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ANALYSIS OF ANTENNA SYSTEM WITH THE STANDARD DESIGN TORQUE COUPLING

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ABSTRACT

The basic purpose of the antenna is to track the various frequency range signals in the field of integrated multi mission ground segment for earth observation satellite technology therefore the need of antenna in remote sensing applications plays a vital role.

The present work basically focused on two prime objectives. One is a Case Study of 7.5 m antenna systems and the other being designing & analysis of the existing Torque Coupling of 4.5 m Antenna system. The Study was done for the 7.5 m Antennas, which are installed at the Remote Sensing Satellite Data Receiving Centre. The main focus was on studying every detail of the Antenna System related to the Mechanical, Design and Materialistic aspects. A brief description, specific to the 7.5 m was given for reference. author closely inspected all the Antennas at each stage. Every function of all the components was justified at the end. In this process, main attention focused on to the working of the torque coupling . The Second part of it was designing the existing "Torque Coupling". After thorough case study, author realized the importance of the component and made the design procedure of the existing Torque coupling. The new Design is explained in the later part of this report along with the required CREO models and in an analysis of "torque coupling"

Keywords:Antenna, Torque Coupling, CREO and ANSYS

I. INTRODUCTION

With the rapid deployment of wireless communications systems during recent years, it is becoming imperative for the radiofrequency subsystem to be multifunctional as well as have smaller size. This is especially true for satellite communications applications where weight and functionality are at a premium and Antennas with high gain performance are the required for some of the applications in communication systems [1],[2]. The design of the directive antenna is based on the transformation of a cylindrical space into a rectangular one and the circular array antenna can be seen as an elementary building block of conformal array antennas with rotational symmetry, just as the linear array is a building block of planar array antennas[3],[4].Phased array antennas are widely used in modern radars for their extremely fast beam steering and switching capability [5], [6]. Traditional phased arrays utilize phase shifters to realize phase shifting or delay between elements [7].

The highest number of satellites revolving around the earth are remote sensing, which gives the data that has very wide application such as geographic, navigation, telecommunication, oceanography, biography, etc. Revolving around the earth at a height of around 800km, these satellites are polar i.e. they pass above the north and south of the earth and the direction of revolution is north to south**.** The maintenance of antennas from time to time is an equal role-playing factor. These characteristics have urged us to go deeper into the case study of

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antennas and to design a better "torque-coupling mechanism" in the internal structure, responsible for the desired motion of the antenna.

1.1 History of the Antenna

The first Antennas were built 1888 by German Physicist heinrich hertz in his pioneering experiment to prove the existence of electromagnetic waves predicted by the theory of james clerk maxwell. hertz placed Dipole Antennas at a focal point of parabolic reflector for both transmitting and receiving.He published his work in "AnnalenderPhysik And Chemie" (vol 36,1889) The Cassegrain Antenna design was adapted from the Cassegrain Telescope ,a type of reflecting telescope developed around 1672 and attributed to French priest laurent cassegrain .The first Cassegrain Antenna was invented and built in JAPAN in 1963 by ntt,kddi & mitsubishi electric.

The Cassegrain design is widely used in Parabolic Antennas, particularly in large Antennas such as those in Satellite Ground Stations, Radio Telescope and communication Satellites.

1.2 Types of Antennas

1.2.1 TELEVISION ANTENNAS It is an antenna specifically designed for the reception of Over- the- air broadcast television signals

1.2.2 DIPOLE ANTENNAS A simple Antenna usually constructed from two wires in opposite phases placed end to end

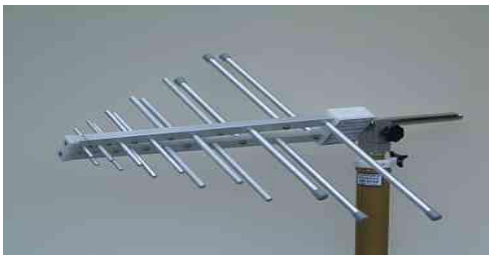
1.2.3 DIRECTIONAL ANTENNAOR **BEAM ANTENNA** is an antenna which radiates or receives greater power in one or more

directions allowing for increased performance and reduced interference from unwanted sources.

1.2.5 HORN ANTENNA A type of directional Antenna shaped like a horn to direct radio waves in a beam.

1.2.6 OMNIDIRECTIONAL ANTENNA An Antenna system which radiates power uniformly in all directions in one plane.





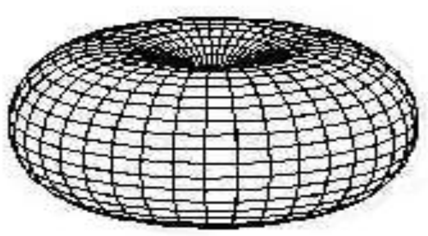



Fig. 1.(a)Television antenna; (b)dipole antenna; (c)directional antenna; (d)horn antenna; (e) omnidirectional antenna

Nomenclature	
d	Diameter of the shaft
d_{fh1}	Diameter of the female part hub1
d_{mh1}	Diameter of the male part hub1
d_b	Diameter of the bolt
t_f	Thickness of female part hub

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II. CASE STUDY OF 7.5 M ANTENNA SYSTEMS

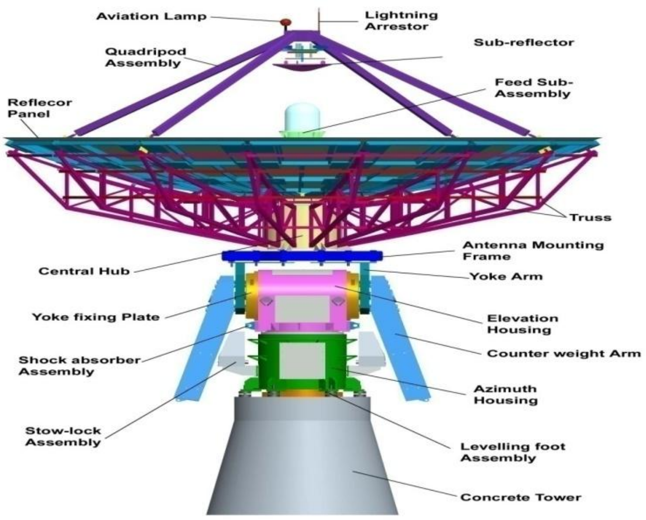

Fig. 2. 7.5 m Antenna System

2.1 Antenna Tracking Pedestal Sub Assembly

2.1.1 Elevation Housing

The Elevation housing is a structural fabricated out of steel plates. The bottom of the elevation housing is machined to suit the fixed part of the Azimuth Slew ring bearing and is fitted to it by high tensile steel bolts. An access is provided in the Elevation housing for routing cables through the hatch. the Yoke arms are attached through Slew ring bearing to Elevation housing. It houses the Elevation drive mechanism.

2.1.2 The Elevation Drive

The Elevation drive is a cylindrical hollow structure responsible for the movement of the parabolic structure about a horizontal axis (which can be rotated in the horizontal plane by Azimuth drive). Hence this drive is responsible for the elevation of the antenna in a given vertical plane in a limited range.

There are two servo motors placed horizontally inside the elevation drive. They are connected to the gear box by means of ***"torque coupling***", which is responsible for resisting high amounts of torque, i.e., the torque in the shaft more than the maximum value. The gearbox is responsible for reduction of the angular speed and has a defined gear ratio. The gear system used is a planetary gear system. The output gear of the shaft is the planet gear and the sun gear is the one that drives hub and is directly responsible for the elevation.

2.1.3 Azimuth Housing

The Azimuth housing consists of a fabricated stiffened cylindrical steel drum supported on a concrete pedestal. The Azimuth Slew ring bearing is supported at the top of the Azimuth housing which is properly machined to match the Slew ring bearing surface and attached to it using high strength bolts .The Azimuth housing is connected to Elevation housing using high tension bolts fitted to inner ring of Azimuth Slew ring bearing. The Azimuth drive mechanism is housed in it.

III. EXISTING TORQUE COUPLING

This Torque coupling consists of so many parts ,there is female part hub in which the bush will rest .The input shaft is inserted into the female part hub and they are locked with the key .The output shaft is inserted into the male part hub and these are also locked with the help of key. As the both shafts and hubs are provided with a slot in which key will rest. On either side of male part there are friction plates provided, when the male part hub is inserted into the female part hub then one of the friction plate get attached or touches with the female part flange and end ring plate is inserted over the male part hub at a position where second friction plate is present in order to hold it. This end ring plate also act as a flange and both the flanges are connected to each other with the help of bolts and they are well tightened such that when female part hub rotates then male part also will rotate.

when the motor runs torque will be generated and this torque is get transmitted by the input shaft of the torque coupling to the female part hub through the key and then from female part hub to the bolts and then through bolts ,torque get transmitted to the male part hub and later to the output shaft through key which is used to lock male part hub and output shaft .Torque also gets transmitted from bush to the male part hub and then to friction plates ,end ring plate and then to output shaft through key. As this process will takes place when there is 53 N-m torque is transmitting but at some times the torque generated will be greater than the limiting one and due to that there will be major damage in gearbox and etc. so in order to avoid these problems there is a feature where when the torque will exceeds the required level than the input shaft rotates but output shaft will not rotate because slip will takes place .due to the bolts connects the input flange and output flange ,so they will rotate. but not shaft .

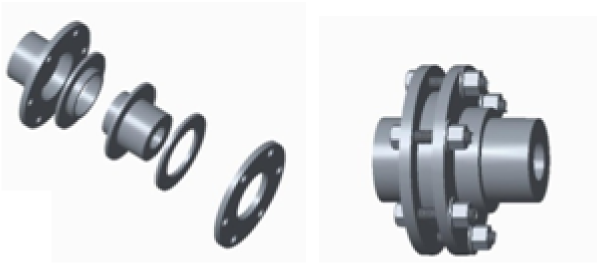

Fig. 3. Parts of torque coupling

IV. DESIAGN OF VARIOUS COMPONENTS

4.1 Design of "Torque Coupling"

Shaft material is AISI type SS304 [9]

Properties of SS304 are:

Yield strength (S_{yt})=215 N/mm^2

As the material is ductile .so s_{yt} is taken into consideration .

For ductile materials "maximum shear stress theory" is applicable

$S_{sy}=0.5s_y$

$S_{allowable} = \frac{Ssy}{fs}$

To find shaft diameter ,we have the relation [8]

$\frac{T}{j} = \frac{\tau}{r}$

Here : $j = \frac{\pi}{32} d^4$

$\mathbf{T= \frac{\pi}{16} d^3 \tau_{allowable}}$

For a given torque using above relation, the shaft diameter is calculated and is at acceptable range Tensional shear stress in the hub can be calculated by considering it as a solid shaft subjected to tensional moment

$\frac{T}{j} = \frac{\tau}{r}$

Where $j = \frac{\pi}{32} * (d^4_h - d^4_h)$

$r = \frac{dh}{2}$

by this we can get,

$\mathbf{T = \tau * \frac{\pi}{16} * (d^4_h - d^4)/d_h.}$

4.2 Design for Flange (Or) End Ring Plate

Area under shear= circumference of the hub * thickness of the flange

$= \pi * d_h * t_f$

Shear stress $= \tau$

Radius of the hub=$\frac{d}{2}$h

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Shear force = area under shear *shear stress

T = shear force *radius of the hub

$T = \pi * d_h * t * \tau * \frac{d_h}{2}$

$T = \frac{1}{2} * \pi * d_h^2 * t * \tau$

We obtained that $\tau_{induced}$ is less than $\tau_{allowable}$ therefore the design is safe

Similarly many other components are designed using above procedure and proved that the design is safe .

V. MODELING OF COMPONENTS USING CREO

Fig. 4. Male Part Hub with Friction Plate and End Ring Plate

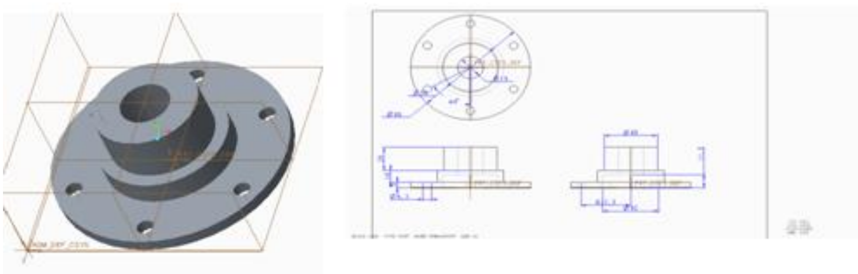

Fig. 5 Female Part Hub

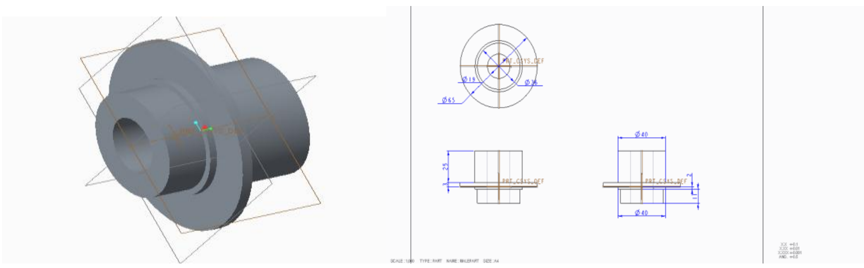

Fig. 6 Male Part Hub

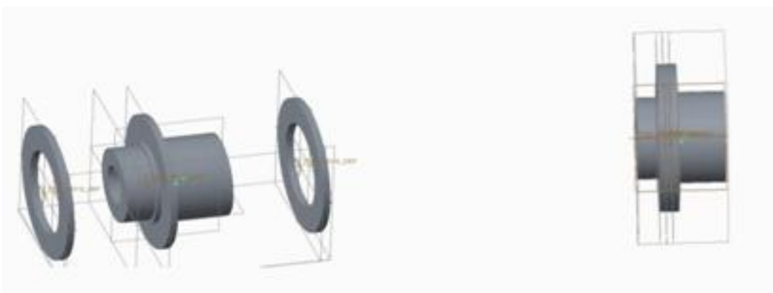

Fig. 7 Male Part Hub with Friction Plate Rings

VI. ANALYSIS OF TORQUE COUPLER IN ANSYS

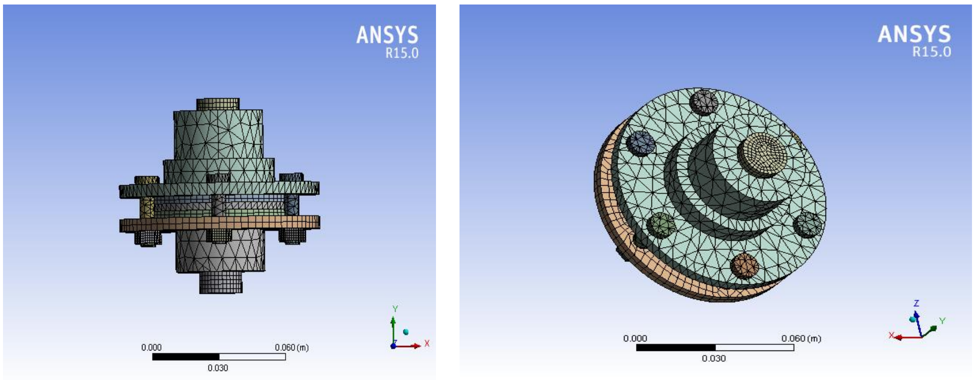

Fig. 8 Meshing of torque coupling

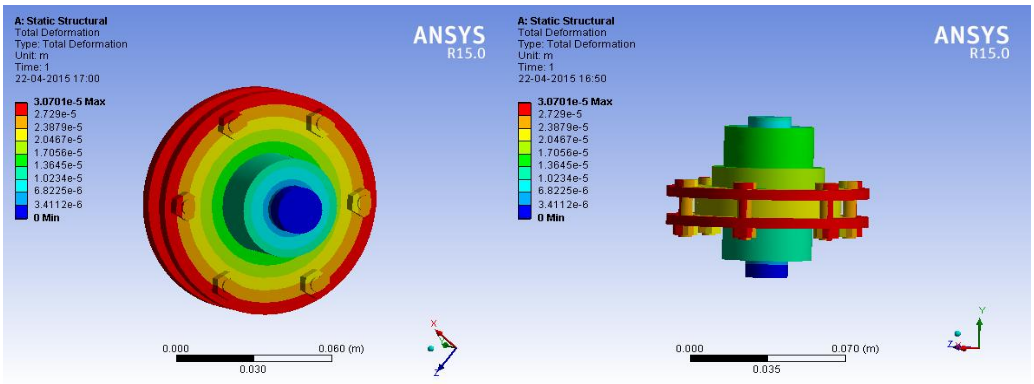

Fig. 9 Deformation of Torque Coupling

VIII.CONCLUSION

The detailed case Study has been done for the 7.5 m Antennas, which are installed at the Remote Sensing Satellite Data Receiving Centre. The author made the attention on studying every detail of the Antenna System related to the Mechanical, Design and Materialistic aspects. After thorough case study, author realized the importance of the component and made the design procedure of the existing Torque coupling. The new Design is explained in this report along with the required CREO models and analysis of "torque coupling" in ANSYS. It is also reported that $\tau_{induced}$ is less than $\tau_{allowable}$ therefore the design is safe for all the components.

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