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HOSTILE ACTS AS A DESIGN APPROACH

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Abstract

The next decade will introduce a new generation of code specified criteria in building codes and life safety codes in the United States as well as other countries. This criteria will be intended to address a new realm of hazards that have previously not been applied to most buildings and structures. Although highly specialized building design criteria has existed for many years, its application and practice has largely been reserved for use on select structures built and occupied by the US Department of Defense and the US Department of State. Traditionally, codes and standards have worked to establish requirements that already resist a variety of loads, perils and hazards. The new model for the design community is certain to move towards consideration of a new layer of design hazard, that may be best characterized as an outline for "Weapons of Mass Destruction", (WMD) design. The parallel model to utilize the transfer of technology to address this problem is largely in existence and should be applied integral to, rather than outside of the design process.

Traditional design hazards have included gravity, seismic and wind loads; debris or impact loads; and fire loads among others. New design hazards and new vulnerabilities must now be contemplated. These include, but are not limited to blast, chemical, biological and nuclear events. In general terms – CBRNE – chemical, biological, radiological, nuclear and explosive scenarios are now being discussed in much wider circles. There is not even wide spread agreement on how to define a terrorist act, and it should not be under estimated that the deign community -architects, engineers, code officials, contractors- will be challenged to find the realm that is 'more than we do now' but something less than 'building a complete fortress'.

A supplement to incorporation of any new criteria must also deal with the delicate issue of what building or structure is a candidate for added hazard protection. This has been successfully managed for wind loads (wind design varies based upon geography); seismic loads (this load varies based upon geographic location); fire loads (this load is managed based upon the use, occupancy and construction of the building). Application, relevance and implementation of a new design hazard will have to be carefully managed and deliberately applied. Public policy makers will also enter this debate and private sector companies, such as the insurance industry are sure to help establish the boundaries of this new concept.

Whole building design, sustainability, usability, occupant security and safety and performance based approaches will be further linked together as vehicle, equipment and personnel access to buildings and structures are recast based upon real or perceived security threats. Code specific criteria will have to be carefully integrated to ensure this transition happens in a manageable way.

Keywords: Weapons of Mass Destruction, design approach, performance-based design, mitigation.

1. Introduction

In the last 18 months, the public has reacted to a series of horrid events that will change our approach to building design, construction and operation forever. Our lexicon of engineering terms now contemplates word usage previously reserved for the military. 'Asymmetrical threats', 'collateral damage', 'sympathetic targets', 'high profile targets' and 'unintended consequences' have new meaning. Hostile acts, or terrorist actions are now closer to the top of the list of design criteria that engineers and architects are being asked to deal with.

Mass, dirty and dusty are the expressions used to describe the new genre of building loads or hazards that, at least in the US, are just now becoming mainstream hazards that we need to carefully consider. Weapons of mass destruction (WMD) are typically described as some set of chemical, biological, radiological, nuclear, or explosive (CBRNE) agent or material. [i]Dirty weapons are generally accepted as being some form of radiological device. [ii]Dusty weapons, utilizing materials that are under 50 microns in diameter with most of the particles between 3 and 30 microns have been described as being used for delivery of biological or chemical agents.

Dirty weapons are largely non-destructive from the physical point of view, but can leave large areas contaminated with lingering radioactive levels that can render these areas unusable for long periods of time. Additionally, individuals exposed to these levels of radioactivity can incur serious health risks. More importantly, the psychological effects left by such devices can devastate a commercial area and any economic viability of such an area. Dusty weapons would tend to be lethal and this technology can defeat the most advanced levels of protective equipment and clothing. For building design, areas exposed to dusty weapons may be virtually impossible to clean up.

2. One Approach

Advocates of 'safer' building design imply that the design community needs to do more to keep occupants protected from some level of these hazards. Safer from what, and safer for how long are the two primary questions that have to be answered. Of course, the two extreme responses are: 1. We do not need to change anything-everything is fine the way it is. 2. We need to protect all of our buildings, all of the time, from all possible hazards for an indefinite period of time. The Council on Tall Buildings and Urban Habitat (CTBUH) and The Infrastructure Security Partnership (TISP) have put fourth discussion and future objectives to get these (and other) questions answered.

CTBUH issued two guideline documents in May of 2002. The CTBUH assessment guideline reinforces the type of systems, features and attributes that any high-rise building should already be equipped with. The corresponding enhancement guideline provides a set of provisions that, ideally, every high-rise should have as a part of its design/build package to further impart a level of building performance that will keep the occupants safe and the building performance at a high level of functionality given a catastrophic event.

The objectives of TISP, while broader in nature, are still important to establish some level of performance for the critical infrastructure of the US. A variety of buildings, structures and systems fall into the category of critical infrastructure. In the broadest sense, TISP works to identify and establish vulnerabilities that could have a negative impact on: 1. The ability of the US military to respond to a national attack or event; 2. The US economy. 3. Interruption to a major transportation center or system. The attacks of 11 September 2001 (prior to the creation of TISP) directly impacted elements two and three. The entire US commercial air transportation system was shut down and, according some economists, an accelerated slow down of the US economy has resulted.

In the microcosm of this effect, two individuals with an off the shelf rifle, a used car and some road maps created a small scale version of a 'hostile act' that, at least in the geographic Washington, DC area also affected items 2 and 3 of these very broad TISP goals. The "Washington, DC Sniper Attacks" in September/October of 2002 shows just how vulnerable a free population can be and how the crudest of weapons can be used to lead to horrific consequences.

In the days when the US air transportation system permitted most types of knives, Leathermann© tools, scissors and other cutting implements, box cutters are likely not going to be on a list of banned or suspicious items. A susceptibility, previously unknown, was identified and exploited. Since then, that potential has been greatly reduced because of new rules, new screening procedures and a new attitude from airline passengers who know that previously viewed innocent mannerisms by fellow passengers may not be so innocent.

3. Building Design and Hostile Acts

Our present day approach to building design offers little in the way of resistance to extraordinary, extreme, hostile or terrorist acts. In some ways, we are still not sure what new or different threats we should be looking at as a part of a building evaluation. Designing against terrorist acts is the most common request that is called for. What exactly does that mean? According to the United Nations[iii], terrorism is more of the action rather than the intended consequence. UNBIS terms for terrorism include the broad expressions of political violence, hijacking of aircraft and ships, and nuclear terrorism. Also included are the related terms of assassination, bombings, hostages, international offences, abduction, massacres and political crimes. The US State Department defines terrorism as "premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine agents, usually intended to influence an audience." [iv] As we now know, anyone of these terms can be applied to, and evaluated for, a potential design scenario for our buildings. How we process that information, how far we carry that information and how we decide what to do with the information is the challenge.

Unsubstantiated calls for changes in building designs and building codes, use of different construction materials, and unsupported criticism of the very systems and features that have protected building occupants for over 100 years have been the meteoric call from the public as well as from a wide range of 'experts'. A group of doctors in the US wants to determine why a political decision was made to curtail use of asbestos on WTC 1 and WTC 2 in the early stages of construction. The inference is somehow that building collapse would not have been an issue. In this frenzy, facts are not really relevant, just an idea that sounds good and that is controversial.

Unfortunately, this requires time to be taken away from investigations and research that may be relevant. There are huge opportunities to learn from 11 September 2001. Does the engineering and design community know everything? Of course not. Can we learn a few new lessons and perhaps do some things differently in the future? Most likely, yes.

Typical building design follows a prescriptive set of rules and criteria that establish a set of goals and objectives. By and large, these goals and objectives contemplate likely hazards or loads that a building would be expected to encounter. While the design of the building has certain innate qualities that might allow it to sustain more than these expected loads, defined limits or safety factors are not really codified in these rules. They do not explicitly state what performance level is predicted or expected under an extra-ordinary circumstance. In reality, building performance under expected hazards is not explicitly defined as an absolute (quantitative) value either.

Limits on building performance are usually only studied when the limit is exceeded and a catastrophic outcome results. We typically do not contemplate or study the thousands, or hundreds of thousand of times that an event occurs and the collective systems and features in the building are able to manage the event. It is this very nature of our design approaches and related code regulations that keep these buildings (high rise as well as low rise) safe from multiple events.

What is best described as a multi-hazard design approach, or multi-hazard mitigation design approach is typical of how building design is achieved. Building designs are not just made to address a fire in the structure, and no other hazard. Likewise, building designs are not just developed to address a seismic event and no other natural hazard. The National Institute of Building Sciences[v] , NIBS, has succinctly defined this concept through the Multihazard Mitigation Council, MMC The purpose of the MMC '...is to reduce the total costs associated with natural and other related hazards to buildings by fostering and promoting consistent and improved multihazard risk mitigation strategies, guidelines, practices, and related efforts.' In this realm, the total cost of building design is a function of casualties, property damage, business interruption and response to the event among other things.

Design loads or design hazards have been as basic as gravity and as complex as seismic events. The challenge imposed by a fire load on the performance of a structure is also a complex phenomenon. The frequency and severity of these complex events is a challenge for the designer. Design for gravity loads is more manageable since gravity is a relatively constant force. Wind, flood and certain debris impact loads are also considered to be conventional loads for deign purposes, but in each way, can require special design approaches to resolve the imparted loads.

Design parameters, however, can extend beyond the norms or limits that we anticipate. The design for the maximum considered earthquake, MCE, can be exceeded. This is not a secret to designers, but the public at large may be totally unaware of this. In fact, architects and engineers all over the world have provided so many superior designs that an expectation of the public has now been fostered that we simply may not be able to live up to it. Public safety bodies and organizations have been asked to establish criteria for a wide range of events. These criterion are typically established through some set of building codes, safety codes, or safety standards.

4. Multihazard Mitigation Approaches to Hostile Acts.

What model then, can be applied to at least allow for consideration of the archetype for building design in an era when the unthinkable is now thinkable? In general terms, design criteria for other events or actions should at least be added to the list of established or traditional design hazards. As a minimum, this can place these subjects on the agenda for discussion. The process for integrating a new batch of design hazards should, in effect, layer them into the provisions that are already largely in place. The process and procedures used to evaluate the other hazards that have been successfully planned for can be expanded to include other, non-traditional hazards.

Fig. 1 shows a model for how a broad view of such an approach to construction or building design might work. In this matrix, the encompassing term of infrastructure is used to categorize transportation, lifelines and buildings that, if the target of a hostile act, may cause some local or global impact. The matrix suggests that a new series of hazards can essentially be added onto the types of events that we already design for.

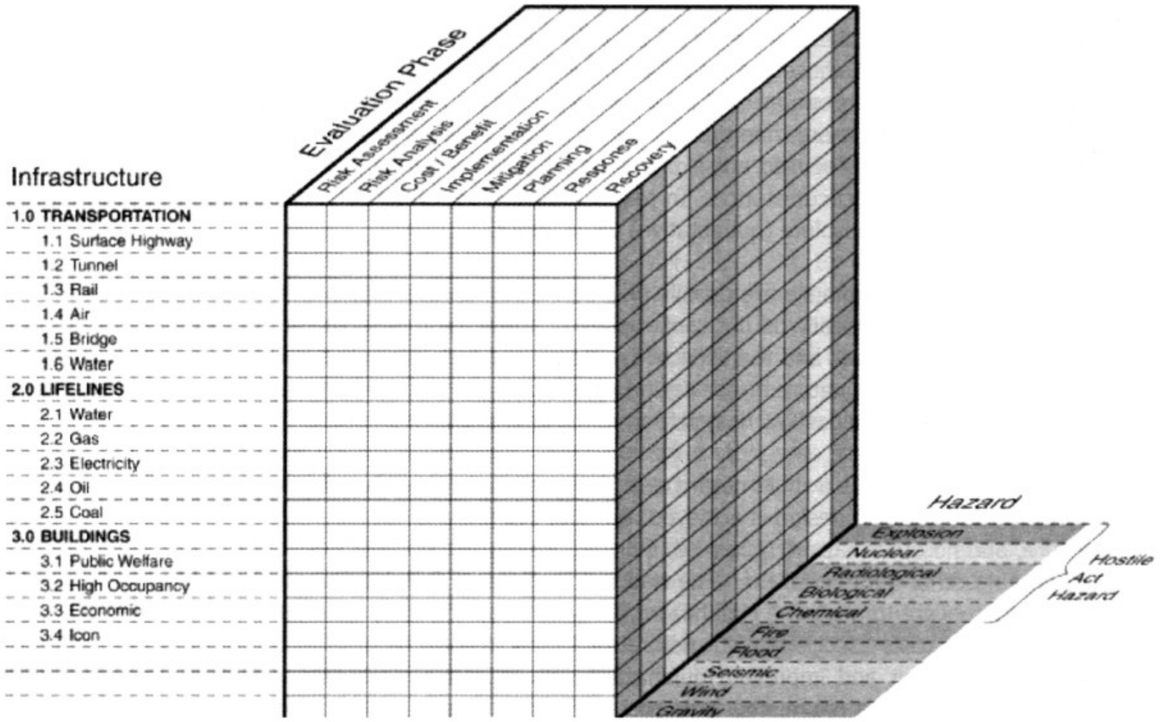

Fig. 1 Hazard Assessment Matrix for Infrastructure

The *Evaluation Phase* of the process should be a constant-regardless of the hazard being contemplated. Each portion of the matrix should be evaluated against a series of attributes to determine their applicability and the extent to which any particular measure would apply. Flood hazard design elements for a rail transportation system would typically involve placement of rail beds away from flood zones to the extent feasible. The assessment and analysis phase should identify the potential problems. The cost to develop and construct a rail bed system away from the hazard may have an impact on the cost of the project. The analysis phase should have established some level of this risk (probability of event and consequence of event). Mitigation and planning scenarios would be likely to include everything from alternate routings for interrupted train sets to pre-positioning of critical repair elements (human resources, ballast, rail, ties). Response and recovery would be expected to encompass an actionable follow-up (implementation) of the planning phase.

Application of this approach to a building design is not necessarily impossible, but it can be difficult. Application of any of the imposed hazards on the design process can require a large number of variations in the design approach that can best address as many, but not necessarily all, of the deign hazards or design scenarios. While not yet bowing to public opinion that large commercial aircraft fully laden with aviation fuel that are purposely flown into a structure at high speed should be a design hazard for a building, a model that at least prompts discussion on one or more new design hazards is in order.

Fig. 2 shows how this model could be layered to address the components and systems within a building. This array can be expanded or collapsed as necessary and is not intended to prioritize any particular element or cover every scenario or feature. The resultant mindset is to try and arrive at an inference that hostile acts should no longer be treated as a syndrome that should be kept on the shelf for all but US military and US State Department projects, but rather to engage the design community and building owners into looking at such hazards as another potential objective that at least needs to be contemplated on every project.

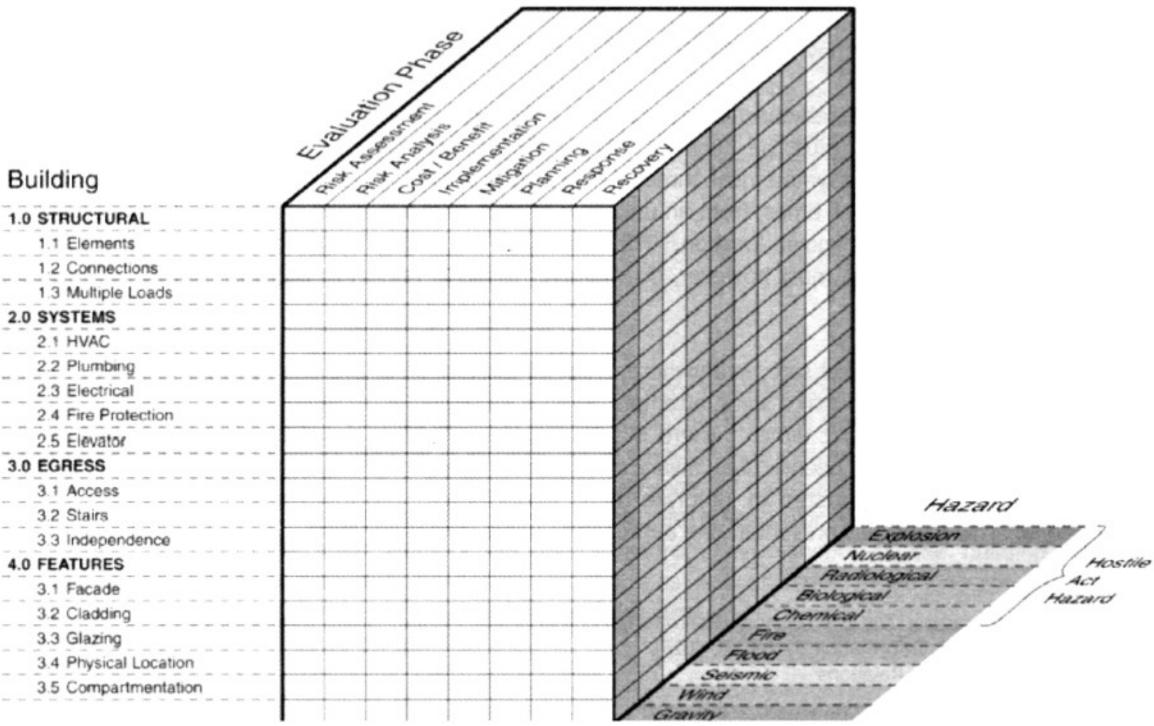

Fig. 2 Hazard Assessment Matrix for Buildings

Some traditional hazards like fire are evaluated, addressed and have some mitigation measure incorporated for every building project. Another traditional hazard like seismic design is evaluated and addressed, and may or may not have some mitigation measure incorporated into a given building project. The level to which these hazards are evaluated, and the level to which a design feature is (or is not) added is a function of many characteristics.

The new threat levels can sometimes combine to create a synergistic effect. For example, an incendiary explosion that disables compartmentation features, fire protection systems and means of egress features as the primary effect, can, in a relatively short time period, present secondary effects. The secondary effects can range from compromised HVAC systems (allowing free movement of smoke and or flame); fire following detonation of an explosive device; or failure of structural connections from an uncontrolled fire. Primary and secondary effects could be graphically represented and accounted for using this model.

Any combination of hazards or threats could be represented by this depiction. Managing the threat or the hazard, determining if it is relevant, and determining how it may interface with one or more other secondary hazards is key to looking at the vulnerability that any single event may have. Design parameters for chemical or biological threats are primarily likely to involve systems or features that preclude readily available means of introducing such elements into a building. Placement of air inlets to defeat external introduction of such material is a purely defensive mechanism. Utilization of detection systems to sense for such compounds can provide the appropriate warning level to occupants, but in this particular case, the mitigation measure to offset the threat is not as obvious.

Conclusions

While the design community has successfully developed any number of systems and features to ameliorate a buildings response to many different threats or hazards, that list has now grown. How the collective of public policy makers, engineers, architects, public safety agencies and organizations, building owners and contractors respond to this challenge will be the center of debate for the foreseeable future. The new paradigm of design must be realistically confronted and it must be realistically debated. The fact is that buildings are not designed to resist every conceivable event, and it is highly unlikely that they ever will be.

A public expectation whereby hostiles acts are not clearly understood, and the protection measures are even less understood, must be debated. Terrorism, or whatever word is used to describe these intentional acts, is an asymmetrical threat. The reality is that the design community will likely be unable to protect us at all times, from an unknown enemy, who will strike with an unknown weapon, at an unknown time, at unknown location. The entirety of the engineering, architectural, regulatory and construction community, must however, do whatever is within reason to address as much of this as is realistically possible.

Public expectations to feel safe, everywhere, from all threats, all of the time are not practical. Saying nothing can be done to make some attempts, even if incremental, to improve the occupant's chances for survival is not realistic either. There is some middle ground to forge that select elements of the design community have been acutely aware of. It appears the time has come to uncloak these systems and features and take a step to integrate them, if warranted, into more of our mainstream building designs. This paper has presented one approach to move in that direction.

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[i] Council on Foreign Relations
[ii] Kenneth A. Hassall, *The Chemistry of Pesticides* (Deerfield Beach, Florida: Verlag Chemie, 1982) p. 31.
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