

Creating unique constructions from metal membranes

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The cycle track 'Krylatskoye' -- sports facility in Moscow, in the Krylatskoye district. Credit: Sergey Krivoshapko

RUDN University Professor Sergey Krivoshapko has assimilated information about metal membrane suspended roofs to allow designing buildings with large spans. These structures are used in the construction of sports complexes, airports and some other buildings. He has published an op-ed article in *Thin-Walled Structures*.

"Metal membranes are used much less often than other types of suspended roofs (among which one can distinguish awning or mesh metal structures, and sheaths of glued wood). It is interesting that Russia

extensively builds these types of constructions; they were first used abroad only 35 years later in the U.S., when they were developed by architect Vladimir Shukhov for four pavilions at the All-Russia industrial and art exhibition in Nizhny Novgorod," Krivoshapko said.

Metal membrane suspended roofs are spatial constructions of thin sheet metal only a few millimeters thick, with rigid support contours. They can be compared with a soap membrane formed after immersion of a wire ring into a diluted dishwashing liquid. Just like a bubble, which is blown out of the contour, a metal membrane can have different curvatures.

In fact, the shape of the middle part is determined by the geometry of the frame to which it is mounted and by the presence of weighting agents. Thanks to them, it is possible to create a membrane in the form of a paraboloid, cone or sphere. Spans with metal membrane roofing can reach hundreds of square meters. For example, the universal stadium at Mira Avenue measuring 224×183 m, which was the largest building of the 1980 Olympics, is roofed by a 5 mm-thick sagging membrane. The [structure](#) only seems to be fragile—the technology involves complex engineering calculations that take into account the climate, metal used for the construction, as well as load created both by the weight of the membrane itself and by falling snow. From a technical point of view, the advantage of metal membranes is that they significantly reduce the weight of the structure. They cut its cost by up to 60 percent, and material consumption up to 70 percent. Moreover, the structure itself implies a combination of bearing and enclosing functions in one material.

"Design features of metal [membrane](#) suspended roofs determine their cost effectiveness. Although today, almost all the problematic issues concerning the design, manufacturing, installation and operation of [metal](#) membranes are theoretically solved, few design bureaus and organizations are ready to take up work. The study of the preconditions

for the appearance of functional solutions in construction, the history of development and the improvement of construction technologies will allow us to summarize the experiences accumulated over decades and issue a fundamentally new solution. Otherwise, architects and engineers will have to replicate what has already been achieved in [construction](#) and architecture," Sergey Krivoshapko concludes.

More information: Sergey N. Krivoshapko, Thin sheet metal suspended roof structures, *Thin-Walled Structures* (2017). [DOI: 10.1016/j.tws.2017.07.014](#)

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