Monitoring strong earthquake shaking at the Penang Air Itam Dam, Malaysia

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The Penang Water Authority, in collaboration with the Universiti Sains Malaysia, recently installed on 8th September, 1994, a free standing solid state accelerograph at the Penang Air Itam Dam. Located on the south-eastern embankment, next to the outlet house, the instrument pier lies on in situ weathered granitic soil derived from coarse-grained megacrystic biotite-granite of the Bunga type in the Northern Penang pluton.

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The purpose of this joint research study is to determine quantitatively the level of vibratory ground motion experienced at the Penang Air Itam Dam from earthquake tremors originating from Sumatra in Indonesia. This study attempts to ascertain (a) the peak acceleration, velocity and displacement values, (b) the duration, and (c) the spectral content and predominant period of earthquake shaking felt at the instrument station.

Whereas mechanical-optical type strong motion accelerograph units recording on photographic film has been installed in this country, their performance have not been satisfactory. The digital accelerograph (a KINEMETRICS SSA-16) installed at Air Itam has instead a 16-bit recording resolution and a frequency response bandwidth from 0 to 50 Hertz. Fully micro-processor controlled, the solid state instrument allows a user selected trigger sensitivity from as small as 2.0×10^{-3} g to 0.2 g. This is the first 16-bit solid state accelerograph to be installed in Malaysia with a SONR of more than 96 dB.

We describe next in brief some practical aspects of data acquisition and reduction. Communication with the accelerograph is by factory released software included in the purchase of the instrument package. A flowchart for data retrieval, down-loading, utility housekeeping and waveform display for a quick review of recorded events will be shown. We simplified keyboard usage by installing the factory supplied communications program on to a Direct Access menu. This over-rides the need for DOS commands which we find efficient in the field. In-house data processing uses proprietary Kinemetric's Seismic Workstation Software to (a) correct the accelerogram record for instrument characteristics and integrate this accelerogram to obtain the velocity and displacement records, and, (b) compute the response spectrum to specified dumping values. An example of this data integration and subsequent Fourier spectrum on a tripartite plot from an artificially created spike impulse will be shown. Calibration constants, determined in the factory prior to shipment, for each accelerometer channel can be checked and updated, if necessary, using a recorded accelerograph functional test. A recently conducted test to determine the natural frequency and damping for one particular channel will be shown.

In conclusion, our study suggests that this installation of the first digital accelerograph in Malaysia at the Penang Air Itam Dam is at best a useful academic exercise. We believe it is a fallacy to base a structural design on the basis of one solitary strong motion station located in a specially constrained environment. A more systematic approach is to assemble a collection of strong motion data in selected high rise buildings, elevated interchanges, hydroelectric dams, long span bridges, and under different soil or geological conditions using appropriate instrumental configurations. This data bank, together with other geological/seismological inputs is envisaged to provide a basis for formulating an earthquake building code peculiar to Malaysia and allows improved and more creative engineering designs than presently practised.