Navigating the Ground-Motion Requirements in Ch 11 & 21 in ASCE 7-16

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Presentation

- Chapter 11
  - Site Coefficient Tables, F_a & F_v (11.4.4)
  - Site-Specific Procedures & Exceptions (11.4.8)
- Chapter 21
  - Deterministic (MCE_R) Ground Motion (21.2.2)
  - Site-Specific MCE_R (21.2.3)

Presentation (cont.)

- Background
- Problems with Ch 11 & 21 in 1st edition of ASCE 7-16
- Corrections in Supplement 1
- Problem in Ch 20 remains

F_a: Pre ASCE 7-16 vs. ASCE 7-10

Site Class	S_s = 1.0		S_s = 1.25		$S_s \geq 1.5$
	pre 7-16	*7-10*	*pre 7-16*	*7-10*	*pre 7-16*
A	0.8	**0.8**	0.8	**0.8**	0.8
B	0.9	**1.0**	0.9	**1.0**	0.9
C	1.2	**1.0**	1.2	**1.0**	1.2
D	1.1	**1.1**	1.0	**1.0**	1.0
E	1.1	**0.9**	1.0	**0.9**	0.8

≥ 10% ⬇

≥ 10% ⬆

New

F_v: Pre ASCE 7-16 vs. ASCE 7-10

Site Class	$S_1 = 0.4$		$S_1 = 0.5$		$S_1 \geq 0.6$
	pre 7-16	*7-10*	*pre 7-16*	*7-10*	*7-16*
A	0.8	**0.8**	0.8	**0.8**	0.8
B	0.8	**1.0**	0.8	**1.0**	0.8
C	1.5	**1.4**	1.5	**1.3**	1.4
D	1.9	**1.6**	1.8	**1.5**	1.7
E	2.4	**2.4**	2.2	**2.4**	2.0

≥ 10% ⬇

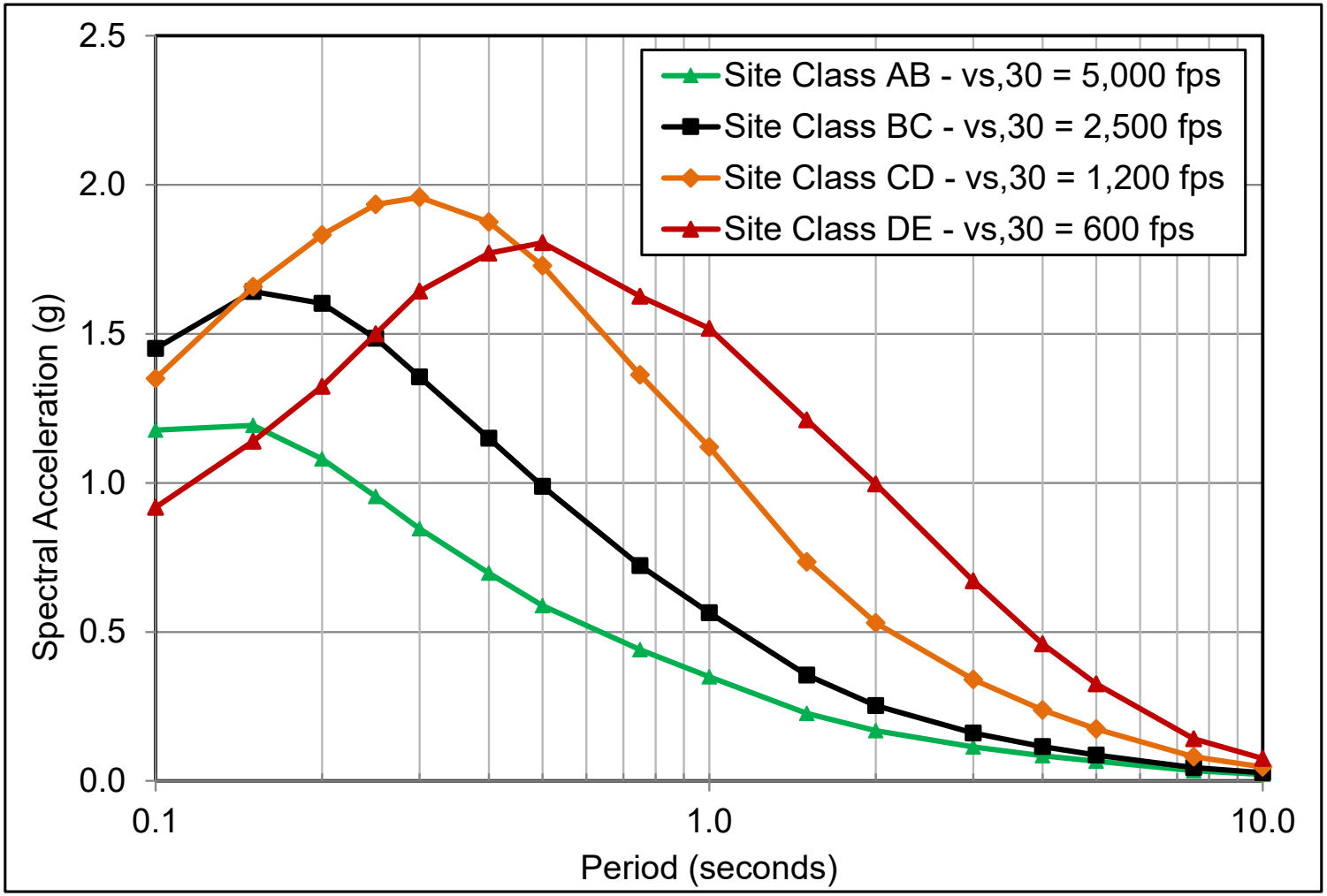
≥ 10% ⬆

New

Problem & "11th Hr" Fix to F_a & F_v Tables

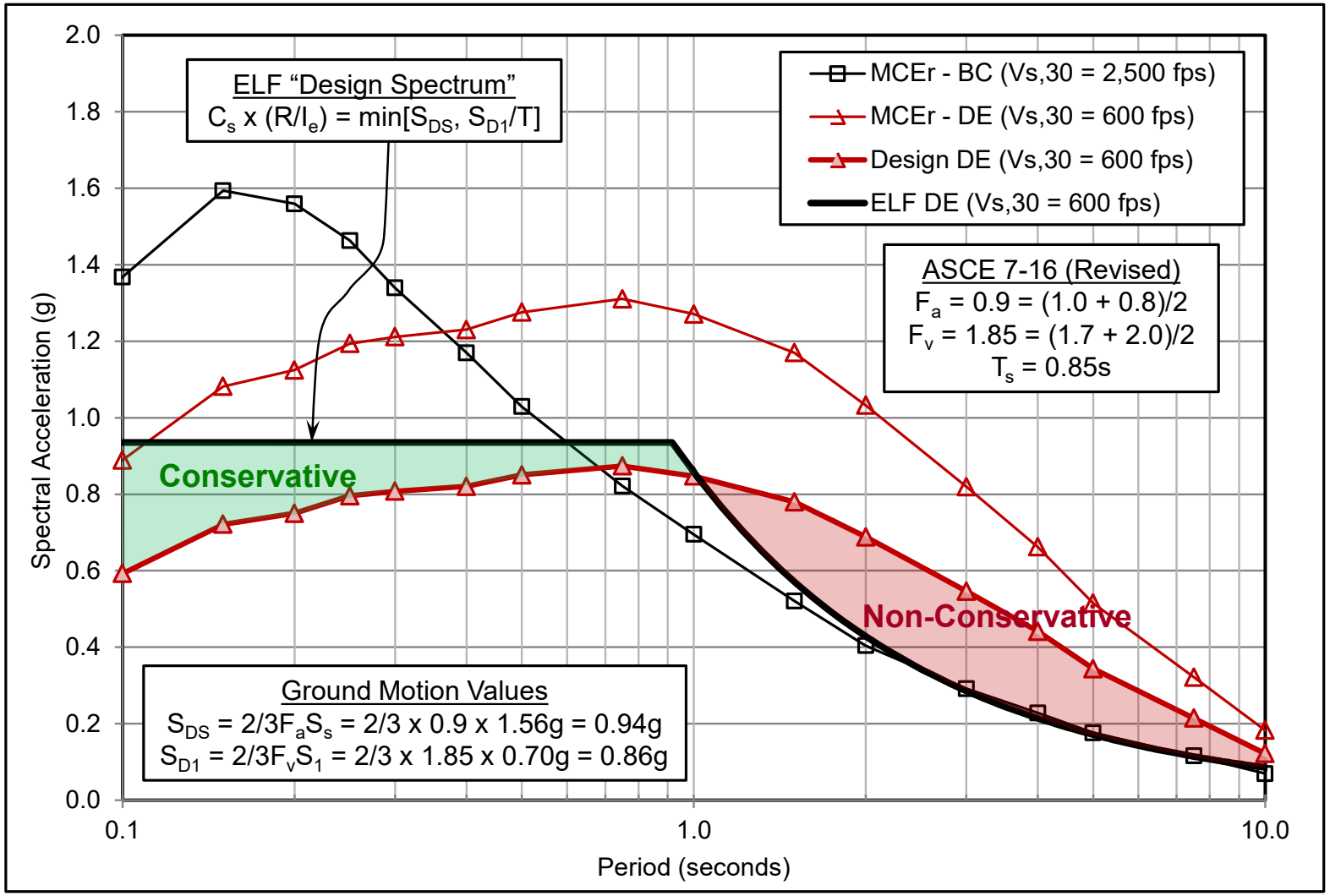
- Observation: Spectral shape for softer site classes in mostly high seismic regions was different than standard S_a shape from F_a & F_v and S_S & S_1
- Problem: Standard S_a shape for softer soils underestimated actual $S_a(T)$ at long T
- Fix: Based on Kircher (2015) report

Example Design Spectra - Deterministic MCE_R Ground Motions (ASCE 7-16)
PEER NGA West2 GMPEs (M7.0 at R_x = 6 km, Site Class boundaries)



From Kircher

Example ELF "Design Spectrum" based on ASCE 7-16 (proposed) Site Factors
M8.0 earthquake ground motions at R_X = 8.5 km, Site Class D/E



From C. Kircher

F_a: Fix in 1st Edition of ASCE 7-16

Site Class	S_S = 1.0	S_S = 1.25	S_S = 1.5
A	0.8	0.8	0.8
B	0.9	0.9	0.9
C	1.2	1.2	1.2
D	1.1	1.0	1.0
E	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

F_v: Fix in 1st Edition of ASCE 7-16

Site Class	S_S = 1.0	S_S = 1.25	S_S = 1.5
A	0.8	0.8	0.8
B	0.8	0.8	0.8
C	1.5	1.5	1.4
D	1.9[a]	1.8[a]	1.7[a]
E	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

[a] Also, see Section 11.4.8

Section 11.4.8

- Requirement: Site-Specific Study (Ch 21) unless an Exception is taken
- Exception 3: Structures on Site Class E with $S_1 \geq 0.2$, provided $T \leq T_S$, and ELF is used
- Problem: Need F_V to compute T_S
- Solution: Insert F_V values for Site Class E in F_V Table

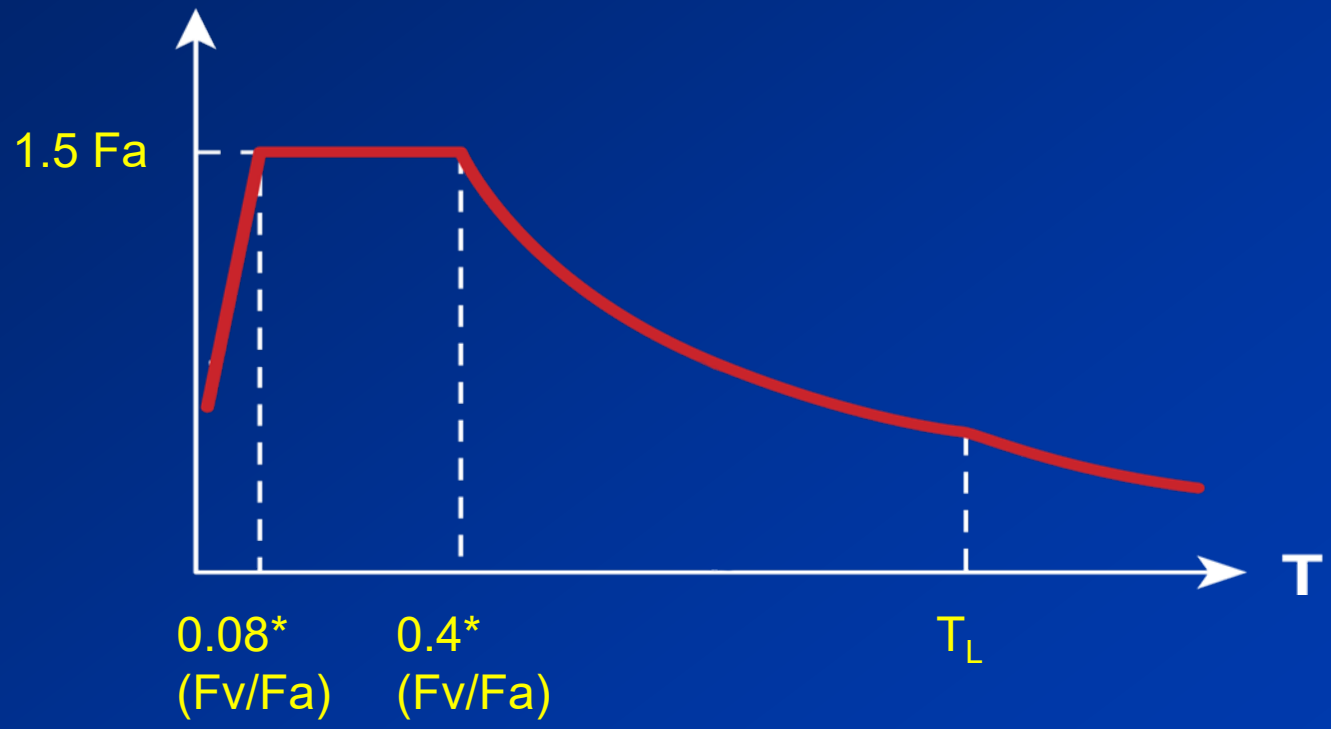
F_v in Supplement 1 of ASCE 7-16

Site Class	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \geq 0.6$
A	0.8	0.8	0.8
B	0.8	0.8	0.8
C	1.5	1.5	1.4
D	1.9[a]	1.8[a]	1.7[a]
E	2.4[a]	2.2[a]	2.0[a]

[a] Also, see Section 11.4.8. These Fv values used only for calculation of Ts.

Ch. 21: Site-Specific Procedure in 7-16

- 1st Edition retained Deterministic Lower Limit (DLL) Spectrum

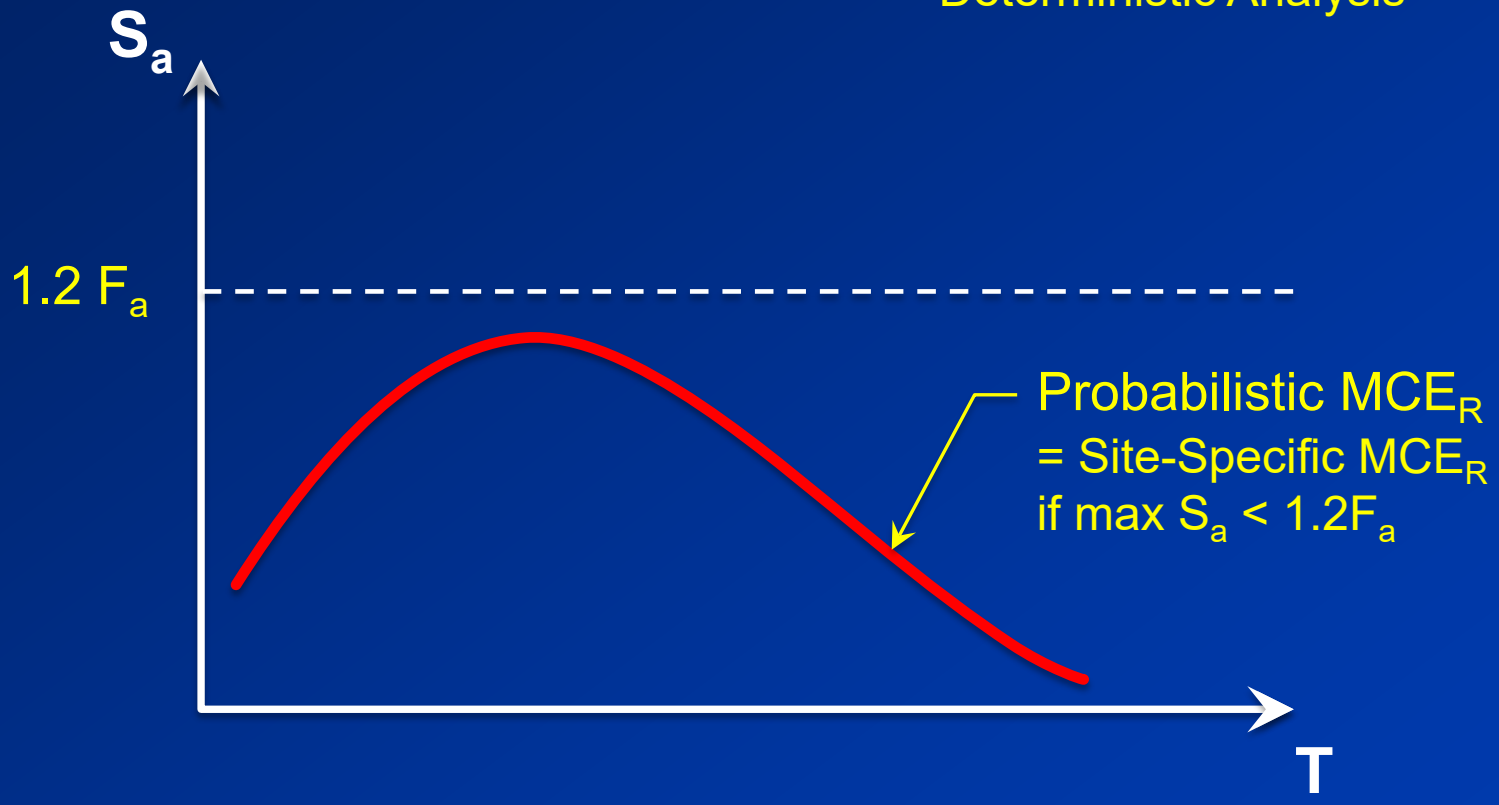


Ch. 21: Site-Specific Procedure in 7-16

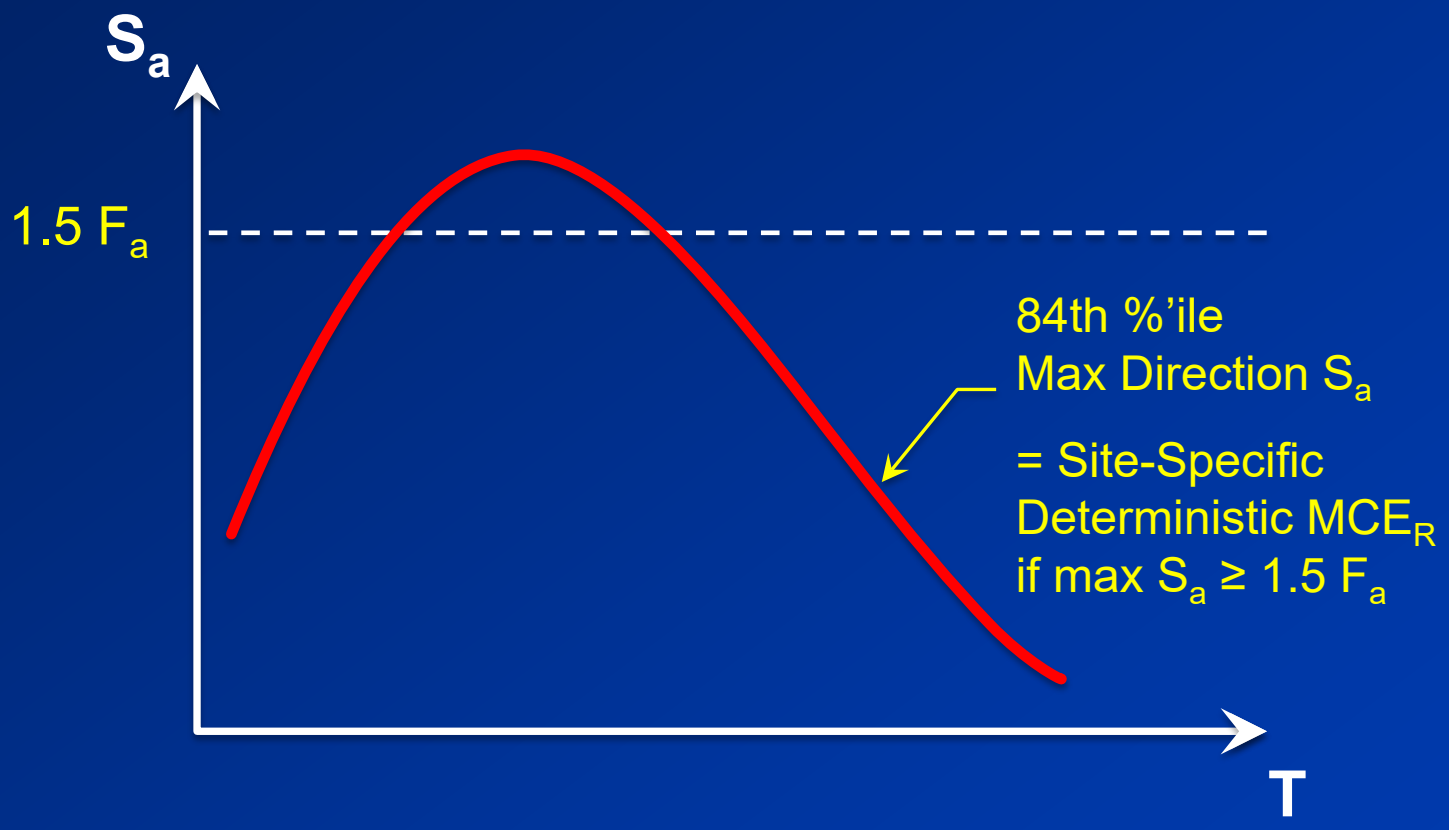
- Supplement 1 deleted DLL & replaced it with revised deterministic procedure
- Reason: Revision better accounts for spectral shape differences for softer site classes
- Best illustrated with figures

Sect. 21.2.2 – Exception to Deterministic MCE_R (Low to Moderate Seismic Area)

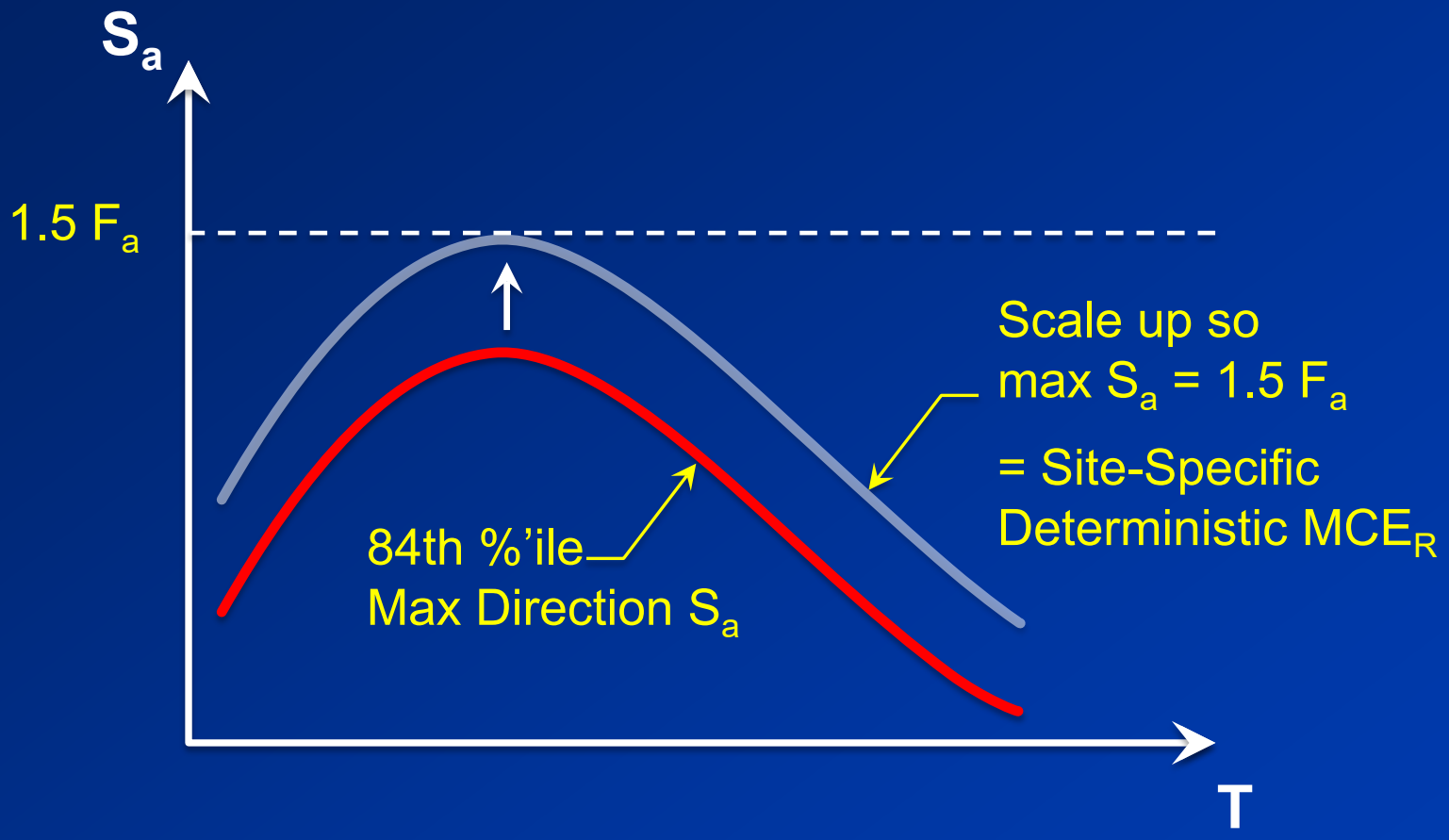
Eliminates Need for Deterministic Analysis



Sect. 21.2: Deterministic MCE_R (Very High Seismic Areas)



Sect. 21.2.2: Deterministic MCE_R (High Seismic Area)



Ch. 21: Supplement 1 Deterministic Procedure

- Supplement 1 provided values of F_a
  - Single value for each site class
  - Covers all S_S values

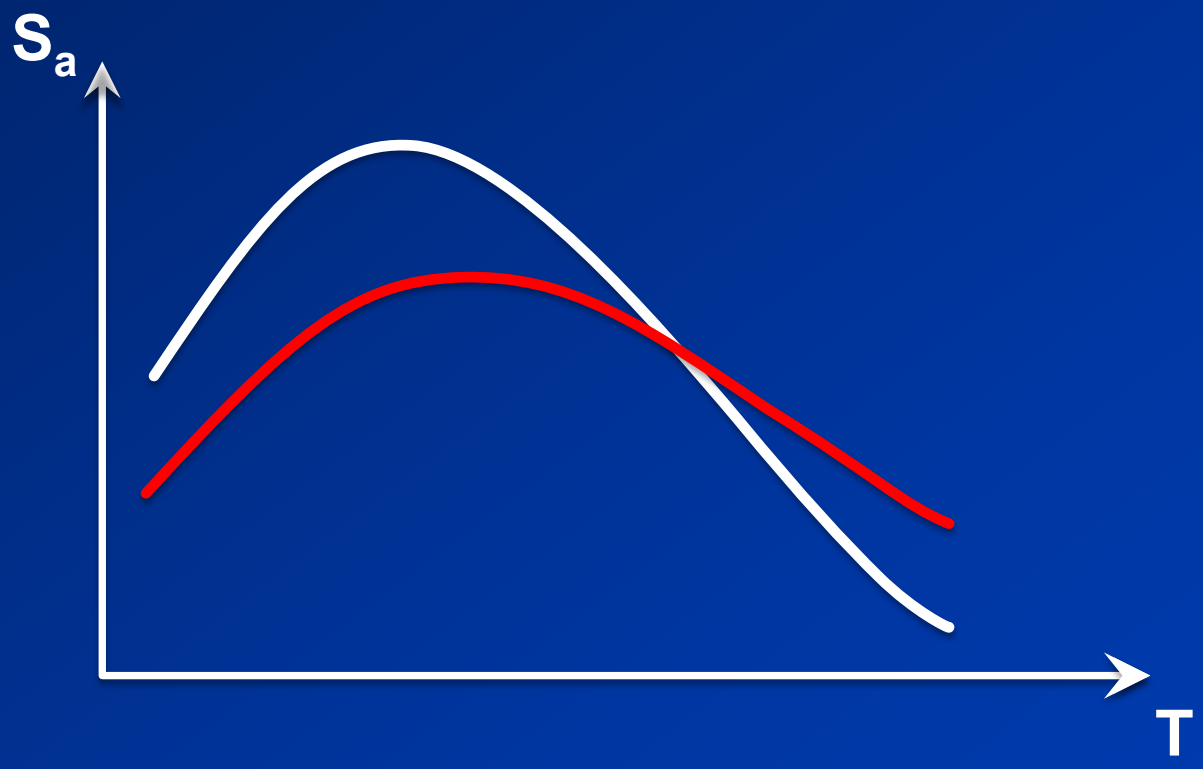
Ch. 21.2: F_a for Deterministic Procedure in Supplement 1

Site Class	F_a for S_S = 1.5
A	0.8
B	0.9
C	1.2
D	1.0
E	1.0

Sect. 21.2.3: Final Site-Specific MCE_R

Take smaller S_a from Prob. & Det. MCE_R at each T

No Change in this Criterion



Sect. 20.3.1: Problem with Site Class F

- Site response analysis required unless exception can be taken
- Exception for Cat. 1 Soils – Soils vulnerable to failure or collapse (e.g., liquefiable soils, quick & highly sensitive clays, collapsible weakly cemented soils)
- Exception says site response analysis not required if T_{1x} & $T_{1y} \leq 0.5$ sec
- Determine site class (C, D, or E), F_a & F_v from Tables 11.4-1 & 11.4-2, and S_{DS} & S_{D1}

Prob.: No F_a for Site Class E in Table 11.4-1

Site Class	S_S = 1.0	S_S = 1.25	S_S = 1.5
A	0.8	0.8	0.8
B	0.9	0.9	0.9
C	1.2	1.2	1.2
D	1.1	1.0	1.0
E	See Section 11.4.8	See Section 11.4.8	See Section 11.4.8

Sect. 20.3.1: Problem with Site Class F

- Fix: none in Supplement 2 of ASCE 7-16
- Solution 1: Do site response analysis
- Solution 2: Request code exception from AHJ and select appropriate values of F_a & F_v

Conclusions

- Need Supplement 1 to navigate the road though Chapters 11 & 21
- Road & ride are not smooth & dead ends in Exception in Sect. 20.3.1 (1) for Site Class E
- ASCE 7-22 should be smoother ride