SAFETY NEEDS OF HUMANS WITHIN ALTERING THE WORLD AND RESPONSIBILITIES OF DESIGNERS

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SUMMARY

All of things over the world are changing depending on furthering time. Many factors such as developing technology, politic self-interest and conflicts, different expectations affect on these changes. And sometimes, these changes bring alone many problems like terrorist attacks for people life. Unfortunately, it is a sad reality of modern life that destruction of building will occur due to terrorist attacks and that people will be subjected to many lost. Nobody can ever guarantee that any bombing event will not be occurred in own buildings. Especially many problems that result from some politic issues over the world are going on their negative effects on human life and property safety. And humans living in buildings designed and built by designers are threatened by same risks such as terrorist attacks. Last appearances presented by bombing incidents like bombing of HSBC building on 20th of November 2003, in Istanbul, and bombing of The World Trade Center on 11th of September 2001, in New York, should steer all designers towards consider of their responsibilities for people living in built environment. If topic is the human life within altering the world and we are professionals as serving people, we must learn changing human needs within these changes in terms of their life and property safety; and we also must learn to response all of them within our responsibilities. So, the designer community can ask itself whether built environment properly designed together with building technology and design methods could have played a role in saving lives, reducing the number and severity of injuries, and protecting property from damages.

Many times, vulnerable buildings are located in urban areas in which only exterior wall of the building stands between outside world and the facility. Safety needs with in altering the world requires to be on the defensive for built environment as well as it appeals to the eyes. In this paper, it will be inquired into explosion risks in built environment with some attractive examples, their effects on built environment and human life safety, and responsibilities of designers. It will be not only like a rules chains, but also like a critics from architectural perspective. Because, I believe that we should have own perspective and accept our responsibility for safe life within the altering world.

1. INTRODUCTION

There are many threats on built environment, urban or architectural, in the contexts of social unrest, war, or terrorist attack. Unfortunately, it is a sad reality of modern life that destruction of building will occur. Sometimes, man's intervention can be equally destructive. Wars, greedy property development, vandalism, and neglect have been the cause of losing more human life and property than many earthquakes and hurricanes put together.

Built environment, in most time, confronts with damages caused by ballistic or missile attacks in modern life. We can never guarantee that any bombing event will not be occurred in our buildings. Taking many events in the past it is not seem surprising that more and more people and buildings will also be under threats of terrorist attack in future.

The central University Library, Bucharest, Romania was one of Bucharest's civic landmarks and part of the main Royal Palace Square. Rebel groups for shelter and as cover used the Library building during the fierce exchange with the Ceausescu's guards, during the Romanian Revolution events of December 1989. It was riddled with bullets damaged by explosions and lost its main cupola and roofs in the tremendous fire that broke out on 22 December 1989 and which continued to rage because of the thousands of rare books and priceless manuscripts the building housed. The fire caused substantial damage.

During the 1991 Gulf War, missiles with conventional warheads using High Explosives attacked the civilian population of Israel. Most of the missiles exploded near residential apartment buildings typically made of reinforced concrete, beams and columns; and standard masonry construction. A large number of apartments were heavily damaged, but the buildings did not collapse even when missile impact was very close. About 500 persons were injured, mainly from secondary glass fragments and flying building materials.

The explosion that ripped through the Alfred P. Murrah Federal Office Building in Oklahoma City, shortly after 9 a.m. on April 19, 1995, killed 168 people including 19 children and injured more than 780. The weapon consisted of a homemade bomb placed in the back of rental truck and caused the partial collapse of Murrah building and structural damage to numerous other buildings in the vicinity. Property losses totaled $ 652 million. Less quantifiable losses include the long-term effects of trauma to the local residents, a significant percentage of whom lost friends and family.

The World Trade Center building, which was reported as a living symbol of man's dedication to world peace by Minoru Yamasaki (1986), the Architect of the World Trade Center Building, will now remain in history as the symbol of evil destruction because of the tragic events, which occurred on 11 September 2001, in New York. Its North Tower was hit by a hijacked 767 commercial jet airplane and loaded with fuel for a trans-continental flight, followed 18 min. later, by an other who hit the South Tower, have been at the forefront of international analysis ever since. The site was a 16 acre formerly run-down area of lower Manhattan, and

towers were part of a group arranged around 5 acre central plaza, they were 110-storeyshigh, with a 10 000 000 ft^2 of rentable space and occupied by about 50 000 people. In 1993, there was another terrorist attack in this building. A bomb exploded in an underground car park, killing 16 people and injured 1402. The bomb attempted to demolish the base of the North Tower causing it to fall into the South one, bit it did not succeed because it was outside the perimeter skin of the tube structure. Also, the towers acted as giant chimneys aspiring the smoke through the lift shafts and stairways. But the reasons of the 11 September 2001 attack was so devastating. There have been dozens, perhaps hundreds of what could be considered large-scale terrorist acts on the Earth in human story, but this was by far the most drastic loss of life in recent memory.



Figure 1. Explosion on 11 September 2001, in The Trade World Center

Bombs had ripped through two British targets in Istanbul on November 20, 2003. In bomb attacks in Levent and Beyoğlu at least 30 murdered and 450 wounded. HSBC Bank Headquarter in Levent and British Embassy in Beyoğlu were the targets of the attacks. One explosion damaged the British consulate, killing at least 14. Moments later, another devastated the Istanbul headquarters of the London-based HSBC bank. The reports indicated that the attack at the consulate was a suicide operation while that on the bank is not known whether it is a suicide attack or not.



Figure 2. The view of the HSBC Bank Office Building in Istanbul After the bombing event

It must be accepted that terrorism in particular has forced a wider focus on the vulnerabilities of public buildings. Addressing the threat of terrorist bombings of commercial and public buildings requires a solid understanding of how structures are affected by explosions and ensuing role that the structure plays in both causing and mitigating injuries and death. Meeting the prescriptive legal requirements contained building codes is not enough anymore. According to Rudy Matalucci, a civil engineer at the U.S. Department of Energy's Sandia National Laborites in Albuqerque, N. M., we need to think beyond the building codes, because no city has a code for terrorists. Building designers must ask to him; "What are the greatest threats to this structure and what can be done about them given the costs?"

The first of several steps would be to incorporate some of the recommendations made in the Department of State-Office of Foreign Buildings Structural Engineering Guidelines for New Embassy Office Buildings. Recommended measures would include maximizing the standoff distance for buildings, continuous reinforcement in vulnerable areas and increasing the ductility of structural elements to absorb a blast. Sandia security experts advised the architect of the federal courthouse in Albuquerque on ways to make the building more resistant to terrorist attack. The seven-story building includes a variety of design features and security technologies to deter or mitigate an attack. In 1995, the National Research Council published Protecting Buildings From Bomb Damage: Transfer of Blast-Effects Mitigation Technologies from Military to Civilian Applications.

As for the bombings, the terrorist threats range from large truck bomb to the mid-size car bomb to the small package or letter bomb. For these assaults, the source can originate either external or internal to the structure. No matter what size

the bomb, there will always be some localized failure, we can prevent triggering a catastrophic structural failure. Optimally, blast mitigation provisions for new buildings should be addressed in the early stages of the design. However, existing buildings can be upgraded to behave better when attacked. High-risk facilities, exposed accidental or terrorist blast considerations, have to design and evaluate new and existing structures for blast effects to protect human lives and property.

The primary objectives of any efforts to improve the blast resistance of commercial and public buildings should be to minimize the number and severity of casualties sustained in the initial blast; limit the subsequent response of building; and improve the chances of successful rescue and recovery of the survivors. Given the many possible consequences of a bomb attack against a building, a through and detailed knowledge of how people are injured and killed in a bombing is an important step to achieving this objective.

2. DESIGNING FOR DEALING WITH WAR, TERRORISM

Defensive Design Techniques

Although it is not really possible to design a “bomb proof” building that survive completely unscathed, there are some countermeasures implemented by architects and engineers into the contexts of the overall security functions of buildings. It is possible to design features that can help reducing injury and minimize damage to the fabric. These security measures can be divided into two groups:

1. Physical,
2. Operational.

Physical or passive security measures do not require human intervention (i.e., barriers, bollards, planters, structural hardening, etc.), whereas operational or active security measures do require human intervention (i.e., guards, sensors, closed circuit television, and other devices). To have a balanced design, both these types of measures need to be implemented into overall security of a facility. If security measures are left as an afterthought, expensive, unattractive, and makeshift security posts are inevitable result.

Strategies in Site-Planning

If there is a potential threat, there is much that can be done architecturally to mitigate the effects of a terrorist bombing on a facility. Many times, vulnerable buildings are located in urban areas in which only exterior wall of the building stands between outside world and the facility. In this case, the first mode of protection is to create a “keep-out zone” that ensures a minimum guaranteed distance between likely explosion and targeted structure. This keep-out zone, which is sometimes termed perimeter line, is achieved by strategically placing at the site perimeter bollards, planters, street furniture, fountains, and other obstacles

that cannot be compromised by ramming with a vehicle. In most urban settings, the typical setback distance from the street to the building façade is 10 to 25 feet, which does not pose any access problems for emergency vehicles for the rescue and firefighting operations. When designing prestigious buildings, including landmark office towards, hospital and museum, these setbacks could be increased to create keep-out distances of more 100 feet with barriers to surely protection but which also could limit emergency vehicle access. If it is necessary, some secondary access must be designed to similarly allow enter.

In some cases, street closing are an option. Off-site parking is recommended for buildings that are vulnerable to terrorist attack. If on-site parking or underground parking is used, take precautions to limit access to these areas to only the building occupants and/or have all vehicles inspected. If an underground area is used, consider placing the garage adjacent to the building rather than directly underneath the building. Another measures is to limit the size of vehicle that is able to enter garage. This can be done physically by imposing a high limitation or an antiram knee wall a fence may be an effective solution.

Access and Entrance Areas Control

Architects and engineers can accommodate these security functions by providing adequate design for these activities, which makes it difficult for a vehicle to crash onto the site. They can use barrier walls or other devices. The second solution for obligating to free incoming is oblique to oncoming streets in design process. So it will be difficult for a vehicle to gain enough velocity to break through the buildings.

If spaces is available between the perimeter line and the building exterior, much can be done to delay an intruder, such as terraced landscape, reflecting pools, staircases, circular driveways, planters, any number of obstacles that will make it difficult to rapidly reach the building.

Improving The Building's Structure Performance

The ultimate goal is to prevent widespread structural failure or progressive collapse. There are two critical challenges for the structural engineer:

1. Ensure against the progressive collapse of the structure, and,
2. Minimize the quantity and hazards of broken glass and other blast-induced debris.

The most negative effects becomes over at the exterior, because it is the part of the building closest to the weapon especially in the events of truck or car bombing. It is also critical line of defense for protecting the occupants of the building.

According to the design philosophy, simplifying the shape of the building to avoid multiple reflections of the explosion is better. Generally, simple geometry with minimal ornamentation are recommended that it consist of a lightweight

material, such as timber or plastic, which less likely to become a lethal projectile in the event of an explosion than, for instance, brick, stone or metal.

The shape of the building can have a contributing effect on overall damage to the structure. “U” or “L” shaped buildings, for instance, tend to trap the wave, which may exacerbate the effect of the air-blast. For this reason, it is an appropriate solution to avoid from the re-entrant corners.

Another important consideration of constituting of blast-resistant exterior is choice of material used for the exterior wall. Depending on the level of protection selected, the exterior wall can be designed to survive or fail in response to an explosion. By constructing the exterior wall of more durable material such as reinforced cast-in-place concrete instead of block walls or curtain walls, at least for lower floors, the building damage. This is because of their heavy weight, monolithic character, and ductile response. For reinforced concrete design to behave well under explosive loading, it is important that ductile connections be used to ensure that failure does not occur at these critical locations. In addition, a properly designed concrete wall will aid in preventing progressive collapse, as the wall will assist in carrying the load of a damage column.

Steel frame constructions may also be effective in resisting explosive effects. For steel structures, the frame has considerable ductility if connections are properly designed and constructed.

Properly detailing beams, girder, and columns to carry damaged slabs or columns may increase structural resistant. Columns are designed to carry additional loads such that if one column is severely damaged to the point where it cannot properly function, the load will be disturbed connections also must be properly detailed terrorist blast loads, which can be upward or downward force.

It can be to enhance the structure’s response to obtain the severe dynamic loading by adding strength to resist blast, ductility to absorb the energy, and redundancy to reduce the chance of progressive collapse.

Another major consideration is to be designed windows for blast-resisting building. Windows are an essential element in building and, unfortunately, are the weak link in the facade design. In the milliseconds following explosion, much of glass in a building is transformed into fragments and shards are attributable to the body of victim being penetrated by these missiles. The amount of blast that enters the spaces is directly proportional to the amount of opening on the façade of structure. Although it may be impractical to design all of windows to resist a large-scale explosive attack, it is desirable to limit the amount of glass breakage to reduce injuries.

Of course, the number and size of windows may be reduced in buildings designed too resist blast events such that fenestration is limited to 15 percent. This helps in the protective design, but it is not provide the proper lighting or open feeling that is required especially in modern office buildings. Where the pressures will be higher from an external explosive threat, it may be used an internal atrium design with windows facing inward, not outward, and used clerestory windows, which are close to the ceiling, above the heads of the occupants.

Frame rebates should be 30 mm thick and glazing beads should be capable of resisting movement in both directions. Openings should have strong hinges, multipoint locking for secure closing and fixings capable to withstand blast loading.

The choice of glazing is crucial. Glass can be chosen to remain integral or remain in place when broken. It is possible to use a more resistant type of glass. Standard annealed glass used in windows section for both homes and office buildings behaves quite poorly in blast loading and failure. But today, several other types of glazing are available for building design, including thermally tempered glazing (TTG), laminated glass or polycarbonate security glazing, also known as bullet-resistance glass. Tempered glass not only breaks at higher-pressure levels, but it breaks into cube-shaped pieces that are considered to be less lethal. It is commonly used in special areas where glass breakage and bodily injury are likely to occur. The polycarbonate glazing also performs quite well under blast loading but does not experience the same failure mode as the TTG. Instead of breaking into small pieces, it remains a single unit as it dislodges from its support frame. The most common use of polycarbonate glazing is the front of windshield of an automobile. When damaged, it develops spider web cracks but does not break into small shards.

Given the necessary parameters, it is possible to design glass that will not break in an explosion, such as laminated toughened glass. A minimum thickness of 7.5 mm is recommended for laminated glass to be used in blast-prone situations, consisting of two 3 mm layers with a PVB (Poly Vinyl Butyral) interlayer of 1.5 mm, which is the key element in ensuring that the glass remains in place. If double-glazed, the inner panes should be of laminated glass, the outer pane preferably of toughened glass. In the case of a blunt dead weight protection can be achieved by 7.5 mm laminated glass with a PVB interlayer of 1.5 mm.

Other window treatments include adding a polyester film to the glass, which will reduce the shards but can discolor and be easily vandalized, reducing its effectiveness. Furthermore, the failure mechanism is similar to the bulletproof glass, which creates large flying obstacles. Blast curtains, which collect the glass fragments, also can be used but reduce the light and view that the windows are trying to provide in the first place.

While these glazing window solutions appear too function quite well, do not expect to see them installed in too many office buildings. Some drawbacks in these high-performance glazing systems include cost and high maintenance. Not only are the windows themselves very costly, but to fail properly, their support and attachment systems must be properly designed, which further increases, the cost.

Protection of Building interior

The protection of building interiors can be provided with two ways, which are functional layout and structural layout. In terms of functional layout, public areas such as the lobby, loading dock, and retail area need to be separated from more secured areas the facility. This can be done by creating internal “hard lines” or by

creating buffer zones, using stairwells, elevator shafts, corridors, and storage areas between public and security areas.

First, especially the building's operational control areas such as electrical systems and utility systems should be protected from direct attack to lessen the negative effects of the blast. For example, they may be placed in protected raceways, critical facilities or operations housed in specially hardened areas or underground, and primary and backup systems located in different parts of the building.

Elevator shafts can behave like chimneys in the event of an explosion, transmitting smoke and heat from explosion to all levels of the building. This may hinder evacuation and increases the risk of injury from smoke inhalation. They should be properly detailed to lessen probable losses.

False ceilings, venetian blinds, ductworks, air conditioners, and other equipment may become flying debris in the event of an explosion. Wherever possible, it is recommended that the design should be simplified to limit these hazards. Placing heavy equipment, such as air conditioners, near the floor rather than the ceiling is one idea for limiting this hazard. Using curtains, rather than Venetian blinds, and using exposed ductwork as an architectural device are other ideas.

In terms of structural layout, it is recommended that the bays of the building are kept to dimensions less than or equal to 9.2m(30 ft) within floor-to-floor heights less than or equal to 5.25 m (16 ft) as a method of good engineering practice. Since outer bay is more vulnerable to collapse than the inner bays, it is worthwhile to consider reducing the depth of the outer bay and to use multiple interior bays to limit the collapse hazard.

Special attention should be paid to some areas that are most accessible to the public, such as underground parking garages, loading dock entrances, lobbies, mail rooms, and retail spaces.

In underground parking areas it is recommended that they be designed such that all nontenant vehicles be inspected prior to entering. In these areas, it is recommended that the columns be designed to span at least two floor heights without buckling. It is necessary because often the floor slabs will be lost, resulting from weapons effects, leaving the columns unbraced for two or more levels. It is important that office space in the basement be relocated less vulnerable areas. One way to limit this hazard is to not use stairwells or elevator shafts that are continues from basement to roof. Another way to reduce the vulnerability of an underground parking garage is to place it adjacent to the building, instead of directly above it.

Loading dock entrances increase the vulnerability of the structure immediately adjacent to them. In these areas, trucks are be able to gain closer access to the building than along the secured perimeter. Also, in these areas, transfer girders are sometimes used to span the entrance. It is recommended that high population areas in spaces facing the entrance be located to less vulnerable locations, and/or the structural components be designed to withstand the direct

effects of an air-blast in these areas. The use of transfer girders is discouraged. Also, hardened design of the roof and walls of the loading dock entranceway is advisable.

Lobbies are difficult to design to resist the effects of an air-blast. Typically, the threat of concern in this area is a briefcase bomb outside the inspection point. Often lobbies contain a lot of glass, which hazardous and open areas difficult the control. Hazard reducing strategies include reducing access to columns through architectural measures and using special hazard mitigating glazing, such as laminated glass.

Mailrooms can be a concern in some facilities. One option to circumvent this vulnerability is to presort mail another site. If this is impossible, then partially contain the weapons effects by using reinforced (in both the horizontal and vertical directions), concrete block walls. To be effective, they should be properly anchored into the floors above and below. They should be used on three sides of the mailroom. The fourth wall should be designed to vent the explosion towards the building exterior. Also, it is a good idea to remove populated areas immediately adjacent to the mailroom to provide a buffer zone.

For retail spaces, or other public areas on the ground floor, it is possible to protect the occupants by designing hardened envelope above and behind these spaces. As an additional precaution, relocate office spaces immediately above or below these areas. Also, special attention should be paid to supporting columns in these areas to prevent the initiation of progressive collapse.

3. CONCLUSION

It is clear that this problem is not addressing only designers alone to solve. It requires a high level public discourse and attention of government and professionals in the same time. But we have to recognize what we can do for the safer world. Of course, more robust design techniques and technologies used in built environment and building technology will not eliminate the consequences of terrorist attacks; but design professionals have an important role to play in finding and promoting rational, balanced solutions to what remains an unbounded threat. The risk management principles relating to risk assessment (threat analyze and vulnerability assessment), acceptable risk, properly solution methods, available technology are the most important issue about create safer and livable environment; and it must be based on correct information.

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