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EQ Response Spectra in Direction X, Y, Z

Peak Ground Acceleration (Horizontal), PGA(g) | Spectral Acceleration (Horizontal) S_S(g), S_1(g)

*Note that **PGA(g)**, **S_S(g)**, **S_1(g)** define the site seismic hazard at the **design** level.*

Factor for EQ in ULS load combos for superstructure ULS design	1.00	
Factor for EQ in SLS load combos for superstructure deflection design	1.00	
Factor for EQ in ULS load combos for foundation ULS design	1.00	
Factor for EQ in SLS load combos for foundation SLS design	0.70	

Location: UBC97 Zone 4, World [UBC97-1997]

Alternate return period, T	475	years	Lubkowski, 20
Ref. PGA, a_{gR}(g) | PGA, PGA(g) | Zone factor, Z(g) | Hazard factor	0.400	g m/s^2	cl.208.4.4.1
Ref. return period, T_R — $\frac{a_g}{a_{gR}} = \left(\frac{T}{T_R}\right)^k$	475	years	
Exponent, k	0.30		Lubkowski, 20

475 Year PGA	0.05g	0.10g	0.20g	0.30g	0.40g
k	0.45	0.435	0.40	0.35	0.30

Multiplier for alternate return period, $(T/T_R)^k$	1.00		
Alternate return period, T	475	years	Lubkowski, 20
Spectral response acceleration at 0.2s, S_S(g)	0.922	g m/s^2	ASCE7 | cl.6.1
Ref. return period, T_R — $\frac{a_g}{a_{gR}} = \left(\frac{T}{T_R}\right)^k$ — $S_S/PGA = 0.3386\ PGA + 2.1696$	475	years	
Exponent, k	0.35		Lubkowski, 20

475 Year S_S	0.20g	0.55g	0.90g	1.20g	1.50g
k	0.46	0.42	0.39	0.35	0.30

Multiplier for alternate return period, $(T/T_R)^k$	1.00		
Spectral response acceleration at 1.0s, S_1(g)	0.331	g m/s^2	ASCE7 | cl.6.1
Ref. return period, T_R — $\frac{a_g}{a_{gR}} = \left(\frac{T}{T_R}\right)^k$ — $S_1/PGA = 0.5776\ PGA + 0.5967$	475	years	
Exponent, k	0.40		Lubkowski, 20

475 Year S_1	0.01g	0.02g	0.05g	0.10g	0.20g
k	0.40	0.40	0.40	0.40	0.40

Multiplier for alternate return period, $(T/T_R)^k$	1.00		
Ref. PGA, a_{gR}(g) | PGA, PGA(g) | Zone factor, Z(g) | Hazard factor, Z(g)	0.400	g m/s^2	cl.208.4.4.
Spectral response acceleration at 0.2s, $(T/T_R)^k.S_S(g)$	0.922	g m/s^2	ASCE7 | cl.6.1
Spectral response acceleration at 1.0s, $(T/T_R)^k.S_1(g)$	0.331	g m/s^2	ASCE7 | cl.6.1

Note spectral response acceleration can be obtained at https://ascehazardtool.org/. ASCE7

Note spectral response acceleration can be obtained at SNI1726-2019 Earthquake Code - Response SNI1726

Design horizontal PGA, $a_g(g) = \gamma_I.a_{gR}(g)$	0.400	g m/s^2	2.1(3) EN1
Design horizontal PGA very low, $a_g(g) \le 0.04g$ | $a_g(g).S \le 0.05g$	N/A		cl.3.2.1(5) EN1
Design horizontal PGA low, $a_g(g) \le 0.08g$ | $a_g(g).S \le 0.10g$	N/A		cl.3.2.1(4) EN1
Design horizontal PGA moderate, $a_g(g) \le 0.30g$ | $a_g(g).S \le 0.375g$	N/A		
Design horizontal PGA high, $a_g(g) > 0.30g$ | $a_g(g).S > 0.375g$	High Seismicity		

Peak Ground Acceleration (Vertical), PGA(g)

Vertical peak ground acceleration factor, k_v	0.67	208.5.3.2 NSCP | cl.7.	
Design vertical PGA, $a_{vg}(g) = \gamma_I.k_v.a_{gR}(g)$	0.267	g m/s^2	
Inclusion of vertical action ? 0.267g > 0.250g	Included		cl.4.3.3.5.2 EN1

Fundamental Building Period, $T_{1,X|Y|Z}$

	X-Dir	Y-Dir	Z-Dir		
Fundamental period of building, $T_{1,X\|Y\|Z}$	0.55	2.40	0.15	s	NOT OK

Note for employing the equivalent lateral static force method, check $T_{1,X|Y} \le 4T_C$ and 2.0s. cl.4.3.3.2.1 EN1

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Importance Factor | Redundancy Factor | Overstrength Factor

Note that the importance factor, redundancy factor, and overstrength factor, ***linearly multiply*** *the horizontal peak ground acceleration, PGA(g) and spectral accelerations $S_S(g)$, $S_1(g)$.*

Importance factor, γ_I | I_e | Probability factor, k_p	1.00	*I1726 | cl.208.4.2 NSC*
Imp. class | Risk cat. | Occupancy cat. | Imp. level		*? SNI1726 | cl.103.1 N*
Cat. IV [Ordinary Buildings] [1.00] [T=475 Years]		
Redundancy factor for horizontal spectra, ρ	1.00	*12.3.4 ASCE7 | cl.7.3.*
Structure w/o. Vertical Irregularity [cl.1630.1.1] [1.00]		
Overstrength factor for horizontal spectra, γ_{Rd} | Ω_0	1.00	*' | cl.8.3.2.1 SNI1726*
10 No Overstrength ULS Effects (Dissipative Element Mechanism) [1.00]		

NSCP | cl.3.2 AS1170.4 | cl.1627 UBC97 | cl.6.2.2.2 IS1893-1

Behaviour Factor, q | Response Modification Factor, R

10

The behaviour factor, q or response modification factor, R ***linearly divides*** *the elastic spectral response to produce the design (inelastic) spectral response.*

	X-Dir	Y-Dir	Z-Dir	
Behaviour factor, q = $q_0.k_w$ | Response mod. factor, R	5.50	5.50	1.00	*.2.2, cl.6.11.3 SNI172*
.2 SNI172(Shear Wall [T.16-N-2 RC Wall] [R=5.50] [Cd=0.7R]			5.50	*.2.2, cl.6.11.3 SNI172*
Moment Frame [T.16-N-3 Intermediate Moment Frame] [R=5.50] [Cd=0.7R]			5.50	*.2.2, cl.6.11.3 SNI172*
12	X-Dir	Y-Dir	Z-Dir	
Prevailing failure mode for walls, k_w	1.00	1.00		*cl.5.2.2.2(11) EN*
N/A			1.00	*cl.5.2.2.2(11) EN*
N/A			1.00	*cl.5.2.2.2(11) EN*

.2 SNI1726

12

1 NSCP | cl.3.2 AS1170.4 | cl.1627 UBC97 | cl.3.28 IS1893-1

.2 SNI1726

.2 SNI1726

998

998

998

2(c) AS1170.4 | cl.1631.2 UBC97 | cl.6.2.3.2 IS1893-1

998

998

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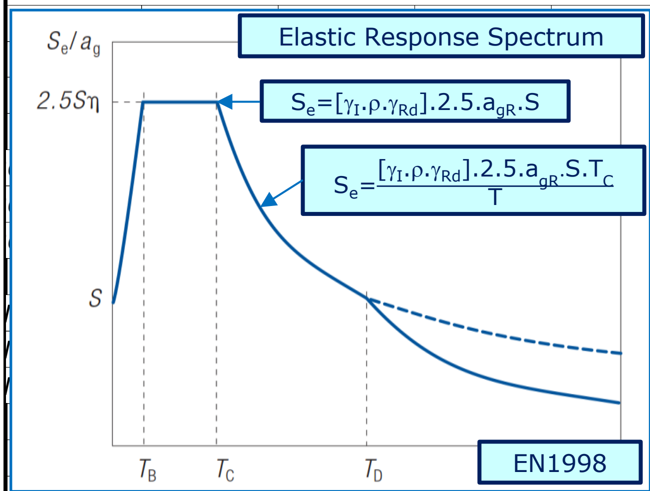
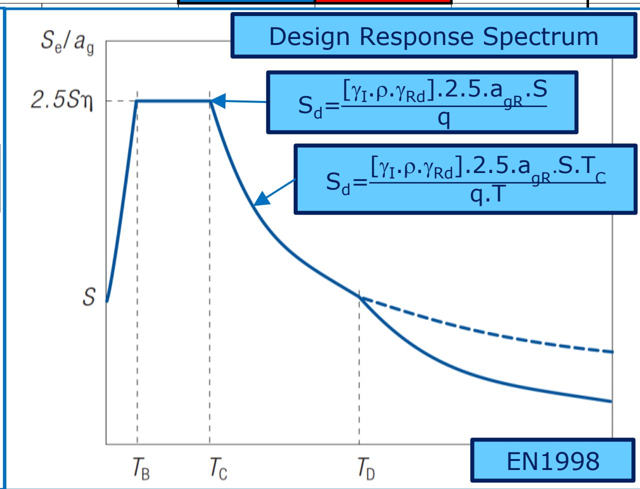
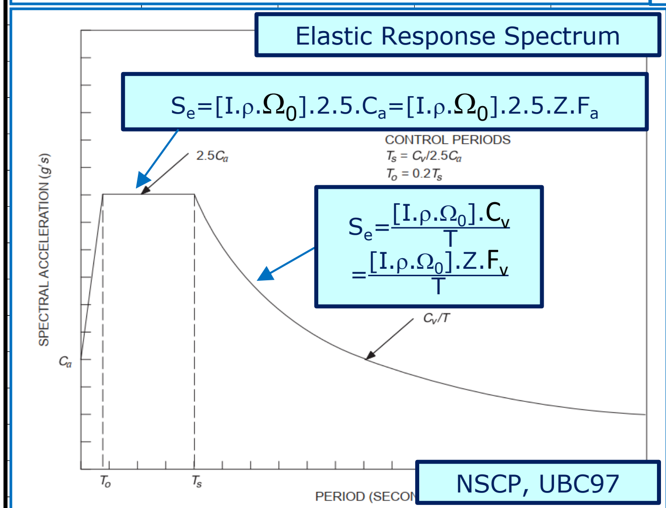
Earthquake Spectra

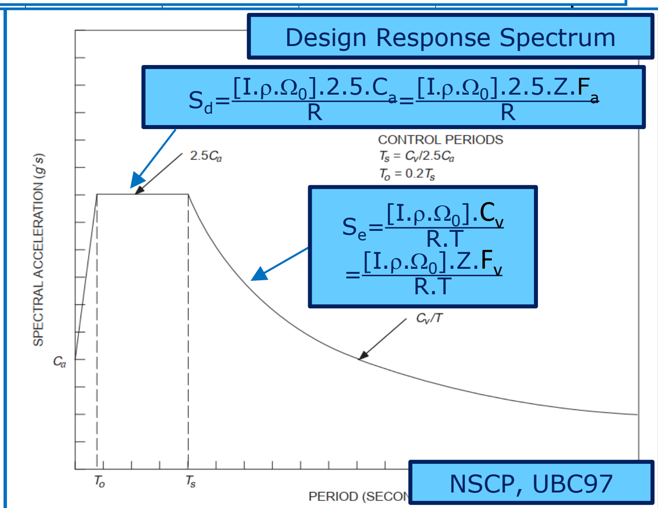
Note that the earthquake spectra define the ***spectral accelerations*** *for all structural periods.*

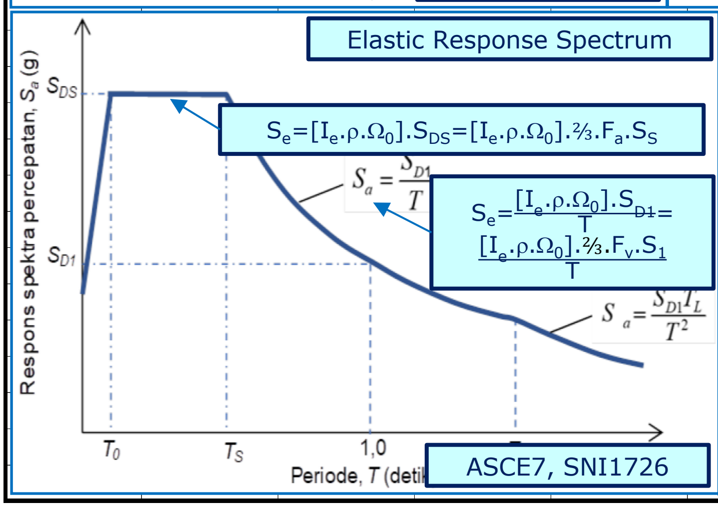
Earthquake spectrum	UBC97 World [1997]			*726 | cl.208.5.3.2 NSC*
A fundamental expectation of ASCE7-16 | SNI1726-2019, is that the S_S and S_1 correspond to MCE_R. The spec				
themselves, will change these MCE levels, to DLE levels, by multiplying 2/3, as per cl.11.4.5, cl.11.9.3 ASCE7-1				
Ground type | Site class | Soil typ	Soil Type D [Stiff Soil, 15<N<50, vs>180m/s, TS<0.70s]			*726 | cl.208.4.3.1 NSC*
Soil response parameter, S | F_{PGA}		N/A		*cl.3.2.2.2 EN19*
Short-period seismic coefficient, F_a		1.10		*3.4.4.4 NSCP | cl.6.4 A*
Long-period seismic coefficient, F_v		1.60		*3.4.4.4 NSCP | cl.6.4 A*
	X|Y-Dir	Z-Dir		
Constant accn. region LL, T_B | T_0	0.12	0.12	s	*3.5.3.2 NSC*
Constant accn. region UL, T_C | Short-period transition, T_S	0.58	0.58	s	*3.5.3.2 NSC*
Constant disp. region LL, T_D | Long-period transition, T_L	4.00	4.00	s	*3.5.3.2 NSC*

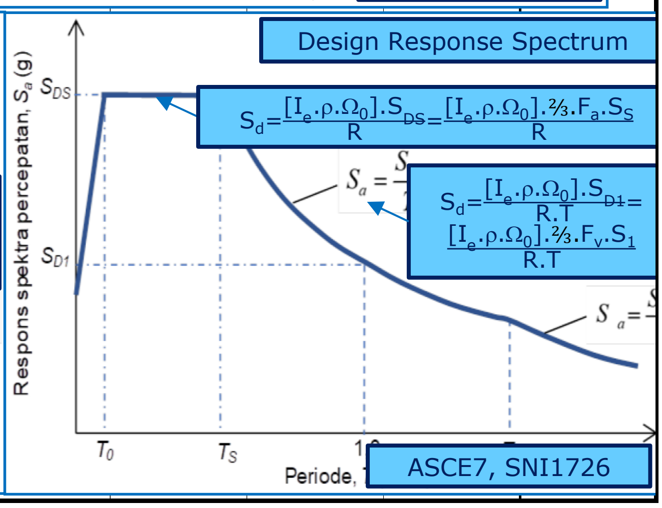












Displacement Compatibility Factor, C_d (Displacements and Non-Seismic Participating Columns)

The displacement compatibility factor, C_d linearly multiplies the design (inelastic) spectra to determine the ***structural displacements*** *and action effects within* ***non-seismic-participating columns****. Herewith, this figure* ***does not*** *affect the presentation of the spectra and resulting forces.*

tra

	X-Dir	Y-Dir	Z-Dir	
6.				
Displacement compatibility factor, C_d	3.85	3.85		*26 | cl.208.6.4.2, cl.8.*
998 Shear Wall [T.16-N-2 RC Wall] [R=5.50] [Cd=0.7R]			3.85	*26 | cl.208.6.4.2, cl.8.*
S1170.4 | Moment Frame [T.16-N-3 Intermediate Moment Frame] [R=5.50] [Cd=0.7R]			3.85	*26 | cl.208.6.4.2, cl.8.*

S1170.4 | cl.1629.4.3 UBC97 | cl.6.2.3.2 IS1893-1	X-Dir	Y-Dir	Z-Dir	
Displacement drift criteria, $[|\Delta\delta_{X|Y}|/h_s]_{limit}$	1:50	1:50		*1726 | cl.208.6.5.1 NS*

P \| cl.6.4 AS1170.4 \| cl.1631.2 UBC97 \| cl.6.2.3.2 IS1893-1

Design Ground Displacement

P \| cl.6.4 AS1170.4 \| cl.1631.2 UBC97 \| cl.6.2.3.2 IS1893-1

Design ground displacement, $d_{g,X|Y} = 0.025.a_g(g).S.T_C.T_D$	N/A	mm	*.2.2.4 EN1*

Non-Structural Component (NSC) Seismic Effects

Weight of NSC, W_a | W_p	80	kN	
Height of NSC from foundation, z	25.0	m	
Building height from foundation, h	25.0	m	

	X-Dir	Y-Dir	Z-Dir		
Inelastic (design) force of NSC, $F_a = W_a.S_a(g)$	N/A	N/A		kN	*.5.2(2) EN*
$S_a(g)=\frac{a_g(g).S.\gamma_a}{q_a}.\left[\frac{3.(1+z/h)}{1+(1-T_{a,X|Y}/T_{1,X|Y})^2}-0.5\right]$	N/A	N/A		g m/s^2	*.5.2(3) EN*
Fundamental period of NSC, $T_{a,X|Y}$	0.50	0.50		s	
Importance factor of NSC, γ_a			1.00		*cl.4.3.5.3 EN1*
Behaviour factor of NSC, q_a			2.00		*cl.4.3.5.4 EN1*
Inelastic (design) force of NSC, $F_p = W_p.S_a(g)$	87	87	11	kN	*13.3.1 ASC*
$S_a(g)=0.4a_p.S_{DS}.[1+2.(z/h)].\Omega_0.I_p/R_p$ $S_{DS}=2/3.F_a.S_S|0.3S_{DS}.I_p\le S_a(g)\le 1.6S_{DS}.I_p$	1.082	1.082	0.135	g m/s^2	*13.3.1 ASC*
Amplification factor of NSC, a_p			2.50		*T.13.5-1, T.13.6-1*
Importance factor of NSC, I_p			1.00		*cl.13.1.3 ASC*
Overstrength factor of NSC, Ω_0			2.00		*T.13.5-1, T.13.6-1*
Response mod. factor of NSC, R_p			2.50		*T.13.5-1, T.13.6-1*
Inelastic (design) force of NSC, $F_p = W_p.S_a(g)$	117	117		kN	*SCP | cl.16*
$0.7C_a.I_p\le S_a(g)=\frac{a_p.C_a.I_p}{R_p}.[1+3.z/h)]\le 4C_a.I_p$	1.467	1.467		g m/s^2	*SCP | cl.16*
Component amplification factor of NSC, a_p			2.50		*T.208-13 NSCP | T.16*
Importance factor of NSC, I_p			1.00		*T.208-1 NSCP | T.16*
Response mod. factor of NSC, R_p			3.00		*T.208-13 NSCP | T.16*

$_{D1}T_L$ / T^2

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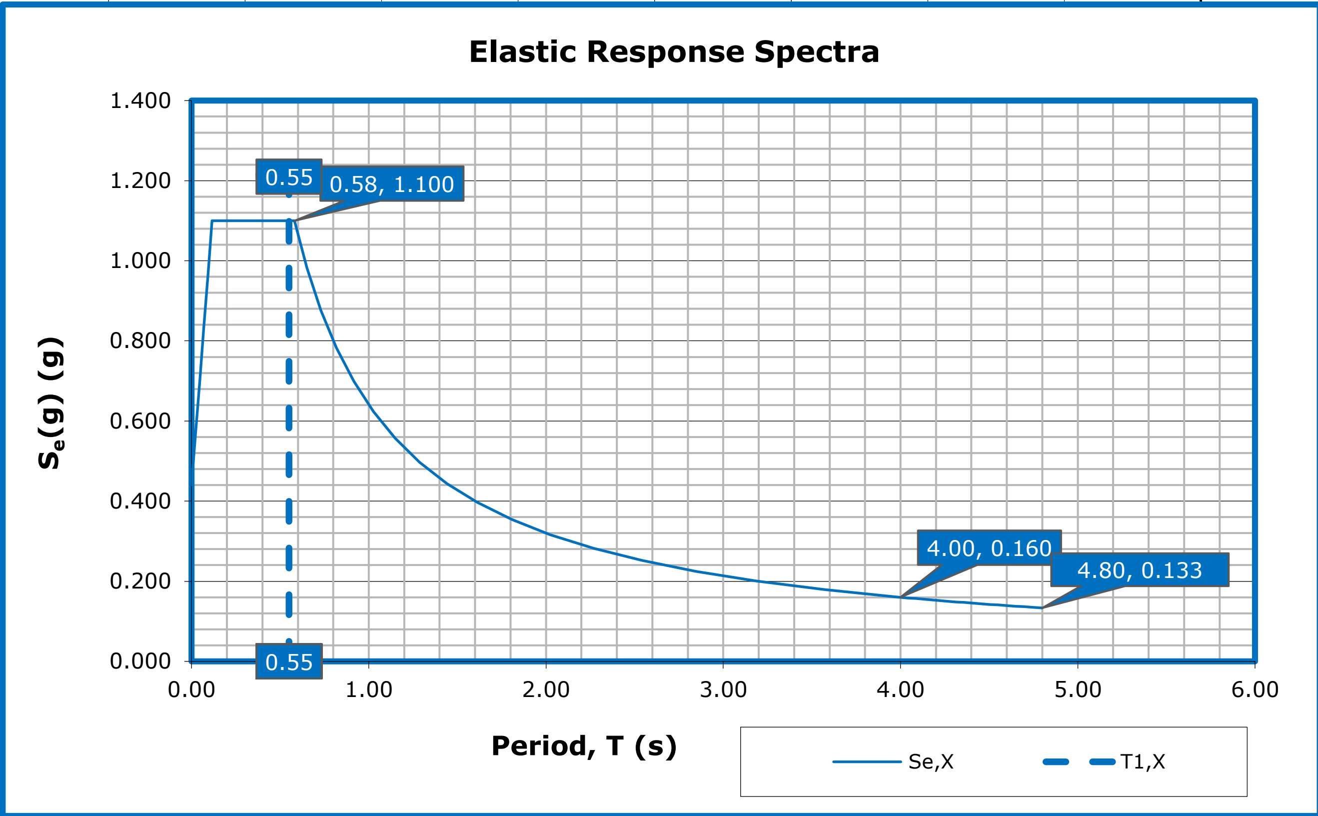
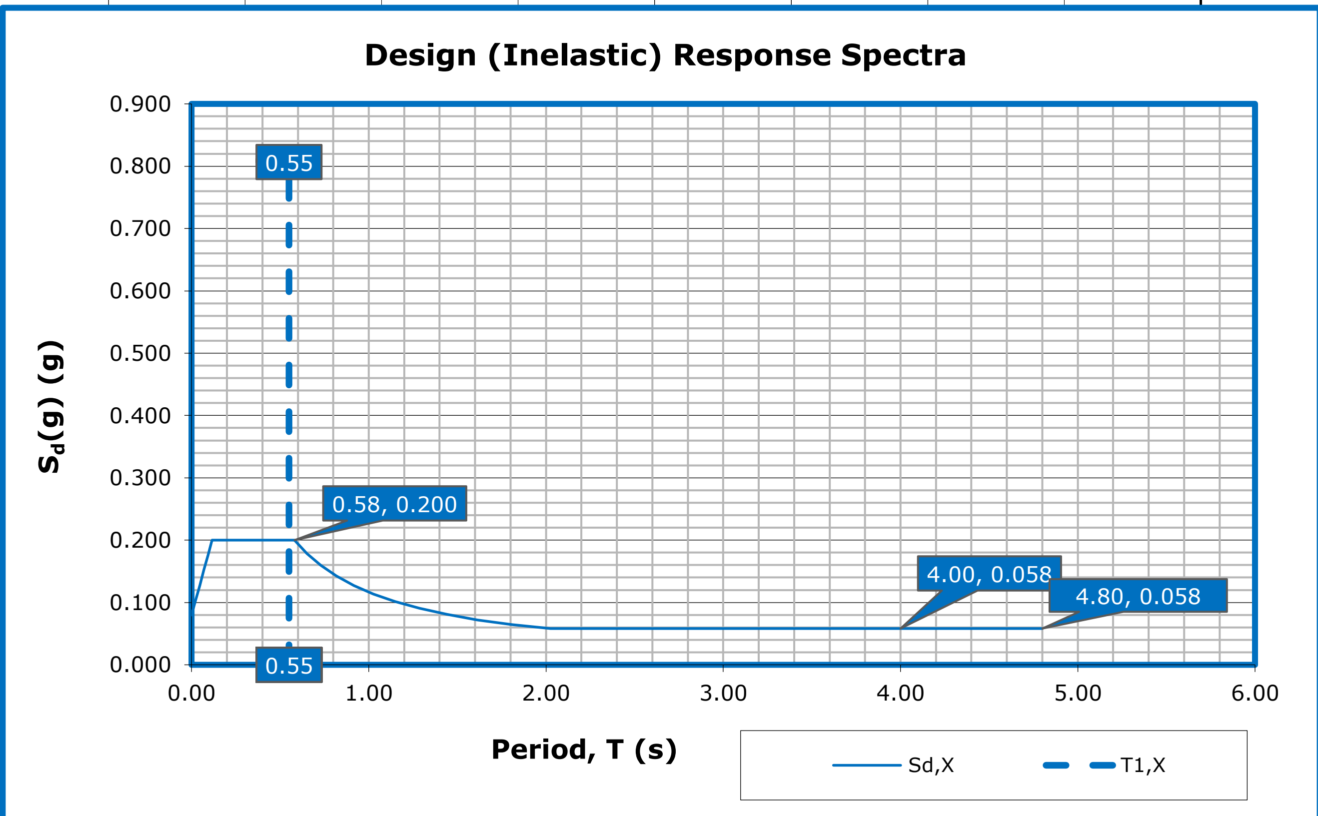


	X-Dir	
Elastic spectral acceleration, $S_e(g)(T_1)$	1.100	g m/s^2
Elastic base shear force, $F_{be}(W) = W.S_e(g)(T_1).\lambda$	1.100	W kN	N1998 | cl.
1998 Eff. mass participation factor, λ 1.00 [RSPEC]	1.00	cl.4.3.3.2.2 EN1



Inelastic (design) spectral acceleration, $S_d(g)(T_1)$	0.200	g m/s^2	
Note spectra level {low inelastic 0.050g – 0.070g, high inelastic 0.150g – 0.200g, high elastic 0.250g – 0.300g};			
Inelastic base shear force, $F_{bd}(W) = W.S_d(g)(T_1).\lambda$	0.200	W kN	N1998 | cl.
Eff. mass participation factor, λ 1.00 [RSPEC]	1.00		cl.4.3.3.2.2 EN1

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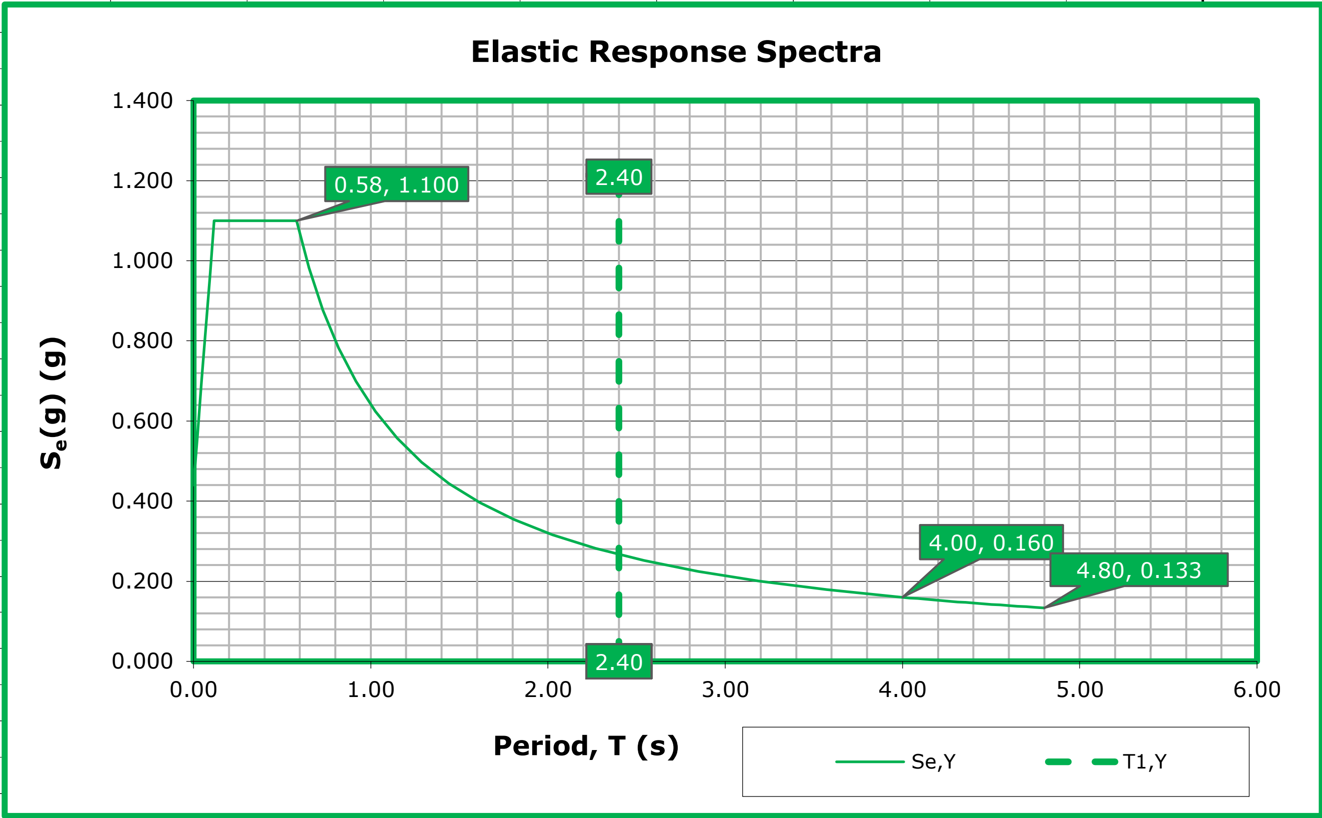
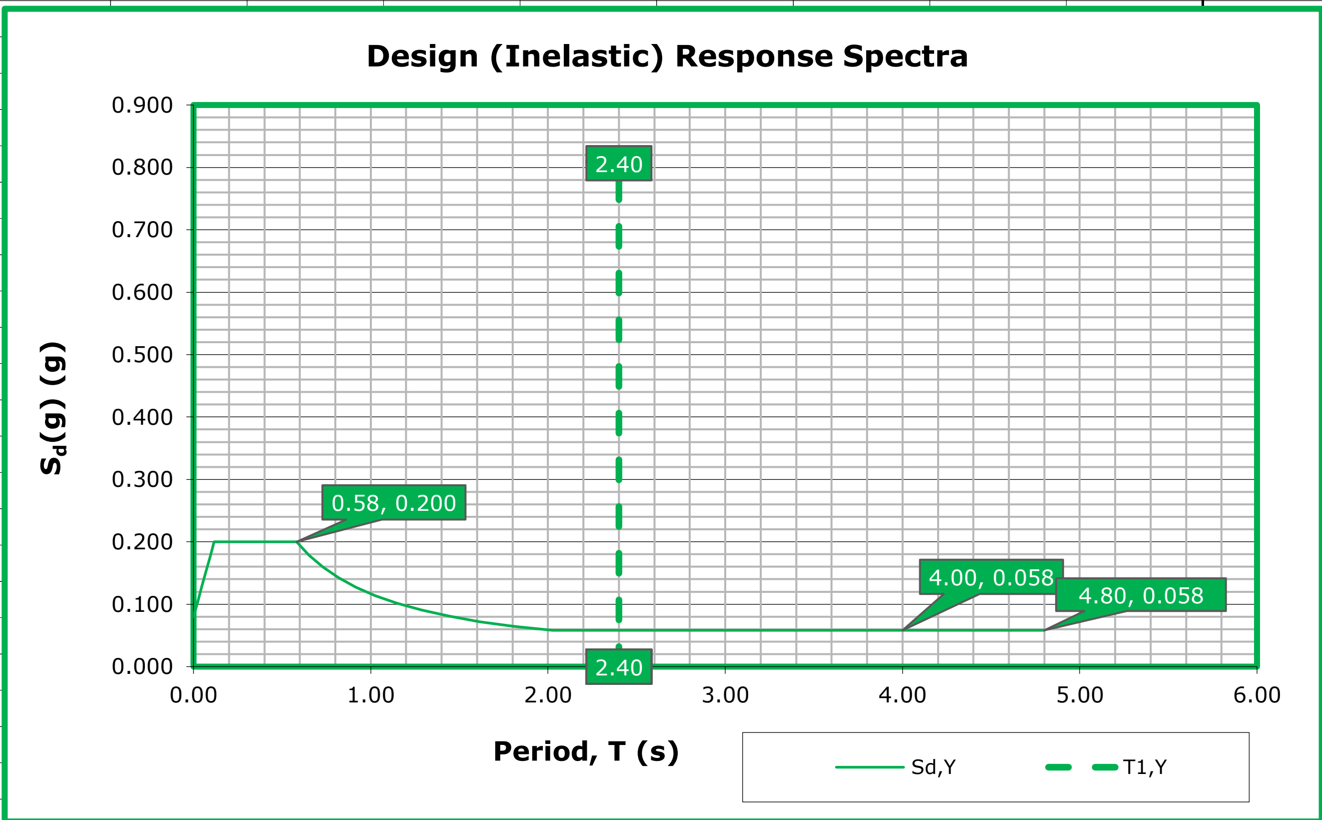
Structure Design - EQ Load Definition and EQ Effects		Made by XX	Date 20/2/2026	Chd.



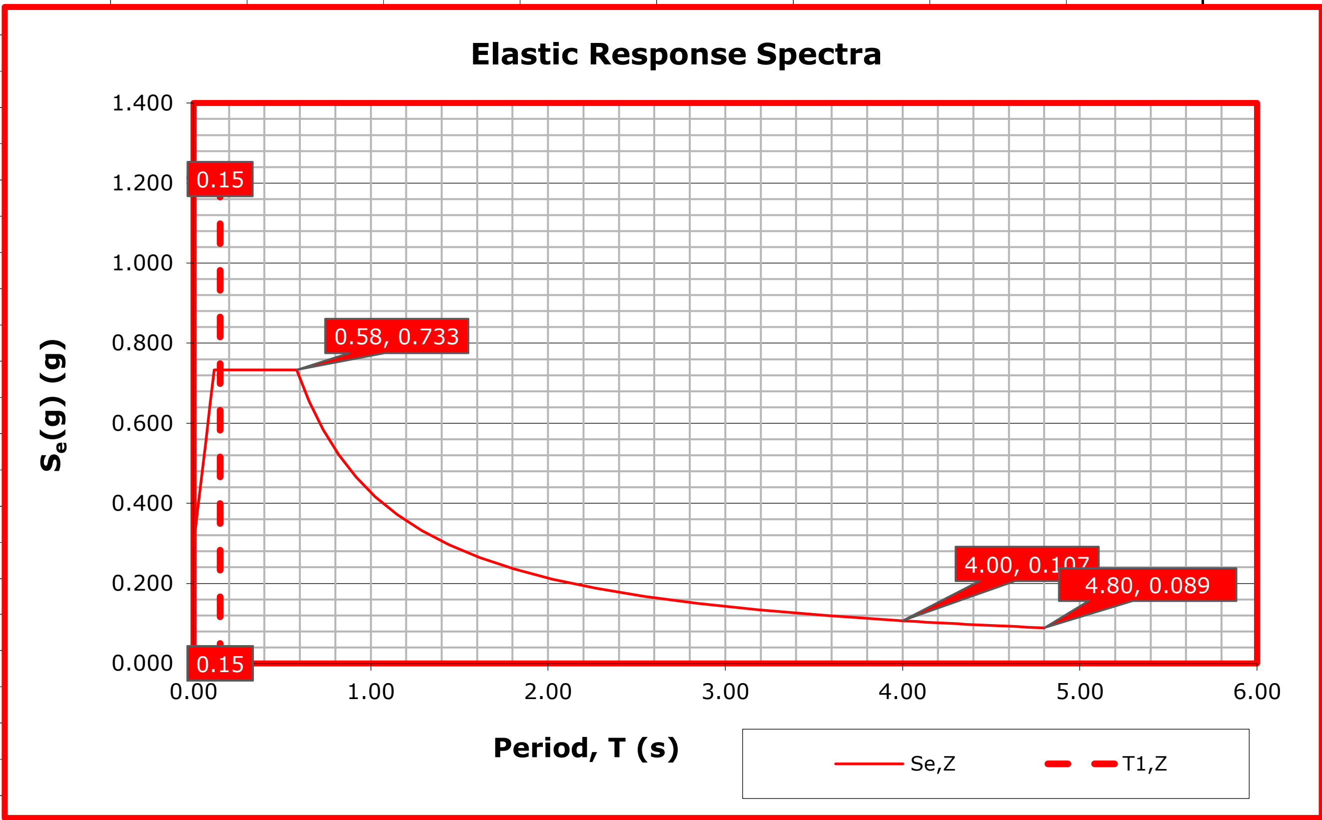
		Y-Dir	
Elastic spectral acceleration, $S_e(g)(T_1)$		0.267	g m/s^2
Elastic base shear force, $F_{be}(W) = W.S_e(g)(T_1).\lambda$		0.267	W kN *N1998 | cl.*
998 Eff. mass participation factor, λ	1.00 [RSPEC]	1.00	*cl.4.3.3.2.2 EN1*



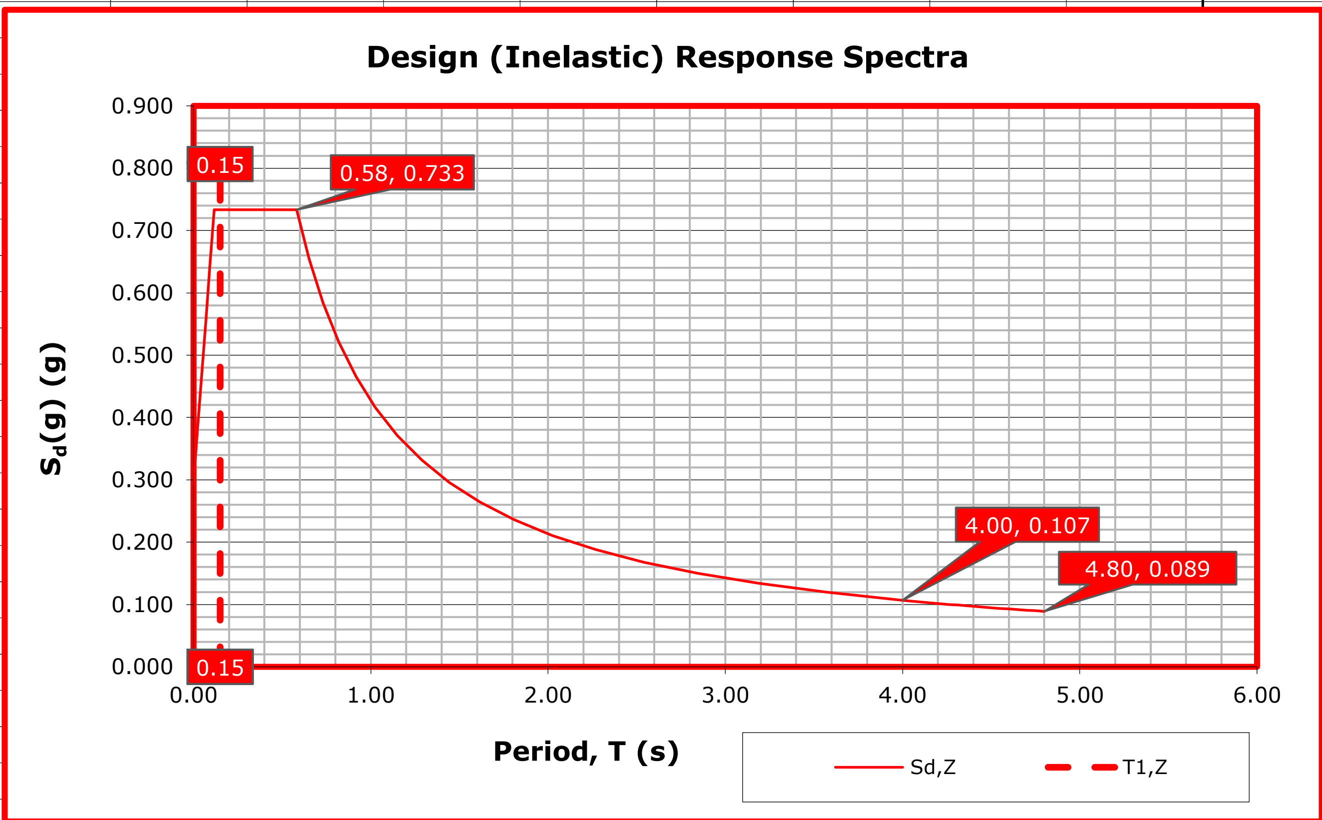
Inelastic (design) spectral acceleration, $S_d(g)(T_1)$		0.058	g m/s^2

Note spectra level {low inelastic 0.050g – 0.070g, high inelastic 0.150g – 0.200g, high elastic 0.250g – 0.300g};

Inelastic base shear force, $F_{bd}(W) = W.S_d(g)(T_1).\lambda$		0.058	W kN *N1998 | cl.*
998 Eff. mass participation factor, λ	1.00 [RSPEC]	1.00	*cl.4.3.3.2.2 EN1*



	Z-Dir		
Elastic spectral acceleration, $S_e(g)(T_1)$	**0.733**	g m/s^2	
Elastic base shear force, $F_{be}(W) = W.S_e(g)(T_1).\lambda$	**0.733**	W kN	*1998 | cl.1*
998 Eff. mass participation factor, λ 1.00 [RSPEC]	**1.00**	*12.4.2.2 ASCE7 | cl.16*	



Inelastic (design) spectral acceleration, $S_d(g)(T_1)$	**0.733**	g m/s^2	
Note spectra level {low inelastic 0.050g – 0.070g, high inelastic 0.150g – 0.200g, high elastic 0.250g – 0.300g};			
Inelastic base shear force, $F_{bd}(W) = W.S_d(g)(T_1).\lambda$	**0.733**	W kN	*1998 | cl.1*
998 Eff. mass participation factor, λ 1.00 [RSPEC]	**1.00**	*12.4.2.2 ASCE7 | cl.16*	