WHITE PAPER

THE BENEFITS OF STRONG-MOTION INSTRUMENTATION IN HOSPITAL FACILITIES

Department of Health Care Access and Information

Hospital Building Safety Board Instrumentation Committee

Date to be added

SUMMARY

Brief summary of the paper, with findings and recommendations. End with benefits to the Hospital Facilities.

INTRODUCTION

There are hundreds of identified faults in California. About 200 of these faults are considered potentially hazardous based on their slip rates in recent geological time (the last 10,000 years). More than 70 percent of California's population resides within 30 miles of a fault where high ground shaking could occur in the next 50 years. Hospitals serving this population are thus located in these same areas.

There are over 400 hospitals in California and strong-motion instrumentation has been installed and operating in approximately 20 percent of these hospitals. These instruments record motions in the hospital buildings when earthquakes occur and are useful in understanding the behavior of those hospital buildings structures due to the earthquake motions. The earthquake records can also provide the basic source data to improve understanding of the behavior and potential for damage of such structures under the forces generated and imposed by catastrophic earthquakes. As a result of this understanding, design and construction practices can be modified so that future earthquake damage is minimized and the objective of maintaining continuous operation may be met.

This white paper seeks to examine the value of the current strong-motion instrumentation program and hopes to explore other uses of the data obtained that may be of great value to hospital operators and to HCAI. This paper will explore possible improvements of the current system and consider new technologies that expand the usefulness of the information.

BACKGROUND

The Alfred E. Alquist Hospital Facilities Seismic Safety Act (HSSA) was enacted by the State Legislature and signed by the Governor in 1973 to protect patients and assure hospitals are reasonably capable of providing services after a disaster. The Act establishes a series of structural and non-structural requirements that reduce the risk of hospitals collapsing and increases their probability of continuing to provide services after a major earthquake.

Hospital instrumentation for recording earthquake motions is part of those requirements. For design of new hospitals, these requirements are mandated in the California Building Code (CBC) in Section 1615A.1.40. Instrumentation is required for new hospital buildings with seismic isolation and/or passive energy dissipation. Instrumentation is also required for hospital buildings that would use seismic resistance systems that are not permitted by the CBC; these technologies may be new or experimental such that the CBC does not yet have provisions for them.

In addition, CBC Section 3415A.I has provisions for earthquake recording instrumentation of existing hospital buildings. This section states:

> *All owners of existing structures, selected by the enforcement agency for the installation of earthquake-recording instruments, shall provide space for the installation and access to such instruments. Location of said instruments shall be determined by the enforcement agency. The enforcement agency shall make arrangements to provide, maintain, and service the instruments.*

As originally envisioned, the hospital instrumentation program was to help earthquake engineering research by providing the basic source data (real ground motions) to improve understanding of the behavior and damage potential of hospital buildings under the forces generated and imposed by potentially catastrophic earthquakes. Thus, earthquake strong-motion instrumentation is an important part of the HSSA program to provide hospital resilience and provide continuity of health services after earthquake events.

CURRENT INSTRUMENTATION

Most of the current instrumentation at hospitals in California consists of strong-motion instruments or sensors that record the motions caused by earthquakes in a particular direction called “accelerographs.” The sensors can record horizontal and vertical motions. These sensors can begin to record earthquake motions when the sensor is triggered by at a preset minimum level. The records will also have a GPS time stamp. The motions of the sensor(s) are received by a recorder that is battery-powered with a solid-state memory. The recordings are transmitted to a central repository for processing and dissemination.

Strong motion instrumentation is generally located in strategic locations in hospital buildings to capture motions in primary directions such as along building axes. Where possible, a triaxial set of sensors will be established in the free field at the hospital facility at a location not affected by surrounding structures. Structural response in terms of inter-story forces and

torsional effects can be evaluated. The recorded time histories can be used to identify when changes in structural behavior occur and provide correlation with observed damage.

CURRENT UTILIZATION OF STRONG-MOTION INSTRUMENTATION DATA

At the present time, the recordings of motions in hospitals from earthquake are primarily to understand the structural behavior of those affected hospital facilities, especially if damage has been experienced. Thus, the performance of structural systems as well as non-structural systems can be modeled and give engineers the opportunity to better understand the physical processes involved during earthquakes. Deficiencies can be identified and corrected from these studies.

The recorded free field ground motions can be used to analyze non-instrumented buildings at the hospital facility to better understand their behavior during an earthquake event, especially if some structural or non-structural distress is observed. These free field ground motions can also be used to analyze non-hospital structures in the vicinity where the ground motions can be reasonably assumed to be similar.

For the most part, strong-motion instrumentation records are primarily used after an earthquake event to understand what has happened.

UTILIZATION OF STRONG-MOTION INSTRUMENTATION DATA IN THE FUTURE

Discuss new uses of data

- Real-time uses – emergency response, structural health monitoring….

ENHANCED INSTRUMENTATION USEAGE

- Going beyond accelerographs
- Discuss new available technologies
- Low-cost sensors to augment/supplement existing technology
- Improvements in data acquisition, transmission and processing
- Artificial intelligence
- Dissemination to affected stakeholders
- Provide examples
- Costing?
- Benefits

CONCLUSIONS