MROZOWSKI J., AWREJCEWICZ J., ŚMIAŁEK R.
Technical University of Łódź
Department of Automatics and Biomechanics
ul. Stefanowskiego 1/15, 90-924 Łódź
tel. +42 631 2226, e-mail: jmrozow@ck-sg.p.lodz.pl

76

STRESS ANALYSIS IN TIBIA AND FIBULA

1. Introduction

One of main problems in the human skeleton mechanics investigations is to determine stresses that occur in its individual elements. However, as the analysis of stresses in the femur has been the topic of numerous publications, the issue of stresses in shinbones has been rather rarely analysed. This study presents an analysis of stresses in shinbones carried out with the finite element method. This method seems to be the most suitable one in the case of investigations of structures with irregular shapes (as it is in the case of shinbones).

2. Construction of the model of lower leg bones

A development of the model consists of five basic steps, namely: a selection of material coefficients, a determination of the model shape, a choice of the kind and size of the element, a reduction of degrees of freedom, and a determination of the load scheme.

A selection of material coefficients has been made on the basis of data taken from literature. They are presented in the Table 2.1.

Table 2.1.

	Cortical bone	Cancellous bone
Modulus of elasticity E [MPa]	15000	350
Poisson's ratio	0.29	0.46

We have tried to represent the shape of shinbones in the sagittal plane and the frontal plane as precisely as possible. Special attention has been paid to maintain distributions of the cancellous tissue in the close and far end of both bones similar to the actual ones. The main axis of the tibia, being the mechanical axis of the pelvic limb simultaneously, has been maintained out of plumb by the angle of 3°.

The meshing has been made using a "tet10node w/rotate 72" tetragonal element with 6 degrees of freedom in each node and the dimension of 4.6 mm.

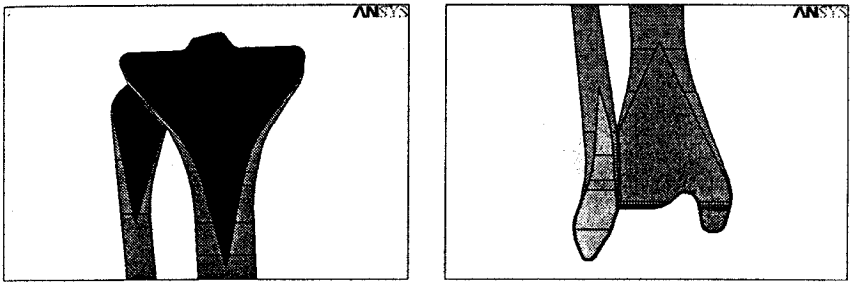

Fig. 2.1. Distribution of the cancellous tissue in the close and far end of both the shinbones.

3. The exemplary numerical results

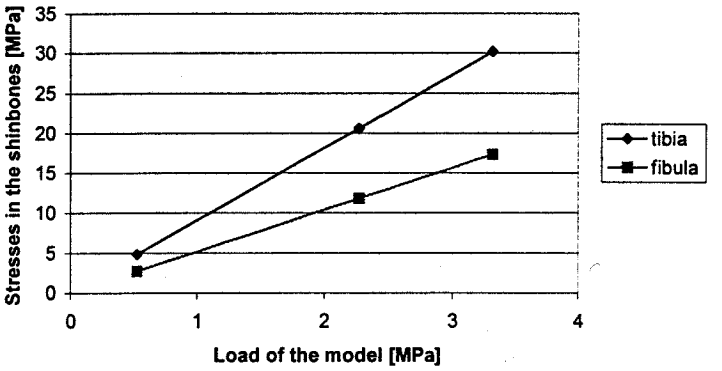

Fig. 3.1. Stresses in the shinbones versus the knee joint load.

4. Conclusions

a) In the case when both the shinbones operate, maximum stresses in the fibula are about 75% of maximum stresses in the tibia.
b) In the model of the tibia itself, maximum stresses occur in two opposite regions of the bone.
c) An increase in maximum stresses in the tibia after a removal of the fibula is of approximately 51%.

References

1. Bochenek A., Reicher M.: Man's Anatomy, PZWL, Warszawa, 1990, In Polish.
2. Zienkiewicz O. C.: Finit Element Method, Arkady, Warszawa, 1972, In Polish.