Five Major Themes
In the History of Earthquake Engineering

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SUMMARY
The five themes discussed here illustrate the fact that earthquake engineering has evolved in the context of broader engineering and social developments. Earthquake engineering has borrowed much from other engineering disciplines in its understanding of inelasticity, in developing probabilistic design approaches, and in considering dynamic factors. During the last half of the 1900s, those three themes became more central to earthquake engineering than in most other civil engineering fields. Another theme is that some but not all damaging earthquakes have had an effect on the development of earthquake engineering, depending on the socio-political context of the place and era. The fifth theme is that there are increasing efforts to make knowledge about earthquake engineering and the implementation of it more global, but the field remains more localized in its outlook and in the way data are communally combined than is the case with several scientific disciplines.

Keywords: history of earthquake engineering

1. INTRODUCTION

The term "earthquake engineering" is used with more than one meaning. For example, the World Conferences on Earthquake Engineering span topics that include several disciplines other than engineering. In this paper, earthquake engineering is defined as the application of engineering, chiefly civil engineering, to the problems of earthquakes. While that may seem to imply that it has only been civil engineers who have advanced the field, in fact there have been notable instances where other disciplines -- physics, mechanical engineering, aeronautical engineering, fire resistance and fire codes, to name a few -- have exerted strong influences on the field. The work presented here is largely based on the author's *Earthquakes and Engineers: An International History* (Reitherman, 2012), which may be consulted for further information and for a large number of references that cannot be cited in this brief paper.

2. INELASTICITY AND DUCTILE BEHAVIOR

The terms "inelasticity" or "inelastic" behavior" are very commonly found in the literature of earthquake engineering today, but it was not always so. During the first half of the twentieth century, during earthquake engineering's pioneering era, these terms are absent from the discussions and writings of earthquake engineers, and the first seismic codes that contain engineering procedures do not mention the concept. The key figures who began around the turn of the nineteenth-twentieth centuries to develop a method to quantify both seismic design loads and seismic structural capacities, such as Riki Sano (1880-1956), Tachu Naito (1886-1970), and Arturo Danusso (1880-1968), did so on an elastic basis. The complete description of that method, still the one most commonly used in various forms in the world today, is the equivalent elastic static lateral (seismic) force method. In addition to refinement of the method to incorporate learning about inelastic rather than just elastic behavior, it was also refined with regard to dynamics to make its representation of earthquake forces as static forces more accurate, as discussed below. General ideas about toughness were in the minds of the more advanced engineers in the early decades of the twentieth century, but specific design ductility requirements were not yet developed in codes and standards.

In the first decades of the 1900s, European structural engineering researchers such as Gabor Kazinczy (1889-1964) in Hungary (Heyman 1999, p. 90) did research as early as 1914 that began to formulate what became ultimate strength design or limit design. The concept of plastic hinges, and how many such hinges can form at particular places in a structure before it collapses, stems from Kazinczy's work. A.L.L. Baker (1905-1986) at Imperial College of Science and Technology later did related research on reinforced concrete, and J.F. Baker at Cambridge University on steel. In the United States, John A. Van Den Broek developed limit state design methods (Bertero 2009, pp. 41-42). Van den Broek elegantly stated what earthquake engineers would only focus on in the last decades of the twentieth century: "emphasis is shifted from permissible safe stresses to permissible safe deformations" (1940). None of the development of limit state structural engineering originated out of a concern for earthquakes.

The concept that portions of a structure could exceed their elastic limits and yet the overall structure could still remain stable was a novel one. Joseph Penzien (1924-2011) recalled giving a talk on elasto-plastic modeling of seismic response in the late 1950s to engineers at an American Society of Civil Engineers Conference in southern California: "That was back when engineers thought that if a structure went above the yield level under dynamic loading it would go on yielding to the point of collapse. Engineers were still thinking that they could not allow yielding, because the thing would collapse (Penzien, p. 31)." Civil engineers were familiar with the laboratory testing example of a steadily applied load, representing gravity's continuous effect rather than an earthquake's momentary overstress of a structure. When the testing machine exceeded the tensile elastic limit of a steel bar and kept on pulling, it caused the bar to continue to stretch until it eventually completely broke. When earthquake engineers realized that an earthquake could generate very large forces within a structure, and that the expense of resisting those forces head-on with elastic capacity was also very large, they began to focus on ductility as one of the chief seismic design virtues. While the first half of the twentieth century developed the basic equivalent elastic lateral force method, the second half went on to conduct testing, analysis, and development of specific code provisions for quantifying the necessary amount of ductility and detailing structures to provide that capacity. The Second World Conference on Earthquake Engineering, held in 1960 in Japan, is a relevant historic benchmark indicating when this emphasis began, with conference papers on elasto-plastic response by Joseph Penzien, Anestis (Andy) Veletsos and Nathan Newmark (1910-1981), and John Blume (1909-2002).

The first edition in 1959 of the SEAOC Blue Book, *Recommended Lateral Force Requirements* (with "*and Commentary*" added from the 1960 edition on when that section was added) defined a K factor that was related to judgments about relative ductilities of overall structures of different types. In the first Blue Book, buildings over 160 ft (49 m) had to have a ductile frame, and that was defined in these terms: “the necessary ductility shall be considered to be provided by a steel frame with moment resistant connections or by other systems proved by tests and studies to provide equivalent energy absorption (SEAOC Seismology Committee 1959, p. 7)." Steel moment-resisting frame buildings were given the most favorable rating because of their "energy absorptive capacity and ability to deform into the plastic range," (SEAOC 1960). It was not until the 1974 edition of the Blue Book that the rationale was more fully explained.

In the 1960s, ductility became the seismic issue that was the focus of competition between the steel and concrete industries in the United States, with the concrete industry eventually developing the research base to substantiate its claim that the building code should permit use of reinforced concrete frames with proper ductile detailing, in parallel with steel frames. The book by Blume, Newmark, and Corning (1961) is the key reference marking the beginning of this debate. The book also foreshadows balanced design or capacity design, the concept of which was explicitly stated by Hollings (1969).

Capacity design could only have evolved in the second half of the twentieth century when engineers were becoming more familiar with inelastic response concepts. The slitted shear wall design of Kiyoshi Muto (1903-1989) in Japan (Muto et al., 1973) and the diagonally braced coupled wall research of Thomas Paulay (1923-2009) in New Zealand (1969) were signs that earthquake engineering's leading minds in several countries were focused on how to strategically provide ductility.

Besides providing a way to handle temporary overloads from seismic motions and to transfer forces from one overstressed portion of the structure to another, the change in frequency of the structure was seen to be another blessing of inelastic response. With a typical response spectrum showing higher forces imparted to the structure if it had a fundamental frequency of more than 2 Hz (a period of half a second or less), with declining response past that plateau into the lower frequency portion of the spectrum, inelastic softening of the structure acted as a seismic response governor. Like the centrifugal governor on mechanical equipment that automatically pushes a control to lower the rate of spinning to keep the revolutions per minute in the right range, inelastic behavior was seen to quickly change the structure and reduce its response. That insight required better documentation of how the ground actually shook in an earthquake, discussed later.

By the end of the twentieth century, while ductility was still central to both earthquake engineering research and practice, the limits of ductility were also recognized -- after all, ductility implies damage. That led to efforts and technologies to allow a building or other construction to undergo strong shaking without sacrificing portions of itself to inelastic behavior, a subject beyond this paper's scope.

3. PROBABILISTIC APPROACHES TO SEISMIC DESIGN

Civil engineers as of 1900 were not taught probability and risk analysis in college, but by the second half of the twentieth century, one particular branch of civil engineering, earthquake engineering, began to emphasize that topic. Design for gravity loads was to have a probabilistic basis as well, but it is inherently simpler to deal with the uncertainties of how much weight a structure will resist than how much earthquake load it will resist. The earthquake load may not only be greater than was estimated -- it may not even occur during the life of the structure. The chance that severe shaking will occur motivates earthquake engineers to diligently provide high levels of earthquake resistance, but the chance of non-occurrence is a brake on overly expensive levels of earthquake protection. Today, while specific seismic design criteria vary from country to country and within countries, the idea that seismic designs should be scaled or proportioned with respect to the probability of various levels of ground motion has essentially become a worldwide commonplace in our field.

Hirosi Kawasumi (1951) produced three maps of Japan showing peak ground acceleration contours expected in 75, 100, and 200 years, an early introduction of probabilistic thinking in the field. Emilio Rosenblueth (1926–1994) of the Universidad Nacional Autónoma de México (UNAM, the National Autonomous University of Mexico), was one of the earliest earthquake engineers to devote attention to probabilistic aspects of the field. In the very first of the World Conferences, he wrote a paper on "Some Aspects of Probability Theory in Earthquake Engineering" (Rosenblueth 1960). With Nathan Newmark of the University of Illinois, Rosenblueth was precocious in introducing probabilistic concepts in the influential textbook, *Fundamentals of Earthquake Engineering* (Newmark and Rosenblueth 1971). Allin Cornell (1938–2007) of the Massachusetts Institute of Technology (MIT) and later Stanford University, co-authored with Jack Benjamin (1917-1998) a textbook that had the somewhat awkwardly worded title, *Statistics and Decision for Civil Engineers* (1970). It was influential in injecting into civil engineering curricula the new probabilistic way of looking at reliability and safety issues. While the book was not just devoted to earthquake engineering, both Cornell and Benjamin specialized in the earthquake engineering sub-discipline of civil engineering.

One paper at the Fifth World Conference on Earthquake Engineering in Rome in 1973 by Robert Whitman (1928-2012) and two of his Massachusetts Institute of Technology students is a significant milepost in how earthquake engineers began to think probabilistically about estimating earthquake loss. The insurance industry had usually been content with average losses to rate their risks, but the damage probability matrix introduced by Whitman (Whitman et al. 1974) broke down expected loss in terms of eight discrete damage levels, assigning a certain percentage of the buildings of one specific type to levels such as no damage, only minor nonstructural damage, on up to collapse. Alternatively, for one given building, the matrix could be interpreted as stating the percentage chance that the building would fall into any of the various damage levels. Later, fragility curves became common in earthquake engineering. The fragility curve was a concept imported from risk analysis in the nuclear power industry. Neither the damage probability matrix nor the fragility curve became widely used in ordinary gravity load design, indicating again the uniqueness of earthquake engineering.

4. DYNAMICS

Dynamics came late into earthquake engineering practice, as compared to the sister disciplines of mechanical engineering and aeronautical engineering. That is not to say that the more advanced thinkers in our field did not recognize early on, even prior to 1900, that the phenomenon of earthquake shaking was a very dynamic one. They realized that a complete understanding of how a building, tower, dam, or other construction responded to that shaking, as well as how the ground beneath the construction responded, had to be based on dynamics. Luigi Sorrentino (2007) has brought to light the advanced dynamical thinking of Arturo Danusso, whose studies after the 1908 Messina-Reggio Earthquake were along modern lines, even considering multi-modal effects. But until the input motion, the strong ground shaking, could be quantified with respect to amplitude, usually amplitude of acceleration but also displacement and velocity, and also with respect to frequency content, dynamics could not be integrated into seismic analysis computations. The strong motion seismograph was not introduced in the United States until 1932, and only slowly did the archives of strong motion records build up. In that year, John Ripley Freeman (1855-1932) published his Earthquake Damage and Earthquake Insurance book, the best single compilation of what was then known on all aspects of earthquake engineering. Freeman (1930, p. 37) stated that “In Japan it has been noted that the destructive oscillations of the ground in an earthquake are chiefly those having a period from 1 second to 1-1/2 seconds; therefore, some of the foremost Japanese engineers take great care in their designs to reduce the oscillation period of a building as nearly as practicable to from 0.5 to 0.6 second, or to less than the period of the most destructive quake, and also strive to increase the rigidity of the building as a whole in every practical way.” Today, we would turn that generalization concerning spectral acceleration around 180 degrees, at least for most sites, because of the patterns revealed in what is today a large set of accelerograms.

Occasionally dynamics enters into the non-seismic design of construction, such as with machinery or footfall vibrations, but in earthquake engineering, one cannot even begin a series of calculations without knowledge of the dynamic properties of both the construction and the ground motion. Periods of vibration and damping are more central to earthquake engineering than to wind engineering, for in the latter case, the majority of buildings are not very tall and flexible, and structural analysis that treats the wind design problem statically has usually proven adequate. Inelastic response is a preoccupation in the earthquake engineering field, but for most wind design applications, it is also not a central concept.

While aeronautical engineers and mechanical engineers had been taking courses on dynamics for years, the introduction of that subject into the civil engineering curriculum, at least in the United States, came later. Three universities were especially influential -- Massachusetts Institute of Technology, University of California at Berkeley, and Stanford University -- and at all of the three, earthquakes were one of the dynamics subjects treated. At MIT, *Structural Design for Dynamic Loads* (Norris et al. 1959) was a book produced from a two-week short course for faculty. Kazuo (John) Minami (1907-1984), who from 1963 to 1977 was the engineer who provided the central point of contact for the International Association for Earthquake Engineering in its Tokyo office, wrote the chapter that was specifically on earthquakes. Other authors were MIT faculty R. J. Hansen, M. J. Holley, J. M. Biggs, and S. Namyet. Based on courses at Berkeley taught from the mid-1950s on, Ray Clough and Joseph Penzien produced *Dynamics of Structures* (1975), which became a popular text for the growing number of civil engineering courses being given on that subject. Both Clough and Penzien received their PhDs from MIT, and Penzien spent a sabbatical there studying subjects such as dynamics (Penzien 2004), so MIT had an influence on the teaching that went on at the other end of the continent in California as well as at its campus in Cambridge, Massachusetts. *Engineering Vibrations* by Lydik Jacobsen (1897-1976) and Robert S. Ayre (1958) at Stanford University was another early textbook available to university instructors, though that book was intended mostly for the mechanical engineer. Jacobsen was the founder of the vibration engineering laboratory at Stanford and later had John Blume as a student. Aeronautical and mechanical engineering textbooks on dynamics had long been produced, and although the theory was the same as in civil engineering, texts for those other disciplines were not ideal for teaching civil engineering students. Earlier at Stanford, a book on *Advanced Dynamics* was produced in 1948 by professors Stephen Timoshenko (1878–1972) and Donovan Young (1904–1980). Timoshenko had much earlier written *Vibration Problems in Engineering* (1928), but when that book delved into particular topics after it presented general approaches, it took up the examples of rotating shafts, hulls of ships affected by waves, and the vibrations of vehicles, rather than civil engineering applications. The book Timoshenko co-authored with Young, who was on the Stanford civil engineering faculty, was more useful for civil engineering students. In 1967, Young introduced a course on random vibrations for structural engineering students at Stanford, a very early instance of such a class for that audience. Young had been a graduate student of Timoshenko's when the latter was on the University of Michigan faculty.

5. WHY HAVE ONLY SOME EARTHQUAKES AFFECTED EARTHQUAKE ENGINEERING?

One cannot study the history of earthquake engineering without studying the history of earthquakes. Some earthquakes have undoubtedly been influential, in particular in the 1930s in providing the necessary motivation to institute seismic provisions in the building code. The 1931 Hawke's Bay Earthquake in the North Island of New Zealand led to the 1935 New Zealand Standard Model Building Law. In the United States, the Long Beach Earthquake in 1933 led to the Field Act requiring state-managed seismic building code provisions for schools and to the Riley Act that had lesser requirements for other buildings. After the 1931 and 1935 Quetta Earthquakes in Baluchistan in what was then British India, now Pakistan, the first zonation and seismic provisions began to be instituted in the Indian building code. The 1939 Chillán Earthquake in Chile induced the inclusion of seismic provisions in the General Code of Construction. And in Turkey, the 1939 Erzincan Earthquake was the motivation for the passage of the 1940 Provisional Construction Requirements in Earthquake Regions.

Note, however, that I have not said that these earthquakes "caused" these seismic codes to come into existence. Along with significant damage to bring attention to the issue of seismic safety, two other prerequisites are necessary, making three in total (Reitherman 2006): "(1) The earthquake was very damaging; (2) it occurred when civil engineering in general, along with seismology, had advanced to the point where earthquake engineering could extend from those fundamentals; and (3) it happened when there was at least minimal political receptivity to the idea of earthquake-resistant construction laws." The pattern followed around the world has been for a country or portion thereof to first adopt a building code, usually to deal with the problem of fire hazard, and only then to graft on provisions that apply to earthquakes (Tobriner 1984). In areas of the world today where building code and planning regulations are not already enforced for non-seismic reasons, it is usually unrealistic to assume that the society can suddenly jump to a significant level of seismic code enforcement. Especially because seismic design methods today have become quite complex, as have the seismic provisions in building and other construction codes, it is unrealistic to expect sophisticated engineering methods to be suddenly applied in such contexts. Instead, earthquake engineering of a "high-tech" nature can be applied in the research realm and then simplified for "low-tech" application, carefully considering local conditions. An early example of that was *Guidelines for Earthquake Resistant Non-engineered Construction*, published by the International Association for Earthquake Engineering (Anand 1986). The term "non-engineered" means the application by non-engineers of construction guidelines that were developed by engineers.

Examples of large and damaging earthquakes that did not lead to building code developments include two in 1906, the Valparaiso Earthquake in Chile and the 1906 San Francisco Earthquake in the United States (though both did instigate significant educational and research initiatives). In China, there had been devastating earthquakes for centuries, but it was not until the end of the Civil War -- that is, the civil war that ended in 1950 -- that earthquake engineering began there, and it was not triggered by any particular earthquake. The inception of earthquake engineering occurred under the leadership of Liu Huixian (1914–1992) with the earthquake engineering programs he started in 1954, when the Institute of Engineering Mechanics (IEM) (originally called the Institute of Civil Engineering and Architecture), was established in Harbin.

Pointing out above which civil war was referred to, the one that ended in victory to the communist side led by Mao Zedong (1893–1976), is necessary because in recent history China experienced not one but three other civil wars (Nien, Taiping, and Hui), lasting 18, 15, and 13 years in the mid-1800s. The Taiping war alone resulted in 20 to 30 million fatalities, the one that ended in 1950 accounted for two-and-a-half million, and there were the deaths of 11 million Chinese in World War II. On a global basis, China stands out as the country where the largest earthquake fatalities have occurred, but on its own historical terms, earthquake losses have been quite small in comparison with losses due to political and military events.

The death date of Mao Zedong is the same as the year of the 1976 Tangshan Earthquake, and of the two, the former event was more influential in its effect on earthquake engineering in China. While the Tangshan Earthquake, with its death toll variously estimated from a quarter million to three-quarters of a million, was momentous in motivating increased earthquake engineering research, education, and implementation, that advance could only occur in a post-Maoist, post-Cultural Revolution context. For the entire decade from the mid-1960s to mid-1970s, political ideology elevated populism and demoted science and engineering. Universities ceased to function, scholarly journals stopped publication, and engineers such as those already beginning work in earthquake engineering at the Institute for Engineering Mechanics or at Tongji University in Shanghai were sent out to jobs in the countryside. It was the modernizing era that followed Mao, led by Deng Xiaoping (1904–1997), that not only re-opened the universities and technical institutes -- it also began capitalist economic innovations and opened the nation to world trade, which made China's economy the huge phenomenon it is today. Vast amounts of economic development and modern construction required a big increase in engineering, including earthquake engineering. Without that construction boom, earthquake engineering in China would not be the growth industry it has become. China's current earthquake construction provisions have been influenced by earthquakes such as 1976 Tangshan, but those seismic regulations cannot simply be said to have been caused by destructive earthquakes. Thus, merely producing chronicles of earthquake engineering in terms of its internal events, without consideration of the broader social context, is not the same as providing a comprehensive picture of the history of earthquake engineering.

Aside from direct effects of earthquakes on the initiation of seismic codes, there are the theories and lessons that can be applied in earthquake engineering, and that learning can often be applied not only in the affected region but in other countries as well. Some examples of earthquakes that have been especially instructive with regard to earthquake engineering are included in Table 5-1.

Table 5-1: Selected Significant Earthquakes That Have Affected Earthquake Engineering

Earthquake	Lesson Learned, Effect on Earthquake Engineering
1755 Lisbon	Lisbon reconstructed with *gaiola* walls (timber frame plus masonry)
1857 Neapolitan	Robert Mallet, an engineer, studies the damage in a scientific way
1880 Yokohama	a small earthquake, but the Seismological Society of Japan was
1891 Nobi	Bunjiro Koto accurately identifies the fault as the cause, not the effect
1906 San Francisco	no code impact, but some research initiatives result
1908 Messina-Reggio	most advanced engineering/code work after an earthquake up to then
1923 Kanto/Tokyo	validation of equivalent static force method of Tachu Naito and Riki Sano
1933 Long Beach	as in many other earthquakes, unreinforced masonry dangers highlighted
1940 El Centro	an often used ground motion record was collected
1946 Aleutian	the time was right to establish the Pacific Tsunami Warning Center
1960 Agadir	pointed out small magnitude (M5.7)/high life loss (12,000 - 15,000) risks
1964 Alaska, Niigata	liquefaction studies begin a growth phase in geotechnical engineering
1967 Caracas	10-story collapse potential vividly illustrated; local soil effects studied
1971 San Fernando	many accelerograms; lessons for dams, fault rupture, hospitals, bridges
1976 Tangshan	Chinese earthquake engineering boost, along with end of Cultural Revolution
1985 Chile	good performance of mid-rise buildings with extensive shear walls
1985 Mexico City	long-distance earthquake threat proved; deep & soft soil effects
1988 Armenia	fragility of pre-cast frame construction with weak connections and joints
1989 Loma Prieta	continuing bridge vulnerabilities pointed out
1993 Marahashtra	another example of vernacular building dangers; need for low-tech solutions
1994 Northridge	fractures of welded steel frames; new and retrofitted bridges do well
1995 Kobe	near-fault motion; post-1981 code performance good; liquefaction of ports
1999 Chi-Chi	tall building collapse potential demonstrated
1999 Kocaeli	indicator of level of loss if an earthquake strikes nearer to Istanbul
2004 Indonesia	tsunami risk demonstrated Indian as well as Pacific Ocean risks
2011 Tohoku	under-estimation of tsunami amplitude and risk; construction overwhelmed

6. LOCAL VS. GLOBAL EARTHQUAKE ENGINEERING METHODS

Some science and engineering fields not only have a global extent; they also operate on the basis of global methods. Warm water off the west coast of Africa can cause hurricanes in the Gulf of Mexico, and meteorologists must internationally coordinate their data to understand that phenomenon. Data on earthquake engineering technologies and seismic design approaches in one country cannot be easily applied elsewhere. Not only are the buildings and other types of construction different, literally being made of different materials and having different details, but the codes and standards differ, along with socio-economic, construction industry, and architectural "boundary conditions."

While earthquake engineering increasingly has the goal of effective worldwide knowledge development (e.g., university engineering education), and application (e.g., effective codes and design and construction practices), earthquake engineers do not have a subject matter that makes it easy for actual collaboration akin to what is done in many of the sciences. A globe that shows only topographic and oceanic features well suits the needs of earth scientists in their studies of earthquakes, as well as climate, gravity or magnetic variations, and other geophysical phenomena. The engineer needs to look at the type of globe that shows the political demarcations of nations, and even boundary lines of prefectures, provinces, states, and cities, because those human-created boundaries have significance.

The International Association for Earthquake Engineering, which oversees the World Conferences on Earthquake Engineering, was established in 1963, a historic accomplishment that helps unify the field. However, that was about six decades after the seismologists had already formed the International Seismological Association in 1901, and seismologists back then and now can put their data in the same "bin," that is, add their seismograms to worldwide catalogs, "adding apples to applies," because the data are comparable. Engineers cannot simply combine damage statistics on a type of building or bridge in one country's earthquake with that of another, because the buildings and bridges are different. The program started by the United Nations in 1990, the International Decade for Natural Hazard Reduction, had a few truly global earthquake engineering collaborations, such as the compilation of a worldwide Global Seismic Hazard Map, which depicted the probability of strong ground motion on a standardized basis (GSHAP 1990). However, in most respects the International Decade for Natural Hazard Reduction was a banner under which various unconnected seismic programs marched. It was not in the same league as the International Geophysical Year (actually a year and a half, July 1957 to December 1958), which included multinational teams of scientists studying planetary-scale topics such as astronomy and the upper atmosphere, Antarctica, and seismology. That scientific effort had been preceded by coordinated explorations and investigations of the International Polar Year in 1882–1883 and in 1932–1933, and back in 1873 the International Meteorological Organization (now World Meteorological Organization) was founded. The word "international" in those activities meant that coordinated, simultaneous international campaigns were launched to collect data on the same kind of phenomenon. Engineers in one country often adopt particular design methods that differ considerably from the methods used by engineers elsewhere. The World Housing Encyclopedia program of the Earthquake Engineering Research Institute, started by Svetlana N. Brzev, is currently one of the most active efforts to get the knowledge of earthquake engineering experts in many countries about their building stocks compiled the way scientists conduct a worldwide bird census or collect data on ocean currents around the globe. The International Association for Earthquake Engineering began compiling seismic codes around the world in 1960, producing ten updates since then, another notable effort, and one which also points out the diversity of earthquake engineering.

The President of the International Association for Earthquake Engineering from 1965 to 1969, John Rinne, made a prediction that has somewhat but not completely come true: "While complete uniformity of practice throughout the world is not necessary, nor even desirable perhaps, it would seem that since the earthquake phenomenon itself is substantially the same as nature displays it world-wide, that eventually we may see more uniform expression of the principles needed to be applied to resist earthquake motions in man-made structures (Rinne 1966)." Undoubtedly some aspects of earthquake engineering have proven themselves to the point where they have been adopted around the world, but national boundaries and internal boundaries in a country between zones of higher and lower seismicity or higher and lower wealth are still very significant barriers to such "uniform expression." As with other globalization trends, one may argue that uniformity has both negative and positive aspects, and there are some positive aspects to the diversity within the earthquake engineering field today. The goal of bringing adequate seismic protection to people is a uniform, global aim, but implementation of that goal may take more than one path.

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