Los Angeles Tall Buildings Structural Design Council
c/o John A. Martin & Associates, Inc. 950 S. Grand Avenue, , Los Angeles, CA 90015
Phone (213) 483-6490 Fax (213) 483-3084

Los Angeles Tall Buildings Structural Design Council – Bulletin 14-01
(Revised on April 30, 2015)

Code References: Los Angeles Building Code Section 91.1613.1 and ASCE 7-10 Table 12.2-1

This bulletin is intended to provide design guidance to structural engineers for seismic force resisting systems classified as "dual systems" that use special reinforced concrete shear walls in combination with special reinforced concrete moment resisting frames.

LATBSDC recommends the following measures be taken for buildings taller than 240 feet with respect to seismic analysis and design of dual systems using special reinforced concrete shear walls and special reinforced concrete moment frames which are designed according to the 2014 Los Angeles Building Code prescriptive analysis and design procedures with the following additional requirements:

1. The dual system shall consist of physically separated shear walls and frames.

   EXCEPTION: Columns of the frame may be embedded in the shear wall outside the shear wall's boundary elements. Such embedded columns, however, shall not be counted towards satisfaction of the 25% of the total base shear strength that has to be provided by the moment frames.

2. Moment Frame column seismic axial forces shall be amplified by Ω_o, but need not be larger than the axial forces generated by the hinging of the moment frame beams. The amplified column axial force in combination with gravity load shall be limited to $0.4f'_c$ times the gross area of concrete columns.

Commentary:

Whereas buildings with seismic force-resisting systems consisting of special reinforced concrete shear walls are limited in height to 240 feet, the Los Angeles Building Code Section 91.1613.1 and ASCE 7-10 Table 12.2-1 impose no height limits on dual systems. Dual systems of any height may therefore be designed using prescriptive code provisions. A review of published tall building research, shows that dual systems, designed to only satisfy prescriptive code provisions may not satisfy the intent of the building code and may be significantly under-designed compared to similarly tall buildings designed according to the latest performance-based design methodologies.

Seismic analyses of tall buildings show that axial force demands on concrete moment frame columns will be severely underestimated when using standard code procedures. In addition, it is impossible for an engineer using the elastic analysis techniques permitted by prescriptive code provisions to accurately determine the displacements in the nonlinear range that are required to

ensure deformation compatibility, which is necessary for acceptable seismic performance.

One reason that elastically-based methodologies permitted by the building code significantly underestimate concrete column axial loads is that current codes do not impose a force amplification factor on reinforced concrete moment frame columns, which are required for similarly situated steel moment frame columns. Contrary to performance based design guidelines; prescriptive design standards do not impose a realistic limit on the column axial force demands. High column axial force demands rob the concrete columns of almost all available ductility. For these reasons, the SEAOC *Blue Book* recommends the use of nonlinear analyses to estimate displacements and demands when lateral systems are combined.

The SEAOC *Blue Book* emphasizes the importance of maintaining the ability of the secondary system (e.g., moment frames) to maintain vertical and lateral support when the primary system (e.g., shear wall) suffers significant damage at large displacements. Accomplishing this goal is difficult, if not impossible, when boundary elements of the shear wall also serve as columns in the moment frame. As the shear wall boundary elements degrade, the moment frame columns at the same locations suffer similar damage, compromising their ability to function as a part of the vertical and seismic load carrying systems. Given these deficiencies in prescriptive code methodologies relative to obtaining realistic estimates of moment frame column axial loads, the concurrent degradation of the shear wall boundary elements and moment frame columns becomes of particular concern.