Brecon Vibrationstechnik GmbH, 50933 Cologne, Germany

Prevention of damage due to the use of a vibrator

Both normal frequency (50/60 Hz) and high frequency (100-200 Hz) vibrators are used for the compaction of concrete. The vibrator is selected primarily for its centrifugal force at a particular speed. At best, achievement of the desired concrete density or at worst, damage, depends on the correct selection and installation of the formwork or machinery. The following tips are designed to help in the correct selection of vibration technology.

Vibration transmission

The vibration transmission in steel moulds requires careful attention both with small vibrating systems to which one or two external vibrators are fitted as well as with large-surface moulds for concrete compaction which may be equipped with 50 external vibrators or more. There are several important criteria in achieving flawless finish and high density in the manufacture of precast concrete elements. These are consistent acceleration and vibration duration and vibration transmission, which provides even compaction. The necessary centrifugal forces are ideally distributed so that they are introduced at as many points of the vibrator equipment as possible. There they produce so-called bending vibrations (flexing of the vibration supports).

The individual external vibrators are fitted so that e.g. in the case of large-surface formwork each external vibrator vibrates the surrounding region and these vibration zones marginally overlap. Where there are several external vibrators attached to a large mould, overlapping causes so-called interference vibrations. These vibration overlaps are audible since the vibration sound rises and decays at distinct intervals. Suitable measures should be taken to avoid resonance in fragile moulds e.g. additional structural stiffening or changes of the vibrator attachment or frequency since there is a danger of weld fracturing and section failures. Correct attachment of several external vibrators (to large-surface formwork) and sufficient stiffness of the mould reduces the local stress on the formwork and increases its service life. Figure 2 shows the effects of the distribution of the centrifugal force over several introduction points.

Fig. 1: Example for an ideal vibrator assembly

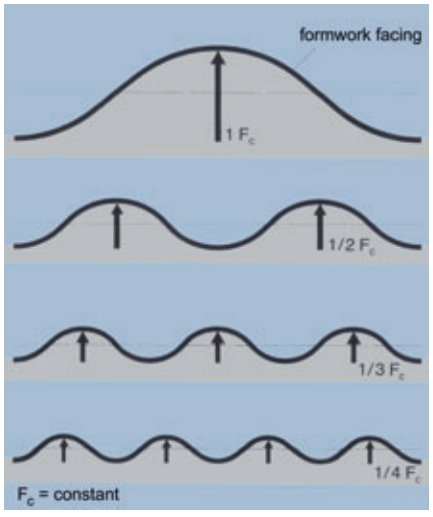

Fig. 2: Bending vibrations of the formwork shell in the case of large-surface formwork. Even vibration distribution (bottom curve) is obtained if the overall centrifugal force F_c is introduced via several vibrators.

Attachment location

The attachment points are selected to guarantee a good transmission of the bending vibrations produced. This is best achieved by ensuring that sufficiently-sized, continuous sections are provided to reinforce the structure during the construction of the vibration equipment. The external vibrators are mounted on these so-called vibrator supports which ensure even vibration distribution. Incorrectly attached external vibrators or technically unsuitable vibration devices can cause dead zones or areas of excessive excitation in the concrete compaction. Smaller, rigid external vibrators are also fitted to ensure consistent vibrating of the vibration equipment, i.e. to produce equally-sized vibrations throughout.

Assembly of the external vibrators

Observing the following points during assembly will ensure that the vibrations produced by the external vibrators are introduced into the vibration system without loss as far as possible:

- Each external vibrator must be attached to a 15-20 mm thick plate. This plate must be flat and carefully welded to the existing structural stiffening sections. If linear vibrations are generated by two contra-directional external vibrators the connection between the external vibrators must be absolutely vibration-resistant to enable synchronisation (absolute synchronicity of the external vibrators). This is achieved by adequate structural stiffening. Figure 3 illustrates an example of such structural stiffening.

- In order to transfer the produced amplitudes without loss to the desired point of impact, the vibrator attachments (plate, supports) must be totally inflexible. For example in the case of high-frequency external vibrators which produce an amplitude of only 0.4 mm at high centrifugal forces, a 0.1-0.2 mm deflection of the vibrator attachment means a loss of 25-50% of the vibration energy. Particular attention must be paid to the two primary impact directions of the centrifugal forces. These are the vertical and parallel centrifugal forces with respect to the attachment surface, wherein the forces which impact at 90 degrees to the desired direction of impact can cause cracking of the welds in the vibrator attachments. Additional structural stiffening elements, e.g. gusset plates, then need to be welded on. Figure 4 shows various options for the described structural stiffening.

- Steel sections are required to distribute the vibrations evenly. HE-B 140 (IPB 140) structural steel sections make particularly good vibrator supports.

- The external vibrators are to be attached to structural stiffening sections and not directly onto thin-walled components like silo walls or precast concrete formwork sheets.

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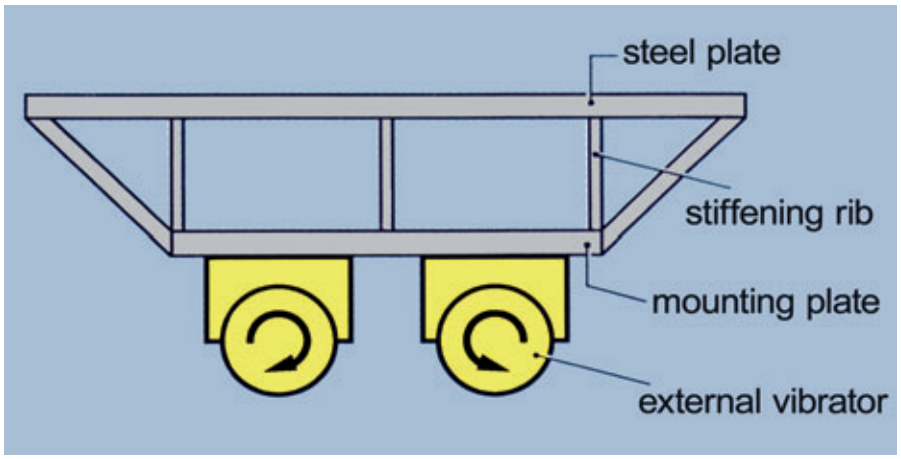

Fig. 3: Small vibrating table with structural stiffening

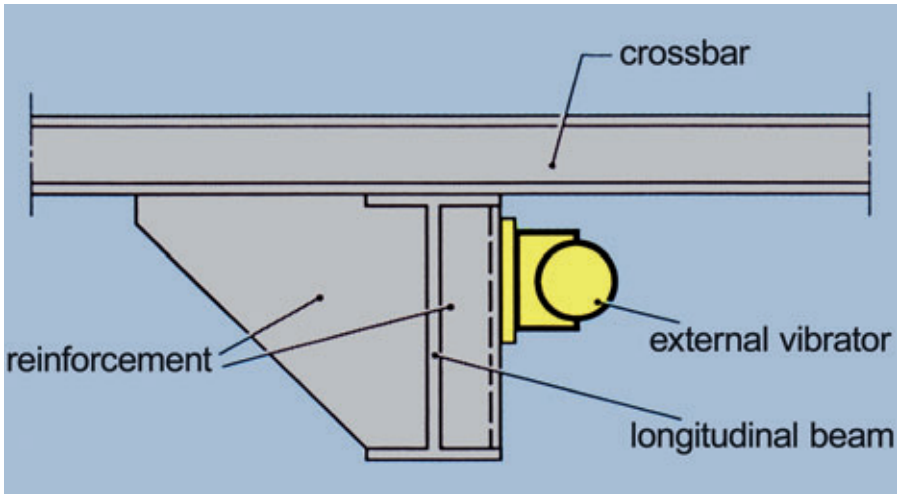

Fig. 4: Vibrator arrangement with structural stiffening on the longitudinal beam of a large vibrating table

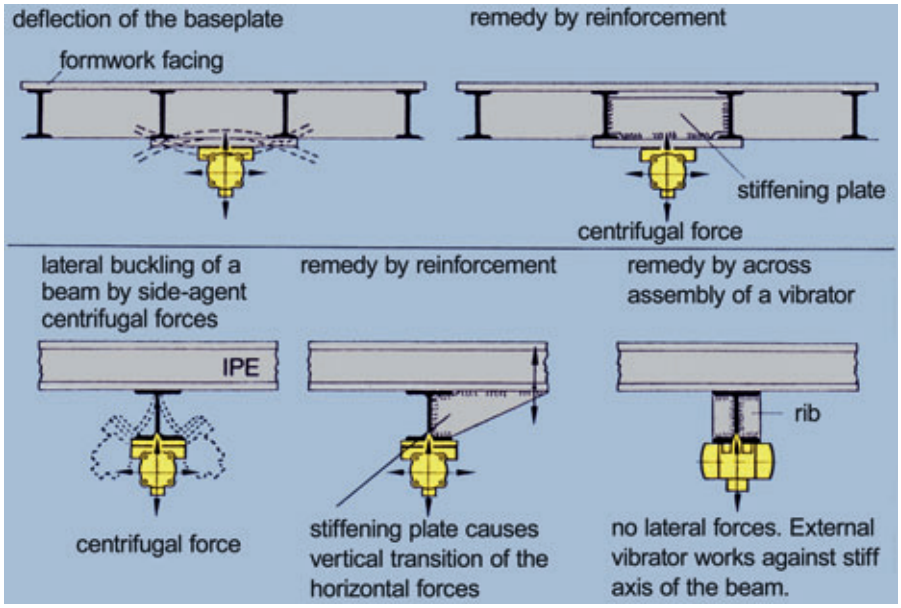

Fig. 5: Possible structural stiffening of the attachment locations of external vibrators

- The secure seating of the external vibrators is important to ensure that external vibrators and the vibrating system form a single vibration unit. The external vibrator must be attached with great care due to the large dynamic load. Hardened and tempered 8.8. quality steel screws (DIN931) and DIN125 washers are suitable. The elasticity of long steel screws increases vibration-safe fastening. This requires a deep housing plinth for screw lengths longer than 120 mm. Screws must be tightened to the specified torque. If securing with bolts, use locknuts. Fastening screws should be retightened after a short period in operation and tested for firm seating at regular intervals. Slackening of the screw connections can cause housings to break, breakdowns of the external vibrators and cracks in the formwork. Defective securing and slackening of the screw connections is one of the most frequent causes of faults.

Since today's vibration technology for concrete formwork is almost always operated with controllers with frequency converters, it is possible to avoid damage by limiting the current of the converter and/or of the motor protection switch. The underlying principle is that when an attachment to an external vibrator comes loose the current consumption suddenly leaps up. The motor protection switch then protects the motor winding by cutting out before it burns through. It is important that the triggering of a motor protection switch is taken seriously and the cause is determined, if necessary with the assistance of vibration specialists. A motor cut-out seldom means a problem with the external vibrator but almost always points to a problem with the attachment or even weld fractures.

FURTHER INFORMATION

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