中華水土保持學報, 38(4): 417-430 (2007)
Journal of Chinese Soil and Water Conservation, 38 (4):*417-430* (2007)

不同型態土石流地聲特性之實驗研究

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摘　　要　本研究以地聲檢知器（geophone）量測人工模擬不同型態土石流流動時所產生之地聲，實驗量測所得之地聲時域訊號經由快速傅立葉轉換（FFT）及 Gabor 轉換分析，以求得地聲之頻域特性。實驗依照水土保持手冊（1992）將土石流的類型區分爲礫石型、一般型及泥流型。實驗結果顯示礫石型土石流地聲頻率主要介於 10 到 300Hz 之間；而泥流型土石流的地聲頻率介於 5 到 20Hz 之間。一般型土石流的地聲頻率則介於兩者之間，當其土石材料中之礫石成份增加時，頻率在 20 到 300Hz 之地聲振幅會明顯增大。由此可知 20 到 300Hz 之地聲主要是由於礫石摩擦、撞擊實驗渠道底床所產生。本研究還利用每單位時間之地聲累積能量與互相關（cross-correlation）的方法來推算土石流之平均流速。結果顯示地聲累積能量方法較容易推算出土石流之流速。然而，當地聲檢知器所測得土石流之地聲訊號微弱時，如泥流型土石流，便不容易以上述兩種方法推算出土石流之流速。

關鍵詞：地聲檢知器、土石流、地表振動（地聲）、頻率、互相關。

Experimental Study of Ground Vibrations Produced by Different Types of Debris Flows

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ABSTRACT　The purpose of this study is to examine the ground vibrations produced by different types of debris flow in the laboratory. Ground vibration was recorded by geophones. Ground-vibration signals in the time domain were transformed into the frequency domain using the Fast Fourier Transform and into the Time-Frequency domain using the Gabor Transform. According to the handbook of soil and water conservation (Soil and Water Conservation Bureau, 1992), debris flows can be classified into three types; the boulder type, the cobble-gravel type, and the muddy type. Experimental results show frequency range of ground vibrations associated with boulder-type debris flows is between 10 to 300Hz, while muddy-type debris flows is between 5 to 20 Hz. The frequency range of the cobble-gravel type debris flows includes both ranges. Ground vibrations of 20 to 300 Hz become notable as larger grains were added to the experimental materials.

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In addition, both the accumulative energy method and the cross-correlation method were used to calculate the average speed of the debris flows.

Key Words: geophone, debris flows, ground vibration (underground sound), frequency, cross-correlation.