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DYNAMIC ANALYSIS OF AN INVESTIGATION ON FLAT SLAB WITH OPENINGS SUBJECT TO BLAST LOAD

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1) INTRODUCTION

1.1 FLAT SLAB:

The Conventional method of construction that's a standard practice is to support slab by beam and beam supported by column. this is often called as a beam slab load transfer construction technique. thanks to this traditional technique of construction net height of the space is reduced. Thus to enhance the aesthetical and structural aspect of multi-storey, shopping malls, offices, warehouses, etc. are constructed in such how where slabs are directly on columns. These Slabs are further divided based on the connection of column and slab.

1.2 OPENINGS IN FLAT SLABS

Openings or openings in slabs are generally provided for the purpose of plumbing, Fire protection, Electrical wiring, Air conditioning vents, conveyor belts, etc. Larger openings that would amount to the elimination of an outsized area within a slab panel are sometimes required for stairs and elevators shafts. For fore designed openings in slabs, the locations and sizes of the openings are usually predetermined accordingly within the early stages of design and accommodated accordingly. This may sometimes provide fire exits and emergency ways.

1.3 PRESTRESSED FLAT SLAB

Flat slabs are mostly pre stressed to act the slab as a whole unit by imparting compressive stresses through the slab. Tendons consisting of high ductile grade strands are combined to act as a single tendon.

1.4 BLAST

Blast is a criterion which increased fear and terror. Though it may be used for beneficial causes, it has same effects which it is not intended to use. This raised a concern of protecting from all sort of such impacts on our surroundings. A blast explosion is instantly explanation for close building exceedingly harmful injury. Thanks to maincatastrophes succeeding fromgas-chemical explosions conclusion in giant dynamic hundreds, larger than the initial sketch various structure by method of this building's exterior and interior structural frames, collapsing of walls, processing out of large expanses of windows, and motion down of significant life security systems like hearth, & smoke evoked injury to structure. blast evoked theimpulsive hundreds bythese hundreds concern s the structure is analysed and designed with in Indian normal limits.

1.5 SAP 2000

SAP 2000 is a finite element package owned by a Computers and Structures Inc. SAP 2000 is used as a single point to use it for Modelling, Analysis, Design. It can handle complex issues of non-linearity and has different functions of time and stability dependant. This may include time variation dependency of prestress, frequencies of ground motion, and other time function-based theories.

1.6 OBJECTIVES

1 To model a G+4 structural frame with flat slab using SAP 2000
2 To induce 3 minor openings in slab and one major opening to analyse stresses around the open region.
3 To implant prestressed tendons to analyse its impact in variation of stresses.
4 To calculate the equivalent blast force coming onto structure and analysing the structural behaviour to blast which is 10m away.

1.7 SCOPE

In order to achieve the above objectives, tasks involving modelling of G+4 frame is modelled with and without prestress tendons. Openings are marked and made in slab and the slab is divided into feasible grid patterns. Blast calculations are done and applied on column joints on the blast face and comparison of storey drift and column end displacements are compared.

2) ANALYTICAL STUDY

Introduction: When slabs are required to have a section cut for multipurpose reasons, they are cut with the percentage area of the slab resting between four columns. They are cut at sections based on the requirement of intrusions on slab. The proportion of area of the opening to overall slab should not be greater than 10%. Plate type flat slabs are easy to construct.

Advantages:

- Any applications of conduits and hoses are taken through the slab without being exposed and breached.
- Any object can be easily accessed in the structure as they have a floor for the technician to stand on.

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- Fire extinguish operations can be carried easily. Each floor can have a fire hose point.

Disadvantages:

- The edges of the slab cut portion have all degrees of freedom and develop edge stresses
- The loss in strength is noticed as the continuity of the member is lost on implementing gaps in member.
- No extra support in form of additional beam or over strengthening material can not be provided.

2.1 Blast Phenomenon: Blast is a sudden outbreak of pressure from a source which may be of any physical property. It is the shock wave front hitting a structure with a magnitude finally called as force. The wave propagates in all directions from source with equal magnitude and frequency. The wave release interval as compressions and rare fraction rate is termed as frequency. The force to time release of blast is plotted as blast wave. The loads are calculated as equivalent force based on the type o blast as calculated above.

2.2 System Development: By considering a G+4 storied RCC and PSC structure. The structure is modelled in Finite Element analysis Package SAP 2000. The details of structure, Members, and materials are detailed below.

S.NO	REGION	MATERIAL	STANDARD	DENSITY KN/mm2
1	INDIA	CONCRETE	M40	40
2	INDIA	CONCRETE	M25	25
3	INDIA	REBAR	Fe 550	78.5
4	INDIA	TENDON	Fe 550	78.5

Structural Properties:

S. No	Description	Specification
1	Plan type	Rectangular-Unsymmetric
2	Dimension	Refer to Fig. 4.2
3	Bays along X	5
4	Bays along Z	5
5	Width of each bay	5.0 m
6	Height of Structure	17.5
7	Height of each storey	3.5m
8	Depth of footing	4.0 m
9	Seismic zone (IS - 1893:2000)	II
10	Blast load code	IS -4991:2000

Section properties

s.no	DESCRIPTION	SPECIFICATIONS
1	Type of Members	Concrete
2	Dimension of Columns	(750 x 750) mm
3	Material property of Column (concrete)	M40
4	Material property of Column beam (rebar)	HYSD 415
5	Clear cover in Column	40mm
6	Type of Slab	Flat Plate Type
7	Thickness of slab	200 mm
8	Material property of slab	M40
9	Material property of Slab (rebar)	HYSD 550
10	Clear cover in Slab (top & bottom)	) mm

3) METHODOLOGY

3.1 Methodology:

- Analysis of G+4 flat plate type RCC and PSC building is modeled in SAP 2000
- The slab is cut open at different slab panels of size 0.5 x 0.5 m on three panel in column strips for two cases.
- To visualise a major section cut, a panel slab of 5m x 5m is cut to facilitate scissor lift facilitating four wheeler lateral movement.
- Prestressing tendons are introduced at 2m interval in both the side for two cases and aligned accordingly.
- Prestressing tendons are placed avoiding edges of the openings to prevent slab from buckling.
- The Prestressing force is calculated by the total load on tendon line and maximum eccentricity give to tendon.
- Dynamic load by blasting 100 kg TNT of explosive, at a standoff distance of 10m at ground perpendicular to the structure is considered.
- Charge weight of blast is taken as equivalent weight of TNT.
- The distance from Blast is unobstructed, direct distance from blast point to lateral members of structure.

4) Modelling:

Modelling of the frame with G+4 columns and slabs resting on the columns is to be drawn using SAP 2000 modelling feature. The basic grid is drawn with required spacing in co-ordinates. The grid should facilitate the easy layout of columns of required spacing.

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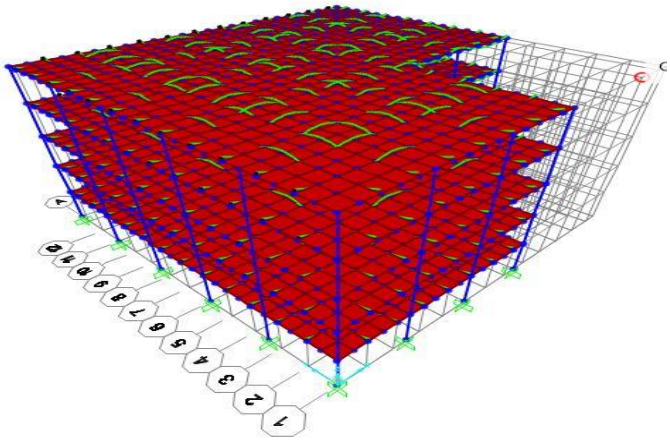
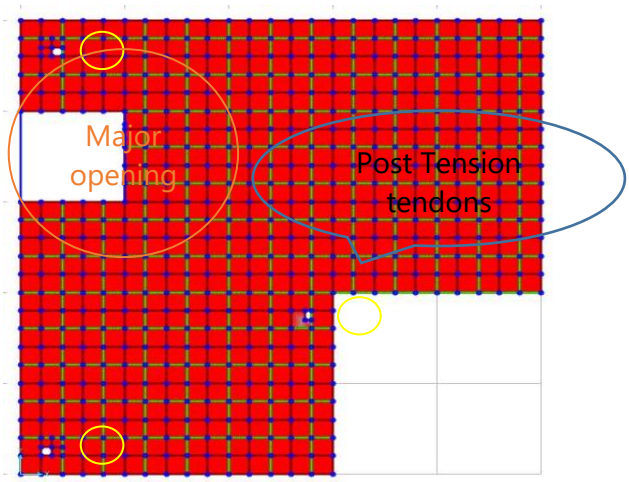
Here a frame of Non symmetrical shape is modelled so as to get the structural non linearity. The initial bays are 5 with bay space of 5 metres. The corner face of 4 square slabs including 4 columns is omitted in order to make it non symmetrical.



Post tensioned Flat slab without openings [PFS]



Post tensioned Flat slab with opening [PFS_o]

5) RESULTS AND DISCUSSIONS

5.1 CASES: Four major models developed the value of slab stresses are recorded and compared without and with blast load. Thee four major models developed and the respective notations are given below;

1. Flast Slab without opening [FS]
2. Flat Slab with opening [FS_O]

i. Flat Slab with minor opening [FS_m]
ii. Flat Slab with major opening[FS_M]

3. Post Tensioned Flat Slab without Opening[PFS]
4. Post Tensioned Flat Slab with Opening [PFS_O]

i. Post Tensioned Flat Slab with minor opening [PFS_m]
ii. Post Tensioned Flat Slab with major opening [PFS_M]

5.2 CASE 1: Without Blast Load

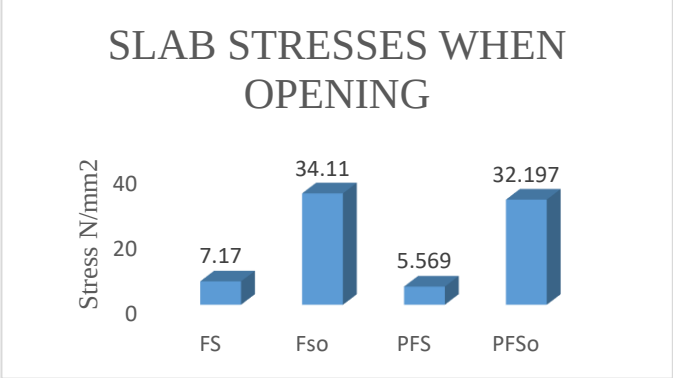
Initially, Slab stresses are measured for both major and minor openings in both Flat slab and Post tensioned flat. The slab stresses recorded for the four major cases are then compared.

Table 6.1 Slab stresses corresponding to three minor openings (without Blast Load)

Slab Stresses	Minor opening 1 (N/mm^2)	Minor opening 2 (N/mm^2)	Minor opening 3 (N/mm^2)
Flat Slab	7.177	2.128	6.593
Post Tensioned Flat slab	5.569	1.744	4.66

5.2.1 Slab stresses corresponding to major and minor openings (without Blast Load)

S.No.	Description	Slab Stresses (N/mm^2)
1.	Flat Slab with minor opening [FS_m]	7.177
2.	Flat Slab with major opening [FS_M]	34.111
3.	Post Tensioned Flat Slab with minor opening [PFS_m]	5.569
4.	Post Tensioned Flat Slab with major opening [PFS_M]	32.197



5.3 CASE 2: With Blast Load

Initially, Slab stresses are measured for both major and minor openings in both Flat slab and Post-tension flat slab. The slab stresses recorded for the four major cases are then compared. Annotation of (*)is used to indicate the value of stresses recorded when subjected to blast load.

Table 6.4 Slab stresses corresponding to three major openings

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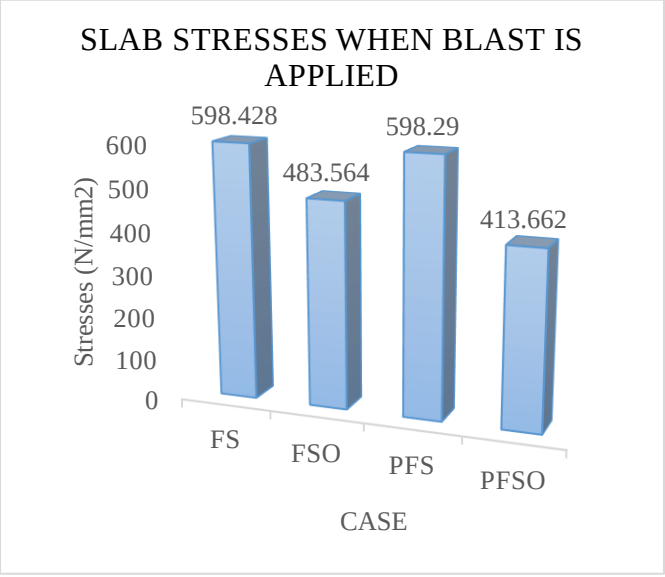
(with Blast Load)

Slab Stresses	Minor opening 1 (N/mm^2)	Minor opening 2 (N/mm^2)	Minor opening 3 (N/mm^2)
Flat Slab	49.367	215.113	56.651
Post Tensioned Flat slab	25.761	53.889	69.093

5.3.1 Slab stresses corresponding to major and minor openings (with Blast Load)

S.No.	Description	Slab Stresses (N/mm2)
1.	Flat Slab with minor opening [*FS_m]	215.113
2.	Flat Slab with major opening [*FS_M]	281.573
3.	Post Tensioned Flat Slab with minor opening [*PFS_m]	69.093
4.	Post Tensioned Flat Slab with major opening [*PFS_M]	233.409



6) CONCLUSIONS

1. The slabs with openings are having higher stresses around the slab cut sections. As they have to transfer the elemental stresses to from each other, the missing element or distributary element made deviate the transfer of stresses and hence increase in edge stresses.
2. The slabs with openings are calculated to have less blast impact as the area of impact of blast waves is less. Since the reduce in area by openings resulted in reducing the force at the joint.
3. The opening (3), aligned in the column strip was observed to have less stresses at the cut edges as the zone has less distance from joint through interconnecting elements.
4. For major cut section (5m x 5m), the edge of the slab had grater stresses than compared to the mid-section of slab. This is due to the freedom of edge elements. Either a concealed beam connecting joints is cast or extra reinforcement normalizing the section as supported by a beam.
5. Comparative reduce in stress in main strip is observed as the hogging effect of prestress cable counter acted the sagging of slab.
6. Special reinforcement around column of 3m x 3m should be done on top layer in order to resist the action of punching shear.

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