Several steel element connections have been tested under simulated seismic loading, and the adequacy of their load-deformation characteristics and strain capacity have been demonstrated (Schultz and Magana 1996). One such connection was used in the five-story building test that was part of the PRESSS Phase 3 research. The connection was used to provide damping and energy dissipation, and it demonstrated a very large strain capacity (Nakaki et al. 2001). Since then, several other steel element connections have been developed that can achieve similar results (Banks and Stanton 2005, Nakaki et al. 2005). In view of these results, it is appropriate to allow yielding in steel elements that have been shown experimentally to have adequate strain capacity to maintain at least 80% of their yield force through the full design displacement of the structure.

C14.2.2.8 Detailed Plain Concrete Shear Walls

Design requirements for plain masonry walls have existed for many years, and the corresponding type of concrete construction is the plain concrete wall. To allow the use of such walls as the lateral force-resisting system in SDC A and B, this provision requires such walls to contain at least the minimal reinforcement specified in Section 22.6.7.2.

C14.2.2.9 Strength Requirements for Anchors

ACI 318-08 requires laboratory testing to establish the strength of anchor bolts greater than 2 in. in diameter or exceeding 25 in. in tensile embedment depth. This modification makes the ACI 318 equation giving the basic concrete breakout strength of a single anchor in tension in cracked concrete applicable irrespective of the anchor bolt diameter and tensile embedment depth.

Korean Power Engineering (KPE) (Lee et al. 2007) has made tension tests on anchors with diameters up to 4.25 in. and embedment depths up to 45 in. and found that the diameter and embedment depth limits of Section D4.2.2 of ACI 318-08 for the design procedure for anchors in tension (Section D5.2) can be eliminated. KPE has also made shear tests on anchors with diameters up to 3.0 in. and embedment depths as large as 30 in. and found no effect of the embedment depth on shear strength. However, the diameter tests showed that the basic shear breakout strength (Eq. D-24) needed some modification for the complete elimination of the 2-in. limit to be fully appropriate (Lee 2006). Use of anchor reinforcement is recommended for that case. Analytical work performed at the University of Stuttgart supports the need for some modification to Eq. D-24. Changes consistent with the Korean and Stuttgart findings have already been made to the FIB Design Guide for anchors.

C14.2.3 Additional Detailing Requirements for Concrete Piles

Chapter 20 of PCI (2004) Bridge Design Manual (Ref. x) provides detailed information on the structural design of piles and on pile to cap connections for precast prestressed concrete piles. ACI 318 does not contain provisions governing the design and installation of portions of concrete piles, drilled piers, and caissons embedded in ground except for SDC D, E, and F structures.

C14.2.3.1.2 Reinforcement for Uncased Concrete Piles (SDC C) The transverse reinforcing requirements in the potential plastic hinge zone of uncased concrete piles in Seismic Design Category C is a selective composite of two ACI 318 requirements. In the potential plastic hinge region of an intermediate moment-resisting concrete frame column, the transverse reinforcement spacing is restricted to the least of (1) eight times the diameter of the smallest longitudinal bar, (2) 24 times the diameter of the tie bar, (3) one-half the smallest cross-sectional dimension of the column, and (4) 12 in. Outside of the potential plastic hinge region of a special moment-resisting frame column, the transverse reinforcement spacing is restricted to the smaller of six times the diameter of the longitudinal column bars and 6 in.

C14.2.3.1.5 Reinforcement for Precast Nonprestressed Concrete Piles (SDC C) Transverse reinforcement requirements in and outside of the plastic hinge zone of precast nonprestressed piles are clarified. The transverse reinforcement requirement in the potential plastic hinge zone is a composite of two ACI 318 requirements (see Section C14.2.3.1.2). Outside of the potential plastic hinge region, the transverse reinforcement spacing is restricted to sixteen (16) times the longitudinal bar diameter. This should permit the longitudinal bars to reach compression yield before buckling. The maximum 8-in. tie spacing comes from current building code provisions for precast concrete piles.

C14.2.3.1.6 Reinforcement for Precast Prestressed Piles (SDC C) The transverse and longitudinal reinforcing requirements given in ACI 318, Chapter 21, were never intended for slender precast prestressed concrete elements and will result in unbuildable piles. These requirements are based on