

School Vulnerability Reduction

Tony Gibbs

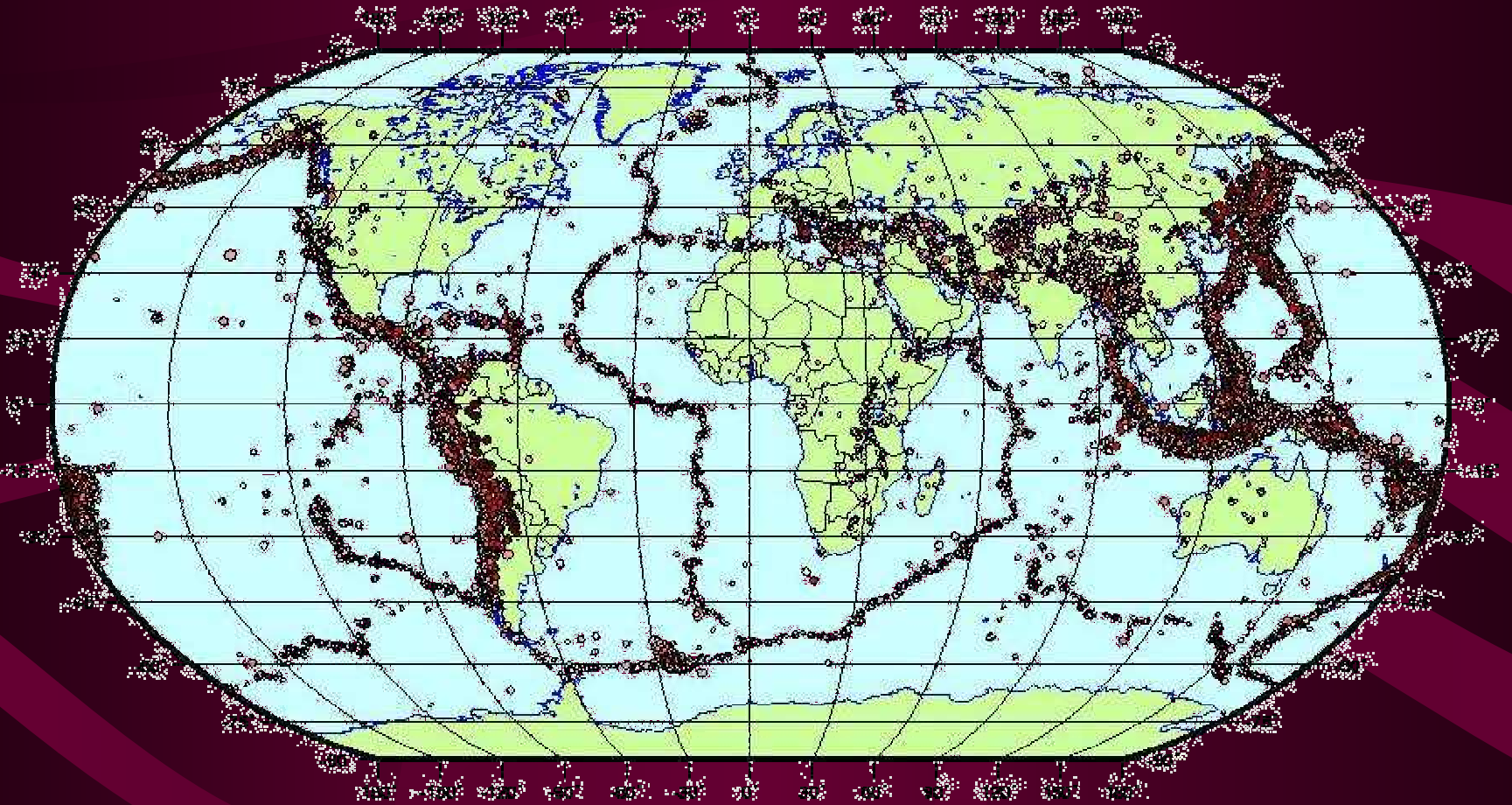
CEP Ltd

Consultant to PAHO/WHO



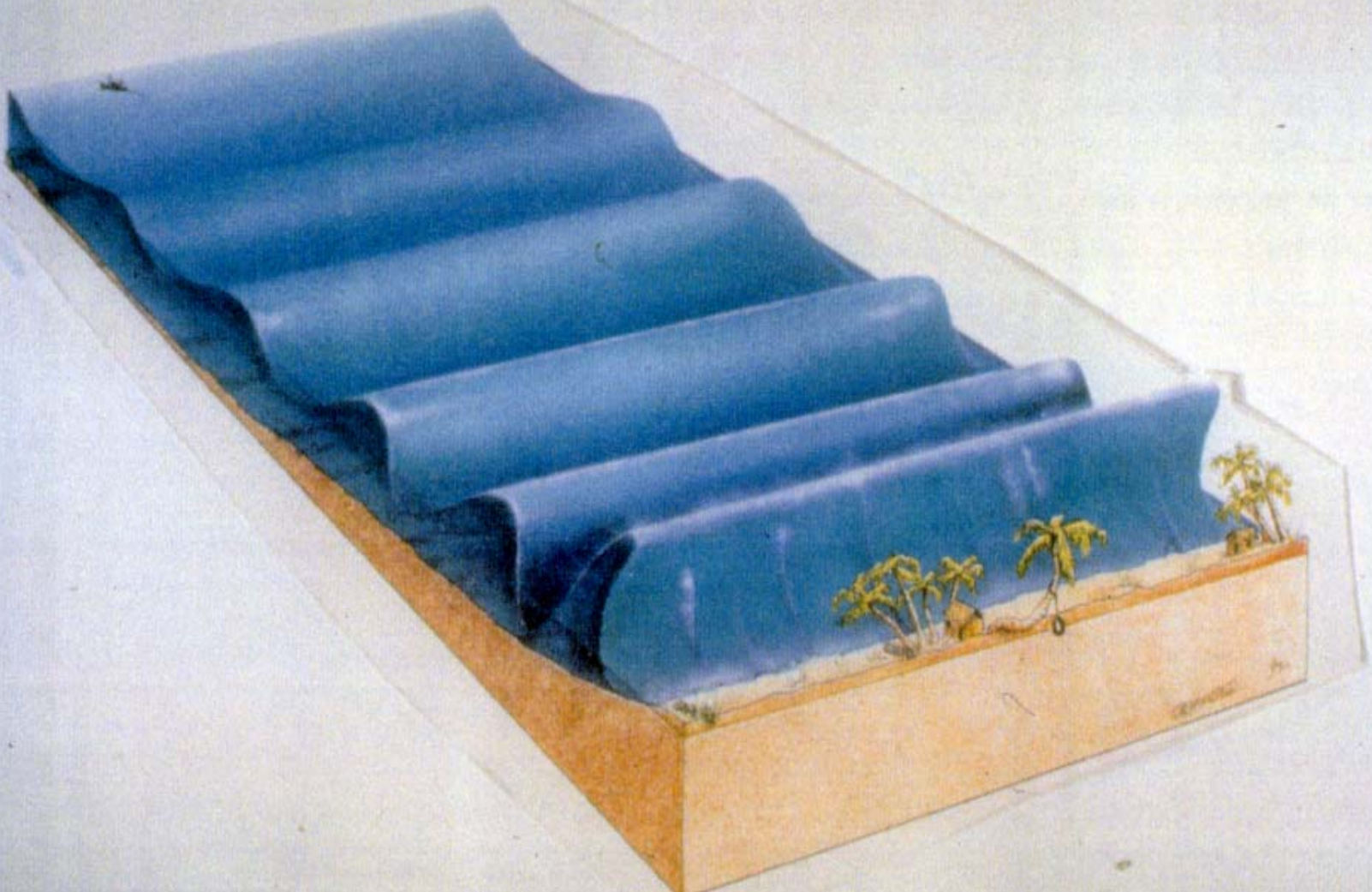
Hasler & Pierce

Worldwide Seismic Activity



British Geological Survey

TSUNAMI





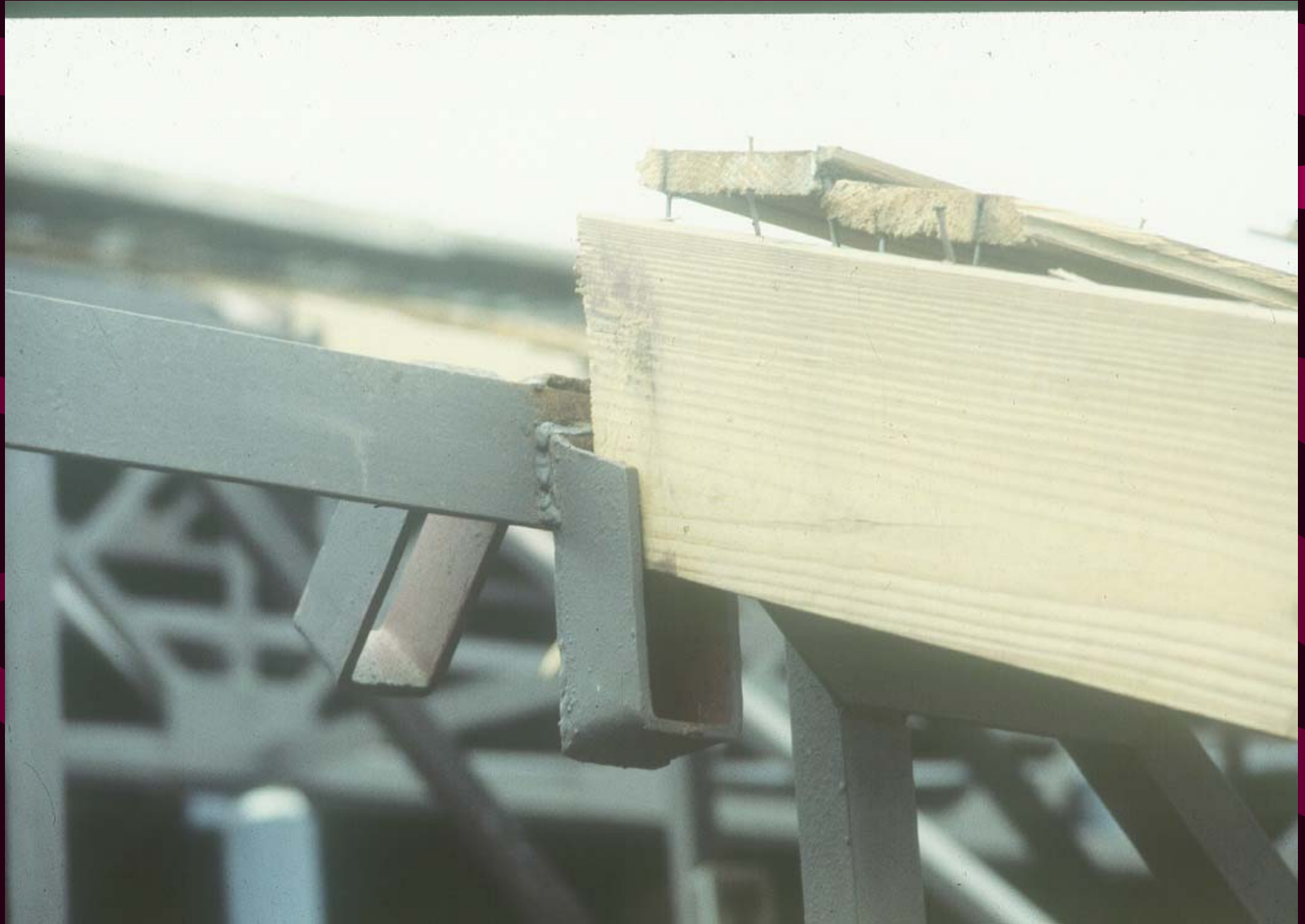
Hasler & Pierce







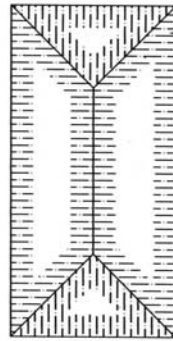




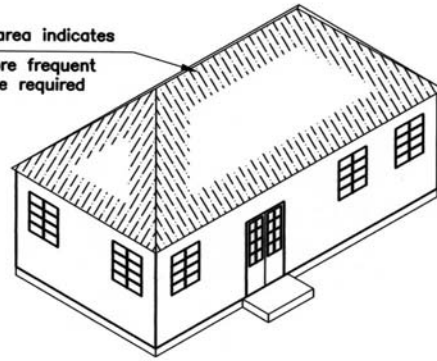
NORMAN MANLEY LAW SCHOOL







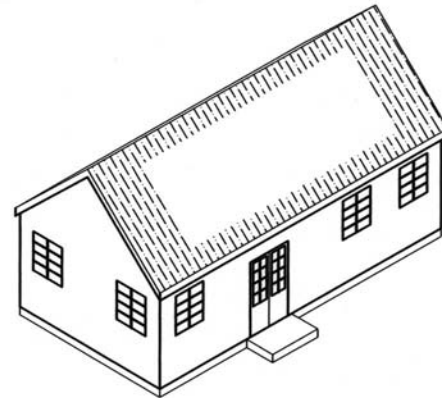
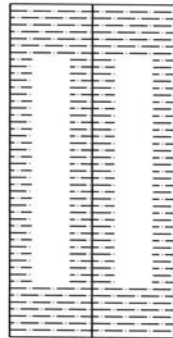
Hatched area indicates
where more frequent
fixings are required



plan

isometric

hip-roof



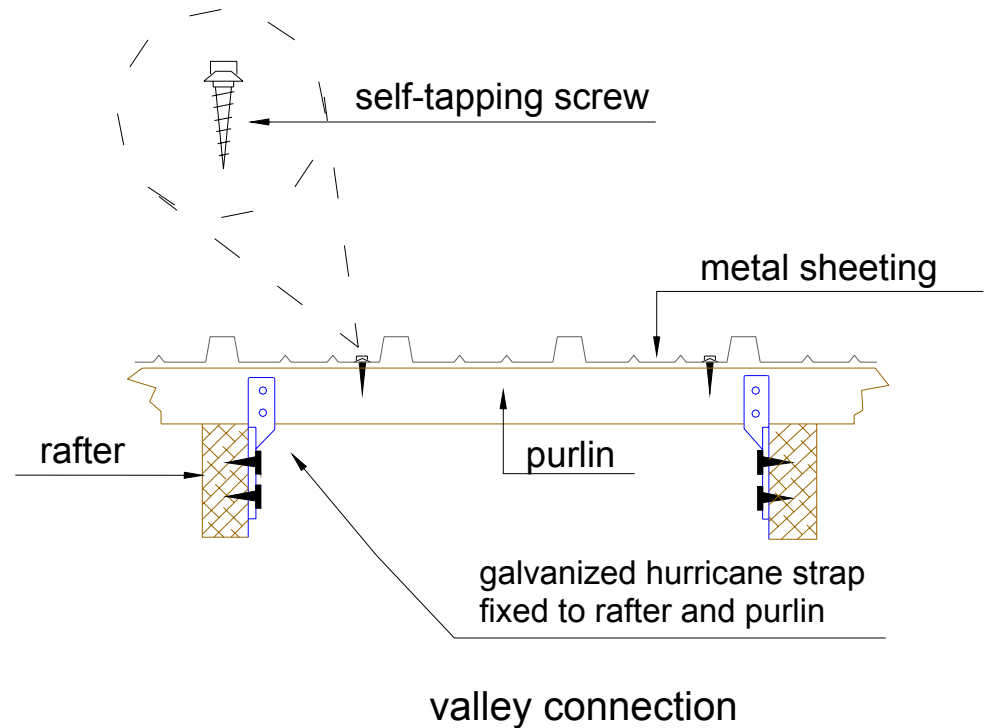
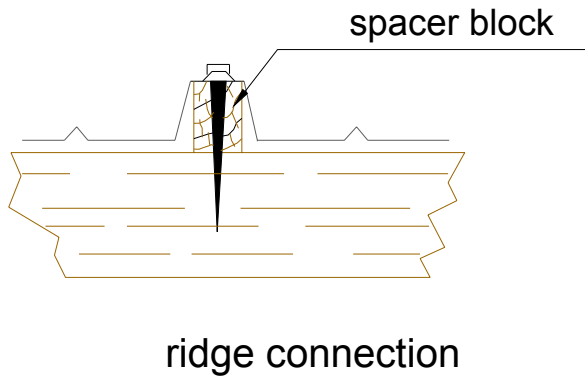
plan

isometric

gable roof

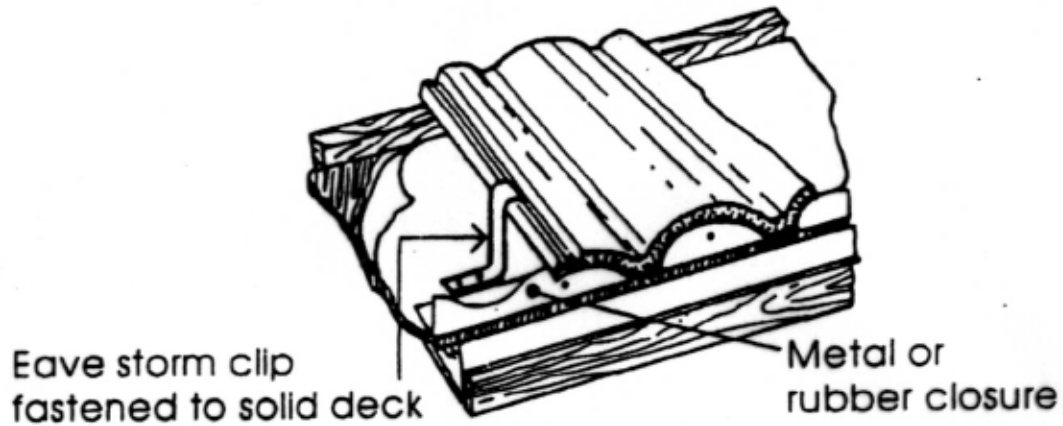
The more vulnerable areas of roofs

Connection details between metal sheet roof and purlins

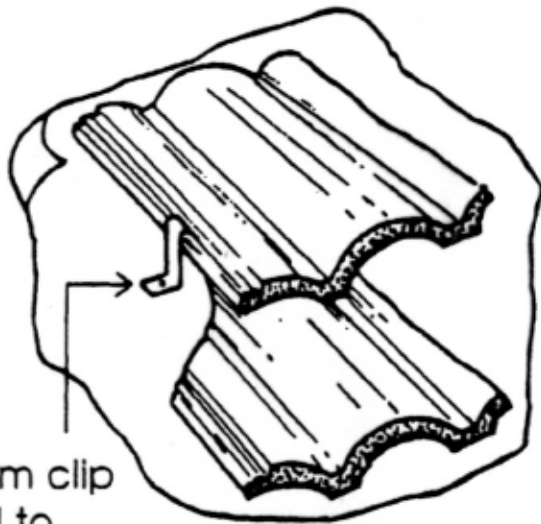


Metal sheet fixings and purlin-to-rafter connection

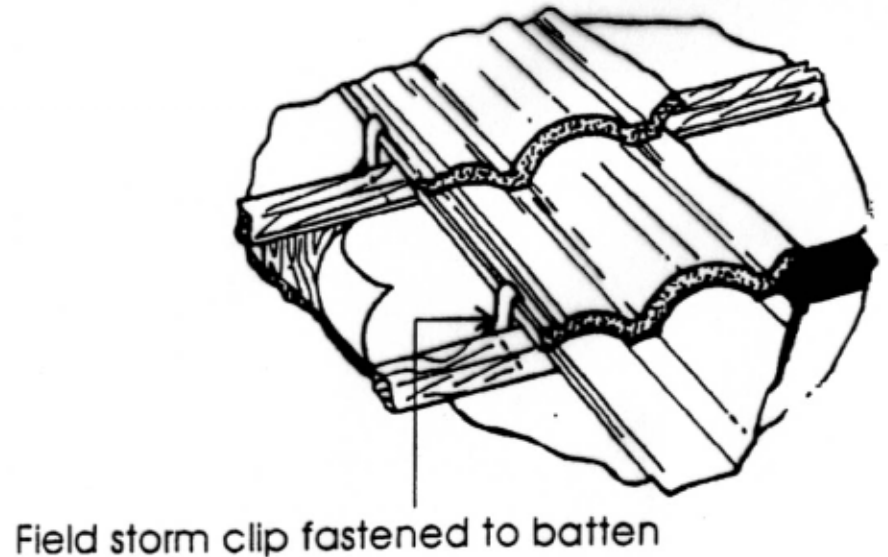
EAVE STORM CLIP FASTENED TO SOLID DECK

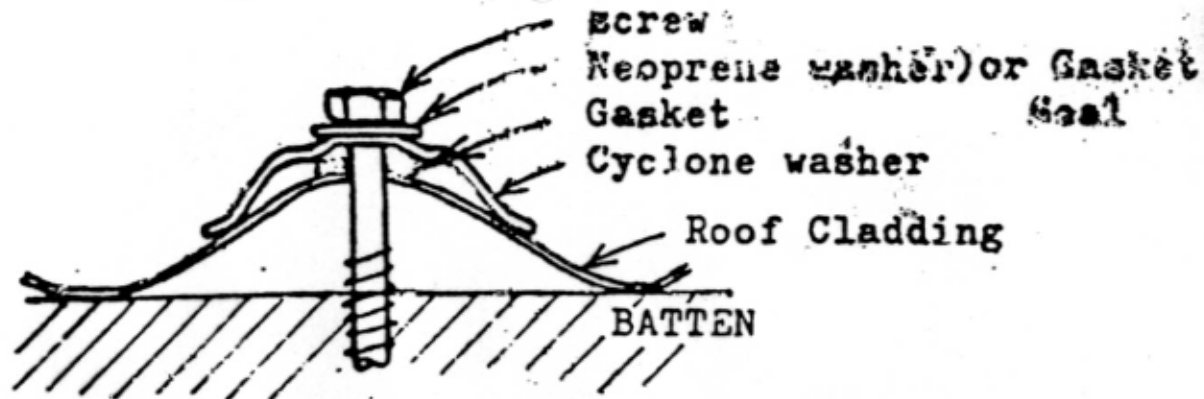
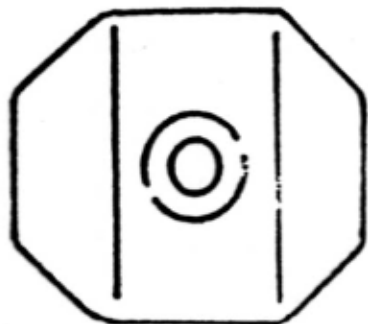


FIELD STORM CLIP FASTENED TO SOLID DECK



FIELD STORM CLIP FASTENED TO BATTEN





Screw Fixing : Example of use of One Type of Cladding Fixing Specified by a Manufacturer for use of a Particular Product in Cyclonic Areas



Cyclone Washer : Example of One Type Specified by Manufacturers

- ALSO SPECIFIED :
- Spacing of fixings
 - Increased fixing at roof edges and changes in slope
 - Special requirements (eg holes through sheet to be predrilled
screws not to be overtightened etcetera)

EXAMPLE OF FIXING FOR SHEET METAL PRODUCT
(Exact Requirements Given by Manufacturer)



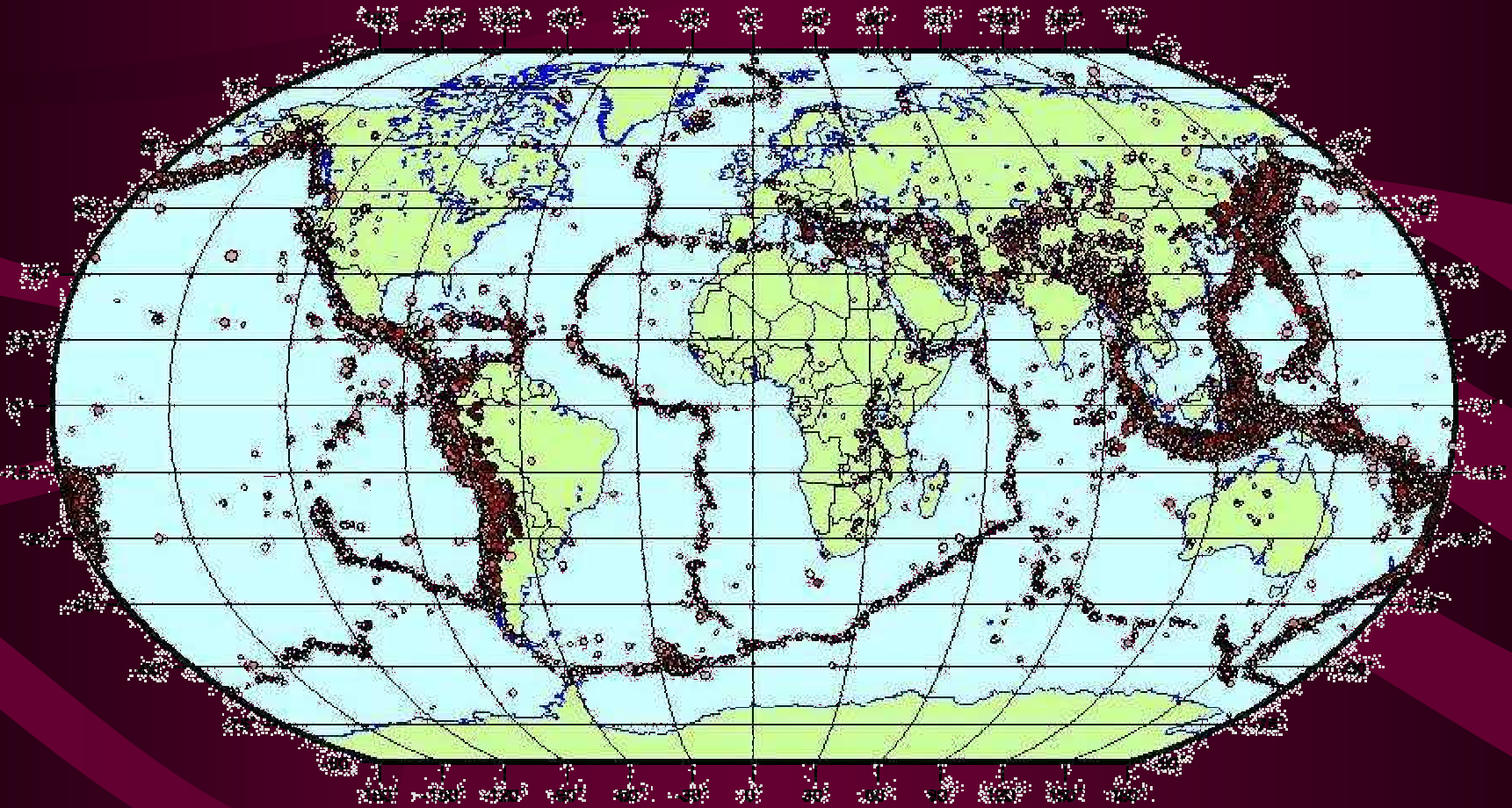
Impact-resistant windows



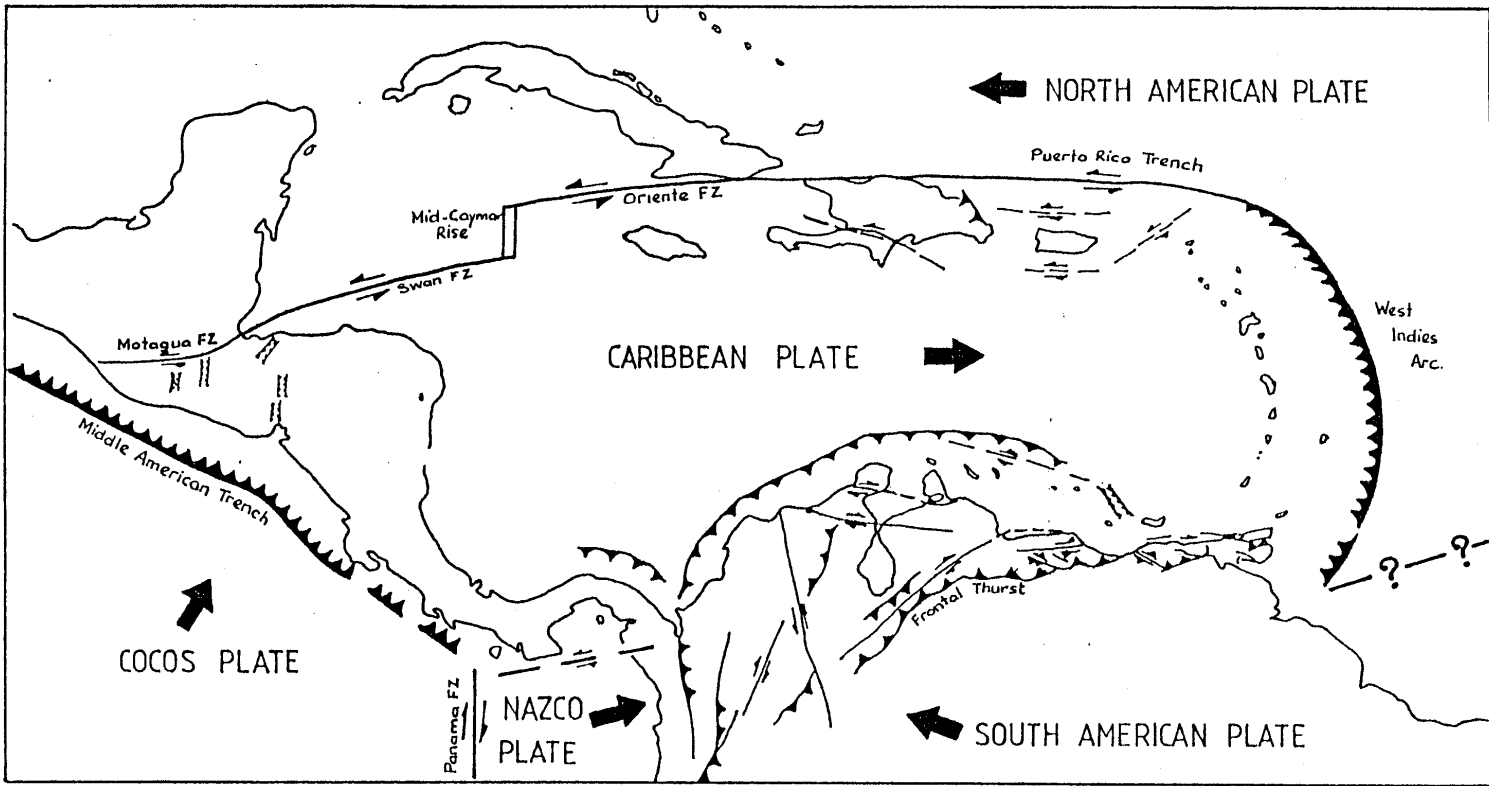




Worldwide Seismic Activity



British Geological Survey



Tectonic Setting of the Caribbean
 (after Molnar and Sykes, 1969)

Figure 1

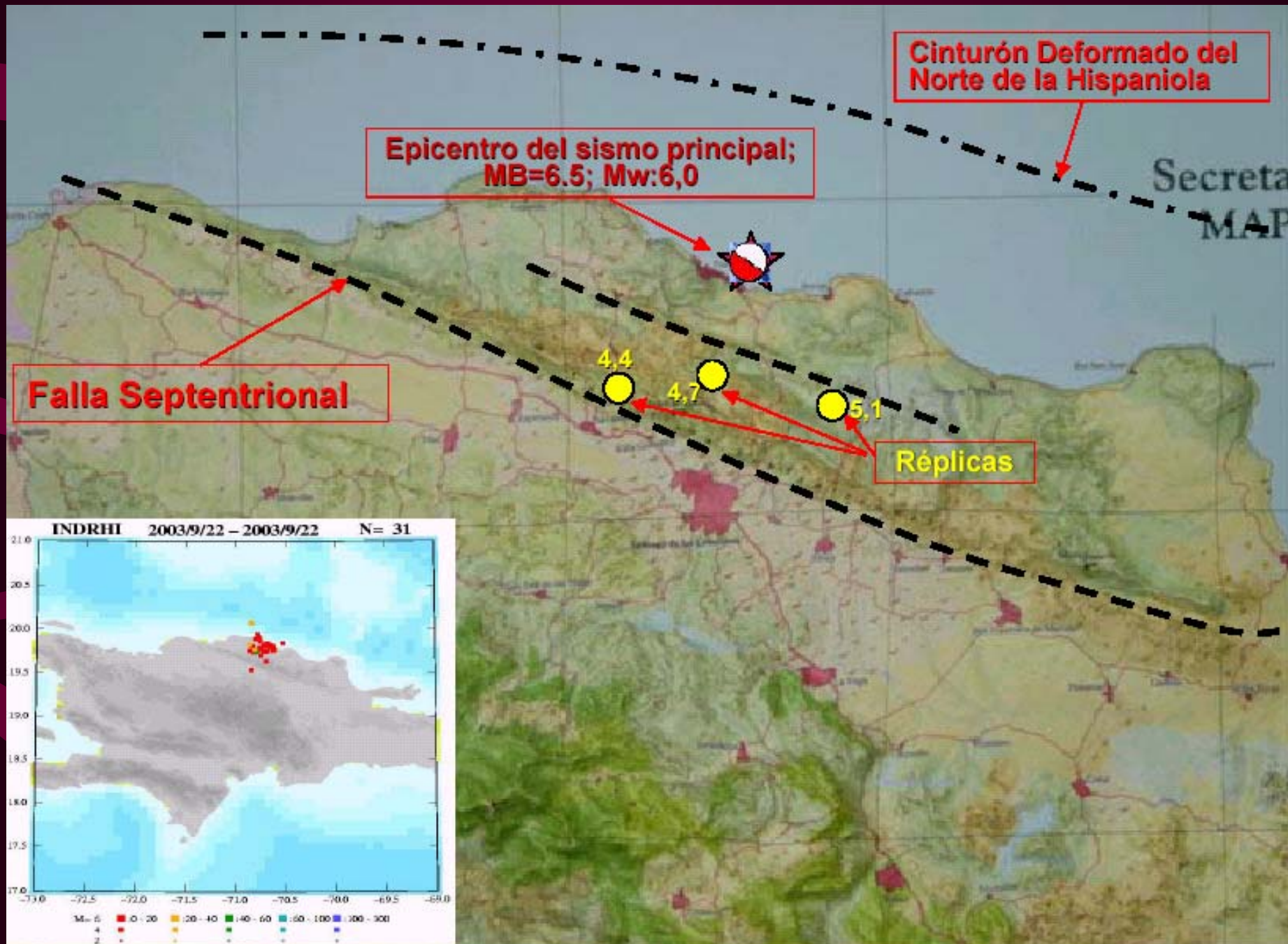












Cinturón Deformado del Norte de la Hispaniola

Epicentro del sismo principal; MB=6.5; Mw:6,0

Falla Septentrional

Réplicas

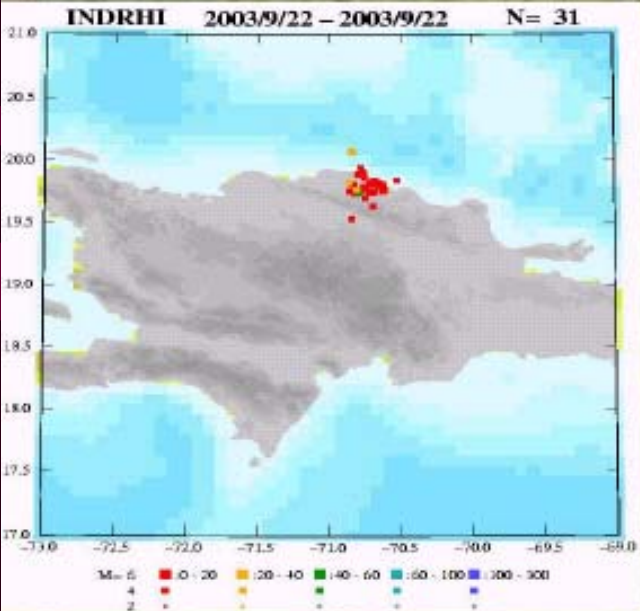




Photo: Jose Manuel Diaz

*All this was a consequence of the tragedy
of San Giuliano di Puglia of October 31, 2002.*

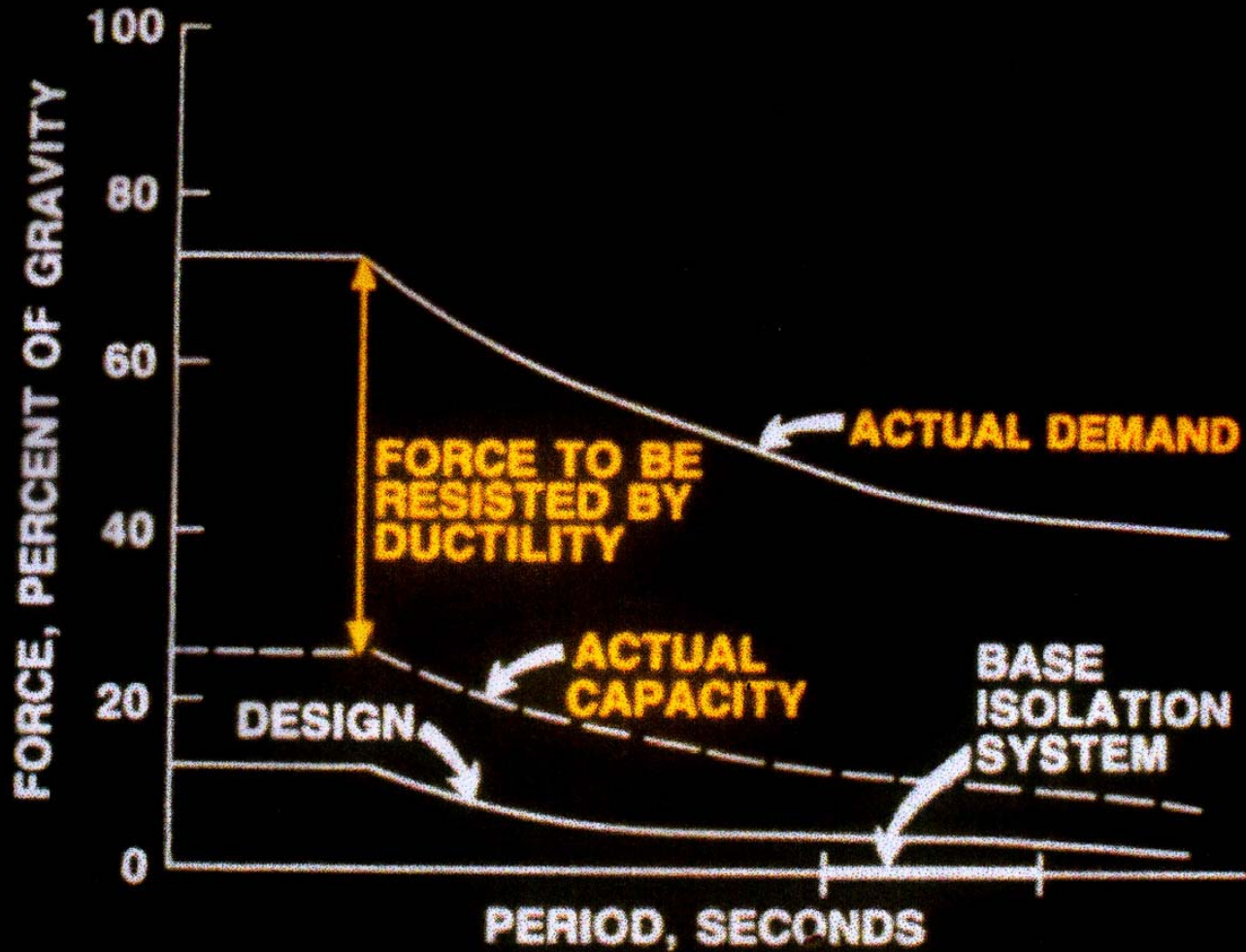


- The epicenter of Molise earthquake of October 31, 2002 was at about 5 km from San Giuliano di Puglia.
- It was of magnitude 5,4.
 - It was followed by a second event of magnitude 5,3 on November 1, 2002.
- *In the last 1000 years significant events had occurred only in the surrounding areas.*



The “Jovine” elementary school of San Giuliano di Puglia after the earthquake of October 31, 2002.

STRUCTURAL DESIGN CONCEPTS



← SHORT, STIFF STRUCTURES ————— TALL, FLEXIBLE STRUCTURES →

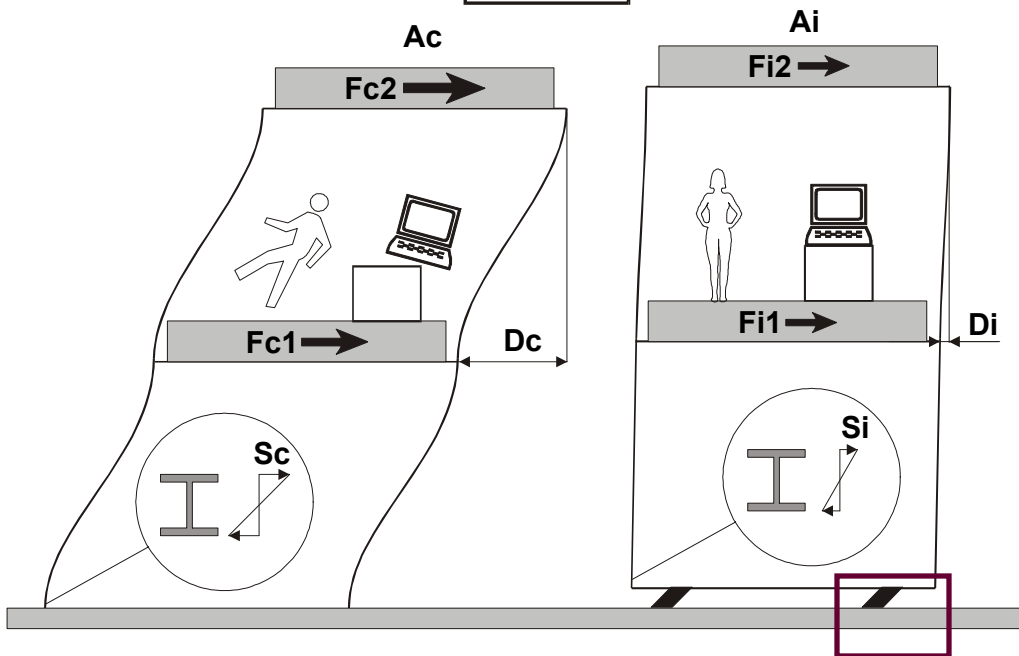


Moving the Goalposts

Conventional building
Fc2 >> Fc1

Ac >> Ai
Fc >> Fi
Dc >> Di
Sc >> Si

Base isolated building
Fi2 ≈ Fi1



BRITE EURAM Project, 1993



Horizontal seismic isolation

(case of High Damping Rubber Bearings – HDRB)

Non-Structural Components

- o all affected by earthquakes
- o only external cladding affected by wind

Suspended ceilings - particularly vulnerable in earthquakes.
(PAHO CD-ROM)



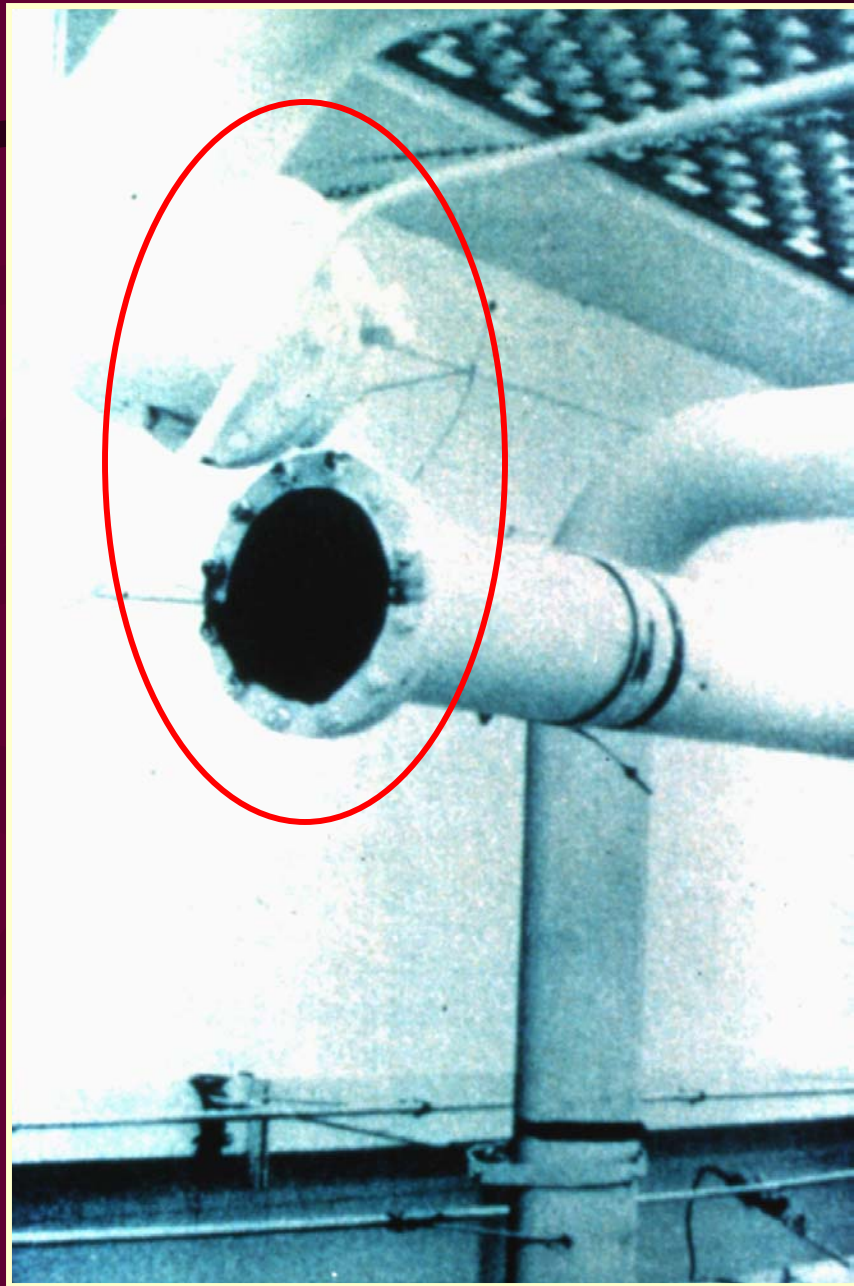
**The loss of clinical
information in hospitals
utilises human resources
necessary for other
priority functions in
emergencies.**

(PAHO CD-ROM)



**Plumbing damaged
because of the absence
of a flexible conection.**

(PAHO CD-ROM)



Performance Basis

1997 BSSC *NEHRP Provisions*

**Building
Performance**

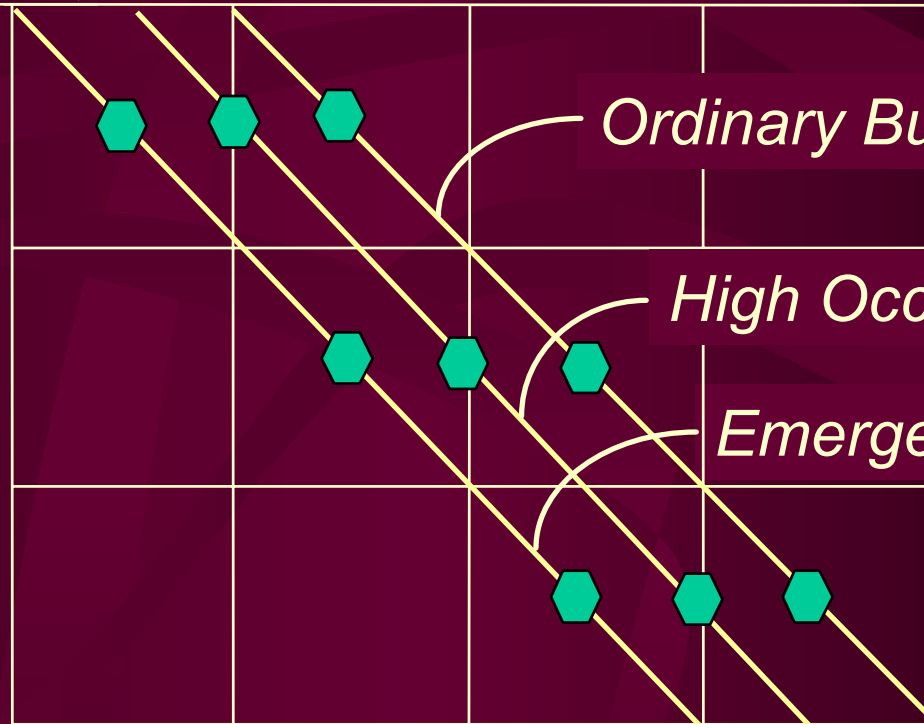
Operational *Immediate
Occupancy* *Life Safe* *Near
Collapse*

Ground Motion

Frequent

Design

Maximum
Considered



Ordinary Buildings

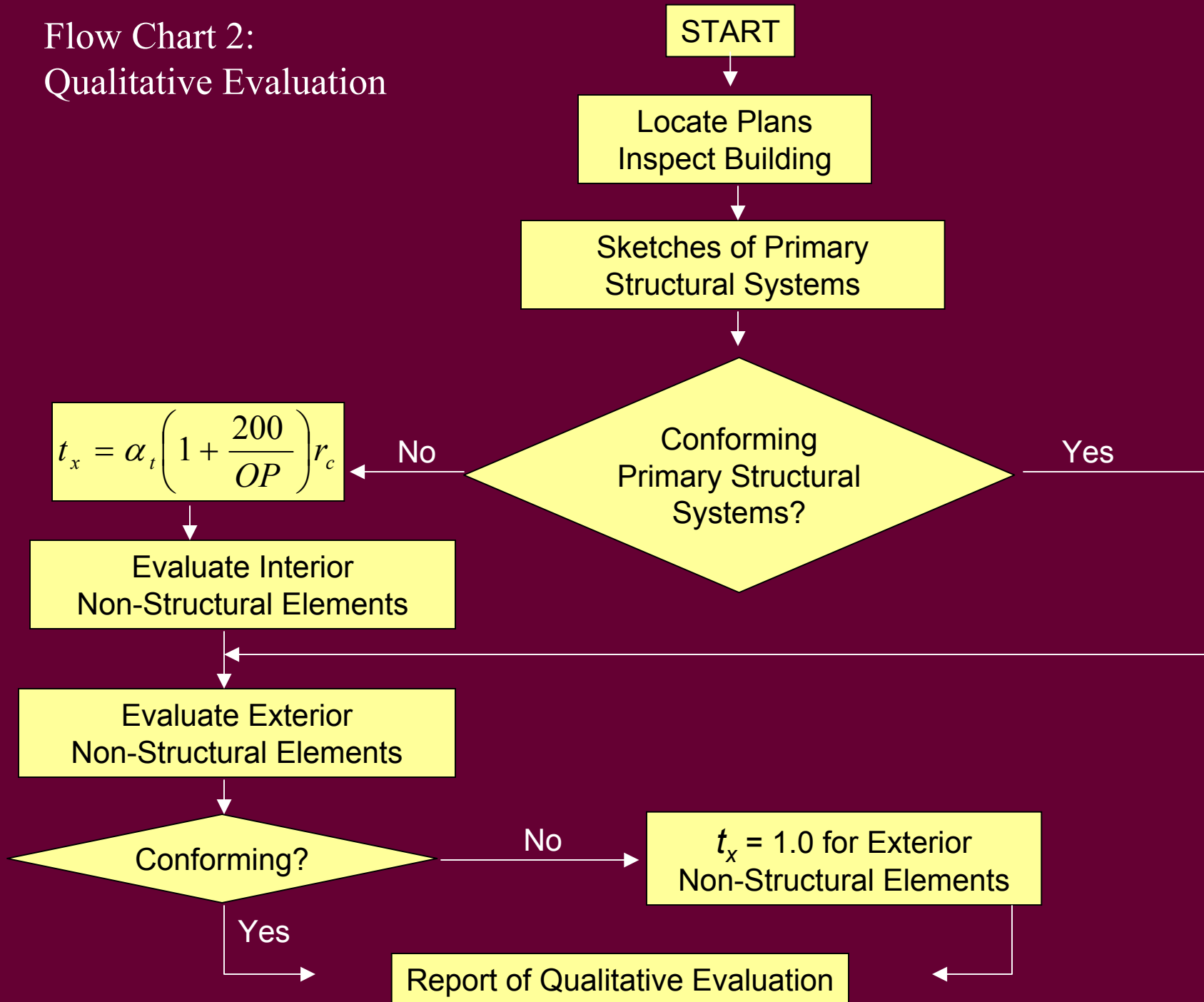
High Occupancy

Emergency Response



*Vulnerability Surveys
and
Determining Priorities*

Flow Chart 2:
Qualitative Evaluation



Requirements for Success:

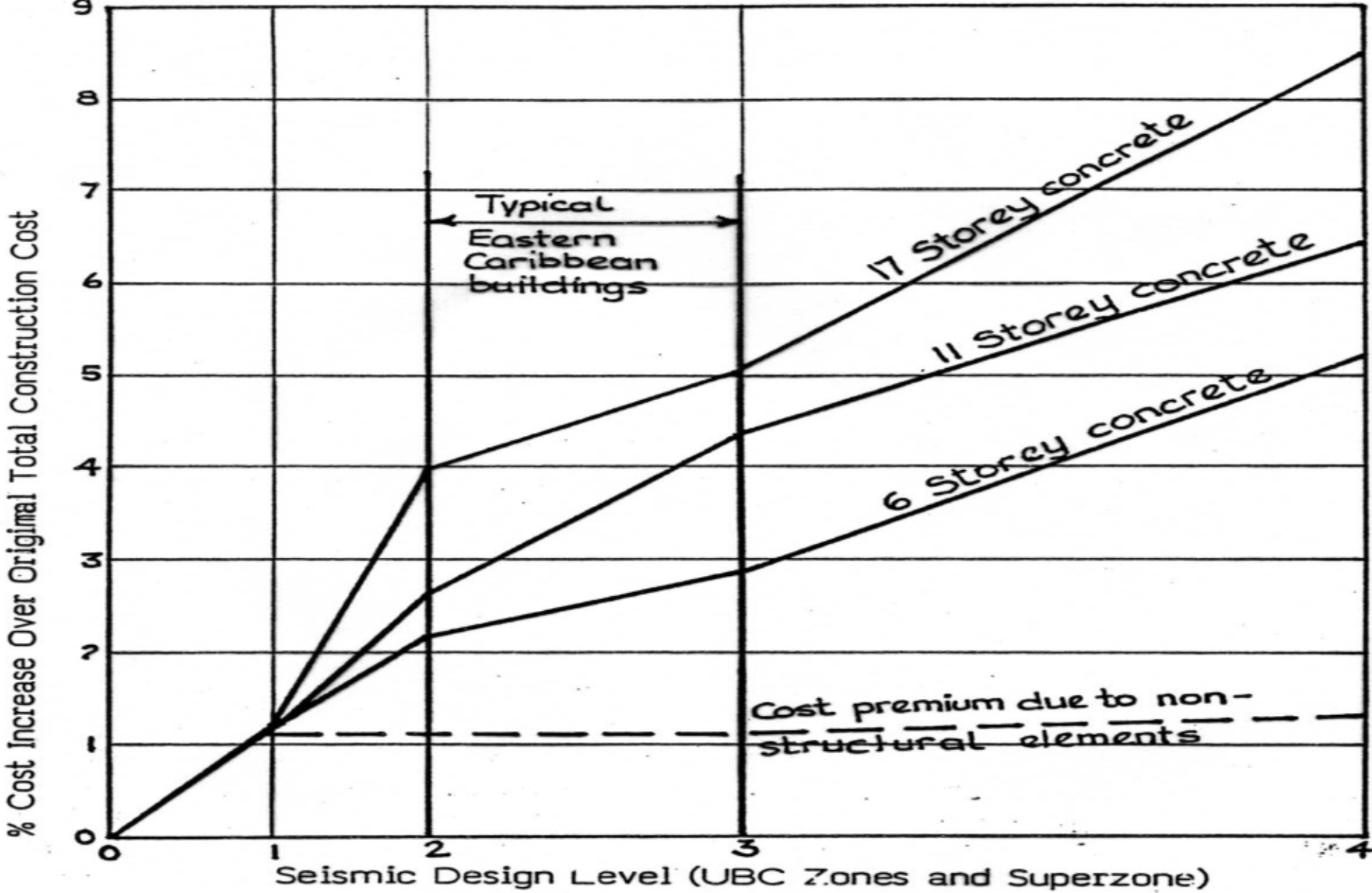
- o Laws*
- o Regulations*
- o Standards development and maintenance*
- o Effective enforcement*
- o Education and training*

Peter Rice's book: The Engineer Imagines

"Others not so closely involved must also be asked to review the project, to question the assumptions and demand explanations. The presence of a competent, dedicated and sceptical checking authority is also very important in this respect." - page 123



*A Question of
Costs?*



Effect on Cost of a Seismic Design of Typical Concrete Apartment Buildings (after Whitman et al)

PERCENTAGE INCREASE * IN CONSTRUCTION COST FOR MODEL DWELLINGS
INCORPORATING SEISMIC OR WIND DESIGN RECOMMENDATIONS **

SEISMIC OR WIND LOADING	DWELLING BY MODEL DESIGNATION										
	'A'	'A' 1.5 x O. T.	'A-1' Sliding door	'A-1' Window	'B'	'B-1'	'C'	'C-1'	'C-2'	E	F
Zone 3	0.3		0.37	0.37	0.42	0.45	0.81	0.74	0.74	0.48	1.4
	0.24		0.29	0.29	0.33	0.35	0.63	0.58	0.58	0.38	1.1
Zone 2	0.28		0.36	0.36	0.29	0.29	0.31	0.28	0.27	0.48	0.24
	0.22		0.28	0.28	0.23	0.23	0.24	0.22	0.21	0.38	0.18
15 psf wind	0.31	0.57	0.41	0.39	0.44	0.61	1.3	1.2	1.2	0.48	0.24
	0.25	0.45	0.32	0.31	0.34	0.47	0.98	0.90	0.95	0.38	0.19
25 psf wind	0.59	1.1	0.60	0.59	0.92	1.0				0.48	0.71
	0.46	0.85	0.47	0.46	0.72	0.79				0.38	0.55
40 psf wind	2.00	2.2	1.6	1.4	2.2	1.9				1.3	1.9
	1.57	1.7	1.2	1.1	1.7	1.5				1.0	1.5

* Estimated upper and lower bounds given.

**Design recommendations as given in the report titled "A Methodology for Seismic Design and Construction of Single-Family Dwellings".

**The most expensive building
is the one that fails.**

PAHO/WHO Documents

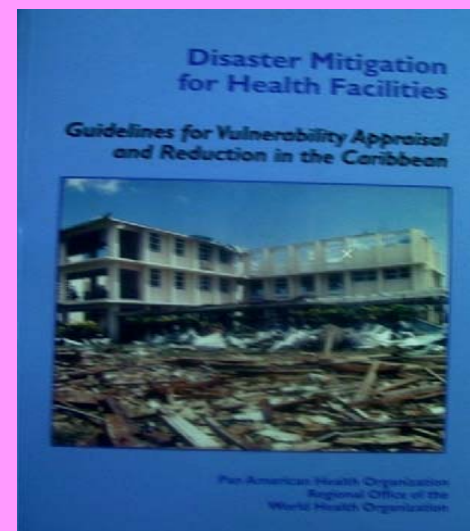
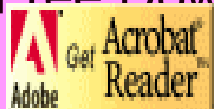
Disaster Mitigation for Health Facilities

Guidelines for Vulnerability Appraisal and
Reduction

in the Caribbean - 2000

Adobe Acrobat Reader required for all files

Free Download



[Disaster Mitigation for Health Facilities \(Full Text\)](#)

Sections:

[Introduction](#)

[Annex I - Checklist for Vulnerability Surveys \(Wind\)](#)

[Annex II - Illustrations \(Wind\)](#)

[Annex III - Checklist for Vulnerability Surveys \(Earthquakes\)](#)

[Annex IV - Illustrations \(Earthquakes\)](#)

[Annex V - Checklists for Maintenance Operators](#)

[Bibliography](#)

**Design Manual
for Health Services Facilities
in the Caribbean**

with particular reference to
Natural Hazards and
Other Low-frequency Events

Prepared by Tony Gibbs



**Pan American Health Organization
Regional Office of the
World Health Organization**