Compensation of Gravity Induced Structural Deformations on a 34-meter Beam Waveguide Antenna

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The NASA Deep Space Network (DSN) is the largest and most sensitive scientific-telecommunications and radio-navigation network in the world, The DSN is made up of three Deep Space Communications Complexes and each complex consists of four Deep Space Stations (DSS). At the Goldstone complex, located in the Mojave Desert in California, a 34-meter diameter beam-waveguide (BWG) antenna, 1]SS-13, was constructed in 1988-1990 and has become an integral part of the advanced systems program and a test-bed for technologies being developed for the several BWG antennas scheduled to be built in the DSN in the next several years.

in the first phase of the performance calibration of1>SS-13, the antenna efficiency at 32 GHz was found to depend significantly on the elevation angle, i.e. it decreased from 45% to 35% as the elevation angle changed from 4S degrees to 20 degrees. (Slobin, JPL Report D-8451). This elevation angle dependence is duc to the deformation in the main reflector caused by the resulting change in the gravitational force applied to the antenna structure. Systems designed to compensate these gravitational errors have been developed at JPL in the past few years and include a variety of technologies ranging from the use of hydraulic actuators (Levy & Strain, JPL TDA Progress Report 42-114), to deformable mirrors (Galindo Israel, Rengarajan, Veruttipong, & Imbriale, IEEE A/P 1993 Symposium Digest) to electronically phased array feeds (Vilnrotter, Rodemich, & Dolinar, IEEE T- Com, Vol. 40, No. 3). in some instances prototypes of these systems have been constructed and tested.

in this paper, the most promising mechanical designs for gravity compensation will be presented along with performance predictions and some recent measurements which can be used to make a relative comparison. The shape of the compensation surfaces are found using electromagnetic analyses. Details concerning the mechanical realization, and tolerances, of these desired shapes will be discussed. 'I'he gravity compensation systems included in this discussion will be the large scale deformation of the entire backup structure, the deformation of a mirror in the BWG, the deformation of the subreflector at the apex of the antenna, and the actuation of the panels on the main-reflector surface.