Rationalized shaping curvilinear steel bar structures

Jolanta DZWIERZYNSKA*, Aleksandra PROKOPSKA

*Faculty of Civil and Environmental Engineering and Architecture
Rzeszow University of Technology
joladz@prz.edu.pl

Abstract

Over the years, development of computer technology has meant that designers have tools that require different view and approach to shaping process. Architectural and structural conditions to shape structures are interrelated, therefore the interdependence of the architectural form of the object and its structural system should always be the main goal of rational shaping from the very beginning of the design process.

Modern tools for shaping structures working in the environment of Rhinoceros 3D such as Grasshopper and Karamba 3D enable algorithmic-aided shaping of structures, while allowing the free flow of information between the geometric model and structural model. The aim of the research is to assess the suitability of the above tools for shaping curvilinear steel bar structures, as well as to develop strategy for algorithmic-aided effective shaping of the above structures. The aforementioned way of shaping structures consists, first of all in creating algorithms defining the geometric model as well as the structural model of the shaped structure, which allows for carrying out various simulations and optimizations. However, by modifying parameters that are variables in given algorithms, it is possible to obtain many alternative solutions. The method of shaping structures proposed in the paper consists in placing the nodes of shaped curvilinear steel bar structure on the so-called base surface. As the base surfaces for shaping, the surfaces with advantageous properties due to discretization are used, as well as the minimal surfaces with favorable mechanical properties. Moreover, the structures are further optimized due to the adopted optimization criteria, which guarantees rational solutions. The examples of curvilinear steel bar structures presented in the paper, after further analysis or modification, may constitute suggestions for some structural solutions of building coverings. On the other hand, the presented research aims to show how it is possible to use generative shaping tools so as not to block the creative process, to obtain effective structural forms that meet both architectural and structural requirements. The elaborated strategy can be further developed creatively depending on the needs.

Algorithmic-aided shaping structures due to its advantages is a direction that deserves further research and development, while the approach to shape curvilinear steel bar structures presented in the paper is a certain contribution to research conducted in this field.

References

[1] R. Woodburg, A. Mohiuddin, “Interactive design galleries: A general approach to interacting with design alternatives”, *Design Studies*, vol. 25, pp.40-72, 2017

[2] J. Dzwierzynska, Algorithmic-aided shaping curvilinear steel bar structures, Publishing House of Rzeszow University of Technology, 2019, ISBN 978-83-7934-300-3

[3] J. Dzwierzynska and A. Prokopska, “Pre-Rationalized Parametric Designing of Roof Shells Formed by Repetitive Modules of Catalan Surfaces,” *Symmetry, Special Issue Civil Engineering*, vol.10:105, 2018

[4] J. Dzwierzynska, “Shaping curved steel rod structures”, *Technical Transactions, Civil Engineering*, vol. 8, pp. 87-98, 218