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Inspection of Concrete Floor Slabs by Means of Dynamic Test

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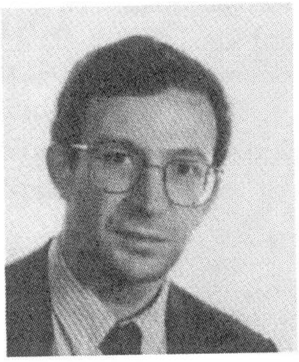

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Summary

The use of dynamic load tests as inspection technique for concrete floor slabs is presented as part of a more global method which considers the combined performance of static and dynamic load tests. The dynamic load test is mainly regarded as an auxiliary tool, inexpensive and very repeatable, which can be widely used over large roof surfaces or entire buildings in order to extend the coverage of the static tests, asses the homogeneity of the elements inspected, or to identify local structural abnormalities. Versatile tools of analyses for the numerical simulation of the dynamic response and for the parameter identification are needed.

Keywords: Non-destructive tests, floor slab, inspection, dynamic test, parameter identification,

1.- Introduction

Due to both technical and economical reasons, the conventional techniques of inspection today available for the assessment of floor slabs show significant inconvenients which actually constrain their applicability and practical possibilities. Among these techniques are the extraction of concrete cores or micro-cores for the mechanical testing, or the static load tests, both of which require to generate some previous deterioration and later repairs. In particular, the performance of the static loading tests may require the removal of some finishes or non-structural elements of the building, as pavements, partitions and ceilings; because of security reasons, scafoldings must be placed throughout all the floors below the one being tested, until reaching the foundation. These severe requirements mean a significant expense on preparatory labor and later repair. If the static loading test is carried out on one or more slabs in a building, there is still some uncertainty about the actual representativity of the measured response concerning the entire building.

In spite of its non-destructiveness, the measurement of the dynamic response of floor slabs subjected to an artificial excitation can provide very valuable information related to the mechanical parameters and state of preservation or damage. There is also the possibility to left untouched the finishes and furniture, and thus to dramatically reduce the cost and time required to execute such a test. However, being the dynamic test an indirect one -based on the measure of dynamic parameters to be correlated with more significant mechanical properties- it is by no means as reliable as the static loading test.

2.- Lay-out of the technique and parametrical studies

The methodology of inspection proposed is based on a special combination of static and dynamic load tests. The static test is considered necessary as a direct and reliable way to measure the loading capacity of the floor slab or, at least, to ensure its capacity to carry up to a certain amount of load. The dynamic test, fast, inexpensive and immediate, can be used to assess large roof surfaces or entire buildings and detect possible heterogeneities or unveil local abnormalities. Thus, the methodology considers two steps: (1) Executing both static and dynamic load tests on a few selected slabs, used to obtain their basic mechanical characteristics and, by comparison, calibrate the dynamic test, and (2) scanning the rest of the slabs through the systematic repetition of the dynamic load test. The numerous data obtained through the dynamic test can be used not only to assess the homogenity and representativity of the load tests, but also to estimate some of the mechanical parameter of the slabs through a parameter identification process.

The dynamic test is based on the measurement of the dynamic response of the slab after it is excited by means of a controlled impulse provided by a hammer of known weight. In the actual phase of the research, the first series of natural frequencies and the shape of the modes of vibration are used as main parameters for the identification process.

The interpretation of the measurements obtained through the dynamic test is achieved by comparison with the numerical results obtained by simulation, which requires a versatile tool of analyses. One of the challenges placed to the numerical analysis is found in the need to account for all the elements which can influence on the dynamic response of the slab: thin wall partitions, possible boundary conditions, influence of the rest of the structure, actual contribution of the concrete topping, mechanical action of the non-structural pavements, dead loads, placed on the slab, and other. At the moment, the procedure is being applied on one-way slabs with precast nerves . Some performed parametrical studies carried out into the present research illustrate the significant dependence which exists between the value of the natural frequency associated with the first flexural modes and factors such as the degree of cracking in the concrete section, the actual support conditions, and other. The influence of the actual boundary conditions at the ends of the slab span can be efficiently characterized through the ratio between frequencies corresponding to subsequent flexural modes of vibration. Also, the possibility to resolve the actual contribution to the stisffness of the concrete topping and the upper pavement from the dynamic response has been also shown in the study of different particular slabs . (See for the references in the 6 page paper).

3.-Real case examples

Two examples of real slabs studied using the presented technique are discussed. The first consists of a single spanned slab built with prestressed concrete precast semibeams, sustained on brick bearing wall, with span and thickness respectively measuring 3.65 m and 15 cm. The second case refers to a two-span one-way slab built with prestressed concrete precast full beams, sustained on a reinforced concrete frame, with pannels having span of 3.55 m and thickness of 22 cm. The studies allowed to conclude about the boundary conditions actually affecting the slabs, which were recongnized as a perfect clamping for the slab sustained on walls. On the other hand, the technique allowed to analyze the stiffening action of the non-structural pavements existing on the slabs, being characterized as non contributing in the first and fully contributing in the second. In the case of the continuous slab on framed structure, the sustaining system of transverse beams and columns had to be included in the model in order to obtain an adequate simulation of the dynamic response.