THE EARTHQUAKE ARCHITECTURE WEBSITE

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ABSTRACT
Following an informal meeting at the 13WCEE held in Vancouver, Canada in 2004, a website called Earthquake Architecture was established. The website (http:/www.curee.org/architecture) is hosted by the Consortium of Universities for Research in Earthquake Engineering (CUREE) and is co-convened by Andrew Charleson of Victoria University of Wellington and Robert Reitherman of CUREE. This paper reports on the website and its intended purpose, which is to provide a forum for those interested in architectural aspects of earthquakes.

KEYWORDS
Architecture, seismic design

1. INTRODUCTION

Only a small number of people who are active in the earthquake engineering field have architectural backgrounds. As one quantitative description of this situation, of the 2,500 members of the Earthquake Engineering Research Institute, only nineteen, or three-fourths of one percent, self-identify in the category of architecture. (EERI 2008, p. 229) By comparison, structural engineering is a disciplinary category containing 988 members, or 40% of the total. (EERI 2008, pp. 232-237). The title of the website, drawn from the same term used in papers by Charleson and Taylor (2004) and Reitherman (1985), is parallel to the term earthquake engineering but is intentionally novel, making one stop to think for a moment what the architectural aspects of earthquake-resistant design might be. This fourteenth in the series of world conferences on earthquake engineering is itself a data point indicating how common the term earthquake engineering is, while earthquake architecture has an unfamiliar sound to it. This lack of architectural involvement in the field has been recognized as a problem for many years, because of several strong effects architecture has on seismic design.

2. HOW DO ARCHITECTS INFLUENCE THE SEISMIC DESIGN OF BUILDINGS?

Architects are typically at the front-end of the building design process. In many instances, the architect has a contract directly with the owner, whereas the other design professionals are in turn retained by and report to the architect. By the time a structural engineer is consulted, some basic design decisions have probably been made by the architect and owner with regard to siting, budget, and occupancy type or types. The architect and owner work out the architectural program, or the performance requirements and objectives of the building, such as how much space should be devoted to rentable offices, how much to shops, and approximately how these uses should be arranged, such as having the ground story devoted to shops and offices on the upper floors. At this point, the building has not been preliminarily sketched, yet some aspects of its design are being determined that only later will receive the attention of the structural engineer. Whether the renovation of an older building will be only cosmetic and nonstructural or whether seismic upgrading of the structure will be a major aim may also be largely decided at this early point in the design process, prior to an engineer joining in the deliberations.

As the design process proceeds, it is the architect who typically controls the configuration of the building. The layout of the building may be seismically positive, as when the design of a bearing-wall building apportions wall

lengths uniformly throughout the plan and around the perimeter. Or, the architect's configuration for the building may pose seismic vulnerabilities, as the building is configured to have one side devoid of structural walls, causing a torsional imbalance in plan. Some of these decisions may be reasonable even if seismically disadvantageous. For example, the unbalanced wall layout might be because a house has a spectacular view in one direction. An art studio or gallery might have this layout to provide extensive glazing on the north side in the northern hemisphere, or south side in the southern hemisphere, so that indirect rather than direct light from the sun is admitted. A number of seismic design configuration problems, and explanations of architectural reasons for why they often arise, are discussed in Arnold and Reitherman (1982).

Many of the nonstructural components of a building are architectural in nature and designed and specified in detail by the architect without review by the structural engineer. These architectural components include partitions, windows, and ceilings, all of which can perform poorly in earthquakes unless their seismic behavior is understood and considered in design. For example, even in highly seismic California, where building code provisions for earthquakes are enforced relatively thoroughly, it is usually only the special case of a hospital where a structural engineer's expertise is applied to the detailing of partitions, and then only if the partitions are loaded with heavy equipment or cabinetry.

A way in which architecture could positively affect the seismic design of buildings but only rarely does so is by visibly expressing the features of the building that resist earthquake shaking or that protect it via load-reducing isolation or damping technologies. Architectural style is a powerful force. As the late University of California at Berkeley architecture professor George Simonds once said, "In architecture, form follows fashion." Styles or fashions expressing other influences on building design have often been featured – why not the influence of earthquake-resistance? The Gothic cathedral with its trademark flying buttresses is regarded by most and certainly by the author as a wonderful accomplishment in architectural aesthetics, and yet that distinguishing feature was added to the previous sans-flying-buttress style of building to solve the lateral force-resisting problem faced by the tall and heavily perforated walls in resisting the arching thrusts and wind loads from the roof structure. In the 1970s, energy conservation was a timely and popular architectural topic that was visually expressed in a variety of ways. Known as green building today, this theme has even been stylistically emphasized in such a visible (and expensive) manner as covering a building's roof with soil and plants. (The structural engineer adds up the kilograms of soil in that green building feature and calculates it increases seismic loads – green trumps seismic in this case). An architectural style emphasizing the lateral force-resistance of a building might be called the Seismic Style, Lateralism, Terremotoism, or Jishenism (Reitherman 1998). There are valid reasons for not making a big architectural feature of the seismic design of a building, even in a highly seismic region. However, it does seem to be a design possibility that is too little explored, both for the purpose of more efficiently integrating architecture and structure and also to create exciting new aesthetic forms, some of which are illustrated in CUREE (2005).

3. WEBSITE STRUCTURE AND CONTENTS

The above argument, that there is little involvement of architects in the field of earthquake engineering and seismic design, and that architectural aspects of that field are important, has led to a modest attempt to improve the situation. The Earthquake Architecture website was developed by Darryl Wong of CUREE, Consortium of Universities for Research in Earthquake Engineering, following an informal lunchtime gathering of about a dozen attendees of the 13WCEE in Vancouver, Canada in 2004. The website (http://www.curee.org/architecture/) has provided an international forum for archiving information in this subject area, notifying interested parties of events in the field, proposing innovative designs, and in general helping people interested in this subject area to collaborate. The website is structured in the categories shown in Table 1.

Table 1: Earthquake Architecture Website Structure

Directory Sign-up
Directory of Interested Individuals
Articles, Papers, and Books
Design Competitions
Conferences
University Curricula
Websites
Gallery of Proposed and Built Projects
Suggested Initiatives

At present, the directory of interested individuals includes individuals from 23 countries: Algeria, Argentina, Bahrain, Barbados, Costa Rica, Croatia, Germany, Greece, India, Iran, Israel, Italy, Japan, Luxembourg, New Zealand, Pakistan, Romania, Serbia and Montenegro, Slovenia, Syria, Turkey, United Kingdom, United States.

The Directory allows individuals to indicate one or more of the following twelve kinds of interests in the context of architectural aspects of earthquakes, which indicates the broad scope of this forum: Practice of Structural Engineering; Practice of Architecture; Teaching Architecture Students; Teaching Engineering Students; Architectural History; Architectural Theory; Expression of Seismic Design, Aesthetics, Architectural Form and Configuration; Vernacular Architecture and Earthquakes; Contributing to a Theme Session for a Major Architecture or Engineering Conference; Contributing to an Exhibit; Contributing Chapters to a Book or Workshop Proceedings; Design Exemplars, Profiles of Instructive Built or Proposed Buildings and Other Works.

4. AN ASSESSMENT

The website has been operated as a service by CUREE without any grant funding, so in terms of value for cost, even a modest value can be considered an efficient accomplishment. However, in terms of overall effect, rather few individuals, 72, have taken advantage of the website by listing their contact information in the Directory, and some features of the website, such as University Curricula, remain unused. One goal of the organizers of the website was that a sizable enough nucleus of interested individuals would coalesce via the website so that some further activities would materialize, such as a conference devoted to the earthquake architecture subject. That has not occurred.

However, there are three grounds for optimism concerning the future of the website. First, it is a well-organized holding place that can expand to accommodate any quick increase in interest in the subject. Second, a number of the individuals using the site are architecture students, who may have an influence on the future. And third, consider the theme session on Architecture and Earthquake Engineering, convened by Andrew Charleson, which is being held at the 14WCEE of which this paper is a part. This is the first time a session has been devoted to that topic since the beginning of the World Conference series a half-century ago in 1956. Increased use of the Earthquake Architecture website, and spin-offs from it, may increase in the future.

REFERENCES

Arnold, Christopher and Reitherman, Robert (1982). *Building configuration and seismic design*. John Wiley & Sons, New York.

Charleson, Andrew and Taylor, Mark (2004). "Earthquake architecture explorations," *Proceedings of the 13th World Conference on Earthquake Engineering*, Vancouver, Canada (paper no. 596).

CUREE (2005). "The expression of seismic design," the 2005 CURE Calendar. Consortium of Universities for Research in Earthquake Engineering, Richmond, CA, available via the World Wide Web at: http://www.curee.org/image_gallery/calendar/essays/2005-CUREE_excerpt.pdf.

EERI (2008). *Membership directory – 2008*. Earthquake Engineering Research Institute, Oakland, CA.

Reitherman, Robert (1985). "Earthquake engineering and earthquake architecture," *Designing for Earthquakes*, American Institute of Architects, Washington, DC.

Reitherman, Robert (1998). Prospecting for the future: Searching for trends that would change structural engineering," *Proceedings of the 1998 Convention of the Structural Engineers Association of California*, Structural Engineers Association of California, Sacramento, CA.