PREPARATION OF EARTHQUAKE ANALYSIS REPORT FOR A TALL (80 METRE) REINFORCED CONCRETE BUILDING

Introduction:

In 1999, Marmara Region of Turkey experienced an earthquake with moment magnitude (Mw) of 7.6 which killed more than 17 000 people and left more than 250 000 people homeless. Before this earthquake, Turkish Building code wasn't as comprehensive as it is today. The earthquake building code of 1975 was only 37 pages and even if everything it said was followed exactly, it wasn't enough to prevent the collapse of certain types of structures. Engineering judgement was required in most cases. As a comparison, current building earthquake code of Turkey has 417 pages just for earthquake-based design and comes with an interactive, location based, seismic map making it one of the most advanced building earthquake codes of the world.

Tall building construction in Istanbul, most populated city of Turkey, skyrocketed in the last 10 years and even more in the last 5 years with new government incentives. The buildings determined to be very old, risky or unsafe had to be demolished and reconstructed. The incentives consisted of homeowners started receiving rent aids and an allowance of more construction area for the same land is given. This resulted in a dramatic increase of tall building construction.

However, in 1990s, there were only few tall buildings that were constructed. In 1996, the year the project of the building I redid the earthquake analysis completed, tallest buildings of Istanbul were the following:

1- Akbank Towers - Sabanci Center (158 m) - Construction Completed: 1993
2- Beybi Giz Plaza (136 m) - Construction Completed: 1996
3- Maya Tower 1 (103 m) - Construction Completed: 1992
4- Akmerkez (100 m) - Construction Completed: 1993
5- The Marmara Hotel Taksim (96 m) - Construction Completed: 1969
6- Harbiye Orduevi (Military Building) (90 m) - Construction Completed: 1974
7- Eston - Beyazit Katli Villalari (80 m) - (86 m with basement levels included) - Construction Completed: 1998

Tallest Residential Building in 1998 in Istanbul:

1- Eston - Beyazit Katli Villalari

Tallest Building in Asian Side of Istanbul in 1998:

1- Eston - Beyazit Katli Villalari

Many earthquakes occurred since 1999 in Turkey. I knew that residents of the buildings constructed before 1999 earthquake were mostly interested in an earthquake analysis since before 1999, most contractors and engineers weren't showing the required attention to their earthquake resistant design and availability of good quality concrete was lacking.

I thought that Beyazit Katli Villalari would be a great candidate for an analysis, and right after an earthquake that occurred near that area, I decided to speak with the management of Beyazit Katli Villalari. I talked about the building and asked about their interest in an earthquake analysis of the building. They told me that they never had such a request before and asked about my ability to do it. I had experience from my previous internships before but never did an analysis of such a large scale project but I said I can do it. The building manager also a known contractor accepted my request. Building management obtained the slab application drawings from the city municipality for me but we couldn't find the proper column application drawings with correct dimensions. Looking at slab drawings and measuring columns, I figured out the column layout and matched the spacing and layout with reinforcement given in old drawings.

I then modeled the building in 3D in one of the most famous software widely used in industry worldwide. I used the built-in section designer to put all the reinforcement one by one.

I did local area-based response spectrum analysis using Turkish Building Earthquake Code 2018.

I also did nonlinear time history analysis using 3 different earthquakes.

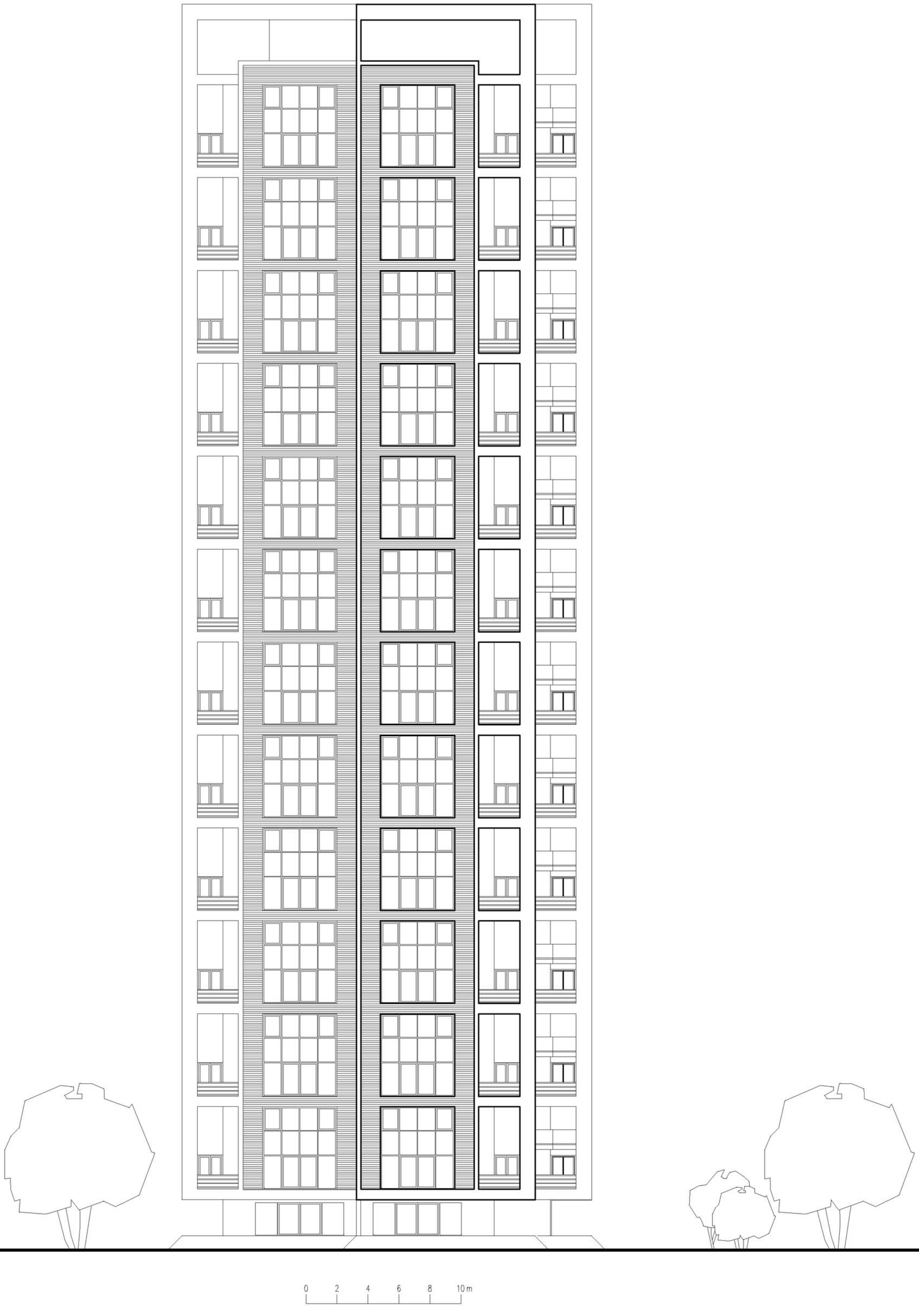
Finally, after everything is done, I prepared a PowerPoint presentation. I presented the results for approximately 2 hours to the management and I gave the models and new drawings in a USB to them.

Some info about the building:

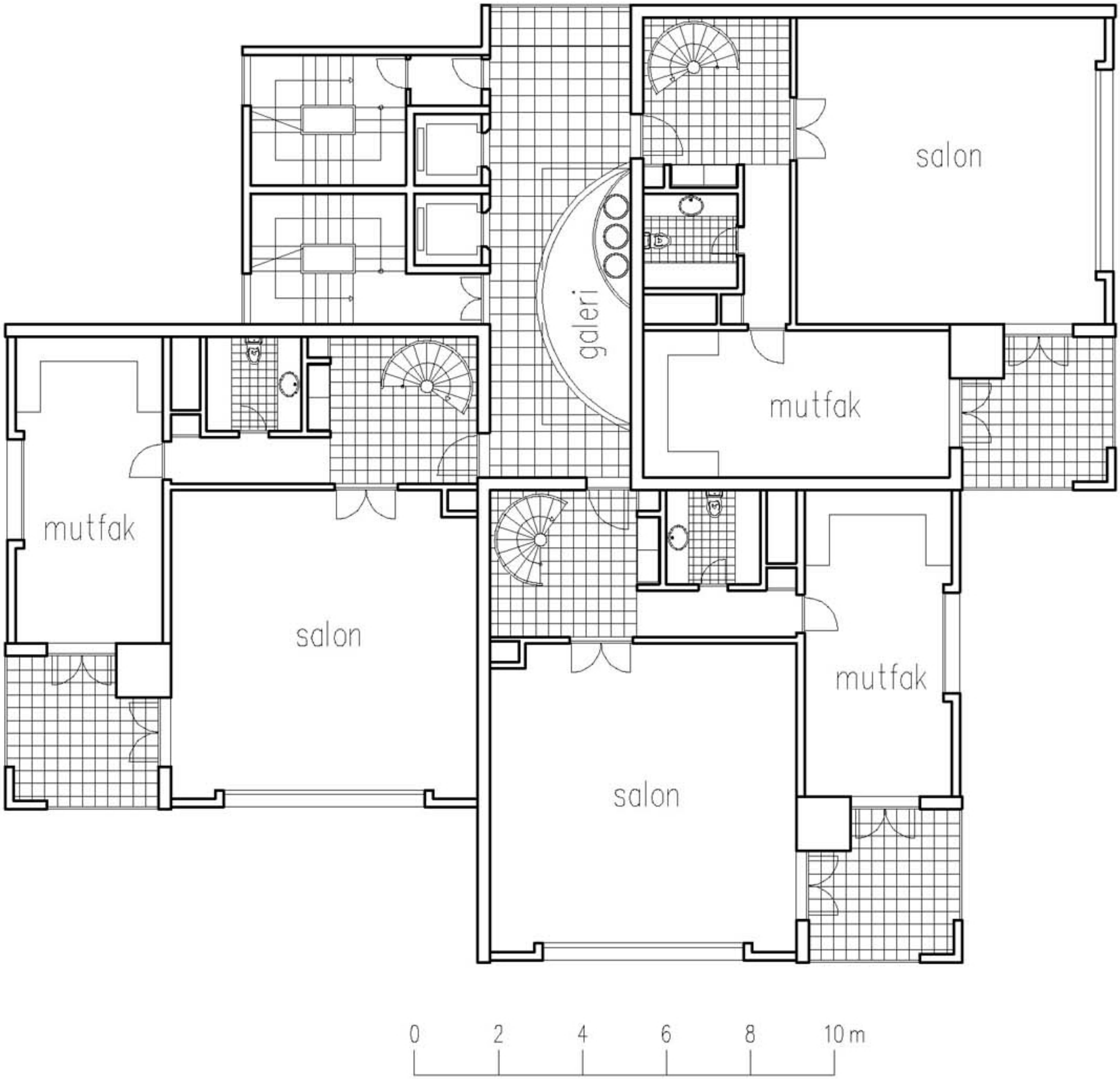
Architecture: Mutlu Cilingiroglu Mimarlik
Original Structural Project: Ismet Babus
Contractor: Eston Construction
Location: Kadikoy, Istanbul, Turkey
Total Land Area: 4480 m^2
Building Height From Ground: 80 m

BUILDING SOUTH FACE VIEW:

South Face Architectural Drawing:

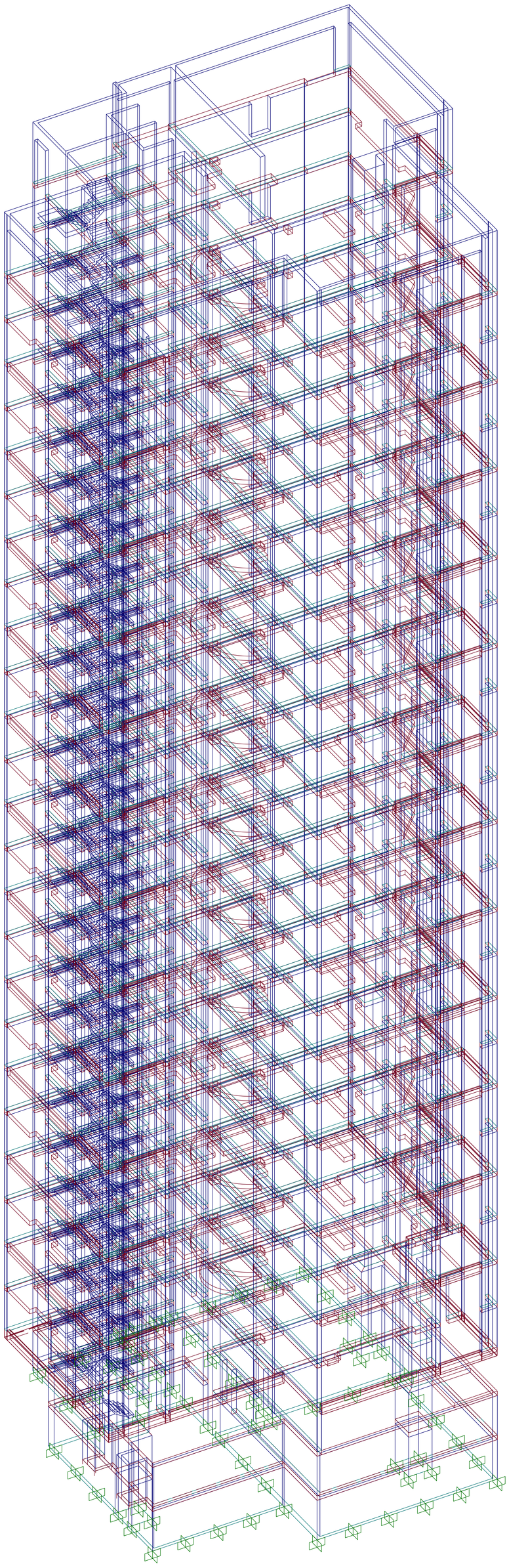


1ST FLOOR ARCHITECTURAL PLAN



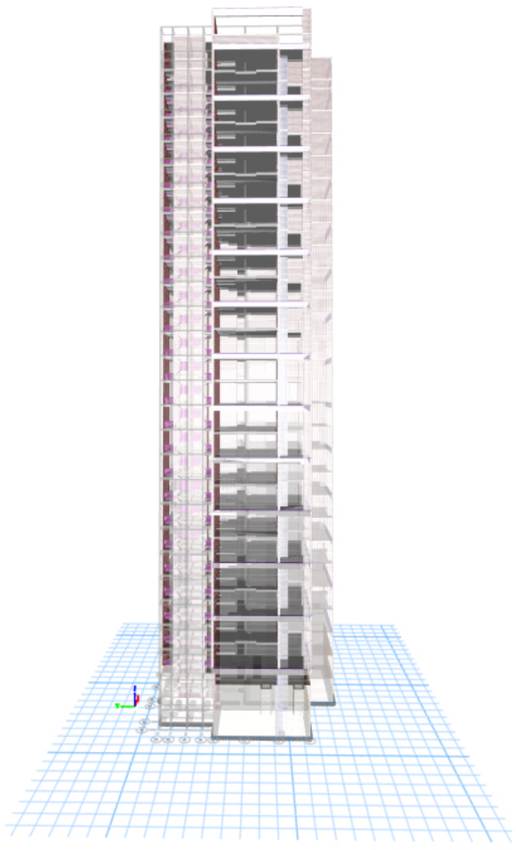
STRUCTURAL SECTION
(SAMPLES FROM MY OWN WORK)

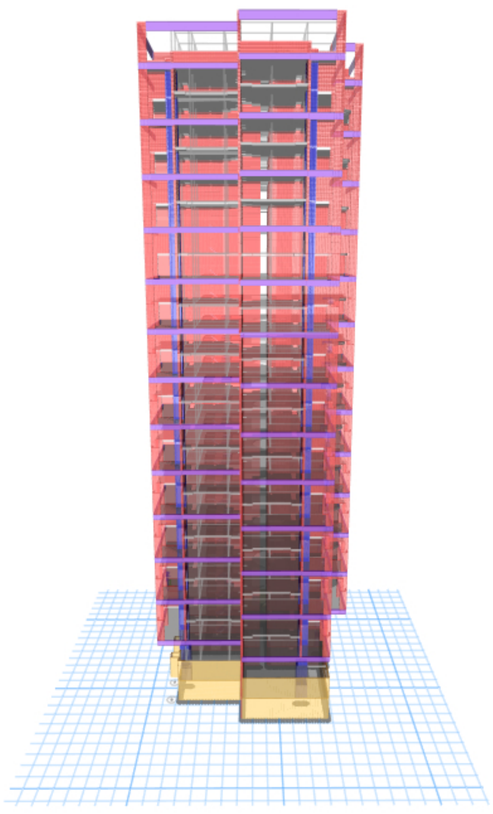
WIREFRAME COMPUTER MODEL OF THE BUILDING

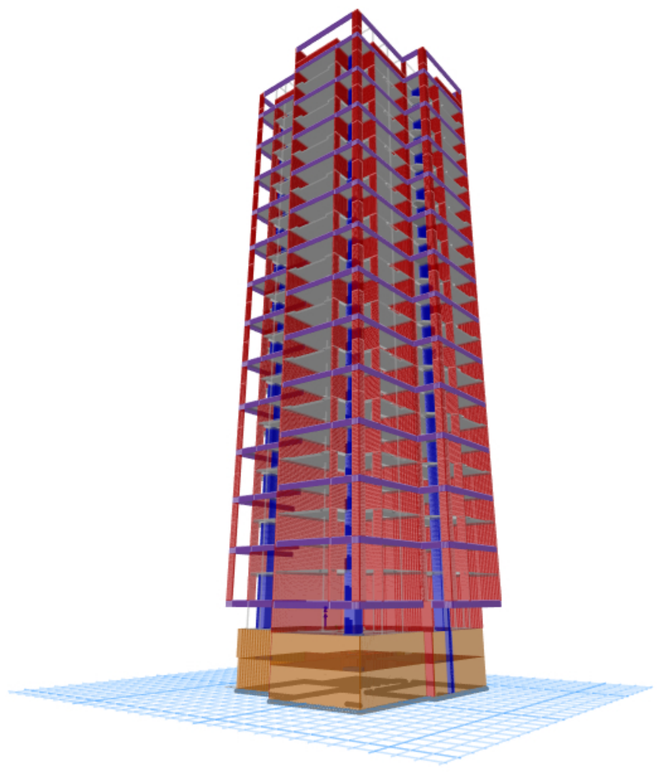


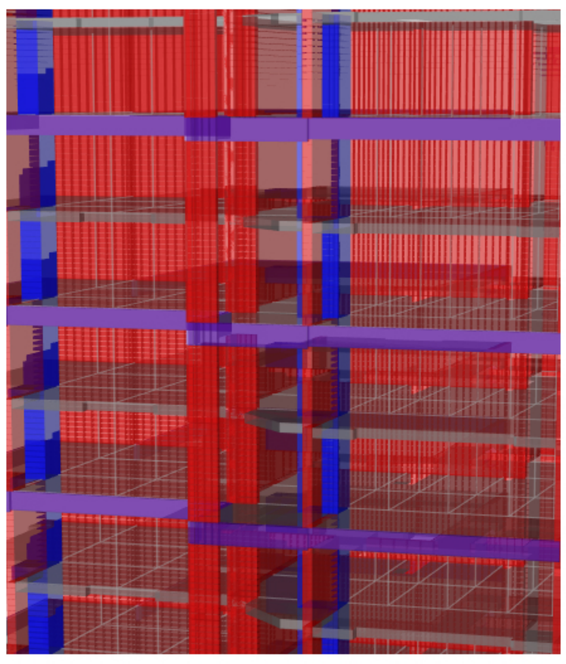
COMPUTER MODEL OF THE BUILDING

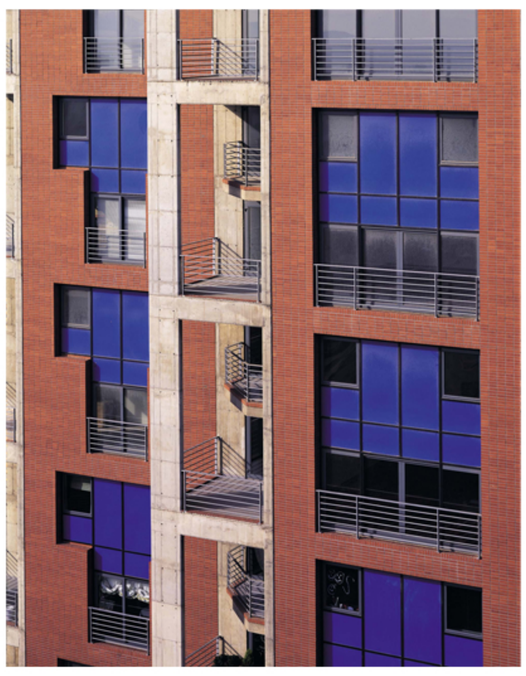
EXTRUDED 3D VIEW & SOME IMAGES

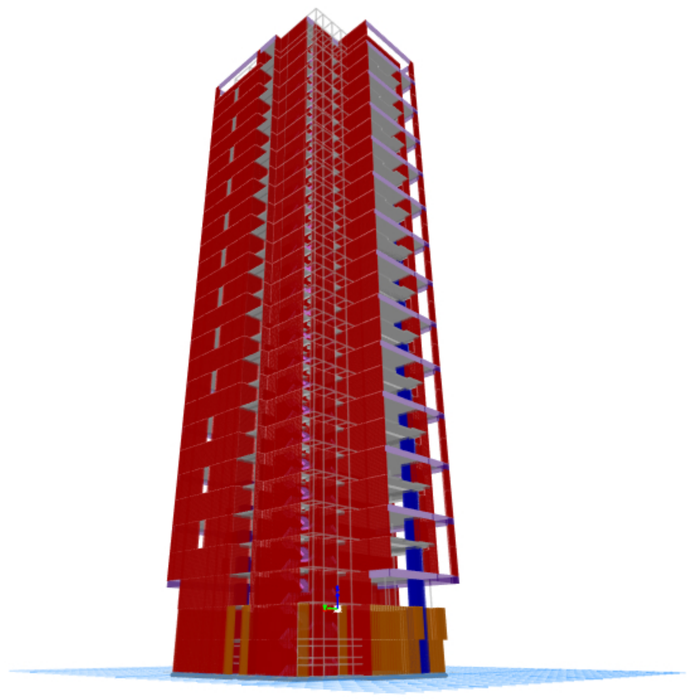


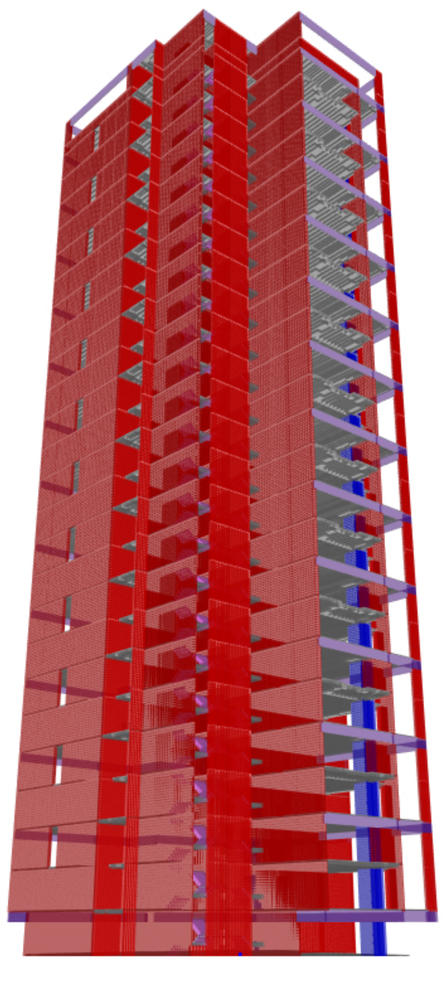


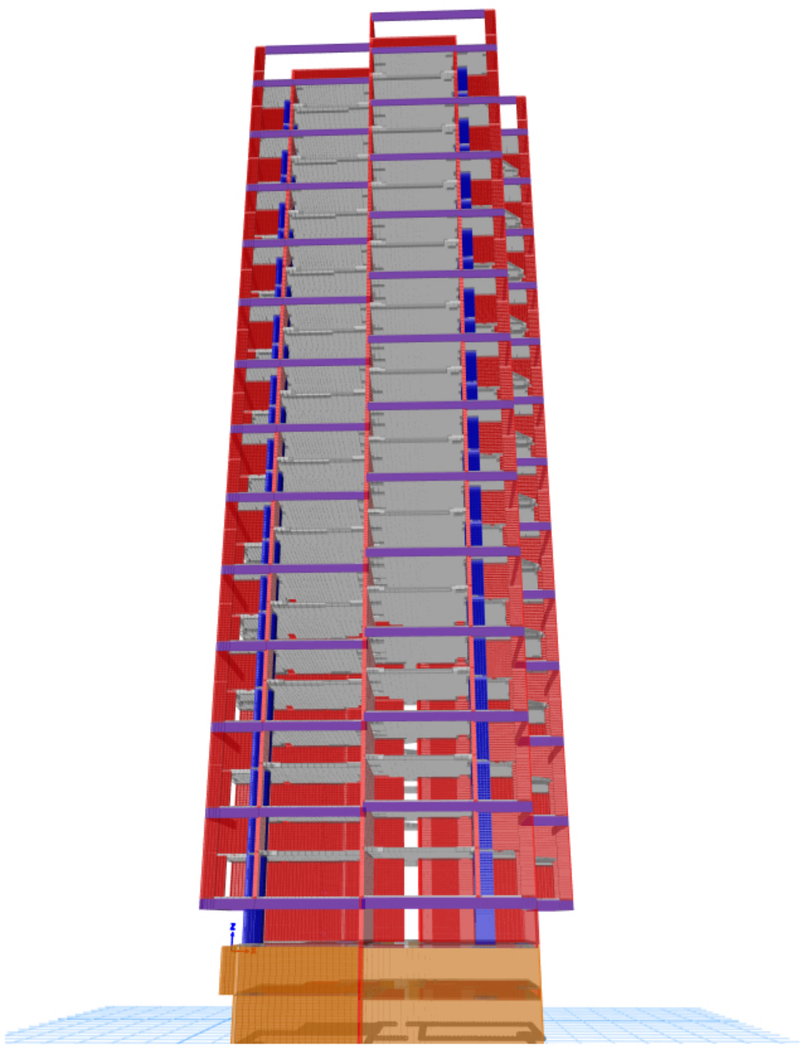


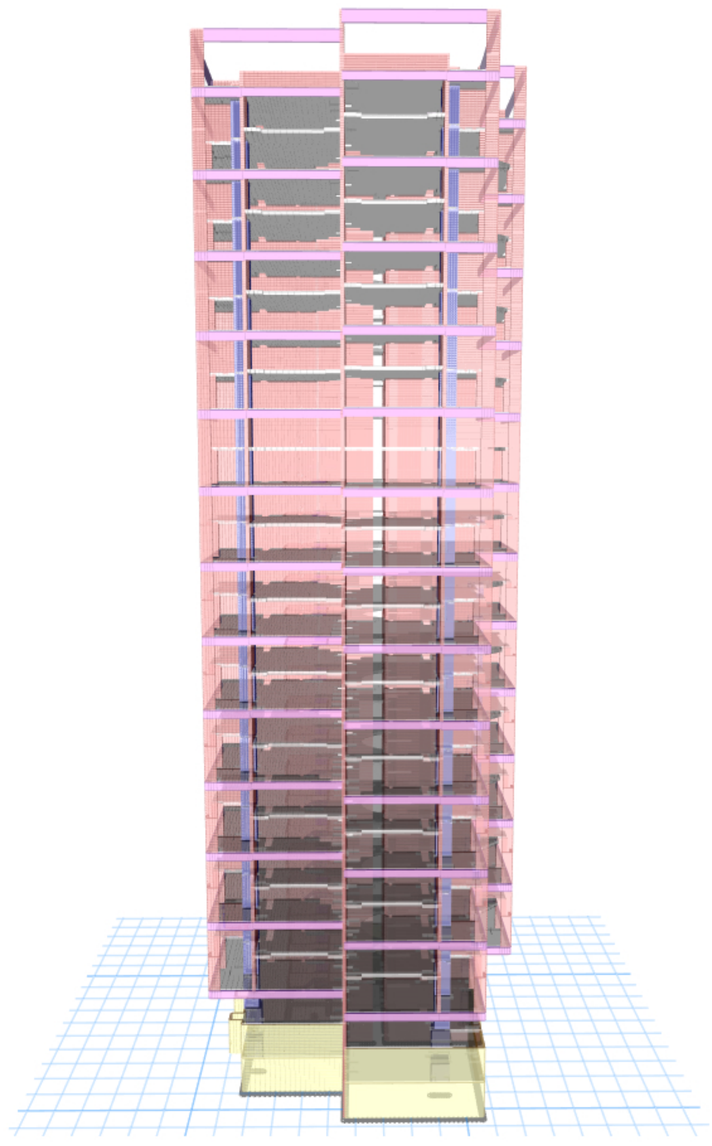


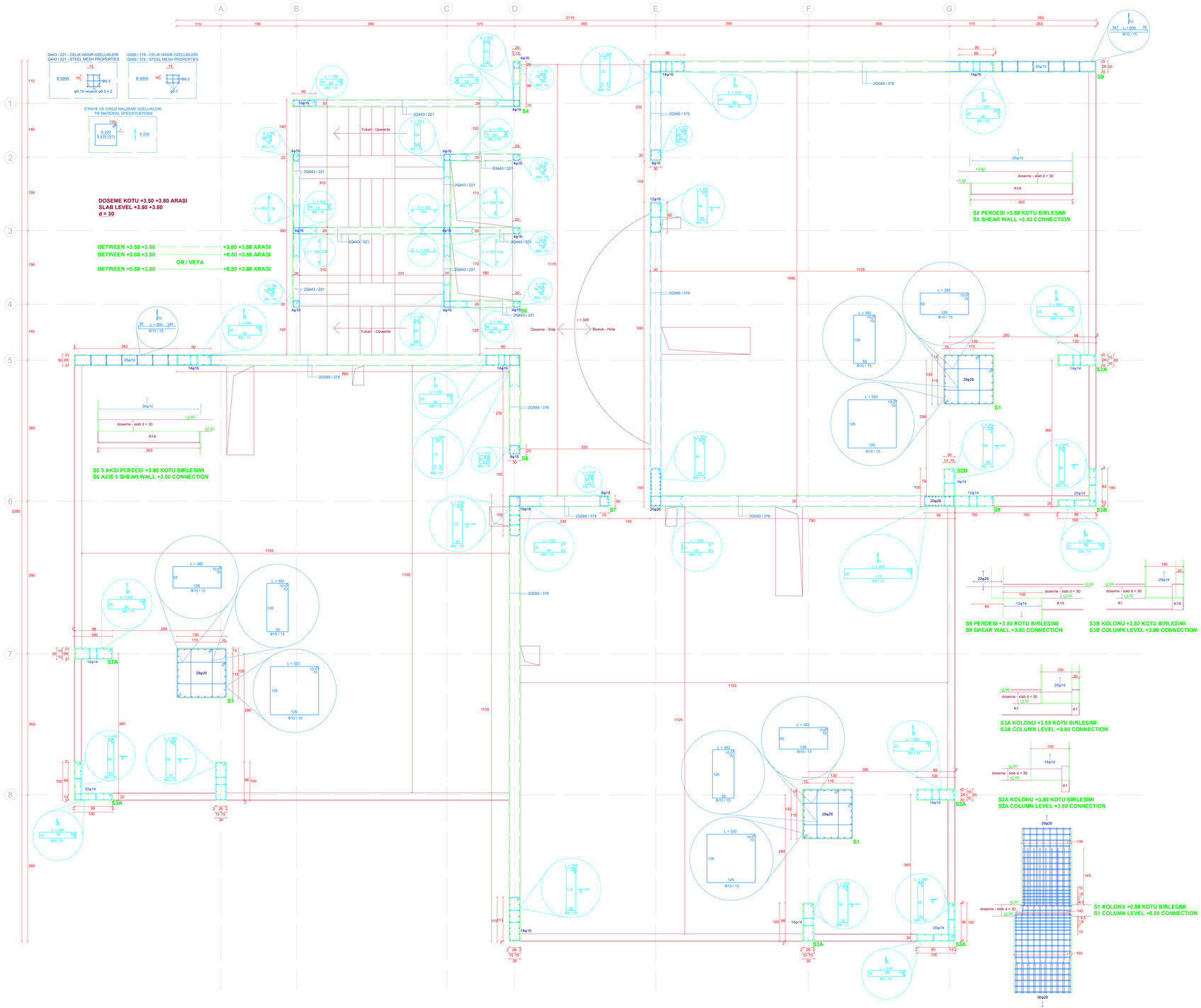












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ESTON - BEYAZIT KATLI VILLALARI
COLUMN APPLICATION PLAN
(BETWEEN +0.80 +3.80 - GROUND FLOOR)
MATERIAL C 25/30 - B 500A - S 420 - S 220

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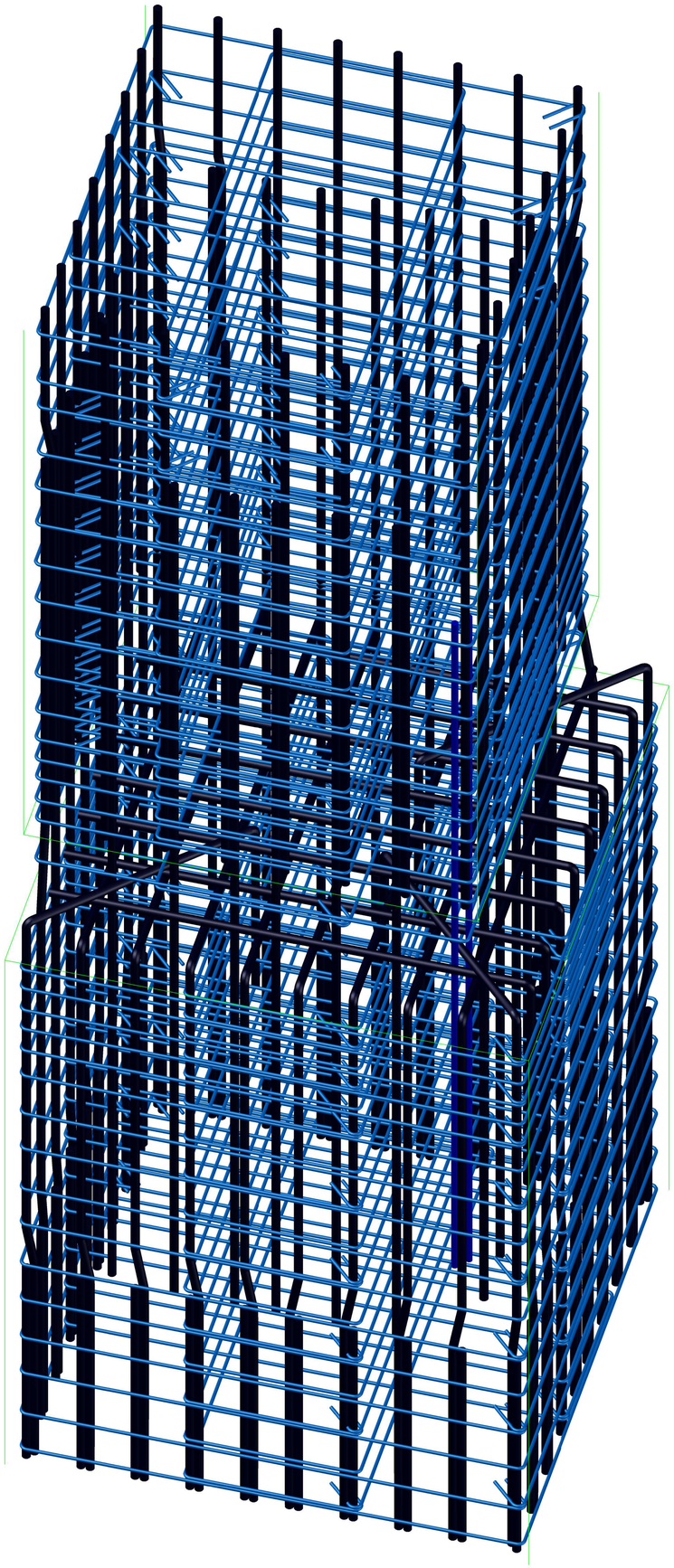
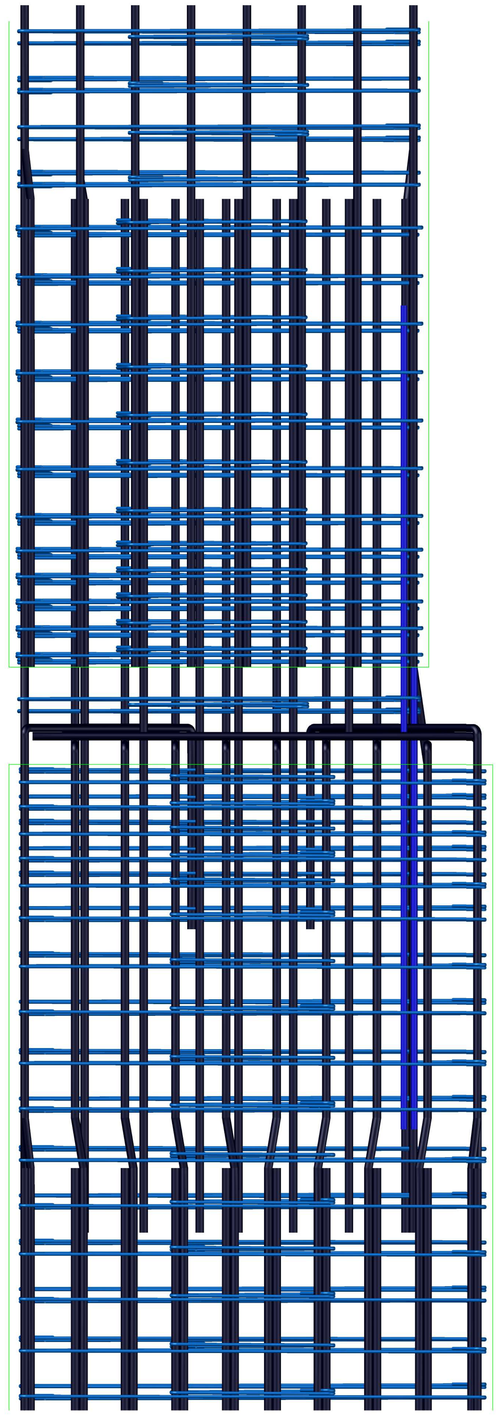
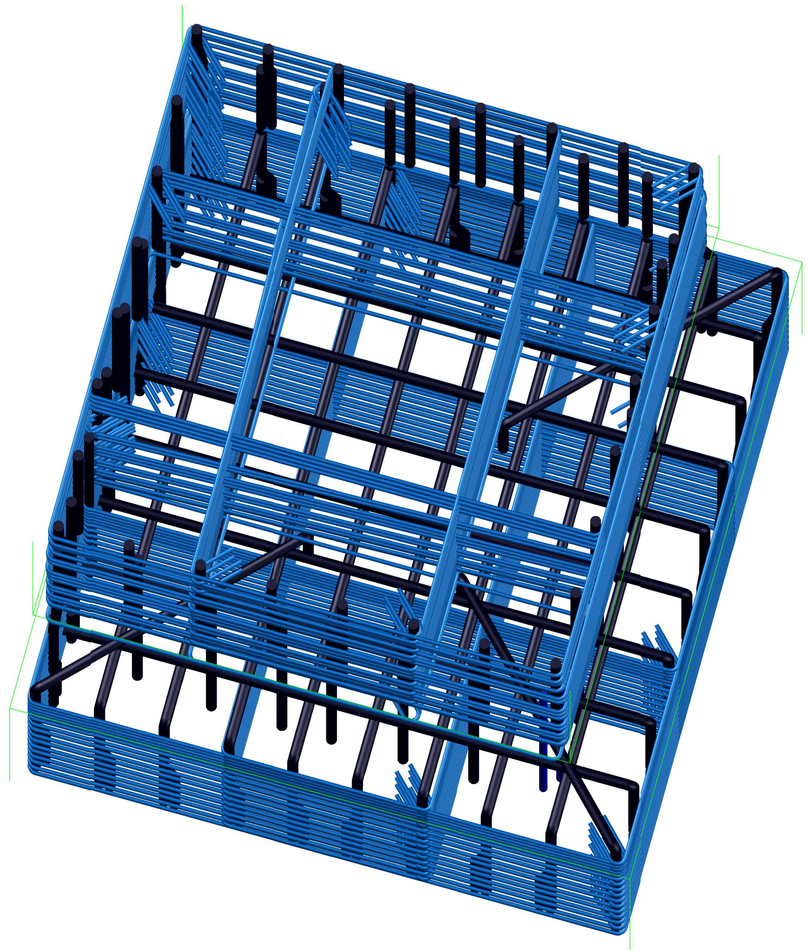
ESTON - BEYAZIT KATLI VILLALARI
KOLON APLIKASYON PLANI
(+0.80 +3.80 ARASI - ZEMIN KAT)
MALZEME C 25/30 - B 500A - S 420 - S 220

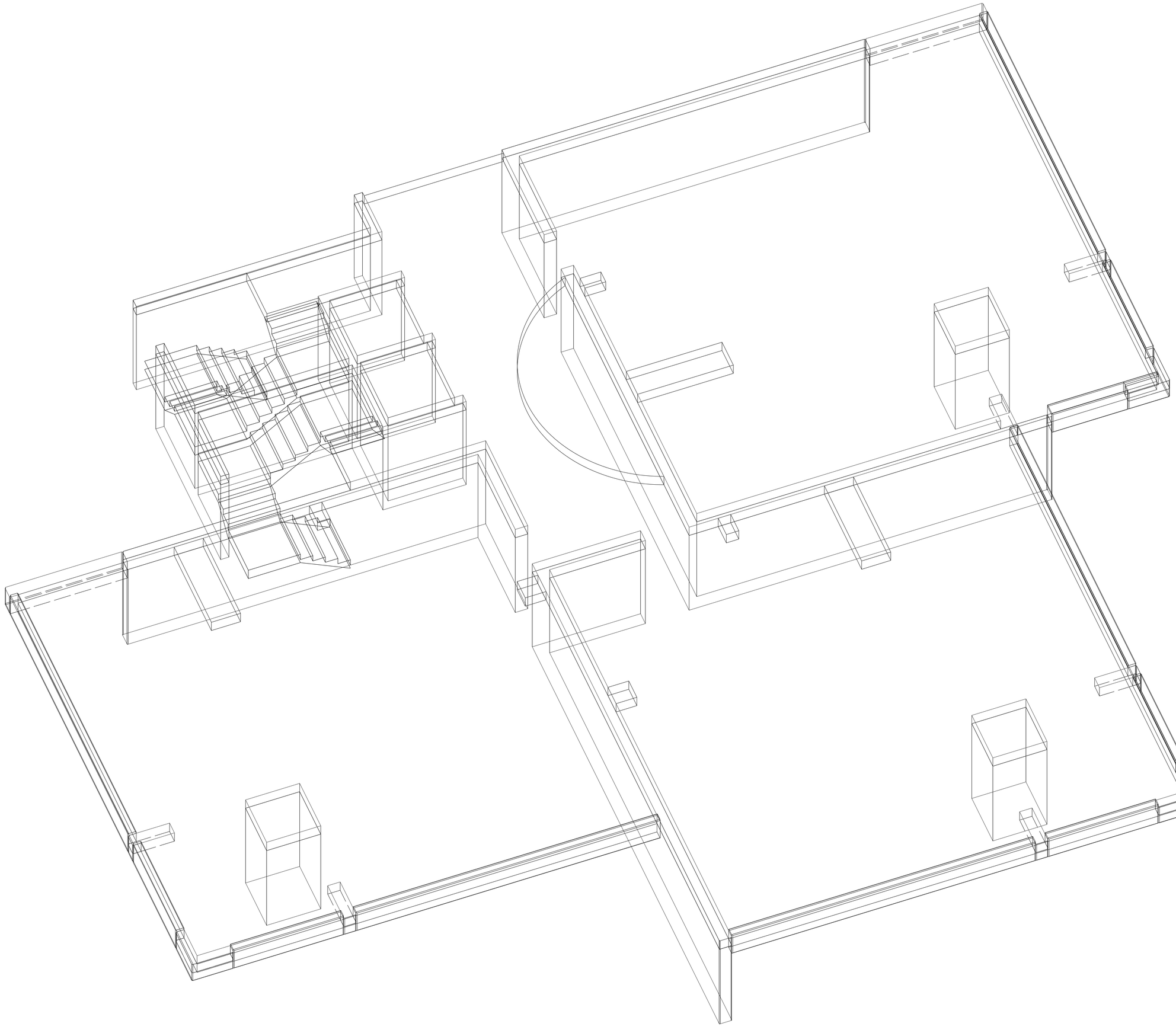
S1 KOLONU -1.50 +2.80 KOTU ARASI 3 BOYUTLU GORUNUS
S1 COLUMN 3D VIEWS BETWEEN LEVELS -1.50 AND +2.80



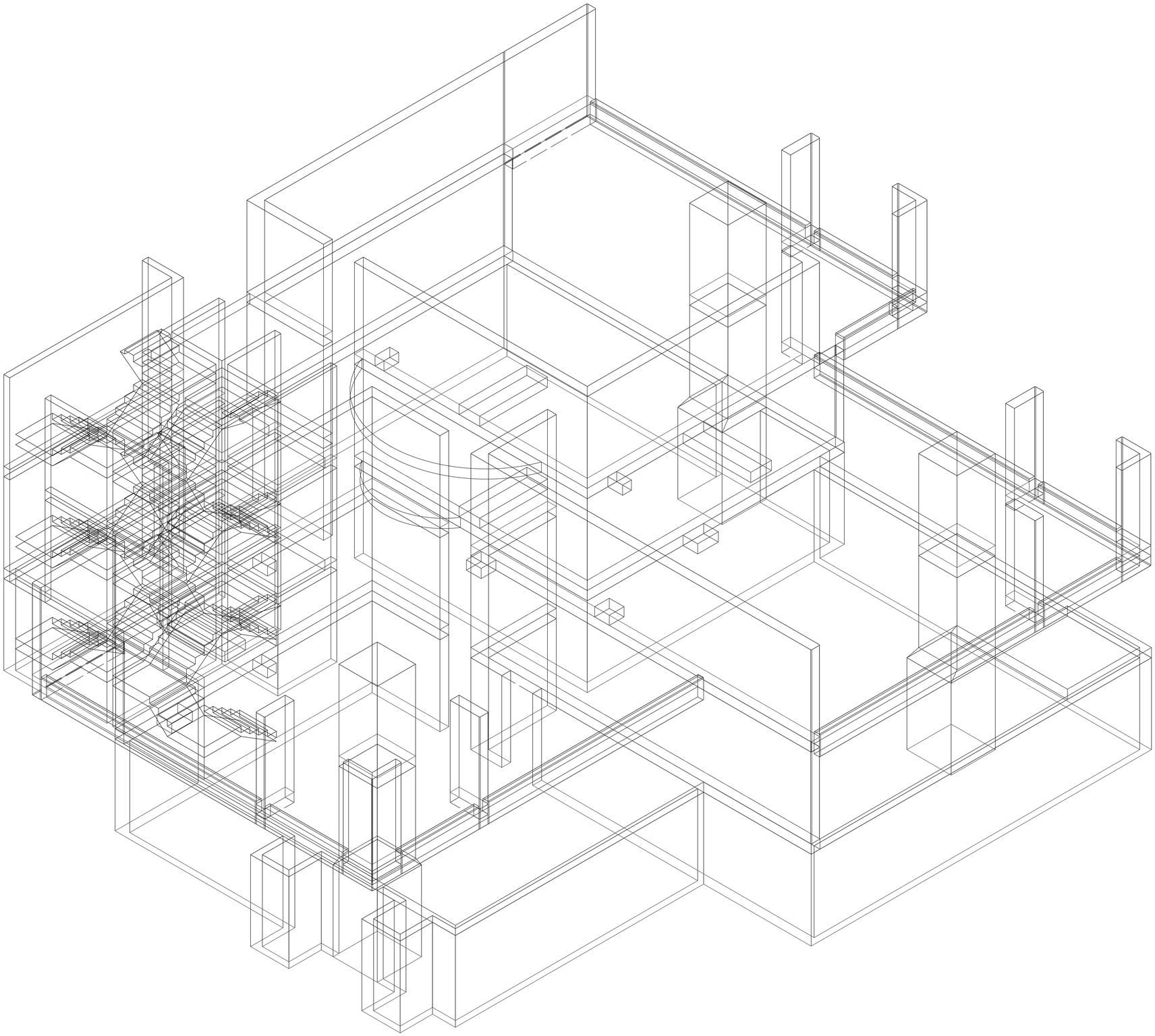




BEYAZIT KATLI VILLALARI GROUND FLOOR LAYOUT (WIREFRAME VIEW)

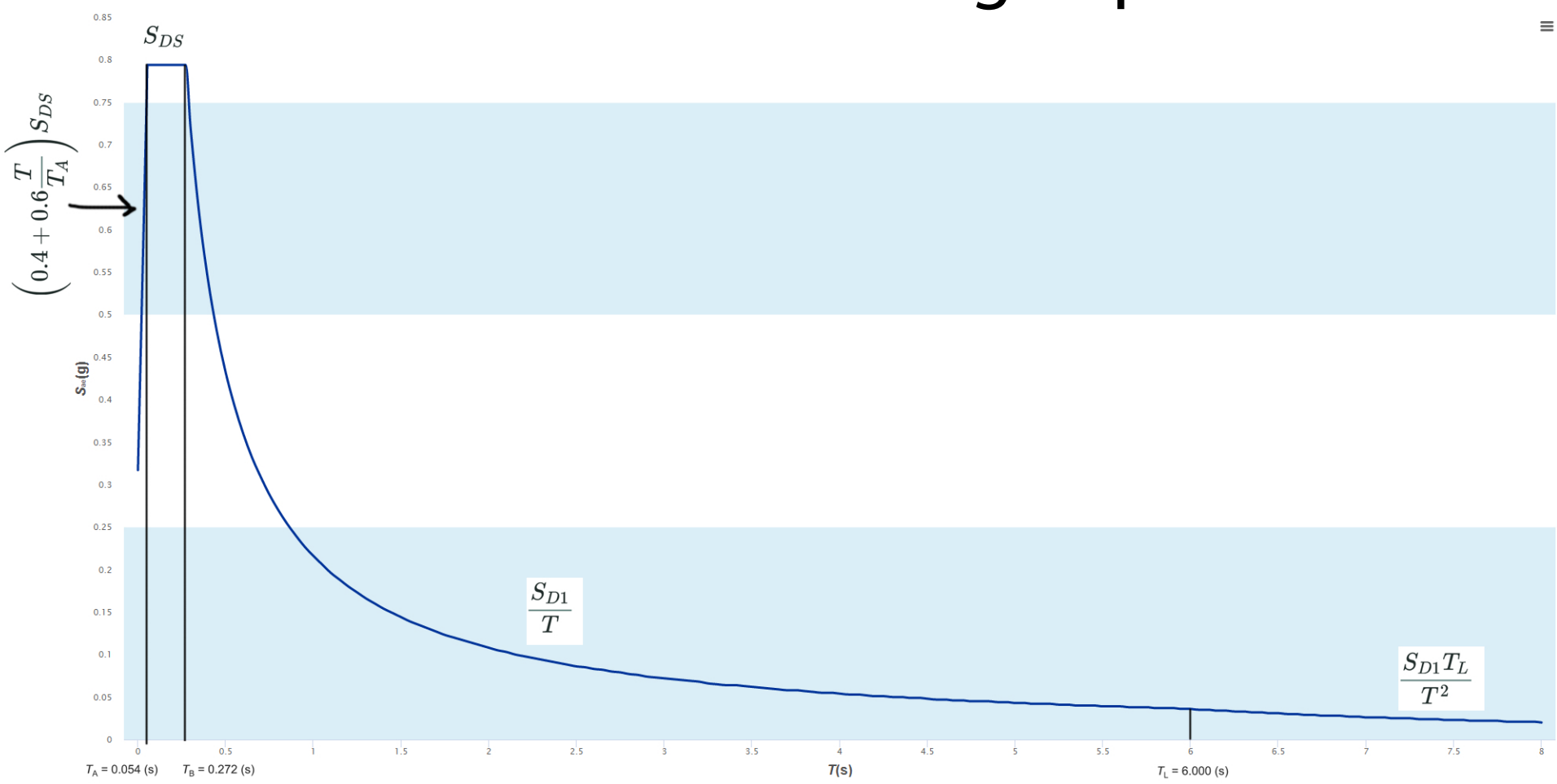


1st Basement, Ground Floor and 1st Floor Layout (Wireframe Model)

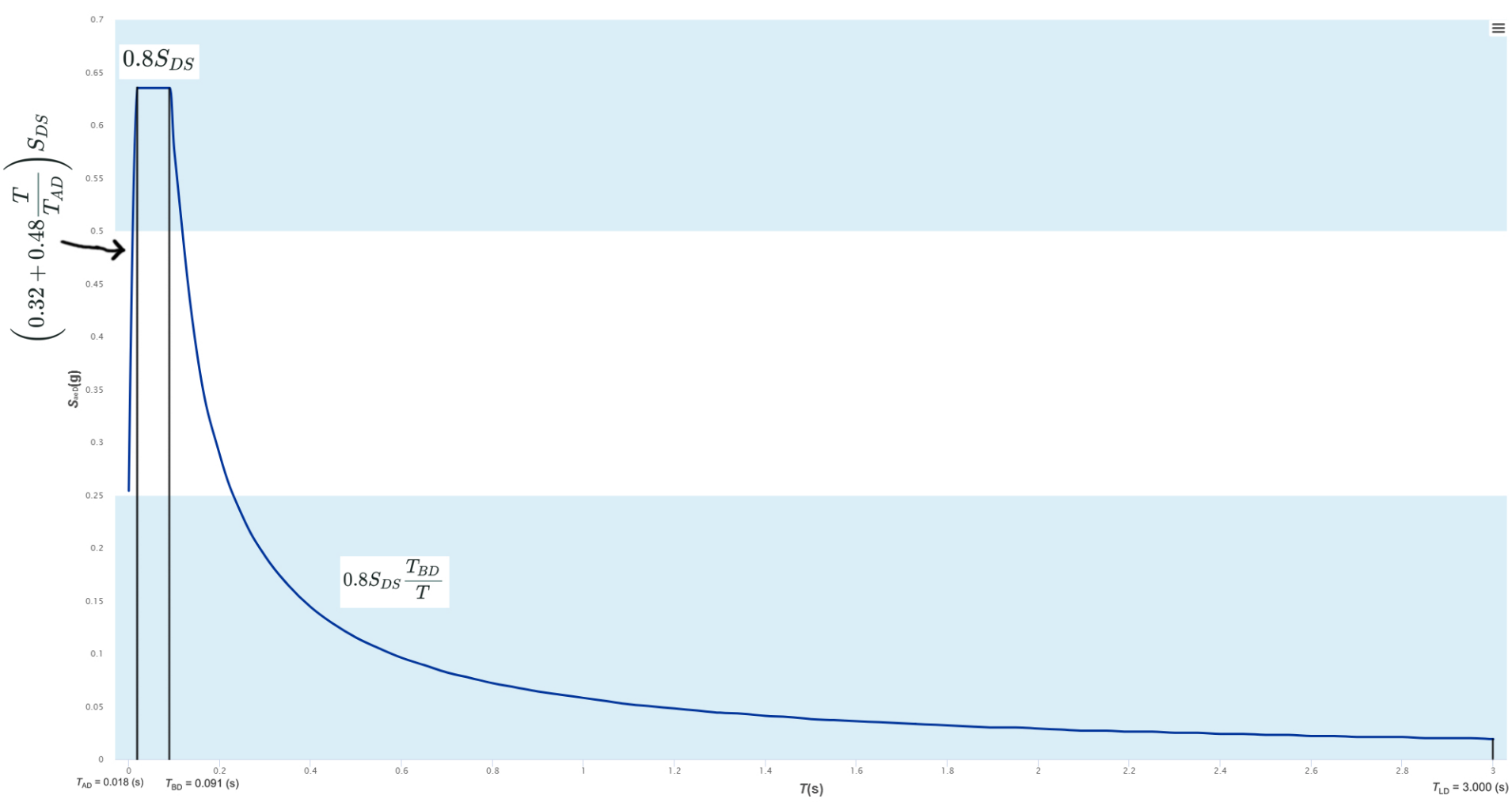


Location Based Design Spectrums used in analysis

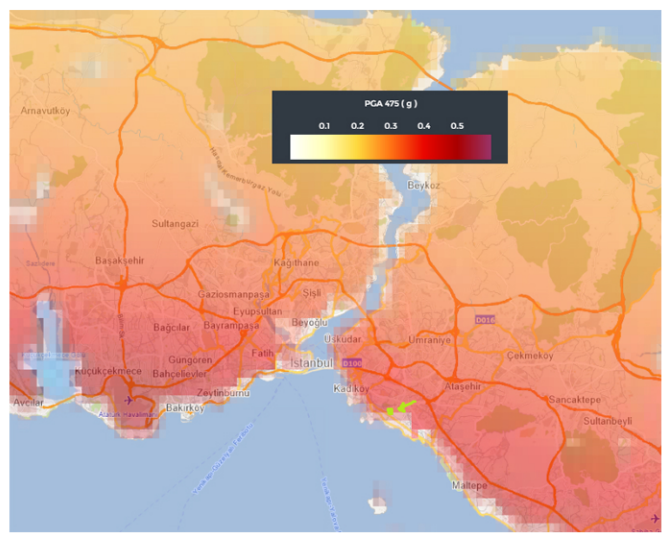
Horizontal Elastic Design Spectrum



Vertical Elastic Design Spectrum

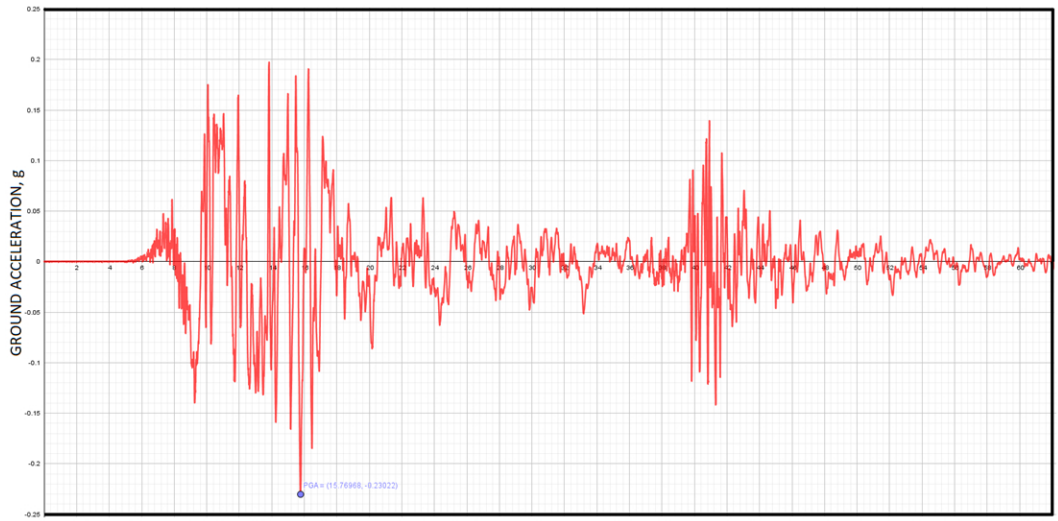


Earthquake Level 2: 10 % Chance of exceedence in 50 Years (475-Year Return Period)
Ground Condition: Strong, stiff rocks
Building Height Class: 1

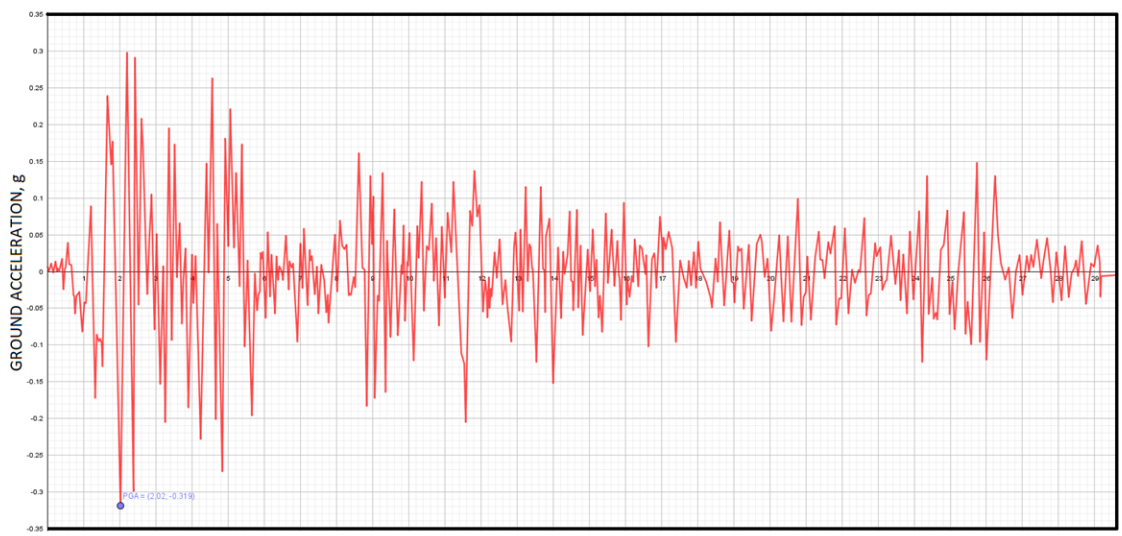
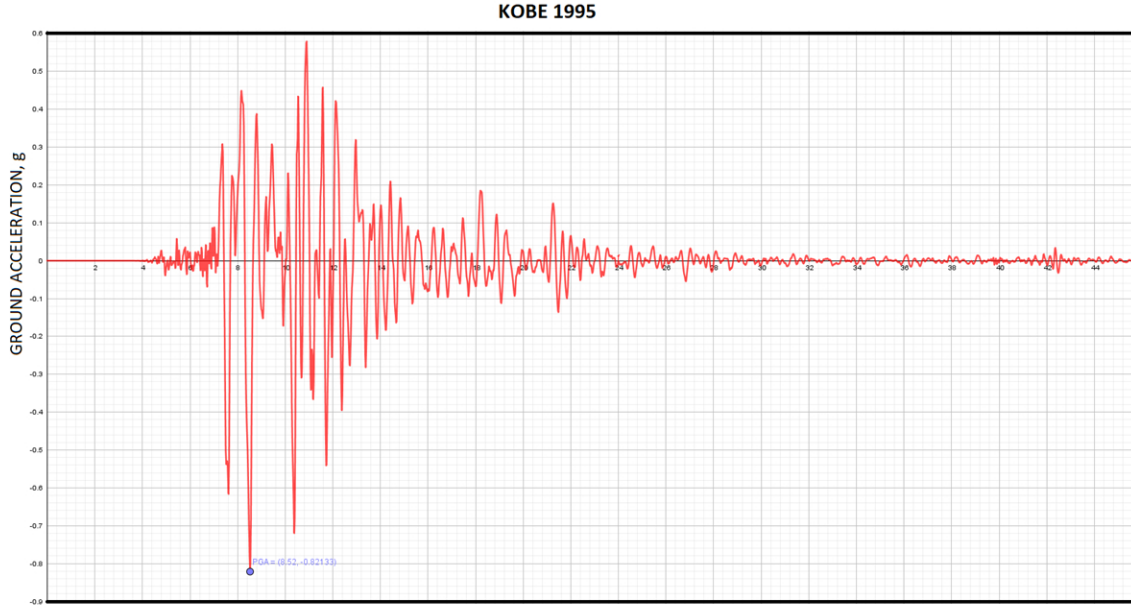


EARTHQUAKES USED FOR TIME HISTORY ANALYSIS

KOCAELI 1999



EL CENTRO 1940



KOBE 1995