HAND-ARM VIBRATION EXPOSURE IN AIRCRAFT MANUFACTURE: MEASURES OF VIBRATION ATTENUATION

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Introduction

Despite a high level of automation, a large number of handheld power tools are still being used during the manufacture of aircraft. In particular, high exposure to vibration occurs during use of a riveting hammer and dolly. Other tools typically used that give rise to vibration exposure are power screwdrivers, saws, and grinding machines. Under the EU Vibration Directive, employers are obliged to take state-of-the-art measures to reduce vibration exposure when the daily vibration exposure A(8) exceeds 2.5 m/s^2.

From the range of measures within a vibration attenuation program (as described in the CR 1030 series of CEN reports), this work studied the use of alternative working methods and the selection of suitable working equipment that could lower vibration exposure.

Methods

Measurements were performed under typical work and plant conditions. Each measurement was repeated several times with a number of different test persons experienced in the use of the equipment. For riveters, a working cycle of 10 riveting operations was specified for each discrete measurement in order to permit comparison between the different tools for a given task. Measurement and analysis of the results were conducted in accordance with ISO 5349.

Results

The frequency-weighted acceleration (a_{hw}) values are between 5.4 and 11.5 m/s^2 for conventional riveting hammers without vibration damping and between 1.75 and 6.8 m/s^2 for riveting hammers with vibration damping. These values are not conclusive, however, since they are determined from the number of riveting operations over the integration period (duration of measurement) according to the hardness of the rivet and the individual pace of progress. The number of riveting operations that can be performed before the daily vibration exposure A(8) of 2.5 m/s^2 is exceeded is 530–1,170 per day for a riveting hammer without damping and 1,830–3,000 for a riveting hammer with damping. This takes into account any breaks necessitated by the work.

Higher exposures occur on the dolly. Here the daily vibration exposure is exceeded after 98 riveting operations per day. The vibration exposure can be reduced by increasing the mass of the dolly (Table 1). Owing to the confined conditions, the use of dollies with vibration damping is frequently not possible (Figure 1).

Vibration attenuation can be improved considerably by the use of an alternative working method. Blind rivet guns employ an impact-free process; a titanium pop rivet is deformed by means of a drawing movement. Blind rivet guns can perform 25,160 riveting operations per day before the daily vibration exposure A(8) of 2.5 m/s^2 is exceeded. Threaded joints also generate lower vibration exposure than riveted joints.

Table 1.—Reduction in vibration exposure as a function of dolly weight

Dolly	No. of riveting operations per day before $A(8) = 2.5\ m/s^2$ is reached
Tungsten, 3.16 kg	538
Steel, 1.61 kg	293
Steel, 0.839 kg	109

Figure 1.—Use of a riveting hammer and dolly in confined conditions.

Further relevant vibration exposure occurs during the sawing of 2 mm sheet aluminium with a pad saw ($a_{hw} = 6.9 \pm 1.7\ m/s^2$) and during the use of random orbital sanders ($a_{hw} = 5.1 \pm 1.1\ m/s^2$).

Summary and Discussion

The effects of vibration attenuation for riveting equipment were investigated. Damping increases the number of riveting operations for riveting hammers roughly by a factor of three. Even more effective for prevention purposes is the use of blind rivet guns, which allow up to 25,160 riveting operations per day before the daily exposure limit is exceeded. This opens alternative options to reduce vibration exposure.

References

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