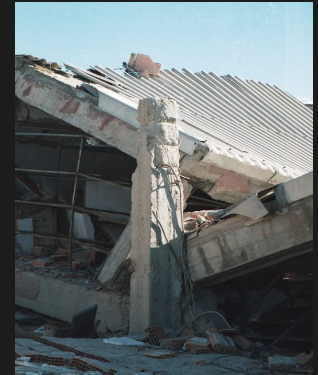


Danni dovuti allo scuotimento del suolo

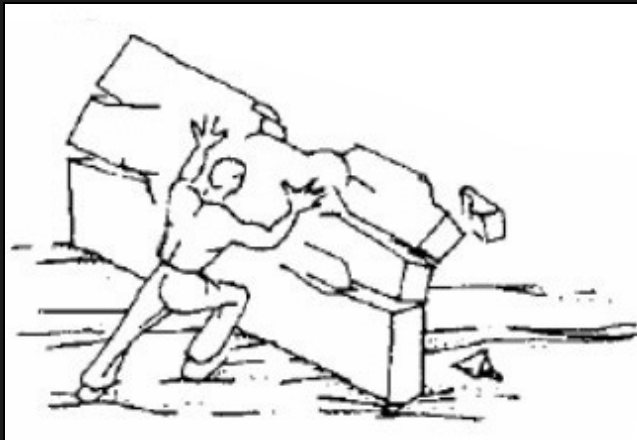
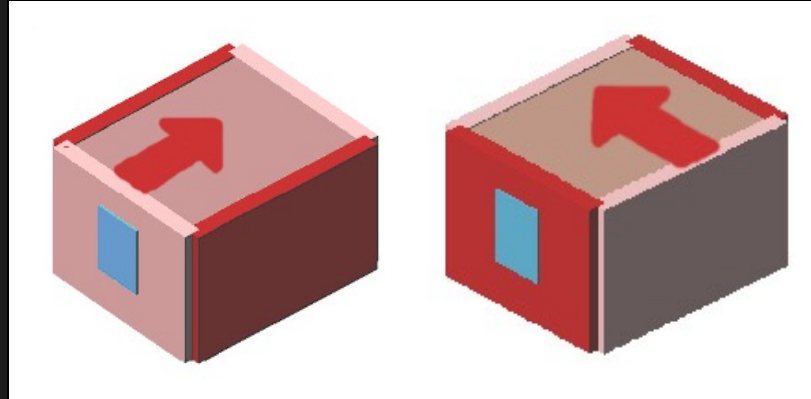
L'**analisi dei danni** provocati da un sisma rappresenta uno strumento fondamentale per **migliorare** le conoscenze e quindi lo stato dell'arte della **pratica progettuale e costruttiva** di strutture sismo-resistenti

La prestazione sismica di una struttura dipende da:

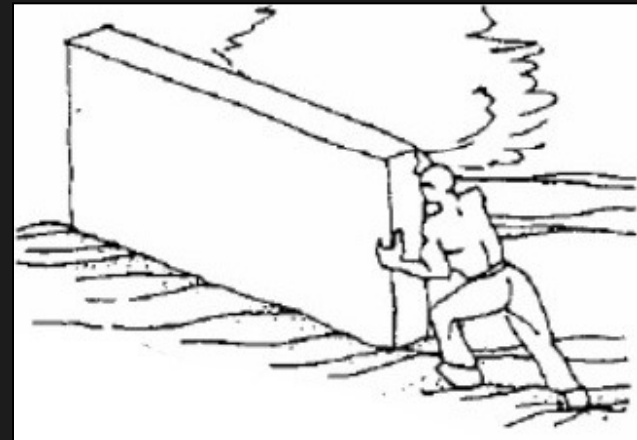
- ① *Tipo di fondazione*
- ① *Distribuzione degli elementi strutturali*
- ① *Caratteristiche meccaniche dei materiali*
- ① *Progettazione ed esecuzione dei dettagli costruttivi*
- ① *Manutenzione degli elementi strutturali*



Strutture in muratura



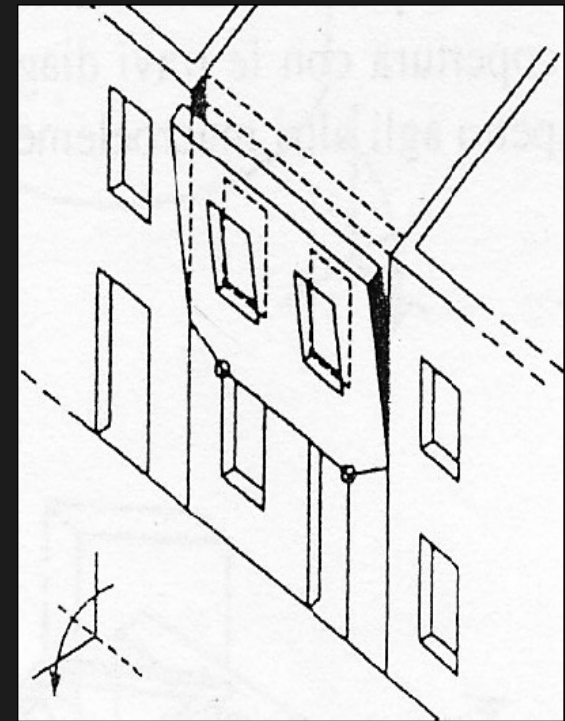
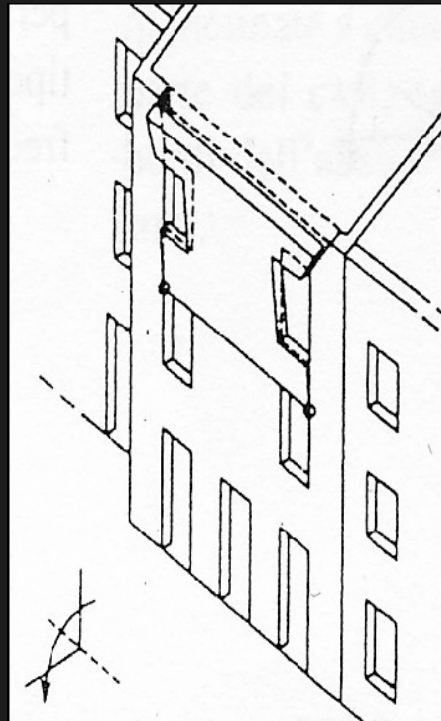
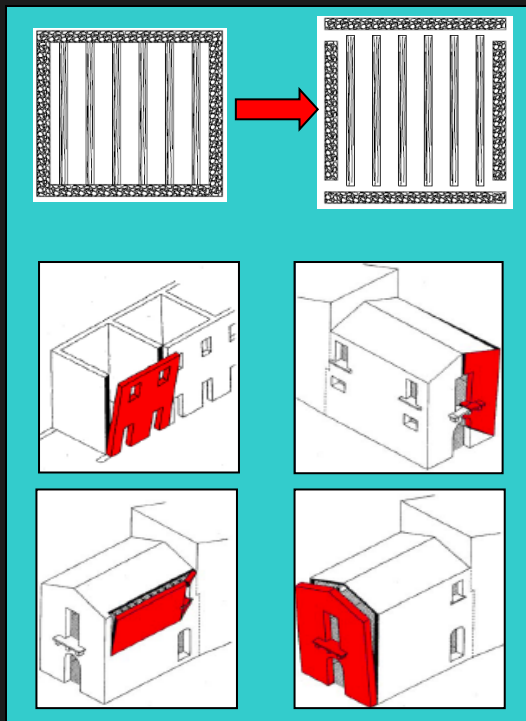
Meccanismi di 1° modo



Meccanismi di 2° modo

Strutture in muratura – Ribaltamento semplice

Rotazione rigida di porzioni di parete attorno ad una cerniera cilindrica orizzontale posta alla base per mancanza di ammorsamenti alle pareti ortogonali.



Strutture in muratura – Ribaltamento semplice



Umbria 1997



Strutture in muratura – Ribaltamento semplice



Messina, 1908



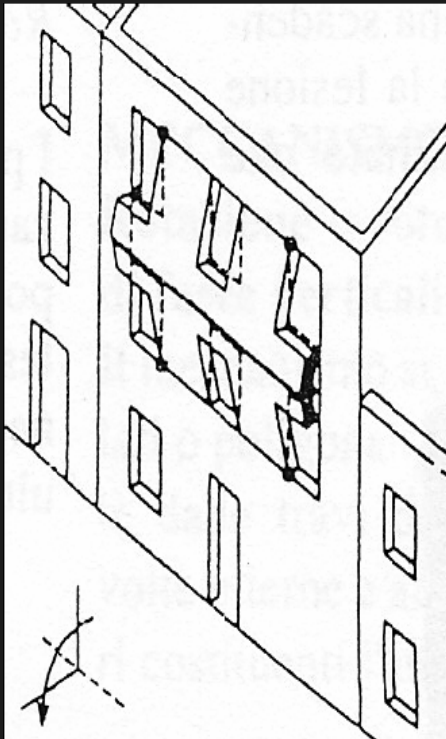
Umbria - Marche, 1997



Umbria 1997

Strutture in muratura – Flessione verticale

Parete connessa in sommità, ma non collegata ai solai intermedi



Umbria 1997

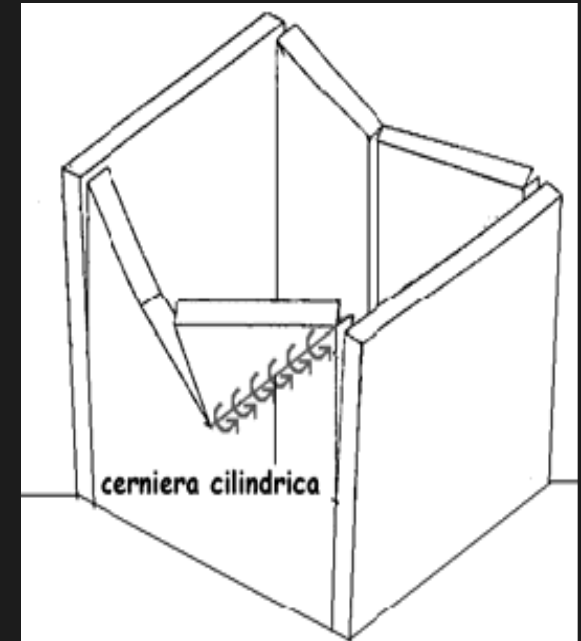
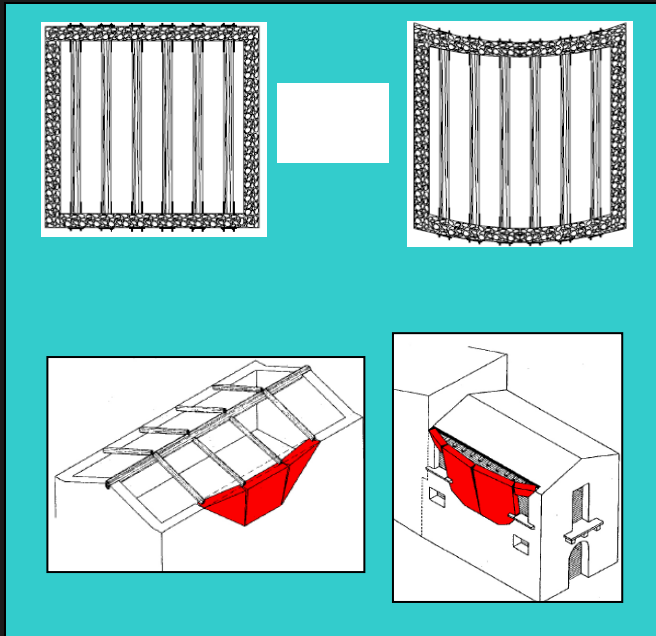
Strutture in muratura – Flessione verticale



Umbria 1997

Strutture in muratura – Flessione orizzontale

Pannelli murari efficacemente vincolati alle pareti ortogonali con il lato sommitale non trattenuto



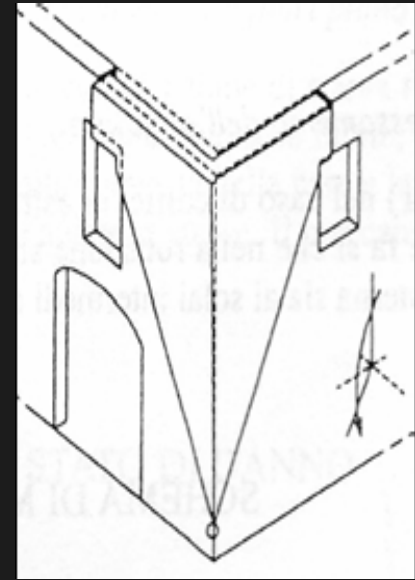
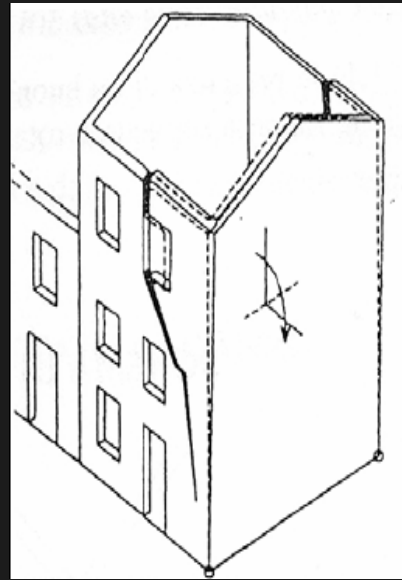
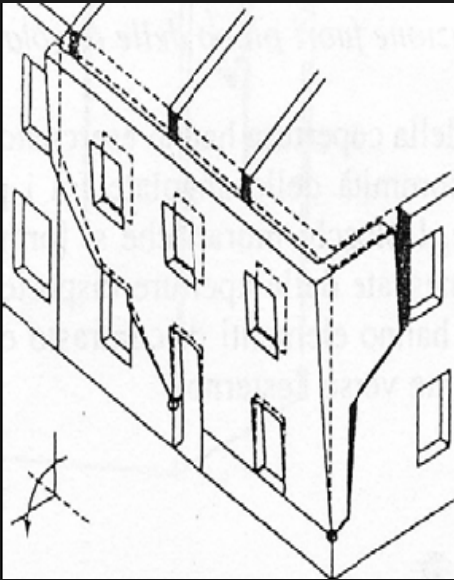
Strutture in muratura – Flessione orizzontale



Umbria 1997

Strutture in muratura – Ribaltamento composto

Ribaltamento di una parete ortogonale all'azione sismica con il trascinarsi di una porzione di parete di spina



Strutture in muratura – Ribaltamento composto



Umbria 1997



Strutture in muratura – Collasso della parete nel piano



Umbria 1997

Strutture in muratura – Collasso della parete nel piano



Umbria 1997

Strutture in muratura – Collasso della parete nel piano



Umbria 1997

Strutture in cemento armato



Nicaragua 1972

Strutture in cemento armato



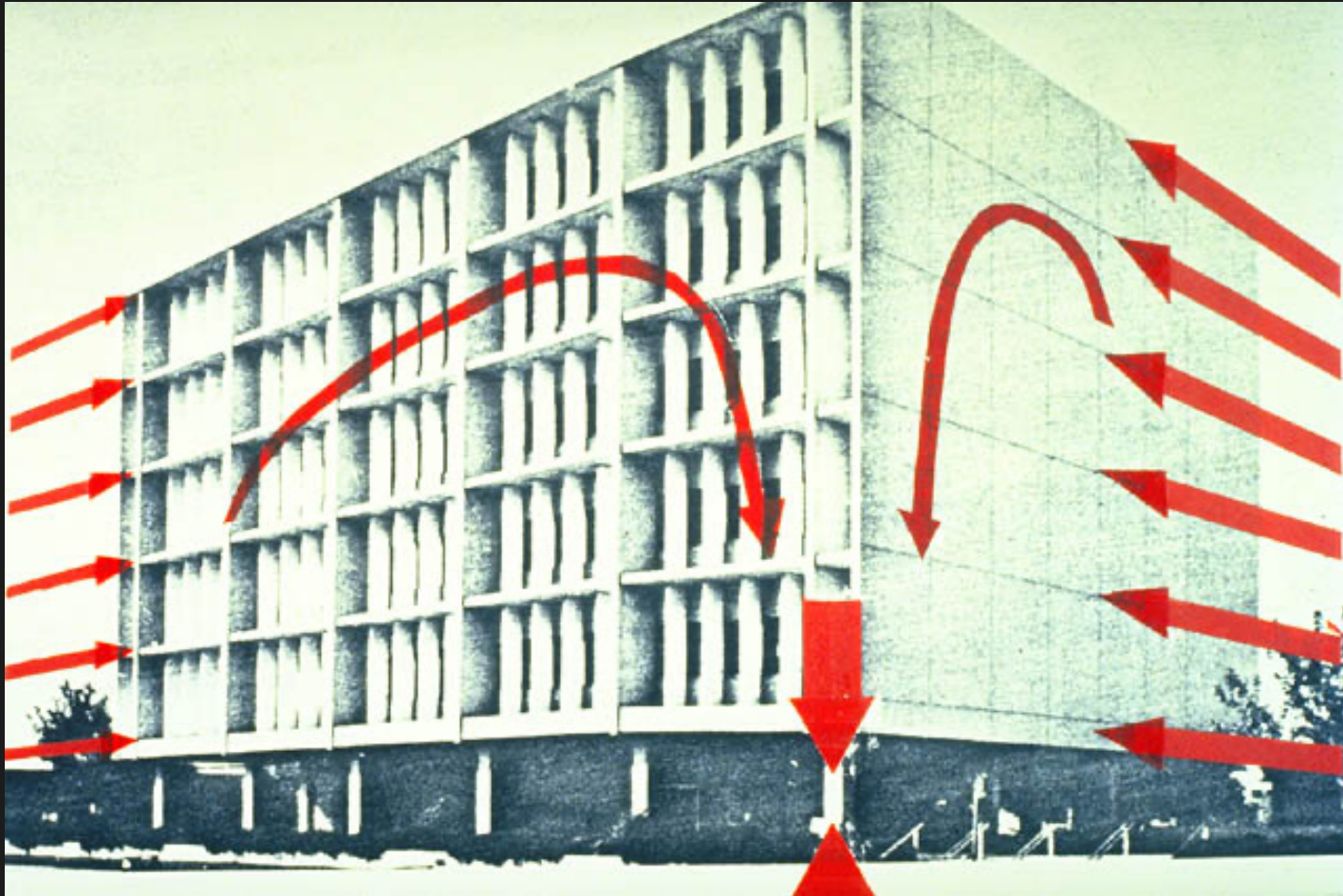
Algeria 1980

Strutture in cemento armato



Alaska 1964

Strutture in cemento armato



California 1979

Strutture in cemento armato



California 1979

Strutture in cemento armato



Strutture in cemento armato



California 1994

Strutture in cemento armato



Cile 1960



Izmit (Turchia) 1999

Strutture in cemento armato



Izmit (Turchia) 1999

Strutture in cemento armato



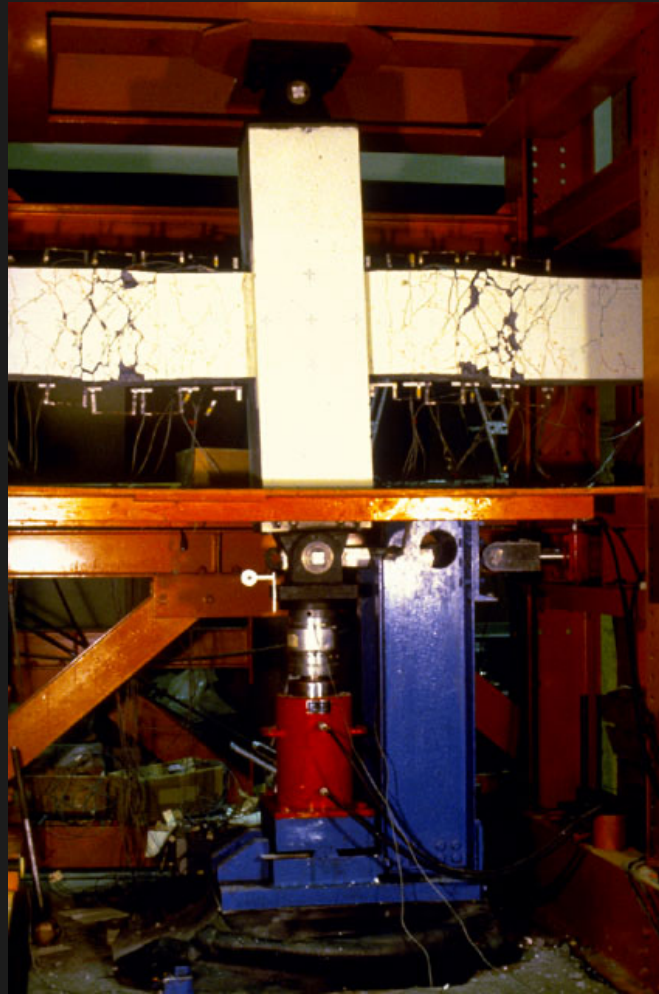
Izmit (Turchia) 1999

Strutture in cemento armato



Izmit (Turchia) 1999

Strutture in cemento armato



Trave debole – colonna forte

Strutture in cemento armato



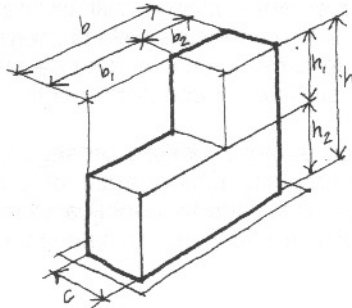
Alaska 1964



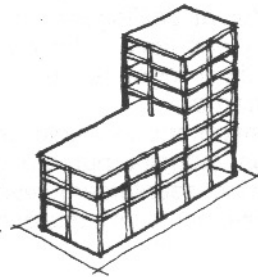
Messico 1985

Principi base per un'efficiente progettazione antisismica

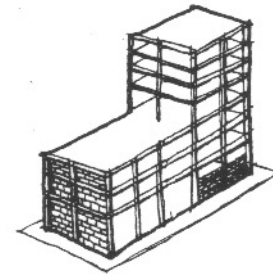
- ④ Evitare le masse non necessarie
- ④ Comprensione del comportamento complessivo della struttura
- ④ Minimizzazione gli effetti indotti dall'evento sismico
- ④ Riduzione delle sollecitazioni
- ④ Corretta configurazione degli elementi resistenti in pianta ed in elevazione



Dimensioni e forma



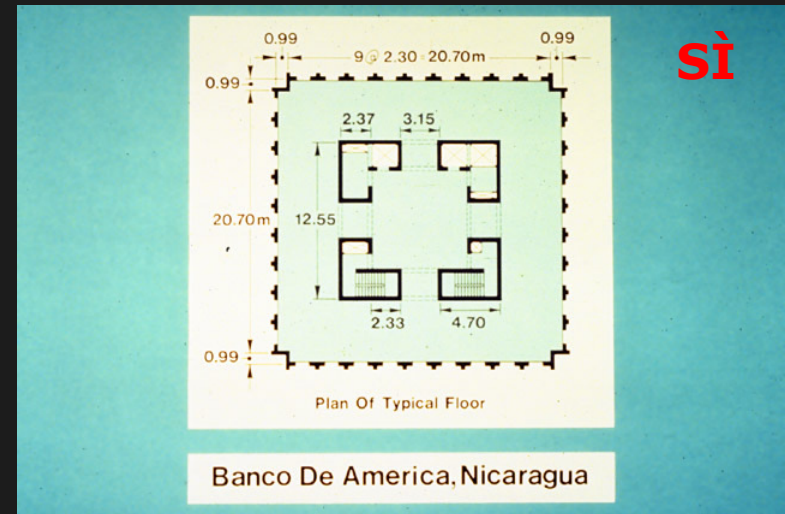
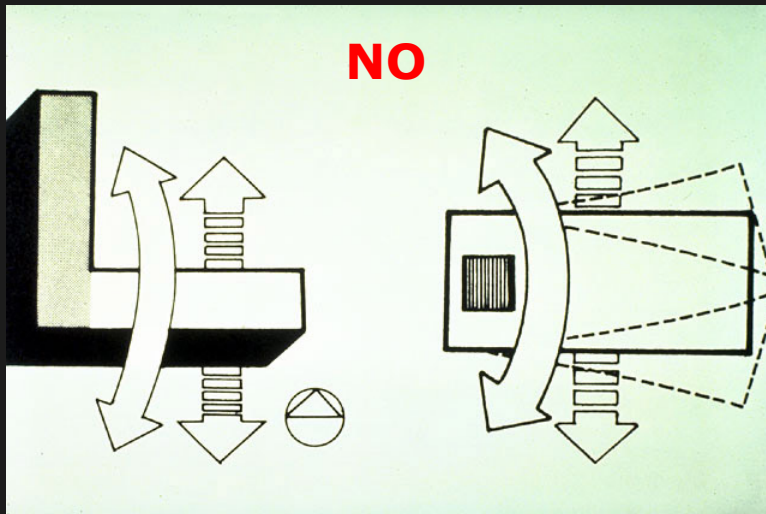
Natura, dimensioni e collocazione di tutti gli elementi strutturali



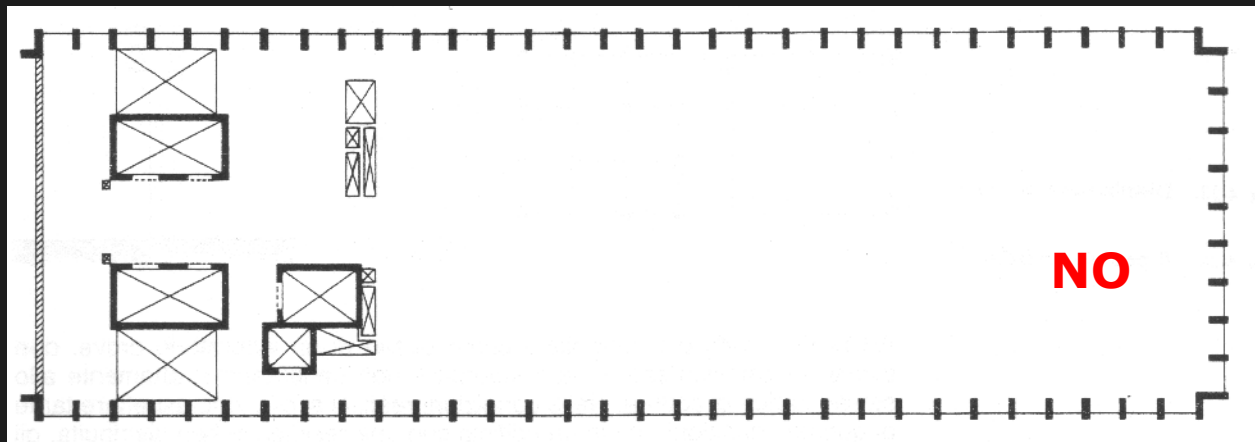
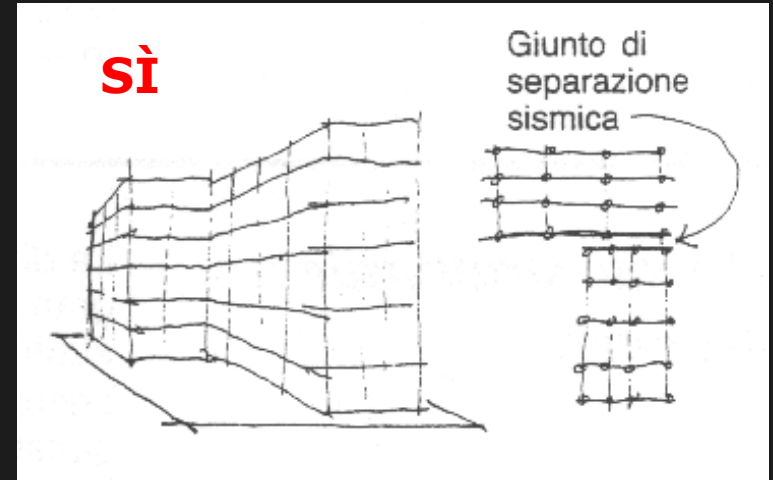
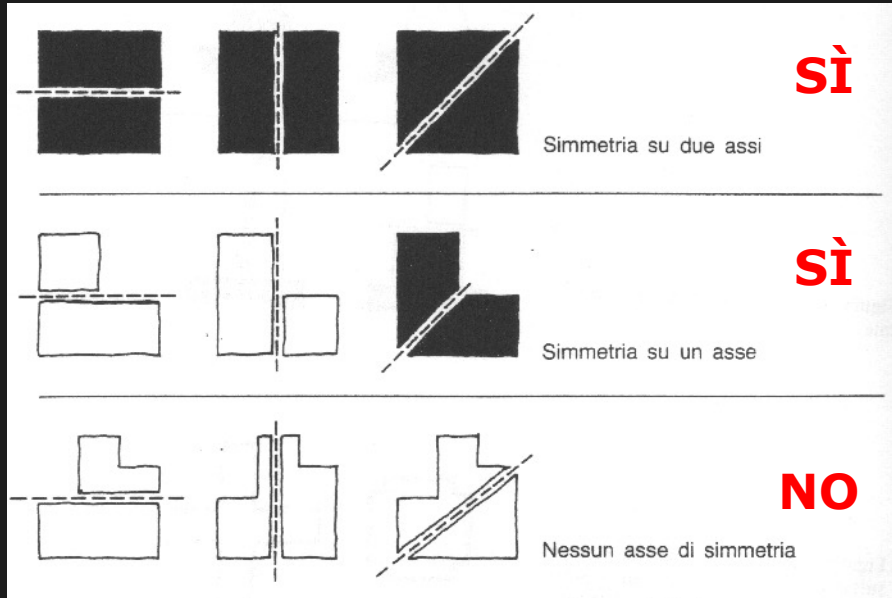
Natura, dimensioni e collocazione di elementi non-strutturali significativi.

Principi base per un'efficiente progettazione antisismica

La struttura in elevazione deve essere semplice, simmetrica e regolare in pianta ed in elevazione, per evitare l'insorgere di forze torsionali significative



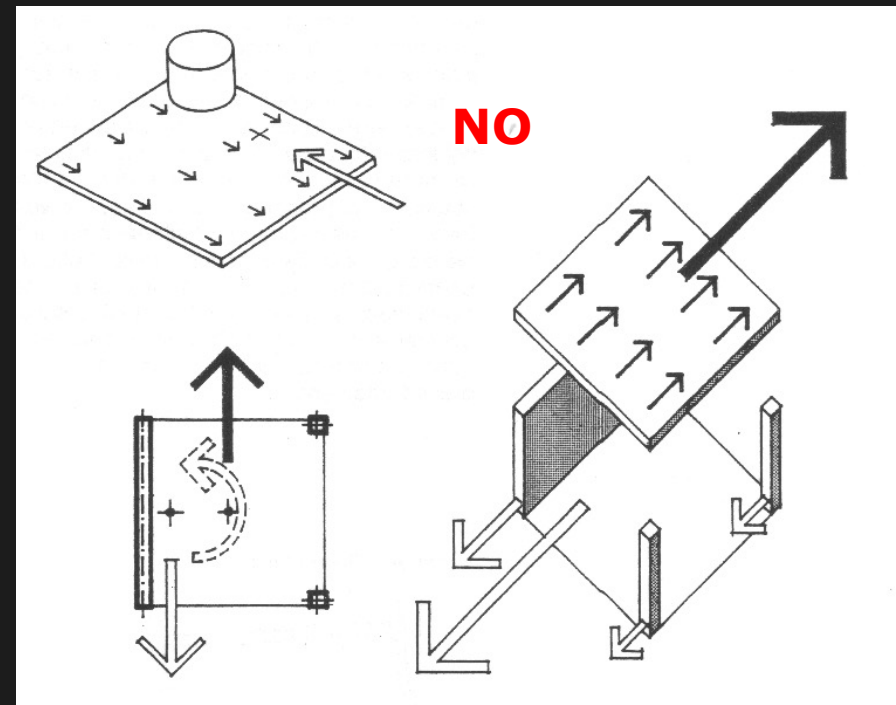
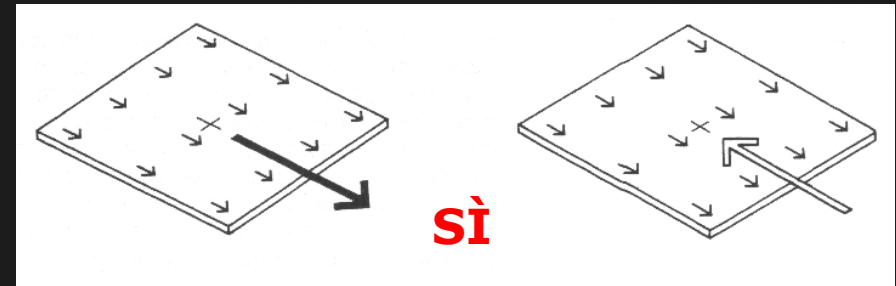
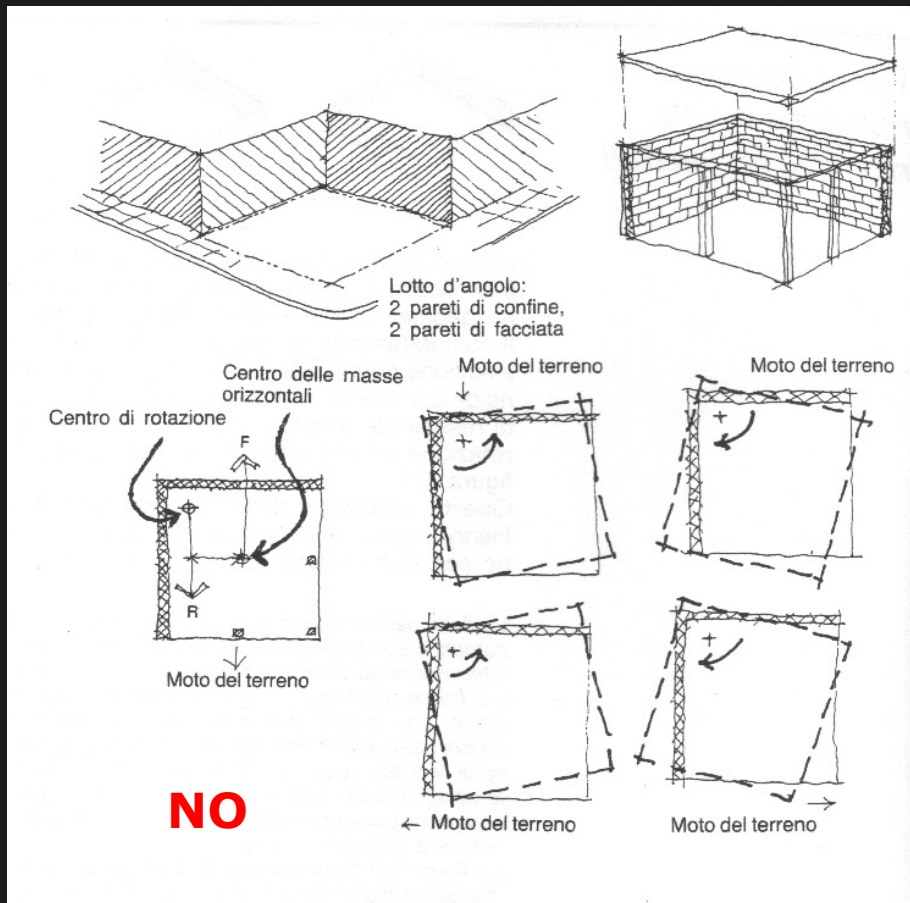
Principi base per un'efficiente progettazione antisismica



Simmetria

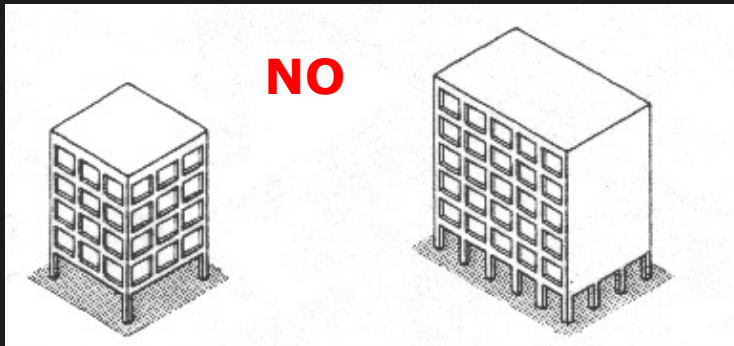
Principi base per un'efficiente progettazione antisismica

Resistenza e rigidezza uniformemente distribuiti tra tutti gli elementi strutturali



Principi base per un'efficiente progettazione antisismica

La struttura in elevazione deve avere una distribuzione uniforme di massa, rigidità e duttilità. Evitare i piani soffici.



Loma Prieta 1989 (California)

Principi base per un'efficiente progettazione antisismica



Loma Prieta 1989 (California)

Principi base per un'efficiente progettazione antisismica



Izmit 1999 (Turchia)

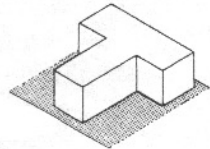
Principi base per un'efficiente progettazione antisismica



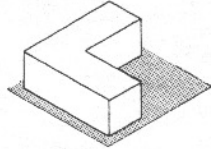
Izmit 1999 (Turchia)

Principi base per un'efficiente progettazione antisismica

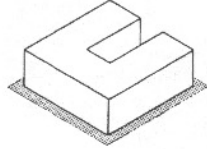
A. EDIFICI CON CONFIGURAZIONI IRREGOLARI



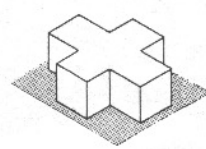
Piante a T



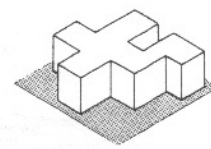
Piante a L



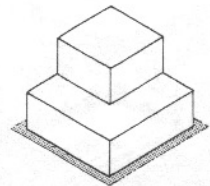
Piante a U



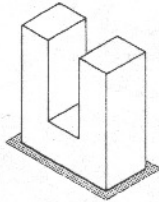
Piante cruciformi



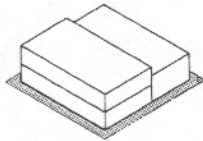
Altre forme complesse



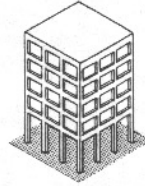
Rientranze verticali



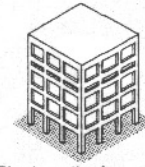
Torri multiple



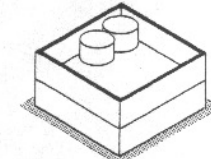
Piani sfalsati



Piani particolarmente alti

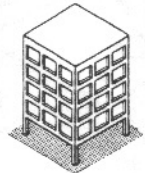


Piani particolarmente bassi

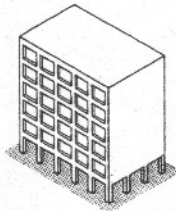


Apparenza esterna uniforme con distribuzione di massa disuniforme, o viceversa

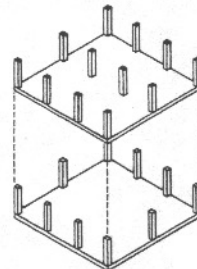
B. EDIFICI CON BRUSCHI CAMBIAMENTI NELLA RESISTENZA LATERALE



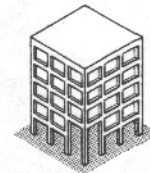
Piani bassi «soffici»



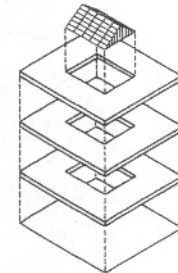
Grandi aperture su muri di taglio



Interruzione di pilastri

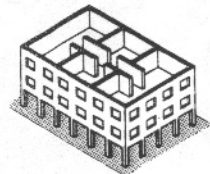


Interruzione di travi

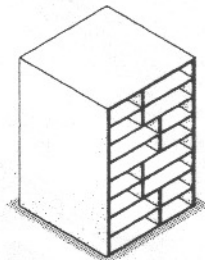


Aperture su diaframmi

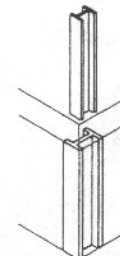
C. EDIFICI CON BRUSCHI CAMBIAMENTI NELLA RIGIDEZZA LATERALE



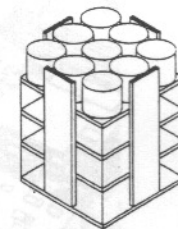
Pareti di taglio su alcuni piani, telai rigidi su altri



Interruzione di elementi resistenti verticali



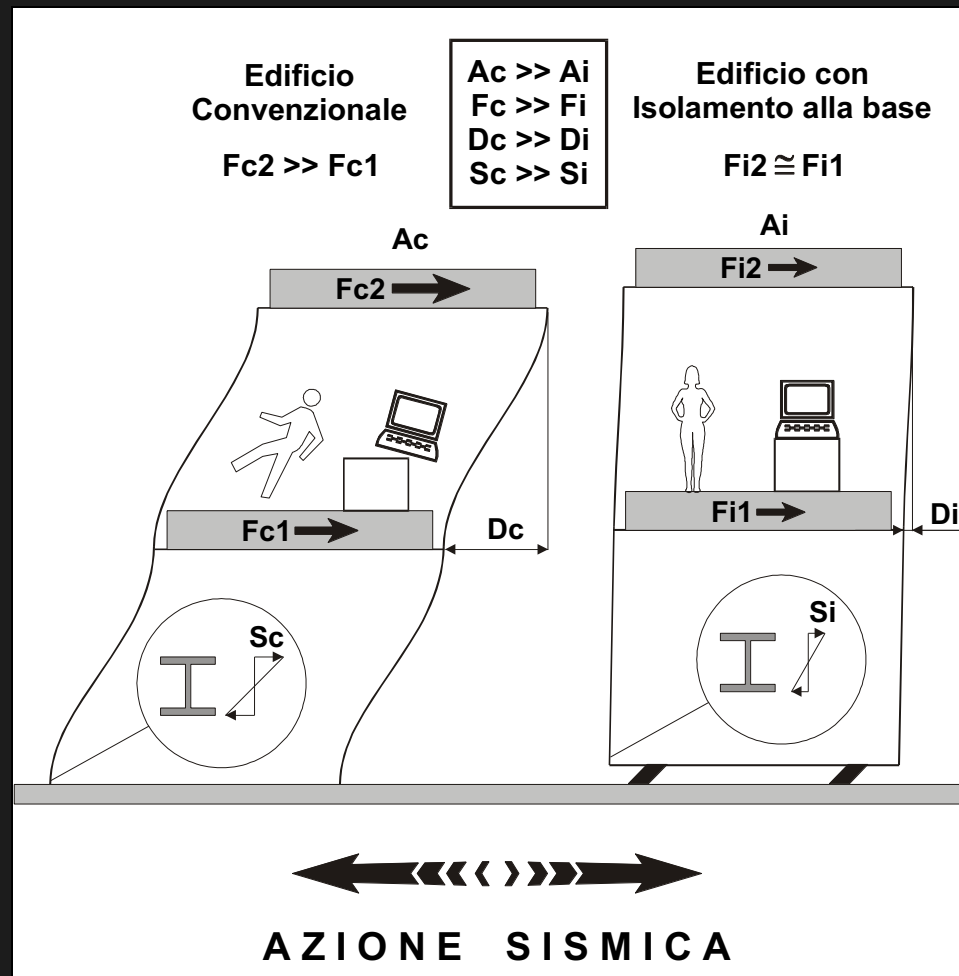
Bruschi cambiamenti di dimensione di componenti



Cambiamenti drastici nel rapporto massa-rigidezza

Metodi moderni di protezione sismica

Isolamento sismico



Metodi moderni di protezione sismica

Struttura non isolata



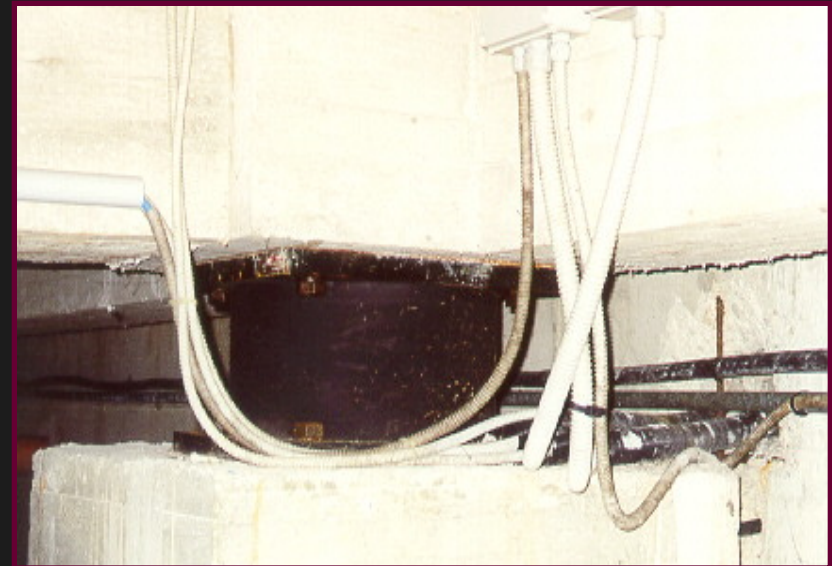
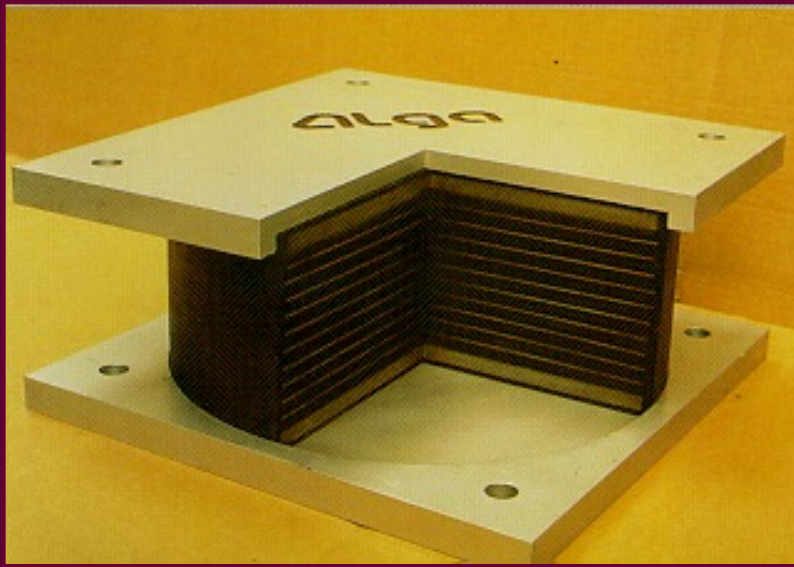
Struttura isolata



Progetto BRIT EURAM 1993
(ISMES)



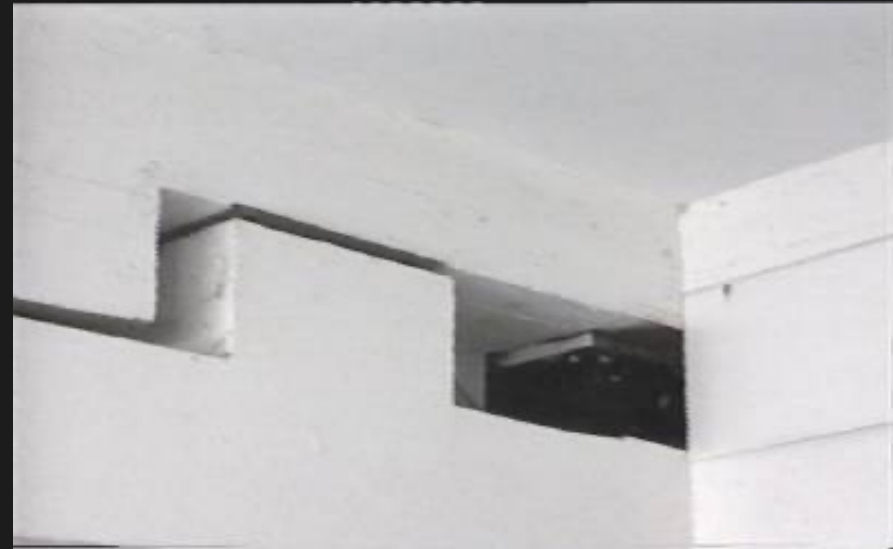
Isolatori HDRB



Alcune applicazioni dell'isolamento in Italia



Edificio residenziale a Squillace
(Catanzaro, 1992)
(43 LDRB & HDRB)



Applicazioni dell'isolamento in Italia



L'ala nuova dell'ospedale Gervasutta in costruzione a Udine
(52 HDRB – primo ospedale isolato in Italia)

Isolamento di edifici esistenti – Centro polifunzionale (Napoli)



← Attrezzatura di contrasto montata su un pilastro

Nuovo solaio irrigidente in acciaio →



← Fase di taglio del pilastro

Disconnessione delle pareti portanti e HDRB inseriti →



HDRB
←posto in opera



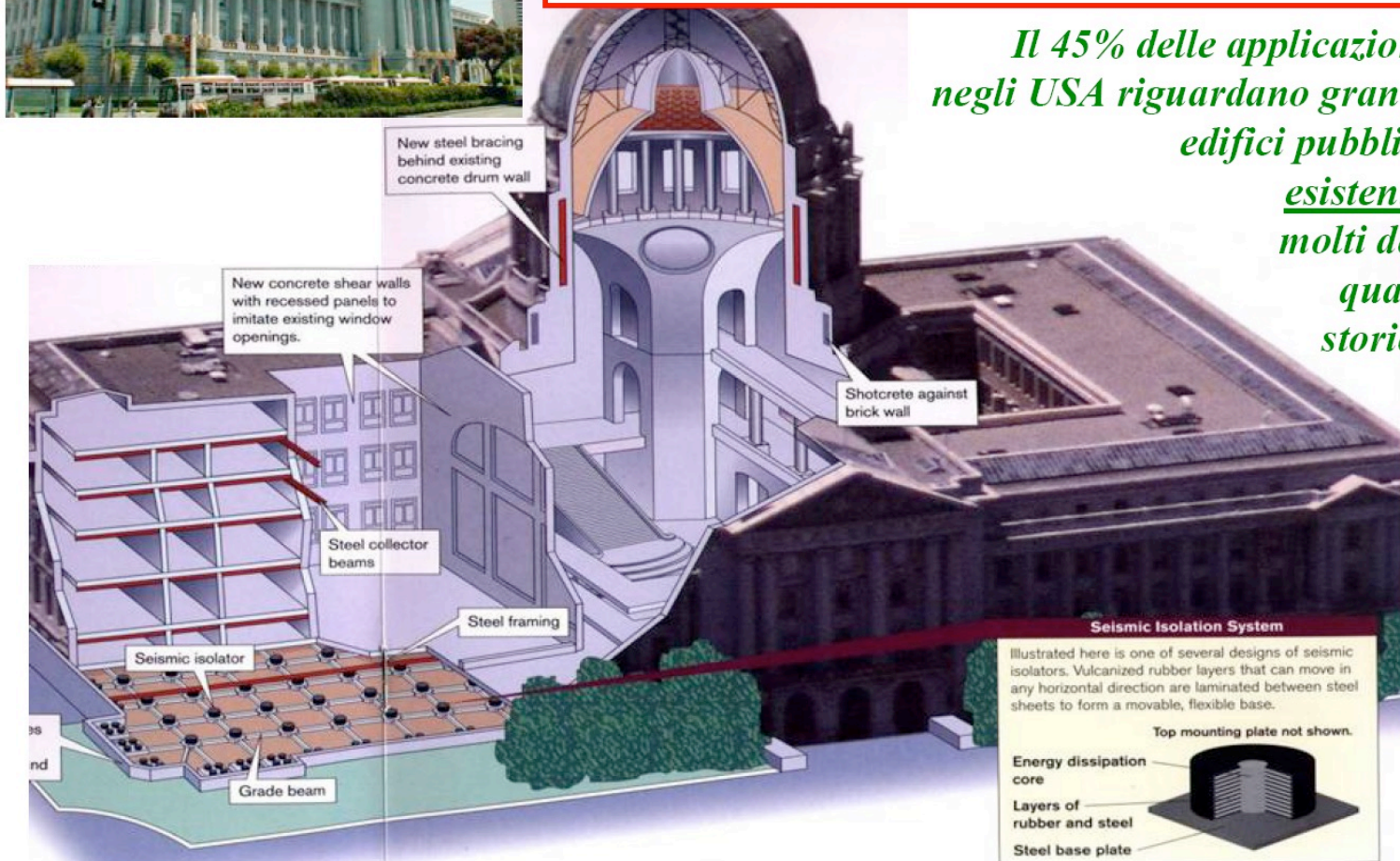
Isolamento di edifici esistenti



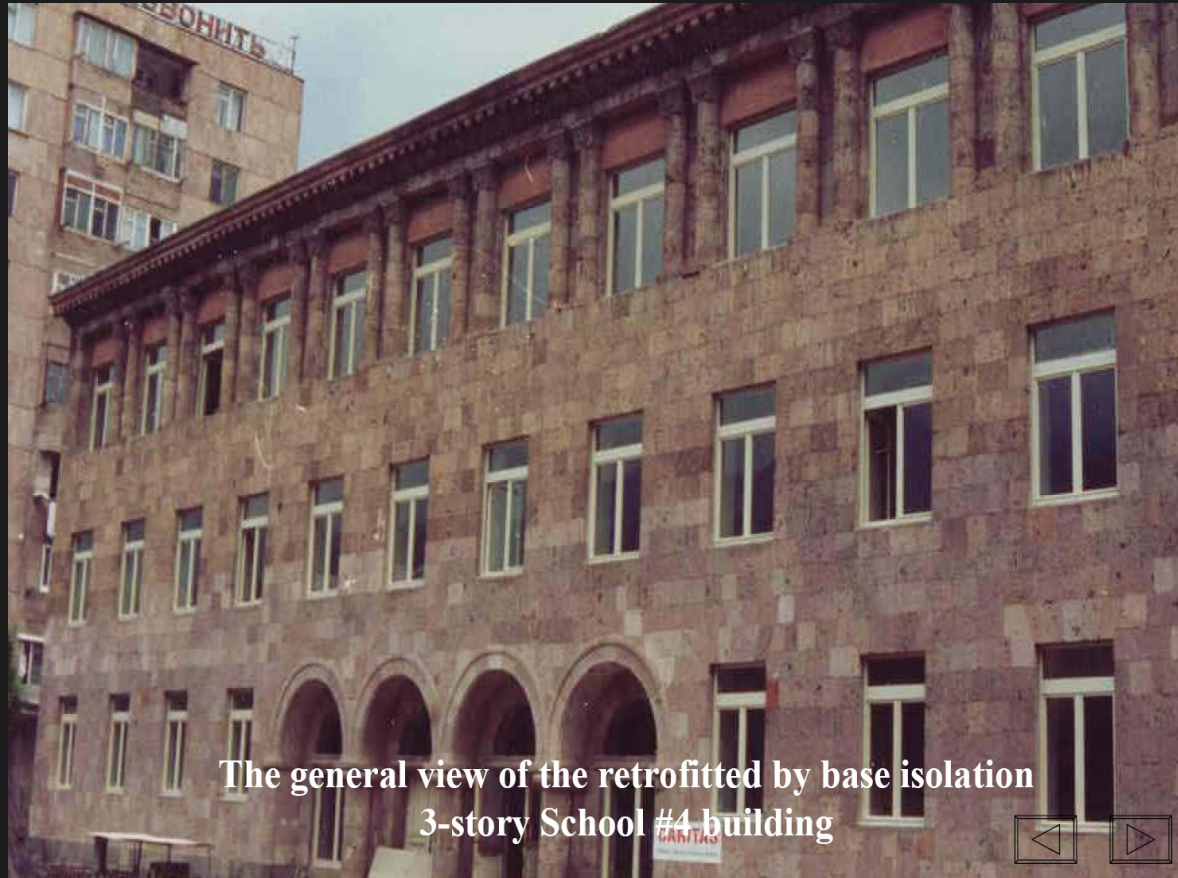
MUNICIPIO DI SAN FRANCISCO, USA

*danneggiato dal sisma di Loma Prieta del 1989
(costo totale del retrofit = 105.000.000 US\$ - 530
LRB, 62 SD)*

*Il 45% delle applicazioni
negli USA riguardano grandi
edifici pubblici
esistenti,
molti dei
quali
storici*

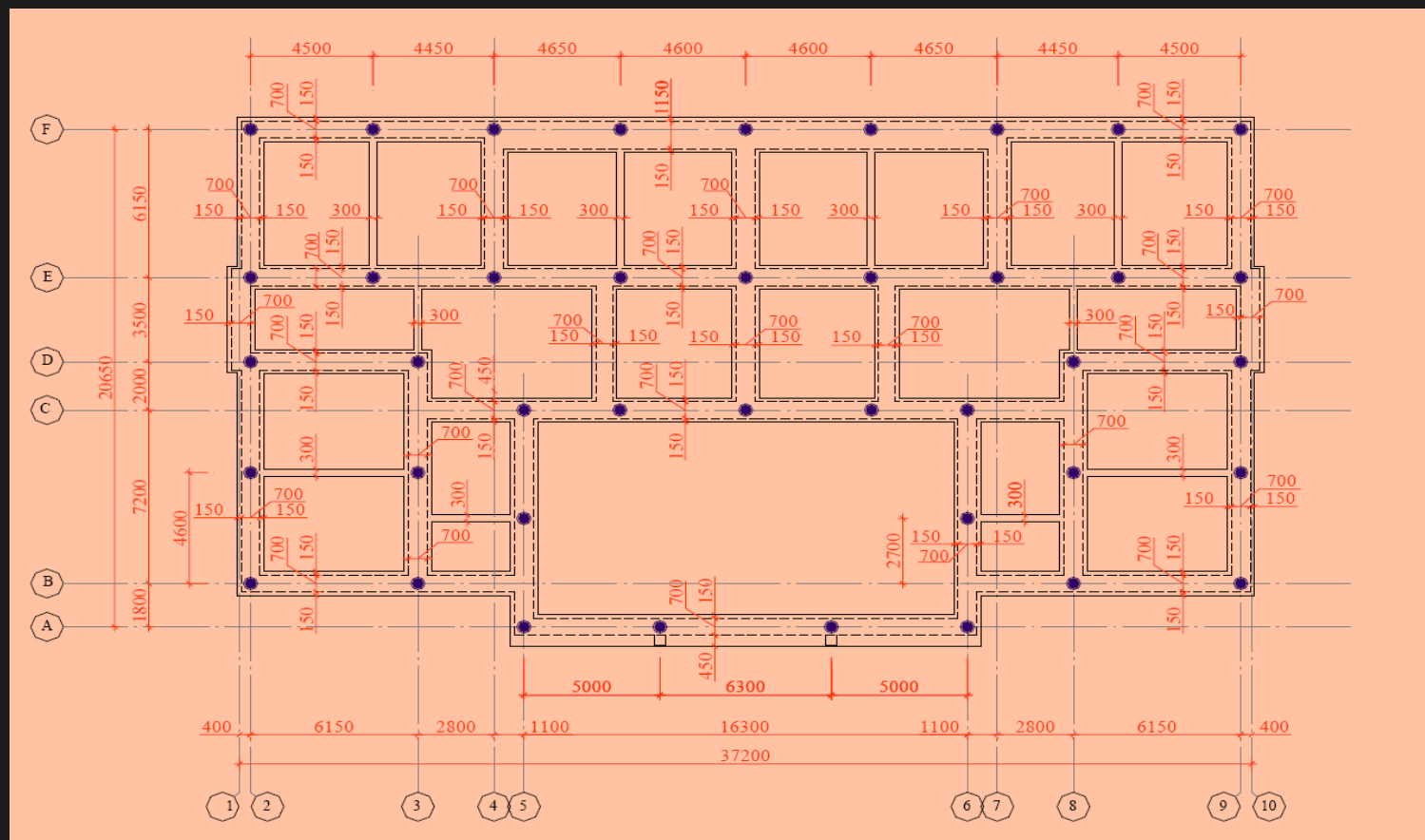


Isolamento di edifici esistenti – Edificio scolastico in Armenia

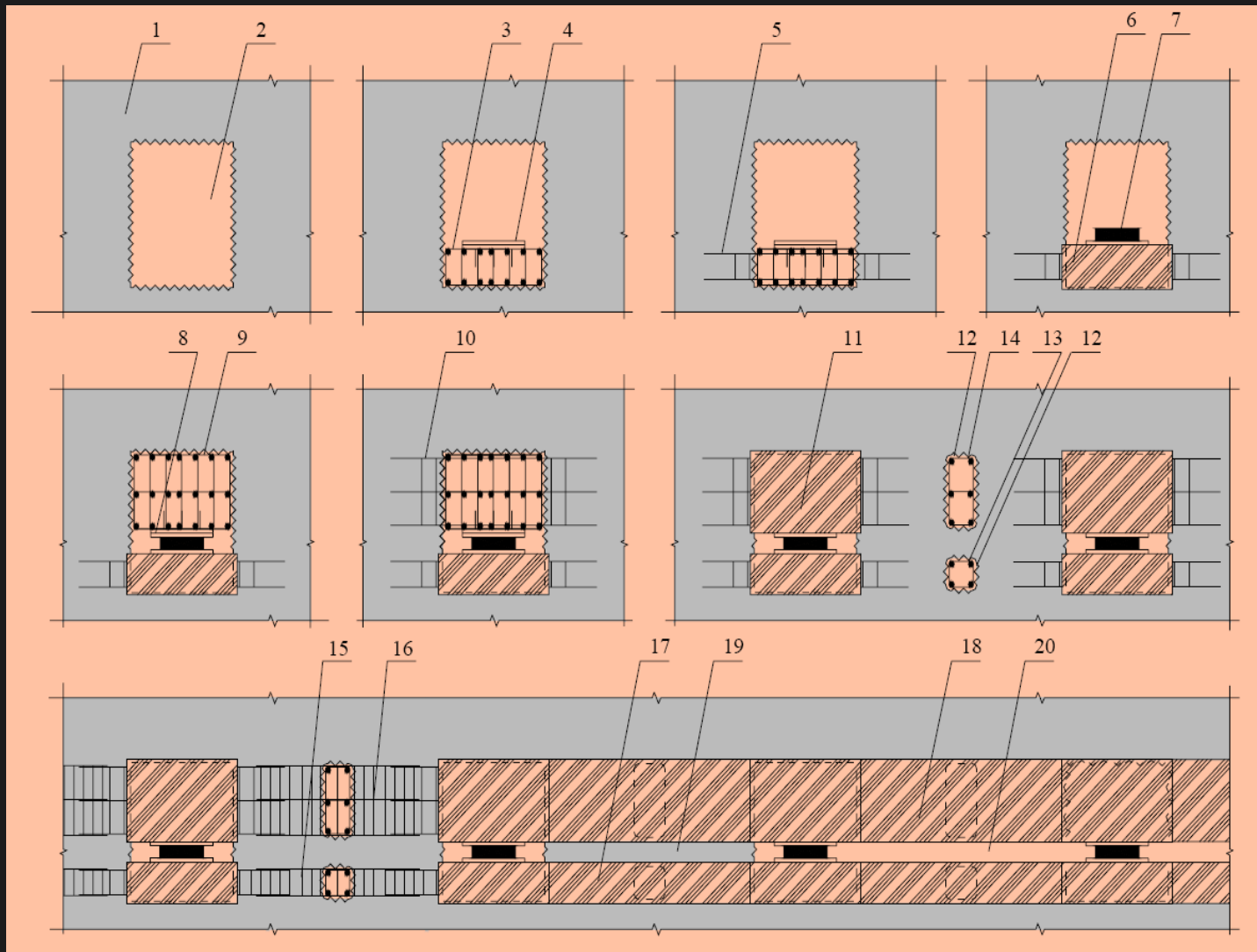


The general view of the retrofitted by base isolation
3-story School #4 building

Isolamento di edifici esistenti – Edificio scolastico in Armenia



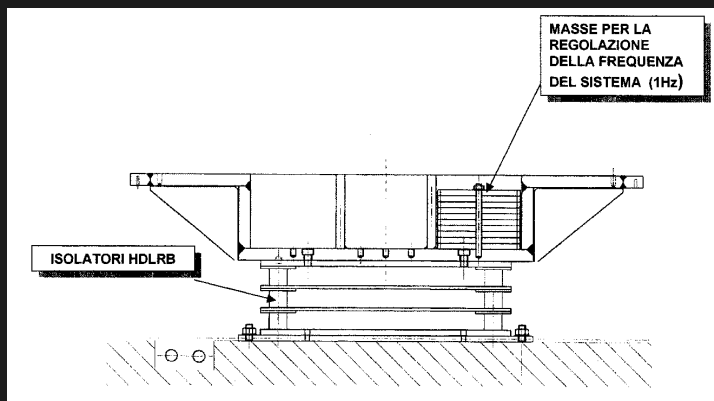
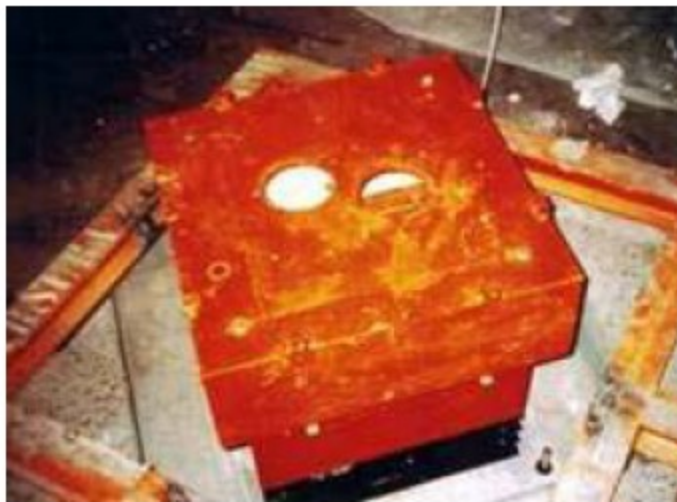
Isolamento di edifici esistenti – Edificio scolastico in Armenia



Isolamento di edifici esistenti – Edificio scolastico in Armenia

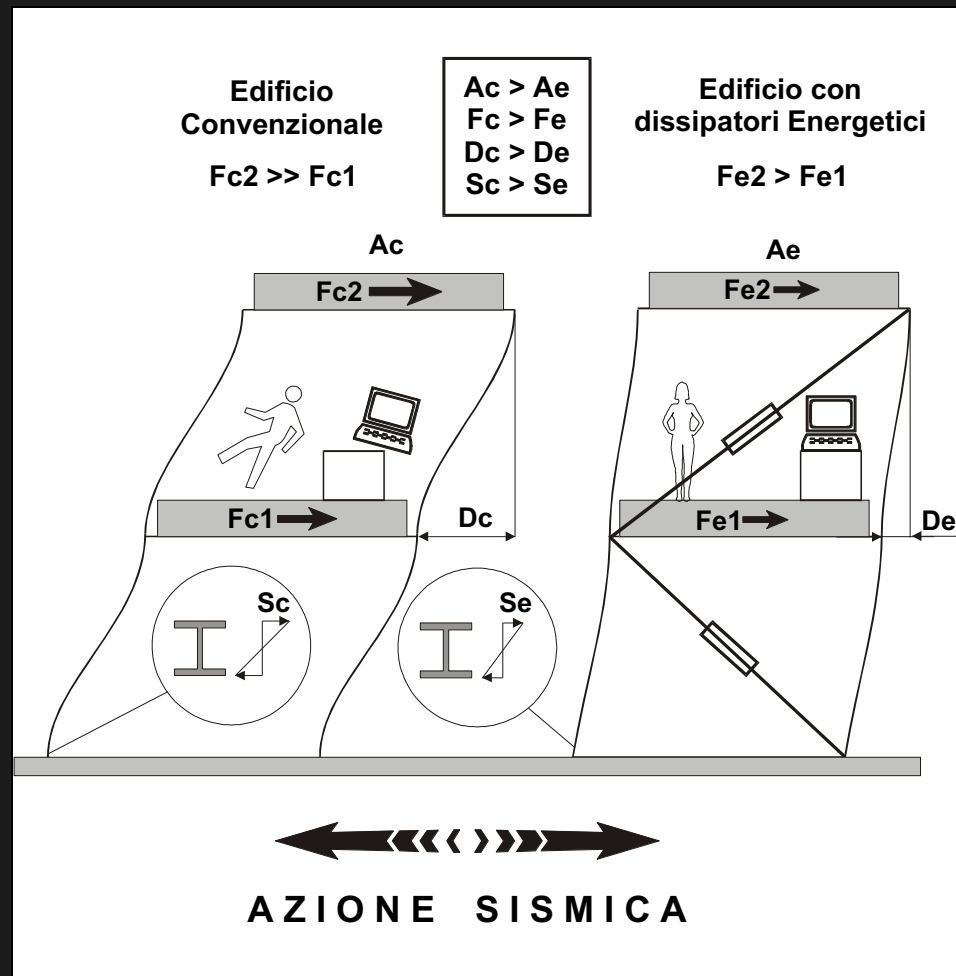


Isolamento dei Bronzi di Riace

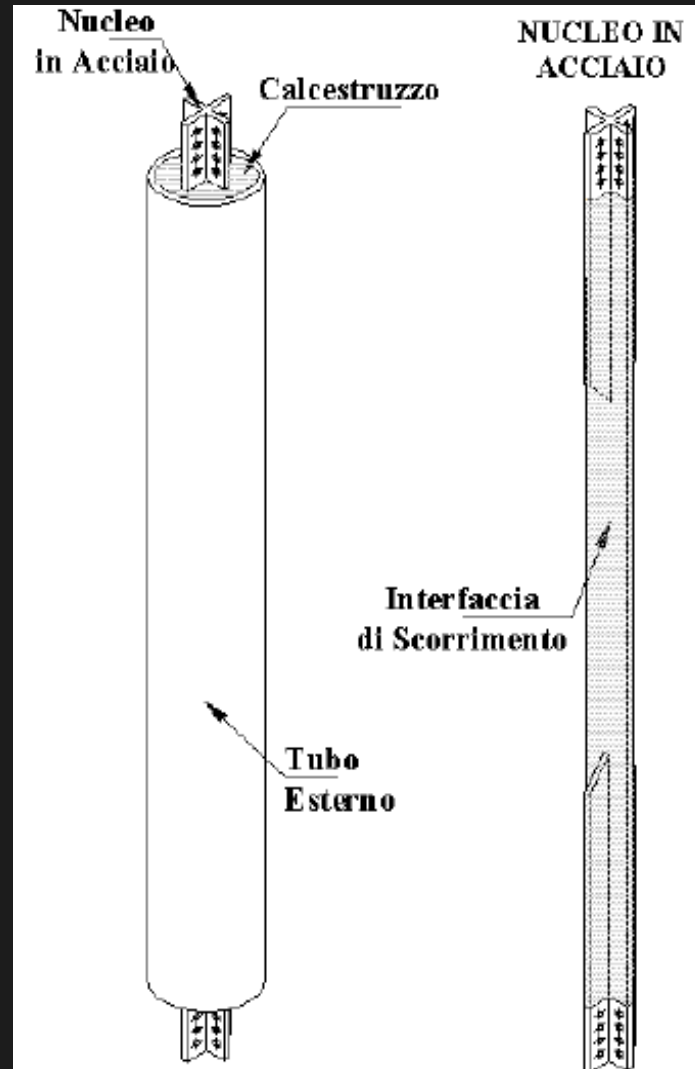
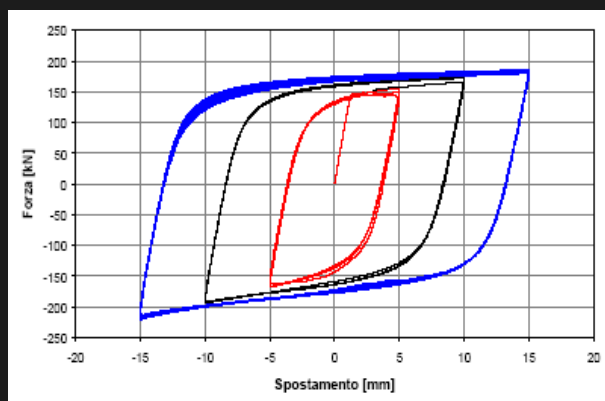
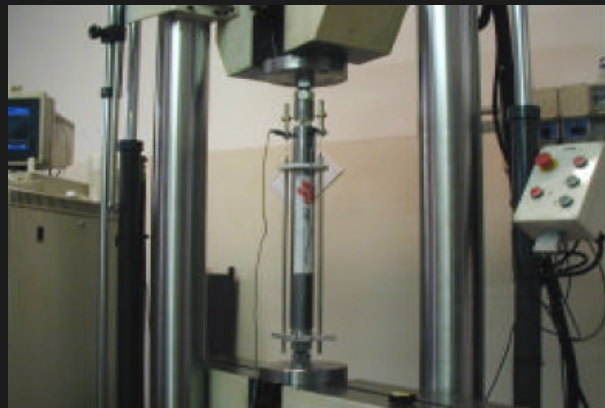


Metodi moderni di protezione sismica

Dissipazione di energia

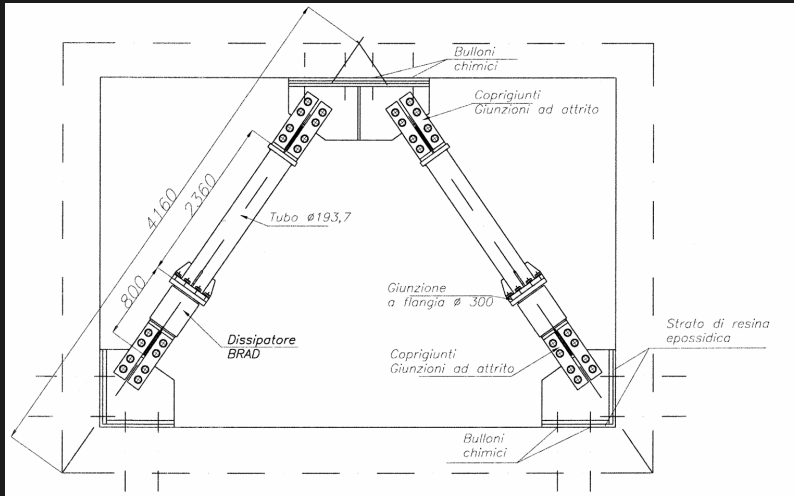


Dissipatori elasto-plastici ad instabilità impedita

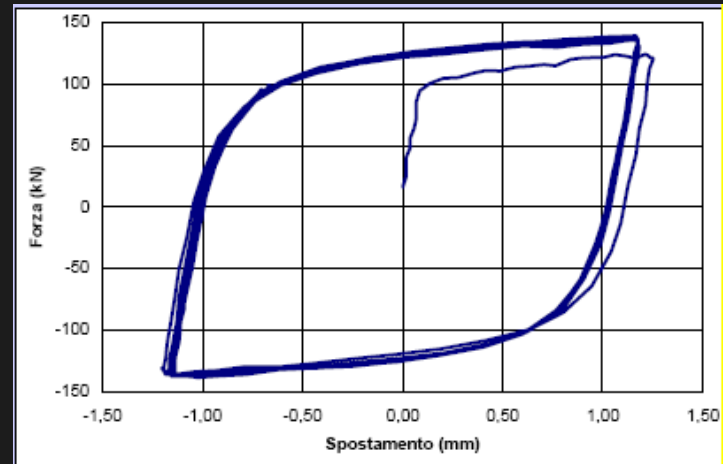
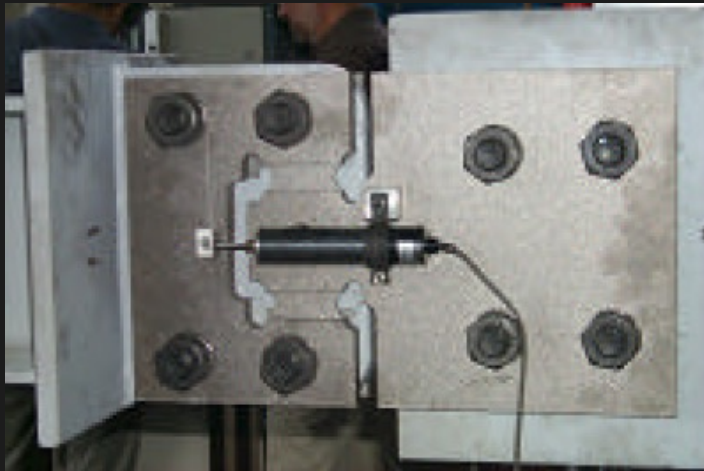


Dissipatori elasto-plastici ad instabilità impedita

Università Politecnica delle Marche



Dissipatori elasto-plastici a deformazione tagliante



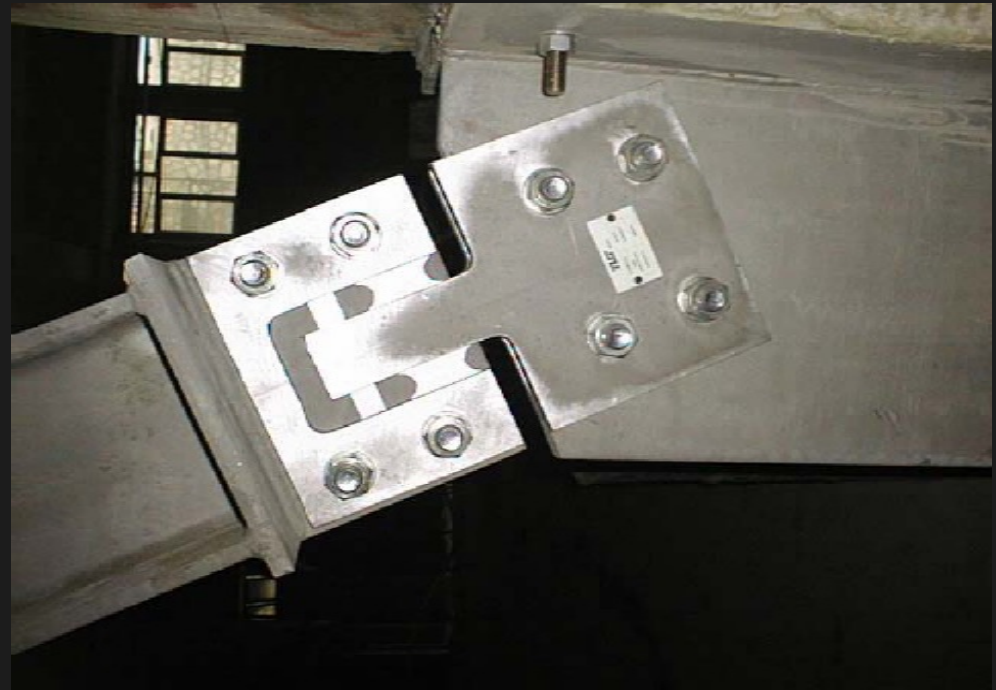
Controventi con coprigiunti elasto-plastici

Scuola "Domiziano Viola" – Potenza
(Dolce e Marnetto 2003)

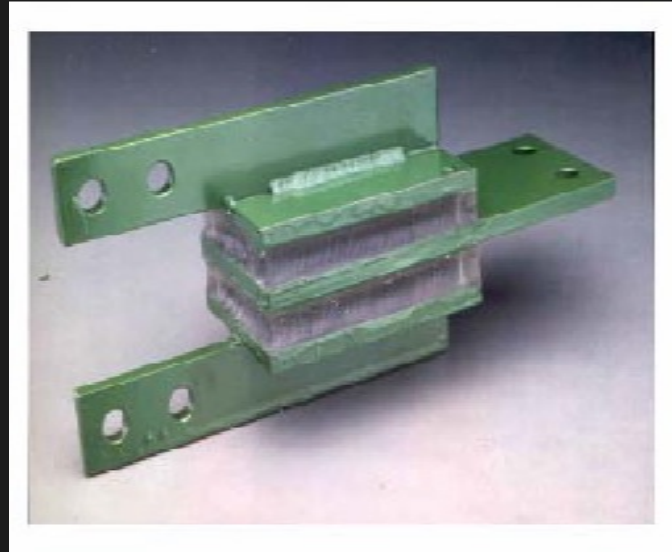
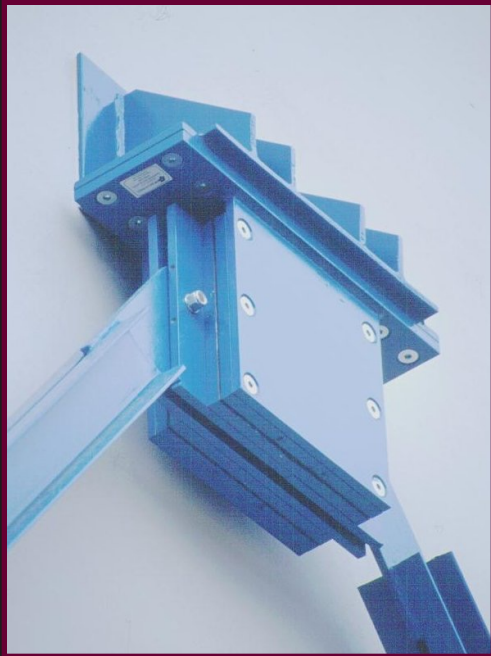


Controventi con coprigiunti elasto-plastici

Scuola "Domiziano Viola" – Potenza
(Dolce e Marnetto 2003)



Dissipatori visco-elastici



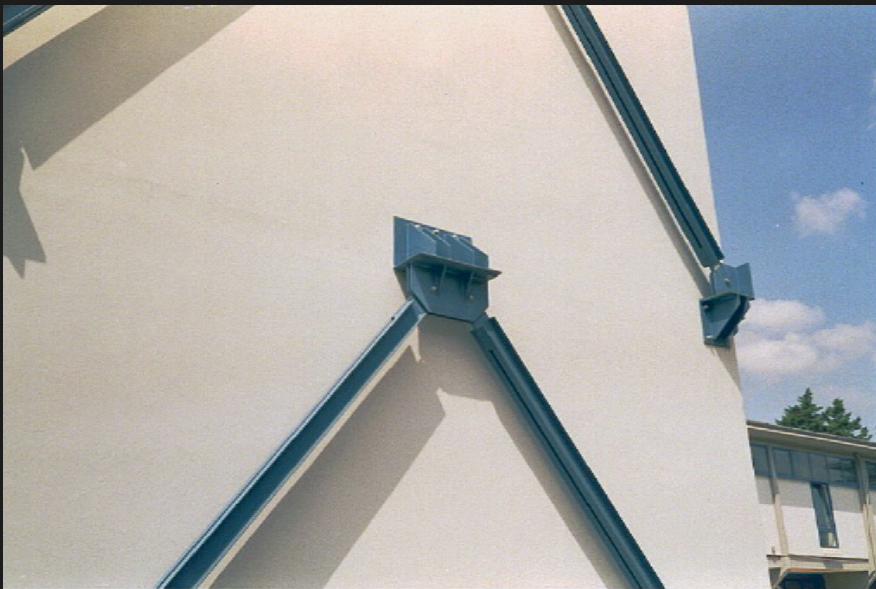
Controventi visco-elastici

Scuola Media "Gentile Fermi" – Fabriano (1992)



Controventi visco-elastici

Scuola Media "Gentile Fermi" – Fabriano (1992)



Dissipatori viscosi



Dissipatori viscosi

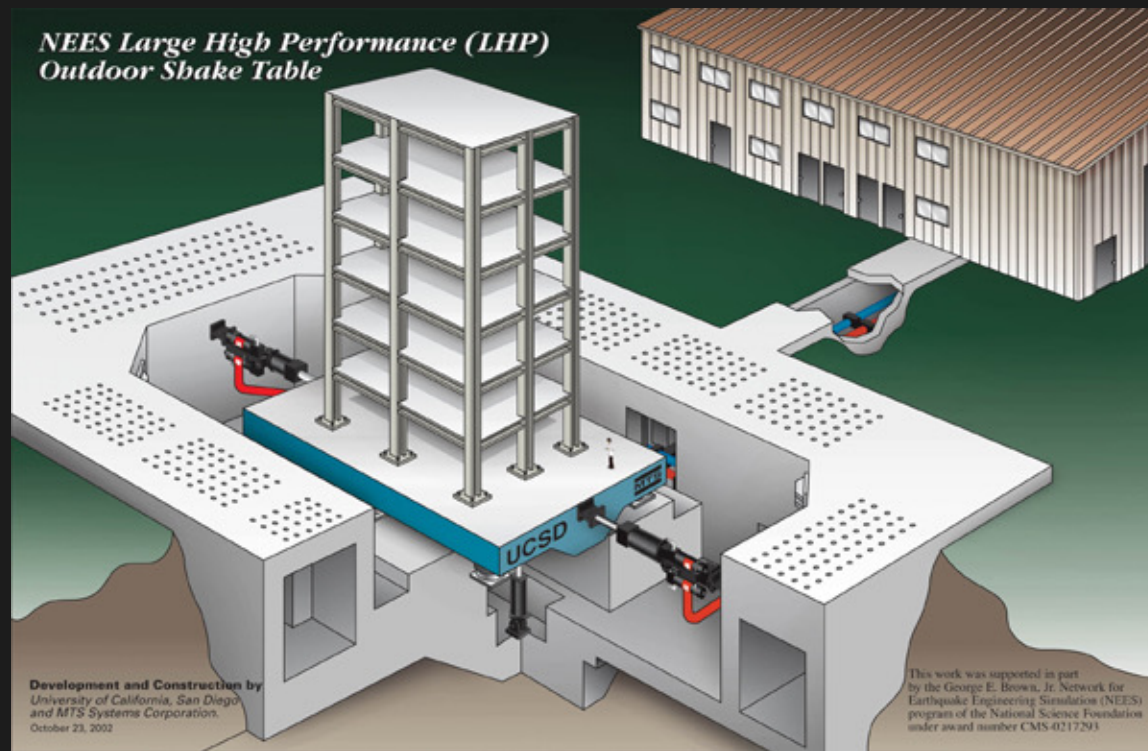
Chiesa "Dives in Misericordia" – Roma 2003



Complesso Olimpico "Pireo" – Atene 2004



Prove sperimentali

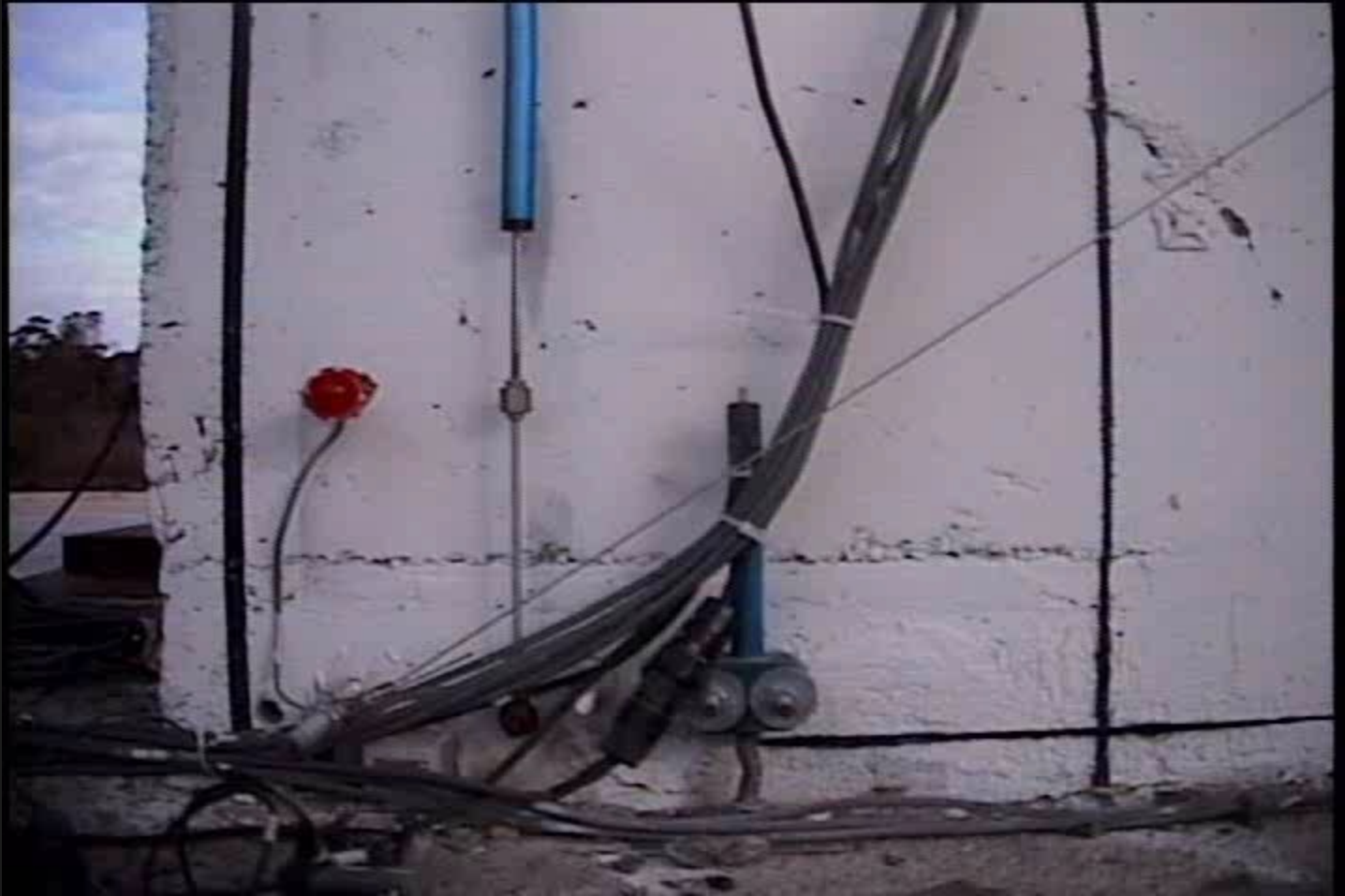


UCSD – University of California at San Diego

Prove sperimentali



Prove sperimentali



Prove sperimentali – E-Defense



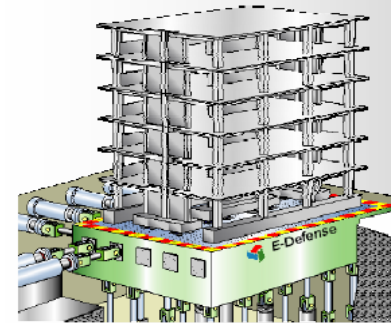
Special Project for Earthquake Disaster Mitigation in Urban Areas – DaiDaiToku Project –

Full-scale Test on Six-story Reinforced Concrete Wall-frame Building at E-defense

National Research Institute for Earth Science and Disaster Prevention
Hyogo Earthquake Engineering Research Center

Taizo Matsumori, Toshimi Kabeyasawa

The first phase test on RC 2005



Six-story @2.5m

Total height 16m

Plan:

2 × 3 bay @5.0m

slab 12.0m × 17.0m

Weight:

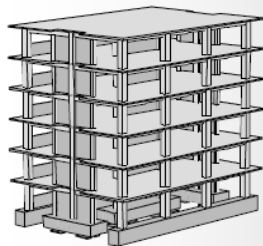
Total 1000tonf

Upper 750tonf @125tonf

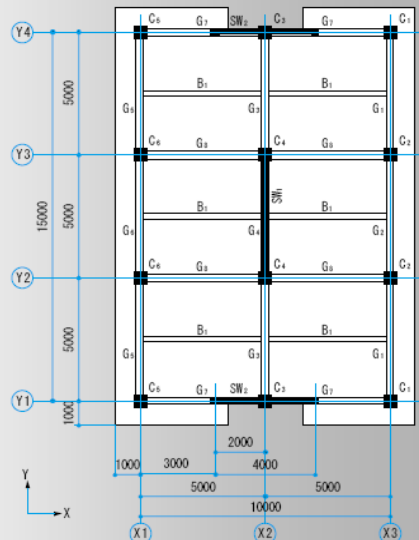
Overview:

Steel frames for safety and measurement,
Non-structural components, steel stairs and
handrails will be added.

Plan

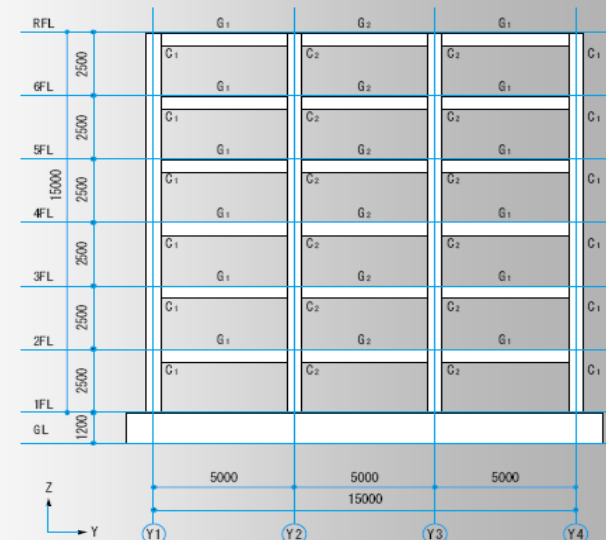
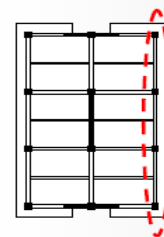


- 1970' design and practice
- Wall in flexural to shear failure
- Wing wall in transverse direction



Elevation

X3-frame
Open frame

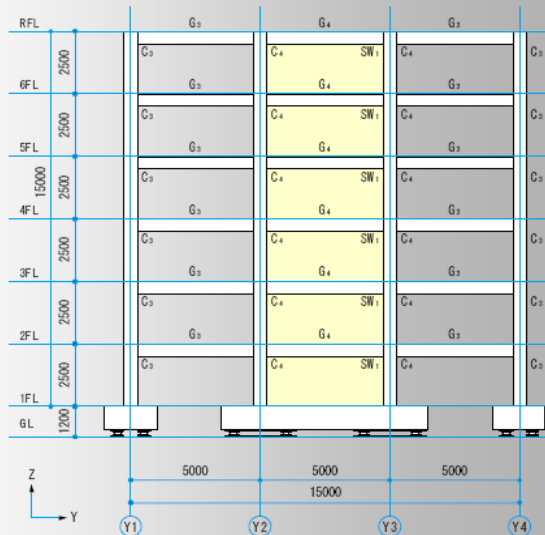
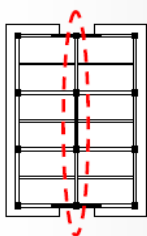


Prove sperimentali – E-Defense

Elevation

X2-frame

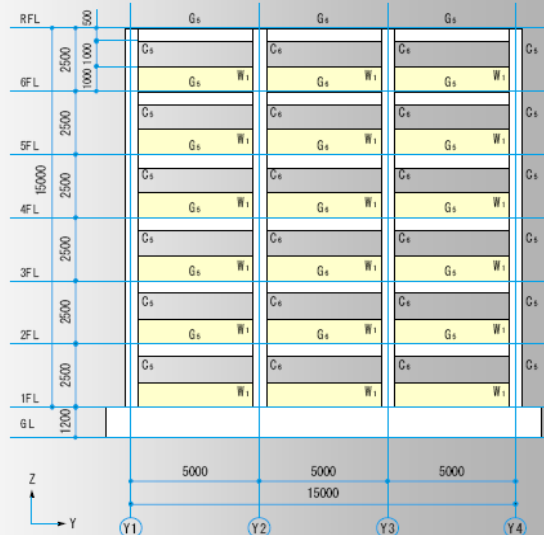
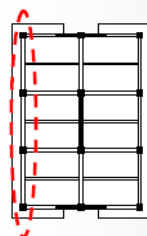
Wall-frame



Elevation

X1-frame

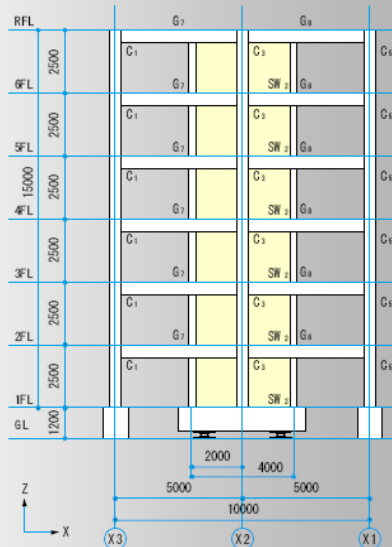
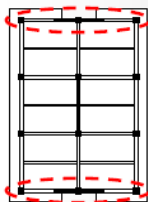
Open frame
with shot columns



Elevation

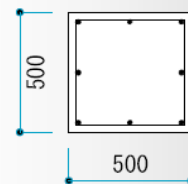
Y1, Y4-frame

Open frame
Column with side wall



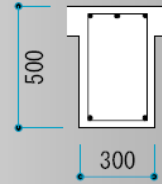
Typical sectional details

柱
(共通)



主筋 : 8-D19
帯筋 : D10@100

梁
2G2



上端筋 : 3-D19
下端筋 : 2-D19
肋筋 : D10@200

壁

SW1
厚さ : 150mm
配筋 : D10@300ダブル

スラブ

共通
厚さ : 150mm
配筋 : 上下D10@200

Prove sperimentali

