Alternative Simplified Chapter 4 Commentary

In recent years, engineers and building officials have become concerned that the *Provisions,* and the building codes based on these *Provisions*, have become increasingly complex and difficult to understand and to implement. The basic driving force for this increasing complexity is the desire of the Provisions Update Committee to provide design guidelines that will provide for the reliable performance of structures. Since the response of buildings to earthquake ground shaking is by nature, very complex, realistic accounting for these effects leads to increasingly complex provisions. However, many of the current provisions have been added as prescriptive requirements relating to the design of irregularities in structural systems. It has been recognized that in order for buildings to be reliably constructed to resist earthquakes, it is necessary that the designers have sufficient understanding of the design provisions so that they can be properly implemented. It is feared that the typical designers of smaller, simpler structures, which possibly represent more than 90 percent of construction in the United States, may have difficulty understanding what the Provisions require in their present complex form.

In recognition of this, as part of the BSSC 2000 Provisions Update Cycle, a special task force was commissioned by BSSC to develop simplified procedures, acting as an ad-hoc group reporting to TS-2. The approach was to develop a simplified set of the Provisions for easier application to low-rise, stiff structures. The procedure was designed to be used within a defined set of structures deemed to be sufficiently regular in configuration to allow a reduction of prescriptive requirements. The procedure was refined and tested over the 2000 and 2003 cycles. It is presented as a stand-alone alternate procedure to Chapter 4. Significant characteristics of this alternative chapter include the following:

1. The simplified procedure would apply to structures up to three stories high in Seismic Design Categories B, C, D, and E, but would not be allowed for systems for which the design is typically controlled by considerations of drift. The task group concluded that this approach should be limited to certain structural systems in order to avoid problems that would arise from omitting the drift check for the drift-controlled systems (steel moment frames, for example). The simplified procedure is allowed for bearing wall and building frame systems, provided that several prescriptive rules are followed that result in a torsionally resistant, regular layout of lateral-load-resisting elements.
2. Given the prescriptive rules for system configuration, the definitions, tables, and design provisions for system irregularities become unnecessary.
3. The table of basic seismic-force-resisting systems has been shortened to include only allowable systems, and deflection amplification factors are not used and have been eliminated from the table.
4. Design and detailing requirements have been consolidated into a single set of provisions that do not vary with Seismic Design Category, largely due to sections rendered unnecessary with the prohibition of system irregularities.
5. The redundancy coefficient has been removed.
6. The procedure is limited to Site Classes A to D. At the same time, it is helpful in the simplified method to have default Site Class F_a values for buildings and regions where detailed geotechnical investigations may not be available to the structural engineer. A simple definition of rock sites is provided in Sec. Alt. 4.6.1. As a practical matter, it should be known from a rudimentary geotechnical investigation whether a site is rock or soil, and so additional seismic shear wave velocity tests or special 100-ft. deep borings will not be necessary when utilizing this procedure.

The default F_a values have also been set to mitigate the tendency for the SDC to be affected by the simplified S_{DS} value.

7. Vertical shear distribution is based on tributary weight. As a result, the special formula for calculation of diaphragm forces is removed, and calculations of diaphragm forces are greatly simplified. The base shear is based on the short period plateau and does not require calculation of the period. This base value is increased 25 percent to account for the vertical distribution method as well as other simplifications. A calibration study, Figure CAlt.4-1, covering a wide range of conditions indicates that the 25 percent adequately covers the simplifications without being overly conservative.

8. Simple rigidity analysis will be required for rigid diaphragm systems, but analysis of accidental torsion and dynamic amplification of torsion would not be required. Untopped metal deck, wood panel, or plywood sheathed diaphragms may be considered flexible, representing another simplification in calculations.

9. Calculations for period, drift, or P-delta effects need not be performed. 1percent drift is assumed when needed by requirements not covered in the simplified provisions. For example, in ACI 318, gravity columns are required to be designed for the calculated drift or to be specially detailed.

Calibration Study **Simplified Lateral Force Analysis Procedure** $V = 1.25 S_{DS} / R$

Fa =	1 for rock	1.4 for soil
Sds =	0.67	0.93
1.25*Sds* =	0.83	1.17

***Fa* Values**

		Z<=0.067	*Z*=0.13	*Z*=0.20	*Z*=0.27	*Z*>=0.33
Site Class		*Ss*<=0.25	*Ss*=0.50	*Ss*=0.75	*Ss*=1.00	*Ss*>=1.25
A	(hard rock)	***0.80***	***0.80***	0.80	**0.80**	**0.80**
B	(rock)	***1.00***	1.00	**1.00**	**1.00**	**1.00**
C	(soft rock)	***1.20***	1.20	**1.10**	**1.00**	**1.00**
D	(stiff soil)	***1.60***	1.40	**1.20**	**1.10**	**1.00**

Ratio of (Simplified S_{DS}) / (S_{DS} = Fa x 2/3 x S_S)

Site Class		*Ss*<=0.25	*Ss*=0.50	*Ss*=0.75	*Ss*=1.00	*Ss*>=1.25
A	(hard rock)	***1.25***	***1.25***	1.25	**1.25**	**1.25**
B	(rock)	***1.00***	1.00	**1.00**	**1.00**	**1.00**
C	(soft rock)	***0.83***	0.83	**0.91**	**1.00**	**1.00**
D	(stiff soil)	***0.88***	1.00	**1.17**	**1.27**	**1.40**

Ratio of base shear for all buildings and overturning moment for one-story buildings

Site Class		*Ss*<=0.25	*Ss*=0.50	*Ss*=0.75	*Ss*=1.00	*Ss*>=1.25
A	(hard rock)	***1.56***	***1.56***	1.56	**1.56**	**1.56**
B	(rock)	***1.25***	1.25	**1.25**	**1.25**	**1.25**
C	(soft rock)	***1.04***	1.04	**1.14**	**1.25**	**1.25**
D	(stiff soil)	***1.09***	1.25	**1.46**	**1.59**	**1.75**

Average net conservatism in overturning moment for two-story buildings

Equal floor masses and first story height equal or up to 1.5 x second story

Site Class		*Ss*.<=0.25	*Ss*=0.50	*Ss*=0.75	*Ss*=1.00	*Ss*>=1.25
A	(hard rock)	***1.44***	***1.44***	1.44	**1.44**	**1.44**
B	(rock)	***1.15***	1.15	**1.15**	**1.15**	**1.15**
C	(soft rock)	***0.96***	0.96	**1.05**	**1.15**	**1.15**
D	(stiff soil)	***1.01***	1.15	**1.34**	**1.46**	**1.61**

Average net conservatism in overturning moment for three-story buildings

Equal floor masses and first story height equal or up to 1.5 x typical story

Site Class		*Ss*<=0.25	*Ss*=0.50	*Ss*=0.75	*Ss*=1.00	*Ss*>=1.25
A	(hard rock)	***1.38***	***1.38***	1.38	**1.38**	**1.38**
B	(rock)	***1.10***	1.10	**1.10**	**1.10**	**1.10**
C	(soft rock)	***0.92***	0.92	**1.00**	**1.10**	**1.10**
D	(stiff soil)	***0.96***	1.10	**1.28**	**1.40**	**1.54**

Bold values indicates Seismic Design Category D in the Equivalent Lateral Force Procedure.
Bold Italic values indicates Seismic Design Category B in the Equivalent Lateral Force Procedure.

Figure CAlt.4-1 Calibration Study.

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