One Day Seminar Earthquake Provisions and Safeguards for M&E Systems in A Building

By Ir. Fam Yew Hin and Mr. Vishnushama Ambikapathi

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The "Earthquake Provisions & Safeguards for M&E Systems in a Building" seminar held on 28 May 2012 was an introductory programme organised by Mechanical Engineering Technical Division (METD). The objective was to educate fellow engineers and contractors on the essential need to appropriately design the M&E components, so that they could withstand and survive potential earthquake, with the ultimate goal to save and prevent communities and businesses from possible loss.

In the introduction session, Ir. Loo Chee Kin of FM Global revealed that parts of Malaysia are known to experience seismic movement due to earthquakes. He recalled the two earthquakes off the coast of Sumatera on 11 April 2012 (with a magnitude of 8.4 and 8.2) that had caused shakes in large part of the west coast of Malaysia. As such, certain parts of Malaysia do face potential risk of an earthquake. Malaysia is located in between Philippines and Indonesia, the two earthquake-active countries. He presented the map below which is sourced from FM Global Property Loss Prevention Data Sheet 1-2. Coincidently, this map has similar shading to MOSTI's report on 'Seismic and Tsunami Hazards and Risks in Malaysia' dated January 2009.

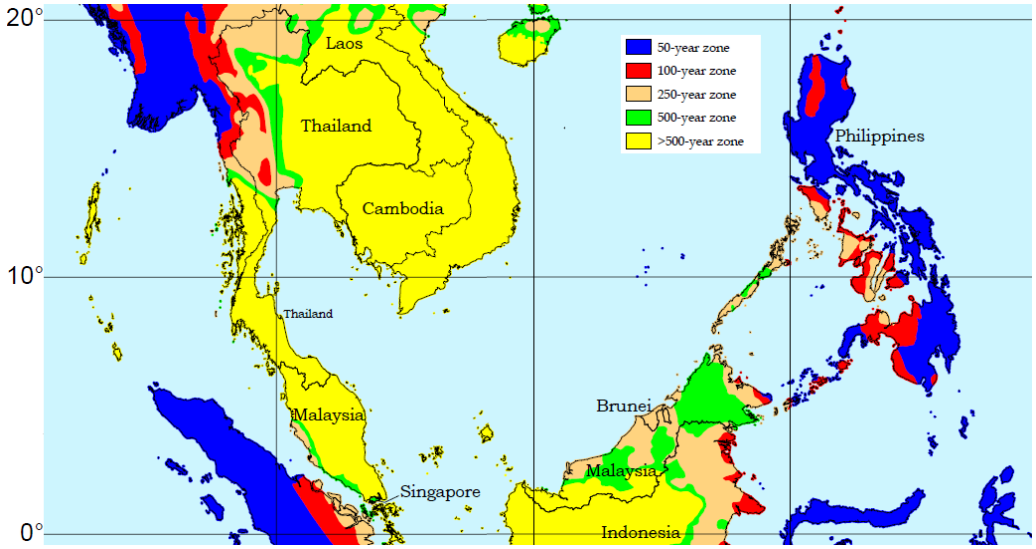

Fig 1: Earthquake zones of Malaysia, and neighboring countries. From FM Global Data Sheet 1-2

Depending on the magnitude, an earthquake can cause significant damages to the M&E systems during and after the incident. The potential damages include fire following an earthquake, sprinkler damage, liquid leakage and escape, other utility damages or services interruption. All these potential non-structural damages should be analysed and properly engineered during the design and installation stage. A list of design standards for the provision of earthquake safeguards was shared by Ir. Loo, for example the FM Global have available data sheets online, namely Data Sheets 2-8, 1-2 and 1-11. These data sheets explain the various design criteria for the abovementioned items, and can be obtained from http://www.fmglobaldatasheets.com.

One of the M&E components that need earthquake reinforcements is the building's HVAC system. Ir. Soong P.S. of Pureaire Sdn. Bhd. explained to the participants that despite the fact that air-condition ducts are made from metal sheets, the weight of a system can be substantial. The main intention to design bracing for ventilation ducts, is to reduce shake damage due to earthquakes. ANSI has developed Seismic Restraint Manuals for the various class of earthquake severity. Items to be considered in duct bracing calculations are the earthquake severity anticipated in a particular region, the weight of the ducts, and the requirement for longitudinal and transverse brace. Meanwhile, new light-weight and non-combustible duct materials are being introduced, to reduce the reinforcements and bracing required.

Having a functioning fire protection system after an earthquake is critical to limit fire occurrence following such events. Thus, it is always critical to reinforce the sprinkler system to reduce seismic damage. The hazard that a sprinkler network could pose during an earthquake is that the shake/vibration effect caused by the earthquake could lead to shear and leak damage to the sprinkler piping system, thus resulting in water damage to the contents of a building. To reduce this exposure, components such as sprinkler pipe bracing, and also flexible couplings should be considered.

The methodology on seismic bracing for sprinkler piping was introduced by Mr. David Jeltes of Erico. He provided the background for such design and shared the available web sources to get the seismic acceleration data (www.usgs.gov) required for the design. The sprinkler pipes should be laterally and longitudinally braced. Erico has downloadable software for the seismic bracing calculation that determines whether or not a design is prepared according to the FM Global or NFPA standards.

It is important to note that pipes cannot be held too rigid, or else it may break at various critical locations such as at joints where there is a direction change or across buildings. Mr. Louis Tan of Victaulic talked about seismic flexibility for sprinkler piping. He presented many videos showing how those pipe couplings performed during seismic shake table tests. By having flexible coupling, any movements in the piping network can be absorbed or dissipated before the pipes break.

There are earthquake reinforced bracing for M&E components, but how do we secure them to the building itself? In order to reduce failure of these bracing, proper seismic has proven that anchoring is required. During an earthquake, the inertia is absorbed by the M&E reinforcement components, and is subsequently transferred to the securement to the building itself. Without adequate seismic anchoring, the securement may fail and render the seismic reinforcement useless. DiplIng Muljady Wongsonegoro of BBP International Sdn. Bhd. introduces the need to use proper anchor bolts. For better seismic anchor performance, the anchor should be tested and listed for cracked concrete conditions. The seismic shear test shall be conducted according to ACI 355.2.

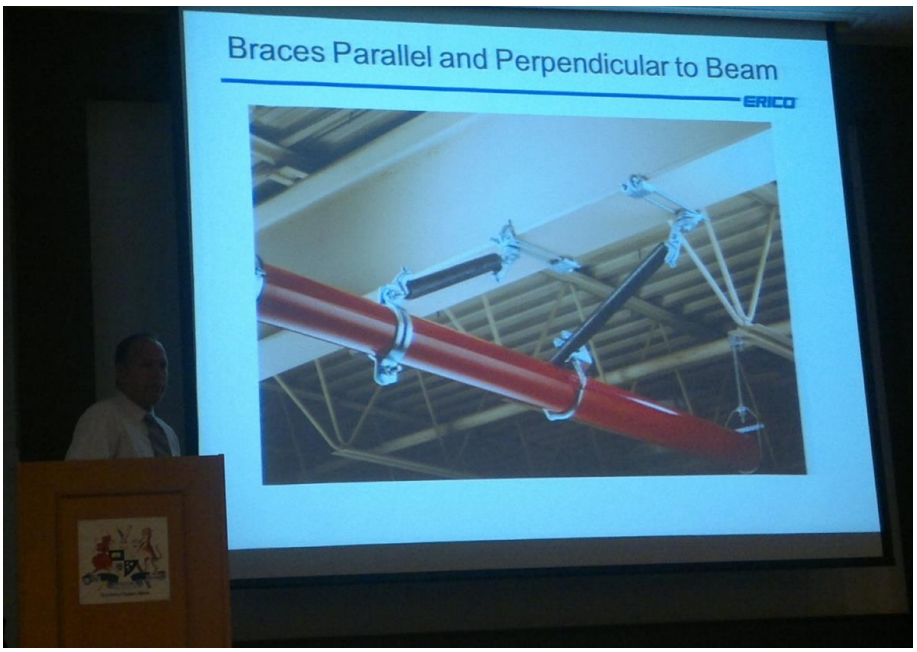

Figure 2: Mr. David Jeltes explaining about seismic bracing for sprinkler piping

One common but key mechanical component in any building is the water tank. Mr. Pareshkumar Rameshchandra Shah of CST Industries presented a range of the FM Approved water tank, which is also approved for different seismic zones. He shared with the participants a few common failure modes for tanks such as the elephant foot buckling, sloshing motion or also known as convective masses, base uplift or sliding and implosion due to rapid loss of liquid.

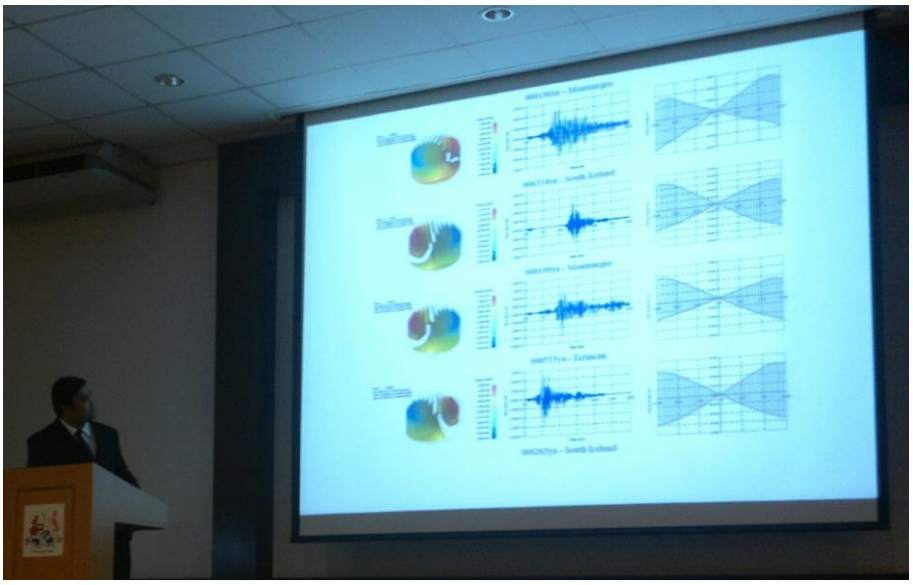
Figure 3: Mr. Pareshkumar showing some simulation of water sloshing in a bolted circular water tank

As a conclusion, there are many other M&E equipments that require seismic reinforcement, but the main objective is to reduce the hazards due to seismic activities. It is always best to prevent than to cure. Restoring a business after extensive earthquake damage would involve a major cost and also a long lead time. Having sufficient non-structural reinforcements would ensure that the operations in the building are safe and sound.