Sound Attenuation Characteristics of Inner Helmet and Bone Dome

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Abstract

THE sound attenuation characteristics of inner helmet and bone dome have been determined by primary method. Significant attenuation is achieved when both the helmets are used together. For lower frequencies, the attenuation is 8—11 db and for higher frequencies, the attenuation ranges between 15—41 db.

Introduction

Glorig[1] conducted audiometric survey of people working in noisy environment and established hearing damage as a result of exposure to noise.

Murty and Verghese[2] carried out a detailed noise survey for most of the aircraft in the Indian Air Force. They observed that noise levels in the helicopters were much above the acceptable safe limits and recommended the assessment of actual protection given by the helmets used by the pilots.

The sound attenuation characteristics of inner helmet and bone dome will add to the parameters of noise levels and frequency characteristics while defining the maximum permissible noise levels in an aircraft.

Basically, there are two procedures to study the sound attenuation characteristics of a noise protection device. One is the physical method where an artificial ear is used as sound sensing device and other is the real ear method where the human ear is the sound sensing agency. The present study has been done using the latter method.

Material and Methods

Twelve healthy subjects volunteered for the test. All the subjects had normal hearing audiometrically and with no past history of ENT disability. Complete ENT examination was carried out to rule out any ENT disease before participation in the test. The study was carried out in an anechoic chamber.

The subjects were seated comfortably. Pure tones generated by the BEL audiometer (Type KN 222A) were used, keeping the headphone at a distance of 25 cms from pinna of the subjects. The threshold of hearing was determined for eight discrete frequencies (250 Hz-8 KHz) in each ear separately without any helmet, with inner helmet and finally with inner helmet and bone dome. The non testing ear was blocked with an insert type of ear defender. Type-6 inner helmet and CBE Mk I Bone Dome have been used for the present study.

Results and Discussion

Table I shows the mean threshold of hearing of subjects.

TABLE I

Mean threshold of hearing of subjects. I-without helmet, II with inner helmet, III-with inner helmet and bone dome

Frequency	Right ear			Left ear		
Hertz	I	II	III	I	II	III
250	66.7	69.2	69.6	67.2	70.4	69.6
500	65.4	69.6	70.0	67.1	70.0	70.8
1000	61.3	65.0	69.6	59.6	64.2	70.8
2000	44.6	54.2	60.0	43.3	52.9	60.0
3000	32.1	47.5	61.7	33.8	49.2	62.5
4000	27.5	45.4	62.1	27.9	47.1	62.9
6000	20.8	43.8	54.2	19.2	43.8	55.0
8000	24.2	48.8	60.4	20.0	48.3	61.7

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The mean differences in threshold of hearing for various frequencies are shown in Table II.

TABLE II

Mean differences in threshold of hearing for various frequencies. I–without helmet, II–with inner helmet and III–with inner helmet and bone dome

Frequency Hertz	Right ear			Left ear		
	I-II	I-III	II-III	I-II	I-III	II-III
250	2.5*	2.9*	0.4£	2.9*	2.1*	0.8£
500	4.5$	4.6$	0.4£	2.9*	3.7*	0.8£
1000	3.7*	8.3$	4.6*	4.6$	11.2$	6.6$
2000	9.6$	15.3$	5.8*	9.6$	16.7$	7.1$
3000	15.4$	29.6$	14.2$	15.4$	28.7$	13.3$
4000	17.9$	34.6$	16.7$	19.2$	35.0$	15.8$
6000	23.0$	33.4$	10.4$	24.6$	35.8$	11.2$
8000	24.6$	3 .2$	11.6$	28.3$	41.7$	13.4$

(£ Not significant, * $P < 0.01$, $ $P < 0.001$)

The mean differences between I and II signifies the attenuation characteristics of the inner helmet. The difference between I and III shows the attenuation by inner helmet and bone dome together, while that between II and III shows the attenuation given by the outer helmet alone.

As seen from the Table I, the attenuation by inner helmet and bone dome separately for low frequencies (250 Hz and 500 Hz) is 2.5–4.2 db and 3.4–4.6 db respectively which appears insignificant. But the attenuation of both the helmets together is 8.3 db at 1 KHz for right side and about 11 db for the left side of the helmets. The attenuation is more for the higher frequencies i.e. 2 KHz and above. The attenuation by inner helmet ranges between 9.6–24.6 db for various high frequencies and by bone dome ranges between 5.8–16.7 db (for discrete frequencies and side, refer to Table II). The attenuation when inner helmet and bone dome are used together (which is the normal practice) ranges between 15.4–41.7 db. Thus the study reveals that a significant amount of noise attenuation is achieved when inner helmet and bone dome are used together. There is an attenuation difference of 1–2 db between two sides of the helmets when used alone. This difference is negligible and could be due to asymmetry of the helmet during manufacture. The possibility of the subjective error also cannot be ruled out.

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