

SMART STRUCTURES


The installation of a high-resolution Kinematics structural monitoring system can potentially transform an instrumented structure into a *smart* structure by providing periodic and post-event information which may lead to useful insight into the structures state-of-health. Kinematics is pleased to offer this service in the form of *smart* structure reports. The main benefits derived from this service are:

- Promotion of user awareness (e.g., building occupants and potential tenants) of the innovative *smart* structure system and its capabilities – see *smart* structure bulletin below
- Useful information about the initial status of the *smart* structure provided in a concise and easily understandable initial report
- Useful information about the *smart* structure’s performance over time (e.g., aging) provided in concise and easily understandable scheduled reports
- Useful information about the *smart* structure’s performance immediately after event (e.g., earthquake) provided in concise and easily understandable post-event reports
- An assessment of the structural monitoring system configuration (e.g., sensor deployment) in light of project objectives
- An established history of the *smart* structure including an event log

SMART STRUCTURE BULLETIN

Promoting awareness in users such as building occupants of the *smart* structure system has many benefits. People tend to enjoy learning that the structures they occupy have state-of-the-art technology and utilize the best available tools to assure a safe environment. Besides educating current building occupants, awareness of the *smart* structure may make property more marketable to potential tenants.

As part of this service, a concise information sheet or bulletin that introduces the *smart* structure is provided as in the example shown here. Ideally, the *Smart* Structure Bulletin should be publicly displayed in the lobby and/or on a website, for example.



YOU ARE IN A SMART BUILDING!

The UCLA Louis Factor Building is a *SMART* building! A high-quality structural monitoring system is installed and continuously sensing the building’s micro-amplitude vibrations. This novel system combines state-of-the-art instrumentation and data acquisition with intelligent processing to infer the structures state-of-health over time and after significant events like earthquakes.

Periodically, data from this system is interpreted by highly trained engineers to discern the structure’s current state-of-health. In the unlikely event of an earthquake, or some other significant event, response data can be used to help rapidly assess the structure’s status and, if needs be, help building inspectors target specific regions of concern. This translates to a safer, more economic structure. Enjoy!

UCLA Louis Factor Building

How Does This Benefit You?

- Feel safer knowing that you are in a *SMART* building that uses the best tools available to assure a safe and sound environment.
- Know that in the event of a large earthquake, inspectors will be better informed so that reoccupation is as fast as possible.
- To learn more, visit www.some-website.com

UCLA Campus

Factor Bldg

GPS sensor on roof

Accelerometers

Free-field sensor

Free-field sensor

Vibration Monitoring System

Diagram labels: FLOOR 15 AND ROOF, FLOOR 14-4, A-LEVEL, B-LEVEL.

SMART STRUCTURE REPORTS

Highly trained engineers with advanced degrees in civil engineering and expertise in structural dynamics and structural health monitoring will collect, process, and analyze data from the *smart* structure system. Ambient, service-level, and event response data will be analyzed using classical and state-of-the-art algorithms and signal processes. Some of the processes and resulting information may include:

- Peak amplitudes of vibration at sensor locations
- Estimated peak amplitudes of vibration for entire structure based on responses at sensor locations
- Perform linear system identification to estimate the structural dynamic properties; natural frequencies, damping ratios, and mode shapes
- If applicable, apply multiple Structural Health Monitoring (SHM) techniques such as; vibration-based approaches, parametric model updating, wave propagation, monitoring of response quantities, and other emerging novel approaches

NOTE *Kinometrics performs data analyses and provides reports that may help authorized inspectors or structural engineers to better assess the condition of the structure either due to aging or right after a significant event. Kinometrics reports by themselves do not constitute a final assessment. A final assessment requires the judgment of an authorized or duly licensed inspector or structural engineer.*

Kinometrics presents the results of the analyses described above in three types of *smart* structure reports; an initial report, periodic or scheduled reports, and post-event reports. These reports are designed to be read by anyone regardless of technical expertise.

INITIAL SMART STRUCTURE REPORT

During system commissioning (if applicable), Kinometrics engineers will collect, process, and interpret ambient vibration and/or service level data. Multiple analyses as outlined earlier will be performed and the results will be interpreted and presented in an Initial *Smart* Structure Report.

- The Initial Smart Structure Report addresses questions such as: how is the structure behaving under normal service level conditions (e.g., traffic loads for bridges), or, for buildings, how close are floor vibrations to published human comfort levels?
- Also provided here is an assessment of the system configuration and sensor deployment to optimize the smart structure considering project objectives.
- The Smart Structure Bulletin is also provided here.

SCHEDULED SMART STRUCTURE REPORT

At some regularly scheduled interval (based on service level option selected), Kinometrics engineers collect, process, and interpret additional ambient vibration and/or service level data. Multiple analyses as outlined earlier will be repeated and the results will be interpreted, compared with previous results, and presented in a Scheduled *Smart* Structure Report.

- The Scheduled Smart Structure Report addresses questions such as: if and how are the dynamic properties changing? This information may lead to an assessment of how the structure aging.
- With multiple reports, a well-documented history of structure is established.
- Also provided here is an assessment of the system configuration and sensor deployment to optimize the smart structure considering project objectives, which may have changed.
- The Smart Structure Bulletin can be updated as well.

POST-EVENT *SMART* STRUCTURE REPORT

After a significant event (to be defined in terms of exceedance of an agreed upon threshold) or at customers request, event data is collected, processed, and interpreted. Multiple analyses as outlined earlier will be repeated and the results will be interpreted and presented in a Post-Event *Smart* Structure Report.

- The Post-Event Smart Structure Report addresses questions such as: what happened during the small earthquake, or strong winds, or storm, or any other significant event? How did the structure behave? If available, how close was the structure to reaching its design or performance limits?
- If a report raises a potential concern, the customer can make a more informed preventive decision; for example, to hire a licensed inspector. Upon making this decision, the customer may then offer the post-event report to the licensed inspector to aid in their inspection process.

NOTE *Use of the post-event report is at the discretion of the licensed inspector.*

- With multiple events, a well-documented event log is established.
- Also provided here is an assessment of the system configuration and sensor deployment to optimize the smart Structure considering project objectives, which may have changed.
- The Smart Structure Bulletin can be updated as well to display how the structure behaved and inform building occupants.
- Post-event reports shall be delivered within two weeks (typically less) of event date.

The frequency of scheduled reports and maximum number of event reports depends on the service level option selected. The table below shows the annual service level options for a single *smart* structure with less than 18 channels. A-la-cart options are available too.

Service Level	Biannual	Quarterly	Monthly
Initial Report (includes <i>Smart</i> Bulletin)	1	1	1
Scheduled Reports (per year)	1	3	11
Post-Event Reports (per year, up to)	1	2	12
Total Reports (per year, up to)	3	6*	12*

* Scheduled reports are not provided in months for which post-event reports are