

The Response of a Buried High-Pressure Natural Gas Pipeline to Surface Coal Mine Vibrations

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Surface coal mine blasting at the McKinley Mine was conducted at distances as close as 150 ft. to a 30 in. diameter Grade X-52 steel natural gas pipeline. The 845-psi operating pressure (MAOP) pipe is buried in alluvium 7.2 ft. (pipe bottom), only a few inches from sandstone bedrock.

The pipeline was excavated on April 27, 2001 and single component velocity geophones were attached as shown in Figs. 1 and 2. A series of 15 blasts were conducted using various blasthole patterns, charge weights and initiation timing to ensure that velocity measurement on the pipeline remained below acceptable, safe levels.

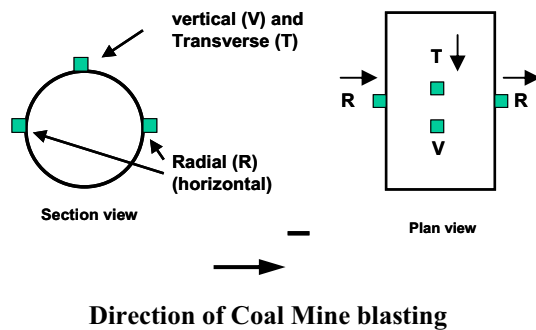


Fig. 1 Section and plan views of geophone placement

Vibration criteria used when blasting near pipelines are often specified by the pipeline transmission industry or a local government agency of authority. Criteria in terms of peak particle velocity often range from 2 to 4 ips measured at the surface above the pipeline. The U.S. Bureau of Mines (Siskind, et al, 1994) recommended 5 ips as a reasonable level for large surface mine blasts near Grade B or better steel pipelines.

In this study, the relationships between vertical (V), radial (R) and transverse (T) components of velocity measured at three locations were analyzed for different shot designs. These locations include the ground surface above the pipeline, on the pipeline (see Fig. 1), and in the ground, buried next to the pipeline at a depth equal to the radial (R) component on the pipeline.



Excavating the 30 in diameter pipeline

Typical results, given in Figs. 3 and 4, show distinct differences in the attenuation properties (as signified by the value of the negative slope of the velocity versus scaled distance plots) for the V and R components, depending on the degree of charge confinement and the amount of charge used in blastholes. The close proximity of the pipeline to the sandstone rock (with a 7000 ft/sec sound speed) resulted in dominant (FFT) frequencies of measured wave time histories between 9 and 26 Hz in the vertical direction. Transverse and radial components show strong motions at 8 Hz and 15 Hz, respectively.

An important fact that this study illustrated is vibrations both in the ground and on the pipe can be lowered within safe vibration criteria with *more energy in the hole* and proper initiation timing providing maximum relief. Figs. 3 and 4 show strong evidence of this.

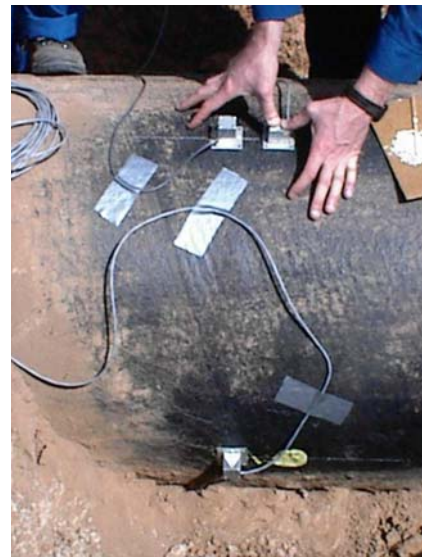


Fig. 2 Gluing geophones to pipeline surface

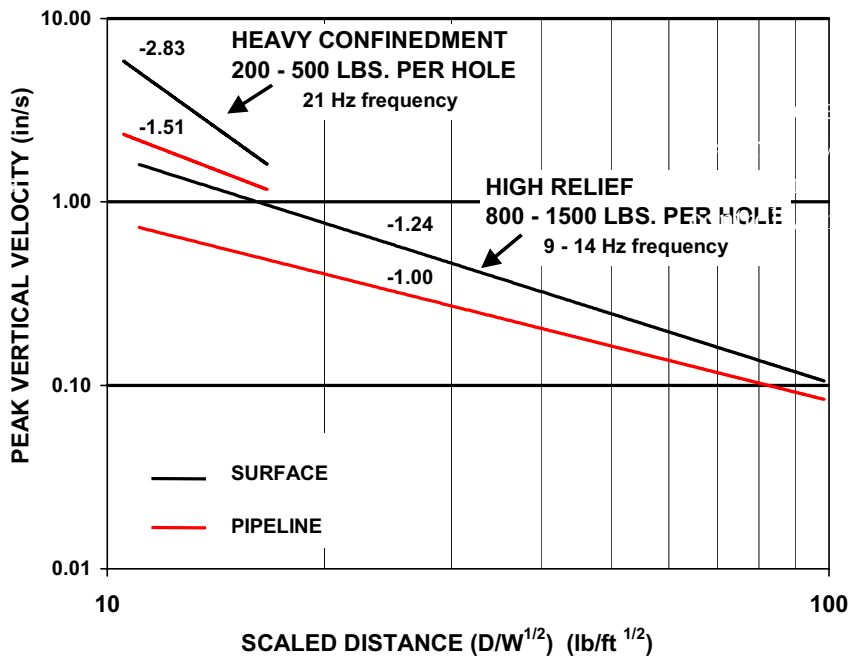


Fig. 3 Vertical peak velocity motion on the pipeline relative to ground surface motion (negative numbers represent the slope of the 50-percentile fit shown)

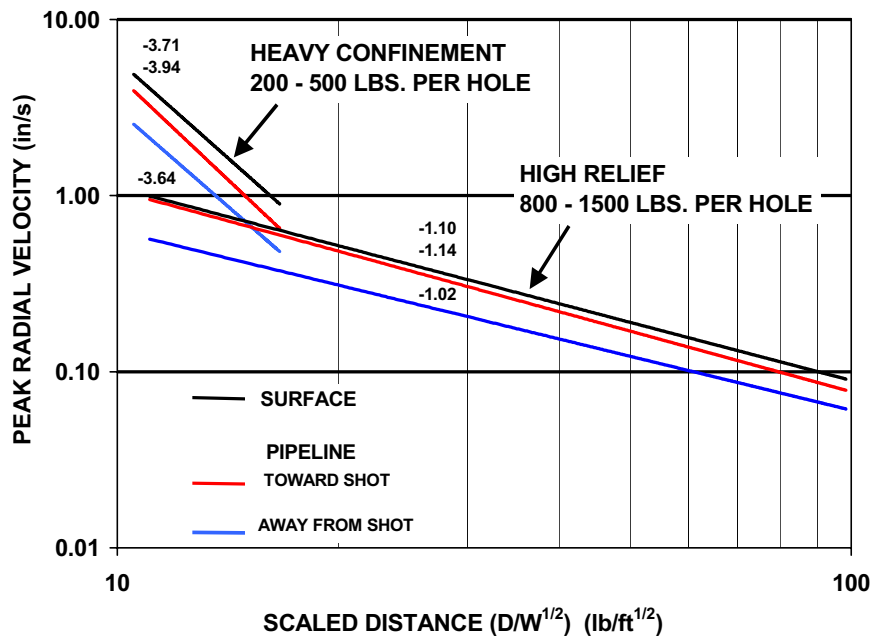


Fig. 4 Radial peak velocity motion on the pipeline relative to ground surface motion (negative numbers represent the slope of the 50-percentile fit shown)

REFERENCE

Siskind, D.E., M.S. Stagg, J.E. Wiegand, and D.J. Schultz, 1994, Surface Mines Blasting Near Pressurized Transmission Pipelines, U.S. Bureau of Mines RI 9523.