

S16-09 for those familiar with S16-01(R05)

The following is a summary of changes in S16 when advancing from S16-01(R05) to S16-09. The following is a partial list and only attempts to bring attention to what are believed to be the more important changes from the standpoint of the Code user.

Note: S16-09 was released September 1, 2009 and will be adopted by NBCC 2010 and derivative standards (BCBC 2011?). Use of S16-09 is not recognized by NBCC 2005 or BCBC 2006. "Cherry-Picking" of clauses from standards differing from the recognized standard is definitely not accepted practice.

Date: October 24, 2010 (Last update this summary).

Clause	Revision
2	Minor updating of definitions and symbols has occurred to bring in line with the changes in the body of the Code.
3	Reference publications have been updated for example A23.3-04 is now referenced instead of A23-94(R2000). This has the result of changing the ϕ factor for concrete from 0.6 to 0.65 and this has a small influence on composite beams and on bearing of column base plates.
4.2.2	The design criteria for seismic loads is now required to be stated on drawings. S16-01 referred to seismic zones which was out-dated when NBCC 2005 dropped the Zone classification in favour of the short period spectral acceleration ratio,
4.2.2	Specified superimposed dead-loads used in design are now required to be shown on drawings.
4.2.2	The designer must show on drawings the protected zone for seismic systems. (See more discussion of this under clause 27).
5.1.3	A572 has been added as an acceptable steel. The specification for this steel is similar to G40.21 and was referenced in the "Blue Pages" of the CISC handbook.
6.7	New clause added to cover requirements under fire conditions - for the most part this references new Annex K on "Structural Design for Fire Conditions". Note an appendix is now called an Annex.
11	Some minor changes in the notation in Clause 11 and the referenced table 1 and table 2 to make more consistent.
13.1	The ϕ factor for concrete has been increased from 0.6 to 0.65 and this has a small influence on composite beams. The resistance factors for beam bearing ϕ_{be} and ϕ_{bi} are now given the table.
13.3.2(b)	Equation added to assist in the evaluation of the flexural buckling of singly symmetric sections such as channels and tees.
13.3.2(c)	Equation added for the flexural buckling of asymmetric sections such as bulb angles. (For angles see 13.3.3)
13.3.3	Clause added to provide guidance for single angle members in compression especially those that are connected in the traditional way of two bolts in one leg. The compressive resistance obtained using these formulas is less than the resistance obtained in the "traditional" calculation including using the lowest principal axis.
13.4.1	Shear clause changed such that there are three simpler equations for beams without stiffeners - the result is three equations and no need to assume take account of a/h ratio for the stiffeners. Prior to S16-09 there were four more equations for beams with stiffeners and the assumptions for a/h had to be made.
13.4.1.3	Clause added to cover shear resistance for circular, square and rectangular HSS members
13.6	The equation for ω for laterally unsupported members has been changed and now effect of moment at quarter-point, mid-point and three-quarter point. This changes the value of ω_2 and reflects current research.

13.6(e)	Additional requirements are provided for the bending resistance of singly symmetric sections. Previously "rational analysis" was required.
13.8.1	Minor revision to the clause that defines when the frame is braced and when it is considered un-braced.
13.8.5	Wording made clearer to show that is evaluated using moments at the ends of the element. Previously the clause talked about ends of the unsupported length which caused confusion if the member was fully supported.
13.9(b)	Its now clearer that the b part of this clause applies only to members with axial tension and bending in an laterally unsupported condition (difficult to achieve in practice!).
13.11	Revised and more rational formula for block shear tension member beam and plate connections are now included. A new factor U_t is now included to differentiate between various member and end conditions, U_t is different for angles than for beams and beams with one row of bolts differ from beams with two rows of bolts.
13.14	The provisions for welds and high strength bolts in combination have been modified.
16.5.1.d	Clause added to cover the requirement that under NBCC load combinations downward wind is to be considered in conjunction with the snow load. Under the effects of snow load the wind is considered a companion load.
16.5.7.6	If mechanical fasteners are to be used for fixing deck to joists the building designer is now required to specify the minimum thickness of joist top chord. Joist top chords that are too thin will not work well with pins or screws.
17.7.2.1	Commonly available studs for composite action are typically 450 MPa and the Clause has been changed to reflect this.
17.7.3	The formula for channel connectors when used in composite construction has been changed and now complies with the bridge code.
22.5	F2250 Washers are now listed as acceptable. F2250 washers are those to go with A490 twist-off bolts
24.4	Guidance is provided for welding over coverings such as primer.
25.4.1.3	Rolled steel bearing plate thickness now increased to incorporate those that are a nominal 2" thick.
27.1.1	Introductory comments to seismic section updated. Many of the seismic requirements of S16-09 are based on the short period spectral acceleration ratio (IEFaSa(0.2)) with higher seismic zones having more onerous detailing rules than the lower zones.
27.1.4	Splices in gravity columns in multi-storey buildings now required to be designed for a minimum shear that takes account of the deformation of the member that occurs under seismic loading.
27.1.5.1	The R_y for HSS members has increased to 1.37 this reflects the cold working of the plates produces higher strength steel that does not yield at the levels expected which is unconservative when sizing the adjacent members. (R_y is computed by back-calculation from the minimum $R_y F_y$ of 460 MPa ($R_y = 460 \text{ MPa} / 350 \text{ MPa} = 1.37$). This will increase the strength requirements for columns of the brace bay and will increase diaphragm forces on buildings using HSS brace members. (Previously under S16 $R_y F_y$ for HSS members was 385 MPa)
27.1.8.1	Notional loads are not required to be considered when the yielding forces of members are placed on the structure. Note that if the notional loads are to be considered when sizing the members prior to consideration of capacity design.
27.1.9	The concept of "protected zones" is introduced the aim is to provide protection to the zones where the inelastic action will take place. In the protected zone the fasteners, welds and holes are not permitted including those for attaching mechanical, electrical or architectural features. The exception is that decks may be spot welded in the protected zone but may not be pinned or screwed. Each of the systems in Clause 27 lists the extent of the protected zone.
27.2.8	The protected zone for moment frames is established. Portions of beams and columns are protected based on the expected inelastic deformations.

27.5.3.1	In high seismic zones the minimum slenderness (kL/r) for HSS bracing members in $R_d=3.0$ systems is now required to be greater than 70 and there are requirements concerning the establishment of the effective length of the member.
27.5.3.4	The designer must consider two levels of force in bracing members when calculating the forces in the supporting elements of those braces: a) The probable compression resistance (computed using ϕ of 1.0 and an effective yield of $R_y F_y$. b) the post buckling capacity of the member.
27.5.5.2	Minimum slenderness requirements for columns both in and outside the brace bay are now specified. The aim is to provide a degree of ductility on those columns that may experience bending moments due to movements of the building under seismic loading. The need for bending resistance in the brace bay columns is greater than those outside the brace bay and the requirements are more restrictive for those columns in the brace bay. Columns in single and multi-story brace bay buildings shall not be class 4.
27.5.6	Protected zone for braces are defined as the full brace and the elements (such as gusset plates) which connect the brace to the adjacent columns and beams. Protected zones require that attachments for deck (and presumably steel stud) be done with arc spot welds and not connectors that penetrate the protected zone such as pins or screws
27.6.6	For $R_d=2.0$ concentric brace frames columns with bracing intersecting between floors is now permitted provided a series of conditions are achieved. These conditions include requirements on the out of plane strength of the column. Previously braces intersecting between floors was prohibited under all circumstances.
27.7.1.3	The protected zone of an EBF is defined as being the link and a zone extending beyond in the beam outside the link zone.
27.7.6.2	Eccentrically braced frames are now permitted to have links constructed from welded plate in a closed section. This makes it possible to have EBF's in locations where bracing would be difficult such as in bridge construction or in elevator shafts.
27.7.12.2	Restrictions are introduced to columns inside the brace bay to require them to have axial interaction low enough to allow the columns to resist their axial load in conjunction with moments induced from deformation of the building.
27.8	A clause is now added to cover buckling restrained brace frames. These systems contain a steel core that can yield under axial load. The steel core is restrained such that it does not buckle by a larger diameter shaft that does not participate in the axial resistance. These elements have similar response in compression and tension. The protected zone consists of the core and the elements that connect the core to columns or beams.
27.9.2.3	Ductile plate walls can now have perforations provided certain rules are followed - there has been a variety of testing on this type of system which allows for some pipes to pass through.
27.9.4.2	Ductile plate walls can now have perforations at the corner intersection between the beam and columns provided certain rules are followed - there has been a variety of testing on this type of system which allows for some pipes to pass through.
27.9.7	The protected zone of ductile plate shear walls are defined. The infill plates are protected as are some areas of the beam and column depending on the expected behaviour of the system.

27.10.	The requirements for limited ductility plate walls are now included in clause 27 and are now subject to capacity design. Previously limited ductility plate walls just had to comply with Clause 20. The limited ductile plate walls must comply with the requirements of Clause 27.9 with the some of the relaxations outlined in clause 27.10
27.11.1	Diaphragm bail-out limits for $R_d=1.5$ buildings are provided. For ductile diaphragms the diaphragms need not be designed for forces greater than: a) $R_d R_o=1.95$ if the diaphragm is ductile b) $R_d R_o=1.3$ if the diaphragm is not ductile.
27.11.3	The height limits for conventional construction ($R_d=1.5$) has been extended provided a variety of conditions are satisfied. The restrictions are such that this extension would mostly apply to industrial buildings. At present "conventional construction" buildings are limited to a height of 15m in higher seismic zones. The desire to extend the height limits on $R_d=1.5$ buildings is primarily for industrial type structures which due to their size and configuration often do not fit into other better defined seismic systems.
25.2	All column bases now require a minimum of four anchor rods unless special precautions are taken.
	<u>Changes to tables</u>
Table 6	The bolt edge distances for plates cut with plasma, laser and water jet are shown to be the same as those cut with gas. Prior to this there was no guidance on bolt edge distance with laser cut or water cut edges.
Table 11	This was a table of importance factors for snow, wind and earthquake - this table has been removed from S16. The user should refer to NBCC for this information which includes various notes that were not present in the S16 version.
Table 12	This was a table of building importance categories - this table has been removed from S16. The user should refer to NBCC for this information which includes various notes that were not present in the S16 version.
Table 13	This was a table of load combinations - this table has been removed from S16. The user should refer to NBCC for this information which includes various notes that were not present in the S16 version.
	<u>Changes to Annexes</u> - note what used to be called an appendix is now considered to be an Annex.
Table D1	Deflections limits are shown as being under live or snow loading. Prior to NBCC 2005 snow was considered to be a live load.
Annex K	New Annex on design under fire conditions. Shows how steel loses strength and stiffness with elevated temperatures. Definitions include practical definitions of "Restrained" and "Unrestrained" construction.
Annex L	A new annex has been added "Design to prevent brittle fracture" the desire is to provide guidance to prevent brittle fracture especially for members exposed to cold temperatures.
	Andrew Metten, P.Eng., Struct.Eng.
	October 24, 2010