neous anisotropic conditions; elasticity; elastic waves; stability constraints; one-parameter expressions for slowness surfaces, slowness curves and wave curves; squared slowness surfaces and squared slowness curves; causes of anisotropy; anisotropy and seismic exploration; eigentensors of the elastic tensor and their relationship with material symmetry. (G.E.Hogson)

961157
Prediction of elastic-wave velocities in sandstones using structural models
S. Bryant & S. Raikes, *Geophysics*, 60(2), 1995, pp 437-446.

Elastic-wave propagation in fluid-saturated sand-stones depends upon two sets of rock features: 1) the volume fractions and elastic constants of the rock constituents (quartz, clay, water, etc.) and 2) microstructural geometry (grain contacts, pore aspect ratios). While the former data are usually obtainable, the latter are relatively inaccessible. The paper presents a new method for determining microstructural data using idealized but physically representative models of sandstone. The key to the method is the simulation of certain depositional and diagenetic processes in a manner that completely specifies the geometry of the resulting models. Hence, the geometric features of the grain space and void space required for various theories of elastic propagation can be calculated directly from the models. The results suggest that it is feasible to predict elastic velocities directly from geological models in the absence of rock samples. (from Authors)

961158
Numerical simulation of elastic wave propagation in granular rock with the boundary integral equation method
K. T. Nihei, L. R. Myer & N. G. W. Cook, *Journal - Acoustical Society of America*, 97(3), 1995, pp 1423-1434.

To better understand the effects of the microstructural properties of granular rocks such as grain packing geometry, grain shape and size, grain contact properties, and grain scale heterogeneity on the velocities and amplitudes of seismic waves, a numerical approach for modeling elastic wave propagation in granular rock has been developed. The approach employs the boundary integral equation method to model the complete dynamic response of a packing of arbitrarily shaped grains. The effects of dry, fluid-filled, and clay-filled grain contacts are incorporated into the numerical formulation using a discontinuity boundary condition with a complex stiffness parameter. (Authors)

961159
On the estimation of the amplitude of shear strain from measurements *in situ*
A. Niemunis, *Soil Dynamics & Earthquake Engineering*, 14(1), 1995, pp 1-3.

It is well known that the shear strain amplitude caused by an elastic wave can be estimated on the basis of measurements of the particle velocity. In this aspect, the difference between a vertically polarized plane shear wave and a plane Rayleigh wave is presented. A particular case is studied in which the vertical component of the velocity of a particle lying on the ground surface is known. The relation between the particle velocity and the strain amplitude is derived and a diagram for evaluation of this amplitude is given. (Author)

961160
Differential effective medium modeling of rock elastic moduli with critical porosity constraints
T. Mukerji, J. Berryman, G. Mavko & P. Berge, *Geophysical Research Letters*, 22(5), 1995, pp 555-558.

Rocks generally have a percolation porosity at which they lose rigidity and fall apart. This paper shows how the conventional Differential Effective Medium (DEM) theory can be modified to incorporate percolation of elastic moduli in rocks by taking the material at the critical porosity as one of the constituents of a two-phase composite. The modified DEM model incorporates percolation behavior, and at the same time is always consistent with the Hashin-Shtrikman bounds. The predictions compare favorably with laboratory sandstone data. (from Authors)

961161
The generalized *SH*-wave equation
J. M. Carcione & F. Cavallini, *Geophysics*, 60(2), 1995, pp 549-555.

The paper presents a generalization of the *SH*-wave equation for anisotropic and dissipative media. The most general case in which *SH*-waves are decoupled from *P*- and *SV*-waves at all propagation angles is that of propagation in the plane of symmetry of a monoclinic medium. In the isotropic case, the *SH* constitutive equation involves only one elastic coefficient (the rigidity); here, three elastic coefficients are needed. Moreover, dissipation is introduced by using Boltzmann's law based on several relaxation mechanisms. Anisotropic attenuation and velocity dispersion are guaranteed by choosing different relaxation functions for the principal axes. The wave equation, in the displacement and velocity-stress formulations, is solved by using time-domain spectral modeling techniques. (from Authors)

961162
Wave propagation in heterogeneous, porous media: a velocity-stress, finite-difference method
N. Dai, A. Vafidis & E. R. Kanasewich, *Geophysics*, 60(2), 1995, pp 327-340.

A particle velocity-stress, finite-difference method is developed for the simulation of wave propation in 2-D heterogeneous poroelastic media. Instead of the prevailing second-order differential equations, this study considers a first-order hyperbolic system that is equivalent to Biot's equations. An original analytic solution for a *P*-wave line source in a uniform poroelastic medium is derived for the purposes of source implementation and algorithm testing. In simulations with a two-layer model, additional 'slow' compressional incident, transmitted, and reflected phases are recorded when the damping coefficient is small. This 'slow' compressional wave is highly attenuated in porous media saturated by a viscous fluid. The simulation also verified that the attenuation mechanism introduced in Bioti's theory is of secondary importance for 'fast' compressional and rotational waves. The method was applied in simulating seismic wave propagation over an expanded steam-heated zone in Cold Lake, Alberta in an area of enhanced oil recovery (EOR) processing. The results indicate that a seismic surface survey can be used to monitor thermal fronts. (from Authors)

961163
Constitutive model and wave equations for linear, viscoelastic, anisotropic media
J. M. Carcione, *Geophysics*, 60(2), 1995, pp 537-548.

Rocks are far from being isotropic and elastic. Such simplifications in modeling the seismic response of real geological structures may lead to misinterpretations, or even worse, to overlooking useful information. It is useless to develop highly accurate modeling algorithms or to naively use amplitude information in inversion processes if the stress-strain relations are based on simplified rheologies. Thus, an accurate description of wave propagation requires a rheology that accounts for the anisotropic and anelastic behavior of rocks. This work presents a new constitutive relation and the corresponding time-domain wave equation to model wave propagation in inhomogeneous anisotropic and dissipative media. The rheological equation includes the generalized Hooke's law and Boltzmann's superposition principle to account for anelasticity. (from Author)

961164
Time domain analysis of generalized viscoelastic models
N. Makris, *Soil Dynamics & Earthquake Engineering*, 14(5), 1995, pp 375-386.

Starting from the constant hysteretic model which was initially proposed to model the behaviour of dry sands, it is shown that the basic response functions of complex-parameter viscoelastic models are complex valued functions. the classical relations between the basic response function and the dynamic modulus are extended for the case of these generalized viscoelastic models. Finally, the time domain response of practical constitutive models with complex parameters is investigated, and the limitations and advantages of the convolution integral method are discussed. (from Author)

961165

Simulation of stochastic waves in a non-homogeneous random field

J. Kiyono, K. Toki, T. Sato & H. Mizutani, *Soil Dynamics & Earthquake Engineering*, 14(5), 1995, pp 387-396.

A simple trend model that uses the Fourier spectrum of the observed wave is proposed. The kriging method is used for the optimum interpolation of random waves. According to the conditional simulation, random stochastic waves were generated on a non-homogeneous random field. The simulated waves are coincident with known time histories at specific points. (from Authors)

961166

Investigation of non-linear site amplification at two downhole strong ground motion arrays in Taiwan

Kuo-Liang Wen, I. A. Beresnev & Yeong Tein Yeh, *Earthquake Engineering & Structural Dynamics*, 24(3), 1995, pp 313-324.

Non-linear seismic response of soil is studied by comparing the spectral ratios of surface to downhole horizontal accelerations on weak and strong motion. Data from two boreholes are analysed. One is drilled in the alluvial deposits in the south-west quadrant of the SMART1 array. The second one penetrates Pleistocene terrace deposits in the northern part of the SMART2 array. Observed weak and strong motion spectral ratios are compared with the theoretical ones predicted by the geotechnical soil model which postulates a hysteretic constitutive law. A significant non-linear response is found at the first site for the events with surface peak acceleration exceeding roughly 0.15 *g*. No statistically significant non-linear response is detected on the second array, that is tentatively accounted for by the stiffer soil conditions and weaker accelerations achieved at the SMART2 site. The results indicate that the non-linear amplification can be detectable at certain soil conditions above a threshold acceleration level. (from Authors)

961167

Lotung downhole array. I: evaluation of site dynamic properties

A. W. Elgamal, M. Zeghal, H. T. Tang & J. C. Stepp, *Journal of Geotechnical Engineering - ASCE*, 121(4), 1995, pp 350-362.

The Lotung large-scale seismic test (LSST) site in Taiwan was instrumented in 1985 with an array of downhole and surface accelerometers, by the Electric Power Research Institute (EPRI), Palo Alto, California, and the Taiwan Power Company (TPC). Taipei, Taiwan. A total of 18 earthquakes were recorded during the period 1985-86. Correlation and spectral analyses of the recorded downhole accelerations are performed to evaluate shear wave propagation characteristics, variation of shear wave velocity with depth, and site resonant frequencies and modal configurations. A shear-beam model, calibrated by the identified site properties, is found to represent the site dynamic response characteristics over a wide frequency range. (from Authors)

961168

Lotung downhole array. II: evaluation of soil nonlinear properties

M. Zeghal, A.-W. Elgamal, H. T. Tang & J. C. Stepp, *Journal of Geotechnical Engineering - ASCE*, 121(4), 1995, pp 363-378.

The characteristics of soil response during earthquake excitations, at a site in Lotung, Taiwan are identified using the Lotung large scale seismic test (LSST) data. A technique is developed to evaluate soil shear stress-strain histories directly from the free-field downhole accelerations. Soil stiffness properties are found to compare satisfactorily with those obtained through laboratory tests. Pore pressure buildup appears to be accompanied by a reduction in soil stiffness. The information obtained in this study demonstrates that downhole accelerometer and pore pressure arrays offer a direct effective means of evaluating seismic soil properties. (from Authors)

961169

Laboratory study of seismic free-field response of sand

K. L. Fishman, J. B. Mander & R. Richards Jr, *Soil Dynamics & Earthquake Engineering*, 14(1), 1995, pp 33-43.

This paper describes a new soil-structure interaction test box for use on a moderately large shaking table. The test box is designed to replicate, as nearly as possible, the free-field seismic response of a soil layer overlying a rigid base. Results from shaking table testing are presented which demonstrate the ability of the test box to serve as a large-scale shear device. The test box is unique in its ability to determine dynamic shear modulus for both high- and low-amplitude shear strain, and also to study the dynamic response of sand under low levels of confining stress. Dynamic shear modulus for standard Ottawa sand was measured over a wide range of shear strain amplitude and compared with data from the existing literature. (from Authors)

961170

Effect of water and gas saturation in layers on elastic parameters of rocks and reflection coefficients of waves

M. Bala, *Acta Geophysical Polonica*, 42(2), 1994, pp 149-158.

Laboratory tests showed that macroscopic distribution of liquid and gaseous phases in pores could affect the character of elastic parameters changes. There may be a case that even a small amount of gas brings about substantial decrease in elastic moduli of rocks. The results of computations of elastic parameters as a function of porosity, water and gas saturation, and pore distribution expressed in terms of pore shape coefficients are presented. The results prove the suggested effects of macroscopic distribution of liquid and gaseous phases in pores on elastic parameters of rocks. (from Author)

961171

Field verification of a theoretical model to predict the dynamic response of a soft clay deposit

V. R. Raju, T. Neidhart & G. Huber, *Soil Dynamics & Earthquake Engineering*, 14(1), 1995, pp 73-77.

A 40-m thick clay deposit was subjected to sinusoidal excitations using a foundation block and an eccentric mass type vibrator. The response of the foundation block and the surrounding soil was measured using geophones inside the soil and on the surface. The phase shift between the excitation signal and the response signal, the accelerations of the foundation block and the particle velocities in the soil are compared with those obtained from a frequency-dependent numerical model based on the exact analytical solution of the boundary value problem of a rectangular foundation resting on a linear elastic halfspace. (Authors)

961172

Amplification of obliquely incident waves by a cylindrical valley embedded in a layered half-space

F. C. P. De Barros & J. E. Luco, *Soil Dynamics & Earthquake Engineering*, 14(3), 1995, pp 163-175.

Extensive numerical results illustrating the harmonic three-dimensional response of cylindrical valleys embedded in uniform and layered media and subjected to obliquely incident P-, SV- and SH-waves are presented. In particular, the effects of the horizontal and vertical angles of incidence. Some of the effects of layering and the dependence of the results on the frequency of the excitation are examined in some detail. (Authors)