Yeni Türkiye Deprem Yönetmeliğinde Yüksek Binaların Tasarımı

Design of Tall Buildings in the Next Turkish Seismic Code

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Performance-based seismic engineering has brought new dimensions to tall building design, leading to a major transformation from traditional/prescriptive strength-based design approach based on linear response under reduced seismic loads to explicit/non-prescriptive deformation-based design approach based on nonlinear response.

In line with this development, special seismic design recommendations/guidelines and consensus documents for tall buildings based on performance-based design principles have been developed and published in the last decade by several institutions.

SEAONC – Structural Engineers Association of Northern California (2007)
“AB-083: Recommended Administrative Bulletin on the Seismic Design & Review of Tall Buildings Using Non-Prescriptive Procedures”, prepared for San Francisco Department of Building Inspection by Tall Buildings Task Group

CTBUH – Council on Tall Buildings and Urban Habitat (2008)
“Guidelines for Performance-Based Seismic Design of Tall Buildings”, prepared by Guidelines Working Group

SFDBI – San Francisco Department of Building Inspection (2014)

Istanbul Metropolitan Municipality – IMM (2008)
“Istanbul Seismic Design Code For Tall Buildings”, Draft Version IV, prepared by Department of Earthquake Engineering, Kandilli Observatory and Earthquake Research Institute, Istanbul
Current Performance-Based Seismic Design Methodology for Tall Buildings

Recent tall building seismic design guidelines / consensus documents (TBI 2010, SFDBI 2014, LATBSDC 2014) are all based on the same, well-established design methodology, starting with

*a preliminary design*

followed by

*two performance evaluation stages.*
A) Preliminary Design

- Tall building structural system is preliminarily proportioned and reinforced in accordance with capacity design principles where linear analysis are generally used to determine the required strength of yielding actions.

- San Francisco practice (SFDBI 2014) treats the preliminary design as a code-level evaluation stage where selected prescriptive provisions including minimum base-shear requirement of the San Francisco Building Code are required to be applied in addition to capacity design principles. Thus, SFDBI (2014) formally applies a three-stage procedure for tall building design.

- However, other recent guidelines (TBI 2010, LATBSDC 2014) do not formally define the preliminary design as a design stage and insist on a non-prescriptive two-stage performance evaluation scheme by completely eliminating the prescriptive code provisions.
B) Performance Evaluation Stages

1 – Serviceability evaluation stage
under the so-called
*service earthquake* with a 50% probability of exceedance in 30 years,
corresponding to a 43 year return period. Damping is taken 2.5%.

*Performance criterion:*
Tall building structural system is required to remain
*essentially elastic*
or nearly elastic with almost negligible nonlinear behavior

2 – Collapse level evaluation stage
under the so-called
*maximum considered earthquake* with a 2% probability of exceedance in 50 years,
corresponding to a 2475 year return period. Damping is taken 2.5%.

*Performance criterion:*
Tall building structural system is required to have a
*reasonably low risk of partial or total collapse*,
corresponding to an acceptable level of damage in terms of ductile response
quantities, while keeping all other brittle response quantities, e.g., internal forces
below their strength capacities, thus preserving the gravity load carrying capacity.
CHAPTER 13 – SPECIAL PROVISIONS FOR TALL BUILDING DESIGN UNDER EARTHQUAKE ACTION (Draft – November 2014)

13.1. SCOPE

13.2. PERFORMANCE BASED DESIGN OF TALL BUILDINGS

13.3. PROFESSIONAL QUALIFICATION AND INDEPENDENT EVALUATION

13.4. TALL BUILDING STRUCTURAL SYSTEMS
   13.4.1. Typical tall building structural systems: Definitions
   13.4.2. Structural system arrangement in tall buildings
   13.4.3. Effective section stiffnesses of reinforced concrete elements

13.5. DESIGN STAGE I: PRELIMINARY DESIGN – PROPORTIONING UNDER STANDARD DESIGN EARTHQUAKE
   13.5.1. Objective and scope
   13.5.2. Stage I structural system modeling
   13.5.3. Implementation of Capacity Design Principles: Ductile and capacity protected elements
   13.5.4. Stage I seismic analysis
   13.5.5. Preliminary proportioning of structural system elements
13.6. DESIGN STAGE II: VERIFICATION / IMPROVEMENT / DESIGN UNDER MAXIMUM CONSIDERED EARTHQUAKE

13.6.1. Objective and scope
13.6.2. Stage II structural system modeling
13.6.3. Stage II seismic analysis
13.6.4. Stage II performance evaluation
13.6.5. Design of foundations

13.7. DESIGN STAGE III: VERIFICATION UNDER SERVICE EARTHQUAKE

13.7.1. Objective and scope
13.7.2. Stage III structural system modeling
13.7.3. Stage III seismic analysis
13.7.4. Stage III performance evaluation

13.8. SEISMIC INPUT FOR TALL BUILDING DESIGN

13.8.1. Response spectra
13.8.2. Selection and scaling of earthquake records seismic analyses

13.9. INDEPENDENT EVALUATION SYSTEM FOR TALL BUILDING SEISMIC DESIGN

13.9.1. Independent Evaluation Board
13.9.2. Earthquake Engineering Higher Commission for Tall Building Design

13.10. HEALTH MONITORING SYSTEMS FOR TALL BUILDINGS
Thank you for your attention