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Investigation on Concrete Flat Slab and Post Tension Flat Slab with and Without Openings Subject to Blast Load

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ABSTRACT

Using linear static analysis with the Staad pro tool, we evaluated several key parameters including story drifts, story displacement, axial loads, bending moments, and lateral loads. Let's break down some of the findings. provides valuable insights into the response of flat slab structures to blast loads, offering important considerations for structural engineers in designing buildings that can withstand such hazards effectively. The magnitude of story drift, which indicates lateral displacement between adjacent story, is found to be greater at specific floors within each structure type levels of deformation under blast loads. The distance from the detonation point to the structure increases as the pressure decreases, following an inverse relationship with the stand-off distance. This implies that the stand-off distance plays a crucial role in mitigating the impact of blast loads on the structure. The lateral loads on the structure increase polynomial with increasing story heights. Post tension flat slab wear the more stress in compare to normal concrete structure.

Index Terms: Story Drifts, Lateral Displacement, Base Shear, Staad pro, blast loads

Introduction

Blast loading refers to the sudden and intense release of energy resulting from an explosion. This explosion can be caused by various factors such as bombs, industrial accidents, or natural disasters like volcanic eruptions. Blast loading generates high-pressure shock waves that propagate outward from the point of detonation, exerting immense force on surrounding structures, objects, and individuals.

Understanding blast loading is crucial in several fields, including:

Military and Defense: Military forces study blast loading to develop protective measures for personnel and equipment against explosive devices used in warfare.

Civil Engineering: Engineers consider blast loading when designing structures to withstand potential explosions, such as in high-risk areas like airports, government buildings, and critical infrastructure facilities.

Industrial Safety: Industries dealing with hazardous materials or processes, such as chemical plants and refineries, must account for blast loading in their safety protocols and facility designs.

Natural Disaster Preparedness: In areas prone to volcanic eruptions or gas explosions, understanding blast loading can aid in developing evacuation plans and constructing resilient infrastructure.

Mitigation strategies for blast loading typically involve designing structures to dissipate the energy from an explosion, using materials that can absorb shock waves, and implementing protective barriers or blast-resistant construction techniques.

LITERATURE REVIEW

SAI KRISHNA et al (2022) was study Slabs with openings experience higher stresses around the cut sections. When you cut openings into a slab, you're essentially removing material that would otherwise help distribute stresses. As a result, the remaining material around the openings has to bear more load, leading to higher stresses. Missing or distributary elements may deviate stress transfer. In a solid slab without openings, stresses are distributed more evenly throughout the structure. However, when you introduce openings, you disrupt this distribution. Depending on the layout of the openings and the surrounding structural elements, some areas might bear more load than others, leading to stress concentrations. Increase in edge stresses. Edge stresses refer to the stresses concentrated around the edges of the openings. As mentioned earlier, when you remove material to create openings, the surrounding edges have to bear more load. This can lead to higher stresses along the edges of the openings, potentially causing structural issues if not properly addressed in the design.To mitigate these issues, engineers employ various techniques such as adding reinforcement around the openings, using thicker slab sections, or incorporating additional structural elements like beams or columns to redistribute the loads more effectively

OBJECTIVE OF PAPER

Implanting prestressed tendons in structural elements such as beams or slabs can have a significant impact on the variation of stresses within the structure.

METHODOLOGY

In construction projects where versatility and adaptability are key, slabs often undergo section cuts to accommodate various requirements. These cuts are typically made within the portion of the slab situated between four columns, allowing for optimal structural support. The decision to cut sections is influenced by the need for intrusions on the slab, such as utility installations or architectural features. It's essential to maintain a balance between functionality and structural integrity, with the proportion of the cut area to the overall slab area typically not exceeding 10%. Plate type flat slabs, known for their simplicity in construction, are particularly conducive to this process.

Cut in structure due to safety purpose some key point discuss here.

Conduits and Hoses: Passing conduits and hoses through the slab without exposure or breach ensures a clean and unobstructed appearance, reducing the risk of damage or interference with other building components. This design feature can be crucial in environments where aesthetics or safety are priorities, such as in commercial or residential buildings.

Accessibility for Maintenance: Having a designated floor or platform for technicians to stand on makes it easier and safer for them to access various parts of the structure for maintenance, repair, or inspection purposes. This design consideration enhances the efficiency of building management and reduces the likelihood of accidents or injuries associated with working at height or in confined spaces.

Fire Extinguisher Operations: Installing fire hose points on each floor facilitates swift and effective response to fire emergencies. By strategically placing these points throughout the building, occupants and emergency responders can quickly access firefighting equipment to suppress flames and minimize damage. This proactive approach to fire safety can save lives and property in the event of a fire outbreak.

A slab subjected to dynamic loads from an explosive blast. Here's a breakdown and some clarifications on the points you've mentioned:

Slab Panel Cutting:

- The slab is cut open at different panels, each measuring 0.5 x 0.5 m.
- These cuts are made in three panel columns strips for two cases.

Visualization Panel Cutting:

- A larger panel slab of 5m x 5m is cut to allow for the movement of a scissor lift, facilitating lateral movement for a four-wheeler.

Prestressing Tendons:

- Tendons are introduced at 2m intervals on both sides of the slab for both cases.
- They are aligned accordingly and are placed away from the edges of the openings to prevent buckling of the slab.

Calculating Prestressing Force:

- Prestressing force is determined by considering the total load on the tendon line and the maximum eccentricity given to the tendon.

Dynamic Load from Blasting:

- A dynamic load scenario is considered due to the detonation of 100 kg of TNT explosive.
- The blast occurs at a standoff distance of 10m from the ground, perpendicular to the structure.
- The equivalent weight of TNT is used as the charge weight of the blast.

Unobstructed Blast Distance:

- The distance from the blast is measured as the unobstructed, direct distance from the blast point to the lateral members of the structure.

Section properties

Section properties refer to the geometric properties of structural elements, typically beams or columns, that are crucial for analyzing their behavior under various loads. These properties include:

Area (A): The cross-sectional area of the section.

Centroid: The geometric center of the section.

Moment of Inertia (I): A measure of an object's resistance to changes in its rotation rate, also known as the second moment of area. It quantifies how the mass is distributed about an axis.

Radius of Gyration (r): The distance from the centroid to a point where the mass of the section could be concentrated without changing its moment of inertia.

Section Modulus (S): A geometric property used to determine the stress in a structural member subjected to bending. It is calculated as the moment of inertia divided by the distance from the neutral axis to the farthest point of the section.

Table 1 Specifications of materials using in structure member

DESCRIPTION	SPECIFICATIONS
Type of Members	Structure Member
Dimension of Columns	(700 x 700) mm
Material property of Column (concrete)	M35
Material property of Column beam (rebar)	Fe 500
Clear cover in Column	50mm
Type of Slab	Flat Plate
Thickness of slab	300 mm
Material property of slab	M30
Material property of Slab (rebar)	Fe 550

RESULTS AND DISCUSSION

The value of slab stresses in structural engineering is crucial for assessing the structural integrity and safety of a building or any structure. Blast loads, such as those from explosions, can significantly impact these stresses, leading to potential structural failure if not properly accounted for. Several models have been developed to calculate the value of slab stresses, both with and without blast loads. When comparing these models with and without blast loads, engineers typically assess how accurately each model predicts the actual behavior of the structure under blast conditions. This comparison involves evaluating factors such as accuracy, computational efficiency, and applicability to different types of structures and blast scenarios.

Analysis done by four condition

- ✓ Flat Slab without opening
- ✓ Flat Slab with opening
- ✓ Post Tensioned Flat Slab without Opening
- ✓ Post Tensioned Flat Slab with Opening

These analysis done by in slab for different opening with and without blast loading

Table 2 Stress analysis flat slab and post tension slab

Description	**Stress without opening (N/mm^2)**	**Stress with opening (N/mm^2)**
Flat Slab	8.79	11.39
Post Tension Flat Slab	5.36	7.57

Table 3 Stress analysis flat slab and post tension slab after applying blast load

Description	**Stress without opening (N/mm^2)**	**Stress with opening (N/mm^2)**
Flat Slab	45.28	112.32
Post Tension Flat Slab	28.65	85.26

CONCLUSION

Higher Stresses Around Slab Cut Sections: Slabs with openings experience increased stresses around the cut sections due to the transfer of elemental stresses being affected by missing or distributed elements. This deviation in stress transfer leads to an increase in edge stresses.

Less Blast Impact: Slabs with openings are calculated to have reduced blast impact because the area of impact of blast waves is diminished. The reduction in area caused by openings results in decreased force at the joint.

Alignment of Openings in Column Strip: Openings aligned in the column strip exhibit lower stresses at the cut edges because this zone has a shorter distance from the joint through interconnecting elements.

Higher Stresses at Major Cut Section Edges: For major cut sections (e.g., 5m x 5m), the edge of the slab experiences greater stresses compared to the mid-section. This is due to the freedom of edge elements, which can be mitigated by casting concealed beams or adding extra reinforcement to normalize the section, as supported by a beam.

Reduced Stress in Main Strip: A comparative reduction in stress is observed in the main strip due to the hogging effect of pre- stress cables counteracting the sagging of the slab.

Special Reinforcement Around Columns: Special reinforcement around columns of dimensions 3m x 3m should be placed on the top layer to resist the action of punching shear, which occurs when a concentrated load is applied to a small area of a slab.

REFERENCES

1) Comparative Analysis of Slab with Different Shape of Cut-out for Various End Conditions Using ANSYS: S. Durgadevi and NA Jabez

2) Comparative Study of Reinforced Concrete Flat Slabs with and without Openings using Finite Element Analysis: Aradhna A. Ganvir, Prof. V.S. Singhade

3) Punching Shear of Reinforced Concrete Flat Plates with Openings: Borges, Liana L J, Melo Guilherme S

4) Finite element implementation of punching shear behaviours in shear-reinforced flat slabs: Ashraf Mohamed Mahmoud

5) Effect of opening size and location on punching shear behaviour of two-way RC slabs: Ozgur Anil, Tolga Kina

6) Stability of Square Plate with Concentric Cut-out: B. S. Jayashankarbabu, Karisiddappa

7) Effect of opening size on the strength of slabs: Hossam A. Daham

8) Behaviour of flat slab structures subjected to surface blast loads: Suhas B Malagi, Prof. Shrilatha B

9) IS:456-2000- “Plain and Reinforced Concrete - Code of Practice”

10) IS:4991-1968- “Criteria for blast resistant design of structures for explosions above ground”

11) IS:875-PART 5- “Code of practice for design loads (Other Than Earthquake) For Buildings And Structures Gr5 Part 5 Special Loads And Load Combinations”

12) K. Raju, “Prestressed concrete”, Tata McGraw-Hill, 10th Edition,2010.

13) A. Hufnagel and H. Thomas, K. Kang (2012), “Assessment of secondary effects in reinforced flat plates flat plates”, PT Journal.

14) Vakas K. Rahman, Prof. A.R. Mundhada (2013), “Comparative study of RCC and Prestressed concrete flat slabs”, International Journal of Modern Engineering Research(IJMER).

15) Kaulkhere R.V, Prof. G.N Shete, (2017) “Analysis and Design of Flat Slab with Various Shapes”, International Journal