Post-disaster damage assessment in Türkiye
Technological aspects

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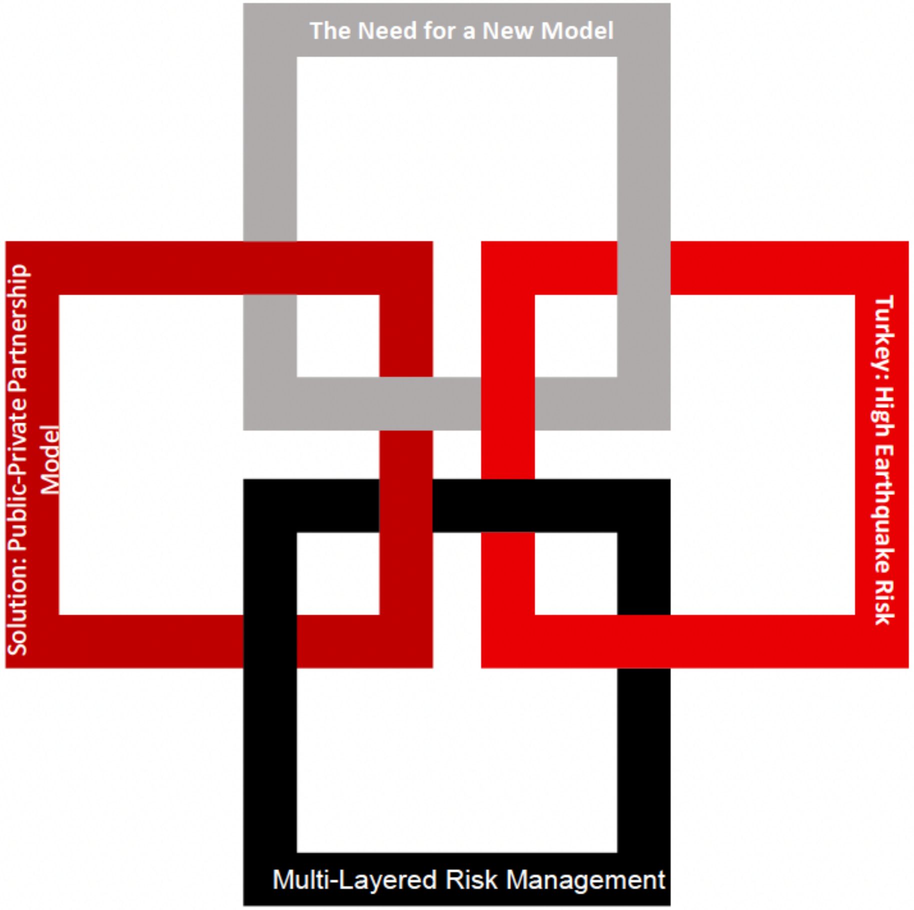
Executive Board Member of Turkish Catastrophe Insurance Pool System (TCIP)

Content

1. What is TCIP?



Turkey: High Earthquake Risk

1999 Marmara Earthquake → 15,000 fatalities & massive economic burden
Only 3% of homes insured → Heavy strain on public finances

The Need for a New Model

Reduce the post-disaster financial burden
Encourage individual responsibility

Solution: Public-Private Partnership Model

2000 → TCIP (DASK) established
First national catastrophe insurance pool in a middle-income country

Multi-Layered Risk Management

Insurance sector → Primary risk bearer
Reinsurance markets → Global risk-sharing
Government → Government-backed financial guarantee

1. What is TCIP?

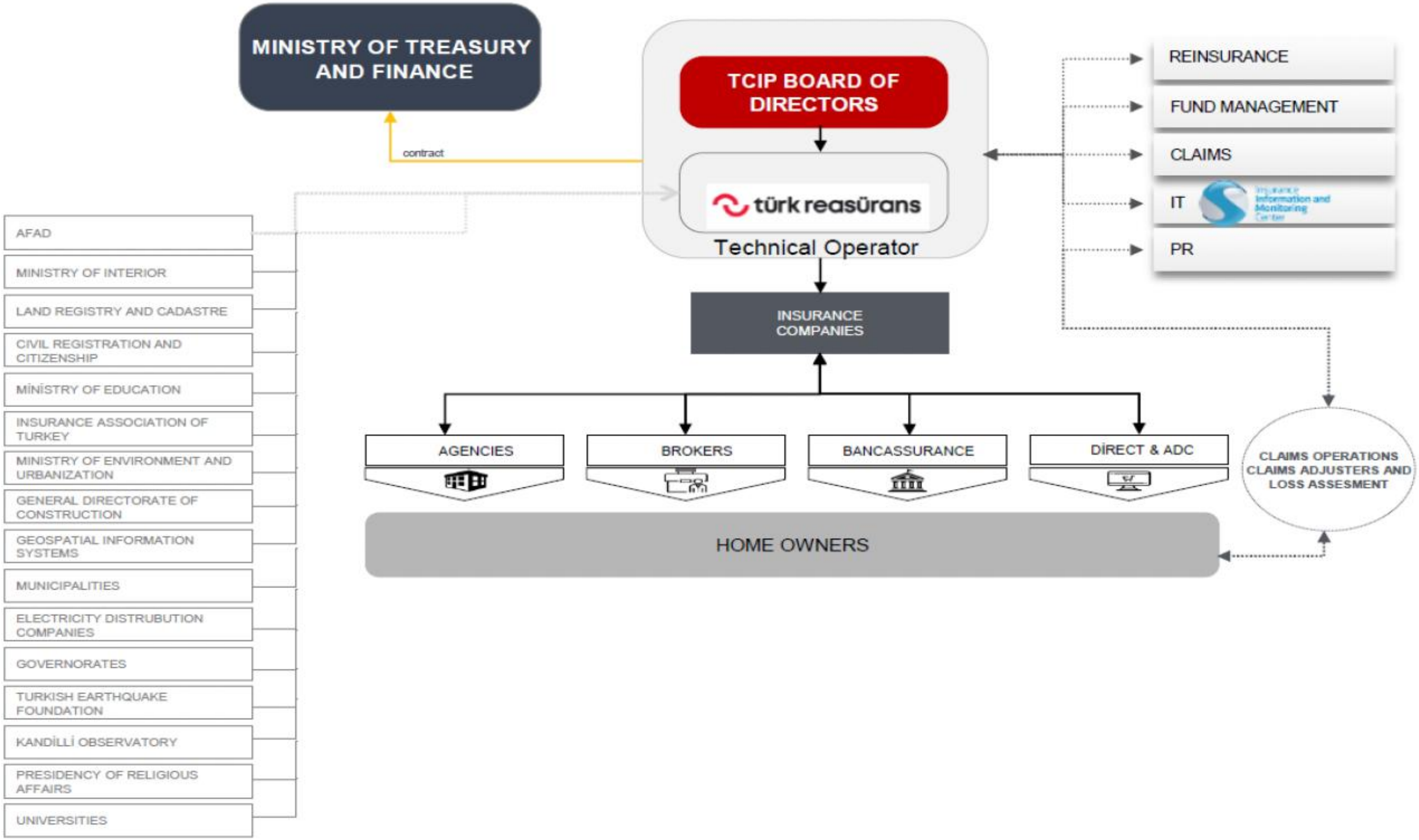
OBJECTIVE

- Insurance Coverage at reasonable prices for people with average income
- Less government expenditure for catastrophes
- Ground for long term fund accumulation
- Sharing the financial burden of earthquake with reinsurance markets
- Improvement of risk culture and insurance consciousness in public
- Coordination of 39 Insurance Companies and about 17.000 agencies to issue Compulsory Earthquake Policy
- Loss assessment and payment of indemnities in case of an earthquake

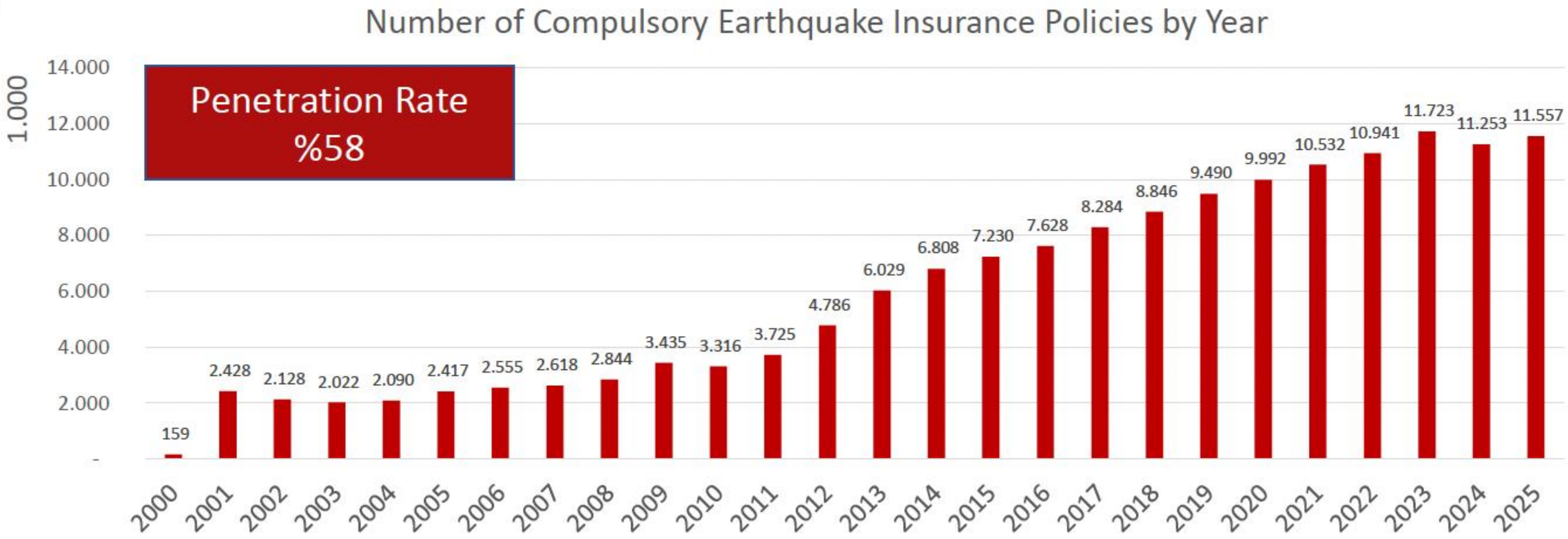
PAYMENT CAPASITY

- DASK has enough **protection & claim payment capacity** in case of an earthquake
  - Accumulated Earthquake Reserve
  - Reinsurance protection
- Whole Reinsurance protection is provided by reputable Reinsurers and Insurers.
- Claim payment capacity of TCIP is **TL 355 Billion** in 2024-2025

1. What is TCIP?



1. What is TCIP?



The Role of Facultative Insurance

- Supplements DASK coverage by offering **additional protections.**
- Covers **contents (furniture, appliances), business interruptions, and additional building damages.**
- Allows policyholders to tailor their insurance coverage to their specific needs.
- Enhances financial security by **offering broader risk protection.**

Number of In-Force Policies	Average Coverage Amount	Average Premium	Total Number of Claim Files	Maximum Coverage
11.5 Billion	**22.988 USD**	**40 USD**	**686.719**	**47.331 USD**

Total Amount of Claims Paid	Solvency	Penetration Rate	General Policy Renewal Rate
1.1 Billion USD	**8,6 Billion USD**	**%58**	**%59**

1. What is TCIP?

EVİMİZDE GÜVEN

ŞEHİRLER YARIŞIYOR SİGORTALILAR KAZANIYOR

GOV.

GOVERNORSHIP
AFAD
LAND REGISTRIES
MUNICIPALITIES
SCHOOLS
MOSQUES

8th in 2022 with a new format and content
With an expanded scope

ÖNCELİĞİMİZ GÜVEN SORUMLULUĞUMUZ GÜVENCE

COMMUNITY

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TEACHERS
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Collaboration with the Ministry of National Education, 250 schools in 25 provinces in the 2022-2023 academic year

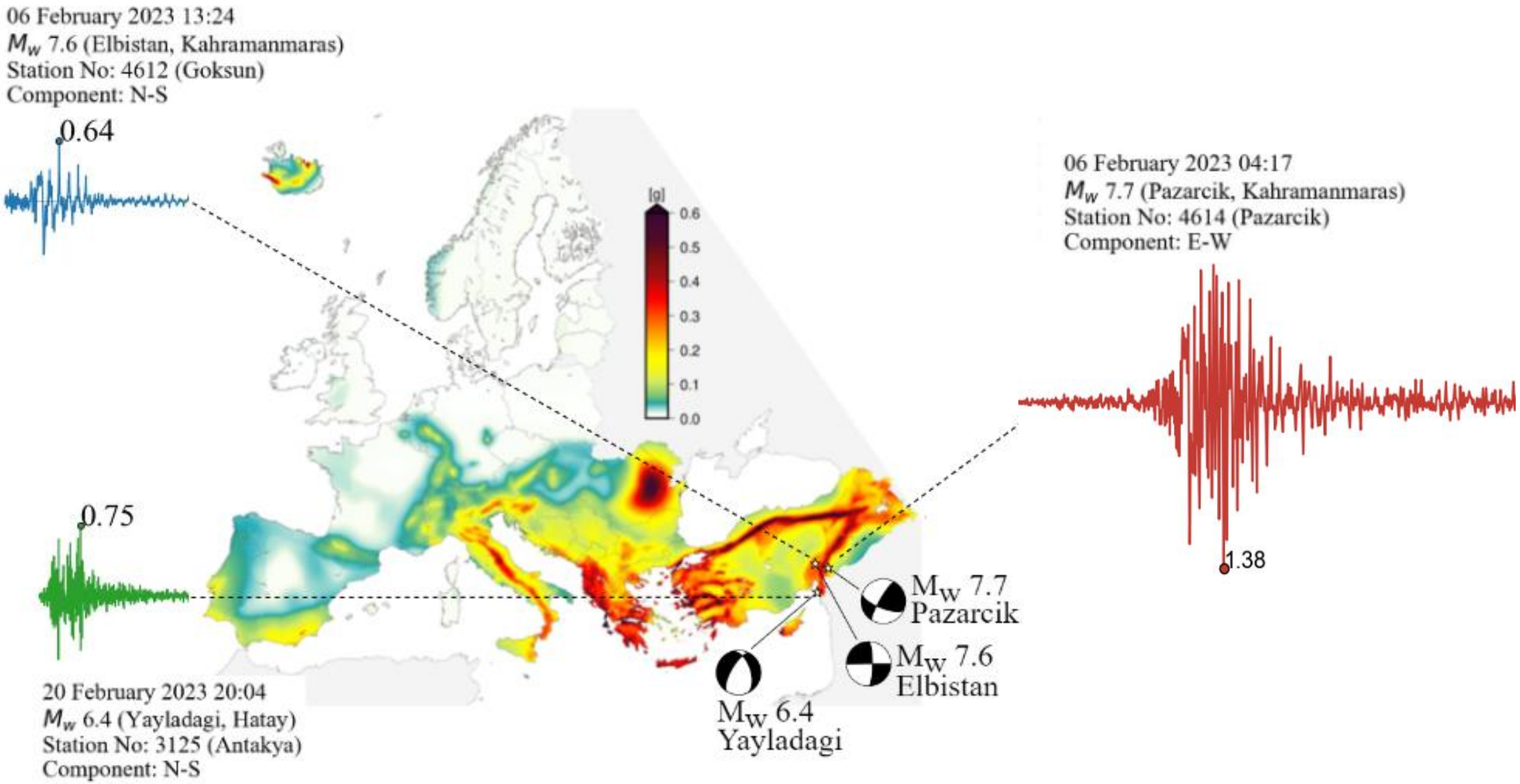
DEPREME DAYANIKLI YAPI TASARIM YARIŞMASI

GOV.

UNIVERSITIES
PROFESSIONALS
IDEA LEADERS

6th TCIP Earthquake Resistant Building Design Competition

2. February 2023 Earthquakes



Acceleration-time histories with the highest PGA values (in terms of *g*) for three earthquakes were plotted onto the European Seismic Hazard Map (2020), which shows PGA mean values for a return period of 475 years

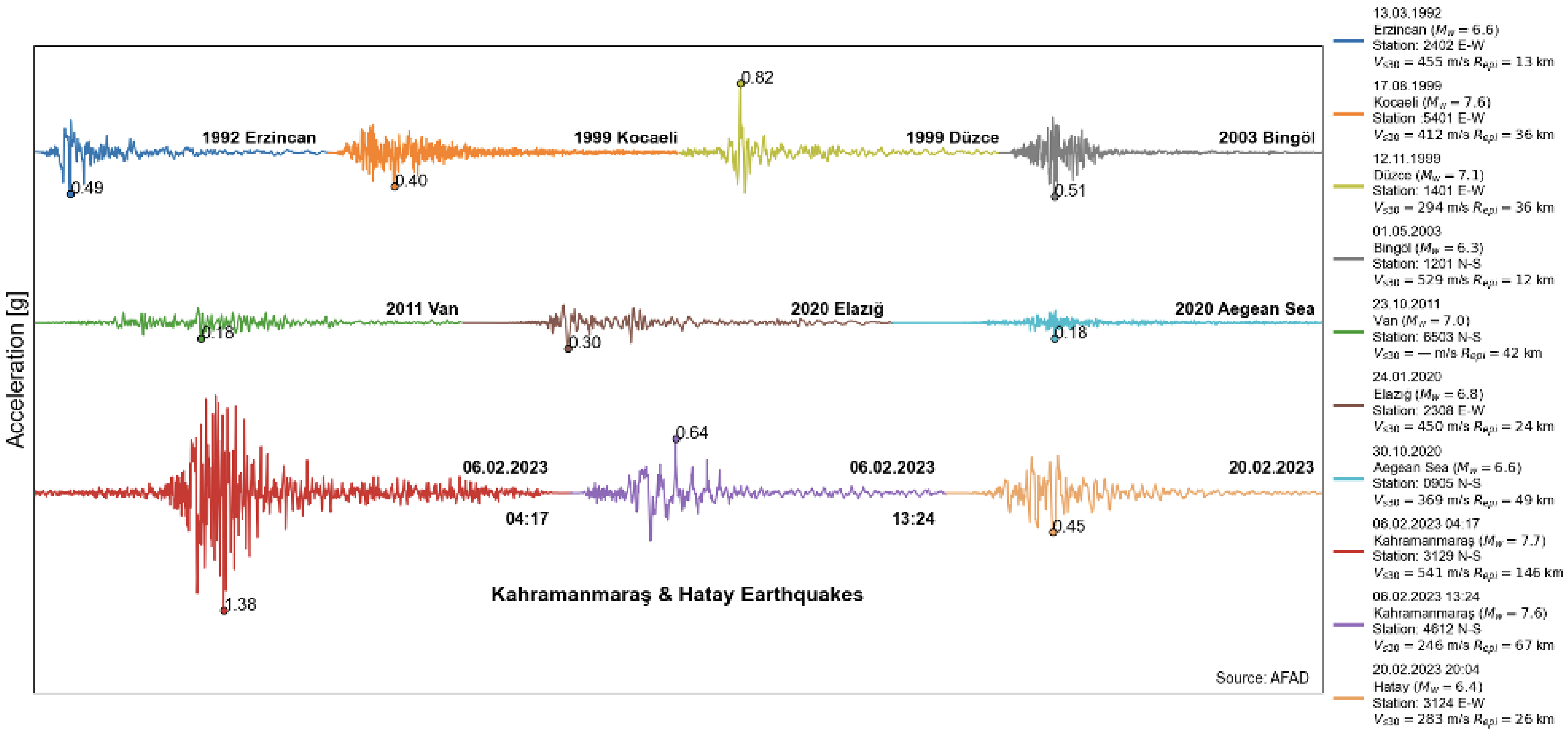
Loss of Life 53k+

Injured 100k+

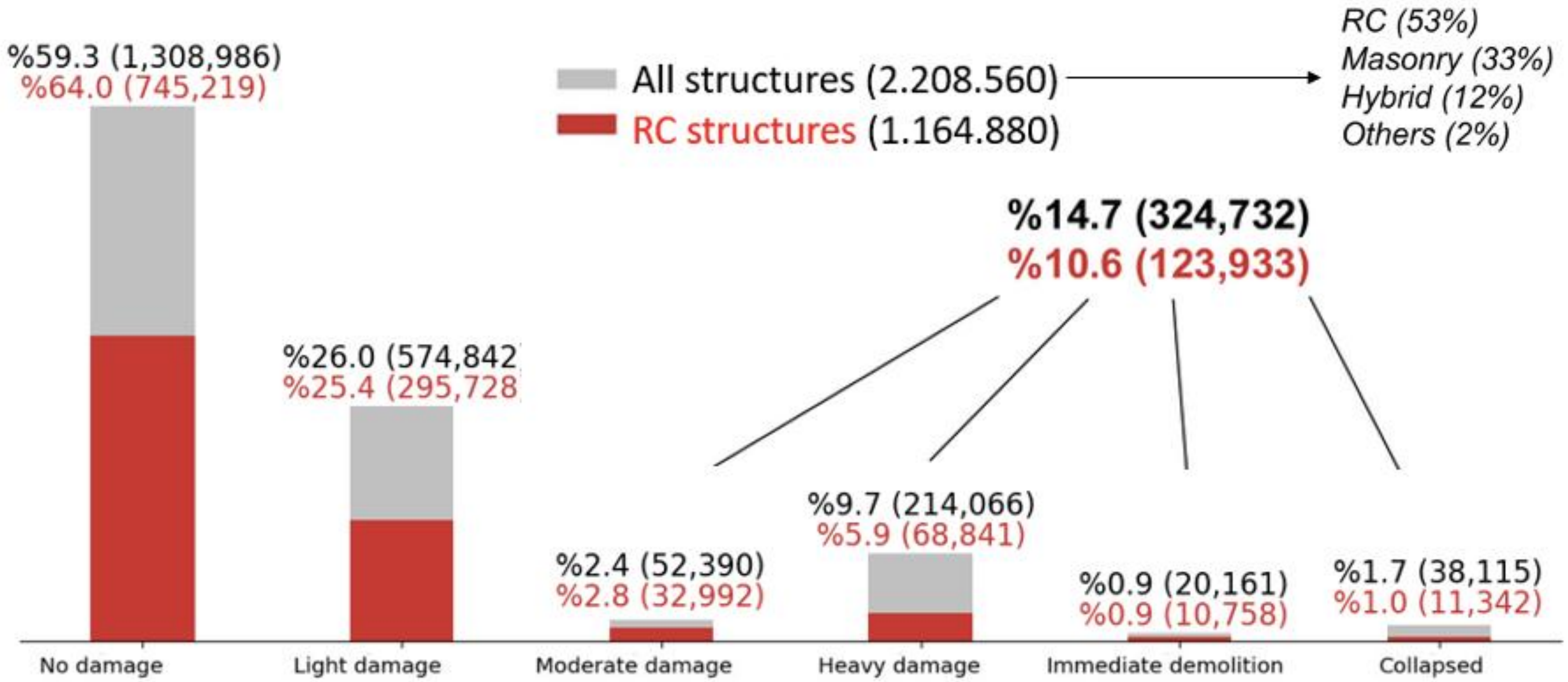
Cost US$100b+

2. February 2023 Earthquakes

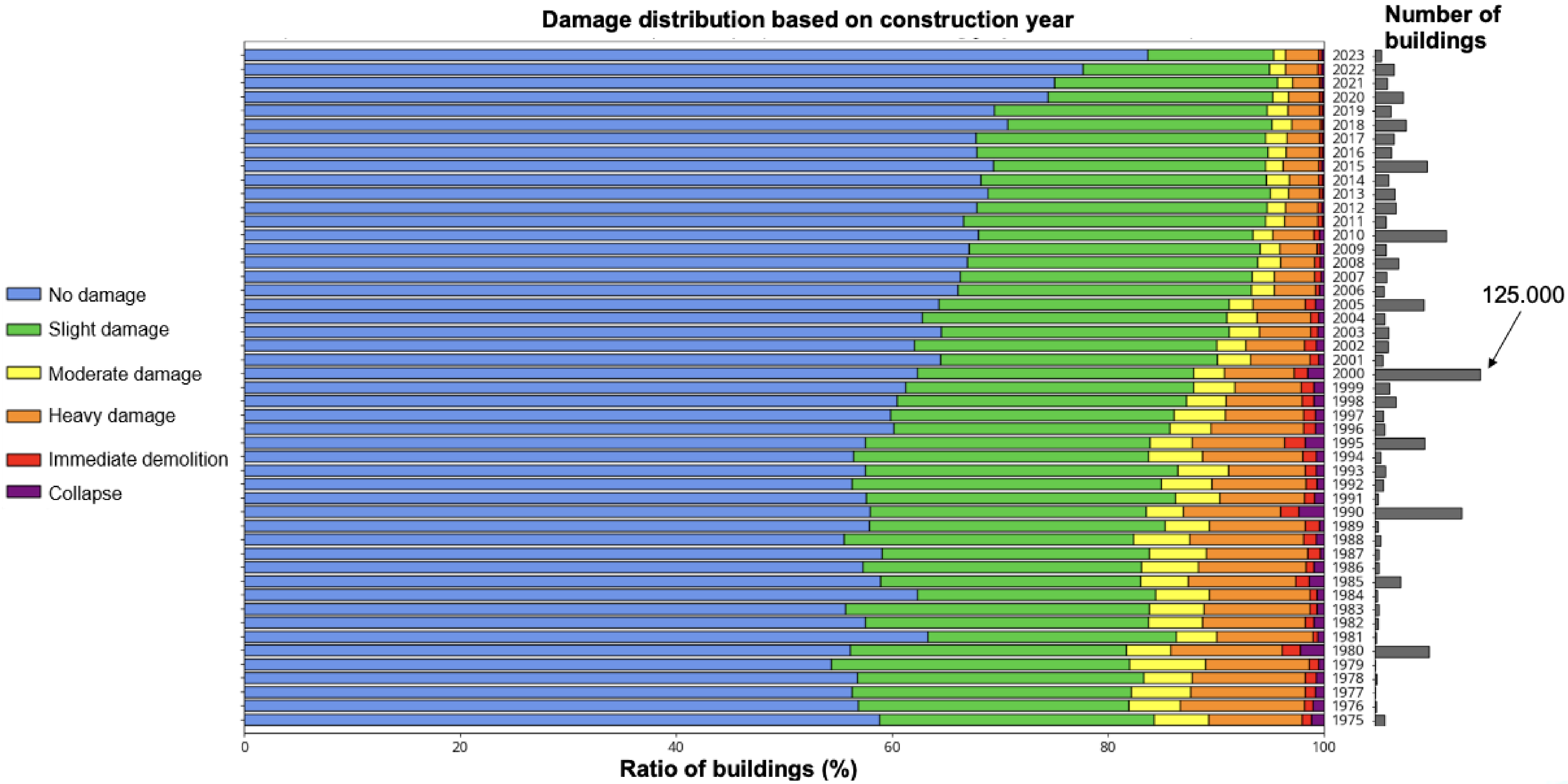
Records that contain the largest horizontal acceleration measured



2. February 2023 Earthquakes



2. February 2023 Earthquakes



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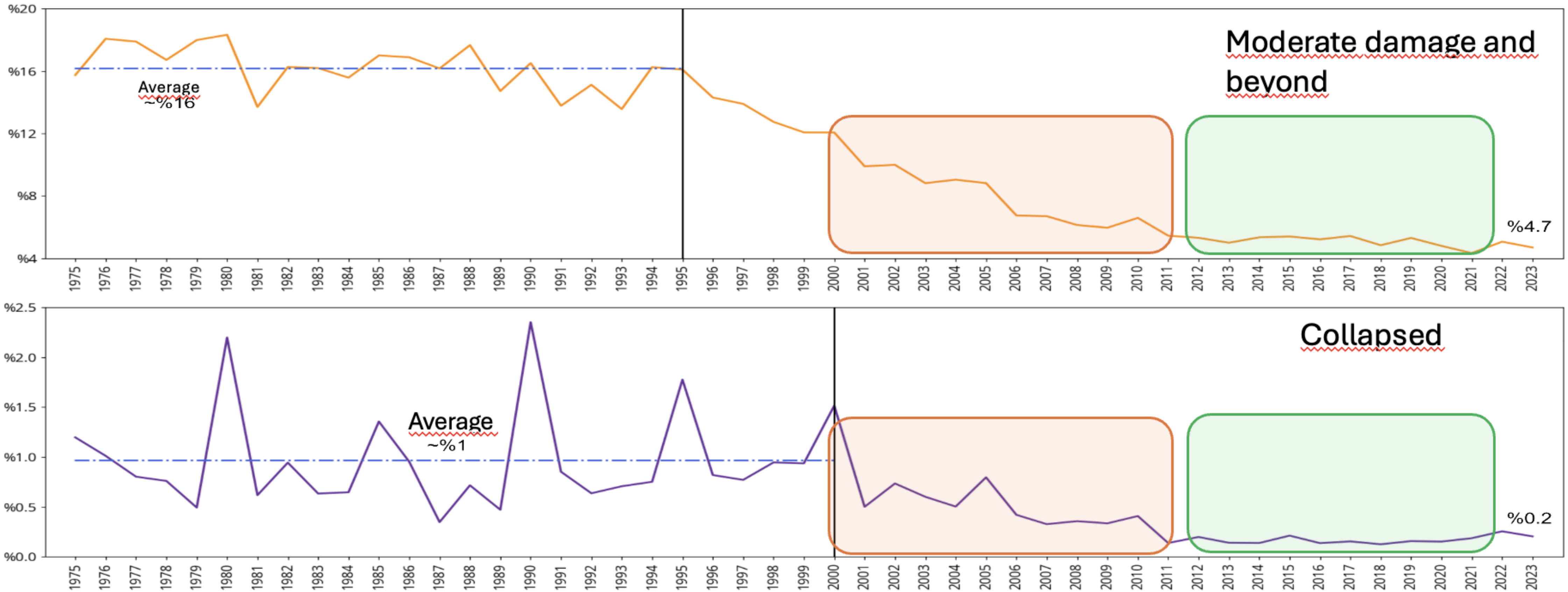


dask
DOĞAL AFET SİGORTALARI KURUMU

3. Damage assessment system in Türkiye

(TCIP and Insurance Companies – AFAD and MEUCC)

AFAD
REPUBLIC OF TURKEY - MINISTRY OF INTERIOR
DISASTER AND EMERGENCY MANAGEMENT AUTHORITY

REPUBLIC OF TÜRKİYE
MINISTRY OF ENVIRONMENT, URBANIZATION AND CLIMATE CHANGE

Decisions to use / futher analyse / demolish

Financial support (extra-ordinary)

Temporary housing provision

Permanent hosuing support/loan (extra-ordinary)

TCIP dask
DOĞAL AFET SİGORTALARI KURUMU

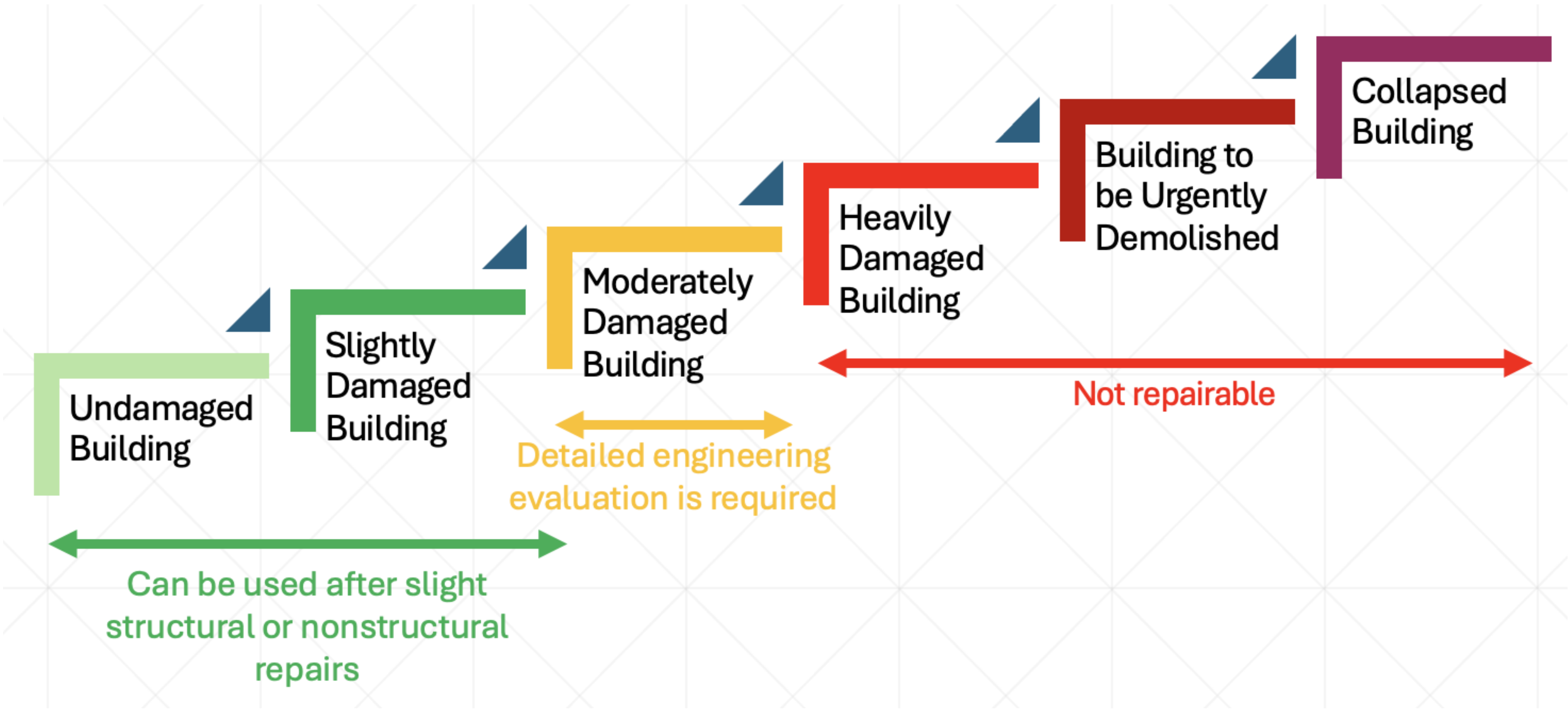
Compulsory insurance

Claim settlement

Insurance Association of Türkiye

Facultative insurance

4. Damage classification methodology and Code (TCIP and MEUCC)



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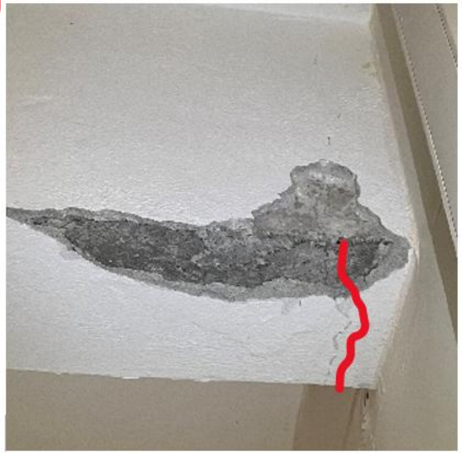


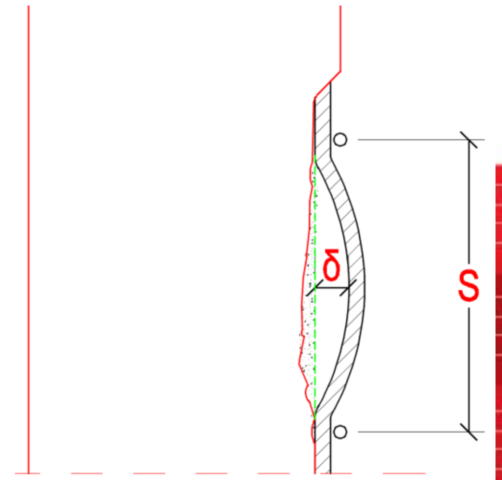
Type A

Type B

Type C

Type D

Damage Category	Residual Crack Width	Compression Damage
Type O	-	-
Type A	≤0.5 mm	-
Type B	0.5 mm< w ≤3 mm	Cover crushing, cover spalling
Type C	>3 mm	Slight buckling of reinforcement (buckling (δ) ≤ stirrup spacing (s) /20 and 1.5 cm)
Type D	-	Core crushing, rupture of reinforcement, buckling of reinforcement (buckling (δ) > stirrup spacing (s) /20 or 1.5 cm)

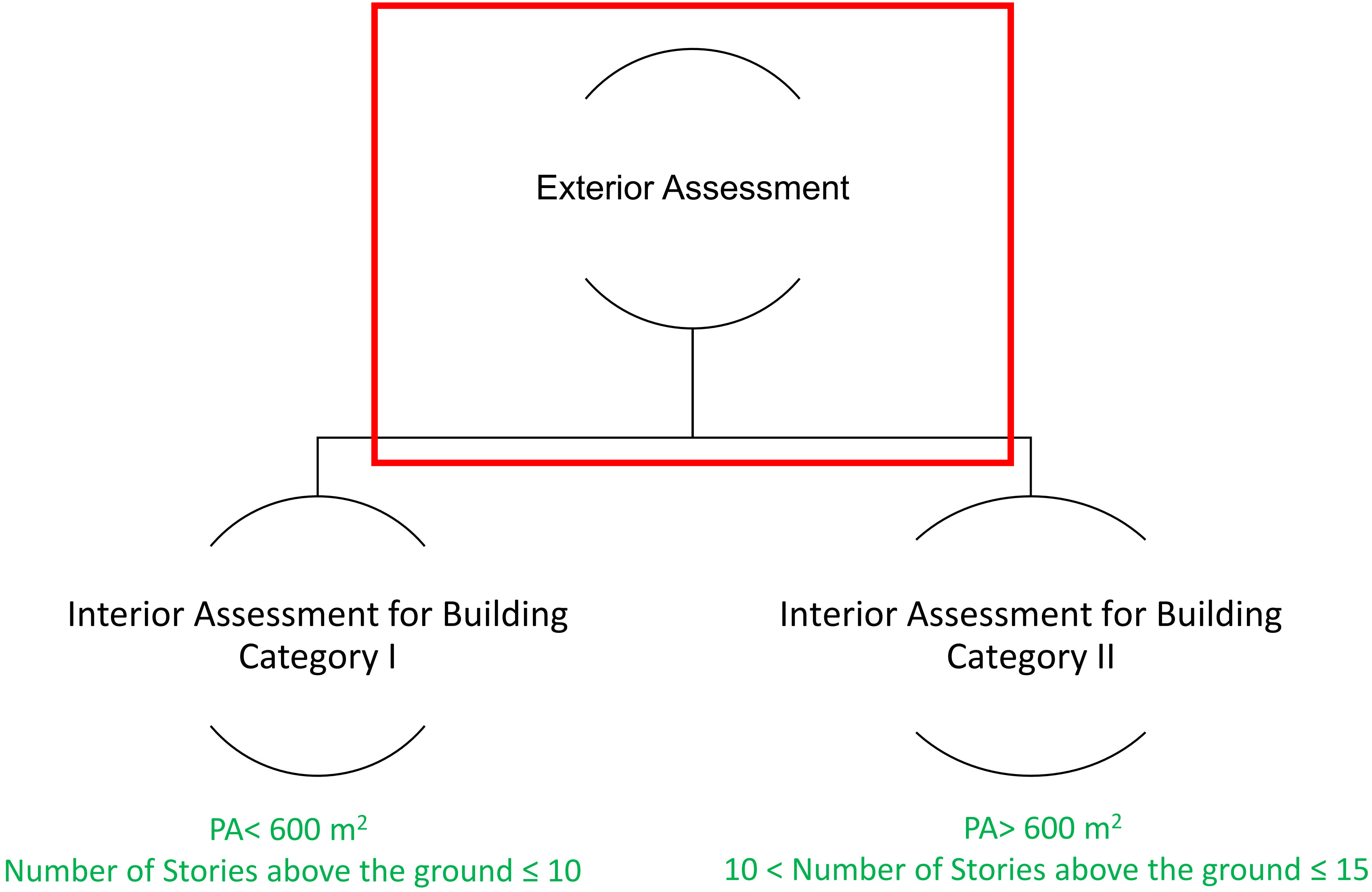


4. Damage classification methodology and Code (TCIP and MEUCC)

Building Category	Reinforced Concrete	Masonry
Building Category I	Plan area is less than 600 m^2 and the number of stories above ground is not greater than 10	The number of stories above ground is not greater than 5
Building Category II	Plan area is greater than 600 m^2 or the number of stories above ground is greater than 10 but not greater than 15	
Building Category III	The number of stories above ground is greater than 15 or special structural elements exist (e.g. isolators, dampers, etc.) or industrial buildings	The number of stories above ground is greater than 5

→ Should be inspected with detailed engineering service

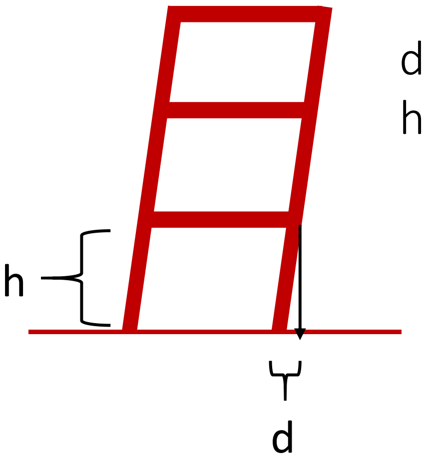
4. Damage classification methodology and Code (TCIP and MEUCC)



4. Damage classification methodology and Code (TCIP and MEUCC)

(a) If the building is totally collapsed → Collapsed Building

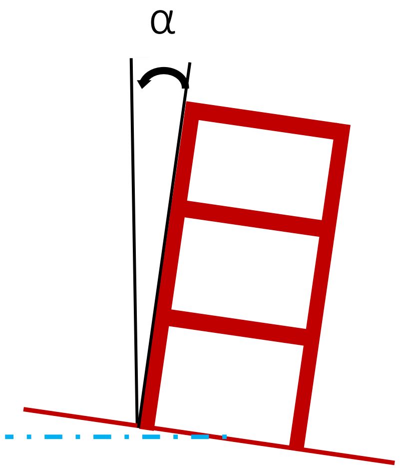
(b) If the building is partially collapsed → Building to be Urgently Demolished



d: Residual displacement
h: Story height

$d/h > 0.01$ → Heavily Damaged

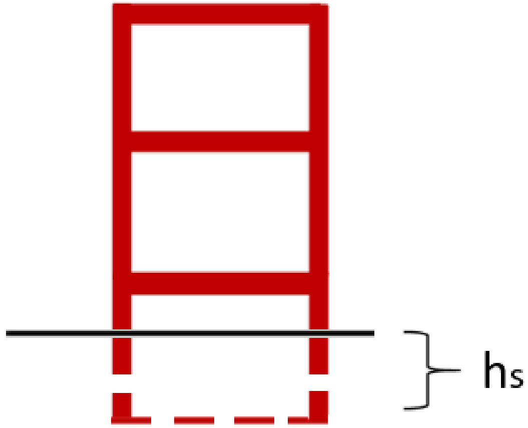
$d/h > 0.03$ → Building to be Urgently Demolished



α: rigid rotation

$\alpha > 1°$ → Heavily Damaged

$\alpha > 3°$ → Building to be Urgently Demolished



$h_s > h/3$ →

4. Damage classification methodology and Code (TCIP and MEUCC)

Exterior Assessment

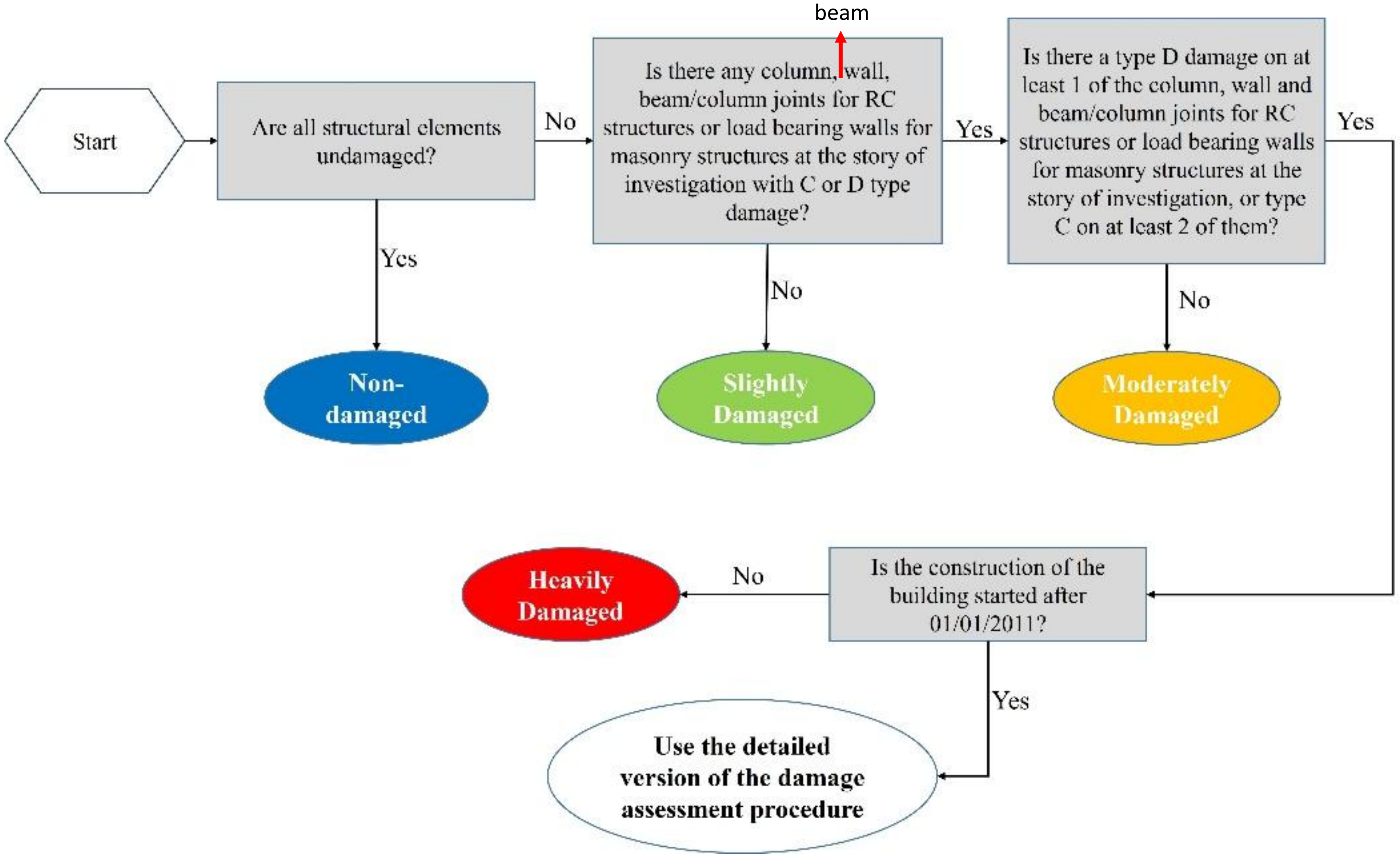
Interior Assessment for Building Category I

PA< 600 m^2
Number of Stories above the ground ≤ 10

Interior Assessment for Building Category II

PA> 600 m^2
10 < Number of Stories above the ground ≤ 15

4. Damage classification methodology and Code (TCIP and MEUCC)

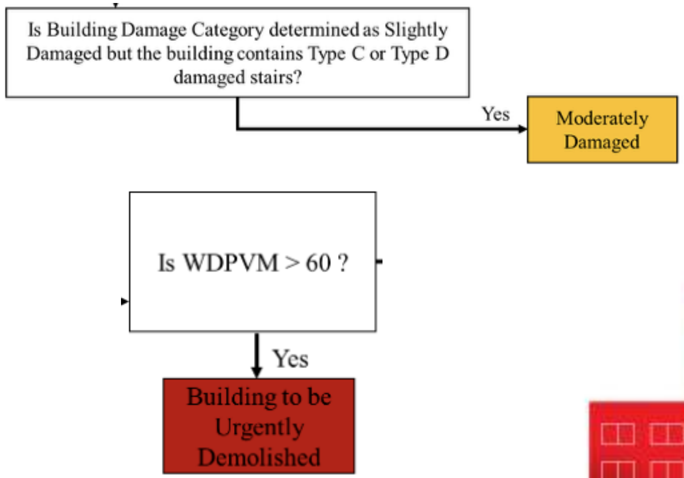


4. Damage classification methodology and Code (TCIP and MEUCC)

Damage class of members	Damage factor
O	0.00
A	0.20
B	0.40
C	0.70
D	1.00

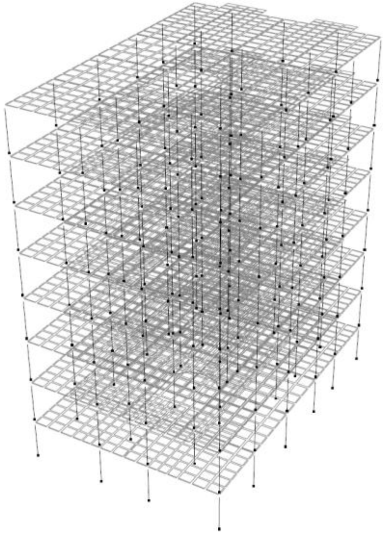
$$WDPVM = \frac{A \times 0.20 + B \times 0.40 + C \times 0.70 + D \times 1.00}{O + A + B + C + D} \times 100$$

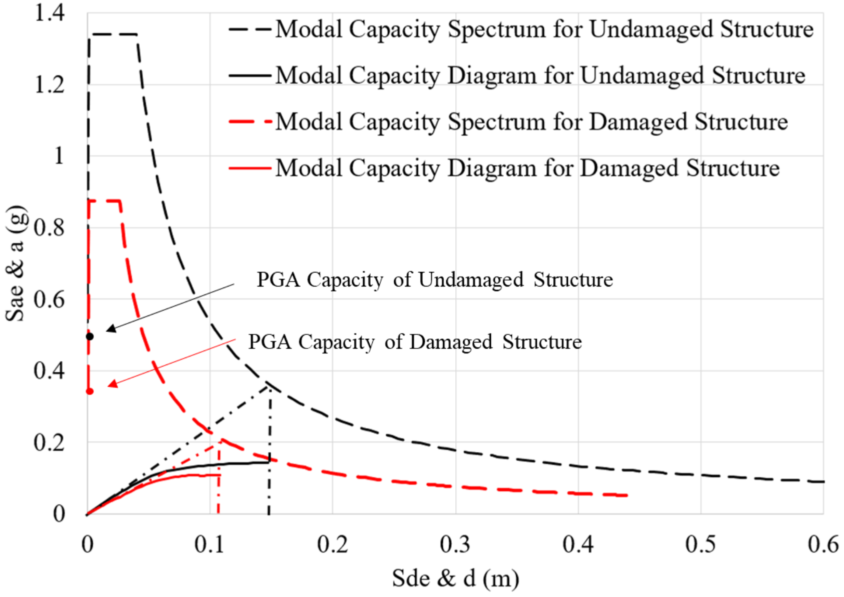
Determination of building damage category		Columns/ Shear Walls/ Joints			
		WDPVM < 10 and C+D = 0	10 ≤ WDPVM <20 or WDPVM <10 and C+D ≥ 1	20 ≤ WDPVM <40	WDPVM ≥ 40
Beams	C ≤ FA/50 and D = 0	Slightly Damaged	Moderately Damaged	Moderately Damaged	Heavily Damaged
Beams	C+D < FA/50 and D ≥ 1	Moderately Damaged	Moderately Damaged	Heavily Damaged	Heavily Damaged
Beams	FA/50 ≤ C + D < FA/20	Moderately Damaged	Moderately Damaged	Heavily Damaged	Heavily Damaged
Beams	C+D ≥ FA / 20	Heavily Damaged	Heavily Damaged	Heavily Damaged	Heavily Damaged



4. Damage classification methodology and Code (TCIP and MEUCC)

Kolon	b	h	HD_1	HD_2	HD_3	HD_4	HD_5	HD_6	HD_7	HD_8	HD_9	HD10	HD11	HD12	HD13	HD14	HD15	HD16	HD17	HD18	HD19	HD20	HD21	HD22	HD23	HD24	
S01	50	50	0	0	0	0	0	0	0.2	0.4	0.4	0.2	0.4	0.7	0.2	0.7	0.7	0.7	0.4	0.7	0.2	0.7	0.2	0.4	0.4	0.2	0.2
S02	40	85	0	0	0	0	0	0	0	0	0.4	0.4	0.4	0.2	0.4	0.4	0.4	0.4	1	0.7	0.4	0.4	0.2	0.4	0.2	0.2	0.2
S03	40	85	0	0	0	0	0	0	0.4	0	0.2	0.4	0.4	0.2	0.4	0.7	0.2	0.4	1	0.4	0.2	1	0.2	0.2	0.4	0.2	0.2
S04	50	110	0.2	0.4	0.2	0.4	0.7	0	0	0.4	0.4	0.2	0.2	0.2	0.2	0.4	0.7	0.7	0.7	0.7	0.2	0.4	1	0.7	0.7	0.4	0.4
S05	50	50	0	0	0	0	0	0	0	0	0.2	0.2	0.4	1	1	0.7	0.2	0.4	0.4	1	0.2	1	1	0.2	0.2	0.2	0.2
S06	70	30	0.2	0	0	0	0.4	0	0.4	0	0.2	0.4	0.7	0.2	0.7	0.4	0.7	0.7	0.7	0.4	0.4	0.4	0.2	0.4	1	0.2	0.2
S07	95	35	0	0.4	0	0	0.2	0.2	0	0.4	0.4	0.7	0.7	0.4	0.4	0.4	0.7	0.4	1	0.7	0.4	0.7	1	0.7	0.2	0.7	0.2
S08	50	100	0.2	0.2	0	0.4	0	0.7	0.7	0.7	0.4	0.2	0.2	1	0.7	1	0.7	0.4	0.4	1	0.7	0.4	0.2	0.2	0.2	0.4	0.4
S09	50	50	0	0	0	0	0.2	0	0	0.2	0.2	0.4	0.7	1	0.2	0.7	0.2	0.7	0.4	0.7	0.7	0.7	0.2	0.4	0.7	0.7	0.2
S10	95	35	0	0	0	0.2	0	0.7	0	0.4	0.4	0.7	0.4	1	0.7	0.4	0.4	0.7	0.4	0.4	0.2	0.4	1	0.2	1	0.2	0.2
S11	50	50	0	0.4	0	0	0.2	0	0	0	0.2	0.4	0.4	0.2	0.4	0.4	0.7	0.7	1	1	0.7	0.7	1	0.4	0.4	0.4	0.4
S12	30	90	0	0.2	0	0.4	0	0	0	0	0.2	0.7	0.2	0.4	0.4	0.7	0.7	1	0.4	0.7	0.4	0.4	1	0.2	0.4	0.2	0.2
S13	40	85	0	0	0	0	0.4	0.4	0	0.2	0.4	0.7	0.7	0.4	0.2	1	0.7	0.7	0.4	0.7	0.4	1	1	0.7	0	0.7	0.7
S14	70	35	0	0.2	0.2	0	0.4	0	0.2	0.4	0.4	0.2	0.2	0.2	0.4	0.7	0.4	0.7	1	0.4	0.7	0.7	1	0.7	0.2	0.2	0.2
S15	50	50	0	0	0	0.2	0	0	0	0.2	0.2	0.4	0.2	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.2	1	1	0.7	0.2	0.2	0.2
S16	90	40	0.2	0.4	0	0.4	0	0.4	0.4	0.4	0.7	0.2	0.7	0.4	0.7	0.7	0.7	0.4	0.7	0.7	0.4	1	0.2	0.2	0	0.2	0.2
S17	40	80	0	0.4	0	0	0.2	0.2	0	0	0.7	0.2	0.2	1	0.2	0.4	0.4	0.4	0.4	0.7	0.4	0.7	0.2	0.4	0.2	0.4	0.4
S18	70	30	0.2	0	0.4	0.2	0	0	0.7	0.2	0.4	0.4	0.2	0.2	0.4	0.7	0.7	0.7	1	0.4	0.7	0.7	0.2	0.4	0	0.2	0.2
S19	90	45	0.2	0.2	0	0	0	0.2	0.4	0.7	0.2	0.4	0.4	0.7	0.7	0.4	0.4	0.7	0.7	0.4	0.4	1	0.2	0.7	0.2	0.2	0.2
S20	50	50	0	0	0	0.4	0	0	0.4	0	0.4	0.7	0.2	0.7	0.7	0.7	0.7	0.4	1	0.7	0.2	0.4	1	0.4	0	0.2	0.2
S21	50	50	0	0	0	0	0	0	0.2	0.4	0.7	0.4	0.2	0.2	0.7	0.4	0.4	0.7	0.7	0.4	0.2	0.7	1	0.7	0.2	0.7	0.7
S22	50	50	0.2	0	0.2	0.2	0	0	0.4	0	0.2	0.4	0.7	0.7	0.2	0.4	0.7	0.4	0.4	0.7	0.4	0.4	1	0.7	0.7	0.2	0.2
S23	50	50	0	0	0.2	0.4	0.4	0	0	0.4	0.2	0.2	0.2	0.4	0.2	0.2	0.7	0.7	0.7	0.7	0.2	0.7	1	0.2	0	0.2	0.2
S24	50	50	0	0	0	0	0	0	0	0	0.4	0.4	1	1	0.4	0.4	1	0.7	0.4	1	0.4	1	0.7	0.2	0.7	0.2	0.7
S25	40	95	0	0	0	0	0.4	0	0	0	0.4	0.4	0.2	0.7	0.4	0.4	0.7	0.4	0.7	0.7	0.7	0.7	1	0.7	0.7	0.4	0.4
S26	40	95	0.2	0	0.4	0	0	0	0.7	0	0.2	0.2	0.4	0.2	0.4	0.4	1	0.7	0.7	0.7	0.4	0.4	1	0.4	0.7	0.2	0.7
S27	50	50	0	0	0.7	0.4	0.4	0.4	0.4	0	0.4	0.4	0.7	0.4	0.2	0.4	0.7	0.4	1	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2
P1	20	300	0.2	0.4	0.2	0	0.2	0	0.2	0.4	0.4	0.7	0.2	0.7	0.7	0.7	0.4	1	0.7	1	0.4	0.7	0.4	0.2	1	0.2	0.2
P2	20	300	0	0	0.4	0	0	0	0.2	0.2	0.2	0.4	0.4	0.4	0.7	0.7	0.4	0.4	0.4	0.7	0.4	0.4	0.4	0.4	0.7	0.2	0.2





4. Damage classification methodology and Code (TCIP and MEUCC)

a) Undamaged
b) Slight Damage
c) Moderate Damage
d) Heavy Damage
e) To be Urgently Demolished
f) Collapsed

5. Field works in damage assessment

- Ministry of Environment, Urbanization and Climate Change (**MoEUCC)**, General Directorate of Construction Works conducted the coordination. AFAD.
- Approximately 10000 personnel at the field: civil engineers and architects from public, private, and civil society organizations.
- Teams, consisting of 2-person, conducted inspections.
- Approx. 2.4 million buildings and 6.6 million independent units examined.
- A software was utilized for damage assessment .
- The conducted studies were shared with institutions, such as TCIP (DASK in Turkish) for payment processes.
- Support was provided by academics for tall buildings and public structures, cultural assets, ongoing construction projects.

5. Field works in damage assessment

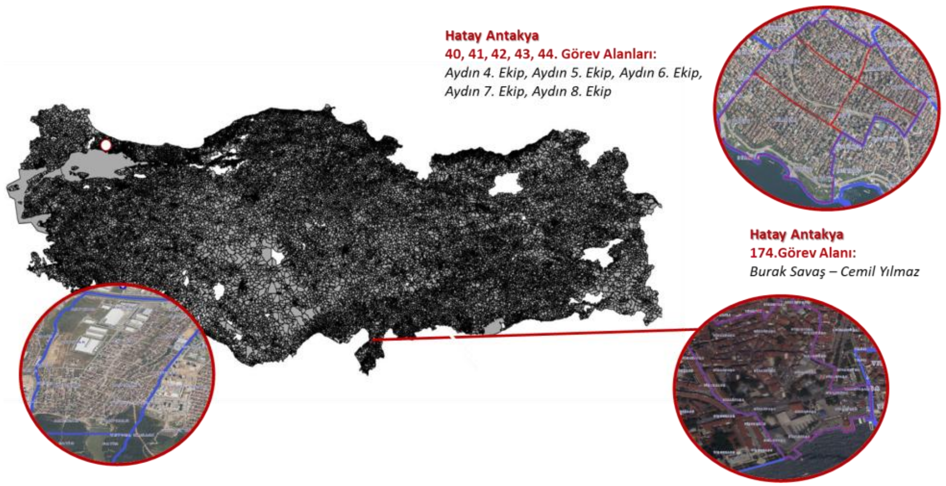
Disaster Coordination Information System

A system developed by the MoEUCC for coordinating the damage assessment studies during disasters.

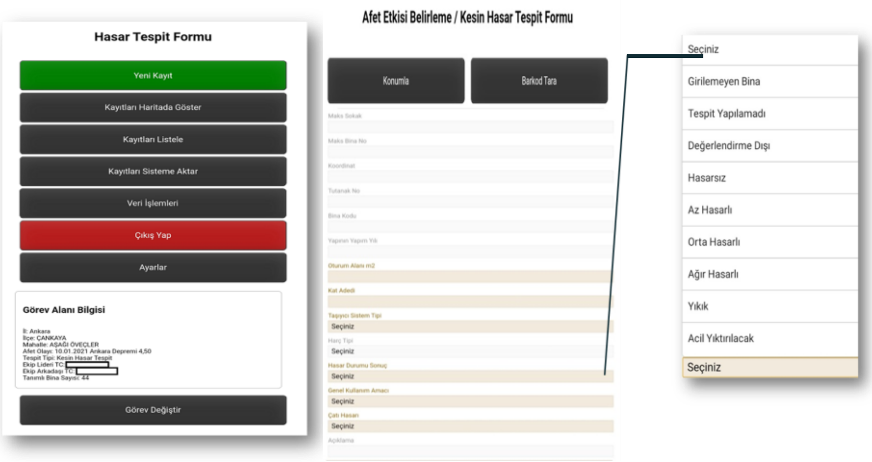
The system provides the digital basis for

- Coordination of damage assessment teams (mission assignment to teams)
- Collection of data from site (through tablets or phones)
- Storage of data
- Reporting
- Presentation of data and damage distribution in a GIS environment
- Sharing of data with relevant instutions and organizations (such as AFAD and DASK)
- Sharing of damage assessment results with the citizens (http://hasartespit.csb.gov.tr and barcodes placed on the buildings)

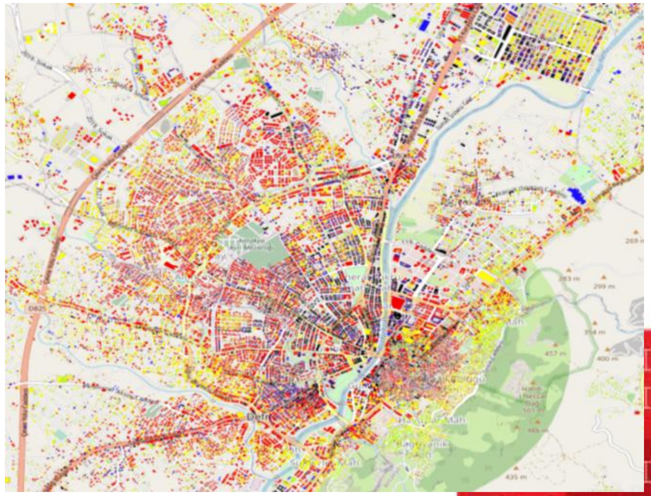
Barcodes placed on the assessed buildings for citizens



Coordination of damage assessment teams and mission assignment

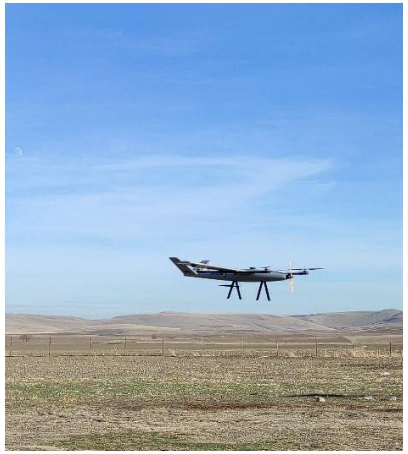


Digital data collection forms filled by the site teams

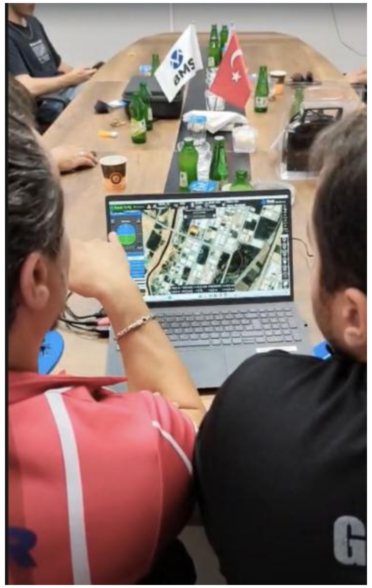


Visualization of results and collected data in a GIS environment

5. Field works in damage assessment

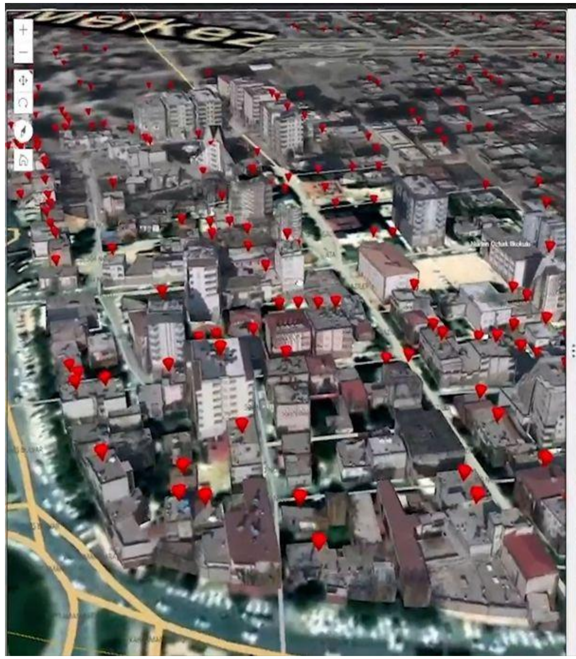



Vertical take off and landing (VTOL) UAV of MoEUCC

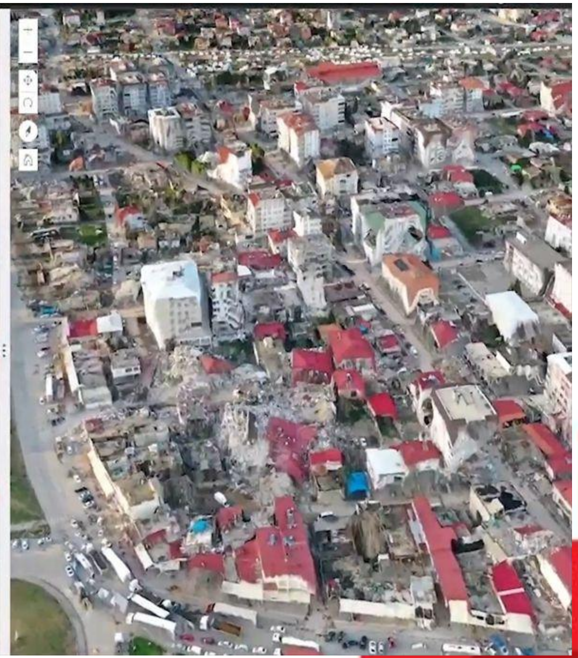



Unmanned Aerial Vehicles (UAVs) provide high resolution images of the EQ affected area and help to conduct a rapid post-earthquake field survey

Also widely used for areas dangerous for humans (fires, chemicals etc.)



Pre-EQ



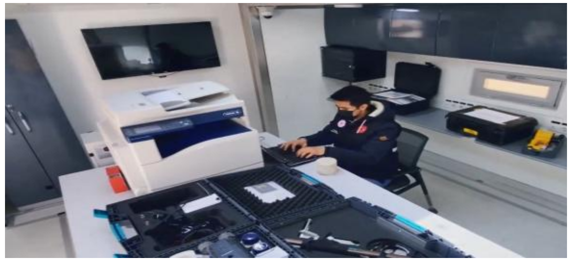
Post-EQ

5. Field works in damage assessment

Mobile coordination center

Mobile communication center

Mobile monitoring systems



Mobile laboratory

5. Field works in damage assessment

Teams arrived in the disaster area from all cities outside the affected region, utilizing both aircraft and road transportation.

The winter season, characterized by heavy rainfall, led to disruptions in accessing the area.

Due to the debris created by the collapsed buildings, rock falls, damaged roads/bridges/tunnels/airports teams encountered difficulties in accessing other structures.

Internet and infrastructure issues.

Systemic risks (earthquake-induced soil slides and rockfalls).

The disruption caused by aftershocks to the continuity of field operations.

Challenges in accommodation and transportation for teams.

5. Field works in damage assessment

All inspected structures

Damage Class	Number of Structures	Independent Section
NO DAMAGE	1.296.267	3.503.790
SLIGHT DAMAGE	640.597	2.029.070
MODERATE DAMAGE	44.689	171.048
HEAVY DAMAGE	207.049	504.138
COLLAPSED	39.451	103.767
URGENT DEMOLITION	21.242	78.505
NOT EVALUATED	95.075	162.732
TOTAL	**2.344.370**	**6.553.050**

Public Buildings:

- Inspected: 60.307 buildings
- Moderate and Further Damage: 6.835 buildings
- Slight and No damage: 49.687 buildings

Appeals

Appeals to assigned building damage category: 3.79% of 2.300.000 assessed buildings

Among these damage category appeals only 0.75% of 2.300.000 building decisions on damage category was revised after a revisit (19% of appeals to building damage category), generally the revision was made in favor of heavier damage than the initial assessment

0.64% of the damage category decisions for independent sections (among 6.500.000 independent sections) were brought to the court, almost half of these lawsuits ended with a change (only 0.32% of 6.500.000 assessed independent sections)

5. Field works in damage assessment

Both pre-disaster and during-disaster, personnel are regularly trained on both use of software (on tablet) and damage assessment methodologies.

Prior to disasters, 54,000 technical personnel from public institutions and organizations was trained online.

9,284 personnel assigned during disasters received face-to-face retraining.

5. Field works in damage assessment

DISASTER CALL CENTER

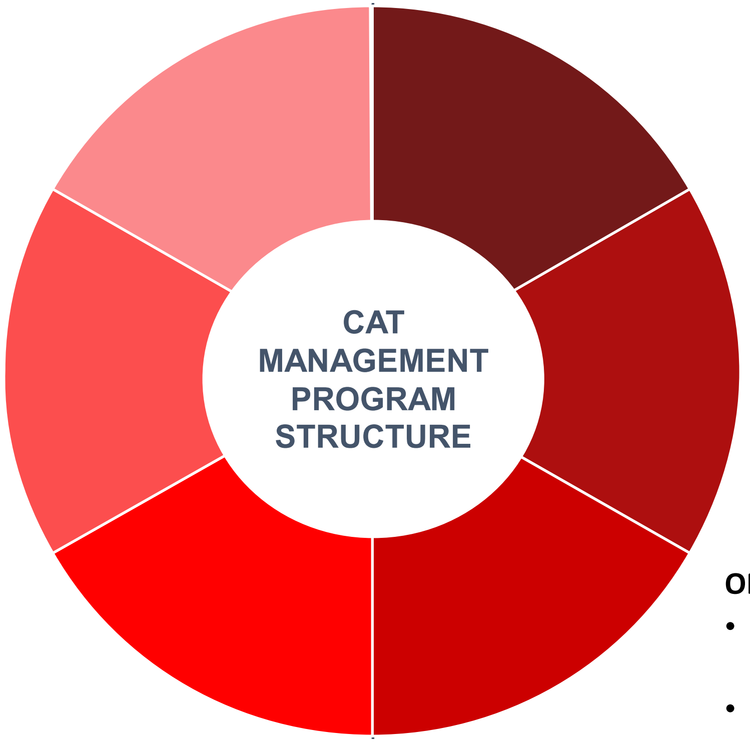
The Disaster Call Centre project is a model study made for an earthquake, the time, place and scale of which are uncertain but the loss effects of which are not possible to be ignored. Solely improved by TCIP due to her EQ & Nat-Cat Operations.

NATURAL DISASTER RISK MANAGEMENT SYSTEM (ARYS)

GIS based decision support platform, for purposes of facilitating the operations management and planning efforts

MOBILE LOSS ASSESSMENT APPLICATION

- Loss assessments are made solely through the Mobile Loss Assessment Application for rapid claim assessment, a simple methodology developed for determining structural damages
- To control costs centrally 22K cost recipes are up-loaded into the software



CLAIM MANAGEMENT IT STRUCTURE

Disaster Management System (DMS) software is developed to be the heart of TCIP's claims system is put into practice in 2016.

CONTINGENCY LOSS ADJUSTER RESOURCE & NATIONAL DAMAGE ASSESSMENT METHODOLOGY

Using technical staff of the Ministry of Environment and Urbanization in case of a big earthquake.

Common methodology for building damage assessment among the institutions who are on the field after an earthquake.

OPERATIONAL EXCELLENCE

- Ankara Emergency Operations Management Center established
- Claim notification system upgraded
- Improved coordination &online integration with Government Stakeholders
- New parametric methodologies to be developed for claims handling instead of traditional damage&loss assessment
- Mobile Office put into operation

CAT MANAGEMENT PROGRAM STRUCTURE

5. Field works in damage assessment

DIGITAL REAL TIME OPERATIONAL PLATFORM (ARYS)

Disaster Risk Management System (ARYS)

Purpose: Decision Support System

- Developed on the infrastructure of **Geospatial Information Systems (GIS)**
- Enabling **easy decision-making processes** through visual infrastructure that provides access to different information and details in one place
- İntegration of ARYS with the loss software allows for **effective and easy** interpretation of claim files, enabling checks and finalization.
- Building on the benefits provided by ARYS in earthquake damages, the development of tracking and decision support systems for other disaster risks, including floods and landslides, as well as related claims and policies, has begun on the ARYS platform.
- Thus, with the sharing of **Spatial Address Location System (MAKS)** data during the process, it will be possible to access the geographic locations of buildings and eventually conduct risk analyses on a building-by-building basis. This structure will also enable more accurate tracking and recording of realized claims.

5. Field works in damage assessment

TCIP’s Analysis for Damaged Dwellings

1. Traditional Method – Loss Adjuster Assessment

- Authorized loss adjusters (surveyors) inspect dwellings on-site.
- Detailed technical evaluation of structural and non-structural damage.
- Digital platform for reporting and managing inspections by using ARYS and Mobile Loss Adjustment Application.
- Compensation: Paid based on the expert’s technical report and ARYS registration.

2. Fast-Track Method – Parametric Compensation

- Implemented in large-scale earthquakes with massive claim volume.
- Relies on official building assessments from the Ministry of Environment, Urbanization and Climate Change.
- Parametric payment approach:
  - Predefined compensation rates according to damage category.
- Allows faster payouts without waiting for detailed inspections.

5. Field works in damage assessment

CLAIM NOTIFICATION CHANNELS

ALO DASK 125
Zorunlu Deprem Sigortası Hattı

TCIP MOBILE APPLICATION

türkiye.gov.tr

WWW.DASK.GOV.TR

Note: With the New Claims System Transition, Adjusters will be able to report new claims during their active field work via the Adjuster Mobile application.

IVR: Interactive voice response

5. Field works in damage assessment

The Role of the Mobile Office

- A specially designed mobile unit traveling across Turkey
- Raises awareness on earthquake preparedness during normal times
- **Transforms into a mobile office immediately after earthquakes**

Post Disaster services

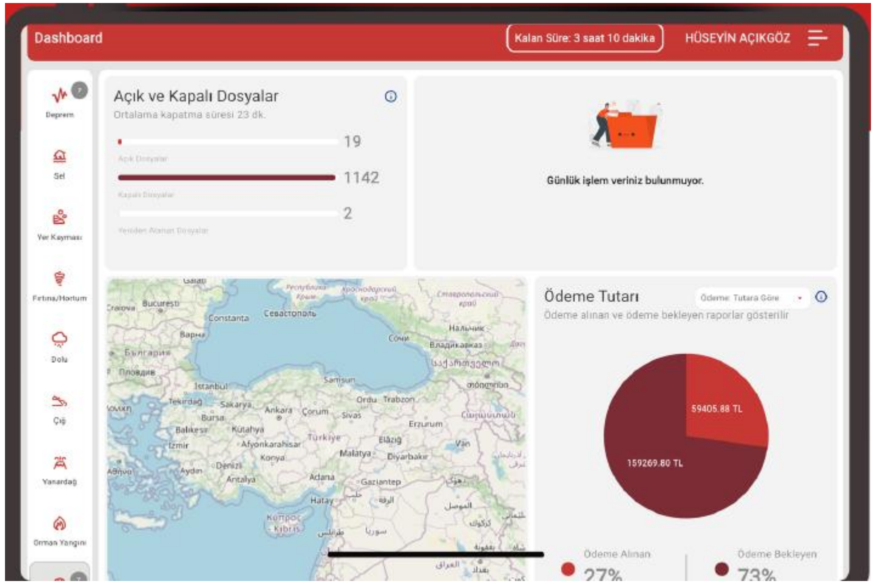
- Acts as a **communication center** for policyholders
- Provides **on-site support** in disaster-affected areas
- Policyholders can;
    - **Open and manage** claim files
    - **Submit documents** and requests directly
    - **Recieve face-to-face** assistance from TCIP staff

Impact

- **Ensures fast and accessible** services for policyholders
- **Becomes a bridge** between TCIP and policyholders **when it matters most**

Mobile Office

5. Field works in damage assessment



Purpose: To ensure rapid, standardized, and reliable recording of building damages in the aftermath of disasters.

Features

- **Real-Time Data Synchronization:** Seamless integration with claim management system.
- **Multi-Hazard Coverage:** Earthquake, flood, landslide, hurricane, hail, avalanche, wildfire.
- **Photo & Document Upload:** On-site evidence captured and instantly uploaded.
- **Automated Damage Classification:** Parametric questionnaires enabling automatic results.

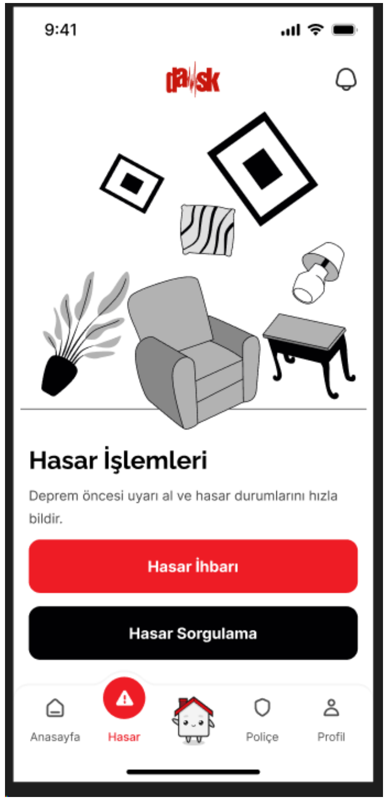
Benefits

- **Faster Claims Handling:** Significant time savings in post-disaster loss assessment.
- **Transparency & Standardization:** Unified methodology across all loss adjusters.
- **Centralized Data Integration:** Damage records fully synchronized with national systems
- **Enhanced Confidence for Reinsurers:** Improved data quality and faster claim resolution.

New Mobile Damage Assessment Application

DOĞAL AFET SİGORTALARI KURUMU

5. Field works in damage assessment



Purpose: To provide citizens with an easy, fast, and reliable digital platform for managing compulsory disaster insurance policies and claims.

Features

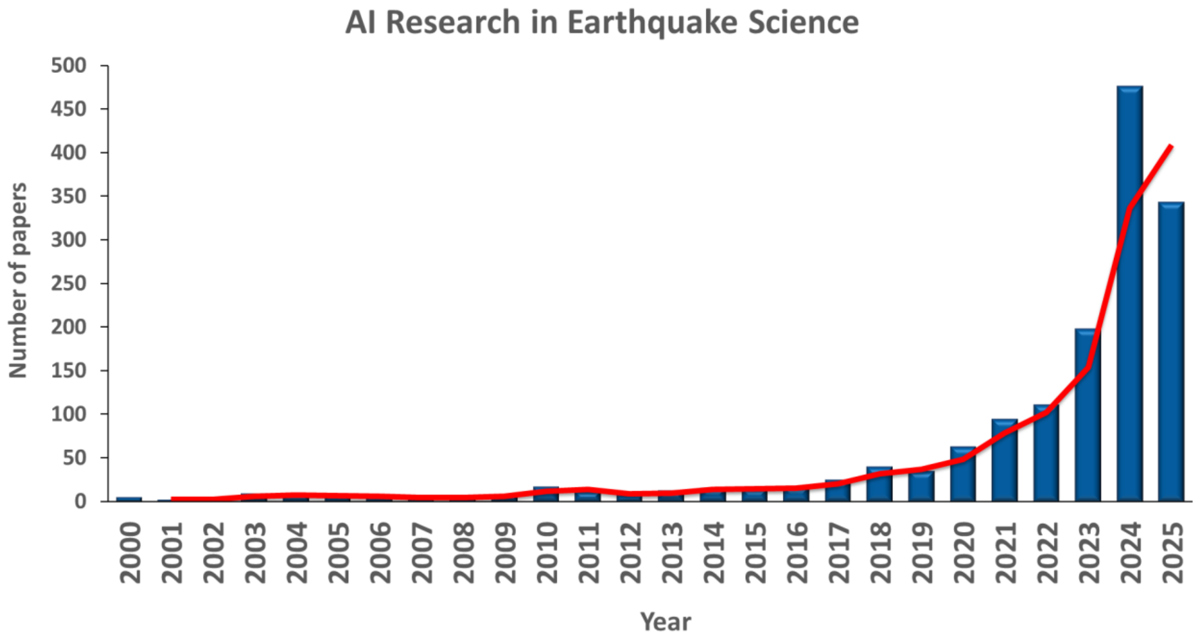
- **Policy Management:** View and renew compulsory insurance policies anytime.
- **Damage Notification:** Submit claims directly through the app after a disaster.
- **Claims Tracking:** Monitor claim status from submission to settlement.
- **Customer Support:** Direct access to DASK call center and support channels.

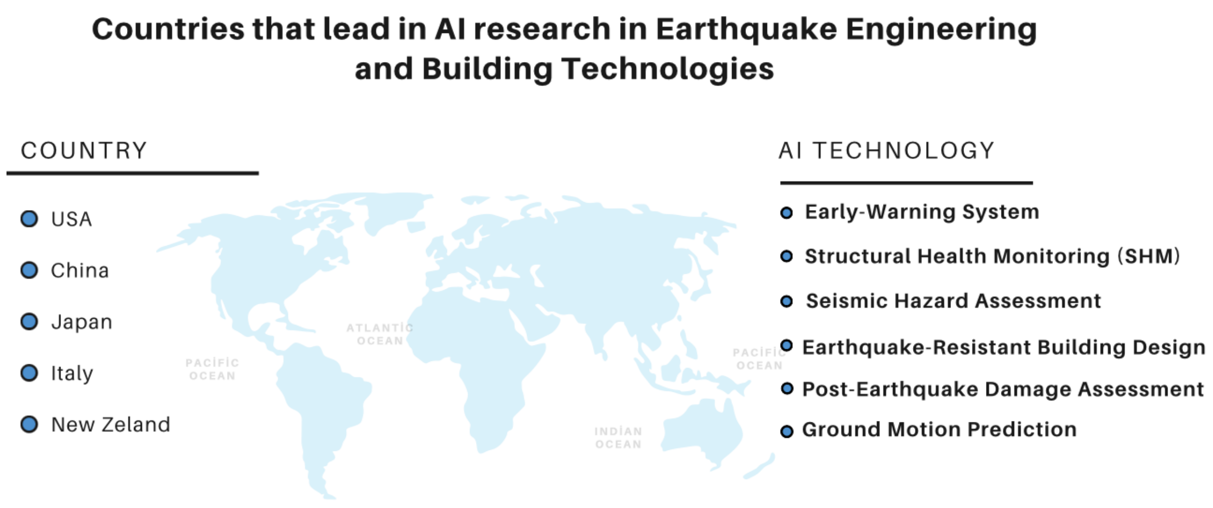
Benefits

- **Direct Citizen Engagement:** Strengthens the link between DASK and policyholders.
- **Higher Insurance Penetration:** Simplified access encourages renewals and wider adoption.
- **Faster Claims Handling:** Citizens can instantly notify damages via the app.
- **Transparency & Trust:** Policyholders can track all steps of their claim journey.

New TCIP Mobile Application (for Policyholders)

6. Damage classification of structural members through use of AI





6. Damage classification of structural members through use of AI

Automated Detection / Decision-Support System

- Damage Detection/Classification

➢After an earthquake, numerous buildings require assessment, often with severe damage in multiple areas, leading to the involvement of **many experts**.

➢**Accurate and rapid** damage evaluation is crucial.

➢AI-powered systems can expedite **decision-making** for technical personnel during on-site inspections, enabling faster emergency response, reconstruction, and risk management.

➢By utilizing **Machine Learning and Computer Vision**, AI can swiftly analyze imagery (satellite, drone, damage photos) to accurately identify damaged buildings.

Moderate Damage ? Severe Damage

OBJECTIVE

To develop AI-based intelligent software (DamageNet) and mobile applications for classifying the seismic damage of reinforced concrete elements.

↓

GOAL

To develop a Decision Support System for field experts, enabling faster and

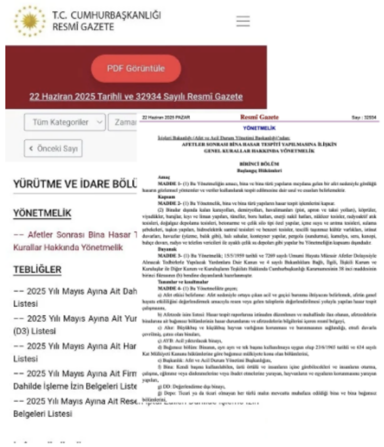
More accurate implementation of damage assessment methods on-site.

Yilmaz, M., **Dogan, G.**, Arslan, M. H., & Ilki, A. (2024). Categorization of post-earthquake damages in RC structural elements with deep learning approach. *Journal of Earthquake Engineering*, 1-32.

6. Damage classification of structural members through use of AI

Post-Earthquake Damage Assessment Code

Published in 2025


T.C. CUMHURBAŞKANLIĞI
RESMÎ GAZETE
PDF Görüntüle
22 Haziran 2025 Tarihli ve 32934 Sayılı Resmi Gazete
YÜRÜTME VE İDARE BÖLÜ
YÖNETMELİK
–– Afetler Sonrası Bina Hasar T
Kurallar Hakkında Yönetmelik
TEBLİĞLER
–– 2025 Yılı Mayıs Ayına Ait Dah
Listesi
–– 2025 Yılı Mayıs Ayına Alt Yur
(D3) Listesi
–– 2025 Yılı Mayıs Ayına Alt Har
Listesi
–– 2025 Yılı Mayıs Ayına Ait Firm
Dahilde İşleme İzin Belgeleri Liste
–– 2025 Yılı Mayıs Ayına Ait Rese
Belgeleri Listesi

Damage Classification of RC Elements

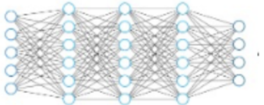
Criteria defined in the code

0 | A | B | C | D

No Damage → Heavy Damage

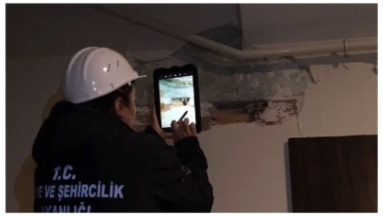
AI-Based Algorithm

Automated detection of damage classes from images



Tablet Integration

On-site use by engineers and technical experts via mobile devices



Official Institutional Implementation

REPUBLIC OF TÜRKİYE
MINISTRY OF ENVIRONMENT, URBANIZATION AND CLIMATE CHANGE

dask
TURKISH NATURAL CATASTROPHE INSURANCE POOL

6. Damage classification of structural members through use of AI

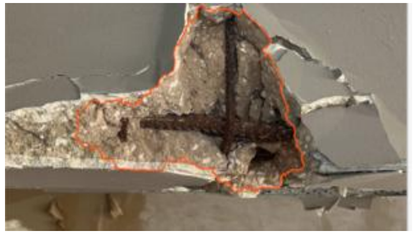
- The developed system operates as a real-time interface application integrated into the damage assessment model on tablets, enabling instant evaluation in the field.
- The developed app is an automated decision support system for use in post-earthquake field studies.
- With the integration of the developed app system on these devices, this work has become a tangible output in an automated system that assists the experts in the field.

Damage Photography

- Earthquake damage is photographed with a tablet from a certain distance, ensuring a perpendicular view of the damage

Identification of Damage Locations

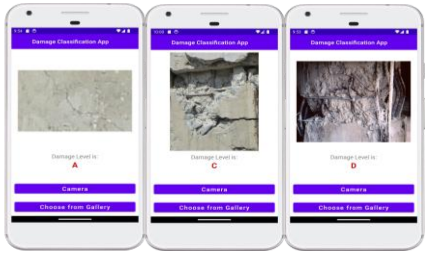
- The damage location and its extent are automatically identified in the background through artificial intelligence.



Estimation of Damage Levels

- The severity of the identified damage is estimated by artificial intelligence based on the damage classification chart.

with **AI Models**



Determination of the Damage Level via App

- The developed model can probabilistically detect the damage severity and location automatically and provide real-time output.

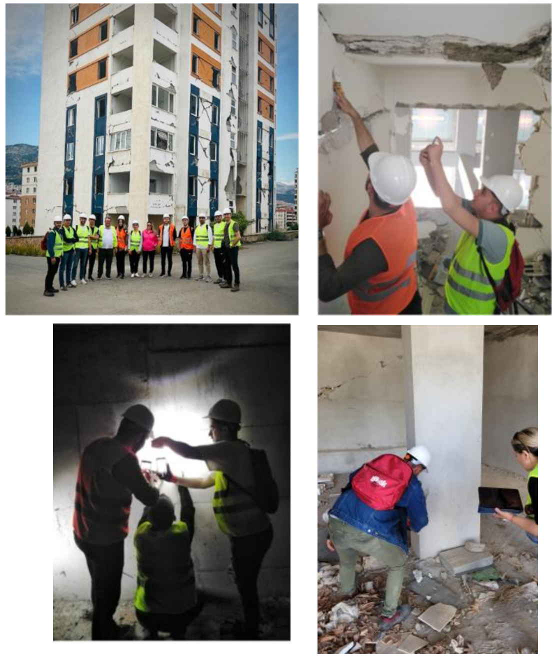
6. Damage classification of structural members through use of AI

Post-Earthquake Data Collection

➢ The damage images were collected from RC buildings through field surveys conducted after recent earthquakes in Turkey that caused significant damage to structures.

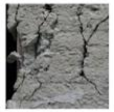
Year	Earthquake	Magnitude (Mw)
2023	Kahramanmaras- Turkey	7.6
2023	Kahramanmaras- Turkey	7.7
2023	Hatay-Turkey	6.4
2022	Duzce-Turkey	5.9
2020	Izmir (Seferihisar)- Turkey	6.6
2020	Elazıg (Sivrice)- Turkey	6.8

Earthquake Disasters in Turkey



Structural Elements

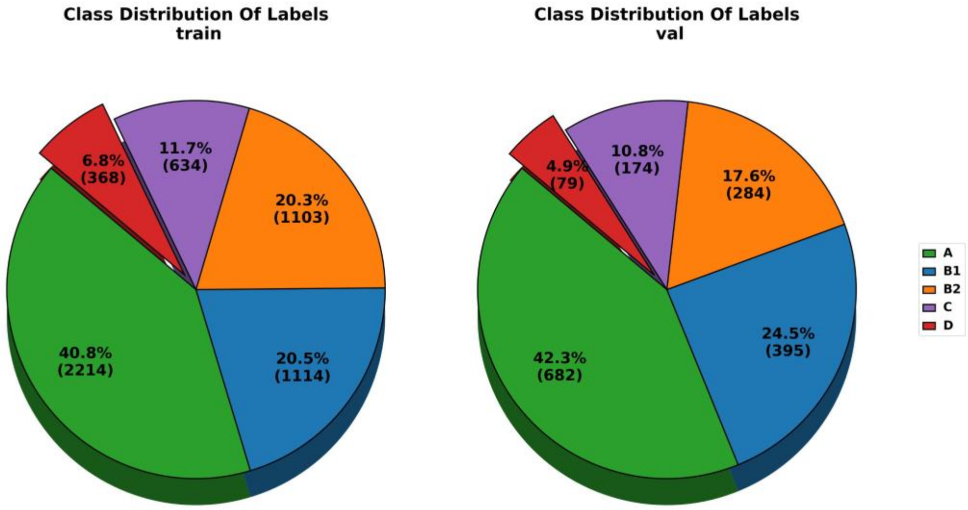
Photographing the Damaged Element in Field Research

Sample Damage Image	Damage Class	Damage Class Defined for AI	Damage Limits
	0	*0*	▪ No damage
	A	*A*	▪ A crack caused by an earthquake with a width of 0.5 mm or less
	B	*B1*	▪ A crack caused by an earthquake with a width between 0.5 mm and 3 mm (0.5 < w < 3 mm).
		B2	▪ Compressive failure in the concrete cover ▪ Concrete cover spalling
	C	*C1*	▪ Cracks caused by an earthquake with a width of 3 mm or greater
		C2	▪ Slight buckling of longitudinal reinforcement
	D	*D1*	▪ Compressive failure in core concrete ▪ Fracture of transverse and/or longitudinal reinforcement bars
		D2	▪ Significant buckling in longitudinal reinforcement

Collected Data on Damaged Elements

6. Damage classification of structural members through use of AI

Post-Earthquake Data Collection- Data Distribution



- As a result, a dataset consisting of RC element damage images was created.
- Totally **12948** label image
- Train and test data were randomly separated and 80% of the data was used as training data and 20% as test data.

Sample Damage Image	Damage Class	Damage Class Defined for AI	Damage Limits
	0	*0*	▪ No damage
	A	*A*	▪ A crack caused by an earthquake with a width of 0.5 mm or less
	B	*B1*	▪ A crack caused by an earthquake with a width between 0.5 mm and 3 mm (0.5 < w < 3 mm).
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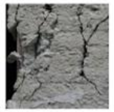
	C	*C1*	▪ Cracks caused by an earthquake with a width of 3 mm or greater
		C2	▪ Slight buckling of longitudinal reinforcement
	D	*D1*	▪ Compressive failure in core concrete ▪ Fracture of transverse and/or longitudinal reinforcement bars
		D2	▪ Significant buckling in longitudinal reinforcement

AI-based Automatic Damage Detection System

Data Pre-Processing

- Dataset preparation by labeling the data for training algorithms- for **Segmentation and Recognition model**

- Labeling in damage groups formed by ***cracks***
- The Computer Vision Annotation Tool (CVAT) was used for the annotation process.

Legend

- A
- B1
- B2
- C1
- C2
- D1
- D2

AI-based Automatic Damage Detection System

Data Pre-Processing

- Dataset preparation by labeling the data for training algorithms- for **Segmentation and Recognition Model**

- Labeling of damage areas in advanced damage classes involving ***compression damages and reinforcement buckling***.

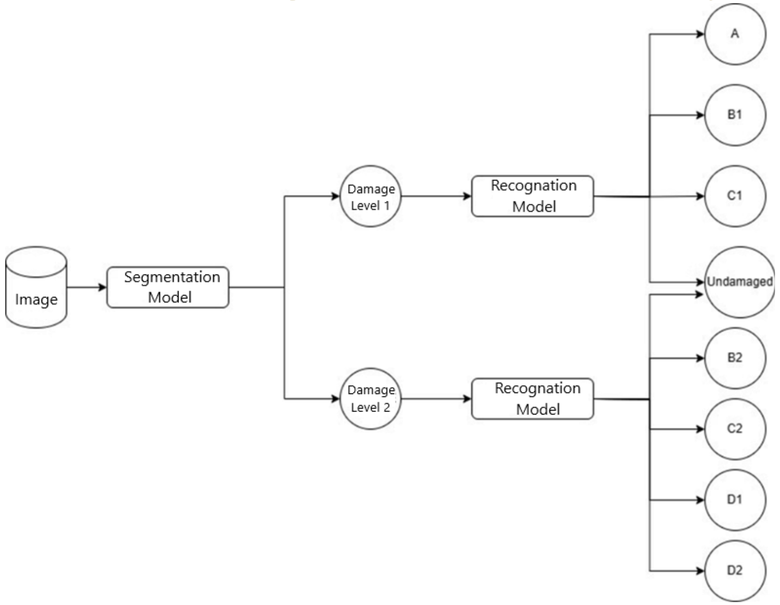
Legend

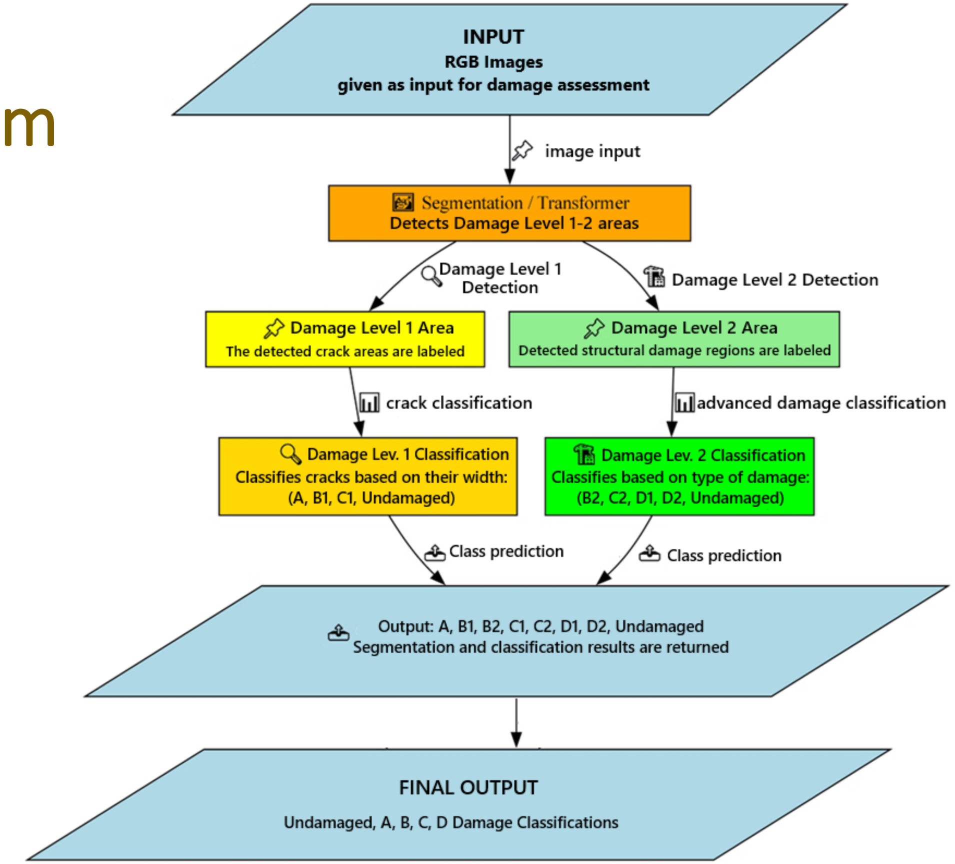
- A
- B1
- B2
- C1
- C2
- D1
- D2

AI-based Automatic Damage Detection System

Algorithm Models

- A total of **132 different algorithms and models**, both individually and in combination, were tested, and the system that yielded the best results for this specific problem was developed.
- Segmentation, Classification, Recognition models (YOLOv5, YOLOv8, YOLOv11, CNN Algorithms such as VGGNet, EfficientNet, InceptionNet etc.)
- **Best/Optimum**: Segmentation + Recognition combination model





- The AI application model integrated into the developed interface is briefly presented technically
- Dataset preparation by labeling the data for training algorithms- for **Segmentation and Recognition model**
- Segmentation and recognition models were used throughout the entire process.
- **Segmentation** is the process of identifying pixels that carry meaning within a given image.
- **Recognition** is the process of identifying the objects or patterns that are either segmented or directly given. In other words, it is understanding what an object is and assigning it a label.
- Segmentation separates objects or regions.
- Recognition determines what these separated objects are.

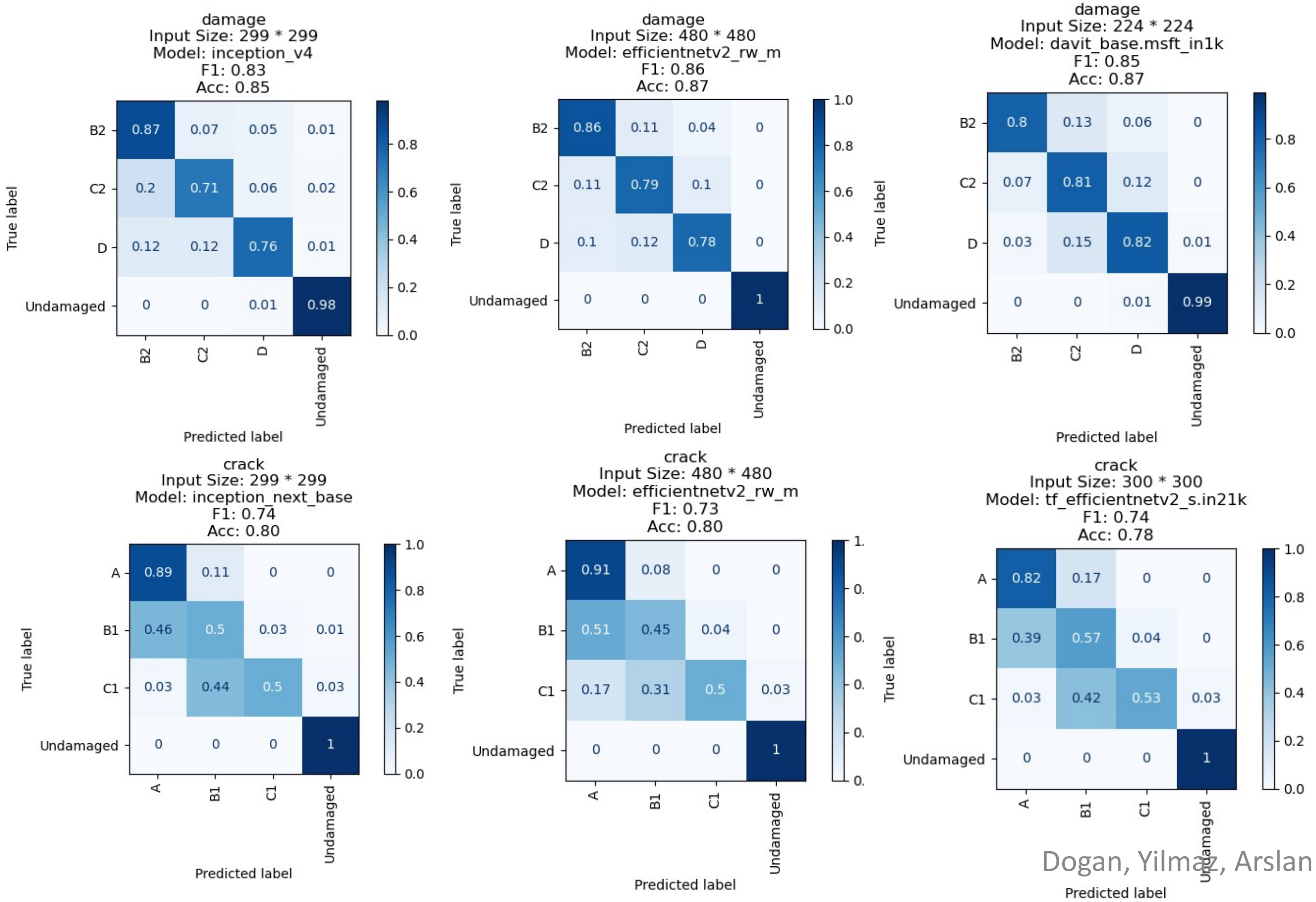
AI-based Automatic Damage Detection System

Results

- A total of 132 different AI algorithm models were extensively tested,
- All model results were compared, and
- A new specific model to the damage classification problem was developed.

- An average success rate of **82%** was achieved in the general classification of damage into 0-A-B-C-D groups.

Best Model Results



Data	Model	Normal Resize		Letterbox Resize (Padding)	
		Model Accuracy (%)	FI Score	Model Accuracy (%)	FI Score
Damage Level 1	maxvit_base_tf_224.in1k	80	74	80	74
	tf_efficientnetv2_s.in21k	80	72	80	75
	efficientnetv2_rw_m	80	73	78	72
	inception_next_base	80	74	80	76
Damage Level 2	maxvit_base_tf_384	83	77	83	77
	efficientnetv2_rw_m	84	79	83	76
	davit_base.msft_in1k	83	77	81	75
	inception_v4	82	74	81	73

AI-based Automatic Damage Detection System

Results

- Sample Model Outputs on Test Data

6. Damage classification of structural members through use of AI

Automated Detection / Decision-Making System

Corrosion Detection

In post-earthquake damage assessment,

- it is crucial to realistically determine the cause of the damage in order to properly **plan future interventions on the building**; (repair methodology, demolition/reconstruction, etc.) and,

- most importantly, to accurately **determine the financial responsibilities** for these interventions, particularly in terms of **insurance coverage**, government support, and owner contributions.

Corrosion Damage

?

Earthquake-induced Damage

OBJECTIVE

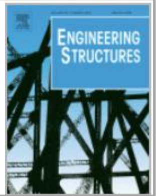
To realistically determine the cause of the damage in order to plan future interventions for the building.

GOAL

To make accurate decisions for financial planning of necessary interventions, and

to facilitate **insurance claim processes**

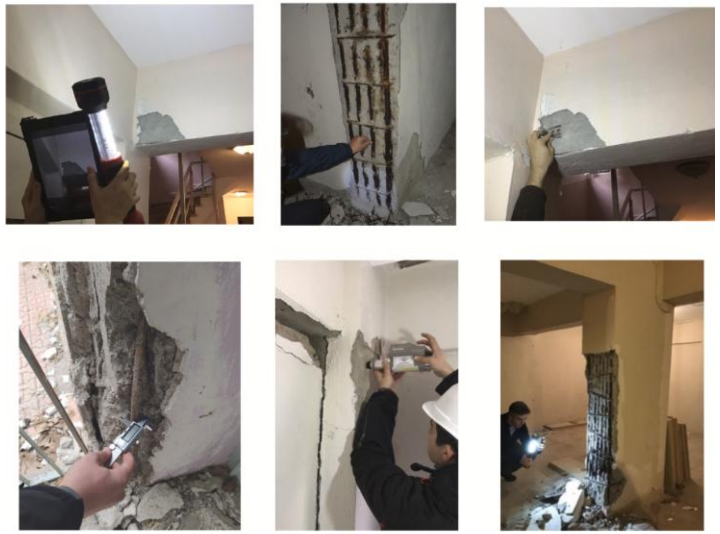
Dogan, G., Arslan, M. H., & Ilki, A. (2023). Detection of damages caused by earthquake and reinforcement corrosion in RC buildings with Deep Transfer Learning. *Engineering Structures*, *279*, 115629.

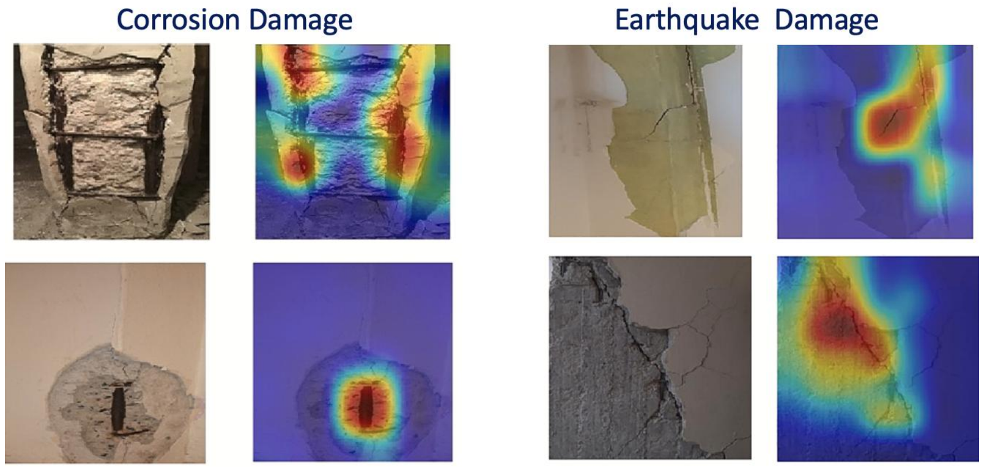


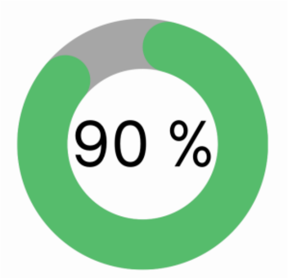
Dogan, Yilmaz, Arslan & Ilki

6. Damage classification of structural members through use of AI

Detection of Corrosion in RC Buildings with AI







Field Research → Algorithm Model Performance (Grad-CAM) → Success

- Turkey- Istanbul-Silivri **(Mw =5.8)** earthquake
- Turkey- Elazig-Sivrice **(Mw =6.8)** earthquake
- Turkey-Izmir-Samos **(Mw =6.6)** earthquake

6. Damage classification of structural members through use of AI

Ongoing research



- In the ongoing study, additional models will be integrated into the AI-based damage classification system to distinguish non-earthquake-induced damages, such as **segregation**, from earthquake-induced damages.
- Currently, the necessary field studies for this purpose have been conducted, and image-based data have been collected.

7. Damage assessment using remote sensing

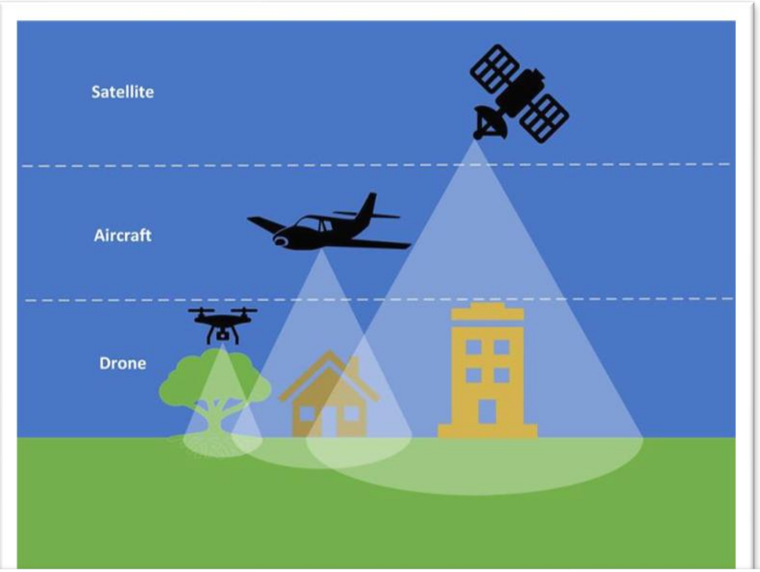
Rapid and objective evaluation of post-disaster impact.

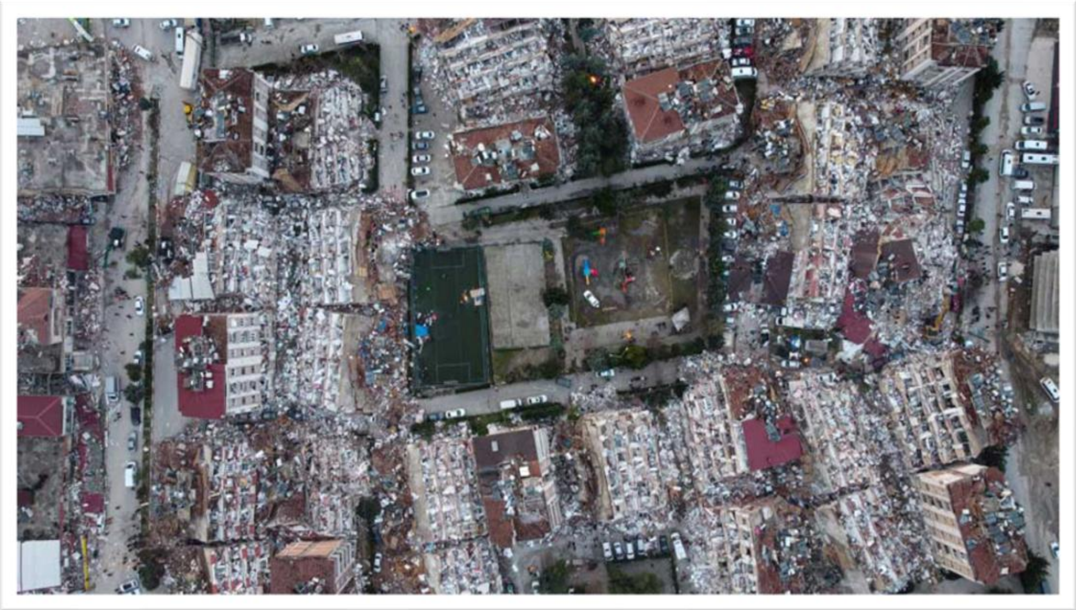
- Remote sensing provides the foundation for large-scale, consistent, and repeatable damage assessment across entire regions.

Satellite imagery offers wide coverage, enabling a bird's-eye overview of impacted zones, while **aerial and drone imagery** deliver very high-resolution views for neighborhood- or building-level inspection.

- Data sources include **optical sensors** (visible color), **SAR** (radar-based, which penetrates clouds and smoke), and thermal sensors (which detect heat anomalies or fires).
- These multi-sensor data streams together form the backbone of modern disaster monitoring systems.

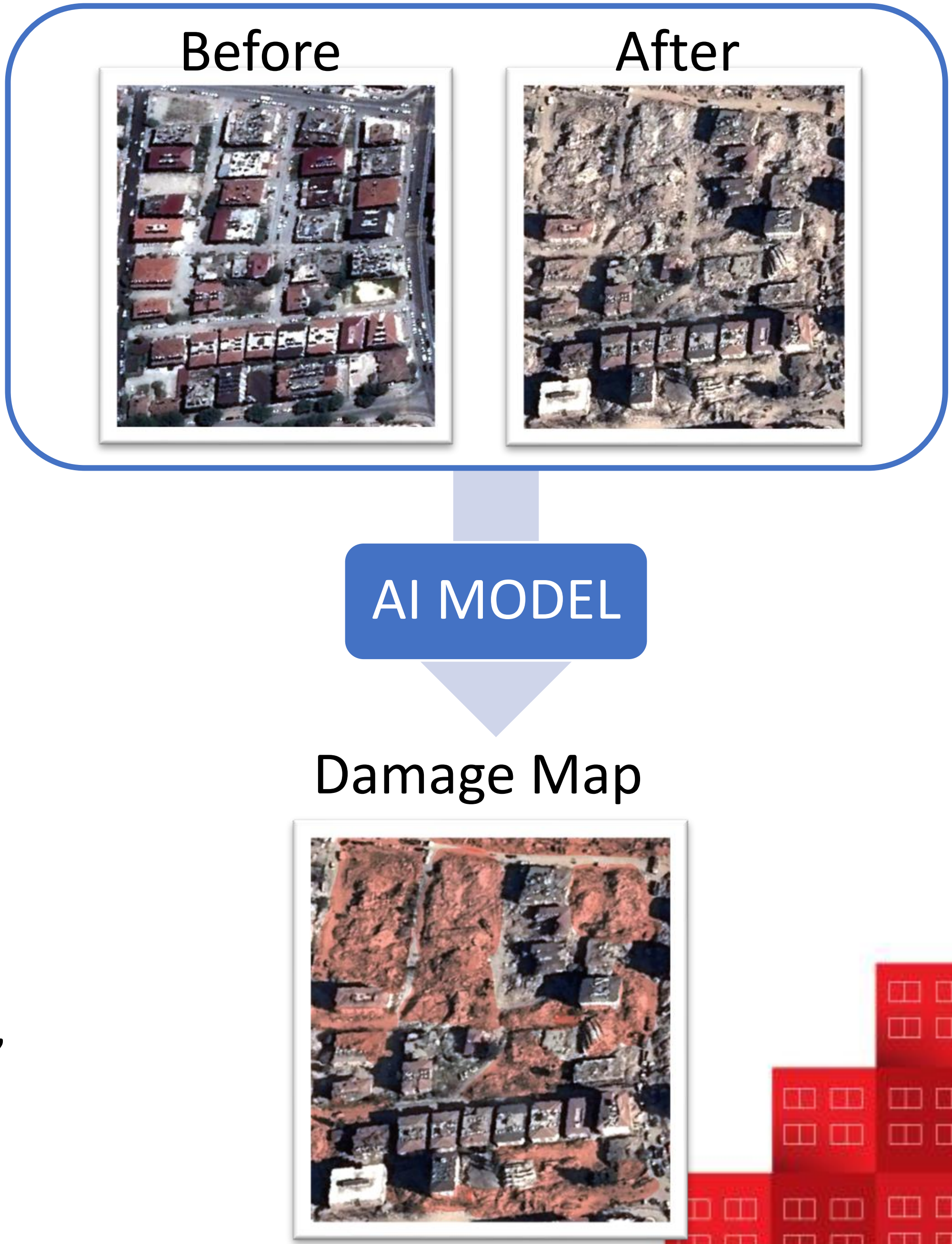
- **AI-driven analysis** automates the interpretation of this imagery, reducing the need for manual visual inspection and allowing decision-makers to act within hours after data acquisition.





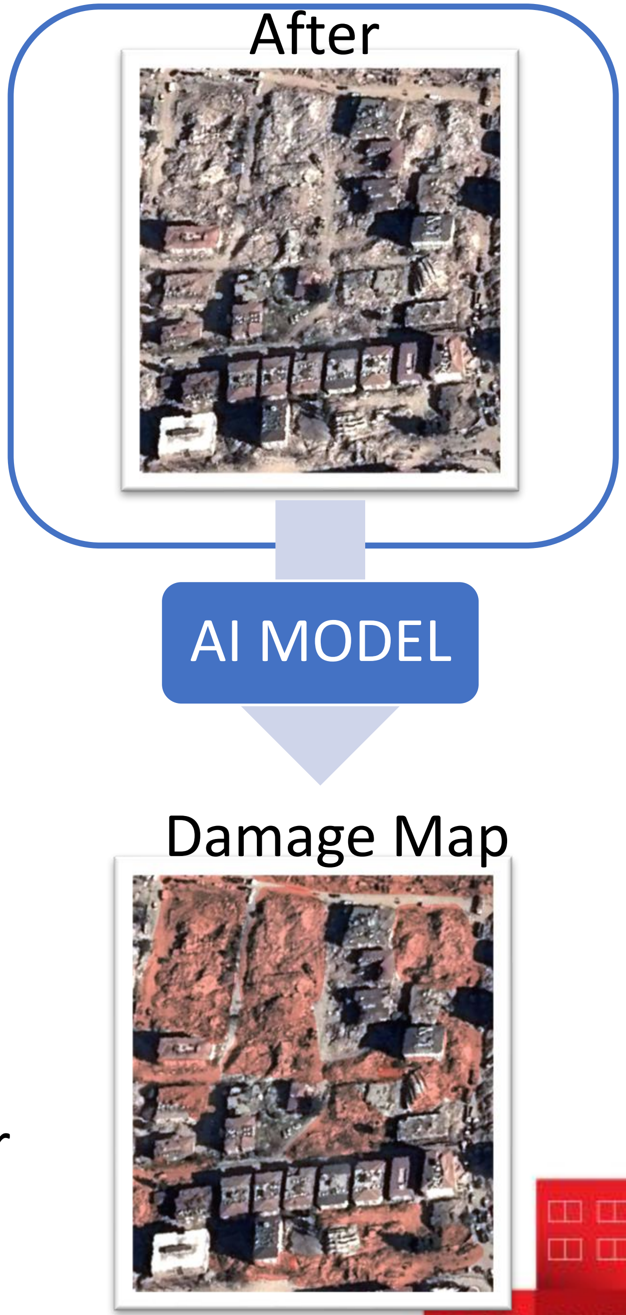
7. Damage assessment using remote sensing

- The AI model compares **pre-event and post-event** drone or satellite images to identify visual changes caused by the earthquake.
- By **analyzing differences in texture, color, and structure**, it detects where buildings have collapsed, roofs have caved in, or debris has appeared.
- This approach is known **as *change detection*,** which enables the model to locate damaged areas even in dense urban scenes.
- The success of this method depends heavily on accurate image alignment and consistent illumination, which modern AI systems can now correct automatically.



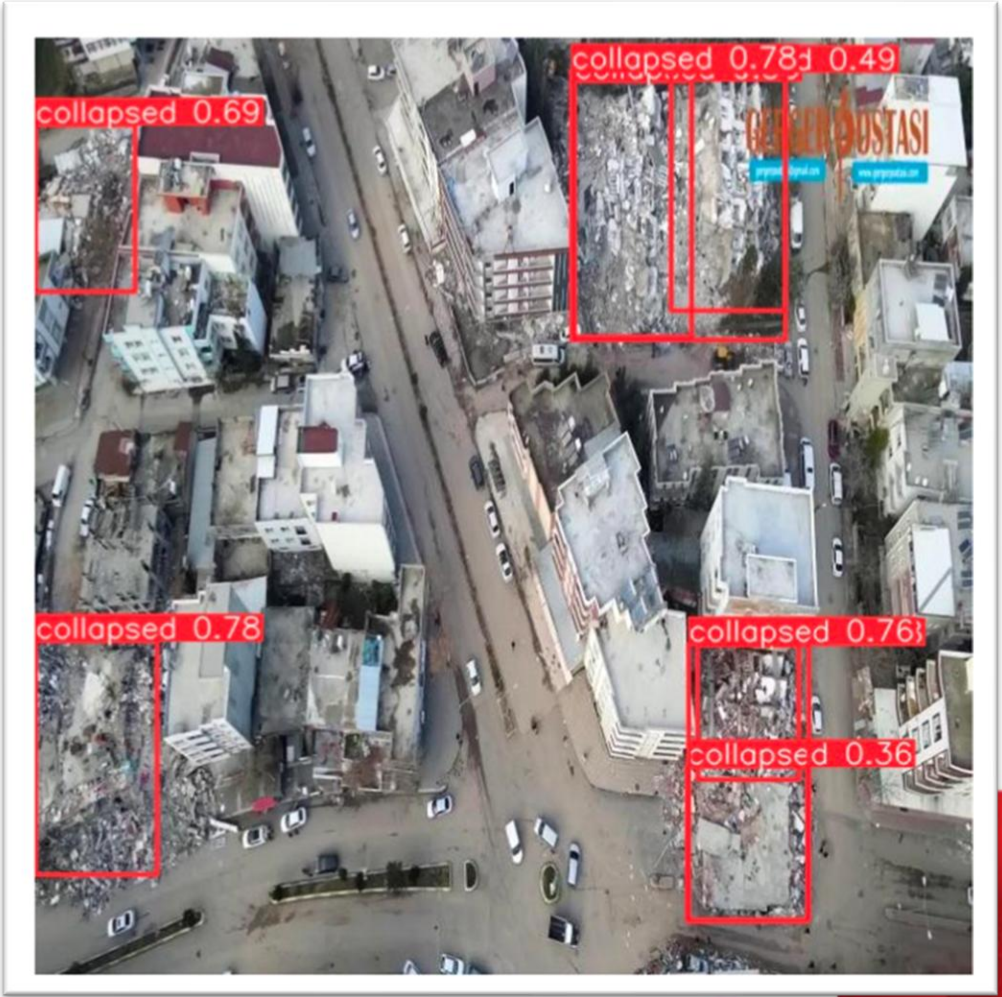
7. Damage assessment using remote sensing

- When pre-disaster imagery is unavailable, the model analyzes only the post-disaster image.
- Instead of directly comparing two time points, it focuses on **spatial and textural cues** that typically indicate destruction — such as collapsed or flattened structures, debris accumulation, missing roof geometry, exposed foundations, dust and rubble patterns, and altered shadow orientations.
- Using these features, the AI model develops an implicit understanding of what "damage" looks like, even without a reference image.
- This **single-date analysis** is especially valuable for **rapid response missions**, when pre-event imagery is outdated or missing, and for **regions that were not previously mapped or surveyed**.



7. Damage assessment using remote sensing

- **Compared to satellites**, drones offer much **higher resolution, faster deployment, and lower cloud interference**.
- Drones enable **rapid, high-resolution mapping** of post-disaster areas **within hours** after the event.
- Provide **centimeter-level imagery**, ideal for inspecting collapsed buildings, debris, and infrastructure damage.
- Offer **on-demand flexibility** — missions can be planned quickly for specific zones or critical sites.
- **AI looks at each building separately**, comparing its shape, color, and texture to what an undamaged building would normally look like, and then estimates how likely it is to be damaged.
- Combine with satellite data for a **multi-scale perspective**: satellites give the overview, drones give local precision.
- Outputs: **building-level damage maps**, **annotated photos**, and **geotagged reports** to guide field teams.



7. Damage assessment using remote sensing

- Enables **rapid, objective, and scalable** damage estimation **as remote sensing covers large regions simultaneously**
- Enable early loss estimation within **24–48 hours**
- Reduces **human bias** and accelerates payout validation
- AI-damage maps integrated with claim management systems
- Prioritize site inspections via high-risk zones

7. Damage assessment using remote sensing

- Remote sensing supports **multi-hazard monitoring/assessment**
- Detects damage from:
  - 🔥 **Wildfires:** burn severity, thermal hotspots
  - 🌊 **Floods:** water extent, inundation depth, infrastructure loss
  - 🪨 **Landslides:** slope failure detection, soil displacement
  - 🌪️ **Storms & Hurricanes:** roof damage, debris mapping
  - 🏭 **Industrial accidents:** oil spills, chemical contamination
- Provides **consistent, repeatable, and scalable** damage analytics
- Enables **comprehensive national risk assessment** for insurance portfolios

8. Damage assessment training through VR

https://www.canva.com/design/DAG2UqVqRBM/tdicQ93NJa2O85MiGqlSaw/edit?utm_content=DAG2UqVqRBM&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

9. Conclusions

TCIP and MEUCC agree on use of a standard and common damage classification procedure (the new code)

They both improve their web-based digital real time operational platforms to implement revised official damage classification system

They both plan to make use of developed AI-based structural member level damage classification decision-support system

They both plan to make use of remote sensing guided AI-based damage assessment at both regional scale and global building scale through satellite and drones.

Face-to-face and on-line trainings on damage assessment/classification for damage assesors continue

We plan to use AI-based training modules for enhancing capacities of damage assesors.

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Thank you and Questions

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