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The Contribution of Non-Structural Components to the Overall Dynamic Behaviour of Concrete Floor Slabs

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Abstract: Pre-stressing and arrival of more-strength material permit constructions of much lean floors slab with least value with natural frequency along with damping. Within some circumstance, vibration because of forcing frequency due to normal man activity can be annoying to occupant. Since the occupant is counted both sources and the sensors, the vibrations can't be isolated and should control by the structural systems. In recent time, there are limit knowledge related to the overall dynamic characteristic of concrete-slab, even including contribution of individual structural along with non-structural component. The programme of modal testing related to slender one-way spanning with 50 percentage scale post-tensioned concrete slabs are reported. Test is carried out by utilization of electro-magnetic shakers, instrument hammers, heel-drops, and walking-excitation, to check all floors dynamic characteristic. With the help of this test, we investigate the effects on vibrations performances of the levels of pre-stress, and even of non-structural addition, which even include vibrations absorber along with effects of occupant. This is noticed that an rise in pre-stressing forces boost with natural frequencies and decrease damping because of closed micro-crack. After that, models are represents to reflect such change in term of effective second moments of areas. Cantilever partition test show energy to dissipate by swaying, and full-height partition was noticed to act like line support which leads to a significant stiffening of the slabs. Analytical model is derived for both form of partition. Test with false floor show a significantly more increase in slabs damping, when the floors panel rest on the pedestal, as opposed to being rigidly fixed to them. Although the addition of visco-elastic screed layer was not noticed to have great effects in damping, analytical models are obtained which shows merits of utilization of this layer. The TMD system is design and installed on the floors, by utilization of plywood sheet, that led to reduce in vibrations response nearly about 80%. Theoretical models are obtained to present the TMD results and design criterions are suggested. Finally, effects of human-structures interactions are carried out. Such analytical models show the natural frequencies of the body equal to 10.43Hz with a damping of 50%. Result is also reported of test on a full-scale field slabs, confirming few of the finding of the models slabs experiment. Broadly, the result indicate that contrary to popular. The presence of non structural component is not necessarily enhances the dynamic behaviours of the systems. The design of such component and natures of installation is important factor which affects their contributions to overall floors vibration behaviours.

I. INTRODUCTION

Nowadays, lacks of knowledge related to the dynamic behaviour of suspend concrete slab. With the arrival of such slender slabs design, especially by utilization of pre-stressing, concrete floor is become much susceptible to vibration. Such vibration is the main issue from serviceability points of views. Such viberation has encountered numerous time before, especially with long span floor of light-construction, like composite floor. Till today, there is limited research into this area of post-tensioned concrete floors vibration, even though such type of floor can slender. Furtermore, the knowledge of the dynamic property of floor, particularly damping and natural frequency, and contribution of non-structural element are in-complete. In this work, issue of vibrations susceptibility of floor to low-level excitation is established. Huge account is present on merit of post tensioned floor over ordinary reinforced slab, and drawback concern vibrations. The area in which, needs of more research is identify and the deficiency of few current designs code is required. The objective along with aim of research programmes is mentioned.

II. POST-TENSIONED FLOOR AND VIBRATIONS SUSCEPTIBILITY

Vibration in structure occurs because of multitude of cause, like walking (inside the building) or wind-load (external to building). Other form of load includes blast, seismic-vibration, construction load, traffics, or man activity like due to dance and jump. While few of such vibration can induce permanently damages, other (e.g. walking) lead to rise in serviceability problem within the structure. Serviceability limits state in buildings condition in which the functions of the buildings are disrupted due to local minor damages or deteriorations of buildings component, or due to occupant discomforts. Vibrations problem in structure is generally the most common serviceability issues face by engineer nowadays. Floor-vibrations are more likely to annoy peoples than to causes overload or fatigues [Allen et al. (1985)]. While safety is normally not a problem with serviceability, the economic consequence may substantial [ASCE (1986)].

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With traditional constructions and designs, by utilization of allowable or working stresses criteria, service-ability normally is not issue. Normally, simples criteria, base on percentages of spans and heights, dealt along cracks and motions relates problem. Moreover, changes in architectural and building uses requirement, couple along improve method of constructions and designs, such as pre-stressing, has led to structural system that are least stiffs and massive. To add more, the utilization of material along least mass to strength ratio (such as more strength steel and concrete), is meant that modern floors area is increasingly more with less slabs thickness. For such flexible and light damped floor, serviceability issue is paramount importance, since such are susceptible to transient vibration induced along less impact, likes man foot-fall. Under certain circumstance, such vibration may annoying to occupant of building [Allen (1974), Allen and Rainer (1976), Vannoy and Heins (1979), Warwaruk (1979), Murray (1981), Bachmann (1992a)]. One of the most important advance in constructions designs had embibe of pre-stressing, that led to more slender and longer spans, structure.

Post-tensioning, that is form of pre-stressing, had used in floors constructions for many decade, particularly in U.S., Australia, the Far East, and to few extent in Europe. Its economic and technical merits are being boosted appreciated, and the percentages of concrete floor being post tensioned are growing [Khans and William (1995)]. Similar to normal reinforced concrete floor, post tensioned floor may make in flats, ribs, one way with beam, or waffle slabs configuration.

Merit of utilization of post-tensioning over normal reinforced concretes member. They includes

1) Increase clear span,
2) Thin slab,
3) Light structure,
4) Reduce cracking and deflection,
5) Reduce storey heights,
6) Rapid constructions, and
7) Better water tight [Concrete Society (1994), BCA (1992)].

Their advantage became more apparent when long span is needed. Generally, post-tensioning is an economical and fast-way of achieving slender floors slab with larger open area. The important drawback of such floor are their susceptibility to vibrations. With increase in span or thinner slab, natural frequency of such floor might reduce to with-in the ranges where man annoyances because of resonances with harmonics of activity, like walk, is same. Moreover, reduce in cracks and deflection, damping capacity of such floor is less. Serviceability vibrations problem has encountered in numerous ways of floor, that include those of composites steel-concrete, precast, and cast-in-place constructions. Reference relates to post-tension, pre-stressed floor is less in number [Bachmann (1992b), Waldron et al. (1993), Caverson et al. (1994), Williams and Waldron (1994)].Such slab became more slender with large span, it is logical to anticipates vibrations as a issue.

III. OVERVIEW OF RESEARCH NEED

A common man response to motions in building is that human became anxious related to safety of structures, even to the extents of refusing to utilize it. Numerous examples of such case has been report like closures of a new departments store due to un-comfortable floors motions, and of the complete loss of secretarial efficiencies in a latest building because of occupant induced floors vibrations [Murray (1981)]. In these case, the actual danger of structural collapses are least, the strain involve often being 10.00 to 100.00 time least than those which may initiate damage [Bachmann et al. (1995)]. Nevertheless, this is a serious case for the designer and correct such situation are generally too difficult and expensives [Murray (1981)]. Moreover, with ever increase number of flexible floor, account must be taken of the man sensitivity to vibrations at the design levels. Such structural designer is acutely aware of potential floors vibrations problem, but until very recently, guideline was not available to aid in the determinations of the suitability of a propose floors systems."Currently serviceability guideline is not useful in numerous case of latest constructions. The absence of meaningful criterias might interpreted by numerous to mean that serviceability is not much important, and encouages attitude toward serviceability. With the continuous trends toward high-strength, flexiblity structures, efficient structural systems, and limit state design, such attitudes shall likes lead to costly issue in latest buildings.... More research can carried out in numerous areas in order to develop or complete the data base needed to prepare rational and practical serviceability guidelines." [ASCE (1986)].

Increase in recommendation is being adopted concerning floors vibration. SCI (1989) and AISC (1997) are 2 designs guide specifically written for composites steel-concrete floor.

“Post-tensioned flats slab usually has more mass and low fundamental natural frequency than slab on profile metals decks.

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Moreover increase in mass of floor reduces the dynamic response, floors of least natural frequency were excited by more larger components of the walk force. It is therefore likes that dynamic responses will control the thickness of least flat slab". [Concrete Society (1994)].

At present, there is lack of knowledge related to controll in floor vibrations in terms of add stiffness along damping. Estimations of dynamic parameters might much inaccurate. In natural frequencies, in particular area of difficulty is the characterization of boundary conditions. Along, equivalent viscous damping ratios of floors in building vary in a huge ranges depends on non-structural element, like as hung ceiling, false floorings, furniture, partitions wall, and many more., and can’t normally stated. Although effect of architectural component has observed in the publish estimate of fundamentals modals damping, [Murray (1975), CSA (1989)1, only weight is consider in the beam formulas for the calculations of fundamentals frequencies [Pernica (1987)]. Common practices amongst designer is to pre suppose damping value base on past-experiences of same structure. Such ways crude ways of calculating a main structural parameters and test has indicates that 2 same building may have floors damping ratio which may different [Bachmann et al. (1995)]. So, this is evident that damping ratios of a complete floors systems are dependent on the damping characteristic of its numerous component, both structural and non-structural. In the end, need of performing test to concrete floor in order that their dynamic behaviours might be fully understoods and the existing base of knowledges be enlarged."Estimates of the stiffness, mass, and damping of building system is required to predicts their dynamic responses.... In such areas of floors vibrations, structural-damping is imp. factors in man reactions to transient vibration that occurs in light damp, long spans floors system. Damping depend on the level of vibrations, and the contributions of non-structural element along human. Additional field investigation of common floors system exhibits noticeable floors vibration are urgently required to determine approx. constructions system and damping level.... Simple along with economical device required to be develop to increase damping in floor." [ASCE (1986)].

IV. RESEARCH OBJECTIVE

Some useful report of field test related to numerous floors structure [Pernica and Allen (1982), Rainer and Swallow (1986), Pernica (1987), Osborne and Ellis (1990), Bachmann (1992a), Caverson et al. (1994), Pavic et al. (1994), Zaman (1996)]. Moreover, some few laboratory experiment has noticed [Lenzen (1966), Pavic and Waldron (1996b), Pavic et al. (1997)]. While field tests provide important information on the behaviour of real structure, it give less opportunity to checkout, in details, the parameter governing vibrational behaviour, or the possible way of improving performances. A program of large scales laboratory test is performed in this wok with the following aim:

A. To check the effects of the levels of Pre-stress on vibrational performance
B. To assess the effect of numerous non-structural addition, which include false floor and partition, on the overall dynamic characteristic of a floor
C. To check out the utilization of high damping admixture, applied as layer of screed on the floors surfaces, in reduce floors vibration
D. To assess the effectiveness of tuned masses damper (TMDs) in reduce floors vibration and to check a sample economical TMD in an efforts to increases amping in these floors
E. Tocheck more to the understanding of man-structures interactions
F. To check the more suitable and accurate methods of vibrations test of actual floor
G. Based on the noticed result, to recommend simples designs guideline for the more effective utilization of Non-structural component on concrete floor.

Such objective has accomplish through a program of modal testing in which a post-tensioned concrete slabs strips is design and built in lab condition, at approx. 50percent of full-scales. The slabs were one-way spanning and simply support, with a span to depth ratios of 39. Such higher slenderness is select deliberately so as to mentions slabs with a low fundamental frequencies, which might expect to be prone to vibrations problem. The model slabs were then altered in configurations and test was conduct with the following:

1) Slabs with bond rebar only (reinforced states), with 57 percentage of designs post tensioning forces (partially tensioned states), along full design post-tensioning forces (fully tensioned state)
2) Add more simulated cantilevers partition in 3 layout
3) Addition of simulated more heights partition in 2 layout

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4) Addition of false flooring in two layouts
5) Addition of screed layer, treated with visco-elastic admixtures, in 2 separated layer with different admixtures concentration
6) Applications of a simple TMD systems consists of ply-wood sheet, tuned with addition of known weight, in four layout.
7) Test with the present of 1 or 2 occupant standing stationaries on the slabs

The apparatus used in dynamic tests of slabs are designed and adapted to tests. The excitations applied into floor at each configurations was:

a) Shaker load test (2 level of sine sweep and 3 level of single sine wave excitation)
b) Instrument hammer test
c) Heel drop test
d) Horizontal walk test
e) Vertical walk test

In additions, field test was carried on:

i) On Edwardian buildings for assessments of vibrations transmissibility
ii) Dance floors for assessments of vibrations characteristic [Falati (1996)]
iii) Office floors for derivations of dynamic behaviour [Williams and Falati (1998)]

V. SCOPE OF WORK

This work restricts in scope to linear, elastics, dynamic behaviour of concrete slab with in serviceability limit. Vertical vibration causes by regular occupancy is checked and imposed excitation are of small amplitude. So, it is assume that at no stage of the research program, damage to the model slabs and in-elastic structural effect has taken places.

REFERENCES

[1] KK. H. Lenzen. Vibration of Steel Joist-Concrete Slab Floors. AISC Engineering Journal, Vol. 3, July 1966, p. 133-136.
[2] K. H. Lenzen and T. M. Murray. Vibration of Steel Beam Concrete Slab Floor Systems. Studies in Engineering Mechanics Report No. 29,Lawrence: Center for Research in Engineering Science. The University of Kansas, USA, 1969.
[3] T. M. Murray. Design to Prevent Floor Vibrations. AISC Engineering Journal, Vol.12, No. 3, 1975, p. 82-87.
[4] T. A. Wyatt. Floor Excitation by Rhythmic Vertical Jumping. Engineering Structures, 1985, p. 208-210.
[5] S. V. Ohlsson. Springiness and Human-Induced Floor Vibrations: A Design Guide. Stockholm. Sweden: Swedish Council for Building Research, 1988.
[6] P. E. Eriksson. Vibration of Low- Frequency Floors - Dynamic Forces and Response Prediction. PhD Thesis (in English). Chalmers University of Technology, Goteborg, Sweden, 1994.
[7] B. Ellingwood. Structural Serviceability: A Critical Appraisal and Research Needs. Journal of Structural
[8] Engineering, ASCE, Vol. 112, No. 12, December 1986, p. 2646-2664.
[9] S. V. Ohlsson. Ten Years of Floor Vibration Research - A Review of Aspects and Some Results. In: Proceedings of the Symposium/Workshop on Serviceability of Buildings (Movements, Deformations, and Vibrations). Vol. 1, Ottawa, Canada, May 1988, p. 419-434.
[10] R. A. Novak. The Influence of Lightweight Partitions on the Loss Factor of Concrete Floors in Multi-Storey Buildings. Applied Acoustics, Vol. 39, No. 4, 1993, p. 253-264.
[11] D. E. Allen, G. Pernica. Control of floor vibration. Construction Technology Updates, published by Institute for Research in Construction, No. 22, December 1998.
[12] T. M. Murray. Floor Vibrations: Tips for Designers of Office Buildings, Structure, 2000,http://www.floorvibe.com/Tips_for_Designers.pdf.
[13] L. M. Hangan. Floor Vibration Serviceability: Tips and Tools for Negotiating a Successful Design.Modern Steel Construction, North American Steel Construction Conference, April 2003, p. 39-46.
[14] C. M. Hewitt and T. M. Murray. Office Fit-Out and Floor Vibrations. Modern Steel Construction, April 2004, p. 35-38.

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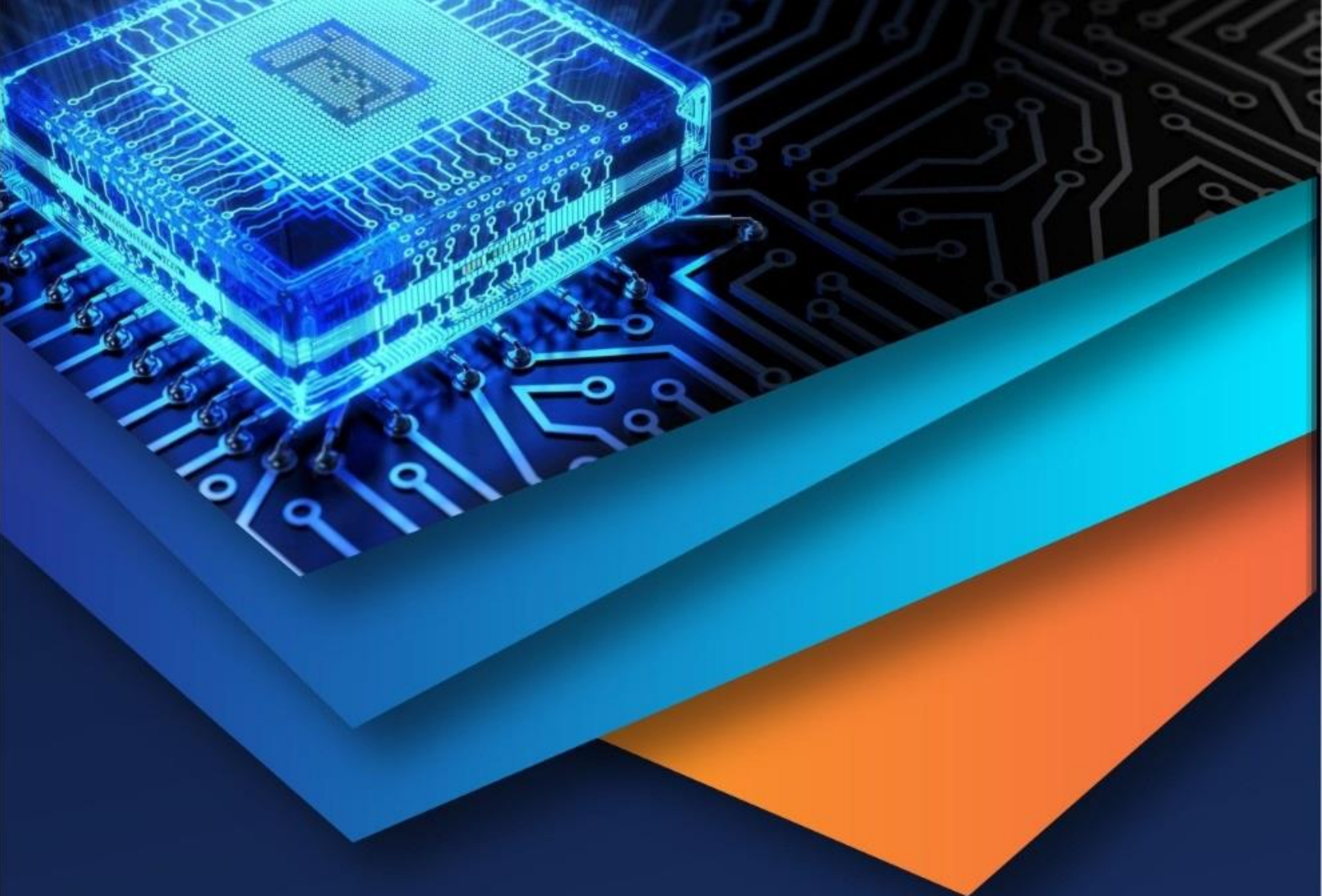

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