美國結構設計經驗分享

栗正暐技師

2022/6/30

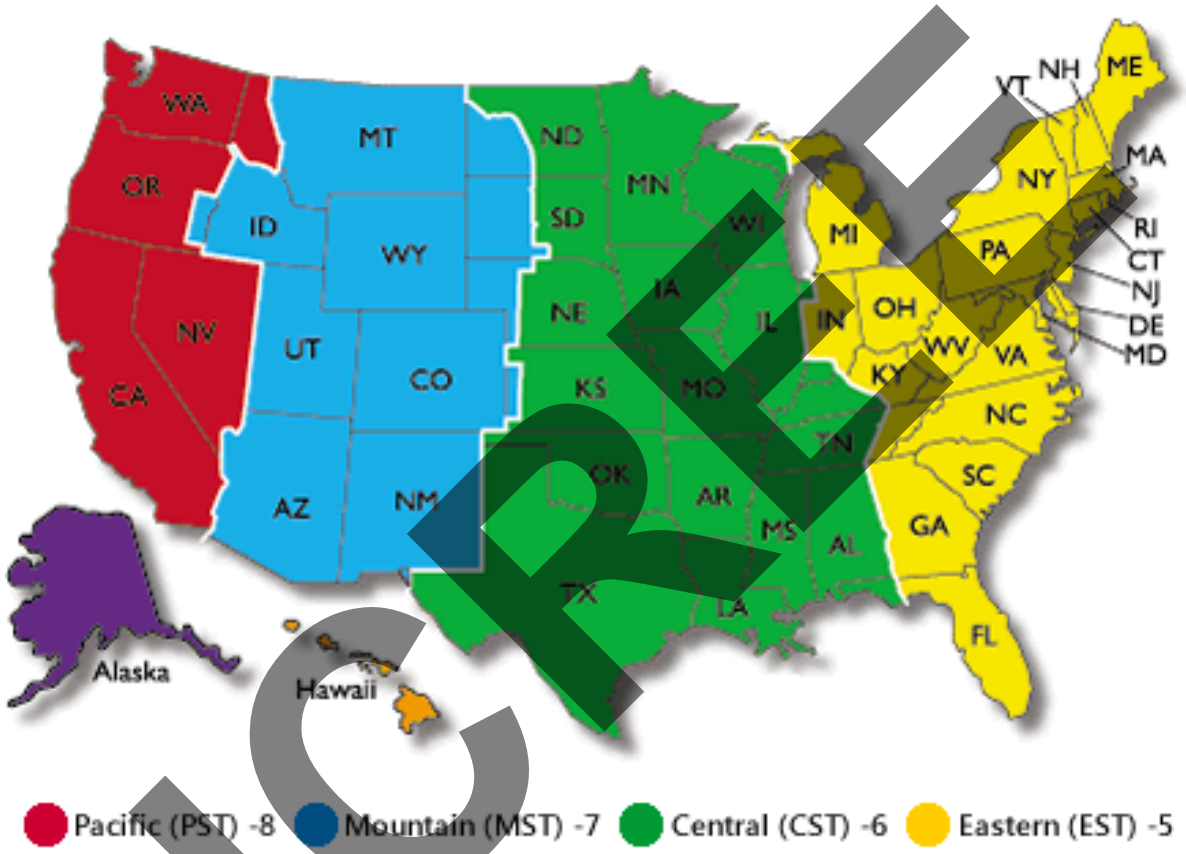
為何要在台灣參與美國的結構設計案?

1. 配合台灣客戶在美國投資的需求。
2. 初期的設計決策工作團隊在台灣。
3. 台灣的設計費可能比美國低?

結構工程師薪資

https://www.talent.com/salary?job=structural+engineer

如何克服時差?

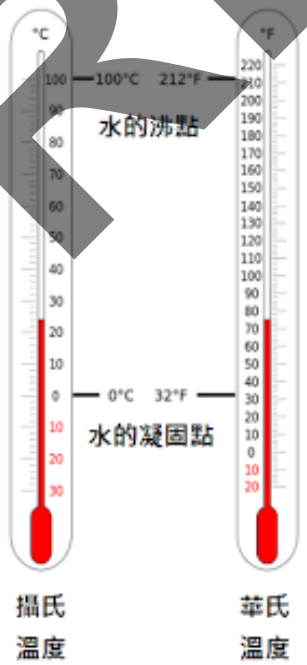


相對台灣時間	+8	+9	+10	+11
最佳開會時間 (台灣時間)	AM7~9 晚上11點接電話			AM7~9 PM9~10

單位轉換的困擾

1. 美國 in, ft , lb, psf, psi, ksi…
2. 台灣mm,cm,m, kgf, kgf/m2, kgf/cm2…
3. 工程師的經驗感覺無法延續。

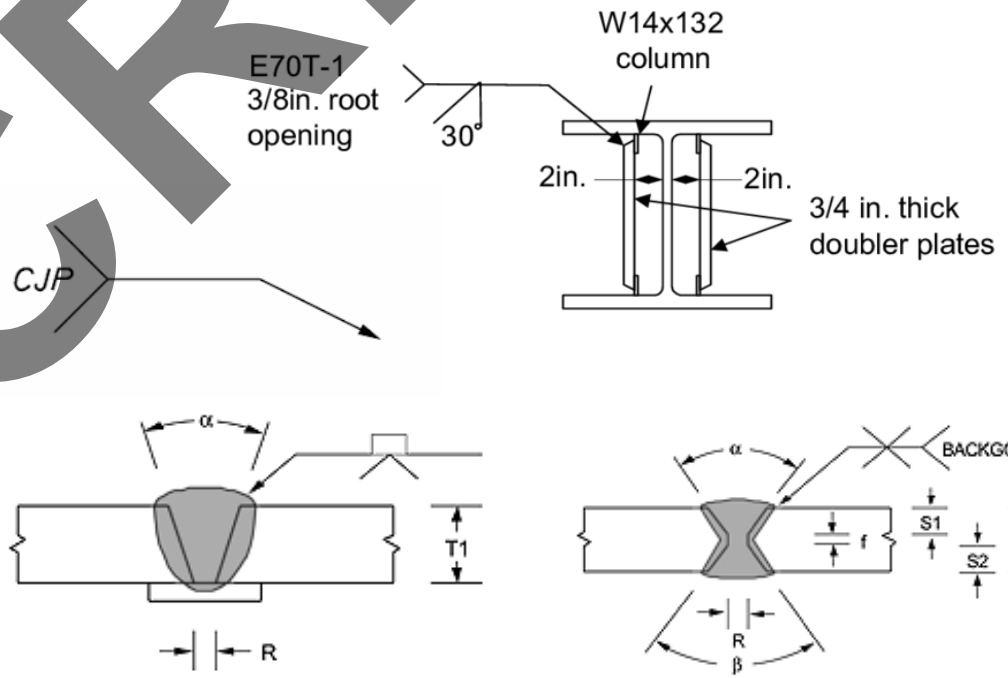
例如: LL=300kgf/m2=60psf (300/5=60)
分數表示: 7/8”=22mm
$USDX29.6= $NTD
溫度: (度F-32)(5/9)=度C



語言溝通

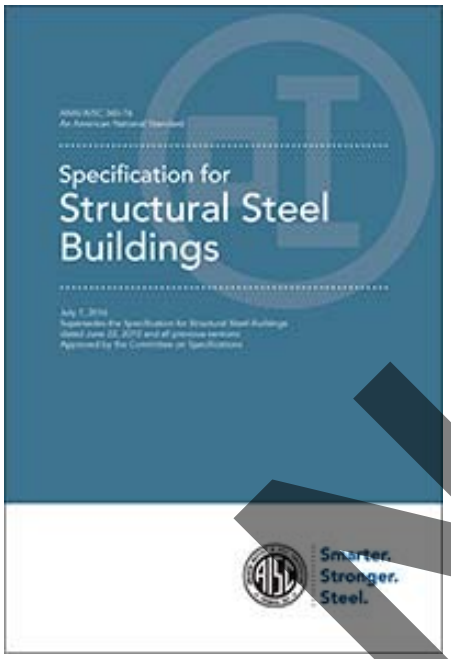
1. 工程英語對話能力(來自不同母語)。
2. 英文書信EMail的基本能力與禮貌。
3. 工程術語熟悉度CJP,PJP...。

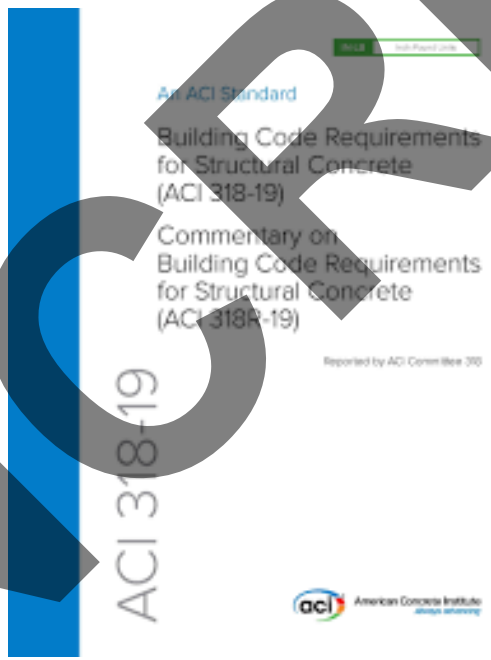
https://ixintu.com/sucai/7zNWagVqV.html

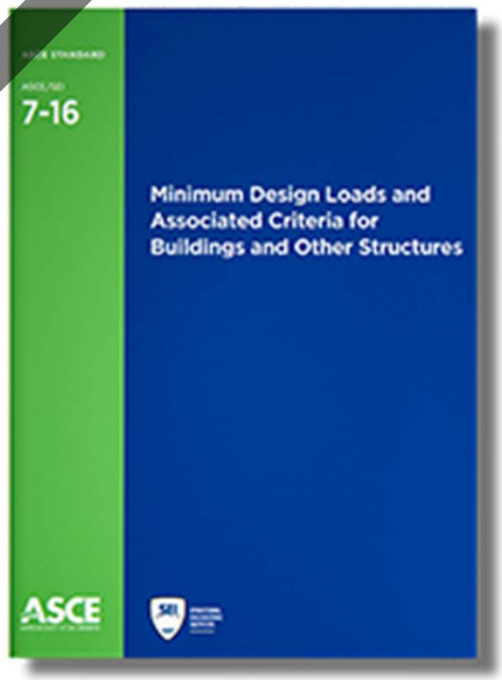


設計規範

1. AISC 360-16, Specification for Structural Steel Buildings
2. ACI 318-19,Building Code Requirements for Structural Concrete
3. ASCE 7-16,Minimum Design Loads and Associated Criteria for Buildings and Other Structures







設計規範

ANSI/AISC 303-16
An American National Standard

Code of Standard Practice for Steel Buildings and Bridges

June 15, 2016

Supersedes the *Code of Standard Practice for Steel Buildings and Bridges* dated April 14, 2010 and all previous versions

Approved by the Committee on the Code of Standard Practice

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
130 East Randolph Street, Suite 2000, Chicago, Illinois 60601
www.aisc.org

Specification for Structural Joints Using High-Strength Bolts

August 1, 2014
(includes April 2015 Errata)

Supersedes the December 31, 2009 *Specification for Structural Joints Using High-Strength Bolts*.

Prepared by RCSC Committee A.1—Specifications and approved by the Research Council on Structural Connections.

boltcouncil
RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
rcsc

www.boltcouncil.org
RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
c/o AISC, One East Wacker Drive, Suite 700, Chicago, Illinois 60601

設計規範參考

COMPANION TO THE
AISC
STEEL CONSTRUCTION MANUAL

Volume 1: Design Examples

Version 15.1

AMERICAN INSTITUTE
OF
STEEL CONSTRUCTION

EXAMPLE II.A-18 SINGLE-PLATE CONNECTION (BEAM-TO-GIRDER WEB)

Given:

Verify a single-plate connection between an ASTM A992 W18×35 beam and an ASTM A992 W21×62 girder web, as shown in Figure II.A-18-1, to support the following beam end reactions:

R_D = 6.5 kips
R_L = 20 kips

The top flange is coped 2 in. deep by 4 in. long, l_{ev} = 1½ in. Use 70-ksi electrodes and an ASTM A36 plate.

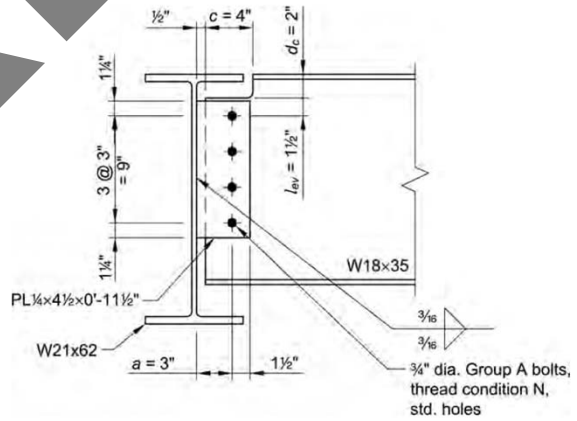
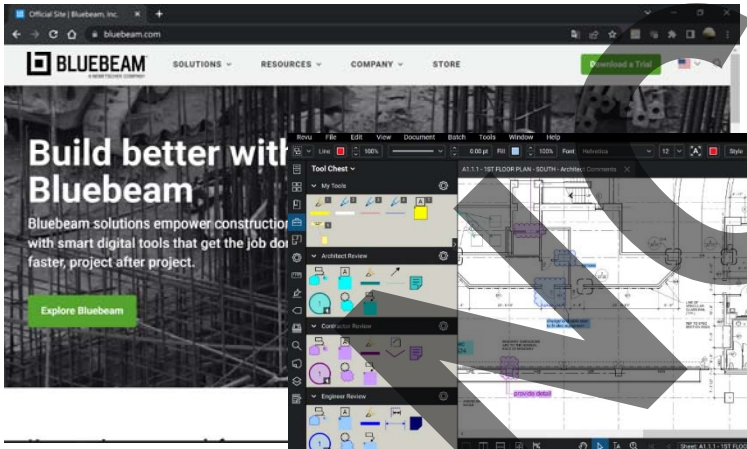
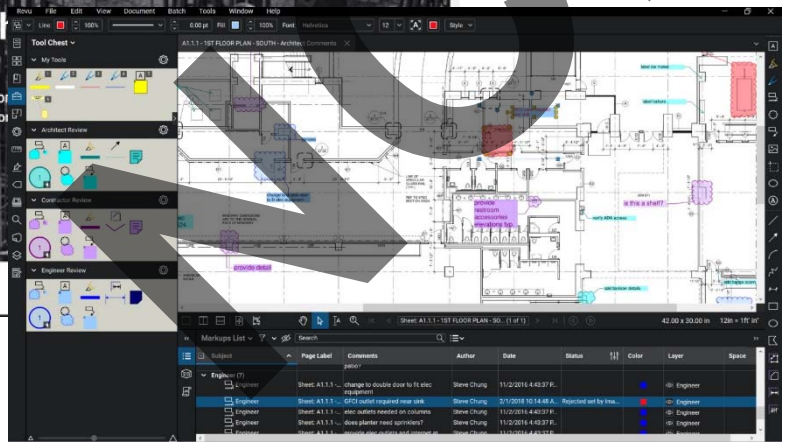


Fig. II.A-18-1. Connection geometry for Example II.A-18.

分析設計軟體與管理工具

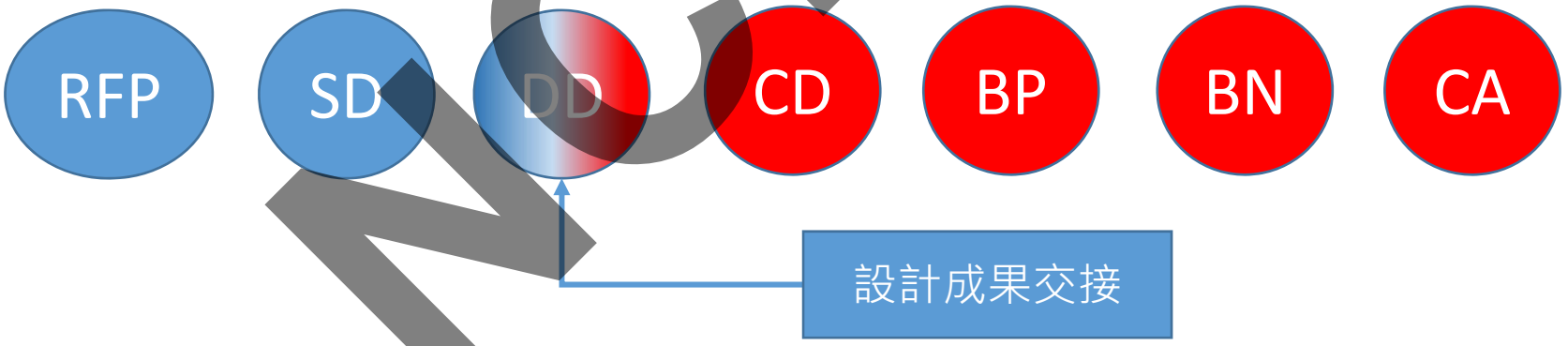
1. ETABS V20
2. SAP2000 V23
3. AutoCAD
4. Revit 2022
5. Tekla 2021
6. PDF 檔案工具
7. BLUEBEAM, Revu 20





台灣的結構設計團隊在設計案的參與程度

1. Concept Design (RFP)
2. Schematic Design (SD)
3. Design Development (DD)
4. Construction Documents (CD)
5. Building Permit (BP)
6. Bidding and Negotiation (BN)
7. Construction Administration (CA)



地震力計算

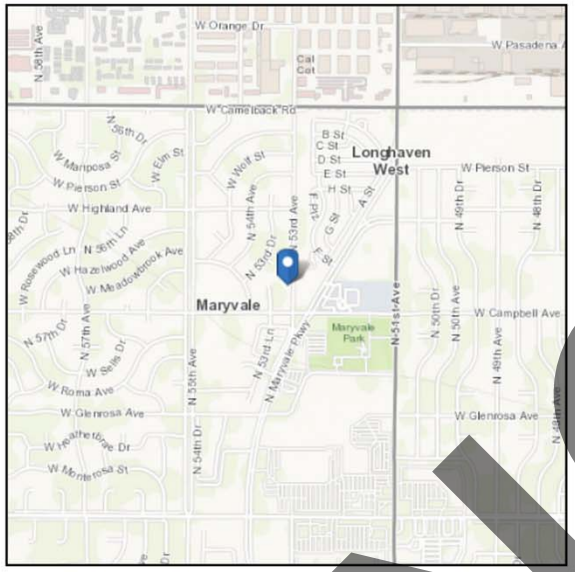
https://asce7hazardtool.online/

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Stiff Soil

Elevation: 1123.53 ft (NAVD 88)
Latitude: 33.503164
Longitude: -112.173444

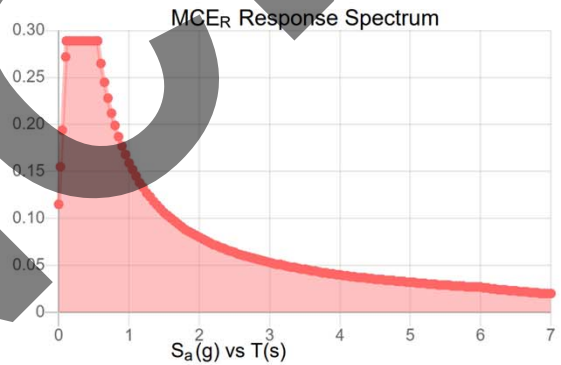


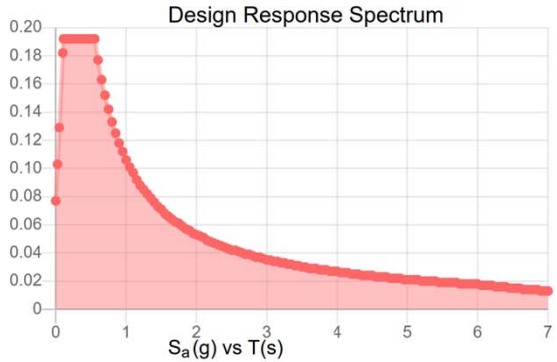
Site Soil Class: D - Stiff Soil

Results:

S_S :	0.18	S_{D1} :	0.106
S_1 :	0.066	T_L :	6
F_a :	1.6	PGA :	0.079
F_v :	2.4	PGA_M :	0.127
S_{MS} :	0.289	F_{PGA} :	1.6
S_{M1} :	0.159	I_e :	1
S_{DS} :	0.192	C_v :	0.7

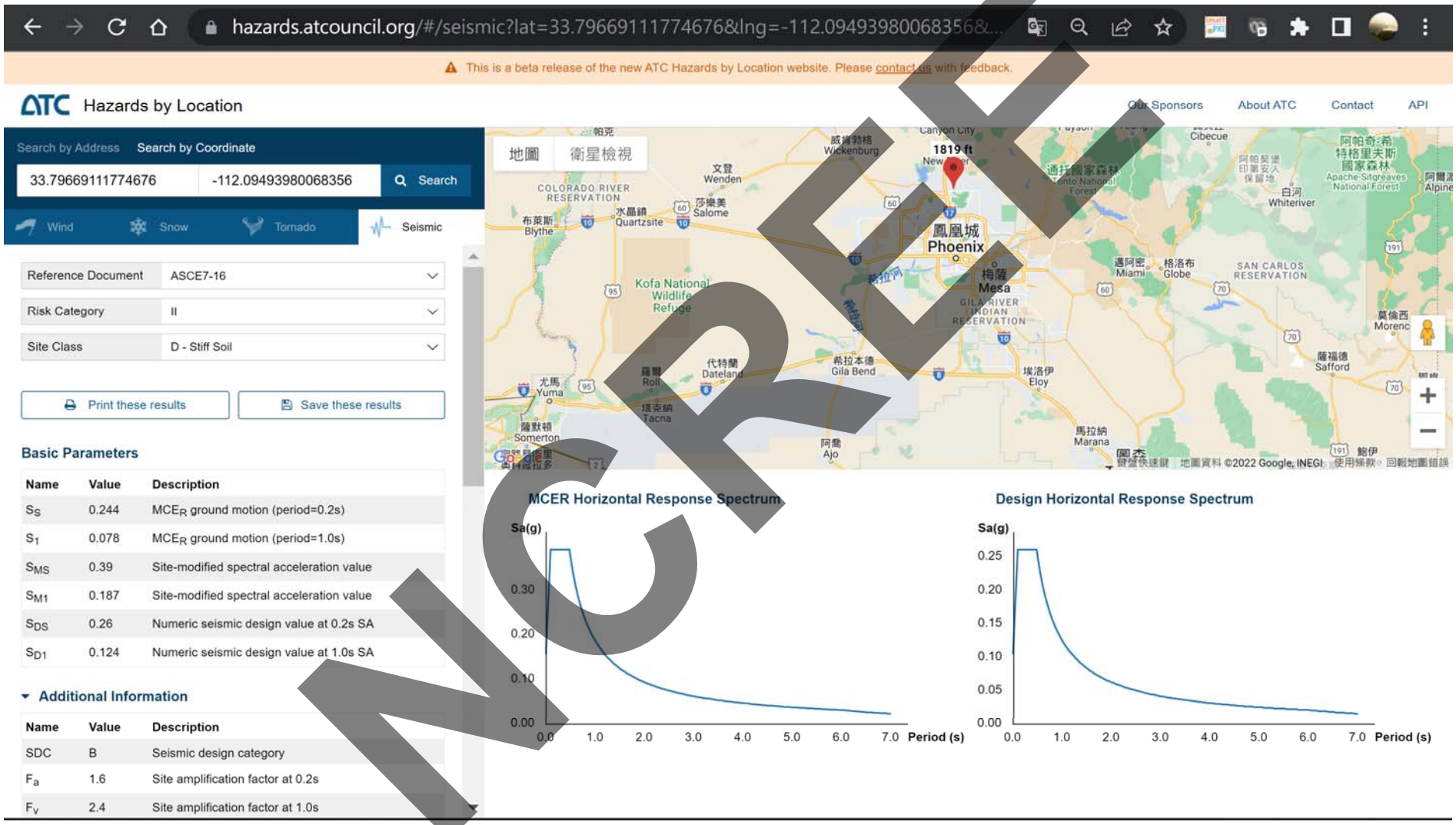
Seismic Design Category B





地震力計算

https://hazards.atcouncil.org/



地震力

DESIGN EARTHQUAKE: The earthquake effects that are two-thirds of the corresponding risk-targeted maximum considered earthquake (MCE_R) effects.

DESIGN EARTHQUAKE GROUND MOTION: The earthquake ground motions that are two-thirds of the corresponding MCE_R ground motions.

Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Response Acceleration: The most severe earthquake effects considered by this standard determined for the orientation that results in the largest maximum response to horizontal ground motions and with adjustment for targeted risk.

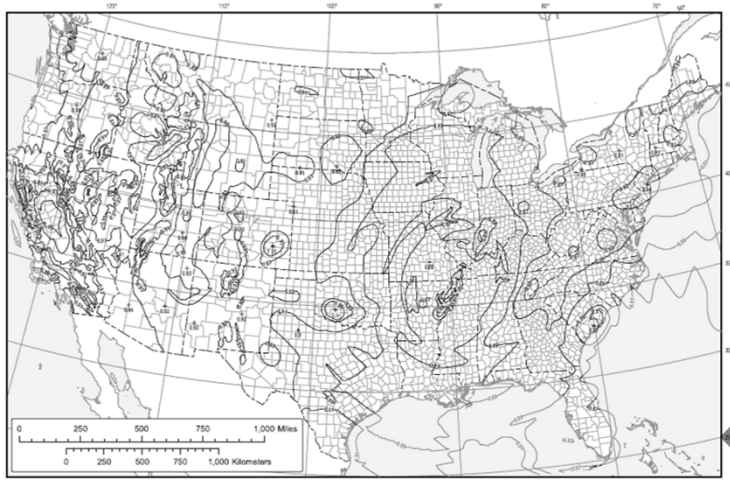
ASCE 7-16

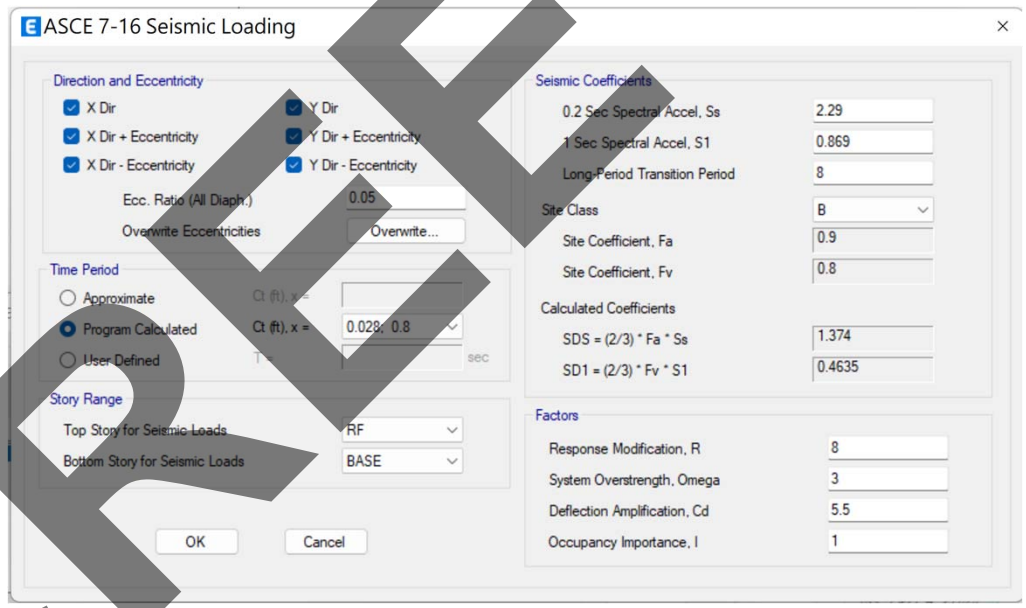
21.2.1 Probabilistic (MCE_R) Ground Motions

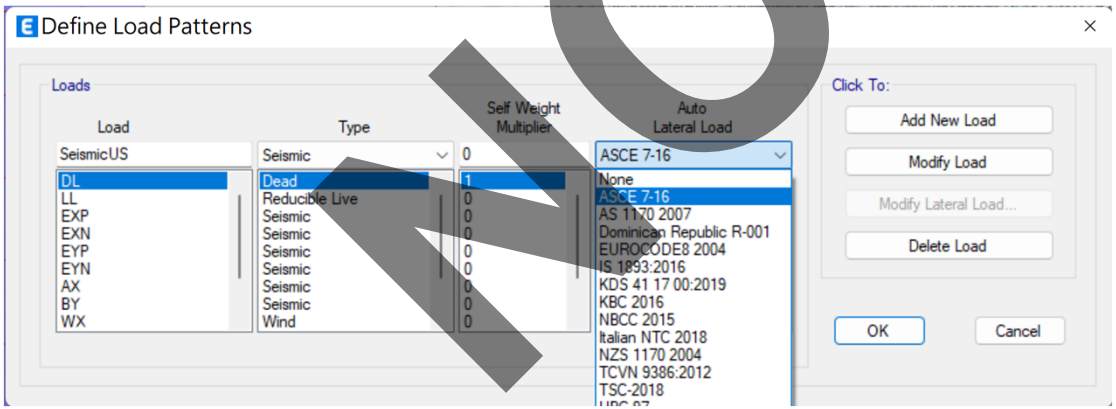
The probabilistic spectral response accelerations shall be taken as the spectral response accelerations in the direction of maximum horizontal response represented by a 5 percent damped acceleration response spectrum that is expected to achieve a 1 percent probability of collapse within a 50-year period.

地震力

依照區域查詢圖表或是網站，並於模型內設置相關係數







ASCE-7 Dead Load 是否包含固定設備?

3.1 DEAD LOADS

3.1.1 Definition. Dead loads consist of the weight of all materials of construction incorporated into the building including, but not limited to, walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items and fixed service equipment, including the weight of cranes and material handling systems.

〔土木401-110〕

https://www.chinatimes.com/newspapers/20200603000280-260210?chdtv

載重 (load)

由全部建築物材料、居住者與其所有物品的重量、環境影響、差異變形及內部尺度變化受束制所導致之力量或其他作用力；永久載重是指這些載重極少或僅小幅度會隨著時間變化，其他所有的載重則是屬可變化的載重。

靜載重 (load, dead)

(a)構材、支撐之結構及永久附屬設施或可能在使用期間設置於結構上之永久裝飾物重量；或(b)符合一般建築規範中特定條件之載重；不含載重因數。

地震力質量來源

Taiwan Seismic Code

W ：建築物全部靜載重。活動隔間至少應計入 75 kgf/m^2 之重量；一般倉庫、書庫應計入至少四分之一活載重；水箱、水池等容器，應計入全部內容物之重量。

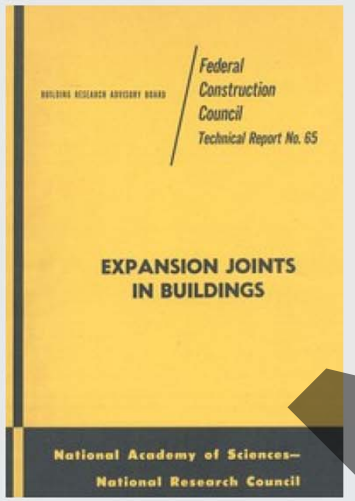
ASCE 7-16

12.7.2 Effective Seismic Weight. The effective seismic weight, W, of a structure shall include the dead load, as defined in Section 3.1, above the base and other loads above the base as listed below:

1. In areas used for storage, a minimum of 25% of the floor live load shall be included.
2. Where provision for partitions is required by Section 4.3.2 in the floor load design, the actual partition weight or a minimum weight of 10 psf (0.48 kN/m2) of floor area, whichever is greater.
3. Total operating weight of permanent equipment.
4. Where the flat roof snow load, Pf , exceeds 30 psf (1.44 kN/m2), 20% of the uniform design snow load, regardless of actual roof slope.
5. Weight of landscaping and other materials at roof gardens and similar areas.

溫差效應

1. 參考Expansion Joints in Buildings : Technical Report No.65
2. 依照不同區域，有規定之溫差 。
3. 如不考慮溫差效應，須依規定設置伸縮縫。
4. 如考慮溫差效應，須於結構設計考量溫差效應。



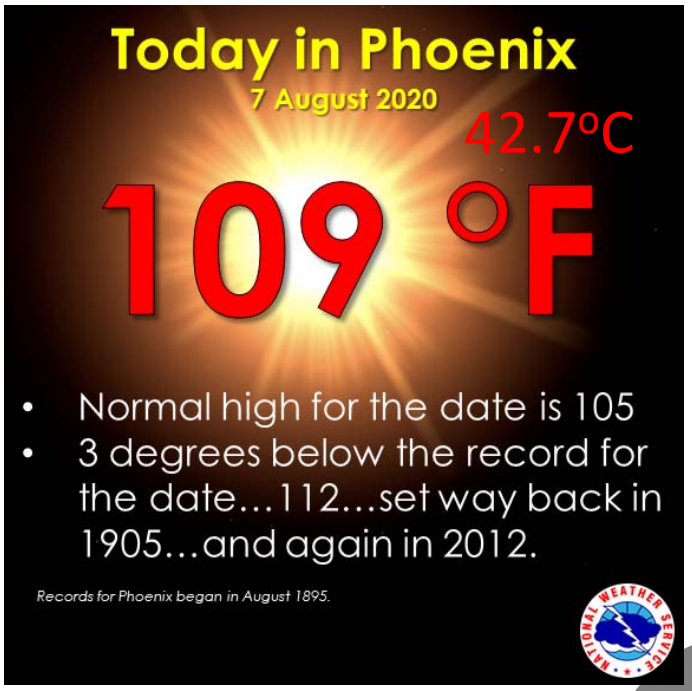
Expansion Joints in Buildings: Technical Report No. 65

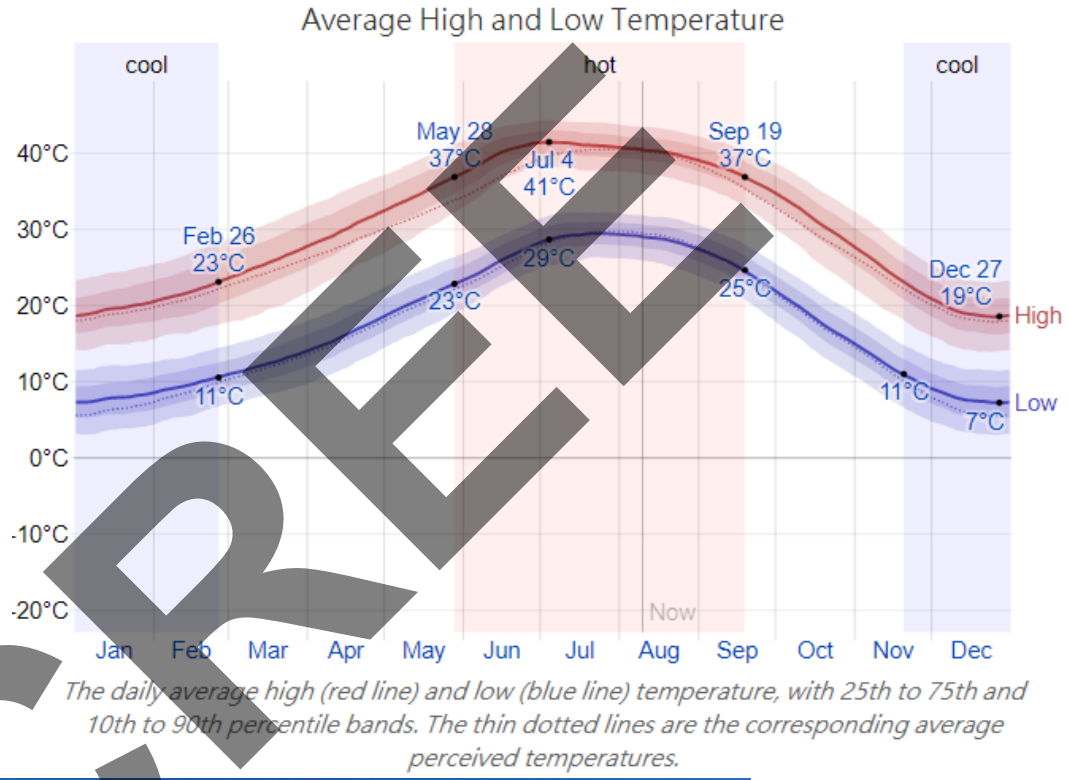
DETAILS

52 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-02233-0 | DOI 10.17226/9801

溫差效應





The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

華氏110°F=攝氏 43°C

Technical Report No.65 溫差效應

b. Design temperature change, which should be computed in accordance with the formula:

$\Delta t = (T_w - T_m)$ or $(T_m - T_c)$, (1)

whichever is greater, where,

T_m = the mean temperature during the normal construction season in the locality of the building. For the purpose of this report, the normal construction season for a locality is defined as that contiguous period in a year during which the minimum daily temperature equals or exceeds 32 °F. [For example, the normal construction season for Anchorage, Alaska, is 5-1/2 months (April 24-October 8) and for Birmingham, Alabama, is year-round (January-December).]

T_w = the temperature exceeded, on the average, only 1 percent of the time during the summer months of June through September in the locality of the building. (In a normal summer there would be approximately 30 hours at or above this design value.)

T_c = the temperature equaled or exceeded, on the average, 99 percent of the time during the winter months of December, January, and February in the locality of the building. (In a normal winter there would be approximately 22 hours at or below this design value.)

(b) If the building will be air conditioned as well as heated, increase the allowable length by 15 percent (provided the environmental control system will run continuously);

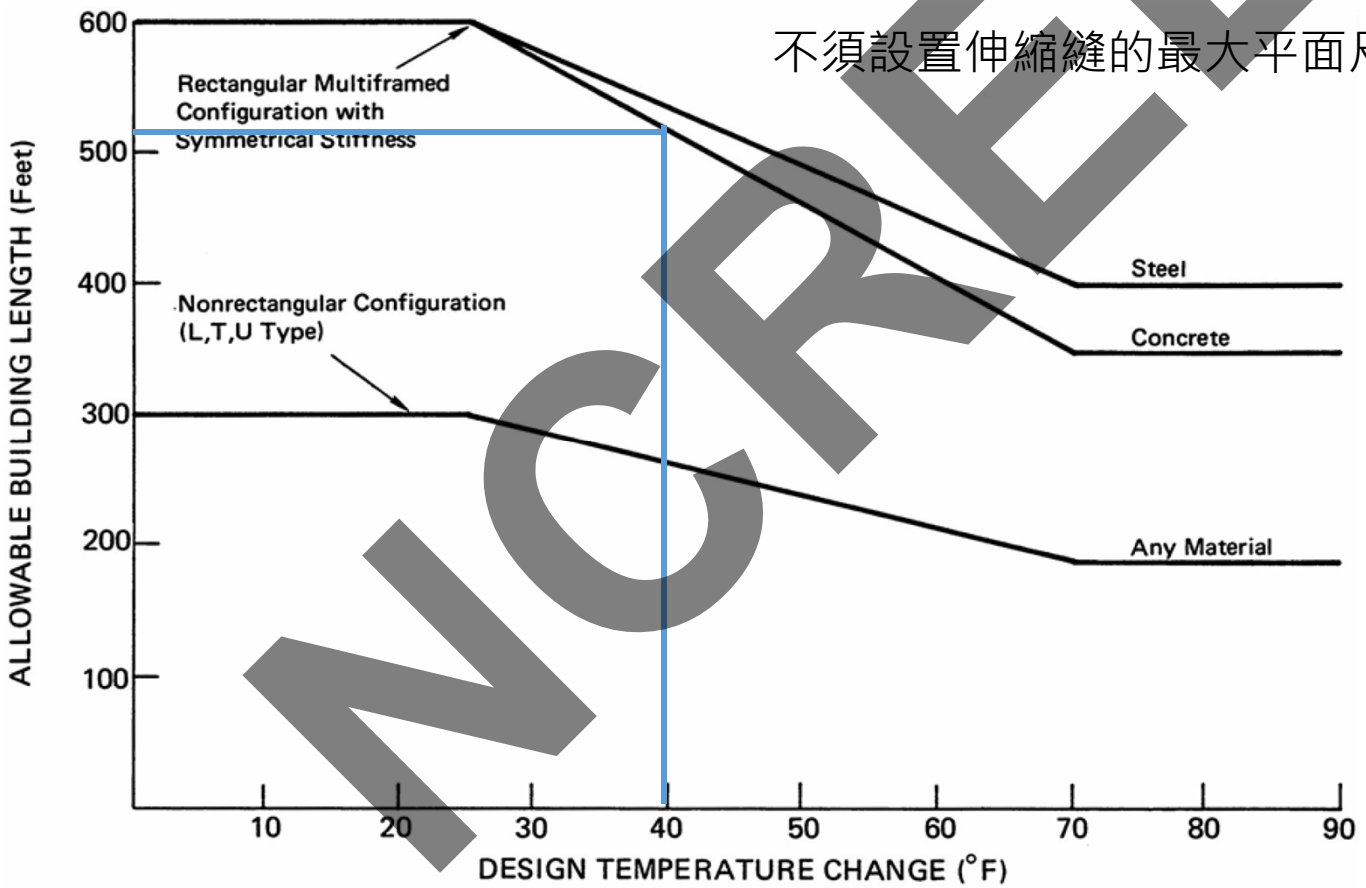
Phoenix溫差 ±39°F (±22°C)

Station	Temperature (°F)		
	T_w	T_m	T_c
Phoenix	108	70	31

Technical Report No.65 溫差效應-Phoenix

- 溫度力 (參考Expansion Joints in Buildings : Technical Report No.65)
  - 如不考慮溫度力，建築物長度不得超過520ft (159m)
  - Phoenix溫差 ±39°F (±22°C)

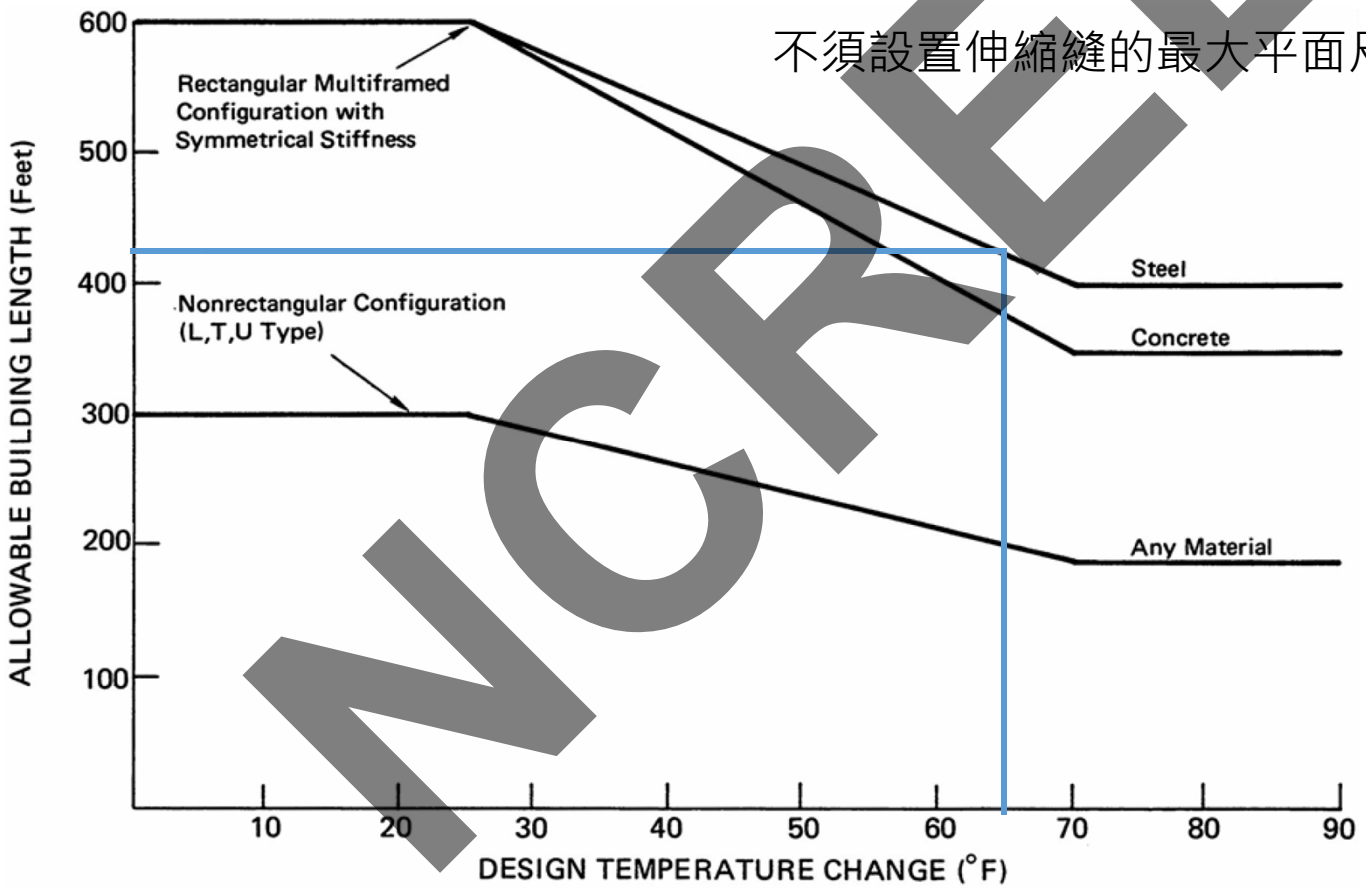
不須設置伸縮縫的最大平面尺度



Technical Report No.65 溫差效應 - Milwaukee

- 溫度力 (參考Expansion Joints in Buildings : Technical Report No.65)
  - 如不考慮溫度力，建築物長度不得超過435ft (133m)
  - Milwaukee溫差 ±66°F (±36°C)

不須設置伸縮縫的最大平面尺度



Technical Report No.65 溫差效應

- 採用Δt=+- 22.0°C溫度載種分析設計
- 屋頂的板,梁等會接觸到溫差效應的平面構件。
- 外牆的梁,柱,斜撐等會接觸到溫差效應的立面構件。

1. $1.4D$ +T
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$ +T
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$ +T
4. $1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$ +T
5. $0.9D + 1.0W$ +T

Station	Temperature (°F) T_w	T_m	T_c
Phoenix	108	70	31

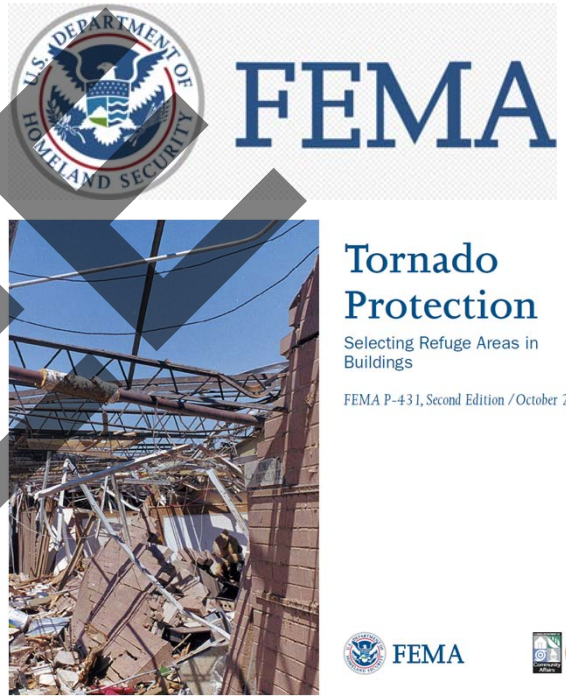
樓 板 溫 度 應 力 圖

Design Wind Load 符合規範及保險公司要求

聯邦緊急事務管理署 FEMA

為美國聯邦政府行政部門防災減災機構

負責緩解自然災害的影響。

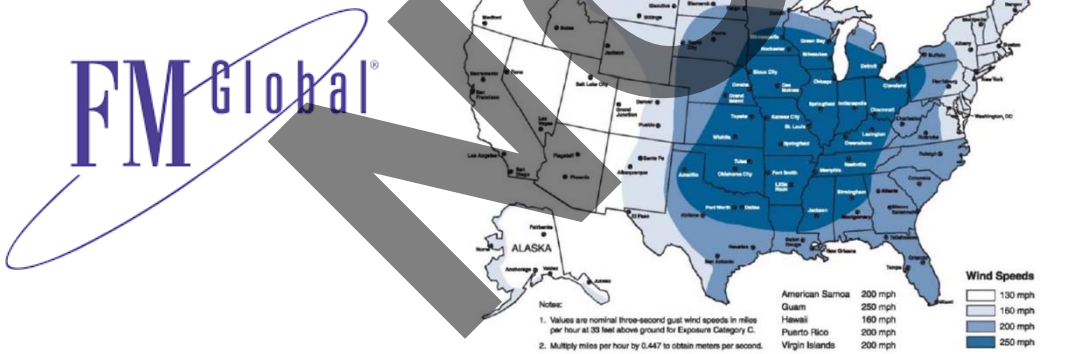


FM Global 保險公司

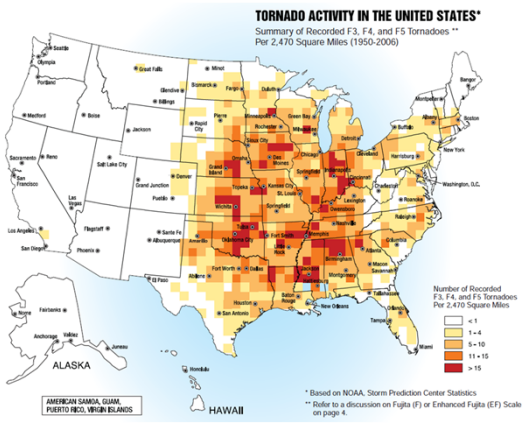
為工商業保險公司之一

通過其所屬的FM認證（FM Approvals）機構

向全球的工業及商業產品提供檢測及認證服務。



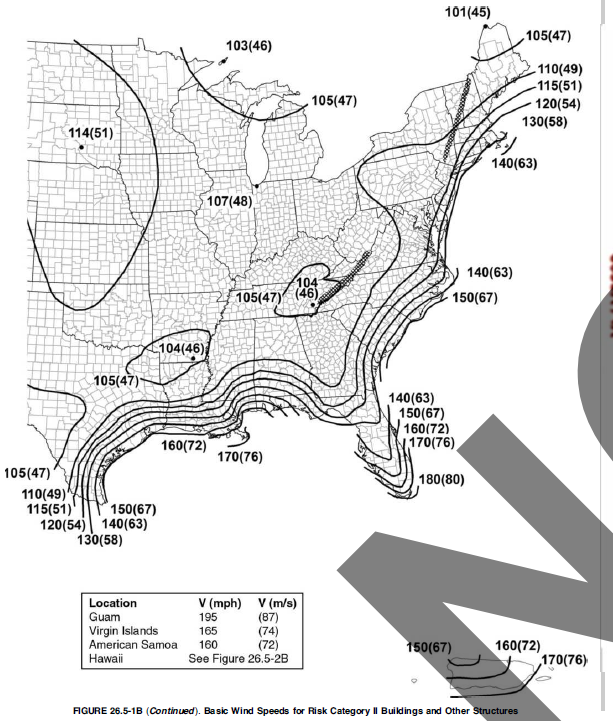
保險公司規定龍捲風避難所設計風速等級



龍捲風侵襲美國各州次數統計

Design Wind Load

1. ASEC 風力規定: 3 sec wind speed 3秒平均風速
2. 台灣風力規定: 10 mins wind speed 10分鐘內平均風速
3. 查詢ASCE規範內風速規定，再以等比例轉換為台灣規範風速
4. 設計風速仍須滿足FEMA及保險公司規定之風速

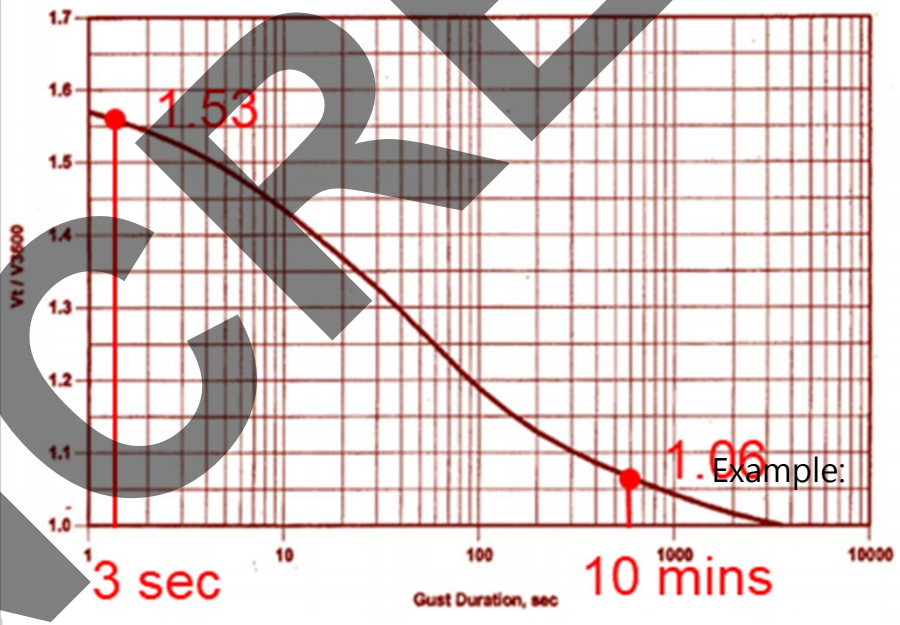


Location	V (mph)	V (m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii	See Figure 26.5-2B	

FIGURE 26.5-1B (*Continued*). Basic Wind Speeds for Risk Category II Buildings and Other Structures

依照規定之風險分級查圖表

設計風力換算之係數



Example:

$V_{3\text{-secs}}$=40 m/s

$V_{10\text{-mins}}=40 \times \frac{1.06}{1.53} = 27.7$ m/s

Design Wind Load

ASEC 7-16

26.7.2 Surface Roughness Categories. A ground surface roughness within each 45° sector shall be determined for a distance upwind of the site, as defined in Section 26.7.3, from the categories defined in the following text, for the purpose of assigning an exposure category as defined in Section 26.7.3.

Surface Roughness B: Urban and suburban areas, wooded areas, or other terrain with numerous, closely spaced obstructions that have the size of single-family dwellings or larger.

Surface Roughness C: Open terrain with scattered obstructions that have heights generally less than 30 ft (9.1 m). This category includes flat, open country and grasslands.

Surface Roughness D: Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats, and unbroken ice.

建築物耐風設計規範及解說

(1)地況 A： 大城市市中心區，至少有 50%之建築物高度大於 20 公尺者。建築物迎風向之前方至少 800 公尺或建築物高度 10 倍的範圍(兩者取大值)係屬此種條件下，才可使用地況 A。

(2)地況 B： 大城市市郊、小市鎮或有許多像民舍高度（10~20 公尺），或較民舍為高之障礙物分布其間之地區者。建築物迎風向之前方至少 500 公尺或建築物高度 10 倍的範圍（兩者取大值）係屬此種條件下，方可使用地況 B。

(3)地況 C： 平坦開闊之地面或草原或海岸或湖岸地區，其零星座落之障礙物高度小於 10 公尺者。

若附近地況為介於地況 A 與地況 B 間或地況 B 與地況 C 間之過渡地況，原則上應採用會產生較大風力之地況，但也可利用可信賴之合理分析法，決定此一過渡地況之風速垂直分布。

Risk Category of Buildings and Other Structures

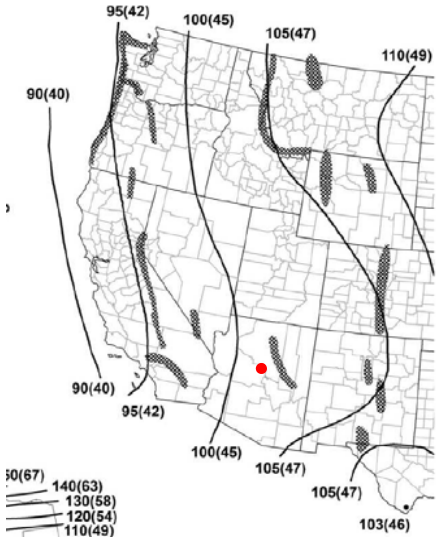
Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life	III
Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure	
Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures designated as essential facilities	IV

Table 1.5-2 Importance Factors by Risk Category of Buildings and Other Structures for Snow, Ice, and Earthquake Loads

Risk Category from Table 1.5-1	Snow Importance Factor, I_s	Ice Importance Factor—Thickness, I_i	Ice Importance Factor—Wind, I_w	Seismic Importance Factor, I_e
I	0.80	0.80	1.00	1.00
II	1.00	1.00	1.00	1.00
III	1.10	1.15	1.00	1.25
IV	1.20	1.25	1.00	1.50

Design Wind Load



ASCE 7-16

26.10.2 Velocity Pressure. Velocity pressure, q_z, evaluated at height z above ground shall be calculated by the following equation:

$$q_z = 0.613 K_z K_{zt} K_d K_e V^2 \ (\mathrm{N/m^2}); \ V \text{ in m/s} \qquad (26.10\text{-}1.\mathrm{si})$$

$$q(z) = 0.06 \ K(z) \ K_{zt} [I \ V_{10}(C)]^2$$

Taiwan

26.14 TORNADO LIMITATION

Tornadoes have not been considered in the wind load provisions.

		ASCE	ASCE	ICC500	ICC500
			Hurricane Threat	Tornado Shelter Design	Hurricane Shelter Design
$V_{3\text{-sec}}$	MPH	103	120	130	160
$V_{3\text{-sec}}$	m/s	46	54	58	72
V_{10}	m/s	31.9	37.2	40.3	49.5

- 保險公司規定Milwaukee的Ultimate Wind Speed不可低於150MPH

ICC/NSSA Standard for the Design and Construction of Storm Shelters

ASCE 7-16 Wind Load

2.3 LOAD COMBINATIONS FOR STRENGTH DESIGN

2.3.1 Basic Combinations. Structures, components, and foundations shall be designed so that their design strength equals or exceeds the effects of the factored loads in the following combinations. Effects of one or more loads not acting shall be considered. Seismic load effects shall be combined loads in accordance with Section 2.3.6. Wind and seismic loads need not be considered to act simultaneously. Refer to Sections 1.4, 2.3.6, 12.4, and 12.14.3 for the specific definition of the earthquake load effect E. Each relevant strength limit state shall be investigated.

1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
4. $1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $0.9D + 1.0W$

〔土木401-110〕

〔土木401-110〕

載重組合
$U = 1.4D$
$U = 1.2D + 1.6L + 0.5\ (L_r \text{ 或 } S \text{ 或 } R)$
$U = 1.2D + 1.6\ (L_r \text{ 或 } S \text{ 或 } R) + (1.0L \text{ 或 } 0.8W)$
$U = 1.2D + 1.6W + 1.0L + 0.5\ (L_r \text{ 或 } S \text{ 或 } R)$
$U = 1.2D + 1.0E + 1.0L + 0.2S$
$U = 0.9D + 1.6W$
$U = 0.9D + 1.0E$

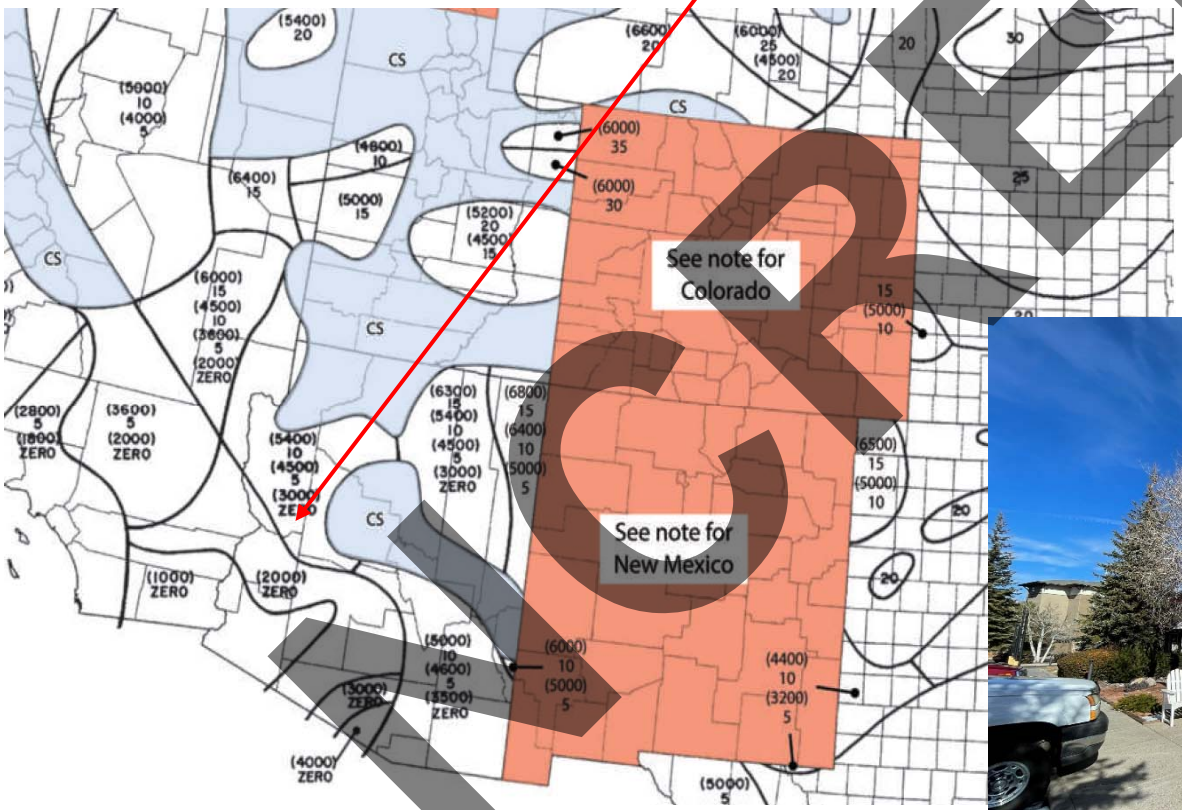
W=Wind Load

有關風力W載重因數，美國ACI 318規範自2011年起，配合ASCE/SEI 7將設計風力由服務載重等級(service-level) 改為強度載重等級 (strength-level)，因而將風力載重因數由過去之1.6與0.8分別降為1.0與0.5，惟本規範考量我國建築物耐風設計規範之風載重採用服務載重等級...

ASEC 7-16 Snow Load

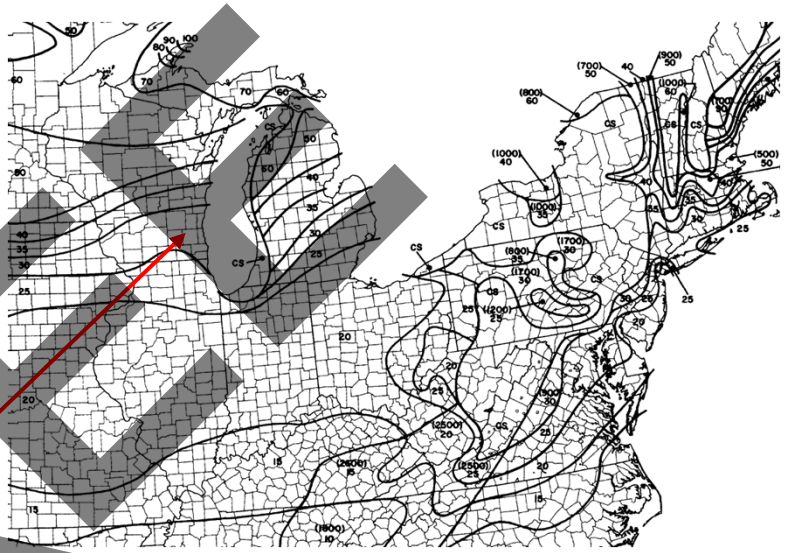
Elevation =1117ft
Ground Snow Load, P_g = 0 psf
Flat Snow Loads, P_f = 0 psf

海拔3000ft以下，Pg=0，
即不須考慮雪載重

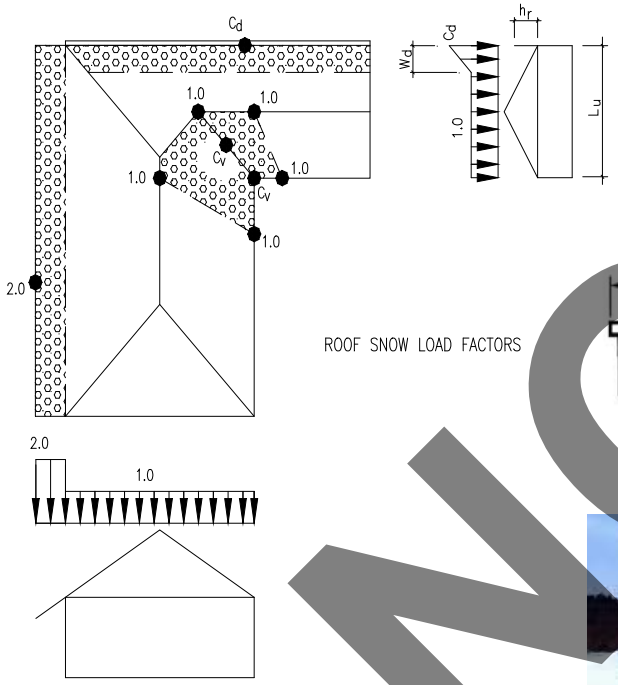


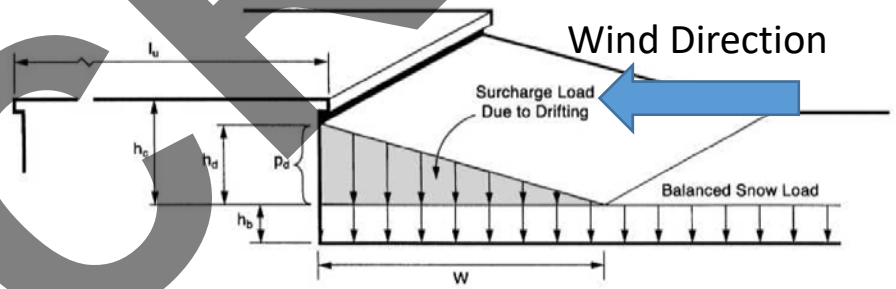
ASEC 7-16 Snow Load - Milwaukee

Elevation	= 617ft
Ground Snow Load, P_g	= 30 psf
Flat Snow Load, P_f	= 21 psf
Roof Design Snow Load	= 21 psf + Drifting snow

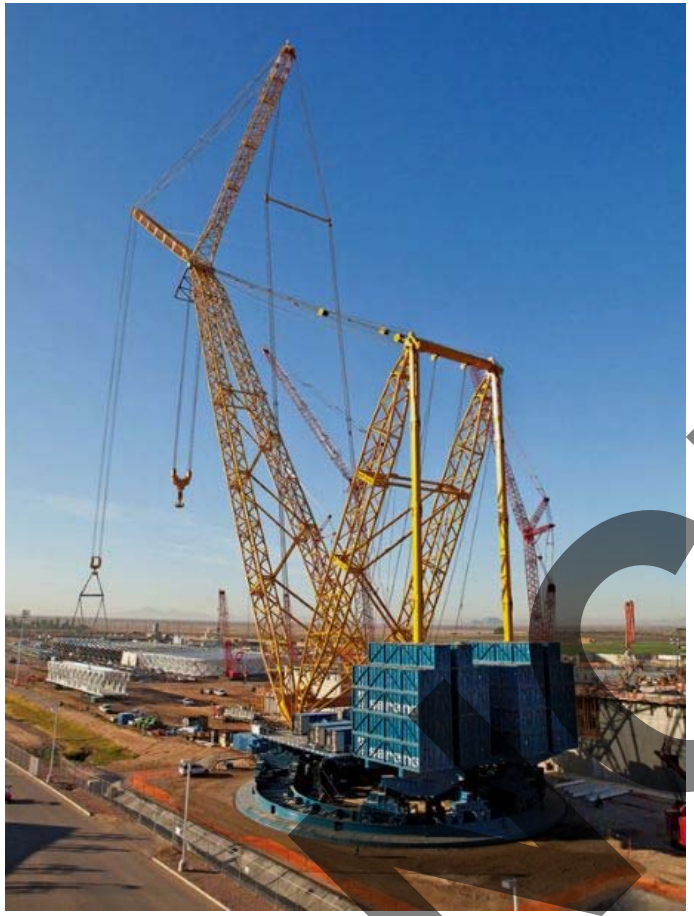


Milwaukee
Pg= 30 psf





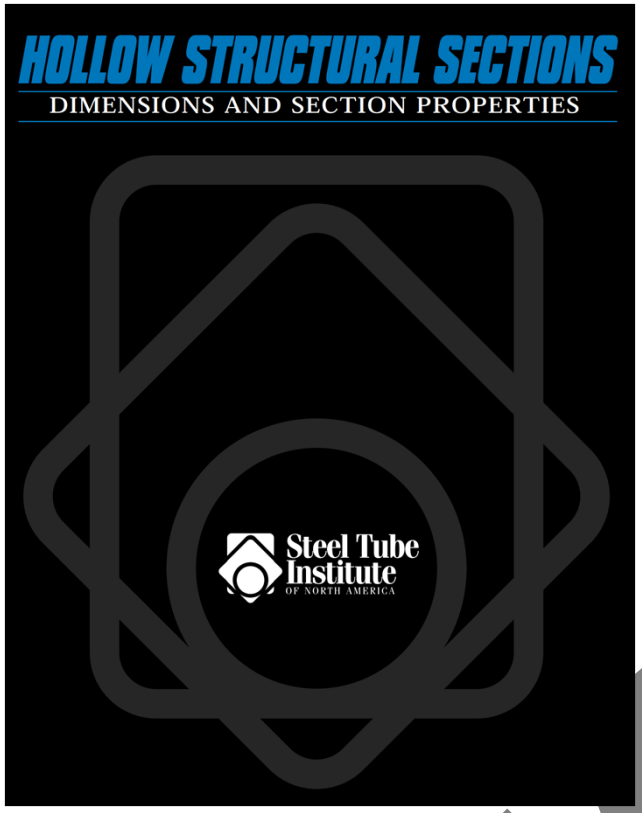
結構設計應採用當地孰悉的材料與工法



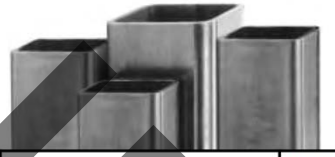
重型機具

工廠製程

型鋼-必須詢問當地設計工程師的常用斷面



DIMENSIONS AND SECTION PROPERTIES OF *SQUARE* HSS



Nominal Size			Weight per Foot	Wall Thickness t	b/t	h/t	Cross Sectional Area	I	S	r	Z	Torsional Stiffness Constant J	Torsional Shear Constant C	Surface Area Per Foot
in.	in.	in.	lb.	in.			in.^{2}	in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	ft.^{2}
32 x 32 x	5/8*		259.83	0.625	48.2	48.2	76.4	12300	771	12.7	890	19700	1230	10.34
	1/2*		210.72	0.500	61.0	61.0	61.9	10100	634	12.8	727	15900	991	10.45
	3/8*		159.37	0.375	82.3	82.3	46.8	7750	485	12.9	553	12000	750	10.51
30 x 30 x	5/8*		242.82	0.625	45.0	45.0	71.4	10100	673	11.9	778	16200	1070	9.68
	1/2*		197.11	0.500	57.0	57.0	57.9	8320	555	12.0	637	13000	869	9.79
	3/8*		149.16	0.375	77.0	77.0	43.8	6370	424	12.1	485	9870	658	9.84
28 x 28 x	5/8*		225.80	0.625	41.8	41.8	66.4	8140	582	11.1	674	13100	933	9.01
	1/2*		183.50	0.500	53.0	53.0	53.9	6730	480	11.2	552	10600	755	9.12
	3/8*		138.95	0.375	71.7	71.7	40.8	5150	368	11.2	421	8010	572	9.17
26 x 26 x	5/8*		208.79	0.625	38.6	38.6	61.4	6460	497	10.3	577	10500	801	8.34
	1/2*		169.89	0.500	49.0	49.0	49.9	5350	411	10.4	474	8430	649	8.45
	3/8*		128.74	0.375	66.3	66.3	37.8	4110	316	10.4	362	6400	492	8.51
24 x 24 x	5/8*		191.78	0.625	35.4	35.4	56.4	5030	419	9.44	487	8180	679	7.68
	1/2*		156.28	0.500	45.0	45.0	45.9	4170	348	9.53	401	6610	551	7.79
	3/8*		118.53	0.375	61.0	61.0	34.8	3210	268	9.60	307	5020	418	7.84
22 x 22 x	5/8*		174.76	0.625	32.2	32.2	51.4	3820	347	8.62	406	6260	567	7.01
	1/2*		142.67	0.500	41.0	41.0	41.9	3190	290	8.72	335	5070	461	7.12
	3/8*		108.32	0.375	55.7	55.7	31.8	2460	223	8.78	256	3850	350	7.17
20 x 20 x	5/8*		157.75	0.625	29.0	29.0	46.4	2830	283	7.81	331	4670	465	6.34
	1/2*		129.06	0.500	37.0	37.0	37.9	2370	237	7.90	275	3790	379	6.45
	3/8*		98.12	0.375	50.3	50.3	28.8	1830	183	7.97	211	2880	288	6.51
18 x 18 x	5/8*		140.73	0.625	25.8	25.8	41.4	2020	224	6.99	264	3370	373	5.68
	1/2*		115.45	0.500	33.0	33.0	33.9	1700	189	7.08	220	2740	305	5.79
	3/8*		87.91	0.375	45.0	45.0	25.8	1320	147	7.15	169	2090	232	5.84
16 x 16 x	5/8		127.37	0.581	24.5	24.5	35.0	1370	171	6.25	200	2170	276	5.17
	1/2		103.30	0.465	31.4	31.4	28.3	1130	141	6.31	164	1770	224	5.20
	3/8		78.52	0.349	42.8	42.8	21.5	873	109	6.37	126	1350	171	5.23
	5/16		65.87	0.291	52.0	52.0	18.1	739	92.3	6.39	106	1140	144	5.25

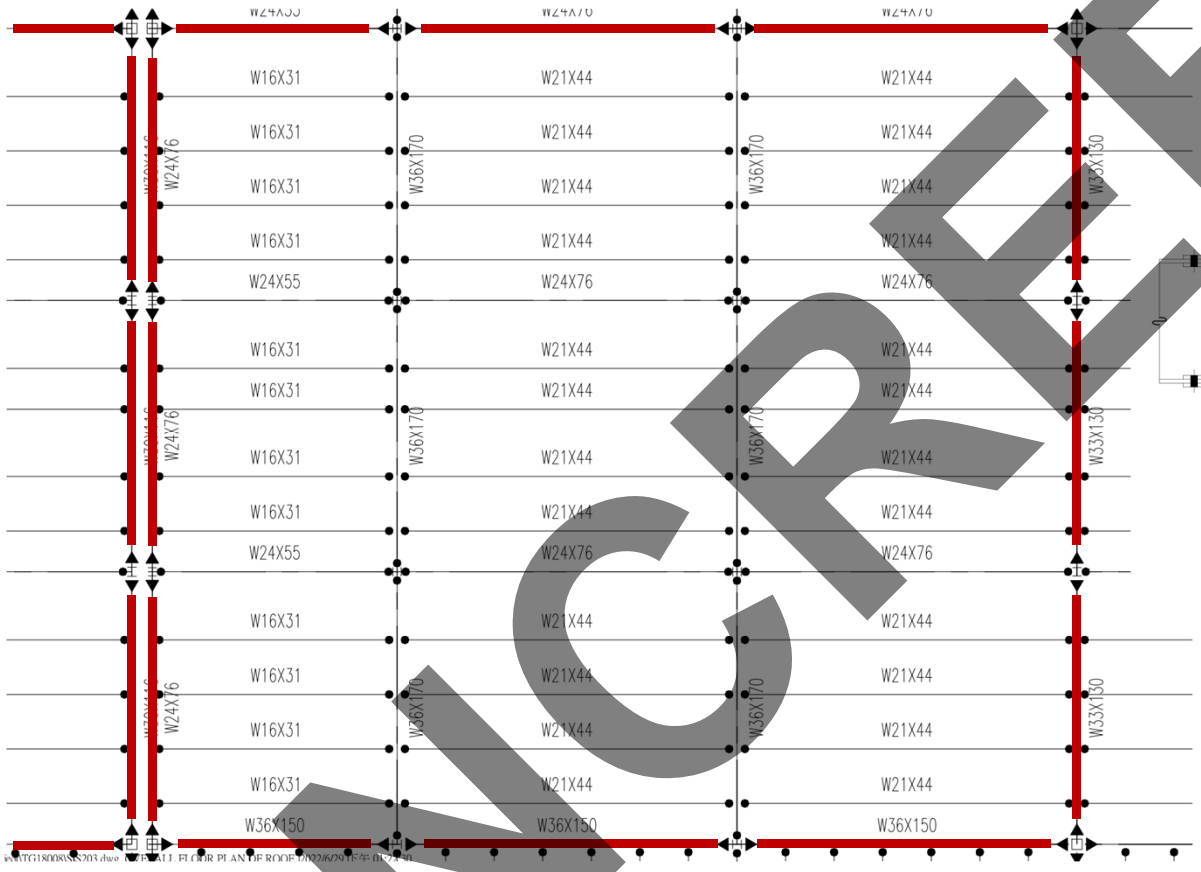
* This size produced by the submerged arc weld (SAW) process

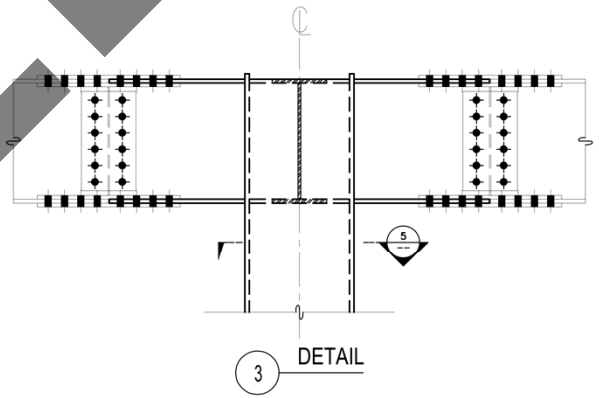
Week Beginning		3-Mar	10-Mar	17-Mar	24-Mar	31-Mar	7-Apr	14-Apr	21-Apr	
NYS Fiscal Week		10	11	12	13	14	15	16	17	
Wide Flange Sections	Mill #									Projected next roll week
W44x16x230-335	2							Shutdown		4/28-5/5 Wks
W40x16x199-593	2	10 C						Shutdown		4/28-5/5 Wks
W40x12x149-327	2	10 C			13 I 3/11			Shutdown		4/28-5/5 Wks
W36x17x487-529	2	10 C						Shutdown		5/5-5/12 Wks
W36x16.5x231-441	2	10 C						Shutdown		5/5-5/12 Wks
W36x12x135-256	2	10 C			13 I 3/11	13 I 3/11		Shutdown		5/5-5/12 Wks
W33x15.75x201-387	2	10 C	10 C					Shutdown		5/5-5/12 Wks
W33x11.5x118-169	2		10 C		>>>>	13 I 3/11		Shutdown		5/5-5/12 Wks
W30x15x173-391	2		10 C					Shutdown		5/5-5/12 Wks
W30x10.5x90-148	2		10 C		>>>>	13 I 3/18		Shutdown		5/5-5/12 Wks

生產排程

結構系統建議

減少抗彎構架數量

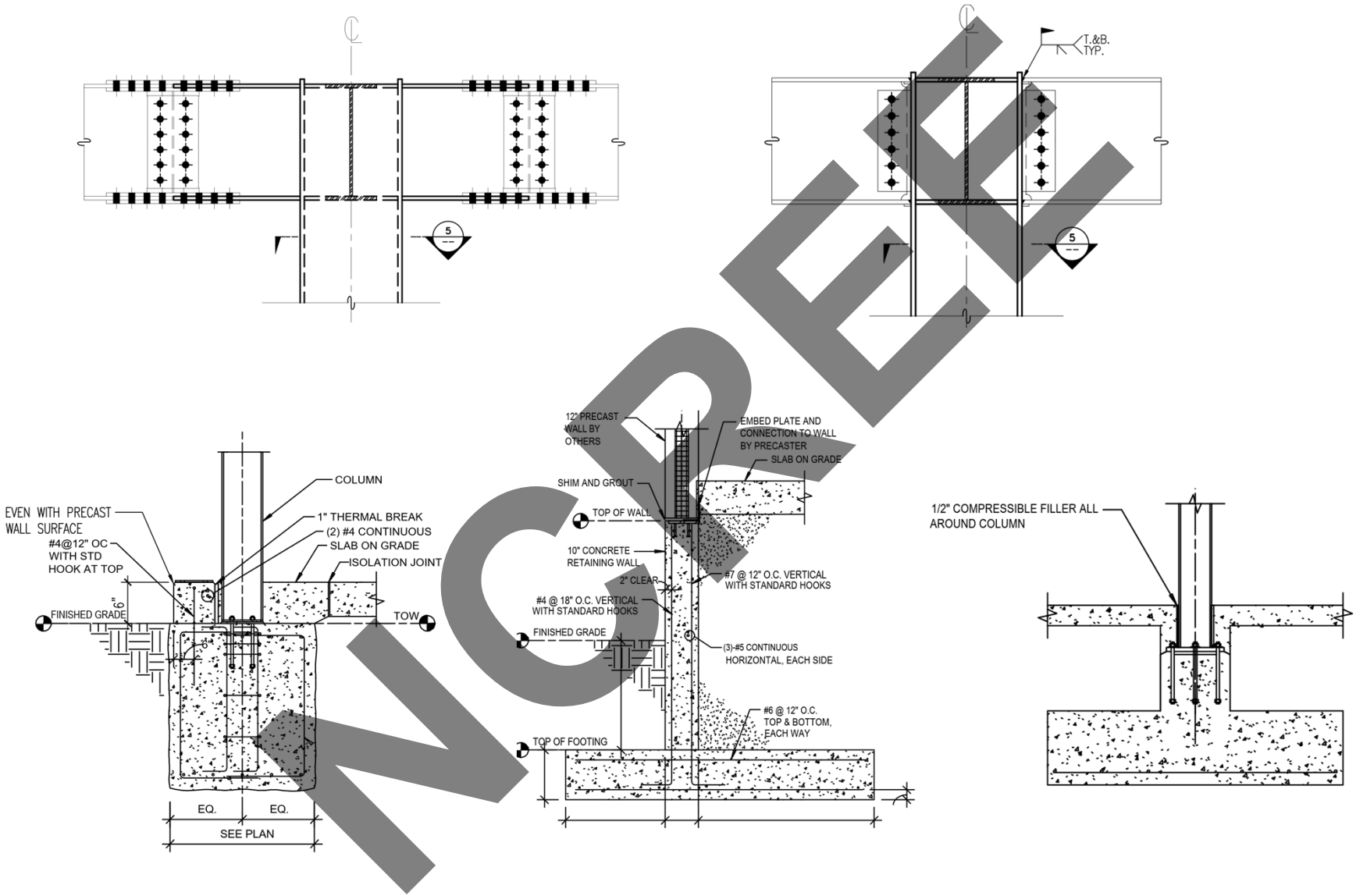




大樑抗彎接頭採用栓接

包含:結構系統,基礎形式,主要構件尺寸,材料規格,基本大樣。

基本設計圖面(基本大樣建議)

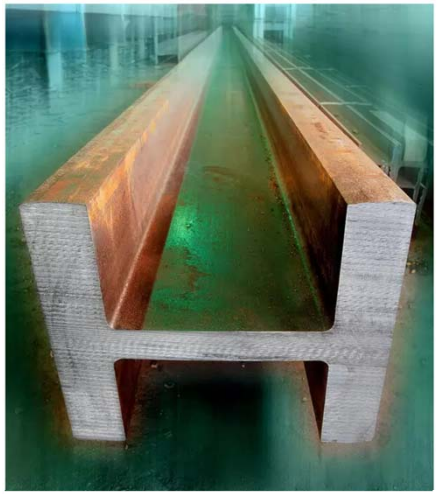


RC預鑄工法

細部接合設計的挑戰
Connection Details

Box Column

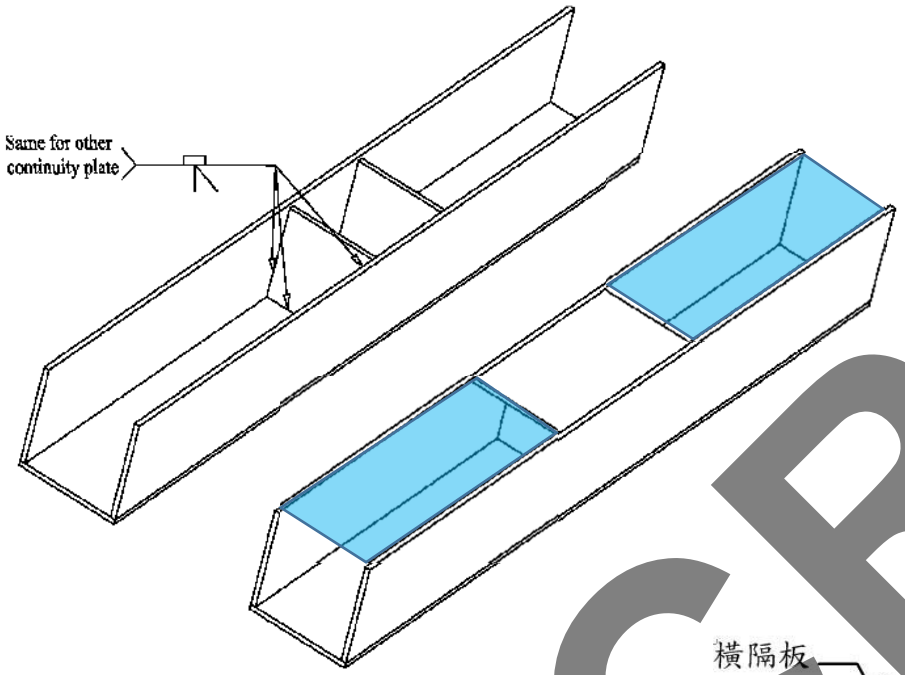
Super Jumbo WF / Weld Box Column



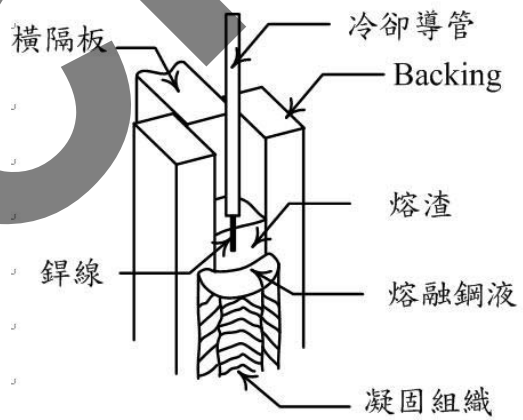
Designation				Dimensions											Steel Grade	
American		European	British	G		h		b		t_w		t_f		r	A572/A709/A992 EN 10025-2/-4	A913/ HISTAR ETA 10/0156
W (imperial)	W (metric)	HD / HL	UB / UC	lbs/ft	kg/m	in.	mm	in.	mm	in.	mm	in.	mm	mm		
W 14 x 16 x 398	W 360 x 410 x 592	HD 400 x 592	UC 356 x 406 x 592	398	592	18.29	465	16.590	421	1.770	45.0	2.845	72.3	15	✓	✓
W 14 x 16 x 426	W 360 x 410 x 634	HD 400 x 634		426	634	18.67	474	16.695	424	1.875	47.6	3.035	77.1	15	✓	✓
			UC 356 x 406 x 634		633.9		474.6		424.0		47.6		77.0	15.2	✓	✓
W 14 x 16 x 455	W 360 x 410 x 677	HD 400 x 677	UC 356 x 406 x 677	455	677	19.02	483	16.835	428	2.015	51.2	3.210	81.5	15	✓	✓
W 14 x 16 x 500	W 360 x 410 x 744	HD 400 x 744	UC 356 x 406 x 744	500	744	19.60	498	17.010	432	2.190	55.6	3.500	88.9	15	✓	✓
W 14 x 16 x 550	W 360 x 410 x 818	HD 400 x 818	UC 356 x 406 x 818	550	818	20.24	514	17.200	437	2.380	60.5	3.820	97.0	15	✓	✓
W 14 x 16 x 605	W 360 x 410 x 900	HD 400 x 900	UC 356 x 406 x 900	605	900	20.92	531	17.415	442	2.595	65.9	4.160	106	15	✓	✓
W 14 x 16 x 665	W 360 x 410 x 990	HD 400 x 990	UC 356 x 406 x 990	665	990	21.64	550	17.650	448	2.830	71.9	4.520	115	15	✓	✓
W 14 x 16 x 730	W 360 x 410 x 1086	HD 400 x 1086	UC 356 x 406 x 1086	730	1086	22.42	569	17.890	454	3.070	78.0	4.910	125	15	✓	✓
W 14 x 16 x 808	W 360 x 410 x 1202	HD 400 x 1202	UC 356 x 406 x 1202	808	1202	22.84	580	18.560	471	3.740	95.0	5.120	130	15	✓	✓
W 14 x 16 x 873	W 360 x 410 x 1299	HD 400 x 1299	UC 356 x 406 x 1299	873	1299	23.62	600	18.755	476	3.935	100	5.510	140	15	✓	✓

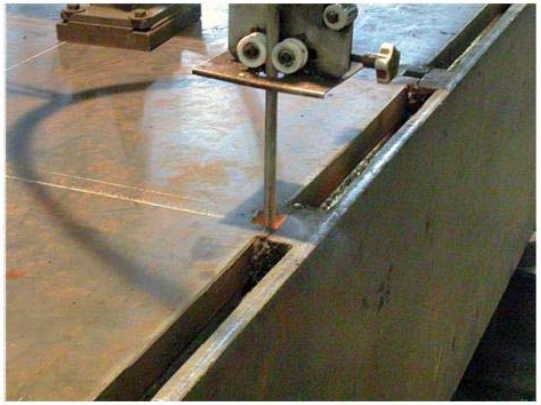
Welded Box Column in US & Taiwan

US



Taiwan





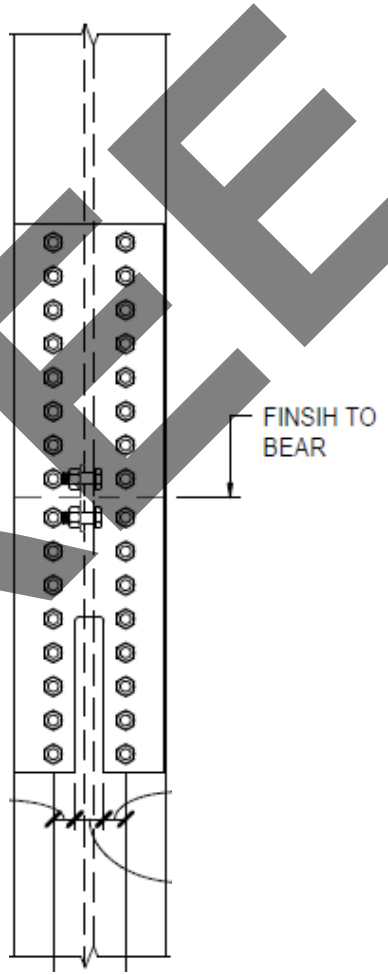
電熱熔渣銲

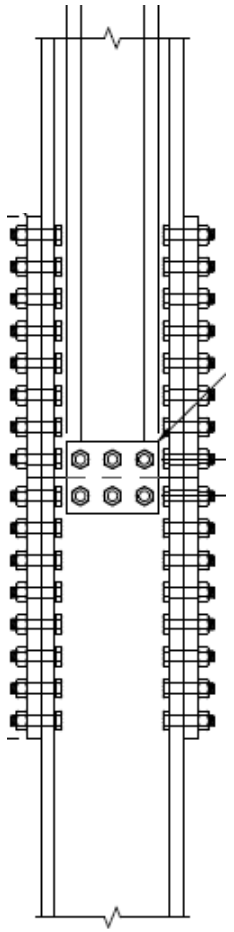
http://www.twce.org.tw/modules/freecontent/include.php?fname=twce/paper/741/3-1.htm

Super Jumbo WF Column Splice

11. Consider finishing to bear.

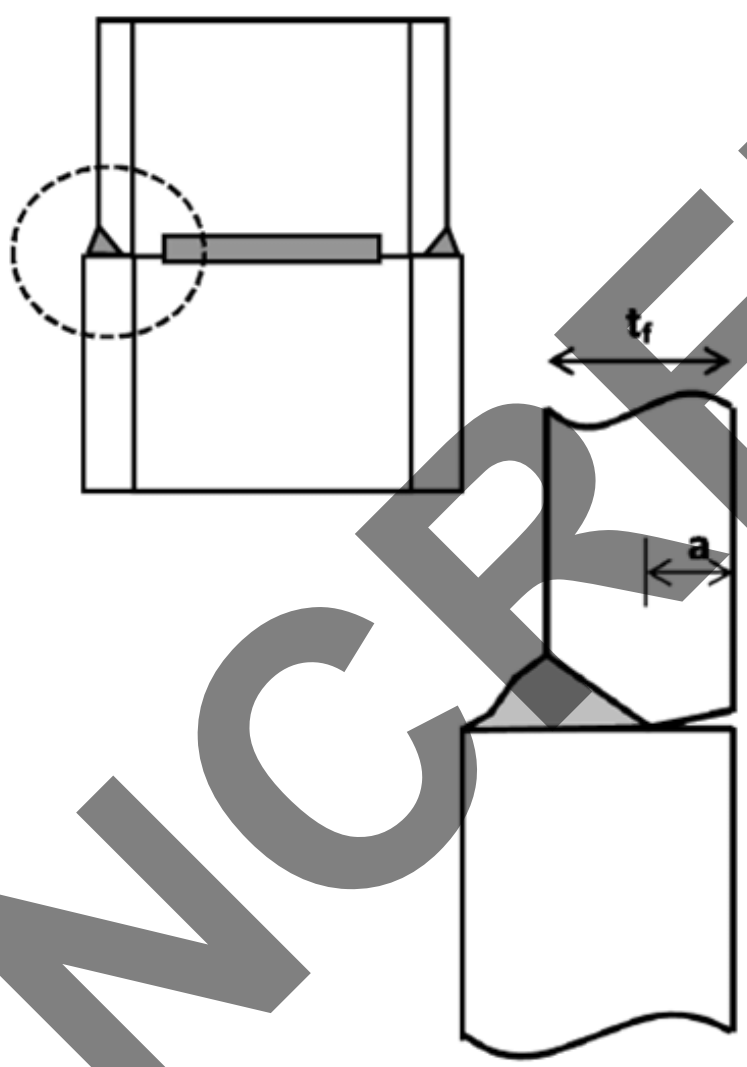
For connections with high compressive loads, it could be more economical to finish the steel to bear and provide AISC's minimum-required weld size instead of transferring the compressive force through large fillet or groove welds. When steel is to be finished to bear, it must be indicated on the connection detail. The detail also should call for the beam flanges to be square to the beam web. In detailing, stiffeners might need to be longer than d-$2t_f$ for beam overrun in depth and variation in beam-flange thickness. Per AISC *Specification* Section M, gaps not exceeding $^1/_{16}$" are permitted in bearing connections.





https://www.aisc.org/globalassets/modern-steel/archives/2004/05/2004v05_good_rules.pdf

PJP Details



https://www.researchgate.net/figure/Typical-column-splice-weld-detail-and-geometry-extracted-from-Stillmaker-et-al-2016_fig22_328571852

Finish to bear

AISC 360-16
M2. FABRICATION

6. Compression Joints

Compression joints that depend on contact bearing as part of the splice strength shall have the bearing surfaces of individual fabricated pieces prepared by milling, sawing or other equivalent means.

7. Dimensional Tolerances

Dimensional tolerances shall be in accordance with Chapter 6 of the AISC *Code of Standard Practice for Steel Buildings and Bridges*, hereafter referred to as the *Code of Standard Practice*.

Finish to bear

AISC Code of Standard Practice

6.2.2. Surfaces that are specified as "finished" in the *contract documents* shall have a roughness height value measured in accordance with ASME B46.1 that is equal to or less than 500 μin. (12.7 μm). The use of any fabricating technique that produces such a finish is permitted.

Commentary:
Most cutting processes, including friction sawing and cold sawing, and milling processes meet a surface roughness limitation of 500 μin. (12.7 μm) per ASME B46.1.

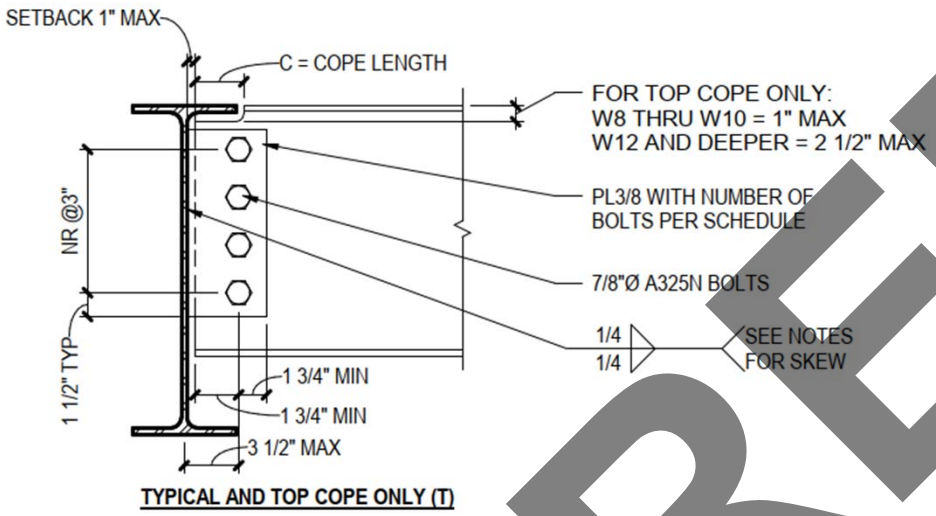
6.4.1. For members that have both ends finished (see Section 6.2.2) for contact bearing, the variation in the overall length shall be equal to or less than $^{1}/_{32}$ in. (1 mm). For other members that frame to other *structural steel* elements, the variation in the detailed length shall be as follows:

For members that are equal to or less than 30 ft (9 000 mm) in length, the variation shall be equal to or less than $^{1}/_{16}$ in. (2 mm).

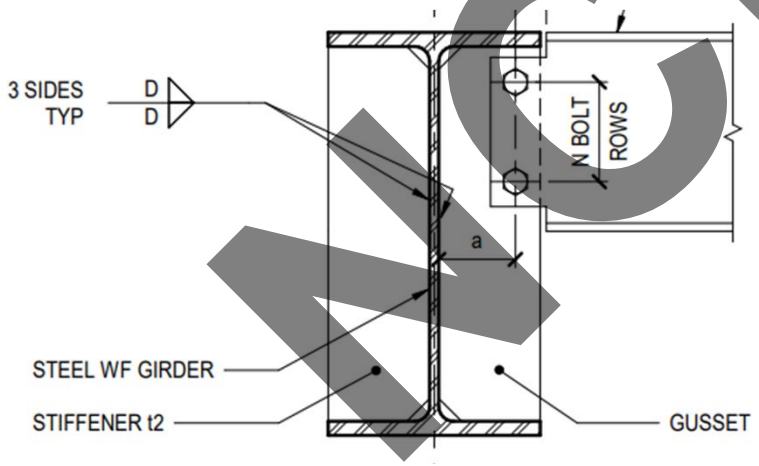
For members that are greater than 30 ft (9 000 mm) in length, the variation shall be equal to or less than $^{1}/_{8}$ in. (3 mm).

Steel Beam Shear Connection

Beam Shear Connection Design



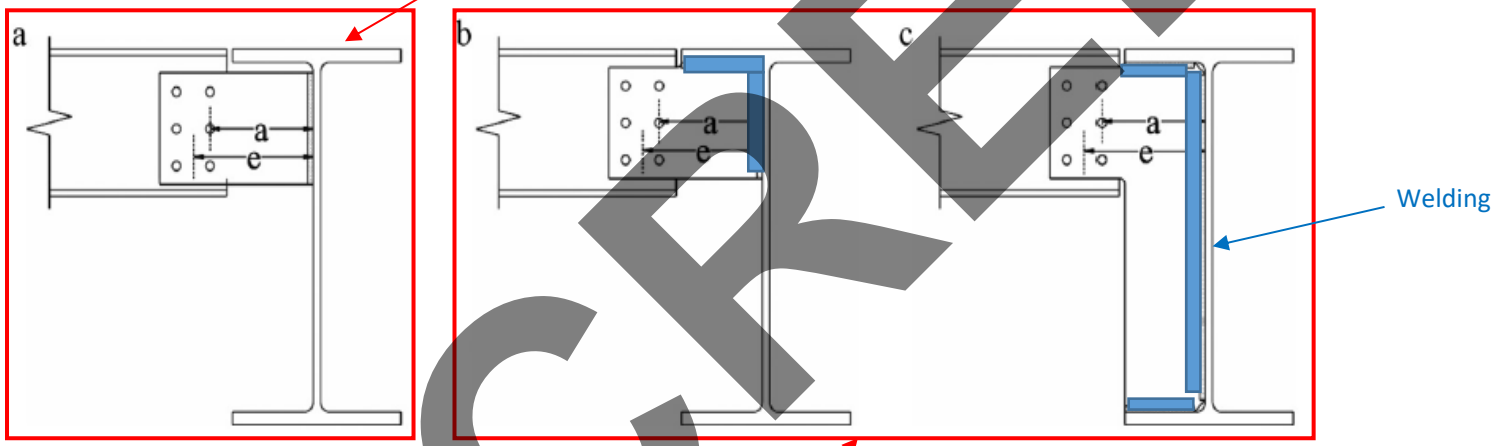
TYPICAL AND TOP COPE ONLY (T)



Beam Shear Connection Design

"Behavior of Stiffened Extended Shear Tab Connections under Gravity Induced Shear Force", *Journal of Constructional Steel Research*, Vol. 148, pp. 336-350

"The AISC design method was originally developed for unstiffened extended shear tabs connected to rigid supports"



. Extended beam-to-girder shear tab connections: (a) partial-depth unstiffened, (b) partial-depth stiffened, (c) full-depth stiffened.

"The AISC design method was not originally developed for use with the partial-depth or full-depth stiffened extended shear tab. The shear tab in this case, may impose higher rotational demands to the supporting member (girder or column), which are typically not considered in frame analysis."

Beam Shear Connection Design

EXAMPLE II.A-25 ECCENTRICALLY LOADED BOLT GROUP (ELASTIC METHOD)

Given:

Determine the largest eccentric force that can be supported by the available shear strength of the bolts using the elastic method for θ = 0°, as shown in Figure II.A-25-1. Compare the result with that of Example II.A-24. Assume that bolt shear controls over bearing and tearout.

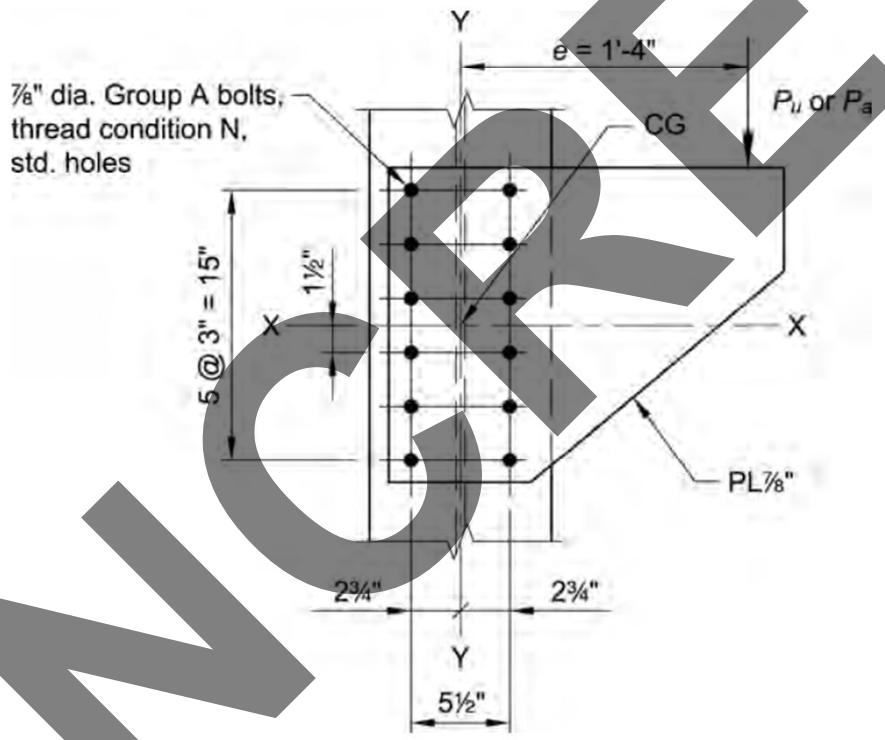


Fig. II.A-25-1. Connection geometry for Example II.A-25.

Solution:

Beam Shear Connection Design

Beam Strength Checks

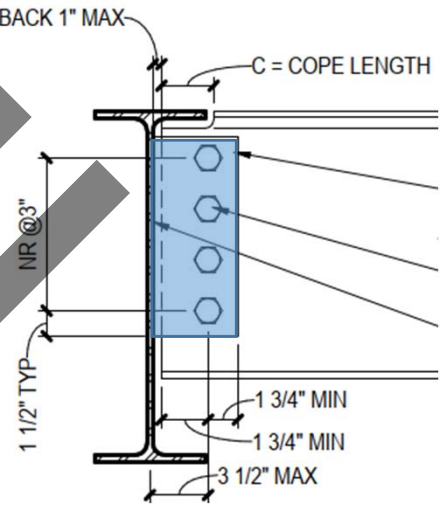
1. Block Shear Check
2. Bolt Bearing Check

Bolt Capacity Checks

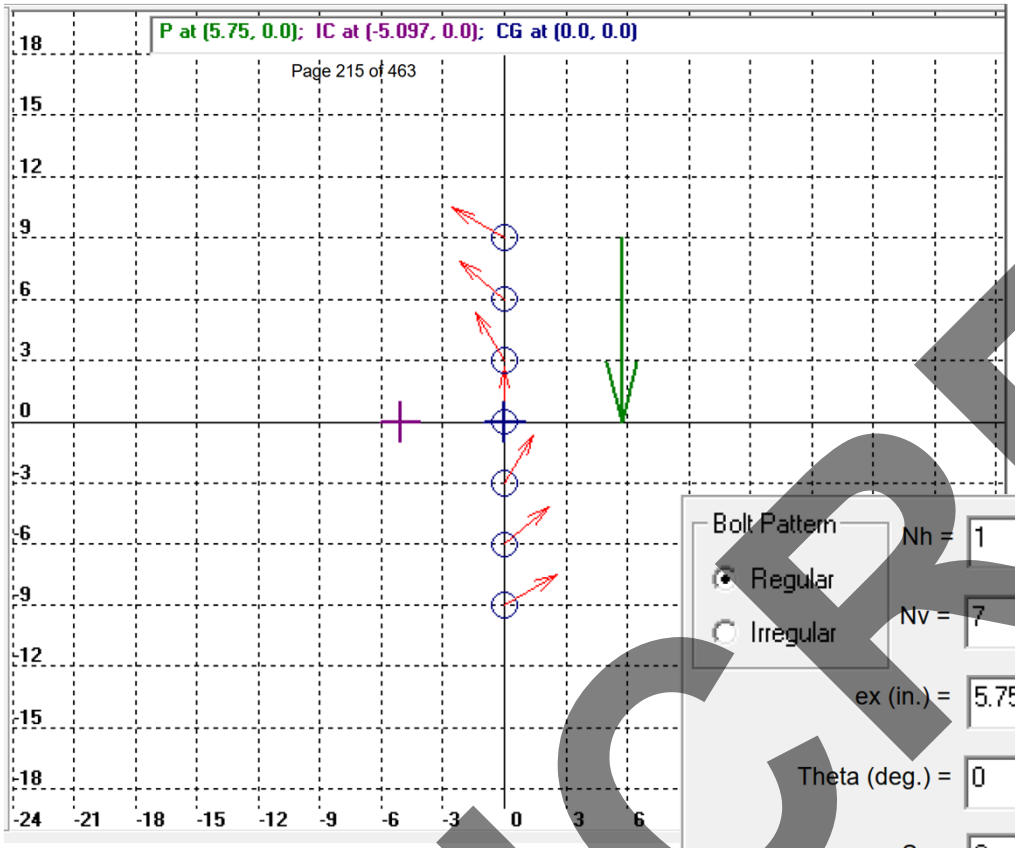
1. Bolt Shear Capacity

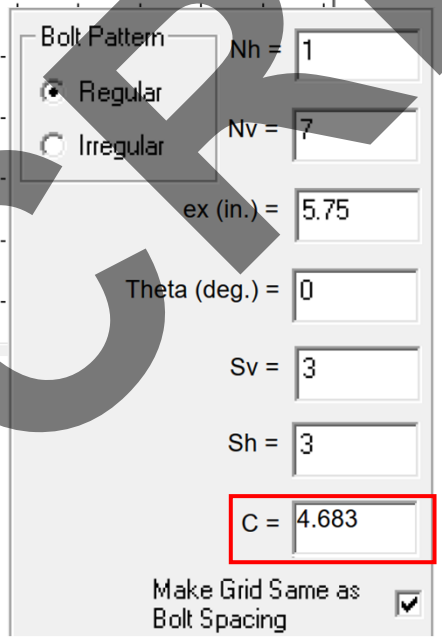
Shear Plate Design Checks

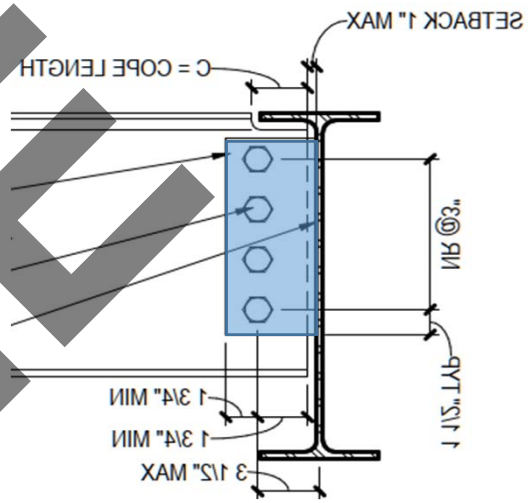
1. Shear Yielding (AISC Eq. J4-3)
2. Shear Rupture (AISC Eq. J4-4)
3. Bolt Bearing in Plate (AISC Eq. J3-6a)
4. Flexural Yielding (AISC Eq. F2-1)
5. Flexural Rupture (AISC § 9, pg 6)
6. Flexural Buckling (AISC § 9, pgs 6-9)
7. Block Shear for Shear Load (AISC Eq. J4-5)
8. Stress Interaction Checks on Plate Block Shear Planes - Von Mises (AISC § 9, pg 3-4)
9. Plate Thickness Ductility Check (AISC § 10, pg 103)



Beam Shear Connection Design



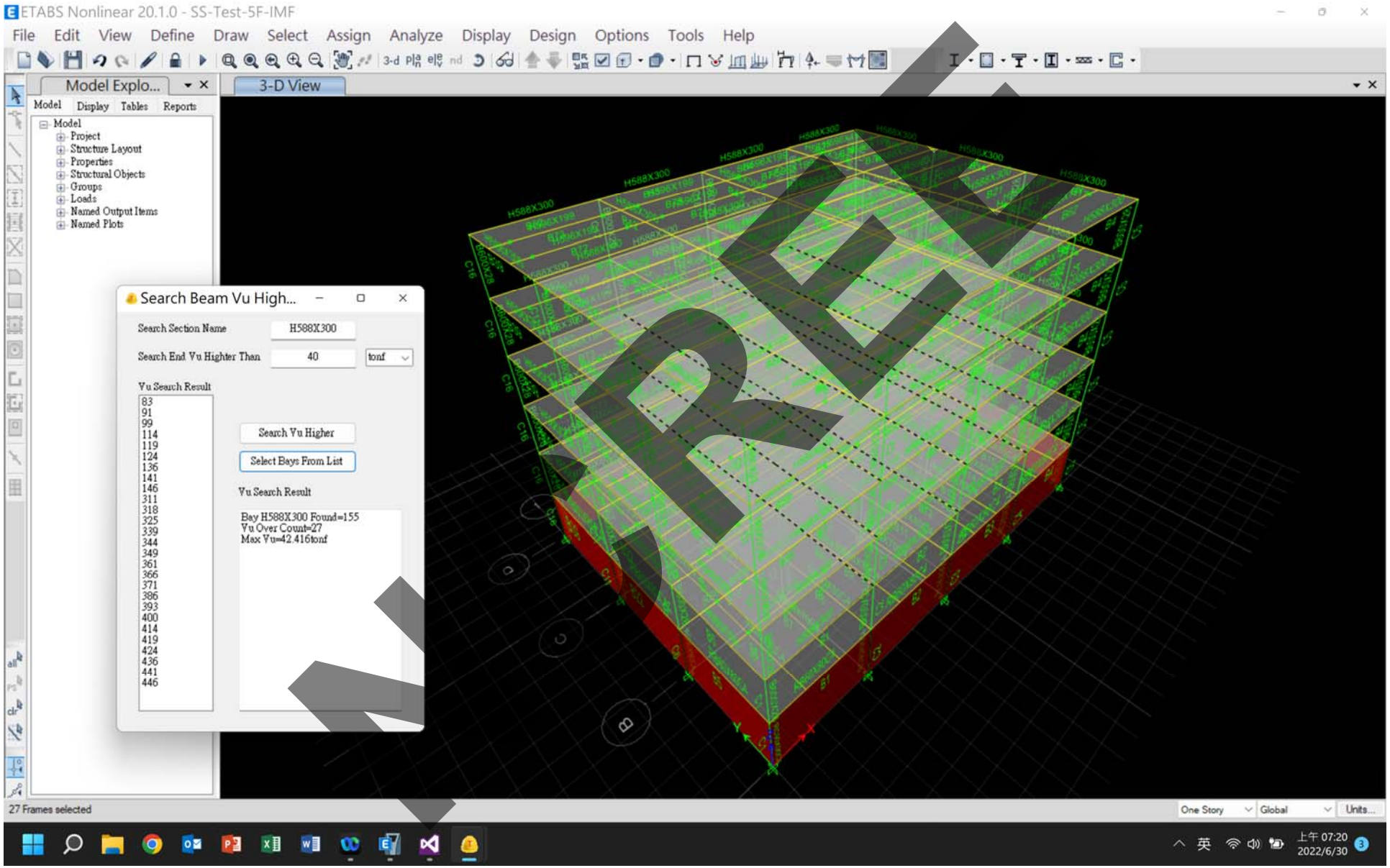




Bolt Data

No. of bolt rows =	7	
No. of bolt cols =	1	
Bolt Group, C =	4.683	
Bolt Dia. =	0.75	in.
Bolt Type:	A325	N
Hole Type:	SSLT	
Hole Dia,vert =	0.875	in.
Hole Dia,horiz =	1.0625	in.
S,vert =	3	in.
S,horiz =	3	in.
Lev =	1.5	in.
Leh =	1.5	in.

ETABS V20 API Programming



Steel Brace Connection

BRB接合設計

挫屈束制支撐與接合設計
雲端運算流程解說

(Server: S13090101 / Client: C13090101)

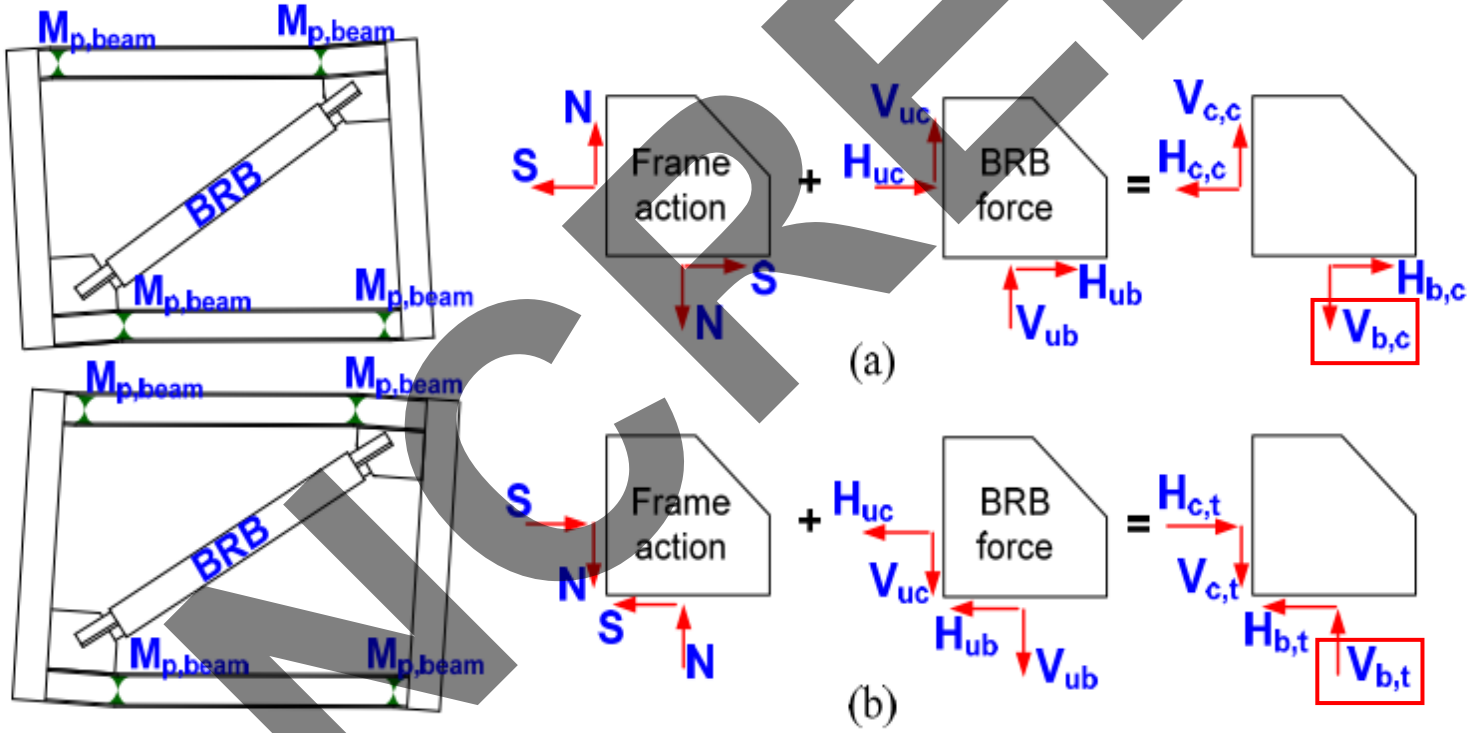


圖 6 梁柱角隅隅板受斜撐軸力與梁柱開合效應受力情形(a) 斜撐受壓梁柱接合處張開，與(b)斜撐受拉時梁柱接合處閉合

BRB接合設計

3. Web Local Crippling

This section applies to compressive *single-concentrated forces* or the compressive component of *double-concentrated forces*.

The *available strength* for the *limit state* of *web local crippling* shall be determined as follows:

$$\phi = 0.75 \text{ (LRFD)} \qquad \Omega = 2.00 \text{ (ASD)}$$

The *nominal strength*, R_n, shall be determined as follows:

(a) When the concentrated compressive *force* to be resisted is applied at a distance from the member end that is greater than or equal to $d/2$:

$$R_n = 0.80 t_w^2 \left[1 + 3\left(\frac{l_b}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}} \qquad \text{(J10-4)}$$

(b) When the concentrated compressive force to be resisted is applied at a distance from the member end that is less than $d/2$:

(i) For $l_b/d \le 0.2$

$$R_n = 0.40 t_w^2 \left[1 + 3\left(\frac{l_b}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}} \qquad \text{(J10-5a)}$$

(ii) For $l_b/d > 0.2$

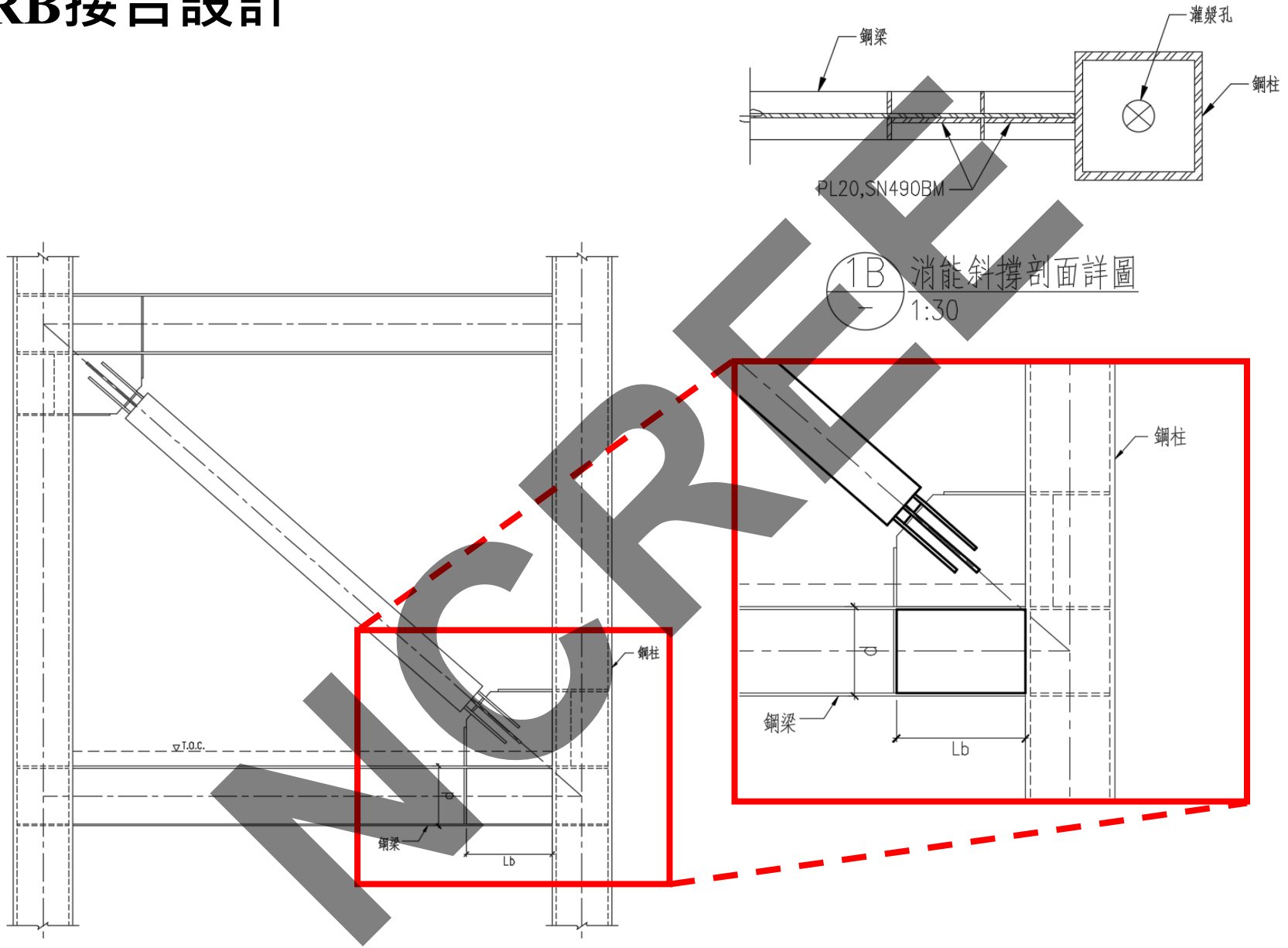
$$R_n = 0.40 t_w^2 \left[1 + \left(\frac{4l_b}{d} - 0.2\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}} \qquad \text{(J10-5b)}$$

where

d = full nominal depth of the section, in. (mm)

When required, a *transverse stiffener*, a pair of transverse stiffeners, or a *doubler* plate extending at least one-half the depth of the web shall be provided.

BRB接合設計



小結

1. 注意法律訴訟風險。
2. 設計需求與規範版本應儘快與簽證技師討論定案。
3. SD階段工作完成後進行設計成果交接。
4. 強烈建議有專業法定責任的工作，必須交由美國當地的團隊執行。
5. 採用當地容易取得的建材。
6. 採用當地熟悉的工法。
7. 美國擅長大型重機械與工廠預製施工。

祝福各位工作順利，身體健康，家庭和樂