AISC 341-22 — DRAFT PUBLIC REVIEW COMMENTS: PROPOSED RESPONSES

Review Period: September 4, 2020 – October 16, 2020

Name of Reviewer	Section of PR Draft	Line Number of PR Draft	Comment	Background/ Rationale	Committee Response	Reviewer Final Response (Enter "Resolved" or "Unresolved")
Peter Maranian (pjmaranian.se @gmail.com)	C2	15	Add "All critical sections at components of members shall be checked by the Von Mises Yield Criterion. This shall include verifying yielding can occur if yielding is the expected performance."	The criterion, which may have been established by James Clerk Maxwell in 1865, was formulated by Von Mises in 1913. It has been in the British specifications for decades but its absence in the AISC Specifications frankly leaves an unnecessary void. [Ref. Dowling (2007), BS 449)]	**NONPERSUASIVE.** Requirements in AISC Specifications for the design of moment frame, braced frame and shear wall systems accounts for yielding of the respective ductile elements of the system. Explicit research through finite element analysis and full-scale testing has been performed to verify the von mises yield criterion for each system. Unless there is a deviation from the specifications, verifying von mises stress for every element could be an excessive task.	
Peter Maranian (pjmaranian.se @gmail.com)	C3	25	Add, "Where dynamic Non-Linear Analysis is not used increased moments due to the phenomena of moment magnification shall be included"	Moment Magnification in columns is due to higher mode effect and can substantially increase the moments in columns such that column yielding may take place. [Ref. Pauley and Priestley (1992), Bondy (1996)] Pauley, T. and Preistley, M.J.N., 1992, "Seismic Design of Reinforced	**NONPERSUASIVE.** The AISC standards are not the right place for this language. Higher mode effects are predominant in tall structures for which dynamic analysis is typically required by the building code officials. Dynamic Analysis with 90% mass participation will consider moment magnification due to higher modes.	

				Concrete and Masonry Buildings". Bondy, K.D., 1996, "A More Rational Approach to Capacity Design of Seismic Moment Frame Columns." Earthquake Engineering Research Institute, Oakland, California.		
Peter Maranian (pjmaranian.se @gmail.com)	C3	25	See (background/rationale) comments	Consideration should be given to checking major structures for fatigue, primarily from wind, followed by major earthquakes (MCE). Reference Partridge et al(2000), Kandvinde et als (2018) Partridge, J.E., Paterson, S.R. and Richard, R.M., 2000, "Low Cycle Fatigue Tests and Fracture Analyses of Bolted-Welded Seismic Moment Frame Connections." July; STESSA 2000, Third International Conference, Montreal, Canada. Kanvinde, A; Maranian, P; Joseph, L; Lubberts, J (2018). "Fracture and Fatigue Design of the Wilshire Grand Tower", Engineering Journal, the American Institute of Steel Construction, Vol. 55, pp 181-189.	**PERSUASIVE**. Include the following sentence in Section C2 – "The effects of fatigue due to low-cycle loading shall be considered in the analysis and design of the members and its connection."	
Peter Maranian (pjmaranian.se @gmail.com)	D1.1	17	Add, "Members, including details associated with the members, shall be	There are many instances where significant yielding may not be able to occur.	**NONPERSUASIVE:** The reviewer is correct in that there are many instances where significant yielding may not be	

			verified that they are able to perform in a ductile manner accounting for bi-axial and/or triaxial conditions	These include but are not limited to the following: (i) Plane strain conditions (ii) Bi-axial conditions such that shear yielding, required for ductility, cannot occur. (iii) Tri-axial conditions again such that shear yielding cannot occur. (iv) Regarding item (iii), the existence of stiffeners at maximum moment could create tri-axial condition limiting the ability of the member to yield. (v) The existence of holes, notches, and the like causing stress concentration (vi) Low service temperature reducing fracture toughness Ref. Dowling (1999), Blodgett (1998): Blodgett, O.W., 1998, "The Effects of Constraints on Ductility in Welded Beam to Column Connections; International Conference on Welded Construction in Seismic Areas", American Welding Society. October 1998, Maui, Hawaii.	able to occur. The ductility requirements in these Provisions address those concerns. The reviewer's rationale is the same as for his comment on AISC 360 and the same response is given here as it relates to applying the Specification requirements. Plastic moment, $M_p=F_yZ_x$, has been reached in most of the conditions listed by the commenter. Common holes, stiffeners, loading conditions regularly can reach M_p so long as the Specification provisions in their entirety are followed. It is worth recalling that M_p does not include benefits of strain hardening and tests in many cases exceed M_p at very small levels of deformation. Other limit states are addressed in other Sections of the Specification.	

				Dowling, N. E., 1999, "Mechanical Behavior of Materials-Engineering Methods for Deformation, Fracture and Fatigue", 2nd Edition., Prentice Hall.		
Peter Maranian (pjmaranian.se@gmail.com)	D1.2	43	Add," Where bracing is required, a minimum of two braces shall be provided"	This is to ensure that the bracing system provides an effective mechanism for stability. Refer to Maranian, Kern and Dhalwala (2012). Also applicable to Intermediate and Special Moment Frames. Maranian, P., Kern, R., Dhalwala, A. (2012). "Considerations on Buckling and Lateral Bracing Issues With an Emphasis on Steel Moment Frames in Seismic Areas". ASCE 6th Congress on Forensic Engineering; San Francisco CA, October 31 – November 3, 2012.	**NONPERSUASIVE**, the committee believes the current requirements are adequate to "ensure that the bracing system provides an effective mechanism for stability."	
Peter Maranian (pjmaranian.se@gmail.com)	D1.2b	81	Add," Where bracing is required it shall be orientated perpendicular to the longitudinal axis of the beam / girder." Alternatively, a properly configured single brace designed for ultimate tensile strength of the beam flanges Will provide acceptable performance.	Bracing not perpendicular to the beam/ girder will tend to adversely restrain the yielding of joint. Refer to Maranian, Kern and Dhalwala (2012). Maranian, P., Kern, R., Dhalwala, A. (2012). "Considerations on Buckling and Lateral Bracing Issues With an Emphasis on Steel Moment Frames in Seismic Areas". ASCE 6th Congress on Forensic Engineering; San	**NONPERSUASIVE** the committee believes the current requirements are adequate and there is no need to require bracing perpendicular to the beam. Lateral bracing provided by floor diaphragms have provided bracing without negative results.	

				Francisco CA, October 31 – November 3, 2012.		
Peter Maranian (pjmaranian.se @gmail.com)	D1.4a(b)	138	Delete sentence starting "It is permitted…."	Applied moments are real effects and thus should be included.	**NONPERSUASIVE**, the requirement states that they may be ignored "unless the moment results from a load applied to the column" thus the Provisions recognize that they are real effects.	
Peter Maranian (pjmaranian.se @gmail.com)	E1.2.	24	See (rationale/background) comment	Although not part of this Specification, it should be verified that use of this Specification along with ASCE 7 reasonably accurately evaluates only minimal inelastic deformation. Similar for other ordinary systems including cantilevers and braced frames.	The provisions in AISC 341 are developed in conjunction with ASCE 7 to reflect the intended behavior for each system, including the ordinary systems.	
Peter Maranian (pjmaranian.se @gmail.com)	E1.6b.(d)	128	User Note; delete "not including overstrength seismic load"	There is no engineering justification not to include overstrength when other systems are required to do so.	As noted in the Commentary to Section E1.6b, designing the panel zone using basic code prescribed loads may result in design where initial yielding of the frame occurs in the panel zones. This is viewed as acceptable behavior due to the high ductility exhibited by panel zones.	
Peter Maranian (pjmaranian.se @gmail.com)	E1.6c	140	After (d), add (e) ; " Drift and stability analysis shall account for PR connection performance."	Increased rotation due to PR connection will increase drift and will reduce stability.	The increased rotation due to PR connections will be considered for the 2028 code cycle.	
Peter Maranian (pjmaranian.se @gmail.com)	E2.2	147	See comment	Although not part of this Specification, it should be verified that use of this Specification along with ASCE 7 reasonably accurately	The provisions in AISC 341 are developed in conjunction with ASCE 7 to reflect the intended behavior for each system, including the ordinary systems.	

				evaluates only limited inelastic deformation. Similar for other ordinary systems including cantilevers and braced frames.		
Peter Maranian (pjmaranian.se @gmail.com)	E3.4a.	287	Add, “Mpc shall exceed moment determined from analysis including the effect of moment magnification.	Moment Magnification in columns is due to higher mode effect and can substantially increase the moments in columns such that column yielding may take place. Also, Section 3.6(b) does not test connections where column yielding occurs.	The strong column / weak beam (SC/WB) provision is not intended to prevent the columns from yielding, and nonlinear response history analyses show column yielding is possible (due to things like higher mode effects) as described in the Commentary to Section E3.4a. The goal of the SC/WB provision is to create a condition where "columns are generally strong enough to force flexural yielding in beams in multiple levels of the frame." Column axial force is considered in the SC/WB calculation in Equation E3-2.	
Peter Maranian (pjmaranian.se @gmail.com)	E3.4c.1(b)	374	Add, “Out of plane forces shall be considered as additional to this requirement”	Significant out of plane forces can occur simultaneously with in plane maximum demands	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section E3 is limited to the additional analysis requirements for SMF, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	E3.4c.1(b)	374	See comment	Please confirm AISC 360 stiffness requirements still apply. Consider adding a statement to confirm this.	In Section A1, the scope of AISC 341 states, "All requirements of the Specification are applicable unless otherwise stated in these	

					Provisions." With no exemption noted here, the requirements of AISC 360 shall apply.	
Peter Maranian (pjmaranian.se @gmail.com)	E4.3b	738	See comments	There should be an equation similar to equation (E3-1) to ensure the system provides for strong column weak Truss Moment Frame? Ensure material strengths are considered as well as moment magnification (see comments above)	In Section E4.3b, titled "Nonspecial Segment," a capacity design requirement for the column is prescribed as follows: "The required strength of nonspecial segment members and connections, including column members, shall be determined using the capacity-limited horizontal seismic load effect. The capacity-limited horizontal seismic load effect, Ecl, shall be taken as the lateral forces necessary to develop the expected vertical shear strength of the special segment acting at mid-length and defined in Section E4.5c. Second-order effects at maximum design drift shall be included." More details regarding how to design columns for the required strength are given in the Commentary E4.3b.	
Peter Maranian (pjmaranian.se @gmail.com)	E4.4a	762	Add, "Out of plane forces shall be considered in addition to in plane demands"	Significant out of plane forces can occur simultaneously with in plane maximum demands. Also, recommend further testing on this system, beyond that by Itani and Goel (1991) to verify performance with both in plane and out of plane force demands.	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section E4 is limited to the additional analysis requirements for SMF, and out-of-plane forces require no	

					analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	E5.3	852	Add, "Design of the cantilever shall include out of plane forces "	Simultaneously out of plane forces with in plane forces can significantly affect the performance of the cantilever and its connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section E5 is limited to the additional analysis requirements for OCCS, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	E6.3	877	Add, "Design of the cantilever shall include out of plane forces	Simultaneously out of plane forces with in plane forces can significantly affect the performance of the cantilever and its connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section E6 is limited to the additional analysis requirements for SCCS, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	F1.3	27	Add, "Design of the braced Frames shall include out of plane forces	Simultaneously out of plane forces with in plane forces can significantly affect performance of the braced frame and its connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section F1 is limited to the additional analysis requirements for OCBF, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	F2	124	See (rationale/background) comment	Justify use of the system since it shows poor performance when tested. (Reference Uriz and Mahin 2004)	The Committee is aware of the results of this referenced test program and has incorporated revisions to the provisions to	

				Uriz, P and Mahin, S.,(2004)"Seismic Performance Assessment of Concentrically Braced Steel Frames". Proceedings of the 13Th World Conference on Earthquake Eng	address relevant issues (e.g., an emphasis on net section checks). Additional extensive testing of SCBF by numerous independent research programs has contributed to the development of the SCBF seismic provisions proposed for 2022. The adequate performance in testing justifies inclusion of the system in AISC 341-22.	
Peter Maranian (pjmaranian.se @gmail.com)	**F2.3**	178	Add, "Design of the braced Frames to include out of plane forces	Simultaneously out of plane forces with in plane forces can significantly affect performance of the braced frame and its connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section F2 is limited to the additional analysis requirements for SCBF, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	F2.6.6c.4	393	Add "Design of gusset plates shall consider frame rotational affects including frame tendency to close when brace is in tension and frame tendency to open when brace is in compression."	Opening and closing of frame can significantly affect gusset plates. Buckling, as well as occurring when the brace is in compression can also occur when the brace is in tension.	The Committee has considered numerous behavioral states in developing the Seismic Provisions including accommodation of brace bucking, rotational capacity requirements for brace connections, and requirements for beam-to-column connection. It is the opinion of the Committee that these provisions adequately address frame performance requirements without incorporating the recommended revisions..	

Peter Maranian (pjmaranian.se @gmail.com)	F3.5b.4 &F3.5b.5	579 &599	Add, "The connection of the link to the diagonal brace shall be checked for the complex stresses including flexural, shear and axial forces utilizing Von Mises Criterion".	See comment on C2 (line 15) above.	The method for evaluating complex stress interactions is outside the scope of AISC 341. While methods are discussed in other AISC publications, such as the AISC Steel Construction Manual, they will not be included in AISC 341.	
Peter Maranian (pjmaranian.se @gmail.com)	F4,3	764	Add, "Design of BRBS to include out of plane forces."	Simultaneously out of plane forces with in plane forces can significantly affect performance of BRBF and their connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section F4 is limited to the additional analysis requirements for BRBF, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	F5	942-1143	See (rationale/background) comments.	(i) There are no requirements for the stiffness of VBEs and HBEs, There should be in order to control stress. The performance should consider Wagner's tension field theory and investigations. Johnston (1976) (ii) There are no requirements or guidance with regard to HBEs with web plate above and below and for VBEs with web plate each side regarding web	The suggested additional requirements and recommendations will be considered for the 2028 code cycle.	

				plate loading. This should include consideration of unbalanced forces. (iii) The analysis needs to include performance at various stages. That is, elastic stage, the yielding stage and partial buckling. Different parts of the shear wall system in a multi-story building will perform differently. The system needs to verified to ensure that the secondary stresses due to gravity and overturning forces do not adversely affect the steel plate system.		
Peter Maranian (pjmaranian.se @gmail.com)	F5.3	988	Add, "Design of Steel Plate Shear Walls to include out of plane forces."	Simultaneously out of plane forces with in plane forces can significantly affect performance of the steel plate shear wall frame and its connections	The analysis requirements for ASCE 7 include consideration of Direction of Loading, including simultaneous orthogonal forces. AISC 341 Section F5 is limited to the additional analysis requirements for SPSW, and out-of-plane forces require no analysis requirements above those in ASCE 7.	
Peter Maranian (pjmaranian.se @gmail.com)	I2.3	59-93	See comments	Welding procedures and fracture toughness requirements need to better address size effects. Refer to Blodgett (1998), Burdekin (1999), Tsai et al (2001), Miller (1993)	These suggestions will be considered for the 2028 cycle of the standard.	

				Thus, procedures need to be established to address required fracture toughness to account for size effects. Blodgett, O.W., 1998, "The Effects of Constraints on Ductility in Welded Beam to Column Connections; International Conference on Welded Construction in Seismic Areas", American Welding Society. October 1998, Maui, Hawaii. Burdekin., M., (1999) "Why Size Matters in Large Structures", Gold Medal Lecture, The Structural Engineer, The Institution of Structural Engineers, Vol. 77/No. 20, London, United Kingdom. Tsai, C., Kim, D., Jaeger, J., Shim, Y., Feng, Z. and Papritan, J., 2001. "Design Analysis for Welding of Heavy W Shapes", The American Welding Society, The Welding Journal, February. Miller, D.K., 1993, "The Challenge of Welding Jumbo Shapes Part 1: The AISC Specifications". The Welding Innovation Quarterly, Volume X, No. 1.		
Peter Maranian (pjmaranian.se @gmail.com)	K1.3	38-48	Add "Column to beam tests shall also be carried out with axial	Significant drag loads can occur and also column yielding may occur due to	It is not practical to require all beam-to-column subassemblage testing to exactly replicate all	

			loads acting on the beams and also allowing column yielding to occur prior to beam yielding"	moment magnification, Pauley and Priestley (1992), Bondy (1996). Pauley, T. and Preistley, M.J.N., 1992, "Seismic Design of Reinforced Concrete and Masonry Buildings". Bondy, K.D., 1996, "A More Rational Approach to Capacity Design of Seismic Moment Frame Columns." Earthquake Engineering Research Institute, Oakland, California.	aspects of a real building including column axial force, beam axial force, beam restraint from a composite slab, and column boundary conditions. Testing under conditions that are as close as possible to those found a real building are recommended in the commentary.	
Peter Maranian (pjmaranian.se @gmail.com)	K1.3	38-48	Consideration should be given for small component testing to check for dynamic effects causing significant strain rates in regions where high strain rates can occur. See comments.	Reference, Maranian and Dhalwala (2019), Mazzolani (2000). Thrust fault earthquakes occur in Southern California that can cause significant vertical and horizontal accelerations and result in high strain rates that can appreciably effect fracture toughness due to the phenomena causing shift in the nil ductility and shift of the DBTT curve thus reducing fracture toughness. Maranian, P and Dhalwala A; 2019, "Considerations regarding the Repair & Retrofit of Existing Welded Moment Frame Buildings", the Structural Engineers of California Convention. Mazzolani F., (2000), Moment Resisting Connections of Steel Frames	High strain rates increase the steel yield strength and the ultimate tensile stress. The increase in Fu is generally less than that on Fy, which may lead to more critical conditions than predictions based on static material properties when verifying a hierarchy of failure modes. Ductility also tends to reduce under high strain rates. If a qualification test on a new connection is to be performed using quasi-static cyclic tests, it would be appropriate to require that components whose strength and ductility can be sensitive to strain rate effects be verified individually by means of real-time component testing. Therefore, Section K1.3 will add the following requirement:	

				in Seismic Areas", includes "Influence of the type of Seismic Ground Motions", Gioncu,V; Mateescu, G; Tirca, L: Anastasiadis, A. CRS Press.	"The behavior of components whose strength and ductility are sensitive to strain rate effects shall be verified by means of real-time component testing."	
Peter Maranian (pjmaranian.se @gmail.com)	K1.6.(b)	129	Add" The report shall include description of buckling modes."	Uncontrolled buckling can be detrimental to the performance. It should be clarified how uncontrolled actions are to be accounted for. For example, uncontrolled local buckling of flanges and web of steel moment frame connections with the potential to fracture due to low cycle fatigue. Ref. Bertero and Popov (1967) Panel zone yielding should not occur per panel zone design requirements. Bertero, V.V. and Popov, E.P., 1967, "Effect of Large Alternating Strains of Steel Beams, Journal of the Structural Division", American Society of Civil Engineers, February.	Section K1.6 is describing requirements for documenting prequalification, and Section K1.6(b) requires that the expected behavior of the connection be described. This is not describing the behavior from a single test. Reporting of results for a single qualification test is described in Section K2.7, which requires documentation of test observations and failure modes.	
Peter Maranian (pjmaranian.se @gmail.com)	K1.6.(b)		Add" The report shall include description of any panel zone yielding"	Panel zone yielding, if occurs, may help towards attaining rotational requirements and thus is not representative. For example, whether or not panel zones yield in a steel moment frame connection can significantly affect its performance. A beam with upper bound strength	Section K1.6 is describing requirements for documenting prequalification, and Section K1.6(b) requires that the expected behavior of the connection be described. This is not describing the behavior from a single test. Reporting of results for a single qualification test is described in Section	

				connected to a column with a lower bound strength can cause yielding in the panel zone whereas the opposite may not.	K2.7, which requires documentation of test observations and failure modes.	