Studying the shape of a helical ramp

Marina RYNKOVSKAYA*

* Department of Civil Engineering, RUDN University
6 Miklukho-Maklaya St, Moscow, 117198, Russian Federation
rynkovskaya_mi@pfur.ru

Abstract

Mathematically helical ramps are usually designed in the shape of a right helicoid which is well-known among civil engineers and designers, while mechanical engineers also know evolvent and convolute helicoids and use them for screws. From mathematical point of view helicoids according to their geometry may be separated into five types: right closed; oblique closed; right open; oblique open; developable. Some researchers with engineering background show other classifications [1], [2], [3] which in some cases are more reasonable for practice and express the engineering logic. In this paper there is an attempt to unite and structure all the knowledge about the ruled helicoids to show their differences and similarities in order to clarify which type is rational to be used for the particular engineering tasks. The paper mostly focuses on the civil engineering and architectural helical structures such as ramps and helical parts of buildings.

It is clearly shown that designers generally do not pay proper attention to the way the surface for a ramp can be formed from mathematical point. However, as it is shown in the paper, different types of helicoids (and ramps as final structures) show different stress-strain and buckling behavior. The review of existing classifications, methods of calculation and differences in geometry of all five types of ruled helicoids are presented. The clear classification which can be used by both mathematicians and engineers is shown, along with the most appropriate methods for calculation. The stress-strain analysis of all types of ruled helicoids are carried out by analytical (where it is possible) and numerical methods, and geometry and stress-strain behavior comparison of several types of helicoids is done in order to find forms which are the most rational for application to ramps and screw elements of buildings.

Thus, the purpose of this paper is to clarify the classification of helicoids and to introduce several types of helicoids to engineers in terms of geometry, stress-strain behavior and exploitation parameters for the practical tasks.

Moreover some ideas of unite analytical approach to calculate the most general type are also suggested. In the case of successful research this approach will let optimize the helical structures in different fields of application (not only for ramps but also for different types of screws). Moreover, the suggested research can be considered as a particular case of form finding used for a form-fixed problem along with specific practical restraints. However this point will be mentioned in the results and discussion section.

References

[1] S.N. Krivoshapko, M. Rynkovskaya, "Five types of ruled helical surfaces for helical conveyers, support anchors and screws", *MATEC Web Conference*, **95** (2017) 06002, 2017.

[2] S.N. Krivoshapko, V.N. Ivanov, "Encyclopedia of Analytical Surfaces", Springer, 752 p., 2015.

[3] V. Jean Paul, "On the investigations of ruled helical shells in 2000-2017", *Structural Mechanics of Engineering Constructions and Buildings*, 3, pp. 9-11, 2017.