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Comparison of the cumulative absolute velocity and acceleration peak value based on Wenchuan earthquake data

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Abstract: This paper discusses and presents the cumulative absolute velocity (CAV) parameters of the Wenchuan earthquake. Additionally, the CAV calculated from recorded data for the earthquake is compared to the peak ground acceleration (PGA), based on a brief analysis of background information. Accordingly, the paper studied the relationship between the CAV and PGA, and 3 CAV/PGA ratio charts were obtained in three different sub-directions. Linear and polynomial fitting operations were then used to analyze the potential discipline and characteristics in these directions. Finally, in the study, we investigated the applicability of using the CAV parameter for earthquake observation systems, and the CAV parameter was paired with the currently used PGA to provide earthquake observers and emergency responders with a theoretical basis.

Key words: Wenchuan earthquake; Cumulative Absolute Vlocity (CAV); Peak Ground Acceleration (PGA); comparative analysis; fitting

1 Introduction

At 14:28 Beijing time on May 12, 2008, a *M*s8.0 earthquake occurred in Yingxiu Town of Wenchuan County in Sichuan Province. This earthquake caused the central and front mountain faults in the Longmenshan fault zone at the western edge of the Sichuan Basin (eastern edge of the Tibetan Plateau) to quickly rupture in the northeast, which formed an approximately 300-km-long earthquake rupture zone, while sliding along the boundaries between the Longmenshan Mountain and Sichuan Basin. Sichuan's 50 counties (cities) and parts of Gansu, Shanxi were seriously affected by the distribution along the fault zone[1]. Using numerous domestic and foreign earthquake examples, we determined that increasing total wealth, expanding city construction, the increasing number of major projects and urban population growth are likely to exacerbate the casualties and property losses caused by earthquakes. To reduce earthquake disasters beyond merely improving the anti-earthquake design of city structures, countries have developed their earthquake observation technologies to increase the input from earthquake observation station networks.

Choosing rational observation parameters is essential for earthquake observation systems. Earthquake-related research always uses the peak ground acceleration (PGA) or peak ground velocity (PGV) as the characteristics or parameters to evaluate earthquake disasters. However, studies and practices have increasingly shown that the PGA and PGV parameters are not necessarily linearly correlated to the earthquake frequency distribution, duration and damage influence. The PGA and PGV data cannot indicate the earthquake wave frequency components or its duration. Additionally, practical experience indicates that a long vibration cycle is

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the key factor in architectural damage for various earthquake disasters. Therefore, the American Electric Power Research Institute[2] proposed the concept of cumulative absolute velocity.

$$CAV = \int_0^t |a(t)| \mathrm{d}t \quad (1)$$

where $a(t)$ represents the acceleration amplitude value at a certain time, and CAV is the continuous accumulation of the acceleration during an earthquake.

This study compares the CAV calculated from Wenchuan earthquake data recorded to the commonly used PGA value to determine the relationship between the CAV and PGA. Hopefully, this study will provide further understanding of the applicability of the CAV parameter for earthquake observation systems in conjunction with the currently used PGA value to provide a theoretical basis for earthquake monitoring and emergency rescue works.

2 Research background information and data source statistics

2.1 Research area background information

The Wenchuan earthquake occurred in the Longmenshan fault zone located in the middle of China. The fault zone extends from the northwest to the southeast with the North-East part obliquely crossing the Qinling fault zone, and the South-West part obliquely crossing the Xianshuihe-Xiaojiang fault[3]. The Jinhe-Qinghe fault zone in southwest Sichuan province is considered an extension of the Longmenshan fault zone. These fault zones are seismic hazard zones with the three main faults capable of causing a *M*s8.0 earthquake, and the Yingxiu-Beichuan fault is seen as the major earthquake fault. Longmenshan and its internal faults belong to a special set of earthquake faults with low seismic activity frequencies that produce potentially dangerously powerful earthquakes. Strike-slip movements are the main activity of these faults. Therefore, the Wenchuan earthquake was a thrust-strike-slip earthquake, and its surface ruptures were distributed across the Yingxiu-Beichuan and Guan County-Peng County faults.

2.2 Strong earthquake information collection and selection

The National Motion Observation Network System (NSMONS) in China recorded the main shock from 455 stations distributed across 19 Provinces/Municipality/Autonomous regions, including Sichuan, Gansu, Shanxi, Yunnan, Ningxia, Qinghai, Shanxi, Shandong, Henan, Hebei, Beijing, Tianjin, Inner Mongolia, Jiangsu, Shanghai, Fujian, Guangdong, Hubei and Anhui, during the Wenchuan earthquake. records exist from 420 stations, and the remaining 35 stations provide incomplete or small amplitude data that was not included in this set. Figure 1 shows the station distribution with the blue triangles as the station locations and red dot as the epicenter.

2.3 Recording instrument parameters

The data collection instruments include six types of digital strong quake recorders and two types of acceleration sensors, and the acceleration sensor performance index distribution is shown in table 1.

2.4 Site conditions

Numerous studies have shown that site-specific effects related to the geological characteristics of the seismic station affect the recorded amplitude with certain geological areas significantly impacting this parameter. Therefore, these site effects can be described more explicitly when studying the seismic characteristics if the sites are properly classified. The multiple groups of uncorrected acceleration data used in this study were classified into Rock and Soil type group according to the site conditions.

3 Analysis method

This study used the LABVIEW (National Instruments, Austin, Texas, America) program to calculate the CAV parameter from the Wenchuan earthquake data records. LABVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programing language that uses icons instead of lines of text to create programs. The threshold selection and CAV calculation result are closely related and were an important influ-