BEHAVIOUR OF RC STRUCTURES SUBJECTED TO BLASTING

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1 Abstract:

The increase in the number of terrorist attacks in the last few years and also the number of natural disasters like earthquake and wind loads has shown that the effect of blast loads on buildings is a serious matter that should be taken into consideration in the design process. A bomb impact inside or immediately nearby a construction can hurt on the structure. The structural collapse will also cause damage to the surrounding of the building. In the present study, P+10 storied RCC building is subjected to 100 Kg charge of explosive at a standoff distance of 20m, 30m, 40m and 50m from the building is considered. IS 4991-1968 is used for the manual calculation of blast load and the models are developed using ETAB with M25 grade concrete for beams, M25 grade concrete for columns and Fe 500 Mpa grade of steel for reinforcement are taken as material properties. The study aims to provide a better and easy understanding of blast load analysis.

2 Introduction

Impact is a tension unsettling influence brought about by the unexpected arrival of energy. The investigation of shoot impacts on structures has been an area of formal specialized examination for north of 60 years. Because of various unplanned or deliberate occasions, the way of behaving of underlying parts exposed to impact stacking has been the subject of examination as of late. Methodologies for impact security have turned into a significant thought for underlying originators as worldwide fear monger assaults go on at a disturbing rate. The impact blast which is close by or inside the construction is either because of tension bomb or vehicle bomb or quarry impacting. A bomb impact inside or immediately nearby a construction can truly hurt on the structure's outside and inner primary edges, imploding of walls and extinguishing of huge spreads of windows. Loss of life and wounds to inhabitants can result from various causes including direct impact impacts, flotsam and jetsam influence, underlying breakdown, fire and smoke. Also, major lamentable damage coming about because of gas-substance blasts brings about huge unique burdens.

The reaction of the design to seismic burden is far not quite the same as the reaction got for shoot stacking on a construction. Impact loads are applied on structure for a brief span of time yet the greatness when looked at is far higher than different burdens. Impact stacking and its consequences for a design is impacted by various elements including charge weight, area of the impact (or deadlock distance), and the mathematical setup and direction of the construction (or course of the impact). Primary reaction will contrast as per the manner in which these variables join. In this way it is essential to comprehend the impact of working under shoot load to safeguard a construction.

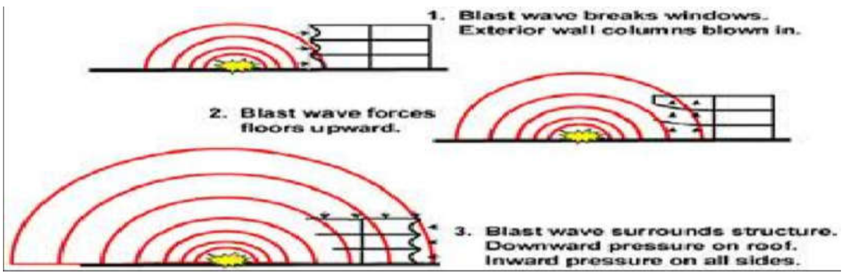


Fig. 1. Blast load effect on building.

3 LITERARTURE REVIEW

3.1 Charge weight and standoff distance

Study and Analysis of Blast Resistance Structure Pranali R. Nikure1, Dr. Valsson Varghese2, 2019

By and large the structures are not intended for impact load, so the impact load makes extremely high tension over a structure than the general stacking. A G+4 story RCC building is exposed to 100Kg, 150Kg, 200Kg and 250Kg Tri nitro toluene (dynamite) shoot sources a ways off of 30m, 40m and 50m from the structure is considered for examination. IS 4991-1968 is utilized for the manual computation of impact burden and power time history is acted in STAAD Star. The huge impact on the structure will happen when the charge weight increments and the ground distance diminishes. Section powers (bowing second) are more when deadlock distance is less as well as the other way around. Pillar powers (shear power and bowing second) diminish as the stalemate distance increments.

A review on study and analysis of blast resistance structure 1 Pranali R. Nikure, 2 Dr. Valsson Varghese, 2019.

As the fear monger exercises expanding step by step and which are essentially happening in jam-packed places is a rising issue in all around a globe. The structures are not commonly intended for the impact load which leads to the underlying harm of building component or breakdown of building .In this manner understanding the impact of impact on building is significant. According to results found shows that the framework was essentially impacted with expansion in control weight and reduction in deadlock distance. The greatness of impact pressure increments on expansion in stalemate distances. Impact pressure increments on expansion in weight of endlessly impact pressure diminish when distance increments deadlock. The appearance season of impact wave increments as the stalemate distance increments.

Behavior of RCC Structural Members for Blast Analysis, Prof. C. M. Deshmukh, Dr. C. P. Pise et. Al, 2016.

A bomb blast inside or close by outside the structure can cause devastating disappointment of building. In present review, the impact load was determined utilizing UFC-340-02 (2008) or IS 4991-1968 for 500 kg and 100 Kg dynamite at stalemate distance of 10m and 30m from face of segment at first floor level. Impact load differs with time and distance. The way of behaving of design enormously relies upon charge of unstable and its stalemate distance. At the point when deadlock diminishes the impact pressure is more as well as the other way around. Because of unexpected delivered hazardous energy causes disappointment of design like breakdown the construction, harm of underlying components and break development in structure.

3.2 Strain energy graph (Deflection)

Study and Analysis of Blast Resistance Structure Pranali R. Nikure1 , Dr. Valsson Varghese2, 2019

. A G+4 story RCC building is exposed to 100Kg, 150Kg, 200Kg and 250Kg Tri nitro toluene (dynamite) shoot sources a ways off of 30m, 40m and 50m from the structure is considered for investigation. IS 4991-1968 is utilized for the manual computation of impact burden and power time history is acted in STAAD Master. The decrease in the impact of second on the structure because of impact stays same (i.e., along Y heading in segment) approx. equivalent to 25 % at 40m distance and 40% at 50m distance. The decrease in the impact of second on the structure because of impact stays same (i.e., along Z heading in section) approx. equivalent to 40 % at 40m distance and 60% at 50m distance. The decrease in the impact of shear force on the structure because of impact stays same for approx. equivalent to 30 % at 40m distance and 45% at 50m distance. The decrease in the impact of second on the structure because of impact stays same (i.e., along Z bearing in bar) approx. equivalent to 25 % at 40m distance and 40% at 50m distance. The decrease in the impact of twist in the pillar on the structure because of impact stays same approx. equivalent to 25 % at 40m distance and 40% at 50m distance.

3.3 Inertia force

BEHAVIOUR OF REINFORCED CONCRETE STRUCTURAL MEMBERS UNDER THE INFULENCE OF IMPLICIT BLAST LOADING, Bharadwaj Vangipuram, Md. Abdul Jabbar Sharief, B. Bala Sandeep, 2019

Impact stacking has forever been hard to comprehend. The impact safe part is planned on the rule of Newton's most memorable Law of movement. The law expresses that the body stays in its condition of movement except if an outside force is applied on it. The opposition presented by it is known as Latency. Mass is utilized as a proportion of latency. In this manner, the size of individuals is expanded which consequently builds mass and protection from impact load. At the point when impact safe section is liable to impact load, the bowing is opposed by expanded mass dormancy. The review led on underlying individuals; traditional individuals are encountering greatest inertial power at mid-range. Impact safe individuals experience a similar impact yet can oppose the heap due to expanded mass by 20%. Mass as a proportion of inertial obstruction has worked somewhat keeping in view the efficient part.

3.4 Architectural view

Role of architectural space in blast resistant buildings, Mahdi Bitarafana, Sayed Bagher Hosseinib et. al., 2008

. Enormous monetary arrangement is spent yearly by and large in creating public and classified structures using different designing plans. Two methodologies are pondered and taken a gander at for instance Delphi procedure and AHP strategy. The Delphi procedure is a cooperation used to appear at a get-together evaluation or decision by looking into a leading group of trained professionals. The logical moderate framework process (AHP), similarly canny request process, is a coordinated procedure for planning and exploring complex decisions, considering science and mind research. Delphi system was used to evaluate the underlying space of effect safe designs, while AHP strategy was used to explore the results. AHP procedure is a powerful, negligible cost, and significantly exact technique in the affirmation of the best and appropriate unique choice. This method can be a nice model as an organization instrument with immaterial time and cost that gives the best choice among the open decisions.

4 Methodology

In this review, P+10 celebrated RCC building is examined. The building is model in ETABS software.

Aspect of building 10.90 x 14.22m. Total height of building is 33m, Height of each storey is 3m and Plinth height above GL is 2m.

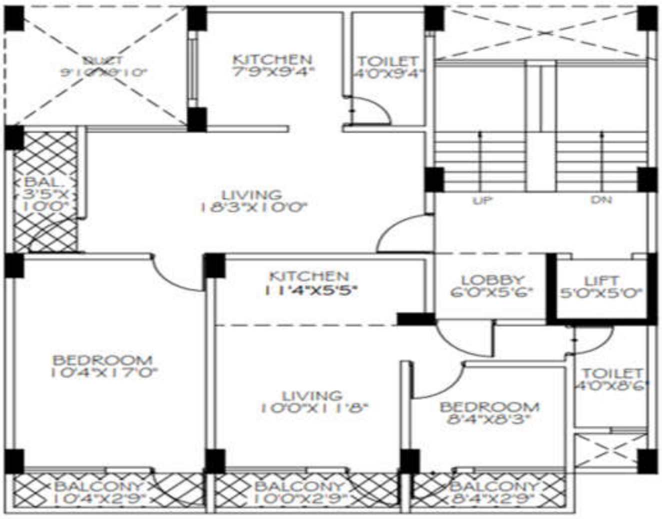


Fig. 2 Building plan

Grade of concrete	M25
Grade of steel	Fe500
Density of concrete	25 KN/m2
Density of concrete	78.5 KN/m2

Table 1. Material properties

Beam	230 x 600mm
Column	300 x 750mm
Shear wall thickness	200mm
Beam cover	40mm
Column cover	40mm
Slab thickness	125mm
Height of parapet wall	1.2m

Table 2. Member properties

4.1 General loading

Live load (IS 875, part 2) = 2kN/m2
Floor finish load =1.5kN/m2,
Sunk load for Toilet (roof) = 4kN/m2
Sunk load for Terrace/balcony (roof) = 3 kN/m2
Floor to floor Height = 3m for all floors.
Wall loads = 7.2Kn/m
Earthquake Load = IS1893:2002
Blast Load = IS-4991 1968

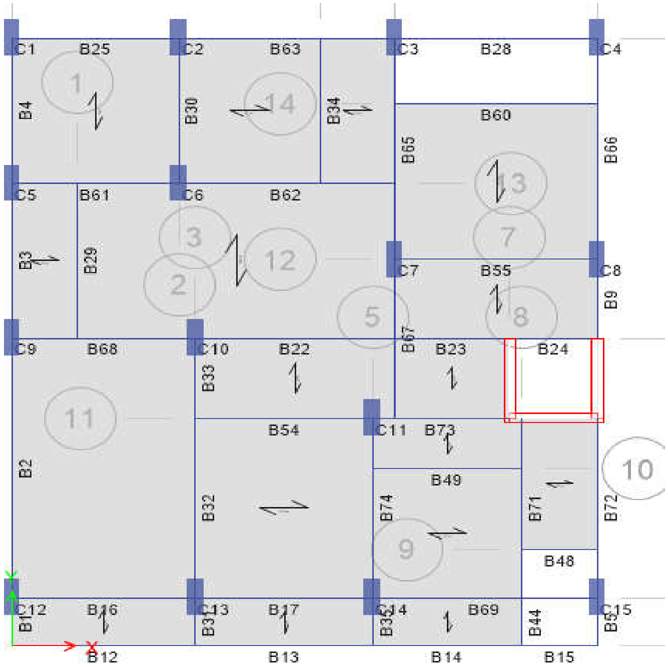


Fig. 3. Typical floor plan on Etab.

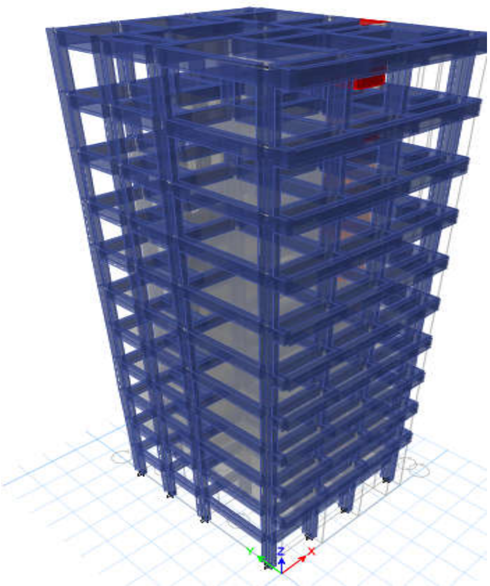


Fig. 4. 3D view of the building

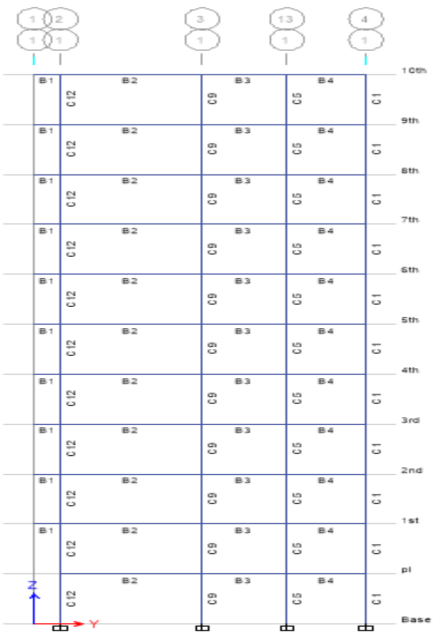


Fig. 5. Elevation of the building

4.2 Blast load calculation

Shoot force for a 100 kg charge of dangerous is considered for the review. The stalemate distances considered are 20m, 30m, 40m and 50m. The impact loads are determined by utilizing following recipe.

Scaled distance (z) = $\frac{\boldsymbol{R}}{\boldsymbol{w^{1}/3}}$

Where,

R is the actual effective distance from the explosion.

W is the charged weight in tons.

The corresponding values of Pro/ Pa are taken from Table 1 of IS: 4991-1968.

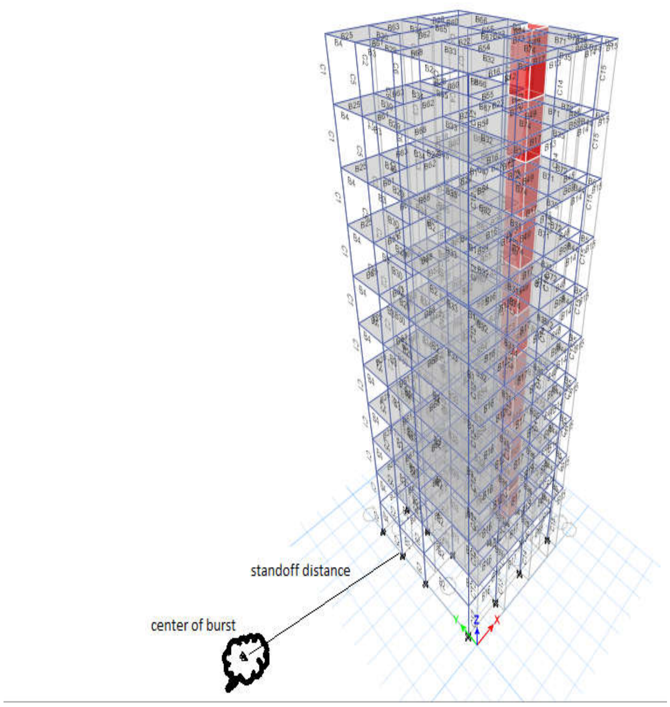


Fig. 6. Render

From the above fig the focal point of burst is on left half of the structure at various deadlock distances.

The impact of impact is focus on left face of building that is height 1, so the rise 1 is consider for use of impact stacking.

Fig. 7. Elevation view-1 for application of blast loading

Blast load is calculated as per IS 4991-1968 from table-1 for elevation-1. The blast load is apply as a pressure then pressure is converted in to point load and applied on each joint in etab. As we can see from the above figure that the elevation elevatrion-1 is taken and each joints are numbered, so there are 4 joints – 1, 2, 3 and 4 for each floor.

Blast load is calculated for respective joint on each floor as per standoff distance and is tabulated below.

Joint	F.L	Stand-off Dist.	Scaled Dist.	Peak reflected overpressure Ratio	Area	F
		R (m)	Z (m)	Pro/Pa (Kn/m2)	A (m2)	Kn
1	G.F.	20.97	45.18	1.648	2.25	370.8
2		20.25	43.63	1.8	4.65	837
3		20	43.09	1.86	6.43	1195.98
4		20.71	44.62	1.7	4.03	685.1
1	1	21.15	45.57	1.622	4.5	729.9
2		20.48	44.12	1.75	9.3	1627.5
3		20.22	43.56	1.81	12.86	2327.66
4		20.92	45.07	1.65	8.06	1329.9
1	2	21.78	46.92	1.53	4.5	688.5
2		21.12	45.50	1.63	9.3	1515.9
3		20.88	44.98	1.66	12.86	2134.76
4		21.56	46.45	1.56	8.06	1257.36
1	3	22.79	49.10	1.39	4.5	625.5
2		22.16	47.74	1.48	9.3	1376.4
3		21.93	47.25	1.51	12.86	1941.86
4		22.58	48.65	1.42	8.06	1144.52
1	4	24.13	51.99	1.23	4.5	553.5
2		23.54	50.72	1.3	9.3	1209
3		23.32	50.24	1.33	12.86	1710.38
4		23.93	51.56	1.25	8.06	1007.5
1	5	25.76	55.50	1.075	4.5	483.75
2		25.2	54.29	1.13	9.3	1050.9
3		25	53.86	1.15	12.86	1478.9
4		25.57	55.09	1.09	8.06	878.54
1	6	27.61	59.48	0.94	4.5	423
2		27.1	58.39	0.97	9.3	902.1
3		26.91	57.98	0.98	12.86	1260.28
4		27.44	59.12	0.95	8.06	765.7
1	7	29.66	63.90	0.826	4.5	371.7
2		29.18	62.87	0.83	9.3	771.9
3		29	62.48	0.86	12.86	1105.96
4		29.49	63.53	0.84	8.06	677.04
1	8	31.85	68.62	0.73	4.5	328.5
2		31.4	67.65	0.74	9.3	688.2
3		31.24	67.30	0.74	12.86	951.64
4		31.7	68.30	0.73	8.06	588.38
1	9	34.17	73.62	0.64	4.5	288
2		33.75	72.71	0.65	9.3	604.5
3		33.6	72.39	0.66	12.86	848.76
4		34.03	73.32	0.648	8.06	522.288
1	10	36.58	78.81	0.57	2.25	128.25
2		36.2	77.99	0.58	4.65	269.7
3		36.06	77.69	0.58	6.43	372.94
4		36.45	78.53	0.57	4.03	229.71

Table 3. Pressure and Joint load acting on the front face of the building due to explosive weight of 100kg at 20m standoff distance.

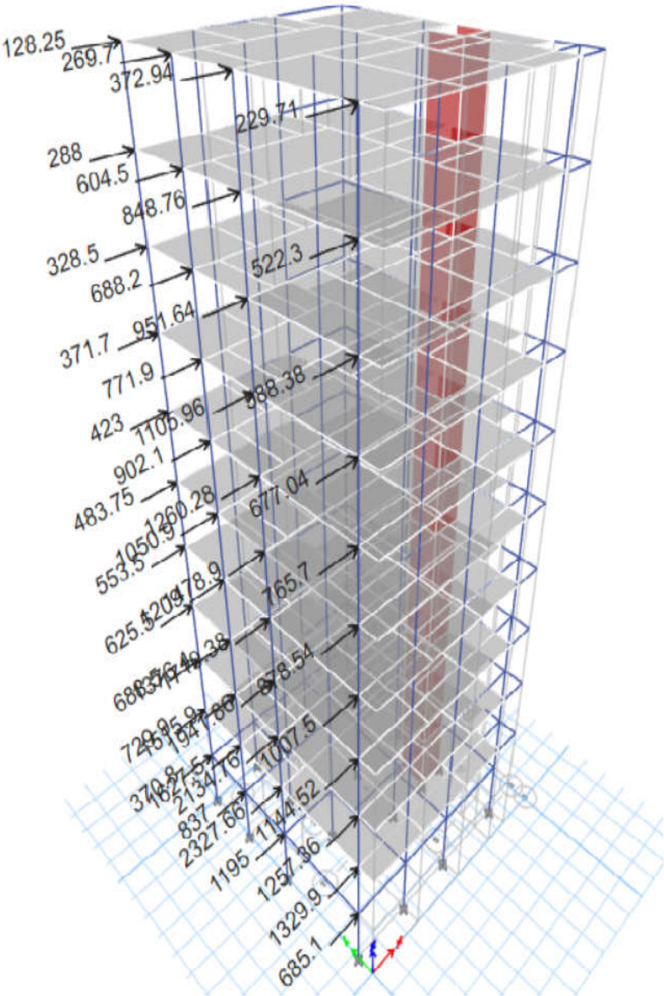


Fig. 8. Application of blast load, 20m standoff distance

Joint	F.L	Stand-off Dist.	Scaled Dist.	Peak reflected overpressure Ratio	Area	F
		R (m)	Z (m)	Pro/Pa (Kn/m2)	A (m2)	Kn
1	G.F.	30.63	65.99	0.77	2.25	173.25
2		30.17	65.00	0.796	4.65	370.14
3		30	64.63	0.81	6.43	520.83
4		30.48	65.67	0.778	4.03	313.534
1	1	30.78	66.31	0.765	4.5	344.25
2		30.32	65.32	0.788	9.3	732.84
3		30.15	64.96	0.797	12.86	1024.94 2
4		30.62	65.97	0.77	8.06	620.62
1	2	31.22	67.26	0.749	4.5	337.05
2		30.76	66.27	0.765	9.3	711.45
3		30.59	65.90	0.77	12.86	990.22
4		31.06	66.92	0.755	8.06	608.53
1	3	31.93	68.79	0.723	4.5	325.35
2		31.48	67.82	0.739	9.3	687.27
3		31.32	67.48	0.745	12.86	958.07
4		31.78	68.47	0.728	8.06	586.768
1	4	32.9	70.88	0.688	4.5	309.6
2		32.47	69.95	0.704	9.3	654.72
3		32.31	69.61	0.709	12.86	911.774
4		32.75	70.56	0.694	8.06	559.364
1	5	34.11	73.49	0.645	4.5	290.25
2		33.69	72.58	0.66	9.3	613.8
3		33.54	72.26	0.665	12.86	855.19
4		33.97	73.19	0.65	8.06	523.9
1	6	35.53	76.55	0.599	4.5	269.55
2		35.13	75.69	0.611	9.3	568.23
3		34.99	75.38	0.614	12.86	789.604
4		35.4	76.27	0.603	8.06	486.018
1	7	37.14	80.02	0.559	4.5	251.55
2		36.76	79.20	0.568	9.3	528.24
3		36.02	77.60	0.585	12.86	752.31
4		37.01	79.74	0.562	8.06	452.972
1	8	38.92	83.85	0.531	4.5	238.95
2		38.55	83.05	0.536	9.3	498.48
3		38.42	82.77	0.538	12.86	691.868
4		38.79	83.57	0.532	8.06	428.792
1	9	40.83	87.97	0.49	4.5	220.5
2		40.49	87.23	0.497	9.3	462.21
3		40.36	86.95	0.5	12.86	643
4		40.72	87.73	0.492	8.06	396.552
1	10	42.88	92.38	0.438	2.25	98.55
2		42.55	91.67	0.447	4.65	207.855
3		42.43	91.41	0.451	6.43	289.993
4		42.76	92.12	0.441	4.03	177.723

Table 4. Pressure and Joint load acting on the front face of the building due to explosive weight of 100kg at 30m standoff distance.

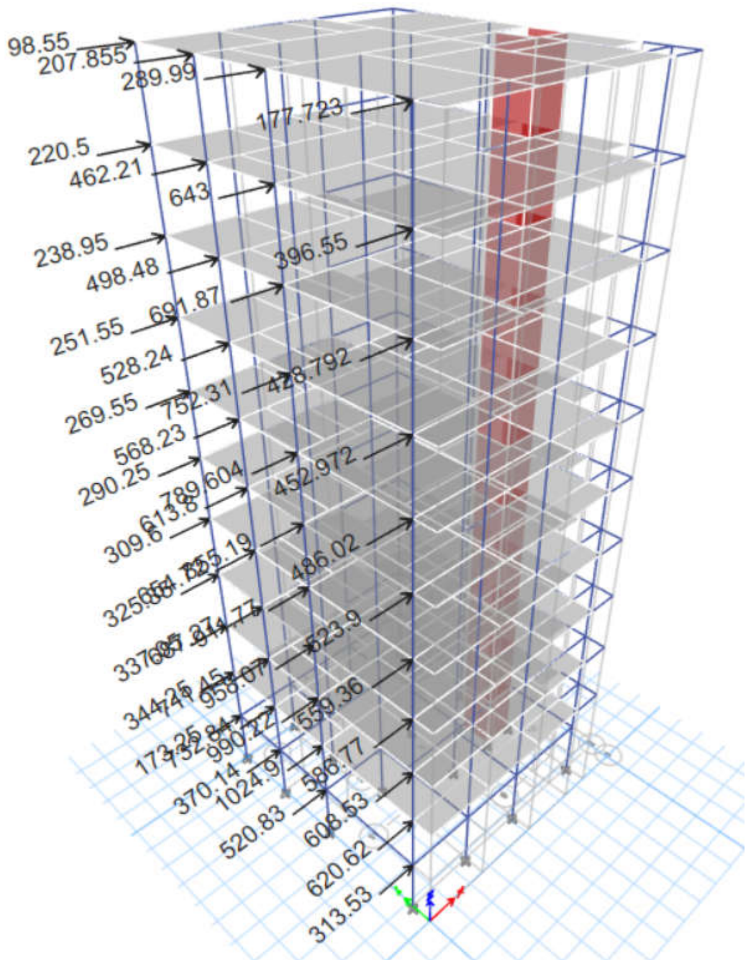


Fig. 9. Application of blast load, 30m standoff distance

Joint	F.L	Stand-off Dist.	Scaled Dist.	Peak reflected overpressure Ratio	Area	F
		R (m)	Z (m)	Pro/Pa (Kn/m2)	A (m2)	Kn
1	G.F.	40.478	87.21	0.497	2.25	111.825
2		40.128	86.45	0.505	4.65	234.825
3		40	86.18	0.508	6.43	326.644
4		40.36	86.95	0.5	4.03	201.5
1	1	40.59	87.45	0.495	4.5	222.75
2		40.24	86.69	0.503	9.3	467.79
3		40.11	86.41	0.506	12.86	650.716
4		40.47	87.19	0.498	8.06	401.388
1	2	40.92	88.16	0.488	4.5	219.6
2		40.57	87.41	0.495	9.3	460.35
3		40.45	87.15	0.498	12.86	640.428
4		40.8	87.90	0.491	8.06	395.746
1	3	40.47	87.19	0.498	4.5	224.1
2		40.13	86.46	0.505	9.3	469.65
3		41	88.33	0.486	12.86	624.996
4		41.35	89.09	0.479	8.06	386.074
1	4	42.22	90.96	0.457	4.5	205.65
2		41.88	90.23	0.466	9.3	433.38
3		41.76	89.97	0.47	12.86	604.42
4		42.1	90.70	0.46	8.06	370.76
1	5	43.17	93.01	0.429	4.5	193.05
2		42.84	92.30	0.439	9.3	408.27
3		42.72	92.04	0.443	12.86	569.698
4		43.06	92.77	0.433	8.06	348.998
1	6	44.3	95.44	0.414	4.5	186.3
2		43.98	94.75	0.418	9.3	388.74
3		43.86	94.49	0.42	12.86	540.12
4		44.19	95.20	0.415	8.06	334.49
1	7	45.6	98.24	0.402	4.5	180.9
2		45.29	97.57	0.404	9.3	375.72
3		45.18	97.34	0.405	12.86	520.83
4		45.5	98.03	0.403	8.06	324.818
1	8	47.06	101.39	0.376	4.5	169.2
2		46.76	100.74	0.382	9.3	355.26
3		46.65	100.50	0.385	12.86	495.11
4		46.96	101.17	0.378	8.06	304.668
1	9	48.66	104.83	0.348	4.5	156.6
2		48.37	104.21	0.353	9.3	328.29
3		48.26	103.97	0.354	12.86	455.244
4		48.56	104.62	0.349	8.06	281.294
1	10	50.38	108.54	0.319	2.25	71.775
2		50.1	107.94	0.324	4.65	150.66
3		50	107.72	0.326	6.43	209.618
4		50.29	108.35	0.321	4.03	129.363

Table 5. Pressure and Joint load acting on the front face of the building due to explosive weight of 100kg at 40m standoff distance.

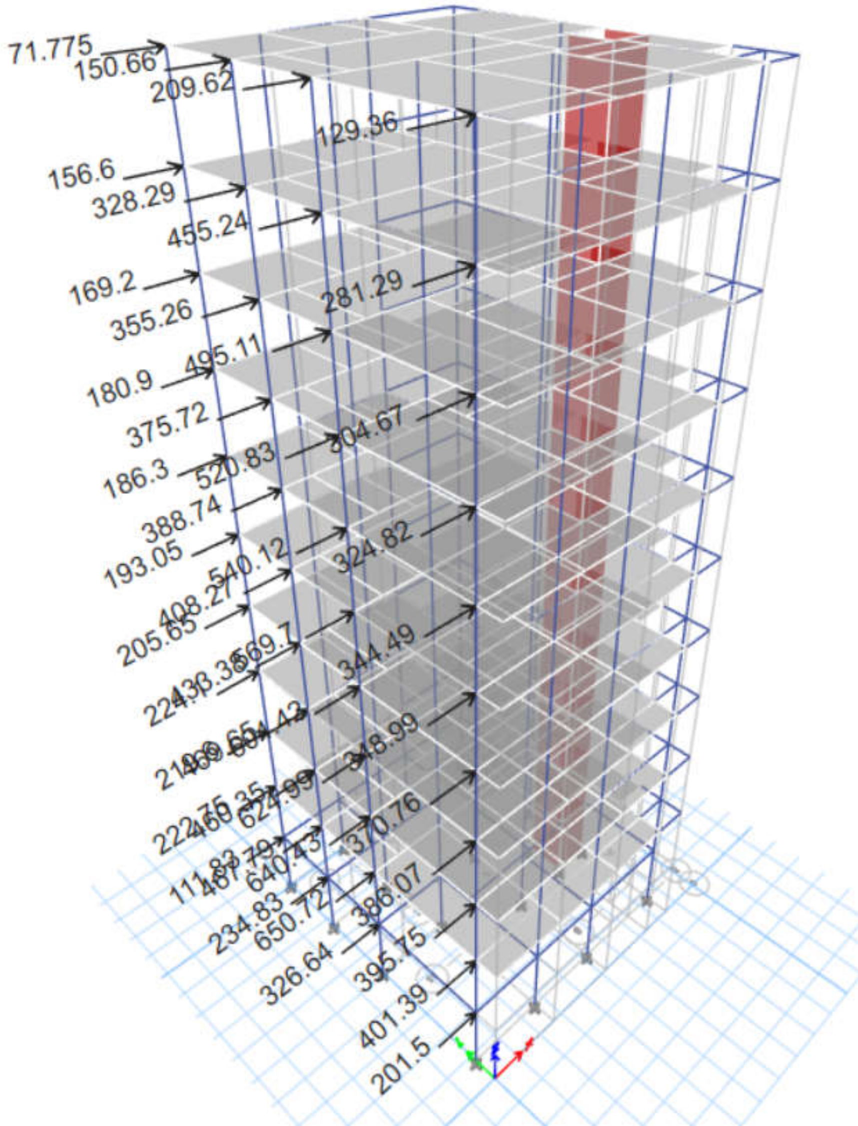


Fig. 10. Application of blast load, 40m standoff distance

Joint	F.L	Stand-off Dist.	Scaled Dist.	Peak reflected overpressure Ratio	Area	F
		R (m)	Z (m)	Pro/Pa (Kn/m2)	A (m2)	Kn
1	G.F.	50.38	108.54	0.319	2.25	71.775
2		50.1	107.94	0.324	4.65	150.66
3		50	107.72	0.326	6.43	209.618
4		50.29	108.35	0.321	4.03	129.363
1	1	50.47	108.73	0.318	4.5	143.1
2		50.19	108.13	0.323	9.3	300.39
3		50.09	107.92	0.324	12.86	416.664
4		50.38	108.54	0.319	8.06	257.114
1	2	50.74	109.32	0.313	4.5	140.85
2		50.46	108.71	0.318	9.3	295.74
3		50.36	108.50	0.32	12.86	411.52
4		50.64	109.10	0.315	8.06	253.89
1	3	51.18	110.26	0.306	4.5	137.7
2		50.9	109.66	0.311	9.3	289.23
3		50.8	109.45	0.312	12.86	401.232
4		51.09	110.07	0.308	8.06	248.248
1	4	51.79	111.58	0.296	4.5	133.2
2		51.52	111.00	0.301	9.3	279.93
3		51.42	110.78	0.302	12.86	388.372
4		51.7	111.38	0.298	8.06	240.188
1	5	52.57	113.26	0.283	4.5	127.35
2		52.3	112.68	0.288	9.3	267.84
3		52.2	112.46	0.289	12.86	371.654
4		52.48	113.06	0.285	8.06	229.71
1	6	53.5	115.26	0.268	4.5	120.6
2		53.24	114.70	0.272	9.3	252.96
3		53.14	114.49	0.274	12.86	352.364
4		53.41	115.07	0.269	8.06	216.814
1	7	54.58	117.59	0.25	4.5	112.5
2		54.33	117.05	0.254	9.3	236.22
3		54.23	116.83	0.256	12.86	329.216
4		54.5	117.42	0.251	8.06	202.306
1	8	55.81	120.24	0.23	4.5	103.5
2		55.55	119.68	0.234	9.3	217.62
3		55.46	119.48	0.235	12.86	302.21
4		55.72	120.05	0.231	8.06	186.186
1	9	57.16	123.15	0.207	4.5	93.15
2		56.91	122.61	0.211	9.3	196.23
3		56.82	122.41	0.213	12.86	273.918
4		57.08	122.98	0.209	8.06	168.454
1	10	58.64	126.34	0.183	2.25	41.175
2		58.4	125.82	0.187	4.65	86.955
3		58.31	125.63	0.188	6.43	120.884
4		58.56	126.16	0.184	4.03	74.152

Table 6. Pressure and Joint load acting on the front face of the building due to explosive weight of 100kg at 50m standoff distance

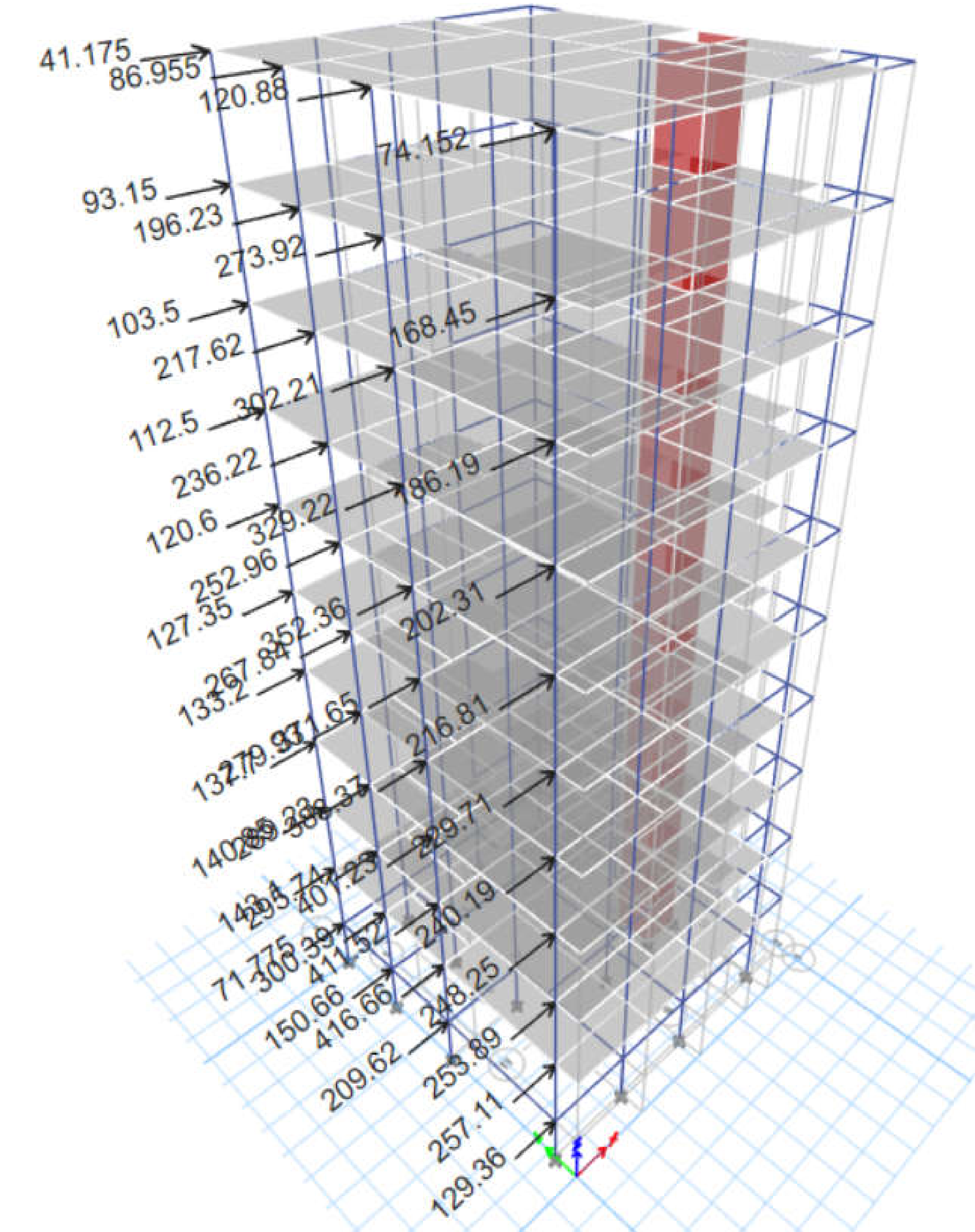


Fig. 11. Application of blast load, 50m standoff distance

5 RESULT

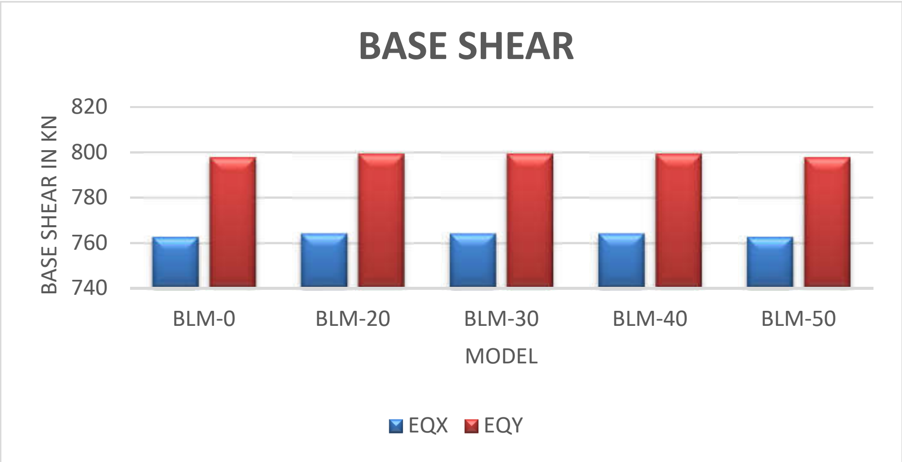
MODEL	DISCRIPTION
BLM-0	MODEL WITHOUT BLAST LOAD
BLM-20	MODEL WITH 20M STANDOFF DISTANCE
BLM-30	MODEL WITH 30M STANDOFF DISTANCE
BLM-40	MODEL WITH 40M STANDOFF DISTANCE
BLM-50	MODEL WITH 50M STANDOFF DISTANCE

Table 7. - Description

5.1 Base shear

MODEL	EQX	EQY
BLM-0	762.56	797.67
BLM-20	764.16	799.34
BLM-30	764.16	799.34
BLM-40	764.16	799.34
BLM-50	762.56	797.67

Table 8. - Base shear

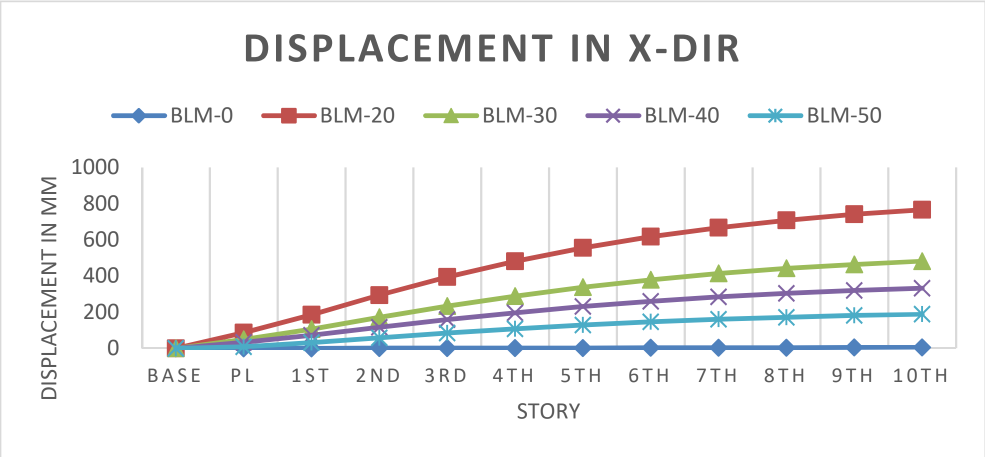


Graph 1: Base shear graph.

5.2 Story displacement

MAX. STORY DISPLACEMENT IN X-DIR.					
STORY	BLM-0	BLM-20	BLM-30	BLM-40	BLM-50
Base	0	0	0	0	0
pl	0.062	85.63	48.328	32.647	7.561
1st	0.21	185.079	105.777	71.649	31.873
2nd	0.496	294.216	170.786	116.059	58.272
3rd	0.884	394.286	232.454	158.464	83.889
4th	1.36	481.587	288.138	196.925	107.328
5th	1.91	555.768	336.959	230.87	127.985
6th	2.525	617.497	378.676	260.084	145.627
7th	3.193	667.942	413.454	284.555	160.244
8th	3.908	708.465	441.684	304.44	171.994
9th	4.664	740.729	464.118	320.232	181.23
10th	5.454	766.294	481.618	332.534	188.364

Table 9. -Maximum story displacement in X-direction**.**

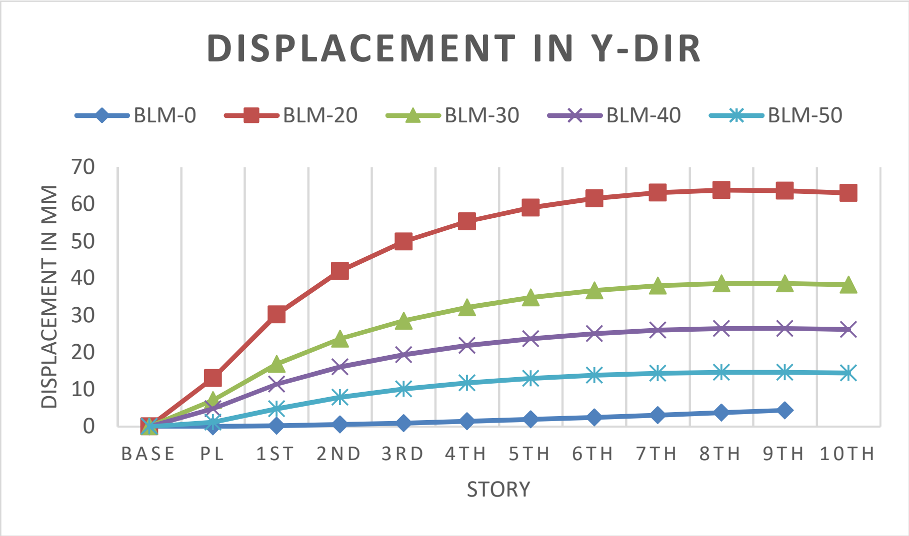


Graph 2: Story displacement in X direction.

As displayed in the above chart, the structure of deadlock distance 20m has the greatest uprooting in the X bearing than different structures having 30m, 40 and 50m as stalemate distance And the least relocation is of the structure without use of impact load.

MAX. STORY DISPLACEMENT IN Y-DIR.					
STORY	BLM-0	BLM-20	BLM-30	BLM-40	BLM-50
Base	0	0	0	0	0
pl	0.073	13.043	7.15	4.824	1.188
1st	0.241	30.233	16.876	11.397	4.824
2nd	0.541	42.033	23.716	16.059	7.886
3rd	0.928	49.929	28.563	19.398	10.123
4th	1.387	55.371	32.143	21.862	11.761
5th	1.906	59.127	34.8	23.709	12.964
6th	2.475	61.636	36.716	25.064	13.82
7th	3.085	63.167	37.988	25.987	14.374
8th	3.726	63.851	38.639	26.467	14.641
9th	4.388	63.706	38.647	26.484	14.624
10th		63.113	38.258	26.214	14.438

Table 10. - Maximum story displacement in Y-direction**.**



Graph 3: Story displacement in Y direction.

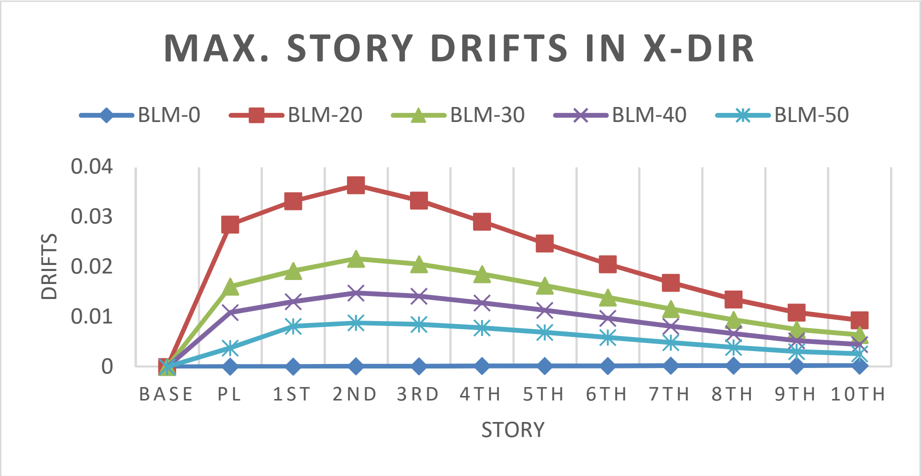
As displayed in the above diagram, the structure of deadlock distance 20m has the most extreme removal in the Y heading than different structures having 30m, 40 and 50m as stalemate distance.

What's more, the least relocation is of the structure without use of impact load.

5.3 Story drifts

MAX. STORY DRIFTS IN X-DIR.					
STORY	BLM-0	BLM-20	BLM-30	BLM-40	BLM-50
Base	0	0	0	0	0
pl	0.000031	0.028543	0.016109	0.010882	0.003781
1st	0.000057	0.033234	0.019204	0.013039	0.008105
2nd	0.000096	0.036397	0.021679	0.014809	0.008805
3rd	0.000129	0.033361	0.020557	0.014135	0.00854
4th	0.000159	0.02911	0.018563	0.012823	0.007814
5th	0.000184	0.024738	0.016276	0.011317	0.006886
6th	0.000205	0.020587	0.013909	0.009739	0.005882
7th	0.000223	0.016824	0.011596	0.008158	0.004874
8th	0.000238	0.013516	0.009413	0.006631	0.003919
9th	0.000252	0.010905	0.007485	0.005266	0.003082
10th	0.000269	0.009325	0.006371	0.004474	0.002605

Table 11. - Maximum story drift in X-direction**.**



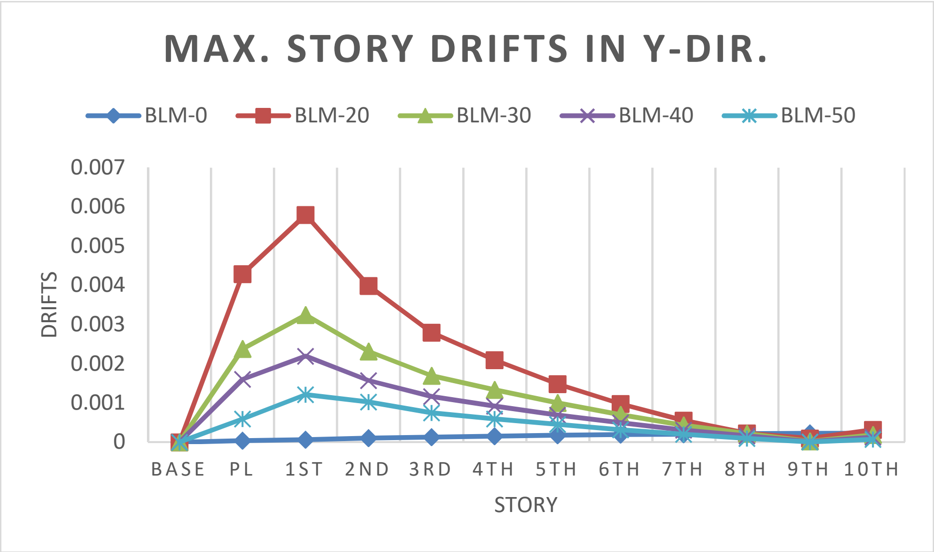
Graph 4: Story drift in X direction.

As displayed in the above diagram, the structure of stalemate distance 20m has the greatest story float in the X bearing than different structures having 30m, 40 and 50m as deadlock distance.

Furthermore, the least story float is of the structure without utilization of impact load.

MAX. STORY DRIFTS IN Y-DIR.					
STORY	BLM-0	BLM-20	BLM-30	BLM-40	BLM-50
Base	0	0	0	0	0
pl	0.000035	0.004287	0.002383	0.001608	0.000594
1st	0.000062	0.005796	0.003245	0.002193	0.001213
2nd	0.000101	0.003987	0.002311	0.001575	0.001024
3rd	0.000131	0.002791	0.001697	0.001164	0.000748
4th	0.000155	0.002093	0.001335	0.000919	0.000593
5th	0.000175	0.001484	0.001	0.000694	0.000451
6th	0.000192	0.000976	0.000699	0.000492	0.000319
7th	0.000205	0.000554	0.000432	0.00031	0.000199
8th	0.000216	0.000228	0.000217	0.00016	0.000093
9th	0.000224	0.000098	0.000023	0.000011	0.00001
10th	0.000229	0.000314	0.000186	0.000127	0.000073

Table 12. - Maximum story drift in Y-direction**.**



Graph 5: Story drift in Y direction.

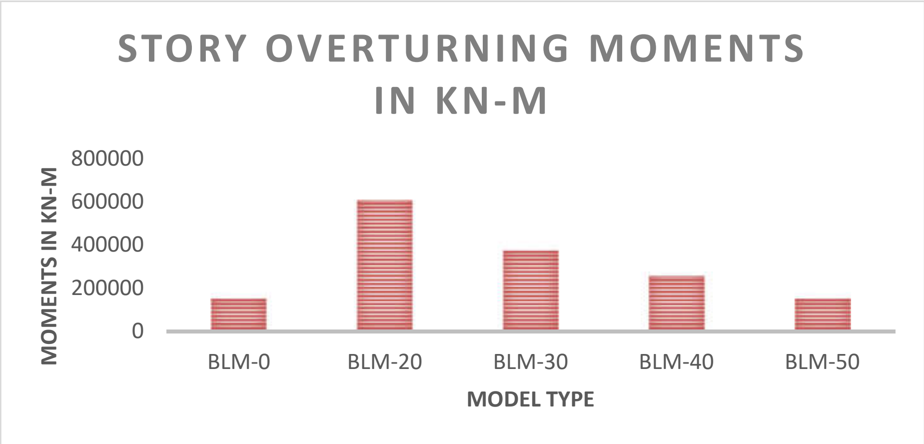
As displayed in the above diagram, the structure of deadlock distance 20m has the most extreme story float in the Y bearing than different structures having 30m, 40 and 50m as stalemate distance.

What's more, the least story float is of the structure without use of impact load.

5.4 Story overturning moments

MODEL	OVERTURNING MOMENTS IN KN-M
BLM-0	150045
BLM-20	604614
BLM-30	372017
BLM-40	255787
BLM-50	150600

Table 13. Overturning moment**.**



Graph 6: Story overturning moments.

As displayed in the above chart, the structure of stalemate distance 20m has the most extreme story upsetting minutes than different structures having 30m, 40 and 50m as deadlock distance.

Additionally the structure without utilization of impact load has less story toppling minutes.

6 Conclusion

1. Base shear for all respective models studied and observed that base shear is not affect by blast loading.
2. Maximum story displacement at each story is studied and observed that displacement at each story for BLM-20 (Blast load model with 20m standoff distance) is more as compared with BLM-30, BLM-40 and BLM-50.
3. From displacement observation as standoff distance is more the effect of blast is less.
4. Maximum story drift at each story is studied and observed that story drift at each story for BLM-20 (Blast load model with 20m standoff distance) is more as compared with BLM-30, BLM-40 and BLM-50.
5. From drift observation as standoff distance is more the effect of blast is less.
6. From above all study it is observed that blast effect is depends upon standoff distance.

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8 Author’s contribution

Swarup anil mane[1]: Conducted primary research including comprehensive literature reviews and analysis. Authored the manuscript and crafted all figures.

Dr. A.B.Pujari[2]: Provided guidance and mentorship throughout the research process.

9 Declaration

Conflict of interest: The work was accomplished with equal contributions from all authors, as far as the authors understanding goes. Therefore, we affirm that there are no conflicts of interest among the authors.

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