مؤتمر الاسكان العربي الثامن / الجزائر 17-19 ديسمبر 2024

وزارة السكن و العمران و المدينة
Ministry of Housing, Urban Planning and the City

مؤتمر الإسكان العربي الثامن
8th ARAB HOUSING CONFERENCE

المركز الوطني للبحث المطبق في هندسة مقاومة الزلازل

National Center of Applied Research in Earthquake Engineering, (CGS)

تحسين استراتيجيات الوقاية من الزلازل: دور الأبحاث التجريبية في الهندسة الزلزالية

Advancing Earthquake Prevention: The Role of Experimental Research in Seismic Engineering

Presented by: Dr. BENCHARIF RAOUF

Senior Researcher

PRESENTATION PROGRESS

1. **GENERAL INFORMATIONS ABOUT ALGERIA**
2. **SEISMICITY & NOTABLE EARTHQUAKES IN ALGERIA**
3. **NATIONAL CENTER OF APPLIED RESEARCH IN EARTHQUAKE ENGINEERING, CGS**
4. **THE MOST IMPORTANT ACHIEVEMENTS REACHED BY THE CGS**
5. **LABORATORIES of CGS**
6. **CONCLUSIONS**

GENERAL INFORMATIONS ABOUT ALGERIA

Geography & Size

Algeria is in North Africa and is the largest country on the African continent and the 10^{th}largest in the world.

The Sahara Desert covers more than 80% of its land area.

Capital & Major Cities

The capital city is Algiers, located on the Mediterranean coast.

Other major cities include Oran, Constantine, and Annaba.

Economy

Algeria has a mixed economy, heavily reliant on hydrocarbons (oil and natural gas), which contribute over 90% of export earnings.

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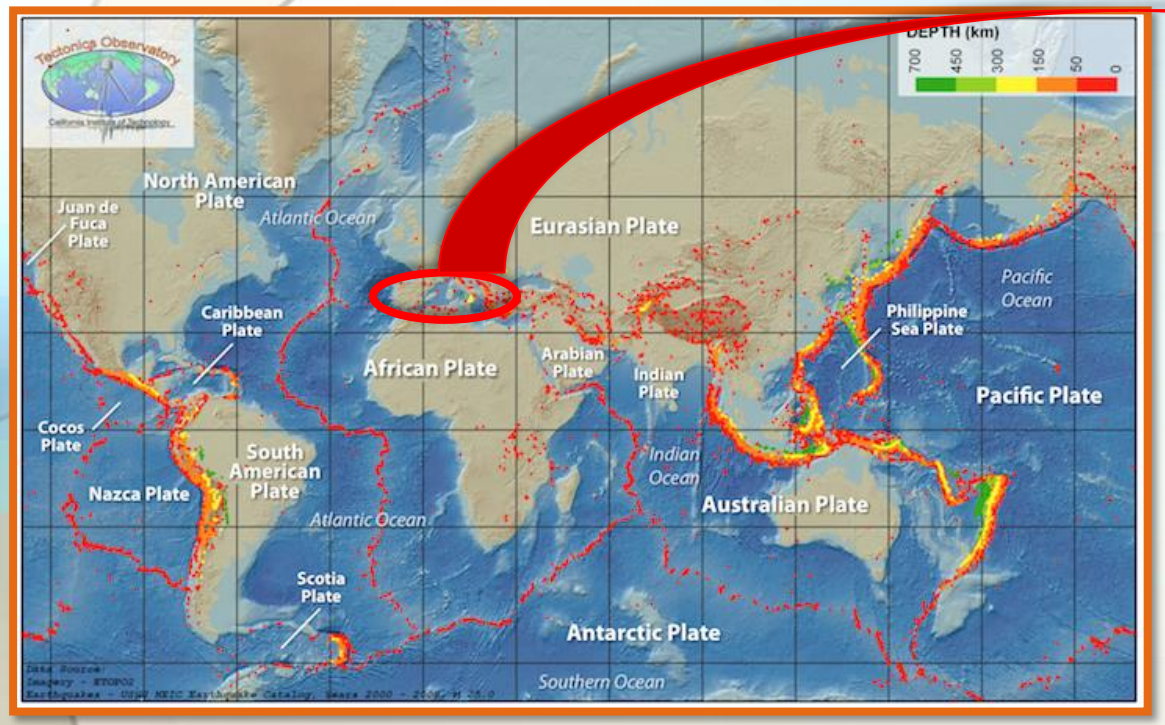
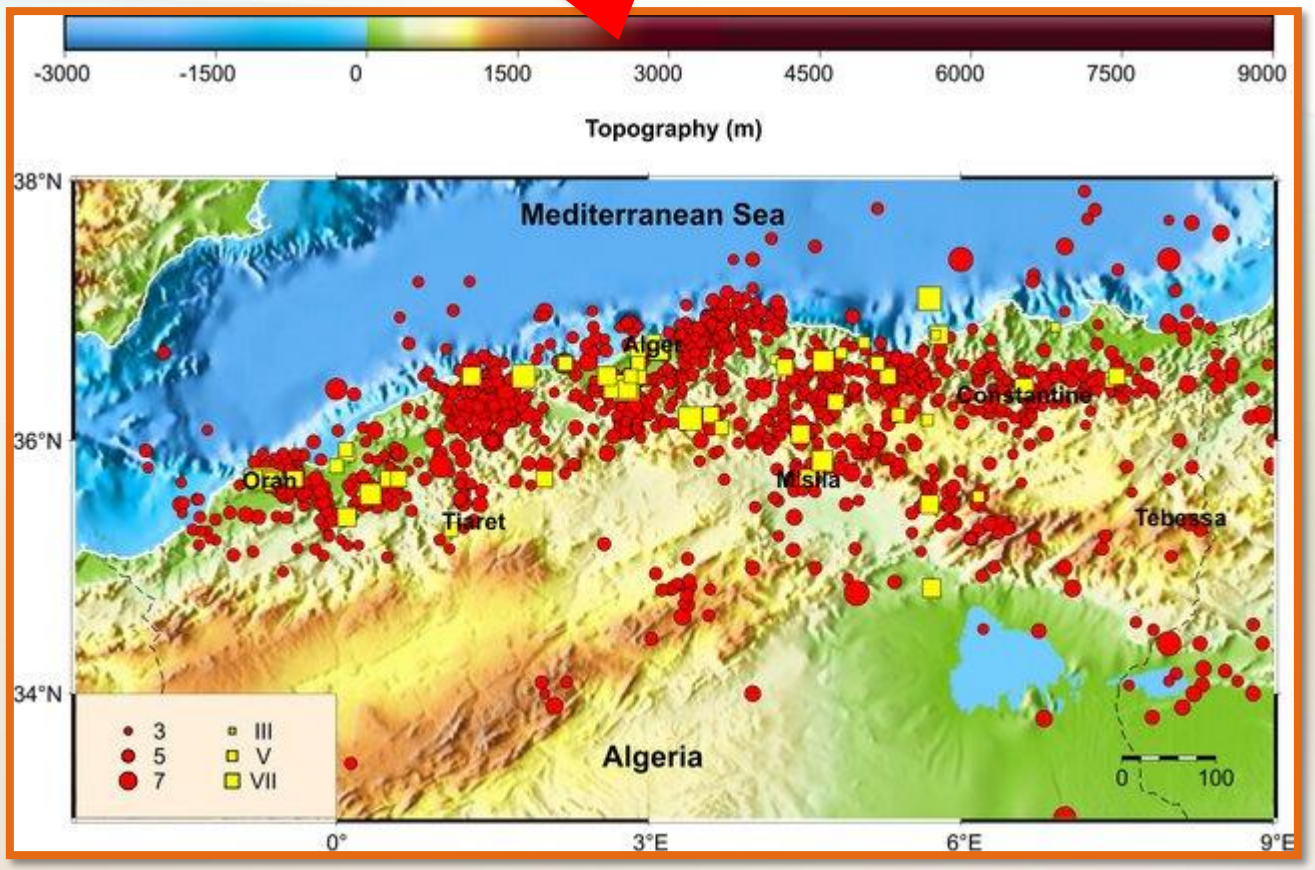
SEISMICITY IN ALGERIA





Seismic activity in northern Algeria from 1365 to 2020 based on the CRAAG database. Yellow squares indicate seismic events before 1900, while red circles represent those occurring after 1900.

NOTABLE EARTHQUAKES IN ALGERIA

1954 El-Asnam Earthquake

On ***September 9, 1954***, the Chlef earthquake hit El-Asnam Province in Algeria at 02:04:43 local time. The event registered ***a magnitude of 6.7*** on the moment magnitude scale and reached a maximum ***Mercalli intensity of XI (Extreme).*** The quake devastated Chlef, then known as ***Orléansville***, resulting in ***at least 1243*** fatalities and over ***5000 injuries***. Damage was estimated ***at $6 million***, and the event was succeeded by numerous aftershocks.

NOTABLE EARTHQUAKES IN ALGERIA

Chlef (Asnam) earthquake (Mw 7.3) October 10th, 1980

The mains causes of damages can be listed as follow:

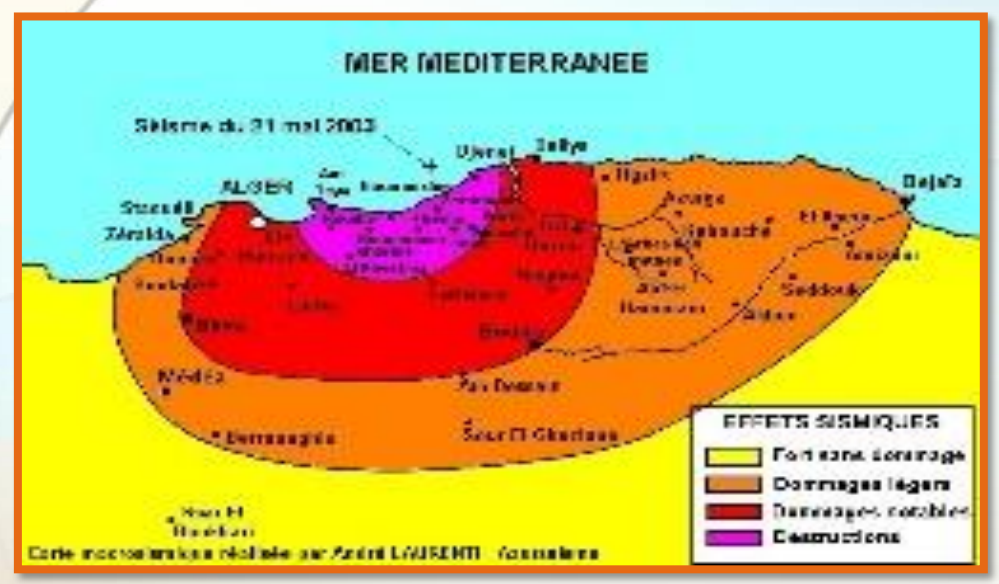
- Damages dues to short columns
- Poor structural material
- Inadequate detailing for structural elements

After El-Asnam earthquake ***10th October 1980*** (***M7.2, 2633 deaths, more than 20000 houses destroyed, 48000 homeless***) "PS 69 Rev. 1973" or "RPA*1981" then "RPA* 1981 Revised in 1983".

(*) REGLES PARASISMIQUES ALGERIENNES

NOTABLE EARTHQUAKES IN ALGERIA

Boumerdès earthquake (2003)



The Boumerdès earthquake was a significant seismic event that struck northern Algeria on May 21, 2003.

Magnitude: 6.8 on the moment magnitude scale.

Epicenter: Near the town of Boumerdès, around 50 km (31 miles) east of Algiers.

NOTABLE EARTHQUAKES IN ALGERIA

Boumerdès earthquake (2003)

Impact

- Casualties: Estimated to have caused over ***2000 deaths and thousands of injuries***.
- Damage: Widespread destruction in Boumerdès and surrounding areas, including Algiers.
- Infrastructure damage: that included collapsed buildings, roads, and utilities.
- Displacement: ***Hundreds of thousands were displaced*** due to damage to homes and buildings.

Response and Recovery

- The Algerian government and international organizations provided immediate assistance, including medical aid, shelter, and supplies for affected populations.
- Long-term recovery efforts included rebuilding infrastructure and improving building ***codes to enhance earthquake resilience.***

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MINISTER OF HOUSING, URBANISM AND THE CITY

Centre National de Recherche Appliquée en Génie Parasismique, (CGS)

(In English: National Center of Applied Research in Earthquake Engineering)

GENERAL DIRECTORATE OF THE CENTER

THE CENTER'S LABORATORIES

Rue Kaddour Rahim prolongée, BP 252, Hussein-Dey, Alger, ALGERIE

Tél : 213 (0) 21 49 55 47 à 49 Fax : 213 (0) 21 49 55 36
Internet : www.cgs-dz.org Email: cgsd@cgs-dz.org ; cgsd@wissal.dz

NATIONAL CENTER OF APPLIED RESEARCH IN EARTHQUAKE ENGINEERING (CGS)

http://www.cgs-dz.org/

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CGS's LABORATORIES

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The CGS hosts several specialized laboratories focused on seismic research and structural dynamics:

- ***Structural Dynamics Laboratory***
- Soil Dynamics Laboratory
- Geophysics Laboratory
- Materials Laboratory
- Seismic Monitoring Laboratory

CGS's LABORATORIES

Structural Dynamics Laboratory

The most important laboratory:

- Unique in Africa and the Arab world.
- Equipped with highly sophisticated equipment, only available in developed countries with high seismic risk.
- Contributes to research and infrastructure safety by analyzing the effects of earthquakes on structures.

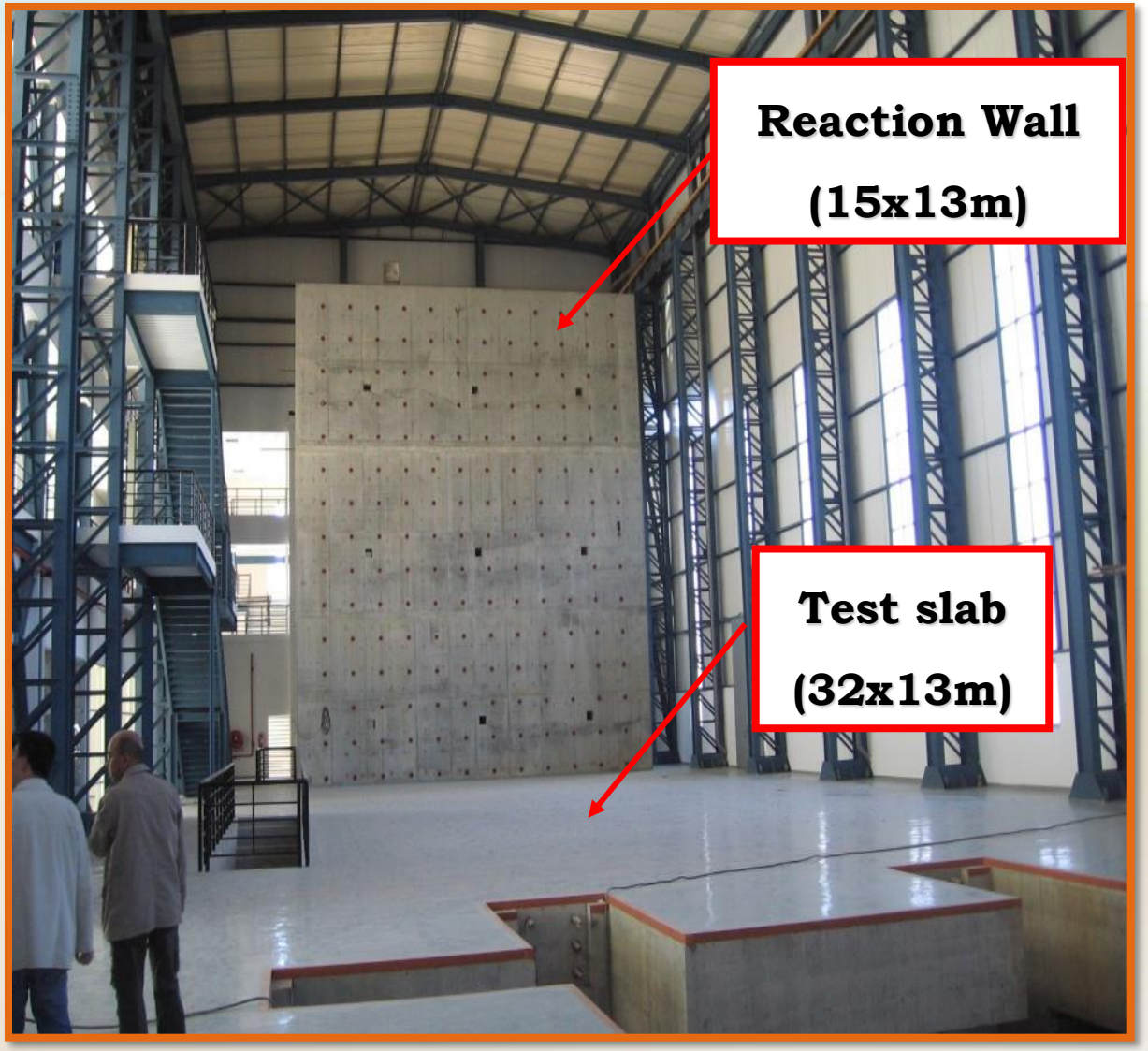
CGS's LABORATORIES

Structural Dynamics Laboratory

CGS's LABORATORIES

Test slab: Prestressed concrete slab with a thickness ***of 1m***. The plan dimensions of the slab are ***32x13m***. The holes for fixing the specimen are spaced 1m apart and have a strength of ***50t each***.

Reaction Wall: It is a prestressed concrete box type wall with a thickness of ***4m***. The height and width of the ***wall are 15 and 13m,*** respectively. The bending capacity is ***120 MN.m and 12 MN shear***



CGS's LABORATORIES

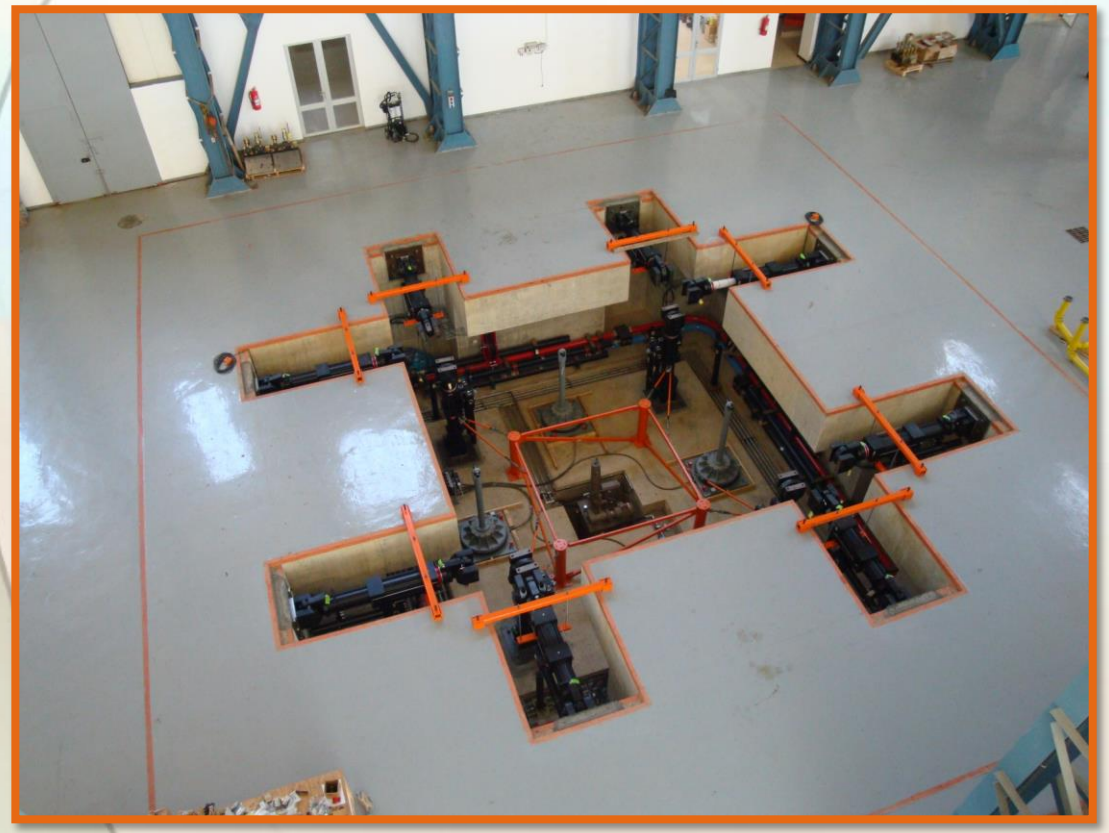
Structural Dynamics Laboratory

Reaction Wall Jacks : There are four (4) jacks for the Reaction Wall, two dynamic and two static.

Model of Jacks (MTS)	Quantity	Stroke (mm)	Force (kN)	Servovalve (LPM)	Classification
244.41S	02	508	±550	1500	Dynamique
244.41	02	1016	±550	57	Statique

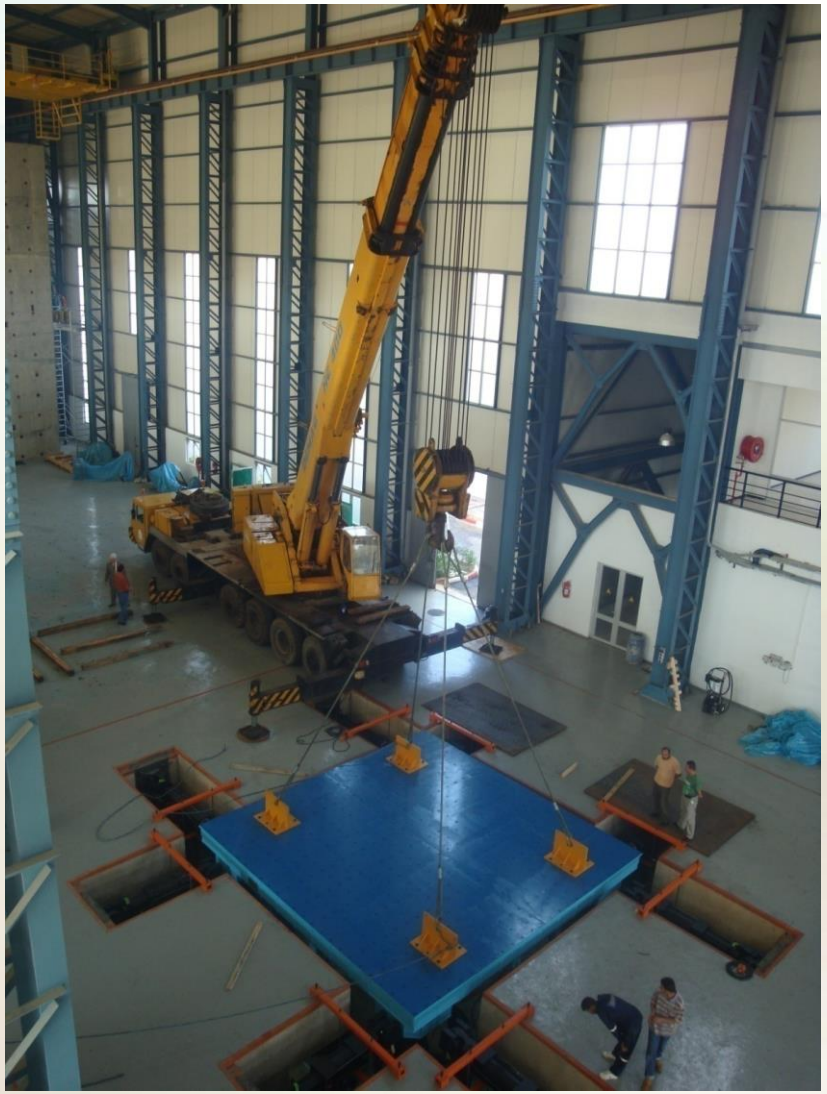
CGS's LABORATORIES

Reservation of the Shaking Table Enclosure



CGS's LABORATORIES

Setting up the Caisson



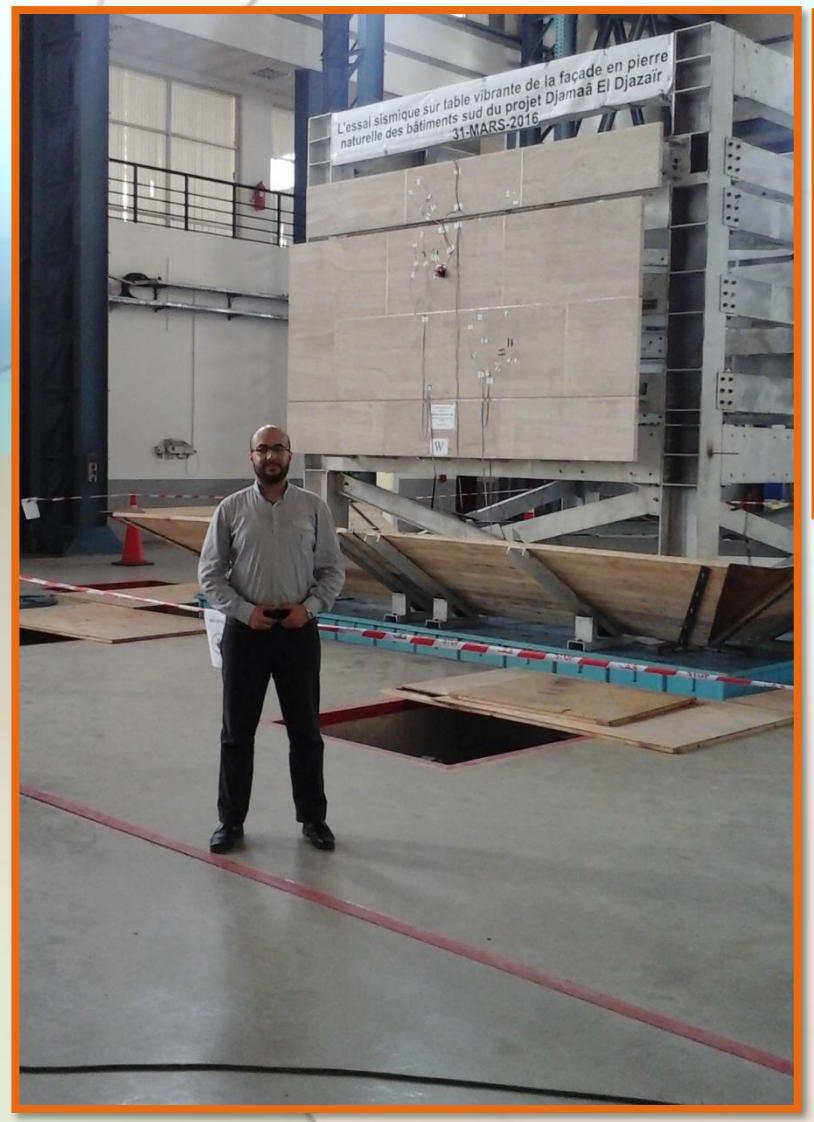
CGS's LABORATORIES

Shaking Table characteristics

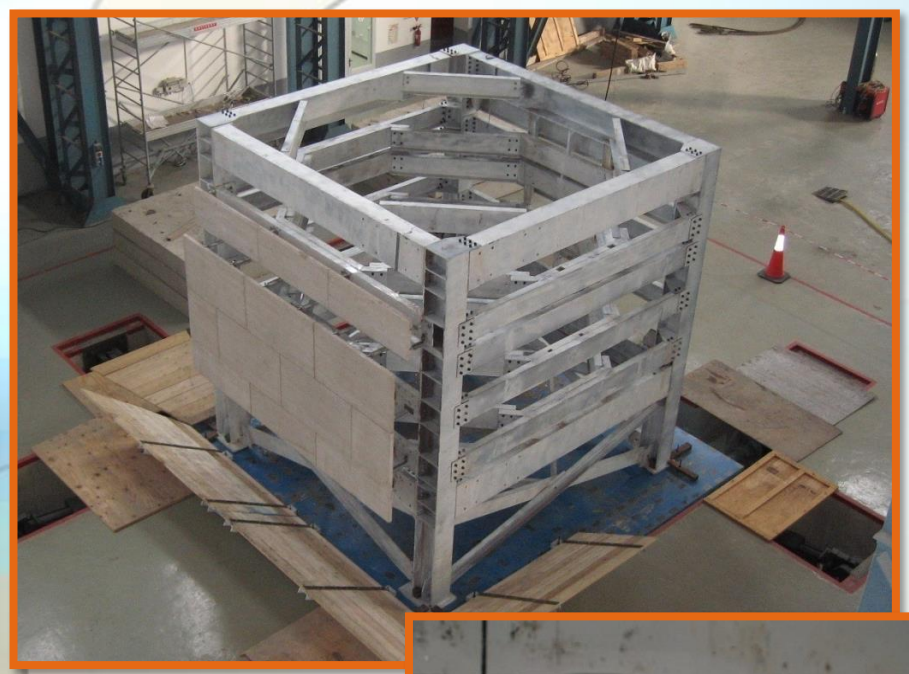
Degree of freedom	06		
Table size(m)	6.1 × 6.1		
Mass of the specimen(Ton)	60		
Direction d'excitation	X-Horizontal	Y-Horizontal	Z-Vertical
Acceleration (g)	±1.0	±1.0	±0.8
Velocity (m/sec)	±1.1	±1.1	±1.0
displacement (m)	±0.25	±0.15	±0.10
Frequency Range(Hz)	0.1-50		

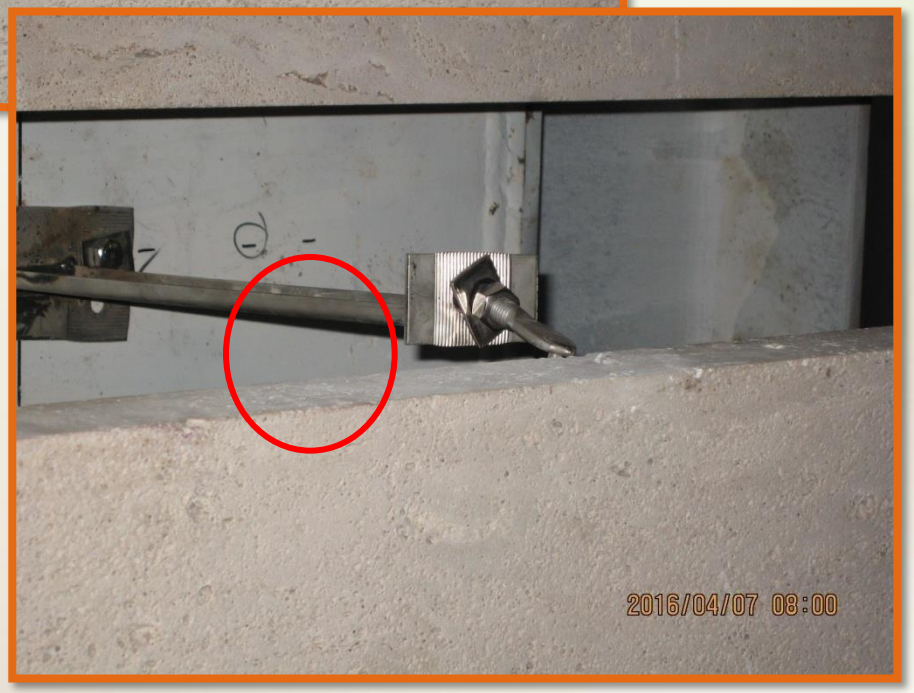
CGS's LABORATORIES

Test of the Minaret of the Great Mosque in Algiers

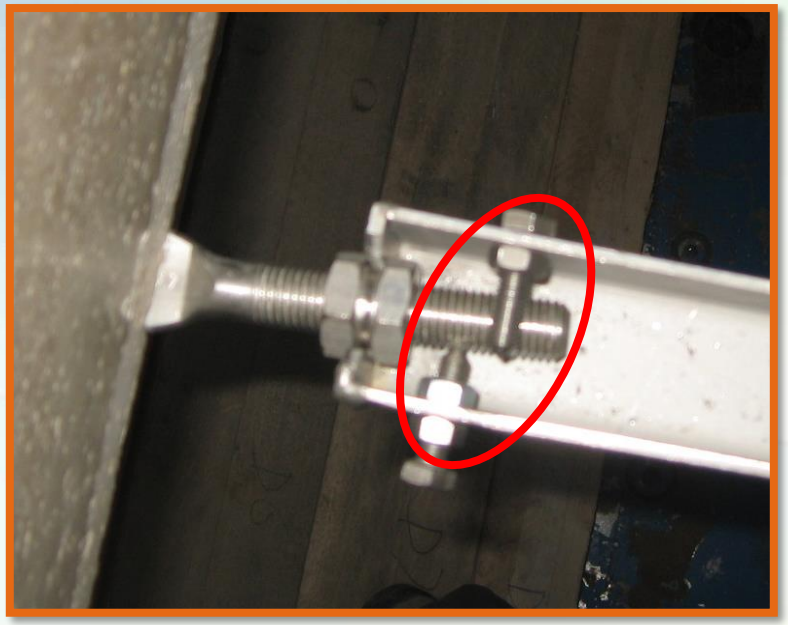


CGS's LABORATORIES

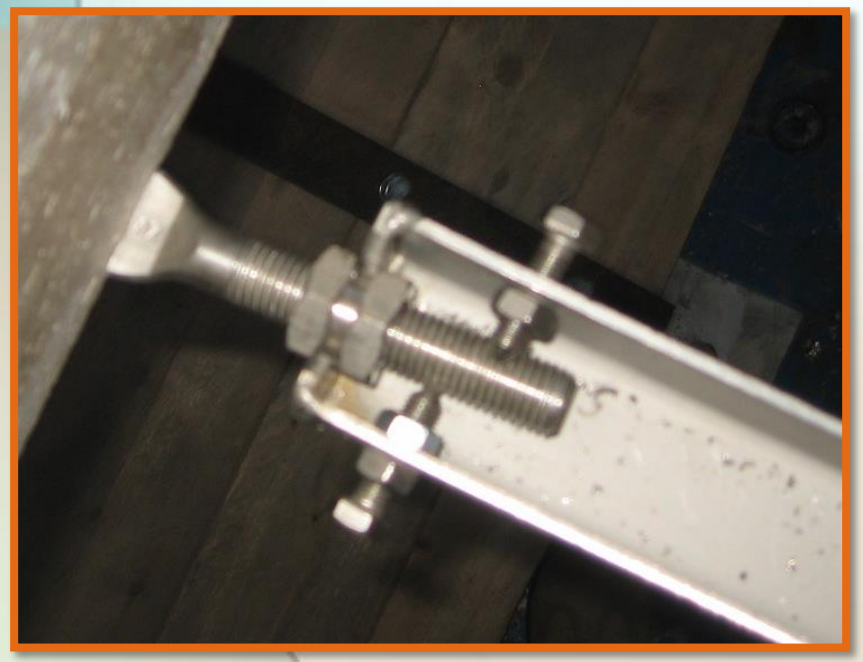




First configuration
-TEST 1-



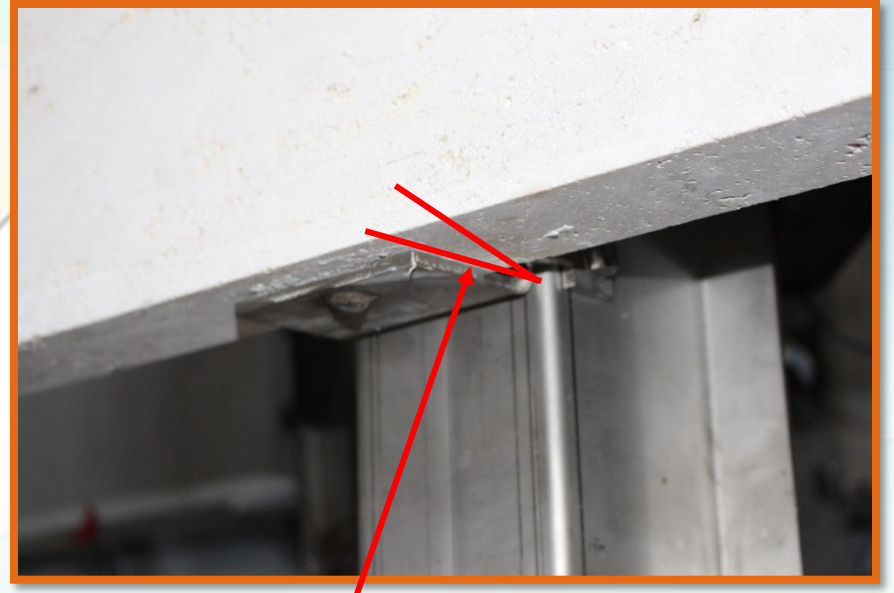
Second configuration
–TEST 2-



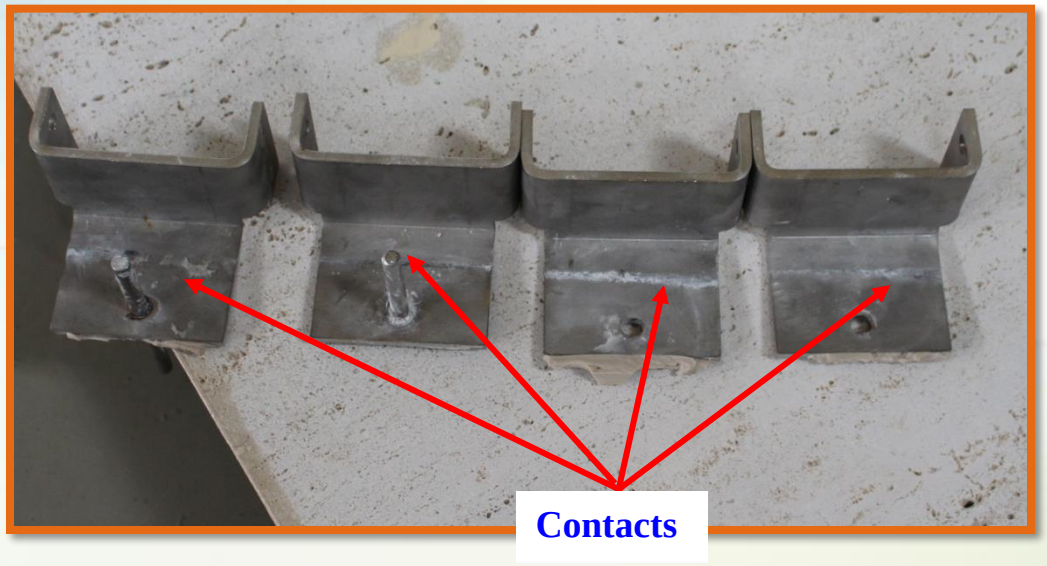
Second configuration
-TEST 2-

Third configuration
-TEST 3-

The PIN system

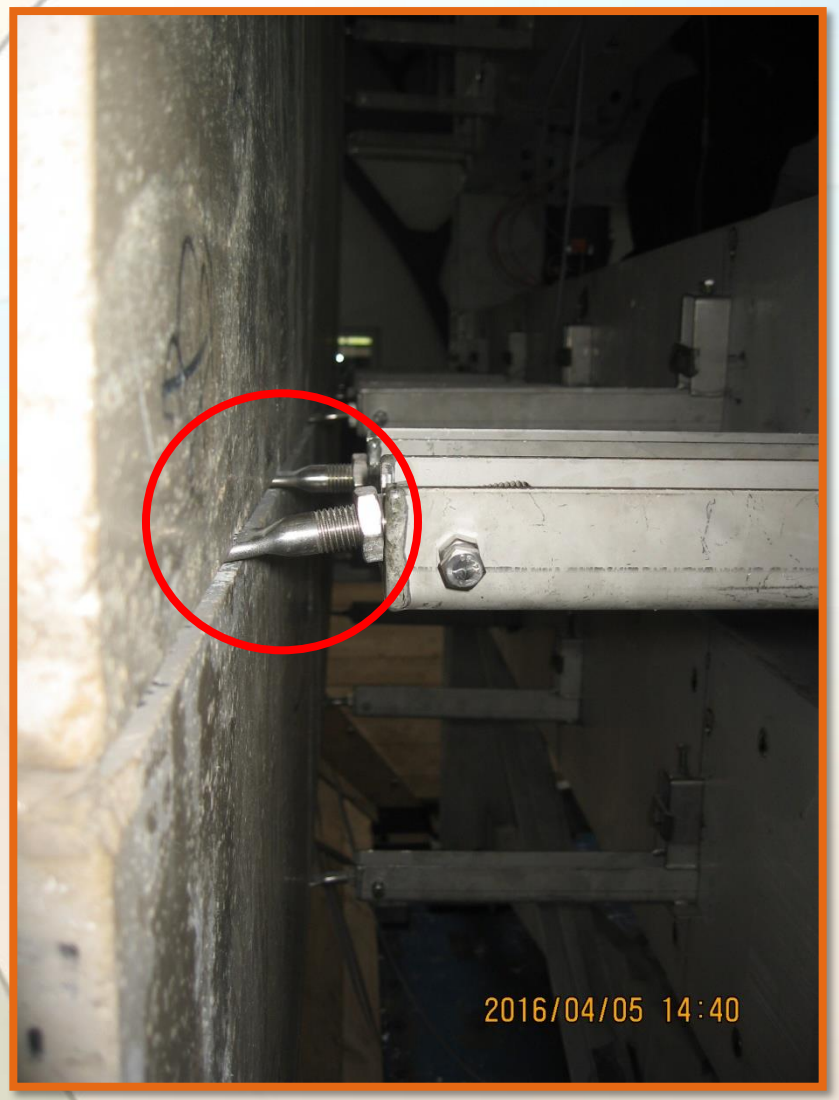


Linear contact between the PIN substrate and the stone

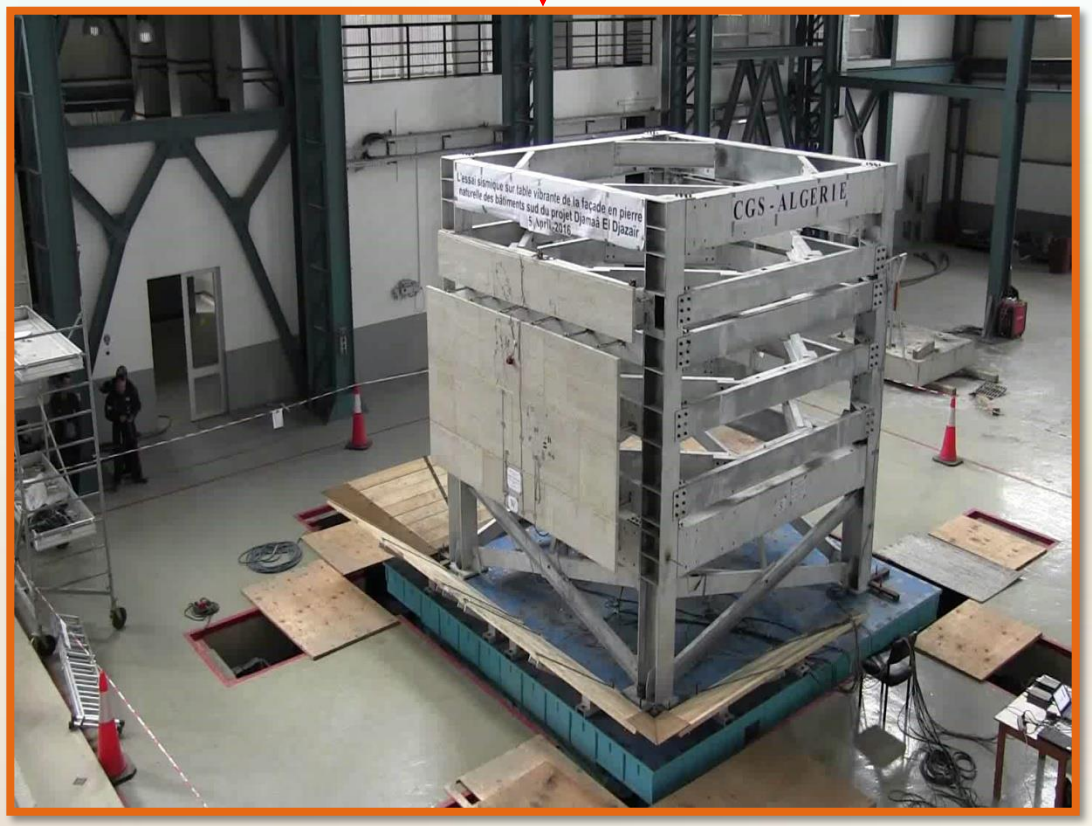


Bolt shearing during disassembly -PIN-

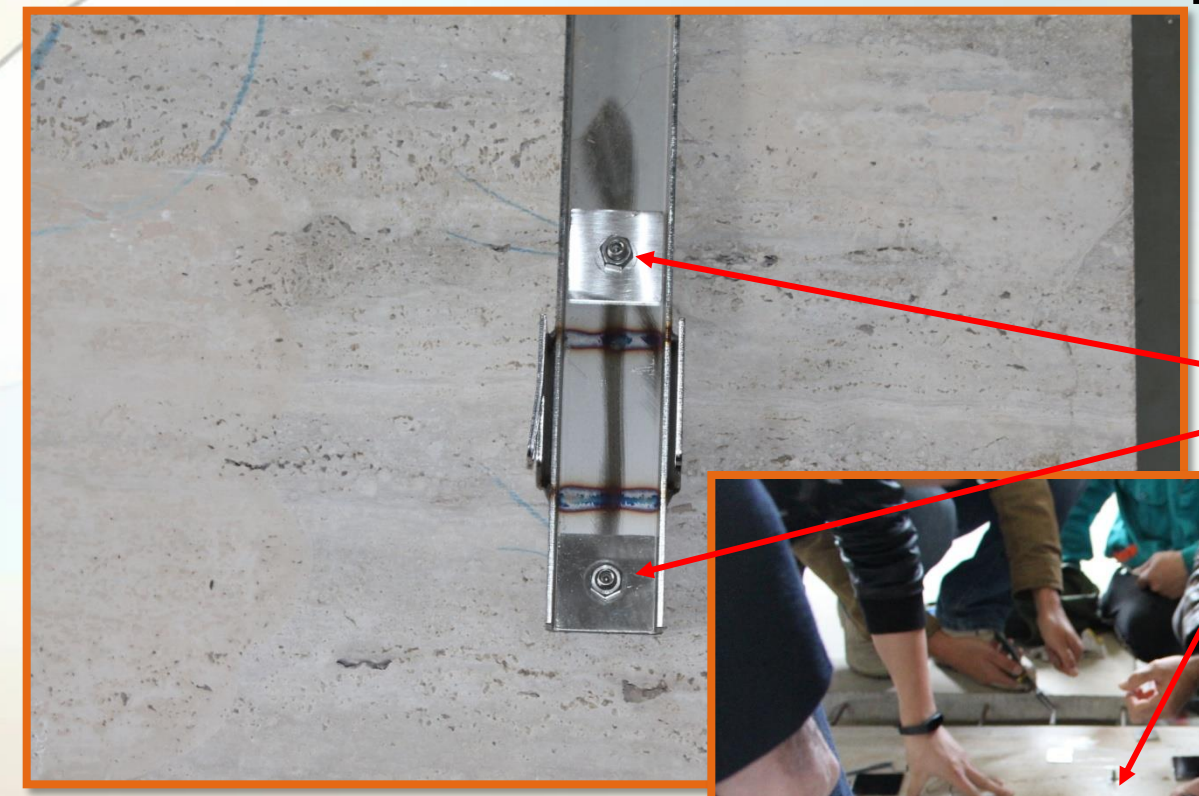
CGS's LABORATORIES



Video



Regarding the GSD system, no damage was observed during seismic tests on the stone or on the stainless steel support.

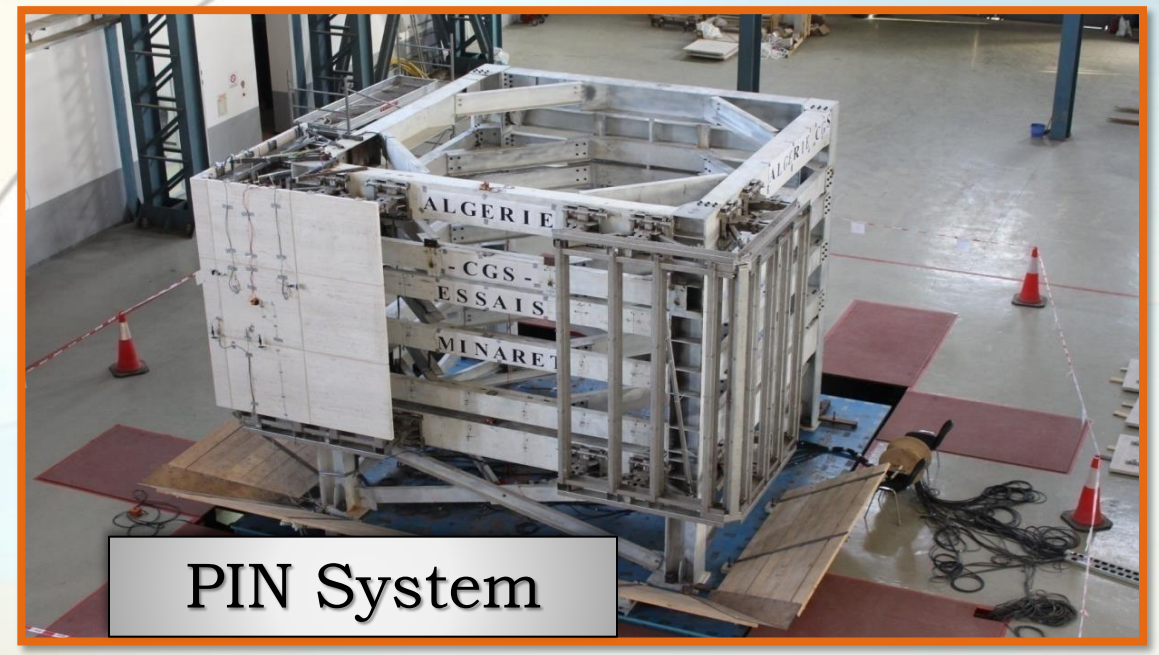


Checking the anchor rods

CGS's LABORATORIES

Video

Project 2: Minaret of Djamâa El-Djazair



PIN System

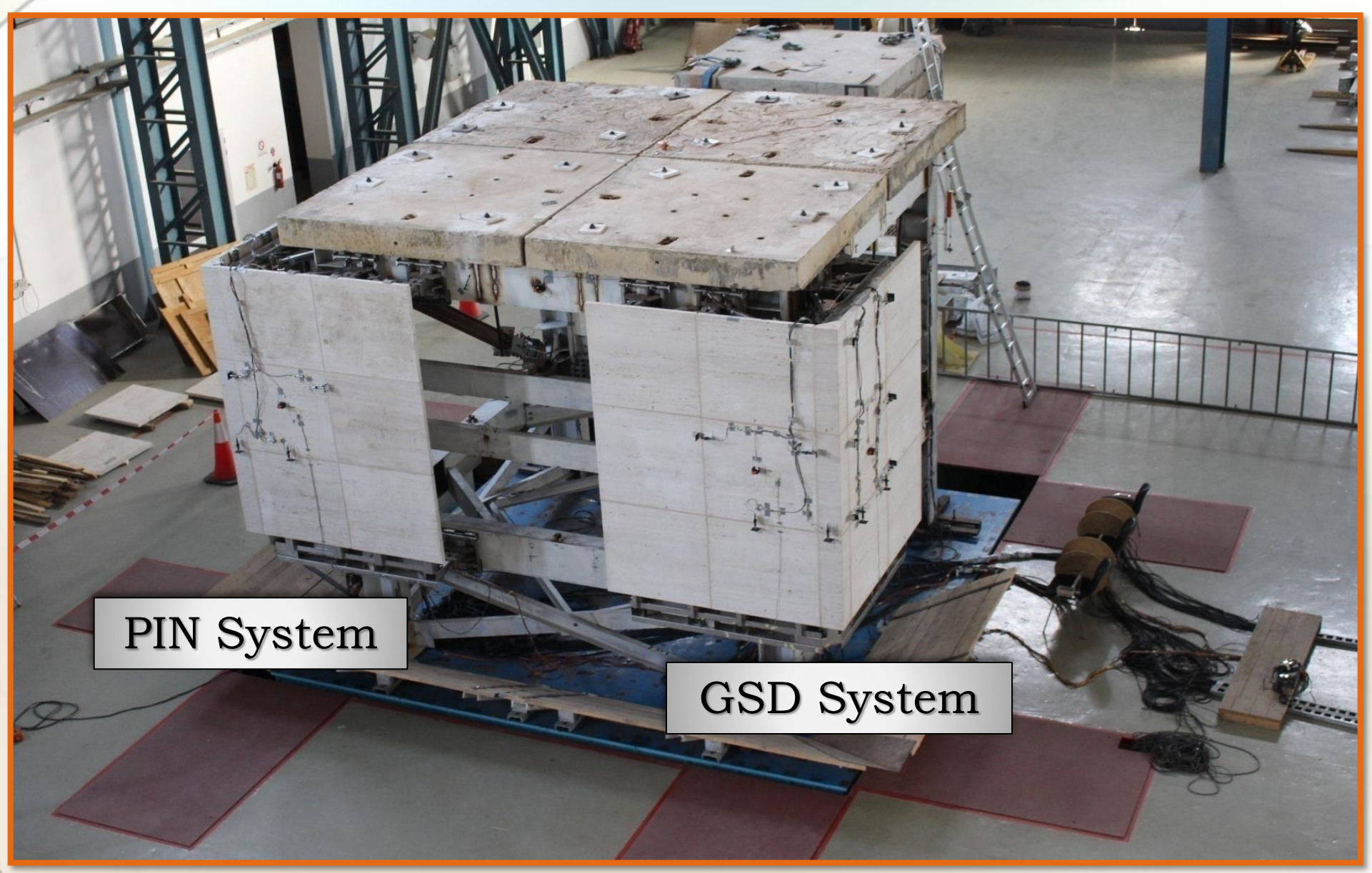
GSD System

-RIGID FRAME-

The tallest minaret in the world: 265m

RIGID FRAME -PIN- (video)-

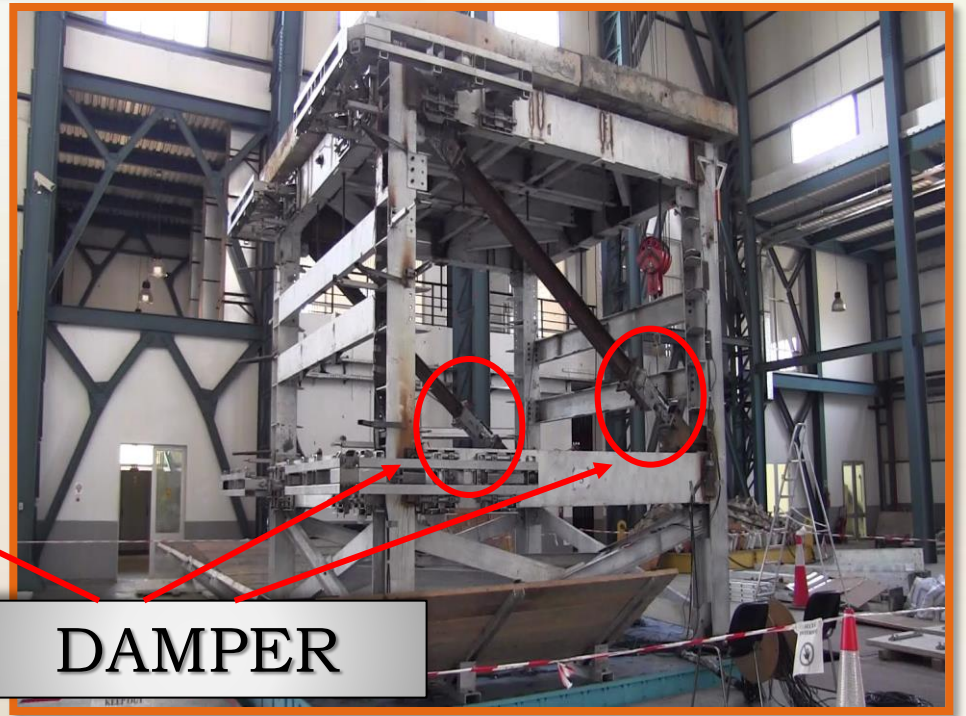
FLEXIBLE FRAME



FRAME MODIFICATION

MASS OF 20T

STIFFEN THE FLOOR



DAMPER

VIDEO PIN-GSD SYSTEM -FLEXIBLE CHASSIS-

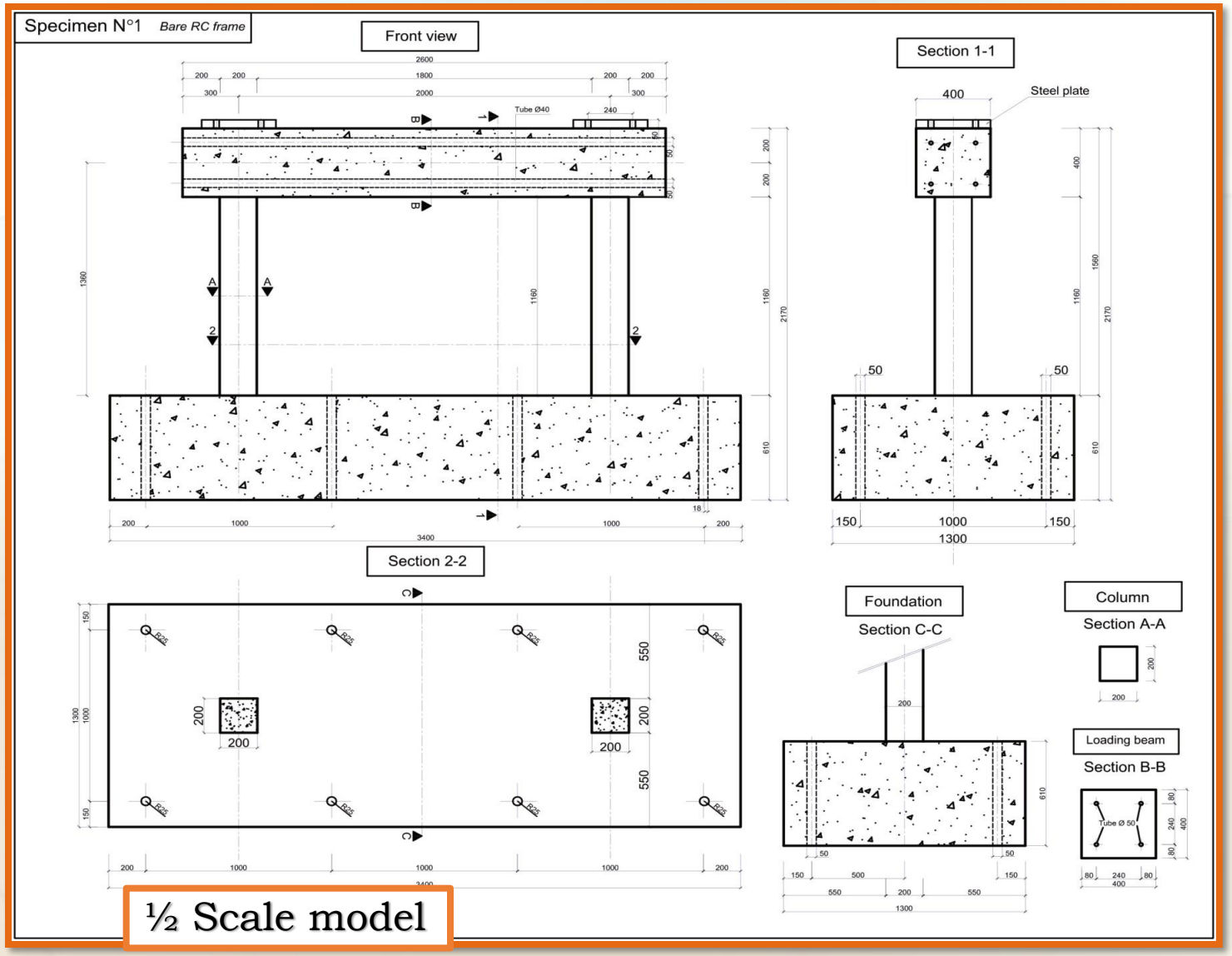
CGS's LABORATORIES

New building with masonry infill walls

Damage to the external infill walls

at lower and higher stories

CGS's LABORATORIES



THE MOST IMPORTANT ACHIEVEMENTS REACHED BY THE CGS

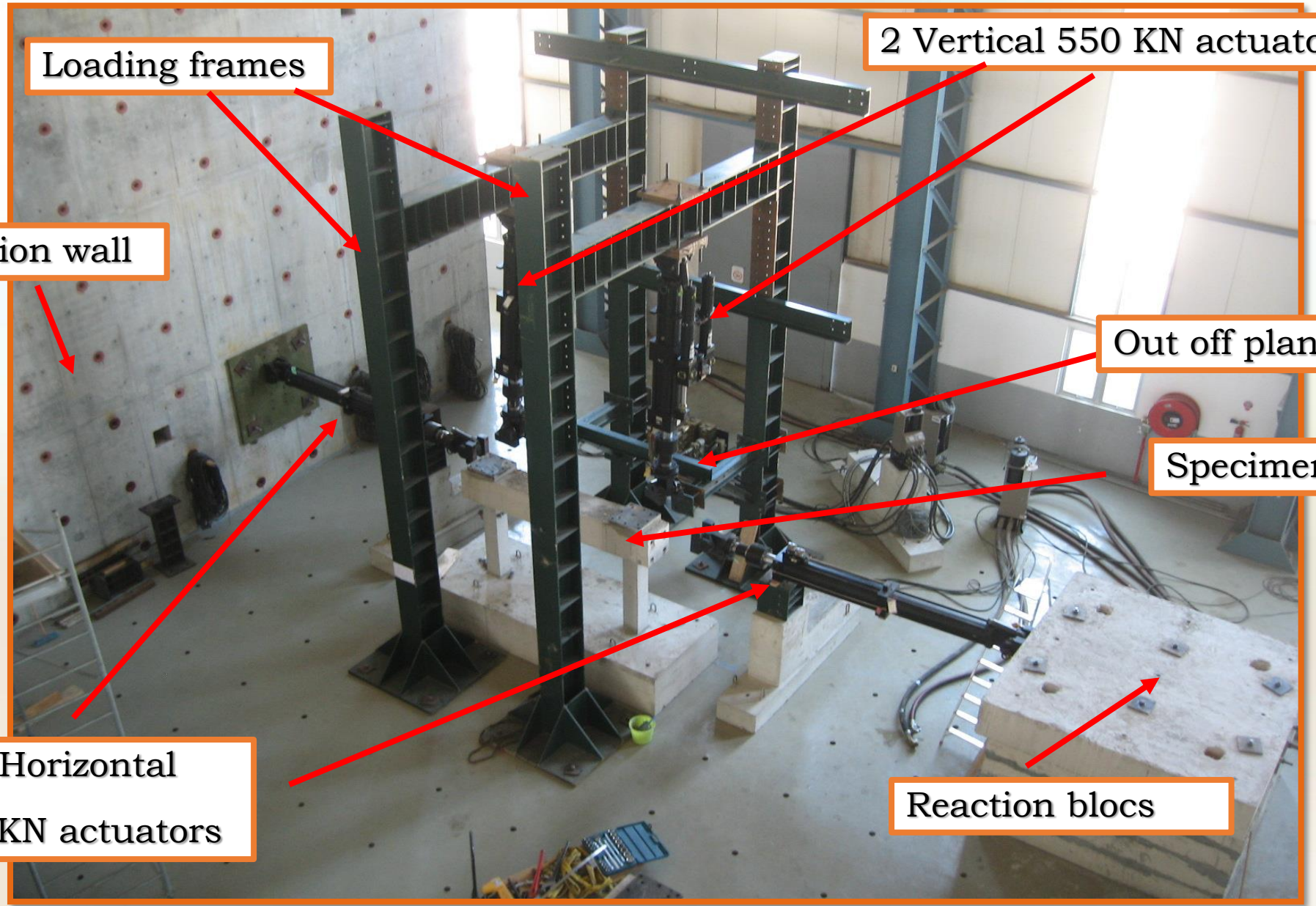
RC frames

RC frame with infill masonry panel

Test setup

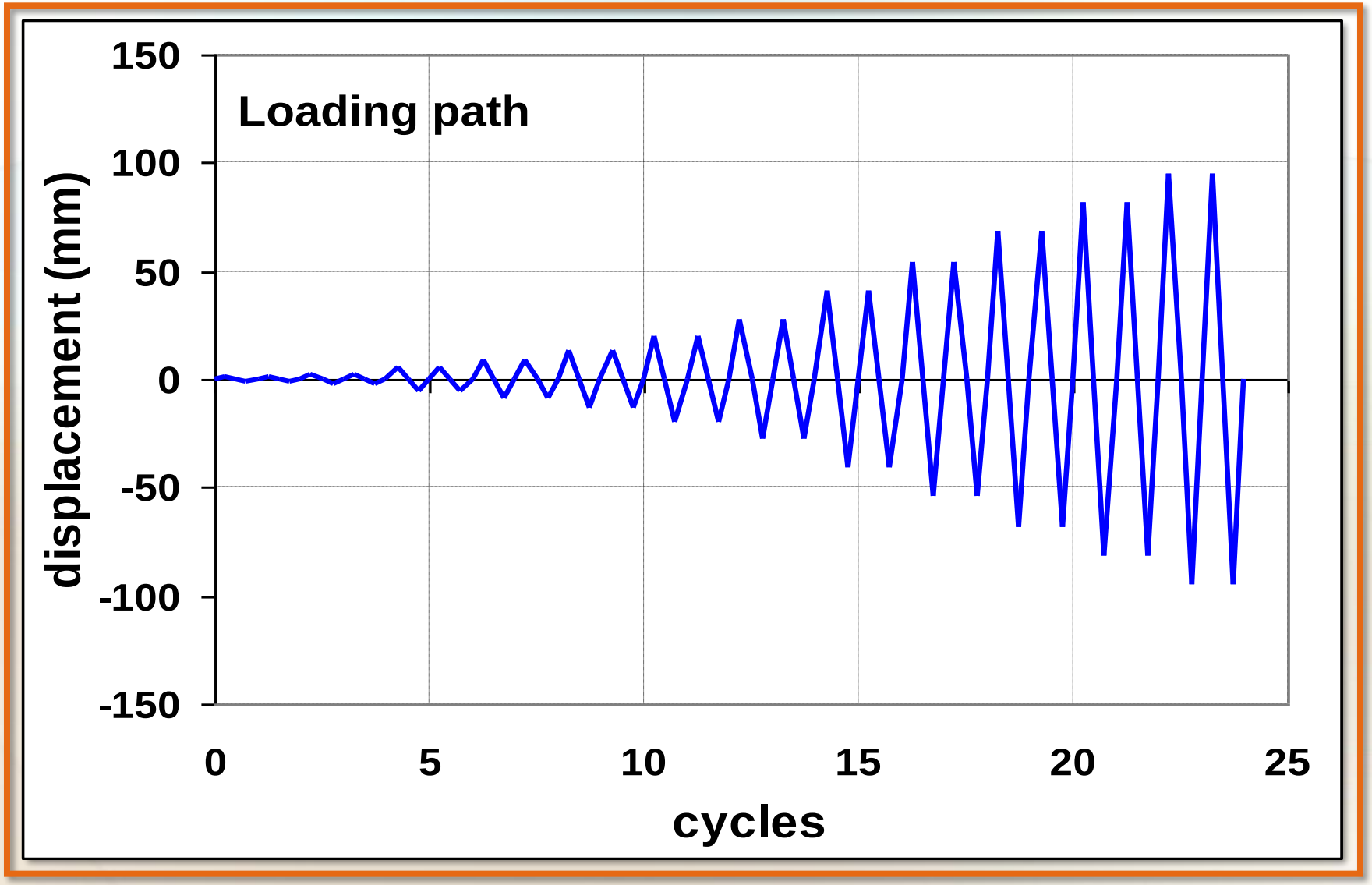
Visit of Mr. SAKASHITA (JICA expert)

Test setup


Loading frames
2 Vertical 550 KN actuators
Reaction wall
Out off plane devise
Specimen
2 Horizontal
550 KN actuators
Reaction blocs

Test setup

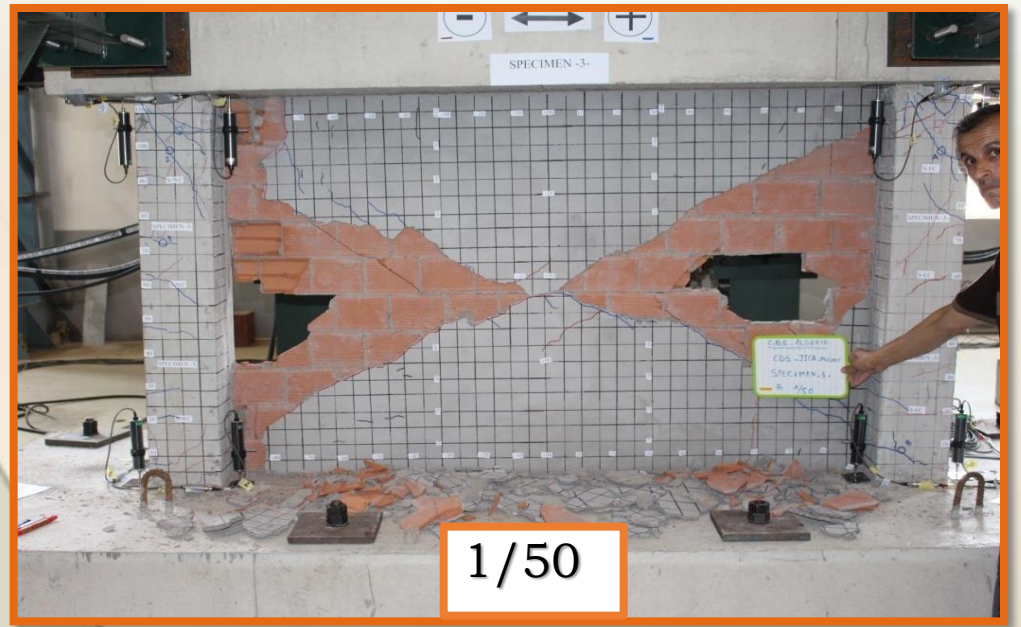
Loading path for cyclic loading



Spécimen 3

1/250

1/100



1/50

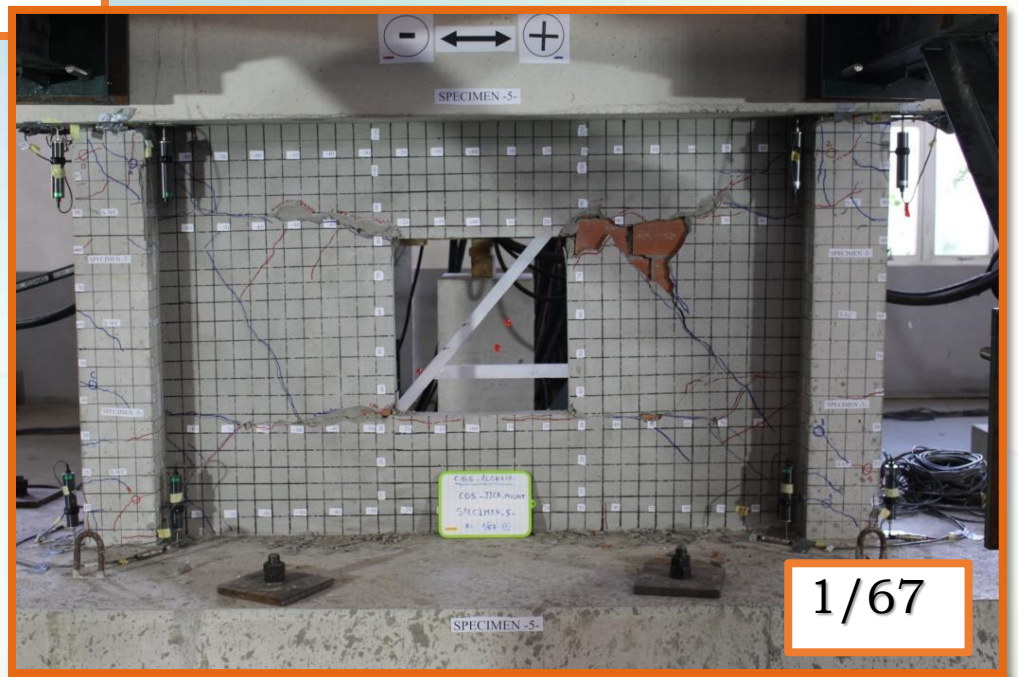
1/25

Specimen 5

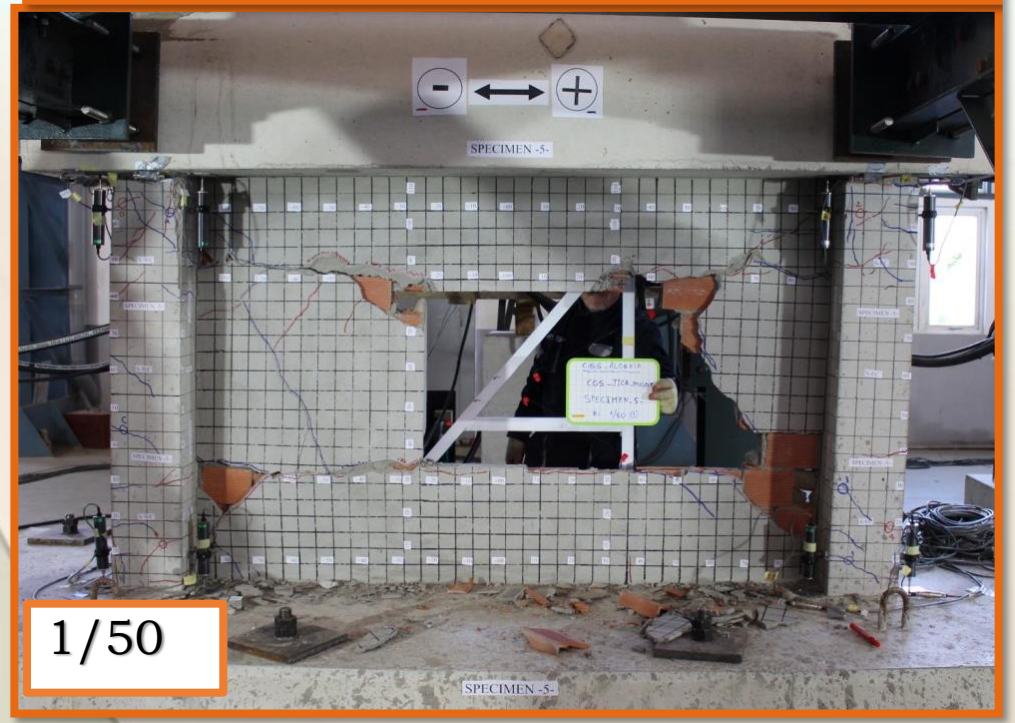
Specimen with opening

Spécimen 5

1/150



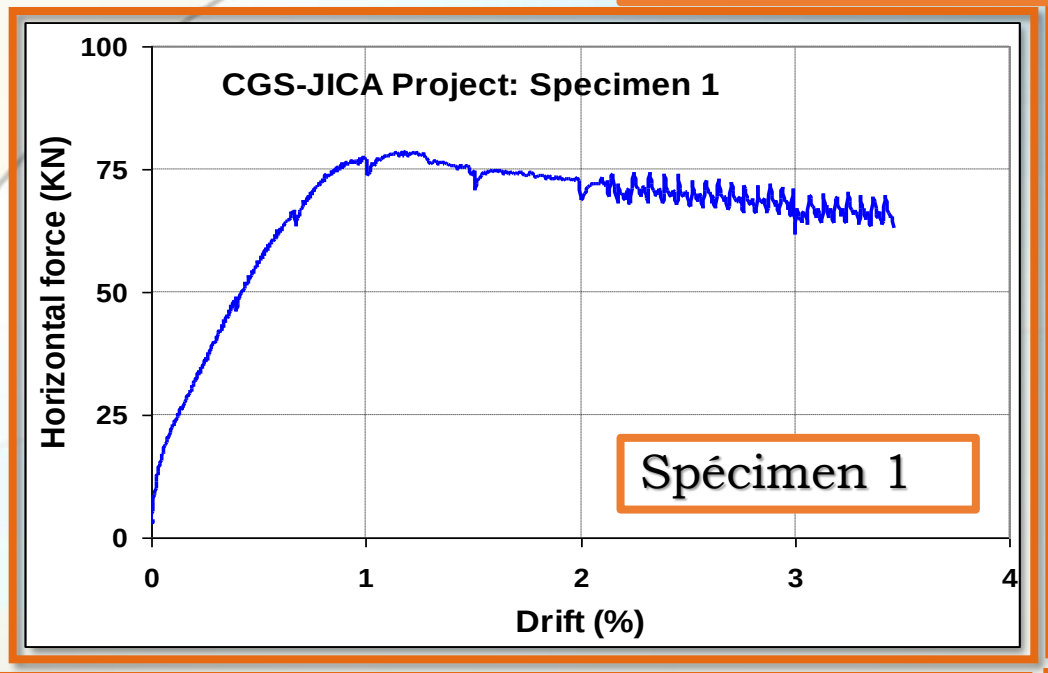
1/67

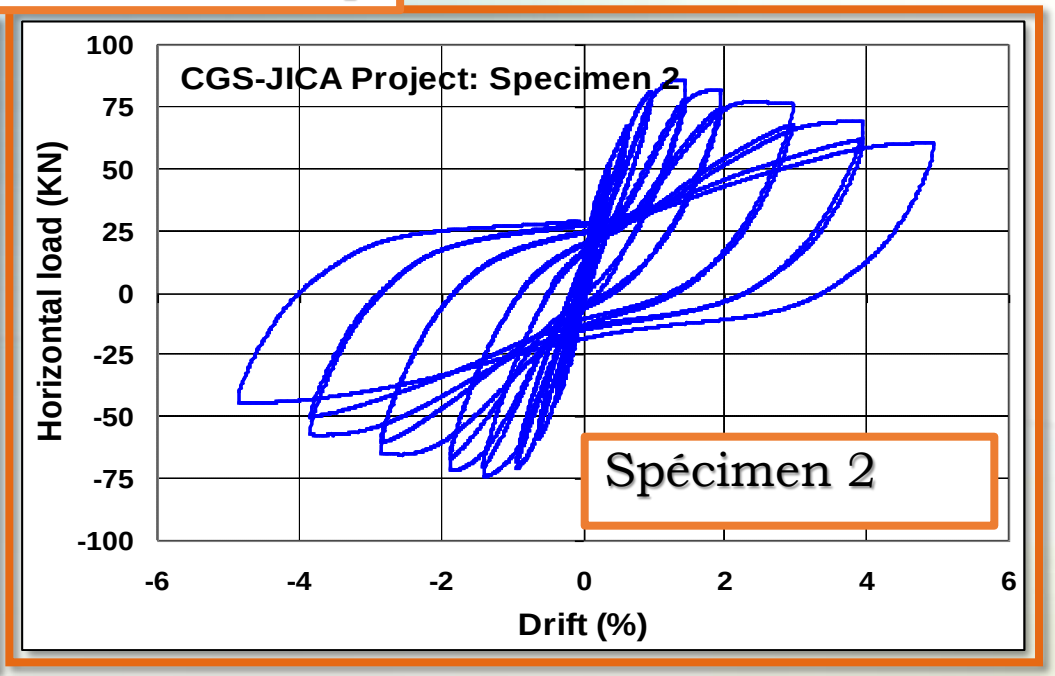


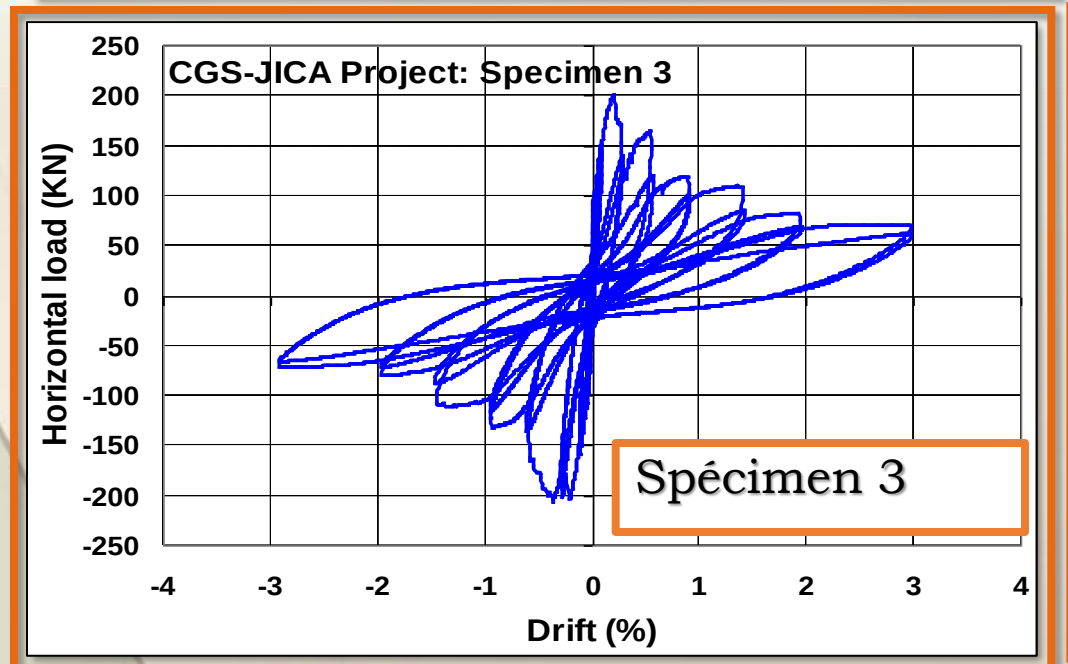
1/50

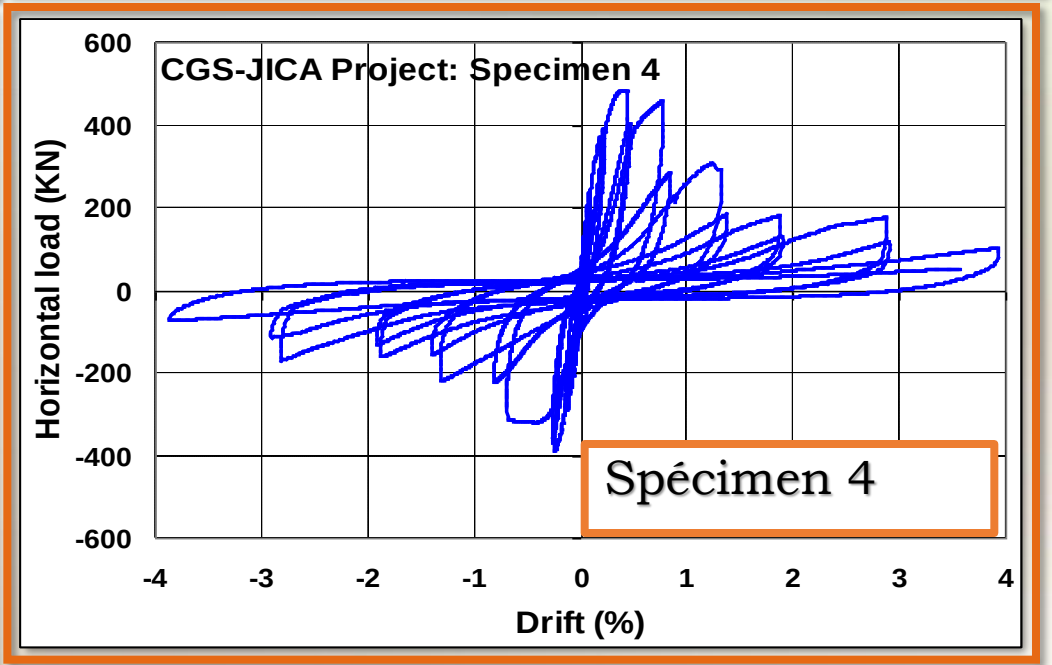
1/33

Horizontal load-drift relationship

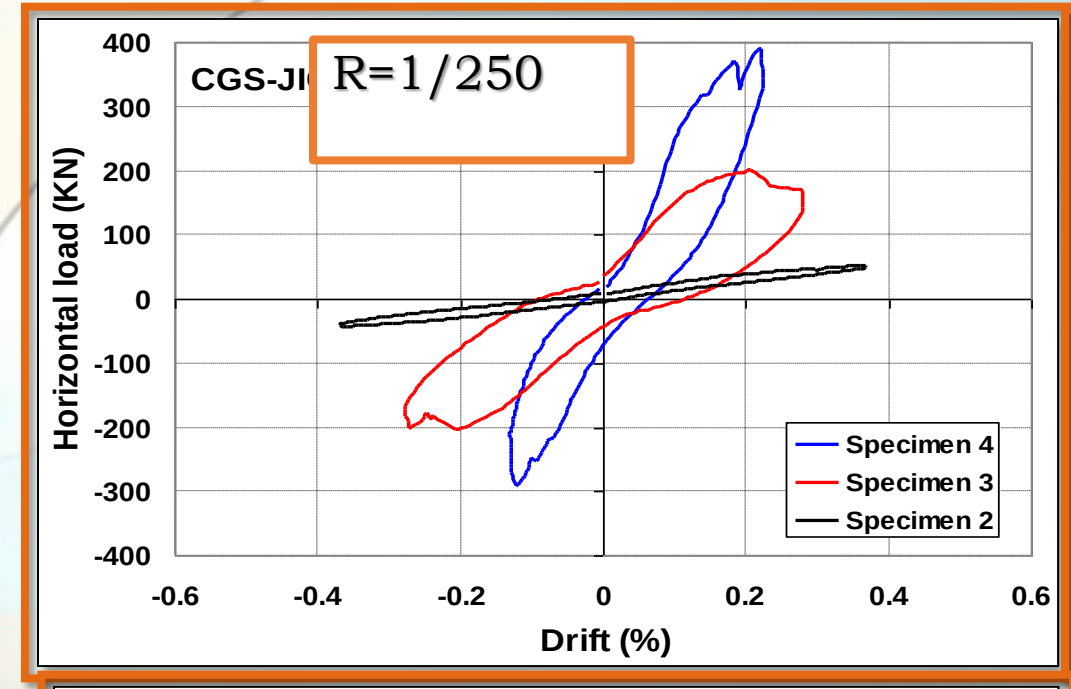


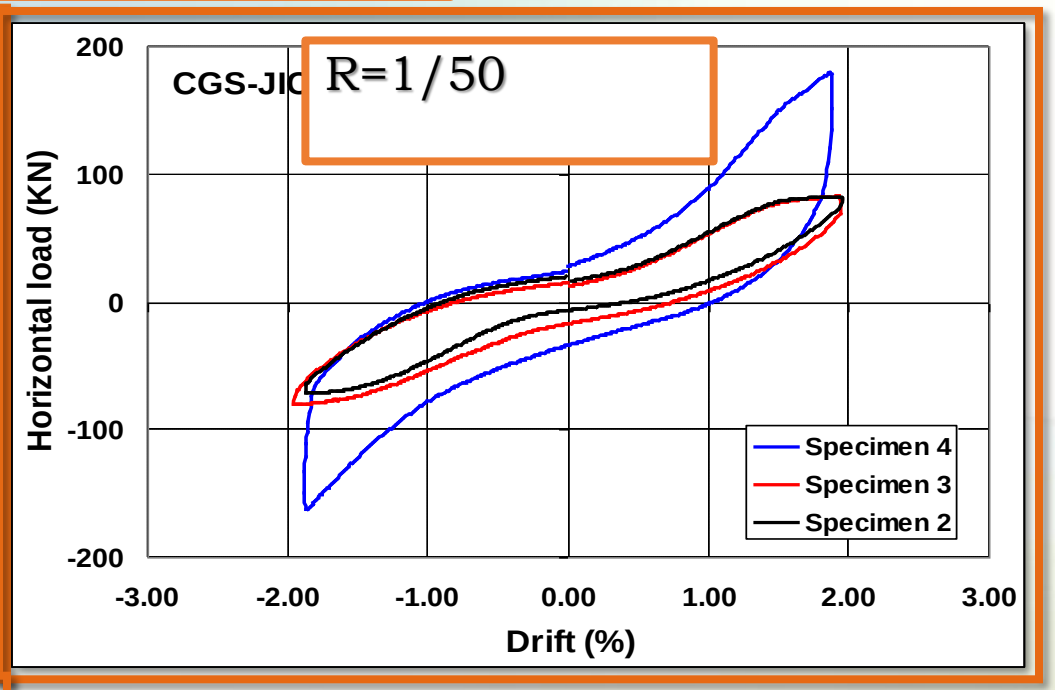


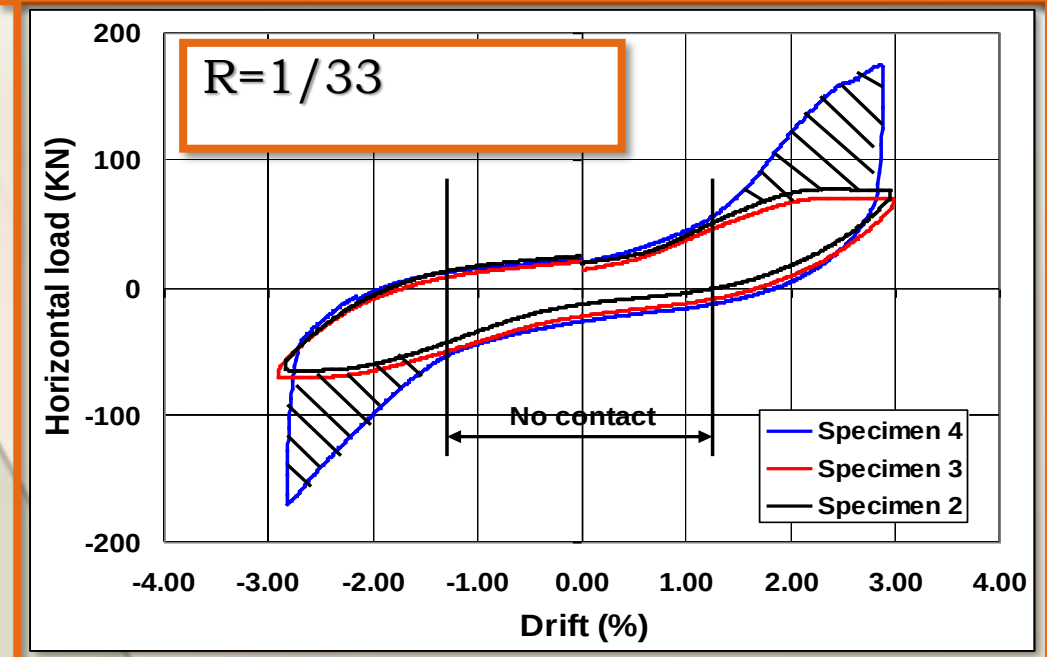




Envelope curves at each drift







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CONCLUSIONS

Earthquakes: An Inevitable Natural Phenomenon

•Earthquakes frequently occur in certain regions of the world.

•While it is impossible to stop an earthquake, it is always possible to reduce its devastating effects on buildings and infrastructure.

Key Steps to Improve Seismic Resilience

- Promote scientific research

Support research across various specialties related to earthquakes (geophysics, structural dynamics, geotechnics, etc.).

- Provide necessary material resources

Scientific research requires advanced equipment to move from theory to practice through laboratory experiments.

- Continuously improve seismic building codes

Adapt and strengthen construction regulations to better resist seismic forces, based on scientific advancements and lessons learned.

Thanks for your attention