Don’t Be Caught Off- Guard:
A Primer on Pre- and Post – Disaster Planning

by

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Natural Disaster Impacts

The damaging effects of natural disasters can be astounding. Everyone is familiar with the news footage following Hurricane Sandy, the 2011 Tohoku (Japan) Earthquake, the 2011 Christchurch (New Zealand) Earthquake and Hurricane Katrina. The image of cities and towns destroyed is hard to forget. The loss of life is undeniably tragic. Because of that, the effects on individual businesses are typically, and rightly so, overshadowed. However, those effects cannot be overlooked. As a result of the 2011 Tohoku Earthquake, 644 businesses were forced to declare bankruptcy (Kyodo News, 2012). Countless others saw significant financial losses due to loss of, or damage to, their facilities.

Following natural disasters, it is common to see figures indicating the financial toll of the disaster. Hurricane Sandy cost $75 Billion, Katrina $108 Billion. The 1994 Northridge Earthquake damage estimate was $20 Billion. These numbers, while staggering, only account for the physical damage of the disaster. They do not capture the additional, and typically much larger, costs associated with lost production, damage to brand or company reputation because of delayed orders and lost market share.

Consider the case of a manufacturing facility in an earthquake prone region. The physical building's replacement cost is $40 Million and there is $25 Million worth of manufacturing equipment inside the facility. At any given moment there is on average about $80 Million of inventory in the facility at various stages of the manufacturing process. That specific facility generates $1.6 Billion dollars in revenue a year for the company. Table 1 shows the estimated financial losses for the facility due to two different earthquake scenarios.

The first scenario is based on a moderate earthquake, one which has a 50% probability of occurring at the site in a 50-year time period. The damage from that earthquake to the physical facility, equipment and inventory is estimated to be about $3 Million. It is also estimated that it would take approximately three weeks to repair the facility and return it to operation. With the facility being down, the organization expects to lose $92 Million. The second scenario is for a rarer, but significantly more devastating earthquake. In that event, the physical loss is estimated to be $12.5 Million. The facility is expected to be down for a little over two months, with an expected loss of $320 Million. In both cases, the lost revenue dwarfs the physical loss of the facility.

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Table 1: Manufacturing Facility Estimated Earthquake Losses

	Current Costs	Moderate Earthquake (50% in 50 years)	Major Earthquake (10% in 50 years)
Building Cost	**$40,000,000**	**$2,000,000**	**$6,000,000**
Equipment Cost	**$25,000,000**	**500,000**	**$1,500,000**
Inventory Cost	**$80,000,000**	**$1,600,000**	**$5,000,000**
Annual Revenue	**$1,600,000,000**	**$92,000,000 (21 days down)**	**$307,000,000 (70 days down)**
Total Damage Cost		**$95,000,000**	**$320,000,000**

There are sometimes misinformed presumptions of resilience because a facility is new and designed to the most up-to-date building code. The building code's intent is to (1.) avoid serious injury and life loss, (2.) avoid loss of function in critical facilities, and (3.) minimize structural and nonstructural repair costs where practical to do so (BSSC, 2009). The code explicitly indicates that its basic intention is to protect life in all buildings and function only in critical buildings, such as hospitals and fire stations. It only seeks to "minimize" damage "where practical," which in many cases is only for minor earthquakes. Therefore, most buildings that are designed to the building code are only designed to be Life Safe, with no consideration given to the amount of damage that may require repair or if the building is even economically viable to repair. Protection of life should obviously be considered the most important, yet protection of a business' assets, revenue, and market share should not be ignored.

The building codes are evolving documents. Every major disaster provides engineers with new information on how buildings perform and what did or did not work. Over the years code requirements have gotten significantly more robust. In some cases, things that engineers thought were safe and permissible by code were found to be seriously unsafe and latter editions of the building code reflected those realizations. Also, as scientists study natural disasters, a greater understanding of their magnitude is realized and has translated into higher design forces.

This is not to say that all modern buildings pose a significant financial risk and all older buildings pose a life safety risk. Performance of all buildings, whether new or old, can vary considerably and be influenced by many factors. The type of structure chosen, the quality of initial design and construction, modifications made after the initial construction, and the location of the building can all affect the performance of the building. Because of that, many companies' risk to a natural disaster, both in terms of life safety and financial loss, is not a simple problem and managing that risk is even more challenging.

Managing risk to natural disasters is a complicated process. It typically involves Risk Mangers, Continuity Planners, Facility Managers and Real Estate personnel working with expert consultants in a coordinated manner. In many instances it will not simply be a matter of understanding the company's own infrastructure's resilience, but also the resilience of key suppliers' infrastructure. This is achieved through thorough planning, which encompasses many tasks which are carried out before any disaster and having a coordinated plan for the immediate aftermath following a disaster.

Pre-Disaster Planning

Part of what makes natural disasters so devastating is that they do not occur regularly and when they do occur their intensity is variable. Over the years scientists and engineers have developed different ways to convey the intensity of various natural disasters. The Richter scale, hurricane categories, and tornado classes (F4, F5, etc.) are examples of this. It has also been observed that different regions have a higher likelihood of experiencing significant disasters. Coastal Florida is much more prone to a category 4 hurricane than coastal California, just like Los Angeles is significantly more likely to have a Magnitude 7 earthquake than Miami is.

The first step in any natural disaster risk mitigation plan is to understand what the natural disaster hazards are at each facility in the company's inventory. Federal and local government agencies publish information on earthquake, hurricane, flood, snow, and tornado hazards. For example, Figure 1 shows a map produced using data from the United States Geologic Survey (USGS) which indicates the earthquake risk for the Western United States. Similar maps are produced for other hazards.

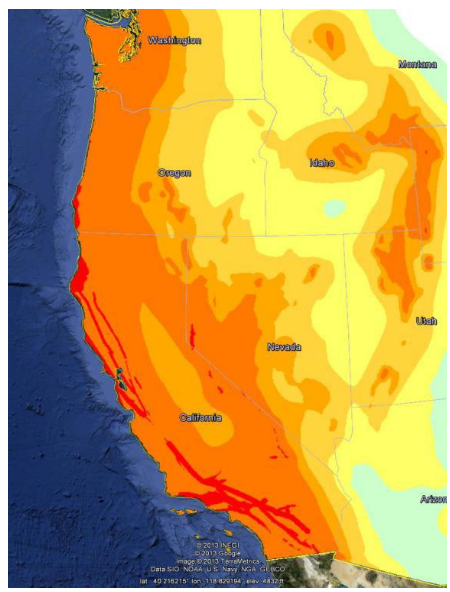

Figure 1: Western US Seismic Hazard

A simple approach to begin a plan would be to develop a matrix of all the facilities' sites and rank the hazard for earthquake, tornado, hurricane, and flood as high, medium, or low. While this may sound simple, it is an effective means to determine which sites have minimal natural disaster risk and which ones have significant risk.

Once an understanding of the hazard at each site is known, then the process of assessing the resilience of the different facilities on each site can occur. As discussed before, not all buildings, even those designed to the same code, will perform the same in a natural disaster. The code sets forth a minimum standard of safety, but not explicit performance objectives related to downtime and damage control. Therefore, it is helpful to have a common way to define building performance.

In any disaster there are three main concerns related to a facility's performance, loss of life, physical damage, and downtime following the disaster. These three metrics may or may not be related to each other. For example a facility could be "Life Safe" but sustain significant damage such that it is not economically feasible to repair. Conversely, a building can have very little damage overall, but a small portion collapsed and killed several people.

For many buildings, Life Safety is the only performance level that need be considered. Most office buildings fall into this category. The lives of the people inside are very important, but the building could be significantly, even irreparably damaged following an earthquake. The workers may be able to work from home until a new facility is found or there are enough additional facilities nearby for the workers to relocate to. On the other hand, the building may house a critical, non-redundant data center or manufacturing, which its loss of operation would cause significant disruption to the company's business. In those cases, the target performance level may be significantly higher than simply Life Safety and considerations for minimal post-disaster downtime may need to be addressed.

It is important to understand what the needs are for each facility in the organization's inventory, so the performance level can be selected for each specific building. Standards can be tailored to a company's specific needs and should be agreed upon, at least in concept before any evaluation is to begin. Evaluations of the buildings can be carried out once the standards are set for which buildings need only be Life Safe, which ones have critical functions and need to be immediately occupied, and which ones need some level of damage control in a disaster.

Evaluating building performance for different natural disasters does not have to be a major undertaking for each building. There are methods which can be employed to provide cursory assessments of all the buildings within a portfolio. Following the cursory evaluation, it can be determined which buildings warrant more in-depth evaluation. Typically, more detailed evaluations are done for critical buildings and for buildings where the cursory evaluation indicates there may be a problem, but the indicators are within the range of conservatism built into the cursory evaluation methods.

Following or concurrent with the initial evaluation of the facilities, it is recommended that company specific natural disaster guidelines be developed. These guidelines should set forth the minimum performance level for each different type of facility in the company's inventory. The guidelines can then be used to direct new construction projects, set forth standards for pre-lease and pre-purchase evaluations, and to determine which current facilities are not up to the performance they should be.

It is important to not add any new moderate or high-risk buildings to the inventory. That is why it is necessary to use the guidelines for all new construction projects and to require assessment of any building the company plans to purchase or lease space in. Depending on the type of facility, the cost of added natural disaster resilience may be very small. However, the building designers may not know that greater resilience is requested and just provide code minimum if not asked to do something more. For a typical office building, the structural cost makes up only 20% of the total building cost, making the structure more resilient may only add 5% to the total building cost. For manufacturing and data centers, the structural cost is an even smaller portion of the total building cost and thus added disaster resilience would cost even less as a percentage of the total cost.

When looking to acquire a new building or simply lease new space, a proper risk due-diligence study should be performed before committing to the purchase or lease. Again, the theme is to not add another moderate or high risk building to the company's inventory. Therefore, the risk study should focus on assessing the building's risk to life safety, damageability, and potential loss of function with respect to the significant natural disaster hazards which may be present at the site. The company's seismic guidelines should have a section which addresses acceptable risk levels for owned and leased buildings based on the occupancies and functions of the buildings.

For existing buildings currently in the company's inventory that do not meet the facility standards, there are four options – Retrofit, Replace, Insure or Accept. Retrofitting to bring a facility up to the required performance may require significant structural modifications or may only involve addressing isolated deficiencies or bracing equipment. Structural retrofits can vary from modifying the structure in isolated areas, to the addition of exterior buttress, augmenting existing member connections, or invasive additions of new structural elements to the interior of the building. Nonstructural elements, such as mechanical and electrical equipment, piping and ducts, and architectural elements, may need to be braced so they can stay in place during earthquake shaking or not be blown over by strong winds. Some nonstructural elements may need to be relocated so they are not located in an area that will be inundated with water if a flood occurs. In any retrofit, it is advantageous to perform the work when the building is vacant or in conjunction with a major tenant improvement. However that is not always feasible. In those cases, the retrofit can be designed to minimize the amount of temporary relocation, be constructed in phases or have the new structural elements added to the exterior of the building.

In some cases the cost of a retrofit may be excessive and approach that of building a new facility. In those cases several options should be explored. One is to build a new, disaster resilient facility. The other might be to build a second facility in another location which can create sufficient redundancy so the loss of one does not significantly impact the company's business operations.

The last two options – insure or accept – both are predicated on the cost of retrofit or replacement being too large to justify in conjunction to the risk exposure. Natural hazard insurance can be costly, but a sufficient way to mitigate the natural disaster risk. However, the time between the disaster and when the insurance claim is fully paid can be quite long. On the other hand, if the facility is redundant and does not pose a threat to the lives of the people inside, the company may choose to accept the risk and self-insure, meaning they will deal with fixing the building following the disaster.

Post-Disaster Planning

The moments after a major natural disaster can be total chaos. However, a well-developed post-disaster plan can serve to make the immediate recovery begin in spite of the chaos. There are a few important concepts that every post-disaster plan should have. The first one is educating all employees what to do immediately during the disaster. Sometimes it is common for people to want to run out of the building. However the more appropriate method, advocated by the Federal Emergency Management Agency among others, is to drop, cover and hold. Second is having on-site personnel trained how to properly inspect buildings to determine if there are any glaring safety hazards. The default position should be to evacuate and wait for an engineer or city building official to evaluate the building to determine it is safe. However, on-site personnel can make assessments as to whether significant hazards exist such as toxics or buildings which are on the verge of collapsing.

It can take weeks for a city inspector to actually make it to a specific facility to inspect it. This is because the demands on the local building department, even when supported by volunteer engineers, are so great that response times are unpredictable. Additionally finding a consulting engineer to hire may be difficult because of the increased demands on their time due to the disaster. Therefore it is important to have pre-arranged retainer agreements with an engineer in place to respond to the facility or multiple facilities. Additionally it is beneficial if the retained engineer has previously evaluated the facilities to have an understanding of them and where the potential damaged areas may be. This will make their evaluation much more effective and can also be used to pre-train the on-site personnel for specific hazards to be aware of.

In San Francisco, following the 1989 Loma Prieta Earthquake, a program was enacted in conjunction with the Structural Engineers Association of Northern California called BORP, Building Operation Resumption Program. In this program, the building owner contracts with the evaluating engineer, who then prepares a post-earthquake inspection plan which is submitted to the City officials. The City officials then approve the plan and that engineer is registered and required to post the safety rating of the building within three days of the disaster. The safety rating is either Green – safe for re-occupancy; Yellow – only safe for limited re-occupancy by trained personnel; or Red – unsafe. While other cities do not have a specific program like BORP, many have been willing to adopt building specific BORP-like programs if the building owner brings a proposed program to the building official or planning department.

Since minimization of downtime is key, another advantage to contracting directly with an engineer for evaluating the facilities is the ability to immediately contract them to begin designing repairs to the building if needed. As stated before, engineers will be in high demand following a major disaster and may be difficult to retain. Also, it is advantageous to have agreements with a contractor to perform repairs following the disaster because of the same scarcity challenges. All of that can lead to a significant minimization of facility loss of function following a natural disaster.

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