Review on Processing and Analysis of Digital Strong Motion Accelerogram and its Importance

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Abstract: **On 25th April 2015, a large earthquake of Magnitude 7.8 occurred along the Himalayan Thrust fault in central Nepal. It was caused by a collision of the Indian Plate below the Eurasian Plate. Gorkha region is an epicenter, and the rupture travelled from epicentral region to the east, passing through the Kathmandu Valley. 8000 people were killed during this event, mostly in Kathmandu and the adjacent districts. We collected a strong ground motion raw data of following earthquake from United State Geological Survey (USGS) organization. We observed that raw data consist of many errors in it, and it is needed to correct and to be used in engineering application, using different routines (steps).**

Keywords: 2015 Gorkha Nepal earthquake, Kathmandu Valley, Strong ground motion, USGS

1. INTRODUCTION

The earth vibrates continuously at periods ranging from milliseconds to day and the amplitude may vary from nanometers to meters. It is pertinent to note that most vibrations are quite weak to even be felt. Such microscopic activity is important for seismologist only. The motion that affects living beings and their environment is of interest for engineers and is termed as strong ground motion.

Vibration of the earth's surface is net consequences of motions, vertical as well as horizontal, caused by seismic waves that are generated by energy release at each material point within the three dimensional volume that ruptures at the fault. These waves arrive at various instants of time, have different amplitudes, and carry different levels of energy. Thus, the motion at any site on ground is random in nature, its amplitude and direction varying randomly with time.

Large earthquakes at great distant can produce weak motions that may not damage structure are even be felt by humans. However, from an engineering viewpoint, strong motion that can possibly damage structure are of interest. This many occurs with earthquake in the vicinity or even with high intensity earthquake at medium to large. The motion of the ground can be described in terms of displacement, velocity or acceleration.

To measure the above parameters, mainly two types of instruments are used namely 1) Analog Instrument & 2) Digital Instrument. The data recorded in analog instruments which has to be stored, needs to be converted in digital data manually by humans, whereas digital instrument records data directly in digital format which actually minimizes human error. Hence now a days digital instruments are used widely.

Meanwhile human error is not the only error recorded. There are many errors recorded in the instrument which needs to be analyzed and processed.

2. LITERATURE REVIEW

Literature review related to the seismic analysis was carried out. The objective was to know the stability and the performance of different seismic units in design. It was noticed that many researchers, academicians and consultants have worked extensively on seismic zones, seismic design, importance of seismic analysis, modern design methods, design formulae etc.

2.1 Collection of Data

According to Jessica R. Murray et al[1]. the USGS Earthquake Science Center collects and processes Global Positioning System (GPS) data throughout the world to measure deformation related to earthquakes and tectonic processes as part of a long-term program of research and monitoring. Here, they outline the data collection procedures and present the GPS dataset built through repeated temporary deployments.

According to J.J. Boomer et al[2] a pilot project has been carried out to make strong ground motion data available. A large database with thousands of data related to seismological, geophysical and engineering parameters are developed. Many of the past earthquake are strong motion records and their source parameters are recalculated surface waves magnitudes, have been re-evaluated. For 863 strong motion records from this regions, the site engineers have determined the data and entered it into the databank.

2.2 Analysis and Processing

According to David M. Boore et al[3]. the strong-motion accelerographs are of fundamental importance in earthquake engineering. The recordings, particularly those from analog instruments, invariably contain noise that can mask and distort the ground-motion signal at both high and low frequencies. It is important to identify the presence of this noise in the digitized time history and its influence on the parameters that are to be derived from the records. If the parameters are affected by noise then proper processing needs to be applied to the records, although it must be accepted from the outset that it is generally not possible to recover the actual ground motion over a wide range of frequencies. Many schemes are available for processing strong-motion data and it is important. It is important to appreciate the effects of the procedures on the records in order to avoid errors in the interpretation and use of the results. Options for processing strong-motion accelerograms are presented, discussed and evaluated from the perspective of engineering application.

According to V.W. Lee[4] a review of the developments in the hardware and software for digitization of strong motion accelerograms, data processing. In the 1980's digital strong motion accelerograms become commercially available, and currently all new deployments are digital. However it takes time to record a large number of strong motion accelerograms, and as of now, by, most of strong motion data has been recorded in analog form.

2.3 Errors in Strong Motion Accelerogram and processing

According to Hu Guorui, Lu Tao et al[5] because of various reasons, the baseline drift in the strong motion accelerogram was often founded, especially in the near-fault accelerogram. The baseline drift could lead to the unreliable velocity and displacement obtained by the accelerogram integration without or with improper specialized baseline correction. For dealing with the problem, in the study, the various reasons causing the baseline drift in accelerogram were analyzed, the baseline correction principle and the different baseline correction methods were discussed, and the problems in the methods were pointed out.

According to Hung-Chie Chiu[6]. Most baseline errors of analog strong-motion data still exist in high- resolution data. In this study, we identify the major baseline errors of digital strong-motion data and propose a three-step algorithm to correct these errors. The baseline errors consist of constant drift in the acceleration, low-frequency noise, the small initial values for acceleration and velocity, and manipulation errors. This three- step algorithm includes fitting the baseline of acceleration by the least squares, applying a high-pass filter in acceleration, and subtracting the initial values in velocity. A least squares fit of a straight line before filtering can easily remove the baseline drift. The filter removes the linear trend and other low-frequency errors that exist in the acceleration. Finally, the subtracting of the initial velocity removes the linear trend of displacement. This three step processing significantly reduces calculations and side effects resulting from manipulation of data. This algorithm has been tested on several types of digital strong-motion data.

According to M. D. Trifunac et al[7]. procedures for the processing of digitized strong motion accelerograms, analysis of error is required. The error analysis described here is divided into two main parts. The first part deals with particular sources of errors. Each major source of error is analyzed individually with the aim of developing methods of error correction at the source wherever feasible. The second part deals with the overall effects of all errors at high and low frequencies. The main aim of this part is to find the optimum frequency band in which the digitized accelerograms does not change by the errors in the recordings and in the data processing steps. The digitized accelerograms represents accurately the absolute ground acceleration in the frequency band between 00.07 and 25.00 cps. This frequency band is significantly wider than anticipated and indicates a wide range of new research possibilities in strong-motion study and earthquake engineering.

3. METHODOLOGY

1. Studying literature related to Strong Ground Motion and errors occurred.
2. A thorough study of the noises recorded in an accelerogram.
3. Visiting the Engineering Seismological division at Central Water and Power Research Station, Pune to acquire knowledge about the instruments used for recording the data. 4. Processing and analysis of the Nepal (Gorkha) Earthquake strong motion data.

4. CONCLUDING REMARK

After reviewing whole literature it was seen that extensive research has been carried out for processing of strong ground motion data, analysis of strong ground motion data, noises recorded in accelerogram and methods to filter them. Although normally analog instruments are used, digital instruments give accurate results. Hence it is mandatory to conduct strong ground motion study.

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