

Residential Retrofitting in Istanbul: How can it happen?

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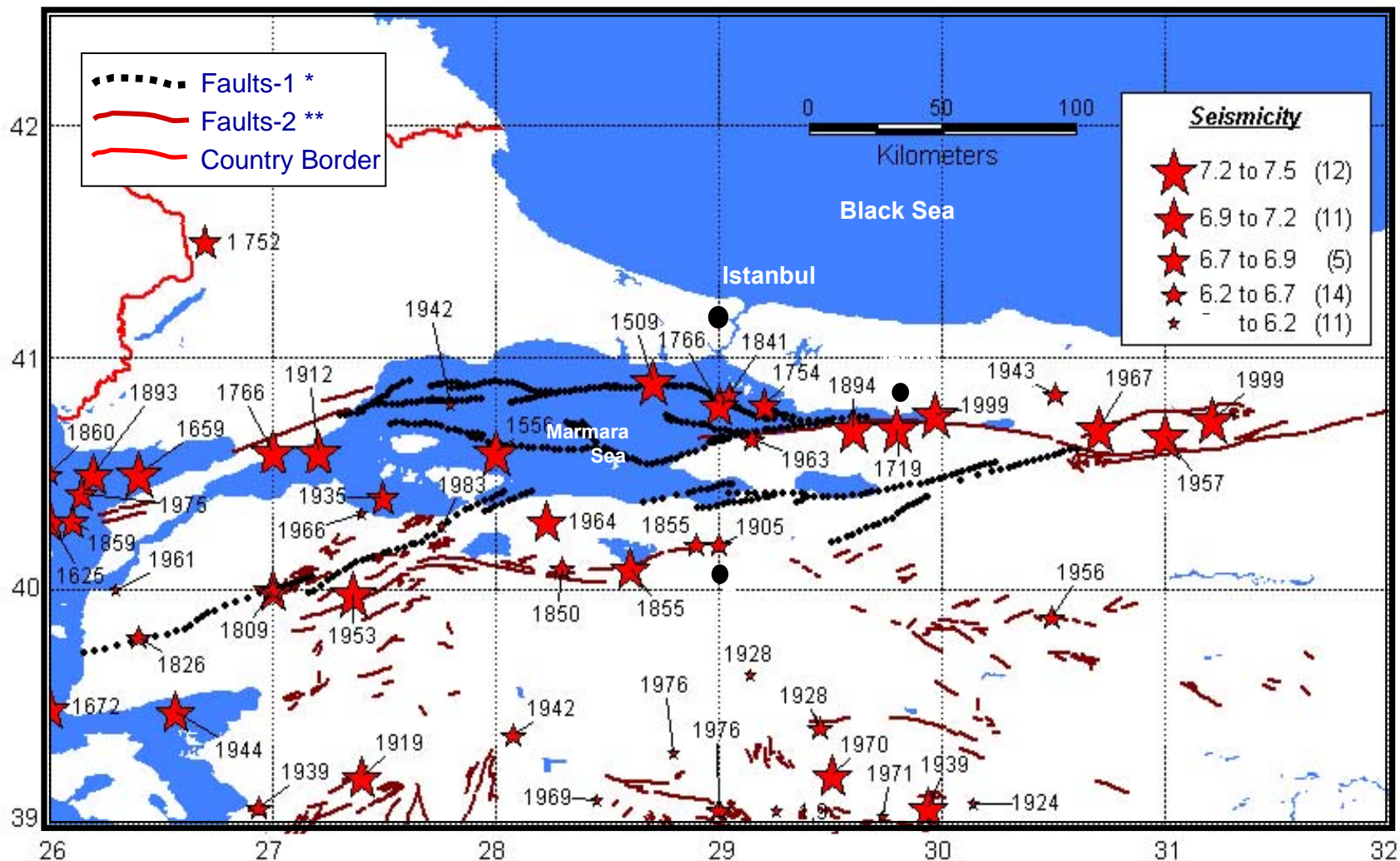


Figure 4.1. Locations of $M_w \geq 6.0$ earthquakes (A.D. 1509-1999)

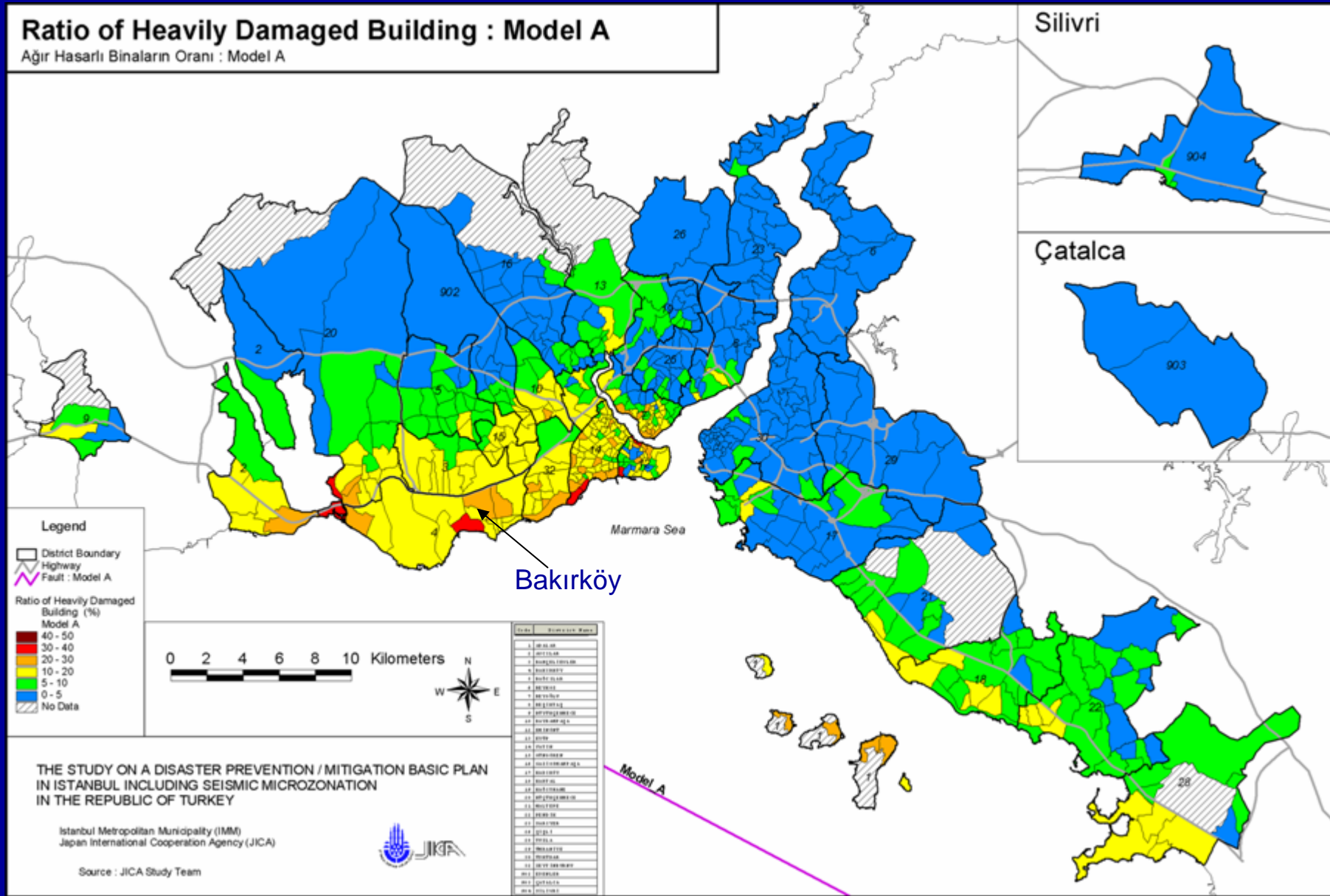
(Note: Parentheses denotes the number of earthquakes falling in that specific magnitude range; Category-1 faults has been recently explored by using bathymetric and seismic reflection data [1-4]; Category-2 faults indicates the previously known faults [MTA]).

- The calculated risk of a major earthquake along the unbroken segment of the Marmara Sea fault which is silent since 1766 is 60 % in the next 30 years.
- This fault is likely to produce an earthquake with magnitude 7.2 - 7.5

Scenario Earthquake in the Marmara Sea (M7.5)



DAMAGE SCENARIO IN ISTANBUL



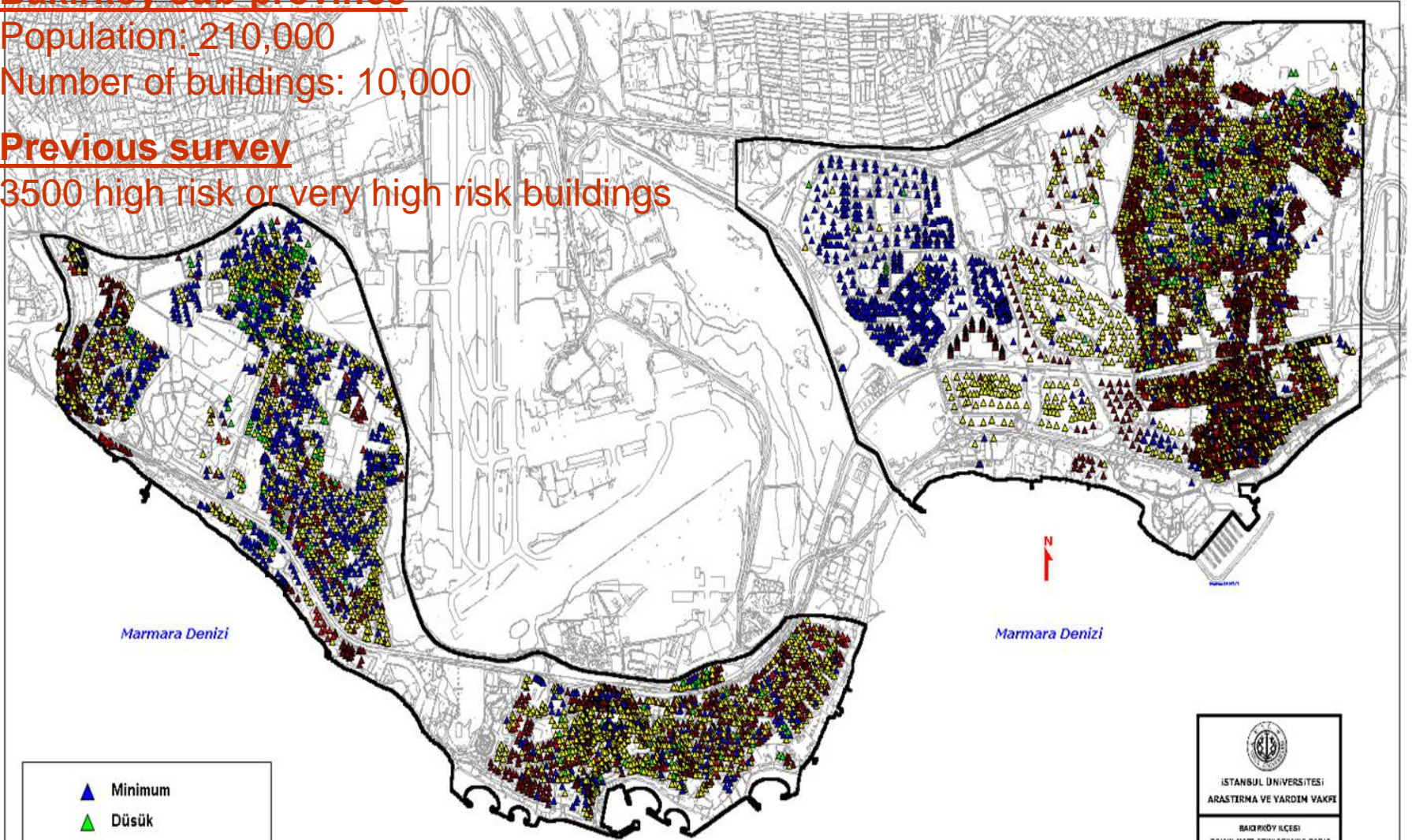
Bakırköy sub-province

Population: 210,000

Number of buildings: 10,000

Previous survey

3500 high risk or very high risk buildings



Marmara Denizi

Marmara Denizi

- ▲ Minimum
- ▲ Düşük
- ▲ Orta
- ▲ Yüksek
- ▲ Çok Yüksek



İSTANBUL ÜNİVERSİTESİ
ARAŞTIRMA VE YARDIM VAKFI

BAKIRKÖY İLÇESİ
ZEMİN-YAPI ETKİLEŞİMİNE BAĞLI
DEPREM RİSKİ ANALİZİ PROJESİ
ÇALIŞMA GRUBU

HAZİRAN 2007

Outline of Retrofitting Studies

- **Retrofit designs for 372 selected buildings**
- **Performance evaluation of retrofitted buildings**
- **Economic assessment of retrofitting**



Geotechnical investigations

Data Collection

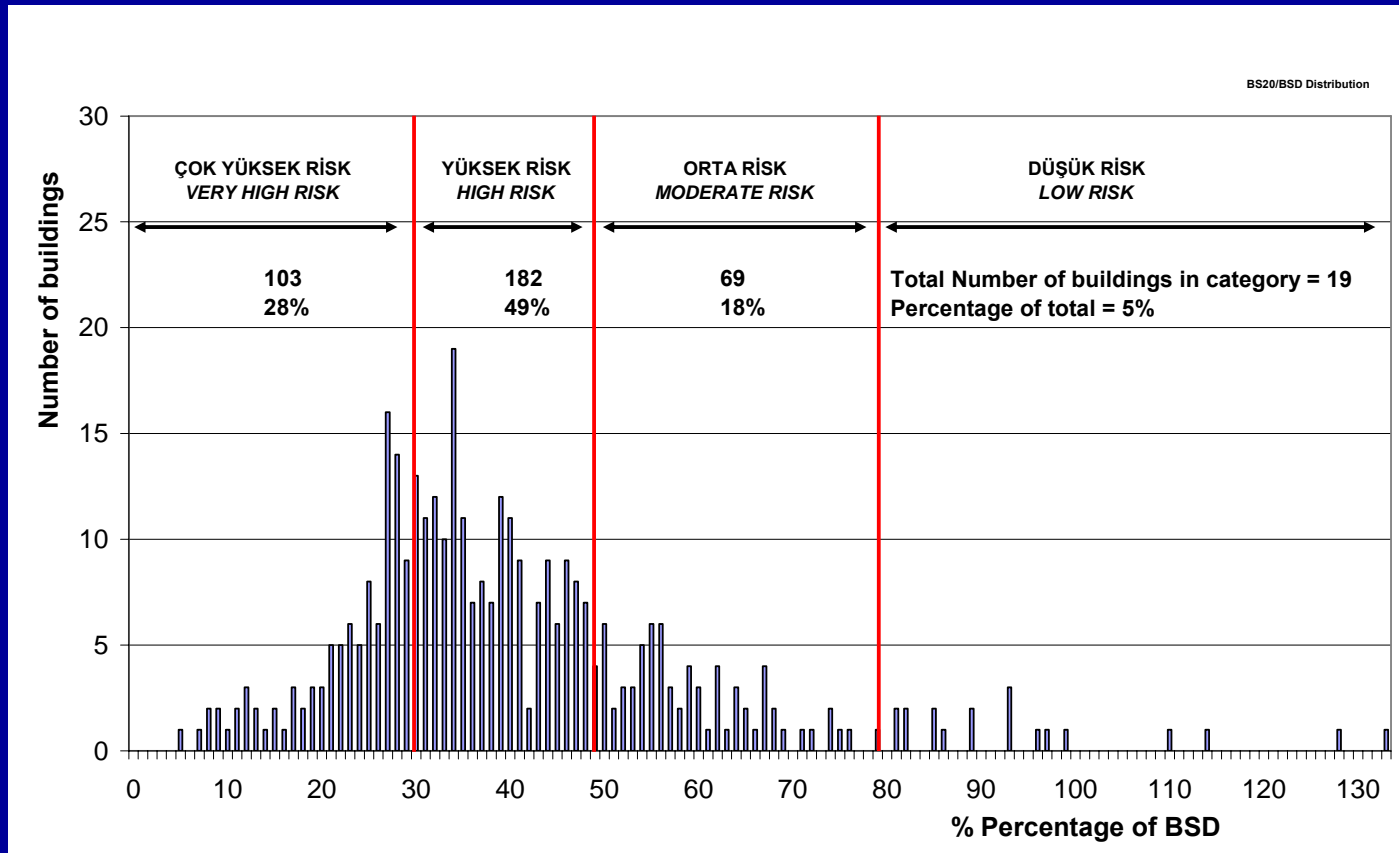


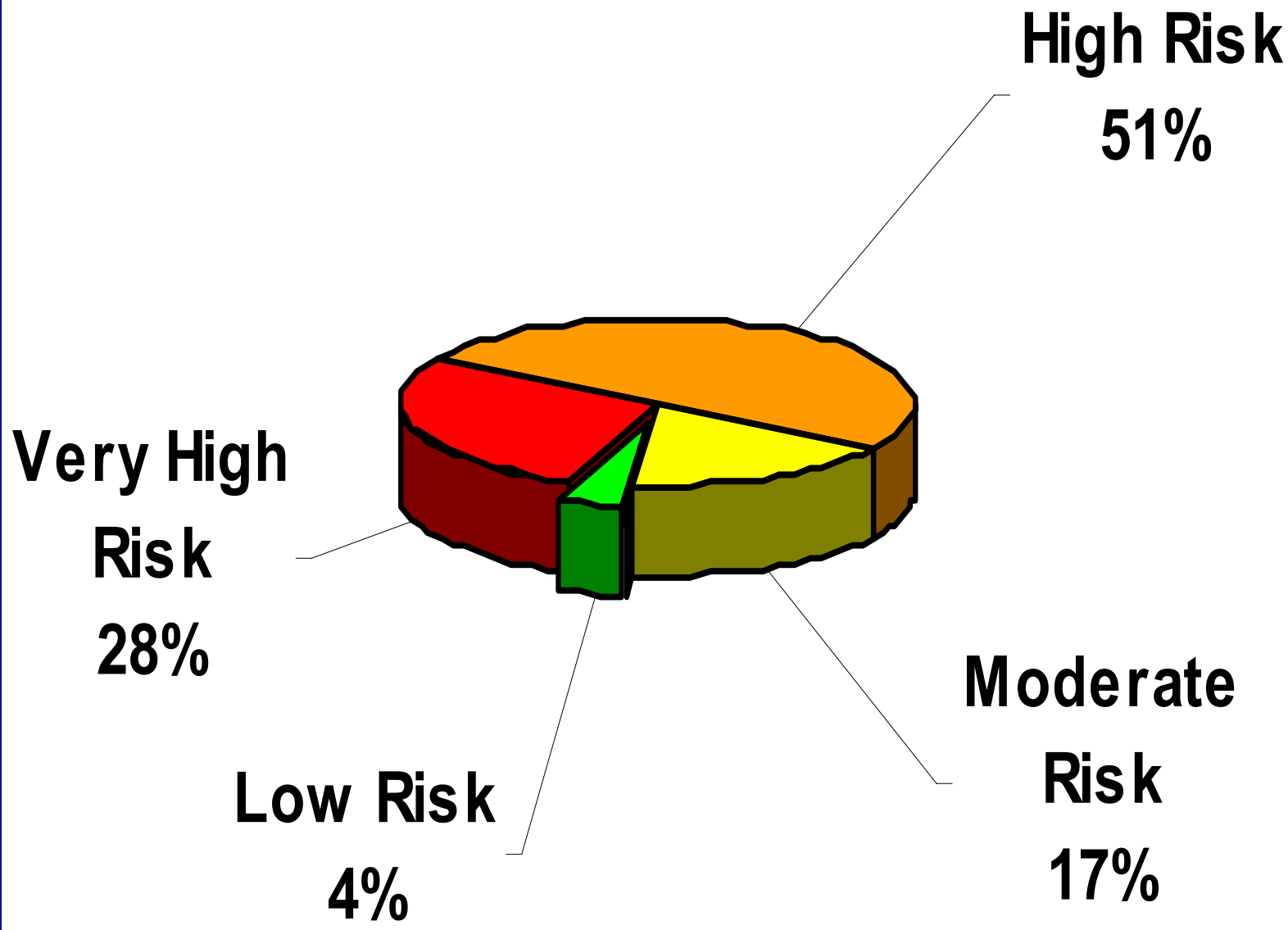
Core Sampling



Checking Steel

Performance Evaluation of 372 Existing Buildings





Retrofitting Concept

Develop

- Technically sound,
- Economically feasible,
- Socially acceptable

retrofit solutions.

- **Performance objective:**

- Reduce probability of collapse in M7.2 scenario earthquake
- Achieve similar risk to that of a new building

- **Target performance level:**

- Site specific spectrum and life safety performance

Retrofitting Options

- **Different techniques of providing strength and stiffness were examined:**
 - **Jacketing of existing deficient columns**
 - **Precast panel or carbon fibre applications to existing masonry walls**
 - **Interior and exterior shear walls, or steel framing**
- **Other options examined included base isolation**

Retrofitting Case Studies

Building ZB26

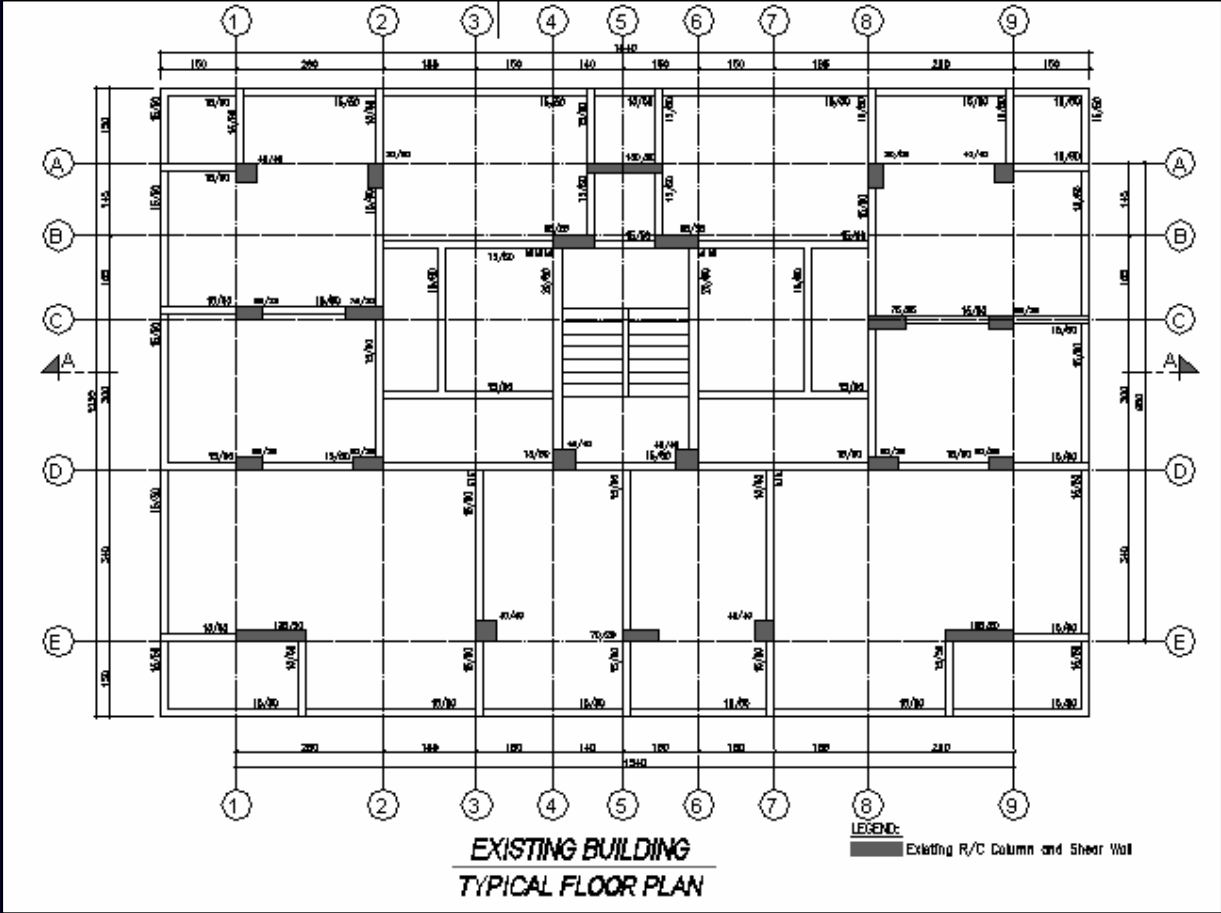
- Interior solution
- Exterior solution

Building K113

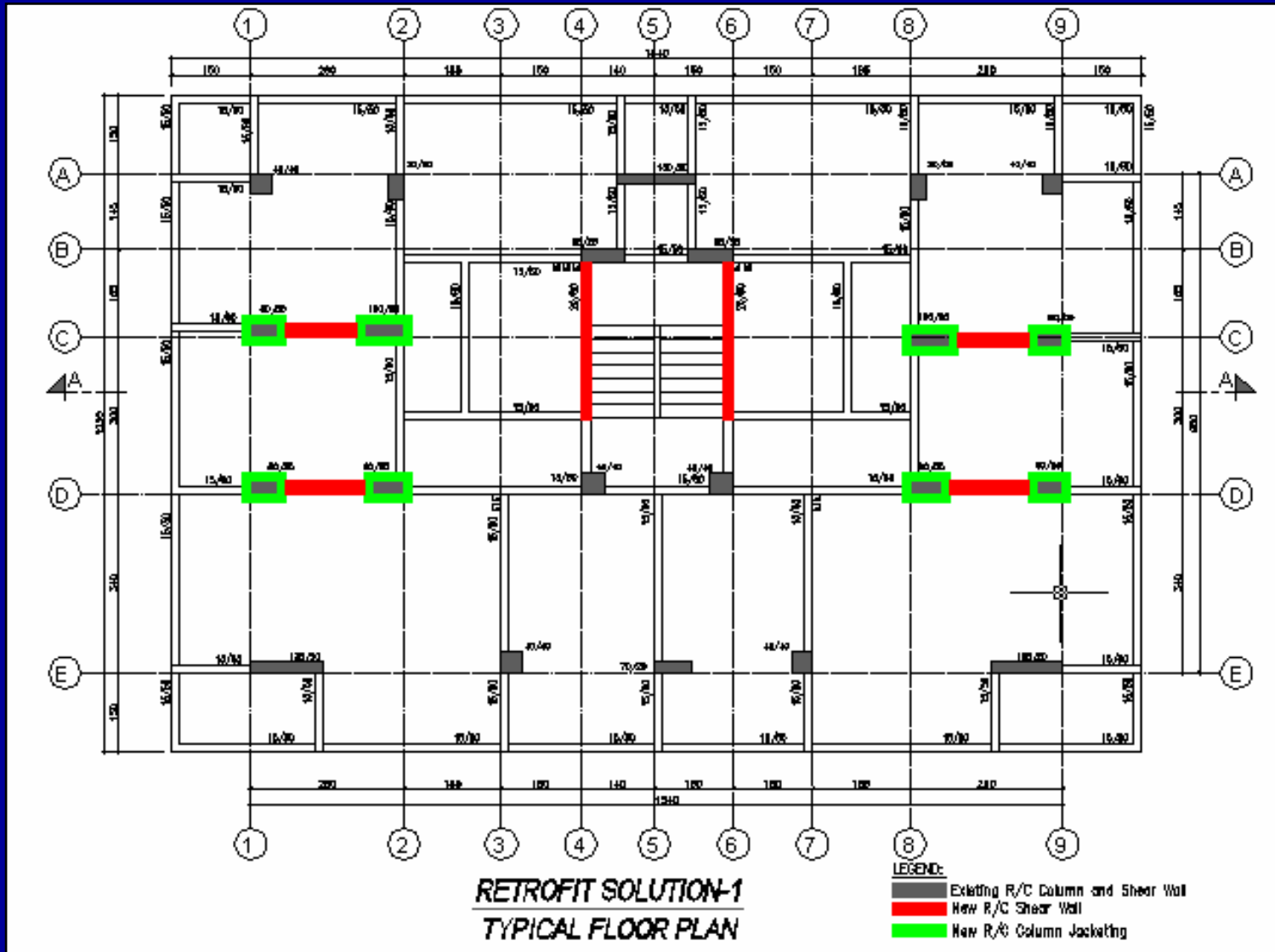
- Interior solution
- Exterior solution
- Base Isolation Solution

Building ZB26

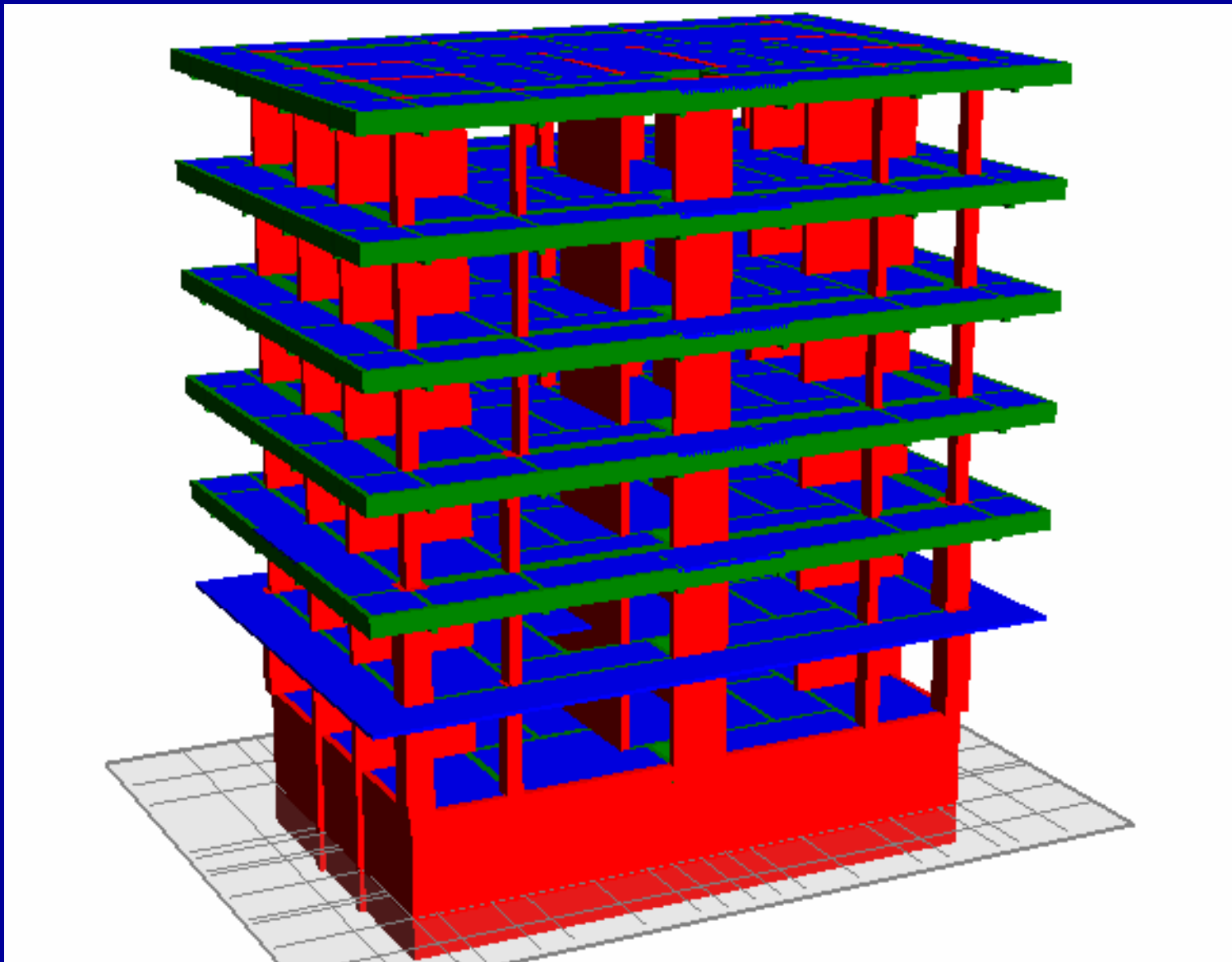
$f_c = 6 \text{ MPa}$
“High Risk”



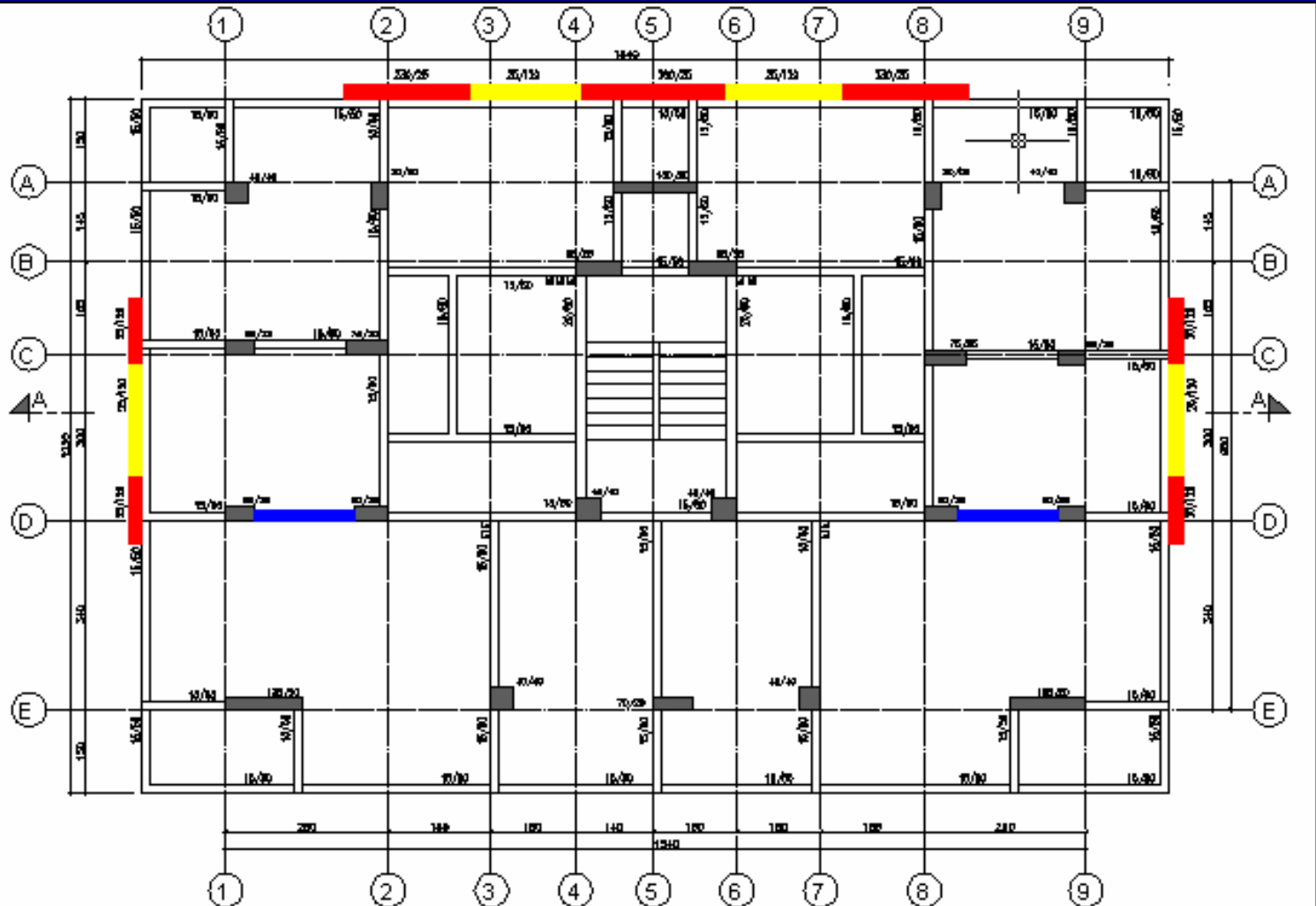
Alternative 1: Interior solution



Alternative 1: Interior solution



Alternative 2: Exterior solution

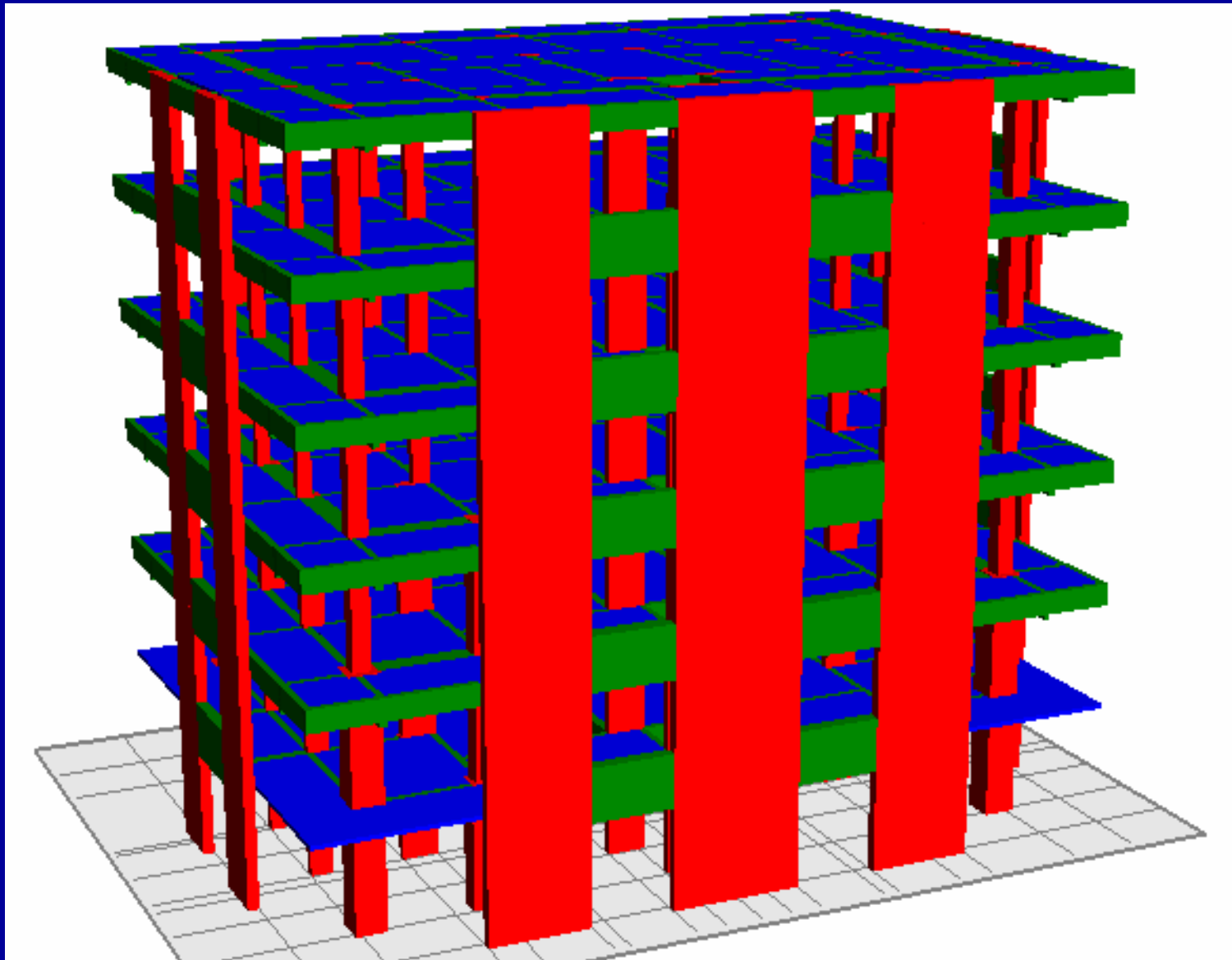


RETROFIT SOLUTION-2
TYPICAL FLOOR PLAN

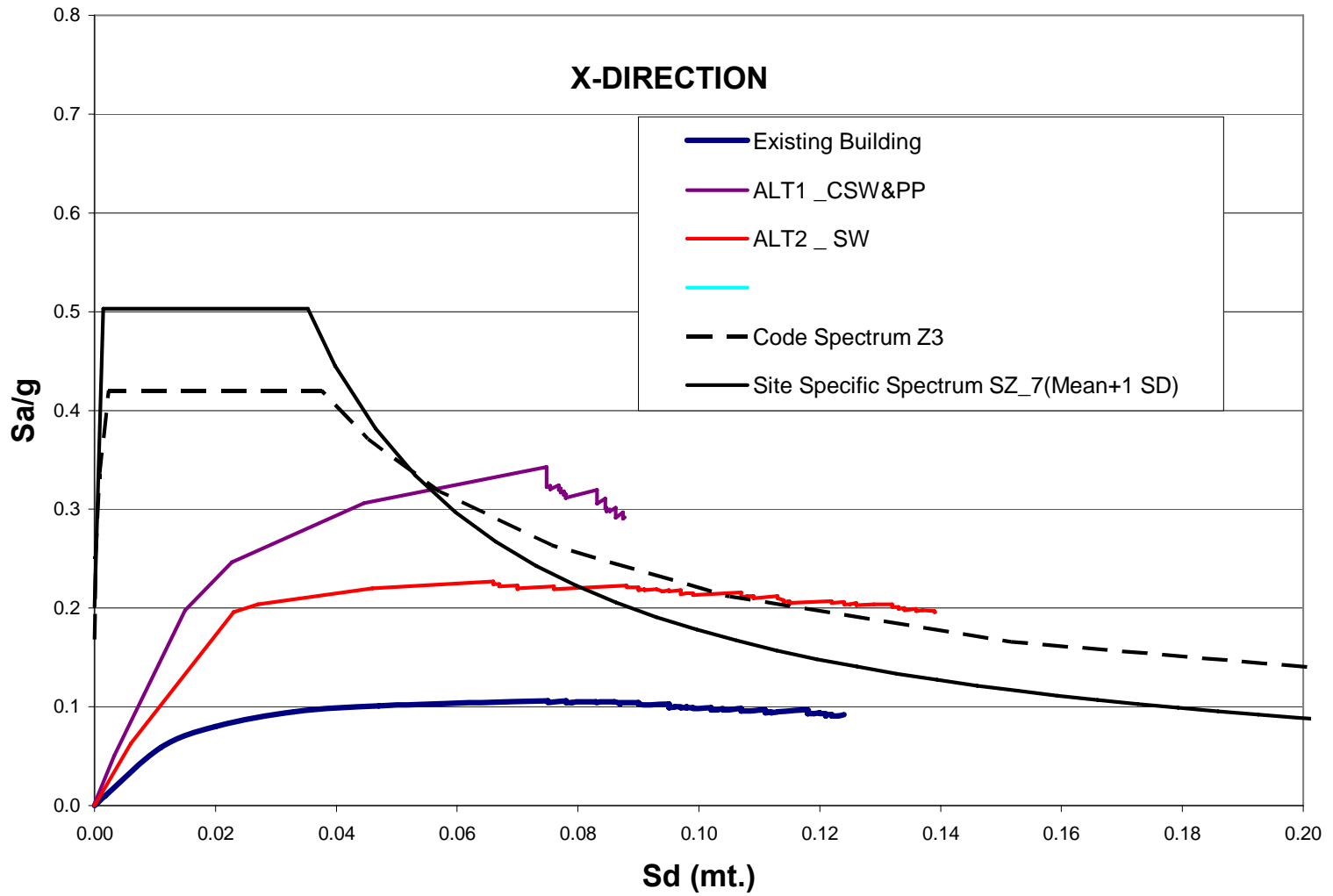
LEGEND:

- Existing R/C Column and Shear Wall
- New R/C Shear Wall
- New R/C Coupling Beam
- Masonry Wall Strengthened with R/C Prestress Posts

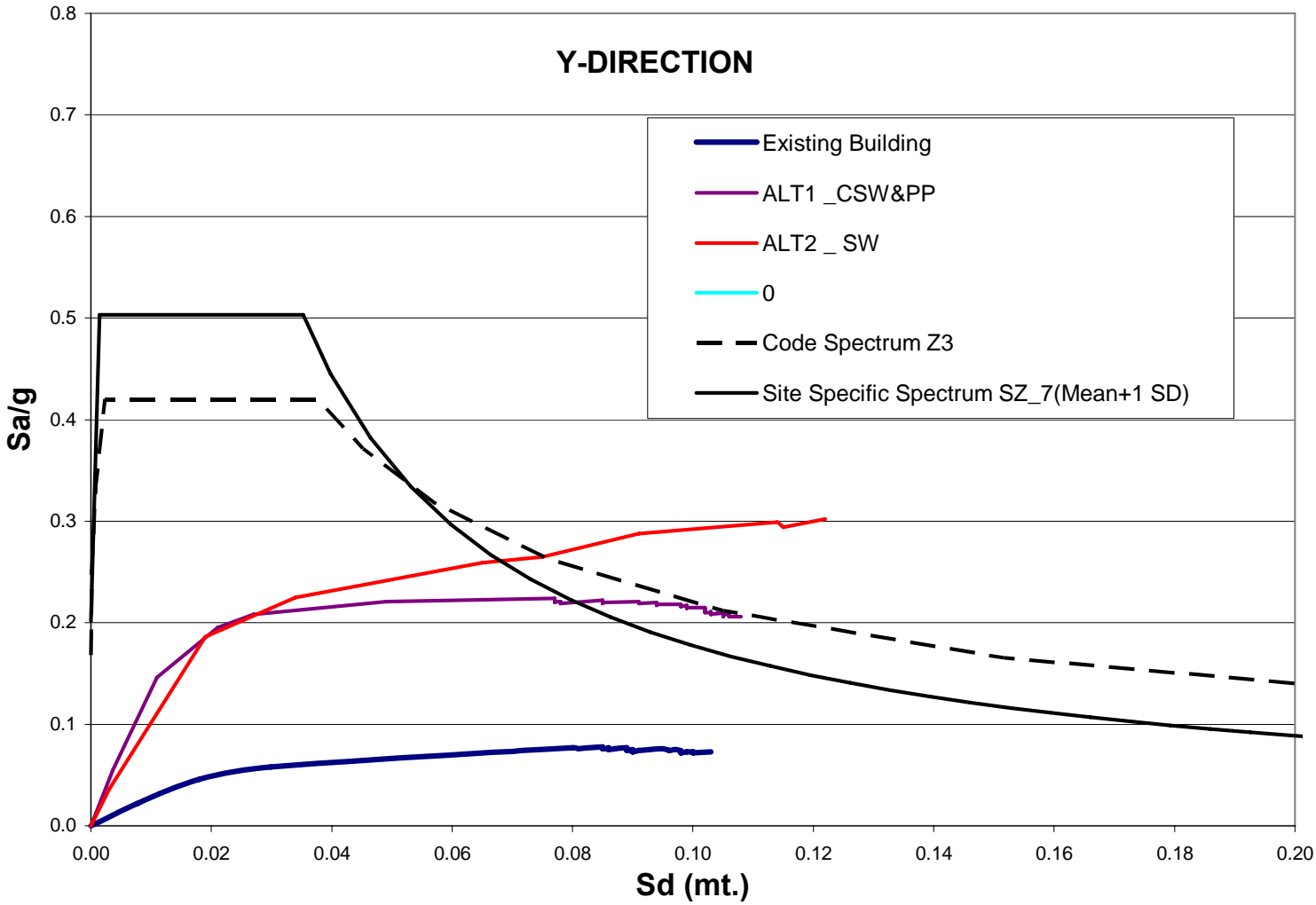
Alternative 2: Exterior solution



X-DIRECTION



Y-DIRECTION



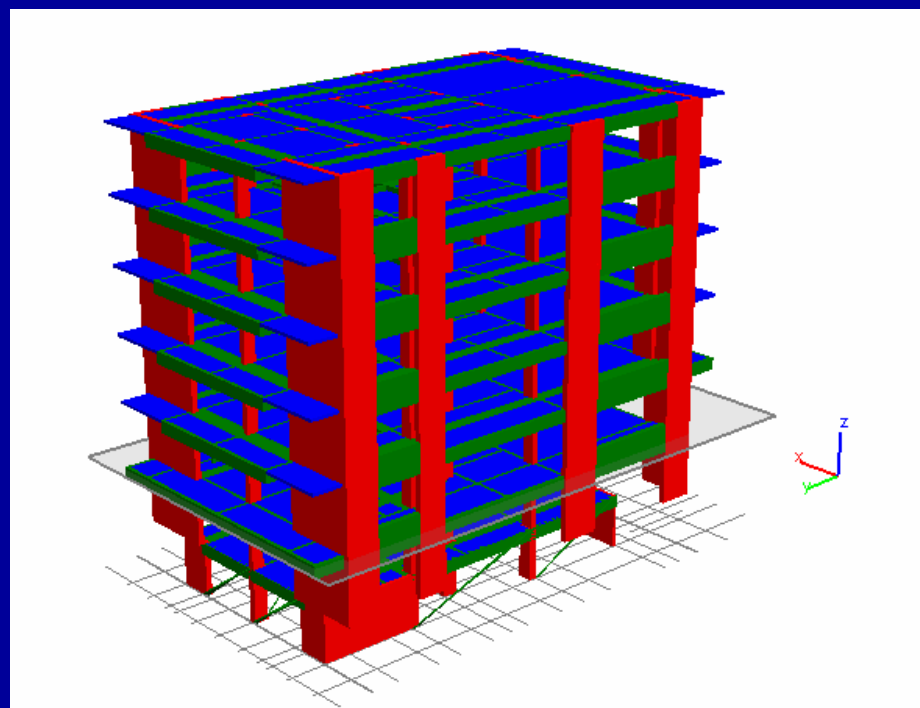
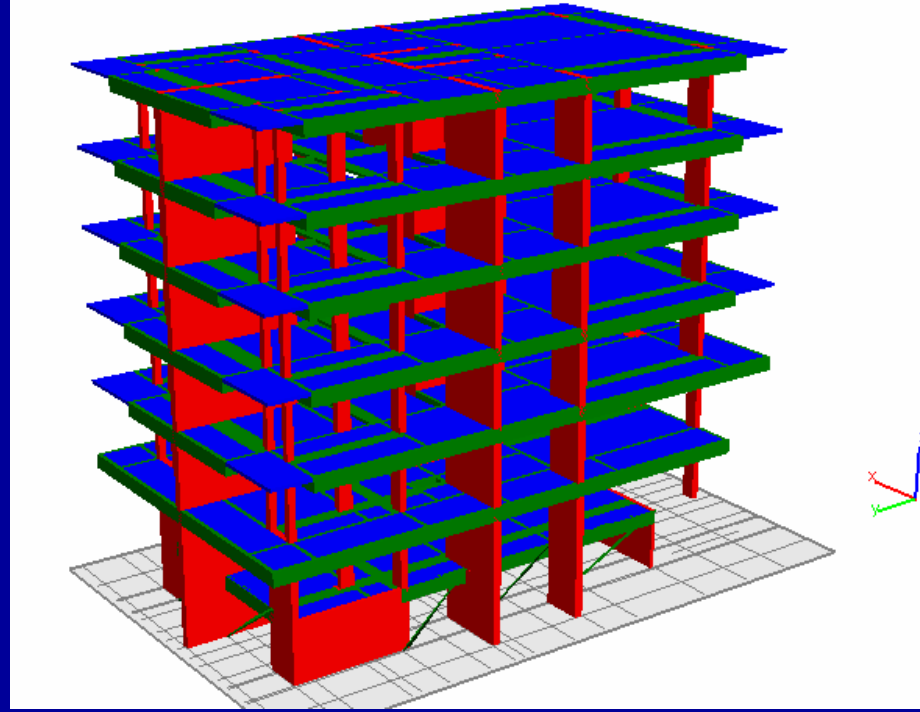
Ratio of initial retrofit cost to reconstruction cost

- Alternative 1- Interior solution : % **39** (4 months downtime)
- Alternative 2- Exterior solution: % **19** (no downtime)

Building K59

$f_c = 12.5 \text{ MPa}$

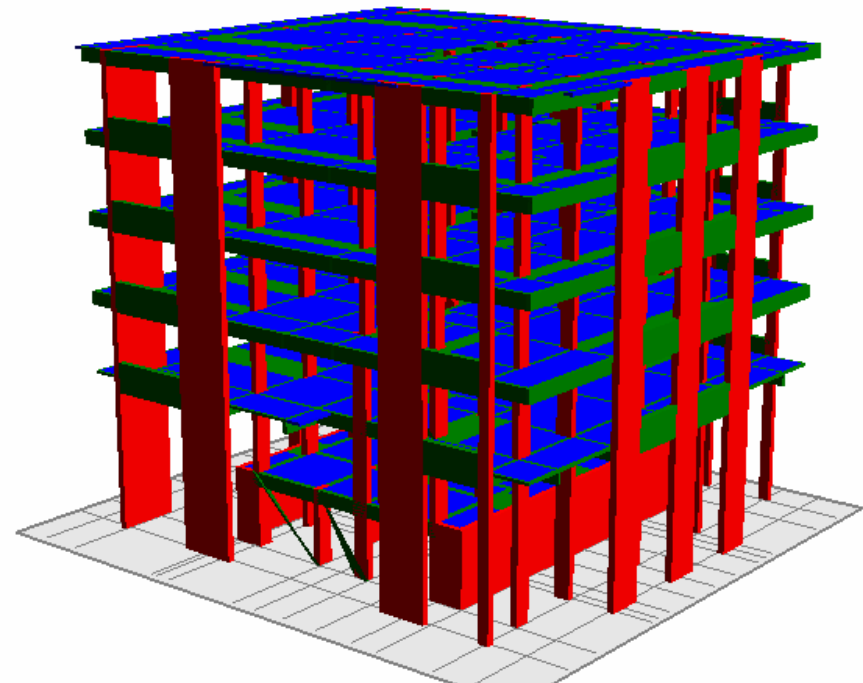
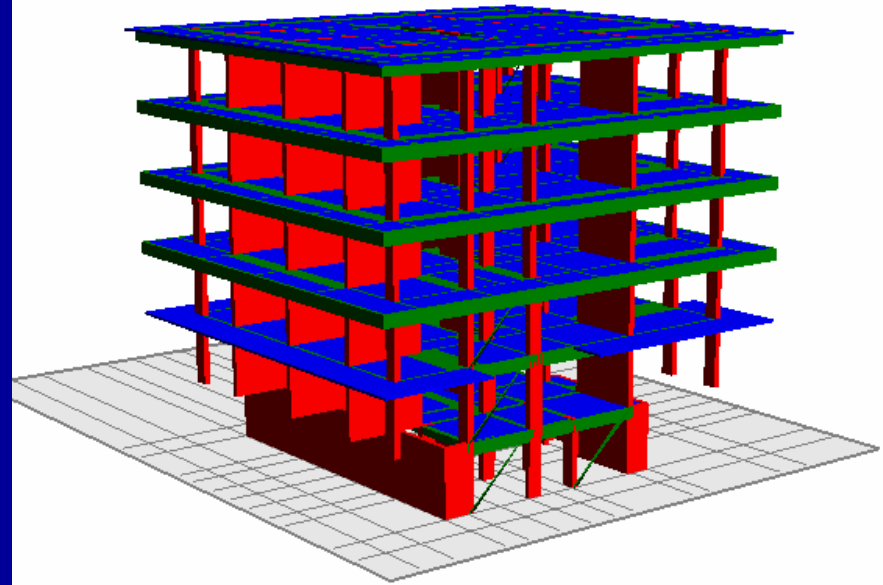
“Very High Risk”



Building YK36

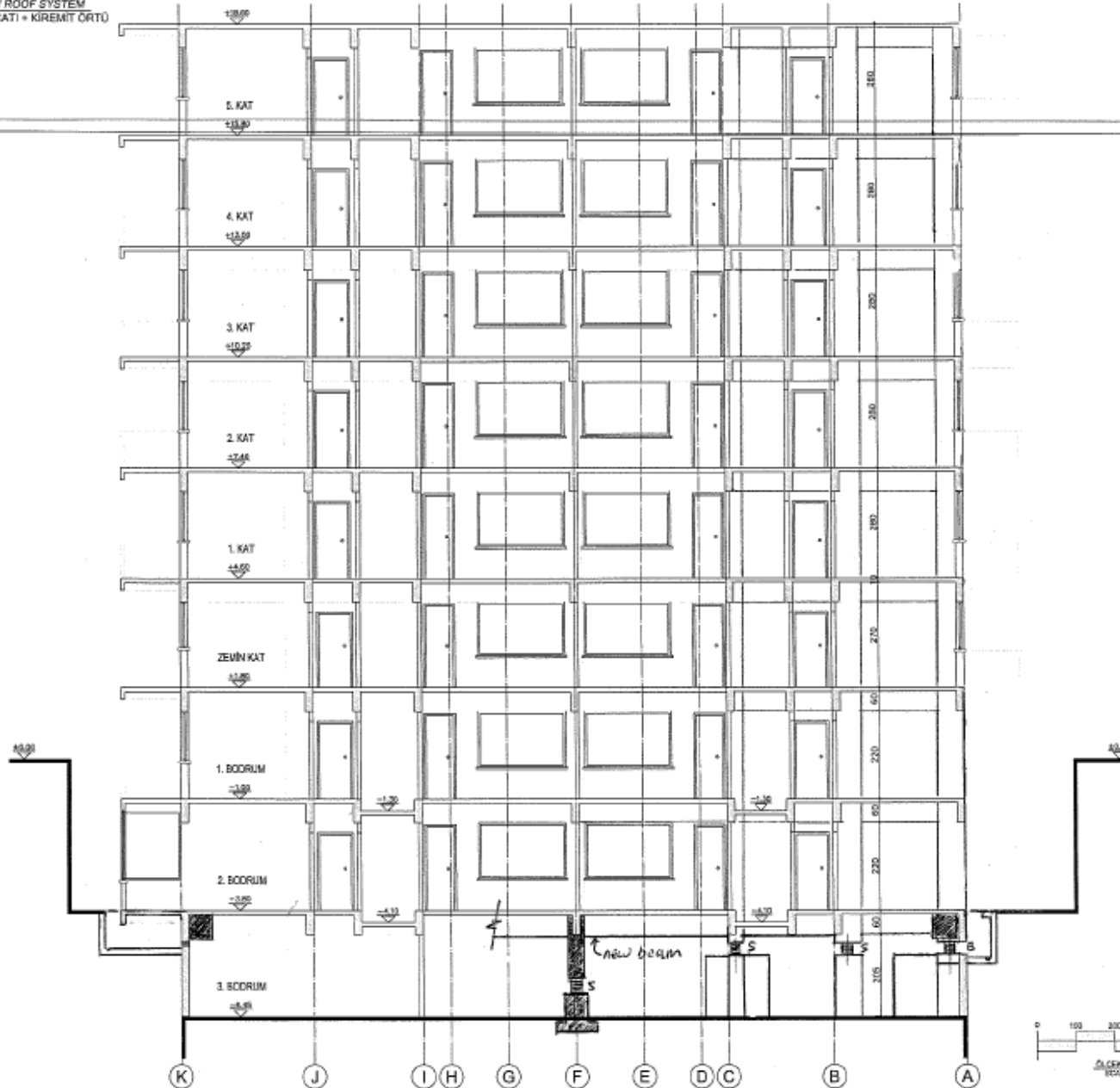
$f_c=9$ MPa

“High Risk”



Building K113 Base Isolation Example

SECTION B - B
ÇATI SİSTEMİ / ROOF SYSTEM
AHSAP OTURTMA ÇATI + KİREMIT ÖRTÜ



4A

MEER-34-B-K113-MR/11

T.C. BAŞBAKANLIK
T.C. PRIME MINISTRY
PROJECT IMPLEMENTATION UNIT (PIU)

MARMARA DEPREM AÇIL YENDEN
YAPILANDIRMA PROJESİ (MEER)
İSTANBUL'DA SEÇİLMİŞ KONUTLARIN TAÇIRIS
EKİLEŞİME YÖNELİK FEASİBİLİTE ÇALIŞMASI
MARMARA EARTHQUAKE EMERGENCY
RECONSTRUCTION PROJECT (MEER)
THE FEASIBILITY STUDIES FOR
THE RETROFITTING OF SELECTED
RESIDENTIAL BUILDINGS IN ISTANBUL

MFR-34-B-K113

BAKIRKÖY 1038 6

B - B KESİTİ
SECTION B - B

MİMARİ RÖLÖVE
ARCHITECTURAL ON-SITE

BEÇ PROTA
JOINT VENTURE / ORTAK GİRİŞİM

YAPIM DİZAYNI VE İZLEME
YAPIM DİZAYNI VE İZLEME
YAPIM DİZAYNI VE İZLEME

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MEER-34-B-K113-MR/11

Building K113

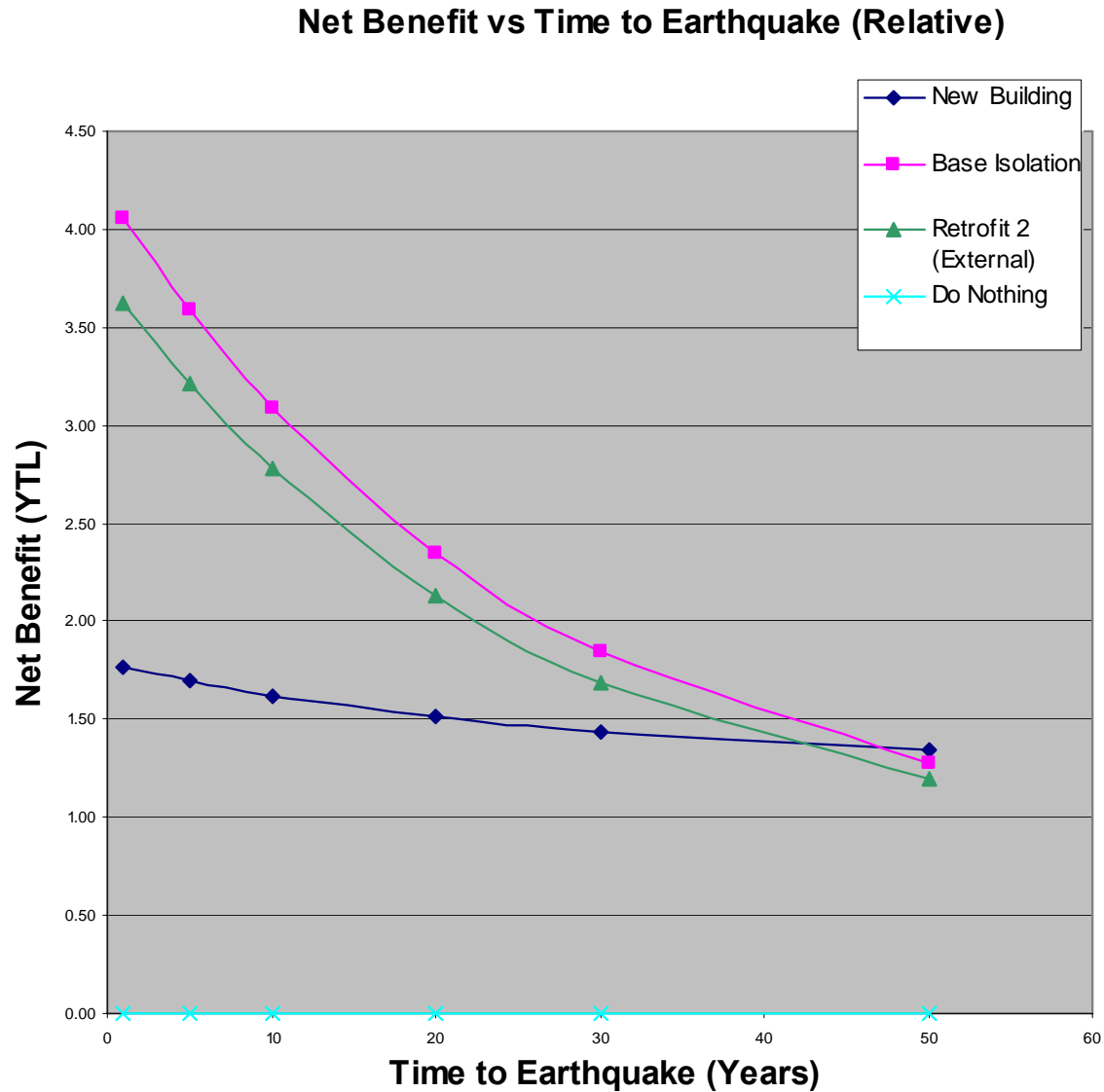
- **Building replacement costs**
 - 2.14 M YTL construction
 - 0.63 M YTL relocation
- **Base isolation solution costs**
 - 0.48M YTL construction
 - 0.0M YTL relocation
- **Interior solution costs –**
 - 0.36 M YTL construction
 - 0.17 M YTL relocation
- **Exterior solution costs –**
 - 0.50 M YTL construction
 - 0.0 M YTL relocation

Benefit-cost analysis

- **Examine three sources of benefits and costs:**
 - **Initial:** retrofitting costs, increased property value
 - **Time-dependent:** reduced maintenance, increased rent, peace of mind
 - **Earthquake-dependent:** reduced building damage, injuries, deaths, personal and community disruption

- **Examine Benefit/Cost ratios for different times to occurrence of scenario earthquake:
0, 5, 10, 20, 30, 50 years.**
- **Show B/C ratios for different retrofit options**

Benefit-Cost Comparison for Building K113

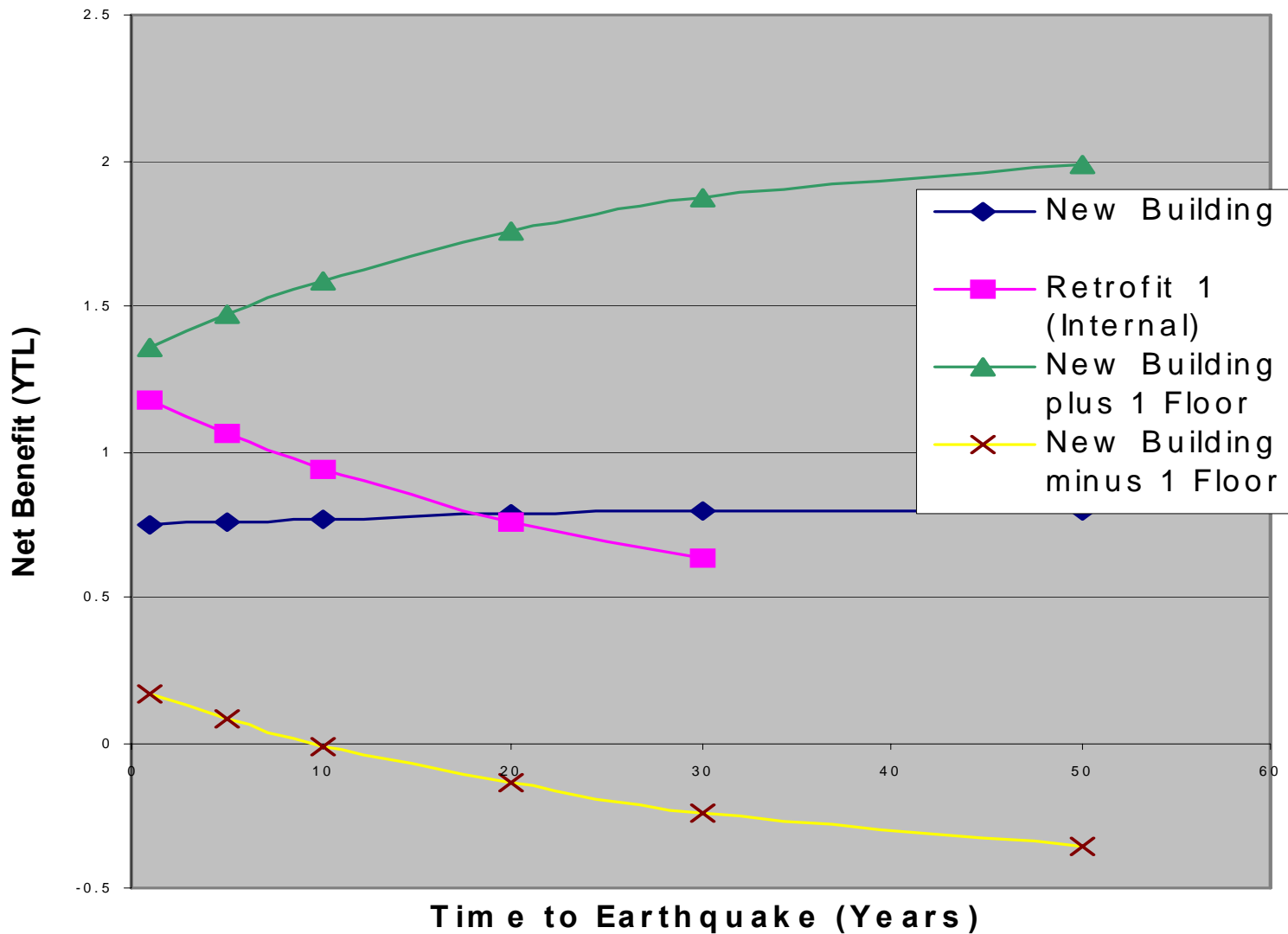


Retrofit Recommendations for 369 Project Buildings

	New Building	Retrofit 1	Retrofit 2	Do Nothing	Total
All buildings	89 (25%)	41 (10%)	221 (60%)	18 (5%)	369 (100%)
VHR Buildings	32 (30%)	10 (10%)	65 (60%)	0 (0%)	107 (30%)
HR Buildings	54 (30%)	21 (10%)	110 (60%)	0 (0%)	185 (50%)
MR Buildings	3 (5%)	10 (15%)	46 (70%)	6 (10%)	65 (17%)
LR Buildings	0 (0%)	0 (0%)	0 (0%)	12 (100%)	12 (3%)

Effect of Height on Economics of Building Replacement

Property Category A



Key Issues

1. Social issues
2. Legal issues
3. City planning issues
4. Design and construction issues
5. Benefit-cost issues
6. Implications for owners, municipalities, IBB and Government

Conclusions

- Residential retrofitting is technically achievable and is a cost-effective investment
- For Bakırköy, an expenditure of **US\$ 560 M** would save:
 - **US\$ 2,080 M** in direct costs to owners
 - **US\$ 1,000 M** in indirect costs to the community
 - **Up to 5000 lives (About 2.5% of the population)**
- Availability of funding is a major impediment.
 - **Innovative approaches are needed to make funds available**
 - **Government and Municipalities can justify supporting a % of the cost.**

Owners must have:

- **beliefs** that there is a serious threat from earthquakes, that retrofitting will reduce their risk and that it is a good investment.

(Project surveys showed that generally owners do believe this).

- **trust** in the design, construction and authority approval processes.

(Owners rated this as vitally important).

- access to **funding** for retrofitting.

(Owners saw this as critical and looked to the authorities to provide some support and/or incentive).

The challenges in providing owners with the necessary ***beliefs, trust*** and ***funding*** are not technical, but social and political.

Acknowledgements

Client

- Government of Turkey, Project Implementation Unit (PIU)
- Bakirkoy Municipality

Project Consultants

- Beca/Prota Joint Venture

Academic Consultants

- Middle East Technical University

Finance

- World Bank

Duration

- 8 Months

Thank you