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The Analysis Against The Characteristics of Vibration-Absorber Glove on Workers Who Use Electric-Based Equipment

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Abstract: *Production machines always vibrated when workers operated the machines perpetually. It caused negative impact on fingers, arms, joints and shoulders. The disturbance was called hand-arm vibration. This effect varied across workers, ranging from whitened fingers to the incapacity to move fingers. This research was aimed to develop a model of work safety device, which in this case was vibration-absorber glove.Research background was health problems suffered by the former workers at their elder age. Method of research was direct testing against glove material with the parameters of displacement, velocity and acceleration of vibration. Result of research gives some indications. Dacron glove can absorb vibration displacement at 0.173 mm, vibration velocity at 12.25 mm/s and vibration acceleration at 6.8 m/s^2. Sponge glove absorbed vibration displacement at 0.086 mm, vibration velocity at 8.65 mm/s and vibration acceleration at 3.6 m/s^2. Leather glove had absorbed vibration displacement at 0.080 mm, vibration velocity at 7.49 mm/s and vibration acceleration at 2.5 m/s^2. Meanwhile, factors influencing workers after using hand tools were blood pressure, minor nerve disturbance on arm (numbness) and distorted heartbeat.*

Keywords: *Electric-based hand tools, hand-arm vibration and hand safety glove*

I. Introduction

Hand-Arm Vibration (HAV) Syndrome was a kind of nuisances against human health. It was popular by the name of "Vibration Disease" and also by its specific symptoms related with brain dysfunction, headache, irritability, sleep nuisance, and impotency. All these symptoms were mostly noted on workers who operate *electric-based machine equipment* (**Bovenzi. M, 2000**). Other opinion stated that the disease sent the effect on health by giving implication to the blood circulation system. This effect was manifesting through finger numbness during the working, the distortion on bone, joint and muscle system, and the perturbation of *osteo articular* (finger joint upset). Nerve system was also implicated, as shown by partiality, sensitivity loss, and disoriented capacity toward differentiation.

Body system had its own frequency of vibration. In general, vibration adversely impacted the body only at frequency from 0.5 to 80 Hz in various conditions of contact from 1 second to 24 hours. But, vibration at low frequency could improve arm performance. Safety instrument used by workers who operate *electric-based machine equipment* was necessary to reduce health nuisance. Problem of research was how to attest the feasibility and performance of *Vibration-Absorber Glove* by utilizing vibration caused by *electric-based machine equipment*.

The objectives of research included:

1. to understand the rate of vibration caused by electric motor based hand tools;
2. to figure out the characteristic of vibration caused by electric motor based hand tools;
3. to recognize the danger due to the vibration on hand tools users; and
4. to examine the resistance of glove to absorb vibration caused by electric motor based hand tools.

Hand-drill

Hand-drill was a machine that rotated the cutter and directed the drilling point feeding toward machine axis (hole-making work).

Hand-slap
Hand-slap was a machine with parallel cutting edge. Its cutting edge was enormous and used to sharpen or to cut work material at certain goal.

Planner
This machine was functioned to smooth the side of wood work after sawing process.

Digital Measurer
Vibration Meter. It can be defined as an instrument or device that measured alternating movements of mechanic components of a certain machine when it reacted to the internal force (force derived from machine) and the external force (force emanated from outside or around machine).
Vibration Sensor. Conceptually, vibration sensor was functioned to convert physical vibration signal into analog vibration signal at the existing electric rate. The usual format of this resultant signal was electric voltage.
Dynamic Signal Analyzer (DSA). It measured machine vibration due to the complex combination of signals from various internal sources of vibration in machine.

Vibration Meter

Magnetic Sensor on Vibration Meter

Vibration Measurement
Three indicators were considered as parameters in measuring vibration:
a. Displacement
Displacement was the change of position of a certain object or thing toward a central point (in this case, the mass of the object was neutral).
b. Velocity
Velocity was about the speed of a certain object when it moved or vibrated during isolation.
c. Acceleration

Acceleration was a total of times needed for the occurrence of velocity. Acceleration was a very important parameter in analyzing rotation machine (rotating equipment), and it was very useful indicator in detecting the breakage of bearing and the problem of high-speed gearbox when it speeded faster and earlier.

The Making of Glove

Glove was made of various materials such as fabric, dacron, sponge and leather. The most dominant material was fabric and dacron, whereas sponge and leather were only supplementary material for the part of hand palm.

Hand-tools Without Work Media

1. Hand-drill

The following table and graphic showed the comparison of various vibration displacements (mm) on many conditions of hand-drill usage without work media.

Table 1

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	0.814	0.673	0.196	0.244
10	0.737	0.256	0.080	0.261
20	0.294	0.277	0.170	0.112
30	0.112	0.271	0.095	0.107
40	0.128	0.167	0.099	0.126
50	0.158	0.195	0.080	0.096
60	0.131	0.156	0.072	0.107
70	0.128	0.183	0.139	0.115
80	0.114	0.112	0.113	0.089
90	0.137	0.177	0.099	0.104

Graphic 1

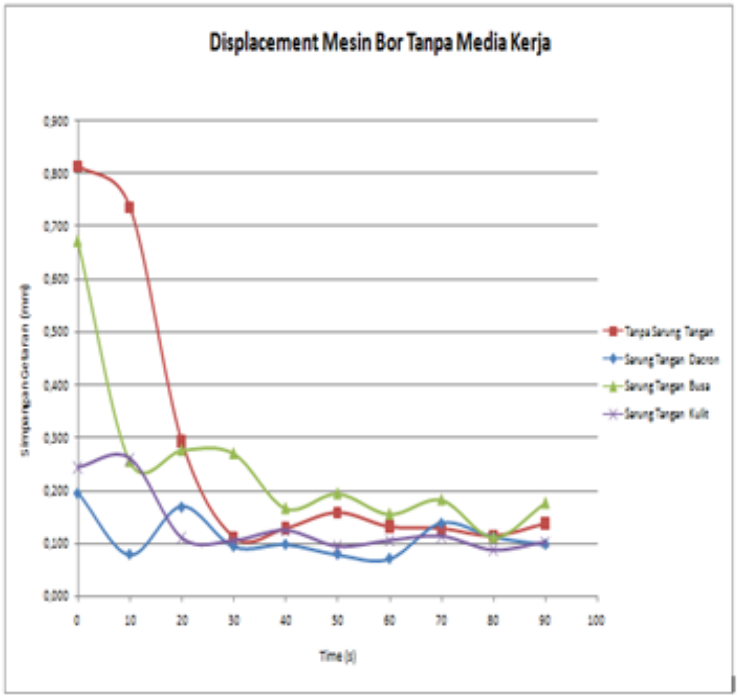
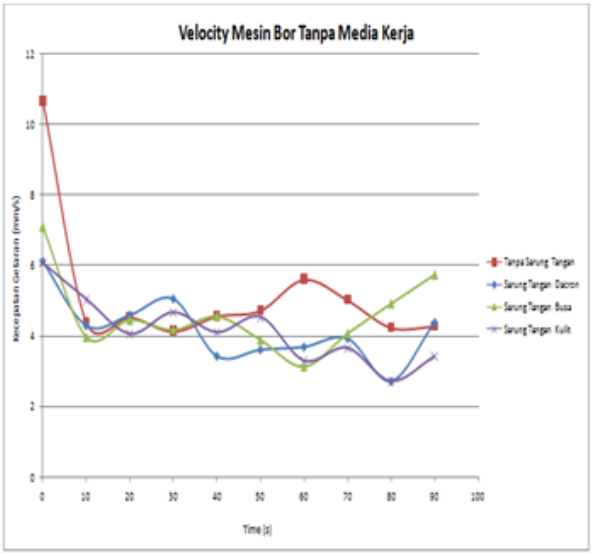


Table and graphic in the following indicated the comparison of various vibration velocities (mm/s) on many hand-drill usage conditions without work media.

Table 2

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	10.67	7.1	6.13	6.07
10	4.4	3.99	4.31	5.05
20	4.55	4.47	4.61	4.07
30	4.14	4.19	5.07	4.68
40	4.57	4.57	3.45	4.11
50	4.73	3.91	3.63	4.55
60	5.61	3.15	3.71	3.31
70	5.03	4.09	3.95	3.67
80	4.25	4.93	2.74	2.73
90	4.29	5.75	4.4	3.43

Graphic 2

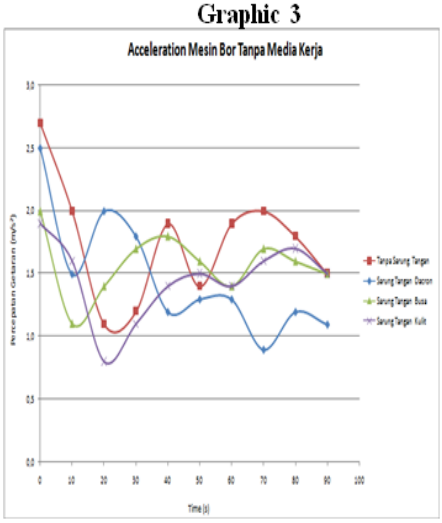


Following was table and graphic that illustrated the comparison of various vibration accelerations (m/s^2) on many usage conditions of hand-drill without work media.

Table 3

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	2.7	2.0	2.5	1.9
10	2.0	1.1	1.5	1.6
20	1.1	1.4	2.0	0.8
30	1.2	1.7	1.8	1.1
40	1.9	1.8	1.2	1.4
50	1.4	1.6	1.3	1.5
60	1.9	1.4	1.3	1.4
70	2.0	1.7	0.9	1.6
80	1.8	1.6	1.2	1.7
90	1.5	1.5	1.1	1.5

Graphic 3



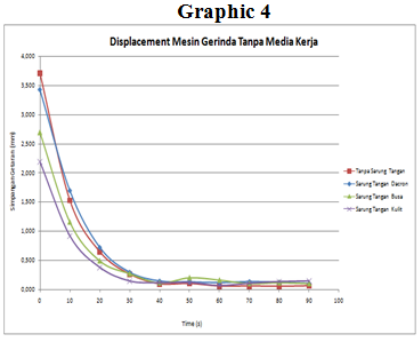
2. Hand-slap

The comparison of various vibration displacements (mm) on many conditions of hand-slap usage without work media was indicated by the following table and graphic.

Table 4

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	3.703	2.693	3.428	2.193
10	1.529	1.157	1.699	0.922
20	0.649	0.492	0.726	0.381
30	0.265	0.272	0.300	0.147
40	0.100	0.113	0.150	0.115
50	0.105	0.203	0.135	0.123
60	0.061	0.163	0.123	0.069
70	0.063	0.102	0.140	0.108
80	0.058	0.118	0.130	0.137
90	0.066	0.102	0.109	0.148

Graphic 4

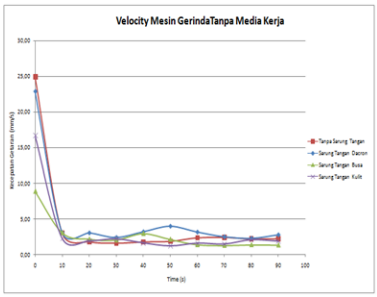


The comparison of various vibration velocities (mm/s) on many hand-slap usage conditions without work media was shown in the following table and graphic.

Table 5

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	24.95	8.91	22.91	16.71
10	3.07	3.11	3.13	2.35
20	1.83	2.20	3.07	1.99
30	1.63	2.09	2.43	2.27
40	1.81	2.99	3.23	1.71
50	1.89	2.17	4.01	1.29
60	2.39	1.43	3.19	1.67
70	2.45	1.31	2.53	1.55
80	2.23	1.41	2.31	2.15
90	2.25	1.37	2.81	1.95

Graphic 5

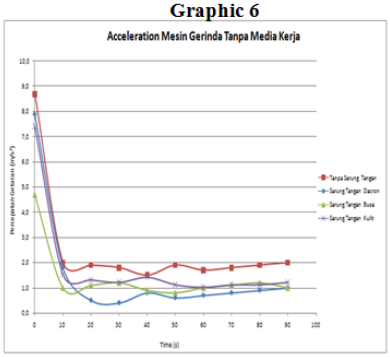


Both table and graphic in the following illustrated the comparison of various vibration accelerations (m/s^2) on many usage conditions of hand-slap without work media.

Table 6

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	8.7	4.7	7.9	7.4
10	2.0	1.0	1.8	1.5
20	1.9	1.1	0.5	1.3
30	1.8	1.2	0.4	1.2
40	1.5	0.9	0.8	1.4
50	1.9	0.8	0.6	1.1
60	1.7	1.0	0.7	1.0
70	1.8	1.1	0.8	1.1
80	1.9	1.2	0.9	1.1
90	2.0	1.0	1.0	1.2

Graphic 6



3. Planner

The following table and graphic indicated the comparison of various vibration displacements (mm) on many conditions of planner usage without work media.

Table 7

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	0.461	0.454	0.381	0.298
10	0.163	0.159	0.132	0.128
20	0.133	0.081	0.114	0.056
30	0.089	0.089	0.135	0.065
40	0.112	0.112	0.093	0.061
50	0.062	0.058	0.125	0.131
60	0.049	0.083	0.088	0.112
70	0.071	0.055	0.100	0.090
80	0.036	0.067	0.107	0.081
90	0.058	0.048	0.094	0.082

Graphic 7

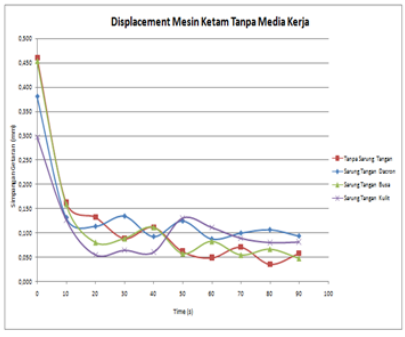
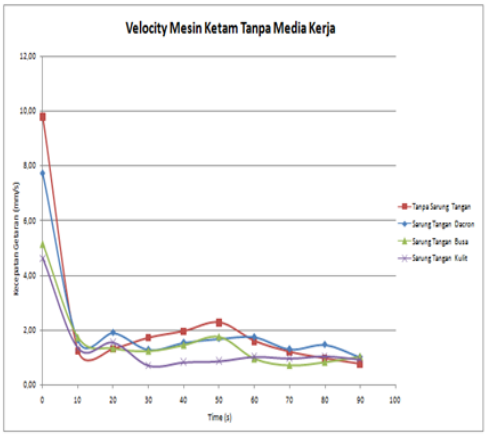


Table and graphic in the following showed the comparison of various vibration velocities (mm/s) on many planner usage conditions without work media.

Table 8

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	9.81	5.15	7.73	4.63
10	1.25	1.73	1.63	1.35
20	1.33	1.33	1.91	1.55
30	1.73	1.23	1.29	0.71
40	1.97	1.45	1.55	0.83
50	2.29	1.75	1.69	0.87
60	1.61	0.95	1.75	1.03
70	1.21	0.71	1.31	0.97
80	0.97	0.83	1.47	1.05
90	0.77	1.03	1.01	0.93

Graphic 8

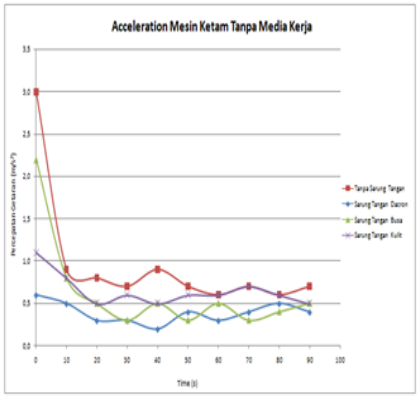


Both table and graphic illustrated the comparison of various vibration accelerations (m/s^2) on many usage conditions of planner without work media.

Table 9

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	3.0	2.2	0.6	1.1
10	0.9	0.8	0.5	0.8
20	0.8	0.5	0.3	0.5
30	0.7	0.3	0.3	0.6
40	0.9	0.5	0.2	0.5
50	0.7	0.3	0.4	0.6
60	0.6	0.5	0.3	0.6
70	0.7	0.3	0.4	0.7
80	0.6	0.4	0.5	0.6
90	0.7	0.5	0.4	0.5

Graphic 9



Handtools With Wooden Work Media

1. Hand-drill

Both table and graphic in the following showed the comparison of various vibration displacements (mm) on many conditions of hand-drill usage with wooden work media.

Table 10

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	0.710	0.463	0.279	0.799
10	0.596	0.314	0.240	0.333
20	0.386	0.224	0.191	0.331
30	0.325	0.201	0.157	0.318
40	0.357	0.218	0.184	0.263
50	0.328	0.222	0.131	0.234
60	0.266	0.207	0.184	0.229
70	0.280	0.193	0.195	0.253
80	0.391	0.182	0.131	0.260
90	0.300	0.178	0.118	0.244

Graphic 10

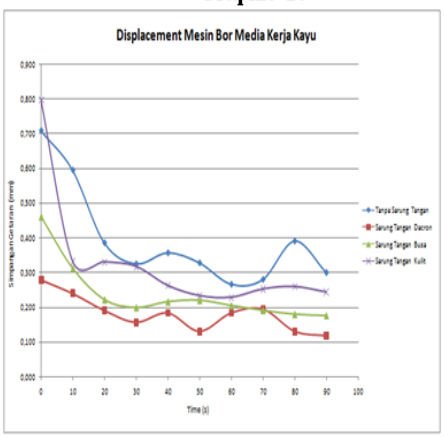
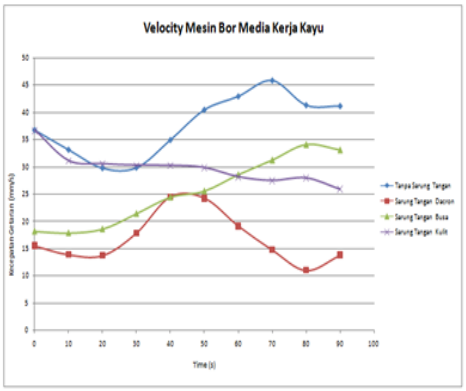


Table and graphic in the following described the comparison of various vibration velocities (mm/s) on many hand-drill usage conditions with wooden work media.

Table 11

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	36.69	18.15	15.49	36.69
10	33.07	17.85	13.89	31.15
20	29.69	18.57	13.73	30.57
30	29.77	21.39	17.85	30.33
40	34.87	24.39	24.48	30.29
50	40.41	25.51	24.25	29.89
60	42.89	28.50	19.15	28.21
70	45.81	31.17	14.77	27.53
80	41.27	34.01	11.01	27.99
90	41.11	33.03	13.77	25.93

Graphic 11

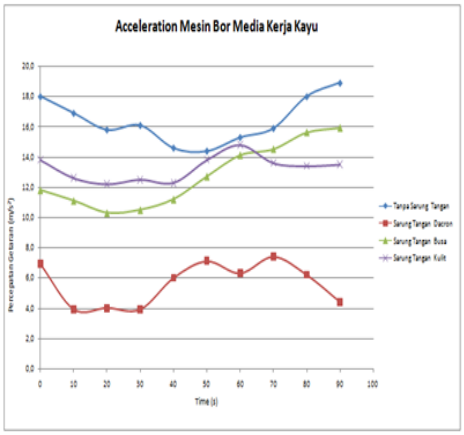


The comparison of various vibration accelerations (m/s^2) on many usage conditions of hand-drill with wooden work media was illustrated in the following table and graphic.

Table 12

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	18.0	11.8	6.9	13.8
10	16.9	11.1	3.9	12.6
20	15.8	10.3	4.0	12.2
30	16.1	10.5	3.9	12.5
40	14.6	11.2	6.0	12.3
50	14.4	12.7	7.1	13.8
60	15.3	14.1	6.3	14.8
70	15.9	14.5	7.4	13.6
80	18.0	15.6	6.2	13.4
90	18.9	15.9	4.4	13.5

Graphic 12



2. Hand-slap

The following table and graphic indicated the comparison of various vibration displacements (mm) on many conditions of hand-slap usage with wooden work media.

Table 13

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	0.878	0.316	0.375	0.430
10	0.358	0.216	0.139	0.224
20	0.342	0.291	0.133	0.286
30	0.391	0.203	0.124	0.256
40	0.277	0.207	0.149	0.250
50	0.212	0.177	0.220	0.208
60	0.218	0.133	0.118	0.231
70	0.193	0.113	0.176	0.338
80	0.188	0.137	0.278	0.267
90	0.155	0.103	0.153	0.217

Graphic 13

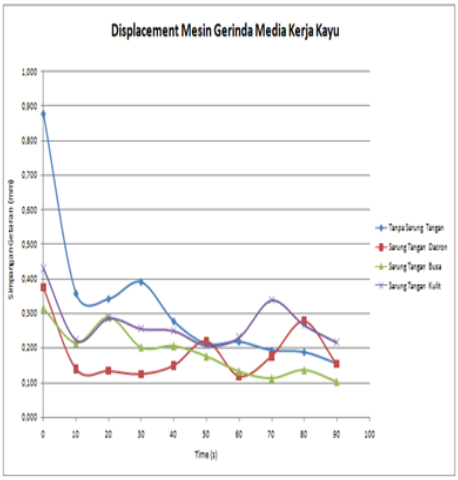
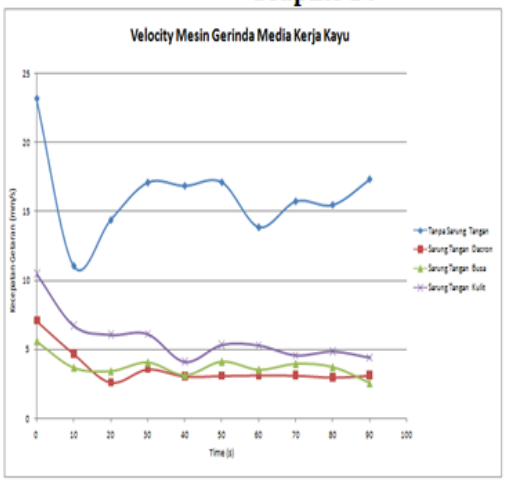


Table and graphic in the following showed the comparison of various vibration velocities (mm/s) on many hand-slap usage conditions with wooden work media.

Table 14

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	23.21	5.65	7.13	10.51
10	11.09	3.73	4.73	6.73
20	14.41	3.47	2.65	6.06
30	17.13	4.11	3.60	6.11
40	16.89	3.18	3.09	4.09
50	17.15	4.17	3.13	5.33
60	13.89	3.58	3.17	5.29
70	15.77	4.01	3.15	4.57
80	15.51	3.77	3.01	4.85
90	17.37	2.61	3.15	4.40

Graphic 14

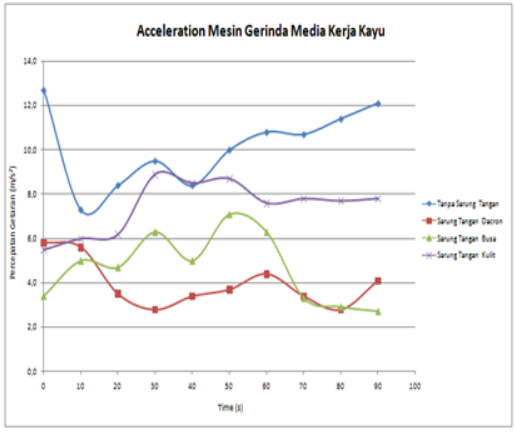


Following was table and graphic that illustrated the comparison of various vibration accelerations (m/s^2) on many usage conditions of hand-slap with wooden work media.

Table 15

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	12.7	3.4	5.8	5.5
10	7.3	5.0	5.6	6.0
20	8.4	4.7	3.5	6.2
30	9.5	6.3	2.8	8.9
40	8.4	5.0	3.4	8.5
50	10.0	7.1	3.7	8.7
60	10.8	6.3	4.4	7.6
70	10.7	3.3	3.4	7.8
80	11.4	2.9	2.8	7.7
90	12.1	2.7	4.1	7.8

Graphic 15



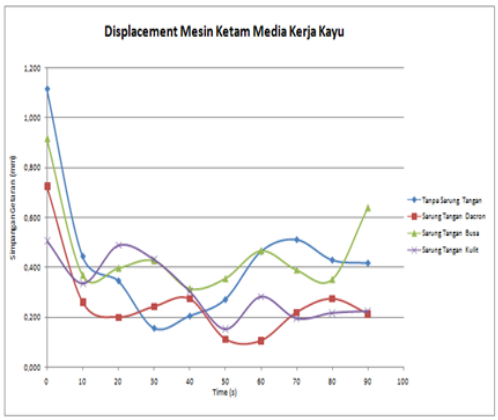
3. Planner

The following table and graphic explained the comparison of various vibration displacements (mm) on many conditions of planner usage with wooden work media.

Table 16

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	1.115	0.919	0.728	0.507
10	0.444	0.370	0.263	0.336
20	0.346	0.398	0.202	0.488
30	0.156	0.428	0.244	0.432
40	0.205	0.316	0.276	0.305
50	0.271	0.356	0.114	0.153
60	0.463	0.468	0.107	0.283
70	0.511	0.391	0.221	0.196
80	0.429	0.353	0.276	0.218
90	0.417	0.641	0.216	0.225

Graphic 16

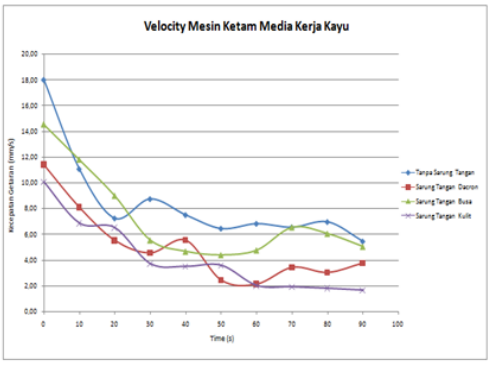


Both table and graphic elucidated the comparison of various vibration velocities (mm/s) on many planner usage conditions with wooden work media.

Table 17

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	18.03	14.55	11.41	10.07
10	11.09	11.81	8.11	6.87
20	7.25	9.00	5.54	6.51
30	8.75	5.55	4.57	3.71
40	7.51	4.68	5.55	3.49
50	6.45	4.40	2.45	3.58
60	6.83	4.77	2.15	2.01
70	6.55	6.55	3.45	1.91
80	6.97	6.06	3.05	1.79
90	5.45	5.05	3.79	1.65

Graphic 17

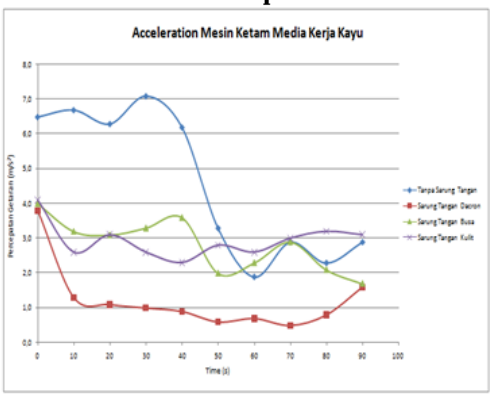


Both table and graphic revealed the comparison of various vibration accelerations (m/s^2) on many usage conditions of planner with wooden work media.

Table 18

Time (s)	Without Glove	Sponge Glove	Dacron Glove	Leather Glove
0	6.5	4.0	3.8	4.1
10	6.7	3.2	1.3	2.6
20	6.3	3.1	1.1	3.1
30	7.1	3.3	1.0	2.6
40	6.2	3.6	0.9	2.3
50	3.3	2.0	0.6	2.8
60	1.9	2.3	0.7	2.6
70	2.9	2.9	0.5	3.0
80	2.3	2.1	0.8	3.2
90	2.9	1.7	1.6	3.1

Graphic 18



II. Discussion

2.1. Handtools Without Work Media

2.1.1.Hand-drill

Both Table 1 and Graphic 1 clearly showed that at 0 second or in the begining of hand-drill activation, all gloves experienced the highest level of vibration displacement because the electric motor was jolted during the initiation, thus inducing high vibration that give enough shock to the hand of drill user. At 30th second, the displacement started to stabilize because electric motor began running well over time and producing more stable vibration if compared to during the initiation. The smallest vibration displacement was indicated by dacron glove.As indicated in Table 2 and Graphic 2, vibration velocity of hand-drill was stable at 10th second. The highest vibration velocity was attained on leather glove. The reason was due to the temporary jolt of electric motor. In the middle of process, the highest vibration velocity was shown by sponge glove at 90th second, and it counted for 5.75 m/s. The reason behind this count was because hand-drill shook little bit at that moment.

From the content of Table 3 and the result of measurement in Graphic 3, in general, the vibration acceleration from dacron glove was better than others. Six low site points of vibration acceleration was observed on dacron glove. The lowest site point was 0.9 m/s^2 at 70th second. The acceleration fluctuated because of some factors such as the exhaustion of human hand and the aging of machine. Factor of aging may induce worn-down and also unstable vibration.

2.1.2.Hand-slap

Table 4 and Graphic 4 indicated almost similar trend among the observed glove conditions without much differential in rates. It may so because hand-slap worked very well in stable manner during measurement and identification of glove material. At 0 second, or when hand-slap was initiated, vibration displacement was the highest because the motor vibrated prominently during the start. The highest displacement was found on without-glove at the rate of 3.703 mm.

As noted in Table 5 and Graphic 5, almost similar trend for vibration velocity was also obtained among glove conditions, but at 50th second, very significant difference was emerging. In this moment, the arm moved following unstable shock of hand-slap, and it became *human error*. Leather glove was good in general or had the smallest velocity smaller than other gloves in 4 site points. As shown in Table 6 and Graphic 6, dacron glove had a very good absorbance against vibration acceleration. It had the lowest vibration acceleration at 8 site points. At 50th second, dacron glove can absorb vibration acceleration at 0.6 m/s^2, while sponge and leather gloves absorbed at 0.8 m/s^2 and 1.1 m/s^2.

2.1.3.Planner

Table 7 and Graphic 7 displayed the fluctuated vibration displacement on all gloves when planner was used. At 0 second, vibration displacement was quite high. The highest score was 0.461 mm observed on without-glove. Planner was stable at 10th second onward. Pursuant to Table 8 and Graphic 8, vibration velocity of planner was stable at 10th second onward. Such trend happened at the start but at 10th second, the velocity drastically decreased because planner motor rotated very fast. The highest vibration velocity emerged after 10th second and this was observed on without-glove condition at 50th second by the rate of 2.29 mm/s. The lowest vibration velocity was 0.71 mm/s found either on leather glove at 30th second and also on sponge glove at 70th second.Table 9 and Graphic 9 indicated that of three gloves observed, at 50th second, sponge glove was favorable in absorbing vibration acceleration of the planner by the rate of 0.3 m/s^2, whereas the absorbance capacity of dracon glove was 0.4 m/s^2 and that of leather glove was 0.6 m/s^2.

2.2. Hand-tools With Wooden Work Media

2.2.1.Hand-drill

The measurement of vibration displacement on hand-drill applied with wooden work media was shown in Table 10 and Graphic 10. At 0 second, dacron glove can absorb vibration displacement at the lowest rate, precisely to 0.279 mm, while sponge glove absorbed vibration displacement at 0.463 mm. Absorbance capacity of leather glove reached 0.799 mm.

Table 11 and Graphic 11 showed the measurement of vibration velocity of hand-drill with wooden work media. At 0 second, dacron glove was still the best by absorbing vibration velocity at 15.49 mm/s. Sponge glove absorbed vibration velocity at 11.8 mm/s. The capacity of leather glove to absorb vibration velocity was 13.8 mm/s.

As shown by Table 12 and Graphic 12, dracon glove was the best in absorbing vibration acceleration of hand-drill usage with wooden work media. Its absorbance rate was 6.9 m/s^2. Next was sponge glove with absorbing vibration acceleration at 3.6 m/s^2. Absorbance capacity of leather glove against vibration acceleration was 3.1 m/s^2.

2.2.2.Hand-slap

Either Table 13 or Graphic 13 showed that at 0 second or during the start of hand-slap, almost all gloves showed high vibration displacement if compared to after initiation. There was a jolt when motor started, and then it was followed with rotation. This rotation produced quite strong vibration. The highest score was 0.878 mm observed at 0 second on without-glove, while the lowest score was 0.103 mm attained at 90th second on sponge glove.

Table 14 and Graphic 14 indicated that all gloves were very influential to vibration because all of them successfully absorbed vibration. However, in mathematic, sponge glove was the best in absorbing vibration velocity of hand-slap at 0 second. Its absorbance rate was 5.65 mm/s, and this was followed by dacron glove with 7.13 mm/s and leather glove with 10.51 mm/s.

As noted in Table 15 and Graphic 15, it was clear that since at 0 second, foam glove was better than other gloves in absorbing vibration acceleration by the rate of 3.4 m/s^2. It was followed by leather glove at 5.5 m/s^2 and dacron glove at 5.8 m/s^2. The highest acceleration rate was 12.7 m/s^2 obtained on without-glove, especially during the start, whereas the lowest was shown by dacron glove with 2.8 m/s^2 at 30th second.

2.2.3.Planner

Both Table 16 and Graphic 16 showed that the capacity of all gloves to absorb vibration displacement was not clear, possibly because during the test, work media or wood surface was not level and therefore, planner movement was stagnant. It can be seen at 20th, 30th and 60th second.

As shown by Table 17 and Graphic 17, vibration velocity decreased over time because the planned wood surface was smooth in such way that planner moved forward smoothly without too many resistances. The highest vibration velocity was obtained on without-glove at 18.03 mm/s during the start, while the lowest was leather glove at 1.65 mm/s during the final second of observation.

Table 18 and Graphic 18 were clearly uncovering that since at 0 second dacron glove was better than others in absorbing vibration acceleration by the rate of 3.8 m/s^2. It was followed by sponge glove with 4.0 m/s^2 and leather glove with 4.1 m/s^2. The highest vibration acceleration was 7.1 m/s^2 found on without-glove at 30^{th} second, while the lowest vibration acceleration was 0.5 m/s^2 on dracon glove at 70^{th} second.

1.3. Analysis on Vibration against Worker

In general, hand-tool user workers in Indonesia did not apply self-protecting device for many reasons. One reason was that wearing it was difficult and it slowed the speed of work. This device was very important on behalf on the long-term health of workers.

Some factors influenced vibration-induced health.

1. Age

Age was very influential to workers' health especially when the age of workers was >30 years old when workers were vulnerable to distortion or health problem due to vibration.

2. Education

Education was greatly influencing human mindset. When someone had higher education, there was better knowledge about the negative impact of vibration and also the positive impact of wearing self-protecting device.

3. Tenure

Tenure represented the length of time given by workers to accomplish work in term of year. This tenure was helpful to recognize the length of vibration exposure suffered by workers. Longer tenure, meaning that the longer was vibration-causing device must be used, forced workers be more susceptible to negative impact of vibration.

4. Work Hour

Work hour was the length of time accomplished by workers in finishing their daily works (< 8 hours or > 8 hours per day). It allowed the observer to understand the length of vibration exposure to workers.

5. The Use of Self-Protecting Device (Glove)

Self-Protecting Device greatly influenced workers' health. If workers applied this self-protecting device (glove), it may minimize the risk of Work-Caused Disease. This risk was measured from workers' claim from vibration exposure.

If workers usually worked in normal condition and rarely experienced Hand-Arm Vibration Syndrome, little reduction on hand skin temperature was felt in the case of exposure after vibration. This temperature increased 1-2 degree points after vibration exposure for 5 minutes. If the exposure was felt on hand arm, it produced short-term effect, including quick exhaustion, discomfort in working, and work productivity decline. Long-term exposure may cause nerve disease or stroke, and other disease related with vibration. Any claims shown by workers may include:

1. Stiffened after using hand-tools too long.
2. Numbness or blood stream distortion.
3. Headache.
4. Nuisance on muscle or joint.
5. Insomnia / sleep difficulty.
6. Sparkle eye.
7. Stagger.

After the breakthrough on self-protecting device (glove) for workers who used hand-tools, the claims for HAV syndrome decreased. Blood stream clog on hand (causing numbness or sensation loss) and quick exhaustion after working too long were also minimized if compared to before glove usage. Better result was obtained when hand-tools were used based on physician's prescription or government guide. The observed data were summarized on the following:

1. Dacron glove can absorb:

a. Displacement at 0.173 mm.
b. Velocity at 12.25 mm/s.
c. Acceleration at 6.8 m/s^2.

It means that by wearing dacron glove, hand-tools can be used for 25 minutes with exposure length for 6-8 hours a day or in normal condition.

2. Foam glove can absorb:

a. Displacement at 0.086 mm.
b. Velocity at 8.65 mm/s.
c. Acceleration at 3.6 m/s^2.

It means that by wearing foam glove, the allocated time for hand-tools can be 17.5 minutes with exposure length for 4-6 hours a day or in normal condition.

3. Leather glove can absorb:

a. Displacement at 0.080 mm.
b. Velocity at 7.49 mm/s.
c. Acceleration at 2.5 m/s^2.

It means that by wearing leather glove, time for using hand-tools can be only 15 minutes with exposure length for 4-6 hours a day or in normal condition.After wearing self-protecting device (glove), workers' condition was better than before. Result of interview discovered the reduction of complaints from workers on their work. This finding was supported by the result of laboratory test on cholesterol, sugar, blood tension, heart beat, and others. Glove was very helpful to extend workers' health and safety despite poor design of the glove that caused difficulty for workers to wear it.

III. Conclusion

1. At the start, hand-tools worked with great vibration because the electric motor in the tools was always jolting causing great shock.
2. Based on the observation of vibration in hand-tools either without work media or with wooden work media, it was shown that dacron glove was better in absorbing vibration rather than foam or leather gloves.
3. Pursuant to the observation of vibration in hand-tools, it was seen that dacron glove can absorb displacement at 0.173 mm, velocity at 12.25 mm/s and acceleration at 6.8 m/s^2, whereas foam glove can absorb displacement at 0.086 mm, velocity at 8.65 mm/s and acceleration at 3.6 m/s^2. Leather glove can absorb displacement at 0.080 mm, velocity at 7.49 mm/s and acceleration at 2.5 m/s^2.
4. As shown by the result of health laboratory, vibration absorber device, including glove, was a factor that influence workers' health, especially on blood tension, minor nerve disturbance on arm (numbness), and heart beat.
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