ABSTRACT

Emergent technologies are expanding into other sectors, often causing disruption in the way companies operate. The construction industry is a very good target for this expansion of technology given the potential productivity gains to be expected.

A recent study by Mckinsey [1], concluded that, over the last 20 years, labour productivity in the construction sector has lagged behind overall economic productivity. R&D spending is less than 1% of revenues in the sector and it is one of the least digitized industries. On the other hand, an estimated $57 trillion are expected to be spent on infrastructure by 2030, the report ends up concluding that the construction industry is “ripe for disruption”.

These new technologies will disrupt traditional workflows and, in the medium term, the role of the engineer will change. Code compliance checks will be mostly automated leaving the engineer free to do more creative work, and that role will often be augmented by computational design tools.

Computational design is one of the fields that is starting to grow in importance in design practices. Currently, most of these tools are used in the conceptual design stage, where full code compliance is not pursued. However, in the final project – where code compliance is critical – such tools have their importance reduced because of the lack of compatibility of the automatically generated solutions with the design codes.

The present work studies the possibility of creating a design tool that can be used not only in the conceptual phase but also in the final stage where a code compliant structure is needed.

The structures optimized in this dissertation are high voltage electricity pylons. This choice was made as the design process is simple enough to be developed in the time frame of the present work, in comparison to other types of structures (buildings, high rise towers, bridges, etc). Although simple in the design phase, the current design codes for such structures are quite strict when it comes to geometry. This provides the main challenge of this thesis, which is to develop an algorithm known to produce organic shapes and make it work according to current design codes.

Valuable technical insight was gathered from Metalogalva – industry partner – that also provided a case study model that was used to benchmark the developed tool against a conventional lattice tower structure.

The result was a software tool capable of returning code compliant lattice towers with 10 % material savings in comparison to the case study model. During the dissertation, several additional modules needed to create code friendly genetic algorithms were also identified. Such findings can be useful for future work dedicated to this field of code compliant computational design tools.

KEYWORDS: Genetic Algorithm, Optimization, Steel Tower, Lattice, Electricity Pylon.