Resilient architecture; a design approach to counter terrorism in building for safety of occupants

F O Okeke, I G Chendo and C G Sam amobi

Department of Architecture, University of Nigeria Enugu Campus, Enugu State
Email: ogochukwu.okeke@unn.edu.ng

Abstract. The intensity of fear of insecurity has increased in 21st century due to the frequency and global spread of terrorism. Homes, public infrastructures and utilities have been damaged; physical and psychological injuries inflicted; economic fortunes wrecked in a minute; many rendered homeless and lives lost as a result of terrorism and threats to terrorism. Historically, bombs and explosives have been a favourite tactic of terrorists, this is because ingredients for homemade bombs are effortlessly obtained in the open market, as are the techniques for its construction and also are easy and quick to execute. However, one area counter terrorism strategy has been universally identical is in architecture and urban planning. The aim of this paper is to reveal the need for a change in ideological approach to design by architects and planners in Nigeria in order to safeguard the environment. It discusses architectural design approach to counter terrorism in building for occupant’s safety and draws analogy from the defensive architecture of ancient times. The paramount theme is on terrorist attack with regards to explosive and bomb, the focus is on an approach that limits damage or mitigates damage rather than a blast-resistant approach. The study employed the use of case study research method with extensive review of literature of the past and present approach to counter terrorism. The result highlights some practical security design strategy that will improve occupant’s safety within a structure if incorporated in architectural designs. This will also facilitate evacuation efforts and enhance rescue endeavour in an unlikely incidence of terror attack. It concludes and advocate for a proactive design strategy for buildings in Nigeria.

1. INTRODUCTION

Terrorism is defined as violent acts (or threats of violent acts) aimed at creating fear (terror), perpetrated for a religious, ideological or political purpose and deliberately targeting or disregarding the safety of non-combatants, such as civilians or neutral military personnel [1]. In November 2004, a United Nations Secretary General report, described terrorism as any act “intended to cause death or serious bodily harm to civilians or non-combatants with the purpose of intimidating a population or compelling a government or an international organization to do or abstain from doing any act. Various ideologies have been associated and identified as the main streams that inspire terrorism. Terrorist see buildings as their best bet because it holds fairly large number of people at a time. The issue yet unresolved with research, is in line with which technique of operation the terrorist will use next? But for present time, suicide bombing and car blast as well as guerrilla tactics are employed in urban areas to cause violence. Other forms of attack which are conventional are not to be considered since the military are prepared to tackle
actions that entail conventional warfare, but the implementation of this scheme can provide safety for occupants even on event of a short time skirmishes in their environment.

Buildings, their materials, shape, texture and space represent culture in its most persuasive physical form therefore destroying a building with explosive robs a culture of its memory, legitimacy and its right to exist. Architects as the master builder and more so, as a design community holds a responsibility towards buildings, humans and nature, having to inculcate security measures in their design. Just as a house without a door has no restriction to movement, building without security measures is prone to terror attacks. The paper seeks to discover how buildings can be made safer against terrorism using architectural design solutions.

1.1 Background of study

Nigeria has been affected greatly by terror attack from different sect of religious beliefs. She ranks third after Iraq (10) and Afghanistan (9.44) in the list published by global terrorism database and institution in 2017 of terror prone nation with index rating of 9.0 as indicated in figure 1 below. 43.68% of terrorist attacks are bombs and explosive. Over 18,000 people have lost their lives to terrorism in Nigeria and over 300,000 people have been greatly affected psychologically, economically, socio-culturally and health wise. [2] From the statistics in figure 1, five countries account for three quarter of all death from terrorism and Nigeria contributes 7.1% of such death. The rapid growth of terrorism especially in Africa and Nigeria in particular requires an adequate measure on which the allied professionals involved in counter terrorism are short of technical know-how to deal with issues relating to terror.

![Figure 1. Global Terrorism Index 2017.](image)

Source: Institute for Economics & Peace 2017

1.2. How is Architecture involved?

Architecture is a field of study for planning and ordering of the built environment through ensuring design safety and functionality which is where terrorist choose as their theatre of operation. Architecture deals with building which is seen as the safest place to be on event of crisis, but when it becomes an object of terror, where will we run to? The building is supposed to provide shelter and safety, which if
destroyed can mitigate against architectural practice. Architecture is directly influenced with the trend in the environment as it stems to provide solution to mishaps in the environment like global warming.

2. LITERATURE REVIEW

Urban planning and Architecture has evolved through civilization and in each age try to address the prevailing condition associated with time and changes in its environment. Early humans are often thought of as dwelling in caves due to local finding of their archeological remain and art in the caves. The cave was used as a source of shelter during winter and similarly, a perfect protection from the wild. As time evolved, the need to control territories for the purpose of finding shelter and food became the trend in the world. Invaders seeking new territories for survival brought about the new trend for urban planning and architecture. Once a territory is established, the new occupant reforms the architecture to suite its defensive capability. The present age of architecture has lowered its regard to increasing the need for building defenses since the need for territorial threat has lowered over the past century, rather, need for sustainability as the incident of global warming due to advancement in technology, without adequate control in the nature cycle is causing global change and nature crisis.

However, the recent height of insecurity has brought about the need for solution in city planning and architecture. Architecture approach design through its elements of planning namely; functionality, aesthetics, safety, convenience and economy. This approach has heightened with the post modernism. This means that architecture can approach the defensive capability in buildings without bearing a sense of tension on the occupants and built environment psychologically or architecture of fear with regard to the elements of design.

The Architecture of Fear according to Nan [3] examines the ways in which the contemporary landscape is shaped by our society's preoccupation with fear, as apparent in home design, security systems, gated communities, semi-public spaces (shopping malls, theme parks, casinos, office atriums), zoning regulations, and cyberspace. This fixation also manifests itself in efforts to provide safety in public parks, but control the problem of homelessness. The demerit is it is architecture of fear and its character is to ward off invaders. The potent for psychological peace may not exist within the occupants and tourist may seem unwelcomed with the site of the environment.

2.1. Historical approach of design by ancient cites to avert attack

In order to understand the present approaches required, there is need to understand building design strategy for defense and security to lives in the ancient time. Different civilizations have experienced unique urban planning policies and architectural designs that modelled their spatial organization to achieve basic rudiments of planning and security against terrorist. Recall of ancient architecture for defense and protection of cities includes;

2.1.1. The Egyptian fortress.

All ceremominal buildings of ancient Egypt, including temples and funerary blocks were intended to function as bastions of order and harmony, requiring at least symbolic fortifications to protect them from terror or surrounding chaos. Unless an enemy was willing to besiege a stronghold until it surrendered or could surprise its garrison and subdue it, he had to conquer it by forcing the gates, by scaling the walls or by breaching them. As shown in figure 2, there were attempts to build fortification walls with massive thickness and of a height that ladders could not be built to scale them. The gates were specifically protected. While the tops of walls are often decayed completely, drawings indicate that there were cornices all around, behind which the defenders could take cover.
2.1.2. Roman defense walls.

Defensive walls are generally a feature of ancient Roman architecture. [4] As seen in figure 3, the Romans fortified their cities, rather than erecting stand-alone fortresses, but there are some fortified camps, such as the Saxon Shore forts. City walls were before now noteworthy in Etruscan architecture, and in the struggle for control of Italy under the early Republic many more were built, using different techniques. The Romans walled major cities and towns in areas they saw as vulnerable, and parts of many walls remain incorporated in later defenses.

2.1.3. Castle architecture of defense.

A castle is a large building, usually of the medieval period, fortified against attack with thick walls, battlements, towers, and often a moat. The castles were built with towers to protect the occupant from aerial attack. The top of the wall is a base for archers to overview an incoming enemy. As depicted in figure 4, castle walls are erected in massive concrete and stone that cannot be easily torn down by an enemy.
Figure 4. Show Castle wall and building of ancient time.  
Source: www.boardgame.geek.com

2.1.4. Architecture of natural & landscape defense (Cliffs, Rivers, Moats, Ditches and Ravelines)
From figure 5, it can be seen that castles were often erected on sites that were naturally defensible, for example on cliff or mountain tops. If no mountain top or cliff was available then, at least a hill could be built.

Figure 5. Castle Building.  
Source: www.castlesandmanorhouses.com

In flat areas as can be seen in figure 6, rivers often provided a good defense for at least part of the castle perimeter. In the absence of river, sometimes one could be diverted and an artificial lake could be constructed. On a smaller scale a moat could be built, again frustrating attempts at undermining. Some of the most remarkable and outstanding castles were built on islands or spits of land spreading into seas or rivers.

Figure 6. Castle on cliff & sea  
Source: www.google.com
2.1.5. **Towers.**

Its main purpose is to provide a high, safe place from which a sentinel or guard may observe the surrounding area. It differs from a turret in that it is usually a freestanding structure.

![Security Tower](www.castlesandmanorhouses.com)

**Figure 7.** Shows Security Tower.  
**Source:** www.castlesandmanorhouses.com

2.1.6. **Bartizan (Echaugettes)** –

Also called guerite, they are small, overhanging turret on a wall or tower. As presented in figure 8, it can be a tower which is projected from a height as a cantilever and not allowed to reach the ground for a defender to have perfect view.

![Bartizan](www.commons.wikimedia.org)

**Figure 8.** Shows the Bartizan.  
**Source:** www.commons.wikimedia.org

2.1.7. **Gates & Barbicans.**

Gateways, like all openings, were recognized weak points in any defensive fortress. For this reason defenders tended to take two simple precautions. The first was to minimize the number of openings, including gateways. The second was to provide additional defense for gateways. Another unmentioned part of the character of ancient cities is its escape route. When cities are under attack, there is a tunnel point which is kept secret but will be used when it is eminent that the city will fall and this leads the occupant to a safe zone of peace and relocation. As revealed in figure 9, the gates bear Spikes and sharp edges therefore terrorist are prevent from coming close to the gate.

![Gates & Barbicans](www.commons.wikimedia.org)

**Figure 9.** Shows Gates & Barbicans.  
**Source:** www.commons.wikimedia.org
3. FINDINGS; Character of a Nigerian City as a Result of Violence (Case of Onitsha)

Onitsha is a city located in Anambra north local government area of Anambra state. It is one of the main stay of commercial power in Nigeria and West Africa. The incident of armed robbery and violent activities in the state during the 80s and 90s depicts the character of its environmental form. Buildings in the area are characterized by tall fence of at least 2.1 meters and can reach up to 3.6 meters. The fence cap is characterized by barb wires and broken bottle edges to resist being attacked. Street flow is limited with the introduction of check point by security at the gate. Most streets entrance has massive gates in order to protect those living in it. This was not the case during the 60s to the early 80s but because of impeding violence, the entire city today is protected by gates. The city is Demerited by poor aesthetic of its environment because of insecurity.

3.1. Similar examples around the world

Terrorism has effect on architecture, for instance, since the world trade center September 11 attack, the new World Trade Centre, Freedom Tower, has been built for maximum resistance against terrorist attacks. With the lower 200 feet of the tower built to withstand car bomb attack, by blanketing the facade of the base with apparently bomb resistant materials. Also, the entire structure of the tower has been built to withstand a variety of possible attack scenarios. Even the lift core and stair wells are 'super reinforced' as to provide safety in the case of a terrorist attack as well as biological weapon, air filters. The building is set 90 feet at any time from the nearest streets. [5] Sure this is one special case, but this is most likely the future for most new supertalls in a changing world.

Similarly in Melbourne, Australia when they re-built half of the Melbourne Cricket Ground (that half has seating for at least 50,000 spectators), after the London Bombings and threats against the stadium with the then - upcoming 2006 Commonwealth games, they had to redesign the plans to allow for better security, better crowd management and they greatly strengthened the entire structure. Also at the Eureka Tower Southbank of Melbourne Australia, although not as effected as Freedom Tower, after 9/11 they changed the plans as to strengthen the tower more, as well as in parts around the tower, building measures to withstand a ground level car bomb attack. These aren’t too drastic, but think about it, if the threat of terrorism we see today didn't exist, most of these measures wouldn't have been considered.
4. SECURITY PRINCIPLES

The ingredient of physical security in the context of a structure’s total security consist of structural stability, intelligence, deceptions and operational defense. All these modules as shown in figure 10 are intertwined and related in operation.

![Figure 10. Ingredient of security.](image)

Prospective terror attack ideally is forestalled by intelligence strategy. This most times utilizes mechanical building systems. Eventually if the outbreak does happen, operational forces e.g., guards, surveillance and sensors combined with physical security measures help to make available layers of protection that impede and/or delay the violence. Deception is important because it leads astray the potential invader to a building section which is not so critical. Designers use this measure to make the facility appear to be a more secure or lower-risk facility than it actually is. As a last recourse, structural stability is put in place so as to expedite evacuation, subsequent rescue and save occupants life by limiting flying debris and foiling building collapse.

4.1. Architecture against terror and crisis

It has been evidently shown that architecture is defined with the principle of solving needs that relates to buildings. This principle has been established since man approached building as a safe place to be in. The purpose of building is not only to provide shelter and warmth but it allows us to be free and act safely within the confines of the spaces existing in it. Studies of terror as it relates to architecture are a recent phenomenon but its response is more rapidly required in today’s world as the threat for global terror grows rapidly. Some organizations have done some research in order to highlight approaches architect should follow to ensure the safety of our environment. The Royal Institute of British Architects [6] published a journal which was the aftermath of The bombing of London’s transport infrastructure on 7 July 2005 and the failed Underground bombings two weeks later, along with the abortive car bomb attacks targeting a central London nightclub and Glasgow Airport in June 2007. Therefore the challenge and opportunity for architects and designers is to design in security features from the outset when any additional cost will be minimal compared to retrofits and how they are integrated and look on site is still maintained by the design team. According to Okeke [7] the traditional approach to design used to be that of man dominating his environment, therefore architects could address this environmental problems by using biomimicry (examining nature’s solutions and applying them to building designs). The concept of biomimicry is based on copying and applying the defensive strategies used by plant and animal against terror to architectural building designs.
4.2. Explosive attacks and damage mechanism

An explosion is an extremely rapid release of energy in the form of light, heat, sound, and a shock wave. The shock wave consists of highly compressed air that wave-reflects off the ground surface to produce a hemispherical propagation of the wave that travels outward from the source at supersonic velocities. As the shock wave expands the incident or over-pressures decrease. When it comes across a surface that is in line-of-sight of the explosion, the wave is reflected, resulting in a great amplification of pressure. Unlike acoustical waves, which reflect with an amplification factor of two, shock waves can reflect with an amplification factor of up to thirteen, due to the supersonic velocity of the shock wave at impact. The magnitude of the reflection factor is a function of the proximity of the explosion and the angle of incidence of the shock wave on the surface.

The degree of damage and severity of injuries in a bombing occurrence cannot be predicted with precise accuracy. Previous happenings shows that the failure patterns for an individual structure resulting from explosive effects and debris (rubbles) impact considerably affect generally the extent of destruction. Damage due to the air-blast shock wave can be classified into direct air blast effects and progressive collapse.

- **Direct air-blast effects** are damage caused by the high-intensity pressures of the air blast close to the explosion. Localized failure of exterior walls, roof systems, windows, columns, and floor systems may result.
- **Progressive collapse** refers to the spread of an initial local failure from element to element, eventually resulting in a disproportionate extent of collapse relative to the zone of initial damage. Localized damage due to direct air-blast effects may or may not progress, depending on the design and construction of the building. To produce a progressive collapse, the weapon must be in close proximity to a critical load-bearing element. Progressive collapse can propagate vertically upward or down ward and or laterally from bay to bay as well.

From structural design perspective, car bomb is of utmost concern. They are able to deliver a sufficiently large quantity of explosives to cause potentially devastating structural damage. [8] Security design to mitigate or limit damage resulting from a car bomb assumes the bomb is detonated at a so-called critical position as shown in the diagram below (figure 11). An alternative explosive threat of attack is the small bomb delivered by hand. Small weapons can cause huge damage when carried into vulnerable, unsecured areas of the interior of the building such as reception, lobby, retail spaces and mail room. Recent happenings around the globe have made it clear that there is an increased likelihood of persons willing and ready to give up their own lives in sacrifice just to deliver and denote bombs. Small hand-transported bombs are usually equivalent to five to ten pounds of TNT. Larger load weights, however, can be easily carried in rolling cases in the equivalent range of 50 to 100 pounds TNT.

![Figure 11. Shows the effect of blast to a structure and the control points](Source: FEMA 427)
Generally, the key feature of a security measure in place is the largest credible explosive size. Each security line can be considered as a filter or screen, plummeting the size of the weapon that can be carried across or gain admittance. The largest weapons are therefore expected in completely unsecured public area (e.g., in an automobile on a public nearby street), and the smallest weapons are considered in the building's most secure spaces. (e.g., briefcase or hand bag smuggled past screening post).

Design threat is defined by two parameters: the size of the weapon, measured in equivalent pounds of trinitrotoluene (TNT), and the standoff. Usually the standoff is the distance or offset measured from the charge's center of gravity to the target component. Conversely, the dramatic aspect of detonations in contexts of the sheer decimation they induce creates a media frenzy that is very efficient in communicating the perpetrator's message to the public.

5. DISCUSSION

5.1. Design approach to counter terrorism

Counter terrorism design approach requires designing security measures into a structure. It involves a complex series of compromises to achieve a balanced design, and both the operational and physical security modes are to be employed within that structure. To have an efficient physical security system against terror, the engineer and building designer have a major role to play as the physical security system complements and expedites the operational security functions. When safety strategy and security design measures are missing from the onset of the design and considered as an addendum or afterthought, it results to an inevitable costly, unappealing, uninviting and uncoordinated make-shift security posts littered around the facility. Terrorism risks can be mitigated in two basic fashions: Proactive and Reactive Strategies.

- The proactive strategy involves introducing physical, technical and procedural protective measures, such as barriers, bollards, landscaping, access control, surveillance devices and by reducing the impact that the loss of a particular element may have on the asset as a whole. This has to do with including defensive strategies in the architectural design right from the drafting board. It is proactive because it must factor in three defense tactics to fight against potential terror. It includes (a) preventing the attack, (b) delaying the attack (c) Mitigating the effects of the attack. The design should be able to perform one or all of these defense strategies in an unlikely event of violence.

- By reactive strategy it means shifting the risk via insurance, redundancy of operations in the form of a back-up capability, or through terminating absolutely that line of activity where the level of risk is determined to be excessively high.

(a) Preventing an attack. This is the first principle to combat terrorism, because in the context of building design it is removing all breeding grounds for terror and eliminating any potential attack even before they strike. It can be translated to mean being ‘battle-ready’ by creating a difficult situation for the implementation and execution of some of the most palpable setups, obvious tactics or attack settings (like parking vehicle with explosive on thoroughfares) or by giving the target the impression to be of little or no significance in relation to the amount of sensation that would be created if it were to be taken on, the potential assailant may become discouraged from aiming for the facility or that portion of the building. Just as the ancient architecture of defense gave their edifice protective cover and still did not jeopardize aesthetics value as of then, contemporary architectural design still can realize this function by use of explosive detecting building components like laser scanner, electronic gates, doors, urban furniture etc, restriction of automobile access to secure perimeter by landscape design, creation of long walking distance for public and institutional buildings as this helps in pedestrian monitoring, application of deconstructivist theory of design to porches, foyer and entrances.
(b) Delaying terror attack. When an attack is instigated or attacks initiated, well landscape design or appropriate use of urban furniture and elements of architectural design can interrupt and delay its accomplishment by creating more challenges or making it difficult for the invader to quickly arrive at the intended target or portion. It provides ample time for the authorities and security forces to mobilize and possibly to halt or circumvent the attack before it is completed. This can be achieved by creating strata of buffer zones between the publicly accessible areas and the important areas of the facility by means of obstacle course, a serpentine and curvilinear path and/or a division of functions within the building. On the other hand, by effective design, the potential attacker can be lured, attracted and deceived to a non-critical section in the building, thereby frustrating the proposed violent attack.

(c) Limiting and or mitigating effects of terror attacks. In context of total security to provide to a facility, structural fortification is usually the last recourse which only come into play and effective when every other measures and efforts to bring the violence under control proves abortive. In the circumstance of an attack, the benefits of enhancements to life-safety systems may be appreciated in numbers of lives rescued. An efficient technique to realize these goal is the formation of security strata in the building as shown in figure 12

![Figure 12. Schematic showing lines of defense against blast. Source: FEMA 427](image)

From the street region to the boundary or the building’s perimeter is the outmost shield, further from this line is the zone of the building approach, before the exterior of the building, and lastly the interior zone of the building. This interior of the structure can be consecutively alienated into reinforced zones of protection, beginning with spaces accessible to the public like the entrance, foyer, retail and storage space, to the areas that are more secluded such as offices and ultimately the crucial regions consisting of control and strong room with emergency roles. The benefit of this type of design style is that when a protection line is penetrated or strata of security is ruptured, it does not result to the building being totally compromised. Creating multiple defense lines gives the security system redundancy, adding to the design robustness. Also, not all attention is on the outside lines of defense by using this approach, which can lead to an unattractive, fortress-like appearance. They must be some uniform and reasonable level of safety along the total length of each ring to ensure a reliable design. Escape route and separate emergency exit for quick evacuation of occupant in times of crisis should be taken seriously. Access leading to such exit should have fire related doors and unobstructed from opposing traffic.

5.1.1. Building Shape Configuration and Exterior. A building's shape and its exterior façade can contribute to the overall structural damage in events of explosive attack. For floor plan shaped with
angles or parts that re-enters itself or with overhangs, it is possible that shock from the wave of blast will be trapped and this magnifies the devastating effects of the explosion as shown in the sketch below (figure 13), therefore such plan shape should be avoided.

Figure 13. Shows floor plan shape that dissipate and accentuate air blast. 

The pressure reflected on a spherical building surface or circular shape is not as much as on building with flat surfaces. Convex shapes stand preferred over concave building profiles when curved surfaces are to be used. For flat surfaces, a larger portion of the building's surface area or facade is engulfed by the progressive impact from the point of explosion resulting in more destruction.

In the context of building exterior the focus shifts from dissuading and delaying the attack to mitigating the effects of an explosion on the exterior of the building. The building's exterior envelope is most vulnerable to an external explosive threat as it is the building's nearest part to the instrument of attack and are usually constructed with brittle and inelastic materials. It can also be seen as important defense lines for inhabitant's protection within the building, therefore the elevation should be a component that will limit damage to the facility. As displayed in figure 14, some façade heighten the effect of air blast and some do mitigate air blast effect. Hence care must be taken in selection and design of building elevation.

Figure 14. Shows façade shape that dissipate and accentuate air blast 

For building elevation; Re-entrant corners, overhangs and large cantilever are design features that should be avoided, this is because just as seen in floor plan shape, they also cage the shock from the wave of blast and intensify the outcome of the explosive. See illustration above.

Unless advanced structural analysis and methods are to be used, it is recommended to use simple geometry and minimal embellishment with modest ornamentation (which may become element of
destruction and flying debris during an explosion). When using ornamentation, it is better to use lightweight materials like plastics or timber that are less probable to become lethal projectiles in the incident of air blast than stone, metal, concrete or brick.

5.1.2. Functional Layout of Building Interior. It is necessary to separate unsecured areas such as the lobby, loading bay, reception, mailroom, store and retail areas from the secured areas of the structure to achieve a functional layout in the facility. Ideally, areas that are unsecured should be sited outside the core facility or lengthwise of the building's boundaries. As exemplified in figures 15 and 16 below.

Figure 15. Shows typical design sketch of a commercial building.  
Source: author’s sketch 2018

Figure 16. Shows an improved design layout against terrorism.  
Source: author’s sketch 2018

Figure 15 is a typical architectural design sketch for a commercial building with unsecured ground floor areas. This entire building will collapse in the event of an attack because the structure's base will be greatly affected. However, in figure 16 separating the lobby, store, loading bay and waiting area outside the building's main outline, improve protection against damage and potential collapse of building on the
occasion of an explosion at these places. If vulnerable zones cannot be placed outside the main footprint of the building, they should be located along the exterior of the building and use the outline of the building to create internal "defense lines" or bulwark zones. Located between public and secured areas should be corridors, lift shafts, storage areas and secondary stairwells.

5.1.3. Intelligent/Smart Buildings. With advancement in technology, building owners and client are demanding versatile building to increase efficiency and productivity. Architects are now specifically tasked with the challenge to provide the safe and secured setting, functional spaces and enabling environment to connect people and support their daily activities; this demand paved way for the introduction of intelligent/Smart buildings. The concept of intelligent architecture started as an interest in the latest integrated building systems operating a single building or facility, so that systems can communicate and exchange information. [9]

Intelligent building according to the Intelligent Building Institute [10], is a structure that creates a cost-effective and productive environment by optimizing its four key elements; system, structure, service and management, and the interrelationship among them. These smart structures utilizes computerized procedures and automated processes to consequently control the facility's operations and activities including ventilation, security, heating, cooling, lighting and different other frameworks, automatically. In order to collect and manage data according to the functions and services of the structure, smart buildings uses actuators, sensors and microchips (Artificial Intelligence) to perform task normally requiring human intelligence. Five sense of an intelligent building includes; Environment monitoring, Visual management, Communication enablement, Security integration, Network connectivity.

The first step to create a safe and secure environment for intelligent buildings is through risk management. This can be achieved with a physical security approach of five layers. The deployment of a layered security strategy can provide the facility with the ability to deter, detect, deny, defend and detain threats to attack on every layer of the building, including the perimeter of the property, reception, floor level, technical spaces and specialized area. This typically adopts a variety of security solutions including video surveillance network, integrated access control, intrusion detection, fire protection systems, and smart sound and lighting system. A truly intelligent building will address the urban architecture design challenge.

6. RECOMMENDATION

Designing a non-combatant structure or civilian facility to completely remain intact after a massive blast is impracticable. Therefore, the protective goals are very crucial as they relate to the building type and its purpose. For instance, a residential facility, retail shop, light industrial building or an office complex, which predominates in property development project has its occupants as the major asset and the target is to abate life loss. Therefore design professionals should be able to reduce building damage by incorporating the following measures.

- Use landscaping or barrier methods to place buildings faraway from any secured perimeter as possible and secure perimeter against intrusion by vehicle.
- Use nonstructural lightweight elements for interior and for the exterior of the building.
- Locate unprotected zones and external functions of the facility in the external bay.
- Integrate measures to withstand the gradual or progressive collapse. In buildings with 7 floors or more the building form should guarantee that debris does not block the access to the building.
- Design exterior window systems and cladding to provide higher or equal resistance to lateral-load than the transparency or panel for the framing, connections and supporting structure.
- Avoid design of windowless structures as in event of explosion widows blow out and limit total collapse of structure.
Employing more than 30% of glass for the opening view surface is forbidden and the glass used of each opening must be resistant. Also avoid the use of glass as false ceiling.

Avoiding windward angles such as L and U in buildings due to trapping shock waves and resonance of explosion. Using circular and preferably convex surfaces, because the intensity of the reflected pressure on it is lower than a flat surface.

Use redundant, separated mechanical/electrical control systems.

7. SUGGESTION FOR FURTHER RESEARCH

An in-depth study should be carried out on landscape architecture and Counter Terrorism techniques to see ways we can use the nature in our environment to achieve safety.

8. CONCLUSION

There is a saying that security is for you and me and if this saying is true, all profession in the building industry especially architects should aim to see that it covers the loop holes relating to its field of operation. Architecture is known to establish profound realities not easily altered once in place and much can be accomplished by architectural design to prevent, delay or minimize the impact of bomb attack on a building. The merit of the ancient architecture is that buildings inculcate resistance to oppression and protect its occupant. These precautionary interventions always cost bantam/nothing if introduced and instated in the design development stage early enough. Counter terrorism design strategies like building shape configuration, design deception, exterior façade, use of lightweight building element, landscaping, building space layout and use of smart building concept enhances the safety of occupants within the facility. Other architectural design parameters such as energy efficiency of building, ease of access, aesthetic appeal, fire prevention, natural hazard mitigation and initial as well as life-cycle costs have to be balanced with security considerations. The architecture we should build is to defend our space not the very same that terrorizes them, serving as ledges onto which vultures perch and wait for their demise. People said sustainability would be too expensive but there’s a real appetite for that now. I predict the same thing will happen with architecture of counter-terrorism.

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