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Two new strong-motion arrays in Hualien, Taiwan

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INTRODUCTION

The SMART-2 is an extension observation program of the SMART-1 array while the Hualien LSST is the extension of the Lotung LSST. After ten years operation of the SMART-1 array, a workshop was held in Taipei (January 14-16, 1988, Taipei, Taiwan, Republic of China). In the workshop, all participants reached a common agreement which recommends to deploy a new SMART-2 array and LSST experiment on hard site in the Hualien area. The planning of these two arrays started right after the workshop. In December 1990, Institute of Earth Sciences installed the first accelerograph of SMART-2 under the funding from Academia Sinica and National Science Council, Republic of China.

Almost at the same time, Electric Power Research Institute (EPRI) in United States, Taipower and Institute of Earth Sciences in Taiwan have worked together in the past two years on the planning of instrumentation for the LSST experiment. Totally, 37 accelerographs (15 on free-field, 12 on free-field downhole and 15 on the 1/4-scale model containment) will be installed in this array. Taipower and its contractors are carrying out the construction of the 1/4-scale model. The instrumentation was scheduled to be started on the end of 1992 and to be completed in the early of 1993.

In this paper, we present the planning of these arrays, current progress in the instrumentation and some preliminary analyses of the SMART-2 data recorded in a recent event.

SMART-2

SMART-2 was designed for studying the rupture process of earthquake faulting and near-field ground motions. Both of these topics are very important in Seismology and Earthquake Engineering. This array is deployed in Hualien area which is the most active seismic region in Taiwan. Within a circle of 60 km, the annual number of earthquake with magnitude greater than 6 is about 1, and with magnitude greater than 5.5, the average number of earthquake is 6.4.

SMART-2 array is deployed on the northern part of the Longitudinal Valley as shown in Figure 1. This Valley, extended 150 km from north to south in the eastern Taiwan, lies between the central Range and the Coastal Range. The main feature in this region is Meilun Fault which strikes northeast and attains an observed length of about five kilometers (Hsu, 1962). The Meilun Fault, covered by SMART-2 array, was considered to be related to the Earthquake of October 22, 1951. There are several faults parallel to the Meilun Fault in this area. It has great opportunity to record near-source ground motion from big event. Based on the seismicity in this area, Hualien is an excellent site which may have quick reward from the investment of strong-motion observation.

The total instruments of SMART-2 will be 45 surface station and six borehole triaxial force-balance accelerometers. The deployment of these instruments started in December 1990 and was scheduled to complete the installation in 1992. Up to May 1992, 42 surface and three boreholes stations have been installed, and another three boreholes are ready for installing accelerometers.The configuration of SMART-2 array is shown in Figure 1. This array covers an area about 110 km^2 and the average spacing between any two stations is about 2 km. A much dense stations with spacing of about 200 meters locate at Peipu in the northern part of this array.

Each surface station consists of a FBA-23 sensor, a SSR-1 digital recorder, and an Omega antenna from Kinemetrics. FBA-23 is bolted to a 125cmx125cmx10cm concrete pad

with FRP(fiber glass) hut. This hut was attached to the pad and provides shelter to the SSR-1 recorder and FBA-23 sensor. FBA-23 sensor is a triaxial force-balance accelerometers, capable of recording 1g ground acceleration. The longitudinal axis of all sensor are set to point to the north. SSR-1 is a 16-bit recorder which provids 3.05×10^{-5}g resolution for a 1g sensor. Each recorder has 2 megabyte solid-state memory which can record 27 minutes three-component data at sampling rate of 200 sps. Also, each recorder is equipped with an Omega clock which provides one millisecond accuracy in timing between any two stations. This accurate timing is kept by continuously synchronizing the clock to the standard station.

Hualien LSST

This experiment is designed for soil-structure interaction researches. A cylindrical reinforced concrete model approximately 1/4-scale of the prototypical nuclear containment is constructed inside of the SMART-2 array (close to the station S49 in the Hualien Airport). This array will be benefitted from the source and ground motion studies of SMART-2 array. Totally, 37 accelerographs will be installed on the scaled model and its surrounding ground. The Free-field instrumentation layout is shown in Figure 2. The instruments in the free-field will provide data for a detailed description of the ground motion both in the vicinity of and also away from the model while the accelerographs on the scaled model will provide the earthquake-induced structure response. Some of these accelerographs used in this experiment will be relocated from Lotung, the others (7 downhole and 7 surface accelerometers) will be the same as used in SMART-2 array.

DATA

The earthquake data in SSR-1 recorder were stored in binary form. In the field, we retrieve these data by a portable personal computer. In the laboratory, we convert these data file into easy-to-read format. Also, these data were converted from the amount of voltage to ground acceleration by introducing the sensitivity of accelerometers. The main features of this data set are high-quality waveform and precise timing. An recent event (29 December, 1990 Hualien earthquake) registered 4.8 in local magnitude triggered SMART-2 array. The epicenter of this event is given in Figure 1. The epicentral distance is about 10 km from station S03 at Hua-Gun Junior high school, and with peak ground acceleration is about 0.23g. The selected L-component accelerograms integrated to velocity and displacement are given in Figure 3. Fig. 4 shown the peak ground acceleration of L-component at station S28 is about 0.003g which may appear to be a straight line in conventional analog recording (e.g. Kinematrics' SMA-1), the integrated velocity and displacement still keep very good waveform.

ACKNOWLEDGMENTS

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REFERENCES

Hsu, T. L., 1962, Recent faulting in the longitudinal valley of eastern Taiwan, Memoir of Geological Society of China, 1, 95-102.

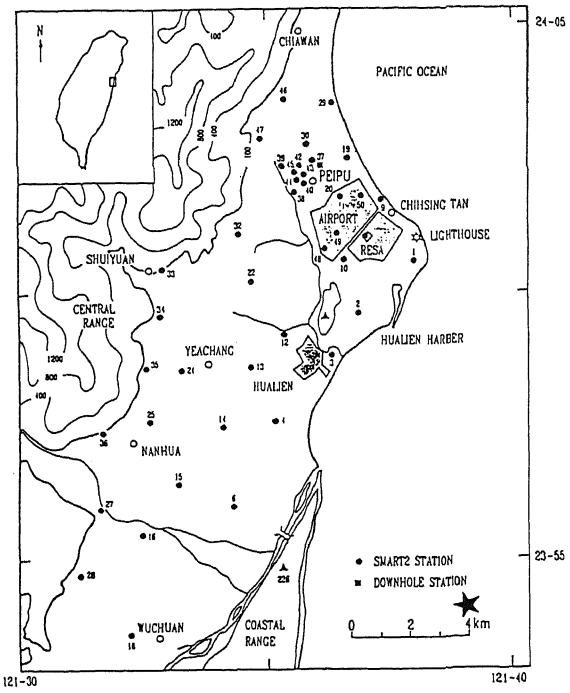

Figure 1. Strong-Motion accelerographs layout for SMART-2 array; solid circle and square represent the free-field and downhole locations respectively. Symbol '★' denotes the epicenter of earthquake December 29, 1990.

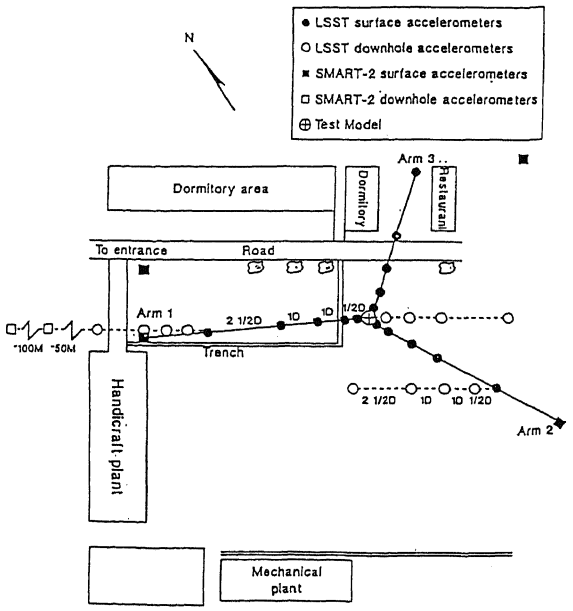

Figure 2. Free-field instrumentation layout for the Hualien LSST project.

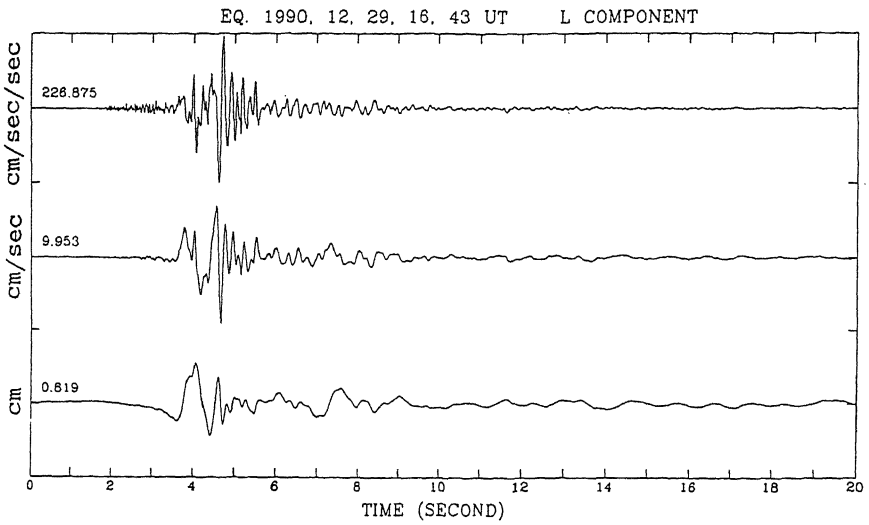

Figure 3. The integrated time histories of velocity and displacement corresponding to the accelerogram recorded by SMART-2 array at S03 (L-component) in December 29, 1990 Hualien earthquake.

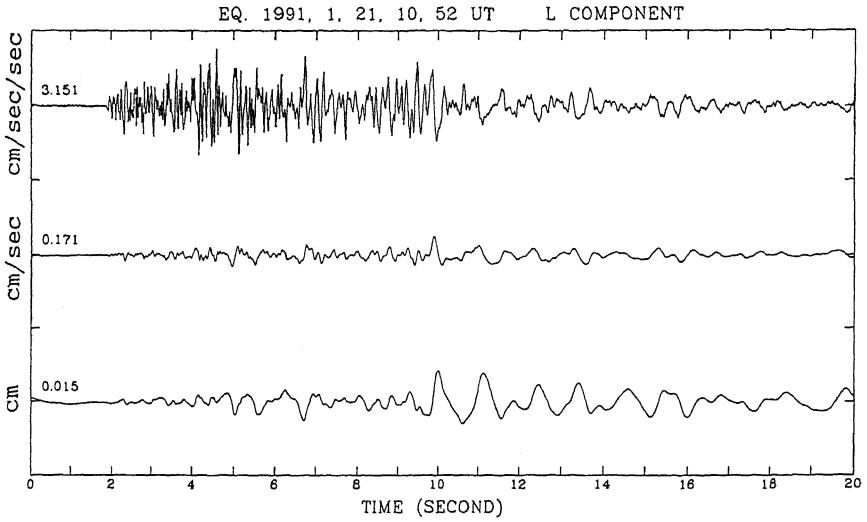

Figure 4. The integrated time histories of velocity and displacement corresponding to the accelerogram recorded by SMART-2 array at S28 (L-component) in January 21, 1991 Hualien earthquake.