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METHODS USED TO REDUCE THE IMPACT OF THE EXPLOSION ON CONCRETE ADMINISTRATIVE BUILDINGS

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Abstract: This paper aims at studying the effect of blast loading on the construction design of a 12-story reinforced concrete residential administrative buildings from the different weights of TNT. This type of loading should be taken into consideration now in Iraq, especially after the terrorist attack from the explosions that the State of Iraq is going through from the year 2003 to the present day. The explosions must be studied in Iraq to avoid significant losses in human lives and human and economic equipment. The same reinforced concrete multistory building was designed twice; once with a traditional gravity building without a shear wall and the second by adding a shear wall to discuss the difference between structuring and analysis from drift, displacement, and story shear. A commercial package ETABS2018 was used to analyze this 36-meter-high building. The building was analyzed according to the American code, while it was designed according to ACI 318-14 and the US Department of Defense TM5-1300. The maximum increase drifts it was seen on the 11th and 12th stories amount 41%, 80% for each weight TNT the maximum increase displacement it was seen on the 11th and 12th stories amount 8.8%, 9.5% for each weight TNT.

Keywords: Blast load, Effects of the blast, Design strategy, Physical design components, ETABS, Tall building.

1. INTRODUCTION

2. THE PHENOMENON OF BLAST The blast is defined in studies and research as a rapid and sudden release of large-scale energy. Explosions are classified according to their nature as physical, nuclear, or chemical events shown in figures (1) and (2). Physical explosions are produced by releasing energy due to a large failure of a cylinder of compressed gas, volcanic eruptions, or mixing of two liquids at different temperatures. The nuclear explosion is carried out by releasing energy within the formation of different atomic nuclei by redistributing protons and neutrons within the reactive nuclei themselves, and rapid oxidation of fuel elements (carbon and hydrogen atoms) is the main source of energy causing chemical explosions.

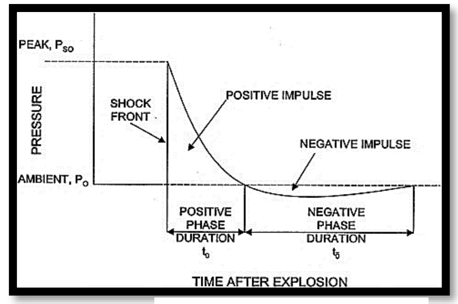


fig (1)

According to their physical condition, explosive substances are classified as solids, liquids, or gaseous. Solid explosives are known to have a very high effect and are known for their sensitivity to high ignition as secondary or primary explosives. This latter type is easy to detonate by simply igniting a spark, flame, or effect of materials such as mercury volume and increased lead and is among

the primary explosives. Secondary explosives when detonated create blast waves (shock) that cause widespread damage in the surrounding areas. Examples include trinitrotoluene (TNT) and ANFO.

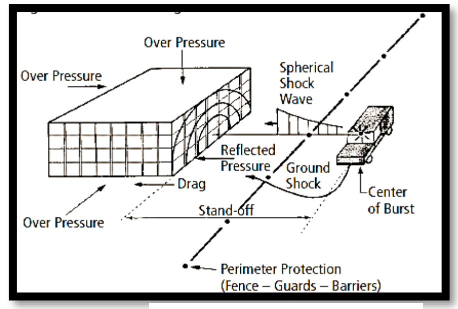


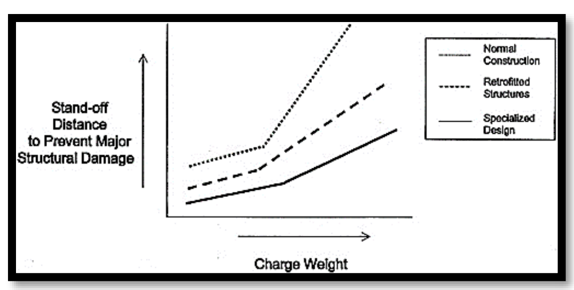
fig (2)

A high-explosive bomb explodes at a pressure of up to 300 kilobar and a temperature of about 3,000-4000°C. The hot gas expands to have to take out the size it occupies. This results in the formation of a layer of compressed air (blast wave) in front of the volume of this gas, which contains most of the energy emitted by the explosion, and the psoriasis wave immediately increases to the value of pressure above the value of the ambient atmospheric pressure. It is noteworthy that the lateral hyper pressure that decomposes outward swells the shock wave from the source of the explosion after a short time, the pressure behind the front falls below the ambient pressure and during this negative phase, a partial vacuum is created in which the air is absorbed and accompanied by high suction winds carrying debris long distances and away from the source of the explosion

3. EFFECTS OF THE BLAST

3.1 IMPACT ON BUILDINGS: In **the first stage** of the explosion, the initial wave of the explosion destroyed all the architectural elements installed in the façade, such as windows, and caused further damage to the façade of the building. The wave also presses horizontal and vertical elements that do not directly encounter the explosion, such as roofs and walls, sometimes damaging them as well. In **the second stage**, the blast wave enters the building and exerts pressure on the construction structure of the building. When directed up, this pressure is devastating to structural elements such as panels and columns, as it acts as a reverse of the design process used to resist gravity loads. Thus, the airburst pressure inside the building increases with the reflection of pressure waves from the surfaces, causing direct injuries through physical translation such as the ear and lung, and damage to other organs or debris of the building's elements and contents. The pressure of the explosion to which the structure of the building is exposed relates to the number of explosives used, and the distance of the building from the explosion as the peak pressure occurring is associated with the weight of the charge and the distance mathematically through an expression that changes as a function of the weight of the explosives and cube of the distance. This mathematical relationship facilitates the process of understanding the effects.

Diagram (1) shows how the distance of confrontation can prevent significant structural damage to a typical commercial building, modifying structures to increase blast resistance, and specially designed blast-resistant structures.

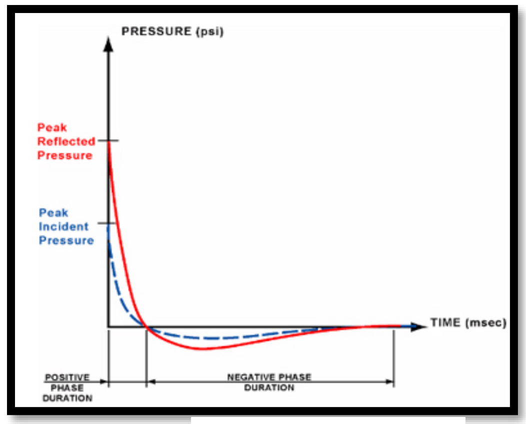


The resistance features that must be provided against the explosion depend on the available distance and the space of the building facing the explosion with the assumed size of the explosive device. Large explosive devices that are detonated on a large area of the facades of buildings work to produce a large pressure but its distribution is regular on the surface of the building, but in the case of the impact of the explosion on a small area of the façade of the buildings, with a small explosive device thus resulting in severe effects locally, such as the crash of the bearing columns, it contributes to the control of the design of the interface to reduce the damage.

The most important step to be taken during the safe design process of any building structure is to determine loads, as this should include determining the load of the explosion - a function of the expected charge weight and proximity distance as it causes local damage, especially windows and non-structural elements. To provide an appropriate basis for risk assessment and cost and benefit assessment, the information used to determine blast loads or expected shipping weights should be as clear as possible.

3.2 IMPACT ON PEOPLE: People are killed or injured by extreme heat and pressure generated at the blast site, with temperatures of 4,000°C and pressures of hundreds of times in the atmosphere. These high pressures damage the main organs of the person, blood vessels, eyes, and ears. Shock and explosion tests also indicated that human exposure to the explosion varies depending on the size of the shock pressure and the duration of the shock.

Once the blast wave enters busy places (inner spaces), the pressure wave is reflected on the walls, floors, and ceilings, forming a series of pressure pulses as a response to repeated impulses. Before affecting the ears and lungs of a single long pulse as has been noted from studies and research that the harmful effects of the pressure of the explosion inside often exceed the effects of an unlimited explosion of a similar size, it is important to reduce the chance of explosion pressures from explosions in the open air to enter places occupied by people and protect these areas from small explosive devices (Cooper, 1996). How the ear and lung respond depends on the impulse and the direction of a person's body to the burst wave - the shorter the pulse duration, the greater the pressure that can be sustained. Lung bleeding begins in the range of 30 to 40 pounds/per square inch, with severe damage occurring above 80 pounds per square inch and dying in the 100 to 120 pounds per square inch, according to cooper's 1996 study.



the diagram (2)

The committee's work is underway and the government's efforts to address the most recent developments in the country are being addressed. For people within structures exposed to the effects of the explosion, penetration by glass fragments and the impact of debris from the explosion were constant causes of death and serious injury (Maloney et al., 1996). So go to use the processors for windows that reduce the production of fragments and catcher systems to retain debris. Humans are exposed to large wounds from furniture, accessories, and components of the building's non-structural elements such as overhead lighting and air ducts that separate from their anchors. Smoke and dust inhalation from the explosion also cause injuries. It is therefore important to make every effort to maintain the blast power outside the building and to secure furniture and non-structural components. To mitigate the risk of explosion, practical guidelines here (FEMA, 1994). Many injuries often occur during the evacuation, especially if there is a large number of evacuation routes scattered from scattered glass or if there are large smoke and dust

4. DESIGN STRATEGY

Many important concepts must be taken into account during the design process of buildings to resist explosion, including energy absorption, safety factors, load structures, resistance functions, structural performance safety considerations, and, most importantly, structural redundancy to prevent the gradual collapse of the building. Design is within the standards of strength and performance, The physical protection of the buildings is part of the basic measures to provide a stable and secure environment against the pressures of the building from the outer perimeter, thus moving these pressures into the interior, destabilizing its internal system, including the structural system of the building with its internal area and design elements leading to collapse, so must separate external threats from the interior areas and mitigate as much as possible from the destruction and debris caused by the pressures of the explosion causing damage to the front of the building, reducing damage and preventing the collapse of the building. The structural integrity designed by architects and builders against collapse is routinely taken into account in the design as designers use flexible systems in buildings to mitigate the effects of the explosion.

5. PHYSICAL DESIGN COMPONENTS

5.1 ARCHITECTURAL PLAN AND FACADE

The shape of the building affects the overall damage to the structure, likely to reserve the angles and entrances hanging the shock wave, which may inflate the effect of the atmospheric explosion. It has been observed that large or progressive extraneous angles have less effect than small or sharp rotating angles shown in figure (3). Therefore, it is preferable to convex shapes instead of concave shapes for the outside of the building. In other countries, the number of people who have been forced to flee their country has increased. Terraces that are treated as lower-load roof systems require framing and detailing to reduce the internal damage of supporting symptoms. Some studies have dealt with the placement of the lobby and the attacked loading dock areas outside the main structure to reduce the likelihood of gradual collapse and it is recommended to use simple geometric shapes, with minimal decoration unless advanced structural analysis techniques are used. If decoration is used, it is recommended to consist of a lightweight material such as wood or plastic that is likely to become fatal projectiles in the event of an explosion of bricks, stone, or metal.

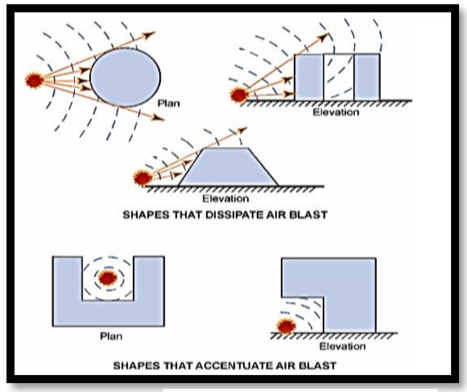


fig (3)

In addition, soils play an active role in reducing the impact of explosives, such as earth walls and buried surfaces to be effective. This type of solution can also be effective in improving the building's energy efficiency. When this approach is used, parking will not be permitted over the building shown in the image (1).

Additional protection from the impact of shrapnel can also be provided by steel support panels, carbon fiber materials, or kevlar's inner wall lining.

Image (1)

5.2 ARCHITECTURAL DETAILS:

5.2.1 FLOORING

The flat plank is represented by reinforced concrete and this system provides maximum use of vertical space, especially for buildings in areas of limited height. When exposed to blast load, cutting perforation and reducing the resistance of the panels will reduce the system's lateral load resistance. Once the torque-resistant panels are lost on the columns, the panel's ability to transfer power to the shear walls is reduced and the structure is severely weakened. In addition to the failure of the floor slab shown in figure (4), this may result in a loss of connection between the panel and the columns to increase the lengths of the unsupported columns, which may lead to the curvature of those columns. Furthermore, the side load resistance system - which consists of shear walls and columns - can enhance floors by paying attention to the design of the details of the outer bays and lower floors, The external explosion is directly threatened, and can be reinforced by the design of circular beams that connect the structure. And to enhance the response of the edge of the tile. Projected panels and column capitols can be used to shorten effective tile length and improve perforation-cutting resistance. If vertical clearance is a problem, the shear heads embedded in the board will improve shear resistance and improve the panel's ability to transmit moments to the columns. Also, the blast pressures entering the structural structure through shattered windows and failed curtain walls will carry the lower side and then the top surfaces of the floorboards along with the height of the building. Both the delay in the load sequence and the difference in load volume will determine the net pressures that run on the panels. Thus, there will be a short time when each floor receives a net ascending load. This upward load, therefore, requires strengthening the board to resist loads that conflict with gravitational effects shown in figure (4).

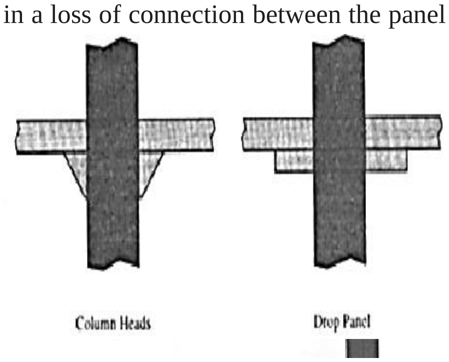


fig (4)

The suppleness and shear capacity requirements required to resist multiple reflections in loads are often forced, so the architect and builder must provide beams that extend along with the tile. The insertion of beams will enhance the ability of the framing system to transfer side loads to the shear walls. The panel shaft façade should have the reinforcing of the attached and properly mounted knees around the bending rods within a specified distance of the face of your column and the lower reinforcement should be provided continuously through the column. This reinforcement prevents communication failure and provides an alternative mechanism for developing shear transfer once the concrete is punctured. The evolution of the movement of the slab membrane, once the concrete fails in the front of the column, provides a safety net for the structure after damage so. The constantly bound reinforcement, which extends in both directions, must be properly tailored to ensure that tensile forces can be developed when winding connections. Reinforcement is also required to be installed on the edge of the tile or at the structural interruption to ensure the development of tensile forces.

5.2.2 COLUMNS:

The characteristics of the structural structure depend on the distance between the building and the blast site, for example, buildings located at a great distance - about 100 feet or more - will be subject to relatively low pressures uniformly distributed on the façade; Due to the direct blast pressures to which it is exposed, the typical building columns, which are designed to resist gravity loads without specific details of the requirements of suppleness, may be subject to severe bending distortions as well as axial loads supported by the columns. to enhance protection against collapses shown in figures (5), and (6).

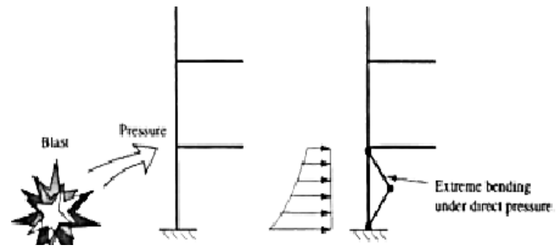


fig (5)

The lower floor columns should be designed to be flexible and powerful enough to withstand the effects of direct sideloading from blast pressure and the impact of explosive debris. Armed concrete poles can be designed to resist the effects of an explosion by providing appropriate longitudinal support, splitting in rail links, as well as providing converging links at plastic hinge sites. The size of the steel columns is determined to withstand the lateral loads and the detail of the columns links is used to develop the plastic moments of the section. It is preferable to wrap the concrete columns with a steel casing or wrap them with composite fibers to trap the concrete core and this contributes to increased shear capacity. Sometimes the steel columns in concrete are wrapped to add a mass or prevent premature twisting of thin lips.

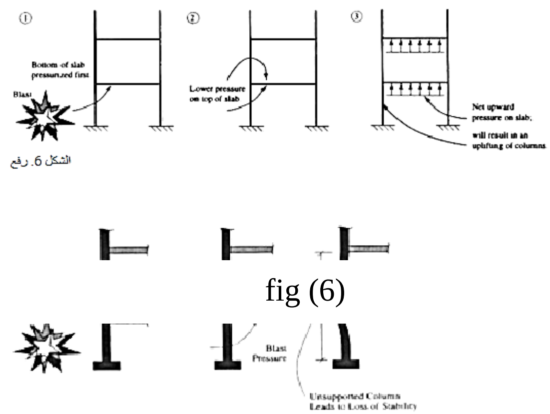
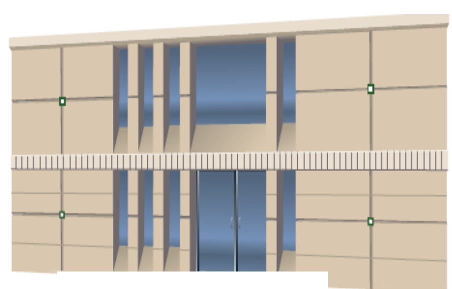


fig (6)

5.2.3 WINDOWS

- **GLAZING SYSTEMS:**

The façade of the building represents the main part of the impact of the explosion, consisting of transparent elements such as glass and non-transparent elements such as external walls, and the glass is affected by the explosion being the first structural element responding to the pressure of the explosion because of its sensitivity to external pressures. Before, the appropriate glass quality should be chosen to be used to resist the collapses that may hit the building as a result of blast pressures, such as the use of non-breakable windows, the installation of curtains and shields, or the use of armored glass. In addition, the large windows are broken faster with the volatilization of shrapnel that causes injuries to the occupants of the building as a result of the pressure of the explosion, so it is preferable to design narrow windows with slanted edges to avoid complete collapse shown in the image (2).


Image(2)

This design is less prone to explosion and its impact on the building to insulate the glass as much as possible from the outside as well as the aesthetic effect and functionality of these narrow and comfortable windows for the design of the building and contributes to reducing the damage of the elements of the interior tires. Typical polished glass with high dynamic load and blast-resistant and other types of glass can resist blast pressure. Thermally diluted glass (ANSI Z97.1 or ASTM C1048) and polycarbonate (also known as bulletproof glass) can be made in sheets up to 1 inch (25 mm) thick and can withstand pressure up to about 30 to 40 lbs per square inch (200 to 275 lbs). Solid glass with 1.4 inches (6 mm) of structural sealant around the inner perimeter is coated (60 ml thickness between layers)

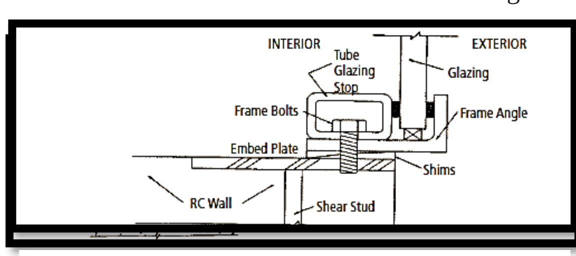


fig (8)

with solid glass with 1.4 inches (6 mm) of a structural sealant around the inner perimeter as it is exposed to minimal damage and provides safety and safety to the occupants of the building.
Window frames are an integrated system with blast-resistant glass selection so it is preferable to use steel and aluminum-reinforced window frames and doors. The window is fixed and supported by continuous fillings on the interior and exterior of the glass. Neoprene fillings are used for glass and Santoprene is used in polycarbonate/glass mode, providing a glass stent for thermal expansion and glass rotation during blast loading shown in figures (7),(8).

- **FISHING SYSTEMS FOR ENERGY ABSORPTION**

This flexible blast protection system is used to connect the concept of the curtain wall system by taking full advantage of the flexibility and ability of the window materials to absorb and dissipate large amounts of blast energy while preventing debris from entering the inner spaces and operating power-absorbing fishing systems also known as cable-protected window systems (CPWS) in such a way that glass is damaged against the cable capture system, which in turn distorts window frames. Intensive explosive tests, as well as sophisticated computer simulations, have proven the effectiveness of these systems in their explosive scan shown in the image (3).

Image (3)

5.2.4 BUILDING MATERIALS/PERKS

Precast concrete is used in the architectural design of the building to mitigate and reduce the effects of the explosion and thus meet the requirements of GSA and DOD. In providing the necessary strength of the building through solid facades, which consist of solid concrete precast construction material. Panels with dynamic loads are designed instead of static. The walls are also designed of precast concrete, being relatively thin bendable elements, and to provide flexibility in response it must be strengthened so it is preferable to increase the thickness and reinforcement of the panels and the amount of bending reinforcements must be limited to ensure the tightening of the arming before cracking occurs in the concrete. It is preferred to use hard shear to increase shear resistance, and restrict bending reinforcements, to prevent bending of the rails in case of pressure.

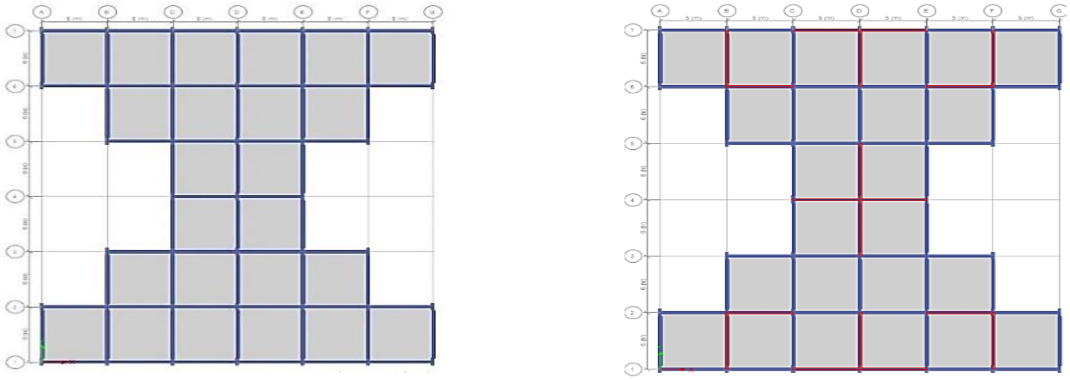
As for pre-cast concrete panels, designers should consider the thickness of the panels to be at least 5 inches (125 mm), with spacing between the ramrods in both directions and not more than the thickness of the board. These structural details will improve the suppleness of the structure and reduce the chance of the concrete fragments flying. The goal of this is to reduce the loads transferred in communication between structures, which need the ability to design to resist the associated loads attached to the curved panels.

The following features are integrated into precast concrete for plank systems, to accommodate and increase blast load:1. Increase the size of the painting to at least two floors or one width to increase flexibility to avoid bending or breaking while maintaining its basic integrity. 2. The panels should be connected to the floors, instead of the columns, to prevent stress from the columns. 3. The design of the panels with integrated and integrated vertical ribs on the back to provide additional support acts as ground-to-ground beams for the distribution of loads, making this chest system softer and more capable of carrying out the external explosion.

As for the structures of the bearing walls, the following details will contribute to increased resistance to gradual collapse by providing a set of vertical and vertical bands in the vertical joints between adjacent or intersecting walls. • Connect the panels across the horizontal joints at a minimum, making two connections per panel. • Connect all resistance elements to the occasional, longitudinal, lateral force, vertical directions, and around the perimeter of the structure. • Provide links between the reinforced cross walls with the panels attached to the floors. • Do not use contact details that produce friction that results from gravity loads.

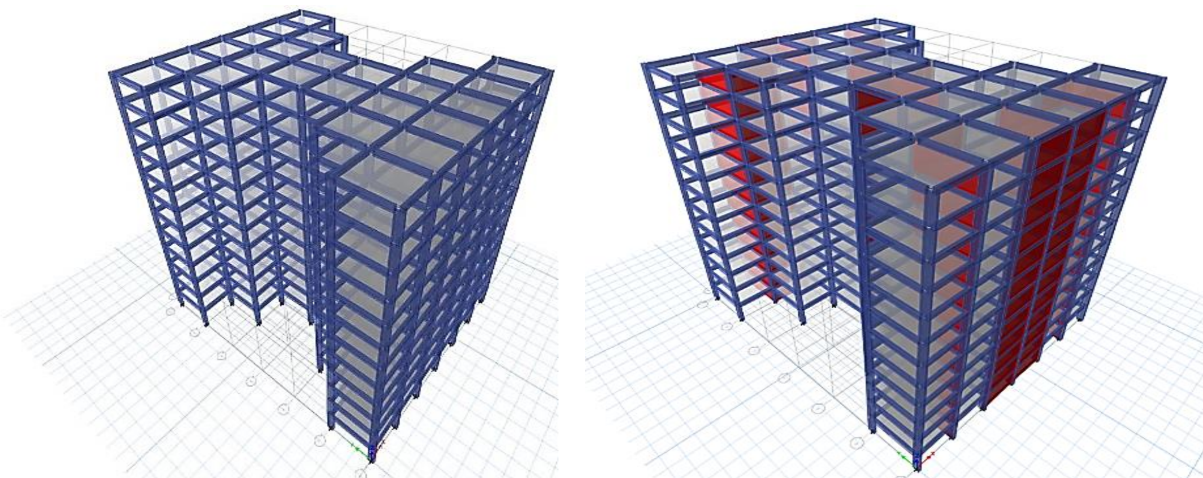
6. Description and Modeling of Building: -

Figures9and10 show the 12-story reinforced concrete residential building which is 36 m in height. It was analyzed using ETABS once under the blast load (with and without shear wall) and another under the seismic load (without shear wall) [9][10].



(a) without shear wall (b) with shear wall

Figures 9- Top view plan of the irregular 12-story building



(a) without shear wall (b) with shear wall

Figures 10 - 3D plan of the irregular 12-story building

6.1 Properties: -

Concrete and steel characteristics were determined by the density properties of each type, and four models were studied with different burst weights as shown in Table 1.

Table 1. Detailed properties

Grade	Model No. 1	Model No. 2	Model No. 3
Concrete	M27	M27	M27
Rebar	Fe415	Fe415	Fe415
Density concrete (kN/m^3)	25	25	25
Density Steel (kN/m^3)	78.5	78.5	78.5
Poisson's ratio	0.2	0.2	0.2
Type of Building	Irregular	Irregular	Irregular
Type of Model	Weight of TNT		
Code Concrete Design	ACI 318-14		
For Effect Load	TM5-1300		
Value for Effect (TNT)	100	350	750

Standoff Distance (m)	5	5	5
Live load (kN/m^2)	2.5	2.5	2.5
Floor finish load (kN/m^2)	1.5	1.5	1.5
Wall load (kN/m)	15	15	15

6.2 Properties of section: -

The dimensions of the columns, beams, walls and slabs were added, along with the dimensions of the building and height as shown in the Table 2.

Table 2. Model Description and Sectional Properties

Plan	30 m × 36 m
X- direction	6 space, 5m
Y- direction	6 space, 6m
The height of each story	3 m
Column Section	500mm × 250mm
Beam Section	600mm × 250mm
Shear wall	250 mm
Slab Thickness	200mm

7. Calculation of structural blast loads

7.1 Blast pressure determination

There are various relationships and approaches for determining the incident pressure value at a specific distance from an explosion. All the proposed relationships entail computation of the scaled distance, which depends on the explosive mass and the actual distance from the center of the spherical explosion.

Kinney [16] presents a formulation that is based on chemical type explosions. It is described by Equation (1) and has been used extensively for computer calculation purposes:

$$P_{so} = P_o \frac{808\left[1+\left(\frac{z}{4\cdot 5}\right)2\right]}{\left[1+\left(\frac{z}{0.048}\right)^2\right]\left[1+\left(\frac{z}{0.32}\right)2\right]\left[1+\left(\frac{Z}{1\cdot 35}\right)^2\right]^{0.5}} \qquad Eq.1$$

where Z (m/kg1/3) is the scaled distance.

Po is the ambient pressure.

Pso is the Peak Incident Pressure.

$$\text{Pso}=\begin{cases} \frac{6.7}{z^3}+1 & ,For \quad p_{s_0} < 10\ bar \\ \frac{0.975}{z}+\frac{1.455}{z^2}+\frac{5.85}{z^3}-0.019 & For\ \ 0\cdot 1 < p_{S0} < 10\ bar \end{cases} \qquad \text{Eq.2}$$

where Z (m/kg1/3) is the scaled distance

$$z = \frac{R}{\sqrt[3]{w}} \qquad Eq.3$$

where, R is the distance from the detonation source to the point of interest [m] and
w is the weight (more precisely: the mass) of the explosive, in kg.

Another formulation that is widely used for computing peak overpressure values for ground surface blast has been proposed by Newmark [17] and does not contain categorization according to the severity of the detonation:

$$P_{so} = 6784\frac{W}{R^3} + 93\sqrt{\frac{W}{R^3}} \quad \textbf{Eq. 4}$$

where Pso is in bars,
W is the charge mass in metric tons (=1000kg) of TNT and
R is the distance of the surface from the center of a spherical explosion in m.

Mills [13] also introduced an expression of the peak overpressure in kPa, in which W is expressed in kg of TNT and the scaled distance Z is in m/kg$^{1/3}$, which reads:

$$P_{so} = \frac{1772}{z^3} - \frac{114}{z^2} + \frac{108}{z} \quad \textbf{Eq.5}$$

The most widely used and accepted approach for the determination of blast parameters is the one proposed by Kingery-Bulmash [18]. Their paper includes formulations for both spherical (free air bursts) and hemispherical pressure waves (surface bursts) and provide the values of the incident and reflected pressures as well as of all other parameters. The proposed blast parameters are valid for distances from 0.05 m to 40 m as the diagrams included in [18] are referred to as 1kg of TNT. For comparison purposes, Figure 6 compiles the curves of the above expressions for peak incident overpressure versus scaled distance for both free-air bursts (spherical waves) and surface bursts (hemispherical waves). The corresponding curves of the Kingery-Bulmash study are included for reference. It is observed that the curves of Equations (2), (4), and (5) substantially deviate from the Kingery-Bulmash ones for small scaled distances. This may be because these equations were developed principally for nuclear blasts and not for conventional explosives. The Kinney curve, Equation (1), yields satisfactory predictions over the whole scaled distance [11][12][13].

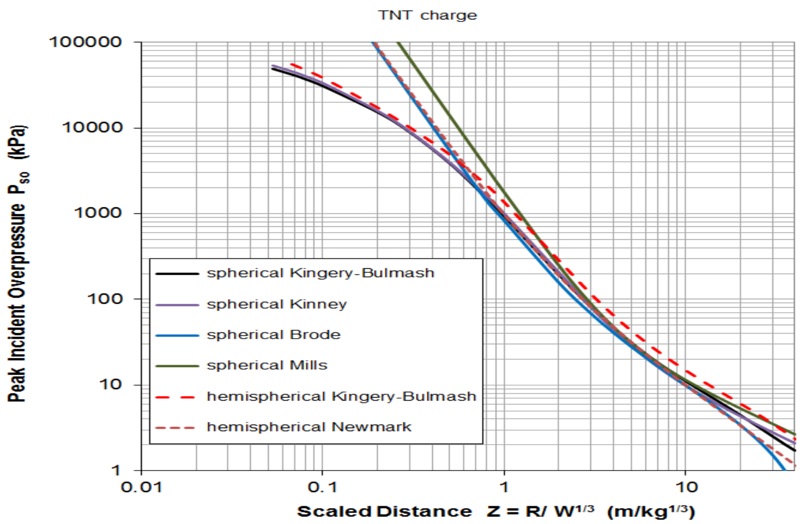


Figure .12 Comparison of curves of peak incident overpressure versus scaled distance for both

Figure (12) shows the diagrams of blast parameters for the positive phase of the blast wave for surface bursts. These diagrams are the metric-unit rendition of the curves contained in references [8] and [9]. They are overall more comprehensive and the curves have been drawn concerning scaled distances from Z=0.05 m/kg$^{1/3}$ to Z=40 m/kg$^{1/3}$. From these diagrams to obtain the absolute value of each parameter, its scaled value has to be multiplied by a factor W$^{1/3}$ to take into account the actual size of the charge. As mentioned above for the Hopkinson-Cranz scaling law, pressure and velocity quantities are not scaled. Most of the symbols encountered in Figure 6 have been defined in Figure 11, where the idealized pressure-time variation curve is shown. The additional symbols stand for:
U= shock wave speed (m/ms)
Lw= blast wavelength (m).
This latter can be defined, for a point at a given standoff distance at a particular time instant, for Lw + as the length which experiences positive pressure (or, negative pressure for Lw -).

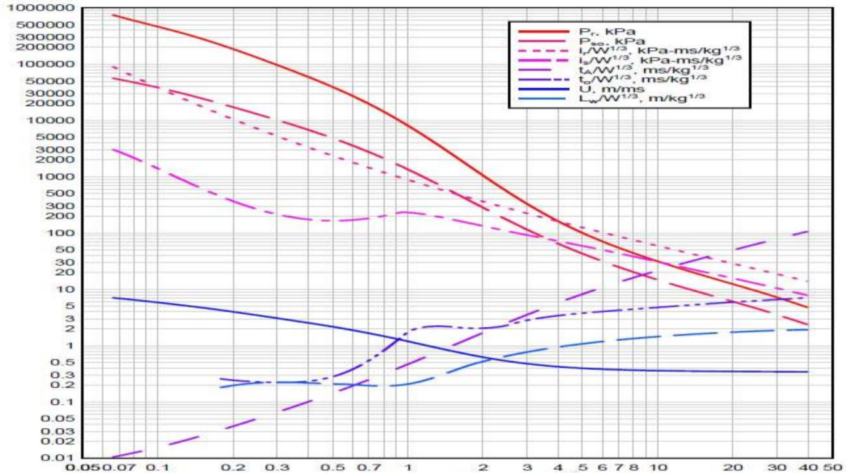


Figure.11 Parameters of the positive phase of shock hemispherical wave of TNT charges from surface bursts

7.2 Parameters of the positive phase of shock hemispherical wave of TNT: -

Table 3 shows the parameters of shock hemispherical wave positive phase, three different TNT weights from the surface, each joint on a side face of the 12-story [14][15].

Table 3: Parameters of blast load and pressure acting on the side face of the building (From Fig.7)						
Value of (Z)	**reflected impulse**	**Incident pressure**	**Incident Impulse**	**reflected Impulse**	**Arrival Time**	**positive duration**
	Pr	**Pso**	**Is**	**Ir**	**Ta**	**To**
1.3	5000	1200	230	850	0.45	1.9
1.7	1600	450	170	400	1.8	2
2	1000	280	150	380	1.9	2
2.2	900	250	150	320	2	2
2.4	600	180	130	300	2.5	2.2
2.6	500	100	100	280	3	2.5

8. **Conclusion**

The importance and effectiveness of the knowledge presented within previous studies regarding the concept of “explosive phenomena” and its role in enhancing the structural performance motive in buildings, leading to the fact that the design that enhances the capabilities of the internal and external environments design and implementation of buildings in reducing this phenomenon, the design is based on the provision of requirements and material elements The architectural and executive aims to achieve safety and psychological comfort by balancing the various design and operational factors. The studies also confirm the importance and effectiveness of the knowledge presented regarding the effective supportive design considerations, according to which it was possible to understand the nature of the explosion wave that caused the pressure and destroyed the elements of the structural structure. Where the results of the application confirmed the importance and effectiveness of the vocabulary of the theoretical framework, which dealt with focusing on evaluating the feasibility of architectural and structural material elements in strengthening the administrative buildings through:

Adopting the work of developing the architect’s plan by employing convex shapes instead of concave shapes for the external facades of the administrative buildings

-. The walls are also designed from precast concrete, being relatively thin bendable elements, and to provide flexibility in response, they must be reinforced, so it is preferable to increase the thickness of the panels and strengthen them.

- The need to use glazing systems for windows, as it is preferable to use typical float glass with high dynamic load and explosion-proof

- The use of technological techniques by employing the elements of energy-absorbing fishing systems

- The slab shaft face shall have stirrup reinforcement with closed collars properly fitted around the bend bars within a specified distance from the shaft face and the lower reinforcement shall be provided continuously through the shaft. This reinforcement prevents failure on connection and provides an alternative mechanism for developing shear transfer once the concrete has been drilled.

9. Recommendations

The research presents a set of recommendations and proposals to improve administrative buildings by achieving harmony between human requirements and work requirements by creating effective and stimulating administrative buildings to perform tasks and reduce the pressures of external explosions. The research recommends:

- Diversifying the design and structural systems between the external facades and creating a supportive structural structure that contributes to the renovation and strengthening of the administrative buildings to reduce the pressures of external and internal explosions.

- Familiarization with modern building techniques, building materials, and contemporary finishes, in addition to keeping pace with technological techniques and modern technological means of communication and exploiting their advanced capabilities to achieve control and sound insulation and prevent the destructive pressures of administrative buildings

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