

IT TOOLS AND HOUSING

The Web-based Encyclopedia of Housing Construction Types in Seismically Prone Areas of the World

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Overview

The Earthquake Engineering Research Institute has a current project underway jointly with the International Association of Earthquake Engineering to use the world wide web to build an interactive, dynamic, web-based encyclopedia of housing construction types in seismically prone areas of the world. The encyclopedia can be viewed on the web and users can also generate the encyclopedia in whole or in part as a conventional hard copy publication. With the expanding capabilities of the world wide web this project is breaking new ground in terms of building a global network and offering instant information exchange among professional colleagues in many diverse countries. Funding for this project is being provided by the EERI Endowment Fund and the Engineering Information Foundation of New York.

This endeavor is linking over 180 volunteer engineers and architects from 50 different countries to date, enabling them to develop and share data, and providing them with the tools to improve housing vulnerable to earthquakes, thereby saving lives and reducing future economic losses. The ultimate goal is to make a product that is useful not only to design professionals but to housing and community development experts as well as international agencies concerned with sustainable development and hazard reduction.

This project was launched in January 2000. The first presentation, calling for participants from all countries with seismic risk, was made to an international audience at the 12th World Conference on Earthquake Engineering in Auckland, New Zealand in February 2000. Over 100 volunteers signed up at that meeting to contribute knowledge on housing construction types in their individual countries, and the roster of participants has grown continuously since then. The current roster can be viewed at the project web

site: www.world-housing.net.

The project is overseen by a steering committee with global representation. Members include: Svetlana Brzev (chair), EERI Vice President, British Columbia Institute of Technology, Canada; Sergio Alcocer, EERI Director, Institute of Engineering at UNAM, and National Center for Disaster Prevention, Mexico; Christopher Arnold, EERI Past President, and Building Systems Development, Inc., USA; Sheldon Cherry, University of British Columbia, Canada, and Past President, International Association of Earthquake Engineering; Craig Comartin, Comartin-Reis, USA; Ian Davis, Disaster Management Centre, Cranfield University, U.K.; Marjorie Greene, EERI Special Projects Manager, USA; Farzad Naeim, John A. Martin and Associates, and member, EERI Endowment Committee, USA; and Ravi Sinha, Indian Institute of Technology, Bombay, India.

Major Categories of Information in the Encyclopedia

For each country in the encyclopedia, the following information is typically available: seismic hazard map; general housing and population statistics and basic information on housing policy and disaster preparedness, from the United Nations Habitat databases; available forms for various construction types (the heart of the encyclopedia); and links to other useful country-specific web sites.

In addition, the encyclopedia also contains basic information on the nature of earthquakes, the earthquake behavior of buildings, and the performance of particular construction materials in earthquakes. There are also links to various publications developed by project participants and particularly relevant to issues in global housing. For example, the Colombian Society of Earthquake Engineering has recently published two excellent volumes on earthquake repair and strengthening—one for masonry and one for typical “bahareque” construction (combination masonry and bamboo) which have useful illustrations and explanations. These are the types of publications which will be linked to the encyclopedia.

Standard Form

The project steering committee has developed a standardized form that is used by project participants to describe individual construction types in their respective countries. The form consists

of over 60 questions, covering relevant aspects of housing construction including architectural features, the structural system, seismic deficiencies and strengths, performance in past earthquakes, available strengthening technologies, building materials used, the construction process, and insurance. The steering committee has identified over 30 generic structural systems covering global housing construction made out of masonry, concrete, timber, and steel. An important feature of the form is that it is able to describe features of both nonengineered rural housing (e.g. adobe masonry) and urban highrises (e.g. concrete shear wall buildings, prefabricated concrete panel buildings, etc.). Using the standard form, participants are encouraged to contribute as many forms describing various urban and rural housing construction types characteristic for their

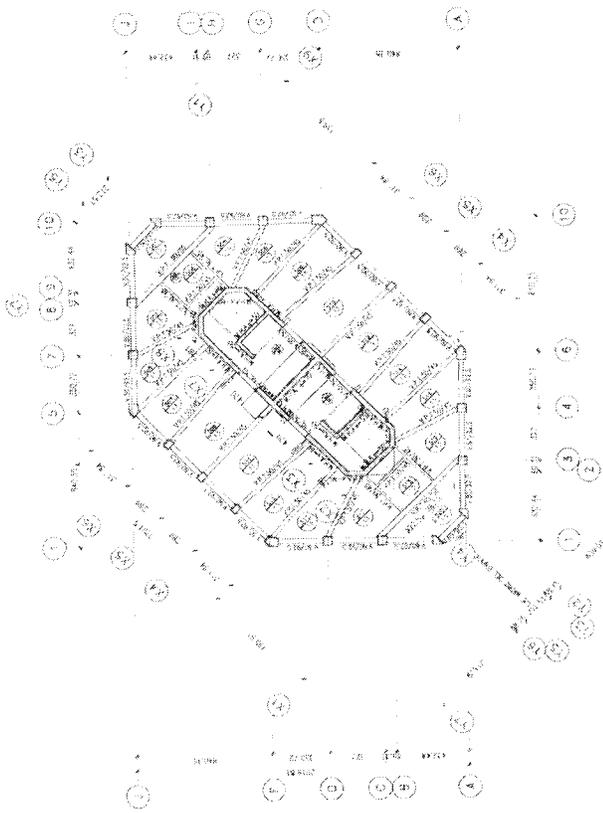


Fig. 1.
Plan of typical concrete frame and shear wall building in Chile



Fig 2. Seismic strengthening of concrete frame and shear wall

countries as possible.

Depending on the structural system and the country, each form contains unique information. However, the fact that participants all respond to a common set of questions makes it possible for comparison. The forms typically contain many illustrations, both photos and figures, that further describe the construction type. These figures, along with all the information provided to each question, are then entered into a database. Figures 1 and 2 illustrate the kinds of figures provided; these figures are from a form

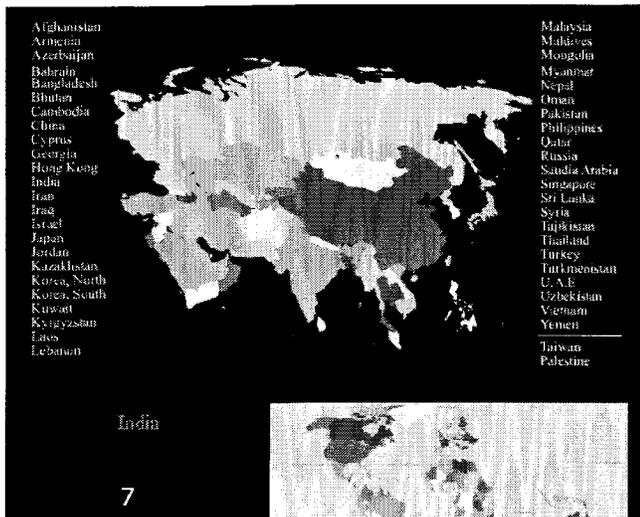


Fig. 3. In this example, seven reports are available from India. A user can specify a continent, and then view all the countries for which reports are available. In the example below, a user has selected Europe, and can see that reports are currently available from Greece, Italy, Romania, Slovenia and Yugoslavia. The user then selects Italy. The seismic hazard map for the country then appears.

describing concrete frame and shear wall construction in Chile.

Each form contains information in the following general categories: General Information; Architectural Features; Socio-economic Issues; Structural Features; Evaluation of Seismic Performance and Seismic Vulnerability; Earthquake Damage Patterns; Building Materials and Construction Process; Construction Economics; Insurance; and Seismic Strengthening Technologies.

General Information

General information includes a summary and information on the typical period of practice for the particular construction type.

Architectural Features

Each form answers a series of questions on architectural features for the particular construction type under description, including openings, siting (typically flat terrain, hillsides, common walls),

building configuration, building function, means of escape and typical modifications made to the building type.

Socio-economic Issues

Included in this section is information on patterns of occupancy, number of housing units in a building, average number of inhabitants in a building, number of bathrooms or latrines, economic level of inhabitants, typical sources of financing and type of ownership/occupancy.

Structural Features

The heart of the form and of the encyclopedia itself is the information describing the structural system. Text describing the lateral load-resisting system and the gravity load-bearing structure is included, as well as tables identifying the structural system, type of foundation, and type of floor/roof system. In addition, participants provide information on typical plan dimensions, typical number of stories, typical story height, typical span, and typical wall density.

Evaluation of Seismic Performance and Seismic Vulnerability

The encyclopedia also contains information on any seismic deficiencies associated with the construction type, as well as its earthquake resilient features and its performance in past earthquakes. Using a table based on FEMA-310, participants indicate the seismic resistance of the various structural and architectural features of the construction type. Seismic deficiencies, earthquake-resilient features and earthquake damage patterns for critical structural elements are summarized in a table. The description is complemented with the illustrations, wherever appropriate.

Earthquake Damage Patterns

Participants are asked to provide information on past earthquakes in their countries that have affected the construction type under discussion. For each of these earthquakes, a table lists year, epicenter, Richter magnitude, and maximum intensity (noting scales used). Additional comments discussing damage may also be included. The participants are encouraged to provide several illustrations of earthquake damage to a particular construction type. Such illustrations are valuable for professionals interested in comparative

seismic performance of different construction types worldwide.

Building Materials and Construction Process

Another section of the encyclopedia includes information on building materials and the construction process, including a description of the characteristic strength of the building material and details regarding the construction process. Design and construction expertise is described, as are building codes and standards, building permits and development control rules, the role of engineers and architects, the phasing of construction, building maintenance, the process for building code enforcement and typical problems associated with this type of construction.

Construction Economics

The unit construction cost is described for each housing type, expressed in local currency and U.S. dollars. The labor requirements are also summarized in terms of the number of days required to complete the construction.

Insurance

Participants are asked to indicate if insurance is available for this construction type, and to indicate if premium discounts or higher coverage is available for seismically strengthened buildings or new buildings built to incorporate seismically resistant features. A brief summary of what earthquake insurance covers is also included.

Seismic Strengthening Technologies

Another important element of the encyclopedia is the discussion of seismic strengthening technologies available for each construction type. In some cases, no strengthening is needed or none has been tried; for other construction types a range of strengthening techniques are available and are summarized in text and through figures. One of the objectives of the encyclopedia is to enable sharing of information related to effective seismic retrofit technologies used for various construction types worldwide. Technologies tested in real earthquakes have been identified and described whenever possible.

Dynamic Web Site

The project has recently made a transition from the static listing of information in each form to a searchable, web-based database of information so that a user can search by various parameters,

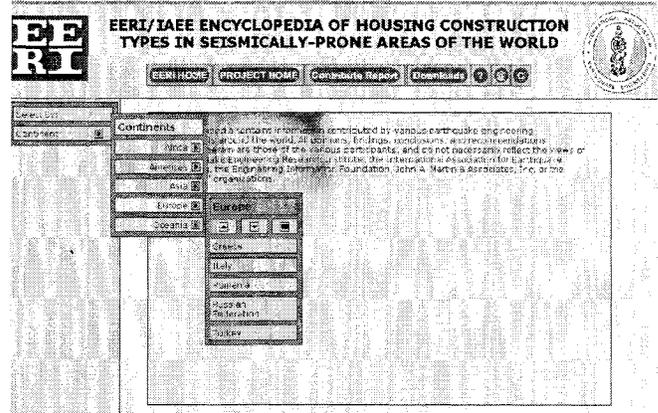


Fig. 4. Currently available reports in Europe
When the user scrolls down, the specific reports available for that country appear. In this example we can see that four reports are available for Italy. The user can select one, either to view on-screen in html format, or as a .pdf file.

| Report ID | Contributors | Building Description | View Report | |
|-----------|---|--|-------------|-----|
| | | | HTML | PDF |
| 26 | <ul style="list-style-type: none"> Dina D'Alagni Ricardo Speranza | Single-family stone masonry houses | | |
| 11 | <ul style="list-style-type: none"> Agustina Cecchi Mauro Corvini Paolo Santoni | Block masonry farmhouse with a "dead box" | | |
| 22 | <ul style="list-style-type: none"> Dina D'Alagni Ricardo Speranza Francesco DiPasquale | Single-family historic brick masonry houses (case uniforme in centro storico, Centro Italia) | | |
| 30 | <ul style="list-style-type: none"> Maurizio Loggini Giuseppe Lacava Roberto Soria | Reinforced concrete frame building | | |

Fig. 5. Reports available for Italy
Each form has 13 sections, including a photo gallery. Above we see the on-line summary and sections for the U.S. contribution on wood frame construction, and the thumbnail photo gallery for the Chinese contribution on base isolation.

including: country; urban/rural construction; seismic hazards; building function; building materials; structural system; seismic vulnerability rating; and economic level of inhabitants.

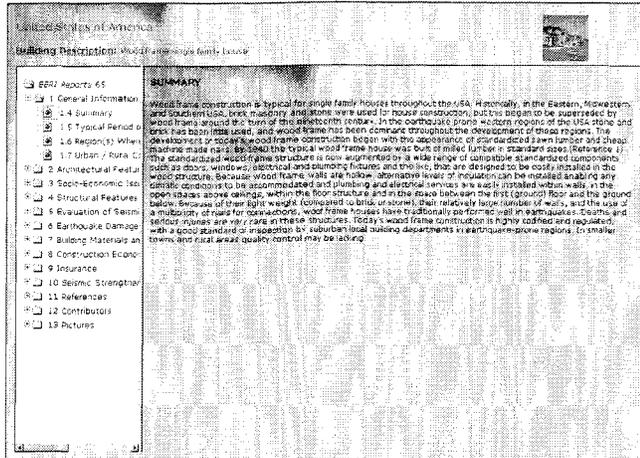


Fig 6. On-line summary from U.S. example on wood frame construction.

The searchable database enables the users to, for example, identify all contributions from a certain country or a continent. In the example below, the user has clicked on the continent of Asia and is given a listing of all countries and regions there. When the cursor passes over a country, it turns red and the number of reports available for that country is indicated in the corner.

Another type of search is by various common features for housing construction types. At the present time, there are 13 major search parameters specified on the web site, as follows:

- Geographical distribution
- Building function
- Urban vs. rural construction
- Period of practice
- Economic level of inhabitants
- Load-bearing structure
- Building material
- Number of stories
- Seismic vulnerability rating
- Seismic strengthening technologies
- Engineered vs. non-engineered construction
- Building codes and standards
- Earthquake insurance

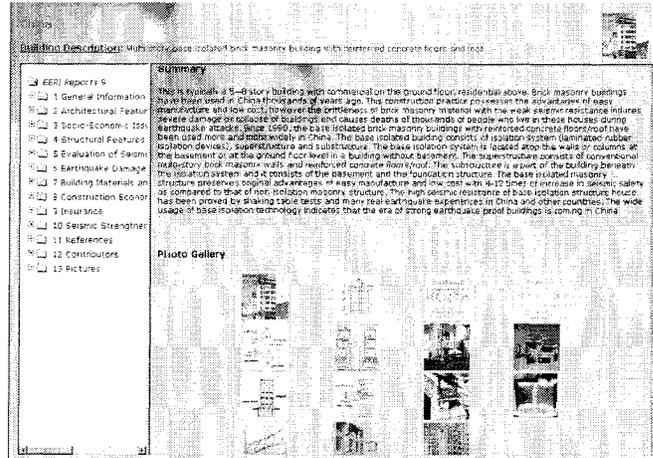


Fig 7. Photo gallery from Chinese example on base isolated apartment building.

For example, a search of geographical distribution and building function would enable the user to identify all single-family housing construction types in India, or all multi-family housing types in Europe. It is also possible to perform searches by the type of load-bearing structure. For example, it is possible to identify all contributions describing concrete moment resisting frame structures in the world or in South America or in Chile. See Figure 8.

Searches on multiple criteria are also possible, for example a search by economic status of inhabitants (e.g. poor) + urban vs. rural construction (e.g. rural) + building material within a country/continent/world. Users of the encyclopedia will be able to compare strengths and vulnerabilities of the various construction systems and strengthening technologies that have been tried in different countries for the various construction types and building materials.

Concluding Remarks

The project is planned for substantial completion by the spring of 2003. However, the web information will remain and can continue to evolve indefinitely, creating a new form of encyclopedia and an expanding international network of professionals interested in improving the seismic performance of various housing construction types. New participants are continually welcomed. While much of

Reports Matching your criteria:

| Contributor | Country | Contributed by | Structure Type | HTML | PDF |
|-------------|---------|--|---|----------------------|---------------------|
| 8 | USA | <ul style="list-style-type: none"> • Chris Brown • Christine Gaudet | Concrete frame, low-rise, 10 stories | HTML | PDF |
| 11 | Canada | <ul style="list-style-type: none"> • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 12 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 13 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 14 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 15 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 16 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 17 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 18 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 19 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 20 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 21 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 22 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 23 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 24 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 25 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 26 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 27 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 28 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 29 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 30 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 31 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 32 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 33 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 34 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 35 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 36 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 37 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 38 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 39 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 40 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 41 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 42 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 43 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 44 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 45 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 46 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 47 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 48 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 49 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |
| 50 | Canada | <ul style="list-style-type: none"> • J. P. Gaudet • Bill Gossens/Ralph | Concrete frame, 10 stories, 100% moment-resisting frame | HTML | PDF |

Fig 8. Results of a search for all contributions of concrete moment-resisting frames.

the initial information has come in from developing countries, the emphasis during the remainder of 2002/2003 will be on collecting construction types from developed countries with high seismic risk, including Japan, New Zealand, the U.S., Mexico and Canada. Further information is available from the web site, www.world-housing.net or by contacting the project chair, Svetlana Brzev, at sbrzev@bcit.ca, or EERI Special Projects Manager, Marjorie Greene, at mgreene@eeri.org