2-11 A3 CASSEGRAIN ANTENNA FED BY FOUR-REFLECTOR BEAM-WAVEGUIDE FOR SATELLITE COMMUNICATIONS EARTH STATION

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This paper describes the design of a Cassegrain antenna fed by four-reflector beam-waveguide, which is scheduled to be operational at KDD's Ibaraki Earth Station in September, 1971.

The antenna is designed to meet all the requirements to accommodate to both of the Intelsat-III and -IV satellite systems, among which the value of G/T is considered most important. Besides, this type of antenna has the following features:

1) Communication equipment can be installed stationarily independent of the steering of antenna beam, which provides easiness of maintenance of communication facilities.

2) Being different from such antennas as open Cassegrain antenna[1], Cassegrain-horn antenna[2] and triply folded horn antenna[3], this antenna has a rotationally symmetrical main reflector, which permits low manufacture-cost.

3) Transmitters can be installed very close to the feeding point of the antenna, thereby making their output power to radiate effectively with little transmission loss.

4) As no rotary joint is needed in the transmission path with reference to azimuthal and elevational rotation, alignment and adjustment in installation phase are considerably easily performed.

Fig. 1 shows the principle and the dimensions of the antenna.

For the feed horn, a corrugated horn is chosen to have a rotationally symmetrical beam[4] through a series of comparison studies between a corrugated horn and a dielectric-loaded one, because the latter were seen to require further development studies to be practically utilized. From electrical, mechanical and economical considerations, the length and the aperture diameter of the horn have been decided to be 4 m and 1 m, respectively.

The four reflectors composing a reflecting beam-waveguide are arranged in the near-field region of each other, to attain high transmission efficiency covering both 4GHz and 6GHz bands. The beam-waveguide is surrounded by metal tube to avoid noise temperature degradation, dust spoil and human danger. Although it is ideal that all the four reflectors should have a curved surface from the view point of electrical performance, two reflectors among the four are plane as seen in Fig. 1. This is because of the easiness of manufacture and alignment of reflectors and the reflectors were arranged so as to give negligible performance degradation compared with the ideal case. The aperture diameters of plane and ellipsoidal reflectors are around 2 m and 2.5 m, respectively, all of which indicate values upperly limited because of the antenna mechanical structure.

The main reflector and subreflector are optimally shaped[5], in accordance with amplitude and phase patterns of the primary radiator and the subreflector, to attain best possible uniform illumination over the aperture of the main reflector[6]. The edge taper illumination of the main reflector at 4GHz is about -3dB to the isotropic level, which provides the maximum value of G/T of the receiving system. The edge level of the subreflector is set to be -20dB with reference to its central level, by compromising the blocking and spillover effects of the subreflector.

The main expected performance characteristics are shown in Table 1, and Table 2 indicates the breakdown of the aperture efficiency.

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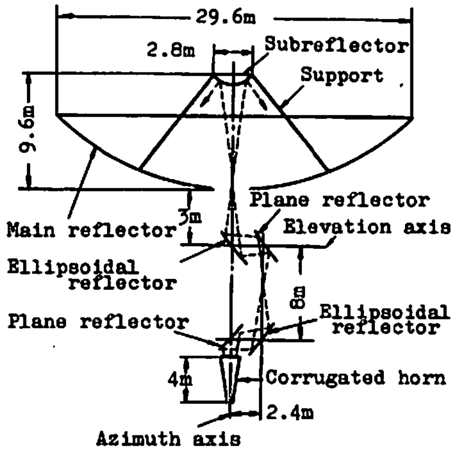

Figure 1 Configuration of the antenna

Table 1 Expected performance

Frequency	4GHz	6GHz
Directive gain	60.6dB	63.7dB
Aperture efficiency	75%	68%

Noise temperature at 4GHz		
Angle of elevation	5^{o}	$39^{o}K$
	30^{o}	$15^{o}K$
	90^{o}	$11^{o}K$

Table 2 Breakdown of aperture efficiency

Frequency	4GHz	6GHz
Loss of corrugated horn	-0.01dB	-0.01dB
Loss of horn cover	-0.01dB	-0.02dB
Transmission efficiency of beam-waveguide	-0.13dB	-0.21dB
Illumination efficiency	-0.60dB	-0.75dB
Spillover from main reflector	-0.05dB	-0.04dB
Spillover from subreflector	-0.05dB	-0.04dB
Blockage of subreflector and its supports	-0.22dB	-0.19dB
Reduction due to reflector surface torelance	-0.19dB	-0.42dB
Total efficiency	-1.26dB	-1.68dB