SEAW Earthquake Engineering Committee	**WHITE PAPER 1-2011**

Code Comparison for Seismic Design from the IBC 2006 to IBC 2009	**Date: April 4, 2011**
ABSTRACT: The intent of this White Paper is to compare the major changes in seismic building design from the 2006 International Building Code to the 2009 International Building Code.	**Task Group Members:** *Michael Bramhall, P.E., S.E., Chair* *Cheryl Burwell, P.E., S.E.* *Scott Douglas, P.E., S.E.* *Cory Hitzemann, P.E., S.E.* *Ed Huston, P.E., S.E.* *Peter Somers, P.E., S.E.* *Andrew Taylor, P.E., S.E.* *Tom Xia, P.E., S.E.*

COMMITTEE STATEMENT:

- *The recommendations in this White Paper represent the opinion of the task group and the Earthquake Engineering Committee. It should only be used as reference by engineers and building officials in conjunction with their own judgment and the actual project design assumptions.*

I. INTRODUCTION:

This memorandum was prepared by the Earthquake Engineering Committee of the Structural Engineers Association of Washington (SEAW) to assist design professionals in understanding recent changes between the provisions the 2006 International Building Code and the 2009 International Building Code and their related reference standards. The focus of this memorandum is restricted to the seismic design provisions for new buildings. No attempt has been made to summarize changes in other provisions of the code, such as wind or snow loads, nor has any attempt been made to address the provisions for existing buildings.

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II. GENERAL PROVISIONS - (IBC CHAPTER 16):

Overview

The provisions of Chapter 16 of the 2009 International Building Code (IBC) "govern the structural design of buildings, structures and portions thereof" (unless modified by a local jurisdiction). Seismic requirements are defined in Section 1613.

16-1	Clarifies provisions on penthouses and imposes additional limitations	**IBC 1509.2**
16-2	Revises the exception to the basic load combinations to indicate roof live load is not to be combined with seismic loads	**IBC 1605.3.1**
16-3	AISI S230 is added to residential structures. AISI S230 is the Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings	**IBC 1609.1.1**
16-4	A provision is added allowing increased building height for steel plate shearwalls	**IBC 1613.6.6**
16-5	Provision added to set requirements for separation distance between adjacent buildings	**IBC 1613.6.7**
16-6	A provision is added exempting some conditions of HVAC ductwork from seismic support	**IBC 1613.6.8**
16-7	Eliminates the 280 plf out-of-plane requirement for concrete and masonry walls	**IBC 1613.7**
16-8	Structural Integrity provision are added for Occupancy Category III or IV high rise buildings (taller than 75 feet above the lowest level of fire department vehicle access)	**IBC 1614**
16-9	Reference to ASCE7-05 includes reference to Supplement No. 2	**IBC Chapter 35**

III. STRUCTURAL TESTS AND SPECIAL INSPECTIONS - (IBC CHAPTER 17):

Overview

Chapter 17 covers Structural Tests and Special Inspections. The provisions of this chapter govern quality and workmanship with special attention paid to special inspection of the seismic resisting system in Section 1707

17-1	Special Inspections required by Section 1704 (rather than all special inspections) are exempt when work is performed by an approved fabricator.	**IBC 1704.2.2**
17-2	Editorial changes and clarifications are made throughout Table 1704.3 for steel verification and inspection	**Table 1704.3**
17-3	A provision is added changing welding of cold-formed steel light frame construction from continuous to periodic if the welder's qualifications are verified prior to start of the work	**IBC 1704.3**
17-4	Inspection of welding and bolting of steel is clarified	**IBC 1704.3.1 and IBC 1704.3.3**
17-5	An exception is added to the statement of special inspections for steel systems in SDC C having an R=3 or less that are not specifically detailed for seismic resistance	**IBC 1705.3.1**
17-6	Special certification of designed seismic systems is clarified	**IBC 1707.1**
17-7	Section 1707.2 on special inspection of structural steel welding is reworded to coordinate with AISC 341	**IBC 1707.2**
17-8	Inspection requirements for shearwalls with Gypsum board, fiberboard or wood structural panel sheathing over cold formed steel light frame construction are relaxed or exempted with fastener spacing greater than 4" oc	**IBC 1707.4**

17-9	Special inspection of masonry is updated to conform to the MSJC and eliminates Section 1708.1 for masonry testing for seismic resistance	**IBC 1708.1**
17-10	Testing and qualification for seismic resistance requirements are clarified	**IBC 1708.1**
17-11	Clarification of the requirements for special certification of designated seismic systems, and clarifies the distinctions between seismic certification and special seismic certification.	**IBC 1708.4**

IV. SOILS AND FOUNDATIONS - (IBC CHAPTER 18):

Overview

Chapter 18 of the 2009 IBC is a complete rewrite of the 2006 IBC Chapter 18 with revisions included. Because this chapter was reorganized, margin lines were not used to mark revisions. Significant changes related to seismic design are listed below.

18-1	2006 IBC sections for cast-in-place piles, driven piles, and composite piles have all been combined into one section, Deep Foundations, in the 2009 IBC.	**IBC 1810**
18-2	More specific design provisions have been added for retaining walls. The 2009 IBC indicates that the appropriate safety factors are to be checked for the following load case: 0.7 times nominal earthquake loads, and 1.0 times other nominal loads (also investigated with one or more of the variable loads set to zero). The minimum safety factor for sliding, when earthquake loads are included, is 1.1.	**IBC 1807.2**
18-3	The footing and pile seismic tie force required in soil site class E and F for shallow foundations in SDC D & above, and for all deep foundations in SDC C & above, need not be designed for more than 25% of the smaller column gravity load. There was previously no upper bound on the tie force, which is defined as the product of the larger footing gravity load, times S_{DS}, divided by 10.	**IBC 1809.13** and **IBC** 1**810.3.13**
18-4	The 2009 IBC has added exceptions to the curvature capacity requirements of section 1810.2.4.1 for piles in SDC D through F and soil site class E or F. Previously the curvature capacity requirement was included in 2006 IBC section 1808.2.23.2.1 and applied to all site classes.	**IBC 1810.2.4.1**
18-5	Exceptions have been added for deep foundation elements supporting R-3 and U occupancies not exceeding two stories of light framing. These elements are not required to meet special seismic detailing requirements of section 1810.3.9.4.1 and 1810.3.9.4.2	**IBC 1810.3.9.4**

V. MINIMUM SEISMIC DESIGN LOADS - (ASCE 7-05):

Overview

The determination of minimum seismic design loads for the design of buildings is set forth by the American Society of Civil Engineers (ASCE) in the reference standard ASCE 7. Since this standard is used in both the 2006 IBC and the 2009 IBC, there are no changes to the minimum seismic design load requirements. IBC Chapter 35 for Referenced Standards, however, includes reference to Supplement No. 2 to ASCE 7-05, which revises the minimum seismic response coefficient, C_s, for building and nonbuilding systems.

VI. CONCRETE DESIGN - (IBC CHAPTER 19 AND ACI 318-08):

Overview

The governing body for the design of concrete is the American Concrete Institute (ACI). The reference standard in the IBC 2009 for the lateral design of concrete is Chapter 21 of ACI 318-08.

IBC Modifications to ACI 318 in Chapter 19

- Most modifications to the ACI 318-08 made in Chapter 1908 of the 2009 IBC are editorial in nature in that they are deleting language that has been incorporated from Chapter 1908 of the 2006 IBC into the ACI 318-08.

Changes within ACI 318 from 2005 to 2008

19-1	Most sections have been re-numbered, and some have been re-named	
19-2	The word "Special" now refers consistently to detailing requirements for systems with high ductility (those systems generally required in SDC's D - F)	
19-3	Detailing requirements are now all based on SDC	**ACI 1.1.9 and ACI 21.1.1**
19-4	For the purpose of computing confining effects of transverse reinforcement, f_{yt} of up to 100 ksi can be used	**ACI 21.1.5.4 and ACI 21.5.5**
19-5	For the purpose of computing shear strength provided by transverse reinforcement, f_y and f_{yt} of up to 60 ksi can be used	**ACI 11.4.2**
19-6	Ordinary Moment Frames are now covered in Chapter 21	**ACI 21.2**
19-7	Changes to design and detailing of Intermediate Moment Frames	**ACI 21.3**
19-8	Slight relaxation on transverse reinforcement requirements in IMF elements supporting discontinuous walls with low axial forces	**ACI 21.6.4.6**
19-9	Changes to design and detailing of Special Moment Frames	**ACI 21.5, ACI 21.6 and ACI 21.7**
19-10	Wall boundary elements: maximum spacing of confining reinforcement has been increased for thin walls	**ACI 21.9.6.4(c)**
19-11	Coupling beams: required reinforcement for various aspect ratios has been clarified. Introduced new alternate confining reinforcement configuration	**ACI 21.9.7**
19-12	Diaphragms: Flexural strength can be computed using all reinforcement, not just boundary element reinforcement. Modifications to computations of shear strength.	**ACI 21.1 and ACI 21.11**
19-13	Appendix D: Three significant changes o New definitions of reinforcement that resists concrete breakout o New requirements related to seismic resistance of anchors o New provisions for breakout of lightweight concrete	**ACI Appendix D** **D.1, D.5.2.9 and D.6.2.9** **D.3.3.1 through D.3.3.6**

VII. Masonry Design - (IBC Chapter 21 & TMS 402/ACI 530/ASCE 5):

Overview

The design of masonry is jointly governed by The Masonry Society (TMS), ACI and ASCE. The reference standard in the IBC 2009 for the lateral design of masonry is TMS 402/ACI 530/ASCE 5

IBC Modifications to TMS 402/ACI 530/ASCE 5 in Chapter 19

- In general the seismic design modifications previously shown in 2006 IBC have been removed and are now incorporated in the TMS 402-08/ACI 530-08/ASCE 5-08, except for the following:

- The requirement for using a 1.5 multiplier for shear design when using ASD (2006 IBC 2106.5.1) has been moved and now applies to any Special Reinforced Shear Wall **TMS/ACI/ASCE 1.17.3.2.6.1.2**
- The requirement for using only the reinforcing steel to calculate the shear strength towards the base of certain shear walls (2006 IBC 2106.5.2) has not been retained.

➢ A few lateral force resisting system definitions have been removed from the 2009 IBC Chapter 21

Changes within TMS 402/ACI 530/ASCE 5 from 2005 to 2008

21-1	Seismic Requirements have been moved from Section 1.14 to Section 1.17 because new sections in Chapter One on beams (1.13), columns (1.14) and anchor bolts (1.16) have been added. In keeping with the direction of ASCE 7, the applicability of certain provisions is now based on type of shear wall system (ordinary, intermediate, or special) as opposed to SDC. For example, while a "special" system must be used in SDC D and above, it may also be used in SDC C and below. Wherever it is used, the same detailing provisions apply.	**TMS/ACI/ASCE 1.17**
21-2	Out of plane wall anchorage loading requirements have been removed from TMS/ACI/ASCE and the user is directed to the IBC & ASCE 7.	
21-3	For flanged shearwalls, the effective compression flange is limited to 6 x wall thickness and effective tension flange is limited to 0.75*(floor-to-floor height)	**TMS/ACI/ASCE 1.9.4.2.3**
21-4	Anchor bolt equations have been revised to be in alignment between ASD & strength design	**TMS/ACI/ASCE 2.1.4 & 3.1.6**
21-5	The design of lightly loaded columns has moved from IBC 2107.4 to TMS/ACI/ASCE	**TMS/ACI/ASCE 1.14.2**
21-6	The maximum spacing of horizontal reinforcement in special reinforced masonry shearwalls in now only required to be the smaller of one-third the length or height of the shear wall when such horizontal reinforcement is required to resist shear forces.	**TMS/ACI/ASCE 1.17.3.2.6(b)**
21-7	The design shear capacity to resist the shear associated with the development of probable moment strength now only applies to special reinforced masonry shear walls and has been moved from section 3.1.3 in the 2005 standard.	**TMS/ACI/ASCE 1.17.3.2.6.1.1**

VIII. STRUCTURAL STEEL DESIGN - (IBC CHAPTER 22 AND AISC 341-05):

Overview

The governing body for the design of steel is the American Institute of Steel Construction (AISC). The lateral design of structural steel members is governed by the provisions of AISC 341-05. This reference standard is used in both the 2006 IBC and the 2009 IBC.

IBC Modifications to AISC 341-05

➢ The modifications to the seismic design of structural steel buildings originally denoted in the 2006 IBC Section 2205 remains unchanged in the 2009 IBC.

Changes within AISC 341

None. The reference standards for structural steel design in the 2009 IBC are the same documents as those referenced in the IBC 2006.

IX. COLD FORMED STEEL DESIGN - (IBC CHAPTER 22 & AISI S213-07):

Overview

The governing body for the design of cold formed steel is the American Iron and Steel Institute (AISI). Prior to this code cycle, the design of cold formed steel was governed by the NAS-01 with standards for various aspects of design including the Lateral-04 document for the lateral design of cold formed steel members. In 2007, AISI revamped and renumbered their format. The new reference standard for the lateral design of cold formed steel is AISI S213-07.

IBC Modifications to AISI S213-07

- The only changes to the cold-formed steel lateral design provisions from the 2006 IBC to the 2009 IBC are editorial in nature recognizing the change in name of the reference standard.

Changes from AISI Lateral 04 to AISI S213-07

22-1	Numerous editorial changes	
22-2	Definitions moved to AISI S200-07 (General Provisions)	
22-3	Incorporation of Canadian Design Code References and Design Values (metric)	
22-4	Incorporation of Fiberboard Panel Sheathing (Seismic Design Categories A, B, and C only)	**AISI C2.2.4**
22-5	Addition of diagonal strap bracing provisions: o Diagonal Strap Bracing R_y and R_t values o Connection Design o Chord Studs and Anchorage o Addition of section regarding limitations for CFS Shear walls to resist seismic forces contributed by concrete and masonry walls	**AISI C5.2**

X. WOOD DESIGN - (IBC CHAPTER 23 & SDPWS-08):

Overview

The 2009 IBC updates for seismic design of wood-frame structures primarily involve a new version of the reference standard, *Special Design Provisions for Wind and Seismic* (SDPWS). As a result, many of the IBC provisions have been deleted because they are now contained in the reference standard.

IBC Modifications to SDPWS-08 in Chapter 23

- Whereas the 2006 IBC permitted the use of SDPWS-05 as an alternate to the seismic provisions in Section 2305, the 2009 IBC requires structures to be designed in accordance with the SDPWS-08 and the additional provisions of Sections 2305, 2306, and 2307. IBC 2305
- Substantial portions of Section 2305 have been removed because they are now contained in the SDPWS-08.
- Since it is a dual format standard, SDPWS-08, is referenced for general design, including seismic, in both Section 2306 (ASD) and Section 2307 LRFD.

Changes within SDPWS from 2005 to 2008

23-1	The shear strength reduction for perforated shear walls has been revised	**SDPWS 4.3.3.5 & SDPWS 4.3.5.3**
23-2	Provisions for unblocked shear walls have been added	**SDPWS 4.3.3.2**

23-3	Provisions for gypsum lath and plaster shear walls have been added	**SDPWS 4.3.7.5.3**
23-4	Provisions for plate washer size and location have been revised	**SDPWS 4.3.6.4.3**
23-5	Provisions for high load wood structural panel diaphragms have been added	**SDPWS 4.2.7.1.2**
23-6	Provisions for shear walls with wood structural panels over gypboard have been added	**SDPWS 4.3.7.2**
23-7	Provisions for framing and nailing for shear walls sheathed on two sides have been added	**SDPWS 4.3.3.3**
23-8	Provisions for stitching 2x framing in lieu of the required 3x framing have been added, consistent with the Commentary to the SDPWS-05 and the 2006 IBC	**SDPWS 4.3.7, item #4 exception**