Geophysical Research Abstracts,
Vol. 11, EGU2009-7189, 2009
EGU General Assembly 2009


# Estimating peak dynamic strains at the ground surface and at depth during earthquake shaking: application to the safety study of a geological storage of CO2

S. Sy (1), J. Douglas (2), and D. Seyedi (3)

(1) BRGM, ARN/RSC, orleans, France (s.sy@brgm.fr), (2) BRGM,ARN/RIS,orleans, France (j.douglas@brgm.fr), (3) BRGM, ARN/RSC, orleans, France (d.seyedi@brgm.fr)

Within the framework of a scenario-based methodology used to evaluate the risks related to the geological storage of $CO_2$, the risk posed by earthquakes to the storage safety must be evaluated. The main aim of this article is to predict by a simple empirical method, verified by numerical simulations, the peak dynamic strains in the reservoir during an earthquake. This allows, following an investigation of the risk of rock rupture or damage in the reservoir and sealing units (i.e. caprock and wells), an evaluation of the seismic risk. However, these subsequent calculations are not carried out in this article, which is limited to a determination of the dynamic stresses during an earthquake.

A simplified procedure for the prediction of maximum soil strains was proposed by Newmark [1] and later used by several authors. In this approach, the peak strain is equal to the horizontal peak ground velocity (PGV) divided by the apparent 'propagation speed' of strong-motion waves, $C$. Using that approximate equation for strain is difficult, because $C$ is not known a priori and depends both on site and wave characteristics. A more recent approach simplifies it by replacing $C$ by $\beta 1$, which is the shear-wave velocity in the uppermost layer of the soil structure, and by including a site-specific corrective factor $A$ [2].

However, all these studies were limited to determining the peak dynamic strains at the ground surface and not at depth. Thus it is necessary for us to evaluate the site-specific corrective factor $A$ for the geological context of studied area for the peak dynamic strain at the surface and also to estimate a similar correlation between strains and $PGV/\beta$ at depth, where $\beta$ is the shear-wave velocity in the considered layer.

A sophisticated one-dimensional site response computer program is used to create a set for analysis of peak strains. It calculates, for a given geological model consisting of parallel layers and a given input accelerogram, the ground accelerations, velocities and displacements, and the dynamic stresses and strains, in each layer. Thus, we can correlate associated peak ground motions, in particular PGV, and the peak dynamic strains. An approximate seismic profile corresponding to the geological structure of North Pyrenees Basin has been used to conduct these simulations using a number of accelerograms recorded on rock that are appropriate for the seismo-tectonic context of this region. These data are then used for statistical analysis to find a linear correlation between the peak dynamic strain and $PGV/\beta$. The dynamic stresses in the ground following an earthquake can be quickly and estimating by assuming linear behaviour. The advantages and disadvantages of such an approach and its limits related to the assumption of linear behaviour and the fact that the 3D structure at the site is not taken account, are finally discussed.

## References

[1] Newmark, N. Problems in wave propagation in soil and rock, *Proc. Int. Symp. on Wave Propagation & Dynam. Properties of Earth Materials*, Albuquerque, pp. 7-26, 1967.

[2] Trifunac M.D., Lee V.W. Peak surface strains during strong earthquake motion, *Soil Dynamics and Earthquake Engineering* **15**, 311-319, 1996.