

Final
Meeting

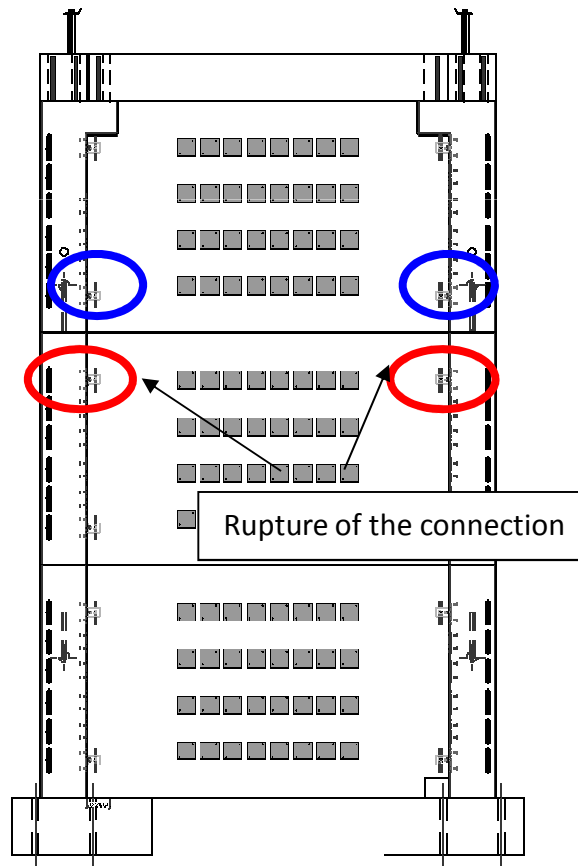
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

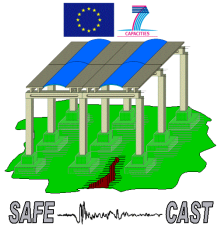
Rome
21st-22nd March
2012

□ 3D large scale dynamic tests on precast cladding panel to column connections

□ Key results

- Rupture of the connection. First test – out of plane test (example)





Final Meeting

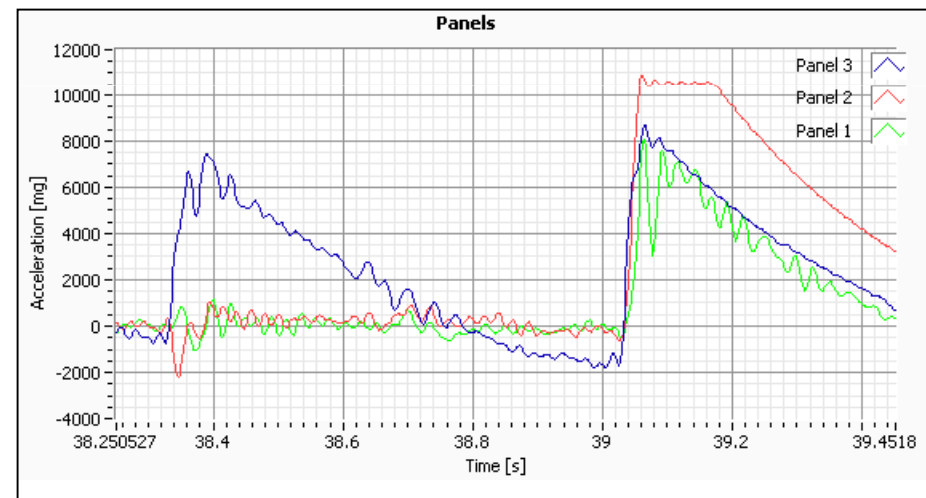
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

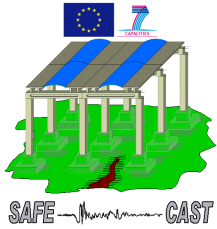
Rome
21st-22nd March
2012

3D large scale dynamic tests on precast cladding panel to column connections

Key results

- Failure of the connection. First test – out of plane test (example)





Final
Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

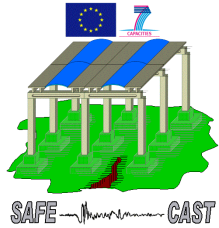
❑ 3D large scale dynamic tests on precast cladding panel to column connections

❑ Key results

- Damage observation



Rupture of the connection



Final
Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

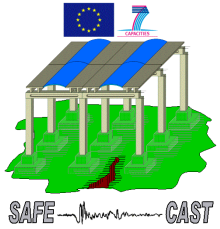
□ 3D large scale dynamic tests on precast cladding panel to column connections

□ Key results

- Damage observation



Spalling of concrete cover and opening of the Cast-In Channels



Final Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

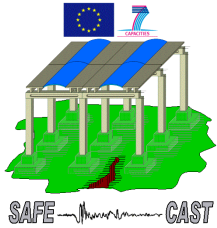
□ 3D large scale dynamic tests on precast cladding panel to column connections

□ Key results

- Damage observation



Cracks in the surrounding concrete



Final Meeting

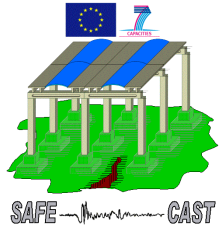
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

❑ 3D large scale dynamic tests on precast cladding panel to column connections

❑ Conclusions

- The first steel angles used in the connections (ST37) due to their manufacturing process, that include bending and galvanization, do not result in a very resistant and ductile steel element. The bending process introduces internal stresses and galvanization makes the steel even more fragile.
- The galvanized hot formed steel plates where no galvanization and no bending (no induced tensions in the bent zone) was applied, so it did not decrease the steel properties.
- The failure of the connection at the central level of the structure was due to gravity loads distribution along the panels.



Final Meeting

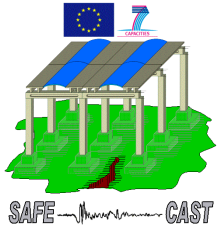
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

□ 3D large scale dynamic tests on precast cladding panel to column connections

□ Conclusions

- The seismic performance of the connection of the cladding panels improves with the installation method (better fastening of the connection, type of steel angle, position of the connection).
- The channels opened so they are not able to resist to these load values.
- The spalling of the concrete at the corner of the column is due to the distance of the channel to the edge that is less than required (100mm).
- Results confirm the high influence of cladding systems upon the building seismic performance.



Final Meeting

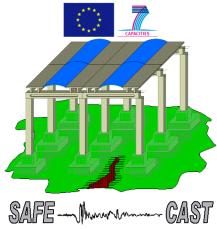
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ Introduction

- The purpose of these tests is to assess the seismic performance of innovative slab-column emulative connections
- Two different types of emulative connections were chosen to be tested:
 - KAPTOR connectors (from Ruredil)
 - HALFEN connectors (from Halfen)
- These slab-column connections are complemented with dowels and in-situ grouting
- The models are real scale slab-column subassemblies with one bay and one storey



Final
Meeting

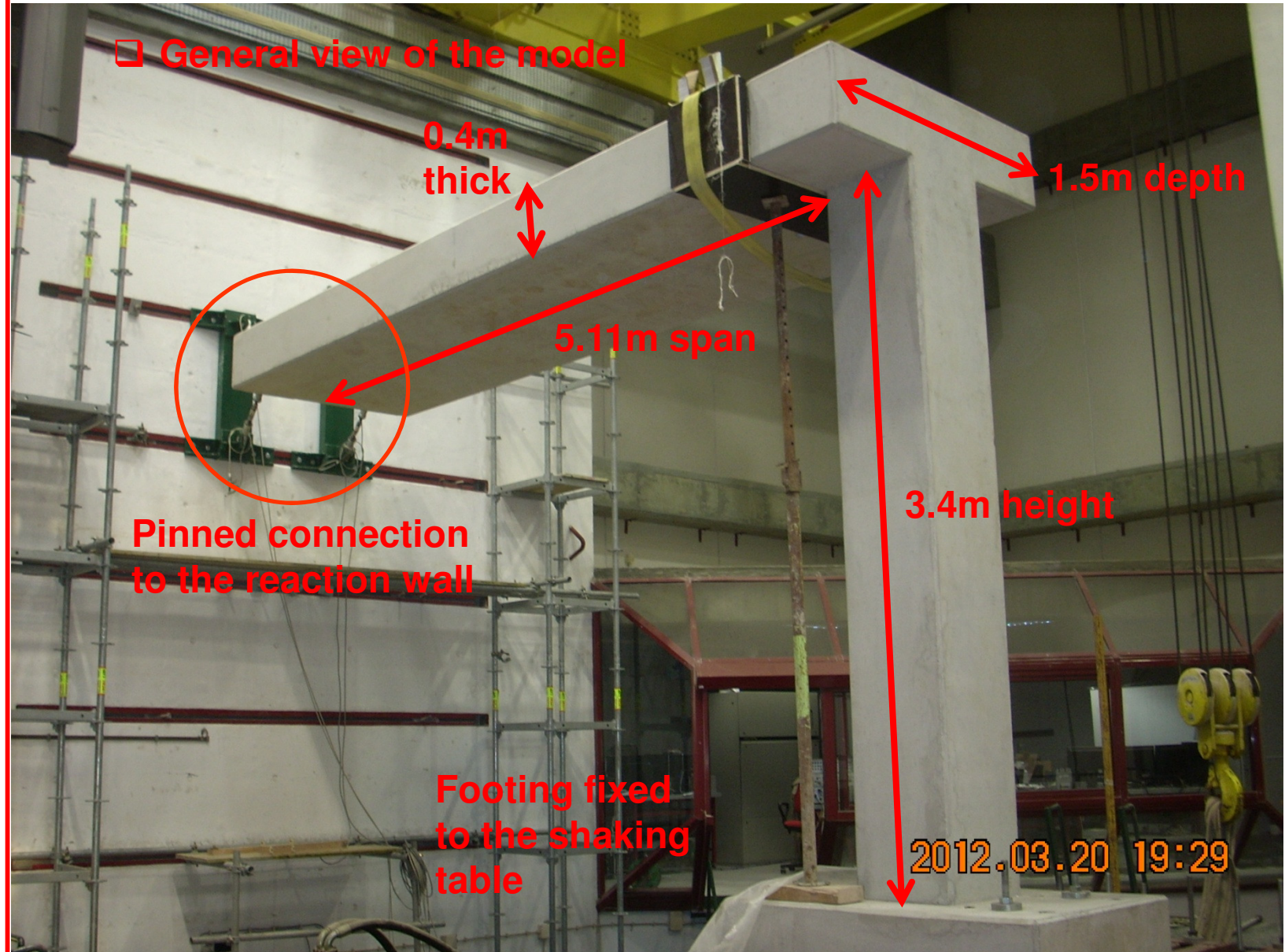
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

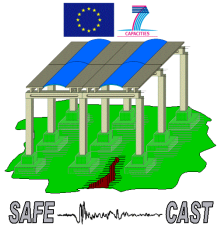
Rome
21st-22nd March
2012

SAFECAST Project – Final Meeting

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ General view of the model





**Final
Meeting**

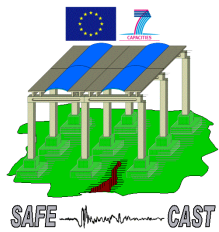
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ Description of the tests

- Two types of tests are to be carried out:
 - Monotonic tests with a maximum displacement of about 380mm which corresponds to a column drift of more than 10%
 - Cyclic tests with increasing levels of displacement according to the established testing protocol
- The testing setup includes the combination of the large 3D shaking for imposing horizontal displacements at the base of the column with horizontal and vertical forces applied by a reaction wall



Final
Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

SAFECAST Project – Final Meeting

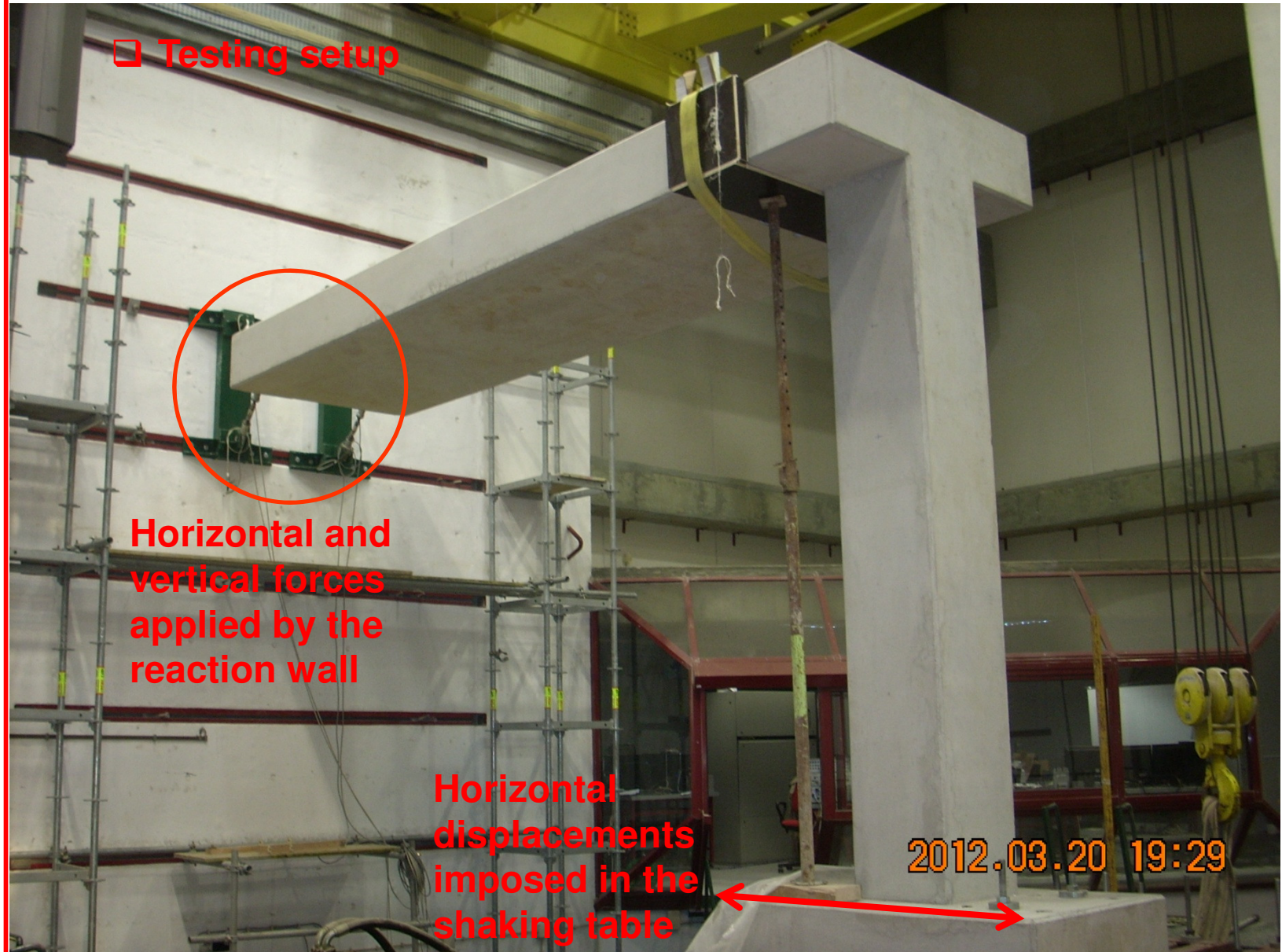
□ 2D real scale static tests on slab-column subassemblies with emulative connections

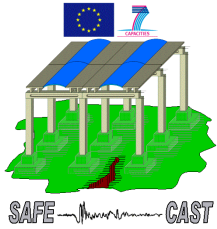
□ Testing setup

Horizontal and
vertical forces
applied by the
reaction wall

Horizontal
displacements
imposed in the
shaking table

2012.03.20 19:29





Final Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

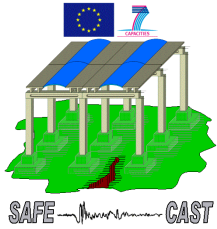
Rome
21st-22nd March
2012

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ KAPTOR connections

- The first model to be tested has KAPTOR connectors





Final
Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

❑ 2D real scale static tests on slab-column subassemblies with emulative connections

❑ **KAPTOR connections**



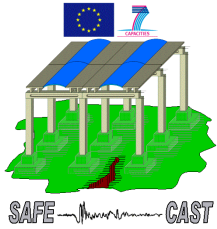
**Top connection,
slab side**

2012.03.13 12:47



**Top connection,
column side**

2012.03.13 12:45



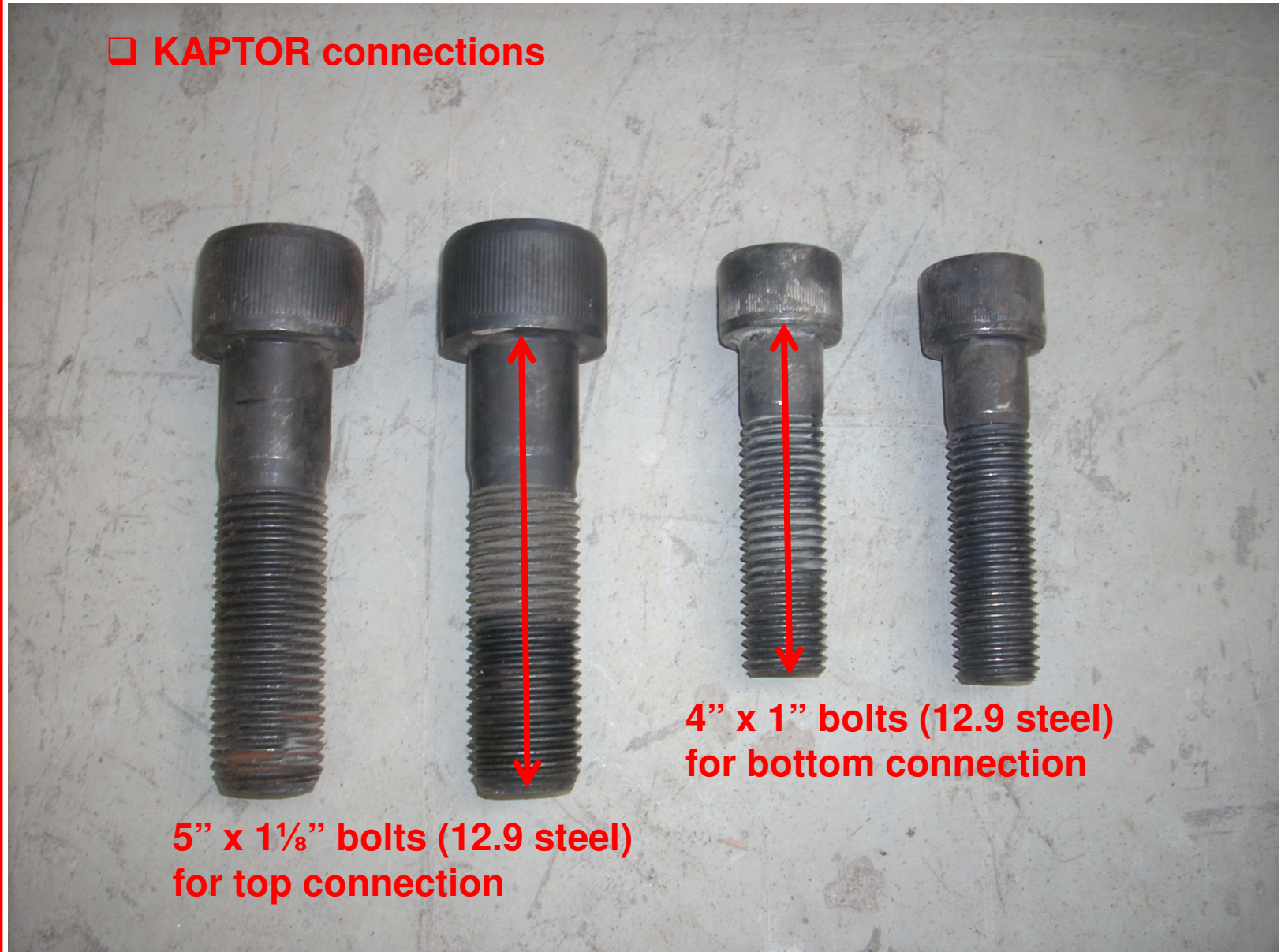
Final Meeting

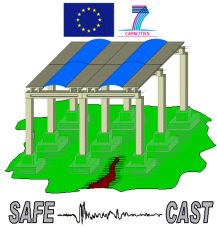
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ KAPTOR connections





Final Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

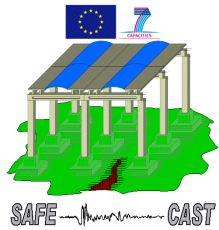
Rome
21st-22nd March
2012

SAFECAST Project – Final Meeting

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ KAPTOR connections





Final Meeting

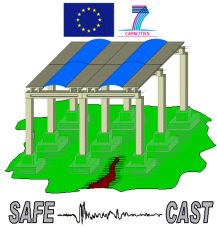
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

□ 2D real scale static tests on slab-column subassemblies with emulative connections

□ Instrumentation plan

- The instrumentation plan includes the measurement of:
 - displacements in the slab-column connection with a dense array of sensors in order to capture the discrete body kinematics
 - displacements along the span of the slab and the height of the column with a sparse distribution of sensors to obtain the respective deformed shapes
 - forces in the hinged struts connecting the slab to the reaction wall
- This instrumentation plan will allow to determine the Force-Displacement and the Moment-Rotation curves that characterize the behavior of the connections and the performance of the sub-assembly



Final
Meeting

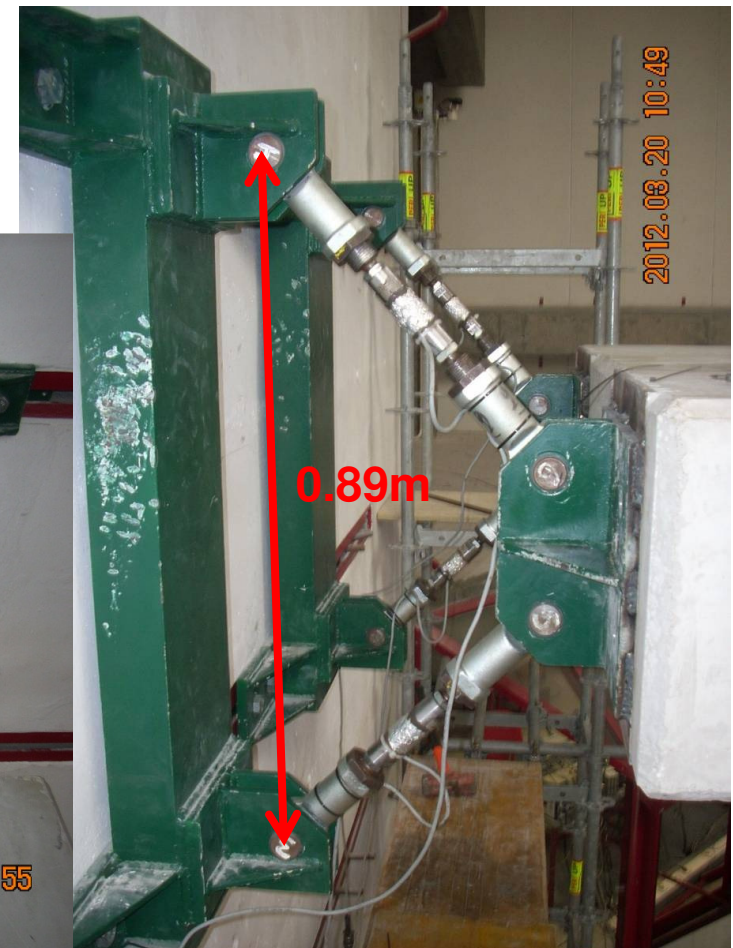
Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

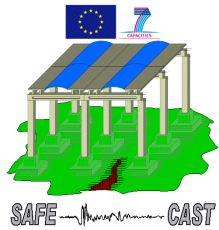
Rome
21st-22nd March
2012

❑ 2D real scale static tests on slab-column subassemblies with emulative connections

❑ Detail of the connection to the reaction wall

- Forces are measured independently on four load cells placed one on each hinged strut





Final Meeting

Ema Coelho
Alfredo Campos Costa
Paulo Candeias
Marta Mateus
Luís Mendes
Márcia Gonçalves
Barros Viegas
Romeu Reguengo
Filipe Saraiva
Serena Gambarelli
Daniela Finizza

Rome
21st-22nd March
2012

❑ 2D real scale static tests on slab-column subassemblies with emulative connections

❑ Testing plan

- The connection elements (KAPTOR and HALFEN) were received by ANIPB near the end of 2011
- Four models were built by Concremat and were ready to test by mid January 2012
- Previous commitments with other research projects prevented LNEC from carrying the tests until now
- The first test (monotonic) with the KAPTOR connectors has been under preparation since last week and is being carried out today
- The second test (cyclic) with the KAPTOR connectors will be carried out immediately after as well as the other two with the HALFEN connectors