Folding a dome

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Abstract

When a dome has to be built of many components, it should be preassembled as a whole to be folded for transport. Because a dome surface is not developable at all without cutting many gaps, the surface of foldable sheet domes shows a fold relief counteracting the good small surface-area-to-volume ratio.

A quad faceted dome [1] defined by modular rotation surface portions (modules) is proved here to be foldable into a flat fanfold pack of sheet strips each comprising a row of different isosceles trapezoids cohering at their parallels forming crease lines. At its slightly oblique sides, each trapezoid adjoins to such a side of a congruent trapezoid of another strip. The 12 modules of the presented dome are shaped each as a large spherical isosceles right triangle. At its equal legs there are small, nearly right-angled, not isosceles triangles left from diagonally cut off trapezoids. Along each common leg of two adjoining modules, small triangles are mirror-symmetrical to each other and coplanar in pairs to be fused into deltoids.

A module can be folded by switching each flat convex, four-sided vertex pyramid gradually along each second series of folds into a concave one. By folding a series of deltoids along their symmetry axes alternately into a sloping ridge or valley, coupled modules can be folded Miura-like (Fig. 1). Only two gaps must be closed to finish a conversely unfolded dome; A gap (Figs. 2 to 4) is bridged by deltoids attached alternately inside and outside along one side of the gap, to encompass the border of the other.

The PP-coated cardboard strips, 390g/m², of the 100” dome are joined by PP-tape outside and inside. This set-up was strong enough for loads occurring in (un)folding states by wind or chaotic configurations before finding a wrinkle-free solution: Recalling this dome’s polyhedral base: a cube, by approximating a diagonally halved cube whose both ridge roof sides are quadrats composed each of 2x2 halfway folded modules and, whose both gables comprise 2 modules each. The proper number of strips per module is 4, 5, or 6. Choosing 3 disables switching in, or out, without wrinkles; 7 enables uncontrolled buckling.

Figures 1 to 4: unfolding states **5:** dome, unfolded by one person **6:** folding again - equal states

Reference

[1] F. Tuczek, “Double Curved Shell,” US Patent 7,591,108 B2, Sep. 22, 2009, Figs. 34–39, 42.