Experimental Investigation of Steel Mold of Prefabricated Concrete Member Under Vibration

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Abstract: ***Worksite knowledge obtained in the manufacture of prefabricate concrete buildings have indicated that, the enough compression of fresh concrete in the mold depends on the tip and place of the external vibrators employed for vibration. The stability of the tip and position of the vibrators with the technic of trial and error bring about missing time and doesn't give good output. Thus, the computer-aided mold design is necessary. In this work, the features of vibration of a mold employed in the generation of Kambeton Company were examined experimentally to install a basis for the computer-aided mold plan. For this goal, the field experiments of prefabricate concrete members have been carried out under vibration with the use of a dynamic strain meter. Time-dependent transverse deflection measurements were recorded at some measuring points on the surface of the mold of this member, for both empty and full of fresh concrete conditions. This paper is mainly concerned with the comparison of the experimental results of the steel mould under vibration by external vibrators. As shown from the test results in Figures, displacement values in empty mold vary quietly from the full mold. The test results show that the fresh concrete-mould interaction has to be considering in the mold plan.***

Keywords: Prefabricated concrete element; External vibrators; Experimental measurements; Vibration

1. Introduction

Despite the numerous endeavors to get another technic, vibration yet survives the dominant method in molding and compacting concrete compositions in the manufacture of prefabricate concrete units. Clamp-on (external) vibrators contains an electrically or pneumatically operated motor with an out-of-balance piece. They operate by vibrating the mold to which they are attached. These vibrations are transmitted to the concrete. These vibrators are mostly for precast concrete work, but it is also employed in cast in place situation, particularly where there is dense reinforcement.

Frequency reach for clamp-on vibrators can be labeled at 4500, 6000, 9000 and 12000 cycles per minute. The slower a high-frequency clamp-on vibrator works, the greater is the amplitude it improves. External vibrators operating at 6000 rpm, corresponding to a frequency of 100 Hz, display a compromise, a sort of middle way in terms of technical equipment and of compaction succeeded. They can present through pattern or other medium a useful input of power in conjunction with a frequency that is wonderful proper from the viewpoint of concrete technology. One significant reason vibrators of such pattern are now most broadly employed is that 6000 rpm external vibrators are quadripolar machines that are powered through 200 Hz converters. Since they have four-pole windings, the frequency they develop at the dies is 100 Hz, i. e., 6000 cycles per minute produced by the rotating eccentric load. Their areas of use are mostly concrete pieces of greater thickness, wall panels, joists, columns, roof trusses, double-T floors, industrial building parts and marble blocks [1].

Location points of the external vibrators on the steel moulds play a very important part in enough compression of mortar. The designer should determine position points of vibrators so that the vibration distributes nearly uniform on the mould. In practice, the abovementioned determination procedure is performed according to the designer's experiences, but mostly, it does not provide the best result, especially for the moulds having complicated geometry. Hence, computer aided plan of steel mold for prefabricate concrete members is necessary.

Behavior of fresh concrete in mold under vibration has not been investigated properly yet. There are limited numbers of studies in literature about the modeling of the behavior of fresh concrete under vibration. While fresh concrete is exposed to vibration, searchers watched important varies in its rheological (yield stress, plastic viscosity) features [2-7]. The fresh concrete under vibration misses its yield stress and acts as a Newtonian liquid, and its plastic viscosity varies, and the concrete turns into shear thinning [8]. It was discovered that the yield stress of fresh concrete decreases to half of its magnitude and in some statuses, became unimportant, and the plastic viscosity is obtained to be unaffected by vibration [9].

The purpose of this work is to examine the behavior of steel mold for prefabricate concrete units while they are exposed clamp-on vibrators. The experiments were carried out by using a displacement transducer to measure the displacement histories of some points on face of the mold for the prefabricate concrete members both for empty and full of fresh concrete cases.

2. Experiments

The experiments were realized on face of mold for prefabricate concrete structural elements by employing a data acquisition system. The test set-up employed in the work is indicated as follows.

2.1. Hardware

Related parts in articles:

a) Dynamic Strain Meter, DA-32D type (Tokyo Sokki Kenkyujo Co., Ltd.) (**Fig.1**)
b) LVDT (Linear Variable Differential Transformer, Displacement Transducer) (**Fig.2**)
c) ISC-16 PCI Data Acquisition Card (RC-Electronics, Inc.)

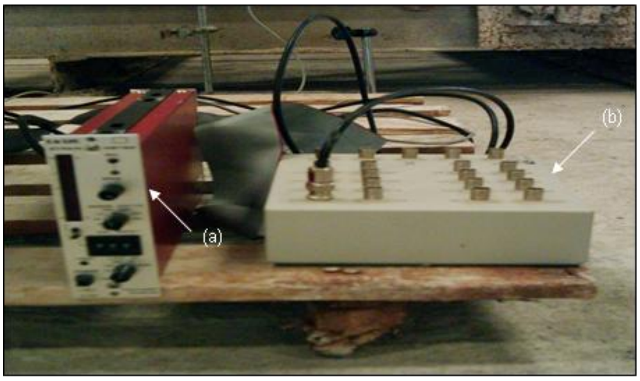

Figure 1: Dynamic Strain Meter, DA-32D type (Tokyo Sokki Kenkyujo Co., Ltd.)

Figure 2: LVDT

2.2. Software

SIGNALYS Program (Ziegler-Instruments GmbH, Germany, 1990)

2.3. Make-up of the experiments

The calibration of LVDT has been performed employing a dial gauge which has the sensitive of 1/100 mm. The set-up of calibration is given in **Fig.3**. Displacements read by transducer have been saved simultaneously with 0.5 ms sample ratio in 4.096 sec.

Figure 3: The set-up of calibration of the displacement transducer

The view of the mold of precast concrete unit (box element) used in the experiment is shown in **Fig.4**.

Clamp-on vibrators employed in tests are attached-on a rigid steel sheet having dimensions of 20×25 cm which is fixed on the surface of the mold. The view of the external vibrator is shown in **Fig.5,** and its specifications are presented in Table 1.

Figure 4: The view of the mold of precast concrete unit (box element)

Figure 5: Clamp-on vibrator's view

Table 1: Clamp-on vibrator's properties

Mechanical Properties					**Electrical Properties**	
Vibrat. range	Centrifugal force		Weight	Max. input power	Max. current A	
Vibr. /min	kg	kN	kg	W	42V	250V
6000 (200 Hz)	1157	11.34	25	1200	23	-

The mold is made of steel plate 5 mm in thick. Steel sections in diverse dimension and section are attached to mold in horizontal, vertical and diagonal directions to power of the system.

The mold's plan view and the coordinates of the points where the measurements were taken are illustrated for box element in Figs 6, 7.

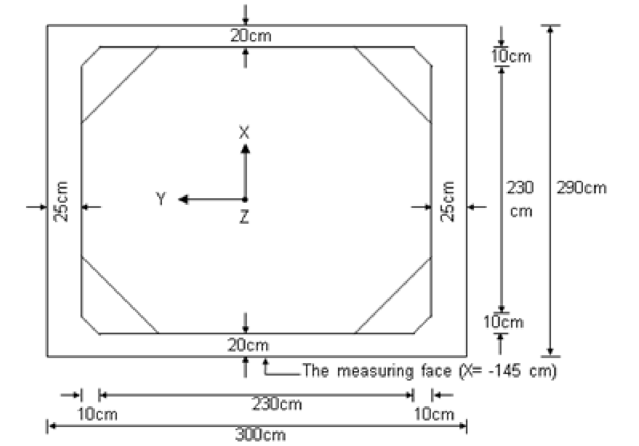

Figure 6: Plan view of the mold of the box element (h = 97 cm)

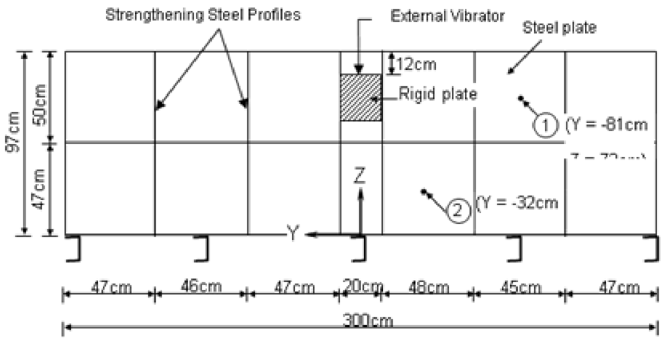

Figure 7: Detail of the measuring face (box element)

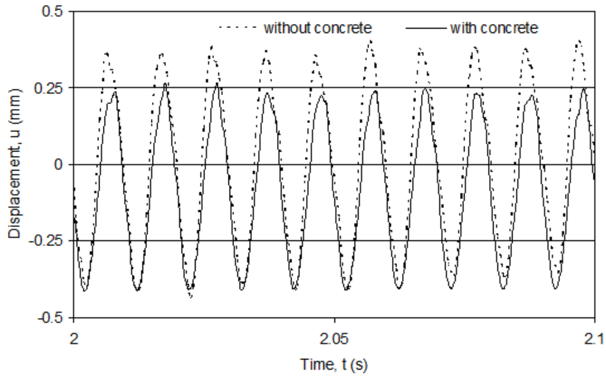

Figure 8: Change of measuring point 1 with respect to time

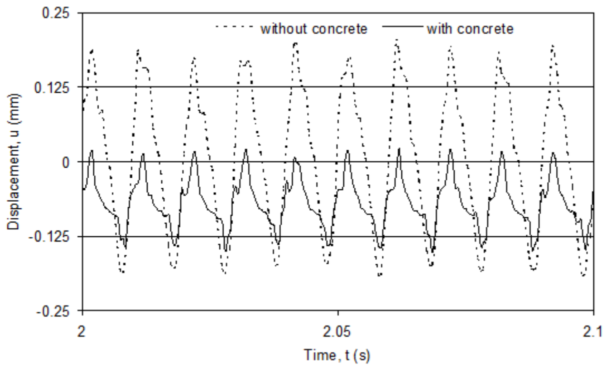

Figure 9: Change of measuring point 2 with respect to time

3. Experimental Findings

The read displacement of some dots of the mold for both the mold is empty and full was matched with each other at the same dots of box member.

In all figures of practice, plus directions for the displacement values are from the surface towards inside of the mold.

Displacement values are in way vertical to face of mold. In figures of practices, matches are displayed in the steady state pieces of attitude. Though some irregularities in manner are seen in the earlier time duration, it vanishes in a very short time and does not affect the whole behavior of the system.

3.1. Practice

Experimental measurements were recorded on the mold of the **box element**, for both empty and full of fresh concrete conditions, by using a 100 Hz. external vibrator, which was clamped-on the surface of the mold where measurements were taken at two dots called 1 and 2 (**see, Fig. 7).** A typical part of the experimental results are compared with each other in **Fig. 8 and 9.**

4. Conclusions

Worksite experiments were carried out on mold of prefabricate member, and the results are compared with each other. Displacement values were read on the face of the mold of this member, both as the mold empty (without concrete) and full of fresh concrete. As displayed in test outcomes above, peak displacement values of the empty mold vary quietly from the full mold. On the other hand, the amplitudes decrease considerably with the distance from the vibration points. It is also seen a variation along the height of the mould. From these observations, the importance of the locations of vibration points and the number of vibrators used for vibration are arisen, and the test results show that fresh concrete-mold interaction was considered in mold design.

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