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Comparison of the Seismic Provisions of the 1997 Uniform Building Code to the 1997 NEHRP Recommended Provisions

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Comparison of the Seismic Provisions of the 1997 Uniform Building Code to the 1997 NEHRP Recommended Provisions

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1.0 EXECUTIVE SUMMARY

Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction,* requires that all new federally owned, leased, assisted, and other regulated buildings be designed and constructed in accordance with the appropriate seismic standards. The Interagency Committee on Seismic Safety in Construction (ICSSC) has recommended the use of building codes which are substantially equivalent to the 1997 *National Earthquake Hazards Reduction Program Provisions for the Development of Seismic Regulations for New Buildings* (NEHRP Provisions).

The objective of this study is to determine whether or not the seismic and material design provisions of the *Uniform Building Code* (UBC) 2000 edition are substantially equivalent to, or exceed, the 1997 NEHRP Provisions.

This report follows three previous reports prepared for the National Institute of Standards and Technology (NIST GCR 91-598, NIST GCR 95-674 and NIST GCR 98-755). Each previous report evaluated the equivalency of the latest edition of the NEHRP Provisions available at the time of the report and the latest editions of the following model codes and standards available at the time of the report: the *BOCA National Building Code* (BOCA/NBC), the *Standard Building Code* (SBC), the *Uniform Building Code* (UBC), ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE 7) and CABO *One- and Two-Family Dwelling Code* (OFTDC).

This report also follows a draft report prepared for the National Institute of Standards and Technology, which evaluated the equivalency of the 1997 NEHRP Provisions and the seismic and material design provisions of the International Building Code (IBC) 2000 edition, the *International Residential Code for One- and Two-family Dwellings* (IRC) 2000 edition, and ASCE 7-98 *Minimum Design Loads for Buildings and Other Structures.*

The seismic design provisions of the 1997 *Uniform Building Code* are based on Appendix C of the 1996 edition of the *Recommended Lateral Force Requirements* published by the Structural Engineers Association of California (SEAOC Blue Book). It also includes many of the features of the 1994 NEHRP Provisions. The earthquake regulations of the 1997 NEHRP Provisions are substantially different from the corresponding requirements of the 1994 Provisions. Partly as a result of this and partly because the 1997 UBC did not include some important features of the1994 NEHRP Provisions, the seismic and material design requirements of the 1997 UBC were found to be not equivalent to those of the 1997 NEHRP Provisions.

2.0 INTRODUCTION

Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction,* requires that all new federally owned, leased, assisted, and other regulated buildings be designed and constructed in accordance with the appropriate seismic standards. The Interagency Committee on Seismic Safety in Construction (ICSSC) has recommended the use of building codes, which are substantially equivalent to the 1997 *National Earthquake Hazards Reduction Program Provisions for the Development of Seismic Regulations for New Buildings* (NEHRP Provisions).

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Comparisons between the 1997 NEHRP Provisions and the UBC are made on the basis of seismic provisions, material design provisions, foundation design requirements, quality assurance provisions, and non-structural element design requirements. In the comparisons, the UBC is judged equivalent if its provisions are equivalent to, or more stringent than, the corresponding requirements in the 1997 Provisions. The UBC is judged not equivalent if the requirements of the 1997 NEHRP Provisions are more stringent than the requirements in the model code.

In certain instances NEHRP includes provisions that the UBC does not. When a model code or standard does not have specific provisions regarding criteria, elements or systems, the design is left to the discretion of the designer. Depending on the judgment of the designer, the design may or may not be equivalent to NEHRP. Therefore, when the UBC is silent on certain issues, equivalency may not be judged.

One item of overriding importance for the purposes of this comparison must be noted at the outset. In the *Uniform Building Code*, the seismic zone in which a structure is located determines permissible structural systems, including the level of detailing required for structural members and joints that are part of the lateral-force-resisting system and for the structural components that are not. It also determines applicable limitations on height of a structural system and structural irregularity, the type of lateral analysis that must be performed as the basis of design, as well as nonstructural component requirements. Seismic zones are regions in which seismic ground motion, corresponding to a certain probability of occurrence, is within certain ranges. The United States is divided into Seismic Zones 0 through 4, with 0 indicating the weakest earthquake ground motion, and 4 indicating the strongest.

The 1997 NEHRP Provisions uses Seismic Design Categories (SDC) as the determinant of seismic design and detailing requirements. The SDC is a function of the location's seismicity, building occupancy and soil type.

Although the 1997 USC "seismic zone" only considers the seismicity of a location (whereas the 1997 NEHRP "Seismic Design Category" takes into account the building occupancy and soil type as well as seismicity), an equivalency between "seismic zone" and "Seismic Design Category" was assumed for this comparison study. The following table identifies which seismic zones were assumed equivalent for Seismic Design Categories A-F:

NEHRP SDC	Assumed Equivalent Seismic Zone
A,B	**0,1**
C	**2**
D, E, F	**3,4**

3.0 1997 NEHRP PROVISIONS

3.1 Overview of NEHRP Provisions

The Federal Emergency Management Agency (FEMA) has contracted the Building Seismic Safety Council (BSSC) to develop the National Earthquake Hazards Reduction Program (NEHRP) Provisions for new buildings. One of the primary goals of the program is to reduce or mitigate losses from earthquakes. *The NEHRP Recommended Provisions for Seismic Regulations for New Buildings* are recommended provisions that have increasingly been adopted in recent times by model codes and standards. The first edition of the NEHRP Provisions was dated 1985. The document is updated on a 3- year cycle. The 1997 edition of the NEHRP provisions is the fourth update of the document.

The NEHRP Provisions present a strength-based approach to design that represents the state of knowledge of seismic design. The seismic design provisions incorporate current research and knowledge from previous earthquakes. Seismicity maps are used to assess the seismic hazard at a particular site. Forces and seismic design requirements are increased with increasing seismic hazard. In the 1997 edition of the NEHRP Provisions, the seismic design category (SDC) of a structure, which is based on occupancy as well as on soil-modified seismic risk at the site of a structure, determines the level of detailing and design requirements. The seismic design category is used to obtain higher levels of performance; however, it does not influence the force level which is increased for structures in higher occupancy categories through an importance factor. In the design base shear equation, a factor R which accounts for system response and inelastic deformability, reduces the strength that would have been needed for elastic response to the design earthquake to a design level. Detailing requirements that are formulated to provide a commensurate amount of inelastic deformability are given in the materials chapters. The design base shear varies with 1/T, where T is the elastic fundamental period of the structure.

3.2 Overview of Major Changes from NEHRP 1994 to 1997

The earthquake regulations of the 1997 NEHRP Provisions are substantially different from the corresponding requirements of the 1994 Provisions. The biggest change is the completely new set of ground motion maps and resulting design ground motion parameters which are now S_{DS} and S_{D1}, rather than the C_a and C_V of the 1994 Provisions and A_a and A_V of earlier Provisions. S_{DS} and S_{D1} are 5%-damped design spectral response accelerations at short periods and 1 sec. period, respectively. S_{DS} and S_{D1} are two-thirds of S_{MS} and S_{M1} which are soil-modified (Maximum Considered Earthquake) spectral response accelerations at 0.2 sec. and 1 sec. period, respectively. S_{MS} and S_{M1} are obtained by multiplying mapped MCE spectral response accelerations S_S (at 0.2 sec. period) and S_1 (at 1 sec. period), respectively, by F_a, the acceleration-related soil factor and F_V, the velocity-related soil factor, respectively. The maximum considered earthquake is the 2500- year return period earthquake (2% probability of exceedance in

50 years) in most of the country, except that in coastal California, it is the largest (deterministic) earthquake that can be generated by the known seismic sources. The design earthquake of the 1997 NEHRP provisions is two-thirds of the MCE, whereas the design earthquake of the 1994 NEHRP Provisions has an average return period of 475 years (10% probability of exceedance in 50 years). The two-thirds is the reciprocal of 1.5 which is agreed to be the "seismic margin" built into structures designed by the 1994 and older editions of the NEHRP Provisions. In other words, a structure designed by the 1994 or older editions of the NEHRP Provisions is believed to have a low likelihood of collapse under an earthquake that is one and one-half times as large as the design earthquake of those documents. The redefinition of the design earthquake in the 1997 NEHRP Provisions is intended to provide a uniform level of safety across the country against collapse in the Maximum Considered Earthquake. This was not the case before because the MCE is only 50% larger than the design earthquake of the 1994 NEHRP Provisions in coastal California, while it can be four or five times as large as the design earthquake of the 1994 Provisions in the Eastern United States. A_a and A_V of the 1994 NEHRP Provisions indicated the effective peak acceleration and the effective peak velocity-related acceleration of the ground corresponding to the design earthquake of the 1994 Provisions on Type S_B soil or soft rock. The mapped MCE spectral response accelerations S_S and S_1 of the 1997 NEHRP Provisions are also mapped on Type S_B soil. The soil classification and the associated site coefficients first introduced in the 1994 NEHRP Provisions have been retained unchanged in the 1997 Provisions.

The second most important difference between the 1994 and the 1997 editions of the NEHRP Provisions is the replacement of the Seismic Performance Category (SPC) with the Seismic Design Category (SDC). In the 1994 and older editions of the NEHRP Provisions, restrictions on building height and structural irregularity, choice of analysis procedures that form the basis of seismic design, as well as the level of detailing required for a structure were all governed by the Seismic Performance Category. The SPC was a function of occupancy (called Seismic Hazard Exposure Group in the 1994 and older NEHRP editions) and of the seismic risk at the site of the structure in the form of A_V, the effective peak velocity-related acceleration coefficient. In the 1997 NEHRP Provisions, the level of detailing and the other restrictions are all governed by the Seismic Design Category, which combines occupancy (called Seismic Use Group in the 1997 NEHRP Provisions) with the soil-modified seismic risk at the site of the structure, in the form of the design spectral response accelerations S_{DS} and S_{D1}. The 1997 NEHRP Provisions for the first time has made detailing as well as the other restrictions a function of the soil characteristics at the site of a structure. This is a major departure from current seismic design practice – a departure that has far-reaching financial and other consequences. The basis for categorizing structures into SDC E was also changed between 1994 and 1997 and a new SDC F was added. In 1994, Category E consisted of Group III structures (essential facilities) in regions anticipated to experience strong ground motion ($A_V > 0.2$). In 1997, Category E consists of Seismic Use Group I and II structures (standard-occupancy structures and assembly buildings) located within a few kilometers of major active faults as indicated by the maximum considered earthquake spectral response maps ($S_1 \geq 0.75g$). Category F includes Seismic Use Group III structures (essential facilities) located within a few kilometers of major active faults. Most buildings assigned to Category E in the 1994 Provisions are assigned to Category D in the 1997 Provisions.

The third most important difference between the 1994 and 1997 editions of the NEHRP provisions is the introduction of the Importance Factor, I. An I-factor was not included in ATC 3, the predecessor document to the NEHRP Provisions, or in any of the NEHRP Provisions through its 1994 edition. ATC 3 and NEHRP opted instead for tighter drift limits and higher levels of detailing for structures in higher occupancy categories. An Occupancy Importance Factor – 1.5 and 1.25 for Seismic Use Group III or II structures, respectively – has been brought into the 1997 NEHRP Provisions, increasing the design force level for higher occupancy categories. This is in addition to the requirements of tighter drift limits and higher levels of detailing for higher occupancy categories.

One notable change from the 1994 to the 1997 NEHRP Provisions is the proliferation of structural systems in Table 5.2.2 of the latest edition. The reason is a policy decision made with respect to the 1997 Provisions. It was decided that each basic-seismic-force-resisting system defined in Table 5.2.2 would have its own unique set of detailing requirements and commensurate R- and C_d- values assigned to it. This eliminated having the same name, R- and C_d- values assigned to two completely different seismic-force-resisting-systems. A case in point illustrating this scenario is the bearing wall system with concrete shear walls. In the 1994 Provisions, the bearing wall system with concrete shear walls was assigned R- and C_d-values of 4.5 and 4, respectively. These values did not change from the high to the low Seismic Performance Categories. In SPC D and E, the shear walls required special detailing, while in SPC A, B, and C, ordinary detailing was all that was needed. Thus, in effect, two different seismic force-resisting systems with different levels of inelastic deformability went under the same name and were assigned the same R- and C_d- values. Thus, four different types of concrete shear walls have been defined: ordinary plain concrete, detailed plain concrete, ordinary reinforced concrete, and special reinforced concrete. This obviously adds to the total number of structural systems defined in the table.

There is an associated change to Table 5.2.2 that should be noted as well. In the 1994 Provisions, overstrength was recognized for the design of a limited number of elements such as columns supporting discontinued lateral-force-resisting elements, and was approximated by the factor 2R/5. In the 1997 Provisions, a separate tabulated Ω_0 factor replaces the arbitrary 2R/5 value. The Ω_0 factors are intended to be approximate, upper-bound estimates of the probable overstrength inherent in the typical lateral-force-resisting systems of common structures.

Finally, the nonbuilding structures requirements which were in 1994 Section 2.6, appear as 1997 Chapter 14 and the requirements have been significantly expanded and modified to reflect the new design procedures for the 1997 Provisions. An appendix is included to provide the user with considerable extra guidance concerning nonbuilding structures for which no formal standards exist.

4.0 1997 UNIFORM BUILDING CODE

4.1 Overview of 1997 UBC

The *Uniform Building Code* (UBC) is published by the International Conference of Building Officials (ICBO), Whittier, California. ICBO is one of three model code groups in the country, the other two being the Building Officials and Code Administrators International (BOCA), Country Club Hills, Illinois, publishers of *The BOCA National Building Code* (BOCA/NBC), and the Southern Building Code Congress International (SBCCI), publishers of the *Standard Building Code* (SBC). The seismic design provisions of the UBC are, and have long been based on the *Recommended Lateral Force Requirements* of the Structural Engineers Association of California (referred to as the SEAOC Blue book). The seismic design requirements of the other two model codes, on the other hand, have in recent times been based on the NEHRP Provisions.

The *Uniform Building Code*, unlike the other two model codes, is a three-volume set, consisting of:

Vol. 1 – Administrative, Fire Safety and Field Inspection Provisions,

Vol. 2 – Structural Engineering Design Provisions,

Vol. 3 – Material, Testing and Installation Standards.

In 1994, the so-called common code format was introduced to the *Uniform Building Code*, making chapter numbering uniform in all three model codes (for instance, structural design requirements are in Chapter 16 in all three codes).

In 1997, the UBC switched in size from 6-1/2 in. x 9 in. pages to 8-1/2 in. x 11 in. pages.

More importantly, the 1997 UBC expanded the adoption of standards by reference, whereas prior codes typically adopted standards by incorporation. Three categories of standards are listed in Chapter 35, Vol. I:

UBC Standards – The Uniform Building Code (or UBC) standards referred to in various parts of the code and listed in Part II of Chapter 35 are declared to be part of the code.

Adopted Standards – The standards referred to in various parts of the code and listed in Part III of Chapter 35 are declared to be part of the code.

Recognized Standards - The standards listed in Part IV of Chapter 35 are recognized standards. Compliance with these recognized standards constitutes prima facie evidence of compliance with the standard of duty established for recognized standards. The standard of duty is that the design, construction and quality of materials for buildings and structures be reasonably safe for life, limb, health, property and public welfare.

4.2 Seismic Design Provisions of 1997 UBC

Changes in seismic design provisions from the 1994 to the 1997 UBC are many and far-reaching in their impact. Part of the reasons for these changes was to incorporate the following lessons learned from the 1994 Northridge and the 1995 Kobe earthquakes:

- Need to consider near-source effects
- Underestimation of damage to members of non-lateral-force-resisting systems
- Need for more redundancy in lateral-force-resisting systems
- Need for improved anchorage between concrete/masonry walls and horizontal diaphragms
- Need for reinforcement in continuous footings and stemwalls in conventional light-frame buildings
- Need for improved anchorage for in-plane shear (sill anchorage) in light wood-frame buildings

The primary reason for significant changes from the 1994 to the 1997 UBC, however, was the realization that the national trend in seismic design has been toward use of the NEHRP Provisions. SEAOC, the proponent of the majority of the code changes approved for the 1997 UBC seismic provisions, made the following strategic planning statement: "Because a unified national building code based on existing codes will be a reality by the year 2000, it is in the best interest of ICBO's membership and user community to make the UBC and NEHRP Provisions as similar as possible in the 1997 UBC." The 1997 UBC seismic changes were designed to provide a smooth transition from the 1994 UBC to the 2000 *International Building Code*, the seismic provisions of which were to be based on the 1997 NEHRP Provisions. This was done by incorporating many of the features of the 1994 NEHRP Provisions (the 1997 NEHRP Provisions were not available until later).

The following are the major changes from the 1994 to the 1997 edition of the *Uniform Building Code*:

1. Strength-level, rather than service-level earthquake design forces are given, which obviously involves changes in the design load combinations as well.

2. Earthquake effect considered in design includes the effect resulting from the vertical component of the earthquake ground motion.

3. A redundancy factor is incorporated into the design load combinations, which increases the design forces for less redundant structures.

4. An overstrength factor, Ω_0, distinct from the response modification factor, R, is introduced, and is incorporated into special design load combinations (applicable,

for instance, to axial forces in columns supporting discontinued shearwalls). The factors are listed for each structural system in Table 16-N.

5. There is an acceleration-dependent near-fault factor and a velocity-dependent near-fault factor introduced for Zone 4 structures located within 10 km (6.2 miles) and 15 km (9.3 miles), respectively, of known active faults, which increase the seismic design force for near-fault structures.

6. Soil classifications are expanded from a four-tier (S_1 through S_4) to a six-tier (S_A through S_F) scheme. Instead of one site factor, there are an acceleration-dependent site factor and a velocity-dependent site factor. Both depend not only on the soil classification as before, but also on seismic risk at the location of the structure (as represented by the seismic zone factor, Z).

7. The seismic design force varies in inverse proportion to the fundamental period of the structure, T, rather than $T^{2/3}$.

8. Instead of one minimum on the design base shear, there are two minima. The second minimum is in consideration of large displacement pulses in near-fault ground motion, which were observed in the 1994 Northridge earthquake.

9. When certain structural elements are designated not to be part of the designated lateral-force-resisting system, they are required to retain their full gravity-load-carrying capacity as they deform together with the lateral-force-resisting system all the way up to the design earthquake intensity. This deformation compatibility requirement is revised in 1997 UBC in view of observations from the 1994 Northridge earthquake.

10. The limitations on inter-story seismic drift are updated.

11. The dynamic analysis provisions are expanded.

12. A simplified static lateral-forced procedure is introduced for the design of: (a) Buildings of any occupancy (including single-family dwellings) not more than three stories in height excluding basements, that use light-frame construction, and (b) Other buildings not more than two stories in height excluding basements.

13. Increased strength of anchorage is required for out-of-plane connections of concrete and masonry walls to flexible diaphragms.

14. Structural observation is required for structures in Seismic Zone 4 with near-source factor $N_a > 1.0$.

15. Nondestructive testing is required for welded fully restrained connections between primary members of ordinary moment frames of steel in Seismic Zones 3 and 4.

16. Minimum 5/8 in. diameter anchor bolts are required for wood foundation plates in Seismic Zone 4.

17. Horizontal reinforcement is required in continuous footings and stemwalls in Seismic Zones 3 and 4.

18. Detailing requirements for structural members that are not part of the lateral-force-resisting system are made significantly more stringent. This change may be looked upon as part of the revised deformation compatibility requirement mentioned above.

19. Significant new restrictions on welded and mechanical splices of reinforcing bars are introduced. In Seismic Zones 2, 3 and 4, within an anticipated plastic hinge region or within a joint: (a) welded splices on billet steel A615 or low-alloy A706 reinforcement shall not be allowed, and (b) only such mechanical connections shall be allowed as are able to develop in tension the lesser of 95 percent of the ultimate tensile strength or 160 percent of the specified yield strength of the spliced reinforcing bars.

20. The Zone 3 and 4 shearwall design provisions that departed from ACI 318 requirements and were first introduced in the 1994 UBC are refined and simplified in many ways.

21. In a very significant development, provisions for seismic design of precast concrete structures in Seismic Zones 3 and 4 are included for the very first time.

22. A number of design standards/specifications are adopted by reference in the steel chapter, thereby dramatically reducing the length of the chapter.

23. ASTM A913 Grade 50 and 65 steels are added to the list of structural steels permitted for lateral-force-resisting systems.

24. The emergency code change approved in response to fractures in beam-column connections of steel moment frames during the 1994 Northridge earthquake is retained in the 1997 UBC. "Connection configurations utilizing welds or high-strength bolts shall demonstrate, by approved cyclic test results or calculations, ability to sustain inelastic rotation and develop strength criteria...considering effect of steel overstrength and strain hardening."

25. A number of design standards/specifications are adopted by reference in the wood chapter, thereby significantly reducing the length of the chapter.

26. Provisions concerning non-structural elements are significantly enhanced and brought in close correspondence with the 1994 NEHRP Provisions.

27. Provisions concerning non-building structures are significantly enhanced.

5.0 COMPARISON OF 1997 UBC TO 1997 NEHRP

Detailed chapter-by-chapter and side-by-side comparisons of the 1997 NEHRP Provisions and the seismic and material design requirements of the 1997 UBC are provided in Table 1. These are summarized below, and some overall conclusions are drawn based on the comparisons

5.1 Chapter 1: General Provisions

The UBC provisions concerning additions to existing buildings and alterations to existing buildings are somewhat less restrictive than those of the 1997 NEHRP Provisions. The occupancy importance factors of the UBC are less than those of the 1997 NEHRP Provisions for Seismic Use Group II and III buildings. The UBC is equivalent to or more restrictive than the NEHRP Provisions in all other areas covered by Chapter 1.

5.2 Chapter 2: Glossary and Notations

This chapter is considered equivalent between the 1997 UBC and the 1997 NEHRP Provisions.

5.3 Chapter 3: Quality Assurance

The 1997 NEHRP Provisions require that a quality assurance plan be submitted to the authority having jurisdiction, gives the details of that plan, and lays down contractor responsibilities for the same. These provisions are not part of the 1997 UBC, making it less stringent. The special inspection provisions can be or are slightly less stringent in the UBC for piers, piles, caissons, and for reinforcing steel. The 1997 NEHRP Provisions include special inspection provisions for structural wood, cold-formed steel framing, architectural components, and mechanical and electrical components, which are not part of the 1997 UBC, making it less stringent. The 1997 NEHRP Provisions have testing requirements for reinforcing and prestressing steel, structural concrete, structural masonry, and mechanical and electrical components that are not included in the 1997 UBC. This also makes the UBC less stringent.

5.4 Chapter 4: Ground Motion

The 1997 NEHRP Provisions require that all structures be assigned to a Seismic Design Category, based on their Seismic Use Group and the design spectral response acceleration coefficients, S_{DS} and S_{D1}, which are soil-modified. The 1997 UBC simply requires that each site be assigned to a seismic zone. These are obviously not equivalent. The 1997 NEHRP Provisions also contain siting restrictions for structures assigned to

Seismic Design Categories E and F, which are not in the 1997 UBC, making it less stringent.

5.5 Chapter 5: Structural Design Criteria

1. The wind and snow loads set forth in ASCE 7-95 and adopted by reference in the 1997 NEHRP provisions are more current and state-of-the-art than the 1997 UBC provisions. The UBC wind loads are based on fastest-mile wind speeds dating back to 1988, whereas the ASCE 7-95 wind loads are based on three-second gust wind speeds, which reflect current data. This makes the UBC non-equivalent.
2. One notable feature of the 1997 NEHRP Provisions is the proliferation of structural systems in Table 5.2.2. For example, in the 1994 Provisions, the bearing wall system with concrete shear walls was assigned R- and C_d- values of 4.5 and 4, respectively. These values did not change from the high to the low Seismic Performance Categories. In SPC D and E, the shear walls required special detailing, while in SPC A, B, and C, ordinary detailing was all that was needed. Thus, in effect, two different seismic-force-resisting systems with different levels of inelastic deformability went under the same name and were assigned the same R- and C_d- values. For the 1997 NEHRP Provisions it was decided that each basic seismic-force-resisting system defined in Table 5.2.2 would have its own unique set of detailing requirements and commensurate R- and C_d- values assigned to it. Thus, four different types of concrete shear walls have been defined: ordinary plain concrete, detailed plain concrete, ordinary reinforced concrete, and special reinforced concrete. This obviously adds to the total number of structural systems defined in the table. R- and Ω_0- values for the same structural system are often different between Table 5.2.2 of the 1997 NEHRP Provisions and Table 16-N of the 1997 UBC. C_d, of course, is not used in the UBC. System limitations are based on Seismic Design Categories in NEHRP, and on Seismic Zones in the UBC. All of this makes the two documents non-equivalent.
3. UBC has no structure height and structural system limitations below Seismic Zone 3; the NEHRP Provisions contain such limitations for structures assigned to Seismic Design Categories B and C. NEHRP has shorter height limits in SDC E than in SDC D and even shorter height limits in SDC F. UBC has the same height limits in Zones 3 and 4. UBC is less restrictive in this regard.
4. With respect to plan and vertical irregularities, the UBC is slightly less stringent because it does not include the extreme torsional irregularity and the extreme soft story irregularity.
5. With respect to redundancy, the UBC is less stringent because: (a) it does not use variable floor areas along the height of the building, (b) it takes ρ as the highest floor-level ρ-value over the lower two-thirds of the building height, while NEHRP considers the entire building height, and (c) for special moment frames in SDC E or F, ρ is restricted to 1.1 by NEHRP, but only to 1.25 by the UBC.
6. UBC is at times somewhat less stringent in its treatment of structures with certain types of structural irregularities.

7. UBC is less stringent with respect to the consideration of vertical earthquake ground motion in special seismic load combinations.
8. NEHRP allows T (rationally computed elastic fundamental period) to be a larger multiple of T_a in lower seismic areas, but restricts it to a lower multiple of T_a (approximate elastic fundamental period) in the highest seismic areas. This makes the UBC somewhat less stringent in high seismic areas.
9. UBC is less stringent with respect to the dynamic amplification of torsion in structures of SDC C, D, E, and F, where Type 1 torsional irregularity exists.
10. Disregard of minimum base shear given by Eq. (30-6) in drift computations makes the UBC less stringent with respect to drift control for tall buildings.
11. UBC is less stringent in its considerations of P-Delta effects.

5.6 Chapter 6: Architectural, Mechanical and Electrical Components Design Requirements

The UBC is less stringent with respect to:

1. Component anchorage,
2. Construction documents,
3. Design of architectural components for seismic relative displacements,
4. Out-of-plane bending of architectural components,
5. Design of suspended ceilings,
6. Design of access floors,
7. Design of partitions, and
8. Mechanical and electrical component design.

5.7 Chapter 7: Foundation Design Requirements

UBC foundation design requirements are related to Seismic Zones, while those of the NEHRP Provisions are related to Seismic Design Categories. There is a lack of equivalency here. The UBC is less stringent with respect to geotechnical investigation in Seismic Zone 2. The UBC is less stringent concerning pile to pile cap connections in buildings assigned to SDC C and higher. The UBC is also less stringent with respect to ties between spread footings founded on Site Class E and F soils.

5.8 Chapter 8: Steel Structure Design Requirements

The UBC references the same standards as the NEHRP Provisions; however, in two cases, the UBC referenced standard is an older edition. The major reference for seismic provisions is an older edition (1992, rather than 1997). Similarly, the specification adopted for design of cold-formed steel structural members is also an older edition (1991, rather than 1996). This makes the UBC non-equivalent. UBC steel design requirements are tied to Seismic Zones, while those of the NEHRP Provisions are tied to Seismic Design Categories. There is a lack of equivalency here as well. The UBC is less stringent with respect to light framed cold-formed steel wall systems in lower seismic zones. This is true of general wall provisions as well as of provisions concerning: (a) boundary members, (b) connections, (c) braced bay members, (d) diagonal braces, and (e) shear walls. The provisions concerning steel cables are equivalent, with the exception of a NEHRP modification to the referenced standard.

5.9 Chapter 9: Concrete Structural Design Requirements

Where prestressing tendons are to be permitted in flexural members, the NEHRP Provisions contain a requirement concerning anchorages for tendons that is not in the UBC, making it less stringent. NEHRP encourages steel failure rather than concrete failure to govern the strength of anchors; this requirement is not in the UBC, making it less stringent. Design tensile strength of an anchor based on concrete failure is less conservative in the UBC than in the NEHRP Provisions. The classification of moment frames and shear walls is not the same in the NEHRP Provisions and the UBC. The NEHRP Provisions classify structural systems based on the level of detailing. The UBC simply indicates which provisions of ACI 318 Chapter 21 are applicable to various structural systems in various seismic zones. NEHRP also imposes detailing requirements on ordinary moment frames that are additional to those of ACI 318-95. These are not included in the 1997 UBC, making it less stringent. NEHRP requires all moment frames forming part of the seismic-force-resisting system of buildings assigned to SDC B and founded on Site Class E or F soils to be intermediate or special moment frames. The UBC contains no corresponding requirement, making it less stringent. NEHRP indicates which structural systems are permitted in the various Seismic Design Categories; structural systems of lower inelastic deformability are excluded in the higher Seismic Design Categories. The UBC simply indicates which provisions of ACI 318 Chapter 21 are applicable to various structural systems in various seismic zones. For columns supporting reactions from discontinuous stiff members such as walls, the UBC is less stringent with respect to detailing requirements as well as the consideration of vertical earthquake ground motion in special seismic load combinations

5.10 Chapter 10: Steel & Concrete Design Requirements

These requirements do no exist in the UBC. Thus, equivalency cannot be judged.

5.11 Chapter 11: Masonry Structure Design Requirements

1. NEHRP adopts ACI 530-95 and ACI 530.1-95 by reference; the UBC does not, making the two documents non-equivalent.
2. UBC masonry design requirements are tied to Seismic Zones, while those of the NEHRP Provisions are tied to Seismic Design Categories. There is a lack of equivalency here.
3. The UBC is non-equivalent with respect to compliance with the specified f'_m.
4. The UBC has working stress design for masonry, while NEHRP does not. This makes the two documents non-uniform.

5. Empirical design is allowed for lateral-force-resisting systems in Seismic Zone 1 of the UBC, while it is not allowed for buildings assigned to NEHRP Seismic Design Category B, making the UBC less stringent.
6. The UBC maximum spacing of reinforcement in a Seismic Zone 3 & 4 shear wall is less restrictive than the NEHRP maximum spacing of reinforcement in a special reinforced masonry shear wall.
7. Where masonry is laid in stack bond in a building assigned to SDC D or higher, NEHRP specifies a maximum horizontal reinforcement spacing of 24 in. A similar spacing limitation does not exist in the UBC for stack bond masonry in Seismic Zones 3 & 4, making it less restrictive.
8. Concrete abutting structural masonry is required to be roughened to a full amplitude of 1/16 in. by the UBC in Seismic Zones 3, 4. The required amplitude is 1/8 in. in the NEHRP Provisions for buildings assigned to Seismic Design Category D and higher.
9. Reinforcement requirements for stack bond masonry are increased from SDC D to SDC E, F in the NEHRP provisions. UBC has the same reinforcement requirements across Zones 3 and 4, making it less stringent.
10. The UBC is less restrictive with respect to the size of reinforcement in reinforced masonry construction.
11. NEHRP prohibits bundling of reinforcing bars in masonry construction. UBC is silent on the topic.
12. The UBC does not contain the following NEHRP requirements: (a) the minimum grout thickness between reinforcing bars and masonry units shall be ¼ in. for fine grout and ½ in. for coarse grout, (b) Longitudinal wires of joint reinforcement shall be fully embedded in mortar or grout with a minimum cover of ½ in. when exposed to earth or weather and 3/8 in. when not exposed to earth or weather, (c) wall ties, anchors and inserts, except anchor bolts not exposed to the weather or moisture, shall be protected from corrosion.
13. NEHRP prohibits the use of lap splices in plastic hinge zones. UBC contains no such prohibition.
14. The stress block assumed for masonry in compression in designs for flexure and axial loads is more liberal in the UBC than in the NEHRP Provisions.
15. NEHRP requires that the design shear strength, ϕV_n, shall exceed the shear corresponding to the development of 1.25 times the nominal flexural strength of the member, except that the nominal shear strength need not exceed 2.5 times V_u. The UBC does not contain a corresponding provision, making it less stringent.
16. NEHRP requires that the nominal moment strength at any section along a member shall not be less than <u>one-half</u> the higher moment strength provided at the two ends of the member in a special moment frame of masonry. In the UBC, the corresponding number is one-quarter, making it less restrictive.
17. NEHRP requires that the clear span of a wall frame beam be not less than <u>four</u> times its depth. In the UBC, the corresponding ratio is <u>two</u>, making it less restrictive.
18. Maximum vertical reinforcement in wall frame columns is more restrictive in NEHRP than in the UBC.

5.12 Chapter 12: Wood Structural Design Requirements

1. The UBC can be less restrictive with respect to the horizontal distribution of shear to lateral-force-resisting elements.
2. The UBC can be less restrictive with respect to detailing of shear wall and diaphragm boundary elements.
3. The UBC requires smaller plate washers than the NEHRP Provisions for shear wall anchorage; and these are only required in Seismic Zones 3 and 4.
4. The UBC panel sheathing size requirement for diaphragms and shear walls apply only in Seismic Zones 3 and 4, making the UBC less restrictive in this regard.
5. The UBC allows a 4:1 aspect ratio for both blocked and unblocked wood structural panel diaphragms, whereas the NEHRP limits the aspect ratio to 3:1 for such unblocked diaphragms, thus making the NEHRP Provisions more restrictive in this regard. Under certain conditions depending upon seismic zone, the UBC allows a higher aspect ratio for shear walls than the NEHRP Provisions.
6. The UBC allows the use of particleboard and fiberboard for shear walls, while the NEHRP Provisions do not allow such usage, making the UBC less restrictive in this regard.
7. For double diagonally sheathed lumber diaphragms, the allowable aspect ratio is less restrictive in the UBC.
8. The UBC is less restrictive as to structures for which conventional light frame construction is allowed.
9. For braced walls of particleboard in conventional light-frame construction, no attachment is specified in the UBC, whereas NEHRP does specify minimum attachment. Another difference is that the UBC requires 7 in. o/c fastener spacing for gypsum board sheathing whereas the NEHRP Provisions require the same size fasteners to be spaced at 4 in. o/c.
10. The UBC is not equivalent to NEHRP with respect to foundations supporting braced wall panels in conventional light-frame construction.
11. NEHRP requires structures assigned to Seismic Design Categories E and F to conform to all of the requirements for engineered construction and to the additional requirements of Section 12.8. The UBC does not contain any such restriction, making it less conservative.

5.13 Chapter 13: Seismically Isolated Structures Design Requirements

NEHRP requires all portions of a structure, including the structure above the isolation system, to be assigned a Seismic Use Group. The UBC specifies that the importance factor, I, for a seismic-isolated building be taken as 1.0 regardless of occupancy category. This makes the UBC non-equivalent.

5.14 Chapter 14: Nonbuilding Structure Design Requirements

The UBC is generally less stringent with respect to the design of steel storage racks.

5.15 Conclusions Regarding 1997 UBC

The seismic and material design requirements of the 1997 UBC were found to be not equivalent to those of the 1997 NEHRP Provisions in a number of important respects (as detailed above):

1. The 1997 NEHRP Provisions require all structures to be assigned to a Seismic Design Category, based on their Seismic Use Group or occupancy and the soil-modified seismic risk at the site of the structure. The 1997 UBC simply requires that each site be assigned to a Seismic Zone. The foundation, concrete, masonry, steel and wood design requirements of the UBC are tied to Seismic Zones, while those of the NEHRP Provisions are tied to Seismic Design Categories.
2. A policy decision was made with respect to the 1997 NEHRP Provisions. It was decided that each basic seismic-force-resisting system defined in Table 5.2.2 would have its own unique set of detailing requirements and commensurate R- and C_d- values assigned to it. This eliminated having the same name, R- and C_d-values assigned to two completely different seismic-force-resisting systems, as is the case with the 1997 UBC. This obviously adds to the total number of structural systems formally recognized by the IBC. R- and Ω_o- values for the same structural system are often different between Table 5.2.2 of the 1997 NEHRP provisions and Table 16-N of the 1997 UBC. C_d, of course, is not used in the UBC. System limitations are based on Seismic Design Categories in NEHRP, and on Seismic Zones in the UBC.
3. The occupancy importance factors of the UBC are less than those of the 1997 NEHRP Provisions for Seismic Use Group II and III buildings (high-occupancy buildings and essential facilities).
4. UBC has no structure height and structural system limitations below Seismic Zone 3; the NEHRP Provisions contain such limitations for structures assigned to Seismic Design Categories B and C. NEHRP has shorter height limits in SDC E than in SDC D and even shorter height limits in SDC F. UBC has the same height limits in Zones 3 and 4.
5. With respect to redundancy: (a) the UBC, unlike NEHRP, does not use variable floor areas along the height of the building, (b) the UBC takes ρ as the highest floor-level ρ -value over the lower two-thirds of the building height, while NEHRP considers the entire building height, and (c) for special moment frames in SDC E or F, ρ is restricted to 1.1 by NEHRP, but only to 1.25 by the UBC.
6. NEHRP restricts rationally computed elastic fundamental period (T) to a lower multiple of the approximate fundamental period (T_a) in regions of high seismicity.
7. UBC disregards the minimum base shear given by Eq. (30-6) in drift computations, thereby making drift control requirements less stringent for tall buildings.
8. The 1997 NEHRP Provisions require that a quality assurance plan be submitted to the authority having jurisdiction, gives the details of that plan, and lays down contractor responsibilities for the same. The UBC does not have such provisions. The special inspection and testing requirements of the NEHRP Provisions are also more onerous than those of the UBC.

9. The NEHRP Provisions are much more comprehensive and onerous with respect to design requirements for architectural, mechanical and electrical components.
10. The UBC is less stringent than NEHRP with respect to: (a) geotechnical investigation in Seismic Zone 2, (b) pile to pile cap connections in buildings assigned to SDC C and higher, and (c) ties between spread footings founded on Site Class E and F soils.
11. The UBC references the same steel standards as the NEHRP Provisions; however, in two cases, the UBC referenced standards are older editions.
12. The classification of concrete moment frames and shear walls is not the same in the NEHRP Provisions and the UBC. The NEHRP Provisions classify structural systems based on the level of detailing. The Provisions indicate which structural systems are permitted in the various Seismic Design Categories; structural systems of lower inelastic deformability are excluded in the higher SDC's. The UBC simply indicates which provisions of ACI 318 Chapter 21 are applicable to various structural systems in various Seismic Zones.
13. NEHRP adopts ACI 530-95 and 530.1-95 by reference for masonry design and construction. The UBC does not.
14. The UBC has working stress design for masonry, while NEHRP does not.
15. Concerning wood structural design: (a) The UBC can be less restrictive with respect to the horizontal distribution of shear to lateral-force-resisting elements, (b) The UBC allows a 4:1 aspect ratio for both blocked and unblocked wood structural panel diaphragms, whereas the NEHRP limits the aspect ratio to 3:1 for such unblocked diaphragms, (c) Under certain conditions depending upon Seismic Zone, the UBC allows a higher aspect ratio for shear walls than the NEHRP Provisions, (d) The UBC allows the use of particleboard and fiberboard for shear walls, while the NEHRP Provisions do not allow such usage, (e) The UBC is less restrictive as to structures for which conventional light frame construction is allowed.
16. The UBC is generally less stringent with respect to the design of steel storage racks.

In view of the above, it is concluded that the seismic and material design requirements of the 1997 UBC are not equivalent to those of the 1997 NEHRP Provisions.

6.0 CONCLUSIONS

In this report, the 1997 NEHRP Provisions are compared to the seismic and material design requirements of the *Uniform Building Code* 1997 edition.

The seismic design provisions of the 1997 *Uniform Building Code* are based on Appendix C of the 1996 edition of the *Recommended Lateral Force Requirements* published by the Structural Engineers Association of California (SEAOC Blue Book). It also includes many of the features of the 1994 NEHRP Provisions. The earthquake regulations of the 1997 NEHRP Provisions are substantially different form the corresponding requirements of the 1994 Provisions. Partly as a result of this and partly because the 1997 UBC did not include some important features of the 1994 NEHRP Provisions, the seismic and material design requirements of the 1997 UBC were found to be not equivalent to those of the 1997 NEHRP Provisions. Detailed chapter-by-chapter and side-by-side comparisons of the 1997 NEHRP Provisions and the seismic and material design requirements of the 1997 UBC are provided in this report, and form the basis of the conclusion just stated.

REFERENCES

1. Assessment of the Seismic Provisions of Model Building Codes. NIST GCR 91-598. *Council of American Building Officials, July 1992.*
2. Comparison of the Seismic Provisions of Model Building Codes and Standards to the 1997 NEHRP Recommended Provisions. NIST GCR 95-674. *Melvyn Green & Associates, Inc., May 1995.*
3. Comparison of the Seismic Provisions of Model Building Codes and Standards to the 1994 NEHRP Recommended Provisions. NIST GCR 98-755. *Degenkolb Engineers, August 1998.*
4. Comparison of the Seismic Provisions of Model Building Codes and Standards to the 1997 NEHRP Recommended Provisions. Partial Draft. *S.K. Ghosh Associates Inc., February 2001.*

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
1 GENERAL PROVISIONS		**SECTION 1626 – GENERAL**		
1.1 PURPOSE	Presents criteria for the design and construction of structures to resist earthquake ground motions.	1626.1 Purpose 1626.2 Minimum Seismic Design	The purpose of the earthquake provisions herein is primarily to safeguard against major structural failures and loss of life, not to limit damage or maintain function. Structures are to be designed for the effects of seismic ground motion, as provided.	NEHRP is more comprehensive. Considered equivalent
1.2 SCOPE AND APPLICATION 1.2.1 Scope	These *Provisions* shall apply to the design and construction of *structures* including *additions*, change of use, and *alterations* to resist the effects of earthquake motions. Every *structure*, and portion thereof, shall be designed and constructed to resist the effects of earthquake motions as prescribed by these *Provisions.* Exceptions: 1. Detached one- and two-family dwellings located where S_{DS} is less than 0.4g are exempt from all requirements of these *Provisions.* 2. Detached one- and two-family wood frame dwellings located where S_{DS} is equal to or greater than 0.4g and that are designed and constructed in accordance with the conventional light frame construction provisions in Sec. 12.5 are exempt from all other requirements of these *Provisions.* 3.Agricultural storage *structures* intended only for incidental human occupancy are exempt from all requirements of these *Provisions.* 4.*Structures* located where S_1 is less than or equal to 0.04g and S_S is less than or equal to	SECTION 1629 – CRITERIA SELECTION 1629.1 Basis for Design 1605 DESIGN 1605.1 General	Similar in intent, with the following exemptions: 1. One- and two-family dwellings in Seismic Zone 1 need not conform to the provisions of this section. 2. Unless otherwise required by BO, buildings or portions thereof that are constructed in accordance with the conventional light-framing requirements specified in Ch. 23 of this code shall be deemed to meet the requirements of this section.	NEHRP has broader exemptions. UBC is more restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	0.15g shall only be required to comply with Sec. 5.2.6.1, (Design Requirements for SDC A).			
		SECTION 3403 – ADDITIONS, ALTERATIONS OR REPAIRS		
1.2.2 Addition	An *addition* that is not structurally independent from an existing *structure* shall be designed and constructed such that the entire *structure* conforms to the seismic-force- resistance requirements for new *structures* unless all of the following conditions are satisfied: 1.The *addition* conforms with the requirements for new *structures*, and 2. The *addition* does not increase the *seismic forces* in any structural *element* of the existing *structure* by more than 5 percent, unless the capacity of the *element* subject to the increased forces is still in compliance with these *Provisions*, and 3. The *addition* does not decrease the seismic resistance of any structural *element* of the existing *structure* to less than that required for a new *structure*.	3403.2 When allowed	1. Additions, alterations or repairs may be made to any building or structure without requiring the existing building or structure to comply with all the requirements of this code, provided the addition, alteration or repair conforms to that required for a new building or structure. 2. Additions or alterations shall not be made to an existing building or structure that will cause the existing building or structure to be in violation of any of the provisions. 3. Such additions or alterations shall not cause the existing building or structure to become unsafe. 4. Any building so altered, which involves a change in use or occupancy, shall not exceed the height, number of stories and area permitted for new buildings.	NEHRP has seismic requirements, whereas UBC has general requirements. UBC is less restrictive.
1.2.3 Change of Use	When a change of use results in a *structure* being reclassified to a higher *Seismic Use Group*, the *structure* shall conform to the requirements of Section 1.2.1 for a new *structure*. Exception: When a change of use results in a *structure* being reclassified from *Seismic Use Group* I to *Seismic Use Group* II, compliance with these *Provisions* is not required if the *structure* is located where S_{DS} is less than 0.3.	SECTION 3405 – CHANGE IN USE	No change shall be made in the character of occupancies or use of any building that would place the building in a different division of the same group of occupancy or in a different group of occupancies, unless such building is made to comply with the requirements of this code for such division or group of occupancy.	NEHRP has specific exceptions. UBC is more restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
1.2.4 Alterations	*Alterations* are permitted to be made to any *structure* without requiring the *structure* to comply with these *Provisions* provided the *alterations* conform to that required for a new *structure*. *Alterations* shall not decrease the lateral-force resisting system strength or stiffness to less than that required by these *Provisions*. The *alteration* shall not cause the existing structural *elements* to be loaded beyond their capacity.	SECITON 3403	Alterations are grouped with addition in Section 3403.2	NEHRP has seismic requirements, whereas UBC has general requirements. UBC is less restrictive.
1.3 SEISMIC USE GROUPS		1629.2 Occupancy Categories		
1.3.1 Seismic Use Group III	Are those having essential facilities that are required for post-earthquake recovery and those containing substantial quantities of hazardous substances (Occupancy importance factor, I = 1.5)	1. Essential facilities 2. Hazardous facilities	Group I, Division 1 - Occupancies having surgery and emergency treatment areas Fire and police stations, etc. (Seismic importance factor, I=1.25) Group H, Divisions 1, 2, 6 and 7 - Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances (I=1.25)	Definitions are equivalent. NEHRP I–value is more stringent.
1.3.2 Seismic Use Group II	Structures are those that have a substantial public hazard due to occupancy or use (I=1.25)	3. Special occupancy structures	Buildings housing Group E, Divisions 1 and 3 - Occupancies with a capacity greater than 300 students, etc. (I=1.0)	Definitions are equivalent. NEHRP I – value is more stringent.
1.3.3 Seismic Use Group I	Structures are those not assigned to Seismic Use Groups III or II (I=1.0)	4. Standard occupancy structures 5. Miscellaneous structures	All structures housing occupancies or having functions not listed in category 1,2 or 3 and Group U Occupancy towers. (I=1.0) Group U Occupancies except for towers. (I=1.0)	Equivalent
1.4 OCCUPANCY IMPORTANCE FACTOR	Based on seismic use group (Table 1.4)	1629.2 Occupancy Categories	Table 16-K	NEHRP is more stringent for SUG II and III.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
2 GLOSSARY AND NOTATIONS		**SECTION 1627 - DEFINITIONS**		
2.1 GLOSSARY 2.2 NOTATIONS		SECTION 1628 – SYMBOLS AND NOTATIONS		Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
3 QUALITY ASSURANCE		**Chapter 17 STRUCTURAL TESTS AND INSPECTIONS**		
3.1 Scope	This chapter provides minimum requirements for quality assurance, special inspection, testing, structural observations and compliance procedures for construction.	1701.1 General	Partly the same. Included are provisions for special inspection, structural observation, nondestructive testing and prefabricated construction.	Equivalency cannot be judged.
3.2 QUALITY ASSURANCE 3.2.1 Details of Quality Assurance Plan 3.2.2 Contractor Responsibility			No corresponding provisions.	NEHRP is more stringent.
3.3 SPECIAL INSPECTION	The owner shall employ a special inspector(s) to observe the construction for compliance with the following:	1701 – SPECIAL INSPECTIONS 1701.1 General 1701.5 Types of Work	See below	
3.3.1 Piers, Piles, Caissons	*Continuous special inspection* during driving of piles and placement of concrete in piers, piles, and caissons. *Periodic special inspection* during construction of drilled piles, piers, and caissons including the placement of reinforcing steel.	1701.5 Item 11 Piling, drilled piers and caissons	Similar provisions, but the UBC is silent on continuous versus periodic special inspection.	UBC is equivalent to less stringent.
3.3.2 Reinforcing steel	*Periodic special inspection* during and upon completion of the placement of reinforcing steel in *intermediate moment frames*, in *special moment frames*, and in *shear walls.* *Continuous special inspection* during the welding of reinforcing steel resisting flexural and axial forces in *intermediate moment frames* and *special moment frames*, in *boundary members* of concrete *shear walls*, and during welding of shear reinforcement.	1701.5 Item 4 Reinforcing steel and prestressing tendons 1701.5 Item 5.3 Welding of reinforcing steel	Similar provisions, except that the inspection can be periodic. Similar provision, except that the inspection can be periodic.	Equivalent UBC is less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
3.3.3 Structural concrete	*Periodic special inspection* during and on completion of the placement of concrete in *intermediate moment frames*, in *special moment frames*, and in *boundary members* of *shear walls.*	1701.5 Item 1 Concrete 1701.5 Item 3 Special moment-resisting concrete frame	Similar provisions, except that continuous special inspection is specifically required for special moment frames.	UBC is more stringent.
3.3.4 Prestressed concrete	*Periodic special inspection* during the placement and after completion of placement of prestressing steel and *continuous special inspection* is required during all stressing and grouting operations and during the placement of concrete.	1701.5 Item 1 Concrete 1701.5 Item 4 Reinforcing steel and prestressing tendons	Essentially the same.	Equivalent
3.3.5 Structural Masonry	*Periodic special inspection* during the preparation of mortar, the laying of masonry units, and placement of reinforcement and prior to placement of grout. *Continuous special inspection* during the welding of reinforcement, grouting, consolidation, reconsolidation and placement of bent-bar anchors as required by Sec. 11.3.12.2.	1701.5 Item 7 Structural masonry 1701.5 Item 5 Structural welding	Very similar provisions, except that placement of bent-bar anchors is not specifically mentioned. An exception is provided that is not in the NEHRP Provisions.	Equivalent Equivalency cannot be judged.
3.3.6 Structural Steel	*Continuous special inspection* for all structural welding. Exception: *Periodic special inspection* is permitted for single-pass fillet or resistance welds and welds loaded to less than 50 percent of their *design strength* provided the qualifications of the welder and the welding electrodes are inspected at the beginning of the work and all welds are inspected for compliance with the approved *construction documents* at the completion of welding. *Periodic special inspection* in accordance with Ref. 8-1 or 8-2 for installation and tightening of fully tensioned high-strength bolts in slip-critical *connections* and in *connections* subject to direct	1701.5 Item 5 Structural welding 1701.5 Item 6 High-strength bolting	Essentially the same	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	tension. Bolts in *connections* identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected *elements* have been brought into snug contact.			
3.3.7 Structural Wood	*Continuous special inspection* during all field gluing operations of *elements* of the *seismic-force-resisting system.* *Periodic special inspections* for nailing, bolting, anchoring, and other fastening of *components* within the *seismic-force-resisting system* including *drag struts*, braces, and *tie-downs.*		No corresponding provisions	UBC is less stringent
3.3.8 Cold-Formed Steel Framing	*Periodic special inspections* during all welding operations of *elements* of the *seismic–force–resisting system.* *Periodic special inspections* for screw attachment, bolting, anchoring, and other fastening of *components* within the *seismic–force–resisting system*, including struts, braces, and hold–downs.		No corresponding provisions	UBC is less stringent
3.3.9 Architectural Components	*Special inspection* for architectural *components* shall be as follows: 1. *Periodic special inspection* during the erection and fastening of exterior cladding, interior and exterior nonloadbearing *walls*, and *veneer* in *Seismic Design Categories* D, E, and F and Exceptions: a. *Structures* 30 feet (9 m) or less in height and b. Cladding and *veneer* weighing 5 lb/ft^2 (240 kg/m^2) or less. 2. *Periodic special inspection* during the anchorage of access floors, suspended ceilings, and *storage racks* 8 feet (2.4 m) or greater in		No corresponding provisions	UBC is less stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	height in *Seismic Design Categories* D, E, and F.			
3.3.10 Mechanical and Electrical Components	*Special inspection* for mechanical and electrical *components* shall be as follows: 1. *Periodic special inspection* during the anchorage of electrical equipment for emergency or standby power systems in *Seismic Design Categories* C, D, E, and F; 2. *Periodic special inspection* during the installation of anchorage of all other electrical equipment in *Seismic Design Categories* E and F; 3. *Periodic special inspection* during installation for flammable, combustible, or highly toxic piping systems and their associated mechanical units in *Seismic Design Categories* C, D, E, and F; and 4. *Periodic special inspection* during the installation of HVAC ductwork that will contain hazardous materials in *Seismic Design Categories* C, D, E, and F.		No corresponding provisions	UBC is less stringent
3.3.11 Seismic Isolation System	*Periodic special inspection* during the fabrication and installation of *isolator units* and energy dissipation devices if used as part of the seismic *isolation system.*	1661.2.8 Inspection and Replacement (Seismically-Isolated Structures) Item 3	Essentially similar provisions.	Considered equivalent
3.4 TESTING	The *special inspector(s)* shall be responsible for verifying that the testing requirements are performed by an approved *testing agency* for compliance with the following:	1703 – NONDESTRUCTIVE TESTING		
3.4.1 Reinforcing and Prestressing Steel	Special testing of reinforcing and prestressing steel shall be as follows: ...		No corresponding provisions	UBC is less stringent
3.4.2 Structural Concrete	Samples of structural concrete shall be obtained at the project site and tested in accordance with requirements of Ref. 9-1		No corresponding provisions	UBC is less stringent
3.4.3 Structural masonry	Quality assurance testing of structural masonry shall be in accordance with the requirements of		No corresponding provisions	UBC is less stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	Ref. 11-1.			
3.4.4 Structural Steel 3.4.4.1 Base Metal Tesing	The testing needed to establish that the construction is in conformance with these *Provisions* shall be included in a *quality assurance plan*. The minimum testing contained in the *quality assurance plan* shall be as required in Ref. 8-3 and the following requirements: .... Base metal thicker than 1.5 in. (38 mm), when subject to through-thickness weld shrinkage strains, shall be ultrasonically tested for discontinuities behind and adjacent to such welds after joint completion. ...		Essentially the same	Equivalent
3.4.5 Mechanical and Electrical Components	As required to ensure compliance with the seismic design requirements herein, the *registered design professional* in responsible charge shall clearly state the applicable requirements on the *construction documents*. ...		No corresponding provisions	UBC is less stringent
3.4.6 Seismically Isolated Structures	For required system tests, see Sec. 13.9.	SECTION 1665 - REQUIRED TESTS OF THE ISOLATION SYSTEM	Essentially similar provisions as in Sec. 13.9 of NEHRP	Equivalent
	No corresponding provisions	1704 – PREFABRICATED CONSTRUCTION		Equivalency cannot be judged
3.5 STRUCUTRAL OBSERVATIONS	*Structural observations* shall be provided for those *structures* included in *Seismic Design Categories* D, E, and F when one or more of the following conditions exist: 1. The *structure* is included in *Seismic Use Group* II or III 2. The height of the *structure* is greater than 75 feet above the *base* 3. The *structure* is in *Seismic Design Category* E	SECTION 1702 – STRUCTURAL OBSERVATION	Structural observation shall be provided in Seismic Zone 3 or 4 when one of the following conditions exists: 1. The structure is defined in Table 16-K as Occupancy Category 1, 2 or 3 2. The structure is required to comply with Section 403 3. The structure is in Seismic Zone 4, N_a as set forth in Table 16-S is greater than one, and a	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	or F and *Seismic Use Group* I and is greater than two *stories* in height.		lateral design is required for the entire structure (Exception: one- and two-story Group R, etc.) 4. When so designated by the architect or engineer of record 5. When such observation is specifically required by the building official	
3.6 REPORTING AND COMPLIANCE PROCEDURES	Details reporting responsibilities of special inspector and contractor.	1701.3 Duties and responsibilities of the special inspector	Essentially identical. But did not spell out the responsibilities of contractor.	UBC is equivalent to less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
4 GROUND MOTION				
4.1 PROCEDURES FOR DETERMINING MCE AND DESIGN EARTHQUAKE GROUND MOTION ACCELEARTIONS AND RESPONSE SPECTRA 4.1.1 Maximum Considered Earthquake (MCE) Ground Motions	The mapped maximum considered earthquake (MCE) spectral accelerations at short periods (S_S) and at 1 second period (S_1) shall be determined from period Maps 1 through 24, representative of a 2% probability of being exceeded in 50 years. Exception: When $S_s \leq 0.15g$ and $S_1 \leq 0.04g$, structures are permitted to be categorized as SDC A.		No corresponding provisions.	See 4.1.2.5
4.1.2 General Procedure for Determining Maximum Considered Earthquake and Design Spectral Response Accelerations	The MCE spectral response acceleration adjusted for site class effects shall be determined in accordance with Sec. 4.1.2.4: $S_{MS} = F_a S_S$ $S_{M1} = F_v S_1$		No corresponding provisions	See 4.1.2.5
4.1.2.1 Site Class Definitions	For all structures ($S_s \geq 0.15g$ and $S_1 \geq 0.04g$), the site shall be classified as one of the following classes: A – Hard rock ($v_s > 5000$ ft/sec) B – Rock (2500 ft/sec $< v_s <$ 5000 ft/sec) C – Very dense soil and soft rock (1200 ft/sec $< v_s <$ 2500 ft/sec) D – Stiff soil (600 ft/sec $< v_s <$ 1200 ft/sec) E – A soil profile with $v_s <$ 600 ft/sec F – Soils requiring site-specific evaluation	1636 SITE CATEGORIZATION PROCEDURE	Essentially the same	Equivalent
4.1.2.5 Design Spectral Response	Design earthquake spectral response acceleration at short periods, S_{DS}, and at 1 second period, S_{D1},	1629.4 Site Seismic Hazard Characteristics	Each structure shall be assigned a seismic zone factor Z, near-source factors N_a and N_v (if in	Approaches are different. Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
Acceleration Parameters	shall be determined as: $S_{DS} = \frac{2}{3} S_{MS}$ $S_{D1} = \frac{2}{3} S_{M1}$	1629.4.1 Seismic zone 1629.4.2 Seismic Zone 4 near source factor 1629.4.3 Seismic response coefficient	Seismic zone 4), and seismic response coefficients C_a and C_v.	in intent. Equivalency of design values not possible to judge except on a case-by-case basis.
4.1.2.6 General Procedure Response Spectrum	The design response spectrum curve shall be developed as follows: $S_a = 0.6 \frac{S_{DS}}{T_0} T + 0.4 S_{DS}$ ($T_0 > T$) $S_a = S_{DS}$ ($T_0 < T < T_s$) $S_a = \frac{S_{D1}}{T}$ ($T > T_s$)	SECTION 1627 DESIGN RESPONSE SPECTRUM	Design Response Spectrum is an elastic response spectrum for 5 percent equivalent viscous damping used to represent the dynamic effects of the Design Basis Ground Motion for the design of structures in accordance with Sections 1630 and 1631. $S_a = 2.5C_a$ ($T_0 < T < T_s$) $S_a = \frac{C_v}{T}$ ($T > T_s$)	Equivalent if $S_{DS} = 2.5C_a$ and $S_{D1} = C_v$ at a particular location.
4.1.3 Site-Specific Procedure for Determining Ground Motion Accelerations 4.1.3.1 Probabilistic MCE 4.1.3.2 Deterministic Limit on MCE ground motions 4.1.3.3 Deterministic MCE ground motion			No corresponding provisions.	See 4.1.3.4
4.1.3.4 Site-Specific Design Ground Motion	Where site-specific procedures are used to determine the *MCE ground motion response spectrum*, the design spectral response acceleration at any period shall be determined and shall be greater than or equal to 80 percent of the S_a determined by the general response spectrum in Sec. 4.1.2.6.	1627 DESIGN RESPONSE STECTRUM 1631.2 Ground Motion 1631.5.4 Item 2	Approach is different.	Largely equivalent in intent. NEHRP is more prescriptive. Equivalency of design values would depend on specifics of situation.
4.2 SEISMIC				

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
DESIGN CATEGORY				
4.2.1 Determination of Seismic Design Category	All structures shall be assigned to a Seismic Design Category based on their Seismic Use Group and the design spectral response acceleration coefficients, S_{DS} and S_{D1}	1629.4.1 Seismic Zone	Each site shall be assigned to a seismic zone. The zone does not include soil characteristics nor occupancy as in SDC of NEHRP.	NEHRP is more stringent.
4.2.2 Site Limitation for Seismic Design Categories E and F	A *structure* assigned to *Seismic Design Category* E or F shall not be sited where there is the potential for an active fault to cause rupture of the ground surface at the *structure.*		No corresponding provisions.	NEHRP is more restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
5 STRUCTURAL DESIGN CRITERIA		**Chapter 16 – Structural Design Requirements**		
5.1 REFERENCE DOCUMENT	Refers to ASCE 7-95 for loads other than earthquakes.	Sections 1606-1612	UBC wind and snow load provisions are outdated.	Not equivalent
5.2 DESIGN BASIS 5.2.1 General		1629. 1 Basis for Design	Essentially similar	Considered equivalent
5.2.2 Basic Seismic-Force-Resisting Systems	The basic lateral and vertical seismic-force-resisting system shall conform to one of the types in Table 5.2.2. The appropriate response modification coefficient, R; system overstrength factor, Ω_0, and deflection amplification factor, C_d, are provided	1629. 6 Structural Systems	Structural systems shall be classified as one of the types listed in Table 16-N. The response modification factor, R, and the seismic force amplification factor, Ω_0, are provided. However, NEHRP Provisions are more comprehensive with modified R and Ω_0. System limitations based on SDCs, not Zones as in UBC.	Not equivalent
5.2.2.1 Dual System	The moment frame shall be capable of resisting at least 25 percent of the design forces. The total seismic force resistance is to be provided by the combination of the moment frame and the shear walls or braced frames in proportion to their rigidities.	1629.6.5 Dual system	Essentially similar	Considered equivalent.
5.2.2.2 Combinations of Framing Systems	Different *seismic-force-resisting systems* are permitted along the two orthogonal axes of the *structure*. Combinations of *seismic-force-resisting systems* shall comply with the requirements of this section.	1630.4 Combinations of Structural Systems 1630.4.2 Vertical combinations 1630.4.3 Combinations along different axes 1630.4.4 Combinations along the same axis	The value of R used in the design of any story shall be less than or equal to the value of R used in the given direction for the story above. In Seismic Zones 3 and 4 where a structure has a bearing wall system in only one direction, the value of R used for design in the orthogonal direction shall not be greater than that used for the bearing wall system.... For other than dual systems and shear wall-frame interactive systems in Seismic Zones 0 and 1, the value of R used for design in that direction shall not be greater than the least value	UBC is more restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
			for any of the systems utilized in that same direction.	
5.2.2.3 Seismic Design Categories B and C	The structural framing system for *structures* assigned to *Seismic Design Categories* B and C shall comply with the *structure* height and structural system limitations in Table 5.2.2.		No similar provisions	UBC is less restrictive.
5.2.2.4 Seismic Design Categories D and E 5.2.2.4.1 Limited Building Height	The height limits in Table 5.2.2 is permitted to be increased to 240 ft (70 m) in *buildings* that have steel *braced frames* or concrete cast-in-place *shear walls*. Such *buildings* shall be configured such that the *braced frames* or *shear walls* arranged in any one plane conform to the following: 1. The *braced frames* or cast-in-place special reinforced concrete *shear walls* in any one plane shall resist no more than 60 percent of the total *seismic forces* in each direction, neglecting torsional effects, and 2. The seismic force in any *braced frame* or *shear wall* resulting from torsional effects shall not exceed 20 percent of the total seismic force in that *braced frame* or *shear wall*.	1629.7 Height Limits	Height limits for the various structural systems in Seismic Zones 3 and 4 are given in Table 16-N Exception: Regular structures may exceed these limits by not more than 50 percent for unoccupied structures, which are not accessible to the general public.	NEHRP has shorter height limits in SDC E than in SDC D, UBC has the same height limits in Zones 3, 4. UBC is less restrictive in this regard. The NEHRP relaxation of height limits for certain buildings is not in the UBC. UBC is more restrictive in this regard.
5.2.2.4.3 Deformational Compatibility	Every structural *component* not included in the *seismic-force-resisting system* in the direction under consideration shall be designed to be adequate for the vertical load-carrying capacity and the induced moments and shears resulting from the design *story* drift, Δ, as determined in accordance with Sec. 5.3.7 (also see Sec. 5.2.7). Exception: Beams and columns and their connections not designed as part of the lateral-force-resisting system but meeting the detailing requirements for either *intermediate moment frames* or *special moment frames*	1633.2.4 Deformation Compatibility 1633.2.4.1 Adjoining rigid elements 1633.2.4.2 Exterior elements	UBC requirement is applicable in Seismic Zones 2, 3 and 4. In general, UBC is more comprehensive and specific. For example, it states that the "Exterior nonbearing, nonshear wall panels or elements that are attached to or enclose the exterior shall be designed to resist the forces per Formula (32-1) or (32-2) and shall accommodate the movements of the structure based on Δ_M and temperature changes. Such elements shall be supported by means of cast-in-place concrete or by mechanical connections and fasteners in accordance with the following	UBC is more stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	are permitted to be designed to be adequate for the vertical load-carrying capacity and the induced moments and shears resulting from the deformation of the *building* under the application of the design *seismic forces*. When determining the moments and shears induced in *components* that are not included in the *seismic-force-resisting system* in the direction under consideration, the stiffening effects of adjoining rigid-structural and nonstructural *elements* shall be considered and a rational value of member and restraint stiffness shall be used.		provisions:" in addition to similar provisions of NEHRP.	
5.2.2.4.4 Special Moment Frames	A *special moment frame* that is used but not required by Table 5.2.2 is permitted to be discontinued and supported by a more rigid system with a lower response modification coefficient, *R*, provided the requirements of Sec. 5.2.6.2.3 and 5.2.6.4.3 are met. Where a *special moment frame* is required by Table 5.2.2, the frame shall be continuous to the foundation.		No corresponding provisions	Does not affect equivalency.
5.2.2.5 Seismic Design Category F	5.2.2.4 applies. In addition, height limitation of 5.2.2.4.1 is reduced from 240 ft to 160 ft.		No corresponding provisions	UBC is less stringent.
5.2.3 Structure Configuration		1629.5 Configuration Requirements 1629.5.1 General	Identical	Equivalent
5.2.3.1 Diaphragm Flexibility	*Diaphragms* constructed of untopped steel decking, wood structural panels, or similar panelized construction shall be considered flexible in *structures* having concrete or masonry *shear walls*. *Diaphragms* constructed of wood structural panels shall be considered rigid in light-frame *structures* using structural panels for lateral load resistance. *Diaphragms* of other types shall be	1630.6 Horizontal Distribution of Shear Para 3	Diaphragm shall be considered flexible for the purposes of distribution of story shear and torsional moment when the maximum lateral deformation of the diaphragm is more than two times the average story drift of the associated story. …	Equivalent, except UBC does not include the specific cases covered by NEHRP.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	considered flexible when the maximum lateral *deformation* of the *diaphragm* is more than two times the average *story* drift of the associated *story*. The loadings used for this calculation shall be those prescribed by Sec. 5.3.			
5.2.3.2 Plan Irregularity	- Irregularity type 1a – Torsional irregularity 1b – Extreme torsional irregularity 2 – Re-entrant corners 3 – Diaphragm discontinuity 4 – Out-of-plane offsets 5 – Nonparallel systems	1629.5.3 Irregular Structures Item 3	Essentially identical except that the case of "extreme torsional irregularity" is not included in UBC.	UBC slightly less stringent.
5.2.3.3 Vertical Irregularity	- Irregularity type 1a – Stiffness irregularity (soft story) 1b – Stiffness irregularity (extreme soft story) 2 – Weight (mass) irregularity 3 – Vertical geometric irregularity 4 – In-plane discontinuity in vertical lateral-force-resisting elements 5 – Discontinuity in capacity (weak story)	1629.5.3 Irregular Structures Item 2	Essentially identical except that the case of "extreme soft story" is not included in UBC.	UBC slightly less stringent.
5.2.4 Redundancy 5.2.4.1 Seismic Design Categories A, B, and C 5.2.4.2 Seismic Design Category D 5.2.4.3 Seismic Design Categories E and F	A reliability factor, ρ, shall be assigned to all structures based on the extent of structural redundancy inherent in lateral-force-resisting system For structures in SDC A, B, and C: $\rho = 1.0$ ρ shall be taken as the largest of the values of ρ_x calculated at each story ($1.0 \le \rho \le 1.5$): $\rho_x = 2 - \frac{20}{r_{max\,x}\sqrt{A_x}}$ where A_x is defined as "floor area of diaphragm level immediately above the story."	1630.1.1 Earthquake loads	$\rho = 2 - \frac{20}{r_{max}\sqrt{A_B}}$ r_{max} = the largest element-story shear ratio which occurs in any of the story levels at or below the two-thirds height level of the building. A_B = ground floor area of structure. ρ shall not be taken less than 1.0 and need not be greater than 1.5. For special moment resisting frames, except when used in dual systems, ρ shall not exceed 1.25.	UBC does not use a variable floor area. Also it considers the lower two-thirds of the building, rather than the entire building height. For special moment frames in SDC E or F, ρ is restricted to 1.1 by NEHRP, to 1.25 by the UBC.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	The value of ρ need not exceed 1.5, which is permitted to be used for any structure. The value of ρ shall not be taken as less than 1.0. Exception: For structures with lateral-force-resisting systems in any direction comprised solely of special moment frames, the LFRS shall be configured such that the value of ρ does not exceed 1.25 (1.1 for SDC E & F)			Overall UBC is less stringent.
5.2.5 Analysis Procedures 5.2.5.1-3	A structural analysis shall be made for all *structures* in accordance with the requirements of this section. This section prescribes the minimum analysis procedure to be followed. Use of the procedure in Sec. 5.4 or, with the approval of the authority having jurisdiction, an alternate generally accepted procedure, including the use of an approved site-specific spectrum, is permitted for any *structure*. The limitations on the *base shear* stated in Sec. 5.4 apply to dynamic modal analysis.	1629.8 Selection of Lateral-force Procedure 1629.8.1 1629.8.3 1629.8.4	Essentially similar	Considered equivalent
	No corresponding provisions	1629.8.2 Simplified static	The simplified static lateral-force procedure may be used for the following structures of Occupancy Category 4 or 5: 1. Buildings of any occupancy (including single-family dwellings) not more than three stories in height excluding basements, that use light-frame construction. 2. Other buildings not more than two stories in height excluding basements.	Equivalency not affected.
5.2.5.4 Diaphragms	The deflection in the plane of the diaphragm shall not exceed the permissible deflection of the attached elements. Permissible deflection shall be that deflection that will permit the attached elements to maintain structural integrity under the individual loading and continue to support the	1633.2.9 Diaphragms Items 1 and 2	Essentially identical except for a minor change in the equation: Floor and roof diaphragms shall be designed to resist design seismic forces determined as follows:	Equivalent where $S_{DS} = 2.5\ C_a$

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	prescribed loads. Floor and roof diaphragms shall be designed to resist design seismic forces determined as follows: $F_{px} = \frac{\sum_{i=x}^{n} F_i}{\sum_{i=x}^{n} w_i} w_{px}$ The force determined from Eq. 5.2.5.4 need not exceed $0.4S_{DS}Iw_{px}$ but shall not be less than $0.2S_{DS}Iw_{px}$. When the *diaphragm* is required to transfer design *seismic force* from the vertical resisting *elements* above the *diaphragm* to other vertical resisting *elements* below the *diaphragm* due to offsets in the placement of the *elements* or to changes in relative lateral stiffness in the vertical *elements*, these forces shall be added to those determined from above Equation.		$F_{px} = \frac{F_t + \sum_{i=x}^{n} F_i}{\sum_{i=x}^{n} w_i} w_{px}$ The force, F_{px}, determined from Formula (33-1) need not exceed $1.0C_aIw_{px}$ but shall not be less than $0.5C_aIw_{px}$.	
5.2.6 Design, Detailing Requirements, and Structural Component Load Effects		SECTION 1633 – DETAILED STSTEMS DESIGN REQUIREMENTS		
5.2.6.1 Seismic Design Category A 5.2.6.1.1 Component Load Effects			No corresponding provisions	Does not affect equivalency
5.2.6.1.2 Connections	All parts of the *structure* between separation *joints* shall be interconnected, and the connections shall be capable of transmitting the *seismic force*, F_p, induced by the parts being connected. Any smaller portion of the *structure* shall be tied to the remainder of the *structure* with *elements* having a *strength* of 0.133 times the short period design spectral response acceleration coefficient, S_{DS},	1633.2.5 Ties and Continuity	All parts of a structure shall be interconnected and the connections shall be capable of transmitting the seismic force induced by the parts being connected. As a minimum, any smaller portion of the building shall be tied to the remainder of the building with elements having at least a strength to resist $0.5C_aI$ times the weight of the smaller portion.	UBC force is higher based on S_{DS} = $2.5C_a$. However, UBC does not prescribe a minimum force.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	times the weight of the smaller portion or 5 percent of the portion's weight, whichever is greater. A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder, or truss to its support. The connection shall have a minimum *strength* of 5 percent of the *dead load* and *live load* reaction.		A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder or truss. This force shall not be less than $0.5C_a I$ times the dead plus live load.	
5.2.6.1.3 Anchorage of Concrete and Masonry Walls	Concrete and masonry *walls* shall be anchored to the roof and all floors and members that provide lateral support for the *wall* or which are supported by the *wall*. The anchorage shall provide a direct connection between the *walls* and the roof or floor construction. The connections shall be capable of resisting a seismic lateral force, F_p, induced by the *wall* of 400 times the short period design spectral response acceleration coefficient S_{DS} in pounds per lineal foot (5840 times S_{DS} in N/m) of *wall* multiplied by the *occupancy importance factor I*. *Walls* shall be designed to resist bending between anchors where the anchor spacing exceeds 4 ft (1.2 m).	1633.2.8 Anchorage of concrete or masonry walls	Concrete or masonry walls shall be anchored to all floors and roofs that provide out-of-plane lateral support of the wall. The anchorage shall provide a positive direct connection between the wall and floor or roof construction capable of resisting the larger of the horizontal forces specified in this section and Sections 1611.4 (280 plf) and 1632...	A comparison of $400S_{DS}$ and 280 plf is obviously dependent on the value of S_{DS}. However, a force similar to the one given in Sec. 1632.2 is used in the NEHRP Provisions for architectural, mechanical and electrical components only (See 6.1.3). So equivalency cannot be judged without running specific numbers.
5.2.6.2 Seismic Design Category B				
5.2.6.2.1 Second-Order Effects	In addition to meeting the requirements of Sec. 5.2.6.1.1, second-order effects shall be included where applicable.	1630.1.3 $P\Delta$ effects	The resulting member forces and moments and the story drifts induced by $P\Delta$ effects shall be considered in the evaluation of overall structural frame stability and shall be evaluated using the	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
			forces producing the displacements of Δ_s...	
5.2.6.2.2 Openings	Where openings occur in *shear walls*, *diaphragms* or other plate-type *elements*, reinforcement at the edges of the openings shall be designed to transfer the stresses into the structure. The edge reinforcement shall extend into the body of the *wall* or *diaphragm* a distance sufficient to develop the force in the reinforcement.		No corresponding provisions. However, requirements covered in materials chapter.	Considered equivalent
5.2.6.2.3 Discontinuities in Vertical System	*Structures* with a discontinuity in lateral capacity, vertical irregularity Type 5 as defined in Table 5.2.3.3, shall not be over 2 stories or 30 ft (9 m) in height where the "weak" *story* has a calculated *strength* of less than 65 percent of the *story* above. Exception: Where the "weak" *story* is capable of resisting a total *seismic force* equal to 75 percent of the deflection amplification factor, C_d, times the design force prescribed in Sec. 5.3.	1629.9.1 Discontinuity	Structures with a discontinuity in capacity, vertical irregularity Type 5 as defined in Table 16-L, shall not be over two stories or 30 ft in height where the weak story has a calculated strength of less than 65% of the story above. Exception: Where the weak story is capable of resisting a total lateral seismic force of Ωo times the design force prescribed in Section 1630.	$0.75C_d$ vs. Ω_o Considered equivalent
5.2.6.2.4 Nonredundant Systems	The design of a *structure* shall consider the potentially adverse effect that the failure of a single member, connection, or *component* of the *seismic-force-resisting system* would have on the stability of the *structure*.		No corresponding provisions.	Does not affect equivalency.
5.2.6.2.5 Collector Elements	*Collector elements* shall be provided that are capable of transferring the *seismic forces* originating in other portions of the *structure* to the *element* providing the resistance to those forces.	1633.2.6 Collector elements	UBC Section contains requirements that in NEHRP are applicable only in SDC C and higher (See sec. 5.2.6.3.2)	UBC is more stringent
5.2.6.2.6 Diaphragms		1633.2.9 Diaphragms Items 1 and 2	Essentially the same if $S_{DS} = 2.5C_a$ and $I = 1.0$.	Considered equivalent
5.2.6.2.7 Bearing Walls	Exterior and interior *bearing walls* and their anchorage shall be designed for a force equal to 40 percent of the short period design spectral response acceleration S_{DS} times the weight of *wall*, W_c, normal to the surface, with a minimum		No corresponding provisions.	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	force of 10 percent of the weight of the *wall.* Interconnection of *wall elements* and connections to supporting framing systems shall have sufficient ductility, rotational capacity, or sufficient *strength* to resist shrinkage, thermal changes, and differential foundation settlement when combined with *seismic forces.*			
5.2.6.2.8 Inverted Pendulum-Type Structures			No corresponding provisions.	Equivalency cannot be judged.
5.2.6.2.9 Anchorage of Nonstructural Systems	When required by Chapter 6, all portions or *components* of the *structure* shall be anchored for the *seismic force*, F_p, prescribed therein.	1632.1 General 1632.2 Design for Total lateral Force	Sec. 1632.2 of UBC compared with Sec. 6.1.3 of NEHRP later.	See 6.1.3
5.2.6.2.10 Columns Supporting Discontinuous Walls or Frames	Columns supporting discontinuous *walls* or frames of *structures* having plan irregularity Type 4 of Table 5.2.3.2 or vertical irregularity Type 4 of Table 5.2.3.3 shall have the *design strength* to resist the maximum axial force that can develop in accordance with the special combination of loads of Sec. 5.2.7.1.	1630.8.2 Elements supporting discontinuous systems 1630.8.2.1 General	Para 1 of 1630.8.2.1 (UBC) is identical to NEHRP.	Considered equivalent
5.2.6.3 Seismic Design Category C				
5.2.6.3.1 Plan Irregularity	*Structures* that have plan structural irregularity Type 5 in Table 5.2.3.2 shall be analyzed for *seismic forces* applied in the direction that causes the most critical load effect. As an alternative, the *structure* may be analyzed independently in any two orthogonal directions and the most critical load effect due to direction of application of *seismic forces* on the *structure* may be assumed to be satisfied if *components* and their foundations are designed for the following combination of prescribed loads: 100 percent of the forces for one direction plus 30 percent of the	1633.1 General	... In Seismic Zones 2, 3 and 4, provisions shall be made for the effects of earthquake forces acting in a direction other than the principal axes in each of the following circumstances: The structure has plan irregularity Type 5 as given in Table 16-M. ..... The requirement that orthogonal effects be considered may be satisfied by designing such elements for 100% of the prescribed design seismic forces in one direction plus 30% of the	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	forces for the perpendicular direction; the combination requiring the maximum *component strength* shall be used.		prescribed design seismic forces in the perpendicular direction. ...	
5.2.6.3.2 Collector Elements		1633.2.6 Collector Elements	Essentially similar, except that the load combinations are different, containing different ground motion parameters. UBC, in addition, prescribes a design strength based on ASD.	Considered equivalent
5.2.6.3.3 Anchorage of Concrete and Masonry Walls		1633.2.8 Anchorage of concrete or masonry walls 1633.2.9 Diaphragm Items 4 and 5	Essentially similar except that the design force per UBC is higher than that per NEHRP.	UBC is more stringent.
5.2.6.4 Seismic Design Category D				
5.2.6.4.1 Orthogonal Load Effects		1633.1	Essentially similar	Considered equivalent
5.2.6.4.2 Collector Elements		1633.2.6 Collector Elements	Essentially similar, except that the load combinations are different containing different ground motion parameters. UBC, in addition, prescribes a design strength based on ASD.	Considered equivalent
5.2.6.4.3 Plan or Vertical Irregularities	..... For *structures* having a plan structural irregularity of Type 1a, 1b, 2, 3, or 4 in Table 5.2.3.2 or a vertical structural irregularity of Type 4 in Table 5.2.3.3, the design forces determined from Sec. 5.3.2 shall be increased 25 percent for connections of *diaphragms* to vertical *elements* and to collectors and for connections of collectors to the vertical *elements*.	1633.2.9 Diaphragms Item 6	Essentially similar with following differences: 1. Vertical irregularity type 4 is not included in UBC. 2. UBC design shall not consider the one-third increase in allowable stress, while design forces are increased by 25% in NEHRP.	UBC less stringent
5.2.6.4.4 Vertical Seismic Forces		1630.1.1 Earthquake loads	Similar provisions but with different ground motion parameters such as $0.5C_a I$ in UBC instead of $0.2S_{DS}$ in NEHRP.	Equivalent in intent. Not necessarily equivalent in design values.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
5.2.6.5 Seismic Design Categories E and F				
5.2.6.5.1 Plan or Vertical Irregularities			No corresponding provisions.	UBC less stringent for extreme soft story and torsional irregularity.
5.2.7 Combination of Load Effects	The effects on the structure and its components due to gravity loads and seismic forces shall be combined in accordance with the factored load combinations as presented in ASCE 7 except that the effect of seismic loads, E, shall be as defined herein. $E = \rho Q_E + 0.2 S_{DS} D$ $E = \rho Q_E - 0.2 S_{DS} D$	1630.1.1 Earthquake loads	Essentially similar except that the term $0.2S_{DS}$ of NEHRP is replaced by $0.5C_aI$ in UBC.	Inclusion of I-term makes the UBC much more stringent.
5.2.7.1 Special Combination of Loads	When specially required by these Provisions, $E = \Omega_0 Q_E + 0.2 S_{DS} D$ $E = \Omega_0 Q_E - 0.2 S_{DS} D$ Ω_0 = system overstrength factor	1612.4 Special Seismic Load Combinations	The effect of vertical earthquake ground motion ($0.2S_{DS}D$) is neglected in the UBC combinations.	UBC is less stringent.
5.2.8 Deflection and Drift Limits	The design *story* drift, Δ, as determined in Sec. 5.3.7 or 5.4.6, shall not exceed the allowable *story* drift, Δ_a, as obtained from Table 5.2.8 for any *story*. i.e. for structures with 4 stories and less (all other structures): $0.025h_x$ ($0.020h_x$)– for Seismic Use Group I $0.020h_x$ ($0.015h_x$)– for Seismic Use Group II $0.015h_x$ ($0.010h_x$)– for Seismic Use Group III $\Delta = (C_d/I)$ times the elastically computed interstory drift under prescribed earthquake forces. The drift limits are tighter for higher occupancy categories. I is taken out of the drift computation.	1630.10 Story Drift Limitation	Story drifts shall be computed using the Maximum Inelastic Response Displacement, Δ_M: $\Delta_M \leq 0.025h_s$ for $T \leq 0.7$ second $\Delta_M \leq 0.020h_s$ for $T > 0.7$ second In UBC, $\Delta_M = 0.7R$ times the elastically computed interstory drift based on prescribed seismic forces. The drift limits are irrespective of occupancy category. I enters into drift calculations.	The schemes are different, but similar in intent. The NEHRP is liable to be somewhat more stringent, particularly for the higher occupancy categories.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
5.3 EQUIVALENT LATERAL FORCE PROCEDURE 5.3.1 General 5.3.2 Seismic Base Shear 5.3.2.1 Calculation of Seismic Response Coefficient	The seismic base shear shall be determined as follows: $V = C_s W$ Seismic response coefficient, C_s is given by 4 equations in terms of S_{DS}, S_{D1}, R, I and T.	1630.2 Static Force Procedure 1630.2.1 Design base shear	The total design base shear in a given direction shall be determined as follows: $V = C_s W$ Seismic response coefficient, C_s is given by 4 equations in terms of C_a, C_v, N_v, Z, R, I and T. In addition, the values of I and R are slightly different in UBC too.	Equivalent in intent. Equivalency of design values would depend upon specific location and structure.
5.3.3 Period Determination 5.3.3.1 Approximate Fundamental Period	The fundamental period of the building, T, in the direction under consideration shall be established using substantiated analysis or the approximate fundamental period, T_a. T should not exceed $1.2T_a$ for $S_{D1} \geq 0.4g$ should not exceed $1.3T_a$ for $S_{D1} = 0.3g$ should not exceed $1.4T_a$ for $S_{D1} = 0.2g$ should not exceed $1.5T_a$ for $S_{D1} = 0.15g$ and should not exceed $1.7T_a$ for $S_{D1} \leq 0.1g$ The approximate fundamental period, T_a, shall be determined as follows: $T_a = C_T h_n^{3/4}$ Where, C_T is a coefficient that varies from 0.020 to 0.035 depending on the type of structural system. Alternatively, the approximate fundamental period, T_a, is permitted to be calculated from the following equation for concrete and steel moment resisting frame structures not exceeding 12 stories in height and having a minimum story height of 10 ft: $T_a = 0.1 N$	1630.2.2 Structure period	The value of T shall be determined from one of the following methods: 1. Method A: For all buildings, the value of T may be approximated from the following formula: $T_a = C_T (h_n)^{3/4}$ C_T value being the same as in NEHRP. However, UBC gives an additional equation for C_T for buildings with shearwalls. 2. Method B: The fundamental period may be calculated using a properly substantiated analysis or using the following formula: $T = 2\pi\sqrt{\left(\sum_{i=1}^{n} \omega_i \delta_i^2\right) \div \left(g \sum_{i=1}^{n} f_i \delta_i\right)}$ - T from Method B $\leq$ 1.3T from Method A in Seismic Zone 4. - T from Method B $\leq$ 1.4T from Method A in Seismic Zones 1, 2 and 3.	The 1997 NEHRP Provisions allows to use the simple equation (0.1N) for steel and concrete moment frames with a height limitation. UBC gives a specific rational period computation procedure, and also an alternative value of C_T for buildings with concrete or masonry shearwalls. NEHRP allows T to be a larger multiple of T_a in lower seismic areas, but restricts it to a lower multiple of T_a in the highest seismic areas. This makes the UBC somewhat less stringent in high

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
				seismic areas and somewhat more stringent in low seismic areas.
5.3.4 Vertical Distribution of Seismic Forces	The lateral force, F_x, induced at any level shall be determined from the following equations: $F_x = C_{vx} \cdot V$ $C_{vx} = \frac{W_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$ k is 1 for T ≤ 0.5 sec. k is 2 for T ≥ 2.5 sec. k is 2 or is to be determined by linear interpolation between 1 and 2 for 0.5 sec. < T < 2.5 sec.	1630.5 Vertical Distribution of Force	- The total force shall be distributed over the height of the structure: $V = F_t + \sum_{i=1}^{n} F_i$ - The concentrated force F_t at the top $F_t = 0.07 \cdot T \cdot V$ F_t need not exceed 0.25V and F_t = 0 where T is 0.7 second or less - The remaining portion of the base shear shall be distributed over the height of the structure: $F_x = \frac{(V - F_t) W_x h_x}{\sum_{i=1}^{n} w_i h_i}$ Similar to NEHRP for T ≤ 0.5 sec.	Considered equivalent especially for short period structures.
5.3.5 Horizontal Shear Distribution	The seismic design *story shear*, V_X, shall be distributed to the various vertical *elements* of the *seismic-force-resisting system* in the *story* under consideration based on the relative lateral stiffnesses of the vertical resisting *elements* and the *diaphragm*	1630.6 Horizontal Distribution of Shear	V_x shall be distributed to the various elements of the vertical lateral-force-resisting system in proportion to their rigidities, considering the rigidity of the diaphragm.	Equivalent
5.3.5.1 Torsion	The design shall include the torsional moment, M_t, resulting from the location of the masses.	1630.7 Horizontal torsional moments	Provisions shall be made for the increased shears resulting from horizontal torsion where diaphragms are not flexible.	UBC mentions diaphragm flexibility. Considered equivalent.
5.3.5.2 Accidental Torsion	The design also shall include accidental tensional moments, M_{ta}, caused by an assumed displacement of the mass each way from its actual location by a distance equal to 5 percent of the dimension of the structure perpendicular to the direction of the applied force.	1630.6 Horizontal Distribution of Shear	Almost the same	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
5.3.5.3 Dynamic Amplification of Torsion	For structures of SDC C, D, E, and F, where Type 1 torsional irregularity exists as defined in Table 5.2.3.1, the effects of torsional irregularity shall be accounted for by multiplying the sum of M_t plus M_{ta} at each level by a torsional amplification factor, A_x, determined from the following equation: $A_x = \left(\frac{\delta_{max}}{1.2\delta_{avg}}\right)^2$ A_x is not required to exceed 3.0	1630.7 Horizontal Torsional Moments	The same amplifier is applied to the accidental torsion only. However, the provision is applicable in all seismic zones.	UBC is less stringent.
5.3.6 Overturning	The structure shall be designed to resist overturning effects caused by the seismic forces determined in Sec. 5.3.4. At any story, the increment of overturning moment (M_x) in the story under consideration shall be distributed to the various vertical-force-resisting elements in the same proportion as the distribution of the horizontal shears to those elements. $M_x = \tau \sum_{i=x}^{n} F_i(h_i - h_x)$ F_i = the portion of the seismic base shear, V, induced at Level i. τ = 1.0 for the top 10 stories τ = 0.8 for the 20th story from the top and below and = 0.8 to 1.0 for the remainder.	1630.8 Overturning	Essentially identical except that the term τ is not included in the UBC.	UBC is equivalent to more restrictive.
5.3.7 Drift Determination and P-Delta Effects	*Story* drifts and, where required, member forces and moments due to *P-delta effects* shall be determined in accordance with this section. Determination of *story* drifts shall be based on the application of the design *seismic forces* to a mathematical model of the physical *structure*. The model shall include the stiffness and *strength* of all *elements* that are significant to the distribution of forces and *deformations* in the *structure* and shall represent the spatial distribution of the mass	1630.1.2 Modeling requirements	Essentially the same	Considered equivalent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	and stiffness of the *structure*. In addition, the model shall comply with the following: 1.Stiffness properties of *reinforced concrete* and masonry *elements* shall consider the effects of cracked sections and 2.For steel *moment resisting frame* systems, the contribution of panel zone *deformations* to overall *story* drift shall be included.			
5.3.7.1 Story Drift Determination	The design story drift, *Δ*, shall be computed as the difference of the deflections at the center of mass at the top and bottom of the story under consideration: $\delta_x = \frac{C_d \delta_{xe}}{I}$ For purposes of this drift analysis only, it is permissible to use the computed fundamental period, T, in seconds, of the structure without the upper bound limitation specified in Sec. 5.3.3 ($T \le C_u T_a$) when determining drift level seismic design forces. Exception: For *structures* of *Seismic Design Categories* C, D, E and F having plan irregularity Types 1a or 1b of Table 5.3.2.1, the design *story* drift, Δ, shall be computed as the largest difference of the deflections along any of the edges of the *structure* at the top and bottom of the *story* under consideration.	1630.9 Drift 1630.9.1 Determination of Δ_s 1630.9.2 Determination of Δ_m 1630.10.3 Limitations	Essentially similar except that the term "C_d/I" of NEHRP is replaced by "0.7R" in UBC. Calculated drift shall include translational and torsional deflections. (This is a little broader than the NEHRP exception) The equivalent of the NEHRP requirement, $T \le C_u T_a$, may be disregarded. The lower bound limit on design base shear, as given by Eq. (30-6), but not Eq. (30-7), may also be disregarded.	Equivalent in intent. Equivalency of design values can be judged only on a case-by-case basis. Disregard of minimum base shear given by Eq. (30-6) makes the UBC less stringent for tall buildings.
5.3.7.2 P-Delta Effects	P-delta effects are not required to be considered when the stability coefficient, θ, as determined by the following equation is equal to or less than 0.10: $\theta = \frac{P_x \Delta}{V_x h_{sx} C_d}$	1630.1.3 *PΔ* effects	Essentially similar except for the following changes: 1. There is no upper limit on θ. 2. In Seismic Zones 3 and 4, *PΔ* need not be considered when the story drift ratio does not exceed 0.02/*R*.	UBC is less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	The stability coefficient, θ, shall not exceed θ_{max} determined as follows: $\theta_{max} = \frac{0.5}{\beta \cdot C_d} \le 0.25$ Where β is the ratio of shear demand to shear capacity for the story between level *x* and *x-1*			
5.4 MODAL ANALYSIS PROCEDURE 5.4.1 General	This chapter provides required standards for the modal analysis procedure of seismic analysis of *structures*. The symbols used in this method of analysis have the same meaning as those for similar terms used in Sec. 5.3, with the subscript *m* denoting quantities in the m^{th} mode.	1631.4.1 Response Spectrum Analysis	An elastic dynamic analysis of a structure utilizing the peak dynamic response of all modes having a significant contribution to total structural response. Peak modal responses are calculated using the ordinates of appropriate response spectrum curve which correspond to the modal periods. Maximum modal contributions are combined in a statistical manner to obtain an appropriate total structural response.	NEHRP gives intent of section. UBC gives definition. Does not affect equivalency.
	No corresponding provisions	1631 DYNAMIC ANALYSIS PROCEDURES 1631.1 General 1631.2 Ground motion		UBC is more general. Equivalency cannot be judged.
	No corresponding provisions	1631.4 Description of Analysis Procedures		UBC is more general. Equivalency cannot be judged.
5.4.2 Modeling	A mathematical model of the structure shall be constructed that represents the spatial distribution of mass and stiffness throughout the structure. In addition, the model shall comply with the following: 1.Stiffness properties of *reinforced concrete* and masonry *elements* shall consider the effects of cracked sections and 2.For steel *moment resisting frame* systems, the contribution of panel zone *deformations* to overall	1631.3 Mathematical Model	Same as in the 1997 NEHRP	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	story drift shall be included.			
5.4.3 Modes	The analysis shall include a sufficient number of modes to obtain a combined modal mass participation of at least 90 percent of the actual mass in each of two orthogonal directions.	1631.5.2 Number of modes	Identical	Equivalent
5.4.4 Modal Properties 5.4.5 Modal Base Shear 5.4.6 Modal Forces, Deflections, and Drifts 5.4.7 Modal Story Shears and Moments		1631.5.1 Response spectrum representation and interpretation of results.	The ground motion representation shall be in accordance with Section 1631.2. The corresponding response parameters, including forces, moments and displacements, shall be denoted as Elastic Response Parameters. Elastic Response Parameters may be reduced in accordance with Section 1631.5.4.	Equivalent in intent. Elastic spectrum of the two documents are different, as mentioned earlier. Equivalency of design values can be established only on case-by-case basis.
5.4.8 Design Values	The design value for the modal *base shear*, V_t, each of the *story shear*, moment and drift quantities; and the deflection at each level shall be determined by combining their modal values as obtained from Sec. 5.4.6 and 5.4.7. The combination shall be carried out by taking the square root of the sum of the squares of each of the modal values or by the complete quadratic combination technique.	1631.5.3 Combining modes	The peak member forces, displacements, story forces, story shears and base reactions for each mode shall be combined by recognized methods.	UBC talks about recognized methods. NEHRP specifically mentions SRSS and CQC. Considered equivalent.
	The base shear, V, using the equivalent lateral force procedure in Sec. 5.3 shall be calculated using a fundamental period of the structure, T, in seconds, of 1.2 times the coefficient for upper limit on the calculated period, C_u, times the approximate fundamental period of the structure, T_a. Where the design value for the modal base shear, V_t, is less than the calculated base shear, V, using the equivalent lateral force procedure,	1631.5.4 Reduction of Elastic Response Parameters for design	UBC adjustment is based on regularity (regular or irregular) and ground motion (elastic design or site-specific). Elastic Response Parameters may be reduced for purposes of design in accordance with the following items, with the limitation that in no case shall the Elastic Response Parameters be reduced such that the corresponding design base shear is less than the Elastic Response Base	Somewhat different philosophies and objectives. Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	the design story shears, moments, drifts and floor deflections shall be multiplied by the following modification factor: $\frac{V}{V_t}$ The modal base shear, V_t, is not required to exceed the base shear from the equivalent lateral force procedure in Sec. 5.3.		Shear divided by the value of R. 1. For all regular structures where the ground motions complies with Section 1631.2, Item1, the corresponding design base shear can be reduced to 90 percent of the base shear determined in accordance with Sec. 1630.2 2. For all regular structures where the ground motion complies with Sec. 1631.2, Item 2, the corresponding design base shear can be reduced to 80 percent of the base shear determined in accordance with Sec. 1630.2.	
5.4.9 Horizontal Shear Distribution	The distribution of horizontal shear shall be in accordance with the requirements of Sec. 5.3.5 except that amplification of torsion per Sec. 5.3.5.3 is not required for that portion of the torsion included in the dynamic analysis model.	1631.1 General 1631.5.6 Torsion	Structures that are designed in accordance with this section shall comply with all other applicable requirements of these provisions.	UBC is less specific concerning amplification of torsion. Considered equivalent.
5.4.10 Foundation Overturning	The foundation overturning moment at the foundation-soil interface shall be permitted to be reduced by 10%.	1631.1 General	Structures that are designed in accordance with this section shall comply with all other applicable requirements of these provisions.	UBC is more stringent. No 10% reduction allowed.
5.4.11 P-Delta Effects	The *P-delta effects* shall be determined in accordance with Sec. 5.3.7.2. The *story* drifts and *story shears* shall be determined in accordance with Sec. 5.3.7.1.	1631.1 General	Structures that are designed in accordance with this section shall comply with all other applicable requirements of these provisions.	See 5.3.7.2. UBC is less stringent.
	No corresponding provisions	1631.5.5 Directional effects		Does not affect equivalency
	No corresponding provisions	1631.5.7 Dual systems		UBC offers more specific guidance. Equivalency is not affected.
	No corresponding provisions	1631.6 Time-history analysis		Equivalency cannot be judged.
5.5 SOIL-STRUCUTRE INTERATCTION	The requirements set forth in this section are permitted to be used to incorporate the effects of soil-*structure* interaction in the determination of		No corresponding provisions. The NEHRP requirements are not mandatory.	Equivalency is not affected.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
EFFECTS	the *design earthquake* forces and the corresponding *displacements* of the *structure*. The use of these requirements will decrease the design values of the *base shear*, lateral forces, and overturning moments but may increase the computed values of the lateral *displacements* and the secondary forces associated with the *P*-delta effects.			

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
CHAPTER 6 ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DESIGN REQUIREMENTS		**SECTION 1632 – LATERAL FORCE ON ELEMENTS OF STRUCTURES, NONSTRUCTURAL COMPONENETS AND EQUIPMENT SUPPORTED BY STRUCTURES**		
6.1 GENERAL	Exception: The following components are exempt from the requirements of this chapter: 1. All components in *Seismic Design Category* A, 2. Architectural components in *Seismic Design Category* B other than parapets supported by bearing walls or shear walls when the importance factor (I_p) is equal to 1.00, 3. Mechanical and electrical components in *Seismic Design Category* B, 4. Mechanical and electrical components in *Seismic Design Category* C when the importance factor (I_p) is equal to 1.00, 5. Mechanical and electrical components in *Seismic Design Categories* D, E, and F that are mounted at 4 ft (1.22 m) or less above a floor level and weigh 400 lb (1780 N) or less and are not critical to the continued operation of the structure, or 6. Mechanical and electrical components in *Seismic Design*	1632.1 General Footnote 3 to Table16-O	NEHRP is more comprehensive and detailed, but has more exceptions. Exceptions 1, 2, 3, 4 and 6 are not in the UBC.	UBC is generally less stringent, because of the more extensive scope of the NEHRP requirements; however, NEHRP has more exceptions. Equivalency is difficult to judge.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	Categories C, D, E, and F that weigh 20 lb (95 N) or less or, for distribution systems, weight 5 lb/ft (7 N/m) or less.			
6.1.1 References and Standards	Many consensus standards that are to be considered part of the provisions and "accepted standards" that represent acceptable procedures for design and construction are cited.	Ch. 35 Part IV Chapter 16 1632.1 General	When permissible design strengths and other acceptance criteria are not contained in or referenced by this code, such criteria shall be obtained from approved national standards subject to the approval of the building official.	Considered equivalent
6.1.2 Component Force Transfer	Components shall be attached such that the component forces are transferred to the *structure* of the building. Component seismic attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.	1632.1 General Paragraph 2	Essentially similar provisions. NEHRP is more specific.	Considered equivalent
6.1.3 Seismic Forces	Seismic forces (F_p) shall be determined as follows: $F_p = \frac{0.4 a_p S_{DS} W_p}{R_p / I_p}\left(1 + 2\frac{z}{h}\right)$ F_p is not required to be taken as greater than: $F_p = 1.6 S_{DS} I_p W_p$ and F_p shall not be taken as less than: $F_p = 0.3 S_{DS} I_p W_p$ R_p, a_p values given in Tables 6.2.2 and 6.3.2	1632.2 Design for Total Lateral Force	The total design lateral seismic force, F_p, shall be determined from the following formula: $F_p = 4.0 C_a I_p W_p$ Alternatively, F_p may be calculated using the following formula: $F_p = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right) W_p$ Except that: F_p shall not be less than $0.7 C_a I_p W_p$ and need not be more than $4 C_a I_p W_p$ R_p, a_p values given in Table 16-O.	Upper- and lower-bound values are the same, on the basis that $S_{DS} = 2.5 C_a$. The F_p formulas are slightly different in variation along height; comparable R_p, a_p are also slightly different. Equivalent in intent. Similar in design values.
6.1.4 Seismic Relative Displacements	Seismic relative displacement (D_p), which a component must be designed to accomodate shall be determined in accordance with the following equations: For two connection points on the same Structure A or the same structural system: $D_p = \delta_{xA} - \delta_{yA}$	1632.4 Relative Motion of Equipment Attachments	The approach is based upon Δ_m and is different.	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	D_p is not required to be taken as greater than: $D_p = (X - Y)\frac{\Delta_{aA}}{h_{sx}}$			
6.1.5 Component Importance Factor	The component importance factor (I_p) shall be selected as follows: I_p = 1.5 Life-safety component is required to function after an earthquake. ...	Table 16-K Column for I_p	Essentially similar except that storage racks in occupancies open to the general public are assigned I_p = 1.5 in NEHRP and I_p = 1.0 in UBC.	Considered equivalent
6.1.6 Component Anchorage 6.1.6.1	... Where component anchorage is provided by expansion anchors, shallow chemical anchors or shallow CIP anchors, a value of R_p = 1.25 shall be used to determine the forces in the connected part.	1632.2 Design for Total Lateral Force	.... Rp is the Component Response Modification Factor that shall be taken from Table 16-O, except that Rp for anchorages shall equal 1.5 for shallow expansion anchor bolts, shall chemical anchors or shallow CIP anchors. The term "expansion anchor" of NEHRP has been changed to "shallow expansion anchor" in UBC.	Considered equivalent
6.1.6.2	Anchors embedded in concrete or masonry shall be proportioned to carry the least of the following: a. The design strength of the connected part, b. 2 times the force in the connected part due to the prescribed forces, and c. The maximum force that can be transferred to the connected part by the component structural system.		No provisions corresponding to 6.1.6.2 through 6.1.6.9 of NEHRP	UBC is less stringent
6.1.7 Construction Documents	Construction documents shall be prepared by a registered design professional in a manner consistent with the requirements of these *Provisions*, as indicated in Table 6.1.7, in sufficient detail for use by the *owner*, building officials, contractors, and inspectors.		No corresponding provisions	UBC is less stringent.
6.2 ARCHITECTURAL COMPONENT				

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
DESIGN				
6.2.1 General	Architectural systems, components, or elements (hereinafter referred to as "components") listed in Table 6.2.2 and their attachments shall meet the requirements of Sec. 6.2.2 through Sec. 6.2.9.		No corresponding provisions	Does not affect equivalency
6.2.2 Architectural Component Forces and Displacements	Architectural components shall meet the force requirements of Sec. 6.1.3 and 6.1.4 and Table 6.2.2. Note: 6.1.4 is on seismic relative displacements	1632.2 Design for Total Lateral Force Table 16-O 1632.4 Relative Motion of Equipment Attachments	Essentially similar provisions Different provisions; apply only to equipment in Categories 1 and 2 buildings.	Considered equivalent Not equivalent
6.2.3 Architectural Component Deformation	Architectural components that could pose a life-safety hazard shall be designed for the seismic relative displacement requirements of Sec. 6.1.4.		No corresponding provisions	UBC is less stringent.
6.2.4 Exterior Nonstructural Wall Elements and Connections	... Such elements shall be supported by means of positive and direct structural supports or by mechanical connections and fasteners in accordance with the following requirements: ..	1633.2.4.2 Exterior elements	The provisions are very similar. The displacements that must be accommodated are somewhat different.	Considered equivalent.
6.2.5 Out-of-Plane Bending	Transverse or out-of-plane bending or deformation of a component or system that is subjected to forces as determined in Sec. 6.1.3 shall not exceed the deflection capability of the component or system.		No corresponding provisions	UBC is less stringent.
6.2.6 Suspended Ceilings 6.2.6.1 Seismic Forces 6.2.6.2 Industry Standard Construction 6.2.6.3 Integral Ceiling/Sprinkler	Suspended ceilings shall be designed to meet the seismic force requirements of Sec. 6.2.6.1. In addition	Table 16-O footnotes 6, 7 and 8 UBC Standard 25-2, Part III	NEHRP is more comprehensive.	UBC is less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
Construction				
6.2.7 Access Floors 6.2.7.1 General 6.2.7.2 Special Access Floors	… The weight of the access floor, W_p, shall include the weight of the floor system, 100 percent of the weight of all equipment fastened to the floor, and 25 percent of the weight of all equipment supported by, but not fastened to the floor. The seismic force, F_p, shall be transmitted from the top surface of the access floor to the supporting *structure*. …	Table 16-O footnote 9	NEHRP is more comprehensive.	UBC is less stringent.
6.2.8 Partitions	Partitions that are tied to the ceiling and all partitions greater than 6 ft (1.8 m) in height shall be laterally braced to the building *structure*. Such bracing shall be independent of any ceiling splay bracing. Bracing shall be spaced to limit horizontal deflection at the partition head to be compatible with ceiling deflection requirements as determined in Sec. 6.2.6 for suspended ceilings and Sec. 6.2.2 for other systems.		No corresponding provisions	UBC is less stringent.
6.2.9 Steel Storage Racks	Steel storage racks shall be designed to meet the force requirements of Chapter 14. See 14.3.3.	Chapter 22 Division X DESIGN STANDARD FOR STEEL STORAGE RACKS	Based on Recommendations by Rack Manufacturers Institute. See 2228.5-2228.7.	See 14.3.3
6.3 MECHANICAL AND ELECTRAL COMPONENT DESIGN 6.3.1 General 6.3.2 Mechanical and Electrical Component Forces and Displacements 6.3.3 Mechanical and Electrical Component		Table 16-O	Table 16-O has some of the same entries as Table 6.3.2 of NEHRP although R_p is different.	UBC is less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
Period 6.3.4 Mechanical and Electrical Component Attachments 6.3.5 Component Supports 6.3.6 Component Certification 6.3.7 Utility and Service Lines at Structure Interfaces 6.3.8 Site-Specific Considerations 6.3.9 Storage Tanks 6.3.10 HVAC Ductwork 6.3.11 Piping Systems 6.3.12 Boilers and Pressure Vessels 6.3.13 Mechanical Equipment Attachments and Supports 6.3.14 Electrical Equipment Attachments and Supports 6.3.15 Alternative Seismic Qualification Methods 6.3.16 Elevator Design Requirements				

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
7 FOUNDATION DESIGN REQUIREMENTS		**CHAPTER 18 FOUNDATIONS AND RETAINING WALLS**		
7.1 GENERAL	Scope limited to seismic requirements. Assumes compliance with other basic requirements.	1801.1 General	UBC scope is broader, not limited to seismic resistance only.	Does not affect equivalency
7.2 STRENGTH OF COMPONENTS AND FOUNDATIONS	The resisting capacities of the foundations, subjected to the prescribed *seismic forces* of Chapters 1, 4 and 5, shall meet the requirements of this chapter.	1802 – QUALITY AND DESIGN	Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the allowable stress design load combinations specified in Section 1612.3.	Equivalent in intent.
7.2.1 Structural Materials	The *strength* of foundation *components* subjected to *seismic forces* alone or in combination with other prescribed loads and their detailing requirements shall conform to the requirements of Chapter 8, 9, 10, 11, or 12. The *strength* of foundation *components* shall not be less than that required for forces acting without *seismic forces*.		No corresponding provisions	Equivalency cannot be judged.
7.2.2 Soil Capacities	The capacity of the foundation soil in bearing or the capacity of the soil interface between pile, pier, or caisson and the soil shall be sufficient to support the *structure* with all prescribed loads, without *seismic forces*, taking due account of the settlement that the *structure* can withstand. For the load combination including earthquake as specified in Sec. 5.2.7, the soil capacities must be sufficient to resist loads at acceptable strains considering both the short duration of loading and the dynamic properties of the soil.	SECTION 1805 – ALLOWABLE FOUNDATION AND LATERAL PRESSURES	The allowable foundation and lateral pressures shall not exceed the values set forth in Table 18-I-A unless data to substantiate the use of higher values are submitted… Allowable bearing pressures provided in Table 18-I-A shall be used with the allowable stress design load combinations specified in Section 1612.3.	Equivalent in intent. Equivalency of design values cannot be judged.
7.3 SEISMIC DESIGN CATEGORIES A AND B	Any construction meeting the requirements of Sec. 7.1 and 7.2 is permitted to be used for *structures* assigned to *Seismic Design Category* A or B.		No corresponding provisions	Does not affect equivalency

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
7.4 SEISMIC DESIGN CATEGORY C	Foundations for *structures* assigned to *Seismic Design Category* C shall conform to all of the requirements for *Seismic Design Categories* A and B and to the additional requirements of this section.		No corresponding provisions. UBC has a different organization. Often there are additional requirements for Zones 3 and 4.	Not equivalent
7.4.1 Investigation	The authority having jurisdiction may require the submission of a written report that shall include, in addition to the requirements of Sec. 7.1 and the evaluations required in Sec. 7.2.2, the results of an investigation to determine the potential hazards due to slope instability, liquefaction, and surface rupture due to faulting or lateral spreading, all as a result of earthquake motions.	1804.2 Investigation	No similar provisions in Zones 0-2 of the UBC.	UBC is less stringent.
7.4.2 Pole-Type Structures	Construction employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth are permitted to be used to resist both axial and lateral loads. The depth of embedment required for posts or poles to resist *seismic forces* shall be determined by means of the design criteria established in the foundation investigation report.	1806.8 Designs Employing Lateral Bracing 1806.8.1 General	Construction employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth may be used to resist both axial load and lateral loads. The depth to resist lateral loads shall be determined by means of the design criteria established herein or other methods approved by the building official. This section applies regardless of Seismic zone.	Same language. Applicability in all seismic zones makes the UBC more stringent.
7.4.3 Foundation Ties	Individual pile caps, drilled piers, or caissons shall be interconnected by ties. All ties shall be capable of carrying, in tension or compression, a force equal to the product of the larger pile cap or column load times S_{DS} divided by 4 unless it can be demonstrated that equivalent restraint can be provided by *reinforced concrete* beams within slabs on grade or *reinforced concrete* slabs on grade or confinement by competent rock, hard cohesive soils, very dense granular soils, or other approved means.	1807.2 Interconnection	Individual pile caps and caissons of every structure subjected to seismic forces shall be interconnected by ties. Such ties shall be capable of resisting, in tension or compression, a minimum horizontal force equal to 10% of the larger column vertical load. The provision applies to all Seismic Zones.	NEHRP has (S_{DS}/4) larger column load, where UBC has a fixed 10%. For S_{DS} > 0.4, UBC is less stringent. For S_{DS} < 0.4, UBC is more stringent. For S_{DS} = 0.4, they are equivalent. Also UBC applicability is brioader.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
7.4.4 Special Pile Requirements	All concrete piles and concrete filled pipe piles shall be connected to the pile cap by embedding the pile reinforcement in the pile cap for a distance equal to the development length as specified in Ref. 6-1. The pile cap connection can be made by the use of field-placed dowels anchored in the concrete pile. For deformed bars, the development length is the full development length for compression without reduction in length for excess area. Where special reinforcement at the top of the pile is required, alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the pile will be permitted provided due consideration is given to forcing the hinge to occur in the confined region. ...		No corresponding provisions.	UBC is less stringent.
7.4.4.1 Uncased Concrete Piles	A minimum reinforcement ratio of 0.0025 shall be provided for uncased cast-in-place concrete drilled piles, drilled piers, or caissons in the top one-third of the pile length or a minimum length of 10 ft (3 m) below the ground. There shall be a minimum of four bars with closed ties (or equivalent spirals) of a minimum 1/4 in. (6 mm) diameter provided at 16-longitudinal-bar-diameter maximum spacing with a maximum spacing of 4 in. (102 mm) in the top 2 ft (0.6 m) of the pile. Reinforcement detailing requirements shall be in conformance with Sec. 9.6.2.	1910.9 Limits for Reinforcement of Compression Members. 1910.9.1 1910.9.2	Area of longitudinal reinforcement for noncomposite comression members shall not be less than 0.01 or more than 0.08 times gross area A_g of section. Minimum number of longitudinal bars in compression members shall be four for bars with rectangular or circular ties, three for bars within triangular ties, and six for bars enclosed by spirals conforming to the following ratio:	UBC is more restrictive.
7.4.4.2 Metal-Cased Concrete Piles	Reinforcement requirement are the same as for uncased concrete piles with some exceptions.	1910.9 Limits for Reinforcement of Compression Members. 1910.9.1	Area of longitudinal reinforcement for noncomposite comression members shall not be less than 0.01 or more than 0.08 times gross area A_g of section.	UBC is more restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
		1910.9.2	Minimum number of longitudinal bars in compression members shall be four for bars with rectangular or circular ties, three for bars within triangular ties, and six for bars enclosed by spirals conforming to the following ratio:	
7.4.4.3 Concrete-Filled Pipe	Minimum reinforcement 0.01 times the cross--sectional area of the pile concrete shall be provided in the top of the pile with a length equal to two times the required cap embedment anchorage into the pile cap.	1808.7 Concrete-filled Steel Pipe Piles 1910.9 Limits for Reinforcement of Compression Members. 1910.9.1 1910.9.2	Area of longitudinal reinforcement for noncomposite comression members shall not be less than 0.01 or more than 0.08 times gross area A_g of section. Minimum number of longitudinal bars in compression members shall be four for bars with rectangular or circular ties, three for bars within triangular ties, and six for bars enclosed by spirals conforming to the following ratio:	UBC is more restrictive.
7.4.4.4 Precast Concrete Piles	Longitudinal reinforcement shall be provided for precast concrete piles with a minimum steel ratio of 0.01. Ties or equivalent spirals shall be provided at a maximum 16-bar-diameter spacing with a maximum spacing of 4 in. (102 mm) in the top 2 ft (0.6 m). Reinforcement shall be full length.	1808.4 Precast Concrete Piles 1808.4.2 Reinforcement Ties 1910.9 Limits for Reinforcement of Compression Members. 1910.9.1	Same longitudinal steel requirement. The following details are changed from NEHRP to UBC: The maximum tie or spiral spacing is 8 in. elsewhere and 3 in. in the top 2 ft. In general, UBC is more comprehensive with regard to ties and spirals.	UBC considered more stringent.
7.4.4.5 Precast-Prestressed Piles	The upper 2 ft (0.6 m) of the pile shall have No. 3 ties minimum at not over 4-in. (102 mm) spacing or equivalent spirals. The pile cap connection is permitted to be by means of dowels as required in Sec. 7.4.4.. Pile cap connection is permitted to be by means of developing pile reinforcing strand if a ductile connection is provided.	1808.5 Precast Prestressed Concrete Piles (Pretensioned)	Partly the same. In general, UBC is more comprehensive.	UBC is more stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
7.5 Seismic Design Categories D, E, and F	Foundations for *structures* assigned to *Seismic Design Categories* D, E, and F shall conform to all of the requirements for *Seismic Design Category* C construction and to the additional requirements of this section.	1809 – FOUNDATION CONSTRUCTION – SEISMIC ZONES 3 AND 4 1809.1 General	In Seismic Zones 3 and 4 the further requirements of this section shall apply to the design and construction of foundations, foundation components and the connection of superstructure elements thereto.	Equivalency difficult to judge.
7.5.1 Investigation	The *owner* shall submit to the authority having jurisdiction a written report that includes an evaluation of potential site hazards such as slope instability, liquefaction, and surface rupture due to faulting or lateral spreading and the determination of lateral pressures on *basement* and retaining *walls* due to earthquake motions.	SECTION 1804 – FOUNDATION INVESTIGATION 1804.2 Investigation	In Seismic Zones 3 and 4, when required by the BO, the potential for seismically induced soil liquefaction and soil instability shall be evaluated as described in Section 1804.5.	Considered equivalent
7.5.2 Foundation Ties	Individual spread footings founded on soil defined in Sec. 4.1.2 as *Site Class* E or F shall be interconnected by ties. Ties shall conform to Sec. 7.4.3.		There is no requirement in UBC to interconnect spread footings in Site Class E or F soil.	UBC is less stringent. Not equivalent
7.5.3 Liquefaction Potential and Soil Strength Loss	The geotechnical report shall assess potential consequences of any liquefaction and soil *strength* loss, including estimation of differential settlement, lateral movement or reduction in foundation soil-bearing capacity, and shall discuss mitigation measures....	1804.5 Liquefaction Potential and Soil Strength Loss	Essentially the same.	Considered equivalent
7.5.4 Special Pile Requirements	Piling shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and *structure* response. Curvatures shall include free-field soil strains (without the *structure*) modified for soil-pile-*structure* interaction coupled with pile deformations induced by lateral pile resistance to *structure seismic forces*. Concrete piles in *Site Class* E or F shall be designed and detailed in accordance with Sec. 9.3.3.3 within seven pile diameters of the pile cap and the interfaces of soft to medium stiff clay or liquefiable strata.	1809.5 Special Requirements for Piles and Caissons (Zones 3 and 4) 1809.5.1 General	Different provisions	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
7.5.4.1 Uncased Concrete Piles	A minimum reinforcement ratio of 0.005 shall be provided for uncased cast-in-place concrete piles, drilled piers, or caissons in the top one-half of the pile length or a minimum length of 10 ft (3 m) below ground. There shall be a minimum of four bars with closed ties or equivalent spirals provided at 8-longitudinal-bar-diameter maximum spacing with a maximum spacing of 3 in. (76 mm) in the top 4 ft (1.2 m) of the pile. Ties shall be a minimum of No. 3 bars for up to 20-in.-diameter (500 mm) piles and No. 4 bars for piles of larger diameter.	1808.2 Uncased Cast-in-place Concrete Piles 1809.5.2.2 Nonprestressed concrete piles (Zones 3 and 4) 1910.9 Limits for Reinforcement of Compression Members. 1910.9.1 1910.9.2	Different provisions Different provisions. UBC transverse reinforcement requirements are more stringent. There are no longitudinal reinforcement requirements. Area of longitudinal reinforcement for noncomposite comression members shall not be less than 0.01 or more than 0.08 times gross area A_g of section. Minimum number of longitudinal bars in compression members shall be four for bars with rectangular or circular ties, three for bars within triangular ties, and six for bars enclosed by spirals conforming to the following ratio:	Overall, UBC appears to be more stringent.
7.5.4.2 Metal-Cased Concrete Piles	Reinforcement requirement are the same as for uncased concrete piles. Exception: Spiral welded metal-casing of a thickness not less than No. 14 gauge can be considered as providing concrete confinement equivalent to the closed ties or equivalent spirals required in an uncased concrete pile, provided that the metal casing is adequately protected against possible deleterious action due to soil constituents, changing water levels, or other factors indicated by boring records of site conditions.	1910.9 Limits for Reinforcement of Compression Members. 1910.9.1 1910.9.2	Area of longitudinal reinforcement for noncomposite comression members shall not be less than 0.01 or more than 0.08 times gross area A_g of section. Minimum number of longitudinal bars in compression members shall be four for bars with rectangular or circular ties, three for bars within triangular ties, and six for bars enclosed by spirals conforming to the following ratio:	UBC is more stringent with respect to longitudinal reinforcement.
7.5.4.3 Precast Concrete Piles	Ties in precast concrete piles shall conform to the requirements of Chapter 9 for at least the top half of the pile. Note that requirements are vague, not clearly	1808.4 Precast Concrete Piles 1809.5.2.2 Nonprestressed	Different provisions. UBC is more comprehensive.	UBC considered more stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	defined.	concrete piles		
7.5.4.4 Precast-Prestressed Piles	For the body of fully embedded foundation piling subjected to vertical loads only, or where the design bending moment does not exceed 0.20M_{nb} (where M_{nb} is the unfactored ultimate moment capacity at balanced strain conditions as defined in Ref. 6-1, Sec. 10.3.2), spiral reinforcing shall be provided such that $\rho_s \geq 0.006$. Pile cap connection shall not be made by developing exposed strand.	1808.5 Precast Prestressed Concrete Piles (Pretensioned) 1809.5.2.3 Prestressed concrete piles (Zones 3 and 4)	Different provisions. UBC is more comprehensive.	UBC appears to be more stringent.
7.5.4.5 Steel Piles	The connection between the pile cap and steel piles or unfilled steel pipe piles shall be designed for a tensile force equal to 10 percent of the pile compression capacity.	1808.6 Structural Steel Piles 1809.5.2.1 Steel piles (Zones 3 and 4)	Different provisions. UBC is comprehensive in some regards, but is silent with respect to the pile cap connection.	Equivalency cannot be judged.
	No corresponding provisions	1806.6 Foundation Plates or Sills 1806.6.1 Additional requirements in Seismic Zones 3 and 4		UBC is more stringent
	No corresponding provisions	1806.7 Seismic Zones 3 and 4 1806.7.1 Foundations with stem-walls 1806.7.2 Slabs-on-ground with turned-down footings		UBC is more stringent
	No corresponding provisions	1809.2 Soil Capacity		Does not affect equivalency
	No corresponding provisions	1809.3 Superstructure to Foundation Connection		Does not affect equivalency
	No corresponding provisions	1809.4 Foundation-Soil Interface		UBC is less stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
8. STEEL STRUCTURE DESIGN REQUIREMENTS		**CHAPTER 22 - STEEL**		
8.1 REFERENCE DOCUMENTS	Gives 8 references for design and construction. The major reference being Ref. 8-3: *Seismic Provisions for Structural Steel Buildings*, American Institute of Steel Construction, 1997, Part I. This standard includes new requirements based on the FEMA funded SAC project and revisions made since the previous 1992 version.		The UBC references the same standards as the NEHRP Provisions; however, in two cases, the UBC referenced standard is the older version. The major reference for seismic provisions is based on an older version (1992). Similarly, the specifications for design of cold-formed steel structural members are also the previous version.	Not equivalent.
8.2 SEISMIC REQUIREMENTS FOR STEEL STRUCTURES	The design of steel *structures* to resist *seismic forces* shall be in accordance with Section 8.3 or 8.4 for the appropriate *Seismic Design Category.*	Division V, Section 2210 – AMENDMENTS Items 2.1 and 2.3	Different provisions are applicable depending upon seismic zone. Seismic zone, unlike seismic design category, does not consider occupancy of structure or soil characteristics of site.	Not equivalent.
8.3 SEISMIC DESIGN CATEGORIES A, B, and C	Allows steel structures in SDC A, B and C not to be detailed in accordance with the referenced standards if a specified R value is used.		Similar provisions not found.	Equivalency cannot be judged.
8.4 SEISMIC DESIGN CATEGORIES D, E, and F	Steel *structures* assigned to *Seismic Design Categories* D, E, and F shall be designed and detailed in accordance with Part I of 1997 edition of the seismic provisions for Structural steel buildings, or Sec. 8.6 for light framed cold-formed steel wall systems.	2205.3 Seismic design provisions for structural steel 2205.6 Design provisions for stud wall system Division V – Seismic provisions for structural steel buildings for use with ASD Division VIII – Lateral	The UBC references the 1992 edition of the seismic provisions for structural steel buildings. The light framed shear wall provisions in the UBC differ slightly from the comparable NEHRP provisions.	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
		resistance for steel stud wall systems		
8.5 COLD-FORMED STEEL SEISMIC REQUIREMENTS	Requires compliance with Ref. 8-4 and 8-5; except as modified. Ref. 8-4: *Specification for the Design of Cold-Formed Steel Structural Members*, American Iron and Steel Institute (AISI), 1996 Ref. 8-5: *Specification for the Design of Cold-Formed Stainless Steel Structural Members*, ANSI/ASCE 8-90, ASCE	2202.2 Design Standards 2205.4 Cold-formed steel construction 2205.5 Cold-formed stainless steel construction Division. VI LRFD Specification for cold-formed steel structural members	Requires compliance with *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members*, American Iron and Steel Institute (AISI), 1991 *and* *Specification for the Design of Cold-Formed Stainless Steel Structural Members*, ASCE, ANSI/ASCE 8-90	Considered not equivalent due to older version of cold-formed steel design standard referenced in UBC.
8.5.1 Modifications to Ref. 8-4	Revise Sec. A5.1.3 of Ref. 8-4 as follows: "A4.4 Wind or Earthquake Loads - Where load combinations specified by the applicable code include wind loads, the resulting forces are permitted to be multiplied by 0.75. Seismic load combinations shall be as determined by these provisions."	SECTION 2218 – AMEMDMENTS Item 2	Identical	Equivalent
8.5.2 Modifications to Ref. 8-5	Substitute a load factor of 1.0 in place of 1.5 for nominal earthquake load.		No corresponding provision	Equivalency cannot be judged.
8.6 LIGHT-FRAMED WALLS	The light framed wall provisions in Section 8.6 apply to all SDCs.	SECTION 2219 - GENERAL SECTION 2220 – SPECIAL REQUIREMENTS IN SEISMIC ZONES 3 AND 4	There are general wall provisions which apply to all seismic zones and then a second set of requirements which apply only in Seismic Zones 3 and 4. These second set of requirements are in NEHRP and apply to all SDCs.	UBC is less stringent.
8.6.1 Boundary Members	All boundary members, chords, and collectors shall be designed to transmit the specified induced axial forces.	2220.1 Item 2	Identical, except only applies in Seismic Zones 3 and 4	UBC is less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
8.6.2 Connections	Connections for diagonal bracing members, top chord splices, boundary members, and collectors shall have a *design strength* equal to or greater than the *nominal* tensile *strength* of the members being connected ...	2220.1 Items 3 and 6	Identical, except only applies in Seismic Zones 3 and 4	UBC is less stringent.
8.6.3 Braced Bay Members	In stud systems where the lateral forces are resisted by braced frames, the vertical and diagonal members in braced bays shall be anchored such that the bottom tracks are not required to resist uplift forces by bending of the track or track web....	2220.1 Items 4 and 5	Essentially identical, except only applies in Seismic Zones 3 and 4	UBC is less stringent.
8.6.4 Diagonal Braces	Provision shall be made for pretensioning or other methods of installation of tension-only bracing to guard against loose diagonal straps.	2220.1Item 7	Identical, except only applies in Seismic Zones 3 and 4	UBC is less stringent.
8.6.5 Shear Walls	Nominal shear values for wall sheathing materials are given in Table 8.6. Design shear values shall be determined by multiplying the nominal values therein by a ϕ factor of 0.55. In structures over one story in height, the assemblies in Table 8.6 shall not be used to resist horizontal loads contributed by forces imposed by masonry or concrete construction. Panel thickness shown in Table 8.6 shall be considered to be minimums. No panels less than 24 inches wide shall be used...Framing members, blocking or strapping shall be provided at the edges of all sheets. Fasteners along the edges in shear panels shall be placed not less than 3/8 inches in from panel edges. The height to length ratio of wall systems listed in Tale 8.6 shall not exceed 2:1. *Wall* studs and track shall have a minimum uncoated base thickness of not less than 0.033	Division VIII SECTION 2219 – GENERAL 2219.3 Design 2220.3 Wood structural panel sheathing	Steel stud wall systems in which shear panels are used to resist lateral loads produced by wind or earthquake shall comply with the requirements of this section. The nominal shear value used to establish the allowable shear value or design shear value shall not exceed the values set forth in Table 22-VIII-C for seismic loads.... No panels less than 12 inches wide shall be used. All panel edges shall be fully blocked. Where horizontal strap blocking is used, it shall be a minimum 1 1/2 inches wide and of the same material and thickness as the track and studs. Studs shall be doubled at shear wall ends. The height to length ratio of wall systems listed in Table 22-VIII-C shall not exceed 2:1. Shear values are required to be multiplied by a ϕ factor of 0.55. The maximum uncoated base metal thickness for wall studs and track is 0.043 inches in the UBC	UBC equivalent to slightly less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	inches (0.84 mm) and shall not have an uncoated base metal thickness greater than 0.048 inches. ...		(compared with 0.048 inches in the NEHRP Provisions)	
Table 8.6 - Nominal shear values for seismic forces for shear walls framed with cold-formed steel studs	Shear values and screw specifications are provided in this table.	Table 22-III-C - Nominal shear values for seismic forces for shear walls framed with cold-formed steel studs	Essentially identical. Shear value for 7/16" OSB, 2" fastener edge spacing is 1625 plf in the UBC and 1700 plf in NEHRP.	Considered equivalent
8.7 SEISMIC REQUIREMENTS FOR STEEL DECK DIAPHRAGMS	Steel deck *diaphragms* shall be made from materials conforming to the requirements of Ref. 8-4 or 8-5. *Nominal strengths* shall be determined in accordance with approved analytical procedures or with test procedures prepared by a *registered design professional* experienced in testing of cold-formed steel assemblies and approved by the authority having jurisdiction. ...		No corresponding provisions	Equivalency cannot be judged.
8.8 STEEL CABLES	The design strength of steel cables shall be determined by the requirements of Ref. 8-7 (*Structural Applications of Steel Cables for Buildings*, ASCE 19-95, ASCE) except as modified by these Provisions. Sec. 5d of Ref. 8-7 shall be modified by substituting $1.5(T_4)$ where T_4 is the net tension in cable due to dead load, prestress, live load, and seismic load. A load factor of 1.1 shall be applied to the prestress force to be added to the load combination of Sec. 3.1.2 of Ref. 8-7.	2205.9 Steel Cables	Structural applications of steel cables for buildings shall be in accordance with the provisions of Division XI (*Structural Applications of Steel Cables for Buildings*, ASCE 19-95, ASCE).	Considered equivalent with the exception of the NEHRP modification

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
Chapter 9 CONCRETE STRUCTURAL DESIGN REQUIREMENTS		**SECTION 1921 – REINFORCED CONCRETE STRUCTURES RESISTING FORCES INDUCED BY EARTHQUAKE FORCES**		
9.1 REFERENCE DOCUMENTS	*Building Code Requirements for Structural Concrete*, American Concrete Institute, ACI 318-95, excluding Appendix A	Ch. 19 Division II	*Refers to Building Code Requirements for Structural Concrete*, American Concrete Institute, ACI 318-95	Equivalent
9.1.1 Modifications to Ref. 9-1				
9.1.1.1	Requires the use of reduced ϕ factors with seismic strength design load combinations.	1612.2.1 Basic Load Combinations Exceptions 2	Factored load combinations of this section multiplied by 1.1 for concrete and masonry where load combinations include seismic forces.	Equivalent
9.1.1.2	Introduces notations related to the modifications made in 9.1.1.	1921.0 Notations	Includes notations from the ACI 318-95 Section 21 plus notations related to the modifications made to ACI 318-95 Ch. 21.	Equivalent
9.1.1.3	Introduces definitions related to the modifications made in 9.1.1.	1921.1 Definitions	Includes definitions from ACI 318-95 Section 21.1 plus definitions related to the modifications made to ACI 318-95 Ch. 21.	Equivalent
9.1.1.4	Replaces Sections 21.2.1.3 and 21.2.1.4 of ACI 318-95 with requirements of Sections 9.4-9.7		The NEHRP modifications are made necessary by the fact that it was Seismic Design categories. These modifications do not exist in the UBC which uses Seismic Zones.	Not equivalent
9.1.1.5	Add seismic design requirements for precast concrete structures to ACI 318-95.	1921.2.1.6 1921.2.1.7	Essentially identical	Equivalent
9.1.1.6	Add seismic design requirements for precast concrete structures to ACI 318-95.	1921.2.2.5 1921.2.2.6 1921.2.2.7	Essentially identical	Equivalent
9.1.1.7	Permits prestressing tendons to be used to resist earthquake-induced flexural and axial forces in frame members subject to restrictions of this	1921.2.5.1 1921.2.5.2	Essentially identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	section.			
	Prestressing tendons shall be permitted in flexural members of frames provided the vaerage prestress, f_{pc}, shall not exceed the lesser of 700 psi or $f_c'/6$ at locations of nonlinear action where prestressing tendons are used in members of frames.	1921.2.5.3	Tthe vaerage prestress, f_{pc}, shall not exceed the lesser of 350 psi or $f_c'/12$ at locations of nonlinear action where prestressing tendons are used in members of frames.	UBC is more stringent
	For members in which prestressing tendons are used together with reinforcement to resist earthquake-induced forces, prestressing tendons shall not provide more than one quarter of the *strength* for both positive moments and negative moments at the *joint* face and shall extend through exterior *joints* and be anchored at the exterior face of the *joint* or beyond. Anchorages for tendons must be demonstrated to perform satisfactorily for seismic loadings. Anchorage assemblies shall withstand, without failure, a minimum of 50 cycles of loading ranging between 40 and 85 percent of the minimum specified tensile strength of the tendon. Tendons shall extend through exterior *joints* and be anchored at the exterior face or beyond.	1921.2.5.4	Essentially identical. The NEHRP requirement concerning anchorages for tendons not included.	UBC is less stringent
	No corresponding provision	1921.2.5.5	Shear strength provided by prestressing tendons shall not be considered in design.	Equivalency cannot be judged.
9.1.1.8	Makes modifications to splicing requirements of Section 21.2.6.1 of ACI 318-95. ... provided (a) ... (b) the center-to-center distance between splices of adjacent bars is 24 in.	1921.2.6.1	UBC drops the staggering requirement. However, it prohibits the use of welded splices in the potential plastic hinge region of a structural member in Zones 2, 3 and 4. It introduces an upgraded Type 2 mechanical splice. The regular Type 1 mechanical splice may not be used within the region of potential plastic hinging of a structural member in Zones 2, 3 and 4.	UBC is more stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
9.1.1.9	Adds a new section to ACI 318-95 on emulation of monolithic construction using strong connection.	1921.2.7	Identical	Equivalent
9.1.1.10	Makes a modification to the design axial strength requirement for columns of Section 21.4.5.3 of ACI 318-95 - a modification taken from the 1997 UBC	1921.4.4.7	Identical	Equivalent
9.1.1.11	Requires use of strength design load combinations of ASCE 7-95 in seismic design of concrete structures.	1612.2.1 basic Load Combinations Exceptions: 2	Factored load combinations of this section multiplied by 1.1 for concrete and masonry where load combinations include seismic forces.	Equivalent.
9.1.1.12	Makes modifications to diaphragm design requirements of Section 21.6.4 of ACI 318-95	1921.6.12	Essentially identical	Equivalent
9.1.1.13	Design of shear walls for flexure and axial loads is changed from the procedure of ACI 318-95 to essentially that of 1997 UBC	1921.6.6	Essentially identical	Equivalent
9.1.1.14	Adds design requirements for coupling beams to ACI 318-95.	1921.6.10	Identical	Equivalent
9.1.1.15	Modifies the requirements of ACI 318-95 Section 21.7 for frame members assumed not to contribute to lateral resistance.	1921.7.1	Essentially the same, except that the estimated design earthquake displacement imposed on the gravity frame may not be the same.	Equivalent in intent. Similar, but not necessarily the same in design values.
9.1.1.16	Changes the title of section from "Requirements for frames in regions of moderate seismic risk" to "Requirements for Intermediate Moment Frames."	1921.8	The title is "Requirements for Frames in Seismic Zone 2." Based on seismic zones instead of structural system, as in NEHRP.	Not equivalent
	No corresponding requirement. Design procedures of NEHRP are all strength-based.	1923 ANCHORAGE TO CONCRETE 1923.1 Service Load Design	Gives provisions for allowable stress design of headed bolts and headed stud anchors cast in normal weight concrete.	Does not affect equivalency.
9.2 BOLTS AND HEADED STUD ANCHORS IN CONCRETE	Gives strength design provisions for headed bolts and headed stud anchors cast in concrete	1923 ANCHORAGE TO CONCRETE 1923.2 Strength Design		

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
9.2.1 Load factor Multipliers	In addition to the load factors in Sec. 5.2.7, a multiplier of 2 shall be used if *special inspection* is not provided or of 1.3 if it is provided. When anchors are embedded in the tension zone of a member, the load factors in Sec. 5.2.7 shall have a multiplier of 3 if *special inspection* is not provided or of 2 if it is provided.	1923. 2 Strength Design Para 2	Essentially identical	Equivalent
9.2.2 Strength of Anchors	*Strength* of anchors cast in concrete shall be taken as the lesser of the *strengths* associated with concrete failure and anchor steel failure. Where feasible, anchor connections, particularly those subject to seismic or other dynamic loads, shall be designed and detailed such that connection failure is initiated by failure of the anchor steel rather than by failure of the surrounding concrete. Reinforcement also shall be permitted to be used for direct transfer of tension and shear loads. Such reinforcement shall be designed with proper consideration of its development and its orientation with respect to the postulated concrete failure planes. The *strength* of headed bolts and headed studs cast in concrete shall be based on testing in accordance with Sec. 9.2.3 or calculated in accordance with Sec. 9.2.4. The bearing area of headed anchors shall be at least one and one-half times the shank area.	1923.3 Strength of Anchors 1923.3.1 General	NEHRP encourages steel failure rather than concrete failure – this is not in the UBC. In NEHRP, nominal strength is mean value derived from tests minus one standard deviation. In the UBC, strength is the average of test values. NEHRP specifies ϕ-values to be applied to nominal strengths based on tests, the UBC does not.	UBC is less stringent. Equivalency cannot be judged.
9.2.3 Strength Based on Tests	The *strength* of anchors shall be based on not less than 10 representative tests conforming to the proposed materials and anchor size and type, embedment length, and configuration as to attachment plates, loads applied, and concrete edge distances. The *nominal strength* shall be the mean value derived from the tests minus one			

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	standard deviation. The *strength* reduction factor applied to the *nominal strength* shall be 0.8 when anchor failure governs in the majority of the tests and 0.65 when concrete failure controls.			
9.2.4 Strength based on Calculations 9.2.4.1 Strength in Tension	1. Design tensile strength governed by steel, $P_s = 0.9A_bF_un$ 2a. For individual anchors or groups of anchors with individual anchors spaced at least twice their embedment length apart and spaced not less than one anchor embedment length from a free edge of the concrete, design tensile strength governed by concrete failure, $\phi P_c = \phi\lambda\sqrt{f_c'}(2.8A_s)n$ 2b. For anchor groups where individual anchors are spaced closer together than two embedment lengths, $\phi P_c = \phi\lambda\sqrt{f_c'}(2.8A_p + 4A_t)n$	1923.3.2 Design strength in tension	The design strength of anchors in tension shall be minimum of P_{ss} or ϕP_c where: $P_{ss} = 0.9A_bf_{ut}$ P_{ss} is the same as P_s of NEHRP for a single bolt, f_{ut} is the same as F_u of NEHRP. For an anchor group where the distance between anchors is less than twice their embedment length or for a single anchor or anchor group where the distance between anchors is equal to or greater than twice their embedment length $\phi P_c = \phi\lambda\sqrt{f_c'}(4A_p)$ A_p, effective area of projected failure surface is very similar to A_s of NEHRP Case 2a and of (A_p+A_t) of NEHRP Case 2b.	Steel failure formulas are equivalent. UBC concrete failure formulas are somewhat less stringent.
9.2.4.2 Strength in Shear	Where anchors are loaded toward an edge with edge distance d_e from the back row of anchors as shown in Figure 9.2.4.2 equal to or greater than 15 anchor diameters and the distance from the front row of anchors to the edge equal to or greater than 6 anchor diameters: $V_s = (0.75A_bF_u)n$ $\phi V_c = (\phi 800A_b\lambda\sqrt{f_c'})n$ Where anchors are loaded toward an edge with d_e less than 15 anchor diameters or the front row closer to the edge than 6 anchor diameters: $V_s = (0.75A_bF_u)n_b$	1923.3.3 Design strength in shear	The design strength of anchors in shear shall be minimum of V_{ss} or ϕV_c where: $V_{ss} = 0.75A_bf_{ut}$ and where loaded toward an edge greater than 10 diameters away, $\phi V_c = \phi 800A_b\lambda\sqrt{f_c'}$ or where loaded toward an edge equal to or less than 10 diameters away, $\phi V_c' = \phi 2\pi d_e^2\lambda\sqrt{f_c'}$ Where d_e equals the edge distance from the anchor axis to the free edge. For group of anchors, the concrete design shear strength shall be taken as the smallest of:	Third formula in the UBC uses $2\pi d_e^2$, whereas NEHRP uses $12.5d_e^{1.5}$. Thus, comparison would depend on the value of d_e. The other two formulas are equivalent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	$\phi V_c = \phi V'_c C_w C_t C_c$ $\phi V_c' = \phi 12.5 d_e^{1.5} \lambda \sqrt{f_c'} \le 800 A_b \lambda \sqrt{f_c'}$ C_w = the adjustment factor for group width C_t = the adjustment factor for member thickness C_c = the adjustment factor for member corner effects		1. The design strength of the weakest anchor times the number of anchors, 2. The design strength of the row of anchors nearest the free edge in the direction of shear times the number of rows or 3. The design strength of the row farthest from the free edge in the direction of shear. For shear loading toward an edge equal to or less than 10 diameters away, or tension or shear not toward an edge less than 5 diameters away, reinforcing sufficient to carry the load shall be provided to prevent failure of the concrete in tension. In no case, shall the edge distance be less than 4 diameters.	
9.2.4.3 Combined Tension and Shear	Where tension and shear act simultaneously, all of the following conditions shall be met: $\frac{1}{\phi}\left(\frac{V_u}{V_c}\right) \le 1.0$ $\frac{1}{\phi}\left(\frac{P_u}{P_c}\right) \le 1.0$ $\frac{1}{\phi}\left[\left(\frac{P_u}{P_c}\right)^2 + \left(\frac{V_u}{V_c}\right)^2\right] \le 1.0$ $\left(\frac{P_u}{P_s}\right)^2 + \left(\frac{V_u}{V_s}\right)^2 \le 1.0$	1923.3.4 Combined tension and shear	Essentially the same except that the exponent 2 in third NEHRP Eq. has been replaced by 5/3 in UBC.	Considered equivalent
9.3 CLASSIFICATION OF SEISMIC-FORCE-RESISTING	Gives a classification of moment frames and shear walls.	1921.2.1.3 1921.2.1.4	UBC indicates which provisions of Ch. 21 apply, depending upon the Seismic Zone	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
SYSTEMS				
9.3.1 Classification of Moment Frames	Gives classification of moment frames.	1921.2.1.3 1921.2.1.4	UBC indicates which provisions of Ch. 21 apply, depending upon the Seismic Zone	Not equivalent
9.3.1.1. Ordinary Moment Frames	The moment frame that satisfies the minimum detailing requirements prescribed for Zone 1 by the UBC is given the name: Ordinary Moment frame.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Seismic Zones 0 and 1	Not equivalent
9.3.1.1.1 9.3.1.1.2	Imposes detailing requirements on Ordinary Moment Frames that are additional to those of ACI 318-95.		No corresponding provisions	UBC is less stringent
9.3.1.2 Intermediate Moment Frames	The moment frame that satisfies the minimum detailing requirements prescribed for Zone 2 by the UBC is given the name: Intermediate Moment Frame. Applicable portions of ACI 318-95 Section 21.2 that must be satisfied by such a frame are pointed out.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in addition to Chs. 1-18, in Seismic Zone 2	Not equivalent
9.3.1.3 Special Moment Frames	The moment frame that satisfies the minimum detailing requirements prescribed for Zones 3 and 4 by the UBC is given the name: Special Moment Frame.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Chs. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.3.2 Classification of Shear Walls	Gives classification of shear walls.	1922.10.2 1922.10.3 1921.2.1.3 1921.2.1.4	UBC indicates which provisions of Chs. 21 and 22 apply depending upon the Seismic Zone	Not equivalent
9.3.2.1 Ordinary Plain Concrete Shear Walls	A plain concrete shearwall conforming to the requirements of ACI 318-95 Ch 22 is given the name: Ordinary Plain Concrete Shear Wall.	1922.10.2	Indicates which provisions of Ch. 22 apply to plain concrete shear walls in Zones 0 and 1	Not equivalent
9.3.2.2 Detailed Plain Concrete Shear Walls	A plain concrete shear wall that additionally has the reinforcement prescribed in this section is given the name: Detailed Plain Concrete Shear Wall.		No corresponding provision	Equivalency cannot be judged
9.3.2.3 Ordinary Reinforced Concrete Shear Walls	The reinforced concrete shear wall that satisfies the minimum detailing requirements prescribed for Zones 0, 1, and 2 by the UBC is given the name:	1921.2.1.3	Indicates which provisions of Ch. 21 apply to reinforced concrete shear walls in Seismic Zones 0, 1, and 2	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	Ordinary Reinforced Concrete Shear Wall.			
9.3.2.4 Special Reinforced Concrete Shear Walls	The reinforced concrete shear wall that satisfies the minimum detailing requirements prescribed for Zones 3 and 4 by the UBC is given the name: Special Reinforced Concrete Shear Wall.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Chs. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.4 SEISMIC DESIGN CATEGORY A	Specifies structural systems that are permitted in buildings assigned to SDC A Ordinary Moment Frames in SDC A are exempt from the extra detailing requirements of Sections 9.3.1.1.1 and 9.3.1.1.2.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zones 0 and 1	Not equivalent
9.5 SEISMIC DESIGN CATEGORY B	Structures assigned to SDC B must satisfy all the requirements for SDC A and the additional requirements of this section.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zones 0 and 1	Not equivalent
9.5.1 Moment Frames	All moment frames forming part of the seismic-force-resisting system of buildings assigned to SDC B and founded on Site Class E or F soils must be Intermediate or Special Moment frames.		No corresponding requirement	UBC is less stringent
9.6 SEISMIC DESIGN CATEGORY C	Structures assigned to SDC C must satisfy all the requirements for SDC B and the additional requirements of this section.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zone 2	Not equivalent
9.6.1 Seismic-Force-Resisting Systems	Seismic-force-resisting systems must satisfy 9.6.1.1 and 9.6.1.2	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zone 2	Not equivalent
9.6.1.1. Moment Frames	Only Intermediate or Special Moment Frames are allowed as part of the Seismic-force-resisting system.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zone 2	Not equivalent
9.6.1.2 Shear Walls	Only Detailed Plain Concrete Shear Walls, Ordinary Reinforced Concrete Shear Walls and Special Reinforced Concrete Shear Walls are allowed as part of the seismic-force-resisting system.	1921.2.1.3	Indicates which provisions of Ch. 21 apply in Zone 2	Not equivalent
9.6.2 Discontinuous Members	Special load combinations must be used in design. Detailing requirements are also given.	1630.8.2.1	Special load combinations must be used in design. No special detailing requirement given for Seismic Zone below 3.	Special load combinations are not the same, as discussed earlier.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
				UBC is less stringent concerning detailing requirement.
9.6.3. Plain concrete	Additional requirements and limitations of this Section, in addition to those of ACI 318-95, must be conformed to.	1922.10.3 Seismic Zones 2, 3 and 4	Structural plain concrete members are not permitted in Zone 2, except as specifically noted.	UBC is more restrictive
9.6.3.1 Walls	Walls forming part of the seismic-force-resisting system must be Detailed Plain Concrete Shear Walls. Other walls not serving as shear walls must be reinforced like Detailed Plain Concrete Shear Walls.	1922.10.3 Seismic Zones 2, 3 and 4	Structural plain concrete members are not permitted in Zone 2, except as specifically noted. Detailed Plain Concrete Shear Walls are not recognized	UBC is more stringent
9.6.3.2 Footings	Isolated footings of *plain concrete* supporting pedestals or columns are permitted provided the projection of the footing beyond the face of the supported member does not exceed the footing thickness. Exception: In detached one- and two-family dwellings three stories or less in height, the projection of the footing beyond the face of the supported member shall be permitted to exceed the footing thickness. *Plain concrete* footings supporting *walls* shall be provided with not less than two continuous longitudinal reinforcing bars. Bars shall not be smaller than No. 4 (#13) and shall have a total area of not less than 0.002 times the gross cross-sectional area of the footing. Continuity of reinforcement shall be provided at corners and intersections. Exception: In detached one- and two-family dwellings three stories or less in height and constructed with stud *bearing walls*, *plain concrete* footings supporting *walls* shall be	1922.10.3 Seismic Zones 2, 3 and 4	Note EXCEPTIONS 1 and 2	UBC is more restrictive

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	permitted without longitudinal reinforcement.			
9.6.3.3 Pedestals	Plain concrete pedestals shall not be used to resist lateral seismic forces.	1922.10.3 Seismic Zones 2, 3 and 4	The same restriction applies	Equivalent
9.7 SEISMIC DESIGN CATEGORIES D, E, OR F	Structures assigned to SDC D, E, or F must satisfy all the requirements for SDC C and the additional requirements of this section.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Ch. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.7.1 Seismic Force Resisting Systems	Seismic-force resisting systems shall conform to Sec. 9.7.1.1 and Sec. 9.7.1.2.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Ch. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.7.1.1. Moment Frames	Only Special Moment Frames are allowed as part of the seismic-force-resisting system.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Ch. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.7.1.2 Shear Walls	Only Special Reinforced Concrete Shear Walls are allowed as part of the seismic-force-resisting system.	1921.2.1.4	Indicates which provisions of Ch. 21 apply, in addition to Ch. 1-17, in Seismic Zones 3 and 4	Not equivalent
9.7.2 Frame Members Not Proportioned to Resist Forces Induced by Earthquakes	All frame *components* assumed not to contribute to lateral force resistance shall conform to Sec. 2.1.7 of Ref. 9-1 as modified by Sec. 9.1.1.15 of this chapter.	1921.2.1.3 1921.2.1.4	In Seismic Zone 2, frame members which are not designed to be part of the lateral-force-resisting system shall conform to Section 1921.7 Invokes Section 1921.7 in Seismic Zones 3,4	UBC is more restrictive
9.7.3 Plain Concrete	Structural plain concrete members are not permitted in buildings assigned to SDC D, E or F, except as noted.	1922.10.3 Seismic Zones 2, 3 and 4	Structural plain concrete members are not permitted in buildings located in Seismic Zones 2, 3 and 4, except as noted	UBC is more restrictive
Appendix to Chapter 9 REINFORCED CONCRETE STRUCTURAL SYSTEMS COMPOSED FROM INTERCONNECTED PRECAST ELEMENTS			The provisions of this appendix are not included in the UBC.	Equivalency cannot be judged

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
Chapter 10 COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS 10.1 REFERENCE DOCUMENTS 10.2 REQUIREMENTS			No similar provisions in the UBC.	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
Ch. 11 MASONRY STRUCTURE DESIGN REQUIREMENTS		**Ch. 21 Masonry**		
11.1 GENERAL		SECTION 2101 – GENERAL		
11.1.1 Scope	The design and construction of reinforced and plain unreinforced masonry components and systems and the materials used therein shall comply with the requirements of this chapter.	2101.1 Scope	The materials, design, construction and quality assurance of masonry shall be in accordance with this chapter.	Considered equivalent
11.1.2 Reference Documents	ACI 530-95 and ACI 530.1-95 are the primary reference documents.		No similar references	Not equivalent
11.1.3 Definitions		2101.3 Definitions	Essentially similar	Considered equivalent
11.1.4 Notations		2101.4 Notations	Essentially similar	Considered equivalent
11.2 CONSTRUCTION REQUIREMENTS		SECTION 2104 – CONSTRUCTION		
11.2.1 General	Refers to ACI 530.1 and the standards referenced therein	2104.1 General	Requires conformance with Section 2104	UBC is equivalent to more stringent.
	No similar provisions	2104.2 Materials: Handling, Storage and Preparation		Does not affect equivalency
	No similar provisions	2104.3 Cold-weather Construction 2104.3.1 General 2104.3.2 Preparation 2104.3.3 Construction 2104.3.4 Protection 2104.3.5 Placing grout and protection of grouted masonry		Does not affect equivalency

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	No similar provisions	2104.4 Placing Masonry Units 2104.4.1 Mortar 2104.4.2 Surfaces 2104.4.3 Solid masonry units 2104.4.4 Hollow-masonry units		Does not affect equivalency
	No similar provisions	2104.5 Reinforcement Placing		Does not affect equivalency
	No similar provisions	2104.6 Grouted Masonry 2104.6.1 General conditions 2104.6.2 Construction requirements		Does not affect equivalency
	No similar provisions	2104.7 Aluminum Equipment		Does not affect equivalency
	No similar provisions	2104.8 Joint Reinforcement		Does not affect equivalency
11.2.2 Quality Assurance	Refers to Chapter 3 of the 1997 NEHRP Provisions	SECTION 2105 - QUALITY ASSURANCE 2105.1 General	Requires conformance with Section 2104	UBC is equivalent to more stringent.
	No similar provisions	2105.2 Scope		Does not affect equivalency
	Ref. 11-1: ACI 530.1-95 Section 1.4B Item 2. Unit strength method Item 3. Prism test method	2105.3 Compliance with f_m' 2105.3.1 General 2105.3.2 Masonry prism testing 2105.3.3 Masonry prism test record 2105.3.4 Unit strength	Different provisions	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
		method 2105.3.5 Testing prisms from constructed masonry		
Ref. 11-2 ACI 530.1-95 Sec. 3.6 Field quality control Item B	When required, test mortar in accordance with the property specifications of ASTM C 270 or evaluate in accordance with ASTM C 780.	2105.4 Mortar Testing	When required, grout shall be tested in accordance with UBC Standard 21-16.	Equivalency cannot be judged.
Ref. 11-2 ACI 530.1-95 Sec. 1.4 System Description Item B2	.... Grout compressive strength equals f_m' but compressive strength is not less than 2000 psi. Determine compressive strength of grout in accordance with ASTM C 1019.	2105.5 Grout Testing	When required, grout shall be tested in accordance with UBC Standard 21-18, which is based on ASTM C1019	Considered equivalent
11.3 GENERAL REQUIREMENTS				
11.3.1 Scope	Masonry structures and components shall comply with requirements of reinforced masonry design, plain (unreinforced) masonry design, empirical design, design for architectural components of masonry, design of glass unit masonry and masonry veneer.	2106.1.1 Scope	The design of masonry structures shall comply with the working stress design provisions of Section 2107, or the strength design provisions of Section 2108, or the empirical design provisions of Section 2109, and with the provisions of this section. Working stress design is not included in NEHRP. While UBC Chapter 21 has a section on glass masonry, provisions for masonry veneer are in Section 1403, Vol. 1.	Not equivalent
11.3.2 Empirical Masonry Design	The requirements of Chapter 9 of ACI 530-95 shall apply to the empirical design of masonry.	2101.2.3 Empirical Design	Masonry designed by the empirical design method shall comply with the provisions of Sections 2106.1 and 2109. Essentially identical	Equivalent
11.3.3 Plain (Unreinforced) Masonry Design 11.3.3.1 11.3.3.2 11.3.3.3	In the design of plain (unreinforced) masonry members, the flexural tensile strength of masonry units, mortar and grout in resisting design loads shall be permitted. In the design of plain masonry members, stresses in reinforcement shall not be considered effective	SECTION 2107 – WORKING STRESS DESIGN 2107.3 Design of unreinforced masonry 2107.3.1 General	The requirements of this section govern masonry in which reinforcement is not used to resist design forces and are in addition to the requirements of Section 2106 and 2107.1.	Strength design vs. working stress design. Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	in resisting design loads. Plain masonry members shall be designed to remain uncracked.			
11.3.4 Reinforced Masonry Design	In the design of reinforced masonry members, stresses in reinforcement shall be considered effective in resisting design loads.	2107.2 Design of Reinforced masonry 2107.2.1 Scope	Essentially similar	Statement of principle is equivalent. Details come later.
11.3.5 Seismic Design Category A	*Structures* shall comply with Sec. 11.3.2 (empirical masonry design), Sec. 11.3.3 (plain masonry design), Sec. 11.3.4 (reinforced masonry design)	2106.1.1 Scope 2106.1.12.2 Special provisions for Seismic Zones 0 and 1	There are no special design and construction provisions in this section.	Considered equivalent
11.3.6 Seismic Design Category B	Lateral-force-resisting system shall comply with Sec. 11.3.3 (plain masonry design) or Sec. 11.3.4 (reinforced masonry design)	2106.1.1 Scope 2106.1.12.2 Special provisions for Seismic Zones 0 and 1	There are no special design and construction provisions in this section. Empirical design is allowed for lateral-force-resisting systems.	UBC is less stringent.
11.3.7 Seismic Design Category C	*Structures* shall conform to the requirements for *Seismic Design Category* B and to the additional requirements of this section.	2106.1.12.3 Special provisions for Seismic Zone 2		See below
11.3.7.1 Material Requirements	Structural clay load-bearing wall tile shall not be used as part of the basic structural system.	2106.1.12.3 Special provisions for Seismic Zone 2 Item 5	The following materials shall not be used as part of the vertical or lateral load-resisting systems: Type O mortar, masonry cement, plastic cement, nonloadbearing masonry units and glass block.	UBC is more stringent.
11.3.7.2 Masonry Shear Walls	Masonry *shear walls* shall comply with the requirements for *detailed plain masonry shear walls* (Sec. 11.11.2), *intermediate reinforced masonry shear walls* (Sec. 11.11.4), or *special reinforced masonry shear walls* (Sec. 11.11.5).	2106.1.12.3 Special provisions for Seismic Zone 2 Items 2 and 3	Although not indicated explicitly, the UBC precludes plain masonry shear walls by prescribing minimum reinforcement requirements.	Equivalent
11.3.7.3 Minimum Wall Reinforcement	Vertical reinforcement of at least 0.20 $in.^2$ (129 mm^2) in cross-sectional area shall be provided continuously from support to support at each corner, at each side of each opening, at the ends of walls and at a maximum spacing of 4 feet (1219 mm) apart horizontally throughout the walls.	2106.1.12.3 Special provisions for Seismic Zone 2 Items 2 and 3	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	Horizontal reinforcement not less than 0.20 $in.^2$ (129 mm^2) in cross section shall be provided as follows: a. At the bottom and top of wall openings extending not less than 24 in. (610 mm) nor less than 40 bar diameters past the opening, b. Continuously at structurally connected roof and floor levels and at the top of walls, c. At the bottom of load-bearing walls or in the top of foundations when doweled to the wall, d. At maximum spacing of 120 in. (3048 mm) unless uniformly distributed joint reinforcement is provided. Reinforcement at the top and bottom of openings, when used in determining the maximum spacing specified in Item d above, shall be continuous in the wall.			
11.3.7.4 Stack Bond Construction	Where stack bond is used, the minimum horizontal reinforcement ratio shall be 0.0007 times the gross cross-sectional area of the wall. This requirement shall be satisfied with uniformly distributed joint reinforcement or with horizontal reinforcement spaced not over 48 in. and fully embedded in grout or mortar.	2106.1.12.3 Special provisions for Seismic Zone 2 Item 4	Identical	Equivalent
	No corresponding provision	2106.1.12.3 Special provisions for Seismic Zone 2 Item 1	Columns shall be reinforced as specified in Sections 2106.3.6, 2106.3.7 and 2107.2.13.	UBC is more restrictive.
11.3.7.5 Multiple Wythe Walls Not Acting Compositely	At least one wythe of a cavity *wall* shall be reinforced masonry designed in accordance with Sec. 11.3.4. The other wythe shall be reinforced with a minimum of one W1.7 wire per 4-in. (102 mm) nominal wythe thickness and spaced at intervals not exceeding 16 in. (406 mm). The		No corresponding provision.	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	wythes shall be tied in accordance with Ref. 11-1, Sec. 5.8.3.2.			
11.3.7.6 Walls Separated from the Basic Structural System	Masonry *walls*, laterally supported perpendicular to their own plane but otherwise structurally isolated on three sides from the basic structural system, shall have minimum horizontal reinforcement of 0.007 times the gross cross-sectional area of the *wall*. This requirement shall be satisfied with uniformly distributed joint reinforcement or with horizontal reinforcement spaced not over 48 in. (1200 mm) and fully embedded in grout or mortar. Architectural components of masonry shall be exempt from this reinforcement requirement.		No corresponding provision.	Equivalency cannot be judged.
11.3.7.7 Connections to Masonry Columns	Structural members framing into or supported by masonry columns shall be anchored thereto. Anchor bolts located in the tops of columns shall be set entirely within the reinforcing cage composed of column bars and lateral ties. A minimum of two No. 4 (13 mm) lateral ties shall be provided in the top 5 inches (127 mm) of the column.	2106.3.7 Column anchor bolt ties	Essentially similar	Considered equivalent.
11.3.8 Seismic Design Category D	*Structures* assigned to *Seismic Design Category* D shall conform to all of the requirements for *Seismic Design Category* C and the additional requirements of this section.	2106.1.12.4 Special provisions for Seismic Zones 3 and 4		
11.3.8.1 Material Requirements	Prohibits use of Type N mortar and masonry cement in basic structural system	2106.1.12.3 Special provisions for Seismic Zone 2 Item 5 2106.1.12.4 Special provisions for Seismic Zones 3 and 4	The following materials shall not be used as part of the vertical or lateral load-resisting systems: Type O mortar, masonry cement, plastic cement, nonloadbearing masonry units and glass block. Type N mortar shall not be used as part of the vertical- or lateral-load-resisting system	Considered equivalent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
		Item 3		
11.3.8.2 Masonry Shear Walls	Masonry shear walls shall comply with the requirements of *special reinforced masonry shear walls*. (Sec. 11.11.5) 11.11.5: In addition to other provisions states that the maximum spacing of vertical (or horizontal) reinforcement shall be smaller of (a) 1/3rd wall length, (b) 1/3rd wall height and (c) 48 in.	2106.1.12.4 Item 2 Shear Walls Item 2.1 Reinforcement	Similar, with the following exception: The spacing of reinforcement in each direction shall not exceed one half the length of the element, nor one half the height of the element, nor 48 in.	UBC is less stringent
11.3.8.3 Minimum Wall Reinforcement	All walls shall be reinforced with both vertical and horizontal reinforcement. The sum of the area of horizontal and vertical reinforcement shall be at least 0.002 times the gross cross-sectional area of the wall and the minimum area of reinforcement in each direction shall not be less than 0.0007 times the gross cross-sectional area of the wall. The spacing of reinforcement shall not exceed 48 in. Except for joint reinforcement, the bar size shall not be less than a No. 3 (10-mm diameter). Reinforcement shall be continuous around wall corners and through intersections, unless the intersecting walls are separated. Only horizontal reinforcement that is continuous in the wall or element shall be included in computing the area of horizontal reinforcement. Reinforcement spliced in accordance with Sec. 11.4.5.6 shall be considered as continuous reinforcement. Architectural components of masonry shall be exempt from this reinforcement requirement.	2106.1.12.4 Item 2.3 Wall reinforcement	Similar	Equivalent.
11.3.8.4 Stack Bond Construction	Where masonry is laid in stack bond, the minimum amount of horizontal reinforcement shall be 0.0015 times the gross cross-sectional area of the wall. If open-end units are used and grouted solid, the minimum amount of horizontal reinforcement shall be 0.0007 times the gross	2106.1.12.4 Item 2.4 Stack bond	Similar except that the limitation of 24 in. on maximum spacing is not specified.	UBC is equivalent to less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	cross-sectional area of the wall. The maximum spacing of horizontal reinforcement shall not exceed 24 in. (610 mm). Architectural components of masonry shall be exempt from these requirements.			
11.3.8.5 Minimum Wall Thickness	The nominal thickness of masonry bearing *walls* shall not be less than 6 in. (152 mm). Nominal 4-in. (102 mm) thick load-bearing reinforced hollow clay unit masonry *walls* with a maximum unsupported height or length to thickness ratio of 27 are permitted to be used provided the net area unit strength exceeds 8,000 psi (55 MPa), units are laid in *running bond*, bar sizes do not exceed 1/2 in. (13 mm) with not more than two bars or one splice in a cell and joints are not raked.	2107.1.3.1 Bearing walls (Working stress design)	Identical	Equivalent
11.3.8.6 Minimum Column Reinforcement	Lateral ties in columns shall be spaced not more than 8 in. on center for the full height of the column. Lateral ties shall be embedded in grout and shall be No. 3 or larger.	2106.1.12.4 Item 1. Column reinforcement ties	Similar. Second line of NEHRP requirements is not included. Column ties are required to terminate in hooks that are specified.	UBC is equivalent to more stringent.
11.3.8.7 Minimum Column Dimension	The nominal dimensions of a masonry column shall not be less than 12 in.	2107.1.3.2 Columns (Working stress design)	Identical	Equivalent
11.3.8.8 Separation Joints	When concrete abuts structural masonry and the joint between the materials is not designed as a separation joint, the concrete shall be roughened so that the average height of aggregate exposure is 1/8-in. and ...	2106.1.12.4 Item 4 Concrete abutting structural masonry	Concrete abutting structural masonry, such as at starter courses or at wall intersections not designed as true separation joints, shall be roughened to a full amplitude of 1/16-in. and ..	UBC is less stringent
11.3.9 Seismic Design Categories E and F	*Structures* assigned to *Seismic Design Categories* E and F shall conform to the requirements of *Seismic Design Category* D and to the additional requirements and limitations of this section.	2106.1.12.4 Special provisions for Seismic Zones 3 and 4		

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.3.9.1 Material Requirements	Construction procedures or admixtures shall be used to minimize shrinkage of grout and to maximize bond between reinforcement, grout, and units.		No corresponding provisions	UBC is less stringent
11.3.9.2 Masonry Shear Walls	Masonry shear walls shall comply with the requirements of *special reinforced masonry shear walls*. (Sec. 11.11.5) 11.11.5: In addition to other provisions states that the maximum spacing of vertical (or horizontal) reinforcement shall be smaller of (a) 1/3rd wall length, (b) 1/3rd wall height and (c) 48 in.	2106.1.12.4 Item 2 Shear Walls Item 2.1 Reinforcement	Similar, with the following exception: The spacing of reinforcement in each direction shall not exceed one half the length of the element, nor one half the height of the element, nor 48 in.	UBC is less stringent
11.3.9.3 Stack Bond Construction 11.3.9.3.1 11.3.9.3.2	Masonry laid in stack bond shall conform to the following requirements: For masonry that is not part of the basic structural system, the minimum ratio of horizontal reinforcement shall be 0.0015 and the maximum spacing of horizontal reinforcement shall be 24 in. (610 mm). For masonry that is part of the basic structural system, the minimum ratio of horizontal reinforcement shall be 0.0025 and the maximum spacing of horizontal reinforcement shall be 16 in. (406 mm). For the purpose of calculating this ratio, joint reinforcement shall not be considered. Reinforced hollow unit construction shall be grouted solid and all *head joints* shall be made solid by the use of open end units.	2106.1.12.4 Item 2.4 Stack bond	Increases in requirement from SDC D to SDC E, F are not part of the UBC.	UBC is less stringent.
11.3.10 Properties of Materials		2106.2.12 Modulus of elasticity of materials		
11.3.10.1 Steel Reinforcement Modulus of Elasticity	Unless otherwise determined by test, steel reinforcement modulus of elasticity (E_S) shall be taken to be 29,000,000 psi (200,000 MPa).	2106.2.12.2 Modulus of elasticity of steel	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.3.10.2 Masonry Modulus of Elasticity	The modulus of elasticity of masonry (E_m) shall be determined in accordance with Eq. 11.3.10.2 or shall be based on the modulus of elasticity determined by prism test and taken between 0.05 and 0.33 times the masonry prism strength: $E_m = 750 f_m'$	2106.2.12.1 Modulus of elasticity of masonry	Essentially identical, except UBC specifies maximum values.	Equivalent
11.3.10.3 Modulus of Rigidity of Masonry	The modulus of rigidity of masonry, E_v, shall be taken equal to 0.4 times the modulus of elasticity of masonry, E_m.	2106.2.13 Shear modulus of masonry	Identical	Equivalent
11.3.10.4 Masonry Compressive Strength		2106.2.2 Specified compressive strength of masonry	No similar restrictions in this section.	
11.3.10.4.1 11.3.10.4.2	The specified compressive strength of masonry, f_m' shall equal or exceed 1,500 psi (10 MPa). The value of f_m' used to determine nominal strength values in this chapter shall not exceed 4,000 psi for concrete masonry and shall not exceed 6,000 psi for clay masonry.	2108.2.3.1 General Design of beams, piers and columns (Strength design) 2108.2.5.1 General wall design for in-plane loads	The value of f_m' shall not be less than 1500 psi. For computational purposes, the value f_m' shall not exceed 4,000 psi.	UBC is more restrictive for clay masonry. Equivalent
11.3.10.5 Modulus of Rupture				
11.3.10.5.1 Out-of-Plane Bending	The modulus of rupture, f_r, for masonry elements subjected to out-of-plane bending shall be taken from Table 11.3.10.5.1.	2107.3.5 Allowable tensile stress (Working stress design of unreinforced masonry)	The allowable tensile stress for walls in flexure without tensile reinforcement using Portland cement and hydrated lime, or using mortar cement Type M or S mortar, shall not exceed the values in Table 21-I. Values in Table 21-I for tension normal to head joints are for running bond; no tension is allowed across head joints in stack bond masonry. These values shall not be used for horizontal flexural members. Table 11.3.10.5-1 values are twice the corresponding Table 21-I values, with one minor exception.	Equivalent assuming a factor of safety of 2.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.3.10.5.2 In-Plane Bending	The modulus of rupture, f_r, normal to bed joints for masonry elements subjected to in-plane forces shall be taken as 250 psi.	2108.2.5.2 Reinforcement (wall design for in-plane loads) Item 2	For fully grouted hollow-unit masonry, $f_r = 4.0(f_m')^{0.5}$, 235 psi maximum For partially grouted hollow-unit masonry, $f_r = 2.50(f_m')^{0.5}$, 125 psi maximum For two-wythe brick masonry, $f_r = 2.0(f_m')^{0.5}$, 125 psi maximum	Equivalency cannot be judged
11.3.10.6 Reinforcement strength	Masonry design shall be based on a reinforcement strength equal to the specified yield strength of reinforcement, f_y, that shall not exceed 60,000 psi (400 MPa).	2108.2.3.7 Reinforcement Item 8 (Strength design)	Essentially identical. UBC has additional restriction.	Considered equivalent
11.3.11 Section Properties	Member strength shall be computed using section properties based on the minimum net bedded and grouted cores cross-sectional area of the member under consideration. Section properties shall be based on specified dimensions.	2106.2.3 Effective thickness 2106.2.5 Effective area	UBC is more detailed; essentially the same in substance.	Considered equivalent
11.3.12 Headed and Bent-Bar Anchor Bolts	All bolts shall be grouted in place with at least 1-inch (25 mm) grout between the bolt and masonry, except that 1/4-inch (6.4 mm) bolts may be placed in bed joints that are at least 1/2 inch (12.7 mm) in thickness.	2108.1.5 Anchor bolts 2106.2.14.1 Para 2	Identical	Equivalent
11.3.12.1	The design axial strength, B_a, for headed anchor bolts embedded in masonry shall be the lesser of two equations: $B_a = 4\phi A_p \sqrt{f_m'}$ $B_a = \phi A_b f_y$ where: ϕ = strength reduction factor, equal to 0.5 for 1st eqn. and equals 0.9 for the 2nd. A_b = effective tensile stress area of the headed anchor bolt, A_p = projected area on the masonry surface of a right circular cone.	2108.1.5.2 Nominal anchor bolt strength 2108.4.5 Anchor	The nominal tensile capacity of anchor bolts shall be determined from the lesser of two equations: $B_m = 1.0 A_p \sqrt{f_m'}$ $B_m = 0.4 A_b f_y$ Anchor bolts: $\phi = 0.8$	UBC is more stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
11.3.12.1.1	The area A_p in Eq. 11.3.12.1-1 shall be the lesser of Eq. 11.3.12.1.1-1 or Eq. 11.3.12.1.1-2: $A_p = \pi l_b^2$ $A_p = \pi l_{be}^2$ l_b = effective embedment length of the headed anchor bolt, in.; and l_{be} = *anchor* bolt edge distance, in.. Where the projected areas A_p of adjacent headed anchor bolts overlap, the projected area A_p of each bolt shall be reduced by one-half of the overlapping area. That portion of the projected area falling in an open cell or core shall be deducted from the value of A_p calculated using Eq. 11.3.12.1.1-1 or Eq. 11.3.12.1.1-2, whichever is less.	2108.1.5.2 Nominal anchor bolt strength	Identical	Equivalent
11.3.12.1.2	The effective embedment length of a headed bolt, l_b, shall be the length of embedment measured perpendicular from the surface of the masonry to the head of the *anchor* bolt.	2106.2.14.1 Para 2	Identical	Equivalent
11.3.12.1.3	The minimum effective embedment length of headed anchor bolts resisting axial forces shall be 4 bolt diameters or 2 in. (51 mm), whichever is greater.	2106.2.14.3 Minimum embedment length	Identical	Equivalent
11.3.12.2	Gives design axial strength for bent-bar anchor bolts (J- or L-bolts) embedded in masonry.		No corresponding provisions	Equivalency cannot be judged
11.3.12.3	Where the anchor bolt edge distance, l_{be}, equals or exceeds 12 bolt diameters, the design shear strength, B_v, shall be the lesser of two equations: $B_v = 1750\phi\sqrt[4]{f'_m A_b}$ $B_v = 0.6\phi A_b f_y$ where: ϕ = strength reduction factor, equal to 0.5	2108.1.5.2 Nominal anchor bolt strength	The nominal share capacity of anchor bolts shall be determined from the lesser of two equations: $B_v = 900\sqrt[4]{f'_m A_b}$ $B_v = 0.25 A_b f_y$	UBC is more stringent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	for 1st eqn. and equals 0.9 for the 2nd. A_b = effective tensile stress area of the headed anchor bolt	2108.4.5 Anchor	Anchor bolts: $\phi = 0.8$	
11.3.12.4		2107.1.5.4 Combined shear and tension	Identical	Equivalent.
11.4 DETAILS OF REINFORCEMENT		2108.2.2 Reinforcement requirements and details		
11.4.1 General 11.4.1.1	Details of reinforcement shall be shown on the contract documents.		No corresponding provisions	Equivalency cannot be judged.
11.4.1.2	Reinforcing bars shall be embedded in grout.	2108.2.2.3 Cover	Essentially the same	Equivalent
11.4.2 Size of Reinforcement				
11.4.2.1	Reinforcing bars used in masonry shall not be larger than a No. 9 bar. The bar diameter shall not exceed one-eighth of the nominal wall thickness and shall not exceed one-quarter of the least clear dimension of the cell, course or collar joint. The area of reinforcing bars shall not exceed 4 percent of the cell area.	2108.2.2.1 Maximum reinforcement (Strength design)	The maximum size of reinforcement shall be No. 9. The diameter of a bar shall not exceed one-fourth the least dimension of a cell. No more than two bars shall be placed in a cell of a wall or a wall frame. The 4 percent requirement is not included.	UBC is less restrictive.
11.4.2.2	Longitudinal and cross wire joint reinforcement shall be a minimum W1.1, (0.011 mm^2) and shall not exceed one-half the joint thickness.		No corresponding provisions	Equivalency cannot be judged
11.4.3 Placement Limits for Reinforcement		2108.2.2.2 Placement		
11.4.3.1	The clear distance between parallel reinforcing bars shall not be less than the nominal diameter of the bars nor less than 1 in.		No corresponding provision	Equivalency cannot be judged

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
11.4.3.2	In columns and pilasters, the clear distance between vertical reinforcing bars shall not be less than one and one-half times the nominal bar diameter, nor less than 1-1/2 in.		In columns and piers, the clear distance between vertical reinforcing bars shall not be less than one and one-half times the nominal bar diameter, nor less than 1 ½ inches.	Equivalent
11.4.3.3	The clear distance limitations between reinforcing bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars		No corresponding provision	Equivalency cannot be judged
11.4.3.4	Reinforcing bars shall not be bundled.		No corresponding provision	UBC is less restrictive
11.4.4 Cover for reinforcement		2108.2.2.3 Cover		
11.4.4.1	Reinforcing bars shall have a minimum thickness of masonry and grout cover not less than 2-1/2d_b nor less than the following: a. Where the masonry face is exposed to earth or weather, 2 in. for bars larger than No. 5 and 1-1/2 in. for No. 5 bar or smaller. b. Where the masonry is not exposed to earth or weather, 1-1/2in.		All reinforcing bars shall be completely embedded in mortar or grout and shall have a cover of not less than 1-1/2 inches nor less than 2.5d_b.	Considered equivalent
11.4.4.2	The minimum grout thickness between reinforcing bars and masonry units shall be ¼ in. for fine grout or ½ in for coarse grout.		No corresponding provision	UBC is less restrictive.
11.4.4.3	Longitudinal wires of joint reinforcement shall be fully embedded in mortar or grout with a minimum cover of ½ in. when exposed to earth or weather		No corresponding provision	UBC is less restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
	and 3/8 in. when not exposed to earth or weather.			
11.4.4.4	Wall ties, anchors, and inserts, except anchor bolts not exposed to the weather or moisture, shall be protected from corrosion.		No corresponding provision	UBC is less restrictive.
11.4.5 Development of Reinforcement		2108.2.2 Reinforcement requirement and details		
11.4.5.1 General	The calculated tension or compression in the reinforcement where masonry reinforcement is anchored in concrete shall be developed in the concrete by embedment length, hook or mechanical device or a combination thereof. Hooks shall only be used to develop bars in tension.		No corresponding provisions	Equivalency cannot be judged.
11.4.5.2 Embedment of Reinforcing Bars and Wires in Tension	The embedment length, l_d, of reinforcing bars shall be determined as follows but shall not be less than 12 in. for bars and 6 in. for wire: $l_d = \left(\frac{1}{\phi}\right)\left(\frac{0.15 d_b^2 f_y}{K\sqrt{f'_m}}\right) \le \frac{52 d_b}{\phi}$	2108.2.2.6 Development	The embedment length of reinforcement shall be determined as follows: $l_d = \left(\frac{1}{\phi}\right)\left(\frac{0.15 d_b^2 f_y}{K\sqrt{f'_m}}\right) \le \frac{52 d_b}{\phi}$ The minimum embedment length of reinforcement shall be 12 inches. Minimum 6 in. for wire is not in the UBC.	Considered equivalent
11.4.5.3 Standard Hooks		2108.2.2.4 Standard hooks		
11.4.5.3.1	The term standard hook as used in this code shall mean one of the following:			
11.4.5.3.1.1	A 180-degree turn plus extension of at least 4 bar diameters but not less than 2-1/2 in. (64 mm) at free end of bar.	Item 1	Identical	Equivalent
11.4.5.3.1.2	A 135-degree turn plus extension of at least 6 bar diameters at free end of bar.	Item 2	Identical	Equivalent
11.4.5.3.1.3	A 90-degree turn plus extension of at least 12 bar diameters at free end of bar.	Item 3	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.4.5.3.1.4	For stirrup and tie anchorage only, either a 135-degree or a 180-degree turn plus an extension of at least 6 bar diameters at the free end of the bar.		No corresponding provision	Equivalency cannot be judged.
11.4.5.3.2	The equivalent embedment length of standard hooks in tension, l_{dh}, shall be as follows: $l_{dh} = 13d_b$		No corresponding provision	Equivalency cannot be judged.
11.4.5.3.3	The effect of hooks for bars in compression shall be neglected in design computations.		No corresponding provision	Does not affect equivalency
11.4.5.4 Minimum Bend Diameter for Reinforcing Bars 11.4.5.4.1	- Minimum diameters of bend 1) No. 3 through No. 7 (Grade=40) = 5 d_b 1) No. 3 through No. 8 (Grade=50 or 60) = 6 d_b 1) No. 9 (Grade=50 or 60) = 8 d_b	2108.2.2.5 Minimum bend diameter for reinforcing bars Table 21-G	- Minimum diameters of bend 1) No. 3 through No. 8 = 6 d_b 1) No. 9 through No. 11 = 8 d_b	Equivalent
11.4.5.5 Development of Shear Reinforcement 11.4.5.5.1 11.4.5.5.2 11.4.5.5.3	Shear reinforcement shall extend the depth of the member less cover distances.		No corresponding provision	Equivalency cannot be judged.
11.4.5.6 Splices of Reinforcement		2108.2.2.7 Splices		
11.4.5.6.1 Lap Splices	Lap splices shall not be used in plastic hinge zones. The length of the plastic hinge zone shall be taken as at least 0.15 times the distance between the point of zero moment and the point of maximum moment.		No corresponding provision	UBC is less restrictive.
11.4.5.6.1.1	The minimum length of lap, l_{ld}, for bars in tension or compression shall be equal to the development length, l_d, as determined by Eq. 11.4.5.2 but shall not be less than 12 in. (305 mm) for bars and 6 in. (152 mm) for wire.	2108.2.2.7 Splices Item 1	Essentially the same. The minimum 6 in. for wire is not in the UBC.	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.4.5.6.1.2	Bars spliced by noncontact lap splices shall be spaced transversely a distance not greater than one-fifth the required length of lap or more than 8 inches.	2108.2.2.7 Splices Item 1	Identical	Equivalent
11.4.5.6.2 Welded Splices	A welded splice shall be capable of developing in tension 125 percent of the specified yield strength, f_y, of the bar.	2108.2.2.7 Splices Item 2	Identical	Equivalent
11.4.5.6.3 Mechanical Connections	Mechanical splices shall have the bars connected to develop in tension or compression, as required, at least 125 percent of the specified yield strength of the bar.	2108.2.2.7 Splices Item 3	Identical	Equivalent
11.4.5.6.4 End Bearing Splices 11.4.5.6.1 11.4.5.6.2 11.4.5.6.3	In bars required for compression only, the transmission of compressive stress by bearing of square cut ends held in concentric contact by a suitable device is permitted. Bar ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bars and shall be fitted within 3 degrees of full bearing after assembly. End bearing splices shall be used only in members containing closed ties, closed stirrups or spirals.		No corresponding provisions	Equivalency cannot be judged.
11.5 STRENGTH AND DEFORMATION REQUIREMENTS		2108 STRENGTH DESIGN OF MASONRY 2108.1 General		
11.5.1 General	Masonry *structures* and masonry members shall be designed to have strength at all sections at least equal to the *required strength* calculated for the factored loads in such combinations as are stipulated in these provisions.	2108.1 General 2108.1.1 General provisions	NEHRP requirement is not stated explicitly.	Does not affect equivalency
11.5.2 Required strength	The *required strength* shall be determined in accordance with Chapters 2 and 3.	2108.1.3 Required strength	Essentially identical	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.5.3 Design Strength	*Design strength* provided by a member and its connections to other members and its cross sections in terms of flexure, axial load, and shear shall be taken as the *nominal strength* multiplied by a strength reduction factor, ϕ, as specified in Table 11.5.3.	2108.1.4 Design strength	Design strength is defined the same way. Not all ϕ–factors are the same.	Equivalency cannot be judged
11.5.4 Deformation Requirements		2108.2.4.6 Deflection design	Different provisions and equations.	Equivalency cannot be judged
11.6 FLEXURE AND AXIAL LOADS				
11.6.1 Scope	This section shall apply to the design of masonry members subject to flexure or axial loads or to combined flexure and axial loads.		No corresponding provision	Does not affect equivalency
11.6.2 Design Requirements for Reinforced Masonry Members		2108.2 Reinforced Masonry 2108.2.1.1 Scope		
11.6.2.1	Strength design of members for flexure and axial loads shall be in accordance with principles of engineering mechanics, and in accordance with the following design assumptions: a. Strain in reinforcement and masonry shall be assumed directly proportional to the distance from the neutral axis, except for deep flexural members with overall depth to clear span ratio greater than 2/5 for continuous span members and 4/5 for simple span members where a nonlinear distribution of strain shall be considered. b. Maximum usable strain, ε_{mu}, at the extreme masonry compression fiber shall be assumed equal to 0.0025 for concrete masonry and 0.0035 for clay-unit masonry. c. Stress in reinforcement below the *specified* yield strength, f_y, shall be taken as the modulus of	2108.2.1.2 Design assumptions	Essentially the same except for the following differences: 1. The parameters of rectangular stress block (in Item e of NEHRP) have been modified: (1) masonry stress changed from 0.8 f_m' to 0.85 f_m'. (2) the parameter "a" has been changed from 0.80 c to 0.85 c. 2. "except for deep flexural members…" in NEHRP item a is not included. 3. Includes an additional explicitly stated assumption. Reinforcement is completely surrounded by and bonded to masonry material so that they work together as a homogeneous material.	The modification of the stress block makes the UBC slightly less restrictive

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	elasticity, E_s, times the steel strain. For strains greater than those corresponding to the *specified* yield strength, f_y, the stress in the reinforcement shall be considered independent of strain and equal to the *specified* yield strength, f_y. d. Tensile strength of masonry shall be neglected in calculating the flexural strength of a *reinforced masonry* cross section. e. Flexural compression in masonry shall be assumed to be an equivalent rectangular stress block. Masonry stress of 0.80 times the *specified* compressive strength, f_m' shall be assumed to be uniformly distributed over an equivalent compression zone bounded by edges of the cross section and a straight line located parallel to the neutral axis at a distance a = 0.80 c from the fiber of maximum compressive strain.			
11.6.2.2	Specifies maximum reinforcement ratios for walls subjected to in-plane as well as out-of-plane forces.		No corresponding provision	Equivalency cannot be judged
11.6.2.3	Members subject to compressive axial load shall be designed for the maximum moment that can accompany the axial load. The required moment, M_U, shall include the moment induced by relative lateral displacements.		No corresponding provision	Equivalency cannot be judged
11.6.3 Design of Plain (Unreinforced) Masonry Members 11.6.3.1 11.6.3.2	 Strength design of members for flexure and axial load shall be in accordance with principles of engineering mechanics. Strain in masonry shall be assumed directly proportional to the distance from the neutral axis.	2107.3 Design of unreinforced masonry (working stress method)	Eq. (7-39) of the UBC is a scaled-down version of Eq. (11.6.3.5-1) of NEHRP, because NEHRP uses strength design, while the UBC uses working stress design.	Equivalency cannot be judged

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.6.3.3 11.6.3.4 11.6.3.5	Flexural tension in masonry shall be assumed directly proportional to strain. Flexural compressive stress in combination with axial compressive stress in masonry shall be assumed directly proportional to strain. Maximum compressive stress shall not exceed $0.85f_m'$. Design axial load strength shall be in accordance with Eq. 11.6.3.5-1 or Eq. 11.6.3.5-2			
11.7 SHEAR				
11.7.1 Scope	Provisions of this section shall apply for design of members subject to shear.		No corresponding provision	Does not affect equivalency
11.7.2 Shear strength 11.7.2.1	Design of cross sections subjected to shear shall be based on: $V_u \leq \phi V_n$		No explicit corresponding provision	Does not affect equivalency
11.7.2.2	The design shear strength, ϕV_n, shall exceed the shear corresponding to the development of 1.25 times the nominal flexural strength of the member, except that the nominal shear strength need not exceed 2.5 times V_u.		No corresponding provision	UBC is less stringent.
11.7.3 Design of Reinforced masonry Members	Nominal shear strength, V_n, shall be computed as follows: $V_n = V_m + V_s$ $V_m = \left[4.0 - 1.75\left(\frac{M}{V_d}\right)\right] A_n \sqrt{f_m'} + 0.25P$ $V_s = 0.5\left(\frac{A_s}{V}\right) f_y d_v$ For $M/Vd_v < 0.25$: $V_{n(max)} = 6\sqrt{f_m'} A_n$ For $M/Vd_v < 1.00$: $V_{n(max)} = 4\sqrt{f_m'} A_n$	2108.2.3.6.2 Nominal shear strength (Beams, piers and columns)	Somewhat different provisions, as shown below: Nominal shear strength, V_n, shall be computed as follows: $V_n = V_m + V_s$ $V_m = C_d A_e \sqrt{f_m'}, \Rightarrow 63 C_d A_e, maximum$ $V_s = A_e \rho_n f_y$ 1. The nominal shear strength shall not exceed the value given in Table 21-J 2. The value of V_m shall be assumed to be zero within any region subjected to net tension factored loads. 3. The value of V_m shall be assumed to be 25 psi where M_u is greater than $0.7M_n$. The required moment, M_u, for seismic design for comparisons	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
			with the $0.7M_n$ value of this section shall be based on an R of 2.	
		2108.2.5.5 Shear strength (Wall design for in-plane loads)	Shear strength shall be as follows: 1. The nominal shear strength shall be determined using either Item 2 or 3 below. Maximum nominal shear strength values are determined from Table 21-J. 2. The nominal shear strength of the shear wall shall be determined from Formula given below, except as provided in Item 3: $V_n = V_m + V_s$ $V_m = C_d A_{mv} \sqrt{f'_m}$ $V_s = A_{mv} \rho_n f_y$ 3. For a shear wall whose nominal shear strength exceeds the shear corresponding to development of its nominal flexural strength, two shear regions exist. …………..	
11.7.4 Design of Plain (Unreinforced) Masonry Members 11.7.4.1	Nominal shear strength, V_n, is given.		No corresponding provision	Equivalency cannot be judged.
11.8 SPECIAL REQUIREMENTS FOR BEAMS				
11.8.1	The spacing between lateral supports shall be determined by the requirements for out of-plane loading, but it shall not exceed 32 times the least width of beam.	2108.2.3.9 Dimensional limits Item 1.2	Only the minimum value is given.	Equivalency cannot be judged.
11.8.2	The effects of lateral eccentricity of load shall be taken into account in determining spacing of lateral supports.		No corresponding provision	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
11.8.3	The minimum positive reinforcement ratio ρ in a beam shall not be less than $120/f_y$ except that this minimum positive steel reinforcement ratio need not be satisfied if the area of reinforcement provided one third greater than that required by analysis for *gravity loads* and the *Seismic Design Category* is A, B, or C.	2108.2.3.10.2 Longitudinal reinforcement Item 2	The nominal flexural strength of a beam shall not be less than 1.3 times the nominal cracking moment strength of the beam. The modulus of rupture, f_r, for this calculation shall be assumed to be 235 psi.	Equivalency cannot be judged.
11.8.4 Deep Flexural Members			No corresponding provisions	Equivalency cannot be judged.
11.9 SPECIAL REQUIREMENTS FOR COLUMNS		2108.2.3.12 Columns		
11.9.1 11.9.2	Area of longitudinal reinforcement for *columns* shall be not less than 0.005 nor more than 0.04 times cross-sectional area of the *column*. There shall be a minimum of four longitudinal bars in *columns*.	2108.2.3.12.2 Longitudinal reinforcement	Essentially the same except that the maximum reinforcement area is $0.03A_e$. in the UBC.	UBC is more stringent.
11.9.3	Lateral ties shall be provided to resist shear and shall comply with the following a. Lateral ties shall be at least 1/4 in. in diameter. b. Vertical spacing of lateral ties shall not exceed 16 longitudinal bar diameters, 48 lateral tie diameters, nor the least cross sectional dimension of the column. c. Lateral ties shall be arranged such that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a lateral tie with an included angle of not more than 135 degrees and no bar shall be farther than 6 in.... d. Lateral ties shall be located vertically not more than one-half lateral tie spacing above the top of footing or slab in any story... e. Where beams or brackets frame into a column from four directions, lateral ties may be terminated	2108.2.3.12.3 Lateral ties 2106.3.6 Lateral ties	1. Lateral ties shall be provided in accordance with Section 2106.3.6. 2. Minimum lateral reinforcement area shall be $0.0018A_e$. The second requirement is not in NEHRP. Similar to NEHRP requirements. Minimum size specified for lateral reinforcement. Distance from top of footing or from bottom of shallowest framing beam not specified.	Considered equivalent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	not more than 3 in. below lowest reinforcement in the shallowest of such beams or brackets.			
11.10 SPECIAL REQUIREMENTS FOR WALLS	The nominal flexural strength of the *wall* for out-of-plane flexure shall be at least equal to 1.3 times the cracking moment strength of the *wall*.	2108.2.4 Wall design for out-of-plane loads	Different provisions. No minimum reinforcement specified.	Not equivalent
11.11 SPECIAL REQUIREMENTS FOR SHEAR WALLS		SECTION 2106 – GENERAL DESIGN REQUIREMENTS		
11.11.1 Ordinary Plain masonry Shear Walls	The design of *ordinary plain masonry shear walls* shall be in accordance with Sec. 11.3.2 (Empirical design) or Sec. 11.3.3 (Unreinforced masonry design). No reinforcement is required to resist seismic forces.		No corresponding provision	Equivalency cannot be judged.
11.11.2 Detailed Plain Masonry Shear Walls	The design of *detailed plain masonry shear walls* shall be in accordance with Sec. 11.3.3 (Unreinforced masonry design). *Detailed plain masonry shear walls* shall have minimum amounts of reinforcement as prescribed in Sections 11.3.7.3 and 11.3.7.4.		No corresponding provision	Equivalency cannot be judged.
11.11.3 Ordinary Reinforced Masonry Shear Walls	The design of *ordinary reinforced masonry shear walls* shall be in accordance with Sec. 11.3.4 (Reinforced masonry design). No prescriptive seismic reinforcement is required for *ordinary reinforced masonry shear walls*		No corresponding provision	Equivalency cannot be judged.
11.11.4 Intermediate Reinforced Masonry Shear Walls	The design of *intermediate reinforced masonry shear walls* shall be in accordance with Sec. 11.3.4 (Reinforced masonry design). *Intermediate reinforced masonry shear walls* shall have minimum amounts of reinforcement as prescribed in Sec. 11.3.7.3 and 11.3.7.4.		No corresponding provision	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
11.11.5 Special Reinforced Masonry Shear Walls	*Special reinforced masonry shear walls* shall meet the requirements for *intermediate reinforced masonry shear walls* (Sec. 11.11.4) in addition to the requirements of this section. The design of *special reinforced masonry shear walls* shall be in accordance with Sec. 11.3.4 (Reinforced masonry design). *Special reinforced masonry shear walls* shall comply with material requirements of Sec. 11.3.8, minimum reinforcement requirements of Sec. 11.3.8.3 and 11.3.8.4, and minimum thickness requirements of Sec. 11.3.8.5. In addition, *special reinforced masonry shear walls* shall be reinforced and constructed as required in this section.		No corresponding provision	Equivalency cannot be judged.
11.11.5.1 Vertical Reinforcement	The maximum spacing of vertical reinforcement in a *special reinforced masonry shear wall* shall be the smaller of: a. One-third the length of the wall b. One-third the height of the wall c. 48 in.	2106.1.12.4. Special provisions for Seismic Zones 3 and 4 2. Shear walls	The spacing of reinforcement in each direction shall not exceed one half the length of the element, nor one half the height of the element, nor 48 inches.	UBC is less stringent.
11.11.5.2 Horizontal Reinforcement	The maximum spacing of horizontal reinforcement in *a special reinforced masonry shear wall* shall be the smaller of: a. One-third the length of the wall b. One-third the height of the wall c. 48 in. d. 24 in. for stack bond masonry	2106.1.12.4. Special provisions for Seismic Zones 3 and 4 2. Shear walls	The spacing of reinforcement in each direction shall not exceed one half the length of the element, nor one half the height of the element, nor 48 inches.	UBC is less restrictive.
11.11.5.3 Shear Keys	Specific provisions are given for cases when a special reinforced masonry shear wall is constructed upon a concrete surface.		No corresponding provision	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.11.6 Flanged Shear Walls 11.11.6.1 11.11.6.2 11.11.6.3	 *Wall* intersections shall be considered effective in transferring shear when either conditions (a) or (b) and condition (c) as noted below are met: a. The face shells of hollow masonry units are removed and the intersection is fully grouted. b. Solid units are laid in running bond and 50 percent of the masonry units at the intersection are interlocked. c. Reinforcement from one intersecting *wall* continues past the intersection a distance not less than 40 bar diameters or 24 inches. The width of flange considered effective in compression on each side of the web shall be taken equal to 6 times the thickness of the web or shall be equal to the actual flange on either side of the web *wall*, whichever is less. The width of flange considered effective in tension on each side of the web shall be taken equal to 3/4 of the *wall* height or shall be equal to the actual flange on either side of the web *wall*, whichever is less.		No corresponding provisions	Equivalency cannot be judged.
11.11.7 Coupled Shear Walls 11.11.7.1 Design of Coupled Shear Walls 11.11.7.2 Shear Strength of Coupling Beams			No corresponding provisions	Equivalency cannot be judged.
11.12 SPECIAL MOMENT FRAMES OF MASONRY		2108.2.6 Design of moment-resisting wall frames		

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
11.12.1 Calculation of Required Strength	The calculation of required strength of the members shall be in accordance with principles of engineering mechanics and shall consider the effects of the relative stiffness degradation of the beams and columns.	2108.2.6.1.3 Analysis	Similar	Considered equivalent
11.12.2 Flexural Yielding	Flexural yielding shall be limited to the beams at the face of the *columns* and to the bottom of the columns at the base of the *structure.*		No similar requirement is explicitly stated.	Does not affect equivalency
11.12.3 Reinforcement		2108.2.6.2.4 Reinforcement		
11.12.3.1	The nominal moment strength at any section along a member shall not be less than 1/2 of the higher moment strength provided at the two ends of the member.	2108.2.6.2.4 Reinforcement Para 1	The nominal moment strength at any section along a member shall not be less than one fourth of the higher moment strength provided at the two ends of the member.	UBC is less stringent.
11.12.3.2	Lap spices are permitted only within the center half of the member length.	2108.2.6.2.4 Reinforcement Para 2	Identical	Equivalent
11.12.3.3	The distance between splices on alternate bars is at least 24 in. along the longitudinal axis	2108.2.6.2.4 Reinforcement Para 3	Identical	Equivalent
11.12.3.4	Reinforcement shall have a specified yield strength of 60,000 psi. The actual yield strength shall not exceed 1.5 times the specified yield strength.	2108.2.6.2.4 Reinforcement Para 4	Reinforcement shall have a specified yield strength of 60,000 psi. The actual yield strength based on mill tests shall not exceed the specified yield strength times 1.3.	UBC is more stringent.
11.12.4 Wall Frame Beams		2108.2.6.2.5 Flexural members (beams)		
11.12.4.1	Factored axial compression force on the beam shall not exceed 0.10 times the net cross-sectional are of the beam, A_n, times the specified compressive strength, f'_m.	2108.2.6.2.5 Flexural members (beams) Para 2	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.12.4.2	Beams shall be limited to a reinforcement ratio of $0.15f'_m / f_y$ or that determined in accordance with Sec. 11.6.2.2	2108.2.6.2.5 Flexural members (beams) 1. Longitudinal reinforcement Para 4	Identical	Equivalent.
11.12.4.3	Clear span for the beam shall not be less than 4 times its depth.	2108.2.6.1.2 Beams: Para 1	Clear span for the beam shall not be less than 2 times its depth.	UBC is less stringent.
11.12.4.4	Nominal depth of the beam shall not be less than 4 units or 32 in. (813 mm), whichever is greater. The nominal depth to nominal width ratio shall not exceed 4.	2108.2.6.1.2 Beams: Para 2	Nominal depth of the beam shall not be less than 2 units or 16 in. (406 mm), whichever is greater. The nominal depth to nominal width ratio shall not exceed 6.	UBC is less stringent.
11.12.4.5	Nominal width of the beams shall equal or exceed all of the following criteria: a. 8 in. (203 mm), b. width required by Sec. 11.8.1, and c. 1/26 of the clear span between *column* faces.	2108.2.6.1.2 Beams Para 3	Essentially the same	Equivalent
11.12.4.6 Longitudinal reinforcement 11.12.4.6.1 11.12.4.6.2 11.12.4.6.3 11.12.4.6.4	Longitudinal reinforcement shall not be spaced more than 8 in. (203 mm) on center. Longitudinal reinforcement shall be uniformly distributed along the depth of the beam. In lieu of the limitations of Sec. 11.8.2, the minimum reinforcement ratio shall be $130/f_y$ (the metric equivalent is $0.90/f_y$ where f_y is in MPa). At any section of a beam, each masonry unit through the beam depth shall contain longitudinal reinforcement.	2108.2.6.2.5 Item 1 Longitudinal reinforcement	Different provisions	Not equivalent
11.12.4.7 Transverse Reinforcement 11.12.4.7.1 11.12.4.7.2	Transverse reinforcement shall be hooked around top and bottom longitudinal bars and shall be terminated with a standard 180-degree hook. Within an end region extending one beam depth	2108.2.6.2.5 Item 2 Transverse reinforcement	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	from *wall* frame column faces and at any region at which beam plastic hinges may form during seismic or wind loading, maximum spacing of transverse reinforcement shall not exceed one-fourth the nominal depth of the beam.			
11.12.4.7.3	The maximum spacing of transverse reinforcement shall not exceed 1/2 the nominal depth of the beam or that required for shear strength.			
11.12.4.7.4	Minimum transverse reinforcement ratio shall be 0.0015.			
11.12.4.7.5	The first transverse bar shall not be more than 4 inches (102 mm) from the face of the pier.			
11.12.5 Wall Frame Columns		2108.2.6.2.6 Members subjected to axial force and flexure		
11.12.5.1	Factored axial compression force on the wall frame column shall not exceed 0.15 $A_n f'_m$. The compressive stress shall also be limited by the maximum reinforcement ratio.	2108.2.6.2.7 Para 2	Essentially the same	Equivalent
11.12.5.2	Nominal dimension of the column parallel to the plane of the wall frame shall not be less than two full units or 32 in., whichever is greater.	2108.2.6.1.2 Piers Para 1	Essentially the same. The UBC also specifies a maximum dimension of 96 in.	Equivalent
11.12.5.3	Nominal dimension of the column perpendicular to the plane of the wall frame shall not be less than 8 in. nor 1/14 of the clear height between beam faces.	2108.2.6.1.2 Piers Para 2	Identical	Equivalent
11.12.5.4	The clear height-to-depth ratio of column members shall not exceed 5.	2108.2.6.1.2 Piers Para 3	Identical	Equivalent
11.12.5.5 Longitudinal Reinforcement		2108.2.6.2.6 Item 1 Longitudinal reinforcement		

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
11.12.5.5.1	A minimum of 4 longitudinal bars shall be provided at all sections of every *wall* frame column member.	2108.2.6.2.6 Item 1 Para 1	Identical. The UBC also requires that variation in reinforcement area between reinforced cells shall not exceed 50%.	UBC is more stringent.
11.12.5.5.2	The flexural reinforcement shall be uniformly distributed across the member depth.	2108.2.6.2.6 Item 1 Para 2	Identical	Equivalent
11.12.5.5.3	The nominal moment strength at any section along a member shall be not less than 1.6 times the cracking moment strength and the minimum reinforcement ratio shall be $130/f_y$.	2108.2.6.2.6 Item 1 Para 3	Minimum reinforcement ratio calculated over the gross cross section shall be 0.002.	Not equivalent
11.12.5.5.4	Vertical reinforcement in wall-frame columns shall be limited to a maximum reinforcement ratio equal to the lesser of $0.15f_m/f_y$ or Sec. 11.6.2.2.	2108.2.6.2.6 Item 1 Para 4	The Sec. 11.6.2.2 requirement does not exist in the UBC. Otherwise the same.	UBC is less stringent.
11.12.5.6 Transverse Reinforcement		2108.2.6.2.6 Item 2 Transverse reinforcement		
11.12.5.6.1	Transverse reinforcement shall be hooked around the extreme longitudinal bars and shall be terminated with a standard 180-degree hook.	2108.2.6.2.6 Item 2 Para 1	Identical	Equivalent
11.12.5.6.2	The spacing of transverse reinforcement shall not exceed 1/4 the nominal dimension of the column parallel to the plane of the *wall* frame.	2108.2.6.2.6 Item 2 Para 2	Identical	Equivalent
11.12.5.6.3	Minimum transverse reinforcement ratio shall be 0.0015.	2108.2.6.2.6 Item 2 Para 4	Identical	Equivalent
11.12.6 Wall Frame Beam-Column Intersection		2108.2.6.2.9 Joints		
11.12.6.1	Beam depth in the plane of the frame shall satisfy the following: $h_b > \frac{1800d_{bp}}{\sqrt{f'_g}}$ and column depth shall be	2108.2.6.2.9 Item 1 General requirements	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	$h_p > \frac{4800 d_{bp}}{\sqrt{f'_g}}$ d_{bp} = diameter of the largest beam longitudinal reinforcing bar passing through, or anchored in, the wall frame beam-column intersection			
11.12.6.2	Beam longitudinal reinforcement terminating in a wall frame column shall be extended to the far face of the column and shall be anchored by a standard hook bent back into the wall frame column. Special horizontal shear reinforcement crossing a potential diagonal beam column shear crack shall be provided such that: $A_s \geq \frac{0.5 V_n}{f_y}$	2108.2.6.2.9 Item 1 and Item 2 Transverse reinforcement	Identical	Equivalent
11.13 GLASS-UNIT MASONRY AND MASONRY VENEER		2110 GLASS MASONRY 1403 VENEER		
11.13.1 Design Lateral Forces and Displacements	Glass-unit masonry and masonry veneer shall be designed and detailed to resist the design lateral forces as described in Sec. 6.1 and 6.2.		No similar requirement is explicitly stated.	Does not affect equivalency
11.13.2 Glass-Unit Masonry Design	Refers to Chapter 11 of ACI 530-95.	2110 GLASS MASONRY	Essentially similar provisions	Considered equivalent
11.13.3 Masonry Veneer Design	Refers to Chapter 12 of ACI 530-95.	1403 VENEER	NEHRP provisions are more comprehensive and detailed.	Equivalency cannot be judged
Appendix to Chapter 11 ALTERNATIVE PROVISIONS FOR THE DESIGN OF MASONRY STRUCTURES			No corresponding provision	Equivalency cannot be judged

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
Chapter 12 WOOD STRUCTURE DESIGN REQUIREMENTS		**CHAPTER 23 - WOOD**		
12.1 General 12.1.1 Scope	The design and construction of wood structures to resist seismic forces and the material used therein shall comply with the requirements of this chapter.	SECTION 2301 – GENERAL 2301.1 Scope	Essentially similar	Considered equivalent
12.1.2 Reference Documents 12.1.2.1 Engineered Wood Construction 12.1.2.2 Conventional Light-Frame Construction 12.1.2.3 Materials Standards	These sections list referenced documents. The documents listed in these sections are not subject to the same rules as applied by the UBC such as mandatory code language and a consensus approval process.	2303 Standards of quality Division III – Design specifications for ASD of wood buildings	UBC standards and recognized standards are listed in Section 2303.	Equivalency cannot be judged.
12.1.3 Notations			Notations are explained as they occur in the text. With the exception of the shear wall dimension notations, the notations in NEHRP deal with those unique to LRFD for wood. The basis for engineered wood design in the UBC is ASD, and therefore these notations are not found in the UBC.	Does not affect equivalency
12.2 DESIGN METHODS		2301.2 Design Methods		
12.2.1 Engineered Wood Design	Engineered design of wood structures shall use load and resistance factor design and shall be in accordance with the references in Sec. 12.1.2.1.	2301.2.1 Allowable stress design	Design using allowable stress design methods … Instead of LRFD method of NEHRP.	Equivalency cannot be judged.
12.2.2 Conventional Light-Frame Construction	Where permitted by Sec. 12.7 and 12.8, wood structures are permitted to be constructed in accordance with the provisions of Sec. 12.5.	2301.2.2 Conventional light-frame construction	Essentially similar	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
12.2.2.1	Provides for cases where a structure of otherwise conventional construction contains structural elements not conforming to conventional construction.	2320.2 Design of Portions		Considered equivalent
12.3 ENGINEERED WOOD CONSTRUCTION				
12.3.1 General			No corresponding provisions	Does not affect equivalency
12.3.2 Framing Requirements	All wood columns and posts shall be framed to provide full end bearing. Alternatively, column and post end connections shall be designed to resist the full compressive loads, neglecting all end bearing capacity…	2314 Post-beam Connections	Essentially similar provisions	Considered equivalent
12.3.3 Deformation Compatibility Requirements	Deformation compatibility of connections within and between structural elements shall be considered in design such that the deformation of each element and connection comprising the seismic-force-resisting system is compatible with the deformations of the other seismic-force-resisting elements and connections and with the overall system. See Sec. 5.2.8 for story drift limitations.	2315.1 General Para 1 and 2	Essentially similar provisions	Considered equivalent
12.3.4 Design Limitations				
12.3.4.1 Wood Members Resisting Horizontal Seismic Forces Contributed by Masonry and Concrete	a. b. c. Combined deflections of diaphragms and shear walls shall not permit per story drift of supported masonry or concrete walls to exceed the limits of Table 5.2.8. d. e.	2315.2 Wood Members Resisting Horizontal Forces Contributed by Masonry and Concrete	Identical except for the following change in drift limit: Deflections of horizontal and vertical diaphragms shall not permit per-story deflections of supported masonry or concrete walls to exceed 0.005 times each story height.	UBC is equivalent to more restrictive

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
12.3.4.2 Horizontal Distribution of Shear	This section 1) defines a flexible diaphragm and a rigid diaphragm, and 2) allows open front structures with rigid wood diaphragms (including those cantilevering past the outermost supporting shear wall) relying on torsional force distribution, provided certain limitations are met.	1630.6 Horizontal distribution of shear 3rd para 2315.1 General 9th para	Both the NEHRP Provisions and UBC define flexible vs. rigid diaphragm the same. The major difference between NEHRP and UBC is that in order to distribute lateral forces by torsion, NEHRP requires that the diaphragm must be rigid. The UBC does not specifically address rigid wood diaphragms which cantilever past the outermost supporting shear wall. NEHRP is more restrictive relative to the length, l, normal to the open end.	UBC is equivalent to less restrictive
12.3.4.3 Framing and Anchorage Limitations	This provision specifies detailing requirements for boundary elements.	2315.5.2 Framing	Partially the same (Latter half of the NEHRP Provisions.)	UBC is equivalent to less restrictive
12.3.4.4 Shear Wall Anchorage	This provision gives 1) specifications for hold-downs, 2) requirements for shear wall plate washer size depending on bolt size and 3) placement requirements for shear wall bolts.	1806.6.1 Additional requirements in Seismic Zones 3 and 4.	This section requires smaller plate washers than the NEHRP Provisions, and they are only required in Seismic Zones 3 and 4.	Not equivalent
12.4 DIAPHRAGMS AND SHEAR WALLS		2315 Wood Shear Walls and Diaphragms		
12.4.1 Diaphragm and Shear Wall Aspect Ratios	This provision gives the permissible aspect ratios depending upon the type of sheathing material. It also addresses shear walls where the openings have been designed for force transfer around the openings.	Section 2315.1 General Paras 4-8 Table 23-II-G Maximum diaphragm dimension ratio Figure 23-II-1	Same except the detailing and design of boundary members around the openings that have been designed for force transfer. The NEHRP Provisions reference the LRFD document (ASCE 16-95).	Considered equivalent
12.4.2 Shear Resistance Based on Principles of Mechanics	Shear resistance of *diaphragms* and *shear walls* shall be permitted to be calculated by principles of mechanics using values of fastener strength and sheathing shear resistance, provided fastener resistance in the sheathing material is based on approved values developed from cyclic loading tests.	2315.3.3 Wood structural panel diaphragms	Similar provisions are included in the UBC.	Considered equivalent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
12.4.3 Sheathing Requirements	The provisions set forth requirements for the construction of shear walls and diaphragms. Shear wall blocking at all edges is required for all SDCs. The panel sheathing size requirements apply to all SDCs as well.	2315.5.3 Wood structural panels 2315.3.3 Wood structural panel diaphragms 2315.1 General - last para	Similar requirements; however, the panel sheathing size requirements apply only in Seismic Zones 3 and 4, thus making the UBC less restrictive in this regard.	UBC equivalent to less restrictive.
12.4.3.1 Structural-Use Panel Sheathing	This provision contains appropriate tables for LRFD shear values and gives permissible aspect ratios as well as glue specifications for the panels.	2315.5.3 Wood structural panels 2315.3.3 Wood structural panel diaphragms Table 23-II-G	There are major differences between the NEHRP and the UBC in these provisions. The shear values given in the NEHRP Provisions are based on LRFD and the values given in the UBC are based on ASD. There is a footnote in the UBC shear wall table regarding 3x foundation plates for certain Seismic Zone 3 and 4 structures, which is not in the NEHRP Provisions, thus making the UBC more restrictive in this regard. The UBC allows a 4:1 aspect ratio for both blocked and unblocked wood structural panel diaphragms, whereas the NEHRP limits the aspect ratio to 3:1 for such unblocked diaphragms, thus making NEHRP Provisions more restrictive in this regard. Under certain conditions depending upon seismic zone, the UBC allows a higher aspect ratio for shear walls than the NEHRP Provisions.	Equivalency cannot be judged.
12.4.3.2 Other Panel Sheathing Materials	Panel materials other than *structural-use panel* sheathing have no recognized capacity for seismic-force resistance and are not permitted as part of the seismic-force-resisting system except in conventional light-frame construction, Sec. 12.5.	2315.4 Particleboard Diaphragms 2315.5.5 Particleboard 2315.6 Fiberboard Sheathing Diaphragms	The UBC allows the use of particleboard and fiberboard for shear walls, thus making the UBC less restrictive in this regard.	UBC is less restrictive. Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
12.4.3.3 Single Diagonally Sheathed Lumber Diaphragms and Shear Walls	This provision prescribes nailing and allowable aspect ratios for subject shear walls and diaphragms.	2315.3.1 Conventional lumber diaphragm construction 2315.5.4 Heavy wood panels Table 23-II-G	Essentially similar, except the maximum aspect ratio for the subject shear walls is limited to 1:1 in Seismic Zone 4 (NEHRP allows 2;1 for this situation).	Considered equivalent.
12.4.3.4 Double Diagonally Sheathed Lumber Diaphragms and Shear Walls	This provision prescribes nailing and allowable aspect ratios for subject shear walls and diaphragms.	2315.3.2 Special lumber diaphragm construction Table 23-II-G	Essentially similar, except the allowable diaphragm aspect ratio is less restrictive in the UBC.	UBC is equivalent to less restrictive.
12.5 CONVENTIONAL LIGHT-FRAME CONSTRUCTION		SECTION 2320 – CONVENTIONAL LIGHT-FRAME CONSTRUCTION DESIGN PROVISIONS		
12.5.1 Scope	Conventional light-frame construction is a system constructed entirely of repetitive horizontal and vertical wood light-framing members selected from tables in Ref. 12-6 and conforming to the framing and bracing requirements of Ref. 12-5, except as modified by the provisions in this section. Structures with concrete or masonry walls above the basement story shall not be considered to be conventional light-frame construction…	2320.1 General 2302 – Definitions (Conventional Light-Frame Construction) 2320.4 Additional Requirements for Conventional Construction in Seismic Zones 0, 1, 2 and 3 2320.5 Additional Requirements for Conventional Construction in Seismic Zone 4	Only the following occupancies may be constructed in accordance with these UBC sections: 1. One-, two- or three-story buildings housing Group R Occupancies. 2. One-story Occupancy Category 4 buildings, as defined in Table 16-K, when constructed on a slab-on-grade floor. 3. Group U Occupancies. 4. Top-story walls and roofs of Occupancy Category 4 buildings not exceeding two stories of wood framing. 5.Interior nonload-bearing partitions, ceilings and curtain walls in all occupancies. The NEHRP Provisions are more restrictive than the UBC because: (1) they prohibit the use of conventional construction for three story dwellings	UBC is less restrictive.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
			assigned to SDC's C and D, (2) they limit the use of masonry veneer.	
12.5.1.1 Irregular Structures 12.5.1.1.1 12.5.1.1.2 12.5.1.1.3 12.5.1.1.4 12.5.1.1.5 12.5.1.1.6 Diaphragm Openings	Irregular *structures* in *Seismic Design Categories* C and D of conventional light-frame construction shall have an engineered *lateral-force-resisting system* designed to resist the forces specified in Chapter 2 in accordance with Sec. 12.2.1. A *structure* shall be considered to have an irregularity when one or more of the conditions described in Sec. 12.5.1.1.1 to 12.5.1.1.7 are present.	2320.4.4 Lateral force-resisting system 2320.5.4 Unusually shaped buildings 2320.5.4.1 2320.5.4.2 2320.5.4.3 2320.5.4.4	Essentially identical. The unusually shaped building definition applies in Seismic Zones 3 and 4.	Considered equivalent
12.5.1.1.7 Stepped Foundation (Irregularity)	A *structure* shall be considered to have an irregularity when the shear walls of a single story vary in height more than 6 feet.		No corresponding provisions	Equivalency cannot be judged.
12.5.2 Braced Walls				
12.5.2.1 Spacing Between Braced Wall Lines	Interior and exterior *braced wall lines* shall be located at the spacing indicated in Table 12.5.1-1.	2320.4.1 Braced wall lines 2320.5.1 Braced wall lines	Essentially similar, except that the maximum spacing in Zones 0, 1, 2, and 3 of UBC is 34 ft. compared to a spacing of 35 ft. in SDC A, B, and C of NEHRP and there is an exception in the UBC, which is not in NEHRP.	Considered equivalent
12.5.2.2 Braced Wall Line Sheathing Requirements		2320.11.3 Bracing 2320.11.5 Cripple walls Table 23-N-C-1 Table 23-N-C-2	Different provisions. The UBC allows 1x4 continuous let-in braces and hardboard panel siding under certain conditions.	Equivalency cannot be judged.
12.5.2.3 Attachment 12.5.2.3.1 12.5.2.3.2 12.5.2.3.3	Most of the attachment requirements are specified in referenced Table 12.5.2-1	2320.11.3 Bracing	In many cases the attachment requirements for the different types of braced panels are the same. However, in the case of particleboard, no attachment is specified in the UBC whereas No. 11 gauge x 1-1/2 in. x 7/16 in. head (galvanized) nails at 3" o/c are specified in the NEHRP Provisions. Another difference is that the UBC requires 7" o/c fastener spacing for gypsum board sheathing whereas the NEHRP Provisions require	UBC is equivalent to less restrictive

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
			the same size fasteners to be spaced at 4" o/c.	
12.5.3 Detailing Requirements				
12.5.3.1 Wall Anchorage	Anchorage of *braced wall line* sills to concrete or masonry foundations shall be provided. Such anchorage shall conform to the requirements in Figure 403.1a of Sec. 403 of Ref 12-5, except that such anchors shall be spaced at not more than 4 ft. (1220 mm) on center for *structures* over two stories in height. For *Seismic Design Categories* C, D, and E, plate washers, a minimum of ¼ inch by 3 inches by 3 inches in size, shall be provided between the foundation sill plate and the nut. Other anchorage devices having equivalent capacity shall be permitted.	2320.6 Foundation Plates and Sills 1806.6 Foundation Plates or Sills 1806.6.1 Additional requirements in Seismic Zones 3 and 4	The differences between the NEHRP Provisions and the UBC are: 1. The UBC requires 5/8" diameter or larger bolts at 6' o/c or smaller spacing in Seismic Zone 4 and ½" diameter or larger bolts at 6' o/c or smaller spacing in all other seismic zones. The NEHRP Provisions require ½" diameter or larger bolts at 4' o/c or smaller for structures over two stories in height and 6' o/c or smaller spacing for other structures. 2. The UBC requires bolt diameter size and spacing to be designed for three-story raised wood floor buildings in Seismic Zones 3 and 4. The NEHRP Provisions do not have such a requirement. 3. The UBC requires 2"x2"x3/16" plate washers in Seismic Zones 3 and 4. The NEHRP Provisions require 3"x3"x1/4" plate washers in SDC C, D and E.	Equivalency cannot be judged.
12.5.3.2 Top Plates	Stud walls shall be capped with double-top plates installed to provide overlapping at corners and intersections. End joints in double-top plates shall be offset at least 4 feet (1220 mm). Single top plates shall be permitted to be used when they are spliced by framing devices providing capacity equivalent to the lapped splice prescribed for double top plates.	2320.11.2 Framing details Para 2	Essentially the same	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
12.5.3.3 Bottom Plates	Studs shall have full bearing on a 2-by (actual 1½ in., 38 mm) or larger plate or sill having a width at least equal to the width of the studs.	2320.11.2 Framing details Last Para	Identical	Equivalent
12.5.3.4 Braced Wall Panel Connections	Accommodations shall be made to transfer forces from roofs and floors to *braced wall panels* and from the *braced wall panels* in upper stories to the *braced wall panels* in the *stories* below. Where platform framing is used, such transfer at *braced wall panels* shall be accomplished in accordance with the following: 1. All *braced wall panel* top and bottom plates shall be fastened to joists, rafters or full depth blocking. *Braced wall panels* shall be extended and fastened to roof framing at intervals not to exceed 50 feet (15.2 m). 2. 3. 4. ...	2320.11.3 Bracing - Last para Table 23-II-B-1 – Nailing schedule	The braced wall panel connections in the NEHRP Provisions and UBC are the same, with a few exceptions. The NEHRP Provisions requires a complete lateral path and requires the braced wall panels to extend to the roof and be fastened to the roof framing at 50 feet min. intervals. These requirements are not in the UBC.	UBC is equivalent to less restrictive
12.5.3.5 Foundation Supporting Braced Wall Panels	For structures with maximum plan dimensions not over 50 ft, foundations supporting braced wall panels are required at exterior walls only. Structures with plan dimensions greater than 50 ft shall, in addition, have foundations supporting all required interior braced wall panels...	2320.5.6 Interior braced wall support	In one-story buildings, interior braced wall lines shall be supported on continuous foundations at intervals not exceeding 50 feet. In buildings more than one story in height, all interior braced wall panels shall be supported on continuous foundations. Section 1806.3 requires bearing walls to be provided with continuous foundations.	Not equivalent
12.5.3.6 Stepped Footings	Where the height of a required *braced wall panel* extending from foundation to floor above varies more than 4 ft. (1.2 m) (see Figure 12.5.3.6), the following construction shall be used: ...		No corresponding provisions	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
12.5.3.7 Detailing for Openings in Diaphragms	For openings with a dimension greater than 4 ft., or openings in structures in Seismic Design Categories D and E, the following minimum detail shall be provided. Blocking shall be provided beyond headers and metal ties not less than 0.058 inch by 1.5 inches wide by 4.8 inches with eight 16d...	2320.8.4 Framing around openings	Trimmer and header joists shall be doubled, or of lumber of equivalent cross section, when the span of the header exceeds 4 feet. The ends of header joist more than 6 feet long shall be supported by framing anchors or joists hangers unless bearing on a beam...	Equivalency cannot be judged.
12.6 SEISMIC DESIGN CATEGORY A	*Structures* assigned to *Seismic Design Category* A are permitted to be designed and constructed using any applicable materials and procedures permitted in the reference documents and, in addition, shall conform to the requirements of Sec. 5.2.6.1.2. *Structures* constructed in compliance with Sec. 12.5 are deemed to comply with Sec. 5.2.6.1.2. Exceptions: ...		No corresponding provision	Equivalency cannot be judged.
12.7 SEISMIC DESIGN CATEGORY B, C, AND D 12.7.1 Conventional Light-frame Construction 12.7.2 Engineered Construction	*Structures* assigned to *Seismic Design Categories* B, C, and D shall conform to the requirements of this section, and Sec. 5.2.6.1.2. Exceptions: ...		No corresponding provision	Equivalency cannot be judged.
12.8 SEISMIC DESIGN CATEGORY E AND F 12.8.1 Limitations	*Structures* assigned to *Seismic Design Categories* E and F shall conform to all of the requirements for engineered construction in accordance with Sec. 12.3 and 12.4 and to the additional requirements of this section. Exception: ..	2315.5 Wood shear walls and diaphragms in Seismic Zones 3 and 4	Similar restrictions on wood diaphragms are not found in the UBC.	Not equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
CHAPTER 13 SEISMICALLY ISOLATED STRUCTURES DESIGN REQUIREMENTS		**APPENDIX: CHAPTER 16 Division IV – EARTHQUAKE REGULATIONS FOR SEISMIC-ISOLATED STRUCTURES**		
13.1 General		**SECTION 1654 - GENERAL**	Identical. Also has a provision concerning wind forces that is not in NEHRP.	Equivalent
13.2 CRITERIA SELECTION		**SECTION 1657 – CRITERIA SELECTION**	Identical	Equivalent
13.2.1 Basis for Design		1657.1 Basis for Design	Essentially the same	Equivalent
13.2.2 Stability of the Isolation System		1657.2 Stability of the Isolation System	Identical	Equivalent
13.2.3 Seismic Use Group	All portions of structure, including the structure above the isolation system, shall be assigned a Seismic Use Group in accordance with the requirements of Sec. 1.3.	1657.3 Occupancy categories	The importance factor, I, for a seismic-isolated building shall be taken as 1.0 regardless of occupancy category.	UBC is less stringent. Not equivalent.
13.2.4 Configuration Requirements		1657.4 Configuration Requirements	Identical	Equivalent
13.2.5 Selection of Lateral Response Procedure		1657.5 Selection of Lateral Response Procedure		
13.2.5.1 General		1657.5.1 General	Identical	Equivalent
13.2.5.2 Equivalent Lateral Force Procedure		1657.5.2 Static analysis	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
13.2.5.3 Dynamic Analysis		1657.5.3 Dynamic analysis	Identical	Equivalent
13.2.5.3.1 Response-Spectrum Analysis		1657.5.3.1 Response-Spectrum Analysis		
13.2.5.3.2 Time-History Analysis		1657.5.3.2 Time-History Analysis		
13.2.5.3.3 Site-Specific Design Spectra	Site-specific ground-motion spectra of the *design earthquake* and the *maximum considered earthquake* developed in accordance with Sec. 13.4.4.1 shall be used for design and analysis of all seismically isolated *structures* if any one of the following conditions apply: 1. The *structure* is located on a Class E or F site or 2. The *structure* is located at a site with S_1 greater than 0.60g.	1657.5.3.3 Site-Specific Design Spectra	Identical except for the following change in Item 2: "The *structure* is located at a site within 10 km of an active fault."	Considered equivalent
13.3 EQUIVALENT LATERAL FORCE PROCEDURE		**SECTION 1658 – STATIC LATERAL RESPONSE PROCEDURE**		
13.3.1 General		1658.1 General	Identical	Equivalent
13.3.2 Deformation Characteristics of the Isolation System		1658.2 Deformation Characteristics of the Isolation System	Identical	Equivalent
13.3.3 Minimum Lateral Displacements		1658.3 Minimum Lateral Displacements		
13.3.3.1 Design Displacement		1658.3.1 Design Displacement	Identical	Equivalent
13.3.3.2 Effective Period		1658.3.2 Effective Period	Identical	Equivalent
13.3.3.3 Maximum Displacement		1658.3.3 Maximum Displacement	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
13.3.3.4 Effective period at Maximum Displacement		1658.3.4 Effective period at Maximum Displacement	Identical	Equivalent
13.3.3.5 Total Displacement		1658.3.5 Total Displacement	Identical	Equivalent
13.3.4 Minimum Lateral Forces		1658.4 Minimum Lateral Forces		
13.3.4.1 Isolation System and Structural Elements At or Below the Isolation System		1658.4.1 Isolation System and Structural Elements At or Below the Isolation System	Identical	Equivalent
13.3.4.2 Structural Systems Above the Isolation System		1658.4.2 Structural Systems Above the Isolation System	Identical	Equivalent
13.3.4.3 Limits on V_s		1658.4.3 Limits on V_s	Identical	Equivalent
13.3.5 Vertical Distribution of Force		1658.5 Vertical Distribution of Force	Identical	Equivalent
13.3.6 Drift Limits	The maximum interstory drift of the structure above the isolation system shall not exceed 0.015 h_{sx}. The drift shall be calculated by Eq. 5.3.7.1 with the C_d factor of the isolated structure equal to the R_I factor defined in Sec. 13.3.4.2.	1658.6 Drift Limits	The maximum interstory drift ratio of the structure above the isolation system shall not exceed $0.010/R_I$.	UBC is more stringent.
13.4 DYNAMIC LATERAL RESPONSE PROCEDURE		**SECTION 1659 – DYNAMIC LATERAL-RESPONSE PROCEDURE**		
13.4.1 General		1659.1 General	Identical	Equivalent
13.4.2 Isolation System and Structural Elements Below the Isolation System		1659.2 Isolation System and Structural Elements Below the Isolation System	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
13.4.3 Structural Elements Above the Isolation System		1659.3 Structural Elements Above the Isolation System	Identical	Equivalent
13.4.4 Ground Motion		1659.4 Ground Motion		
13.4.4.1 Design Spectra		1659.4.1 Design Spectra	Similar, but ground motion parameters are different. Also, site-specific spectra are required for design of all structures with an isolated period, T_M, greater than 3.0 seconds or located in Seismic Zone 1, 2A or 2B. The requirement for lower seismic zones is somewhat surprising.	UBC is more stringent.
13.4.4.2 Time Histories		1659.4.2 Time Histories	Identical	Equivalent
13.4.5 Mathematical Model		1659.5 Mathematical Model		
13.4.5.1 General		1659.5.1 General	Identical	Equivalent
13.4.5.2 Isolation System		1659.5.2 Isolation System	Identical	Equivalent
13.4.5.3 Isolated Building 13.4.5.3.1 Displacement 13.4.5.3.2 Forces and Displacements in Elements of the Lateral-Force-Resisting System		1659.5.3 Isolated Building 1659.5.3.1 Displacement 1659.5.3.2 Forces and Displacements in Key Elements	Identical	Equivalent
13.4.6 Description of Analysis Procedures		1659.6 Description of Analysis Procedures		
13.4.6.1 General		1659.6.1 General	Identical	Equivalent
13.4.6.2 Input Earthquake		1659.6.2 Input Earthquake	Identical	Equivalent
13.4.6.3 Response-Spectrum Analysis	.... The design shear at any *story* shall not be less	1659.6.3 Response-Spectrum Analysis	Identical except that the last paragraph of NEHRP Provisions is not included in the UBC.	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	than the *story* shear obtained using Eq. 13.3.5 and a value of V_S taken as that equal to the *base shear* obtained from the response-spectrum analysis in the direction of interest.			
13.4.6.4 Time-History Analysis		1659.6.4 Time-History Analysis	Identical	Equivalent
13.4.7 Design Lateral Force		1659.7 Design Lateral Force		
13.4.7.1 Isolation System and Structural Elements At or Below the Isolation System		1659.7.1 Isolation System and Structural Elements At or Below the Isolation System	Identical	Equivalent
13.4.7.2 Structural Elements Above the Isolation System		1659.7.2 Structural Elements Above the Isolation System	Identical	Equivalent
13.4.7.3 Scaling of Results		1659.7.3 Scaling of Results	Identical	Equivalent
13.4.7.4 Drift Limits		1659.7.4 Drift Limits	Identical	Equivalent
13.5 LATERAL LOAD ON ELEMENTS OF STRUCTURES AND NONSTRUCTURAL COMPONENTS SUPPORTED BY BUILDINGS		**SECTION 1660 – LATERAL LOAD ON ELEMENTS OF STRUCTURES AND NONSTRUCTURAL COMPONENTS SUPPORTED BY STRUCTURES**		
13.5.1 General		1660.1 General	Identical	Equivalent
13.5.2 Forces and Displacements		1660.2 Forces and Displacements		
13.5.2.1 Components At or Above the Isolation Interface		1660.2.1 Components At or Above the Isolation Interface	Identical	Equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
13.5.2.2 Components Crossing the Isolation Interface		1660.2.2 Components that Cross the Isolation Interface	Identical	Equivalent
13.5.2.3 Components Below the Isolation Interface		1660.2.3 Components Below the Isolation Interface	Identical	Equivalent
13.6 DETAILED SYSTEM REQUIREMENTS		**SECTION 1661 - DETAILED SYSTEM REQUIREMENTS**		
13.6.1 General		1661.1 General	Identical	Equivalent
13.6.2 Isolation System		1661.2 Isolation System		
13.6.2.1 Environmental Conditions		1661.2.1 Environmental Conditions	Identical	Equivalent
13.6.2.2 Wind Forces		1661.2.2 Wind Forces	Identical	Equivalent
13.6.2.3 Fire Resistance		1661.2.3 Fire Resistance	Essentially identical with some additional requirements to the NEHRP provisions.	UBC is more stringent.
13.6.2.4 Lateral-Restoring Force		1661.2.4 Lateral-Restoring Force	Essentially identical	Equivalent
13.6.2.5 Displacement Restraint		1661.2.5 Displacement Restraint	Essentially identical	Equivalent
13.6.2.6 Vertical-Load Stability		1661.2.6 Vertical-Load Stability	Essentially identical	Equivalent
13.6.2.7 Overturning		1661.2.7 Overturning	Identical	Equivalent
13.6.2.8 Inspection and Replacement		13.6.2.8 Inspection and Replacement	Essentially identical with one additional requirement to the NEHRP provisions.	Considered equivalent
13.6.2.9 Quality Control		1661.2.9 Quality Control	Identical	Equivalent
13.6.3 Structural System		1661.3 Structural System 1662 NONBUILDING STRUCTURES		

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
13.6.3.1 Horizontal Distribution of Force		1661.3.1 Horizontal Distribution of Force	Identical	Equivalent
13.6.3.2 Building Separations		1661.3.2 Building Separations	Identical	Equivalent
13.6.3.3 Nonbuilding Structures		**1662 NONBUILDING STRUCTURES**	Essentially the same	Equivalent
13.7 FOUNDATIONS		**SECTION 1663 - FOUNDATIONS**	Identical	Equivalent
13.8 DESIGN AND CONSTRUCTION REVIEW		**SECTION 1664 - DESIGN AND CONSTRUCTION REVIEW**		
13.8.1 General		1664.1 General	Essentially the same	Equivalent
13.8.2 Isolation System		1664.2 Isolation System	Essentially the same. UBC has one added requirement.	Equivalent
13.9 REQUIRED TESTS OF THE ISOLATION SYSTEM		**SECTION 1665 - REQUIRED TESTS OF THE ISOLATION SYSTEM**		
13.9.1 General		1665.1 General	Identical	Equivalent
13.9.2 Prototype Tests		1665.2 Prototype Tests		
13.9.2.1 General		1665.2.1 General	Identical	Equivalent
13.9.2.2 Record		1665.2.2 Record	Identical	Equivalent
13.9.2.3 Sequence and Cycles		1665.2.3 Sequence and Cycles	Essentially the same, but uses different ground motion parameters.	Equivalent
13.9.2.4 Units Dependent on Loading Rates		1665.2.4 Units Dependent on Loading Rates	Identical	Equivalent
13.9.2.5 Units Dependent on Bilateral Load	...... The force-deflection properties of an *isolator unit* shall be considered to be dependent on bilateral load if the bilateral and unilateral force-deflection	1665.2.5 Units Dependent on Bilateral Load	Essentially the same, but replaces the difference from $\pm15\%$ in NEHRP to $\pm10\%$.	Considered equivalent

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
	properties have greater than a plus or minus 15 percent difference in effective stiffness at the *design displacement*.			
13.9.2.6 Maximum and Minimum Vertical Load		1665.2.6 Maximum and Minimum Vertical Load	Essentially the same	Equivalent
13.9.2.7 Sacrificial-Wind-Restraint Systems		1665.2.7 Sacrificial-Wind-Restraint Systems	Identical	Equivalent
13.9.2.8 Testing Similar Units		1665.2.8 Testing Similar Units	Identical	Equivalent
13.9.3 Determination of Force-Deflection Characteristics		1665.3 Determination of Force-Deflection Characteristics	Identical	Equivalent
13.9.4 Test Specimen Adequacy		1665.4 System Adequacy	Essentially the same, but uses different ground motion parameters. In addition, changes the difference in the average effective stiffness (between the average and each test results) from 15% in NEHRP to 10% in UBC.	Considered equivalent
13.9.5 Design Properties of the Isolation System		1665.5 Design Properties of the Isolation System	Identical	Equivalent
13.9.5.1 Maximum and Minimum Effective Stiffness		1665.5.1 Maximum and Minimum Effective Stiffness		
13.9.5.2 Effective Damping		1665.5.2 Effective Damping	Identical	Equivalent
Appendix to Chapter 13 PASSIVE ENERGY DISSIPATION SYSTEMS			No corresponding provisions	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	Provision	Section	Provision	Comments
CHAPTER 14 NONBUILDING STRUCTURE DESIGN REQUIREMENTS		**SECTION 1634 – NONBUILDING STRUCTURES**		
14.1 GENERAL		**1634.1 General**		
14.1.1 Scope	*Nonbuilding structures* considered by these *Provisions* include all self-supporting *structures* which carry *gravity loads*, with the exception of: *buildings*, vehicular and railroad bridges, nuclear power generation plants, offshore platforms, and dams. *Nonbuilding structures* are supported by the earth or supported by other *structures*, and shall be designed and detailed to resist the minimum lateral forces specified in this chapter	1634.1.1 Scope 1634.1.2 Criteria	Essentially the same	Considered equivalent
14.1.2 Nonbuilding Structures Supported by Other Structures	If a *nonbuilding structure* is supported above the *base* by another *structure* and the weight of the *nonbuilding structure* is less than 25 percent of the combined weight of the *nonbuilding structure* and the supporting *structure*, the design *seismic forces* of the supported *nonbuilding structure* shall be determined in accordance with the require-ments of Sec. 6.1.3. ...		No corresponding provisions.	Equivalency cannot be judged.
14.1.3 Architectural, Mechanical, and Electrical Components	Architectural, mechanical, and electrical *components* supported by *nonbuilding structures* shall be designed in accordance with Chapter 6 of these *Provisions.*	SECTION 1632 LATERAL FORCE ON ELEMENTS OF STRUCTURES, NONSTRUCTURAL COMPONENETS AND EQUIPMENT SUPPORTED BY STRUCTURES	Comparison done elsewhere	Does not affect equivalency

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
14.1.4 Loads	In addition to other provisions, states that W should include snow and ice loads when these loads constitute 25% or more of W.	1634.1.3 Weight W 1630.1.1	In addition to other provisions, states that W should include snow load where it exceeds 30 psf.	Considered equivalent
14.1.5 Fundamental Period	The fundamental period of the *nonbuilding structure* shall be determined by methods as prescribed in Sec. 5.3.3 or by other rational methods.	1634.1.4 Period	Identical	Equivalent
14.1.6 Drift Limitations	The drift limitations of Sec. 5.2.8 need not apply to *nonbuilding structures* if a rational analysis indicates they can be exceeded without adversely affecting structural stability. *P-delta effects* shall be considered when critical to the function or stability of the *structure*.	1634.1.5 Drift	Essentially the same	Equivalent
14.1.7 Materials Requirements	The requirements regarding specific materials in Chapters 8, 9, 10, 11, and 12 shall be applicable unless specifically exempted in this chapter.		No corresponding provisions	Does not affect equivalency
14.2 STRUCTURAL DESIGN REQUIREMENTS 14.2.1 Design Basis	*Nonbuilding structures* having specific seismic design criteria established in approved standards shall be designed using the standards as amended herein. In addition, *nonbuilding structures* shall be designed in compliance with Sec. 14.3 and 14.4 to resist minimum seismic lateral forces which are not less than the requirements of Sec. 5.3.2, with the following additions and exceptions:	**1634.5 Other Nonbuilding Structures**	Some similarities. UBC has slightly different R and Ω_o factors from those in NEHRP. NEHRP has a more comprehensive approach. The UBC includes minimum base shear formulas, whereas NEHRP does not.	Equivalency cannot be judged.
14.2.1.1 Seismic Factors	Specifies the seismic factors such as R, Ω_o and C_d and the applicability of different structural systems and height limits under different SDCs.	Table 16-P	NEHRP is more comprehensive and has slightly different R and Ω_o factors from those in the UBC. No height limits are given in the UBC.	Equivalency cannot be judged.
14.2.1.2 Importance Factors and Seismic Use Group Classifications	The importance factor (*I*) and *seismic use group* for *nonbuilding structures* are based on the relative hazard of the contents, and the function. The value of I shall be the largest value determined by the approved standards, or the largest value as selected from Table 14.2.1.2.		No corresponding provisions.	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
14.2.2 Rigid Nonbuilding Structures	*Nonbuilding structures* that have a fundamental period, *T*, less than 0.06 sec, including their anchorages, shall be designed for the lateral force obtained from the following: $V = 0.30\, S_{DS}\, W\, I$	1634.3 Rigid Structures	Similar provisions, except that the term $0.3S_{DS}$ of NEHRP has been replaced by $0.7C_a$ in UBC.	Equivalent, assuming $S_{DS} = 2.5C_a$.
14.2.3 Deflection Limits and Structure Separation	Deflection limits and *structure* separation shall be determined in accordance with these *Provisions* unless specifically amended in this chapter.		No corresponding provisions.	Does not affect equivalency
14.3 NONBUILDING STRUCTURES SIMILAR TO BUILDINGS 14.3.1 General	*Nonbuilding structures* that have structural systems that are designed and constructed in a manner similar to buildings and have a dynamic response similar to building *structures* shall be designed similar to building *structures* and in compliance with these *Provisions* with exceptions as contained in this section. ...	**1634.2 Lateral Force**	Essentially similar. NEHRP is more comprehensive.	Considered equivalent
14.3.2 Pipe Racks 14.3.2.1 Design Basis	Pipe racks supported at the base shall be designed to meet the force requirements of Sec. 5.3 or 5.4. ...		No corresponding provisions	Equivalency cannot be judged.
14.3.3 Steel Storage Racks	NEHRP Provisions are based on 1990 RMI (Rack Manufacturing Institute) Specification.	Ch. 22 Dvn. X . DESIGN STANDARD FOR STEEL STORAGE RACKS Table 16-O Footnote 4 2205.8 Steel Storage Racks	UBC is based on the 1990 RMI Specification. However, the UBC is less stringent for the following reasons: 1. Higher R values. 2. $I_p = 1.0$ versus $I_p = 1.5$ for storage occupancies open to the general public as specified in NEHRP Section 6.1.5. In the cases where the occupancy is not open to the general public and the rack is required by the UBC to be designed for a W equal to the total dead load plus 100% of the contents, the UBC base shear force will be greater.	UBC is generally less stringent.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
14.3.4 Electrical Power Generating Facilities 14.3.4.1 General 14.3.4.2 Design Basis	Electrical power generating facilities are power plants that generate electricity by steam turbines, combustion turbines, diesel generators or similar turbo machinery. Electrical power generating facilities shall be designed using these *Provisions* and the appropriate factors contained in Sec. 14.2.		No corresponding provisions	Equivalency cannot be judged.
14.3.5 Structural Towers for Tanks and Vessels 14.3.5.1 General	Structural towers which support tanks and vessels shall be designed to meet the provisions of Sec 14.1.2. In addition, the following special considerations shall be included:		No corresponding provisions	Equivalency cannot be judged.
14.3.6 Piers and Wharves 14.3.6.1 General 14.3.6.2 Design Basis	Piers and wharves are *structures* located in water-front areas that project into a body of water or parallel the shore line. Piers and wharves shall be designed to comply with these *Provisions* and approved standards. ...		No corresponding provisions	Equivalency cannot be judged.
14.4 NONBUILDING STRUCTURES NOT SIMILAR TO BUILDINGS 14.4.1 General	*Nonbuilding structures* that have structural systems that are designed and constructed in a manner such that the dynamic response is not similar to buildings shall be designed in compliance with these *Provisions* with exceptions as contained in this section. ...	**1634.4 Tanks with Supported Bottoms** **1634.5 Other Nonbuilding Structures**	The NEHRP provisions are more comprehensive. The UBC includes minimum base shear formulas, whereas NEHRP does not.	Equivalency cannot be judged.
14.4.2 Earth Retaining Structures 14.4.2.1 General	This section applies to all earth retaining *walls.* The applied *seismic forces* shall be determined in accordance with Sec. 7.5.1 with a geotechnical analysis prepared by a *registered design professional.*		No corresponding provisions	Equivalency cannot be judged.
14.4.3 Tanks and Vessels 14.4.3.1 General	This section applies to all tanks and vessels	1634.4 Tanks with Supported Bottoms 1634.5 Other	Different provisions	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
14.4.3.2 Design Basis 14.4.3.3 Additional Requirements	storing liquids, gases, and granular solids supported at the base.	Nonbuilding Structures		
14.4.4 Electrical Transmission, Substation, and Distribution Structures 14.4.4.1 General 14.4.4.2 Design Basis	This section applies to electrical transmission, substation, and distribution *structures*. Electrical transmission, substation wire support and distribution *structures* shall be designed to resist seismic lateral forces determined from a substantiated analysis using approved standards.	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
14.4.5 Telecommunication Towers 14.4.5.1 General 14.4.5.2 Design Basis	This section applies to telecommunication towers. Self-supporting and guyed telecommunication towers shall be designed to resist seismic lateral forces determined from a substantiated analysis using approved standards.	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
14.4.6 Stacks and Chimneys 14.4.6.1 General 14.4.6.2 Design Basis	Stacks and chimneys are permitted to be either lined or unlined, and shall constructed from concrete, steel, or masonry. Steel stacks, concrete stacks, steel chimneys, concrete chimneys, and liners shall be designed to resist seismic lateral forces determined from a substantiated analysis using approved standards. ...	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.

Table 1. Detailed Comparison of Structural Provisions of 1997 NEHRP to 1997 UBC (continued)

1997 NEHRP		1997 UBC		
Section	**Provision**	**Section**	**Provision**	**Comments**
14.4.7 Amusement Structures 14.4.7.1 General 14.4.7.2 Design Basis	 Amusement *structures* are permanently fixed *structures* constructed primarily for the conveyance and entertainment of people. Amusement *structures* shall be designed to resist seismic lateral forces determined from a substantiated analysis using approved standards.	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
14.4.8 Special Hydraulic Structures 14.4.8.1 General 14.4.8.2 Design Basis	 Special hydraulic *structures* are *structures* that are contained inside liquid containing *structures*. ... Special hydraulic *structures* shall be designed for out-of-phase movement of the fluid. ...	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
14.4.9 Buried Structures 14.4.9.1 General 14.4.9.2 Design Basis	 Buried *structures* are subgrade *structures* such as tanks, tunnels, and pipes. ... Buried *structures* shall be designed to resist minimum seismic lateral forces determined from a substantiated analysis using approved standards. ...	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
14.4.10 Inverted Pendulums	These *structures* are a special category of *structures* which support an elevated lumped mass, and exclude water tanks.	1634.5 Other Nonbuilding Structures	No corresponding provisions	Equivalency cannot be judged.
Appendix to Chapter 14	The sections are included here so that the design community specializing in these *nonbuilding structures* can have the opportunity to gain familiarity with the concepts, update their standards, and send comments on this appendix to the BSSC.		No corresponding provisions	Equivalency cannot be judged.