<u>Making America Safer: A Proposal to Increase Building Resilience Against Terrorism</u>

<u>Abstract</u>

With the rise of the Islamic State in Iraq and Syria (ISIS) and the most recent attacks in Paris and Beirut, it appears that the world is becoming increasingly less secure. Since the September 11th attacks, the international community has worked to create a more secure world which mitigates and defends against threats, minimizes risks, and maximizes the ability to respond to and recover from attacks; however, threats still persist. One of the main threats is to buildings. This proposal recognizes that buildings in which civilians inhabit every day must be structurally adequate to keep those inside safe. It will outline a plan to determine terrorist target buildings, evaluate said building's level of risk based on a tier system, analyze current design strategies, and implement new safety codes in order to create resilient structures which can withstand explosive attack at any given moment.

<u>Introduction</u>

Northeastern University's Professor Denise Garcia defines security as the absence of threats to bodily harm. Terrorism is "the threatened or actual use of illegal force by non-state actors in order to attain a political, economic, religious, or social goal through fear, intimidation, or coercion" [Institute of Hazard, Risk, and Resilience Blog 2012]. Despite U.S. efforts to combat terrorism in the Middle East and around the world since 9/11, studies show that it has seen an almost fivefold increase in fatalities since then. Last year alone, the Global Terrorism Index reported almost 18,000 deaths, a sixty percent increase from the prior year. Terrorist-related fatalities appear to only be getting worse each year, going from 3,361 in 2000 to 17,958 in 2013, it is also becoming much more widespread as a number of new countries fall victim to attacks each year. Since the launch of the "War on Terror" following the 2001 attacks on Washington and New York, the U.S. has spent 4.4 trillion dollars on a policy which clearly is ineffective in combatting violent radical groups [MacAskill 2014].

Businesses and government facilities are the most sought after terrorist targets across major cities in the U.S. [Viegas 2010]. Terrorist groups' targets of choice are noncombatants and infrastructure. The outdated nature of U.S. infrastructure poses a major risk of destruction by explosive attack [Flynn 2008]. In the 9/11 attacks alone, 1,402 employees died in Tower One in New York and 614 were killed in Tower Two [New York Magazine 2014]. It is important to recognize that the majority of these people did not lose their lives from the initial impact of the airplanes; instead, they were trapped in the buildings when the structure failed.

This proposal calls for a reformation of US strategy for fighting terrorism through the consideration of the design of future structures that are critical to society and thus vulnerable. It requires the collaboration of government agencies and the private sector to impose new codes and regulations with incentives for builders to follow. This includes, but is not limited to, the involvement of congress and lawmakers to approve the incentives outlined later on in this proposal. The proposal aims to generate a drastic decrease in fatalities through the creation of safer, sturdier buildings. While much thought has been given to a proposed solution, it requires support in both facilitating policy generation and implementation, as well as research funding to study resiliency in structures.

Background

According to Discovery News, New York is the most frequent site of terrorism in the United States. Between 1970 and 2007, 70% of all attacks in the Big Apple involved bombs or other explosives [Viegas 2010]. Following closely behind New York are Miami, San Francisco, Washington D.C., and Los Angeles [ibid]. **Figure 1** shows this statistic in a map the representing the number of attacks in the United States based on location. The New York Police Department (NYPD) has coined the concept of ***engineering security*** as a means of assessing risk and designing security in new building construction [NYPD 2009]. Engineering security implements a risk ranking system that categorizes buildings based on certain variables involving the threat, vulnerability, and potential impact associated with a terrorist attack [ibid]. Each risk tier correlates to a set of protective security design recommendations, which include attack prevention and mitigation measures and provide guidance to building owners and designers [ibid]. The NYPD has also issued a "risk calculator" which allows you to enter each variable category as limited, moderate, or significant and yields a "risk score" based on tier and number of buildings [ibid]. For example….An example of how this risk calculator works using the Empire State Building can be found in the **Proposed Solution** section under the *Code Requirements* subsection.

Figure 1. *This is a map of the United States showing a graphical representation of the number of terrorist attacks based on their location. As illustrated, New York City has experienced the*

greatest amount of attacks. [IHRRB, 2012]

As the threat of terrorist attacks became more imminent, the field of structural engineering began conceptualizing new design strategies that mitigate potential danger. The new methods of planning a building involve the use of newly developed materials as well as advanced engineering techniques. For example, a typical modern building in the United States is specified to use a concrete mix design that cures to a compressive strength of 3,000 to 4,000 pounds per square inch. Considering the history of the site in downtown Manhattan, the designers of One World Trade Center used a concrete mix that can "withstand pressure of up to 15,000 pounds per square inch," [Grunbaum, 2011] which makes it the strongest ever used in a New York City building. The mix is up to five times stronger than an average mix and is not required by code, but significantly increases the resistance to explosions. In addition to new materials, engineers have also developed new design techniques. Before much thought was given to explosive blasts from terrorists attacks, lower-level floor columns were "designed primarily to resist gravity loads" [Smilowitz, 2011]. Now engineers design these columns to have higher ductility to resist lateral loads by increasing the amount reinforcing bars in concrete columns or by encasing steel columns in concrete. There are numerous methods that have been developed to provide buildings and their occupants with greater protection against terrorist threats.

Unfortunately, although new design methods exist, engineers are not always required to implement them by code. After the Twin Towers attack in 2001, an investigation was conducted by the U.S. National Institute of Standards and Technology (NIST). In 2008 the investigation concluded and the NIST "issued 31 recommendations to improve the safety of high-rises" which contributed to "23 changes to the 2009 editions of the International Codes" [Choi, 2011]. These changes are based primarily on the height of a building, not necessarily the risk of attack or the critical nature of the structure. In fact, according to the Department of Homeland Security, "critical infrastructure meets *minimum* codes for safety" [DHS, 2012]. The changes that did make it into the International Building Code (IBC) did not have an overwhelming impact on how the structural frame of a building is designed to resist attacks. Rather, these changes included alterations such as "glow-in-the-dark markings that show the exit path" or an "extra exit stairwell" [Choi, 2011]. Although these are helpful steps in the right direction that will allow for efficient evacuation in an emergency scenario, they are not helpful in preventing collapse. Structural failure, as shown in the World Trade Center attack, yields the greatest loss – both in the form of loss of life and financial damage.

Proposed Solution

The proposed solution involves two components that will lead to higher resilience against terrorist attacks on buildings: implementing code requirements that are contingent on risk analysis and an incentives program to encourage developers to design for resiliency.

Code Requirements

Buildings in the United States are currently designed using various codes outlined by the International Building Code (IBC) and state building codes. Requirements are assigned for different load types such as snow, wind, and earthquake loads. However, in order to design efficiently, these load categories are not equal throughout the nation or even throughout a state. For example, buildings in California must be designed to resist higher earthquake loads than buildings in Massachusetts because of the likelihood and magnitude of earthquakes experienced in California. If Massachusetts was required to follow California codes, the results would be overly robust structures that are a waste of resources and money. Similarly, within a state, different regions fall under varying snow load requirements based on the average snowfall in different regions. This type of code requirement assignment strategy can be applied to designing against terrorist attacks—(1) through the implementation of risk-based code requirements and (2) importance-based code requirements.

The concept behind integrating risk-based code requirements is closely aligned to the earthquake, snow, and wind applications described above. This provision would enforce that a preliminary risk assessment be done prior to the design of a new building. The risk of attack associated with a new building would be based on a variety of factors that include: region, attractiveness of the target, and potential occupancy of the building. These three factors can be described as follows:

- **Region** The region factor would be based on historical instances of terrorist attacks. For example, New York City, which is the most frequent site of terrorism in the U.S., would receive a higher risk score than a suburb in Montana.

- **Attractiveness** The attractiveness of the target can be assessed by considering the potential public reaction to a terrorist attack. The intent of terrorists is to inspire fear in people. Therefore, attacking certain buildings would facilitate this to a greater extent than others. For example, the choice of attacking the World Trade Center towers in New York City likely had a greater public reaction than attacking a small apartment building might have. This is why the attractiveness of the target can be used to assess building risks.

- **Occupancy** the potential occupancy of a building also contributes to the threat level associated with it. A skyscraper that 1,000 people may occupy at one time is at higher risk of attack than a general store which only has 10 people in it at a time.

  The New York City Police Department (NYPD) has developed the risk calculator that takes into account similar factors outlined above. **Figure 2** shows the risk calculator developed by the NYPD. The calculator is not explicitly being used in building design; however, it does have this potential. As an example, the Empire State Building will be analyzed. The first category of the calculator is Threat. Considering the frequency of attacks experienced by New York relative other locations, the threat profile would be considered “significant.” The building itself is iconic and would therefore lend itself as an attractive target. Moving on to the Vulnerability category, the “Adjacency” factor would be considered “significant” because the building is located in a city with many neighboring structures. That being said, because the city is congested and has increased security, the “Accessibility” factor would be “limited”. The “Structural Performance” can be considered “moderate.” The last category given by the NYPD is the “Impact.” For the Empire State Building, the “occupancy/height” would be considered “significant,” while the “economic criticality” and “transportation criticality/proximity” are “moderate”. Lastly, the “critical infrastructure proximity” factor can be considered limited because the building is not located near any vital infrastructure such as a dam. This calculator determines that the score for the Empire State Building places it into the “High Tier” of risk exposure. A similar process can be applied to proposed buildings. Before design, buildings would be scored based on different risk levels. The buildings would then follow certain design requirements based on the risk level, similar to how buildings are designed for snow and earthquake loads. A building that is determined to have higher risk will require more material to make it stronger, thus increasing the cost. The system described above will allow for efficient design by only requiring more resources and costs for buildings that call for it based on the analysis of the risk facing the structure. The risk calculations can also be updated throughout the years depending on need.

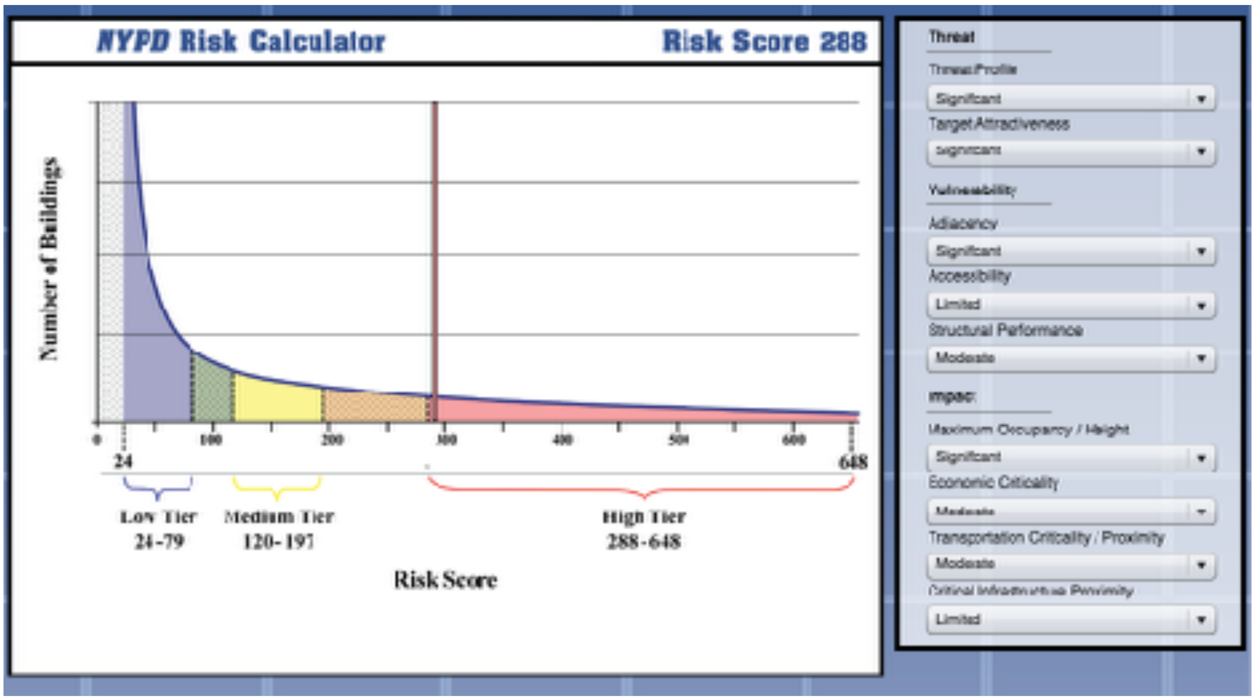

Figure 2. *Risk calculator for buildings developed by the New York Police Department. A similar analytical tool can be used when determining the code requirements based on the proposed solution. [NYPD, 2009]*

Incentives

One important component to facilitate engineering security of new buildings is through the use of incentives. A system involving incentives has been implemented by the Leadership in Energy and Environmental Design [USGBC 2014]. They offer a reduced duration of the review and permitting process, which can typically take up to 18 months if building developers abide by their criteria and “go green” [ibid]. They also award height and density bonuses for the building and this requires little to no additional costs from the municipality [ibid]. Additionally, they offer an abundance of financial rewards to companies who cooperate, which is crucial for the counterterrorism industry which loses money each time a structure collapses [ibid]. These include tax credits, fee reductions or waivers for permit review, grants and revolving loan funds [ibid]. Furthermore, contractors could be awarded complementary technical assistance if they are unfamiliar with the new procedures as well as assistance with their marketing [ibid].

These same principles can be applied in designing buildings to withstand terrorism, yielding greater compliance in adhering to risk-based building codes. Every building project is required to go through a permitting phase that can take up to a year and a half. This process has the capability of delaying the expected construction completion date. Therefore, the incentive of expediting the permit process would be highly sought after, and, if introduced, could significantly increase the likelihood of resilient design. From a financial perspective, designing for higher resiliency has the potential to increase construction costs. To counter this, tax credits can be used as additional incentive to build against terrorism. These credits should not be a fixed value, but should depend on the square footage of the building. This way, developers of a skyscraper have the same enticement as designers of a small box building. The tax credit would range between $1.00/Sq. Ft. and $7.00/Sq. Ft. depending on how resilient the building design is. The degree of resiliency can be represented by a three tier system. A gold tier building would require that the building is designed with the highest extent of resiliency currently possible with modern design practices. The silver and bronze tiers would fall below the gold in increments defined by a council centered on resilience. These ranks can also be used for gaining publicity and public education about the program. If a building is following the incentivized provisions, then it is eligible to have its resiliency rank publicized. This public ranking supports marketing objectives for the developers, owners, and designers. These incentives would be instrumental in achieving the utmost cooperation from developers towards achieving resilient designs.

Limitations

A perfect solution to any problem is almost always unachievable, and unfortunately this solution is no exception. Although introducing incentives and new code requirements would be a great step forward in protecting against terrorist attacks, these propositions are not without drawbacks. Both initiatives involve introducing new costs into building designs and the length of a new building project would increase.

As with anything new, the introduction of an incentive program would usher in new expenses for a building project. An accurate dollar amount is difficult to account for, however it would be comprised of the money required to fund a program such as LEED, the finances necessary to develop and regulate the incentives and their requirements, and, of course, the funding needed to back the incentives. However, all of this required capital will not fall on the shoulders of one entity, but will distributed between those involved in new building development. More simply, the cost of new buildings will also likely go up due to code requirements that require more material in order to fulfill higher safety regulations. The solution addresses this to an extent by providing different requirements based on the potential risk, however it is not completely unavoidable. However, in the end, the safety of the citizens is invaluable.

The implementation of an incentive program also brings with it an extended duration to the building construction process; in order to achieve the incentives, a certified inspector must approve the design and visit the construction site to make sure the requirements are being met. A construction schedule must factor in the time required for site inspections and certain work will not be able to progress without the approval of the inspector. The new code requirement might also have an impact on a building’s completion period. A permitting process is required for every building and the introduction of new code will elongate the review time. Ultimately, however, these time delays are quite small and are only a drop in a vast ocean compared to the recovery time needed after a devastating tragedy.

Implications & Benefits

Although the proposed solution is not without flaws, the issues it aims to resolve far outweigh the blemishes. As with any new initiative, there is a cost associated with the plan described earlier; however when compared to the “$600 million” estimated cost required to cleanup up the “1.8 million” tons of debris after the World Trade Center attack in 2001, the amount required for the proposed solution is likely negligible [New York Magazine, 2014]. Ultimately, this solution has the potential to save money in the long run by making buildings more resilient. In fact, the benefit of this resiliency is not only limited to terrorist attacks; it also defends against natural disasters, which are incredibly costly. It is always important to consider the economics behind a solution, however in this case money is not the largest issue.

A dollar amount cannot be placed on the lives lost in terrorist attacks. The emotional toll will always be significant, but perhaps it can be lessened to a degree. An attack will almost undoubtedly result in death; however, the number of deaths can be controlled to an extent. By designing buildings to be more resistant to terrorist attacks, the occupants of these buildings will be less susceptible to building collapse and the tragedy it brings down with it. In a perfect world, terrorism would not exist and buildings would not need the extra strength required to mitigate such catastrophes. Regrettably, this is not the world as it exists today. The solution proposed above addresses this reality and will help save the lives of the innocent civilians.

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