Estimation the blast wave pressure effecters by apply Remote Sensing (RS) and Geographic Information System (GIS) techniques

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Abstract

After the year 2003 terrorist attacks knock Baghdad city capital of Iraq using bomb explosion various, shook the nation, and made public resident of Baghdad aware of the need for better ways to protect occupants, assets, and buildings cause the terrorist gangs adopt style burst of blast to injury vulnerability a wider range form, and many structures will suffer damage from air blast when the overpressure concomitant the blast wave, (i.e., the excess over the atmospheric pressure 14.7 pounds per square inch at standard sea level conditions are about one-half pound per square inch or more) to attainment injury. Then, the distance to which this overpressure level will extend depends primarily on the energy yield (§1.20) of the burst of blast. Accordingly, must been have adopted a changing philosophy to provide appropriate and effective protection for preservation of psyche and building occupants, by establishment of a protected perimeter and the design of a debris mitigating facade, the isolation of internal explosive threats that may to dodge detection through the screening stations or may enter the public spaces prior to screening and the protection of the emergency evacuation, rescue and recovery systems. By reason of this above-mentioned, the study simple contribution of determined phenomena risk containment. Moreover, in this study may be applied remote sensing (RS) and geographic information system (GIS) techniques to estimation the blast wave overpressure of bomb explosive effecters for damage that building of materials (i.e., facade, building glass, secondary of roof, fashioning tools and furniture), and how avoid this problem, therefore, selection justice ministry of Iraq building in Salehyiea region at Baghdad city, it destroyed at 28/10/2009 by motocar bombs explosion.

Key words

Blast effect, shock wave, building congregation, RS and GIS Application.

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تخمين تاثيرات ضغط موجة الانفجار بوساطة تطبيق تقانات التحسس النائي ونظم المعلومات الجغرافية

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الخلاصة

بعد عام 2003 ضربت الهجمات الإرهابية العاصمة العراقية بغداد بعنف باستخدام أنواع مختلفة من القنابل المنفلقة. أحدثت هزة بالأمة، أحدثت إدراك لعموم ساكني مدينة بغداد بالحاجة إلى إيجاد طرائق حماية للسكن، الممتلكات، والبنايات بسبب العصابات الإرهابية التي اتخذت اسلوب التدفق الهائل من الانفجار لأذية الأماكن الحساسة والمكشوفة بمديات واسعة كذلك الانشائات التي عانت التدمير من الهواء المصاحب للضغط العالي لموجة الانفجار (مثال، أعلى زيادة بمقدار 1.5 باوند لكل واحد انج مربع عن الضغط الجوي والذي هو بمقدار

14.7 باوند لكل مربع انج فوق مستوى البحر) تحقق الأذى. ومن هذه الخاصية فان المسافة هي التي تحدد اتساع مستوى أعلى ضغط وتعتمد على طاقة ابتدائية بمقدار 1.20 من انفلاق الانفجار. وبناءا على ذلك، لابد من اتخاذ فلسفة مغايرة للتزود بحماية خاصة ومؤثرة للحفاظ على النفس البشرية وقاطني الأبنية، بواسطة تأسيس نطاق حماية وتصميم واجهات أبنية للتخفيف من الحطام، بعزل مخاطر الانفجار داخليا وتفاديها من خلال مواقف حواجز الكشف أو بمقدور إدخال فضاءات عامة مسبقة كحاجز وحماية وأماكن طوارئ وإنقاذ وأنظمة إسعاف. ولأسباب ما سلف ذكره، هذه الدراسة مساهمة بسيطة لتحديد مخاطر الظاهرة واحتوائها. علاوة على ذلك، في هذه الدراسة طبقت تقنيات التحسس النائي ونظم المعلومات الجغرافية لتحديد الضغط العالي لموجة الانفجار وتأثير دمار القنابل المنفلقة على المواد والأبنية (مثل، واجهات الأبنية، زجاج الأبنية، السقوف الثانوية، أدوات الزينة، والأثاث)، وكيف نتجنب هذه المشكلة، لذلك، تم اختيار بناية وزارة العدل العراقية في منطقة الصالحية من مدينة بغداد والتي دمرت بتاريخ 28/10/2009 بواسطة شاحنة ملغمة.

Introduction

Perception the nature of threat, there are many design options available to reduce the risk to any building. The goal of protective design against the effects of blast is the protection of the building occupants and the reduction of casualties. feasible design for terrorism attack protection requires an integrated approach to facility site, operation programming of interior spaces, employment of active and passive security measures (land use) employing both technological security provisions and human security provisions. This study illustrated the threat from a terrorist bombing to require avoid and finding the most effective way to meet the standards for enhanced safety that currently exist. It researched only the external blasts. And aimed to perception the terrorist attack physical, why they used bomb explosion various plurality, the group gang exploit the blast forces to destroy, damaged behavior and injuries vulnerability building congregation (official, commercial, religious and inhabitants). Optimally, blast mitigation provisions for a new building should be addressed in the early stages of project design to minimize the impact on architecture and cost. And, when safety regulations, budgetary constraints and watching accessibility, these components to lend a helping hand to the criminal person and established the force source and the gang terrorist limitation. The building's congregation exterior is first real defense against the effects of a bomb explosion. How the facade responds to blast loading will significantly affect with behavior of structure. Remote Sensing (RS) and Geographic Information System (GIS) applications are implemented to specify the geographic coordinates of the utilized images and maps and matching them with the geographic coordinates of the simulated crime event locations.

Study area

The study area represented samples' of vulnerability building congregation in Baghdad city, therefore select the justice ministry building in Salehyiea region at Baghdad city capital of Iraq, see Fig.1. Baghdad lies between latitudes 33°73 and 32°80 N, and longitudes 43°82 and 44°95 E. The top photomap has the top at 33°73'15'' N, left at 32°81'15''E, right at 43°83'10''W and bottom at 44°94'10''E. Spanning 51.170 km^2. The administrative areas of Baghdad are consisting of ten districts and thirty two sub-districts. The population focus in al and count is about 7.457772 millions. The study area to occur in Salehyiea region at Al-Karkh district centre lies between latitudes 3688065.501 and longitudes 443442.457 projection WGS_1984 Datum UTM_Zone_38N representation truck bombs explosion. The study area consisting in place

includes two building, one of them represents justice ministry collection (*side 1*), and other represent municipality ministry (*side 2*) is vacant in moment bomb explosion. The two buildings locate on crossroads square and one side main road penetrates. The distance from facade of structure to the road dock about 5 meter which representation stand off from center motorcar bomb explosion and facade of building.

Methodology

Geography plays an important role in policing and crime analysis. Response capabilities often rely on a variety of data from multiple agencies and multiple sources. The ability to access and process information quickly while displaying it in a spatial and visual medium allows authorities to allocate resources quickly and more effectively. In the "mission-critical" nature of policing, information about the location of a crime, incident, suspect, or victim is often crucial to determine the manner and size of the response. GIS takes the traditional statistical information used in crime analysis and places it on a map, showing specific crime pattern and relationships. GIS analysis of traffic data assists in the identification of selective enforcement locations.

The main goal of this research is to evaluate the terrorist crimes in a selected part of Baghdad province represent building congregation damage, and perception, why the terrorist are actives concern concentration the vary explosion blast wave operation. Simulation RS and GIS techniques are management these operations. Used QUIKBIRD satellite imagery 0.6 m resolution produced 205 to explicit assessment and determination the blast effect injuries, and avoid or protection from these by change Building external structures scientific method.

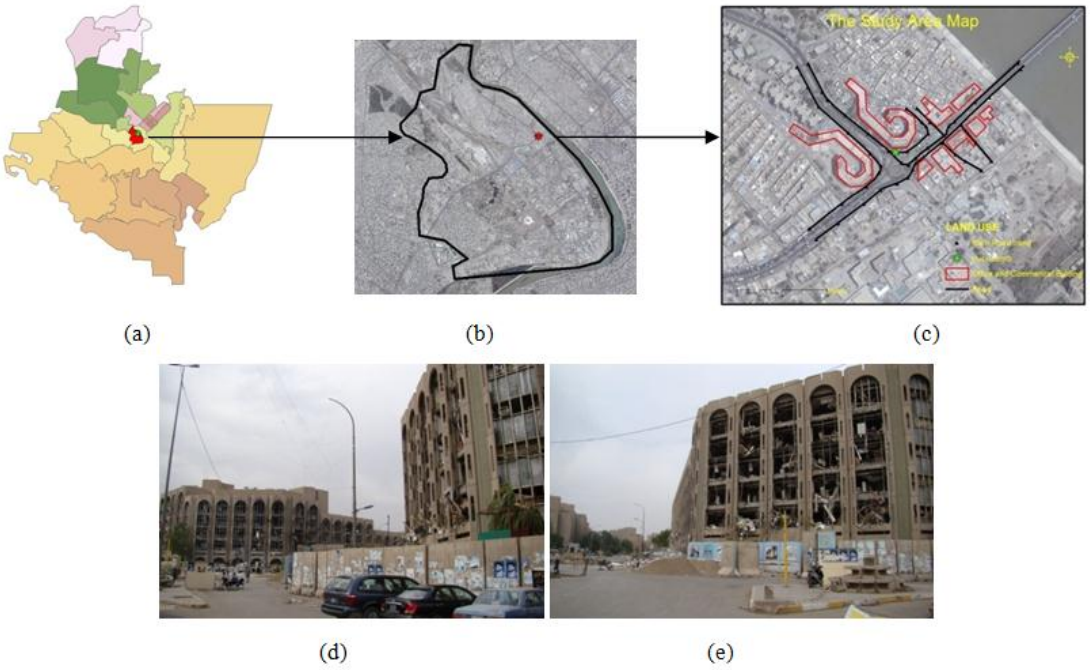


Fig.1: (a) Baghdad city capital of Iraq, (b) Al - Karkh district centre of Baghdad, and the star red represent truck Bomb Explosion, (c) Illustration the study area is sample contain building congregation (official, commercial, and inhabitants) in red color, The main road in black line, The star green represent truck bomb, and (d) (e) building target destroys.

Bombs

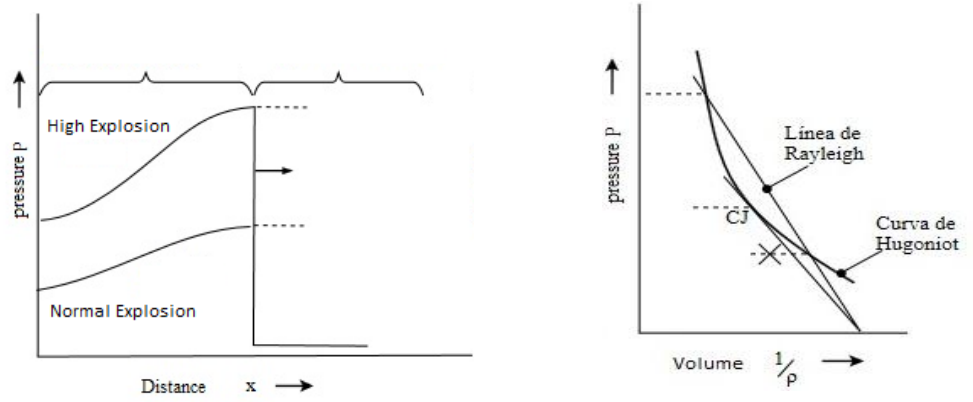
Estimation the amount of energy, which would be released by the explosion of an atomic bomb in air, the postulated for an idealized point source of energy, the spatial distributions of the flow variables would have the same form during a given time interval, the variables differing only in scale [1]. (Thus the name of the "similarity solution") this hypothesis allowed the partial differential equations in terms of *r* (the radius of the blast wave) and *t* (time) to be transformed into an ordinary differential equation in terms the similarity variable,

$$\frac{r^5 \rho_0}{t^2 E} \quad (1)\ [1]$$

where p_0 the density of the air, and E is the energy that's released by the explosion. This result allowed the estimation the yield of the first atomic explosion was determined by using the equation,

$$E = \left(\frac{\rho_0}{t^2}\right)\left(\frac{r}{C}\right)^5 \quad (2)$$

where C^5 is a dimensionless constant, which is a function of the ratio of the specific heat of air at constant *pressure* and the specific heat of air at constant volume, see Fig. 2.



(a) (b)

Fig. 2: (a) Spatial distributions of pressure with distance, and (b) constant pressure with volume [1].

Blast effects

In start explosion, production height rapid exothermic chemical reaction occurs. When the explosive material consists solid or liquid is reaction progresses convert to really hot, concentrations gas, high pressure gas. And expand huge velocities to result from to make until equilibrium with groundings air, causing a shock wave yield propagation pressure pulse (supersonic). It is travelling outward of the source supersonic velocities. And available in most high explosives are released in the detonation processing.

The residual of high explosive are released slowly as the detonation products burn mixing with air.

The burn process are effected on the primary blast wave, because this process occurs high slower in region explosion in blockaded space. Generation from this process is created an incident blast wave. Representation, consist peak overpressure by an almost instantaneous rise from atmospheric pressure [2].

A negative pressure phase occurs, when the shock front are expands pressure decays back to surroundings pressure, which is usually longer in duration than the positive phase as see Fig.3.

The negative phase design is neglect than positive phase for less important. Then, the incident pressure

wave traverse on targets, that is not parallel direction of the wave move, it is reflecting and cement, consist that is known reflection pressure, That, the reflection pressure is greater than the incident pressure in the same distance of explosion. Also, the shock wave of reflection wave varies with the angle of incident pressure. When the shock wave traverse a target surface is perpendicular to the direction the wave moving, in this moment considered point of impact that will be supposed experience maximum reflection pressure.

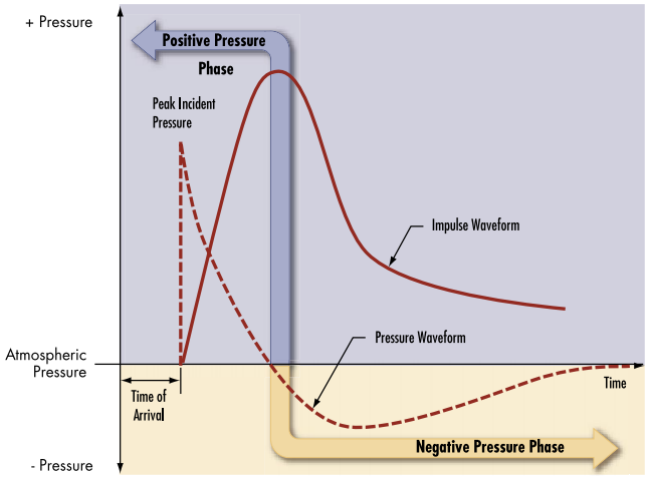


Fig.3: Representation, relationship between pressure pulse and impulse and the shock front expands pressure to surroundings pressure (negative and positive pressure phase [2].

Blast wave

Blast waves established and initiated from exploding bombs and other weapons made high explosives. A blast wave is the pressure and flow resulting from the deposition of a large amount of energy in a small much localized volume form a pressure and flow. The flow field will be leading shock wave and synchronizer subsonic flow field. A blast wave is representing area of pressure expanding supersonically outward from explosive center. It has consisted of shock front of compressing gas. The blast wind followed blast waves consist of negative pressure. All victims and hazards harmful from the blast wave especially when everyone entities the center or at a location of structure inside, see Fig.4.

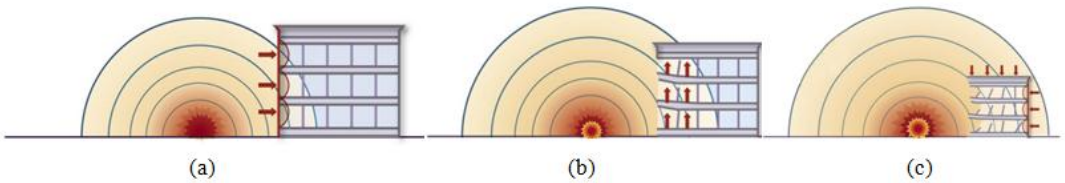


Fig. 4: (a), Blast wave breaks windows structure in columns may be damaged, (b) Blast Wave break by forces floors upward, and (c) Blast wave surrounds structure pressure on all sides [2].

Sources of blast waves

High of explosives (HE) are much forceful than low of explosives (LE). HE detonates determined to consist supersonic which is over pressurization shock wave. Many sources of HE

include C_4, nitroglycerin, Semtex, Trinitrotoluene, and ammonium nitrate fuel oil. LE may be propagated through the shock to create a subsonic of explosion and lack HE's over pressurization wave. Sources of LE represented gunpowder, pipe bombs, and most pure petroleum bombs such as Molotov. HE and LE yield different injury, sample victims and middle hazardous patterns. In this search interested in HE producing true blast waves [3] see Fig. 5.

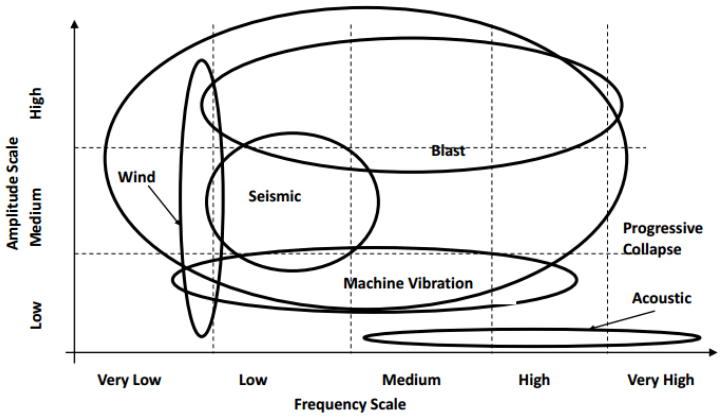


Fig. 5: Distribution for different hazards produced from HE and LE [3].

Blast waves characteristics and properties

The simplest depict of blast wave can be called the Friedlander waveform [4]. Properties prediction of blast wave can be observed the physics of waves, the light or sound waves when pass through a narrow opening may be diffract, and when pass through materials may be refract, (one term of these transmitted, two term absorbed, and remnant term is reflected), this case depend on the number of material will be impeded the wave causing, see Fig. 6.

Friedlander waveform equation, explain the pressure of the blast wave (p), which describes a function of time (t):

$$\left[P(t) = P_s e^{-\frac{t}{t^*}}\left(1 - \frac{t}{t^*}\right)\right] \qquad (3)\ [4]$$

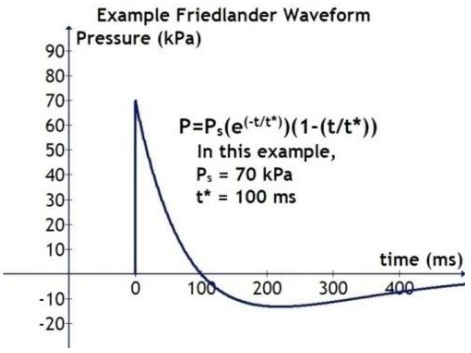


Fig. 6: A Friedlander wave form is explanation rapid transition pressure with the time [4].

where t* is a time and P_s is a peak pressure at which the pressure first transition the horizontal axis (before the reversal phase). Blast waves will envelop around structures. Therefore, anything's (persons or objects) behind a large structure are becoming danger and reason hazardous from a blast that when started on the opposite side of the structure. This equation and chart can be using sophistication mathematical models to predict how

structures will be respond to a pressure of blast wave in order to design effective barriers and safer structures [5].

Constructive and destructive interference

In interference phenomena happened when to face two correlated waves each other and product increasing or lowering the amplitude consist constructive or destructive phenomena. Happened in wave amplitude increased, if wave crest is meeting another wave crest in the same point happened the crest interference constructively, unlike, if wave crest is meeting in the same point a trough another wave happened interference destructively, then the amplitude will be decreased [4].

When, the pressure of blast wave's strikes any face as a building and happened reflection waves may be interacting with any wave meeting causing an increasing in pressure wave blast in certain place consist a constructive interference, un like, if the negative interaction with wave meeting, this case is little happening. in this manner can be understanding the interaction of pressure blast wave corresponding the water waves and sound waves, see Fig.7.

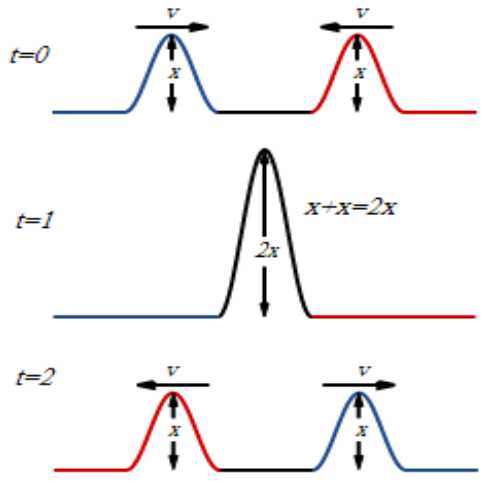


Fig.7: Representation, constructive interference phenomena [4].

Shock wave

The properties of a shock wave representation is an ordinary wave, it is depict kind of propagating disturbance. The waves comprise energy and permeate through a medium, such as gas, liquid, solid and plasma, until empty medium, the shock wave consist an a abrupt shape and discontinuous change in medium, this case accompany rise of flow rapid extremely as pressure, density and temperature [6]. This cases will be accompanies supersonic flow and expansion fan.

Another property of shock waves is moving than an ordinary wave in high speed through media. While a shock wave move through medium, the energies are preserved and extracted causing work decrease and entropy increase.

How blast waves cause damage

In a few millisecond, a pressure blast wave moving faster than the speed of sound and to go pass the shock wave, in this case, the blast wave a combination of inflexible of the air in front propagation of the waves, consist a shock front, and the set wind that follow. The people and anything majority can expose the cause damage by the blast wave wind, fires and broken remains, [7]. Also, anything fragments will be traveling very fast from explosion. And broken remains can doing push and swept up at pressure blast wave causing more injuries, such as wounds, broken bones, bleeding blood, cutting parts of bodies, or lead to death. And another distinguish of blast waves cause damage, that the area of the blast wave wind happened low pressure also causes debris and fragment to cause actually rush back towards the original explosion. Also causes a fires and high temperatures which result from detonation from physical destruction of

any exploding containing objects, see Fig. 8 and Table 1, show affect the blast wave pressure damage according to the bomb explosive weight, [8], and the estimation distance by below equation,

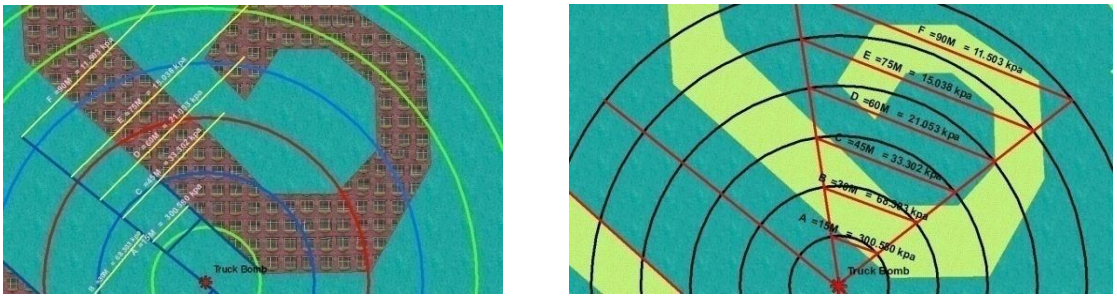
$$[P_0= ((35.6/X)(W_{TNT})^{1/3}) + ((134/x^2)(W_{TNT})^{2/3})) + (1359W_{TNT}/X^3) – 0.2756].$$
$$[P_0= ((97.5/X)(W_{TNT})^{1/3}) + ((145/x_2)(W_{TNT})^{2/3})) + (585W_{TNT}/X^3) – 1.9] \quad (4)$$

where: $1.4 < p_0 < 145$ Psi or $(10 < p_0 < 1000$ kpa) (Psi= pounds per square inch, kpa= kilo Pascal)

P_0 = initial blast pressure at distance "X", psi or (kpa).

W_{TNT} = mass of TNT used in explosion, Ibs or (kg). (1 kg = 2202.643 Ibs).

X = distance from the origin of the blast, ft or (m).



(a) (b)

Fig. 8: (a) pressure distribution from 2212.389 Ibs (1 ton) of TNT with a standoff distance of 49.3 ft (15m) and above the ground1.64 ft (0.5m). (b) Blast wave distribution track.

Table 1: The blast pressure dimension effect with the parameter bomb explosion quantity, by apply equations 1, (1m=3.289 foot) and kpa=20.857 psf).

Standoff	Meter	Foot	pressure		Weight (TNT)
			psf	kPa	
A	15	49.3	6269.197	300.580	1 Ton
B	30	98.6	1424.595	68.303	1 Ton
C	45	148	694.579	33.302	1 Ton
D	60	197.3	439.102	21.053	1 Ton
E	75	246.7	313.647	15.038	1 Ton
F	90	296	239.918	11.503	1 Ton
G	180	592	84.512	4.052	1 Ton
H	270	888	40.274	1.931	1 Ton
I	360	1184	19.313	0.926	1 Ton
J	450	1480	7.070523	0.339	1 Ton
K	540	1776	-0.938565	-0.045	1 Ton

These pressures may be appropriate for designing the roof, sidewalls, and rear walls of the building. However for the side facing the blast, the front part of the blast wave is reflected off the building surface back into the wave effectively magnifying the pressure. Therefore, depending upon the configuration and the design parameters, structural elements facing a blast may require higher design pressures than those.

Experimental and result

Hazards estimation process should determine explosive of bomb sizes used in the locality or region domain. Security institution may be envisioning

quantity information, which may be used to estimate the set of likely explosive weights, and the protection level must be even threat.

They must be knowledge at least account measure the distance from the explosive bomb center to facade any object location threat as building, markets and crowded place. The distance between the explosive bomb center and the target, such as justice ministry building in this search, known as standoff (distance from center of truck bomb to facade of building) distance, see Fig.9. That the nearest building is 10 meter distance from the truck bomb detonate, and mention above Table 1, notice that the pressure inverse proportional with distance, finding 15.2 meter with 17.5 kpa, instance, if motorcar bombs typically carried 10,000 pounds of TNT or any explosive equivalent, and depending on the size and capacity the motorcar used became the deliver weapon], see Fig.10. According the official source that the track bomb was curried about 500,000 pound even 1 ton. That meaning the terrorists attack actives depend on the blast wave of bomb explosive detonate and pressure of shock wave effectives, see Fig.11. By viewer accident occurs location of terrorist attack finding the distance of destruction effect about 90 m, that according to Fig.4 the blast wave surrounds structure downward pressure proof inward pressure on all building (side 1) appropriate than side 2, that illustration the blast wave pressure was effected by reflectance multiply. That considerable the distance 90 m is lethal injuries. This meaning, that the bomb parameter using and the blast wave effected investment to cause the greatest damage (fraction of glass, scatter of furniture, destroy of roof slabs, floor slabs, rebound of girders, storming, and fire). These, to lead personnel and customers exposure to lethal injuries, addition to nearest cars exposure damage of bomb expulsion, see Fig. 12.

Fig.9: Illustration the standoff distance from truck bomb about 15m to main target side 1 (justice ministry) and 30m at second target side 2.

Additionally, finding several injuries from truck bomb from afar, the explosion products prim extend at high velocity, and an attempt to reach of balance with the air medium, see Fig.13. In this travel of explosion many ancient building may be damage by disturbed foundation of infrastructure and fraction of glass, as in Fig.12 (a). Because, the transmit

wave at a medium more rapidly in a space. And the height buildings are exposure accident blast wave from low building.

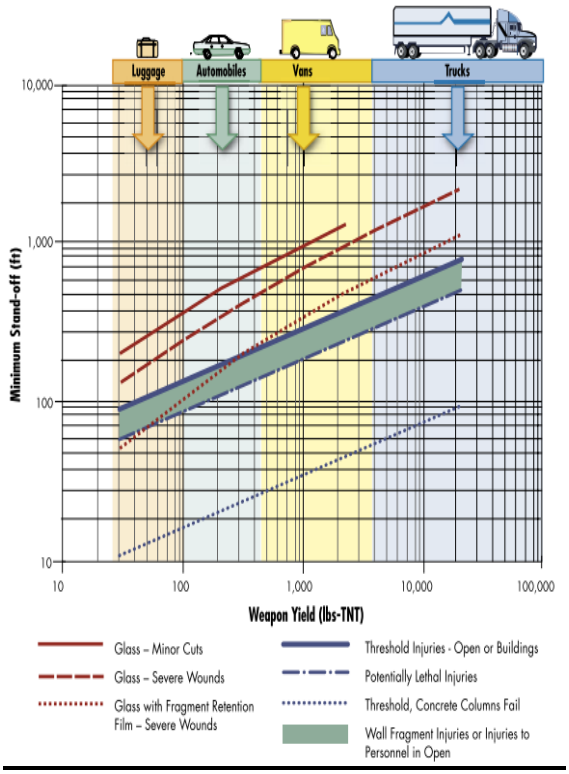


Fig. 10: Explosives environments with blast range to effects, [9].

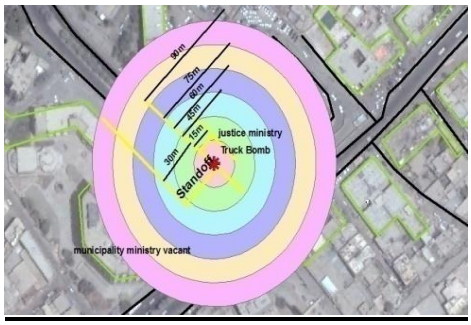


Fig. 11: The initial blast wave pressure distance from truck bomb with 15 meter multiply.

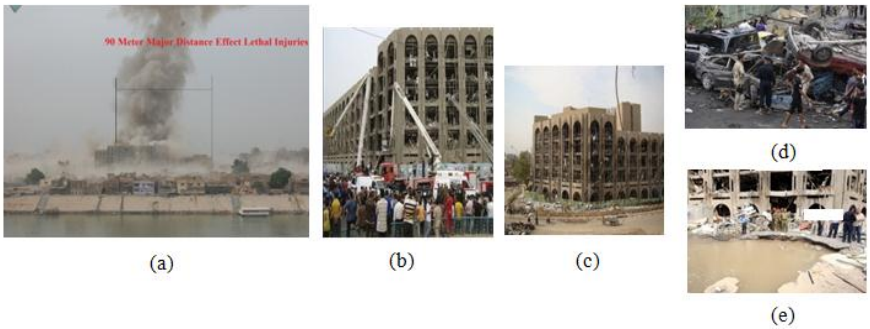


Fig. 12: (a) Illustration the blast wave pressure destroyed region effects, (b) huge initial destroy the building side 1, (c) secondary destroy the building side 2, (d) adjacent cars of truck bomb pressure destroy, (e) strength of truck bomb occur crater about 10m diameter and 1m in depth.

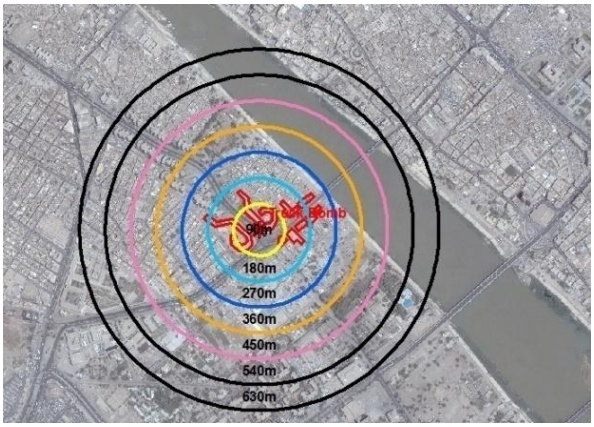


Fig. 13: The rings of blast wave effect damage show the yellow track represented the probable lethal injuries, the three rings later represented damage, and the rings remain represented probable injuries.

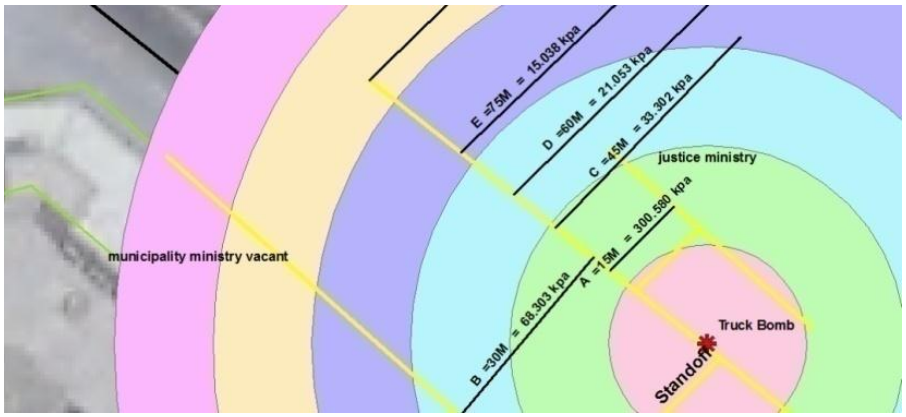


Fig. 14: Illustration, the blast wave pressure proportional inverse with standoff (distance from center of truck bomb to Initial blast wave pressure). Initial blast pressure.

Conclusions

The air blast wave pressure may be caused damage by divided into direct air blast effects in any ways and progressive crash. Always, the flaccid place exposed collapse from the high pressure blast wave of explosive, such as windows, floor system, facade of building, exterior wall, building structure and building far away from a road.

The blast wave pressure is the primary damage techniques in an explosion. The air pressure effect on objects surface magnitude greater than the building structure, such as upward on the face and floor system the justice ministry building (side 1). In this side is destruction response, the air blast wave pressure first aim to the weakest point in the façade structure, typically the exterior cover of the structures forceful. Then, the blast wave pressure strike flaccid region and pushes to the exterior walls caused fall and windows face were breakage. In moment, also the shock wave continues to expand to entry the structure and high pressure pushing both upward on the roofs and downward on the floors, such as the terrorist attack operation ulterior, they are doing to take a form style.

Typically, the establish protection from damage or injuries, that will be considered the most important design parameter for blast wave pressure resistance for the simple reason that an increase in standoff distance results in a marked decrease in load. For instance as shown in Figs.1, 4 and 5, used (1 ton) of TNT at a standoff distance of (15 m) produces a blast wave pressure

(300.580 kPa) at Point target side 1 effect, and standoff distance of (30 m) produces a blast wave pressure (68.303 kPa) at Point target side 2 effect. If the standoff distance is increased to (90 m) the blast wave pressure will be reduced and later to be dispersed arrived to blast wave pressure (0.339 kpa) at standoff distance of (540 m), as the Table 1.

Additionally, the unpredictability of the blast intensity due to variations terrorist attack instrument, the distance to the source and size of charge used necessary, the most common blast design philosophies recognize that protection is not an absolute. The goal is not necessarily to withstand a blast, but rather to limit the extent of collapse, minimize loss of life, and facilitate evacuation and rescue. Casualties near the blast may be unavoidable, but preventing progressive collapse of the building reduces further fatalities. The design process should include a risk assessment to help determine what level of damage or potential injury is acceptable, considering public access to the building, aesthetics, and economics.

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