A cell is the fundamental unit of life. Mechanical forces in a cell are a driving factor in the many essential life processes of the cell. The cytoskeleton of the cell is a key contributor in the generation of mechanical forces in the cell. These mechanical forces play a major role in many essential processes of a cell such as growth, proliferation and metastasis. More insight into such dynamic behaviour of cells is required in order to design better treatment for diseases such as cancer. Simulations models which consider the discrete elements of the cytoskeleton is necessary to analyse cells. There is sufficient evidence that the cytoskeleton of a cell surprisingly exhibits similarities with the dynamics of a prestressed tensegrity structure. The main aim of the study is to develop an FEM model of a cancer cell, using tensegrity structures, which exhibits the dynamic characteristics of cancer cells. An effective simulation model of a cancer cell helps biologists to analyse cancer cells under different Mechanical stimuli, for which experimentation is expensive.

In the present study, the geometry and dynamics tensegrity structures are studied. Along with the popular 6 strut spherical tensegrity, higher order complex spherical tensegrities are mathematically studied and successfully generated. These structures are incorporated to represent the cytoskeleton and nucleus of a cancer cell. The mathematical formulations of the system parameters like the mass and stiffness matrices are studied and successfully implemented in MATLAB. Simulation of the tensegrity models is performed on ANSYS APDL platform. MATLAB functions are used to automate the process of generating the necessary APDL codes to build the model.

Each of the tensegrity models are generated in MATLAB conform to a standard structure. The most fundamental data of any tensegrity model is the cartesian coordinates of its node points. The next essential data required is the elements connections which contains the details of the pairs of nodes which for the various elements of the tensegrity (struts, cables and interfilaments). On the next level of hierarchy, we have the lists of elements which are struts, cables and interfilaments. The hierarchy of these data is captured in Figure 1.

**Fig. 1** **Common structure of each tensegrity model**

The tensegrity model generation happens on a MATLAB package consisting over 25 scripts. These scripts enable the easy generation of a large number of configurations and combinations of tensegrity models. They are compatible with any tensegrity model which significantly simplify the process of visualization and validation. These codes also help a lot in carrying over the tensegrity model onto the ANSYS simulation platform by automatically generation the necessary APDL codes. The nodal coordinates and element connections are directly printed using a MATLAB script which is pasted into the APDL macro code file. This enables rapid model development for any tensegrity structure and also avoids human error while generating the model.

Tensegrity structures are remarkable models which are capable of displaying many. These structures show a lot of potential in capturing the complex behavior of many elements found in nature. Development of mathematical and simulation models on tensegrity bridges the gap between mechanics and biology at the cellular level which promises to solve larger biological complex problems.

**References**

**Tensegrity Models of cells:**

[1] Ingber, D. E., “Cellular Tensegrity: Deﬁning New Rules of Biological Design That Govern the Cytoskeleton,” Journal of Cell Science 104, 1993, p. 613-627

[2] Scarr, G., 2014, Biotensegrity: The Structural Basis of Life, Handspring Publishing, Scotland. <http://www.tensegrityinbiology.co.uk/>

[3] Hwabok Wee, Arkady Voloshin. 2014. Dynamic Analysis of a Spread Cell Using Finite Element Method. Mechanics of Biological Systems and Materials Vol 4. pp 135 - 140.

**Videos:**

* [Dr Donald Ingber Special Presentation to Victorian Secondary School Science Students](https://www.youtube.com/watch?v=w8QZGOIQxXQ)
* [Science On Tap: Biologically Inspired Engineering with Donald E. Ingber, MD, PhD](https://www.youtube.com/watch?v=YdvE-sawpXs&t=416s)
* <https://www.cancercenter.com/community/blog/2018/02/how-does-cancer-do-that-sizing-up-cells-and-their-shapes>

**Form Finding:**

[4] Gan, B.S. (2019).Computational modeling of tensegrity structures: Art, nature, mechanical and biological systems.Cham, Switzerland: Springer InternationalPublishing. <https://link.springer.com/book/10.1007%2F978-3-030-17836-9>

[5] G. Gomez Estrada, H.-J. Bungartz, C. Mohrdieck, Numerical form-finding of tensegrity structures, International Journal of Solids and Structures, Volume 43, Issues 22–23,, 2006, Pages 6855-6868, ISSN 0020-7683, <https://doi.org/10.1016/j.ijsolstr.2006.02.012>.