

**THE RESPONSE OF SEISMICALLY-ISOLATED HOSPITALS  
IN THE  
KAHRAMANMARAS EARTHQUAKES OF FEBRUARY 6, 2023**

**AN OBSERVATION REPORT**

**by the**

**TURKISH ASSOCIATION FOR SEISMIC ISOLATION / TASI  
(Deprem İzolasyon Derneđi / DID )**

**May 10, 2023**



**DEPREM İZOLASYON DERNEĐİ**  
Turkish Association for Seismic Isolation

## 1.0 EXECUTIVE SUMMARY

On February 6, 2023 M7.7 and M7.6 earthquakes struck southeastern Türkiye causing extensive damage, destruction and loss of life in the region extending into northern Syria.

Of the approximately 100 isolated buildings in Türkiye, there are 11 isolated hospitals in the region of the M7.7 and M7.6 events (Figure 1).

On 10-12 February, a five-member reconnaissance team representing the Turkish Association for Seismic Isolation / TASI (Deprem İzolasyon Derneği / DID), visited all eleven seismically-isolated hospitals. The TASI team comprised

- Dr. Bahadır Şadan, TASI President and ASSISi Executive Committee member
- Mr. Mehmet Emre Özcanlı, TASI Vice-President
- Dr. Cüneyt Tüzün, TASI Secretary General
- Mr. Ömer Ülker, TASI member
- Mr. Uğurcan Özçamur, TASI member

This short report presents the initial findings of the TASI reconnaissance team investigation.

The report contains a summary information sheet for each of the eleven hospitals, comprising location and general information about the building and isolation system, a map that shows the hospital location relative to the nearest strong motion recording station with hospital to epicenter and hospital to recording station distances, and recording station response data. The strong motion data is presented as 5% damped response spectra compared to the Turkish Building Code DD1 (2475-year return period) and DD2 (475-year return period) spectra, and time history plots of the horizontal and vertical acceleration records. Building condition observations are provided, along with a selection of photos.

With the exception of two hospitals, all strong motion recording station data presented is for the M7.7 first event. Malatya State Hospital and Malatya Battalgazi State Hospital experienced stronger shaking, on the basis of PGA values, in the M7.6 event than in the M7.7 event, and the acceleration time histories and spectra shown for these two hospitals are for the M7.6 event. Further, Malatya Doganşehir State Hospital and Kahramanmaraş Elbistan State Hospital are also expected to have experienced stronger shaking in the M7.6 event, however, for these two hospitals it appears that the nearest strong motion recording stations experienced instrument problems in this event and data is not available. Lastly, there appear to be data problems with the recording stations nearest to the Adiyaman State Hospital, and thus no data is presented for this hospital.

The isolation systems for all eleven hospitals comprised curved surface sliders: ten hospitals used double-pendulum bearings and one used triple-pendulum bearings.

Only one of the eleven hospitals included an active strong motion accelerometer system, one hospital included displacement scratch plate devices, whilst the remaining nine had no response monitoring system. The reconnaissance inspection utilized an electronic borescope for internal inspection of the isolation bearings. The borescope allowed close-up detailed inspection of the isolators and observation of movement scuff marks on the sliding surface for estimates of the maximum isolation bearing

movement. Close-up inspection and measurements also allowed determination of residual displacement offset of the bearings.

Inspection access was granted to ten of the eleven facilities, and for the remaining hospital, Guney Adana Seyhan State Hospital, only exterior observation was possible.

Five of the hospitals were in varying stages of construction at the time of the earthquakes, ranging from being only about 30% structurally complete to basically finished and ready to open for service. The varying levels of completion have implications on the weight of the isolated structure and consequently the isolation bearing behavior. These aspects of response will be the subject of future investigation.

The following summary observations are made. In general, the isolated structures performed very well under the strong shaking compared to conventional buildings in the earthquake region. No structural damage was observed in any of the hospitals. Some non-structural damage was observed. This was due to poor design detailing, bad workmanship (especially for infill walls) and inadequate clearances at seismic movement joints. Flexible superstructures, such as framing systems with no shear walls, were more susceptible to infill wall damage than stiffer structures. Further analysis is needed to thoroughly understand the detailed behavior of the seismically isolated hospitals.

Based on the reconnaissance observations, a number of immediate recommendations are made:

- Seismic movement gaps and moat cover details need to be specially designed.
- Seismic bracing for suspended ceilings and mechanical/electrical/plumbing systems is necessary, even in isolated structures.
- Building occupants should be informed about seismic isolation and expected movement, and building users should understand the importance of maintaining seismic movement clearances.
- Structural health monitoring systems are essential to understand the performance of seismically-isolated structures.

This findings presented herein are the observations of the TASI reconnaissance team.

Significant contributions to the report, in the form of data collection, evaluation of ground motion records and report preparation were made by TASI member, SIE, Inc.

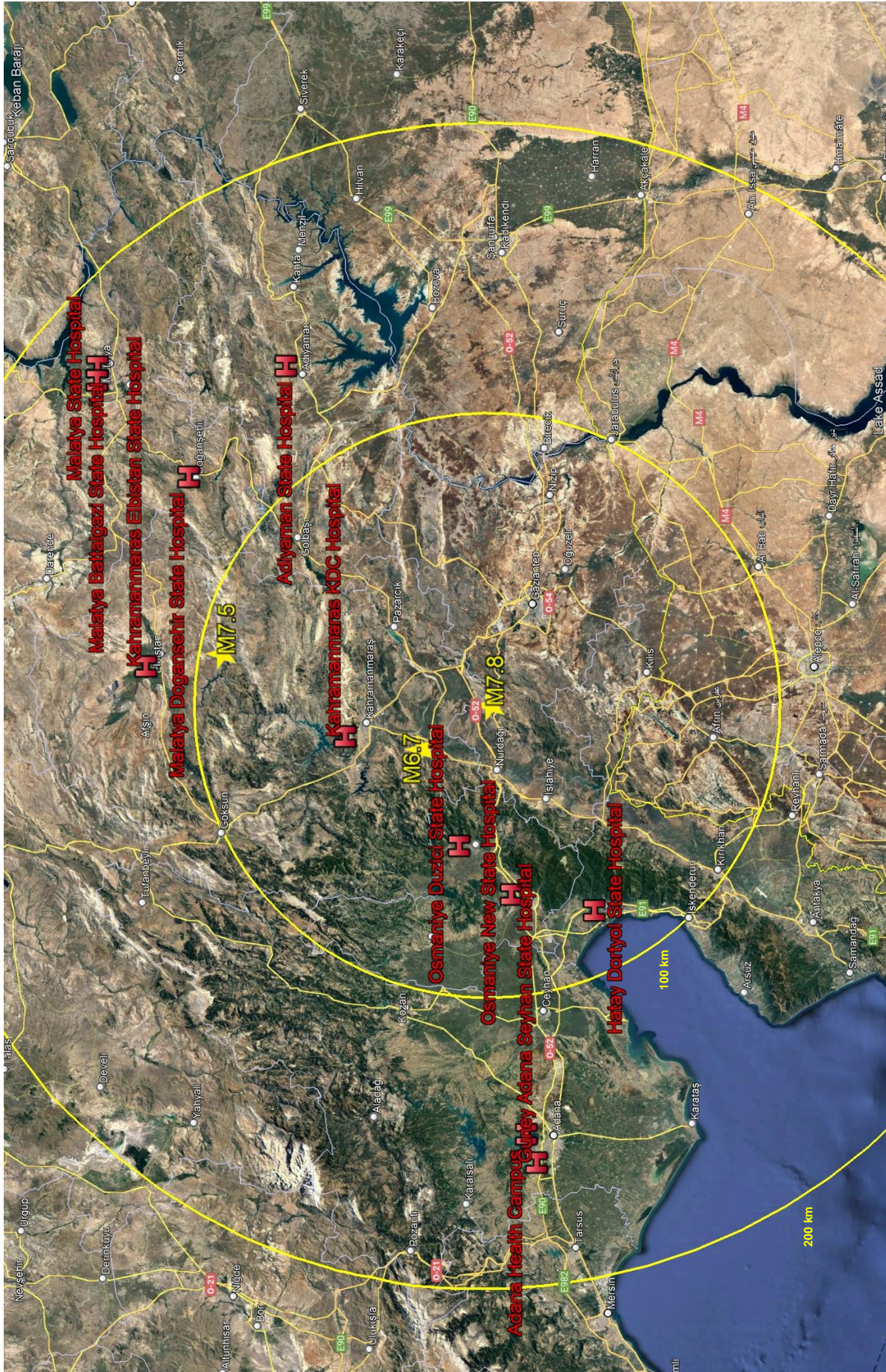


Figure 1. Seismically-isolated hospitals in M7.8 epicentral region

## 2.0 ACKNOWLEDGEMENTS

The seismically-isolated hospitals were visited just a few days after the earthquakes in what were challenging circumstances for the facilities. Many personnel at the hospitals visited were generous with their time and provided assistance and support to the TASI team. There are too many to name individually, but TASI extends thanks to all those who supported our work.

In particular, sincere thanks are extended to Dr. Erol Karaaslan, Chief Physician of Malatya Battalgazi State Hospital, and DKR İnşaat, general contractor for the Kahramanmaraş KDC Hospital, who provided overnight accommodations to the reconnaissance team.

## Table of Contents

1.0. Executive Summary.....	2
2.0. Acknowledgements.....	5
Table of Contents.....	6
3.0 Observations.....	7
3.1 Malatya Battalgazi State Hospital (Malatya Battalgazi Devlet Hastanesi) .....	8
3.2 Malatya State Hospital (Malatya Merkez KDÇ Hastanesi) .....	10
3.3 Malatya Doganşehir State Hospital (Malatya Doğanşehir Devlet Hastanesi).....	12
3.4 Kahramanmaraş Elbistan State Hospital (Kahramanmaraş Elbistan Devlet Hastanesi).....	14
3.5 Kahramanmaraş KDC Hospital (Kahramanmaraş KDÇ Hastanesi) .....	16
3.6 Adiyaman State Hospital (Adiyaman Merkez Devlet Hastanesi) .....	18
3.7 Osmaniye Duzici State Hospital (Osmaniye Düziçi Devlet Hastanesi) .....	20
3.8 Osmaniye State Hospital (Osmaniye Devlet Hastanesi) .....	22
3.9 Hatay Dört Yol State Hospital (Hatay Dört Yol Devlet Hastanesi).....	24
3.10 Adana Güney Seyhan Hospital (Adana Güney Seyhan Devlet Hastanesi) .....	26
3.11 Adana Health Campus (Adana Şehir Hastanesi).....	27

### 3.0 OBSERVATIONS

Information sheets for each of the eleven seismically-isolated hospitals visited by the reconnaissance team are provided, with the following information:

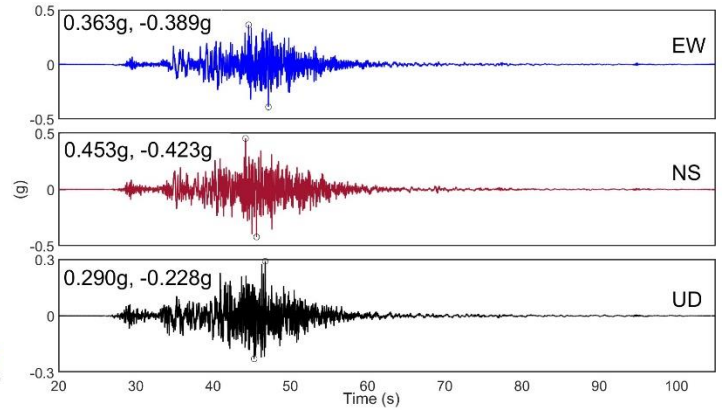
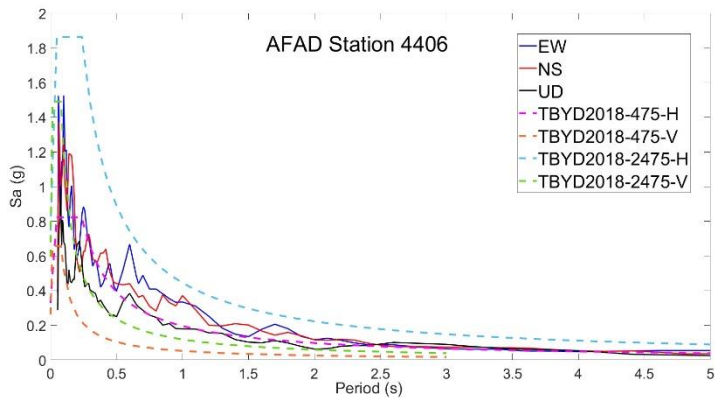
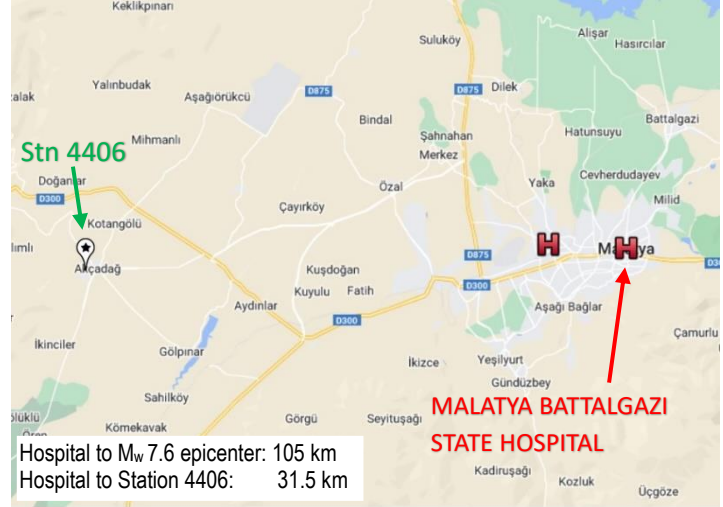
- Hospital name (English and Turkish), geographic coordinates, and some basic facts (no. of beds, no. of stories, structural system, type and number of seismic isolation bearings, and bearing displacement capacity (where known))
- Map showing hospital and nearest strong ground motion station(s), with hospital to earthquake epicenter and hospital to strong ground motion station distances.
- Response spectra and ground acceleration time history records for the nearest strong ground motion station.
- Summary observations made by the reconnaissance team.
- Photographs of the structure, and notable aspects of response.

## 3.1 MALATYA BATTALGAZI STATE HOSPITAL

[ MALATYA BATTALGAZI DEVLET HASTANESİ ]

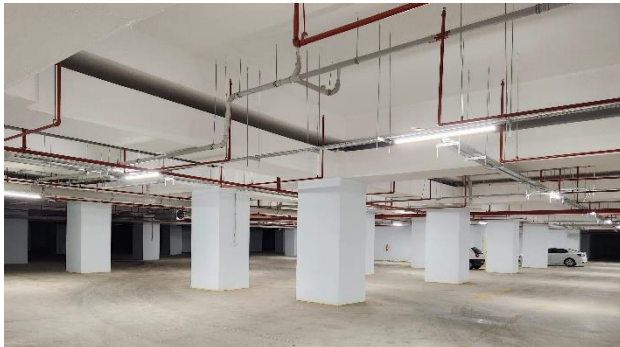
38.334222 °N / 38.346867 °E

*Capacity* 300 beds  
*Superstructure* 10 stories, RC frame and infill walls  
*Isolators* 222 double pendulum bearings, displacement capacity 450 mm



### Observations:

- Isolation worked effectively and hospital operation not affected by earthquake.
- In addition to ongoing hospital operation, the building was also serving as a shelter.
- Maximum isolator displacement was approximately 17 cm, and about 1.5 cm residual offset.
- No damage observed to isolation bearings or connections.
- No damage observed to utility or piping systems crossing isolation plane.
- Some minor cracking observed at joints between structural framing and non-structural partition walls.



Suspended elevator/staircase and cracks in partition walls

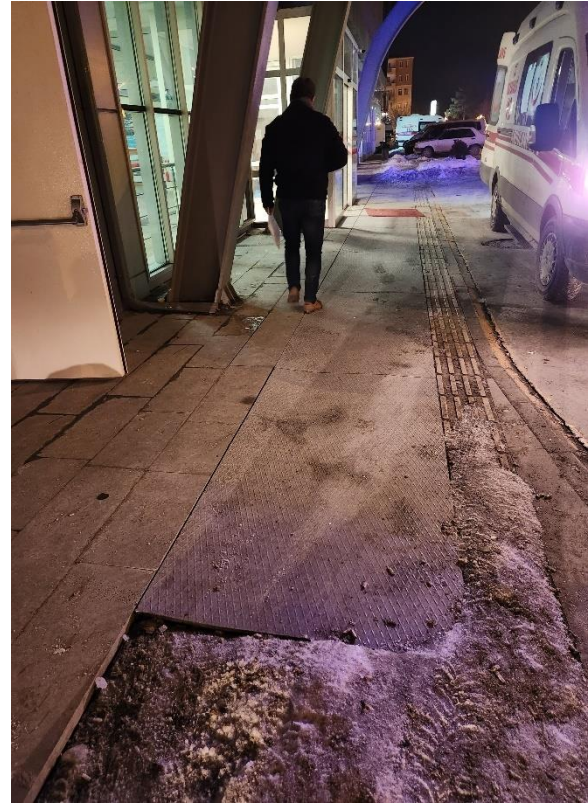


General view of isolation basement





Exterior view of hospital



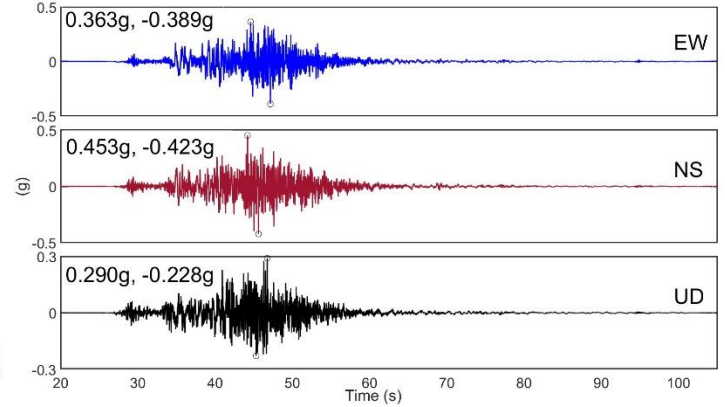
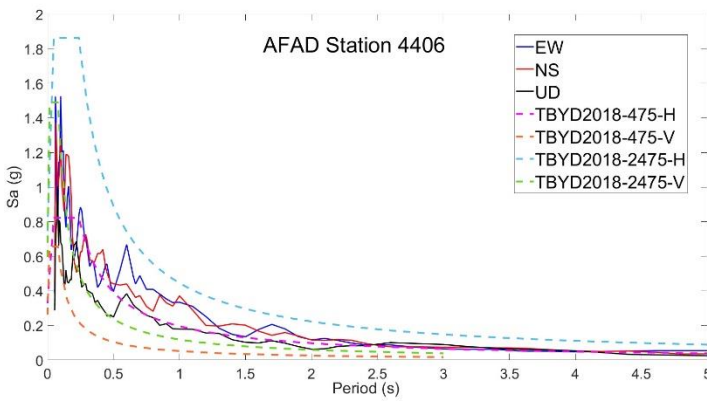
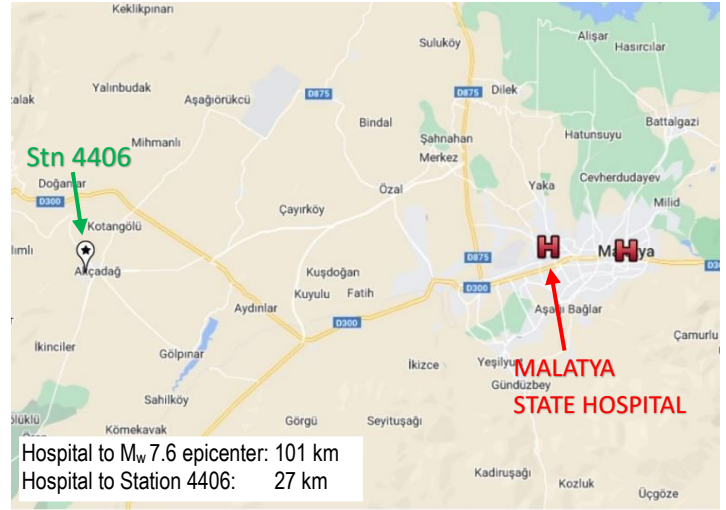
Moat cover at emergency entrance

## 3.2 MALATYA STATE HOSPITAL

### [ MALATYA MERKEZ KDÇ HASTANESİ ]

38.280313° N / 38.348946° E

Capacity 300 beds  
Superstructure 15 stories, RC shear wall frame and infill walls  
Isolators 246 double pendulum bearings, displacement capacity 360 mm



#### Observations:

- Hospital operational at time of inspection visit.
- Maximum isolator displacement was approximately 4 cm.
- No damage observed to isolation bearings or connections.
- No structural damage, but non-structural damage observed (walls, suspended ceilings).
- Seismic gaps and clearances around the building not correctly implemented in some places.
- Soil retaining walls connected to isolated structure at perimeter joint.
- No damage observed to utility or piping systems crossing isolation plane.



Damage at perimeter joint



Damage at perimeter joint



General view of isolation basement



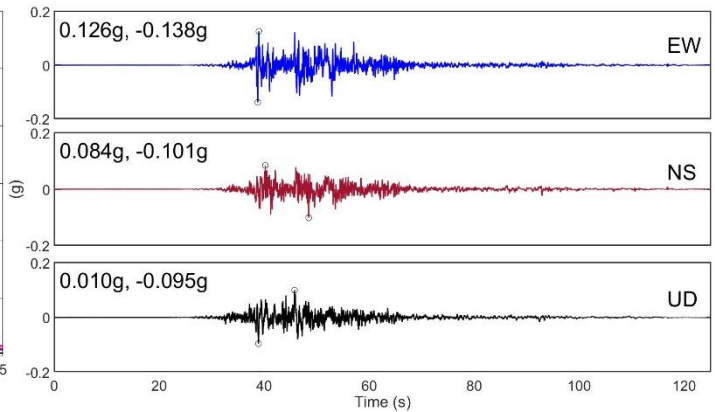
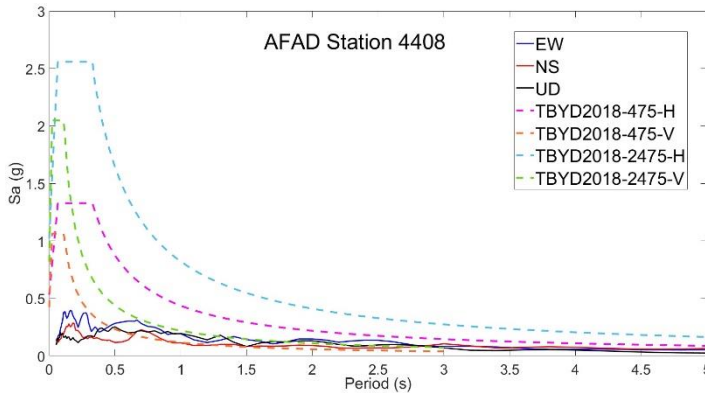
Basement wall damage due to lack of movement joint

## 3.3 MALATYA DOĞANŞEHİR STATE HOSPITAL

[ MALATYA DOĞANŞEHİR DEVLET HASTANESİ ]

37.895738 °N / 38.068787 ° E

Capacity 100 beds  
Superstructure 10 stories, RC frame and infill walls  
Isolators 122 double pendulum bearings, displacement capacity 490 mm



### Observations:

- Hospital operations disrupted by earthquake damage and not in-service at time of inspection visit.
- Maximum isolator displacement approximately 9 cm, and about 1 cm residual offset.
- No damage observed of isolation bearings or connections.
- No structural damage, but non-structural damage observed.
- Unrestrained partition walls toppled and caused damage to suspended ceilings.
- Seismic gaps filled with soil and debris, soil retaining walls connected to isolated structure.



General view of hospital at time of post-earthquake inspection visit



Double pendulum bearing, with small residual offset visible



Damage due to no movement clearance between isolated structure and retaining wall



Spalling of plaster at perimeter joint



Damage to tilework at moat perimeter



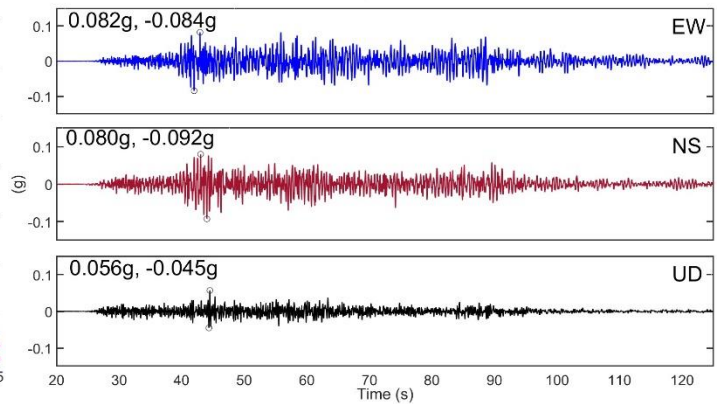
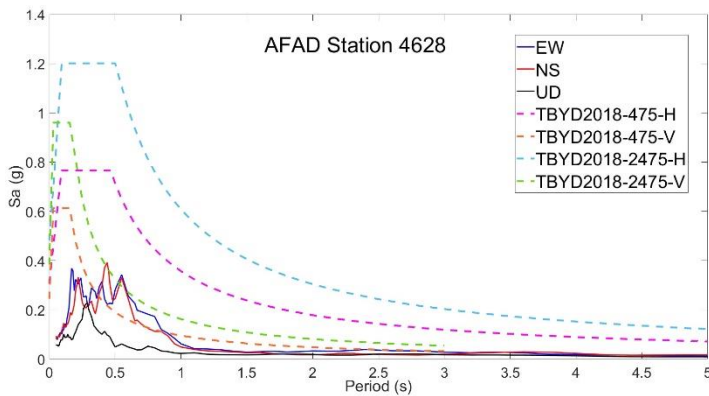
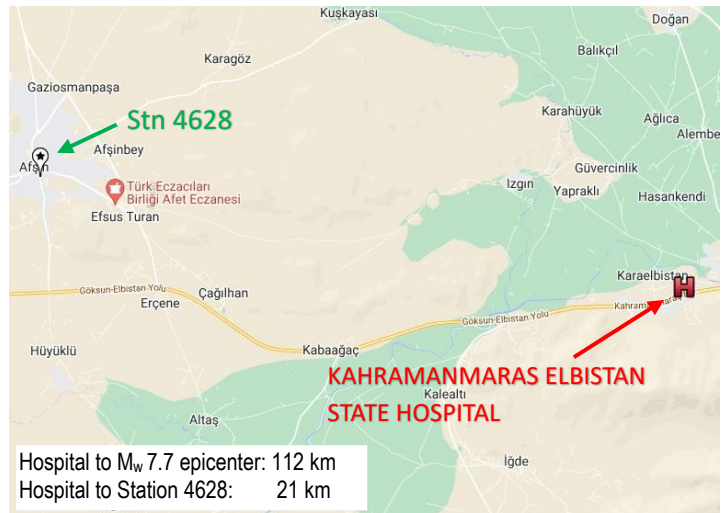
Suspended ceiling damage

## 3.4 KAHRAMANMARAŞ ELBİSTAN STATE HOSPITAL

[ KAHRAMANMARAŞ ELBİSTAN DEVLET HASTANESİ ]

37.157334 °N / 38.2044 ° E

Capacity 300 beds  
Superstructure 8 stories, RC shear wall frame and infill walls  
Isolators 455 double pendulum bearings, displacement capacity 300 mm



### Observations:

- Hospital operation not affected by the earthquakes.
- Overall, seismic isolation system and movement detailing all functioned well.
- Maximum isolator displacement was approximately 4 cm, and about 1 cm residual offset.
- No damage observed to isolation bearings or connections.
- No damage observed to utility systems crossing isolation plane, or perimeter moat covers.
- Some minor damage to tilework at front entrance movement joint.
- Some minor cracking observed at joints between structural framing and non-structural partition walls.



General view of hospital at time of post-earthquake inspection



Close-up of isolation bearing slider unit below dust protection skirt



Damage to tile at entryway movement joint



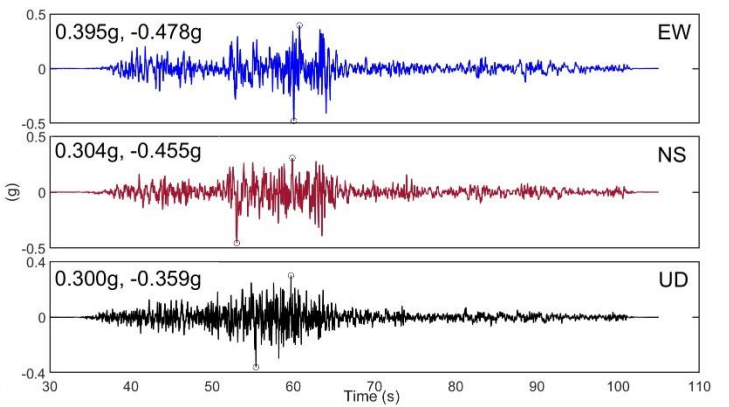
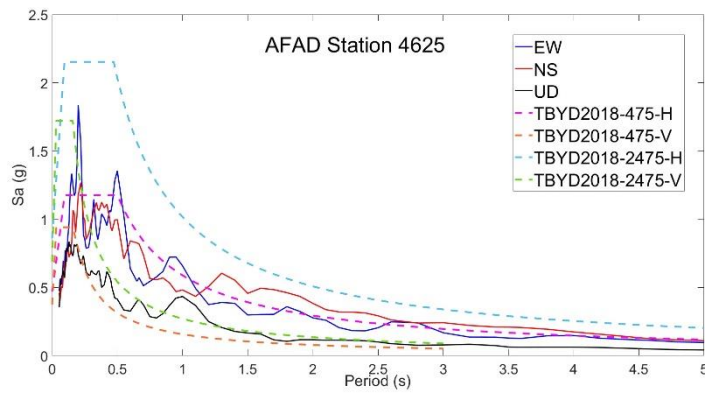
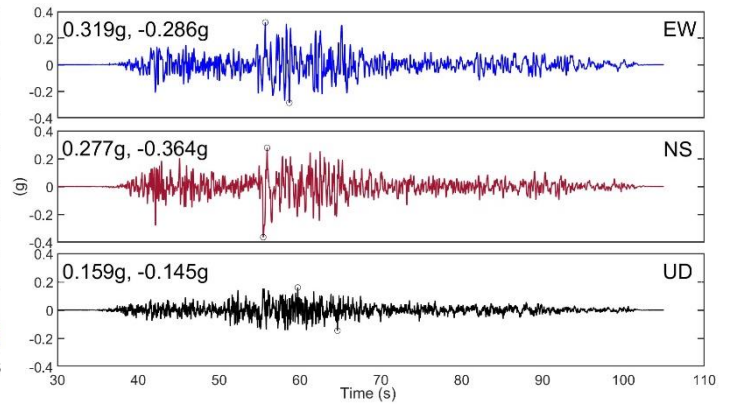
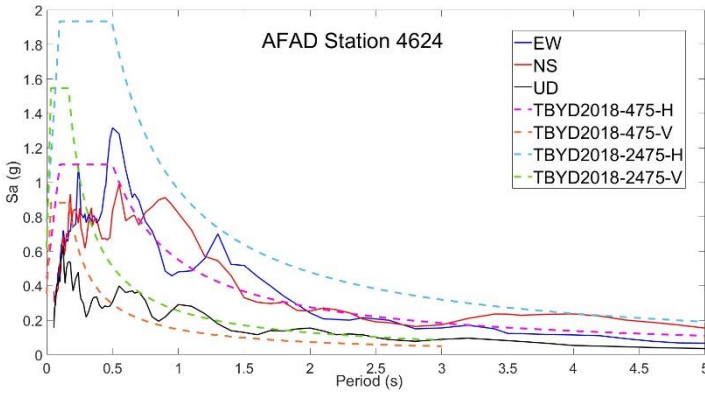
Damage to floor tile at emergency entrance

# 3.5 KAHRAMANMARAS KDC HOSPITAL

[ KAHRAMANMARAŞ KDÇ HASTANESİ ]

37.005590 °N / 37.501952 ° E

Capacity 300 beds  
Superstructure 8 stories, RC frame and infill walls  
Isolators 361 double pendulum bearings, displacement capacity 1000 mm



**Observations:**

- Hospital under construction at the time of the earthquakes, structurally about 30% complete.
- Isolators had shipping locking bolts attached, which were bent and broken.
- Maximum isolator displacement was approximately 16 cm, and about 4 cm residual offset.





State of construction at time of earthquakes



General view of isolation basement



Inspection of isolation bearing with boroscope



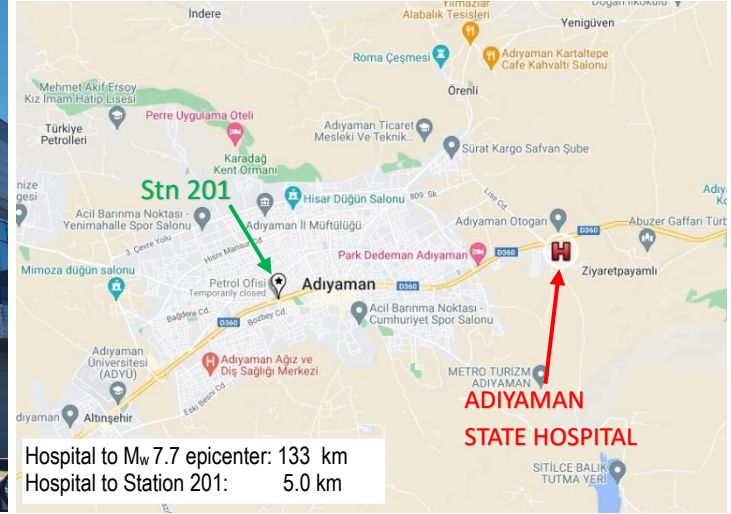
Isolation bearing with offset and disconnected shipping bolts

## 3.6 ADIYAMAN STATE HOSPITAL

### [ ADIYAMAN MERKEZ DEVLET HASTANESİ ]

38.32346°N / 37.76697° E

Capacity 300 beds  
Superstructure 10 stories, RC frame and infill walls  
Isolators 264 double pendulum bearings, displacement capacity 350 mm



AFAD strong motion data still being evaluated

AFAD strong motion data still being evaluated

#### Observations:

- Hospital under construction at the time of the earthquakes: RC frame and infill walls complete, exterior cladding and internal partition walls in progress.
- Maximum isolator displacement was approximately 12 cm, and about 2 cm residual offset.
- Design of moat and seismic clearances OK, but some perimeter locations restricted with soil fill/construction debris.
- No damage observed to isolation bearings or connections.
- Out-of-plane failure of some unrestrained interior partition walls.
- No damage observed to exterior cladding or window systems.



State of construction at time of earthquakes



Soil fill at moat cover perimeter



Soil movement at moat cover perimeter



Estimated maximum displacement approximately 12 cm



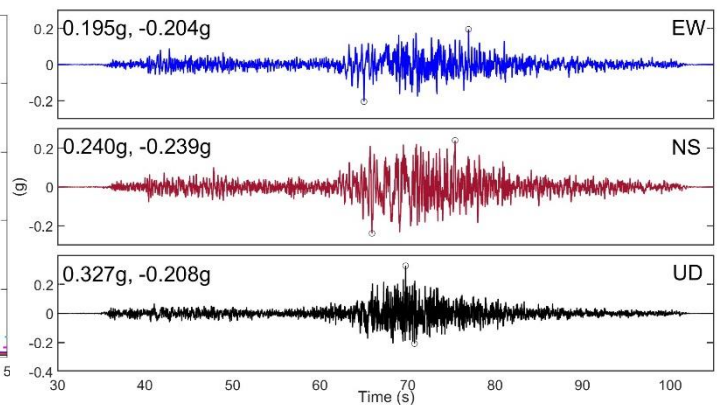
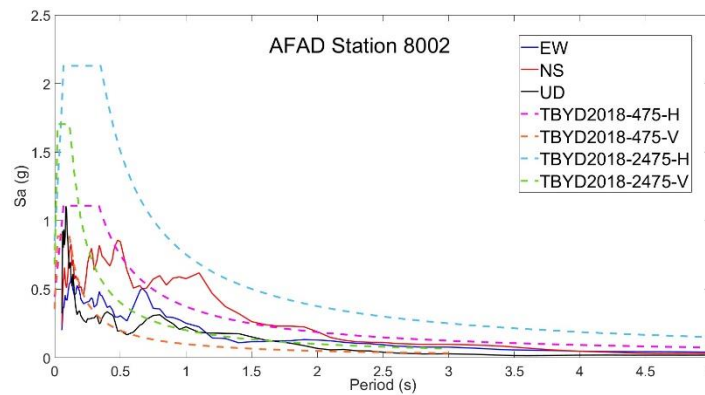
Damage at movement joint with inadequate clearance

## 3.7 OSMANIYE DÜZİCİ STATE HOSPITAL

[ OSMANIYE DÜZİCİ DEVLET HASTANESİ ]

36.461281°N / 37.244404° E

Capacity 100 beds  
Superstructure 5 stories, RC frame and infill walls  
Isolators 206 double pendulum bearings, displacement capacity 590 mm



### Observations:

- Hospital under construction at the time of the earthquakes, RC frame, infill walls and interior partition walls complete; installation of ceilings and MEP systems in progress.
- Maximum isolator displacement was approximately 8 cm.
- No damage, structural or non-structural, observed.
- Good seismic detailing for infill walls and suspended ceilings.
- Inadequate clearances at perimeter seismic gap likely restricted movement of building.
- Improper movement joint/gap detailing in a number of places.



Status of construction at time of earthquake



Inspection of isolation bearing using boroscope



Construction debris and soil at perimeter joint



Construction debris restricting movement at moat cover perimeter



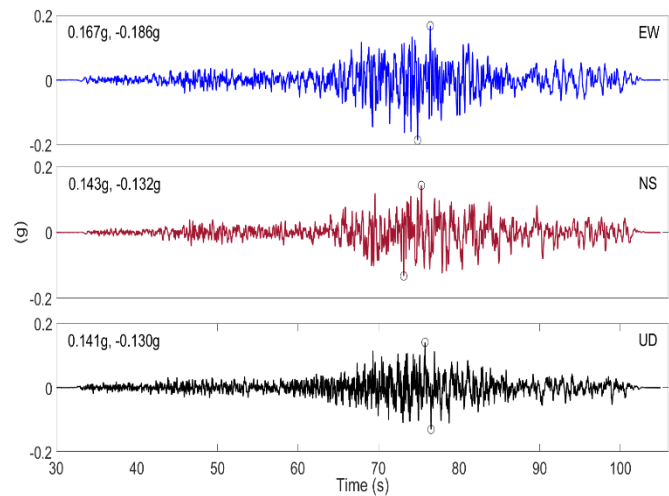
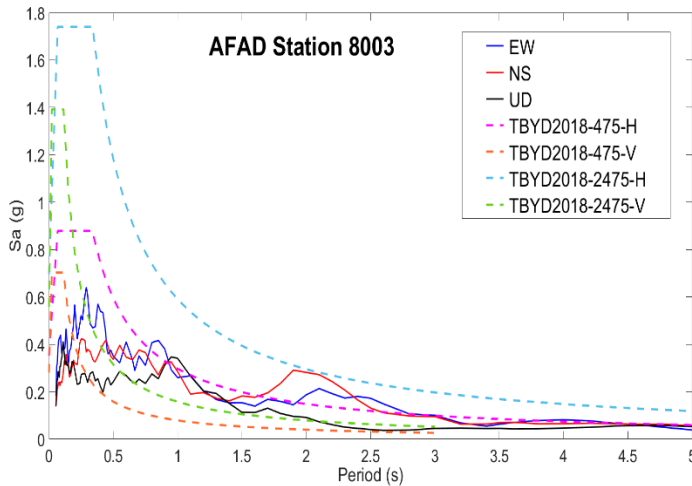
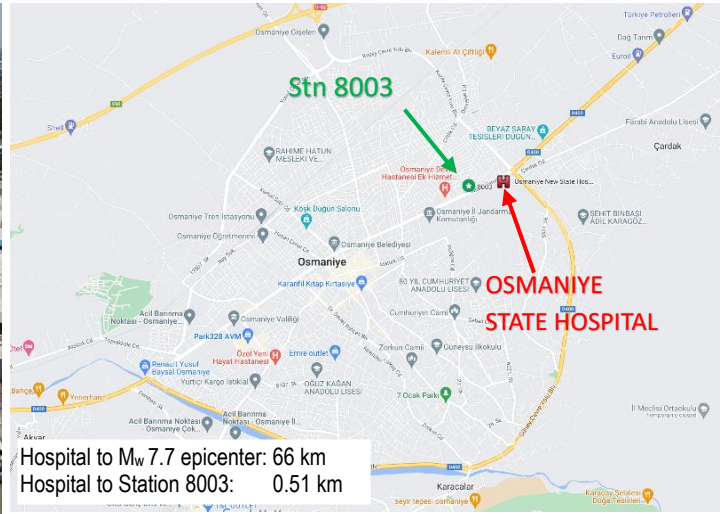
No movement clearance between perimeter moat cover and adjacent wall

## 3.8 OSMANIYE STATE HOSPITAL

### [ OSMANIYE DEVLET HASTANESİ ]

36.27499°N / 37.0836° E

Capacity 600 beds  
Superstructure 9 stories, RC frame and infill walls  
Isolators 541 double pendulum bearings, displacement capacity 450 mm



#### Observations:

- At time of earthquakes, construction complete and hospital ready to open.
- Maximum displacement was 4 to 5 cm determined from dust marks on isolator sliding plate, and permanent offset displacement was about 1 cm. Displacement of soil at moat cover perimeter suggested movement of about 12-13 cm.
- Accelerometer instrumentation system installed but not active.
- Monitoring system included two displacement scratch plates.
- Some minor cracking observed at joints between structural framing and non-structural partition walls.
- Unfastened electric box at roof level overturned.
- Damage observed at some mechanical pipes between isolated building and non-isolated parking space due to incorrect function of flexible joints.



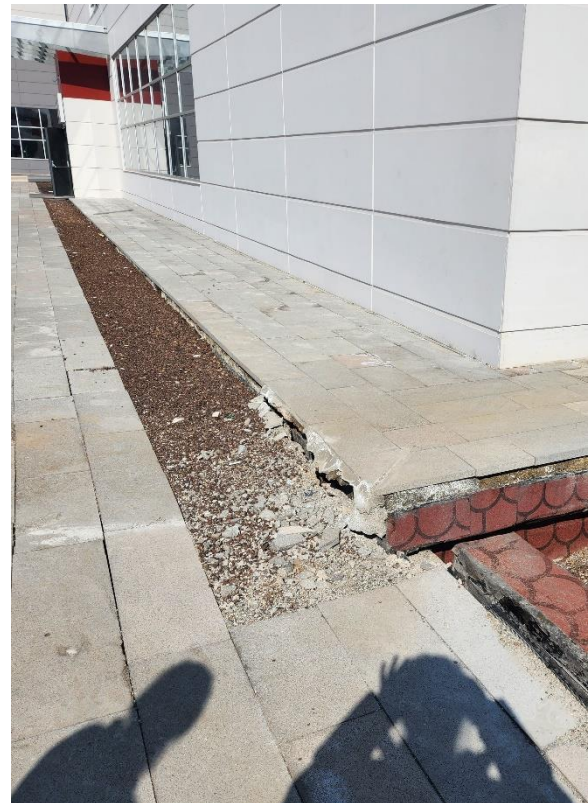
Scratch plate indicating approx. 4 cm maximum movement



Damage to piping system support due to incorrect function of flexible joint



Moat filled with crushed pumice stone and signs of movement



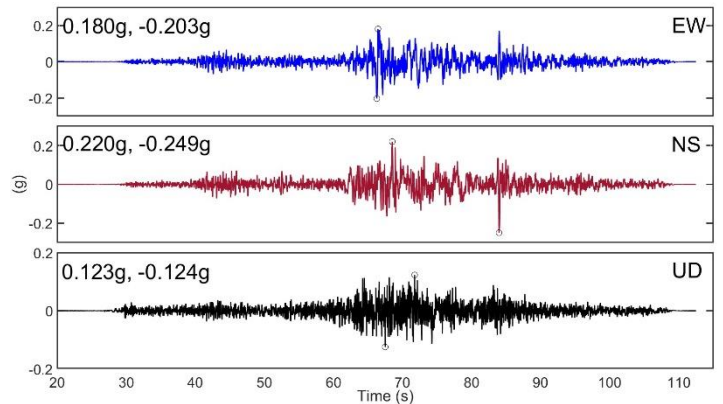
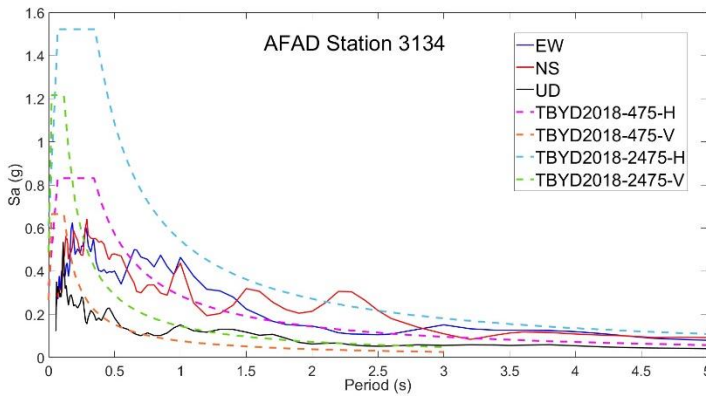
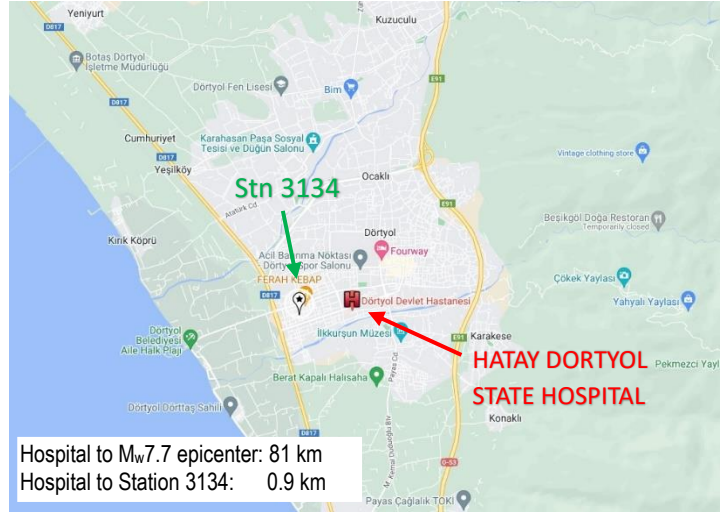
Perimeter joint

## 3.9 HATAY DORTYOL STATE HOSPITAL

[ HATAY DÖRTYOL DEVLET HASTANESİ ]

36.214954 °N / 36.828394 ° E

**Capacity** 250 beds  
**Superstructure** 11 stories, RC frame and infill walls  
**Isolators** 340 double pendulum bearings, displacement capacity 400 mm

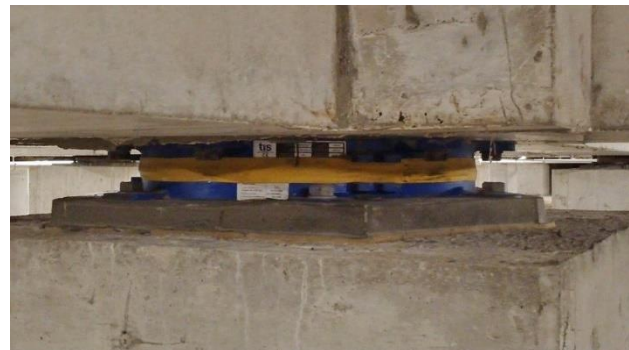


### Observations:

- Isolation worked effectively and hospital operation not affected by earthquake.
- Maximum isolator displacement was approximately 3 cm, and about 1 cm residual offset.
- No structural damage observed.
- Some minor non-structural damage between column framing and partition walls.
- No damage observed to isolation bearings or connections.
- No damage observed to utility or piping systems crossing isolation plane.
- Building does not have an electronic seismic monitoring system.

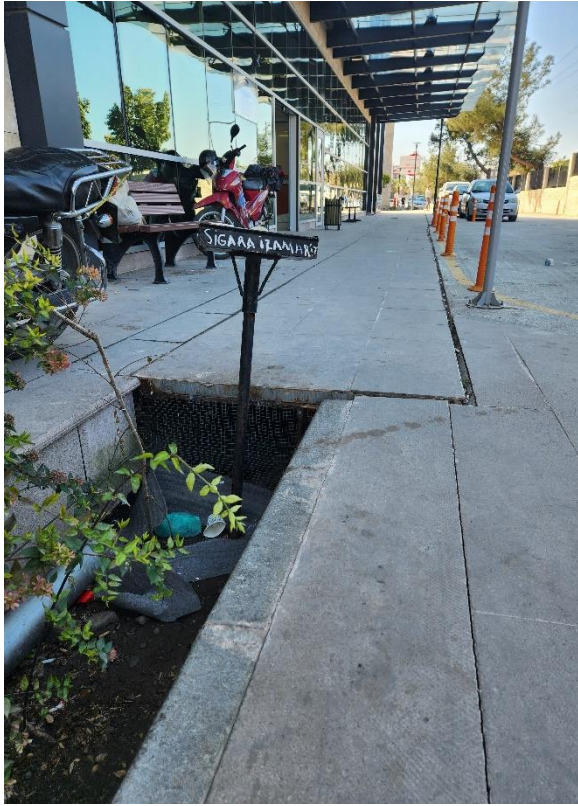


General view of isolation basement



Double pendulum isolator





Perimeter joint and moat cover



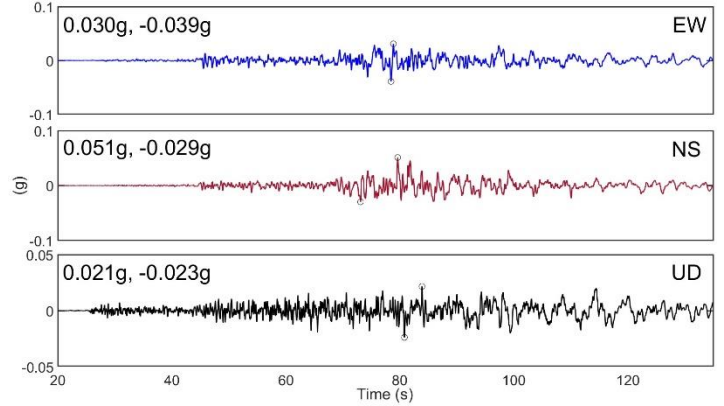
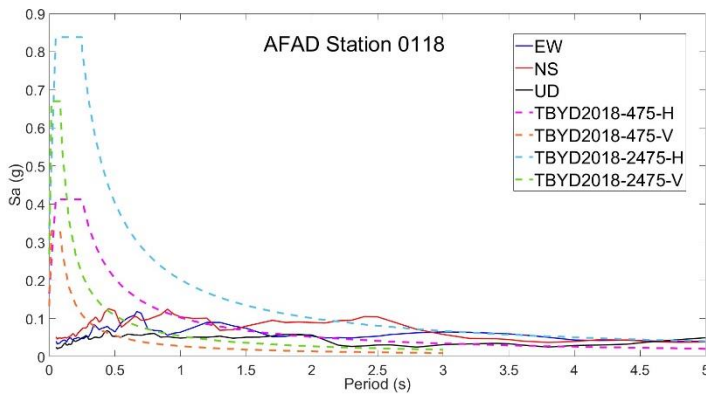
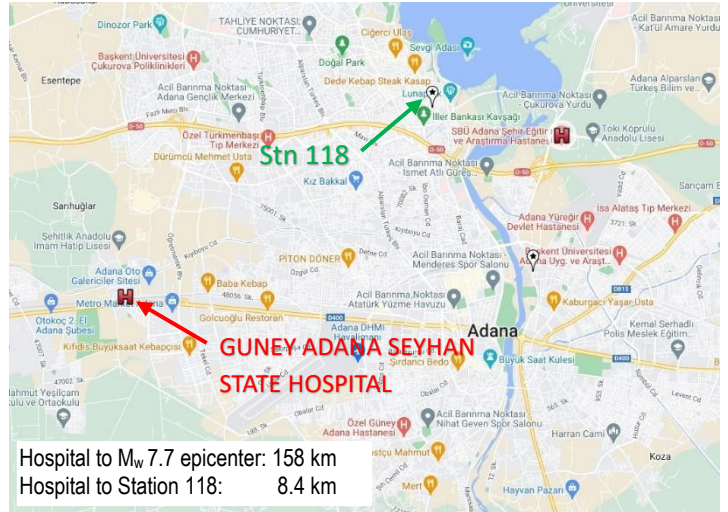
Perimeter joint and moat cover, view from under side

## 3.10 ADANA GÜNEY SEYHAN STATE HOSPITAL

[ADANA GÜNEY SEYHAN DEVLET HASTANESİ]

35.238766 °N / 36.996164 ° E

**Capacity** 150 beds  
**Superstructure** 4 stories, RC frame and infill walls  
**Isolators** 251 double pendulum bearings, displacement capacity 235 mm



### Observations:

- Hospital ready to open, but not operational at time of earthquakes.
- Access inside hospital building not granted so only exterior observations were made.
- From observations, no clear indication of seismic movement.
- Inadequate seismic movement clearance at one location.



Movement joint at front entrance and crushed pumice stone used as moat infill



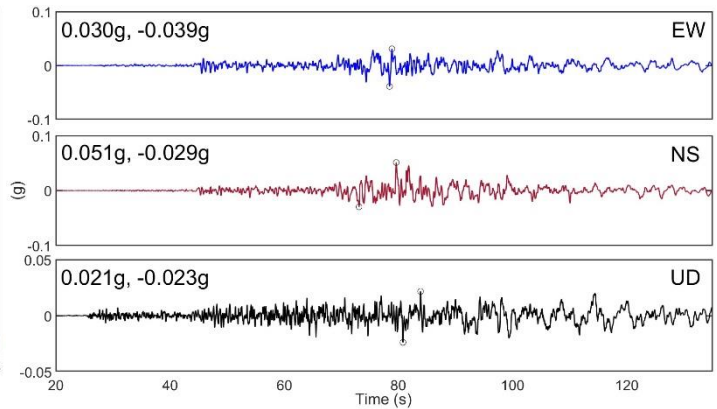
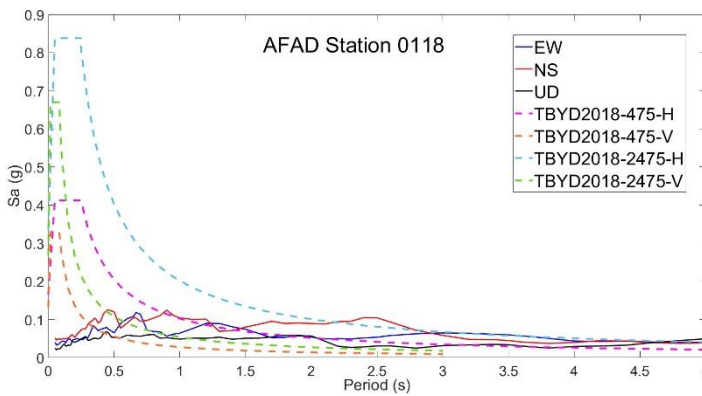
Inadequate movement clearance at pedestrian walkway

## 3.11 ADANA HEALTH CAMPUS

### [ ADANA ŞEHİR HASTANESİ ]

35.348202 °N / 37.028385 ° E

Capacity 1550 beds  
Superstructure 10 stories, RC frame shear wall and infill walls  
Isolators 1552 triple pendulum bearings



#### Observations:

- Hospital operations not affected by earthquake.
- Maximum isolator displacement was approximately 3 cm; isolator core is offset from center.
- Detailing of seismic joint and clearances OK.
- Building has an electronic seismic monitoring system, but at the time of observation visit response data not available.
- Some cracking in grout under isolator base plates observed, but not obvious if due to earthquake.
- No damage observed to interior partition walls, suspended ceilings, or utilities crossing isolation plane.



General view of isolation basement



Grout cracking under isolator base plate



General view of hospital and seismic joint in foreground



Seismic joint cover around elevator/stairway shaft in basement