Geophysical Research Abstracts
Vol. 12, EGU2010-14010, 2010
EGU General Assembly 2010

Detecting stress changes in an engineering structure with elastic waves

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Monitoring of the complex wave field in heterogeneous media lead to outstanding seismological measurements of weak structural changes in volcanoes and fault zones. Also in laboratory experiments the sensitivity of scattered waves to weak changes in the propagation medium has been demonstrated. Here we present an investigation on an intermediate scale to monitoring stress induced velocity variations in a concrete construction. The construction is a highway bridge in Germany made of reinforced concrete. It was build with the timed-shifting method. This means that construction takes place at one side of the bridge which is successively pushed over the pillars as the constructions continues. During the movement of the construction over the pillars the stress in the deck slab undergoes changes from tension to compression.

We used seismic equipment to induce elastic waves in the deck slab of the bridge at different position of the array relative to the supporting pillars. Comparing reverberating waves in the slab recorded at different stress states we can infer changes in the propagation velocity. The observed velocity changes agree with the predicted variations based on modeled stress concentrations in the slab.

Since structural integrety is important for every engineering structure the use of scattered elastic waves offers a great potential for effective monitoring.