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PROBLEMS CONCERNING THE CONSTRUCTION OF AN EFFECTIVE VIBRATION ISOLATING GLOVE.

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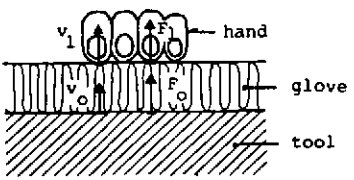
INTRODUCTION

During the latest years vibration induced White Fingers (VWF) have become a frequent occupational disease. Its causes are well known and its epidemiology well mapped. In quite a number of groups exposed to vibration prevalences of well above 50% can be observed. The exposure in these groups is normally considerable above the recommendations of ISO DP 5349.
Research efforts have mainly concentrated on describing the problem and not on the possibilities of solving it. Therefore it is normally not possible to suggest alternative low-vibration tools, and the question "What should I do to protect myself against vibration?" is thus highly relevant.
Literature often suggests the use of gloves. As gloves help to keep hands warm, they contribute towards preventing attacks of VWF during work. Therefore the use of gloves is certainly not meaningless. However, it is not obvious to what degree gloves reduce the hazard of vibration exposure. Even if tool manufacturers do manage to develop low-vibration tools, it must be realized that as long as for instance cutting stone or metal is done by some kind of mechanical tool, the vibration problem will not be eliminated. Therefore the need of means for personal protection will still be there.

MEASUREMENT PROCEDURE



By the vibration isolating efficiency of a glove is here meant the transmissibility of v_1/v_o.

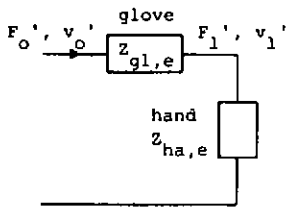
Ref. [1] gives the transmissibility in terms of impedances.

Fig. 1. Mechanical system of tool-glove-hand.

It follows from Ref. [1] that the vibration isolating efficiency varies with a rather large number of parameters such as grip force, pull-push force, arm angle, just to mention a few. These parameters must be expected to vary constantly during a working situation. To compare glove materials, absolute measures of transmissibilities during a working situation are therefore not a very relevant aim.
Returning to the above-mentioned equation of ref. [1] it is seen that measuring some of the parameters seems to be quite impossible.

To simplify a measurement procedure two assumptions are made:
- 1: The force is "stiff", i.e. independent of loading
- 2: The mass of the glove material can be neglected.

The electrical analogy of Fig. 1 is described in Ref. [2]. The two assumptions simplify the electrical analogy to Fig. 2.



Using an admittance/impedance analogy it follows that the transmissibility is calculated as the voltage drop over the impedance $Z_{gl,e}$ where the electrical impedances are to be understood as the reciprocated mechanical impedances. Thus

$$\frac{v_1}{v_o} = \frac{v_1'}{v_o'} = \frac{Z_{ha,e}}{Z_{ha,e} + Z_{gl,e}} = \frac{Z_{gl}}{Z_{ha} + Z_{gl}}$$

Fig. 2. Simplified analogy of mechanical system.

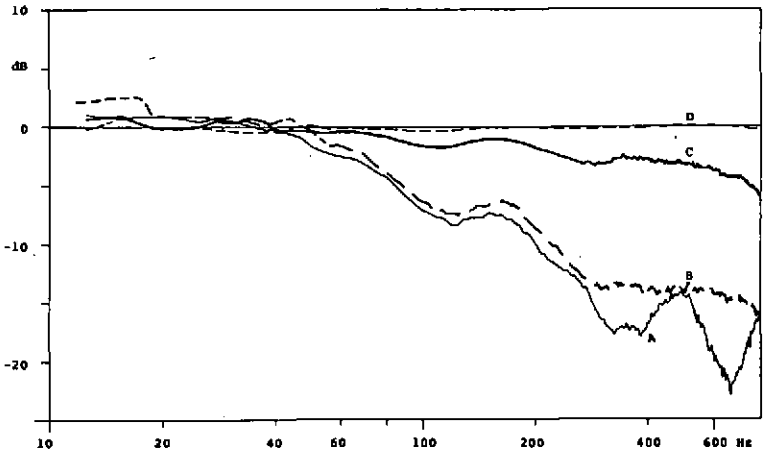
RESULTS & DISCUSSION

Using a method where loading impedance and transfer impedance of a test sample are determined seperately the transmissibility of the system is calculated from the above mentioned equation this procedure has been carried out for more than 200 materials or combination of materials.
Furthermore, ordinary glove types and gloves sold as vibration isolating gloves have been investigated. Measurements have been carried out using different hand/finger impedances as loading. Fig. 3 shows characteristic results.

Signatures for Fig. 3.

A:	3-layer design	soft cell rubber / foam / soft cell rubber
B:	Sold in DK as anti-vibration glove, Japanese - aircushion design.	
C:	Sold in DK as anti-vibration glove, Japanese - contains thin foam.	
D:	Ordinary working glove made of leather.	

Transmissibility.
Loading: middle section of index finger.
4 different test samples.



Transmissibility.
Comparison of different loadings.

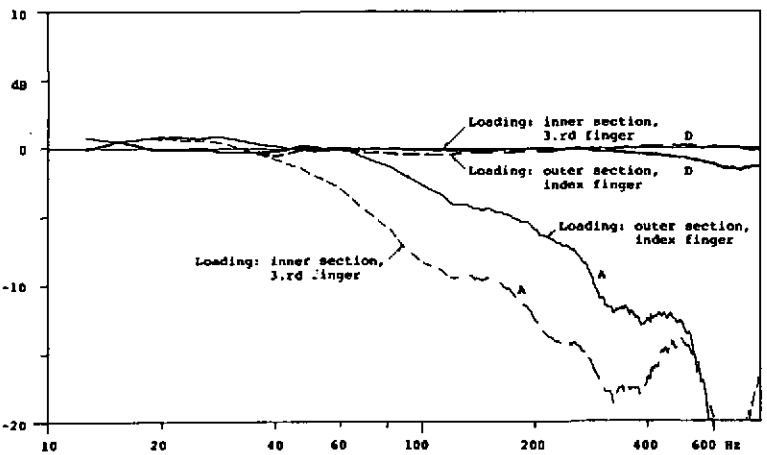


Fig. 3. Characteristic results.

The measurements showed that the efficiency reported for test sample A cannot be further improved as the limitation now seems to be the limited impedance of the load.
Thus the results suggest that vibration exposure at frequencies above ∿60-80 Hz can be reduced by using an adequate glove.
Results also showed that using point impedances of the palm leads to far smaller transmissibilities than indicated in Fig. 3 and that the loading of the outer sections of the fingers leads to "good" transmissibilities.
Thus, the obtained reduction of vibration exposure is not only dependent on the dominant frequencies produced by the tool, but also on the way in which the tool is held during work.

RECOMMENDATIONS

- The results reported in this paper differ significantly from the results of other papers published on the subject (see references). But as the results of none of the references agree with each other, this fact only seems to show the need for a standardized method of measuring the efficiency of gloves. In Denmark such a "standard" would certainly prevent glove manufacturers from claiming unrealistic efficiencies, such as: "this glove reduces vibration-exposure by 85%.
- Further research into hand impedance during work seems to be necessary in order to obtain agreement on realistic loading impedance for a labelling test procedure. Thus, the impedance of a full hand - as some references have described - seems to lead to too optimistic vibration isolating efficiencies.

REFERENCES

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