Seismic Study of the Dynamic Response of Rock to Cylindrical Charges Fired in a Half and a Qarter Space Geometry

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ABSTRACT

A series of controlled seismic experiments was performed in a limestone quarry in southern Germany to study seismic effects of cylindrical charges fired in both a half space (HS) (burden 63 m) and quarter space (QS) (burdens of 3 and 3.5 m) geometry. Charge columns contained from 20-32 kg of explosives and initiated from the bottom. The explosives formed a cylinder 4 m (20 kg) and 5 m (32 kg) high and 90 mm in diameter at depths from 3-8 m below ground level. Prior to each of the larger explosions, small charges of 0.12 kg seismogelit were fired at 4 m and 8 m depths in the same boreholes. Seismograms were obtained from 23 three component surface stations and up to 10 three component borehole stations (6 m depth). For each experiment, stations were located on three linear profiles of length 72 m at different azimuths from the source and one semicircular profile at a constant range of 30 m. Analysis of four refraction profiles results in a first order approximation velocity model consising of an upper layer of 7.4 m thickness with a P wave velocity of 2730 m/s underlain by a faster half space of 4950 m/s. Seismograms from the azimuthal profile show as much as 90% variation in amplitude values for a given component and charge weight. Wave shape differences are characterized by very emergent to reasonably sharp onset first arrivals. Seismic signals from the smaller explosions provide empirical models of the seismic wave propagation from the source to the seismic receivers for both the HS and QS experiments. Linear superposition of the 0.12 kg charges using interpolated seismograms between 4 and 8 m depth produces seismograms for use in deconvolving the source time function of the cylindrical charges. Deconvolution results indicate that vertical and radial amplitudes are reduced from HS to QS by as much as 46% and 39% even though the charge weights were identical. Transverse energy generated in the source region of the half space is highly attenuated (58-75%) in the quarter space source time functions.