NEW TIDAL PREDICTION DIAGRAM (DG-02)

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(1) The elevation of the tide above mean sea level is given by a sum of terms of the form A cos α. These terms may be put in logarithmic form :

$$\log A \cos \alpha = \log A - \operatorname{colog} \cos \alpha$$

The value of colog cos α in terms of α is represented by the curve plotted in figure 1. The values are positive, as the cosines, between 0° and 90° and between 270° and 360°; they are negative in the two other quadrants.

The curve in figure 1 is actually printed on a sheet of transparent celluloid.

Below the curve is a 0 to 150 logarithmic scale, placed upside down. This is printed on cardboard, and the curve printed on celluloid is placed over it.

Let us compute the value of A cos α, where $A = 50$ cm and $\alpha = 300°$. By superposing the logarithmic scale curve so that the base coincides with the value 50 and the 300°-angle coincides with the right-hand side of the scale, we get :

$$50 \cos 300° = +26$$

for the obvious reason that AB is colog cos 300°, AC is log 50, and hence BC is equal to log 50 — colog cos 300°.

(2) Let us take a semi-diurnal constituent. The phase at 0 hour is equal to $360° - (V_0 + u) + g$, and the phase decreases by approximately 29° per hour. $360° - (V_0 + u)$ is given for each constituent and for 0 hour each day in table DG-02; by applying the value of g for the constituent we get α_0. The value of A is obtained by multiplying H for the constituent by the factor f, using the same table. Let $A = 50$ cm, $\alpha_0 = 300°$, and the constituent be semi-diurnal. The contributions of the constituent at successive hours are the ordinates of the plotted curve, taken at 29°-intervals (fig. 1).

If the constituent were diurnal, the ordinates would be taken at 14.5°-intervals; if quarter-diurnal, at 54°-intervals. The successive ordinates are represented on the logarithmic scale by equidistant vertical lines.

As we consider the velocity of all the semi-diurnal (29°), diurnal (14.5°), and quarter-diurnal (54°) constituents to be equal, the constituents :

M_2 S_2 N_2 K_2 L_2 μ_2 ν_2
K_1 O_1 P_1
M_4 MS_4

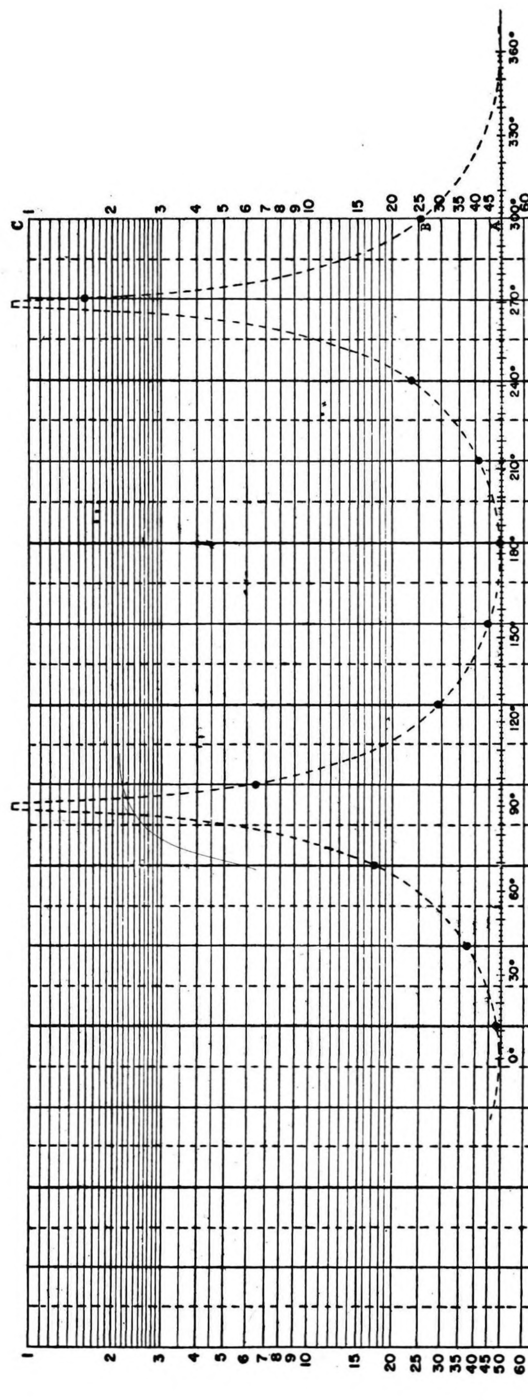
C
n
n
A
B
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
360°
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40
45
50
60
70
80
90
100
150

FIGURE 1

will retain during the day their initial setting and may be treated jointly by their component at 0 hour.

The method of obtaining this component is greatly facilitated by the diagram. We need only have, for each constituent with the same index, the contribution at 0 hour and for a certain number of subsequent hours; and take the algebraic sum of the contributions, attempting to adjust the curve to the sum of such values. This is the position of the component.

An example will help to clarify matters. Let us assume that the tide at Rio de Janeiro, Ilha Fiscal, is to be predicted for 3 January 1957.

(*a*) Copy on the computation form (fig. 2) the tidal elements *g*, H, Z_0 (elevation of mean level above datum level), and, as required, the monthly correction.

EXEMPLO : MARE NA ILHA FISCAL, A 3 DE JANEIRO DE 1957

DG-02

MARÉ NO DIA: 3 de Janeiro de 1957 NO PORTO DE: RIO DE JANEIRO (I. FISCAL)

Z_0 = 112 cm
Correção mensal = − 2 cm
Z'_0 = 110 cm

ONDAS	M_2		S_2		N_2		K_2		L_2		μ_2		ν_2		K_1		O_1		P_1		M_4		MS_4	
g e H	85	33	89	19	109	4	89	5	69	3	109	2	109	1	145	7	89	11	145	2	82	5	190	2
A e f	40	1.03	0	1	208	1.03	142	0.83	44	0.87	80	1.03	271	1.03	340	0.93	63	0.88	12	1	79	1.05	40	1.05
SOMA E PRODUTO	125	34	89	19	317	4	231	4	113	3	189	2	380	1	485	7	152	10	157	2	161	5	230	2
-360° ou -720°												—	360	-	360									
α_0 e A_0	125	34	89	19	317	4	231	4	113	3	189	2	20	1	125	7	152	10	157	2	161	5	230	2

SEMIDIURNAS

ONDA	às 0 horas		às 2 horas	
M_2		-20	+13	
S_2	0		+16	
N_2	+ 3		0	
K_2		-2.5		- 4
L_2		-1	+2	
μ_2		-2		-1,3
ν_2		-		-1
SOMA	+ 3	-26,5	31	-6,3
A_2 e α_2	50	118°		

DIURNAS

ONDA	às 0 horas		às 4 horas	
K_1		- 4	+2,6	
O_1		-9	0	
P_1		- 2	0	
SOMA		-15	+2,6	
A_1 e α_1	19,5	140°		

QUATERDIURNAS

ONDA	às 0 horas		às 1 horas	
M_4		-5		-1
MS_4		-1		-2
SOMA		-6		-3
A_4 e α_4	6	178°		

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
SEMIDIURNAS	-23	0	25	42	50	44	28	4	-20	-40	-49	-46	-32	-9	14	31	48	49	37	15	-8	-32	-46	-50
DIURNAS	-15	-11	-7	-2	3	7	12	15	18	19	19	18	16	13	9	4	0	-5	-10	-14	-17	-19	-19	-19
QUATERDIURNAS	-6	-3	+3	6	4	-2	-6	-4	1	6	4	0	-5	-5	0	5	5	0	-5	-6	-1	4	6	2
Z'_0	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
SOMA	66	96	131	156	167	159	144	125	109	95	84	82	89	109	133	150	163	154	132	105	84	63	51	43

FIGURE 2

(*b*) Copy on the computation form arguments A and *f* taken from table DG-02 for the year.

(*c*) Compute $g + A = \alpha_0$, $gH = A_0$.

(*d*) For each semi-diurnal constituent, place the logarithmic-scale curve so that the graduated base coincides with horizontal line A_0, and angle α_0 with the right-hand side of the logarithmic scale. In figure 3, the curve has been placed for M_2 of Rio de Janeiro ($\alpha_0 = 125$, $A_0 = 34$ cm). Note the initial contribution of the constituent (in this case — 20 cm) and the contribution for a certain number of subsequent hours (here 2 semi-diurnal hours) : + 13.

In the same way, we get the initial contribution for $S_2 N_2 K_2 L_2$, and the contribution for the subsequent 2 semi-diurnal hours; the sum of these contributions is the contribution of the semi-diurnal component, *i.e.* — 23.5 and + 24.7.

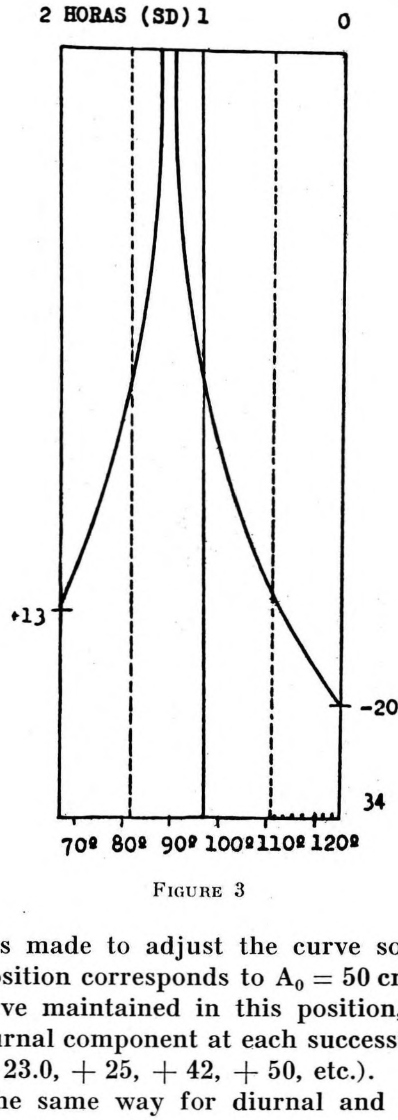

FIGURE 3

(*e*) An attempt is made to adjust the curve so as to produce these values (fig. 4). The position corresponds to $A_0 = 50$ cm, $\alpha_0 = 118°$.

(*f*) With the curve maintained in this position, we have the contribution of the semi-diurnal component at each successive semi-diurnal hour, starting at 0 hour (— 23.0, + 25, + 42, + 50, etc.).

(*g*) Proceed in the same way for diurnal and quarter-diurnal constituents.

(*h*) The sum of the contributions with the Z_0 value and the monthly correction is the tidal height.

Two important facts should now be noted :

(*a*) When the curve ends, as in fig. 1, to continue reading the contributions we need only shift it towards the right so that the angle indicated at the last time read (12°, if the constituent is semi-diurnal, as in fig. 1) is indicated on the right-hand side of the logarithmic scale.

(*b*) The sign of the contribution is that of the cosine; hence the contribution is positive between 0° and 90°, and between 270° and 360°; it is negative otherwise. Hence, whenever it is appropriate to work with $180 + \alpha$, rather than α, the sign of the contribution is reversed.

If A is very small (3 cm for instance), a value 10 times as great may be used (30 cm), and the contributions divided by 10.

Figure 5 shows the predicted tide curve.

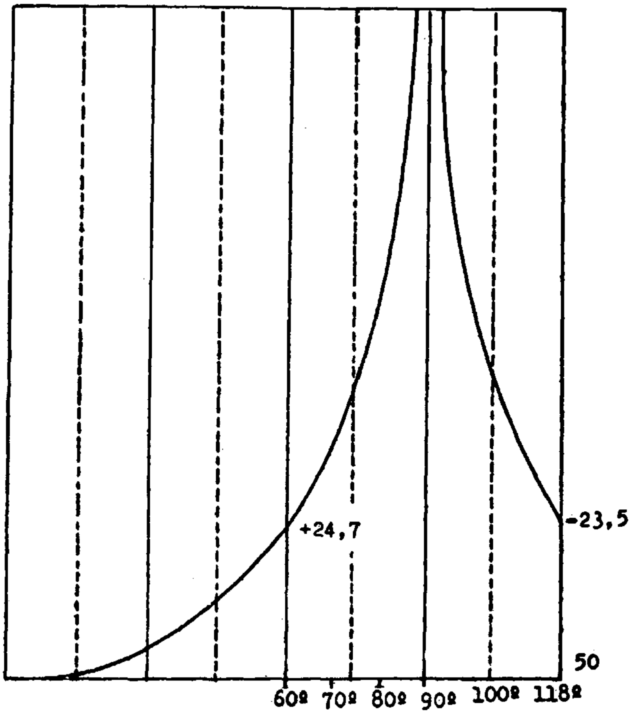

FIGURE 4

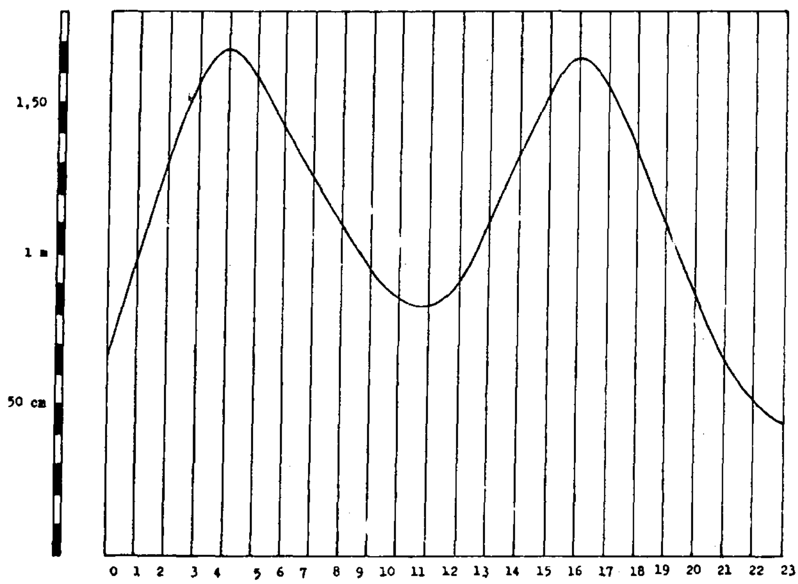

FIGURE 5