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COLLECTION AND ARCHIVING OF CODE ACCELEROGRAPH DATA FROM THE NORTHRIDGE EARTHQUAKE

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ABSTRACT

More than 480 film accelerograms of the January 17, 1994 Northridge Earthquake were retrieved from private, building code-required strong motion accelerographs in over 280 buildings. This significant data set will provide extensive information on the linear and nonlinear response of buildings during very strong ground shaking.

The Northridge Earthquake has provided a wealth of strong motion data. The largest number of accelerograms was recorded by privately-owned "Code Accelerographs." These accelerographs are strong motion recorders required by the building codes of Los Angeles City and a few other local municipalities for commercial buildings taller than 10 stories. The instruments are privately owned, but recorded earthquake data are to be given to the government for research purposes.

After the Northridge Earthquake, an effort to collect these valuable accelerograms was jointly funded by the National Science Foundation and the California Division of Mines and Geology (CDMG). Film records were retrieved from buildings currently maintaining their Code Accelerographs by the investigation team. Instrument, station, and building information was also gathered. The accelerograms were turned over to CDMG in Sacramento, California for archiving, digitizing, and data processing. An electronic database containing instrument, station, and building information was created to complement the strong motion data.

KEYWORDS

Code Accelerograph; Northridge Earthquake Records; Strong Motion Records; Accelerograms

INTRODUCTION

Over the last few decades, many California buildings and other structures have been instrumented with seismic accelerographs to record strong-motion during an earthquake. A number of these instruments are part of university or government research projects, however, a large number are privately owned and were installed due to local building codes or regulations.

The primary purpose of these strong-motion recorders is to provide the earthquake engineering community with information on the response of structures to earthquakes. Once enough data is collected and analyzed,

it may be possible to provide generalities as to the performance of certain types of structures or structures located on certain types of geologic conditions. This information may also be instrumental in the development and revisions of building codes and laws. However, in order to make use of this valuable data, the strong-motion records need to be retrieved and analyzed after each earthquake, and structural information on the instrumented buildings needs to be assembled.

BACKGROUND

The January 17, 1994, Northridge Earthquake has provided a wealth of strong motion data. Many accelerograms were recorded by instruments in the various government and university arrays. The California Strong-Motion Instrumentation Program maintains a network of approximately 193 stations in the Los Angeles area. The U.S. Geological Survey maintains instruments of its own and of other agencies in this area, and the University of Southern California also maintains a network of approximately 80 ground-response stations in the Los Angeles basin. In addition to these stations, smaller groups of stations are maintained by Caltech, Southern California Edison, Department of Water Resources and other agencies. However, the largest number of accelerograms was recorded by privately-owned "Code Accelerographs."

In the 1970's, a requirement was added to the *Uniform Building Code* (International Conference of Building Officials, 1991) which states that "In Seismic Zones 3 and 4 every building over six stories in height with an aggregate floor area of 60,000 square feet or more, and every building over 10 stories in height regardless of floor area, shall be provided with not less than three approved recording accelerographs."

Many cities in California, including the City of Los Angeles, have adapted this U.B.C. requirement in their local building codes. Therefore, these Code Accelerographs are strong motion recorders required by these codes. The instruments are privately owned, but recorded earthquake data are to be given to the government (local or state) for research purposes upon request. It is estimated that there are over 800 Code Accelerographs installed in buildings in the Los Angeles area. Many of these are not properly maintained and are therefore not operational. In past earthquakes, data from only a small portion of these instruments have been retrieved and analyzed.

DATA RETRIEVAL

Shortly after the Northridge Earthquake, an effort was jointly funded by the National Science Foundation and the California Division of Mines and Geology to retrieve valuable accelerograms from Code Accelerographs in buildings in Los Angeles, Ventura, Orange, and other Counties.

The first task of this project involved identifying all buildings containing code accelerographs in Los Angeles and Ventura Counties and some buildings in other counties. Almost 500 buildings were identified in Los Angeles and Ventura Counties. These buildings were then assigned a priority number of 1 through 3. A priority ranking of 1 was given to buildings having 2 or 3 instruments, which are located north of Interstate 10 and west of Interstate 5 - the area affected the most by the Northridge Earthquake. Priority 2 buildings are those which have only 1 instrument, which are located north of Interstate 10 and west of Interstate 5, or buildings with 3 instruments located outside of this area. A priority 3 ranking was assigned to all other buildings.

This prioritized listing was used to determine which records were to be retrieved since time constraints did not allow for the retrieval of all the records. Priority 1 records were of the most concern, however, Priority 2 and 3 records were also collected to provide information from a wide ranging area.

The accelerograph service companies were contracted to physically retrieve film records from code accelerographs, document the physical accelerograph condition, develop the film records, complete a

standard retrieval form, and transmit the film record and documentation to the Principal Investigator. The service companies also documented any visible damage to the structure.

Between April, 1994, and September, 1994, a total of 433 records were retrieved from Code Accelerographs in 265 buildings in Los Angeles and Ventura Counties - areas which were heavily affected by the earthquake. Fifty-two accelerograms were also retrieved from 18 buildings in minimally affected areas in Orange County and other counties. Table 1 summarizes the number of film records collected and the breakdown per priority group. Figures 1 through 3 are maps showing the locations of some of these accelerograph stations in Los Angeles and Ventura Counties.

Table 1. Summary of Code Accelerograph Records Retrieved and Prioritization Breakdown

Total Number of Code Accelerograph Records Retrieved:	488
L.A. and Ventura Counties, Buildings Only	433
Other Counties, Buildings Only	52
Other Structures	3
Total Number of Buildings From Which Records Were Retrieved:	
L.A. and Ventura Counties	265
Other Counties	18
Prioritization Breakdown for L.A. and Ventura Counties:	
Priority 1 Stations	90
Priority 2 Stations	150
Priority 3 Stations	25

The U.S. Geological Survey also maintains and digitizes several code accelerograph records for stations in Los Angeles and Orange Counties. Copies of the accelerograms, some station information and maximum accelerations can be found in the U.S.G.S. Northridge Earthquake report (Department of the Interior, 1994).

DATA ARCHIVING

The original film records retrieved from the code accelerographs were turned over to the California Division of Mines and Geology in Sacramento, California for archiving, digitizing, and data processing. Figure 4 is a sample of a digitized accelerogram for a typical Code Accelerograph station.

An electronic database was created which would document station information for the code accelerograph buildings. This database will include information for approximately 100 of the code accelerograph buildings from which records were retrieved and will consist primarily of Priority 1 structures.

Each of these buildings were visited and photographs were taken. Any information that could be visually obtained was noted. Questionnaires were distributed to most Building Managers/Engineers, however, few questionnaires were completed. Data was also collected from previously published documents, such as *High Rise Office Buildings in the Los Angeles - Orange County Region*, (Western Economic Research Co., 1985), *San Fernando, California, Earthquake of February 9, 1971*, (U.S. Department of Commerce, 1971) and available geological maps.

Based on previous CDMG practice, a Station Name and Number and a Code number was assigned to each building to protect the identity of the structure. The database includes a table listing the station name and number, the code number, the latitude and longitude of the building, the epicentral distance of the building from the earthquake, and the site geology. Another set of tables was created which contains the station

name and number, the structure type, the epicentral distance, and the maximum acceleration for each component of the accelerograms.

DIGITIZATION AND DATA DISSEMINATION

This extensive database will then be compiled into a report to be published by CDMG. A draft report has already been completed, and the final report should be completed soon. The report will consist of maps showing the station locations, the above mentioned tables, and three to four page sets of documentation for each station. The first page of each set contains the station name and number, a photograph of the building, and as much of the following information that could be obtained: number of stories above/below ground, plan shape, base dimensions, typical floor dimensions, design date, construction date, vertical load carrying system, lateral force resisting system, and the foundation type.

The second page for each station contains any available elevations of the building and any available floor plans at the levels of the accelerographs. The location of the accelerograph sensors will be indicated on the floor plan. The third and fourth pages contain photocopies of the accelerograms for that building.

SUMMARY

The final CDMG report of the Northridge Earthquake will prove to be very valuable to the engineering community. It will provide not only copies of the accelerograph records and peak acceleration values, but information about the station geology, the structure type, and the distance from the epicenter of the earthquake. This will be useful in characterizing the response of structures based on local soil conditions as well as construction type. This significant data set will also provide extensive information on the linear and nonlinear response of buildings during very strong ground shaking.

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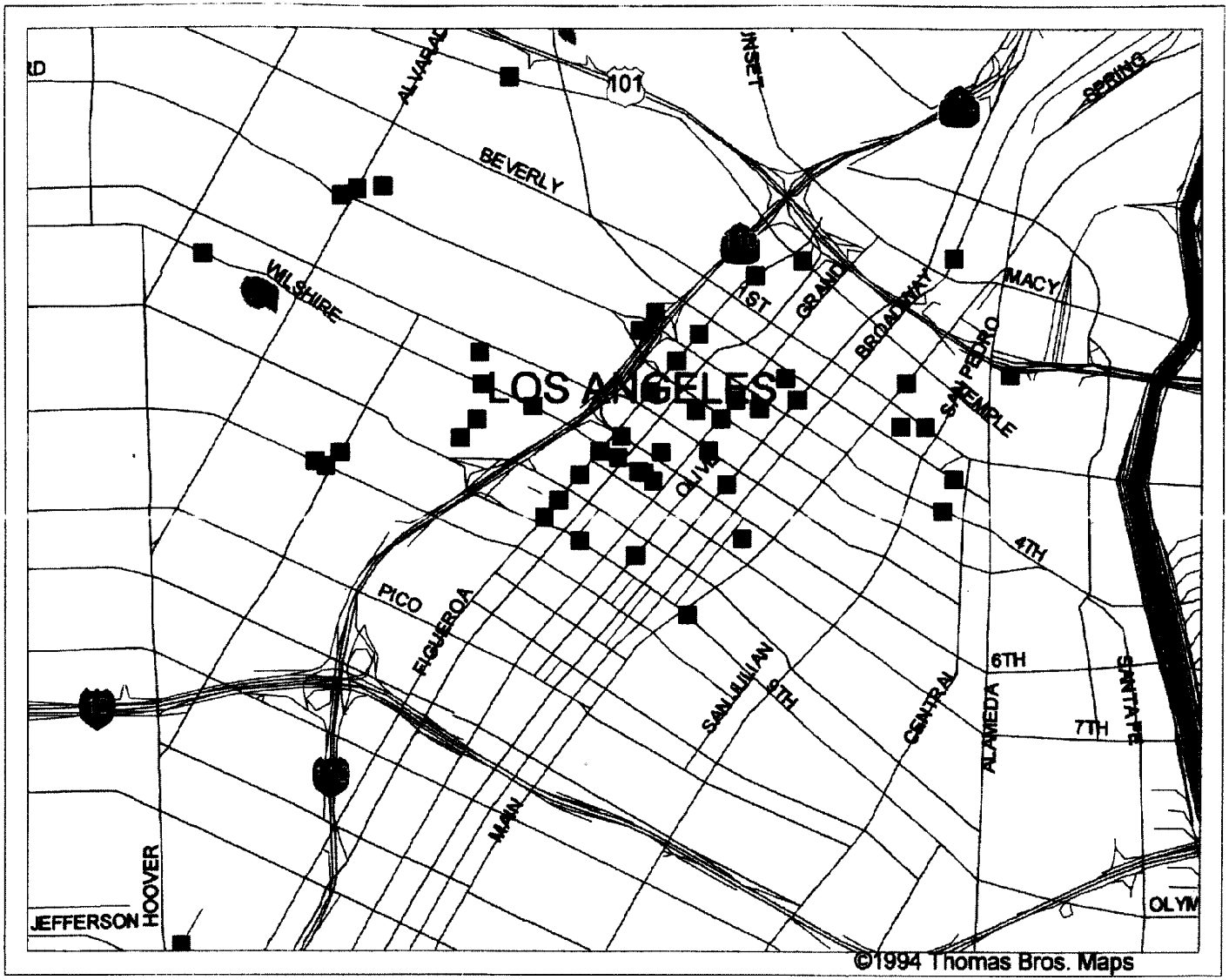

Fig. 2. Locations of Code Accelerograph Buildings in the Downtown Los Angeles Area

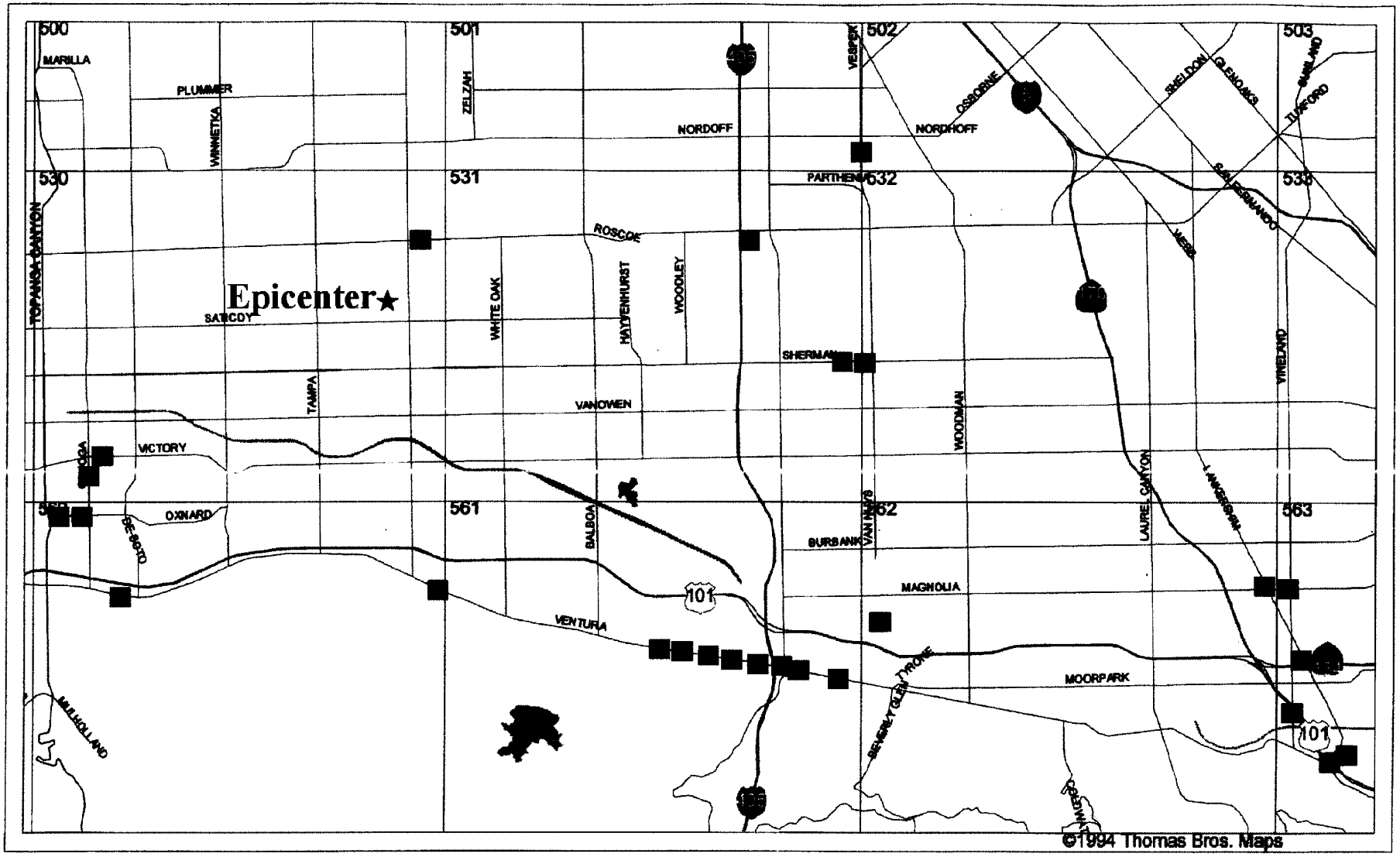

Fig. 3. Locations of Code Accelerograph Buildings in the San Fernando Valley Area

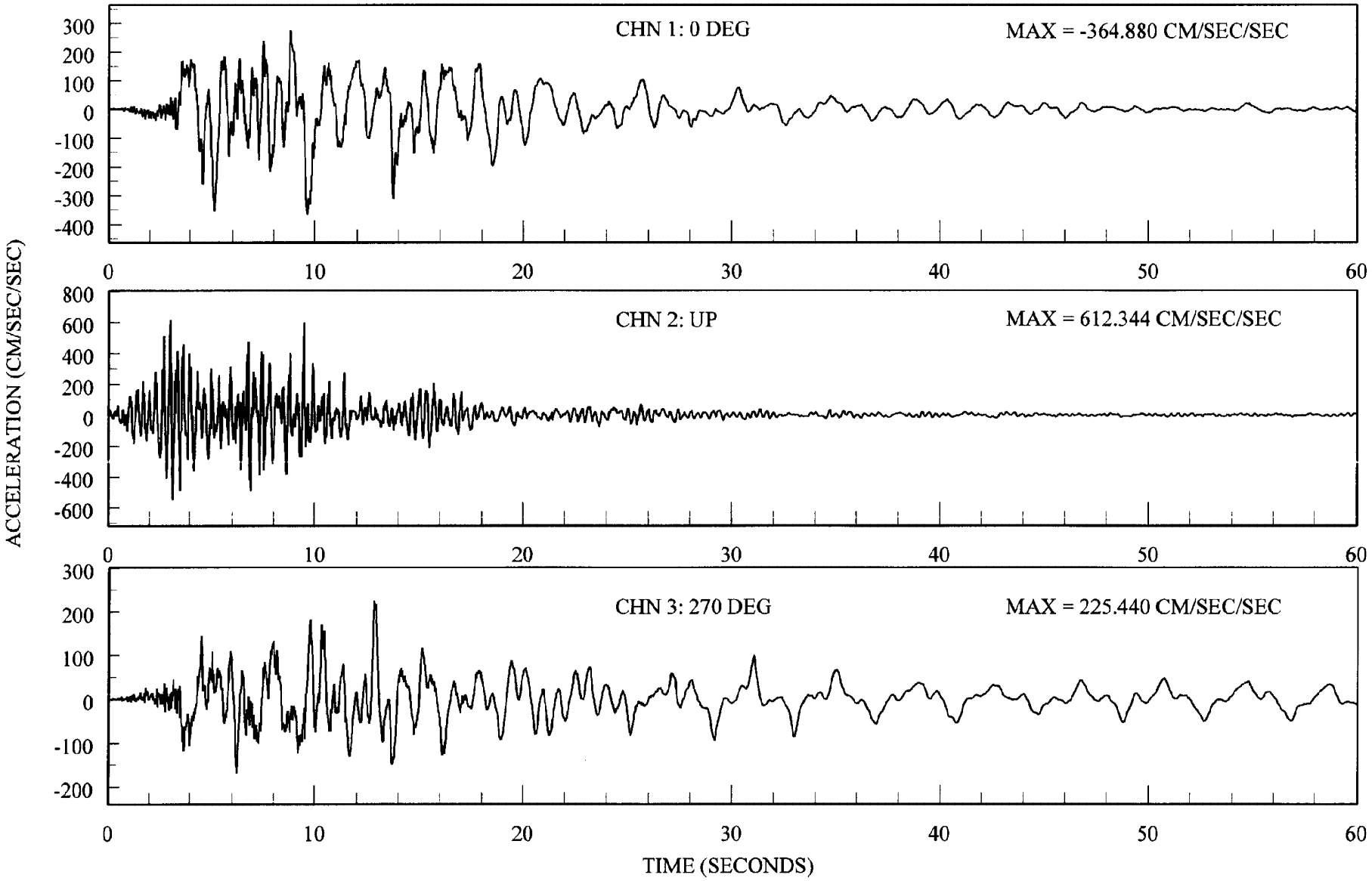

Fig. 4. Sample Corrected Accelerogram From Typical Code Accelerograph Building (Darragh *et al*, 1995)