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A Review on Research on Critical Analysis on Performance of RCC Structure under various Blast Condition

Parth Samarth[1], Amey Khedikar[2]
[1, 2]Department of Civil Engineering, RTMNU

Abstract: The main aim of this paper is design and implement Critical Analysis on Performance of RCC Structure Under Various Blast Condition. Advance in technology over the past few decades have necessitated the dynamic effect of loading blast such as wind and earthquake loads. The main purpose of this study is to gain access to materials on blast loads that can be designed, to assess vulnerabilities and to provides guidance to designed to economically reduce the impact of explosion on building and provide protection to human and infrastructure. A case study is performed on an RC column subject to blast loading; the effect of force on the deflection over time, the stress rate on the tensile is studies. The compression mechanism is studies by following the alternative path method for minimum design load for building and other structures. The 2-storey building is analyzed and the displacement and blast loading and standoff distance on the floor vehicles are studied by adding X-type brackets and shear wall to make them explosion resistant. Structural, architectural and managerial aspects of the design are also included in the report so that the structures become blast resistant.

Keywords: Blast Loading, Standoff Distance, Ductility, Collapse Mechanism, Aspects of Design

I. INTRODUCTION

Explosion loading was not so important in earlier eras. Advance in technology have led to increase terrorist activity over the past few decades, highlighting the importance of taking dynamic effect of explosion loading into structure such as winds and earthquakes. Attacks are exceptional cases, man-made disasters and the likelihood of events occurring cannot be accurately determined. Nor can terrorist acts be stopped. Terrorists use new chemicals and technologies, which pose a serious threat to life as well as property. Regarding the safety of life property, explosion resistant designs were brought to light. Designing a fully explosion-proof structure is neither economical nor realistic. However; various strategies can be followed from the planning stage with the advancement of knowledge of current engineering and architecture. The impact of large explosion can be greatly reduced in new structures and even in existing structure.

The main objectives of this study are to access materials on explosion loads that can be subjected to the structure, to assess insecurity, to guide the designer in an economical way to reduce the impact of explosions on buildings and to provide protection to human and infrastructure.

A. Explosive Type And Explosion

Some of the chemical explosives are TNT, TATP, RDX, PETN and Azirozide Azide etc. Among them TNT is the most commonly used explosive chemical which is very easy and convenient to handle. The complete form of TNT is try nitrate-toluene.

It is transmitted as a benchmark, where all other explosives are expressed as equivalent masses of TNT, and the most common method of similarity is the specific energy ratio of the explosive to the specific energy of the TNT.

There are mainly three types of explosions, namely unconfined explosive, limit explosives and explosions caused by explosives attached to the explosion structure.

Incomplete explosion is caused by air blowing or surface cracking. When air explodes, the explosives explode above ground level. The immediate amplification of the shock wave is due to the reflection of the ground; Before the initial blast wave of the building. As the waves continue to spread outwards on the surface of the ground, a front is formed known as the match stem; By the interaction of the initial waves and the reflected waves.

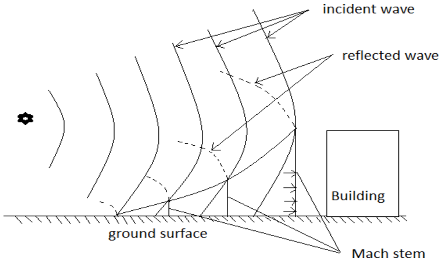

Fig 1: Air burst

When the terrain is very close to or close to the surface, the surface cracks. The initial shock waves are reflected and extend through the ground surface, creating reflective waves. Unlike when an air blast occurs, the reflected wave merges into the incident wave at the site of the explosion; Resulting in a single wave. In most cases of terrorist acts, the built-in area, the equipment is placed on or near the ground surface.

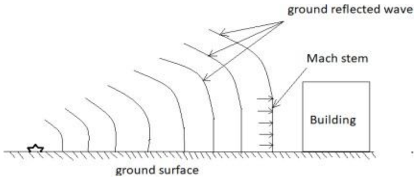

Fig 2: surface burst

When an explosion occurs in a building, the pressure created by the initial shock front will be high and as a result; The reflection will be enhanced in the building. This type of explosion is commonly known as a limited explosion. In addition, depending on the extent of the limitation, the effect of high temperature, the accumulation of gas product due to chemical reaction at the time of explosion will create additional pressure, which will increase the duration of the load in the structure. Based on extent of vent, various types of confined explosion may take place as show fig.2

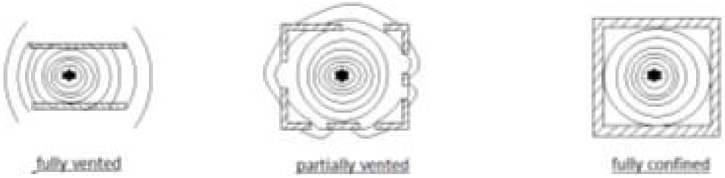

Fig 3: Type of explosion

If the explosive is attached to a structural member such as columns, it will create immediate stress, as shock waves will come to the surface and destroy the resulting material. In addition, if an explosion occurs in the structure, the effect will be similar to that of limited and incomplete explosions.

B. Shock Waves

An explosion occurs when a gas, liquid, or solid rapidly undergoes a chemical reaction and produces very high temperatures and pressures near the source. Explosions result in the formation of shock waves; Travels outward at extremely high speeds in all directions from the point of explosion and creates explosion waves; Reflect on any object. As the gases move, so does the air. The compressed air passage of the blast wave damages the structure. As the waves move away from the source, the intensity of the waves decreases and so does the effect on the object. However; If there is a closed road like a tunnel, the blast wave travels less and less.

The surrounding area is subject to different types of loading due to the effect of the explosion, which can be grouped under three heads; As a result of the compression of the surrounding air, the air is known as a shock wave. The chemical reaction of explosions causes the accumulation of gases to cause air pressure and air movement, which is known as dynamic pressure. The effects that cause the ground to shrink rapidly are called ground shock waves.

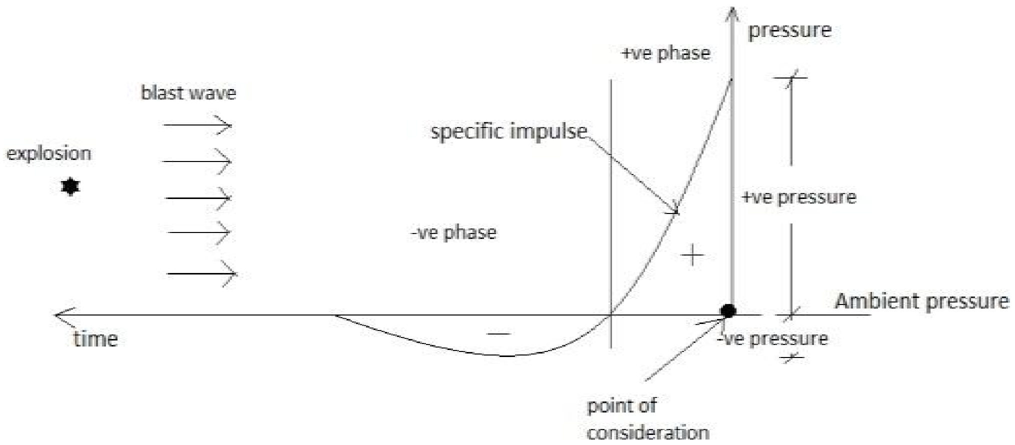

Fig 4: Shock waves created by blast

Air shock waves cause an immediate increase in pressure above the atmospheric pressure at the point of consideration, some distance from the source; Which is generally known to be higher than the pressure. As a result, different pressures are created between the atmosphere and the air; Which is known as negative pressure. When air returns to its original state equilibrium.
Approximately 1 kg of explosives produces approximately $1m3$ gases and the gas displaces and damages nearby air and objects by external expansion. The effects of dynamic pressure are rapidly diminishing as we move away from the source.
The ground hock wave consists of three main components, the wave travels radioly from a source known as the compression wave; The waves travel radially and the particles move in the radial direction in the normal plane; Where the shock wave intersects with the surface, known as shear waves and surface or relay waves; These waves propagate with different speeds and frequencies.

II. LITERATURE REVIEW

A. Protective design of concrete buildings under blast loading; Structures under Shock and Impact(3)

Author name: Mir M Ali

Terrorist evidence investigated several issues of the building. He fulfilled the design recommendation for RCC design as per TM-5-1300; Accordingly the concrete casing on both sides of the member is effective in resisting explosions, even if the concrete was crushed, but the steel should be intact so as not to destroy the entire structure. Similarly, concrete strength greater than 400 psi (28 MPa), steel of grade 60, ASTMA A should be used, total size should be limited to 1 inch (25.4 mm), slab reinforcement should be in both directions and reinforcement should be continuous in any direction. In his work, he also included a case study in the well-known Blast. Murray Federal Building, Oklahoma City, USA, 1996. The Federal Emergency Management Agency (FEMA) investigated the incident and insisted that the transfer girder should be avoided on the lower floor, where the third floor of the building was supporting the transfer girder above and three columns. Below are the columns, causing half of the building to collapse. There were also normal moments of resistance in the frame and if a resistive frame was created at a particular moment If used, the loss can be reduced by 50 to 80%. Second, Riyadh, Saudi Arabia, and Amjad monitored the structural reactions of the building during the missile attacks during the Gulf War, and mainly gave the structure a two- to five-story RC frame. Buildings Were designed for normal and wind loading, and the damage to buildings was similar to that caused by earthquakes. They studied explosion loading, standoff distance, incidence, and pressure reflection. The bomber struck shortly after noon in front of a Saudi military base. He summarized the results of recent research conducted on concrete slabs, subject to high dynamic loading; And the dynamic final load capacity was found to be 22-27% higher than the final static load capacity.

B. Determination Of Blast Load Parameters For 2d Framed Over The Faã§Ade Of Structure(2)

Author name: B. Murali Krishna, Dr. V. Sowjanya Vani

The analysed (G+14) floor building has been constructed with a floor height of m m, a total height of 522 m; Which detects the linear dynamic response of a 2-D building. Various parameters such as measured ground distance, peak positive event pressure, reflective pressure, shock front velocity are measured. Load pressure is determined analytically by the analysis of history; TM-5 is analysed by 1300. Graphs of peak impulse pressure VS time are obtained for each floor. The results show that the distribution of the reflected pressure decreases with height 0.

C. Structural Analysis Of Blast Resistant Structures(1)

Author name: Demin George, Varnitha M.S.

Analyzed that the 2 storey building was completed using ETAB. Here 4 cases are considered with different types of explosive and standoff spacing .. Also 4 models are considered as normal frame, normal frame with cross section between beam and column, common frame connecting shear wall and X-type braking. The load is calculated according to IS-4991-1968, the pressure on the building, the load on the front face, the roof and the side walls are fixed. The effect of the model with shear wall and X-type braking will be reduced by 95% to 80% in maximum floor displacement, respectively. Increasing the size of the beam and column will also improve the resistance, but also due to the serviceability issue of the huge cross section; This is not feasible. The shear wall thus found is also more economical and convenient.

D. Non-linear response of reinforced concrete containment structure under blast loading(8)

Author name: A.K. Pandey etc.

Studied the effects of external explosions on the outer reinforced concrete shell of a typical detached container structure. The linear content that is not suitable for the final stage has been analyzed using the model. The analytical process for nonlinear analysis has been implemented in the finite component code by adopting the above model dynamic.

E. Blast loaded stiffened plates(7)

Author name: A. Khadid et al.

To determine the dynamic reaction of plates with different stiffener configurations, fully determined rigid plates under the influence of blast loads were studied to consider the effect of mesh density, time duration, and strain rate sensitivity. To obtain numerical solutions they used the finite component method and the central differential method to combine the nonlinear equations of motion.

III.CASE STUDY

1) RC Column Subjected to Blast Loading: RC column of ground floor of height 6.4m of a multi-storied building is analysed in this case. Parameters considered for study are-Strength- 40MPa for NSC (Normal Strength Concrete)

- 80MPa for HSC (High Strength Concrete).
- 80MPa for HSC (High Strength Concrete).
- Spacing of stirrups- 400mm for OMRF (Ordinary moment Resisting Frame).
- 100mm for SMRF (Special Moment Resisting Frame).

It has been found that the size of the column can be effectively reduced by increasing the compressive strength of the concrete. The size column for NSC (500 × 900) mm can be reduced to (350 × 750) mm for HSC with the same axial load carrying capacity.

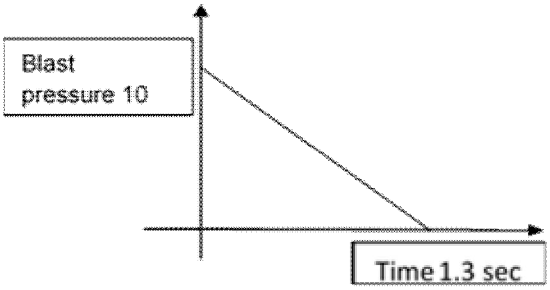

Fig.5 Blast loading

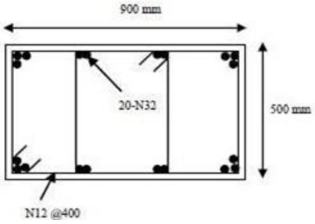

Fig.6 C/S of NSC column-ordinary detaling with 400 mm spacing

Column	Sizes (mm)	fc (MPa)	Stirrup spacing
NSC	500×900	40	400mm and 100mm
HSC	350×750	80	400mm and 100mm

The 3-D column was analysed using the nonlinear clear code LS-Diana 3D (2002), regardless of the line of both the material and the geometry. The result of blast loading is dynamically analysed to obtain the deflection time history in the column.

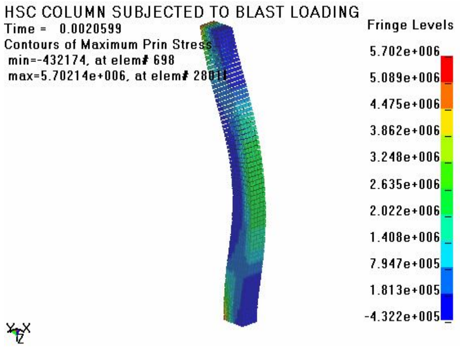

Fig.7 Model of the column using explicit code LS-Dyna3D

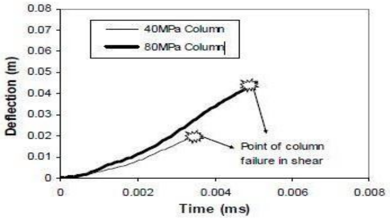

Fig 8: Lateral deflection with time at mid-point of column with 400 mm spacing of stirrup (OMRF)

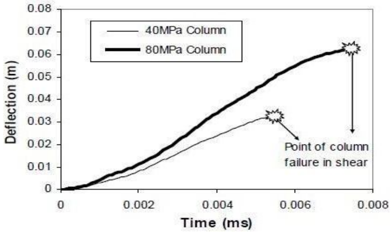

Fig 9: Lateral deflection with time at mid-point of column with 100 mm spacing of stirrup (SMRF)

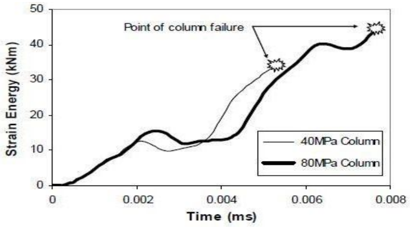

Fig 10: Comparison of energy absorption capacities with 100mm stirrup spacing.

The lateral deflection of the column at the center height of the column with time is shown graphically. (Fig.8 and Fig.9) for both NSC and HSC columns which show lateral resistance in the column. This shows that both NSC and HSC fail due to shear due to near standoff distance. However, the HSC column with low cross section shows better energy absorption capacity than the 40 MPa column of NSC, with a high lateral deflection of 80 MPa. From Fig. 8 and fig. 9, it is clear that the shear reinforcement effect is also significant. Ultimate end-side displacements failing for HSC columns increase from stir 45mm to 63mm 40mm 100mm respectively; Which are 20mm to 32 mm for the NSC with stirrup spacing 400mm and 100mm respectively.

2) *Effect Of Strain-Rate On Ductility*

It is clear that increasing the loading rate will increase the strength and stiffness of the concrete, increase the productivity of the steel and also increase the load-bearing capacity of the flexible member. Parametric studies are performed to investigate the effect of high stress-rates on the durability of reinforced concrete members and their elasticity and shear capacity.

Column	400mm spacing	100mm spacing
NSC	12.0 kNm	33.9 kNm
HSC	27.6 kNm	43.5 kNm

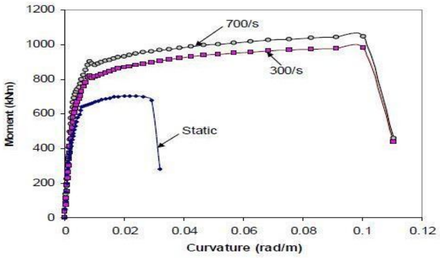

Fig 11: M-Ø curve of a cross-section of a column at different strain rates

Fig. 11 shows the M-Ø relationship from which it is clear that, at high stress rates, the productivity and compressive strength of concrete also increase the elastic capacity and the density of the reinforced concrete beam. The shear capacity of the column is measured using modified compression field theory.

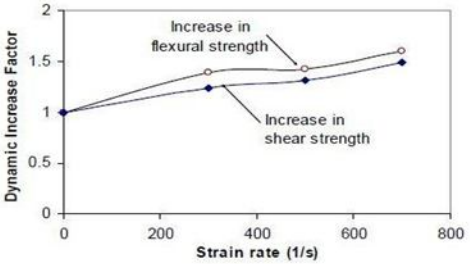

Fig 12: DIFs for flexural strength and shear strength of a column at different strain rates

Fig. Above. 12 shows, at higher stress rates, the increasing proportion of elastic capacity (MUDIN / MUSTATE) and shear capacity (WUDIN / WUSTATE) is compared to the capacities under constant loading. It has also been found that the increase in elastic strength is greater than the increase in shear strength; What shows an increase in physical strength in the dynamic state can lead to brittle shear failure rather than ductile elastic failure.

IV. PROGRESSIVE COLLAPSE ANALYSIS

Following the collapse of the 22-story Ronan Point apartment building, design recommendations for progressive collapse analysis have been applied to British standards since 1968. Since then, several European countries, the USA and Canada have included progressive collapse provisions in their building codes. The American National Standards Institute (ANSI) Standard A 88.1-1-1982, “Minimum Design Loads for Buildings and Other Structures,” recommends an alternative route that allows local failure but provides alternative routes around the failed person. Is required. Creative members.

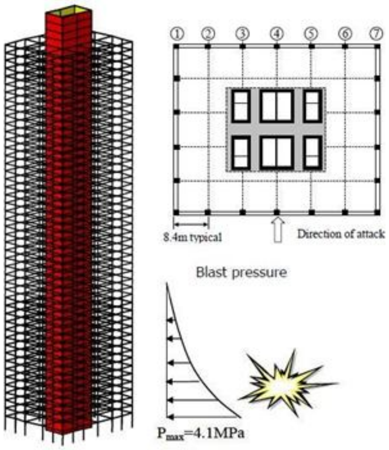

Fig:13 Structural configuration

The modified type of typical building in Australia is a 52-story high 3. . The plan and structural configuration of the building are shown in Fig. 12. The distance between the columns is 8.4 m / c in circumference, which are connected by spindle beams to support the front face support. The lateral load is resisted by a 6 core box in the center of the scheme. The building is designed to withstand background loads due to wind and seismic loading as specified in the Australian Loading Standards AS1170.2 and AS1170.4. Slabs, columns and core walls are laid on site. Background load resistance is provided by the Lateral Load Resistance System (LLRS) of the core walls, which is about 80% of the total capacity.85-storey building, analysed in this study.

Here, the local damage caused by ground-level bombings and the progressive collapse of the building is studied. Structural stability and integrity of the building are evaluated, taking into account the consequences of failure of floor slabs due to perimeter, spindle beams and floor over-pressure. The main purpose of this analysis is to examine whether the failure of any primary structural member can lead to a progressive collapse, which can propagate at the floor level to the vertical or next vertical structural member above or below the affected member.

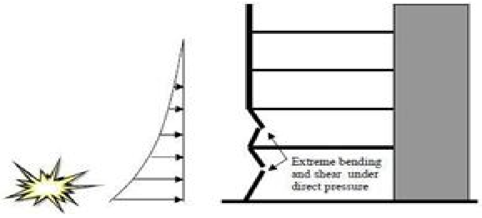

Fig 14: Direct column loading

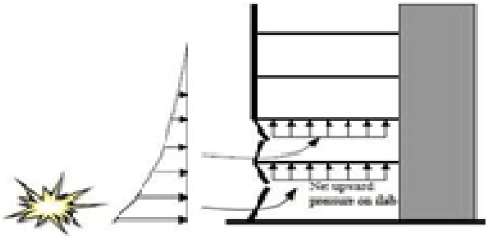

Fig 15: Uplifting of floor slabs

Fig. 14 and 15 show the effect of explosion pressure on columns and beams on the perimeter of the building on the perimeter and floor slabs. The thickness of the building slab is 125 mm, supported by pre-stressed wide band beams. The direct explosion of the part of the slab near the blast occurred at high pressure. Normal glazing in the fade of a building provides negligible resistance to blast waves. As a result, after the failure of the glazing system, the blast fills the structural bay above and below each floor slab. The explosion below the slab causes the pressure to be higher than the pressure above it and this causes a net upward load on each slab.

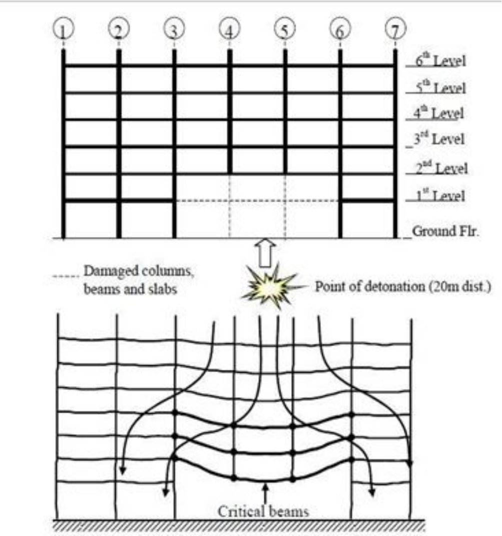

Fig16: Progressive collapse analysis of the perimeter frame, caused by blast loading

To detect local damage, explosion analysis is performed on the beam, and columns on the perimeter of the building and floor slabs, under the pressure of the actual explosion on each component. In Fig. 15, the results are plotted, showing the failure of column levels 4, 5 and 5 floors due to the direct effect of the blast wave. Also the slabs and beams in column lines 3 to 6 collapsed. The Member Assessment (RESPONSE) (2001) program was based on the improved compression field theory and LSDYNA. It also shows that, if the reinforcement details are in accordance with the requirements of the Special Moment Resisting Frame (SMRF), the shear capacity and shrinkage will be significantly improved, which will improve the explosion and impact resistance of the member. In the damaged model of the perimeter frame, the failed components were removed and re-analyzed for re-examination.

Fig. 16 shows the alternate load paths, which pass through the columns surrounding the damaged area, from which the vertical load is transferred. The failure of the auxiliary columns makes the beams and floor slabs in that area critical. The overall stability of a structure depends on the continuity and durability of these components that redistribute forces in the structure. Falling debris, collapsed members also impose heavy loading on the floors below, and thus it is necessary to check whether the overload can be carried forward without further collapse.

V. OBJECTIVE

A. The main objective of the study is to minimize the impact of building explosions in an economic way to protect human and infrastructure from multiple extreme events.
B. Study and analysis of the effect of different explosives on the structure considering the weight and different distances.
C. The purpose of blast proof building design is to prevent complete collapse and damage to the building.
D. Improvements in the process of structural design to increase safety from the effects of explosives and against techniques in design.
E. To study the managerial aspects of structural, architectural and structural design structure.
F. To study the use of software in designing.

VI.FUTURE SCOPE

In this paper,to detect local damage, explosion analysis is performed on the beam, and columns on the perimeter of the building and floor slabs, under the pressure of the actual explosion on each component. In the results are plotted, showing the failure of column levels 4, 5 and 5 floors due to the direct effect of the blast wave. Also the slabs and beams in column lines 3 to 6 collapsed. The Member Assessment (RESPONSE) (2001) program was based on the improved compression field theory and LSDYNA. It also shows that, if the reinforcement details are in accordance with the requirements of the Special Moment Resisting Frame (SMRF), the shear capacity and shrinkage will be significantly improved, which will improve the explosion and impact resistance of the member. In the damaged model of the perimeter frame, the failed components were removed and re-analysed for re-examination.

VII. CONCLUSION

Blast result in ‘air bursts’ when an explosion occurs and ‘surface bursts’ when an explosion occurs near the ground. Due to the number of terrorist attacks, many investigators conducted extensive research. The advancement of technology has increased day by day; In which the effect of blast waves, modelling and analysis of RCC structure is done and design considerations are discussed. This report studies case studies in RC columns subject to blast loading, considered for NSC and HSC studies, showing both the deflection and energy absorption of concrete; Which shows that both NSC and HSC fail due to shear due to near standoff distance. However, HSC columns of power with a lower cross section have higher lateral deflection, indicating better energy absorption capacity than columns of NSC, the effect of shear reinforcement is studied.

The study is conducted to study the effect of high stress-rate on the durability of reinforced concrete members and their elasticity and shear capacity. It is clear from the M-Ø relationship that, at higher stress rates, as the productivity and compressive strength of concrete increases, the elastic capacity and shrinkage of reinforced concrete beams increase; And also indicates whether the increase in elastic strength is greater than the increase in shear strength; Which leads to an increase in physical strength in the kinetic state resulting in increased brittle shear rather than dutile flexural failure.

A 52-story building is considered to study the progressive collapse mechanism. Considering the impact of ground level bomb blasts and local level blast beams and floor slab level failures, spatial analysis of the building's pile to and the building's progressive fallen component is analysed. The stability and integrity of the building is assessed, to verify that the failure of any primary structural member will lead to a progressive collapse, which may propagate to a floor level, above or below the affected member vertically or to the next vertical structural member. If the reinforcement details as required by the special moment resisting frame (SMRF), then the shear capacity and durability will be significantly improved, which will improve the member's explosion and impact resistance. “Minimum design load for buildings and other structures”, which recommends an alternative route method for studying compression systems, where local failures are allowed, but alternative routes around failed structural members must be provided and surcharges for failed structure design considered as waste mode.

For the study, a 2-storey building with TNT weighing 100 kg and stand-off spacing weighing 300 kg is analysed. Blast loading parameters are calculated and four different models are created using ETAABS, including the common frame with normal cross-section of beta and columns and X braking and shear wall attachment. The effect of standoff distance on blast loading and draft and displacement is studied. The blast load increases and the standoff distance shows the effect of maximizing displacement and decreasing the story-carrying growth. By increasing the size of the beams and columns, the resistance of the structure can be improved, but is practical from the point of view of the serviceability of the structure. Adding shear wall and X type steel bracket Will effectively resist explosion loads. The use of steel braking around the structure gives good results; But the shear wall gives a more desirable result and it is also economical.

The report also covers the structural, architectural and managerial aspects of explosion-resistant design. According to structural requirements, in order to be explosion resistant, all structural members must be durable, so that local failures can occur, but the entire structure cannot fail. For which special attention should be paid to beam column joints. In critical areas, full moment-resistant connections are made to ensure the load-bearing capacity of the structural members after an explosion. Beam works primarily in the beam can also apply significant axial load during explosion. Columns of reinforced concrete structures are the most important members that should be protected in the event of an explosion. Similarly in the case of slabs, cast-in-situ reinforced concrete floor slabs are preferred for explosion resistant buildings, but precast floors can also be used in some situations. Similarly the planning and layout of the building should be done and the structural form and internal layout should be designed in such a way as to minimize the impact of the explosion. To reduce the impact of the explosion, increase the stand-off distance by providing bollards, trees and street furniture. Uniform single-story buildings are more explosion-proof than complex-sized and multi-storey buildings. Bomb Shelter Area b.

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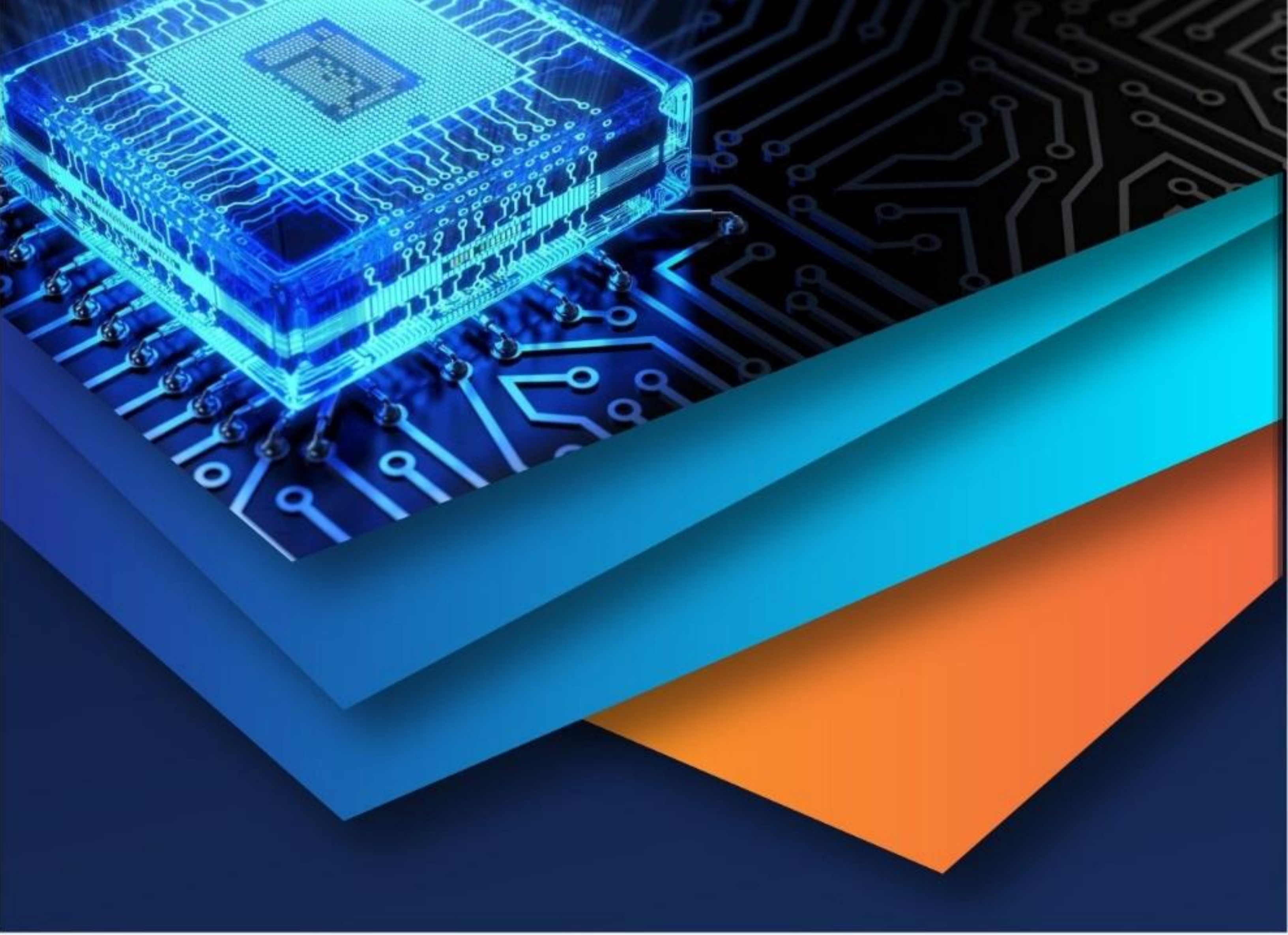

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