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ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS AGAINST BOMBING ATTACKS AT LAND PORTS OF ENTRY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
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BY
Reha Oğuzhan TÜREL

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FOR
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The thesis study titled "ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS AGAINST BOMBING ATTACKS AT LAND PORTS OF ENTRY" is submitted by Reha Oğuzhan TÜREL in partial fulfillment of the requirements for the degree of Master of Science in the Department of Architecture, Gazi University by the following committee.

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ETHICAL STATEMENT

I hereby declare that in this thesis study I prepared in accordance with thesis writing rules of Gazi University Graduate School of Natural and Applied Sciences;

- All data, information and documents presented in this thesis have been obtained within the scope of academic rules and ethical conduct,
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Reha Oğuzhan TÜREL
26/06/2019

ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS AGAINST BOMBING ATTACKS AT LAND PORTS OF ENTRY

(M. Sc. Thesis)

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ABSTRACT

In this study, it is aimed to conduct a research on architectural passive security arrangements against bombing attacks at land port of entry. By this way, it is intended to provide data for new land port of entry projects and land port of entry revision projects in context of arhitectural passive security arrangements. For this purpose, firstly the concepts of risk management and explosion have been mentioned in general terms, then the general principles of architectural passive security arrangements have been explained under two main headings as building and site. In the following, it was discussed how these principles could be applied in land port of entry site and buildings. In the last part, an architectural passive security assessment was done through an example land port of entry.

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KARAYOLU SINIR KAPILARINDA BOMBALI SALDIRILARA KARŞI MİMARİ PASİF GÜVENLİK DÜZENLEMELERİ

(Yüksek Lisans Tezi)

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GAZİ ÜNİVERSİTESİ

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ÖZET

Bu çalışmada kritik bir ulaşım ve lojistik altyapısı olan karayolu sınır kapılarında gerçekleşmesi muhtemel bombalı saldırılara karşı önlem olarak uygulanabilecek mimari pasif güvenlik düzenlemelerinin neler olduğu araştırılmıştır. Böylelikle Türkiye'de yeni yapılacak karayolu sınır kapısı projelerine ve mevcut karayolu sınır kapılarında gerçekleştirilecek revizyon çalışmalarına pasif güvenlik uygulamaları bağlamında veri sağlamak amaçlanmıştır. Bunun için öncelikli olarak risk yönetimi ve patlama kavramlarından genel hatları ile bahsedilmiş, ardından mimari pasif güvenlik düzenlemeleri genel prensipleri yapı ve saha odaklı olmak üzere iki başlık altında belirlenmiştir. Devamında, belirlenen bu prensiplerin karayolu sınır kapıları özelinde nasıl uygulanabileceği tartışılmış ve örnek bir sınır kapısı üzerinden bir mimari pasif güvenlik değerlendirmesi yapılarak çalışma sonlandırılmıştır.

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Anahtar Kelimeler	:	Kritik altyapıların korunması, karayolu sınır kapısı, pasif güvenlik, mimari tasarım
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SYMBOLS AND ABBREVIATIONS

The symbols and abbreviations used in this study are presented below with their explanations.

Symbols	**Explanations**
cm	Centimeter
kg	Kilogram
kPA	Kilopascal
m	Meter
m/s	Meter/second

Abbreviations	**Explanations**
APSA	Architectural Passive Security Arrangements
ASTM	American Society for Testing and Materials
CBRN-E	Chemical Biological Radiological Nuclear- Explosive
CCTV	Close Circuit Television
CMU	Concrete Masonry Unit
ESCAP	The Economic and Social Commission for Asia and the Pacific
FEMA	Federal Emergency Management Agency
GSA	General Services Administration
GCA	Graphic Created by Author.
LPOE	Land Port of Entry
NA	Not Available / Not Applicable
OECD	The Organization for Economic Co-operation and Development
TEM	Transit European Motorway
TNT	Trinitrotoluen
USA	United States of America
VBIP	Veterinary Border Inspection Point
VIP	Very Important Personality

1. INTRODUCTION

In parallel with increasing number of terrorist attacks, protection of critical infrastructures claims more and more space in security agendas of countries of the world. A successful attack on the critical infrastructures not only damages the public security, but also leads to serious economic losses. For this reason, it is very important to prevent any possible attacks on critical infrastructures, and in case of failure, to minimize the loss of life and property, and to ensure that the infrastructure under attack can still fulfill its critical functions.

Transportation and logistics infrastructures are among the most important critical infrastructures. Ports of entry, and especially the land ports of entry stand out among transport and logistics infrastructures due to the economic and strategic importance they have. Unfortunately, though, the subject of protection of the critical infrastructures in Turkey mainly focuses on the digital defense strategies against cyber attacks, and measures taken against physical attacks are limited to improvement of the structural strength of the buildings. However, according to the OECD data [1], disabled land ports of entry may cause the loss of 4 percent of the daily trade volume, and due to this potential impact, it is clear that the land ports of entry should have comprehensive security measures. Architectural passive security arrangements, together with other security components, are a critical part of these measures. Creation of an extensive academic literature on the security of land ports of entry is extremely important in a country such as Turkey, which is positioned on a harsh geopolitical environment and intensely threatened by terror, particularly for the security of land ports of entry located in the high-risk areas such as eastern and southeastern borders.

Purpose of the study

This thesis studies architectural passive security arrangements that can be applied as a precaution against possible bomb attacks at land ports of entry and thus; intends to provide data for projects of new construction and revisions of land ports of entry in Turkey in the context of passive security applications.

Scope of the study

It's possible to focalize the passive security arrangements to different assault types as well as it is possible to apply them to all components of the built enviroment. For instance, while in case of a possible arson attack on critical information technology infrastructures such as a data center, architectural passive security arrangments will be focusing on subjects like fire resistance, fire spreading, escape routes, cleaning out the smoke etc. in the context of data center buildings; in case of an armed attack against a religious building, architectural passive security arrangments will focus on different subjects in context of that religious building. This study discusses architectural passive security arrangements against a possible bomb attack on land ports of entry which is a critical transportation and logistics infrastructure. Scope of the study has been illustrated in a diagram in the Figure 1.1.

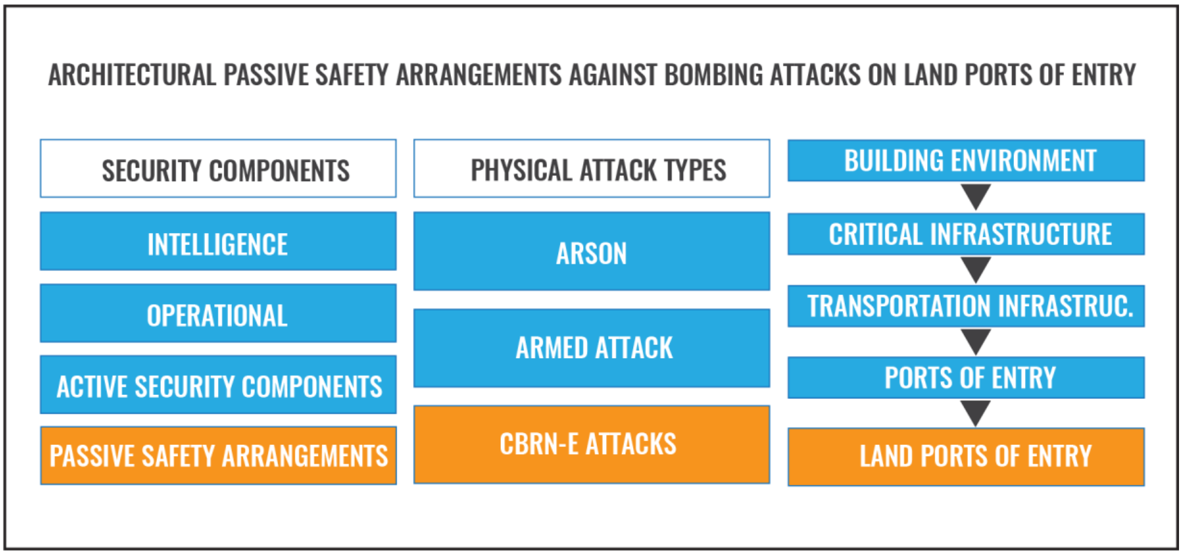


Figure 1.1. Scope of the study [GCA]

Method of the study

In this thesis study, firstly, the process of risk management and the stages leading to the decision and application of architectural passive security measurements are explained. Then, information on explosions and their effects were given to physically establish the concept of architectural passive security arrangements. Next, utilizing the literature surveys, architectural passive security arrangements are outlined under two headings as structure and site oriented and two very important concepts in terms of security regulations are explained; layer of defense and standoff distance. With general lines of the principles of security arrangements defined; physical and operational structures of land ports of entry are explained in the light of literature surveys. Next, application of the principles of architectural passive security arrangements at border gates is discussed in seperate titles for each basic component of border gates. Lastly, a checklist for passive security assessment at border gates has been created for establishing a theoric base in the context of security for both new projects and revision projects. This checklist have been exampled by the case study of and example land port of entry. Method of study has been diagramatically shown in Figure 1.2.

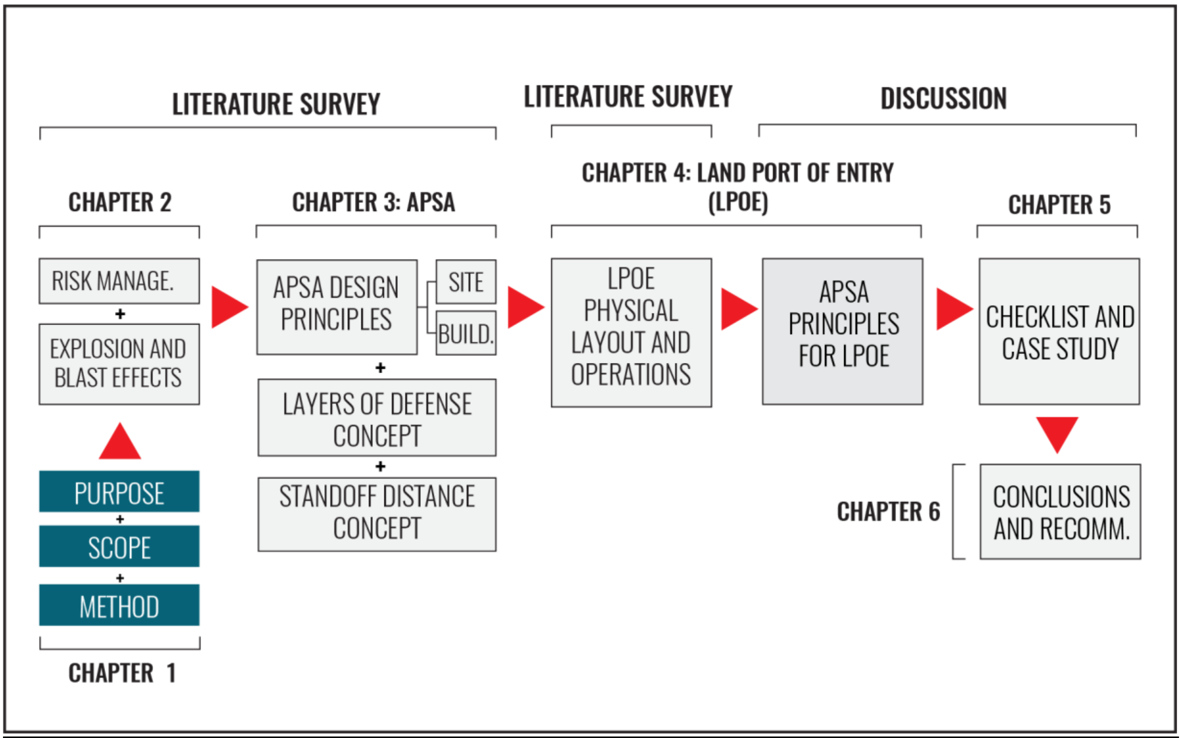


Figure 1.2. Method of the study [GCA]

2. RISK MANAGEMENT AND EXPLOSIONS

Architectural passive security arrangements are protective measures against attack risks. The decision on which of these measures will be applied to the existing structure or site is made as a result of certain stages. The process of going through these stages is called risk management. In this part of the study, the risk management process will be outlined for the purpose of understanding the stages through which architectural passive security arrangements have been decided and applied and then information will be given on explosions and their effects in order to physically establish the concept.

2.1. Risk Management

The physical security arangements to be implemented on a structure and site vary depending on two important factors. One of the factors is the possible threats against the structure and site and the other one of the factors is the security level for this structure and site predicted by the authorities. The method, size, probability of occurence of the threats in question and the highest level of risk that the authorities are willing to take are the determining factors at this point. Whether during the architectural design or during the revisioning process, there are three possible decisions that authorities can make after the risk assessment. First, taking all the possible risks without arranging any security measures, second, taking security measures for certain areas and accepting certain level of risks for the remaining areas, third and last, as a result of very detailed security planning, reducing the level of risk to the lowest [2]. The most determining factor in these decisions is the budget, in an other way of saying, is the economical cost of fulfilling the security requirements of the building and the site. The process of deciding which risks are going to be taken, and for which ones there are going to be security measures in the structure and site is called Risk Management. And a large portion of this process is Risk Assessment. Because, possible threats, results of these threats in case they are realized, precautions that can be taken against these threats and cost of these precautions can be evaluated as a result of risk assessment.

Risk management consists of five fundemental phases (Figure 2.1). These phases are 1. Threat Identification and Rating, 2. Consequence (Asset Value) Assessment, 3. Vulnerability Assessment, 4. Risk Assessment, 5. Mitigation Option or Protective Measures.

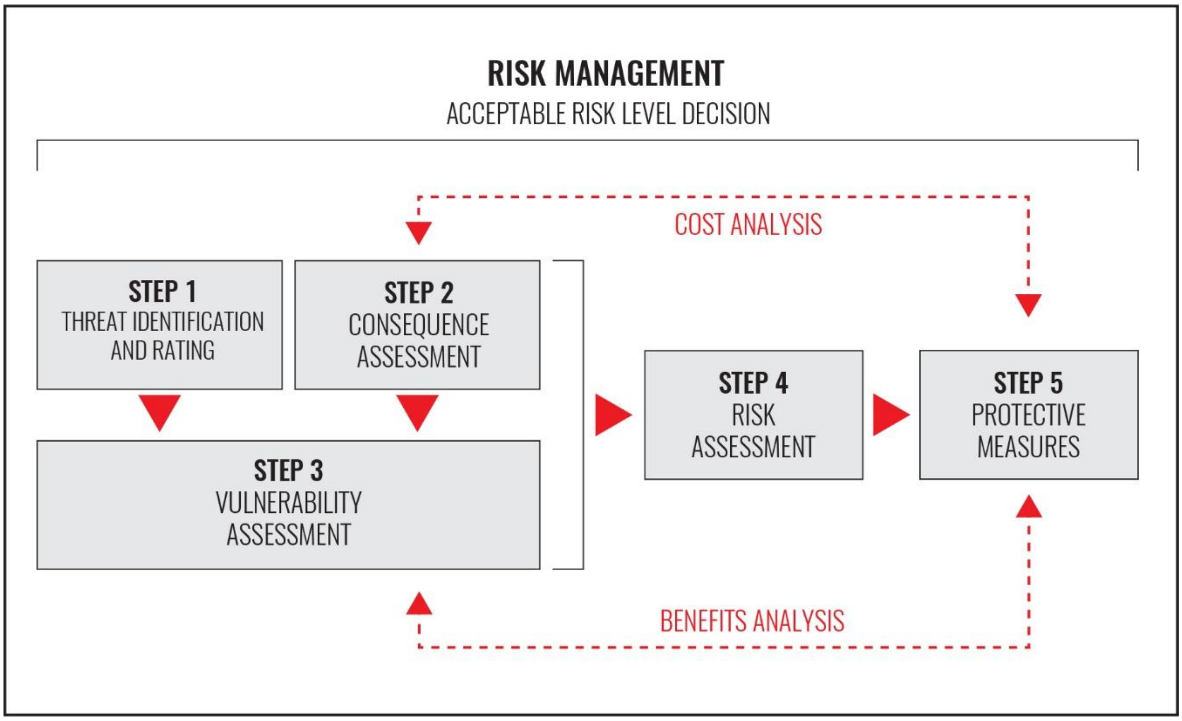


Figure 2.1. Risk management [2] [GCA]

In the Threat Identification and Rating phase it is aimed to obtain all kinds of information about the possible threats that may target the structure and site. Data obtained at the end of this phase includes; the terrorist groups which are potential attackers to the structure and the site, their potential targets in specific conditions, their methods and attack scales, their weapons and so on. In the Consequence (Asset Value) Assessment phase, all the data on the existing situation of the building and site is comprehensively documented. Function of the building and the site, its environment and environmental relations, users, user behaviour and structural patterns, all the information on the existing building and its environment, furnishing, equipments, locations of all the places inside or outside of the building and their relations, structural strength. Material types and their qualities, critical regions and infrastructures within the building and the site should be documented. Vulnerability Assessment is the phase where the building and the site is assessed by its preparedness and precautions against a possible attack. Weak points of the building and the site, how much damage it may suffer in case of an attack, possible loss of life and property, assessment of the critical functionality of building and the site after a possible attack, performance assesments of emergency evacuation and emergency response are all obtained after this phase. Evaluations and assessments up to this stage are called the Risk Assessment. In this assessment, the data and ratings related to the previous three assessments are poured into a matrix and a general picture is created on which parts of the building and the site are exposed to the risks and to what extent they are prepared for these risks. The information regarding the protective measures to be taken to mitigate these risks and the economic impact of these measures can be reached through studies carried out at the phase of Mitigation Options (or Protective Measures). In addition, questions such as the extent to which security measures will reduce the risk in the decision process and what their economic costs will be, should be answered with the benefit and cost analysis. Table 2.1. provides information on each step of the risk management process and what key questions should be answered [3].

Table 2.1. Phases of risk management [2]

Phases	Tasks	Key Questions
Threat Identification and Rating	• Define the threats and collect information on them. • Define the main threat. • Assess the threat rating.	• What are the known groups and organizations? • Have they attempted terrorist attacks before? What are their attack methods? • How are their attitude towards the government, commercial or industrial enterprises, or the people?
Consequence (Asset Value) Assessment	• Define critical functions and critical infrastructures in the building and the site. • Assess their value ratings.	• How critical is this asset? • What are the possible losses and damage in case of an attack? Would the building continue to function? • What is the possible number of lost lives? • What is the social and economic impact of the attack?
Vulnerability Assessment	• Collect information on the site. Create a vulnerability report including the GIS maps and other related data. • Define layers of defense. • Evaluate the building and the site. • Assess vulnerability ratings.	• What are the weak points of the building and site in case of an attack? • Is physical security of the building adequate? Are there any measures taken to make sure building can continue to function after an attack? • Is there an alternative place fort he building? • Are there reserved spaces for critical services and operations? • How much time is needed before the building is functioning again?

Table 2.1. (continued) Phases of Risk Management [2]

Phases	Tasks	Key Questions
Risk Assessment	• Prepare the Risk Assessment matrices. • Assess the risk ratings. • Start with the highest rated risks and prioritize observations that are Identified as vulnerabilites to target oıtential mitigation measures	• Which vulnerabilities are to be prioritized?
Mitigation Options Or Protective Measures	• Define preliminary protective measures. • Go through protective measures for interaction and convenience in each layer of defense. • Define possible cost of protective measures. • Define the measures to be applied and set a timetable for them.	• Which protective measures will reduce risk the most, especially for highest risks identified in risk matrices? • Which options should be taken to detect, deter, or deny an attack in regard to available layers of defense? • Which legal regulations impact these options? • What are the most effective security measures for the proposed budget? • How do site and layout design protection and control measures balance against building hardening measures?

2.2. Explosions

Explosives are, in general terms, solid or liquid meta-stable chemical mixture or components which are intended to be activated by a blast to produce gas, heat, and light. Depending on the blast rates they divide into two as low and high explosives. In cases of explosions that low explosives were used, the damage caused by pressure effect will be observed at minimum level and highly localized. Also the damage caused by fragmantation effect is very limited in these explosions. In the case of explosions using high explosives, however, the pressure caused by explosion reaches very high amounts in a very short time. Therefore, a destructive shockwave spreads rapidly from the center of explosion. Boosters are very sensitive to the heat and physical impact and their explosive power they contain is the lowest among the high explosives. They act as booster for secondary explosives that have much more power yet not very sensitive to heat and impact [4].

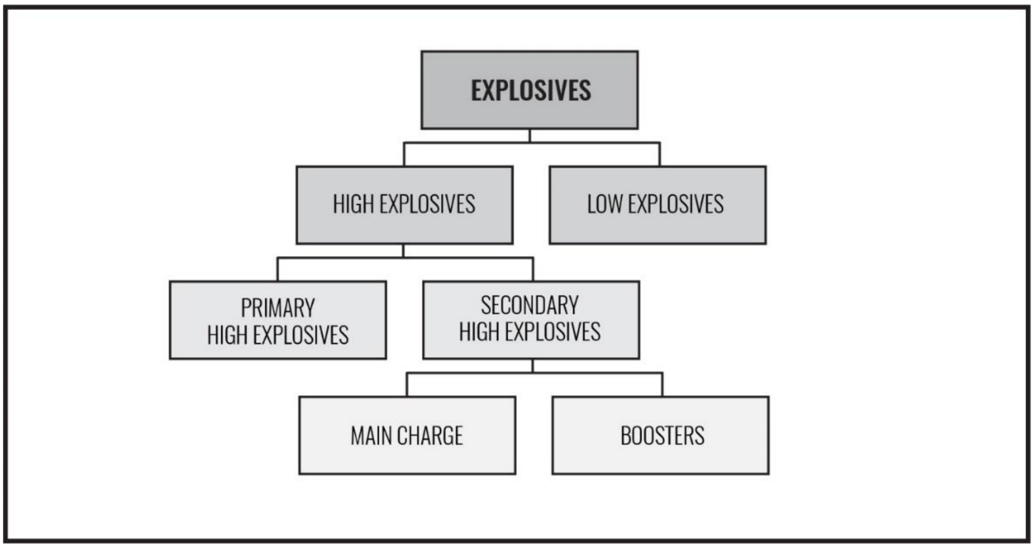


Figure 2.2. Classification of explosives [4] [GCA]

Explosions are basically rapid chemical reactions and consequently releasing excessive amount of gas, heat and energy. This sudden and large amount of gas and energy output results in large atmospheric pressure changes in the blast zone in microseconds. Main reason for the primary blast injury is these changes in the atmospheric pressure and resulting shock waves. Shock waves rapidly spread spherically from the Center of the explosion. For high explosives this speed is very high, ranging between 6000-8000 m/s. While shock waves are very fast, their wavelength is consequently very short and cross-sectional thickness of the shock wave that occurs after the explosion is thin enough to be measured in milimeters [5].

The size and spread of the blast wave that formed after an explosion depends on different conditions/elements. These conditions include but not limited to, the type of the explosive that causes the explosion, type and amount of released energy, location of the explosion relative to the building, increased blast force due to the reflection of the blast from the ground and surrounding buildings. An explosion creates a positive pressure wave at first. Negative pressure wave, which can be defined as displacement of the space caused by the first wave, is less powerful than positive pressure wave, however it lasts longer than it. Also, the negative pressure wave is capable of sucking the objects scattered by the positive pressure wave back to the center of the explosion. This pressure effect is responsible for the shattered glass pieces to be found both inside and outside of the building [4]. The graphic below (Figure 2.4) explains the changes in the positive and negative pressure waves over time.

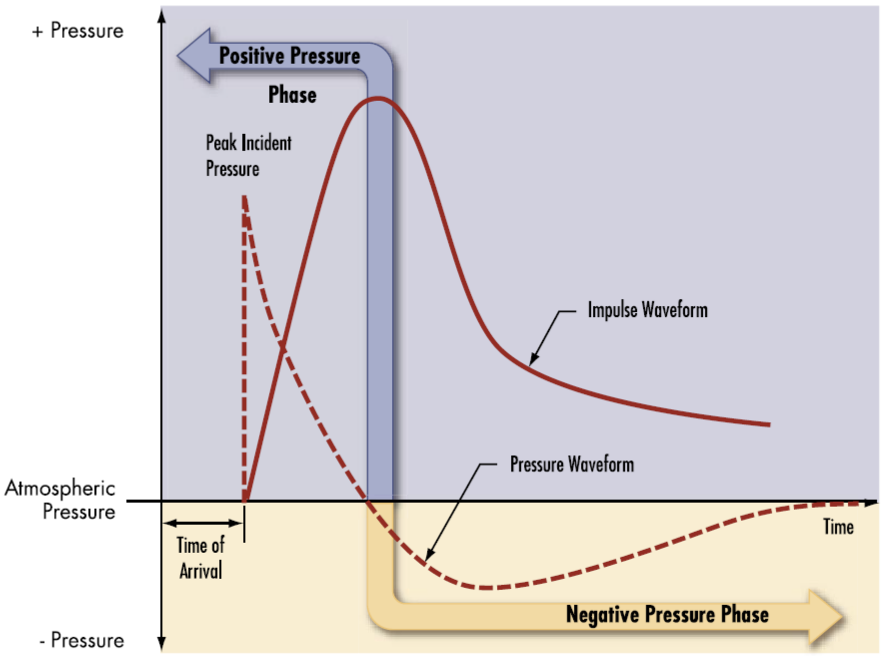


Figure 2.3. Pressure impulse graphic [5]

When a bomb explode, the pressure will break up or rupture the outer shell and spread it around in great speeds. About half of the energy released after the explosion will be used in shattering the outer Shell and launching the fragments around. The effect caused by fragments thrown around because of the explosion is called primary fragmentation effect. Sometimes this effect is increased by placing nails and metal pieces inside the explosive. The effect created by fragments thrown around or fragments that break off from buildings or cars around with the pressure created by the primary fragmentation effect is called secondary fragmentation effect. The resulting injuries and deaths after an explosion are caused by; directly from pressure or pressure reflection and primary and secondary fragmentation effects (Figure 2.3) [4]. The degree of injuries due to the explosions vary by the properties of the explosive, the distance to the explosion center, or whether the explosion occurred indoors are outdoors [5].

In case of a bombed attack, the impact of the explosion is affected by the scale of the explosion (explosive type and amount), and the distance to the center of the explosion. The pressure caused by the explosion, depending on the size of the explosion, can shatter the Windows, and damage the building envelope, outer walls and the columns near the center of the explosion. In large-scale explosions, slabs can be damaged by the pressure in upward direction. Explosion pressure wraps buildings, pressures the roofs downward and all the side-surfaces inward (Figure 2.5). The closest part of a building or area to the center of the explosion will be impacted the most. Since the pressure wave as a result of the explosion will diminish with distance, most of the time distance to the blast center is the main determinant. Thus, while taking physical security measures on buildings and sites, it is intended to increase the distance to the high-risk areas as much as possible [6].

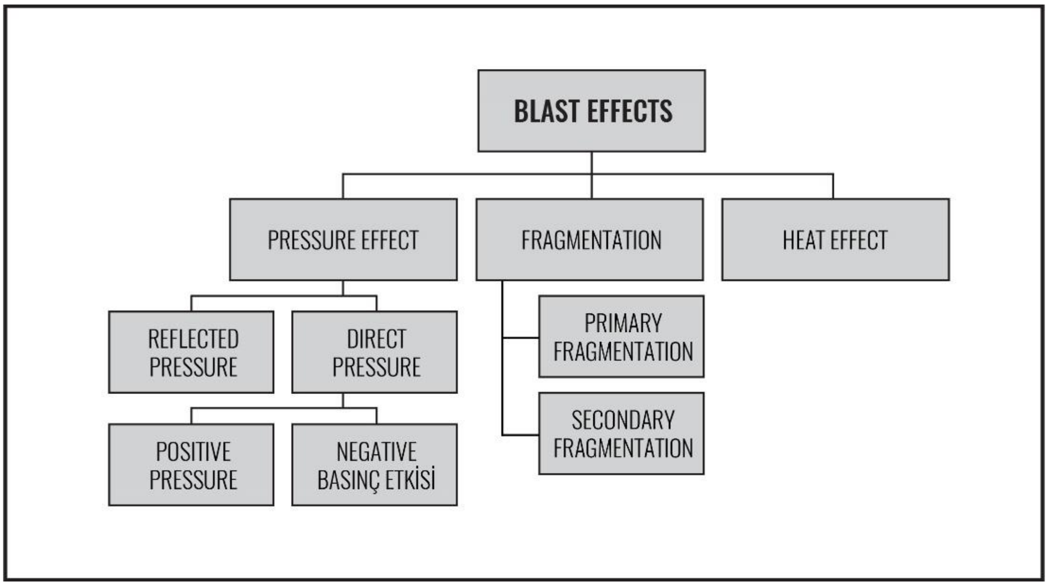


Figure 2.4. Effects of Explosions [4] [GCA]

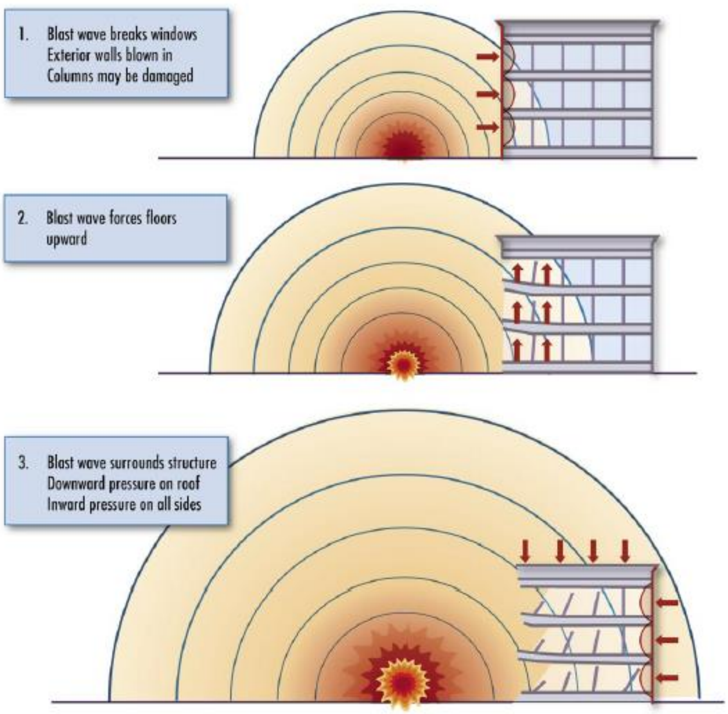


Figure 2.5. Effects of Explosion pressure on the building [6]

3. GENERAL DESIGN PRINCIPLES OF ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS

Architectural Passive Security Arrangements (APSA) are the arrangements focusing on the passive precautions against an attack in the physical structures of the buildings and their sites. These arrangements include but not limited to; the fundamental architectural decisions in the design of the building and the site, positioning of the buildings in the site and their orientation, physical relations with surrounding sites, buildings and roads, arrangements in entries and exits, surrounding walls and standoff distances, shape and height of the building, architectural elements and materials, structural strength and building envelope design. These arrangements should be considered during the design process, but also can be applied as revision projects to the existing buildings and sites

Objectives of Architectural Passive Security Arrangements are defined to address three different time periods. These are; before the attack, during the attack and after the attack. In the period before the attack, APSA aims to create deterrent factors that prevents the building to be chosen as a target, make scouting before an attack difficult, and to detect the people scouting the site and the building. During the attack, the arrangements are aimed to gain time for operational elements by holding the attack up, and in case of an explosion, mitigate the loss of life and building damage caused by the explosion. APSA’s post-attack aims are to maket the critical functions of the building intact and create a suitable physical environment for emergency teams.

Main objective of architectural passive security arrangements is minimize the risk. However, these arrangements should be adapted to the daily functions and operations of the building. Although measures are depended on Security level and its requirements, they are usually not building despotic castles. In highly populated public buildings and site, this arrangements should be integrated in a way unnoticable as possible. Also, different scenarios (different threat level, change of function, change in the numbers of users) that are possible to occur in future should be considered when determining the security arrangements. At this point, it important to have a flexible design that is capable to adapting different situations.

There are two major concepts in architectural passive security arrangements. These are the concepts of layer of defense and standoff distance.

Concept of layer of defence

Layers of defence are classifications regarding the physical structure of the site trying to evaluate physical security measures. These classifications are required for a more detailed and better associated designs for each of the layers. Layers of defence are classified –altough there are similarites- differently in each of the basic sources. In the Risk Management Series of FEMA [2, 6, 7, 8], layers of defence are grouped under three titles. First layer of defense defines an area ranging from the close environment of the site to the defended perimeter. Second layer of defense is the area between defended perimeter and the building in the site. Third layer of defense is the building envolope, structure and entire building. The width and qualities of these layers may differ according to the location of the building and whether it is located in an open field, in a campus or in a dense urban environment. In the related publishing of GSA [9], layers of defense, under the name security zones, discussed under three titles. First zone adresses the close environment, second zone the perimeter, third zone the entry points and parking areas, fourth zone the site, fifth zone the building envelope, and the sixth and last zone adresses the building and its operating processes. In the related publishings security measures are discussed under these classifications. In Figure 3.1. Classifications of FEMA and GSA are diagrammatized.

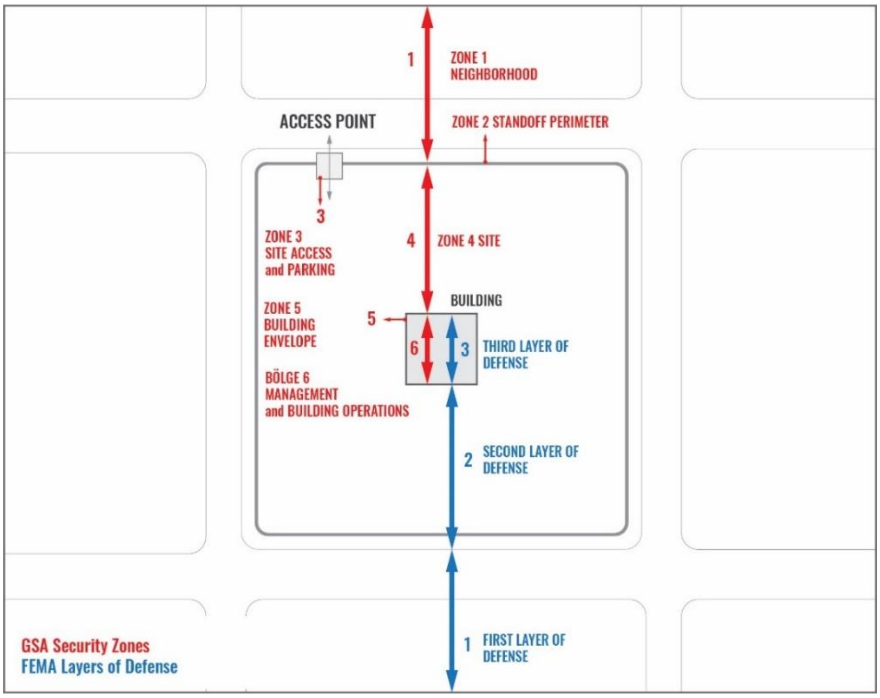


Figure 3.1. FEMA layers of defense and GSA security zones [GCA]

Concept of standoff distance

The distance between any façade of a building and the closest point to that façade a bombed car can reach is called standoff distance. The most efficient and least costly way to minimize the loss of life and property is to move the closest point a car armed with explosives from high risk areas to most remote location possible, ie to create adequate standoff distance. When it's been desired to define a specific standoff distance, the distance between center of gravity of the car when it is at the closest point to the building and the façade of the building close to that point is taken as basis [7]. When defining the required standoff distance, possible explosive type and amount, predicted security level for the building or site, type of the building, structural strength and conditions of the outer shell are taken into consideration. Some buildings may not provide the adequate standoff distances. In such cases, standoff distance increasement methods shall be used to achieve the desired standoff distance and/or structural strengthening studies should be done. In order to increase standoff distances, landscape arrangements can be made, fixed barriers can be used or the vehicle traffic may be blocked in the streets. The figures and tables below, data regarding the explosive amount and standoff distances are provided.

Table 3.1. Stand-off distances for injuries and damages [2]

Injury and/or Damage	Stand-off distance	
	225 kg Explosive	2250 kg Explosive
Threshold of failure, concrete columns	9 meters	18 meters
Potentially lethal injuries	45 meters	105 meters
Injuries from wall fragments or to people in open	45-75 meters	105-150 meters
Severe glass wounds (glass with applied film)	75 meters	200 meters
Severe glass wounds (unprotected glass)	150 meters	300+ meters
Minor cuts	245 meters	300+ meters

Table 3.2. Typical explosion damage due to the amount of pressure [10]

Pressure (kPa)	Damage	Pressure (kPa)	Damage
0,15	Jarring sound	35	Damage to the wooden telephone/electric posts
0,20	Shattering of previously damaged large glasses	50	Train carriages topple
0,30	Loud sound	50-55	Damage to the light brick walls
0,70	Shattering of previously damaged small glasses	50-65	Collapse of steel framed buildings
1,0	Typical glass shattering	50-70	Cars seriously crushed
2,0	Damage to the suspended ceilings	55-70	Collapse of the light brick walls
3,0	Small scale structural damage	65	Steel space frame bridges collapse
3,5-7,0	Explosion of large and small windows, damage to some window frames	> 70	Collapse of non reinforced concrete buildings
5,0	Small scale damage in weak buildings. Roof tiles falling off.	90	Collapse of heavy brick/stone buildings
7,0	Serious damage to the weak buildings.	490	Collapse of heavy masonry buildings, reinfoced concrete buildings and bridges

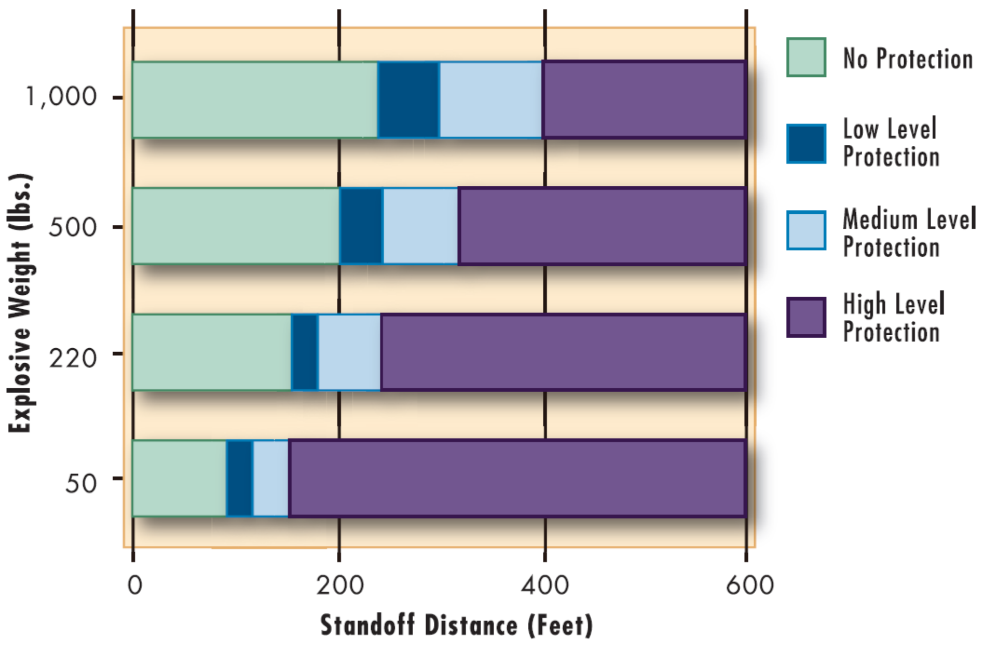


Figure 3.2. Explosive weight- standoff distance graphic [2]

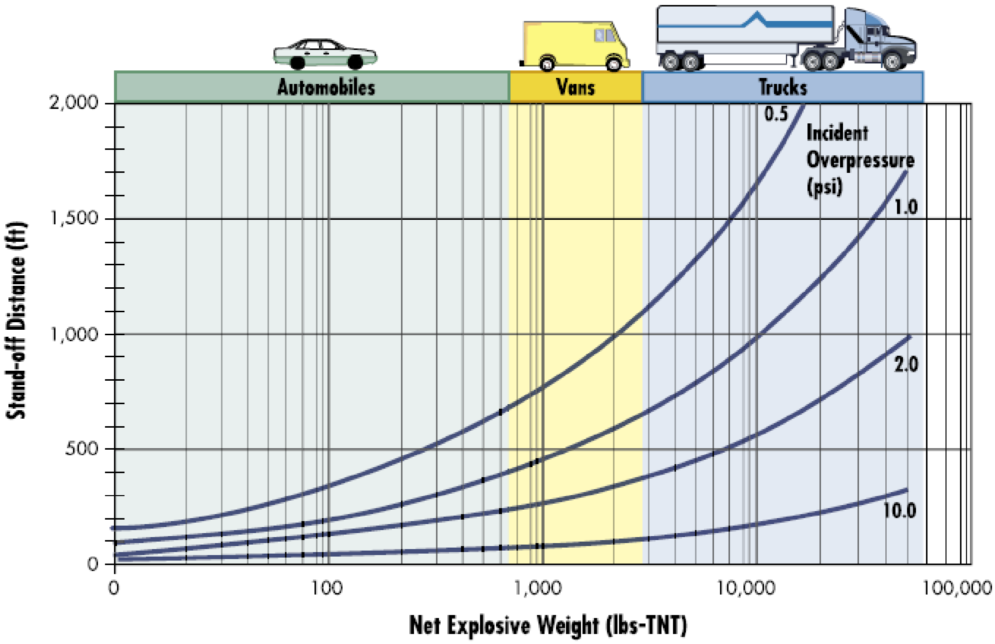


Figure 3.3. Incident overpressure measured in pounds per square inch, as a function of standoff distance and net explosive wight (pounds-TNT) [6]

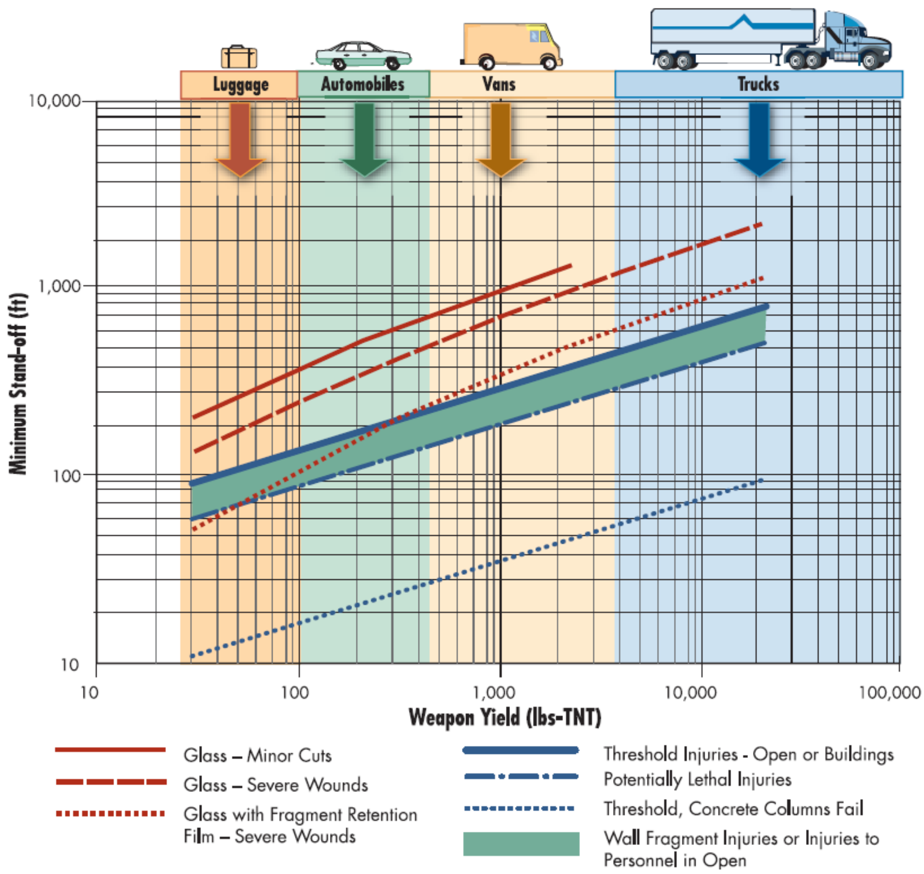


Figure 3.4. Explosives environments – blast range to effects [2]

In the following pages of the thesis study, architectural passive security arrangements will be discussed under two main titles. Site oriented security arrangements including the layouts of the site, periemeter and close environment and access control, and building oriented security arrangements including the architecture of the building, structural system and the building environment.

3.1. Site Security Arrangements

Site-oriented security arrangements will be covered under two titles; layout plan and access control.

3.1.1. Site layout plan

When evaluating a site from a security perspective; The location, size, and topography of the site, natural components within its boundaries, the neighboring site, and the nature of buildings should be considered. When the relation of the site with a building is evaluated in terms of security; the positioning and orientation of the building, its distance to the site boundaries and neighboring areas, the number of buildings in the site, the size of the buildings, their location against the boundaries of the site and each other, their orientation and relations, the presence of natural elements that can function as guiding and shielding natural physical barriers in the site, the restrictive effect of the site topography on pedestrian and vehicle traffic in the site, and its potentials come into prominence.

It is possible to take advantage of the topographic potential of the site during surveillance as a security measure inside and outside the site. The topographic situation of the site can also be used to block or direct the visual access from outside into the site and the building. The sites located higher than their surroundings have the potential to create a suitable environment for the surveillance of the close environment from the site.

In order to ensure adequate standoff distance, a building should be positioned as far as possible from the site boundaries. If the building is centrally planned, it should be located in the middle of the site, if not, by leaving the maximum possible security distance on each side, and positioning the narrowest facade with less spacing towards the narrowest side. If some streets near the site carry a greater risk than others, the building should be located away from the risky side. If there are more than one high-risk street on more than one side of the site, and if there is not enough standoff distance due to the size of the site, the building can be positioned away from the risky side of the site by closing one of these streets. (Figure 3.5.). The narrow facades of the buildings should be oriented towards the roads and streets where the user density is high. Thus, in case of an explosion in the road open to public access, therefore with high risk, the damage incurred to the building will be reduced. If a choice is to be made between narrow facades, it will be safer to have the facade with fewer windows and openings, and where the areas with user density are located in the building, oriented towards the road [6].

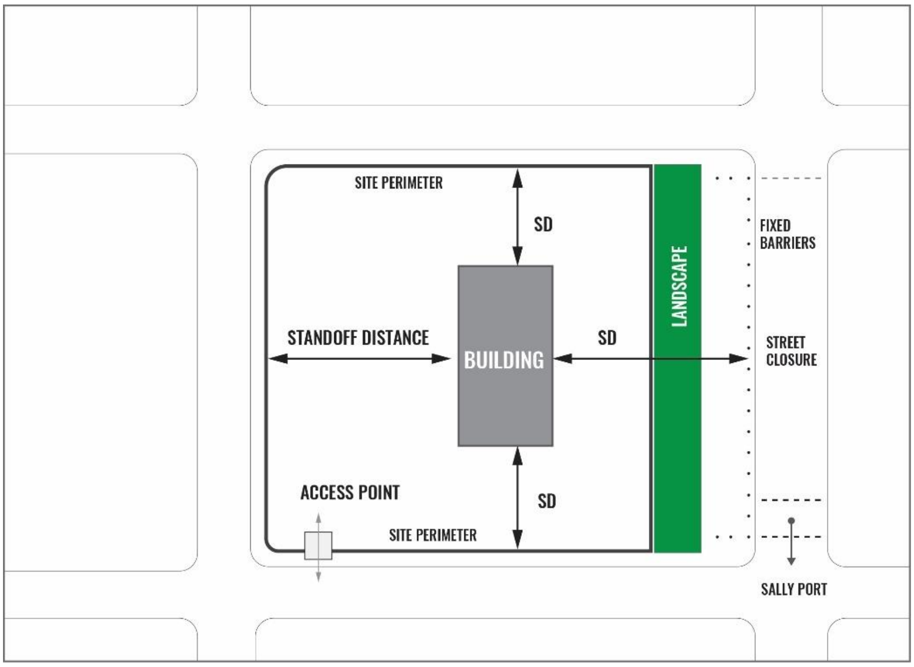


Figure 3.5. Standoff distance increasing methods and sally port [GCA]

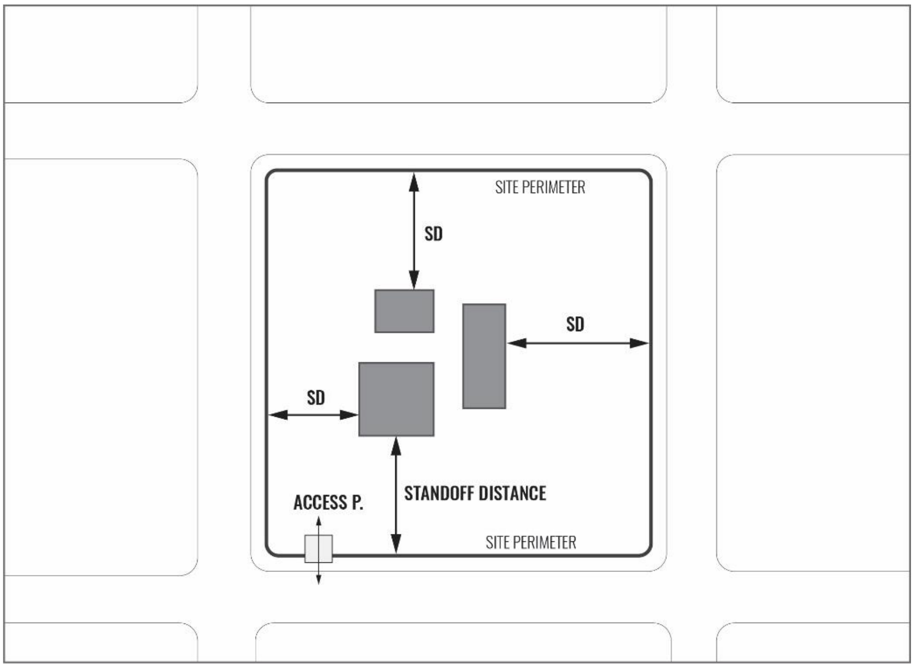


Figure 3.6. Placement of buildings within the site [GCA]

There may be a single building in a site, as well as multiple buildings. In such a case, the distance and location of the buildings in relation to each other and the site boundaries are important. Concentration of building settlements at certain points within the site may lead to a potential explosion in that area to cause more damage. However, the fact that the buildings are positioned apart from each other can be a problem in terms of ensuring an effective control environment and sufficient standoff distance. Therefore, the decision should be given specific to the relevant site, considering other variables (Figure 3.6).

3.1.2. Access control

When implementing security measures in the immediate vicinity of a site, first of all, the vehicular traffic in the immediate vicinity must be controlled. The primary objective of the traffic control is to control traffic speed and direction. The point of entry of the site must be positioned perpendicular to the traffic direction (Figure 3.7). In this way, if an explosive-loaded vehicle tries to enter the side from the point of entry, its speed will decrease because of its angular movement, preventing direct collision. In order to reduce the speed of vehicle traffic close to the site boundaries and the site entrance, it is possible to take advantage of different design methods such as roundabouts, curved roads, artificial bends, speed bumps and elevated pedestrian roads. For buildings with high security requirements, necessary inspections must be made on the relevant traffic lane before the vehicles reach the site entrance. Thus, necessary measures can be taken before the attacker reaches the site. In addition, while positioning check points for detailed inspection, adequate standoff distance between the building and these areas should be provided.

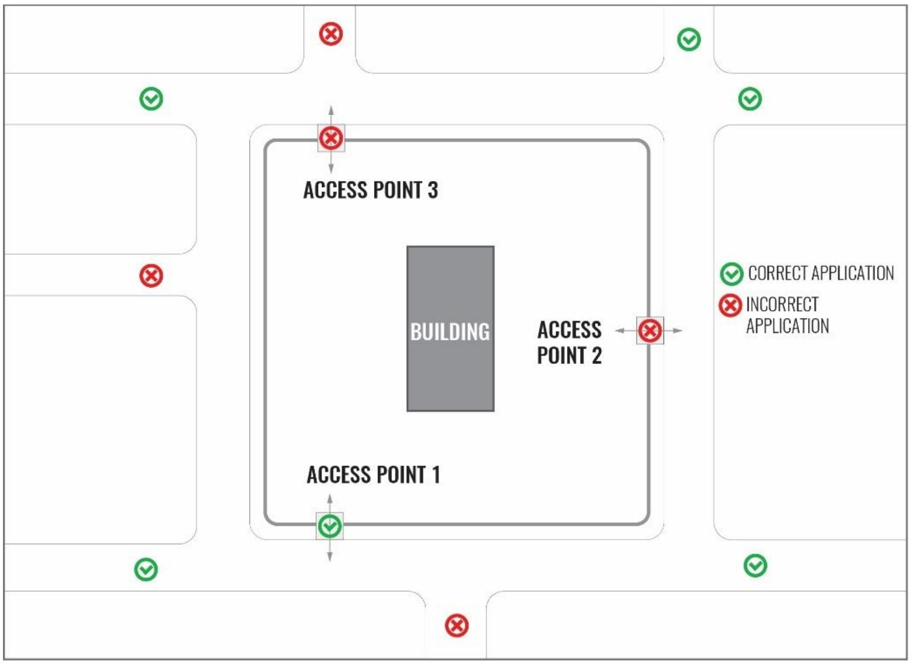


Figure 3.7. Neighborhood arrangements and access point locations [GCA]

The purpose of the checkpoints at the site entrance is to prevent unauthorized entry into the site and to control authorized access. Security booths at the points of entry should be designed to enable the officer to keep the traffic, the vehicle and pedestrian approach and orientation, and the vehicle queue under visual control, facilitating the vehicle inspection process. All components, such as the site entry points, the relevant traffic lane, the gate, the security booth and the guest area, should be positioned and designed taking into account the security procedures and the operation. The structural strength of a security booth will be crucial in the face of a potential explosion. Therefore, load-bearing columns should not be placed closely and exposed to the risky areas. Security booths should be positioned on the driver's side of the entering vehicle, so that the officer does not need to move around the vehicle to talk to the driver. The approach to the site should be planned in such a way as to serve for heavy vehicle traffic and long vehicle queues, and the points of entry should be designed accordingly. The inspection areas at the points of entry should be large enough to allow inspection of at least one vehicle easily. The uses and measurements of the relevant inspection equipment are important in this respect. In a building with high security requirements, in the case of that the location and size of the lobby are not suitable regarding security, suitable areas may be created at the points of entry to implement the procedures to be performed in the lobby. In high security areas, a final barrier must be added before allowing the vehicle to enter the site after inspection. Thus, in case of a last moment situation or suspicion, the access of the vehicle into the site is prevented. Legible markings and adequate lighting should be provided for control and inspection areas. In case of very high security requirements, vehicles are taken to the sally port, an area closed on both sides, before entering the desired area. First, one of the barriers is opened and closed when the vehicle enters. The vehicle between is not allowed to move, so that the necessary inspection procedures are made easily. If there is no problem, the other barrier opens and the vehicle is allowed into the site. This method can be used for entry to the site, as well as for entry to roads and streets when required. (See. Figure 3.5).

Another important issue regarding the perimeter security is the barrier systems. There are two basic barrier types. Passive (fixed) barriers and active (moving) barriers. Passive barriers are fixed to somewhere, do not allow the passage of vehicles, and enables to secure the perimeter. These include barges, structurally strengthened pots, heavy objects and trees, walls and topographic elements, water barriers, concrete barriers and fences. Active barriers are movable barriers that can be opened and closed at the checkpoint in a controlled manner. These include movable barges, rising barrier systems, rotating barrier systems, arm barriers, road blockers, and crash-proof gate systems. Concrete barriers are among fixed barriers (Image 3.1.), and are artificial elements that act as barriers or obstacles placed on the roadside (on the shoulder / or the central refuge side) in order to ensure safe traffic [11]. However, they are an ideal barrier solution, which is often used to control traffic in the immediate vicinity of a site and does not exhibit secondary particle behavior against explosive loads. In addition, concrete barriers are safer than steel barriers as the effect spreads to a large area during collision [12].

Image 3.1. Examples of fixed and movable barriers [13]

Only the vehicles that have been inspected should be allowed to approach or park in the parking areas within the standoff distance. There must be sufficient standoff distance between the parking areas and buildings. If this distance cannot be provided, additional structural reinforcement work should be carried out on the buildings. If possible, guest parking areas and public parking spaces must be located beyond the standoff distance. When possible, only one-way circulation should be allowed in the parking spaces to facilitate surveillance. Vehicle parking direction should not be directly towards the building. Parking areas should be planned to be open to visual access from the building and outside, and landscape arrangements should be made accordingly. If possible, parking areas should not be positioned above or below the building, they should be located outside the base area of the building. The parking spaces between the two structures must not be allowed due to a potential reflected pressure effect. CCTV camera surveillance systems should be located in the parking areas and an illumination system should be designed to enable spotting any activity. Figure 3.8. shows how vehicle parking areas should be positioned / oriented within the site. In bomb attacks, most of the injuries are caused by the secondary particle effect of shattered glass. Parking areas located without sufficient standoff distance facing the large facades of buildings with large windows and gates will increase the loss of life in a potential explosion. Therefore, they should be positioned so that the parking areas are facing the narrow facade of the building and that there is sufficient standoff distance between them. Concrete barrier walls and landscape elements can be used to prevent the effects of primary and secondary particles in a potential explosion and to reduce the effect of the pressure wave.

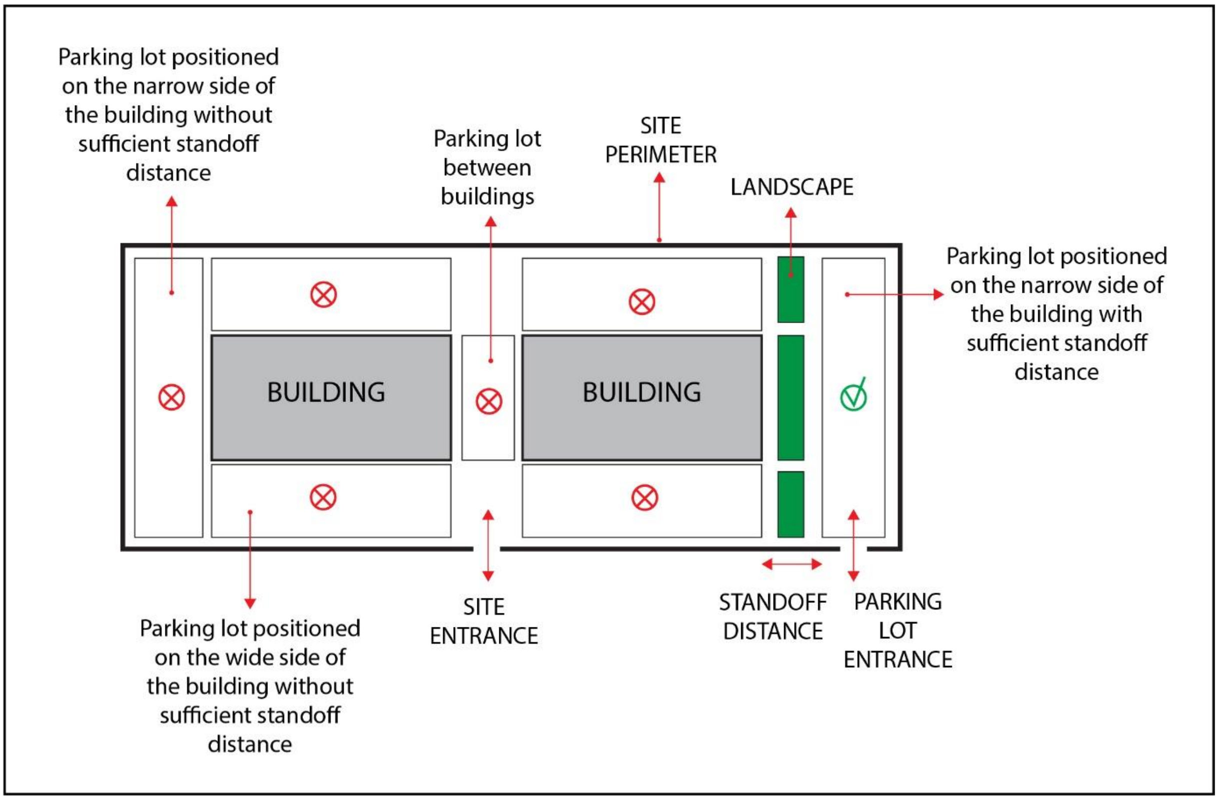


Figure 3.8. Parking lots placement on site [GCA]

Dead ends, niches, and corners that allow hiding should be avoided in the construction of independent parking buildings. Pedestrian and vehicle circulation areas should be planned to be strictly separated from each other within the building. Sufficient standoff distance should be maintained between the parking buildings and other structures around. If the vehicular traffic and parking on the streets is not suitable due to high risks, these areas can be closed to traffic during certain periods. As this application will affect traffic and accessibility in a negative way, it should be applied only if a different solution can not be found. In busy areas such as city centers, only authorized persons should be allowed to park in the parking areas around the site. If there is area any parking in the neighboring areas, there must be sufficient standoff distance between this site and the building. In cases where the parking area has to be located under the building, the vehicles entering the car park should be checked in detail, sufficient illumination should be provided in the parking area, and the formation of blind and dead-end areas in which can be used to hide vehicles should be avoided. In addition, the load-bearing elements in the parking area should be coated with protective material to damp the pressure effect against explosive loads. Finally, in parking buildings, inspection areas should be located outside the building where possible and sufficient standoff distance should be maintained [6].

3.2. Building Security Arrangements

Building-oriented security arrangements will be covered under three titles; architecture, structural system and building envelope.

3.2.1. Architecture

Architectural issues such as the height, shape, facade components, location of buildings etc. are directly related to the performance of the building against explosion loads. Therefore, architectural passive regulations on these issues will be mentioned in this part of the study.

Low-rise buildings spread over a larger area in the site, considering their floor areas. This makes the collapse of the whole building with a single explosion a very low probability. In addition, such buildings allow for the creation of architectural elements such as the inner court or atrium, which provide natural lighting and ventilation, and do not require the addition of openings that may pose a risk. However, low-rise buildings cause the roof to be exposed to higher explosion loads. The reinforcement works in an existing building to increase the strength of the roof against explosion loads are very costly. Therefore, the choice of structure in a low-rise building with high security requirements must be correct at the design stage. The use of sloped roofs in low-rise buildings has a positive effect in reducing damage to the structure by deflecting the blast wave. In high-rise buildings, the upper floors of the building need less reinforcement against explosion loads compared to lower floors. Because the explosion load and effect will decrease rapidly as distance increases. High buildings are often found in dense urban areas. In such places, because the land is very valuable, the distance between the building and the public space is very short. This means that usually the sufficient standoff distance cannot be achieved against the effects of explosion. In such a case, increasing the standoff distance by narrowing the ground settlement area of the building and blocking the vehicle access with fixed barriers to the site can be used as a method. (Figure 3.9). In addition, structural reinforcement should be performed on the lower floors of the building.

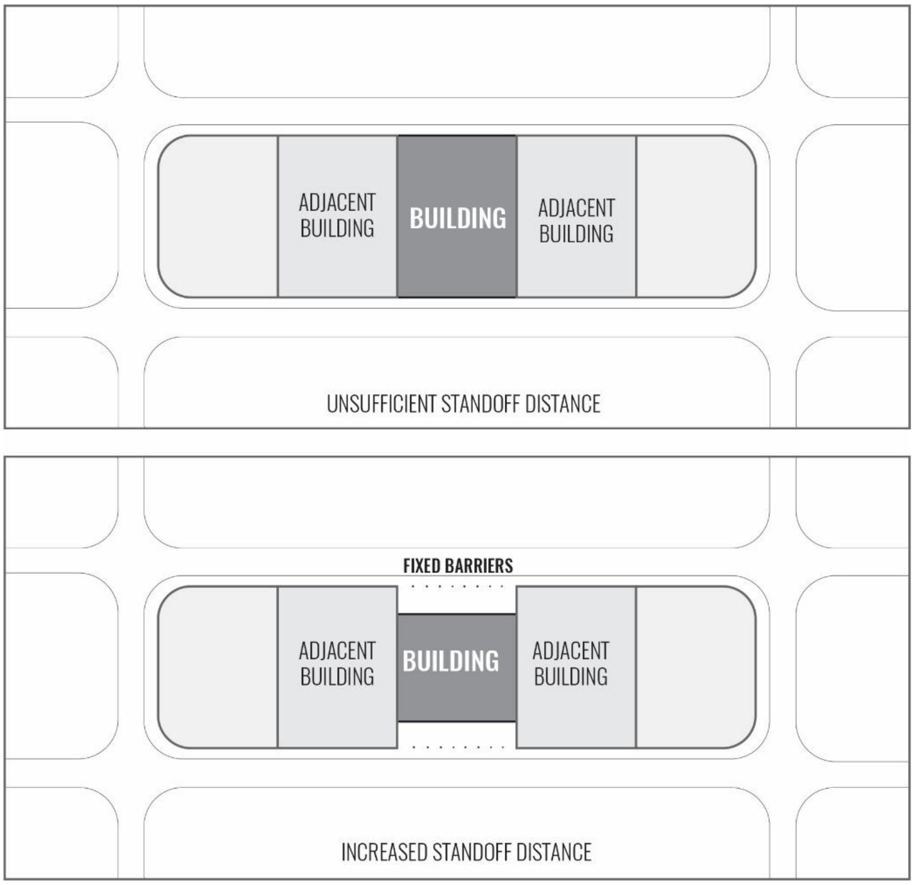


Figure 3.9. Standoff distance increasing method in dense urban areas [GCA]

The geometry of a structure significantly influences the performance of the structure against blast loads. In U or L shaped buildings or in buildings with similar geometry, recessed corners increase the effect of the explosion by intensifying the explosion load as they hold and reflect the shock wave. (Figure 3.9). In convex shaped structures with more circular geometry, the effect of explosion pressure is reduced. The reflection pressure on the surfaces of a building with a curved shape is lower than that of a structure with orthogonal shape. Therefore, for security reasons, it is more suitable to use curved surfaces (convexity) in buildings with high security requirements.

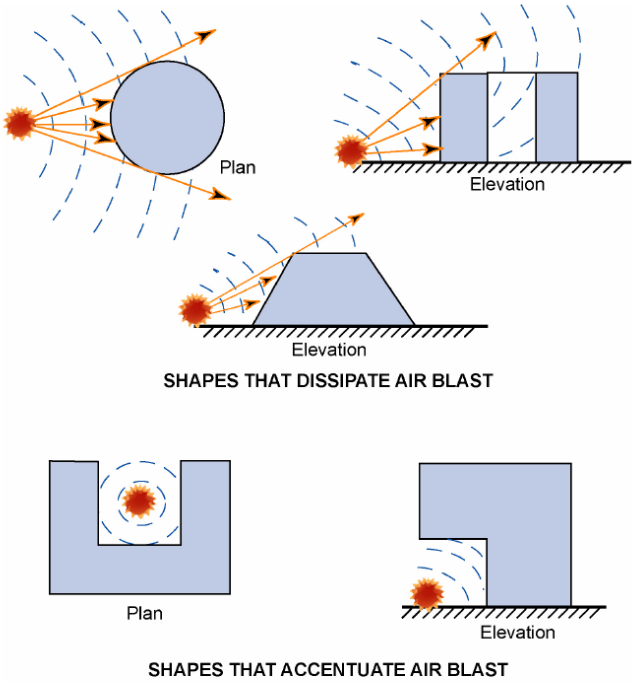


Figure 3.10. Schematics showing the effect of building shape on air-blast impacts [6]

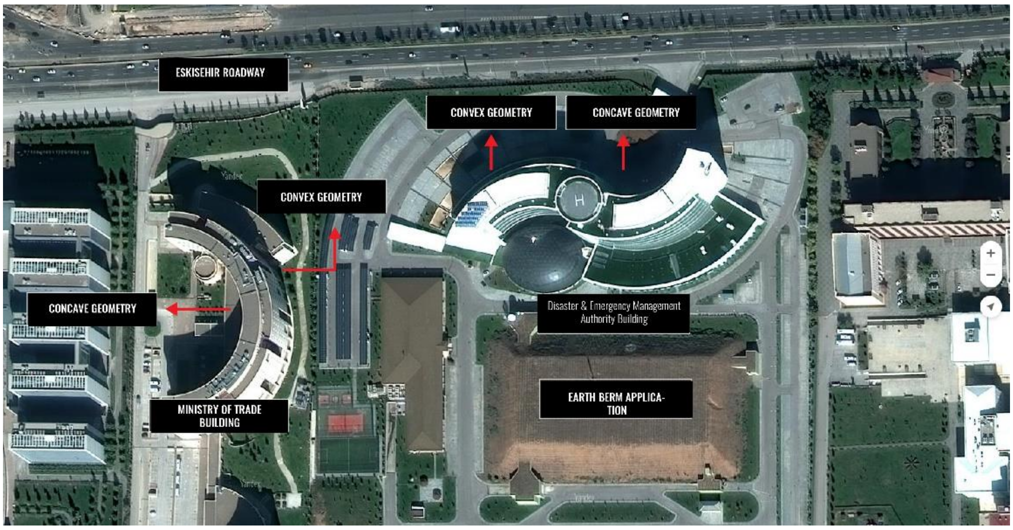


Image 3.2. Examples of building shapes. Satellite images are taken from Yandex map

Buildings with indoor parking areas, courtyards, concave and large surfaces, and that are overhanging, close to each other, and high-rise are greatly damaged by the explosion pressure and the pressure reflected by growing. Convex buildings (Figure 3.2) with small surfaces, that are away from the road, and are surrounded by trees and buildings are more secure [14]. If changes that can be considered geometric irregularities are to be made in a building with high security needs due to aesthetic concerns, the potential situation of the building against explosion loads should be evaluated by experts to determine the final design. Furthermore, for buildings with high security requirements, the ground level elevation should be at least 1.2 meters above the road level [7]. In this way, the pressure wave on the floor surface will be angular, the distance will decrease, and the effect will decrease relatively.

Overhanging elements such as a balcony should not be located on the facade of a building facing high risk areas should or with no adequate standoff distance, otherwise it should be designed considering the security elements. Because the overhanging roofs and the fringes in the buildings will increase the explosion load by reflecting shock waves, such architectural elements should not be used in low-rise buildings. In the case of high-rise buildings, such components often do not pose much problems, since the distance to the building roof provides sufficient standoff distance. In a structure with high security requirements, it is generally more convenient to use simple forms and to keep the facade decoration to the minimum possible if it is not designed with advanced structural analysis techniques. This results in higher performance against pressure and secondary particle effect in case of an explosion. If facade decorations are to be used, light materials such as wood and plastic should be used, and the use of materials that could cause fatal damage in the event of a potential explosion, such as brick, stone and metal, should be avoided [7].

In a building, there are high risk areas and areas with high security requirements. High risk areas are the places that are open to public access. Entrance lobbies, restaurants and bars at the entrance are examples of these areas. Areas with high security requirements are the places where the user density is high within the structure and that are generally not accessible to unauthorized persons. There is a greater chance of a bomb attack in an areas open to public access with higher risk, such as an entrance lobby. In this case, it is necessary to reduce the effect of a potential explosion in these areas to other areas with high user density. At the design stage of the building, these areas should be identified and separated by placing certain buffer zones (corridors, storage rooms, etc.) between them. High risk areas and areas with high security requirements should not be positioned next to each other without a buffer zone.

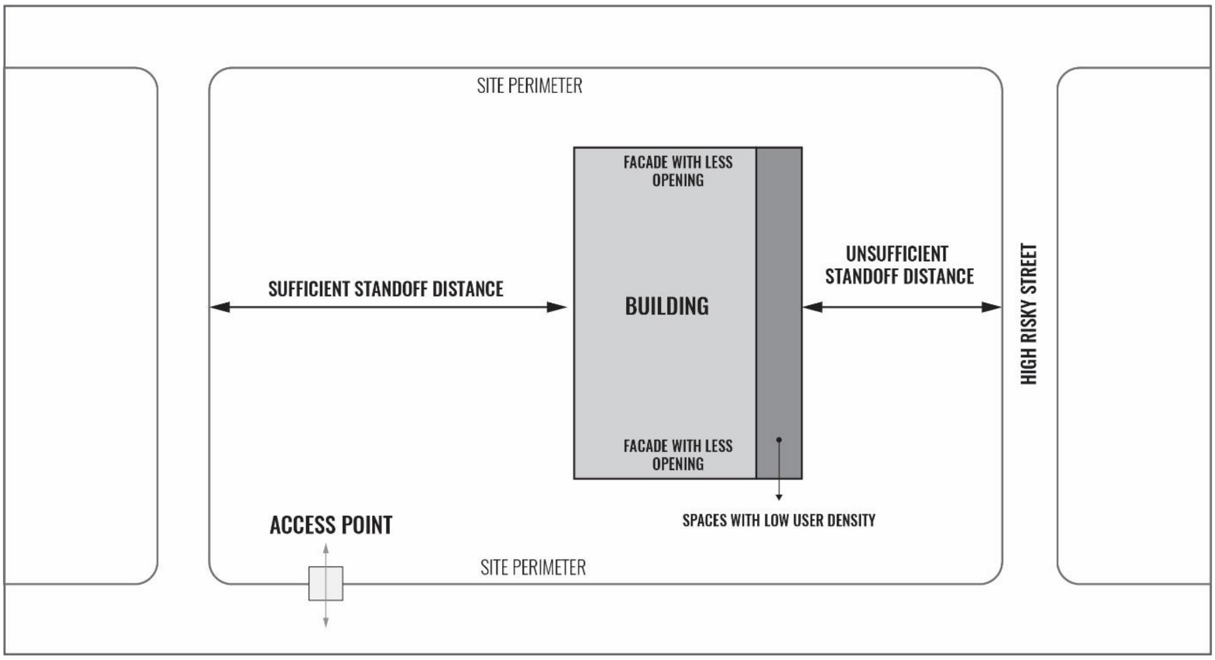


Figure.3.11. Space placement in building [GCA]

If there is not enough standoff distance around the building, it is necessary to place the areas with low user density on the facades facing the part where the building does not have sufficient standoff distance. (Figure 3.11). For example, if the sufficient standoff distance can be provided for a building on three sides depending on its placement in the site, the facade with less distance to the risky area will be weaker in case of a bomb attack. In such a case, as mentioned above, it is necessary to position the areas with low user density, such as a storage room, in that facade of the building during the architectural design phase. Thus, the loss of life in a potential explosion is reduced.

Another important issue for the site positioning and relations is the need to leave a certain standoff distance between the primary and back-up areas and systems that are critical to the performance of the building after the explosion. For example, elevators and ladders will be highly critical architectural elements for emergency evacuation after an explosion. If there is no sufficient standoff distance between these two elements, they may be out of use in case of a potential explosion. In such a case, the loss of life will increase because of the failure in emergency evacuation. Another example of this is the technical systems. If all of the power generators are located in the same area and all of them are damaged in an explosion, the performance of the building decrease. Therefore, power generators and other technical systems of critical importance should be located in different locations with a minimum standoff distance of at least 15 meters between them.

In the selection and positioning of non-structural architectural elements both inside and outside the building, such as coatings, lighting and ventilation elements, the possibility of creating a secondary particle effect in a potential explosion should be considered. Positioning of heavy equipment, such as ventilation, close to the floor and not to the ceiling will be effective in reducing the damage caused by the explosion.

High-risk areas, such as lobbies, loading areas and car parks, should be located outside the projection of the building. If it is not possible to design them independently of the building, they must be placed along the outer face of the building. High risk areas that may be located within the building such as lobbies, service and loading areas, registry areas, parking lots should be positioned as physically separated from the rest of the building as possible and structural reinforcement should be made against explosion loads. Circulating components such as elevators, stairs and doors should not provide direct access to high-risk areas such as the lobby. In buildings with high security requirements, lobbies should be positioned separately from the building. If this is not possible, they can be positioned adjacent to the building. However, in such cases, the walls at the points where the lobbies are attached to the structure should be reinforced structurally. If the lobbies will be located inside the building, buffer zones such as corridors should be placed between the lobbies and other of the building, and the walls of these areas should be reinforced structurally (Figure 3.12) [7].

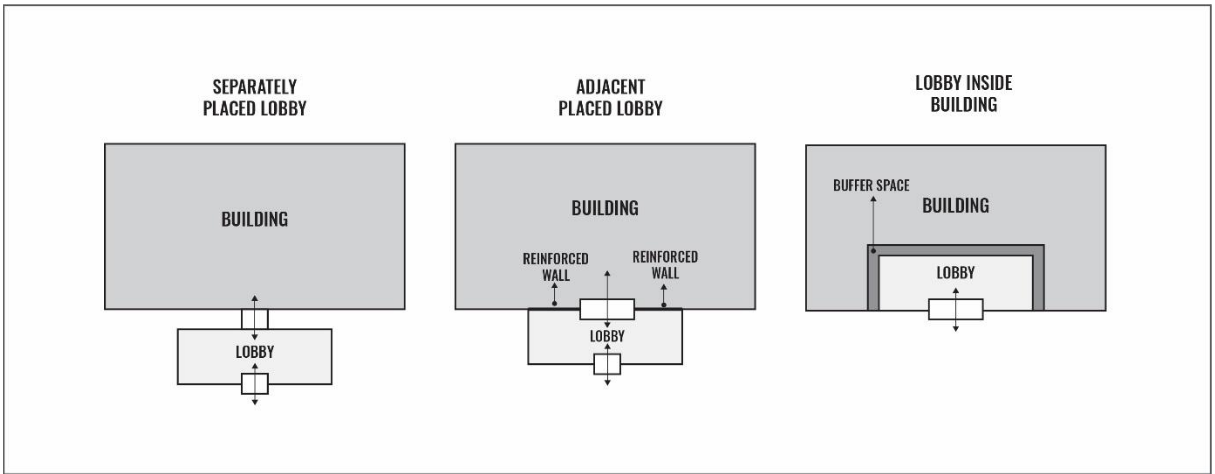


Figure 3.12. Lobby placement [GCA]

Ventilation openings to the outside of the structure should be provided in high risk areas within buildings. This provides a measure against the gas and the smoke released after the explosion, and prevents the increase in the pressure effect caused by the reflection by discharging the pressure in the case of an explosion inside the building. The working and resting areas of the security personnel in the structure should be positioned so as to prevent visual access from outside the building. If this is not possible, the visual access should be prevented by different methods, e.g. window filters etc.

3.2.2. Structural system

There are two main objectives in the design of structural systems for buildings that are resistant to explosion loads. These are to design structural elements that are resistant to explosion loads and to create a structural system that will continue to operate even if any structural element is damaged. At this point, the structure system and elements to be selected, their location and dimensions, construction techniques and the material used are extremely important.

The most preferred material in the buildings which are resistant to explosion loads is the cast-in-place concrete. The mass of the cast-in-place concrete is a feature which increases the resistance against explosion loads. In addition, for the continuity of structural elements in terms of the construction method, the best choice will be the cast-in-place concrete. Precast and prestressed systems are not preferred in buildings expected to be resistant to explosion loads. In addition, lightweight structures are not preferred because they are not resistant to explosion pressure. As a result, the cast-in-place concrete system reinforced by double-sided beams h should be preferred in a building which is resistant to explosion loads.

Since the explosion effect is greatly reduced at very short distances, one of the main issues is the situation of the regional structural elements against these loads. In the frame structures, there should be no large openings between the columns. Wide column spacing is not suitable for the safe distribution of the load in the case of any column is out of function. In addition, the structural elements should be designed in such a way that they cannot be accessed partially or completely from the outside of the building. Arcade construction should be avoided especially in buildings with high security requirements. If possible, access to inner columns within the building should be prevented, or they should be hidden or the access should be limited to a certain distance by certain methods such as coating.

The use of transfer girder in buildings should be avoided as much as possible. They are usually used in loading areas and grand entrances. However, they reduce the building resistance against the explosion pressure. Beams at a certain depth between two floors generally perform well against the explosion pressure. Side beams that surround the floor should be used in general for buildings that are intended to be resistant to explosion loads. These beams play an important role in the distribution of vertical loads as well as strengthening the connection of the floor and columns.

If there are load-bearing walls in the building, they should not be too long and there should be spacing between them at certain intervals. Thus, both the building is more stable and a lateral damage that may occur is taken under control. If there are load-bearing walls in the facade of the building, the resistance of the wall against explosion loads can be increased by adding other perpendicular walls or wall piers in certain intervals. When sufficiently reinforced, load-bearing concrete walls can be considered as an ideal solution for the walls of the building located near the perimeter.

Since the masonry walls are relatively fragile, they can cause large damages in the event of an explosion with the secondary particle effect. These walls are not recommended due to the damage they will cause in case of an explosion [10]. They are useful in the sense that they prevent the gradual collapse if the inner walls have a certain amount of load-bearing property and if they are connected to the floor from the top and the bottom. It is extremely important to use reinforced inner walls in the vicinity of the emergency evacuation route against both explosions and other disasters. CMU (concrete masonry units) blocks completely filled with mortar are reliable solutions if they are reinforced horizontally and vertically, and supported laterally. In addition, the bending capacities of these walls can be increased by anchoring them from the upper and lower parts.

The outer surfaces of the structural elements should be covered with an architectural coating of at least 15-20 cm. Since the explosion pressure decreases significantly in short distances, every cm in the coating thickness is of great importance in this respect [10].

3.2.3. Building envelope

It is often not possible to provide sufficient standoff distance for many sites and buildings, especially in areas with dense urban texture. In such cases, where adequate standoff distances cannot be achieved, the main measure is to structurally reinforce the building and to strengthen the facades, which are the closest points to the risky areas, against the explosion loads. Because, the first line of defense against explosion-induced pressure and scattered particles is the exterior walls of the building. The purpose of the exterior wall design is to ensure that the elements behave not in a fragile but ductile manner. In addition, the walls should be able to withstand the loads transferred through windows and doors. Special strengthening and anchoring systems should also be applied for windows and doors which are resistant to explosion loads. While the cast-in-site concrete provides the highest level of protection, there are other solutions that provide lower levels of protection, such as precast concrete, CMU (Concrete masonry unit) blocks and light metal systems. Precast concrete panels, for example, are more advantageous than other non-load bearing conventional wall systems [15]. For pre-cast concrete panels, there must be at least 12 cm thick closely spaced struts at both sides, thus increasing the ductility of the walls and reducing the possibility of scattering concrete fragments. If CMU or a different masonry wall is to be used especially on the facades of buildings facing risky areas, they must be connected with frames and special connectors [16].

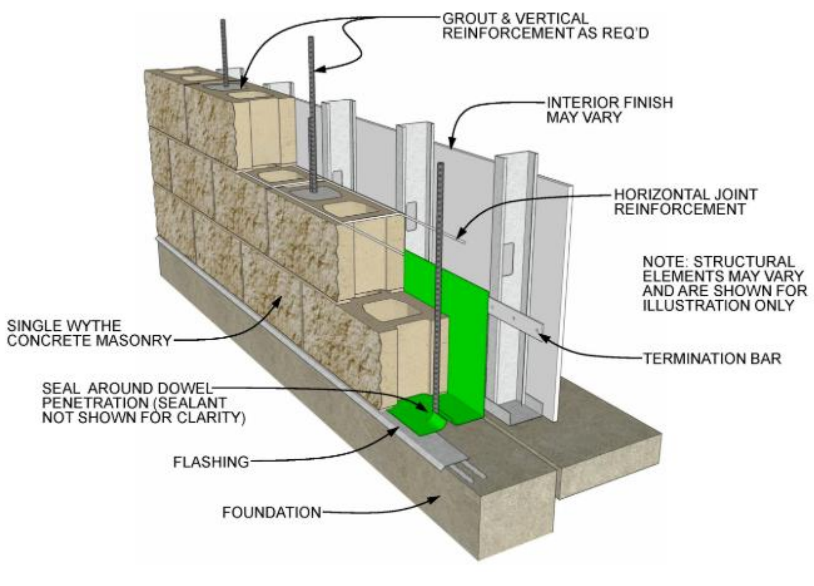


Figure 3.13. Sample cross section of a concrete block wall (CMU) reinforced against the effects of explosion [17]

The thickness of CMU blocks should be at least 20 cm. In addition, CMU blocks must be completely filled with mortar and vertically reinforced with heavy iron bars. Reinforcement elements should be placed for each layer horizontally. The connections of the wall with the structure should be designed to maximize the lateral resistance of the wall. The use of non-structural elements, such as covering the exterior surface of the building with bricks, should be avoided. If this is to be done, their connections must be strengthened to prevent them from scattering in an explosion. In light metal buildings, the metal struts must be placed behind one another and mechanically assembled to each other. A wire mesh or steel plate can be placed on the exterior surface of the light metal building to prevent parts from scattering in case of an explosion.

Image 3.3. Exploded masonry exterior wall images [18]

Windows are generally the weakest architectural elements of a building. Typical annealed glass breaks even at low pressure levels, and a large proportion of the injuries that occur in a large-scale explosion are caused by these glass fragments scattered around. If the glass has a higher resistance than the support elements in the window, the entire window will enter the structure with pressure, but this is not desirable. Therefore, the resistance of the glass against explosion loads should not be higher than other window elements. In order to improve the structural strength of the joinery, the joinery wall compositions should be reinforced. As a measure against explosions outside the building, the number of windows on the lower floors that will be exposed to higher pressure should be reduced as much as possible. If possible, an internal atrium should be added to the structure and the windows should be placed so that they are facing the atrium. Where possible, windows should be positioned close to the ceiling and above the human head level. If the window angles are not positioned perpendicular to the road, the effect of the pressure will decrease. Two types of fragmentation in windows cause less damage. These are the glass that is broken but remained in the frame and the glass that breaks out of the frame but remain within 3 meters. The solution that should be preferred in new structures is laminated annealed glass fixed with structural paste to the frame. The film on the outer surface of the glass holds the broken glass in the frame. Thus, injuries resulting from scattered glass particles are reduced. The desired situation in the case of an explosion is that there is no damage to any of the glass and window elements, if this is not possible, that the glass is broken but remains the the frame, and finally, that the glass fragments are spread within an area with a maximum diameter of 3 meters [7].

Image 3.4. Laminated annealed glass that does not exhibit secondary particle behavior against an explosion load [19]

The shape and the lamination type of the explosion-proof glass are similar to bullet-proof glasses, but the glass sheets in such products are softer and more elastic than that of the bullet-proof glass. These glasses absorb the force of the first shock wave of the explosion. They are usually cracked and / or broken in the face of the explosion but do not exhibit secondary particle effect. For glass and joinery close to high-risk points, products conforming to the relevant standards of ASTM should be used. [19]. The pressure wave resulting from the explosion loses significant power at very short distances. Therefore, the main measure in architectural passive security arrangements is always to leave an adequate standoff distance between risky points and target structures. Site-oriented titles such as the site placement and access control are also arrangements to control the standoff distance. Measures such as structural reinforcement, material selection, facade arrangements, site settlements etc. are passive security arrangements that vary in degree depending on the standoff distance. As a result, the basic passive security measure against a bomb attack is always to ensure a sufficient standoff distance. Other measures are taken to eliminate the weakness when this distance cannot be achieved, and as the standoff distance decreases, the degree and importance of these measures increases.

Table 3.3. APSA checklist against bomb attacks

CONDITIONS / REQUIREMENTS		APSA	APPROVAL
Site-Oriented Arrangements			
Layout Plan			
Natural Components	Preventing visual access to the site and supervision opportunity inside and outside the site	. Location, size, topography, neighboring area and nature of the site should be considered.	
		. The following issues should be taken into consideration: - Distance to site boundaries and neighboring sites, - Number and size of structures in the site - Their position and relations against the site boundaries and each other - Natural physical barriers and routers in the site - Restrictive effect of site topography on pedestrian and vehicle traffic in the site and its potentials	
Physical Planning	Adequate standoff distance	. Structures should be located at the farthest place from site boundaries	
		. It should be placed in the middle of the site in central plans	
		. In other cases, the narrowest and massive facade should be placed towards the side where the distance is insufficient.	
	Presence of streets and roads with greater risk around the site	. The high-risk street should be closed to traffic and buildings should be located away from risky streets	
		. The narrowest facades with the least facade opening, where places with low user density are located, should be directed to these streets and roads.	
	The placement of multiple structures within the site	. Avoid building density within the site	
		. An effective inspection environment should be provided when determining distances between structures	
Access Control			
Vehicle Traffic Control	Controlling traffic speed and direction	. The site's point of entry should be positioned perpendicular to the direction of traffic	
		. Different design methods such as roundabouts, curved roads, artificial bends, speed bumps and elevated pedestrian roads should be used to reduce the speed of vehicle traffic near the site boundaries and entrances	
		. For buildings with high security requirements, necessary inspections must be made on the relevant traffic lane before the vehicles reach the site entrance.	
		. Security booths at the points of entry should be designed to enable the officer to keep the traffic, the vehicle and pedestrian approach and orientation, and the vehicle queue under visual control, facilitating the vehicle inspection process.	
		. In high security areas, a final barrier must be added before allowing the vehicle to enter the site after inspection.	
		. Legible markings and adequate lighting should be provided for control and inspection areas.	
		. Passive barriers: Fixed barges, structurally strengthened pots, heavy objects and trees, walls and topographic elements, water barriers, concrete barriers and fences, and so on.	
		. Active barriers: Movable barges, rising barrier systems, rotating barrier systems, arm barriers, road blockers and effect resistant door systems etc.	

Table 3.3. (continued) APSA checklist against bomb attacks

<table>
<tr><th colspan="2">CONDITIONS / REQUIREMENTS</th><th>APSA</th><th>APPRO.</th></tr>
<tr><td colspan="4">Site-Oriented Arrangements</td></tr>
<tr><td colspan="4">Access Control</td></tr>
<tr><td rowspan="10">Control of Parking Areas</td><td rowspan="3">Preventing the vehicles to approach the buildings in the site</td><td>. Adequate standoff distance should be provided between parking areas and buildings</td><td></td></tr>
<tr><td>. Additional structural reinforcement should be carried out on buildings if the distance cannot be provided</td><td></td></tr>
<tr><td>. Guest parking areas and public parking spaces should be located beyond the standoff distance</td><td></td></tr>
<tr><td rowspan="4">Surveillance opportunity</td><td>. One-way circulation should be allowed in parking areas</td><td></td></tr>
<tr><td>. CCTV camera surveillance systems should be installed in parking areas</td><td></td></tr>
<tr><td>. Parking spaces should be planned to be open to visual access from inside the building and outside</td><td></td></tr>
<tr><td>. Dead ends, niches, and corners that allow hiding should be avoided</td><td></td></tr>
<tr><td rowspan="3">The standoff distance and reducing the explosion effect</td><td>. Vehicle parking directions should be positioned so that they are not directly facing the structure</td><td></td></tr>
<tr><td>. Parking areas should not be positioned above or below the building, they should be located outside the base area of the building.</td><td></td></tr>
<tr><td>. There should be no parking spaces between the two buildings</td><td></td></tr>
<tr><td colspan="4">Building-Oriented Arrangements</td></tr>
<tr><td colspan="4">Architectural Arrangements</td></tr>
<tr><td rowspan="2">Building Height</td><td>High-rise Buildings: Explosion load and effect are higher on the lower floor, it is reduced in upper floors</td><td>. Structural reinforcement should be made on the lower floors</td><td></td></tr>
<tr><td>Low-rise Buildings:</td><td>. The effect of explosion on the whole structure should be reduced with the structures spread over the wide base area</td><td></td></tr>
<tr><td rowspan="2">Building Geometry</td><td rowspan="2">The effect of recessed corners by absorbing and reflecting the shock wave and intensifying the explosion load</td><td>. U - L shaped or similar planning and other geometric irregularities should be avoided</td><td></td></tr>
<tr><td>. Reflection pressure should be reduced by using convex forms</td><td></td></tr>
<tr><td rowspan="3">Facades</td><td>Facades facing high-risk areas without adequate standoff distance</td><td>. Overhanging elements such as balcony etc. should be avoided</td><td></td></tr>
<tr><td rowspan="2">Buildings with high security requirements</td><td>. Facade decorations should be kept as low as possible</td><td rowspan="2"></td></tr>
<tr><td>. Lightweight materials such as wood and plastic should be used for facade decorations; materials that may cause fatal damage, such as brick, stone and metal, should not be used or wire mesh or steel plate should be placed on the exterior surface to prevent particles from breaking away</td></tr>
<tr><td rowspan="3">Roofs</td><td rowspan="3">Exposure to a stronger explosion effect in low-rise buildings</td><td>. Selecting a high-strength structure</td><td></td></tr>
<tr><td>. Using Inclined Roofs</td><td></td></tr>
<tr><td>. Roof overhangs and eaves should be avoided</td><td></td></tr>
</table>

Table 3.3. (continued) APSA checklist against bomb attacks

CONDITIONS / REQUIREMENTS		APSA	APPROVAL
Building-Oriented Arrangements			
Architectural Arrangements			
Other architectural	Natural ventilation and lighting needs of high-risk spaces	. Reducing facade openings with courtyard and atrium solutions and protecting risky spaces from external effects	
Organization of Space	Public areas with high risk (entrance lobbies, restaurants and bars at entrances, registration areas, car parks)	. Should be separated from other locations with buffer zones (corridors, storage rooms, etc.)	
		. Circulating components such as elevators, stairs and doors should not provide direct access to high-risk areas such as the lobby.	
	Areas with high security requirements (areas with high user density and areas not accessible to unauthorized persons)	. High risk areas and areas with high security requirements should not be positioned next to or over/under each other without a buffer zone.	
		. The working and resting areas of the security personnel in the structure should be positioned so as to prevent visual access from outside the building. If this is not possible, the visual access should be prevented by different methods, e.g. window filters etc.	
	Lack of adequate standoff distance around the building / Security of life	. Placing areas with low user density on the facades facing the part where the structure does not have sufficient standoff distance	
	Performance of the structure after the explosion	. A certain standoff distance (at least 15 meters) should be provided between the main and backup areas and systems with critical importance (technical systems such as elevators, ladders, power generator rooms)	
	The presence of non-structural architectural elements, such as lighting and ventilation	. They should be positioned close to the floor instead of the ceiling . There should be ventilation openings in the building in high risk areas.	
Layout	Buildings in dense urban areas with insufficient standoff distance against the explosion effect	. Restricting vehicle access to the site boundaries by narrowing the site settlement area with fixed barriers	
		. Structural reinforcement on the lower floors of the building	
		. Starting the ground floor elevation at least 1.2 meters above the road level	

Table 3.3. (continued) APSA checklist against bomb attacks

CONDITIONS / REQUIREMENTS		APSA	APPRO.
Building-Oriented Arrangements			
Structural System Arrangements			
Structure System	Resistance to explosion effects and continuity of structural elements	. Cast-in place concrete system supported by double-sided beams should be preferred	
		. Pre-cast and pre-stressed systems should not be used or should be reinforced with at least 12 cm thick struts positioned in both directions with close spacing	
		. Lightweight structures should not be preferred or the metal posts should be placed one behind the other and mechanically mounted to each other	
		. The use of transfer beams should be avoided and the edge beams surrounding the floor should be used	
		. The spacing between columns in frame structures should not be too large	
		. Structural elements should be designed in such a way that they cannot be accessed partially or completely from the outside of the building.	
		. Intermediate floor construction should be avoided especially in buildings with high security requirements	
Walls	Resistance to explosion effects and preventing collapse	. Load-bearing walls should not be too long and spaces should be left at regular intervals.	
		. The load-bearing walls on the exterior of the building must be strengthened against explosion loads by adding other walls or wall piers perpendicular to these walls.	
		. Masonry walls with secondary particle effect should be avoided	
		. The inner walls must be connected to the top and bottom floors (especially the emergency evacuation route and surroundings).	
		. All walls should be supported with lateral elements when necessary	
		. The surfaces of all structural elements should be covered at least 15 cm	
Building Envelope Arrangements			
Exterior walls	Where a sufficient standoff distance cannot be achieved	. Structural elements and facades must be reinforced against explosion loads	
		. Exterior walls must be ductile	
		. The use of non-structural elements, such as covering the exterior surface of the building with bricks, should be avoided.	
Windows- Doors	Resistance to explosion loads	. Special reinforcement and anchorage systems should be applied	
		. The resistance of the glass against explosion loads should not be higher than other window elements.	
		. Joinery- wall compositions should be strengthened	
		. The number of windows on the lower floors should be reduced as much as possible	
		. Where possible, windows should be positioned close to the ceiling and above the human head level.	
		. The glass should be fixed to the frame with structural paste and laminated annealed glass should be used	
		. For glass and joinery close to high-risk points, products that comply with the relevant standards of ASTM (American Society for Testing and Materials) should be used.	

4. ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS AT LAND PORTS OF ENTRY

The critical infrastructure protection has become a more and more important concept, especially in the United States after the September 11 attacks. Important steps have been taken in order to identify critical infrastructures and to protect these infrastructures against all kinds of threats and hazards. In the case when a critical infrastructure of a country with geostrategic importance like Turkey is disabled, situations may occur that may lead to chaos not just within the country, but also in other countries dependent to Turkey. In the face of a environmental, physical or cyber danger that the oil-gas pipeline passing through Turkey is exposed to, not only Turkey but all the countries who import energy through Turkey will be affected by this situation [20]. Similarly, in the case when one of the land ports of entry in Turkey is disabled even for a certain period of time, all the countries engaged in commercial transportation via transnational logistics networks, where these ports of entry are the crossing points, will be adversely affected by this situation. This shows that the security of critical infrastructures is of great importance not only for the countries they belong to, but also for other countries. The tables below present the definitions included in the studies carried out in different countries and unions related to critical infrastructures (Table 4.1), and how the basic infrastructures in these countries are categorized into the basic titles (Table 4.2).

Table 4.1. Critical infrastructure definitions in the studies carried out in different countries [20-22]

EU	Critical infrastructures consist of physical and information technology facilities, networks, services and assets that will have a significant impact on citizens' health, security, security, economic well-being, or the effective functioning of the government when they are disabled or destroyed.
USA	Critical infrastructures are physical or virtual systems and entities that, if disabled or destroyed, will have a negative (weakening) effect on security, national economic security, national public health and security, or any combination thereof.
Japan	Critical infrastructures consist of business units that provide irreplaceable services and are indispensable for people's social lives and economic activities. If the functioning of an infrastructure is stopped, reduced, or becomes inaccessible, the social lives and economic activities of people will be turned upside down.

Table 4.1. (continued) Critical infrastructure definitions in the studies carried out in different countries

Canada	The critical infrastructure refers to the processes, systems, facilities, technologies, networks, assets and services necessary for health, security, security, economic prosperity and effective functioning of the government. The critical infrastructure may be interconnected within and among provinces, regions and national boundaries. The deterioration of the critical infrastructure can lead to great loss of life, negative economic impacts and damage to the social security environment.
Turkey	The critical Infrastructure is the whole of the network, assets, systems and structures that will have a serious impact on the health, security and economy of the citizens as a result of the negative impact on the environment, social order and public services when its function is not fulfilled in whole or in part.

Table 4.2. Critical infrastructure classifications in studies carried out in different countries [20-23]

EU	USA	Japan	Canada	Turkey
Energy	Energy	Electricity	Energy	Energy
		Gas		
Nuclear and CBR Industries	Nuclear			
	Chemical			
Information and Communication	Information Technology	Telecommunication	Information and Communication	Telecommunication
	Communication			
Finance	Finance	Finance	Finance	Finance
Healthcare	Healthcare	Healthcare	Healthcare	Healthcare
	Emergency Services			
Food	Food and Agriculture		Food	Food and Agriculture
Water	Water and Sewerage	Water	Water	Water and Dams
	Dams			
Transportation	Transportation	Railway	Transportation	Transportation
		Civil Aviation		
		Logistics		
Security			Security	
	Defense Industry			
Civil Administration	Administrative Facilities	Public Administration	Public Administration	Critical Public Services
	Commercial Facilities			Critical Production and Commercial Facilities
	Critical Production		Production	
Space Researches				
				Culture and Tourism

According to the data released by Start (National Consortium for The Study of Terrorism and Responses to Terrorism), a joint study of the US Department of National Security and the University of Maryland, for 2017; Only in 2017, 10,900 terrorist attacks occurred worldwide and 35% of these attacks took place in the Middle East and North Africa Region, which includes Turkey. 159 of these attacks were carried out by PKK, a terrorist organization active in Turkey, and 190 people have lost their lives as a result of attacks [24]. It is clear how important it is to be prepared against terrorist attacks in a country like Turkey, where the impact of the terror felt strongly. Critical Infrastructure Protection has a very important role at this point. Bombing attacks carried out in Mardin, Sirnak, Sanliurfa and Diyarbakir provinces against Kirkuk-Yumurtalık Oil Pipeline targeted the energy infrastructure of Turkey, and the attacks carried out in Diyarbakir and Gumushane against dams targeted the water infrastructure. The attack that took place at Cilvegözü Border Crossing in Hatay where 13 people, 5 of whom are Turkish, lost their lives and 24 people were seriously injured [25], the attack that took place at Iğdır Dilucu Border Crossing where 13 police officers were martyred, [26] and finally the attack that took place at Cobanbey Border Crossing where 3 people were seriously injured [27] were the terrorist bombing attacks targeting Turkey's transportation and logistics infrastructure. This also shows that one of the aims of terrorist organizations active in Turkey is to damage the critical infrastructure in Turkey and to adversely affect the economy and the business reputation of the country. At this point, it is crucially important to take security measures especially in transportation and logistics infrastructures. The ports of entry security, an important element of the infrastructure under this title, should be evaluated in this context.

In transnational trade and passenger crossings, the infrastructure and systems components established to prevent illegal crossings and to keep legal crossings under control are called the border gates or ports of entry. Ports of entry are highly critical infrastructures for both transnational crossings and international logistics networks. There are four types of ports of entry: Land, Railway, Sea and Air. In Turkey, there are a total of 30 active and inactive land, 8 railway, 83 sea and 62 air ports of entry [28]. While railway ports of entry also function as trains stations, sea ports of entry as harbors, and airports of entry as airports, land ports of entry serve as individual infrastructures only for transnational commercial and passenger crossings.

Turkey is bordered by Greece and Bulgaria to its northwest; Georgia, Armenia, and Nakhchivan (Azerbaijan) to its northeast; Iran to the east, and Iraq and Syria to the south. On these borders, there are 30 land ports of entry in total, 2 of which is on the border with Greece, 3 on the border with Bulgaria, 4 on the border with Georgia, 1 on the border with Nakhcivan, 3 on the border with Iran, 6 on the border with Iraq, and 11 on the border with Syria [29]. While Kapıkule Border Crossing is used for Bulgaria-Serbia-Montenegro-Croatia-Austria and Bulgaria-Romania-Hungary-Austria-Ukraine-Russian Federation routes, and Gürbulak Border Crossing for Iran-Turkmenistan-Kazakhstan routes; Sarp Border Crossing is an important port of exit for the Georgian-Russian Federation route, and Cilvegözü Border Crossing and Habur Border Crossing provide access to the Middle East countries through Syria and Iraq, respectively [30]. The table below (Table 4.3) provides basic information about the Land and Railway Ports of Entry in Turkey.

Table 4.3. General information about Land and Railway Ports of Entry in Turkey. [29, 31]

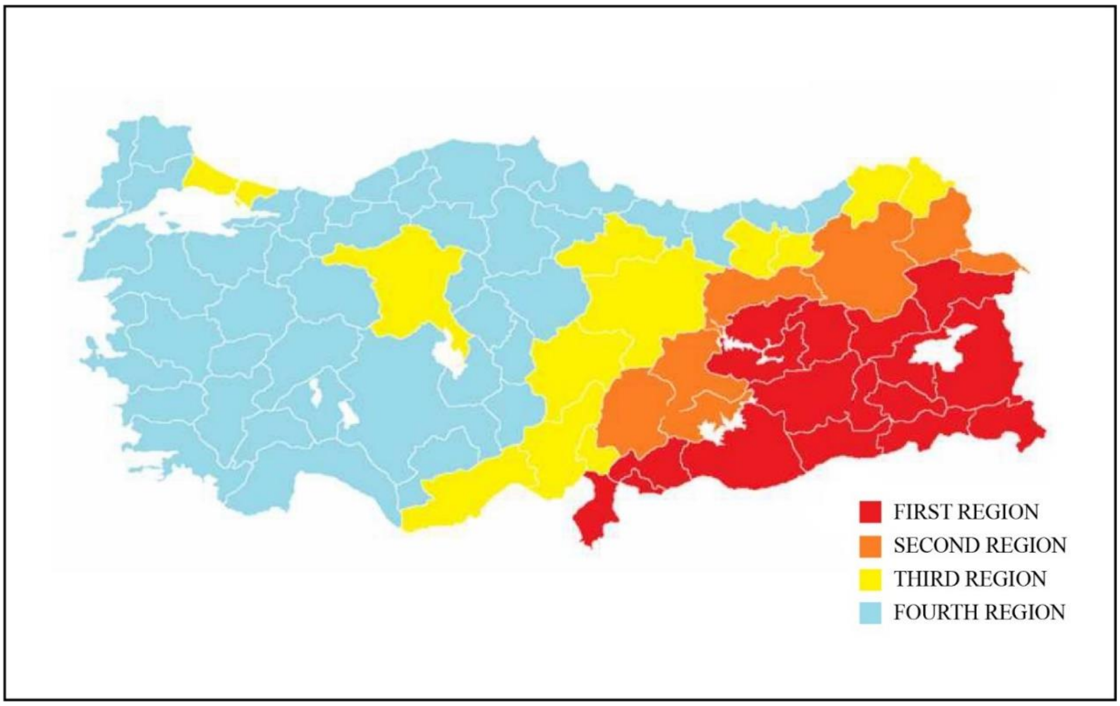
No	Direction	Province	Port of Entry	The Opposite Port of Entry	Type	Status	Opening	Area
GREECE								
1	NW	Edirne	İpsala	Kipoi	Land	Active	1961	106.000 m^2
2	NW	Edirne	Pazarkule	Kastanies	Land	Active	1952	3.400 m^2
1	NW	Edirne	Uzunköprü	Pythion	Railway	Passive	NA	NA
BULGARIA								
3	NW	Edirne	Hamzabeyli	Lesova	Land	Active	2004	64.000 m^2
4	NW	Kırklareli	Dereköy	Malko Trnova	Land	Active	1969	17.000 m^2
5	NW	Edirne	Kapıkule	Kapitan And.	Land	Active	1953	333.000 m^2
2	NW	Edirne	Kapıkule	Kapitan And.	Railway	Active	NA	NA
GEORGIA								
6	NE	Ardahan	Türkgözü	Vale	Land	Active	1995	24.000 m^2
7	NE	Ardahan	Çıldır-Aktaş	Kartsakhi	Land	Active	1995	76.000 m^2
8	NE	Artvin	Sarp	Sarpi	Land	Active	1988	36.000 m^2
9	NE	Artvin	Muratlı	Kirnati	Land	Passive	2013	NA
3	NE	Kars	Kars Train Station	Kartsakhi	Railway	Active	NA	NA
ARMENIA								
4	NE	Kars	Akyaka	Gyumri	Railway	Passive	NA	NA
NAKHCHIVAN (AZERBAIJAN)								
10	NE	Iğdır	Dilucu	Nakhchivan	Land	Active	1992	73.000 m^2
IRAN								
11	E	Ağrı	Gürbulak	Bazargan	Land	Active	1953	137.500 m^2
12	E	Hakkâri	Esendere	Serov	Land	Active	1964	50.000 m^2
13	E	Van	Kapıköy	Razi	Land	Active	2010	61.000 m^2
5	E	Van	Kapıköy	Razi	Railway	Active	NA	NA

Table 4.3. (continued) General information about Land and Railway Ports of Entry in Turkey.

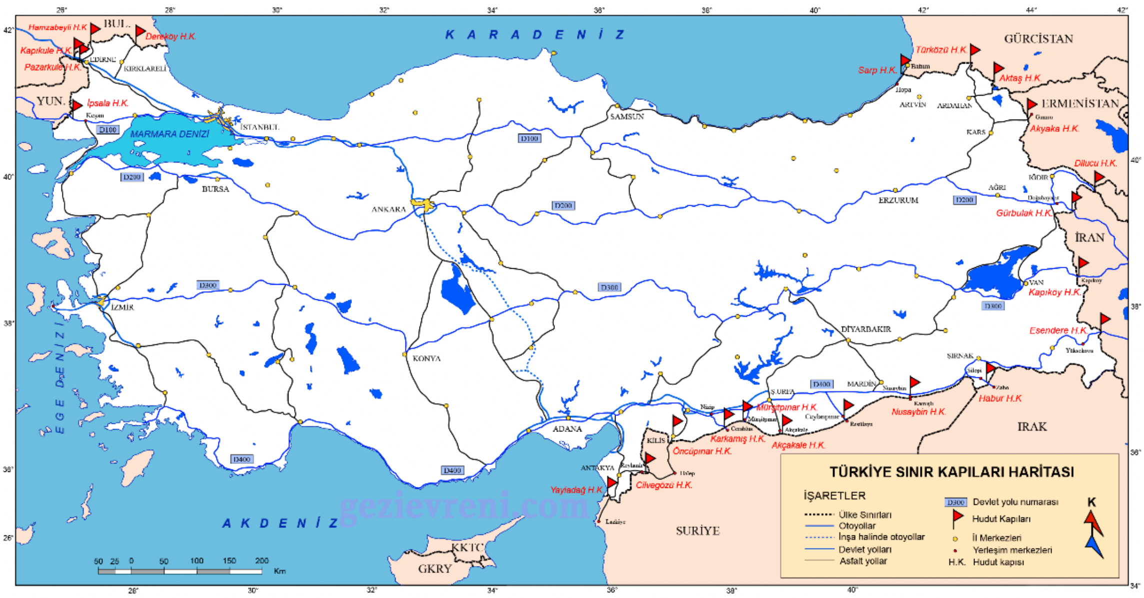
No	Direction	Province	Port of Entry	The Opposite Port of Entry	Type	Status	Opening	Area
IRAQ								
14	SE	Şırnak	Habur	Zaho-El Halil	Land	Active	1969	320.000 m^2
15	SE	Hakkâri	Üzümlü	Serzeare	Land	Active	2015	NA
16	SE	Hakkâri	Derecik	Mergesur	Land	Passive	2011	NA
17	SE	Şırnak	Gülyazı	Zaho	Land	Passive	2012	NA
18	SE	Şırnak	Aktepe	Bacuka	Land	Passive	2014	NA
19	SE	Şırnak	Ovaköy	Karavala	Land	Passive	2014	NA
SYRIA								
20	SE	Hatay	Yayladağı	Kesap	Land	Active	1953	11.125 m^2
21	SE	Hatay	Cilvegözü	Bab El-Hava	Land	Active	1953	85.000 m^2
22	SE	Hatay	Kumlu	Afrin	Land	Active	2018	NA
23	SE	Gaziantep	Karkamış	Jarablus	Land	Active	1953	NA
24	SE	Kilis	Öncüpınar	Azez	Land	Active	1953	NA
25	SE	Kilis	Çobanbey	Akderun	Land	Active	2013	NA
26	SE	Mardin	Nusaybin	Kamışlı	Land	Passive	1953	NA
27	SE	Mardin	Şenyurt	Derbesiye	Land	Passive	1953	NA
28	SE	Şanlı Urfa	Akçakale	Tel-Abyat	Land	Passive	1974	NA
29	SE	Şanlı Urfa	Ceylanpınar	Resul-Ayn	Land	Passive	1999	NA
30	SE	Şanlı Urfa	Mürşitpınar	Aynel-Arab	Land	Passive	2010	NA
6	SE	Kilis	Çobanbey	Akderun	Railway	Passive	NA	NA
7	SE	Gaziantep	İslâhiye	Ekbez	Railway	Passive	NA	NA
8	SE	Mardin	Nusaybin	Kamışlı	Railway	Passive	NA	NA

According to the data of Anadolu Agency for the first six months of 2017, the share of the land transportation in Turkey's foreign trade was 28.3% in total exports, and 16.2% in exports. In the first six-month period of 2017, the total export amount realized by land transportation was 23.2 billion dollars and the import amount was 19.9 billion dollars [32]. Moreover, these figures are only the data on Turkey's trade. Considering that Turkey, due to its geopolitical position, is located on international E-road Network, and international land routes such as ESCAP and TEM, the economic importance of the land transportation, hence land ports of entry, in both national and international context is better understood [33].

There are two basic criteria that determine the physical structure of a land port of entry. These are the capacity of the border gate and security requirements. As the capacity requirement changes depending on which international logistics routes and the borders of countries the port of entry is located, security requirements will also change depending on the geography. Map 4.1 shows Turkey risk map, which was created based on terrorism statistics [18]. Map 4.2 shows land ports of entry in Turkey. Based on these maps, it is possible to put forward an idea on the security requirements of the land ports of entry in Turkey.



Map 4.1. Turkey Risk Map created based on terrorism statistics [18]



Map 4.2. Map of Turkey land ports of entry [34]

Receiving information about a bombing attack via intelligence and operational activities prior to the attack at the land ports of entry, and identifying and preventing the bomb vehicle or person before he/she reaches the port of entry is desired primarily. However, where this is not possible, the port of entry should be physically prepared for an attack. This can only be achieved by providing an effective on-site inspection environment and taking necessary physical measures against a potential attack. Before discussing how architectural passive security arrangements can be applied to land ports of entry, it is necessary to be familiar with the general physical layout and operating procedures of the land ports of entry.

4.1. General Physical Layout and Site Components of Land Ports of Entry

Land Ports of Entry are not directly located on borders, but within the borders of the country which they belong. Although there are common border crossing projects, each country usually has a separate port of entry. (Figure 4.1) A vehicle that will cross from one country to another, primarily passes through the port of exit of the country, comes to the buffer zone between the border gates, and proceeds to the port of entry of the other country. The length and physical structure of the buffer zone vary depending on the terrain conditions, location and capacities of the ports of entry. While some ports of entry are located very close to each other (e.g. Kapıkule Border Gate and Kapitan Andrevo Border Gate), some of them requires to take a certain distance from one border to another (e.g. İpsala Border Gate and Kipoi Border Gate).

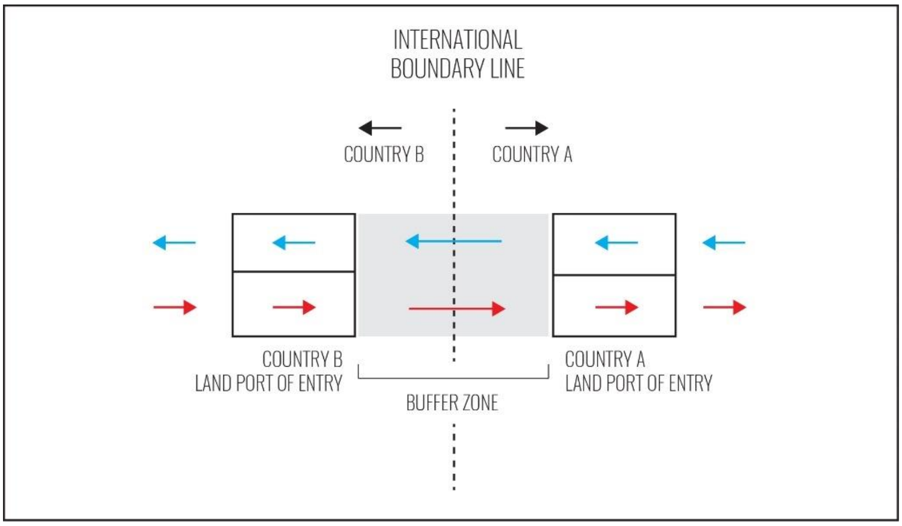


Figure 4.1 Schematic representation of opposite ports of entry [GCA]

It is not desirable for vehicles to wait in the buffer zone. Due to different working hours, control applications etc., there may be differences between the working capacities of the ports of entry. Even if a port of entry can handle the crossing procedures of vehicles very quickly by working at full capacity, the crossing speed does not have any meaning if the opposite port of entry cannot answer this density. Therefore, these ports of entry need to work in coordination with each other regarding the issues such as the number of vehicles, security etc. As a precaution against possible queues due to seasonal density and cross-border capacity-speed differences, parking spaces such as Truck Parking can be created especially at the entrance of border gates for commercial vehicles. In this way, the number and density of the vehicles to pass are kept under control by the appropriate physical arrangement and infrastructure.

Crossings from a port of entry can be handled under two main titles (commercial crossings and passenger crossings) and four different types (commercial vehicles, non-commercial vehicles, pedestrians and buses). 1. Commercial crossing: Commercial vehicles (tow trucks, trailers, tankers, trucks and vans), 2. Passenger crossing: Non-commercial vehicles (cars, motorcycles, caravans, etc.), pedestrians and buses. In addition, these crossings can be divided into four different groups by the route they follow within the site of the port of entry and the procedures implemented: 1. Outbound commercial crossings, 2. Inbound commercial crossings, 3. Outbound passenger crossings, 4. Inbound passenger crossings (Figure 4.2).

The physical structure of ports of entry may vary depending on the circumstances such as land, location, capacity, intensity of use and so on. Physical capacities of the ports of entry with a large capacity and high usage density, such as Kapikule, Gurbulak and Habur, and small ports of entry with relatively little usage density will naturally be different from each other. While separate roadways should be provided for each of the inbound commercial, outbound commercial, inbound passenger and outbound passenger crossings in large ports of entry to ensure an effective control environment, it may be more economical to make commercial and passenger crossings in two separate roadways as inbound and outbound in smaller ports of entry. However, crossing of vehicles with different crossing procedures through the same area will require some design solutions about the physical properties of the crossing checkpoints (the problem with the physical feature of the checkpoint resulting from a truck and a non-commercial vehicle glass height being different). Regardless of the type of the crossing, there are three different checkpoints through the border crossing; the first checkpoint, the main checkpoint, and the final control point. At the first checkpoint, a visual inspection of the outside the vehicle is performed, the criminal record of the vehicle is checked by the license plate reading system, and the information about the vehicle, e.g. the plate, brand, site entry time, etc., are saved and conveyed to the other checkpoint. If it is desired to sterilize the vehicle, it can be directed to the sterilization area before proceeding to the next checkpoint. According to the practice in Turkish ports of entry, after the first checkpoint, vehicles go to the passport control and scale area (the area in which the weight of commercial vehicles is measured). However, there are also efforts for transition to the One-Stop System in Turkey [35]. In one stop system, passport control and weight measurement are performed at the main checkpoint. Figure 4.2. schematically shows the general physical layout of ports of entry.

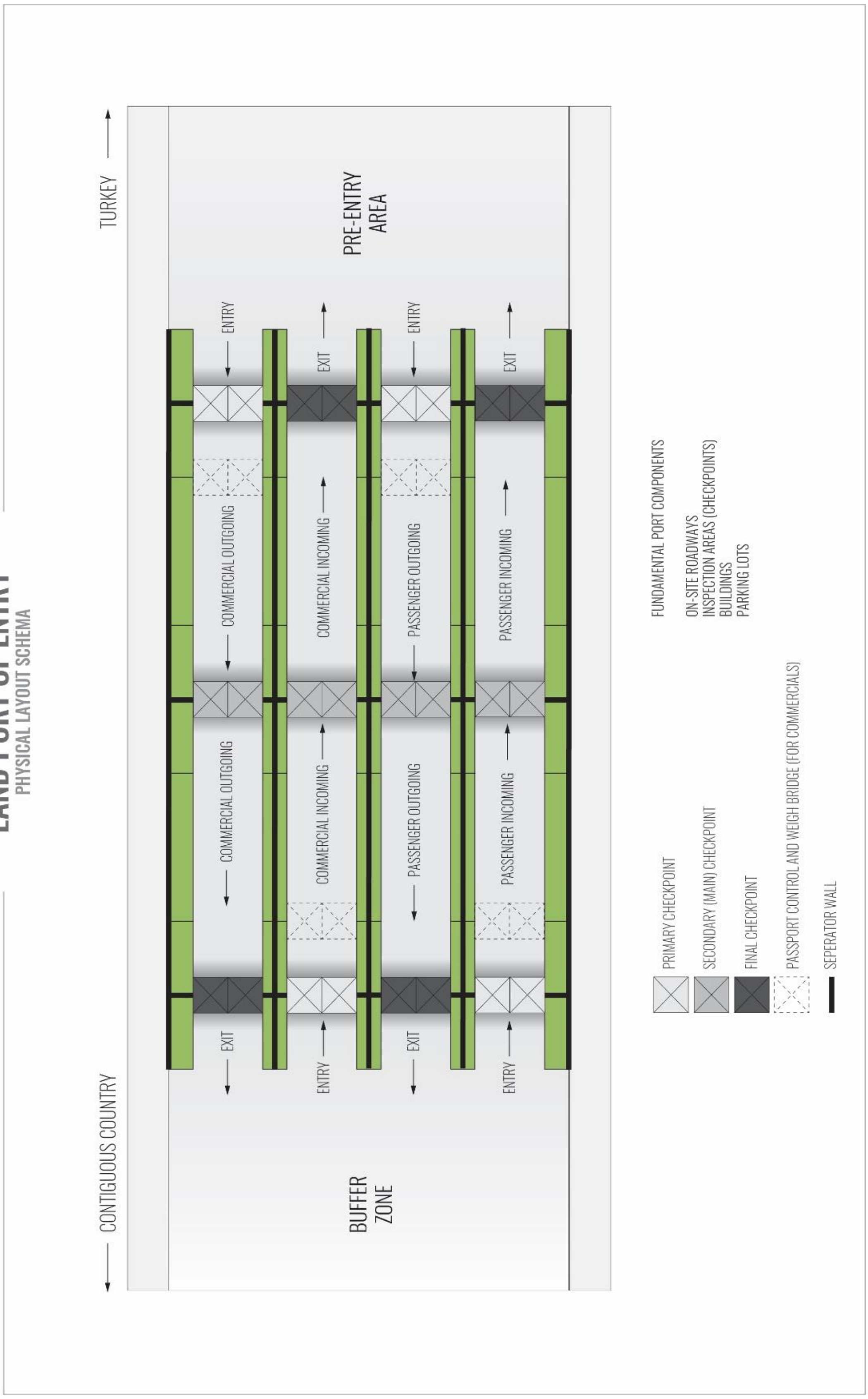


Figure 4.2. Land port of entry physical layout schema [GCA]

At ports of entry, vehicles reach the main checkpoint after crossing through the first checkpoint. Here, the vehicles are subjected to security screenings and document controls are performed. Suspicious vehicles can be directed to the X-ray and searching shed or a more detailed search. If it is found that a criminal case such as smuggling has taken place, Customs Enforcement Teams intervene. A vehicle reaches the final checkpoint after crossing through the main checkpoint. At the last checkpoint, approval checks of vehicle's documents are made and the information, such as the time of exit of the vehicle from the site, is saved and transferred to the database.

A port of entry site consists of site components such as buildings, in-site vehicle roads, checkpoints, special control areas (veterinary border inspection area etc.), vehicle parking areas, technical areas and pedestrian corridors (not available at every port of entry). However, it is possible to mention four main site components: 1. In-site vehicle roads, 2. Checkpoints Buildings, 4. Parking areas [36].

In order to ensure an effective control environment within a port of entry, vehicles entering the site are desired to complete the procedures as quickly as possible and exit from the site. However, the organization of in-site traffic may be difficult and the vehicle accumulation may occur in the site due to reasons such as the control of the goods carried by commercial vehicles, more detailed control procedures at the veterinary border inspection point (sending the samples to the laboratory to be analyzed and receiving them takes a long time), the passenger and commercial vehicles crossing through the main control point use the duty free shopping center and social areas within the site, and outbound commercial vehicles benefiting from tax-free fuel stations. Although the accumulation of vehicles may increase in different periods of time (before and after long holidays), it is possible to overcome these problems with the correct structuring of the spatial organization in the site. This is only possible by making an accurate analysis of crossing procedures and relevant spatial requirements.

Although ports of entry have common features across the country, it is not possible to design a common prototype for all. There is no universally accepted design solution. Therefore, as with all other building designs, it is necessary to develop specific program and design solutions for a certain port of entry [37].

4.2. Architectural Passive Security Arrangements at Land Ports of Entry

The architectural design of a port of entry should have primarily a non-despotic but *formal* expression. The user must understand that the port of entry is equipped with high security measures but he/she should not feel being treated as a potential criminal. In addition, a port of entry should be regional and local in style and sensitive to existing historical structures. Also, local landscape and climate characteristics should be considered in the design process. Continuity of operations is essential in the design of a port of entry. Spatial features must be provided to ensure that the entire process is fluent from the time a vehicle enters the site to the time it leaves.

It is also very important that the border gate has a flexible design that can be adapted to the possible changes in function and capacity that may occur in the future. This can only be achieved by leaving reserved areas for the site elements such as checkpoints and parking areas. When designing a port of entry, the on-site vehicle and pedestrian circulation must be designed in a simple, direct movement of traffic, providing clear circulation patterns. In order to provide an effective inspection environment within the site, all processes, patterns and related spaces in the site should be easily readable by the users. Otherwise, it becomes extremely difficult to control vehicle and pedestrian distribution within the site. In the lightening of the port of entry site, sharp light contrasts should be avoided, and acoustic problems that may occur due to vehicle noise and the physical structure of canopies should be considered. In addition, in the design of ports of entry, optimum solutions should be proposed for other issues such as maximum use of daylight, utilization of natural ventilation methods, pollution resulting from high noise and exhaust fumes [36]. Another important issue to be considered in the design of ports of entry is the arrangements regarding border security.

In the design of a port of entry, there are major design decisions that should be given primarily about the general physical layout of the site. These include the number of corridors within the port of entry site and their organization models, the anticipated model for the checkpoints, the distance and positions of the first and last checkpoints at both ends of the site, the physical relation between the opposite ports of entry, the decisions about the buffer zone and pre-entry area, which types of traffic are allowed to pass through the border crossing and whether special spaces (pedestrian corridor, etc.) will be provided, which buildings and special areas (veterinary border inspection points) will be located in the site and where. All of these decisions are directly related with the principle of providing an efficient inspection and security environment which is emphasized in the study.

In the case of architectural passive security arrangements against bomb attacks, the priority measure is always to ensure adequate standoff distance between risky areas and target areas. Likewise, the first measure against a bomb attack that may occur at land ports of entry is to provide adequate standoff distance between the risky areas and the target areas inside and outside the site. Different standoff distances are applied depending on the load carrying capacity of the vehicles for different crossing types to be made at Land Ports of Entry. Although these distances cannot be provided in all areas within the port of entry site, they should be provided for the areas with the highest risk in and around the site.

The riskiestareas in a port of entry site are pre-entry areas and buffer zones. Since the vehicles approaching the pre-entry areas come from within the country, they are less risky compared to the buffer zone. Vehicles coming into the buffer zone may not have passed a healthy inspection mechanism for border gates, especially in high-risk areas, although they have crossed the opposite port of entry. As a matter of fact, in the bombings targeting both the Cilvegözü Border Gate (Figure 4.5) and Çobanbey Border Gate, the vehicles coming from Syria were detonated in the buffer zones. The risky areas in the port of entry site are rated in Figure 4.5.

As shown in the graph in Figure 4.5, in the case of an attack in the pre-entrance area and buffer zone, which are the highest risk areas in the port of entry site, the greatest damage occurs in the vehicles and pedestrians waiting to enter in these areas, the vehicles in the parking area and the nearby checkpoints. Since the detailed search for the vehicles is made at the main checkpoints, the areas before the main checkpoints are classified as medium-risk areas, and the areas after that are classified as low-risk areas. Arrangements regarding the pre-entry area and the buffer zone, and the design principles of the checkpoints are discussed in the following parts of the study.

Image 4.1. The point of attack at Cilvegözü Border Gate. Satellite images are taken from Yandex map

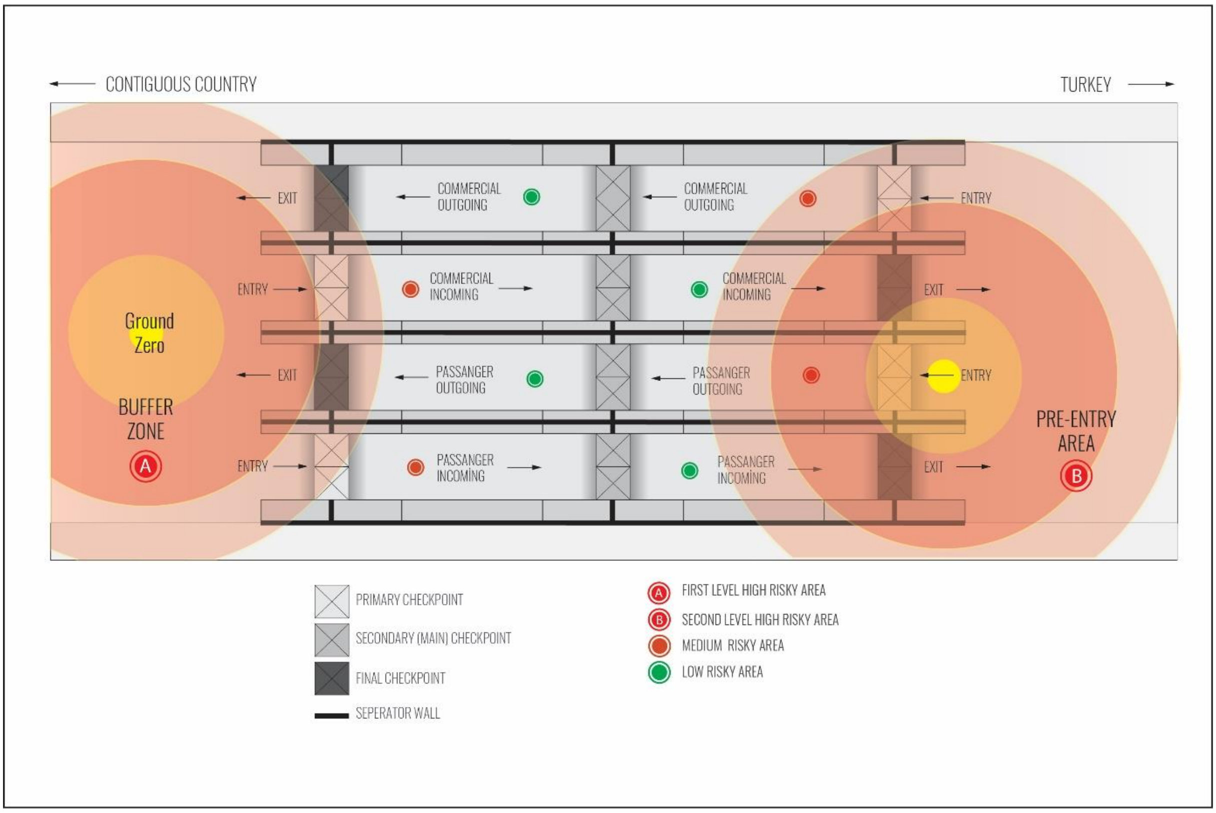


Figure 4.3 Risky areas at land ports of entry [GCA]

4.2.1. On-site roadways arrangement models

The on-site roadways arethe name given to the route a vehicle follows in the port of entry area from the first checkpoint to the final checkpoint. The spatial characteristics of on-site roadways vary depending on the type of transition (incoming commercial, outbound commercial, arriving passenger, outgoing passenger). For example, the right to use tax-free fuel stations within the port of entry area belongs only to outbound commercial vehicles. Therefore, tax-free fuel stations are located on the on-site roadway for the commercial vehicles driving and between the main checkpoint and the final checkpoint. In addition, the crossing procedures and speed of a commercial vehicle and the crossing procedures and speed of a non-commercial passenger vehicle are different. Moreover, depending on the physical differences of vehicles, the physical structures of the control cabinets at checkpoints also differ. Depending on different process and physical needs, vehicles with different spatial requirements will have negative consequences for the operation of the control mechanism in the site (especially at the ports of entry with intensive use) and for the provision of an effective security environment. At some ports of entry with a relatively lower capacity, such as Esendere and Cildir-Aktas Border Gate in Turkey, two on-site roadways are provided for outbound and inbound vehicles without differentiating as commercial and passenger, due to economic reasons such as the physical structure and number of staff. However, even in these applications, necessary reserve areas should be left by considering a possible capacity increase in the future.


Image 4.2. Kapıkule Border Gate (Left) and Türkgözü Border Gate (Right). Satellite images are taken from Yandex map

It is possible for different on-site roadways to be arranged in different ways within the port of entry site. When designing a land port of entry, the first decision to be made is how many different on-site roadways will be in port of entry site and how these roadways will be arranged. This is a decision that will directly affect the overall physical structure and operation procedures of the whole port of entry area and change the position and form of all physical elements within the site. For example, if the arrangement pattern that you have decided requires that the inbound commercial on-site roadways to be placed in the middle of the site and between the other roadways (as in the Kapıkule Border Gate), the veterinary border inspection point and the parking area that should be located on this roadway will also be located in the middle of the site and therefore between the other roadways. The presence of such a large area in the middle of the port of entry will have negative consequences both for security and for the fluidity in the site, as well as for the future capacity increase. As a matter of fact, in Kapikule Border Gate, due to the increasing capacity for the veterinary border inspection point, this problem has been tried to be solved by the inclusion of a certain area within the outbound passenger on-site roadway into the on-site roadway for inbound commercial vehicles. As can be seen from the example, on-site roadway arrangement models are important decisions that have the potential to directly affect the entire operation within the site. In this study, 6 different models were formed under two basic categories related to on-site roadway arrangements, (Figure 4.5) and each model is evaluated in terms of security, provision of an effective inspection environment and facilitation of operational processes.

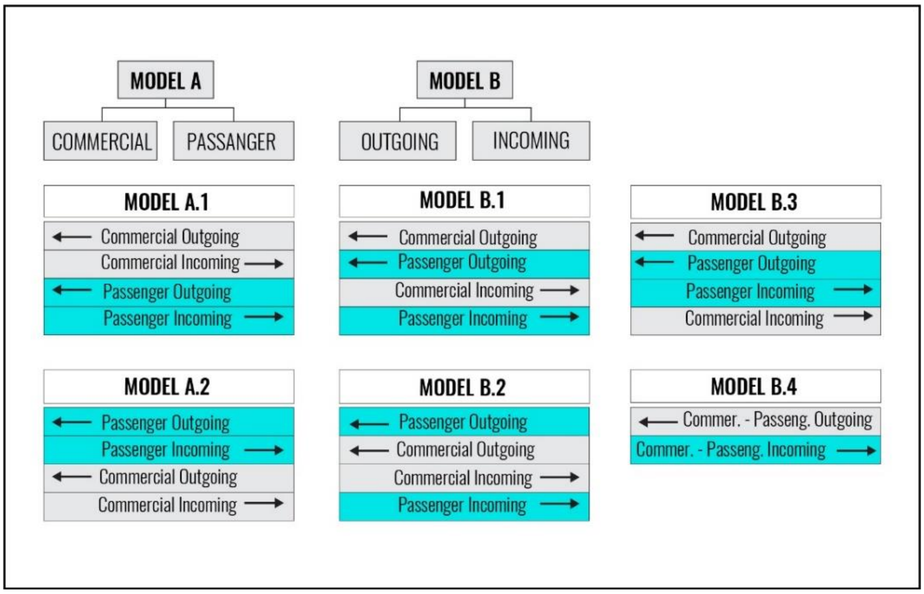


Figure 4.4 On-site roadway arrangement models [GCA]

Arrangement models are grouped under two main categories: Model A and Model B. While commercial and passanger on-site roadways are adjacent in Model A, the outbound and inbound on-site roadway are positioned adjacent to each other in Model B. Both categories have advantages and disadvantages. The Model A, in which the outbound-inbound commercial roadways are positioned adjacent to each other and outbound-inbound passenger roadways are adjacent to each other, is more suitable for the effective operation of control and inspection mechanisms. The customs office buildings located at the ports of entry are usually located on the roadway in the middle of the site so that they can control the whole site. In some high-capacity ports of entry (e.g. Kapikule Border Gate), since the number of crossings, and therefore the number of transactions is high, these offices can serve in two different buildings as the customs office for passengers and the customs office for trucks. In such a case, the customs office for passengers is responsible for the crossings through outbound and inbound passenger on-site roadways, while the customs office for trucks is responsible for the crossings through outbound and inbound commercial on-site roadways. Therefore, it is the best option to position them on the intermediate roadway between these two on-site roadways so that they can control both of the on-site roadways they are responsible for. While this is possible in systems where commercial and passenger crossings are located adjacent to each other in Model A, there will be difficulties in providing an effective control and security environment since the roadways will be far from each other at least in one of the commercial and passenger categories.

An owner of a vehicle passing through an on-site roadway should be able to handle all of his / her procedures on the roadway and without passing to other roadways unchecked. Model A is suitable in this respect. However, due to the flow direction of the traffic, the arrangement models in Model B may be more functional for authorized persons. Roads to the ports of entry are most probably divided into two lanes as inbound and outbound. Model B provides a great convenience to take traffic flowing in this way into the port of entry. However, in Model A, it will be necessary to utilize methods such as signalized junction, overpass and underpass to make the incoming traffic compatible with each other within the port of entry site. This will require more cost and more complex organization. In the context of the provision of an effective on-site inspection and security environment, Model A provides a more cost-effective and easier solution compared to Model B, where the traffic flow is aligned within and outside the port of entry site. Finally, since the number of crossings and transactions at the low-capacity border gates will be low, a separate on-site roadway for each type of crossing may not be seen as an optimal decision considering the results of the risk-cost analysis. In such a case, the inbound and outbound vehicle crossings may be provided on two separate on-site roadways, as in Model B.4, regardless of whether they are passenger or commercial. However, even in this system, it would be safe to separate these two roadways from each other with explosion-proof walls. In addition, it is necessary to leave the necessary reserve areas for a possible capacity increase in the future.

Another important issue with the on-site roadways is that uncontrolled crossings between different roadways within the site are allowed. In order to prevent different type of pedestrians and vehicle crossings to the other on-site roadways, obstacles must be placed between the roadways in the site (walls, guard rails, etc.). However, appropriate vehicle / pedestrian crossing areas should be established for supervised access and staff access. According to the result of the risk assessment of the port of entry site, the separating structures between on-site roadways can be made of materials that are heavier and more resistant to explosion pressure than light iron structures. This is because the function of these separating structures is to prevent uncontrolled crossings between the on-site roadways, as well as to narrow the impact area of the explosion by blocking the explosion pressure in a potential bomb attack on any roadway and to limit the reach of the primary and secondary particles due to the explosion pressure. On-site roadways are risky areas because they are the route of all the crossing vehicles. The necessary standoff distance between parking areas and buildings should be provided.

4.2.2. Pre-entrance area and buffer zone

Pre-entry areas and buffer zones are the areas of accumulation at the ports of entry and therefore have the highest risk. Regulating the traffic in this area, controlling the traffic flow rate and direction, arranging the position of the parking areas, the locations and forms of the entry and exit points of these areas, in short, the location, form and physical relations of all physical elements of the pre-entry area and buffer zone are of vital importance to reduce the loss of life and property in the event of a bomb attack.

An important issue for the organization of pre-entry areas and buffer zones is the arrangement of on-site roadways. Differentiation in the number of on-site roadways and arrangement models will lead to differences in the physical structure of the pre-entry area and the buffer zone. For example, at a low-capacity port of entry, there will be two on-site roadways, most likely for outbound and inbound, without commercial-passenger separation. In such a case, as the road after the checkpoints at the entrance and exit of the port will be divided into two lanes as inbound and outbound, parking areas for vehicles passing through relevant roadways can easily be located on the outer side of the roadways. ImageHowever, in a high-capacity port of entry with four different on-site roadways, (Image 4.4) the control of the traffic in the pre-entry area and the buffer zone, and the secure positioning of vehicle parking areas in appropriate locations will require a more complex planning process. In the case of a port of entry with four different on-site roadways as given in the example below, a suitable parking area should be established for the each type of crossings in the pre-entry area. The need for these parking areas is not uniformly distributed throughout the year, and the required capacity varies depending on the decrease in the intensity of the crossing at the ports of entry in various time periods. When deciding on the capacity of the parking areas, the period with the highest density should be taken. The design of these areas can be flexible to be used for different needs when the density is low.

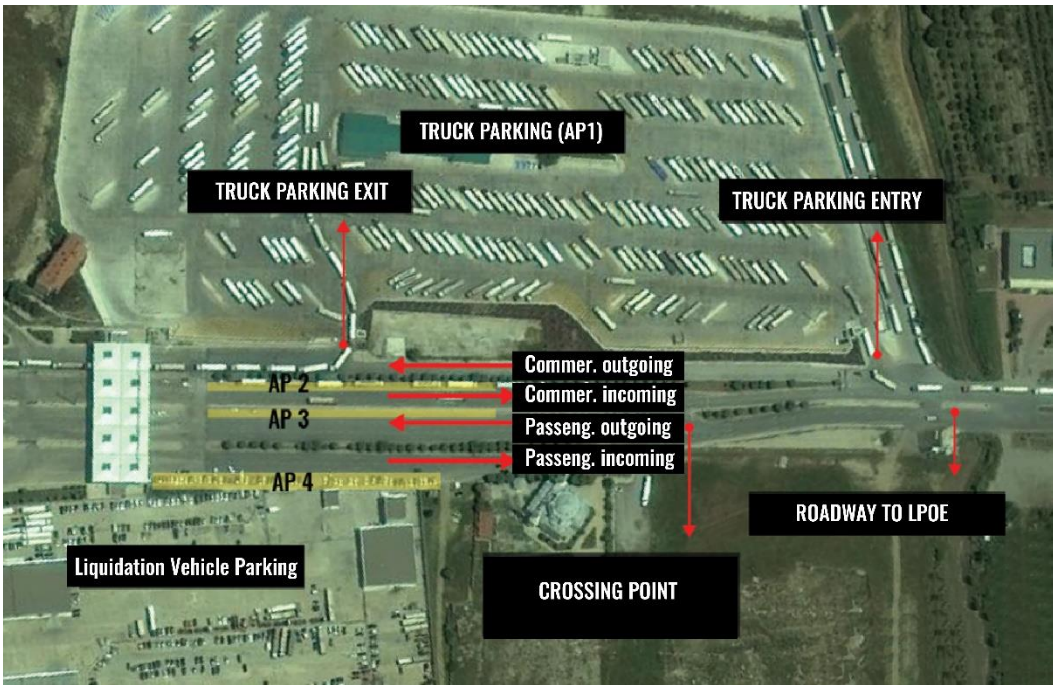


Image 4.3. Kapıkule Border Gate pre-entrance area and truck parking. Satellite images are taken from Yandex map

Four different parking areas should be planned in the pre-entry area of a port of entry with four on-site roadways. These are; AP1 (See. Image 4.4) parking areas for outbound commercial vehicles (truck parking areas has been created at Kapıkule and Hamzabeyli Border Gates in Turkey for this kind of crossings) [29]), AP 2 parking areas for inbound commercial vehicles, AP 3 parking areas for outbound passenger vehicles, and finally AP 4 parking areas for inbound passenger vehicles. Among all these parking areas, the critical ones AP 1 and AP 3 in terms of security. Since the vehicles parking AP 2 and AP 4 areas pass through the border gate, necessary security controls will be made. These parking areas can be located close to the checkpoints, other buildings, and physical components in the pre-entry area. However, since AP 1 and AP3 are the parking areas for vehicles that have not yet passed a control stage, it is undesirable in terms of security to locate them close to the checkpoints, buildings, and other parking areas without adequate standoff distance and security walls.

The four on-site roadways arrangement model in the above-mentioned Kapikule Border Gate corresponds to Model A.1 of the on-site roadways arrangement models presented in the previous part of the study. In this model, inbound and outbound passenger vehicles intersect at the pre-entry area specified in Image 4.4. Similarly, in all A models, there will be such intersections in pre-entry areas and buffer zones (if the roadways are not synchronized with the other port of entry). These intersections may be a major problem in terms of traffic control and flow in busy periods, but that can be solved by using methods such as building overpass and underpass for vehicles (this is not usually preferred due to high costs) and signalized intersections. Since the on-site roadways are arranged as inbound and outbound not as commercial and passenger, B models are compatible with the existing routes to the port of entry and do not pose such intersection problems in pre-entry areas.

At most of the ports of entry, the criminal record of the license plates is checked at the first checkpoint. However, a vehicle license plate recognition system located on the road leading to the port of entry makes the criminal record checks of the vehicles before they reach the port of entry and allows the operational elements to have time to intervene when necessary.

4.2.3. Checkpoints

Checkpoints are the areas where basic control processes of vehicles and passengers are carried out. Information on inspections at checkpoints is given in previous parts of the study. Another important issue regarding the physical structures of checkpoints is their location. While there are separate first and final checkpoints for all the on-site roadways at the port of entry site, these checkpoints are located side by side along in the majority of ports of entry in Turkey Within the scope of the study, three different models are presented for the positioning of the first and final checkpoints used at the entry and exit of the port of entry site; Single canopy system, two-canopy system and four-canopy system (Figure 4.6).

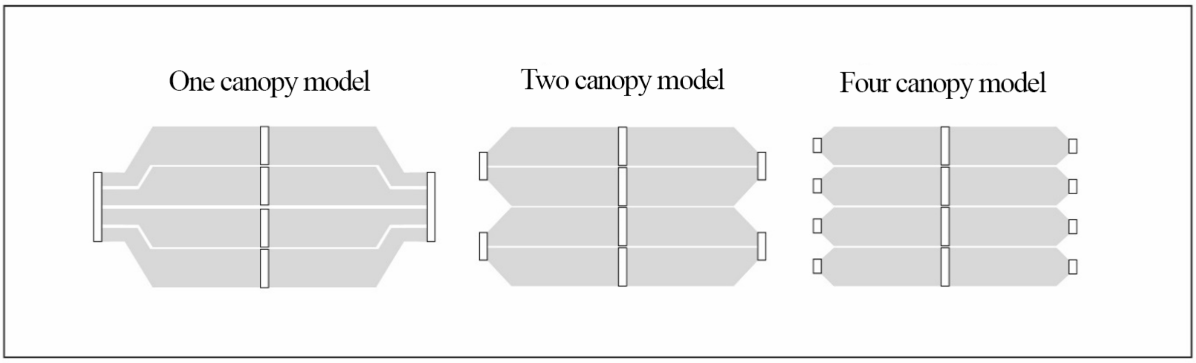


Figure 4.5 Checkpoints layout models [GCA]

In the single canopy system, all the points of entry and exit in the same direction of the border are positioned under a single canopy, side by side. In the two-canopy system, commercial entry and exit points are located under separate canopies and at a certain distance from each other. Finally, in the four-canopy system, the points of entry and exit of all on-site roadways are positioned under separate canopies and again at a certain distance from each other. Image 4.7 and Image 4.8 present examples of two-canopy and singe-canopy system.

As the checkpoints approach each other, a stronger visual communication is achieved between the staff and this is an important issue at a port of entry. Moreover, close checkpoints can be considered as a more economical method considering the number of high-cost technological devices to be used and the number of personnel to work in busy periods. However, in the single canopy system, density at the site will increase in these areas as the point of entry and exit of all crossings will be made at the same location. Therefore, the loss of life and property caused by a potential explosion will increase accordingly. For systems under separate canopies and at a distance from each other, the damage resulting from the explosion effect is minimized and the density at the points of entry and exit will be minimized. Moreover, if any control point is disabled after the attack, these systems allow to continue the critical functions of the site through other checkpoints. The bombing attack at Hatay Cilvegozu Border Gate in Turkey, where 18 people were killed 24 people were seriously injured, took place in a very close distance to checkpoints, and all the checkpoints suffered heavy damage (Picture 4.6) [38].

Image 4.4. Checkpoints at Cilvegozu Border Gate after the attack and the top layer that exhibited secondary particle behavior [38]

If the control points are positioned at a distance from one another, as the separation of vehicles has to take place at a certain distance from the port of entry, it is much more convenient in terms of security. However, architectural security arrangements often do not comply with economic solutions. As a result of the threat and risk analysis, the single-canopy system may be found to be more advantageous for the ports of entry that do not have high security requirements and have relatively low usage density. The risk to be taken is a decision which should be given by the authorized persons together with the expert opinions.

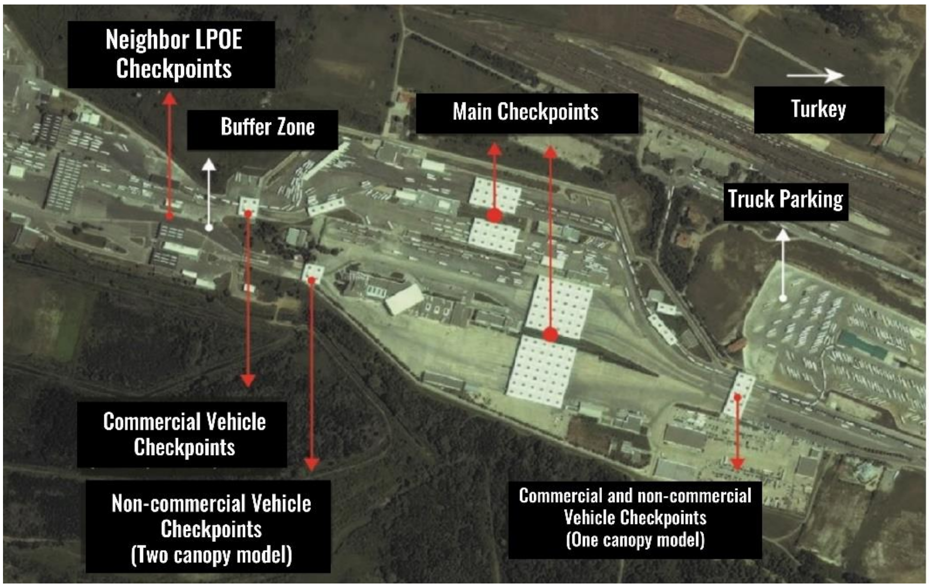


Image 4.5. Kapıkule Border Gate on Bulgarian border. Satellite images are taken from Yandex map

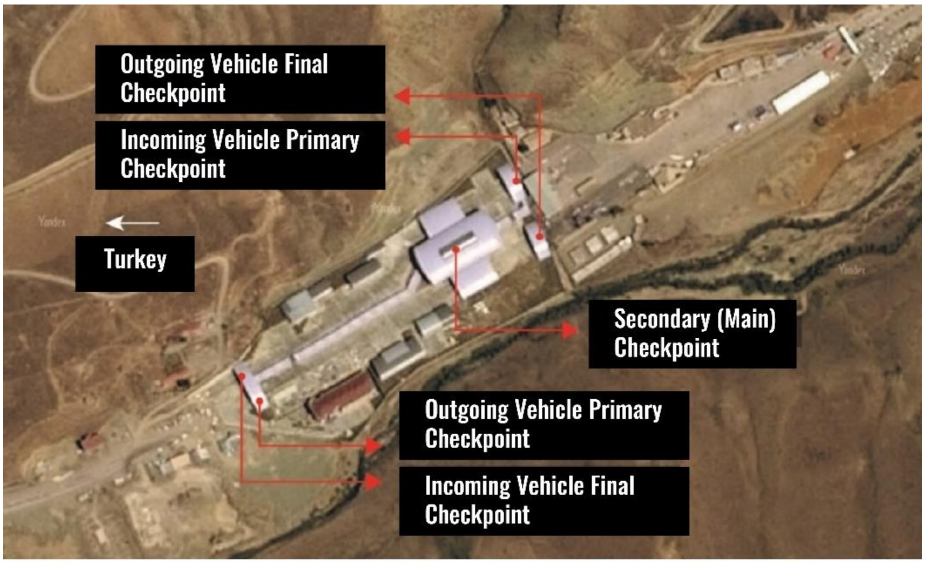


Image 4.6. Esendere Land Port of Entry on Iran Border. Satellite images are taken from Yandex map

The canopies, which are located at the checkpoints and used as a cover element for the control buildings, should be made of durable materials with mounting rigidity. If possible, they should not be coated with materials prone to show the secondary particle effect, and exposed concrete structures should be preferred in high-risk areas. Otherwise, canopy covers may exhibit secondary particle behavior depending on the explosion pressure in a potential bomb attack and may scatter around uncontrolledly, causing loss of life and damage. Image 4.9 shows the control cabins damaged by the attack at Cilvegozu Border Gate.

Image 4.7. Control cabins after the attack at Cilvegözü Border Gate [39]

Control cabins should support the visual contact with the approaching vehicle and should be designed to allow wide-angle visual interaction. The glass to be used should be multilayer laminated glass resistant to explosion loads. If the resistance of the glass against explosion loads is higher than that of the joinery, it may be thrown out of the wall where the whole joinery is connected with the effect of explosion, into the control cabin. Therefore, the strength of the glass and joinery at the checkpoints should be considered together. Furthermore, the angularity in the external form of the control buildings should be avoided and the curved forms that facilitate the dispersion of the explosion pressure should be preferred. The outer surface of the control cabin should not be covered with heavy materials which may exhibit secondary particle effect with the effect of an explosion. Finally, aperture areas should be designed in a suitable area to provide pressure relief to prevent the pressure from being reflected by the walls and rising in the event of an explosion.

All checkpoints (control cabins and canopies), especially the first and final checkpoints out of the site, should be structurally reinforced against a potential explosion. If the reinforcement works can be done partially due to economic reasons, the checkpoints in the direction of the opposite port of entry or the buffer zone should be prioritized. As a matter of fact, the explosions at both the Cilvegözü and Çobanbey Border Gates took place in the buffer zone, and the checkpoints of the Cilvegözü Border Gate were heavily damaged (See. Image 4.9).

The load-bearing columns should not be positioned in the front of the control cabin and in the open in a way that they limit the visual interaction of the staff. They should be hidden and positioned as far away as possible in the opposite direction to the vehicle's approach to the control cabins. Pressure waves lose significant power even at very short distances. It is therefore necessary to prevent the load-bearing elements from being uncovered and to provide the highest possible standoff distance between high-risk points to avoid the collision of columns, the first desired to be protected in the case of an explosion. In cases where the load-bearing columns should be positioned close to the open and risky points, the part of the column close to the floor should be covered with at least 15-20 cm thick protective material which will increase the resistance against pressure [10].

4.2.4. Buildings and on-site placements

The buildings to be located within the border crossing area is directly related to the capacity and location of the port of entry. At some of the large-capacity ports of entry, there are separate customs offices for commercial and passenger crossings, while in most of them there is only one customs office. Some ports of entry have rooms for VIP meetings because of their location, while others do not. In general, a duty-free shopping center and social areas, which vary in size, are located at most ports of entry. In addition, ports of entry with a large capacity have Customs Enforcement Directorates, while they are located in provincial or district centers at those with smaller capacity. Buildings for settlement and contraband storages, operator company buildings, technical areas, emergency service buildings, the veterinary border inspection building and X-ray building, and searching hangars are among other buildings that are likely to be included in the site.

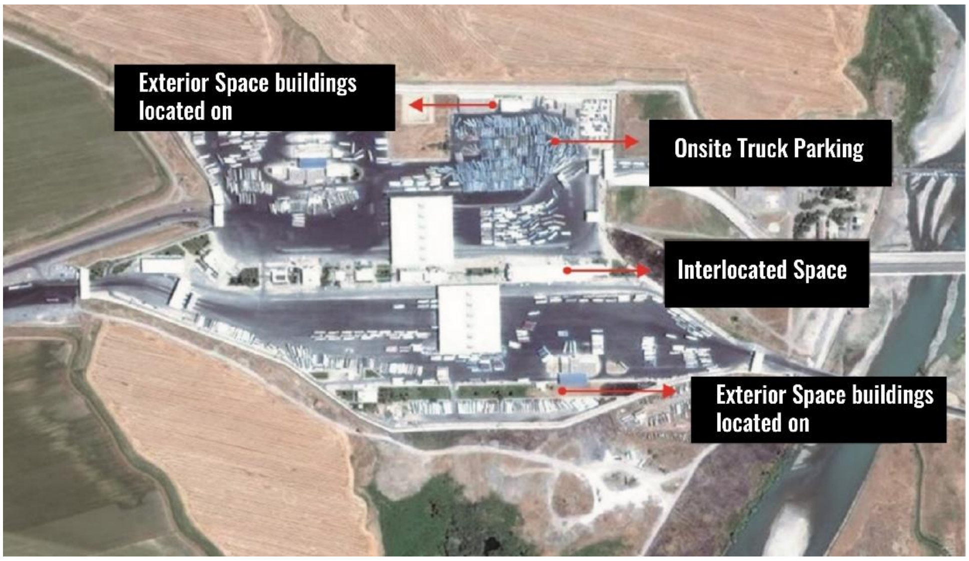


Image 4.8. Habur Border Gate at the border of Turkey with Iraq. Satellite images are taken from Yandex map

Ideally, only the structures related to crossing procedures should be included in the port of entry and the other structures should be located in another area connected to the site. Customs Directorates etc. structures, which are subject to administrative duty, are open to non-personnel access at the ports of entry. Some transactions related to the process both in commercial and passenger crossings are performed in these directorates. Therefore, free movement of pedestrians within the port of entry area is allowed. This problem can be solved by creating special sites close to checkpoints for the necessary transactions. In this way, pedestrians can complete the procedures in an area near the point where they enter the site, without having to walk long distances among the vehicles. The on-site positioning of duty-free shopping centers remains a significant problem about the processes. A passenger or commercial vehicle user must have undergone main control procedures to use the duty-free shopping center. In such a case, if the shopping center is not to be located in separate buildings, it should be positioned between the control points as a possible solution, which may have negative consequences to provide an effective security environment. In addition, an architectural plan design should be created within the same building where customers coming from different on-site roadways cannot pass to other areas. As a result, the buildings within the site should be positioned at a certain distance to the risky areas in a way that they do not to interfere with the process flow.

In the placement of the buildings on intermediate roadways between on-site roadways or on the outer roadways, their narrow facades should be oriented towards the on-site roadways and there should be as few openings as possible on the facades facing the risky areas. There should be buffer areas, such as a corridor, technical room, storage room etc., between the public areas and the areas with high user density and critical functions in the buildings. In addition, power generators and other technical systems of critical importance should be located in different areas with sufficient standoff distance (at least 15 meters). All the windows on the first two floors of the building facades facing roads or parking areas must be explosion-proof. In these windows, multi-layer laminated annealed glasses produced in accordance with the relevant standards [40] and reinforced joinery, explosion-resistance of which should not be lower than that of windows, with reinforced connection with walls should be used. Even if all these measures are taken, the distance between the facades of the buildings and the vehicle roads and parking areas should be at least 75 meters (See. Table 3.2). This distance is considered to be 200 meters (if high risk factor is present) on the routes of commercial vehicles. (See. Table 3.2). If the width of the site is suitable to provide sufficient standoff distance and if the building windows and doors are not suitable for explosion loads, a minimum distance of 150 meters should be left between the building and the risky areas (See. Table 3.2). Another important area in the site is the detector dog houses. Detector dog houses and pentathlons are normally located near the search hangars. However, for times when security measures need to be increased, it is necessary to establish suitable areas near the first and main checkpoints to allow these dogs to rest.

4.2.5. Parking lots

Parking areas located outside the site have high risk because they are open to public access. Parking areas in the site can be considered more secure as the vehicles are inspected at the checkpoints. However, the positioning of these areas within the site is extremely important. As a matter of fact, when the car that exploded on August 18, 2016 at the bomb attack against Elâzığ Police Department where 4 police officers were martyred and 217 people were wounded, [41] it was in the parking area of the police headquarters. Although passive security arrangements and active security measures have been taken intensively at checkpoints and site boundaries, a weakness of operational elements may cause bomb-loaded vehicles to enter the parking area in the site. Therefore, passive security arrangements in parking areas are of great importance.

In the context of security arrangements, the basic criterion for parking areas is their on-site positioning and physical relationships with the surrounding buildings / areas. The application of standoff distance is the most critical measure against the explosion effect in bombing attacks. Explosion loads lose considerable power at very short distances. For this reason, sufficient standoff distance between high-risk areas and other areas with high user density will have critical consequences in terms of reducing life and property loss. Within the port of entry site, after the commercial and passenger vehicles pass the main control point, people usually park their vehicles in close proximity to the relevant areas in the site to take advantage of the social places within the site and to shop from the duty-free shopping mall. In addition, there is a space where commercial vehicles are parked for detailed control of goods in the commercial area and a veterinary border inspection parking space for vehicles carrying goods related to veterinary to park. Parking areas in and around the land port of entry site are given in Figure 4.3 taxonomically.

Image 4.9. Damage caused by the explosion that took place in the parking area of Elâzığ Police Department [42]

Parking areas should be positioned so that they maintain the necessary standoff distance with checkpoints and buildings. Personnel parking areas, guest parking areas and border-crossing vehicle parking areas should be separated from each other. In addition, parking areas should not be positioned so that they are directly facing the buildings, and they should not be on or under the building except for the compulsory cases. Due to the reflected pressure effect, no parking area should be located between the two buildings and necessary surveillance and adequate lighting systems should be installed in parking areas. Vehicle and pedestrian circulation areas should be separated in parking areas.

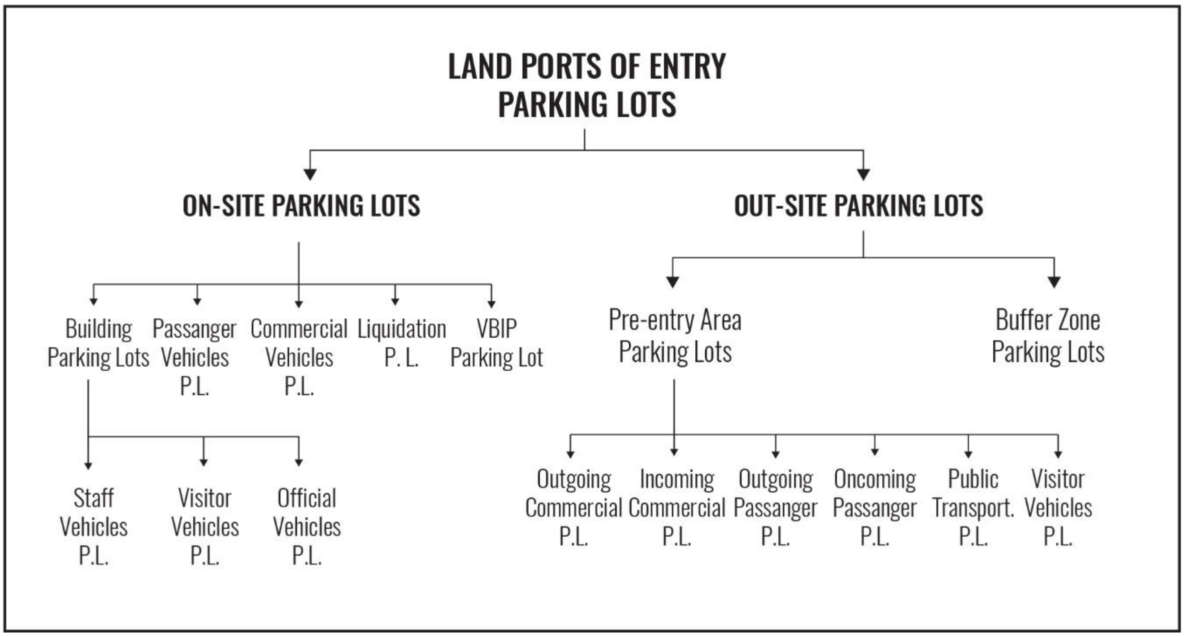


Figure 4.6. Land port of entry parking lots classification [GCA]

The parking areas in buffer zones outside the site have the highest risk factor among all the parking areas. In these areas, vehicles from the opposite country are parked in an uncontrolled manner. The standoff distance between parking areas, particularly for those located in the buffer zones of the ports of entry with high security requirements, and the checkpoints, which are the closest part of the port of entry to this area, should be at least 75 meters for passenger vehicles and at least 200 meters for commercial vehicles. These figures apply when the control cabins and top covers in checkpoints are explosion-proof. It is a necessity for all checkpoints in all ports of entry to be resistant to explosion loads. However, it is especially important for control cabins located in the eastern and southeastern ports of entry in Turkey, and especially for those facing the buffer zone, and their top covers to be explosion-proof.

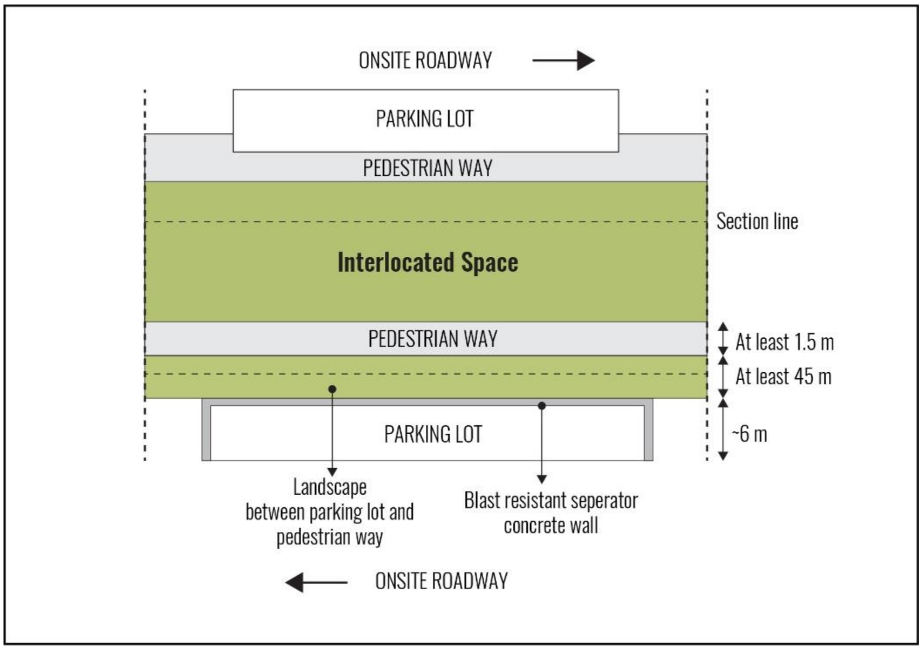


Figure 4.7. Positioning of parking areas in the site [GCA]

Figure 4.4. shows the parking areas on the on-site roadways for commercial and passenger vehicles within the port of entry area on an intersection of the roadway. There are areas where the vehicles crossing the border can park on the right and left sides of the on-site roadways. Especially those located before the main checkpoint are in the medium risk area because the vehicles have not yet passed through detailed controls (See. Figure 4.5). A minimum standoff distance of 45 m should be provided (See. Table 3.1) between the parking areas and pedestrian roads. Within this distance, natural barriers can be established with landscape elements. Figure 4.4 shows a security arrangement model.

4.2.6. Veterinary border inspection point, tax-free gas station and pedestrian corridor

Veterinary border inspection points are located within the port of entry site and are assigned to perform quality and health checks of all livestock, all animal products including animal by-products, and some crops like straw, which are at risk of transmitting disease, that will enter the country through the port of entry [43]. These areas have to be connected to the commercial on-site roadways within the site since they are responsible for the control of -generally commercial-goods. In addition, the control processes of the vehicles that will pass through the veterinary border inspection point, such as sampling, laboratory tests and so on., may last longer than others for reasons related to procedures. This necessitates the creation of suitable parking spaces for commercial vehicles waiting on the VBIP within the site and physically connected the on-site roadway. As international logistics networks and ports of entry on these networks have been identified, the ports of entry with dense commercial crossings subject to the VBIP have been identified. Therefore, there is no need for customized sites for VBIP at all ports of entry.

The location where the VBIP is located within the site may vary depending on the chosen on-site roadway model, but it should always be positioned on the inbound commercial on-site roadway (on the inbound on-site roadway at the ports of entry with two roadways) and before the main checkpoint. Ideally, the VBIP should be located on one of the exterior facades of the port of entry site due to the need for parking space. This is possible at ports of entry with two on-site roadways and at those with four on-site roadways where the commercial on-site roadway is located at the exterior side of the site. Due to the fact that the VBIP will be located in the middle of the site at the ports of entry that use other on-site roadway arrangement models, sufficient width should be left between on-site roadways considering both the required parking space and a possible capacity increase in the future.

The office buildings and laboratories in the VBIP (if any) should be located at a sufficient standoff distance from the VBIP parking area and the on-site roadway. Doors, windows, exits, decorative elements etc. architectural elements should not be present on the facades of the buildings facing these two areas. As these buildings are generally low-rise, they are exposed to high explosion pressure from the top as well as from the sides in the case of an attack. Therefore, the using flat roof in these buildings is not appropriate in the context of security. A construction technique with high structural strength and the materials which will not exhibit the secondary particle effect in the event of an explosion should be preferred for the roofs.

A tax-free fuel station system is established to support exports and the right to buy fuel from these places belongs to commercial vehicles only. Therefore, it should be positioned in a physical relationship with the on-site roadways for commercial vehicles. It is very unlikely that an explosion in this area will be caused by an outbound commercial vehicle, since it is available to vehicles that have passed through the security checks at the first and main checkpoints. Hence, the main criterion is that tax-free fuel stations in port of entry site should be located away from other on-site roadways and parking areas. Thus, Model A.2 and Model B.2 are not suitable in terms of security due to the fact that the outbound commercial on-site roadways are located in the middle of the site.

Image 4.10. Kapıkule Border Gate tax-free gas station. Satellite images are taken from Yandex map

A large number of outbound commercial vehicles want to benefit from tax-free fuel stations, so there will be long vehicle queues in this area. This situation poses a problem in terms of controlling the intra-site traffic flow and ensuring an effective inspection environment. Therefore, it is more appropriate to plan the tax-free fuel stations as a separate area associated with the exterior side of the port of entry site and by providing adequate standoff distance between the x-ray buildings and searching sheds where the outbound commercial vehicles pass through security checks in terms of security and to facilitate in-site organization.

Crossings through ports of entry can be basically classified under four titles. These are commercial vehicle crossings, non-commercial vehicle crossings, bus crossings and pedestrian crossings. Each one of these types of crossings requires specialized areas within the port of entry site. However, not all of these crossings are allowed at every border gate. For example, while pedestrian crossings are not allowed at Kapıkule Border Gate, there are closed pedestrian corridors specialized for this type of crossing at Sarp and Esendere Border Gates. (Figure 4.1).

Pedestrian corridors can be arranged in different ways depending on the crossing density and climate conditions. The boundaries of the corridors can be open areas defined by methods such as metal railing, metal handrails or strip barriers, or they can be constructed as closed areas where lighting, ventilation, and belt conveyors are included. The image below shows the closed pedestrian corridor at Sarp Border Gate site, the most preferred port of entry for pedestrian crossings in Turkey with 7 million crossings per year [1], which was put into service in 2019 after the modernization of works.

Image 4.11. An example of closed pedestrian corridor at Sarp Border Gate [1]

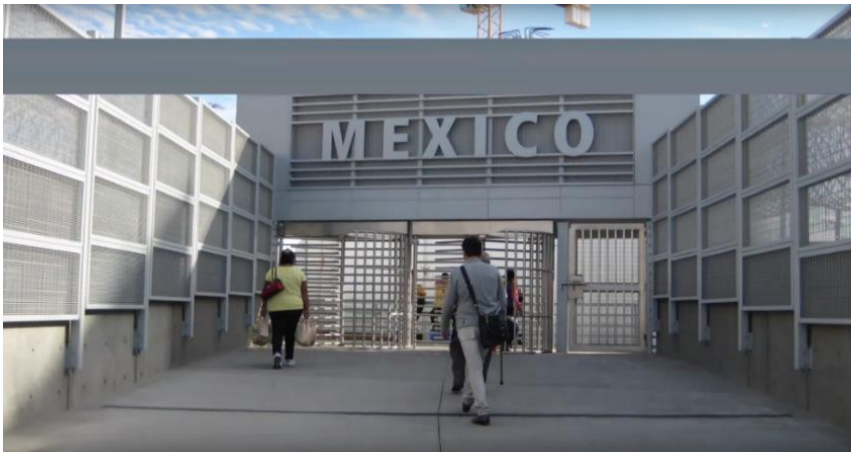


Image 4.12. An example of open pedestrian corridor at US-Mexico border Otay Mesa Border Gate [44]

At the entrance to the pedestrian corridors, the person to pass and his/her belongings they are subjected to security checks. The person goes along the corridor to reach the passenger lounge, which is located in the middle of the port of entry site. There, he/she passes through the paper check. There should be waiting areas and facilities in the passenger lounge for the people going through inspection. Duty-free shopping areas where people can shop are also located here. The person whose paper check is completed leaves the pedestrian corridor in the direction of the country he/she is going. An important point here is that people who have completed paper checks are not allowed to go back from the same checkpoint without permission. Inbound and outbound pedestrian corridors should be separated. Uncontrolled transitions between different areas within the corridor should not be allowed. At the ports of entry with a high pedestrian crossing density, a belt conveyor may be provided to facilitate the crossing of passengers. There should also be rest benches in the corridor in certain intervals.

Image 4.13. Closed pedestrian corridor at Esendere Border Gate [29]

Emergency evacuation points should be placed on both sides of the corridor for an attack or emergency situation during the crossing, which will allow both the intervention teams to reach the corridor and rapid evacuation. (Figure 4.7). In addition, a vehicle crossing should be established to allow the vehicles on both sides of the corridor to pass through. (Figure 4.13). A sufficient standoff distance should be provided between the pedestrian corridors and on-site vehicle roadways and the parking areas on these roadways against a possible explosion. If the pedestrian corridors are planned as a closed corridor, they should be transparent so that their side surfaces receive daylight, but also resistant enough to prevent the secondary particle effect against explosion loads. In an explosion, most of the injuries are caused by objects that exhibit secondary particle effect scattering around with the effect of the explosion. In a building that extends across the port of entry site where large glass surfaces such as pedestrian corridors are present, it is critical for the glass to be explosion proof to reduce the loss of life losses that may occur as a result of an explosion.

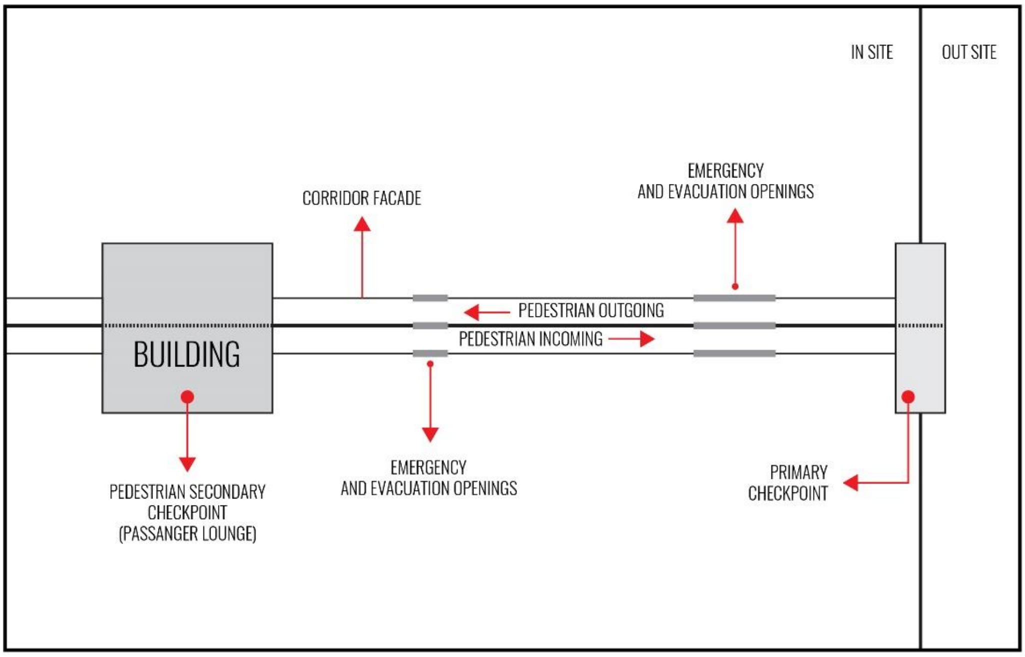


Figure 4.8. Schematic representation of the pedestrian corridor [GCA]

4.2.7. Emergency response and evacuation arrangements

One of the objectives of the architectural passive security arrangements is to provide emergency evacuation after the attack and appropriate physical conditions for the emergency response teams to intervene to the scene in the easiest way. In an explosion at the port of entry, the first intervention is made by the emergency response officials who are in the port of entry, and then the teams coming from the nearby settlements take the necessary steps to evacuate the scene, extinguish a possible fire and transport the wounded to the hospital. It is of utmost importance that the port of entry site is well organized and that security teams can easily access the site from the inside or outside the site. For such cases, there should be controlled vehicle and pedestrian crossing points between the different roadways within the port of entry site. In addition, an emergency response road should be established around the site to ensure fast access between the remote parts of the site. Emergency intervention can be places between on-site roadways if sufficient space is available. In this way, it is possible to reach to every point of the site quickly and the standoff distance among the on-site roadways is increased. Finally, a rapid access platform with sufficient width should be located at the checkpoints where emergency response teams can quickly enter and exit the port of entry site.

Table 4.4. APSA checklist against bomb attacks at land port of entry

HEADINGS	APSA	APPROVAL
General Decisions		
Capacity	. Is the border gate capacity specified?	
	. Are there any considerations in the design for possible capacity changes in the future?	
Security level	. Is the security level required at the border gate specified?	
Crossing types	. Is the crossing types that are permitted at the border gate specified?	
	. Are there specalized areas within the site specified for different types of crossings?	
Counterpart gate	. Is the border gate physically compatible with the opposing border gate?	
	. Is there procedural cooperation and compability with the opposing border gate?	
Topography	. Is the border gate located on the appropriate topography?	
Nearby border gates	. Is there another border gate of the same or different type near the border gate?	
	. Is the physical relationship with the nearby border gate planned correctly?	
On-site Roadways Sorting Models		
Onsite roadways sorting models	. Is the selected onsite roadway sorting model suitable for the capacity and security needs of the border gate?	
	. Are the appropriate solutions provided for the disadvantages of the selected model?	
Seperator walls	. Are the onsite roadways separated by separator walls with appropriate physical properties?	
Crossing control	. Are there controlled vehicle and pedestrian passages between the onsite roadways?	
	. Are all transitions between the onsite roadways controlled?	
	. Are all roadways in the areas before and after the main control point located roadways controlled?	
Interlocated spaces	. Are there approppriately wide interlocated spaces between onsite roadways?	
Standoff distance	. Are the stand-off distances between onsite roadways and the interlocated spaces and parking spaces adequate?	

Table 4.4. (continued) APSA checklist against bomb attacks at land port of entry

HEADINGS	APSA	APPROVAL
Pre-Entrance Area, Semi-trailer Truck Parking Space and Buffer Zone		
Onsite roadways sorting models	. Are the arrangements in the pre-entrance area compatible with the onsite roadway sorting model?	
	. Is there any suggestions for the traffic problems caused by the chosen onsite roadway sorting model?	
Checkpoint layout model	. Is the pre-entrance area compatible with the checkpoint layout model?	
Parking lots	. Are there semi-trailer truck parking spots in the pre-entrance area? And are the necessary precautions taken fort hem?	
	. Are there parking areas for every type of crossing in the pre-entrance area?	
	. Are there adequate standoff distances between pre-entrance parking areas and checkpoints?	
	. Are there any dedicated spaces for mass transit in pre-entrance area?	
Pedestrian area	. Are there a waiting area for pedestrians in pre-entrance area?	
Buffer zone	. Are there sufficient buffer zone between the border gate and its counterpart at the other side of the border?	
	. Are there parking areas in the buffer zone? If so, are there adequate standoff distances between them and checkpoints?	
Emergency Response and Discharge Arrangements		
Emergency response area	. Are there any emergency response areas within the site? Do they have the required equipments?	
Quick access	. Are there security roads connecting different areas of the site?	
	. Are there controlled crossing points for vehicles and pedestrians between on-site roadways?	
Emergency crossing platforms	. Are there emergency crossing platforms with appropriate physical conditions in checkpoints?	
Emergency scenarios	. Are there emergency respond and evacuation scenarios for emergencies like explosion, fire etc. at different points of the site?	

Table 4.4. (continued) APSA checklist against bomb attacks at land port of entry

HEADINGS	APSA	APPROVAL
Checkpoints		
Checkpoints layout model	. Is the selected checkpoint layout model suitable for the capacity and security needs of the border gate?	
Control cabin	. Are there control cabins suitable for each type of crossing?	
	. Do the control cabins have the appropriate architectural structural for explosive impacts?	
	. Are there sufficient visual interaction for the control cabin personnel?	
	. Are the glass surfaces in the control panel strengthened against explosive impacts?	
	. Are the joineries in the control panel strengthened against explosive impacts?	
	. Are the structural units of the control cabins suitably positioned against explosive impacts?	
	. Is the connections between joineries and the walls strengthened against explosive impacts?	
	. Are the materials of the exterior wall coverings of the control cabins suitable for not acting like secondary fragmentation in case of an explosion?	
	. Are there security barriers in front of checkpoints, preventing direct collisions?	
Canopies	. Do the canopies above the checkpoints have suitable structural systems and materials against explosion impacts?	
	. Do the structural units of the canopies suitably positioned against explosive impacts? If not, are they covered with appropriate securty materials?	
Standoff distance	. Are there adequate standoff distances with the checkpoints and the other areas?	
Buildings and Their Layout in the Site		
Building placement	. Are the buildings not directly related with border crossings positioned in areas connected to but outside of the site?	
Standoff distance	. Are there adequate standoff distances between the buildings and roads and parking areas in the site?	
	. Are there adequate standoff distances between the buildings and the checkpoints?	
Vehicle parking areas	. Are the parking areas of the buildings seperated for visitors and personnel?	
Building orientation	. Are the interlocated spaces that the buildings are located have enough width?	
	. Are the buildings facing the high-risk areas with their narrow façades?	
Building architecture	. Are the structural systems, architectural forms, façades, Windows and siding strengths of the buildings near high-risk areas planned suitably against explosion loads?	
	. Are the areas inside the building designed according to the security requirements?	

Table 4.4. (continued) APSA checklist against bomb attacks at land port of entry

HEADINGS	APSA	APPROVAL
Vehicle Parking Areas		
Vehicle parking areas outside the site	. Are there adequate standoff distances according to the vehicle types between parking spaces outside the site and the other areas. If not, are there suitable security measures against an explosion?	
Vehicle parking areas inside the site	. Are there adequate standoff distances according to the vehicle types between parking spaces inside the site and the other areas. If not, are there suitable security measures against an explosion?	
Lighting and surveillance	. Are there sufficient lighting and surveillence in the parking areas?	
Veterinary Border Inspection Point, Tax-free Gas station and Pedestrian Corridor		
Veterinary Border Inspection Point (VBIP)	. Is the veterinary border inspection point located in accordance with the on-site roadway sorting model?	
	. Are there reserved spaces suitable for possible expansions of the veterinary border inspection point?	
	. Are there adequate stand-off distances between the VBIP parking areas and other buildings, roads and parking areas?	
	. Are the buildings in the veterinary border inspection point have suitable physical structures, locations and orientations against an explosion loads?	
Tax-free gas station	. Is the tax-free fuel statio located in accordance with the on-site roadway sorting model?	
	. Are there adequate stand-off distances between the tax-free gas station and other buildings, roads and parking areas?	
Pedestrian corridor	. Are there specialized pedestrian corridors for pedestrian crossings in the site?	
	. Is the corridors planned as open corridors?	
	. Is the corridors planned as closed corridors?	
	. Are there adequate stand-off distances between pedestrian corridors and vehicle roads and parking areas?	
	. Are the incoming and outgoing passenger crossings inside the pedestrian corridors physically seperated? Are the unctrolled transitions between these two areas being prevented?	
	. Are the materials on the side and ceiling surfaces of the pedestrian corridors have blast resistance?	
	. Are there emergency exits in defined intervals on the pedestrian corridors?	
	. Are there suitable openings for vehicle and pedestrian transitions between the on-site roadways. Are there any measures taken to prevent uncontrolled transitions in these areas?	

5. ASSESSMENT OF ARCHITECTURAL PASSIVE SECURITY ARRANGEMENTS AT AN EXAMPLE LAND PORT OF ENTRY

Example land port of entry allows commercial and passenger crossing, while pedestrian passage is not permitted. It has four different on-site roadways, and is an A.1 type model according to the sorting models presented in the study (See Figure 4.4). There are seperator walls between on-site roadways. These are concrete walls with metal barriers on top. In the pre-entrance area there is a semi-trailer parking lot for commercial vehicles. As a negative effect of its onsite roadway sorting model, incoming commercial vehicle road and outcoming passenger vehicle road are crossing each other in the pre-entrance area. Discharge area is too close to the checkpoints at the Turkey direction. Besides, in the pre-entrance area, vehicle parking spaces fort he incoming passenger, outgoing passenger and incoming commercial vehicles does not have the appropiate stand-off distance. It is positioned next to the neighbour land port of entry at the opposite side of the border, resulting in a very limited buffer zone.

While the checkpoints at the Turkey direction are under a single canopy, the checkpoints at other direction are seperate canopies for commercial and passenger transitions. According to the checkpoints layout models presented in the study (See Figure 4.5), while the single canopy system is used at the Turkey direction, two canopy system is used at other direction. All checkpoints are covered with steel construction canopies. The control cabins in at checkpoints have angular forms. There are some design problems, limiting the visual interaction of the personnel in the cabins. Heavy materials have been used at the façades of the control cabins are possible to show secondary fragmentation characteristics in case of an explosion. The glass used in the control cabins have boosted bursting strength and joineries have been strengthened against explosion loads.

At the site of the gate there are two customs office for passengers as commercial transitions and these are located between their relative onsite roadways. Customs enforcement office is located between outgoing passenger and incoming commercial roadways. Also, there are two seperate social buildings in between passenger roadways and commercial roadways. Between the checkpoints on the incoming and outgoing passenger roadways there is a passenger hall for passengers using mass transit. Additionally, there are x-ray buildings and security search hangars behind the main checkpoints in each roadway. There are also contractor company building in site and discharge related buildings and warehouses in an area connected to the site. Lastly, between the two canopies at the Bulgaria direction there is a building where VIP halls are located.

The buildings inside the land port of entry site are positioned on the interlocated spaces between the on-site roadways and on the outer spaces between the site boundaries and roadways. However, width of these interlocated and outer spaces are not sufficient for adequate standoff distances between them and the roadways. Because of them being narrow, parking areas are positioned too close to the related buildings. This issue also restrains the buildings from turning their narrow sides to the risk areas. Since pedestrian crossing is not permitted, there is no specialized pedestrian corridor as in Sarp Border Gate or Esendere Border Gate.

APSA assessment and suggestions

An example land port of entry is assessed with the checklist prepared for land ports of entry and the results are given in the table below:

Table 5.1. Example Land Port of Entry APSA checklist

HEADINGS	APSA	APPROVAL
General Decisions		
Capacity	. Is the border gate capacity specified?	+
	. Are there any considerations in the design for possible capacity changes in the future?	+
Security level	. Is the security level required at the border gate specified?	+
Crossing types	. Is the crossing types that are permitted at the border gate specified?	+
	. Are there specalized areas within the site specified for different types of crossings?	+
Counterpart gate	. Is the border gate physically compatible with the opposing border gate?	+
	. Is there procedural cooperation and compability with the opposing border gate?	+
Topography	. Is the border gate located on the appropriate topography?	+
Nearby border gates	. Is there another border gate of the same or different type near the border gate?	+
	. Is the physical relationship with the nearby border gate planned correctly?	+
On-site Roadways Sorting Models		
Onsite roadways sorting models	. Is the selected onsite roadway sorting model suitable for the capacity and security needs of the border gate?	+
	. Are the appropriate solutions provided for the disadvantages of the selected model?	-
Seperator walls	. Are the onsite roadways separated by separator walls with appropriate physical properties?	+
Crossing control	. Are there controlled vehicle and pedestrian passages between the onsite roadways?	+
	. Are all transitions between the onsite roadways controlled?	-
	. Are all roadways in the areas before and after the main control point located roadways controlled?	-
Interlocated spaces	. Are there approppriately wide interlocated spaces between onsite roadways?	-
Standoff distance	. Are the stand-off distances between onsite roadways and the interlocated spaces and parking spaces adequate?	-

Table 5.1. (continued) Example Land Port of Entry APSA checklist

HEADINGS	APSA	APPROVAL
Pre-Entrance Area, Semi-trailer Truck Parking Space and Buffer Zone		
Onsite roadways sorting models	. Are the arrangements in the pre-entrance area compatible with the onsite roadway sorting model?	+
	. Is there any suggestions for the traffic problems caused by the chosen onsite roadway sorting model?	-
Checkpoint layout model	. Is the pre-entrance area compatible with the checkpoint layout model?	+
Parking lots	. Are there semi-trailer truck parking spots in the pre-entrance area? And are the necessary precautions taken fort hem?	+
	. Are there parking areas for every type of crossing in the pre-entrance area?	-
	. Are there adequate standoff distances between pre-entrance parking areas and checkpoints?	-
	. Are there any dedicated spaces for mass transit in pre-entrance area?	-
Pedestrian area	. Are there a waiting area for pedestrians in pre-entrance area?	-
Buffer zone	. Are there sufficient buffer zone between the border gate and its counterpart at the other side of the border?	-
	. Are there parking areas in the buffer zone? If so, are there adequate standoff distances between them and checkpoints?	-
Emergency Response and Discharge Arrangements		
Emergency response area	. Are there any emergency response areas within the site? Do they have the required equipments?	+
Quick access	. Are there security roads connecting different areas of the site?	+
	. Are there controlled crossing points for vehicles and pedestrians between on-site roadways?	+
Emergency crossing platforms	. Are there emergency crossing platforms with appropriate physical conditions in checkpoints?	+
Emergency scenarios	. Are there emergency respond and evacuation scenarios for emergencies like explosion, fire etc. at different points of the site?	+

Table 5.1. (continued) Example Land Port of Entry APSA checklist

HEADINGS	APSA	APPROVAL
Checkpoints		
Checkpoints layout model	. Is the selected checkpoint layout model suitable for the capacity and security needs of the border gate?	+
Control cabin	. Are there control cabins suitable for each type of crossing?	+
	. Do the control cabins have the appropriate architectural structural for explosive impacts?	-
	. Are there sufficient visual interaction for the control cabin personnel?	-
	. Are the glass surfaces in the control panel strengthened against explosive impacts?	+
	. Are the joineries in the control panel strengthened against explosive impacts?	+
	. Are the structural units of the control cabins suitably positioned against explosive impacts?	+
	. Is the connections between joineries and the walls strengthened against explosive impacts?	+
	. Are the materials of the exterior wall coverings of the control cabins suitable for not acting like secondary fragmentation in case of an explosion?	-
	. Are there security barriers in front of checkpoints, preventing direct collisions?	-
Canopies	. Do the canopies above the checkpoints have suitable structural systems and materials against explosion impacts?	+
	. Do the structural units of the canopies suitably positioned against explosive impacts? If not, are they covered with appropriate securty materials?	-
Standoff distance	. Are there adequate standoff distances with the checkpoints and the other areas?	-
Buildings and Their Layout in the Site		
Building placement	. Are the buildings not directly related with border crossings positioned in areas connected to but outside of the site?	-
Standoff distance	. Are there adequate standoff distances between the buildings and roads and parking areas in the site?	-
	. Are there adequate standoff distances between the buildings and the checkpoints?	-
Vehicle parking areas	. Are the parking areas of the buildings seperated for visitors and personnel?	-
Building orientation	. Are the interlocated spaces that the buildings are located have enough width?	-
	. Are the buildings facing the high-risk areas with their narrow façades?	-
Building architecture	. Are the structural systems, architectural forms, façades, Windows and siding strengths of the buildings near high-risk areas planned suitably against explosion loads?	-
	. Are the areas inside the building designed according to the security requirements?	-

Table 5.1. (continued) Example Land Port of Entry APSA checklist

HEADINGS	APSA	APPROVAL
Vehicle Parking Areas		
Vehicle parking areas outside the site	. Are there adequate standoff distances according to the vehicle types between parking spaces outside the site and the other areas. If not, are there suitable security measures against an explosion?	-
Vehicle parking areas inside the site	. Are there adequate standoff distances according to the vehicle types between parking spaces inside the site and the other areas. If not, are there suitable security measures against an explosion?	-
Lighting and surveillance	. Are there sufficient lighting and surveillence in the parking areas?	+
Veterinary Border Inspection Point, Tax-free Gas station and Pedestrian Corridor		
Veterinary Border Inspection Point (VBIP)	. Is the veterinary border inspection point located in accordance with the on-site roadway sorting model?	+
	. Are there reserved spaces suitable for possible expansions of the veterinary border inspection point?	-
	. Are there adequate stand-off distances between the VBIP parking areas and other buildings, roads and parking areas?	-
	. Are the buildings in the veterinary border inspection point have suitable physical structures, locations and orientations against an explosion loads?	-
Tax-free gas station	. Is the tax-free fuel statio located in accordance with the on-site roadway sorting model?	+
	. Are there adequate stand-off distances between the tax-free gas station and other buildings, roads and parking areas?	-
Pedestrian corridor	. Are there specialized pedestrian corridors for pedestrian crossings in the site?	-
	. Is the corridors planned as open corridors?	NA
	. Is the corridors planned as closed corridors?	NA
	. Are there adequate stand-off distances between pedestrian corridors and vehicle roads and parking areas?	NA
	. Are the incoming and outgoing passenger crossings inside the pedestrian corridors physically seperated? Are the unctrolled transitions between these two areas being prevented?	NA
	. Are the materials on the side and ceiling surfaces of the pedestrian corridors have blast resistance?	NA
	. Are there emergency exits in defined intervals on the pedestrian corridors?	NA
	. Are there suitable openings for vehicle and pedestrian transitions between the on-site roadways. Are there any measures taken to prevent uncontrolled transitions in these areas?	NA

The table above is the applied form of architectural passive security arrangements checklist for land ports of entry for example land port of entry. Firstly, the headings regarding the general physical structure of the border gate were given. After that there are questions for each physical component. A '+' sign in the approval column indicated the presence of the necessary arrangements regarding the question. If there is a '-'sign, that indicates that the necessary arrangements are missing. Lastly, 'NA' sign indicates that the question is not applicable for this specific land port.

Although it is one of the most busy land ports of entry in Turkey, security requirement for example land port of entry is not as much as the border gates on the eastern and southeastern borders. It allows both passenger and commercial crossings. However, passenger transitions are only allowed for vehicles and pedestrian crossings are not permitted. Thus, there is no specialized pedestrian corridors in the site. Example land port of entry is compatible with the opposing border gate in terms of physical properties and procedures. A railway border gate is also near the site and there are also compatible arrangements between these two border gates. There are four on site roadways on land port of entry, each of them is dedicated to a seperate crossing type. These roadways are seperated from each other with seperator walls and and there are appropriate buildings and areas for crossings. There is a security road around the site for emergencies. The arrangements for rapid transportation between distant areas inside the side in case of emergencies are existent. There are emergency crossing platforms at checkpoints.

In the pre-entrance area there is a semi-trailer truck parking space for commercial vehicles, however there isn't a parking area for every type of crossing and the standoff distance between the parking areas and the checkpoints is not adequate. In a similar manner, the parking spaces inside the site does not have the adequate standoff distances to the surrounding areas and buildings. Since the interlocated spaces between the on-site roadways are not adequately wide, it is not possible for the buildings to have their narrow façades towards the risky areas. In situations like this where the adequate standoff distances and the proper building orientations are not existent, the lower floor windows of the buildings should be resistant to the explosive loads to increase their explosion effectives. In the on-site roadway sorting model that the border gate utilizes, the incoming commercial vehicle roadway is positioned between other roadways, at the center of the site. This results in veterinary border inspector point (VBIP) buildings and the parking spaces also being at the center of the border gate site. If the commercial roadway was located at the outer bands, there would be sufficient expansion area for the VBIP which constantly needs more space due to the increasing capacity of the border gate. However, since this sorting model is implemented for the border gate and there is no reserved sufficient space for capacity increase, the expansion space needed for VBIP is tried to be created by engulfing some parts of the outgoing passenger roadway. As a result, efficieny of the organizational processes and controls are affected negatively.

The buildings which are not directly related with the crossing processes in the border gate site should be moved to areas outside of the site but should still be physically connected to it. The parking spaces in the pre-entrance area should be in a secure place adequately distanced from the checkpoints. Adequate standoff distances between the parking and the pedestrian ways and buildings in the site should be provided, and in cases it is not possible, buildings should be strengthened to mitigate the security flaws. The exterior of the checkpoints should be covered with lighter materials to prevent them creating secondary fragmentation. The double sided checkpoints should be designed in a way that does not limit the visual range of the personnel. The load bearing units of the canopy which are located in the open should be covered with protective materials. Veterinary border inspection point and its parking space should be moved to a place at the site perimeter where there is sufficient space for an expansions.

6. CONCLUSION AND RECOMMENDATION

Forensic architecture is the field of science that examines the interaction between forensic events and the built/natural environment. As in this study, the architectural measures which is taken against physical attacks are evaluated in this context. In additon, forensic architecture includes the crimes aimed at structure, the witnessing of architecture, architecture as a crime scene and crimes as a result of wrong architectural solutions [45].

Bomb attacks are serious threats to important buildings, especially to critical infrastructures thus, Architectural Passive Security Arrangements (APSA) are of great importance for these types of buildings. In this context, primarily, the bomb attacks and their effects on the structures were studied. Secondly, Architectural Passive Security Arrangements (APSA) were determined for these types of structures and a checklist was established. Thirdly, the checklist prepared was developed for one of the most critical infrastructures, land port of entry and the issues that emphasized in this framework were written. Lastly, the checklist which was specifically created for land port of entry was used in order to evaluate Kapıkule Border Gate and suggestions were made according to the results.

The primary measure in Architectural Passive Security Arrangements (APSA) is always to ensure a sufficient standoff distance between risky spots and target structures. Site focused topics, such as layout plan and access control, include arrangements to control this standoff distance. Measures regarding structural consolidation, building materials selection, façade arrangements, room placements, etc. are passive security arrangements. The importance of these arrangements change depending on the standoff distance. Consequently, the basic passive security arrangement against a bomb attack is always to ensure a sufficient standoff distance and all the other measures are taken due to lack of security when standoff distance cannot be achieved. The importance and degree of these measures increase as the standoff distance decreases.

Architectural Passive Security Arrangements (APSA) for land port pf entry can be summarized in ten articles.

1. All structures and areas that are not directly related to crossing procedures should be located outside the site boundaries but should be physically connected to the site.

2. There should be separating concrete walls between the onsite roadways which are resistant to the explosive charges. Very large areas within the site should always be divided into sub-areas with explosive charge resistant walls against airblasts, primary and secondary impacts.

3. Interlocated spaces between roadways should be wide enough to allow adequate standoff distance between buildings, vehicle roads and parking lots. The width should be sufficient for the narrow façades of buildings to face vehicle roads. The ground levels of buildings should be at least 1,2 m above the ground in risky places and the windows of the first two floors must be blast resistant. The façades of the buildings should be as simple as possible and unnecessary cantilevers and architectural components such as eaves, balconies and decorative elements should be avoided.

4. Vehicles should not be allowed to park near the inspection points, especially in pre-enterance areas and buffer zones. If the windows are blast proof, the minimum standoff distance is 75 m.

5. Control cabins and windows of these cabins should have a curved U form. The load bearing structural components should not be exposed. If this is not possible, they should be cladded with protective materials. Glasses should be laminated, tempered and blast proof. Connections between the windows and the walls should be reinforced.

6. For the canopies of the checkpoints at the border gates especially on the Eastern and South-Eastern borders of Turkey, the materials of the structure and cladding showing secondary fragmentation effect should not be used. In very high risk places, the ideal solution is the concrete waffle slab.

7. Heavy cladding materials should not be used for control cabins. If possible, CMU (Concrete Masonry Unit) walls with horizontal and vertical reinforcements should be used. If not, lightweight cladding materials should be used and the connections should be reinforced.

8. The locations of the veterinary border inspection point and the tax-free gas station and the sufficiency of the sizes of the areas they need are particularly important considerations.

9. The emergency response units in the site should be located in a way that personnel can easily reach every point of the site. There must be controlled openings between the onsite roadways

for vehicles and pedestrians providing fast transition. In addition, there must be an emergency response and evacuation route surrounding the site.

10. There are two important issues in order to ensure an effective inspection environment and to provide quick and easy procedures. Firstly, the procedures and spaces related to these procedures should be simple and easily recognizable. Secondly, procedures should be physically synchronized with the counterpart gate at the other side of the border. But in fact, a single and common gate system is the ideal solution if the political circumstances permit.

In this study, not only principles of architectural passive security arrangements were determined, but also application of these principles for border gates were discussed. For this purpose, first of all, It is necessary to have knowledge about the operation procedures and general physical layout of border gates. In the national literature, the history of border gates, their importance in terms of transportation and logistics and the information on crossing procedures are easily accessible. On the other hand, sources of information on physical layout and architectural design principles are very limited. Considering foreign literature (such as USA), although there are several basic sources, access to most of these sources is restricted due to security reasons. Because of these reasons, the study contributes to the literature by means of systematization of the general physical layout of border gates even though the security arrangements against bomb attacks is the focus of this study. Moreover, schematic description of general physical layout of border gates, onsite roadways sorting models, introduction of settlement patterns of inspection lines and points, classification of parking lots, etc. are included in this study.

During the study, it was concluded that two types of sources are needed in Turkey due to the constraints of information sources.

1. Securit design and planning guide book.

This study should be a guide book on step-by-step risk managementprocedures for all types of structures and sites. Even though there are similar studies in the foreign literature, a study focused on terrorist attacks and based on the dynamics of Turkey is needed. In this guide book, the main articles should be the risk management steps. Issues such as how to work on each article should be clearly stated. For each step, checklists, questionnaires, detailed and systematic databases that will give access to the needed information and notes on how to document this information in the planning process should be provided. For example, a periodically updated database on active terrorist groups and their methods according to regions serves as a fundamental source of information in order to determine risk factors for a sytucture to be built in any region. Likewise, a database showing risk mitigation options with respect to risk types facilitates security design related selection and decision processes during the selection of security measures. In addition, implementation costs can be calculated via this database. The guide book should include measures for bomb attack, as well as other important types of physical attacks, such as armed attacks, arson and particularly dirty bombs.

2. Land port of entry architectural design guide and standarts.

In the recommended guşde book, the procedures of all crossing types within the border gates should be explained and the spatial needs of these procedures should be determined. It is not possible to design a simple standardized project for all border gates. Different land and climatic conditions, different regional security and capacity needs and above all different political circumstances require differences in the physical layout of the border gates. However, depending on these parameters, It is possible to determine certain design and security standards for the border gates. For instance, depending on a crossing statistics study, the number of onsite roadways and their sorting models, the number of checkpoints and the standards for the settlement plan can be determined. In addition regardless of capacity and security requirements, It is possible to prepare a standard for the physical layout of the checkpoints for all border gates, parking lots and buildings forms and layouts. To sum up, the physical layout of of the basic components of the site and their locations within the site can be standardized. Lastly, this guide book should not be limited to border gates only. A series of guidebooks should be prepared on the other types of ports of entry too. In these guide books, issues like security, energy conservation, fire resistance and accessibility regarding to critical infrastrures should be explained for the benefit of responsible experts. In addition, these guidebooks will contribute to the national literature significantly.

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