International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 06, 2020

ISSN: 1475-7192

# ARCHITECTURAL AND STRUCTURAL DESIGN TO COMPARE THE EFFECT OF BLAST LOAD ON IRREGULAR BUILDINGS FROM VIEW POINT STEEL BRACES

[1]Ali Kifah Kadhum, [2]Lina K. Kadhum

***Abstract---*** *This paper aims at a study comparing the effect of high load on two types of structural design for a residential building, the first type is with steel frame and the second type with steel braces. each building is composed of 12 floors of different weight of TNT material. This type of loading should now be taken into account in Iraq, especially after the terrorist attack from the bombings that the country is going through from 2003 to the present day. Explosions must be studied in Iraq to avoid significant losses in lives and human and economic equipment. The same multi-frame building is designed with a steel frame with three different weights of TNT 100,350 and 750 kg in order to discuss the difference between the two types of structures in terms of analysis of drift, displacement and shear story and base shear. An ETABS2018 commercial package was used to analyze this 36-meter-high building. The building was analyzed according to the American code, while it was designed according to AISC 360-10 (LRFD) and the U.S. Department of Defense TM5-1300 to carry the explosion. the maximum increase drift it was seen on the 3rdand6th storeys amount 393%,358% for weight 100 kg and same story 392%,363% for weight 350 kg and the maximum increase drift on the 2nd,3rd storeys amount 426%,329% for weight 750 kg TNT. the maximum increased story shear by about 257 % of blast load 100 kg-350, and the maximum increase story shear it was seen in the amount 298% for weight TNT between 350kg-750kg. the maximum increase story shear it was seen in the amount 747% for weight TNT between 100kg-750kg. the maximum increase displacement it was seen on the 6th and 7th storeys amount 360%,357%for weight 100 kg and 350 kg and the maximum displacement increase on the 2nd,3rd storeys amount 438%,393% for weight 750 kg TNT.*

**Keywords--** *Blast load, ETABS, Tall building, standoff, TNT. Irregular building, steel braces*

## I INTRODUCTION

Since the 1980's terrorists have used car bombs to attack buildings throughout the world, causing tragic consequences, loss of lives and injuries to thousands of people. Figure 1.1 shows the three important measures taken to protect buildings against car bomb attacks. The first and most effective measure is to gather intelligence on terrorist activities in an effort to find out about those activities in advance and prevent their occurrence. The second step is to provide physical barriers and standoff distances around the buildings such that car bombs cannot be detonated close to buildings. The third line of defense is to harden the building. The hardening, which is done through blast-resistant design, should be done such that

[1] *Assistant Lecturer /University of AL-Mustansiriyah /College of Engineering/ Department of Water Resources 1, https://orcid.org/0000-0002-6722-1890, E-mail: alikifah@uomustansiriyah.edu.iq*

[2] *Assistant Lecturer /University of AL-Mustansiriyah /College of Engineering/ Department of Water Resources, E-mail: linakifah33a@gmail.com*

**Received: 22 Feb 2020 | Revised: 13 Mar 2020 | Accepted: 05 Apr 2020** 

if the first and second steps fail and the car bomb explodes close to the building casualties are prevented and injuries to people and damage to the building are minimal with no progressive collapse. Past experience with car bomb attacks on buildings indicate that if a progressive collapse occurs, it can cause a very high number of casualties and injuries. The third measure is the responsibility of the engineer designing the blast

The resistance of the building and this report is prepared to be of some help to that end. Structural engineers and other design professionals are often asked what can be done to protect

- To minimize local damage and;
- To prevent progressive and catastrophic collapse

A terrorist attack applying ground-based explosions, such as car bombs, or using a flying object, such as airplanes or rockets, can result in:

1. Serious but very localized damage to a few columns and beams in the vicinity of the

Impacted zone, and;

2. Progressive collapse initiated by the local failures which spreads in a domino effect resulting in the collapse of large portions or even the entire structure. In the case of critical buildings, such as nuclear power plants and military command and control centers, even a local damage to a small portion of the building can have catastrophic consequences. Therefore, for those structures, even a local damage due to terrorist or other attacks using explosives is not tolerated. The Progressive collapse of the U.S. buildings either abroad or at home has resulted in thousands of deaths in military barracks in Beirut in the 1980’s, in embassy buildings in Africa and in Murrah Federal building in the 1990’s, in the World Trade Center and Pentagon in 2001 and various civilian buildings throughout the world. In other less sensitive buildings, such as office or residential buildings, assuming a low probability of a terrorist attack, currently the protection measures are not so unanimously accepted [1].

## II PROBLEM STATEMENT

Understanding the exhibition of elevated structures under blast is vital to supply structures which dispose of or limit harm to assembling furthermore, property in the event of impact, especially with the progressing flood in uncommon activities centered at structures with useful business regards. Plan consideration towards blasts is amazingly necessary of excessive upward push services kind of community and commercial great buildings due to the fact there are dense buildings who may lie beneath chance regarding detonation loading although not in the beginning intended for equivalent. The investigation and tastefulness regarding impact sure constructions require an all assuming regarding explosives influence wonders then germination penalties because of structures. Accordingly, it's indispensable after accumulate the on-hand composition survey of explosives, have an effect on marvels, stun worry adjuvant then because of this the reaction concerning structures in conformity with affect loads.

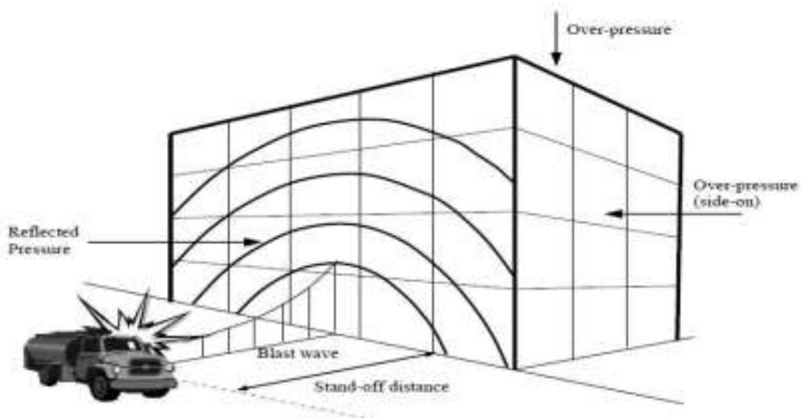



Figure. 1: Blast loading on the building

## III CHARACTERISTICS OF BLAST WAVE

A speedy addition in volume and release of vitality in an extraordinary manner, usually by the age of very warm and arrival of gases is described as impact. Blasts either happen in the kind of deflagration then burst depending over eating velocity all through the blast. Deflagration is engendered by using the freed explanation on heat conductivity; resulting tier regarding bloodless material is touched far away with the aid of the ceaseless eating material then consumes such and alongside this traces the approach continues as a way. Most "fire" observed in pathway concerning life, beyond flares in imitation of impacts is deflagration. The explosion might remain an entirely sore who includes a supersonic exothermic front enlivening thru a middling to that amount within the give up drives a stunned look multiplying legitimately in look concerning it.

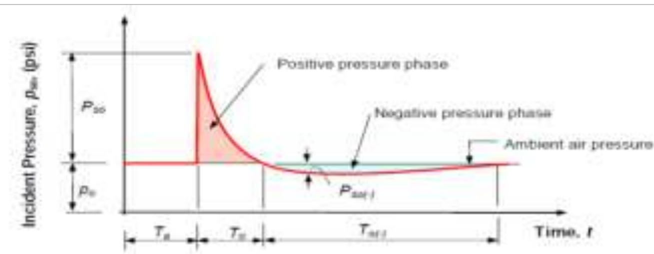



Figure 2: Typical the blast wave pressure-time profile

## IV THE BUILDING'S ARCHITECTURALLY BLAST-RESISTANT DESIGN

The architectural knowledge of the design of building structures resistant to the effects of explosions is important in strengthening the buildings to mitigate the effects of this. The Planning and layout is the most important stage to be taken into consideration. When designing a new building to reduce potential threats and associated risks of injury and damage to the building. The risk of explosion should be considered, as the appropriate shelter spaces within the building should be allocated to provide explosive protection for structural and non-structural organs, and with regard to the external threat, the priority should be to create as much confrontation as possible between the explosion and the building. This can be

Received: 22 Feb 2020 | Revised: 13 Mar 2020 | Accepted: 05 Apr 2020 

achieved through the strategic location of obstacles such as pollards, trees and street furniture. The architectural firm also has a significant impact on the building's explosion loads. Architectural elements such as arches and domes are structural elements that minimize the effects of the explosion of the building. The architectural plan has a significant impact on the size of the blast load it faces. Keep away from the layout of complex shapes (u-shaped buildings) which in turn cause multiple reflections of the blast wave. It was noted that one-story buildings are more explosively more resistant than multi-story buildings. The event of explosions. As for the internal planning of the building has a great effect to resist the effects of the explosion by protecting the foyer areas with armed concrete walls; With control of the entrance of the building and separate it from other parts of the building of a solid building to provide physical protection of the building. The presence of the basements within the building or the parking lot at the bottom of the building should also be avoided unless access can be effectively controlled.

## V BLAST LOADING TYPES

As an explosive price detonates among urban areas the surroundings, yet the can placement about the explosion, affects the loading about the structures. The kind concerning blast as is considered between that treatise is unconfined, non-contact explosions as are external in imitation of the constructing structure. As Carlos et al. Writes, the type is furcating of three subtypes certain as show fig 3.

- Free-air bursts,
- Air bursts.
- Surface bursts.

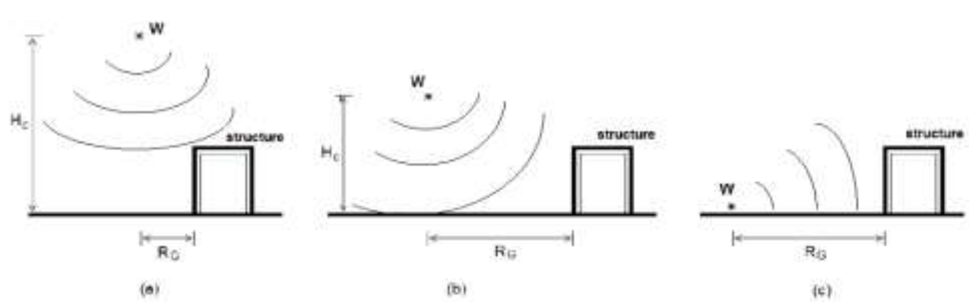


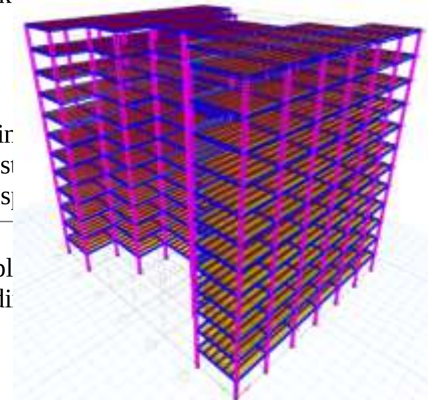

Figure 3: Blast loading from explosion types

## VI MODELLING AND ANALYSIS

### VI.I. *Description and Modeling of Building*

The goal over that assignment is according to ask abroad the response concerning informal building. To understand the behavior of structural different condition two cases building first case Fig 4: (a) without steel braces 2nd case Fig 4: (b) steel braces, also with different condition charge weights of 100 kg and 350 kg and 750 kg are applied at a standoff distance of 5m the objective over that task is as per ask abroad the is reaction concerning the casual building.

To comprehend the conduct of structure in various condition charge loads of 100 kg and 350 kg and 750 kg are applied at a standoff separation of 5m Prior a few scientists chipped away at the structures with shaft segment associations. The impact of shoot load on chunk are considered by just a couple of scientists. Henceforth, during this work. This errand manages displaying and the examination of (G+11), structure exposed to 100kg of TNT explosives with various showdown separations utilizing ETABS 2016. The foreordained impact loads are appointed as static joint loads inside the level chunk structure and straight static examination is directed for level piece structures. At first, the structures are displayed and broke down for the doled out shoot stacks in ETABS. Apparatus and consequently the structures are made safe for different material properties and area properties. The level chunk structures are broken down for seismic examination and time-history investigation right off the bat.



### VI.II. *Computer Modeling and Analysis*

ETABS programming program is utilized in light of the fact that demonstratin of casing component chunks are demonstrated so hold components in flexible s floors firm help situation is applied. Blast load estimations are regulated to be s in share five of explosion loads concerning entire over the turn face right surface structure. techniques or diagrams, named at impact class through are partners, which hundreds for qualities about

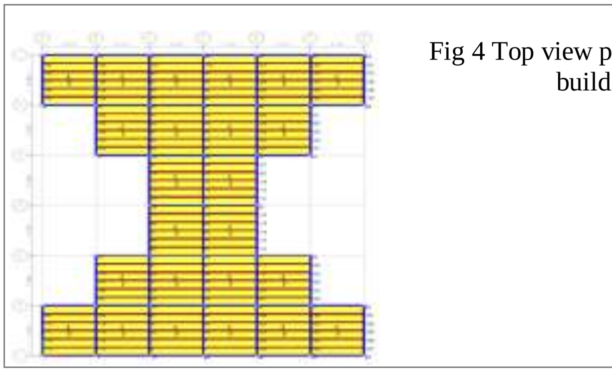
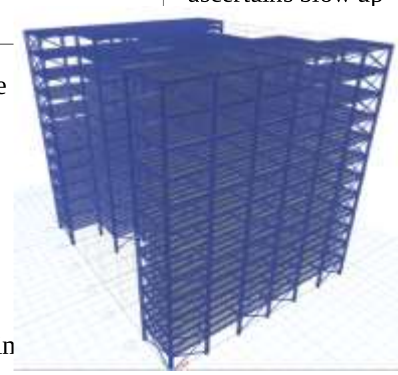


Fig 4 Top view pl buildi

TM5-1300 programming was once best in applied query ascertains blow up



standoff separations. This product computes explosion loads solid parameters like or time concerning

$Z=R/W^{1/3}$

Z- Scale

R - Distance from the center of a

W - Charge mass expressed in kilograms of TNT.

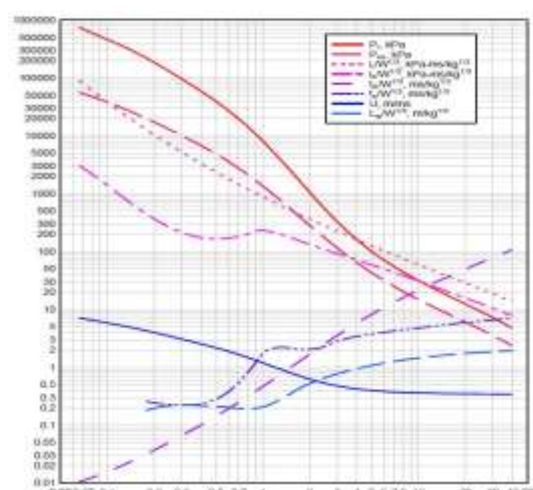
### VI.III. *Determination of Blast Pressure and Blast Durations*

Unified Facilities Criteria (UFC). (2008): Introduced a chart to calculate the maxin for a free-air burst as shown in fig7

### VI.IV. *Model Description*

Plan: 30m x 36m
X- direction: 6 space 5m
Y- direction: 6 space 6m
The height of each story 3m

### VI.V. *Properties of materials*



| Grade | |
|---|---|
| Concrete | M27 |
| rebar | Fe415 |
| Density concrete | 25kN/m3 |
| Density Steel | 78.5kN/m3 |
| Poisson's ratio | 0.2 |

**Table 1: define material**

Figure 6 - 3D plan of irregular building with steel braces

Fig.ure 5 - 3D plan of irregular building without steel braces

**Fig.7 Positive phase shock wave**

**parameters for TNT explosion of free-air**

| Standoff 5 m | | | | | | | Area m2 | | | P kN | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z | reflected impulse | Incident pressure | Incident Impulse | reflected Impulse | Arrival Time | positive duration | | | | 9 m2 | 18 m2 | 4.5m2 |
| joint | Pr | Pso | Is | Ir | Ta | To | | | | | | |
| **1.3** | 5000 | 1200 | 230 | 850 | 0.45 | 1.9 | 9 | 18 | 4.5 | 10800 | 21600 | 5400 |
| **1.7** | 1600 | 450 | 170 | 400 | 1.8 | 2 | 9 | 18 | 4.5 | 4050 | 8100 | 2025 |
| **2** | 1000 | 280 | 150 | 380 | 1.9 | 2 | 9 | 18 | 4.5 | 2520 | 5040 | 1260 |
| **2.2** | 900 | 250 | 150 | 320 | 2 | 2 | 9 | 18 | 4.5 | 2250 | 4500 | 1125 |
| **2.4** | 600 | 180 | 130 | 300 | 2.5 | 2.2 | 9 | 18 | 4.5 | 1620 | 3240 | 810 |
| **2.6** | 500 | 100 | 100 | 280 | 3 | 2.5 | 9 | 18 | 4.5 | 900 | 1800 | 450 |
| **2.8** | 400 | 90 | 95 | 250 | 3.2 | 2.8 | 9 | 18 | 4.5 | 810 | 1620 | 405 |
| **3** | 310 | 95 | 90 | 220 | 3.8 | 3 | 9 | 18 | 4.5 | 855 | 1710 | 427.5 |
| **3.5** | 250 | 80 | 80 | 190 | 4.5 | 3.4 | 9 | 18 | 4.5 | 720 | 1440 | 360 |
| **4** | 180 | 60 | 70 | 180 | 6 | 3.5 | 9 | 18 | 4.5 | 540 | 1080 | 270 |
| **4.5** | 140 | 45 | 65 | 150 | 6.5 | 3.9 | 9 | 18 | 4.5 | 405 | 810 | 202.5 |
| **5** | 100 | 40 | 60 | 140 | 8 | 4 | 9 | 18 | 4.5 | 360 | 720 | 180 |
| **5.5** | 80 | 35 | 55 | 120 | 8.5 | 4 | 9 | 18 | 4.5 | 315 | 630 | 157.5 |
| **6** | 60 | 30 | 50 | 105 | 11 | 4.1 | 9 | 18 | 4.5 | 270 | 540 | 135 |
| **6.5** | 55 | 25 | 45 | 95 | 13 | 4.2 | 9 | 18 | 4.5 | 225 | 450 | 112.5 |
| **7** | 50 | 22 | 40 | 90 | 15 | 4.3 | 9 | 18 | 4.5 | 198 | 396 | 99 |
| **7.5** | 45 | 20 | 38 | 85 | 16 | 4.6 | 9 | 18 | 4.5 | 180 | 360 | 90 |
| **8** | 40 | 19 | 35 | 80 | 17 | 4.8 | 9 | 18 | 4.5 | 171 | 342 | 85.5 |
| **8.5** | 37 | 18 | 32 | 75 | 18 | 4.85 | 9 | 18 | 4.5 | 162 | 324 | 81 |
| **9** | 35 | 17 | 30 | 70 | 19 | 4.9 | 9 | 18 | 4.5 | 153 | 306 | 76.5 |
| **9.5** | 32 | 16 | 30 | 65 | 19.5 | 4.95 | 9 | 18 | 4.5 | 144 | 288 | 72 |
| **10** | 30 | 15 | 30 | 63 | 20 | 5 | 9 | 18 | 4.5 | 135 | 270 | 67.5 |
| **11** | 28 | 14 | 29 | 60 | 24 | 5.1 | 9 | 18 | 4.5 | 126 | 252 | 63 |
| **12** | 25 | 13 | 26 | 55 | 28 | 5.15 | 9 | 18 | 4.5 | 117 | 234 | 58.5 |
| **13** | 20 | 12 | 25 | 50 | 30 | 5.2 | 9 | 18 | 4.5 | 108 | 216 | 54 |
| **14** | 19 | 11 | 24 | 45 | 32 | 5.3 | 9 | 18 | 4.5 | 99 | 198 | 49.5 |
| **15** | 17 | 10 | 23 | 40 | 36 | 5.5 | 9 | 18 | 4.5 | 90 | 180 | 45 |
| **16** | 15 | 8 | 20 | 38 | 39 | 5.6 | 9 | 18 | 4.5 | 72 | 144 | 36 |
| **17** | 14.5 | 7 | 18 | 35 | 40 | 5.65 | 9 | 18 | 4.5 | 63 | 126 | 31.5 |
| **18** | 14 | 6.5 | 17 | 33 | 45 | 5.7 | 9 | 18 | 4.5 | 58.5 | 117 | 29.25 |

**Table 3. Pressure and the joint load acting on the front face of the building acting at 5m at a charge weight of 100,350,750kg**

### VI.VI. *Sectional Properties*

**Received: 22 Feb 2020 | Revised: 13 Mar 2020 | Accepted: 05 Apr 2020**

International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 06, 2020
ISSN: 1475-7192

Column: HE360
Beam: IPE330
Secondary beams=W12X30
Deck Slab: 155 mm
Slab concrete = 80 mm
Ribbed Deck=75 mm
shear Stud= 127 mm
steel braces = L 102X76X7.9 mm

### VI.VII. *General Loadings*

Live load: 2.5kN/m2 (Floor)
Floor Finish: 1.5 kN/m2
Wall load: 15 kN/m
Parapet Wall load: 3.0kN/m

**Table -2:** Model Description

| Model No. | Type of Building | Weight TNT (kN) | Standoff Distance (m) |
|---|---|---|---|
| M1 | Irregular | 100 | 5 |
| M2 | Irregular | 350 | 5 |
| M3 | Irregular | 750 | 5 |

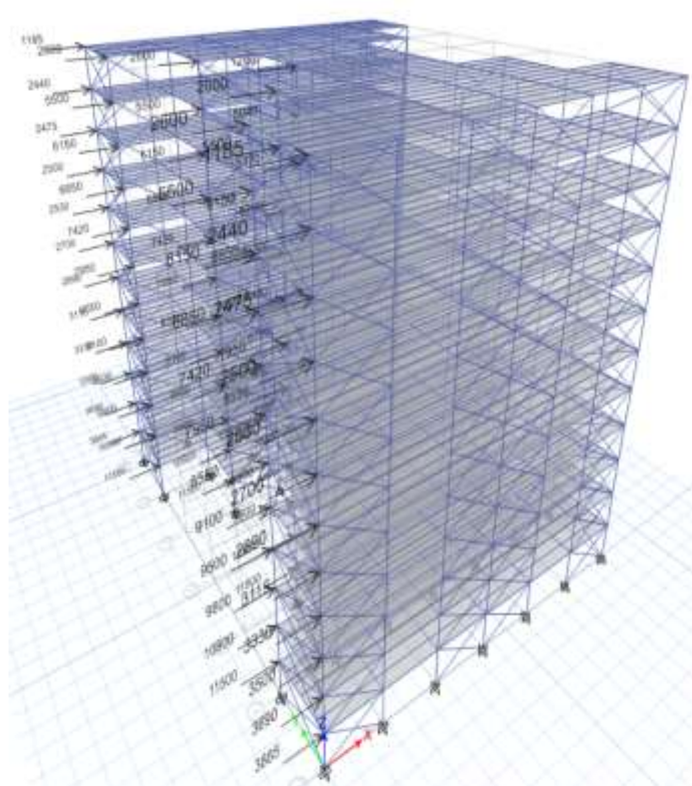


Fig 8. Apply blast load (side face)

| Joint / Story | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 730 | 1600 | 1600 | 1500 | 1600 | 1600 | 730 |
| 2 | 715 | 1450 | 1450 | 1482 | 1450 | 1450 | 715 |
| 3 | 700 | 880 | 880 | 1464 | 880 | 880 | 700 |
| 4 | 680 | 855 | 855 | 1430 | 855 | 855 | 680 |
| 5 | 665 | 825 | 825 | 1400 | 825 | 825 | 665 |
| 6 | 640 | 790 | 790 | 1380 | 790 | 790 | 640 |
| 7 | 620 | 780 | 780 | 1355 | 780 | 780 | 620 |
| 8 | 590 | 765 | 765 | 1320 | 765 | 765 | 590 |
| 9 | 575 | 758 | 758 | 1290 | 758 | 758 | 575 |
| 10 | 550 | 750 | 750 | 1260 | 750 | 750 | 550 |
| 11 | 543 | 742 | 742 | 1200 | 742 | 742 | 543 |
| 12 | 278 | 374 | 374 | 265 | 374 | 374 | 278 |

**Table 3.1 (p kN) story with joint standoff 5m 100kg**

## VII RESULTS

### VII.I. *Drift:-*

According to the results the chart 1 ,2 and 3 show the different amount case between building with and without steel braces , From chart1, 2 and 3, we can see the increase drift with building without steel braces more than from with steel braces, take result story 2nd,3rd,6th,7th,11th and story12th, amounts increased by about 346%-393% -358%-332%-181% and 136 % of blast load 100 kg. Amounts increased by about 347%-392%-363%-334%-178% and 132% of blast load 350 kg. Amounts increased by about 426%-329%-202%-180%-107% and 93% of blast load 750 kg, the maximum increase drift it was seen on the 3rdand6th storeys amount 393%,358% for weight 100 kg and same story 392%,363% for weight 350 kg and the maximum increase drift on the 2nd,3rd storeys amount 426%,329% for weight 750 kg TNT.

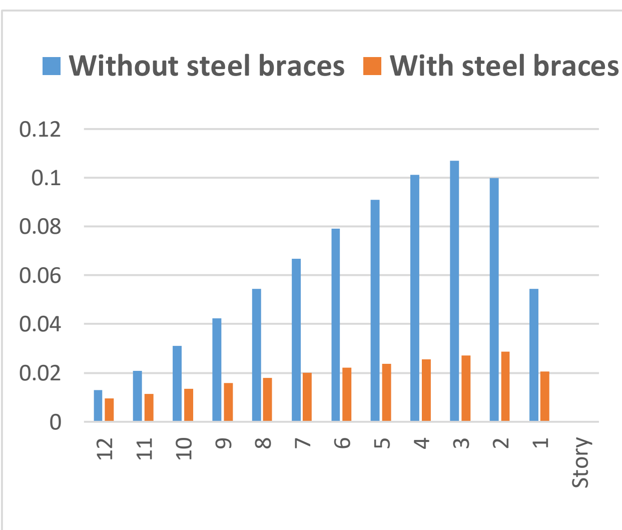


chart 1:Max drift for Standoff 5 m TNT 100 kg

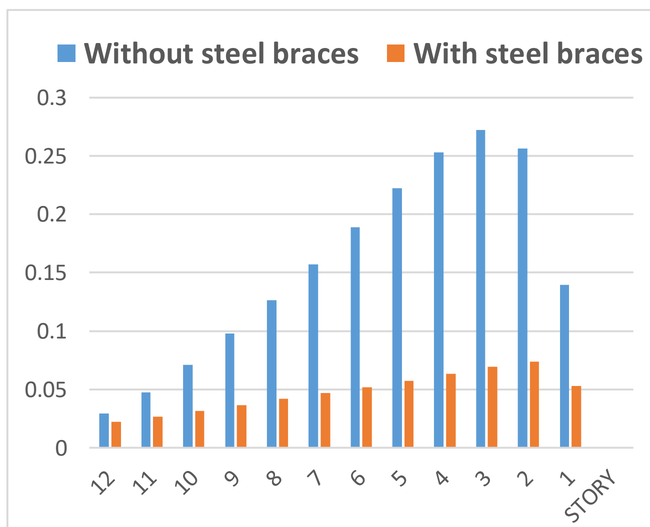
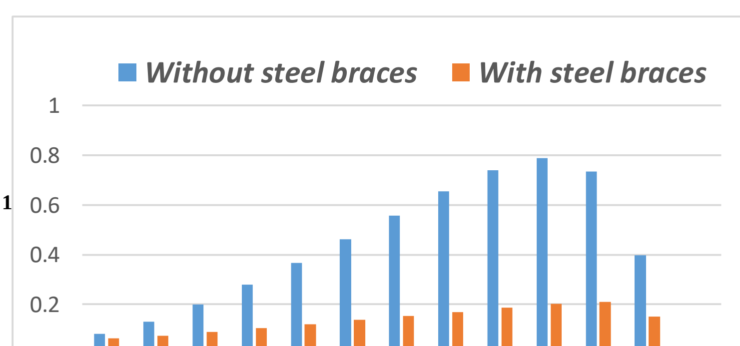


chart 2:Max drift for Standoff 5 m TNT 350 kg



### VII.II. *Storyshear:- -*

According to the results the chart 4,5 and 6 show the different amount building, we can see the increase story shear with different weight 100kg-350kg, and 740 kg take result story shear, amounts increased by about 257 % of blast

| Story | Elevation | X-Dir |
|---|---|---|
| | m | kN |
| S 12 | 36 | -2780.4 |
| S11 | 33 | -9085.2 |
| S 10 | 30 | -15517.2 |
| S 9 | 27 | -22069.2 |
| S 8 | 24 | -28707.6 |
| S 7 | 21 | -35973.6 |
| S 6 | 18 | -42909.6 |
| S 5 | 15 | -49977.6 |
| S 4 | 12 | -57429.6 |
| S 3 | 9 | -65090.4 |
| S 2 | 6 | -75544.8 |
| S 1 | 3 | -86776.8 |
| Base | 0 | 0 |

Table 4 Story Shears 100 kg

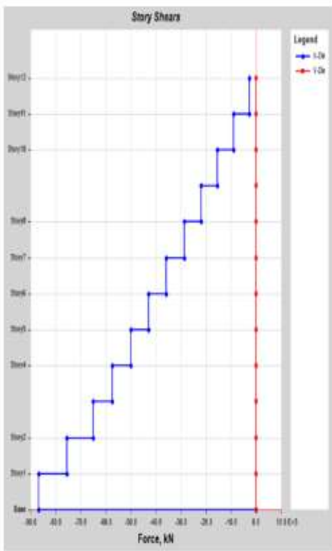



chart 4: Story Shears 100kg

| Story | Elevation | X-Dir |
|---|---|---|
| | m | kN |
| S 12 | 36 | -6840 |
| S11 | 33 | -20196 |
| S 10 | 30 | -35186.4 |
| S 9 | 27 | -50396.4 |
| S 8 | 24 | -66320.4 |
| S 7 | 21 | -83114.4 |
| S 6 | 18 | -100598.4 |
| S 5 | 15 | -121004.4 |
| S 4 | 12 | -143420.4 |
| S 3 | 9 | -167984.4 |
| S 2 | 6 | -194528.4 |
| S 1 | 3 | -222920.4 |
| Base | 0 | 0 |

Table 5 Story Shears 350kg

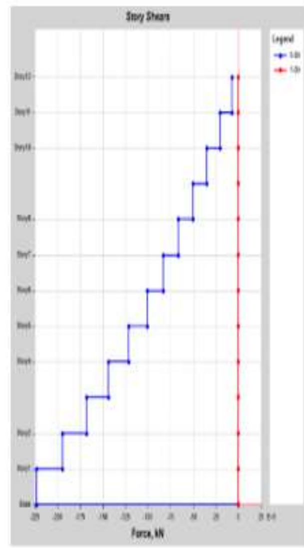


chart 5: Story Shears 350kg

| Story | Elevation | X-Dir |
|---|---|---|
| | m | kN |
| S 12 | 36 | -16764 |
| S11 | 33 | -55068 |
| S 10 | 30 | -96972 |
| S 9 | 27 | -142692 |
| S 8 | 24 | -191736 |
| S 7 | 21 | -244128 |
| S 6 | 18 | -300240 |
| S 5 | 15 | -359796 |
| S 4 | 12 | -422184 |
| S 3 | 9 | -486816 |
| S 2 | 6 | -556872 |
| S 1 | 3 | -630996 |
| Base | 0 | 0 |

Table 6 Story Shears 750 kg

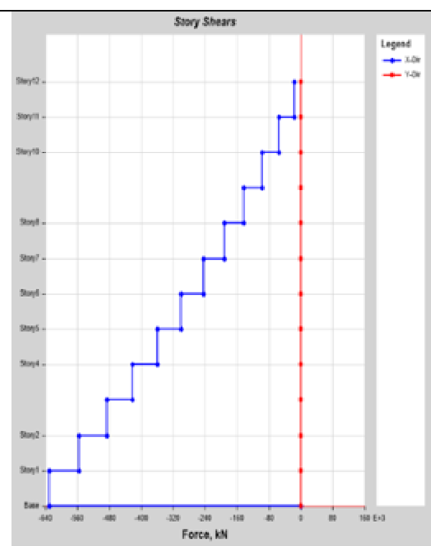



chart 6: Story Shears 750 kg

Received: 22 Feb 2020 | Revised: 13 Mar 2020 | Accepted: 05 Apr 2020 

load 100 kg-350, and the maximum increase story shear it was seen in the amount 298% for weight TNT between 350kg-750kg. the maximum increase story shear it was seen in the amount 747% for weight TNT between 100kg-750kg

### VII.III. *Displacements:-*

According to the results the chart 7 ,8 and 9 show the different amount case between building with and without steel braces, From chart7, 8 and 9, we can see the increase displacement with building without steel braces more than from with steel braces, take result story 2nd,3rd,6th,7th,11th and story12th, amounts increased by about 315%-342% -360%-357%-330% and 323 % of blast load 100 kg. Amounts increased by about 315%-342%-360%-357%-330% and 323% of blast load 350 kg. Amounts increased by about 438%-393%-296%-275%-219% and 209% of blast load 750 kg, the maximum increase displacement it was seen on the 6th and 7th storeys amount 360%,357%for weight 100 kg and 350 kg and the maximum displacement increase on the 2nd,3rd storeys amount 438%,393% for weight 750 kg TNT.

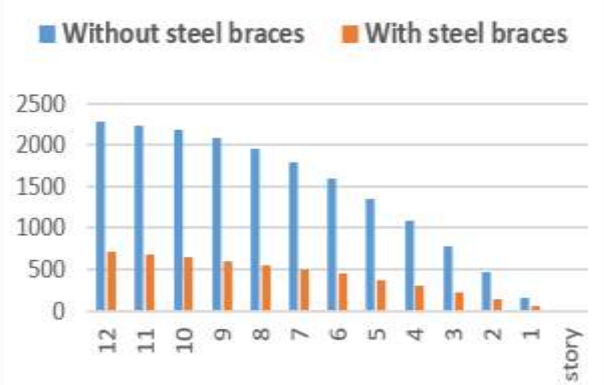



chart 7: Max Disp (mm) for Standoff 5 m TNT 100 kg

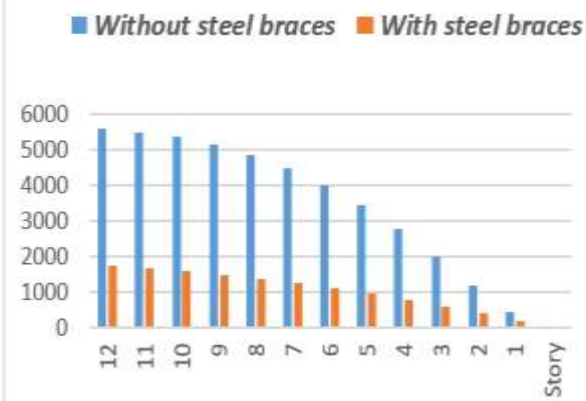



chart 8: Max Disp (mm) for Standoff 5 m TNT 350 kg

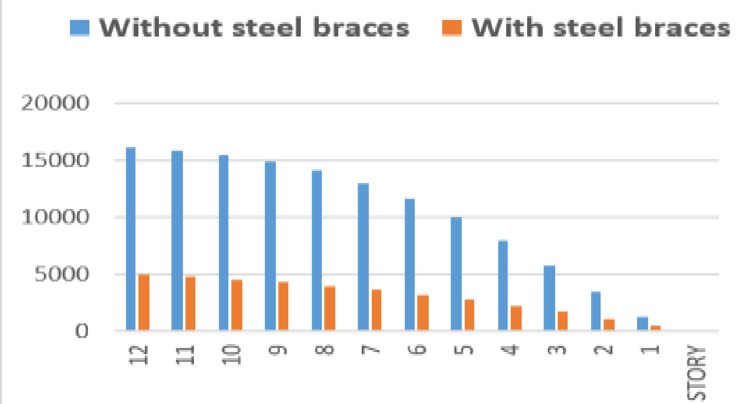



chart 9: Max Disp (mm) for Standoff 5 m TNT 750 kg

## VIII CONCLUSION

The blast load applied affective lateral forces on the building side. This effect was obvious in the compare building of two cases with steel braces and without steel braces. Columns, beams and steel braces, especially in the joints between them. These joints have been strengthened by additional reinforcement to withstand the lateral forces of the blast load.

- About drift, the results the chart 1 ,2 and 3 show the different amount case between building with and without steel braces, From chart1, 2 and 3, we can see the increase drift with building without steel braces more than from with steel braces,. the maximum increase drift it was seen on the 3rdand6th storeys amount 393%,358% for weight 100 kg and same story 392%,363% for weight 350 kg and the maximum increase drift on the 2nd,3rd storeys amount 426%,329% for weight 750 kg TNT.

- the increase story shear with different weight 100kg-350kg, and 740 kg take result story shear, the maximum increased story shear by about 257 % of blast load 100 kg-350, and the maximum increase story shear it was seen in the amount 298% for weight TNT between 350kg-750kg. the maximum increase story shear it was seen in the amount 747% for weight TNT between 100kg-750kg.
- the maximum increase displacement it was seen on the $6^{th}$ and $7^{th}$ storeys amount 360%,357%for weight 100 kg and 350 kg and the maximum displacement increase on the $2^{nd}$,$3^{rd}$ storeys amount 438%,393% for weight 750 kg TNT.
- Through the results, the building equipped with steel braces is recommended from the architectural side because of its low risk during the explosion, according to the study presented in this research paper. Therefore, when increasing the weight of the TNT material, it will increase the amount (displacement, erosion and basic shear), which leads to an increase in the failure of the building. In order for this failure to be addressed, there will be an increase in the dimensions and the materials used that increase the cost of the building and the weight of the building.

-

## REFERENCES


1. TM5 – 1300 (1990). Design of Structures to resist the effect of accidental explosions. Washington D C. U. S. Department of Army.
2. Aditya C Bhatt, Snehal V Mevada, Sumant B Patel –Comparative Study of Response of Structures Subjected to Blast and Earthquake Loading - International Journal of Engineering Research and Applications, ISSN:2248-9622, Vol. 6, Issue 5, (Part - 2) May 2016.
3. Dusenberry, D. O. (2010). Handbook for blast resistant design of building. Hoboken, New Jersey: John Wiley & Sons, Inc.
4. Jayashree S M, Helen Santhi M, RakulBharatwaj R –Dynamic response of a space framed structure subjected to blast load - International Journal of Civil and Structural Engineering, ISSN: 0976-4399, Volume 4, No 1, 2013.
5. Ahmed A Bayoumey and Walid A Attia (2016)"Assessment of existing structures under the action of gravity, earthquake and blast loads" International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 5, Issue 3, pp: 37-47.
6. Ali Kifah Kadhum and Khattab Saleem Abdul-Razzaq Effect of Seismic Load on Reinforced Concrete Multistory Building from Economical Point of View, International Journal of Civil Engineering and Technology (IJCIET) 9(11), 2018, pp. 588–598.
7. http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=9&IType=11
8. Hrvoje Draganic and Vladimir Sigmund (2012). Blast Loading on Structures. Journal: International Journal of Engineering Research and Applications (IJERA) ISSN 1330 – 3651 UDC/UDK 624.01.04:662.15. Technical Gazette 19, 3.

ISSN: 1475-7192

9. Zeynep Koccaz, Fatih Sutcu and Necdet Torunbalci (2008)"Architectural and Structural design for Blast resistant buildings" The 14th World conference on Earthquake Engineering, Beijing, China, pp:37-50
10. Osman Shallan, AtefEraky, TharwalSakr, ShimaaEmad – Response of Building Structures to Blast Effects – International Journal of Engineering and Innovative Technoogy, ISSN: 2277-3754, Volume 4(2), August 2014.
11. Swathi Ratna. K, Analysis of RCC and Simcon Buildings Subjected To Blast Effects. International Journal of Civil Engineering and Technology, 7(4), 2016, pp.223–233. http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=7&IType=4.
12. Ahmed Amer, Walid Attia, Sherif Elwan and Kamel Tamer. International Journal of Civil Engineering and Technology (IJCIET) Volume 10, Issue 10, October 2019, pp. 479-488, Article ID: IJCIET_10_10_046 Available online at http://www.iaeme.com/ijciet/
13. UFC, 2008. Unified Facilities Criteria 3-340-02: Structures to resist the effects of
14. accidental explosions, Dept. of the Army, the NAVY and the Air Force, Washington DC, USA.
15. Smith P.D., Hetherington J.G. (1994) Blast and ballistic loading of structures. Butterworth Heinemann.
16. Hill J.A., Courtney M.A. (1995). The structural Engineer's Response to Explosion Damage. The Institution of Structural Engineer's Report, SETO Ltd, London.
17. Ali Kifah Kadhum. a. K. S. Abdul-Razzaq, "Effect of Seismic Load on Reinforced Concrete Multistory Building from Economical Point of View," International Journal of Civil Engineering and Technology (IJCIET, vol. 9, no. 11, pp. 588-598, 2018. http://www.scopus.com/inward/record.url?eid=2-s2.0-85082727286&partnerID=MN8TOARS