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Nonstructural Damage Database

by

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Technical Report MCEER-99-0014

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This report describes a nonstructural damage database, which provides damage information on nonstructural components in buildings and other constructed facilities in earthquakes from the Alaska Earthquake of 1964 to the present. It contains nearly 3,000 entries encompassing more than 50 earthquakes. Within each entry is a description of the damage to the nonstructural component, along with information on the building in which the damage occurred, as well as strong ground motion records, when available. Information has been gathered from various available publications, such as books, reports and periodicals. The database, in Access format, can be downloaded from the publications section of MCEER's web site (http://mceer.buffalo.edu/pubs.html).

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Preface

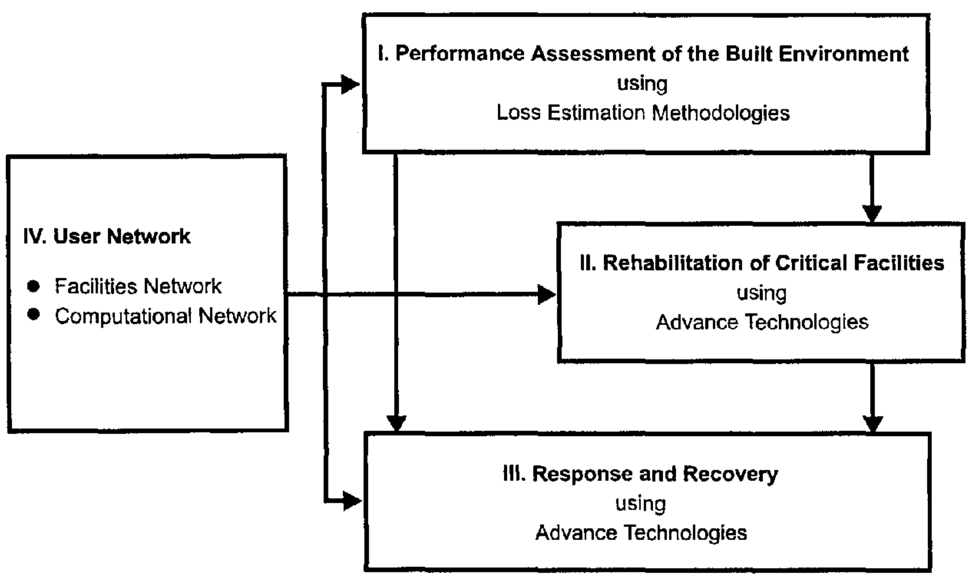
The Multidisciplinary Center for Earthquake Engineering Research (MCEER) is a national center of excellence in advanced technology applications that is dedicated to the reduction of earthquake losses nationwide. Headquartered at the University at Buffalo, State University of New York, the Center was originally established by the National Science Foundation in 1986, as the National Center for Earthquake Engineering Research (NCEER).

Comprising a consortium of researchers from numerous disciplines and institutions throughout the United States, the Center's mission is to reduce earthquake losses through research and the application of advanced technologies that improve engineering, pre-earthquake planning and post-earthquake recovery strategies. Toward this end, the Center coordinates a nationwide program of multidisciplinary team research, education and outreach activities.

MCEER's research is conducted under the sponsorship of two major federal agencies: the National Science Foundation (NSF) and the Federal Highway Administration (FHWA), and the State of New York. Significant support is derived from the Federal Emergency Management Agency (FEMA), other state governments, academic institutions, foreign governments and private industry.

The Center's NSF-sponsored research is focused around four major thrusts, as shown in the figure below:

- quantifying building and lifeline performance in future earthquake through the estimation of expected losses;
- developing cost-effective, performance based, rehabilitation technologies for critical facilities;
- improving response and recovery through strategic planning and crisis management;
- establishing two user networks, one in experimental facilities and computing environments and the other in computational and analytical resources.



This report describes a database which provides damage information for nonstructural components in buildings and other constructed facilities. It contains nearly 3,000 entries encompassing more that 50 earthquakes from the 1964 Alaska earthquake to the present. Information from various publications, including books, reports and periodicals, was gathered and recorded, including a description of the damage to the nonstructural component, information about the building where the damage occurred, and strong ground motion records, when available. The database is a work in progress, and will continue to be updated as new information becomes available.

The nonstructural components database, in Access format, can be downloaded from the publications section of MCEER's web site (http://mceer.buffalo.edu/pubs.html).

ABSTRACT

This report describes a Nonstructural Damage Database, which provides damage information on nonstructural components in buildings and other constructed facilities in earthquakes from the Alaska Earthquake of 1964 to the present. It contains nearly 3,000 entries encompassing more than 50 earthquakes. Within each entry is a description of the damage to the nonstructural component, along with information on the building in which the damage occurred, as well as strong ground motion records, when available.

Information has been gathered from various available publications, such as books, reports and periodicals. Information on damage to nonstructural components is not easily available; most earthquake reconnaissance reports and other publications concentrate on structural or geological elements. Therein lies the challenge facing the development of this database. It will never be completely finished, as earthquakes continue to occur and new information becomes available. This database is presented as a living document, which will continue to be updated and evolve.

ACKNOWLEDGEMENTS

The work presented in this report was partially funded by the Multidisciplinary Center for Earthquake Engineering Research (MCEER), Projects 981504 and 982401. This support is gratefully acknowledged. The authors also wish to acknowledge the support of the MCEER Information Services, which provided working space, equipment, and staff support during the course of this study.

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SECTION 1

INTRODUCTION

Nonstructural components of a building are those systems, parts, elements, or components that are not part of the structural load-bearing system but are subjected to the building dynamic environment caused by, for example, an earthquake. Typical examples of nonstructural components include architectural partitions, piping systems, ceilings, building contents, mechanical and electrical equipment, and exterior cladding. The importance of nonstructural component issues in seismic design and performance evaluation is now well recognized by researchers as well as practicing engineers. The subject received special attention after the San Fernando earthquake in 1971 when it became clear that damage to nonstructural components not only can result in major economic loss, but also can pose real threat to life safety. For example, an evaluation of various veterans hospitals following the San Fernando earthquake revealed that many facilities still structurally intact were no longer functional because of loss of essential equipment and supplies. Economic loss due to seismic nonstructural damage can also be considerable. A case in point is the seismic damage sustained by a seven-story hotel during the 1971 San Fernando earthquake. Of $143,000 in total damage in 1972-value dollars, only $2,000 was structural damage while the remaining 98.56% was nonstructural.

These damage patterns were repeated in more recent earthquakes as well. After the Loma Prieta earthquake of 1989, for example, a survey of 60 hospitals in the affected six-county area showed widespread minor damages to nonstructural components. Numerous pieces of equipment broke loose from their attachments and separated from ductwork or piping, causing problems for the affected facilities. Older vibration isolators and machine mounts in some cases literally exploded during the event. Elevators in these facilities posed a separate problem. Of the 428 elevators in the survey, 282 or 65.9% were tripped by motion detectors and out of service for between 10 minutes to three weeks, 50 of these sustained damage ranging from loosened bolts attaching the guide rails to twisted rails due to vibration of the counterweights.

Similarly, several major hospitals and medical centers were forced to curtail their services and evacuate patients after the Northridge earthquake in January, 1994. None of these hospitals had serious structural damage; however, they were forced to close due to nonstructural damage. Within the city of Los Angeles, the loss of Holy Cross and Northridge Medical Centers was particularly acute, since these facilities were the local trauma centers as well as paramedic base stations.

As a result, considerable attention has been paid in recent years to this problem area in order to generate better understanding of the seismic behavior of nonstructural components. Observed nonstructural damage during major earthquakes has played an important role in the investigation of a wide range of research issues dealing with seismic behavior of nonstructural components. These include realistic assessment of their seismic hazards, formulation of codes and provisions for nonstructural components which specify safety levels at which these components must be anchored or attached to a primary structure, and development of seismic design guidelines for their anchorage details and restraints. Hence, the importance of developing a comprehensive nonstructural damage database cannot be over-emphasized.

This report describes a Nonstructural Damage Database developed for the purposes described above. It provides damage information on nonstructural components in buildings and other constructed facilities in earthquakes from the Alaska Earthquake of 1964 to the present. It contains nearly 3,000 entries encompassing more than 50 earthquakes. Within each entry is a description of the damage to the nonstructural component, along with information on the building in which the damage occurred, as well as strong ground motion records, when available.

Information has been gathered from various available publications, such as books, reports, and periodicals. Information on damage to nonstructural components is not easily available; most earthquake reconnaissance reports and other publications concentrate on structural or geological elements. Therein lies the challenge facing the development of this database. It will never be completely finished, as earthquakes continue to occur and new information becomes available. This database is presented as a living document, which will continue to be updated and evolve.

Included in the database is a detailed user's manual, which provides more information on what the database covers, including a description of all the fields. It also explains how to use some tools that may be helpful in sorting through the information. The user's manual and the database are provided on MCEER's web site at *http://mceer.buffalo.edu* . The user guide is a Microsoft Word 97 document and the database is available as a Microsoft Access 97 file; the files are compressed using Winzip.

It is strongly suggested that the user refers to Microsoft's documentation on the Access database to manipulate the data presented herein. Brief descriptions of the manner which was used to set up the database are included, but these descriptions are by no means comprehensive.

SECTION 2

DATABASE DESCRIPTIONS

The database has been built using Microsoft Access 97. It contains a variety of functions, each of which is given a tab. The two main tabs used here are the ***Tables*** tab and the ***Forms*** tab. Tables are basically laid out like a spreadsheet, and are very similar in appearance. Forms are entry forms, the standard method to enter data in Access. The main form has been designed to present all of the necessary data in an orderly fashion. A summary of the different tables and forms is as follows:

Table 2-1: List of Tables and Forms

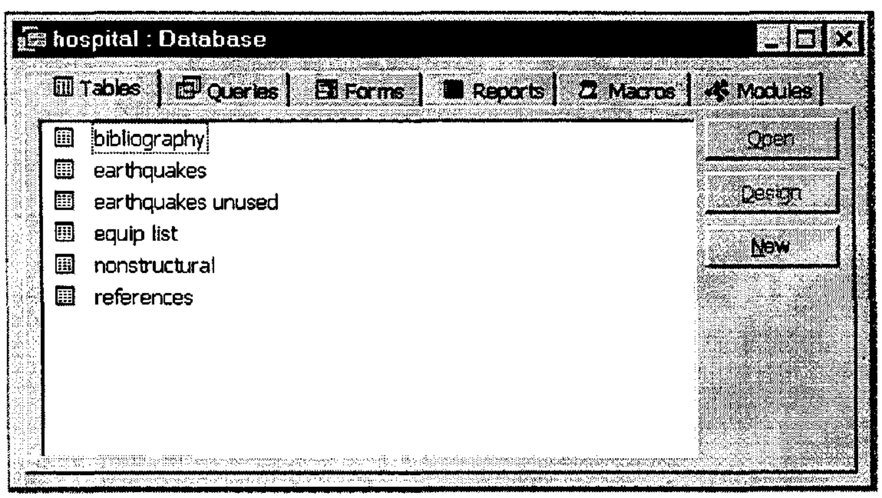
Tables	Forms
bibliography earthquakes earthquakes unused equip list nonstructural references	bibliography nonstructural references

The form entitled "nonstructural" is the main form used for data entry. The contents of these tables and forms will be discussed in more detail in the following sections.

2.1 Contents

2.1.1 Tables. The tables contain the information used to build other parts of the database, such as forms and reports. Currently, the database consists of six tables as shown in Table 2-2.

Table 2-2: View of Tables



- **bibliography** – This is a list of relevant sources that were scrutinized but not actually referenced in the database. This is provided to illustrate the coverage of the research involved in developing this database.
- **earthquakes** – A list of all of the earthquakes that have entries in the database. The format of the listing is the name of the earthquake, followed by an approximate date, i.e., "Northridge, 1/94" or "Alaska, 3/64".
- **earthquakes unused** – A listing of earthquakes that were researched, but for which no useful or quantifiable information on nonstructural damage was found. These earthquakes do not have entries in the database. Provided here are the names of the earthquakes and the dates on which they occurred.
- **equip list** – This is a list of the different categories contained in the fields **equipment type** and **building type**. This list is linked to the **nonstructural** form and will be discussed further there.
- **nonstructural** – This is the main database in table form. It is linked to the **nonstructural** form, where it will be described in detail.
- **references** – A list of all the sources that were used to enter information into the database, in table format. These sources have been referenced in the **Reference** field in the **nonstructural** form.

Tables 2-3 and 2-4 provide partial views of the **earthquakes** table and the **nonstructural** table.

Table 2-3: The **earthquakes** table (partial view)

earthquakes : Table

Earthquakes
Northridge, 1/94
Kobe, 1/95
San Fernando, 2/71
Whittier Narrows, 10/87
Loma Prieta, 10/89
Philippines, 7/90
Umbria-Marche, 9/97
Landers, 6/92
Coalinga, 5/83
Morgan Hill, 4/84
New Zealand, 3/87
Alaska, 3/64
Iran, 6/90
Costa Rica, 4/91
Mexico, 9/85
Lijiang, 2/96
Cape Mendocino, 4/92

Record: 42 of 42

Table 2-4: The **nonstructural** table (partial view)

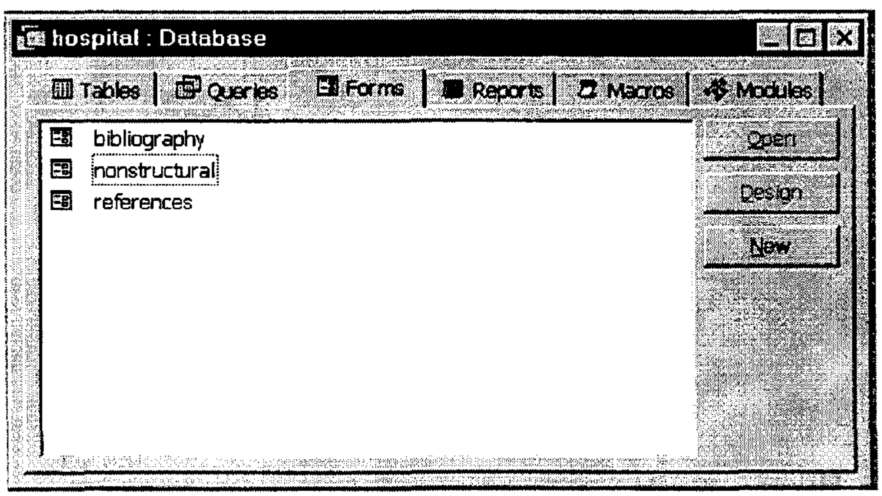
nonstructural : Table

Equipment	Damage	Impact	D
pipe	2 ft. x 3/4" diameter pipe broke at its (	hampered use c	
oxygen tank	vertical liquid, 8,000 gallon tank shear	failure of tank di	
fan unit	several 3/4" diameter anchor bolts fail	failure of the an	
ceiling tiles	dropped.	limited non-struc	a
seismic joint covers	crumpled. Building is separated from	limited non-struc	
ceiling, suspended acoustical	slight damage around column penetra	very limited dam	
sprinkler system	none, main lines effectively braced ag		
ceiling tiles	fell off; grid system failed in many loc	considerable da	8(
lights	fixtures dropped, hanged by electrica	vacant building,	5(
sprinkler	nearly all column and sprinkler penetr	vacant building,	ne
ceiling	grid damaged by impacting perimeter	failure affected	5(
lights	safety wires prevented them from falli	failure of ceiling	
sprinkler	heads interacted with the tile, but were		
ceiling tiles	4 ft. x 4 ft. tiles fell out of grid		7!
floor	elevated floor distorted enough to binc	did not compror	sc
light fixtures	some fell, others were restrained by s		

Record: 1 of 1894

2.1.2 Forms. The forms present the data in a more organized manner, making the information easier to digest and view. Currently, there are three forms: **references, bibliography,** and **nonstructural**.

Table 2-5: View of Forms

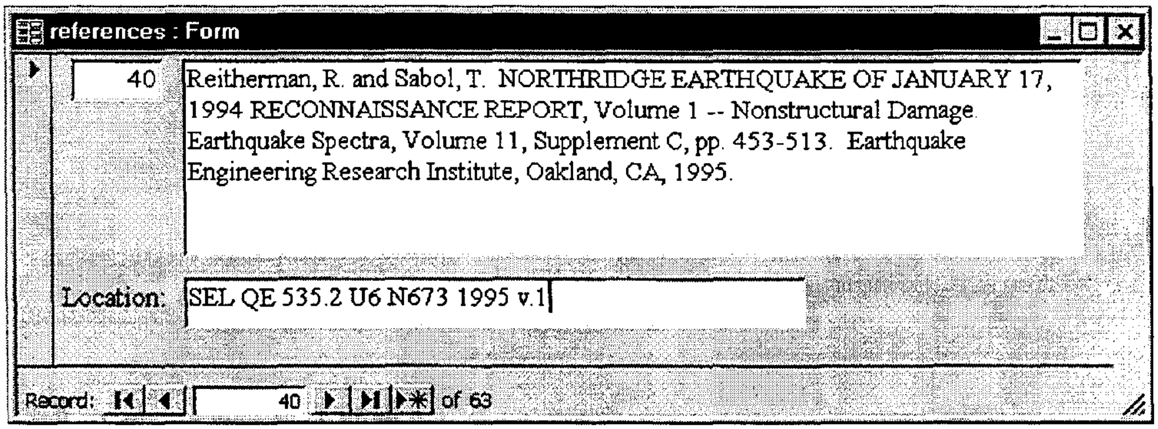


references form

This is the form version of the **references** table. It contains the following fields, linked from the **references** table:

- **Reference Number** – This is an Autonumber, automatically assigned to each entry by Access as they are entered.
- **Reference Name** – This contains all of the relevant information required when listing references, such as author, title, publisher, date of publication, and report number or volume number when necessary.
- **Location** – The call number of the reference at the Science and Engineering Library at SUNY at Buffalo. This is provided for internal use, for easy reference.

Table 2-6: The **references** form



The references are not in alphabetical order. They are numbered in the order that they are found and entered into the database.

bibliography form

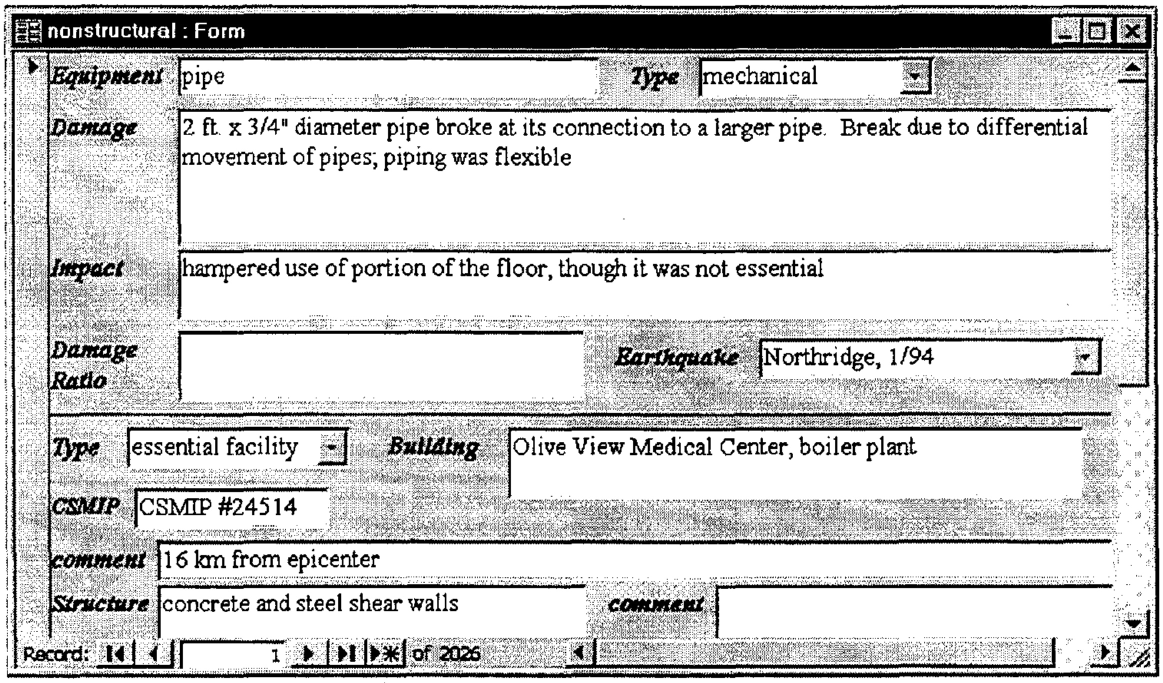
This is the form version of the **bibliography** table. Its fields are identical to those in the **references** form, except that they are linked to the fields in the **bibliography** table.

nonstructural form

This is the main form of the database, containing all the information related to the performance or nonstructural components. It is discussed in detail in the next section.

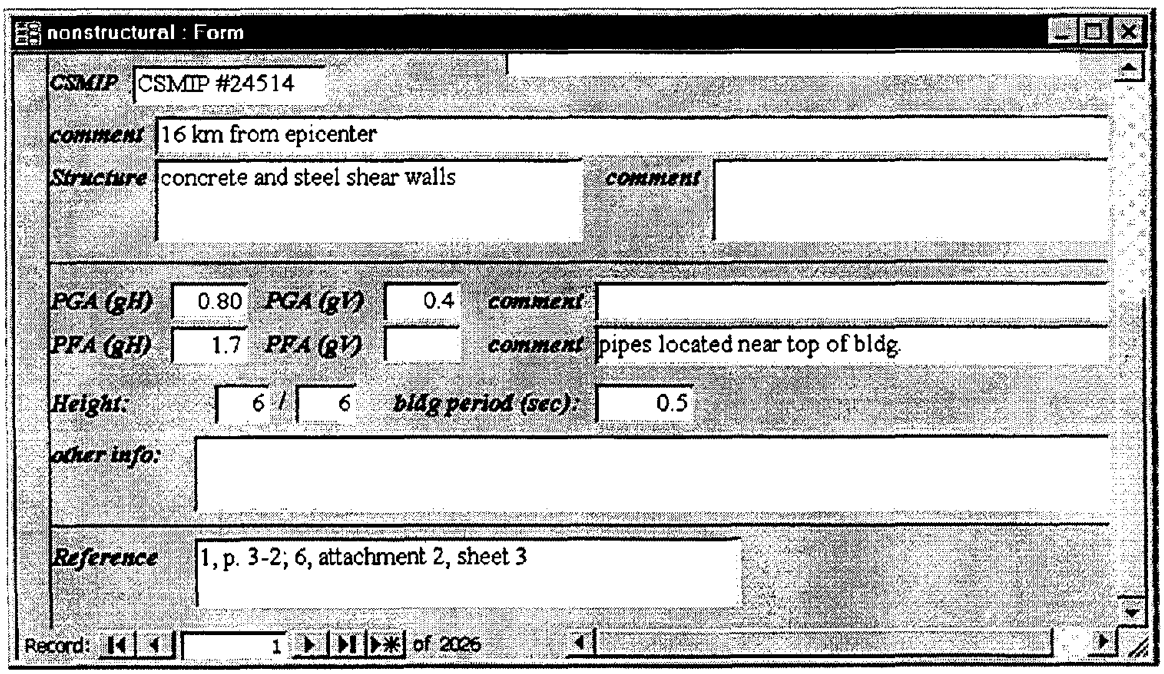
2.1.3 The Nonstructural Form. This is a long form with many fields, which are divided into the following categories: **Equipment Info, Building Info, Earthquake Info,** and **Reference.**

Table 2-7: The **nonstructural** form (top portion)


nonstructural : Form

Equipment: pipe
Type: mechanical
Damage: 2 ft. x 3/4" diameter pipe broke at its connection to a larger pipe. Break due to differential movement of pipes; piping was flexible
Impact: hampered use of portion of the floor, though it was not essential
Damage Ratio:
Earthquake: Northridge, 1/94
Type: essential facility
Building: Olive View Medical Center, boiler plant
CSMIP: CSMIP #24514
comment: 16 km from epicenter
Structure: concrete and steel shear walls
comment:
Record: 1 of 2026

Table 2-8: The **nonstructural** form (bottom portion)


nonstructural : Form

CSMIP: CSMIP #24514
comment: 16 km from epicenter
Structure: concrete and steel shear walls
comment:
PGA (gH): 0.80
PGA (gV): 0.4
comment:
PFA (gH): 1.7
PFA (gV):
comment: pipes located near top of bldg.
Height: 6 / 6
bldg period (sec): 0.5
other info:
Reference: 1, p. 3-2; 6, attachment 2, sheet 3
Record: 1 of 2026

Equipment Info. This group of fields describes the equipment or nonstructural component that was damaged. These fields are:

- **Equipment.** Name of the piece of equipment that was damaged. This is usually a general name such as “piping”, “ceiling”, or “elevator”, which would be expanded upon in the **Damage** field below. This could also be a more specific name such as "elevator, counterweight", or "piping, fire sprinkler". An entry of "none" means that there was no reported damage.

- **Type.** This refers to the category of equipment, linked from the **equipment type** list from the **equip list** table. This field is implemented as a pull-down menu for easy access. It was decided to follow the NEHRP Guidelines for the Seismic Rehabilitation of Buildings, FEMA-273/October 1997, with the addition of medical equipment for the purposes of this database. The equipment type categories are:
    - **architectural** – exterior skin (veneers, glass blocks, panels, glazing), partitions, interior veneers, ceilings, parapets and appendages, canopies and marquees, chimneys and stacks, and stairs.
    - **mechanical** – mechanical equipment (boilers, furnaces, machinery, HVAC), storage vessels and water heaters, various piping, and ductwork.
    - **electrical/comm.** – electrical and communications equipment (generators, batteries, telephone equipment, etc.), and lighting fixtures.
    - **furnishing/interior** – storage racks, bookcases, computer access floors, hazardous materials storage, computer and communication racks, elevators, and conveyors.
    - **medical** – various hospital equipment.

  If the equipment name was "none", then the **Type** field is left blank.
- **Damage.** A basic description of the damage, as detailed as the space will allow. In some cases, the description occupies the entire four lines allotted for the field with useful details and background information. In others, "damaged" is all the information that is available.
- **Impact.** A description of the direct impact of the damage, i.e. length of time the facility was closed as a result, number of people killed, necessary repairs, fires, floods, etc.
- **Damage Ratio.** This refers to how many pieces of identical equipment at the facility were damaged, in relation to the total number at the site. For example, if there were 4 oxygen tanks at the facility and 2 were damaged, the damage ratio would be "2/4". This field is not strictly a fraction; it could also be a percentage, or if clarification is necessary, it could read, "2 of 4 fell over."
- **Earthquake.** Name of the earthquake in which the equipment was damaged. This field is implemented as a pull-down menu for easy access, linked from the **Earthquakes** table.

Building Info. This section describes the building in which the damage (or lack of damage) occurred.

- **Type.** This is the category to which the building belongs. It is implemented as a pull-down menu linked from the **building type** list in the **equip list** table. The categories are:
    - **hospital** – This encompasses, in addition to hospitals, any kind of medical facility such as a psychiatric institute.
    - **essential facility** – This is a building that needs to remain functional, especially in times of crisis (such as an earthquake). This would include fire

and police departments, airports, power plants, and communication facilities. Hospitals would also fit here, but they are given their own category.

- **academic** – schools and university buildings.
- **office** – office, or commercial buildings.
- **various** – This is for references that provide general data on several different types of facilities. If information is given for several facilities of the same type, then the normal category is still used.
- **unknown** – for references that do not specify the building type.
- **other** – buildings that do not fit into the other categories. Common entries of this type are residential buildings (apartments, houses, hotels), retail establishments, military facilities, etc.

- **Building.** Name of the building. This may include a specific part of a building complex, as well as the city it is in, i.e., "boiler plant, Olive View Medical Center, Sylmar".
- **CSMIP.** This is the identification number for buildings in the California Strong Motion Instrumentation Program, so it is only applicable for instrumented buildings in the state of California. "USGS" means that the building is monitored by the U.S. Geological Survey.
- **comment (#1).** This field usually contains the building's distance from the epicenter (in kilometers) if it is available. Otherwise, it could contain the street or town where the building is, or any geographical information that would be helpful in locating the building.
- **Structure.** This describes the building's structure type, i.e. steel frame, reinforced concrete, concrete and shear walls, etc.
- **comment (#2).** This comment field contains other information about the building's structure that might be helpful, i.e. the number of stories; whether it has a basement; or the date that it was built, which would help give an idea of the building standards in practice at the time of its construction.

Earthquake Info. This section provides information on the earthquake, and the building's performance in the earthquake.

- **PGA (gH).** Peak Ground Acceleration in the horizontal direction at the site, or near the site. Listed in units of g.
- **PGA (gV).** Peak Ground Acceleration (in g) in the vertical direction, at or near the site.
- **comment (#3).** This provides comments on the PGA's, which could be further explanation of the PGA fields, or where the strong motion readings came from if the site itself was not instrumented, i.e. "from Santa Monica City Hall, 0.8 km away."
- **PFA (gH).** Peak Floor Acceleration (in g) in the horizontal direction, at the floor where the equipment was located.
- **PFA (gV).** Peak Floor Acceleration (in g) in the vertical direction, at the floor where the equipment was located. Note: The PFA's are not commonly available as the site itself would need to be instrumented to have this information.
- **comment (#4).** Any additional details or explanation of the PFA fields. In some cases, the reference only provides the PFA at the roof of the building, but not at the

floor on which the equipment was located. That information could still be entered here as it could be useful as well.

- **Height.** This includes two fields, the first being the floor on which the equipment was located, and the second being the total number of floors in the building. For example, a piece of radiology equipment located on the 3rd floor of the 6-story Olive View Hospital would read, "3 / 6". If the height reads one greater than the total number of floors, such as "7 / 6", then that means the equipment was located in the penthouse or on the roof of the building.
- **bldg period (sec).** This is the building period in seconds at the time of the earthquake. This information is not usually available, unless the building itself was instrumented.
- **other info.** This is for additional information, such as: a brief description of the structural damage, information about the building or equipment that could not fit elsewhere, recommendations or lessons learned from the damage provided by the reference, or any other information that might be helpful.

Reference. This section of the form contains only a single field, named **Reference.** This is for citing the source from which the information for all the fields in the entry came from. The format is first the reference number (which corresponds to the number in the **references** form), followed by a comma, and then the page numbers, i.e. "25, p. 420-421". If multiple references are used, then they are separated with a semicolon.

SECTION 3

DATABASE COVERAGE

This section contains two parts: the Earthquake List, and Earthquakes Unused. They are provided here to give a general idea of the coverage of this database.

The Earthquake List covers earthquakes that have entries in the database. Earthquakes Unused covers earthquakes that were researched, but do not have entries since information on damage to nonstructural components in them was not found.

3.1 Earthquake List

The following is a list of all earthquakes covered by this database, and the number of entries they have.

Earthquake	Number of Entries
Northridge, 1/94	804
Loma Prieta, 10/89	261
Alaska, 3/64	237
Kobe, 1/95	151
Managua, Nicaragua, 12/72	117
Morgan Hill, 4/84	111
Miyagi-Ken-Oki, 6/78	105
San Fernando, 2/71	91
Coalinga, 5/83	77
Guam, 8/93	75
North Palm Springs, 7/86	69
Killari, 9/93	67
Imperial Valley, 10/73	64
San Salvador, 10/86	64
Whittier Narrows, 10/87	55
Newcastle, 12/89	53
Mexico, 9/85	50
Costa Rica, 4/91	40
Philippines, 7/90	40
Lima, 10/74	38
Bay of Plenty, NZ, 3/87	31
Montenegro, 4/79	29
Adak Island, 5/86	26
Erzincan, Turkey, 3/92	20
Umbria-Marche, 9/97	20

Earthquake	Number of Entries
Armenia, USSR, 12/88	19
Superstition Hills, 11/87	19
Alum Rock, CA, 6/88	14
Roermond, Netherlands, 4/92	13
Chile, 3/85	13
Cape Mendocino, 4/92	12
Livermore, CA, 1/80	12
Tokachi-oki, 5/68	12
Gorman, CA, 6/88	11
Saguenay, Quebec, 11/88	11
N. Italy, 5/6/76	10
Northern Kentucky, 7/80	10
Landers, 6/92	9
Quindio, Colombia, 1/25/99	8
Tonagawa, 7/68	8
Nihon-Kai Chubu, 5/83	6
Lijiang, 2/96	6
Iran, 6/90	5
Sanriku-Haruka-oki, 12/94	4
Seattle, 4/65	3
New Zealand, 3/87	3
Guatemala, 2/76	1
Izu Ohshima, 1978	1
Mindanao, Phillipines, 8/76	1
Kushiro-oki, 1993	1
Niigata, 6/64	1
Santa Barbara, 1978	1
Total:	**2909**

3.2 Earthquakes Unused

The following earthquakes have been researched, but information on damage to nonstructural components caused during them was not found. They do not have entries in the database.

Earthquake	Date
Jabalpur	May 22, 1997
Mexico Valley	June 9, 1980
Tangshan, China	July 28, 1976
Qir, southern Iran	April 10, 1972
El-Asnam, Algeria	October 10, 1980
Campania-Basilicata, Italy	November 23, 1980
Thessaloniki, Greece	June 20, 1978
Honomu, Hawaii	April 26, 1973
Miramichi, New Brunswick	January 9 and 11, 1982
Mindoro, Philippines	November 15, 1994
Muradiye-Caldiran, Turkey	November 24, 1976
Ecuador	March 5, 1987

SECTION 4

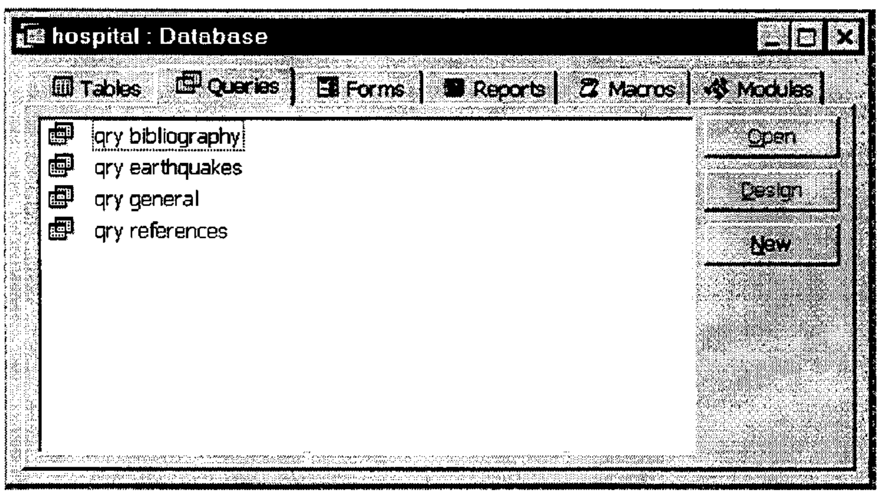
DATABASE FEATURES

It is not always desirable to view all of the entries in the database at once. This database can be manipulated like any other Access database to select applicable entries. A number of queries and reports are included in this database to ease this process.

4.1 Queries

Queries are used to find specific entries, or to sort the data without changing the corresponding table, as well as many other functions. Queries can be linked to tables or other queries, and are automatically updated as the linked data is entered or changed. This database contains four queries.

Table 4-1: View of Queries



The names of the queries begin with the prefix "qry" so that they are not confused with their corresponding tables.

- **qry bibliography** and **qry references** – These queries are used to sort the references in numerical order, by Reference Number. They are linked to the **bibliography** and **references** tables, respectively.
- **qry earthquakes** – This query provides a list of all the earthquakes with entries in the database. It also contains a count of entries that each earthquake has, and sorts them from the one with the most entries (Northridge) on top, down to the one with the least. In order to do this count, the "Total:" row is required, which is obtained by selecting the Σ (Totals) icon on the toolbar.

Table 4-2: **qry earthquakes** – Design View

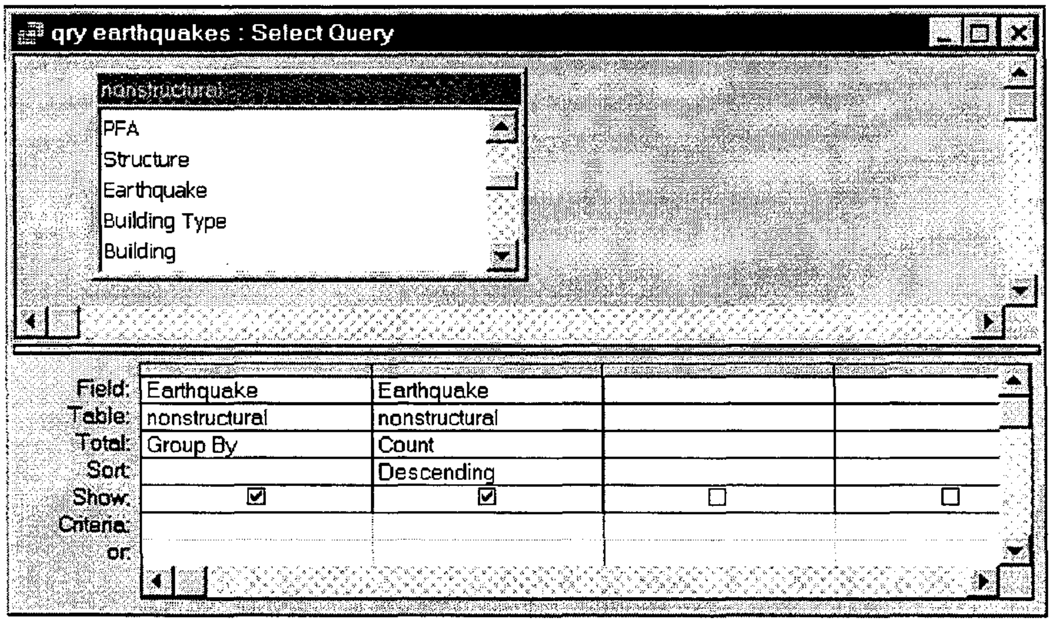


Table 4-3: **qry earthquakes** – Datasheet View

qry earthquakes : Select Query

Earthquake	CountOfEarthquake
Northridge, 1/94	804
Alaska, 3/64	237
Kobe, 1/95	151
Miyagi-Ken-Oki, 6/78	105
San Fernando, 2/71	91
Morgan Hill, 4/84	87
Loma Prieta, 10/89	81
Killari, 9/93	67
San Salvador, 10/86	64
Newcastle, 12/89	44
North Palm Springs, 7/86	41
Lima, 10/74	38
Montenegro, 4/79	29
Costa Rica, 4/91	25
Whittier Narrows, 10/87	21
Umbria-Marche, 9/97	20

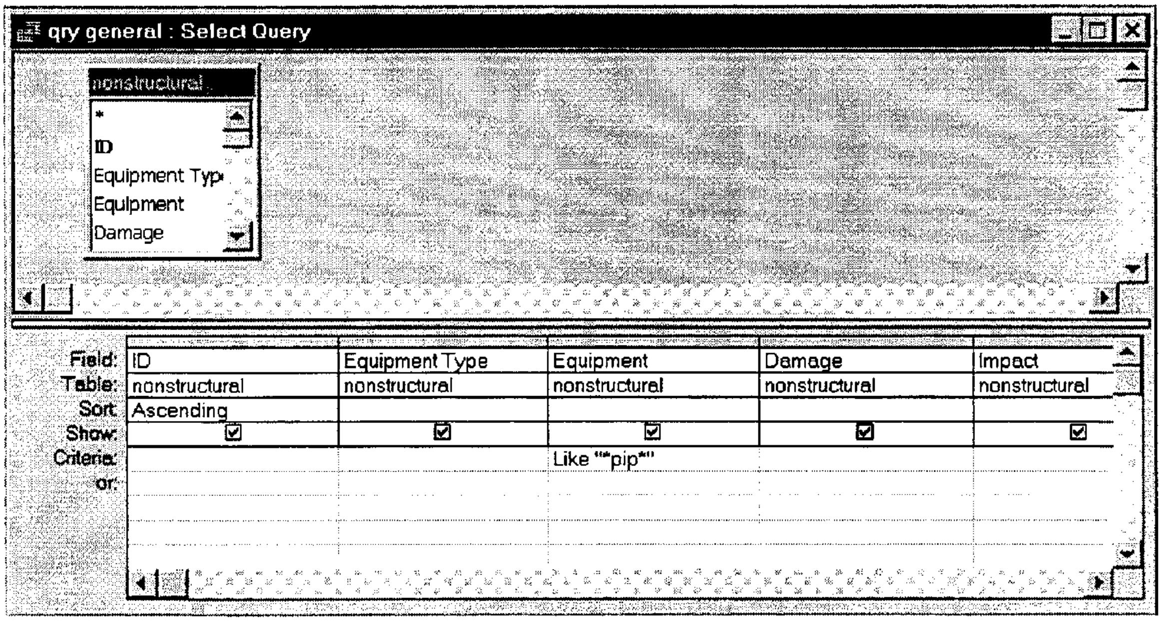
Record: 42 of 42

The functions of the query are set in Design View, and are implemented when the query is switched to Datasheet View.

- **qry general** – This query contains every field in the **nonstructural** table. It can be used to filter data for any field in the main database by entering conditions in the row labeled "Criteria".

For example, entries pertaining to piping systems could be obtained by doing the following:

Table 4-4: **qry general** – Design View



- Enter 'Like "*pip*"' in the "Criteria" row, under the "Equipment" column. This will filter the database so that only entries with equipment names that contain the string "pip" will be displayed. This is necessary since equipment names are not standardized, so the criteria must be flexible to include "pipe", "piping", "water pipe", "fire sprinkler piping", etc. The asterisks act as wildcards. Therefore, entering 'Like "pip*"' would only include entries with equipment names that *begin* with the string "pip".
- The "sort" row under the "ID" column can be set to "Ascending", using the pull-down menu. This will sort the filtered entries by their ID numbers, in ascending order.
- Switch to Datasheet View by selecting the View icon in the left-hand corner of the toolbar, or by selecting the ! (Run) icon, also on the toolbar. The filtered entries are then displayed.

Table 4-5: **qry general** – Datasheet View

qry general : Select Query

ID	Equipment Type	Equipment	Damage
1	mechanical	pipe	2 ft. x 3/4" diameter pipe broke at its
21	mechanical	water pipe, domestic	cast iron pipe broke at its nozzle du
37	mechanical	sprinkler, pipe	lines broken at connection just abov
79	mechanical	pipes	water pipes broke, resulting water d
82	mechanical	pipe	fire water line, incoming, buried, ha
93	mechanical	pipe	fresh water supply lost due to broke
95	mechanical	pipe	waste water disposal system inoper
119	mechanical	pipes	4" chilled water and smaller heating
120	mechanical	pipes	water pipes- 1/2" connection sheare
127	mechanical	pipes	water pipes- minor failure in steam,
128	mechanical	pipes	deionized water pipes- 1/2" and 3/4'
137	mechanical	pipe	valve seals failed
138	mechanical	pipe	underground fire sprinkler water ma
139	mechanical	pipe	domestic cold water and domestic h
149	mechanical	pipe	fire hose rack 1-1/2" nipple failed at

Record: 165 of 165

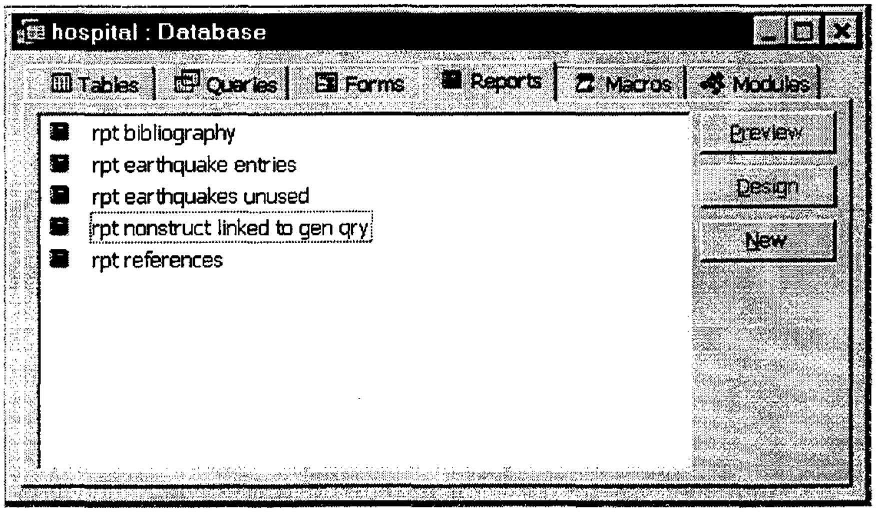
Other fields can be filtered in a similar fashion. For example, to obtain entries with PGA greater than 0.5 g, enter ">0.5" in the "Criteria" row under the appropriate column. To only view entries concerning the Northridge earthquake, enter "Northridge, 1/94" in the "Criteria" row under the "Earthquake" column. Separate criteria may be run at the same time to further narrow down the number of entries to be displayed. To display all entries in the database, do not enter any criteria.

The main purpose of the queries in this database is to manipulate and organize the data. Queries display information in a datasheet like tables. If the information in a query is to be printed out, it should be linked to a report.

4.2 Reports

Reports are designed to be printed out, and thus are capable of presenting the data in the most attractive manner. Data is obtained from tables or queries, though almost all of the reports included in this database are linked to queries. Reports can be generated automatically by Access, using the Report Wizard, but for best presentation, the user should design them.

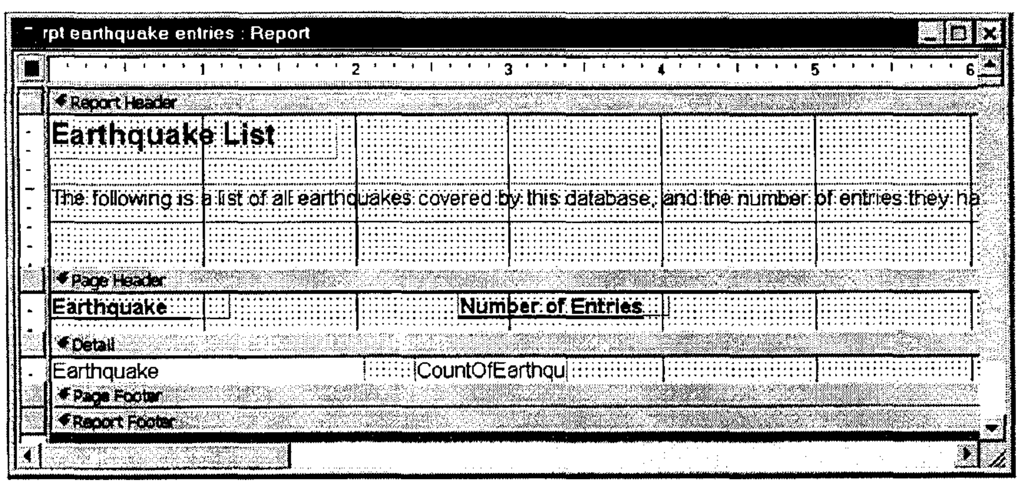
Table 4-6: View of Reports



- The reports **rpt bibliography** and **rpt references** are used to print out reference lists. They are linked to their corresponding queries, **qry bibliography** and **qry references.**
- **rpt earthquake entries** is linked to **qry earthquakes**, and prints out the information in a table-like format.
- **rpt earthquakes unused** is linked to the table **earthquakes unused**. It was not necessary to sort the data in that table.
- **rpt nonstruct linked to gen qry** is linked to **qry general**. This report is designed to resemble the **nonstructural** form, and fits two entries per page. The data that is printed will reflect the current filter selections used in **qry general.**

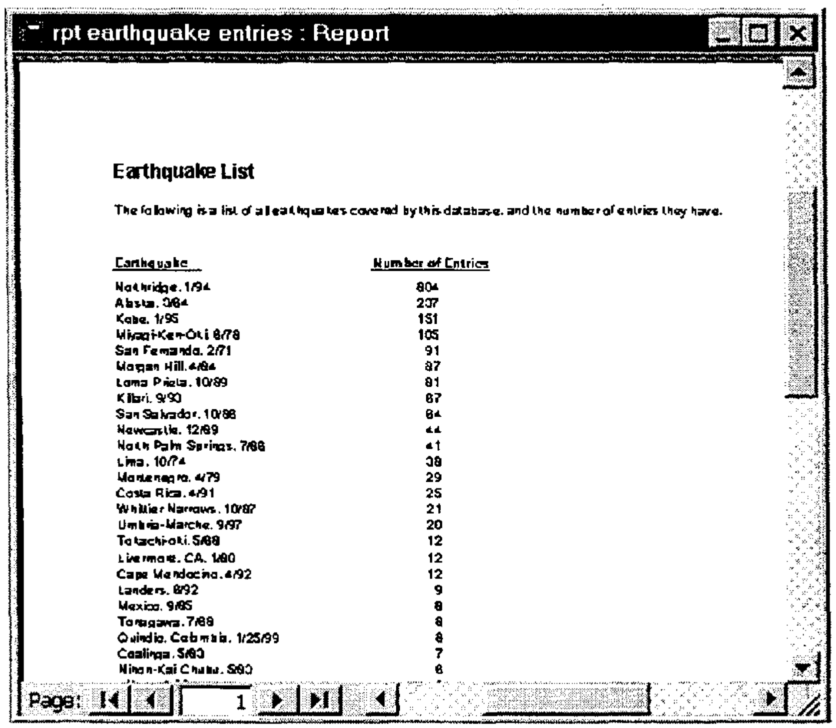
These reports were used to print out parts of this user's manual. Below is the report designed to print the list of earthquakes.

Table 4-7: **rpt earthquake entries –** Design View



This report is linked to the query **qry earthquakes**, which was chosen when the report was created. That query contains two fields, "Earthquake", and "CountOfEarthquake". While in Design View, these fields are accessed by pressing the "Field List" icon on the toolbar, and can be dragged on to the report, into the "Details" section. The sizes of the boxes in which the fields will appear can be adjusted accordingly. Labels can then be created in the header or footer sections. When the design of the report is finished, switching to Print Preview will give a general idea of what the report will look like when it is printed out.

Table 4-8: **rpt earthquake entries** – Print Preview (50% view)


rpt earthquake entries : Report

Earthquake List

The following is a list of all earthquakes covered by this database, and the number of entries they have.

Earthquake	Number of Entries
Northridge, 1/94	804
Alaska, 3/64	237
Kobe, 1/95	151
Miyagi-Ken-Oki 6/78	105
San Fernando, 2/71	91
Morgan Hill, 4/84	87
Loma Prieta, 10/89	81
Killari, 9/93	67
San Salvador, 10/86	64
Newcastle, 12/89	44
North Palm Springs, 7/86	41
Lima, 10/74	38
Montenegro, 4/79	29
Costa Rica, 4/91	25
Whittier Narrows, 10/87	21
Umbria-Marche, 9/97	20
Tokachi-oki, 5/68	12
Livermore, CA, 1/80	12
Cape Mendocino, 4/92	12
Landers, 6/92	9
Mexico, 9/85	8
Toragawa, 7/88	8
Quindio, Colombia, 1/25/99	8
Coalinga, 5/83	7
Nihon-Kai Chubu, 5/83	6

Page: 1

Other reports were designed in a similar fashion. The following is a sample page from **rpt nonstruct linked to gen qry**, which is used to print out hardcopies of entries from the database. This sample was linked to a query (in **qry general**) for piping systems where the horizontal PGA was greater than 0.5 g.

4.3 Form Navigation

For basic viewing of the database, Access provides many convenient features to navigate through forms. For viewing purposes, it is not necessary to run queries.

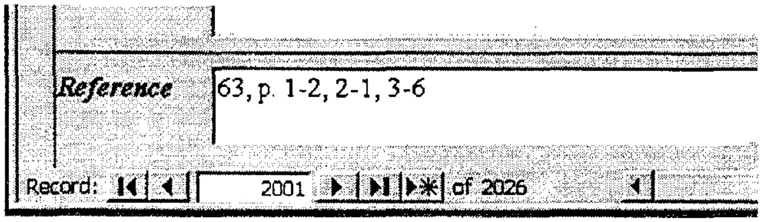
The small toolbar at the bottom of the form handles basic navigation.

Table 4-9: Sample page from **rpt nonstruct linked to gen qry**

Equipment:	sprinkler, pipe	***Type:***	mechanical	***Record #:***	37
Damage:	lines broken at connection just above sprinkler heads. Pipe broke completely at threaded elbow joint of drop to run. Caused by differential motion within ceiling plenum. Old (UPS FM Model F946 135/165 degree F) cans with brass arms twisted & failed.				
Impact:					
Damage Ratio:		***Earthquake:***	Northridge, 1/94		
Type:	hospital	***Building:***	Olive View Medical Center, Sylmar		
CSMIP:	CSMIP #24514				
comment:	16 km from epicenter				
Structure:	concrete and steel shear walls	***comment:***			
PGA (gH):	0.8	***PGA (gV):***	0.4	***comment:***	
PFA (gH):		***PFA (gV):***		***comment:***	located in rated corridors with 12" dropped ceilings
Height:	/ 6	***bldg period (sec):***	0.5		
other info:	replacement heads (Model GI) are stronger				
Reference:	3, p.5-10; 1, p.3-1, 3-2; 4 p.63; 6, attachment 2, sheet 3; 8, p. 4-24				

Equipment:	pipe	***Type:***	mechanical	***Record #:***	1
Damage:	2 ft. x 3/4" diameter pipe broke at its connection to a larger pipe. Break due to differential movement of pipes; piping was flexible.				
Impact:	hampered use of portion of the floor, though it was not essential				
Damage Ratio:		***Earthquake:***	Northridge, 1/94		
Type:	essential facility	***Building:***	Olive View Medical Center, boiler plant		
CSMIP:	CSMIP #24514				
comment:	16 km from epicenter				
Structure:	concrete and steel shear walls	***comment:***			
PGA (gH):	0.8	***PGA (gV):***	0.4	***comment:***	
PFA (gH):	1.7	***PFA (gV):***		***comment:***	pipes located near top of bldg.
Height:	6 / 6	***bldg period (sec):***	0.5		
other info:					
Reference:	1, p. 3-2; 6, attachment 2, sheet 3				

Table 4-10: The navigation toolbar

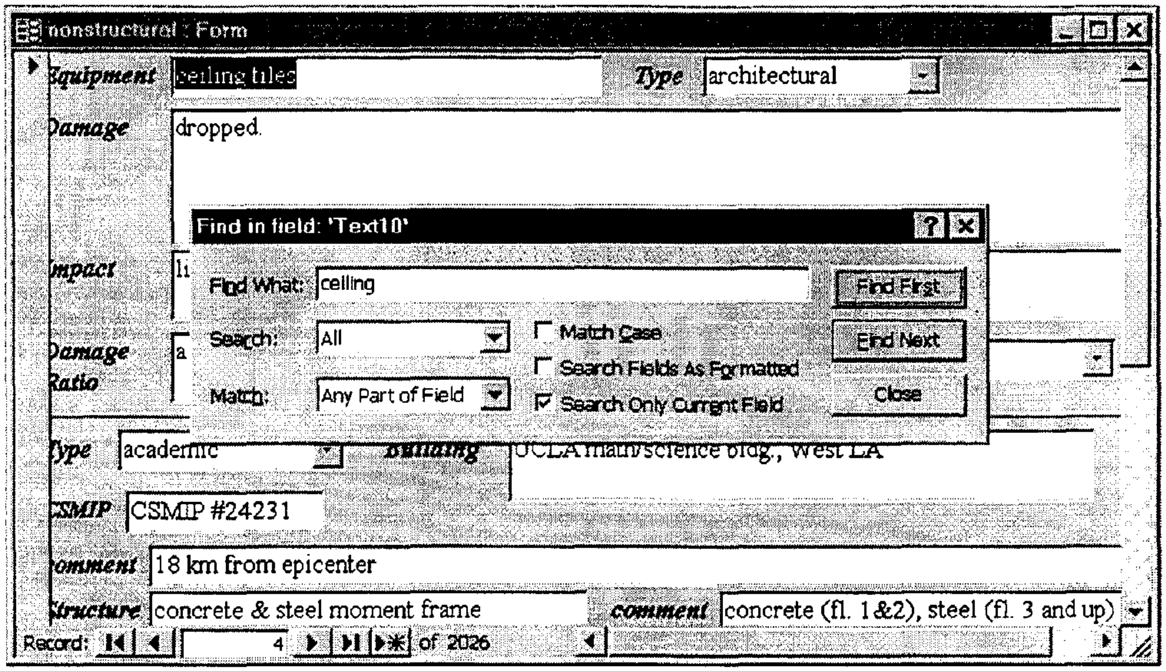


The leftmost button brings the database to the first record. The left arrow goes back one record, the right arrow goes forward one record. The right arrow with bar takes the database to the last record, and the right arrow with star makes a new record. Entering a number in the record number box and then pressing "Enter" brings the database directly to that record number.

Find... It is also possible to search for any word in any field of the form. For example, to find entries in the **nonstructural** form containing the word "ceiling" in the Equipment field, do the following:

- Select the Equipment field by clicking inside of it.
- Start the search by clicking "Find..." under the "Edit" menu, or by hitting 'Ctrl+F'. This brings up the "Find in field" dialogue box.
- Next to "Find What:" enter "ceiling", or whatever word is wanted.
- Next to "Match:" select "Any Part of the Field" to make the search more flexible. Selecting "Whole Field" will result in only searching for exact matches.
- Click on "Find First" to go to the first entry in the database which matches the search, or click on "Find Next", which goes to the next matching entry.
- Click on "Close" to close the "Find in field" dialogue box, and to view the entire record.

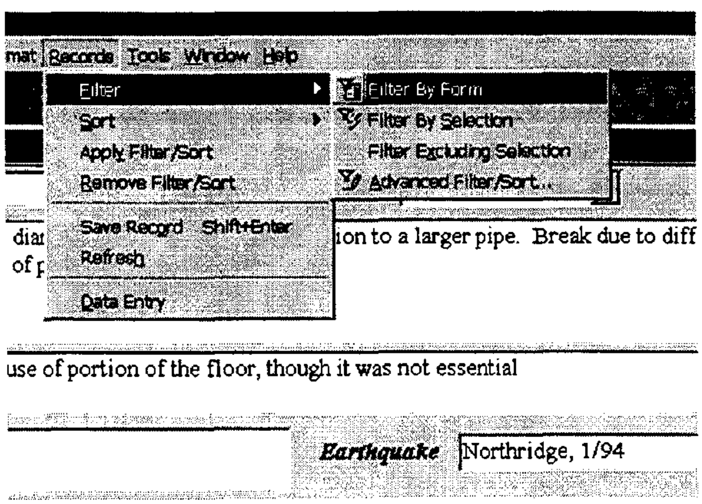
Table 4-11: The "Find in field" dialogue box



Another convenient feature is the filter function. This can achieve the functions of a query without having to leave the form. There are basically two ways to filter the database: "Filter by Form" and "Filter by Selection".

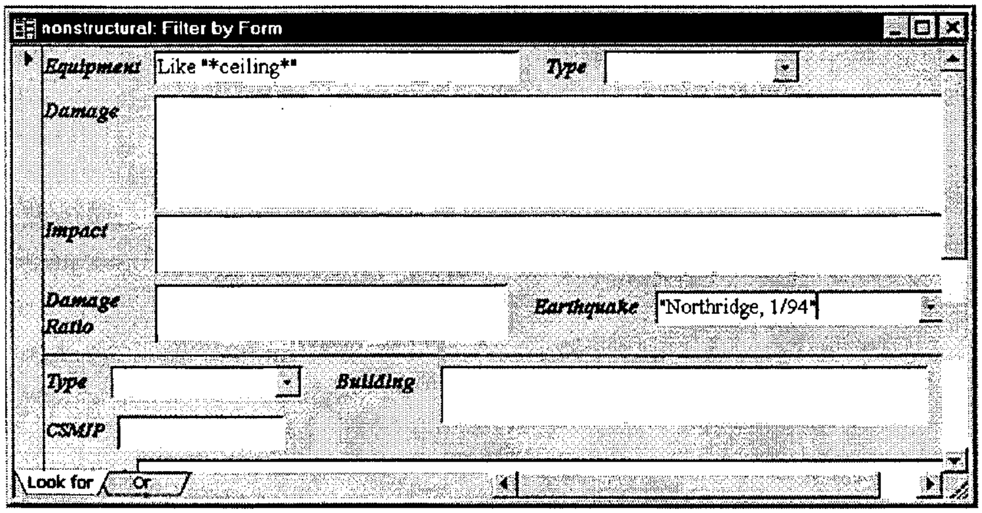
Filter by Form. To "Filter by Form", click on the "Records" menu at the top, place the cursor over "Filter", and then click on "Filter by Form".

Table 4-12: "Filter by Form" menu



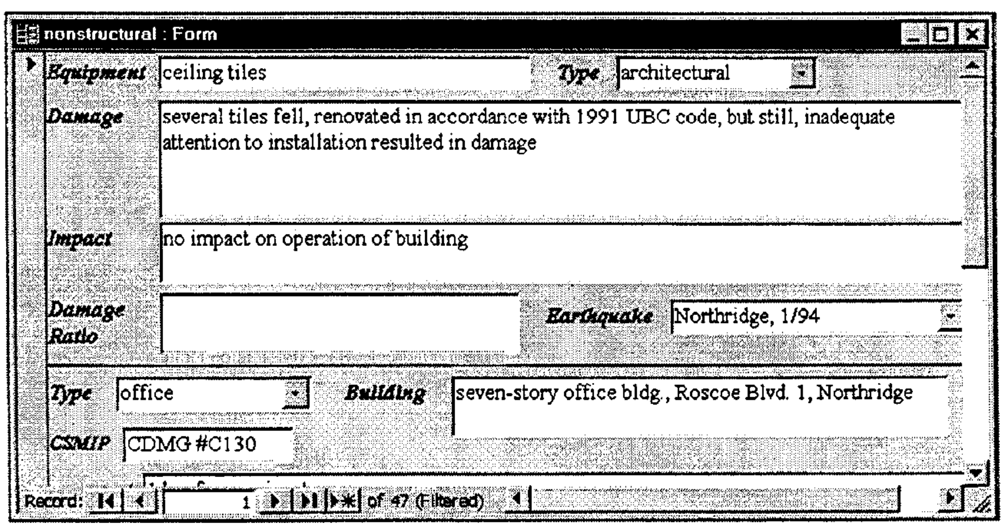
Once in "Filter by Form", enter the criteria in the fields in the same format as in queries. For example, to filter for ceiling damage in the Northridge earthquake, enter 'Like "*ceiling*"' in the Equipment field, and enter "Northridge, 1/94" in the Earthquake field. Pull-down menus are available here for the Equipment Type, Earthquake, and Building Type fields.

Table 4-13: Filter by Form



When finished entering criteria, click on the "Filter" menu on top, and then click on "Apply Filter/Sort" to apply the filter. In the resulting form, only entries that match the criteria will be available for navigation.

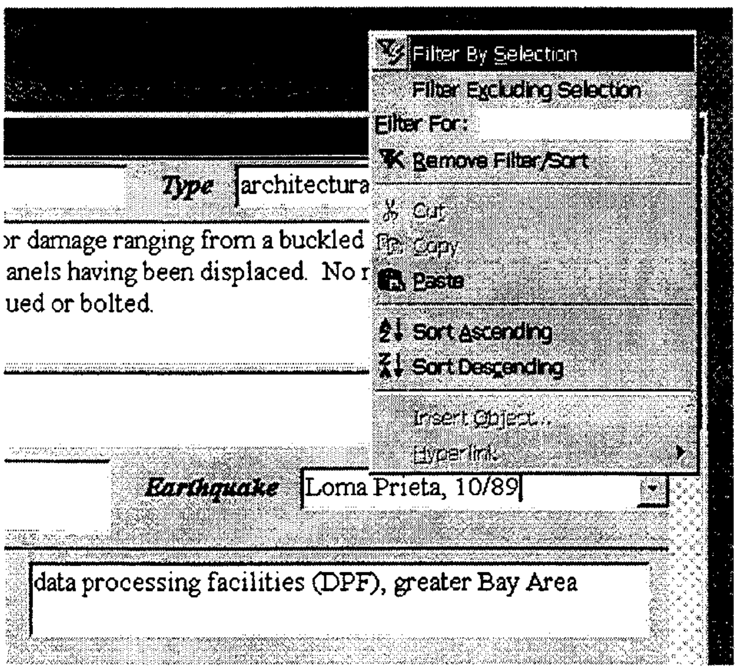
Table 4-14: Filtered form



To remove the filter and return to the complete database, click on the "Records" menu on top, and then click on "Remove Filter/Sort". Or, as a shortcut, right-click anywhere on the form, and in the resulting pop-up menu, click on "Remove Filter/Sort".

Filter by Selection. "Filter by Selection" is a quick way to filter without having to "Filter by Form". It basically filters the database by matching the field of a record that is currently being viewed. For example, while viewing a record pertaining to the Loma Prieta earthquake and it is desired to see all records that pertain to Loma Prieta, right-click in the Earthquake field to bring up the pop-up menu, and then click on "Filter by Selection". (This can also be done by clicking on the "Records" menu on top, and then clicking on "Filter by Selection".)

Table 4-15: Right-click menu, Filter by Selection



The resulting filtered database is identical to a "Filter by Form" with "Loma Prieta, 10/89" entered as criteria in the Earthquake field.

In general, "Filter by Selection" is good for fields that have standardized names, such as the ones with pull-down menus: Equipment Type, Earthquake, and Building Type.

SECTION 5

CONCLUDING REMARKS

An attempt has been made to develop a comprehensive damage database for nonstructural components in buildings and other constructed facilities. The information contained in this database were gathered from available publications such as books, reports, and periodicals through an exhaustive search of all relevant sources. It contains nearly 3,000 entries encompassing more than 50 earthquakes beginning with Alaska Earthquake of 1964. Each entry provides three basic information blocks. They are:

(a) Type of the nonstructural components and damage description, including impact and damage ratio as defined in the report.

(b) Description of the structure in which nonstructural damage occurred including building name, building type and properties, type of construction, epicenter distance, location of nonstructural components, and other relevant comments

(c) Earthquake information, including name of earthquake, peak ground accelerations at building site, peak floor accelerations at the nonstructural component location, and other relevant comments.

It is clear that, in most cases, information gathered would not provide complete information as desired and interpretation of documented observations was necessary in data entry. Indeed, much of the published information on nonstructural damage is descriptive in nature and therein lies the challenge of translating these descriptions to entries into the information blocks of the database. Every attempt, however, has been made to make data entries consistent with the published information.

This database will be continuously updated as more information becomes available and as future earthquakes occur. Updated editions of the database will be communicated to the users as they become available through the MCEER's web site at http://mceer.buffalo.edu .

SECTION 6

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