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ACOUSTIC RESPONSE OF STRUCTURES TO BLASTING ANALYZED AGAINST COMFORT LEVELS OF RESIDENTS NEAR SURFACE COAL OPERATIONS

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Project Description and Objectives:

Ground vibration and airblast regulations have been established to prevent damage to private property next to surface coal operations due to blasting activity. However, complaints about blasting are common. For the blaster, the challenge transforms from a structural damage prevention issue into one about abating complaints. The key to this problem lies somewhere else besides the levels of vibration alone. The solution converges on two paths. The first path encompasses determining how residents experience blast events within their homes. The second path consists of how the residents affected by blasting receive relevant technical information. To determine how residents experience the blast events within their homes, the acoustic response was measured inside a structure subjected to nearby surface coal mine blasting. The second path was studied by administering a survey to residents living in proximity to the surface coal mine.

Applicability to Mining and Reclamation:

Blast vibrations induce sounds within residences. The acoustic response inside a house may be related to airblast or ground vibration. If the frequency content of the sound recordings are in the audible range, the house is responding to either ground vibration or airblast. The neighbors may not be able to tell the difference between sounds generated by airblast and those generated by ground vibration without further information. The ability to determine if peak acoustic response is generated by ground vibration or airblast is important for public relations planning and response.

Methodology:

A house wide vibration and sound monitoring system was installed in a West Virginia home which was subjected to blasts at various distances and direction. Eighty-five blast events were monitored. Fifteen channels of data were collected including three triaxial geophones, one airblast microphone, one uniaxial geophone mounted to the wall of the house (response channel), and four microphones that recorded CD quality sound waves inside the house. Each of these channels was recorded on the same time scale. The response channel signal was easily separated into ground vibration and airblast induced movement due to the differences in their times of arrival.

ABOVE PHOTO: Typical house in West Virginia near a surface coal mining operation. This particular house was instrumented for this project.

Highlights:

- Ground vibration and airblast induces sounds inside homes near surface coal mine blasting.
- In this site specific case, ABRF data showed that maximum response was generated by ground vibration and not airblast without exception at distances beyond 2,500 ft.
- Preblast surveys should include audits and recommendations for potential sound producers (loose doors, windows, and fixtures) and not only structural/cosmetic damage.
- Use a linear scale units such as pressure in PSI or millibars to communicate airblast information.

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Results/Findings:

The monitoring system used to collect the data described in this research can differentiate between sounds induced by ground vibration and that produced by airblast due to the difference in times of arrival. In order to establish the source of acoustic response, a new factor is proposed, the AirBlast Response Factor (**ABRF**) relating the peak arrival times of the response of the house (midwall response) to the time of peak arrival time for the Airblast.

$$ABRF = \frac{Time_{Peak\_Response}}{Time_{Peak\_Airblast}}$$

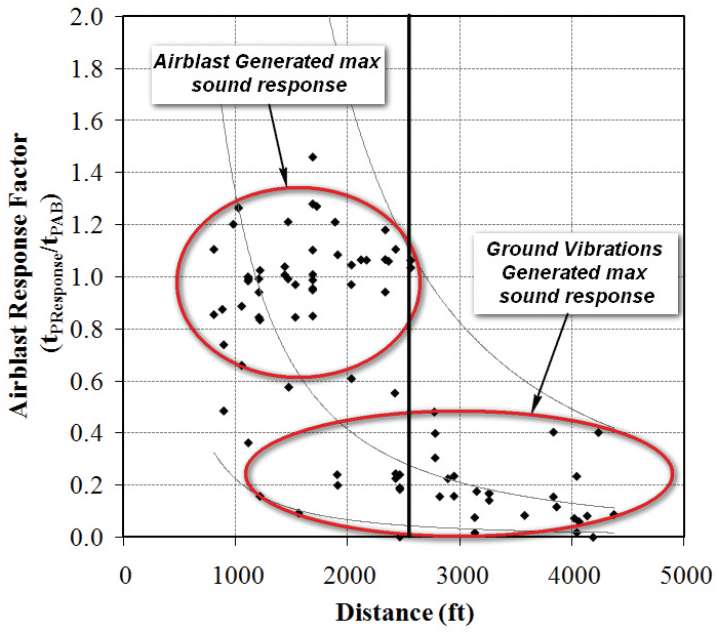
Acoustic responses inside of homes are generated by two sources: ground vibration and airblast. In the near field (< 2500 ft), the component that generated the maximum response varied between airblast and ground vibration (ABRF range from 0.1-1.4). In the far field (> 2500 ft), maximum response was generated by ground vibration without exception (ABRF range from 0.0 to 0.4). In the near field the source can be either airblast or ground vibration while the ground vibration is the predominant generator in the far field. In this case 2500 ft was considered the threshold between near and far field. This distinction was based on the AirBlast Response Factor analysis required to generate the graphic.

In this case, if complaints are received from residents living greater than 2500 feet from the blast, ground vibration is likely the source of the complaint. In addition, the data has shown that reducing ground vibration amplitude may not reduce the sound amplitude induced in the house. Furthermore, residents would not be able to audibly distinguish airblast induced sounds from ground vibration induced sounds due to the similarity in frequency content. In such cases, a further investigation into the types of alarming sounds which are causing complaints is warranted. There is a possibility that preventative measures could be employed to satisfy the neighbors and thus create positive public relations.

Based on the conclusions of this project, a general public relations program can be developed that includes the following items.

- Survey mine neighbors to determine preferred units for communication as well as levels of understanding for the units used to describe airblast and ground vibration.
- Utilizing the results of the survey, design a site specific blasting seminar to address the specific concerns of neighbors.
- Work closely with the party selected to conduct preblast surveys at neighboring homes to identify potential noise sources in the houses.
- During the blasting seminar and preblast surveys, provide neighbors with contact information for questions about blasting.
- Guide residents to less noisy rooms during blasting, in this case the kitchen was the noisiest.
- Report ground vibration and airblast data in the preferred unit system. A linear scale such as PSI is recommended for airblast data while a simple unit system such as inches of displacement is recommended for ground vibration data.

Most of these recommendations could be applied to other operations in Central Appalachia.



Above Photo: ABRF Vs Distance Location.

Website Information:

The final project report can be found at http://www.techtransfer.osmre.gov/NTTMainSite/appliedscience/2007appscience/CompletedProjects/KYAcousticResponseKEltschlager07FR.pdf

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