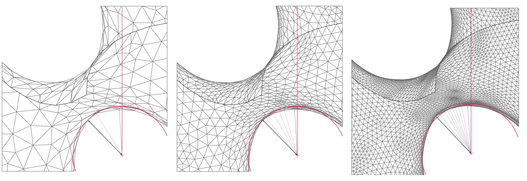
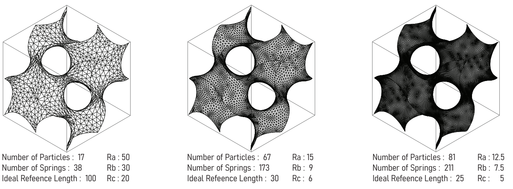
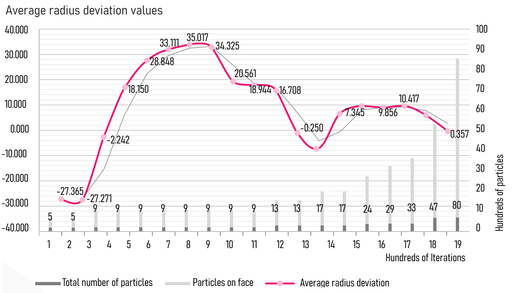
DESCRIPTION AND GENESIS OF MINIMAL SURFACES

Rest of the second part my work was design choice for slab, walls atc. Going throught alternatives, I was interested in Alan Schoen research.
A minimal surface is a surface whose mean curvature is always zero. This definition answers to the Plateau problemproposed by Lagrange in 1760: if a closed polygon or oblique plane is assigned, then there is always a system of surfaces, including all possible surfaces that touch the frame, which are able to minimise the area. The minimal area of the soap film's surface of is one of the many examples that illustrates a well-known physical principle governing forms and motions of natural objects: the principle of least energy waste (or least action). It states that any physical configuration assumes its state or path in such a way that the energy requirement is minimal. In soap films, the shape minimizes the potential energy balancing the intermolecular force. Therefore this energy is directly proportional to the surface area of the soap films (assuming that the thickness of soap films is uniform) and, as a result, the soap films achieve minimal area. This means that minimal surface combine structure and material in a very efficient manner by aligning force and geometric form in an organic shape. A triply periodic minimal surface (TPMS) is a minimal surface, which is periodic in three independent directions. TPMS are described in terms of a fundamental patch or asymmetric unit from which the entire surface may be built up by its symmetry elements. A single minimal surface is characterised by different curvatures: in other words, some surfaces are flatter than others. It follows that not all points of the surface support any concentrated loads equally well. If the same surface is, however, associated with a periodic distribution the physical iteration between the modules causes a compensatory effect that greatly increases their structural efficiency.

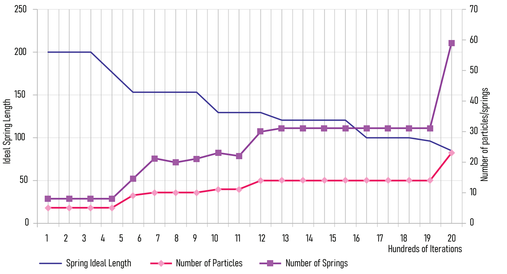




Multiple Ideal Spring Lengths instances of the Schwarz G (Gyroid) Surface.

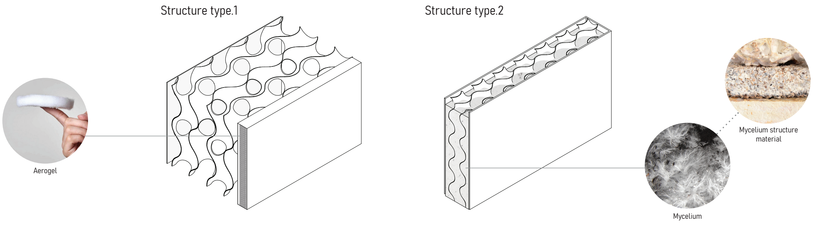


Radius deviations and the graph of the average deviation from the radius of the circular boundary on the face of the cube.

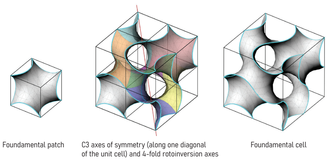


Graph illustrating the increase in number of the particles in relation with the decrease of the ideal spring length.

The conventional construction methods pose several environmental issues such as generating heat, pollution and waste. The growing population and in turn, growing need for more construction set an almost insurmountable challenge for the practitioners and the industry as a whole. The concepts have inspired the adoption of discoveries and contributions of other disciplines such as biology, mycology and mathematics.
Mycelium composite is a promising alternative material in terms of thermal and acoustic as well as fire safety performance. The study on the types of lattice structures led to the adoption of Triply Periodic Minimal Surfaces as the solution for the adaptive lattice structure. Manufacturing of these surfaces is not possible with conventional manufacturing techniques. The rise of additive manufacturing technologies, however, enables the production of highly complex topologies including Triply periodic minimal surfaces.

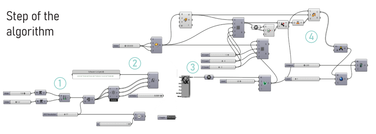


Constructure principles of TPMS (Triply periodic minimal surfaces) based on Gyroid

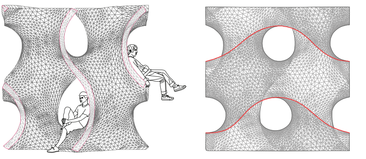


that, the study of TPMS for design purposes is particularly fascinating. These surfaces may be made by defining and evolving their fundamental region, which is usually very simple due to the high symmetry, and then displaying many suitably transformed copies. Several fundamental regions are one of Coxeter's kaleidoscopic cells. Many of these surfaces were described by Alan Schoen in a famous NASA report. [10] The first step was to find a way to generate and control the TPMS in digital environment. The computation played an essential role in the simulation and modelling process of such complex phenomena. It was used Grasshopper, a graphical algorithm editor tightly integrated with Rhino's 3- D modelling tools in order to create an algorithm able to describe and to control various types of TPMS. This research applies minimal surfaces that can be described by implicit form, typically a linear function of three variable, f (x, y, z) = 0. The trigonometric form is appropriate to the digital description because it allows the handling of the large number of elements that characterize TPMS, without overload the calculation process and also does not allow selfintersections. Using Grasshopper it's possible to define algorithms that are able to describe with good approximation any minimal surfaces directly from its implicit formulation. The algorithm translates the algebraic equation into a finished form that can be studied, manipulated and replicated.

Step of the algorithm

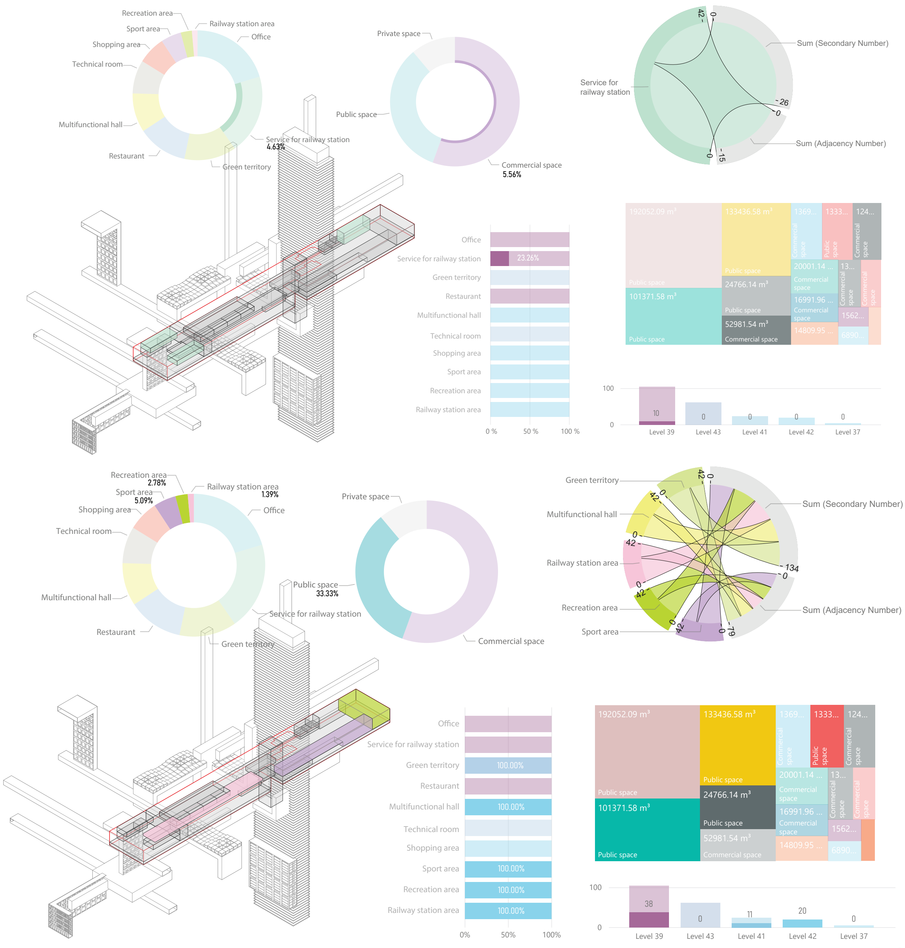


1. Definition of points in the fundamental cell;
2. Triangulation creates the surface;
3. Gyroid surface;
4. Invariant translation to create a TPMS based on Gyroid.



BIM-ANALYTICS. ROOM SCHEDULE (CENTRAL HUB)

AUTODESK REVIT → SCHEDULES/QUANTITIES. ROOM SCHEDULES → EXPORT DATA → EXCEL → MICROSOFT POWER BI



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