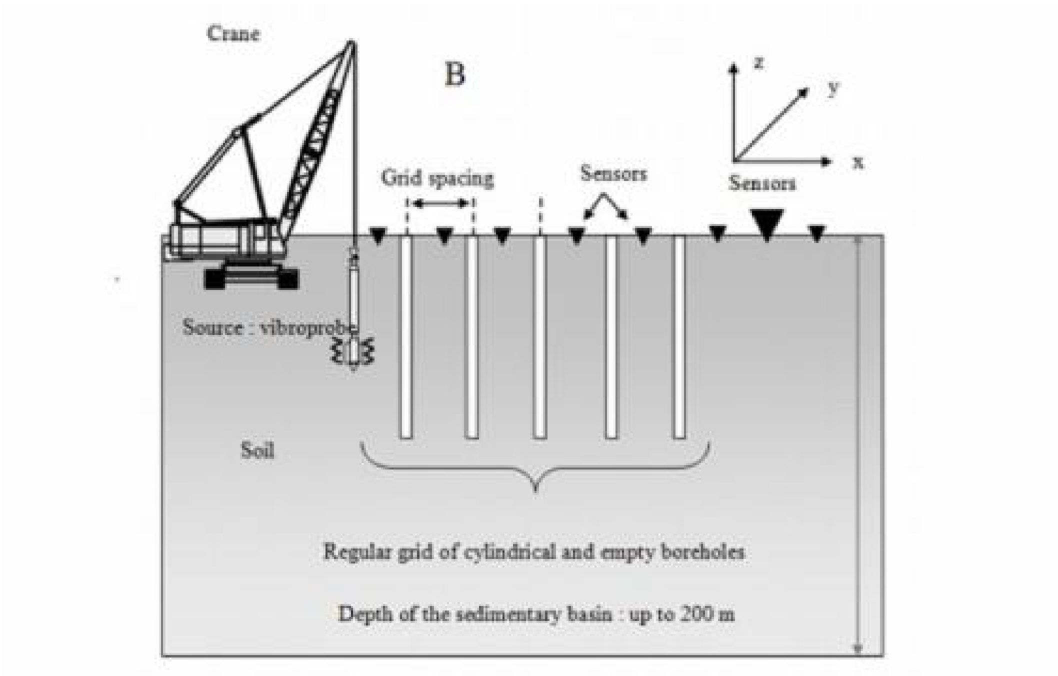
# How to prevent earthquake damage: make buildings invisible

February 12 2013, by Marcia Malory




(Phys.org)—When an earthquake strikes, damage to buildings such as nuclear power stations can worsen the catastrophe. Researchers from France's Institut Fresnel and the French division of Menard, a ground-improvement specialist company, have developed an invisibility cloak that could protect buildings during an earthquake by redirecting seismic waves around them.

The researchers studied invisibility cloaks that make objects invisible to light waves. These cloaks are made of metamaterials smaller than the wavelength of light. They divert light waves around themselves, so light cannot reach anything hidden inside.

While invisibility cloaks are standard fare in science fiction and fantasy, in reality, it is very difficult to create a metamaterial capable of manipulating light waves, which are extremely short and travel very long distances. Seismic waves, however, are longer than light waves and do not travel as far, so developing a seismic metamaterial could be easier.

Last year, physicists at Mokpo National Maritime University in South Korea and the Australian National University in Canberra developed a model for a seismic invisibility cloak. The French team, however, was the first to build and test one.

The team simulated an earthquake by using a vibraphone to create 50-hertz acoustic waves across a silty clay alluvial basin, up to 200 meters deep, near Grenoble, France. Acoustic sensors measured the waves' movement.

They then created a metamaterial by drilling three rows of holes into the basin. There were 10 holes in each row, spaced 1.73 meters apart. Each hole was about five meters deep and had an average diameter of 320 millimeters.

When the French team re-transmitted the 50-hertz waves, energy levels near the source of the waves almost doubled, indicating that the metamaterial was reflecting the waves, which barely made it past the second row of holes. While a seismic metamaterial like this might eventually save lives during an earthquake, engineers and physicists still need to address some important issues.

For example, it is impossible to predict the length of an earthquake's seismic waves. This makes it difficult to determine how far to space the holes in the array. A way to get around this might be to arrange the holes to match the resonance of the building needing protection.

There is also a danger that seismic waves reflected off a building could damage nearby buildings. A metamaterial that absorbs, rather than reflects, seismic waves might be a better choice.

**More information:** arxiv.org/abs/1301.7642