TECHNOLOGY

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Applying 3D Laser Scanning to MEP Seismic Restraint Retrofits

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Many buildings have been structurally retrofitted to meet current seismic codes, but what about the Mechanical, Electrical, and Plumbing or MEP systems? When the next big earthquake hits, will the sprinkler system's Victaulic couplings fail because the supports allowed the piping to swing excessively? Will the cable tray resting comfortably above the suspended ceiling come crashing down, smashing though the fluorescent lighting fixtures? In many cases, the addition of MEP seismic restraints would have prevented much of the secondary damage we see in the aftermath of earthquakes. Today, insurance companies who provide work interruption insurance to major factories are hiring engineering firms to assess the MEP systems' seismic adequacy. They would rather pay to increase the systems' robustness now, than pay the factory owners millions of dollars because their factory is offline. In this article, we will look at the process required to assess MEP systems and introduce how 3D laser scanning is used to perform this task in a more cost effective manner, with the added benefit of providing as-built information of the owner's facility.

There are a variety of standard bracing components that are routinely used for seismic restraint. The majority of requirements can be determined by prescriptive standards defined by the insurance/risk management company for the various cases found in the field. The particular cases which apply will be determined in part by the building's Occupancy Category, which influences the level of restraint that is required. An assortment of seismic code parameters is used in determining the matrix of what restraints are required for each type of component. Thus, the bulk of the design work consists of: identifying those objects which require seismic bracing; determining which prescriptive case they are covered by; accurately determining their location in the facility; and producing the drawings and documents required for bill of materials, approval, and construction support. Special cases not covered by the prescriptive codes would require attention from a qualified structural engineer to determine what restraints they require.

The typical approach to evaluating MEP systems is to send designers and/or engineers to the facility where they go through and confirm drawings by eyeball from a distance, and crawl (often literally) through the suspended maze of piping, wiring, and duct work to measure and document the existing MEP systems and their restraints. This information is then used to develop estimates and construction packages for the retrofit work. Because of the complexity of MEP systems, follow-up visits are often needed, or final construction details are left to be handled in the field where costs and quality are much harder to manage.

The first FARO Focus3D™ Laser Scanner delivered to the USA scanning a manufacturing plant in support of a MEP seismic retrofit. Can you imagine designing and locating over 1000 seismic braces in a busy plant like this?

An alternate approach is to scan the MEP systems with a 3D laser scanner and create a very detailed and accurate 3D point cloud model, which is then used as the basis of the engineering and design efforts. Today's high speed laser scanners are quite suitable for this purpose as they can, in minutes, make tens of millions of measurements with better than 2 mm accuracy over the moderate ranges involved. Scans are taken from various positions in order to provide sufficient coverage of equipment and to fill in shadows cast by other objects. The scans are then registered together to bring them all into the same coordinate system.

By removing the appropriate ceiling tile, it is possible to laser scan above a drop ceiling, traditionally a very difficult location to gather data. In most cases, any item you can see you can scan. With this approach, the cost required to obtain accurate measurements is reduced while the level of detail is significantly increased. It also reduces or even eliminates the need for repeat site visits. The engineer/designer uses the highly detailed and accurate 3D point cloud dataset to virtually fly through the cramped, elevated spaces of the above-ceiling area, allowing them to identify the MEP systems and their current support systems. Knowing the exact distances from the suspended pipes, conduits, etc. to the ceiling above is vital; one of the key variables that determine whether or not seismic restraint is required is the distance from the supporting structure to the suspended element. If the duct, pipe or conduit is less than 12 inches below the ceiling, it may not require any seismic restraint, while those elements suspended further from the ceiling may require a series of restraints. Using laser scanning data, the designer can virtually fly through thousands of square feet of space, making accurate measurements of even hard to reach systems components.

After the designer has completed an assessment of the as-built condition of the MEP systems, he refers to the matrix of restraints

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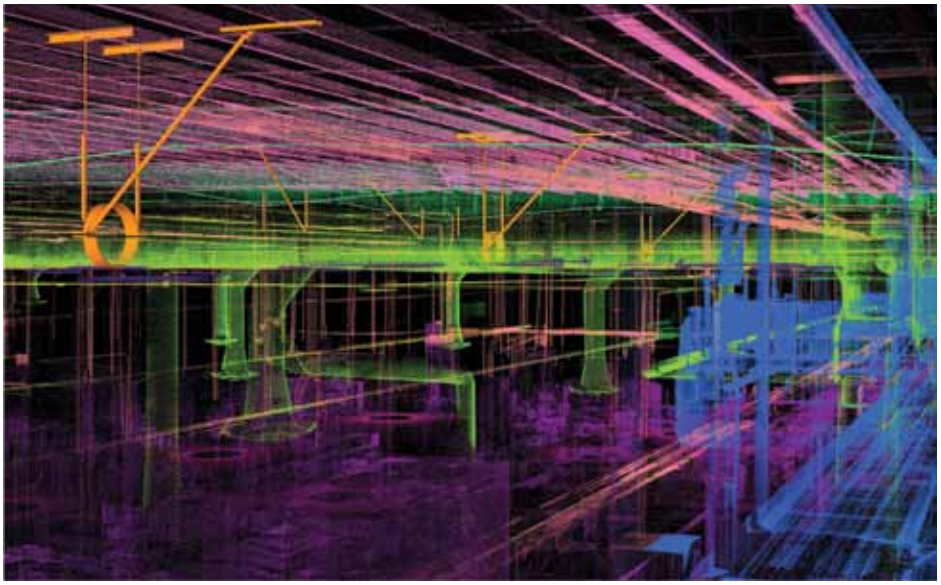

Models of seismic braces shown along with scan data that has been isolated into major systems (HVAC, piping, etc.). For more information about isolated scan data, visit ***www.sead.com****.*

determined by the prescriptive codes or, if necessary, the structural engineer, and again virtually flies through the congested MEP ceiling space identifying locations for required bracing supports. Where these supports are needed, the designer pulls a 3D model of the required support from a CAD library of supports and places it in the correct location. Clash detection can be performed by displaying the point cloud data along with the CAD models.

At this point, it is a simple matter for the designer to extract from the 3D model the information that describes the type of supports required and where they need to be installed, and produce a plan view of these elements in the facility. We now have everything the installation contractor needs to bid and install the restraints: a 3D model, a set of plan views showing which support goes where, and a bill of materials.

There is a growing number of contractors who are using 3D visualization programs such as Autodesk's NavisWorks™ to take advantage of the accurate 3D models that the proper use of 3D laser scanning provides. These programs help constructors visualize work flow and planning efforts, and efficiently resolve problems as they come up. These tools also help engineers and designers provide assistance remotely, reducing the level of non-construction resources required in the field.

While it is possible to field measure, design, and install seismic restraints of MEP systems without the aid of 3D laser scanning, the cost will be more difficult to predict and control. Accuracy will suffer, and the project schedule will most likely be extended. Laser scanning can greatly increase speed and accuracy when documenting the existing conditions in industrial facilities, hospitals, power plants or any facility with congested MEP systems. It can also be very useful in mapping the locations of existing architectural and structural elements. Employing 3D scanning in the process allows managers to move forward with confidence, removing many of the headaches caused when accurate field verification of existing construction is important.▪