The Icosahedron as a Biologic Support System

This is a pdf copy of the abstract page from the Proceedings, 34th Annual Conference on Engineering in Medicine and Biology, Volume 23, September 21-23, 1981, Huston, Texas. It was my first publihed paper on biotensegrity. I had previously presented its content at several conferences. This was presented in a poster session at the Alliance for Engineering in Medicine and Biology annual conference. My concepts haven't changed much since then. 2009-08-08

P6.6 THE ICOSAHEDRON AS A BIOLOGIC SUPPORT SYSTEM

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Present concepts of engineering, as applied to biologic structures are based on a cubic system. These structures are conceived as columnar loaded, with lever-torque angular relationships and moment joints. Tensional forces merely act as the glue to hold the structure together. Such a structure is inherently unstable and has unidirectional orientation with rigid joints and poor strength-to-weight ratios and maximum energy requirements for any movement capabilities. If we follow the natural laws of closest packing of structures, triangulation, and the natural creation of forms and structures according to the requirements of minimal energy, we are led to the icosahedron, a structure that is omnidirectional, symmetrically compressible and expandable and local-load distributing. This structure is omnipresent in nature and is the basis for the supporting framework of all viable structures from viruses to vertebrates, including man.

Triangulated frameworks exhibit inherent stability and can be built without moment joints and with axial-loaded members that may be in tension or compression. This results in high strength per weight, minimum energy requirement structures. The regular polyhedra structures, the tetrahedron, octahedron, and icosahedron are fully triangulated and are shown to be ubiquitous in nature. The icosahedron has the largest volume per surface area of any polydron, and can be constructed with an exo- or endo-support system. Once constructed, no matter how a force is applied, a tension member always remains a tension member, and a compression member always remains a compression member, a truly omnidirectional system. Icosahedra are adaptable to the natural laws of close packing of spheres and the hierarchy of intrinsic and extrinsic forces in balance. Icosahedra can be combined in periodic arrays of an infinite variety of shapes and sizes, so that the structure is entirely integrated and omnidirectional with flexible hinges and local-load distribution, as are all animated structures. Examples of icosahedra are demonstrated in adenoviruses, radiolaria, and up the evolutionary scale to vertebrate structures, such as the shoulder girdle, the sacro-iliac joints and the radiohumeral syndesmosis. Experimental confirmation using arthroscopic evaluation of joints in humans is presented. Icosahedral structures do not have compressive loads across joints. In vivo examinations of human knees, elbows and ankles were performed and loads applied. No compressive loading across the joints could be demonstrated.

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