

What Structural Engineers do with Response Spectra

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1629A.8.3 Static. The static lateral force procedure of Section 1630A may be used for the following structures:

1. *Not adopted by DSA.*
2. Regular structures under 240 feet (73 152 mm) in height with lateral force resistance provided by systems listed in Table 16A-N, except where Section 1629A.8.4, Item 4, applies.
3. Irregular structures *with flexible diaphragms not more than three stories or 30 feet (9144 mm) in height.*
4. Structures having a flexible upper portion supported on a rigid lower portion where both portions of the structure considered separately can be classified as being regular, the average story stiffness of the lower portion is at least 10 times the average story stiffness of the upper portion and the period of the entire structure is not greater than 1.1 times the period of the upper portion considered as a separate structure fixed at the base.
5. *Wood-frame structures having wood shear walls and wood diaphragms.*
6. *Irregular structures with reentrant corners, plan irregularity Type 2, Table 16A-M, which are otherwise eligible for static analysis.*



1629A.8.4 Dynamic. The dynamic lateral-force procedure of Section 1631A shall be used for all other structures, including the following:

1. Structures 240 feet (73 152 mm) or more in height.
2. Structures having a *plan or vertical irregularity*, as defined in Tables 16A-L or 16A-M, except as permitted by *Section 1629A.8.3 and Section 1630A.4.2*.
3. Structures over five stories or 65 feet (19 812 mm) in height in Seismic Zones 3 and 4 not having the same structural system throughout their height except as permitted by Section 1630A.4.2.
4. Structures, regular or irregular, *except those defined in Section 1629A.8.3, Items 3 and 5*, located on Soil Profile Type S_F , that have a period greater than 0.5 second *as calculated in accordance with Method B in Section 1630A.2.2*. The analysis shall include the effects of the soils at the site and shall conform to Section 1631A.2, Item 4.



1631A.5.4 Reduction of Elastic Response Parameters for design. Elastic Response Parameters may be reduced for purposes of design in accordance with the following items, with the limitation that in no case shall the Elastic Response Parameters be reduced such that the corresponding design base shear is less than the Elastic Response Base Shear divided by the value of R .

1. For all regular structures, * * * Elastic Response Parameters may be reduced such that the corresponding design base shear is not less than 100 percent of the base shear determined in accordance with Section 1630A.2.

2. *[For OSHPD 1 & 4 and DSA/SS] For irregular structures with vertical irregularity Types 1a, 2, or 5, as defined in Table 16A-L, or irregular structures with plan irregularity Type 1b, as defined in Table 16A-M, Elastic Response Parameters, may be reduced such that the corresponding design base shear is not less than 125 percent of the base shear determined in accordance with Section 1630A.2.*

Exception: *The Elastic Response Parameters for structures with Vertical Irregularity Types 1a or 2, as defined in Table 16A-L, or plan irregularity Type 1b, as defined in Table 16A-M, may be reduced such that the corresponding design base shear is not less than 100 percent of the base shear determined in accordance with Section 1630A.2, if no interstory drift ratio under design lateral load is greater than 130 percent of the interstory drift ratio of the story immediately above. Torsional effects need not be considered in the calculation of story drifts for the purposes of this determination. The story drift ratio relationships for the top two stories of the structures are not required to be evaluated.*

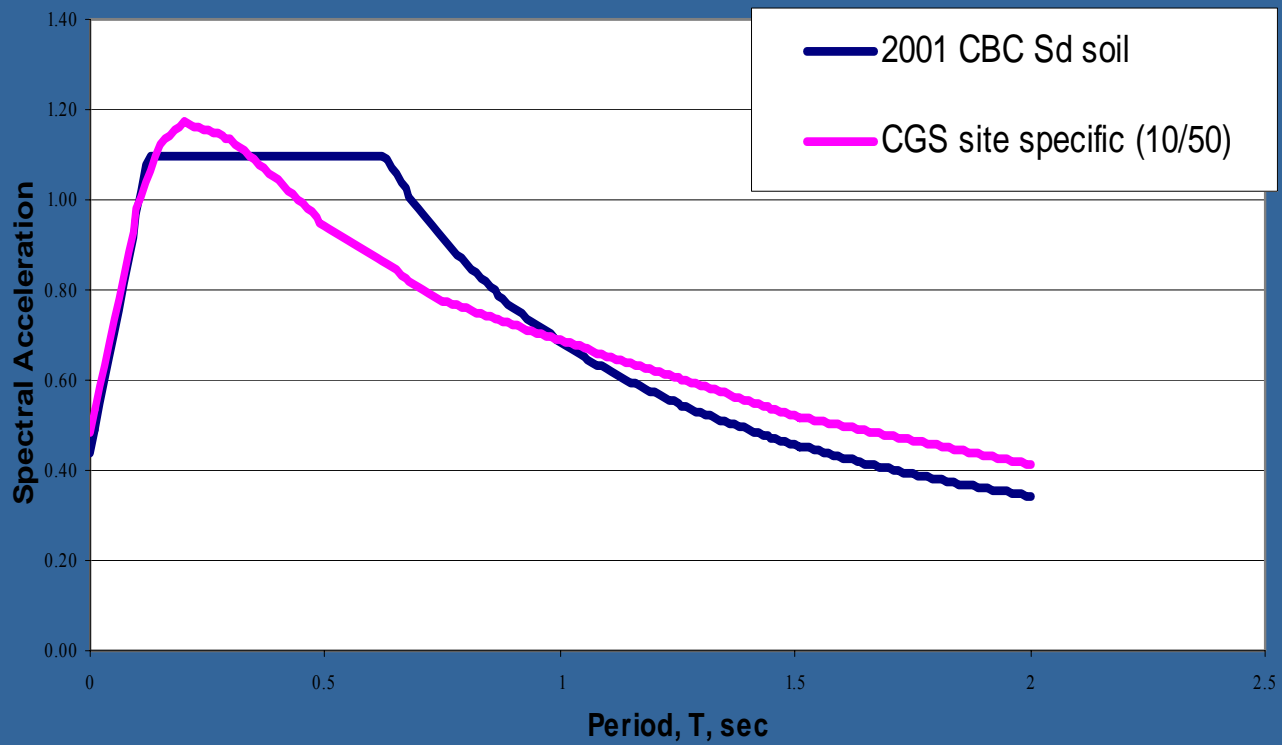
3. *For all other structures, Elastic Response Parameters may be reduced such that the corresponding design base shear is not less than 100 percent of the base shear determined in accordance with Section 1630A.2.*

The reduced design seismic forces shall be used for design in accordance with Section 1612A.

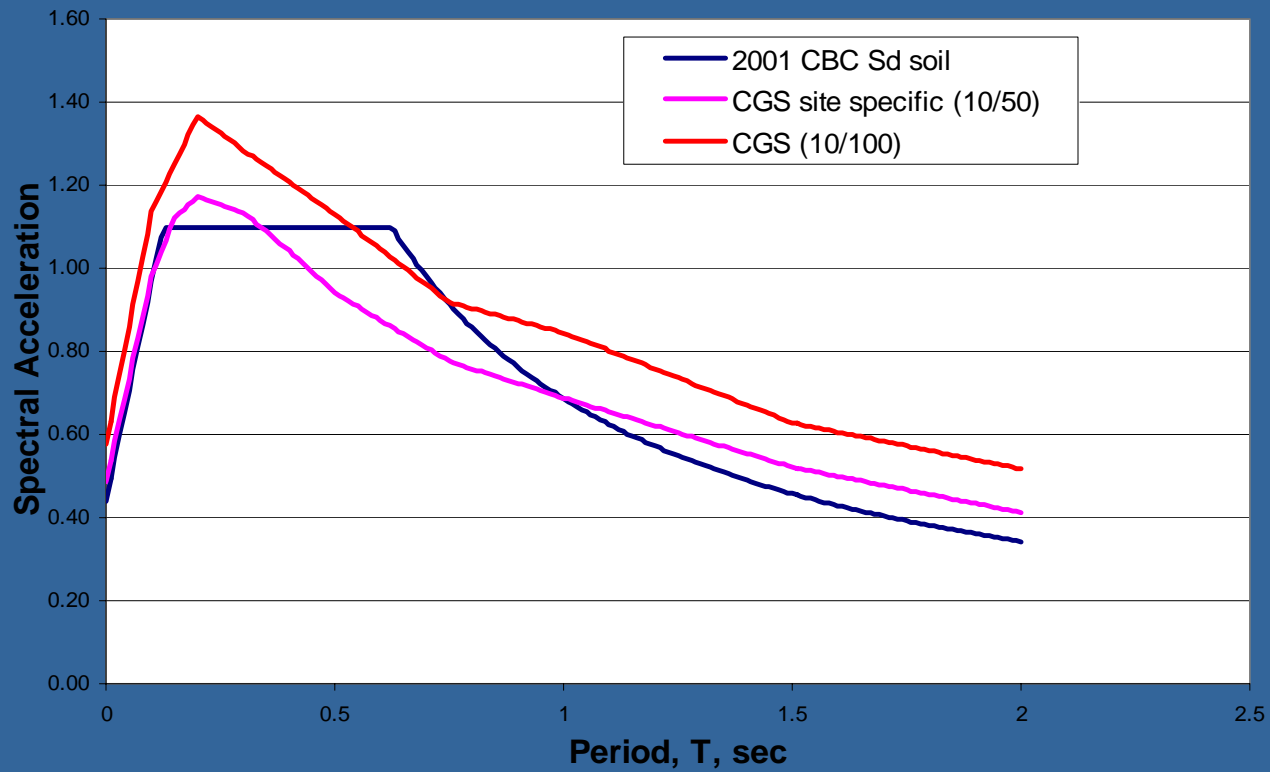


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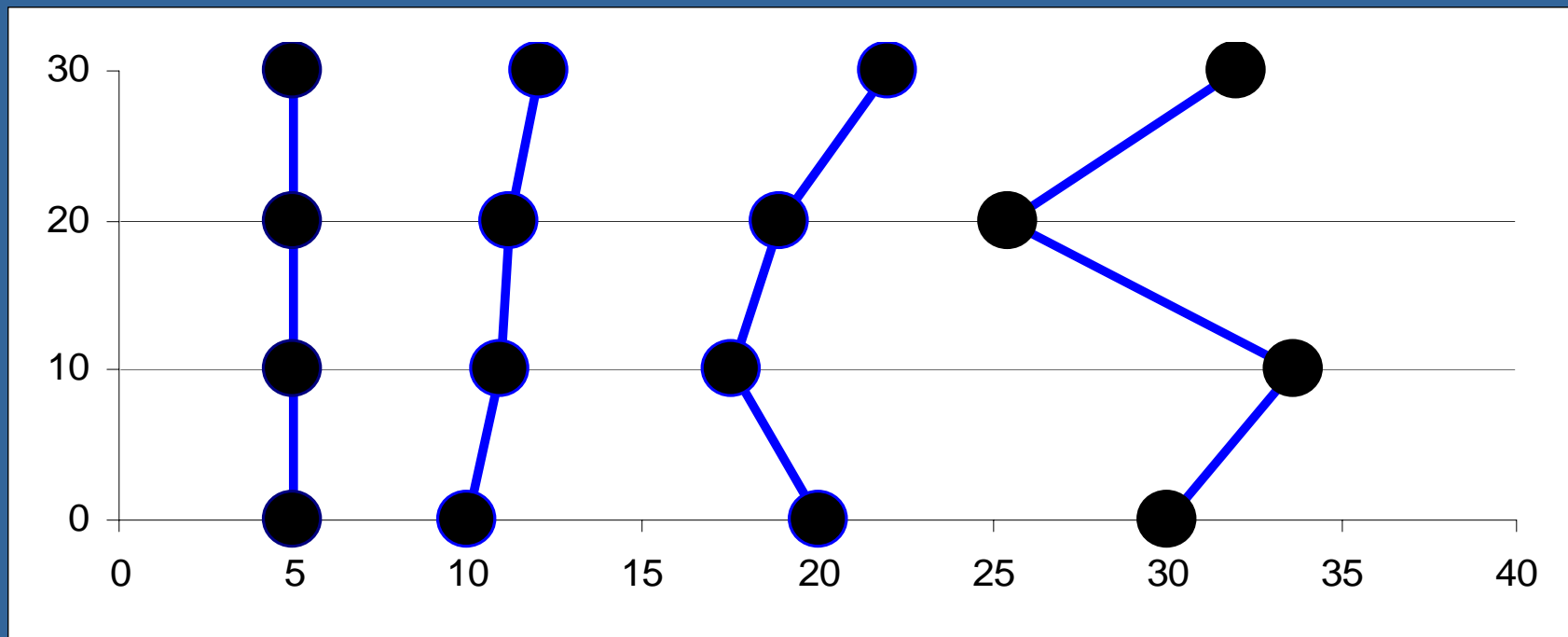
4th and Howard



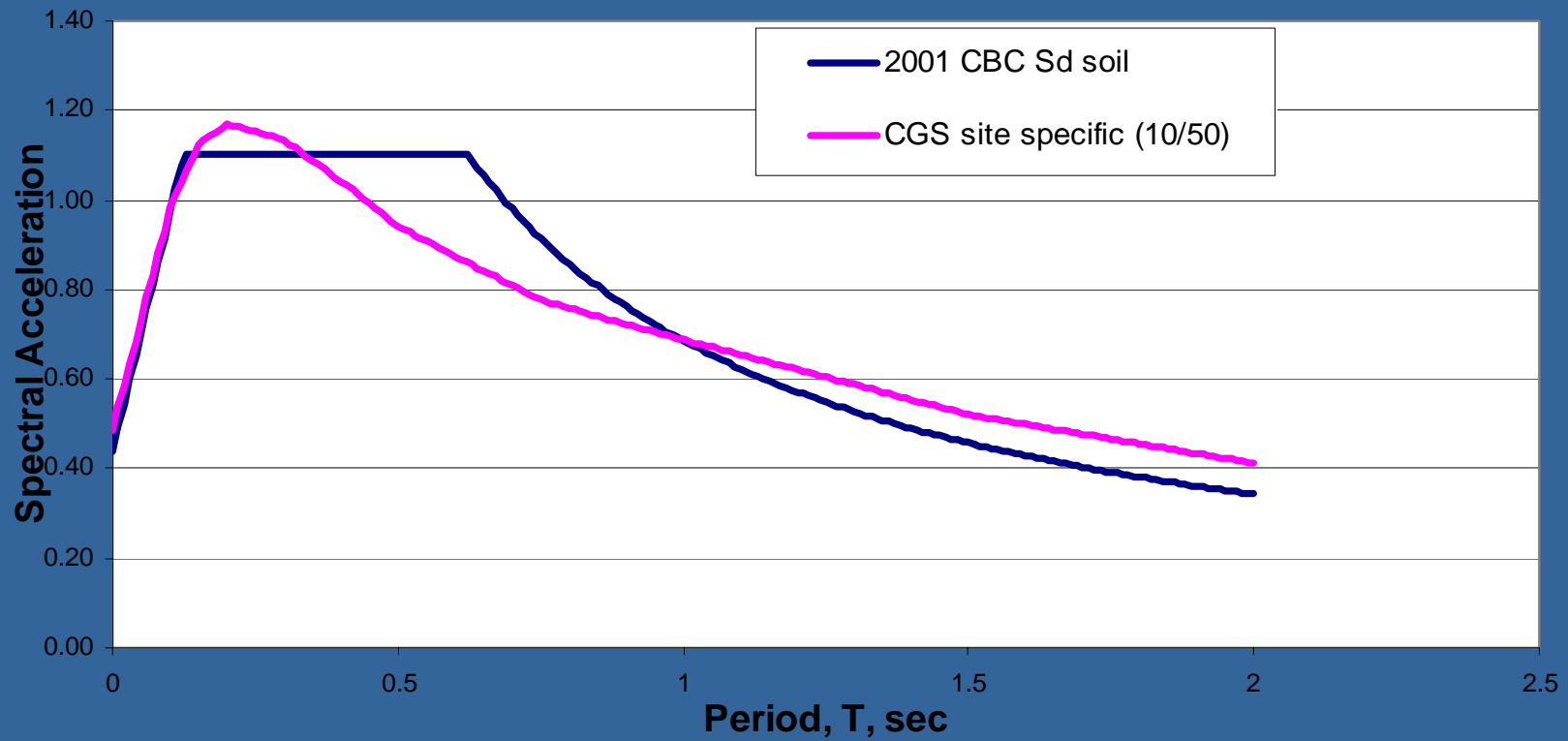
4th and Howard



Mode Shapes



4th and Howard



Summary of the Dynamics

Mode	Period , T (sec)	PM _i	W _i	S _{Ass}	S _{Acode}
1	.893	.914	1059.6	.727	.771
2	.319	.071	82.09	1.17	1.1
3	.221	.011	12.65	1.16	1.1
		Σ=	1154.3		



Dynamic Base Shear, V

$$V = \sum_{i=1}^3 W_i S_{Ass}$$

- V=881 kips, but the code only requires 90% PM
- V could be reduced to 770 kips (we will use 881)



Scaling Dynamic Results

- For CBC – all occupancies except schools and hospitals-
- Elastic response parameters modified to-
90% of static forces with CBC spectrum
80% with site-specific, and
100% for all irregular structures



Scaling Dynamic Results

- For schools and hospitals –
 - 125% for some irregularities
 - 100% all other structures



Scaling Dynamic Results

- Section 1630A.2.2 limits building period-
- Method A $T_A = C_t(h_n)^{3/4}$, or
- Method B- T_B from the dynamic analysis but not greater than $1.3 T_A$ (in seismic zone 4)
- 1.4 in seismic zone 3



Scaling Dynamic Results

- From the code -
- $T_A = .384$ sec.
- $T_B = .893$ but not greater than $1.3T_B = .499$
- $V_{\text{static}} = 2.5C_a W = (2.5)(.44)1154.3 = 1269.7\text{k}$

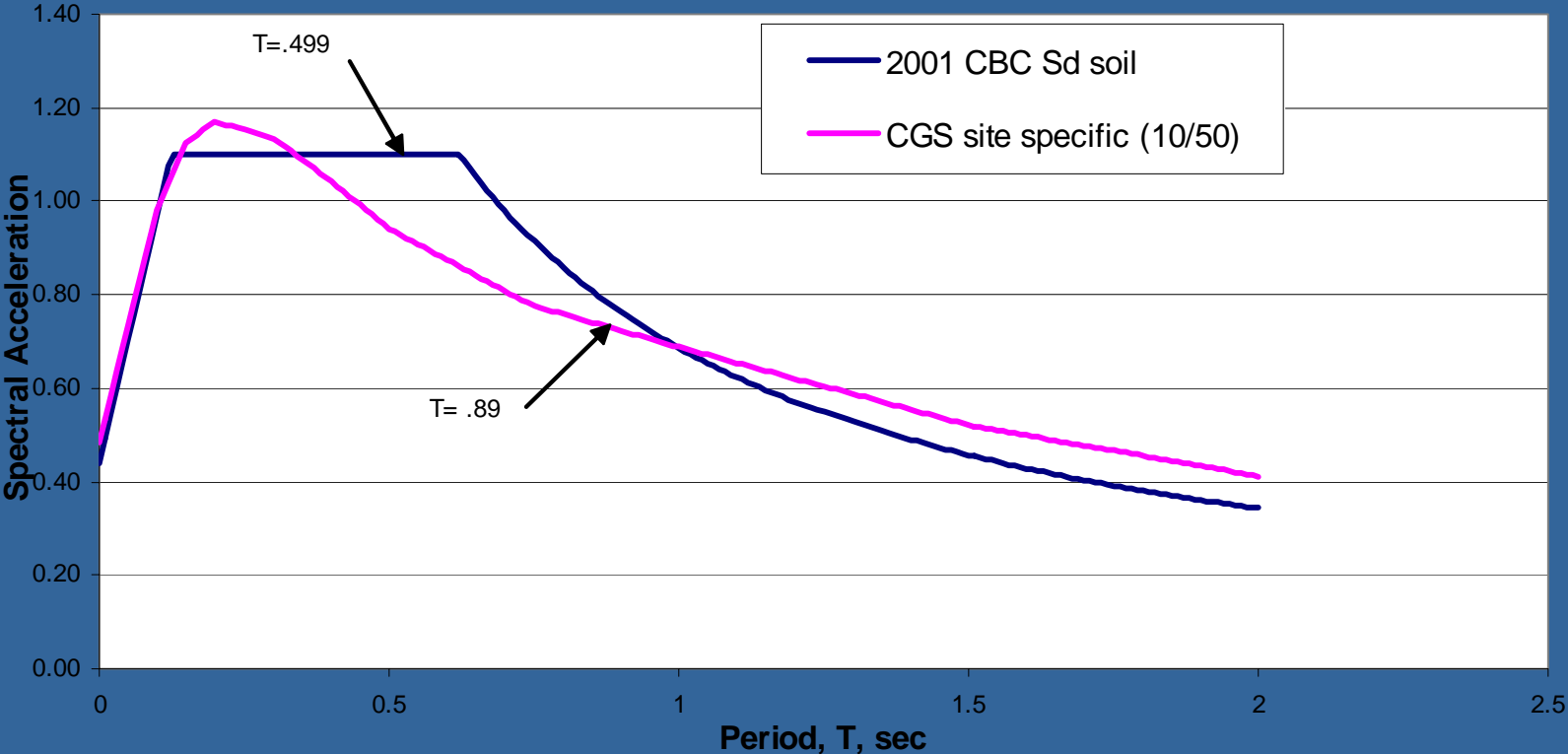


Scaling Dynamic Results

- Scale results of dynamic analysis up by
- $1269.7/881 = 1.44$
- Results are further scaled by I/R



4th and Howard

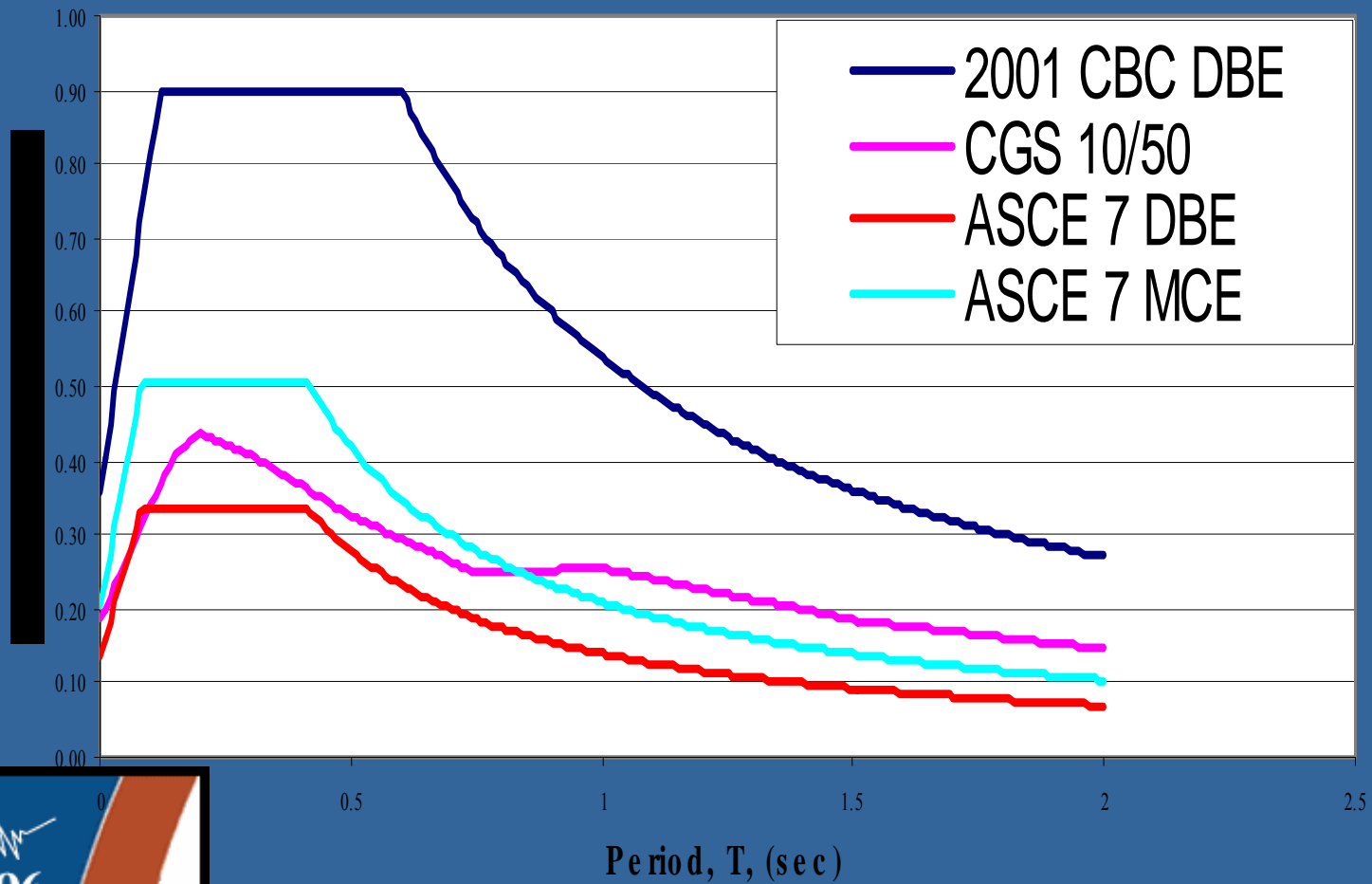


Scaling Dynamic Results

- Limits on T are for strength only
- For calculating drifts- Use T_B
- Base Shear, V becomes 881k instead of 1269.7k
- Still reduce results by I/R



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Summary of the Dynamics

Mode	Period T	PM _i	W _i	S _{A-CGS}	S _{A-DBE} (2001)
1	.893	.914	1059.6	.252	.606
2	.319	.071	82.09	.4	.90
3	.221	.011	12.65	.431	.90
		Σ=	1154.3		

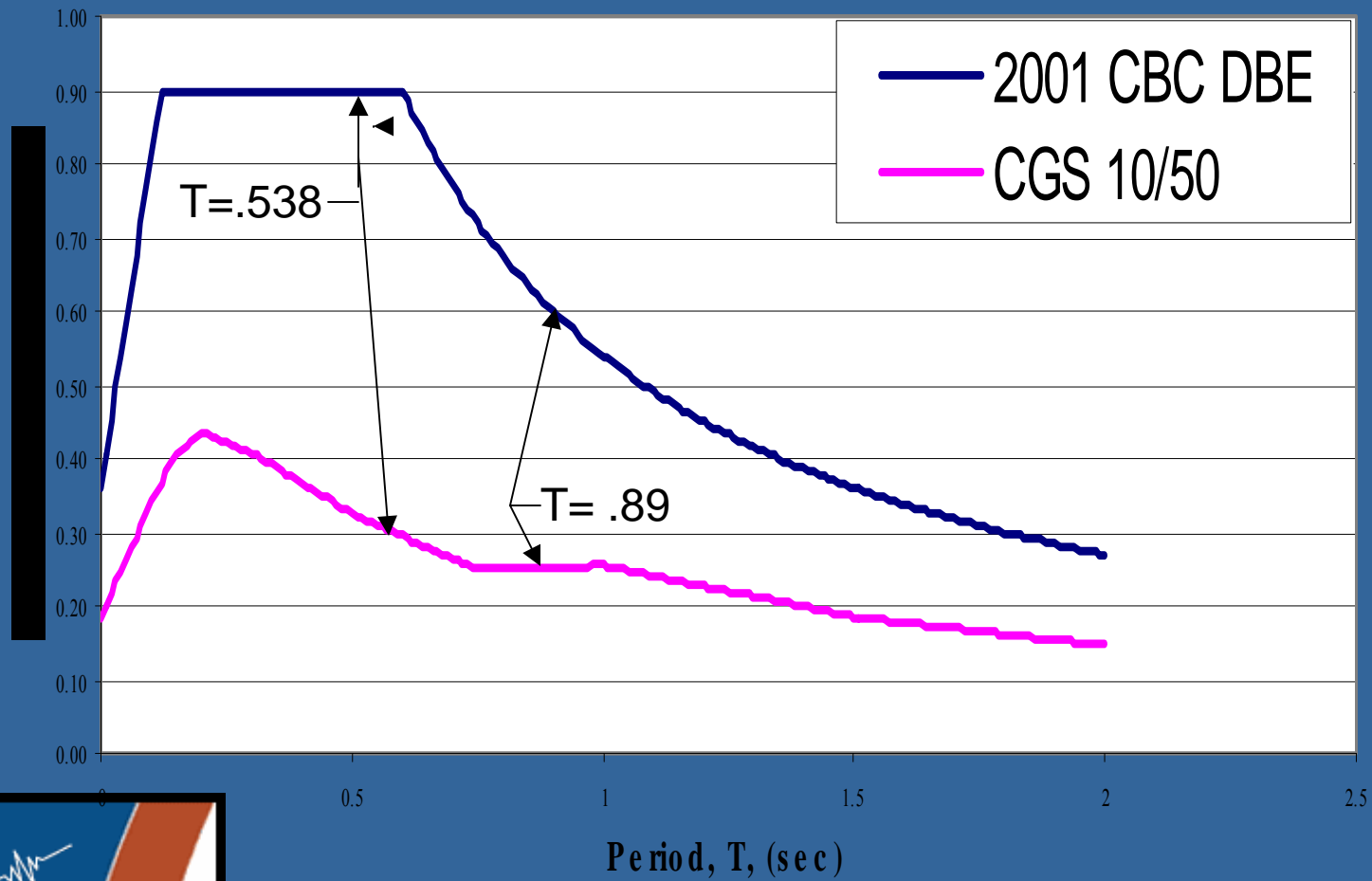


Scaling Dynamic Results

- From the code -
- $T_A = .384$ sec.
- $T_B = .893$ but not greater than $1.4T_B = .538$
- $V_{\text{static}} = 2.5C_a W = (2.5)(.36)1154.3 = 1038.9\text{k}$



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Scaling Dynamic Results

- Scale results of dynamic analysis up by
- $1038.9/727.4 = 1.43$
- Results are scaled down by I/R



Scaling Dynamic Results

- Limits on T are for strength only
- For calculating drifts- Use T_B
- Base Shear, V becomes 727.4k instead of 1038.9k
- Still reduce results by I/R



Response Spectra

For
2006 IBC and ASCE 7



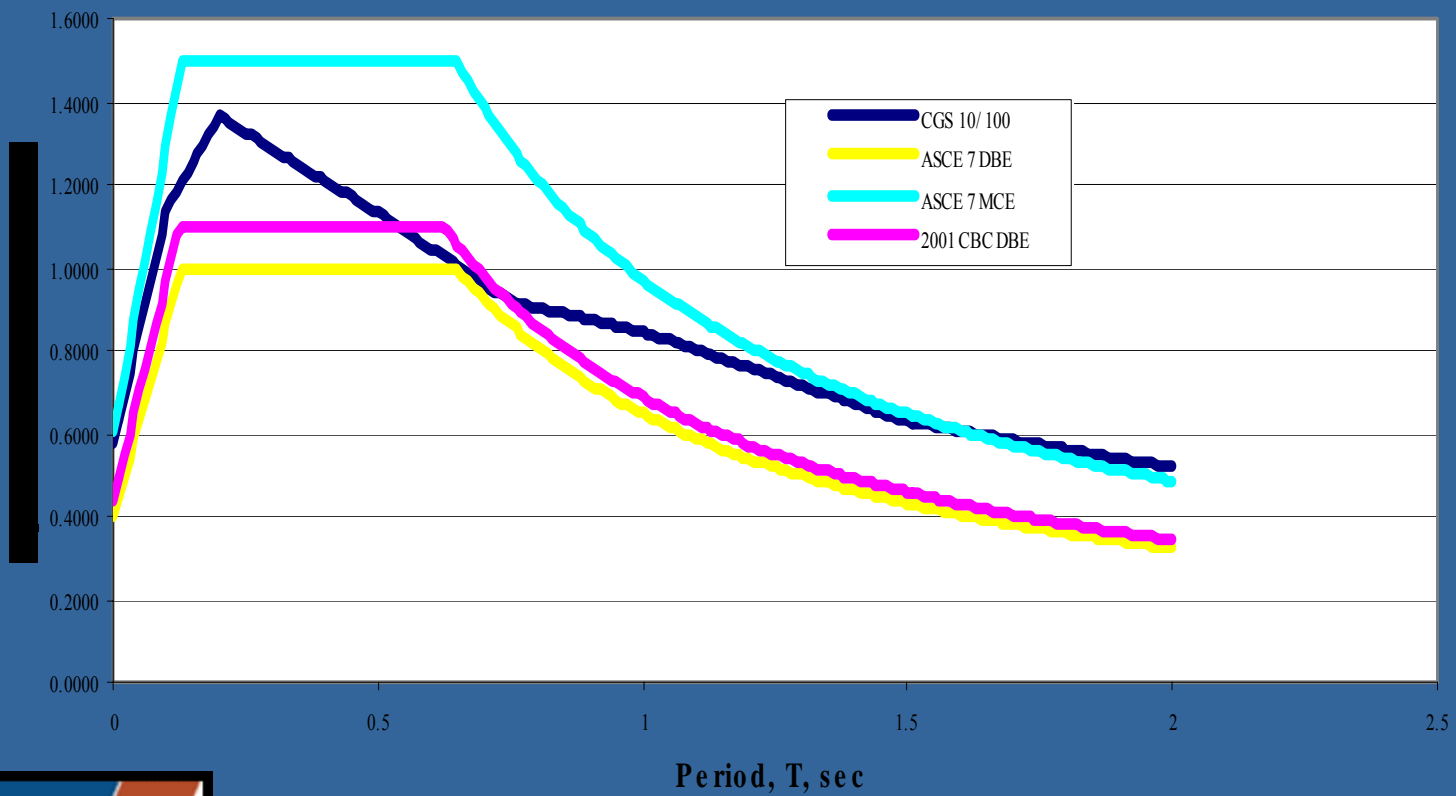
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For OSHPD and DSA

- Code Spectrum is allowed, except;
- Type “F” soils,
- < 10km from an active fault,
- Time history analysis
- Seismic isolation



4th and Howard Comparison

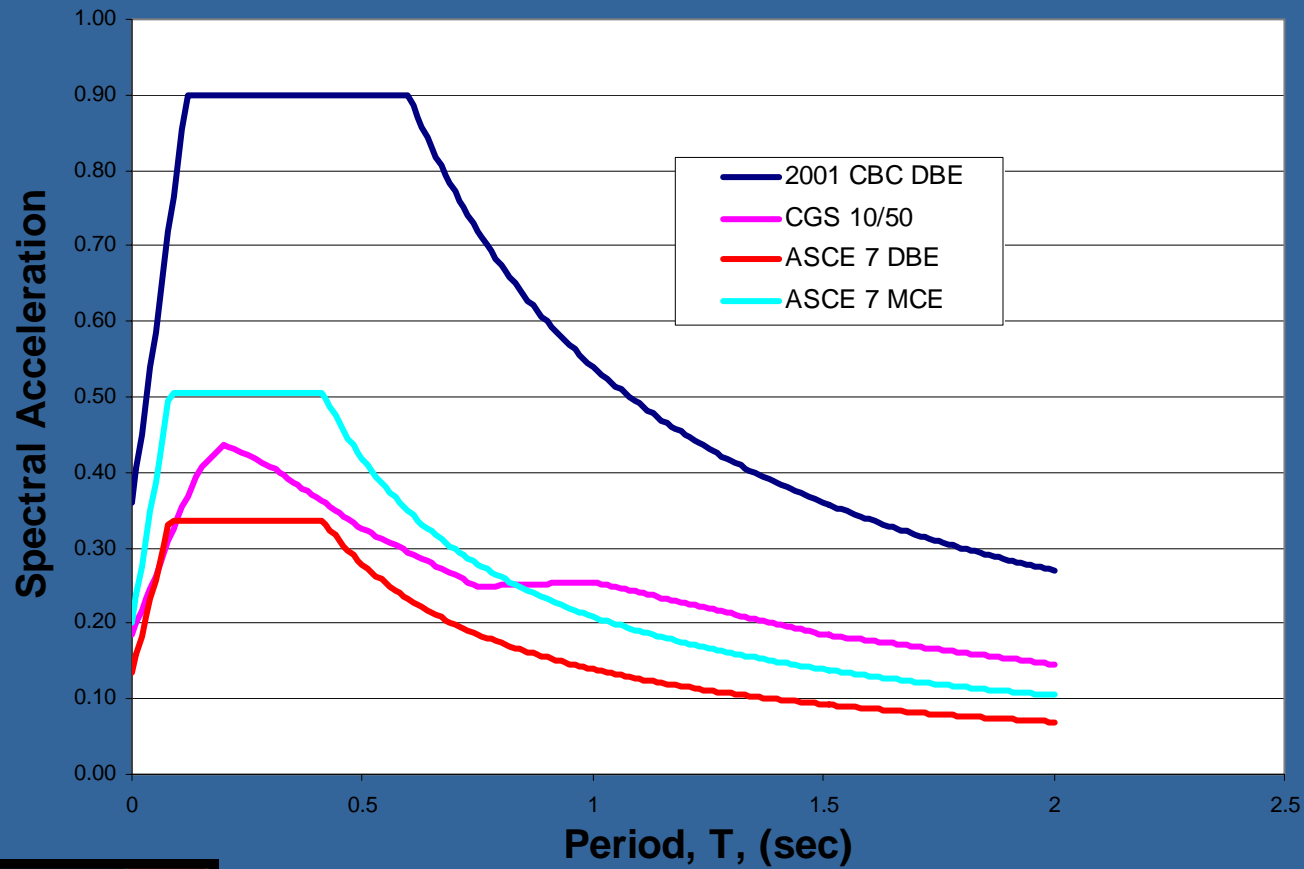


Caution!

- If S_1 calculated is greater than 0.75 –
- In general-
- Site is in an A-P zone, and
- Site-specific spectrum required!



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Thank You!

?Questions?



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