*International Journal of Latest Engineering and Management Research (IJLEMR)*
*ISSN: 2455-4847*
*www.ijlemr.com || Volume 03 - Issue 03 || March 2018 || PP. 04-19*

# Parametric Study of Dome Structure under Pulse Loading History of Blast Load

Mohammed sahal M. Kazi[1], Dipali Y. Patel[2]
[1](*Post Graduate Student (Structural Engineering), Department of Civil Engineering, Chandubhai S. Patel Institute of Technology, Charotar University of Science and Technology, Changa, Gujarat, India)*
[2](*Assistant Professor, Department of Civil Engineering, Chandubhai S. Patel Institute of Technology, Charotar University of Science and Technology, Changa, Gujarat, India)*

**Abstract :**Now a days, due to increasing terrorist attacks, a need is arise to design the dome structures which can resist the blast loads. The bomb explosion can cause vary serious damage on the dome structure. In this paper an attempt has been made to analyze the dome structure for different pulse history of blast load and to check the effect of same by changing the thickness of dome. Some critical four pulses like Half + and half – triangular pulse, full cycle cosine pulse, rectangular pulse and irregular pulseare developed in C sharp. Analysis of dome is carried out to study the effect of four-critical pulse loading history with variable thickness of 150 mm, 200 mm, 250 mm and 300 mm with different blast explosion of 0.1 tonne, 0.5 tonne and 1 tonne. Thus, on the dome structure some stresses and acceleration may develop due to that pulses and the same are critically assessed.

**Keywords:**Spherical domes, Pulse loading history, C sharp, Stresses, acceleration.

## I. INTRODUCTION

The pre-eminence of Domes is in their strength and stiffness that they stand without support of columns. Curvatures rotate about central axis to form a surface characteristically used as a roof to create a dome. Most of them are created by revolution of surfaces. It creates maximum amount of space with minimum weight which leads to be very economical in terms of constructional materials. They are most efficient structure specially as roof structures. The axial behavior of domes and coupling among the bending which make them difficult to analyze. The function of domes largely affected by geometry and shape. The loads acting on domes are resisted by its own weight. The domes are one of the most efficient shapes in the world. It is lightest structure to cover up the circular shape. R.C.C. domes are water, fire and wind resistant. Dome structure is easy to maintain and also economic then other buildings. The structure has many different accept that make it the best choice in construction. The other buildings life measured in decades but the life of dome can be measured in centuries. Dome having arch shape often used for a concrete shell as they are naturally strong due to their shape. Different kinds of loads like DL, LL and WL are acting on structures during its entire life period but due to increasing number of terrorist attacks and the accident accurse in laboratories so it is very important to analysis and thedesignof dome structure to be safer against the blast load. Due to blast, air pressure generate on a structure above ground level is basically a single pulse and can frequently idealize by simple shapes. A blast is characterized as a sudden arrival of energy. These can be further set by physical, substance and atomic occasions. In physical blasts, vitality might be discharged from the calamitous disappointment of a barrel of a compacted gas, volcanic ejection or notwithstanding blending of two fluids at various temperatures. In an atomic blast, vitality is discharged from the development of various nuclear cores by the redistribution of the protons and neutrons inside the collaborating cores, while the quick oxidation of fuel components (carbon and hydrogen iota's) is the principle wellspring of vitality on account of chemical blasts. To comprehend the impact of this blast on structure, we have to characterize the "Blast Wave". It is a pressure wave produced noticeable all around by quick arrival of vitality put away. This vitality can be put away as gas or vapor, either hot or frosty. The cases of blasts are disappointment of a high weight gas stockpiling vessel or boiler which offers ascend to an impact wave in air.

Numbers of researchers have acquired the development of shock spectra for different pulse shapes using C sharp. Manav et al. (2017) has worked on development ofthe sock spectra for special impulse excitation. Single degree of freedom (SDOF) system used to evaluate the effect of damping on various shock spectra. To evaluate the response of system, piece-wise differential equation method has been considered. The different shape of pulse like First half triangular pulse, second half triangular pulse, Full cycle sine wave pulse, Trapezoidal pulse are developed. 0%, 5%, 10%, and 20% damping ratios are considered. This shape of pulse developed to generate different shock spectra using C Sharp. For given value of impulse load the dynamic magnification factor (DMF) is the maximum for Full sine wave pulse followed by trapezoidal pulse, first half triangle pulse and second half triangular pulse. Reductions seem proportion for change in damping. Raise in damping reduce the dynamic magnification factor(DMF) values for all impulse loads.

Abdalla and Mohammed (2008) have worked on the parametric study of the relationship between reinforced concrete dome thickness, height, shape, and their dynamic characteristics, frequency of vibration. United Arab Emirates (UAE) is contiguous to the Iranian plateau which is one of the most seismically active areas of the world. The large span of domes with different shapes like ellipsoidal, spherical paraboloidal are considered. The behavior of large span reinforced concrete domes under earthquake loading and the incorporation between these domes and the rest of the structure is not studied. The first step towards the assessment of seismic vulnerability of building with large reinforced concrete domes. Form study concluded that the increase in the dome thickness, increases the frequency of vibration of both paraboloidal and spherical domes. The increases in dome height decrease the frequency of vibration of both paraboloidal and spherical domes.

## II. MODELING AND ANALYSIS

**(A) Analysis of dome with variable thickness**

Analysis of dome for blast parameters due to the detonation of 1 tonne, 0.5 tonne and 0.1 tonne explosive, situated at 30m from ground zero.

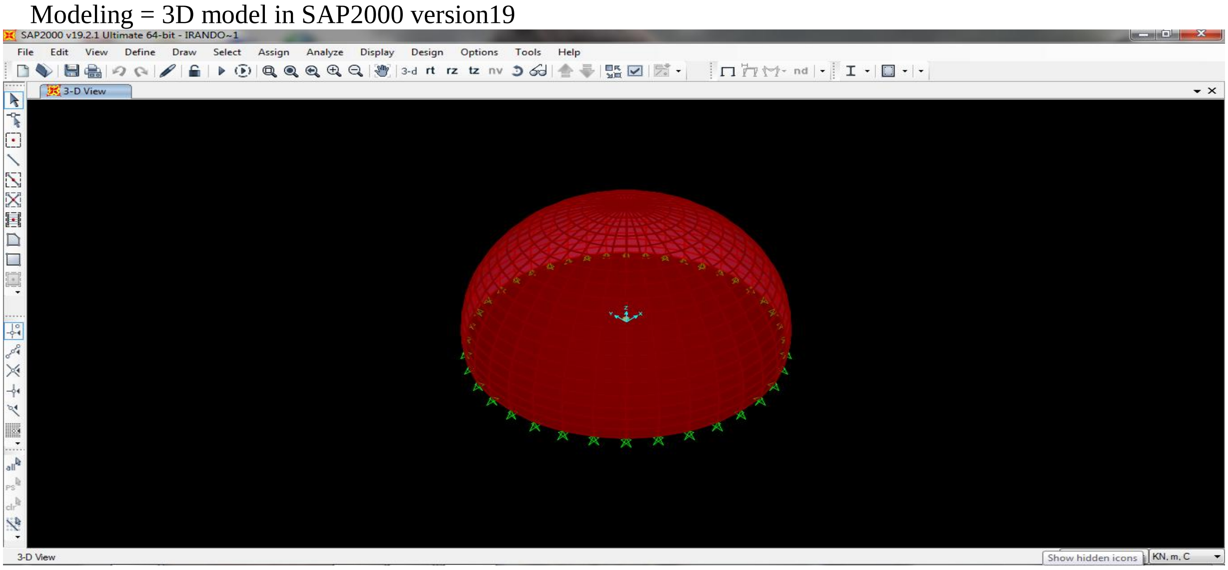
- Dome Structure data

| Diameter (D) m | Height (H) m | Radius (R) m | Thickness (t) m | Material and Dome Type (R.C.C) |
|---|---|---|---|---|
| 13.7 | 6.85 | 6.85 | 0.15 | Spherical |
| | | | 0.20 | |
| | | | 0.25 | |
| | | | 0.30 | |

Material property

Weight per unit volume (Concrete) = 25 kN/$m^3$

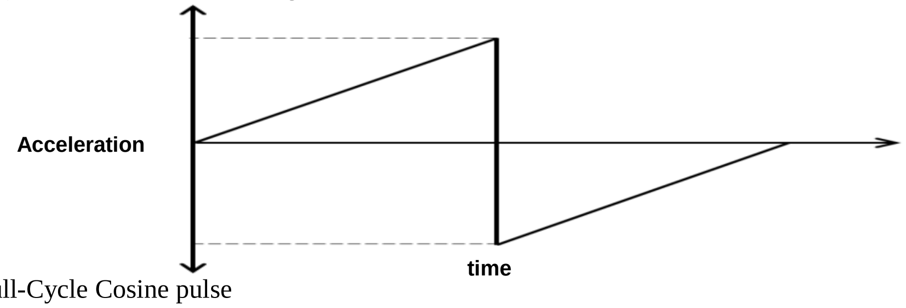
Modeling = 3D model in SAP2000 version19



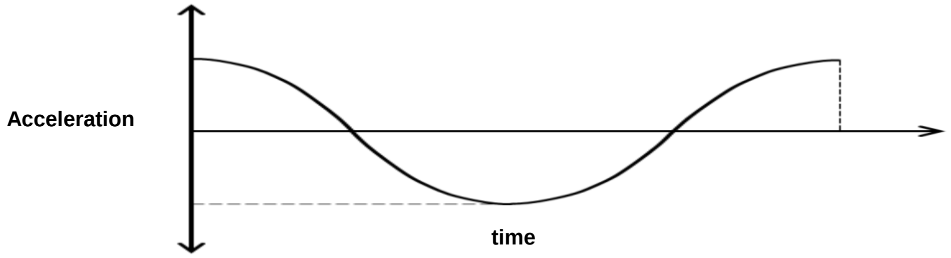

- Following are the different blast pulse acting on the dome structure which may be created in C sharp in form of time vs. acceleration.

1. Half + and Half – Triangular Pulse
2. Full Cycle Cosine Pulse
3. Rectangular Pulse
4. Irregular Pulse

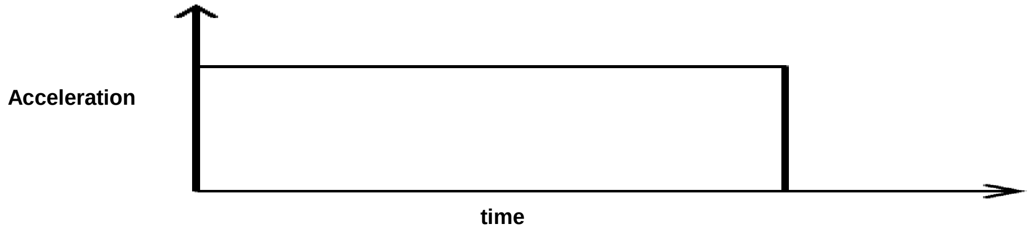
(1) Half + and Half – Triangular Pulse



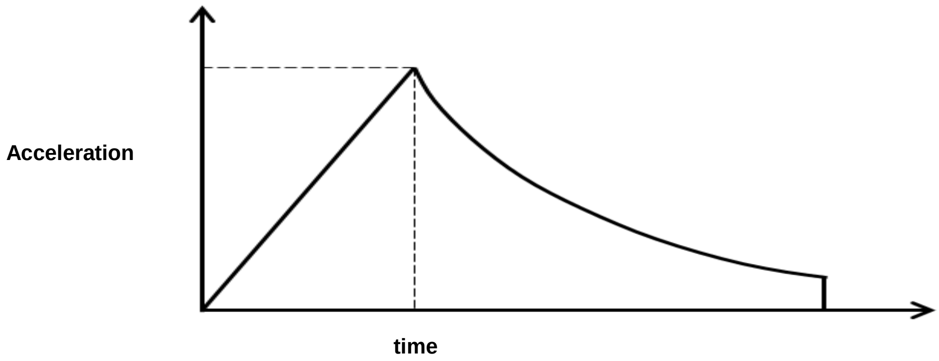

(2) Full-Cycle Cosine pulse




(3) Rectangular Pulse




(4) Irregular Pulse




## III. ANALYSIS RESULTS AND DISCUSSION

1 tonne explosive analysis result

Table 1 Stresses for Half + and Half – triangular pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness (m) | Stress ($N/mm^2$) |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 31.26 |
| 2 | | | 0.20 | 22.14 |
| 3 | | | 0.25 | 17.52 |
| 4 | | | 0.30 | 14.33 |

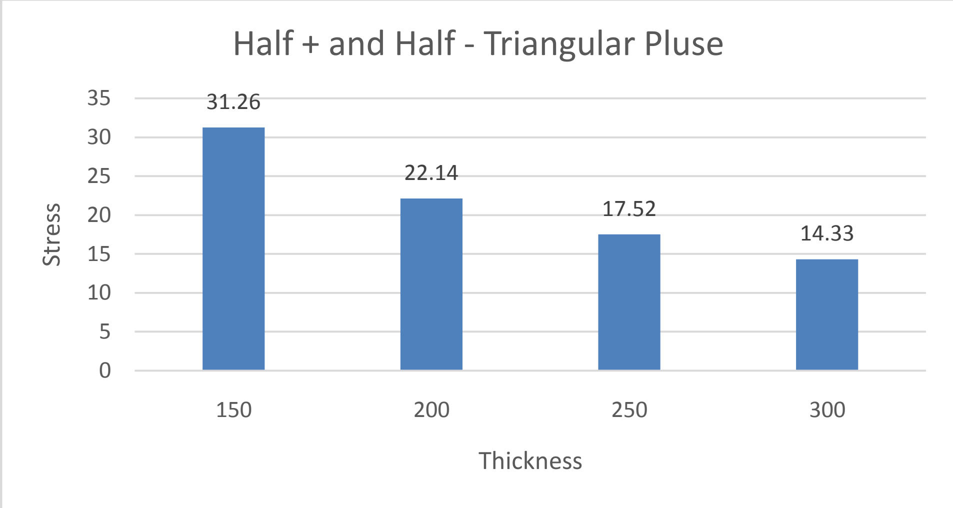



Table 2 Acceleration for Half + and Half – triangular pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 287 |
| 2 | | | 0.20 | 197 |
| 3 | | | 0.25 | 151 |
| 4 | | | 0.30 | 121 |

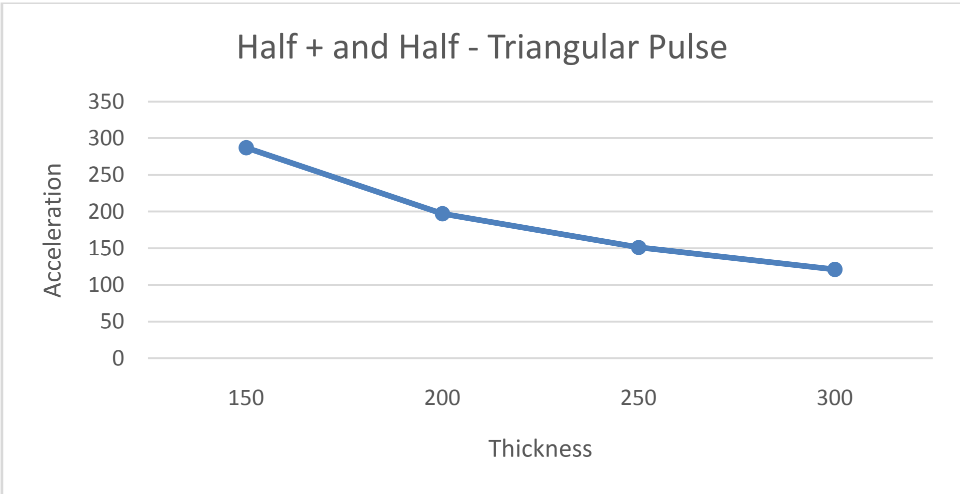



Table 3 Stresses for Full cycle cosine pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full cycle cosine pulse | 0.15 | 22.71 |
| 2 | | | 0.20 | 16.14 |
| 3 | | | 0.25 | 12.77 |
| 4 | | | 0.30 | 10.48 |

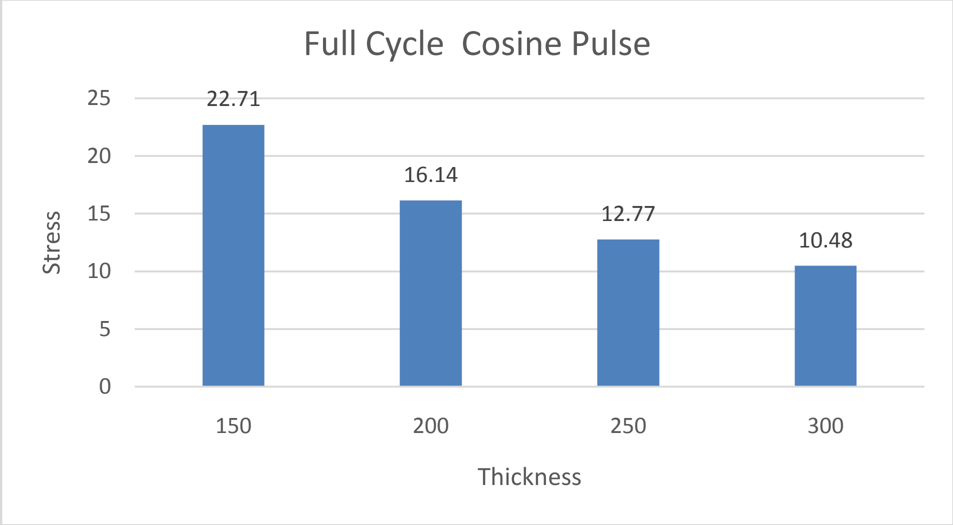



Table 4 Acceleration for Full cycle cosine pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full cycle cosine pulse | 0.15 | 167 |
| 2 | | | 0.20 | 115 |
| 3 | | | 0.25 | 88.4 |
| 4 | | | 0.30 | 71 |

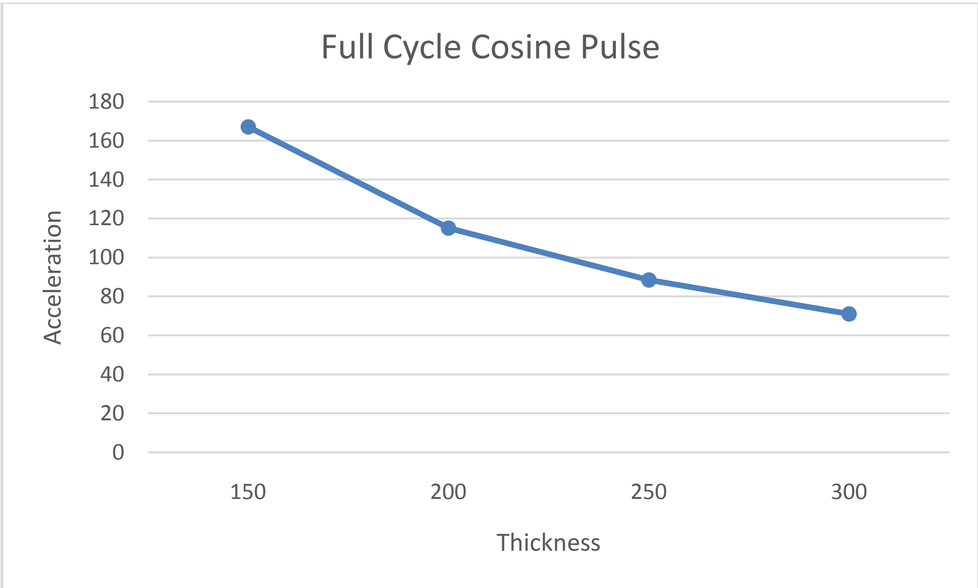



Table 5 Stresses for Rectangular pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 22.71 |
| 2 | | | 0.20 | 16.14 |
| 3 | | | 0.25 | 12.77 |
| 4 | | | 0.30 | 10.48 |

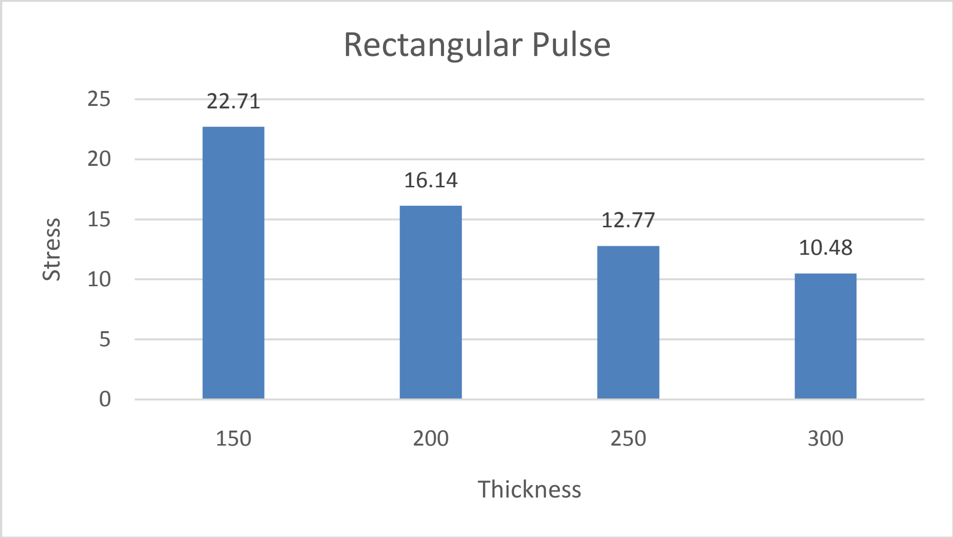



Table 6 Acceleration for Rectangular pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 167 |
| 2 | | | 0.20 | 115 |
| 3 | | | 0.25 | 88.4 |
| 4 | | | 0.30 | 71 |

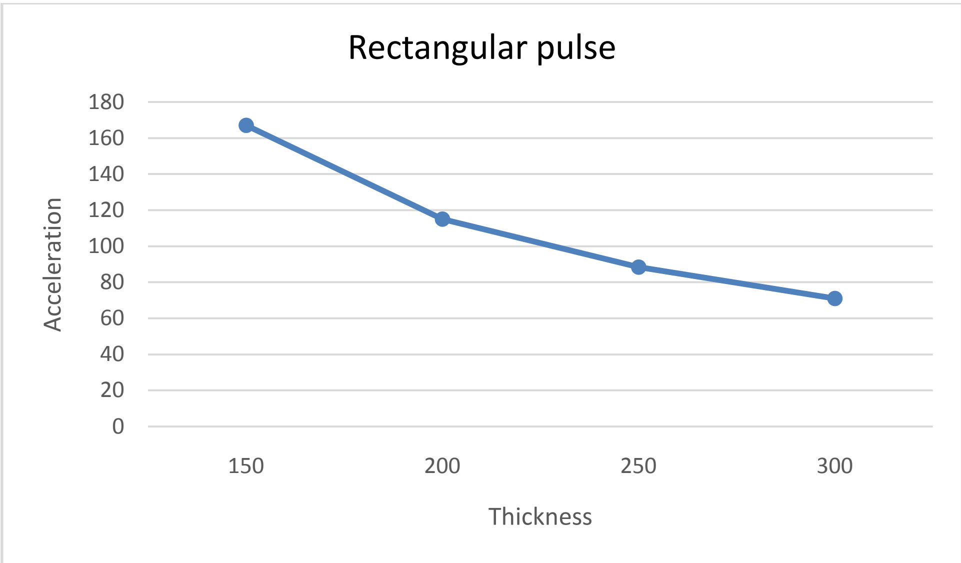



Table 7 Stresses for Irregular Pulse for 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 13.2 |
| 2 | | | 0.20 | 9.3 |
| 3 | | | 0.25 | 7.41 |
| 4 | | | 0.30 | 6 |

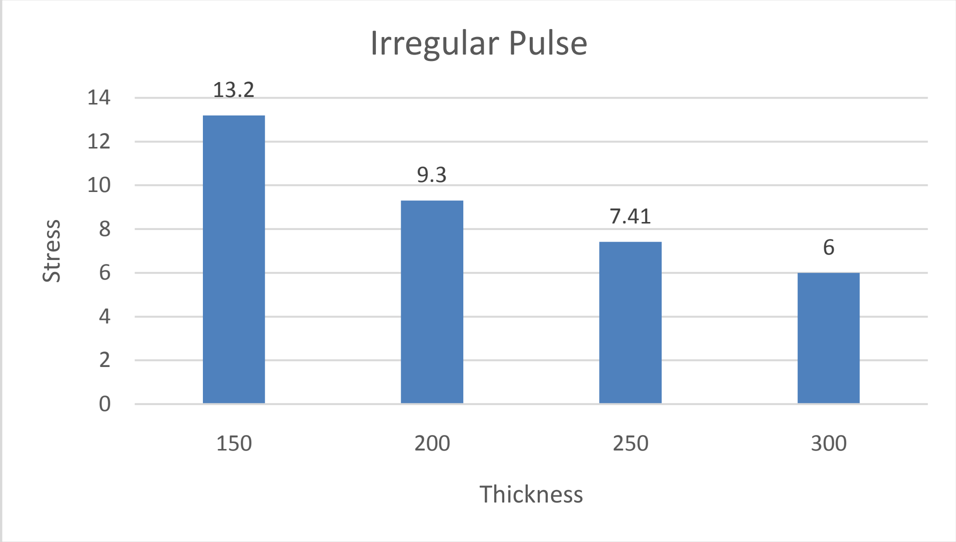
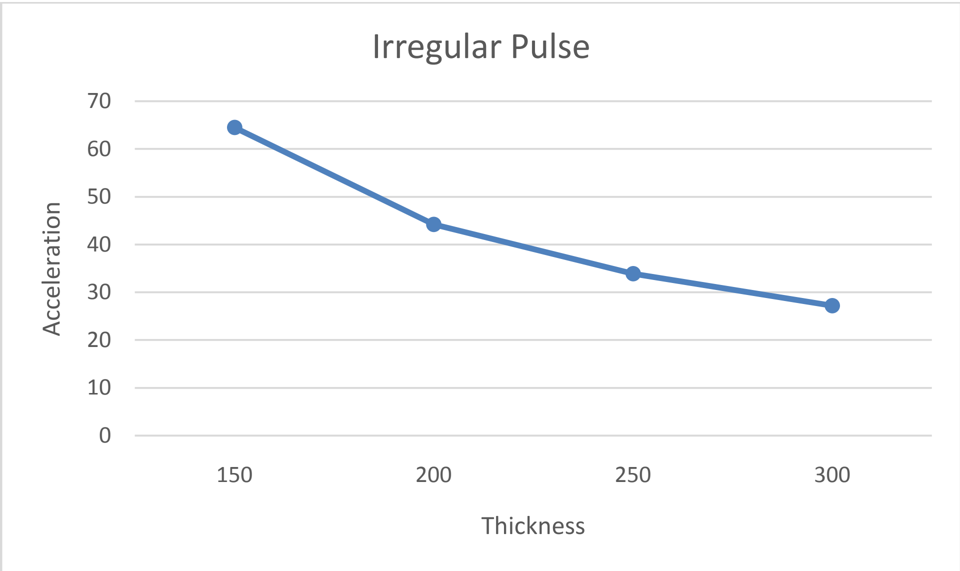



Table 8Acceleration for Irregular Pulse of 1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 64.5 |
| 2 | | | 0.20 | 44.2 |
| 3 | | | 0.25 | 33.9 |
| 4 | | | 0.30 | 27.2 |




0.5 tonneexplosive analysis result

Table 9 Stresses for Half + and Half – triangular pulse for 0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 21.58 |
| 2 | | | 0.20 | 15.3 |
| 3 | | | 0.25 | 12.11 |
| 4 | | | 0.30 | 9.9 |

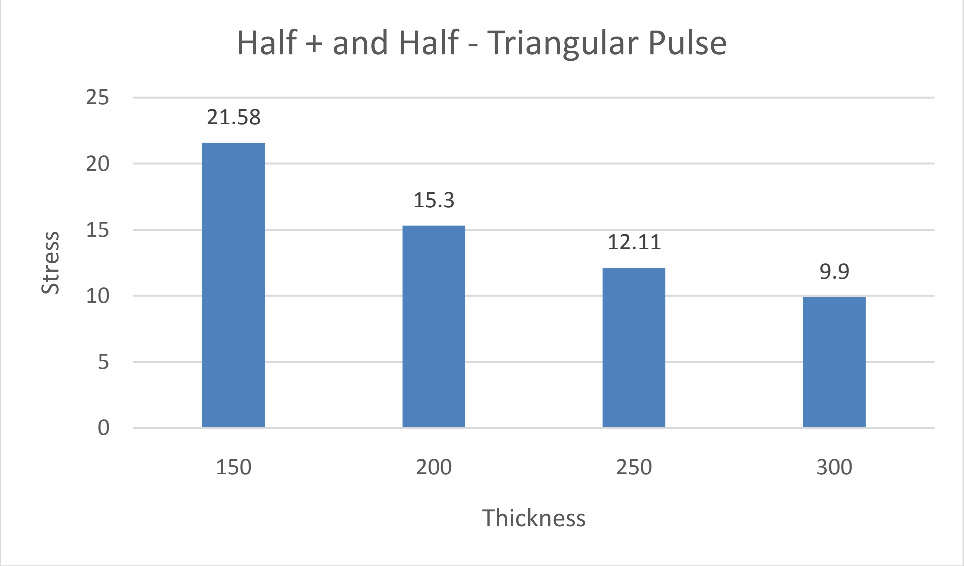



Table 10 Acceleration for Half + and Half – triangular pulse for 0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 198 |
| 2 | | | 0.20 | 135 |
| 3 | | | 0.25 | 104 |
| 4 | | | 0.30 | 83.6 |

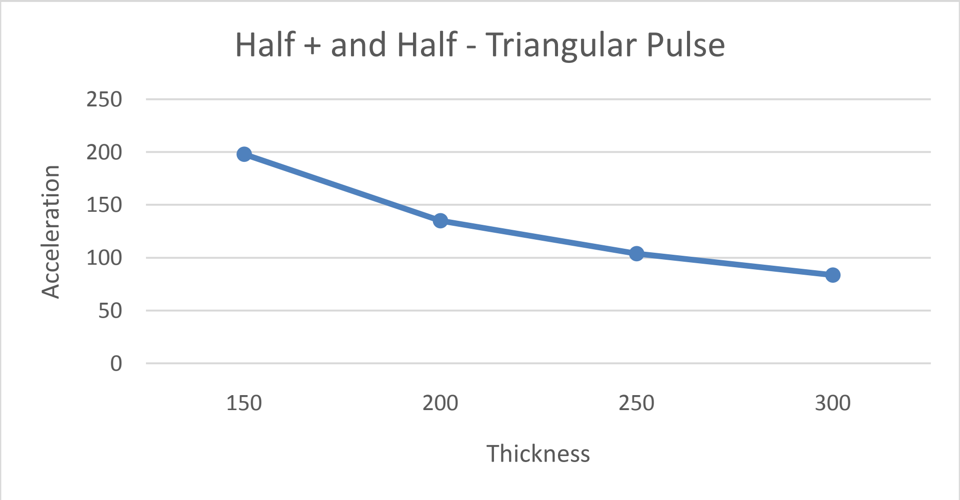



Table 11 Stresses for Full cycle cosine pulse for0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full cycle cosine pulse | 0.15 | 15.69 |
| 2 | | | 0.20 | 11.16 |
| 3 | | | 0.25 | 8.8 |
| 4 | | | 0.30 | 7.2 |

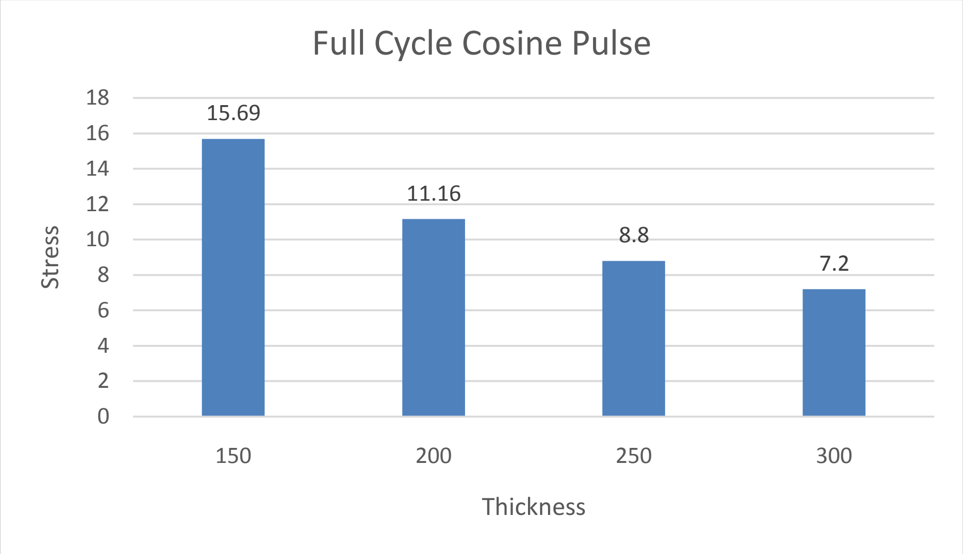



Table 12 Acceleration for Full cycle cosine pulse for0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full cycle cosine pulse | 0.15 | 115 |
| 2 | | | 0.20 | 79.4 |
| 3 | | | 0.25 | 60.9 |
| 4 | | | 0.30 | 48.9 |

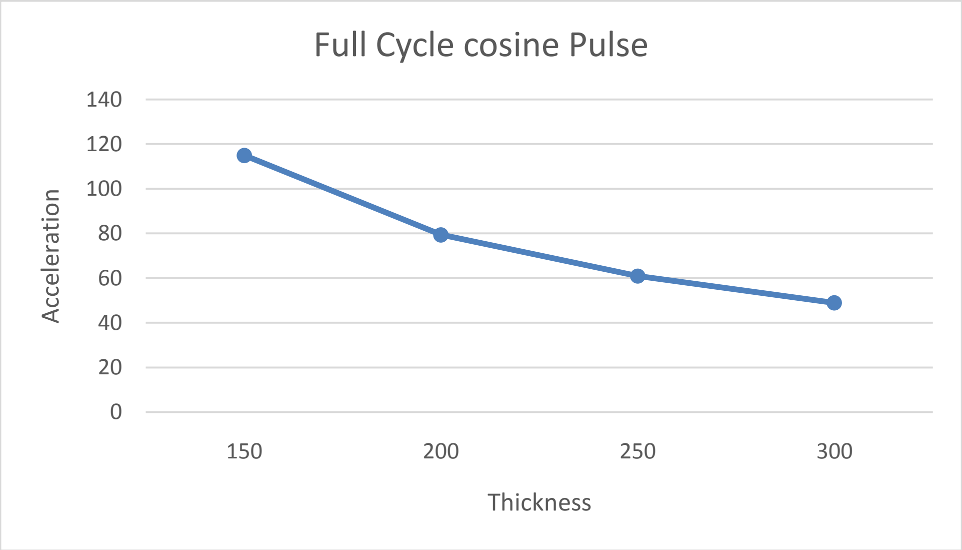



Table 13 Stresses for Rectangular pulse for 0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 15.69 |
| 2 | | | 0.20 | 11.16 |
| 3 | | | 0.25 | 8.8 |
| 4 | | | 0.30 | 7.2 |

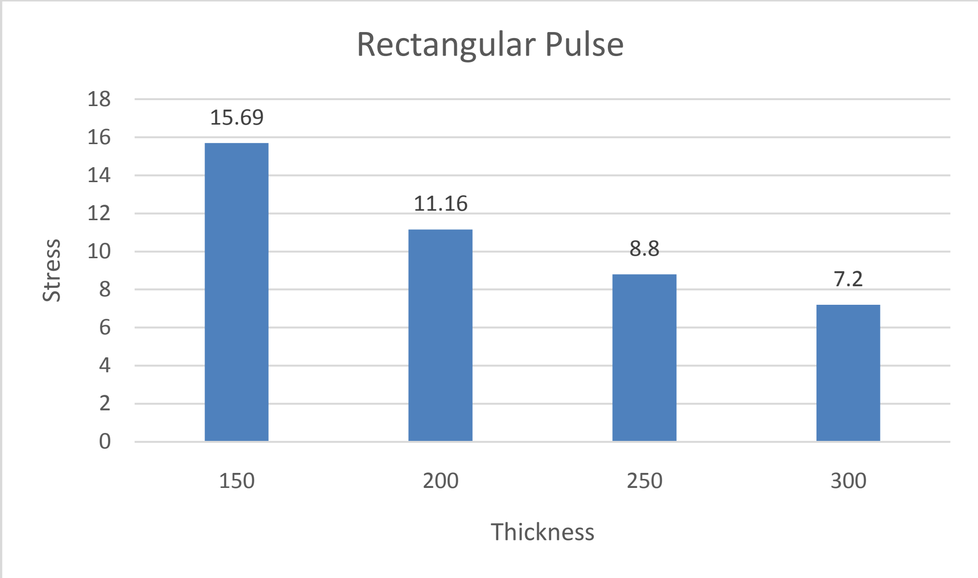



Table 14 Acceleration for Rectangular pulse for0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 115 |
| 2 | | | 0.20 | 79.4 |
| 3 | | | 0.25 | 60.9 |
| 4 | | | 0.30 | 48.9 |

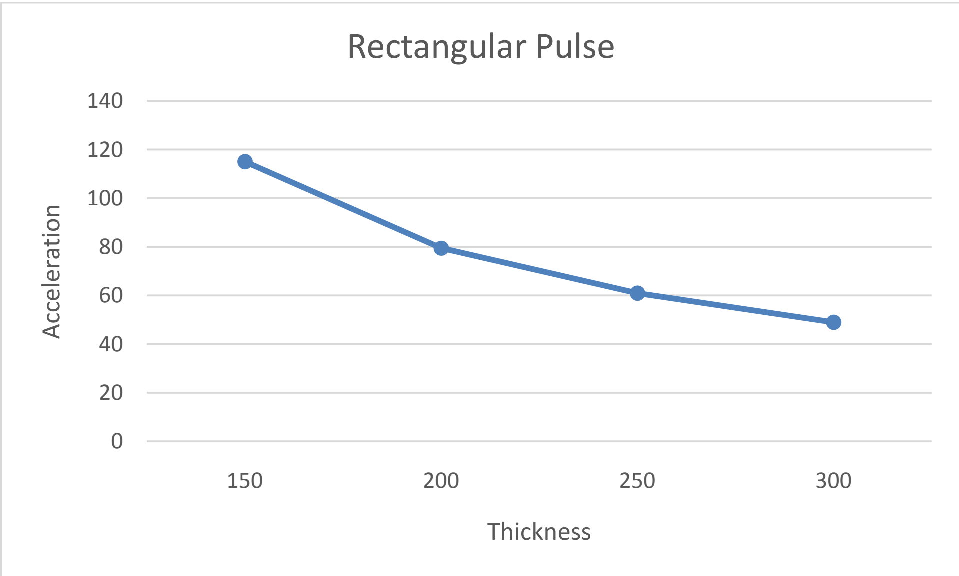



Table 15 Stresses for Irregular Pulsefor 0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 9.13 |
| 2 | | | 0.20 | 6.5 |
| 3 | | | 0.25 | 5.1 |
| 4 | | | 0.30 | 4.2 |

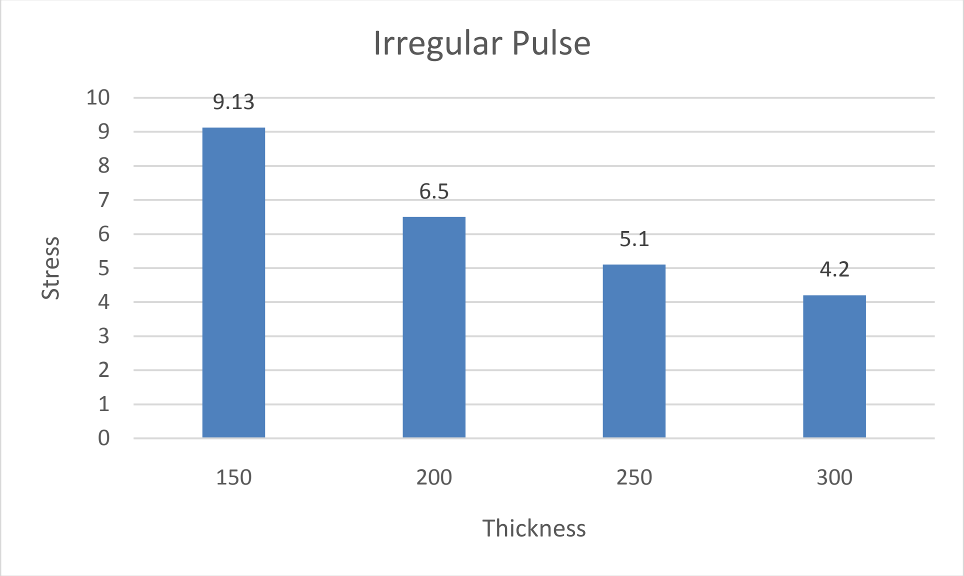
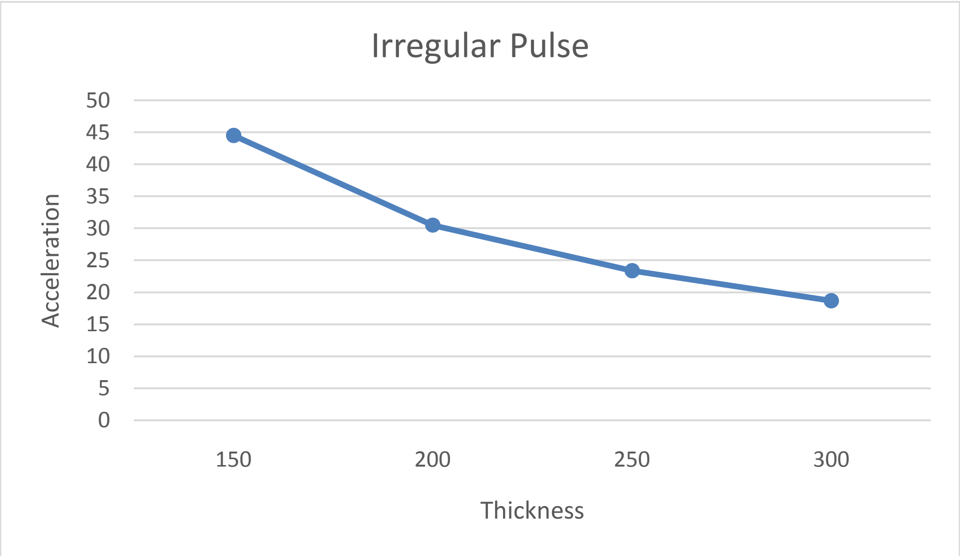



Table 16 Acceleration for Irregular Pulsefor 0.5 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 44.5 |
| 2 | | | 0.20 | 30.5 |
| 3 | | | 0.25 | 23.4 |
| 4 | | | 0.30 | 18.7 |




0.1 tonneexplosive analysis result

Table 17 Stresses for Half + and Half – triangular pulse for 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 9 |
| 2 | | | 0.20 | 6.3 |
| 3 | | | 0.25 | 5 |
| 4 | | | 0.30 | 4.1 |

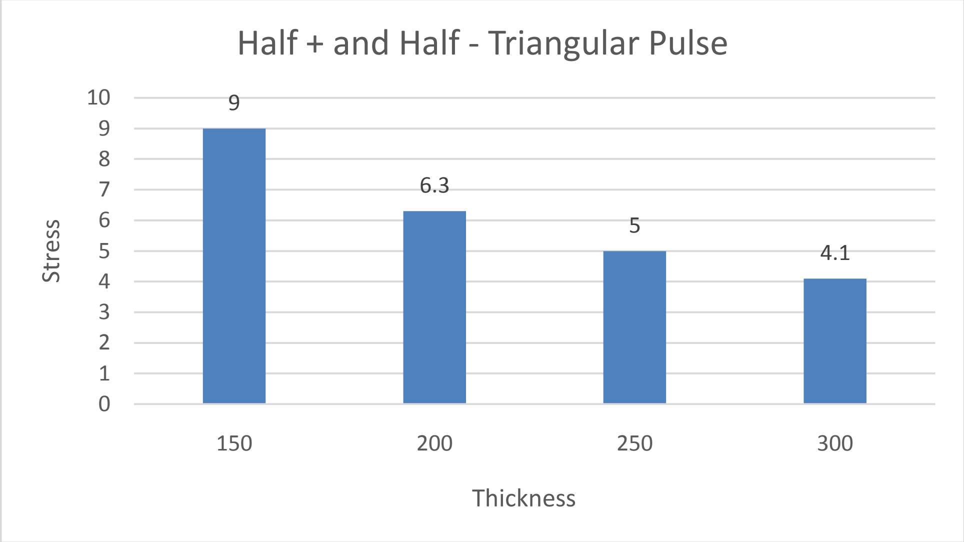



Table 18 Acceleration for Half + and Half – triangular pulse for 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Half + and Half – triangular pulse | 0.15 | 81.7 |
| 2 | | | 0.20 | 56 |
| 3 | | | 0.25 | 43 |
| 4 | | | 0.30 | 34.5 |

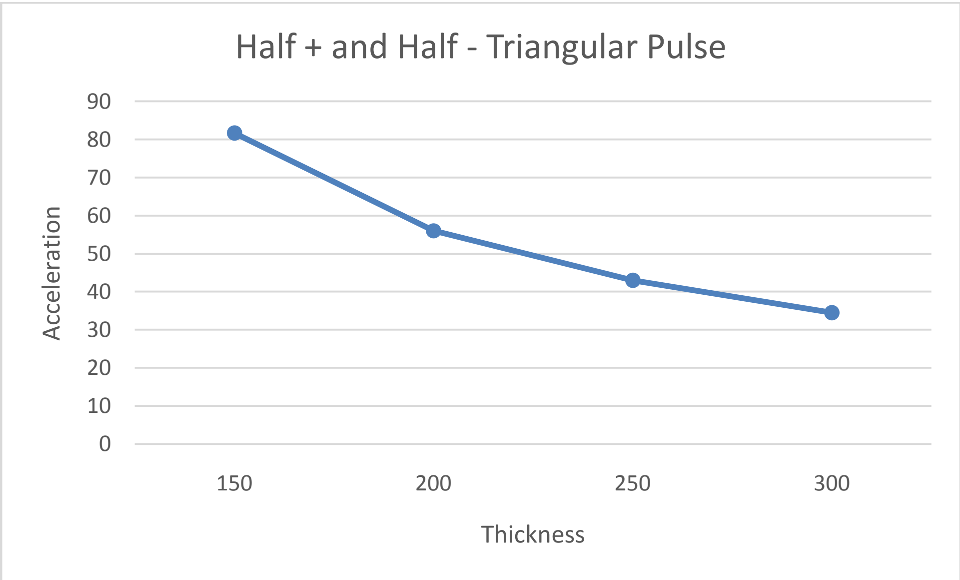



Table 19Stresses for Full Cycle cosine pulse for 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full Cycle cosine pulse | 0.15 | 6.5 |
| 2 | | | 0.20 | 4.6 |
| 3 | | | 0.25 | 3.6 |
| 4 | | | 0.30 | 3 |

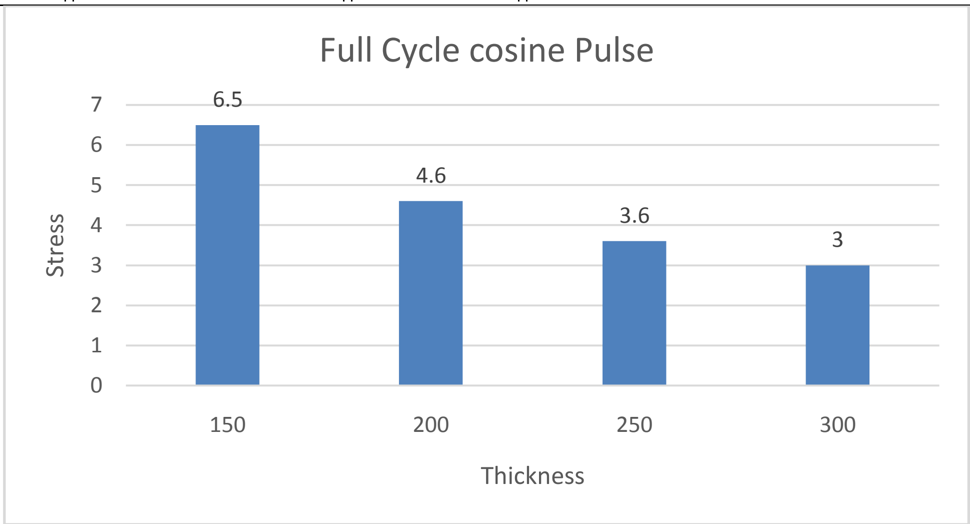



Table 20 Acceleration for Full Cycle cosine pulse for0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Full Cycle cosine pulse | 0.15 | 47.6 |
| 2 | | | 0.20 | 32.7 |
| 3 | | | 0.25 | 25.1 |
| 4 | | | 0.30 | 20.2 |

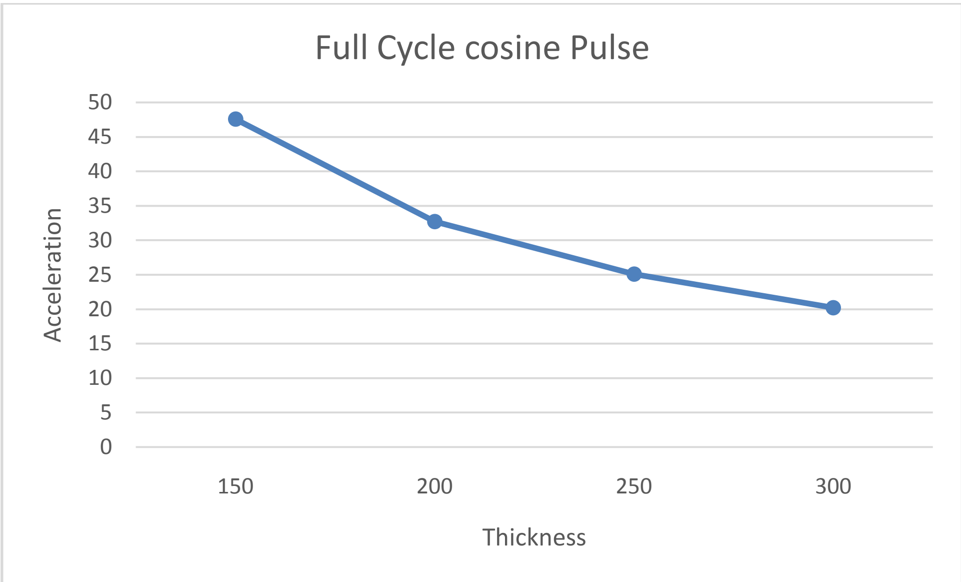



Table 21 Stresses for Rectangular pulse for 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 6.5 |
| 2 | | | 0.20 | 4.6 |
| 3 | | | 0.25 | 3.6 |
| 4 | | | 0.30 | 3 |

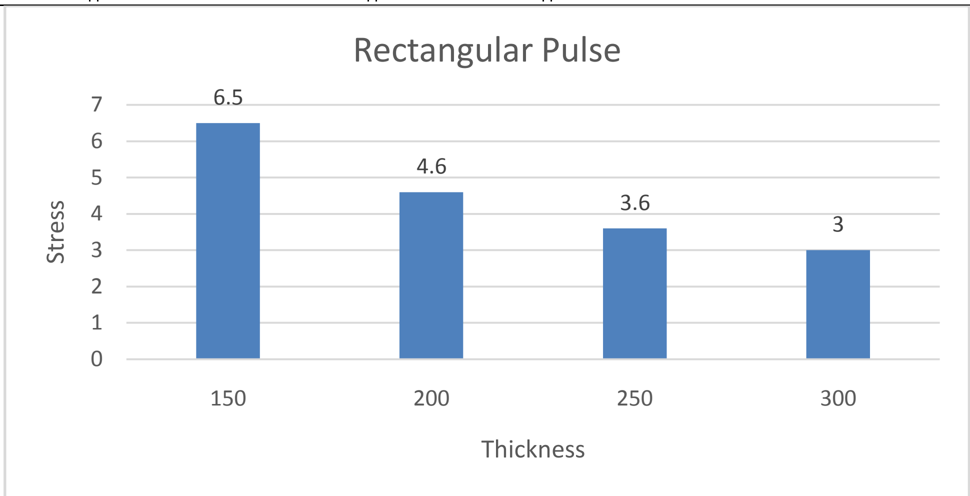



Table 22 Acceleration for Rectangular pulse for 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Rectangular pulse | 0.15 | 47.6 |
| 2 | | | 0.20 | 32.7 |
| 3 | | | 0.25 | 25.1 |
| 4 | | | 0.30 | 20.2 |

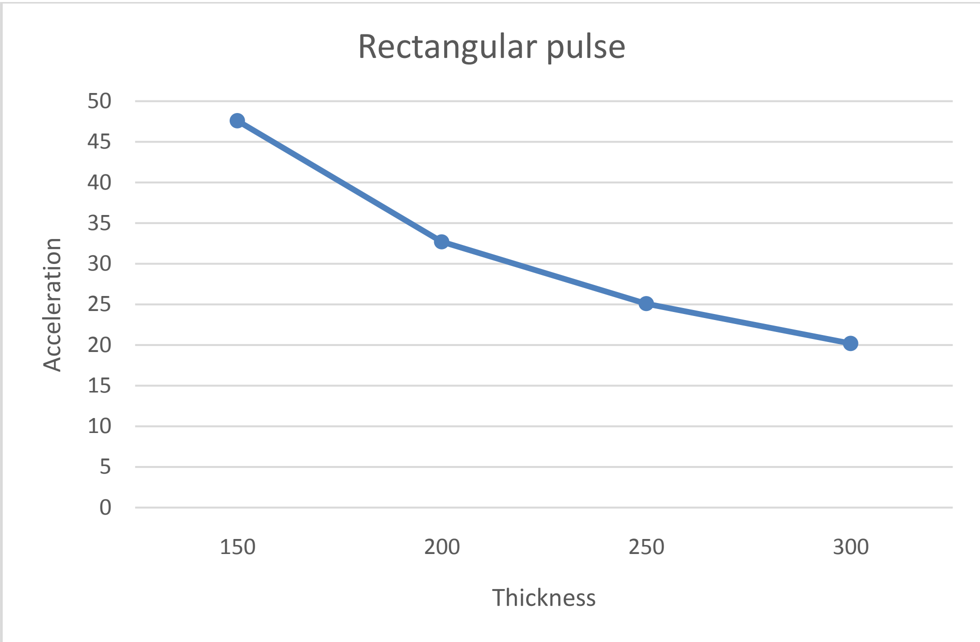



Table 23 Stresses for Irregular Pulsefor 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Stress N/mm$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 5.3 |
| 2 | | | 0.20 | 2.7 |
| 3 | | | 0.25 | 2.1 |
| 4 | | | 0.30 | 1.7 |

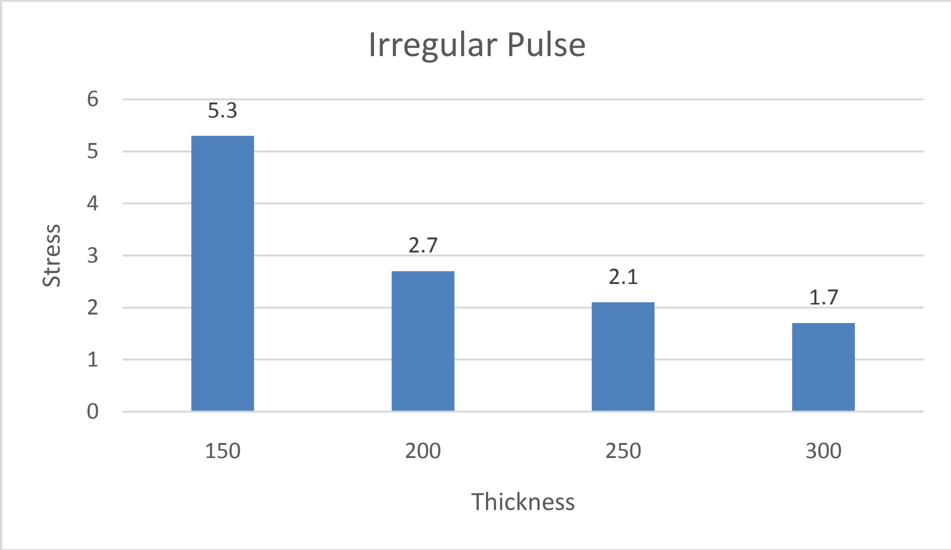
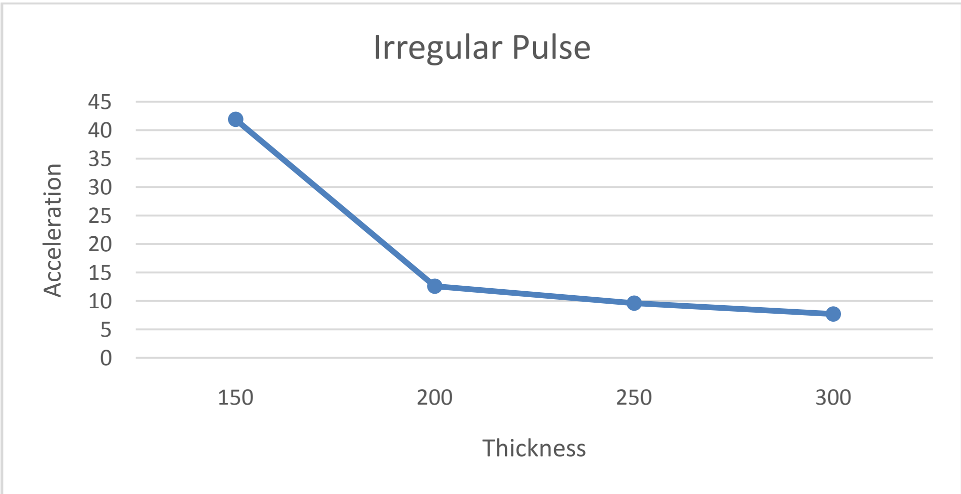



Table 24 Acceleration for Irregular Pulsefor 0.1 tonne blast explosion

| No. | Structure | Type of pulse | Thickness m | Acceleration m/sec$^2$ |
|---|---|---|---|---|
| 1 | Dome | Irregular Pulse | 0.15 | 41.9 |
| 2 | | | 0.20 | 12.6 |
| 3 | | | 0.25 | 9.6 |
| 4 | | | 0.30 | 7.7 |




## IV. CONCLUSION

Parametric study of spherical dome structure is carried out for the different thickness of 150mm, 200mm, 250mm and 300mm with the blast explosive weight of 0.1 tonne, 0.5 tonne and 1 tonne.

- It is concluded after the analysis that the maximum stresses are developed in the dome with lowest thickness of 150 mm. A dome with 150 mm thickness is safe for 0.1 tonne explosion of blast but for 0.5 tonne to 1 tonne explosion of blast the stresses are varying from 21.58 MPa to 31.26 MPa and which exceed the permissible limit of 8.5 MPa as per IS 456: 2000.
- 200mm and 250mm thickness of dome structure are safe for 0.1 to 0.5 tonne explosion of blast and not safe for 1 tonne explosion of blast as the stresses are 22.14 and 17.52 respectively. They are beyond the permissible limit as per IS 456:2000.
- 300mm thickness of dome structure is safe for blast explosion of 0.1 to 0.5 tonne and the stresses are nearest to the permissible limit for 1 tonne explosion of blast.

- Increasing the acceleration due to the increasing of blast explosion and decreasing the thickness of dome structure. Maximum acceleration is developed in 1 tonne explosion of pulse loading history in the dome structure with minimum thickness of 150 mm.

## REFERENCES

**Journal Papers:**

[1] Manav Patel and Dr. V. R. Panchal (2017), ‘Development of shock spectra for different pulse shapes using C sharp’ International Conference on Research and Innovations in Science, Engineering & Technology, pp. 418-423.

[2] J.A.Abdalla and A.S.Mohammed (2008),‘Dynamic characteristics of large reinforced concrete domes’ The 14th World Conference on Earthquake Engineering, Beijing, China.

[3] Anil Kumar (2014), ‘Effect of damping on shock spectra of impulse loads’ International Journal of Scientific & Engineering Research, Volume 5, Issue 5, ISSN 2229-5518, pp.78-85.

[4] Galawezh Saber and Ghaedan Hussein (2013), ‘Analysis and optimum design of curved roof structures’ 2nd International Balkans Conference on Challenges of Civil Engineering, BCCCE, pp.23-25.

[5] EuripidisMistakidis (2014), ‘Construction of the steel dome of the multipurpose al-sadd sports hall in Doha, Qatar’AKTOR S.A.P.O. Box 37108, Doha, Qatar.

[6] Ms. M.A.Jain (2016),‘Parametric Study of Dome’ International Journal for Scientific Research & Development, vol. 4, pp. 1669-1671Panchal, V. R. and Jangid, R. S. (2007), ‘Variable friction pendulum system for seismic isolation of liquid storage tanks’, Nuclear Engineering and Design, Vol. 238, pp. 1304-1315.

[7] Anuj Chandiwala (2014), ‘Analysis and Design of Steel Dome Using Software’ International Journal of Research in Engineering and Technology, Eissn: 2319-1163, pissn:2321-7308, pp.35-39.

[8] Nelson Lam and priyanMendis (2004), ‘Response spectrum solution for blast loading’ Electronic Journal of Structural Engineering, volume 4, pp.28-44.

[9] Zubair Iman Syed (2016), ‘Effect of large negative phase of blast loading on structural response of RC elements’ MATEC Web of Conferences, Owned by the authors, published by EDP Sciences, pp.1-8.

[10] Shaik Tahaseen (2016), ‘Reinforced Cement Concrete (RCC) Dome Design’ International Journal of Civil and Structural Engineering Research, vol. 3, pp. 39-45.