DM Berg Consultants, P.C.

Summer 2001

Why We Design for a *Seismic Event* in Massachusetts

by Frederic P. Carrie, Staff Engineer

DM BERG CONSULTANTS, P.C. is a structural engineering firm providing services for both public and private-sector clientele. Our business focus is:

- Building designs for new construction
- Analyses, forensics, and report writing
- Rehabilitation and restoration for existing buildings and parking structures
- Envelope and weatherproofing designs for new and existing building roofing and cladding systems

Project Types

Assembly
Civic
Commercial
Educational
Healthcare
Hospitality
Industrial
Institutional
Parking Garages
Residential
Retail
Specialty

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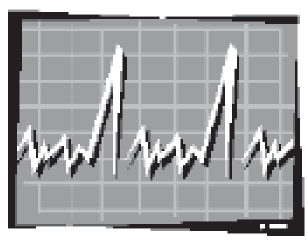
The earth is comprised of tectonic plates that are constantly moving in relation to each other causing an energy release in the ground that we stand on. While some areas of the world are well known as earthquake susceptible, others may be associated with different natural phenomenon, such as hurricanes. The State of California versus the South Carolina coast would be an example illustrating this fact. Most Massachusetts residents may have never felt earthquake tremors and it may seem superfluous to design a structure for such an event. So, what is the deal with the engineers worrying about the unlikely?

It is easier to approach this question from a definition of a performance-based design approach and a simplistic description of the effect of an earthquake on a structure. The basis of the integration of Massachusetts as part of an earthquake-zone map and the structural implications will also clarify the need for such Code requirements.

The 50-year design performance approach is based on a 10% probability of a determined ground acceleration occurring within a 50-year design span. The structure should be capable of withstanding the forces generated by the ground acceleration of this "50-year" earthquake without a catastrophic failure. This allocates adequate warning time for the safe evacuation of the occupants from the building. Hence, once the design earthquake has taken place, the lateral system of the structure, at the least, will need a thorough capacity evaluation, since the cyclical loading effect of the ground acceleration on the lateral system may have seriously reduced its effectiveness. As a precautionary measure, the gravity system should also be investigated for potential hazards. The Building Code mandates only life-safety minimums for seismic design and does not guarantee the use of the building after such an event.



A relationship between the "Richter Scale" and the associated ground motion is particularly explanatory. Hence, a "0.15g" acceleration relates approximately to a 6.0 magnitude on the Richter Scale (MA designs for 0.12g). The intensity of the energy released by such a ground acceleration is not expected to cause major structural failures. However, if a building is configured to withstand only minor ground movements, the "6.0" may leave the traces of an "8.0" magnitude! This is fundamentally the reasoning behind the design of structures in low to moderate seismic zones.

Massachusetts is classified as "Zone 2A" in the seismic contour maps presented in the UBC code (i.e., the Code most prevalent in the Western States). This zone is based on the soil behavior under seismic activities, the interaction of the soil and the upper structure during the ground acceleration, historic earthquake facts, and the likelihood that a "0.12g" acceleration occurs within any 50 year period in the life of a structure. To recall a few, in 1999 Merrimac, MA felt a "3.0" level earthquake, and in June 2000, Westfield, MA felt a "3.3". Who is to say that the famous Cape Ann earthquake (6.0 magnitude) of the eighteenth century is not due for a comeback this century!

Factors that are relevant to the design of a structure for seismic conditions include the period of a building mass, which can simplistically be described as the response or behavior of the structure during the earthquake excitation. This response is fundamental to the designer because it is unique to each building and site designed. Motion sickness experienced by occupants of the John Hancock tower in Chicago, for instance, can be associated with the period of the building. This is the reason why two buildings of the same geometry could theoretically be erected within a few feet of each other and yet be subjected to different lateral system requirements. Other factors, such as the local soil conditions, also affect the performance of the building. The lateral system selected generally affects the structural requirements imposed by the governing Building Code. Finally, ground-acceleration-induced forces may topple over unattached elements in a building. Hence, the necessity for "tying" all potential life-safety elements is essential. From bracing the top of partitions, such as masonry walls, to anchoring all the shear walls with "tie-downs" at each level of a structure, are necessary to provide a level of safety for the occupants. ■

Project Highlight . . . . Staff Profile

HINGHAM HIGH SCHOOL
HINGHAM, MASSACHUSETTS
by Dana Dewey, Production Manager

Hingham High School
Hingham, Massachusetts

Architect:
The Design Partnership of Cambridge, Inc.

General Contractor:
Bacon Construction

Total Cost: *$25,900,000*

New: *72,000 sq.ft.*

Renovated: *146,000 sq.ft.*

The addition to the existing high school consists of 24 new classrooms and a new administration wing along with much needed space for choral, band, and drama activities. The existing building underwent an extensive renovation program in order to give the Town a state of the art facility.

The new structure is a two-story steel-framed building with steel girders and open web steel joists supporting cast-in-place concrete slabs over steel form deck. Lateral load resistance is provided by ordinary moment frames of steel and reinforced masonry shear walls. Care was taken in foundation and slab-on-grade design to accommodate the existing soil and trench conditions. ■

We recently enjoyed our **2nd Annual Golf Tournament** (photo to right). As a team, Tom Heger and Mike Peddie were the best cheaters!

Front Row - Tom Heger and Scott Webber
Back Row - Tom Ball, Steve Crockett, Peter Shedlock, Matt Johnson, Mike Peddie, and Dave Shepard

Our improved website **www.dmberg.com** is up and running ... Come visit us!

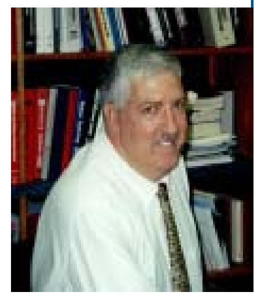
Technical Note

We no longer call out tubular sections as "TS" on our drawings. In 1997, the American Institute of Steel Construction (AISC), in conjunction with the Steel Tube Institute (STI), published the *Hollow Structural Sections Connection Manual*. Due to this publication, tubes are now called "Hollow Structural Sections" (HSS).

Old designation: TS 6x4x1/4
New designation: HSS 6x4x1/4

Follow along in our future newsletters as we break down seismic design in Massachusetts, explaining why today's buildings continue to change. Articles will include the necessity for wood hold-downs in shear walls, seismic load paths, seismic bracing of cmu walls, and seismic upgrades and hazard mitigation as required by Chapter 34 of the Massachusetts State Building Code.

DANA DEWEY
PRODUCTION MANAGER



Mr. Dewey has over 24 years of experience in this field, including positions as structural drafter, construction administrator, and production manager at DMBC for 16 years. Mr. Dewey was also associated with the U.S. Army for more than 20 years with three years active duty, fifteen years Army Reserve, and over two years in the National Guard. His primary duties in the military were in areas of drafting, survey crew chief, and construction manager. As a senior non-commissioned officer, Mr. Dewey managed people and equipment.

Mr. Dewey received his Associates Degree in Architectural Engineering from Franklin Institute of Boston, a Certificate of Professional Achievement in Construction Management, and successfully completed an OSHA training course in Construction Safety and Health from Northeastern University.

In addition to the Hingham High School project featured to the left, Mr. Dewey is managing the following projects:

Brockton Public Library - Brockton, Massachusetts
Architect: Burt Hill Kosar Rittelmann Associates

Nissitissit Middle School - Pepperell, Massachusetts
Country & Woodland Schools - Weston, Massachusetts
Wetherbee School - Lawrence, Massachusetts
Architect: The Design Partnership of Cambridge, Inc. ■

Recently Completed

Fuller Village
Retirement Community
Milton, Massachusetts
Architect: DiMella Shaffer Associates, Inc.

DMBC, P.C. strives to create a working atmosphere where, through mutual cooperation and respect amongst staff and clients, the process of designing structures can be carried out with efficiency for all concerned including owners, developers, other clients, and end users.