|| Volume 6 || Issue 6 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

REVIEW PAPER ON DYNAMIC ANALYSIS OF MILITARY BUNKERS SUBJECTED TO AIR BLAST

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Abstract: **In this study, Terror attacks and activities are becoming a significant global issue, including the prevention, response and recovery of terrorist acts. In this work, a bunker design based on three distinct soil types has been analysed and designed. Every bunker, however with most identical components and equipment, is always conducted with distinctive concepts and optimum procedures while analysing and designing civil structures at a facility. This article is thus based on fresh and distinct analytical, design and optimisation factors. One aim is to explore the distinction among the analyses and designs of modal analysis and the significant structures. In military bunkers, there are vast various devices sensitive to axial thrust and vibrations. The findings of the structure are discovered using 'ANSYS.' Optimum analyses lead to optimal design. Since disasters are shocking, all underground buildings have to be constructed to detect and monitored for various sorts of design disasters although some of these need maintain or survive the greatest earthquake movement.**

Keywords: *Air Blast, Dynamic analysis, Military bunkers, Blast load*

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I INTRODUCTION

A bunkers is a strategic construction meant to protect persons or valuable materials from explosions or assault of any kind. During the First Global Conflict, World War Ii and Cold War, bunkers were employed extensively. They were command centres, weapons shops and distributors.

1.1 Uses of Bunkers

In particular, bunkers prevent harm caused by enemy bombers from human beings and precious resources.

- The bunkers also protect individuals from hazardous radiation by restricting their entrance in locations of refuge.
- The Bunkers prevent hearing or external damage caused by the drops by the bomb from nearby explosion. Bunkers must be constructed in order to stand up to a nuclear assault and its sub-pressure that lasts for several seconds after the waves of shock.
- The entrances of the bunkers should be just as sturdy as their sidewalls and should be ventilated if they are living for several days. Furthermore, bunkers serve a function in preventing damage of artillery facilities.
- Weapon protection allows combatants access sufficient weaponry to assist the conflicts successful. Bunkers may be beneficial for tornadoes, other from military usage.

II STATE OF DEVELOPMENT

2.1 Sangwoo Park and Young-Jun Park (2020) In this article, Compared with surface semiautomatic weapons, the consequences of lowering the distance were assessed for underwater assault weapons. The projected economic and environmental implications for land-type assault weapons were examined on the basis of the findings. Then, numerical simulations were proposed for the construction of the subterranean ammo stockpile, which effectively reduces the travel time. The placement of tanks at various depths and the use of explosion reduction technology were considered within the chamber. Finally, on the basis of past studies, the most accurate model to build the subsurface munitions magazine was studied a technique of donation and licensing program. Research on design methodologies for subterranean semiautomatic weapons was decided that future subterranean munitions magazine project vitality was urgently needed. [1]

2.2 Luke Bennett (2020) In this article, This special issue analyses the way in the End Of the cold war, half a century that after downfall of the Berlin Wall, demilitarisation and repurposition continue to be carried out among old mining bunker. The Introduction explains how the contributions have a similar purpose of exploring the way potential innovations and meanings apply to these recalcitrant constructions. The physical erasing of these large defensive fortification is realistically not achievable. The introduction demonstrates by adopting a particularly wide interpretation of 'cultural life' (that is able to accommodate the mould, instrumentation and sarcasm as cultural trends), how sources find those other locations dead or trapped by military aims thru the their encapsulated discovery and informational investigation. Rather, the life of the bunker has been discovered to be a subject of continuous cultural creation, functioning via a range of current adaptations. [2]

2.3 Sangwoo Park and Young-Jun Park (2020) The article Compared with surface bump stocks, the consequences of lowering the proper distance were assessed for underwater

semiautomatic weapons. The projected economic and environmental implications for land-type semiautomatic weapons were examined on the basis of the findings. Then, numerical simulations were proposed for the construction of the subterranean ammo stockpile, which effectively reduces the travel time. The placement of compartments at various depths and the use of explosion reduction technology were considered within the bunkers. Finally, on the basis of past studies, the most accurate model to build the subterranean munitions magazine was studied a technique of donation and licensing project. Research on design methodologies for subterranean semiautomatic weapons was decided that future subterranean munitions magazine project vitality was urgently needed. [3]

2.4 Bradley Garrett and Ian Klinke (2018) In this research focused on an omnipresent political arena of the 20th century that has long been disregarded the bunker. This book relies on a number of theoretical ideas and examines many historical settings, however most of them stays linked to the seminal paper of the German Atlantic Wall by Late Paul Virilio in the 1970s. As Virilio's theoretical view is enlightening, the modern arguments on the purpose, substance, and duration of a Bunker have been restricted. Here we try in three methods to counteract this restriction. Firstly, we dispute the notion of the bunkers as an area of human safety and propose for a broader conceptualization, which takes into account the bunker as an extermination location. Secondly, the supposed concrete material of the bunker is challenged and a broader typology is recommended, using other materials and media. In conclusion, we use bunker readings to illustrate the continuous production, reappropriation and vision of this structural forme as an outmoded remnant. [4]

2.5 Muhammad Umair Saleem, Hassan Khurshid, Hisham Jahangir Qureshi1 and Zahid Ahmad Siddiqi (2018) In this article, Silos and bunkers of concrete are ubiquitous buildings used to store various commodities extensively. Subject to intensive seismic stresses, these buildings are particularly fragile. Specific source code methods are required for the design and development guidelines for these constructions available. The bending time, frictional strength and axial force profiles for an example silo were then provided after the study and analysis of complex siloes. For multiple elements of silo including a plates, walls and hopper, the findings produced from the suggested development strategy were verified with FEM values. The evaluation of circumferential and diagonal pressures, bending stresses, shear forces and strengthening ratios of multiple elements of silos showed a strong consistency with the findings of the FEM model. It encourages the adoption of the suggested research methodology to develop steel and concrete silos efficiently. [5]

2.6 A. Caçoilo, R. Mourão, B. Belkassem, F. Teixeira-Dias , J. Vantomme and D. Lecompte (2018) This paper combines the use of this composite reliability (cr and use of a tiny modeling of a composite surviving box mostly with analysis of finite elements (LS-DYNA), to create and evaluate a numerical model for the spread of the blast wave. The first portion of this paper discusses the design methodology of an explosive charge detonating a crayon drawing of a survivability container. There are numerous areas of the model recording the pressure time records. In the second half the numerical findings were presented and the data collected were compared. [6]

2.7 Hrvoje DraganiT and Damir Varevac (2018) In this research, Numerical simulated results from explosive events rely heavily on the meshes. Because such simulations need considerable processing times, an ideal mesh size has to be determined to speed up the computation and provide sufficient results. In addition, combined loading tests were undertaken for occurrences and deflected bubble waves to develop ideal meshes for subsequent large-scale theoretical calculations of Earthquake Excitation Interactions and Overpasses (up to 5 m). For the axisymmetric blasting of incoming forces and 3 D environments for reflection forces, ANSYS Autodyn was utilised for hydro coding programme. Only the explosion waves was studied in the axisymetric environment and the 3 D environment examined blast wave contact and reflectivity of a hard surface. Extrapolation by Richardson was used in order to extrapolate ideal mesh sizes for the examined situations of blasting. [7]

2.8 Aswin Vijay, Dr. K Subha (2017) As we know, the world's population is exponentially rising. The vast growth of infrastructure worldwide takes place in order to meet the demands of this rise in the population. Every day in many parts of the world there are a great number of bridge, urban centers, tunnels, flyover etc. These buildings may be built of concrete reinforced, steel, etc. Most of these buildings still consist of concrete. The pipes may also remain on piers consisting of reinforced cement even now in multiplied by the adjustment and viaducts. As the population is increasing, accidents have also increased. Vandalism and terrorist activity throughout the world have also increased. These two occurrences might lead to blows in different places. One of the main places where such explosions might happen is close to the foundations of these viaducts, subway and bridges. The breakdown of these steel and concrete piers might lead to a great many causes, particularly when explosions are caused to cause the piers of viaduct constructions such as bridges, fly overpins, metros etc. In the case of an explosion, many sorts of loads are created. These loads work on the foundations and the piers might be partly or totally ruined. [8]

2.9 Alok Dua and Abass Braimah (2016) In this paper, Blow loads may be classified in terms of scaled distance as lengthy and relatively close loads. Detonations occurring at scaled ranges of more or less than 1,18 m/kg 1/3 are connected with the loading of far- and located close. The explosive waves from a distant explosion simultaneously reach and force on a destination evenly

dispersed. Calculated response may be done using sub equations (charts) described in UFC-3-3 40, ConWep, or high-level physics tools, such as LS-DYNA, AUTODYN and ABAQUS software. Calculations are possible. The interactions among blast waves and buildings are, from the other hand, more complicated for approaching explosives. Approaching occurrences are characterised by high fireball and very high level, non-uniform tensile stress both geographically and temporally. Many studies have documented the inaccuracy of recent literature connections to establish blasting parameters for relatively close explosives. There are numerical programmes that are used to represent the explosion process, shock wave propagation and surprise interaction. There are, however, few well-established scientific proof to verify these concepts. In addition, the testing data are provided on the reaction of the sheets/walls, façade components and stainless steel plates for the reinforced concrete (RC). The literature study reveals that the testing work on RC columns in the approaching and, in particular, on contact explosives, is restricted. This paper covers the cutting-edge state-of-the-art located close and touch explosives to comprehend existing understanding and identify research requirements and gaps. [9]

2.10 Rupert G. Williams, William A. Wilson, and Reisa Dookeeram (2016) In current history, the anticipated hazards of explosive cargo assaults or similar structural accidents have increased substantially. Blast Design is consequently an essential part of construction design worldwide and must be adapted appropriately. Blast Design The following is an effort to calculate the number response of a Single Degree of Freedom (SDOF) seismically put work for blast loading. The SDOF concept was developed to stand up to the normal seismic occurrence in the north of Trinidad as a portal framework. The model then was charged with blast loads created by the weighting of a 500 kg TNT charge at standing distances between 45 m, 33 m and 20 m. Intermolecular forces were used to calculate the blast load on the frame. During transmission of the blasting load up to the crucial stop-over distance, the seismically-developed SDOF planar aset reached the plastic area. [10]

2.11 Sayed M. Soleimani, Nader H. Ghareeb, Nourhan H. Shaker, Muhammad B. Siddiqui (2016) In this paper, Modeling and simulation might thus be seen as a suitable option utilising an appropriate technology. The Finite Element ABAQUS® programme is used in these research projects to analyse the behaviour of steel sandwich panels in hexagonal and squared wave under the explosive impacts of various levels of trinitrotoluene; (TNT). The findings of modelling in a particular wave configuration are firstly confirmed by comparison with published present measurements. She then investigates multiple configurations with various geometrical features of the wall and compares the findings to the original model. Finally, we evaluate the efficiency of the core form and the thickness of the wall and draw conclusions. [11]

2.12 Carl Lofquist (2016) This Master's thesis aims to explore and build dynamic models combining appropriate accuracy with computing efficiency to structures carried out by explosive wave stresses. This may be done by evaluating two scenarios with differing handling of the earthquake excitation burden. In the first situation the cargo is handled as a triangle pulse charge and in the second instance the load is handled by changing it into speeds per the rules of moment and impulse. These examples are represented in a complete model and a Ritz vector model. [12]

2.13 Sangjin Park, Jiwon Kang, Young Jun Park (2016) In this research, the expand of metropolitan areas and the creation of infrastructure, the need to take account of stability of the subterranean buildings beneath or nearby munitions dumps has risen. There are nonetheless some literature on the effect on subsurface structures of inadvertent explosions. This paper suggests the procedure of evaluating the stability of subterranean structures and checks their application via the case study. The construction and mechanical analysis of AUTODYN and SPACECLAIM is executed and the effects of explosion is evaluated and vibrations speeds computed. Based on the results of this test case, it has been established that the hypothetical detonation might seldom affect the subterranean structure created 70 m beneath ground. The technique in this research might be utilised to build the subterranean munition complex and to analyse the stability of subterranean installations affected by periodic vibration. [13]

2.14 Pavel Jiricekaand and Marek Foglar (2015) In this article, A number of numerical simulations were been out to introduce this subject. The simulations examine the effect on the Czechoslovak pre-WW2 army bunkers of normal and subcaliber projectiles. The penetration of military items is widely documented and comparable. The model numeric consists of a section of a defensive equipment wall. A standard and sub-caliber bullet affects the concrete block. To facilitate the assessment of the findings, the model is separated into layers. In ANSYS AUTODYN software, simulations are processed. A nonlinear damage and built-in strain model of material was applied. Due to damage caused by the concrete block, the numerical simulation results are analysed. Damage progress against time is given. The numerical simulation gives the recorded penetrations an excellent match. [14]

2.15 Zac Liskay Shane Rugg and Conor Thompson (2014) In this article, Terrorist attacks and unintentional explosions lead to significant and unusual loading of the building, its residents and the onlookers and may cause extensive damages. Structural integrity and adequate building safety standards are provided by the innovative construction building design. The behaviour of the structure during an explosion is driven both by the type and quality of the explosion and by the structure's structural features. The establishment of a security level also requires non-structural components, such as stagnant distances, security glass, and

accessible construction exits. Flashing resistive construction provides extra safety layers and redundancies which safeguard the occupant's well-being and even the building's structural completeness. [15]

2.16 Osman Shallan, Atef Eraky, Tharwat Sakr, Shimaa Emad (2014) In recent years, explosive loads have been receiving tremendous attention because to the recurring terrorist attacks throughout the globe targeting critical military buildings. The research evaluates the effect of explosive loads on three structures with varied aspect ratios using numerical simulations. These buildings were built using Finite Element Models utilising AUTODYN, the final element application. Blast loads were applied positioned at two places with various standing distances and separated apart from the structure. The simulations revealed that, when the standoff distance of the building and when the voltage levels of the residences vary, the effect of blast charge decreases with no difference in column shifts due to the explosive load, while the real impact of blast lowering in the other element of the building decreases with the aspect ratio increased. [16]

2.17 Quazi Kashif, Dr. M. B. Varma (2014) In recent years, because of the heightened terrorist activities, the need to develop some key buildings to prevent explosive loads has increased. The exterior and interior structural frameworks of the building may be severely damaged by a bomb explosion. In the region of the explosion source, the failure of one building structure may induce crucial pressure wealth transfers and cause the collapse of additional members and ultimately the whole organisation. Because of the hazard caused by such intense load conditions, work was done to create strategies to withstand blasting and structural analysis. Detailed knowledge of blast events and their consequences on diverse structural components is necessary to analyse and design the constructions susceptible to blast loading. In reality, blast charges are term derives that are much like seismic and wind charges, should be calculated properly. This document contains an impact analysis on an RCC five-story structure by Blast loading. The varied explosion source weight effect is estimated at a distance of 30 metres from the explosion site. Due to a pressure structural system, the explosive charge was analytically computed and a numerical structural model was developed in SAP2000. The effects of the buckling response by explosions is computed and classified on the basis of peak breakaways, speed, accelerations, intershape drift. [17]

2.18 Daniel Makovicka (2014) the paper follows on the theory of the explosion and the interplay of an explosive and structural impact wave. There are, in general, a lot of mathematical formulae about the features of the blast and the structure endangered for the structural analysis. The concepts of simplified structural design of an explosion-laden structure were utilised as an example of a vibration loading of a modern reinforced cement structure overloaded with a shockwave. During time periods estimated internal deformation of specific building elements, the manner of a structural collapse was investigated. As component of the order to create a new response evaluation, the criteria for structural element failure as a result of explosive load effects were established. [18]

2.19 Amol B. Unde , Dr. S. C. Potnis (2013) Terrorism is today's world's most deadly concern. Despite the advances in technology, the issue has produced the sense of unease among the population, counterintelligence. Spite of the fact that there are no ideal measures to decrease the impact of the explosions and the loads it causes, the extent of the explosion cannot be expected. As the technology has progressed and the Software for Finite Elements is introduced, a trustworthy conclusion may now be achieved. The study and design of blast load special systems a details of blast phénomens and the dynamical reaction of different structural components. The research is conducted to assess the qualities of blast waves at different charging distances by determining the blast wave characteristics. For modeling techniques of many storeys, the impact of TNT (trinitrotoluene) explosives on column base on different levels of TNT charges across different distances is examined and given in this article. [19]

2.20 M. Teich & N. Gebbeken (2012) This work analyses the impacts of the interaction between air structure and proposes a novel coupling model for low burden systems. While standard steel structural frameworks have little coupling effects, lightweight but more flexible systems such as films, blast shields, or cables facade may be able to dominate the seismic behaviour. A traditional decoupled study, i.e. a disregard of surrounding air impact, might dramatically overstate deflects and stresses for these systems. There are provided results of parameter analyses and suggestions for the blast-resistant construction of flexible retaining walls. [20]

2.21 Hrvoje Draganić, Vladimir Sigmund (2012) The study outlines the methodology of assessing explosiveness on materials and presents a graph representation of the fake structure subjected to this load. The purpose of this report was to familiarise oneself with the problem of the explosive load due to the increasing terror threat and the absence of guidance under national and EU rules on the testing of explosive constructions. Due to a pressure stability analysis, the explosive charge was analytically computed and a numerical structural model was developed in SAP2000. The findings confirmed that it is feasible to model explosive effects using ordinary software and offer a preliminary structural evaluation. [21]

2.22 Gordon P. Warn, M.ASCE and Michel Bruneau, F.ASCE (2009) In this article, Shear walls of steel plate Space resistance systems have becoming more prevalent in constructions. While the latest advances were initially designed to withstand earthquake forces, SPSWs were not able to withstand blast loading, which would prevent the plate from

resisting out-of-plan instant pressures. To examine this, two single-story specimens SPSW were produced and submitted to exposure on 0.4 scale, reflecting the first level of a four-story concept SPSW. The mis program analytic FEA and return line theory were used to investigate an out impedance of the inserting plate. The results of these analysis methods show that the out-of-plane opposition is regulated by the wide deformities, and the comportements of the inelastic material. In contrast with the countable evaluation for infill plates typical for SPSW construction, this yield line theory was significantly underestimated. On this basis, it is suggested to evaluate the out of plan impedance of the SPSW infill plates, which is well-established using FEA findings, in a simpler plastic analysis approach. The results of the tests indicated that SPSW had a small resistance to off-plane blast loading and could not use the normal seismic details to link the filler plate to a border frame for blast applications. [22]

2.23 Zeynep Koccaz , Fatih Sutcu and Necdet Torunbalci (2008) In this article, The rise, particularly in recent years, of the numbers of terrorist acts shows that a key issue in the construction process is the effects of burst loads on facilities. Although such assaults are extraordinary, human-made tragedies; blast loads are really term derives that need to be evaluated carefully, just like wind and earthquake loads. This research aims to shed light on building project principles that are blast-resistant and to improve building safety against the impacts of explosives in architectural as well as structural design processes and design approaches that must be used. First, explosives and sorts of explosions were briefly described. In order to clear up the consequences of the explosive on building, broad features of the explosion process were also discussed. A greater knowledge of explosives and features of explosions will allow us to produce a more efficient construction of blast-resistant buildings. An construction and installation approach discusses essential ways for strengthening the building's capability to give protection from explosive consequences. [23]

2.24 SHI Yanchao, LI Zhongxian and HAO Hong (2008) In the analysis of explosion vibrations and structural interaction, numerical approach is common. However, the computational findings are vulnerable to limit working capacity sizes given the very brief length of both the blasting waves and executive control between individual grids. Earlier numerical simulation indicates that, although the differences between these two settings are very small, an acceptable aspect ratio for one explosion circumstance may not be adequate for a further scenario, indicating that the appropriate analytical nm diameter standardisation test may not guarantee exact numerical results. In various blasting situations, the mesh-sizes influence on results obtained of blast-wave transmission and impact with structures were therefore investigated using both coarse and fine mesh. Based on statistical results and comparing with field test findings and TM5-1300 design charts, a numerical approach for altering the effects of the pipe diameter on the overall consideration was provided. The numerical findings of blasting oscillations and blast loads in structure may be readily improved. [24]

2.25 T. Ngo, P. Mendis, A. Gupta & J. Ramsay (2007) In this research**,** The Vehicle bombs were a priority in order by terrorist groups across the globe to strike metropolitan centres. A bomb explosion in or near a structure may destroy the structural frames of the structure, crash its walls, blast out major areas of the windows, and shut off key life-safety systems. Lost lives and injuries for inhabitants may be attributed to many sources, including direct explosion, structural collapse, the impact of debris, cigarette smoke. The secondary consequences may lead to more injuries or to the inhibition or prevention of early evacuation. Moreover, significant disasters due to the gas explosions produce huge dynamic loads on many buildings, which are higher than the actual dynamic loading. In the last three decades, efforts were undertaken to clinical commissioning group analysis and design methodologies to withstand blast loads because of the danger from these severe loading conditions. The study and design of blast load structures requires a details of blast phénomens and the dynamic reaction of different structural components. This study provides an outline of the structural impacts of explosion. The origin of pyrotechnics and blast wave mechanism in free air are explained. This study also presents several methodologies for the estimation of earthquake load and building reaction. [25]

2.26 A. Ghani Razaqpur, Ahmed Tolba And Ettore Contestabile (2006) In this article, The behaviour of reinforced cement panels or sheets, which are retrofitted by GFRP, and exposed to the load, is examined. Eight 1000 · 1000 · 70 mm of 40 MPa concrete panels were built of reinforced steel mesh on the top and bottom. The entire lot were replaced with 500 mm wide adhesive laminate GFRP strips on both sides and one in every parallel direction to the borders of the panel. Five panels were employed in the control. The panels had explosive charge of 22.4 kg or 33.4 kg ANFO which was in an explosion of 3 m. The explosive charge was exposed to the detonation. Characteristics of blast waves, comprising transmitted and reflected stress and impetus, central panel deflection and steel pressure and surface/FRP were measured. The damage and failure manner of each panel were inspected postblast, and the remaining strength was then statically evaluated in those panel that have not been entirely destroyed by the blast. The overall performance of the retrofitted GFRP panels greater than the control panels of the companion was found whereas the retrofitted panels suffered major damage and therefore could not be statically evaluated after the blow. The second observation is consistent with earlier studies that the blow pressure owing to nominally equal loads as well as the stopping distance at pretty

near ranges may vary greatly and result in varied damage levels. [26]

2.27 Bibiana Luccioni and Daniel Ambrosini (2005) In this work we examine the assessment of pressure and impulses generated by explosion charges using hydro coding. Numerical findings are compared for the various scaling distance and pressure distribution with current analytical formulas. The capability of both approaches to collect various mirrors of the explosion load is investigated in details. The impact of pipe diameter on the distribution of pressure and pulse are also examined. There are some intriguing insights on determining the appropriate mesh size to calculate real events. It is also researched how convenient the use of mesh finish near to the explosive zone is. Finally, in Buenos Aires, Argentina, in July 1994, the study of the explosion of the building assault on the AMIA (Israel-Argentina Mutual Association). A computer dynamic study of the crowded urban environment was carried out on the same roadway, corresponding to the opposing rows of buildings in a building block. These results are expressed and evaluated for various explosive charge placements. [27]

III CONCLUSIONS

This article solely focuses on the examination of literature of past investigations. The results of this investigation are the Magazine for Underground Ammunition. Research on design methodologies for subterranean munition magazines was determined that future subterranean munitions magazine projects needed immediately. During deployment of blast load to the crucial standoff distance, seismically built SDOF flat frame model reached the plastic area. A great range of causes might occur owing to the collapse of these thick concrete piering platforms, particularly if explosions fail to produce viaduct piers such as bridges, flyover platforms, metros, etc. In the case of an explosion, many sorts of loads are created. Study on techniques of design for underground munitions magazines was decided that future underground munitions magazine projects were urgently needed. In addition, the research was conducted. The afterlife of the bunker is discovered to be an issue of constant cultural creation that is perpetuated in a number of current ways: some disputed and others humorously undetermined.

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