

FEDERICO M. MAZZOLANI

University of Naples “Federico II”, Italy



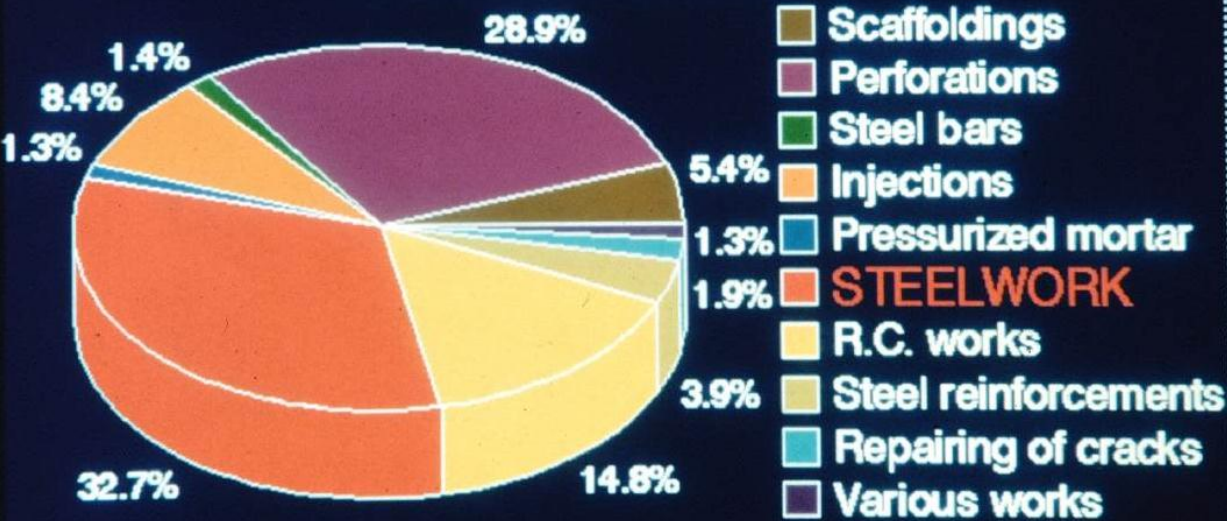
THE USE OF STEELWORK IN CONSOLIDATION

THE USE OF STEELWORK IN CONSOLIDATION FOR SEISMIC UPGRADING

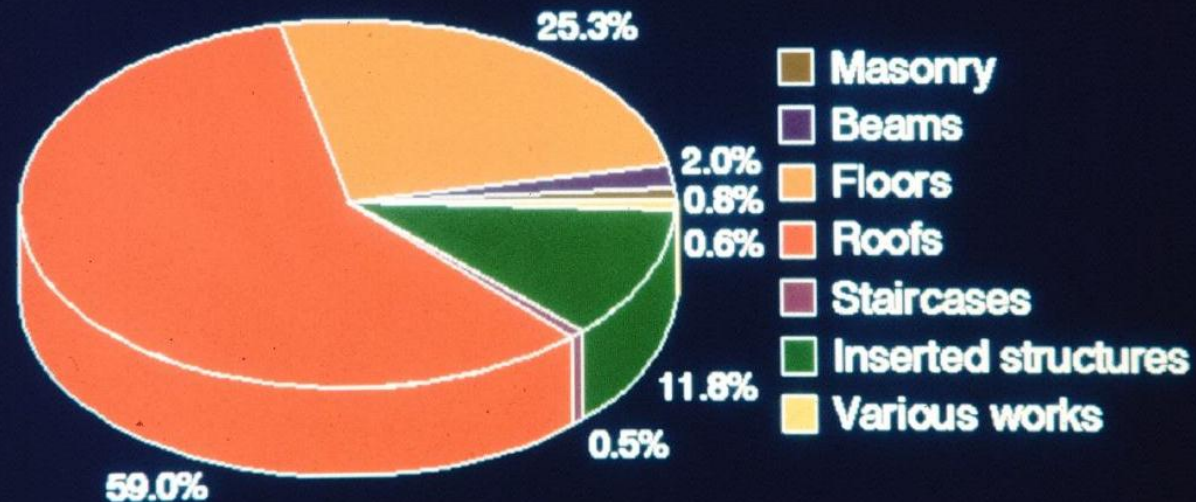
General Data

Historical Buildings

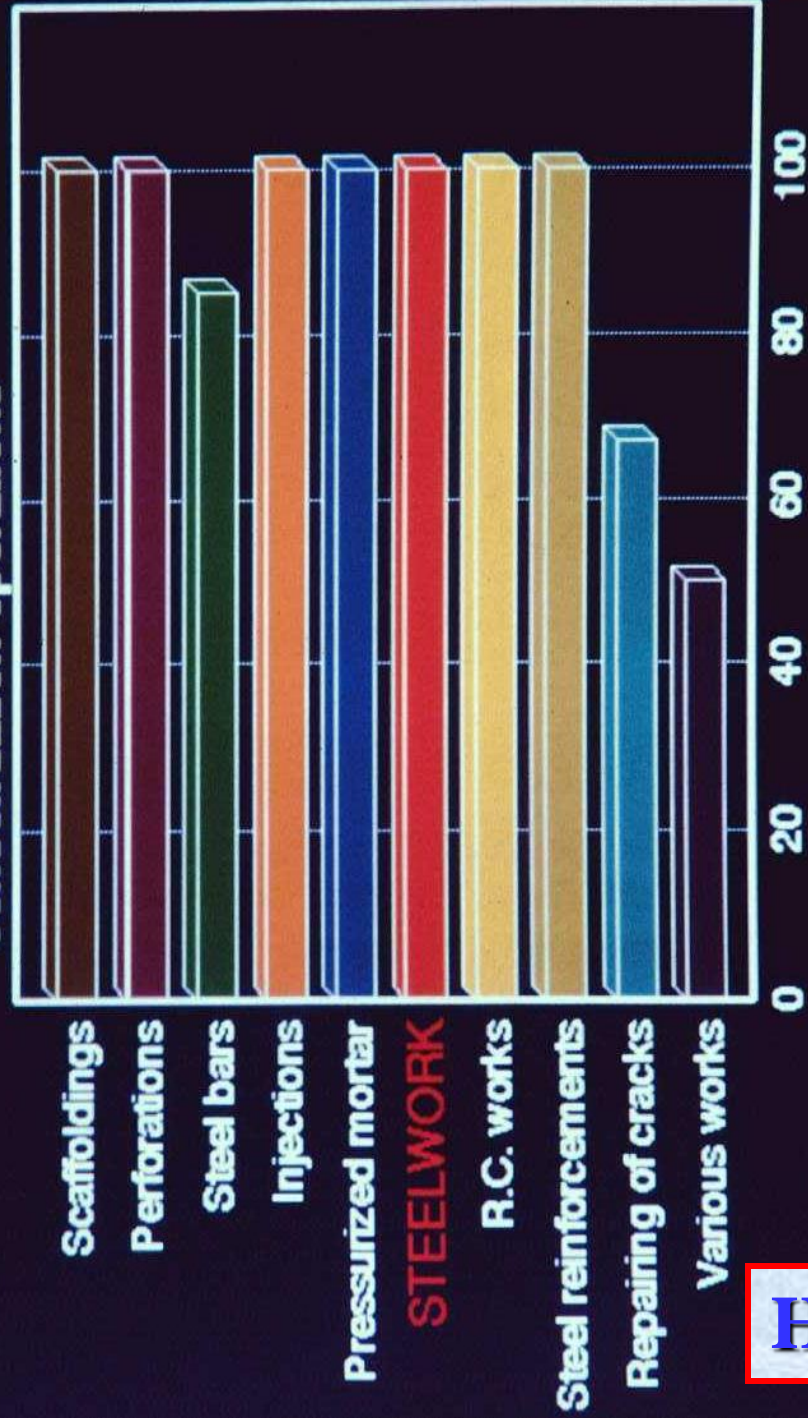
Percentage cost distribution of consolidation operations



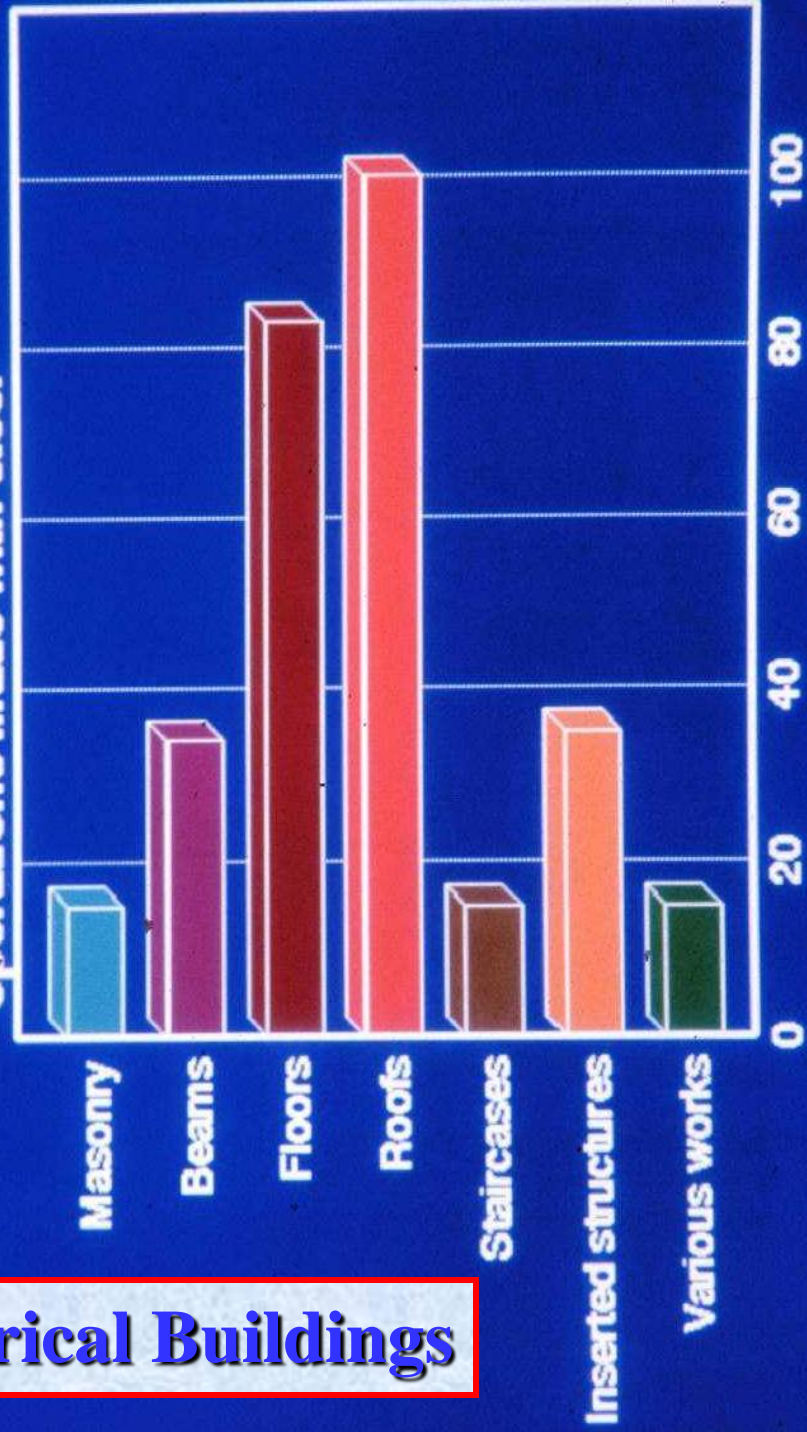
Percentage cost distribution of consolidation operations made with steel



Percentage distribution of consolidation operations



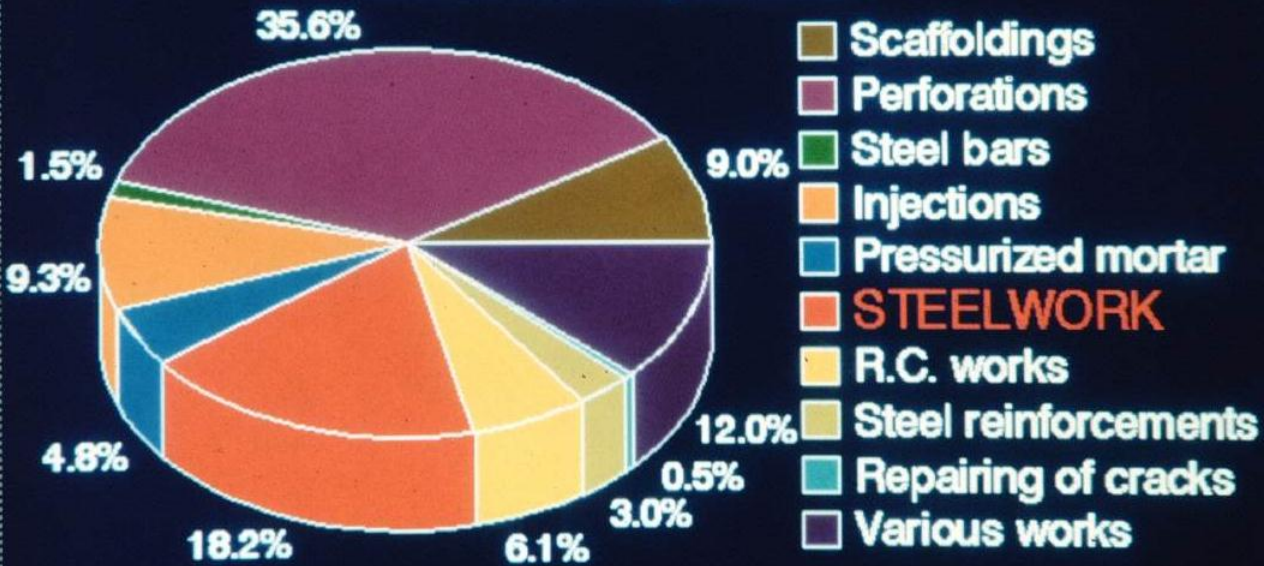
Percentage distribution of consolidation operations made with steel



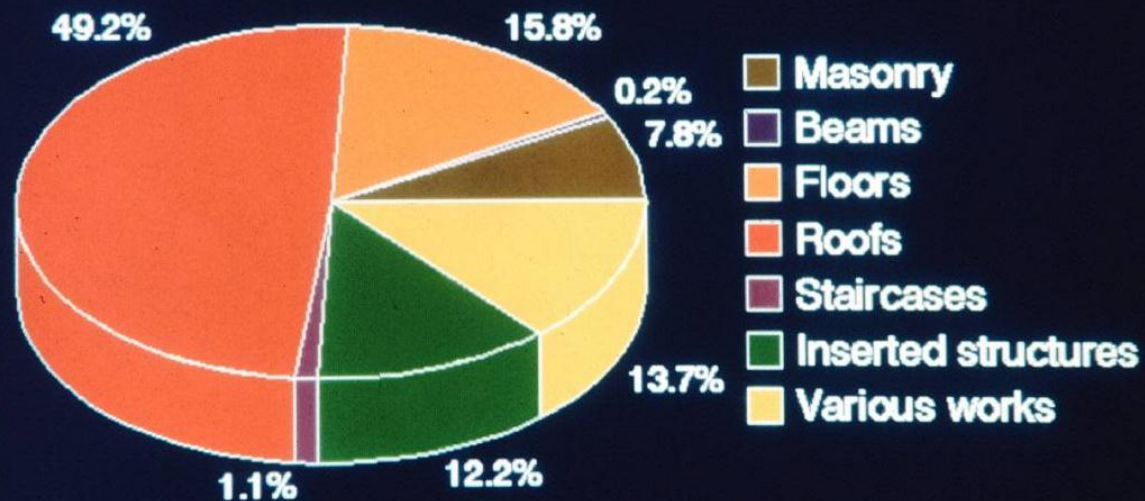
Historical Buildings

Church Buildings

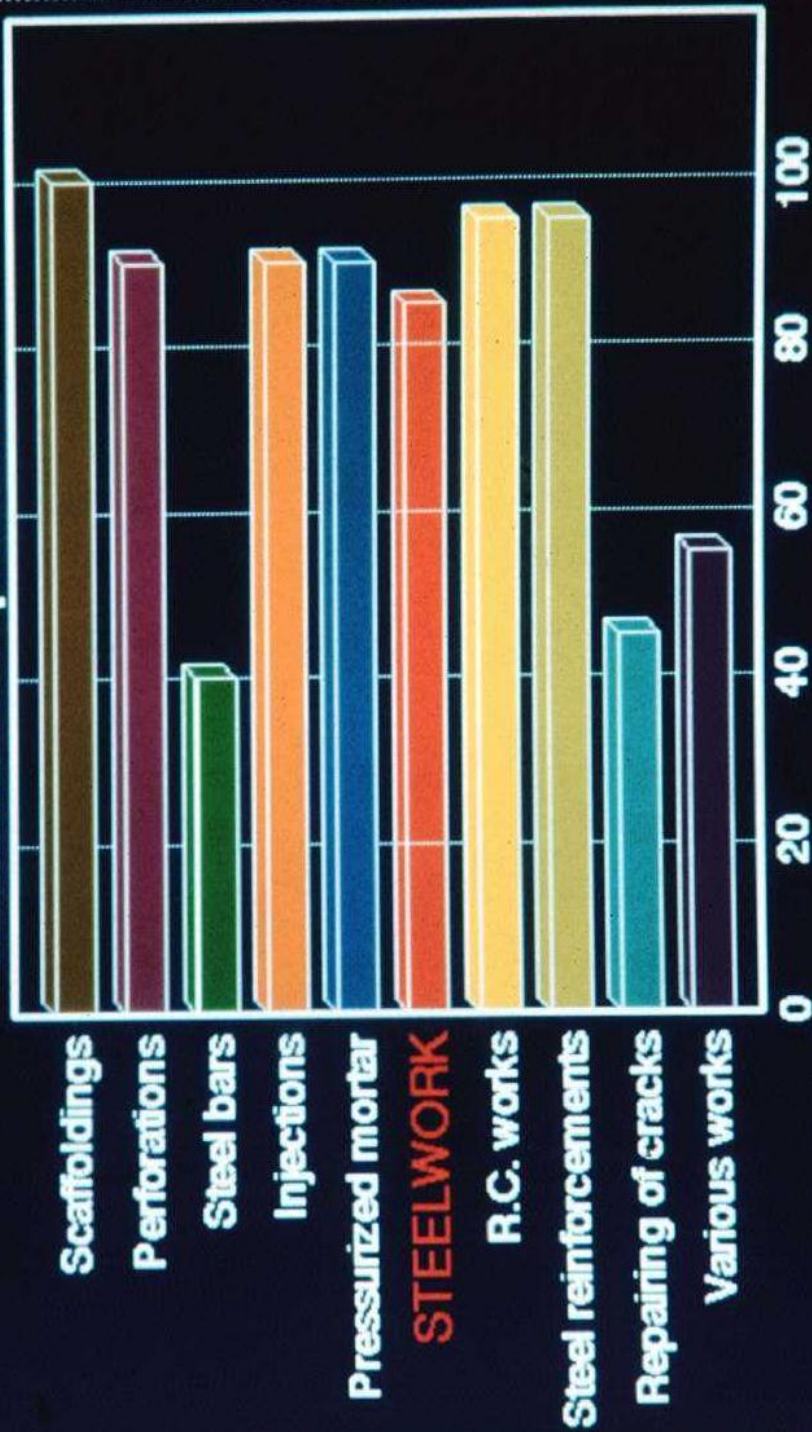
Percentage cost distribution of consolidation operations



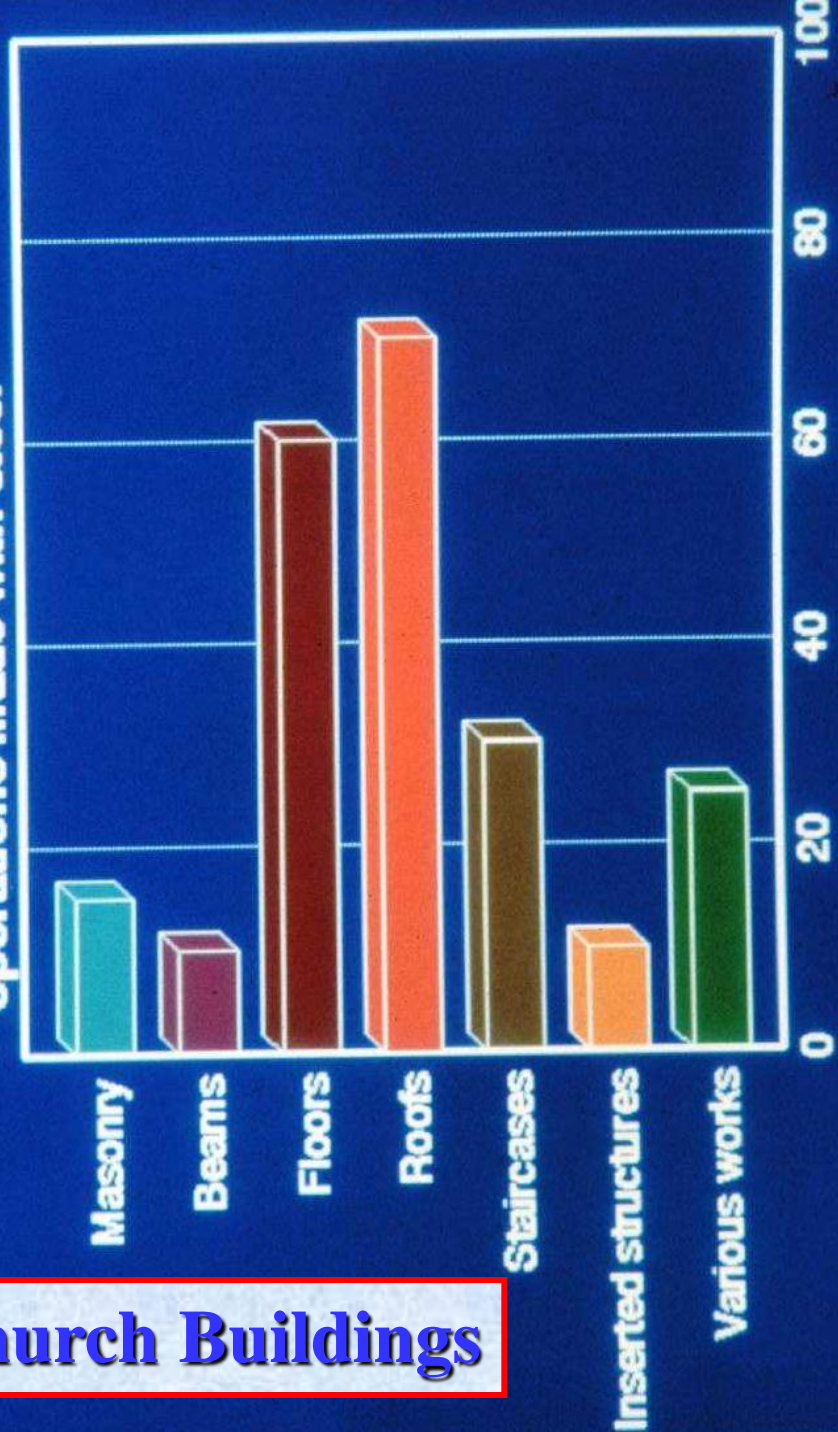
Percentage cost distribution of consolidation operations made with steel



Percentage distribution of consolidation operations



Percentage distribution of consolidation operations made with steel



Church Buildings

Why steel in refurbishment

- resistance
- lightness
- easy erection
- reversibility
- “new material”





Consolidation Levels

1. Safeguard
2. Repair
3. Reinforcing
4. Restructuring



■ **Safeguard**

action of temporary nature
to achieve adequate safety for
both the public and the site,
prior to starting definitive
operations.



SCAFFOLDING SYSTEMS



**Guardia dei Lombardi
(Avellino, Italy)**



Tortora (Cosenza, Italy)

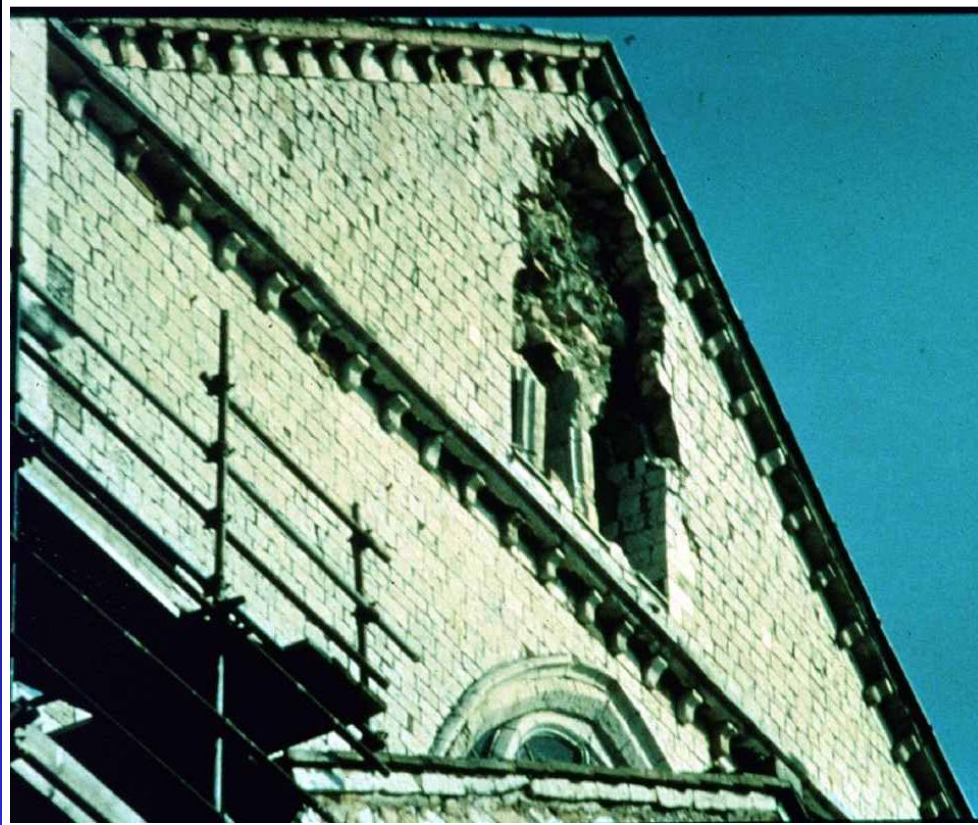




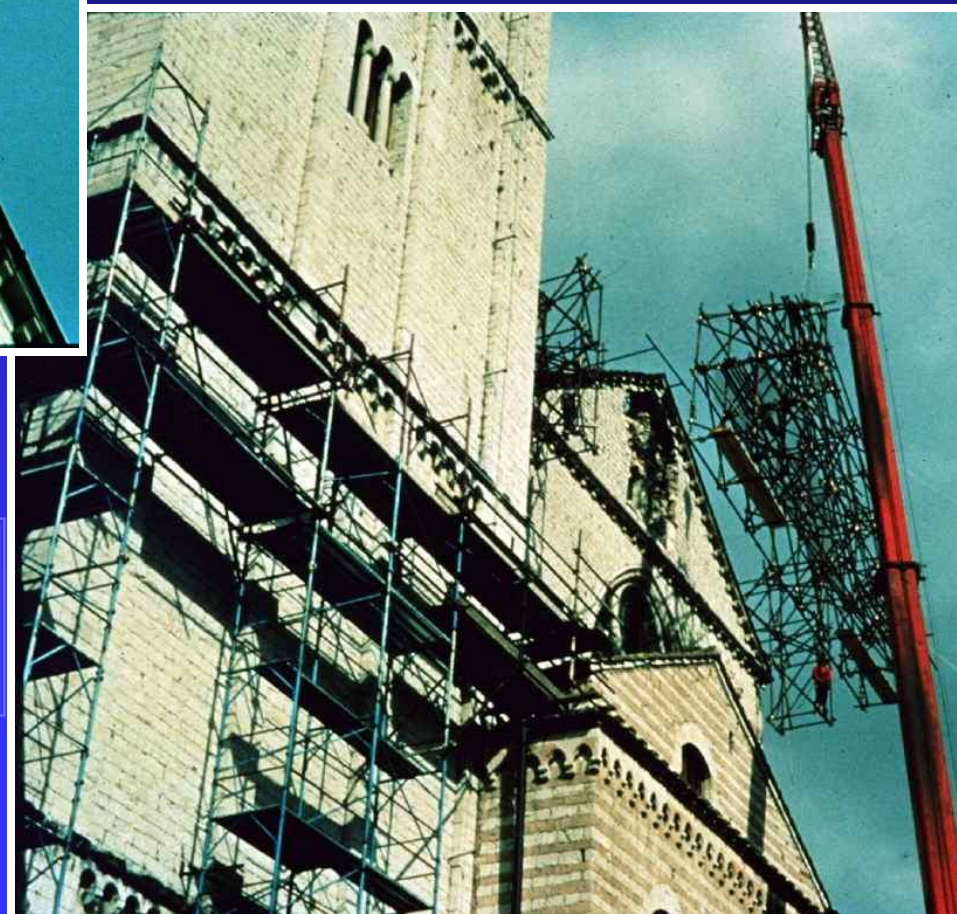
Lisbon (Portugal)

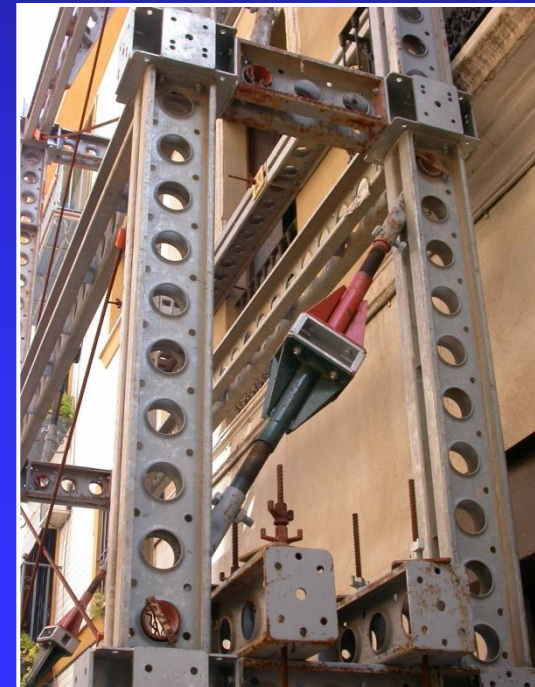
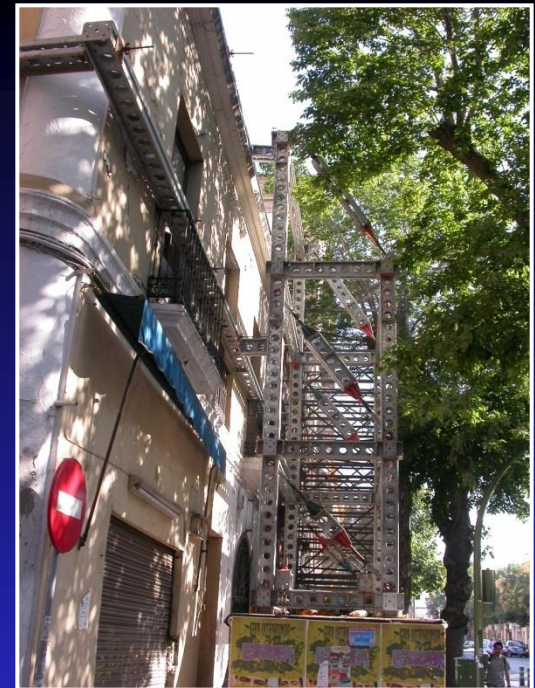
Lisbon (Portugal)





**St. Francesco Church
(Assisi, Italy)**

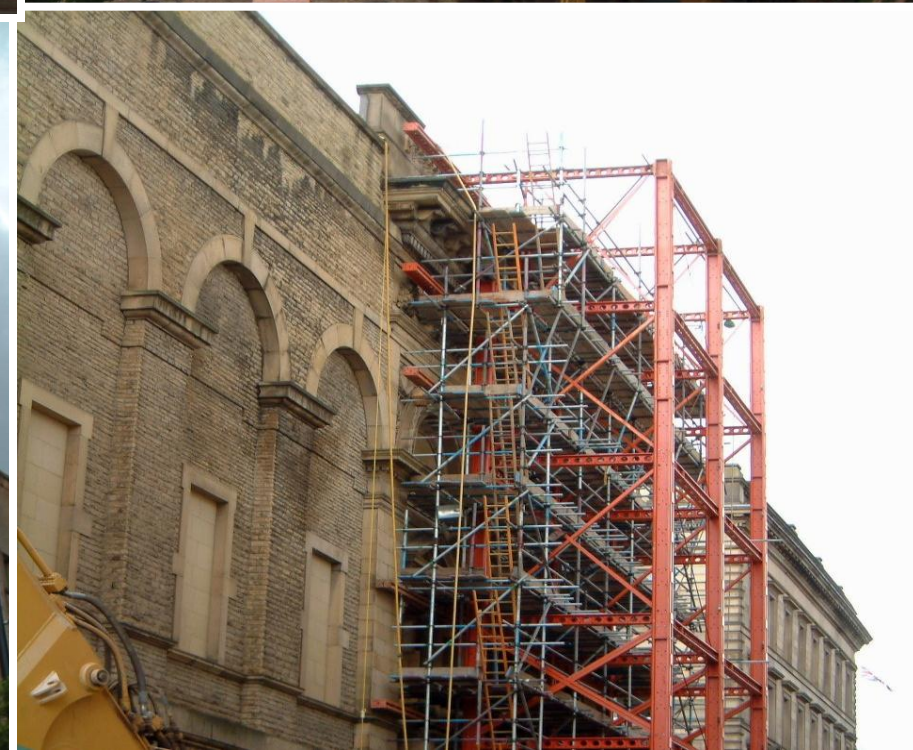


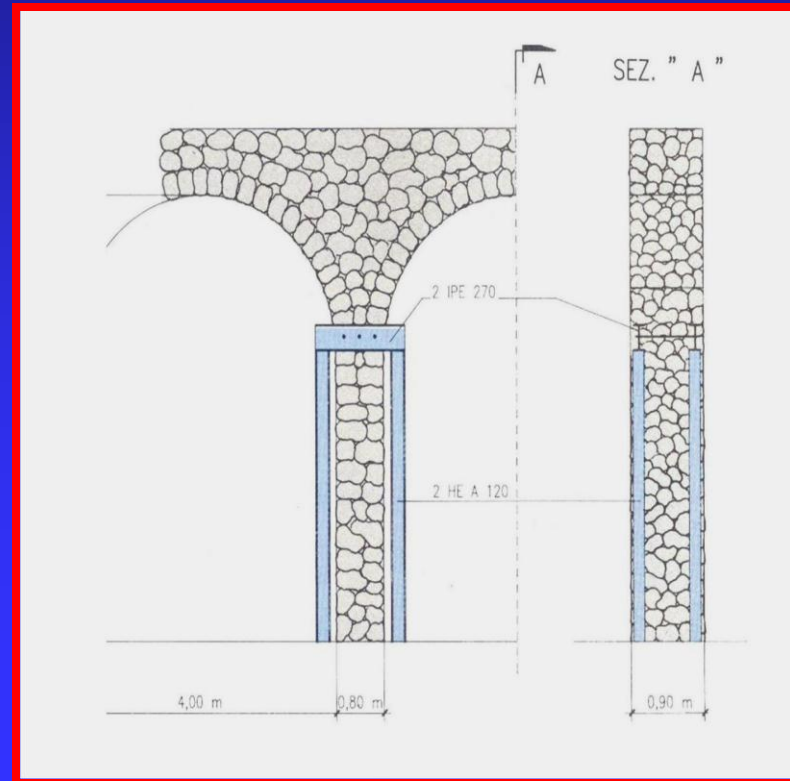
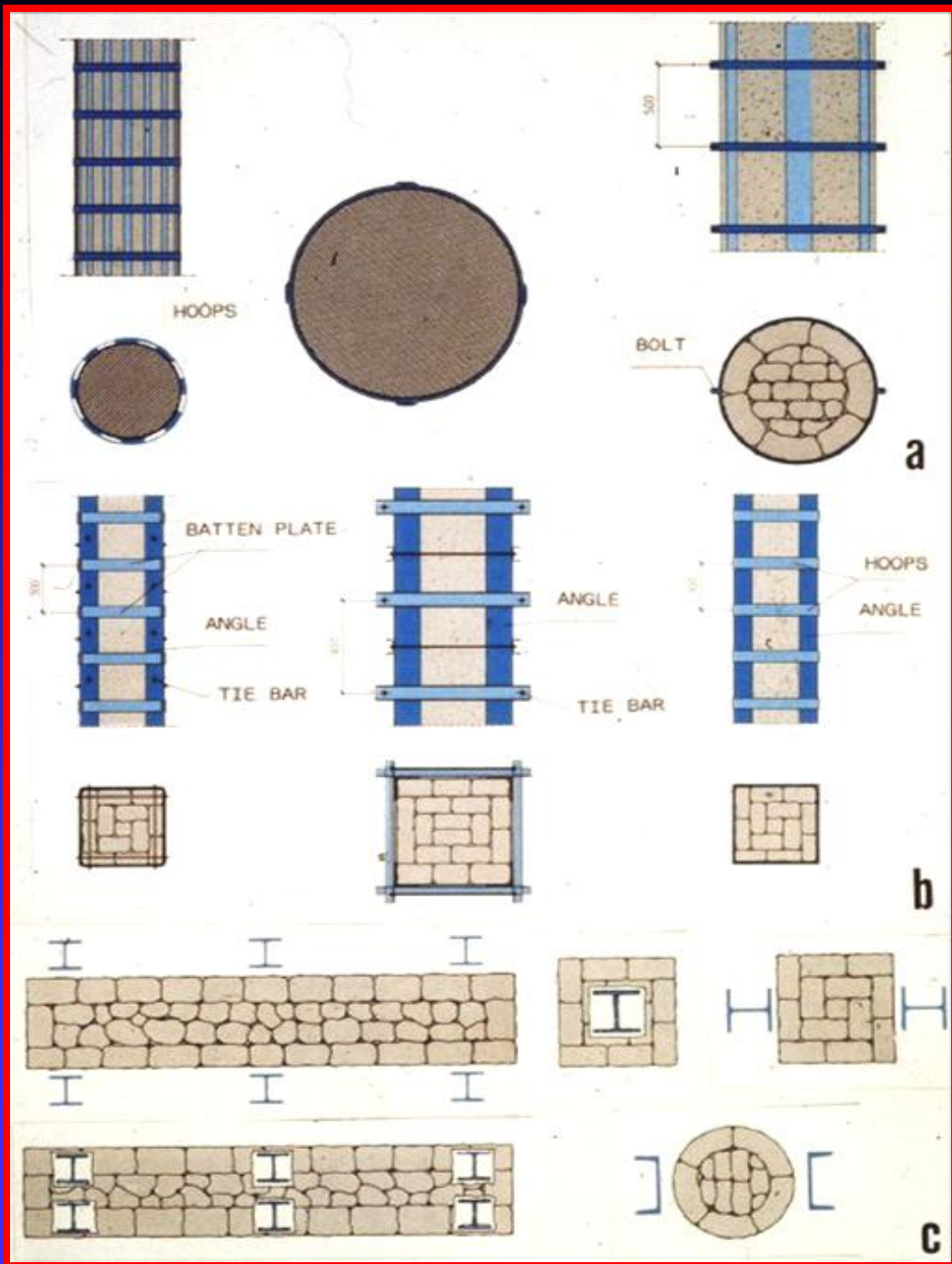


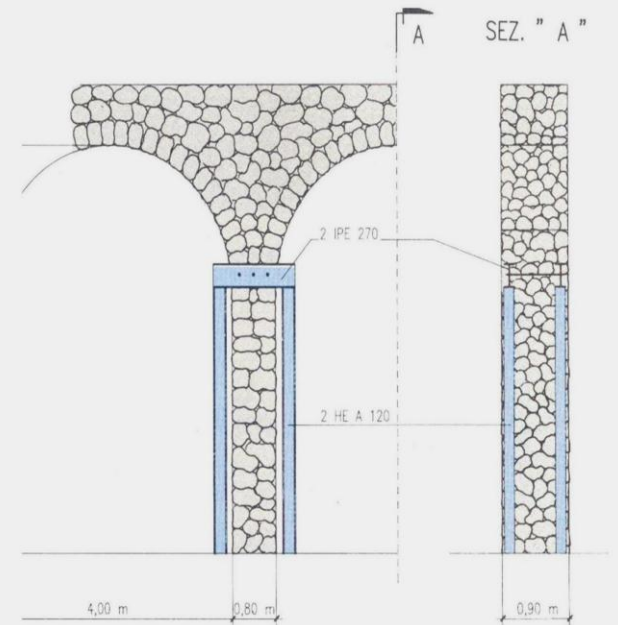
Siviglia (Spain)

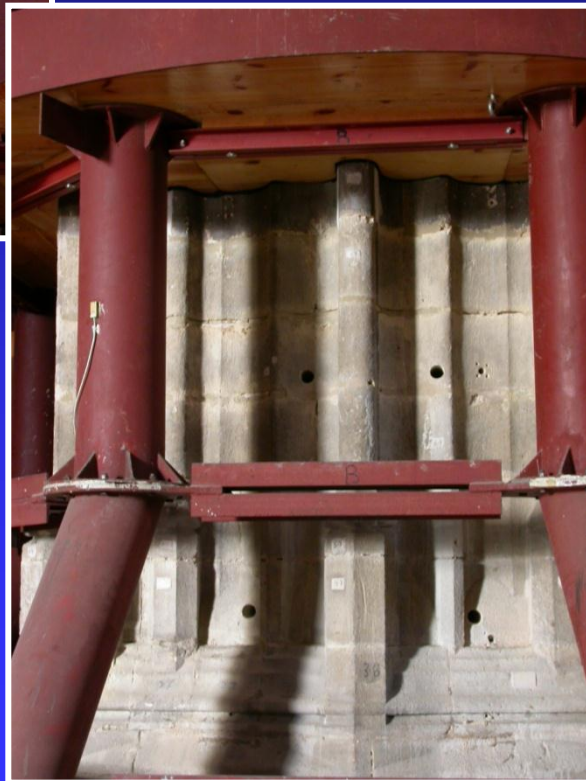
- **Repair** = series of operations necessary to restore the former structural efficiency before the damage occurred

CONSOLIDATION OF MASONRY STRUCTURES

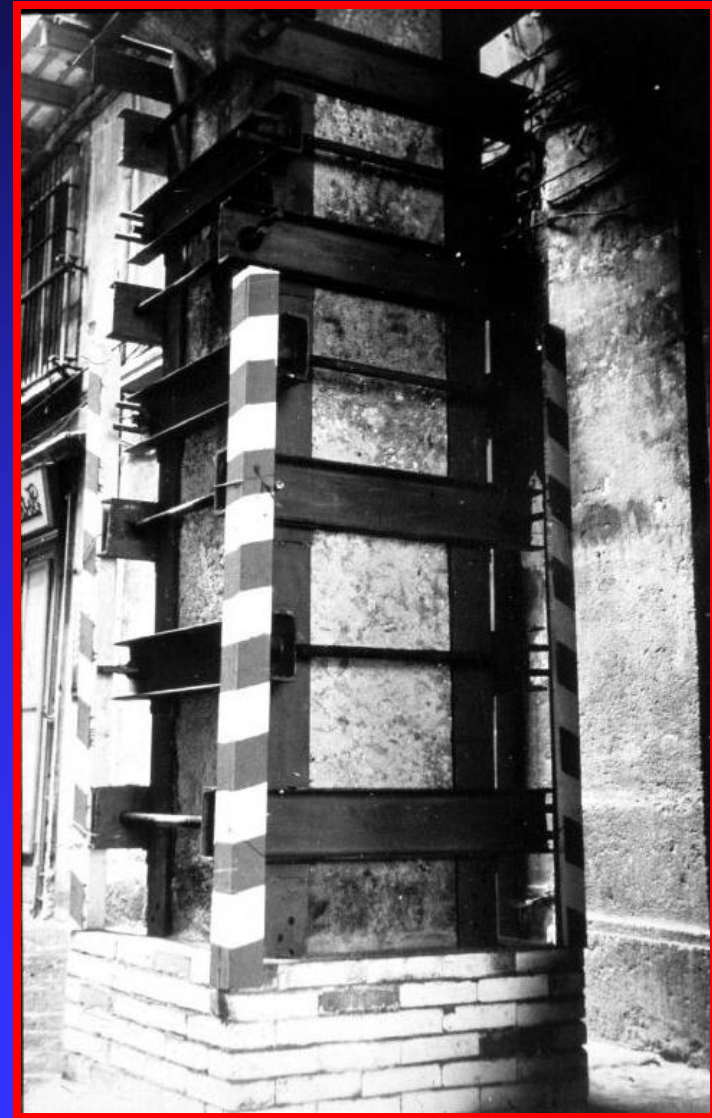
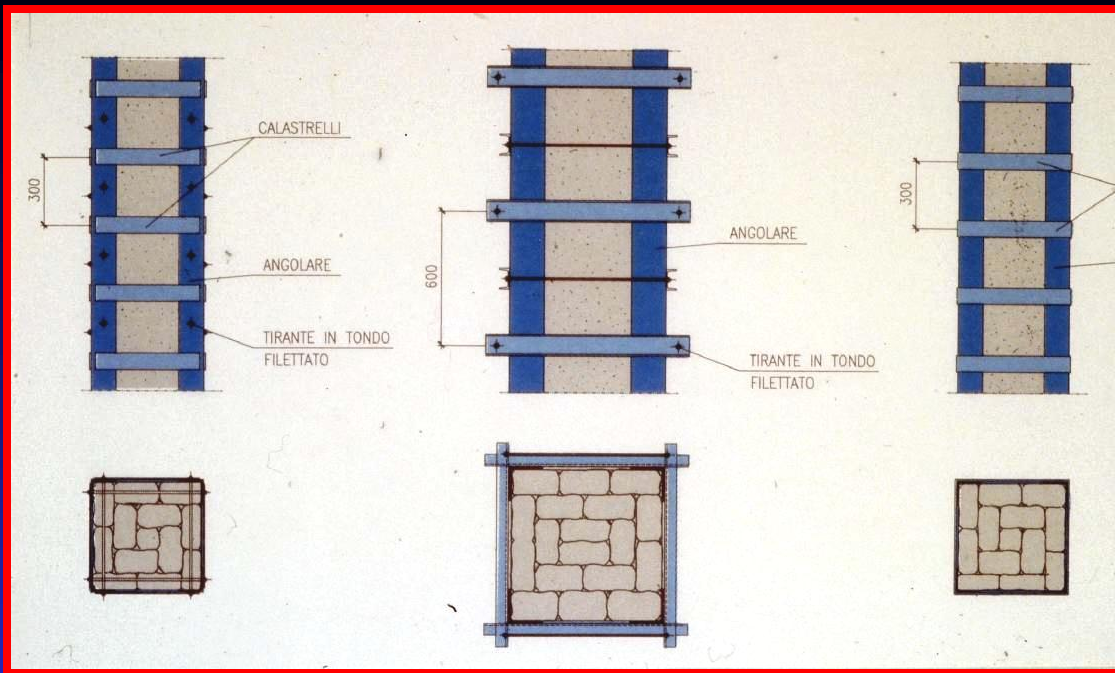


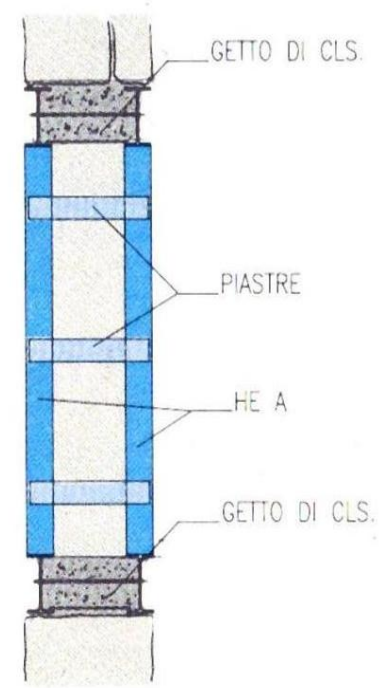
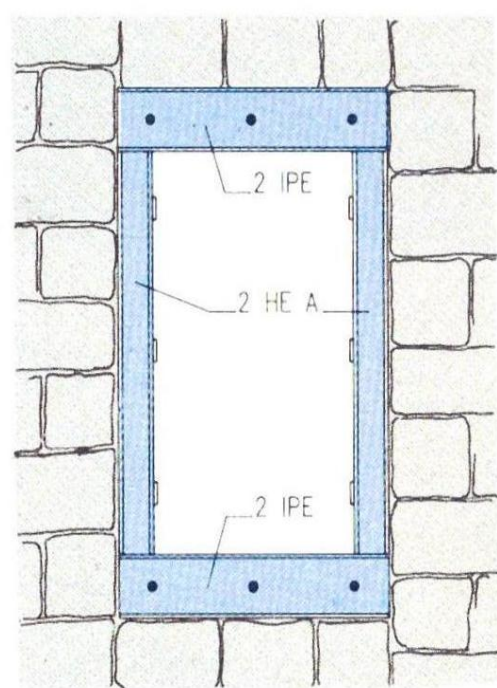
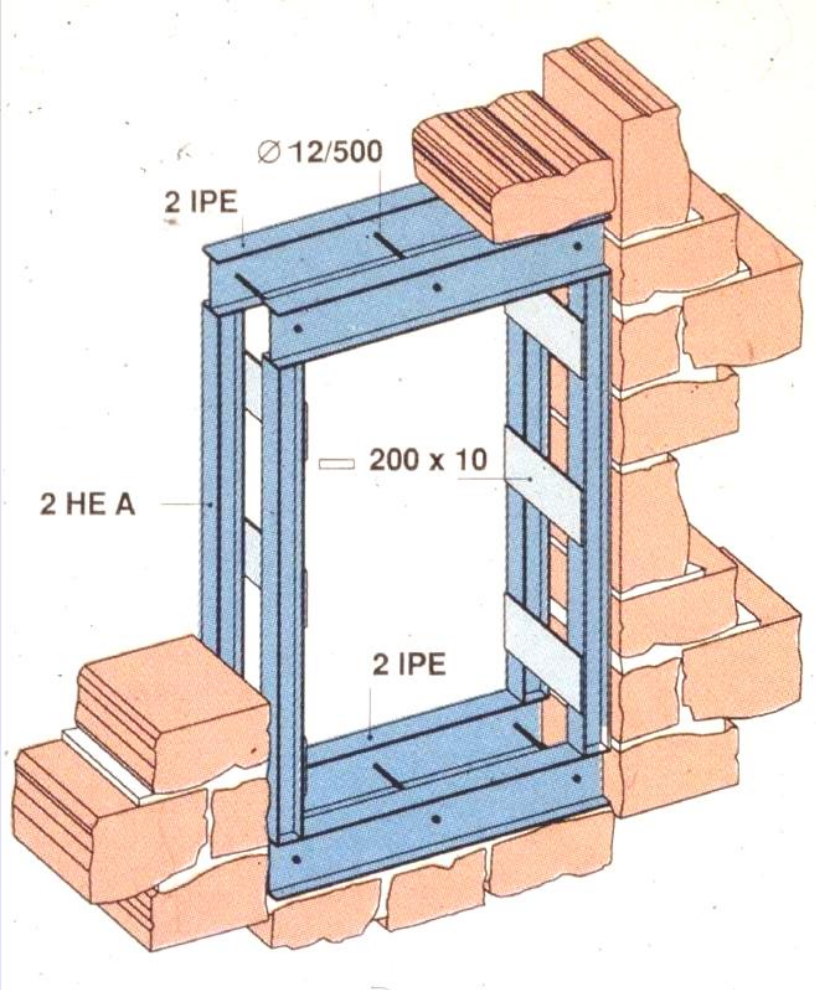


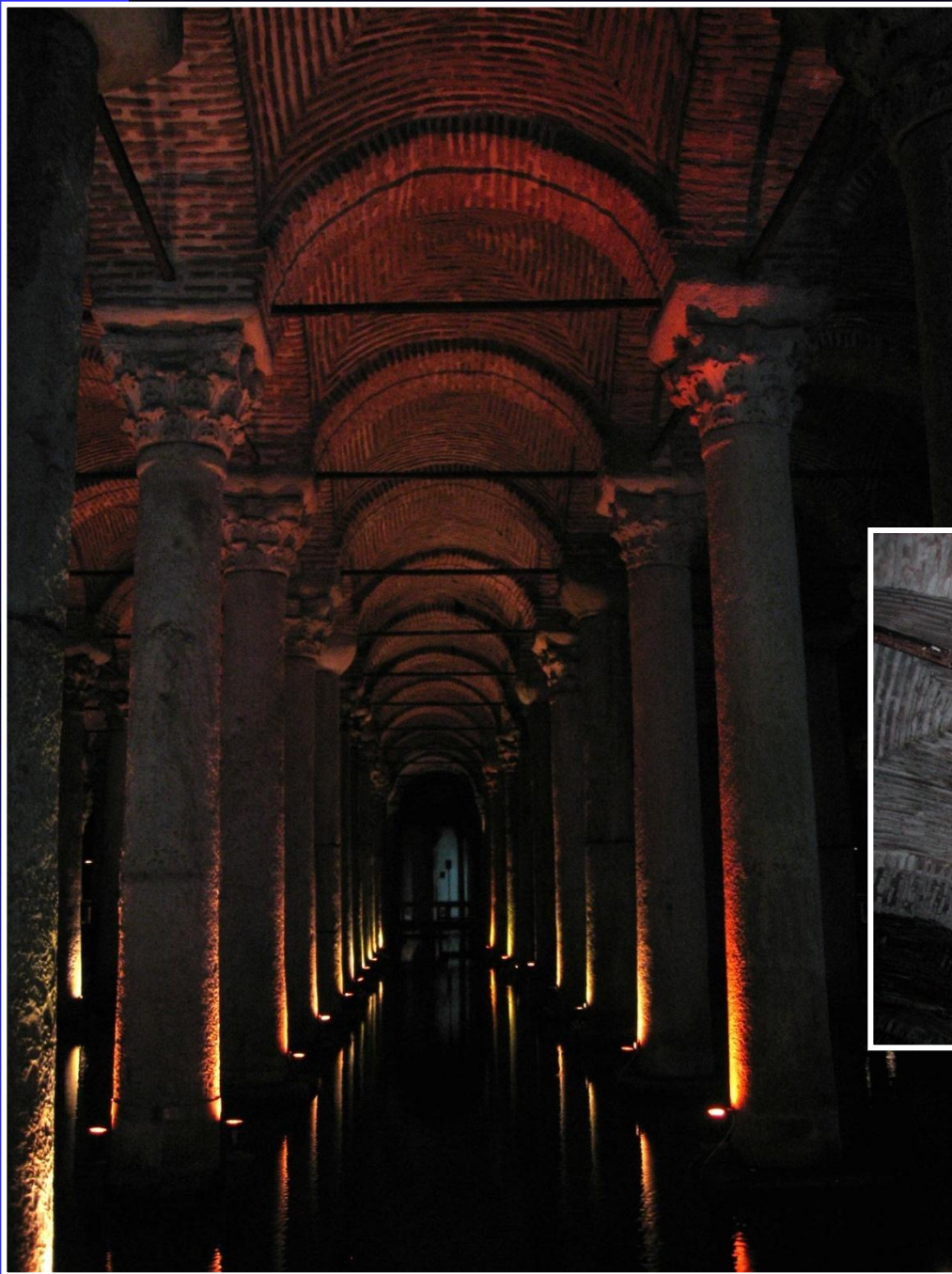












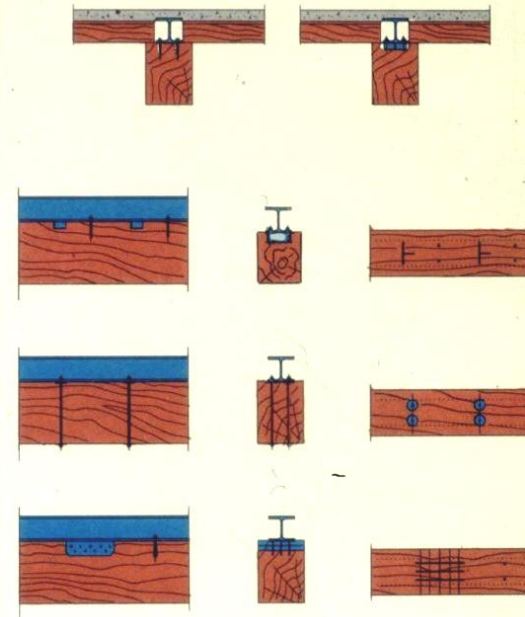
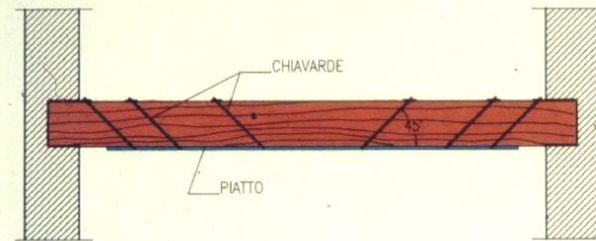
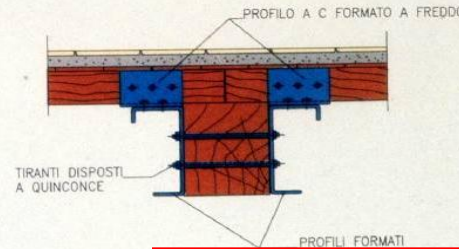
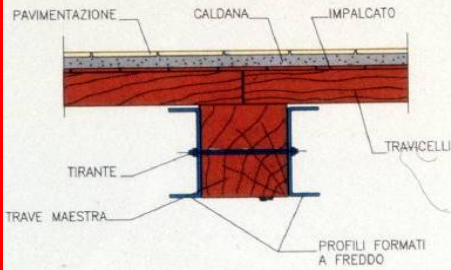
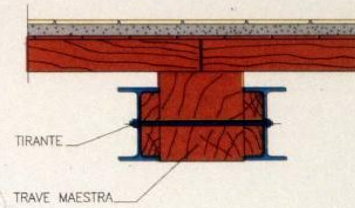
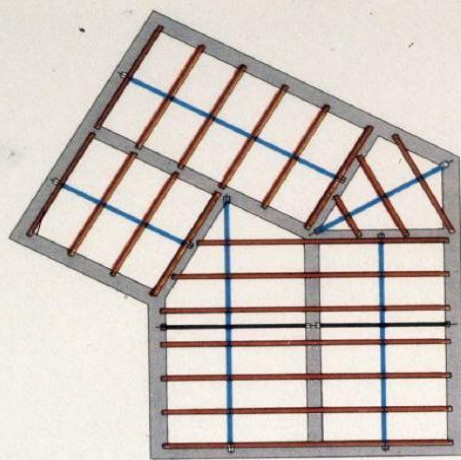
CONSOLIDATION OF WOODEN STRUCTURES

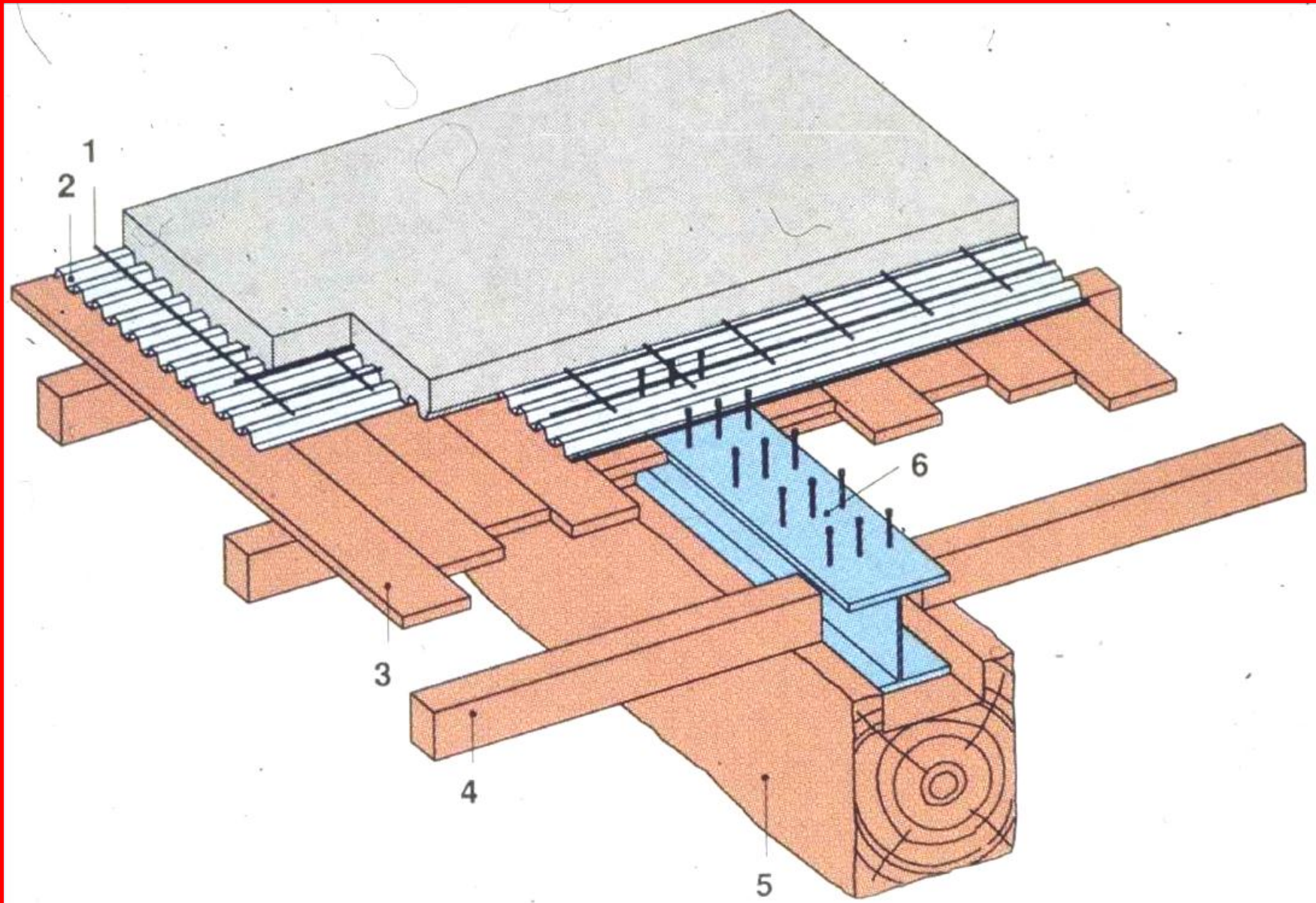


CONSOLIDATION OF WOODEN FLOORS

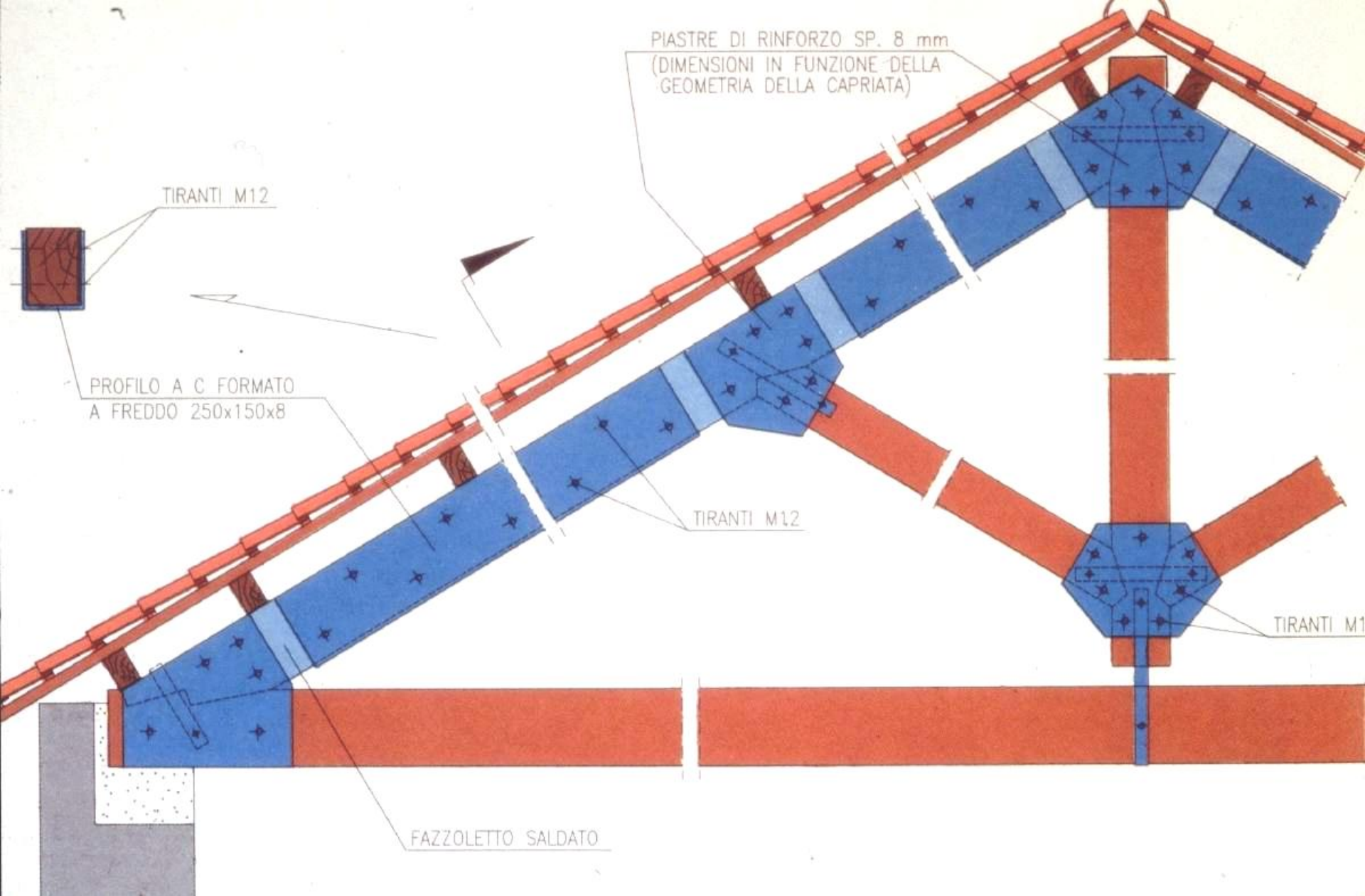


CONSOLIDATION OF WOODEN BEAMS





**COMPOSITE SOLUTION :
WOOD-STEEL-CONCRETE STRUCTURE**

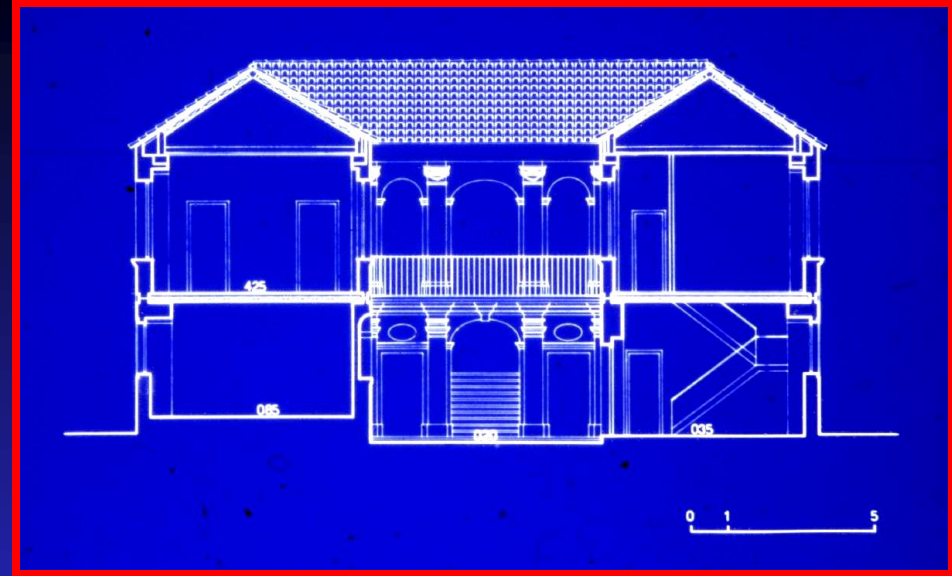
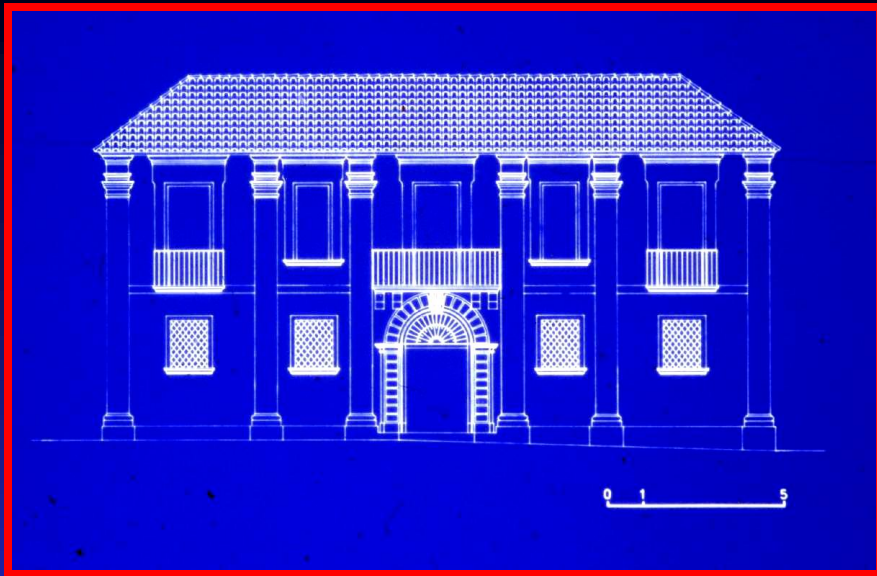


CONSOLIDATION OF WOODEN TRUSSES

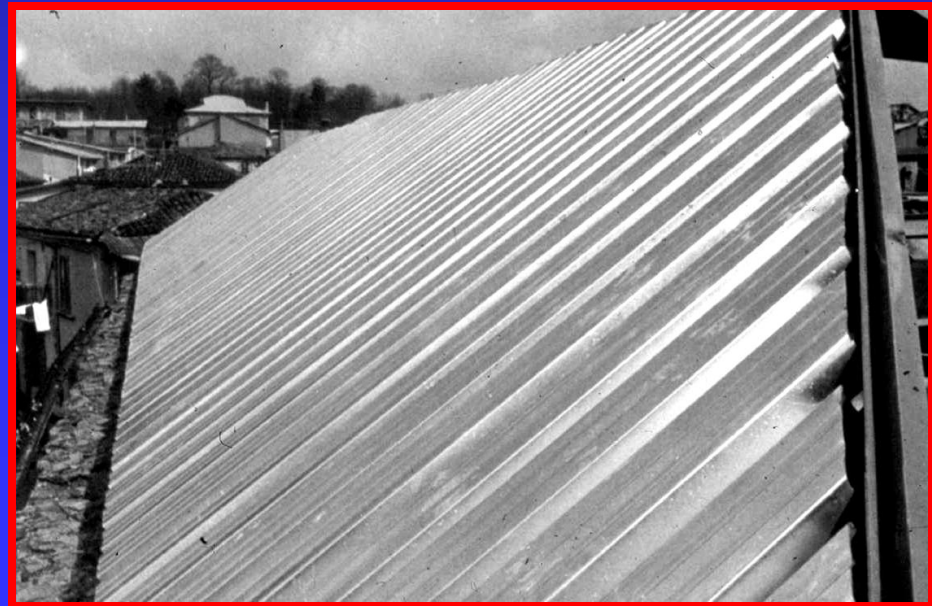
SUBSTITUTION OF WOODEN ROOFS WITH STEEL ROOFS



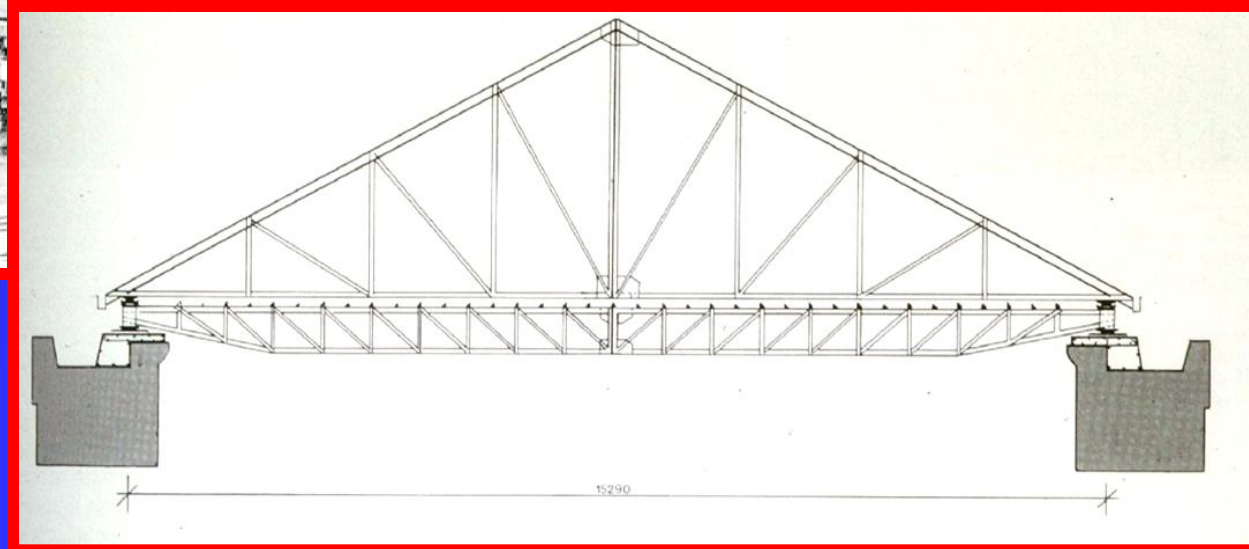
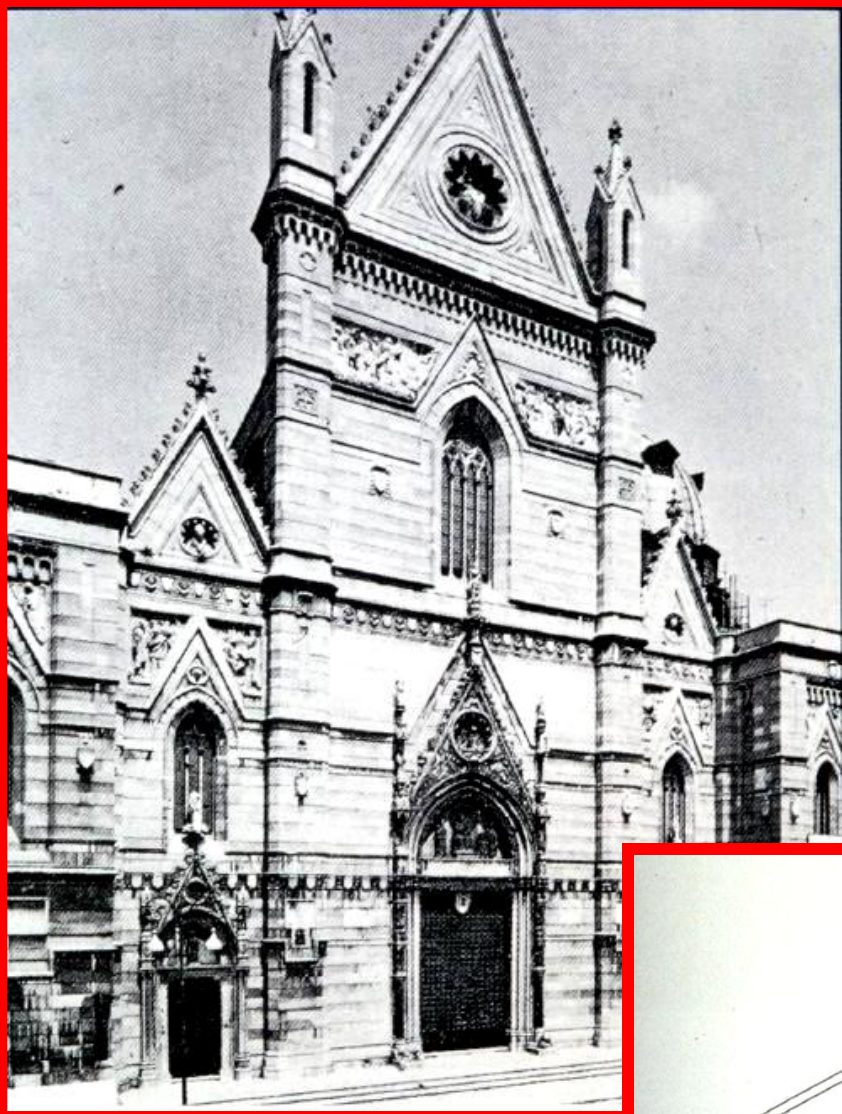
**NEW STEEL ROOF IN
A CHURCH**



NEW STEEL ROOF IN A MONUMENTAL BUILDING



THE STEEL ROOF OF THE NAPLES CATHEDRAL



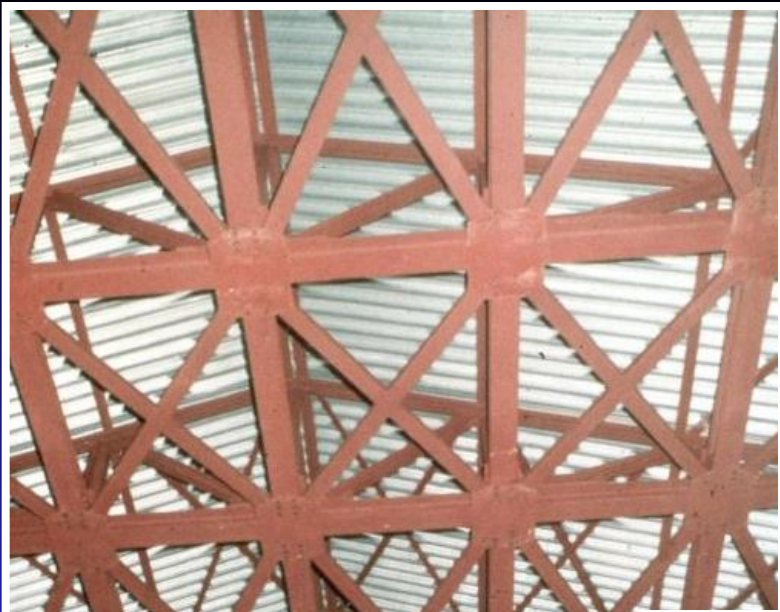


SUCCIVO CASERTA(ITALY)

A PENTHOUSE IN A MASONRY BUILDING



STEEL DIAPHRAGM IN A MASONRY CHURCH



**SOLOFRA
(AVELLINO)**



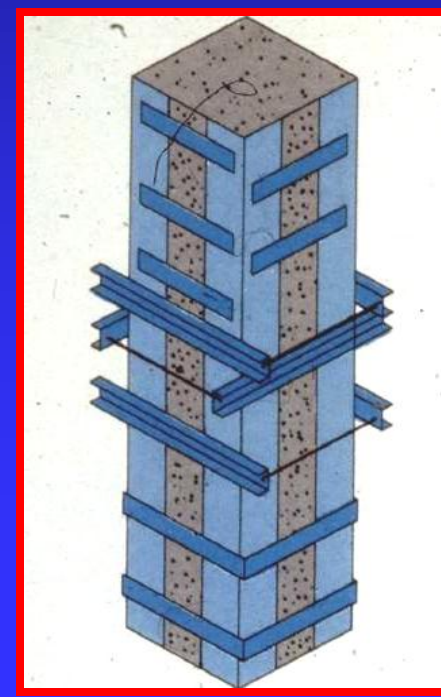
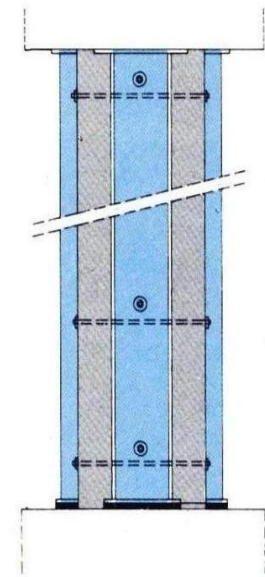
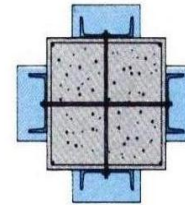
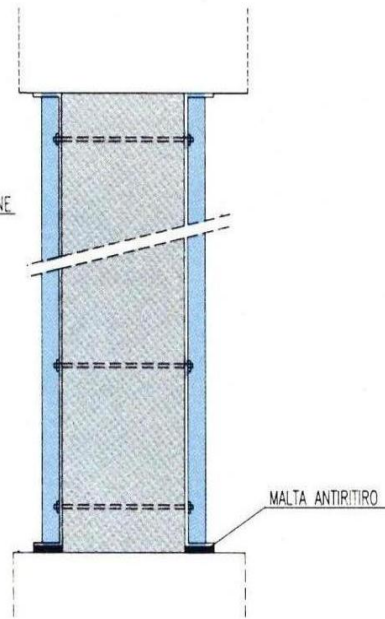
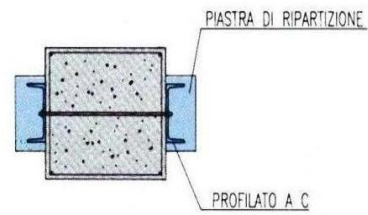
SPECIAL SEISMIC DEVICES

**ST.GIOVANNI IN
CARIFE (AVELLINO)**



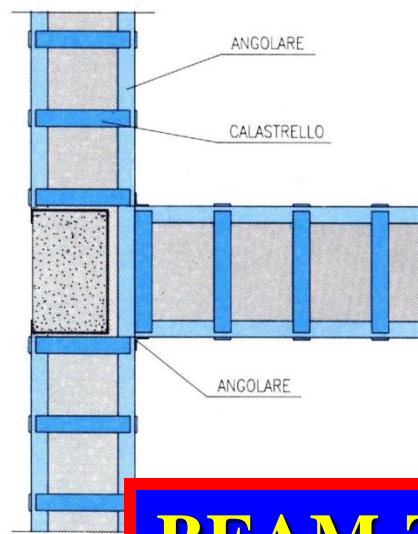
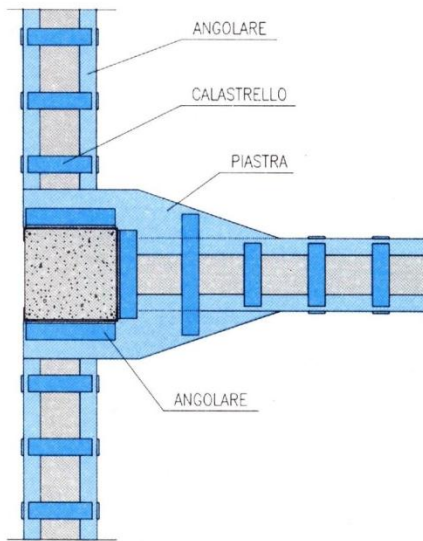
CONSOLIDATION OF R.C. STRUCTURES

COLUMNS

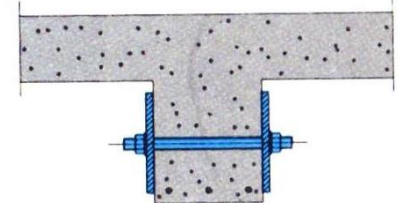
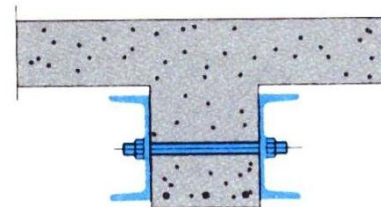
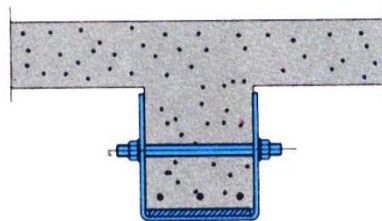
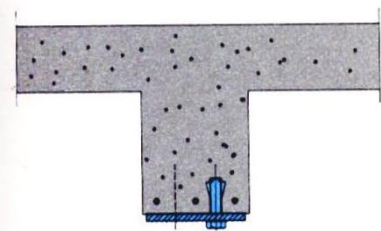


Mexico City



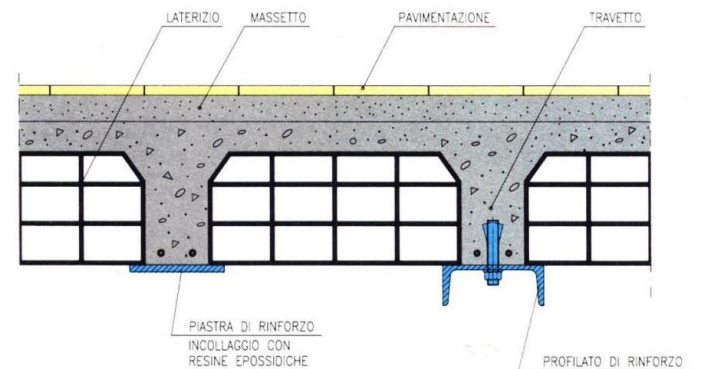


BEAM-TO-COLUMN NODES



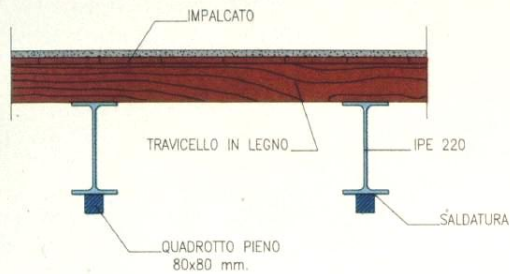
BEAMS

FLOOR STRUCTURES

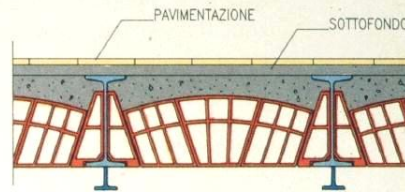


CONSOLIDATION OF STEEL STRUCTURES

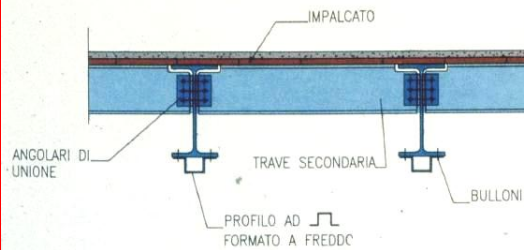
SOLAIO IN TRAVI METALLICHE E TRAVICELLI IN LEGNO



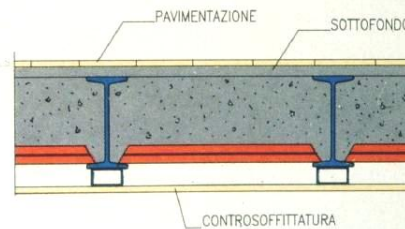
SOLAIO IN TRAVI METALLICHE E VOLTERRANE IN LATERIZIO



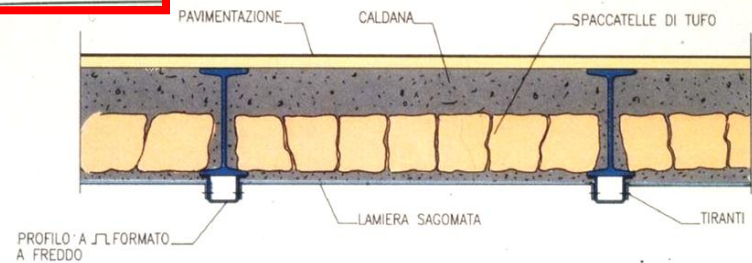
SOLAIO CON TRAVI PRINCIPALI E SECONDARIE IN METALLO



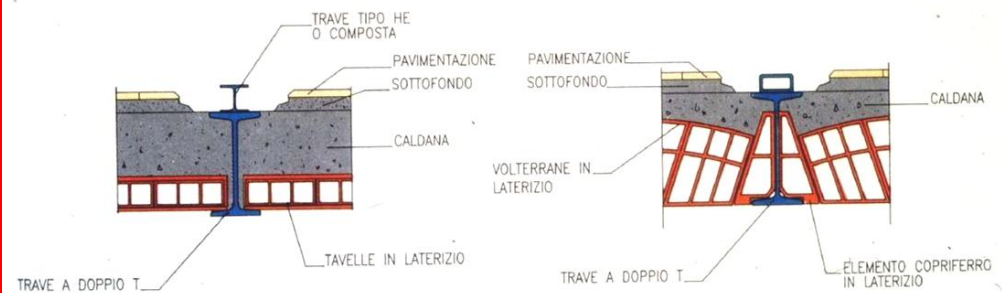
SOLAIO IN TRAVI METALLICHE E TAVELLONI IN LATERIZIO



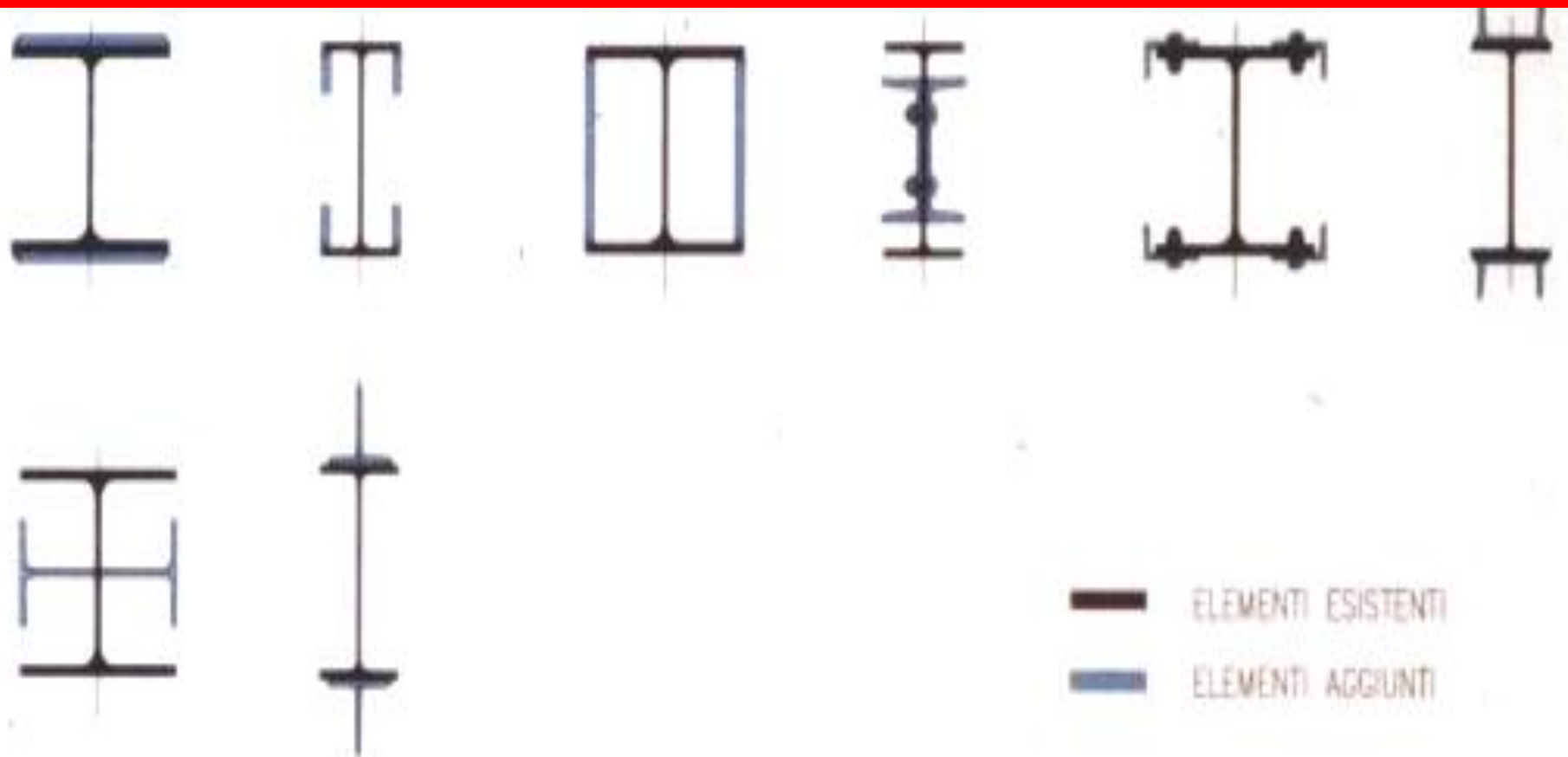
SOLAIO CON TRAVI METALLICHE E SPACCATELLE DI TUFO



STEEL FLOORS



STEEL SECTIONS

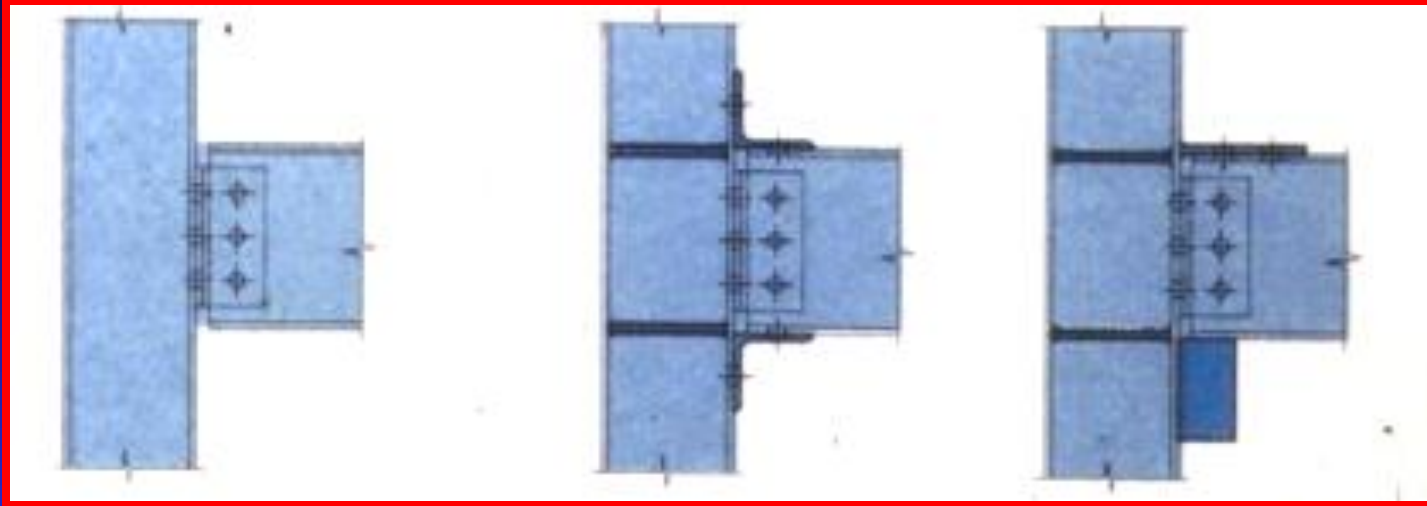


STEEL NODES

pinned



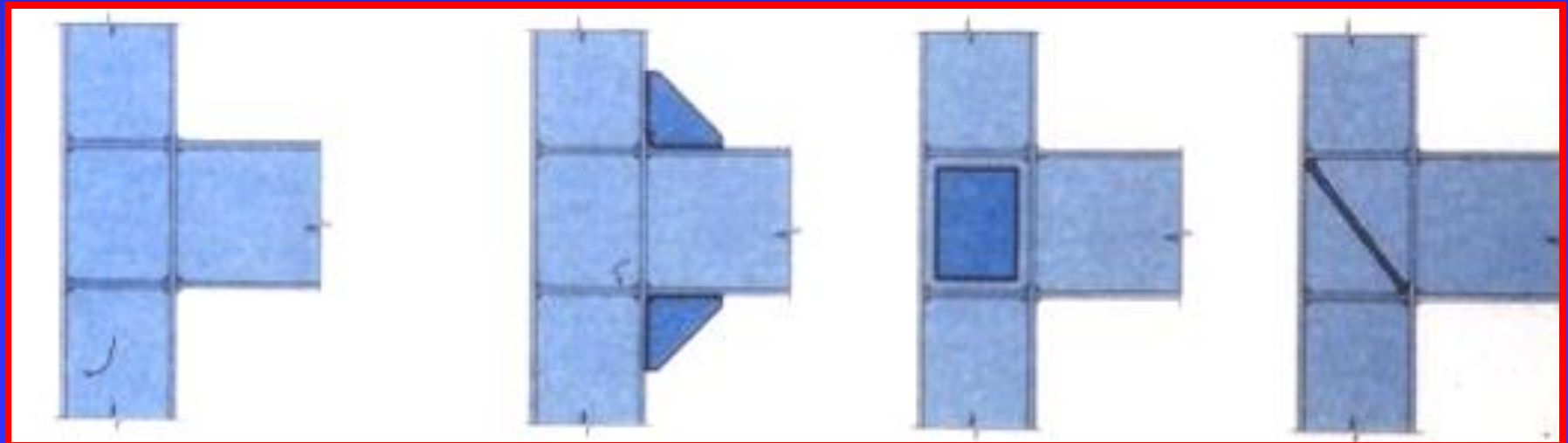
rigid

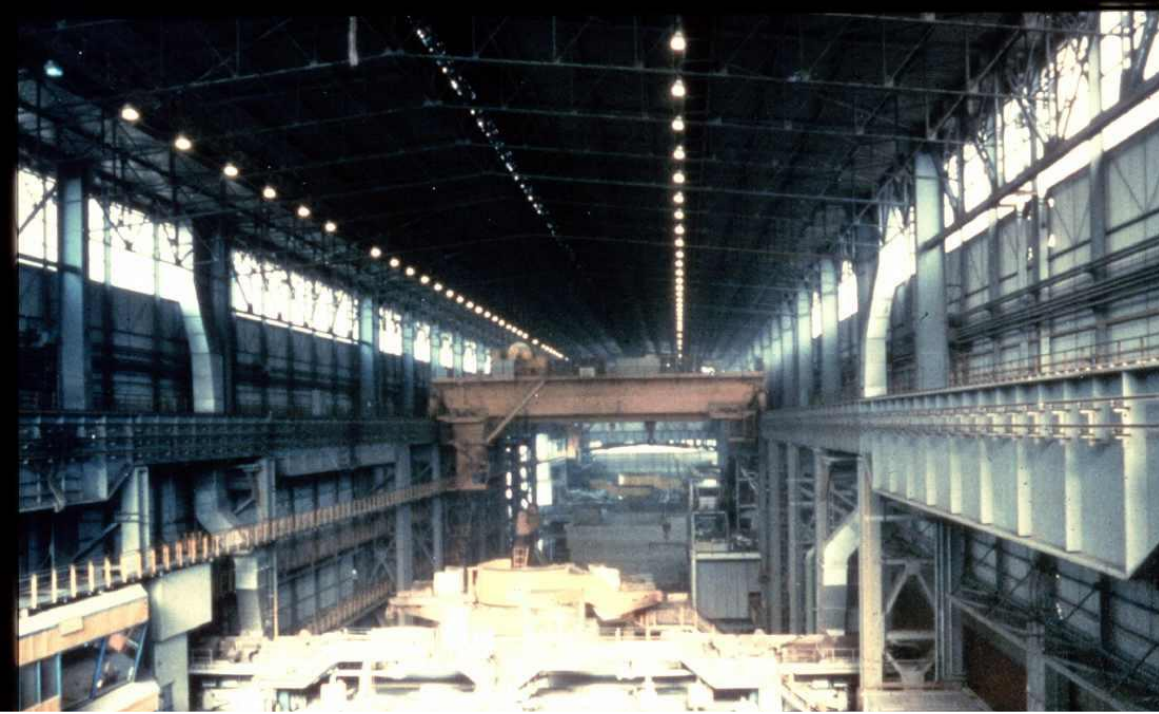


semi-rigid



rigid

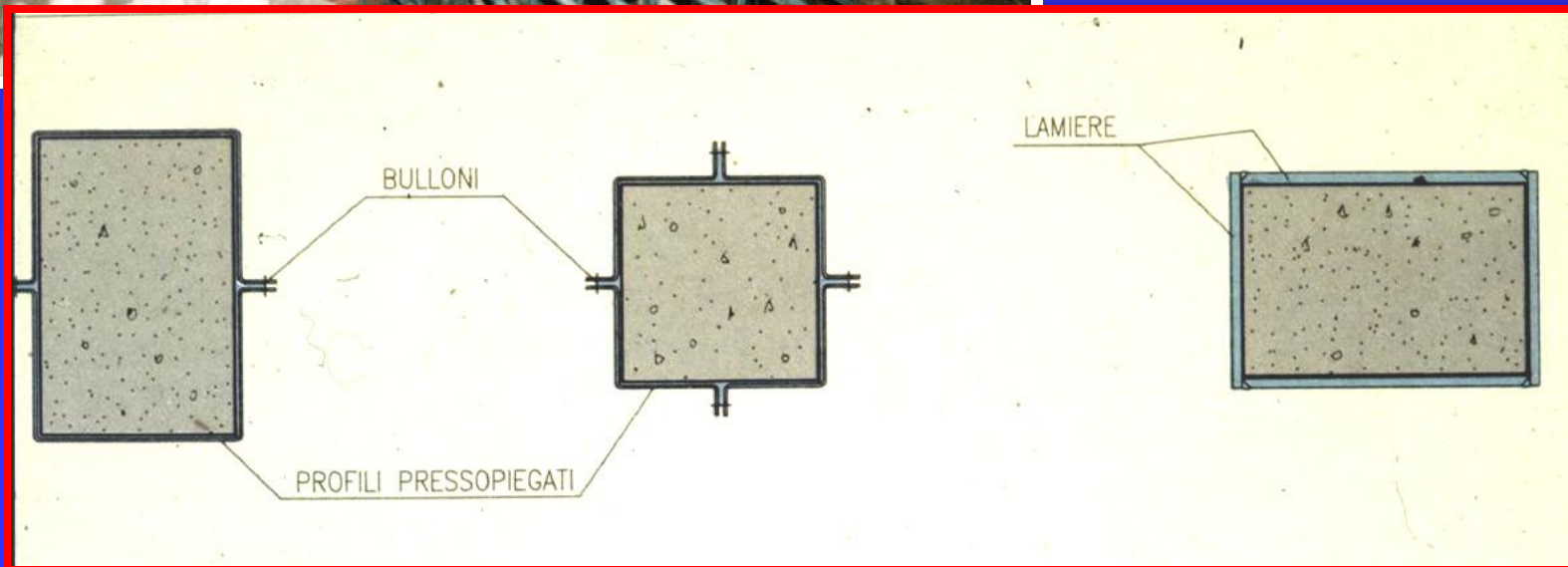


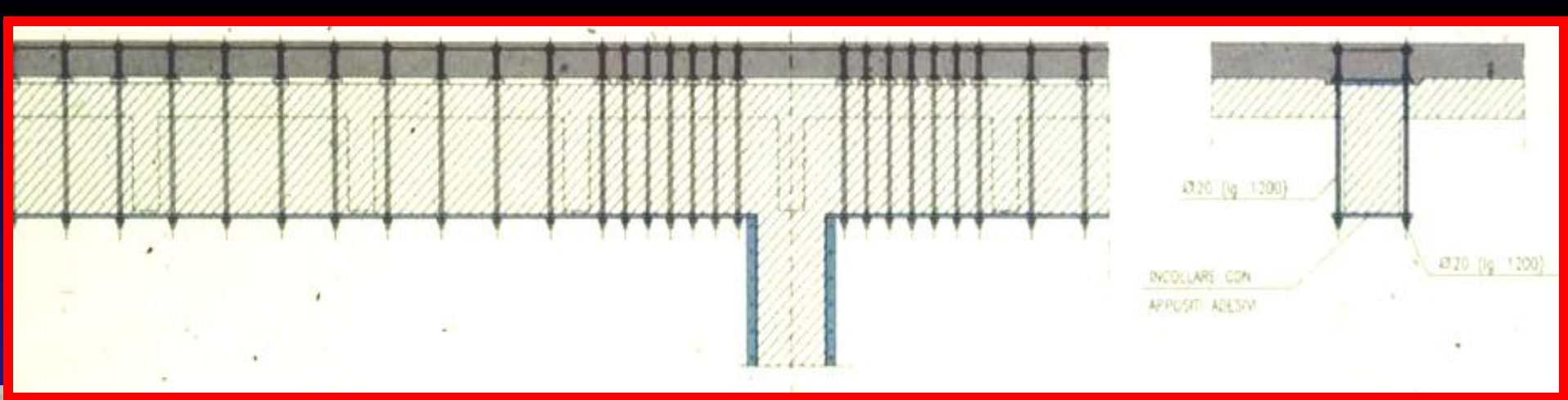


**ILVA steel mill
(Bagnoli - Naples, Italy):
seismic upgrading**

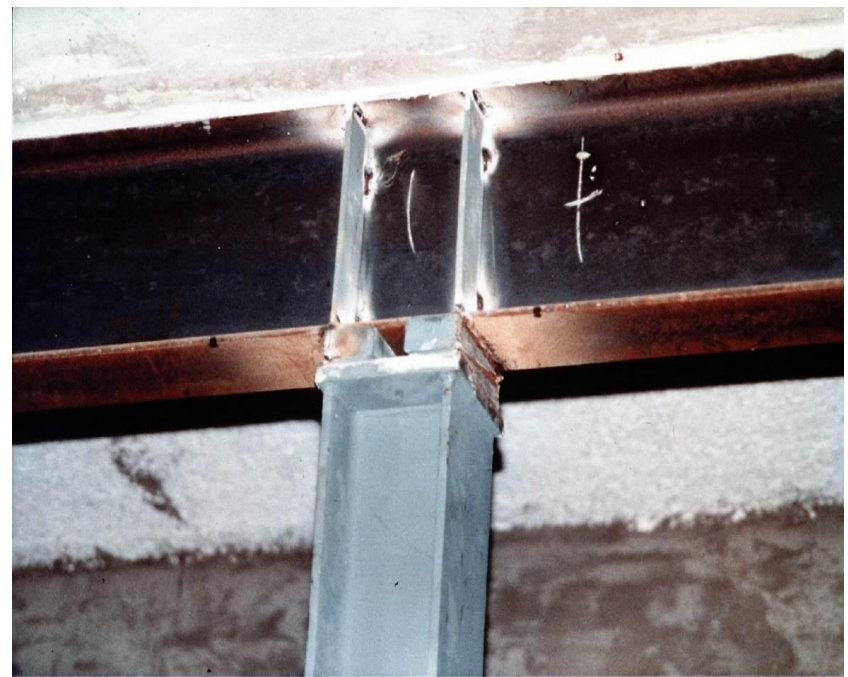
- **Reinforcing** = improving of the structural performance in order to make the building able to fulfil new functional requirements or enviromental conditions

“Sigma coating” industrial building in Agnano (Naples, Italy)

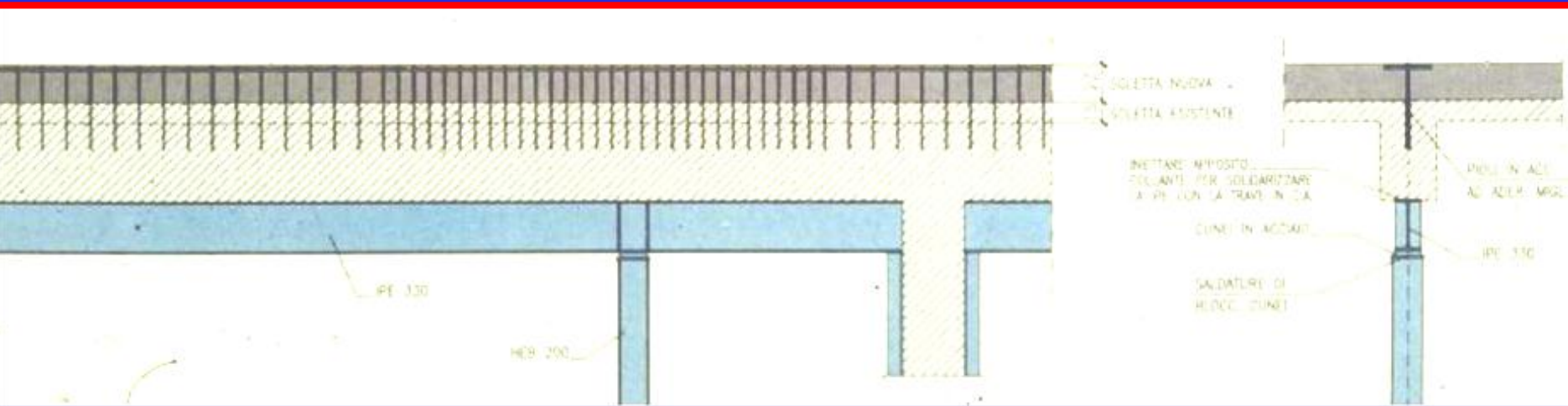




**“Sigma coating”
industrial building
in Agnano (Naples, Italy)**

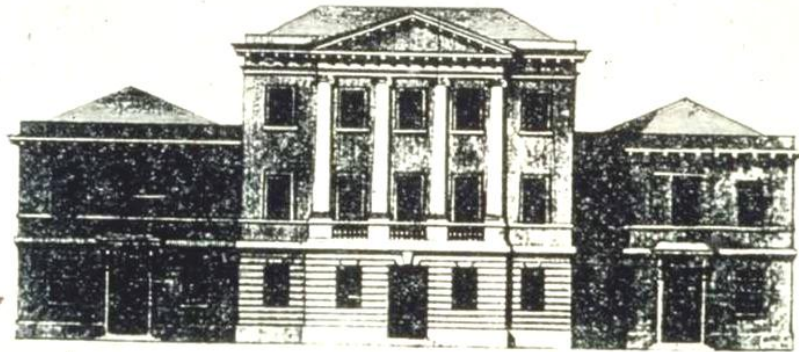
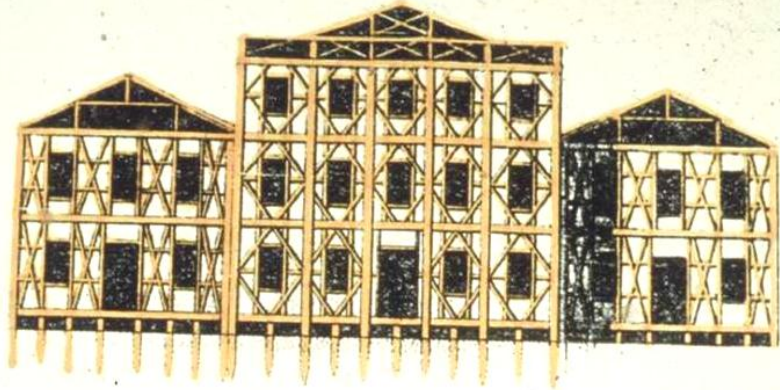


“Sigma coating” industrial building in Agnano (Naples, Italy)

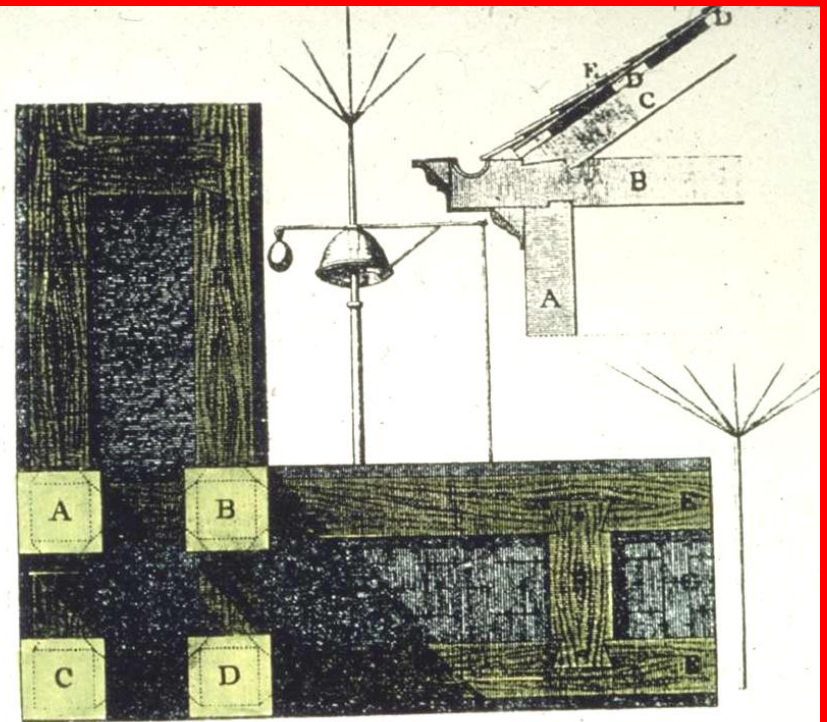


SEISMIC UPGRADING WITH BRACING SYSTEMS

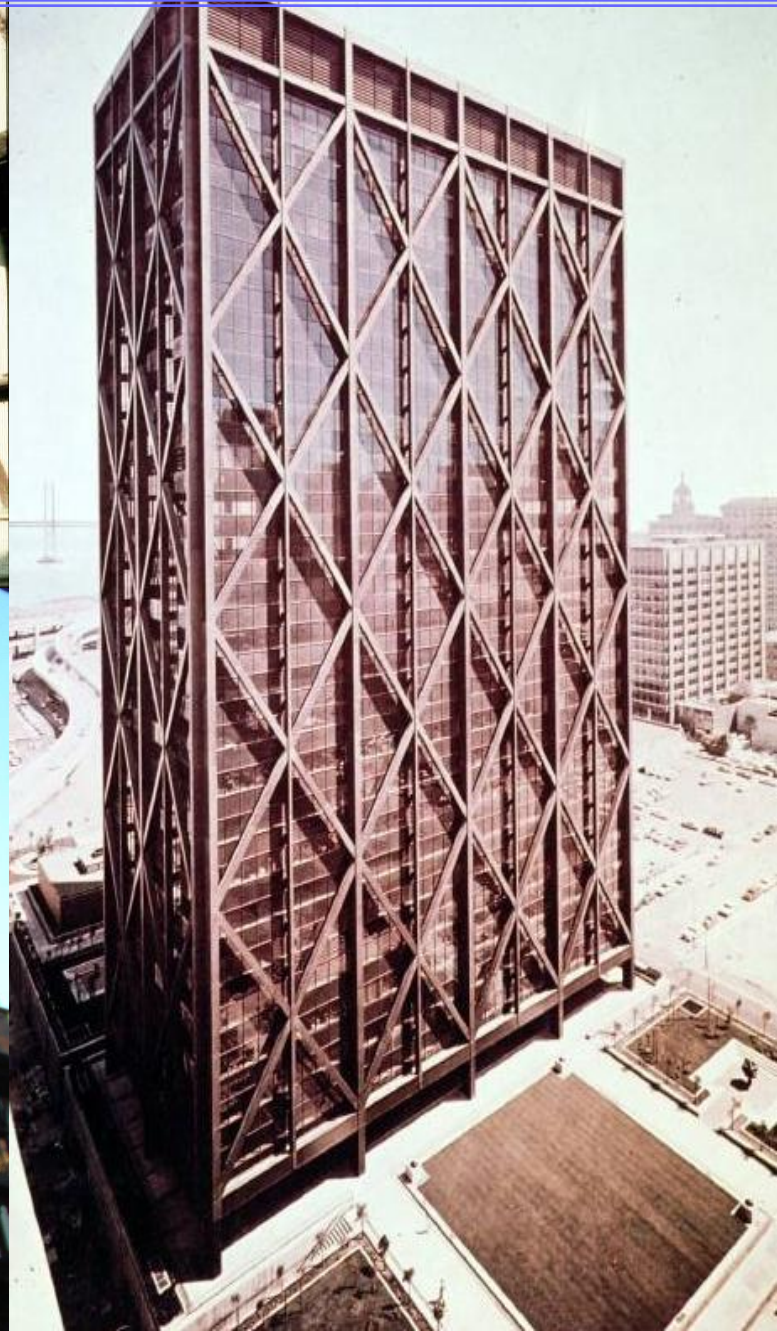




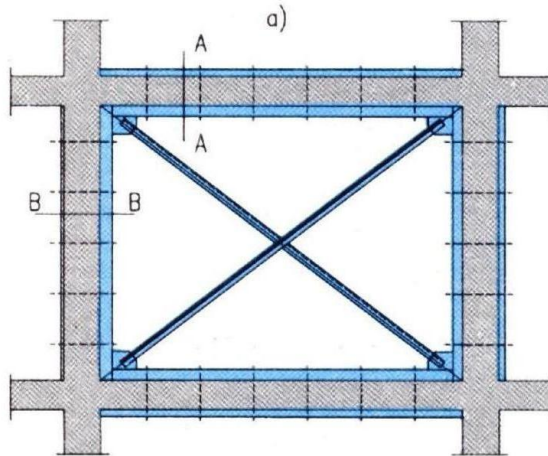
**“Case Baraccate”
(Calabria, Italy)**



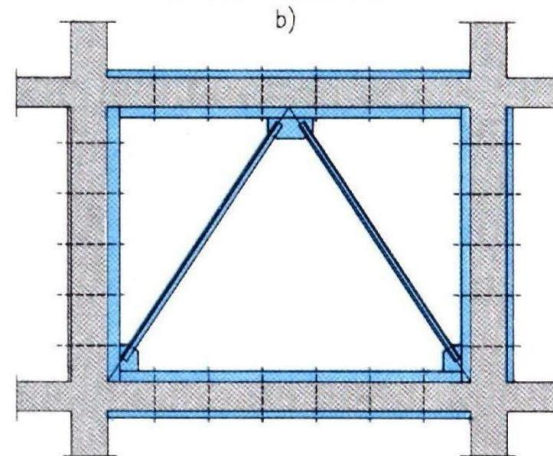
Old and new bracing systems



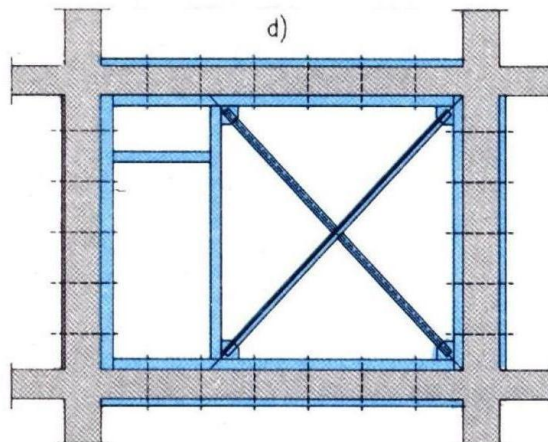
Contr. a croce di S. Andrea



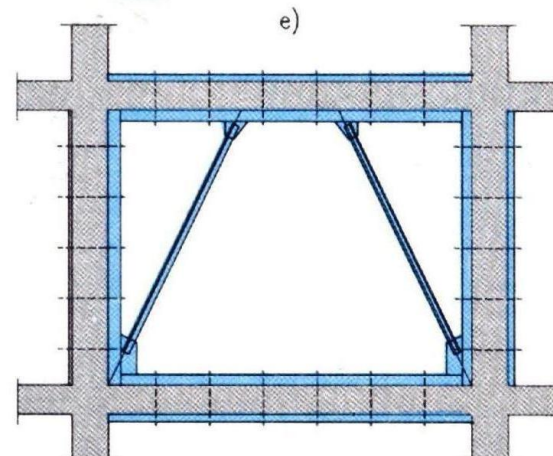
Controvento a K



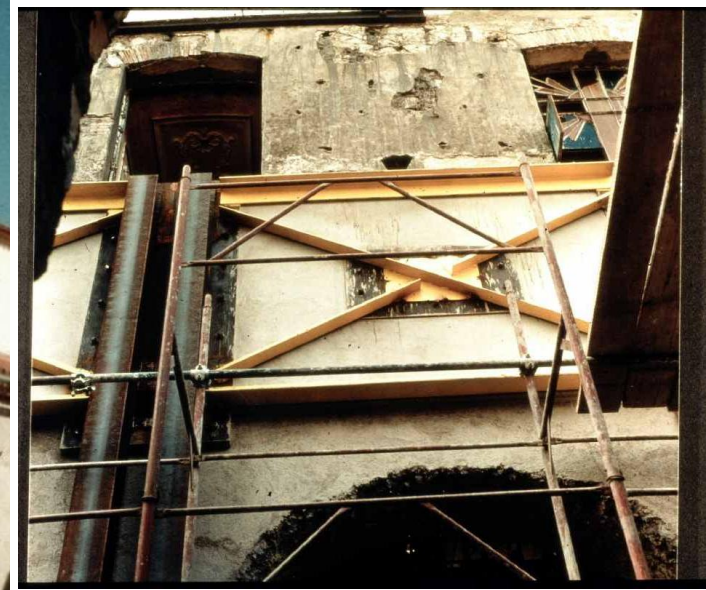
Controventi con aperture



Controventi eccentrici

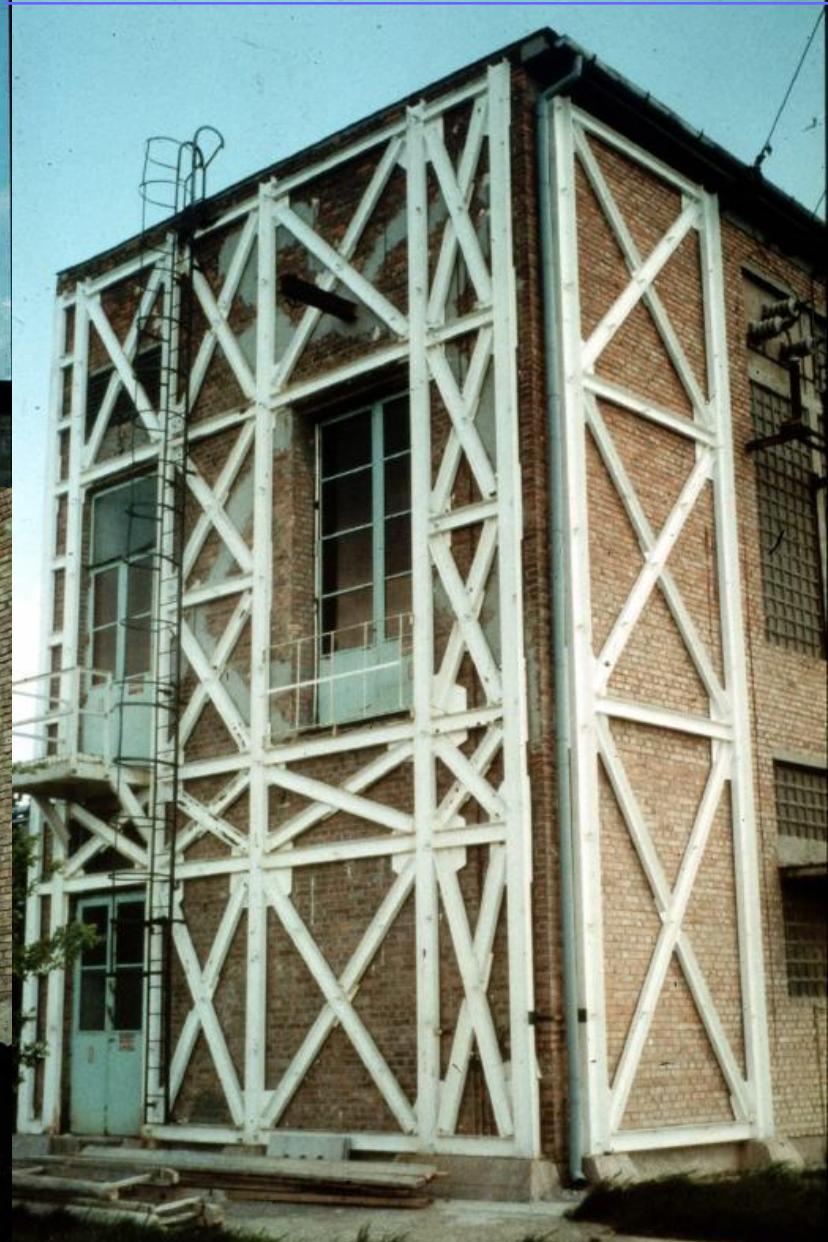
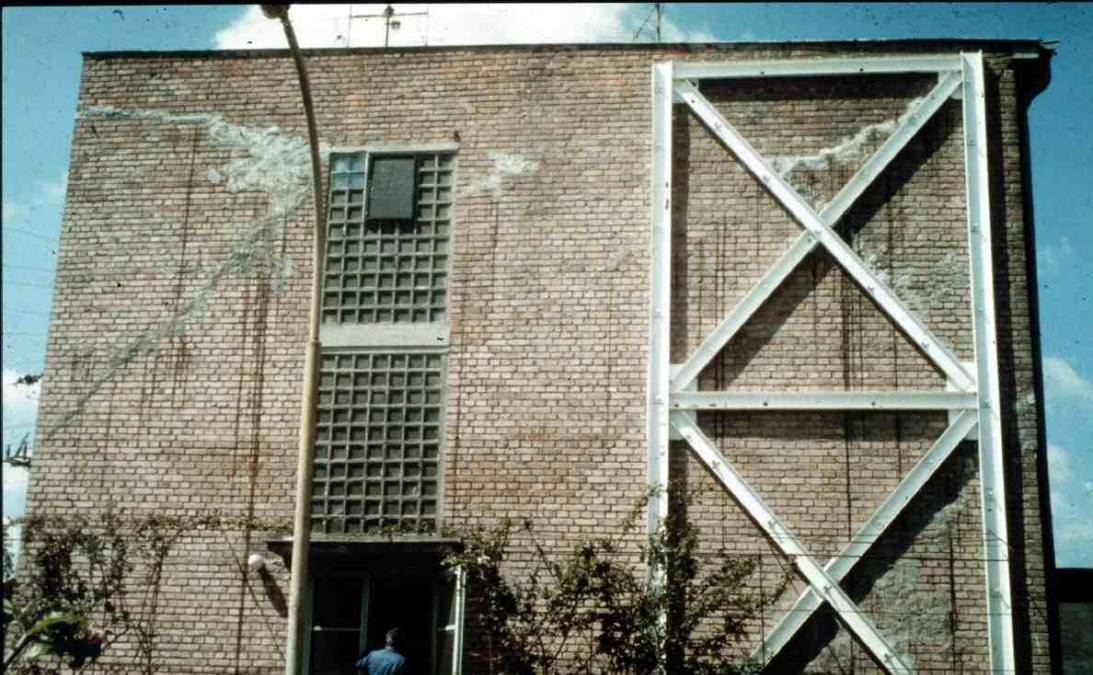


Bracing systems for masonry structures

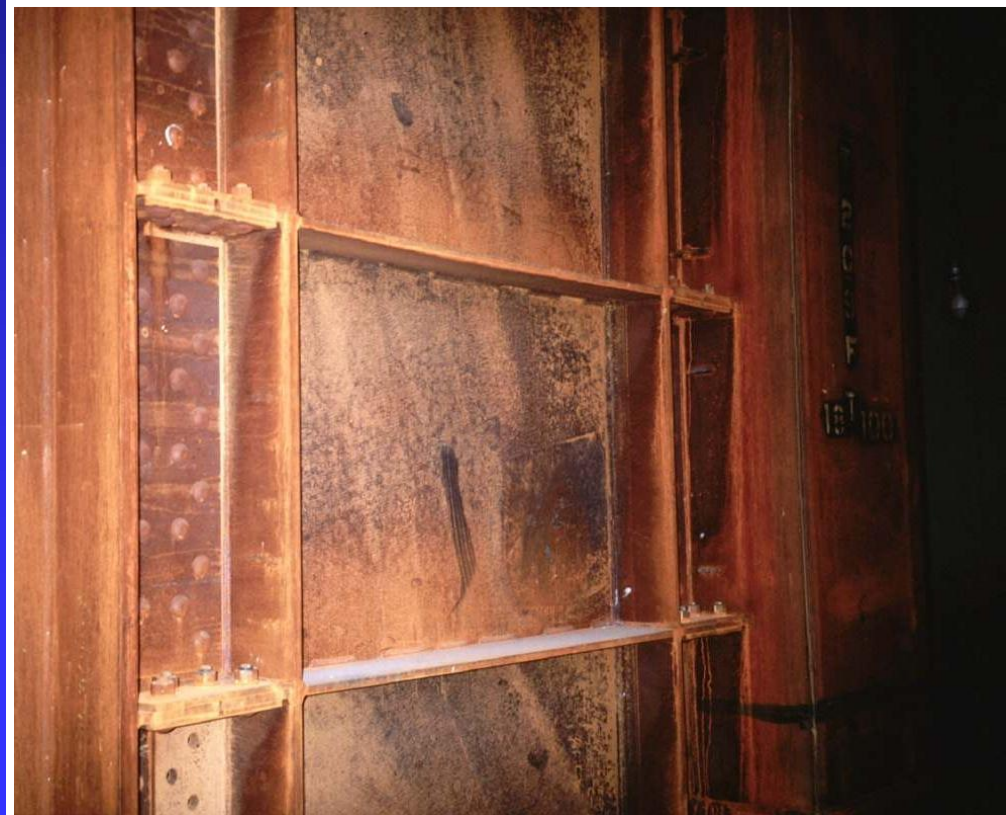
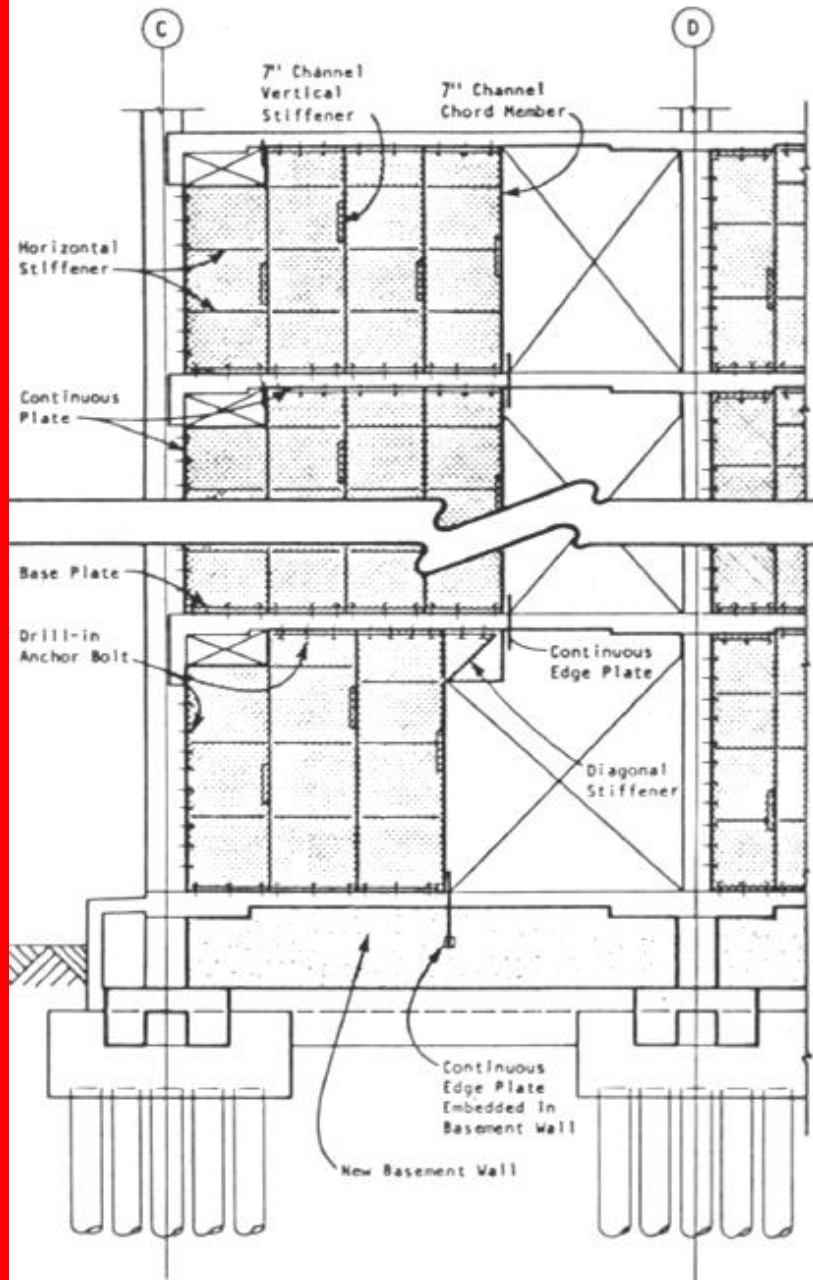


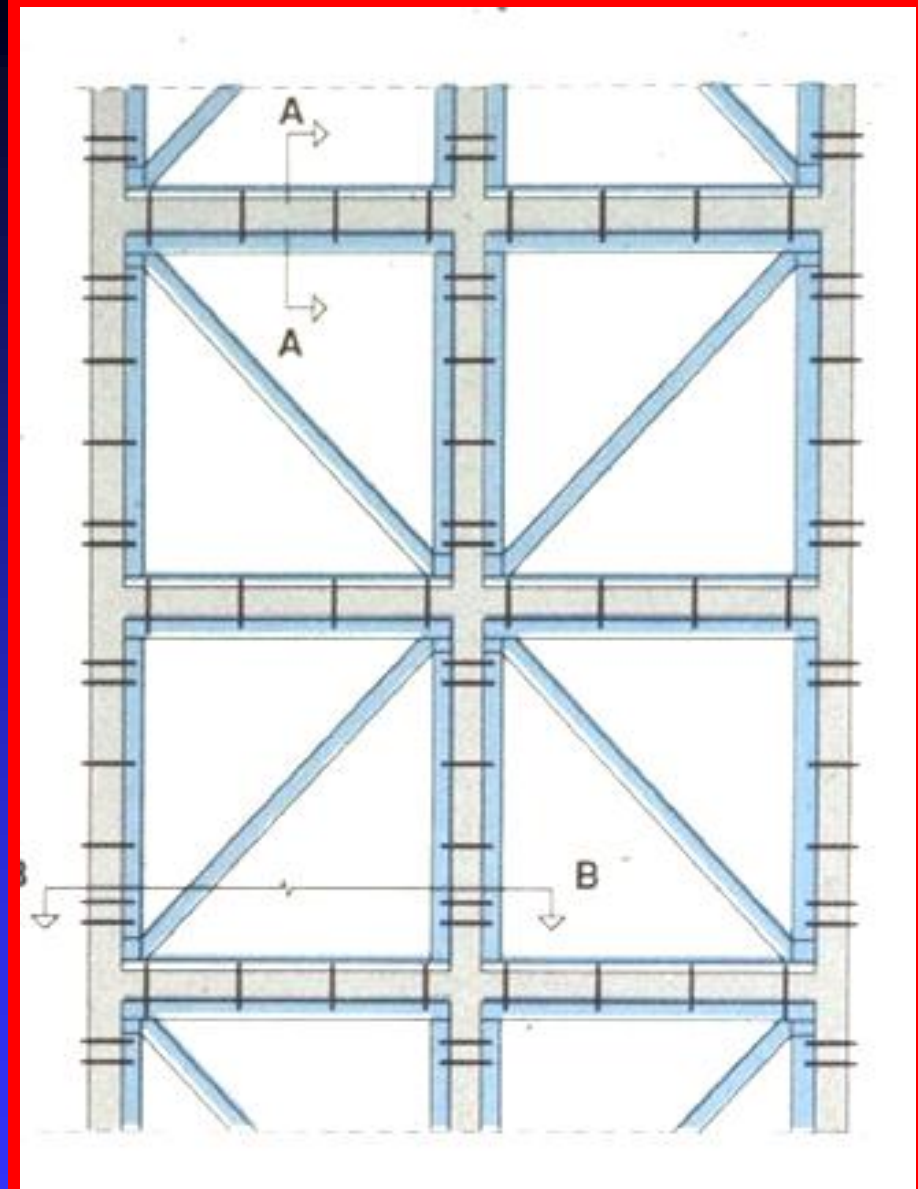
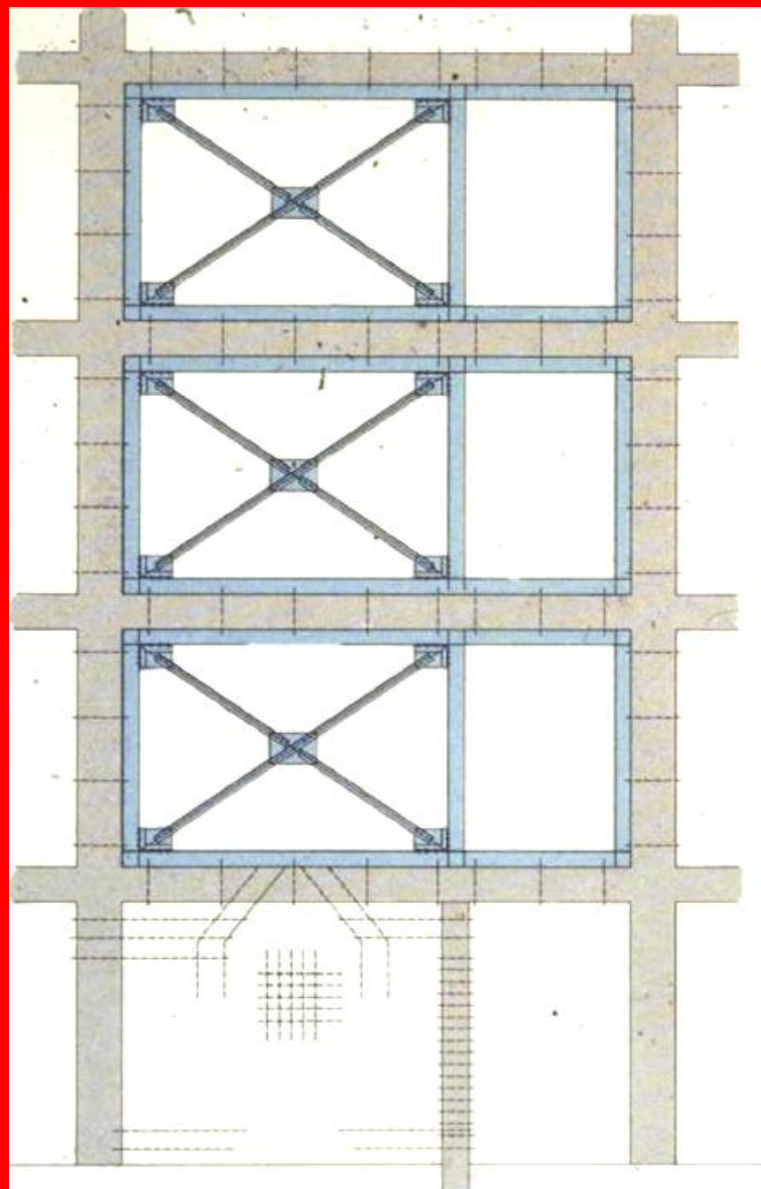
**Montemarano Church
(Avellino, Italy)**

Electrical power station (Hungary)



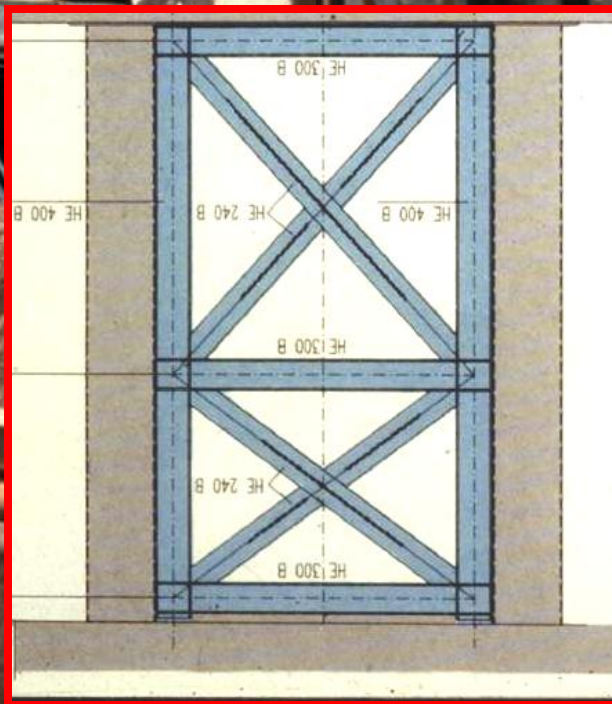
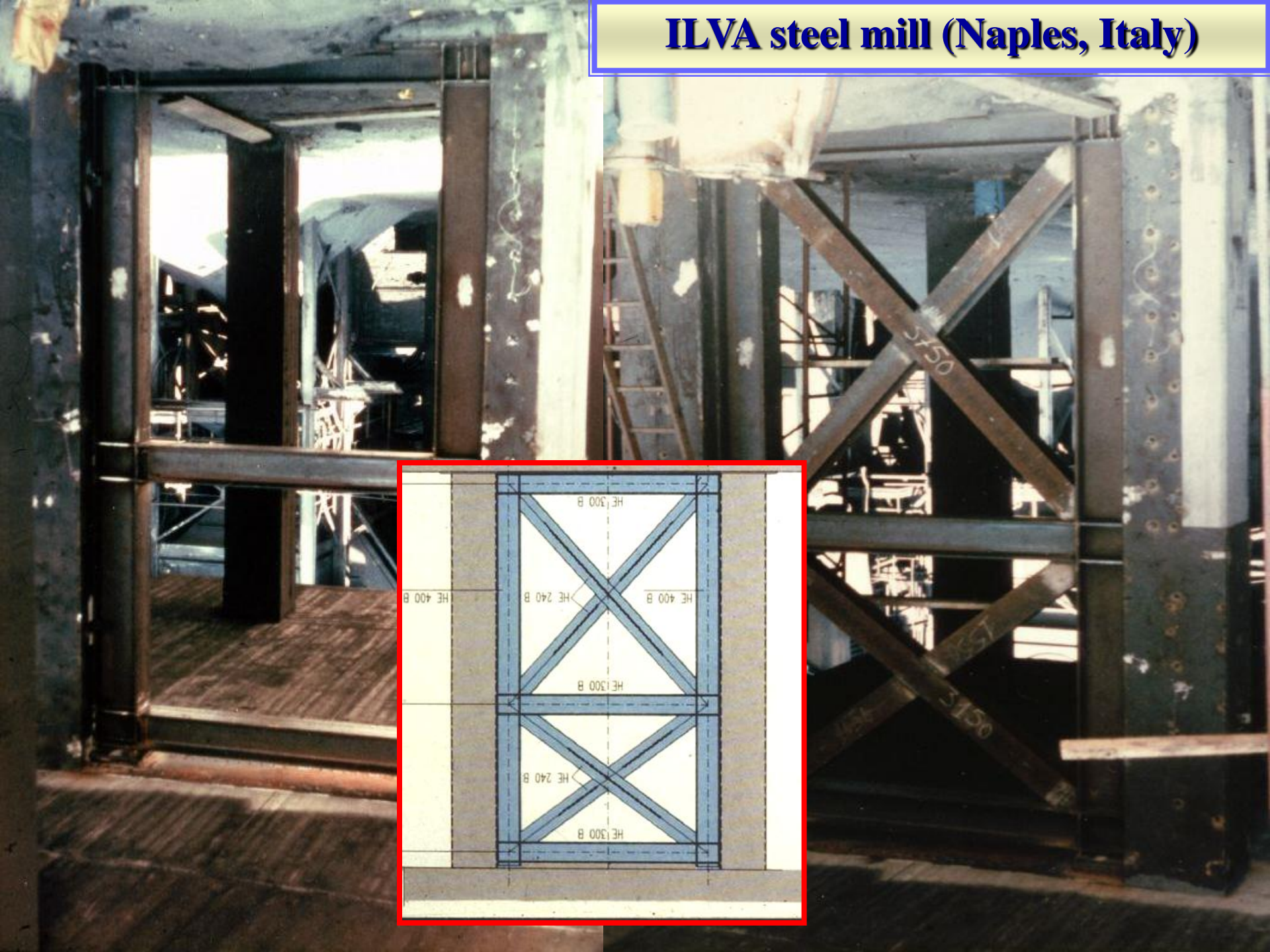
Bracing panels

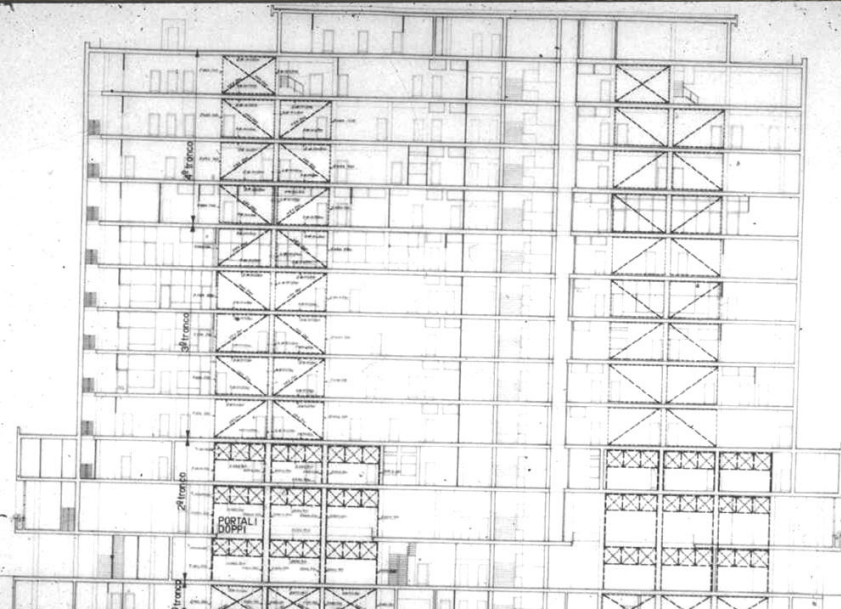
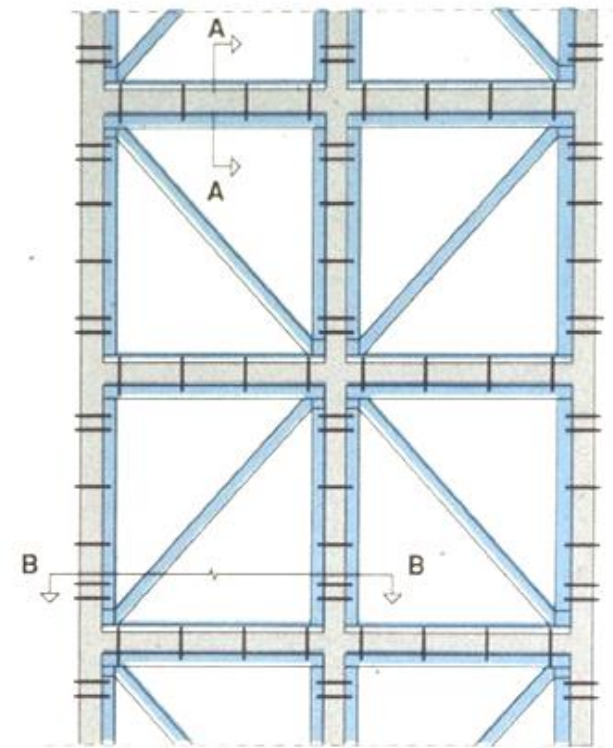




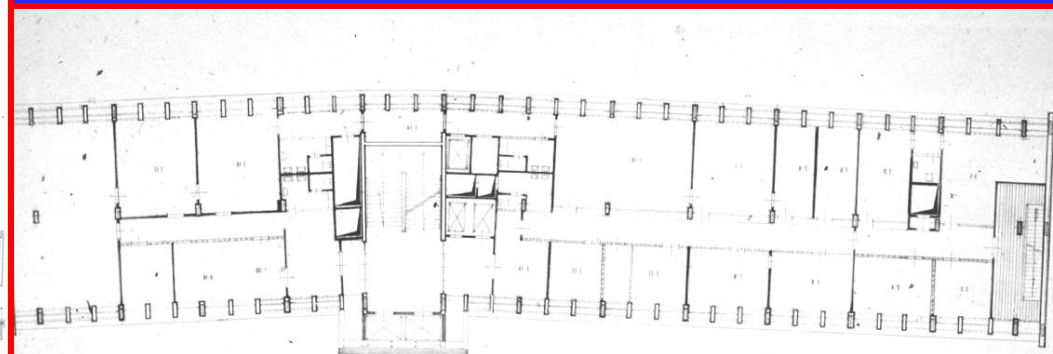
Steel bracing schemes

ILVA steel mill (Naples, Italy)



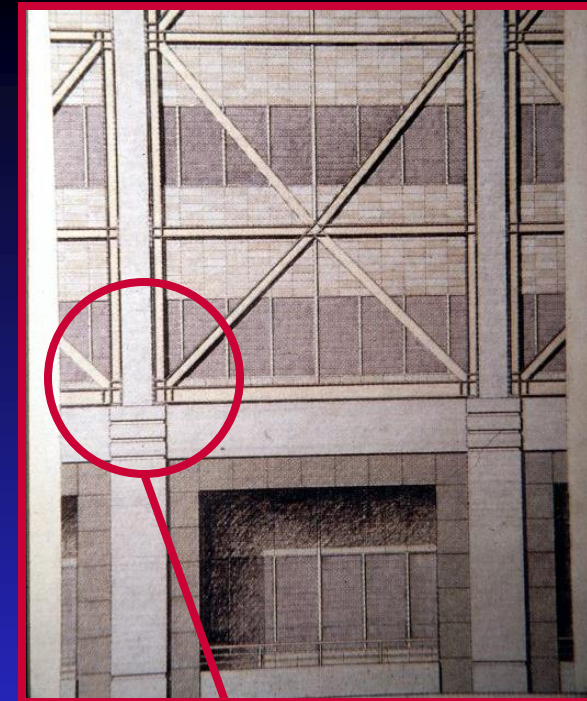


Engineering Faculty (Naples, Italy)

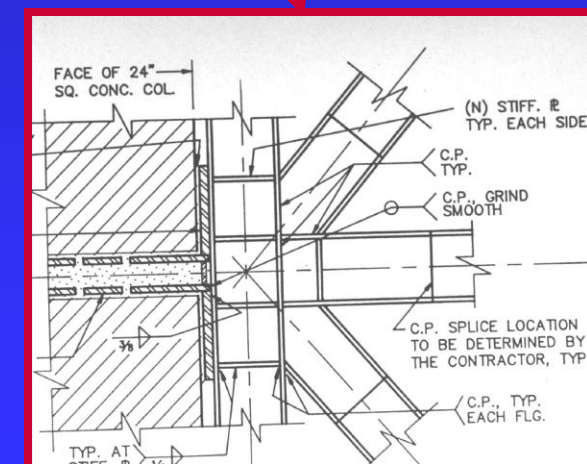


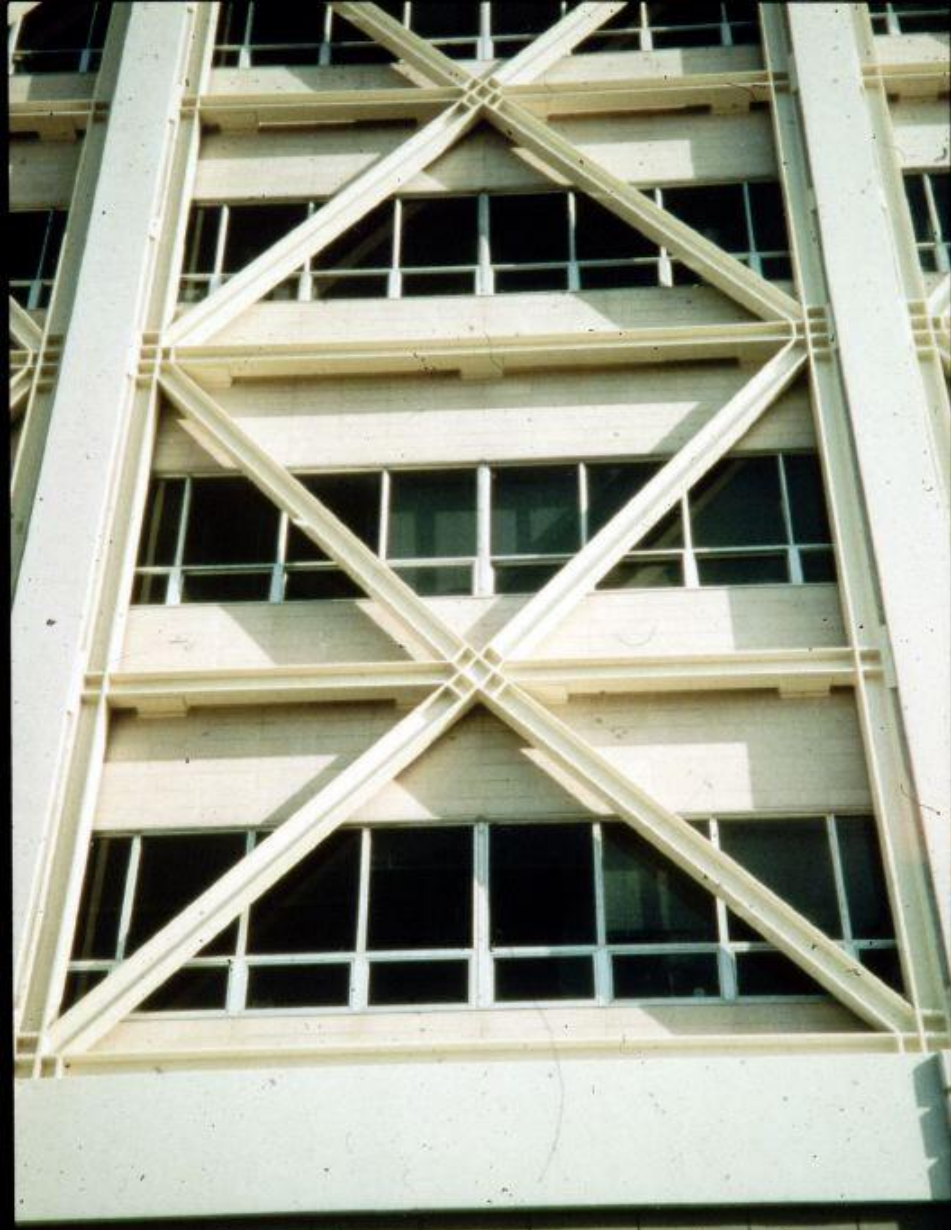
Mexico City





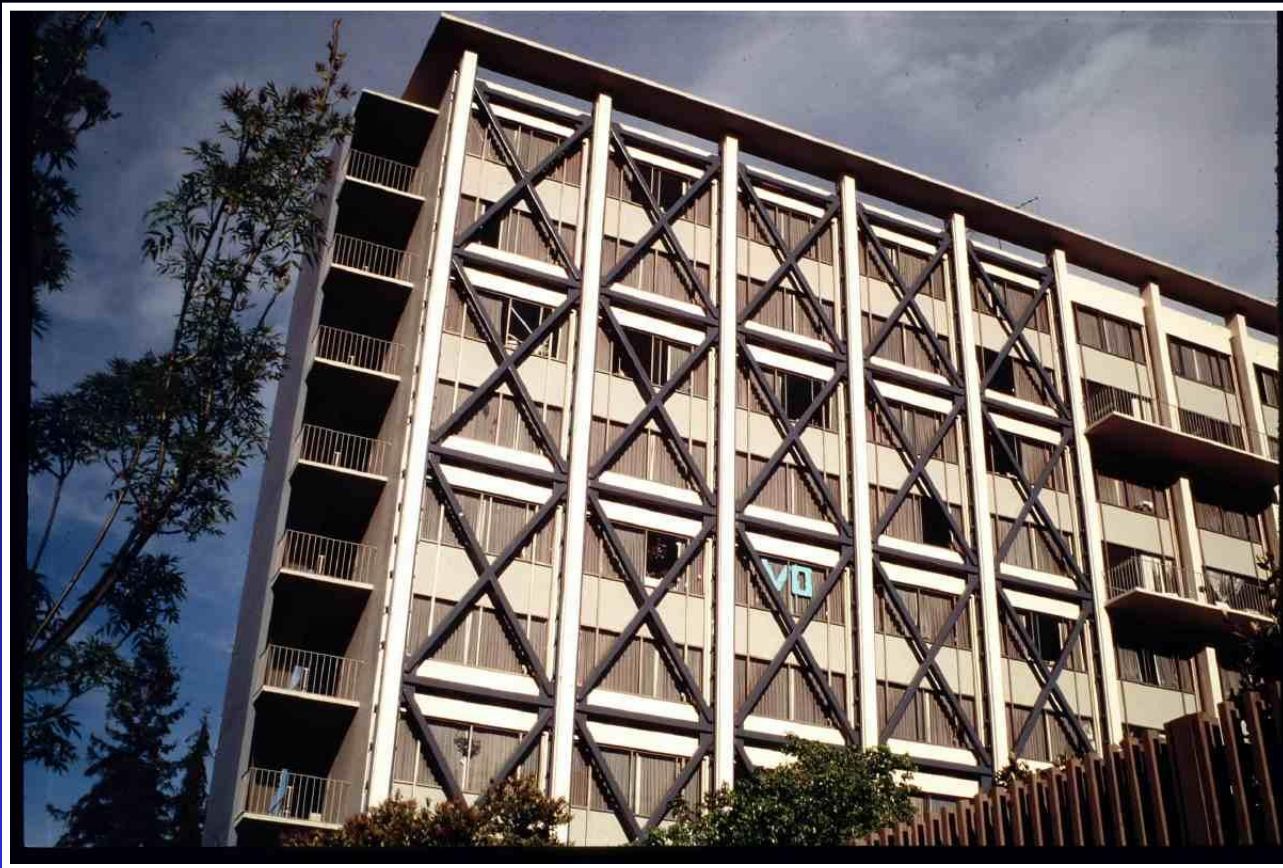
**University Hall
(Berkeley, California)**





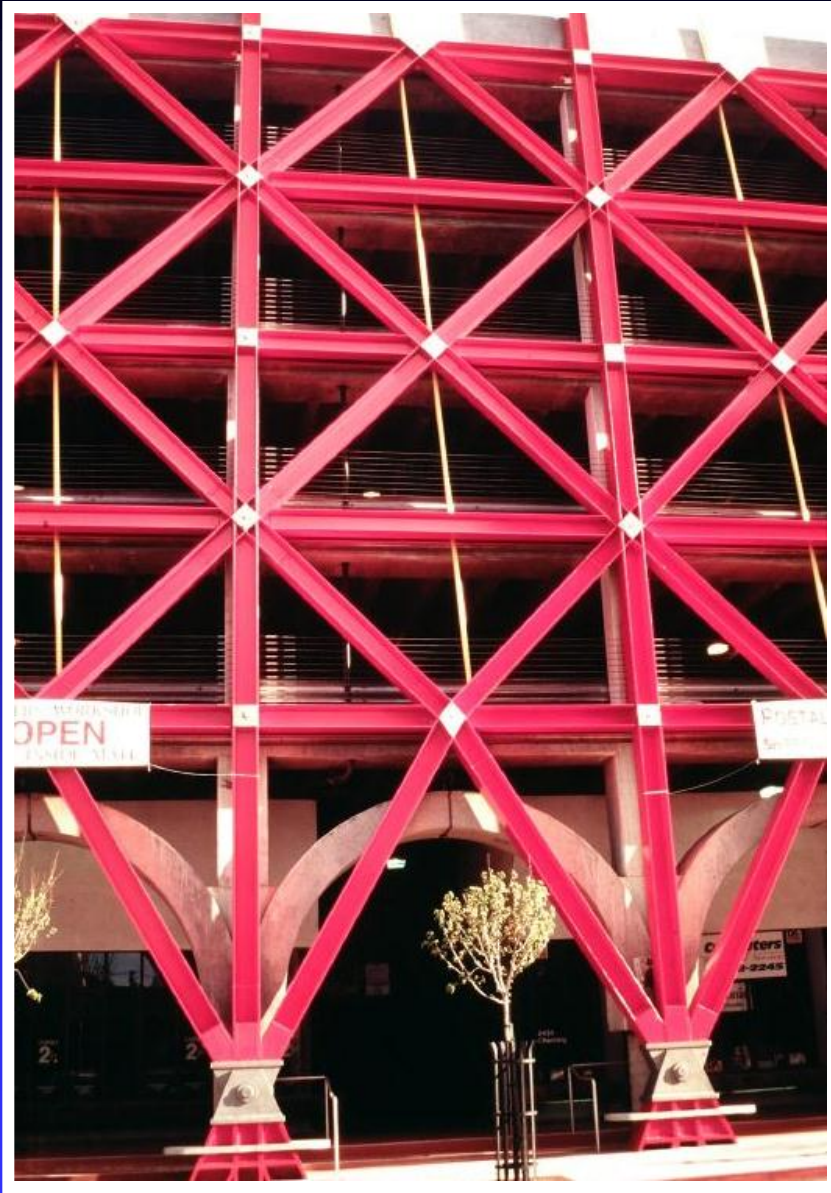
**University Hall
(Berkeley, California)**



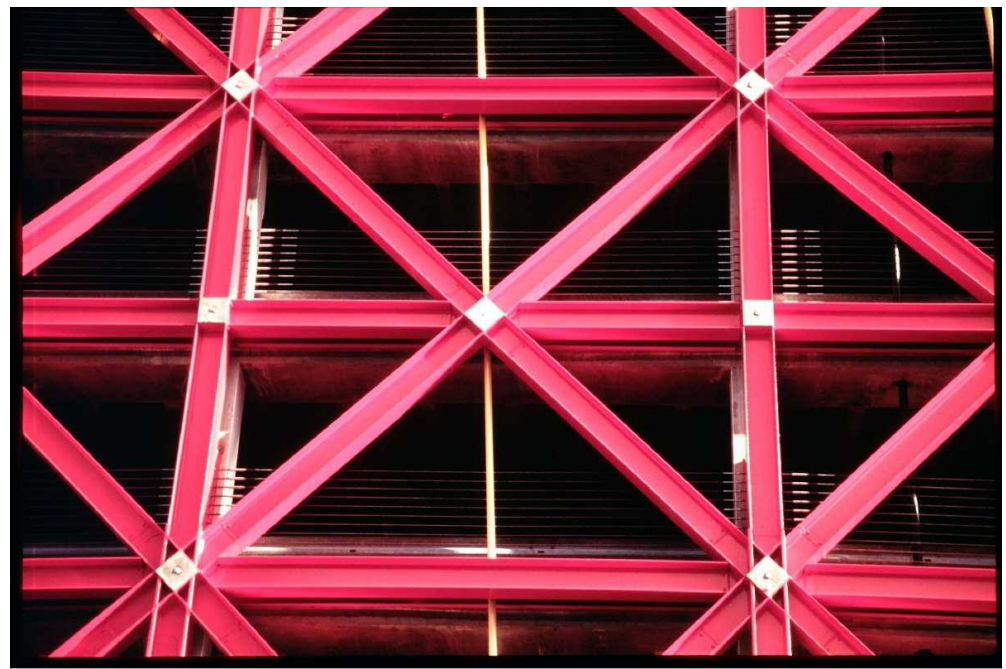


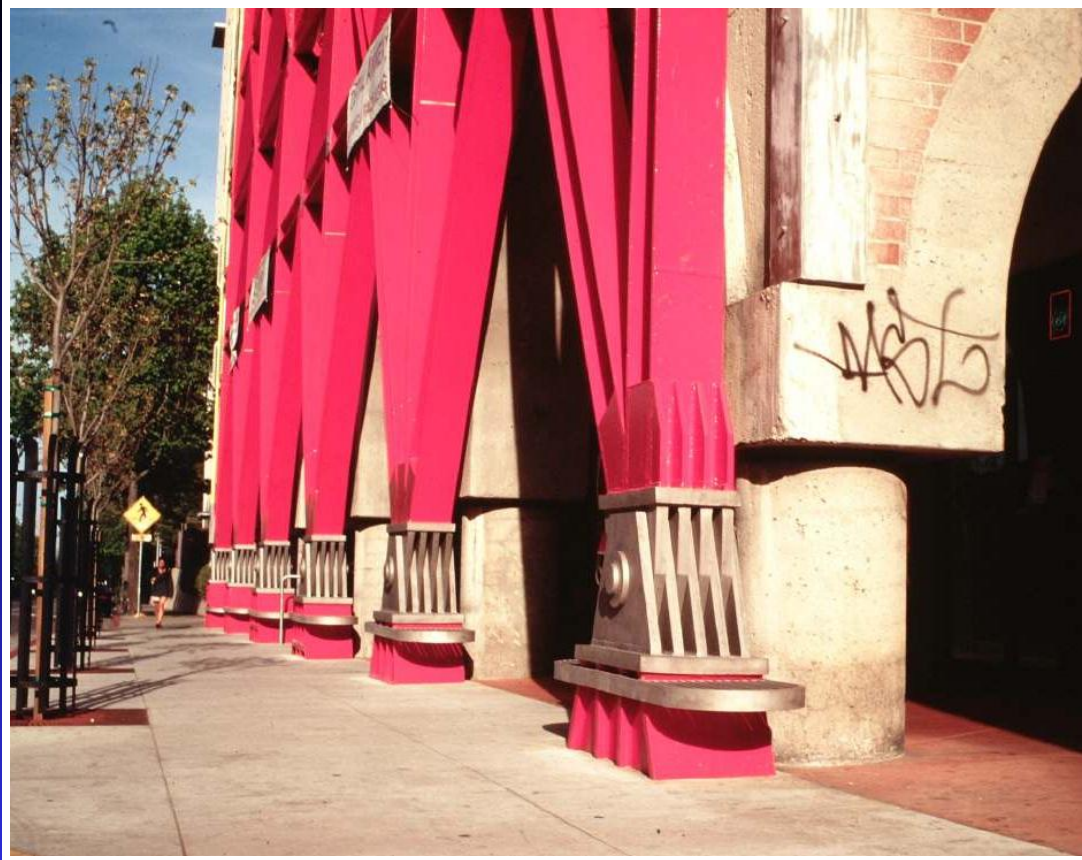
**Apartment building
(Berkeley, California)**



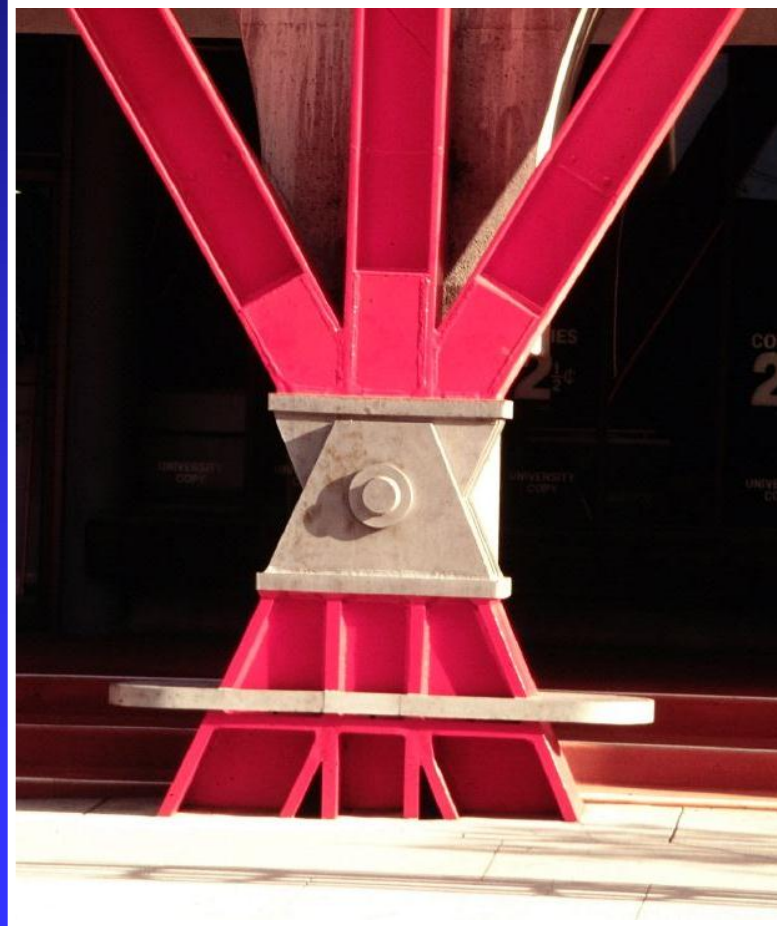


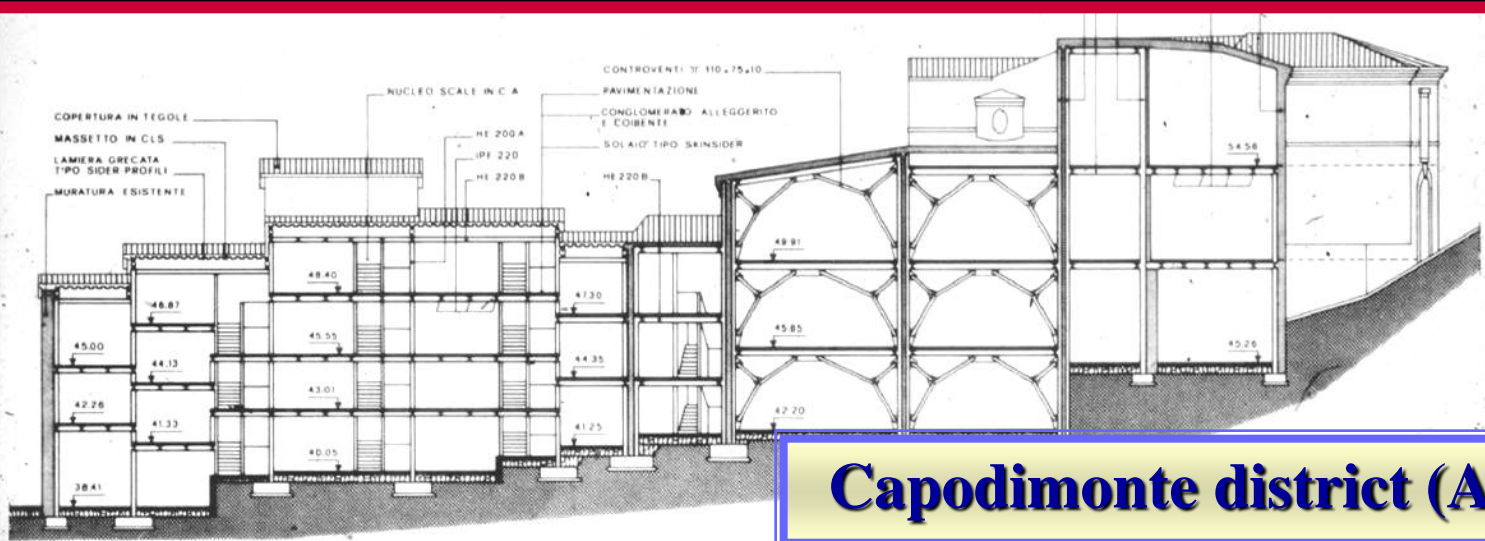
Autoshelos (Berkeley, California)



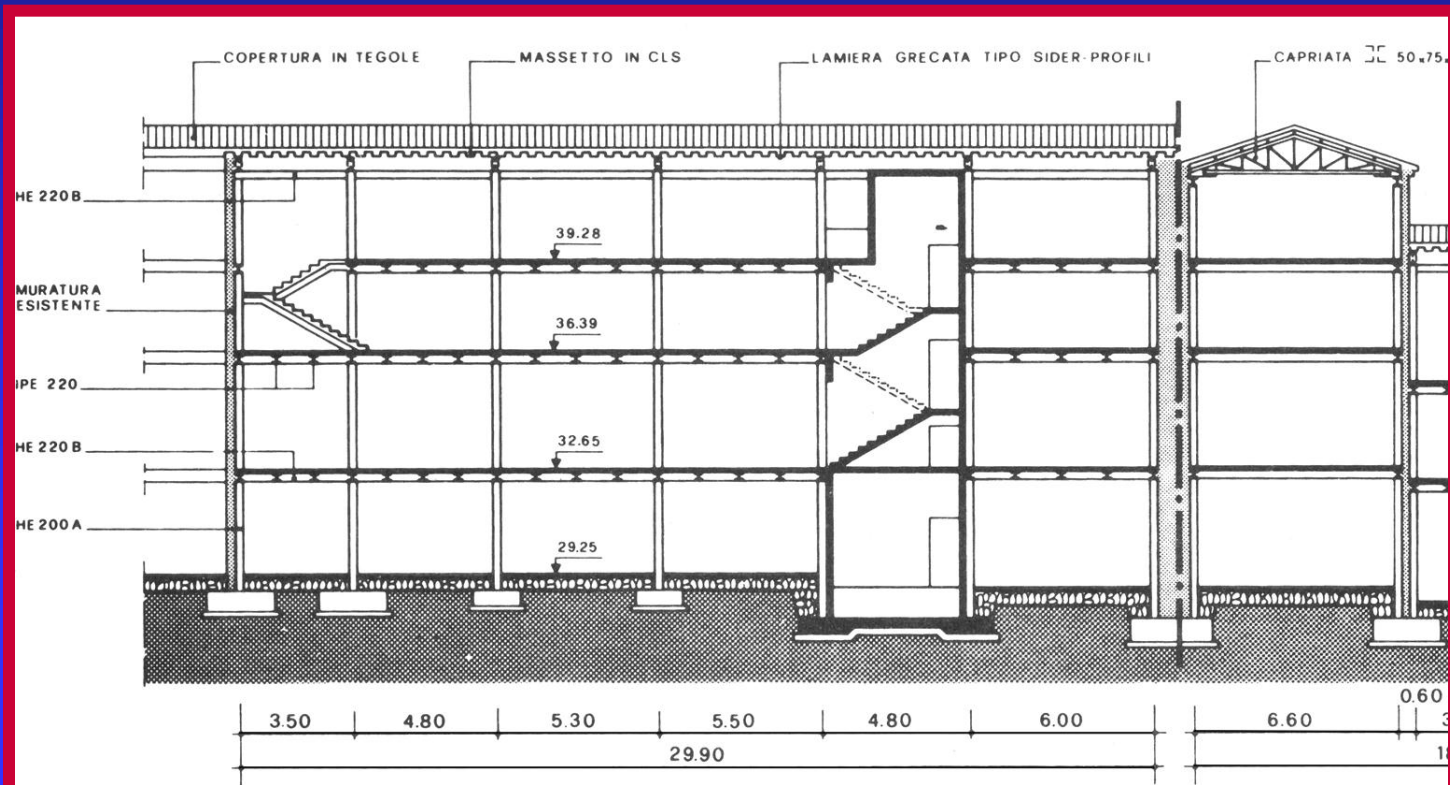


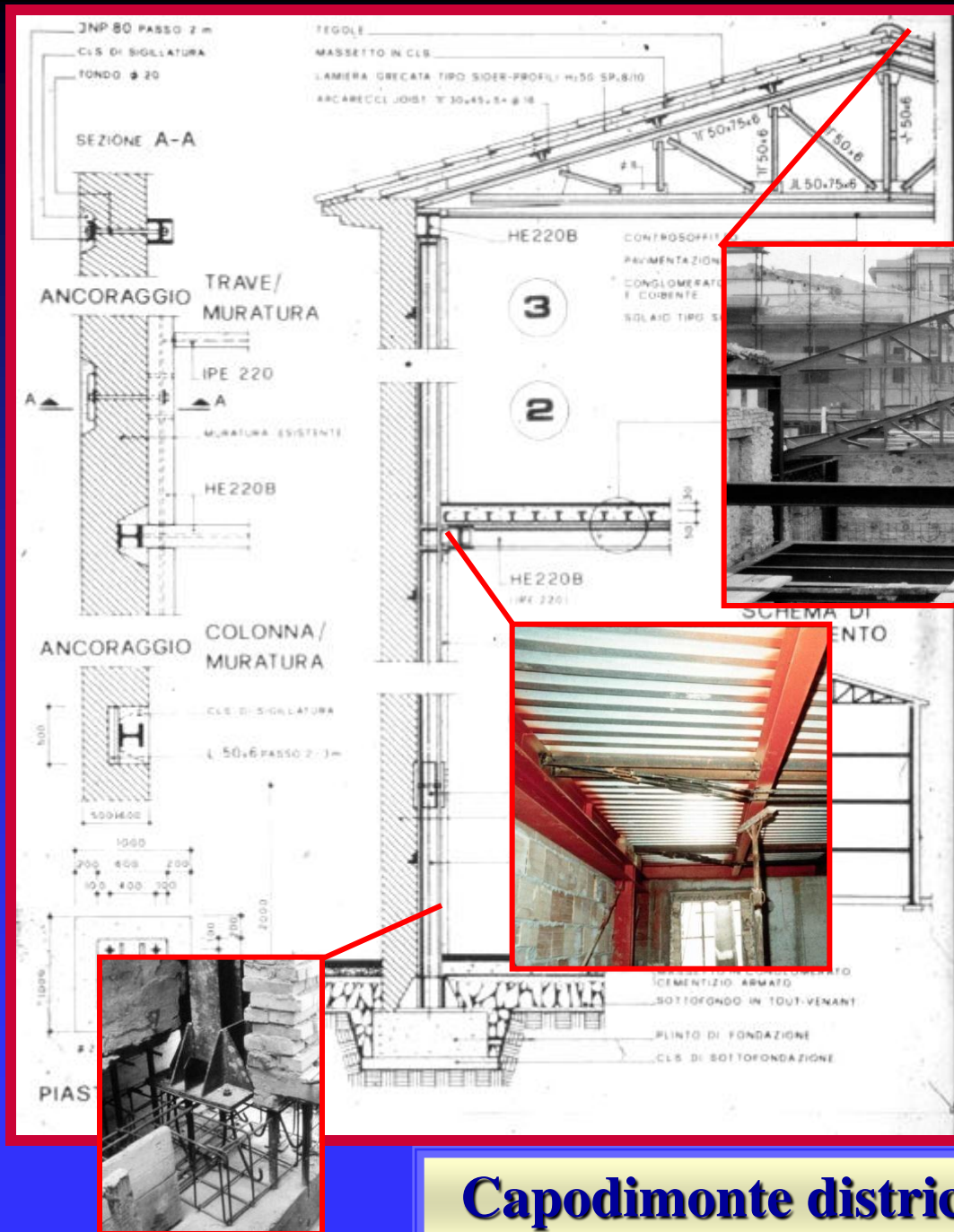
Autosylos (Berkeley, California)





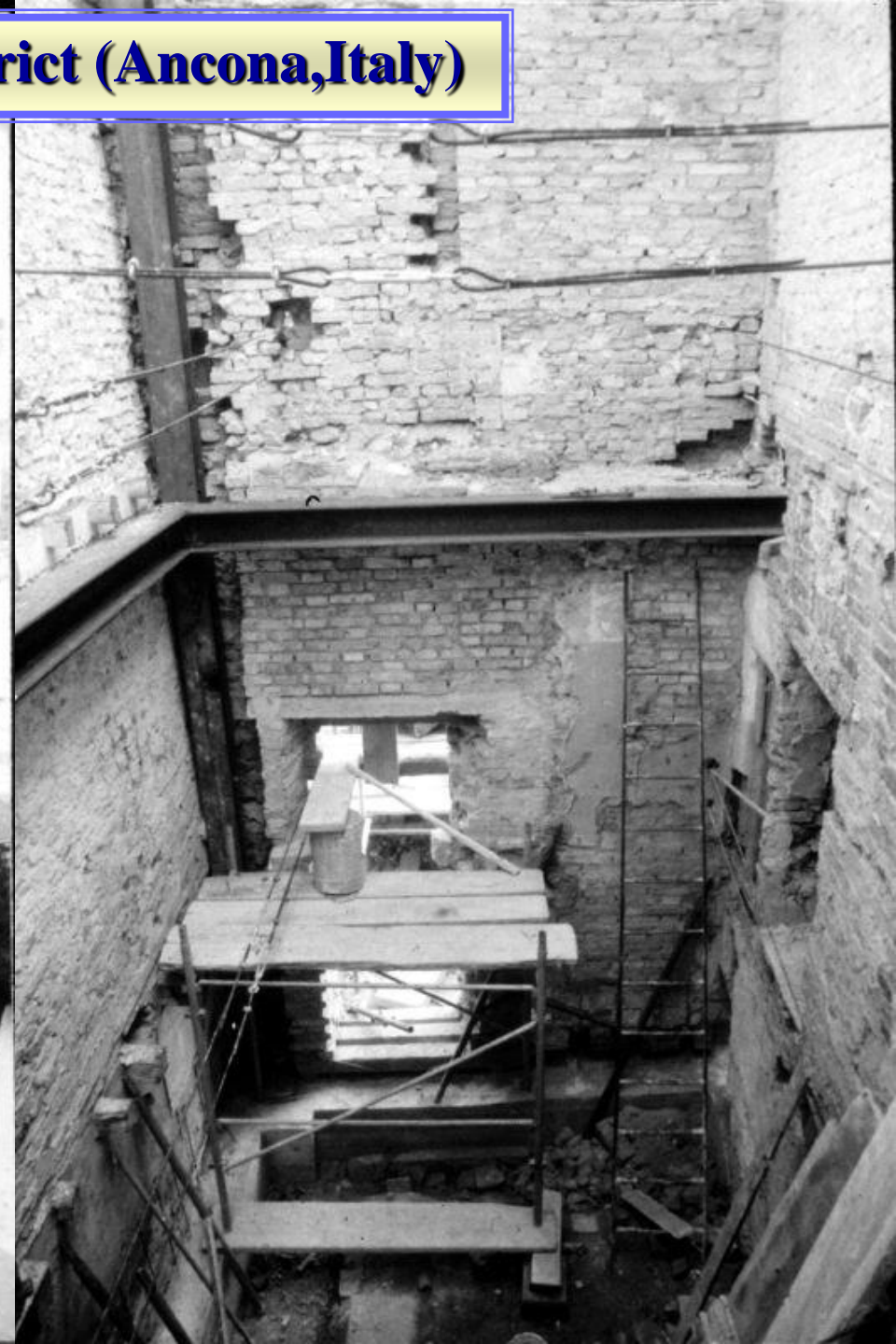
Capodimonte district (Ancona, Italy)





Capodimonte district (Ancona, Italy)

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Capodimonte district (Ancona, Italy)





Capodimonte district (Ancona, Italy)

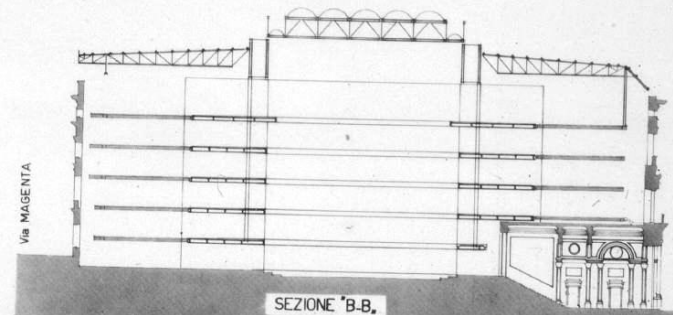
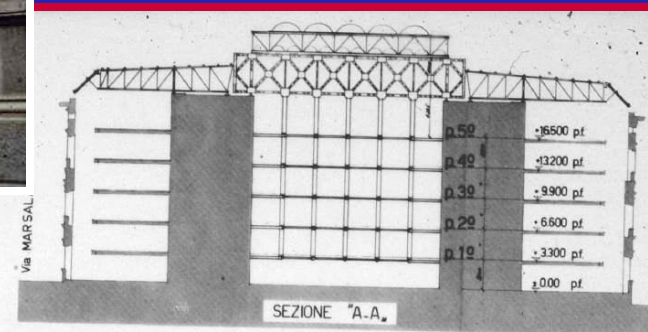
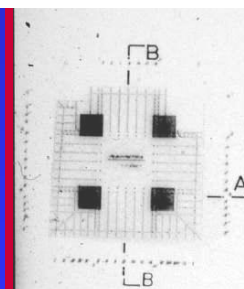
■ **Restructuring** = operation involving a drastic change of the original system due to the modification of the functional lay-out with new volumes and new areas



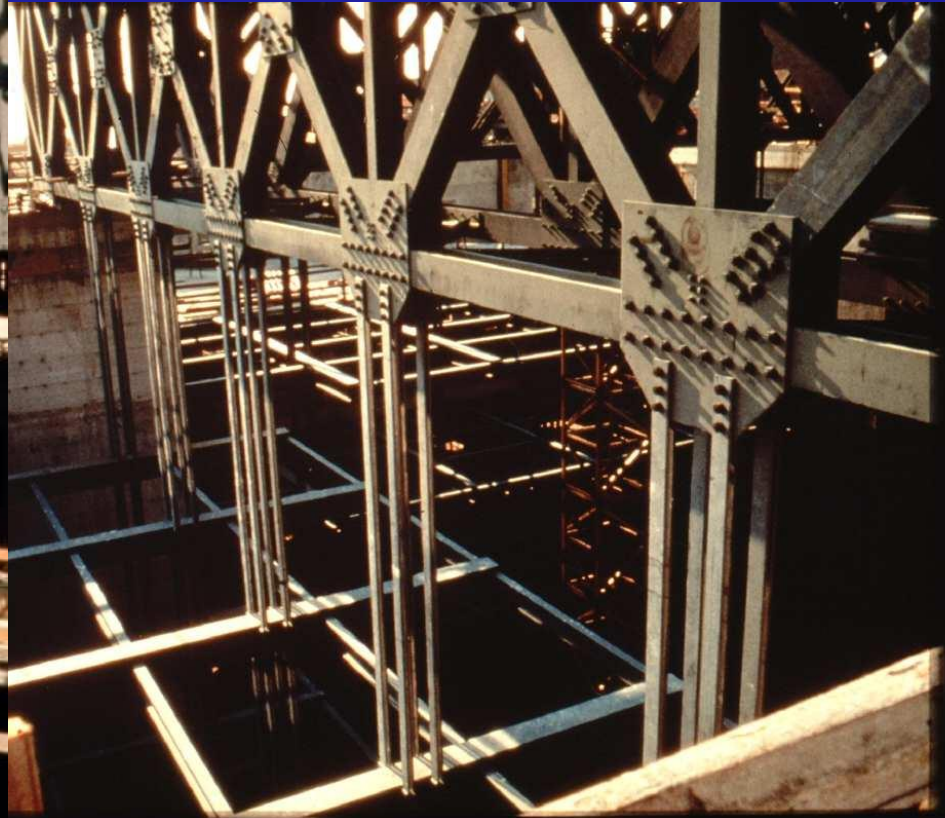
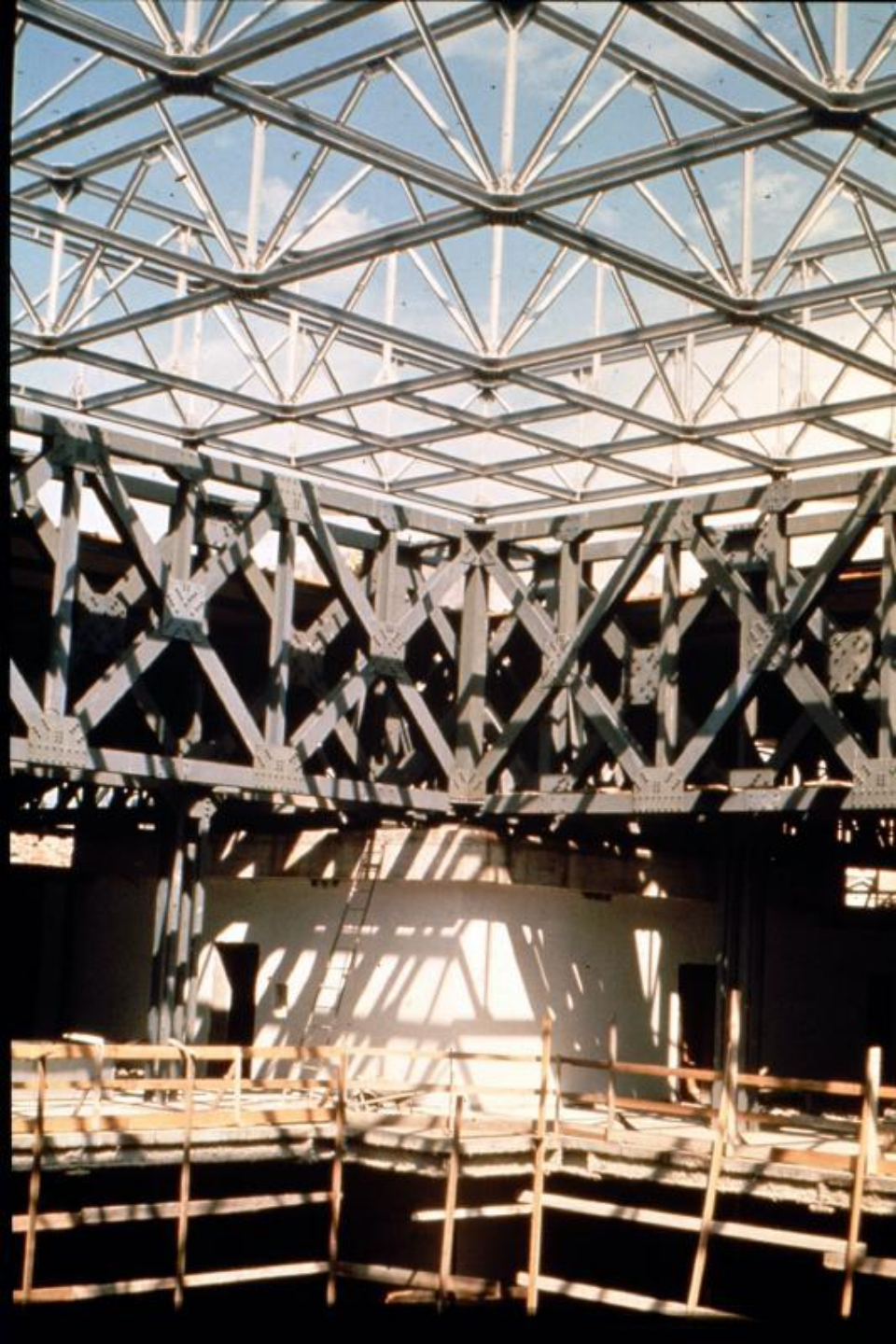
Law Court Palace of Ancona (I)

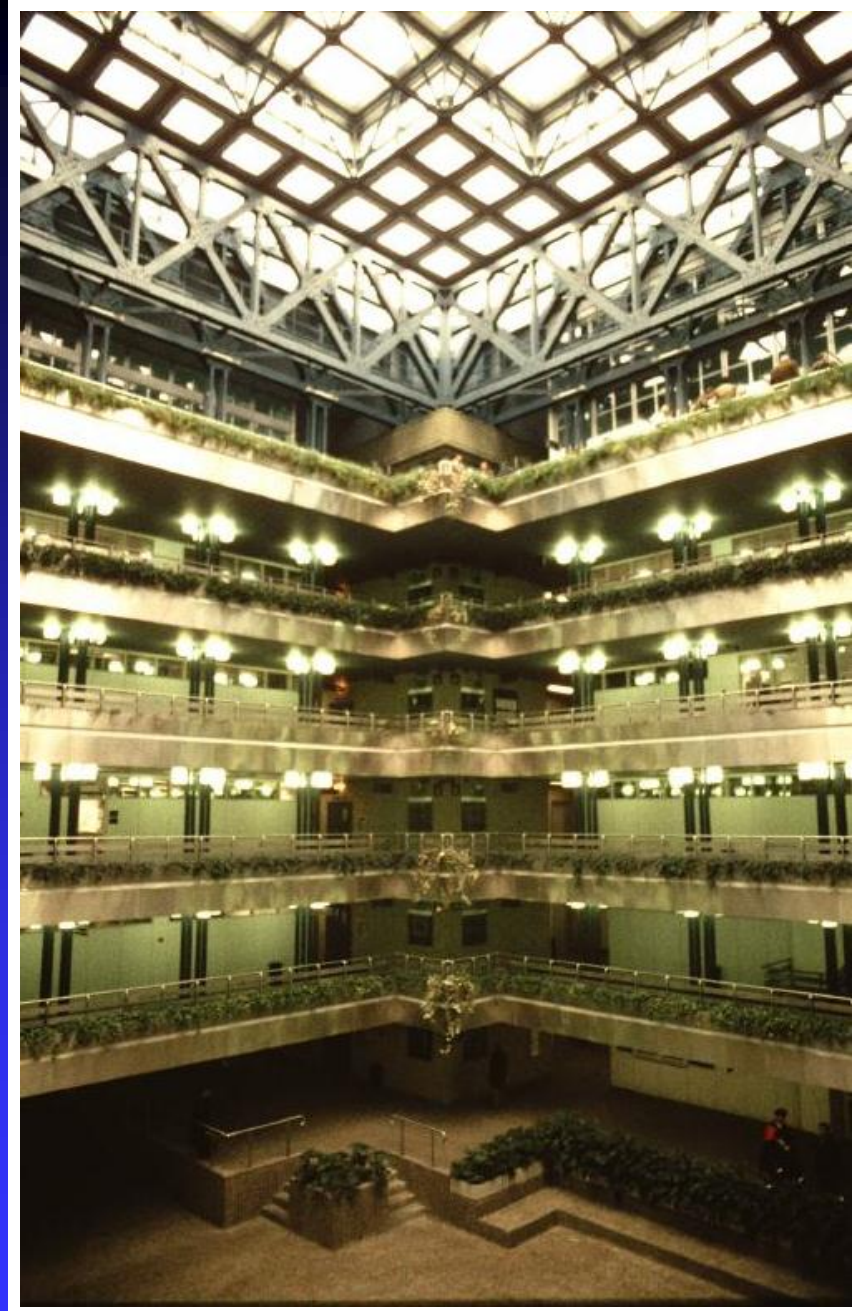


Law Court Palace of Ancona (I)

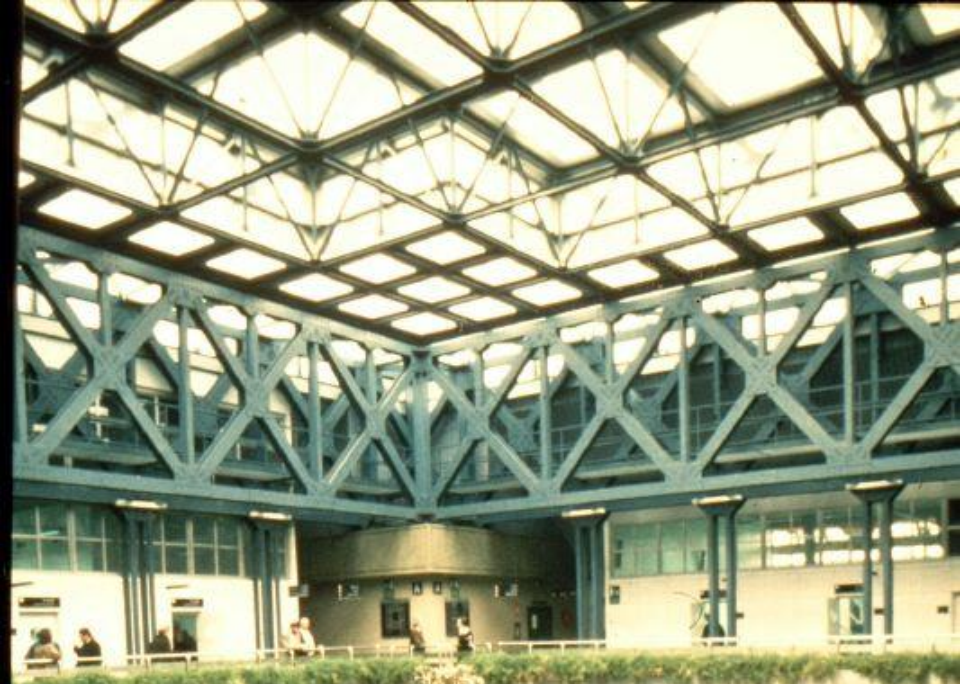


Law Court Palace of Ancona (I)





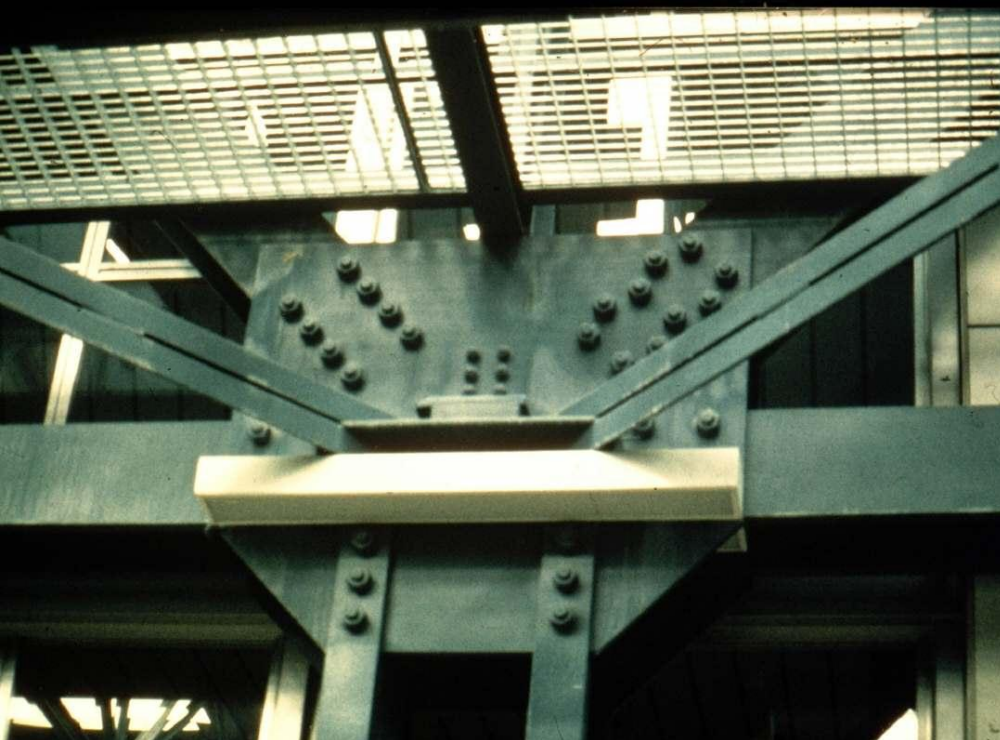
Law Court Palace of Ancona (I)



Law Court Palace of Ancona (I)



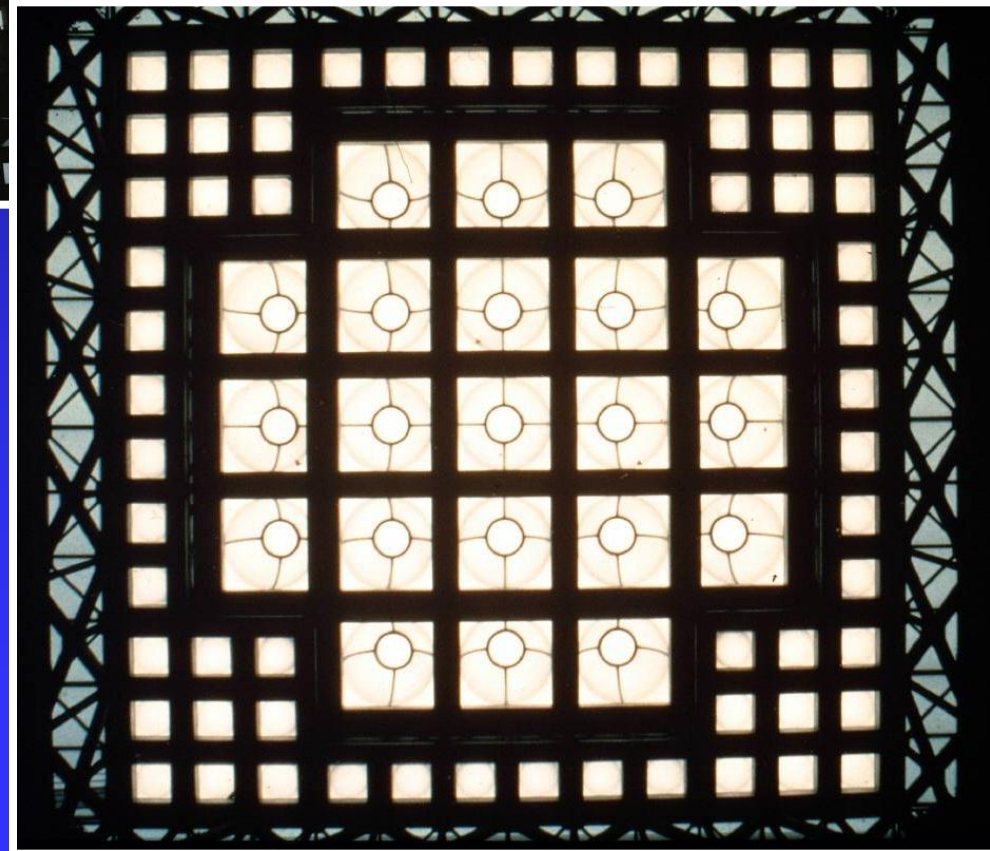
Law Court Palace of Ancona (I)



Law Court Palace of Ancona (I)



Law Court Palace of Ancona (I)



Law Court Palace of Ancona (I)





Law Court Palace of Ancona (I)



San Rocco Church in Morra de Sanctis (I)

San Rocco Church in Morra de Sanctis



MINISTERO PER I BENI CULTURALI E AMBIENTALI
SOPRINTENDENZA S.A.A.S. DI SALERNO E AVELLINO
OPERE a CARICO del PROV. alla D.D. PP. della CAMPANIA
LAVORI DI RICOSTRUZIONE DEL
SACRARIO DI S. ROCCO
D.P.M. N. 26123 DEL 15-10-86
PROGETTO: S.A.A.S. DI SALERNO
STRUTTURE: PROF. ING. F. MALLAMONE
DIR. LAVORI: OFF. TECNICA SOPRINTENDENZA S.A.A.S. - SA-SV
IMPRESA: S.L.E.S. - NAPOLI



The Sacrarium for the earthquake victims



**San Rocco Church
in Morra de Sanctis**

Matrix for mutual co-operation among materials

NEW COMPOSITE MATERIALS

		MATERIALS FOR CONSOLIDATION				
		STEEL	CONCRETE	MASONRY	WOOD	FRP
DAMAGED STRUCTURES	STEEL	★				★
	CONCRETE	★	★			★
	MASONRY	★	★	★	★	★
	WOOD	★			★	★

COMPETITION AMONG MATERIALS

