In [1]:
```
# pip install matplotlib
```

In [2]:
```
import pandas as pd
import numpy as np
import math
from math import pi
import matplotlib
import matplotlib.pyplot as plt

%matplotlib inline
%config InlineBackend.figure_format = 'retina'
```

동적문서 도입 (Dynamic Document)

주피터 노트북

- "문서와 웹애플리케이션을 합친 형태" 의 문서
- python, nodejs, clojure 등의 여러 언어를 지원한다.

pdf 와 다른점

$$P_n = F_{cr} A_g$$

pdf에서 이 수식은 그냥 글자일 뿐이지만,

주피터노트북에서는 엑셀처럼 입력값에 따라 다른 결과물을 반환해주는 코드이다.

In [3]:
```
##### 사용자 입력 1 ########
Fcr = 300
Ag = 0.84
```

In [4]:
```
Pn = Fcr * Ag

##### 결과 출력 1 ########
print(Pn)
##### 결과 출력 1 ########
```

```
252.0
```

In [5]:
```
##### 사용자 입력 2 ########
Fcr = 350
Ag = 1.07
```

In [6]:
```
Pn = Fcr * Ag

##### 결과 출력 2 ########
print(Pn)
##### 결과 출력 2 ########
```

374.5

excel 보다 편한점 (문서작성 예시)

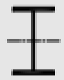
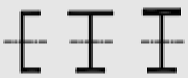
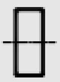
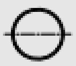
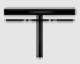
E1. GENERAL PROVISIONS

The design compressive strength, φcPn, and the allowable compressive strength, Pn/Ωc, are determined as follows. The nominal compressive strength, Pn, shall be the lowest value obtained based on the applicable limit states of flexural buckling, torsional buckling, and flexural-torsional buckling

$$\varphi_c = 0.90(LRFD)$$

$$\Omega_c = 1.67(ASD)$$

TABLE USER NOTE E1.1
Selection Table for the Application of Chapter E Sections

Cross Section	Without Slender Elements		With Slender Elements	
	Sections in Chapter E	Limit States	Sections in Chapter E	Limit States
	E3 E4	FB TB	E7	LB FB TB
	E3 E4	FB FTB	E7	LB FB FTB
	E3	FB	E7	LB FB
	E3	FB	E7	LB FB
	E3 E4	FB FTB	E7	LB FB FTB
	E6 E3 E4	FB FTB	E6 E7	LB FB FTB
	E5		E5	
	E3	FB	N/A	N/A
Unsymmetrical shapes other than single angles	E4	FTB	E7	LB FTB

FB = flexural buckling, TB = torsional buckling, FTB = flexural-torsional buckling, LB = local buckling, N/A = not applicable

E2. EFFECTIVE LENGTH

The effective length, L_c, for calculation of member slenderness, L_c/r, shall be determined in accordance with Chapter C or Appendix 7,

where
K = effective length factor

$L_c = KL$ = effective length of member, in. (mm)
L = laterally unbraced length of the member, in. (mm)
r = radius of gyration, in. (mm)

User Note: For members designed on the basis of compression, the effective slenderness ratio, L c/r, preferably should not exceed 200.

User Note: The effective length, Lc, can be determined through methods other than those using the effective length factor, K.

E3. FLEXURAL BUCKLING OF MEMBERS WITHOUT SLENDER ELEMENTS

This section applies to nonslender-element compression members, as defined in Section B4.1, for elements in axial compression.

User Note: When the torsional effective length is larger than the lateral effective length, Section E4 may control the design of wide-flange and similarly shaped columns.

The nominal compressive strength, Pn, shall be determined based on the limit state of flexural buckling:

$$P_n = F_{cr} A_g \tag{E3-1}$$

The critical stress, F_{cr}, is determined as follows:

(a) When $\dfrac{L_c}{r} \le 4.71\sqrt{\dfrac{E}{F_y}}$ (or $\dfrac{F_y}{F_e} \le 2.25$)

$$F_{cr} = \left(0.658^{\frac{F_y}{F_e}}\right) F_y \tag{E3-2}$$

(b) When $\dfrac{L_c}{r} > 4.71\sqrt{\dfrac{E}{F_y}}$ (or $\dfrac{F_y}{F_e} > 2.25$)

$$F_{cr} = 0.877 F_e \tag{E3-3}$$

where

A_g = gross cross-sectional area of member, in.^{2} (mm^2)
E = modulus of elasticity of steel = 29,000 ksi (200 000 MPa)

F_e = elastic buckling stress determined according to Equation E3-4, as specified in Appendix 7, Section 7.2.3(b), or through an elastic buckling analysis, as applicable, ksi (MPa)

$$= \frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2} \tag{E3-4}$$

F_y = specified minimum yield stress of the type of steel being used, ksi (MPa)
r = radius of gyration, in. (mm)

User Note: The two inequalities for calculating the limits of applicability of Sections E3(a) and E3(b), one based on L_c/r and one based on F_y/F_e, provide the same result for flexural buckling.

TABLE C-E3.1
Limiting values of L_c/r and F_e

F_y, ksi (MPa)	Limiting $\frac{L_c}{r}$	F_e, ksi (MPa)
36 (250)	134	16.0 (110)
50 (345)	113	22.2 (150)
65 (450)	99.5	28.9 (200)
70 (485)	95.9	31.1 (210)

In [7]:
```
def findFcr(E, Fy, sldns):
    Fe = pi**2 * E / (sldns ** 2)

    if sldns <= 4.71*math.sqrt(E/Fy):
        Fcr = math.pow(0.658, Fy/Fe) * Fy
    else:
        Fcr = 0.877 * Fe

    return Fcr
```

In [8]:
```
result = lambda a: [findFcr(250000, a, x) for x in range(1,201)] ## 탄성계수 입력
res250 = result(250)
res345 = result(345)
res345
```

Out[8]:
```
[344.9798101340706,
 344.919247625235,
 344.8183337362034,
 344.6771038910017,
 344.4956076542477,
 344.2739087021612,
 344.01208478533135,
 343.7102276832731,
 343.3684431508089,
 342.98685085631945,
 342.5655843119146,
 342.1047907955812,
```

341.60463126537115,
341.0652802656998,
340.48692582583163,
339.86976935063456,
339.2140255036936,
338.5199220828768,
337.7876998884558,
337.0176125838878,
336.2099265493708,
335.36492072829117,
334.4828864666877,
333.56412734586,
332.6089590082581,
331.6177089767908,
330.5907164676992,
329.5283321971439,
328.43091818166147,
327.29884753264736,
326.1325042450302,
324.93228298030397,
323.69858884409007,
322.431837158404,
321.132453228807,
319.80087210662384,
318.4375383464139,
317.0429057588835,
315.6174371594327,
314.1616041125309,
312.6758866721174,
311.16077311822926,
309.6167596900559,
308.04435031562576,
306.4440563383299,
304.81639624049063,
303.1618953641828,
301.4810856295185,
299.7745052506051,
298.04269844938887,
296.2862151675959,
294.5056107769825,
292.70144578810863,
290.8742855578459,
289.02469999583354,
287.1532632700932,
285.26055351201444,
283.34715252092224,
281.4136454684341,
279.4606206028167,
277.4886689535483,
275.4983840362927,
273.490361558487,
271.46519912574723,
269.4234959492888,
267.365852554561,
265.2928704912893,
263.20515204511827,
261.10329995104433,
258.98791710882494,
256.85960630054785,
254.71896991054047,
252.5666096477965,
250.40312627109313,
248.22911931696868,
246.04518683072644,
243.85192510062723,
241.64992839542893,
239.43978870542614,
237.2220954871411,
234.99743541181022,

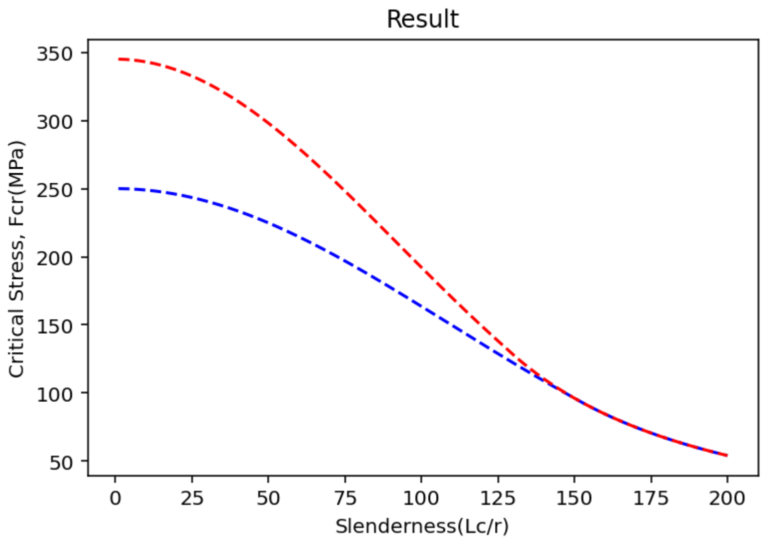
232.766392117808,
230.52954596714477,
228.2874738061698,
226.04074873060785,
223.78993985505116,
221.53561208702462,
219.27832590573732,
217.01863714562816,
214.75709678480845,
212.49425073849946,
210.23063965755796,
207.9667987321769,
205.70325750084424,
203.44053966463773,
201.17916290692676,
198.91963871854932,
196.6624722285259,
194.40816204036605,
192.15720007402055,
189.91007141352398,
187.6672541603699,
185.42921929265435,
183.1964305300182,
180.9693442044145,
178.74840913672168,
176.53406651921776,
174.32674980392719,
172.12688459684523,
169.93488855804156,
167.75117130763928,
165.5761343376603,
163.41017092972427,
161.2536660785834,
159.10699642147037,
156.97053017323313,
154.84462706722496,
152.72963830191472,
150.6259064931778,
148.53376563222375,
146.45354104911314,
144.38554938181244,
142.3300985507309,
140.28748773868085,
138.25800737619906,
136.24193913216214,
134.1627357516797,
132.07463164909922,
130.03489964177882,
128.04205709697285,
126.09467775414261,
124.19138917233938,
122.33087031142753,
120.51184923918697,
118.73310095686374,
116.99344533622629,
115.29174516164109,
113.62690427110068,
111.9978657905306,
110.40361045606335,
108.84315501930696,
107.3155507309483,
105.8198818983247,
104.35526451286852,
102.92084494358342,
101.51579869294622,
100.13932921184883,
98.7906667704,
97.4690673815973,
96.17381177505962,

```
94.90420441817646,
93.6595725821867,
92.43926545084547,
91.24265326947385,
90.0691265323139,
88.91809520623116,
87.78898798891807,
86.68125159985746,
85.59435010240266,
84.5277642554235,
83.48099089305357,
82.45354233115538,
81.44494579919612,
80.45474289629838,
79.4824890702972,
78.52775311869799,
77.5901167104895,
76.66917392782177,
75.76453082661118,
74.87580501518482,
74.00262525012282,
73.1446310485006,
72.30147231577538,
71.4728089885996,
70.65831069188054,
69.8576564094409,
69.07053416766706,
68.29664073156299,
67.53568131265696,
66.78736928823585,
66.05142593140751,
65.32758015151677,
64.6155682444636,
63.91513365249414,
63.226026733055996,
62.5480045363291,
61.88083059106184,
61.22427469836016,
60.57811273309375,
59.94212645259948,
59.31610331237745,
58.69983628848855,
58.09312370637712,
57.49576907585401,
56.907580931987944,
56.32837268166497,
55.75796245558611,
55.19617296548417,
54.642831366350386,
54.09776912347104]
```

In [9]:

```
plt.plot(range(1,201), res250, 'b--')
plt.plot(range(1,201), res345, 'r--')

plt.xlabel("Slenderness(Lc/r)")
plt.ylabel("Critical Stress, Fcr(MPa)")
plt.title("Result")
plt.show()
```



E4. TORSIONAL AND FLEXURAL-TORSIONAL BUCKLING OF SINGLE ANGLES AND MEMBERS WITHOUT SLENDER ELEMENTS

This section applies to singly symmetric and unsymmetric members, certain doubly symmetric members, such as cruciform or built-up members, and doubly symmetric members when the torsional unbraced length exceeds the lateral unbraced length, all without slender elements. These provisions also apply to single angles with $b/t > 0.71\sqrt{E/F_y}$, where b is the width of the longest leg and t is the thickness.

The nominal compressive strength, P_n, shall be determined based on the limit states of torsional and flexural-torsional buckling:

$$P_n = F_{cr} A_g \qquad \text{(E4-1)}$$

The critical stress, F_{cr}, shall be determined according to Equation E3-2 or E3-3, using the torsional or flexural-torsional elastic buckling stress, F_e, determined as follows:

(a) For doubly symmetric members twisting about the shear center

(For H 형강)

$$F_e = \left(\frac{\pi^2 E C_w}{L_{cz}^2} + GJ\right)\frac{1}{I_x + I_y} \qquad \text{(E4-2)}$$

(b) For singly symmetric members twisting about the shear center where y is the axis of symmetry

(For C, T, Double Angle)

$$F_e = \left(\frac{F_{ey} + F_{ez}}{2H}\right)\left[1 - \sqrt{1 - \frac{4F_{ey}F_{ez}H}{\left(F_{ey} + F_{ez}\right)^2}}\right] \qquad \text{(E4-3)}$$

User Note: For singly symmetric members with the x-axis as the axis of symmetry, such as channels, Equation E4-3 is applicable with F_{ey} replaced by F_{ex}.

(c) For unsymmetric members twisting about the shear center, F_e is the lowest root of the cubic equation

(거의 없음)

$$(F_e - F_{ex})(F_e - F_{ey})(F_e - F_{ez}) - F_e^2(F_e - F_{ey})\left(\frac{x_o}{\bar{r}_o}\right)^2 - F_e^2(F_e - F_{ex})\left(\frac{y_o}{\bar{r}_o}\right)^2 = 0 \qquad \text{(E4-4)}$$

where

C_w = warping constant, in.^{6} (mm^6)

$$F_{ex} = \frac{\pi^2 E}{\left(\dfrac{L_{cx}}{r_x}\right)^2} \quad \text{(E4-5)}$$

$$F_{ey} = \frac{\pi^2 E}{\left(\dfrac{L_{cy}}{r_y}\right)^2} \quad \text{(E4-6)}$$

$$F_{ez} = \left(\frac{\pi^2 E C_w}{L_{cz}^2} + GJ\right)\frac{1}{A_g \bar{r}_o^2} \quad \text{(E4-7)}$$

G = shear modulus of elasticity of steel = 11,200 ksi (77 200 MPa)

H = flexural constant

$$= 1 - \frac{x_o^2 + y_o^2}{\bar{r}_o^2} \quad \text{(E4-8)}$$

I_x, I_y = moment of inertia about the principal axes, in.^{4} (mm^4)

J = torsional constant, in.^{4} (mm^4)

K_x = effective length factor for flexural buckling about x-axis

K_y = effective length factor for flexural buckling about y-axis

K_z = effective length factor for torsional buckling about the longitudinal axis

L_{cx} = $K_x L_x$ = effective length of member for buckling about x-axis, in. (mm)

L_{cy} = $K_y L_y$ = effective length of member for buckling about y-axis, in. (mm)

L_{cz} = $K_z L_z$ = effective length of member for buckling about longitudinal axis, in. (mm)

L_x, L_y, L_z = laterally unbraced length of the member for each axis, in. (mm)

$\bar{r}_o$ = polar radius of gyration about the shear center, in. (mm)

$$\bar{r}_o^{\,2} = x_o^2 + y_o^2 + \frac{I_x + I_y}{A_g} \quad \text{(E4-9)}$$

r_x = radius of gyration about x-axis, in. (mm)

r_y = radius of gyration about y-axis, in. (mm)

x_o, y_o = coordinates of the shear center with respect to the centroid, in. (mm)

User Note: For doubly symmetric I-shaped sections, C_w may be taken as $I_y h_o^2/4$, where h_o is the distance between flange centroids, in lieu of a more precise analysis. For tees and double angles, omit the term with C_w when computing F_{ez} and take x_o as 0.

(d) For members with lateral bracing offset from the shear center, the elastic buckling stress, F_e, shall be determined by analysis.

> **User Note:** Members with lateral bracing offset from the shear center are susceptible to constrained-axis torsional buckling, which is discussed in the Commentary.

EXAMPLE E.1D W-SHAPE AVAILABLE STRENGTH CALCULATION

H 형강

표준 단면치수 mm					단면적 cm^2	단위 무게 kg/m	참고					
							단면 2차 모멘트 cm^4		단면 2차 반지름 cm		단면계수 cm^3	
호칭 치수 (높이 X 변)	H X B	t1	t2	r			Ix	Iy	ix	iy	Zx	Zy
100X50	100X50	5	7	8	11.85	9.30	187	14.8	3.98	1.12	37.5	5.91
100X100	100X100	6	8	10	21.90	17.2	383	134	4.18	2.47	76.5	26.7
125X60	125X60	6	8	9	16.84	13.2	413	29.2	4.95	1.32	66.1	9.73
125X125	125X125	6.5	9	10	30.31	23.8	847	293	5.29	3.11	136	47.0
150X75	150X75	5	7	8	17.85	14.0	666	49.5	6.11	1.66	88.8	13.2
150X100	148X100	6	9	11	26.84	21.1	1 020	151	6.17	2.37	138	30.1
150X150	150X150	7	10	11	40.14	31.5	1 640	563	6.39	3.75	219	75.1
175X90	175X90	5	8	9	23.04	18.1	1 210	97.5	7.26	2.06	139	21.7
175X175	175X175	7.5	11	12	51.21	40.2	2 880	984	7.50	4.38	330	112
200X100	198X99	4.5	7	11	23.18	18.2	1 580	114	8.26	2.21	160	23.0
	200X100	5.5	8	11	27.16	21.3	1 840	134	8.24	2.22	184	26.8
200X150	194X150	6	9	13	39.01	30.6	2 690	507	8.30	3.61	277	67.6
200X200	200X200	8	12	13	63.53	49.9	4 720	1 600	8.62	5.02	472	160
	*200X204	12	12	13	71.53	56.2	4 980	1 700	8.35	4.88	498	167
	*208X202	10	16	13	83.69	65.7	6 350	2 200	8.83	5.13	628	218
250X125	248X124	5	8	12	32.68	25.7	3 540	255	10.4	2.79	285	41.1
	250X125	6	9	12	37.66	29.6	4 050	294	10.4	2.79	324	47.0
250X175	244X175	7	11	16	56.24	44.1	6 120	984	10.4	4.18	502	113
250X250	*244X252	11	11	16	82.06	64.4	8 790	2 940	10.3	5.98	720	233
	*248X249	8	13	16	84.70	66.5	9 930	3 350	10.8	6.29	801	269
	250X250	9	14	16	92.18	72.4	10 800	3 650	10.8	6.29	867	292
	*250X255	14	14	16	104.7	82.2	11 500	3 880	10.5	6.09	919	304
300X150	298X149	5.5	8	13	40.80	32.0	6 320	442	12.4	3.29	424	59.3
	300X150	6.5	9	13	46.78	36.7	7 210	508	12.4	3.29	481	67.7
300X200	294X200	8	12	18	72.38	56.8	11 300	1 600	12.5	4.71	771	160
	*298X201	9	14	18	83.36	65.4	13 300	1 900	12.6	4.77	893	189

표준 단면치수 mm					단면적 cm^2	단위 무게 kg/m	참고					
							단면 2차 모멘트 cm^4		단면 2차 반지름 cm		단면계수 cm^3	
호칭 치수 (높이 X 변)	H X B	t1	t2	r			Ix	Iy	ix	iy	Zx	Zy
300X300	294X302	12	12	18	107.7	84.5	16 900	5 520	12.5	7.16	1 150	365
	*298X299	9	14	18	110.8	87.0	18 800	6 240	13.0	7.50	1 270	417
	300X300	10	15	18	119.8	94.0	20 400	6 750	13.1	7.51	1 360	450
	300X305	15	15	18	134.8	106	21 500	7 100	12.6	7.26	1 440	456
	*304X301	11	17	18	134.8	106	23 400	7 730	13.2	7.57	1 540	514
	*310X305	15	20	18	165.3	130	28 600	9 470	13.2	7.57	1 850	621
	*310X310	20	20	18	180.8	142	29 900	10 000	12.9	7.44	1 930	645
350X175	346X174	6	9	14	52.68	41.4	11 100	792	14.5	3.88	641	91.0
	350X175	7	11	14	63.14	49.6	13 600	984	14.7	3.95	775	112
	*354X176	8	13	14	73.68	57.8	16 100	1 180	14.8	4.01	909	135
350X250	*336X249	8	12	20	88.15	69.2	18 500	3 090	14.5	5.92	1 100	248
	340X250	9	14	20	101.5	79.7	21 700	3 650	14.6	6.00	1 280	292
350X350	*338X351	13	13	20	135.3	106	28 200	9 380	14.4	8.33	1 670	534
	344X348	10	16	20	146.0	115	33 300	11 200	15.1	8.78	1 940	646
	344X354	16	16	20	166.6	131	35 300	11 800	14.6	8.43	2 050	669
	350X350	12	19	20	173.9	137	40 300	13 600	15.2	8.84	2 300	776
	*350X357	19	19	20	198.4	156	42 800	14 400	14.7	8.53	2 450	809
400X200	396X199	7	11	16	72.16	56.6	20 000	1 450	16.7	4.48	1 010	145
	400X200	8	13	16	84.12	66.0	23 700	1 740	16.8	4.54	1 190	174
400X300	390X300	10	16	22	136.0	107	38 700	7 210	16.9	7.28	1 980	481
400X400	*388X402	15	15	22	178.5	140	49 000	16 300	16.6	9.54	2 520	809
	*394X398	11	18	22	186.8	147	56 100	18 900	17.3	10.1	2 850	951
	*394X405	18	18	22	214.4	168	59 700	20 000	16.7	9.65	3 030	985
	400X400	13	21	22	218.7	172	66 600	22 400	17.5	10.1	3 330	1 120
	*400X408	21	21	22	250.7	197	70 900	23 800	16.8	9.75	3 540	1 170
	*406X403	16	24	22	254.9	200	87 000	26 200	17.5	10.1	3 840	1 300
	*414X405	18	28	22	295.4	232	92 800	31 000	17.7	10.2	4 480	1 530
	*428X407	20	35	22	360.7	283	119 000	39 400	18.2	10.4	5 570	1 930
	*458X417	30	50	22	528.6	415	187 000	60 500	18.8	10.7	8 170	2 900
	*498X432	45	70	22	770.1	605	298 000	94 400	19.7	11.1	12 000	4 370

Given:

H.W #2 상기 그림과 같이 작성된 도표를 이용하여 다음 조건의 기둥의 압축 설계 강도 ? (Design Example E.1D 참조)

Unit- kN.mm

부재 형상		kLx(S)	kLy(W)			ψPn	Pn/ψ	단위무게
H-248 x 249x 8 x 13		3000	3000					66kg/m
H-248 x 249x 8 x 13		6000	3000					
H-248 x 249x 8 x 13		3000	6000					
H-248 x 249x 8 x 13		6000	6000					
H-400 x 200 x 8 x 13		3000	3000					66kg/m
H-400 x 200 x 8 x 13		6000	3000					
H-400 x 200 x 8 x 13		3000	6000					
H-400 x 200 x 8 x 13		6000	6000					

In [10]:

```
mydata = {
    "size": [
        "H-248 x 249x 8 x 13",
        "H-248 x 249x 8 x 13",
        "H-248 x 249x 8 x 13",
```

```
        "H-248 x 249x 8 x 13",
        "H-400 x 200 x 8 x 13",
        "H-400 x 200 x 8 x 13",
        "H-400 x 200 x 8 x 13",
        "H-400 x 200 x 8 x 13",
    ],
    "Lx": [
        3000,
        6000,
        3000,
        6000,
        3000,
        6000,
        3000,
        6000,
    ],
    "Ly": [
        3000,
        3000,
        6000,
        6000,
        3000,
        3000,
        6000,
        6000,
    ],
    "Ag": [
        8470,
        8470,
        8470,
        8470,
        8412,
        8412,
        8412,
        8412,
    ],
    "rx": [
        108,
        108,
        108,
        108,
        168,
        168,
        168,
        168,
    ],
    "ry": [
        62.9,
        62.9,
        62.9,
        62.9,
        45.4,
        45.4,
        45.4,
        45.4,
    ],
}
```

In [11]:

```
mydata["size"][1]
```

Out[11]:

```
'H-248 x 249x 8 x 13'
```

Solution:

Fy = 250

In [12]:

```
Fy = 250
E = 200000
Ag = 84.7*10**2 ## (mm2)
K = 1
Lx = 3000
Ly = 3000
rx = 10.8 * 10 ## radius of gyration
ry = 6.29 * 10 ## radius of gyration
```

Slenderness Check

In [13]:

```
def designStrength(_Fy, _E, _K, mydata, i):
    Fy = _Fy
    E = _E
    size = mydata["size"][i]
    Ag = mydata["Ag"][i]
    K = _K
    Lx = mydata["Lx"][i]
    Ly = mydata["Ly"][i]
    rx = mydata["rx"][i]
    ry = mydata["ry"][i]

    def govSldns(K, Lx, Ly, rx, ry):
        def chckSldns(K, L, r):
            return (K * L) / r
        Sldns_x = chckSldns(K, Lx, rx)
        Sldns_y = chckSldns(K, Ly, ry)
        gov = max(Sldns_x, Sldns_y)
        return gov
    sldns = govSldns(K, Lx, Ly, rx, ry)
    Fcr = findFcr(E, Fy, sldns)
    Pn = Fcr * Ag / 1000 ## kN
    ϕc = 0.9
    Ωc = 1.67
    LRFD = ϕc * Pn
    ASD = Pn / 1.67

    result = {
        "부재형상" : size,
        "kLx" : Lx,
        "kLy" : Ly,
        "ϕPn" : LRFD,
        "Pn/Ω" : ASD,
    }

    return result
```

Critical Stress

Design Compressive Strength

Case 1. Fy = 250 MPa

In [14]:

```
result = [designStrength(250, 200000, 1, mydata, i) for i in range(len(mydata["size"]
data = pd.DataFrame(result)
```

In [15]:

```
data
```

Out[15]:

	부재형상	kLx	kLy	φPn	Pn/Ω
0	H-248 x 249x 8 x 13	3000	3000	1689.257346	1123.923717
1	H-248 x 249x 8 x 13	6000	3000	1618.119151	1076.592915
2	H-248 x 249x 8 x 13	3000	6000	1176.482522	782.756169
3	H-248 x 249x 8 x 13	6000	6000	1176.482522	782.756169
4	H-400 x 200 x 8 x 13	3000	3000	1501.609516	999.074861
5	H-400 x 200 x 8 x 13	6000	3000	1501.609516	999.074861
6	H-400 x 200 x 8 x 13	3000	6000	749.864339	498.911736
7	H-400 x 200 x 8 x 13	6000	6000	749.864339	498.911736

Case 2. Fy = 345 MPa

In [16]:

```
result = [designStrength(345, 200000, 1, mydata, i) for i in range(len(mydata["size"]
data = pd.DataFrame(result)
```

In [17]:

```
data
```

Out[17]:

	부재형상	kLx	kLy	φPn	Pn/Ω
0	H-248 x 249x 8 x 13	3000	3000	2226.764351	1481.546475
1	H-248 x 249x 8 x 13	6000	3000	2098.401174	1396.141832
2	H-248 x 249x 8 x 13	3000	6000	1351.642987	899.296731
3	H-248 x 249x 8 x 13	6000	6000	1351.642987	899.296731
4	H-400 x 200 x 8 x 13	3000	3000	1897.739886	1262.634654
5	H-400 x 200 x 8 x 13	6000	3000	1897.739886	1262.634654
6	H-400 x 200 x 8 x 13	3000	6000	750.378380	499.253746
7	H-400 x 200 x 8 x 13	6000	6000	750.378380	499.253746

In [ ]:

```

```