3.1 Generation of Geometry

The first part of the program consists of the generation of the lattice geometry. The user is allowed to select between different Lattice unit cells both 2D and 3D.

Geometrical parameters as structure thickness, cell size and relative density can be imposed.

The lattice pattern is generated by symmetrical repetition of the unit cell in the three directions of space.

The Geometrical generation module allows also to create functional grading of relative density.

Two different codes are used for the 2D case and 3D case. This way the degrees of freedom of the bidimensional lattice analysis can be reduced.

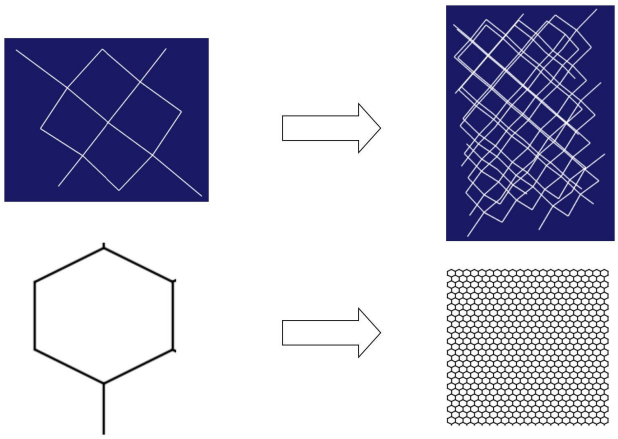

Figure 3.1: Generation of the geometry 2D and 3D

3.2 Fatigue Analysis

The Fatigue analysis module requires to perform two different FE calculations for each structure failure. The loading cycle data are inserted in the model through Maximum Force on the top plate of the specimen and R ratio.
Two FE analysis are performed corresponding to maximum and minimum macroscopic loading. This way a stress cycle can be determined for every beam element constituting the structure.
For the calculation of the beam element displacements Anastruct (R.Vink 2019) module was used for the 2D analysis, while for the three dimensional case Pynite (J.Wock 2019) module was used.
Both those Python open source classes calculate beam elements force and displacements, but they were adapted to calculate stresses and deal with lattice structures.
After FE analysis, maximum stress is examined in order to see if it's bigger than ultimate strength of the base material.
If one ore more elements surpass ultimate stress level, static failure is supposed to happen, and the element with the higher stress is removed and the analysis repeated.
Thanks to this procedure, if several elements are supposed to statically fail, they can be removed in a progressive way to take into account the stress redistribution after every static failure.
If stress levels are consistent with fatigue analysis, mean stress correction is applied and life of each structure is calculated using the Basquin relation.
Damage is updated using Miner's Rule of linear damage accumulation. Statically failed ligaments don't contribute to the damage accumulation and to the general fatigue life.
The process is iterated and repeated until the final collapse is reached.

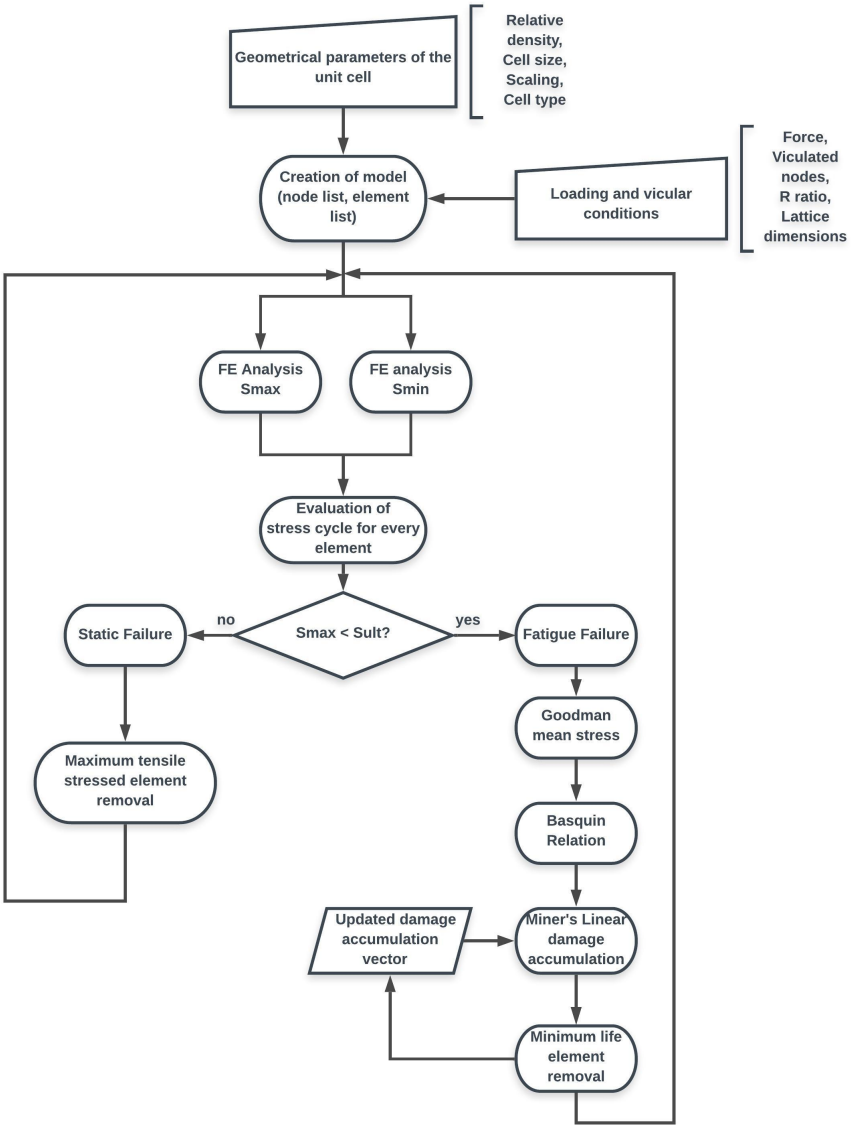

Figure 3.2: Algorithm flow chart