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On the Standardization of Metal Structures in Antenna Devices in the USSR

Sur la standardisation des ossatures métalliques pour antennes en URSS

Über die Typisierung von Metallkonstruktionen der Antenneneinrichtungen in der USSR

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In spite of a relatively small share of metal consumption for antenna installations (about 2 per cent) as compared with the total metal consumption in construction, great attention is given in the U.S.S.R. to the problem of metal structure standardization. Such attention is caused by two reasons, namely: first, the importance of this domain development for the national economy and, secondly, a great number of purposes and, hence, lots of structural solutions for antenna installations. Under these conditions both standardization and unification of solutions are one of the principal trends in increasing the efficiency and quality.

The classification of antenna installations and further standardization and unification may be elaborated with respect to a number of indications the principal of which are as follows: functional purpose, nature and particular features of force influences, structural features.

The functional purpose of antennae has an essential influence upon their structural solution and with this in mind the antennae designed for broadcasting, television, radio-relay communication, radiolocation, aeronavigation, satellite and space communication have well definite inherent structural forms. The antennae of each of the above mentioned groups may differ from one another in terms of applied radio-engineering circuit and used range of radio waves, say, the antennae of direct visibility radio-relay communication, truposperic communication and ionospheric scattering utilization have various principal solutions. Such examples may be also obtained for the antennae of any other functional purpose.

The nature and particular features of force and temperature effects are dependent upon functional purpose and structural solution of antennae and their location in either geographic region characterized by the force effects due to wind, ice formation, snow, temperature and seismic forces.

The structural features may be different but they are dependent upon the functional purposes of antennae and force effect nature as well as they shall satisfy radio-engineering requirements at minimum cost (with due regard for the shortest-term realization and further modernization possibilities).

Table I gives the major factors affecting the possibility of standardization and unification of the antenna structures.

Table II presents the classification of engineering structures in antenna devices in terms of separated or combined radio-engineering and mechanical functions of antennae.

In view of such various nature of structural solutions with respect to external effects both standardization and unification are based on the following assumptions:

(1) Elaboration of an unified standard documentation "Structural Standards and Rules", definitions and instructions for the development of corresponding sections of these standards (I- a,B to u);

(2) Elaboration of unified methods designing the structures (2 to 12) and their members (I - б).

(3) Elaboration of unified methods of standardization and unification, namely, unified principles of formulation, based on the modular design and similarity, interchangeability of members, reduction in quantity of members in shipping units, preassemblage of large units at the shop, reduction in the number of erection operations, knowledge of economic solutions. The basis for working out a standard documentation lies in experience in the designing

Table I

I. Antenna purpose	II. Force effect nature	III Structural solution
1. Broadcasting[x] 2. Television 3. Relay communication[x] 4. Aeronavigation[x] 5. Radiolocation[x] 6. Satellite and Space communication	1. Geographic regions: (a) Wind[xx] (b) Ice formation[xx] (c) Snow[xx] (e) Temperature[xx] (f) Seismic 2. Gravitation forces 3. Inertia forces 4. Explosions[xx]	1. Supports: (a) Towers[x] (b) Masts[x] (c) Combined solutions 2. Systems 3. Parabolic full revolving antennae 4. Special full revolving or partially revolving antennae 5. Devices for supporting antennae structures

x) Both stationary and transportable.
xx) Antennae placed into radio-penetratable covers are neither fully nor partially affected by these effects.

Table 2

Metal structures of antenna devices where radio-engineering and mechanical functions are:

Separated				Combined			
Antenna and its parts	Supports			Stationary	Rotary		
	Stationary		Moving or rotary		over the angle of site only	over the azimuth only	Full revolving
Wire, turnstile, sharp-directional (horn, parabolic, flat, slotted and other) reflectors, vibrators, complex wave guides etc.	Towers, masts, Installations	Placed for ever	Towers	Various reflecting surfaces to be used within the range from several centimetres to hundreds of metres for a sharp-directional communication within the terrestrial globe. Antenna devices of the umbrella type and others where drives take part in the whole system operation. Radiotelescopes using the earth's revolution and electric ray oscillation	Radiotelescopes using the earth's revolution around its axis as rotation over the azimuth. The solutions similar to Mills Cross are applied to them.	Location Devices operating in the zone around the earth	Radiotelescopes of various systems with angle-of-site or other directions of revolution
		Transportable					

and operation of antenna devices, obtained by a number of different works and offices and generalized in the Central Research and Design Institute of Structural Steelwork.

Both standardization and unification are worked out in the following directions:

(I) Standardization of shipping units;
(2) Standardization of structures in the whole;
(3) Standardization of production processes.

Aims and purposes of standardization with respect to shipping units lie inelaboration of standard joints and standard unified members made at the shop, wide latitude in the use of reiterative members, elaboration of definite standard procedures in fabrication and erection, mechanization and automation of production processes.

The purpose of standardization as to structures in the whole consists in realization of a system of standard designs for individual types of antenna installations which are often repeated in practice.

The standardization with respect to production processes permits to obtain the standard members on the basis of identical solutions for structures and results in the assemblage in jigs, mechanization and automation of fabrication processes. The trends of standardization are interconnected, but their development occurs independently of each other.

Since the fourties the aerodynamic method associated with the use of tubular and round sections is assumed as a basis for designing antenna installations.

The use of tubular sections has caused the development of standard joints the principal of which are the butt joints, joints with fit-in gussets and gussetless joints being made under the shop conditions, as well as flange joints in chords and joints of struts with fit-in gussets being put between the flanges of chords in the field joints (Fig.1)

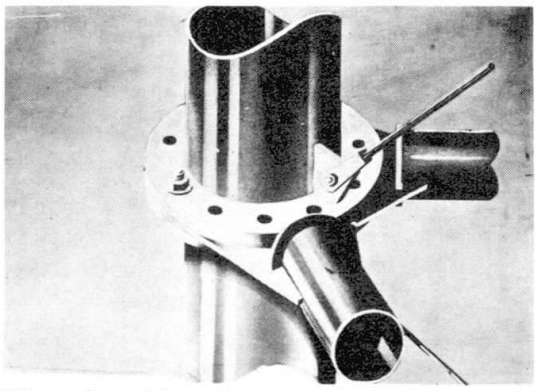

Fig.1. Standard field joint in the tower chords with prestressed diagonals.

The steel rounds are used for prestressed diagonals. In the field diagonals are fastened by gussets and axles to the gussets of chords and tensioned by screw couplings. At the shop the diagonals are welded into the slots of chord gussets and tensioned by the use of electric heating and applied technological welding process.

Recently, in connection with the construction of towers under the low temperature conditions, in some tower structures there are used the diagonals made of prestressed steel cables.

For the guys of masts there are worked out and improved, with due regard for safety requirements revealed in the course of long-term service, appropriate sockets, turnbuckles and stretching means. The machined parts for guys are produced in lots at specialized shops.

Some types of antenna installations are seldom or once repeated, but the majority of joints used are unified and of the same type as those of structures of the mass use.

Particular attention is given to the problems of standardization with respect to the mass use structures, namely: supports of radio-relay lines, television re-translators, radio stations. For these installations there are available the standard designs of individual members and also of structures in the whole.

The principal modulus in the supports is the vertical size. By virtue of that the members of supports may be made in the same jigs, conveyed by the same transportation means and erected by the self-lifting cranes with the pitch equal to the vertical modulus. The modulus in the supports is a dependent quantity. First, it is governed by the linear loading gauge of transportation facilities and, secondly, by the erection equipment load capacity. If the second condition is not observed, the strength of supports will be defined by erection loads rather than meteorological effects. In addition, the vertical modulus may be dependent upon a pitch of both technological and operation equipment located on the support, say, a pitch of the yard lift run etc. For the same installation the constant modulus is observed all over the height.

The mast shaft structures are the most suitable for standardization since the shaft is a continuous multispan beam of constant overall size section.

The transverse standard-sizes of mast sections are different; they are dependent upon both strength and stiffness and are governed by the mast height and transverse railway lorry loading gauge.

The first unified streamlined mast sections consisting of pipes and steel rounds as well as their connections, developed in the early fifties are in use to date with some negligible modifications. These lattice mast sections of triangular section in plan are as follows: "collapsible" sections with 2200-mm base, 6750 mm long, for the mast height up to 350 m, sections with 1350 mm "reduced base", 6750 mm long, for the mast height up to 250 m and sections with 800-mm "small base", 4500 mm long, for the mast height up to 150 m.

Two sections with 2200-mm base or 12 sections with 1350-mm base or up to 30 sections with 800-mm base may be loaded on a two-axle railway lorry. The sections are connected to one another by flanges and bolts of normal precision.

For television masts with panel antennae located on the sides of a square over the height up to 130 m a number of standard designs is available for the masts 190, 235 and 350 m high, providing different alternatives as for location of the antenna equipment. For these masts there are available the standard tetrahedral sections of 2500x2500 mm cross section, 6750 mm high (Fig.2).

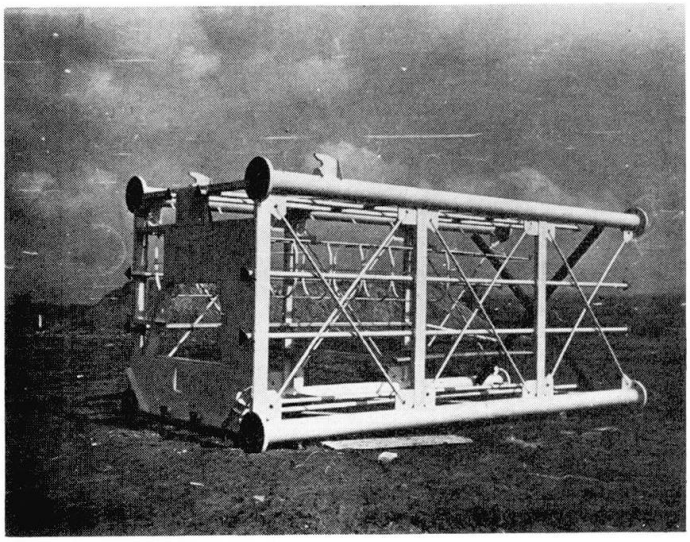

Fig.2. Standard Section of a television mast.

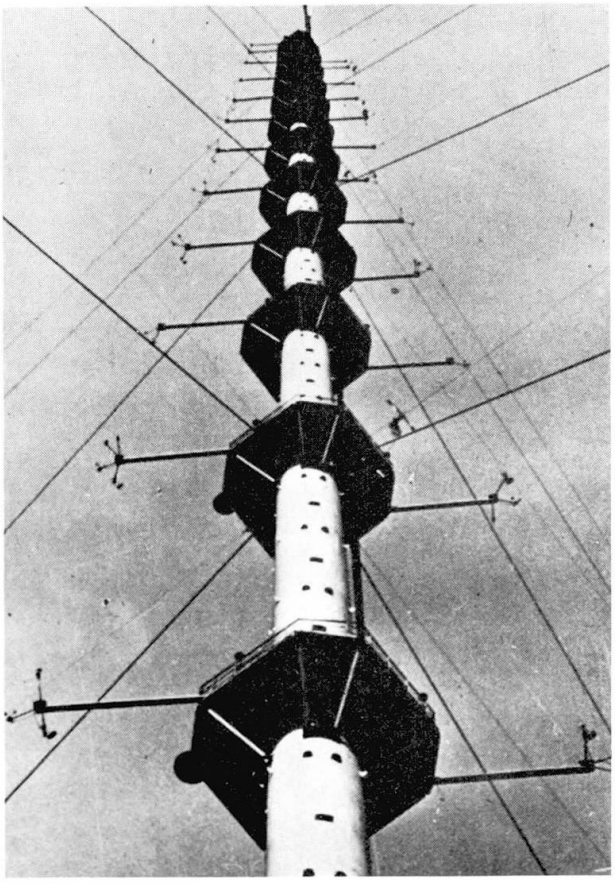

Fig.3. Mast shaft made of steel plates.

while the tower panels are 4.0,

For tower structures there shoes and fixing members of the

The antenna sections differ from the intermediate sections by additional members which are intended for fixing the antennae. For the standard masts there are provided standard systems consisting of a set of any sections being placed in any sequence according to diagrams subjoined.

In the U.S.S.R. there are in common use the round cylindrical masts of steel plates (Fig.3). The vertical size of sections for these masts is taken as 4.0, 5.0 and 6.0 m in terms of standard steel plate width of 1.5 and 2.0 m. The diameters of tubular sections are assumed as equal to 1600, 2200 and 2500mm as a function of both height and purposes of masts.

In the U.S.S.R., equally with the structures made of pipes and steel rounds, the masts and towers of small height are designed of angle sections, namely: small height towers as well as radio-relay line masts consisting of 2400x2400 mm standard all-welded sections where the chords are made of angles and diagonals are of steel rounds.

In connection with elaboration of standard mast sections the shops of structural steelwork were provided with a stationary equipment,e.g., volumetric slips, jigs, manipulators. At the same time a line production system was introduced. By virtue of interchangeability of these sections, provided by jigs, the erection of masts was allowed to be carried out by speed methods with the use of self-lifting cranes which lift a section and, next move up it against the previously lifted section.

The vertical modulus of lattice towers is 4.0m, i.e.equal to the vertical wave guide section, 8.0 and 12.0m high.

are available standard seating insert parts of foundations (Fig.4).

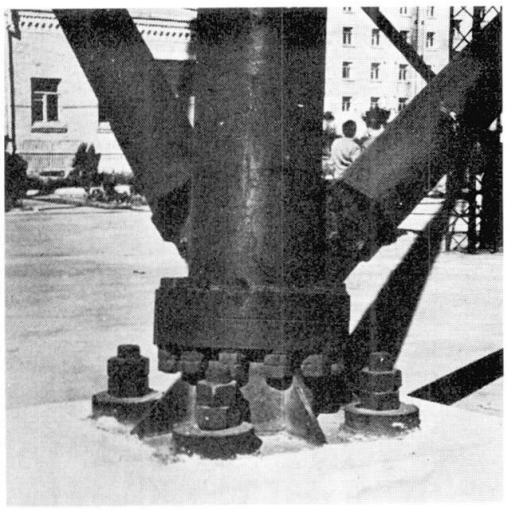

Fig.4. Standard support tower chord-to-foundation connection.

The whole range of forces in standard radio-relay towers 30 to 120 m high was allowed to be covered by using only two diameters of pins arranged in different combinations.

In designing the reflecting surfaces of tropospheric communication a tendency to unification has allowed to work out the parabolic cover structures consisting of identical cold-formed shapes.

Recently, the standardization of parabolic full revolving antennae was carried out and their mass construction is realized. Fig.5 shows one of such antennae 12.0 m dia. Being used for communication through artificial satellites ISZ.

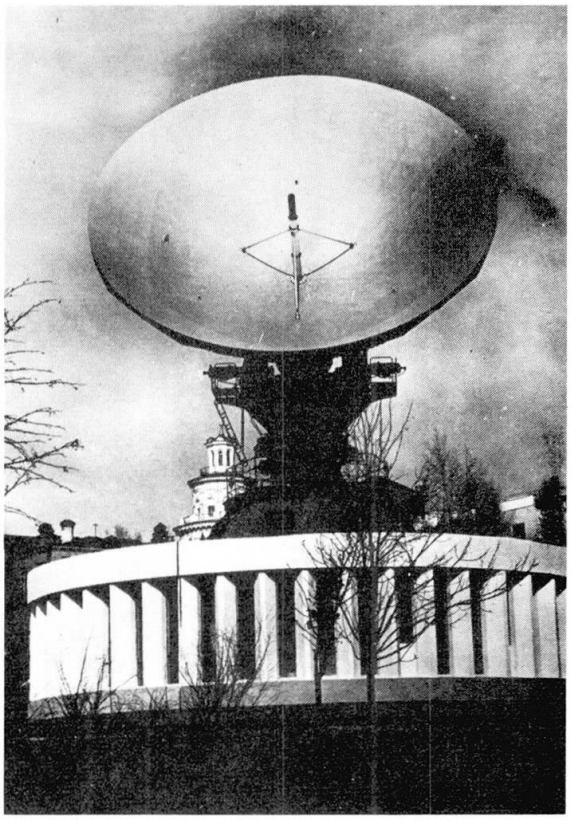

Fig.5. Standard full revolving antenna 12.0m dia.

The antenna installations being built in the U.S.S.R. according to the standard and reusable designs exceed 50 per cent of all metal structures in antenna installations, while the use of standard members and joints in those exceeds 90 per cent of all metal structures in this field.

In connection with some greater cultural and industrial progress of North regions in our country the problem of standard designs for these regions is of great importance. For the industrial production of antenna structures having various specific features it is imperative to have strictly specialized plants and shops.

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These concepts are realized in the course of development of the metal construction domain.

SUMMARY

The conclusions to be drawn on the basis of many years experience obtained in the USSR on the problem of standardization are as follows:

1. The elaboration of an unified standard documentation is compulsory for both standardization and unification of solutions.

2. It is imperative to use such structural solutions which provide any further modernization with the least difficulties. For some types of structures this is associated with the conjunction of functions of carrying and enclosing structures.

RESUME

Les conclusions obtenues en URSS après de nombreuses années d'expérience dans le domaine de la standardisation sont les suivantes:

1. L'élaboration d'une documentation unifiée est obligatoire, tant pour la standardisation que pour l'unification des solutions.

2. Il est urgent d'utiliser des solutions qui permettent une modernisation ultérieure la plus aisée possible. Pour certaines constructions, cette condition est associée à la combinaison de la fonction porteuse et de la fonction de fermeture.

ZUSAMMENFASSUNG

Die aufgrund langjähriger Erfahrungen in der USSR gewonnenen Schlüsse zum Problem der Typisierung sind die folgenden:

1. Die Ausarbeitung einer einheitlichen Standard-Dokumentation ist sowohl für die Typisierung wie für die Vereinheitlichung von Lösungen obligatorisch.

2. Es ist dringend notwendig, solche Lösungen zu benützen, die eine weitere Modernisierung bei geringsten Schwierigkeiten erbringen. Für einige Typen von Konstruktionen ist die Verbindung der Tragfunktion und der Raumabschliessung notwendig.

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