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ROZPRAWA DOKTORSKA

RUCHOME PRZEKRYCIA– BUDOWA GEOMETRYCZNA, KINEMATYKA, TECHNOLOGIA WYKONANIA

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ABSTRACT

This paper addresses issues related to retractable roof systems. Facilities with this type of roof system offer considerable flexibility and adaptability, allowing it to quickly react to changing weather conditions. This solution enables optimal use of space, making the space multi-functional. These roof systems are commonly used in sports stadiums, allowing them to hold different sports or cultural events, both outdoors (with favorable weather) and indoors (when the weather is adverse).

Modifications to the shape of the roof have a tremendous impact on the visual and aesthetic perception of the building, the harmonization of the facility with the surroundings and the attractiveness of the entire complex. Hence, there is a constant search for new innovative solutions aiming to improve roof geometry, roofing materials, roof structures, colors and lighting.

The comprehensive analysis of different retractable roof systems presented in this work has shown that the movement of the roof, or any part of it, results in obtaining one specific shape. Then, the question of whether it is possible to modify the shape of the roof while changing its position has been raised. If it is so, what geometric, kinematic or technological requirements have to be met?

This research study was inspired by complex surfaces such as NURBS, constituting an ideal retractable roof system model. A preliminary research study has shown that modifications to roof systems would be possible when using special connectors, which may change their length, and elastic deformable materials. Current solutions do not use such materials and, therefore, it was necessary to simplify the research model to surfaces made up of rectangular components.

The thesis advanced in this paper assumes that it is possible to conceptualize a roof system in the form of a flat mechanism that enables movement of the roof system, and multiple modifications to the roof system, while displacing its components.

This research study proceeded in three stages, according to the title of this dissertation, which were the study of retractable roof systems in terms of their geometry, technological solutions and kinematics.

1. Geometric analysis of existing roof systems including both fixed and movable roof coverings. The author presented an up-to-date classification of fixed roof coverings, dividing them into roofs with flat, curved and complex surfaces. The movable roof systems were classified by applying two different criteria: the type of roof covering movements and the type of roof component materials.
2. As far as retractable roof system manufacturing technologies are concerned, the current literature was reviewed. The study covered a wide range of scientific papers, patents, technical documents, standards and norms. The author analyzed mainly foreign studies, as current literature in the Polish language is very limited. The existing buildings with retractable roof systems were analyzed

in terms of their structure and construction, outlining the main component of these coverings and dividing them into two groups:

- roofs with stiff panels,
- roofs with changeable panels.

3. Roof covering movements inspired a search for new solutions for the structure of the mechanisms. The study included flat mechanisms, 2nd class. Movable components of such mechanisms make sliding and rotational movements, which corresponds to movements in the implemented projects. Four research models were developed based on 2nd class mechanisms. For each model, detailed studies were performed to review their kinematics (i.e. movement range and working area) and water drainage systems. The author outlined solutions which met the predetermined criteria (e.g. open space of over 70°). For all research models, apart from those carried out with detailed parametric AutoCAD 2014 analyses, their digital models were developed using Inventor Professional 2015 and 2016. They were provided using the knowledge obtained within the course of the technological studies. The author proposed a set of solutions for separate components analogical to that of the existing facilities with retractable roof systems. For the provided research models, roof covering kinematic simulations were presented.

Within the framework of the assessment of the obtained results, the author presented conclusions drawn after having carried out the research study, with constraints limiting the number of the results. In the conclusion, the author confirmed the correctness of the advanced thesis, assessed contributions the study made to the development of current knowledge and presented guidelines for further research.