

SEISMIC ASSESSMENT AND RETROFIT STUDIES OF EXISTING PUBLIC BUILDINGS IN ISTANBUL

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Engineer's experience

Pre-earthquake Studies

- 2005 Tepsco - Orient Research JV. 38 selected high priority building complexes, 120 structural blocks 300,000 m²
- 1998 Laing – Owen Williams JV. 51 hospital complexes, 630 structural blocks 1,000,000 m²

Post-earthquake Studies

- Various projects with and in collaboration with Universities following the earthquakes of Erzincan, Erzurum, Dinar and Kocaeli



Hospitals





Schools





Scope of the studies

1. Define performance criteria
2. Measured surveys, destructive and non-destructive testing, lab and in-situ tests
3. Structural and non-structural preliminary assessments
4. Detail assessment, concept retrofit design, feasibility studies
5. Detail retrofit studies and design, incl. non-structural issues
6. Preparation of tender documents, reports

Code and Performance

FEMA Regulations with modifications to reflect local materials. Until March 2006, there was no Turkish assessment Code for existing structures
General performance criteria for public buildings:

- Hospitals – Immediate Occupancy for 10% in 50 years earthquake
- Schools – Immediate Occupancy for 50% in 50 years earthquake

However both must satisfy the Life Safety criteria for 2% in 50 years.



Data Collection

- Search in archives for drawings and SI data
- Very few drawings available. Measured surveys
- Destructive and Non-destructive testing
 - Schmidt hammer
 - Concrete coring
 - Exposure of reinforcements
 - Cover meter surveys
 - Geotechnical investigations (desk top studies, boreholes, foundation exposure, in-situ and lab tests)



Concrete strengths

| Construction Year | Percent Buildings with Characteristic Strength (N/mm²) | | |
|--------------------------|--|---------------|----------------|
| | 0 - 7 | 7 - 14 | 14 - 21 |
| 1997 - 1990 | 10 | 3 | 0 |
| 1989 - 1975 | 16 | 14 | 0 |
| 1974 - 1968 | 20 | 4 | 0 |
| 1967 - 1963 | 15 | 8 | 0 |
| 1962 - 1953 | 2 | 7 | 0 |
| 1952 - 1940 | 3 | 0 | 0 |
| | | | |
| Total | 65 | 35 | |

| Construction Year | Percent Buildings with Standard Deviation (N/mm²) | | |
|--------------------------|---|---------------|----------------|
| | 0 - 5 | 5 - 10 | 10 - 15 |
| 1997 - 1990 | 5 | 8 | 0 |
| 1989 - 1975 | 18 | 12 | 1 |
| 1974 - 1968 | 11 | 13 | 0 |
| 1967 - 1963 | 8 | 15 | 0 |
| 1962 - 1953 | 4 | 4 | 0 |
| 1952 - 1940 | 0 | 3 | 0 |
| | | | |

Preliminary Assessment

- Visual inspection and assessment
- Quick checks
 - Shear
 - Gravity
 - Stability -over turning and foundation capacity
- Structural modelling and analysis including retracing design procedures use at the date of construction for establishing design properties



Detail Assessment

- Detail modelling including actual material properties and structural analysis performed
- Concept retrofit involving latest proprietary systems eg unbonded brace, FRP, base isolators and various conventional technology
- Non-structural mitigation issues
- Geotechnical assessment -liquefaction potential, bearing capacity and foundation suitability
- Recommend structural retrofit solutions

Considerations accounted for disruption to services, inconveniences, loss of space and use, practicality of retrofit, cost etc.



Non-structural issues

Often over looked and concerns underestimated.
Minimum recommended is protection of Egress
Routes

- Masonry infill
- Glass in windows and partitions
- Special equipments
- Fire suppression, ducts and pipes
- Lighting and HVAC installations
- Chemical and hazardous materials



Feasibility Studies

- Cost of viable structural and non-structural retrofit solutions were estimated
- Cost of displacement and inconveniences to users were estimated
- Cost of new build
- Comparisons for all the schemes made
- Priority ranking established
- Overall preferred options recommended



Detail design

- Based on preferred options
- Exhaustive iterative analytical process - adding and modifying structural elements
- Design calculations and check Code compliance
- Contract documentation e.g. BOQ, Specifications, Contracts, drawings etc....
- Reports



Conclusions

- Buildings deficient to assessed performance criteria.
- Possibility of uncertainty about existing data
- Required a high degree of structural and non-structural intervention
- Existing configuration limiting retrofit options
- Extensive disruption to existing services and inconveniences
- High investment cost with potentially low benefits



Considerations

- Relocation of facilities with respect to city growth
- Quality of neighbourhood buildings and accessibility in case of emergencies
- Services offered by existing buildings
- Modernisation requirements
- Long term cost benefit



Recommendations

- Comprehensive studies for all the Public building stock but limited to Stage 1 to 4.
- Quick check procedures employed to determine retrofit possibilities.
- Selling of priced city land to fund new projects
- New super hospitals and schools at strategic locations served by infrastructure with respect to city planning
- Availability of the legal statutes to enable decision process.
- Trained professionals to safeguard construction quality of tomorrow

Thank you

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