Study on the Effect of Blast Load on Industrial Structure

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Abstract- **This study investigates some of the special aspects of the response of industrial steel structures to blast loading. A hemispherical surface burst for various explosives, weights of charge and standoff distance are considered for generating the surface blast loading. The main parameters consider in this study are displacement, demand capacity ratio(D/C) by providing different blast mitigation system and compare the blast load effect with or without mitigation system.**

Index Terms- **Blast Load, Industrial Steel Structure, Displacement, D/C. ratio, Stress in elements, Bending Moment, Software, Mitigation system.**

I. INTRODUCTION

Explosions are widely used for demolition purpose such as in construction or development works, military applications and destruction. But also it is common to use in terrorist activities and easy to produce with a great power to cause structural damage and injuries. The blast load effect of different explosives depend on two factors, the charge weight (W), and the standoff distance between the blast source and target(R). The main objective of this study is to understand the effect of blast loading on industrial steel structure using various explosives, weights of charge and standoff distance by providing blast mitigation system.

Now days many industries impart a major part in the growth of countries, due to this terrorist attack occur on the industrial structure. Due to blast, pressure wave produced surrounding the building structure by this building is damage and completely collapse hence the behavior of structural components Subjected to blast loading has been the subject of considerable research effort in recent year to prevent the building component to completely collapse.

II. ANALYSIS DATA

Blast load mainly depends on the two parameters,
    1.Stand off distance
    2.Weight of charge

We have considered the different stand off distance and weight of charge for the study of the blast load effect on the structure.
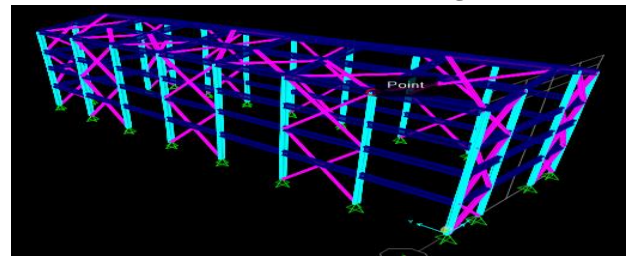
We have considered the different stand off distance like 5m, 6m, 7m, 8m, 9m,10m

We have considered weight of charge like 50kg, 60kg, 70kg, 80kg, 90kg, 100kg

We have studied the parameters for different stand off distance, weight of charge, Displacement, D/C ratio, Stress in elements and Bending Moment.
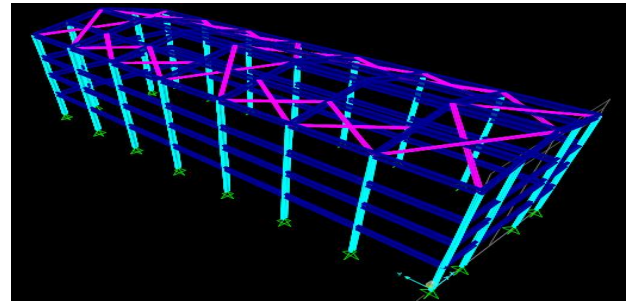
Truss without Bracing

Truss with Bracing

III. CONCLUSION

Conclusion for 5 meter standoff distance:

Charge of weight (kg)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)
50	81.3	2.7	214.8	294.3	76.1	3.9	158.3	186.5
60	89.7	2.9	219.4	295.6	84.4	4.2	162.9	187.8
70	91.6	3.0	225.8	302.3	86.8	4.4	169.3	194.5
80	96.5	3.1	230.4	306.9	90.6	4.5	173.9	199.1
90	100.2	3.2	235.6	312.5	95.4	4.6	179.1	204.7
100	105.6	3.5	241.7	318.7	99.8	4.9	185.2	210.9

- For 5 meter stand of distance 100kg of charge of weight displacement, stress, moment decrease by 5.5% , 23.4% ,

33.8% respectively while Demand capacity ratio increased by 40% for industrial building with bracing.

- For 5 meter stand of distance 90kg of charge of weight displacement, stress, moment decrease by 4.8% , 24% , 34.5% respectively while Demand capacity ratio increased by 43.8% for industrial building with bracing.

- For 5 meter stand of distance 80kg of charge of weight displacement, stress, moment decrease by 6.1% , 24.5% , 35.1% respectively while Demand capacity ratio increased by 45.2% for industrial building with bracing.

- For 5 meter stand of distance 70kg of charge of weight displacement, stress, moment decrease by 5.2% , 25% , 35.7% respectively while Demand capacity ratio increased by 46.7% for industrial building with bracing.

- For 5 meter stand of distance 60kg of charge of weight displacement, stress, moment decrease by 5.9% , 25.8% , 36.5% respectively while Demand capacity ratio increased by 47.4% for industrial building with bracing.

- For 5 meter stand of distance 90kg of charge of weight displacement, stress, moment decrease by 6.4% , 26.3% , 36.6% respectively while Demand capacity ratio increased by 42.3% for industrial building with bracing.

Conclusion for 6 meter standoff distance:

Charge of weight (kg)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)
50	59.0	1.9	170.4	242.7	53.8	2.9	115.2	134.5
60	61.5	2.1	175.1	247.2	54.5	3.2	119.8	139.0
70	64.6	2.2	180.9	253.7	58.4	3.4	125.7	145.5
80	66.8	2.3	186.3	256.7	60.1	3.5	131.1	148.5
90	67.8	2.4	191.5	260.4	61.9	3.6	133.7	152.2
100	74.7	2.7	196.2	265.9	68.8	3.9	138.4	157.7

- For 6 meter stand of distance 100kg of charge of weight displacement, stress, moment decrease by 7.9% , 29.5% , 40.7% respectively while Demand capacity ratio increased by 44.4% for industrial building with bracing.

- For 6 meter stand of distance 90kg of charge of weight displacement, stress, moment decrease by 8.7% , 30.2% ,

41.6% respectively while Demand capacity ratio increased by 50% for industrial building with bracing.

- For 6 meter stand of distance 80kg of charge of weight displacement, stress, moment decrease by 10% , 29.6% , 42.2% respectively while Demand capacity ratio increased by 52.2% for industrial building with bracing.

- For 6 meter stand of distance 70kg of charge of weight displacement, stress, moment decrease by 9.6% , 30.5% , 54.5% respectively while Demand capacity ratio increased by 44.4% for industrial building with bracing.

- For 6 meter stand of distance 60kg of charge of weight displacement, stress, moment decrease by 11.4% , 31.6% , 43.8% respectively while Demand capacity ratio increased by 52.4% for industrial building with bracing.

- For 6 meter stand of distance 50kg of charge of weight displacement, stress, moment decrease by 8.8% , 32.4% , 44.6% respectively while Demand capacity ratio increased by 52.6% for industrial building with bracing.

Conclusion for 7 meter standoff distance:

Charge of weight (kg)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)
50	45.5	1.2	128.6	187.2	36.9	1.7	70.3	82.3
60	49.5	1.4	138.4	198.3	42.4	2.0	80.6	93.8
70	48.0	1.5	147.7	204.9	40.9	2.4	89.5	100.4
80	56.7	1.6	156.4	217.2	51.9	2.6	99.0	112.9
90	59.0	1.7	162.2	224.1	55.0	2.8	105.2	119.9
100	64.0	2.0	184.0	252.8	60.1	3.2	127.0	148.8

- For 7 meter stand of distance and 100kg of charge of weight displacement, stress, moment decrease by 6.1 %, 31% , 41.1% respectively while Demand capacity ratio increased by 59.2% for industrial building with bracing.

- For 7 meter stand of distance and 90kg of charge of weight displacement, stress, moment decrease by 6.8 %, 35.1% , 46.5% respectively while Demand capacity ratio increased by 64.7% for industrial building with bracing.

- For 7 meter stand of distance and 80kg of charge of weight displacement, stress, moment decrease by 8.5 %, 36.7% , 48% respectively while Demand capacity ratio increased by 62.5% for industrial building with bracing.

- For 7 meter stand of distance and 70kg of charge of weight displacement, stress, moment decrease by 14.8%, 39.4% , 51% respectively while Demand capacity ratio increased by 60 % for industrial building with bracing.
- For 7 meter stand of distance and 60kg of charge of weight displacement, stress, moment decrease by 14.3 %, 41.8%,52.7% respectively while Demand capacity ratio increased by 44.3% for industrial building with bracing.
- For 7 meter stand of distance and 50kg of charge of weight displacement, stress, moment decrease by 18.9 %, 45.3% , 56% respectively while Demand capacity ratio increased by 38.3% for industrial building with bracing.

Conclusion for 300 kg charge of weight

Stand of Distance (m)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)
10	89.9	2.9	170.0	248.3	85.3	4.3	166.7	189.9
9	106.4	3.1	200.4	279.9	101.0	5.2	197.8	226.5
8	109.2	3.6	205.3	278.6	103.0	5.7	202.8	233.7
7	110.4	3.8	210.8	267.3	102.7	5.9	207.8	239.2
6	121.3	4.1	231.1	306.0	113.7	6.2	224.1	259.4
5	130.3	4.3	242.7	321.2	121.3	6.4	235.6	270.6

- For 300kg charge of weight and 5 meter stand of distance, displacement, stress, moment decrease by 6.9%, 2.9% , 15.8% respectively while Demand capacity ratio increased by 48.8% for industrial building with bracing.
- For 300kg charge of weight and 6 meter stand of distance, displacement, stress, moment decrease by 6.3%, 3% , 15.2% respectively while Demand capacity ratio increased by 48.8% for industrial building with bracing.
- For 300kg charge of weight and 7 meter stand of distance, displacement, stress, moment decrease by 7%, 1.4% , 10.5% respectively while Demand capacity ratio increased by 55.3% for industrial building with bracing.
- For 300kg charge of weight and 8 meter stand of distance, displacement, stress, moment decrease by 5.7%, 1.2% ,

16.1% respectively while Demand capacity ratio increased by 48.8% for industrial building with bracing.
- For 300kg charge of weight and 9 meter stand of distance, displacement, stress, moment decrease by 5.1%, 1.3% , 19.1% respectively while Demand capacity ratio increased by 70.5% for industrial building with bracing.
- For 300kg charge of weight and 10 meter stand of distance, displacement, stress, moment decrease by 5.1%, 2% , 23.5% respectively while Demand capacity ratio increased by 49.8% for industrial building with bracing.

Conclusion for 400 kg charge of weight

Stand of Distance (m)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm²)	Moment (kN.m)
10	112.1	3.8	208.2	300.0	105.0	5.6	206.0	235.1
9	116.6	3.9	212.5	312.1	109.3	5.7	210.3	247.2
8	118.2	4.1	218.1	313.3	110.9	5.9	215.3	248.4
7	123.5	4.2	237.8	330.8	116.4	6.0	229.5	265.9
6	133.4	4.6	254.0	346.6	124.5	6.4	244.3	281.7
5	141.0	4.8	272.5	362.8	132.3	6.6	262.8	297.9

- For400kg charge of weight and 5 meter stand of distance, displacement, stress, moment decrease by 6.2%, 3.6% , 17.9% respectively while Demand capacity ratio increased by 37.5% for industrial building with bracing.
- For400kg charge of weight and 6 meter stand of distance, displacement, stress, moment decrease by 6.7%, 3.8% , 18.7% respectively while Demand capacity ratio increased by 40% for industrial building with bracing.
- For400kg charge of weight and 7 meter stand of distance, displacement, stress, moment decrease by 5.7%, 3.5% , 19.6% respectively while Demand capacity ratio increased by 40% for industrial building with bracing.
- For400kg charge of weight and 8 meter stand of distance, displacement, stress, moment decrease by 6.2%, 1.3% , 20.7% respectively while Demand capacity ratio increased by 43.9% for industrial building with bracing.

- For400kg charge of weight and 9 meter stand of distance, displacement, stress, moment decrease by 6.3%, 1% , 20.8% respectively while Demand capacity ratio increased by 45.8% for industrial building with bracing.
- For400kg charge of weight and 10 meter stand of distance, displacement, stress, moment decrease by 6.4%, 1.1% , 21.6% respectively while Demand capacity ratio increased by 49.3% for industrial building with bracing.

Conclusion for 500 kg charge of weight

Stand of Distance (m)	Without Bracing				With Bracing			
	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)	Maximum displacement (mm)	Demand capacity (ratio)	Stress (N/mm^2)	Moment (kN.m)
10	123.0	4.3	229.4	319.6	115.5	6.1	226.8	259.5
9	127.3	4.4	233.7	331.8	119.8	6.2	231.1	271.7
8	134.0	4.6	239.3	334.3	126.5	6.4	236.4	274.2
7	140.3	4.7	259.0	351.8	132.8	6.5	250.6	291.7
6	149.3	4.9	275.3	367.6	141.8	6.7	265.4	307.5
5	157.7	5.1	293.9	383.8	150.2	6.9	284.2	323.7

- For500kg charge of weight and 5 meter stand of distance, displacement, stress, moment decrease by 4.8%, 3.3% , 15.7% respectively while Demand capacity ratio increased by 35.3% for industrial building with bracing.
- For500kg charge of weight and 6 meter stand of distance, displacement, stress, moment decrease by 5%, 3.6% , 16.3% respectively while Demand capacity ratio increased by 36.7% for industrial building with bracing.
- For500kg charge of weight and 7 meter stand of distance, displacement, stress, moment decrease by 5.3%, 3.2% , 17.1% respectively while Demand capacity ratio increased by 38.3% for industrial building with bracing.
- For500kg charge of weight and 8 meter stand of distance, displacement, stress, moment decrease by 5.6%, 1.2% , 18% respectively while Demand capacity ratio increased by 39.1% for industrial building with bracing.
- For500kg charge of weight and 9 meter stand of distance, displacement, stress, moment decrease by 5.9%, 1.1% ,

18.1% respectively while Demand capacity ratio increased by 40.9% for industrial building with bracing.
- For500kg charge of weight and 10 meter stand of distance, displacement, stress, moment decrease by 6.1%, 1.1% , 18.8% respectively while Demand capacity ratio increased by 41.9% for industrial building with bracing..

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