LABORATORY AND FIELD MEASUREMENTS OF BUCKING BAR VIBRATIONS

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Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

Introduction

In an on-going collaboration with the 72nd Aerospace Medicine Squadron, Bioenvironmental Engineering Flight at Tinker Air Force Base (AFB) in Oklahoma, the Physical Effects Research Team (PERT) from the NIOSH Health Effects Laboratory Division is studying hand-transmitted vibration (HTV) emissions of riveting tools. The goal of these endeavors is to reduce occupational HTV exposures to aircraft assembly and maintenance workers. One of the primary methods for reducing HTV exposures at Tinker AFB is the practice of identifying and selecting reduced-vibration tools. To assist in these efforts, the PERT team completed an earlier study to evaluate reduced-vibration riveting hammers.[1] In the present study, the NIOSH team turned its attention to the bucking bar side of the manual riveting process. The specific aims of the present study were to develop a laboratory-based methodology for assessing rivet bucking bar vibrations, to evaluate a number of traditional and innovative bucking bar models in the lab and in the workplace, and to compare the lab and field results.

Methods

Nine rivet bucking bars were evaluated in this study: 1) three traditional bars made from cold rolled steel, 2) three bars with the same shapes as the traditional bars but made from tungsten alloys, and 3) three bars incorporating recoilless dampeners. The bucking bars were evaluated in two study segments; the first segment was conducted at Tinker AFB under actual working conditions; the second part was conducted at the NIOSH laboratory using a simulated work task.

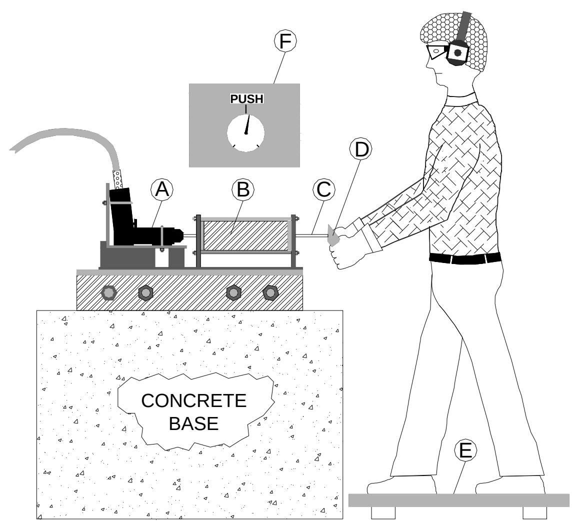

Fig. 1. NIOSH lab test setup and operator posture. (A) riveting hammer; (B) energy absorber; (C) simulated rivet; (D) bucking bar; (E) force plate to measure push force; (F) push force

The workplace and laboratory assessments employed the same test matrix and data collection schemes; in each segment, nine operators completed three trials with each bucking bar. At Tinker AFB, the nine bucking bars were assessed as they were operated during three typical sheet metal riveting tasks. The bucking bars were operated by experienced sheet metal mechanics regularly assigned to these specific work tasks. At Tinker AFB, a trial consisted of the setting of five actual rivets in a 30-second time period. In the NIOSH lab, a trial consisted of the simulation of setting five rivets in 30 seconds. While there is a standardized laboratory-based method for assessing HTV emissions of riveting hammers,[2] there is no such standard for evaluating rivet bucking bars. Thus, a major component of this study was the development of a laboratory-based apparatus (Fig. 1) and method for simulating a riveting task and evaluating rivet bucking bar vibrations. In an earlier study, engineers at Atlas Copco developed a bucking bar test stand and procedure.[3] The bucking bar apparatus developed by

NIOSH incorporates the Atlas Copco-designed energy absorber that comprises a steel tube filled with hardened steel balls. With the NIOSH method, a remote-controlled riveting hammer provides the vibration input to the energy absorber. The energy absorber dissipates a portion of the dynamic reaction force which enables stable and reproducible vibration stimuli to the simulated rivet inserted into the opposite end of the energy absorber. During the simulated riveting task, the bucking bar operator presses the flat surface of the bucking bar against the simulated rivet while applying the specified push force (80±10 N). During the lab test, the on/off operation of the riveting hammer is controlled remotely via a control station. In this study, the control station was programmed to automatically cycle the vibration on and off to mimic the conventional rhythm of the riveting tasks evaluated at Tinker AFB.

Piezoelectric triaxial accelerometers were used to measure the vibrations at the surface of each bucking bar during the lab and field evaluations in accordance with ISO 5349-1 (2001).[4] Bucking bar comparisons made in this study were primarily based on frequency-weighted bucking bar vibration measurements (a_{hv}).

Results and Conclusions

The acceleration averages and rank-orders of the nine bucking bars for the lab evaluations at NIOSH and the field evaluations at Tinker AFB are presented in Table 1. In general, the cold rolled steel bars produced higher vibrations than the tungsten alloy and recoilless dampener models in both the lab and in the field. The results indicate that the three tungsten alloy bucking bars exhibited consistently lower frequency-weighted and unweighted acceleration than their similarly-shaped cold rolled steel models regardless of task. While the lab measurements were consistently lower than the workplace measurements, the NIOSH lab test shows promise as a method for comparing bucking bars in terms of vibration; by and large, the bucking bars that produced the lowest frequency-weighted accelerations during the field tasks at Tinker AFB also produced lower accelerations during the NIOSH lab assessments.

Table 1. The frequency-weighted (a_{hv}) bucking bar acceleration averages (in m/s^2), coefficients of variation (COV), and ranking from lowest to highest vibration for the nine bucking bars.

		Lab			Field		
Bar	Type	a_{hv}	COV	Rank	a_{hv}	COV	Rank
A	cold rolled steel	6.00	0.12	9	10.76	0.29	8
B	cold rolled steel	4.52	0.10	6	9.02	0.29	6
C	cold rolled steel	4.84	0.18	8	11.04	0.40	9
D	tungsten alloy	4.53	0.10	7	5.89	0.18	3
E	tungsten alloy	3.27	0.13	2	5.07	0.29	1
F	tungsten alloy	4.03	0.09	4	6.36	0.21	4
G	recoilless dampener	4.15	0.29	5	7.74	0.21	5
H	recoilless dampener	3.34	0.28	3	5.23	0.28	2
I	recoilless dampener	2.66	0.19	1	9.34	0.23	7

References

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5th American Conference on Human Vibration

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This activity is an Accredited Group Learning Activity (Section 1) as defined by the Maintenance of Certification program of The Royal College of Physicians and Surgeons of Canada and approved by Occupational Medicine Specialists of Canada (OMSOC). The activity has been approved for up to 13 hours for the 3 day course (1 credit per hour).

Forward – Welcome Address

On behalf of my conference co-chairs, I am pleased to welcome you to Guelph, Ontario, Canada for the 5th American Conference on Human Vibration. The 5th ACHV is being co-hosted by the University of Guelph, Laurentian University, Western University and the University of Toronto. We are honored to be hosting this biennial conference on the University of Guelph campus. As the premier North American conference for human exposure to vibration, the conference provides a unique and convenient opportunity for researchers, engineers, medical professionals and industry representatives to exchange information on all aspects of vibration control and human responses to hand-transmitted vibration and whole-body vibration. The theme for this year's meeting is "Human Vibration - From Theory to Industrial and Clinical Applications".

Founded in 1827, Guelph was named after the British Monarch King George IV, who was from the House of Hanover. Selected as the headquarters of a British development firm called "The Canada Company", Guelph was designed by John Galt, who was a Scottish Novelist. The town was designed to resemble a European city center comprised of squares, wide main streets and narrow side streets. Guelph was home to Lieutenant Colonel John McCrae, the author of "In Flanders Fields". Its references to the red poppies that grew over the graves of fallen soldiers resulted in the remembrance poppy becoming one of the world's most recognized memorial symbols for fallen soldiers. Guelph was also the home of North America's first cable TV system. Fredrick T. Metcalf created MacLean Hunter Television (now part of Rogers Communications) and their first broadcast was of current monarch Queen Elizabeth II's Coronation in 1953. With a population of over 120,000, Guelph is part of a technology triangle which is comprised of the cities of Guelph, Kitchener, Cambridge and Waterloo. Guelph is consistently rated as one of Canada's best places to live because of its low crime rate, clean environment, high standard of living and low unemployment rate. Almost one quarter of Guelph employment is provided through the manufacturing sector with over 10% provided through Educational services. The City of Guelph has identified life science, agri-food and biotechnology, environmental management and technology companies as industries on which to focus future economic development activities.

Many thanks to Elyse Dubé from Conference Services at the University of Guelph for all of her hard work in helping to plan and sort through the conference logistics. We'd also like to thank Guelph Engineering students Gregor Scott and Dan Leto as well as School of Engineering technician Carly Fennell for their help in setting up the laboratory tours. We hope that your visit to the 5th ACHV and Guelph will be both educational and enjoyable.

Sincerely,

Michele Oliver, Jim Dickey, Tammy Eger and Aaron Thompson