Supporting structures made of aluminium alloys

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20. Supporting Structures Made of Aluminium Alloys

Design Institute: TSNIIproektstalkonstructsiya, USSR
Dimensions:
Span of the laboratory hall roof: 90 m
Gantry crane span: 86 m
Hothouse span: 2 x 36 m
Material:
Aluminium alloys: Al-Mg-Si and Al-Zn-Mg
Mass:
Consumption of aluminium alloys:
Roof of the laboratory hall: 15.7 kg/m2
Hothouse: 4.8 kg/m2

Effectiveness of aluminium alloys for supporting structures becomes apparent when such specific features of aluminium alloys as a light weight and a high corrosion resistance can be favourably used. Aluminium alloy roofs spanned 90 m of a synchrophasotron laboratory hall of the Academy of Sciences of the USSR (Fig. 1) and aluminium alloy covering of a gantry crane spanned 86 m (Fig. 2) have been designed and constructed by the Institute. The supporting structures of the roof are made as hingeless arches of a circular shape. The choice of the hingeless system was stipulated by the less elastic modulus comparing to steel – the flexibility of such an arch was 30 o/o lower comparing to a double-hinged arch. The arch cross-section is an equilateral triangle with the 2 m sides, a section 1.73 m high or 1/52 of the span. The radius of a circle of the arch is 106 m, the rise is 10 m (Fig. 1). At such an arch geometry forces in the members of a circular and parabolic shape differ insignificantly while the fabrication process of the circular arch members is simplified. Special V-shapes extruded members of 230 x 230 mm size, made of aluminium alloy Al-Mg-Si are located in the triangle vertices. The arch upper chord in combination with aluminium roof panels used as struts ensures the arch stability in a horizontal plane. The lower chord is braced by two inclined faces which excludes the necessity of bracing in the plane of the arch lower chord. The whole structure of the arch consists of 12 m long sections, the members of which are fastened by rivets. All field joints are secured by steel cadmium-plated high-strength bolts. A gantry crane with a span 86 m and load carrying capacity 40 t is erected in the same building and is provided for equipment operation. Its frame is a curved collar-beam and its supports are made of aluminium alloy Al-Mg-Si, the tie beam is of steel, the joints are of the same type as in the arches of the roof. More than a 10-year usage of the roof and the crane gives reasons for a conclusion that fastening by means of steel cadmium-plated high-strength bolts is an effective type of fastening for supporting structural members made of heat-treated aluminium alloys. Now the cost of 1 t of such structures is one of the lowest for the structural aluminium members.

A long-span hothouse near Moscow has been in operation for 5 years. The roof supporting structures are made as continuous double-span space trusses of a trihedral shape with the spans 2 x 36 m. The supporting frame is positioned outside to decrease the hothouse volume to be heated. All members of the trusses are made of extruded round tubes fabricated of aluminium alloy Al-Zn-Mg.

The truss spanned 36 m is assembled of three trihedral units 12 m long with welded joints. The units are connected by stainless steel bolts by means of flanges. The truss has a hinge connection to the steel posts. The middle support is rigidly fixed in the bottom. The end posts have hinge supports in the bottom and due to the fact they may have deflection from the vertical thus excluding the necessity of taking the thrust from the trusses.

The structure of an aluminium latticed spherical shell of 20 to 60 m dia. has been worked out and put into operation. It may be used for various buildings of a pavilion type. (Fig. 3) The shell skeleton is assembled of rods and members made of extruded shapes of aluminium alloy Al-Mg-Si. These members are secured by steel high-strength bolts. The skeleton members from a space shell by means of flat aluminium sheets being connected to the skeleton by self-tapping bolts (along the contour).

The above mentioned examples showed the advantages of bolted joints as well as a complete lack of maintenance expenses for a periodic painting of metal.

(S.S. Karmilov)

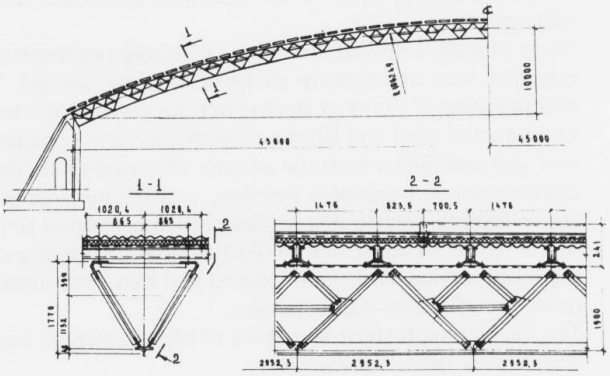

Fig. 1 Trusses for the Laboratory Building Roof

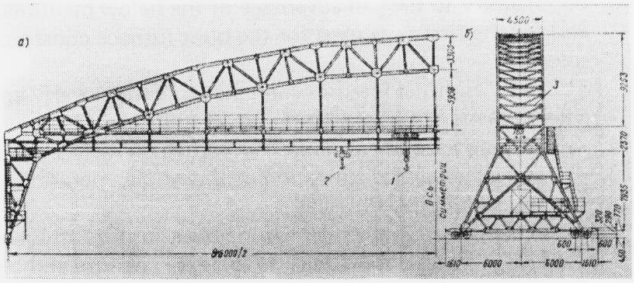

Fig. 2 Gantry Crane Made of Aluminium Alloys

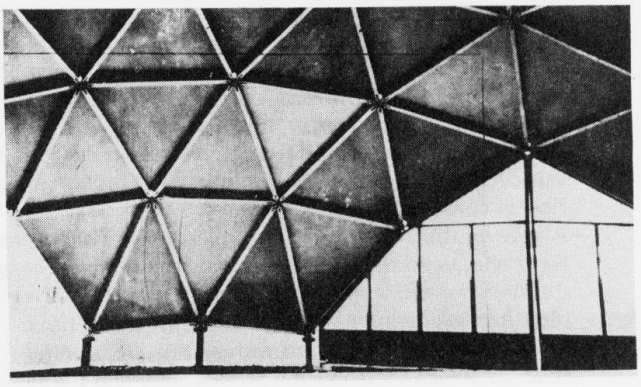

Fig. 3 Interior View of the Latticed Spherical Shell