

International Memorial Symposium

27 th of June 2012 Wednesday  
at GRIPS

地震工学分野のさらなる研究協力の重要性

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

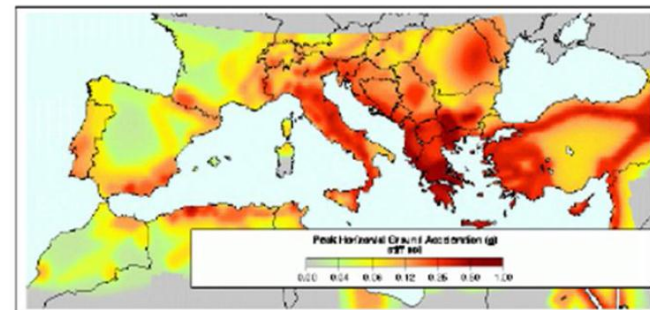
An example : SAFECAST project in Europe

ヨーロッパにおけるSAFECASTプロジェクトを例にして

イスタンブール工科大学  
ファルク・カラドアン  
Faruk Karadogan

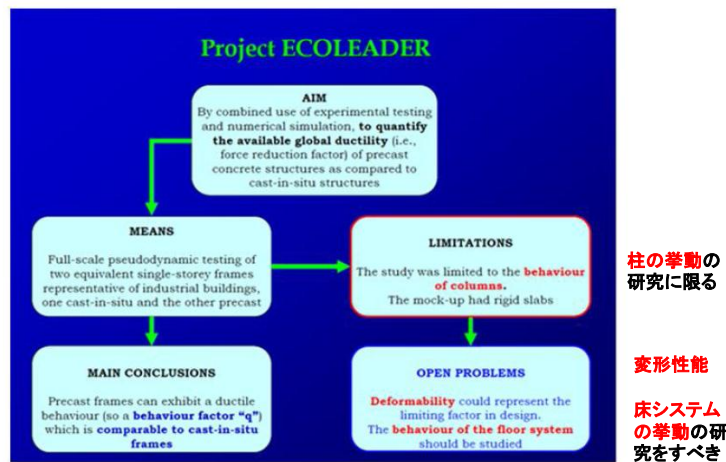
Seismically active Zones around the Mediteranian Sea

地中海周辺の地震活動地帯



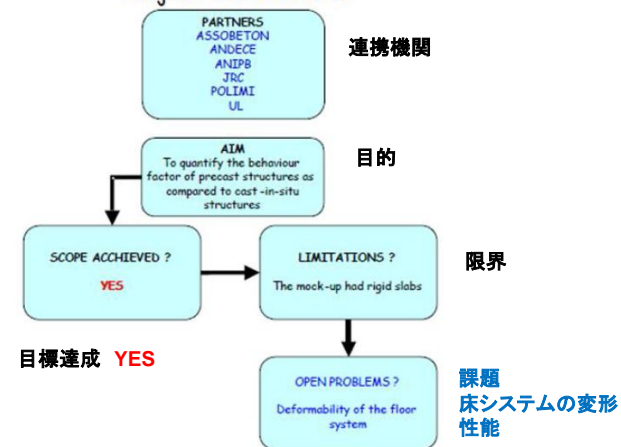
初期のプロジェクト ECOLEADER

An earlier project ECOLEADER

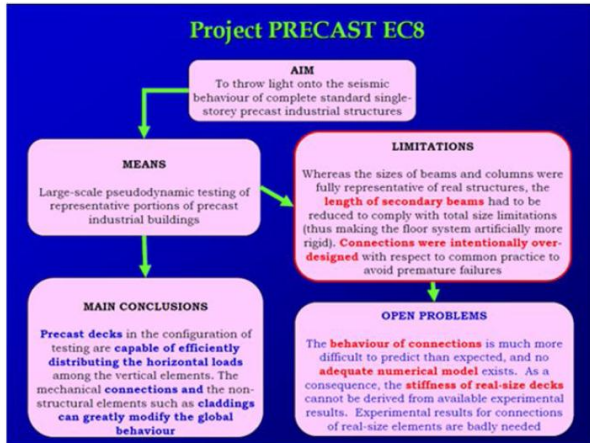


プロジェクト ECOLEADER

Project ECOLEADER



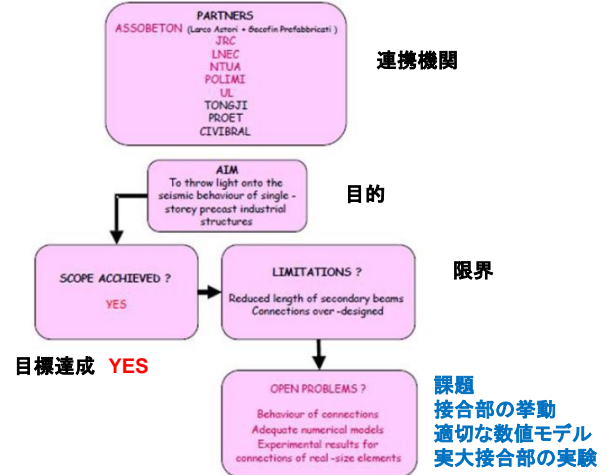
他の初期のプロジェクト PRECAST EC8  
Another earlier project PRECAST EC8



接合部は国際的に過剰設計

接合部の挙動に関する適切な数値モデルがない

プロジェクト PRECAST EC8  
Project PRECAST EC8



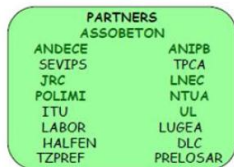
連携機関

目的

限界

課題  
接合部の挙動  
適切な数値モデル  
実大接合部の実験

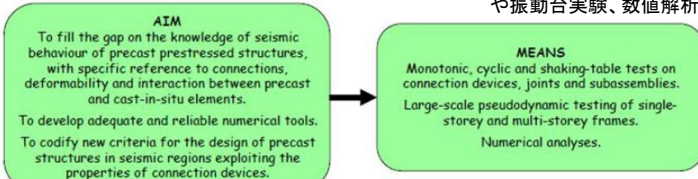
プロジェクト SAFECAST  
Project SAFECAST



連携機関

**目的**  
プレキャスト・プレストレス構造の地震時の挙動に関する知識

**手法**  
接合部や接合部材の繰返しや振動台実験、数値解析など



適切な信頼できる数値モデルの開発など

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

プレキャスト建築構造における新型接合方法の耐震性能

- Grant agreement no. 218417 資金協定 218417
- Research for SME associations SME組合のための研究
- Project start date: 1st March 2009 Duration: 36 months
- Coordinator: Dr. Antonella COLOMBO, ASSOBETON (AXB), Italy
- プロジェクト期間 2009年3月1日から 36ヶ月間  
コーディネーター アントネラ・コロombo博士 イタリア

## プレキャスト構造の耐震性能

### Seismic performance of precast structures



#### SAFECAST – the Consortium

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

関係(受益)機関  
Beneficiary name

略称  
Beneficiary short name

国名  
Country

(coordinator) **ASSOBETON** - National Italian Association of Precast Concrete Producers AXB **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 concrete producers **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 プロジェクト PRECAST EC8

### AIM 目的

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

### MEANS 手法

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

### MAIN CONCLUSIONS 主な結論

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 限界

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 課題

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

## SAFECAST の作業計画

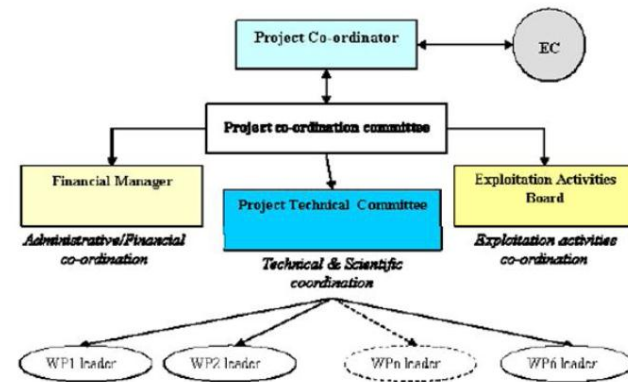


作業項目 名称 活動種別

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

- 1 文献調査、需要把握
- 2 実験的活動
- 3 分析モデルの開発
- 4 実大構造実験評価
- 5 数値モデルの評価
- 6 設計基準の誘導
- 7 研修と普及
- 8 マネージメント

プロジェクト関係者の組織図



SAFECAST に関する追加情報  
More about SAFECAST

Seismic performance of precast structures

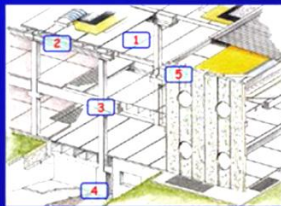
Connection typologies:

Wet, Dry, Emulative, Non emulative

1) adjacent floor or roof elements

2) floor or roof panels and supporting beams

3) columns and beams

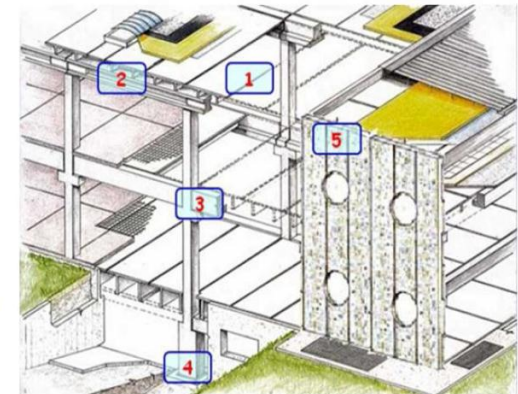


5) cladding panels and structural elements

4) segments of columns or columns and foundations

接合部  
Connections

1. Floor - Floor  
床-床
2. Floor - Beam  
床-はり
3. Beam - Column  
はり-柱
4. Column - Foundation  
柱-基礎
5. Cladding - Frame  
外装材-構造体
6. Cladding - Cladding  
外装材-外装材
7. Cladding - Foundation  
外装材-基礎



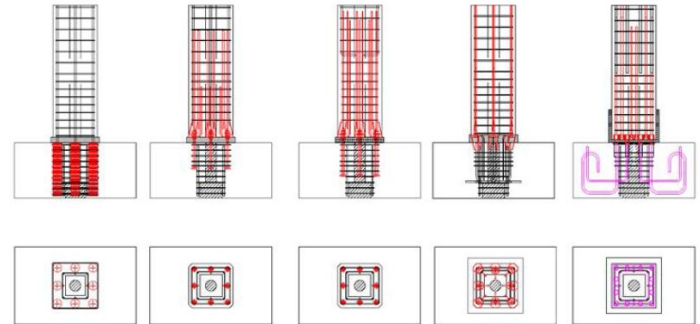
## 柱から基礎への接合部 POLIMU

### Column to Foundation Connections POLIMU

- Pocket Foundation            ポケット基礎
- Protruding bars                外伸(突出)鉄筋
  - Separated protruding bars    分離した外伸鉄筋
- Bolted Sockets                 ソケットボルト
  - Weakened Bolted Sockets    柔軟ソケットボルト
  - Inverted Bolted Sockets      逆ソケットボルト
- Bolted Flanges                フランジボルト
- Couplers                        カプラー(結合器)

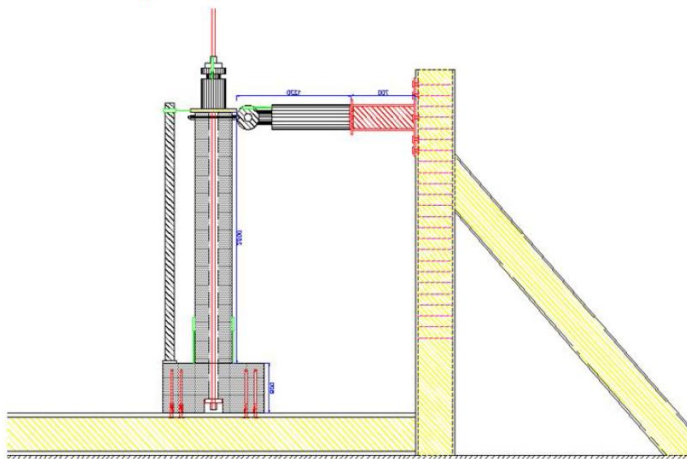
## POLIMU

### 柱から基礎への接合部



## 柱から基礎への接合部の試験装置

### Testing Setup for column to foundation connections

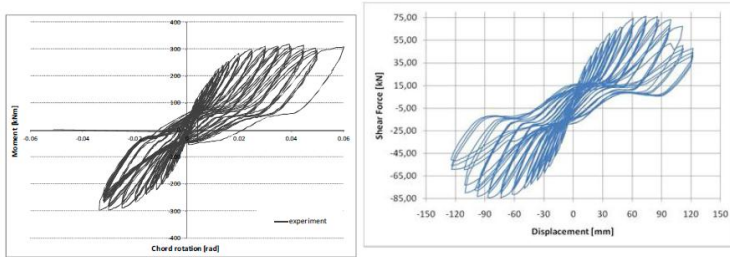


## 柱から基礎への接合部の試験

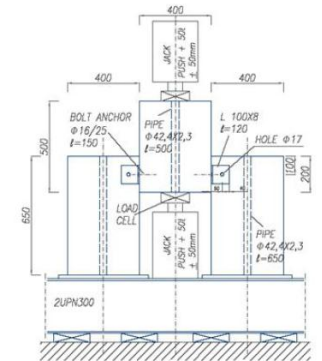


## Typical Load – Deflection Curves

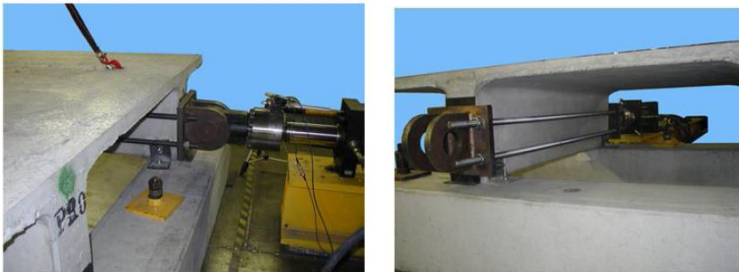
### 典型的な荷重-変形カーブ



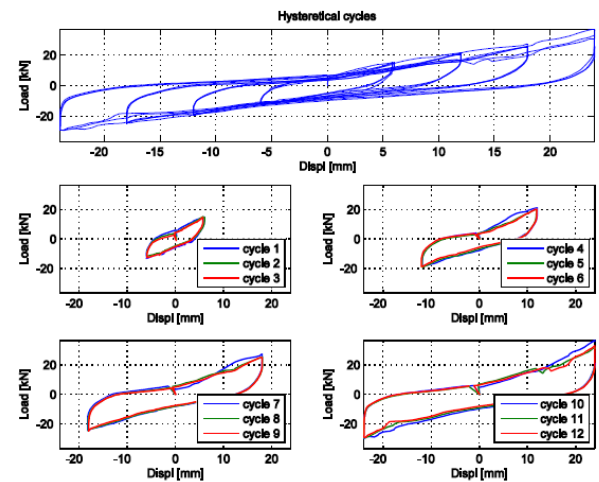
## プレキャスト部材の試験



## プレキャスト部材の試験



## プレキャスト部材の試験結果



イスタンブール工科大学の貢献

Contributions  
of  
Istanbul Technical University

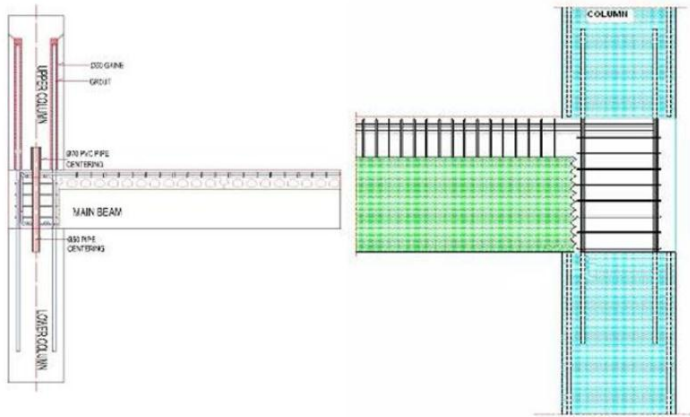
ハイブリッド接合の試験  
構造分析と設計

Tests on Hybrid Connections  
Structural Analyses & Design

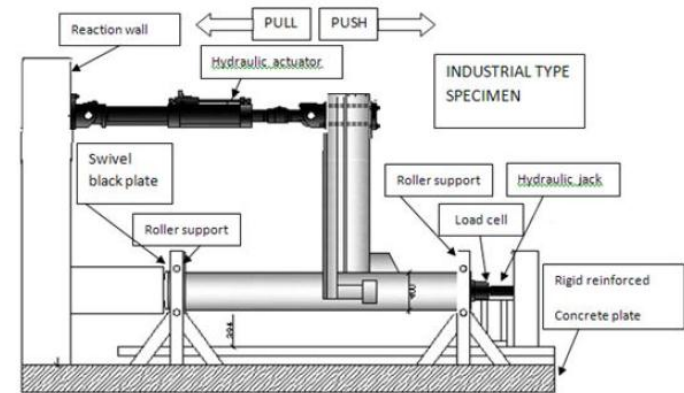
Industrial Type  
Beam to column connections  
工業タイプの柱はり接合部



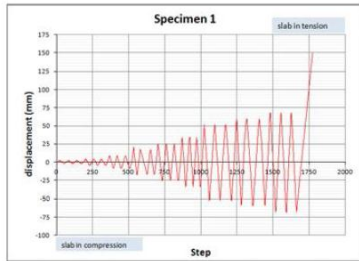
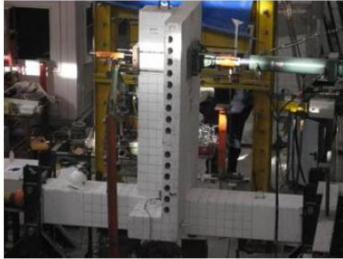
Residential Type  
Beam to column to column connections  
住居タイプの柱・柱はり接合部



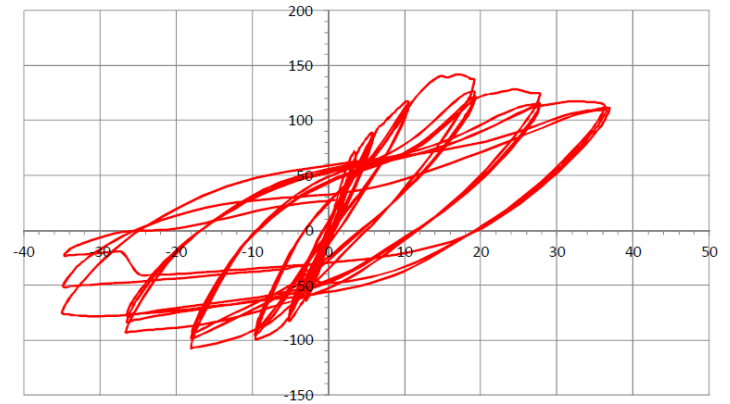
プレキャスト部材の試験



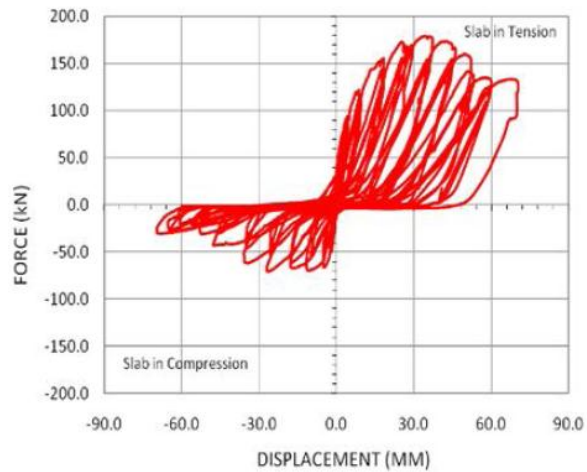
## プレキャスト部材の試験



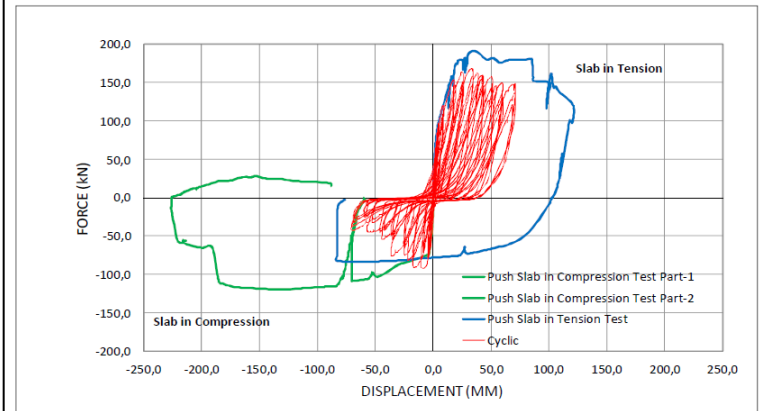
## プレキャスト部材の試験結果



## プレキャスト部材の試験結果



## プレキャスト部材の試験結果





## 観察された柱はり接合部の一般的特徴

The observed general characteristics of beam to column connections

They are not symmetric

Strength degradation

Stiffness degradation

Heavy pinching for Residential Types

対称的でない

強度低下

剛性低下

住居タイプにおける

激しいピンチング

Important differences between Monotonic and

Cyclic

P-D Diagrams

単純・繰返しの

重要な差異

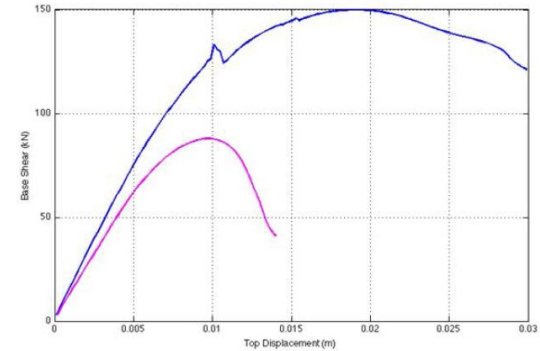
P-D図

## 非対称の接合部を持つ構造体のプッシュオーバー2曲線

Two push over curves for a structure with asymmetric connections.

Which direction the structure should be pushed?

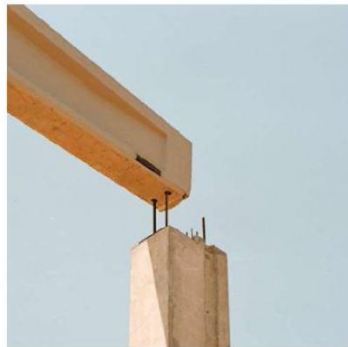
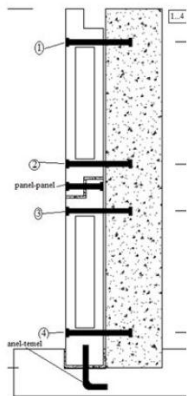
どちらの方向に構造体が加力されるか？



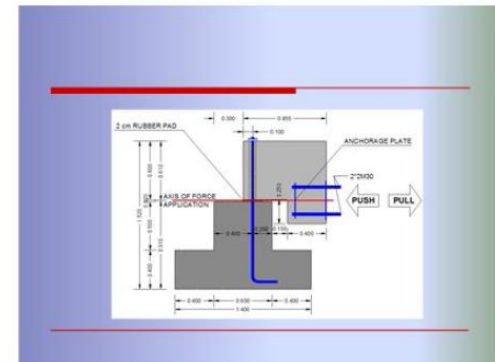
## 合い釘による接合 NTUA - UL

Dowel Connections

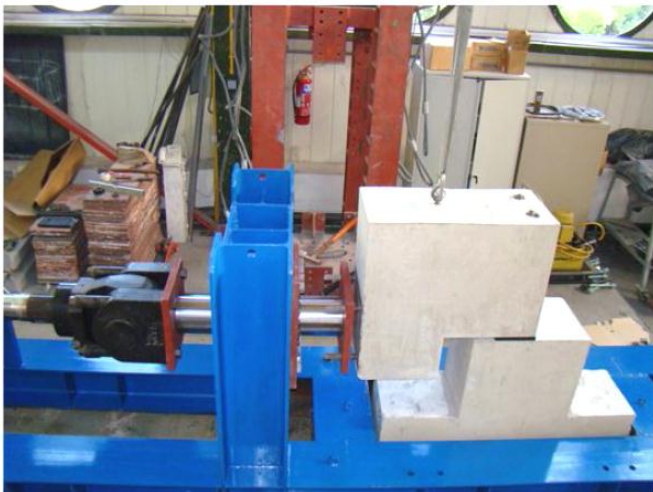
NTUA - UL



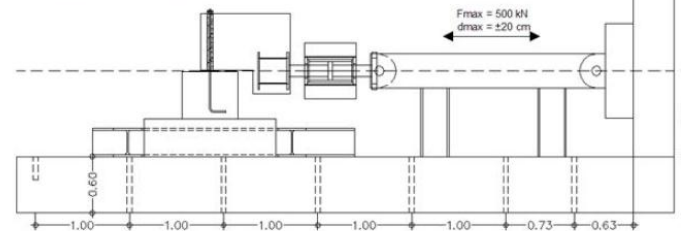
## NTUA



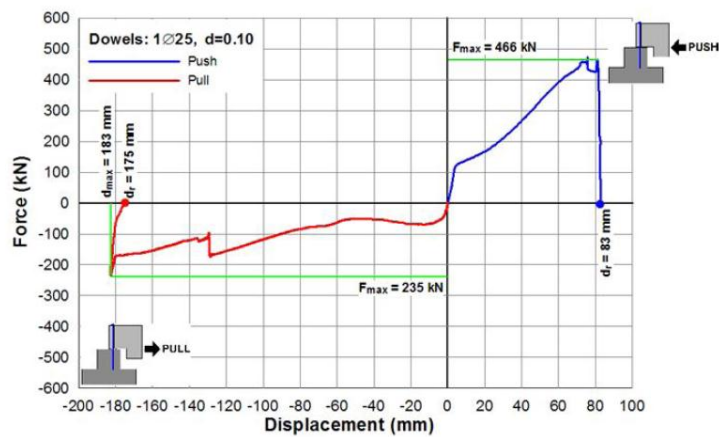
### プレキャスト部材の試験



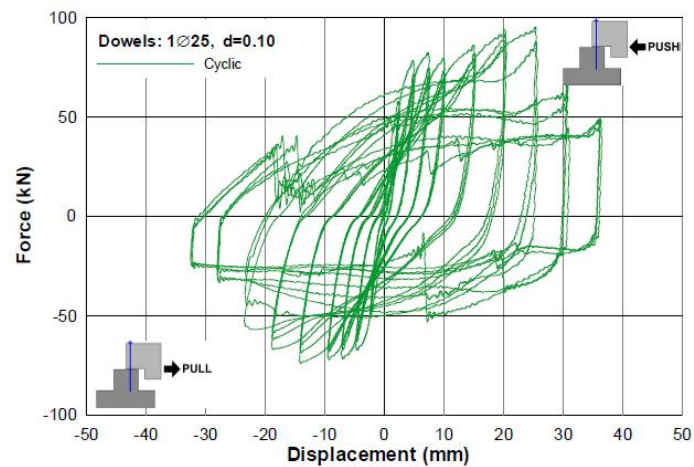
### プレキャスト部材の試験



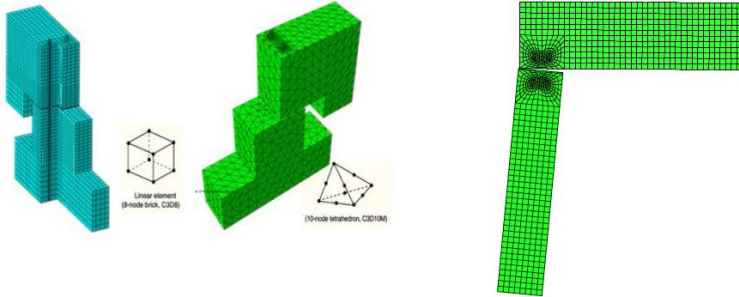
### プレキャスト部材の試験結果



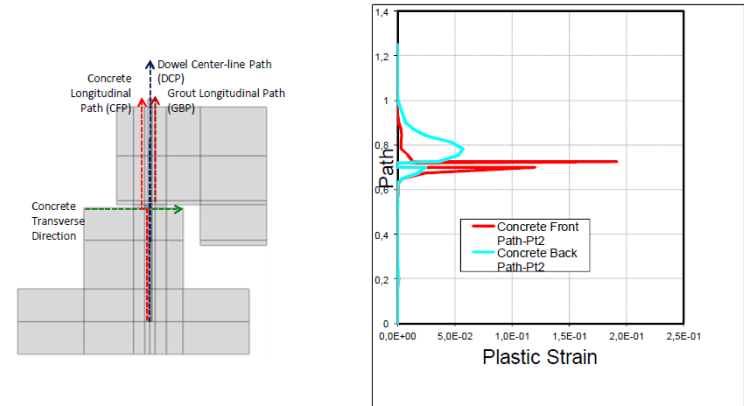
### プレキャスト部材の試験結果



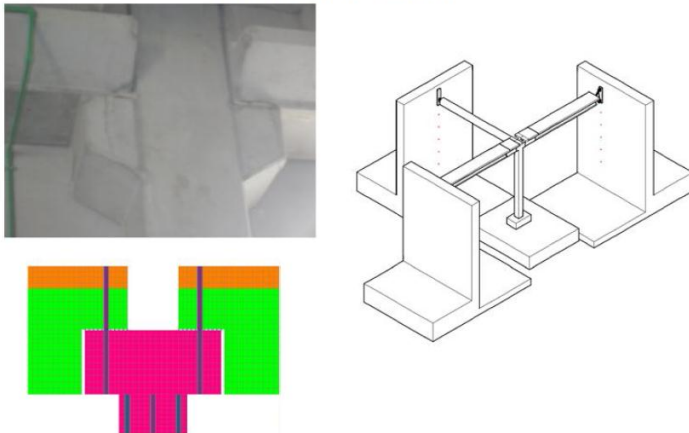
## 有限要素法による解析 Finite Element Analyses



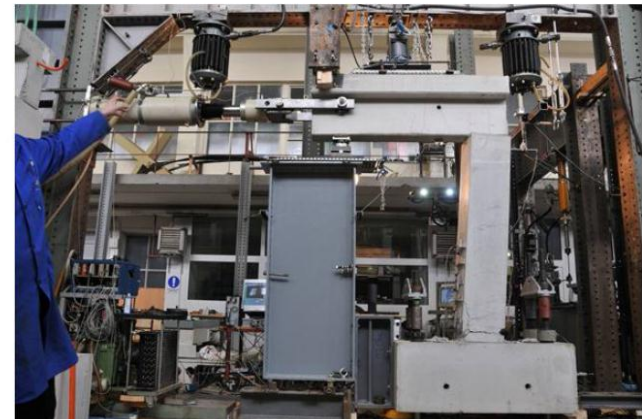
## プレキャスト部材の試験結果



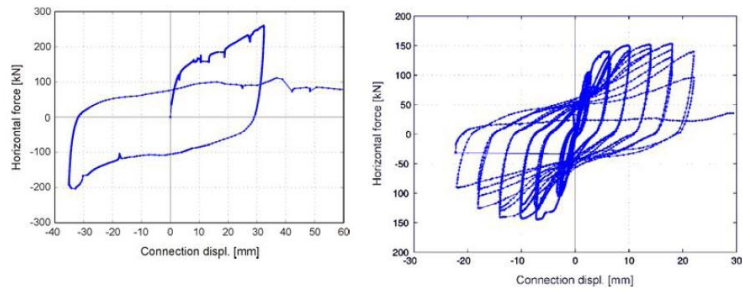
## 柱はり接合部の試験 LNECの効果 Tests on beam-to-column connections Contribution of LNEC



## Tests on beam-to-column connections Contribution of UL 柱はり接合部の試験 ULの効果



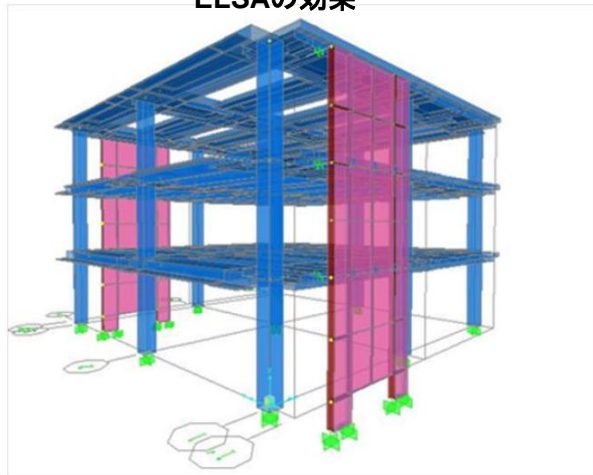
### 柱はり接合部の試験結果



### Shaking table tests Contribution of NTUA 振動台実験 NTUAの効果



### ELSA Contribution ELSAの効果





An IPRED Collaboration - Van Mission in Turkey

IPREDの協力 トルコ バン地震調査団の派遣

25.0 E  
42.0 N

45.0 E  
36.0 N

NEOGENIC (N)  
TERTIARY (T)  
QUATERNARY (Q)

## Conclusions

### まとめ

- Regional 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 ?
- 
- ・地域協力は優先的に促進されるべき
  - ・協力活動の予算額は増加させるべき
  - ・地域団体と住民は地域の課題を体現
  - ・IPREDは協力活動の調整役となるか？