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CASE: INSTALLATION OF MECHANICAL SHOPS IN AN OFFICE-BUILDING

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INTRODUCTION

This paper is dealing with acoustical problems and solutions on the installation of mechanical shops in an existing ex-office building constructed from concrete cassette-elements. The new purpose for this building mainly is to have re-located a lot of existing shops for manufacturing orthopeadic and other handicap aids of different kinds.

Since the shops and the machines were to be located in the middle of the multi-storey building the main task was to avoid disturbing structure-borne noise in offices and other sensitive areas also accomodated in the building. Several machines like lathes, grinders and milling-cutters would have generated disturbing vibrations into the structure unless very efficient vibration insulation would be attained through different measures.

Also in many working places sledge and anvil is used for the moulding of metal details. This working process causes impulsive forces and very strong vibrations.

Seen from an acoustical point of view the comparatively thin concrete slabs were not well suited for this new purpose. However, by means of special arrangements a very good result was reached. Further the design more in detail together with measured structure-borne noise data is described.

MAIN PROBLEMS AND STRATEGY

Some important data and demands to be taken care of in designing a good vibration insulation in practice is discussed.

It is known that the suppression of force-transmission (i.e. the efficiency of the isolating system) depends upon the ratio of excitation frequency to natural frequency.

The simpel formula below illustrates the force transmitted into the ground from an elastically supported machine.

$$P_R = P_m \times V_p \text{ with } V_p = \left[\frac{1}{1-Z^2}\right] \qquad \text{and } Z = \frac{n_m}{n_e}$$

P_R = Transmitted force
P_m = Excitation force
V_p = Transmissibility factor
n_m = Excitation frequency
n_e = Natural frequency
Z = Tuning ratio

Anyhow this simple formula can not be put into practice without further considerations. Some reasons are discussed below.

The combination of source, mountings and foundation must be considered
The graph below illustrates briefly what would happen if the machine and the vibration mountings were put together not taking into account the foundation but only the static (actually dynamic) deflexion of the elastic mountings and the frequency of the periodically excited vibrations from the source (not only the value of Z).

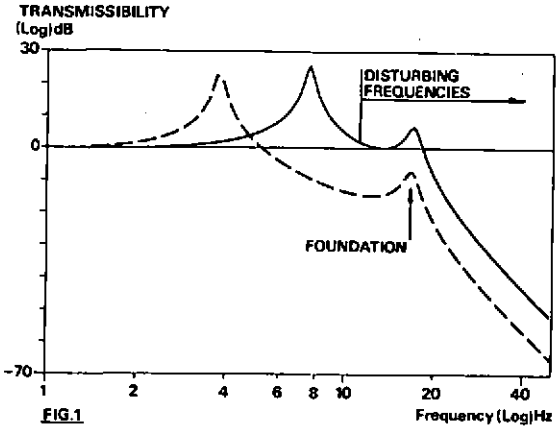

FIG.1

——— NOT PREFERABLE (THE NEGATIVE EFFECT OF RESONANCES IN THE SLABS WILL BE INCREASED)

– – – – CASE

In this project the first thing to check in practice was the natural frequencies of the concrete slabs. By means of impact excitations and an optic x-y writer approximately 15 Hz was registered in most cases.

It is evident that the influence of this resonance (the frequency with load is somewhat decreased) must not be neglected. The graph shows that we designed the natural frequencies of most installations low enough (4-5 Hz) to get a good effect.

Another comment to figure 1 is: in this project generally the point impedance of the concrete slab (and the footings) was high enough compared with weights and frequencies of interest. However, for the heaviest machines (e.g. lathes and some cutting mills) it was necessary to make some special arrangements and unload the slabs (also for static reasons). Below I will examplify some solutions in practice but before then I want to mention other aspects to get well functioning measures.

* In spite of acoustical demands upon very soft mountings there must not be any resign on the stability of the machine (to assure proper handling)

* In Sweden there are security-regulations on machine installations. The machine must be fixed to prevent falling over. This means that you must prevent the mountings from shortcircuit.

* The conditions on handling the machine must in general not be altered through "too high mountings".

THEORIES WERE PUT INTO PRACTICE BY MEANS OF PROTOTYPES

The No. 2 and 3 figures below illustrate some examples from this project. It is evident that a very good insulation effect was obtained with those special arrangements. Furthermore all demands above are fulfilled. The design was also accepted and influenced by the operators themselves.

The microphone position is equivalent for the No. 2 and 3 figures - in a special test-room under the sound sources (only structure-borne noise was registered).

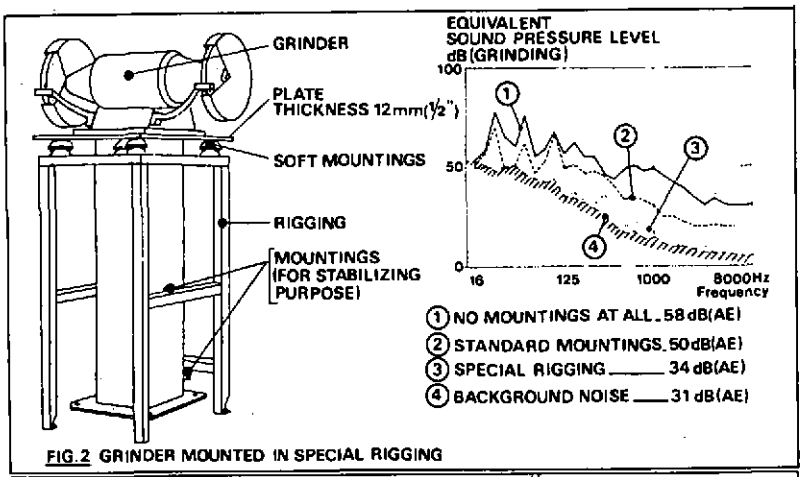

FIG.2 GRINDER MOUNTED IN SPECIAL RIGGING

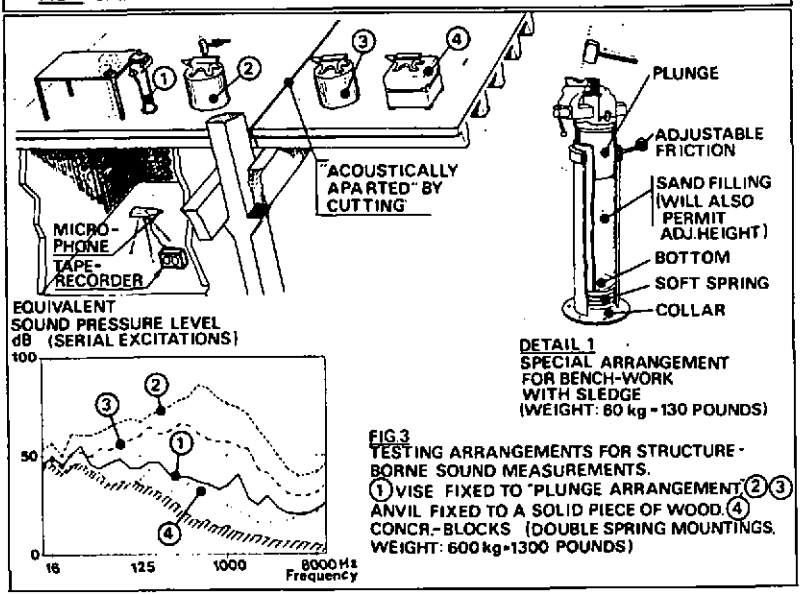

FIG.3
TESTING ARRANGEMENTS FOR STRUCTURE-BORNE SOUND MEASUREMENTS.
① VISE FIXED TO "PLUNGE ARRANGEMENT" ②③ ANVIL FIXED TO A SOLID PIECE OF WOOD. ④ CONCR.-BLOCKS (DOUBLE SPRING MOUNTINGS, WEIGHT: 600 kg = 1300 POUNDS)