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COMPARATIVE STUDY OF SEISMIC BHAVIOR OF VERIOUS FLAT SLAB WITH CONVENSIONAL SLAB

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Abstract

With the increase in demand for space, constructions of multistoried buildings are becoming a necessary part of our living style. The dearth of space is forcing us to raise the height of buildings as much as possible to accommodate maximum number of people and also in harmony with the architectural necessities. A popular form of concrete building construction uses a flat concrete slab (without beams) as the floor system. This system is very easy to construct, and is efficient in that it required the minimum building height for a given number of stories. This report presents the comparison between flat slab and normal conventional slab with factors of comparisons -Applying technical aspect checks with both manually and by using software. (shear, bending moment) and Quantity and cost estimation of material required (steel, concrete). Although flat slabs have been in construction for more than a century now, analysis and design of flat slabs are still the active areas of research and there is still no general agreement on the best design procedure. Presently Indian standard codes of practice outline design procedures only for slab with regular geometry and layout. But in recent times, because of space crunch, height limitations and many other factors, deviations from a geometry and regular layout are becoming quite common. In this paper a review of seismic behavior of flat slab and conventional slab is done using various software which will gives comparative study of these both slabs.

Index Terms: *Flat Concrete slab; Shear; Bending moment; Seismic Behavior; Software analysis*

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1. INTRODUCTION

The Construction of multistoried buildings is becoming a necessary part of our living style with increase in demand for space. The lack of space is forcing us to raise the height of structures as much as possible to accommodate maximum number of people, and also in harmony with the architectural necessities. These multistoried buildings can be constructed using various structural systems. Also with increase in height the need of resisting lateral loads like wind and earthquake also comes in pictures. Two main groups according to the arrangement of slabs, beams and girders, and columns are framed building and flat slab building. The choice of a particular system depends upon the total height of the building i.e. commercial and residential etc. and finally the total cost of the structure.

The practice of design and construction is to support the slabs using beams and support the beams using columns. This may be called as beam-slab construction. The flat slab buildings in which slab is directly supported using columns, have been adopted in many buildings constructed in recent times due to advantage of reduced floor to floor heights to meet the cost-effective and architectural demands. The beams decrease the obtainable net clear ceiling height. Hence in warehouses, offices and public halls occasionally beams are avoided and slabs are directly supported by columns. For commercial buildings flat slab rising up to 10 to 20 stories is quite popular. This type of construction is aesthetically appealing also. These slabs which are directly held by columns are called Flat Slabs.

A reinforced concrete flat slab, also named as beamless slab, is a slab held directly using columns without beams. A part of the slab restricted on every four sides by Centerline of column is named panel. The flat slab is often stiffened closed to supporting columns to deliver adequate strength in shear and to reduce the amount of -ve reinforcement in the support regions. The stiffened portion i.e. the projection beneath the slab is named drop or drop panel.

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REVIEW

By Hal Amrick, Tao Xu And Michal Gendreau Collin Gordon And Associates, San Bruno, California USA. "the role of buildings and slabs - on – grade in the suppression of low amplitude ambient ground vibration" (2004). This paper discuses the manner in which the stiffness of a slab – on – grade or building will alter the free flow vibrations at a building site. This phenomenon is dependent upon the rigidity of slab or foundation in the direction of wave propagation, and the relation between the wave length and a dimension of a slab or foundation in the direction of wave propagation. Measurements from field study are used as a examples.

W.P.Graf and mehrdad mehrain "analysis and a testing of a flat slab concrete building" (1992). A 14 storey reinforced concrete flat slab building in southern California was assessed for earthquake risk. The mid 1960"s design uses frame action between the slab and column for lateral force resistance. Unlike other flat slab building damage in past earthquake this building has large, deep, pyramid-shaped deop panel to reinforce the critical slab-column joint.

Preliminary linear analysis identified probable structural weakness and seismic demands on the structure, but the earthquake performance of the drop panel could not be assessed. Test at the university California, Berkely campus investigated the ductility of slab-column connection, and provide data for analytical modal reinforcement. Result showed stiffness degradation as expected, but loss of the strength within anticipated maximum drifts was negligible. Finally test data was used to calibrate should perform well in moderate to large earthquake, although large drifts are expected.

R.A. Apostolska, G.S. Neceska-vetanovska, J.P. Cvetanovska and N. Niracle " seismic performance of flat-slab building structural system"(2008). Flat-slab building structures possesses major advantages over traditional slab-beam-column structures because of te free design of space, shorter construction time, architectural-functional and economical aspects. Because of the absence of the deep beams and shear wall, falt-slab structural system is significantly more flexible for lateral loads the traditional RC frame system and that make the system more vulnerable under seismic events. The results from the analysis for few types of construction systems which is presented in the paper show tah flat slab system with certain modifications (design of beam in the perimeter of the building and/or RC walls) can achieve rational factor of behavior considering EC8 and can be consider as a system with acceptable seismic risk. Modifications with additional construction elements improve small bearing capacity of the system and increase strength amd stiffness, improving seismic behavior of flat-slab construction system. Selected results from the analysis are presented in the paper.

M.G. Sahab " sensitivity of the optimum design of reinforced concrete Flat Slab building to the unit cost components and characteristics material strength" (2008). In this

paper the influence of the unit cost of the steel, concrete and framework and the characteristics strengths of the steel and concrete on the optimum design of reinforced concrete flat slab building is investigated. Size optimization of the flat slab buildings according to the British code of practice is carried out. The objective function is the total cost of the building including the cost of the building includes the cost of floors, columns and foundations. The total cost of the building includes the cost of material and labour for concrete reinforcements and formwork. Excavation cost is also considered in the cost of foundations the optimization process is handled in two levels. In the first level the optimum cross-sectional dimensions of the reinforcement concrete elements is determined using hybrid algorithm based on genetic algorithm. In the second levels an exhaustive search is applied to seek the optimum size and the number f the steel bars for each individual type of the structural elements. A practical example is given to each individual type cost saving and sensitivity of the optimum design to the unt cost item and the characteristics strength of steel and concrete.

Seung – chang lee, jae – yo kim, jung-keun oh, and ahmad abdelraraq "sequential analysis of flat – slab construction and its impact on construction cycle" all of Samsung corporation (engineering & construction). Dr. lee and mr. abdelrazaq will present the paper. Extensive studies and research have been performed to evaluate flat-plate/flat-slab system behavior during construction and the resulting short-term and long-term behaviors of the system. Present material technologies, especially as they relate to high performance (HPC), may have some influence on the construction sequence of these systems. Proper precautions in practice may influence the behavior positively. Especially as it relates to cracking and stiffness control because of (HPC) use.

This presentation will discuss the purpose of the paper, which was to study the behavior flat-plate slab system behavior when utilizing HPC during construction and its impact on long term performance. Though the study, a construction sequence analysis was performed that took in account the effect of slab strength and stiffness during construction cycle, prop member stiffness, and the cracking effects on the long and short term behavior of flat-plate construction.

This study is necessary to optimize the shoring method of a high rise building system with flat-plate floor construction as it may influence a typical floor construction cycle in a high-rise building.

Dan-vasike bompa and traian onet "an incursion on punching of reinforced concrete flat slab" (2009). Starting from the early 60"s continuous studies have been made regarding punching concrete flat slab. The evolution of technology and calculus systems influenced this engineering branch now-a-days is possible to account in structural analysis all the non-linear behavior of reinforced and pre-stressed concrete and to get the most close structural response in comparison with the real behavior. As a controversy matter, several tests and theories have been developed. Now-a-days

researchers try to find the most accurate and economic formula for punching.

Since 1956, a series bench of tests, over 400, has been gained due several numerical investigations and experimental tests. One of the most important centers, where the most comprehensive theories and best experimental results were gained is the department of structural engineering from Stockholm polytechnic under the surveillance of professor herik nylander and professor sven kinnunen. The most representative that studied that studied this problem are: kinnunen and nylander, moe, braestrup and nielson, menterey, shehta, bazant and cao, georgopoulus, broms, bortolotii, Alexander/simmonds. Their models are presented in FIB bulletin 12. Even if punching was not a very important discussion topic in FIB taskgroups. On the background of the economical growth and the necessity of many more administrative buildings this theme is back o the list of "priorities". At this moment a coherent and accurate formulation for punching is sought

Gregory a. macrae "a concept for consideration of slab effects on building seismic performance" (2006). Slabs exist in the majority of buildings worldwide but they are seldom modeled explicitly in analysis for design. In traditional steel moment frame system, where the slab is not separated from the column flanges the beam overstrength is increased, whereas separating the slab from the column flanges minimizes the beam overstrength. In gap opening systems made of materials such as steel, traditional reinforced concrete, or precast concrete, the column demands are increased due to beam/slab overstrength and beam elongation, and the slab is also damaged during

the deformation. This paper describes the development of a simple model for explicit evaluation of the slab effect on moment-resisting (MR) structural systems which considers the slab contribution to the beam overstrength at different storey drifts and the slab opening displacements which can be related to damage. The model captures important aspects of the behavior of a reinforced concrete joint with the floor slab, well.

Vikunj k.Tilva, Prof. B.A.Vyas and Assit.Prof. Parth Thaker "COST COMPARISON BETWEEN FLAT SLABS WITH DROP AND WITHOUT DROP IN FOUR STOREY LATERAL LOAD RESISTING BUILDING":The objective of this paper is to avail a cost comparison between flat slab panel with drop and without drop in four storey lateral load resisting building. A four storey building (having 6mx6m panel) is subjected to gravity load + lateral load in ETABS (Extended 3D Analysis of Building Systems) software and then each storey is exported to SAFE(Slab Analysis by the Finite Element Method) software for analyzing punching effect due to lateral loads. On the basis of permissible punching shear criteria according to IS 456, economical thickness of flat slab with drop and without drop are selected and cost comparison is done by using S.O.R. (Schedule Of Rates 2008-09).

Prof. K S Sable, Er. V A Ghodechor, Prof. S B Kandekar "COMPARATIVE STUDY OF SEISMIC BEHAVIOR OF MULTISTORY FLAT SLAB AND CONVENTIONAL REINFORCED CONCRETE FRAMED STRUCTURES":Tall commercial buildings are primarily a response to the demand by business activities to be as close to each other, and to the city centre as possible, thereby putting intense pressure on the available land space. Structures with a large degree of indeterminacy is superior to one with less indeterminacy, because of more members are monolithically connected to each other and if yielding takes place in any one of them, then a redistribution of forces takes place. Therefore it is necessary to analyze seismic behavior of building for different heights to see what changes are going to occur if the height of conventional building and flat slab building changes.

Amit A. Sathawane & R.S. Deotale "ANALYSIS AND DESIGN OF FLAT SLAB AND GRID SLAB AND THEIR COST COMPARISON": The FLAT slab system of construction is one in which the beam is used in the conventional methods of construction done away with the directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Drops or columns are generally provided with column heads or capitals. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The aim of the project is to determine the most economical slab between flat slab with drop, Flat slab without drop and grid slab. The proposed construction site is Nexus point apposite to Vidhan Bhavan and beside NMC office, Nagpur. The total length of slab is 31.38 m and width is 27.22 m. total area of slab is 854.16 sqm. It is designed by using M35 Grade concrete and Fe415 steel. Analysis of the flat slab and grid slab has been done both manually by IS 456-2000 and by using software also. Flat slab and Grid slab has been analyzed by STAAD PRO. Rates have been taken according to N.M.C. C.S.R

Dhananjay D. Joshi, Dr. Pranesh B. Murnal " PERFORMANCE OF FLAT SLAB STRUCTURE USING PUSHOVER ANALYSIS" : Performance Based Seismic Engineering is the modern approach to earthquake resistant design. It is a limit-state based design approach extended to cover complex range of issues faced by structural engineers. Flat slabs are becoming popular and gaining importance as they are economical as compared to beam-column connections in conventional slab. Many existing flat slabs may not have been designed for seismic forces so it is important to study their response under seismic conditions and to evaluate seismic retrofit schemes. In this paper we have discussed the results obtained by performing push over analysis on flat slabs by using most common software SAP2000. A (G+7) frame having 5 bays is considered for analysis. It is observed that the performance point of flat slab is more as compared to conventional building.

SCOPE

The lateral behavior of a typical flat slab structure which is planned according to I.S. 456-2000 is evaluated by means of seismic analysis. The inadequacies of these buildings are discussed by means of comparing the behavior using conventional beam column framing. Conventional slab system is selected for this purpose. To study the result of drop panels on the behavior of flat slab during lateral loads. Software ETABS 2015 is used for this purpose.

CONCLUSIONS

- The stiffness of a slab – on – grade or building will alter the free flow vibrations at a building site. This phenomenon is dependent upon the rigidity of slab or foundation in the direction of wave propagation.
- It is found that because of the absence of the deep beams and shear wall, falt-slab structural system is significantly more flexible for lateral loads the traditional RC frame system and that make the system more vulnerable under seismic events.
- For increasing the shear strength, the drops are the important criteria in flat slab and increasing drop thickness, rigidity of the slab increases.
- Drop with head are very helpful for resisting punching shear in flat slab.
- The positive and negative moment found to be more in flat slab as compared conventional slab structure.
- Quantity of steel and concrete is more in flat slab then the conventional slab although beams are present in conventional slab.
- Story displacement at roof is maximum than at the base level and story displacement of flat slab without drop is more than conventional slab structure, there is some amount of average displacement variation in different zones for all the type of structure.

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