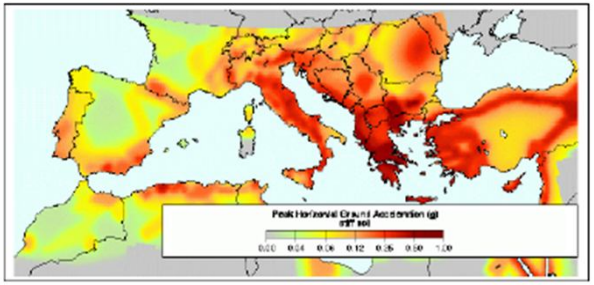
International Memorial Symposium
27 th of June 2012 Wednesday
at GRIPS

The importance of collaboration for complementary research in the field of earthquake engineering

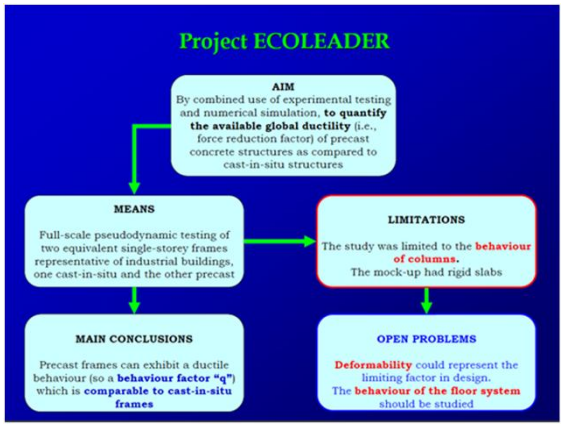
An example : SAFECAST project in Europe

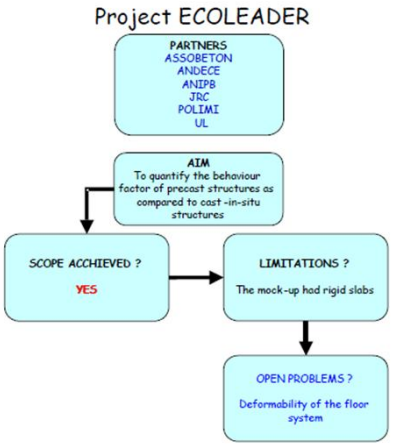
Faruk Karadogan

Seismically active Zones around the Mediteranian Sea

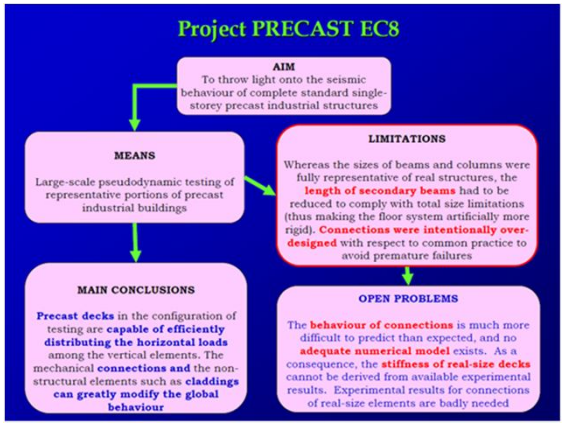


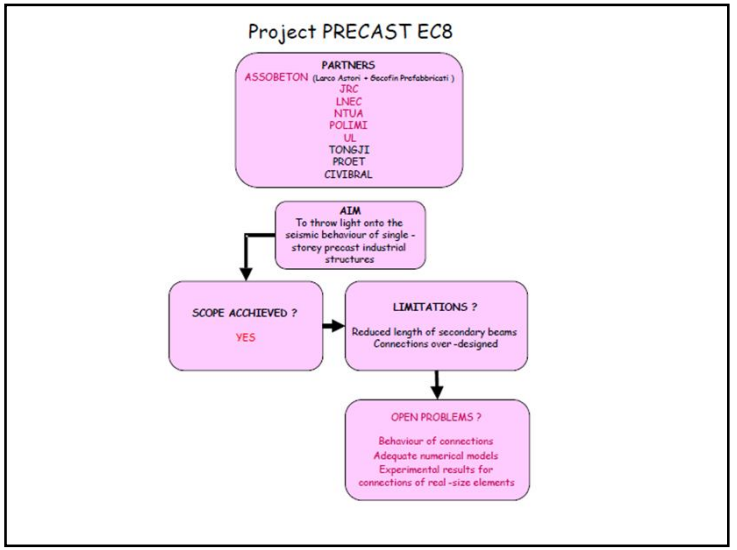
An earlier project ECOLEADER

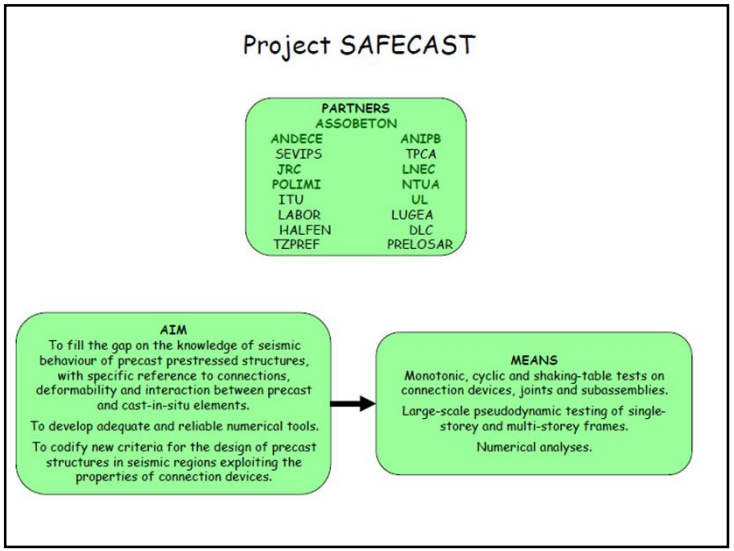




Another earlier project PRECAST EC8







PERFORMANCE OF INNOVATIVE MECHANICAL CONNECTIONS IN PRECAST BUILDING STRUCTURES UNDER SEISMIC CONDITIONS

- **Grant agreement no. 218417**
-
- **Research for SME associations**
-
- **Project start date: 1st March 2009 Duration: 36 months**
-
- **Coordinator: Dr. Antonella COLOMBO, ASSOBETON (AXB), Italy**
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Seismic performance of precast structures

SAFECAST – the Consortium

SME-AGs:	**ASSOBETON**, ANDECE, ANIPB, SEVIPS, TPCA
Role:	to fix priorities and needs
RTD-Performers:	JRC, POLIMI, NTUA, ITU, LNEC, UL, LABOR
Role:	to carry out research
Others:	DLC, PRELOSAR, LUGEA, HALFEN
Role:	to guarantee constant feedback on the results and their applicability

Beneficiary name	Beneficiary short name	Country
(coordinator) ASSOBETON - National Italian Association of Precast Concrete Producers AXB	**ITALY**	Italy
Asociación Nacional de Prefabricados y Derivados del Cemento	**ANDECE**	Spain
National Portuguese Association of Precast Concrete Producers	**ANIPB**	Portugal
SEVIPS - Greek National association of precast concreteproducers	**SEVIPS**	Greece
Turkish Precast Concrete Association	**TPCA**	Turkey
Joint Research Centre – Elsa Laboratory	**JRC**	Belgium
Politecnico di Milano	**POLIMI**	Italy
National Technical University of Athens	**NTUA**	Greece
Istanbul Technical University	**ITU**	Turkey
Laboratorio Nacional de	**LNEC**	Portugal
University of Ljubljana	**UL**	Slovenia
Labor srl	**LABOR**	Italy
DLC srl	**DLC**	Italy
Truzzi Prefabbricati	**TZPREF**	Italy
PRELOSAR SL – Losas Riojanas SL	**PRELOSAR**	Spain
LU.GE.A Progetti Costruzione Gestione Spa	**LUGEA**	Italy
HALFEN GmbH	**HALFEN**	Germany

Project PRECAST EC8

AIM
To throw light onto the seismic behaviour of complete standard single-storey precast industrial structures

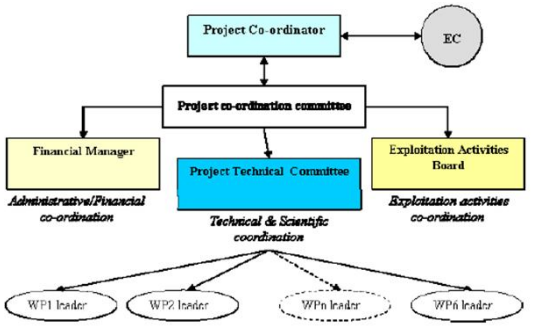
MEANS
Large-scale pseudodynamic testing of representative portions of precast industrial buildings

MAIN CONCLUSIONS
Precast decks in the configuration of testing are capable of efficiently distributing the horizontal loads among the vertical elements. The mechanical connections and the nonstructural elements such as claddings can greatly modify the global behaviour

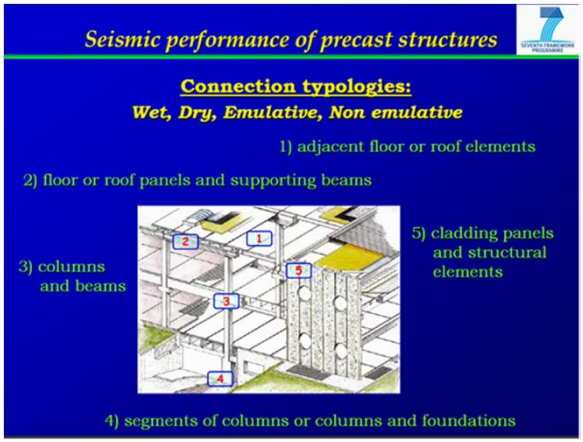
LIMITATIONS
Whereas the sizes of beams and columns were fully representative of real structures, the length of secondary beams had to be reduced to comply with total size limitations (thus making the floor system artificially more rigid). Connections were intentionally over-designed with respect to common practice to avoid premature failures

OPEN PROBLEMS
The behaviour of connections is m uch more difficult to predict than expected, and no adequate numerical model exists. As a consequence, the stiffness of realsize decks cannot be derived from available experimental results. Experimental results for connections of real-size elements are badly needed

Work package No	Work package title	Type of activity
WP 1	Literature survey and identification of needs	RTD
WP 2	Experimental activity on new and existing connections	RTD
WP 3	Development of analytical models	RTD
WP 4	Experimental assessment on real structures	RTD
WP 5	Numerical model validation	RTD
WP 6	Derivation of design rules	RTD
WP 7	Training and dissemination	OTH
WP 8	Management	MNGT

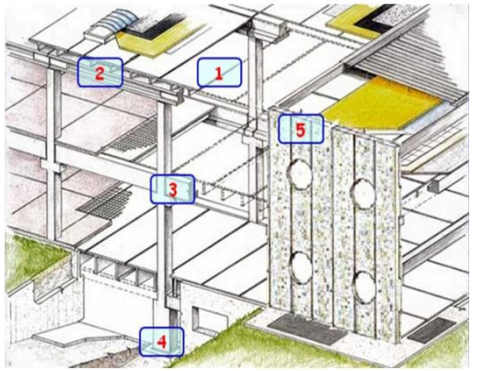


More about SAFECAST



Connections

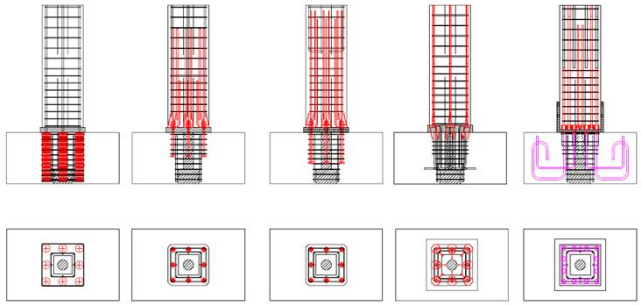
1. **Floor - Floor**
2. **Floor - Beam**
3. **Beam - Column**
4. **Column - Foundation**
5. **Cladding - Frame**
6. Cladding - Cladding
7. Cladding - Foundation



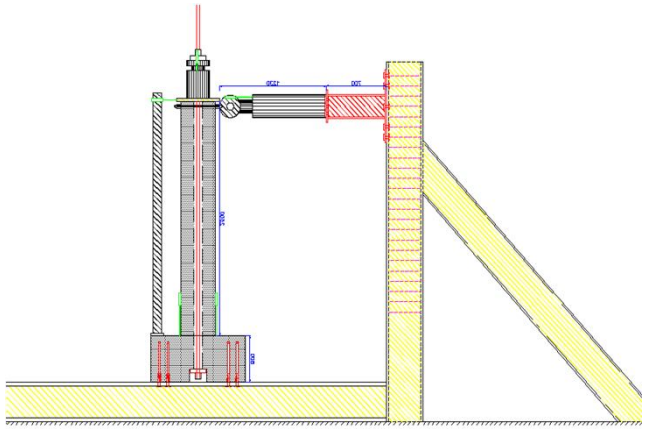
Column to Foundation Connections
POLIMU

- Pocket Foundation
- Protruding bars
  - Separated protruding bars
- Bolted Sockets
  - Weakened Bolted Sockets
  - Inverted Bolted Sockets
- Bolted Flanges
- Couplers

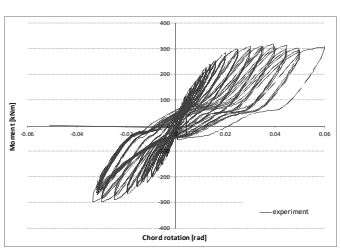
POLIMU

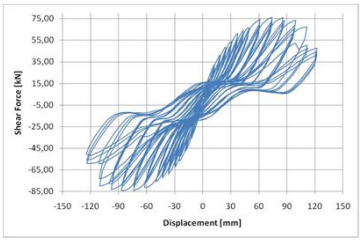


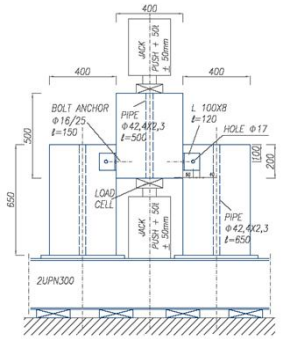
Testing Setup for column to foundation connections

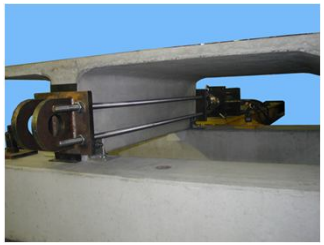


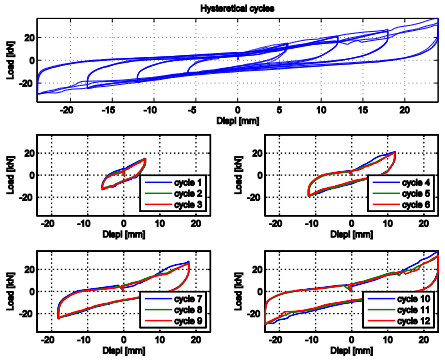
Typical Load – Deflection Curves









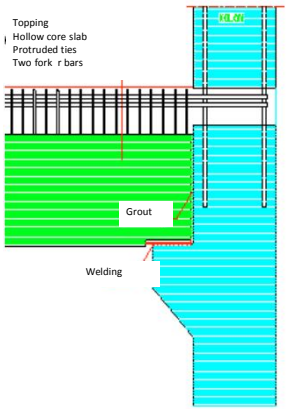


Contributions
of
Istanbul Technical University

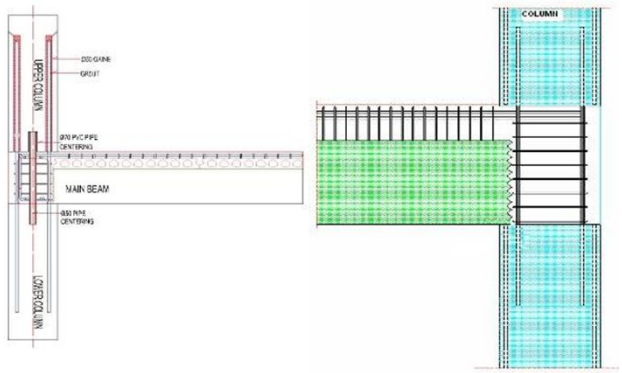
Tests on Hybrid Connections

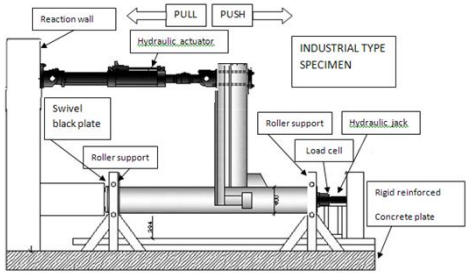
Structural Analyses & Design

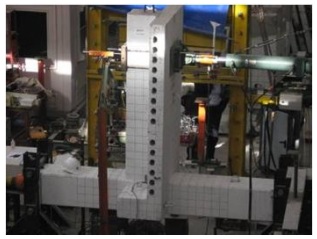
Industrial Type
Beam to column connections

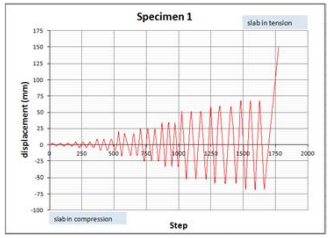


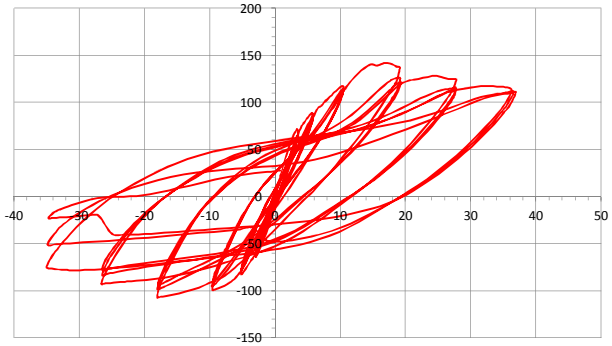
Residential Type
Beam to column to column onnections

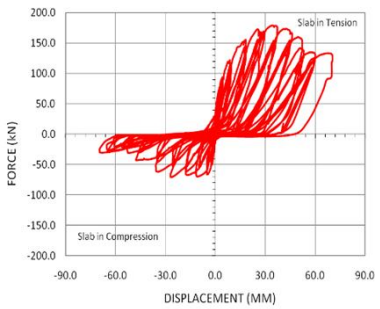


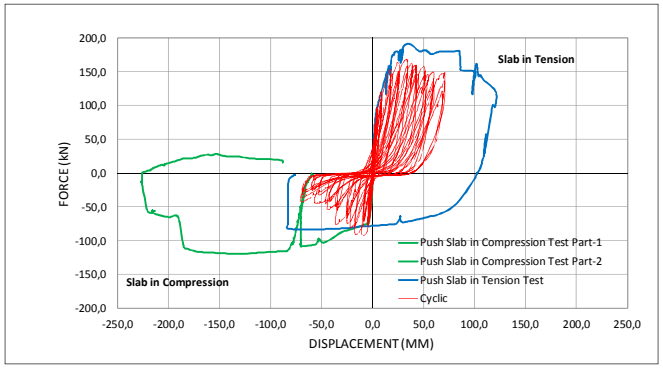





Specimen 1
slab in tension
displacement (mm)
slab in compression
Step


200
150
100
50
0
-50
-100
-150
-40
-30
-20
-10
0
10
20
30
40
50


Slab in Tension
Slab in Compression
FORCE (kN)
DISPLACEMENT (MM)


Slab in Tension
Slab in Compression
FORCE (kN)
DISPLACEMENT (MM)
Push Slab in Compression Test Part-1
Push Slab in Compression Test Part-2
Push Slab in Tension Test
Cyclic

The observed general characteristics of beam to column connections

They are not symmetric

Strength degradation

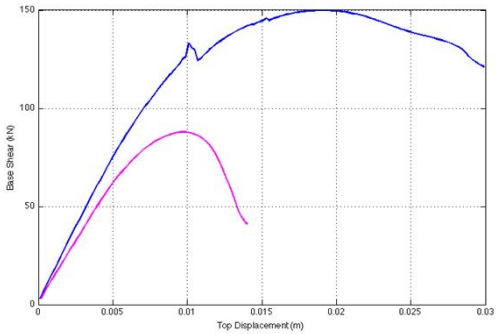
Stiffness degradation

Heavy pinching for Residential Types

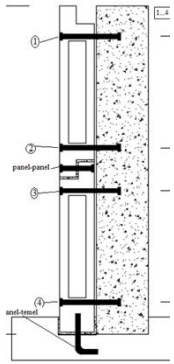
Important differences between Monotonic and Cyclic

P-D Diagrams

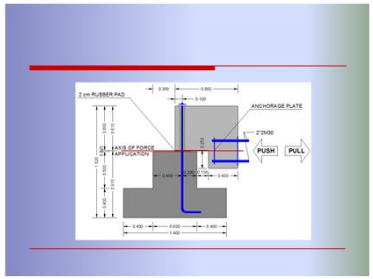
Two push over curves for a structure with asymettric connections. Which direction the structure should be pushed?

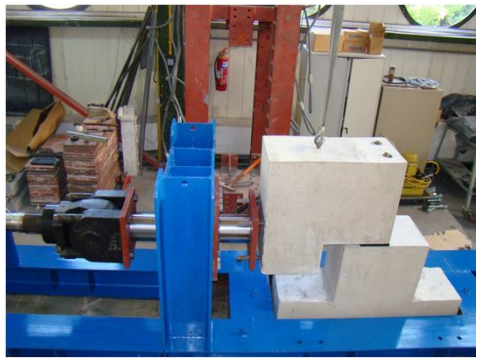


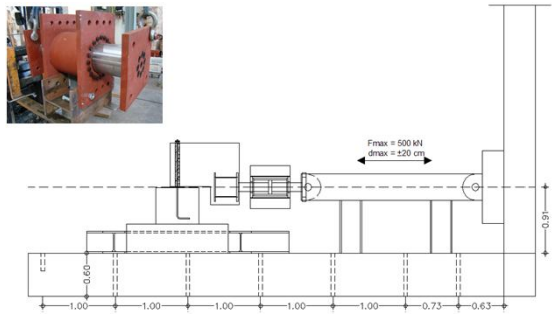
Dowel Connections
NTUA - UL

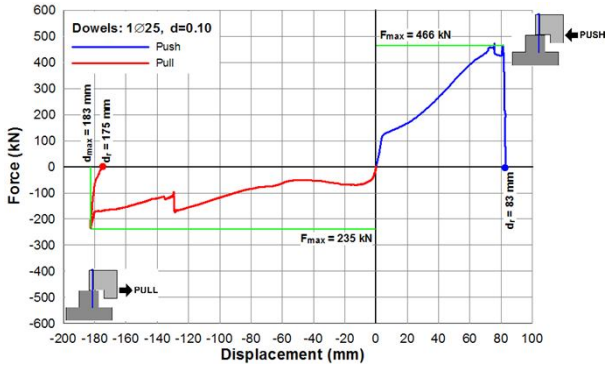


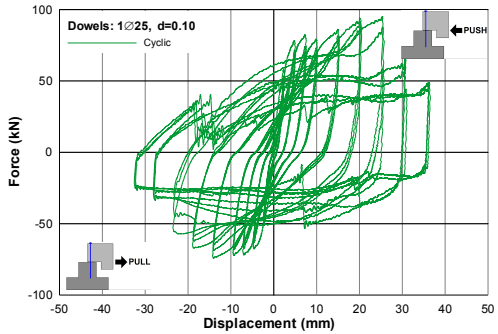
NTUA



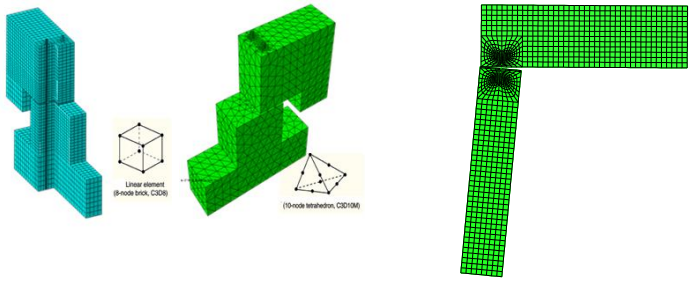


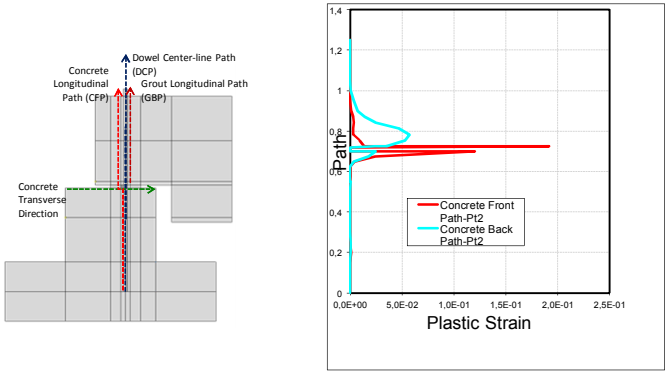

Fmax = 500 kN
dmax = ±20 cm
0.91
0.60
1.00
1.00
1.00
1.00
1.00
0.73
0.63


Dowels: 1∅25, d=0.10
Push
Pull
Fmax = 466 kN
Fmax = 235 kN
dmax = 183 mm
df = 175 mm
df = 83 mm
PUSH
PULL
Force (kN)
Displacement (mm)

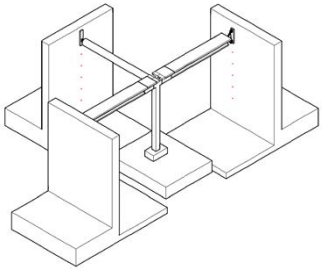

Dowels: 1∅25, d=0.10
Cyclic
PUSH
PULL
Force (kN)
Displacement (mm)

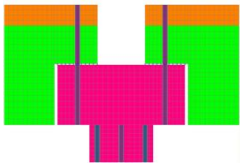
Finite Element Analyses



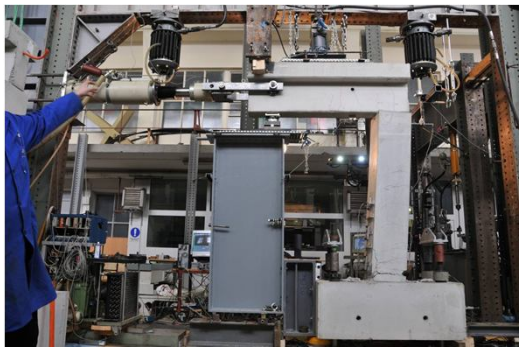


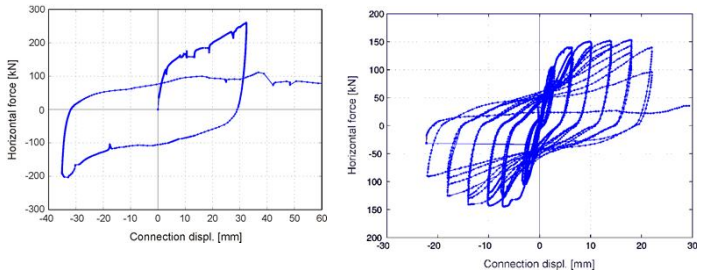
Tests on beam–to–column connections
Contribution of LNEC





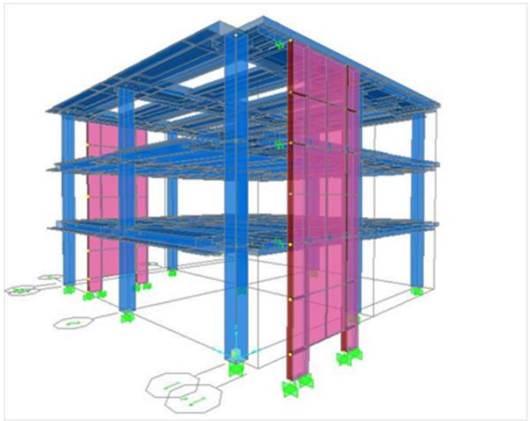
Tests on beam–to–column connections
Contribution of UL

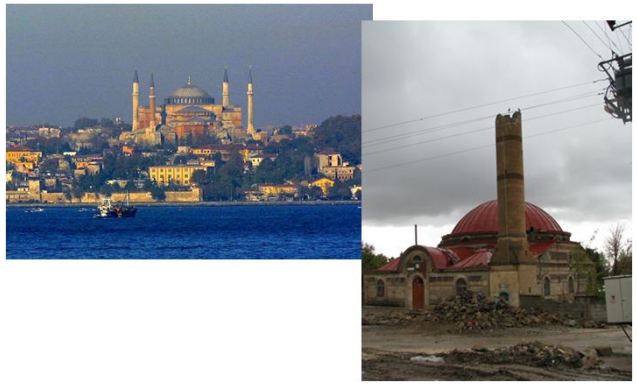




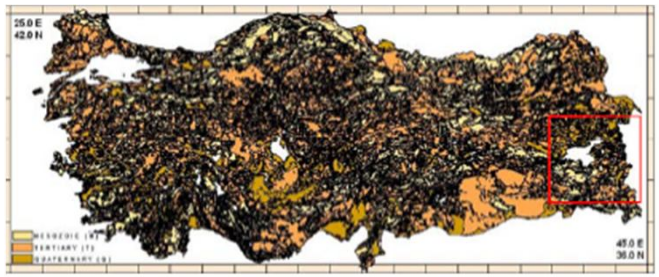
Shaking table tests
Contribution of NTUA

ELSA Contribution





An IPRED Collaboration - Van Mission in Turkey



Conclusions

- Reginal cooperations should have priorities and have to be encouraged
- Budget of the cooperative works should be increased
- Local administrative bodies and the people should be a part of the problems to satisfy the local needs
- Can IPRED be improved to such an organisation to coordinate the predefined collaborative works ?