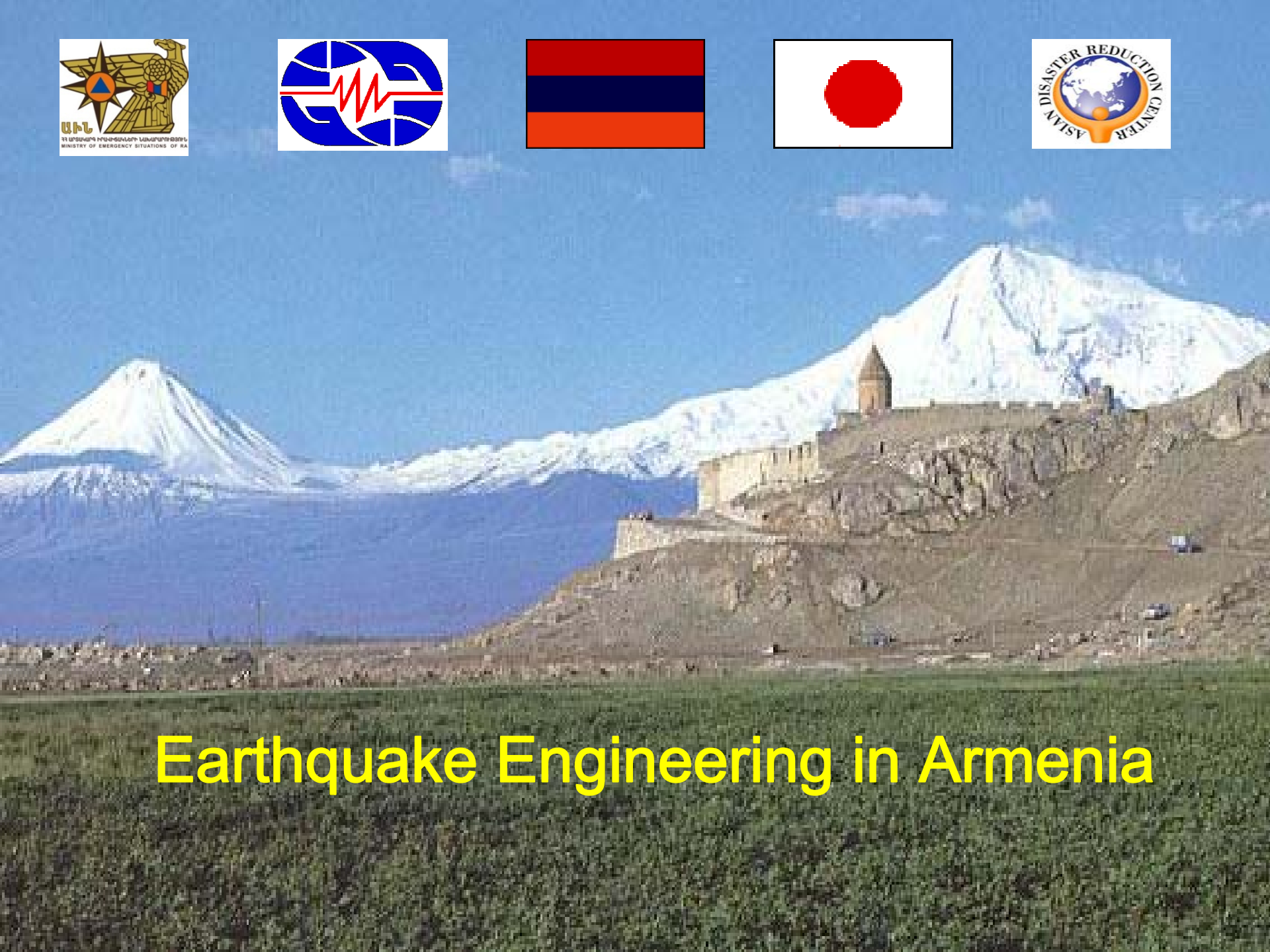


Earthquake Engineering in Armenia

SPITAK DEVASTATING EARTHQUAKE M7.1

Armenia 07.12.1988.

Brief Information on Spitak M7.1 Earthquake

Grave consequences

- Casualties: 25 000
- Invalids 19 000
- Homeless: 500 000
- Destruction extent: 40 percent of the area
- Desrupted: 21 towns and settlements
- Collapsed: 10 000 apartment buildings, hundreds of kindergartens and schools and tens of higher education establishments, 2000 public facilities
- Property loss: 13 billion USD

Collapsed facilities

Town of Spitak


Town of Gyumri


Town of Gyumri


Town of Gyumri

Basically destructed buildings

Destructed buildings

Destructed buildings

Heavily damaged buildings

Recreation building

Hospital

Settlements and buildings damaged during earthquakes in some countries

Skopje, Macedonia, 26.07.1963, M7.2

Skopje, Macedonia, 26.07.1963, M7.2

Skopje, Macedonia, 26.07.1963, M7.2

Gujarat, India, 26.01.2001, M7.7

Gujarat, India, 26.01.2001, M7.7

Izmit, Turkey, 17.08.99 M7.4

Izmit, Turkey, 17.08.99 M7.4

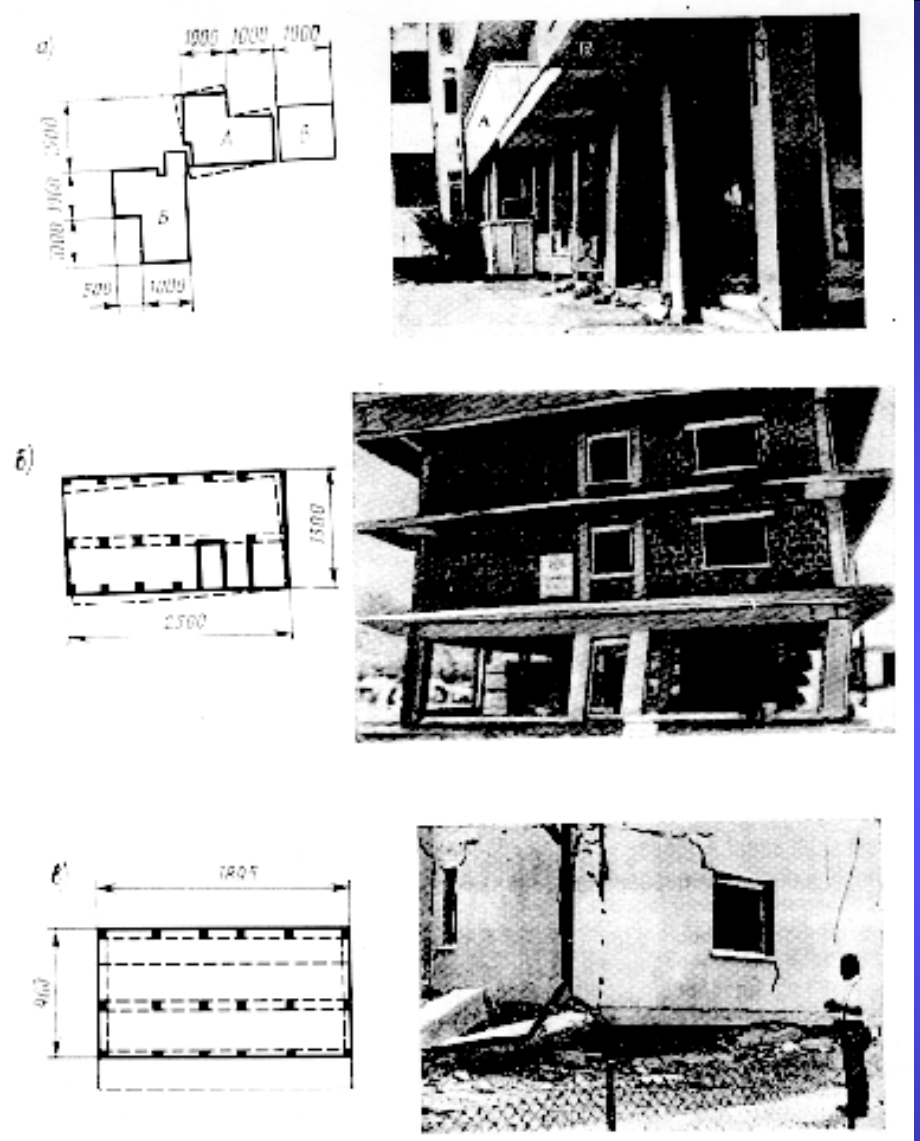


Рис. IV.4. Повреждения зданий типа 3 во время Фриульского землетрясения [IV.25]:

а — схематический план жилого 8-этажного здания и фото после землетрясения (видно большое смещение отсека *А* по отношению к отсеку *Б* и повреждение колонн 1-го этажа); б — план 3-этажного здания и фото после землетрясения; в — план 4-этажного здания и фото его после землетрясения (первый этаж обрушился)

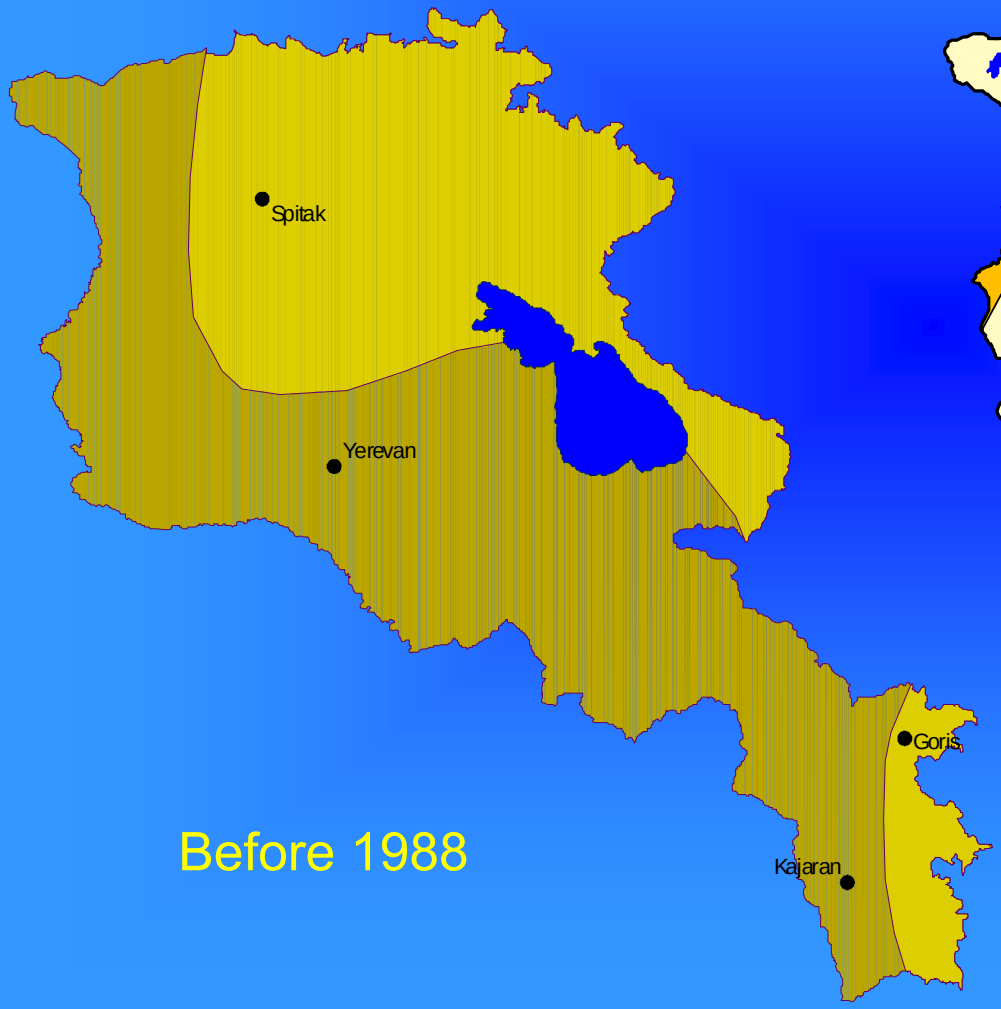
Friulli, Italy, 06.05.1976, M6.5

Main reasons of destruction

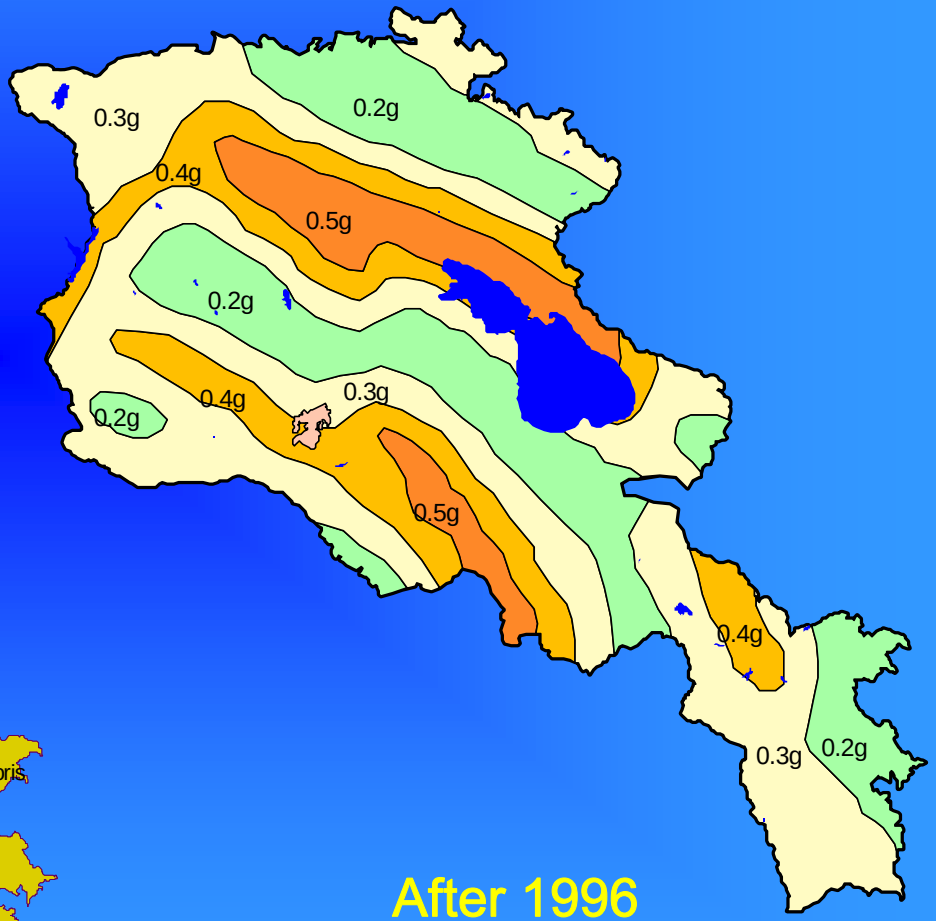
1. Untrue assessment of seismic hazard
2. Not strict seismic building codes
3. Faults in constructive solutions
4. Low quality of construction
5. Unproper exploitation

Untrue Assessment of Seismic Hazard

Seismic Zoning Maps of Armenia



Before 1988



After 1996

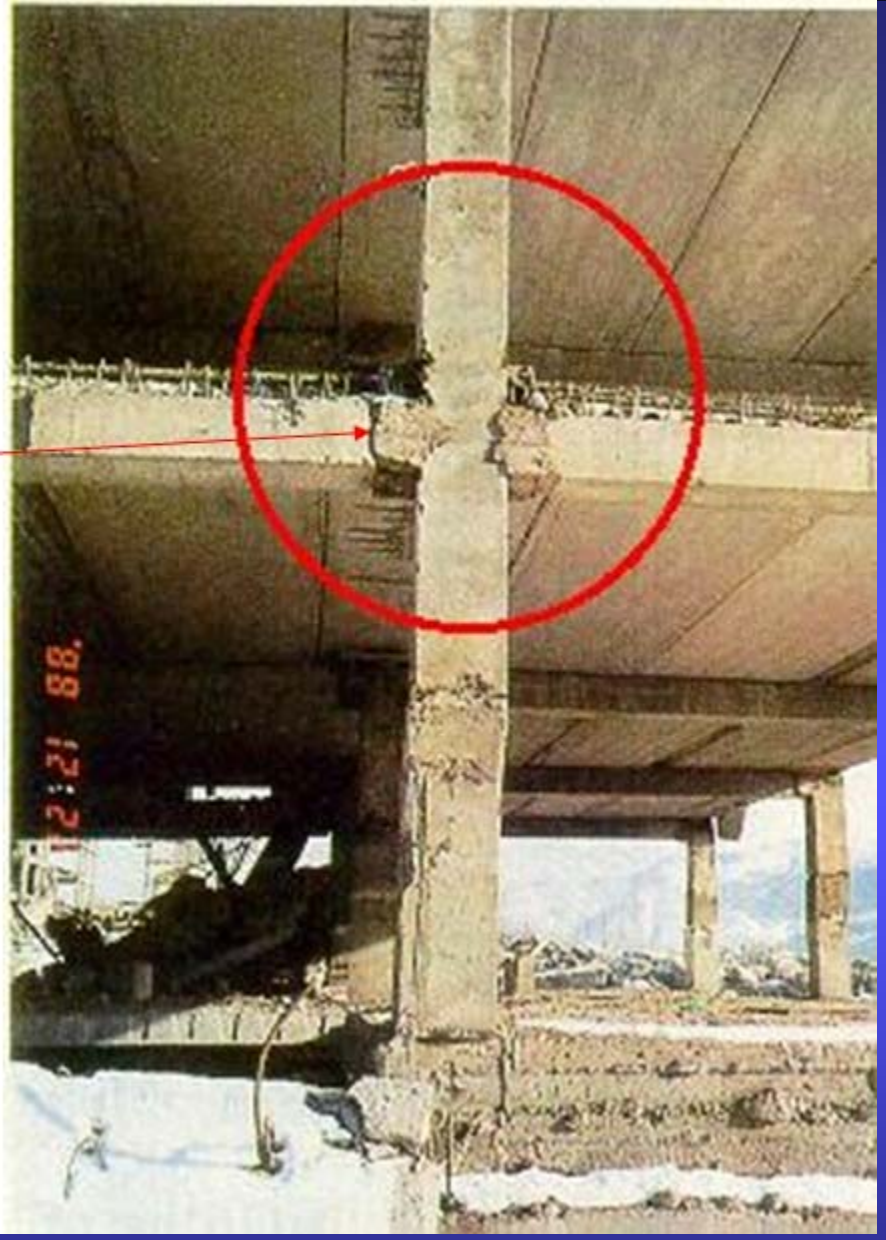
Not Strict Seismic Building Codes

Seismic building codes ¥.~ â.. JT.8/92!xfsf!jo!gpsdf!jo!Bsnfojo!evsjoh!Tpwjfu!fsb!

Since 1994 the Regulations “Seismic ally Resistant Construction. Design Codes ” ՀՀՇՆ II-2.02-94 have been applied in Armenia

Since 2006 the updated Regulations “Seismically Resistant Construction. Design Codes” ՀՀՇՆ II-6.02-2006 were in force in Armenia

Faults in Constructive Solutions



Low Quality of Construction

Low quality of construction works


06.03.2007 13:07


21.05.2007 08:00

Unproper Exploitation

Classification of Buildings by Constructive Solutions in Armenia

1. Stone-wall (masonry) (up to 5 story)
2. Large panel buildings (9 story)
3. Frame-panel buildings (9 story)
4. Buildings with frame-tied system (12-16 story)
5. Buildings constructed with story-raising technology (12-16 story)
6. Buildings construted with new constructive solutions

office@nssp-gov.am

Stone-wall (masonry) buildings (up to 5 story)

- 30 percent of building stock
- High vulnerability
- Retrofitting required

Large Panel Buildings (9 story)

10 percent of building stock

Low vulnerability

office@nssp-gov.am


25.07.2007 18:58


25 07

Frame Panel Buildings (9 story)

15 percent of building stock

High vulnerability

After Spitak 1988 Earthquake were not constructed

Retrofitting required


25.07.2007 18:57

Buildings with Frame-Tied System

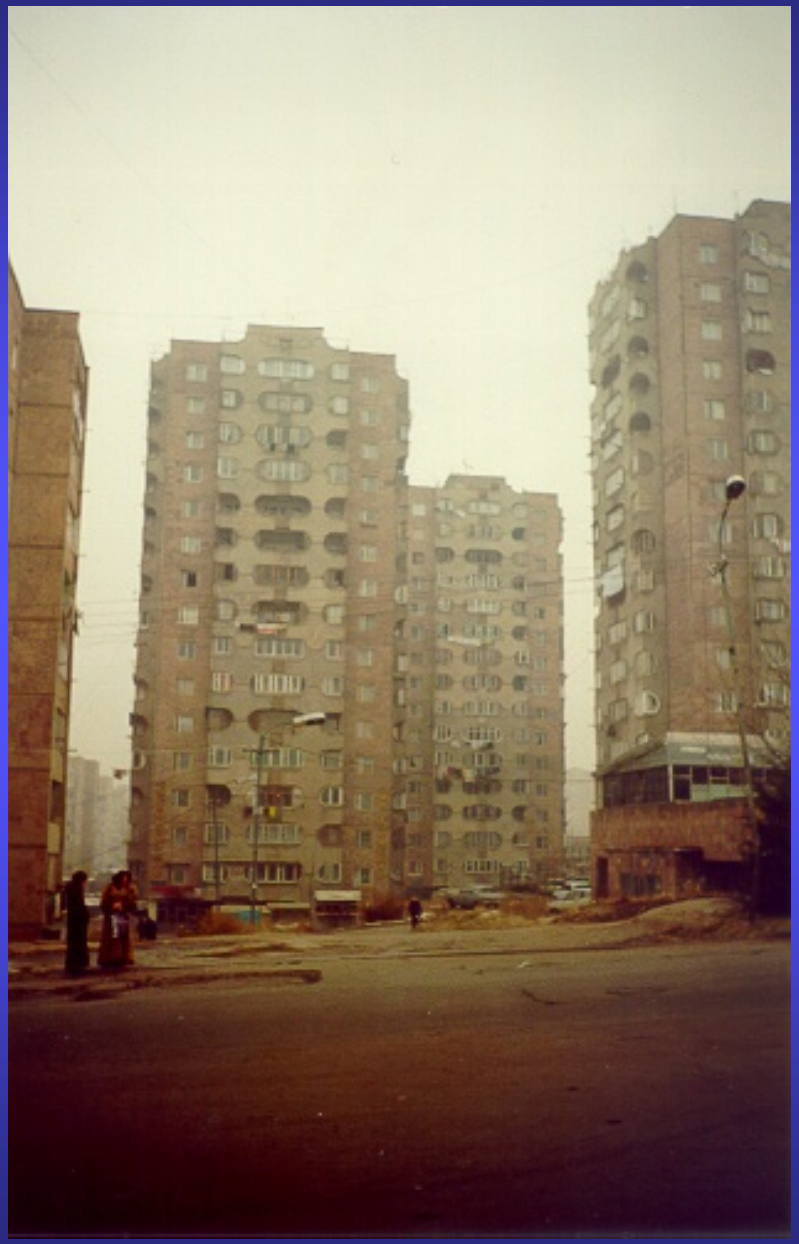
(12-16 story)

15 percent of building stock

Low vulnerability

office@nssp-gov.am


ПРЕМЬЕР
АЛСАН




25.07.2007 19:32

Buildings Constructed with Slab Lift Technology (12-16 story)

7 percent of building stock, mainly in Yerevan-city

After Spitak 1988 Earthquake were not constructed

High-rise Buildings with New Constructive Solutions

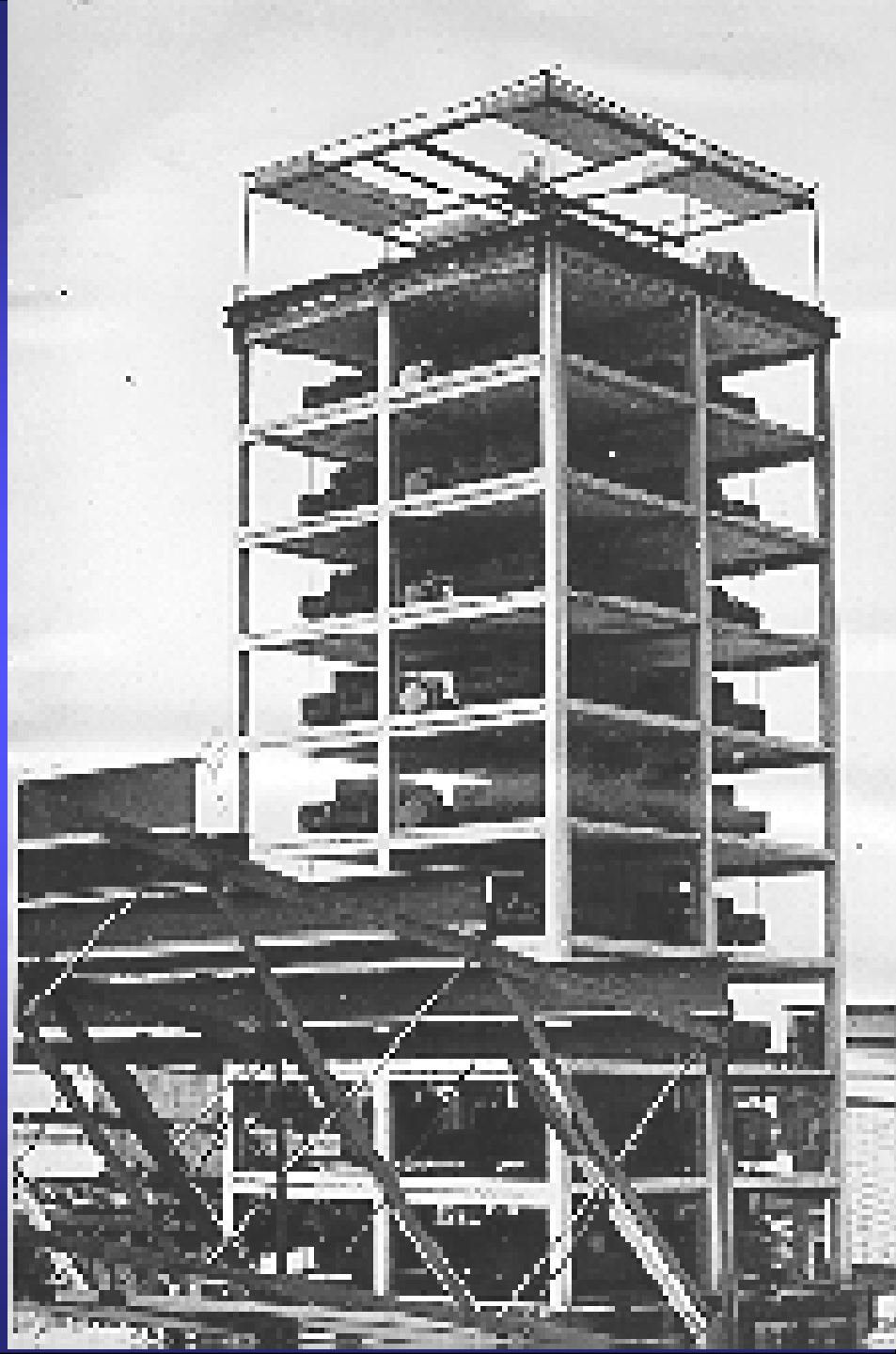

08.11.2008 08:59

Special Seismically Resistant Systems

- Dynamic vibration dampers
- Switch on and switch off ties
- Rubber-metallic layered bearings
- Vibration Damping increasing constructions
- Bonding of existing structure with newly constructed rigid structure

Vibration Dynamic Dampers

Model of 9 story frame building with dynamic damper



Building in Vanadzor town strengthened with dynamic damper

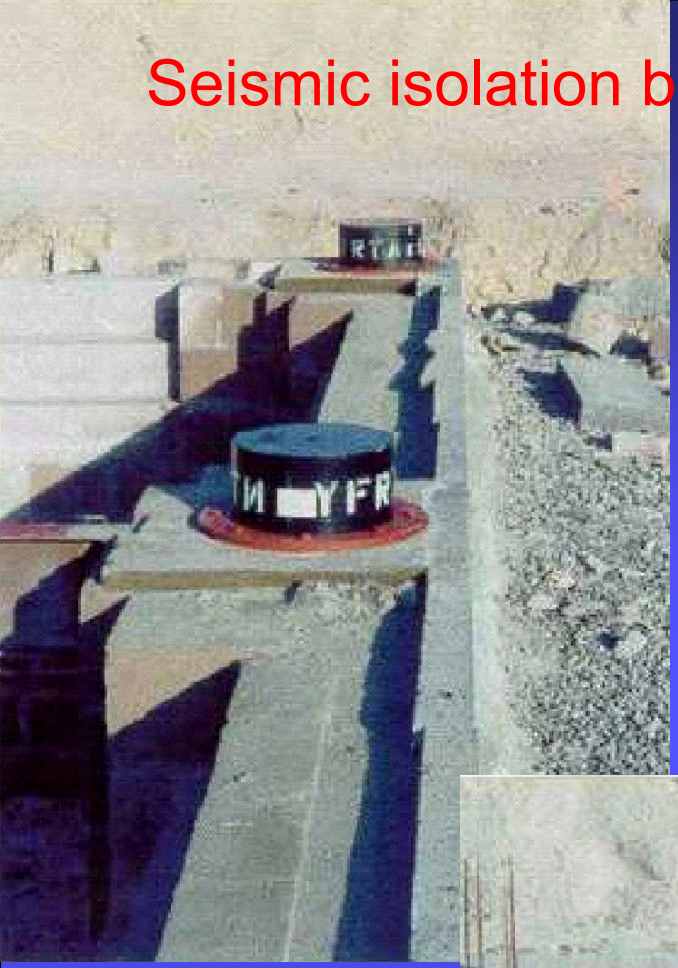
Upper flexible story on rubber metallic bearings

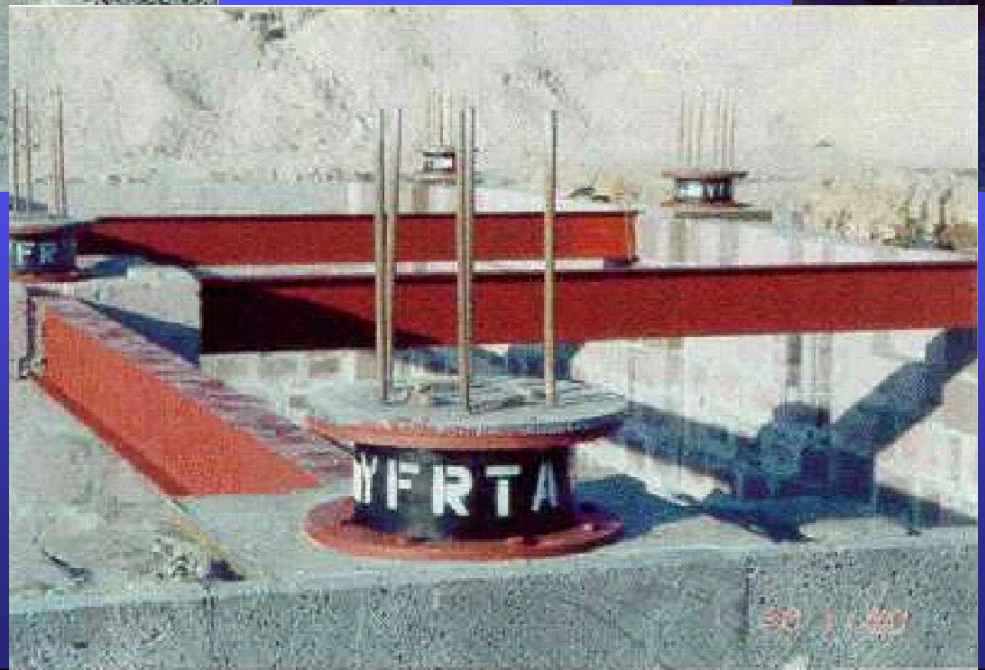

25.06.2005 12:19


AVAN SHUSHI PLAZA HOTEL

Rubber metallic layered bearings

Seismic isolation bearings at the buildings



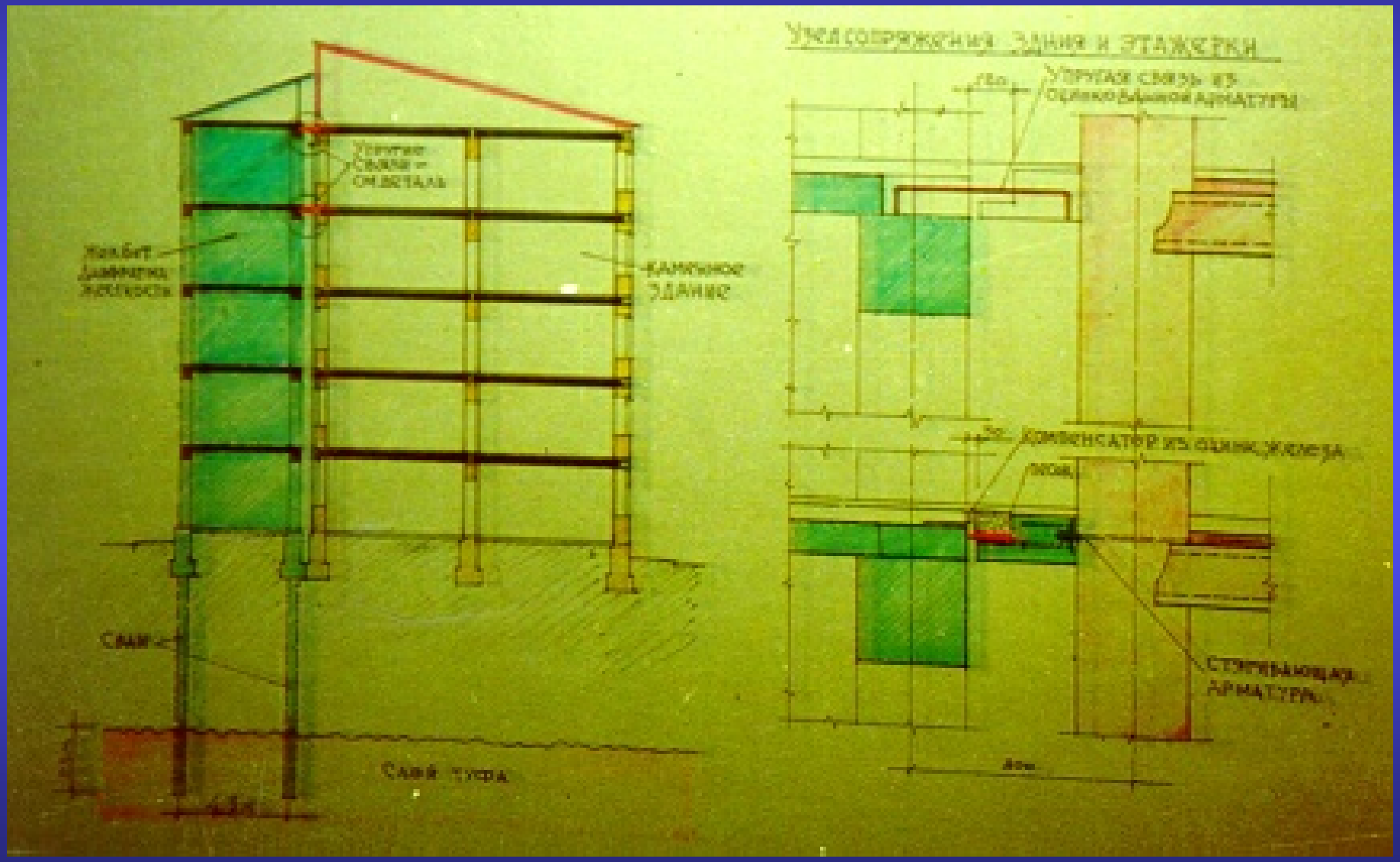


Armenian International Airport
Production of rubber metallic bearings
(Kuala Lumpur, Robinson Seismic Ltd NZ)

Bonding existing structure with newly constructed facility

Building before reconstruction

Constructive solutions



Building after reconstruction

Thank You