FUNDAMENTAL DYNAMIC CHARACTERISTICS OF HUMAN SKULL
Part I – Experimental Modal Analysis and FE Modelling of Basic Vibration Properties

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This contribution presents experimental investigations of the frequency modal and damping characteristics and finite element (FE) modelling of the basic vibration properties of the human skull. Original experimental results of the vibration modal analysis of two different male skulls are presented and the frequency dependent transfer functions between selected, anthropologically important points on the skull are studied. The influence of the soft brain tissues on dynamics of the skull was approximately simulated by especially prepared gelatine. The FE model of the human skull was developed from the computer tomograph (CT) scanning of the identical skull measured in the laboratory. The developed FE model is verified by the results of the measurements of fundamental frequency – modal characteristics and the transfer functions for selected points on the skull. In a general way the study is focused on problems of bone conduction hearing. The FE model, which incorporates the interaction of the skull bones and soft tissues (brain), should enable an approximate modelling of the dynamic response of the skull near the hearing organs to the external noise or to the excitation by own human voice.

Key words: *biomechanics of human head, biomechanics of voice and hearing, phoniatry, bone conduction of sound, modal analysis, finite element model of the skull*

1. Introduction

Biomechanics of human voice and hearing is closely related to vibration and noise. Many researchers are frequently engaged in modelling of vibroacoustic properties of various systems, however, a rare case is the calculation of vibroacoustic characteristics of human hearing and voice systems. In general, the vibrating deformable body and the surrounding acoustic space or a fluid region creates a coupled acoustic-structural or fluid-structural system, which can be modelled by FE methods as one dynamic system. This approach enables to predict vibroacoustic characteristics of such systems. However, the computational models must be verified by experiments. The substantial problem is to model correctly the real material properties of the system.

The purpose is to create a computational FE model of the sound transmission chain and to use such model in simulation of the influence of external noise on the human being or the effects of various weak spots of sound transmission paths causing hearing disorders.

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