Total Dead Load on top of the Quadripod of the 45 m dishes of the GMRT

by, Gerald Sequira and Govind Swarup
NCRA-TIFR, Pune University Campus
Pune 411007.

Summary: After a detailed investigation, we find that the total existing Dead Load (DL) on the top of the quadripod of the 45m dishes of the GMRT is 1164.8 kg. TCE had assumed Total Dead Load as 1300kg. We attach a Table-1 giving details of the total Dead Load. The total DL of the antenna feeds, supporting stools, electronic boxes, cables and harnessing clamps is about 522 kg in contrast to a value of 300 kg specified to TCE in 1989. It is desirable that DL of any new feeds being replaced is kept the same or less in weight. Further, one may consider using stools made of Al that may save more than 50 kg. Further, projected area of the Rotating Turret, Stools and Feeds should not exceed 10 sq. m.

Technical Note

In the introduction to the Report titled TCE. G18/DR/CAL/153-DISHCRAD dated 18 Feb. 1990 , it is stated in "Section 2.1.3, "Other Loads: A load of 1300 kg is assumed as the weight of the feed drive system, rotating feed cage, feeds and attachment of feeds to the feed cage. A moment of 12000 kgcm is assumed for the unbalanced dead load about the axis of the system". The DL at the top of the quadripod has three consequences: (1). The DL gives rise to compression of the structural members, particularly when the 45m dish is parked at zenith. (2). The DL results in structural deflection of the quadripod when the 45m dish is rotated towards the horizon and thus this deflection is one of the major   contributor to pointing errors of the 45m dishes. (3). Unbalanced weight gives rise to a moment that would result in additional stress and particularly give rises to a play and pointing error in the drive system of the rotating feed cage (it is important to balance the rotating turret by putting steel plates on the stools (to be tested on the quadripod behind the receiver room building of NCRA).

(1). The weight of several feeds, stools, and electronic boxes had been determined by weighing and estimated for some items by Shri Mathikare in the year ~2000 and by Shri Rajmohan in 2004. Their data was available with one of us (G. Swarup) and has been tabulated in the Table-1 in Cols. 3 and 4. The two data are quite consistent, except for the weights of the Stools supporting the feeds and electronic boxes. The weight of the Stools has been calculated by one of us from detailed drawings of the GMRT obtained from the NCRA library and tabulated in Col. 5. The total value of the DL of antenna feeds, supporting stools, electronic boxes, cables and harnessing clamps is about 522 kg in contrast to a value of 300 kg specified to TCE in 1989. *Detailed calculations are given in Tables T2 to T5 for items 18-24.*

(2) I strongly suggest that any new feeds, including test feeds, should be placed on the rotating turret in future only after clearance by a technical note regarding the admissible dead loads and wind loads, and if required after referring to TCE, particularly if the surface area is large and also weights of the feeds.

(3). Item 23 of table T1 gives total dead load of the Rotating Feed Cage-Turret with square shape + bearings = 318.3 kg, as determined from TCE drawings by G. Sequira. *Figures 1(a), 1(b) and 1(c) illustrate details of the complex set up of the Rotating Feed Cage-Turret, bearings and drive system.*
As indicated in Fig. 1(a), the 4 legs of the quadripod are joined at the top by 3 horizontal pipe of

large diameter. Over these pipes the rotating Turret is suitably connected through bearings on either side.

(4). Item 24 of Table T2 gives total dead load of the 4 lightening arrestors that are welded on the 4 legs of the quadripod. It should be noted that in calculating the design of the quadripod and other structural members of the 45 m dish, TCE did not include in the Computer model 4 lightening arrestors and rotating turret. The total load of all the items at the top of the quadripod was taken as 1300 kg as described in Para 1 of this Technical Note.

Conclusion:

As can be seen from computer outputs of maximum stress in various structural members of the 45m dish as given Report titled TCE. G18/DR/CAL/153-DISHCRAD dated 18 Feb. 1990, Dish Crad 4.1, page 156, the maximum stress in the top member of the quadripod is close to the allowable stress. Hence, it is strongly advised by one of us (G.Swarup) that total dead load on the quadripod should not exceed 1200 kg and wind loads on total projected area of < ~ 10 sq. m.

Enclosed Fig. 1 and Tables T1 to T5.

Table-T1: Estimate of Total Dead Load on the Quadripod including Feeds, Stools, RF Boxes + Roating Turret, Cage Bearings, Motor Drive and Lightning Arrestor (collated by G. Swarup).

Sr.	Item/Particulars	Weight kg Mathikere ~ 2000	Weight kg Rajamohan 2004	Weight kg Sequeira 2011-12	Weight kg FINAL 2012
1	2	3	4	5	6
1	Feed Motor+WormGear+Pinion	49.7	48.63	..	49.7
2	Fedd Cable Wrap	33.5	..	..	33.5
3	150 MHz Front end Box	15	15.4	..	15.4
4	233 MHz Front end Box	15	14.6	..	14.6
5	327 MHz Front end Box	16	15	..	15
6	610 MHz Front end Box	12	13.85	..	13.9
7	Power Supply Box	..	28	..	28
8	Common Box	17	16.4	..	16.4
9	1420 MHZ Feed + Amplifier	60	61	..	61
10	610 MHz feed	50	52.5	..	52.5
11	327 MHz Feed	25	27.85	..	27.9
12	150 MHz Feed	28	34.2	..	34.2
13	Sundary	..	..	..	0
14	Cables	17.5	..	..	17.5
15	Harnessing Clamps	26	..	..	26
16	Omron Limit Switch, Cam,plate	6	6	..	6
17	Mesh/Jali	10	..	..	10
18	610 MHz Stool	2*	16.6	24.29	24.3
19	1420 MHz Stool		20.1	25.52	25.5
20	150 MHz Stool	0*	31.2	50.41	50.4
21	327 MHz Stool		31.6	50.41	50.4
22	Fasteners	5	..	..	5
23	Feed Cage, Bearings + Turret	..	..	318.28	318.3

| 24 | Lightening Arrestor | | 269.28 | 269.3 |

Total Dead Load on Quadri-pod　　　　　　　　　　　　　　　　　　　**1164.8**

Note: Dead Loads of items 1 to 17in Col. 6 have been tabulated by G. Swarup from sheets available with him as given by Shri Mathikare in 2004 and those by Shri Rajmohan in 2004, and Dead Loads for items 18-24 based on calculations by G. Sequeira (Tables T2 to T5).
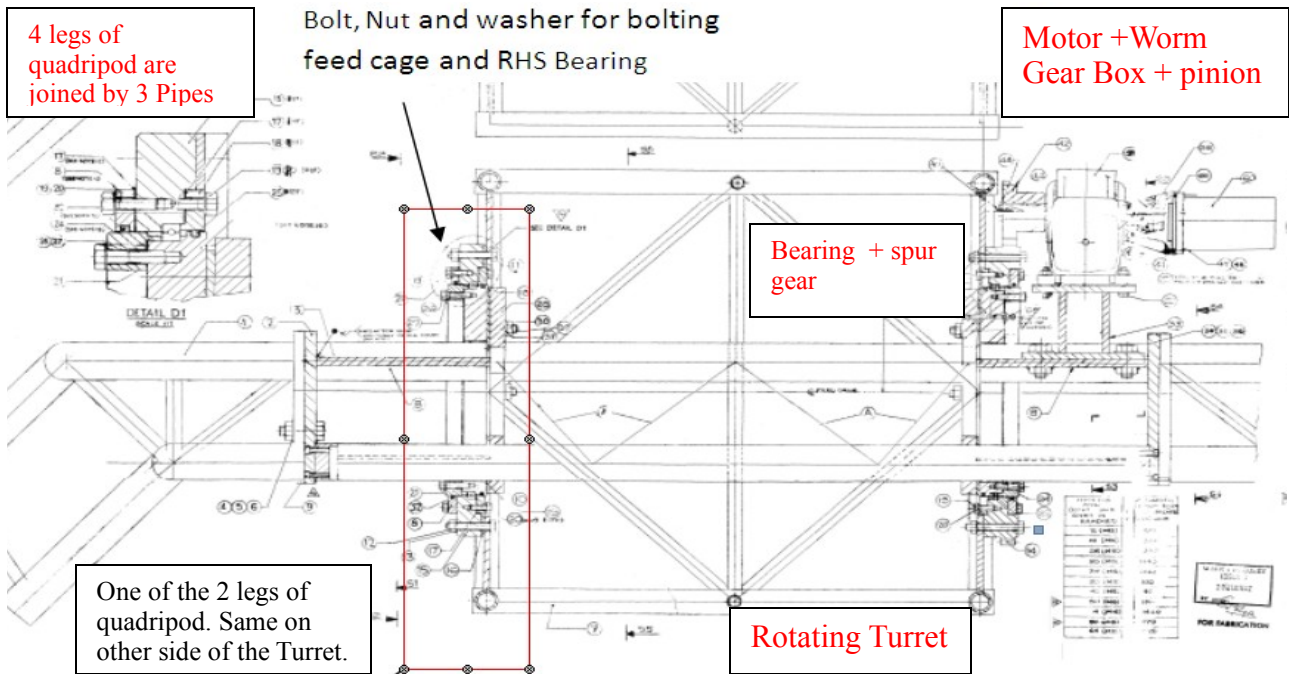

4 legs of quadripod are joined by 3 Pipes

Bolt, Nut and washer for bolting feed cage and RHS Bearing

Motor +Worm Gear Box + pinion

Bearing + spur gear

One of the 2 legs of quadripod. Same on other side of the Turret.

Rotating Turret

Fig. 1(a). A detailed sketch showing the attachmet of bearing supports (left and right sides of the Fig.) mounted on the central three Pipes of the quadripod, to which are attached a SQUARE ROTATING TURRET, shown in the central part of the Fig 1. On the right side of this Fig. is shown the motor, worm gear box and a pinion that drives a spur gear attached to the roating turret. Primary antenna Feeds are mounted on 4 stools that are rigidly bolted on the 4 sides of the Roating Turret. (Fig. made by G. Sequira from a drawing of TCE-G18-153-GA-1005 Sheet 1/2   ).
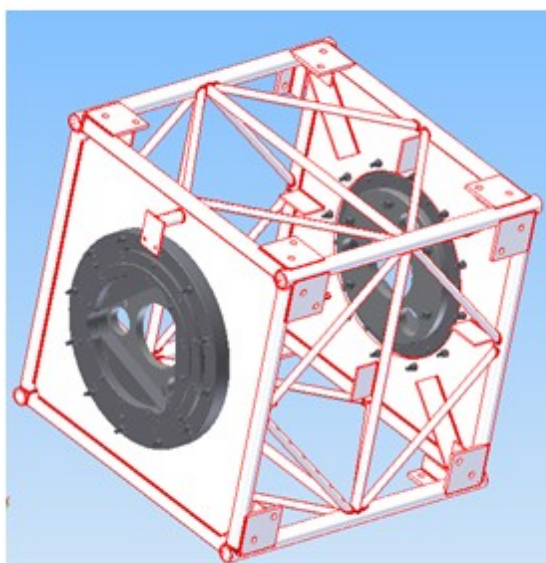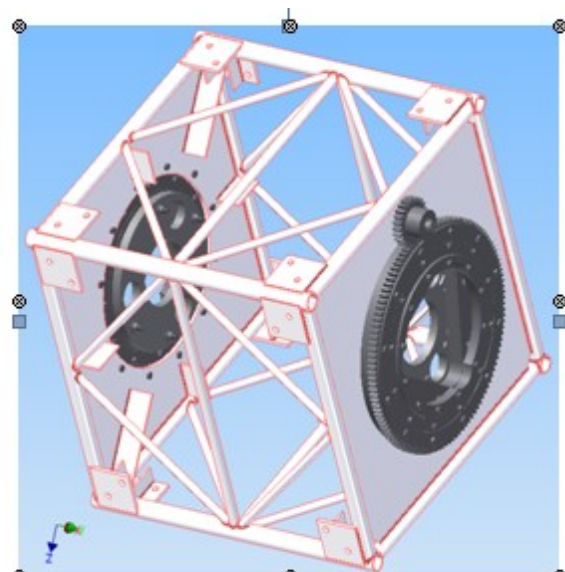

Fig. 1(b): Rotating Turret and bearings either side

Fig. 1(c): Rotating Turret and Spur gear + pinion.

Table- T2: Weight of Feed Cage (Gerald Sequira)

Weight of the Feed cage.xls [Compatibility Mode]

TOTAL WEIGHT OF FEED CAGE ONLY

Description	O.D. (mm)	width (mm)	L (mm)	Nos.	Density	Weight/ no (Kg)	Total Weight (Kg)
Pipe NB 40	48.4	4.05	888	4	0.00000786	3.938528858	15.75411543
Pipe NB 32	42.9	4.05	816	8	0.00000786	3.170360321	25.36288256
Pipe NB 15	21.43	3.25	543	16	0.00000786	0.792226724	12.67562758
Pipe NB 20	27.2	3.25	798	4	0.00000786	1.53378395	6.135135799
Pipe NB 25	33.8	3.25	102	1	0.00000786	0.250073208	0.250073208
Plate	122	10	122	16	0.00000786	1.1698824	18.7181184
Plate	100	6	70	8	0.00000786	0.33012	2.64096
Plate	235	6	70	8	0.00000786	0.775782	6.206256
Plate with holeo of dia 500 m	784	8	784	2	0.00000786	26.30311015	52.6062203
Plate	100	6	70	1	0.00000786	0.33012	0.33012
Plate	115	6	43	16	0.00000786	0.2332062	3.7312992
Total							144.4108085

Table- T3: Weight of Right Side Bearing Assembly of Rotating Turret (G. Sequira)

GMRT-Feed-Weight of RHS bearing assembly.xls [Compatibility Mode]

ITEM	QTY	PART NUMBER	DESCRIPTION	MASS (Kg)	TOTAL MASS (Kg)
1	1	Bearing seat adaptor		2.306	2.306
2	1	Bearing Seat		19.483	19.483
3	1	Cover		4.96	4.96
4	1	split cover		8.623	8.623
5	1	rubber gasket (Split cover)		0.023	0.023
6	1	end cover		5.572	5.572
7	2	rubber gasket (end cover)		0.034	0.068
8	1	bearing support		36.218	36.218
9	1	CSCD160	Radial ball bearing	1.401	1.401
10	1	Felt ring_25		0.017	0.017
11	1	spacer (bearing support)		3.222	3.222
12	1	Felt ring_32		0.042	0.042
13	1	Shim (Bearing Seat adaptor)		0.217	0.217
14	12	DIN 125-2 - B 10.5	Washer	0.004	0.048
15	12	DIN 125 - A 10.5	Washer	0.004	0.048
16	12	ISO 4017 - M10 x 40	Hexagon head screws	0.035	0.42
17	24	ISO 4017 - M10 x 30	Hexagon head screws	0.029	0.696
18	12	ISO 7089 - 10 - 140 HV	Plain washers - Normal series - Product grade A	0.004	0.048
19	6	ISO 4762 - M16 x 80	Hexagon Socket Head Cap Screw	0.167	1.002
20	6	DIN 125 - A 17	Washer	0.011	0.066
21	6	DIN 555-5 - M16	Hex Nut	0.034	0.204
TOTAL WEIGHT OF RIGHT HAND SIDE BEARING ASSEMBLY					**84.684**

Table T4: Total weight of each of the 327 MHz, 150 MHz, 610 MHz and 1420 MHz stools (G. Sequira).

GMRT-Weight of the Stool for various Feeds.xls [Compatibility Mode]

TOTAL WEIGHT OF Each of 327 MHz and 150 MHz Feed Stool

Sr.	Description	O.D. / w (mm)	Δ D/w (mm)	L (mm)	Nos.	ρ(Kg/mm³)	Wt/ no (Kg)	Total Wt(Kg)
1	Pipe NB 20	27.2	3.25	1220	4	0.00000786	2.34488273	9.37953092
2	Pipe NB 15	21.43	3.25	684	12	0.00000786	0.99794306	11.9753167
3	Pipe NB 15	21.43	3.25	920	8	0.00000786	1.34226259	10.7381007
4	ISA 35 x35x 4	35	4	748	4	0.00000786	1.55212992	6.20851968
5	ISA 25 x25x 5	25	4	748	4	0.00000786	1.08178752	4.32715008
6	Plate	106	10	106	4	0.00000786	0.8831496	3.5325984
7	Plate	106	10	106	4	0.00000786	0.8831496	3.5325984
8	Hex head bolt M8 x25 long SS	--	--	25	24		0.015	0.36
	Nut M8 SS	--	--	--	24		0.005	0.12
	Lock Nut M8 SS	--	--	--	24		0.01	0.24
	Total Weight (Kg)							50.4138149

TOTAL WEIGHT OF 610 Mhz Feed Stool

Sr. No	Description	O.D. / width (mm)	Thickness (mm)	Length (mm)	Nos.	Density (Kg/mmm3)	Weight/ no (Kg)	Total Weight (Kg)
1	Plate	106	10	106	8	0.00000786	0.8831496	7.0651968
2	Pipe NB 20	27.2	3.25	685	8	0.00000786	1.316593992	10.53275194
3	Pipe NB 20	27.2	3.25	324	4	0.00000786	0.622739348	2.490957392
4	Pipe NB 20	27.2	3.25	755	4	0.00000786	1.451136444	5.804545775
5	Pipe NB 20	27.2	3.25	355	8	0.00000786	0.682322434	5.458579471
	Total Weight (Kg)							24.28683457

TOTAL WEIGHT OF 1420 Mhz Feed Stool

Sr. No	Description	O.D. / width (mm)	Thickness (mm)	Length (mm)	Nos.	Density (Kg/mmm3)	Weight/ no (Kg)	Total Weight (Kg)
1	Plate	106	10	106	8	0.00000786	0.8831496	7.0651968
2	Pipe NB 20	27.2	3.25	685	8	0.00000786	1.316593992	10.53275194
3	Pipe NB 20	27.2	3.25	430	4	0.00000786	0.826475061	3.305900243
4	Pipe NB 20	27.2	3.25	770	4	0.00000786	1.479966969	5.919867877
5	Pipe NB 20	27.2	3.25	375	8	0.00000786	0.720763134	5.766105075
	Total Weight (Kg)							25.52462513

Table T5: Weight (Wt) of each of the 4 lightning Arrestors (total for 4 lightning arrestors = 269.28 (G. Sequira).

Sr.	Part No	O.D./thk(mm)	Thk (mm)	L (mm)	Nos.	ρ(Kg/mm³)	Wt/ no (Kg)	Total Wt (Kg)
		Weight (Wt) of one of the 4 lightning Arrestors.						
1	1	33.7	4.05	3109.93	1	0.00000786	9.221525116	9.221525 116
2	2	33.7	4.05	3112.61	1	0.00000786	9.229471818	9.229471 818
3	3	33.7	4.05	3297	1	0.00000786	9.776222715	9.776222 715
4	4	33.7	4.05	345.44	1	0.00000786	1.02429432	1.024294 32
5	5	33.7	4.05	344.23	1	0.00000786	1.020706444	1.020706 444
6	6	21.3	3.25	464.64	1	0.00000786	0.67305349	0.673053 49
7	7	21.3	3.25	266.37	1	0.00000786	0.385849815	0.385849 815
8	8	21.3	3.25	400.24	8	0.00000786	0.579766979	4.638135 828
9	9	33.7	4.05	400.24	1	0.00000786	1.186786588	1.186786 588
10	10	33.7	4.05	401.14	1	0.00000786	1.189455256	1.189455 256
11	11	42.4	4.05	85	2	0.00000786	0.325995598	0.651991 196
12	12	55	6	55	2	0.00000786	0.142659	0.285318
13	13	21.3	3.25	630.42	4	0.00000786	0.91319383	3.652775 321
14	13A	21.3	3.25	633.39	1	0.00000786	0.917496019	0.917496 019
15	14	21.3	3.25	284.34	5	0.00000786	0.411880229	2.059401 143
16	15	42.4	4.05	140	16	0.00000786	0.536933926	8.590942 822
17	16	42.4	4.05	110	8	0.00000786	0.421876656	3.375013 252
18	17	21.3	3.25	430.52	1	0.00000786	0.623629022	0.623629 022
19	18	21.3	3.25	267.57	1	0.00000786	0.387588073	0.387588 073
20	19	21.3	3.25	401.18	8	0.00000786	0.581128614	4.649028 911
21	20	42.4	4.05	180	2	0.00000786	0.69034362	1.380687 239
22	21	140	6	150	2	0.00000786	0.99036	1.98072
23	22	30	6	150	2	0.00000786	0.21222	0.42444
Total								67.32453 239