Mitigation Framework for Seismic Prone Zone

Considering a Cost Effectiveness Analysis

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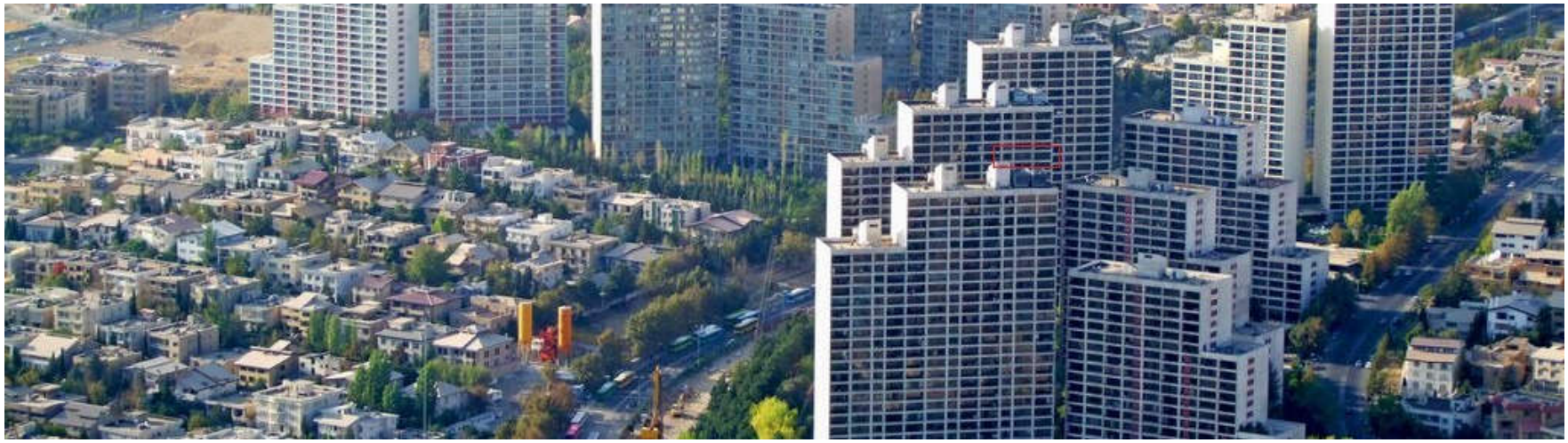
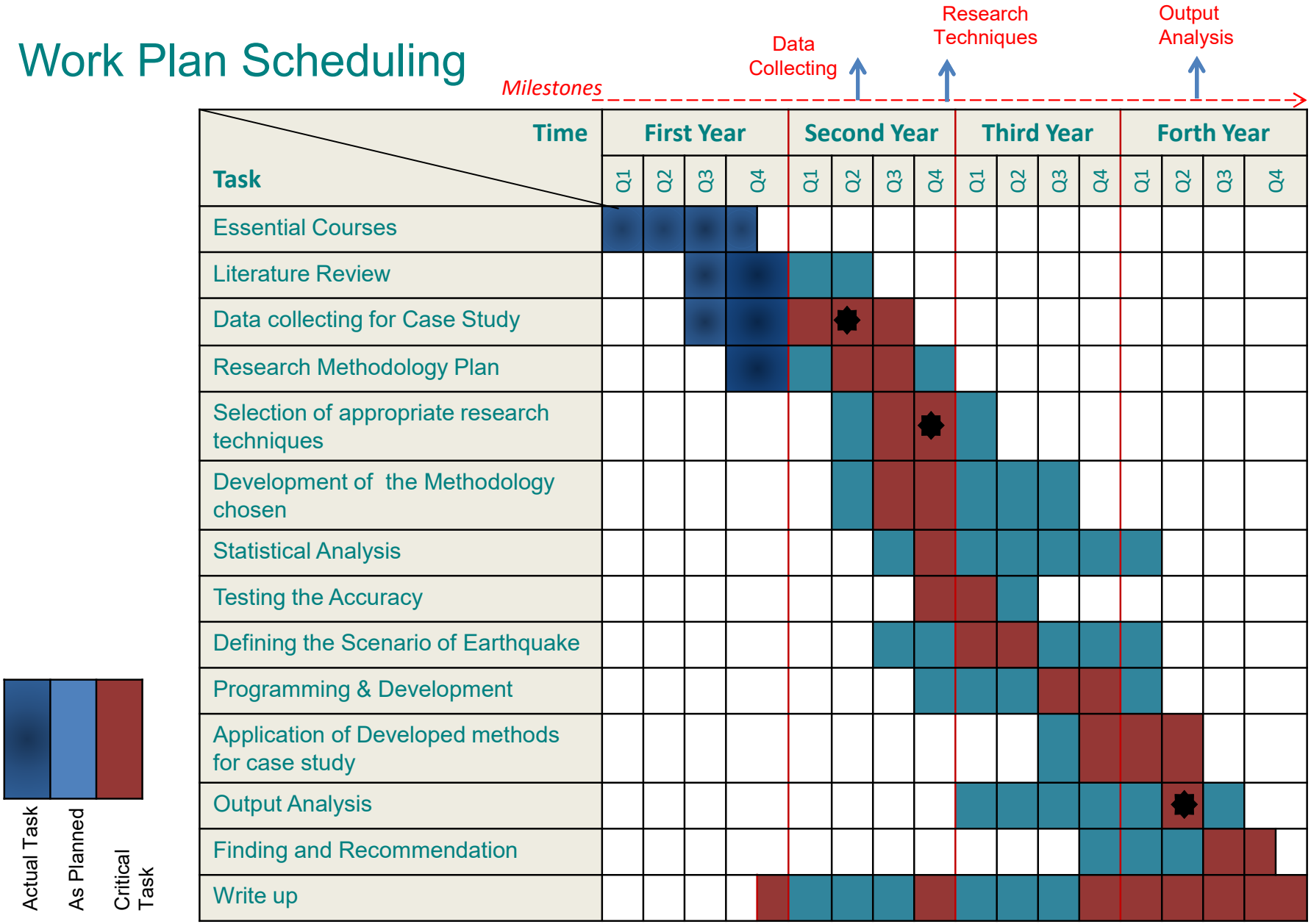
Sustainable Seismic Risk and Mitigation Strategies; Cost Effectiveness Analysis

Objective

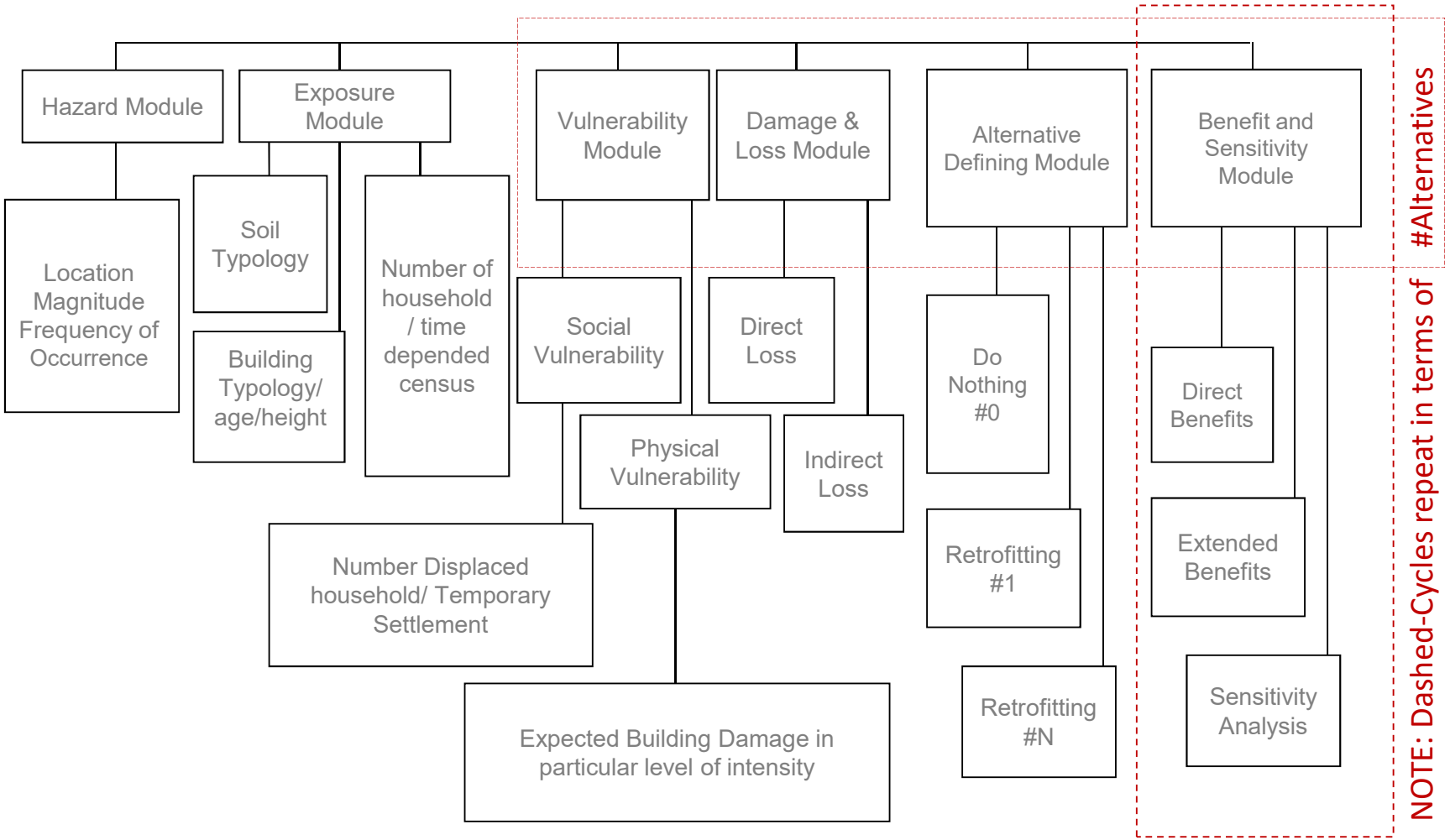
- Applicable Mitigation Framework for Decision Making in Seismic Risk
- Development of Cost Benefit Analysis Model
- Evaluation of the Most Effective Mitigation Strategies
- Definition of strengthening Policies for Urban Areas in Metropolitan (Tehran)
- One Step forward to Conquer Risk Reduction Conflict



Work Plan Scheduling



Applicable Mitigation Framework; Cost Effectiveness Analysis



Mitigation Framework Modules

Hazard Module

Exposure Module

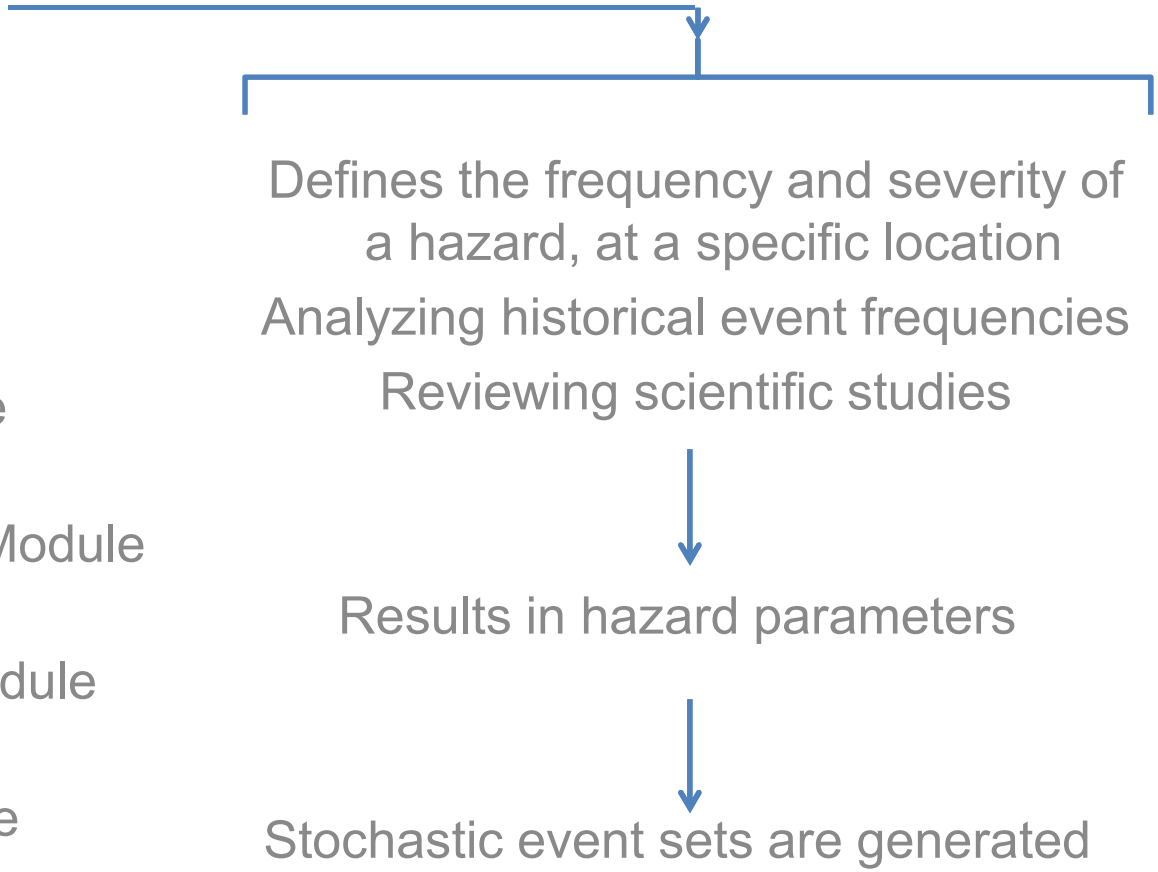
Vulnerability Module

Loss & Damage Module

Retrofitting Alternative Module

Benefit & Sensitivity Module

Decision Making Module



Mitigation Framework Modules

Hazard Module

Exposure Module

Vulnerability Module

Loss & Damage Module

Retrofitting Alternative Module

Benefit & Sensitivity Module

Decision Making Module

- ✓Building Typology
- ✓Building Height/ Building Age
- ✓Number of Floors/ Status of Building
- ✓Population Density/ Different Hours

Mitigation Framework Modules

Hazard Module

Exposure Module

Vulnerability Module

Loss & Damage Module

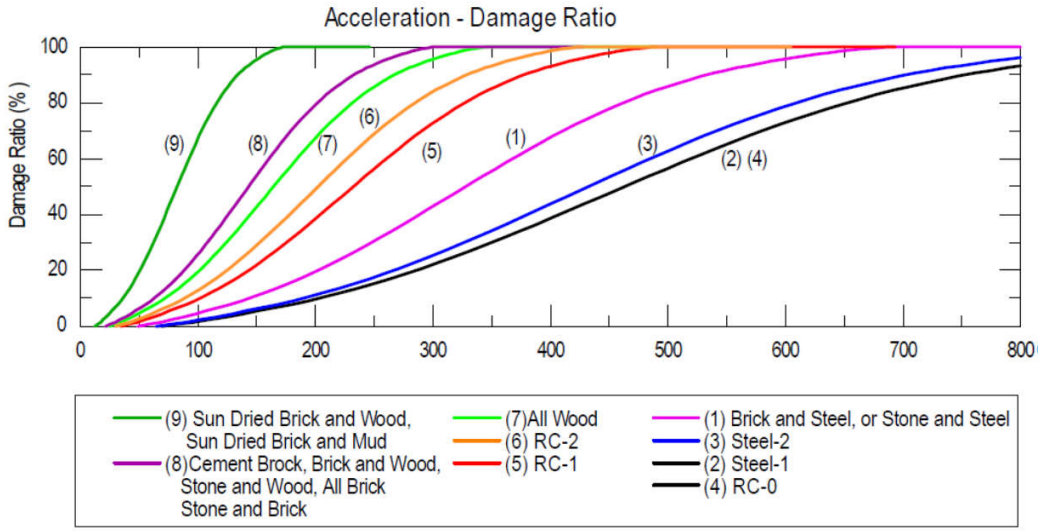
Retrofitting Alternative Module

Benefit & Sensitivity Module

Decision Making Module

Building vulnerability is the measurement of the damage, building is likely to experience when it is subjected to ground shaking of a specified intensity.

Fragility Curves; Capacity Curves



Mitigation Framework Modules

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Decision Making Module

Several measures are introduced to calculate the loss

- Damage Ratio
- Mean Damage Ratio
- Average Annual Loss
- Loss Exceedance Curve
- Probable Maximum Loss
- Discount rate

Mitigation Framework Modules

Hazard Module

Exposure Module

Vulnerability Module

Loss & Damage Module

Retrofitting Alternative Module

- Do Nothing
- Have time/ Have money
- Have money/ No time
- Have money/ Technical issue
- Limited money/ Unlimited time
- Common technical alternative
- Innovative retrofitting alternative

Benefit & Sensitivity Module

Decision Making Module

Mitigation Framework Modules

Hazard Module

Exposure Module

Vulnerability Module

Loss & Damage Module

Retrofitting Alternative Module

Benefit & Sensitivity Module

Decision Making Module

- Specify the nature of the problem
- Determine the direct and indirect cost
  of the mitigation alternatives
- Determine the benefits of mitigation alternatives;
  direct benefit
  indirect benefits
- Calculate attractiveness of mitigation alternatives
- Choose the best mitigation alternative;
  highest BCR.

Mitigation Framework Modules

Hazard Module

Exposure Module

Vulnerability Module

Loss & Damage Module

Retrofitting Alternative Module

Benefit & Sensitivity Module

Decision Making Module

Combination of Software-Personal Perception of Decision Makers

- Software/ Logic trees
- Multi-criteria decision making
- Correlations/Interdependencies
- Expert judgment,
- Sensitivity/ Priority / Importance
- Feasibility/ CBA of alternatives

Case Study : Tehran; IRAN

Country: **Iran**

Capital: **Tehran**

Area of the Capital:

686.3 km²

Distance of the Nearest Mountain to City : **10 km**

Altitude Approaching; **3933 m**

Number of Residents:

8.154 million (2011)

Number of Neighborhood:

22

First Severe Recorded Earthquake: **855**

Last Severe Earthquake:

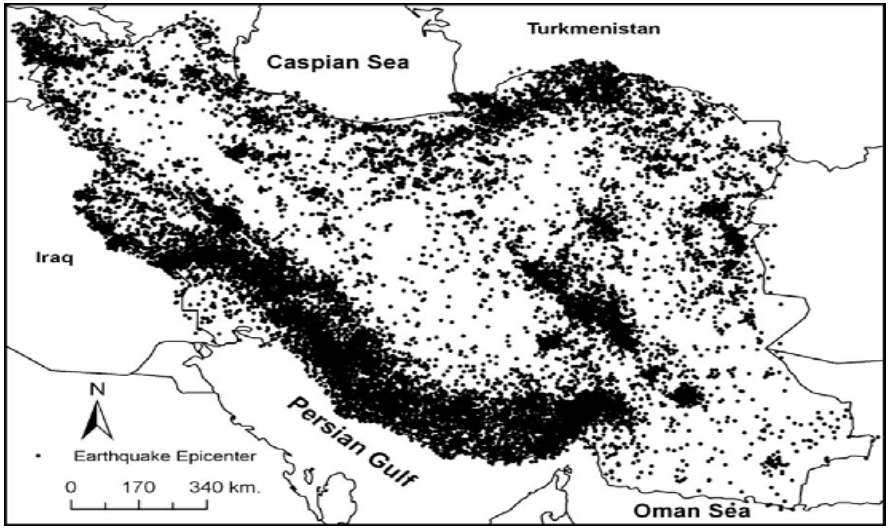
1830

Number of Active Fault:

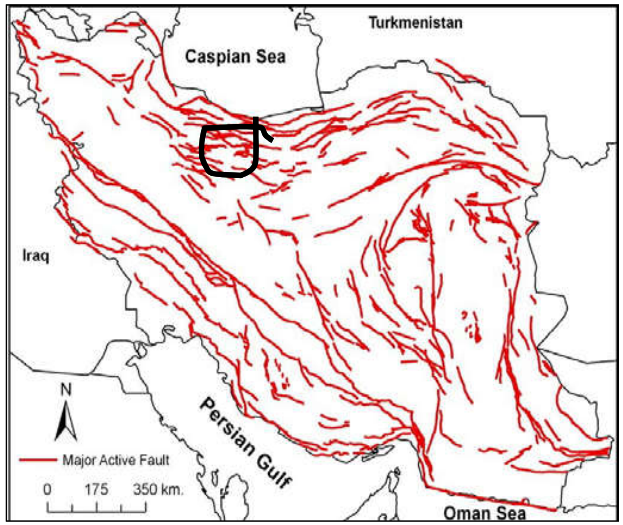
15

Typology of Building:

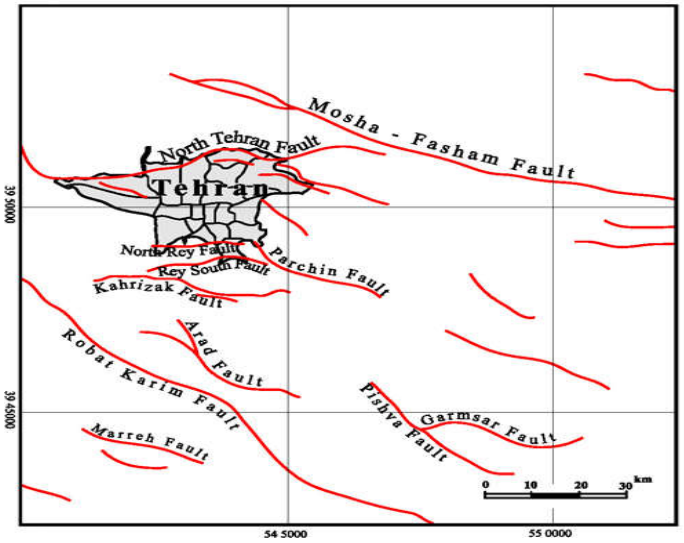
- Steel 60 %
- Concrete 18%
- Others 20%



Epicenteral map of instrumentally recorded earthquakes of the Iranian region from 1900 to 2010, extracted from different catalogs (e.g., ISC, USGS, IIEES), with M>4.0



Maps showing major active faults of Iran



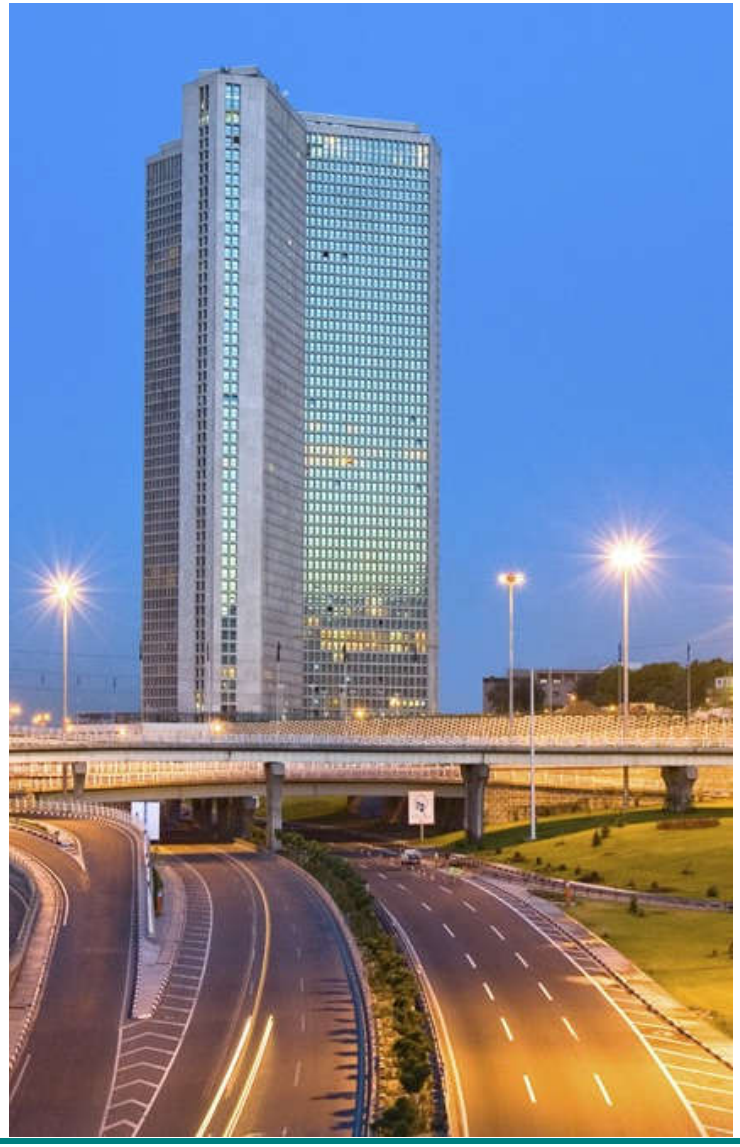
15 active faults of Tehran city

Tehran has experienced rapid urban development and increasing population density in recent decades.

1950

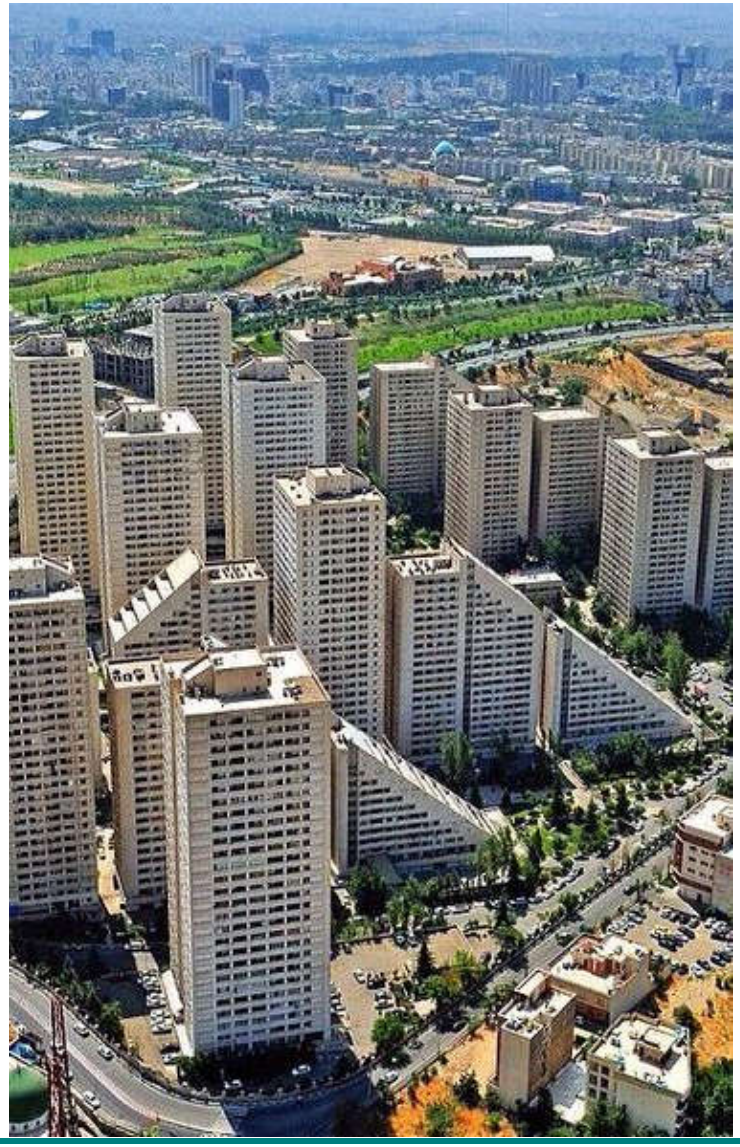
2010

Buildings in Tehran



Tehran International Tower	
Building System	Concrete
Number of Story	56
Type	Residential
Location	Tehran, Iran
Coordinates	35.7426808°N 51.3991446°ECoordinates: 35.7426808°N 51.3991446°E
Construction started	1996
Completed	2005
Opening	2007
Height	162 m (531 ft)
Floor area	220,000 m^2 (2,400,000 sq ft)

Buildings in Tehran…



Tehran AtiSaz	
Building System	Concrete
Number of Story (depends on type)	9 - 32
Type	Residential Complex
Location	Tehran, Iran
Coordinates	35°47'6"N 51°23'25"E
Construction started	1975
Completed	1987
New Phase	2001
Complex Area	155000 square meters
Number of Structures in Complex	23

Work Done

- **Uncertainty / Reliability Courses (IST)**
- **Innovation / Leadership Courses (UMinho)**
- **Literature review of seismic risk and mitigation strategies**
  - ✓ Applicable Mitigation Framework
- **Data collecting for Case Study (as if Tehran is approved)**
  - ✓ Census and statistics of residents in Tehran, 2011
  - ✓ Typology of buildings and statistics 2006

Under Progress:

- **Data Request Correspondence with Following Sectors**
  - ✓ Tehran Disaster Mitigation and Management Organization (TDMMO)
  - ✓ Contacting with International Institute of Earthquake Engineering and Seismology (IIEES)
  - ✓ Tehran Urban Research and Planning Center
  - ✓ Statistical Center of Iran
  - ✓ Tehran Construction Engineering Organization (TCEO)
  - ✓ Tehran University Natural Disaster Management Center
  - ✓ Iranian Seismological Center

Next Steps

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- ❑Research Methodology Plan
- ❑Selection of appropriate research techniques
- ❑Development of the Methodology chosen
- ❑Statistical Analysis
- ❑Testing the Accuracy
- ❑Defining the Scenario of Earthquake

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Thank You for Your Consideration…