Design Standard
Structural Design Guidelines

Purpose

The following Structural Design Guidelines establish basic design parameters for the East Side Union High School District with the goal of providing enhanced structural performance, optimizing end user flexibility and serviceability, and encouraging green building practices. These guidelines are in addition to the current building code requirements and are to be used in conjunction with specific requirements identified for each building.

Design Standard

A. Requirement for use of Latest Edition of Design Provisions

Building Codes do not always keep up with the constantly evolving Design Provisions upon which they are based. Therefore, the District anticipates that the design professional shall utilize the latest edition of the Design Provisions that the Building Code is based upon for all designs. This requirement provides improved structural system (seismic) performance by conformance to improved system detailing based on lessons learned from recent seismic events. These practices will be mandated over the next few years but may not be fully in place at the time the Design professional submits the documents for approval by the Division of the State Architect. Compliance with this structural design standard will ensure that buildings, when constructed, have structural systems that reflect the most current national standards.

The purpose of Earthquake Design is defined in CBC Section 1626A.1 and states: "The purpose of the earthquake provisions herein is primarily to safeguard against major structural failures and loss of life." Therefore, Code level design does not provide for other factors that are also important to the District, including limiting damage to structural, mechanical or architectural elements, maintaining functionality of structure post-earthquake, and allowing for simple repair of damaged structural elements.

The following is an example of this requirement: The 2001 California Building Code, Chapter 22/22A-Steel, Division IV-Seismic Provisions for Structural Steel Buildings, is currently based upon the Seismic Provisions for Structural Steel Buildings of the American Institute of Steel Construction, dated April 15, 1997. However, a more recent version of the Seismic Provisions for Structural Steel Buildings is dated March 9, 2005. This later version incorporates many of the advances achieved as part of research programs and other investigations and developments related to the seismic design of steel buildings.

- **Cost Impact:** No cost impact.

B. Special Inspection Requirements

Special Inspection services are required on a majority of building construction projects, and these services are typically borne by the Owner as a soft cost of the project. The

design professional will provide to the District a list of the special inspections required for the proposed structural design(s), along with alternate solutions, so that the District can make informed decisions about which design solutions offer the best value. This includes, but is not limited to, geotechnical inspection requirements indicated in the soils report and special inspection requirements as specified in the California Building Code, Chapter 17/17A – Structural Tests and Inspections. This requirement provides benefit to ESUHSD by allowing comparison of total project costs.

- **Cost Impact:** Minimal cost impact.

C. Structural Irregularities

Structural irregularities typically consist of plan irregularities such as reentrant corners (L-shaped buildings) or vertical irregularities such as discontinuous lateral resisting systems (shear walls that are not continuous to the foundation). These structural irregularities are defined in the California Building Code, Chapter 16A – Structural Design Requirements, Section 1629A.5.3., and are listed in CBC Tables 16A-L and 16A-M. The presence of structural irregularities can influence the overall seismic performance of the building and necessitate the use of amplification factors which may increase overall structural costs. Therefore, the District anticipates that the design professional will limit or eliminate such structural irregularities. The District will review exceptions on a case by case basis.

- **Cost Impact:** Significant cost savings, up to 25% of the cost of the lateral system.

D. Structural Systems

The District understands that when designing a structural system, the design professional has choices. The District anticipates that the design professional will consider the advantages and disadvantages of the options, present them to the District during design development, and make a recommendation on which structural system is most appropriate for the project. The design professional will also consider the current code governing the design of the project against any known upcoming code changes, and make a recommendation on whether to design to the upcoming code requirement.

1. **Steel Moment Frames** provide the greatest amount of flexibility and good seismic performance. However, there are a number of disadvantages to steel moment frames: there are limited connections pre-qualified per FEMA 350; high initial cost and the requirement for special inspections; they are only tested for the strong axis; damage can be significant and costly to repair or replace.
2. **Concrete** is durable, has good seismic performance, negates the need for an additional building skin system, and provides acoustic, thermal, security and fire benefits. However, concrete has limited flexibility and high cost for initial construction and special inspections.
3. **Tilt-Up Construction** is durable, cost effective, has limited special inspection requirements, allows for speedy construction, and provides acoustic, thermal, security and fire benefits. However, the joints may pose possible maintenance issues, large slab or casting beds are required, and there is limited future flexibility.

4. **Masonry** is durable, LEED friendly, the colored split-faced type is aesthetically pleasing, and provides acoustic, thermal, security and fire benefits. However, there is a greater propensity for cracking and special inspections are required.
5. **Wood** is readily available, ubiquitous in the existing ESUHSD environment, and cost effective. Exposed long span wood joists can add an aesthetic component unavailable through other materials. However, wood is subject to rot and pestilence. TJI® Joists and/or other structural members using oriented strand board may only be used when concealed.

E. Minimum Floor Live Loads

Building uses can change over time. In order to maintain greater flexibility for new building spaces, a minimum floor live load is required by ESUHSD. The floor live load shall be as indicated in the California Building Code, Chapter 16/16A, latest edition, but no less than 80 pounds per square foot (psf) floor live load concurrently with a minimum 20 psf partition load (dead load) for the design of all gravity members, 100 psf at corridors and 250 psf at storage areas. This requirement sets a minimum live loading only. The use of higher live loads may be required for certain use types. It is the responsibility of the design professional to determine the appropriate live loading for floors if they exceed this minimum set amount.

Also in addition to the uniform live loads the framing systems shall be capable of supporting a 1,000 pound concentrated point load at any location, not required to be simultaneous with the uniform loads.

- **Cost Impact:** Minimal cost impact.

F. Floor Fire Ratings

Building uses can change over time. In order to maintain greater flexibility for new building spaces, a minimum 2-hour fire separation in the structural system of the floor is required by ESUHSD. This requirement maximizes flexibility for future reuse of space.

- **Cost Impact:** Moderate cost impact, approximately $10 per sq. ft.

G. Floor Vibration Design Parameters

The vibration of floors due to walking, rhythmic activities, or mechanical equipment can have a negative impact on the comfort level and productivity of building occupants. Vibration control is not mandated by building codes but is easily addressed and controlled during the design process. Therefore, ESUHSD anticipates that the design professional will design all suspended floor areas per the *Design Guide 1: Minimizing Floor Vibration* by the Applied Technology Council. Specific floor areas in proposed buildings with known rhythmic activities will be designated as such in the building specific criteria.

To verify that designated areas have been designed for vibration control per the *Design Guide 1: Minimizing Floor Vibration*, the District requires the design professional to submit their vibration control design, including drawings and calculations signed and stamped by a licensed Structural Engineer in the State of California, as part of the 90% Construction Document submittal package for review by the Owner's Representative.

- **Cost Impact:** Minimal cost impact, approximately $2 to 5 per sq. ft.

H. Slab-on-grade Design Parameters

Slabs-on-grade with excessive water/cement ratios and improper subgrade systems can lead to excessive cracking of the slab, curling of the edges of the slab, and moisture entrapment which can affect the attachment of architectural finishes to concrete floors. Therefore, the District anticipates that the design professional shall specify concrete mix designs with a maximum water/cement ratio of 0.45 and a minimum concrete compressive strength of 4000 psi. The subgrade shall be as specified by the geotechnical engineer except that it shall not include a space between the vapor barrier and the underside of the concrete slab where moisture can get trapped.

- **Cost Impact:** None to minimal cost impact.

I. Seismic Joint Guidelines

Seismic joints typically provide a separation between buildings with different lateral systems and/or provide a joint for expansion and contraction of very large or long structures. Their use, however, can complicate detailing and construction of architectural, mechanical, electrical and plumbing systems and may require a greater degree of maintenance over the building's lifespan. Therefore, the District anticipates that the design professional will minimize the use of seismic joints to the greatest extent possible. The District will review exceptions on a case by case basis. The design professional will present locations of proposed seismic joints during the design development phase.

- **Cost Impact:** Moderate cost savings.

J. Lateral Resisting Brace System Requirements

Buckling restrained braced frames (BRBF) have emerged as providing a vast improvement in performance over traditional ordinary braced frame and special concentric braced frame systems (SCBF). BRBF's provide enhanced performance over traditional braced frame systems due to their improved hysteretic behavior, which dissipates seismic energy, their smaller connection plates, and their ease of replacement following a seismic event. Therefore, the District anticipates that the design professional will consider the use of BRBF's for all brace frame systems indicated for the primary lateral resisting system. Exceptions include one-story buildings, rooftop penthouses and bracing of mechanical equipment supports. The design professional shall follow the Seismic Provisions for Structural Steel Buildings, latest edition, by the American Institute for Steel Construction, for the design requirements for buckling restrained braced frames.

- **Cost Impact:** None to minimal cost impact.

K. Concrete on Metal Deck Roofs

Anchorage of mechanical, electrical and plumbing systems, structural bracing and architectural features to the roof structure can be problematic for a bare metal deck roof

structure. State regulatory agencies have strict requirements for anchorages to structure, which are not easily met for a bare metal deck roof. In addition to facilitating structural attachments, the use of structural concrete fill over the metal decking can help control sound and vibration transmission, negate the use of sprayed on fire proofing, and maximize flexibility for future adaptability. Therefore, the District anticipates that the design professional will provide structural concrete fill on all metal deck roofs. The District shall consider exceptions on a case by case basis, during the design development phase. Exceptions may include architectural features such as canopies and stand-alone covered walkways.

- **Cost Impact:** None to minimal cost impact.

L. Framing Layout Requirements

East Side Union High School District has set district wide standards for the modular size of different systems including furniture and cubicles. In the interest of maintaining flexibility of spaces in the future, the District anticipates the Design professional will provide a design that accommodates these modular standards. The modular standards are indicated in the Administrative Space and Instructional Space Design Standards.

- **Cost Impact:** Minimal cost impact.

M. Sustainable Building Requirements

East Side Union High School District is committed to building sustainable structures. Sustainable buildings not only reduce our impact on the environment but provide for a more efficient structure with an improved quality of indoor work space. Sustainability can be achieved by incorporating a variety of sustainable features. The design professional is expected to incorporate as many sustainable features into the structural system as reasonably possible.

1. Fly Ash: A common green building practice includes the substitution of fly ash or slag for cement in foundation concrete mix designs. The use of fly ash improves concrete's durability and workability, diverts fly ash from landfill and reduces cement production, and the slower set times (56 days vs. 28 days) do not affect foundation work. Additionally, the more refined finished surface may negate the need for a flooring finish, reducing cost and improving indoor air quality. Therefore, the District anticipates that the design professional will specify a high volume fly ash (50%) foundation concrete mix design that maximizes the percentage of fly ash/slag replacement for cement while maintaining the code design requirements for the foundation.
2. Structural Steel: Approximately 95% of steel is recycled, making it a good material for achieving sustainability goals. This includes steel shapes, reinforcing bars and metal decking.
3. Recycled Aggregates: Recycled aggregates can be used for slab sub-base.
4. Regional Materials: When possible, specify regional materials (within a 500 mile radius), locally harvested products, and locally manufactured products to support local economies and reduce transportation waste.

- **Cost Impact:** No cost impact.

N. Peer Review of Geotechnical Report

East Side Union High School District requires peer reviews of geotechnical reports. This requirement promotes the completeness of reports, challenges overly conservative recommendations that can add significant construction cost, and can explore possible efficiencies (for example, increases in allowable bearing pressures can result in significant savings during construction). It is in the District's best interest to have geotechnical reports peer reviewed.

- **Cost Impact:** Minimal cost impact, possible significant cost savings.

Substitutes Allowed?

- Not applicable

Associated Design Standards and Construction Specifications

- Space Design Standard for Administrative Space
- Space Design Standard for Instructional Space

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