



Bureau of Mines Report of Investigations/1980

**Structure Response and Damage
Produced by Ground Vibration
From Surface Mine Blasting**

**By D. E. Siskind, M. S. Stagg, J. W. Kopp,
and C. H. Dowding**



UNITED STATES DEPARTMENT OF THE INTERIOR

Report of Investigations 8507

**Structure Response and Damage
Produced by Ground Vibration
From Surface Mine Blasting**

**By D. E. Siskind, M. S. Stagg, J. W. Kopp,
and C. H. Dowding**



**UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary**

**BUREAU OF MINES
Lindsay D. Norman, Director**

STRUCTURE RESPONSE AND DAMAGE PRODUCED BY GROUND VIBRATION FROM SURFACE MINE BLASTING

by

D. E. Siskind¹, M.S. Stagg², J. W. Kopp³, and C. H. Dowding⁴

ABSTRACT

The Bureau of Mines studied blast-produced ground vibration from surface mining to assess its damage and annoyance potential, and to determine safe levels and appropriate measurement techniques. Direct measurements were made of ground-vibration-produced structure responses and damage in 76 homes for 219 production blasts. These results were combined with damage data from nine other blasting studies, including the three analyzed previously for Bureau of Mines Bulletin 656.

Safe levels of ground vibration from blasting range from 0.5 to 2.0 in/sec peak particle velocity for residential-type structures. The damage threshold values are functions of the frequencies of the vibration transmitted into the residences and the types of construction. Particularly serious are the low-frequency vibrations that exist in soft foundation materials and/or result from long blast-to-residence distances. These vibrations produce not only structure resonances (4 to 12 Hz for whole structures and 10 to 25 Hz for midwalls) but also excessive levels of displacement and strain.

Threshold damage was defined as the occurrence of cosmetic damage; that is, the most superficial interior cracking of the type that develops in all homes independent of blasting. Homes with plastered interior walls are more susceptible to blast-produced cracking than modern gypsum wallboard; the latter are adequately protected by a minimum particle velocity of approximately 0.75 in/sec for frequencies below 40 Hz.

Structure response amplification factors were measured; typical values were 1.5 for structures as a whole (racking) and 4 for midwalls, at their respective resonance frequencies. For blast vibrations above 40 Hz, all amplification factors for frame residential structures were less than unity.

The human response and annoyance problem from ground vibration is aggravated by wall rattling, secondary noises, and the presence of airblast. Approximately 5 to 10 pct of the neighbors will judge peak particle velocity levels of 0.5 to 0.75 in/sec as "less than acceptable" (i.e., unacceptable) based on direct reactions to the vibration. Even lower levels cause psychological response problems, and thus social, economic, and public relations factors become critical for continued blasting.

¹ Geophysicist, Twin Cities Research Center, Bureau of Mines, Twin Cities, Minn.

² Civil engineer, Twin Cities Research Center, Bureau of Mines, Twin Cities, Minn.

³ Mining engineer, Twin Cities Research Center, Bureau of Mines, Twin Cities, Minn.

⁴ Civil engineer, Professor of Civil Engineering, Northwestern University, Evanston, Ill.

This publication has been cataloged as follows:

United States. Bureau of Mines

Structure response and damage produced by ground vibration
from surface mine blasting.

(Report of investigations - Bureau of Mines : 8507)

Bibliography: p. 69-70.

1. Blast effect. 2. Buildings-Vibration. 3. Soils-Vibration.
4. Strip mining-Environmental aspects. I. Siskind, D. E. II. Title.
III. Series: United States. Bureau of Mines. Report of investigations :
8507.

TN23.U43 [TA654.7] 622s [690'.21] 80-607825