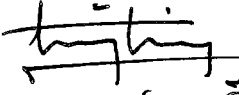


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**YILDIZ TEKNİK ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ**


Prof. A. Zafer Öztürk


Prof. Dr. Fehmi Özalp
05.02.1997


Prof. Naci Yüceler
5.2.1997

**ÇELİK ÇERÇEVELERDE
UYGUN FORMUN ARAŞTIRILMASI**

İnş.Müh. Şahin SÖZEN

**F.B.E. İnşaat Mühendisliği Ana Bilim Dalında
Hazırlanan**

YÜKSEK LİSANS TEZİ

Tez Danışmanı : Prof.Dr. A.Zafer ÖZTÜRK

İSTANBUL, 1997

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TEŞEKKÜR

Çalışmamın tasarı aşamasından başlayarak sonuçlanıncaya kadar her kademedede bilgi ve tecrübesiyle yol gösteren sayın hocam Prof.Dr.A.Zafer ÖZTÜRK'e ve yetişmemde büyük emekleri bulunan diğer hocalarıma en kalbi şükran ve saygılarımı arz ederim.

Çalışmamın ülkeme, bana olduğu gibi diğer arkadaşlarıma da faydalı olmasını dilerim.

Şahin SÖZEN



ÖZET

Bu çalışma Yıldız Teknik Üniversitesi İnşaat Mühendisliği Anabilim dalı, Yapı Bilim dalı'nda YÜKSEK LİSANS tezi olarak hazırlanmıştır.Çalışmamda aynı fiziksel ortamda olduğu ve aynı fiziksel etkilere maruz kaldığı varsayılan biri dolu gövdeli,diğeri kafes sistem iki farklı yapının ekonomiklik yönünden birbiriyle karşılaştırılması yapılmıştır.

Bunun için, üç bölümden oluşan çalışmamın birinci ve ikinci bölümlerinde yapıların maruz kaldıkları yükler ayrı ayrı hesaplanmış, ve bu yükler altında açıklığı ve yüksekliği ayrı ayrı değişen sistemlerin, bilgisayar programı yardımıyla statik analizi yapılmıştır.Elde edilen sonuçlar değerlendirildikten sonra, sistemi oluşturan elemanlar boyutlandırılmıştır.Açıklığı ve yüksekliği değişen her yapı için çubukların toplam ağırlıkları hesaplanmış, ve aşık ve stabilite bağlantıları ağırlıkları da ilave edilerek her $1m^2$ 'ye düşen çelik ağırlığı tesbit edilmiş ve tablolastırılmıştır.Tablolaştırılan bu değerler üçüncü ve son bölüm olan sonuç bölümünde ele alınarak irdelenmiştir.

Ayrıca sonuç bölümünde çözüm yöntemleriyle alakalı bazı tesbitlere yer verilmiştir.

SUMMARY

A SURVEY,ABOUT AN INVESTIGATION OF A SUITABLE FORM FOR STEEL FRAMES

This study is prepared as a high level degree thesis in department of civil engineering on the branch of construction science at Yıldız Technical University.

In my study,two different structures that one of them is full-filled carcass,and the other is frame system which are supposed to be exposed in the same physical effects and in the same physical atmosphere are compared each other in economical way.

For this,in the first and second section of my study which is formed in three section, the loads on the structures are calculated one by one and the structures under these loads whose length and height are changing differently are calculated by the help of computer programme.The elements which are formed the system are sized after realizing the results.For every structure,which has a changing length and height, the total weight of bars is calculated and by adding the weight of purlin and stable connections, the total steel weight is stablized and tabulated for every meters square.This tabulated values are examined in the third and final section.

On the other hand, in the conclusion section, some appreciation about solution method are given.

1.0 GİRİŞ

Çalışmamda açıklıkları 10 m'den 30 m'ye ve yükseklikleri 6 m'den 16 m'ye kadar ayrı ayrı değişen iki farklı sisteme sahip yapıyı boyutlandırımdım.

Boyutlandırılan yapılardan birisi dolu gövdeli, diğeri hadde profili kolonlar üzerine oturan kafes sistemdir. Çalışmamda her iki yapı grubu için de önce yüksekliği sabit tutup açıklığı 10 m'den 30 m'ye kadar her çözüm için 5'er metre arttırdım. Daha sonra açıklığı 10 m olarak sabit tutup yüksekliği 6 m'den 16 m'ye kadar her çözüm için 2'şer metre arttırdım. Aynı şeyi, açıklığı 20 m'de sabit tutup, yüksekliği değiştirerek yaptım. Böylece her yapı grubu için 15 adet olmak üzere toplam 30 farklı çözüm ve boyutlandırma yaptım.

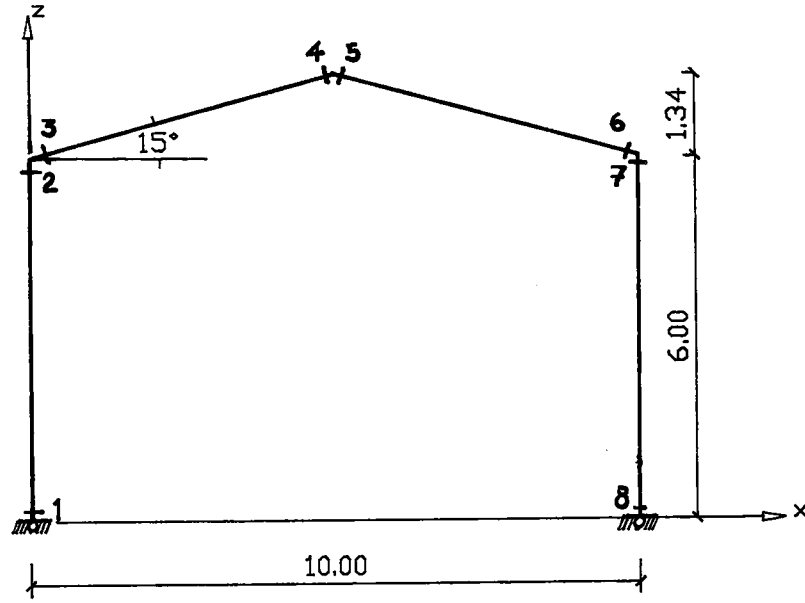
Boyutlandırmada amaç ekonomiklik yönünden her iki yapıyı karşılaştırmaktır. Gayet kolay anlaşılacağı üzere, bu karşılaştırmada sadece çelik malzeme sarfiyatı dikkate alınmış, ekonomikliği etkileyen diğer faktörler göz ardı edilmiştir. Buradan hareketle, yapıların her ikisi için de aynı fiziksel ortam ve etkilerin geçerli olduğu kabulü baştan yapılmıştır. Yine malzeme sarfiyatı hesabında, aşık ve stabilite bağlantıları ağırlıkları, çubuk ağırlıkları toplamının % 20'si olarak yaklaşık hesap edilmiştir. Her bir yapı için ağırlıklar toplamı ayrı ayrı hesap edildikten sonra, birim alana düşen çelik miktarı ton olarak tesbit edilmiştir. Tablolaştırılan bu değerler, çalışmanın sonuç bölümünde açıklığı ve yüksekliği aynı her yapı için birer birer ele alınmış, ve çalışmanın asıl amacı olan ekonomiklik karşılaştırılması yapılmıştır. Burada ekonomiklik karşılaştırmasının sadece malzeme sarfiyatının dikkate alınarak yapıldığını, ve bir yapı sistemi için ekonomik veya gayri ekonomik hükmünün buna göre verildiğini tekrarlamakta fayda vardır. Bu anlamda, malzeme sarfiyatının ekonomikliği etkileyen önemli faktörlerden sadece biri olduğunu, ve burada anılmayan birçok unsurun ekonomikliği önemli derecede etkileyebilecek olduğunu unutmamak gerekir.

Yapıların statik analizinde, yapıların zati ağırlıkları, kar yükleri ve rüzgâr yükleri esas alınmış olup, bu yükler yardımıyla, zati yük, kar yükü, yarım kar yükü, rüzgâr

soldan ve rüzgâr sağdan yüklemelerinden oluşan beş farklı yükleme yapılmış ve bu yüklemeler altında yapıların statik analizi SAP90 paket programı yardımıyla yapılmıştır. Elde edilen statik sonuçlar tablolştırılmış ve her bir elemanın boyutlandırılması için kullanılacak iç kuvvet değeri tesbit edilmiştir. Yapı elemanlarının boyutlandırılmasında, eğilme ve basınca çalışanların eğilmeli burkulma hesabı TS648’de gösterilen yolla yapılmış, DIN 4114’de gösterilen yolla kontrol edilmiştir. Sonuç bölümünde farklı standartlarda yer alan bu iki yöntem hakkında bir takım karşılaştırmalar yapılmıştır.



1.1. ÇÖZÜM A1



Sekil 1.1

Tablo 1.1.

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	6.00
3	5.00	7.34
4	10.00	6.00
5	10.00	0.00

1.1.1. SİSTEME ETKİYEN YÜKLER

1.1.1.1. ÖZ AĞIRLIK

Çatı örtüsü Ytong + iki kat bitümlü mukavva

Ytong öz ağırlığı 63 kg/m² (Çatı Düzlemi)

Bitümlü mukavva öz ağırlığı 24 kg/m² (Çatı Düzlemi)

87 kg/m² (Çatı Düzlemi)

Çatı düzlemindeki yükler yataya indirgenirse;

$$g_{T1} = \frac{g}{\cos 15} \quad g_{T1} = \frac{87}{0.9659} \quad g_{T1} = 90.069 \text{ kg/m}^2 \text{ (Yatay Düzlemde)}$$

Aşık ağırlığı 9 kg/m² (Yatay Düzlemde)

Stabilite Bağlantıları 3 kg/m² (Yatay Düzlemde)

Çerçeve öz ağırlığı 30 kg/m² (Yatay Düzlemde)

$$g_{T2} = 42 \text{ kg/m}^2 \text{ (Yatay Düzlemde)}$$

Toplam ölü yük $g_T = 132.069 \text{ kg/m}^2$

Çerçeve aralığının 6 m olduğu dikkat alınarak hesaplanan bu yük çizgisel yayılı yüke dönüştürülürse;

$$g_T = 132.069 \times 6 \quad g_T = 792.414 \text{ kg/m} \quad g_T = 0.792 \text{ t/m}$$

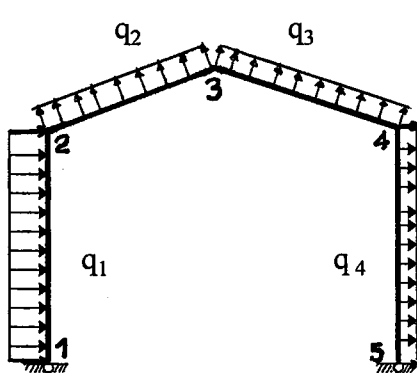
1.1.1.2. KAR YÜKÜ : $\alpha = 15^\circ < 30^\circ$ olduğundan kar yükü $P_{ko} = P_k$ olarak hesaba girecek ve bu yük çatı alanımızın plandaki düzgün yayılı yükü olarak dikkate alınacaktır. Denizden yükselti 600 m ve kar bölgesi III için, TS 498 Çizelge 11'den

$$P_{ko} = 80 \text{ kg/m}^2$$

makas aralığı 6 m için çizgisel yayılı yüke dönüştürülürse;

$$P_k = 80 \times 6 = 480 \text{ kg/m} \quad P_k = 0.480 \text{ t/m}$$

1.1.1.3. RÜZGÂR YÜKÜ : TS 498 Şekil 1'den



$$q = 50 \text{ kg/m}^2$$

$$q_1 = 0.8 \times 50 \quad q_1 = 40 \text{ kg/m}^2$$

$$q_2 = (1.2 \times \sin \alpha - 0.4) \times 50 \times q_2 = -4.471 \text{ kg/m}^2$$

$$q_3 = 0.4 \times 50 \quad q_3 = 20 \text{ kg/m}^2$$

$$q_4 = 0.4 \times 50 \quad q_4 = 20 \text{ kg/m}^2$$

Şekil 1.2

Makas aralığı 6 m için bu yükler çizgisel yayılı yüke dönüştürülürse;

$q_1 = 40 \times 6$	$q_1 = 240 \text{ kg/m}$	$q_1 = 0.240 \text{ t/m}$
$q_2 = -4.471 \times 6$	$q_2 = 26.826 \text{ kg/m}$	$q_2 = 0.026 \text{ t/m}$
$q_3 = 20 \times 6$	$q_3 = 120 \text{ kg/m}$	$q_3 = 0.120 \text{ t/m}$
$q_4 = 20 \times 6$	$q_4 = 120 \text{ kg/m}$	$q_4 = 0.120 \text{ t/m}$

1.1.2 STATİK ÇÖZÜM İÇİN SAP 90 VERİSİ

COZUM A-1

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=6

3 X=5 Y=0 Z=7.34

4 X=10 Y=0 Z=6

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR
 3 WG=0.24,0,0 :RUZGAR SOLDAN
 4 WL=0,0.02682,0 :RUZGAR SOLDAN
 5 WL=0,0.12,0 :RUZGAR SOLDAN
 6 WG=0.12,0,0 :RUZGAR SOLDAN
 7 WG=-0.24,0,0 :RUZGAR SAGDAN
 8 WL=0,0.02682,0 :RUZGAR SAGDAN
 9 WL=0,0.12,0 :RUZGAR SAGDAN
 10 WG=-0.12,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.1.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-1

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT
1	-----		
1	-3.96		
	.0	.77	.00
	6.0	.77	4.63
2	-2.40		
	.0	.47	.00

		6.0	.47	2.80
3	.31			
		.0	-1.13	.00
		4.7	.00	-2.67
		6.0	.31	-2.47
4	-1.05			
		.0	.90	.00
		6.0	.18	3.26
5	-1.80			
		.0	.23	.00
		6.0	.23	1.40
2	-----			
1	-1.26			
		.0	-3.63	4.63
		4.9	.00	-4.27
		5.2	.20	-4.24
2	-.76			
		.0	-2.20	2.80
		4.9	.00	-2.59
		5.2	.12	-2.57
3	-.22			
		.0	.38	-2.47
		5.2	.52	-.13
4	-.45			
		.0	-.97	3.26
		5.2	-.34	-.13
5	-.38			
		.0	-1.68	1.40
		3.7	.00	-1.74

		5.2	.64	-1.29
3		-----		
1	-1.26			
		.0	-.20	-4.24
		.3	.00	-4.27
		5.2	3.63	4.63
2	-.76			
		.0	-.12	-2.57
		.3	.00	-2.59
		5.2	2.20	2.80
3	-.45			
		.0	.34	-.13
		5.2	.97	3.26
4	-.22			
		.0	-.52	-.13
		5.2	-.38	-2.47
5	-.38			
		.0	.52	-1.29
		5.2	.52	1.40
4		-----		
1	-3.96			
		.0	-.77	4.63
		6.0	-.77	.00
2	-2.40			
		.0	-.47	2.80
		6.0	-.47	.00
3	-1.05			
		.0	-.18	3.26
		6.0	-.90	.00

4	.31			
	.0	-.31	-2.47	
	1.3	.00	-2.67	
	6.0	1.13	.00	
5	-.60			
	.0	-.23	1.40	
	6.0	-.23	.00	

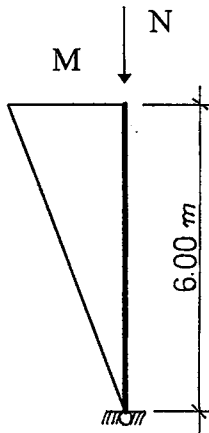
Tablo 1.2

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	0.31	0.00	1.05	0.00	6.36	0.00	7.41
2	4.63	3.96	1.40	1.80	2.80	2.40	M=2.67 N=2.47	0.31	3.26	1.05	7.89	6.36	10.69	7.41
3	4.63	1.26	1.40	0.38	2.80	0.76	2.47	0.22	3.26	0.45	7.89	2.02	10.69	2.47
4	4.27 M=4.24	1.26	1.74 M=1.29	0.38	2.59 M=2.57	0.76	0.13	0.22	0.13	0.45	6.83 M=6.81	2.02	6.83 M=6.94	2.47
5	4.24	1.26	1.29	0.38	2.57	0.76	0.13	0.45	0.13	0.22	6.81	2.02	6.94	2.47
6	4.27 M=4.63	1.26	1.40	0.38	2.59 M=2.80	0.76	3.26	0.45	2.47	0.22	7.89	2.02	6.86 M=10.7	2.47
7	4.63	3.96	1.40	0.60	2.80	2.40	3.26	1.05	2.67 M=2.47	0.31	7.89	6.36	10.69	7.41
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	1.05	0.00	0.31	0.00	6.36	0.00	7.41

M Açıklıkta maximum moment

1.1.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.1.4.1. 1 Nolu Eleman (Kolon)



Şekil 1.3.

$$M = 7.89 \text{ tm} \quad N = 6.36 \text{ t (Basınç)}$$

$$\ell_{kx} = 2 \times \ell = 2 \times 600 = 1200 \text{ cm} \quad \ell_{ky} = \frac{\ell}{2} \quad \ell_{ky} = \frac{600}{2} = 300 \text{ cm}$$

y - y yönü burkulmasında kolonun ortasından tutulduğu varsayılmıştır.

$$\text{Seçilen I380} \quad A = 107 \text{ cm}^2 \quad W_x = 1260 \text{ cm}^3$$

$$i_x = 15 \text{ cm} \quad i_y = 3.02 \text{ cm} \quad b = 14.9 \text{ cm} \quad d = 1.37 \text{ cm} \quad t = 2.05 \text{ cm}$$

$$S_x = h - 2 \times t \quad S_x = 38 - 2 \times 2.05 = 33.9 \text{ cm}$$

Elemanın eğilmeli burkulma hesabı TS 648'de gösterilen yolla yapılmış olup DIN 4114'de önerilen yolla kontrol edilmiştir.

$$\lambda_x = \frac{\ell_{kx}}{i_x} = \frac{1200}{15} = 80 \quad \lambda_y = \frac{\ell_{ky}}{i_y} = \frac{300}{3.02} = 99.337$$

$$\lambda_y = 99.337 \text{ için } \sigma_{bem} = 0.7334 \text{ t/cm}^2$$

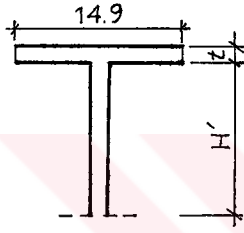
$$\sigma_{eb} = \frac{N}{F} = \frac{6.36}{107} = 5.9439 \times 10^{-2} \text{ cm}^2$$

$$\sigma_{e'} = \frac{\pi^2 \times E}{(K \times \frac{S_b}{i_b})} \times \frac{1}{2.5}$$

$$\sigma_{e'} = 1.295 \text{ t/cm}^2$$

$$\sigma_b = \frac{M}{W_x} = \frac{789}{1260}$$

$$\sigma_b = 0.626 \text{ t/cm}^2$$



Şekil 1.4.

$$H' = \frac{S_x}{6} = \frac{33.9}{6} = 5.65 \text{ cm}$$

$$F_B = b \times t + H' \times d = 14.9 \times 2.05 + 1.37 \times 5.65 \quad F_B = 38.285 \text{ cm}^2$$

$$I_{yB} = \frac{t \times b^3}{12} + \frac{H' \times d^3}{12} \quad I_{yB} = \frac{2.05 \times 14.9^3}{12} + \frac{5.65 \times 1.37^3}{12} \quad I_{yB} = 566.31 \text{ cm}^4$$

$$i_{yB} = \sqrt{\frac{I_{yB}}{F_B}} = \sqrt{\frac{566.31}{38.285}} \quad i_{yB} = 3.84 \text{ cm} \quad \frac{S}{I_{yB}} = \frac{600}{3.84} = 156.25$$

$\frac{S}{i_{yB}}$ değeri ile $\sqrt{\frac{30 \times 10^6 \times C_b}{\sigma_a}}$ değeri karşılaştırılacak σ_B değeri hesaplanır. Buna

göre bu değer, $\frac{S}{i_{yB}}$ değeri $\sqrt{\frac{30 \times 10^6 \times \sigma_b}{\sigma_a}}$ değerinde küçük ise;

$$\sigma_B = \left[\frac{2}{3} - \frac{\sigma_a \times (s/i_y)^2}{90 \times 10^6 \times C_b} \right] \times \sigma_a < 0.6 \times \sigma_a \text{ formülü ile, büyük ise}$$

$$\sigma_B = \frac{10 \times 10^6 \times C_b}{(S/i_y)^2} \text{ formülü ile hesaplanacaktır.}$$

$$\sqrt{\frac{30 \times 10^6 \times C_b}{\sigma_a}} = \sqrt{\frac{30 \times 10^6 \times 1.75}{2400}} = 147.901 \quad 156.25 > 147.901$$

$$\text{Buna göre } \sigma_B = \frac{10 \times 10^6 \times C_b}{(S/i_y)^2} = 0.719 \text{ t/m}^2$$

$$\text{Gerilme Kontrolleri } \frac{\sigma_{eb}}{\sigma_{bem}} + \frac{C_m \times \sigma_b}{(1 - \frac{\sigma_{eb}}{\sigma_{e'}})\sigma_B} \leq 1.0 \text{ ve}$$

$$\frac{\sigma_{eb}}{0.60 \times \sigma_a} + \frac{\sigma_b}{\sigma_B} < 1.0 \text{ formülleri yardımıyla yapılacaktır. buna göre;}$$

$$\text{Gerilme Kontrolleri } \frac{5.9439 \times 10^2}{0.7334} + \frac{0.85 \times 0.626}{(1 - \frac{5.9439 \times 10^{-2}}{1.295})0.719} = 0.85687 < 1$$

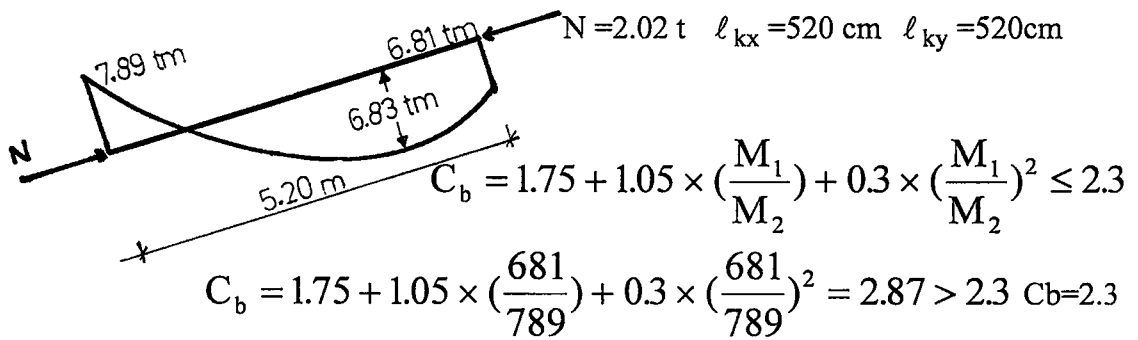
$$\frac{5.9439 \times 10^{-2}}{0.60 \times 2400} + \frac{0.626}{0.719} = 0.91212 < 1$$

2. Kontrol

$$\lambda_x = 80 \text{ için } \omega_x = 1.67$$

$$\sigma = \omega \times \frac{N}{W} + 0.9 \times \frac{M}{W} = 1.67 \times \frac{6.36}{107} + 0.9 \times \frac{789}{1260} \quad \sigma = 0.662 \text{ t/m}^2 < \sigma_{em}$$

1.1.4.2. 2 Nolu Eleman (Kiriş)



Şekil 1..5

Seçilen I320 $A = 77.7 \text{ cm}^2$ $W_x = 782 \text{ cm}^3$ $i_x = 12.7 \text{ cm}$ $i_y = 2.67 \text{ cm}$

$S_x = 32 \cdot 2 \times 1.7 = 28.54 \text{ cm}$ $b = 13.1 \text{ cm}$ $d = 1.15 \text{ cm}$ $\lambda_x = 40.944$

$\lambda_y = 194.756$ $\sigma_{bem} = 0.218 \text{ t/cm}^2$ $\sigma_{eb} = 0.0256 \text{ t/m}^2$ $\sigma_e = 4.944 \text{ t/m}^2$

$\sigma_b = 1.0089 \text{ t/m}^2$ $H' = 4.75 \text{ cm}$ $F_B = 28.133 \text{ cm}^2$ $I_{yB} = 324.70 \text{ cm}^4$

$i_{yB} = 3.39 \text{ cm}$ $S/i_{yB} = 153.06$ $\sigma_B = 0.9480 \text{ t/cm}^2$

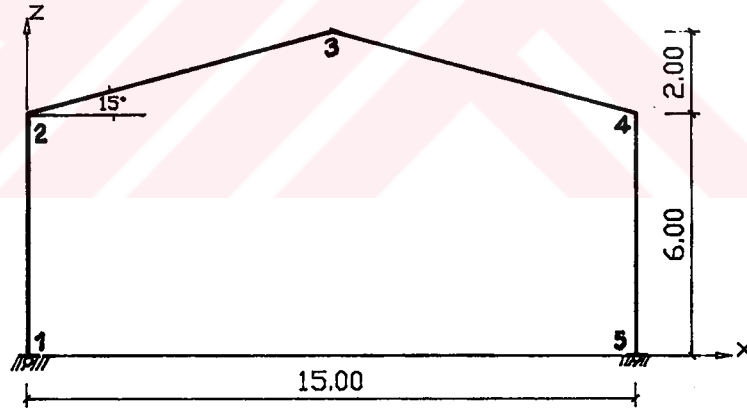
Gerilme Kontrolleri $0.906436 < 1$

$1.082000 \approx 1$

2. Kontrol

$$\lambda_x = 40.94 \text{ için } \omega_x = 1.18 \quad \sigma = 1.18 \times \frac{2.02}{77.7} + 0.9 \times \frac{789}{782} = 0.938 \text{ t/cm}^2 < \sigma_{em}$$

1.2. ÇÖZÜM A2



Sekil 1.6

Tablo 1.3.

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	6.00
3	7.50	8.01
4	15.00	6.00
5	15.00	0.00

1.2.1. SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen, öz ağırlık, kar ve rüzgar yükleri ÇÖZÜM A1’de hesaplananlar ile tamamen aynıdır.

1.2.2. STATİK ÇÖZÜM İÇİN SAP 90 VERİSİ

COZUM A-2

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=6

3 X=7.5 Y=0 Z=8.010

4 X=15 Y=0 Z=6

5 X=15 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN
 4 WL=0,0.02682,0 :RUZGAR SOLDAN
 5 WL=0,0.12,0 :RUZGAR SOLDAN
 6 WG=0.12,0,0 :RUZGAR SOLDAN
 7 WG=-0.24,0,0 :RUZGAR SAGDAN
 8 WL=0,0.02682,0 :RUZGAR SAGDAN
 9 WL=0,0.12,0 :RUZGAR SAGDAN
 10 WG=-0.12,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.2.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-2

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT

1 -----

1	-5.94		
	.0	1.84	.00
	6.0	1.84	11.02
2	-3.60		
	.0	1.11	.00
	6.0	1.11	6.68
3	-.03		
	.0	-1.02	.00
	4.2	.00	-2.16
	6.0	.42	-1.79

4	-1.07		
	.0	.95	.00
	6.0	.23	3.57
5	-2.70		
	.0	.56	.00
	6.0	.56	3.34
2	-----		
1	-2.54		
	.0	-5.26	11.02
	7.1	.00	-7.72
	7.8	.48	-7.57
2	-1.54		
	.0	-3.19	6.68
	7.1	.00	-4.68
	7.8	.29	-4.59
3	-.42		
	.0	.08	-1.79
	7.8	.29	-.37
4	-.50		
	.0	-.97	3.57
	7.8	-.04	-.37
5	-.77		
	.0	-2.46	3.34
	5.5	.00	-3.44
	7.8	1.01	-2.29
3	-----		
1	-2.54		
	.0	-.48	-7.57
	.6	.00	-7.72

		7.8	5.26	11.02
2	-1.54			
		.0	-.29	-4.59
		.6	.00	-4.68
		7.8	3.19	6.68
3	-.50			
		.0	.04	-.37
		7.8	.97	3.57
4	-.42			
		.0	-.29	-.37
		7.8	-.08	-1.79
5	-.77			
		.0	.73	-2.29
		7.8	.73	3.34
4	-----			
1	-5.94			
		.0	-1.84	11.02
		6.0	-1.84	.00
2	-3.60			
		.0	-1.11	6.68
		6.0	-1.11	.00
3	-1.07			
		.0	-.23	3.57
		6.0	-.95	.00
4	-.03			
		.0	-.42	-1.79
		1.8	.00	-2.16
		6.0	1.02	.00
5	-.90			

.0 -0.56 3.34
6.0 -0.56 .00

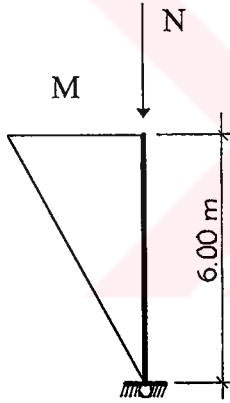
Tablo1.4

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	5.94	0.00	2.70	0.00	3.60	0.00	0.03	0.00	1.07	0.00	9.54	0.00	10.61
2	11.02	5.94	3.34	2.70	6.68	3.60	2.16	0.03	3.57	1.07	17.70	9.54	21.27	10.61
3	11.02	2.54	3.34	0.77	6.68	1.54	1.79	0.42	3.57	0.50	17.70	4.08	21.27	4.58
4	7.72	2.54	3.44	0.77	4.68	1.54	0.37	0.42	0.37	0.50	12.40	4.08	12.4	4.58
	M=7.57		M=2.29		M=4.59						M=12.06		M=12.5	
5	7.57	2.54	2.29	0.77	4.59	1.54	0.37	0.50	0.37	0.42	12.16	4.08	12.53	4.58
6	7.72	2.54	3.34	0.77	4.68	1.54	3.57	0.50	1.79	0.42	12.40	4.08	12.4	4.58
	M=11.02				M=6.68						M=17.70		M=21.3	
7	11.02	5.94	3.34	0.90	6.68	3.60	3.57	1.07	1.79	0.03	17.70	9.54	21.27	10.61
8	0.00	5.94	0.00	0.90	0.00	3.60	0.00	1.07	2.16	0.03	0.00	9.54	0.00	10.61
									M=0.00					

M Açıklıkta maximum moment

1.2.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.2.4. 1 Nolu Eleman



Şekil 1.7

$$M = 17.70 \text{ tm} \quad N = 9.54 \text{ t} \quad \ell_{kx} = 2 \times 600 = 1200 \text{ cm} \quad \ell_{ky} = 300 \text{ cm}$$

$$\text{Seçilen I 450} \quad A = 147 \text{ cm}^2 \quad W_x = 2040 \text{ cm}^3 \quad i_x = 17.7 \text{ cm}$$

$$i_y = 3.43 \text{ cm} \quad S_x = 45 - 2 \times 2.43 = 40.14 \text{ cm} \quad b = 17 \text{ cm} \quad 1.62 \text{ cm}$$

$$t = 2.43 \text{ cm} \quad \lambda_x = 67.796 \quad \lambda_y = 87.463 \quad \sigma_{bem} = 0.82299 \text{ t/cm}^2$$

$$\omega_x = 1.45 \quad \sigma_{eb} = 6.489795 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 1.80359 \text{ t/cm}^2$$

$$\sigma_b = 0.86764 \text{ t/cm}^2 \quad H' = 6.69 \text{ cm} \quad F_B = 52.1478 \text{ cm}^2$$

$$i_{yB} = 997.252 \text{ cm}^4 \quad i_{yB} = 4.373 \text{ cm} \quad S/i_{yB} = 137.203 \quad \sigma_B = 0.91154 \text{ t/cm}^2$$

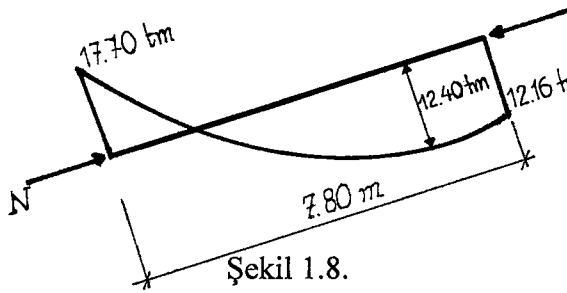
$$\text{Gerilme Kontrolleri } 0.917464 < 1$$

$$0.996909 < 1$$

2 Kontrol :

$$\sigma = \omega \times \frac{N}{A} + 0.9 \times \frac{M}{W} \quad \sigma = 1.45 \times \frac{9.54}{141} + 0.9 \times \frac{1770}{2040} = 0.874 \text{ t/cm}^2 < \sigma_{em}$$

1.2.4.2 Nolu Eleman .



$$\ell_{kx} = 780 \text{ cm} \quad \ell_{ky} = 780 \text{ cm}$$

$$N = 4.08 \text{ t} \quad \text{Seçilen I 475} \quad A = 163 \text{ cm}^2$$

$$W_x = 2380 \text{ cm}^3 \quad i_x = 18.6 \text{ cm} \quad i_y = 3.60 \text{ cm}$$

$$S_x = 47.5 - 2 \times 2.56 \quad S_x = 42.38 \text{ cm}$$

$$b = 17.8 \text{ cm} \quad d = 1.71 \text{ cm} \quad t = 2.56 \text{ cm}$$

$$\lambda_x = 41.935 \quad \lambda_y = 216.66$$

$$\sigma_{bem} = 0.1761 \text{ t/cm}$$

$$\sigma_{eb} = 2.5030674 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_e = 4.714017 \text{ t/cm}^2 \quad \sigma_b = 0.74369 \text{ t/cm}^2$$

$$H' = 7.063 \text{ cm} \quad F_B = 57.646 \text{ cm}^2 \quad I_{yB} = 1206.09 \text{ cm}^4 \quad i_{yB} = 4.574 \text{ cm} \quad S/i_{yB} = 170.525$$

$$\sigma_B = 0.7909 \text{ t/cm}^2$$

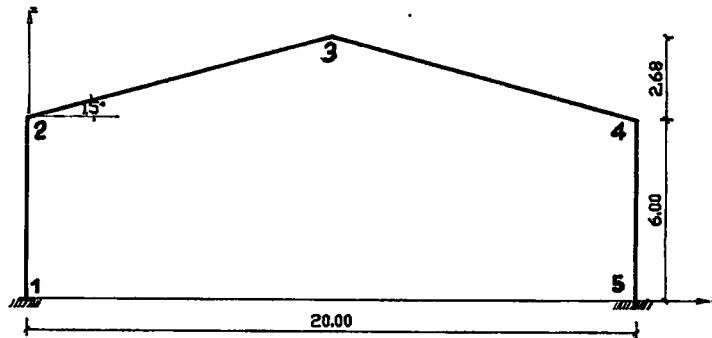
$$\text{Gerilme Kontrolleri} \quad 0.70503 < 1$$

$$0.95764 < 1$$

2. Kontrol :

$$\lambda_x = 41.93 \rightarrow 42 \text{ için } \omega_x = 1.19 \quad \sigma = 1.19 \times \frac{4.08}{163} + 0.9 \times \frac{1770}{2380} = 0.699 \text{ t/cm}^2 \sigma_{em}$$

1.3. ÇÖZÜM A3



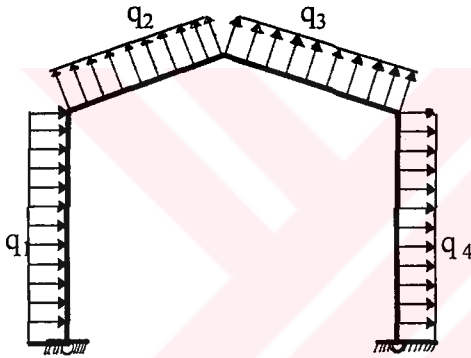
Şekil 1.9

Tablo 1.5

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	0.00
3	10.00	8.68
4	20.00	6.00
5	20.00	0.00

1.3.1. SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen öz ağırlık ve kar yükü ÇÖZÜM A1'de hesaplananlar ile tamamen aynıdır.

1.3.1.1 RÜZGÂR YÜKÜ

$$\begin{aligned}
 q_1 &= 0.8 \times 50 = 40 \text{ kg/m}^2 & q_1 &= 0.24 \text{ t/m} \\
 q_2 &= -7.153 \text{ kg/m}^2 & q_2 &= 0.0428 \text{ t/m} \\
 q_3 &= 0.4 \times 80 = 32 \text{ kg/m}^2 & q_3 &= 0.192 \text{ t/m} \\
 q_4 &= 0.4 \times 50 = 20 \text{ kg/m}^2 & q_4 &= 0.12 \text{ t/m}
 \end{aligned}$$

Şekil 1.10

1.3.2 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**COZUM A-3**

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=6

3 X=10 Y=0 Z=8.679

4 X=20 Y=0 Z=6

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.12,0,0 :RUZGAR SOLDAN

7 WG=-0.24,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.24,0 :RUZGAR SAGDAN

10 WG=-0.12,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.3.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-3

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -7.92
 .0 3.30 .00
 6.0 3.30 19.80

2 -4.80
 .0 2.00 .00
 6.0 2.00 11.99

3 -.62
 .0 -.61 .00
 2.6 .00 -.79
 6.0 .83 .63

4 -2.04
 .0 1.18 .00
 6.0 .46 4.91

5 -3.60
 .0 1.00 .00
 6.0 1.00 6.00

2 -----

1 -4.21
 .0 -6.80 19.80
 9.2 .00 -11.47
 10.4 .85 -10.98

2 -2.55
 .0 -4.12 11.99

		9.2	.00	-6.95
		10.4	.52	-6.65
3	-.96			
		.0	-.39	.63
		9.1	.00	-1.14
		10.4	.05	-1.10
4	-.97			
		.0	-1.85	4.91
		7.7	.00	-2.22
		10.4	.64	-1.38
5	-1.28			
		.0	-3.22	6.00
		7.2	.00	-5.57
		10.4	1.42	-3.32
3	-----			
1	-4.21			
		.0	-.85	-10.98
		1.2	.00	-11.47
		10.4	6.80	19.80
2	-2.55			
		.0	-.52	-6.65
		1.2	.00	-6.95
		10.4	4.12	11.99
3	-.86			
		.0	-.43	-1.10
		2.2	.00	-1.59
		10.4	1.56	4.71
4	-1.16			
		.0	.07	-1.38

	10.4	.51	1.59
5	-1.28		
	.0	.90	-3.32
	10.4	.90	6.00
4	-----		
1	-7.92		
	.0	-3.30	19.80
	6.0	-3.30	.00
2	-4.80		
	.0	-2.00	11.99
	6.0	-2.00	.00
3	-1.72		
	.0	-.43	4.71
	6.0	-1.15	.00
4	-.79		
	.0	-.99	1.59
	4.1	.00	-.43
	6.0	.45	.00
5	-1.20		
	.0	-1.00	6.00
	6.0	-1.00	.00

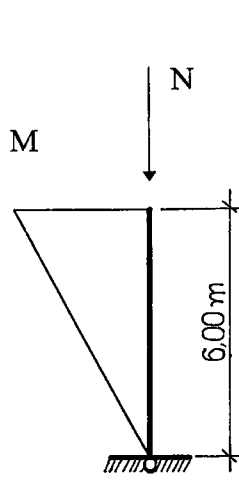
Tablo 1.6

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	0.62	0.00	2.04	0.00	12.72	0.00	14.76
2	19.80	7.92	6.00	3.60	11.99	4.80	0.79 M=0.63	0.62	4.91	0.97	31.79	12.72	36.70	14.76
3	19.80	4.21	6.00	1.28	11.99	2.55	0.63	0.96	4.91	0.97	31.79	6.76	36.70	7.73
4	11.47 M=10.98	4.21	5.57 M=3.32	1.28	6.95 M=6.65	2.55	1.14 M=1.10	0.96	2.22 M=1.38	0.97	18.42 M=1763	6.76	20.6 M=19.0	7.73
5	10.98	4.21	3.32	1.28	5.65	2.55	1.10	0.86	1.38	1.16	17.63	6.76	19.01	7.73
6	11.47 M=19.80	4.21	6.00	1.28	6.95 M=11.99	2.55	1.59 M=4.71	0.86	1.59	1.16	18.42 M=31.79	6.76	20.0 M=36.5	7.73
7	19.80	7.92	6.00	1.20	11.99	4.80	4.71	1.72	1.59	0.79	31.79	12.72	36.50	14.76
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	1.72	0.43 M=0.000	0.79	0.00	12.72	0.00	14.76

M Açıklıkta maximum moment

1.3.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.3.4.1 1 Nolu Eleman



$$\ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 300 \text{ cm}$$

$$M = 31.79 \text{ tm} \quad N = 12.72 \text{ t} \quad \text{Seçilen I 550}$$

$$A = 212 \text{ cm}^2 \quad W_x = 3610 \text{ cm}^3 \quad i_x = 21.6 \text{ cm} \quad i_y = 4.02 \text{ cm}$$

$$S_x = 55 - 2 \times 3 = 49 \text{ cm} \quad b = 20 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.0 \text{ cm}$$

$$\lambda_x = 55.55 \quad \lambda_y = 74.626 \quad \sigma_{bem} = 0.9355 \text{ t/cm}^2$$

$$\sigma_{eb} = 0.06 \text{ t/cm}^2 \quad \sigma_{e'} = 2.685 \text{ t/cm}^2 \quad \sigma_b = 0.880609 \text{ t/cm}^2$$

$$H' = 8.166 \text{ cm} \quad F_B = 75.5168 \text{ cm}^2 \quad i_{yB} = 2004 \times 667 \text{ cm}^4$$

$$i_{yB} = 5.152 \text{ cm} \quad i_{yB} = 116.453 \quad \sigma_B = 1.10404 \text{ t/cm}^2$$

Şekil 1.11

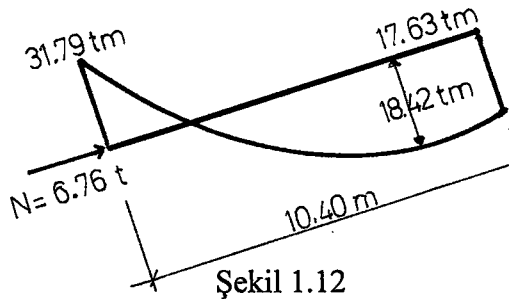
$$\text{Gerilme Kontrolleri} \quad 0.75760 < 1$$

$$0.83928 < 1$$

2. Kontrol

$$\lambda_x = 55.5 \rightarrow 56 \text{ için } \omega_x = 1.32 \quad \sigma = 1.32 \times \frac{12.72}{212} + 0.9 \times \frac{3179}{3610} \quad \sigma = 0.8717 \text{ t/cm}^2 < \sigma_{em}$$

1.3.4.2 2 Nolu Eleman:



Şekil 1.12

$$C_b = 2.42 \quad C_b = 2.3 \quad \ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$\text{Seçilen HE - A 450} \quad A = 178 \text{ cm}^2$$

$$W_x = 2900 \text{ cm}^3 \quad i_x = 18.9 \text{ cm} \quad i_y = 7.29 \text{ cm}$$

$$S_x = 44 - 2 \times 2.1 = 39.8 \text{ cm} \quad b = 30 \text{ cm}$$

$$d = 1.15 \text{ cm} \quad t = 2.1 \quad \lambda_x = 55.026 \quad \lambda_y = 142.66$$

$$\sigma_{bem} = 0.4054 \text{ t/cm}^2 \quad \sigma_{eb} = 3.79775 \times 10^{-2} \text{ t/cm}^2$$

$$\sigma_{e'} = 2.73786 \text{ t/cm}^2 \quad \sigma_b = 1.0962 \text{ t/cm}^2 \quad H' = 6.6333 \text{ cm} \quad F_B = 70.628 \text{ cm}^4$$

$$i_{yB} = 4725.84 \text{ cm}^4 \quad I_{yB} = 8.179 \text{ cm} \quad S/i_{yB} = 127.14 \quad \sigma_B = 1.1502 \text{ t/cm}^2$$

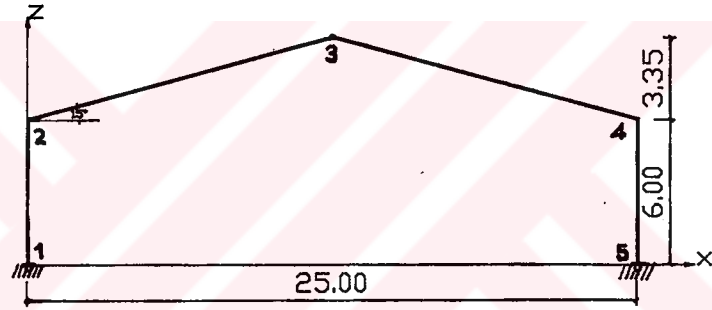
$$\text{Gerilme Kontrolleri} \quad 0.915172 < 1$$

$$0.97943 < 1$$

2. Kontrol.

$$\lambda_x = 55.026 \rightarrow 56 \text{ için } \omega_x = 1.32 \quad \sigma = 1.32 \times \frac{6.16}{178} + 0.9 \times \frac{3179}{2900} \quad \sigma = 1.0321 \text{ t/cm}^2 < \sigma_{em}$$

1.4 ÇÖZÜM A4



Sekil 1.13

Tablo 1.7

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	6.00
3	12.50	6.35
4	25.00	6.00
5	25.00	0.00

1.4.1. SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A3'de hesaplananlar ile tamamen aynıdır.

1.4.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-4

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=6

3 X=12.5 Y=0 Z=9.35

4 X=25 Y=0 Z=6

5 X=25 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.12,0,0 :RUZGAR SOLDAN

7 WG=-0.24,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.12,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.4.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-4

FRAME ELEMENT FORCES

ELT LOAD		AXIAL DIST		1-2 PLANE	
ID	COND	FORCE	ENDI	SHEAR	MOMENT
1	-----				
1	-9.90				
	.0	5.11	.00		
	6.0	5.11	30.64		
2	-6.00				
	.0	3.09	.00		
	6.0	3.09	18.56		
3	-.90				
	.0	-.32			
	1.3	.00	-.21		
	6.0	1.12	2.42		
4	-2.04				
	.0	1.34	.00		
	6.0	.62	5.91		
5	-4.50				
	.0	1.55	.00		

		6.0	1.55	9.28
2	-----			
1	-6.21			
		.0	-8.24	30.64
		11.2	.00	-15.34
		12.9	1.32	-14.15
2	-3.76			
		.0	-4.99	18.56
		11.2	.00	-9.29
		12.9	.80	-8.57
3	-1.32			
		.0	-.57	2.42
		12.9	-.02	-1.42
4	-1.13			
		.0	-1.81	5.91
		9.4	.00	-2.61
		12.9	.68	-1.42
5	-1.88			
		.0	-3.95	9.28
		8.8	.00	-8.11
		12.9	1.85	-4.29
3	-----			
1	-6.21			
		.0	-1.32	-14.15
		1.8	.00	-15.34
		12.9	8.24	30.64
2	-3.76			

		.0	-.80	-8.57
		1.8	.00	-9.29
		12.9	4.99	18.56
3	-1.13			
		.0	-.68	-1.42
		3.5	.00	-2.61
		12.9	1.81	5.91
4	-1.32			
		.0	.02	-1.42
		12.9	.57	2.42
5	-1.88			
		.0	1.05	-4.29
		12.9	1.05	9.28
4	-----			
1	-9.90			
		.0	-5.11	30.64
		6.0	-5.11	.00
2	-6.00			
		.0	-3.09	18.56
		6.0	-3.09	.00
3	-2.04			
		.0	-.62	5.91
		6.0	-1.34	.00
4	-.90			
		.0	-1.12	2.42
		4.7	.00	-.21
		6.0	.32	.00
5	-1.50			
		.0	-1.55	9.28

6.0 -1.55 .00

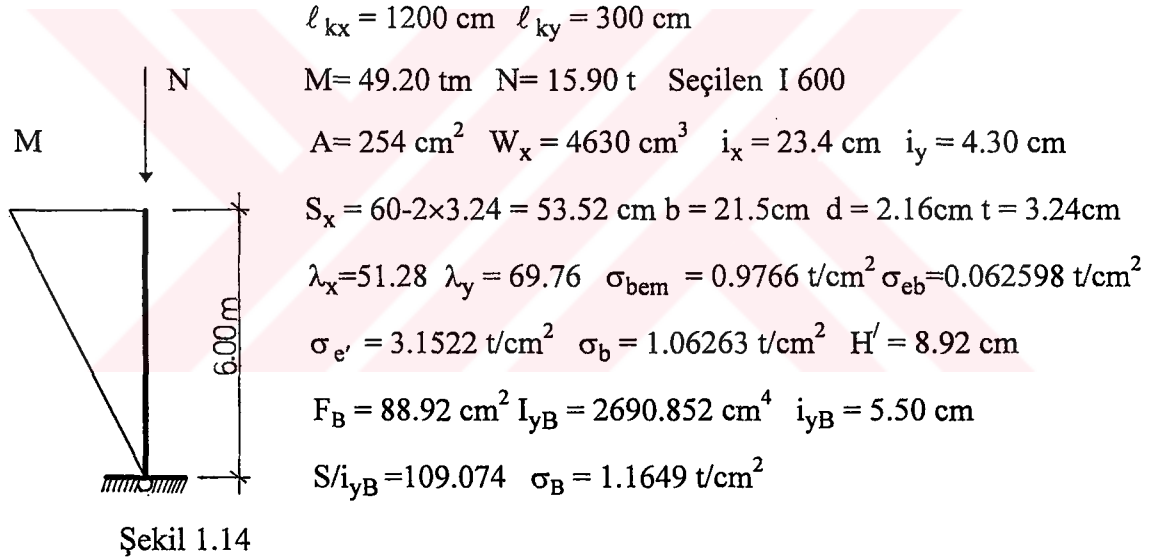
Tablo 1.8

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	9.90	0.00	4.50	0.00	6.00	0.00	0.90	0.00	2.04	0.00	15.90	0.00	17.94
2	30.64	9.90	9.28	4.50	18.56	6.00	0.21 M=2.42	0.90	5.91	2.04	49.20	15.90	55.11	17.94
3	30.64	6.21	9.28	1.88	18.56	3.76	2.42	1.32	5.91	1.13	49.20	9.97	55.11	11.29
4	15.3 M=14.1	6.21	8.11 M=4.29	1.88	9.29 M=8.57	3.76	1.42	1.32	2.61 M=1.42	1.13	24.64 M=22.72	9.97	27.2 M=24.1	11.29
5	14.15	6.21	4.29	1.88	8.57	3.76	1.42	1.13	1.42	1.32	22.72	9.97	24.14	11.29
6	15.3 M=30.6	6.21	9.28	1.88	9.29 M=18.56	3.76	2.61 M=5.91	1.13	2.42	1.32	24.64 M=49.20	9.97	27.2 M=5.11	11.29
7	30.64	9.90	9.28	1.50	18.56	6.00	5.91	2.04	2.42	0.90	49.20	15.90	55.11	17.94
8	0.00	9.90	0.00	1.50	0.00	6.00	0.00	2.04	0.21 M=0.00	0.90	0.00	15.90	0.00	17.94

M Açıklıkta maximum moment

1.4.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

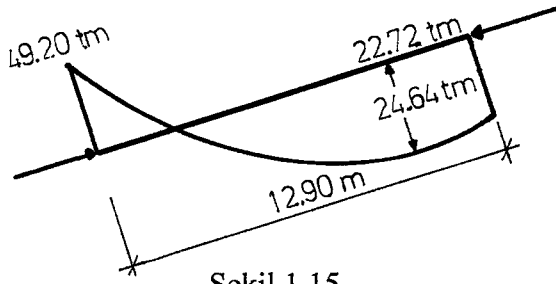
1.4.4.1 1 Nolu Eleman

Gerilme Kontrolleri $0.85518 < 1$ $0.95568 < 1$

2 Kontrol.

$$\lambda_x = 51.28 \rightarrow 52 \text{ için } \omega_x = 1.28 \quad \sigma = 1.28 \times \frac{15.90}{254} + 0.9 \times \frac{4920}{6240} \quad \sigma = 0.7687 \text{ t/cm}^2 < \sigma_{em}$$

1.4.4.2 2 Nolu Eleman .



Şekil 1.15

$$C_b = 2.299 \quad \ell_{kx} = 1290 \text{ cm} \quad \ell_{ky} = 1290 \text{ cm}$$

$$N = 9.97 \text{ t} \quad \text{Seçilen HE-A 700 } A = 204 \text{ cm}^2$$

$$W_x = 6240 \text{ cm}^3 \quad i_x = 28.8 \text{ cm} \quad i_y = 6.84 \text{ cm}$$

$$S_x = 69 - 2 \times 2.7 = 63.6 \text{ cm} \quad b = 30 \text{ cm}$$

$$d = 1.45 \text{ cm} \quad t = 2.7 \text{ cm} \quad \lambda_x = 44.791$$

$$\lambda_y = 188.5964 \quad \sigma_{bem} = 0.2321 \text{ t/cm}^2$$

$$\sigma_{eb} = 4.8872 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_e = 4.1319 \text{ t/cm}^2$$

$$\sigma_b = 0.78846 \text{ t/cm}^2 \quad H' = 10.6 \text{ cm}$$

$$F_B = 96.37 \text{ cm}^2 \quad I_{yB} = 6077.692 \text{ cm}^4$$

$$\sigma_{bs} = 0.39487 \text{ t/cm}^2 \quad i_{yB} = 7.94 \text{ cm} \quad S/i_{yB} = 162.44 \quad \sigma_B = 0.8654 \text{ t/cm}^2$$

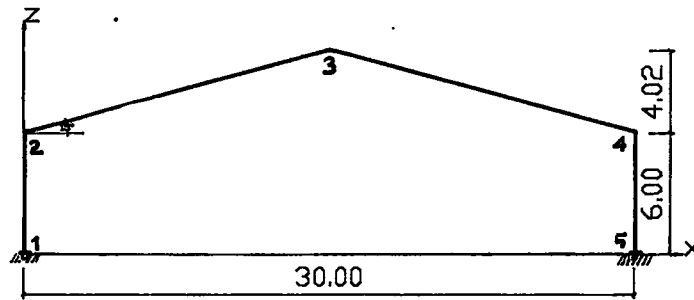
$$\text{Gerilme kontrolleri} \quad 0.60303 < 1$$

$$1.09449 \approx 1$$

2. Kontrol.

$$\lambda_x = 44.79 \rightarrow 45 \text{ için } \omega_x = 1.21 \quad \sigma = 1.21 \times \frac{9.97}{204} + 0.9 \times \frac{4920}{6240} \quad \sigma = 0.7687 \text{ t/cm}^2 < \sigma_{em}$$

1.5 ÇÖZÜM A5



Şekil 1.16

Tablo 1.9

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	6.00
3	15.00	10.02
4	30.00	6.00
5	30.00	0.00

1.5.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A3'de hesaplananlar ile tamamen aynıdır.

1.5.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**COZUM A-5****SYSTEM**

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=6

3 X=15 Y=0 Z=10.012

4 X=30 Y=0 Z=6

5 X=30 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.12,0,0 :RUZGAR SOLDAN

7 WG=-0.24,0,0 :RUZGAR SAGDAN

8 WL=0,0.042885,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.12,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.5.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-5

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -11.89

.0 7.21 .00

6.0 7.21 43.29

2 -7.20

		.0	4.37	.00
		6.0	4.37	26.22
3	-1.15			
		.0	.03	.00
		6.0	1.47	4.48
4	-2.38			
		.0	1.59	.00
		6.0	.87	7.37
5	-5.40			
		.0	2.19	.00
		6.0	2.19	13.11
2	-----			
1	-8.51			
		.0	-9.62	43.29
		13.0	.00	-19.26
		15.5	1.86	-16.91
2	-5.15			
		.0	-5.83	26.22
		13.0	.00	-11.66
		15.5	1.13	-10.24
3	-1.71			
		.0	-.73	4.48
		15.5	-.06	-1.66
4	-1.45			
		.0	-2.07	7.37
		10.8	.00	-3.81
		15.5	.91	-1.66
5	-2.58			
		.0	-4.65	13.11

	10.4	.00	-11.04
	15.5	2.30	-5.12
3	-----		
1	-8.51		
	.0	-1.86	-16.91
	2.5	.00	-19.26
	15.5	9.62	43.29
2	-5.15		
	.0	-1.13	-10.24
	2.5	.00	-11.66
	15.5	5.83	26.22
3	-1.45		
	.0	-.91	-1.66
	4.7	.00	-3.81
	15.5	2.07	7.37
4	-1.71		
	.0	.06	-1.66
	15.5	.73	4.48
5	-2.58		
	.0	1.17	-5.12
	15.5	1.17	13.11
4	-----		
1	-11.89		
	.0	-7.21	43.29
	6.0	-7.21	.00
2	-7.20		
	.0	-4.37	26.22
	6.0	-4.37	.00
3	-2.38		

	.0	-0.87	7.37
	6.0	-1.59	.00
4	-1.15		
	.0	-1.47	4.48
	6.0	-.03	.00
5	-1.80		
	.0	-2.19	13.11
	6.0	-2.19	.00

Tablo 1.10

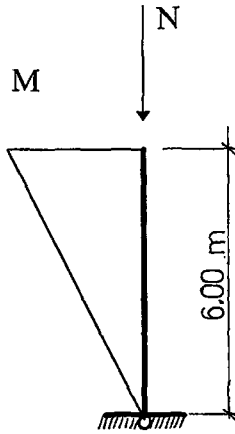
NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	11.89	0.00	5.40	0.00	7.20	0.00	1.15	0.00	2.38	0.00	19.09	0.00	21.47
2	43.29	11.89	13.11	5.40	26.22	7.20	4.48	1.15	7.37	2.38	69.51	19.09	76.88	21.47
3	43.29	8.51	13.11	2.58	26.22	5.15	4.48	1.71	7.37	1.45	69.51	13.66	76.88	15.37
4	19.2 M=16.9	8.51	11.0 M=5.12	2.58	11.66 M=10.24	5.15	1.66	1.71	3.8 M=1.66	1.45	3.92 M=27.15	13.66	34.7 M=28.8	15.37
5	16.91	8.51	5.12	2.58	10.24	5.15	1.66	1.45	1.66	1.71	27.15	13.66	28.81	15.37
6	19.2 M=43.2	8.51	13.11	2.58	11.66 M=26.22	5.15	3.8 M=7.37	1.45	4.58	1.71	30.92 M=69.51	13.66	34.7 M=76.8	15.37
7	43.29	11.89	13.11	1.80	26.22	7.20	7.37	2.38	4.48	1.15	69.51	19.09	76.88	21.47
8	0.00	11.89	0.00	1.80	0.00	7.20	0.00	2.38	0.00	1.15	0.00	19.09	0.00	21.47

M Açıklıkta maximum moment

1.5.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.5.4.1 1 Nolu Eleman

$$\ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 300 \text{ cm}$$



M= 69.51 tm N= 19.09 t Seçilen HE-A 650

$$A = 242 \text{ cm}^2 \quad W_x = 5470 \text{ cm}^3 \quad i_x = 26.9 \text{ cm} \quad i_y = 6.97 \text{ cm}$$

$$S_x = 6455 - 2 \times 2.6 = 58.8 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.35 \text{ cm} \quad t = 2.6 \text{ cm}$$

$$\lambda_x = 44.609 \quad \lambda_y = 43.041 \quad \sigma_{bem} = 1.1873 \text{ t/cm}^2$$

$$\sigma_{eb} = 7.888429 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 4.16578 \text{ t/cm}^2$$

$$\sigma_b = 1.2707 \text{ t/cm}^2 \quad H' = 9.8 \text{ cm} \quad F_B = 91.23 \text{ cm}^2$$

$$I_{yB} = 5852.009 \text{ cm}^4 \quad i_{yB} = 8.00 \text{ cm} \quad S/i_{yB} = 74.9147$$

$$\sigma_B = 1.39475 \text{ t/cm}^2$$

Şekil 1.17

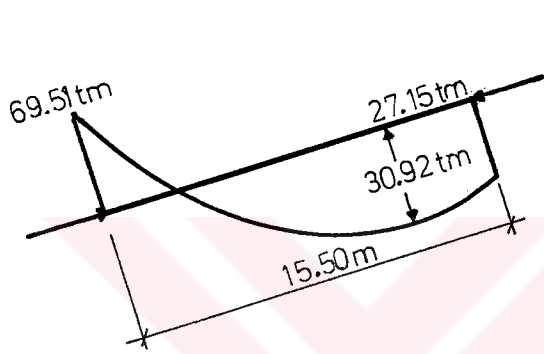
Gerilme Kontrolleri $0.855816 < 1$

$0.965873 < 1$

2. Kontrol.

$$\lambda_x = 44.609 \rightarrow 45 \text{ için } \omega_x = 1.21 \quad \sigma = 1.21 \times \frac{19.09}{242} + 0.9 \times \frac{6951}{5470} \quad \sigma = 1.2391 \text{ t/cm}^2 < \sigma_{em}$$

1.5.4.2 2 Nolu Eleman



Şekil 1.18

$$\ell_{kx} = 1550 \text{ cm} \quad \ell_{ky} = 1550 \text{ cm}$$

$$N = 13.66 \text{ t} \text{ Seçilen HE-B 1000 } A = 400 \text{ cm}^2$$

$$W_x = 12890 \text{ cm}^3 \quad i_x = 40.1 \text{ cm} \quad i_y = 6.38 \text{ cm}$$

$$S_x = 100 - 2 \times 2.3.6 \quad S_x = 92.8 \text{ cm}$$

$$b = 30 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.6 \text{ cm}$$

$$\lambda_x = 38.653 \quad \lambda_y = 242.946 \quad 243$$

$$\sigma_{bem} = 0.1404 \text{ t/cm}^2 \quad \sigma_{eb} = 0.03415 \text{ t/cm}^2$$

$$\sigma_{e'} = 5.5485 \text{ t/cm}^2 \quad \sigma_b = 0.5392 \text{ t/cm}^2$$

$$H' = 15.466 \text{ cm} \quad F_B = 137.386 \text{ cm}^2$$

$$I_{yB} = 8108.84 \text{ cm}^4 \quad \sigma_b = 0.23987 \text{ t/cm}^2 \quad i_{yB} = 7.682 \text{ cm} \quad S/i_{yB} = 201.75$$

$$\sigma_B = 0.5417 \text{ t/cm}^2$$

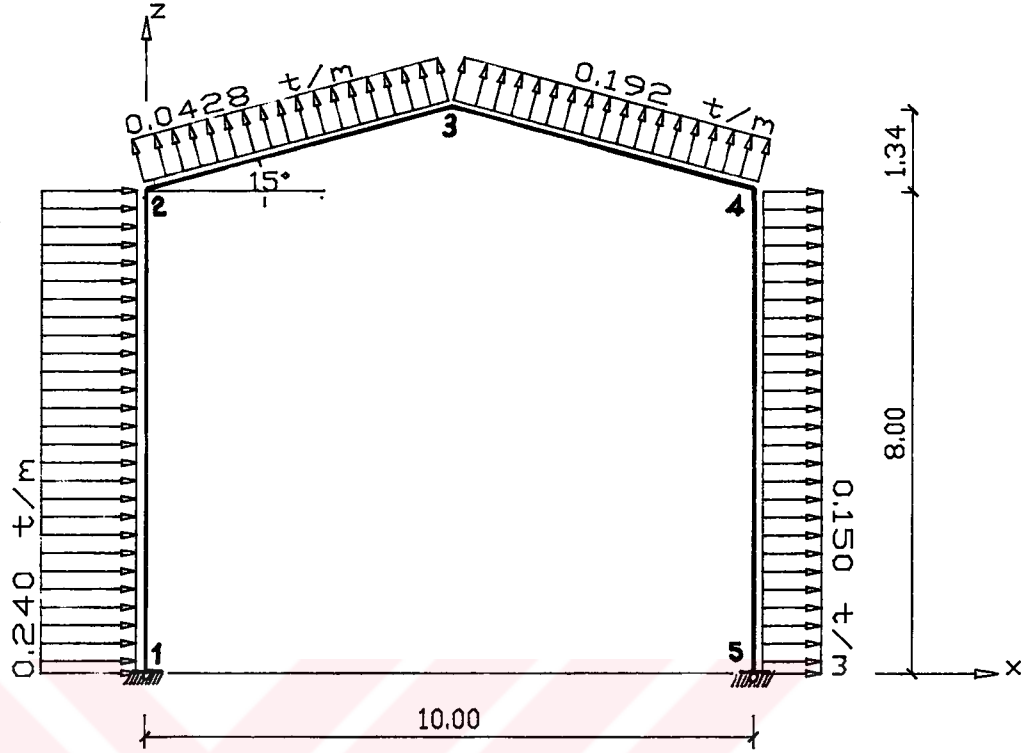
Gerilme Kontrolleri $0.621961 < 1$

$1.0192 \approx 1$

2. Kontrol.

$$\lambda_x = 38.63 \rightarrow 39 \text{ için } \omega_x = 1.16 \quad \sigma = 1.16 \times \frac{13.66}{400} + 0.9 \times \frac{6951}{5470} \quad \sigma = 0.5249 \text{ t/cm}^2 < \sigma_{em}$$

1.6. ÇÖZÜM A6



Sekil 1.19

Tablo 1.11

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	8.00
3	5.00	9.34
4	10.00	8.00
5	10.00	0.00

1.6.1 SİSTEME ETKİYEN YÜKLER

Rüzgar yükü hariç diğer yükler, ÇÖZÜM A3'de hesaplananlar ile tamamen aynıdır.

1.6.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-6

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=8

3 X=5 Y=0 Z=9.34

4 X=10 Y=0 Z=8

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.12,0,0 :RUZGAR SOLDAN

7 WG=-0.24,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.12,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.6.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-6

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -3.96

.0 .54 .00

8.0 .54 4.31

2 -2.40

.0 .33 .00

8.0 .33 2.61

3 .58

.0 -1.50 .00

6.2 .00 -4.68

8.0 .42 -4.30

4 -1.75

.0 1.18 .00

8.0 .22 5.62

5 -1.80

.0 .16 .00

8.0 .16 1.31

2 -----

1 -1.03

.0 -3.69 4.31

5.0 .00 -4.88

		5.2	.14	-4.87
2	-.63			
		.0	-2.23	2.61
		5.0	.00	-2.96
		5.2	.08	-2.95
3	-.26			
		.0	.67	-4.30
		5.2	.89	-.28
4	-.67			
		.0	-1.64	5.62
		5.2	-.64	-.28
5	-.31			
		.0	-1.70	1.31
		3.8	.00	-1.91
		5.2	.62	-1.48
3	-----			
1	-1.03			
		.0	-.14	-4.87
		.2	.00	-4.88
		5.2	3.69	4.31
2	-.63			
		.0	-.08	-2.95
		.2	.00	-2.96
		5.2	2.23	2.61
3	-.67			
		.0	.64	-.28
		5.2	1.64	5.62
4	-.26			
		.0	-.89	-.28

	5.2	-.67	-4.30
5	-.31		
	.0	.54	-1.48
	5.2	.54	1.31
4	-----		
1	-3.96		
	.0	-.54	4.31
	8.0	-.54	
2	-2.40		
	.0	-.33	2.61
	8.0	-.33	
3	-1.75		
	.0	-.22	5.62
	8.0	-1.18	.00
4	.58		
	.0	-.42	-4.30
	1.8	.00	-4.68
	8.0	1.50	.00
5	-.60		
	.0	-.16	1.31
	8.0	-.16	.00

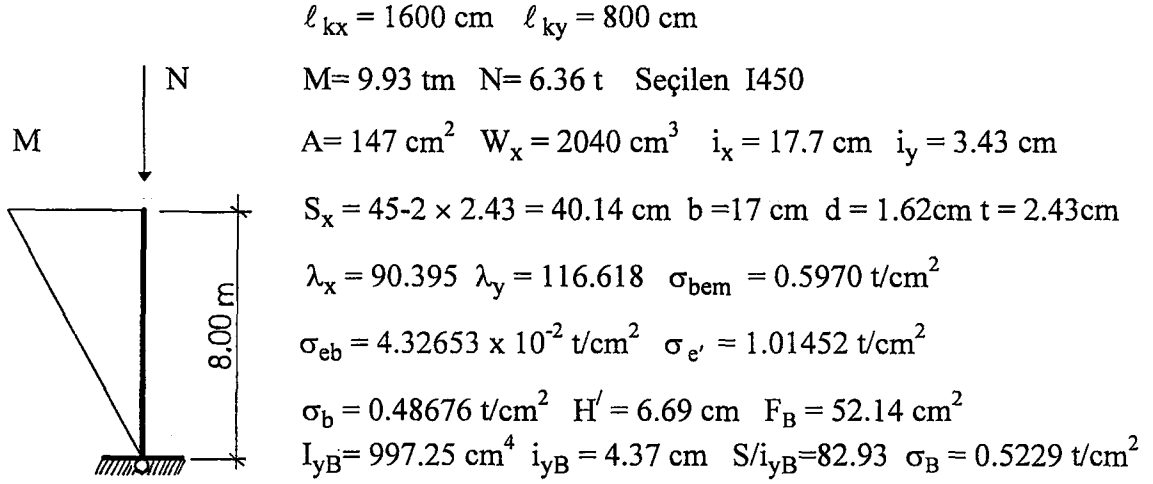
Tablo 1.12

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDA		RÜZGAR SAĞDA		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	0.58	0.00	1.75	0.00	6.36	0.00	8.11
2	4.31	3.96	1.31	1.80	2.61	2.40	4.6	0.58	5.62	1.75	9.93	6.36	12.54	8.11
3	4.31	1.03	1.31	0.31	2.61	0.63	4.30	0.26	5.62	0.67	9.93	1.70	12.54	2.33
4	4.88 M=4.87	1.03	1.91 M=1.48	0.31	2.96 M=2.95	0.63	0.28	0.26	0.28	0.67	7.84 M=7.82	1.70	7.84 M=8.10	2.33
5	4.87	1.03	1.43	0.31	2.95	0.63	0.28	0.67	0.28	0.26	7.82	1.70	8.10	2.33
6	4.88 M=4.31	1.03	1.31	0.31	2.96 M=2.61	0.63	5.62	0.67	4.30	0.26	9.93	1.70	7.84 M=12.5	2.33
7	4.31	3.96	1.31	0.60	2.61	2.40	5.62	1.75	4.30	0.58	9.93	6.36	12.54	8.11
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	1.75	4.6 M=0.0	0.58	0.00	6.36	0.00	8.11

M Açıklıkta maximum moment

1.6.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.6.4.1 1 Nolu Eleman



Şekil 1.20

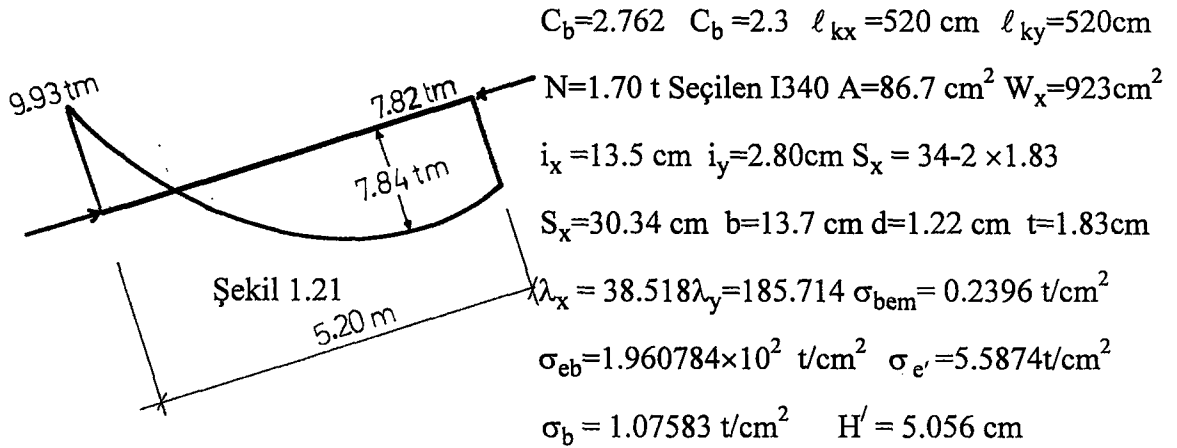
Gerilme Kontrolleri $0.898962 < 1$

$0.960921 < 1$

2. Kontrol.

$$\lambda_x = 90.395 \rightarrow 91 \text{ için } \omega_x = 1.77 \quad \sigma = 1.77 \times \frac{6.36}{147} + 0.9 \times \frac{993}{2040} \quad \sigma = 0.5146 \text{ t/cm}^2 < \sigma_{em}$$

1.6.4.2 2 Nolu Eleman .



Şekil 1.21

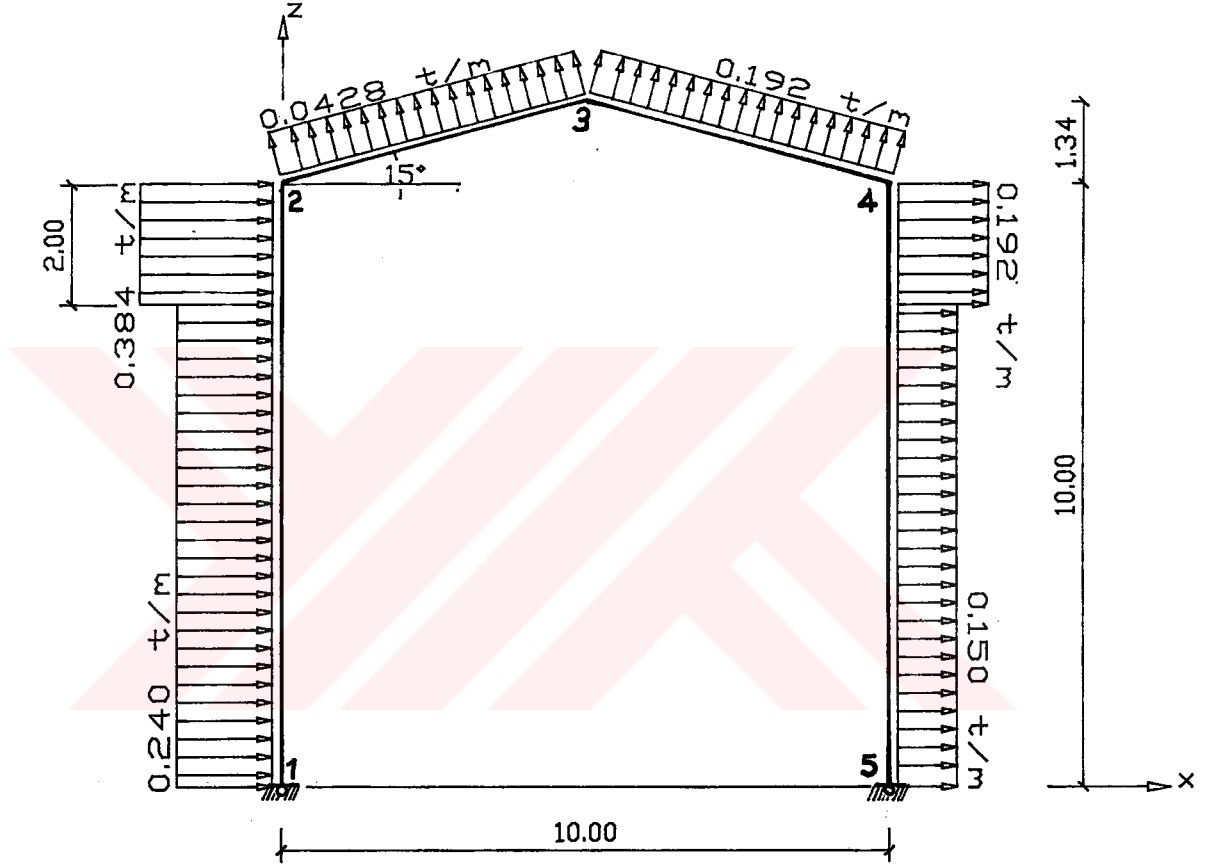
$$F_B = 31.240 \text{ cm}^2 \quad I_{yB} = 392.896 \text{ cm}^4 \quad i_{yB} = 3.546 \text{ cm} \quad S/i_{yB} = 146.629 \quad \sigma_B = 1.0017 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.805116 < 1$
 $1.08759 \approx 1$

2. Kontrol.

$$\lambda_x = 38.518 \rightarrow 39 \text{ için } \omega_x = 1.16 \quad \sigma = 1.16 \times \frac{1.70}{86.7} + 0.9 \times \frac{993}{923} \quad \sigma = 0.9910 \text{ t/cm}^2 < \sigma_{em}$$

1.7 ÇÖZÜM A7



Sekil 1.22

Tablo 1.13

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	00	0.00
2	0.00	10.00
3	5.00	11.34
4	10.00	10.00
5	10.00	0.00

1.7.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler, rüzgar yükleri hariç ÇÖZÜM A3 'de hesaplananlar ile tamamen aynıdır.

1.7.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-7

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=10

3 X=5 Y=0 Z=11.34

4 X=10 Y=0 Z=10

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN
 6 WG=0.192,0,0 :RUZGAR SOLDAN
 7 WG=-0.384,0,0 :RUZGAR SAGDAN
 8 WL=0,0.04288,0 :RUZGAR SAGDAN
 9 WL=0,0.192,0 :RUZGAR SAGDAN
 10 WG=-0.192,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.7.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-7

FRAME ELEMENT FORCES

ELT LOAD		AXIAL DIST		1-2 PLANE	
ID	COND	FORCE	ENDI	SHEAR	MOMENT
1 -----					
1		-3.96			
		.0	.40	.00	
		10.0	.40	4.01	
2		-2.40			
		.0	.24	.00	
		10.0	.24	2.43	
3		2.27			
		.0	-3.18	.00	
		8.3	.00	-13.16	
		10.0	.66	-12.59	
4		-3.44			

		.0	2.38	.00
		10.0	.46	14.21
5	-1.80			
		.0	.12	.00
		10.0	.12	1.22
2	-----			
1	-.90			
		.0	-3.72	4.01
		5.0	.00	-5.36
		5.2	.10	-5.36
2	-.55			
		.0	-2.26	2.43
		5.0	.00	-3.25
		5.2	.06	-3.24
3	-.05			
		.0	2.36	-12.59
		5.2	2.58	.20
4	-1.34			
		.0	-3.20	14.21
		5.2	-2.21	.20
5	-.27			
		.0	-1.71	1.22
		3.8	.00	-2.04
		5.2	.61	-1.62
3	-----			
1	-.90			
		.0	-.10	-5.36
		.1	.00	-5.36
		5.2	3.72	4.01

2	-0.55		
	.0	-.06	-3.24
	.1	.00	-3.25
	5.2	2.26	2.43

3	-1.34		
	.0	2.21	.20
	5.2	3.20	14.21

4	-.05		
	.0	-2.58	.20
	5.2	-2.36	-12.59

5	-.27		
	.0	.55	-1.62
	5.2	.55	1.22

4 -----

1	-3.96		
	.0	-.40	4.01
	10.0	-.40	.00

2	-2.40		
	.0	-.24	2.43
	10.0	-.24	

3	-3.44		
	.0	-.46	14.21
	10.0	-2.38	.00

4	2.27		
	.0	-.66	-12.59
	1.7	.00	-13.16
	10.0	3.18	.00

5	-.60		
	.0	-.12	1.22

10.0 -12 .00

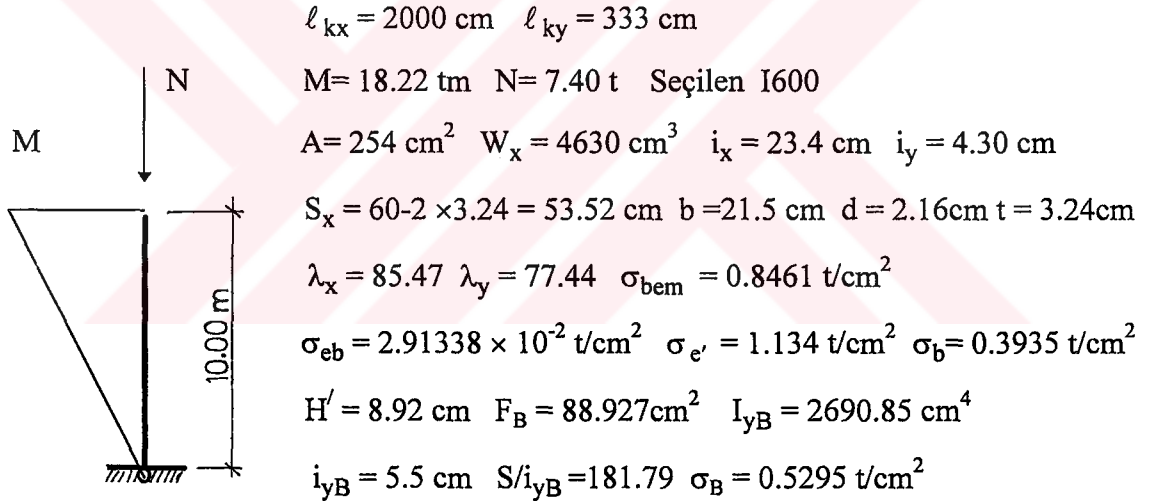
Tablo 1.14

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	2.27	0.00	3.44	0.00	7.40	0.00	9.8
2	4.01	3.96	1.22	1.80	2.43	2.40	13.1 M=12.59	2.27	14.21	3.44	8.58 M=18.22	7.40	7.3 M=20.6	9.8
3	4.01	0.90	1.22	0.27	2.43	0.55	12.59	0.05	14.21	1.34	18.22	2.24	7.3 M=20.6	2.79
4	5.36 M=5.36	0.90	2.04 M=1.62	0.27	3.25 M=3.24	0.55	0.20	0.05	0.20	1.34	8.61 M=8.6	2.24	8.61 M=8.40	2.79
5	5.36	0.90	1.62	0.27	3.24	0.55	0.20	1.34	0.20	0.05	9.60	2.24	8.40	2.79
6	4.01	0.90	1.22	0.27	3.25 M=2.43	0.55	14.21	1.34	12.59	0.05	18.22 M=8.58	2.24	7.36 M=20.6	2.79
7	4.01	3.96	1.22	0.60	2.43	2.40	14.21	3.44	12.59	2.24	18.22 M=8.58	7.40	7.3 M=20.6	9.8
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	3.44	13.1 M=0.00	2.27	0.00	7.40	13.1 M=0.00	9.8

M Açıklıkta maximum moment

1.7.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.7.4.1 1 Nolu Eleman



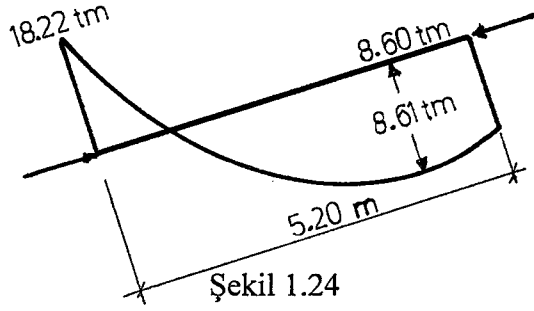
Şekil 1.23

Gerilme Kontrolleri $0.68275 < 1$ $0.76337 < 1$

2. Kontrol.

$$\lambda_x = 85.47 \rightarrow 86 \text{ için } \omega_x = 1.70 \quad \sigma = 1.70 \times \frac{7.40}{254} + 0.9 \times \frac{1822}{4630} \quad \sigma = 0.4036 \text{ t/cm}^2 < \sigma_{em}$$

1.7.4.2 2 Nolu Eleman .



$$C_b = 2.313 \quad C_b = 2.3 \quad \ell_{kx} = 520 \text{ cm} \quad \ell_{ky} = 520 \text{ cm}$$

$$N = 2.24 \text{ t} \quad \text{Seçilen I450} \quad A = 132 \text{ cm}^2$$

$$W_x = 1740 \text{ cm}^3 \quad i_x = 16.7 \text{ cm} \quad i_y = 3.30 \text{ cm}$$

$$S_x = 42.5 - 2 \times 2.3 = 37.9 \text{ cm} \quad b = 16.3 \text{ cm}$$

$$d = 1.53 \text{ cm} \quad t = 2.3 \text{ cm} \quad \lambda_x = 31.137 \quad \lambda_y = 157.57$$

$$\sigma_{bem} = 1.696 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{eb} = 1.696 \times 10^{-2} \text{ t/cm}^2$$

$$\sigma_e = 8.55 \text{ t/cm}^2 \quad \sigma_b = 1.047 \text{ t/cm}^2 \quad H' = 6.31 \text{ cm} \quad F_B = 47.154 \text{ cm}^2 \quad I_{yB} = 831.94 \text{ cm}^4$$

$$i_{yB} = 4.20 \text{ cm} \quad S/i_{yB} = 123.79 \quad \sigma_B = 1.1735 \text{ t/cm}^2$$

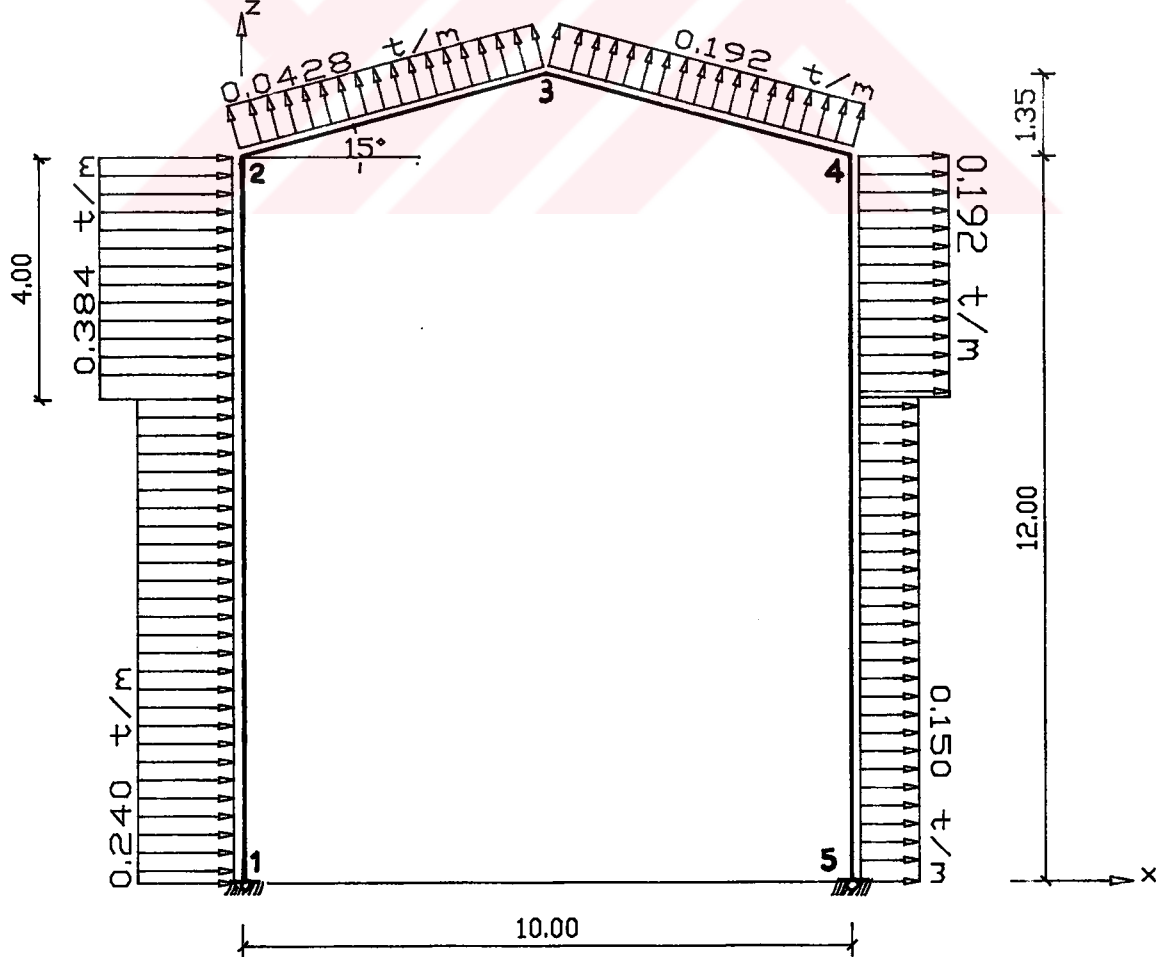
$$\text{Gerilme Kontrolleri} \quad 0.4102190 < 1$$

$$0.9040713 < 1$$

2. Kontrol.

$$\lambda_x = 31.13 \rightarrow 32 \text{ için } \omega_x = 1.11 \quad \sigma = 1.11 \times \frac{2.24}{132} + 0.9 \times \frac{1822}{1740} \quad \sigma = 1.9612 \text{ t/cm}^2 < \sigma_{em}$$

1.8. ÇÖZÜM A8



Şekil 1.25

Tablo 1.15

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	12.00
3	5.00	13.34
4	10.00	12.00
5	10.00	0.00

1.8.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler çözüm A7’de hesaplananlar ile tamamen aynıdır.

1.8.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**COZUM A-8**

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=12

3 X=5 Y=0 Z=13.34

4 X=10 Y=0 Z=12

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3
 1 WG=0,0,-0.79236 :ZATI
 2 WG=0,0,-0.48 :KAR
 3 WG=0.384,0,0 :RUZGAR SOLDAN
 4 WL=0,0.04288,0 :RUZGAR SOLDAN
 5 WL=0,0.192,0 :RUZGAR SOLDAN
 6 WG=0.192,0,0 :RUZGAR SOLDAN
 7 WG=-0.384,0,0 :RUZGAR SAGDAN
 8 WL=0,0.04288,0 :RUZGAR SAGDAN
 9 WL=0,0.192,0 :RUZGAR SAGDAN
 10 WG=-0.192,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0
 :

1.8.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-8

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1	-3.96		
	.0	.31	.00
	12.0	.31	3.74
2	-2.40		
	.0	.19	.00
	12.0	.19	2.27

3	3.49		
	.0	-3.85	.00
	10.0	.00	-19.27
	12.0	.76	-18.52
4	-4.67		
	.0	2.87	.00
	12.0	.56	20.56
5	-1.80		
	.0	.09	.00
	12.0	.09	1.13

2 -----

1	-.81		
	.0	-3.75	3.74
	5.1	.00	-5.75
	5.2	.08	-5.75
2	-.49		
	.0	-2.27	2.27
	5.1	.00	-3.48
	5.2	.05	-3.48
3	.17		
	.0	3.57	-18.52
	5.2	3.79	.55
4	-1.75		
	.0	-4.36	20.56
	5.2	-3.37	.55
5	-.25		
	.0	-1.71	1.13
	3.8	.00	-2.15
	5.2	.60	-1.74

3 -----

1 -1.81
 .0 -.08 -5.75
 .1 .00 -5.75
 5.2 3.75 3.74

2 -1.49
 .0 -.05 -3.48
 .1 .00 -3.48
 5.2 2.27 2.27

3 -1.75
 .0 3.37 .55
 5.2 4.36 20.56

4 .17
 .0 -3.79 .55
 5.2 -3.57 -18.52

5 -1.25
 .0 .56 -1.74
 5.2 .56 1.13

4 -----

1 -3.96
 .0 -.31 3.74
 12.0 -.31 .00

2 -2.40
 .0 -.19 2.27
 12.0 -.19 .00

3 -4.67
 .0 -.56 20.56
 12.0 -2.87 .00

4 3.49

	.0	-.76	-18.52
	2.0	.00	-19.27
	12.0	3.85	.00
5	-.60		
	.0	-.09	1.13
	12.0	-.09	

Tablo 1.16

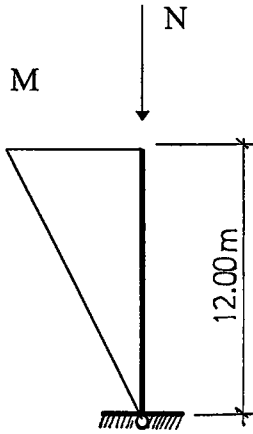
NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	3.49	0.00	4.67	0.00	8.63	0.00	11.03
2	3.74	3.96	1.13	1.80	2.27	2.40	19.2 M=18.52	3.49	20.56	4.67	14.78 M=2.43	8.63	13.6 M=26.57	11.03
3	3.74	0.81	1.13	0.25	2.27	0.49	18.52	0.17	20.56	1.75	14.78 M=2.43	2.56	13.6 M=26.57	3.05
4	5.75	0.81	2.15 M=1.74	0.25	3.48	0.49	0.55	0.17	0.55	1.75	9.23	2.56	8.56	3.05
5	5.75	0.81	1.74	0.25	3.48	0.49	0.55	1.75	0.55	0.17	9.23	2.56	8.68	3.05
6	3.74	0.81	1.13	0.25	2.27	0.49	20.56	1.75	18.52	0.17	14.78 M=24.3	2.56	13.6 M=26.5	3.05
7	3.74	3.96	1.13	0.60	2.27	2.40	20.56	4.67	18.52	3.49	14.78 M=24.3	8.63	13.6 M=26.57	11.03
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	4.67	19.2 M=0.00	3.49	0.00	8.63	19.2 M=0.00	11.03

M Açıklıkta maximum moment

1.8.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.8.4.1 1 Nolu Eleman

$$\ell_{kx} = 2400 \text{ cm} \quad \ell_{ky} = 400 \text{ cm}$$



$$M = 2430 \text{ tm} \quad N = 8.63 \text{ t} \quad \text{Seçilen HE-A 450}$$

$$A = 178 \text{ cm}^2 \quad W_x = 2900 \text{ cm}^3 \quad i_x = 18.9 \text{ cm} \quad i_y = 7.29 \text{ cm}$$

$$S_x = 44 - 2 \times 2.1 = 39.80 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.15 \text{ cm} \quad t = 2.1 \text{ cm}$$

$$\lambda_x = 126.98 \quad \lambda_y = 54.86 \quad \sigma_{bem} = 0.5161 \text{ t/cm}^2$$

$$\sigma_{eb} = 4.848314 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 0.51409 \text{ t/cm}^2$$

$$\sigma_b = 0.83793 \text{ t/cm}^2 \quad H' = 6.633 \text{ cm} \quad F_B = 70.628 \text{ cm}^2$$

$$I_{yB} = 4725.84 \text{ cm}^4 \quad i_{yB} = 8.179 \text{ cm} \quad S/i_{yB} = 146.700$$

$$\sigma_B = 0.812946 \text{ t/cm}^2$$

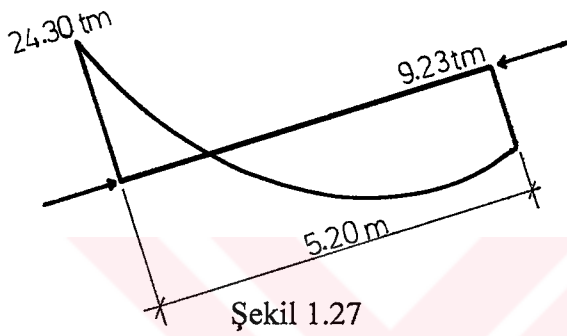
Şekil 1.26

Gerilme Kontrolleri $1.06129 \approx 1$
 $1.06400 \approx 1$

2. Kontrol.

$$\lambda_x = 126.98 \rightarrow 127 \text{ için } \omega_x = 2.79 \quad \sigma = 2.79 \times \frac{8.63}{178} + 0.9 \times \frac{2430}{2900} \quad \sigma = 1.8894 \text{ t/cm}^2 < \sigma_{em}$$

1.8.4.2 2 Nolu Eleman .



$$C_b = 2.19 \quad \ell_{kx} = 520 \text{ cm} \quad \ell_{ky} = 520 \text{ cm}$$

$$N = 2.56 \text{ t} \text{ Seçilen I450 } A = 147 \text{ cm}^2$$

$$W_x = 2040 \text{ cm}^3 \quad i_x = 17.7 \text{ cm} \quad i_y = 3.43 \text{ cm}$$

$$S_x = 45 - 2 \times 2.43 \quad S_x = 40.14 \text{ cm} \quad b = 17 \text{ cm}$$

$$d = 1.62 \text{ cm} \quad t = 2.43 \text{ cm} \quad \lambda_x = 29.378 \quad \lambda_y = 151.603$$

$$\sigma_{bem} = 0.3588 \text{ t/cm}^2 \quad \sigma_{eb} = 1.74149 \times 10^2 \text{ t/cm}^2$$

$$\sigma_{e'} = 9.6049 \text{ t/cm}^2 \quad \sigma_b = 1.19117 \text{ t/cm}^2$$

$$H' = 6.69 \text{ cm} \quad F_B = 52.14 \text{ cm}^2$$

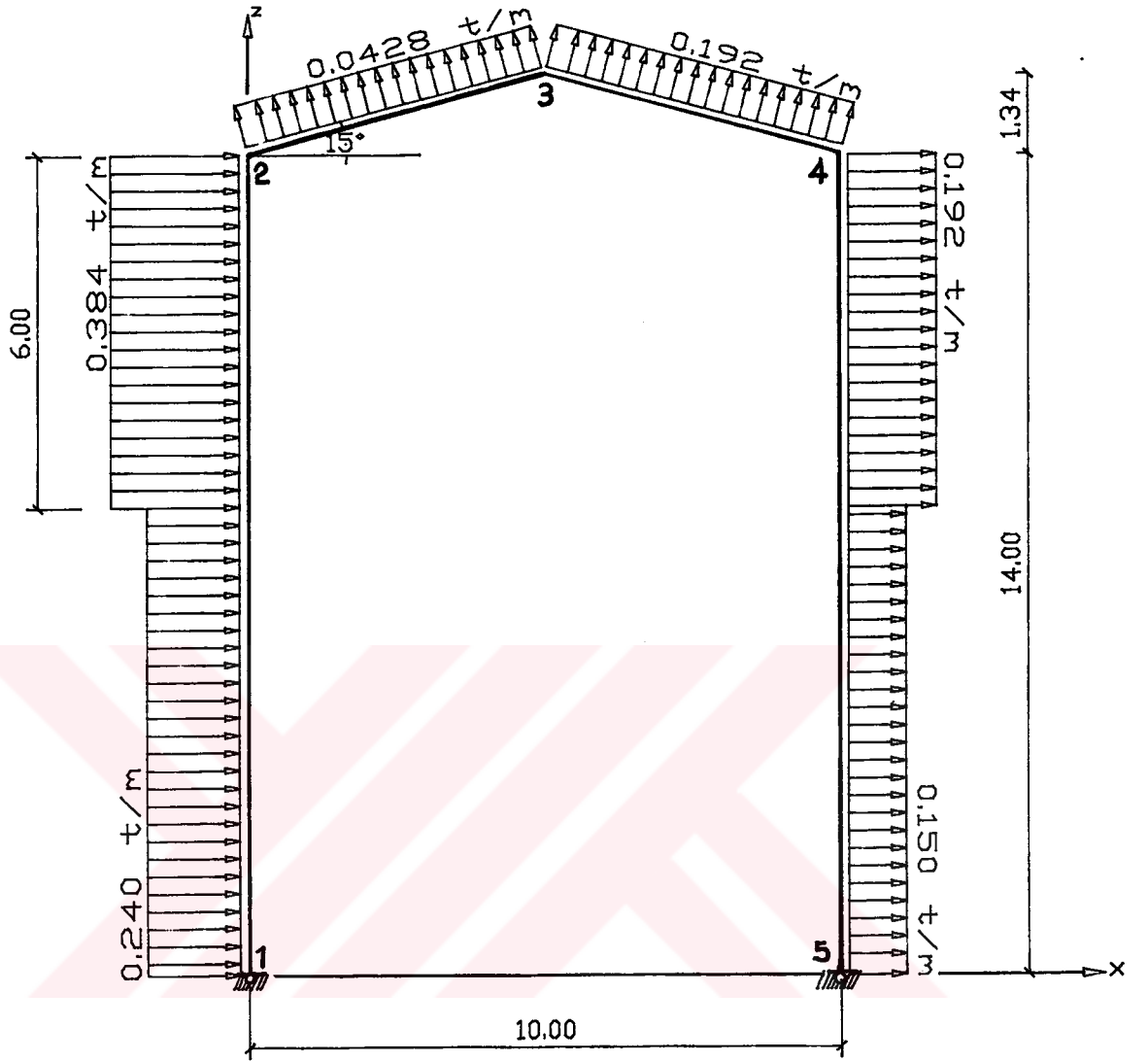
$$I_{yB} = 972.25 \text{ cm}^4 \quad i_{yB} = 4.373 \text{ cm} \quad S/i_{yB} = 118.910 \quad \sigma_B = 1.1867 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.373179 < 1$
 $1.015791 \approx 1$

2. Kontrol.

$$\lambda_x = 29.38 \rightarrow 30 \text{ için } \omega_x = 1.09 \quad \sigma = 1.09 \times \frac{2.56}{147} + 0.9 \times \frac{2430}{2040} \quad \sigma = 1.0910 \text{ t/cm}^2 < \sigma_{em}$$

1.9.ÇÖZÜM A9



Sekil 1.28

Tablo 1.17

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	14.00
3	5.00	15.34
4	10.00	14.00
5	10.00	0.00

1.9.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler, rüzgar yükü hariç ÇÖZÜM A7’de hesaplananlar ile tamamen aynıdır.

1.9.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-9

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=14

3 X=5 Y=0 Z=15.34

4 X=10 Y=0 Z=14

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI
 2 WG=0,0,-0.48 :KAR
 3 WG=0.384,0,0 :RUZGAR SOLDAN
 4 WL=0,0.04288,0 :RUZGAR SOLDAN
 5 WL=0,0.192,0 :RUZGAR SOLDAN
 6 WG=0.192,0,0 :RUZGAR SOLDAN
 7 WG=-0.384,0,0 :RUZGAR SAGDAN
 8 WL=0,0.04288,0 :RUZGAR SAGDAN
 9 WL=0,0.192,0 :RUZGAR SAGDAN
 10 WG=-0.192,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0
 :

1.9.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-9

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----
 1 -3.96
 .0 .25 .00
 14.0 .25 3.50
 2 -2.40

		.0	.15	.00
		14.0	.15	2.12
3	4.95			
		.0	-4.51	.00
		11.7	.00	-26.48
		14.0	.87	-25.50
4	-6.13			
		.0	3.35	.00
		14.0	.67	28.15
5	-1.80			
		.0	.08	.00
		14.0	.08	1.06
2				
1	-.75			
		.0	-3.76	3.50
		5.2	.06	-6.07
2	-.46			
		.0	-2.28	2.12
		5.2	.04	-3.68
3	.44			
		.0	5.01	-25.50
		5.2	5.23	.98
4	-2.23			
		.0	-5.74	28.15
		5.2	-4.75	.98
5	-.23			
		.0	-1.72	1.06
		3.8	.00	-2.24
		5.2	.60	-1.84

3 -----

1 -.75
 .0 -.06 -6.07
 5.2 3.76 3.50

2 -.46
 .0 -.04 -3.68
 5.2 2.28 2.12

3 -2.23
 .0 4.75 .98
 5.2 5.74 28.15

4 .44
 .0 -5.23 .98
 5.2 -5.01 -25.50

5 -.23
 .0 .56 -1.84
 5.2 .56 1.06

4 -----

1 -3.96
 .0 -.25 3.50
 14.0 -.25 .00

2 -2.40
 .0 -.15 2.12
 14.0 -.15 .00

3 -6.13
 .0 -.67 28.15
 14.0 -3.35 .00

4 4.95
 .0 -.87 -25.50
 2.3 .00 -26.48

	14.0	4.51	.00
5	-.60		
	.0	-.08	1.06
	14.0	-.08	.00

Tablo 1.18

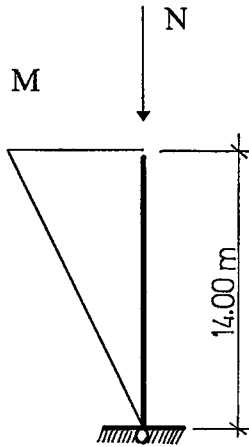
NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	4.95	0.00	6.13	0.00	10.09	0.00	12.49
2	3.50	3.96	1.06	1.80	2.12	2.40	26.4 M=25.50	4.95	28.15	6.13	22.0 M=31.65	10.09	20.9 M=33.77	12.49
3	3.50	0.75	1.06	0.23	2.12	0.46	25.50	0.44	28.15	2.23	22.0 M=31.65	2.98	20.9 M=33.77	3.44
4	6.07	0.75	2.24 M=1.84	0.23	3.68	0.46	0.98	0.44	0.98	2.23	9.75	2.98	8.77	3.44
5	6.07	0.75	1.84	0.23	3.68	0.46	0.98	2.23	0.98	0.44	9.75	2.98	8.77	3.44
6	3.50	0.75	1.06	0.23	2.12	0.46	28.15	2.33	25.50	0.44	31.65 M=22.0	2.98	20.9 M=33.7	3.44
7	3.50	3.96	1.06	0.60	2.12	2.40	28.15	6.13	25.50	4.95	31.65 M=22.0	10.09	20.9 M=33.77	12.49
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	6.13	26.4 M=0.00	4.95	26.48 M=0.00	10.09	26.4 M=0.00	12.49

M Açıklıkta maximum moment

1.9.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.9.4.1 1 Nolu Eleman

$$\ell_{kx} = 2800 \text{ cm} \quad \ell_{ky} = 466 \text{ cm}$$



M= 3165 tm N= 10.09 t Seçilen HE-A 650

$$A = 242 \text{ cm}^2 \quad W_x = 5470 \text{ cm}^3 \quad i_x = 26.9 \text{ cm} \quad i_y = 6.97 \text{ cm}$$

$$S_x = 64 - 2 \times 2.6 = 58.8 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.35 \text{ cm} \quad t = 2.6 \text{ cm}$$

$$\lambda_x = 104.08 \quad \lambda_y = 66.857 \quad \sigma_{bem} = 0.6933 \text{ t/cm}^2$$

$$\sigma_{eb} = 4.1694214 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 0.76514 \text{ t/cm}^2$$

$$\sigma_b = 0.57861 \text{ t/cm}^2 \quad H' = 9.8 \text{ cm} \quad F_B = 91.23 \text{ cm}^2$$

$$I_{yB} = 5852 \text{ cm}^4 \quad i_{yB} = 8.00 \text{ cm} \quad S/i_{yB} = 174.8 \quad \sigma_B = 0.57272 \text{ t/cm}^2$$

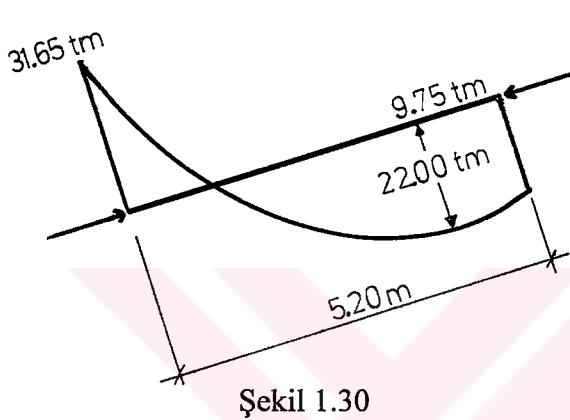
Şekil 1.29

Gerilme Kontrolleri $1.96835 < 1$
 $0.03922 \approx 1$

2. Kontrol

$$\lambda_x = 104.08 \rightarrow 105 \text{ için } \omega_x = 1.08 \quad \sigma = 1.08 \times \frac{10.09}{242} + 0.9 \times \frac{3165}{5470} \quad \sigma = 0.6074 \text{ t/cm}^2 < \sigma_{em}$$

1.9.4.2 2 Nolu Eleman .



$$C_b = 2.101 \quad \ell_{kx} = 520 \text{ cm} \quad \ell_{ky} = 520 \text{ cm}$$

$$N = 2.98 \text{ t} \quad \text{Seçilen I500} \quad A = 179 \text{ cm}^2$$

$$W_x = 2750 \text{ cm}^3 \quad i_x = 19.6 \text{ cm} \quad i_y = 3.72 \text{ cm}$$

$$S_x = 50 - 2 \times 2.7 \quad S_x = 44.6 \text{ cm}$$

$$b = 18.5 \text{ cm} \quad d = 1.8 \text{ cm} \quad t = 2.7 \text{ cm}$$

$$\lambda_x = 26.53 \quad \lambda_y = 139.78 \quad \sigma_{bem} = 0.423 \text{ t/cm}^2$$

$$\sigma_{eb} = 1.6648044 \times 10^2 \text{ t/cm}^2 \quad \sigma_{e'} = 11.77768 \text{ t/cm}^2$$

$$\sigma_b = 1.150909 \text{ t/cm}^2 \quad H' = 7.433 \text{ cm}$$

$$F_B = 63.33 \text{ cm}^2 \quad I_{yB} = 1428.22 \text{ cm}^4$$

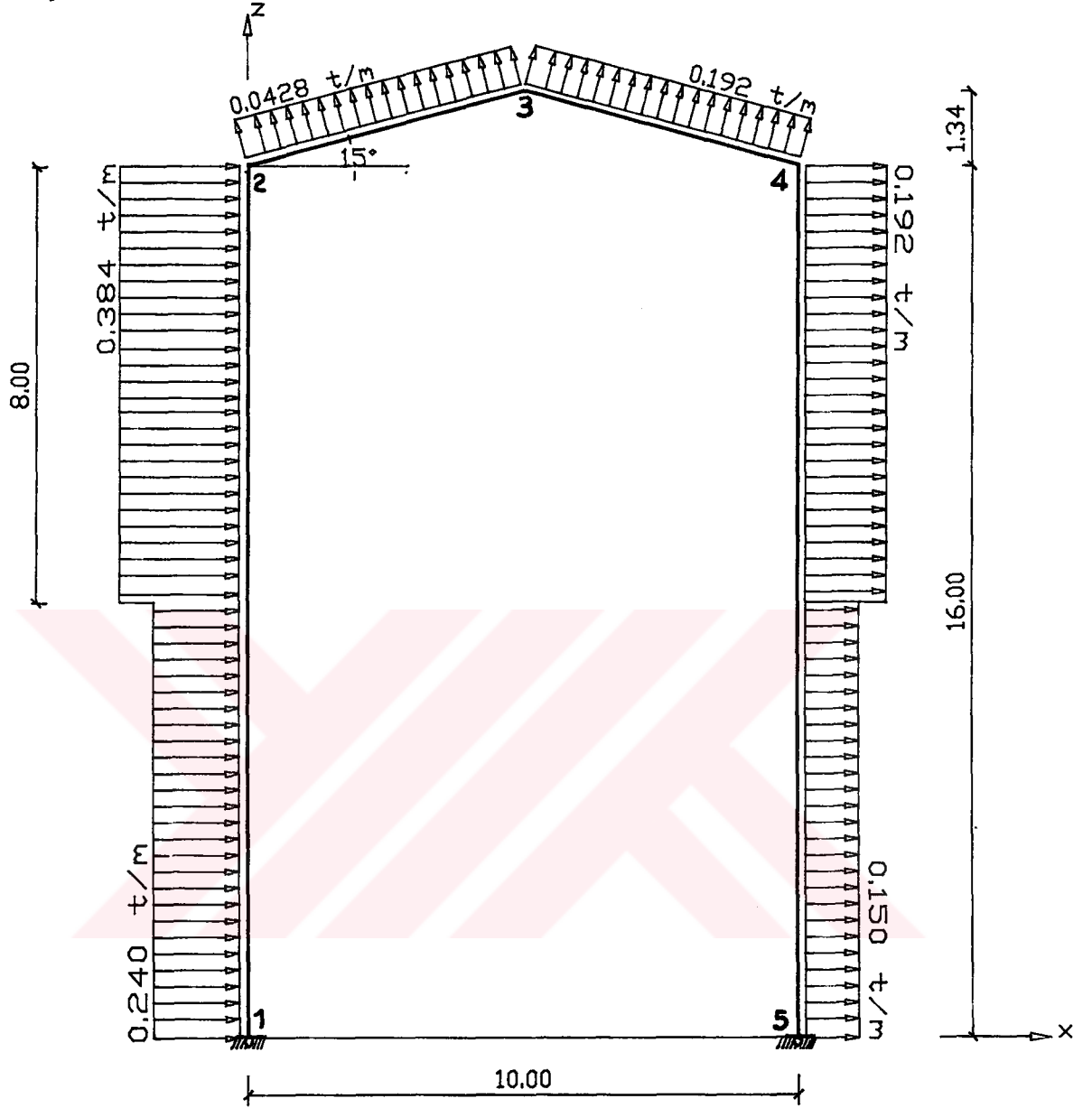
$$i_{yB} = 4.748 \text{ cm} \quad S/i_{yB} = 109.498 \quad \sigma_B = 1.23476 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.832753 < 1$
 $0.943648 \approx 1$

2. Kontrol.

$$\lambda_x = 26.53 \rightarrow 27 \text{ için } \omega_x = 1.07 \quad \sigma = 1.07 \times \frac{2.93}{179} + 0.9 \times \frac{3165}{2750} \quad \sigma = 1.0536 \text{ t/cm}^2 < \sigma_{em}$$

1.10.ÇÖZÜM A10



Şekil 1.31

Tablo 1.19

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	16.00
3	5.00	17.34
4	10.00	16.00
5	10.00	0.00

1.10.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler, rüzgar yükü hariç ÇÖZÜM A7'de hesaplananlar ile tamamen aynıdır.

1.10.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-10

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=16

3 X=5 Y=0 Z=17.34

4 X=10 Y=0 Z=16

5 X=10 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3 E=2700000

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN
 5 WL=0,0.192,0 :RUZGAR SOLDAN
 6 WG=0.192,0,0 :RUZGAR SOLDAN
 7 WG=-0.384,0,0 :RUZGAR SAGDAN
 8 WL=0,0.04288,0 :RUZGAR SAGDAN
 9 WL=0,0.192,0 :RUZGAR SAGDAN
 10 WG=-0.192,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.10.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-10

FRAME ELEMENT FORCES

ELT	LOAD	AXIAL	DIST	1-2 PLANE
ID	COND	FORCE	ENDI	SHEAR
				MOMENT
1	-----			
1		-3.96		
	.0	.21	.00	
	16.0	.21	3.28	
2		-2.40		
	.0	.12	.00	
	16.0	.12	1.99	
3		6.64		
	.0	-5.17	.00	
	13.5	.00	-34.79	
	16.0	.97	-33.56	

4	-7.81		
	.0	3.85	.00
	16.0	.77	36.97

5	-1.80		
	.0	.06	.00
	16.0	.06	.99

2 -----

1	-.71		
	.0	-3.77	3.28
	5.2	.05	-6.35

2	-.43		
	.0	-2.29	1.99
	5.2	.03	-3.84

3	.78		
	.0	6.66	-33.56
	5.2	6.89	1.52

4	-2.77		
	.0	-7.35	36.97
	5.2	-6.35	1.52

5	-.22		
	.0	-1.72	.99
	3.8	.00	-2.32
	5.2	.60	-1.92

3 -----

1	-.71		
	.0	-.05	-6.35
	5.2	3.77	3.28

2	-.43		
	.0	-.03	-3.84

		5.2	2.29	1.99
3	-2.77			
		.0	6.35	1.52
		5.2	7.35	36.97
4	.78			
		.0	-6.89	1.52
		5.2	-6.66	-33.56
5	-.22			
		.0	.56	-1.92
		5.2	.56	.99
4	-----			
1	-3.96			
		.0	-.21	3.28
		16.0	-.21	.00
2	-2.40			
		.0	-.12	1.99
		16.0	-.12	.00
3	-7.81			
		.0	-.77	36.97
		16.0	-3.85	.00
4	6.64			
		.0	-.97	-33.56
		2.5	.00	-34.79
		16.0	5.17	.00
5	-.60			
		.0	-.06	.99
		16.0	-.06	.00

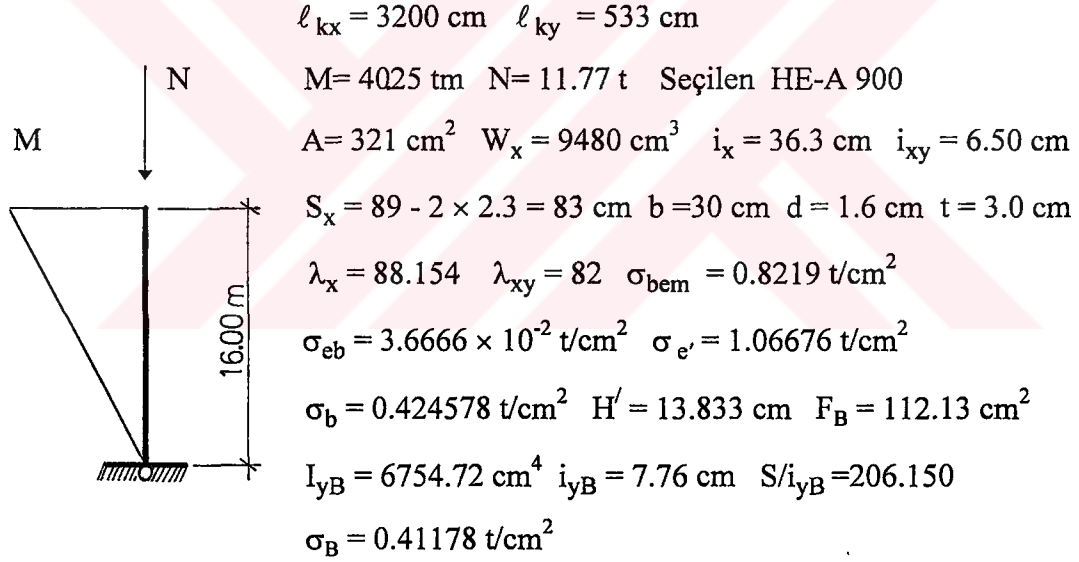
Tablo 1.20

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	3.96	0.00	1.80	0.00	2.40	0.00	6.64	0.00	7.81	0.00	11.77	0.00	14.17
2	3.28	3.96	0.99	1.80	1.99	2.40	34.7 M=33.56	6.64	36.97	7.81	30.28 M=40.25	11.77	29.2 M=42.5	14.17
3	3.28	0.71	0.99	0.22	1.99	0.43	33.56	0.78	36.97	2.77	30.28 M=40.15	3.48	29.2 M=42.5	3.91
4	6.35	0.71	2.32 M=1.92	0.22	3.84	0.43	1.52	0.78	1.52	2.77	10.19	3.48	8.67	3.91
5	6.35	0.71	4.92	0.22	3.84	0.43	1.52	2.77	1.52	0.78	10.19	3.48	8.67	3.91
6	3.28	0.71	0.99	0.22	1.99	0.43	36.97	2.77	33.56	0.78	40.25 M=30.28	3.48	29.2 M=42.2	3.91
7	3.28	3.96	0.99	0.60	1.99	2.40	36.97	7.81	33.56	6.64	40.25 M=30.28	11.77	29.2 M=42.5	14.17
8	0.00	3.96	0.00	0.60	0.00	2.40	0.00	7.81	34.7 M=0.00	6.64	0.00	11.77	34.7 M=0.00	14.17

M Açıklıkta maximum moment

1.10.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.10.4.1 1 Nolu Eleman



Şekil 1.32

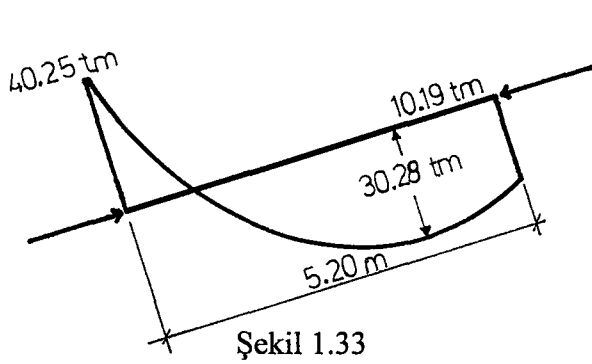
Gerilme Kontrolleri 0.952214 < 1

1.056529 ≈ 1

2. Kontrol

$$\lambda_x = 88.154 \rightarrow 89 \text{ için } \omega = 1.75 \quad \sigma = 1.75 \times \frac{11.77}{321} + 0.9 \times \frac{4025}{9480} \quad \sigma = 0.4462 \text{ t/cm}^2 < \sigma_{em}$$

1.10.4.2 2 Nolu Eleman .



Şekil 1.33

$$C_b = 2.035 \quad \ell_{kx} = 520 \text{ cm} \quad \ell_{ky} = 520 \text{ cm}$$

$$N = 3.48 \text{ t} \text{ Seçilen I550 } A = 212 \text{ cm}^2$$

$$W_x = 3610 \text{ cm}^3 \quad i_x = 21.6 \text{ cm} \quad i_y = 4.02 \text{ cm}$$

$$S_x = 49 \text{ cm} \quad b = 20 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.0 \text{ cm}$$

$$\lambda_x = 24.074 \quad \lambda_y = 129.353 \quad \sigma_{bem} = 0.4916 \text{ t/cm}^2$$

$$\sigma_{eb} = 1.641509 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 14.303 \text{ t/cm}^2$$

$$\sigma_b = 1.11495 \text{ t/cm}^2 \quad H' = 8.166 \text{ cm} \quad F_B = 75.516 \text{ cm}^2 \quad I_{yB} = 2004.66 \text{ cm}^4 \quad i_{yB} = 5.152 \text{ cm}$$

$$S/i_{yB} = 100.926 \quad \sigma_B = 1.27965 \text{ t/cm}^2$$

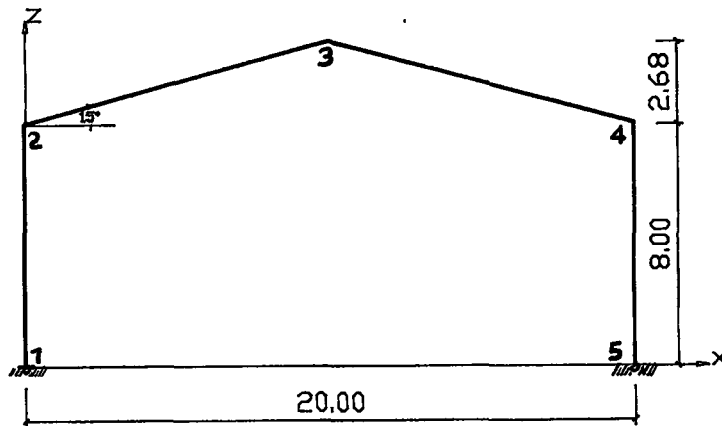
$$\text{Gerilme Kontrolleri} \quad 0.774845 < 1$$

$$0.882697 < 1$$

2. Kontrol.

$$\lambda_x = 24.074 \rightarrow 25 \text{ için } \omega_x = 1.06 \quad \sigma = 1.06 \times \frac{3.48}{212} + 0.9 \times \frac{4025}{3610} \quad \sigma = 1.0208 \text{ t/cm}^2 < \sigma_{em}$$

1.11.ÇÖZÜM A11



Şekil 1.34

Tablo 1.21

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	16.00
3	5.00	17.34
4	10.00	16.00
5	10.00	0.00

1.11.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A6'da hesaplananlar ile tamamen aynıdır.

1.11.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**COZUM A-11**

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=8

3 X=10 Y=0 Z=10.68

4 X=20 Y=0 Z=8

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.24,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.12,0,0 :RUZGAR SOLDAN

7 WG=-0.24,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.12,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.11.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-11

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -7.92
 .0 2.45 .00
 8.0 2.45 19.60

2 -4.80
 .0 1.48 .00
 8.0 1.48 11.87

3 -.41
 .0 -1.15 .00
 4.8 .00 -2.76
 8.0 .77 -1.53

4 -1.94
 .0 1.33 .00
 8.0 .37 6.79

5 -3.60
 .0 .74 .00
 8.0 .74 5.94

2 -----

1 -3.39
 .0 -7.02 19.60
 9.5 .00 -13.73
 10.4 .63 -13.46

2 -2.05
 .0 -4.25 11.87
 9.5 .00 -8.32
 10.4 .38 -8.15

3 -.85
 .0 -.20 -1.53
 4.6 .00 -1.99
 10.4 .24 -1.29

4	-1.86		
	.0	-1.78	6.79
	9.2	.00	-1.41
	10.4	.21	-1.29
5	-1.03		
	.0	-3.29	5.94
	7.3	.00	-6.11
	10.4	1.35	-4.08
3	-----		
1	-3.39		
	.0	-.63	-13.46
	.9	.00	-13.73
	10.4	7.02	19.60
2	-2.05		
	.0	-.38	-8.15
	.9	.00	-8.32
	10.4	4.25	11.87
3	-1.86		
	.0	-.21	-1.29
	1.1	.00	-1.41
	10.4	1.78	6.79
4	-1.85		
	.0	-.24	-1.29
	5.7	.00	-1.99
	10.4	.20	-1.53
5	-1.03		
	.0	.97	-4.08
	10.4	.97	5.94
4	-----		

1	-7.92			
	.0	-2.45	19.60	
	8.0	-2.45	.00	
2	-4.80			
	.0	-1.48	11.87	
	8.0	-1.48	.00	
3	-1.94			
	.0	-.37	6.79	
	8.0	-1.33	.00	
4	-.41			
	.0	-.77	-1.53	
	3.2	.00	-2.76	
	8.0	1.15	.00	
5	-1.20			
	.0	-.74	5.94	
	8.0	-.74		

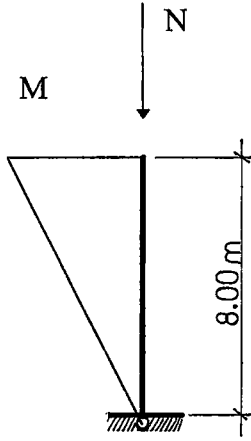
Tablo 1.22

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	0.41	0.00	1.94	0.00	12.72	0.00	14.66
2	19.60	7.92	5.94	3.60	11.87	4.80	2.76 M=1.53	0.41	6.79	1.94	31.47	12.72	38.26	14.66
3	19.60	3.39	5.94	1.03	11.87	2.05	1.53	0.85	6.79	0.86	31.47	5.44	38.26	6.30
4	13.7 M=13.4	3.39	6.11 M=4.08	1.03	8.32 M=8.15	2.05	1.9 M=1.29	0.85	1.4 M=1.2	0.86	22.05 M=21.61	5.44	24.0 M=22.9	6.30
5	13.46	3.39	4.08	1.03	8.15	2.05	1.29	0.86	1.29	0.85	21.61	5.44	22.90	6.30
6	13.7 M=19.6	3.39	5.94	1.03	8.32 M=11.87	2.05	1.4 M=6.79	0.86	1.9 M=1.5	0.85	22.05 M=31.47	5.44	23.4 M=38.2	6.30
7	19.60	7.92	5.94	1.20	11.87	4.80	6.79	1.94	1.53	0.41	31.47	12.72	38.26	14.66
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	1.94	2.76 M=0.00	0.41	0.00	12.72	0.00	14.66

M Açıklıkta maximum moment

1.11.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.11.4.1 1 Nolu Eleman



Şekil 1.35

$$\ell_{kx} = 1600 \text{ cm} \quad \ell_{ky} = 400 \text{ cm} \quad M = 31.47 \text{ tm} \quad N = 12.72 \text{ t}$$

$$\text{Seçilen I600} \quad A = 254 \text{ cm}^2 \quad W_x = 4630 \text{ cm}^3 \quad i_x = 23.4 \text{ cm}$$

$$i_y = 4.30 \text{ cm} \quad S_x = 60 - 2 \times 3.24 = 53.52 \text{ cm} \quad b = 21.5 \text{ cm}$$

$$d = 2.16 \text{ cm} \quad t = 3.24 \text{ cm} \quad \lambda_x = 68.37 \quad \lambda_y = 93.02$$

$$\sigma_{bem} = 0.7816 \text{ t/cm}^2 \quad \sigma_{eb} = 5.007 \times 10^{-2} \text{ t/cm}^2$$

$$\sigma_{e'} = 1.773 \text{ t/cm}^2 \quad \sigma_b = 0.67969 \text{ t/cm}^2 \quad H' = 8.92 \text{ cm}$$

$$F_B = 88.927 \text{ cm}^2 \quad I_{yB} = 2690.85 \text{ cm}^4 \quad i_{yB} = 5.5 \text{ cm}$$

$$S/i_{yB} = 145.432 \quad \sigma_B = 0.82648 \text{ t/cm}^2$$

$$\text{Gerilme Kontrolleri} \quad 0.783421 < 1$$

$$0.857168 < 1$$

2.Kontrol.

$$\lambda_x = 68.37 \rightarrow 69 \text{ için } \omega_x = 1.46 \quad \sigma = 1.46 \times \frac{12.72}{254} + 0.9 \times \frac{31.47}{4630} \quad \sigma = 0.6848 \text{ t/cm}^2 < \sigma_{em}$$

1.11.4.2 2 Nolu Eleman .

$$C_b = 2.612 > 2.3 \quad C_b = 2.3$$

$$\ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$N = 5.44 \text{ t} \quad \text{Seçilen I600} \quad A = 47 \text{ cm}^2$$

$$S_x = 45 - 2 \times 2.43 \quad S_x = 40.14 \text{ cm}$$

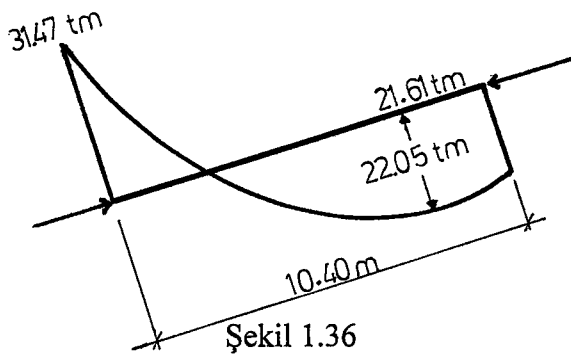
$$\lambda_x = 44.44 \quad \lambda_y = 241.860 \quad \sigma_{bem} = 0.1416 \text{ t/cm}^2$$

$$\sigma_{eb} = 2.1417 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 4.196 \text{ t/cm}^2$$

$$\sigma_b = 0.6796 \text{ t/cm}^2 \quad H' = 8.92 \text{ cm}$$

$$F_B = 88.9272 \text{ cm}^2 \quad I_{yB} = 2690.85 \text{ cm}^4$$

$$i_{yB} = 5.5 \text{ cm} \quad S/i_{yB} = 189.06 \quad \sigma_B = 0.643452 \text{ t/cm}^2$$



Şekil 1.36

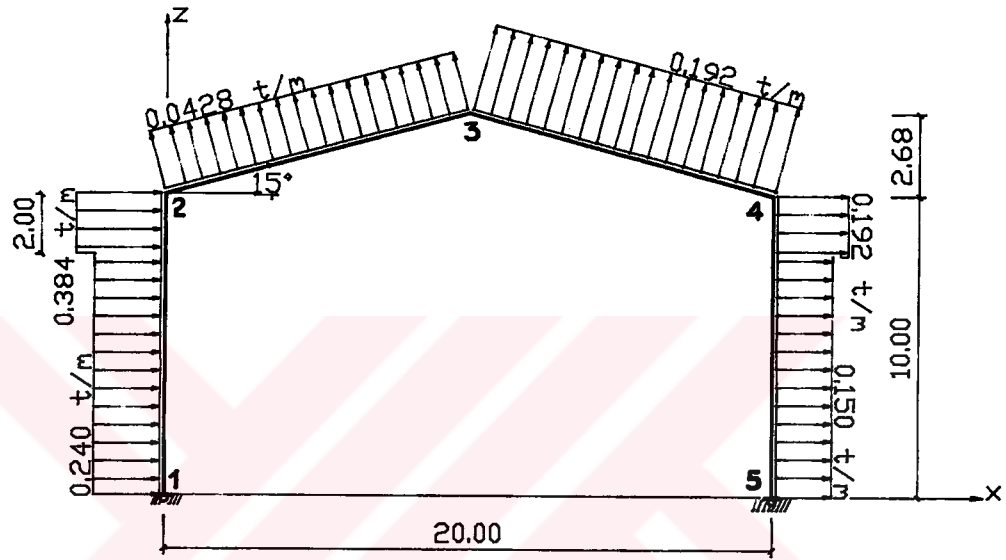
Gerilme Kontrolleri 1.0537 $\approx$ 1

1.0712 $\approx$ 1

2. Kontrol.

$$\lambda_x = 44.44 \rightarrow 45 \text{ için } \omega_x = 1.21 \quad \sigma = 1.21 \times \frac{5.44}{254} + 0.9 \times \frac{3147}{4630} \quad \sigma = 0.6376 \text{ t/cm}^2 < \sigma_{em}$$

1.12.ÇÖZÜM A12



Sekil 1.37

Tablo 1.23

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	10.00
3	10.00	12.68
4	20.00	10.00
5	20.00	0.00

1.12.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A7’de hesaplananlar ile tamamen aynıdır.

1.12.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-12

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=10

3 X=10 Y=0 Z=12.68

4 X=20 Y=0 Z=10

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.192,0,0 :RUZGAR SOLDAN

7 WG=-0.384,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.192,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.12.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-12

FRAME ELEMENT FORCES

ELT LOAD	AXIAL	DIST	1-2 PLANE	
ID COND	FORCE	ENDI	SHEAR	MOMENT
1	-----			
1	-7.92			
	.0	1.91	.00	
	10.0	1.91	19.11	
2	-4.80			
	.0	1.16	.00	
	10.0	1.16	11.57	
3	.41			
	.0	-2.91	.00	
	7.6	.00	-11.03	
	10.0	.93	-9.90	
4	-2.76			
	.0	2.45	.00	
	10.0	.53	14.90	
5	-3.60			

		.0	.58	.00
		10.0	.58	5.79
2	-----			
1	-2.87			
		.0	-7.16	19.11
		9.7	.00	-15.56
		10.4	.49	-15.39
2	-1.74			
		.0	-4.34	11.57
		9.7	.00	-9.42
		10.4	.30	-9.32
3	-.79			
		.0	.64	-9.90
		10.4	1.08	-1.00
4	-1.23			
		.0	-2.53	14.90
		10.4	-.54	-1.00
5	-.87			
		.0	-3.33	5.79
		7.4	.00	-6.57
		10.4	1.31	-4.66

3	-----			
1	-2.87			
		.0	-.49	-15.39
		.7	.00	-15.56
		10.4	7.16	19.11
2	-1.74			
		.0	-.30	-9.32
		.7	.00	-9.42

		10.4	4.34	11.57
3	-1.23			
		.0	.54	-1.00
		10.4	2.53	14.90
4	-.79			
		.0	-1.08	-1.00
		10.4	-.64	-9.90
5	-.87			
		.0	1.01	-4.66
		10.4	1.01	5.79
4	-----			
1	-7.92			
		.0	-1.91	19.11
		10.0	-1.91	
2	-4.80			
		.0	-1.16	11.57
		10.0	-1.16	.00
3	-2.76			
		.0	-.53	14.90
		10.0	-2.45	.00
4	.41			
		.0	-.93	-9.90
		2.4	.00	-11.03
		10.0	2.91	.00
5	-1.20			
		.0	-.58	5.79
		10.0	-.58	.00

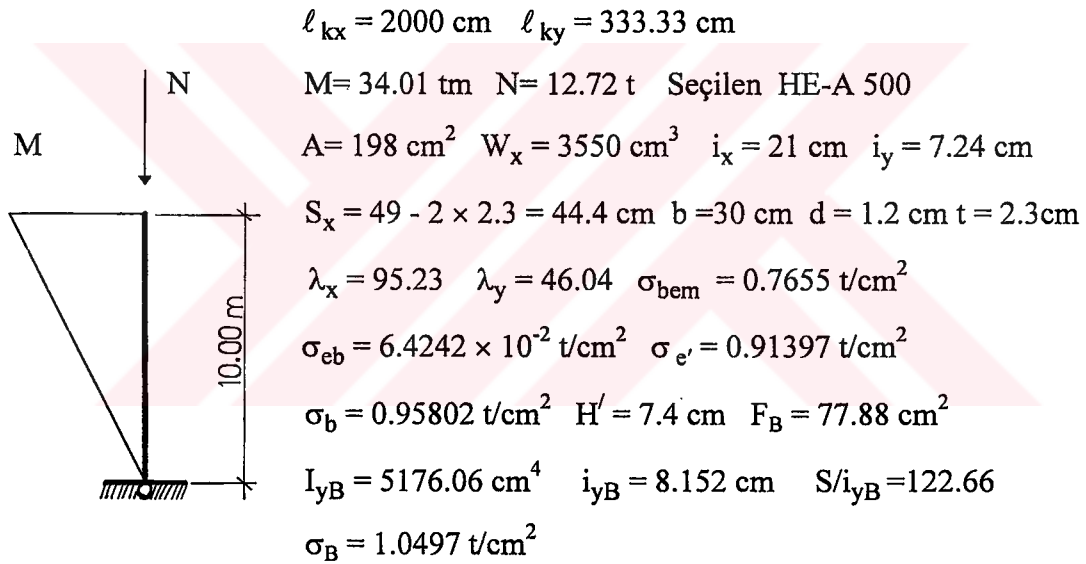
Tablo 1.24

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	0.41	0.00	2.76	0.00	12.72	0.00	15.48
2	19.11	7.92	5.79	3.60	11.57	4.80	41.0 M=9.90	0.41	14.90	2.76	34.01	12.72	45.58	15.48
3	19.11	2.87	5.79	0.87	11.57	1.74	9.90	1.23	14.90	1.23	34.01	4.61	15.55	5.84
4	15.5 M=15.3	2.87	6.57 M=4.66	0.87	9.42 M=9.32	1.74	1.00	1.23	1.00	1.23	24.9 M=24.7	4.61	24.9 M=25.7	5.84
5	15.39	2.87	4.66	0.87	9.32	1.74	1.00	1.23	1.00	0.79	24.71	4.61	25.71	5.84
6	15.5 M=19.1	2.87	5.79	0.87	9.42 M=11.57	1.74	14.90	1.23	9.90	0.79	34.01	4.61	24.9 M=45.5	5.84
7	19.11	7.92	5.79	1.20	11.57	4.80	14.90	2.76	9.90	0.41	34.01	12.72	45.08	15.48
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	2.76	11.0 M=0.00	0.41	0.00	12.72	0.00	15.48

M Açıklıkta maximum moment

1.12.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.12.4.1 1 Nolu Eleman



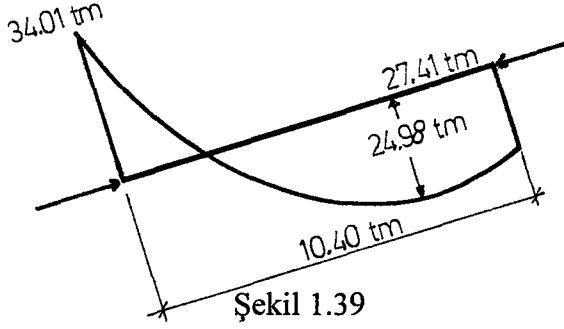
Şekil 1.38

Gerilme Kontrolleri $0.918309 < 1$ $0.957246 < 1$

2. Kontrol.

$$\lambda_x = 95.23 \rightarrow 96 \text{ için } \omega_x = 1.88 \quad \sigma = 1.88 \times \frac{12.72}{198} + 0.9 \times \frac{3401}{3550} \quad \sigma = 0.9830 \text{ t/cm}^2 < \sigma_{em}$$

1.12.4.2 2 Nolu Eleman



$$C_b = 2.79 > 2.3 \quad C_b = 2.3$$

$$\ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$N = 4.61 \text{ t} \text{ Seçilen HE-A 450 } A = 178 \text{ cm}^2$$

$$W_x = 2900 \text{ cm}^3 \quad i_x = 18.9 \text{ cm} \quad i_y = 7.29 \text{ cm}$$

$$S_x = 44 - 2 \times 2.1 = 39.8 \quad b = 30 \text{ cm} \quad d = 1.15 \text{ cm}$$

$$t = 21.1 \text{ cm} \quad \lambda_x = 55.02 \quad \lambda_y = 142.66$$

$$\sigma_{bem} = 0.4054 \text{ t/cm}^2 \quad \sigma_{eb} = 0.02589 \text{ t/cm}^2$$

$$\sigma_e' = 2.737861 \text{ t/cm}^2 \quad \sigma_b = 1.17275 \text{ t/cm}^2 \quad H' = 6.63 \text{ cm} \quad F_B = 70.628 \text{ cm}^2 \quad I_{yB} = 4725.84 \text{ cm}^4$$

$$i_{yB} = 8.18 \text{ cm} \quad S/i_{yB} = 127.14 \quad \sigma_B = 1.150 \text{ t/cm}^2$$

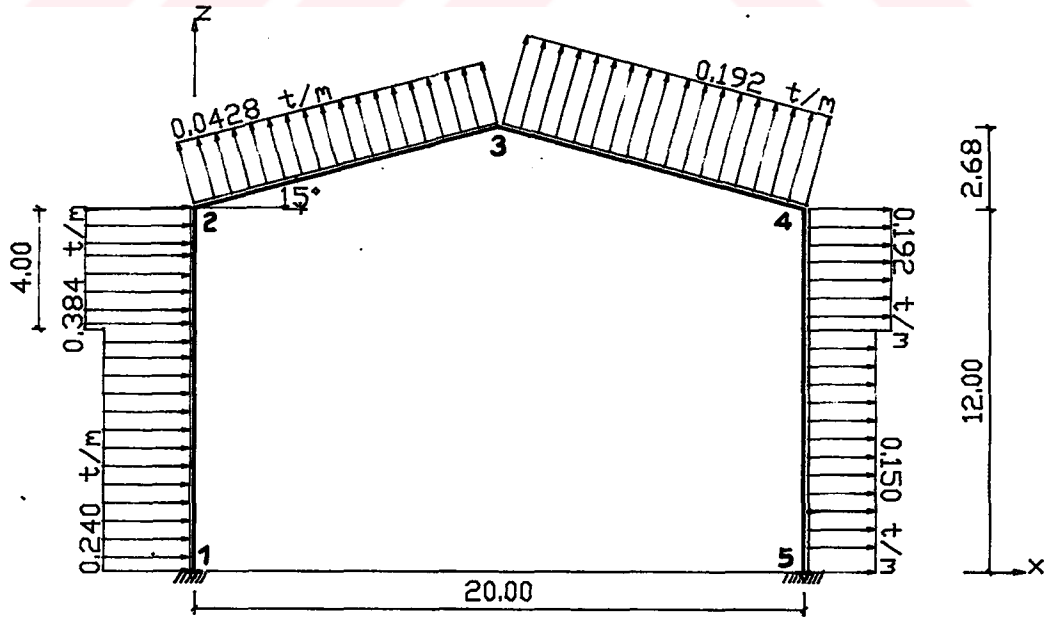
$$\text{Gerilme Kontrolleri} \quad 0.938831 < 1$$

$$1.037597 \approx 1$$

2. Kontrol.

$$\lambda_x = 55.02 \rightarrow 56 \text{ için } \omega_x = 1.32 \quad \sigma = 1.32 \times \frac{4.61}{178} + 0.9 \times \frac{3401}{2900} \quad \sigma = 1.0896 \text{ t/cm}^2 < \sigma_{em}$$

1.13 ÇÖZÜM A13



Şekil 1.40

Tablo 1.25

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	12.00
3	10.00	14.68
4	20.00	12.00
5	20.00	0.00

1.13.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A8’de hesaplananlar ile tamamen aynıdır.

1.13.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**COZUM A-13**

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=12

3 X=10 Y=0 Z=14.68

4 X=20 Y=0 Z=12

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.192,0,0 :RUZGAR SOLDAN

7 WG=-0.384,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.192,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.13.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-13

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -7.92

.0 1.54 .00

12.0 1.54 18.51

2 -4.80

		.0	.93	.00
		12.0	.93	11.21
3	1.01			
		.0	-3.62	.00
		9.4	.00	-17.09
		12.0	.98	-15.83
4	-3.35			
		.0	2.89	.00
		12.0	.59	20.85
5	-3.60			
		.0	.47	.00
		12.0	.47	5.61
2				
1	-2.52			
		.0	-7.25	18.51
		9.8	.00	-17.09
		10.4	.40	-16.98
2	-1.52			
		.0	-4.39	11.21
		9.8	.00	-10.35
		10.4	.24	-10.28
3	-.69			
		.0	1.23	-15.83
		10.4	1.67	-.84
4	-1.43			
		.0	-3.09	20.85
		10.4	-1.10	-.84
5	-.76			
		.0	-3.36	5.61

		7.5	.00	-6.97
		10.4	1.28	-5.14
3		-----		
1	-2.52			
		.0	-.40	-16.98
		.5	.00	-17.09
		10.4	7.25	18.51
2	-1.52			
		.0	-.24	-10.28
		.5	.00	-10.35
		10.4	4.39	11.21
3	-1.43			
		.0	1.10	-.84
		10.4	3.09	20.85
4	-.69			
		.0	-1.67	-.84
		10.4	-1.23	-15.83
5	-.76			
		.0	1.04	-5.14
		10.4	1.04	5.61
4		-----		
1	-7.92			
		.0	-1.54	18.51
		12.0	-1.54	.00
2	-4.80			
		.0	-.93	11.21
		12.0	-.93	.00
3	-3.35			
		.0	-.59	20.85

	12.0	-2.89	.00
4	1.01		
	.0	-.98	-15.83
	2.6	.00	-17.09
	12.0	3.62	.00
5	-1.20		
	.0	-.47	5.61
	12.0	-.47	.00

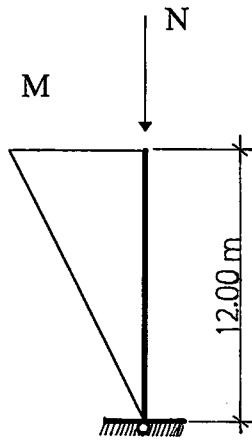
Tablo 1.26

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	1.01	0.00	3.35	0.00	12.72	0.00	16.07
2	18.51	7.92	5.61	3.60	11.21	4.80	17.0	1.01	20.85	3.35	39.36	12.72	50.57	16.07
3	18.51	2.52	5.61	0.76	11.21	1.52	15.83	0.69	20.85	1.43	39.36	4.04	50.57	5.47
4	17.0	2.52	6.97	0.76	10.3	1.52	0.84	0.69	0.84	1.43	27.4	4.04	27.4	5.47
	M=16.9		M=5.14		M=10.2						M=27.2		M=28.1	
5	16.98	2.52	5.14	0.76	10.28	1.52	0.84	1.43	0.84	0.69	27.26	4.04	28.10	5.47
6	17.0	2.52	5.61	0.76	10.3	1.52	20.85	1.43	15.83	0.96	17.09	4.04	50.57	5.47
	M=18.5				M=11.21						M=39.36			
7	18.51	7.92	5.61	1.20	11.21	4.80	20.85	3.35	15.83	1.01	39.36	12.72	50.75	16.07
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	3.35	17.0	1.01	0.00	12.72	0.00	16.07
									M=0.00					

M Açıklıkta maximum moment

1.13.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.13.4.1 1 Nolu Eleman



$$\ell_{kx} = 2400 \text{ cm} \quad \ell_{ky} = 400 \text{ cm} \quad M = 39.36 \text{ tm} \quad N = 12.72 \text{ t}$$

$$\text{Seçilen HE-A 600 } A = 226 \text{ cm}^2 \quad W_x = 4790 \text{ cm}^3 \quad i_x = 25 \text{ cm}$$

$$i_y = 7.05 \text{ cm} \quad S_x = 59 - 2 \times 2.5 = 54 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.3 \text{ cm}$$

$$t = 2.5 \text{ cm} \quad \lambda_x = 96 \quad \lambda_y = 56.737 \quad \sigma_{bem} = 0.7575 \text{ t/cm}^2$$

$$\sigma_{eb} = 5.628318 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 0.899522 \text{ t/cm}^2$$

$$\sigma_b = 0.821711 \text{ t/cm}^2 \quad H' = 9 \text{ cm} \quad F_B = 86.7 \text{ cm}^2$$

$$I_{yB} = 5626.64 \text{ cm}^4 \quad i_{yB} = 8.05 \text{ cm} \quad S/i_{yB} = 148.95 \quad \sigma_B = 0.788689 \text{ t/cm}^2$$

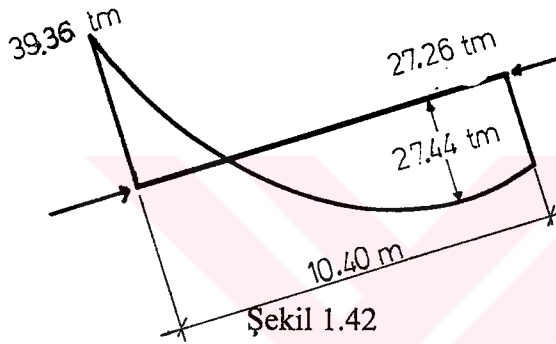
Şekil 1.41

Gerilme Kontrolleri $1.0190 \approx 1$
 $1.0809 \approx 1$

2. Kontrol.

$$\lambda_x = 96 \text{ için } \omega_x = 1.88 \quad \sigma = 1.88 \times \frac{12.72}{226} + 0.9 \times \frac{3936}{4790} \quad \sigma = 0.8453 \text{ t/cm}^2 < \sigma_{em}$$

1.13.4.2 2 Nolu Eleman .



$$C_b = 2.621 > 2.3 \quad C_b = 2.3$$

$$\ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$N = 4.04 \text{ t} \text{ Seçilen HE-A 500 } A = 198 \text{ cm}^2$$

$$W_x = 3550 \text{ cm}^3 \quad i_x = 21 \text{ cm} \quad i_y = 7.24 \text{ cm}$$

$$S_x = 49 - 2 \times 2.3 = 44.4 \quad b = 30 \text{ cm} \quad d = 1.2 \text{ cm}$$

$$t = 2.3 \text{ cm} \quad \lambda_x = 49.52 \quad \lambda_y = 143.646$$

$$\sigma_{bem} = 0.3998 \text{ t/cm}^2 \quad \sigma_{eb} = 0.020404 \times 10^2 \text{ t/cm}^2$$

$$\sigma_{e'} = 3.38 \text{ t/cm}^2 \quad \sigma_b = 1.108732 \text{ t/cm}^2$$

$$H' = 7.4 \text{ cm} \quad F_B = 77.88 \text{ cm}^2 \quad I_{yB} = 5176.06 \text{ cm}^4 \quad i_{yB} = 8.1524 \text{ cm} \quad S/i_{yB} = 127.569$$

$$\sigma_B = 1.147159 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.877550 < 1$
 $0.980671 < 1$

2. Kontrol.

$$\lambda_x = 49.52 \rightarrow 50 \text{ için } \omega_x = 1.26 \quad \sigma = 1.26 \times \frac{4.04}{198} + 0.9 \times \frac{3936}{3550} \quad \sigma = 1.0235 \text{ t/cm}^2 < \sigma_{em}$$

Tablo 1.27

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=14

3 X=10 Y=0 Z=16.68

4 X=20 Y=0 Z=14

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN

6 WG=0.192,0,0 :RUZGAR SOLDAN

7 WG=-0.384,0,0 :RUZGAR SAGDAN

8 WL=0,0.04288,0 :RUZGAR SAGDAN

9 WL=0,0.192,0 :RUZGAR SAGDAN

10 WG=-0.192,0,0 :RUZGAR SAGDAN

1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0

2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2

3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0

4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0

:

1.14.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-14

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -7.92
.0 1.28 .00

14.0 1.28 17.87

2 -4.80
.0 .77 .00
14.0 .77 10.83

3 1.71
.0 -4.32 .00
11.2 .00 -24.30
14.0 1.06 -22.85

4 -4.06
.0 3.34 .00
14.0 .66 28.01

5 -3.60
.0 .39 .00
14.0 .39 5.41

2 -----

1 -2.26
.0 -7.32 17.87
9.9 .00 -18.40

		10.4	.33	-18.32
2	-1.37			
		.0	-4.44	10.83
		9.9	.00	-11.14
		10.4	.20	-11.10
3	-.58			
		.0	1.93	-22.85
		10.4	2.37	-.58
4	-1.69			
		.0	-3.75	28.01
		10.4	-1.77	-.58
5	-.68			
		.0	-3.38	5.41
		7.5	.00	-7.32
		10.4	1.26	-5.55
3	-----			
1	-2.26			
		.0	-.33	-18.32
		.4	.00	-18.40
		10.4	7.32	17.87
2	-1.37			
		.0	-.20	-11.10
		.4	.00	-11.14
		10.4	4.44	10.83
3	-1.69			
		.0	1.77	-.58
		10.4	3.75	28.01
4	-.58			
		.0	-2.37	-.58

	10.4	-1.93	-22.85
5	-68		
	.0	1.06	-5.55
	10.4	1.06	5.41
4	-----		
1	-7.92		
	.0	-1.28	17.87
	14.0	-1.28	.00
2	-4.80		
	.0	-.77	10.83
	14.0	-.77	.00
3	-4.06		
	.0	-.66	28.01
	14.0	-3.34	.00
4	1.71		
	.0	-1.06	-22.85
	2.8	.00	-24.30
	14.0	4.32	.00
5	-1.20		
	.0	-.39	5.41
	14.0	-.39	.00

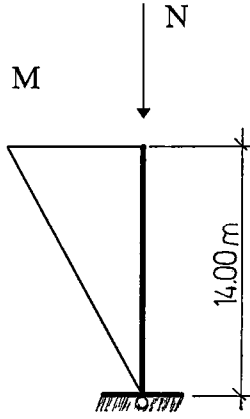
Tablo 1.28

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDAN		RÜZGAR SAĞDAN		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	1.71	0.00	4.06	0.00	12.72	0.00	16.78
2	17.87	7.92	5.41	3.60	10.83	4.80	24.3 M=22.8	1.71	28.01	4.06	45.88	12.72	56.71	16.78
3	17.87	2.26	5.41	0.68	10.83	1.37	22.85	0.58	28.01	1.69	45.88	3.96	56.71	5.32
4	18.4 N=18.3	2.26	7.32 M=5.55	0.68	11.14 M=11.10	1.37	0.58	0.58	0.58	1.69	29.5 M=29.4	3.95	29.5 M=30.0	5.32
5	18.32	2.26	5.55	0.68	11.10	1.37	0.58	1.69	0.58	0.58	29.42	3.95	30.00	5.32
6	18.4 M=17.8	2.26	5.41	0.68	11.14 M=10.83	1.327	28.01	1.69	22.85	0.58	45.88	3.95	29.5 M=56.7	5.32
7	17.87	7.92	5.41	1.20	10.83	4.80	28.01	4.06	22.85	1.71	45.88	12.72	56.71	16.78
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	4.06	24.3 M=0.00	1.71	0.00	12.72	0.00	16.78

M Açıklıkta maximum moment

1.14.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.14.4.1 1 Nolu Eleman



$$\ell_{kx} = 2800 \text{ cm} \quad \ell_{ky} = 466.667 \text{ cm}$$

$$M = 45.88 \text{ tm} \quad N = 12.78 \text{ t} \quad \text{Seçilen HE-A 900}$$

$$A = 321 \text{ cm}^2 \quad W_x = 9480 \text{ cm}^3 \quad i_x = 36.3 \text{ cm} \quad i_y = 6.5 \text{ cm}$$

$$S_x = 89 - 2 \times 3 = 83 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.6 \text{ cm} \quad t = 3 \text{ cm}$$

$$\lambda_x = 77.134 \quad \lambda_y = 71.794 \quad \sigma_{bem} = 0.9192 \text{ t/cm}^2$$

$$\sigma_{eb} = 3.962616 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 1.39332 \text{ t/cm}^2$$

$$\sigma_b = 0.483966 \text{ t/cm}^2 \quad H' = 13.83 \text{ cm} \quad F_B = 112.133 \text{ cm}^2$$

$$I_{yB} = 6754.721 \text{ cm}^4 \quad i_{yB} = 7.76 \text{ cm} \quad S/i_{yB} = 180.381$$

$$\sigma_B = 0.537841 \text{ t/cm}^2$$

Şekil 1.44

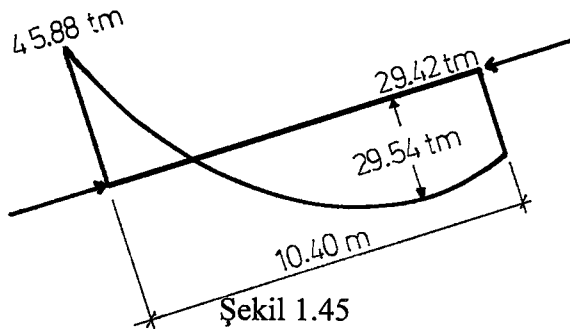
$$\text{Gerilme Kontrolleri} \quad 0.830353 < 1$$

$$0.927347 < 1$$

2. Kontrol.

$$\lambda_x = 77.13 \rightarrow 78 \text{ için } \omega_x = 1.58 \quad \sigma = 1.58 \times \frac{12.78}{321} + 0.9 \times \frac{4588}{9480} \quad \sigma = 0.4984 \text{ t/cm}^2 < \sigma_{em}$$

1.14.4.2 2 Nolu Eleman .



$$C_b = 2.546 < 2.3 \quad C_b = 2.3$$

$$\ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$N = 3.95 \text{ t} \quad \text{Seçilen HE-A 550} \quad A = 212 \text{ cm}^2$$

$$W_x = 4150 \text{ cm}^3 \quad i_x = 23 \text{ cm} \quad i_y = 7.15 \text{ cm}$$

$$S_x = 54 - 2 \times 2.4 = 49.2 \quad b = 30 \text{ cm} \quad d = 1.25 \text{ cm}$$

$$t = 2.4 \text{ cm} \quad \lambda_x = 45.217 \quad \lambda_y = 145.454$$

$$\sigma_{bem} = 0.3889 \text{ t/cm}^2 \quad \sigma_{eb} = 1.863207 \times 10^{-2} \text{ t/cm}^2$$

$$\sigma_{e'} = 4.05455 \text{ t/cm}^2 \quad \sigma_b = 1.10554 \text{ t/cm}^2$$

$$H' = 8.2 \text{ cm} \quad F_B = 82.25 \text{ cm}^2 \quad I_{yB} = 5401.33 \text{ cm}^4 \quad i_{yB} = 8.103 \text{ cm} \quad S/i_{yB} = 128.33$$

$$\sigma_B = 1.141696 \text{ t/cm}^2$$

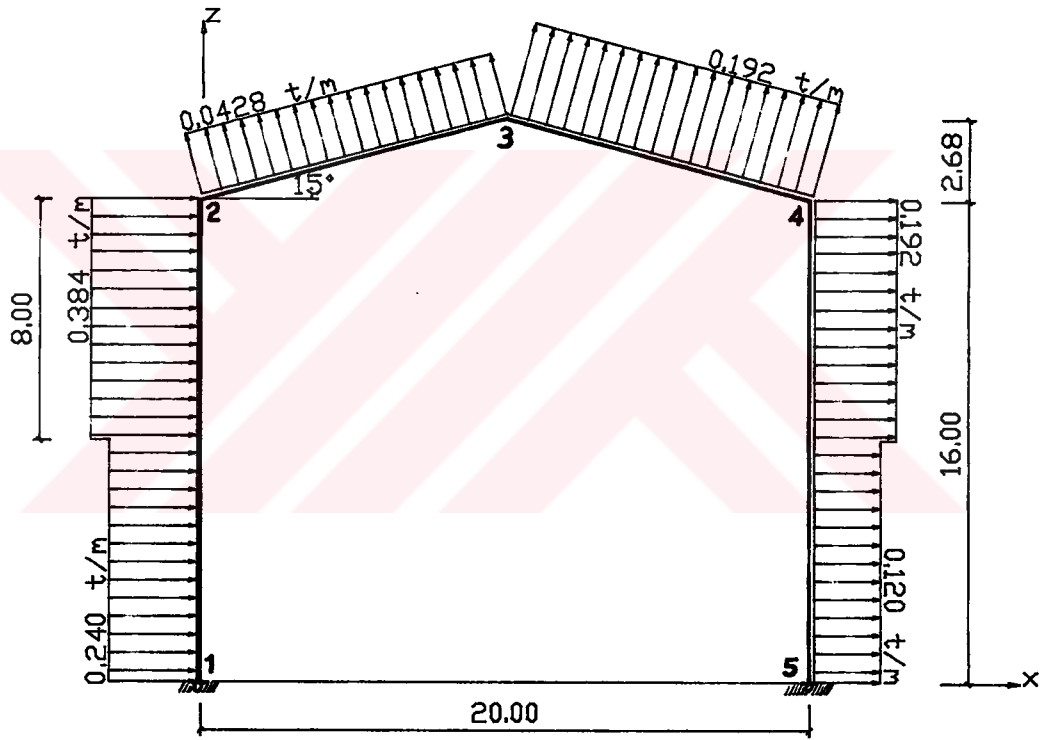
$$\text{Gerilme Kontrolleri} \quad 0.874792 < 1$$

$$0.981272 < 1$$

2. Kontrol.

$$\lambda_x = 45.21 \rightarrow 46 \text{ için } \omega_x = 1.22 \quad \sigma = 1.22 \times \frac{3.95}{212} + 0.9 \times \frac{4588}{4150} \quad \sigma = 1.0177 \text{ t/cm}^2 < \sigma_{em}$$

1.15 ÇÖZÜM A15



Sekil 1.46

Tablo 1.29

DÜĞÜM NOKTALARI KOORDİNAT TABLOSU		
No	X (m)	Z (m)
1	0.00	0.00
2	0.00	16.00
3	10.00	18.68
4	20.00	16.00
5	20.00	0.00

1.15.1 SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükler ÇÖZÜM A10'da hesaplananlar ile tamamen aynıdır.

1.15.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

COZUM A-15

SYSTEM

L=5

:

JOINTS

1 X=0 Y=0 Z=0

2 X=0 Y=0 Z=16

3 X=10 Y=0 Z=18.68

4 X=20 Y=0 Z=16

5 X=20 Y=0 Z=0

:

RESTRAINTS

1 R=1,1,1,1,0,1

2 R=0,1,0,1,0,1

3 R=0,1,0,1,0,1

4 R=0,1,0,1,0,1

5 R=1,1,1,1,0,1

:

FRAME

NM=1 NL=10

1 A=0.69 I=0.098E-3 E=2700000

1 WG=0,0,-0.79236 :ZATI

2 WG=0,0,-0.48 :KAR

3 WG=0.384,0,0 :RUZGAR SOLDAN

4 WL=0,0.04288,0 :RUZGAR SOLDAN

5 WL=0,0.192,0 :RUZGAR SOLDAN
 6 WG=0.192,0,0 :RUZGAR SOLDAN
 7 WG=-0.384,0,0 :RUZGAR SAGDAN
 8 WL=0,0.04288,0 :RUZGAR SAGDAN
 9 WL=0,0.192,0 :RUZGAR SAGDAN
 10 WG=-0.192,0,0 :RUZGAR SAGDAN
 1 1 2 M=1 LP=2,0 NSL=0,0,3,10,0
 2 2 3 M=1 LP=2,0 NSL=1,2,4,9,2
 3 3 4 M=1 LP=2,0 NSL=1,2,5,8,0
 4 4 5 M=1 LP=2,0 NSL=0,0,6,7,0
 :

1.15.3 STATİK ÇÖZÜM SONUÇLARI

COZUM A-15

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT

1 -----			
1	-7.92		
	.0	1.08	.00
	16.0	1.08	17.24
2	-4.80		
	.0	.65	.00
	16.0	.65	10.45
3	2.54		
	.0	-5.01	.00
	13.0	.00	-32.63
	16.0	1.14	-30.95

4	-4.89		
	.0	3.81	.00
	16.0	.74	36.39
5	-3.60		
	.0	.33	.00
	16.0	.33	5.22
2	-----		
1	-2.07		
	.0	-7.37	17.24
	10.0	.00	-19.54
	10.4	.28	-19.49
2	-1.25		
	.0	-4.47	10.45
	10.0	.00	-11.84
	10.4	.17	-11.80
3	-.44		
	.0	2.75	-30.95
	10.4	3.19	-.21
4	-1.98		
	.0	-4.53	36.39
	10.4	-2.54	-.21
5	-.63		
	.0	-3.39	5.22
	7.6	.00	-7.63
	10.4	1.24	-5.90
3	-----		
1	-2.07		
	.0	-.28	-19.49
	.4	.00	-19.54

		10.4	7.37	17.24
2	-1.25			
		.0	-.17	-11.80
		.4	.00	-11.84
		10.4	4.47	10.45
3	-1.98			
		.0	2.54	-.21
		10.4	4.53	36.39
4	-.44			
		.0	-3.19	-.21
		10.4	-2.75	-30.95
5	-.63			
		.0	1.07	-5.90
		10.4	1.07	5.22
4	-----			
1	-7.92			
		.0	-1.08	17.24
		16.0	-1.08	
2	-4.80			
		.0	-.65	10.45
		16.0	-.65	.00
3	-4.89			
		.0	-.74	36.39
		16.0	-3.81	.00
4	2.54			
		.0	-1.14	-30.95
		3.0	.00	-32.63
		16.0	5.01	.00
5	-1.20			

.0	-.33	5.22
16.0	-.33	.00

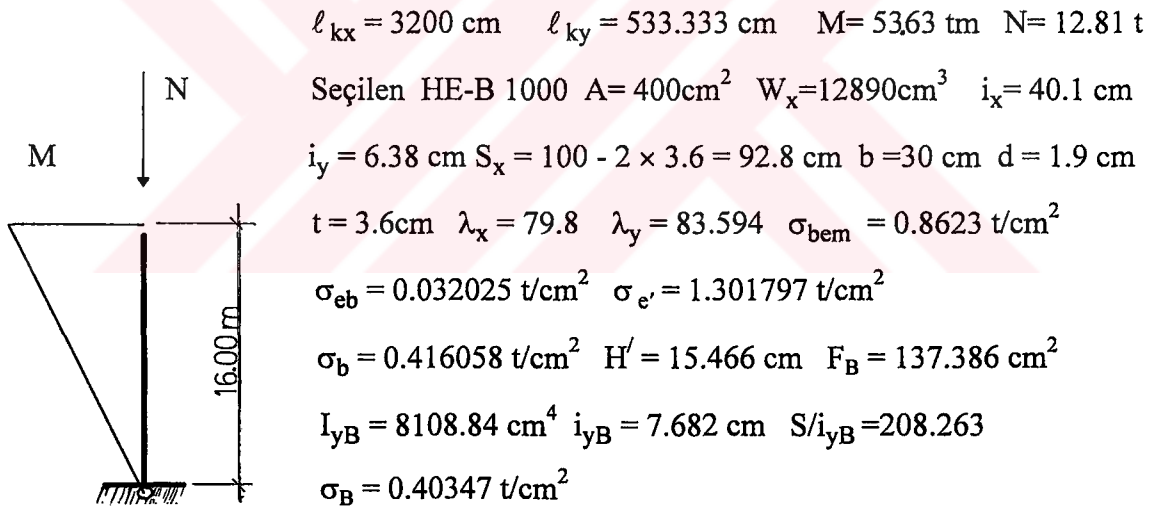
Tablo 1.30

NOKTA	ÖZ AĞIRLIK		YARIM KAR		TAM KAR		RÜZGAR SOLDA		RÜZGAR SAĞDA		EY		EİY	
NO	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)	M(tm)	N (t)
1	0.00	7.92	0.00	3.60	0.00	4.80	0.00	2.54	0.00	4.89	0.00	12.84	0.00	17.61
2	17.24	7.92	5.22	3.60	10.45	4.80	32.6 M=30.9	2.54	36.39	4.89	53.63	12.84	64.08	17.61
3	17.24	2.07	5.22	0.63	10.45	1.25	30.95	0.44	36.39	1.98	53.63	4.05	64.08	5.3
4	19.5 M=19.4	2.07	7.63 M=5.90	0.63	11.84 M=11.80	1.25	0.21	0.44	0.21	1.98	31.36 M=31.29	4.05	31.3 M=31.5	5.3
5	19.49	2.07	5.90	0.63	11.80	1.25	0.21	1.98	0.21	0.44	31.29	4.05	31.50	5.3
6	19.5 M=17.2	2.07	5.22	0.63	11.84 M=10.45	1.25	36.39	1.98	30.95	0.44	53.63	4.05	31.3 M=64.0	5.3
7	17.24	7.92	5.22	1.20	10.45	4.80	36.39	4.89	30.95	2.54	53.63	12.84	64.08	17.61
8	0.00	7.92	0.00	1.20	0.00	4.80	0.00	4.89	32.6 M=0.00	2.54	0.00	12.84	0.00	17.61

M Açıklıkta maximum moment

1.15.4 ÇERÇEVE ELEMANLARININ BOYUTLANDIRILMASI

1.15.4.1 1 Nolu Eleman



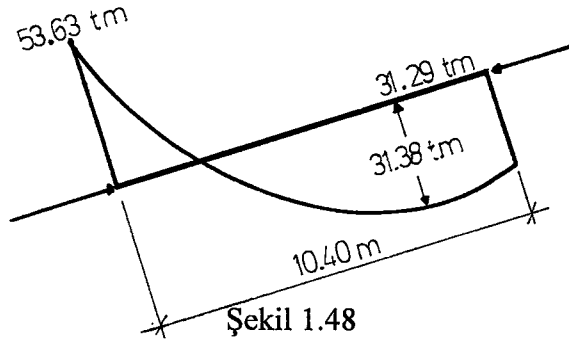
Şekil 1.47

Gerilme Kontrolleri $0.935765 < 1$ $1.053438 \approx 1$

2. Kontrol.

$$\lambda_x = 79.8 \rightarrow 80 \text{ için } \omega_x = 1.67 \quad \sigma = 1.67 \times \frac{12.81}{400} + 0.9 \times \frac{53.63}{12980} \quad \sigma = 0.4253 \text{ t/cm}^2 < \sigma_{em}$$

1.8.4.2 2 Nolu Eleman .



$$C_b = 2.464 \quad C_b = 2.3$$

$$\ell_{kx} = 1040 \text{ cm} \quad \ell_{ky} = 1040 \text{ cm}$$

$$N = 4.05 \text{ t} \text{ Seçilen HE-A 600 } A = 226 \text{ cm}^2$$

$$W_x = 4790 \text{ cm}^3 \quad i_x = 25 \text{ cm} \quad i_y = 7.05 \text{ cm}$$

$$S_x = 59 - 2 \times 2.5 \quad b = 30 \text{ cm} \quad d = 1.3 \text{ cm}$$

$$t = 2.5 \text{ cm} \quad \lambda_x = 41.6 \quad \lambda_y = 147.61$$

$$\sigma_{bem} = 0.3785 \text{ t/cm}^2 \quad \sigma_{eb} = 1.792035 \times 10^2 \text{ t/cm}^2$$

$$\sigma_{e'} = 4.79035 \text{ t/cm}^2 \quad \sigma_b = 1.119624 \text{ t/cm}^2$$

$$H' = 9 \text{ cm} \quad F_B = 86.7 \text{ cm}^2 \quad I_{yB} = 5626.64 \text{ cm}^4 \quad i_{yB} = 8.05 \text{ cm} \quad S/i_{yB} = 129.097$$

$$\sigma_B = 1.13624 \text{ t/cm}^2$$

$$\text{Gerilme Kontrolleri} \quad 0.888056 < 1$$

$$0.997816 < 1$$

2. Kontrol.

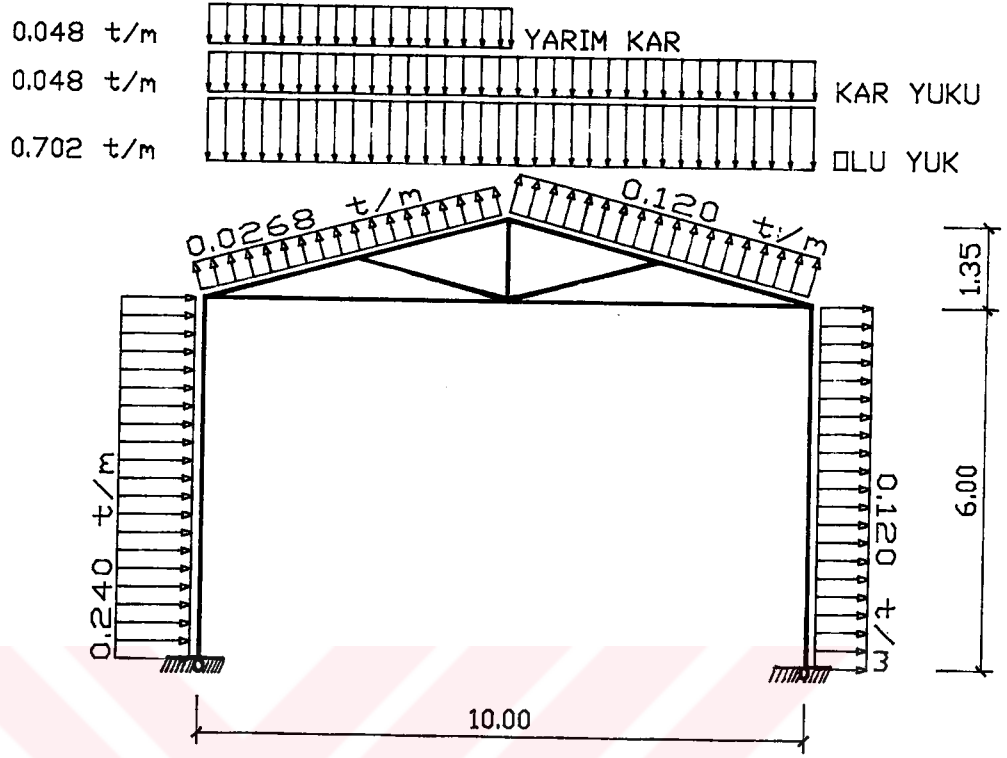
$$\lambda_x = 41.6 \rightarrow 42 \text{ için } \omega_x = 1.19 \quad \sigma = 1.19 \times \frac{4.05}{226} + 0.9 \times \frac{5363}{4790} \quad \sigma = 1.0289 \text{ t/cm}^2 < \sigma_{em}$$

1.16 A GRUBU ÇÖZÜMLERİ GENEL KAREKTERİSTİKLERİ

Tablo 1.31

ÇÖZÜM NO	AÇIKLIK (m)	YÜKSEKLİK (m)	KOLONLAR	KİRİŞLER	TOPLAM AĞIRLIK (t/m ²)
A1	10.00	6.00	I 380	I 320 5.2 m	0.0328688
A2	15.00	6.00	I 450	I 500 7.8 m	0.047728
A3	20.00	6.00	I 550	I 600 10.4 m	0.061432
A4	25.00	6.00	I 600	HE-A 700 12.9 m	0.0612096
A5	30.00	6.00	HE-A 650	HE-B 1000 15.5m	0.0800933
A6	10.00	8.00	I 450	I 340 5.2 m	0.0509648
A7	10.00	10.00	I 600	I 450 5.2 m	0.10352
A8	10.00	12.00	HE-A 450	I 450 5.2 m	0.09112
A9	10.00	14.00	HE-A 650	I 500 5.2 m	0.135728
A10	10.00	16.00	HE-A 900	I 550 5.2 m	0.196016
A11	20.00	8.00	I 600	I 600 10.4 m	0.073232
A12	20.00	10.00	HE-A 500	HE-A 450 10.4 m	0.06012
A13	20.00	12.00	HE-A 600	HE-A 500 10.4 m	0.07496
A14	20.00	14.00	HE-A 900	HE-A 550 10.4 m	0.105088
A15	20.00	16.00	HE-B 1000	HE-A 600 10.4 m	0.137504

2.1. ÇÖZÜM B1



Sekil 2.1

2.1.1 SİSTEME ETKİYEN YÜKLER

2.1.1.1. ÖZ AĞIRLIK

Çatı Örtüsü Ytong + 2 kat bitümlü mukavva

Ytong öz ağırlığı.....63.00 kg/m² (Çatı Düzleminde)

Mukavva öz ağırlığı 24.00 kg/m² (Çatı Düzleminde)

$\underline{g = 87.00 \text{ kg/m}^2}$ (Çatı Düzleminde)

Yatay Düzlemde $g_{T1} = \frac{q}{\cos \alpha} = \frac{87}{\cos 15}$ $g_{T1} = 90.06 \text{ kg/m}^2$

Aşık Öz ağırlığı.....9.00 kg/m² (Yatay Düzlemde)

Stabilite Bağlantıları.....3.00 kg/m² (Yatay Düzlemde)

Makas Öz ağırlığı.....15.00 kg/m² (Yatay Düzlemde)

$\underline{g_{T2} = 27.00 \text{ kg/m}^2}$ (Yatay Düzlemde)

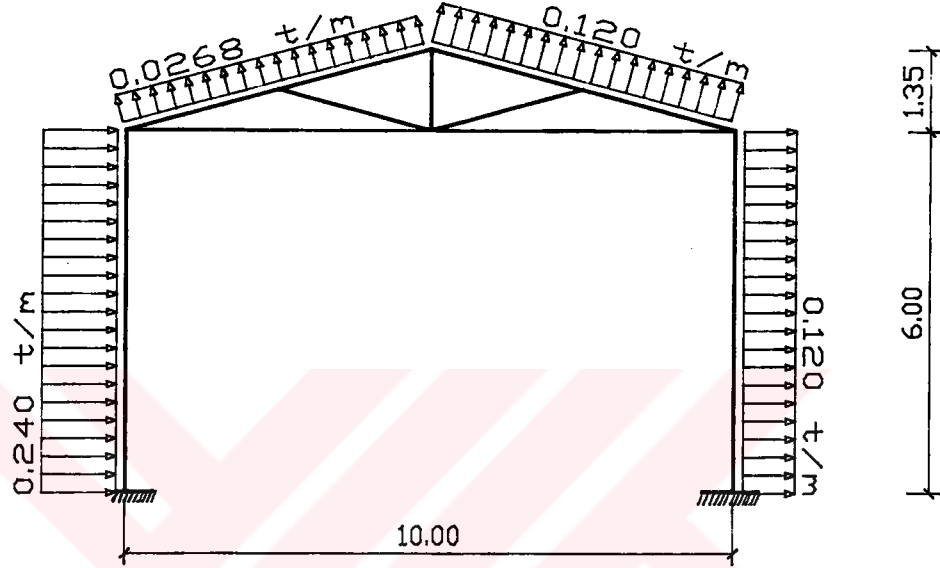
Toplam Ölü Yük $g_T = 90.06 + 27 = 117.06 \text{ kg/m}^2$

2.1.1.2. KAR YÜKÜ

$\alpha = 15^\circ < 30^\circ$ $P_{ko} = P_k$ yükselti 600m III. Bölge $P_{ko} = 80 \text{ kg/m}^2$

$P_k = 80 \text{ kg/m}^2$

2.1.1.3 RÜZGÂR YÜKÜ



Sekil 2.2

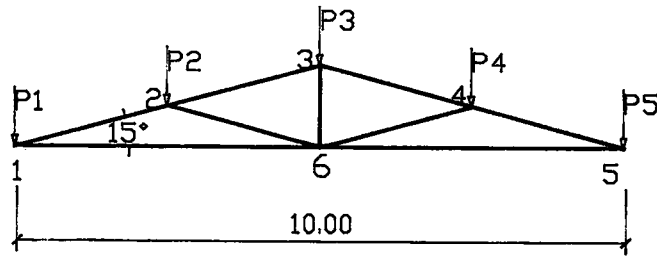
$q_1 = 40 \text{ kg/m}^2$

$q_2 = 4.47 \text{ kg/m}^2$

$q_3 = 20 \text{ kg/m}^2$

$q_4 = 20 \text{ kg/m}^2$

2.1.2. DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI



Sekil 2.3

2.1.2.1 ÖLÜ YÜKLER

$$P_1^{\delta} = 117.06 \times \frac{2.5}{2} \times 6 \quad P_1^{\delta} = 877.95 \text{ kg} \quad P_2^{\delta} = 117.06 \times 2.5 \times 6$$

$$P_2^{\delta} = 1755.9 \text{ kg} \quad P_3^{\delta} = 117.06 \times 2.5 \times 6 \quad P_3^{\delta} = 1755.9 \text{ kg} \quad P_4^{\delta} = 1755.9 \text{ kg}$$

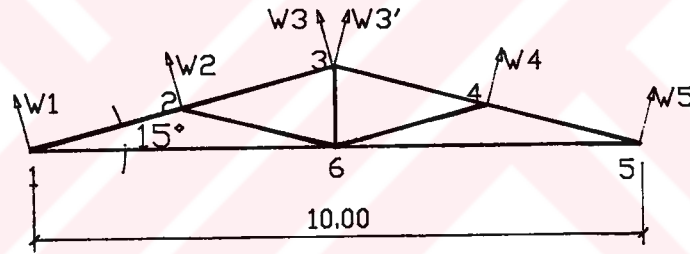
$$P_5^{\delta} = 877.95 \text{ kg}$$

2.1.2.2. KAR YÜKÜ

$$P_1^K = 80 \times \frac{2.5}{2} \times 6 \quad P_1^K = 600 \text{ kg} \quad P_2^K = 80 \times 2.5 \times 6 \quad P_2^K = 1200 \text{ kg}$$

$$P_3^K = 1200 \text{ kg} \quad P_4^K = 1200 \text{ kg} \quad P_5^K = 1200 \text{ kg}$$

2.1.2.3 RÜZGÂR YÜKÜ



Sekil 2.4

$$W_1 = 4.471 \times 6 \times \frac{2.588}{2} \quad W_1 = 34.712 \text{ kg} \quad W_2 = 4.471 \times 6 \times 2.588$$

$$W_2 = 69.425 \text{ kg} \quad W_3 = 4.471 \times 6 \times \frac{2.588}{2} \quad W_3 = 34.712 \text{ kg} \quad W_3' = 20 \times 6 \times \frac{2.588}{2}$$

$$W_3' = 155.28 \text{ kg} \quad W_4 = 20 \times 6 \times 2.588 \quad W_4 = 310.560 \text{ kg} \quad W_5 = 20 \times 6 \times \frac{2.588}{2}$$

$$W_5 = 155.280 \text{ kg}$$

RÜZGAR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Yatay Bileşen	$W_x = W \times \sin 15^\circ$	Makasın sol yarısında	Makasın Sağ Yarısında
Düşey Bileşen	$W_z = W \times \cos 15^\circ$	$W_x = -W \times \sin 15^\circ$	$W_x = W \times \sin 15^\circ$
		$W_z = W \times \cos 15^\circ$	$W_z = W \times \cos 15^\circ$

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
---------------	---------------	---------------	---------------

1 Nolu Düğüm Noktası

2 Nolu Düğüm Noktası

$W_x = 8.984 \text{ kg}$	$W_x = 40.189 \text{ kg}$	$W_x = 17.968 \text{ kg}$	$W_x = 80.378 \text{ kg}$
$W_z = 33.529 \text{ kg}$	$W_z = 149.988 \text{ kg}$	$W_z = 33.529 \text{ kg}$	$W_z = 299.977 \text{ kg}$

3 Nolu Düğüm Noktası

4 Nolu Düğüm Noktası

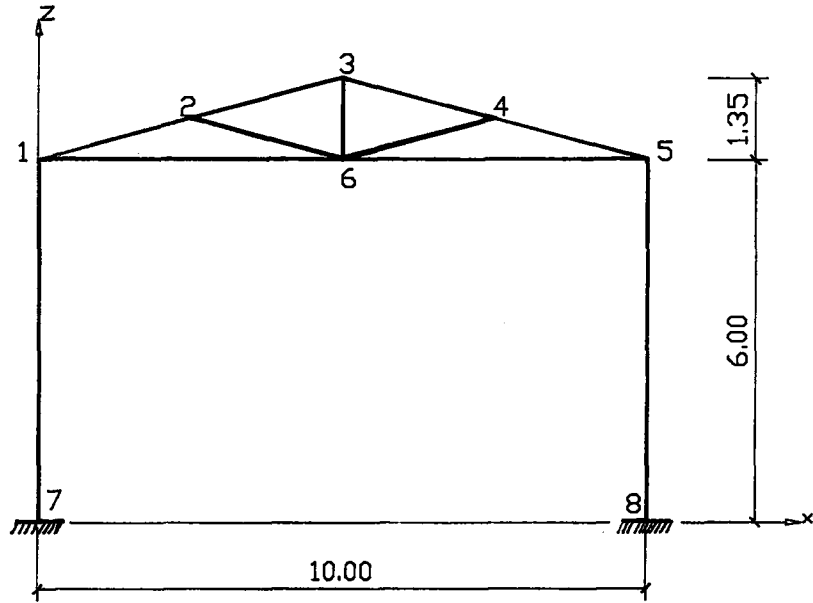
$W_x = 8.984 \text{ kg}$	$W_x = 40.189 \text{ kg}$	$W_x = 80.378 \text{ kg}$	$W_x = 17.968 \text{ kg}$
$W_z = 33.529 \text{ kg}$	$W_z = 149.988 \text{ kg}$	$W_z = 299.977 \text{ kg}$	$W_z = 67.059 \text{ kg}$

$W_x' = 40.189 \text{ kg}$	$W_x' = 8.984 \text{ kg}$
$W_z' = 149.988 \text{ kg}$	$W_z = 33.529 \text{ kg}$

5 Nolu Düğüm Noktası

$W_x = 40.189 \text{ kg}$	$W_x = 8.984 \text{ kg}$
$W_z = 149.988 \text{ kg}$	$W_z = 33.529 \text{ kg}$

2.1.3. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ



Sekil 2.5

ÇÖZÜM B1

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=7.34

1 X=0 Y=0 Z=6 G=1,3,1

5 X=10 Y=0 Z=6 G=3,5,1

6 X=5 Y=0 Z=6

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 WG=0.24,0,0

2 WG=0.12,0,0

3 WG=-.24,0,0

4 WG=-.12,0,0

1 1 2 M=1 LP=2,0 G=3,1,1,1

5 1 6 M=1 LP=2,0

6 6 5 M=1 LP=2,0

7 2 6 M=2 LP=2,0

8 3 6 M=2 LP=2,0

9 4 6 M=2 LP=2,0

10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 5 4 L=1 F=0,0,-0.87795,0,0,0

2 4 1 L=1 F=0,0,-1.75590,0,0,0

1 5 4 L=2 F=0,0,-0.600,0,0,0

2 4 1 L=2 F=0,0,-1.200,0,0,0

1 3 2 L=3 F=0,0,-0.600,0,0,0

2 L=3 F=0,0,-1.200,0,0,0

1 L=4 F=-8.984E-3,0,33.529E-3,0,0,0

2 L=4 F=-17.968E-3,0,67.059E-3,0,0,0

3 L=4 F=31.205E-3,0,183.517E-3,0,0,0

4 L=4 F=80.378E-3,0,299.977E-3,0,0,0

5 L=4 F=40.189E-3,0,149.988E-3,0,0,0
 1 L=5 F=-40.189E-3,0,149.988E-3,0,0,0
 2 L=5 F=-80.378E-3,0,299.977E-3,0,0,0
 3 L=5 F=-31.205E-3,0,183.517E-3,0,0,0
 4 L=5 F=17.968E-3,0,67.059E-3,0,0,0
 5 L=5 F=8.984E-3,0,33.529E-3,0,0,0
 :

2.1.4. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B1

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT
1 -----			
1	-10.17		
2	-6.95		
3	-4.64		
4	.87		
5	1.26		
2 -----			
1	-6.78		
2	-4.64		
3	-2.32		
4	.75		
5	.72		
3 -----			

1 -6.78

2 -4.64

3 -2.32

4 .72

5 .75

4 -----

1 -10.17

2 -6.95

3 -2.32

4 1.26

5 .87

5 -----

1 9.77

2 6.68

3 4.46

4 -.90

5 -1.36

6 -----

1 9.77

2 6.68

3 2.22

4 -1.36

5 -.90

7 -----

1 -3.39

2 -2.32

3 -2.32

4 .14

5 .62

8 -----

1 1.76

2 1.20

3 .60

4 -.20

5 -.20

9 -----

1 -3.39

2 -2.32

3 .00

4 .62

5 .14

10 -----

1 -3.51

.0 .06 -.34

6.0 .06 .00

2 -2.40

.0 .04 -.24

6.0 .04 .00

3 -1.80

.0 .02 -.12

6.0 .02 .00

4 .26

.0 -1.37 3.92

5.7 .00 -.01

6.0 .07 .00

5 .48

.0 .91 -3.30

6.0 .19 .00

11 -----

1	-3.51			
	.0	-.06	.00	
	6.0	-.06	-.34	
2	-2.40			
	.0	-.04	.00	
	6.0	-.04	-.24	
3	-.60			
	.0	-.02	.00	
	6.0	-.02	-.12	
4	.48			
	.0	-.19	.00	
	6.0	-.91	-3.30	
5	.26			
	.0	-.07	.00	
	.3	.00	-.01	
	6.0	1.37	3.92	

Tablo 2.1

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGAR SOLDAN (t)	RÜZGAR SAĞDAN(t)	EY (t)	EİY (t)
1	10.17	4.64	6.95	-0.87	-1.26	17.12	16.25
2	6.78	2.32	4.64	-0.75	-0.72	11.42	10.70
3	6.78	2.32	4.64	-0.72	-0.75	11.42	10.70
4	10.17	2.32	6.95	-1.26	-0.87	17.12	16.25
5	9.77	4.46	6.68	0.90	1.36	16.45	15.55
6	9.77	2.22	6.68	1.36	0.90	16.45	15.55
7	3.39	2.32	2.32	-0.14	-0.62	5.71	5.57
8	-1.76	-0.60	-1.20	0.20	0.20	-2.96	-2.76
9	3.39	0	2.32	-0.62	-0.14	5.71	5.57
10	3.51 M=0.34	1.80 M=0.12	2.40 M=0.24	-0.24 M=3.92	-0.48 M=13.3	5.91 M=0.58	5.43 M=3.88
11	3.51 M=0.34	0.60 M=0.12	2.40 M=0.24	-0.48 M=3.30	-0.26 M= -3.92	5.91 M=0.58	5.43 M=3.88

Moment tm

2.1.5. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$N = -17.12 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \text{ m} \quad \sigma = \omega \times \frac{N}{A} \leq \sigma_{em}$$

$$\sigma = 2.41 \times \frac{17.12}{23} \quad \sigma = 1.79 > 1.44 \quad \text{Seçilen } \frac{1}{2} \text{ I } 260 \quad A = 26.7 \text{ cm}^2 \quad i_y = 2.32 \text{ cm}$$

$$i_x = 3.85 \text{ cm} \quad \lambda = \frac{258.8}{2.32} = 111.55 \rightarrow 112 \quad \omega = 2.26 \quad \sigma = 2.26 \times \frac{17.12}{26.7} \quad \sigma = 1.44 \text{ t/cm}^2 = \sigma_{em}$$

ALT BAŞLIK

$$N = 16.45 \text{ t} \quad \text{Seçilen L } 70.70.9 \quad A = 11.9 \text{ cm}^2 \quad \sigma = \frac{16.45}{11.9} = 1.382 \text{ t/cm}^2 < \sigma_{em}$$

DİYAGONALLER

7 ve 9 nolu elemanlar

$$N = -5.71 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \text{ m} \quad \text{seçilen L } 90.90.9 \quad A = 15.5 \text{ cm}^2$$

$$i_x = 3.45 \text{ cm} \quad i_y = 1.76 \text{ cm} \quad \lambda = \frac{258.8}{1.76} = 147.045 \rightarrow 148 \quad \omega = 3.80 \quad \sigma = 3.80 \times \frac{5.71}{15.5}$$

$$\sigma = 1.399 \text{ t/cm}^2 < \sigma_{em}$$

DİKMELER

8 Nolu Eleman

$$N = 2.96 \text{ t} \quad \text{Seçilen L } 50.50.5 \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{2.96}{4.80} = 0.616 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$N = 5.91 \text{ t} \quad M = 0.58 \text{ tm} \quad \text{Seçilen I } 220 \quad A = 39.50 \text{ cm}^2 \quad W_x = 278 \text{ cm}^3 \quad i_x = 8.80$$

$$i_y = 2.02 \text{ cm} \quad S_x = 22 \times 1.22 = 19.56 \text{ cm} \quad b = 9.8 \text{ cm} \quad d = 0.81 \text{ cm} \quad t = 1.22 \text{ cm}$$

$$\lambda_x = 81.81 \quad \lambda_y = 148.51 \rightarrow 149 \quad \sigma_{bem} = 0.3734 \text{ t/cm}^2 \quad \sigma_{eb} = 0.1496 \text{ t/cm}^2$$

$$\sigma_e = 1.238 \text{ t/cm}^2 \quad \sigma_b = 0.2086 \text{ t/cm}^2 \quad H' = 3.26 \text{ cm} \quad F_B = 14.596 \text{ cm}^2 \quad I_{yB} = 95.832 \text{ cm}^4$$

$$i_{yB} = 2.56 \text{ cm} \quad S/i_{yB} = 234.164 \quad \sigma_B = 0.31915 \text{ t/cm}^2$$

Gerilme Kontrolleri $1.0327 \approx 1$
 $0.7570 < 1$

2. Kontrol

$$\sigma = 1.64 \times \frac{5.91}{39.50} + 0.9 \times \frac{58}{278} \quad \sigma = 0.433 \text{ t/cm}^2 < \sigma_{em}$$

EİY YÜKLEMESİ İÇİN

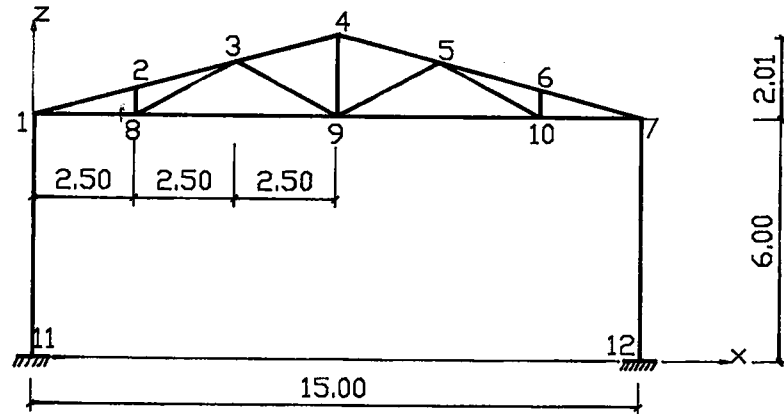
$N = 5.43 \text{ t}$ $M = 3.88 \text{ tm}$ Seçilen I 320 $A = 77.7 \text{ cm}^2$ $W_x = 782 \text{ cm}^3$ $i_x = 12.7 \text{ cm}$
 $i_y = 2.67 \text{ cm}$ $S_x = 32 - 2 \times 1.73 = 28.54 \text{ cm}$ $b = 13.1 \text{ cm}$ $d = 1.15 \text{ cm}$ $t = 1.73 \text{ cm}$
 $\lambda_x = 56.692$ $\lambda_y = 112.359$ $\sigma_{bem} = 0.723465$ $\sigma_{eb} = 6.988416 \times 10^{-2} \text{ t/cm}^2$
 $\sigma_e = 2.96616 \text{ t/cm}^2$ $\sigma_b = 0.49616 \text{ t/cm}^2$ $H' = 4.756 \text{ cm}^2$ $F_B = 28.133 \text{ cm}^2$
 $I_{yx} = 324.702 \text{ cm}^4$ $i_{yB} = 3.39 \text{ cm}$ $S/i_{yB} = 176.61$ $\sigma_B = 0.561051 \text{ t/cm}^2$

Gerilme Kontrolleri $0.866428 < 1$
 $0.932876 < 1$

2. Kontrol

$$\lambda_x = 56.69 \rightarrow 57 \text{ için } \omega = 1.33 \quad \sigma = 1.33 \times \frac{5.43}{77.7} + 0.9 \times \frac{388}{782} \quad \sigma = 0.5816 \text{ t/cm}^2 < \sigma_{em}$$

2.2. ÇÖZÜM B2



Sekil 2.6

2.2.1 SİSTEME ETKİYEN YÜKLER

Toplam Ölü Yük.....117.06 kg/m²

Kar Yüğü.....80.00 kg/m²

Rüzgar yükü Çözüm B1’de hesaplananlar ile tamamen aynıdır.

2.2.2. DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI

2.2.2.1 ÖLÜ YÜKLER

$$p_1^{\circ} = 117.06 \times \frac{2.5}{2} \times 6 \quad p_1^{\circ} = 877.95 \text{ kg} \quad P_2^{\circ} = 1755.9 \text{ kg} \quad P_3^{\circ} = 1755.9 \text{ kg}$$

$$P_4^{\circ} = 1755.9 \text{ kg} \quad P_5^{\circ} = 1755.9 \text{ kg} \quad P_6^{\circ} = 755.9 \text{ kg} \quad P_7^{\circ} = 87.95 \text{ kg}$$

2.2.2.2. KAR YÜKÜ

$$P_1^K = 80 \times \frac{2.5}{2} \times 6 \quad P_1^K = 600 \text{ kg} \quad P_2^K = 1200 \text{ kg} \quad P_3^K = 1200 \text{ kg}$$

$$P_4^K = 1200 \text{ kg} \quad P_5^K = 1200 \text{ kg} \quad P_6^K = 1200 \text{ kg} \quad P_7^K = 600 \text{ kg}$$

2.2.2.3 RÜZGÂR YÜKÜ

$$W_1 = 34.712 \text{ kg} \quad W_2 = 69.425 \text{ kg} \quad W_3 = 69.425 \text{ kg} \quad W_4 = 34.712 \text{ kg}$$

$$W_4' = 155.28 \text{ kg} \quad W_5 = 310.560 \text{ kg} \quad W_6 = 310.560 \text{ kg} \quad W_7 = 155.280 \text{ kg}$$

RÜZGÂR YÜKLERİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan

Rüzgâr Sağdan

Rüzgâr Soldan

Rüzgâr Sağdan

1 Nolu Düğüm Noktası

2 Nolu Düğüm Noktası

W_x = 8.984 kg

W_x = - 40.189 kg

W_x = 17.968 kg

W_x = - 80.378 kg

W_z = 33.529 kg

W_z = 149.988 kg

W_z = 67.059 kg

W_z = 299.977 kg

3 Nolu Düğüm Noktası

$$\begin{aligned}
 W_x &= 17.968 \text{ kg} & W_x &= - 80.378 \text{ kg} \\
 W_z &= 67.059 \text{ kg} & W_z &= 299.977 \text{ kg} \\
 W_x' &= 40.189 \text{ kg} & W_x' &= 8.984 \text{ kg} \\
 W_z' &= 149.988 \text{ kg} & W_z &= 33.529 \text{ kg}
 \end{aligned}$$

4 Nolu Düğüm Noktası

$$\begin{aligned}
 W_x &= 8.984 \text{ kg} & W_x &= - 40.189 \text{ kg} \\
 W_z &= 33.529 \text{ kg} & W_z &= 149.988 \text{ kg}
 \end{aligned}$$

5 Nolu Düğüm Noktası

$$\begin{aligned}
 W_x &= 80.378 \text{ kg} & W_x &= 17.968 \text{ kg} \\
 W_z &= 299.977 \text{ kg} & W_z &= 67.059 \text{ kg}
 \end{aligned}$$

6 Nolu Düğüm Noktası

$$\begin{aligned}
 W_x &= 80.378 \text{ kg} & W_x &= 17.968 \text{ kg} \\
 W_z &= 299.977 \text{ kg} & W_z &= 67.059 \text{ kg}
 \end{aligned}$$

7Nolu Düğüm Noktası

$$\begin{aligned}
 W_x &= 40.189 \text{ kg} & W_x &= 8.984 \text{ kg} \\
 W_z &= 149.988 \text{ kg} & W_z &= 337.529 \text{ kg}
 \end{aligned}$$

2.2.3. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B2

SYSTEM

L=5

:

JOINTS

4 X=7.5 Y=0 Z=8

1 X=0 Y=0 Z=6 G=1,4,1

7 X=15 Y=0 Z=6 G=4,7,1

10 X=12.5Y=0 Z=6

8 X=2.5 Y=0 Z=6 G=8,10,1

11 X=0 Y=0 Z=0

12 X=15 Y=0 Z=0

:

RESTRAINTS

1 10 1 R=0,1,0,1,0,1

11 12 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

1 WG=0.24,0,0

2 WG=0.12,0,0

3 WG=-0.24,0,0

4 WG=-0.12,0,0

1 1 2 M=1 LP=2,0 G=5,1,1,1

7 1 8 M=1 LP=2,0

8 8 9 M=1 LP=2,0

9 9 10 M=1 LP=2,0

10 10 7 M=1 LP=2,0

11 2 8 M=2 LP=2,0

12 8 3 M=2 LP=2,0

13 3 9 M=2 LP=2,0

14 4 9 M=2 LP=2,0

15 9 5 M=2 LP=2,0

16 5 10 M=2 LP=2,0

17 10 6 M=2 LP=2,0

18 11 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

19 7 12 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 7 6 L=1 F=0,0,-877.95E-3,0,0,0

2 6 1 L=1 F=0,0,-1755.9E-3,0,0,0
 1 7 6 L=2 F=0,0,-600E-3,0,0,0
 2 6 1 L=2 F=0,0,-1200E-3,0,0,0
 1 4 3 L=3 F=0,0,-600E-3,0,0,0
 2 3 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F= -8.984E-3,0,33.529E-3,0,0,0
 2 3 1 L=4 F= -17.968E-3,0,67.059E-3,0,0,0
 4 L=4 F=31.205E-3,0,183.517E-3,0,0,0
 5 6 1 L=4 F=80.378E-3,0,299.977E-3,0,0,0
 7 L=4 F= 40.189E-3,0,149.988E-3,0,0,0
 1 L=5 F= -40.189E-3,0,149.988E-3,0,0,0
 2 3 1 L=5 F= -80.378E-3,0,299.977E-3,0,0,0
 4 L=5 F= -31.205E-3,0,183.517E-3,0,0,0
 5 6 1 L=5 F=17.968E-3,0,67.059E-3,0,0,0
 7 L=5 F=8.984E-3,0,33.529E-3,0,0,0
 :

2.2.4. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B2

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1-----

1 -17.04
 2 -11.64
 3 -8.15
 4 1.38
 5 2.18

2 -----

1 -17.04
2 -11.64
3 -8.15
4 1.40
5 2.27

3 -----

1 -10.22
2 -6.99
3 -3.49
4 1.14
5 1.10

4 -----

1 -10.22
2 -6.99
3 -3.49
4 1.10
5 1.14

5 -----

1 -17.04
2 -11.64
3 -3.49
4 2.27
5 1.40

6 -----

1 -17.04
2 -11.64
3 -3.49
4 2.18

5 1.38

7 -----

1 16.34

2 11.16

3 7.83

4 -1.35

5 -2.28

8 -----

1 13.04

2 8.91

3 5.58

4 -1.21

5 -1.68

9 -----

1 13.04

2 8.91

3 3.33

4 -1.68

5 -1.21

10 -----

1 16.34

2 11.16

3 3.33

4 -2.28

5 -1.35

11 -----

1 -1.76

2 -1.20

3 -1.20

4 .07

5 .32

12 -----

1 3.73

2 2.55

3 2.55

4 -.15

5 -.68

13 -----

1 -3.73

2 -2.55

3 -2.55

4 .15

5 .68

14 -----

1 3.51

2 2.40

3 1.20

4 -.39

5 -.39

15 -----

1 -3.73

2 -2.55

3 .00

4 .68

5 .15

16 -----

1 3.73

2 2.55

3 .00

4 -.68

5 -.15

17 -----

1 -1.76

2 -1.20

3 .00

4 .32

5 .07

18 -----

1 -5.27

.0 .12 -.75

6.0 .12 .00

2 -3.60

.0 .09 -.51

6.0 .09 .00

3 -2.70

.0 .04 -.26

6.0 .04

4 .39

.0 -1.41 4.15

6.0 .03 .00

5 .71

.0 .93 -3.45

6.0 .21 .00

19 -----

1 -5.27

.0 -.12 .00

6.0 -.12 -.75

2	-3.60		
	.0	-.09	.00
	6.0	-.09	-.51
3	-.90		
	.0	-.04	.00
	6.0	-.04	-.26
4	.71		
	.0	-.21	.00
	6.0	-.93	-3.45
5	.39		
	.0	-.03	.00
	6.0	1.41	4.15

Tablo 2.2

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	17.04	8.15	11.64	-1.38	-2.18	28.68	27.30
2	17.04	8.15	11.64	-1.40	-2.27	28.68	27.28
3	10.22	3.49	6.99	-1.14	-1.10	17.21	16.11
4	10.22	3.49	6.99	-1.10	-1.14	17.21	16.11
5	+17.04	3.49	+11.64	-2.27	-1.40	28.68	27.28
6	17.04	3.49	11.67	-2.18	-1.38	28.71	27.33
7	-16.34	-7.38	-11.16	1.35	2.28	-27.50	-26.15
8	-13.04	-5.58	-8.91	1.21	1.68	-21.95	-20.74
9	-13.04	-3.33	-8.91	1.68	1.21	-21.95	-20.74
10	-16.34	-3.33	-11.16	2.28	1.35	-27.50	-26.15
11	1.76	1.20	1.20	-0.07	-0.32	2.96	2.89
12	-3.73	-2.55	-2.55	0.15	0.68	-6.28	-6.28
13	3.73	2.55	2.55	-0.15	-0.68	6.28	6.13
14	-3.51	-1.20	-2.40	0.39	0.39	-5.91	-5.52
15	3.73	0	2.55	-0.68	-0.15	6.28	6.13
16	-3.73	0	-2.55	0.68	0.15	-6.28	-6.13
17	1.74	0	1.20	-0.32	-0.07	2.96	2.89
18	M=0.75 N=5.27	M=0.26 N=2.70	M=0.51 N=3.60	M=4.15 N= - 0.39	M=+3.45 N=-0.71	M=1.26 N=8.87	M=4.71 N=8.16
19	M=0.75 N=5.27	M=0.26 N=0.90	M=0.51 N=3.60	M=3.45 N= - 0.71	M=4.15 N= - 0.39	M=1.26 N=8.87	M=4.71 N=8.16

Momentler tm

2.2.5. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$N = 28.68 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \quad \text{Seçilen } \frac{1}{2} \text{ I } 320 \quad A = 38.9 \text{ cm}^2$$

$$i_x = 4.78 \text{ cm} \quad i_y = 2.67 \text{ cm} \quad \lambda_x = \frac{258.8}{2.67} \quad \lambda_y = 96.928 \rightarrow 97 \quad \omega = 1.90$$

$$\sigma = 1.90 \times \frac{28.68}{38.9} \quad \sigma = 1.400 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 27150 \text{ t} \quad \text{Seçilen } \frac{1}{2} \text{ I } 220 \quad A = 19.8 \text{ cm}^2 \quad \sigma = \frac{2750}{19.80} \quad \sigma = 1.388 \text{ t/cm}^2 < \sigma_{em}$$

DİKMELER

11 ve 17 Nolu Elemanlar

$$N = -2.96 \text{ t} \quad \ell_{kx} = \ell_{ky} = 67 \text{ cm} \quad \text{Seçilen L } 50.50.5 \quad A = 4.80 \text{ cm}^2$$

$$i_x = 1.90 \text{ cm} \quad i_y = 0.98 \text{ cm} \quad \lambda_y = \frac{67}{0.98} = 68.367 \rightarrow 69 \quad \omega = 1.46 \quad \sigma = 1.46 \times \frac{2.96}{4.80}$$

$$\sigma = 0.900 \text{ t/cm}^2 < \sigma_{em}$$

14 Nolu Eleman

$$N = 5.91 \text{ t} \quad \text{Seçilen L } 50.50.5 \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{5.91}{4.80} = 1.231 \text{ t/cm}^2 \leq \sigma_{em}$$

DİYAGONALLER

12 ve 16 Nolu Eleman

$$N = -6.28 \text{ t} \quad \text{Seçilen L } 50.50.5 \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{6.28}{4.80} \quad \sigma = 1.3083 \text{ t/cm}^2 < \sigma_{em}$$

13 ve 15 Nolu Eleman

$$N = -6.28 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.836 \text{ m} \quad \text{Seçilen L90. 90.13} \quad A = 21.8 \text{ cm}^2$$

$$i_x = 3.39 \text{ cm} \quad i_y = 1.74 \text{ cm} \quad \lambda = \frac{283.6}{1.74} \quad \lambda = 162.98 \rightarrow 163 \quad \sigma = 4.61 \times \frac{6.28}{21.8}$$

$$\sigma = 1.328 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$N = 8.87 \text{ t} \quad M = 1.26 \text{ tm} \quad \text{Seçilen I 260} \quad A = 53.3 \text{ cm}^2 \quad W_x = 442 \text{ cm}^3 \quad i_x = 10.4 \text{ cm}$$

$$i_y = 2.32 \quad S_x = 26 - 2 \times 1.41 = 23.18 \text{ cm} \quad b = 11.3 \text{ cm} \quad d = 0.94 \text{ cm} \quad t = 1.41 \text{ cm} \quad \lambda_x = 69.23$$

$$\lambda_y = 129.310 \quad \omega = 1.47 \quad \sigma_{bem} = 0.4916 \text{ t/cm}^2 \quad \sigma_{eb} = 0.16641 \text{ t/cm}^2 \quad \sigma_e = 1.729 \text{ t/cm}^2$$

$$\sigma_b = 0.28506 \text{ t/cm}^2 \quad H' = 3.863 \text{ cm} \quad F_B = 19.564 \text{ cm}^2 \quad I_{yB} = 169.80 \text{ cm}^4 \quad i_{yB} = 2.946 \text{ cm}$$

$$S/i_{yB} = 203.66 \quad \sigma_B = 0.42191 \text{ t/cm}^2$$

$$\text{Gerilme Kontrolleri} \quad 0.97396 < 1$$

$$0.79122 < 1$$

EİY YÜKLEMESİ İÇİN

$$N = 8.16 \text{ t} \quad M = 4.71 \text{ tm} \quad \text{Seçilen I 340} \quad A = 86.7 \text{ cm}^2 \quad W_x = 923 \text{ cm}^3 \quad i_x = 13.5 \text{ cm}$$

$$i_y = 2.80 \quad S_x = 34 - 2 \times 1.83 = 30.34 \text{ cm} \quad b = 13.7 \text{ cm} \quad d = 1.22 \text{ cm} \quad t = 1.83 \text{ cm} \quad \lambda_x = 53.3$$

$$\lambda_y = 107.142 \quad \sigma_{bem} = 0.7697 \quad \sigma_{eb} = 9.411764 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_e = 3.3516 \text{ t/cm}^2$$

$$\sigma_b = 0.51029 \text{ t/cm}^2 \quad H' = 5.05 \text{ cm}^2 \quad F_B = 31.24 \text{ cm}^2 \quad I_{yX} = 392.89 \text{ cm}^4 \quad i_{yB} = 3.54 \text{ cm}$$

$$S/i_{yB} = 169.18 \quad \sigma_B = 0.611365 \text{ t/cm}^2$$

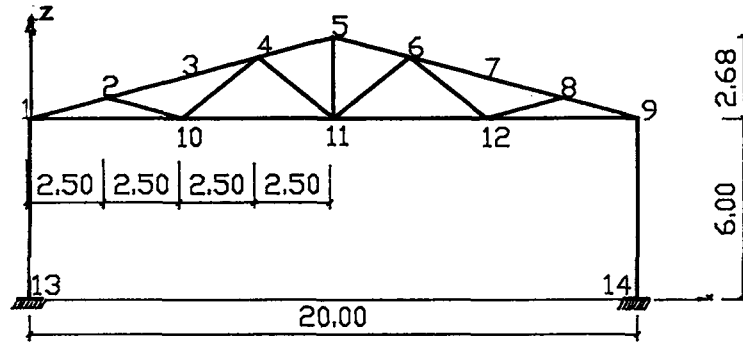
$$\text{Gerilme Kontrolleri} \quad 0.852252 < 1$$

$$0.900000 < 1$$

2. Kontrol

$$\lambda_x = 56.69 \rightarrow 57 \text{ için } \omega = 1.33 \quad \sigma = 1.33 \times \frac{8.16}{86.7} + 0.9 \times \frac{471}{923} \quad \sigma = 0.5816 \text{ t/cm}^2 < \sigma_{em}$$

2.3 ÇÖZÜM B3



Sekil 2.7

2.3.1 SİSTEME ETKİYEN YÜKLER

Toplam Ölü Yük.....90.06+ (9+3+20) = 122.06 kg/m²

Kar Yüğü.....80.00 kg/m²

2.3.2 DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI

2.3.2.1 ÖLÜ YÜKLER

$$P_1^{\circ} = 122.06 \times \frac{2.5}{2} \times 6 \quad P_1^{\circ} = 915.45 \text{ kg} \quad P_2^{\circ} = 22.06 \times 2.5 \times 6 \quad P_2^{\circ} = 1830.90 \text{ kg}$$

$$P_4^{\circ} = P_4^{\circ} = P_6^{\circ} = P_7^{\circ} = P_8^{\circ} = 1830.90 \text{ kg} \quad P_9^{\circ} = 915.45 \text{ kg}$$

2.3.2.2 KAR YÜKÜ

$$P_1^K = 600 \text{ kg} \quad P_2^K = P_3^K = P_4^K = 1200 \text{ kg} \quad P_5^K = 1200 \text{ kg}$$

$$P_6^K = P_7^K = P_8^K = 1200 \text{ kg} \quad P_9^K = 600 \text{ kg}$$

2.3.2.3 RÜZGAR YÜKÜ

$$W_1 = 4.471 \times \frac{2.588}{2} \times 6 \quad W_1 = 34.712 \text{ kg} \quad W_2 = 4.471 \times 2.588 \times 6 \quad W_2 = 69.425 \text{ kg}$$

$$W_3 = 69.425 \text{ kg} \quad W_4 = \left(\frac{4.471}{2} \times 2.588 + 7.153 \times \frac{2.588}{2} \right) \times 6 \quad W_4 = 90.248 \text{ kg}$$

$$W_5 = 7.153 \times \frac{2.588}{2} \times 6 \quad W_5 = 55.535 \text{ kg} \quad W_5' = 32 \times \frac{2.588}{2} \times 6 \quad W_5' = 248.448$$

$$W_6 = \left(32 \times \frac{2.588}{2} + 20 \times \frac{2.588}{2} \right) \times 6 \quad W_6 = 403.728 \text{ kg} \quad W_7 = 20 \times 2.588 \times 6 \quad W_7 = 310.56 \text{ kg}$$

$$W_8 = 310.56 \text{ kg} \quad W_9 = 20 \times \frac{2.588}{2} \times 6 \quad W_9 = 155.28 \text{ kg}$$

RÜZGAR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
1 Nolu Düğüm Noktası		2 Nolu Düğüm Noktası	
$W_x = 8.984 \text{ kg}$	$W_x = - 40.189 \text{ kg}$	$W_x = 17.968 \text{ kg}$	$W_x = - 80.378 \text{ kg}$
$W_z = 33.529 \text{ kg}$	$W_z = 149.988 \text{ kg}$	$W_z = 67.059 \text{ kg}$	$W_z = 299.977 \text{ kg}$
3 Nolu Düğüm Noktası		4 Nolu Düğüm Noktası	
$W_x = 17.968 \text{ kg}$	$W_x = - 80.378 \text{ kg}$	$W_x = 23.357 \text{ kg}$	$W_x = - 104.492 \text{ kg}$
$W_z = 67.059 \text{ kg}$	$W_z = 299.977 \text{ kg}$	$W_z = 87.172 \text{ kg}$	$W_z = 389.971 \text{ kg}$
5 Nolu Düğüm Noktası		6 Nolu Düğüm Noktası	
$W_x = 14.373 \text{ kg}$	$W_x = 64.303 \text{ kg}$	$W_x = 104.492 \text{ kg}$	$W_x = 23.357 \text{ kg}$
$W_z = 53.642 \text{ kg}$	$W_z = 239.982 \text{ kg}$	$W_z = 389.971 \text{ kg}$	$W_z = 87.172 \text{ kg}$
$W_x' = 64.303 \text{ kg}$	$W_x' = 14.373 \text{ kg}$		
$W_z' = 239.982 \text{ kg}$	$W_z = 53.642 \text{ kg}$		

7Nolu Düğüm Noktası

$W_x = 80.378 \text{ kg}$ $W_x = 17.968 \text{ kg}$
 $W_z = 299.977 \text{ kg}$ $W_z = 67.968 \text{ kg}$

8 Nolu Düğüm Noktası

$W_x = 80.378 \text{ kg}$ $W_x = 17.968 \text{ kg}$
 $W_z = 299.977 \text{ kg}$ $W_z = 67.059 \text{ kg}$

9 Nolu Düğüm Noktası

$W_x = 40.189 \text{ kg}$ $W_x = 8.984 \text{ kg}$
 $W_z = 149.988 \text{ kg}$ $W_z = 33.529 \text{ kg}$

2.3.3 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ**ÇÖZÜM B3****SYSTEM**

L=5

:

JOINTS

5 X=10 Y=0 Z=8.679

1 X=0 Y=0 Z=6 G=1,5,1

9 X=20 Y=0 Z=6 G=5,9,1

12 X=15 Y=0 Z=6

10 X=5 Y=0 Z=6 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4
 2 A=6.91E-4
 3 A=118E-4 I=29210E-8 W=92.6E-3
 4 A=35.5E-4 I=691E-8
 1 WG=0.24,0,0
 2 WG=0.12,0,0
 3 WG=-0.24,0,0
 4 WG=-0.12,0,0
 1 1 2 M=1 LP=2,0
 2 2 3 M=4 LP=2,0 G=1,1,1,1
 4 4 5 M=1 LP=2,0 G=1,1,1,1
 6 6 7 M=4 LP=2,0 G=1,1,1,1
 8 8 9 M=1 LP=2,0
 9 1 10 M=1 LP=2,0
 10 10 11 M=1 LP=2,0 G=1,1,1,1
 12 12 9 M=1 LP=2,0
 13 2 10 M=2 LP=2,0
 14 10 4 M=2 LP=2,0
 15 4 11 M=2 LP=2,0
 16 11 5 M=2 LP=2,0
 17 11 6 M=2 LP=2,0
 18 6 12 M=2 LP=2,0
 19 12 8 M=2 LP=2,0
 20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :
 LOADS
 1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
 2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0

1 9 8 L=2 F=0,0,-600E-3,0,0,0
 2 8 1 L=2 F=0,0,-1200E-3,0,0,0
 1 5 4 L=3 F=0,0,-600E-3,0,0,0
 2 4 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-8.984E-3,0,33.529E-3,0,0,0
 2 3 1 L=4 F=-17.968E-3,0,67.059E-3,0,0,0
 4 L=4 F=-23.357E-3,0,87.172E-3,0,0,0
 5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 6 L=4 F=104.492E-3,0,389.971E-3,0,0,0
 7 8 1 L=4 F=80.378E-3,0,299.977E-3,0,0,0
 9 L=4 F=40.189E-3,0,149.988E-3,0,0,0
 1 L=5 F=-40.189E-3,0,149.988E-3,0,0,0
 2 3 1 L=5 F=-80.378E-3,0,299.977E-3,0,0,0
 4 L=5 F=-104.492E-3,0,389.971E-3,0,0,0
 5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 6 L=5 F=23.357E-3,0,87.172E-3,0,0,0
 7 8 1 L=5 F=17.968E-3,0,67.968E-3,0,0,0
 9 L=5 F=8.984E-3,0,33.529E-3,0,0,0
 :

2.3.4. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B3

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -24.76

2 -16.23

3 -11.59

4 2.28

5 3.54

2 -----

1 -19.69

.0 -.88 .00

2.6 -.88 -2.29

2 -12.91

.0 -.58 .00

2.6 -.58 -1.50

3 -8.27

.0 -.58 .00

2.6 -.58 -1.50

4 2.10

.0 .03 .00

2.6 .03 .09

5 2.73

.0 .16 .00

2.6 .16 .40

3 -----

1 -19.22

.0 .88 -2.29

2.6 .88 .00

2 -12.60

.0 .58 -1.50

2.6 .58 .00

3 -7.96

.0 .58 -1.50

2.6 .58 .00

4	2.10			
	.0	-.03	.09	
	2.6	-.03	.00	

5	2.73			
	.0	-.16	.40	
	2.6	-.16	.00	

4 -----

1	-14.15
2	-9.27
3	-4.64
4	1.90
5	1.85

5 -----

1	-14.15
2	-9.27
3	-4.64
4	1.85
5	1.91

6 -----

1	-19.22		
	.0	-.88	.00
	2.6	-.88	-2.29

2	-12.60		
	.0	-.58	.00
	2.6	-.58	-1.50

3	-4.64		
	.0	.00	.00
	2.6	.00	.00

4	2.73
---	------

		.0	.16	.00
		2.6	.16	.40
5	2.10			
		.0	.04	.00
		2.6	.04	.09
7	-----			
1	-19.69			
		.0	.88	-2.29
		2.6	.88	.00
2	-12.91			
		.0	.58	-1.50
		2.6	.58	.00
3	-4.64			
		.0	.00	.00
		2.6	.00	.00
4	2.73			
		.0	-.16	.40
		2.6	-.16	.00
5	2.10			
		.0	-.04	.09
		2.6	-.04	.00
8	-----			
1	-24.76			
2	-16.23			
3	-4.64			
4	3.53			
5	2.29			
9	-----			
1	23.68			

2 15.52

3 11.12

4 -2.16

5 -3.62

10 -----

1 16.85

2 11.04

3 6.64

4 -1.89

5 -2.42

11 -----

1 16.85

2 11.04

3 4.40

4 -2.42

5 -1.89

12 -----

1 23.68

2 15.52

3 4.40

4 -3.62

5 -2.16

13 -----

1 -5.31

2 -3.48

3 -3.48

4 .21

5 .93

14 -----

1 2.19

2 1.44

3 1.44

4 -.09

5 -.38

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .20

5 .89

16 -----

1 5.49

2 3.60

3 1.80

4 -.68

5 -.68

17 -----

1 -4.38

2 -2.87

3 .00

4 .89

5 .20

18 -----

1 2.19

2 1.44

3 .00

4 -.38

5 -.09

19 -----

1 -5.31

2 -3.48

3 .00

4 .93

5 .21

20 -----

1 -7.32

.0 .24 -1.43

6.0 .24 .00

2 -4.80

.0 .16 -.94

6.0 .16

3 -3.60

.0 .08 -.47

6.0 .08 .00

4 .62

.0 -1.48 4.55

6.0 -.04 .00

5 1.07

.0 .97 -3.65

6.0 .25 .00

21 -----

1 -7.32

.0 -.24 .00

6.0 -.24 -1.43

2 -4.80

.0 -.16 .00

6.0 -.16 -.94

3	-1.20		
	.0	-.08	.00
	6.0	-.08	-.47
4	1.06		
	.0	-.25	.00
	6.0	-.97	-3.65
5	.63		
	.0	.04	.00
	6.0	1.48	4.55

Tablo 2.3

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	24.76	11.59	16.23	-2.28	-3.54	40.99	38.71
2	M=2.29 N=19.69	M=1.50 N=8.27	M=1.50 N=12.91	M= -0.09 N= -2.10	M= -0.4 N= -2.73	M= 3.79 N= 32.60	M= 3.70 N= 30.5
3	M= 2.29 N=19.22	M= 1.50 N= 7.96	M=1.50 N= 12.60	M= -0.09 N= -2.10	M= -0.40 N= -2.73	M= 3.79 N= 31.82	M= 3.70 N= 29.72
4	14.15	4.64	9.27	-1.90	-1.85	23.42	21.57
5	14.15	4.64	9.27	-1.85	-1.91	23.42	21.57
6	M= 2.29 N=19.22	M= 0 N= 4.64	M= +1.50 N=12.60	M= -0.4 N= -2.73	M= -0.09 N= -2.73	M=3.79 N= 31.82	M= 3.70 N=29.72
7	M= 2.29 N= 19.69	M= 0 N= 4.64	M= 1.50 N=12.91	M= -0.4 N= -2.73	M= -0.09 N= -2.10	M= 3.79 N=32.60	M=3.70 N= 30.5
8	24.76	4.64	16.23	-3.53	-2.29	40.99	38.70
9	-23.68	-11.12	-15.52	2.16	3.62	-39.20	-37.04
10	-16.85	-6.64	-11.04	1.89	2.42	-27.89	-26.00
11	-16.85	-4.40	-11.04	2.42	1.89	-27.89	-26.00
12	-23.68	-4.40	-15.52	3.62	2.16	-39.20	-37.04
13	5.31	3.48	3.48	-0.21	-0.93	8.79	8.58
14	-2.19	-1.44	-1.44	0.09	0.38	-3.63	3.54
15	4.38	2.87	2.87	-0.20	-0.89	7.25	7.05
16	-5.49	-1.80	-3.60	0.68	0.68	-9.09	-8.41
17	4.38	0	2.87	-0.89	-0.20	7.25	7.05
18	-2.19	0	-1.44	0.38	0.09	-3.63	-3.54
19	5.31	0	3.48	-0.93	-0.21	8.79	8.58
20	M=1.43 N=7.32	M=0.47 N=3.60	M=0.94 N=4.80	M= -4.55 N= -0.62	M=3.65 N= -1.07	M=2.37 N=12.12	M=6.02 N=11.05
21	M=1.43 N=7.32	M=0.47 N=1.20	M=0.94 N=4.80	M= -1.06 N= 3.65	M= -4.55 N= -0.63	M=2.37 N=12.12	M=6.02 N=11.06

Momentler tm

2.3.5. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$\begin{aligned}
 N &= -32.60 \text{ t} & M &= 3.79 \text{ tm} & \text{Seçilen } \frac{1}{2} I &= 550 & A &= 106 \text{ cm}^2 & W_x &= 366 \text{ cm}^3 \\
 i_x &= 8.29 \text{ cm} & i_y &= 4.02 \text{ cm} & S_x &= 27.5 - 3 = 24.5 \text{ cm} & b &= 20 \text{ cm} & d &= 1.9 \text{ cm} & t &= 3 \text{ cm} \\
 \lambda_x &= 31.218 & \lambda_y &= 64.378 & \sigma_{bem} &= 1.018 \text{ t/cm}^2 & \omega_x &= 1.11 & \sigma_{eb} &= 0.30754 \text{ t/cm}^2 \\
 \sigma_{e'} &= 8.506 \text{ t/cm}^2 & \sigma_b &= 1.035 \text{ t/cm}^2 & H' &= 4.083 \text{ cm} & F_B &= 67.7 & I_{yB} &= 2001.33 \\
 i_{yB} &= 5.436 \text{ cm} & \sigma_B &= 1.517 \text{ t/cm}^2
 \end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.90400 < 1$$

$$0.89600 < 1$$

2. Kontrol

$$\lambda_x = 31.21 \rightarrow 32 \text{ için } \omega = 1.11 \quad \sigma = 1.11 \times \frac{32.60}{106} + 0.9 \times \frac{379}{366} \quad \sigma = 1.273 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 39.20 \text{ t} \quad \text{Seçilen } \frac{1}{2} I = 280 \quad A = 30.5 \text{ cm}^2 \quad \sigma = \frac{39.20}{30.5} = 1.285 \text{ t/cm}^2 < \sigma_{em}$$

DİYAGONALLER

13 ve 19 Nolu Elemanlar

$$N = -8.79 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \text{ cm} \quad \text{seçilen } L 90.90.16 \quad A = 26.4 \text{ cm}^2$$

$$i_y = 1.73 \text{ cm} \quad \lambda = \frac{258.8}{1.73} = 149.59 \rightarrow 150 \quad \omega = 3.40 \quad \sigma = 3.40 \times \frac{8.79}{26.4} = 1.13204 \text{ t/cm}^2 < \sigma_{em}$$

15 ve 17 Nolu Eleman

$$N = 7.25 \text{ t} \quad \text{Basınç} \quad \ell_{kx} = \ell_{ky} = 320.1 \text{ cm} \quad \text{seçilen } 2 \times L 70.70.9$$

$$\begin{aligned}
 I_x &= 2 \times I_x & i_x &= 2.10 \text{ cm} & I_y &= [52.6 + (2.10^2 \times 11.9)] \times 2 & I_y &= 210.158 & i_y &= 2.971 \text{ cm} \\
 \lambda &= \frac{320.1}{2.10} & \lambda &= 152.42 & 153 & \omega &= 4.07 & \sigma &= 4.07 \times \frac{7.25}{2 \times 11.9} & \sigma &= 1.239 \text{ t/cm}^2 < \sigma_{em}
 \end{aligned}$$

DİKMELER

16 Nolu Eleman

$$N = 9.09 \text{ t} \quad \text{Seçilen L 50.50.7} \quad A = 6.56 \text{ cm}^2 \quad \sigma = \frac{9.09}{6.56} = 1.385 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$\begin{aligned} N &= 12.12 \text{ t} \quad M = 2.37 \text{ tm} \quad \text{Seçilen I 300} \quad A = 69 \text{ cm}^2 \quad W_x = 653 \text{ cm}^3 \quad i_x = 11.9 \text{ cm} \\ i_y &= 2.56 \quad S_x = 30 - 2 \times 1.62 < 26.76 \text{ cm} \quad b = 12.5 \text{ cm} \quad d = 1.08 \text{ cm} \quad t = 1.62 \text{ cm} \quad \lambda_x = 60.504 \\ \lambda_y &= 117.18 \quad \sigma_{bem} = 0.5889 \text{ t/cm}^2 \quad \sigma_{eb} = 0.1756 \text{ t/cm}^2 \quad \sigma_e = 2.264 \text{ t/cm}^2 \\ \sigma_b &= 0.36294 \text{ t/cm}^2 \quad H' = 4.46 \text{ cm} \quad F_B = 25.06 \text{ cm}^2 \quad I_{yB} = 264.14 \text{ cm}^4 \quad i_{yB} = 3.246 \text{ cm} \\ S/i_{yB} &= 184.80 \quad \sigma_B = 0.51223 \text{ t/cm}^2 \end{aligned}$$

$$\begin{aligned} \text{Gerilme Kontrolleri} \quad 0.95117 &< 1 \\ 0.83052 &< 1 \end{aligned}$$

EİY YÜKLEMESİ İÇİN

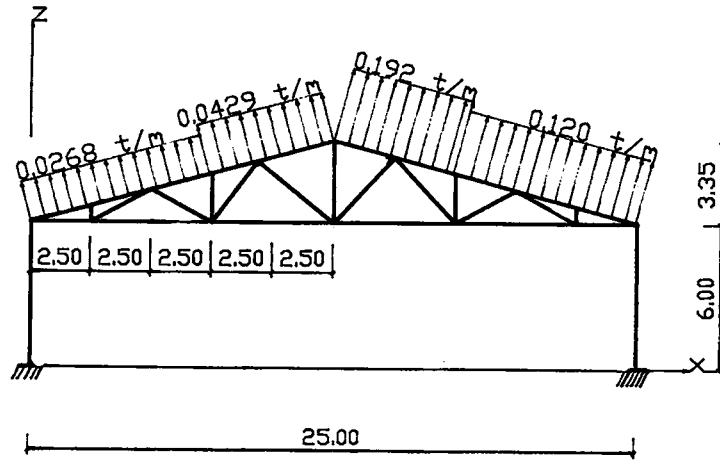
$$\begin{aligned} N &= 11.05 \text{ t} \quad M = 6.02 \text{ tm} \quad \text{Seçilen I 360} \quad A = 97 \text{ cm}^2 \quad W_x = 1090 \text{ cm}^3 \quad i_x = 14.2 \text{ cm} \\ i_y &= 2.90 \quad S_x = 36 - 2 \times 1.95 = 32.1 \text{ cm} \quad b = 14.3 \text{ cm} \quad d = 1.3 \text{ cm} \quad t = 1.95 \text{ cm} \quad \lambda_x = 50.704 \\ \lambda_y &= 103.44 \quad \sigma_{bem} = 0.8066 \quad \sigma_{eb} = 0.113917 \text{ t/cm}^2 \quad \sigma_e = 3.7082 \text{ t/cm}^2 \\ \sigma_b &= 0.5523 \text{ t/cm}^2 \quad H' = 5.35 \text{ cm} \quad F_B = 34.84 \text{ cm}^2 \quad I_{yB} = 392.89 \text{ cm}^4 \quad i_{yB} = 3.69 \text{ cm} \\ S/i_{yB} &= 162.29 \quad \sigma_B = 0.66437 \text{ t/cm}^2 \end{aligned}$$

$$\begin{aligned} \text{Gerilme Kontrolleri} \quad 0.87023 &< 1 \\ 0.910407 &< 1 \end{aligned}$$

2. Kontrol

$$\lambda_x = 50.704 \rightarrow 51 \text{ için } \omega = 1.27 \quad \sigma = 1.27 \times \frac{11.05}{97} + 0.9 \times \frac{602}{1090} \quad \sigma = 0.6417 \text{ t/cm}^2 < \sigma_{em}$$

2.4. ÇÖZÜM B4



Sekil 2.8

2.4.1. SİTEME ETKİYEN YÜKLER

Çatı Örtüsü.....	90.06 kg/m ²
Aşık + Stabilite bağlantıları.....	12.00 kg/m ²
Makas Öz Ağırlığı.....	25.00 kg/m ²
Kar Yüğü.....	P = 80.00 kg/m ²
Toplam Ölü Yüğü.....	g = 127.06 kg/ m ²

2.4.2. DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI

2.4.2.1 ÖLÜ YÜKLER

$$P_1^o = 127.06 \times \frac{2.5}{2} \times 6 \quad P_1^o = 952.95 \text{ kg} \quad P_2^o = 127.06 \times 2.5 \times 6 \quad P_2^o = 1905.9 \text{ kg}$$

$$P_3^o = P_4^o = P_5^o = P_6^o = 1905.9 \text{ kg} \quad P_7^o = P_8^o = P_9^o = P_{10}^o = 1905.9 \text{ kg}$$

$$P_{11}^o = 952.95 \text{ kg}$$

2.4.2.2. KAR YÜKÜ

$$P_1^K = 80 \times \frac{2.5}{2} \times 6 \quad P_2^K = P_3^K = P_4^K = P_5^K = P_6^K = P_7^K = 1200 \text{ kg}$$

$$P_8^K = P_9^K = P_{10}^o = 1200 \text{ kg} \quad P_{11}^o = 600 \text{ kg}$$

2.4.2.3 RÜZGAR YÜKÜ

$$W_1 = 4.471 \times \frac{2.588}{2} \times 6 \quad W_1 = 34.712 \text{ kg} \quad W_2 = 4.471 \times 2.588 \times 6 \quad W_2 = 69.425 \text{ kg}$$

$$W_3 = 69.425 \text{ kg} \quad W_4 = \left(4.471 \frac{2.588}{2} + 7.153 \times \frac{2.588}{2}\right) \times 6 \quad W_4 = 90.248 \text{ kg}$$

$$W_5 = 7.153 \times 2.588 \times 6 \quad W_5 = 111.071 \text{ kg} \quad W_6 = 7.153 \times \frac{2.588}{2} \times 6 \quad W_6 = 55.535 \text{ kg}$$

$$W_6' = 32 \times \frac{2.588}{2} \times 6 \quad W_6' = 248.448 \text{ kg} \quad W_7 = 32 \times 2.588 \times 6 \quad W_7 = 496.896 \text{ kg}$$

$$W_8 = \left(32 \times \frac{2.588}{2} + 20 \times \frac{2.588}{2}\right) \times 6 \quad W_8 = 403.728 \text{ kg} \quad W_9 = 20 \times 2.588 \times 6$$

$$W_9 = 310.56 \text{ kg} \quad W_{10} = 310.56 \text{ kg} \quad W_{11} = 20 \times \frac{2.588}{2} \times 6 \quad W_{11} = 155.28 \text{ kg}$$

RÜZGAR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
1 Nolu Düğüm Noktası		2 Nolu Düğüm Noktası	
$W_x = 8.984 \text{ kg}$	$W_x = - 40.189 \text{ kg}$	$W_x = 17.968 \text{ kg}$	$W_x = - 80.378 \text{ kg}$
$W_z = 33.529 \text{ kg}$	$W_z = 149.988 \text{ kg}$	$W_z = 67.059 \text{ kg}$	$W_z = 299.977 \text{ kg}$
3 Nolu Düğüm Noktası		4 Nolu Düğüm Noktası	
$W_x = 17.968 \text{ kg}$	$W_x = - 80.378 \text{ kg}$	$W_x = 23.357 \text{ kg}$	$W_x = - 104.492 \text{ kg}$
$W_z = 67.059 \text{ kg}$	$W_z = 299.977 \text{ kg}$	$W_z = 87.172 \text{ kg}$	$W_z = 389.971 \text{ kg}$
5 Nolu Düğüm Noktası		6 Nolu Düğüm Noktası	
$W_x = -28.747 \text{ kg}$	$W_x = -128.606 \text{ kg}$	$W_x = 14.373 \text{ kg}$	$W_x = -64.303 \text{ kg}$
$W_z = 107.286 \text{ kg}$	$W_z = 479.964 \text{ kg}$	$W_z = 53.642 \text{ kg}$	$W_z = 239.982 \text{ kg}$

$$\begin{aligned} Wx' &= 64.303 \text{ kg} & Wx' &= 14.373 \text{ kg} \\ Wz' &= 239.982 \text{ kg} & Wz &= 53.642 \text{ kg} \end{aligned}$$

7Nolu Düğüm Noktası

$$\begin{aligned} Wx &= 128.606 \text{ kg} & Wx &= 28.747 \text{ kg} \\ Wz &= 479.964 \text{ kg} & Wz &= 107.286 \text{ kg} \end{aligned}$$

8 Nolu Düğüm Noktası

$$\begin{aligned} Wx &= 104.492 \text{ kg} & Wx &= 23.357 \text{ kg} \\ Wz &= 389.971 \text{ kg} & Wz &= 87.172 \text{ kg} \end{aligned}$$

9 Nolu Düğüm Noktası

$$\begin{aligned} Wx &= 80.378 \text{ kg} & Wx &= 17.968 \text{ kg} \\ Wz &= 299.977 \text{ kg} & Wz &= 67.059 \text{ kg} \end{aligned}$$

10 Nolu Düğüm Noktası

$$\begin{aligned} Wx &= 80.378 \text{ kg} & Wx &= 17.968 \text{ kg} \\ Wz &= 299.977 \text{ kg} & Wz &= 67.059 \text{ kg} \end{aligned}$$

11 Nolu Düğüm Noktası

$$\begin{aligned} Wx &= 40.189 \text{ kg} & Wx &= 8.984 \text{ kg} \\ Wz &= 149.988 \text{ kg} & Wz &= 33.259 \text{ kg} \end{aligned}$$

2.4.3. STATİK ÇÖZÜM İÇİN SAP90 VERSİ

ÇÖZÜM B4

SYSTEM

L=5

:

JOINTS

6 X=12.5 Y=0 Z=9.35

1 X=0 Y=0 Z=6 G=1,6,1

11 X=25 Y=0 Z=6 G=6,11,1

16 X=22.5 Y=0 Z=6

12 X=2.5 Y=0 Z=6 G=12,16,1

17 X=0 Y=0 Z=0

18 X=25 Y=0 Z=0

:

RESTRAINTS

1 16 1 R=0,1,0,1,0,1

17 18 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

1 WG=0.24,0,0

2 WG=0.12,0,0

3 WG=-0.24,0,0

4 WG=-0.12,0,0

1 1 2 M=1 LP=2,0 G=9,1,1,1

11 1 12 M=1 LP=2,0

12 12 13 M=1 LP=2,0 G=3,1,1,1

16 16 11 M=1 LP=2,0

17 2 12 M=2 LP=2,0

18 12 3 M=2 LP=2,0

19 3 13 M=2 LP=2,0

20 4 13 M=2 LP=2,0

21 13 5 M=2 LP=2,0

22 5 14 M=2 LP=2,0

23 6 14 M=2 LP=2,0

24 14 7 M=2 LP=2,0

25 7 15 M=2 LP=2,0

26 8 15 M=2 LP=2,0

27 15 9 M=2 LP=2,0

28 9 16 M=2 LP=2,0

29 10 16 M=2 LP=2,0

30 17 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

31 11 18 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 11 10 L=1 F=0,0,-952.95E-3,0,0,0

2 10 1 L=1 F=0,0,-1905.9E-3,0,0,0

1 11 10 L=2 F=0,0,-600E-3,0,0,0

2 10 1 L=2 F=0,0,-1200E-3,0,0,0

1 6 5 L=3 F=0,0,-600E-3,0,0,0

2 5 1 L=3 F=0,0,-1200E-3,0,0,0

1 L=4 F=-8.984E-3,0,33.529E-3,0,0,0

2 3 1 L=4 F=-17.968E-3,0,67.059E-3,0,0,0

4 L=4 F=-23.357E-3,0,87.172E-3,0,0,0

5 L=4 F=-28.747E-3,0,107.286E-3,0,0,0

6 L=4 F=49.93E-3,0,293.624E-3,0,0,0

7 L=4 F=128.606E-3,0,479.964E-3,0,0,0

8 L=4 F=104.492E-3,0,389.971E-3,0,0,0

9 10 1 L=4 F=80.378E-3,0,299.977E-3,0,0,0

11 L=4 F=40.189E-3,0,149.988E-3,0,0,0

1 L=5 F=-40.189E-3,0,149.988E-3,0,0,0

2 3 1 L=5 F=-80.378E-3,0,299.977E-3,0,0,0

4 L=5 F=-104.492E-3,0,389.971E-3,0,0,0

5 L=5 F=-128.606E-3,0,479.964E-3,0,0,0

6 L=5 F=-49.93E-3,0,293.624E-3,0,0,0

7 L=5 F=28.747E-3,0,107.286E-3,0,0,0

8 L=5 F=23.357E-3,0,87.172E-3,0,0,0

9 10 1 L=5 F=17.968E-3,0,67.059E-3,0,0,0

11 L=5 F=8.984E-3,0,33.529E-3,0,0,0

:

2.4.4. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B4

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -33.13

2 -20.86

3 -15.07

4 3.14

5 4.94

2 -----

1 -33.13

2 -20.86

3 -15.07

4 3.16

5 5.02

3 -----

1 -25.77

2 -16.22

3 -10.43

4 2.90

5 3.86

4 -----

1 -25.77

2 -16.22

3 -10.43

4 2.93

5 3.97

5 -----

1 -18.41

2 -11.59

3 -5.79

4 2.61

5 2.56

6 -----

1 -18.41

2 -11.59

3 -5.79

4 2.56

5 2.61

7 -----

1 -25.77

2 -16.22

3 -5.79

4 3.97

5 2.93

8 -----

1 -25.77

2 -16.22

3 -5.79

4 3.86

5 2.90

9 -----

1 -33.13

2 -20.86

3 -5.79

4 5.02

5 3.16

10 -----

- 1 -33.13
- 2 -20.86
- 3 -5.79
- 4 4.94
- 5 3.14

11 -----

- 1 31.62
- 2 19.91
- 3 14.43
- 4 -2.92
- 5 -5.01

12 -----

- 1 28.07
- 2 17.67
- 3 12.19
- 4 -2.79
- 5 -4.41

13 -----

- 1 20.95
- 2 13.19
- 3 7.72
- 4 -2.50
- 5 -3.12

14 -----

- 1 20.95
- 2 13.19
- 3 5.48
- 4 -3.12

5 -2.50

15 -----

1 28.07

2 17.67

3 5.48

4 -4.41

5 -2.79

16 -----

1 31.62

2 19.91

3 5.48

4 -5.01

5 -2.92

17 -----

1 -1.91

2 -1.20

3 -1.20

4 .07

5 .32

18 -----

1 4.03

2 2.54

3 2.54

4 -.15

5 -.68

19 -----

1 -4.03

2 -2.54

3 -2.54

4 .15

5 .68

20 -----

1 -1.91

2 -1.20

3 -1.20

4 .09

5 .42

21 -----

1 5.21

2 3.28

3 3.28

4 -.23

5 -1.01

22 -----

1 -5.21

2 -3.28

3 -3.28

4 .26

5 1.17

23 -----

1 7.62

2 4.80

3 2.40

4 -1.05

5 -1.05

24 -----

1 -5.21

2 -3.28

3 .00

4 1.17

5 .26

25 -----

1 5.21

2 3.28

3 .00

4 -1.01

5 -.23

26 -----

1 -1.91

2 -1.20

3 .00

4 .42

5 .09

27 -----

1 -4.03

2 -2.54

3 .00

4 .68

5 .15

28 -----

1 4.03

2 2.54

3 .00

4 -.68

5 -.15

29 -----

1 -1.91

2 -1.20

3 .00

4 .32

5 .07

30 -----

1 -9.53

.0 .38 -2.29

6.0 .38

2 -6.00

.0 .24 -1.44

6.0 .24

3 -4.50

.0 .12 -.72

6.0 .12 .00

4 .85

.0 -1.55 4.97

6.0 -.11 .00

5 1.43

.0 1.00 -3.83

6.0 .28 .00

31 -----

1 -9.53

.0 -.38 .00

6.0 -.38 -2.29

2 -6.00

.0 -.24 .00

6.0 -.24 -1.44

3 -1.50

.0 -.12 .00

	6.0	-1.12	-0.72
4	1.43		
	.0	-.28	.00
	6.0	-1.00	-3.83
5	.85		
	.0	.11	.00
	6.0	1.55	4.97

Tablo 2.4

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	33.13	15.07	20.86	-3.14	-4.94	53.99	50.85
2	33.13	15.07	20.86	-3.16	-5.02	53.99	50.85
3	25.77	10.43	16.22	-2.90	-3.86	41.99	39.09
4	25.77	10.43	16.22	-2.93	-3.97	41.99	39.09
5	18.41	5.79	11.59	-2.61	-2.56	30.00	27.44
6	18.41	5.79	11.59	-2.56	-2.61	30.00	27.44
7	25.77	5.79	16.22	-3.97	-2.93	41.99	39.09
8	25.77	5.79	16.22	-3.86	-2.90	41.99	39.09
9	33.13	5.79	20.86	-5.02	-3.16	53.99	50.83
10	33.13	5.79	20.86	-4.94	-3.14	53.99	50.85
11	-31.62	-14.43	-19.91	2.92	5.01	-51.53	-48.61
12	-28.07	-12.19	-17.67	2.79	4.41	-45.74	-42.95
13	-20.95	-7.72	-13.19	2.50	3.12	-34.14	-31.64
14	-20.95	-5.48	-13.19	+3.12	2.50	-34.14	-31.64
15	-28.07	-5.48	-17.67	4.41	2.79	-45.74	-42.95
16	-31.62	-5.48	-19.91	5.01	2.92	-51.53	-48.61
17	1.91	1.20	1.20	-0.07	-0.32	3.11	3.04
18	-4.03	-2.54	-2.54	0.15	0.68	-6.57	-6.42
19	4.03	2.54	2.54	-0.15	-0.68	6.57	6.42
20	1.91	1.20	1.20	-0.09	-0.42	3.11	3.02
21	-5.21	-3.28	-3.28	0.23	1.01	-8.49	-8.26
22	5.21	3.28	3.28	-0.26	-1.17	8.49	8.23
23	-7.62	-2.40	-4.80	1.05	1.05	-12.42	-11.37
24	5.21	0	3.28	-1.17	-0.26	8.49	8.23
25	-5.21	0	-3.28	1.01	0.23	-8.49	-8.26
26	1.91	0	1.20	-0.42	-0.09	3.11	3.02
27	4.03	0	-2.54	-0.68	-0.15	6.57	6.42
28	-4.03	0	-2.54	0.68	0.15	-6.57	-6.42
29	1.91	0	1.20	-0.32	-0.07	3.11	3.04
30	M=+2.29 N=9.53	M=+0.72 N=4.5	M=+1.44 N=6.00	M= - 4.97 N= -0.85	M=3.83 N= -1.43	M=3.73 N=15.53	M=7.56 N=14.10
31	M=2.29 N=9.53	M=+0.72 N= 1.5	M=1.44 N=6.00	M= 3.83 N= -1.43	M= -4.97 N= -0.85	M=3.73 N=15.53	M=7.56 N=14.10

Moment tm

2.4.5 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$N = -53.99 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \text{ cm} \quad \text{Seçilen } \frac{1}{2} \text{ I } 425 \quad A = 66.2 \text{ cm}^2$$

$$i_y = 3.30 \text{ cm} \quad \lambda = \frac{2.588}{3.30} = 78.424 \rightarrow 79 \quad \omega = 1.59 \quad \sigma = 1.59 \times \frac{53.99}{66.2}$$

$$\sigma = 1.296 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 51.53 \text{ t} \quad \text{Seçilen } \frac{1}{2} \text{ I } 320 \quad A = 38.9 \text{ cm}^2 \quad \sigma = \frac{51.53}{38.9} = 1.324 \text{ t/cm}^2 < \sigma_{em}$$

DİKMELER

17 ve 29 Nolu Elemanlar

$$N = -3.11 \text{ t} \quad \ell_{kx} = \ell_{ky} = 0.67 \text{ m} \quad \text{Seçilen L } 50.50 \text{ 5} \quad A = 4.80 \text{ cm}^2 \quad i_y = 0.98 \text{ cm}$$

$$\lambda = \frac{67}{0.98} = 68.367 \rightarrow 69 \quad \omega = 1.46 \quad \sigma = 1.46 \times \frac{3.11}{4.80} \quad \sigma = 0.9459 \text{ t/cm}^2 < \sigma_{em}$$

20 ve 26 Nolu Elemanlar

$$N = -3.11 \text{ t} \quad \ell_{kx} = \ell_{ky} = 200 \text{ cm} \quad \text{Seçilen L } 65.65 \text{ 9} \quad A = 11.0 \text{ cm}^2 \quad i_y = 1.25 \text{ cm}$$

$$\lambda = \frac{200}{1.25} = 160 \rightarrow \omega = 4.45 \quad \sigma = 4.45 \times \frac{3.11}{11.0} = 1.258 \text{ t/cm}^2 < \sigma_{em}$$

23 Nolu Eleman

$$N = 12.42 \text{ t} \quad \text{Seçilen L } 60.60 \text{ 8} \quad A = 9.03 \text{ cm}^2 \quad \sigma = \frac{12.42}{9.03} = 1.375 \text{ t/cm}^2$$

DİYAGONALLER

18 ve 28 Nolu Elemanlar

$$N = 6.57 \text{ t} \quad \text{Seçilen L } 50.50 \text{ 5} \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{6.57}{4.80} = 1.368 \text{ t/cm}^2 < \sigma_{em}$$

19 ve 27 Nolu Elemanlar

$$N = -6.57 \text{ t} \quad \ell_{kx} = \ell_{ky} = 283.6 \text{ cm} \quad \text{Seçilen L 90.90.13} \quad A = 21.8 \text{ cm}^2$$

$$i_y = 1.74 \text{ cm} \quad \lambda = \frac{283.6}{1.74} = 162.98 \rightarrow 163 \quad \omega = 4.61 \quad \sigma = 4.61 \times \frac{6.57}{21.8} = 1.389 \text{ t/cm}^2 < \sigma_{em}$$

21 ve 25 Nolu Elemanlar

$$N = 8.49 \text{ t} \quad \text{Seçilen L 50.50 7} \quad F = 6.56 \text{ cm}^2 \quad \sigma = \frac{8.49}{6.56} = 1.294 \text{ t/cm}^2 < \sigma_{em}$$

22 ve 24 Nolu Elemanlar

$$N = 8.49 \text{ t} \quad \ell_{kx} = \ell_{ky} = 366.5 \text{ cm} \quad \text{Seçilen } 2 \times \text{L 75.75.10} \quad i_x = 2.25$$

$$\lambda = \frac{366.5}{2.25} = 162.8 \rightarrow 163 \quad \omega = 4.61 \quad \sigma = 4.61 \times \frac{8.49}{(2 \times 14.1)} = 1.387 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$N = 15.53 \text{ t} \quad M = 3.73 \text{ tm} \quad \text{Seçilen I 340} \quad A = 86.7 \text{ cm}^2 \quad W_x = 923 \text{ cm}^3 \quad i_x = 13.5 \text{ cm}$$

$$i_y = 2.80 \text{ cm} \quad S_x = 34 - 2 \times 1.83 = 30.34 \text{ cm} \quad b = 13.7 \text{ cm} \quad d = 1.22 \text{ cm} \quad t = 1.83 \text{ cm}$$

$$\lambda_x = 53.33 \quad \lambda_y = 107.14 \quad \sigma_{bem} = 0.6693 \text{ t/cm}^2 \quad \sigma_{eb} = 0.179 \text{ t/cm}^2 \quad \sigma_e = 2.914 \text{ t/cm}^2$$

$$\sigma_b = 0.404 \text{ t/cm}^2 \quad H' = 5.05 \quad F_B = 31.24 \text{ cm}^2 \quad I_{yB} = 392.85 \text{ cm}^4 \quad i_{yB} = 3.546$$

$$S/i_{yB} = 169.19 \quad \sigma_B = 0.61136 \text{ t/cm}^2$$

$$\text{Gerilme Kontrolleri} \quad 0.8660 < 1$$

$$0.7850 < 1$$

EİY YÜKLEMESİ İÇİN

$$N = 14.10 \text{ t} \quad M = 7.56 \text{ tm} \quad \text{Seçilen I 380} \quad A = 107 \text{ cm}^2 \quad W_x = 1260 \text{ cm}^3 \quad i_x = 15 \text{ cm}$$

$$i_y = 3.02 \text{ cm} \quad S_x = 38 - 2 \times 2.05 = 33.9 \text{ cm} \quad b = 14.9 \text{ cm} \quad d = 1.37 \text{ cm} \quad t = 2.05 \text{ cm}$$

$$\lambda_x = 48 \quad \lambda_y = 99.3 \quad \sigma_{bem} = 0.8434 \text{ t/cm}^2 \quad \sigma_{eb} = 0.13177 \text{ t/cm}^2 \quad \sigma_e = 4.1378 \text{ t/cm}^2$$

$$\sigma_b = 0.6 \text{ t/cm}^2 \quad H' = 5.65 \text{ cm} \quad F_B = 38.285 \text{ cm}^2 \quad I_{yB} = 566.318 \text{ cm}^4 \quad i_{yB} = 3.846 \text{ cm}$$

$$S/i_{yx} = 156.00 \text{ cm} \quad \sigma_B = 0.71905 \text{ t/cm}^2$$

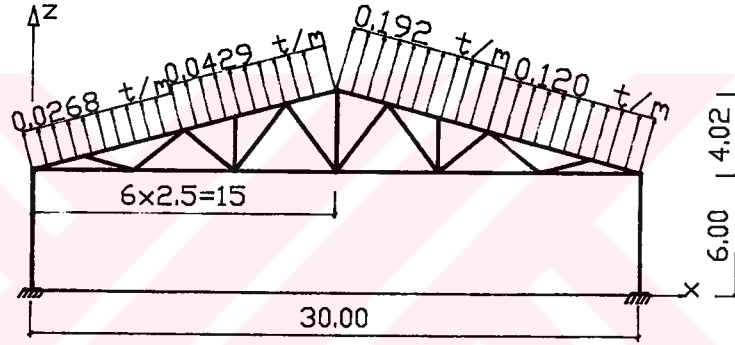
$$\text{Gerilme Kontrolleri} \quad 0.88883 < 1$$

$$0.92593 < 1$$

2. Kontrol

$$\lambda_x = 48 \text{ için } \omega = 1.24 \quad \sigma = 1.27 \times \frac{11.05}{97} + 0.9 \times \frac{602}{1090} \quad \sigma = 0.6417 \text{ t/cm}^2 < \sigma_{em}$$

2.5. ÇÖZÜM B5



Sekil 2.9

2.5.1. SİSTEME ETKİYEN YÜKLER

Çatı Örtüsü.....	90.06 kg/ m ²
Aşık + Stabilite bağlantıları.....	12.00 kg/ m ²
Makas Öz Ağırlığı.....	30.00 kg/ m ²
Toplam Ölü Yük.....	g = 132.06 kg/ m ²

2.5.2 DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI

2.5.2.1 ÖLÜ YÜKLER

$$P_1^o = 132.06 \times \frac{2.5}{2} \times 6 \quad P_1^o = 990.45 \text{ kg} \quad P_2^o = 132.06 \times 2.5 \times 6 \quad P_2^o = 1980.9 \text{ kg}$$

$$P_3^{\delta} = P_4^{\delta} = P_5^{\delta} = P_6^{\delta} = P_7^{\delta} = 1980.9 \text{ kg} \quad P_8^{\delta} = P_9^{\delta} = P_{10}^{\delta} = P_{11}^{\delta} = P_{12}^{\delta} = 1980.9 \text{ kg}$$

$$P_{13}^{\delta} = 990.45 \text{ kg}$$

2.5.2.2. KAR YÜKÜ

$$P_1^K = P_{13}^K = 600 \text{ kg} \quad P_2^K = P_3^K = P_4^K = P_5^K = P_6^K = P_7^K = P_8^K = P_9^K = P_{10}^K = P_{11}^K = P_{12}^K = 1200 \text{ kg}$$

2.5.2.3 RÜZGAR YÜKÜ

$$W_1 = 34.712 \text{ kg} \quad W_2 = W_3 = 69.425 \text{ kg} \quad W_4 = (4.471 \frac{2.588}{2} + 7.153 \times \frac{2.588}{2}) \times 6$$

$$W_4 = 90.248 \text{ kg} \quad W_5 = W_6 = 7.153 \times 2$$

$$.588 \times 6 \quad W_5 = W_6 = 111.071 \text{ kg}$$

$$W_7 = 7.153 \times \frac{2.588}{2} \times 6 \quad W_7 = 55.535 \text{ kg} \quad W_7' = 32 \times \frac{2.588}{2} \times 6 \quad W_7' = 248.448 \text{ kg}$$

$$W_8 = W_9 = 496.896 \text{ kg} \quad W_{10} = (32 \times \frac{2.588}{2} + 20 \times \frac{2.588}{2}) \times 6 \quad W_{10} = 403.728 \text{ kg}$$

$$W_{11} = 20 \times 2.588 \times 6 \quad W_{11} = W_{12} = 310.56 \text{ kg} \quad W_{13} = 20 \times \frac{2.588}{2} \times 6 \quad W_{13} = 155.28 \text{ kg}$$

RÜZGAR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
1 Nolu Düğüm Noktası		2 Nolu Düğüm Noktası	
W _x = 8.984 kg	W _x = - 40.189 kg	W _x = 17.968 kg	W _x = - 80.378 kg
W _z = 33.529 kg	W _z = 149.988 kg	W _z = 67.059 kg	W _z = 299.977 kg
3 Nolu Düğüm Noktası		4 Nolu Düğüm Noktası	
W _x = 17.968 kg	W _x = - 80.378 kg	W _x = 23.357 kg	W _x = - 104.492 kg
W _z = 67.059 kg	W _z = 299.977 kg	W _z = 87.172 kg	W _z = 389.971 kg

5 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= -28.747 \text{ kg} & W_x &= -128.606 \text{ kg} \\ W_z &= 107.286 \text{ kg} & W_z &= 479.964 \text{ kg} \end{aligned}$$

6 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= -28.747 \text{ kg} & W_x &= -128.606 \text{ kg} \\ W_z &= 107.286 \text{ kg} & W_z &= 479.964 \text{ kg} \end{aligned}$$

7 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 14.373 \text{ kg} & W_x &= 64.303 \text{ kg} \\ W_z &= 53.642 \text{ kg} & W_z &= 239.982 \text{ kg} \\ W_x' &= 64.303 \text{ kg} & W_x' &= 14.373 \text{ kg} \\ W_z' &= 239.982 \text{ kg} & W_z' &= 53.642 \text{ kg} \end{aligned}$$

8 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 128.606 \text{ kg} & W_x &= 28.747 \text{ kg} \\ W_z &= 479.964 \text{ kg} & W_z &= 107.286 \text{ kg} \end{aligned}$$

9 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 128.606 \text{ kg} & W_x &= 28.747 \text{ kg} \\ W_z &= 479.964 \text{ kg} & W_z &= 107.286 \text{ kg} \end{aligned}$$

10 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 104.492 \text{ kg} & W_x &= 23.357 \text{ kg} \\ W_z &= 389.971 \text{ kg} & W_z &= 87.172 \text{ kg} \end{aligned}$$

11 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 80.378 \text{ kg} & W_x &= 17.968 \text{ kg} \\ W_z &= 299.977 \text{ kg} & W_z &= 67.059 \text{ kg} \end{aligned}$$

12 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 80.378 \text{ kg} & W_x &= 17.968 \text{ kg} \\ W_z &= 299.977 \text{ kg} & W_z &= 67.059 \text{ kg} \end{aligned}$$

13 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 40.189 \text{ kg} & W_x &= 8.984 \text{ kg} \\ W_z &= 149.988 \text{ kg} & W_z &= 33.529 \text{ kg} \end{aligned}$$

2.5.3. STATİK ÇÖZÜM İÇİN SAP90 VERSİ

ÇÖZÜM B5

SYSTEM

L=5

:

JOINTS

7 X=15 Y=0 Z=10.02

1 X=0 Y=0 Z=6 G=1,7,1
 13 X=30 Y=0 Z=6 G=7,13,1
 18 X=25 Y=0 Z=6
 14 X=5 Y=0 Z=6 G=14,18,1
 19 X=0 Y=0 Z=0
 20 X=30 Y=0 Z=0

:

RESTRAINTS

1 18 1 R=0,1,0,1,0,1
 19 20 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4
 2 A=6.91E-4
 3 A=118E-4 I=29210E-8 W=92.6E-3
 4 A=34.5E-4 I=691E-8
 1 WG=0.24,0,0
 2 WG=0.12,0,0
 3 WG=-0.24,0,0
 4 WG=-0.12,0,0
 1 1 2 M=1 LP=2,0
 2 2 3 M=4 LP=2,0 G=1,1,1,1
 4 4 5 M=1 LP=2,0 G=5,1,1,1
 10 10 11 M=4 LP=2,0 G=1,1,1,1
 12 12 13 M=1 LP=2,0
 13 1 14 M=1 LP=2,0
 14 14 15 M=1 LP=2,0 G=3,1,1,1
 18 18 13 M=1 LP=2,0

19 2 14 M=2 LP=2,0
 20 14 4 M=2 LP=2,0
 21 4 15 M=2 LP=2,0
 22 5 15 M=2 LP=2,0
 23 15 6 M=2 LP=2,0
 24 6 16 M=2 LP=2,0
 25 16 7 M=2 LP=2,0
 26 16 8 M=2 LP=2,0
 27 8 17 M=2 LP=2,0
 28 9 17 M=2 LP=2,0
 29 17 10 M=2 LP=2,0
 30 10 18 M=2 LP=2,0
 31 18 12 M=2 LP=2,0
 32 19 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 33 13 20 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 13 12 L=1 F=0,0,-990.45E-3,0,0,0
 2 12 1 L=1 F=0,0,-1980.9E-3,0,0,0
 1 13 12 L=2 F=0,0,-600E-3,0,0,0
 2 12 1 L=2 F=0,0,-1200E-3,0,0,0
 1 7 6 L=3 F=0,0,-600E-3,0,0,0
 2 6 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-8.984E-3,0,33.529E-3,0,0,0
 2 3 1 L=4 F=-17.968E-3,0,67.059E-3,0,0,0
 4 L=4 F=-23.357E-3,0,87.172E-3,0,0,0
 5 6 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 7 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 8 9 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0

10 L=4 F=104.492E-3,0,389.971E-3,0,0,0
 11 12 1 L=4 F=80.378E-3,0,299.977E-3,0,0,0
 13 L=4 F=40.189E-3,0,149.988E-3,0,0,0
 1 L=5 F=-40.189E-3,0,149.988E-3,0,0,0
 2 3 1 L=5 F=-80.378E-3,0,299.977E-3,0,0,0
 4 L=5 F=-104.492E-3,0,389.971E-3,0,0,0
 5 6 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 7 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 8 9 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 10 L=5 F=23.357E-3,0,87.172E-3,0,0,0
 11 12 1 L=5 F=17.968E-3,0,67.059E-3,0,0,0
 13 L=5 F=8.984E-3,0,33.529E-3,0,0,0

:

2.5.4. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B5

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT

1 -----

1 -42.09

2 -25.50

3 -18.54

4 3.99

5 6.36

2 -----

1 -36.60

.0 -.96 .00

2.6 -.96 -2.48

2 -22.17

.0 -.58 .00

2.6 -.58 -1.50

3 -15.22

.0 -.58 .00

2.6 -.58 -1.50

4 3.81

.0 .03 .00

2.6 .03 .09

5 5.56

.0 .16 .00

2.6 .16 .40

3 -----

1 -36.09

.0 .96 -2.48

2.6 .96 .00

2 -21.86

.0 .58 -1.50

2.6 .58 .00

3	-14.91		
	.0	.58	-1.50
	2.6	.58	.00
4	3.81		
	.0	-.03	.09
	2.6	-.03	.00
5	5.56		
	.0	-.16	.40
	2.6	-.16	.00

4 -----

1	-30.61
2	-18.54
3	-11.59
4	3.61
5	4.68

5 -----

1	-30.61
2	-18.54
3	-11.59
4	3.64
5	4.81

6 -----

1	-22.96
2	-13.91
3	-6.95
4	3.29
5	3.24

7 -----

1	-22.96
---	--------

2 -13.91

3 -6.95

4 3.24

5 3.29

8 -----

1 -30.61

2 -18.54

3 -6.95

4 4.81

5 3.64

9 -----

1 -30.61

2 -18.54

3 -6.95

4 4.68

5 3.61

10 -----

1 -36.09

.0 -96 .00

2.6 -96 -2.48

2 -21.86

.0 -58 .00

2.6 -58 -1.50

3 -6.95

.0 .00 .00

2.6 .00 .00

4 5.56

.0 .16 .00

2.6 .16 .40

5	3.81		
	.0	.03	.00
	2.6	.03	.09

11 -----

1	-36.60		
	.0	.96	-2.48
	2.6	.96	.00

2	-22.17		
	.0	.58	-1.50
	2.6	.58	.00

3	-6.9		
	.0	.00	.00
	2.6	.00	.00

4	5.56		
	.0	-.16	.40
	2.6	-.16	.00

5	3.81		
	.0	-.03	.09
	2.6	-.03	.00

12 -----

1	-42.09
---	--------

2	-25.50
---	--------

3	-6.95
---	-------

4	6.36
---	------

5	3.99
---	------

13 -----

1	40.08
---	-------

2	24.28
---	-------

3	17.74
---	-------

4 -3.66

5 -6.41

14 -----

1 32.68

2 19.80

3 13.26

4 -3.39

5 -5.21

15 -----

1 25.29

2 15.32

3 8.78

4 -3.06

5 -3.72

16 -----

1 25.29

2 15.32

3 6.54

4 -3.72

5 -3.06

17 -----

1 32.68

2 19.80

3 6.54

4 -5.21

5 -3.39

18 -----

1 40.08

2 24.28

3 6.54

4 -6.41

5 -3.66

19 -----

1 -5.74

2 -3.48

3 -3.48

4 .21

5 .93

20 -----

1 2.37

2 1.44

3 1.44

4 -.09

5 -.38

21 -----

1 -4.74

2 -2.87

3 -2.87

4 .20

5 .89

22 -----

1 -1.98

2 -1.20

3 -1.20

4 .11

5 .51

23 -----

1 6.18

2 3.74

3 3.74

4 -.30

5 -1.33

24 -----

1 -6.18

2 -3.74

3 -3.74

4 .32

5 1.42

25 -----

1 9.90

2 6.00

3 3.00

4 -1.40

5 -1.40

26 -----

1 -6.18

2 -3.74

3 .00

4 1.42

5 .32

27 -----

1 6.18

2 3.74

3 .00

4 -1.33

5 -.30

28 -----

1 -1.98

2 -1.20

3 .00

4 .51

5 .11

29 -----

1 -4.74

2 -2.87

3 .00

4 .89

5 .20

30 -----

1 2.37

2 1.44

3 .00

4 -.38

5 -.09

31 -----

1 -5.74

2 -3.48

3 .00

4 .93

5 .21

32 -----

1 -11.89

.0 .58 -3.46

6.0 .58 .00

2 -7.20

.0 .35 -2.10

		6.0	.35	.00
3	-5.40			
		.0	.17	-1.05
		6.0	.17	
4	1.07			
		.0	-1.62	5.42
		6.0	-.18	.00
5	1.80			
		.0	1.02	-3.98
		6.0	.30	.00
33	-----			
1	-11.89			
		.0	-.58	.00
		6.0	-.58	-3.46
2	-7.20			
		.0	-.35	.00
		6.0	-.35	-2.10
3	-1.80			
		.0	-.17	.00
		6.0	-.17	-1.05
4	1.80			
		.0	-.30	.00
		6.0	-1.02	-3.98
5	1.07			
		.0	.18	.00
		6.0	1.62	5.42

Tablo 2.5

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	42.09	18.54	25.50	-3.99	-6.36	67.59	63.60
2	M= 2.48 N= 36.60	M=1.50 N=15.22	M=1.50 N=22.17	M= -0.09 N= -3.81	M= -0.40 N= -5.56	M= 3.98 N= 58.77	M= 3.89 N= 54.96
3	M= 2.48 N= 36.09	M= 1.50 N= 14.91	M= 1.50 N= 21.86	M= -0.09 N= -3.81	M= -0.40 N= -5.46	M= 3.98 N= 57.95	M= 3.89 N= 54.14
4	30.61	11.59	18.54	-3.61	-4.68	49.15	45.54
5	30.61	11.59	18.54	-3.64	-4.81	49.15	45.51
6	22.96	6.95	13.91	-3.29	-3.24	36.87	33.63
7	22.96	6.95	13.9	-3.24	-3.29	36.87	33.63
8	30.61	6.56	18.54	-4.81	-3.64	49.15	45.51
9	30.61	6.95	18.54	-4.68	-3.61	49.15	45.54
10	M= 2.48 N= 36.09	M= 0 N= 6.95	M= 1.50 N= 21.86	M= -0.40 N= -5.56	M= -0.07 N= -3.81	M= 3.98 N= 57.95	M= 3.89 N= 54.14
11	M= 2.48 N= 36.60	M= 0 N= 6.95	M= 1.50 N= 22.17	M= -0.40 N= -5.56	M= -0.07 N= -3.81	M= 3.98 N= 58.77	M= 3.89 N= 54.96
12	42.09	6.95	25.50	-6.36	-3.99	67.59	63.60
13	-40.08	-17.74	-24.28	3.66	6.41	-64.36	-60.70
14	-32.68	-13.26	-19.80	3.89	5.21	-52.48	-48.49
15	-25.29	-8.78	-15.32	3.06	3.72	-40.61	-37.55
16	-25.29	-6.54	-15.32	3.72	3.06	-40.61	-37.56
17	-32.68	-6.54	-19.80	5.21	3.39	-52.48	-49.09
18	-40.08	-6.54	-24.28	6.41	3.66	-64.36	-60.70
19	5.74	3.48	3.48	-0.21	-0.93	9.22	9.01
20	-2.37	-1.44	-1.44	0.09	0.38	-3.81	-3.72
21	4.74	2.87	2.87	-0.20	-0.89	7.61	7.41
22	1.98	1.20	1.20	-0.11	-0.51	3.18	3.07
23	-6.18	-3.74	-3.74	0.30	1.33	-9.92	9.62
24	6.18	3.74	3.74	-0.32	-1.42	9.92	9.60
25	-9.90	-3.00	-6.00	1.40	1.40	-15.90	-14.50
26	6.18	0	3.74	-1.42	-0.32	9.92	9.60
27	-6.18	0	-3.74	1.33	0.30	-9.92	-9.62
28	1.98	0	1.20	-0.51	-0.11	3.18	0.07
29	4.74	0	2.87	-0.89	-0.20	7.61	7.41
30	-2.37	0	-1.44	0.38	0.09	-3.81	-3.72
31	4.74	0	3.48	-0.93	-0.21	9.22	9.01
32	M= 3.46 N= 11.89	M= 1.05 N= 5.40	M= 2.10 N= 7.20	M= -5.42 N= -1.07	M= 3.98 N= -1.80	M= 5.56 N= 19.09	M= 9.54 N= 17.29
33	M= 3.46 N= 11.89	M= 1.05 N= -1.80	M= 2.10 N= 7.20	M= 3.98 N= -1.80	M= -5.42 N= -1.07	M= 5.56 N= 19.09	M= 9.54 N= 17.29

Momentler tm

2.5.5 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$\begin{aligned}
 N &= 58.77 \text{ t} \quad M = 3.98 \text{ tm} \quad \text{Seçilen } \frac{1}{2} \text{ I } 600 \quad A = 127 \text{ cm}^2 \quad W_x = 491 \text{ cm}^3 \\
 i_x &= 9.12 \text{ cm} \quad i_y = 4.29 \text{ cm} \quad S_x = 30 - 3 \times 24 = 26.76 \text{ cm} \quad b = 21.5 \text{ cm} \quad d = 2.16 \text{ cm} \\
 t &= 3.24 \quad \lambda_x = 28 \rightarrow 29 \quad \lambda_y = 60.326 \rightarrow 61 \quad \sigma_{bem} = 1.0513 \text{ t/cm}^2 \quad W_x = 1.08 \\
 \sigma_{eb} &= 0.46275 \text{ t/cm}^2 \quad \sigma_e = 10.2947 \text{ t/cm}^2 \quad \sigma_b = 0.81059 \text{ t/cm}^2 \quad H' = 4.46 \text{ cm} \\
 F_B &= 79.29 \text{ cm}^2 \quad I_{yB} = 2687.10 \text{ cm}^4 \quad i_{yB} = 5.82 \text{ cm} \quad S/i_{yB} = 44.457 \quad \sigma_B = 1.52771 > \\
 1.44 \text{ t/cm}^2 \quad \sigma_B &= 1.44 \text{ t/cm}^2
 \end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.94116 < 1$$

$$0.88426 < 1$$

2.Kontrol

$$\sigma = 1.08 \times \frac{58.77}{127} + 0.9 \times \frac{398}{491} = 1.229 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 64.36 \text{ t} \quad \text{Seçilen } \frac{1}{2} \text{ I } 360 \quad A = 48.5 \text{ cm}^2 \quad \sigma = \frac{64.36}{48.5} = 1.327 \text{ t/cm}^2$$

DİYAGONALLER

19 ve 31 Nolu Elemanlar

$$\begin{aligned}
 N &= -9.22 \text{ t} \quad \ell_{kx} = \ell_{ky} = 258.8 \text{ m} \quad \text{Seçilen } L 90.90.16 \quad A = 26.4 \text{ cm}^2 \\
 i_y &= 1.73 \text{ cm} \quad \lambda = \frac{258.8}{1.73} = 149.59 \rightarrow 150 \quad \omega = 3.40 \quad \sigma = 3.40 \times \frac{9.22}{26.4} = 1.1874 \text{ t/cm}^2 < \sigma_{em}
 \end{aligned}$$

20 ve 30 Nolu Elemanlar

$$N = 3.81 \text{ t}$$

$$\text{Seçilen } L 50.50.5 \quad A = 4.80 \text{ cm}^2$$

$$\sigma = \frac{3.81}{4.80} = 0.793 \text{ t/cm}^2 < \sigma_{em}$$

21 ve 29 Nolu Elemanlar

$$N = 7.61 \text{ t} \quad \ell_{kx} = \ell_{ky} = 320.15 \text{ cm} \quad \text{Seçilen } 2 \times L 70.70.9 \quad i_x = 2.10 \text{ cm}$$

$$\lambda = \frac{320.15}{2.10} = 152.45 \rightarrow 153 \quad \omega = 4.07 \quad \sigma = 4.07 \times \frac{7.61}{2 \times 11.9} = 1.30137 \text{ t/cm}^2 < \sigma_{em}$$

23 ve 27 Nolu Elemanlar

$$N = 9.92 \text{ t} \quad L 60.60.6 \quad A = 6.91 \text{ cm}^2 \quad \sigma = \frac{9.92}{6.91} = 1.4356 \text{ t/cm}^2$$

24 ve 26 Nolu Elemanlar

$$N = -9.92 \text{ t} \quad \ell_{kx} = \ell_{ky} = 335 \text{ cm} \quad \text{Seçilen } 2 \times L 75.75.10 \quad A = 14.1 \text{ cm}^2 \quad i_x = 2.25$$

$$\lambda = \frac{335}{2.25} = 148.8 \rightarrow 149 \quad \omega = 3.86 \quad \sigma = 3.86 \times 9.92 / (2 \times 14.1) = 1.357 \text{ t/cm}^2 < \sigma_{em}$$

DİKMELER**22 ve 28 Nolu Elemanlar**

$$N = -3.18 \text{ t} \quad \ell_{kx} = \ell_{ky} = 268 \text{ cm} \quad \text{Seçilen } L 75.75.10 \quad A = 14.1 \text{ cm}^2$$

$$i_y = 1.45 \text{ cm} \quad \lambda = \frac{268}{1.45} = 184.827 \quad \omega = 5.94 \quad \sigma = 5.94 \times \frac{3.18}{14.1} = 1.339 \text{ t/cm}^2 < \sigma_{em}$$

25 Nolu Eleman

$$N = 15.90 \text{ t} \quad L 75.75.8 \quad A = 11.5 \text{ cm}^2 \quad \sigma = \frac{15.90}{11.5} = 1.382 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$N = 19.9 \text{ t} \quad M = 5.56 \text{ tm} \quad \text{Seçilen } I 360 \quad A = 97 \text{ cm}^2 \quad W_x = 1090 \text{ cm}^3 \quad i_x = 14.2 \text{ cm}$$

$$i_y = 2.90 \text{ cm} \quad S_x = 36 - \times 32.1 \text{ cm} \quad b = 14.3 \text{ cm} \quad d = 1.3 \text{ cm} \quad t = 1.95 \text{ cm} \quad \lambda_x = 50 \times 70 \rightarrow 51$$

$$\lambda_y = 103.44 \rightarrow 104 \quad \sigma_{bem} = 0.7014 \quad \omega = 1.27 \quad \sigma_{eb} = 0.19680 \text{ t/cm}^2 \quad \sigma_e = 3.224 \text{ t/cm}^2$$

$$\sigma_b = 0.5100 \text{ t/cm}^2 \quad H' = 5.35 \text{ cm} \quad F_B = 34.84 \text{ cm}^2 \quad I_{yB} = 476.163 \text{ cm}^4 \quad i_{yB} = 3.696$$

$$S/i_{yB} = 162.297 \quad \sigma_B = 0.66437 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.975618 < 1$
 $0.904440 < 1$

EİY YÜKLEMESİ İÇİN

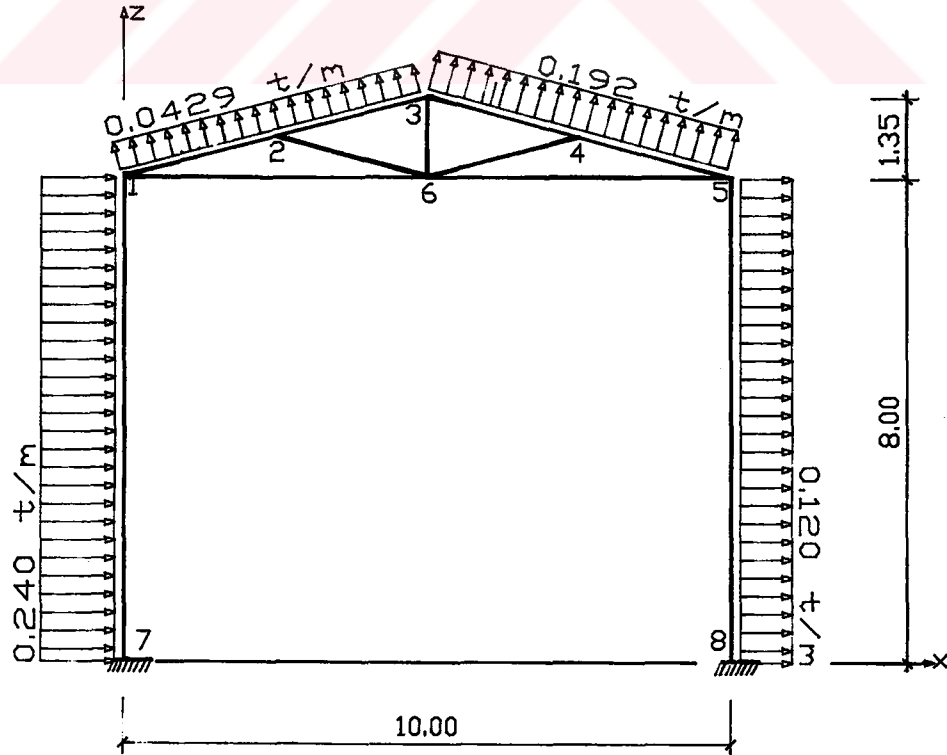
$N = 17.29 \text{ t}$ $M = 9.54 \text{ tm}$ Seçilen I 400 $A = 118 \text{ cm}^2$ $W_x = 1460 \text{ cm}^3$ $i_x = 15.7 \text{ cm}$
 $i_y = 3.13 \text{ cm}$ $S_x = 40 - 2 \times 2.16 = 35.68 \text{ cm}$ $b = 15.5 \text{ cm}$ $d = 1.44 \text{ cm}$ $t = 2.16 \text{ cm}$
 $\lambda_x = 45.85$ $\lambda_y = 95.84$ $\sigma_{bem} = 0.8803 \text{ t/cm}^2$ $\sigma_{eb} = 0.14652 \text{ t/cm}^2$ $\sigma_{e'} = 4.5330 \text{ t/cm}^2$
 $\sigma_b = 0.6534 \text{ t/cm}^2$ $H' = 5.946 \text{ cm}$ $F_B = 42.04 \text{ cm}^2$ $I_{yB} = 671.777 \text{ cm}^4$ $i_{yB} = 3.99 \text{ cm}$
 $S/i_{yx} = 150.102 \text{ cm}$ $\sigma_B = 0.77672 \text{ t/cm}^2$

Gerilme Kontrolleri $0.905406 < 1$
 $0.943014 < 1$

2. Kontrol

$\lambda_x = 45.85 \rightarrow 46$ için $\omega = 1.22$ $\sigma = 1.22 \times \frac{17.29}{118} + 0.9 \times \frac{954}{1460}$ $\sigma = 0.7668 \text{ t/cm}^2 < \sigma_{em}$

2.6. ÇÖZÜM B6



Sekil 2.10

2.6.1. SİSTEME ETKİYEN YÜKLER

Çatı Örtüsü.....	90.06 kg/ m ²
Aşık + Stabilite bağlantıları.....	12.00 kg/ m ²
Makas Öz Ağırlığı.....	10.00 kg/ m ²
Toplam Ölü Yük.....	g = 112.06 kg/ m ²

2.6.2 DÜĞÜM NOKTASI YÜKLERİNİN BULUNMASI

2.6.2.1 ÖLÜ YÜKLER

$$P_1^o = 112.06 \times \frac{2.5}{2} \times 6 \quad P_1^o = 840.45 \text{ kg} \quad P_2^o = P_3^o = P_4^o = 1680.9 \text{ kg}$$

$$P_5^o = 840.45 \text{ kg}$$

2.6.2.2. KAR YÜKÜ

$$P_1^K = P_5^K = 600 \text{ kg} \quad P_2^K = P_3^K = P_4^K = 1200 \text{ kg}$$

2.6.2.3 RÜZGÂR YÜKÜ

$$W_1 = 7.153 \times \frac{2 \times 588}{2} \times 6 \quad W_1 = 55.535 \text{ kg} \quad W_2 = 7.153 \times 2.588 \times 6 \quad W_2 = 111.071 \text{ kg}$$

$$W_3 = 7.153 \times \frac{2.588}{2} \times 6 \quad W_3 = 55.535 \text{ kg} \quad W_3' = 32 \times \frac{2.588}{2} \times 6 \quad W_3' = 248.448 \text{ kg}$$

$$W_4 = 32 \times 2.588 \times 6 \quad W_4 = 496.896 \text{ kg} \quad W_5 = 248.448 \text{ kg}$$

RÜZGAR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
1 Nolu Düğüm Noktası		2 Nolu Düğüm Noktası	
W _x = -14.373 kg	W _x = - 64.303 kg	W _x = -28.747 kg	W _x = - 128.606 kg
W _z = 53.642 kg	W _z = 239.982 kg	W _z = 107.286 kg	W _z = 479.964 kg

3 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= -14.373 \text{ kg} & W_x &= -64.303 \text{ kg} \\ W_z &= 53.642 \text{ kg} & W_z &= 239.982 \text{ kg} \end{aligned}$$

$$\begin{aligned} W_x' &= 64.303 \text{ kg} & W_x' &= 14.373 \text{ kg} \\ W_z' &= 239.982 \text{ kg} & W_z &= 53.642 \text{ kg} \end{aligned}$$

4 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 128.606 \text{ kg} & W_x &= 28.747 \text{ kg} \\ W_z &= 479.964 \text{ kg} & W_z &= 107.286 \text{ kg} \end{aligned}$$

5 Nolu Düğüm Noktası

$$\begin{aligned} W_x &= 64.303 \text{ kg} & W_x &= 14.373 \text{ kg} \\ W_z &= 239.982 \text{ kg} & W_z &= 53.642 \text{ kg} \end{aligned}$$

2.6.3. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B6

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=9.34

1 X=0 Y=0 Z=8 G=1,3,1

5 X=10 Y=0 Z=8 G=3,5,1

6 X=5 Y=0 Z=8

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 WG=0.24,0,0

2 WG=0.12,0,0

3 WG=-.24,0,0

4 WG=-.12,0,0

1 1 2 M=1 LP=2,0 G=3,1,1,1

5 1 6 M=1 LP=2,0

6 6 5 M=1 LP=2,0

7 2 6 M=2 LP=2,0

8 3 6 M=2 LP=2,0

9 4 6 M=2 LP=2,0

10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 5 4 L=1 F=0,0,-840.45E-3,0,0,0

2 4 1 L=1 F=0,0,-1680.9E-3,0,0,0

1 5 4 L=2 F=0,0,-0.600,0,0,0

2 4 1 L=2 F=0,0,-1.200,0,0,0

1 3 2 L=3 F=0,0,-0.600,0,0,0

2 L=3 F=0,0,-1.200,0,0,0

1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0

2 L=4 F=-28.747E-3,0,107.286E-3,0,0,0

3 L=4 F=49.93E-3,0,293.624E-3,0,0,0

4 L=4 F=128.606E-3,0,479.964E-3,0,0,0

5 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 3 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 4 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 5 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.6.4 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B6

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE
ID COND	FORCE ENDI	SHEAR MOMENT
1 -----		
1	-9.74	
2	-6.95	
3	-4.64	
4	1.39	
5	2.01	
2 -----		
1	-6.49	
2	-4.64	
3	-2.32	
4	1.20	
5	1.15	
3 -----		
1	-6.49	
2	-4.64	

3 -2.32

4 1.15

5 1.20

4 -----

1 -9.74

2 -6.95

3 -2.32

4 2.01

5 1.39

5 -----

1 9.38

2 6.70

3 4.47

4 -1.41

5 -2.15

6 -----

1 9.38

2 6.70

3 2.23

4 -2.15

5 -1.41

7 -----

1 -3.25

2 -2.32

3 -2.32

4 .22

5 .99

8 -----

1 1.68

2 1.20

3 .60

4 -.31

5 -.31

9 -----

1 -3.25

2 -2.32

3 .00

4 .99

5 .22

10 -----

1 -3.36

.0 .02 -.19

8.0 .02

2 -2.40

.0 .02 -.13

8.0 .02

3 -1.80

.0 .01 -.07

8.0 .01

4 .41

.0 -1.84 7.07

7.7 .00 -.01

8.0 .08 .00

5 .76

.0 1.24 -6.04

8.0 .28 .00

11 -----

1 -3.36

		.0	-.02	.00
		8.0	-.02	-.19
2	-2.40			
		.0	-.02	.00
		8.0	-.02	-.13
3	-.60			
		.0	-.01	.00
		8.0	-.01	-.07
4	.76			
		.0	-.28	.00
		8.0	-1.24	-6.04
5	.41			
		.0	-.08	.00
		.3	.00	-.01
		8.0	1.84	7.07

Tablo 2.6

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	9.74	4.64	6.95	-1.39	-2.01	16.69	15.3
2	6.49	2.32	4.64	-1.20	-1.15	11.13	9.98
3	6.49	2.32	4.64	-1.15	-1.20	11.13	9.98
4	9.74	2.32	6.95	-2.01	-1.39	16.69	15.30
5	-9.38	-4.47	-6.70	1.41	2.15	-16.08	-14.67
6	-9.38	-2.23	-6.70	2.15	1.41	-16.08	-14.67
7	3.25	2.32	2.32	-0.22	-0.99	5.57	5.35
8	-1.68	-0.60	-1.20	0.31	0.31	-2.88	-2.57
9	3.25	0	2.32	-0.99	-0.22	5.57	5.35
10	M= 0.19 N= 3.36	M= 0.07 N= 1.80	M= 0.13 N= 2.40	M= -7.07 N= -0.41	M= -6.04 N= -0.76	M= 0.32 N= 5.76	M= 6.36 N= 5.35
11	M= 0.19 N= 3.36	M= 0.07 N= 0.60	M= 0.13 N= 2.40	M= 6.04 N= -0.76	M= -7.07 N= -0.41	M= 0.32 N= 5.76	M= 6.36 N= 5.35

Momentler tm

2.6.5 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$N = 16.69 \text{ t} \quad \ell_{kx} = \ell_{ky} = \text{Seçilen } \frac{1}{2} I 260 \quad A = 26.7 \text{ cm}^2 \quad i_y = 2.32 \text{ cm}$$

$$\lambda = \frac{258.8}{2.32} = 111.551 \quad \omega = 2.26 \quad \sigma = 2.26 \times \frac{16.69}{26.7} = 1.412 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 16.08 \text{ t} \quad \text{Seçilen } L 70.70.9 \quad A = 11.9 \text{ cm}^2 \quad \sigma = \frac{16.08}{11.9} = 1.351 \text{ t/cm}^2 < \sigma_{em}$$

DİYAGONALLER

7 ve 9 Nolu Elemanlar

$$N = 5.57 \text{ t} \quad \ell_{kx} = \ell_{ky} = 258.8 \text{ cm} \quad \text{Seçilen } L 80.80.14 \quad A = 20.6 \text{ cm}^2$$

$$i_y = 1.54 \text{ cm} \quad \lambda = 168.051 \rightarrow 169 \quad \omega = 4.96 \quad \sigma = 4.96 \times \frac{5.57}{20.6} = 1.341 \text{ t/cm}^2 < \sigma_{em}$$

DİKMELER

8 Nolu Eleman

$$N = 2.88 \text{ t} \quad \text{Seçilen } L 50.50.5 \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{2.88}{4.80} = 0.600 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$N = 5.76 \text{ t} \quad M = 0.32 \text{ tm} \quad l = 800 \text{ cm} \quad \ell_{kx} = 960 \text{ cm} \quad \ell_{ky} = 400 \text{ cm} \quad \text{Seçilen } I 240$$

$$A = 46.1 \text{ cm}^2 \quad W_x = 354 \text{ cm}^3 \quad i_x = 9.59 \text{ cm} \quad i_y = 2.20 \text{ cm} \quad S_x = 24 - 2 \times 1.31 = 21.38 \text{ cm}$$

$$b = 10.6 \text{ cm} \quad d = 0.87 \text{ cm} \quad t = 1.31 \text{ cm} \quad \lambda_x = 100.104 \quad \lambda_y = 181.81 \rightarrow 182$$

$$\sigma_{bem} = 0.2503 \quad \sigma_{eb} = 0.12494 \text{ t/cm}^2 \quad \sigma_e = 0.82787 \text{ t/cm}^2 \quad \sigma_b = 9.03954 \times 10^{-2}$$

$$H' = 3.56 \text{ cm} \quad F_B = 16.986 \text{ cm}^2 \quad I_{yB} = 130.214 \text{ cm}^4 \quad i_{yB} = 2.76 \quad S/i_{yB} = 288.93$$

$$\sigma_B = 0.2096 \text{ t/cm}^2$$

Gerilme Kontrolleri $0.93095 < 1$

$0.51801 < 1$

EİY YÜKLEMESİ İÇİN

$N = 5.35 \text{ t}$ $M = 6.36 \text{ tm}$ $l = 800 \text{ cm}$ $\ell_{kx} = 920 \text{ cm}$ $\ell_{ky} = 400 \text{ cm}$ Seçilen I 400

$A = 118 \text{ cm}^2$ $W_x = 1460 \text{ cm}^3$ $i_x = 15.7 \text{ cm}$ $i_y = 3.13 \text{ cm}$ $S_x = 40 - 2 \times 2.16 = 35.68 \text{ cm}$

$b = 15.5 \text{ cm}$ $d = 1.44 \text{ cm}$ $t = 2.16 \text{ cm}$ $\lambda_x = 61.146$ $\lambda_y = 127.79$ $\sigma_{bem} = 0.584 \text{ t/cm}^2$

$\sigma_{eb} = 4.53389 \times 10^{-2} \text{ t/cm}^2$ $\sigma_e = 2.54981 \text{ t/cm}^2$ $\sigma_b = 0.43561 \text{ t/cm}^2$ $H' = 5.95 \text{ cm}$

$F_B = 42.04 \text{ cm}^2$ $I_{yB} = 671.777 \text{ cm}^4$ $i_{yB} = 3.99 \text{ cm}$ $S/i_{yx} = 200.136 \text{ cm}$

$\sigma_B = 0.436905 \text{ t/cm}^2$

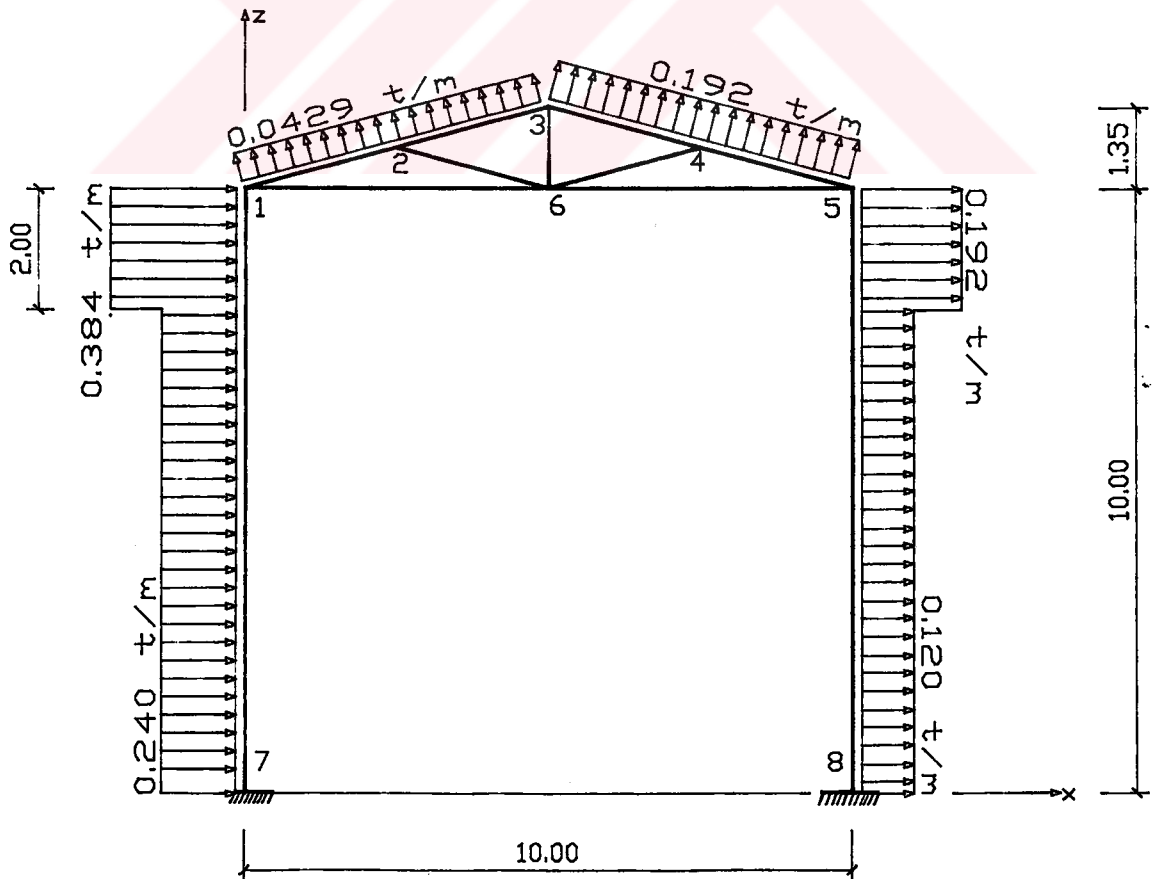
Gerilme Kontrolleri $0.940469 < 1$

$1.028534 \approx 1$

2. Kontrol

$\lambda_x = 61.14 \rightarrow 62$ için $\omega = 1.38$ $\sigma = 1.38 \times \frac{5.35}{118} + 0.9 \times \frac{6.36}{1460}$ $\sigma = 0.4546 \text{ t/cm}^2 < \sigma_{em}$

2.7. ÇÖZÜM B7



Sekil 2.11

2.7.1. SİSTEME ETKİYEN YÜKLER

Kolonlardaki Rüzgar Yüğü hariç bütün yükler ÇÖZÜM B6 için hesaplananlar ile tamamen aynıdır.

2.7.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B7

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=11.34

1 X=0 Y=0 Z=10 G=1,3,1

5 X=10 Y=0 Z=10 G=3,5,1

6 X=5 Y=0 Z=10

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,10,0.384,0

2 TRAP=0,-0.192,0,2,-0.192,0,2,-0.12,0,10,-0.12,0

3 TRAP=0,0.384,0,2,0.384,0,2,0.24,0,10,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,10,-0.192,0

1 1 2 M=1 LP=2,0 G=3,1,1,1
 5 1 6 M=1 LP=2,0
 6 6 5 M=1 LP=2,0
 7 2 6 M=2 LP=2,0
 8 3 6 M=2 LP=2,0
 9 4 6 M=2 LP=2,0
 10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :

LOADS

1 5 4 L=1 F=0,0,-840.45E-3,0,0,0
 2 4 1 L=1 F=0,0,-1680.9E-3,0,0,0
 1 5 4 L=2 F=0,0,-0.600,0,0,0
 2 4 1 L=2 F=0,0,-1.200,0,0,0
 1 3 2 L=3 F=0,0,-0.600,0,0,0
 2 L=3 F=0,0,-1.200,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 3 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 4 L=4 F=128.606E-3,0,479.964E-3,0,0,0
 5 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 3 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 4 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 5 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.7.3. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B7

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE
ID COND	FORCE ENDI	SHEAR MOMENT
1	-----	
1	-9.74	
2	-6.95	
3	-4.64	
4	1.39	
5	2.01	
2	-----	
1	-6.49	
2	-4.64	
3	-2.32	
4	1.20	
5	1.15	
3	-----	
1	-6.49	
2	-4.64	
3	-2.32	
4	1.15	
5	1.20	
4	-----	
1	-9.74	
2	-6.95	

3 -2.32

4 2.01

5 1.39

5 -----

1 9.40

2 6.71

3 4.47

4 -1.52

5 -2.26

6 -----

1 9.40

2 6.71

3 2.23

4 -2.26

5 -1.52

7 -----

1 -3.25

2 -2.32

3 -2.32

4 .22

5 .99

8 -----

1 1.68

2 1.20

3 .60

4 -.31

5 -.31

9 -----

1 -3.25

2 -2.32

3 .00

4 .99

5 .22

10 -----

1 -3.36

.0 .01 -.12

10.0 .01 .00

2 -2.40

.0 .01 -.09

10.0 .01 .00

3 -1.80

.0 .00 -.04

10.0 .00

4 .41

.0 -2.50 12.75

8.0 -.58 .40

9.5 .00 -.04

10.0 .18 .00

5 .76

.0 1.73 -11.13

8.0 .77 -1.15

10.0 .38 .00

11 -----

1 -3.36

.0 -.01 .00

10.0 -.01 -.12

2 -2.40

.0 -.01 .00

	10.0	-.01	-.09
3	-.60		
	.0	-.00	.00
	10.0	-.00	-.04
4	.76		
	.0	-.38	.00
	2.0	-.77	-1.15
	10.0	-1.73	-11.13
5	.41		
	.0	-.18	.00
	.5	.00	-.04
	2.0	.58	.40
	10.0	2.50	12.75

Tablo 2.7

ELEMAN NO	YÜKLEME NO	N (t)	M (tm)
10	4	-0.41	-12.75
10	5	-0.76	11.13
10	4	-0.76	11.13
10	5	-0.41	-12.75

Tablo 2.8

	ELEMAN NO			
	10		11	
	M (tm)	N (t)	M (tm)	N (t)
EY	0.21	5.76	0.21	5.76
EİY	12.54	5.35	+12.54	5.35

2.7.4. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Tüm makas elemanları ÇÖZÜM B6'da hesaplananlar ile aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

$$N = 5.76 \text{ t} \quad M = 0.21 \text{ tm} \quad (EY) \quad l = 10 \text{ m} \quad \ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 333 \text{ cm}$$

$$N = 5.35 \quad M = 12.54 \text{ tm} \quad (EİY)$$

$$\text{Seçilen I 240} \quad \lambda_x = 125.13 \quad \lambda_y = 151.363 \quad \sigma_{bem} = 0.3588 \text{ t/cm}^2 \quad \sigma_{eb} = 0.12494 \text{ t/cm}^2$$

$$\sigma_{e'} = 0.52945 \text{ t/cm}^2 \quad \sigma_b = 0.05932 \text{ t/cm}^2 \quad H' = 3.56 \text{ cm} \quad F_B = 16.986 \text{ cm}^2$$

$$I_{yB} = 130.214 \text{ cm}^4 \quad i_{yB} = 2.768 \text{ cm} \quad S/i_{yB} = 361.174 \quad \sigma_B = 0.134154 \text{ t/cm}^2$$

$$\text{Gerilme Kontrolleri} \quad 0.840193 < 1$$

$$0.528960 < 1$$

EİY YÜKLEMESİ İÇİN

$$N = 5.35 \text{ t} \quad M = 12.54 \text{ tm} \quad l = 1000 \text{ cm} \quad \ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 333 \text{ cm} \quad \text{Seçilen I 550}$$

$$A = 212 \text{ cm}^2 \quad W_x = 3610 \text{ cm}^3 \quad i_x = 21.6 \text{ cm} \quad i_y = 4.02 \text{ cm} \quad S_x = 55 - 2.3 = 49 \text{ cm}$$

$$b = 20 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.0 \text{ cm} \quad \lambda_x = 55.55 \quad \lambda_y = 82.83 \quad \sigma_{bem} = 1.000 \text{ t/cm}^2$$

$$\sigma_{eb} = 2.5235 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 3.0888 \text{ t/cm}^2 \quad \sigma_b = 0.34736 \text{ t/cm}^2 \quad H' = 8.16 \text{ cm}$$

$$F_B = 75.516 \text{ cm}^2 \quad I_{yB} = 2004.66 \text{ cm}^4 \quad i_{yB} = 5.15 \text{ cm} \quad S/i_{yB} = 194.088 \text{ cm} \quad \sigma_B = 0.46455 \text{ t/cm}^2$$

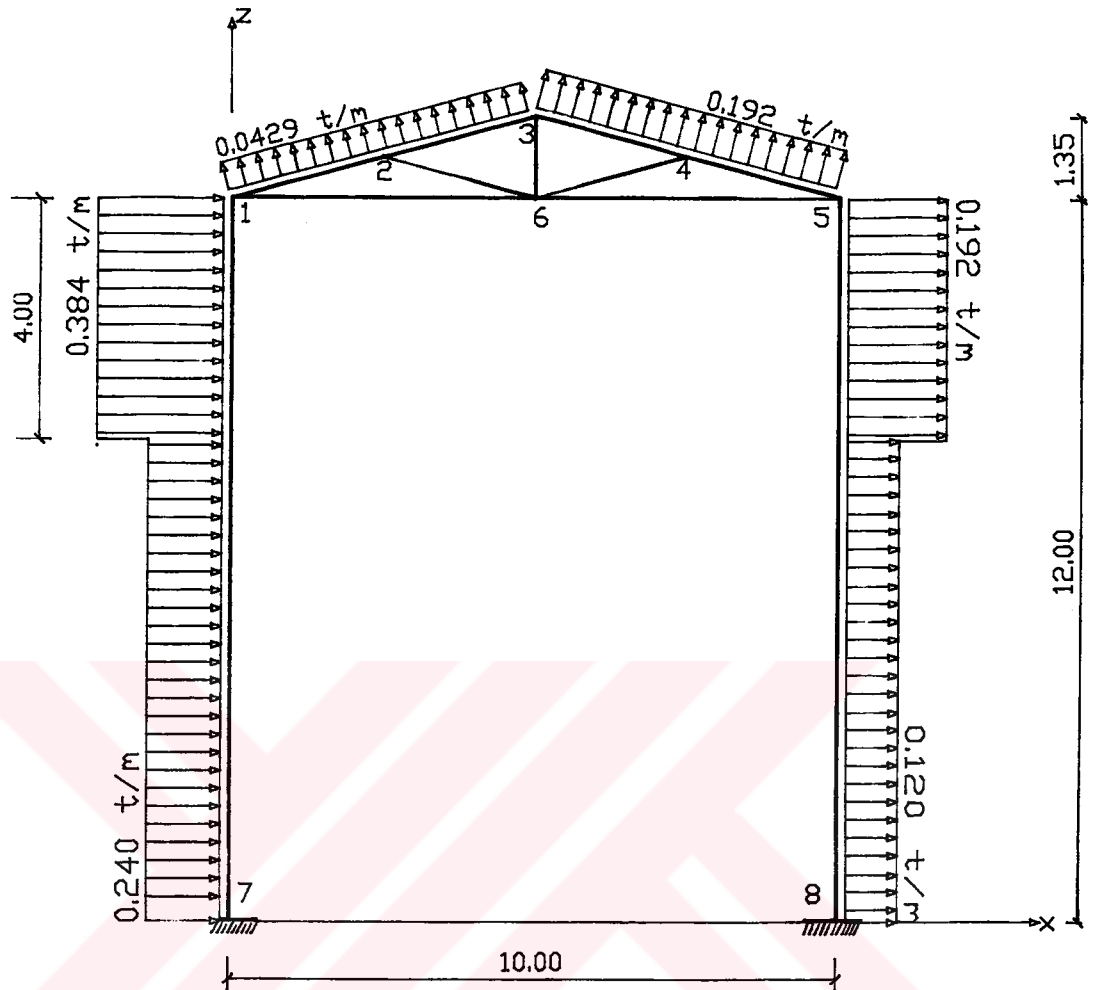
$$\text{Gerilme Kontrolleri} \quad 0.666050 < 1$$

$$0.765268 < 1$$

2. Kontrol

$$\lambda_x = 55.55 \rightarrow 56 \text{ için } \omega = 1.32 \quad \sigma = 1.32 \times \frac{535}{118} + 0.9 \times \frac{636}{1460} \quad \sigma = 0.3459 \text{ t/cm}^2 < \sigma_{em}$$

2.8. ÇÖZÜM B8



Sekil 2.12

2.8.1. SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgar yükü hariç bütün yükler ÇÖZÜM B6 için hesaplananlar ile tamamen aynıdır.

2.8.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B8

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=13.34

1 X=0 Y=0 Z=12 G=1,3,1

5 X=10 Y=0 Z=12 G=3,5,1

6 X=5 Y=0 Z=12

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,12,0.384,0

2 TRAP=0,-0.192,0,4,-0.192,0,4,-0.12,0,12,-0.12,0

3 TRAP=0,0.384,0,4,0.384,0,4,0.24,0,12,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,12,-0.192,0

1 1 2 M=1 LP=2,0 G=3,1,1,1

5 1 6 M=1 LP=2,0

6 6 5 M=1 LP=2,0

7 2 6 M=2 LP=2,0

8 3 6 M=2 LP=2,0

9 4 6 M=2 LP=2,0

10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 5 4 L=1 F=0,0,-840.45E-3,0,0,0

2 4 1 L=1 F=0,0,-1680.9E-3,0,0,0

1 5 4 L=2 F=0,0,-0.600,0,0,0

2 4 1 L=2 F=0,0,-1.200,0,0,0

1 3 2 L=3 F=0,0,-0.600,0,0,0

2 L=3 F=0,0,-1.200,0,0,0

1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0

2 L=4 F=-28.747E-3,0,107.286E-3,0,0,0

3 L=4 F=49.93E-3,0,293.624E-3,0,0,0

4 L=4 F=128.606E-3,0,479.964E-3,0,0,0

5 L=4 F=64.303E-3,0,239.982E-3,0,0,0

1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0

2 L=5 F=-128.606E-3,0,479.964E-3,0,0,0

3 L=5 F=-49.93E-3,0,293.624E-3,0,0,0

4 L=5 F=28.747E-3,0,107.286E-3,0,0,0

5 L=5 F=14.373E-3,0,53.642E-3,0,0,0

:

2.8.3. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B8

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -9.74

2 -6.95

3 -4.64

4 1.39

5 2.01

2 -----

1 -6.49

2 -4.64

3 -2.32

4 1.20

5 1.15

3 -----

1 -6.49

2 -4.64

3 -2.32

4 1.15

5 1.20

4 -----

1 -9.74

2 -6.95

3 -2.32

4 2.01

5 1.39

5 -----

1 9.40

2 6.71

3 4.48

4 -1.61

5 -2.35

6 -----

1 9.40

2 6.71

3 2.24

4 -2.35

5 -1.61

7 -----

1 -3.25

2 -2.32

3 -2.32

4 .22

5 .99

8 -----

1 1.68

2 1.20

3 .60

4 -.31

5 -.31

9 -----

1 -3.25

2 -2.32

3 .00

4 .99

5 .22

10 -----

1 -3.36

.0 .01 -.08

12.0 .01 .00

2	-2.40		
	.0	.00	-.06
	12.0	.00	.00
3	-1.80		
	.0	.00	-.03
	12.0	.00	
4	.41		
	.0	-3.18	19.71
	8.0	-1.26	1.96
	11.3	.00	-.10
	12.0	.28	.00
5	.76		
	.0	2.21	-17.24
	8.0	1.25	-3.44
	12.0	.48	.00
11	-----		
1	-3.36		
	.0	-.01	.00
	12.0	-.01	-.08
2	-2.40		
	.0	-.00	.00
	12.0	-.00	-.06
3	-.60		
	.0	-.00	.00
	12.0	-.00	-.03
4	.76		
	.0	-.48	.00
	4.0	-1.25	-3.44
	12.0	-2.21	-17.24

5 .41

.0	-.28	.00
.7	.00	-.10
4.0	1.26	1.96
12.0	3.18	19.71

Tablo2.9

Eleman	Yükleme No	N (t)	M (tm)
10	4	-0.49	-19.71
10	5	-0.76	17.24
11	4	-0.76	17.24
11	5	-0.41	-19.71

Tablo2.10

	ELEMEN NO			
	10		11	
	M (tm)	N (t)	M (tm)	N (t)
EY	0.14	5.76	0.14	5.76
EİY	-19.57	5.35	-19.57	5.35

2.8.4. SİSTEM ELEMENLARININ BOYUTLANDIRILMASI

Tüm makas elemanları ÇÖZÜM B6'da hesaplananlar ile tamamen aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

Seçilen I 240 $l = 1200 \text{ cm}$ $\ell_{kx} = 1440 \text{ cm}$ $\ell_{ky} = 400 \text{ cm}$ $A = 46.1 \text{ cm}^2$
 $W_x = 354 \text{ cm}^3$ $i_x = 9.59 \text{ cm}$ $i_y = 2.20 \text{ cm}$ $S_x = 21.38$ $b = 10.6 \text{ cm}$ $d = 0.87 \text{ cm}$
 $t = 1.31 \text{ cm}$ $\lambda_x = 150.156$ $\lambda_y = 181.818$ $\sigma_{bem} = 0.2503 \text{ t/cm}^2$ $\sigma_{eb} = 0.12494 \text{ t/cm}^2$
 $\sigma_{e'} = 0.36767 \text{ t/cm}^2$ $\sigma_b = 0.039548 \text{ t/cm}^2$ $H' = 3.56 \text{ cm}$ $F_B = 16.986 \text{ cm}^2$
 $I_{yB} = 130.214 \text{ cm}^4$ $i_{yB} = 2.768 \text{ cm}$ $S/i_{yB} = 433.409 \text{ cm}$ $\sigma_B = 0.0931627 \text{ cm}^2$

Gerilme Kontrolleri $1.0450 \approx 1$
 $0.5110 < 1$

EİY YÜKLEMESİ İÇİN

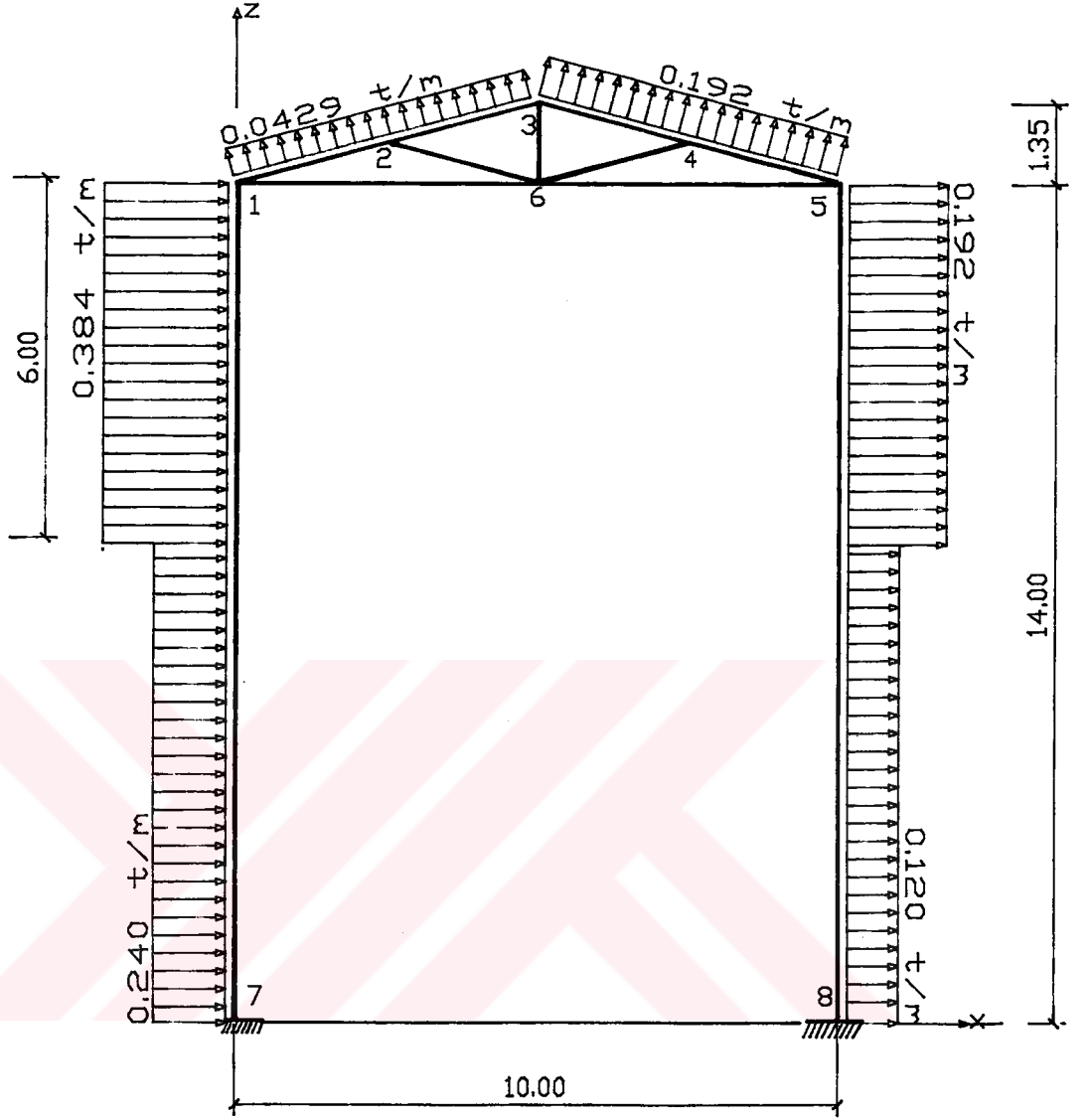
$N = 5.35 \text{ t}$ $M = 19.57 \text{ tm}$ $l = 1200 \text{ cm}$ $\ell_{kx} = 1440 \text{ cm}$ $\ell_{ky} = 400 \text{ cm}$
Seçilen HE - A 400 $A = 159 \text{ cm}^2$ $W_x = 2310 \text{ cm}^3$ $i_x = 16.8 \text{ cm}$ $i_y = 7.34 \text{ cm}$
 $S_x = 39 - 2 \times 1.9 = 35.2 \text{ cm}$ $b = 30 \text{ cm}$ $d = 1.1 \text{ cm}$ $t = 1.9 \text{ cm}$ $\lambda_x = 83.33$ $\lambda_y = 54.49$
 $\sigma_{bem} = 0.9916 \text{ t/cm}^2$ $\omega = 1.67$ $\sigma_{eb} = 3.36477 \times 10^{-2} \text{ t/cm}^2$ $\sigma_{e'} = 1.3728 \text{ t/cm}^2$
 $\sigma_b = 0.84718 \text{ t/cm}^2$ $H' = 5.86 \text{ cm}$ $F_B = 63.45 \text{ cm}^2$ $I_{yB} = 4275.65 \text{ cm}^4$ $i_{yB} = 8.20 \text{ cm}$
 $S/i_{yB} = 146.18 \text{ cm}$ $\sigma_B = 0.94121 \text{ t/cm}^2$

Gerilme Kontrolleri $0.81823 < 1$
 $0.92346 < 1$

2. Kontrol

$$\lambda_x = 83.33 \rightarrow 84 \text{ için } \omega = 1.67 \quad \sigma = 1.67 \times \frac{5.15}{159} + 0.9 \times \frac{1957}{2310} = 0.818659 \text{ t/cm}^2 < \sigma_{em}$$

2.9. ÇÖZÜM B9



Sekil 2.13

2.9.1. SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgâr yükü hariç bütün yükler ÇÖZÜM B6 için hesaplananlar ile tamamen aynıdır.

2.9.2. STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B9

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=15.34

1 X=0 Y=0 Z=14 G=1,3,1

5 X=10 Y=0 Z=14 G=3,5,1

6 X=5 Y=0 Z=14

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,14,0.384,0

2 TRAP=0,-0.192,0,6,-0.192,0,6,-0.12,0,14,-0.12,0

3 TRAP=0,0.384,0,6,0.384,0,6,0.24,0,14,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,14,-0.192,0

1 1 2 M=1 LP=2,0 G=3,1,1,1

5 1 6 M=1 LP=2,0

6 6 5 M=1 LP=2,0

7 2 6 M=2 LP=2,0

8 3 6 M=2 LP=2,0

9 4 6 M=2 LP=2,0

10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4

11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 5 4 L=1 F=0,0,-840.45E-3,0,0,0

2 4 1 L=1 F=0,0,-1680.9E-3,0,0,0

1 5 4 L=2 F=0,0,-0.600,0,0,0

2 4 1 L=2 F=0,0,-1.200,0,0,0

1 3 2 L=3 F=0,0,-0.600,0,0,0

2 L=3 F=0,0,-1.200,0,0,0

1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0

2 L=4 F=-28.747E-3,0,107.286E-3,0,0,0

3 L=4 F=49.93E-3,0,293.624E-3,0,0,0

4 L=4 F=128.606E-3,0,479.964E-3,0,0,0

5 L=4 F=64.303E-3,0,239.982E-3,0,0,0

1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0

2 L=5 F=-128.606E-3,0,479.964E-3,0,0,0

3 L=5 F=-49.93E-3,0,293.624E-3,0,0,0

4 L=5 F=28.747E-3,0,107.286E-3,0,0,0

5 L=5 F=14.373E-3,0,53.642E-3,0,0,0

:

2.9.3. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B9

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -9.74

2 -6.95

3 -4.64

4 1.39

5 2.01

2 -----

1 -6.49

2 -4.64

3 -2.32

4 1.20

5 1.15

3 -----

1 -6.49

2 -4.64

3 -2.32

4 1.15

5 1.20

4 -----

1 -9.74

2 -6.95

3 -2.32

4 2.01

5 1.39

5 -----

1 9.40

2 6.71

3 4.48

4 -1.69

5 -2.44

6 -----

1 9.40

2 6.71

3 2.24

4 -2.44

5 -1.69

7 -----

1 -3.25

2 -2.32

3 -2.32

4 .22

5 .99

8 -----

1 1.68

2 1.20

3 .60

4 -.31

5 -.31

9 -----

1 -3.25

2 -2.32

3 .00

4 .99

5 .22

10 -----

1 -3.36

.0 .00 -.06

14.0 .00 .00

2 -2.40

.0 .00 -.04

14.0 .00 .00

3 -1.80

.0 .00 -.02

		14.0	.00	.00
4	.41			
		.0	-3.86	27.94
		8.0	-1.94	4.73
		13.1	.00	-.17
		14.0	.36	.00
5	.76			
		.0	2.67	-24.39
		8.0	1.71	-6.83
		14.0	.56	.00
11	-----			
1	-3.36			
		.0	-.00	.00
		14.0	-.00	-.06
2	-2.40			
		.0	-.00	.00
		14.0	-.00	-.04
3	-.60			
		.0	-.00	.00
		14.0	-.00	-.02
4	.76			
		.0	-.56	.00
		6.0	-1.71	-6.83
		14.0	-2.67	-24.39
5	.41			
		.0	-.36	.00
		.9	.00	-.17
		6.0	1.94	4.73
		14.0	3.86	27.94

2.9.4. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Tüm makas elemanları için ÇÖZÜM B6'da hesaplananlar ile tamamen aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

Tablo 2.11

Eleman	Yükleme No	N (t)	M (tm)
10	4	-0.41	-24.94
10	5	-0.76	+24.39
11	4	-0.76	24.39
11	5	-0.41	-27.94

Tablo 2.12

	ELEMAN NO			
	10		11	
	M (tm)	N (t)	M (tm)	N (t)
EY	0.10	5.76	0.10	5.76
EİY	-27.84	5.35	-27.84	5.35

KOLONLAR

$$\begin{aligned}
 l &= 1400 \text{ cm} \quad \ell_{kx} = 1680 \text{ cm} \quad \ell_{ky} = 466.66 \text{ cm} \quad \text{Seçilen I 260} \quad A = 53.3 \text{ cm}^2 \\
 W_x &= 442 \text{ cm}^3 \quad i_x = 10.4 \text{ cm} \quad i_y = 2.32 \text{ cm} \quad S_x = 23.18 \text{ cm} \quad b = 11.3 \text{ cm} \quad d = 0.94 \text{ cm} \\
 t &= 1.41 \text{ cm} \quad \lambda_x = 161.538 \quad \lambda_y = 201.15 \quad \sigma_{bem} = 0.2032 \text{ t/cm}^2 \quad \sigma_{eb} = 0.108067 \text{ t/cm}^2 \\
 \sigma_{e'} &= 0.317689 \text{ t/cm}^2 \quad \sigma_b = 2.26244 \times 10^{-2} \text{ t/cm}^2 \quad H' = 3.86 \text{ cm} \quad F_B = 19.564 \text{ cm}^2 \\
 I_{yB} &= 169.807 \text{ cm}^4 \quad i_{yB} = 2.946 \text{ cm} \quad S/i_{yB} = 475.20 \quad \sigma_B = 7.7494 \times 10^{-2} \text{ t/cm}^2
 \end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.907919 < 1$$

$$0.366996 < 1$$

EİY YÜKLENMESİ İÇİN

$$\begin{aligned}
 N &= 5.35 \text{ t} \quad M = 27.84 \text{ tm} \quad \text{Seçilen HE - A 600} \quad A = 226 \text{ cm}^2 \quad W_x = 4790 \text{ cm}^3 \\
 i_x &= 25 \text{ cm} \quad i_y = 7.05 \text{ cm} \quad S_x = 59 - 2 \times 2.5 = 54 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.3 \text{ cm} \quad t = 2.5 \text{ cm} \\
 \lambda_x &= 67.2 \quad \lambda_y = 66.19 \quad \sigma_{bem} = 1.14206 \text{ t/cm}^2 \quad \sigma_{eb} = 2.36725 \times 10^{-2} \text{ t/cm}^2
 \end{aligned}$$

$$\sigma_e = 2.1111 \text{ t/cm}^2 \quad \sigma_b = 0.58121 \text{ t/cm}^2 \quad H' = 9 \text{ cm} \quad F_B = 86.7 \text{ cm}^2 \quad I_{yB} = 5626.64 \text{ cm}^4$$

$$i_{yB} = 8.05 \text{ cm} \quad S/i_{yB} = 173.78 \text{ cm} \quad \sigma_B = 0.57944 \text{ t/cm}^2$$

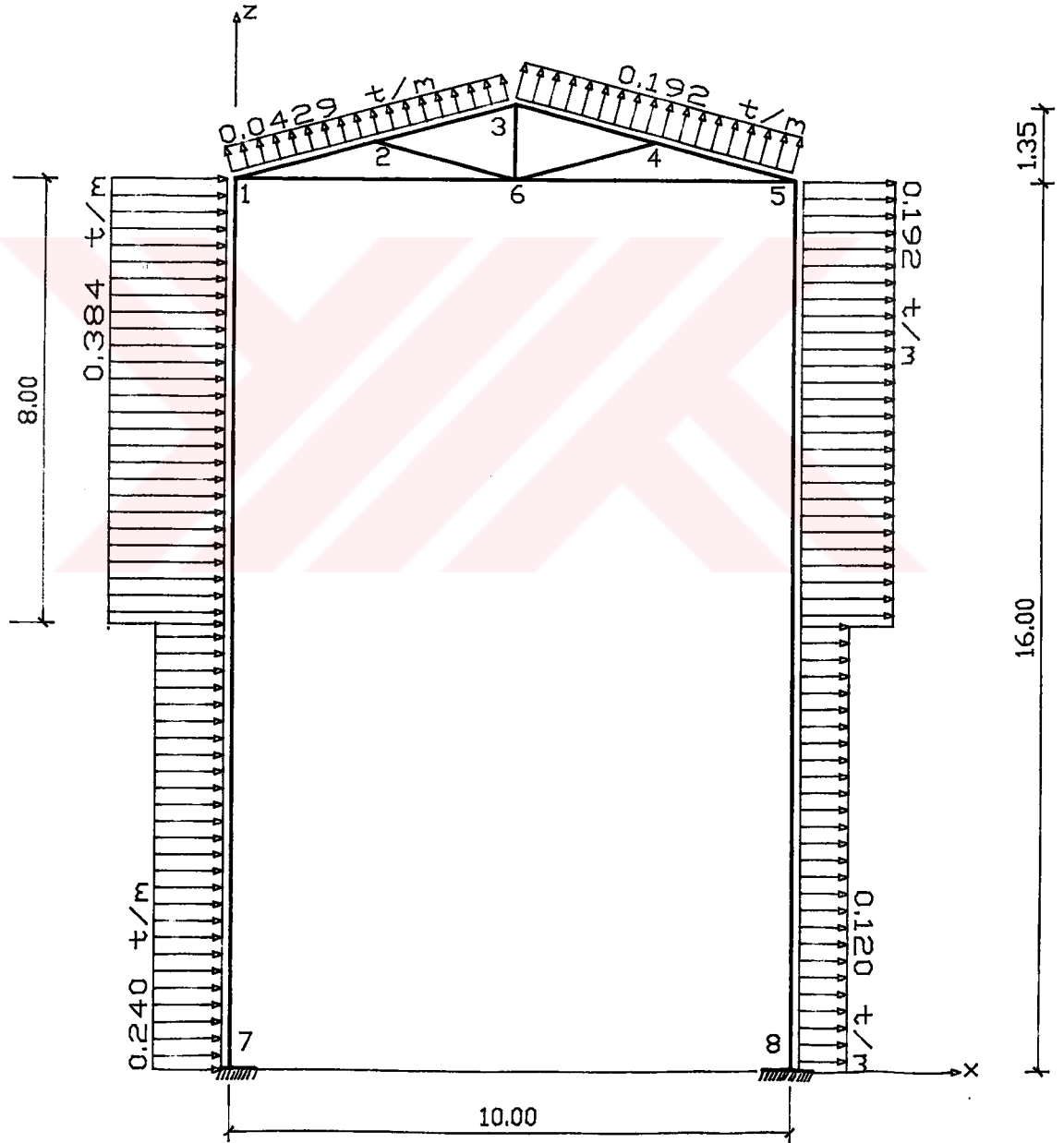
$$\text{Gerilme Kontrolleri} \quad 0.8820 < 1$$

$$1.0190 \approx 1$$

2. Kontrol

$$\lambda_x = 67.2 \rightarrow 68 \text{ için } \omega = 1.45 \quad \sigma = 1.45 \times \frac{5.35}{226} + 0.9 \times \frac{2784}{4790} \quad \sigma = 0.5574 \text{ t/cm}^2 < \sigma_{em}$$

2.10. ÇÖZÜM B10



Sekil 2.14

2.10.1. SİSTEME ETKİYEN YÜKLER

Sisteme etkiyen yükeler kolonlardaki rüzgar yükü hariç ÇÖZÜM B6 için hesaplananlar ile tamamen aynıdır.

2.10.2.STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B10

SYSTEM

L=5

:

JOINTS

3 X=5 Y=0 Z=17.34

1 X=0 Y=0 Z=16 G=1,3,1

5 X=10 Y=0 Z=16 G=3,5,1

6 X=5 Y=0 Z=16

7 X=0 Y=0 Z=0

8 X=10 Y=0 Z=0

:

RESTRAINTS

1 6 1 R=0,1,0,1,0,1

7 8 1 R=1,1,1,1,1,1

:

FRAME

NM=3 NL=4

1 A=34.5E-4 :ALT,ÜST BAŞLIK

2 A=6.91E-4 :DİYAGONALLER

3 A=118E-4 I=29210E-8 W=92.6E-3 :KOLONLAR

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,16,0.384,0

2 TRAP=0,-0.192,0,8,-0.192,0,8,-0.12,0,16,-0.12,0

3 TRAP=0,0.384,0,8,0.384,0,8,0.24,0,16,0.24,0
 4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,16,-0.192,0
 1 1 2 M=1 LP=2,0 G=3,1,1,1
 5 1 6 M=1 LP=2,0
 6 6 5 M=1 LP=2,0
 7 2 6 M=2 LP=2,0
 8 3 6 M=2 LP=2,0
 9 4 6 M=2 LP=2,0
 10 7 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 11 5 8 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :

LOADS

1 5 4 L=1 F=0,0,-840.45E-3,0,0,0
 2 4 1 L=1 F=0,0,-1680.9E-3,0,0,0
 1 5 4 L=2 F=0,0,-0.600,0,0,0
 2 4 1 L=2 F=0,0,-1.200,0,0,0
 1 3 2 L=3 F=0,0,-0.600,0,0,0
 2 L=3 F=0,0,-1.200,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 3 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 4 L=4 F=128.606E-3,0,479.964E-3,0,0,0
 5 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 3 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 4 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 5 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.10.3 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B10

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -9.74

2 -6.95

3 -4.64

4 1.39

5 2.01

2 -----

1 -6.49

2 -4.64

3 -2.32

4 1.20

5 1.15

3 -----

1 -6.49

2 -4.64

3 -2.32

4 1.15

5 1.20

4 -----

1 -9.74

2 -6.95

3 -2.32

4 2.01

5 1.39

5 -----

1 9.41

2 6.71

3 4.48

4 -1.78

5 -2.52

6 -----

1 9.41

2 6.71

3 2.24

4 -2.52

5 -1.78

7 -----

1 -3.25

2 -2.32

3 -2.32

4 .22

5 .99

8 -----

1 1.68

2 1.20

3 .60

4 -.31

5 -.31

9 -----

1 -3.25

2 -2.32

3 .00

4 .99

5	.22			
10	-----			
1	-3.36			
	.0	.00	-.05	
	16.0	.00		
2	-2.40			
	.0	.00	-.03	
	16.0	.00	.00	
3	-1.80			
	.0	.00	-.02	
	16.0	.00	.00	
4	.41			
	.0	-4.55	37.44	
	8.0	-2.63	8.74	
	14.8	.00	-.26	
	16.0	.44	.00	
5	.76			
	.0	3.14	-32.57	
	8.0	2.18	-11.29	
	16.0	.64	.00	
11	-----			
1	-3.36			
	.0	-.00	.00	
	16.0	-.00	-.05	
2	-2.40			
	.0	-.00	.00	
	16.0	-.00	-.03	
3	-.60			
	.0	-.00	.00	

	16.0	-.00	-.02
4	.76		
	.0	-.64	.00
	8.0	-2.18	-11.29
	16.0	-3.14	-32.57
5	.41		
	.0	-.44	.00
	1.2	.00	-.26
	8.0	2.63	8.74
	16.0	4.55	37.44

2.10.4. SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Tüm makas elemanları ÇÖZÜM B6'da hesaplananlar ile tamamen aynı olup boyutlandırma yalnız kolonlar için yapılacaktır.

Tablo 2.13

Eleman	Yükleme No	N (t)	M (tm)
10	4	-0.41	-37.44
10	5	-0.76	32.57
11	4	-0.76	32.57
11	5	-0.41	-37.44

Tablo 2.14

	ELEMAN NO			
	10		11	
	M (tm)	N (t)	M (tm)	N (t)
EY	0.08	5.76	0.08	5.76
EİY	-37.36	5.35	-37.36	5.35

KOLONLAR

$$\begin{aligned}
l &= 1600 \text{ cm} \quad \ell_{kx} = 1920 \text{ cm} \quad \ell_{ky} = 533.33 \text{ cm} \quad \text{Seçilen I 280} \quad A = 61.1 \text{ cm}^2 \\
W_x &= 542 \text{ cm}^3 \quad i_x = 11.1 \text{ cm} \quad i_y = 2.45 \text{ cm} \quad S_x = 24.96 \text{ cm} \quad b = 11.9 \text{ cm} \quad d = 1.01 \text{ cm} \\
t &= 1.52 \text{ cm} \quad \lambda_x = 172.97 \quad \lambda_y = 217.68 \quad \sigma_{bem} = 0.1744 \text{ t/cm}^2 \quad \sigma_{eb} = 9.42716 \times 10^{-2} \text{ t/cm}^2 \\
\sigma_{e'} &= 0.27707 \text{ t/cm}^2 \quad \sigma_b = 0.01476 \text{ t/cm}^2 \quad H' = 4.16 \text{ cm} \quad F_B = 22.28 \text{ cm}^2 \\
I_{yB} &= 213.81 \text{ cm}^4 \quad i_{yB} = 3.09 \text{ cm} \quad S/i_{yB} = 516.6 \quad \sigma_B = 0.06557 \text{ t/cm}^2
\end{aligned}$$

$$\begin{aligned}
\text{Gerilme Kontrolleri} \quad 0.830548 &< 1 \\
0.290500 &< 1
\end{aligned}$$

EİY YÜKLEMESİ İÇİN

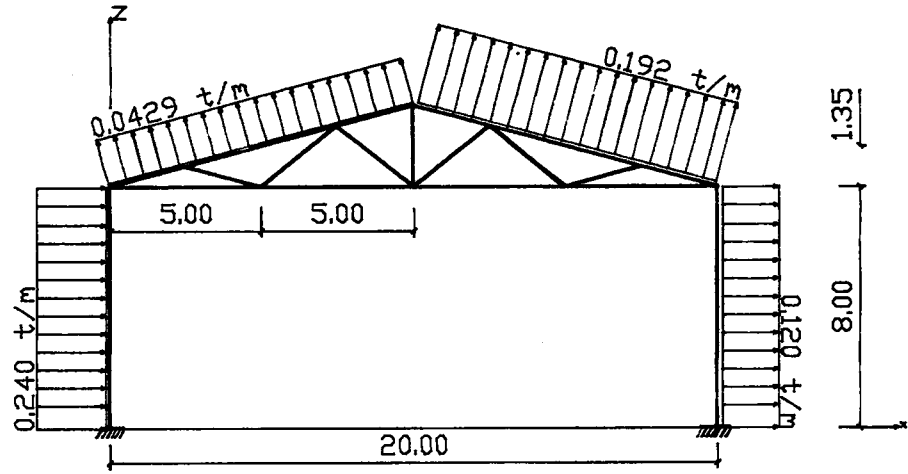
$$\begin{aligned}
N &= 5.35 \text{ t} \quad M = 37.36 \text{ tm} \quad l = 1600 \text{ cm} \quad \text{Seçilen HE - A 900} \quad A = 321 \text{ cm}^2 \\
W_x &= 9480 \text{ cm}^3 \quad i_x = 36.3 \text{ cm} \quad i_y = 6.50 \text{ cm} \quad S_x = 80 - 2 \times 3 = 83 \text{ cm} \quad b = 30 \text{ cm} \\
d &= 1.6 \text{ cm} \quad t = 2.0 \text{ cm} \quad \lambda_x = 52.89 \quad \lambda_y = 82.05 \quad \sigma_{bem} = 1.000 \text{ t/cm}^2 \\
\sigma_{eb} &= 1.666 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 3.40771 \text{ t/cm}^2 \quad \sigma_b = 0.39409 \text{ t/cm}^2 \quad H' = 13.83 \text{ cm} \\
F_B &= 112.13 \text{ cm}^2 \quad I_{yB} = 6754.72 \text{ cm}^4 \quad i_{yB} = 7.76 \text{ cm} \quad S/i_{yB} = 206.15 \text{ cm} \\
\sigma_B &= 0.411785 \text{ t/cm}^2
\end{aligned}$$

$$\begin{aligned}
\text{Gerilme Kontrolleri} \quad 0.834144 &< 1 \\
0.968608 &< 1
\end{aligned}$$

2. Kontrol

$$\lambda_x = 52.89 \rightarrow 53 \text{ için } \omega = 1.29 \quad \sigma = 1.29 \times \frac{5.35}{321} + 0.9 \times \frac{3736}{9480} \quad \sigma = 0.3761 \text{ t/cm}^2 < \sigma_{em}$$

2.11. ÇÖZÜM B11



Sekil 2.15

2.11.1 SİSTEME ETKİYEN YÜKLER

2.11.1.1 ÖLÜ YÜKLER

$$P_1^o = 915.45 \text{ kg} \quad P_2^o = 1830.90 \quad P_3^o = P_4^o = P_5^o = P_6^o = P_7^o = P_8^o = 1830.90 \text{ kg}$$

$$P_9^o = 915.45 \text{ kg}$$

2.11.1.2 KAR YÜKÜ

$$P_1^K = 600 \text{ kg} \quad P_2^K = P_3^K = P_4^K = P_5^K = P_6^K = P_7^K = P_8^K = 1200 \text{ kg} \quad P_9^K = 600 \text{ kg}$$

2.11.1.3 RÜZGAR YÜKÜ

$$W_1 = 7.153 \times \frac{2.588}{2} \times 6 \quad W_1 = 55.535 \text{ kg} \quad W_2 = 7.153 \times 2.588 \times 6 \quad W_2 = 111.071 \text{ kg}$$

$$W_3 = W_4 = 69.425 \text{ kg} \quad W_5 = 55.535 \text{ kg} \quad W_5' = 32 \times \frac{2.588}{2} \times 6 \quad W_5' = 248.448 \text{ kg}$$

$$W_6 = 32 \times 2.588 \times 6 \quad W_6 = 496.896 \text{ kg} \quad W_7 = W_8 = 496.896 \text{ kg} \quad W_9 = 248.448 \text{ kg}$$

RÜZGÂR YÜKLERİNİN BİLEŞENLERE AYRILMASI

Rüzgâr Soldan	Rüzgâr Sağdan	Rüzgâr Soldan	Rüzgâr Sağdan
1 Nolu Düğüm Noktası		2 Nolu Düğüm Noktası	
$W_x = 14.373 \text{ kg}$	$W_x = -64.303 \text{ kg}$	$W_x = 28.747 \text{ kg}$	$W_x = -128.606 \text{ kg}$
$W_z = 5.642 \text{ kg}$	$W_z = 239.982 \text{ kg}$	$W_z = 107.286 \text{ kg}$	$W_z = 479.964 \text{ kg}$
3 Nolu Düğüm Noktası		4 Nolu Düğüm Noktası	
$W_x = -28.747 \text{ kg}$	$W_x = -128.06 \text{ kg}$	$W_x = -28.747 \text{ kg}$	$W_x = -128.606 \text{ kg}$
$W_z = 107.286 \text{ kg}$	$W_z = 479.964 \text{ kg}$	$W_z = 107.286 \text{ kg}$	$W_z = 479.964 \text{ kg}$
5 Nolu Düğüm Noktası		6 Nolu Düğüm Noktası	
$W_x = -14.373 \text{ kg}$	$W_x = -64.303 \text{ kg}$	$W_x = 128.606 \text{ kg}$	$W_x = 28.747 \text{ kg}$
$W_z = 53.642 \text{ kg}$	$W_z = 239.982 \text{ kg}$	$W_z = 479.964 \text{ kg}$	$W_z = 107.286 \text{ kg}$
$W_x' = 64.303 \text{ kg}$	$W_x' = 14.373 \text{ kg}$		
$W_z' = 239.982 \text{ kg}$	$W_z = 53.642 \text{ kg}$		
7 Nolu Düğüm Noktası		8 Nolu Düğüm Noktası	
$W_x = 128.606 \text{ kg}$	$W_x = 28.747 \text{ kg}$	$W_x = 128.606 \text{ kg}$	$W_x = 28.747 \text{ kg}$
$W_z = 479.964 \text{ kg}$	$W_z = 107.286 \text{ kg}$	$W_z = 479.964 \text{ kg}$	$W_z = 107.286 \text{ kg}$
9 Nolu Düğüm Noktası			
$W_x = 64.303 \text{ kg}$	$W_x = 14.373 \text{ kg}$		
$W_z = 239.982 \text{ kg}$	$W_z = 53.642 \text{ kg}$		

2.11.2 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B11

SYSTEM

L=5

:

JOINTS

5 X=10 Y=0 Z=10.679

1 X=0 Y=0 Z=8 G=1,5,1

9 X=20 Y=0 Z=8 G=5,9,1

12 X=15 Y=0 Z=8

10 X=5 Y=0 Z=8 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

4 A=34.5E-4 I=691E-8

1 WG=0.24,0,0

2 WG=0.12,0,0

3 WG=-0.24,0,0

4 WG=-0.12,0,0

1 1 2 M=1 LP=2,0
 2 2 3 M=4 LP=2,0 G=1,1,1,1
 4 4 5 M=1 LP=2,0 G=1,1,1,1
 6 6 7 M=4 LP=2,0 G=1,1,1,1
 8 8 9 M=1 LP=2,0
 9 1 10 M=1 LP=2,0
 10 10 11 M=1 LP=2,0 G=1,1,1,1
 12 12 9 M=1 LP=2,0
 13 2 10 M=2 LP=2,0
 14 10 4 M=2 LP=2,0
 15 4 11 M=2 LP=2,0
 16 11 5 M=2 LP=2,0
 17 11 6 M=2 LP=2,0
 18 6 12 M=2 LP=2,0
 19 12 8 M=2 LP=2,0
 20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

:

LOADS

1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
 2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0
 1 9 8 L=2 F=0,0,-600E-3,0,0,0
 2 8 1 L=2 F=0,0,-1200E-3,0,0,0
 1 5 4 L=3 F=0,0,-600E-3,0,0,0
 2 4 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 4 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0

9 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 4 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 9 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.11.3 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B11

FRAME ELEMENT FORCES

ELT LOAD	AXIAL DIST	1-2 PLANE	
ID COND	FORCE ENDI	SHEAR	MOMENT
1 -----			
1	-24.76		
2	-16.23		
3	-11.59		
4	2.99		
5	4.95		
2 -----			
1	-19.69		
	.0	-.88	.00
	2.6	-.88	-2.29
2	-12.91		
	.0	-.58	.00
	2.6	-.58	-1.50
3	-8.27		
	.0	-.58	.00

		2.6	-.58	-1.50
4	2.71			
		.0	.06	.00
		2.6	.06	.14
5	3.66			
		.0	.25	.00
		2.6	.25	.64
3	-----			
1	-19.22			
		.0	.88	-2.29
		2.6	.88	.00
2	-12.60			
		.0	.58	-1.50
		2.6	.58	.00
3	-7.96			
		.0	.58	-1.50
		2.6	.58	.00
4	2.71			
		.0	-.06	.14
		2.6	-.06	.00
5	3.66			
		.0	-.25	.64
		2.6	-.25	.00
4	-----			
1	-14.15			
2	-9.27			
3	-4.64			
4	2.42			
5	2.37			

5 -----

1 -14.15

2 -9.27

3 -4.64

4 2.37

5 2.42

6 -----

1 -19.22

.0 -.88 .00

2.6 -.88 -2.29

2 -12.60

.0 -.58 .00

2.6 -.58 -1.50

3 -4.64

.0 .00 .00

2.6 .00 .00

4 3.66

.0 .25 .00

2.6 .25 .64

5 2.71

.0 .06 .00

2.6 .06 .14

7 -----

1 -19.69

.0 .88 -2.29

2.6 .88 .00

2 -12.91

.0 .58 -1.50

2.6 .58 .00

3	-4.64		
	.0	.00	.00
	2.6	.00	.00
4	3.66		
	.0	-.25	.64
	2.6	-.25	.00
5	2.71		
	.0	-.06	.14
	2.6	-.06	.00

8 -----

1	-24.76
2	-16.23
3	-4.64
4	4.95
5	2.99

9 -----

1	23.82
2	15.61
3	11.17
4	-2.84
5	-5.08

10 -----

1	16.98
2	11.13
3	6.69
4	-2.41
5	-3.16

11 -----

1	16.98
---	-------

2 11.13

3 4.45

4 -3.16

5 -2.41

12 -----

1 23.82

2 15.61

3 4.45

4 -5.08

5 -2.84

13 -----

1 -5.31

2 -3.48

3 -3.48

4 .33

5 1.49

14 -----

1 2.19

2 1.44

3 1.44

4 -.14

5 -.62

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .28

5 1.23

16 -----

1 5.49

2 3.60

3 1.80

4 -.94

5 -.94

17 -----

1 -4.38

2 -2.87

3 .00

4 1.23

5 .28

18 -----

1 2.19

2 1.44

3 .00

4 -.62

5 -.14

19 -----

1 -5.31

2 -3.48

3 .00

4 1.49

5 .33

20 -----

1 -7.32

.0 .10 -.81

8.0 .10 .00

2 -4.80

.0 .07 -.53

	8.0	.07	
3	-3.60		
	.0	.03	-.27
	8.0	.03	.00
4	.83		
	.0	-1.96	7.97
	8.0	-.04	.00
5	1.52		
	.0	1.32	-6.74
	8.0	.36	.00
21	-----		
1	-7.32		
	.0	-.10	.00
	8.0	-.10	-.81
2	-4.80		
	.0	-.07	.00
	8.0	-.07	-.53
3	-1.20		
	.0	-.03	.00
	8.0	-.03	-.27
4	1.52		
	.0	-.36	.00
	8.0	-1.32	-6.74
5	.83		
	.0	.04	.00
	8.0	1.96	7.97

Tablo 2.15

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
1	24.76	11.59	16.23	-2.99	-4.95	40.99	38.00
2	M= +2.29 N= 19.69	M= 1.50 N= 8.27	M= 1.50 N= 12.91	M= -0.14 N= -2.71	M= -0.64 N= -3.66	M= 3.79 N= 32.60	M= 3.65 N= 29.89
3	M= 2.29 N= 19.22	M= 1.50 N= 7.96	M= 1.50 N= 12.60	M= -0.14 N= -2.71	M= -0.64 N= -3.66	M= 3.79 N= 31.82	M= 3.65 N= 29.11
4	14.15	4.64	9.27	-2.42	-2.37	23.42	21.05
5	14.15	4.64	9.27	-2.37	-2.42	23.42	21.05
6	M= 2.29 N= 19.22	M= 0 N= 4.64	M= 1.50 N= 12.60	M= -0.64 N= -3.66	M= -0.14 N= -2.71	M= 3.79 N= 31.82	M= 3.65 N= 29.11
7	M= -2.29 N= 19.69	M= 0 N= 4.64	M= 1.50 N= 12.91	M= -0.64 N= -3.66	M= -0.14 N= -2.71	M= 3.79 N= 32.60	M= 3.65 N= 29.89
8	24.82	-11.17	-15.61	2.84	5.08	-39.43	-36.59
9	-23.82	-11.17	-15.61	2.84	5.08	-39.43	-36.59
10	-16.98	-6.69	-11.13	2.41	3.16	-28.11	-25.70
11	-16.98	-4.45	-11.13	3.16	2.41	-28.11	-25.70
12	-23.82	-4.45	-15.61	5.08	2.84	-39.43	-36.59
13	5.31	3.48	3.48	-0.33	-1.49	8.79	8.46
14	-2.19	-1.44	-1.44	0.14	0.62	-3.63	-3.49
15	4.38	2.87	2.87	-0.28	-1.23	7.25	6.97
16	-5.49	-1.80	-3.60	0.94	0.94	-9.09	-8.15
17	4.38	0	2.87	-1.23	-0.18	7.25	6.97
18	-2.19	0	-1.44	0.62	0.14	-3.63	-3.49
19	5.31	0	3.48	-1.49	-0.33	8.79	8.46
20	M= 0.81 N= 7.32	M= 0.27 N= 3.60	M= 0.53 N= 4.80	M= -7.97 N= -0.03	M= 6.74 N= -1.52	M= 1.34 N= 12.12	M= 8.08 N= 10.6
21	M= 0.81 N= 7.32	M= 0.27 N= +1.20	M= 0.53 N= 4.80	M= 6.74 N= -1.52	M= -7.97 N= -0.83	M= 1.34 N= 12.12	M= 8.08 N= 10.6

Momentler tm

2.11.4 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

ÜST BAŞLIK

$$N = 32.60 \text{ t} \quad M = 3.79 \text{ tm} \quad \text{Seçilen } \frac{1}{2} \text{ I } 550 \quad A = 106 \text{ cm}^2 \quad W_x = 366 \text{ cm}^3$$

$$i_x = 8.29 \text{ cm} \quad i_y = 4.02 \text{ cm} \quad S_x = 27.5 - 3.0 = 24.5 \text{ cm} \quad b = 20 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.0$$

$$\lambda_x = 31 \quad 218 \quad \lambda_y = 64.37 \rightarrow 65 \quad \sigma_{bem} = 1.018 \text{ t/cm}^2 \quad \sigma_{eb} = 0.30754 \text{ t/cm}^2$$

$$\sigma_{e'} = 8.50618 \text{ t/cm}^2 \quad \sigma_b = 1.03551 \text{ t/cm}^2 \quad H' = 4.083 \text{ cm} \quad F_B = 67.758 \text{ cm}^2$$

$$I_{yB} = 2002.333 \text{ cm}^4 \quad i_{yB} = 5.436 \text{ cm} \quad S/i_{yB} = 47.60 \quad \sigma_B = 1.441 \text{ t/cm}^2$$

$$\begin{aligned}\text{Gerilme Kontrolleri } 0.936282 < 1 \\ 0.932684 < 1\end{aligned}$$

2. Kontrol

$$\lambda_x = 31.218 \rightarrow 32 \text{ için } \omega = 1.11 \quad \sigma = 1.11 \times \frac{32.60}{106} + 0.9 \times \frac{379}{366} \quad \sigma = 1.2733 \text{ t/cm}^2 < \sigma_{em}$$

ALT BAŞLIK

$$N = 39.43 \text{ t} \quad \text{Seçilen } \frac{1}{2} \text{ I } 280 \quad A = 30.5 \text{ cm}^2 \quad \sigma = \frac{39.43}{30.50} = 1.292 \text{ t/cm}^2 < \sigma_{em}$$

DİYAGONALLER

13 ve 19 Nolu Elemanlar

$$\begin{aligned}N &= -8.79 \text{ t} \quad \ell_{kx} = \ell_{ky} = 2.588 \text{ cm} \quad \text{Seçilen } L 90.90.16 \quad A = 26.4 \text{ cm}^2 \quad i_y = 1.73 \text{ cm} \\ \lambda &= \frac{258.8}{1.73} = 149.59 \rightarrow 150 \quad \omega = 3.40 \quad \sigma = 3.40 \times \frac{8.79}{26.4} = 1.132 \text{ t/cm}^2 < \sigma_{em}\end{aligned}$$

14 ve 18 Nolu Elemanlar

$$N = 3.63 \text{ t} \quad \text{Seçilen } L 50.50.5 \quad A = 4.80 \text{ cm}^2 \quad \sigma = \frac{3.63}{4.80} = 0.7560 \text{ t/cm}^2 < \sigma_{em}$$

15 ve 17 Nolu Elemanlar

$$\begin{aligned}N &= 7.25 \text{ t} \quad \ell_{kx} = \ell_{ky} = 320.1 \text{ cm} \quad \text{Seçilen } 2 \times L 70.70.9 \\ i_{\min} = i_x &= \frac{320.1}{2.10} = 152.42 \rightarrow 153 \quad \omega = 4.07 \quad \sigma = 4.07 \times \frac{7.25}{2 \times 11.9} = 1.239 \text{ t/cm}^2 < \sigma_{em}\end{aligned}$$

DİKMELER

16 Nolu Eleman

$$N = 9.09 \text{ t} \quad \text{Seçilen } L 50.50.7 \quad A = 6.56 \text{ cm}^2 \quad \sigma = 1.385 \text{ t/cm}^2 < \sigma_{em}$$

KOLONLAR

$$\begin{aligned}
N &= -12.12 \text{ t} \quad M = 1.34 \text{ tm} \quad \text{Seçilen I 320} \quad A = 77.7 \text{ cm}^2 \quad W_x = 782 \text{ cm}^3 \\
i_x &= 12.7 \text{ cm} \quad i_y = 2.67 \text{ cm} \quad S_x = 32 - 2 \times 1.73 \text{ cm} \quad b = 13.1 \text{ cm} \quad d = 1.15 \text{ cm} \quad t = 1.73 \text{ cm} \\
\lambda_x &= 75.59 \quad \lambda_y = 149.81 \rightarrow 150 \quad \sigma_{bem} = 0.3685 \text{ t/cm}^2 \quad \sigma_{eb} = 0.15598 \text{ t/cm}^2 \quad \sigma_{e'} = 1.4508 \text{ t/cm}^2 \\
\sigma_b &= 0.17135 \text{ t/cm}^2 \quad H' = 4.756 \text{ cm} \quad F_B = 28.133 \text{ cm}^2 \quad I_{yB} = 324.702 \text{ cm}^4 \quad i_{yB} = 3.39 \\
S/i_{yB} &= 235.48 \quad \sigma_B = 0.315591 \text{ t/cm}^2
\end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.94041 < 1$$

$$0.65128 < 1$$

EİY YÜKLEMESİ İÇİN

$$\begin{aligned}
N &= 10.6 \text{ t} \quad M = 8.08 \text{ tm} \quad l = 800 \text{ cm} \quad \ell_{kx} = 960 \text{ cm} \quad \ell_{ky} = 400 \text{ cm} \quad \text{Seçilen I 425} \\
A &= 132 \text{ cm}^2 \quad W_x = 1740 \text{ cm}^3 \quad i_x = 16.7 \text{ cm} \quad i_y = 3.30 \text{ cm} \quad S_x = 42.5 - 2 \times 2.3 = 37.9 \text{ cm} \\
b &= 16.3 \text{ cm} \quad d = 1.53 \text{ cm} \quad t = 2.3 \text{ cm} \quad \lambda_x = 57.48 \quad \lambda_y = 121.21 \quad \sigma_{bem} = 0.6401 \text{ t/cm}^2 \\
\sigma_{eb} &= 0.080303 \text{ t/cm}^2 \quad \sigma_{e'} = 2.8849 \text{ t/cm}^2 \quad \sigma_b = 0.46436 \text{ t/cm}^2 \quad H' = 6.31 \text{ cm} \\
F_B &= 47.154 \text{ cm}^2 \quad I_{yB} = 831.94 \text{ cm}^4 \quad i_{yB} = 4.20 \text{ cm} \quad S/i_{yx} = 190.46 \text{ cm} \\
\sigma_B &= 0.482424 \text{ t/cm}^2
\end{aligned}$$

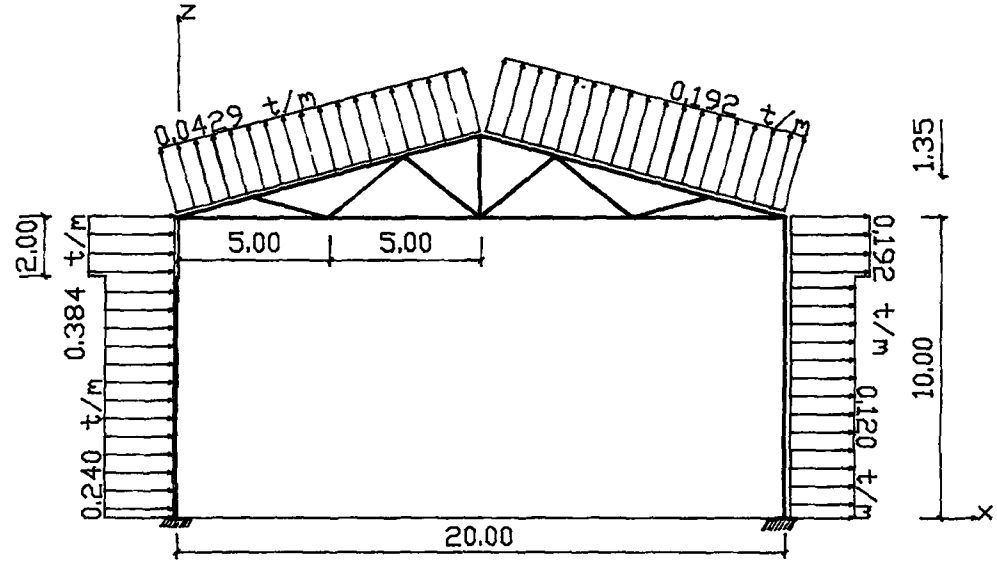
$$\text{Gerilme Kontrolleri} \quad 0.96706 < 1$$

$$1.01833 \approx 1$$

2. Kontrol

$$\lambda_x = 57.48 \rightarrow 58 \text{ için } \omega = 1.34 \quad \sigma = 1.34 \times \frac{10.6}{132} + 0.9 \times \frac{808}{1740} \quad \sigma = 0.5255 \text{ t/cm}^2 < \sigma_{em}$$

2.12. ÇÖZÜM B12



Sekil 2.16

2.12.1 SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgâr yükü hariç bütün yükler ÇÖZÜM B11 için hesaplananlar ile tamamen aynıdır.

2.12.2 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B12

SYSTEM

L=5

:

JOINTS

5 X=10 Y=0 Z=12.679

1 X=0 Y=0 Z=10 G=1,5,1

9 X=20 Y=0 Z=10 G=5,9,1

12 X=15 Y=0 Z=10

10 X=5 Y=0 Z=10 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

4 A=34.5E-4 I=691E-8

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,10,0.384,0

2 TRAP=0,-0.192,0,2,-0.192,0,2,-0.12,0,10,-0.12,0

3 TRAP=0,0.384,0,2,0.384,0,2,0.24,0,10,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,10,-0.192,0

1 1 2 M=1 LP=2,0

2 2 3 M=4 LP=2,0 G=1,1,1,1

4 4 5 M=1 LP=2,0 G=1,1,1,1

6 6 7 M=4 LP=2,0 G=1,1,1,1

8 8 9 M=1 LP=2,0

9 1 10 M=1 LP=2,0

10 10 11 M=1 LP=2,0 G=1,1,1,1

12 12 9 M=1 LP=2,0

13 2 10 M=2 LP=2,0

14 10 4 M=2 LP=2,0

15 4 11 M=2 LP=2,0

16 11 5 M=2 LP=2,0

17 11 6 M=2 LP=2,0

18 6 12 M=2 LP=2,0
 19 12 8 M=2 LP=2,0
 20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :

LOADS

1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
 2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0
 1 9 8 L=2 F=0,0,-600E-3,0,0,0
 2 8 1 L=2 F=0,0,-1200E-3,0,0,0
 1 5 4 L=3 F=0,0,-600E-3,0,0,0
 2 4 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 4 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0
 9 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 4 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 9 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.12.3 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B12

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -24.76

2 -16.23

3 -11.59

4 2.99

5 4.95

2 -----

1 -19.69

.0 -.88 .00

2.6 -.88 -2.29

2 -12.91

.0 -.58 .00

2.6 -.58 -1.50

3 -8.27

.0 -.58 .00

2.6 -.58 -1.50

4 2.71

.0 .06 .00

2.6 .06 .14

5 3.66

.0 .25 .00

2.6 .25 .64

3 -----

1 -19.22

.0 .88 -2.29

2.6 .88 .00

2 -12.60

.0 .58 -1.50

2.6 .58 .00

3 -7.96

		.0	.58	-1.50
		2.6	.58	.00
4	2.71			
		.0	-.06	.14
		2.6	-.06	.00
5	3.66			
		.0	-.25	.64
		2.6	-.25	.00
4	-----			
1	-14.15			
2	-9.27			
3	-4.64			
4	2.42			
5	2.37			
5	-----			
1	-14.15			
2	-9.27			
3	-4.64			
4	2.37			
5	2.42			
6	-----			
1	-19.22			
		.0	-.88	.00
		2.6	-.88	-2.29
2	-12.60			
		.0	-.58	.00
		2.6	-.58	-1.50
3	-4.64			
		.0	.00	.00

		2.6	.00	.00
4	3.66			
		.0	.25	.00
		2.6	.25	.64
5	2.71			
		.0	.06	.00
		2.6	.06	.14
7	-----			
1	-19.69			
		.0	.88	-2.29
		2.6	.88	.00
2	-12.91			
		.0	.58	-1.50
		2.6	.58	.00
3	-4.64			
		.0	.00	.00
		2.6	.00	.00
4	3.66			
		.0	-.25	.64
		2.6	-.25	.00
5	2.71			
		.0	-.06	.14
		2.6	-.06	.00
8	-----			
1	-24.76			
2	-16.23			
3	-4.64			
4	4.95			
5	2.99			

9 -----

- 1 23.87
- 2 15.64
- 3 11.18
- 4 -2.96
- 5 -5.19

10 -----

- 1 17.03
- 2 11.16
- 3 6.70
- 4 -2.53
- 5 -3.27

11 -----

- 1 17.03
- 2 11.16
- 3 4.46
- 4 -3.27
- 5 -2.53

12 -----

- 1 23.87
- 2 15.64
- 3 4.46
- 4 -5.19
- 5 -2.96

13 -----

- 1 -5.31
- 2 -3.48
- 3 -3.48
- 4 .33

5 1.49

14 -----

1 2.19

2 1.44

3 1.44

4 -.14

5 -.62

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .28

5 1.23

16 -----

1 5.49

2 3.60

3 1.80

4 -.94

5 -.94

17 -----

1 -4.38

2 -2.87

3 .00

4 1.23

5 .28

18 -----

1 2.19

2 1.44

3 .00

4	-62			
5	-14			
19	-----			
1	-5.31			
2	-3.48			
3	.00			
4	1.49			
5	.33			
20	-----			
1	-7.32			
	.0	.05	-.52	
	10.0	.05	.00	
2	-4.80			
	.0	.03	-.34	
	10.0	.03	.00	
3	-3.60			
	.0	.02	-.17	
	10.0	.02	.00	
4	.83			
	.0	-2.61	13.82	
	8.0	-.69	.61	
	9.8	.00	-.01	
	10.0	.08	.00	
5	1.52			
	.0	1.82	-12.07	
	8.0	.86	-1.34	
	10.0	.48	.00	
21	-----			
1	-7.32			

		.0	-.05	.00
		10.0	-.05	-.52
2	-4.80			
		.0	-.03	.00
		10.0	-.03	-.34
3	-1.20			
		.0	-.02	.00
		10.0	-.02	-.17
4	1.52			
		.0	-.48	.00
		2.0	-.86	-1.34
		10.0	-1.82	-12.07
5	.83			
		.0	-.08	.00
		.2	.00	-.01
		2.0	.69	.61
		10.0	2.61	13.82

Tablo 2.16

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
20	0.52 7.32	0.17 3.60	0.34 4.80	-13.82 -0.83	12.07 -1.52	0.86 12.12	12.93 10.6
21	M= 0.52 N= 7.32	M= 0.17 N= 1.20	M= 0.34 N= 4.80	M= 12.07 N = -1.52	M=-13.82 N= -0.83	M= 0.86 N= 12.12	M= 12.93 N = 10.6

Momentler tm

2.12.4 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Makas ÇÖZÜM B11 ile aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

$$\begin{aligned}
N &= 12.12 \text{ t} \quad M = 0.86 \text{ tm} \quad l = 10 \text{ m} \quad \ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 333 \text{ cm} \quad \text{Seçilen I 320} \\
A &= 77.7 \text{ cm}^2 \quad W_x = 782 \text{ cm}^3 \quad i_x = 12.7 \text{ cm} \quad i_y = 2.67 \text{ cm} \quad S_x = 32 - 2 \times 1.73 \text{ cm} \\
b &= 13.1 \text{ cm} \quad d = 1.15 \text{ cm} \quad t = 1.73 \text{ cm} \quad \lambda_x = 94.48 \quad \lambda_y = 124.71 \quad \sigma_{bem} = 0.5323 \text{ t/cm}^2 \\
\sigma_{eb} &= 0.15598 \text{ t/cm}^2 \quad \sigma_{e'} = 0.9285 \text{ t/cm}^2 \quad \sigma_b = 0.10997 \text{ t/cm}^2 \quad H' = 4.75 \text{ cm} \quad F_B = 28.13 \text{ cm}^2 \\
I_{yB} &= 324.7 \text{ cm}^4 \quad i_{yB} = 3.39 \quad S/i_{yB} = 294.351 \quad \sigma_B = 0.20197 \text{ t/cm}^2
\end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.84929 < 1$$

$$0.65280 < 1$$

EİY YÜKLEMESİ İÇİN

$$\begin{aligned}
N &= 10.6 \text{ t} \quad M = 12.93 \text{ tm} \quad \ell_{kx} = 1200 \text{ cm} \quad \ell_{ky} = 333.30 \text{ cm} \quad \text{Seçilen I 550} \\
A &= 212 \text{ cm}^2 \quad W_x = 3610 \text{ cm}^3 \quad i_x = 21.6 \text{ cm} \quad i_y = 4.02 \text{ cm} \quad S_x = 55 - 2 \times 3 = 49 \text{ cm} \\
b &= 20 \text{ cm} \quad d = 1.9 \text{ cm} \quad t = 3.0 \text{ cm} \quad \lambda_x = 55.55 \quad \lambda_y = 82.917 \quad \sigma_{bem} = 1.001 \text{ t/cm}^2 \\
\sigma_{eb} &= 0.05 \text{ t/cm}^2 \quad \sigma_{e'} = 3.088 \text{ t/cm}^2 \quad \sigma_b = 0.358171 \text{ t/cm}^2 \quad H' = 8.16 \text{ cm} \\
F_B &= 75.516 \text{ cm}^2 \quad I_{yB} = 2004.66 \text{ cm}^4 \quad i_{yB} = 5.15 \text{ cm} \quad S/i_{yx} = 194.08 \text{ cm} \\
\sigma_B &= 0.46455 \text{ t/cm}^2
\end{aligned}$$

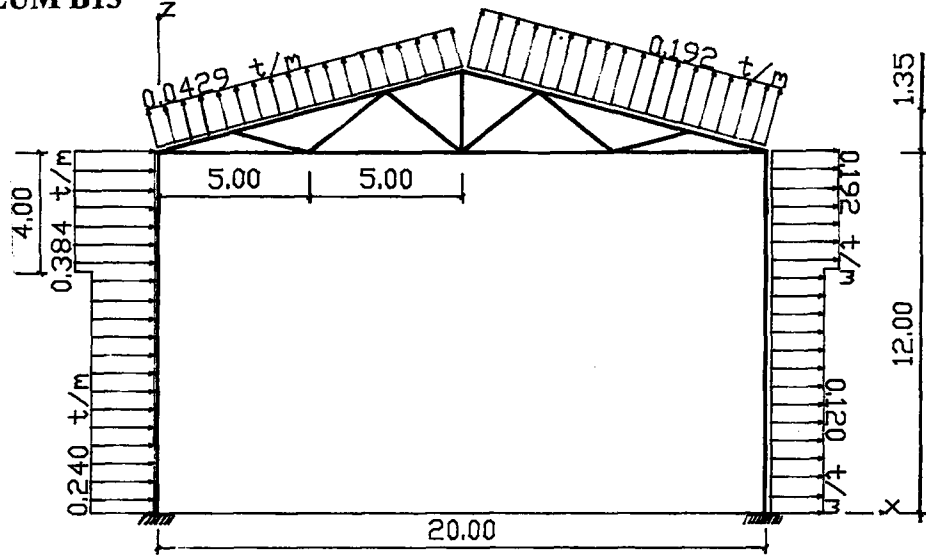
$$\text{Gerilme Kontrolleri} \quad 0.716081 < 1$$

$$0.80572 < 1$$

2. Kontrol

$$\lambda_x = 55.55 \rightarrow 56 \text{ için } \omega = 1.32 \quad \sigma = 1.32 \times \frac{10.6}{212} + 0.9 \times \frac{1293}{3610} \quad \sigma = 0.3883 \text{ t/cm}^2 < \sigma_{em}$$

2.13 ÇÖZÜM B13



Sekil 2.17

2.13.1 SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgâr yükü hariç bütün yükler ÇÖZÜM B11 için hesaplananlar ile tamamen aynıdır.

2.13.2. STATİK ÇÖZÜM İÇİN SAP 90 VERİSİ

ÇÖZÜM B13

SYSTEM

L=5

:

JOINTS

5 X=10 Y=0 Z=14.679

1 X=0 Y=0 Z=12 G=1,5,1

9 X=20 Y=0 Z=12 G=5,9,1

12 X=15 Y=0 Z=12

10 X=5 Y=0 Z=12 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

4 A=34.5E-4 I=691E-8

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,12,0.384,0

2 TRAP=0,-0.192,0,4,-0.192,0,4,-0.12,0,12,-0.12,0

3 TRAP=0,0.384,0,4,0.384,0,4,0.24,0,12,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,12,-0.192,0

1 1 2 M=1 LP=2,0

2 2 3 M=4 LP=2,0 G=1,1,1,1

4 4 5 M=1 LP=2,0 G=1,1,1,1

6 6 7 M=4 LP=2,0 G=1,1,1,1

8 8 9 M=1 LP=2,0

9 1 10 M=1 LP=2,0

10 10 11 M=1 LP=2,0 G=1,1,1,1

12 12 9 M=1 LP=2,0

13 2 10 M=2 LP=2,0

14 10 4 M=2 LP=2,0

15 4 11 M=2 LP=2,0

16 11 5 M=2 LP=2,0

17 11 6 M=2 LP=2,0

18 6 12 M=2 LP=2,0
 19 12 8 M=2 LP=2,0
 20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :

LOADS

1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
 2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0
 1 9 8 L=2 F=0,0,-600E-3,0,0,0
 2 8 1 L=2 F=0,0,-1200E-3,0,0,0
 1 5 4 L=3 F=0,0,-600E-3,0,0,0
 2 4 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 4 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0
 9 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 4 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 9 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.13.3. STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B13

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -24.76

2 -16.23

3 -11.59

4 2.99

5 4.95

2 -----

1 -19.69

.0 -.88 .00

2.6 -.88 -2.29

2 -12.91

.0 -.58 .00

2.6 -.58 -1.50

3 -8.27

.0 -.58 .00

2.6 -.58 -1.50

4 2.71

.0 .06 .00

2.6 .06 .14

5 3.66

.0 .25 .00

2.6 .25 .64

3 -----

1 -19.22

.0 .88 -2.29

2.6 .88 .00

2 -12.60

.0 .58 -1.50

2.6 .58 .00

3	-7.96		
	.0	.58	-1.50
	2.6	.58	.00
4	2.71		
	.0	-.06	.14
	2.6	-.06	.00
5	3.66		
	.0	-.25	.64
	2.6	-.25	.00

4 -----

1	-14.15
2	-9.27
3	-4.64
4	2.42
5	2.37

5 -----

1	-14.15
2	-9.27
3	-4.64
4	2.37
5	2.42

6 -----

1	-19.22		
	.0	-.88	.00
	2.6	-.88	-2.29
2	-12.60		
	.0	-.58	.00
	2.6	-.58	-1.50
3	-4.64		

		.0	.00	.00
		2.6	.00	.00
4	3.66			
		.0	.25	.00
		2.6	.25	.64
5	2.71			
		.0	.06	.00
		2.6	.06	.14
7	-----			
1	-19.69			
		.0	.88	-2.29
		2.6	.88	.00
2	-12.91			
		.0	.58	-1.50
		2.6	.58	.00
3	-4.64			
		.0	.00	.00
		2.6	.00	.00
4	3.66			
		.0	-.25	.64
		2.6	-.25	.00
5	2.71			
		.0	-.06	.14
		2.6	-.06	.00
8	-----			
1	-24.76			
2	-16.23			
3	-4.64			
4	4.95			

5 2.99

9 -----

1 23.89

2 15.66

3 11.19

4 -3.05

5 -5.29

10 -----

1 17.06

2 11.18

3 6.71

4 -2.62

5 -3.37

11 -----

1 17.06

2 11.18

3 4.47

4 -3.37

5 -2.62

12 -----

1 23.89

2 15.66

3 4.47

4 -5.29

5 -3.05

13 -----

1 -5.31

2 -3.48

3 -3.48

4 .33

5 1.49

14 -----

1 2.19

2 1.44

3 1.44

4 -.14

5 -.62

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .28

5 1.23

16 -----

1 5.49

2 3.60

3 1.80

4 -.94

5 -.94

17 -----

1 -4.38

2 -2.87

3 .00

4 1.23

5 .28

18 -----

1 2.19

2 1.44

3 .00 .
 4 -.62
 5 -.14

19 -----

1 -5.31
 2 -3.48
 3 .00
 4 1.49
 5 .33

20 -----

1 -7.32
 .0 .03 -.36

 12.0 .03

2 -4.80
 .0 .02 -.24

 12.0 .02

3 -3.60
 .0 .01 -.12

 12.0 .01

4 .83
 .0 -3.28 20.96

 8.0 -1.36 2.38

 11.5 .00 -.04

 12.0 .17 .00

5 1.52
 .0 2.30 -18.40

 8.0 1.34 -3.83

 12.0 .57 .00

21 -----

1	-7.32			
	.0	-.03	.00	
	12.0	-.03	-.36	
2	-4.80			
	.0	-.02	.00	
	12.0	-.02	-.24	
3	-1.20			
	.0	-.01	.00	
	12.0	-.01	-.12	
4	1.52			
	.0	-.57	.00	
	4.0	-1.34	-3.83	
	12.0	-2.30	-18.40	
5	.83			
	.0	-.17	.00	
	.5	.00	-.04	
	4.0	1.36	2.38	
	12.0	3.28	20.96	

Tablo 2.17

ELEMAN NO	ÖLÜ YÜKLER (t)	KAR (t)	YARIM KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
20	M=0.36 N=7.32	M=0.24 N=4.80	M=0.12 N=3.60	M=-20.96 N=-0.83	M=18.40 N=-1.52	M=0.60 N=12.12	M=19.00 N=10.6
21	M= 0.36 N= 7.32	M= 0.24 N= 4.80	M= 0.12 N= 1.20	M= 18.40 N = -1.52	M=-20.96 N= -0.83	M= 0.60 N= 12.12	M= 19.00 N = 10.6

Moment tm

2.13.4 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Makas ÇÖZÜM B11 ile aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

$$\begin{aligned}
 N &= 12.12 \text{ t} \quad M = 0.60 \text{ tm} \quad l = 1200 \text{ cm} \quad \ell_{kx} = 1440 \text{ cm} \quad \ell_{ky} = 400 \text{ cm} \quad \text{Seilen I 320} \\
 A &= 77.7 \text{ cm}^2 \quad W_x = 782 \text{ cm}^3 \quad i_x = 12.7 \text{ cm} \quad i_y = 2.67 \text{ cm} \quad S_x = 28.54 \text{ cm} \quad b = 13.1 \text{ cm} \\
 d &= 1.15 \text{ cm} \quad t = 1.73 \text{ cm} \quad \lambda_x = 113.385 \quad \lambda_y = 149.812 \quad \sigma_{bem} = 0.3685 \text{ t/cm}^2 \\
 \sigma_{eb} &= 0.15598 \text{ t/cm}^2 \quad \sigma_{e'} = 0.644817 \text{ t/cm}^2 \quad \sigma_b = 7.67263 \times 10^{-2} \text{ t/cm}^2 \quad H' = 4.75 \text{ cm} \\
 F_B &= 28.133 \text{ cm}^2 \quad I_{yB} = 324.702 \text{ cm}^4 \quad i_{yB} = 3.39 \quad S/i_{yB} = 353.32 \quad \sigma_B = 0.14026 \text{ t/cm}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Gerilme Kontrolleri} \quad 1.0366 &\approx 1 \\
 0.6553 &< 1
 \end{aligned}$$

EİY YÜKLEMESİ İÇİN

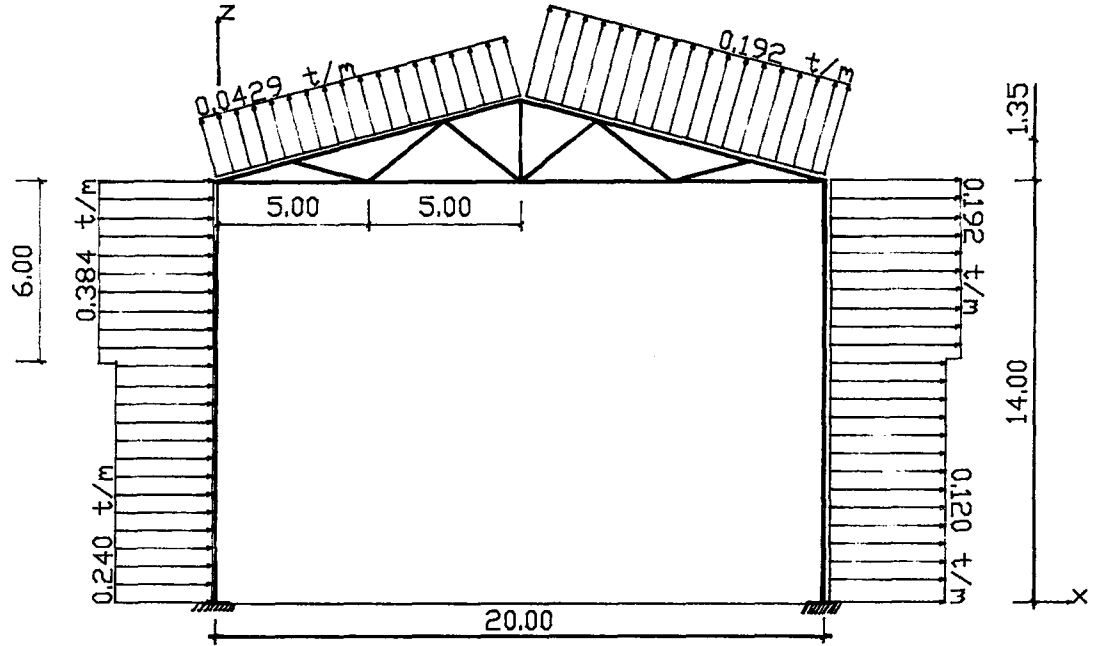
$$\begin{aligned}
 N &= 10.6 \text{ t} \quad M = 19 \text{ tm} \quad \text{Seilen HE-A 400} \quad A = 159 \text{ cm}^2 \quad W_x = 2310 \text{ cm}^3 \quad i_x = 16.8 \text{ cm} \\
 i_y &= 7.34 \text{ cm} \quad S_x = 39 - 2 \times 1.9 = 35.2 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.1 \text{ cm} \quad t = 1.9 \text{ cm} \quad \lambda_x = 85.71 \\
 \lambda_y &= 54.49 \quad \sigma_{bem} = 1.97302 \text{ t/cm}^2 \quad \sigma_{eb} = 6.666 \text{ t/cm}^2 \quad \sigma_{e'} = 1.29761 \text{ t/cm}^2 \\
 \sigma_b &= 0.822510 \text{ t/cm}^2 \quad H' = 5.86 \text{ cm} \quad F_B = 63.453 \text{ cm}^2 \quad I_{yB} = 4275.65 \text{ cm}^4 \\
 i_{yB} &= 8.20 \text{ cm} \quad S/i_{yx} = 146.186 \text{ cm} \quad \sigma_B = 0.94121 \text{ t/cm}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Gerilme Kontrolleri} \quad 0.85154 &< 1 \\
 0.920175 &< 1
 \end{aligned}$$

2. Kontrol

$$\lambda_x = 85.71 \rightarrow 86 \text{ için } \omega = 1.70 \quad \sigma = 1.70 \times \frac{10.6}{159} + 0.9 \times \frac{1900}{2310} \quad \sigma = 0.8535 \text{ t/cm}^2 < \sigma_{em}$$

2.14 ÇÖZÜM B14



Sekil 2.18

2.14.1 SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgâr yükü hariç bütün yükler ÇÖZÜM B11 için hesaplananlar ile tamamen aynıdır.

2.14.2 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B14

SYSTEM

L=5

:

JOINTS

5 X=10 Y=0 Z=16.679

1 X=0 Y=0 Z=14 G=1,5,1

9 X=20 Y=0 Z=14 G=5,9,1

12 X=15 Y=0 Z=14

10 X=5 Y=0 Z=14 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

4 A=34.5E-4 I=691E-8

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,14,0.384,0

2 TRAP=0,-0.192,0,6,-0.192,0,6,-0.12,0,14,-0.12,0

3 TRAP=0,0.384,0,6,0.384,0,6,0.24,0,14,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,14,-0.192,0

1 1 2 M=1 LP=2,0

2 2 3 M=4 LP=2,0 G=1,1,1,1

4 4 5 M=1 LP=2,0 G=1,1,1,1

6 6 7 M=4 LP=2,0 G=1,1,1,1

8 8 9 M=1 LP=2,0

9 1 10 M=1 LP=2,0

10 10 11 M=1 LP=2,0 G=1,1,1,1

12 12 9 M=1 LP=2,0

13 2 10 M=2 LP=2,0

14 10 4 M=2 LP=2,0

15 4 11 M=2 LP=2,0

16 11 5 M=2 LP=2,0

17 11 6 M=2 LP=2,0
 18 6 12 M=2 LP=2,0
 19 12 8 M=2 LP=2,0
 20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
 21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3
 :

LOADS

1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
 2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0
 1 9 8 L=2 F=0,0,-600E-3,0,0,0
 2 8 1 L=2 F=0,0,-1200E-3,0,0,0
 1 5 4 L=3 F=0,0,-600E-3,0,0,0
 2 4 1 L=3 F=0,0,-1200E-3,0,0,0
 1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
 2 4 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
 5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0
 9 L=4 F=64.303E-3,0,239.982E-3,0,0,0
 1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
 2 4 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
 5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
 6 8 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
 9 L=5 F=14.373E-3,0,53.642E-3,0,0,0
 :

2.14.3 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B14

FRAME ELEMENT FORCES

ELT LOAD AXIAL DIST 1-2 PLANE

ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -24.76

2 -16.23

3 -11.59

4 2.99

5 4.95

2 -----

1 -19.69

 .0 -.88 .00

 2.6 -.88 -2.29

2 -12.91

 .0 -.58 .00

 2.6 -.58 -1.50

3 -8.27

 .0 -.58 .00

 2.6 -.58 -1.50

4 2.71

 .0 .06 .00

 2.6 .06 .14

5 3.66

 .0 .25 .00

 2.6 .25 .64

3 -----

1 -19.22

 .0 .88 -2.29

 2.6 .88 .00

2 -12.60

 .0 .58 -1.50

	2.6	.58	.00
--	-----	-----	-----

3	-7.96		
---	-------	--	--

	.0	.58	-1.50
--	----	-----	-------

	2.6	.58	.00
--	-----	-----	-----

4	2.71		
---	------	--	--

	.0	-.06	.14
--	----	------	-----

	2.6	-.06	.00
--	-----	------	-----

5	3.66		
---	------	--	--

	.0	-.25	.64
--	----	------	-----

	2.6	-.25	.00
--	-----	------	-----

4 -----

1	-14.15		
---	--------	--	--

2	-9.27		
---	-------	--	--

3	-4.64		
---	-------	--	--

4	2.42		
---	------	--	--

5	2.37		
---	------	--	--

5 -----

1	-14.15		
---	--------	--	--

2	-9.27		
---	-------	--	--

3	-4.64		
---	-------	--	--

4	2.37		
---	------	--	--

5	2.42		
---	------	--	--

6 -----

1	-19.22		
---	--------	--	--

	.0	-.88	.00
--	----	------	-----

	2.6	-.88	-2.29
--	-----	------	-------

2	-12.60		
---	--------	--	--

	.0	-.58	.00
--	----	------	-----

	2.6	-.58	-1.50
--	-----	------	-------

3	-4.64		
	.0	.00	.00
	2.6	.00	.00
4	3.66		
	.0	.25	.00
	2.6	.25	.64
5	2.71		
	.0	.06	.00
	2.6	.06	.14

7 -----

1	-19.69		
	.0	.88	-2.29
	2.6	.88	.00
2	-12.91		
	.0	.58	-1.50
	2.6	.58	.00
3	-4.64		
	.0	.00	.00
	2.6	.00	.00

4	3.66		
	.0	-.25	.64
	2.6	-.25	.00
5	2.71		
	.0	-.06	.14
	2.6	-.06	.00

8 -----

- 1 -24.76
- 2 -16.23
- 3 -4.64

4 4.95

5 2.99

9 -----

1 23.90

2 15.67

3 11.19

4 -3.14

5 -5.38

10 -----

1 17.07

2 11.19

3 6.71

4 -2.71

5 -3.46

11 -----

1 17.07

2 11.19

3 4.47

4 -3.46

5 -2.71

12 -----

1 23.90

2 15.67

3 4.47

4 -5.38

5 -3.14

13 -----

1 -5.31

2 -3.48

3 -3.48

4 .33

5 1.49

14 -----

1 2.19

2 1.44

3 1.44

4 -.14

5 -.62

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .28

5 1.23

16 -----

1 5.49

2 3.60

3 1.80

4 -.94

5 -.94

17 -----

1 -4.38

2 -2.87

3 .00

4 1.23

5 .28

18 -----

1 2.19

2 1.44
 3 .00
 4 -.62
 5 -.14

19 -----

1 -5.31
 2 -3.48
 3 .00
 4 1.49
 5 .33

20 -----

1 -7.32

.0 .02 -.27

14.0 .02 .00

2 -4.80

.0 .01 -.17

14.0 .01 .00

3 -3.60

.0 .01 -.09

14.0 .01 .00

4 .83

.0 -3.96 29.38

8.0 -2.04 5.35

13.3 .00 -.09

14.0 .26 .00

5 1.52

.0 2.77 -25.75

8.0 1.81 -7.42

14.0 .66 .00

21 -----

1	-7.32			
	.0	-.02	.00	
	14.0	-.02	-.27	
2	-4.80			
	.0	-.01	.00	
	14.0	-.01	-.17	
3	-1.20			
	.0	-.01	.00	
	14.0	-.01	-.09	
4	1.52			
	.0	-.66	.00	
	6.0	-1.81	-7.42	
	14.0	-2.77	-25.75	
5	.83			
	.0	-.26	.00	
	.7	.00	-.09	
	6.0	2.04	5.35	
	14.0	3.96	29.38	

Tablo 2.18

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
20	M= 0.27 N= 7.32	M= 0.09 N= 3.60	M= 0.17 N= 4.80	M= -29.38 N= -0.83	M= 25.75 N= -1.52	M= 0.44 N= 12.12	M= 26.19 N= 10.60
21	M= 0.27 N= 7.32	M= 0.09 N= 1.20	M= 0.17 N= 4.80	M= 25.75 N= -1.52	M=-29.38 N= -0.83	M= 0.44 N= 12.12	M= 26.19 N= 10.60

Momentler tm

2.14.4 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Makas ÇÖZÜM B11 ile aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

$$\begin{aligned}
N &= 12.12 \text{ t} \quad M = 0.44 \text{ tm} \quad l = 1400 \text{ cm} \quad \ell_{kx} = 1680 \text{ cm} \quad \ell_{ky} = 466.667 \text{ cm} \\
\text{Seçilen I 340} \quad A &= 86.7 \text{ cm}^2 \quad W_x = 923 \text{ cm}^3 \quad i_x = 13.5 \text{ cm} \quad i_y = 2.80 \text{ cm} \\
S_x &= 34 - 2 \times 1.83 = 30.34 \text{ cm} \quad b = 13.7 \text{ cm} \quad d = 1.22 \text{ cm} \quad t = 1.83 \text{ cm} \quad \lambda_x = 124.44 \\
\lambda_y &= 166.66 \quad \sigma_{bem} = 0.2973 \text{ t/cm}^2 \quad \sigma_{eb} = 0.139792 \text{ t/cm}^2 \quad \sigma_{e'} = 0.535307 \text{ t/cm}^2 \\
\sigma_b &= 4.76706 \times 10^{-2} \text{ t/cm}^2 \quad H' = 5.05 \text{ cm} \quad F_B = 31.24 \text{ cm}^2 \quad I_{yB} = 392.896 \text{ cm}^4 \quad i_{yB} = 3.54 \\
S/i_{yB} &= 394.77 \quad \sigma_B = 0.11229 \text{ t/cm}^2
\end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.95859 < 1$$

$$0.52160 < 1$$

EİY YÜKLEMESİ İÇİN

$$\begin{aligned}
N &= 10.6 \text{ t} \quad M = 26.19 \text{ tm} \quad \ell = 1400 \text{ cm} \quad \ell_{kx} = 1680 \text{ cm} \quad \ell_{ky} = 466.667 \text{ cm} \\
\text{Seçilen HE-A 600} \quad A &= 226 \text{ cm}^2 \quad W_x = 4790 \text{ cm}^3 \quad i_x = 25.0 \text{ cm} \quad i_y = 7.05 \text{ cm} \\
S_x &= 59 - 2 \times 2.5 = 54 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.3 \text{ cm} \quad t = 2.5 \text{ cm} \quad \lambda_x = 67.2 \quad \lambda_y = 66.19 \\
\sigma_{bem} &= 1.2379 \text{ t/cm}^2 \quad \sigma_{eb} = 4.69026 \times 10^{-2} \text{ t/cm}^2 \quad \sigma_{e'} = 2.111 \text{ t/cm}^2 \\
\sigma_b &= 0.54676 \text{ t/cm}^2 \quad H' = 9 \text{ cm} \quad F_B = 86.7 \text{ cm}^2 \quad I_{yB} = 5626.64 \text{ cm}^4 \quad i_{yB} = 8.05 \text{ cm} \\
S/i_{yB} &= 173.78 \text{ cm} \quad \sigma_B = 0.57944 \text{ t/cm}^2
\end{aligned}$$

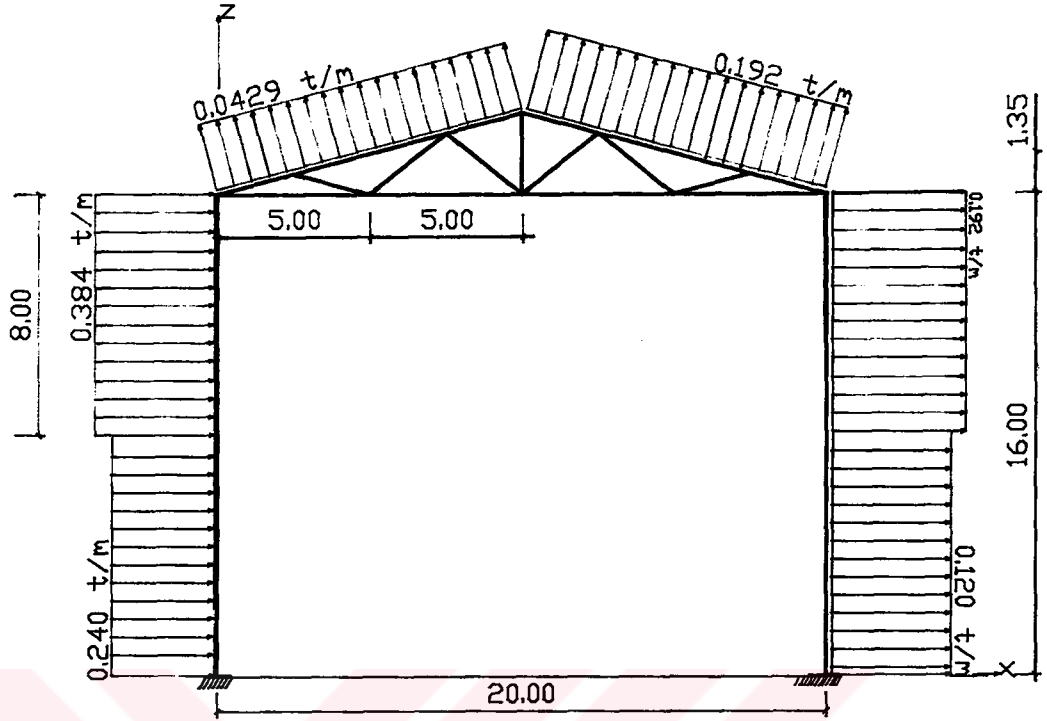
$$\text{Gerilme Kontrolleri} \quad 0.85817 < 1$$

$$0.97617 < 1$$

2. Kontrol

$$\lambda_x = 67.2 \rightarrow 68 \text{ için } \omega = 1.45 \quad \sigma = 1.45 \times \frac{10.6}{226} + 0.9 \times \frac{2619}{4790} \quad \sigma = 0.5600 \text{ t/cm}^2 < \sigma_{em}$$

2.15 ÇÖZÜM B15



Sekil 2.19

2.15.1 SİSTEME ETKİYEN YÜKLER

Kolonlardaki rüzgâr yükü hariç bütün yükler ÇÖZÜM B11 için hesaplananlar ile tamamen aynıdır.

2.15.2 STATİK ÇÖZÜM İÇİN SAP90 VERİSİ

ÇÖZÜM B15

SYSTEM

L=5

:

JOINTS

5 X=10 Y=0 Z=18.679

1 X=0 Y=0 Z=16 G=1,5,1

9 X=20 Y=0 Z=16 G=5,9,1

12 X=15 Y=0 Z=16

10 X=5 Y=0 Z=16 G=10,12,1

13 X=0 Y=0 Z=0

14 X=20 Y=0 Z=0

:

RESTRAINTS

1 12 1 R=0,1,0,1,0,1

13 14 1 R=1,1,1,1,1,1

:

FRAME

NM=4 NL=4

1 A=34.5E-4

2 A=6.91E-4

3 A=118E-4 I=29210E-8 W=92.6E-3

4 A=34.5E-4 I=691E-8

1 TRAP=0,0.24,0,8,0.24,0,8,0.384,0,16,0.384,0

2 TRAP=0,-0.192,0,8,-0.192,0,8,-0.12,0,16,-0.12,0

3 TRAP=0,0.384,0,8,0.384,0,8,0.24,0,16,0.24,0

4 TRAP=0,-0.12,0,8,-0.12,0,8,-0.192,0,16,-0.192,0

1 1 2 M=1 LP=2,0

2 2 3 M=4 LP=2,0 G=1,1,1,1

4 4 5 M=1 LP=2,0 G=1,1,1,1

6 6 7 M=4 LP=2,0 G=1,1,1,1

8 8 9 M=1 LP=2,0

9 1 10 M=1 LP=2,0

10 10 11 M=1 LP=2,0 G=1,1,1,1

12 12 9 M=1 LP=2,0

13 2 10 M=2 LP=2,0

14 10 4 M=2 LP=2,0

15 4 11 M=2 LP=2,0
16 11 5 M=2 LP=2,0
17 11 6 M=2 LP=2,0
18 6 12 M=2 LP=2,0
19 12 8 M=2 LP=2,0
20 13 1 M=3 LP=2,0 LR=0,1,0,0,0,0 NSL=0,0,0,1,4
21 9 14 M=3 LP=2,0 LR=1,0,0,0,0,0 NSL=0,0,0,2,3

⋮

LOADS

1 9 8 L=1 F=0,0,-915.45E-3,0,0,0
2 8 1 L=1 F=0,0,-1830.9E-3,0,0,0
1 9 8 L=2 F=0,0,-600E-3,0,0,0
2 8 1 L=2 F=0,0,-1200E-3,0,0,0
1 5 4 L=3 F=0,0,-600E-3,0,0,0
2 4 1 L=3 F=0,0,-1200E-3,0,0,0
1 L=4 F=-14.373E-3,0,53.642E-3,0,0,0
2 4 1 L=4 F=-28.747E-3,0,107.286E-3,0,0,0
5 L=4 F=49.93E-3,0,293.624E-3,0,0,0
6 8 1 L=4 F=128.606E-3,0,479.964E-3,0,0,0
9 L=4 F=64.303E-3,0,239.982E-3,0,0,0
1 L=5 F=-64.303E-3,0,239.982E-3,0,0,0
2 4 1 L=5 F=-128.606E-3,0,479.964E-3,0,0,0
5 L=5 F=-49.93E-3,0,293.624E-3,0,0,0
6 8 1 L=5 F=28.747E-3,0,107.286E-3,0,0,0
9 L=5 F=14.373E-3,0,53.642E-3,0,0,0

$$\vdots$$

2.15.3 STATİK ÇÖZÜM SONUÇLARI

ÇÖZÜM B15

FRAME ELEMENT FORCES

11-1-1944

ELT LOAD AXIAL DIST 1-2 PLANE
ID COND FORCE ENDI SHEAR MOMENT

1 -----

1 -24.76

2 -16.23

3 -11.59

4 2.99

5 4.95

2 -----

1 -19.69

 .0 -.88 .00

 2.6 -.88 -2.29

2 -12.91

 .0 -.58 .00

 2.6 -.58 -1.50

3 -8.27

 .0 -.58 .00

 2.6 -.58 -1.50

4 2.71

 .0 .06 .00

 2.6 .06 .14

5 3.66

 .0 .25 .00

 2.6 .25 .64

3 -----

1 -19.22

 .0 .88 -2.29

 2.6 .88 .00

2 -12.60

		.0	.58	-1.50
		2.6	.58	.00
3	-7.96			
		.0	.58	-1.50
		2.6	.58	.00
4	2.71			
		.0	-.06	.14
		2.6	-.06	.00
5	3.66			
		.0	-.25	.64
		2.6	-.25	.00

4 -----

1	-14.15
2	-9.27
3	-4.64
4	2.42
5	2.37

5 -----

1	-14.15
2	-9.27
3	-4.64
4	2.37
5	2.42

6 -----

1	-19.22		
		.0	-.88
		2.6	-.88
2	-12.60		
		.0	-.58
			.00

		2.6	-.58	-1.50
3	-4.64			
		.0	.00	.00
		2.6	.00	.00
4	3.66			
		.0	.25	.00
		2.6	.25	.64
5	2.71			
		.0	.06	.00
		2.6	.06	.14
7	-----			
1	-19.69			
		.0	.88	-2.29
		2.6	.88	.00
2	-12.91			
		.0	.58	-1.50
		2.6	.58	.00
3	-4.64			
		.0	.00	.00
		2.6	.00	.00
4	3.66			
		.0	-.25	.64
		2.6	-.25	.00
5	2.71			
		.0	-.06	.14
		2.6	-.06	.00
8	-----			
1	-24.76			
2	-16.23			

3 -4.64

4 4.95

5 2.99

9 -----

1 23.91

2 15.67

3 11.19

4 -3.22

5 -5.46

10 -----

1 17.07

2 11.19

3 6.71

4 -2.79

5 -3.54

11 -----

1 17.07

2 11.19

3 4.48

4 -3.54

5 -2.79

12 -----

1 23.91

2 15.67

3 4.48

4 -5.46

5 -3.22

13 -----

1 -5.31

2 -3.48

3 -3.48

4 .33

5 1.49

14 -----

1 2.19

2 1.44

3 1.44

4 -.14

5 -.62

15 -----

1 -4.38

2 -2.87

3 -2.87

4 .28

5 1.23

16 -----

1 5.49

2 3.60

3 1.80

4 -.94

5 -.94

17 -----

1 -4.38

2 -2.87

3 .00

4 1.23

5 .28

18 -----

1 2.19

2 1.44

3 .00

4 -.62

5 -.14

19 -----

1 -5.31

2 -3.48

3 .00

4 1.49

5 .33

20 -----

1 -7.32

.0 .01 -.20

16.0 .01

2 -4.80

.0 .01 -.13

16.0 .01

3 -3.60

.0 .00 -.07

16.0 .00

4 .83

.0 -4.65 39.06

8.0 -2.73 9.55

15.1 .00 -.15

16.0 .34 .00

5 1.52

.0 3.24 -34.14

8.0 2.28 -12.08

	16.0	.74	
21	-----		
1	-7.32		
	.0	-.01	.00
	16.0	-.01	-.20
2	-4.80		
	.0	-.01	.00
	16.0	-.01	-.13
3	-1.20		
	.0	-.00	.00
	16.0	-.00	-.07
4	1.52		
	.0	-.74	.00
	8.0	-2.28	-12.08
	16.0	-3.24	-34.14
5	.83		
	.0	-.34	.00
	.9	.00	-.15
	8.0	2.73	9.55
	16.0	4.65	39.06

Tablo 2.19

ELEMAN NO	ÖLÜ YÜKLER (t)	YARIM KAR (t)	KAR (t)	RÜZGÂR SOLDAN (t)	RÜZGÂR SAĞDAN (t)	EY (t)	EİY (t)
20	M= 0.20 N= 7.32	M= 0.07 N= 3.60	M= 0.13 N = 4.80	M= -39.06 N= -0.83	M=+34.14 N= -1.52	M= 0.33 N= 12.12	M= 34.47 N= 10.60
21	M= 0.20 N= 7.32	M= 0.07 N= 1.20	M= 0.13 N = 4.80	M= 34.14 N = -1.52	M=-39.06 N= -0.83	M= 0.33 N= 12.12	M= 34.47 N = 10.60

Momentler tm

2.15.4 SİSTEM ELEMANLARININ BOYUTLANDIRILMASI

Makas ÇÖZÜM B11 ile aynı olduğundan boyutlandırma yalnız kolonlar için yapılacaktır.

KOLONLAR

$$\begin{aligned}
N &= 12.12 \text{ t} \quad M = 0.33 \text{ tm} \quad l = 1600 \text{ cm} \quad \ell_{kx} = 1920 \text{ cm} \quad \ell_{ky} = 533.33 \text{ cm} \\
\text{Seçilen I 360} \quad A &= 97 \text{ cm}^2 \quad W_x = 1090 \text{ cm}^3 \quad i_x = 14.2 \text{ cm} \quad i_y = 2.90 \text{ cm} \\
S_x &= 36 - 2 \times 1.95 = 32.1 \text{ cm} \quad b = 14.3 \text{ cm} \quad d = 1.3 \text{ cm} \quad t = 1.95 \text{ cm} \quad \lambda_x = 135.2 \\
\lambda_y &= 183.9 \quad \sigma_{bem} = 0.2449 \text{ t/cm}^2 \quad \sigma_{eb} = 0.12494 \text{ t/cm}^2 \quad \sigma_{e'} = 0.45344 \text{ t/cm}^2 \\
\sigma_b &= 3.02752 \times 10^{-2} \text{ t/cm}^2 \quad H' = 5.35 \text{ cm} \quad F_B = 34.84 \text{ cm}^2 \quad I_{yB} = 476.163 \text{ cm}^4 \quad i_{yB} = 3.69 \\
S/i_{yB} &= 432.703 \quad \sigma_B = 9.34277 \text{ t/cm}^2
\end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.890411 < 1$$

$$0.410819 < 1$$

EİY YÜKLEMESİ İÇİN

$$\begin{aligned}
N &= 10.6 \text{ t} \quad M = 34.47 \text{ tm} \quad \text{Seçilen HE-A 800} \quad A = 286 \text{ cm}^2 \quad W_x = 7680 \text{ cm}^3 \\
i_x &= 32.6 \text{ cm} \quad i_y = 6.65 \text{ cm} \quad S_x = 79 - 2 \times 2.8 = 73.4 \text{ cm} \quad b = 30 \text{ cm} \quad d = 1.5 \text{ cm} \quad t = 2.8 \text{ cm} \\
\lambda_x &= 58.8 \quad \lambda_y = 80.2 \quad \sigma_{bem} = 1.01959 \text{ t/cm}^2 \quad \sigma_{eb} = 3.70629 \times 10^{-2} \text{ t/cm}^2 \\
\sigma_{e'} &= 2.74843 \text{ t/cm}^2 \quad \sigma_b = 0.44882 \text{ t/cm}^2 \quad H' = 12.23 \text{ cm} \quad F_B = 102.35 \text{ cm}^2 \\
I_{yB} &= 6303.44 \text{ cm}^4 \quad i_{yB} = 7.84 \text{ cm} \quad S/i_{yx} = 203.88 \text{ cm} \quad \sigma_B = 0.421 \text{ t/cm}^2
\end{aligned}$$

$$\text{Gerilme Kontrolleri} \quad 0.95491 < 1$$

$$1.0918 \approx 1$$

2. Kontrol

$$\lambda_x = 58.8 \rightarrow 59 \text{ için } \omega = 1.35 \quad \sigma = 1.35 \times \frac{10.6}{286} + 0.9 \times \frac{3447}{7680} \quad \sigma = 0.4539 \text{ t/cm}^2 < \sigma_{em}$$

2.16 B GRUBU ÇÖZÜMLERİ GENEL KAREKTERİSTİKLERİ

Tablo 2.20

ÇÖZÜM	Açıklık (m)	Yükseklik (m)	Kolonlar	Çubuk Ağırlıkları Toplamı (t)	Toplam Ağ (t/m ²)
B1	10.00	6.00	I320	0.3777	0.0222
B2	15.00	6.00	I340	0.8365	2.2049x10 ⁻²
B3	20.00	6.00	I360	2.4668	2.8176x10 ⁻²
B4	25.00	6.00	I380	2.4495	0.0276
B5	30.00	6.00	I400	4.7679	0.0391
B6	10.00	8.00	I400	0.3979	0.0375
B7	10.00	10.00	I550	0.3979	0.0675
B8	10.00	12.00	HE-A400	0.3979	0.0679
B9	10.00	14.00	HE-A600	0.3979	0.1076
B10	10.00	16.00	HE-A900	0.3979	0.1692
B11	20.00	8.00	I425	2.4668	0.0413
B12	20.00	10.00	I550	2.4668	0.0581
B13	20.00	12.00	HE-A400	2.4668	0.0546
B14	20.00	14.00	HE-A600	2.4668	0.0745
B15	20.00	16.00	HE-A800	2.4668	0.0963

SONUÇ

Bu bölümde boyutlandırmada kullanılan iki hesap metoduyla alakalı tesbitlere yer verilmiş ve yapıların ekonomiklik yönünden karşılaştırılması yapılmıştır.

Çalışmanın giriş bölümünde de belirtildiği üzere, eğilme ve basınca çalışan elemanların eğilmeli burkulma hesabı TS 648'de gösterilen yolla yapılmış olup, DIN 4114'de gösterilen yolla tüm elemanların hesabı kontrol edilmiştir. Bu noktada yapılan karşılaştırmada, DIN 4114'de önerilen yolun daima daha emniyetli sonuçlar verdiği tesbit edilmiştir. Eğilme ve basınca çalışan elemanlarda bazı durumlarda TS 648'de önerilen hesap metodu daha büyük kesitler seçmeye zorlarken, diğer metodla yapılan hesapta, seçilen kesitin çok çok güvenli olduğu tesbit edilmiştir. Burkulma boyunun kısa ve momentle normal kuvvet arasında büyüklük açısından denge olduğu durumlarda daha emniyetli olmak kaydıyla DIN 4114'de önerilen metodun TS 648'de önerilen metoda daha yakın sonuçlar verdiği görülmüştür.

Malzeme sarfiyatı bakımından ekonomiklik kıyasında kafes sistem yapının her çözüm için daha ekonomik olduğu gözlenmiştir. Bu ekonomiklik kafes sistem dizaynına da bağlı olarak bazı çözümlerde bariz bir farkla ortaya çıkmıştır. Bu noktada her yapı için kafes sistemin geometrisinde istenildiği gibi değişiklik yapılabileceği de dikkate alınırsa, daha ekonomik çözümlerin de elde edilebileceği unutulmamalıdır.

Açıklık ve yüksekliğin ayrı ayrı değiştiği çözümler için her iki yapının malzeme sarfiyatına ait oranlar aşağıdaki tabloda verilmiştir.

Tablo 2.21

ÇÖZÜM NO	AÇIKLIK (m)	YÜKSEKLİK (m)	TOPLAM AĞIRLIK		MALZEME SARFIYATI ORANI B/A
			A GRUBU t/m^2	B GRUBU t/m^2	
1	10.0	6.00	0.0328688	0.02220	0.6754
2	15.00	6.00	0.047728	2.2049×10^{-2}	0.4620
3	20.00	6.00	0.061432	2.8176×10^{-2}	0.4587
4	25.00	6.00	0.0612096	0.0276	0.4509
5	30.00	6.00	0.0800933	0.0391	0.4882
6	10.00	8.00	0.0509648	0.0375	0.7358
7	10.00	10.00	0.10352	0.0675	0.6520
8	10.00	12.00	0.09112	0.0679	0.7452
9	10.00	14.00	0.135728	0.1076	0.7928

10	10.00	16.00	0.196016	0.1692	0.8632
11	20.00	8.00	0.073232	0.0413	0.5640
12	20.00	10.00	0.06012	0.0581	0.9664
13	20.00	12.00	0.07496	0.0546	0.7284
14	20.00	14.00	0.105088	0.0745	0.7089
15	20.00	16.00	0.137504	0.0963	0.7003

Yukarıdaki tabloda, karşılaştırmanın kolay yapılabilmesi açısından, her çözüm için açıklık, yükseklik, toplam çelik ağırlığı ve B grubu çözümünde elde edilen ağırlık değerinin A grubunda elde edilene oranı, verilmiştir. Tabloda A grubu dolu gövdeli sistemi, B grubu kafes sistemi temsil etmektedir.

Tablodan görüldüğü üzere 15 çözümünden 4'ünde, B grubu çözümündeki malzeme sarfiyatının A grubuna oranla %50'nin altında, 8 tanesinde %50 ile %75 arasında, 3 tanesinde %75'in üzerindedir. Çözümlerden sadece birinde malzeme sarfiyatı birbirine çok yaklaşmış ve %96.64 gibi bir rakama ulaşmıştır.

Yüksekliğin sabit tutularak açıklığın artırıldığı ilk 5 çözümde, açıklığın arttıkça ekonomikliğin arttığı görülmektedir. Açıklığın sabit tutularak yüksekliğin artırıldığı ikinci grup çözümde, yüksekliğin açıklıkla eşit değer alınca kadar, her artmasında daha ekonomik sonuçlar verdiği, yüksekliğin açıklığı geçtiği durumlarda ise bu ekonomikliğin giderek azaldığı görülmektedir. Açıklığın 20 m'de sabit tutularak yüksekliğin artırıldığı son grup çözümde benzer şekilde yüksekliğin arttıkça ekonomikliğin arttığı müşahade edilmektedir. Yalnız bu grupta yüksekliğin açıklık değerini geçmediğine dikkat edilmektedir.

Bu çalışmadan elde edilen sonuçlar ışığında, genel bir değerlendirme olarak, yüksekliğin açıklığı geçmediği çözümlerde açıklık ve yüksekliğin arttığı durumlarda ekonomikliğin de giderek arttığı tesbit edilmiştir. Yüksekliğin açıklık değerini geçmesiyle ekonomikliğin giderek azaldığı, fakat her çözümde kafes sistem yapının daima ekonomik sonuçlar verdiği görülmüştür.

Giriş bölümünde de belirtildiği üzere, burada üzerinde durulan ekonomiklik kıyası, yalnız malzeme sarfiyatı bakımındandır. Yapıların aynı fiziksel ortamda bulundukları ve aynı fiziksel etkilere maruz kaldıkları ön kabulüyle bu kıyaslama yapılmıştır. Ekonomikliği etkileyen sair önemli faktörlerinde bulunduğu dikkatten kaçırılmamalıdır.

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ÖZGEÇMİŞ

1972 yılında Tokat'ta doğdu. İlk ve orta öğrenimini aynı ilde tamamlayarak 1988 yılında Karadeniz Teknik Üniversitesi'ndeki İnşaat Mühendisliği öğrenimine başladı. 1992 yılında mezun olduktan 1 yıl sonra Tokat Gaziosmanpaşa Üniversitesi'nde Araştırma Görevlisi olarak göreve başladı. Aynı yıl Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İnşaat Mühendisliği Anabilim Dalı, Yapı Bilim Dalında Yüksek Lisans öğrenimine başladı.

