STRUCTURAL HEALTH MONITORING

STRUCTURAL HEALTH MONITORING (SHM)

- The Disaster management aims to prevent events that result in disaster or to reduce their losses.
- Monitoring of engineering buildings, identification of unusual movements and taking the necessary precautions are very crucial for determination of the disaster risk so possible prevention could be taken to reduce big loss.

STRUCTURAL HEALTH MONITORING (SHM)

- The importance of these high structures is invaluable because the regions where these structures are located are regions where the populations are intense.
- For this reason, continuous monitoring of these structures should be carried out to check that they have reached their design lifetime and their remaining lifetime should be determined(Im et al., 2013).

STRUCTURAL HEALTH MONITORING (SHM)

''The process of implementing a damage detection and characterization strategy for engineering structures''

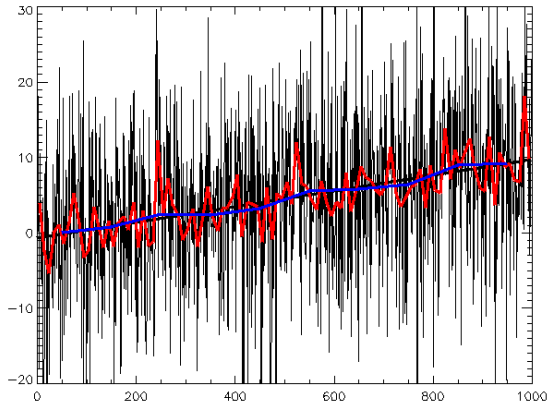
- Health Monitoring
- Operational Evaluation
- Data Feature Extraction
- Statistical Models Development

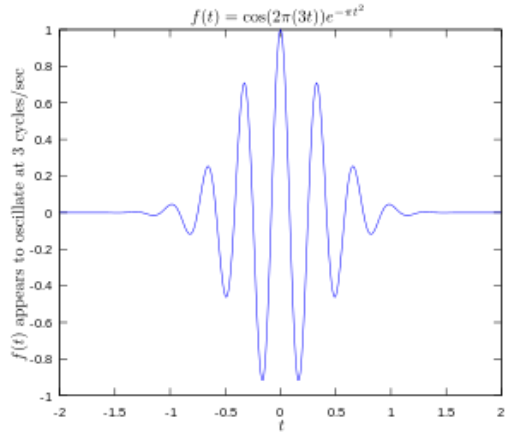
STRUCTURAL HEALTH MONITORING

- Observation of these changes on the buildings and determination of damage can be done with a systematic Structural Health Monitoring.
- Today, it is observed that Global Positioning Systems (GPS) are used intensively in the observation of dynamic deformations in order to determine structural vibrations for structures such as long bridges, towers, high buildings.

Objective of SHM

- Performance enhancement of an existing structure
- Monitoring the structure affected by external forces / factors
- Feedback loop to improve future design based on experience
- Assessment of post-earthquake structural integrity





SHM Applications

Buildings

Bridges

Tunnels

Dams

Any critical engineering structure

SHM Applications

Wind Generators

Nuclear Facilities

Offshore Facilities

Any critical engineering structure

Importance of SHM

Importance of SHM

Geometrical changes that can be occurred on the structures can be determined by using and combining different surveying techniques

Importance of SHM

Monitoring the movements of engineering structures has a great importance for detecting the potentially dangerous situations and taking necessary precautions on time.

Worldwide SHM Projects

Tsing Ma Bridge, Hong Kong

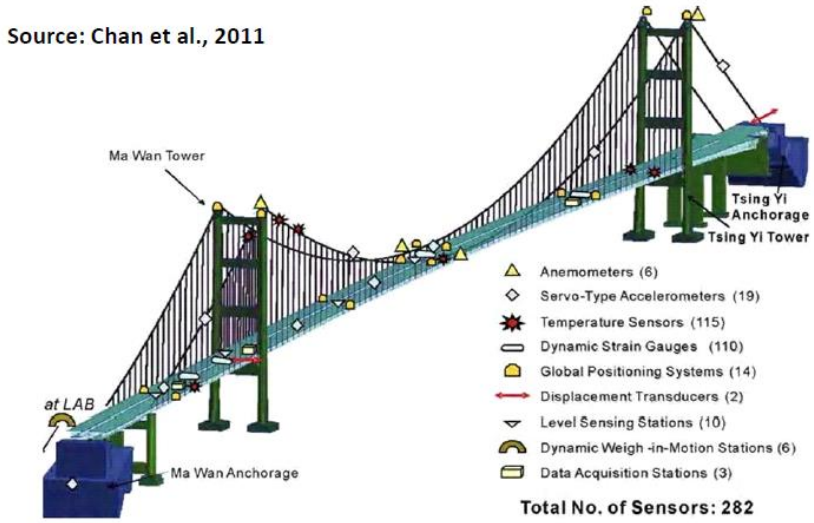
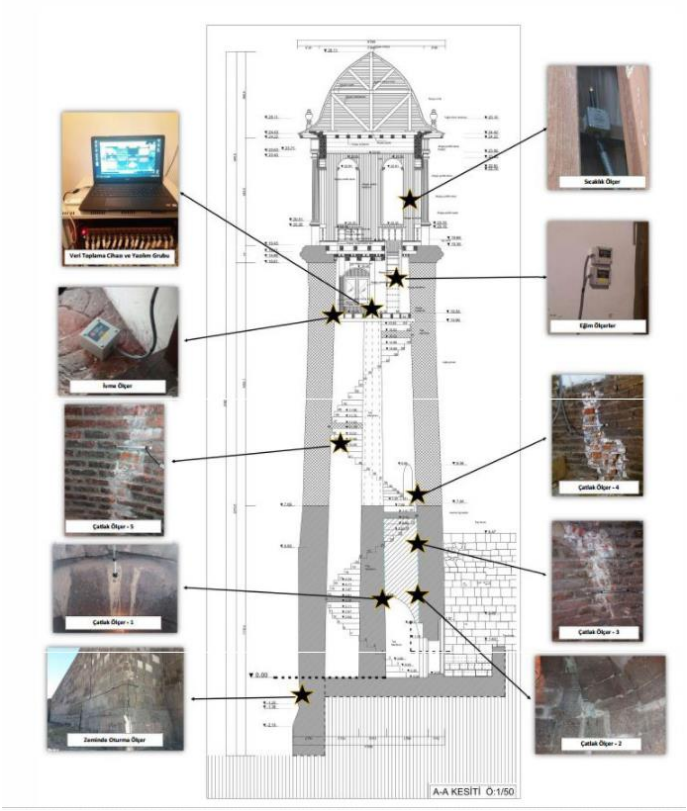


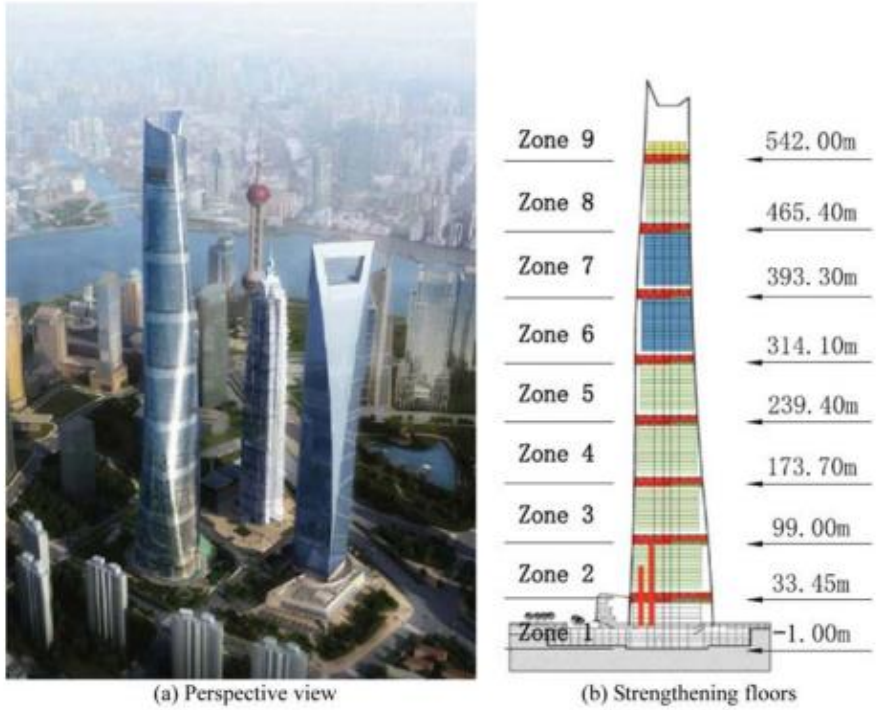
Figure 1. Instrumentation layout in Tsing Ma Bridge

Istanbul Bogazici Suspended Bridge

Worldwide SHM Projects

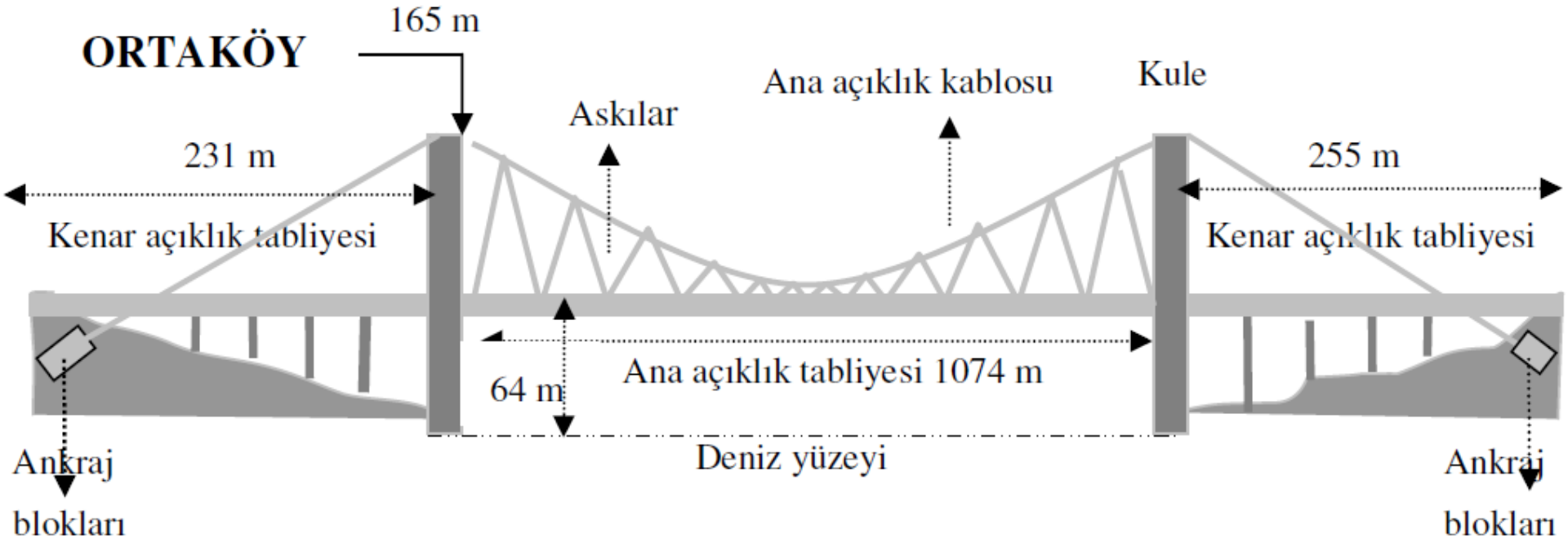


Erzurum Historical Clock Tower, Turkey

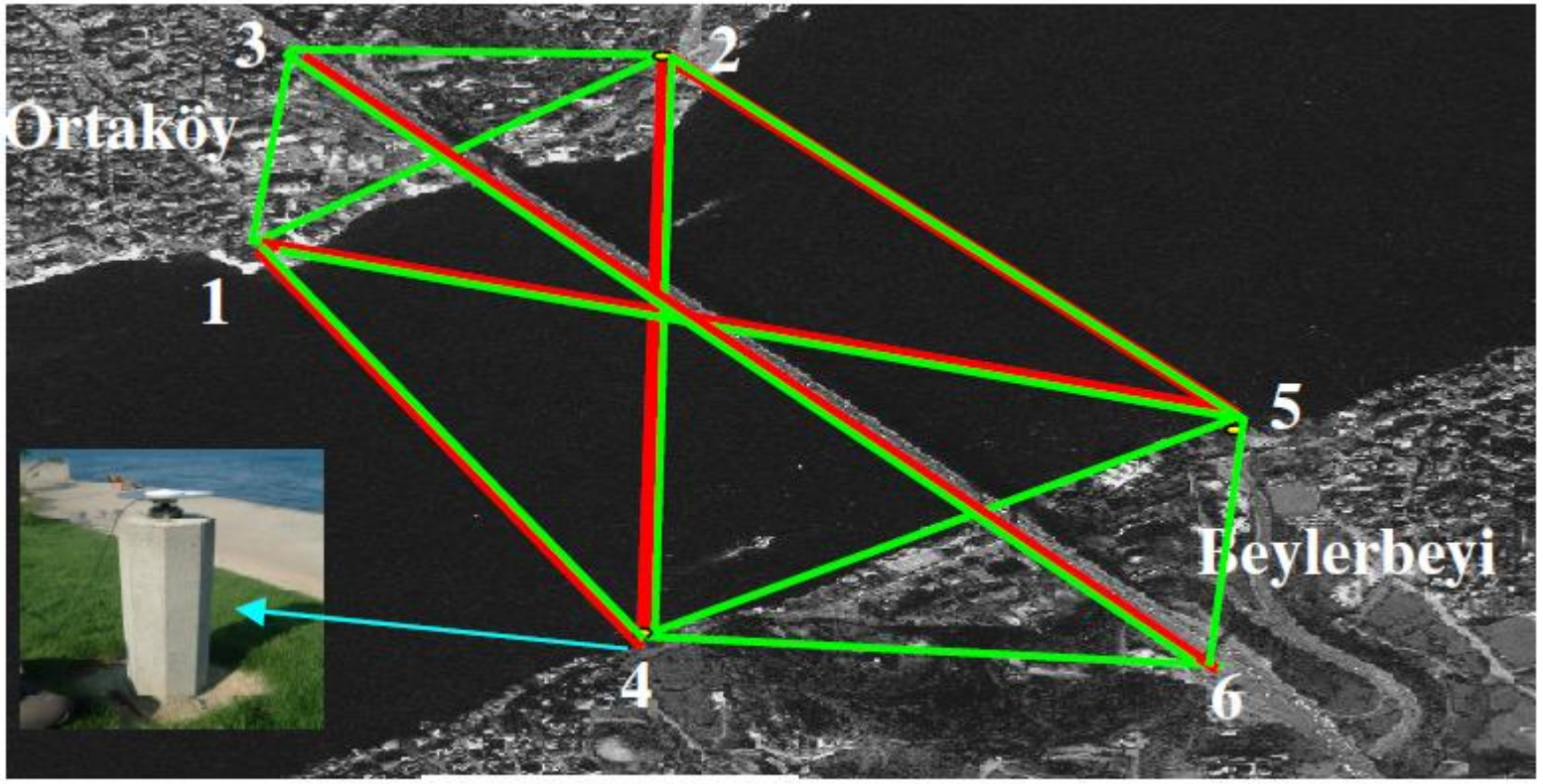


Shanghai Tower, Qilin Zhang et al.

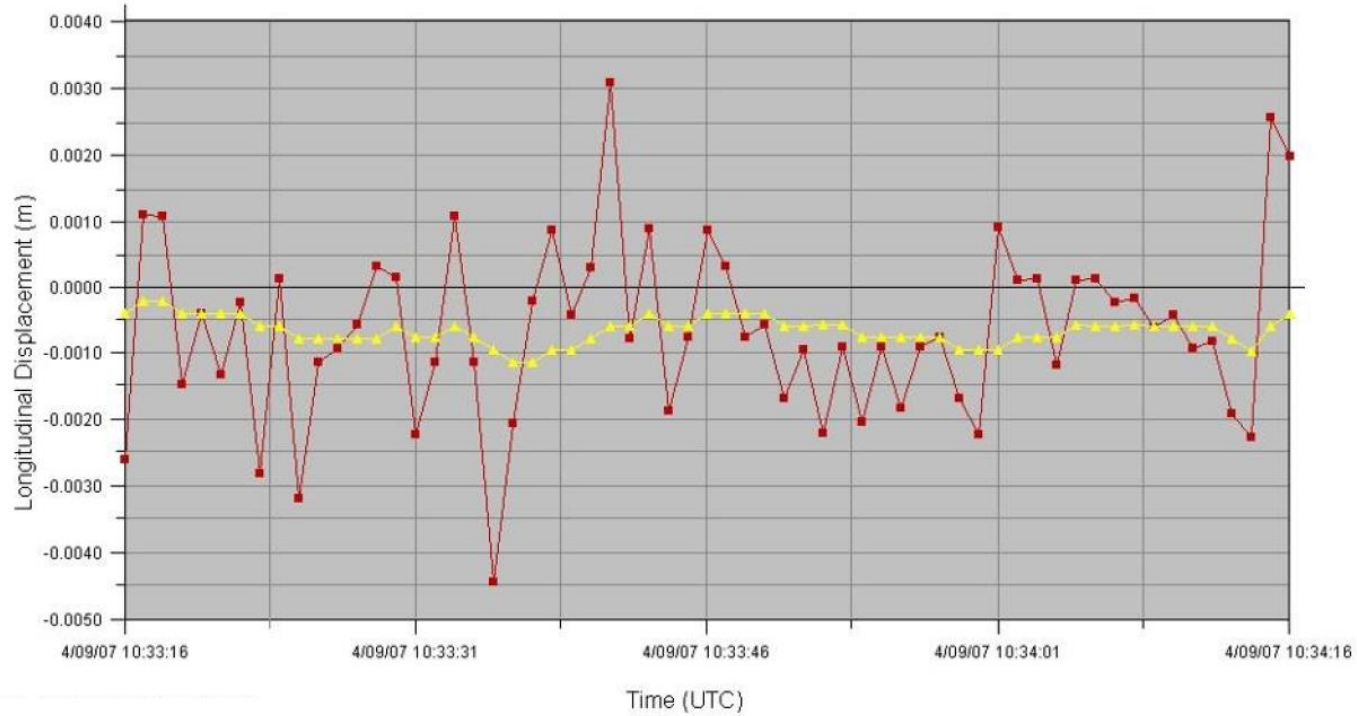
Worldwide SHM Projects



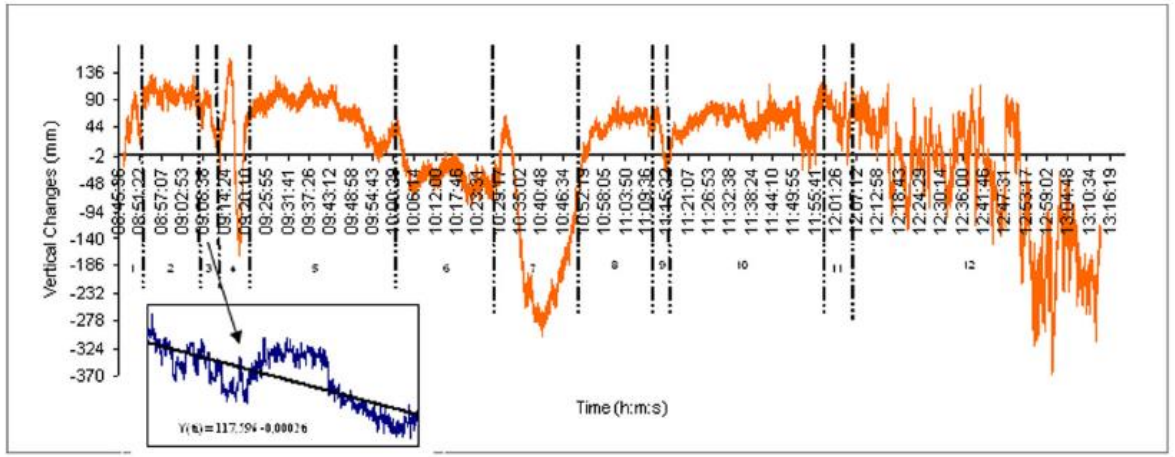
Worldwide SHM Projects



Worldwide SHM Projects



Worldwide SHM Projects



Part no.	Load	Maximum changes above mean movement level (mm)	Maximum changes below mean movement level (mm)	Amplitude values for maximum periodical movements (mm)
1	Low vehicle load	+117	–18	46.7
2	Empty 1	+132	–	7.3
3	Marathon (rhythmic run)	+131	–	21.2
4	11 buses + pedestrian	+159	–169	100.4
5	Pedestrian activities	+131	–19	19.5
6	Low pedestrian load	+8	–81	13.8
7	Pedestrian + vehicle	+63	–303	206.6
8	Low pedestrian load	+95	–35	23.1
9	Buses + trucks + pedestrians	+64	–28	34.1
10	Empty 2	+118	–28	17.7
11	Traffic on the North Side	+120	–16	18.3
12	Opened for traffic	+116	–390	51.5

İSTANBUL BÜYÜKŞEHİR BELEDİYESİ
İMAR MÜDÜRLÜĞÜ

İSTANBUL YÜKSEK BİNALAR DEPREM YÖNETMELİĞİ

Deprem Muhendisliği Anabilim Dalı
Kandilli Rasathanesi ve Deprem Araştırma Enstitüsü
Boğaziçi Üniversitesi
Çengelköy, İstanbul

Versiyon – IV

Mayıs 2008

TÜRKİYE BİNA DEPREM YÖNETMELİĞİ
(TBDY)

Yayın tarihi: 01.00.2016, Resmi Gazete No.:00000

6. YAPI SAĞLIĞI İZLEME SİSTEMLERİ

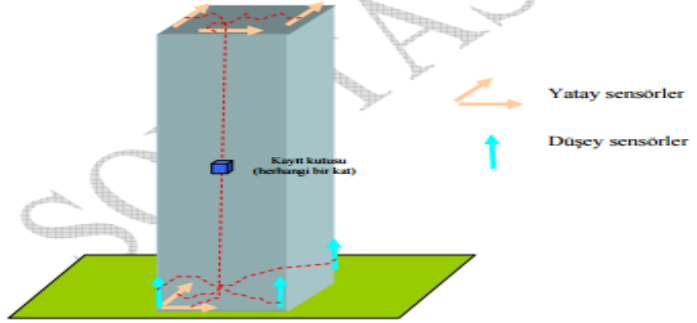
Yüksek binaların gerçek davranışlarını izlemek, mevcut yönetmelikleri iyileştirmek ve büyük bir deprem sonrasında yapıda hasar olup olmadığını kısa sürede tahmin edebilmek amacıyla binalarda en az 8 ivme ölçerden oluşan ve **Şekil 6.1**'de gösterildiği gibi yerleştirilecek **yapı sa lı ı izleme sistemleri** kurulacaktır.

(a) İvme ölçerler senkronize olarak en az 20-bit duyarlığında ve GPS zaman kartlı digital bir kayıt sistemine bağlanacaktır. Kayıt sistemi bina titreşimlerini sürekli olarak kaydedecek ve verileri belirlenen merkezlere internet, modem veya benzeri kanallardan gerçek zamanlı olarak transfer edebilecektir. Sistem, elektrik veya iletişimin kesilmesi durumunda en az bir hafta süreyle çalışabilecek ve veriyi kendi içinde saklayabilecek batarya ve disk kapasitesine sahip olacaktır.

(b) İzleme sisteminde kullanılacak sensör ve kayıt sistemlerinin teknik şartnamesi İstanbul Büyükşehir Belediyesi tarafından ayrıca hazırlanacaktır.

(c) Titreşim kayıtları gerçek zamanlı olarak İstanbul Büyükşehir Belediyesi'nde kurulacak **Yapı Sa lı ı zleme Merkezi**'ne gönderilecek ve kayıtlar hem bina sahibi hem de bu merkez tarafından saklanacaktır.

(d) Bina sahipleri bu sistemin bakımından ve korunmasından sorumlu olacaktır.



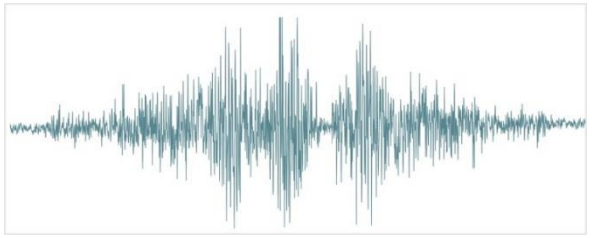
Şekil 6.1

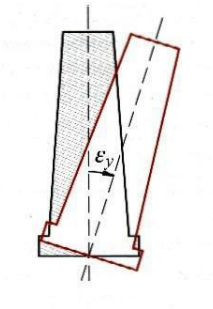
Structural Heath Monitoring

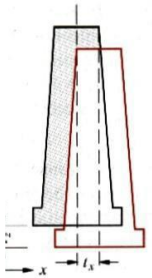
Accelerometers
Vibrations

Inclinometer, Tiltmeter
Vertical Deviations

GNSS
Displacements







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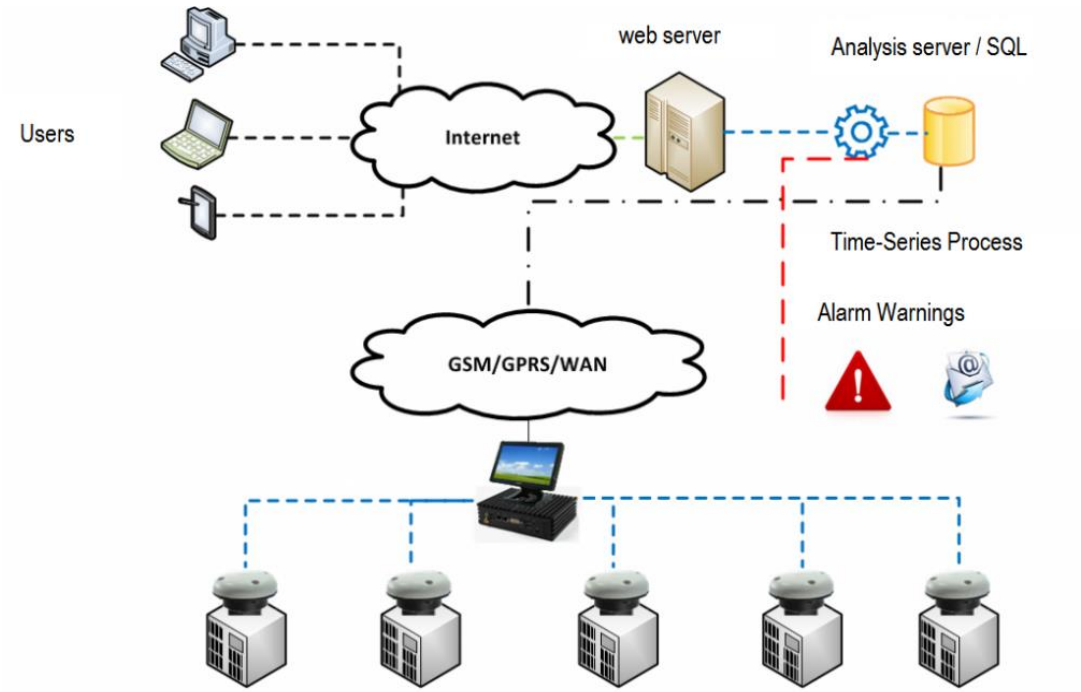
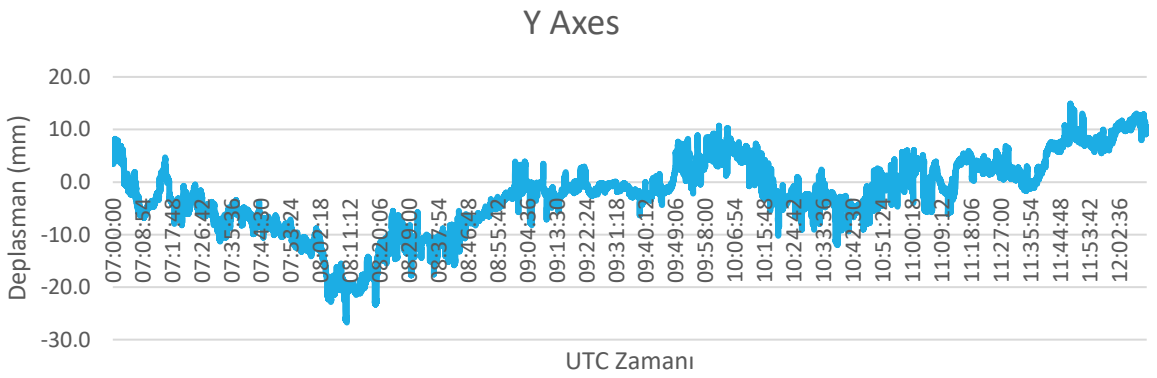
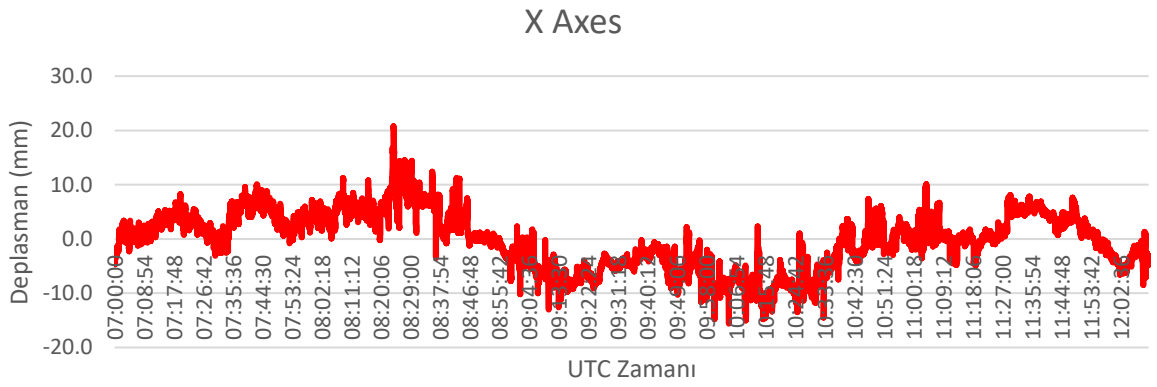
Structural Heath Monitoring

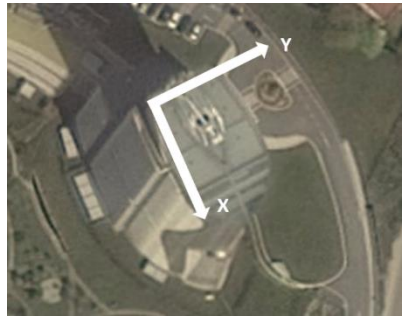


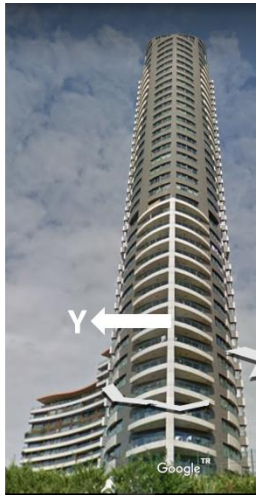
Structural Heath Monitoring

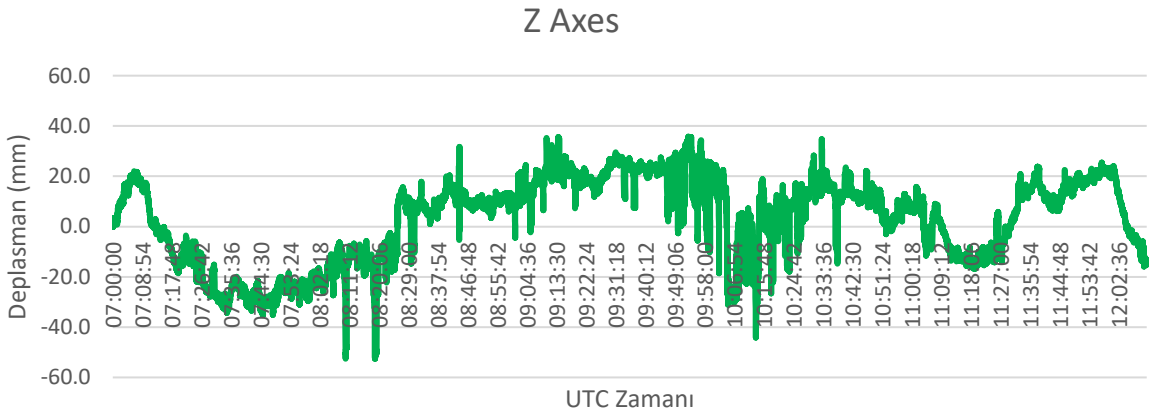


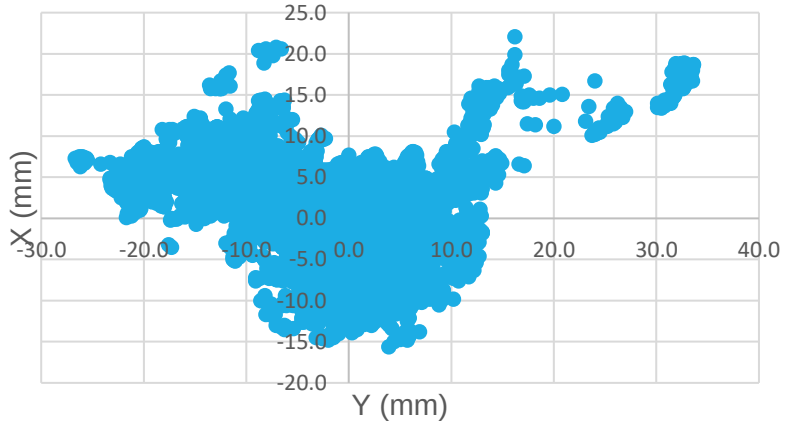


Structural Heath Monitoring









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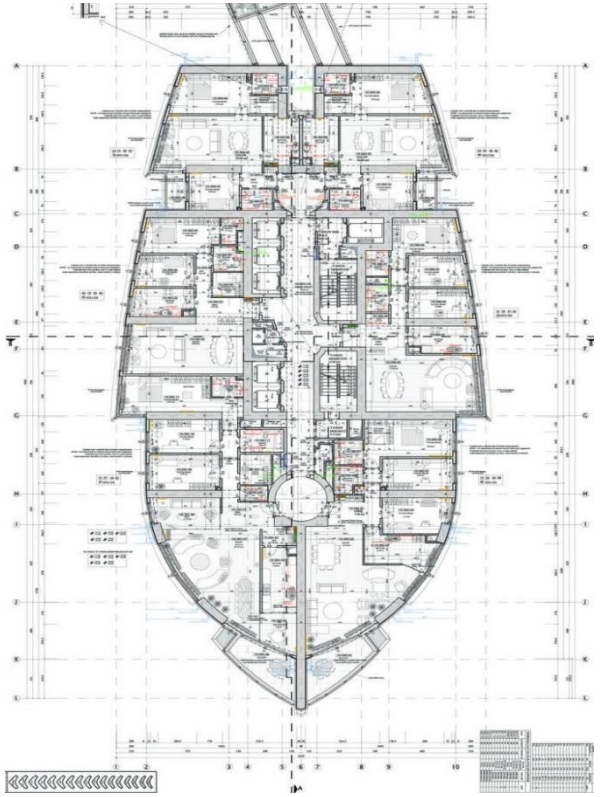
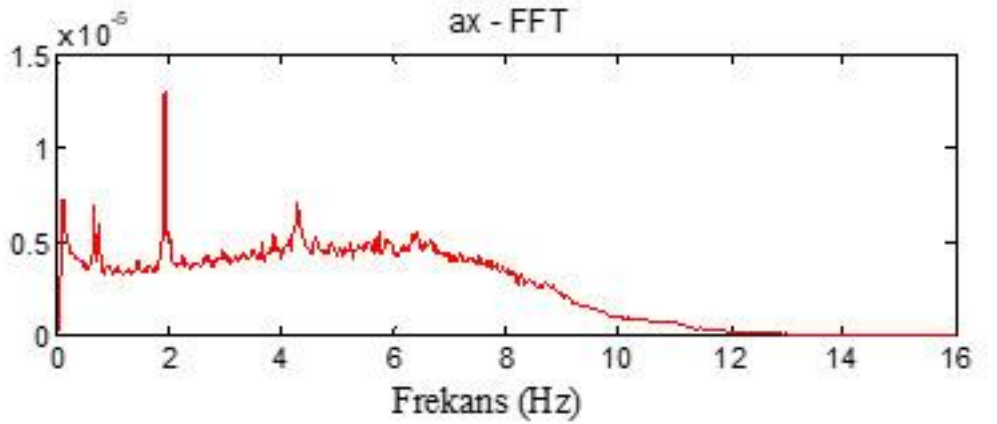
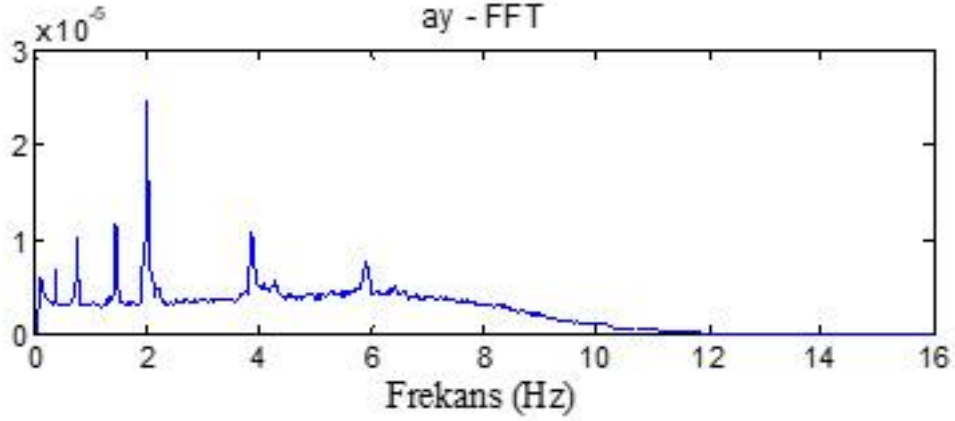
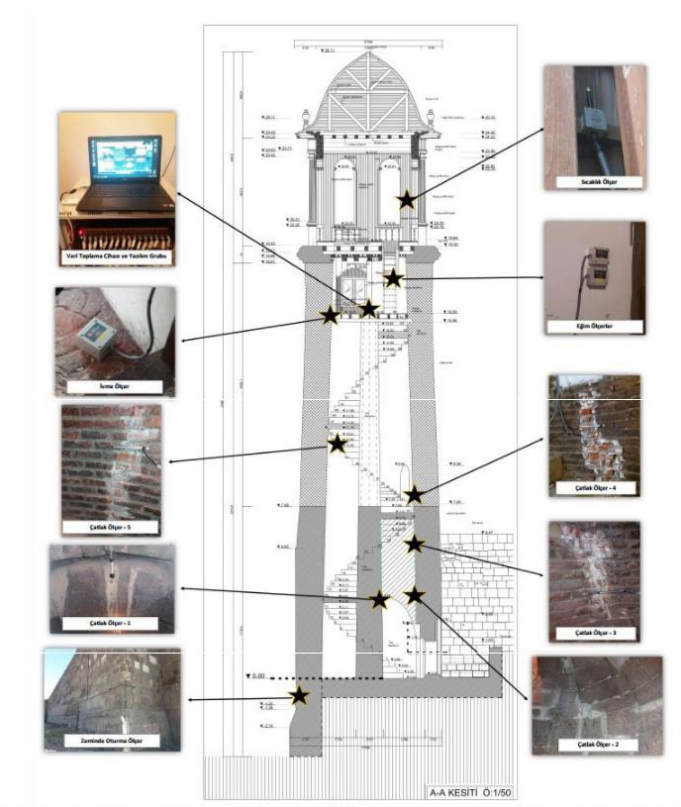




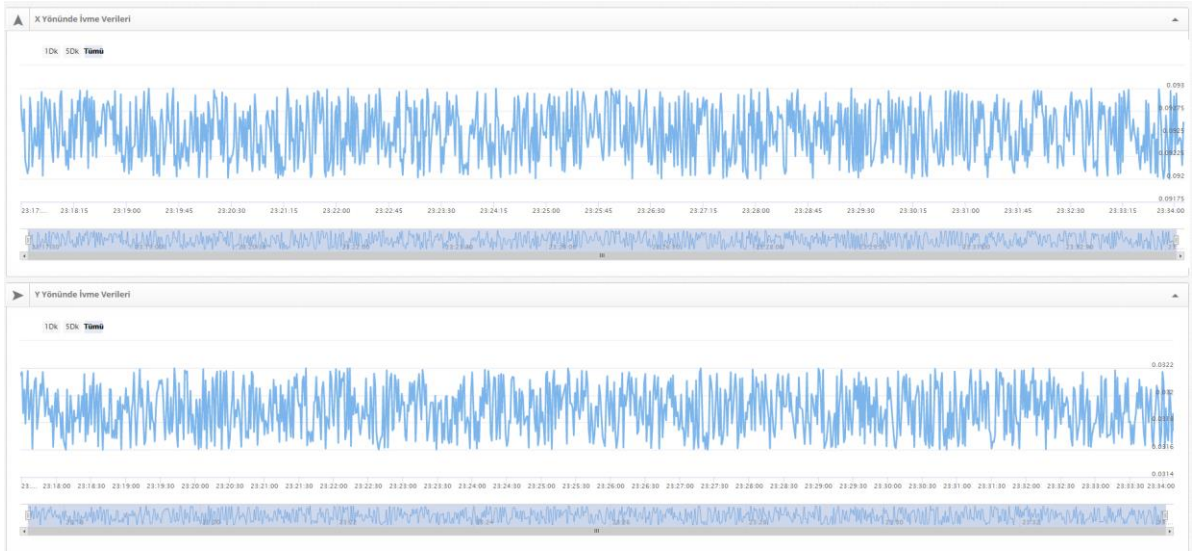


Structural Heath Monitoring



Erzurum Historical Clock Tower, Turkey

Real Time Accelerometer Data

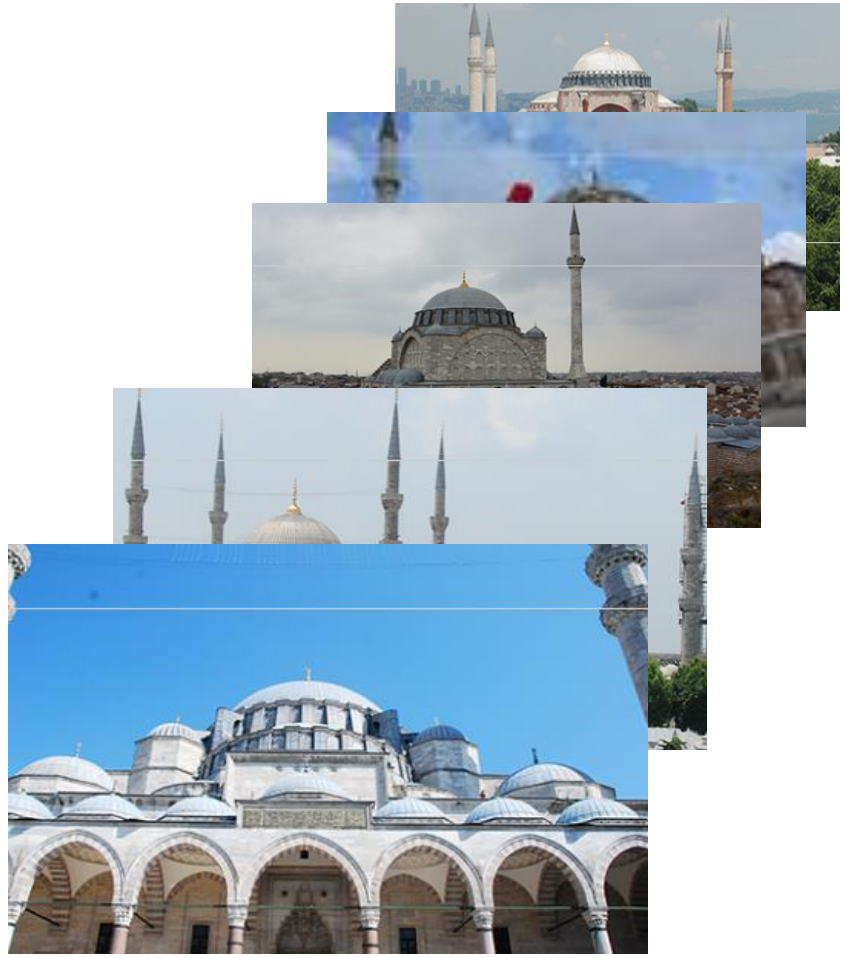


Assoc. Prof. Dr. Burak AKPINAR

Structural Heath Monitoring

Historic Buildings

- Ayasofya Museum
- Fatih Mosque
- Mihrimah Sultan Mosque
- Sultan Ahmet Mosque
- Suleymaniye Mosque



(https://eqe.boun.edu.tr/tr/yapi-sagligi-izleme-sistemleri).

High Buildings

- Safir AVM
- Kanyon AVM
- Polat Tower Residence
- İs Bank Towers

(https://ege.boun.edu.tr/tr/yapi-sagligi-izleme-sistemleri).

Bridges and Towers

- Fatih Sultan Mehmet Bridge
- Marmaray
- Historical Istanbul Walls

(https://ege.boun.edu.tr/tr/yapi-sagligi-izleme-sistemleri).