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Research Article
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Occupational Whole Body Vibration Transmitted from Feet to Head in Indian Forging Unit

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Abstract

The occurrence of floor vibrations in all three directions naming vertical, lateral and lengthwise, are utilised to calculate head motions of standing workers. During the upright floor vibrations, postures of straight legs, very little stooped legs and stooped legs were inquired. While exhibiting sidelong floor vibrations, workers remain firm feet 300 mm aside. The objectives of this study investigate the transmissibility at back and head. Ten male workers were apprised to remain in two poses while disclosing to lengthwise axes: retaining a banister gently and stiffly ahead them. Inter and intra workers variations were examined for three axes and all posture. Then head and floor transmissions were calculated for all situations. Mid sagittal plane head motion chiefly happened during upright vibrations. The result shows that the leg stooped pose lead to the maximum transmissibility frequency approximately 12 Hz along z direction whereas, minimum motion shown by straight leg pose and vice versa at higher frequencies. Sidelong floor vibrations renders more head motions particularly below 20 Hz as well as with 300 mm foot detachment than the other poses. In case of lengthwise floor vibrations, mid sagittal plane was the master point of head motions.

Keywords: Whole body vibration; Hand arm vibration; Floor vibrations; Hammer

Introduction

Several researchers attempted to measure the transmissibility at head, wrist, palm, shoulder and other upper extremities of worker's body. For instance using standing postures of workers while working on different type of power press and drop forging hammer in forging industries, WBV and HAV are major source of generation from forging hammer. These vibrations results into the devastating occupational diseases in industrial workers such as joint deformities, muscular abnormalities as well as soft and hard tissue destructions [1].

Ten males subjects were selected to study the effect of vibration transmitted from ground to head, at three standing posture at frequency at 3 Hz and 5Hz. The study reported that higher transmissibility in light grip than rigid grip [2]. The study to investigate that how back seat angle affect comfortable back during whole body vibration. Twenty subjects were participated in this study during average age 21-53 years and weight 78 kg. The study reported that the 0 degree was most uncomfortable position while 45 degree least comfortable positions [3]. The experiment conducted for seat for predication whole body vibration anxious when workers sitting tilted back rest. In conclusion, frequencies greater than 8 Hz found to be a cause of increased vibration anxiety at back rest, especially when tilted to 30°, 60° and much anxiety at head or neck. Ten male subjects were used to study the vibration exposure in car at speed 60 km/hr. The VDV is measured along three directions. With along increase back rest angles the VDV increases [4]. The research investigate that the result of experimental investigations which were conducted to assess the subjective response of seated human subjects under vertical harmonic vibrations. 12 human males were subjected to amplitudes of excitation and frequencies of 5, 8, 2, 16 and 20 Hz. By and large with the increase in inclination of back rest, comfort level increases along with the shift of responding segments in certain cases [5]. The responses from all the subjects' form of vibrations being felt by them at different body segments, their severity and significance and comfort level were recorded in subjective form. The study to investigated diseases caused by using hand arm tools in coal workers in northern china. The study reported that disease occurs to workers was head ache, tunnel syndrome and memory loss among coal workers [6]. Eight human was used to study the effect of vibration transmitted from hand to neck, back and head. The result showed that the Musculoskeletal disorders among various workers [7]. Many studies have investigated under hand arm vibration for driving performance under simulated driving conditions. The result showed that the vibration transmitted from hand tool to forehead which causes the hand arm syndrome [8-10].

Methodology

The present study was conducted to find out transmissibility at back and forehead of standing forging workers by whole body vibrations. Ten male workers were exposed at frequencies 12 and 20 Hz and acceleration 0.10, 0.18, 0.70 and 1.6 m/s^2 rms. The input parameters were selected for the studies were selected as follows [11-14].

Ten different workers participated in this study with no back around records of increased disc pressure caused by higher back muscle activity and cardiovascular problem. The height of workers varies from 175 to 184 cm; SD; 5.02 and weight varied from 61 to 75 kg; SD: 4.80. Anthropometric data of Indian workers are shown in Table 1.

Assumptions

1) The workers in standing posture.

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Workers	Age (Yr)	Height (cm)	Weight (Kg)	Foot Length (cm)	Foot Breath (cm)
1	42	175	75	240	95
2	45	177	70	250	100
3	35	180	65	235	98
4	31	169	62	230	91
5	25	174	71	242	98
6	27	175	61	245	97
7	29	178	67	233	91
8	33	181	70	231	90
9	26	184	74	238	93
10	29	180	72	233	92
Mean (cm)	32.2	177.30	68.7	237.70	94.50
Standard Deviation	6.69	5.02	4.80	6.53	3.56

Table 1: Anthropometric data of Indian workers.

2) The distance between two legs was 30 cm apart.

3) Each worker stands on platform (5” × 3” feet) about 1 min for recording vibration exposure (WBV) while the power presses are working because the high speed of power press.

4) The vibration data recorded in all three directions and analyzed (Figure 1).

Figure 1: Standing posture of workers during experimentation.

Experimentation layout

The study conducted at Guru Nank forging unit, Kurali, Punjab (India). The positions of workers were in standing posture while recording WBV at backrest, forehead and keep body erect posture.

Figure 2 shows in that workers working near the drop forging power press, in forging unit while standing posture. The WBV and HAV exposed that power press (capacity 2000 ton) to workers backrest and forehead by foot and hands. Figure 2 shows work during experiment in shop floor at forging unit and vibration analyzer (*SVAN 958A*) was used to record whole body vibration during trails to record simultaneous noise measurements and tri-axial vibration assessment. This allows obtaining broad-band results such as Lmin, Lmax, RMS, Leq, L peak together with 4 channel analysis octave band analyses.

Results and Discussion

The vibration were measured and analyzed along the foot to the head of the worker in standing posture as shown in Figure 1. The tri-accelerometer (Svan 958A) was attached to bed of the power press with magnet attached to the power press (capacity 2000 ton) to measure the vibration transmitted the floor to head of the worker. The power press was running at speed 1500 rpm to record the output acceleration. The vibration measurements were recorded using whole body accelerometer (SV 38V) with piezoelectric sensor which measures the vibration in tri axial direction of sensitivity 50 mv/ms^2 of range 0.1 to 100 Hz. An elastic wrap utilized to cling the head sensor attached to the head of worker. Five trials were carried out by same elastic wrap on same place in all workers. The transmissibility, RMS, VDV were measured with WBV and HAV and communicate in one third octave bands with frequencies from 0 to 6300 Hz and 95 db (Table 2).

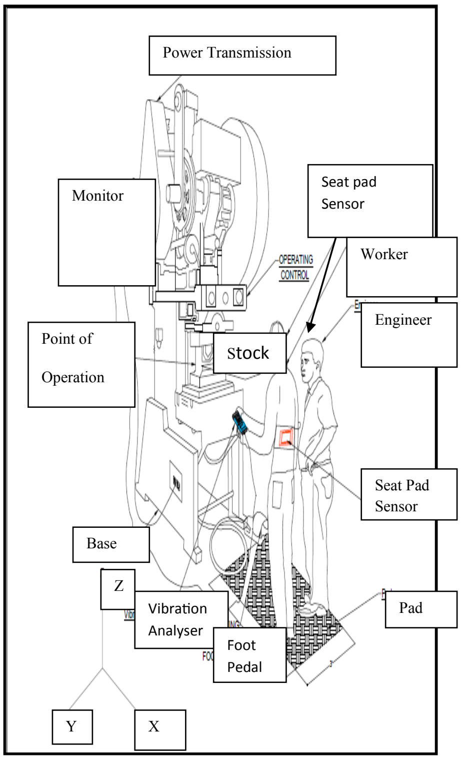

Figure 2: Systematic representation of experiment set up.

Total five trials and 238 experiments (Figure 2) were conducted on 10 male workers who were already informed about the risk related to vibration exposure. The seat pad sensor was mounted on backrest and hand arm senor was mounted on head of workers with elastic wrap. Both sensors recorded the vibration simultaneous on backrest and forehead using vibration analyzer with tri axial direction with piezoelectric sensor. The workers were asked to keep erect posture during recording. The measurements time lapse was 1second and sample rate 6000/second which varies with respect to workers and place of sensor. The workers were asked to keep both legs 30 cm apart and measured the vibration WBV on z axis direction.

The floor vibration was measured by piezoelectric sensor (Svan 958A) in which records WBV in tri axial direction generated from power press of capacity (2000 ton) in which a magnet was mounted to the bed of power press. The channel 1was used to measure vibration in x axis shown by red colour and channel 2 was used to measure vibration in y axis shown by green colour and channel 3 was used to measure vibration in z direction shown by blue colour (Appendix Tables 1-3).

The back rest and forehead vibration were measured by piezoelectric sensor in tri axial direction at head transmitted from foot. The channel 4 was used to measure vibration in x-axis shown by red colour and channel 5 was used to measure vibration y-axis shown by green colour and channel 6 was used to measure vibration in z-axis shown by green colour. The maximum acceleration was recorded 0.75 m/s^2 at frequency at 12 Hz (Figures 3 and 4).

Calculation of transmissibility

The transmissibility in all three directions is calculated by:

$$T_r head = \frac{F_{L-j}}{H_L - j} \; j = X,\ Y,\ Z \qquad (1)$$

Where, T_r is the total transmissibility at head. F_L is floor vibration recorded by accelerometer. H_L is head vibration recorded by vibration analyzer.

Total vibration

$$T_{vib} = \int T_{floor+} \int T_{back} + \int T_{head} \qquad (2)$$

The total vibration of the entire system is calculated by eqn. (2) in which the vibration transform from floor to the back and head.

The eqn. (1) is used to calculate the transmissibility at backrest and forehead. The transmissibility curve at back and head was shows in Figure 3. But the transmissibility change with mass at frequency above 10 Hz. The transmissibility values are large at foot as compared to back and head. Figures 3 and 4 show the transmissibility to the foot, back and head for 10 workers under different conditions. The transmissibility determined at back and head by vibration analyser as shows in Figure 3. The resonant frequency of both foot and head are different. The vertical vibration measured in z directions and transmissibility at back and forehead calculated in all three directions. The highest transmissibility is observed at back at 10 Hz and at head 20 Hz with resonance peak 1.0. The transmissibility decreases when distance increase from foot to head. The above conclusion suggests that at point back and head do not affect the biodynamic of foot and legs in the whole frequency range, while the vibration effects on soft and hard tissue. There were some research describe that the vibration transmission to head could not perceive auditory effect of vibration in head. Because at the low frequency resonance in with limited extent transmitted to head.

Range of vibration	Scale of discomfort
< 0.315 m/s^2	Not uncomfortable
≤ 0.315−0.63 m/s^2	A little uncomfortable
≤ 0.5−1.0 m/s^2	Fairly uncomfortable
≤ 0.8−1.6 m/s^2	Uncomfortable
≤ 1.2 −2.5 m/s^2	Very uncomfortable
> 2.0 m/s^2	Extremely uncomfortable
Less than 0.315 m/s^2	Not uncomfortable

Table 2: Scale of discomfort suggested in BS 6841 and ISO 2631.

Trail	X-axis (m/s^2)	Y-axis (m/s^2)	Z-axis (m/s^2)	RMS (m/s^2)	Transmissibility (m/s^2)
1	0.36	0.87	0.52	0.32	0.32
2	0.25	0.18	0.19	0.22	0.08
3	0.37	0.46	0.41	0.51	0.16
4	0.27	0.81	0.47	0.11	0.33
5	0.62	1.80	0.86	0.34	0.40

Table 3: Recording head vibration.

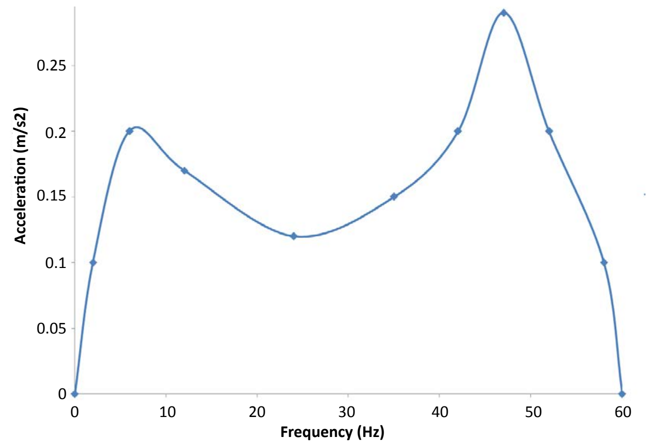

Figure 3: Vibration transfer from feet to head.

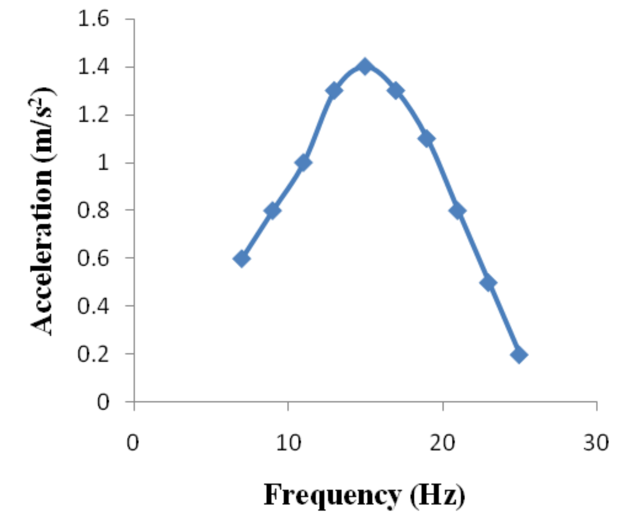

Figure 4: Transmissibility.

Figure 4 shows the vibration exposure of 10 workers at different frequency and amplitude. From the above sketches it showed that the workers retaliate WBV at 10 Hz for backrest and 20 Hz for head feeling anxiety.

Some of observation from the experimentation of 10 workers at different frequencies and amplitude are given follows (when the workers standing posture and the distance between legs were 30 cm apart) (Table 3).

- At frequency 4 Hz and acceleration 0.2 m/s^2 for backrest, the observation was that the workers feeling difficulty positioning hands.

- At frequency 8 Hz and acceleration 0.40 m/s^2 for backrest, the observation was that the workers feeling lumbar vertebrae resonate.
- At frequency 12 Hz and acceleration 1.0 m/s^2 for backrest, the observation was that the workers feeling resonance of gastrointestinal system.
- At frequency 13 Hz to 20 Hz and acceleration 1.6 m/s^2, the observation was that for forehead the workers feeling voice warbles vision blurred (resonance of the eyeballs).

Conclusions

The above conclusion that at frequency 6 Hz the greater transfer of vibration from the ground to the head motion, at this frequency there are matching of natural frequencies of human body and power press. The transmission of vibration was not depending upon weight and age. It was depend upon posture of workers from above conclusion from the experiment data.

The above analysis shows that the transmissibility decrease with increase in distance from ground at generating source. The maximum value of transmissibility was at 6 Hz at which was less than at back and feet. The vibration transmission at back frequency 7 Hz and head 17 Hz due to the resonance frequency of human body because the frequency of the human body reacted to vibration and the vibration transfer to the backrest and head. The transmissibility received at back and head to define the vibration exposure in all three directions (x-axis, y-axis, and z-axis).

References

1. Brazil B, Griffin MJ (2010) The vibration of inclined backrest perception and discomfort of vibration applied normal to the back in the X-axis of the body. International Journal of Sound and Vibration 330: 4646-4659.
2. Paddan GS, Griffin MJ (1991) The of translational floor vibration to the heads of standing subjects. Journal of Sound and Vibration 160: 503-521.
3. Paddan GS, Mansfield NJ, Arrowsmith CI, Rimell AN, King SK, et al. (2012) The influence of seat backrest angle on perceived discomfort during exposure to vertical whole body vibration. Ergonomics 55: 923-936.
4. Nawayseh N, Michael G (2004) Tri axial forces at the seat and backrest during whole body vertical vibration. International Journal of Sound and Vibration 277: 309- 326.
5. Ishbir S, Nigam SP, Saran VH (2016) Effect of backrest inclination on sitting subjects exposed to WBV. 3rd International Conference on Innovations in Automation and Mechatronics Engineering, ICIAME 23: 76-83.
6. Xiaolu Z, Yi Q, Michael JG (2015) Transmission of vertical vibration through a seat Effect of thickness of foam cushions at the seat pan and the backres. Int J Ind Ergon 48: 40-45.
7. Xueyan S, Xu Ren G,Christopher W (2017) Vibrations transmitted from human hands to upper arms, shoulder, back, neck and head, Int J Ind Ergon 62: 1-12.
8. Xueyan S, Xu Ren G,Christopher W (2017) Vibrations transmitted from human hands to upper arms, shoulder, back, neck and head, Int J Ind Ergon 62: 1-12.
9. Lynn M, Nigel E, Corlett (1993) A survey method for investigation of work related upper limb disorders. International Journal of Applied Ergonomics 24: 91-99.
10. Rittweger J, Beller G,Felsenberg D (2000) Acute physiological effects of exhaustive whole body vibration exercise in men. Clinical Physiology 20: 134-142.
11. Roberto D, Angela C,Christian P (2017) Whole-body vibration: measurement of horizontal and vertical transmissibility of an agricultural tractor seat. International Journal of Industrial Ergonomics 58: 69-72.
12. Zhu S, Sakakibara H, Yamada S (1997) Combined effects of hand-arm vibration and noise on temporary threshold shifts of hearing in healthy subjects. Int Arch Occup Environ Health 69: 433-436.
13. Zehsaz M, Sadeghi MH, Ettefagh MM,Shams F (2011) Tractor cabin's passive suspension parameters optimization via experimental and numerical methods. Journal of Terra Mechanics 48: 439-450.
14. Zhou Z, Griffin MJ (2014) Response of the seated human body to whole-body vertical vibration biodynamic responses to sinusoidal and random vibration. Ergonomics 57: 693-713.