Hand-Arm Vibration Associated with the Use of Riveting Hammers in the Aerospace Industry and Efficiency of "Antivibration" Devices.

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INTRODUCTION

Riveting hammers are widely used in the aerospace industry for assembling aircraft panels. The process of riveting usually involves punching strokes on the rivet head while a bucking bar is held on the other end of the rivet for closing it up. The installation of a rivet takes only a fraction of a second but is known to subject both the operators of the riveting hammer and of the bucking bar to significantly high levels of vibration[1]. Such vibrations are susceptible to contribute to the development of vibration white finger disease of which Raynaud's phenomenon is most widely known[2].

The purpose of this work was to evaluate the exposure levels associated with the use of typical riveting hammers and bucking bars used in an assembly plant, some of these devices being characterized as "antivibration" devices, in an effort to evaluate their efficiency for reducing vibration exposure following the ISO 5349 [3] guidelines. In addition, an evaluation of specially designed vacuum pads [4], mainly aimed at reducing the noise radiated, was also attempted to establish their potential effect on hand-transmitted vibration levels.

VIBRATION EXPOSURE LEVELS

Tables 1 and 2 present the overall frequency weighted acceleration (6.3-1250 Hz) measured on the handle of the different riveting hammer/bucking bar combinations. Riveting hammers A and B are of equivalent size but A represents a conventional hammer while B is considered "antivibration". Riveting hammers C and D are smaller and are equivalent except for the fact that the handle of D has been covered with a resilient material and incorporates a muffler to reduce the noise. The conventional bucking bar consists of a piece of steel having a mass of approximately 1 kg while the antivibration bucking bar is a commercial unit aimed at reducing vibration exposure at the bucker's hands. However, when measuring on the hammer itself, accelerometers are fixed at a point where there is no resilient material. Therefore, the levels measured on hammers C and D should be similar; only the vibrations measured on the wrist should give some indication of the efficiency of the resilient material for attenuating the vibration.

Efficiency of Antivibration Bucking Bar

The use of an antivibration bucking bar equipped with a spring to damp the vibration is seen to represent a significant improvement over a conventional metal bar for lowering the overall frequency weighted acceleration at the bucker's hands. The vibration levels can be reduced by as much as 10 dB by using the antivibration bucking bar, bringing the levels almost equivalent to those recorded on the hammer side. The effect of the bucking bar is not apparent on the riveting hammer side except perhaps when the antivibration hammer B is being used. When using a conventional metal bucking bar, it can be expected that the bucking bar operator will be exposed to vibration levels which can be 3 to 5 times the levels recorded for the riveting hammer operator.

Efficiency of Antivibration Riveting Hammer

A comparison of riveting hammers A and B, B being a commercial antivibration hammer equipped with an air servo installed between the handle and the vibrating parts of the tool, indicates a slight improvement of the vibration levels at the riveter's hands, the improvement being best achieved in conjunction with the antivibration bucking bar. However, the use of the antivibration hammer leads to an important increase in vibration exposure for the bucking bar operator, indicating that the blow energy , instead of being dissipated, is directly transmitted to the rivet, and consequently, to the bucking bar. On the riveting hammer side, best performance is achieved using the antivibration hammer with the antivibration bucking bar. On the bucking bar side, best performance is achieved using a conventional hammer with the antivibration bucking bar. A suitable compromise would thus appear to be the use of this latter combination such that both the riveter and the bucker would be exposed to similar vibration levels.

A comparison of hammers C and D shows no real significant difference on both the riveter's and bucker's sides.

Efficiency of Vacuum Pads

The use of vacuum pads fixed on the structure for dampening the radiated noise is seen to have only a slight effect for reducing vibration exposure, depending on the hammer/bucking bar combination. Best improvement is seen to be achieved when conventional hammers A and C are used in conjunction with the antivibration bucking bar on both the riveter's and bucker's sides.

CONCLUSION

The efficiency of an antivibration bucking bar, riveting hammer and vacuum pads have been evaluated during typical riveting operations in an effort to establish their efficiency for lowering exposure to hand-transmitted vibration. The use of an antivibration bucking bar has been shown to reduce exposure by as much as 10 dB at the bucker's hands while generally having no significant effect on the riveter's side. A slight decrease of vibration was noted on the riveter's side when using a riveting hammer treated against vibration at the expense of increasing exposure on the bucker's side. The best compromise appeared to be the use of a conventional hammer along with an antivibration bucking bar. The use of vacuum pads was seen to have only a slight effect on vibration exposure, although beneficial effects were only noted for certain hammer/bucking bar combinations.

REFERENCES

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Table 1. Overall frequency-weighted acceleration measured on the bucking bars

Riveting Hammer	Without "vacuum pads" Conventional bucking bar $a_{h,w}$ (ms^{-2})	Without "vacuum pads" Antivibration bucking bar $a_{h,w}$ (ms^{-2})	With "vacuum pads" Conventional bucking bar $a_{h,w}$ (ms^{-2})	With "vacuum pads" Antivibration bucking bar $a_{h,w}$ (ms^{-2})
A	19.9 ± 0.9	6.0 ± 1.2	18.0 ± 1.0	4.3 ± 1.2
B	28.0 ± 2.0	10.6 ± 1.4	25.0 ± 2.0	10.0 ± 2.0
C	15.0 ± 1.5	4.6 ± 1.0	14.0 ± 0.7	2.7 ± 0.4
D	14.9 ± 1.5	4.2 ± 0.8	13.0 ± 0.7	4.2 ± 0.9

Table 2. Overall frequency-weighted acceleration measured on the riveting hammers

Riveting Hammer	Without "vacuum pads" Conventional bucking bar $a_{h,w}$ (ms^{-2})	Without "vacuum pads" Antivibration bucking bar $a_{h,w}$ (ms^{-2})	With "vacuum pads" Conventional bucking bar $a_{h,w}$ (ms^{-2})	With "vacuum pads" Antivibration bucking bar $a_{h,w}$ (ms^{-2})
A	6.5 ± 0.4	7.0 ± 0.7	5.7 ± 0.2	5.8 ± 0.4
B	5.1 ± 0.4	3.6 ± 0.4	5.2 ± 1.4	5.1 ± 1.5
C	4.4 ± 0.3	4.8 ± 0.5	3.9 ± 0.4	3.3 ± 0.5
D	5.0 ± 0.4	5.7 ± 0.7	4.4 ± 0.2	3.9 ± 1.1