YAPILARIN NORMAL TİTREŞİM MODLARININ

VE PERİYOTLARININ TAYİNİ

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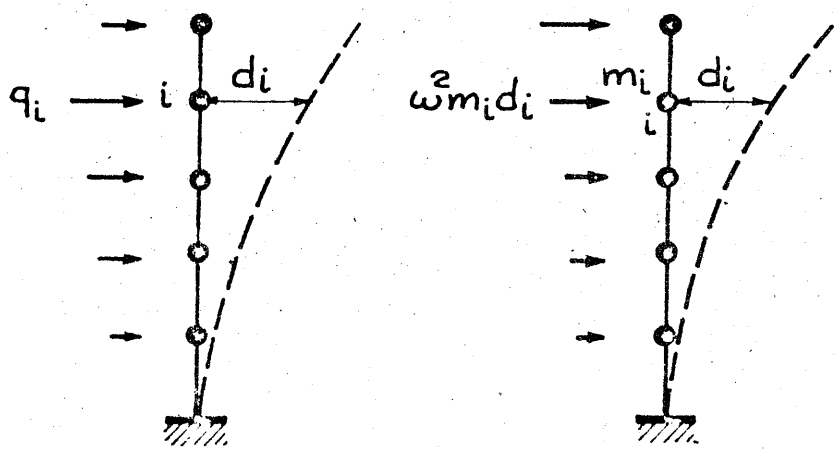
1976

■ YAPILARIN NORMAL TİTREŞİM MODLARININ VE PERİYOTLARININ TAYİNİ :



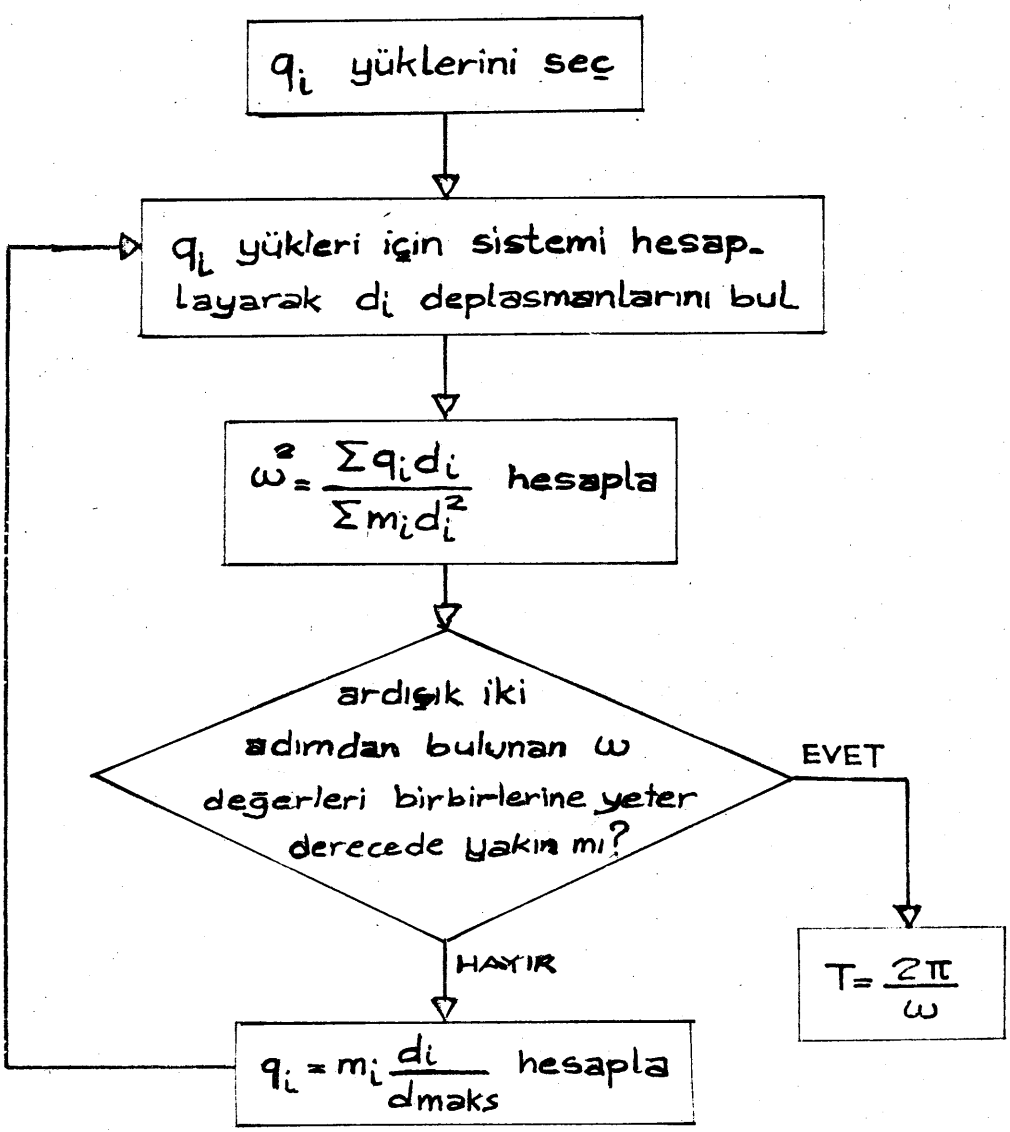
■ Betti karşıtlık teoreminden :

$$\Sigma q_i d_i = \omega^2 \Sigma m_i d_i^2$$

■ Özel açısal frekans: $\boxed{\omega^2 = \dfrac{\Sigma q_i d_i}{\Sigma m_i d_i^2}}$ [1]

■ Özel periyot: $\boxed{T = \dfrac{2\pi}{\omega}}$ [2]

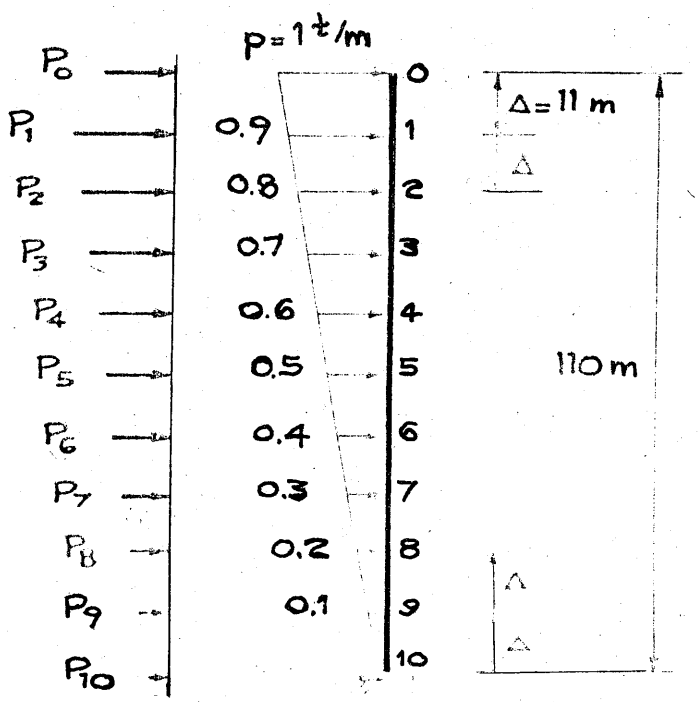
■ HESAPTA İZLENECEK YOL :



■ ÖRNEK : 1 BACA ÖZEL PERİYODUNUN HESABI

Malzeme	Tabanda		Tepede	
	D_d (m)	D_i (m)	D_d (m)	D_i (m)
Betonarme	9.40	8.64	3.40	3.04
Chamot tuğlası	8.64	8.18	3.04	2.58
Ateş tuğlası	8.18	7.97	2.58	2.37

D_d = dış çap D_i = iç çap



Kesit No.	I (m^4)	p (t/m)	P (t)	$\frac{M}{EI} 10^{-5}$	$\varphi . 10^{-4}$	$d . 10^{2}$ (m)	m (tsn^2/m)	Simpson Sayıları	$md . 10^{2}$ (tsn^2)
1	2	3	4	5	6	7	8	9	10

- Özel açısal frekans:

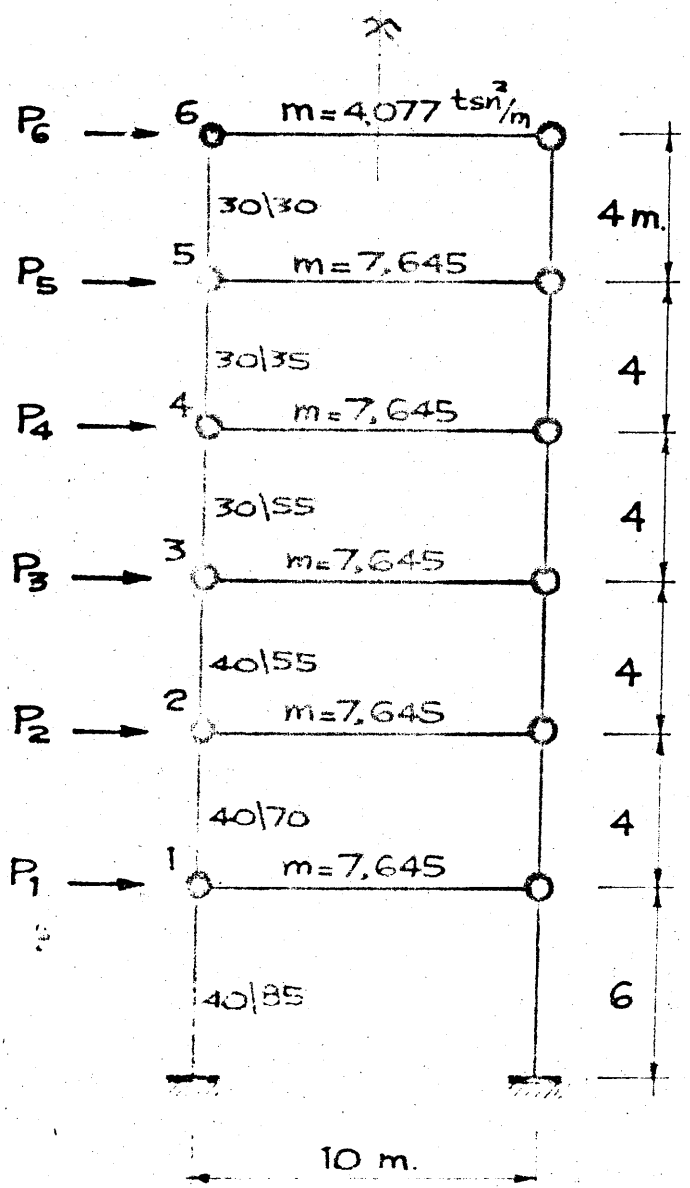
$$\omega^2 = \frac{\Sigma P_i d_i}{\Sigma m_i d_i^2} = 9.136 \qquad \omega = 3.02 \ \frac{1}{sn}$$

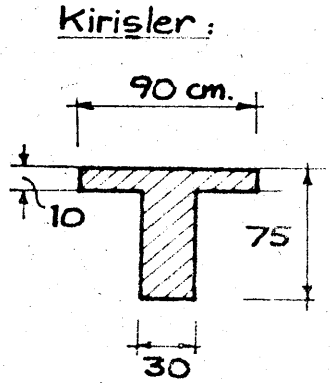
- Özel periyot:

$$T = \frac{2\pi}{\omega} = 2.08 \ sn$$

ÖRNEK: 2

ÇERÇEVE ÖZEL PERİYODU HESABI





Sistem : Betonarme

Çerçeve aralığı : 5m.

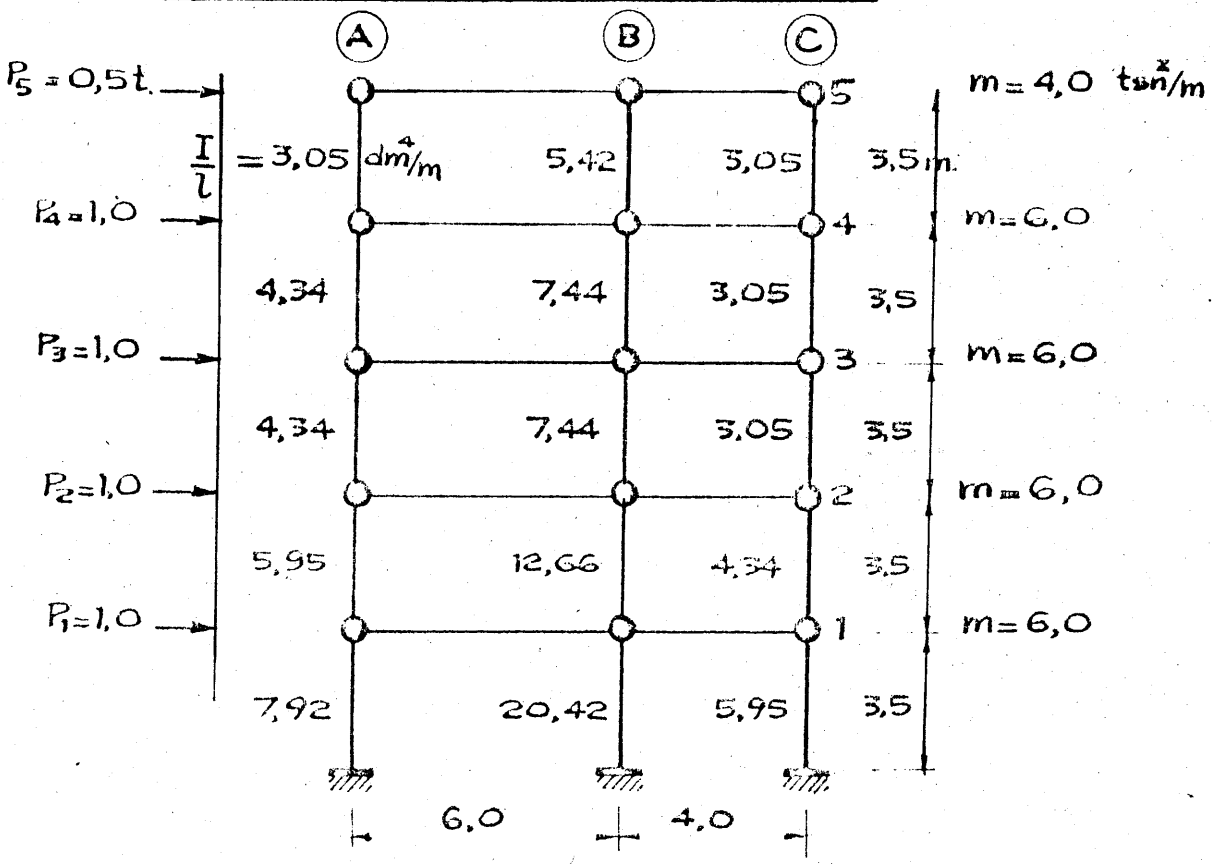
Kat No.	$\frac{I}{l}$	r_o / r_u	R=ΣD (t/m)	P (t)	ΣT (t)	$\delta.10^2$ (m)	$d.10^2$ (m)	m (tsn^2/m)	$P.d.10^2$	$md^2.10^4$
1	2	3	4	5	6	7	8	9	10	11

- Özel periyot .

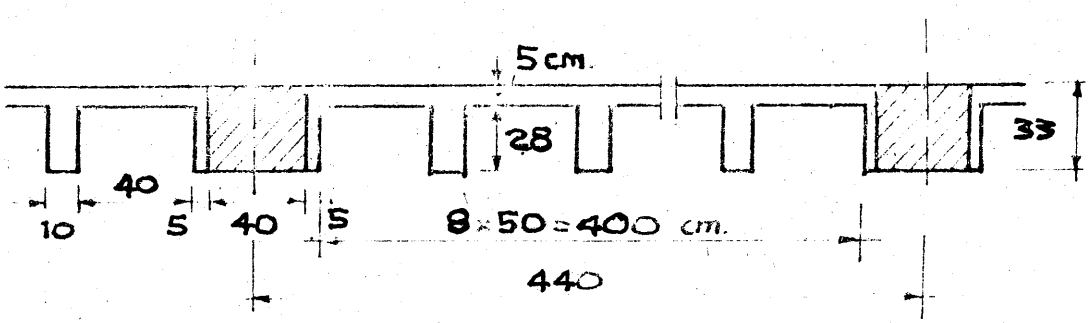
- Lineer artan P kuvvetleri için : T = 1.78 sn
- Eşit P kuvvetleri için : T = 1.78 sn
- P kuvvetleri olarak rüzgar yüklerinin alınması halinde : T = 1.76 sn
- Kesin sonuç T = 1.74 sn
- Maksimum rolatif hata : % 2

ÖRNEK : 3

NERVÜRLÜ DÖŞEMELİ SİSTEM (I)



Çerçeve aralığı = 4,40 m.



(Döşeme kesiti)

○ Nervür fazlası kirişi : $I_K = 11,98\ dm^4$

○ Boyuna kirişler :

A ve C akslarında : (60x33) $J_t = 46,79\ dm^4$

B aksında : (80x33) $J_t = 70,72\ dm^4$

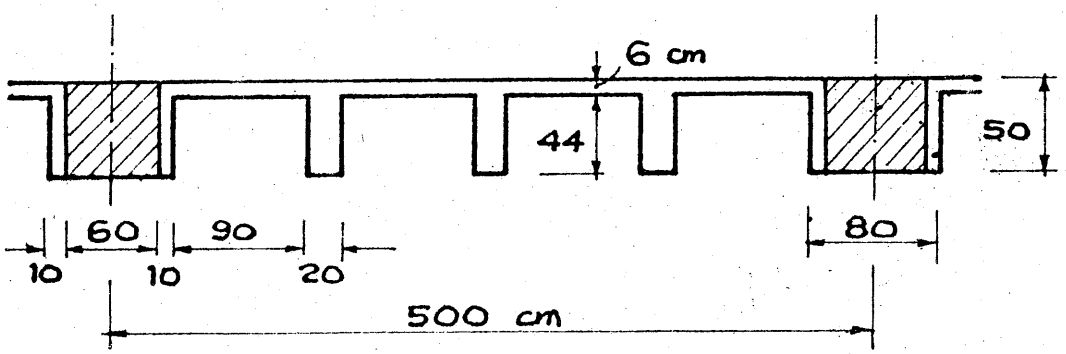
$E = 2.10^6\ t/m^2$ $E/G = 8/3$

○ Özel periyod : $T = 1,19$ sn

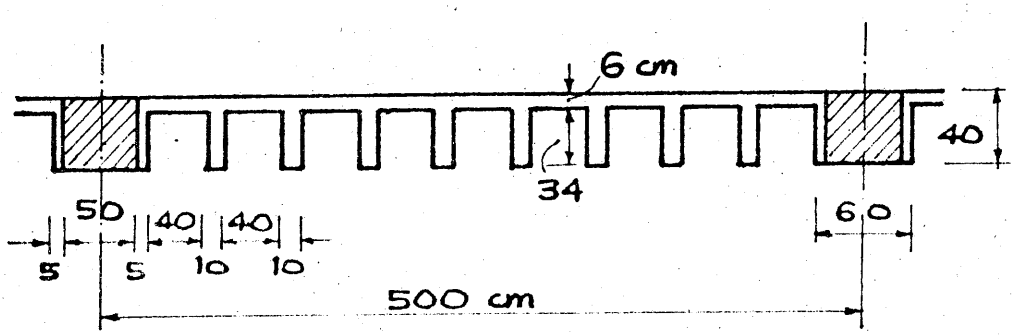
ÖRNEK : 4

NERVÜRLÜ DÖŞEMELİ SİSTEM (II)

- Örnek:2 deki sistemin nervürlü döşeme için özel periyodları



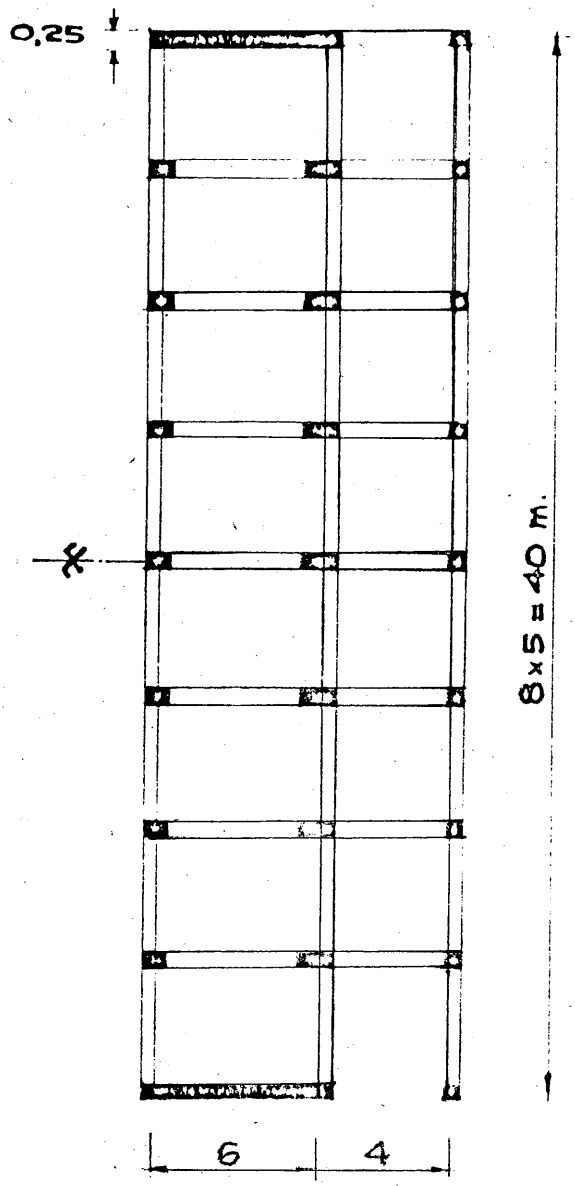
- $T = 1{,}69$ sn.



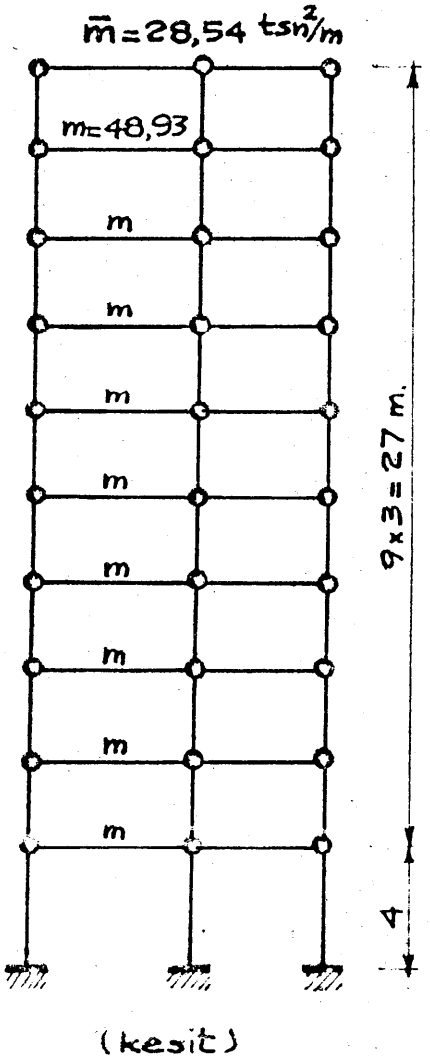
- $T = 2{,}44$ sn.

ÖRNEK : 5

ÇERÇEVE VE PERDELERDEN OLUŞAN SİSTEM



(plân)

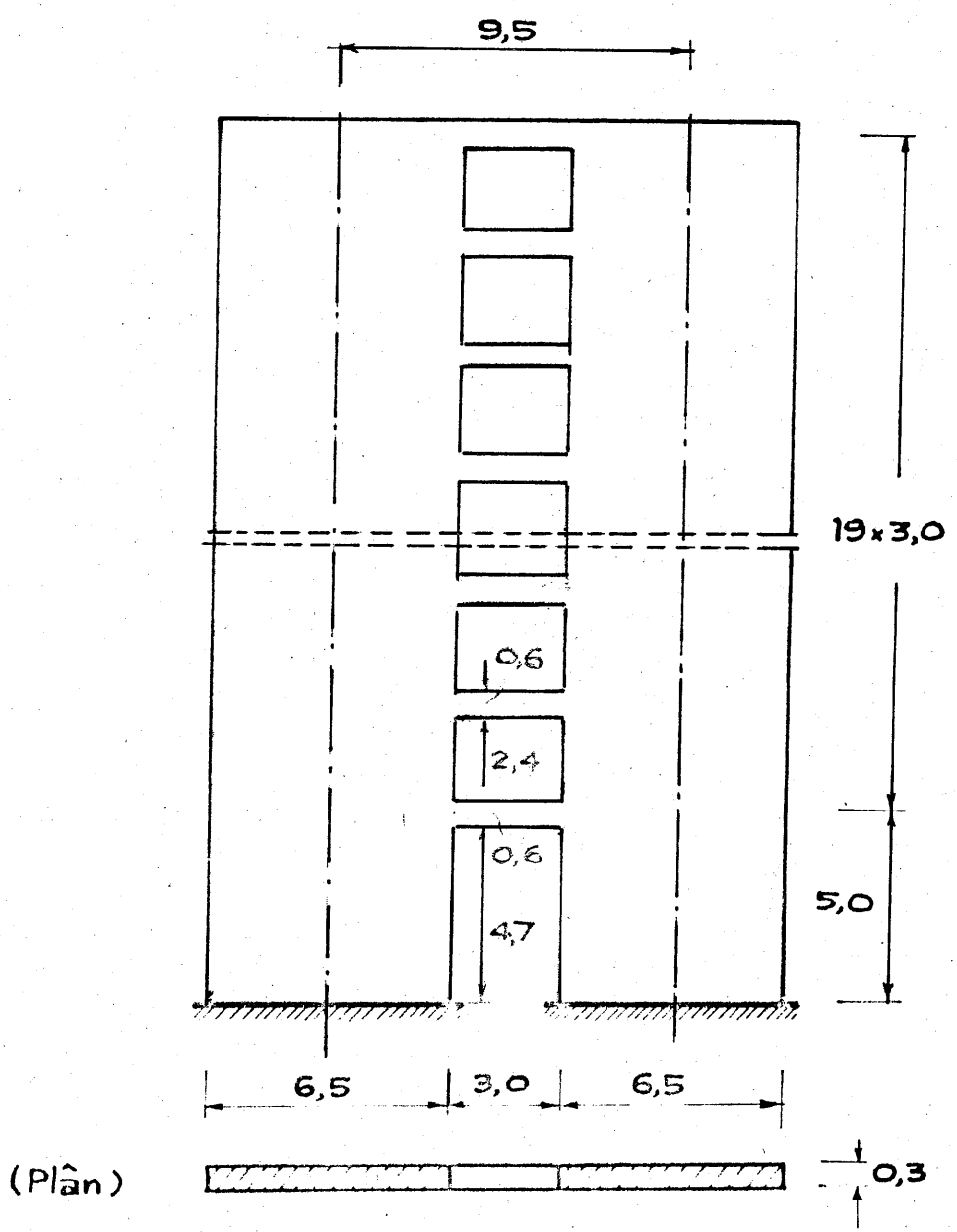


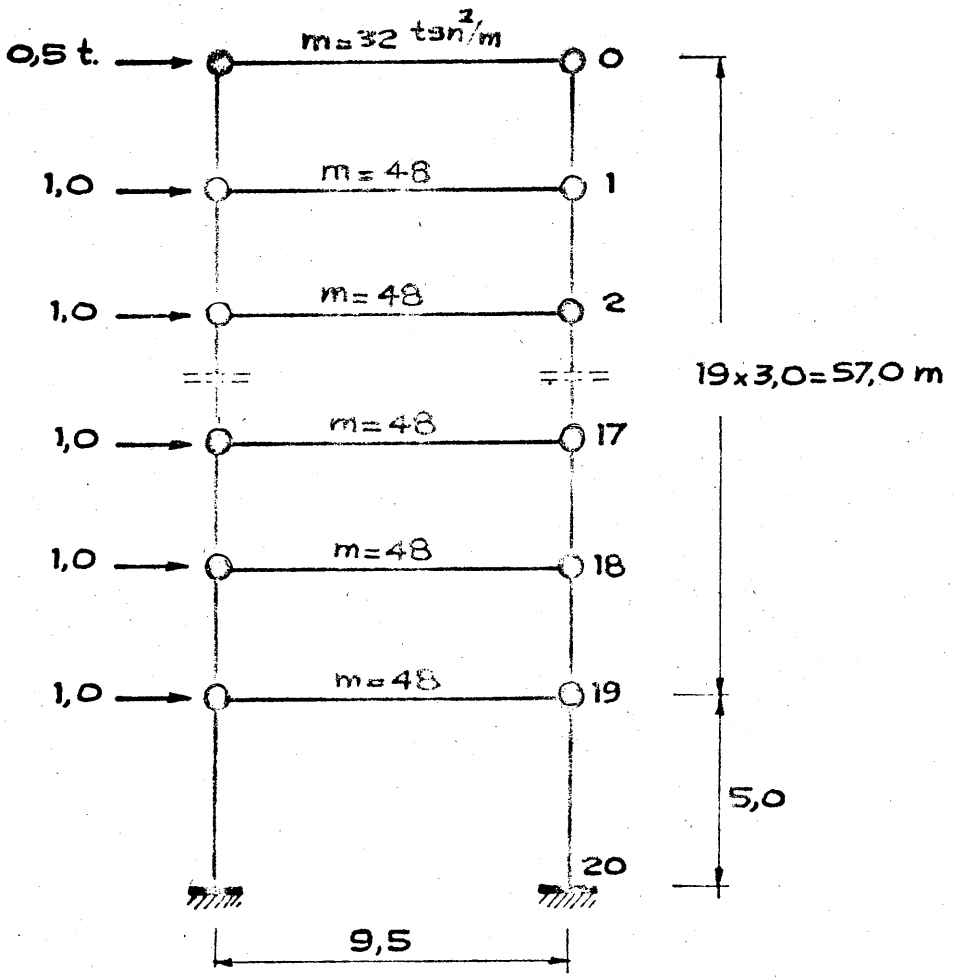
(kesit)

● Özel periyod: T = 0,946 sn.

ÖRNEK : 6

BOŞLUKLU PERDE ÖZEL PERİYODU HESABI

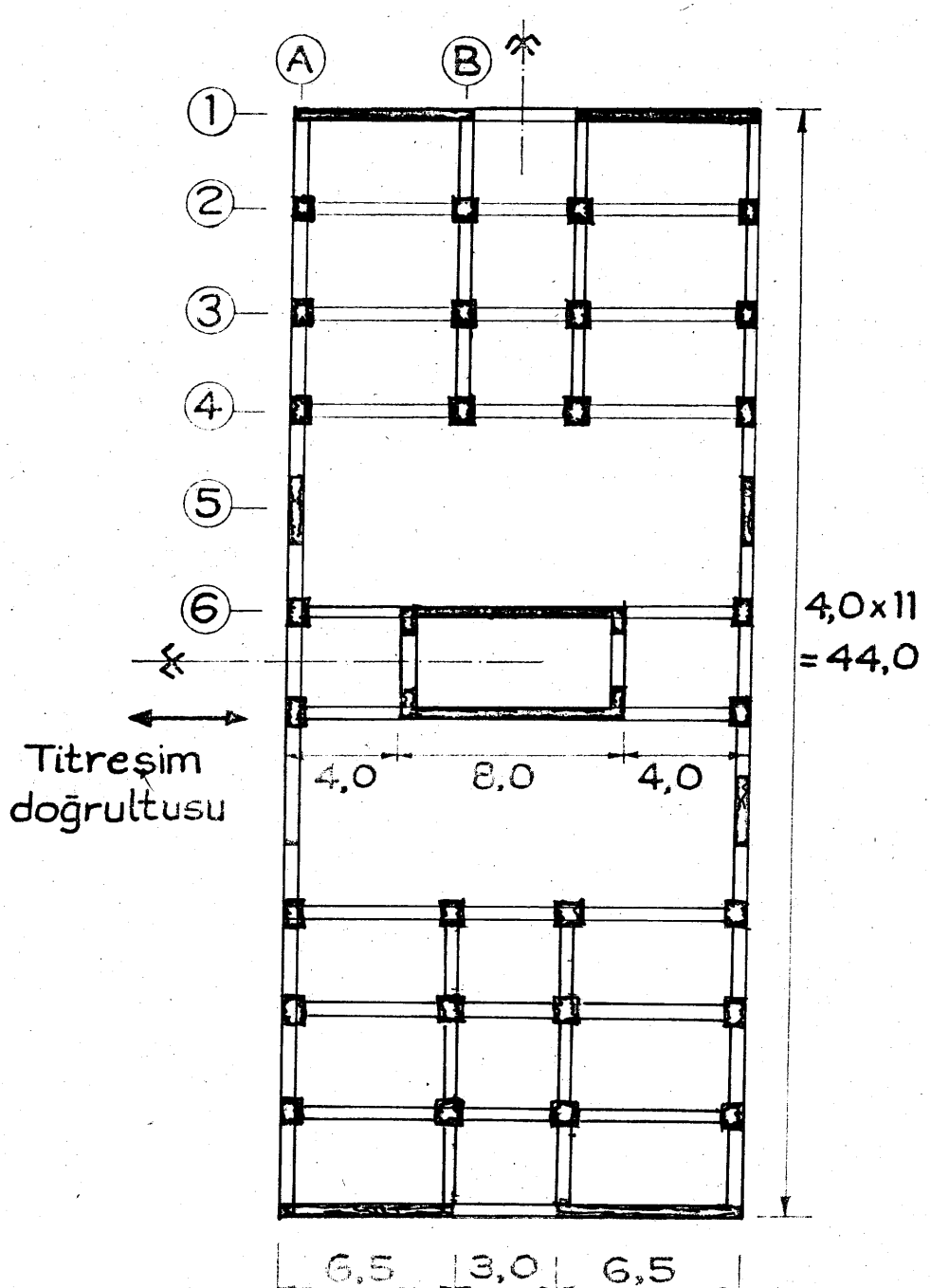


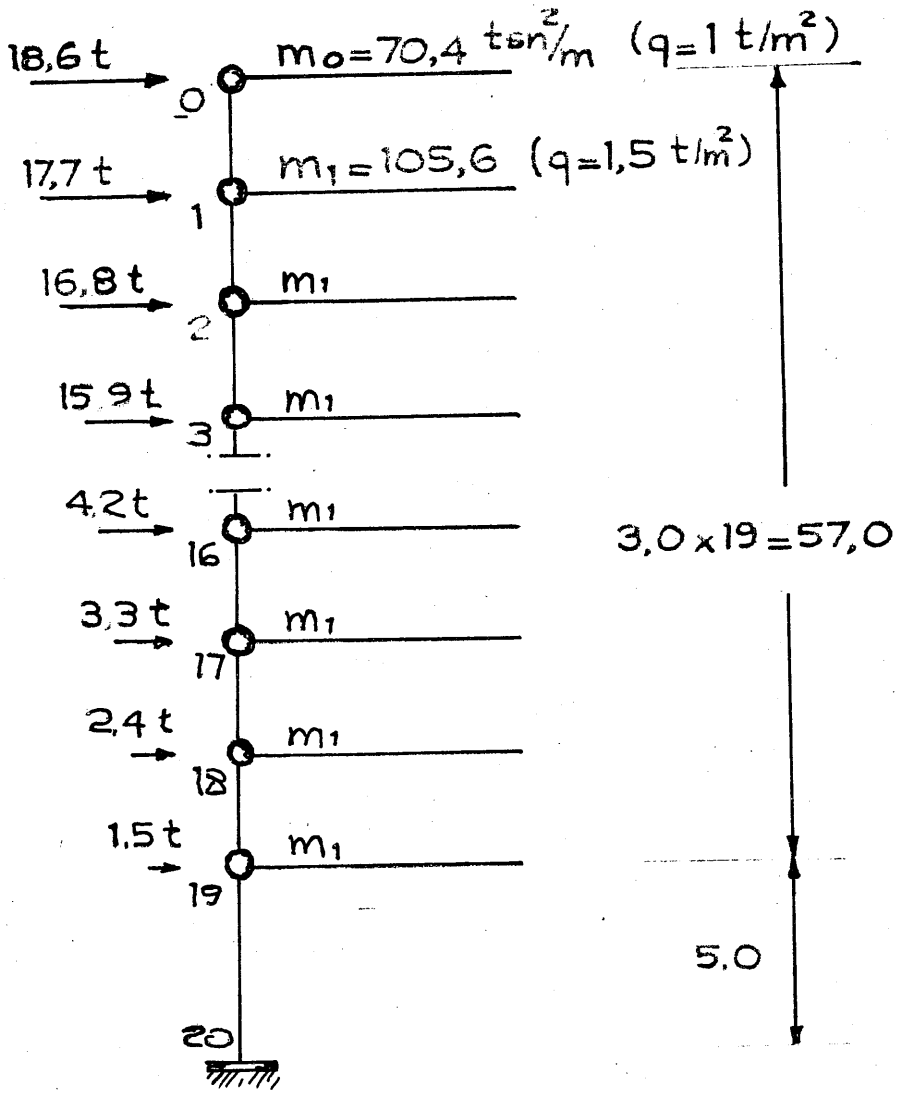


- Özel periyod : T= 1,98 sn.

■ ÖRNEK : 7

■ Çerçeveler, perdeler ve boşluklu perdelerden oluşan sistem :





Özel periyot : T= 1,34 sn

■ İKİNCİ NORMAL MODUN TAYİNİ

$\tilde{q}_i^{(2)}$: ikinci normal mod için seçilen yükler

$$\tilde{q}_i^{(2)} = \alpha_1 q_i^{(1)} + \alpha_2 q_i^{(2)} + \alpha_3 q_i^{(3)} + \dots \qquad [3]$$

$$\sum_i \tilde{q}_i^{(2)} d_i^{(1)} = \alpha_1 \sum q_i^{(1)} d_i^{(1)} + \underbrace{\alpha_2 \sum q_i^{(2)} d_i^{(1)}}_{0} + \underbrace{\alpha_3 \sum q_i^{(3)} d_i^{(1)}}_{0} + \dots$$

$$\alpha_1 = \frac{\sum \tilde{q}_i^{(2)} d_i^{(1)}}{\sum q_i^{(1)} d_i^{(1)}} \qquad [4]$$

■ İkinci normal mod için kullanılacak yükler:

$$\tilde{q}_i^{(2)} - \frac{\sum \tilde{q}_i^{(2)} d_i^{(1)}}{\sum q_i^{(1)} d_i^{(1)}} q_i^{(1)} \qquad [5]$$

■ ÜÇÜNCÜ NORMAL MODUN TAYİNİ

$\tilde{q}_i^{(3)}$: üçüncü normal mod için seçilen yükler

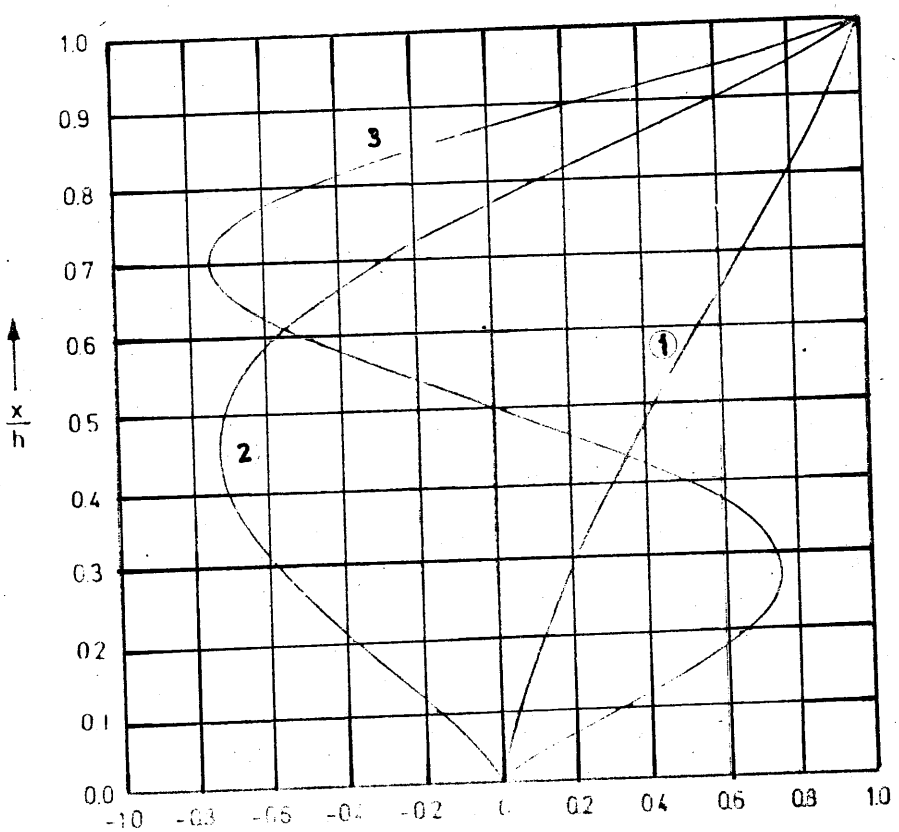
■ Üçüncü normal mod için kullanılacak yükler:

$$\tilde{q}_i^{(3)} - \frac{\sum \tilde{q}_i^{(3)} d_i^{(1)}}{\sum q_i^{(1)} d_i^{(1)}} q_i^{(1)} - \frac{\sum \tilde{q}_i^{(3)} d_i^{(2)}}{\sum q_i^{(2)} d_i^{(2)}} q_i^{(2)} \qquad [6]$$

- n. normal mod için kullanılacak yükler:

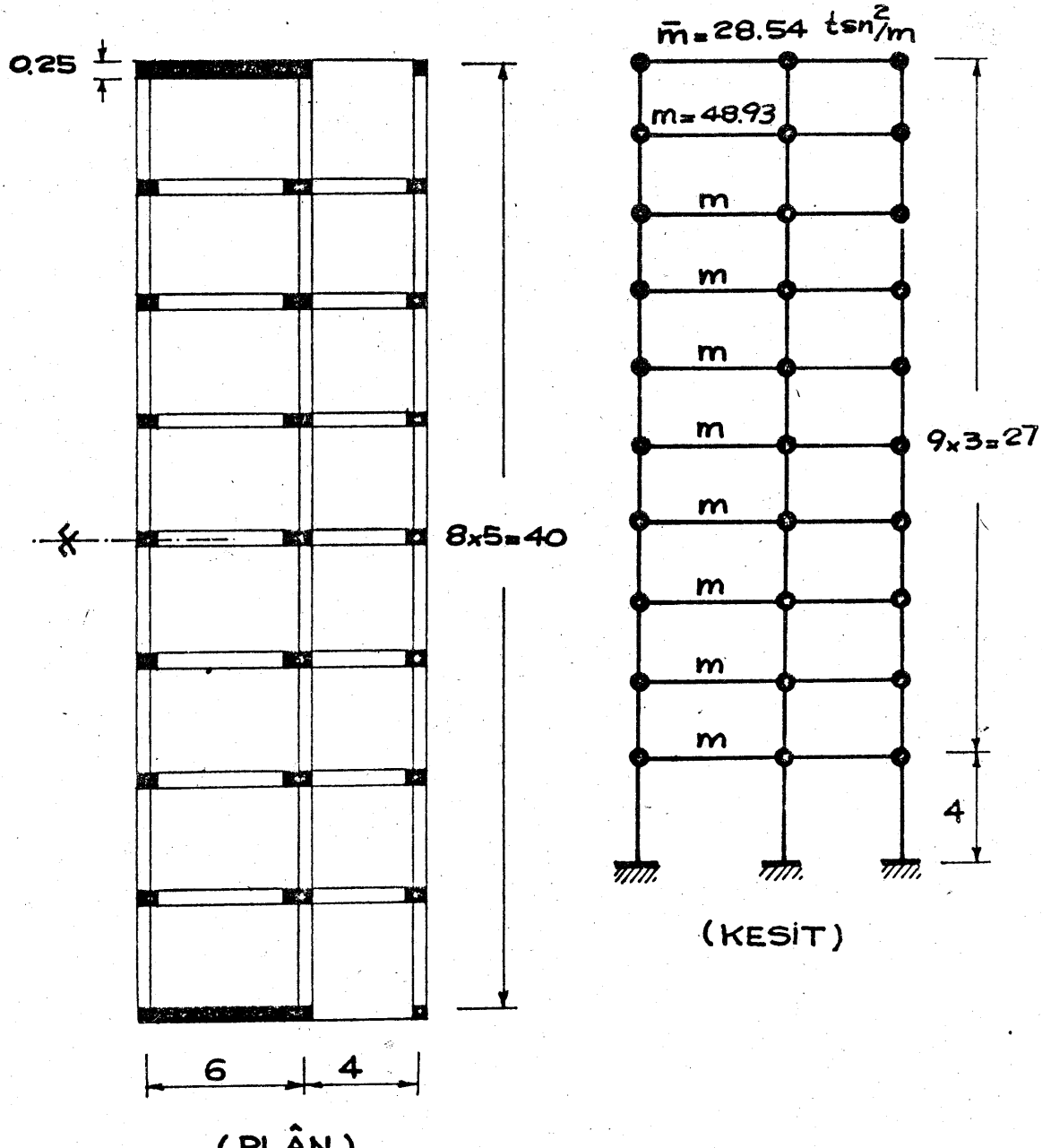
$$\tilde{q}_i^{(n)} - \frac{\sum \tilde{q}_i^{(n)} d_i^{(1)}}{\sum q_i^{(1)} d_i^{(1)}} q_i^{(1)} - \cdots\cdots - \frac{\sum \tilde{q}_i^{(n)} d_i^{(n-1)}}{\sum q_i^{(n-1)} d_i^{(n-1)}} q_i^{(n-1)} \qquad [7]$$

- İLK ÜÇ NORMAL MODA AİT q_i BAŞLANGIÇ YÜKLERİNİN SEÇİMİ



■ ÖRNEK :

■ ÇERÇEVE VE PERDELERDEN OLUŞAN SİSTEMİN İLK ÜÇ NORMAL MODUNUN TAYİNİ :



1. MOD **1 ADIM**

KAT NO.	m (tsn^2/m)	$q^{(1)}$ (t)	$d^{(1)} \times 10^3$ (m)
10	28.54	28.54	24.80
9	48.93	44.28	21.48
8	↓	38 85	18 19
7		32.98	14.98
6		26.96	11.91
5		20.99	9.05
4		15 36	6.43
3		10.28	4.12
2	↓	5.92	2.20
1	48.93	2.45	0.79

$\Sigma qd = 3.527$

$\Sigma md^2 = 0.08137$

$\omega_1^2 = \frac{3.527}{0.08137} = 43.35$

$\omega_1 = 6.584$

2. ADIM $q_i^{(1)} = \frac{m_i d_i^{(1)}}{d_{10}^{(1)}}$

28.54	23 15
42.38	20.03
35 89	16.93
29 56	13.91
23 51	11.04
17 85	8.36
12 68	5 93
8.13	3.79
4.34	2.02
1.55	0.72

$\Sigma qd = 3.053$

$\Sigma md^2 = 0.07045$

$\omega_1^2 = \frac{3.053}{0.07045} = 43.34$

$\omega_1 = 6.583$

$T_1 = \frac{2\pi}{\omega_1} = 0.954$ sn

2. MOD | 1 ADIM

KAT No.	m (tsn²/m)	$\tilde{q}^{(2)}$ (t)	$q^{(2)}$ (t)	$d^{(2)} \times 10^4$ (m)
10	28.54	28.54	26.45	14.10
9	48.93	29.55	26.45	7.26
8	↓	6.80	4.17	0.81
7		-13.55	-15.72	-4.63
6		-27.94	-29.66	-8.46
5		-34.89	-36.20	-10.28
4		-34.54	-35.47	-10.07
3		-28.33	-28.93	-8.14
2		-18.50	-18.81	-5.17
1	48.93	-8.02	-8.14	-2.10

$\Sigma qd = 0.1971$

$\Sigma md^2 = 2.773 \times 10^{-4}$

$\omega_2^2 = 711.3$

$\omega_2 = 26.67$

$$\left.\begin{aligned} \Sigma \tilde{q}^{(2)} d^{(1)} &= 0.2239 \\ \Sigma q^{(1)} d^{(1)} &= 3.053 \end{aligned}\right\} \quad \alpha_1 = \frac{0.2239}{3.053} = 0.0733$$

$$q^{(2)} = \tilde{q}^{(2)} - 0.0733\, q^{(1)}$$

2. MOD | 2. ADIM

$$\tilde{q}_i^{(2)} = \frac{m_i d_i^{(2)}}{d_{10}^{(2)}}$$

$\tilde{q}^{(2)}$ (L)	$q^{(2)}$ (t)	$d^{(2)} \times 10^4$ (m)
28.54	28.44	14.14
25.19	25.04	7.25
2.80	2.68	0.77
-16.08	-16.19	-4.67
-29.36	-29.44	-8.47
-35.69	-35.75	-10.26
-34.95	-34.99	-10.02
-28.26	-28.29	-8.08
-17.93	-17.95	-5.12
-7.29	-7.30	-2.08

$\Sigma qd = 0.1964$

$\Sigma md^2 = 2.764 \times 10^{-4}$

$\omega_2^2 = 710.6$

$\omega_2 = 26.66$

$T_2 = 0.236$ sn.

$$\alpha_1 = \frac{0.01076}{30.53} = 0.00352$$

$$q^{(2)} = \tilde{q}^{(2)} - 0.00352\, q^{(1)}$$

3. MOD | 1. ADIM

KAT No.	m (tsn²/m)	$\tilde{q}^{(3)}$ (t)	$q^{(3)}$ (t)	$d^{(3)} \times 10^5$ (m)
10	28.54	28.54	26.05	19.62
9	48.93	12.43	9.69	2.98
8	↓	-23.63	-24.91	-9.83
7		-36.31	-36.32	-14.66
6		-24.66	-23.75	-10.33
5		0.34	1.79	0.05
4		24.46	26.03	10.72
3		36.60	37.93	16.27
2	↓	32.34	33.21	14.38
1	48.93	16.05	16.41	7.14

$\Sigma qd = 0.03054$

$\Sigma md^2 = 0.6307 \times 10^{-5}$

$\omega_3^2 = 4842$

$\omega_3 = 6958$

$\Sigma \tilde{q}^{(3)} d^{(1)} = 0.0958 \qquad \alpha_1 = \frac{0.0958}{3.053} = 0.0314$

$\Sigma \tilde{q}^{(3)} d^{(2)} = 0.0110 \qquad \alpha_2 = \frac{0.0110}{0.1964} = 0.0561$

$q^{(3)} = \tilde{q}^{(3)} - 0.0314\, q^{(1)} - 0.0561\, q^{(2)}$

3. MOD | 2. ADIM | $\tilde{q}_i^{(3)} = \dfrac{m_i d_i^{(3)}}{d_{10}^{(3)}}$

$\tilde{q}^{(3)}$ (t)	$q^{(3)}$ (t)	$d^{(3)} \times 10^5$ (m)
28.54	28.40	20.60
7.42	7.30	3.11
-24.51	-24.53	-10.27
-36.56	-36.48	-15.35
-25.75	-25.62	-10.91
0.13	0.30	-0.06
26.74	26.90	11.22
40.57	40.70	17.18
35.87	35.95	15.26
17.82	17.85	7.60

$\Sigma qd = 0.03384$

$\Sigma md^2 = 0.6992 \times 10^{-5}$

$\omega_3^2 = 4840$

$\omega_3 = 69.57$

$T_3 = 0.090$ sn.

$q^{(3)} = \tilde{q}^{(3)} - 0.00007\, q^{(1)} - 0.0047\, q^{(2)}$