IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 21, Issue 5 Ser. 1 (Sept. – Oct. 2024), PP 25-30
www.iosrjournals.org

Analysis Of Blast Resistant Structure

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Abstract:
The response of reinforced concrete buildings subjected to blast loading under variable mass of TNT and different statical system will be discussed. The study was carried out using the finite element program (ABAQUS) by using solid slab model. The plastic behavior of steel reinforced bars and concrete has been incorporated.
The results obtained from the two models are in terms of Von-Mises stresses, deflection and concrete damage against varying mass of TNT. The results indicate that using double reinforced mesh has great influence on reinforced concrete slabs to withstand blast loads and the damage in concrete happened under blast loads in solid slab system.
The response of reinforced concrete buildings subjected to blast loading under variable mass of TNT and different statical system will be discussed. The study was carried out using the finite element program (ABAQUS) by using Solid slab system. The plastic behaviour of steel reinforced bars and concrete has been incorporated. The results obtained for stresses, deflection and concrete damage against varying mass of TNT.
Key Word: *Blast loading, ABAQUS, RC Structure, E-Tabs 2021.*

Date of Submission: 05-09-2024 Date of Acceptance: 15-09-2024

I. Introduction

Structures, majorly that have higher chances of being target of terrorist attacks should be safe from the blast effects. It is important to study accordingly into this area to reduce the losses caused due to the blast effects on the buildings. The dynamic replica of the structure to blast loading is complicated to analyse because of the non-linear action of material. Blast explosions result in voluminous dynamic loads, more complex than the original design loads, so for analysis and design of blast loading detailed knowledge is required of blast and its phenomena. Due to increase in technology, the buildings mostly in large cities are concentrated much on the comfort of living and the safety against earthquake and wind loads but not concentrated much on the blast loads. As explosions are becoming common in metropolitan cities consideration of blast loads on tall buildings especially public and commercial buildings is necessary. In blast analysis, one can determine the acceptable damage level that a structure can go through and designed accordingly so that the structure can manage to withstand even under worst conditions. When the explosion occurs, the damage can occur directly or indirectly, externally or internally and so it should be possibly safe in all the ways; prediction, prevention and mitigation of such events are of major concern. This study refers to the analysis of the building under blast load and its impact on the structure in response to storey displacement and storey drift for different models implemented with different structural elements. The models are analysed and compared to know the blast resistant building model to prevent overall collapse of the building in reference to the storey displacement and storey drift.

II. Literature Review

1.Chunwei Zhang, Gholamreza Gholipour, Asma Alsadat Mousavi

This paper aims to comprehensively review on existing analytical, numerical, and experimental studies in the literature investigating the loading mechanisms, dynamic responses and failure behaviours of various concrete structures subjected to blast loads. In addition, the sensitivity of the blast responses of RC structures to various structural- and loading-related parameters

2.Yao S-J, Zhang D, Lu F-Y, Wang W, Chen X-G

Damage features and dynamic response of RC beams under blast. Eng Fail Anal 2016;62:103–11. Do

3. Talaat M, Yehia E, Mazek SA, Genidi MM, Sherif AG

Finite element analysis of RC slabs subjected to blast loading. Int J Civil Struct Eng Res 2020;8(2):1–10

4. Sajal Verma, Mainak Choudhury, Purnachandra Saha

In this paper an attempt is made to review the various methods applied to different types of structure, such as, masonry, concrete, steel and the effectiveness of each method of blast loading.

5.Mays GC, Smith PD

Blast effects on buildings. Design of buildings to optimize resistance to blast loading. In: Blast effects on buildings. Design of buildings to optimize resistance to blast loading. doi:

III. Objectives And Methodology

Objectives

1. To study the theoretical background of blast load, existing provisions in the prediction of blast loads in the current design codes and typical damage mode and failure behaviors of various concrete structures
2. To Analyze the structure against blast loading using ABAQUS.
3. Structures deflection reduces with an increase in standoff distance.

Methodology:

ANALYSIS OF STRUCTURES UNDER BLAST LOADING :
Z=Scaled distance
R= Radial Distance from Explosive
Z= $(R/\sqrt[3]{w})$ W= Equivalent mass of TNT(kg)
t0= Positive duration
Pso=Peak incident Pressure
.Decay coefficient
b=Z^2-3.72Z+4.2

Time History Profile
Ps(t)=Pso(1-t/t0)e^(-b t/t^0)
b= Decay coefficient
Z= Scaled Distance Calculated
Pso=Peak Possitive pressure from graph

t0= Total time duration of positive phase
t=Pso at any time interval

The type of materials
Steel structures can absorb lot of strain energy because of its ductility property.

Flexible components can absorb higher energy contents as they resist blast loads through elastic and plastic strains.

A higher mass causes less energy imparted to the system. In such system, whole structure gets affected by blast waves.

Scaled distance (Z)= Z=$(R/\sqrt[3]{w})$

R= Radial Distance from Explosive W= Equivalent mass of TNT(kg)
For W=5kg Z=$(1/\sqrt[3]{5})$
R=3m Scaled Distance =0.584m

Cases considered for analysis:

Case 1: Blast of 5kg explosive with standoff distance of 3m and 6m
Case 2: Blast of 10kg explosive with standoff distance of 3m and 6m
Case 3: Blast of 20kg explosive with standoff distance of 6m

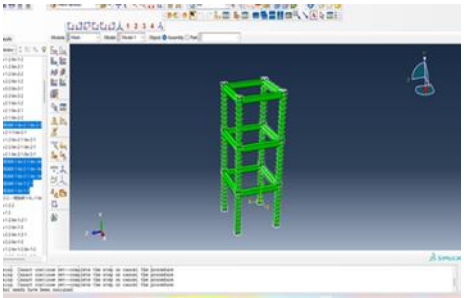


Fig -1 Mesh design of structure

Table -1: Cases data

Blast Parameters	Case 1	Case 2	Case 3
Blast (kg)	5	10	20
Standoff distance (m)	3	6	6
Scaled distance (m)	0.526	0.835	0.663
pa (kg/cm$^{2)}$	1	1	1
pso(kg/cm$^{2)}$	0.724	0.232	1.120
pro(kg/cm$^{2)}$	1.858	0.508	2.981
qo(kg/cm$^{2)}$	0.170	0.018	0.388
ta(milliseconds)	0.074	0.0744	0.046

Table -2: Model data

No of grid in x direction	3
No of grid in y direction	3
Spacing of grid in x direction	3
Spacing of grid in y direction	3
No of storey	2
Storey height	3 m
Bottom storey height	3 m
Size of column	230*300 mm
Size of beam	230*300 mm
Thickness of slab	150 mm
Live Load	3 kn/m^2
Brick Masonry external wall	0.230 m
Brick Masonry internal wall	0.115 m

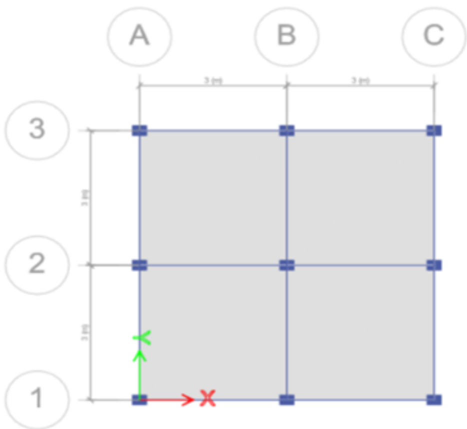
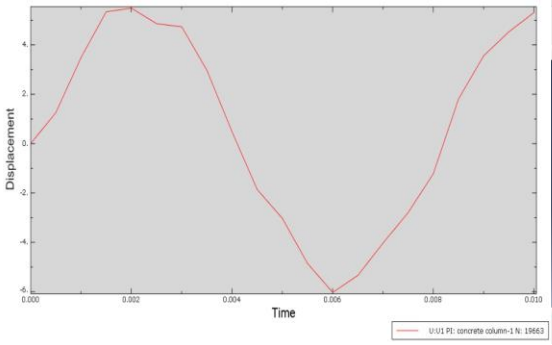


Fig -2: Plan view



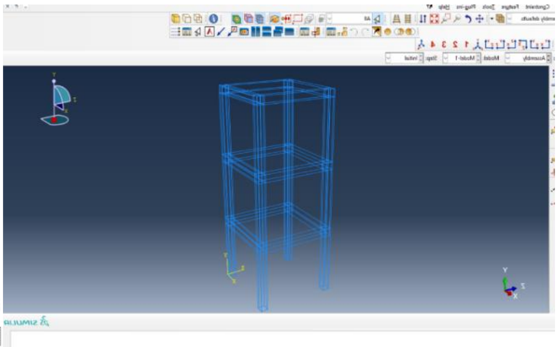


Fig -3: Displacement vs time of the structure **Fig -4:** Reinforcement of structure

Model 1: Among the three cases analyzed the case 3 has the maximum displacement . It shows that for increase in blast load and decrease in standoff distance, displacement increases drastically.

Model 2: For creating the model 2, the model 1 is considered and changes are done in terms of blast load. Column is a structural element that transmits, through compression, the weight of the structure above to the other structural elements below. Beam is a horizontal member spanning an opening and carrying a load that may be a brick or stone wall above the opening. The model is then analyzed and response in terms of storey displacement is observed.

Model 3: For creating the model 3, the model 1 is considered and changes are done in terms of increasing blast loading to 20kg T.N.T at 6m standoff distance The model is then analysed and the failure of structure is observed on application of blast loading.

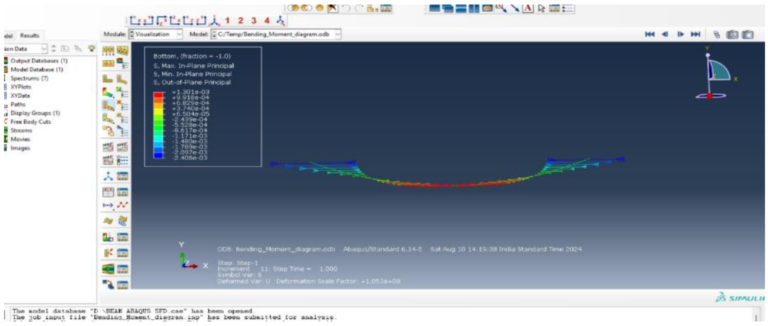


Fig -5:Beam

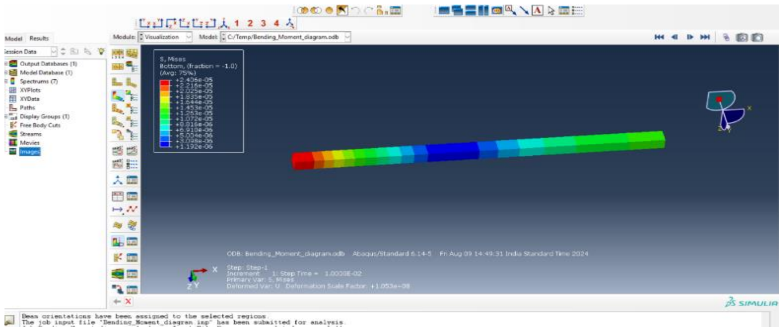


Fig -6: Beam with loadings of 5kg and 10kg T.N.T

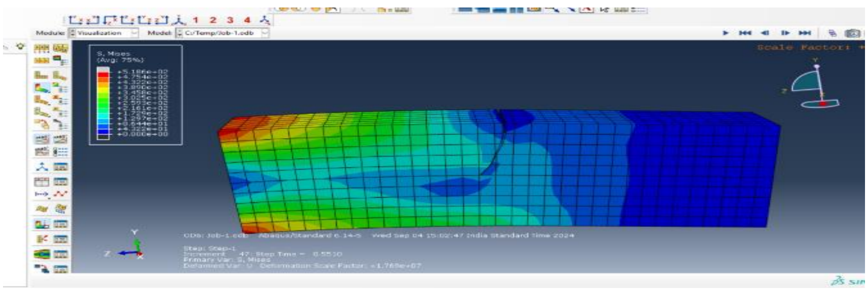


Fig -7: Beam with loadings of 20kg T.N.T

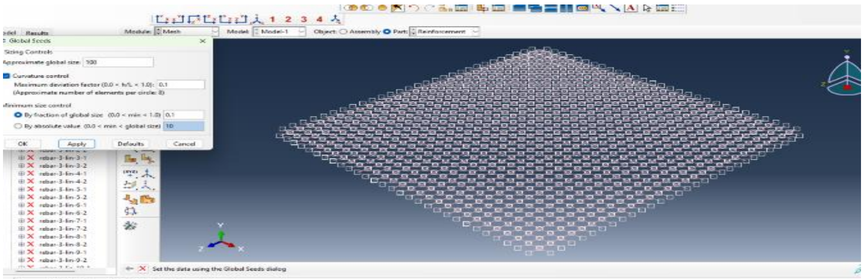


Fig -8: Slab with loadings of 5kg and 10kg T.N.T

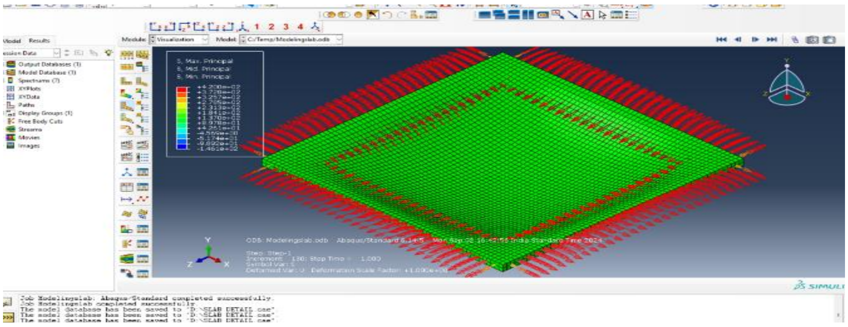


Fig -9: Slab with loadings of 5kg and 10kg T.N.T

Table 9.1: Series of explosive analysis with charge

Specimen	R (m)	W (kgs)	R/(W)1/3	Deflection (mm)
T.N.T	3.0	5	0.5041	6.104
T.N.T	6.0	5	1.00	2.633
T.N.T	9.0	5	1.512	2.222
T.N.T	3.0	10	0.4404	11.350
T.N.T	6.0	10	0.8808	3.916
T.N.T	9.0	10	1.3212	2.835

IV. Results And Discussions

The aim of blast resistant building study is to prevent the overall collapse of the building and prevent more damage to the building. In spite of the fact that the extent of the explosion and the loads cannot be predicted perfectly or accurately. The most possible actions and considerations will help to find the necessary engineering solutions for it.

- The pressure intensity drops with increasing standoff distance, and deflection like wise does so.
- According to the analysis's findings, the blast event's impact on the structure is localized at tiny scales.
- However, the column's central deflection appears to be so large, the global reaction of the column may be determined when the scaled distance is large enough.
- Design of blast resistant structure which can withstand loadings of 5kg,10kg TNT.

V. Conclusion

a) We deduced from the observation that the Structures deflection reduces with an increase in standoff distance.
b) The deflection of structure analysed is using ETABS and ABAQUS whose values are similar.
c) The G+2 structure when subjected to blast loading generated by the charge weight of 5kg,10kg T.N.T with stand off distances 3m,6m, respectively, they hardly had any effect on the structure.
d) The same structure when subjected to blast load developed by 20kg T.N.T with stand off distance of 6m the failure of structure is observed.
e) The structure is Analysed to be safe only for the charge weight of 5kg and 10kg T.N.T. Whereas for 20kg T.N.T the structure fails.
f) The mesh provided for the structure is more likely to improve the deflections of structures.

Acknowledgements

It is my pleasure to thank many people who made this thesis possible.

I wish to thank **Assistant Prof. Sameer Chitnis,** Department of Civil Engineering, S.D.M.C.E.T, Dharwad, for guiding and encouragement through the work.

I would like to extend many thanks to **Dr. R.J Fernandes** Professor, and Head, Department of Civil Engineering, Government engineering college, Haveri, for his guidance and during my M.Tech dissertation work.

I extend my heartfelt thanks to **Dr.R.L. Chakrasali**, Principal, S.D.M.C.E.T, Dharwad for his support and encouragement to complete my M.Tech thesis work.

I thank the teaching and non-teaching staff of Civil Engineering Department for their constructive suggestions and timely help while working on this dissertation.

I also thank our classmates and friends for their encouragement in the duration of this dissertation.

Above all, my heartfelt gratitude goes to my family for their inspiration and constant support without which the project would not have accomplished.

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