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Building Instrumentation Requirements for Seismic Monitoring

Application Note #73

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SUMMARY

The primary objective of structural monitoring is to improve safety and reliability of building systems by providing data to improve computer modeling and enable damage detection for post-event condition assessment. The following instrumentation requirements are based on various building code requirements, engineering and design experience.

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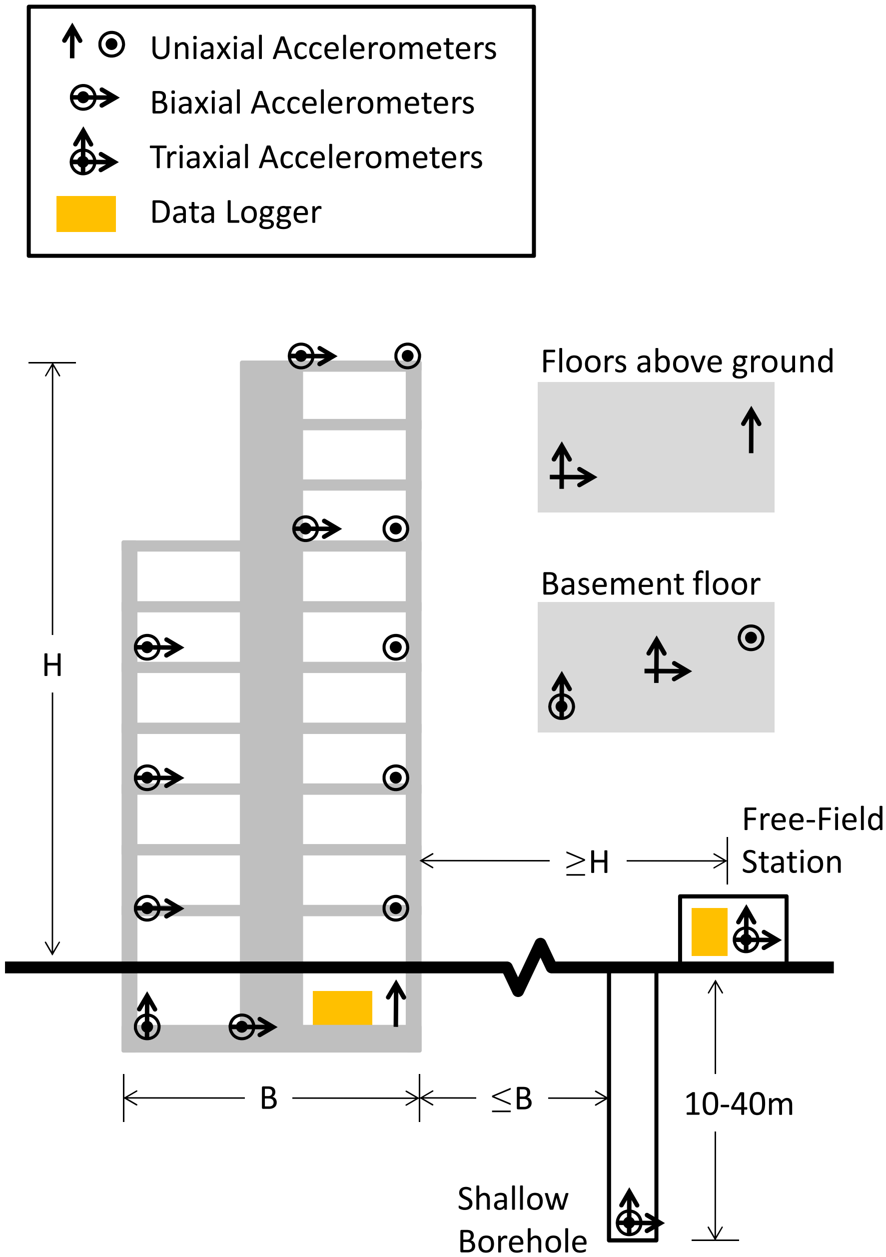
Example Deployment Illustration



Data from a building with this level of instrumentation will enable engineers to accurately estimate input ground motions, spectral accelerations, effects of soil-structure interaction, overturning, interstory drifts, torsional effects, modal properties (periods, damping ratios, mode shapes), and peak floor accelerations, velocities, and displacements.

The minimum number of channels required for floors above ground is proportional to building height as per the following table whose first two columns are taken from "An Alternative Procedure for Seismic Analysis and Design of Tall Buildings Located in The Los Angeles Region", *Los Angeles Tall Buildings Structural Design Council*, 2008.

Number of Stories Above Ground	Minimum number of Channels above ground	Total Number of Channels
10 – 20	15	26
20 – 30	21	32
30 – 50	24	35
> 50	30	41

For example, the 10 story building in the figure above requires 15 channels or five floors above ground each instrumented with three sensors (1 uniaxial and 1 biaxial) as depicted. Including the sensors at the basement level (5 channels), the free-field station, (3 channels), and the shallow borehole (3 channels), yields a total of 26 channels required. The last column in the table above provides results of similar calculations for buildings with additional number of stories.

Typically, all analog sensors will be cabled to a central data logger. However, depending on the project-specific distances, separate data loggers may be provided for the free-field and/or the shallow borehole seismometer. If multiple data loggers are used, they must be networked (e.g., via TCP/IP) for common timing and triggering.

Additional sensors for other engineering response quantities may be warranted for structures employing novel systems. For example, for an isolated building, a direct measurement of isolator displacement is critical. Similarly, displacement of friction dampers should be directly monitored. For buildings with large footprints, tilt meters on the foundation slab can indicate the onset of differential settlement. If additional sensors are used, they should be time stamped and logged in the central data logger in order to provide a complete and synchronized dataset.

The instrumentation described herein satisfies or exceeds the building instrumentation requirements set forth by the Advanced National Seismic System (ANSS) guidelines (Open-File Report 2005-1039) of the U.S. Geological Survey (USGS), Strong Motion Instrumentation Program (SMIP) requirements (CGS/DGS SYSREQ 2007-TR) of the California Geological Survey (CGS), and the standards provided in Information Bulletin P/BC 2008-40 by the Los Angeles Department of Building and Safety (LA-DBS) for S1613.8 of the Los Angeles Building Code.