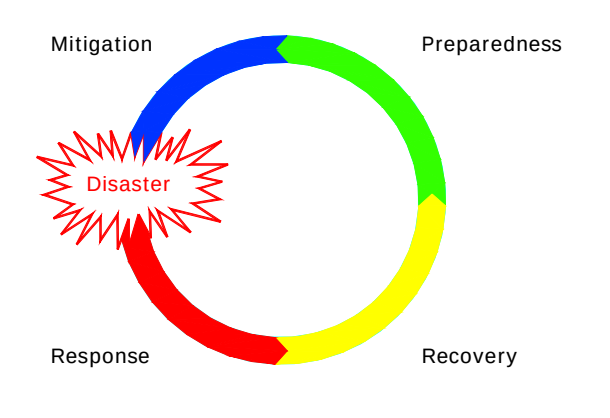
Terminology: Basic terms of disaster risk reduction

ISDR International Strategy for Disaster Reduction
Terminology of disaster risk reduction

(Risk) Prevention:
Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters.

Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".

All the prevention activities are formulated within an open-ended process: the Emergency Management Cycle



International Strategy for Disaster Reduction
Terminology of disaster risk reduction

Response:
The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected.

Recovery:
Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.
Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.

Preparedness:
Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Mitigation:
Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

International Strategy for Disaster Reduction
Terminology of disaster risk reduction

Structural / non-structural measures

Structural measures refer to any **physical construction** to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure.

Non-structural measures refer to **policies**, **awareness**, **knowledge development**, public commitment, and methods and **operating practices**, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.

Quite always the physical construction requires to establish **policies**, to **raise awareness**, to **develop the knowledge**, and to define **operating practices**, in advance

Structural and non structural measures are strongly interconnected.

An example:
The retrofit of the 100 most risky schools

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

Risk is the convolution of

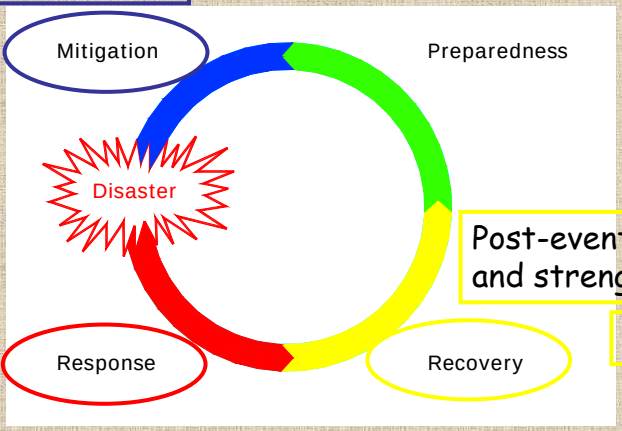
Hazard * Vulnerability * Exposure

Structural measures mitigate the risk throughout the reduction of the vulnerability

When are structural measures implemented within the EMC?

Normal-time repair and strengthening

Almost never



Post-event repair and strengthening

Sometime

Immediate risk removal (propping, shoring, ...)

Very often

In the following we will focus on risk mitigation programs involving a large number of buildings

Single building mitigation will not be addressed, but many concept applies as well

Large scale programs requires massive financial investments and produce benefits in the long term, so that public authorities are in charge of mitigating building risk in the public and in the private sector as well

Risk mitigation strategies

1. Improving standards for new buildings and infrastructures
   - Seismic code
   - Seismic hazard
   - Microzonation
   - Land use & Urban planning
   - Controls

2. Strengthening existing buildings and infrastructures
   - peace time strengthening (10-30 year programs)
   - post-earthquake strengthening (3-5 year programs)

Cost of the mitigation strategies (buildings)

1. Improving standards for new buildings and infrastructures

Cost of the structure	25-30% of total construction cost
Increase of the structural cost for increased seismic capacity	+20%-30% of the structural cost
Increase of total cost	5%-10%

Cost of the mitigation strategies (buildings)

2. Strengthening existing buildings
   from 150 to 500 Euro per square meter
   approx 15-40% of total construction costs

Strengthening existing building is much more costly than building seismic resistant buildings

This is the first reason why the strengthening of a large number of existing buildings is seldom implemented

Political payback

1: Building new construction
   immediate, within one legislature

2: Strengthening existing buildings
   10-30 years, maybe never

This is the second and more important reason why the strengthening of a large number of existing building is seldom implemented

There are also other minor reasons:

There are much more existing buildings than new construction. This imply an overall larger cost

Seismic codes for existing buildings are less detailed and reliable

Professionals have lower skill on existing buildings than in new buildings

The building materials and detailing are usually not known and cannot be known even after a large number of in situ tests.

Post earthquake strengthening (Italian experience)

Year	Location	Intensity I_{MCS}	Financial contribution
1980	Irpinia	IX-X	30,000
1996	Novellara	VII	120
1997	Umbria-Marche	VIII-IX	12,000
1997-8	Rieti	V-VI	100
1998	Pollino	VI-VII	500
2000	Canterano	VI	30

Governmental financial contribution in million Euro

Building strengthening in developing countries

Transfer of knowledge in design

Transfer of knowledge in construction practices

Low cost & effective interventions

Main items in the program establishment

1. The conception
   Aim, overall funding, time, type of building to be addressed

2. The overall strategy
   Priorities, individual costs, safety level to be achieved, ...

3. The implementation
   Administrative procedures and technical guidelines
   Special offices devoted to the program

1. The conception of the program

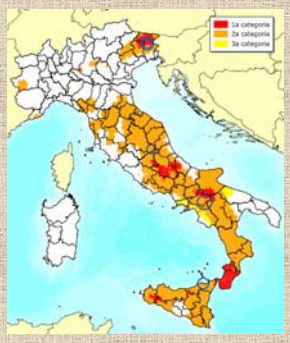
When?

Usually (always ?) after destructive events, when the society is devastated and the risk is highly perceived

S. Giuliano di Puglia Molise 2002 eqk - M=5.4

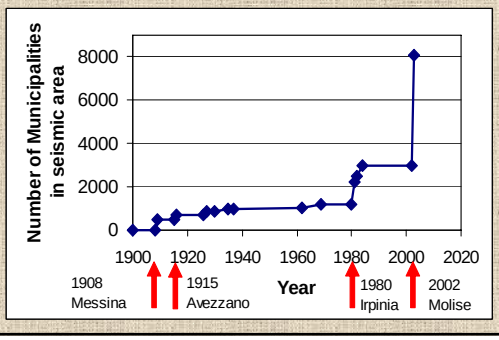
The collapsed school

S. Giuliano di Puglia Molise 2002 eqk - M=5.4



1984

2002



1. The conception of the program: Building types to be addressed

Building use to be addressed
- Strategic (Hospital, California)
- Relevant in case of collapse (School, Italy)
- Residential (Umbria Region, Sicily, Italy)

2. The overall strategy: costs and safety level to be achieved

The cost of strengthening an existing building may be very high. An analysis is the required in deciding whether to strengthen or demolish and rebuilt

What level of protection the society (or an individual owner) should demand ?

Costs depend on the safety level achieved after the intervention works. Hence the decision whether to strengthen or demolish and rebuilt is based on the accepted risk after the intervention

In practice three approaches are possible:

1. Full retrofitting: The building after the intervention complies with the code for new buildings. Very costly, a lower number of buildings can be addressed.
2. Upgrading: the intervention works have to increase, even slightly, the building capacity. Less costly, a greater number of buildings can be addressed, but it is not guaranteed that the safety level achieved is above some standard.
3. Upgrading with a predetermined safety level, lower than the one for new buildings. Intermediate situation.

The three approached can be summarized, introducing one parameter:

$$\alpha = \frac{\text{capacity of the strengthened building}}{\text{capacity of a new building}}$$

Full retrofitting: $\alpha=1$

Upgrading: $\alpha>\alpha_o$

Upgrading with a predetermined safety level, $\alpha>\alpha^*$

In the recent Italian experience

National school seismic safety program α>0.65

National plan for the seismic assessment
of strategic buildings and first intervention
depends from Regions
In Latium Region α=1.00

Reconstruction after 1980 Irpinia eqk α=1.00
Reconstruction after 1997 Umbria-Marche eqk α>0.65
Reconstruction after 1987-98 Rieti eqk α>0.50

A value greater than 0.5 should be used and possibly also greater than 2/3

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

2. The overall strategy: costs and safety level to be achieved

Selection among different strategies is based on cost-benefit analysis

If the considered cost is the only economic cost of the building repair (direct losses), than the mitigation strategy has a positive benefit only in high seismic areas

If the considered generalized cost include also the business disruption or the loss of human life (indirect losses), than mitigation always pays.

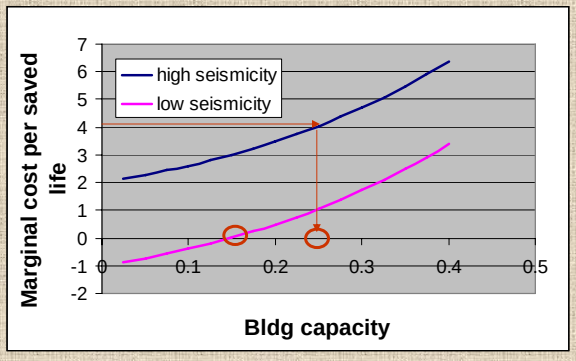
One useful parameter is the marginal cost per saved life

Cost=
Building value (constant) +
Present value of the intervention costs +
Present value of direct and indirect costs in case of event

High seismic resistance → high number of saved life → higher costs

Low seismic resistance → low number of saved life → lower costs

The marginal cost per saved life curve is an increasing function of the seismic resistance



If the cost of the mitigation strategy has been already established, selecting the buildings with the lower cost per saved life, assure the maximum reduction in victims
Usually the low cost interventions are the ones that can save lives with lower payback period

An interesting solution is targeting the most vulnerable buildings, identifying the "killer" buildings

Study after Mexico city eqk
Sample area High occupancy buildings
Strategy I: Worst 8% strengthened
50% reduction in fatalities
5000$ cost per saved live

Strategy II: Worst 18% strengthened
80% reduction in fatalities
7000$ cost per saved live

Strategy II cost / Strategy I cost = 2/1

2. The overall strategy
Priorities, costs, safety level to be achieved,...

Since for economical reasons it is not possible to address all the buildings within the selected use (all the schools, hospital, etc), priorities have to be defined (building targeting).

Usually based on risk

Which indicator (economic damage, usability, non repairability, collapse,...) ?

Each indicator will provide a different list of buildings

2. The overall strategy: Priorities

Problem 1

Which indicator (economic damage, usability, non repairability, collapse,...) ?

Each indicator will provide a different list of buildings

Problem 2

Very often the data needed to evaluate the risk are not known. This requires a long campaign of data collection that delay the priority list and the intervention works. This is usually not possible when the mitigation program has been established at political level and fund have bene already allocated.

2. The overall strategy: Priorities

Problem 3

The buildings to be included in the program will never be based on the only risk assessment

The social, cultural and political context are always very important (a school in a depopulating municipality will probably not included in the program)

Nevertheless a "technical" list based on risk will be probably the first step towards prioritisation

3. The implementation:Administrative procedures and technical guidelines

Strategies are to be formulated into action programs

They have to be clearly understood by

- Building owners
- Government legislators
- Technical offices
- Building occupants

Usually a special committee is established to draft the administrative procedures and the technical guidelines

3. The implementation: Administrative procedures

They include:
- Requirements for funding
- Request for funding
- Deadlines
- Priorities for funding access (residence, presence of old people, low income people, ...)
-Maximum allowed contribution
-Type of controls

An efficient mitigation programs always starts with clear administrative procedures. Otherwise during the implementation someone may bring a lawsuit against the administration in charge of the program

3. The implementation: Technical guidelines

They include:
-Safety level to be achieved after the intervention
-Allowed interventions
-Calculations required (before and after the intervention,..)
-Documentation required (drawings, calculations, pictures,..)

Very often advanced professional training courses are organized for the professionals involved in the design of the intervention works

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

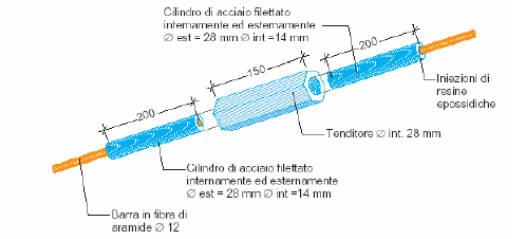
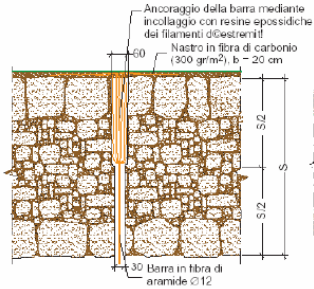


Fig. 11. Tenditore per barre in aramide



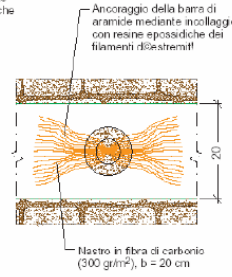


Fig. 12. Ancoraggio esterno della barra in aramide

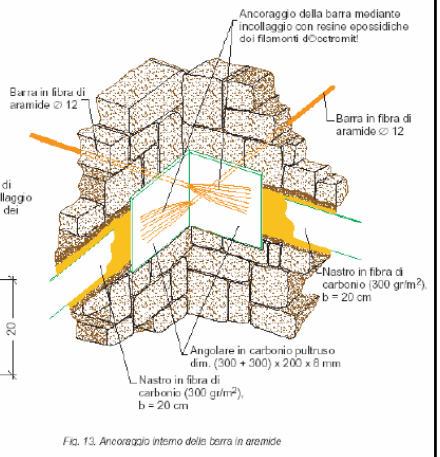
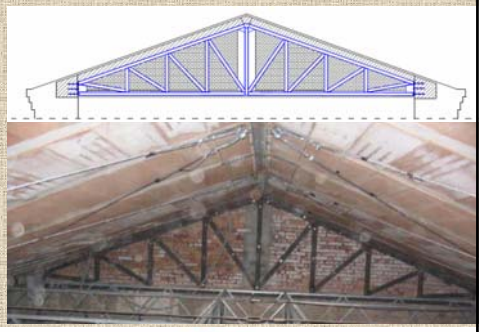
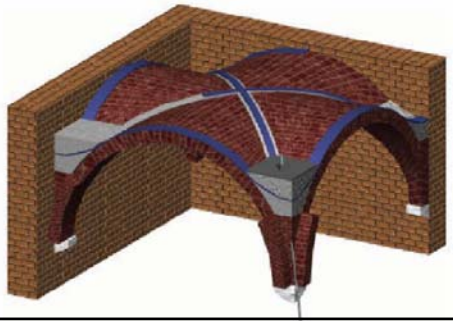
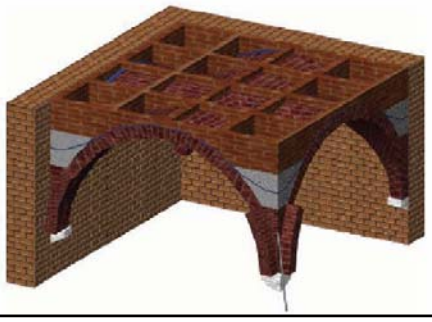


Fig. 13. Ancoraggio interno della barra in aramide

Figura B.12.3 – Esempio : collegamenti di piano con ancoraggio a paletto all'esterno[6]
Palazzo Ducale Larino (CB)







3. The implementation: Special offices devoted to the program

The existing administrative and technical offices are usually charged with the ordinary work

It is important, in order to speed up the program, the have special offices devoted to the implementation of the program and to the control of the design and works

Few items required for an efficient mitigation program (structural measures)

Aims:	clear and realistic
Funding:	assured in the long term, possibly require co-financing
Deadlines:	short, once funds has been made available
Personnel:	Administrative, Technical, Lawyer
Controls:	in every phase of the program

Examples of recent normal time mitigation programs

- Seismic risk mitigation program for residential buildings in Umbria Region, Italy
- Seismic risk mitigation program for residential buildings in Sicily, Italy
- Italian national plan for school seismic risk mitigation
- California plan for Hospital seismic risk mitigation
- Italian National Plan for Seismic Assessment of Strategic and Relevant Buildings and Infrastructures

Seismic risk mitigation program for residential buildings in Umbria Region, Italy (Regional program)

Regional Law n. 18/2002
Financial contribution up to 50% of the cost of the structural works (and finishing correlated) with the maximum of 20,000 Euros for each dwelling

Allowed interventions: all able to reduce the seismic vulnerability of city blocks

Type of buildings: Masonry buildings only

Other requirements: private owners, mostly residential dwellings, taxes on the building correctly paid

Maximum % contribution for finishing: 25%

Funding increase

10% if the block contains more than one building

15% if the building is historical

10% if the building is located on an unstable slope

10% if the building has more than 10 owners

Maximum increase = 30%

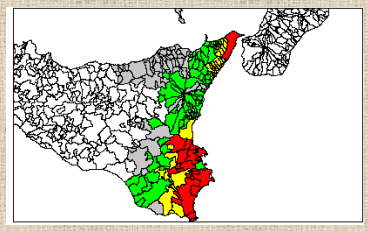
Status of the program

MUNICIPALITY	NUMBER OF REQUESTS	FUNDING (EURO)
Citerna	1	23.000,00
Città di Castello	28	894.500,00
Lisciano Niccone	0	0,00
Monte S.M. Tiberina	1	20.000,00
Montone	8	705.000,00
Pietralunga	40	1.472.000,00
San Gemini	10	484.000,00
S. Giustino	5	240.000,00
Umbertide	1	160.000,00
TOTAL	**94**	**3.998.500,00**

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

Seismic risk mitigation program for residential buildings in Eastern Sicily, Italy (national program)

1908 Messina eqk
80,000 victims



Prevention program stated by law
120 million of Euro (Law 433/1991)

The territory includes:
4 provinces (Catania, Messina, Ragusa, Siracusa)
199 municipalities in seismic area
1 million dwellings
96 million of building floor area
2,4 million of inhabitants

Buildings can have access to funding according to a priority list based on the following indicator:

$$I_{RS} = N_{vt} P_c(V)$$

N_{vt} is the number of victims given the building collapse and $P_c(V)$ is the collapse probability given the bldg vulnerability

I_{RS} is then the expected number of victims and it is a social risk indicator (in comparison with the individual risk)

I_{RS} favors the highly populated buildings (large volume) in comparison with small buildings. The use of a priority list based on the marginal cost per saved life would have required the selection of the intervention prior the funding, complicating the access to funding.

Technical guidelines specifically drafted
- Minimum safety level to be achieved
- The works have to be completed within 3 years
- At least one resident in the building.

The financial contribution ranges from 225 Euro/m2 to 280 Euro/m2 including VAT and technical fees.
50% reduction for dwellings used as temporary housing.

In case of low income people, the contribution can be increased up to 450 Euro/m2

With this contribution it is expected that 5,000 dwellings can be strengthened corresponding to a floor area of 450.000 mq (total floor area in the area 96,000,000) (0.46%)

Italian national plan for school seismic risk mitigation

Law 289/2002, art. 80
Ministry of Infrastructure, Ministry of Education and Technical Support of Civil Protection Department
Recently all the Regions have been involved

Cost for the seismic upgrading of all the schools in Italy: about 13,000 million Euros (!!) (0.5% of GDP)

Prioritizing the schools, considering all the most vulnerable school in seismic zone 1 (higher hazard) and 30% of the most vulnerable in seismic zone 2, the needs reduces to 4,000 million Euros

Through loans to be paid for 15 years, 460 million Euro have been made available

First plan : 158 million Euro
738 schools
average cost of the intervention 210.000 Euro

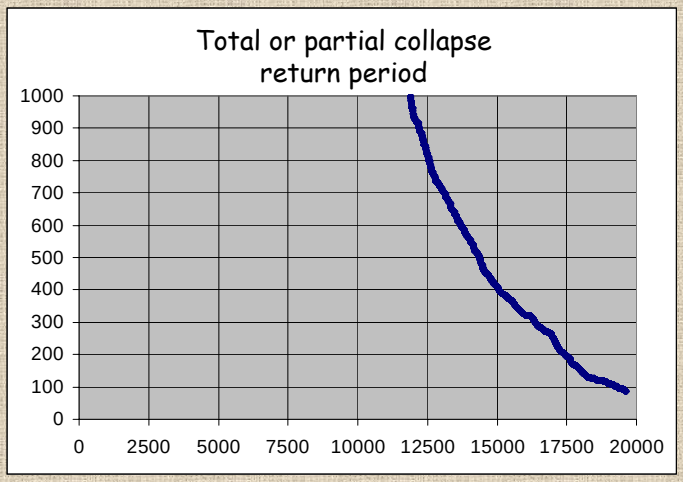
Second plan: 295 million Euro
876 schools
average cost of the intervention 336.000 Euro

Schools, Vulnerability and Hazard in South Italy

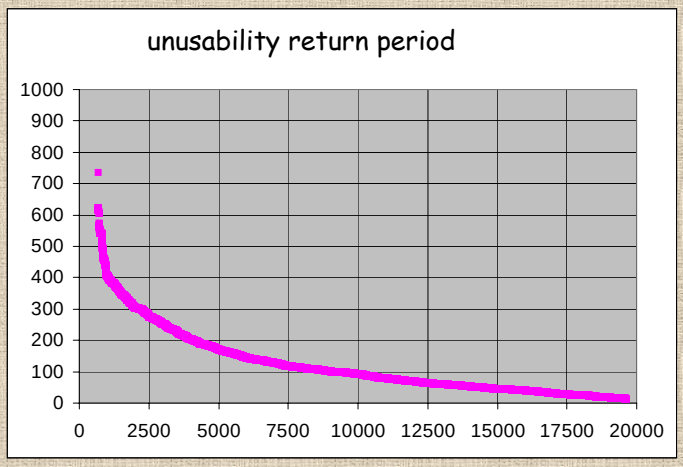
Vulner\Hazard	Zona 1	Zona 2	Zona 3	Totale
Low	950	2104	357	3411
Medium-Low	1616	3302	305	5223
Medium	323	2222	69	2614
Medium-High	1535	2546	561	4642
High	758	1596	337	2691
Total	5182	11770	1629	18581

Vulner\Hazard	Zona 1	Zona 2	Zona 3	Totale
Low	5.1%	11.3%	1.9%	18.4%
Medium-Low	8.7%	17.8%	1.6%	28.1%
Medium	1.7%	12.0%	0.4%	14.1%
Medium-High	8.3%	13.7%	3.0%	25.0%
High	4.1%	8.6%	1.8%	14.5%
Total	27.9%	63.3%	8.8%	100.0%

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08



About 300 schools with return period lower than 100 years
About 5,000 schools with return period lower than 475 years



About 8,500 schools with return period of unusability lower than 75 years
About 1,000 schools with return period of unusability lower than 20 years

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California plan for Hospital seismic risk mitigation

1994 – Senate Bill 1953

Plan to bring all the hospital in the compliance with the code (operational after major eqk) by the year 2030 (or abandoned)

Hospital buildings with high collapse probability cannot be used for acute care purposes after January 1, 2008
These buildings must be demolished, abandoned or retrofitted

Estimated cost of the program 14 billion $ in 1990
No funding was provided by the State

http://www.oshpd.ca.gov/fdd/sb1953/index.html

Seismic performance categories
for structural and
non structural components

Once assigned to the building they will become public

56% of the hospital in California, according to OSHPD, do not meet the safety requirements

The cost of the program increased to 42 billion $ in 2002 (RAND estimate) and continue to increase due to increase in construction costs

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

In 2007, Senate Bill 306 authorizes qualified hospital owners, including city or county hospitals or hospitals that meet strict financial hardship criteria, to receive a seven year extension from the 2013 seismic safety deadline and instead require the hospitals to replace those buildings by January 1, 2020 (instead of 2030).

Summary of Requests for 2020 Seismic Safety Extensions

	Date Received	Facility Name	Address	Last Updated	Status
1	5/9/2008	Parkview Community Hospital	3865 Jackson Street, Riverside CA, 92503	08/05/08	Application withdrawn
2	7/7/2008	Seton Medical Center	1900 Sullivan Ave, Daly City CA, 94015	07/31/08	Approved
3	7/7/2008	St. Vincent Medical Center	2131 West 3rd Street, Los Angeles CA, 90057	07/31/08	Approved
4	7/11/2008	Alameda County Medical Center	1411 East 31st Street, Oakland CA, 94602	07/31/08	Approved
5	7/16/2008	Marin General Hospital	250 Bon Air Road, Greenbrae CA, 94904	08/18/08	Denied
6	9/24/2008	San Mateo Medical Center	222 W. 39th Avenue, San Mateo, CA 94403	10/08/08	Incomplete
7	10/2/2008	Hollywood Presbyterian Medical Center	1300 North Vermont Ave, Los Angeles, CA 90027	10/30/08	Approved
8	10/21/2008	Victor Valley Community Hospital	15248 Eleventh St., Victorville, CA 92392	10/30/08	Secondary Review
9	10/21/2008	Memorial Hospital of Gardena	1145 W. Redondo Beach Blvd., Gardena, CA 90247	10/30/08	Secondary Review
10	10/23/2008	East Los Angeles Doctors Hospital	4060 E. Whittier Blvd,, Los Angeles, CA 90023	10/30/08	Approved
11	10/30/2008	Delano Regional Medical Center	1401 Garces Hwy, Delano, CA 93215	10/31/08	Financial Review
12	10/31/2008	Pacifica Hospital of the Valley	9449 San Fernando Road, Sun Valley, CA 91352	11/12/08	Financial Review
13	11/3/2008	Colorado River Medical Center	1401 Bailey Avenue, Needles, CA 92363	11/12/08	Financial Review
14	11/3/2008	Sonoma Valley Hospital	347 Andreux St, PO Box 600, Sonoma, CA 95476	11/12/08	Financial Review
15					

Italian National Plan for Seismic Assessment of Strategic and Relevant Buildings and Infrastructures

OPCM 3274/2003

100 million Euro in 2004
100 million Euro in 2005

Co-financing (30-50%) of seismic assessment (2 Euro/m^3) and urgent strengthening works (150 Euro/m^3) of critical buildings and infrastructures
Priority for seismic zone 1 and 2
construction period <1984

32.5% to State (Fire Brigades, Police, Motorways,...)
67.5% to Regions (Regional, Provincial and Municipal bldgs)

Buildings to be assessed

Seismic zone	1	2	3	4
Population (%)	5.3%	35.4%	25.7%	33.6%
Volume (million of m^3)				
Education	20.5	130.0	94.9	123.6
Civil	9.4	49.8	36.8	47.4
Health	4.9	24.9	18.5	23.8

The number of buildings built before 1984 to be assessed has been estimated around 75,000, of which 35,000 in zone 1 and 2 (Not considering infrastructures, lifelines, cultural assets, commercial and industrial buildings)

Considering 200 million Euro, about 5,700 Euro were available for each assessment. Some prioritization has to be introduced

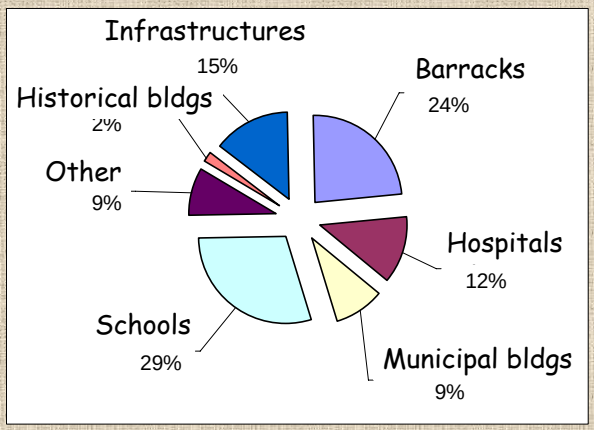
Distribution between Assessment and Strengthening (State & Regions, 2004-2005)

	Total	Assessment	Strengthening
Number	6,718	97.0%	3.0%
Cost	380 Meuro	38.1%	61.9%

3% strengthening → 62% of cost

Cost of strengthening / cost of assessment = 50 / 1

Use distribution in the assessment (State & Regions, 2004-2005).



Difficulties in the implementation

- Lack of prior knowledge on existing buildings and infrastructures
- Delay in the activation of the Regions
- Regional and State priorities sometimes improvised
- Lack of technical guidelines (different in each Regions)
- Professionals not skill on existing buildings (capacity sometimes is null)
- Errors on volume and identification (same buildings included twice in the plan)

Agostino Goretti, "Risk Management strategies. Risk prevention. Structural measures", Lisbon 19.11.08

The End