

## Introduction

The work in the SCC Consortium has been in progress for 1½ year and within the last ½ year focus has a.o. been to examine if there is actual improvements of the occupational health by using SCC for vertical castings.

The present newsletter describes testing carried out in DR-Byen in Ørestaden, where MT Højgaard is responsible for the construction of Segment 3.

## Occupational health –vibration of concrete

It is generally accepted that the occupational health is improved when using SCC. For example do many manufacturers of prefabricated concrete components report that the production halls are almost noiseless as it is not necessary to vibrate the concrete.

To assess the effect of using SCC, Byggeriets Arbejdsmiljøcenter (O, H & S for the construction industry) has made measurements of the occupational health during vertical casting with conventional concrete. Noise level, stress from vibration and the number of hazardous operating positions in connection with vibration have been measured. The results are compared with the limit values and recommendations of the Danish Working Environment Authority.

The measurements have been carried out on a vertical wall; dimensioned length = 23 m, height = 5 m and width = 0.35 m equal to an area of 115 m<sup>2</sup> and a volume of 40 m<sup>3</sup>.

Based on the compactness of the reinforcement a poker vibrator with a diameter of 48 mm and a weight of 11 kg was chosen.

The sequence of the casting can shortly be described as follows

13.50: Two concrete mixers arrive and filling from the hose starts. Two men lead the pump hose and two men vibrate the concrete

- 14.30: After 40 minutes of vibration all the men take a break. The team is replaced and they wait for the next concrete mixers to arrive
- 15.17: Three concrete mixers arrive and the filling continues with two men who lead the pump hose and three men who carry out the vibration of the concrete
- 16.10: The mould is completely filled and two men continue to vibrate the concrete
- 16.15: Two men finish the vibration of the concrete and the team finishes the top surface.

## Noise

The Danish Working Environment Authority describes among others noise at the workplace as follows:

- No person must be exposed to a noise load above 85 dB during the work.
  - If the noise load exceeds 80 dB, the employer is only allowed to let the work to be carried out if hearing protective devices are available at the workplace.
- As far as hazardous effects concerns, an ongoing noise load of
- 75-80 dB may cause a hearing impairment
  - 85 dB may cause severe hearing impairment
  - 90 dB, may cause severe hearing impairment and the risk is three times as high as at a noise load of 85 dB.

The noise level is measured in the immediate vicinity of the person who carries out the vibration and in the following situations; 1) at vibration between reinforcement in the middle of the wall mould and 2) at vibration between the reinforcement and the mould.

The average noise level for situation 1 and 2 is 83.7 dB (maximum: 107 dB) and 90.9 dB (maximum: 107 dB), respectively.

## Load of vibration

The risk of getting “white fingers” depends on the load of vibration, which consists of a combination of the vibration level and the duration of vibration. The vibration level depends on the placement of the hand on the poker vibrator in proportion to the bottle. The Danish Working Environment Authority recommends that the vibration level itself is below  $3 \text{ m/s}^2$  but states limit values for maximum time of vibration, when the this vibration level is exceeded.

For about 4 hours during which the concrete is vibrated it is assessed that the workers actually hold on to the poker vibrator for about 2 hours. Assuming that the exposed hand is placed on the poker vibrator for about 40 minutes at each distance of 0.3 m, 1 m, and 2 m from the bottle, respectively, the average vibration level is about  $6 \text{ m/s}^2$  corresponding to the fact that one worker may not vibrate for more than about 2 hours and 20 minutes per day.

## Operating positions

Figure 1 shows the hazard limits of a operating position depending on the weight of the load of the and how far it is carried from the loin set out by the Danish Working Environment Authority.

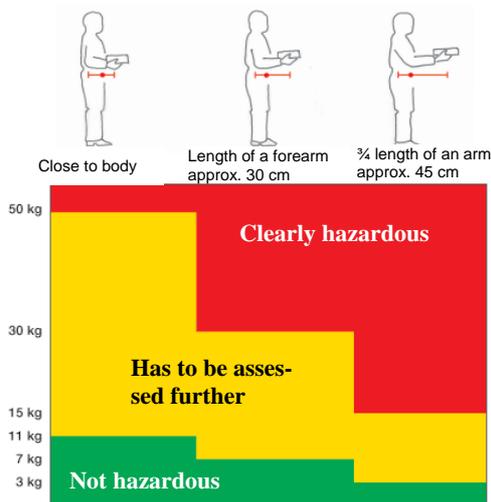


Figure 1. The guidance of the Danish Working Environment Authority for hazards of different operation positions (2002)

Operating positions in connection with vibration consist of a combination of lifting, hauling and carrying of the poker vibrator.

The number of hazardous operating positions is estimated after observing three persons performing casting and vibration of the concrete.

The photos of operation positions are shown in Figure 2. The three persons use practically the same technique and even though they from time to time vary their operating position by standing with one leg on each side of the mould, it does not change the total physical loading.



A: Waiting time



B: The hose is hauled up



C: It takes about 5-10 seconds



**D: The hose is almost up**



**E: The hose is carried to the next entrance**



**F: The hose is lowered again**

Figure 2. Operating positions.

The following operating positions are assessed to belong to the red section indicating clearly hazardous operation positions (cf. Figure 1).

- At photo B and C in Figure 2 there is more than 45 cm from where the poker vibrator is lifted to the loin, which must absorb the loading. It immediately places the lift in the yellow zone in third column but as the lift is worsened by twist in the back, influence of the weather and poor support, the lift is considered to belong to the red zone and is therefore clearly hazardous.
- In photo D and E the poker vibrator is moved to the next place for vibration and it takes place in a forearm's length of 30 - 45 cm from the loin. Even though the poker vibrator is not moved more than 2 m, it is assessed that the poker vibrator must be held for so long that it is analogous to that the poker vibrator is carried. Even though the carrying is in a forearm's distance, the carrying belongs in the red zone, when taking into account the other factors that will contribute to aggravation at the operating position.

## **Conclusion**

Based on the measurement the following conclusions can be made:

- Vibration can contribute to development of reduced hearing if hearing protective devices are not used. Values above the limit values for noise of the Danish Working Environment Authority have been measured.
- The total vibration time is approximately 370 sec. per m<sup>3</sup> concrete. Assuming that the team of concrete workers divide the vibration work equally the total vibration load will be below the limit values of the Danish Working Environment Authority. The risk of getting white fingers from vibration is therefore assessed to be less than for instance drilling and cutting.
- In total 85 hazardous lifts, pulls and carrying of the poker vibrators are made per hour, which is a considerable cause of attrition of the back.

The result of the study shows with out doubt that the vibration work clearly expose the concrete workers to hazardous lifts, hauls and carrying as well as they may be exposed to hazardous vibrations and noise if the necessary precautions are not made. These exposures will be eliminated

# Newsletter No 3 from the SCC-Consortium

August 2005

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completely by using SCC instead of conventional concrete.

It is therefore possible to reduce the risk of a too early attrition of the concrete workers, which has both physical and financial consequences for the exposed workers as well as the company and society.

The next measurements of the occupational health will include noise measurements and measurement of the numbers of lifts, hauls and carrying during horizontal castings with conventional concrete and SCC, respectively.

## **SCC-Portal**

The first Danish SCC portal on “Knowledge on SCC” is now available at the web-address

[www.VoSCC.dk](http://www.VoSCC.dk)

The purpose of the portal is to impart knowledge on SCC within manufacturing, mix design, execution etc. The portal will currently be updated with results from the SCC-Consortium.

## **Further information**

Cf: [www.scc-konsortiet.dk](http://www.scc-konsortiet.dk)

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