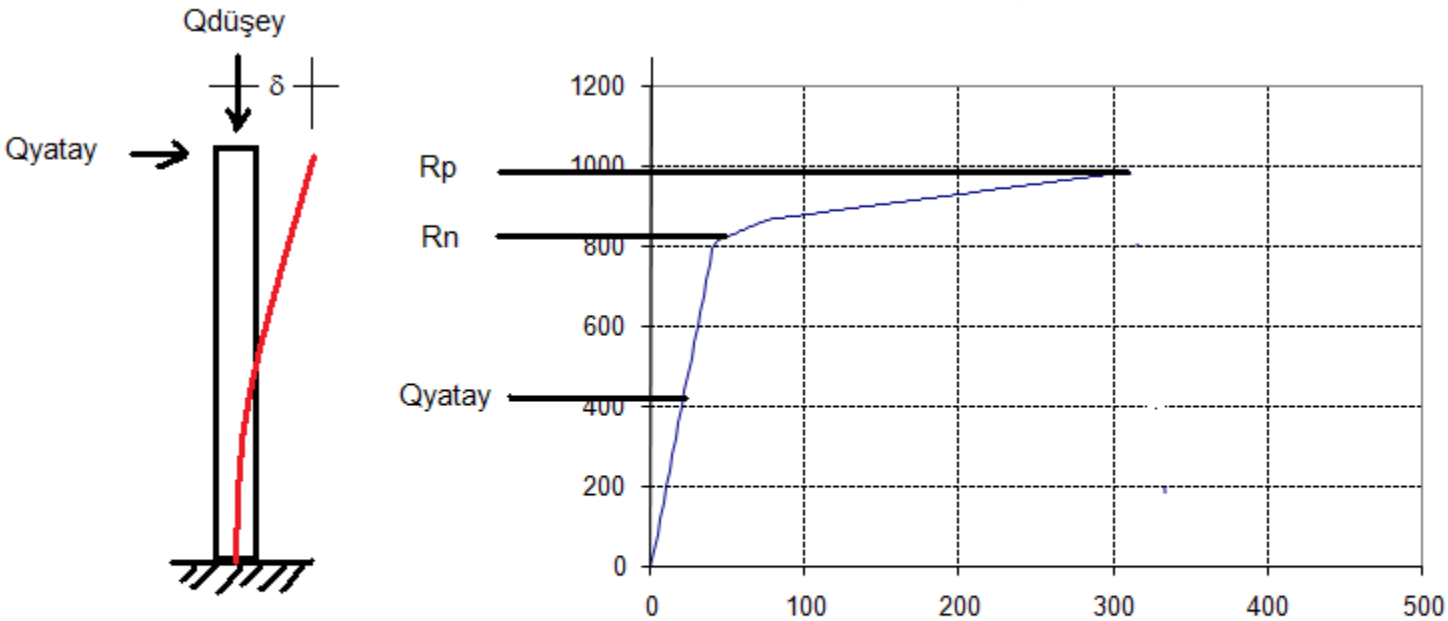
AASHTO LRFD ve LFD ARASINDAKİ FARKLILIKLAR

Alp Caner

Direnim ve Yük



Rn - dayanımın veya stabilitenin kaybedilmeğe başladığı seviye veya akmanın geliştiği seviye - Madde 1.3.2.4 -(Dayanım Sınır Durumu)

Rp - plastikleşme direnimi

Q - yük

Tasarım sistemleri

Emniyet Gerilmeleri Sınır Durumu

$Rn/FS > \gamma\beta Q$

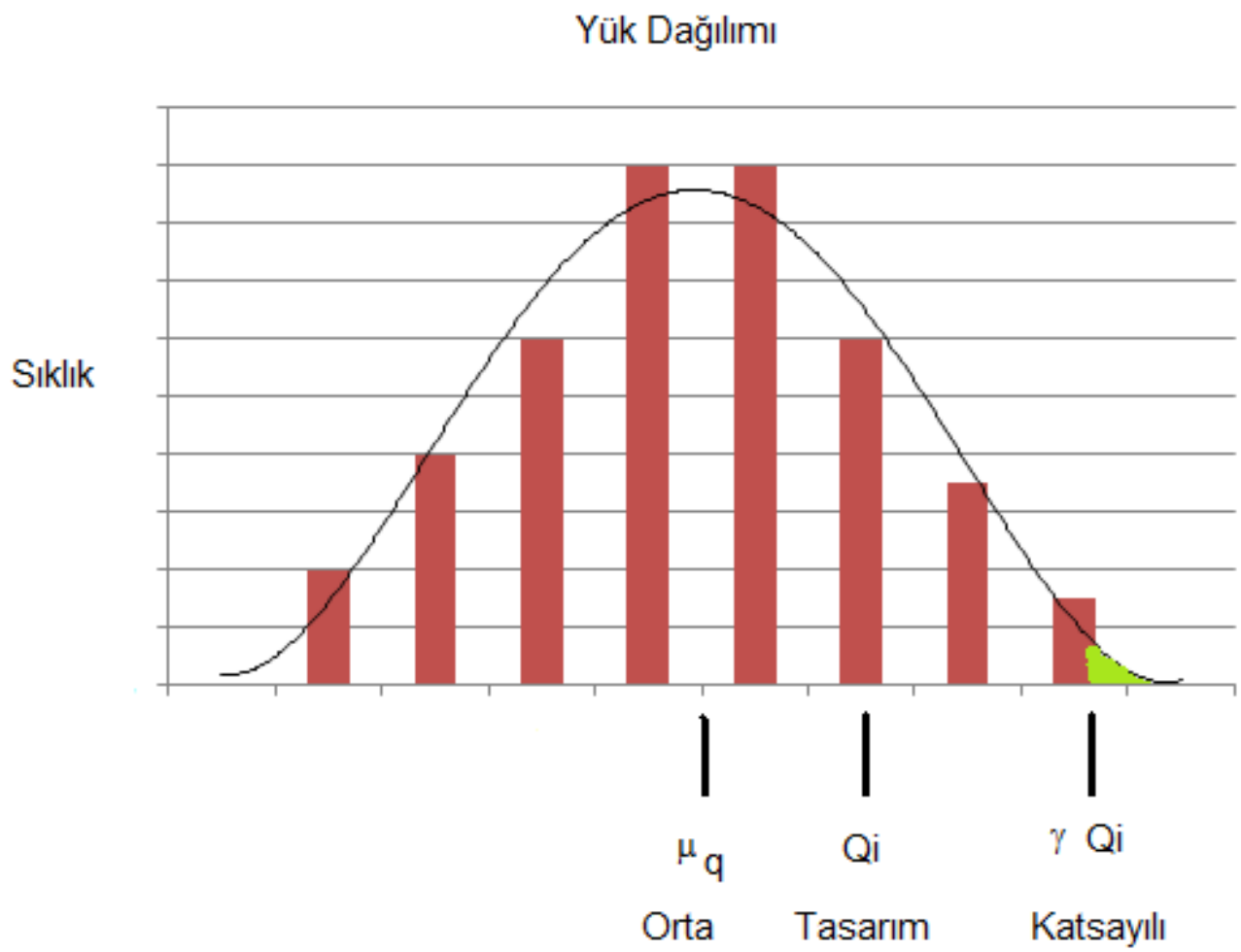
Taşıma Gücü – LFD

$\phi Rn > \gamma\beta Q$

Yük ve Diremin Katsayıları Yöntemi (İstakiksel verilere dayanılarak geliştirilmiştir.)

$\phi Rn > \eta\gamma Q$

Yük Dağılımı – Sabit ve Hareketli



Sabit Yükler - ABD

AASHTO LFD'ye göre sabit yükler aynı katsayılar ile büyütülüyordu. [5]

AASHTO LRFD'ye göre ise sabit yükler ikiye ayrılmış durumda ve değişik katsayılar ile büyütülüyor. [6]

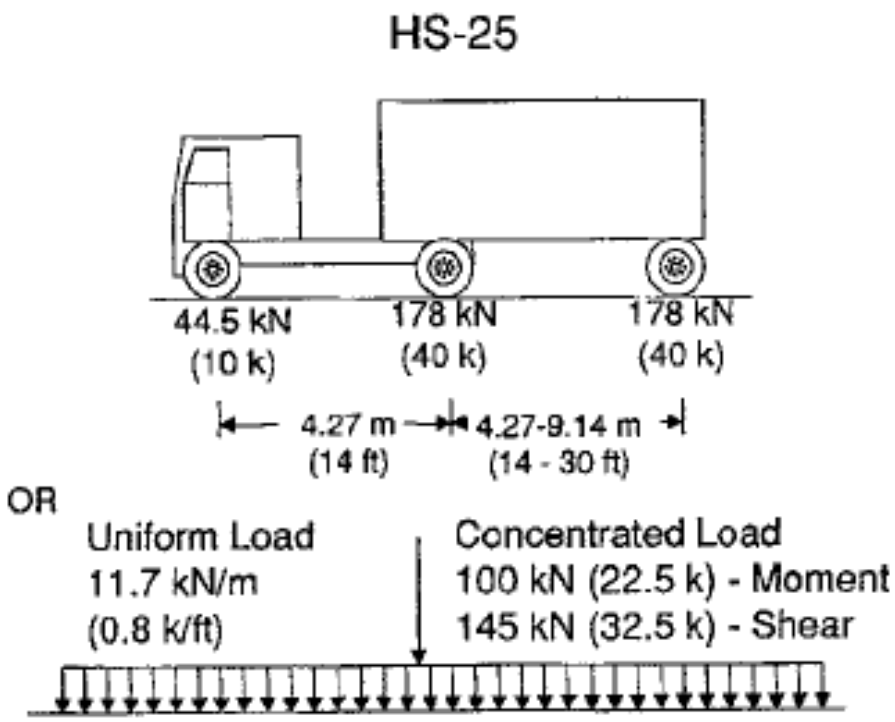
DC – kalıcı sabit yükler

DW – eklenip çıkarilabilen kalıcı yükler

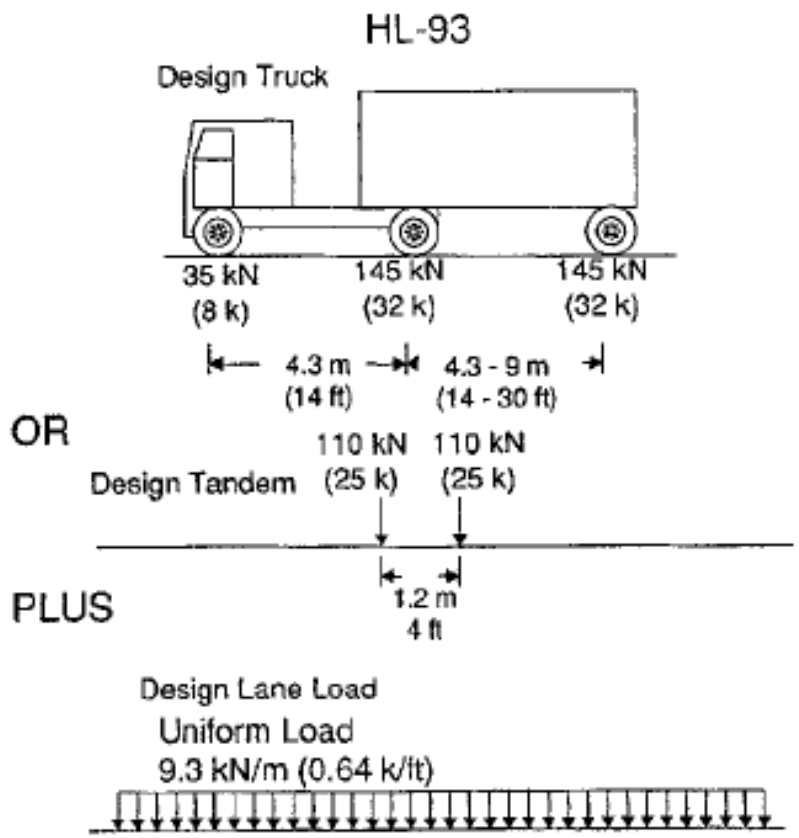
Hareketli Yükler

Vehicle Type	Current Maximum (tonnes)	Proposed Maximum (tonnes)
	15.0	16.0
	22.5	23.0
	39.0	40.0
	42.5	45.5
	62.5	68.0
	79.0	85.7
	115.5	125.2

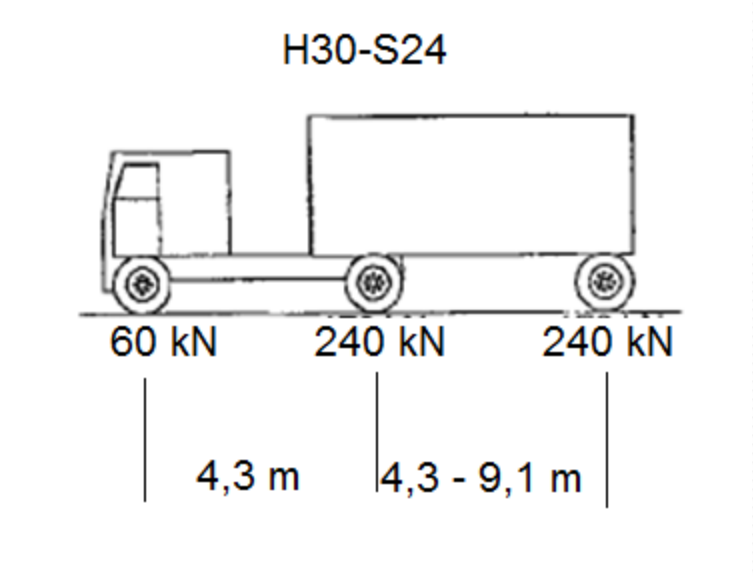
Hareketli Yükler- AASHTO LFD



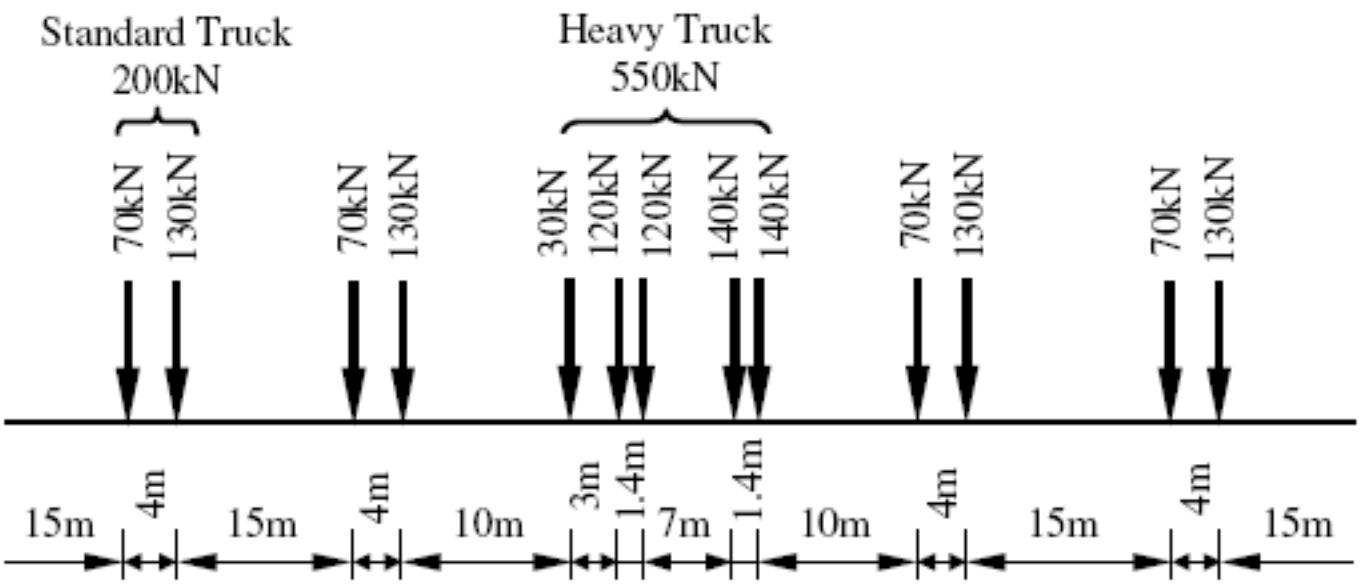
Hareketli Yükler – AASHTO LRFD



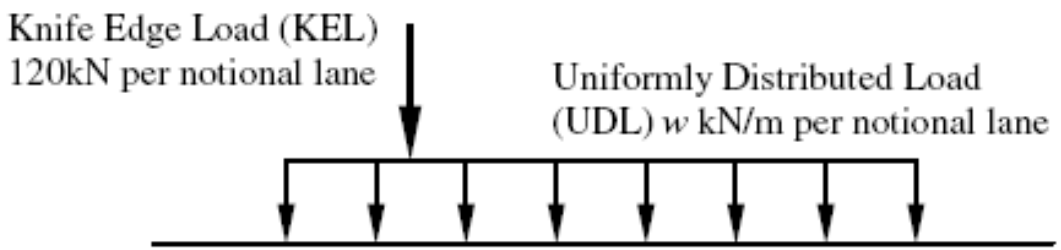
Hareketli Yükler - Türkiye



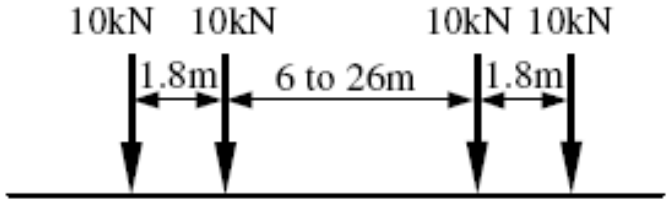
Hareketli Yükler - Çin



Hareketli Yükler – Hong Kong Dinamik Etkiler Dahil



. Design HA live load specified by Hong Kong Code [3].

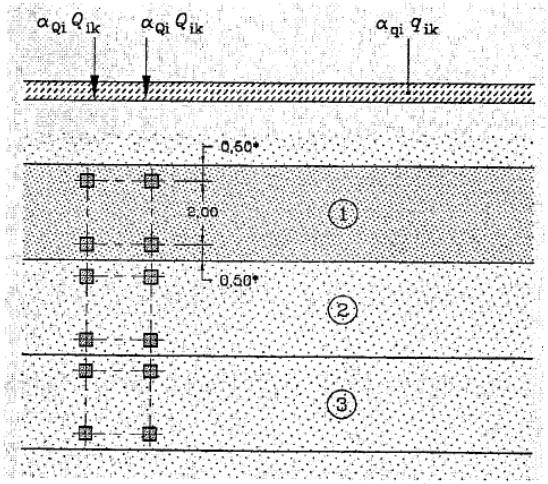


Design unit HB live load specified by Hong Kong Code [3] (not to scale).

Hareketli Yükler – Avrupa Dinamik Etkiler Dahil

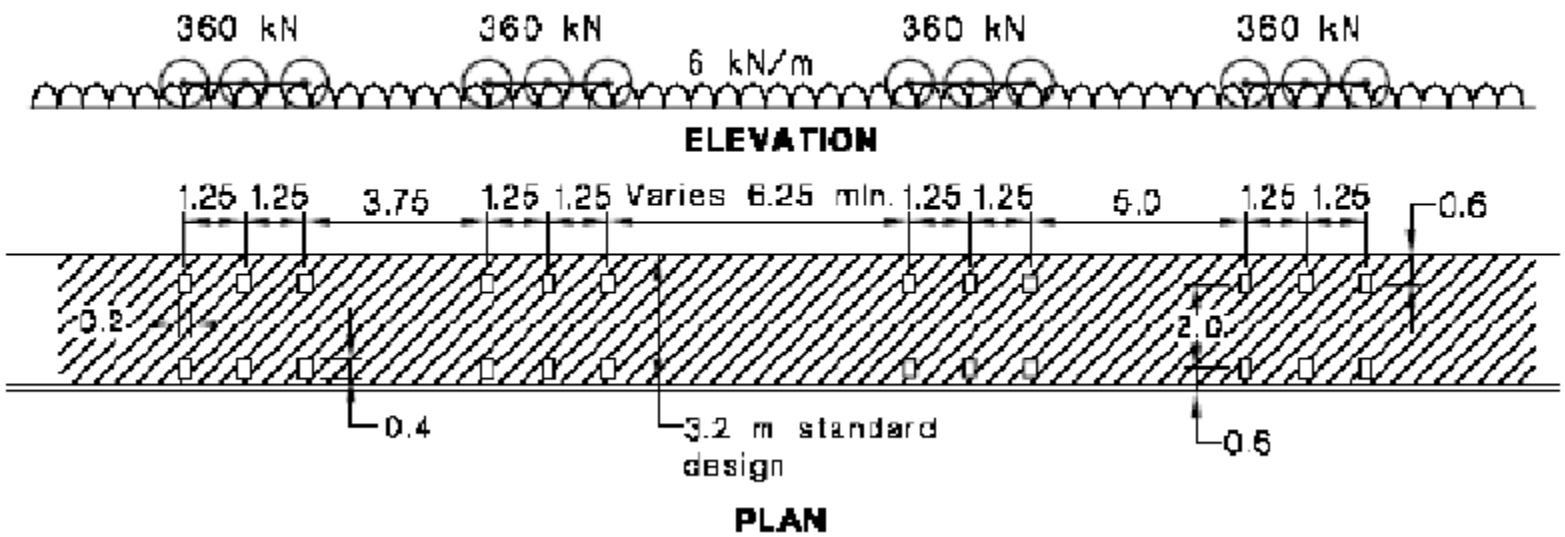
Location	Tandem system *TS*	*UDL* system
	Axle loads Q_{ik} (kN)	q_{ik} (or q_{ik}) (kN/m^2)
Lane Number 1	300	9
Lane Number 2	200	2,5
Lane Number 3	100	2,5
Other lanes	0	2,5
Remaining area (q_{rk})	0	2,5

The details of Load Model 1 are illustrated in Figure 4.2a.



Key
(1) Lane Nr. 1 : Q_{1k} = 300 kN ; q_{1k} = 9 kN/m^2
(2) Lane Nr. 2 : Q_{2k} = 200 kN ; q_{2k} = 2,5 kN/m^2
(3) Lane Nr. 3 : Q_{3k} = 100 kN ; q_{3k} = 2,5 kN/m^2
* For w_l = 3,00 m

Hareketli Yükler - Avusturalya



Hareketli Yük Kombinasyonları

AASHTO-LFD

= 1,3DL + 2,17(LL+I)

AASHTO LRFD

=1,25DC+1,50DW+1,75(LL+IM)

ÇİN

= 1,50D1+1,50D2+1,50D3 + 1,75(LL+IM)

HONG KONG

= 1,265D1+1,65D2+1,925D3+1,43(LL+IM)

AVRUPA

=1,35G+1,35Q

Hareketli Yükler Dinamik Etkiler

AASHTO LRFD şartnamesinde dinamik etkiler sabitlenmiştir.

AASHTO LFD şartnamesinde ise uzunluğun fonksiyonudur.

Sehim

AASHTO LFD de mecbur olan sehim hesapları LRFD içerisinde sadece Mal sahibi mecbur tutar ise hesaplanacaktır.

AASHTO LRFD içerisinde sadece dilimsel ard germeli köprüler için sehim hesabı mecburi tutulmuştur.

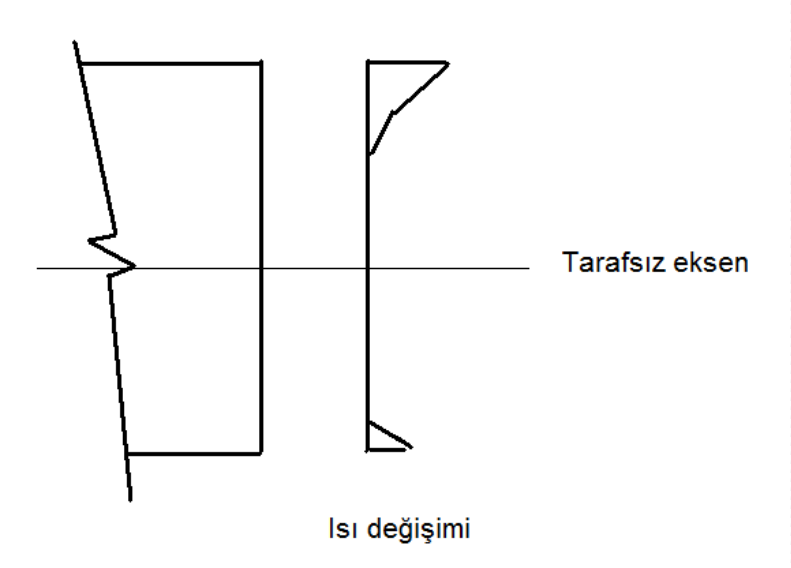
Rüzgar

LRFD içerisinde biraz da uzun açıklıklı veya yüksek köprüler düşünülerek rüzgar hesapları detaylandırılmıştır. Köprülerin rüzgar stabiletesi üstüne maddeler eklenmiştir.

LFD ve LRFD içerisinde tasarım rüzgar hızı 160 km/hr olarak alınmıştır.

Sıcaklık değişimleri

LRFD şartnamesi içerisinde ısı değişimleride detaylandırılmış ve derinliği fazla olan kutu kesit köprüler için sadece köprü üst yüzeyinin değişken bir şekilde isinma durumuda göz önüne alınmıştır.



Deprem

AASHTO LFD içerisinde köprüler genelde 475 sene dönüşümlü depreme göre tasarlanmaktadır.

AASHTO LRFD içerisinde köprüler sınıflandırıldıktan sonra köprünün önemine göre 475 ya da 2500 senelik deprem için inclenecektir.

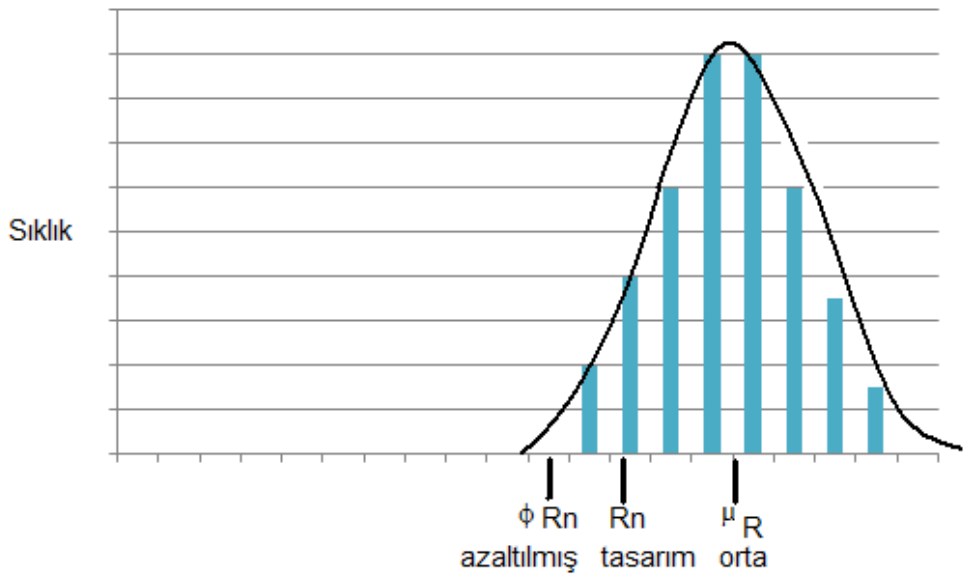
AASHTO LRFD içerisinde kullanılan R-faktörleri LFD de bulunan faktörlerden tümü ile değişiktir.

Direnim Dağılımı

Direnim'deki belirsizlikler: Malzeme Özellikleri (M), Yapımdaki hatalar (F), Analizlerdeki varsayımlar (P)

$R = R_n$ MFP

Belirisizlik katsayısı $V_r = (V_m^2 + V_f^2 + V_p^2)^{1/2}$

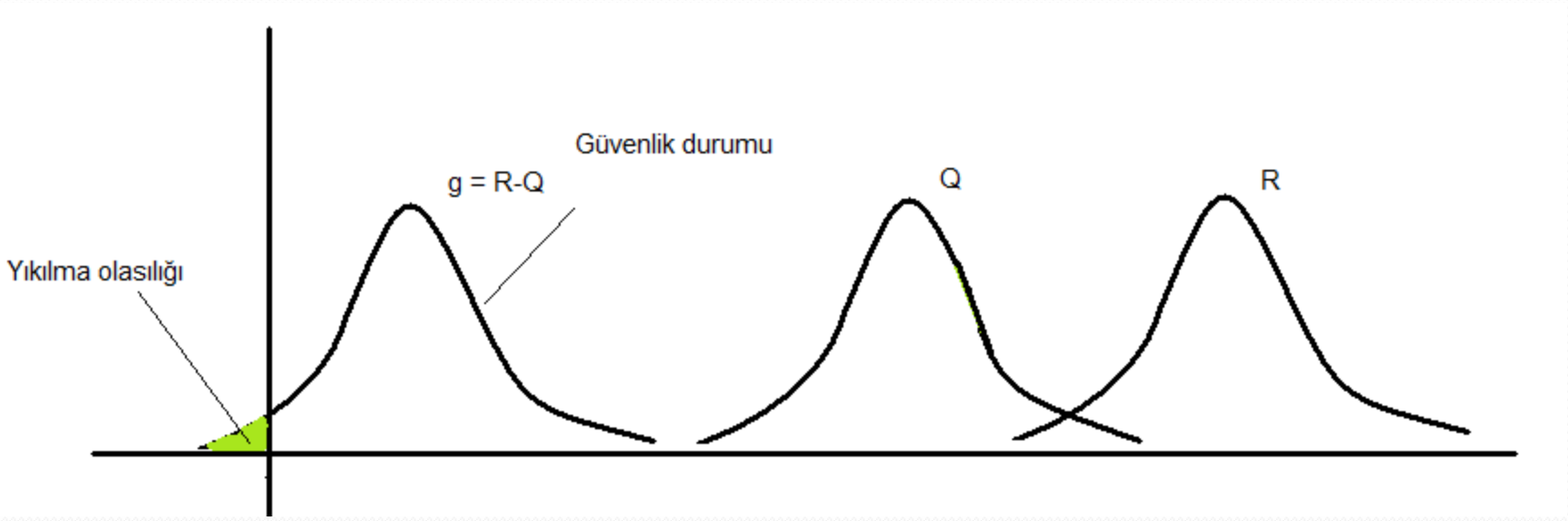


Dayanım Limit Durumu

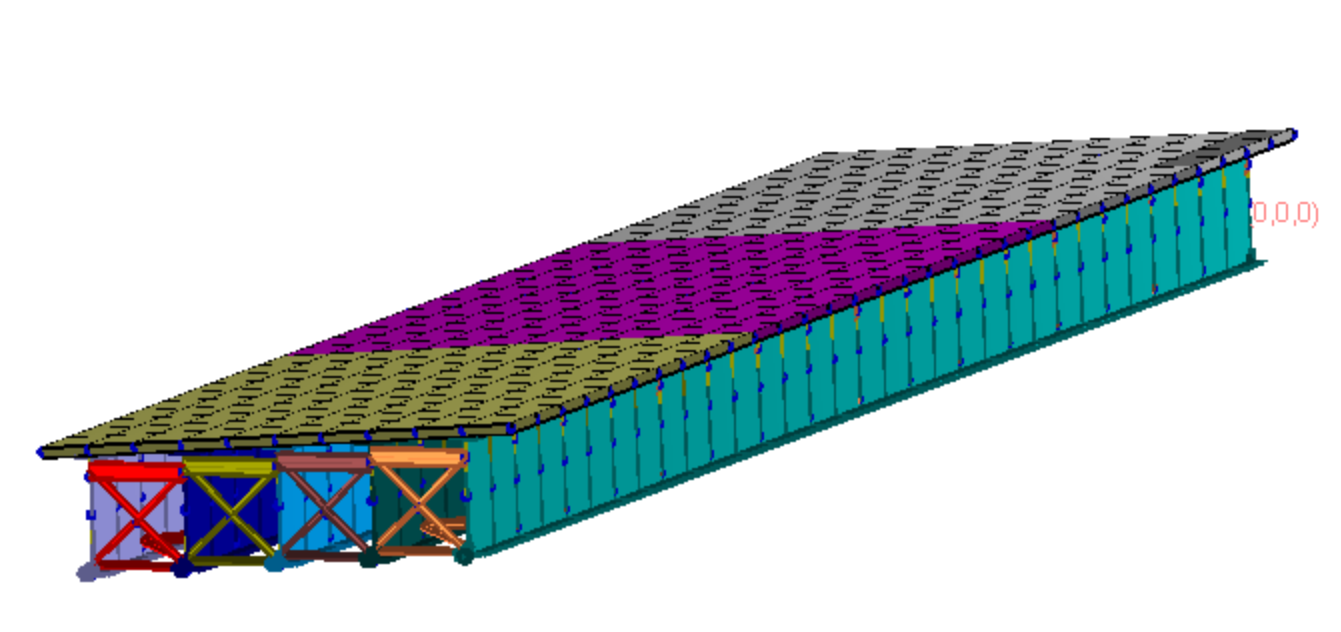
Güvenirlik katsayısı = μ_g/σ_g

μ_g = orta g = R-Q
σ_g = g fonksiyonun standard sapması

Yıkılma olasılığı g<0 veya R-Q<0 olma durumu olarak adlandırılabilir

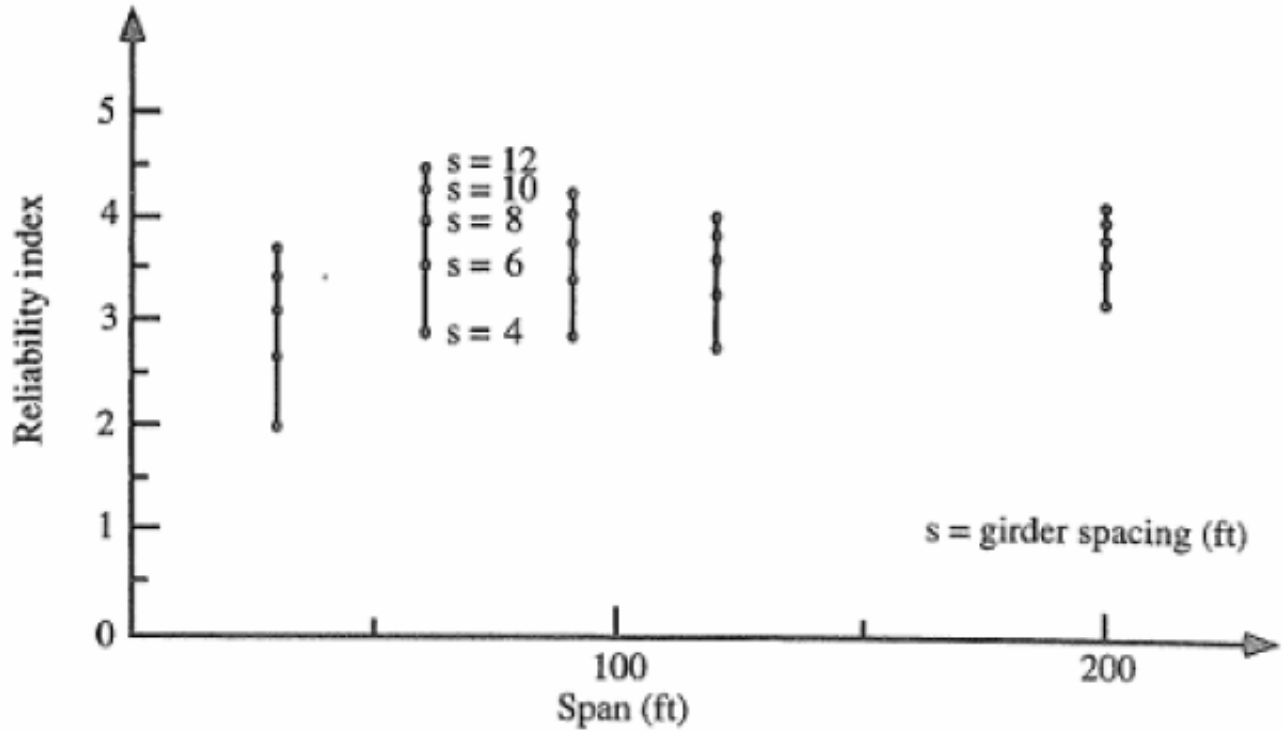


Çelik köprüler [1]



Güvenirlilik katsayısı – LFD [1]

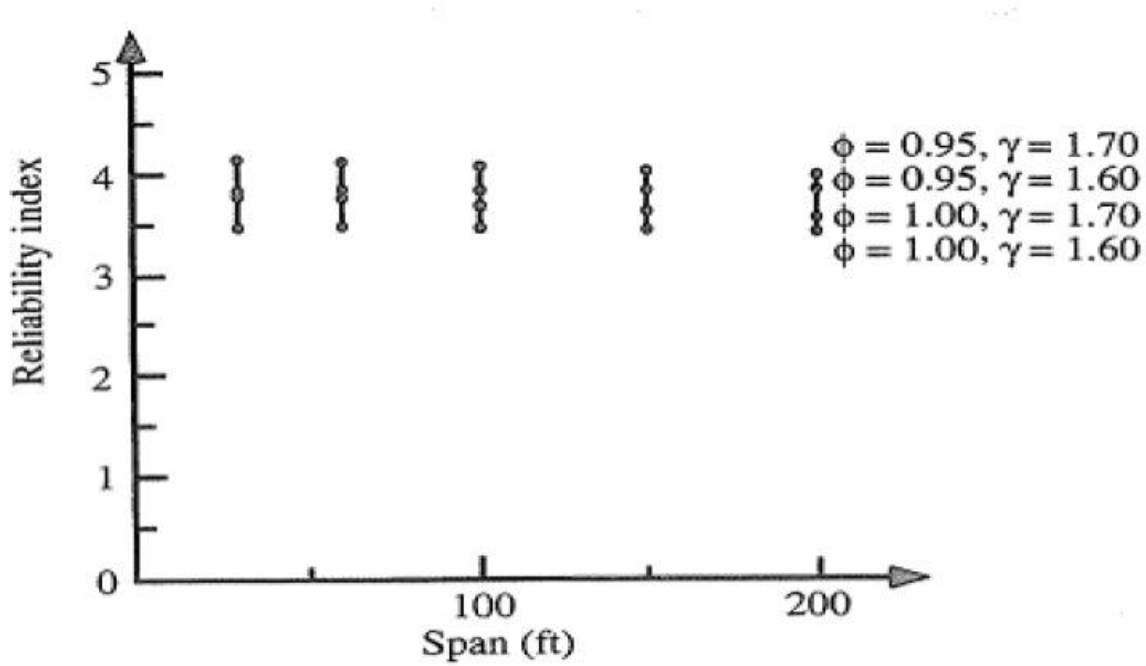
$\phi R > 1{,}3D + 2{,}17\,(L+I)$



Reliability indexes for steel girders, bending limit state (AASHTO, 1992).

Hedeflenen Güvenilirlik Katsayısı – LRFD [1]

$\phi Rn > 1.25DC + 1,50DW + 1,75\ (LL+IM)$

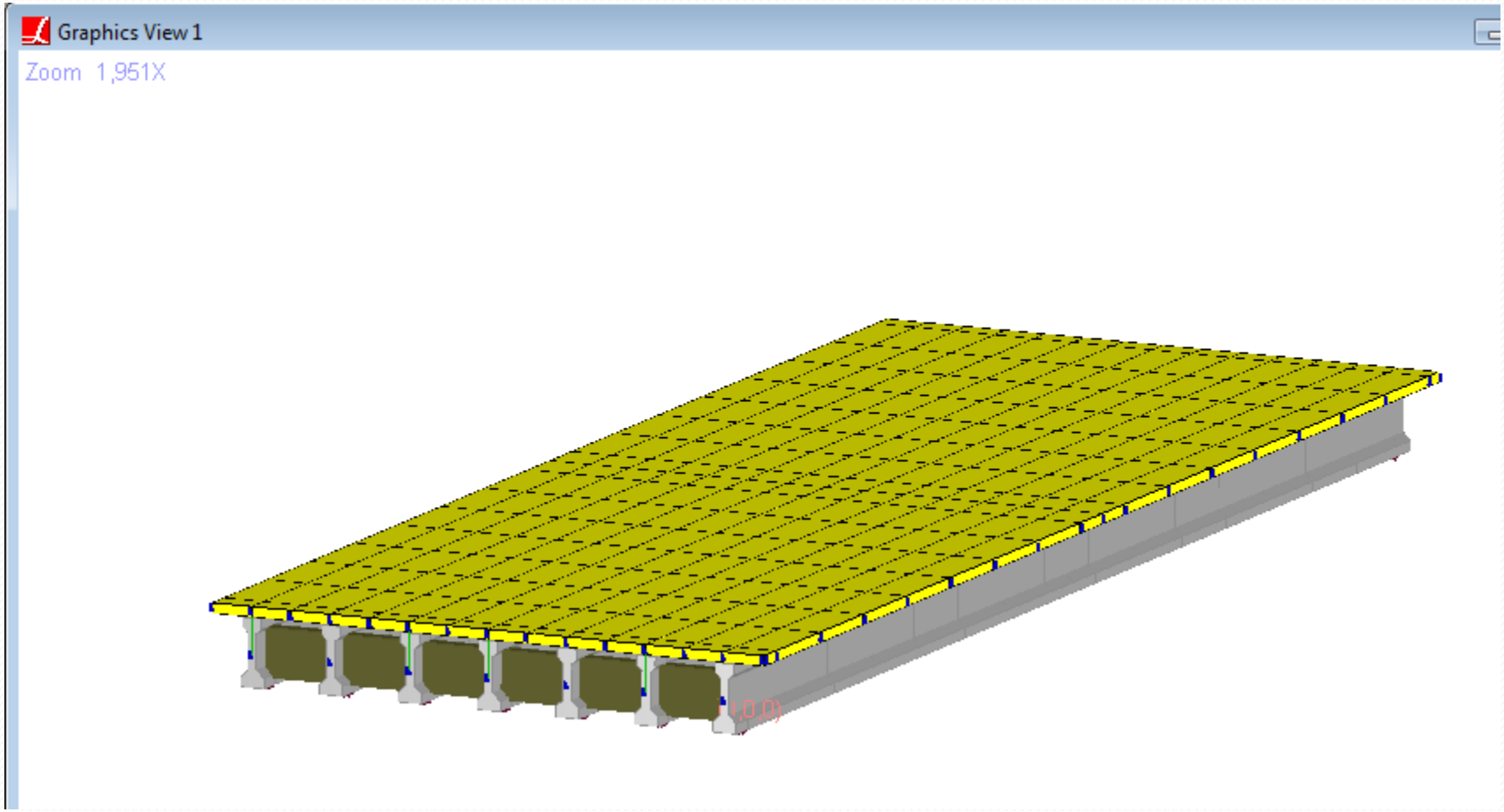


Reliability indexes for steel girders, bending limit state (new code).

Yorulma Analizleri – Çelik köprüler

LRFD de bulunan yorulma analizleri köprüler için daha fazla detaylandırılmıştır. Genel bağlantı yorulma sınıflarına ek olarak özel köprü bağlantılarına has tablolar eklenmiştir.

Öngerilmeli I-kiriş köprüler



Öngerilmeli I-kiriş köprüler [3]

LRFD – daha fazla kesme donatısı gerekmektedir

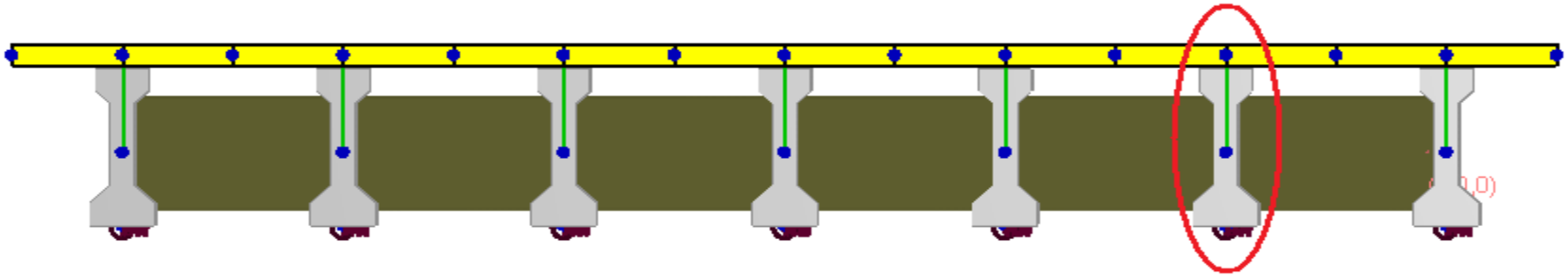
- daha fazla döşeme konsol donatısı gerekmektedir

- kenar ayak kalkan duvarında daha fazla donatıya ihtiyaç olmaktadır.

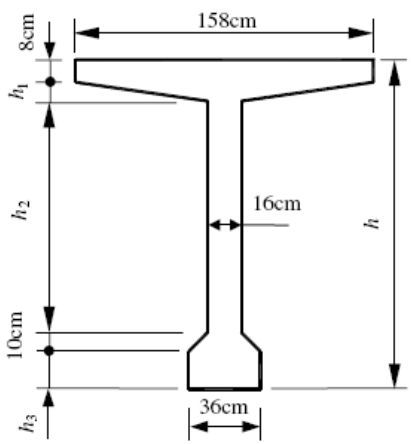
Öngerilmeli I – Kirişli Köprüler

Orta Açıklık Momenti, Açıklık = 30m (Kenardan 2. Kiriş)

	M_{dc} (kN-m)	M_{dw} (kN-m)	$M_{llım}$ (kN-m)	M_{udl} (kN-m)	M_u (kN-m)	$M_{ui}/M_{u\ TR\text{-}LFD}$
TR - LFD - H30S24	2103	336	1564		6564	1,00
TR -LRFD - H30S24	2103	336	1691		6092	0,93
TR-LRFD-H30S24+UDL	2103	336	1691	442	6866	1,05
AASHTO-LFD HS20	2103	336	1043		5433	0,83
AASHTO -LFD HS25	2103	336	1303		5999	0,91
AASHTO-LRFD HL93 +UDL	2103	336	1127	442	5879	0,90
Çin	2103	336	1270		5881	0,90
Avrupa	2103	336	1454	776	6303	0,96



Öngerilmeli T-kiriş köprüler [2]



Parameters of T-Girder

Span	Parameters (cm)			
	h	h_1	h_2	h_3
25m	145	10	98	19
30m	175	10	128	19
35m	200	12	142	28
40m	230	12	172	28

Fig. 1. Dimensions of typical T-girder sections studied.

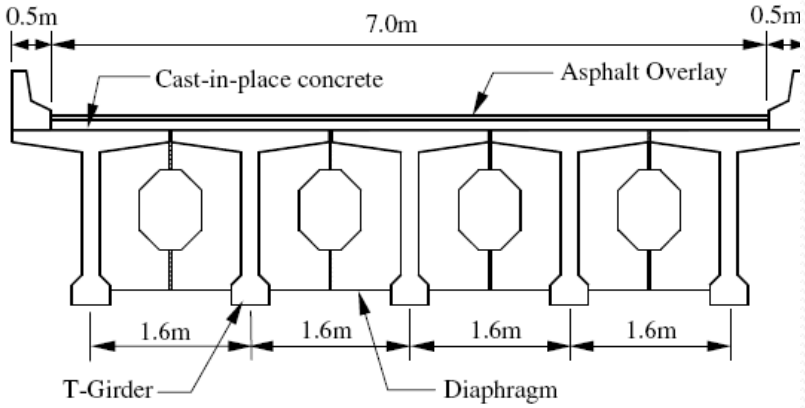


Fig. 2. Cross-section of bridge deck studied.

Öngerilmeli T-kiriş köprüler [2]

Table 1
Unfactored dead load moment per girder from deterministic analysis (kN/m)

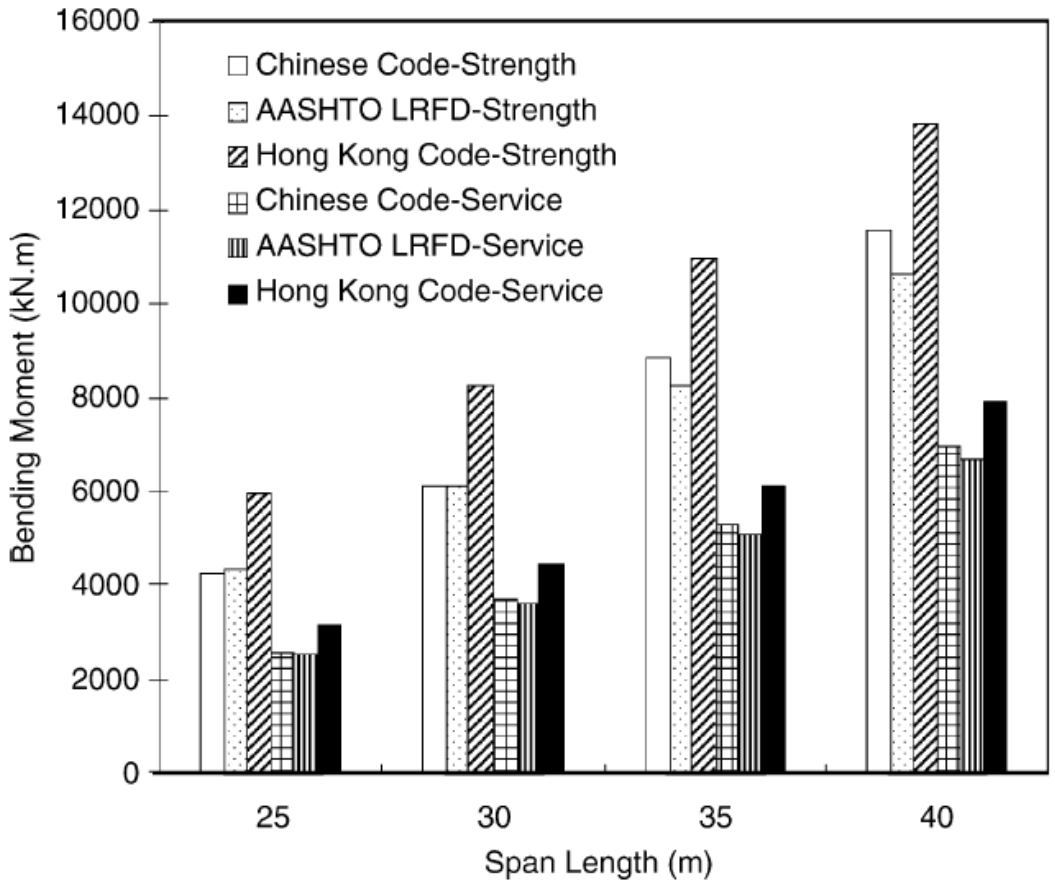
Bridge span	Chinese Code			Hong Kong Code			AASHTO LRFD		
	M_{D1}	M_{D2}	M_{D3}	M_{D1}	M_{D2}	M_{D3}	M_{D1}	M_{D2}	M_{D3}
25 m	976	218	93	976	209	91	937	218	91
30 m	1520	383	164	1520	367	160	1459	383	160
35 m	2452	522	224	2452	500	219	2354	522	219
40 m	3468	676	290	3468	648	284	3329	676	284

Table 2
Maximum unfactored live load moment per girder from deterministic analysis (kN/m)

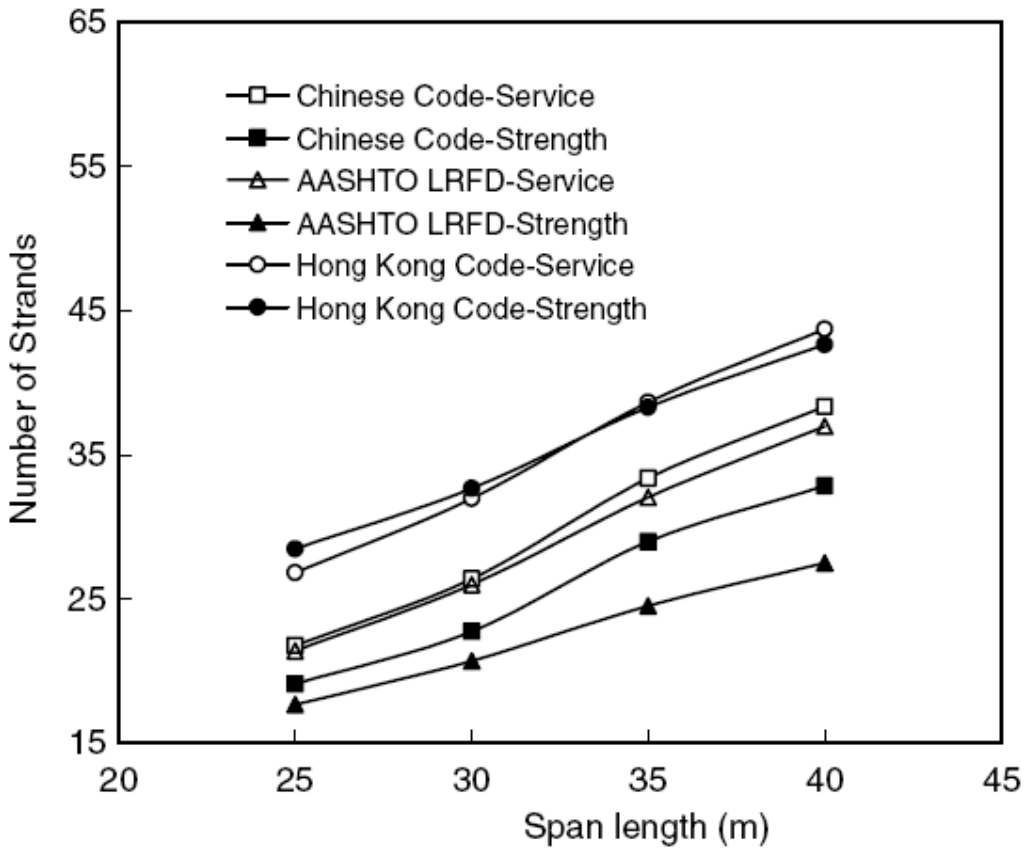
Bridge span	M_{LL+IM}			
	Chinese Code	Hong Kong Code		AASHTO LRFD Code
		HA + HB45	HA + HB25	
25 m	1254	2932	1668	1564 (1500)
30 m	1619	3788	2164	2037 (1957)
35 m	2084	4603	2635	2476 (2425)
40 m	2496	5454	3125	2986 (2925)

Note: Live load moments calculated from loading specified by the AASHTO LRFD Code using the Guyon–Massonnet method are shown within parentheses.

Öngerilmeli T-kiriş köprüler [2]



Öngerilmeli T-kiriş köprüler [2]



Öngerilmeli T-kiriş köprüler [2]

$$\eta = N_{\text{ser}}/N_{\text{str}}.$$

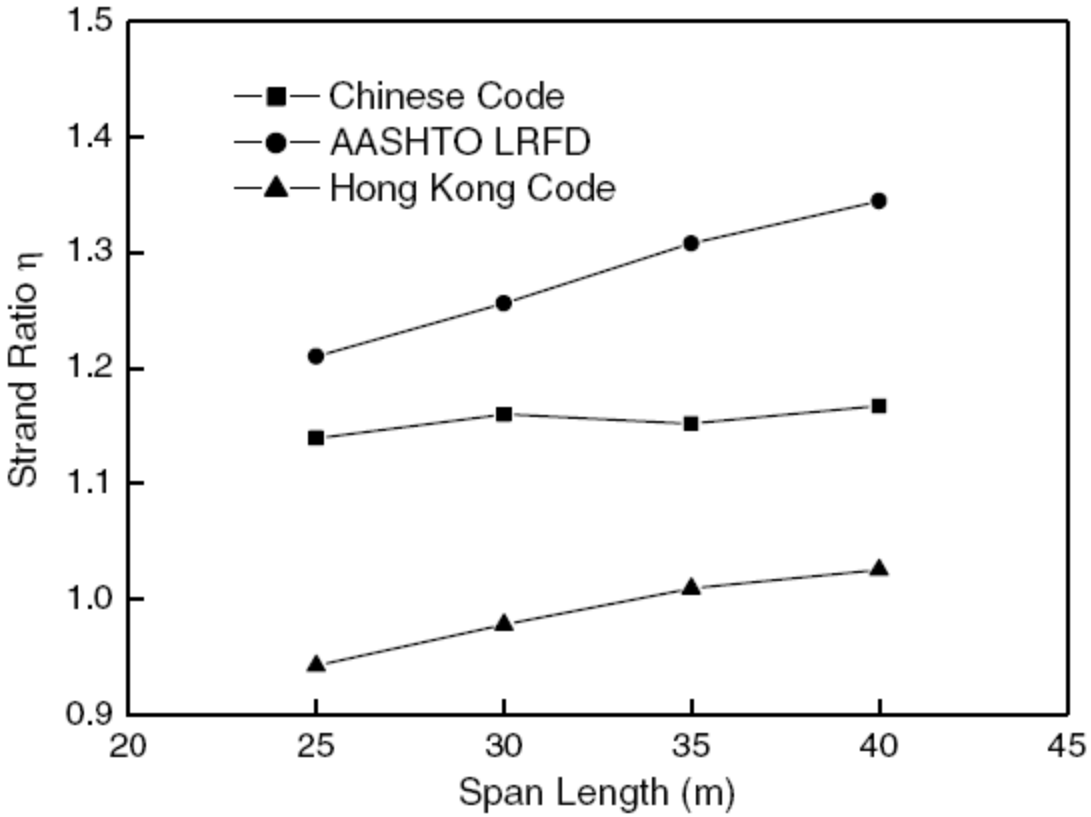
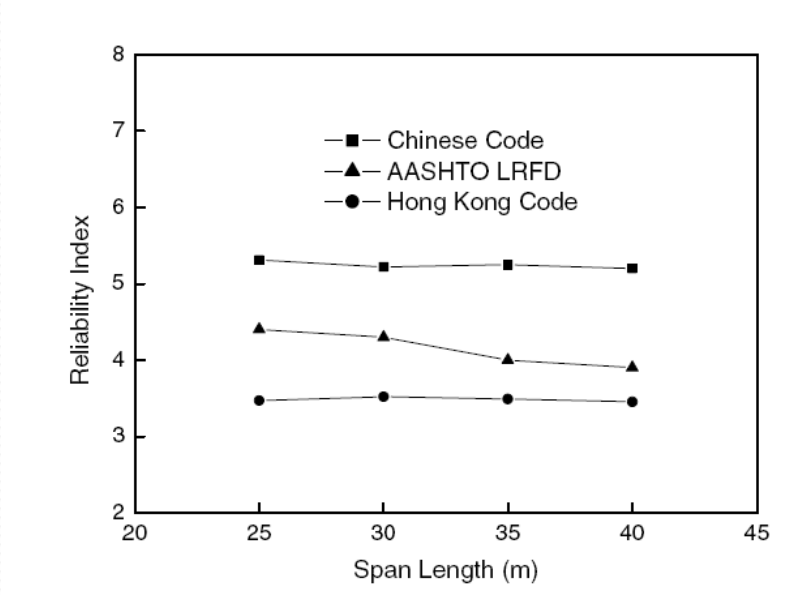
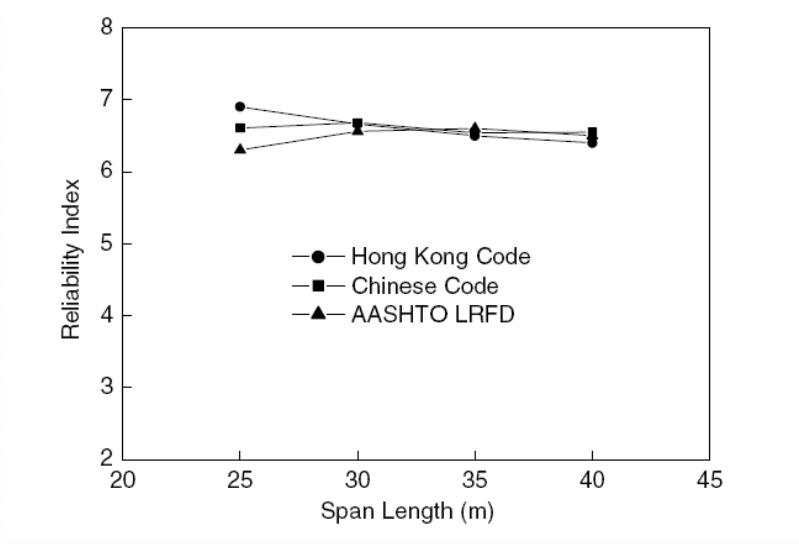


Fig. 9. Strand ratio η in the three codes.

Öngerilmeli T-kiriş köprüler [2]

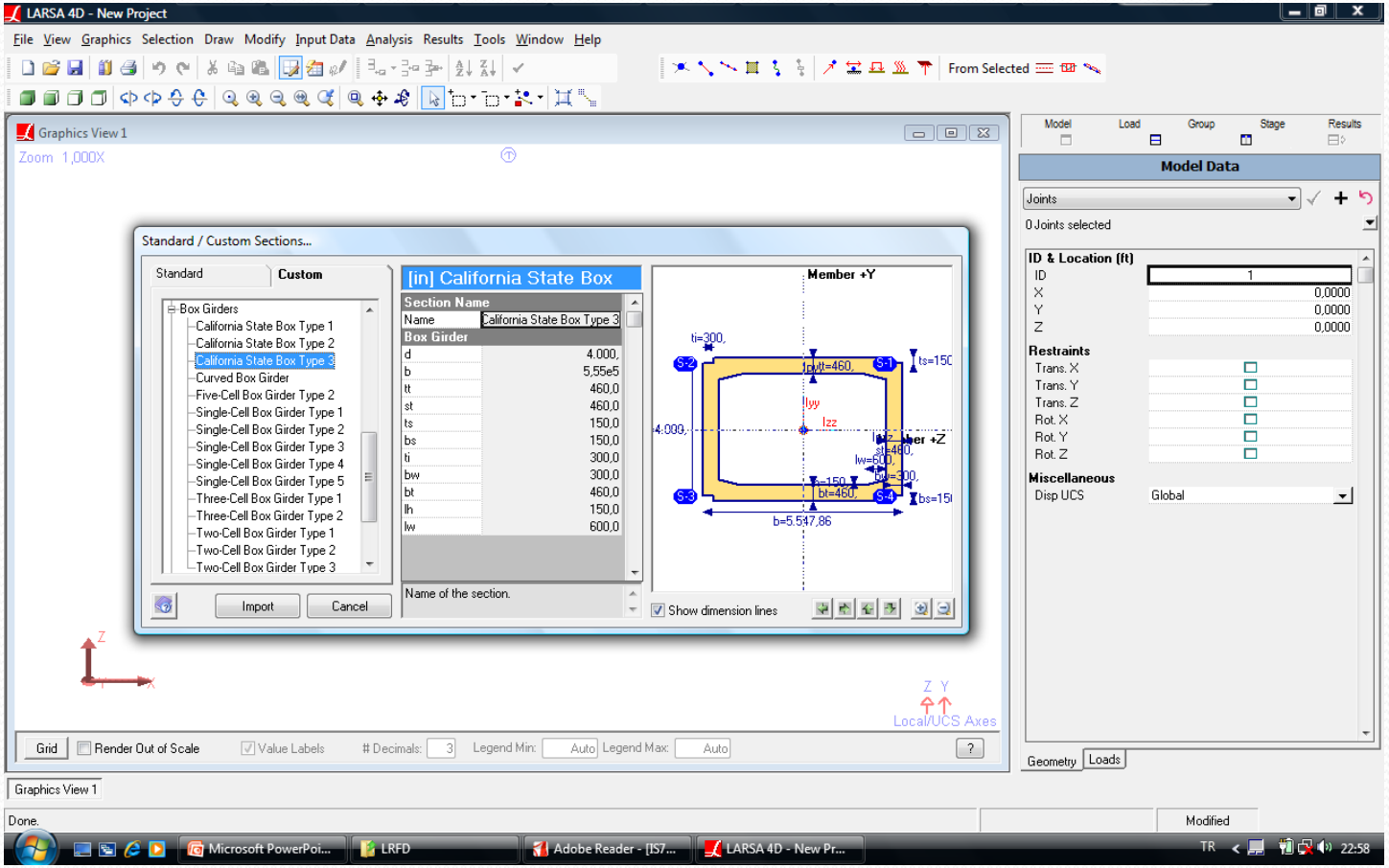


DAYANIM SINIR DURUMU

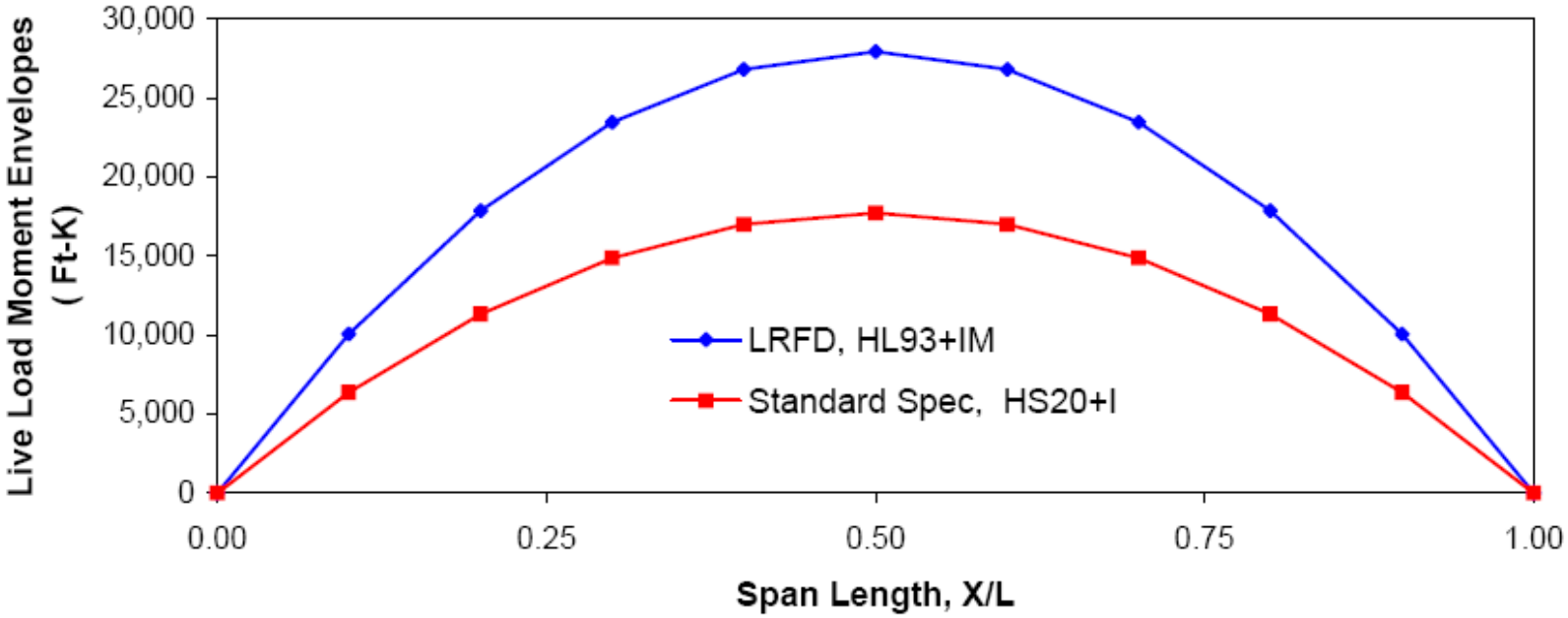


KULLANIM SINIR DURUMU

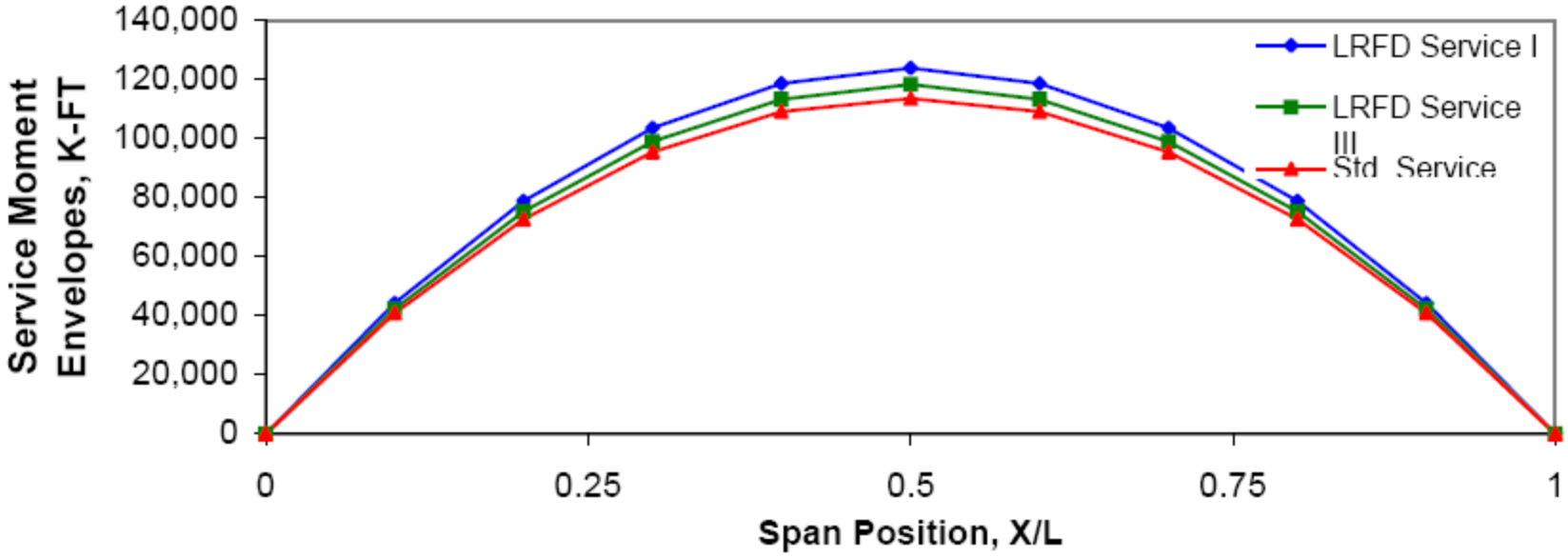
Ard Germeli Kutu Üst Yapılar [4]



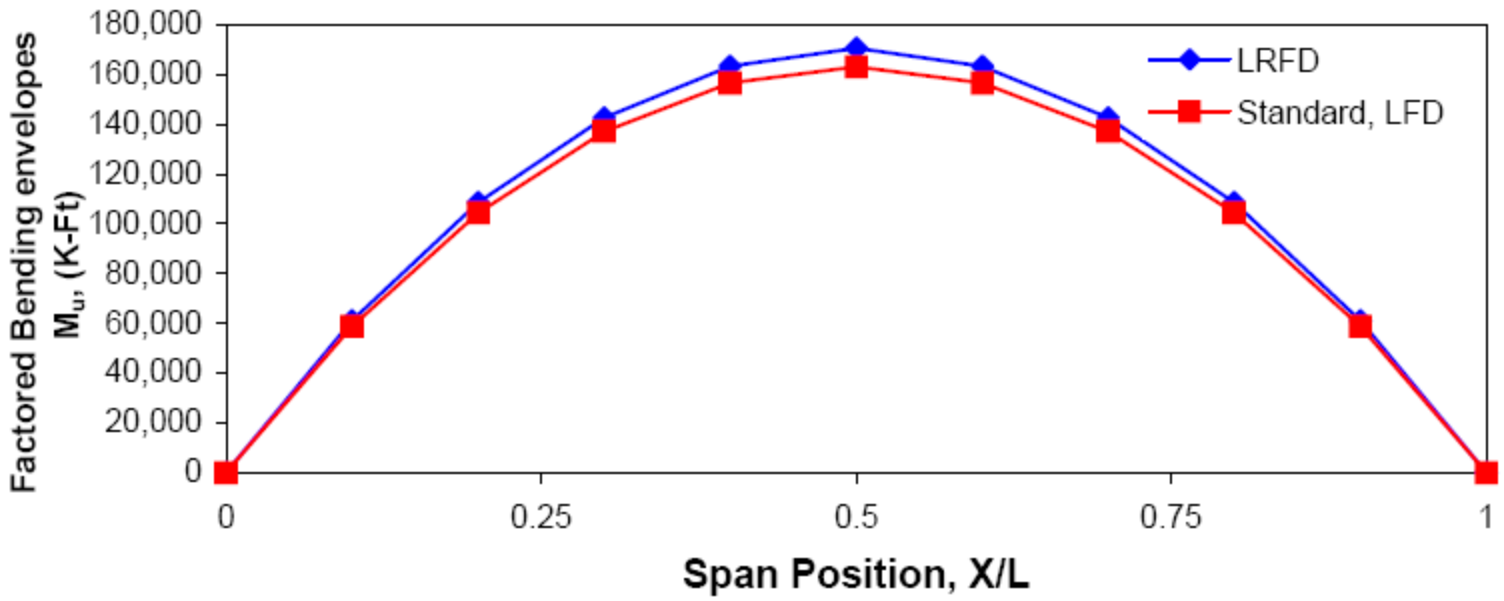
Hareketli Yük Momentleri [4]



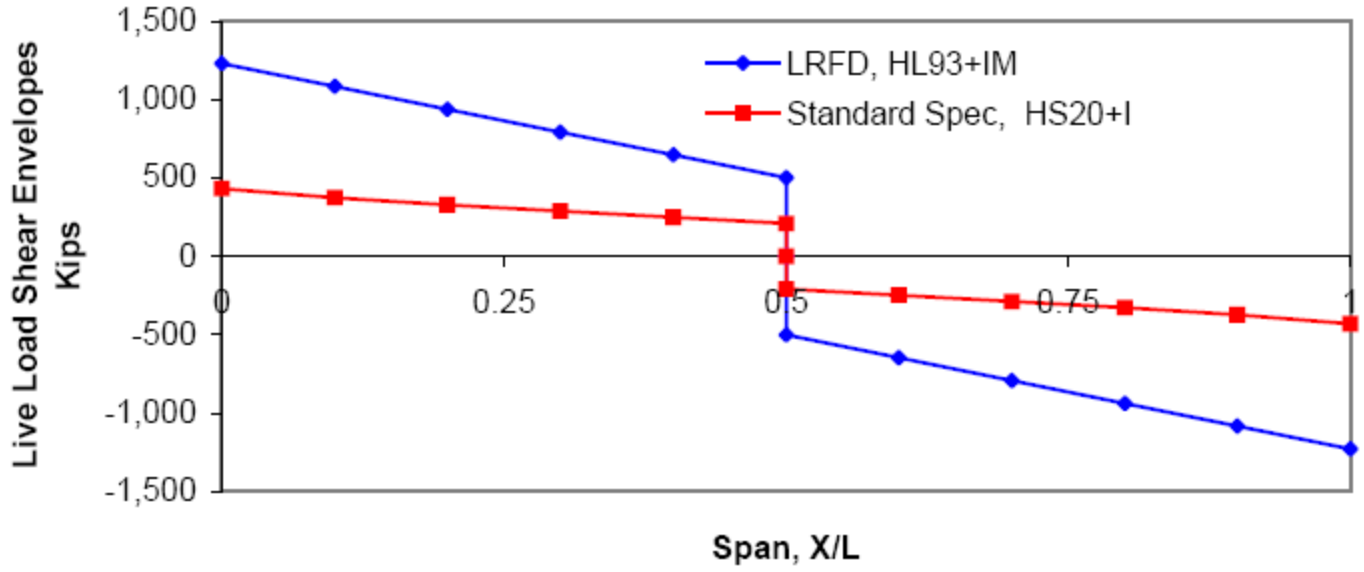
Kullanım Sınır Durumu Momentleri [4]



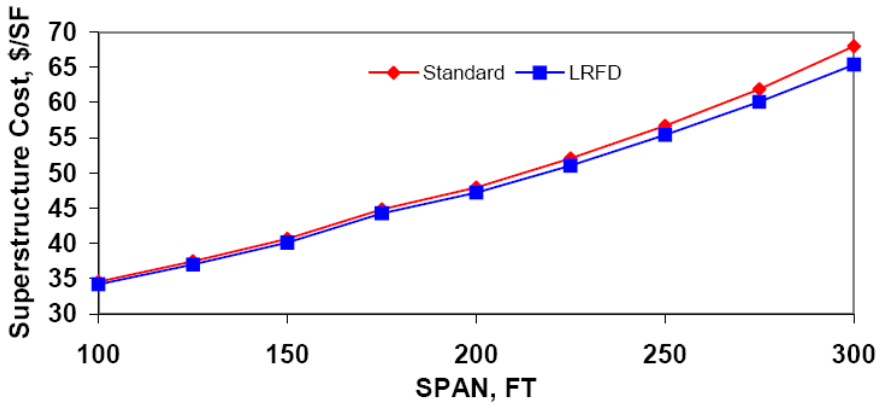
Dayanım 1 Momentleri

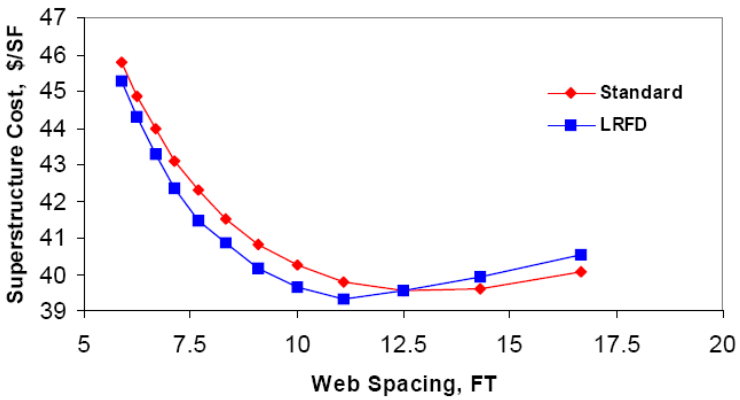


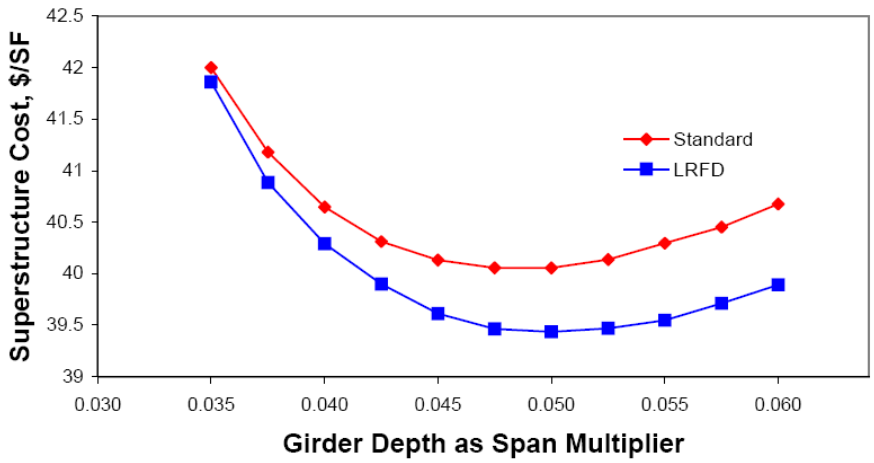
Hareketli Yük Kesme [4]



Maliyet


Superstructure Cost, $/SF
70
65
60
55
50
45
40
35
30
100
150
200
250
300
SPAN, FT
Standard
LRFD


Superstructure Cost, $/SF
47
46
45
44
43
42
41
40
39
5
7.5
10
12.5
15
17.5
20
Web Spacing, FT
Standard
LRFD


Superstructure Cost, $/SF
42.5
42
41.5
41
40.5
40
39.5
39
0.030
0.035
0.040
0.045
0.050
0.055
0.060
Girder Depth as Span Multiplier
Standard
LRFD

Kaynakça

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