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Research

Some Properties of Bones and Fluorapatite

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Abstract

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of dried phalanx, dried femur, fresh phalanx, and fluorapatite are calculated. The relation of the scalar parts norm and the other parts norms and the anisotropy of the dried bovine phalanx, fresh bovine phalanx, dried bovine femur, human cortical bone, children, human cortical bone, adult and fluorapatite are presented. The norm ratios are used to study anisotropy of the dried phalanx, dried femur, fresh phalanx, and fluorapatite and the relationship of their structural properties and other properties with their anisotropy are given.

Keywords: Dried Phalanx; Dried Femur; Fresh Phalanx; Cortical Bone; Fluorapatite; Norm; Anisotropy and Elastic constants.

Introduction

The decomposition procedure and the decomposition of elastic constant tensor is given in [1-4], also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [1-4]. As the ratio N_S/N becomes close to one the material becomes more isotropic, and as the ratio N_n/N becomes close to one the material becomes more anisotropic as explained in [1-4].

Calculations

The elastic constants used for the different materials are taken from previous published studies [5-6] and reported in Table 1. By using and the decomposition of the elastic constant tensor, we have calculated the norms and the norm ratios as shown in table 2.

Results and Conclusion

From Table 2 and the Graphs (Graph 1 to Graph 3) and analyzing the ratio $\frac{N_d}{N}$, we can conclude that Dried Bovine Femur is the most isotropic material, and Human Cortical Bone, Adult (50-91 years) and Human Cortical Bone, Children (5-18 years) are the least isotropic materials and the most anisotropic materials because the values of N_S/N are the smallest and the values of $\frac{N_d}{N}$ and $\frac{N_d}{N}$ are the largest". "However, we can say that that Human Cortical Bone, Children (5-18 years) is more isotropic than Human Cortical Bone, Adult (50-91 years). Moreover, we notice that Fresh Bovine Phalanx is more isotropic than Dried Bovine Phalanx and Dried Bovine Phalanx is more Anisotropic than Fresh Bovine Phalanx because the value of $\frac{N_d}{N}$ is more small and the values of $\frac{N_d}{N}$ and $\frac{N_n}{N}$ are more large for Dried Bovine Phalanx.

The Fluorapatite (which solid material and not a bone) is more isotropic than Dried Bovine Phalanx, Fresh Bovine Phalanx, Human Cortical Bone, Children (5-18 years), and Human Cortical Bone, Adult (50-91 years). In addition we can notice by considering the value of $\boldsymbol{N}$ that this value is the highest (336.0716) in the case of Fluorapatite material so we can say that the Fluorapatite elastically is the strongest, and the in the case of Human Cortical Bone, Children (5-18 years) (29.2745) where the value of $\boldsymbol{N}$ is the smallest so we can say that the Human Cortical Bone, Children (5-18 years) elastically is the least strong material.

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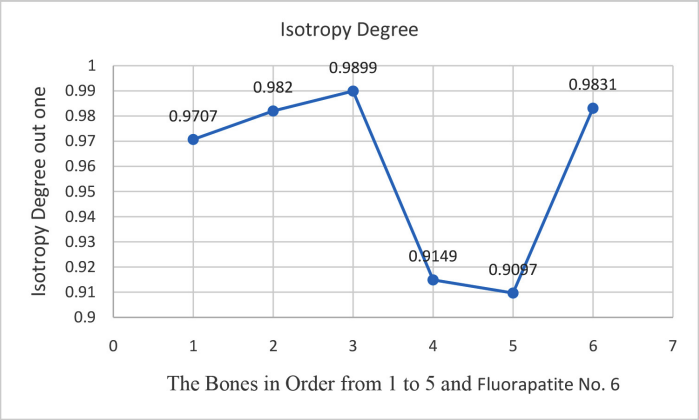
Table 1 : Elastic Constants (GPa), [3,4]

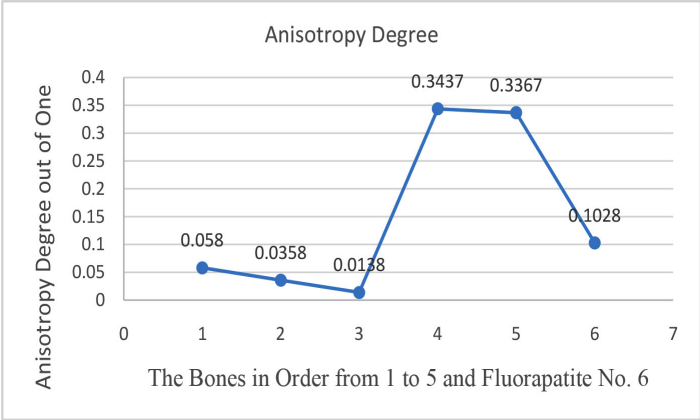
No.		C_{11}	C_{22}	C_{33}	C_{12}	C_{13}	C_{44}	C_{55}	C_{66}
1	Dried Bovine Phalanx	21.2	21.2	37.4	9.5	10.2	7.5	7.5	5.85
2	Fresh Bovine Phalanx	19.7	19.7	32	12.1	12.6	5.4	5.4	3.8
3	Dried Bovine Femur	23.8	23.8	33.4	10.2	11.2	8.2	8.2	6.8
4	Human Cortical Bone, Children (5-18 years)	16.1	15.3	23.6	-	-	4.1	4.0	3.0
5	Human Cortical Bone, Adult (50-91 years)	17.9	17.9	28.8	-	-	4.8	4.9	3.6
6	Fluorapatite	166.7	166.7	139.6	13.1	65.5	66.3	66.3	76.8

Table 2 : The norms and norm ratios

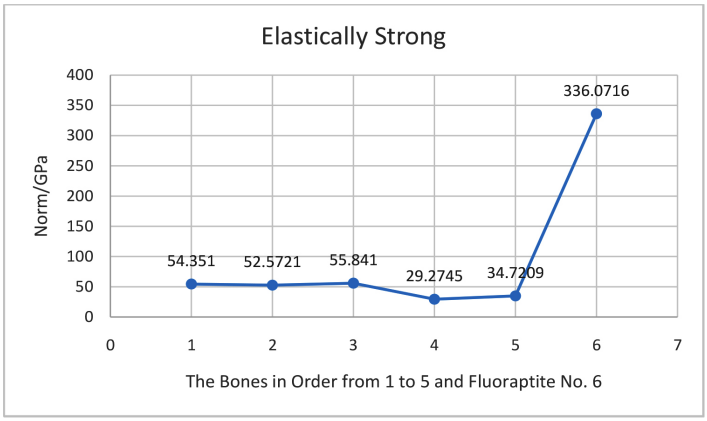
No.	**Material**	N_s	N_d	N_n	N	N_s / N	N_d / N	N_n / N
1	Dried Bovine Phalanx	52.7594	12.6708	3.1520	54.3510	0.9707	0.2331	0.0580
2	Fresh Bovine Phalanx	51.6248	9.7847	1.8835	52.5721	0.9820	0.1861	0.0358
3	Dried Bovine Femur	55.2781	7.8699	0.7688	55.841	0.9899	0.1409	0.0138
4	Human Cortical Bone, Children (5-18 years)	26.7823	6.2039	10.0606	29.2745	0.9149	0.2119	0.3437
5	Human Cortical Bone, Adult (50-91 years)	31.5842	8.4442	11.6908	34.7209	0.9097	0.2432	0.3367
6	Fluorapatite	330.401	50.8441	34.5540	336.0716	0.9831	0.1513	0.1028



Graph 1. The Isotropy Degree of the given bones and Fluorapatite.



Graph 2. The Anisotropy Degree of the given bones and Fluorapatite.



Graph 3. The elastically strong of the given bones and Fluorapatite.

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