The Seismic Assessment of Existing Buildings

Proposed Technical Revision of Section C5 *Concrete Buildings*: Changes from Version 1

Overview

The main changes from the July 2017 version of Section C5 can be summarised as follows:

- Material properties improved, including concrete tensile strength and elastic modulus and per-grade reinforcement, with explicit warning on cold-drawn mesh (C5.4.2. C5.4.3)
- Improved provisions for inadequate splices (C5.4.4)
- Material added for assessing couplers/mechanical anchors, welded connections and drossbachs/grout sleeves and inserts in more modern construction (C5.4.5)
- Provisions to better address 'single crack' scenarios in concrete members (C5.5.1 and C5.5.3.4)
- Improved guidance on effective stiffness of elements (C5.5.1 and C5.5.3.1)
- Improved guidance on the contribution of flanges to capacity (C5.5.1)
- Addition of guidance on deformation limits arising from lateral buckling of walls and columns (C5.5.3.2)
- Introduction of the direct rotation method for determining rotation capacity as an alternative to the existing moment-curvature/hinge length approach (C5.5.3)
- Refinement of aspects of the moment-curvature method (C5.5.3.4)
- Guidance added for the limiting conditions leading to the loss of gravity support in columns, slab-column connections, and walls (C5.5.4)
- A column shear strength model better aligned to experimental results has been adopted (C5.5.5)
- Strength degradation for lightly reinforced joints reintroduced (C5.6.2)
- Content added for 'modern' beam-column joints (C5.6.2)
- Introduction of a "deemed to comply" approach for obviously robust diaphragms (C5.6.3.1)
- A full revision to the appendix on assessing precast concrete floors (was C5G, now C5E)
- The deletion of appendices C5B, C5E and C5J due to concerns about their relevance, completeness, and/or correctness

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An initial phase of the revision involved the correction of eight equations within C5, and this was completed in April 2018. These corrections form an addenda to Version 1, and are incorporated into this revised version of C5.

Detailed list of changes from Version 1

Page	Reference	Change
General		Sections re-ordered to improve usability
C5-18	Section C5.2	General editorial revisions
C5-24	Section C5.3.2	Improved and more stringent definition of 'non-ductile' column SSW
C5-53	Section C5.4.2.2	Assumed probable compressive strength reduced for specified strengths greater than 40 MPa
C5-55	Section C5.4.2.3	Guidance added on probable elastic modulus of concrete
C5-55	Section C5.4.2.4	Guidance added on probable tensile strength of concrete
C5-56	Table C5.4	Grade specific guidance on reinforcing steel properties added
C5-56	Section C5.4.3	Information about historic bar sizes moved to Appendix C5B
C5-57	Section C5.4.4	Improved and less conservative guidance added on capacity of lap splices
C5-58	Section C5.4.5.1	Guidance added on capacity of welded and mechanical reinforcing bar connections
C5-59	Table C5.5	Probable capacities added for common types of mechanical reinforcing bar connection
C5-60	Section C5.4.5.2	Guidance added on assessing Drossbach connections
C5-61	Table C5.6	Probable capacities added for common types of welded reinforcing bar connection
C5-61	Section C5.4.5.4	Guidance added on assessment of anchors to concrete elements
C5-63	Section C5.5	Improved explanation of method used to calculate deformation capacity of elements
C5-68	Section C5.5.1.6	Guidance added regarding identification of locations where deformation is expected to concentrate at a single crack.
C5-69	Section C5.5.1.7	Guidance added on effective stiffness, including effect of bar slip at beam-column joints
C5-71	Section C5.5.2.1	Method added to calculate the probable cracking strength of a section
C5-71	Section C5.5.2.2	Probable flexural strength explicitly defined as corresponding to the occurrence of a compression strain of -0.003 at the extreme compression fibre
C5-73	Section C5.5.2.2	Improved guidance provided regarding effect of flanges on beam flexural strength
C5-75	Section C5.5.2.2	Guidance added regarding effect of flanges on wall flexural strength
C5-75	Section C5.5.2.2	Guidance improved regarding the capacity of elements containing lap splices
C5-77	Section C5.5.3	Explanation added regarding reason for introducing the direct rotation method for determining deformation capacity
C5-78	Section C5.5.3.1	Factor added to include impact of shear deformation on yield displacement of squat elements
C5-81	Section C5.5.3.2	Guidance added regarding deformation limits for walls and columns arising from lateral buckling
C5-85	Section C5.5.3.3	Methods added to allow direct calculation of member rotation

Page	Reference	Change
		capacity for beams, columns, and walls – the 'direct rotation' method
C5-98	Section C5.5.3.4	Plastic hinge length noted to be not less than twice the strain penetration length in accordance with source material
C5-99	Section C5.5.3.4	Improved method provided for calculating the plastic hinge length for elements where deformation is expected to concentrate at a single crack
C5-100	Table C5.10	Changes made to strain limits for confined concrete and for unconfined concrete surrounding drossbach ducts
C5-101	Section C5.5.3.4	Changes made to conditions where concrete should be assumed to be unconfined
C5-103	Section C5.5.3.4	Improved method for determining occurrence of bar buckling added
C5-103	Section C5.5.3.4	Berry & Eberhard method for calculating deformation at onset of bar buckling deleted
C5-104	Section C5.5.4	Methods added for calculating the deformation at onset of axial failure for columns, slab-column connections, and walls
C5-112	Section C5.5.5.2	Sezen model for column shear strength introduced, replacing the UCSD model used previously
C5-114	Section C5.5.5.3	Section identifying need to check interface shear strength ('shear friction') added
C5-116	Section C5.6.1	Section added outlining application of strut-and-tie methods. Limitation that only reinforcement with strain capacity greater than 0.05 should be relied on when calculating capacity of ties
C5-117	Section C5.6.2.1	Method for calculating effective area of joint shear reinforcement added
C5-118	Section C5.6.2.1	Method added for determining effective dimensions of a beam-column joint
C5-119	Section C5.6.2.2	Method for assessing degradation of strength of poorly reinforced beam-column joints reintroduced after omission from July 2017 version
C5-121	Section C5.6.2.2	Guidance on joint shear deformation simplified
C5-121	Section C5.6.2.3	Methods added for calculating the strength of well reinforced beam-column joints
C5-130	Section C5.6.3.1	'Deemed to comply' approach added for obviously robust diaphragms
C5-132	Section C5.6.3.1	Option added to verify minimally stressed diaphragms by an elastic analysis
C5-139	Section C5.6.3.7	Section added describing how to determine extent of diaphragm cracking (moved from previous Appendix C5G)
C5-141	Section C5.6.4	Section added on assessment of precast panels
C5-143	Section C5.7	Conditions governing global building capacity added
C5-143	Section C5.7	Previous guidance on global building capacity simplified and reduced
	Appendix C5A	Shortened – idealised historic detailing examples removed
	Appendix C5B	Previously Appendix C5C Expanded to include information previously in body of document. Information for pre-1960s reinforcement corrected Information for 1960s reinforcement added

Page	Reference	Change
	Appendix C5E	Previously Appendix C5G Completely rewritten and greatly expanded to provide full guidance on assessment of precast concrete floors
	Appendix C5F	Previously Appendix C5H Shortened to remove detailed discussion of research on buckling of bars subject to cyclic loading.
	Appendix C5G	Previously Appendices C5I and C5J Appendices merged and re-edited to improve cohesiveness
	Deleted appendices	Previous Appendix C5B – Historical concrete requirements – deleted as considered neither useful nor adequately verified Previous Appendices C5E – Evolution of Standard Design Details - deleted as considered neither useful, complete, nor adequately verified